

TREE FLORA of SABAH AND SARAWAK

Volume One

edited by
E. Soepadmo and K.M. Wong

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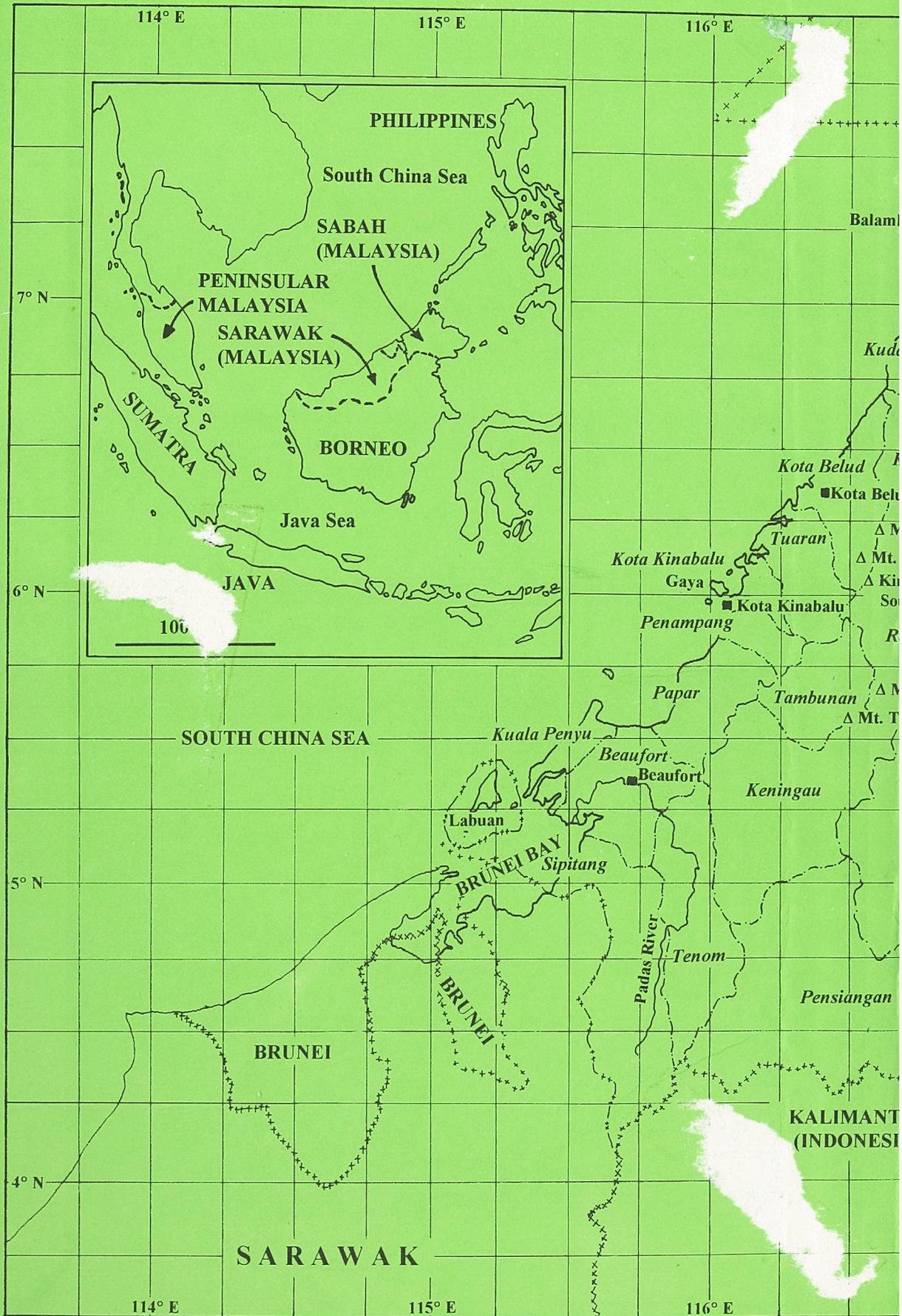
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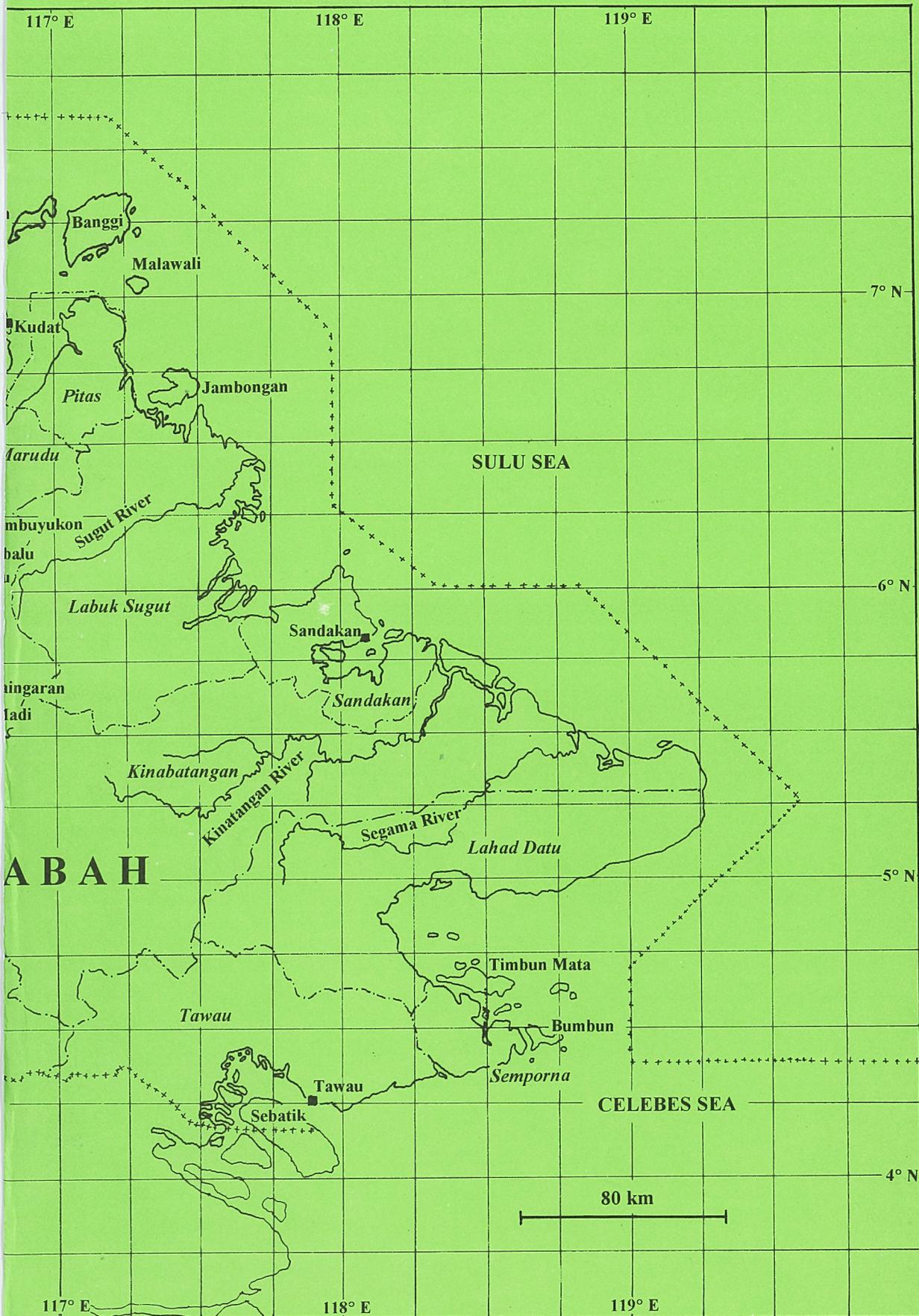


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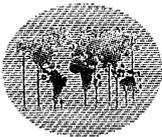


TREE FLORA
of
SABAH AND SARAWAK

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E. Soepadmo and K.M. Wong

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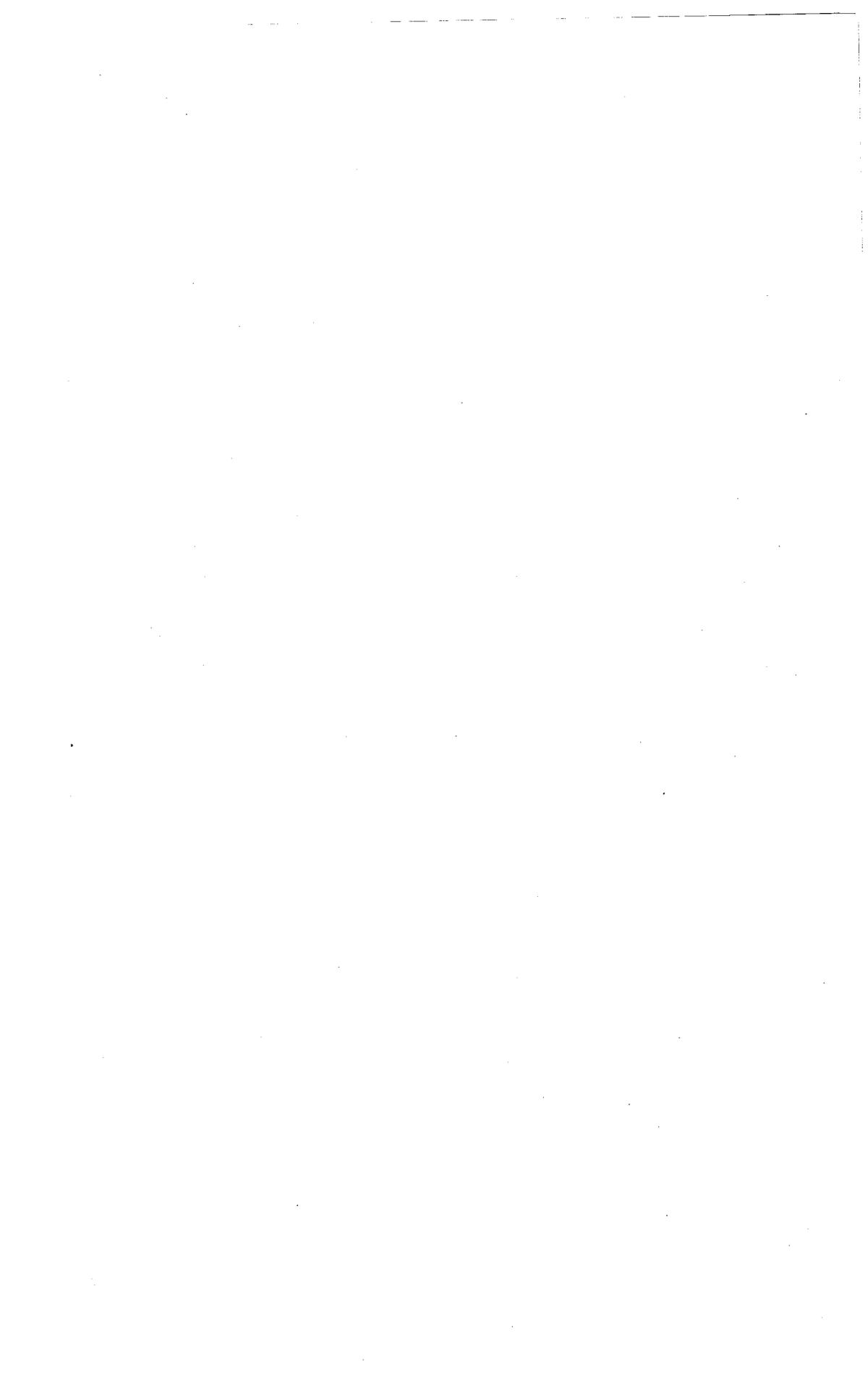
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FOREWORD

Providing a foreword to the first volume of any flora is always a rare and pleasurable task, but at the same time a conscience-demanding one. In a region like Borneo, where the Malaysian states of Sabah and Sarawak are located, and where a complete documentation of the flora of any one sizeable area is not available, a beginning volume of a new flora is an exciting endeavour. Yet the work to continue with further volumes must press on, and we can only congratulate ourselves within that first limit.

The plant biodiversity of Sabah and Sarawak is a daunting topic. Estimates by specialists throughout the decades vary but are in the region of 10,000 species of vascular plants for the whole of Borneo. This is not likely to differ very much from the total for the habitat-rich and topographically varied territories of Sabah and Sarawak. To engage enough specialists to carry out the immense responsibilities of preparing such a flora is therefore conceivably a hugely expensive and time-consuming task. To divide the work into workable components is an equally complicated affair: how does one select certain families of importance, or determine which revisions should await more expert attention at some later time?

The Tree Flora of Sabah and Sarawak addresses those plant families that contain arborescent species for the mere fact that trees form the main framework of the rain forests and are of a fundamental ecological and conservation importance. The basic idea has always been to be able to identify these species, so that work in conservation, management and sustainable use of species and products have a sound scientific basis, without which no systematic applied work can proceed with ease. Our task is a major national effort with the Forest Research Institute Malaysia, the Sabah Forestry Department and the Sarawak Forestry Department as the key partners. We have the support of the universities and other research agencies in Malaysia, as well as key institutions involved with Southeast Asian botany within our region, in Australia, Japan, the United Kingdom, Europe and North America, without which would have made the work extremely tedious and time-consuming.

The bulk of the funding for this enormous project comes from the Malaysian Government (especially through its funds for the IRPA, or the Intensification of Research by Priority Areas programme, disbursed to the participating institutions), the Overseas Development Administration (ODA) of the United Kingdom, and the International Tropical Timber Organization (ITTO). Such support has been crucial to the initiation of the Flora on an organized basis and will be the essential fuel for continuing work. The main testimony to the successful production of this first volume of the Flora, and the research now going on for further volumes, however, remains the local, regional and international cooperation among scientists, research managers and other resource people who have given time and importance to this project. During the projected ten-year period of the project, a new

generation of tropical botanists would have developed; in this, which is of paramount significance to the continuing and future undertaking of conservation and forestry management, the Tree Flora project would have served an enriching and catalytic role.

We would like to congratulate Prof. Soepadmo the project leader, and the scientists involved in the project for their dedication and commitment, and acknowledge all national and international agencies for their support. A ten-year project is a long-term project which needs commitment and dedicated support and we hope that both elements will continue to be present to take this project to its ultimate successful end.

Dato' Dr. Salleh Mohd. Nor

Director-General

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Haji Awang Tengah bin Haji Awang Amin

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Sabah Forestry Department, Malaysia

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Numerous other institutions and individuals have also contributed invaluable advice, time and effort to this undertaking. Foremost in mind are our collaborating institutions in Malaysia (the Universiti Kebangsaan Malaysia, Universiti Malaya, Universiti Malaysia Sarawak, Universiti Pertanian Malaysia, Malaysian Agriculture Research and Development Institute, Sabah Parks Department) and abroad (the Royal Botanic Gardens, Kew, U.K.; the Oxford Forestry Institute, U.K.; the Rijksherbarium, Leiden, the Netherlands; the Royal Botanic Garden, Edinburgh, U.K.; the Herbarium Bogoriense, Indonesia; the Singapore Botanic Garden; the Arnold Arboretum of Harvard University, U.S.A.; the Institute of Biological Sciences, University of Aarhus, Denmark; the Botanical Garden and Museum in Berlin-Dahlem, Germany). We extend our gratitude also to colleagues who have specially helped with facilities and research matters, at Kew (its director Prof. G.T. Prance, Prof. G.L. Lucas, Dr. J. Dransfield, M.J.E. Coode, Dr. D. Kirkup, Diane Bridson, P. Bygrave, N. Martland, A.M. Smith), Leiden (its director Prof. P. Baas, Dr. M. Roos, Dr. C. Kalkman, Dr. J.F. Veldkamp, Dr. W.J.J.O. de Wilde, Dr. Ding Hou, Dr. M.M. van Balgooy, Dr. P. van Welzen, Dr. P. Kessler, Dr. E.F. de Vogel, Stans Kofman, H. Lut), Harvard (Prof. P.S. Ashton, Prof. P.F. Stevens), Oxford (Dr. P. Bacon, Dr. D. Filer, Prof. D.J. Mabberley), Vienna (Dr. C. Puff) and the C.S.I.R.O., Australia (Dr. M. Dallwitz, Dr. T.G. Hartley). The Keepers and Curators of the herbaria at Aarhus (A), the Arnold Arboretum (AA), Berlin-Dahlem (B), Bogor (BO), British Museum (Natural History) (BM), Oxford (FHO), the Philippine National Herbarium (PNH), Sabah Parks, Sandakan (SAN), Singapore (SING), Universiti Kebangsaan Malaysia (UKMB), and the Universiti Pertanian Malaysia have assisted with loans of specimens, the provision of working facilities and information.

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BACKGROUND TO THE TREE FLORA OF SABAH AND SARAWAK PROJECT

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Why a Tree Flora of Sabah and Sarawak?

Borneo, the third largest island in the world, of which Sabah and Sarawak are parts, has been frequently acknowledged as one of the most important centres of plant diversity in the world. The island, which occupies a total land area of approximately 740,000 sq. km, is conservatively estimated to harbour 10,000–12,000 species of flowering plants, representing about 5–6% of the world total (Merrill 1950; van Steenis 1950; Kiew 1984; Mat-Salleh *et al.* 1992). Of these, 40–50% are endemic to the island, and up to 80% of the endemic species in Borneo occur in Sabah and Sarawak.

In certain localities in Sabah and Sarawak, where botanical exploration has been carried out more intensively, the species diversity is indeed extremely high. Beaman & Beaman (1990), for instance, have found that the flora of the Mt Kinabalu Park, Sabah, encompassing an area of about 700 sq. km, contains not less than 4,000 species of vascular plants in 180 families and 980 genera.

For a number of economically important families and genera of flowering plants, Borneo (Sabah and Sarawak in particular), is also known as the centre of distribution and species diversity. For example, of the 386 known species of the Dipterocarpaceae, 291 species or about 75% are recorded from Borneo, of which 257 species or about 66% occur in Sabah and Sarawak. Of the 291 species occurring in Borneo, 156 or about 54% are endemic, of which 59 species or about 20% are restricted to Sabah and Sarawak (Ashton 1982). In the genus *Durio* (Bombacaceae), of the 30 species which have been described to date, 20 species or about 66% are recorded from Borneo, with 16 species or about 53% occurring in Sabah and Sarawak (Kostermans 1958; 1990). Nine or about 45% of the 20 species known from Borneo are endemic, and all occur in Sabah and Sarawak. Similarly, the genus *Mangifera* (Anacardiaceae), comprising about 50 species, also has its centre of distribution and species diversity in Borneo, where 20 indigenous species have been recorded (Bompard & Kostermans 1992; Kostermans & Bompard 1993; Kochummen, pers. comm. 1995). Of these, 18 species are known from Sabah and Sarawak.

For non-woody components of the flora, e.g., orchids and rafflesias, Borneo and Sabah and Sarawak in particular, also house the most number of species in the Malesian phytogeographic region. In this region, the orchid family or the Orchidaceae is known by

3,000–4,000 species, representing 12–16% of the entire flora (Chan *et al.* 1994). Of these, Lamb (1991) has estimated that 2,500–3,000 species are found in Borneo, equivalent to about 75% of the Malesian orchid flora. A great number of the Bornean species have been recorded from Sabah and Sarawak. The genus *Rafflesia* (Rafflesiaceae) with the largest flower in the world, also has its centre of species diversity in Borneo where 5–6 of the 14 species known to date have been recorded, and all occur in Sabah and Sarawak (Meijer 1984; Mat-Salleh 1991; Nais 1992).

Other Old World tropical families which have their centres of distribution and species diversity in Borneo include the Anacardiaceae, Burseraceae, Celastraceae, Clusiaceae (Guttiferae; *Calophyllum*), Euphorbiaceae, Fagaceae, Myrtaceae (*Syzygium* or *Eugenia*), Rhizophoraceae, and several others (Airy Shaw 1975; Ding Hou 1958, 1962, 1978; Kochummen 1995; Leenhouts 1956; Merrill & Perry 1939; Soepadmo 1972; Stevens 1980).

The presence of high species diversity in the natural forests of Sabah and Sarawak also means that there is a wealth of forest products to be harvested. There is no doubt that, in the past few decades, the harvesting and utilisation of these forest products, e.g., tropical hardwood timbers and rattans, has contributed significantly toward the socio-economic development of these two eastern Malaysian states. In recognising that of late, the exploitation and conservation of biodiversity in Sabah and Sarawak has become the focus of international attention and scrutiny, and the need to strike an acceptable balance between development and conservation of natural resources in these two states, it is imperative that up-to-date botanical inventories should be carried out without further delay. Such basic information is of paramount importance to the understanding of the availability, distribution, ecological and conservation requirements, and economic potential of the plant resources. Without such information, it will be extremely difficult if not impossible to develop and manage the available resources on a sustained basis.

The need for a Flora of Borneo

The flora of a given region provides an inventory of plant species occurring in that region, facilitates a means of species identification, and provides a source of information pertaining to up-to-date taxonomic and conservation status, distribution, ecological amplitude, and economic potential of the treated species. It is, therefore, unfortunate to note that despite the widespread national and international recognition of the great economic and conservation value of Bornean rain forests, and that botanical exploration and collection in Borneo has begun as early as 1822, and botanical accounts of its flora have appeared since 1894 (*cf.* Wong 1995 for more details), to date this species-rich island has neither a comprehensive flora of any kind nor even a concise checklist of plant species. For this reason Kiew (1984) has highlighted the need and urgency of producing a simple “Flora of Borneo” in order to facilitate the implementation of sustainable management practices of forest resources of this species-rich island. She argued that by using Merrill’s (1921) and Masamune’s (1942) enumerations as a basis, and by adopting a pragmatic approach, a concise “Identification Flora of Borneo” can be readied within 10 years. However, due mainly to the lack of or insufficient institutional and financial support, as well as shortage of qualified man-power, the proposed project never materialised.

The Tree Flora of Sabah and Sarawak Project

In recognising the urgent need of producing a "Flora of Sabah and Sarawak" of any kind, that recent collections (more than 200, 000 numbers from Sabah and Sarawak up to 1990) necessitate revision and updating of taxonomic accounts in the Flora Malesiana itself, and that trained scientific personnel is now available at various national institutions, the Tree Flora of Sabah and Sarawak Project was officially launched by the Director-General of the Forest Research Institute Malaysia on the 18th of November 1991.

The modest 10-year project is executed jointly by the Forest Research Institute Malaysia (FRIM), the Sabah Forestry Department (FD Sabah), and the Sarawak Forestry Department (FD Sarawak) with the collaboration of other research institutions and universities. The main objectives of the project are:

- To document and update the taxonomic status of all tree-species (taken as reaching at least 5 m in height, and 10 cm in diameter) native to Sabah and Sarawak.
- To publish 8 volumes (each containing 300–400 species) of a concise Tree Flora of Sabah and Sarawak within 10 years.
- To upgrade Malaysian capability and expertise in plant taxonomic research and the survey and documentation of tree diversity.
- To develop and strengthen the management capability of herbaria and their related data bases in the three participating institutions (FRIM, FD Sabah and FD Sarawak).

For the first 5 years, the project is jointly funded by the Malaysian Government, the Overseas Development Administration (ODA) of the United Kingdom, and the International Tropical Timber Organization (ITTO).

To prepare the manuscripts of the estimated 109 families comprising about 3,000 tree-species, botanists of the following national and international institutions are taking part:

Malaysia—Forest Research Institute Malaysia, FD Sabah, FD Sarawak, Universiti Kebangsaan Malaysia (UKM), Universiti Malaya (UM), Universiti Malaysia Sarawak (UNIMAS), Universiti Pertanian Malaysia (UPM), Mt Kinabalu Park, Malaysian Agricultural Research and Development Institute (MARDI), and the WWF-Malaysia. In all 36 botanists are involved.

Overseas—Institute of Botany, University of Vienna, Austria; University of Brunei Darussalam, Brunei; University of Aarhus, Denmark; Botanischer Garten und Botanisches Museum, Berlin, Germany; University of Hong Kong, Hong Kong; Rijksherbarium Leiden, the Netherlands; Singapore Botanic Garden, Singapore; Oxford Forestry Institute, Oxford, United Kingdom; Royal Botanical Gardens, Kew, United Kingdom; Arnold Arboretum, Harvard University, USA; University of Florida, USA; and Everglades National Park, Florida, USA. A total of 21 botanists are involved.

Coverage. Being an identification type of flora intended to be “user-friendly” to non-specialist readers, the Tree Flora will be written in simple and easy-to-understand English. The use of highly technical botanical terms is, therefore, to be avoided.

In the Tree Flora, all dicotyledonous trees, here defined as woody plants with the main upright stems measuring not less than 5 m tall and 10 cm diameter, will be treated in full. Non-tree and introduced tree species known only in cultivation will be given cursory treatment and annotated in the keys only. For each tree-taxon (family, genus, species), treatment will be confined to the following aspects—correct/accepted scientific name, major references, description of diagnostic characters, vernacular names (if applicable), distribution, ecology, uses, notes on taxonomy (if applicable), and key(s) to lower rank taxa. For each genus, at least one line-drawing depicting important vegetative and reproductive characters will be provided.

Format. To standardise the format of manuscripts to be published in the Tree Flora, a set of guidelines has been prepared by the Editors (*cf.* Soepadmo & Wong 1995). This guideline is obtainable from the project Secretariat at FRIM. Among the main guidelines which should be adhered to by contributors of manuscripts are the following:

- **Nomenclature**—Names of families and genera will normally follow Brummitt (1992), but in cases of potential confusion and controversy, authors of revisions for the Tree Flora are requested to confirm the accepted names with the Chief Editor.
- **References**—Only selected references most relevant to the taxonomy and distribution of the family, genus, and species and which are relevant to Borneo in general and Sabah and Sarawak in particular will be cited. Unless listed in the “Guidelines”, book names should be cited in full. Names of journals and other serials are to be cited following van Steenis-Kruseman (1956).
- **Derivation of genus and species names**—Language and meaning of root words to be indicated.
- **Basionym and synonym**—Basionym to be given if it indicates a new taxonomic perspective of the taxon being treated. Only synonyms relevant to Borneo are to be included.
- **Typification**—Whenever possible, citation of type specimen(s) of accepted species should be provided.
- **Description**—Required for any family with more than one genus worldwide, for genera, and for species, and should account for the following aspects: habit; leaf arrangement and type; stipules; inflorescence type and position; flower sexuality, symmetry, merism, details of fusion of parts; fruit type; seed, embryo, cotyledons, endosperm, aril and others if very relevant.
- **Vernacular names**—Only names commonly used in Sabah and Sarawak will be included. The dialect or language of each entry of vernacular name should be indicated.

- **Distribution**—Number of genera and/or species is to be mentioned, followed by global and Malesian distribution, and followed by that in Sabah and Sarawak. If the taxon also occurs in Brunei and/or Kalimantan, it should be indicated following the distribution in Sabah and Sarawak.
- **Ecology**—For a family or a genus to be given only if general trends can be summarised. For a species, information on forest type, soil/rock type, and altitudinal range is required.
- **Uses**—For a family or a genus to be provided only if there are general or interesting uses. For a species as much information as possible should be given.
- **Taxonomy**—To be provided only if there are taxonomic controversies regarding the taxon. Brief commentary could be given if this will clarify the taxonomic status of the taxon under consideration.
- **Key(s) to lower rank taxa**—Bracket key structure is to be used. Couplets to be numbered once only, the individual leads in the couplet not further numbered. In constructing the keys, only diagnostic vegetative and/or reproductive characters are to be used. Non-tree taxa are to be annotated only.
- **Infraspecific taxa**—In cases where two or more infraspecific taxa exist in Sabah and Sarawak, a full description of the species, including all variations known in Sabah and Sarawak, should be given in the species description. This should be followed immediately by a key to the taxa in which each infraspecific taxon is annotated.

In cases where only one of the infraspecific taxa is known to occur in Sabah and Sarawak, the species description should follow the following format: species name and authority, derivation of species name, reference for the species; infraspecific taxon name and authority, reference, basionym, type specimen, synonyms, description of the sole infraspecific taxon which represents the species in Sabah and Sarawak, vernacular name(s), distribution, ecology, uses, and taxonomy.

Other project activities

Apart from preparing and publishing eight volumes of the Tree Flora of Sabah and Sarawak, the project also carries out a number of activities relevant to its overall objectives. These activities include:

- Organisation of collecting expeditions to a number of botanically little-known localities in Sabah and Sarawak.
- Establishment of a data base for specimens and taxonomic references using BRAHMS and related softwares.
- Conducting workshops and specialised training on flora writing, documentation software, botanical illustration, editing, curation and management of herbarium specimens, etc.

- Postgraduate training to upgrade Malaysian capability in plant taxonomic research and the inventory and documentation of plant/tree diversity.
- Collaboration with other institutions and agencies with similar aims in the Malaysian region.

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A BRIEF HISTORY OF BOTANICAL COLLECTING AND DOCUMENTATION IN BORNEO

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Much of the information on early botanical collections in Borneo is summarised, by collectors' names, in the great Cyclopaedia of Collectors for the Flora Malesiana (van Steenis-Kruseman 1950, 1958, 1974). The present account attempts to collate this information, together with some information on collectors beyond van Steenis-Kruseman (1974) so that the progress of plant exploration in Borneo may be followed through each period and in as chronological an order as possible. Collectors of lesser significance, in that they have only gathered very few numbers, are not normally listed here. We give importance here to collections made up to only around the beginning of the 1980s, as these are often less immediately known to unfamiliar botanists, because they are not held in herbaria in the region (through historical factors) or because they have rarely been referred to in the literature. Many collectors, though not all and not in every instance, since the 1950s, have distributed good sets of their collections to regional herbaria serving areas where the collections have been taken, and in general there is a better chance that the more recent collections made (especially as the 1970s and 1980s are approached) may now be found deposited in local herbaria and are easily accessible for study locally. The period beyond this is not covered in the present account as it can be expected that such modern collections will be easily found for reference in either the local herbaria (Bogor, Kepong, Kuala Lumpur, Sandakan, Sarawak, Singapore) or in the large botanical institutions abroad that have a long-standing association with the study of Bornean plants.

Early collectors and documentation

The earliest significant efforts at plant collecting in Borneo were those of the early to middle 19th century, and were motivated initially either by an interest to study or collect groups of horticultural interest, or by the interest of specialists in Europe, Java (where the Dutch administration of the Indonesian islands was based) and Malaya and Singapore (the seat of English administration in the region then) to document interesting and rare life forms of a little explored, faraway tropical land that was virtually *terra incognita* as far as scientific documentation is concerned.

As early as 1822, **George Müller**, the Acting Resident in Dutch West Borneo, made explorations and plant collections in the Kapuas valley and Pontianak, and around Kutei

and the Mahakam River until 1826, when he is thought to have been murdered near the upper Kapuas. Müller collected for Carl Ludwig Blume, Director of the Buitenzorg (Bogor) Botanic Garden around this time.

In 1836, Dutch botanist Pieter Willem **Korthals**, a member of the Commission for Natural Sciences for the Dutch East Indies who had explored parts of Java and Sumatra, collected in southeast Borneo, mainly in the Banjarmasin, Barito River and Mt Pamatton areas, together with **Salomon Müller** (a German member of the Commission) and Ludwig Horner (Swiss member of the Commission, who apparently did not collect plants on this expedition). Merrill (1921) and van Steenis-Kruseman (1950) point out it is likely that some of Korthals's Borneo records are probably of Sumatran or Javanese origin, owing to confusion in labelling after the collecting. Korthals's collections are principally at the Leiden herbarium. In 1842, the "United States Exploring Expedition" under the command of Charles Wilkes, which began its journey in 1838 and had travelled through the Philippines, visited the Banggi and Balabac Islands off the northernmost tip of Borneo, during which expedition botanists William **Rich** and J.D. **Brackenridge**, with the help of zoologist C. **Pickering**, made some plant collections (now principally with the U.S. National Herbarium and the Gray Herbarium at Harvard). Between 1852 and 1855, Cornelis **de Groot**, Chief of the Mining Department of the Dutch East Indies collected in southeast and east Borneo, including the Banjarmasin, Tanjung Batu, Mahakam and Samarinda areas.

Among the more significant early collectors of Bornean plants must count also the Rajah James **Brooke**, who had helped the Sultan of Brunei in suppressing a revolt in 1840 and was consequently given Sarawak to rule in the following year. He was also made Governor of Labuan and Consul General of Borneo in 1847, and collected some plant specimens which the Kew herbarium acquired in 1853–1855. Hugh **Low**, appointed by the Rajah Brooke first as his secretary in 1845 and later as Colonial Treasurer of Labuan between 1848 and 1877, and who made the first documented climb by a European to the summit of Kinabalu in 1851, was well known even at the time for his interest in orchids. Low's successful third trip to Kinabalu in 1858, together with Spenser **St. John**, secretary to the Rajah Brooke, included the first collections from Marai Parai, the ultramafic western spur of the mountain. Low had also collected in the Kuching area, Mt Penrissen and Lawas. Low sent most of his orchid specimens to John Lindley at the London University and Joseph Hooker at Kew.

Low's plant-collecting contemporaries included James **Motley**, a civil engineer at the Labuan coal mine during 1851–1854 and who was later (1854–1859) at Banjarmasin in south Borneo (Motley's Labuan collections were often sent to Kew by E. Barber Scott labelled "coll. Barber, Labuan", although his Kalimantan collections were distributed under his own name), and Thomas **Lobb**, who made an unsuccessful attempt to reach the summit of Kinabalu in 1856. Lobb, who was collecting plants of horticultural value for the firm of Messrs Veitch in England, also collected some herbarium specimens from Sarawak and Labuan. Lobb is thought to have intentionally falsified localities on some labels in order to increase the value of his collections for the firm of Veitch; a specimen labelled "Luzon" in one herbarium may be labelled "Borneo" or "Singapore" or "Java" in another (van Steenis-Kruseman 1950). The well-known zoogeographer Alfred Russel **Wallace** visited and

collected mainly ferns in Sarawak (Sarawak, Simunjon and Sadong Rivers) during 1854–1856, at the start of his travels through the Malay Archipelago.

Willem Hendrik **de Vriese**, a botanist at Leiden at some time during this period, collected in Dutch West Borneo in 1860. Eduard von **Martens**, Custodian of the Berlin Zoological Museum, also made plant collections in Dutch West Borneo in 1863. Between 1865 and 1867, Odoardo **Beccari**, the well known Italian naturalist, made many plant and animal collections in Sarawak; many of his collections were made from around Kuching and Matang, and the Sarawak River and Batang Lupar. He also collected from the Bintulu area and the Rejang valley, and was also briefly in Labuan, Brunei and the then Dutch West Borneo. His plant collections number around 20,000; he wrote many papers, especially on palms. Perhaps his most well known book is *Nelle Foreste di Borneo* (Wanderings in the Great Forests of Borneo) (Beccari 1902). Burt (1964) points out that although Beccari ascended the Poi range, he did not climb Mt Poi (Poe or Pueh) as that name is used on modern maps, but a more south-easterly peak called Mt Berumput. Somewhat less illustrious than Beccari but nevertheless a collector who during 1866–1869 sent several cases of important plant specimens from Sarawak and Sambas in Dutch West Borneo to the herbarium at Buitenzorg was a man documented only as a coffee planter in Java and manager of an estate in Sarawak, called **Martin**.

In 1874–1875, the well-known botanical explorer Johannes Elias **Teijsmann** (also Curator of the Buitenzorg Botanic Gardens in 1831–1869) explored Dutch West Borneo, making numerous collections in the Pontianak, Kapuas River, Kenepei River, Pencin Mts, Biang Mts and other areas. His Borneo collections are mainly in the Bogor, Leiden, Kew and Florence herbaria. In 1881–1884 Friederich **Grabowsky**, a German zoologist, collected a few hundred plant specimens from southeast Borneo, mainly around the Banjarmasin and Kapuas River areas. His collections are principally at the Berlin and British Museum herbaria. During 1879–1880, the Danish explorer, ethnographer and zoological collector Carl **Bock** made an expedition to northeast and southeast Borneo, collecting also some plants along the Mahakam and Telen and in the Samarinda and Banjarmasin areas.

Another important plant collector about this time was Frederick William **Burbidge**, a collector for the Veitch nurseries in England, who collected in Labuan and Kinabalu with Peter **Veitch** in 1877 and in the Sandakan area with William **Pryer**, the founder of Sandakan, in 1878. He also collected along the Lawas, Meropok, Limbang and Pandaruan rivers in the northern part of Sarawak. Burbidge's botanical plates and sketches from Borneo are housed in the British Museum of Natural History. In 1880, two other Veitch collectors, David **Burke** and Charles **Curtis** collected in Sarawak; Curtis later (1884) became the Superintendent of Gardens and Forests in Penang.

The Hose family, comprising of the Reverend **George Frederick Hose** (Bishop of Singapore, Labuan and Sarawak, 1881–1908), his nephews **Charles Hose** (district officer in the Baram in 1884 and afterwards, Sibul) and **Ernest Hose** (a planter), and his daughter **Gertrude Hose** all collected plants in Sarawak. The Rev. Hose collected on Matang and (with Charles and Alfred Hart **Everett**, freshly retired Resident of Trusan and Hon'ble of the 4th Division) on Mt Dulit, and other places, taking especially grasses, sedges and ferns,

as his daughter did. Charles Hose made zoological studies as well as collected plants, in the Baram, Mt Dulit, Mt Mulud, Kayang, Rejang and Niah areas. Their collections were sent mainly to the Kew and Edinburgh herbaria.

Between 1883 and 1885 when he was murdered, M. **Fraser**, Medical Officer of the Chartered Company in North Borneo, collected several hundred plant specimens from Kudat, the Marudu Bay, Balambangan and Banggi Islands, Gaya Island and Papar. These specimens are at Kew. Around 1885 and 1890, a Singapore schoolmaster, R. **Hullett** visited Sarawak and collected several hundred specimens, now mostly in the Singapore and Kew herbaria. In 1886, Ignatz F. **Förstermann**, in the employ of the English horticultural firm of Sander & Sons, collected ferns and orchids in Sarawak. John **Whitehead**, an ornithologist, collected a small number of plants during his famous expedition to Kinabalu in 1887–1888.

In 1892, George D. **Haviland**, Curator of the Sarawak Museum at Kuching, visited Kinabalu (with his brother H.A. Haviland) and collected about 450 numbers on its upper slopes. Both Burbidge's and Haviland's collections were studied by Otto Stapf of the Royal Botanic Gardens, Kew, who wrote the first monograph on the Kinabalu flora (Stapf 1894), enumerating 360 species of flowering plants, ferns and bryophytes. Haviland also collected at Kuching, Mt Braang, Mt Penrissen, Limbang, Sibuluan, Ulu Tawaran, and (with Charles Hose) Mt Lambia. van Steenis-Kruseman (1954) has compiled a list of Haviland's collections in Borneo as then known. Edward **Bartlett**, a zoologist who also collected a small number of plant specimens in Sarawak around 1893, later succeeded Haviland in 1895. Robert W.C. **Shelford**, who in 1897 was the Curator of the Sarawak Museum, collected Sarawak plants between 1897 and 1903, mainly in the Kuching and Trusan areas. Charles van de Leur **Creagh**, the Governor of North Borneo during 1888–1895, collected at least 1839 numbers on Kinabalu and also made collections from Pulau Gaya, Kimanis and Labuan on the west coast to Cowie Harbour, Tawau and Sandakan on the east coast (Meijer 1969). Johannes **Waterstradt**, Danish zoological collector, collected mainly orchids as well as insect specimens on his trips in Borneo. He went to the Padas River (North Borneo) in 1891, the mouth of the Lawas River and Kinabalu (1892–1893), Kudat, Banggi, Balambangan, Labuan, Kinabalu (N Borneo) and the Lawas and Limbang Rivers (Sarawak) (1894), Kinabalu (1895), Brunei (1902), and again Kinabalu (1903, 1908 and 1912). Much of his orchid collections before his return to Europe in 1904 went to the firm of Hugh Low in London.

This was the time when the great Dutch explorer and ethnologist, Anton Willem **Nieuwenhuis**, made his expeditions into Dutch Borneo, exploring with German botanist Johann Gottfried **Hallier** (then an assistant at the Buitenzorg herbarium; he also used the initial 'H' for 'Hans') and Dutch geologist Gustaaf Frederik **Molengraaff** in 1893–1894 the Mandai, Kenepai and Mendalam Rivers, the Kapuas delta and the Pontianak area; with Indonesian plant collector **Jaheri** (of the Buitenzorg Botanical Garden) in 1896–1897 the Mendalam and Mahakam areas; with Indonesian collectors **Amdjah** and **Sakaran** (of the Buitenzorg Botanical Garden) in 1898–1899 the Kapuas, Mahakam and Samarinda areas; and in 1899–1900 the Apo Kayan highlands. These collections (several thousand numbers) are principally at the Bogor and Leiden herbaria. Amdjah collected again in northeast Borneo in 1912.

Early 20th Century collectors

H.N. **Ridley**, Director of Gardens and Forests, Straits Settlements during 1888–1900, and Director of the Singapore Botanic Garden during 1901–1912, visited and collected in Bau, Matang and Lundu in Sarawak in 1893. In 1897 he collected in Labuan, Kudat, Sandakan and the Labuk Bay area, and in Sarawak again. His subsequent visits to Sarawak were in 1903, 1905 and 1915. Ridley's collections are principally at the Kew and Singapore herbaria. John **Hewitt**, who became Curator of the Sarawak Museum during 1905–1908, collected plants mainly in the Kuching, Saribas, Baram and Limbang areas.

The German orchid specialist Friedrich R.R. **Schlechter** collected in Labuan, Kudat, Sandakan in British North Borneo, and Banjarmasin, Balikpapan, Samarinda and the Kutei region in Dutch Borneo in 1901, and later in Kuching in Sarawak during 1906–1907. H. **Witkamp**, a mining engineer with the Royal Batavian Oil Company, made plant collections in Kutei district in east Borneo in 1905, 1907, 1910 and 1928.

Around this time, Cecil J. **Brooks**, a chemist with the Borneo Company which exploited gold in Sarawak, collected plants, mainly ferns, along the Sarawak River and on Mts Santubong and Poe, and around Bau and the Bungo Range, between 1907 and 1910.

In 1908 the German botanist **Hubert Winkler** collected more than a thousand numbers during his trip to east and southeast Borneo, covering the Banjarmasin, Barito River, Balikpapan, Samarinda and Mahakam areas. His collections are principally at the herbaria at Breslau, Berlin, Geneva and Manila (the last destroyed in the Second World War). During 1910–1914, the Dutch geologist Louis Martin Robert **Rutten** collected plants in east and northeast Borneo in the Balikpapan and Samarinda areas, along the Kayan and Rappah Rivers, and in the Sangkulirang Bay area.

Lilian Suzette **Gibbs**, an English botanist interested in tropical alpine floras, made collections in the Beaufort area and the Tambunan plain, and also collected on Mount Kinabalu in 1910 (she collected on the Gurulau and Marai Parai spurs and ascended to the summit via Kamborangoh). Gibbs collected about 1000 numbers from North Borneo. Her paper on Kinabalu (Gibbs 1914) was the second monograph on the Kinabalu flora after Stapf's. The American botanist Frederick William **Foxworthy**, serving at the Bureau of Science in Manila (1906–1911), collected in the Lundu, Niah, Mt Poe, Mt Santubong and Kuching areas in Sarawak in 1908 and also climbed Kinabalu in 1910. John Coney **Moulton**, Curator of the Sarawak Museum during 1905–1915, collected widely in Sarawak between 1909 and 1920, and on Kinabalu in 1913. Moulton's collections are largely in the Edinburgh, Kew and Singapore herbaria. Sarawak's first Conservator of Forests in 1919, John Phillips **Mead**, also collected plant specimens. Eric P. **Mjöberg** collected in Mt Murud, Mt Dulit, Mt Poe, the Bidi Caves, Mt Matang, Mt Penrissen and other areas in Sarawak when he was Director of the Sarawak Museum in 1922–1924, and afterwards in Dutch East Borneo and Southeast Borneo in 1925–1926. Forest Ranger D. **Carroll** collected several hundred specimens, mainly from the Kuching, Lundu and Sadong areas in Sarawak between 1922 and 1953.

The **Forest Research Institute, Buitenzorg** began sending its collectors to Dutch (Indonesian) Borneo since about 1913. Johan Philip **Pfeiffer**, a Dutch chemical engineer, made botanical collections in 1913 in south and southeast Borneo (in the Sampit and Martapura areas), in 1915–1916 in northeast Borneo (in the Telok Selimau, Tanjung Mangkalihat and Berouw River areas) and again in 1918 in northeast Borneo (Telok Selimau); his collections are mainly at the Bogor and Leiden herbaria.

Johan Frederik **Labohm**, Forest Officer in southeast Borneo, collected many plant specimens in the Banjarmasin, Sampit, Balikpapan and Samarinda areas during 1916–1920. At this time (1917–1925), a Forest Overseer in the same district, Carel Nicolaas Johan **Delmaar**, also collected many plant specimens from the Kuala Kapuas area. **Mohamad Dachlan**, another overseer in southeast Borneo, too, made several hundred collections around the Banjarmasin, Martapura and Kuala Kapuas areas between 1918 and 1939. Frederik Hendrik **Hildebrand** of the Buitenzorg Forest Research Institute made some small collections of plants in 1925 and 1928 in southeast Borneo. Another Forest Officer, Laurens **Verhoef**, also collected in southeast Borneo in 1928–1929.

Joseph Clemens, a chaplain in the U.S. army, and his wife **Mary Strong Clemens** made substantial collections during several trips to Kinabalu between 1915 and 1917 (collecting at least 1,839 numbers) and between 1931 and 1933 (making more than 7,000 collections). Most of these have been sent to the Arnold Arboretum in the U.S.A. and the British Museum of Natural History. Their specimens were worked on by Merrill and others, and subsequently enumerated by H. Heine (1951, 1953). David L. **Topping**, a government official in the Philippines, collected more than 500 fern specimens on Kinabalu together with Mary Clemens in 1915. A smaller collection of about a hundred numbers was also made on Kinabalu by George A.G. **Haslam** in 1916.

The Chartered Company which administered British North Borneo formed its Forestry Department based in Sandakan, with American forester D.M. **Matthews** as the first conservator in 1914, who had an interest in Philippine dipterocarps. The North Borneo Forest Department started botanical collecting around 1915 (when its collector Aniceto **Villamil** was joined by Foxworthy to make the first collections for the Sandakan herbarium), and sent its dipterocarp specimens to the Bureau of Science in Manila for study by Foxworthy, who also served as advisor to the Forestry Department in North Borneo during 1915–1916. In 1916, the Forest Department had obtained collections representing 537 species. In 1916 also, the first bulletin of the forest department, on the timbers and minor forest products of North Borneo, was published (Foxworthy 1916). Another American, Devillo D. **Wood**, transferred from the Bureau of Forestry in Manila in 1916 and who became conservator in North Borneo in 1917, began encouraging active botanical collecting in the east coast lowlands. The Forestry Department maintained close links with its counterparts in the Philippines and sent plant specimens to the Bureau of Science in Manila for identification. In 1920 Maximo **Ramos**, a trained collector borrowed from the Bureau of Science in Manila, collected 1256 specimens in Sabah, mostly in the lowlands around Sandakan. By 1921 Wood's own collections had numbered at least 2555 and in 1922 together with Jose **Agama**, a Filipino forest ranger who joined the British North Borneo forestry service in 1915, he collected on Balambangan Island off the north coast. In 1922 he sent forest officers P. **Castro** and F. **Melegrito** to collect on Balambangan and the

nearby Banggi island. Other forest officers who took part in this collecting effort during this time were L. **Apostol**, P. **Orolfo** and Aniceto Villamil. These collections, and those of the Clemenses from Kinabalu and of Hose from Sarawak, were the principal basis of a number of botanical papers on the North Bornean flora by Elmer Drew Merrill, first a botanist and later the director at the Bureau of Science in Manila (Merrill 1916, 1917a, b, 1918, 1922a, b, 1924, 1926). Merrill, who published a bibliographic enumeration of Bornean plants (Merrill 1921), also studied the collections of Adolph Daniel Edward **Elmer**, a botanist and collector for the Bureau of Science, who collected in the Sandakan and Labuk Bay area in 1921, and the Tawau area in 1922–1923 (about 1,523 numbers) (Merrill 1929). The zoologist C.B. **Kloss**, of the Federated Malay States Museum in Taiping, also visited the Sandakan area and Balambangan and Banggi Islands in 1927 and Kinabalu in 1928, and collected a few plant specimens. Merrill left for the University of California at Berkeley in 1924, where many duplicates from North Borneo (including those of Elmer) were then sent, and moved to the New York Botanical Garden in 1930.

The German botanist **Hans Winkler**, Director of the Botanical Garden at Hamburg, collected in Dutch West and Central Borneo in 1924–1925; these collections are mainly in the Hamburg, New York, Leiden and Bogor herbaria. Frederik Hendrik **Ender** of the Buitenzorg Forest Research Institute made collecting expeditions to Dutch Borneo in 1925 (around Kutei in northeast Borneo), 1928 (Tanah Blomboe in southeast Borneo) and 1938 (Sanggau, Sambas and Paloh areas in West Borneo). The 1928 expedition was made together with Dirk Fok **van Slooten**, an assistant of the Buitenzorg herbarium. Ender's several thousand Borneo collections are principally at the Forest Research Institute in Bogor, while the 200-odd collections of van Slooten are at the Bogor herbarium.

Between 1929 and 1932 Jan Pieter **Schuitemaker**, Forest Officer in Dutch West Borneo, made a number of collections there. The Dutch botanist, Oene **Posthumus**, collected in the Samarinda, Balikpapan and Tengarong areas in east Borneo in 1930; the collections, mostly of ferns, are mainly in the Bogor herbarium. In 1931–1933, the Assistant Resident of Dutch West Borneo, Louis **Coomans de Ruiter** likewise collected plant specimens there. Betje **Polak**, temporarily attached to the Buitenzorg Botanic Gardens and later the Buitenzorg Soil Science Institute, collected plant specimens in West Borneo (around Pontianak) in 1930, southeast Borneo (around Banjarmasin) in 1939 and West Borneo in 1940.

Richard Eric **Holtum**, Director of the Singapore Botanic Garden, made a collection of about 300 ferns, mosses and other plants on Kinabalu in 1931 together with the Clemenses. In 1932, also together with the Clemenses, Caetano Xavier **Furtado** (Assistant Curator in the Straits Settlements Gardens Department and a specialist in palms) collected on Kinabalu. In 1933, Cedric Errol **Carr**, a retired rubber planter in Malaya, collected about 2,000 numbers (including 700 orchids) on Kinabalu. Carr's collections are in the Singapore herbarium.

The next conservator in North Borneo, Henry George **Keith**, who assumed headship of the Forest Department in 1931, continued to encourage botanical collecting and also collected plant specimens himself after his arrival in North Borneo in 1925. Keith was interested in pursuing a foresters' flora and also compiled a preliminary list of North Borneo plant

names (Keith 1937); he based much of his work on identifications provided by H.K. Airy Shaw at the Kew herbarium. Many of the duplicates of collections at this time were despatched to the Kew, Singapore and Kepong herbaria, the last where dipterocarp specimens were identified by the Forest Botanist of Malaya, Colin Fraser **Symington** (who visited the Kabili-Sepilok Forest Reserve, Semporna and the Betotan and Segaliud areas in North Borneo, and Brunei in 1938). By 1940, the Sandakan Herbarium had amassed 10,803 sheets.

During the Oxford University Expedition to Sarawak of 1932–1933, its botanist, Paul Westmacott **Richards**, made about 2,800 collections, from Miri up the Baram to Marudi, the Dulit range, Bidi, Bau and Santubong. The specimens are principally at the Kew, Oxford, British Museum of Natural History, Singapore and Sarawak herbaria. Patrick M. **Synge**, who assisted Richards but fell ill, collected principally orchids and pitcher plants. At about this time, C.O. **Flemmich**, who was appointed State Forest Officer in Brunei made a substantial collection from trees in Brunei, which are mainly at the Kepong herbarium.

In 1937, the American ornithological collector John Augustus **Griswold** collected over a hundred plants on Kinabalu during the Asiatic Primate Expedition of Harvard to Siam and Borneo. Expedition leader H.J. **Coolidge**, who never went up Kinabalu, is sometimes erroneously credited as having collected Kinabalu plants with Griswold.

In 1938, the Japanese Nobuhira **Hanada** collected specimens of woody climbers of the Menispermaceae mainly from the Kuching area. He was probably assisting botanist Yoshimatsu **Yamamoto** who was a specialist in the family and who collected in Tawau in North Borneo and Pontianak and Banjarmasin in West and South Borneo in 1939.

In 1940, Pieter **Buwalda** of the Buitenzorg Forest Research Institute collected more than 300 numbers from the Sampit region in south Borneo.

Post-War Collectors

When the Second World War intervened, Australian air raids on Sandakan in 1944 destroyed the herbarium. Still with Keith as conservator, the herbarium's collection programme resumed in 1947, assisted by a return of some 1,000 sheets of specimen duplicates from the Singapore Herbarium. In the same year Keith (1947) published his account of North Borneo timbers. Dipterocarp specimens, in particular, which had been sent to Kepong for study and identification by Symington, were, after his death in 1943, also sent to van Slooten in Bogor and later Amsterdam, until van Slooten also died in 1953.

Java-born Dutchman Andre J.G.H. **Kostermans**, of the Botanical Division of the Buitenzorg Forest Research Institute, made a number of expeditions to Borneo around this time: in 1948 and 1953 around Sampit in south Borneo; in 1951, 1952, 1953–1954, 1955 and 1957 (and also later in 1963) in northeast and east Borneo; and in 1955 and 1956 in central Borneo. Kosterman's 1952 and 1953 trips were partly joined by Willem **Meijer**, an

assistant in the Bogor Herbarium then, and later in 1955 a lecturer at the Faculty of Agriculture in Pajakumbuh in Sumatra before his repatriation in 1958. Anne **Johnson**, demonstrator in botany at the University of Malaya in Singapore, collected some Sarawak plants, mainly bryophytes and ferns, in 1951; these are found in the Singapore herbarium. James **Sinclair**, Curator of the Singapore Herbarium, collected around Santubong in Sarawak in 1949, on Kinabalu and around Sandakan in 1957, and in Sarawak and Brunei in 1960. In 1955, John William **Purseglove**, Director of the Singapore Botanic Garden, collected in the 1st Division of Sarawak (with **Mohamad Shah** of the Singapore Herbarium), and again in the Bako National Park in 1956 (with Hamish Boyd **Gilliland** of the University of Malaya and **Mohamad Shah**). George **Alphonso**, Curator of the Singapore Botanic Gardens, also collected in Sabah (on the Crocker range, near Tenom, Tambunan and Patau, and around Keningau) in 1959; his further trips to Borneo (1965 to Sarawak, with **Samsuri Ahmad**; 1966 to Kinabalu) did not yield many more herbarium specimens. Hsuan **Keng**, botany lecturer at the University of Malaya in Singapore, made a short collecting trip to Sarawak (Baram district) in 1961.

In Sarawak, James Aidan Robb **Anderson**, who became Assistant Conservator during 1951–1954 and Forest Research Officer in Kuching in 1955 before transfer to Brunei as State Forest Officer in 1956, and back to Sarawak later as Forest Research Officer, made substantial collections, especially of peat-swamp plants in the Rejang, Baram and Kayangeran areas (Sarawak) and Badas (Brunei). His collections are mainly at the Sarawak and Kepong herbaria. Anderson published a guide to the peat-swamp flora (Anderson 1963). At this time Francis George **Browne** was the Conservator, and Browne also made some plant collections besides writing a compendium (Browne 1955) of common forest trees. Anderson's successor as Assistant Conservator, and later also State Forest Officer in Brunei, was a German forester, F.W.O. Eberhard **Brünig**, who collected especially the flora of podzolized soils in the 1st and 2nd Divisions in Sarawak and Brunei (Brünig 1968).

During the Oxford University Expedition to Borneo, 1955–1956, led by G. Arnold, forester Gordon Harold **Pickles** collected plant specimens (lodged principally at Forest Herbarium, Oxford, Singapore and Kuching) in the Plieran Valley along the Rejang River, the Usun Apau Plateau, Mt Kalulong and along the Baram River.

In 1952, Keith was succeeded as conservator in North Borneo by A.B. Walton from the Malayan forestry service, who continued to emphasize floristic inventory work. Dipterocarp collection and inventory continued to dominate botanical work based at the forest department when, upon the recommendation of John **Wyatt-Smith** (Forest Botanist of the Federation of Malaya, at Kepong), Geoffrey Howorth Spencer **Wood** was appointed the first Forest Botanist for North Borneo in 1954, when G.L. Carson succeeded Walton as conservator. In the same year Wyatt-Smith and Wood collected in North Borneo together, and afterwards Wood spearheaded the department's botanical collecting and began to specialize in the dipterocarps. After a year's home leave to Britain, Wood returned in 1957 and went on a collecting trip to Brunei with P.S. Ashton, Brunei's newly arrived and first Forest Botanist. Wood died in Brunei from an accidental explosion in camp. Between 1948 and 1958, John Kidman **Cox** of the North Borneo Agriculture Department collected mainly orchids there (including on Kinabalu); he made about 900 collections from North Borneo, which were sent to Singapore, Kew, the British Museum, Berkeley and Leiden.

Bertram Evelyn **Smythies**, State Forest Officer in Brunei in 1952–1959 and thereafter Conservator of Forests in Sarawak until 1964, when he joined the Royal Society Expedition to Kinabalu for a short period, also added substantially to the botanical collections. He published a simple guide to common Sarawak trees from 34 families (Smythies 1965). Peter Frederick **Burgess**, Deputy Conservator at Sandakan during 1956–1965 (when North Borneo became Sabah), and who wrote an excellent account of the timbers (Burgess 1966), also made small numbers of collections, especially in the east coast areas.

Timothy Charles **Whitmore** collected in Sarawak (around Kuching), Brunei and North Borneo (Labuan, Lungmanis, Sandakan, Kalabakan, Tawau areas) in 1957 when principally studying dipterocarps in the field; he returned when serving as Colombo Plan botanist at Kepong to collect in Sarawak (at Semengoh) in 1966. Whitmore's Borneo collections are mainly at Cambridge, Sandakan, Singapore and Leiden. During this period, Marius **Jacobs** of the Bogor herbarium made collecting trips to Sarawak, Brunei and Kinabalu in North Borneo in 1958, taking nearly 800 numbers. University of Malaya plant physiologist John **Carrick** collected in Sarawak (Bako) in 1959 (with I.C. **Enoch**) and 1961; his collections, about 600, are in the university herbarium (Kuala Lumpur) and in the herbaria in Singapore and Kuching.

A successor to Wood who would want to travel out to North Borneo was not easily found, and the job was finally given in 1959 to Meijer, who had just been repatriated from Sumatra. Meijer continued working on dipterocarps, building on manuscript notes left by Wood. Shortly after Meijer's arrival, the wooden Sandakan Herbarium building was razed by fire that spread from an adjacent veneer factory in 1961, when almost all its 15,000 mounted specimens were destroyed. In 1961, Dan H. **Nicholson**, then a student at Cornell University, collected mainly aroids in Sarawak (Semengoh, Matang, Bau, Bako, Setapok). Peter Shaw **Ashton**, who left Brunei in 1961, became Forest Botanist in Sarawak between 1962 and 1966. Although there were suggestions for a herbarium in the Sarawak Forest Department in 1947, a combined Sarawak Museum and Forest Department herbarium came into being only by 1959, and Sarawak Museum specimens (including Haviland collections) were then incorporated into a new herbarium in its own building in 1961. Some specimens collected by Haviland, Hose and the Clemenses from the Brunei, Sandakan and Singapore herbaria were also returned to the Sarawak herbarium. Ashton's numerous collections of Brunei plants (as well as those of **Hasan Pukul**, with whom Ashton sometimes collected) and Sarawak plants are mainly at the Sarawak, Brunei, Kew and Kepong herbaria. He collected again in Brunei in 1965. Ashton wrote a manual to Brunei dipterocarps (Ashton 1964), published the same year as the one by Wood & Meijer (1964) for Sabah, followed by a supplement (Ashton 1968), and also completed by 1973 the manuscript for a book on 25 non-dipterocarp families in Sarawak, which publication was delayed until 1988 (Ashton 1988). Based at the Sarawak herbarium, collectors of importance include herbarium assistant **Ilias Paie** (from 1962, active until the 1980s), tree climber **Banyeng** anak Nyudong, together with **Ardzi Arshid**, **Bojeng Sitam**, **Galau**, and **Rashid Taggoi**.

In Sandakan, the 1960s saw a new drive in collecting with herbarium assistants Leopold **Madani** (from 1960 and still collecting in the 1990s) and **Aban Gibot** (from 1962, active until the 1980s); there, others with substantial collections to their credit include George

Mikil, J. Ampuria, James Ah Wing, David Brand, Jaswir Singh, Muin Chai, David Charington, Abdul Rahim, Masirom Rundi, and Henry Sinanggul. Through the massive recollection programme some 17,200 specimens (including about 13,600 post-1961 collections) had been accessioned in 1964, when a new herbarium building was ready (Meijer 1964). Meijer, Aban and Madani also collected with both Royal Society expeditions to Kinabalu (1961, 1964), but used the SAN number series.

Interest in the Kinabalu flora had not waned during this period. Although there were very few who collected frequently on the mountain apart from Forest Department staff, there was also some notable exploration carried out, such as the exploration by Sheila **Collenette** (formerly Iris Sheila **Darnton**) of Kinabalu from Kundasang over the Pinusuk Plateau in 1960. Her collections, at first largely within the Kota Belud area where she was headquartered in 1954, and later more generally in North Borneo, number nearly 2,000 and are mainly with the herbaria of the British Museum of Natural History and at Leiden. University of Minnesota professor Ernst Cleveland **Abbe** and his wife Lucy B. Abbe collected during 1959–1960 in Kuching, Brunei and (accompanied by his research assistants Linn **Bogle** and Robert Bruce **Kaul**) on Kinabalu (which the Abbés revisited in 1962) and in 1964 in Sarawak; their collections, many of oaks, are mainly in the herbaria at the Arnold Arboretum, Kew, Edinburgh, the University of Minnesota and Singapore.

With the encouragement of Carson, Edred John Henry **Corner** from the University of Cambridge led two Royal Society expeditions to Kinabalu, in 1961 (Corner 1964) and 1964. Corner was Assistant Director of the Singapore Botanic Garden during 1929–1941. The other principal botanical collectors on these expeditions, which represented an important advance in knowledge for one of the richest floras in the tropics, were John David Adam **Stainton**, a barrister-at-law and assistant organizer of the expedition (in 1961) and **Chew Wee Lek** (both expeditions), first botanist and later Keeper of the Singapore herbarium. Chew also collected in Sarawak in 1962 (Niah, Baram, Mt Mulu, Mt Api and Mt Benarat); 1963 (the Bau limestones, Mt Gading, Priam River, Mt Mentawa, Mt Maja), 1966 (Lambir, Marudi, Baram, Limbang, and the Tutoh and Melinau Rivers) and 1967 (Mt Api, Mt Benarat, the Tiang Bekap limestones near Kuching, Mt Mentawa and Mt Maja). Corner had previously collected in Brunei and Sarawak (Bako National Park) in 1959, and also collected in the vicinity of Kuching in Sarawak after the first expedition to Kinabalu in 1961. These collections are principally at the Kew herbarium; Chew's other collections were lodged mainly with the Singapore herbarium, and duplicated at the Leiden, Kew and the Arnold Arboretum herbaria. Kinabalu collections were also made during the 1964 expedition by Martin Edward Duncan **Poore**, Professor of Botany at the University of Malaya, and student **Ho Coy Choke** and deposited mainly in the University of Malaya herbarium in Kuala Lumpur.

Brian Laurence **Burt** and Patrick James Blythe **Woods**, botanists from the Royal Botanic Garden, Edinburgh, collected in Sarawak in 1962 (Kuching, Niah, Marudi, Mulu, Lambir, Kapit, Lundu, Poi) and 1967 (Kuching, Hose Mountains, Kelabit Highlands). The collections are mainly at the Edinburgh, Leiden and Sarawak herbaria. Swiss Hans Peter **Fuchs**, a Shell Company research palynologist, collected in Sarawak (Santubong, Semengoh, the Bau limestone, Baram, Marudi, Niah, Lambir), Brunei and Sabah (Kinabalu) in 1963; parts of his Kinabalu trips were with Meijer, Sheila Collenette and Hermann Otto **Sleumer**,

a Leiden botanist who continued to Sarawak (Mt Matang) to collect. Duplicates of Fuchs's collections are also at Leiden, Kew and Sarawak. Eduardo **Quisumbing**, Filipino orchidologist, collected in 1963 in Sarawak (Bako, Santubong, Semengoh, Bau limestones), Brunei and Sabah (Mt Kinabalu). In 1963, T.D. **Pennington** from Oxford University collected mainly Meliaceae from Sarawak (Lundu, Rejang River, Kapit) and Sabah (Sepilok, Kinabalu); these are mainly at the Forestry Herbarium, Oxford, Singapore, Kuching and Sandakan.

The Japanese botanist Mitsuru **Hotta** collected, while on a Kyoto University expedition to Borneo with Minoru **Hirano** of the Osaka City University as leader, in Brunei (Temburong) and Sarawak (including the Tatau River and the Mt Mulu area, Limbang, Marudi) in 1963–1964 (Hotta 1964). About 10,000 collections were taken, deposited mainly at the Kyoto, Kuching, Leiden and Kew herbaria. This resulted in a whole series of papers (Hotta 1964, 1965a, b, c, 1966a, b, 1967a,b; Iwatsuki 1965a,b; Tagawa 1965, 1967; Tagawa & Iwatsuki 1966).

Harold Emery **Moore, Jr.**, Director of the Bailey Hortorium, collected palm specimens in Sarawak (Matang, Bako, the Bau limestones, Bintulu, Nyabau) in 1963–1964 and Sabah (Sandakan, Sepilok, Kimanis, Beaufort, Tenom, the Crocker Range, Kota Belud, Jesselton; with Meijer) in 1964; the collections are mainly at the Bailey Hortorium, Kew, Kuching and Sandakan herbaria. In Brunei; Joannes Petrus **van Niel**, a Shell Company palynologist, made herbarium collections between 1964 and 1971; these are at Leiden.

Andries **Kanis**, a Dutch botanist stationed by the Dutch Ministry of Foreign Affairs at the Sandakan herbarium in 1965, and acting head of that herbarium for about nine months before returning to Leiden in 1966, collected about 250 numbers in Sabah (as North Borneo became known then); he also collected in Brunei and Sarawak (Baram, Lambir Hills, Nyabau and Segan Forest Reserves, Bintulu, Matang, Semengoh, Bako) in 1966. Bruce **Weber**, an American botanist, was attached to the Sabah Parks and Forest Department during 1965–1967 and collected some plants. In 1966, a Chinese botanist who came to be settled in the Netherlands and employed at the Rijksherbarium in Leiden, Ding **Hou**, also visited to collect in Sabah (mainly in the Sandakan and east coast districts, and on Kinabalu) and Sarawak (mainly the Kuching, Bau, Bintulu, Sibul and Nyabau areas). Thomas Kenneth **Newell**, a graduate student at the University of Hawaii, made a small collection, mainly of monocots, in Sabah (Sandakan, Jesselton, Tamparuli and Kundasang) in 1966; his collections are at the Bishop Museum, Sandakan, Paris, Leiden, Florence and Kew. Meijer left Sabah in 1968, when also Ken **Ogata** from the Meguro Forest Experiment Station in Tokyo collected a large number of herbarium vouchers together with wood samples from Sabah. Shigeo **Kurata** of the Japanese Insectivorous Society collected pitcher-plant specimens in Sabah (mainly Kinabalu) during a Mindoro/North Borneo expedition in 1967–1968. Others in Sabah collected actively during this period, including planter Jim B. **Comber**, who took mainly orchids and ferns, principally from the Tenom area and the Crocker Range; his collections were given to Kew. Engkik **Soepadmo** (University of Malaya) collected with Anderson in the Simanggang and Bau areas in Sarawak in 1961, the collections numbered by Anderson under the Sarawak herbarium series, and with Gordon **Smith** (University of Malaya) and Paul Chai (Sarawak herbarium) in the Kapit and Bau areas in Sarawak in 1969.

John Dransfield collected in Brunei and Sarawak (Bako, Matang, Bintulu) in 1968 (as a research student), and Kalimantan Timor (east Borneo: Balikpapan, Samarinda, Kutei) and Kalimantan Selatan (southeast Borneo: Djaro, and Mt Sarempaka; with Indonesian botanist Kuswata **Kartawinata** and Dutch botanist Eduard Ferdinand **de Vogel**) in 1971 (while a Colombo Plan botanist at Bogor); his collections were distributed mainly to Kew, Ithaca, Bogor, Leiden, Kepong and Singapore. W. **Soegeng** Reksodihardjo, botanist of the Bogor Herbarium, collected in the Kutei Nature Reserve in East Kalimantan in 1970; the collections are mainly at Bogor.

Hotta collected again in Sabah in 1968–1969 with Shohei **Kokawa**, on Kinabalu and the Trus Madi area, and in the Tawau Hills and on Mt Silam. In 1969, Peter Francis **Cockburn** was appointed Forest Botanist at Sandakan and continued a statewide collecting drive. He left in 1977. David **Mabberley** from Oxford collected in Sabah in 1974. Around this time, there are some collections by Anthony **Lamb**, of the Sabah Agriculture Department, registered; his collections were mostly orchids and although between 1977 and 1981 he used Sandakan herbarium collecting numbers, the specimens are not always lodged with the herbarium there. Lamb continued collecting into the 1990s, in the later part using his own numbers; many of his collections were sent to Kew or Leiden. P.S. **Shim**, a plantation silviculturist in the Forest Department in Sandakan also collected (mostly ferns and orchids), using the herbarium's number series. Gary **Shea**, a Canadian University Service Overseas volunteer attached to the herbarium in Sandakan, also collected widely in Sabah during 1971–1972; Shea's collections are at Sandakan and distributed to Kew, Kepong and Leiden. Cockburn organized the Trees of Sabah project, which saw the publication of two volumes (Cockburn 1976, 1980) that covered, in a very superficial and cursory manner, 44 angiosperm families and two conifer families of tree. Shea assisted with the write-ups for several families in the first volume. K.K. **Tiong** was appointed Forest Botanist in Sandakan in 1977, and continued the collection in Sabah.

Paul P.K. **Chai** became Forest Botanist in Sarawak in 1970, collecting widely throughout Sarawak. Ilias & Chai also collected with the 1964 Royal Society Expedition to Kinabalu in Sabah. Hans Peter **Nooteboom**, Leiden botanist, made collecting trips to Sabah (Mt Alab, Mt Lumarku, Mt Trus Madi, Tambunan) in 1969, and Sabah (Kinabalu, Sandakan) and Sarawak (Bario, Mt Murud, Apo Batu Buli Range; with Paul Chai) in 1970. Nooteboom and Chai's collections number about 1600, distributed to the Sandakan, Kuching and Leiden herbaria. In 1971 Anderson returned to collect in the Mt Mulu area in Sarawak. Chai again collected in the Mulu area (Mt Api, Mt Benarat, Mt Buda, the Melinau Gorge) in 1975 together with B.L. Burt.

De Vogel collected again in Kalimantan Selatan (Jaro, Mt Sarempaka) in 1972 and 1973; his collections are principally at Bogor and Leiden. In 1972, University of Hull research assistant R.J. **Morley** made a small collection of plants on Kinabalu, distributed to the University of Hull, Kew and Leiden. In 1973, a New Zealander, David Wilson **Ives**, consultant with the N.Z. Colombo Plan aid to Indonesia's beef industry, collected plant specimens in Kalimantan Selatan (Tandjung, Tabanio River, Djilatan, Djurong); his specimens are at the Christchurch herbarium.

Benjamin Clemens **Stone** from the University of Malaya, who had collected in Sabah and Sarawak in 1967, also collected in Sabah's Danum Valley in 1976 as a World Wildlife Fund (WWF) consultant botanist, on Gaya Island and on Balambangan Island in 1977

(Stone 1980) in the same capacity. These several hundred collections were lodged with the Sandakan, Kuching and University of Malaya herbaria. Earlier in 1970, Sabah Forest Department ecologist J.E.D. **Fox** had also collected on Balambangan (about 80 numbers). P.J. **Martin** and A. Clive **Jermy** of the British Museum (Natural History) collected on Mt Mulu and along the Melinau and Melinau Paku Rivers in Sarawak in 1976.

In 1976, Hotta again collected in Sabah (Kota Kinabalu, Kinabalu, Ranau, Telupid, Sandakan, Madai) and Sarawak, together with another botanist Michio **Tamura** on yet another Kyoto University Expedition to Borneo (Kobayashi & Hotta 1978). Further Kyoto University expeditions followed (Iwatsuki *et al.* 1983). In a 1978–1979 expedition to East Kalimantan (Sekatak lowlands near Tarakan, Samarinda, Sebulu, Tabang, Balikpapan, Mt Beratus) and South Kalimantan (Banjarmasin, Mt Besar), led by Kunio **Iwatsuki** and joined by G. **Murata**, Masahiro **Kato**, J.P. **Mogea** and K. **Kartawinata**, some 4,650 numbers were collected. Another expedition in 1980–1981 to East Kalimantan, led by H. **Ogawa** together with Kato and Kunihiko **Ueda** and joined by Dedy **Darnaedi** of the Bogor Herbarium, and which collected about 2,500 specimens, surveyed Sebulu, Tabang, the Menubar River, Mt Kongkat, Mt Kongbotak, and the limestone Mt Njapa and Mt Buntung. In a further expedition to East Kalimantan in 1981, led by Iwatsuki and joined by Kato, Motoharu **Okamoto** and Ueda, Darnaedi and Eko Baroto **Walujo** of the Bogor Herbarium, and Rob **Geesink** of the Rijksherbarium in Leiden, the Long Bawan region near the Sarawak border and the Balikpapan and Samarinda areas were explored, netting some 4,750 numbers for the Japanese collectors. Kalimantan collections were distributed mainly to the Kyoto, Bogor and Leiden herbaria; Sabah specimens to the Kyoto, Sandakan and Leiden herbaria. Two other Japanese collectors, **Suehiro** and **Harigae**, are credited with Kinabalu collections made in 1979, deposited in the Kyoto herbarium (Iwatsuki *et al.* 1983).

During the Royal Geographical Society Expedition to Mt Mulu in Sarawak in 1977–1978 (Jermy & Kavanagh 1982; Jermy 1984), several botanists collected in the area at different times, including: Chai, Anderson, George **Argent** (Royal Botanic Garden, Edinburgh), J.A.R. **Kerby** (Edinburgh), Ivan C. **Nielsen** (University of Aarhus in Denmark), Carlo K. **Hansen** (Copenhagen Botanical Museum), J. Dransfield, B.C. Stone, Ruth **Kiew** (Agricultural University of Malaysia), Barbara S. **Parris** (University of Cambridge), A. C. Jermy, A. **Touw** (Leiden), Walter F.B. **Julich** (Leiden), B. **Coppins** (Edinburgh) and N. **Sammy** (a Singapore-trained biologist working in Australia).

Dransfield collected rattans in Sabah in 1979 while on secondment from the Royal Botanic Gardens, Kew, to the British Overseas Development Administration project in Sabah to carry out a rattan survey. He was accompanied by his wife, **Soejatmi Dransfield**, who collected bamboos. John and Soejatmi Dransfield were in Sarawak in 1981, collecting rattans during a similar survey there.

Of check-lists and floras

Undoubtedly, the account by Stapf (1894) of the Kinabalu plant life must be the earliest systematic account of the flora of any one place in Borneo. Stapf enumerated 360 species of flowering plants, ferns and bryophytes. After Gibbs (1914), which updated this Kinabalu account, it was largely people like Merrill (see

references here), Copeland (1917, 1935), Ames & Schweinfurth (1920), Fisher (1932), Christensen & Holttum (1934), and others who produced numerous papers on Bornean plant taxa. Hallier (1916) probably made the first attempt at a flora of Borneo (in German). Merrill's bibliographic enumeration of Bornean seed plants (Merrill 1921), which lists 4,924 species, not including the 120 orchid species listed by Ames & Schweinfurth (1920), giving a total of 5,044 species (in 1,162 genera and 156 families), was strong motivation for continuing work. Merrill's 1921 estimate was a Bornean flora of some 9,000 flowering plants including 3,000 species of tree. This work is essentially uncritical, as is the subsequent enumeration by Masamune (1942), listing 7,201 species (1,310 genera, 165 families) of seed plants, that reproduces Merrill's list with few changes and adds partial information from the intervening period. Masamune also published a list of Bornean pteridophytes (Masamune 1945), which lists 963 species of ferns and fern-allies in 118 genera.

To Masamune's enumeration, Merrill (1950) adds another 200 species of seed plants published by Ridley, Airy Shaw and others and not consulted by Masamune; estimating the size of the Bornean flora at 12,000 to 15,000 species (including seed plants, ferns and fern-allies), he laments the lack of a descriptive flora.

While specialists in the large western herbaria continued to work on a taxonomic basis, foresters' check-lists of trees and dipterocarp floras ("identification manuals") heralded a next phase of botanical development in Borneo, beginning with those of Wood & Agama (1956), Hasan & Ashton (1964), Wood & Meijer (1964) and Ashton (1964, 1968). van Steenis (1950) pointed out that Borneo had the largest number of endemic genera among islands in western Malesia and Airy Shaw (1975), who named many Bornean collections at the Kew herbarium and continued an interest in Bornean plants over a long period, considered Borneo to be "...floristically and phytogeographically...an area of prime importance—almost the 'hub' of Western Malesia..." Forest floras and tree floras continued to be in the ambitions of the forest departments of North Borneo (after 1963, Sabah) and Sarawak, and early attempts include Ashton's manual of non-dipterocarp trees of Sarawak (revising only 25 families of tree, completed by 1973 but published only in 1988) and the two volumes of the "Trees of Sabah" (accounting for 46 families of tree: Cockburn 1976, 1980). Anderson (1980) published a check-list of Sarawak trees and a guide to the Moraceae of Sarawak (Primack 1983) appeared to push on with what Ashton began, but the writing of such manuals in the same series was not continued. Kiew (1984) called for a concerted effort towards a flora of Borneo and in 1985, an attempt to continue the "Trees of Sabah" project by B.C. Stone, then of the Academy of Natural Sciences, Philadelphia, never materialised (Wong 1994).

For Indonesian Borneo, local check-lists and floras were longer in coming (Whitmore, Tantra & Sutisna 1990a, b, c) and did not, in the case of some large and taxonomically complex families, attempt to list beyond a few common taxa. However, keys by Ashton to all known Bornean dipterocarp species and genera are given. One of the more recent accounts includes that by Kessler & Sidiyasa (1994), of the trees of the Balikpapan-Samarinda area in East Kalimantan.

Aside from the tree flora, modern identification manuals, amounting to floristic enumerations, of the rattans of Sabah and Sarawak (J. Dransfield 1984, 1992), and the bamboos of Sabah (S. Dransfield 1992) have been published. Modern compilations of the

orchids of Borneo (Chan *et al.* 1994, Vermeulen 1991) as well as a check-list for Borneo (Wood & Cribb 1994) have also been published.

In the meantime, the incredibly high plant diversity of Kinabalu, Borneo's highest mountain, continues to attract systematic study. As part of a modern botanical enumeration of Kinabalu's vascular plant flora, John Beaman and associates have published annotated check-lists of the ferns (Parris, Beaman & Beaman 1992) and orchids (Wood, Beaman & Beaman 1993). Farther south, a new inventory of the Brunei flora towards compiling a modern check-list, initiated in 1989 between the Brunei Forestry Department and the Royal Botanic Gardens, Kew, is yielding more information of a very rich flora, with many novelties.

Current estimates of the Bornean vascular flora hover between 9,000 (Merrill's original estimate in 1921) and 15,000 (the upper limit of Merrill's subsequent estimate in 1950). This state of uncertainty surely reflects the existence of large gaps still in our knowledge.

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BIOGEOGRAPHY AND ECOLOGY

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The physical setting

Botanists from Peninsular Malaysia who visit Sabah and Sarawak for the first time, and who are interested in floristic ecology, are startled to find that their traditional reference points are missing. The customary altitudinal sequence—lowland dipterocarp, hill dipterocarp, upper dipterocarp, (lower) montane oak and (upper) ericaceous forest—is either unrecognisable as in the case of these categories of dipterocarp forest, or does not consistently adhere to the expected altitudinal sequence. With closer familiarity, a new set of forest types correlated to soil becomes recognisable, which more or less obscures the altitudinal sequence. Furthermore, the varied coastline in the northwest, which is mostly bordered by vast peat swamps for which there is no peninsular equivalent, lacks any consistent coastal hill association. It was Symington (1943) who first put forward the floristic classification of Peninsular Malaysian forests which is still adhered to, but up to now no East Malaysian scheme has been proposed. Why is it that the floristic ecology of East Malaysian forests is so different?

The hills of Peninsular Malaysia are thought to have remained above sea level since before the origin of the flowering plants, in the Jurassic era perhaps 150 million years ago, and the present landscape may be dated from perhaps the Cretaceous, *c.* 100 million years ago (Richardson 1947; Gobbett and Hutchinson 1973). Their soil cover is extraordinarily deep: as a rule, soils there exceed two meters over rotting rock through which occasional roots may penetrate, and sometimes much more. By contrast, in much of northern Borneo it is difficult to find soils as deep as one meter. This is because northern Borneo is at the southeastern edge of the ancient Laurasian continent and continues, even now, to experience coastal up- and downwarping, alternately sinking and accumulating sediments, then lifting and rapidly eroding, and thereby forming series of anti- and synclinally folded sedimentary rocks (Liechti *et al.* 1960). The result is a sharply dissected terrain of parallel, narrow interior ridges and valleys, in which ridge-top, slope and valley bottom are sharply differentiated. This landscape is much more rugged than the peninsular main range, which is gentle by comparison and with a dendritic lattice of ridges.

Each successive period of uplift and erosion has led to a further loss of clay minerals and nutrients, and to the creation of new hills to the north and east near the coast which each time become sandier and with poorer soils, and whose rocks are successively softer. These sandy, infertile soils are mostly yellow, but are so acidic that litter decomposition is slow

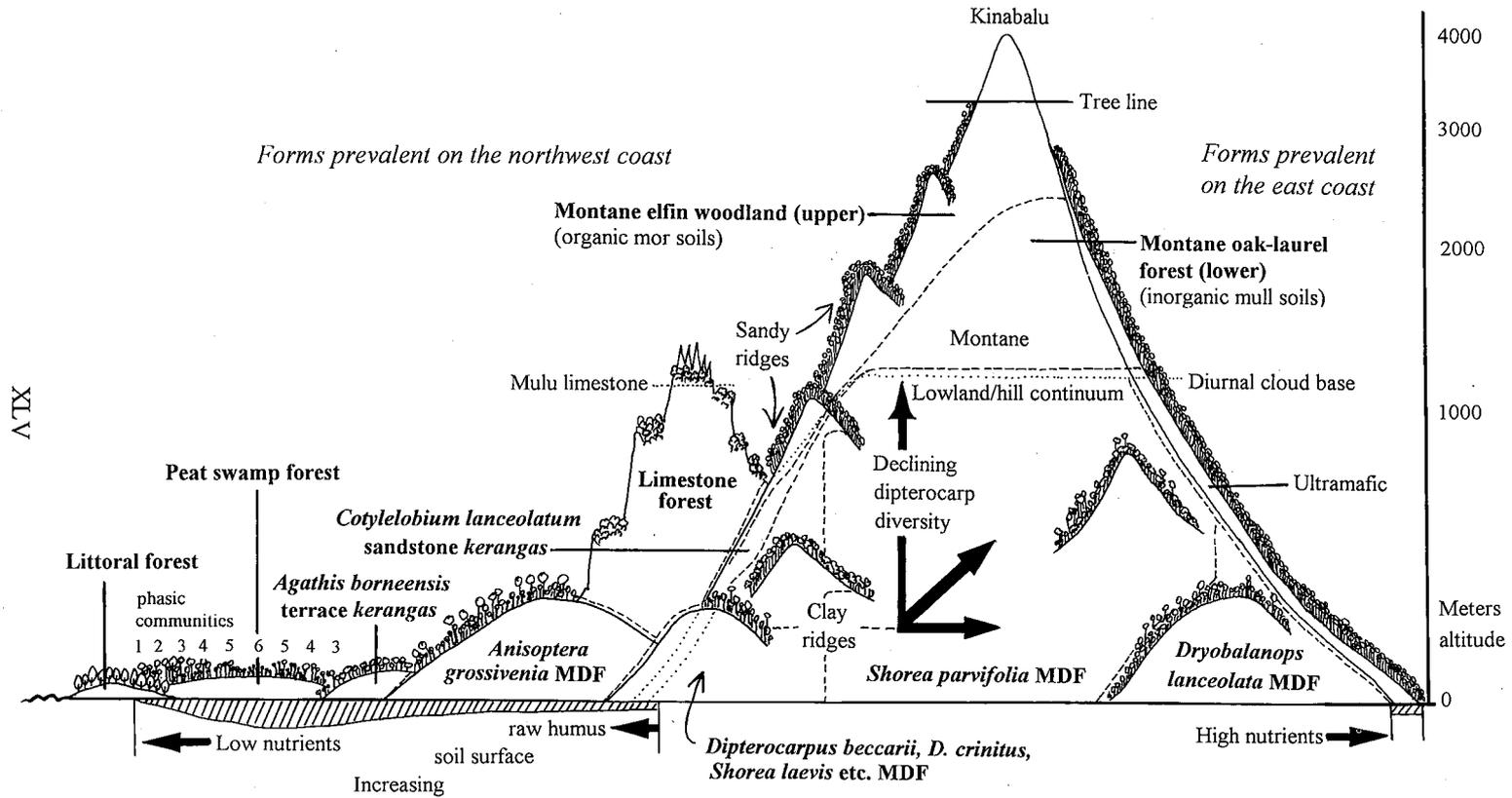
and a mantle of peaty organic matter forms. They are known as humult ultisols. The organic layer impedes surface erosion and, as a result, these young sandy hills alone quickly develop a mature rounded topography and remarkably deep soils. This contrasts with coastal clay hills which, where they occur, remain steep even if low, with clear signs of surface erosion; there, the only deep soils are formed by slumping downslope. Superimposed on this landscape in the lowlands, along the northwestern coast where the tectonic activity is greatest, are the imprints of changing sea levels during and after the ice ages: the current coastline, mostly a straight, sandy shore often bordered with *Casuarina equisetifolia* and its associates, is backed by a vast peat swamp which originated as an embayed mangrove when the sea level last declined, about 5,500 years ago. Behind again, and also perched on the hills which in places push to the coast between Bintulu and Kota Kinabalu, are extensive white sand terraces bearing giant podsol soils with deep, peaty organic surface layers (except where they have been burned); these were former coastlines during high sea levels, between the great ice ages.

Inland, the predominating sedimentary hills are intruded by volcanic masses, granite, and limestone. The volcanic rocks, which are mainly tertiary, are as diverse as the sediments, from acid rhyolites yielding similar humult ultisols to the sandy coastal hills, through dacites and base-rich fertile basalts, to ultramafic rocks which carry diverse soil types and consequently floras, and which are widespread in northern and eastern Sabah but absent from Sarawak. The granites are young, rocky and covered with shallow soils. The outstanding example of a granite formation in this territory is the great dome of Kinabalu, the highest mountain between the Himalayas and New Guinea, which arose less than one million years ago. There are other, tertiary, granite mountains in West Sarawak. The several limestone massifs in eastern Sabah and northeastern and western Sarawak are generally of a pure dolomitic limestone which erodes only by solution, yielding no mineral soil. What soils there, are organic and surprisingly acidic.

The floristic composition of forests is most markedly differentiated where the soils are limiting to plant growth and survival, by adverse water conditions or low nutrients. The combination of sharply defined topography, extraordinarily diverse rock substrates, and generally shallow, low nutrient soils in most of Sabah and Sarawak has led to a greatly diversified forest cover in which soils-correlated differentiation of forest types dominates over altitudinal and other influences. This is particularly so between Kota Kinabalu and the west coast of Borneo south to Pontianak in Kalimantan, where sandy sedimentary soils and the often deep and diversified coastal peat swamps create a diversified landscape quite different from those found elsewhere in the country.

Impact on taxonomy

A notable result, familiar to the experienced field botanist in Sabah and Sarawak but a potential pitfall to the herbarium taxonomist, is a marked and complex pattern of small-scale variation in the characteristics of widespread species which occur in the many disjunct habitats of the region. Identification of countless species from ecological plots scattered through Brunei and Sarawak persuade us that finely distinguished species based on single specimens will rarely be maintained as knowledge increases, and that van Steenis' (1957) admonition to hold to a conservative and broad species concept may prove wise.



Diagrammatic chart of the major floristic associations in Sabah and Sarawak forests

MDF stands for Mixed Dipterocarp Forest

Forest types

The overall ecology of the main forest types has been well summarised by Whitmore (1984). Here, emphasis is given to the major floristic associations. The lowland as well as mountainous forests of Sabah and Sarawak vary dramatically in stature and canopy structure, from less than 10 m tall with dense, even canopy to over 70 m, with scattered clumps of giant emergent dipterocarps or *Koompassia*, or sometimes lofty, dense, even canopy as in the *alan* (*Shorea albida*) peat swamps. However, forest stature and structure, which correlate with soil water availability, do not always correlate in Borneo with species composition, which correlates most closely with soil chemistry. Floristic variation is actually continuous, but there are also certain rather sharp environmental boundaries which differentiate major floristic associations. The following main lowland types can therefore be recognised:

Mixed dipterocarp forest (MDF). Although dipterocarps decline in abundance and in number of species with altitude, and although there are some ten species which are confined to higher altitudes, the change in flora with altitude is continuous and no altitudinally zoned types can be recognised. Most strikingly *seraya* (*Shorea curtisii*), although scattered in the coastal hills of Sarawak and southwestern Sabah, is local and never dominant there, and is rare on the inland ridges. Therefore, there is no consistent coastal hill species association, nor is there a recognisable "hill dipterocarp forest." In Borneo, the upland forests on yellow-red soils which are dominated by dipterocarps in the emergent canopy are termed Mixed Dipterocarp Forests (MDF) to distinguish them from others, such as the *S. albida*-dominated peat swamp forests, in which one or only a few emergent dipterocarp species occur. The major floristic division in these forests is between Mixed Dipterocarp Forests in which either *Dryobalanops lanceolata* or *Shorea parvifolia* (often also with *Shorea macroptera*) are among the commonest species, and which are confined to clay-rich soils lacking an acid matted surface organic mat; and forests in which *Anisoptera grossivenia* and variously *Dryobalanops aromatica* and *Dipterocarpus globosus*, or in western Sarawak *Shorea falcifera*, are among the commonest emergent species, and which are confined to humult ultisols. Probably fewer than one quarter of species are shared between these two major types (cf. Ashton 1964: 34). There is also a widespread type on intermediate, sandy clay soils of the lowlands and also inland ridges, of which *Dipterocarpus crinitus* is a characteristic representative, and in which *Shorea macroptera* is also common.

These major types vary geographically and with habitat, but they are almost always sharply distinguishable and separated in the landscape, whereas variation within them is continuous. Within the first type, giant forests in which *Dryobalanops lanceolata*, *Shorea superba*, and *Dipterocarpus caudiferus* were abundant; and *Octomeles sumatrana*, *Pterocymbium tubulatum* and *Pterospermum javanicum* were characteristic pioneers, once clothed the extensive fertile volcanic hills and sedimentary clay loams of lowland east Sabah as well as the lower basalt massifs and low clay hills of Sarawak. These forests were the first to be logged and their land converted to agriculture but some remain at Quoin Hill in Tawau, Bukit Mersing in Sarawak, and elsewhere. The *Shorea parvifolia* subtype is the prevailing forest of inland Sabah and Sarawak, on the shallower yellow clays and sandy clays which cover much of the inland sediments.

The most distinctive forest type on humult ultisols is that which is confined to its deepest soils, and therefore to low soft sandstone hills which are mostly but not always near the coast. The most extensive areas are in the Lambir Hills and the Andulau and Labi Hills of Brunei. Smaller islands occur at Beaufort Hill in southwest Sabah, in the Ulu Tutoh, Baram and Belait in Brunei, in Similajau, Nyabau and Segan forests in Bintulu, on the Arip rhyolite, in the northernmost hills between the lower Balingian and Mukah rivers, and in some small patches west of the Lupar including the foothills of Gunong Gaharu, and Bukit Undan in Bau. This type deserves special mention on account of the confinement of certain well known peninsular species there (including *Dryobalanops aromatica* and *Shorea curtisii*), because it appears to be the richest in species of all forest types in Malaysia, because of its remarkable endemism, and because it still remains unfamiliar to many foresters and biologists. The commoner dipterocarp species which are concentrated in or confined to it include *Anisoptera grossivenia*, *Dipterocarpus globosus*, *D. lowii*, *D. rigidus*, *D. sarawakensis*, *Dryobalanops aromatica*, *Hopea beccariana*, *H. treubii*, *H. tenuinervula*, *Shorea acuta*, *S. crassa*, *S. curtisii*, *S. cuspidata*, *S. elliptica*, *S. falcifera*, *S. flemmichii*, *S. geniculata*, *S. kunstleri*, *S. ladiana*, *S. laxa*, *S. ovata*, *S. rubella*, and *S. slootenii*; species apparently confined to this type which appear in this first volume of the **Tree Flora** include *Anisophylla ferruginea*, *Canarium divergens*, *C. grandifolium*, *Santiria megaphylla*, *Sarawakodendron filamentosum*, *Parinari metallica*, *Allantospermum borneense* (often the most abundant species, and very characteristic), and *Quassia borneensis*.

A variety of other MDF, floristically related to this but generally poorer in endemics but more widespread in Sabah and Sarawak, occur on humult ultisols richer in clay, where up to 30% of the flora also occur in the *S. parvifolia* subtype. *Dipterocarpus crinitus*, *Shorea macroptera* and on ridges *Dryobalanops beccarii* distinguish this association. There is also a range of MDF on shallower, frequently more sandy soils, where there is an increasing heath (*kerangas*) forest element.

Heath (*kerangas*) forest. These are forests, often but not invariably of low stature and lacking emergents, that are confined to organic white sand podsol soils. Their flora is very distinctive, with perhaps fewer than one half of species also occurring in MDF, usually on humult ultisol soils. Although Brunig's monograph (1974) provides extensive insight into the great floristic diversity of *kerangas* forest, the relationship between floristic and habitat variation remains even more poorly understood in this type of environment than is the case with MDF. *Kerangas* occurs in two principal habitats: on raised beach terraces where the podsoles are generally deep except in the center and along the lower edges where they are often poorly drained; and on sandstone ridges and plateaux where they are generally shallow and often rocky. There appear to be floristic differences between—and to perhaps a lesser extent within—these habitats; lowland *Agathis*, for instance is almost entirely confined to terraces. Certain families of *kerangas* are also particularly well represented in upper montane forest ("elfin woodland"). They include Myrtaceae, Theaceae, and Podocarpaceae, and to some extent Ericaceae: Clusiaceae (Guttiferae) and Ebenaceae are also well represented in *kerangas*.

Peat swamps. There are extensive peat swamps up the northwestern coast, eastwards to Papar in Sabah. Anderson (1963) recognised six phasic communities from the margins to the centers of individual swamps, which he regarded as succeeding one another over the

time scale of the development of the dome of the raised bog. Anderson documented a total vascular flora of only 317 species of flowering plants, including several which are confined to certain districts and which otherwise are known from *kerangas* or MDF on humult ultisols. The endemic flora is small, most species being found also in *kerangas*. Notable is the tendency towards canopy dominance of *Shorea albida* and, towards the centers, *Litsea palustris*, *Combretocarpus rotundatus* and sometimes *Dactylocladus stenostachys*; but there are no subcanopy dominants.

Other specialized lowland forests. There are major limestone formations in Bau District of western Sarawak, Mulu National Park, and in East Sabah, and also many minor exposures. The limestone flora is rich in endemics, particularly among herbaceous species; the general characteristics are similar to the limestone outcrops of Peninsular Malaysia. The highest limestone in Malaysia is at Gunung Benarat, Mulu NP, at 1,300 m, which bears upper montane elfin woodland on its jagged upper slopes.

In several parts of Sabah, notably on the slopes of G. Kinabalu and in the northeast and east, are extensive exposures of ultramafic rocks. These exposures can bear freely draining acid soils with a surface organic layer. In this case the forest is of more or less short stature with elements of both the MDF on humult ultisols, and *kerangas*. A small but important element of Bornean affinities are present, such as the strictly endemic *Borneodendron aenigmaticum* Airy-Shaw (Euphorbiaceae). In other areas, however, as at Kinabalu, the soil is a friable red-brown loam and the flora bears affinities with that found on basalt.

The mangroves of Sabah and Sarawak do not compare in extent with those of the Peninsular west coast, but are noteworthy because they are far richer in species than any others in the world. The most extensive are at the mouths of the Kinabatangan River, and around the Bay of Brunei where some magnificent primary stands still survive. The floristic formations are similar to those of the Peninsula, as in most respects are those of the inland river banks and alluvium.

Altitudinal zonation

The sharp topography and bold ridge lines of the mainly sedimentary mountains of Sabah and Sarawak cast a stamp on vegetation differentiation which obscures the zonation recognisable in the Peninsula. Below 1,200 m the primary differentiation is between ridge and slope forests (cf. Ashton 1964: 66-70). Lower, broader shale ridges bear the tallest forests, but those with the fewest endemics. Higher ridges are variably supported by sandstone strata: Where the soils are deep, a variety of MDF on shallow humult ultisols or yellow clay types will be present; *Dryobalanops beccarii*, *Shorea laevis* and *Shorea multiflora* are characteristic species. The slopes bear *S. parvifolia*-type MDF with pockets of *Dryobalanops lanceolata* on gentle lower surfaces. On shallow soils, which increase on the ridges with the altitude, a distinct short-stature ridge forest is widespread between 800 and 1,200 m, where *Shorea flaviflora*, *Vatica umbonata* and *V. dulitensis* are characteristic of dipterocarps, and *Engelhardia* spp. are common. Where sandstone is exposed, short-stature *kerangas* prevails, and this grades imperceptibly and continuously on sandstone substrates into "upper montane" ericaceous elfin forest; this retains many *kerangas* species, such as *Eugenia (Syzygium) bankense* and *Calophyllum nodosum*. Nevertheless, true upper

montane elements such as *Weinmannia blumei*, *Leptospermum flavescens*, *Xanthomyrtus* spp., *Rhododendron quadrasianum*, *Drimys piperita*, *Dacrydium comosum* and *Phyllocladus hypophyllum* can begin to appear as low as 600 m on the most exposed peaks and skeletal soils, but only become common above 1,300 m.

On the slopes at about 1,300 m as in the Peninsula, there is an ill-defined transition on clay-rich soils to oak-laurel dominated "lower montane forest" that is at approximately the same altitude at which the upper montane elements become common on the sandstone ridges. Again, it is the differentiation between ridge and slope, and between soils with and without a surface organic horizon, which primarily correlate with forest type differentiation, although the slopes adjacent to exposed summit ridges do become clothed in organic soils and ericaceous forest.

Historical biogeography

This **Tree Flora** will for the first time provide a sound basis for historical biogeographic analysis of the northern Borneo flora. For the present, two provinces are recognised, Northwest Borneo from Pontianak in West Kalimantan northeast to the Crocker Range and Kota Kinabalu, and Sabah north and east of the Crocker Range.

The Northwest Borneo Province has phytogeographic connections with the Riau Archipelago and eastern coastal Peninsular Malaysia, that is the Riau Pocket of Corner (Corner 1960, Ashton 1992). Within it, two subprovinces are recognisable, being apparently divided east and west of the Lupar Valleys in west Sarawak and the Kapuas Lakes in Kalimantan (Ashton 1972, 1992). The western subprovince contains a number of endemics, and also a number of Peninsular Malaysian species not found elsewhere in Borneo such as the dipterocarps *Shorea dasyphylla*, *S. dealbata*, *S. falcifera*, and *S. resinosa*, and, in this first volume of the **Tree Flora**, *Dacryodes rubiginosa*, *Glyptopetalum quadrangulare*, and *Lophopetalum pachyphyllum*. The many endemic species include the dipterocarps *Dryobalanops fusca*, *Shorea alutacea*, *S. bakoensis*, *S. cuspidata*, *S. elliptica*, *S. induplicata*, *S. lunduensis*, *S. pallidifolia*, *S. richetia*, *S. splendida*, *S. stenoptera*, *S. subcylindrica*, *Vatica compressa*, *V. pedicellata* and, in this volume, *Alangium circulare*, *Haplolobus beccarii*, *H. inaequifolius*, *Anisophyllea rhomboidea*, *Ellipanthus beccarii* var. *beccarii*, *Mastixia glauca*, *Schuermansiella angustifolia*, *Sarcotheca macrophylla*, *Glycosmis longisepala* and *Maclurodendron parviflorum*. Likewise, a number of species of the Province are absent from this subprovince including, surprisingly, *Dryobalanops aromatica* and *Shorea curtisii*.

Ecological plots provide evidence that the habitats which occur in ecological islands, notably the areas of the organic podsols and humult ultisols so characteristic of this Province but also the areas of limestone and ultramafic rocks, experience significant between-locality variation in the characters of many species, and also the apparent fortuitous absence of species from suitable localities. The lack, to date, of any record of the usually common humult ultisol species *Upuna borneensis* from the Lambir Hills is a striking example.

The Northeastern Province is not so clearly subdivided, but it includes two habitats unique for all Borneo. Kinabalu, owing to its great height, is the home both of many endemics and,

on a smaller scale presumably owing to its youth, a regionally widespread upper montane and alpine element. The extensive ultramafic extrusions support a number of endemics, both in the lowlands and also on Kinabalu to which such notable species as *Scaevola micrantha*, *S. chanii* and *Pittosporum linearifolium* are confined. But the Province is notable in addition for its lowland endemic flora, which includes the dipterocarps *Dryobalanops keithii*, *Hopea badiifolia*, *Parashorea tomentella*, *Shorea symingtonii*, *S. waltonii*, all of *S. parvifolia* type MDF, and, in this volume, *Dacryodes elmeri*, *Kokoona sabahana*, *Microtropis sabahensis*, *Parinari argento-sericea*, *Connarus agamae*, *Atuna cordata*, *Sarcotheca rubrinervis*, *Maclurodendron pubescens*, *Melicope jugosa*, *M. sororia*, *M. subunifoliolata*, *Monanthocitrus oblanceolata*, and *Turpinia nitida*. Also, a number of Philippine species including *Dipterocarpus validus*, *Protium connarifolium*, *Pittosporum resiniferum*, *Melicope bonwickii*, *M. denhamii*, *Turpinia borneensis* and *Scaevola micrantha*, and species such as *Canarium asperum*, *C. decumanum* and *Kibara obtusa* are only known from this part of Borneo. Several of these are confined to ultramafic substrates.

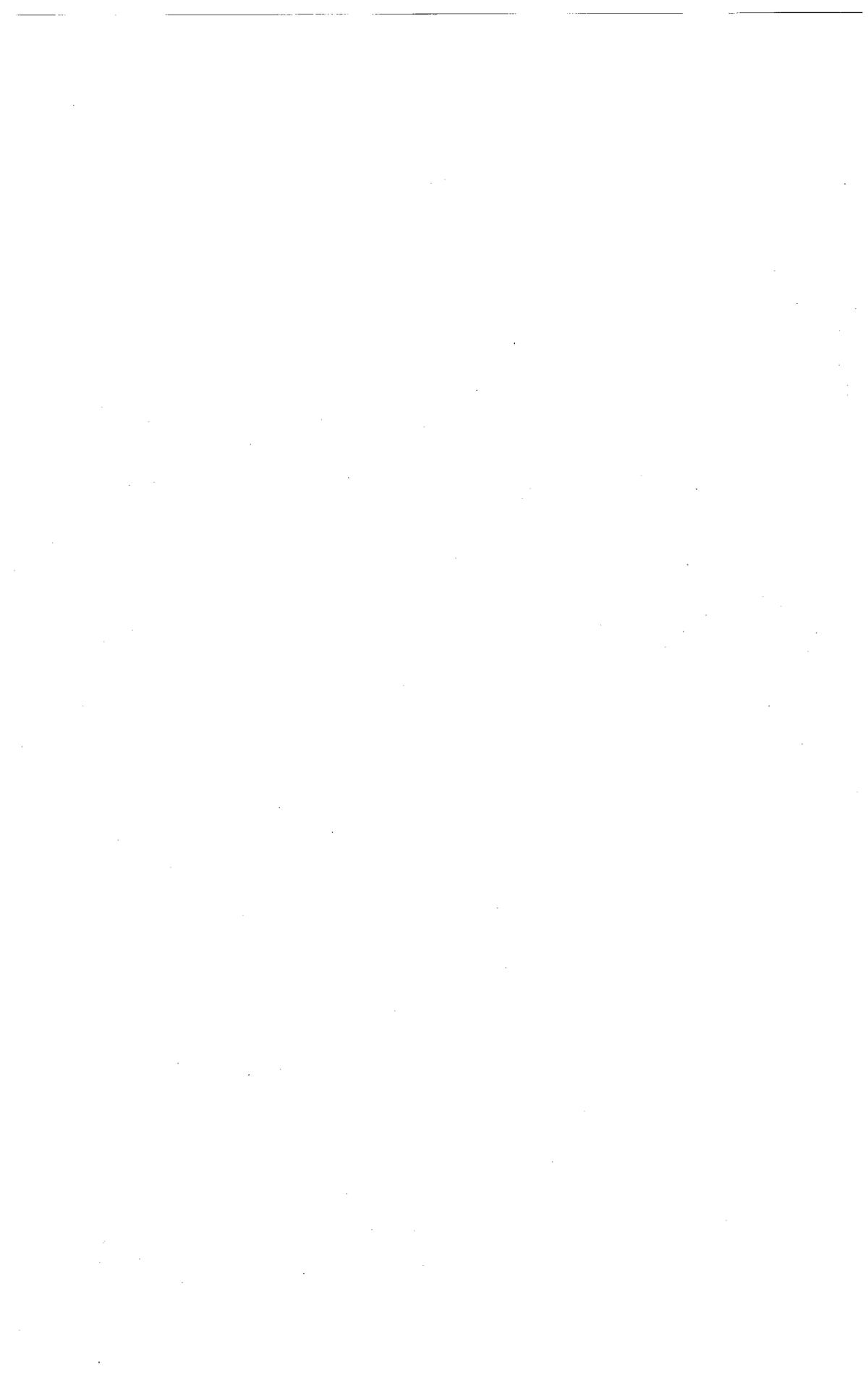
The southward extent of this Province into East Kalimantan is as yet inadequately understood. There is limited ultramafic rock in Kalimantan but some species of the zonal clay soils, such as *D. keithii*, hardly reach Tidung while others, such as *H. badiifolia*, extend as far as Balikpapan. This variable extent of ranges is not surprising in the *Shorea parvifolia* type MDF on clay soils, which extends continuously over the hills of East and Central Borneo. A number of other Philippine species such, for instance, as the dipterocarps *Parashorea malaanonan*, *Shorea almon* and *S. falciferoides*, also extend westward into north and central Sarawak.

Lastly, there is an element in the *Shorea parvifolia* type MDF, represented by such species as *Dipterocarpus mundus*, *D. pachyphyllus*, *Hopea bullatifolia*, *H. centipeda*, *H. dasyrrhachis*, *H. fluvialis*, *H. megacarpa*, *Shorea agamii* ssp. *diminuta*, *S. asahi*, *S. collaris*, *S. iliasii*, *Vatica endertii* and *V. granulata*, which have been found from innermost lowland Sarawak across to the Ulu Barito, and which may eventually delineate a distinct central Bornean transmontane floristic province.

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THE TREE FLORA PROPER

ACERACEAE

A. Noorsiha

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Koorders & Valeton, Bijdr. Booms. Java 9 (1903) 252; Bloembergen, FM 1, 4 (1948) 3; Backer & Bakhuizen *f.*, FJ 2 (1965) 143; Keng, OFMSP (1969) 416; Whitmore, TFM 2 (1973) 1; Anderson, CLTS (1980) 133; Cockburn, TS 2 (1980) 14; Ashton, MNDTS 2 (1988) 1; Whitmore, Tantra & Sutisna, CLK 1 (1989) 11.

Trees or shrubs. *Buds with protective scales. Leaves opposite-decussate, simple, palmately or pinnately veined, without stipules. Flowers in fascicles, panicles, racemes or corymbs, regular, often unisexual; sepals and petals 4–5, rarely without petals; disc annular or lobed, or reduced to teeth, rarely absent, intra- or extra-staminal; stamens (or staminodes) (4–)8(–10), hypogynous or perigynous, filaments free; ovary often present in rudimentary form in male flower, in female flowers 2-locular, superior, compressed, styles 2, free or connate at base, ovules 2 in each locule, placentation axile. Fruit composed of 2 one-seeded, one-winged samaras. Seeds without endosperm; embryo with folded cotyledons.*

Distribution. Two genera (*Acer* and *Dipteronia*) with about 200–250 species distributed mainly in mixed deciduous forests of the northern temperate zone. Only one genus (*Acer*) with one species in western Malesia.

Taxonomy. Closely allied to the Sapindaceae, from which it can be distinguished by its opposite/decussate simple leaves, samara-type fruit, and seed without endosperm.

ACER L.

(Latin name of the maple tree)

Sp. Pl. 1 (1753) 1054; Koorders & Valeton *l.c.* 253; Bloembergen *l.c.* 3; Backer & Bakhuizen *f. l.c.* 143; Whitmore *l.c.* 1; Anderson *l.c.* 133; Cockburn *l.c.* 14; Ashton *l.c.* 1; Whitmore, Tantra & Sutisna *l.c.* 11.

Deciduous trees or shrubs with smooth bark. *Leaves pinnately veined, more or less distinctly 3-veined at the base, long-stalked. Flowers unisexual, male and female on the same or different trees, organised in terminal or axillary racemes, corymbs, or panicles; sepals and petals imbricate in buds. Other floral, fruit and seed characters as in the family.*

Distribution. As for the family.

Ecology. The samaras are wind-dispersed.

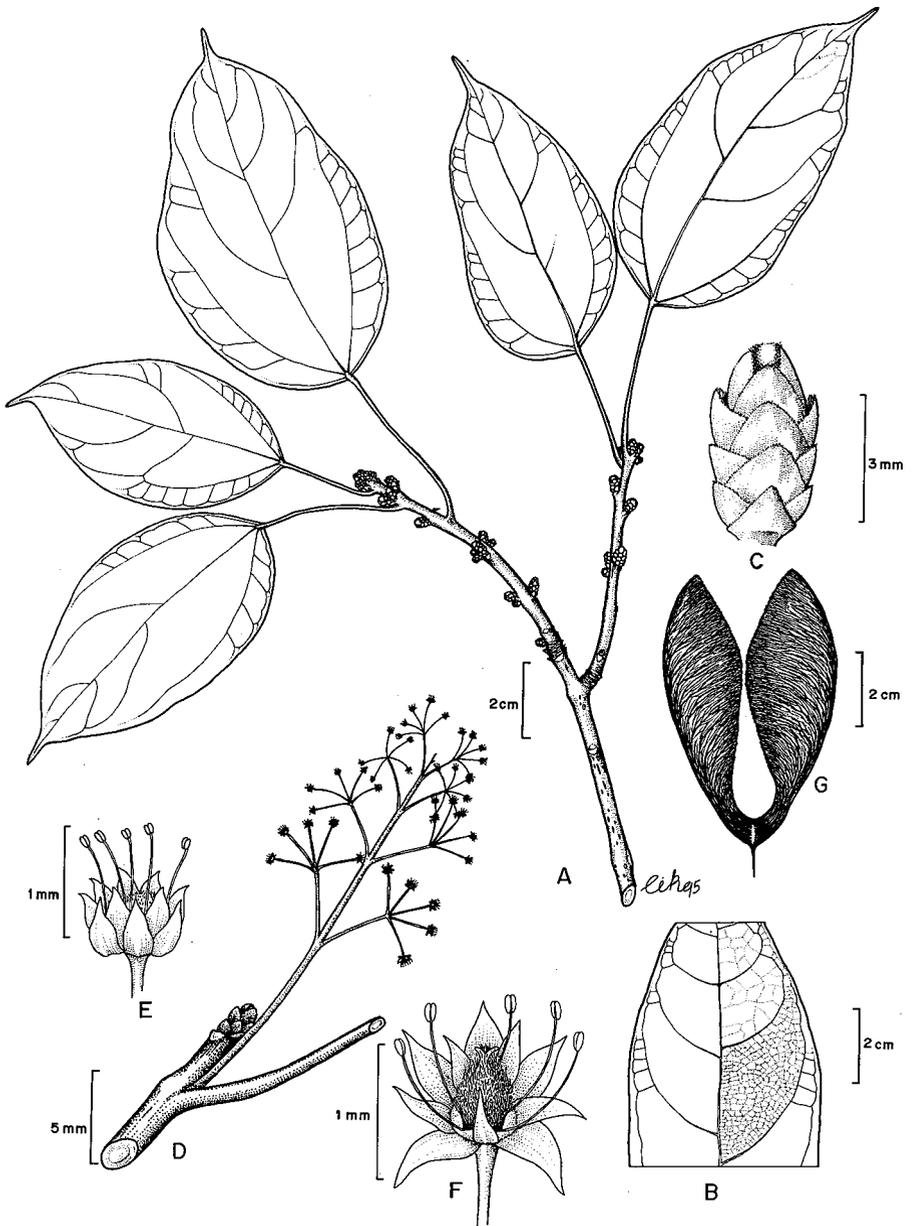


Fig. 1. *Acer laurinum*. A, leafy twig; B, leaf venation; C, terminal vegetative bud; D, inflorescence; E, male flower; F, female flower; G, fruit. (A–C from SAN 36157, D from Haviland 2092, E–F from Forman 106, G from SAN 124720.)

Uses. Many temperate species yield valuable timbers and a few others produce sugar/maple syrup obtained by boring holes through the bark in February and March each year. A number of shrubby species make excellent ornamental plants because of their strikingly coloured (yellow, red and purple) aging foliage. The timber of the Malesian species is only occasionally used for light construction.

Taxonomy. In a number of earlier publications (e.g., Blume, *Rumphia* 3 (1847) 193; Miquel, *Fl. Ind. Bat.* 1, 2 (1859) 581; Bentham & Hooker *f.*, *Gen. Pl.* 1 (1867) 409; Hooker *f.*, *Fl. Brit. Ind.* 1 (1875) 692) the genus was included in the Sapindaceae.

***Acer laurinum* Hassk.**

Fig. 1.

(Latin, *laurinum* = resembling *Laurus*; the blue-grey colour of the leaves)

in Hoenen & de Vriese, *Tijd. Nat. Gesch. & Phys.* 10 (1843) 138; van Steenis, *FM* 1, 4 (1954) 592; Backer & Bakhuizen *f. l.c.* 143; Anderson *l.c.* 133; Cockburn *l.c.* 14; Delendick, *Reinwardtia* 9, 4 (1980) 395; Ashton *l.c.* 1; Whitmore, *Tantra & Sutsina l.c.* 11. **Type:** *Jungluhn, s.n.*, West Java, Megamendong (holotype L; isotype BO). **Synonyms:** *A. javanicum* Jungh. *apud* Hoenen & de Vriese, *Monatsber. Verh. Ges. Erdk. Berlin* 3 (1842) 96; *A. niveum* Blume, *Jaarb. Kon. Ned. Maatsch. Aanm. Tuin* (1844) 84; *A. caesiaefolium* Blume, *Rumphia* 3 (1847) 193; *A. philippinum* Merr., *Philip. Govt. Lab. Bull.* 35 (1909) 36; *A. curranii* Merr., *Philip. J. Sc.* 4 (1909) 285; *A. caesium* (Reinw. *ex* Blume) Kosterm., *Reinwardtia* 7 (1965) 141 (based on *Laurus caesia* Reinw. *ex* Blume, *Bijdr.* (1826) 553); *non A. caesium* Wall. *ex* Brandis, *For. Fl. NW. & C. Ind.* (1874) 3).

Medium-sized to large tree up to 50 m tall; clear bole straight, cylindrical, up to 28 m tall and 70 cm diameter; buttresses about 1.5 m high and 2 m out, thin, spreading, slightly concave; crown dense, pale fresh green from below, more or less conical to hemispherical, deciduous to semi-evergreen. **Bark** initially smooth, greenish grey, becoming rich red to grey-brown and longitudinally fissured and flaky with age; inner bark *c.* 1.5 cm thick, firmly fibrous, yellow-brown to red-brown, somewhat mottled, sometimes laminated. Heartwood absent; sapwood white to pale yellow, with rather distinct concentric growth rings. Twigs slender, terete or ribbed, drying nearly black, with numerous leaf-scars and minute lenticels. Buds numerous, *c.* 4 mm long, covered by 4–11 pairs of decussate, caducous scales of *c.* 2 mm long. **Leaves** thinly leathery, glabrous, elliptic to ovate-lanceolate, 7–23 x 3–6 cm, glaucous to grey beneath, upper surface dark green when fresh, drying dull red-brown; base rounded to obtuse, margin entire, apex acute to acuminate-caudate; midrib slender, slightly raised above, more or less prominent beneath; lateral veins 4–9 pairs, very slender, with a pair at the base of the midrib; intercostal veins fine, reticulate; stalk 2–7.5 cm long, slender. **Inflorescences** in the axils of fallen leaves, paniculate or corymbose, 3–10 cm long, 30–50-flowered; bracts and bracteoles fairly well-developed. **Male flowers:** sepals and petals (3–)5, free, obliquely erect, respectively 2.5–3 and 1.5–2.5 mm long; stamens (4–)6(–8), arranged in one whorl on a flat, glabrous to woolly disc, filaments *c.* 5 mm long, anthers *c.* 1 mm long; pistillode strongly reduced. **Female flowers** with sepals and petals as in the males; staminodes strongly reduced; ovary densely hairy, *c.* 2 mm across; styles 2, *c.* 1.5 mm long, stigmas 2, sessile. **Fruits** red, wings 4–7.5 x 1–2.5 cm, asymmetrical, narrowed towards the base, pubescent. Young seedling leaves coarsely and distantly toothed; sapling leaves whorled.

Vernacular name. Sarawak—*perdu* (Malay).

Distribution. Burma, possibly Thailand, Sumatra, Peninsular Malaysia, Java, Borneo, the Phillipines, Celebes and Lesser Sunda Islands. Rare in truly non-seasonal parts of Peninsular Malaysia, Sumatra and Borneo, but relatively common elsewhere. In Sabah uncommon, known only from 2 collections from Mt. Kinabalu (*SAN 38438*) and Nabawan (*SAN 124720*). In Sarawak, it has a very local distribution, but is frequent where it occurs, e.g., in the Hose Mts. (3rd Div.), Mt. Meluku (2nd Div.), and Usun Apau Highlands (4th Div.).

Ecology. Apparently confined to soils of relatively high nutrient status, on igneous rocks at 200–1500 m in the upper limits of Mixed Dipterocarp Forest and on granodiorite rocks in the oak-laurel lower montane forests around 1200–1600 m. Flowering has been recorded in April–August and fruiting in July–November. In Sabah, fruiting has been rarely recorded.

ALANGIACEAE

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Merrill, PEB (1929) 232; Masamune, EPB (1942) 517; Backer & Bakhuizen *f.*, FJ 2 (1965) 159; Eyde, J. Arn. Arb. 49 (1968) 167; Kochummen, TFM 1 (1972) 56; Anderson, CLTS (1980) 133; Cockburn, TS 2 (1980) 15; Ashton, MNDTS 2 (1988) 4; Whitmore, Tantra & Sutisna, CLK 1 (1989) 11.

The family consists of only one genus, *Alangium*, distributed in tropical Africa, and E Asia, Malesia, eastern Australia and some South Pacific Islands.

Taxonomy. *Alangium* has in the past been included in the Cornaceae. Eyde *l.c.* investigating the anatomy of the flower and discussing the relationships of *Alangium*, concluded that this genus was not closely related to the Cornaceae. Instead, he suggested that the alkaloid characteristics and floral morphology indicate that *Alangium* has its closest relatives in the Rubiaceae. The evidences have not been further examined and the most recent treatments accept the Alangiaceae as a monogeneric family, usually placed in the Cornales.

ALANGIUM Lam.

(after the Malabar plant name, *alangi*)

kondolon (Dusun, Sabah), *midong* (Iban, Sarawak)

Encycl. Meth. Bot. 1 (1783) 174; Merrill, EB (1921) 459 (as part of Cornaceae), *l.c.* (1929) 232; Bloembergen, Blumea 1, 2 (1935) 241, Bull. Jard. Bot. Btzg. 3, 16 (1939) 139; Masamune *l.c.* 517; Kochummen *l.c.* 56; Anderson *l.c.* 133; Cockburn *l.c.* 15; Ashton *l.c.* 4; Whitmore, Tantra & Sutisna *l.c.* 12; Berhaman, Sandakania 4 (1994) 31.

Trees, more rarely shrubs or woody climbers, *often with thin buttresses or stilt-roots*. **Bark** smooth, thin, grey-brown, often with pale lichen patches; inner bark thick, yellowish brown. **Leaves** simple, alternate, entire, pinnately veined, or sometimes 3–5-veined at the base; stalk terete or slightly grooved or flattened on upper side; *stipules none*. **Inflorescence** an axillary cyme, few- to many-flowered. **Flowers** bisexual, sessile or stalked (the stalks, if present, articulate); calyx-tube connate with the ovary wall, truncate or with 4–10 teeth or lobes; petals 4–10, valvate, linear, becoming recurved, alternate with the calyx-teeth, usually white; stamens as many as or 2–6-times the number of petals; anthers linear, dehiscing laterally or introrsely; disc intrastaminal, well-developed; *ovary inferior*, 1–2-

celled, style single, usually as long as the corolla, ovule 1 in each locule, anatropous. **Fruit** a *drupe*, globose to ellipsoid and somewhat bilaterally compressed, often longitudinally ribbed, crowned by the persistent calyx-teeth and disc. **Seed** 1–2 per fruit with a copious endosperm; cotyledons foliaceous, flat, palmately veined at base; radicle straight.

Distribution. 21 species, distributed as noted for the family. 10 species in Sabah and Sarawak, including *A. kurzii* Craib, a new record for Borneo.

Ecology. Primary and secondary forests, lowlands to 1500 m.

Taxonomy. Bloembergen *l.c.* (1939) recognised four sections, *Angolam* Baill. (which Eyde *l.c.* points out should be called section *Alangium* as it contains the type species), *Marlea* Baill., *Rhytidandra* Baill., and *Conostigma* Bloemb.; all except *Rhytidandra* are represented in Sabah and Sarawak. Eyde *l.c.* has found that differences in style and stigma structure, stamen number, the pattern of floral vasculature, pollen morphology, and fruit endocarp characteristics support Bloembergen's designation of the four sections.

Key to *Alangium* species

1. Woody climbers.....2
 Trees.....3

2. Leaf coriaceous with domatia in the axils of main veins. Inflorescence almost sessile, with less than 15 flowers.....
 Alangium sp. 1.
 Woody climber. Leaves obovate-elliptic, 12–15 x 4.5–6 cm, coriaceous; base 3-veined, cuneate; apex acuminate; lateral veins 4–5 pairs; stalk 1.2–1.5 cm long, glabrous.
 Only one specimen, *SAN 79310*, from Telupid in Sabah known, with young flower buds.

 Leaf thinly chartaceous, without domatia. Inflorescence with stalk up to 4 cm long, and 17–30 flowers.....
 A. scandens Bloemb.
 l.c. (1935) 264, *l.c.* (1939) 193; Masamune *l.c.* 518; Whitmore, Tantra & Sutisna *l.c.* 12; Berhaman *l.c.* 32. Type: *Enderit 4076*, Sarawak, 4th Division, Long Petah (lectotype BO).
 Woody climber. Leaves ovate to ovate-elliptic, 8–15.5 x 3.5–6 cm, chartaceous to thinly coriaceous; base subcordate to rounded, apex acuminate; lateral veins 6–7 pairs; stalk hairy, 1–1.5 cm long.
 Sumatra and Borneo. Hill to lower montane forest, common in Sabah and Sarawak.

3. Leaf base 3–5-veined.....4
 Leaf base pinnately veined.....9

4. Leaves markedly obovate with narrowed base, or if elliptic and base rounded then lateral veins 6–7 pairs..... **6. A. longiflorum**

- Leaves rounded to broadly ovate with rounded to cordate base, or if (rarely) elliptic and base narrowed then lateral veins 4–5 pairs.....5
5. Leaf length at least twice the width.....2. **A. griffithii**
 Leaf length not reaching twice the width.....6
6. Leaf-stalk densely hairy; lateral veins 9–12 pairs. Inflorescence-stalk less than 8 mm long. Flowers almost sessile.....7. **A. nobile**
 Leaf-stalk glabrous to sparsely hairy; lateral veins less than 8 pairs. Inflorescence-stalk more than 10 mm long. Flowers distinctly stalked7
7. Leaf-apex blunt to emarginate; lateral veins 4–5 pairs. Petals *c.* 28 mm long and 5 mm wide at base, covered by tiny stellate scales.....1. **A. circulare**
 Leaf-apex acute to acuminate; lateral veins 5–7 pairs. Petals less than 15 mm long and 1–2 mm wide at base, covered by straight hairs.....8
8. Leaf lower surface velvety (seldom sparsely) hairy; midrib and lateral veins on upper surface densely hairy. Calyx-tube densely hairy, teeth to only about 0.5 mm long5. **A. kurzii**
 Leaf lower surface glabrous to sparsely hairy, never velvety; midrib and lateral veins on upper surface glabrous. Calyx-tube sparsely hairy, teeth more than 1 mm long8. **A. rotundifolium**
9. Plants of mixed swamp forest. Leaf-base typically asymmetric. Calyx-limb with distinct triangular teeth. Style thickly yellow hairy. Stamen filaments broadened and thickly woolly hairy at base.....3. **A. havilandii**
 Plants of lowland mixed dipterocarp forest. Leaf-base typically symmetric (rarely asymmetric). Calyx-limb subtruncate. Style sparsely white-hairy. Stamen filaments uniformly thick throughout, subglabrous to sparsely short-hairy at base.....4. **A. javanicum**

1. **Alangium circulare** Stone & Kochummen

(Latin, *circularis* = circular; the round-shaped leaves)

Blumea 22 (1975) 219; Ashton *l.c.* 4. **Type:** *Salleh ak Nantah S. 24325*, Sarawak, 1st Division, Bukit Siol, Kuching (holotype SAR; isotypes A, BO, K, KEP, L, SAN, SING).

Small to medium-sized tree to 15 m tall. **Bark** smooth, grey-brown; inner bark pale brown. **Sapwood** pale yellow. Twigs grey to brown. **Leaves** broadly ovate-elliptic-obovate to subcircular, 8.5–10.5 x 8–10 cm, coriaceous; base rounded to cordate, 3-veined, apex blunt to emarginate; midrib raised on both surfaces; lateral veins 4–5 pairs, slightly raised on both surfaces, glabrous; stalk glabrous, 7–10 mm long, 2–3 mm diameter, grooved on upper surface. **Inflorescence** a short cyme, 1–2-times branched, stalk 11–14 mm long, finely greyish pubescent, 1–3-flowered. **Flowers** 5-merous, subsessile to shortly stalked, stalks 2–3 mm long; calyx funnel-shaped, 3–4 mm long, 3 mm across, finely stellate-pubescent, teeth 5, triangular, to 1 mm high; petals linear-lanceolate, *c.* 28 mm long, *c.* 5 mm wide at base, abaxial side covered with minute stellate hairs; stamens as many as petals, linear, 10–11 mm long; ovary 1-celled, style hairy, 22–26 mm long. Fruit and seed unknown.

Distribution. Endemic to Sarawak, recorded from Bukit Siol, Sempadi Forest Reserve and Gunung Pueh in the 1st Division. Apparently a species of *kerangas* forest.

2. *Alangium griffithii* (Clarke) Harms

(W. Griffith, 1810–1845, doctor and botanist in India and Malacca)

in Engl. & Prantl., Pfl. Fam. 3, 8 (1898) 262; Bloembergen *l.c.* (1935) 266, *l.c.* (1939) 194; Masamune *l.c.* 517; Kochummen *l.c.* 58; Cockburn *l.c.* 16; Anderson *l.c.* 134; Ashton *l.c.* 5; Whitmore, Tantra & Sutisna *l.c.* 11; Berhaman *l.c.* 32. **Basionym:** *Marlea griffithii* Clarke in Hooker *f.*, Fl. Brit. Ind. 2 (1879) 742. **Type:** Griffith 3387, Malacca (lectotype K; isolectotypes B, BM). **Synonym:** *Marlea densiflora* Koord. & Valetton, Bijdr. Booms. Java 5 (1899) 84.

Medium-sized tree to 20 m tall, 30 cm diameter, sometimes with spreading buttresses to 50 cm wide. **Bark** smooth, grey to dark brown; inner bark pale yellow. **Sapwood** white to pale yellow. Twigs dark brown, smooth to hairy. **Leaves** chartaceous, *elliptic to narrowly ovate*, 5.5–18.5 x 2–8 cm, *length at least twice the width*, hairy on the lower surface, mainly on the main veins, grey to dark brown when dry; base cuneate, asymmetric, 3–5-veined, apex acuminate; midrib flat on upper side, hairy on the lower surface; lateral veins 4–5(–6) pairs, usually glabrous between the veins on upper surface; stalk 5–15 mm long, sparse to densely hairy. **Inflorescence** hairy, 3–4-times branched, 3–6.5 cm long, many-flowered, stalk 1–2.2 cm long. **Flowers** 5-merous, white to cream, fragrant; calyx-tube densely hairy, with teeth 0.25–0.5 mm long, limb spreading; petals linear, swollen at base, glabrous to sparsely hairy outside, cream, 8.5–15 mm long; stamens as many as petals, 8–14 mm long; ovary 1-celled, style glabrous, cream, 8–11 mm long. **Fruit** ovoid, 14–21 x 8–10 mm, dark brown when dry, faintly grooved, crowned by the persistent calyx-limb, dark blue when ripe.

Vernacular names. Sabah—*gadong hutan* (Brunei Malay). Brunei—*mayam kampong* (Malay).

Distribution. Peninsular Thailand, Sumatra, Peninsular Malaysia, Java, and Borneo. In Sabah, quite common but in Sarawak only found in the Tinjar Forest Reserve. Also in Brunei and Kalimantan.

Ecology. Primary and secondary forest, 60–400 m.

3. *Alangium havilandii* Bloemb.

(J.D. Haviland, 1857–1901, first Sarawak Medical Officer and plant and insect collector)

l.c. (1935) 277, *l.c.* (1939) 213; Masamune *l.c.* 518; Anderson *l.c.* 134; Ashton *l.c.* 8; Whitmore, Tantra & Sutisna *l.c.* 11. **Type:** Omar 54, Sarawak, 1st Division, Gunung Sedilu Forest Reserve (holotype SING).

Small to medium-sized tree to 25 m tall, 30 cm diameter, with tall prominent thin flying buttresses. **Bark** smooth, greyish; inner bark yellow. **Sapwood** pale whitish to yellowish. **Leaves** ovate to elliptic, 5–15 x 3.5–6 cm, chartaceous or thinly coriaceous; *base typically asymmetric, rarely symmetric, pinnately veined*, apex long acuminate to acute; midrib flat

on the upper surface; lateral veins, 6–9 pairs, raised on the lower surface; stalk 5–12 mm long, slender. **Inflorescence** a short cyme, 1–2-times branched, 1–6-flowered, stalk 1–1.5 cm long. **Flowers** 4–5-merous; *calyx-tube* tomentose, c. 2 mm long, *limb with distinct triangular teeth*; petals 15–20 mm long, prominently dilated at base; stamens as many as petals, 14–17 mm long, *filaments broadened and thickly woolly hairy at base*; ovary 1-celled, *style thickly yellow hairy*, 11–13 mm long. **Fruit** ellipsoid-ovoid, finely hairy, 10.5–18 x 6–9 mm, flattened when dried, crowned by the persistent calyx-limb, ripening pink.

Vernacular names. Sarawak—*dadam* or *jadam paya* (Melanau), *jenangan* (Melanau, Bintulu), *sisit* (Malay).

Distribution. Sarawak, Brunei and Kalimantan, not yet recorded in Sabah.

Ecology. Frequent and locally common in mixed peat swamp forest at low altitude.

4. *Alangium javanicum* (Blume) Wangerin (of Java)

Fig. 1.

in Engl. & Prantl., Pfl. Fam. 4, 220b (1910) 14; Bloembergen *l.c.* (1935) 281, *l.c.* (1939) 218; Merrill *l.c.* (1921) 458, *l.c.* (1929) 232, *in syn.*; Masamune *l.c.* 518; Cockburn *l.c.* 16, *in syn.*; Kochurnmen *l.c.* 57, *in syn.*; Ashton *l.c.* 10; Anderson *l.c.* 133, *in syn.*; Whitmore, Tantra & Sutisna *l.c.* 12; Berhaman *l.c.* 33. **Basionym:** *Styrax javanicum* Blume, Bijdr. 13 (1825) 671. **Type:** Blume, *s.n.*, Java (holotype BO; isotype NY).

Medium-sized tree to 30 m tall and 35 cm diameter, often with flying buttresses. **Bark** smooth, yellowish to pale brown; inner bark yellowish to reddish. **Sapwood** yellowish. **Leaves** ovate-elliptic to obovate, (8–)15(–35) x (2.5–)5.5(–15.5) cm, chartaceous to coriaceous, lower surface glabrous to short-hairy on the midrib, or sometimes short velvety all over, drying pale olive-brown to purplish brown; base cuneate to rounded, *symmetric (rarely asymmetric), pinnately veined*, apex acute to acuminate; midrib flat to raised, rarely sunken on the upper surface; lateral veins 6–9(–19) pairs; stalk 0.5–3.8 cm long, slender, sometimes grooved on the upper surface and densely hairy. **Inflorescence** 1–3-times branched, with up to 35 flowers, stalk 2–8 mm long. **Flowers** (4–)6(–7)-merous, 2–2.5 cm long; *calyx-tube* campanulate, *limb subtruncate*, glabrous to densely covered by silky long hairs; corolla usually swollen at base, densely covered by long silky hairs or densely or sparsely stellate-hairy; petals 8.5–17 mm long, stamens as many as petals, *filaments uniformly thick throughout, subglabrous to sparsely short-hairy at base*; ovary 1-celled, *style 4–10 mm long, sparsely white-hairy*. **Fruit** ellipsoid-ovoid, variable in size, smooth to strongly ridged, crowned by the persistent calyx, 1–5 mm high and 2–10 mm wide.

Vernacular names. Sabah—*satu inchi* (colloquial Malay). Sarawak—*jadam* (Malay).

Key to varieties

1. Corolla densely covered by silky long hairs (velutinous). Lower side of leaf short-hairy on midrib only.....

var. javanicum

Synonyms: *A. bogoriense* Wangerin, Fedde. Repert. 4 (1907) 338; *A. borneense* Merr., J. Str. Br. R. As. Soc. 86 (1922) 10; *A. javanicum* "form B" of Ashton *l.c.* 11; *A. ebenaceum* "var. C" of Cockburn *l.c.* 18.

Sumatra, Java and Borneo. Common in all districts in Sabah and Sarawak. Primary mixed dipterocarp and secondary forest.

Corolla sparsely to densely covered with stellate hairs, not long-hairy. Lower side of leaf glabrous, or sometimes short-velvety all over.....2

2. Leaves drying pale olive-brown, typically smaller, 8–12 cm long, but exceptionally reaching 27 cm long. Calyx-limb of mature fruit smaller, 1–2 mm high and 2–5 mm wide.....

var. meyeri (Merr.) Berhaman

l.c. 34. Basionym: *A. meyeri* Merr., Publ. Govern. Labor. 35 (1906) 54. Type: *Meyer F.B.* 2284, Philippines, Luzon, Cagayan Province (lectotype BO; isolectotypes B, K, NY, S). Synonyms: *A. tutela* Ridl., J. Str. Br. R. As. Soc. 61 (1912) 10; *A. ebenaceum* var. *tutela* (Ridl.) Kochummen, Fed. Mus. J. 13 (1970) 133; *A. javanicum* "form C" (*pro parte*) & "form D" of Ashton *l.c.* 11; *A. ebenaceum* "var. B" (*pro parte*), "var. D", "var. E", and "var. G" of Cockburn *l.c.* 18 (*pro parte*).

Peninsular Malaysia, Java, Borneo, and the Philippines. Very common in all districts in Sabah and Sarawak, in primary and secondary mixed dipterocarp forest.

Leaves drying purplish brown, (at least markedly so on the lower side), typically longer or larger (24–39 cm long). Calyx-limb of mature fruit larger, 2–5 mm high and 3–10 mm wide.....

var. ebenaceum (Clarke) Berhaman

l.c. 33. Basionym: *Marlea ebenacea* Clarke in Hooker *f.*, Fl. Brit. Ind. 2 (1879) 742. Type: *Griffith 3383*, Malacca (lectotype K). Synonyms: *A. ebenaceum* (Clarke) Harms in Engl. & Prantl *l.c.* (1898) 262; *A. ridleyi sensu* Ashton *l.c.* 14, non King (1902); *A. mezianum* Wangerin, *l.c.* 338; *A. sessiliflorum* Merr. *l.c.* (1929) 232; *A. javanicum* "form C" of Ashton, *l.c.* 11 (*pro parte*); *A. ebenaceum* "var. B" (*pro parte*) and "var. G" of Cockburn *l.c.* 18 (*pro parte*).

Peninsular Malaysia, Java, Borneo, and the Philippines. Common in all districts in Sabah and Sarawak. All these forms appear to be confined to clay-rich soils in mixed dipterocarp and associated secondary forest.

5. Alangium kurzii Craib

(W.S. Kurz, 1834–1878, German soldier and naturalist, Bogor and Calcutta)

Kew Bull. (1911) 60; Bloembergen *l.c.* (1935) 262, *l.c.* (1939) 183; Kochummen *l.c.* 58; Berhaman *l.c.* 31. **Type:** *Kerr 1172*, Thailand, Chiangmai, Doi Sutep (holotype K). **Synonyms:** *Alangium chinensis* var. *tomentosum* Merr., Philip. J. Sci., 21, 5 (1922) 505; *Alangium begoniæifolium* Ridl., FMP 1 (1922) 894.

Small tree to 15 m tall, 20 cm diameter, with short buttresses. **Bark** smooth, dark grey, lenticellate; inner bark orange and cream mottled. **Sapwood** soft, pale brown. **Leaves** thin coriaceous to chartaceous, lower surface velvety (*seldom sparsely*) hairy, ovate to broadly ovate, 8–20 x 5–10.5 cm; base markedly asymmetric, broadly rounded to cordate, 3–5-veined, apex acuminate-acute; midrib and major veins on upper surface densely hairy;

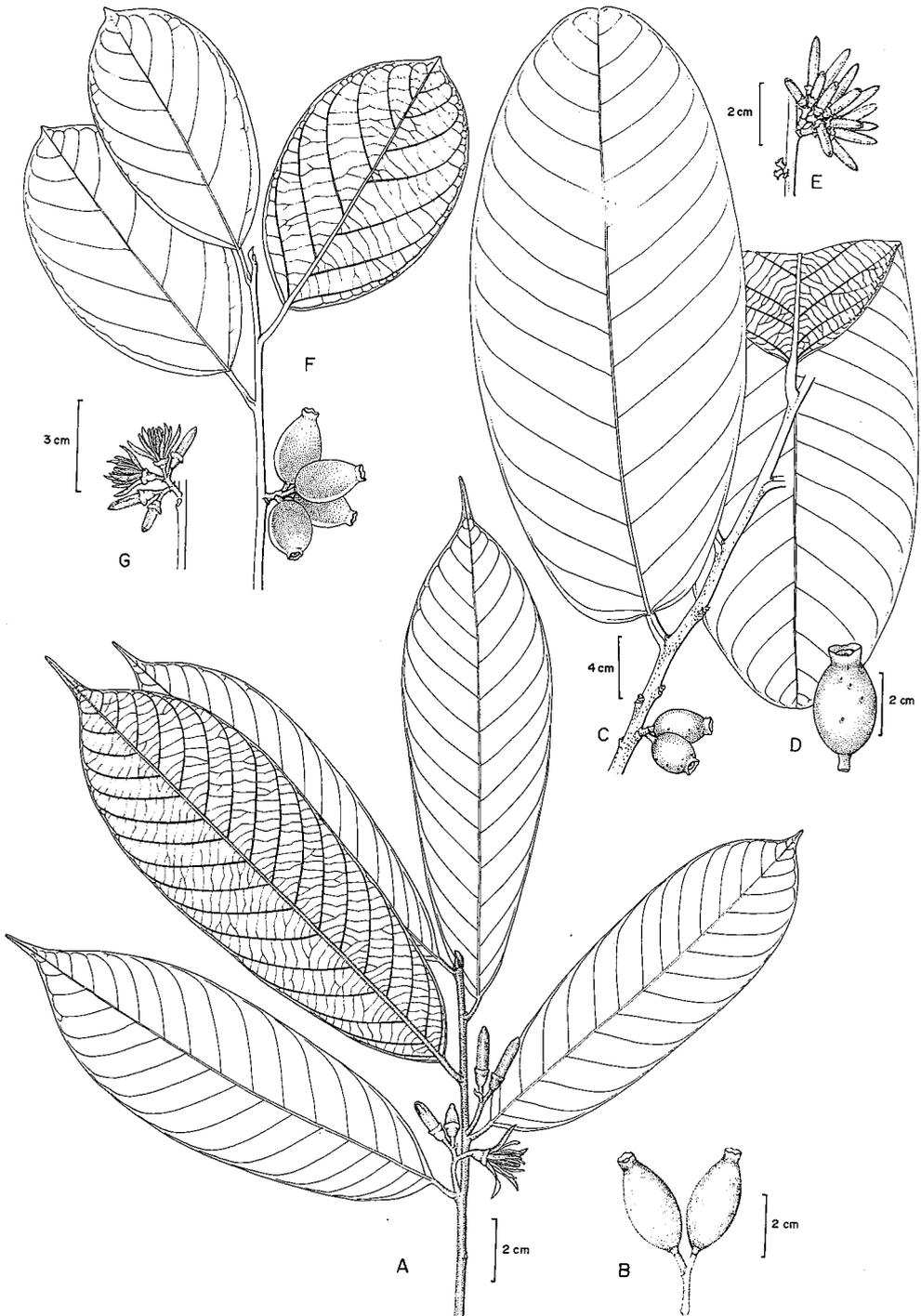


Fig. 1. *Alangium javanicum*. A–B, var. *javanicum*; C–E, var. *ebenaceum*; F–G, var. *meyeri*. A, flowering leafy twig; B & D, fruits; C & F, fruiting leafy twigs; E & G, inflorescences. (A from SAN 110170, B from SAN 39285, C & D from S. 34940, E from SAN 26087, F from SAN 82215, G from SAN 75771.)

lateral veins 5–7 pairs; stalk 2.5–3 cm long, glabrous to sparsely hairy. Inflorescence hairy, 2–4-times branched with 3–15 flowers per branch, stalk 11–15 mm long. Flowers pale greenish to yellow creamy; calyx-tube densely hairy, 1.25–2.5 mm long, teeth hairy, 0.25–0.5 mm long; petals (5–)9(–10), 5.5–10 mm long, swollen at base for 2–3 mm, covered by straight hairs; stamens as many as petals, 5–10 mm long, densely covered with long straight hairs; ovary (1–)2-celled, style glabrous, 5–8 mm long. Fruit ellipsoid 1–1.5 x 0.5–0.7 cm, crowned with the persistent calyx-limb.

Vernacular name. Sabah—*marapangi* (Dusun Tambunan).

Distribution. Myanmar (Burma), China, Indo-China, Thailand, Sumatra, Peninsular Malaysia, Java, and Borneo. In Sabah, recorded only from Kota Marudu (*SAN 99531*), Ranau (*SAN 62010*) and Tambunan (*SAN 11355*). Not recorded for Sarawak.

Ecology. Lowland to submontane forest to 1300 m. Flowering from January to July; fruiting from May to August.

6. *Alangium longiflorum* Merr.

(Latin, *longus* = long, *florum* = flowers)

Philip. J. Sci. Bot. 7 (1912) 319; Bloembergen *l.c.* (1935) 253, *l.c.* (1939) 159; Cockburn *l.c.* 16; Anderson *l.c.* 134; Ashton *l.c.* 11; Whitmore, Tantra & Sutisna *l.c.* 12; Berhaman *l.c.* 32. **Type:** *Darling FB 14773*, Philippines, Malueg, Cagayan Province (holotype L; isotype BO). **Synonyms:** *Alangium salvifolium* subsp. *hexapetalum sensu* Merr. *l.c.* (1912) 321; *A. lamarckii* Thwaites, Enum. Pl. Zeyl. (1850) 133; *A. hirsutum* Bloemb. *l.c.* (1939) 161.

Medium-sized tree to 20 m tall and 25 cm diameter. **Bark** smooth, dark brown; inner bark yellowish. **Sapwood** white. **Leaves** markedly obovate with narrowed base and 4–7 pairs of lateral veins or if elliptic and base rounded then with 6–7 pairs of lateral veins, velvety hairy on lower surface, 8–12 x 2.5–8 cm, chartaceous; base 3-veined, apex long-acuminate; midrib raised and sparsely hairy on the upper surface; stalk slender, hairy, 8–13 mm long. **Inflorescence** a short cyme with 1–5 flowers, densely hairy, almost sessile or with stalk to 1.5 mm long. **Flowers** white, 30–50 mm long; calyx-tube campanulate, densely hairy, teeth 0.25–0.5 mm long, limb 1–1.5 mm long; petals 5, white, 35–50 mm long, densely hairy outside, swollen at the base; stamens 30–50 mm long, 2–6-times as many as petals; ovary 1-celled, style glabrous, 30–45 mm long. **Fruit** ellipsoid to ovoid in dry state, rounded at both ends, 20–25 cm long, crowned by the persistent calyx-limb, ripening pinkish.

Distribution. Borneo and Philippines. Very uncommon in Sabah (e.g., *SAN 30390*, *SAN 83891*) and Sarawak (e.g., *S. 21704*, *S. 43342*), also known in Kalimantan.

Ecology. Primary mixed dipterocarp and associated secondary forests to 1200 m, on high nutrient clay soils. Flowering in March to July; fruiting in August to December.

One specimen, *SAN 14167* (Sabah, Ranau) bears spines, but the leaf characters are very close to that for *A. longiflorum*.

7. *Alangium nobile* (Clarke) Harms

(Latin, *nobilis* = distinguished, noble, probably referring to the growth habit)

in Engl. & Prantl *l.c.* (1898) 262; Bloembergen *l.c.* (1935) 275, *l.c.* (1939) 211; Masamune *l.c.* 518; Kochummen *l.c.* 58; Anderson *l.c.* 134; Ashton *l.c.* 12; Whitmore, Tantra & Sutisna *l.c.* 12; Berhaman *l.c.* 32. **Basionym:** *Marlea nobilis* Clarke in Hooker *f. l.c.* 743; Ridley, Agr. Bull. Str. Settl. & Fed. Mal. St. 1 (1902) 181. **Type:** *Griffith 3385*, Malacca (lectotype K; isolectotypes B, BM).

Medium-sized tree to 20 m tall, 30 cm diameter. **Bark** smooth, brown; inner bark thin, yellow to pale brownish. **Sapwood** medium-hard, whitish. **Leaves** rounded to broadly obovate, 9–23 x 5–18 cm, chartaceous to coriaceous, upper surface hairy to glabrous, lower surface hairy to densely hairy; base rounded to cordate, 5-veined, apex rounded to acute, rarely acute to acuminate; midrib flattened to raised on the upper surface, densely hairy on the lower surface; lateral veins 9–12 pairs, raised and hairy below, flattened on the upper surface; stalk densely hairy, 2.5–4.5 cm long and 3–5 mm thick. **Inflorescence** a short cyme, stalk 5–7 mm long, 1–2-branched with 1–5 flowers. **Flowers** 4–5-merous, almost sessile; calyx-tube campanulate, hairy, lobes 5–7; petals swollen at base, 10–15 mm long, densely hairy outside; stamens as many as petals, 9–14 mm long, with filaments broadened at base; ovary 1-celled, style hairy, 7–12 mm long. **Fruit** ellipsoid-ovoid, 25–30 x 15–20 mm, grooved, velvety hairy, crowned by the persistent calyx-lobes.

Distribution. Sumatra, Peninsular Malaysia and Borneo. In Sabah and Sarawak, uncommon in mixed dipterocarp forest (e.g., *SAN 73205* and *S. 38479*).

Ecology. Lowland to submontane forest to 1500 m.

8. *Alangium rotundifolium* (Hassk.) Bloemb.

(Latin, *rotundus* = rounded in outline, *folium* = leaves)

l.c. (1935) 258, *l.c.* (1939) 179; Masamune *l.c.* 518; Kochummen *l.c.* 60; Cockburn *l.c.* 16; Whitmore, Tantra & Sutisna *l.c.* 12; Berhaman *l.c.* 38. **Basionym:** *Diacaeacarpium rotundifolium* Hassk., Bonplandia 7 (1859) 172. **Type:** *Sine coll., s.n.*, Java, probably from Tjibodas, Cult. Bogor Botanic Garden (holotype BO; isotype L). **Synonyms:** *Marlea rotundifolia* (Hassk.) Teijsm. & Binn., Cat. Pl. Hort. Bot. Bogor. (1866) 238; *Alangium begoniifolium* Harms in Engl. & Prantl *l.c.* (1898) 261; *Marlea begoniifolia* (Harms) Ridl., J. Fed. Malay. St. Mus., 8, 4 (1917) 44; *Alangium rotundatum* Ridl. ex Burkill & Henders., Gard. Bull. Str. Settl. 3 (1925) 380.

Tree to 28 m tall, 40 cm diameter. **Bark** smooth to slightly scaly, white to pale grey; inner bark yellowish. **Sapwood** white to pale yellow. Twig dark brown to pale brown. **Leaves** glabrous to sparsely hairy on the lower surface, never velvety, rounded to broadly ovate or triangular-ovate, 9.5–22 x 7.5–14 cm, chartaceous; base rounded to cordate, sometimes cuneate, 3–5-veined, apex acuminate to acute; midrib and lateral veins on upper surface glabrous; lateral veins 5–7 pairs; stalk 2.5–3.5 cm long, glabrous to sparsely hairy. **Inflorescence** a cyme, 3–4-times branched with 4–15 flowers, covered by short hairs, stalk 12–20 mm long. **Flowers** fragrant, white or cream to yellow; calyx-tube sparsely hairy, 1.5–3 mm long, limb flared with teeth 1–1.5 mm long; corolla swollen at the base; petals

white or cream, 6–14(–18) mm long; stamens as many as petals, 6–18 mm long; ovary usually 1-celled, rarely 2-celled, style glabrous, 5–15 mm long. **Fruit** glabrous or thinly hairy, ovate-ellipsoid, cuneate or rounded at base, crowned by the flared persistent calyx-limb 1–1.5 mm long, reddish when ripe.

Vernacular name. Sabah—*marapangi* (Dusun Ranau).

Distribution. Sumatra, Peninsular Malaysia, Java, and Borneo. In Sabah only recorded from Mt. Kinabalu (e.g., *SAN 46772*, *SAN 48064*) and Crocker Ranges (*SAN 83987*). Not recorded for Sarawak.

Ecology. Primary and secondary forest on ultramafic soils, at 400–1600 m.

Excluded species

A. kinabaluense W.W. Sm., Not. Bot. Gard. Edinb. 8 (1915) 315; Merrill *l.c.* (1921) 459, is based on a specimen collected from Mt. Kinabalu, *Native Coll.* 49 (E, K), which is *Polyosma hookeri* Stapf.

ANISOPHYLLEACEAE

K.M. Wong & L. Madani

Forest Research Centre,
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Sandakan, Malaysia

Merrill, EB (1921) 420 (as part of Rhizophoraceae); Ridley, FMP 1 (1922) 692 (as Anisophylleae at family rank); Masamune, EPB (1942) 515 (as part of Rhizophoraceae); Ding Hou, FM 1, 5 (1958) 429 (as part of Rhizophoraceae); Burgess, TBS (1966) 431 (as part of Rhizophoraceae); Corner, WSTM 1 (1988) 131 (as Anisophylleaceae); Ashton, MNDTS 2 (1988) 342 (as part of Rhizophoraceae); Juncosa & Tomlinson, Ann. Missouri Bot. Gard. 75 (1988) 1278 (as Anisophylleaceae); Kochummen, TFM 4 (1989) 302 (as part of Rhizophoraceae); Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 295 (as part of Rhizophoraceae).

Trees or shrubs, very rarely (in *Combretocarpus*) with small stilt-roots or pneumatophore ("breathing") roots. **Bark** invaginating finely and regularly into wood in most species. Branches highly differentiated architecturally from the trunk, twigs solid, branch nodes not swollen; supernumerary axillary buds present (in *Anisophyllea*) or not. **Leaves** alternate (2-ranked in *Combretocarpus*, basically 4-ranked in *Anisophyllea*), simple, often (in *Anisophyllea*) dimorphic, 3–7-veined from the base or (in *Combretocarpus*) pinnately veined; *stipules* none. **Inflorescence** fundamentally paniculate or racemose, axillary, multiflorous, bisexual or (rarely) unisexual. **Flower** unisexual (*Anisophyllea*, but plants monoecious) or bisexual (*Combretocarpus*), radially symmetrical, 3–5-merous; calyx valvate; *petals* free, lobed or lacinate, rarely entire; *stamens* free or (in *Anisophyllea*) epipetalous and episepalous, 2-times the number of petals, anthers 4-celled, dorsifixed, splitting lengthwise; *ovary* inferior, 3–5-locular, ovules 1–2 per carpel, *style* single or (mostly) several and free; *disc* annular, lobed. **Fruit** a drupe or (in *Combretocarpus*) a dry, 3-winged structure. **Seed** one; without *endosperm*; embryo a solid structure with reduced or no cotyledons; germination hypogeal.

Distribution. 4 genera and c. 35 species, tropical Africa to S America and Malesia. In Sabah and Sarawak, 2 genera, *Anisophyllea* and *Combretocarpus*, with 10 species.

Ecology. *Combretocarpus* is found mainly in peat-swamp forest, and *Anisophyllea* species occur mainly in primary moist lowland forest and sometimes in secondary lowland forest.

Uses. Several *Anisophyllea* species and *Combretocarpus* grow to timber size and are exploited for logs.

Taxonomy. The members of the Anisophylleaceae have traditionally been treated as part of the Rhizophoraceae. Ridley (*l.c.*) appears to have been the first to consider the group (only *Anisophyllea* as was known then for Malaya) at family rank, equivalent to Bentham & Hooker's designation of the tribe Anisophylleae within the Rhizophoraceae in 1865 (in

their *Genera Plantarum* 1, 2). Although Melchior (1964) (*Engler's Syllabus der Pflanzenfamilien*, 12th Edition, Vol. 2) and Cronquist (1981) (*An Integrated System of Classification of Flowering Plants*) both adopted the Anisophylleaceae, this has not been widely adopted until multidisciplinary studies demonstrated the distinctness of the Anisophylleaceae as a family (Juncosa & Tomlinson *l.c.* and Dahlgren, *Ann. Missouri Bot. Gard.* 75 (1988) 1259). Basically, the Anisophylleaceae is distinct from the Rhizophoraceae by the following characteristics: alternate leaves, absence of stipules, simple (not scalariform) vessel perforation, mostly paniculate or racemose (not cymose) inflorescences, inferior ovary with separate styles (the Rhizophoraceae have a superior to inferior ovary and a single style), relatively thin pollen wall tapetum, lack of subepidermal floral laticifers (in the ovary and calyx), and lack of endosperm in the seed.

Key to genera

Leaves basically 4-ranked on lateral branches (although in many species the reduced leaves of the two upper ranks are hard to notice or fall away early), with 3–7 veins from the leaf base. Leaf axils each with several axillary buds in a row. Fruit a drupe.....**1. Anisophyllea**

Leaves 2-ranked on lateral branches, pinnately veined. Leaf axils each with only one distinct axillary bud. Fruit a 3-winged structure.....**2. Combretocarpus**

1. ANISOPHYLLEA R. Br. ex Sabine

(Greek, *anisos* = unequal, *phullon* = leaf; the dimorphic leaves)

menengang (Murut, Sarawak), *mertama* (Iban, Sarawak),
mopu (Bidayuh, Sarawak), *sireh sireh* (Malay, Sabah)

Trans. Hort. Soc. 5 (1824) 466; Merrill *l.c.* 422; Ridley *l.c.* 701; Masamune *l.c.* 515; Ding Hou *l.c.* 474; Corner *l.c.* 131; Anderson, CLTS (1980) 290; Ashton *l.c.* 344; Kochummen *l.c.* 304; Whitmore, Tantra & Sutisna *l.c.* 295; Madani, Sandakania 3 (1993) 49. **Synonyms:** *Anisophyllum* G. Don ex Hook., *Niger Fl.* (1849) 342, 575; *Tetracrypta* Gardn. & Champ. in Hooker, *J. Bot. Kew Misc.* 1 (1849) 314.

Trees and shrubs, trunk not buttressed but sometimes fluted at base. **Bark** smooth or minutely cracked or flaky; inner bark invaginating finely and regularly into the wood. **Sapwood** pale to reddish brown, with conspicuous pale radiating lines. *Branches developing on the young stem in widely separated tiers; axillary buds several in a series in each leaf axil.* **Leaves** basically 4-ranked, often dimorphic (but reduced leaves of the two upper ranks hard to notice or fall away early in most species), 3–7-veined from the base. **Flower** unisexual (but plants monoecious), 3–5-merous; petals entire, lobed or lacinate; *stamens epipetalous and episepalous*, usually unequal in length; ovary 3–5-celled, ovule 1 per cell, *styles* 3–4, free. **Fruit** a drupe, ellipsoid or pear-shaped, smooth or ridged, fruit-wall usually hard and fibrous (fleshy in *A. disticha*). **Seed** solitary, globose to ellipsoid.

Distribution. *c.* 30 species, tropical Africa, Sri Lanka, India, South East Asia, and West Malesia (Sumatra, Peninsular Malaysia and Borneo). 9 species in Sabah and Sarawak.

Ecology. Primary or old secondary lowland and hill forests to *c.* 1000 m.

Key to *Anisophyllea* species

1. Leaves along branches of two markedly different sizes, arranged in four rows, the larger ones on the two lower rows trapezoid.....2
 Leaves of only one type easily discernible, basically elliptic or ovate, arranged in two rows (reduced leaves scantily developed and falling early, and usually not noticed).....3
2. Larger leaves not longer than 3–3.5 cm. Fruiting racemes 0.5–2.7 cm long, typically bearing a solitary fruit.....4. **A. disticha**
 Larger leaves typically 5–10 cm long. Fruiting racemes 4–10 cm long, typically bearing several fruits.....9. **A. rhomboidea**
3. Lateral veins all arising from the very base of the leaf-blade.....4
 One or both pairs of lateral veins arising from the midrib away from the base of the blade.....6
4. Intercostal veins on the lower leaf surface conspicuously raised, forming a fine tessellated pattern.....3. **A. corneri**
 Intercostal veins on the lower leaf surface not conspicuously raised, forming a loose reticulation and not distinctly tessellated.....5
5. Leaves coriaceous, broadly ovate, upper surface drying glossy, the lateral veins raised. Inflorescence axes persistently densely covered with velvety purple-brown hairs.....8. **A. nitida**
 Leaves chartaceous, elliptic, upper surface drying dull or matt, the lateral veins sunken or flat. Inflorescence axes subglabrous or only minutely pale-brown hairy.....2. **A. chartacea**
6. Leaves rusty hairy on lower surface, the remains of the hairs always visible with 10X magnification, even on old leaves; intercostal veins on lower surface finely tessellate5. **A. ferruginea**
 Leaves glabrous, intercostal veins on lower surface indistinct or forming only a loose network.....7
7. All veins, including the intercostal veins, on upper leaf surface sunken. Mature fruit globose.....7. **A. impressinervia**
 Veins flat or raised on upper leaf surface. Mature fruit ellipsoid or globose.....8
8. Leaves thinly coriaceous; apex rather abruptly caudate; midrib conspicuously thicker than lateral veins. Mature fruit ellipsoid.....1. **A. beccariana**
 Leaves chartaceous; apex acute; midrib similar to lateral veins in thickness. Mature fruit globose.....6. **A. globosa**

1. *Anisophyllea beccariana* Baill.

(Odoardo Beccari, Italian explorer and botanist, 1843-1920)

Adansonia 11 (1875) 311; Merrill *l.c.* 422; Masamune *l.c.* 515; Ding Hou *l.c.* 474; Ashton *l.c.* 345; Whitmore, Tantra & Sutisna *l.c.* 295. **Type:** *Beccari PB 1001*, Sarawak (lectotype K, here chosen; isolectotypes G, P).

Small to medium-sized tree to 25 m tall. **Bark** scrolled to scaly; inner bark brownish. **Sapwood** yellowish. **Leaves** of one form mainly, in two distinct ranks along the branches, elliptic or ovate, 7.5–10.5 x 3–5 cm, *thinly coriaceous*, drying matt or slightly glossy on upper surface, lower side with scattered tiny but conspicuous dot-glands; base cuneate, *apex abruptly caudate*; *midrib conspicuously thicker than lateral veins*, flat to slightly depressed on the upper side; *lateral veins* (one or both pairs) arising from the midrib away from the base of the blade, *flat or elevated on upper side*, elevated on lower side; *intercostal veins forming only a loose network* or somewhat obscure; glabrous; stalk 4–8 mm long. **Inflorescence** a raceme or basally branched panicle to 10 cm long, axes minutely pale-brown pubescent. **Flowers** unisexual; calyx pubescent outside, lobes 4; petals 0.6–0.7 mm long; stamens in male 0.5–0.7 mm long, replaced by staminodes (stamen rudiments) in the female; pistil in female 0.5–0.7 mm long, with 4 styles, replaced by pistillode (pistil rudiments) in the male. **Fruit** ellipsoid, *c.* 3 x 2.5 cm, smooth on the surface when dry.

Vernacular name. Sarawak—*pei* (Kayan).

Distribution. CE Sumatra and Borneo. In Sabah, recorded from Lahad Datu and Sandakan districts; in Sarawak from the Kuching and Bintulu districts. Also in Brunei and Kalimantan.

Ecology. Mixed dipterocarp forest on leached, often shallow humult soils, and *kerangas* (heath) forest in the lowlands, to *c.* 570 m.

2. *Anisophyllea chartacea* Madani

(Latin, *chartaceus* = papery; the leaves)

Sandakania 3 (1993) 51. **Type:** *Othman S. 29055*, Sarawak, 3rd Division, Kapit, Ulu Balleh, Ng. Mengiong (holotype KEP; isotypes A, BO, K, L, MEL, SAR, SING).

Medium-sized tree to 33 m tall, 80 cm diameter. **Leaves** of one form mainly, in two distinct ranks along the branches, elliptic, 5.5–7 x 2.5–3.5 cm, chartaceous, drying matt on upper surface, *lower side without conspicuous dot-glands*; base cuneate, apex acuminate; *midrib* not conspicuously thicker than lateral veins, *sunken on upper side*; *lateral veins* arising from the very base of the leaf-blade, *sunken on upper side*, elevated on lower side; *intercostal veins forming only a loose network*; glabrous; stalk 5–7 mm long. **Inflorescence** a raceme 1.5–5 cm long, axis minutely pale-brown pubescent. **Flowers** unisexual; calyx pubescent outside, lobes 4; petals 0.6–0.7 mm long; stamens in male 0.5–0.7 mm long; female unknown. **Fruit** unknown.

Distribution. Known only from the type collection from Ulu Balleh in the Kapit district in Sarawak.

Ecology. Lowland mixed dipterocarp forest.

3. *Anisophyllea corneri* Ding Hou

(E.J.H. Corner, 20th Century eminent tropical botanist)

l.c. 47B; Corner *l.c.* 132; Ashton *l.c.* 347; Kochummen *l.c.* 305; Whitmore, Tantra & Sutisna *l.c.* 295.
Type: *Corner SFN 25927*, Malay Peninsula, Trengganu (holotype SING; isotypes BO, KEP).

Small to medium-sized tree to 30 m tall, 55 cm diameter. **Bark** smooth; inner bark dark brown. **Sapwood** reddish brown. **Leaves** of one form mainly, in two distinct ranks along the branches, elliptic or oblong, 7.5–13.5 x 2.5–5.5 cm, thinly coriaceous, drying matt on upper surface, lower side without conspicuous dot-glands; base cuneate, apex acute; midrib conspicuously thicker than lateral veins, raised on the upper side; *lateral veins arising from the very base of the leaf-blade*, elevated on both sides; *intercostal veins forming a dense and tessellated network of raised fine veins*; glabrous; stalk 5–10 mm long. **Inflorescence** a raceme-like panicle with reduced side-branches, 4–9 cm long, axes minutely pale-brown pubescent. **Flowers** unisexual; calyx pubescent outside, lobes 4–5; petals 0.1–0.2 mm long; stamens in male 0.3–0.5 mm long, replaced by staminodes in the female; pistil in female 0.5 mm long, with 4 styles, replaced by pistil rudiments in the male. **Fruit** broadly ellipsoid, 6–13.5 x 4–6 cm, smooth on the surface when dry.

Vernacular names. Sarawak—*mertama* (Iban), *sireh sireh* (Malay).

Distribution. Peninsular Malaysia, Borneo. In Sabah and Sarawak in all districts. Also in Brunei and Kalimantan.

Ecology. Locally common in mixed dipterocarp forest in the lowlands on leached yellow humult soils, and to submontane forest at 1200 m.

4. *Anisophyllea disticha* (Jack) Baill.

(Latin, *distichus* = 2-ranked; the leaf arrangement on branches)

l.c. (1875) 311; Merrill *l.c.* 422; Masamune *l.c.* 515; Ding Hou *l.c.* 479 (excl. *A. rhomboidea* in syn.); Corner *l.c.* 132; Ashton *l.c.* 347 (excl. *A. rhomboidea* in syn.); Kochummen *l.c.* 307; Whitmore, Tantra & Sutisna *l.c.* 295. **Basionym:** *Haloragis disticha* Jack, Mal. Misc. 2 (1822) 19.
Type: *Jack, s.n.*, Sumatra (lectotype L, here chosen; isolectotype FI). **Synonyms:** *Anisophyllum trapezoidale* Baill., *Adansonia* 3 (1862) 24, 36.

Shrub or small tree to 7 m tall, 5 cm diameter. **Bark** smooth; inner bark dark brown. **Sapwood** pale brown. **Leaves** of two forms, in four distinct ranks along the branches, those of the lower 2 ranks oblong-rhomboid, those of the upper 2 ranks tiny and subulate to falcate, *the larger leaf form 1.5–3.5 x 0.5–1.5 cm*, the smaller leaf form 0.5–0.7 x 0.1–0.3 cm, chartaceous to thinly coriaceous, drying matt on upper surface, lower side without conspicuous dot-glands; base cuneate, apex acute; midrib slightly thicker than lateral veins, flat on the upper side; lateral veins one pair arising from the very base of the leaf-blade and a third (unpaired) lateral vein arising from the midrib away from the base of the leaf-blade

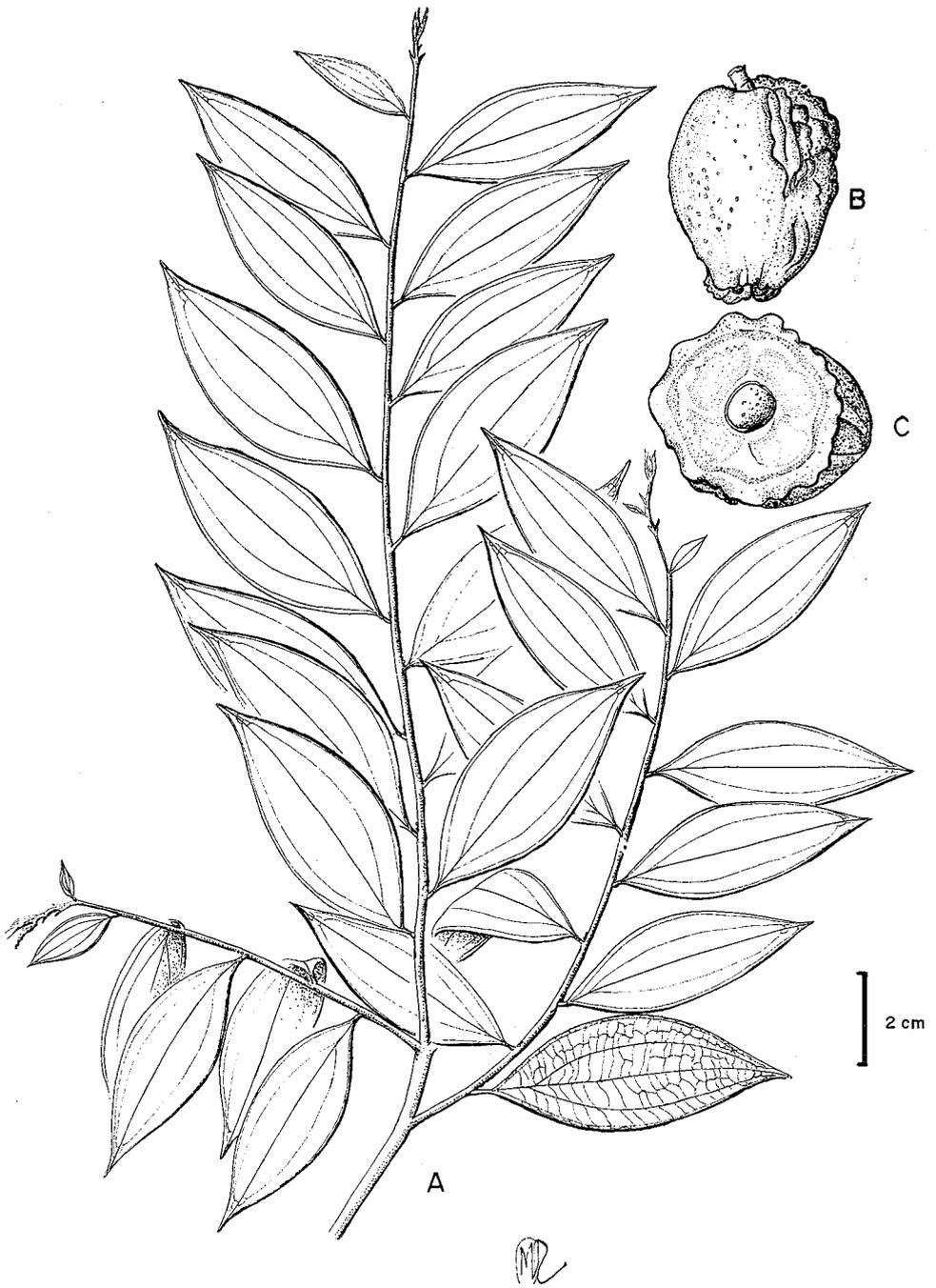


Fig. 1. *Anisophyllea globosa*. A, leafy twig; B, fruit; C, fruit, cut transversely. (From SAN 76131.)

on the acroscopic side of the midrib, flat on upper side, elevated on lower side; intercostal veins scalariform or forming a dense and tessellated network of flat to slightly raised pale fine veins; glabrous; stalk none or very short, 0–1 mm long. **Inflorescence** a raceme, 0.5–2.7 cm long, in the axils of the large leaves, axes pale-brown fine-hairy. **Flowers** unisexual; calyx pubescent outside, lobes (3–)4(–5); petals 1.2–1.3 mm long; stamens in male 0.3–0.5 mm long, replaced by staminodes in the female; pistil in female 0.5–0.8 mm long, with 1 style, replaced by pistil rudiments in the male. **Fruit** usually one per raceme, ellipsoid, 1.5–2.5 x 0.5–1 cm, ripening bright red, smooth on the surface when dry.

Vernacular names. Sarawak—*ambun ambun* (Kedayan), *kayu runap* (Punan Tutoh), *mertama* (Iban).

Distribution. Sumatra, Peninsular Malaysia, Borneo. In Sabah and Sarawak in all districts. Also in Brunei and Kalimantan.

Ecology. Understorey of mixed dipterocarp forest and old secondary forest, lowlands to ridges to 1000 m, recorded on alluvial, sandstone, granite and ultramafic soils.

5. *Anisophyllea ferruginea* Ding Hou

(Latin, *ferrugineus* = red-brown; the hairs on the leaves)

l.c. 477; Ashton *l.c.* 349; Whitmore, Tantra & Sutisna *l.c.* 295. **Type:** *bb.* 25118, E Borneo (holotype BO; isotype L).

Medium-sized tree to 30 m tall, 40 cm diameter. **Bark** smooth to cracking or slightly fissured; inner bark dark brown. **Sapwood** pale brown. **Leaves** of one form mainly, in two distinct ranks along the branches, ovate to elliptic, 12–16 x 4–6 cm, coriaceous, drying matt on upper surface, lower side without conspicuous dot-glands; base cuneate to rounded, apex acute to shortly cuspidate; midrib slightly thicker than lateral veins, raised on the upper side; *lateral veins (one or both pairs) arising from the midrib away from the base of the leaf-blade*, elevated on both sides; *intercostal veins forming a dense and tessellated network of raised fine veins*; glabrous on upper side, *rusty hairy on lower side* (the remains of the hairs always visible even on old leaves under 10X magnification); stalk 10–17 mm long. **Inflorescence** a panicle, 4–9 cm long, axes minutely pale brown pubescent. **Flowers** unisexual; calyx pubescent outside, lobes (3–)4(–5); petals 0.1–0.2 mm long; stamens in male *c.* 0.3 mm long, replaced by staminodes in the female; pistil in female 0.5 mm long, with 4 styles, replaced by pistil rudiments in the male. **Fruit** ellipsoid, to 8 x 5.5 cm, smooth on the surface when dry.

Vernacular names. Sarawak—*belian landak*, *dajak*, *kepajang*, *kepajang landak*, *sangkuak*, *tengoda* (Malay).

Distribution. W and SE Borneo. In Sarawak recorded from the Semengoh (Kuching) and Balingian, Bintulu (Nyabau FR) and Miri (Lambir NP) areas. Not recorded for Sabah. Also in Brunei and Kalimantan.

Ecology. A characteristic species of deep sandy humult ultisol soils in mixed dipterocarp forest to 600 m; uncommon but locally frequent.

6. **Anisophyllea globosa** Madani
(Latin, *globosus* = round; the fruits)

Fig. 1.

l.c. 53. **Type:** *Shea & Minjulu SAN 76131*, Sabah, Kudat, Bengkoka Peninsula (holotype SAN; isotypes K, L).

Small tree to 10 m tall, 10 cm diameter. **Bark** smooth; inner bark red-brown. **Sapwood** white. **Leaves** of one form mainly, in two distinct ranks along the branches, narrowly elliptic, 5–7 x 1.5–2.5 cm, *chartaceous*, drying matt on upper surface, lower side with scattered tiny but conspicuous dot-glands; base cuneate, *apex acute to acuminate*; *midrib similar to lateral veins in thickness*, flat or slightly sunken on the upper side; *lateral veins* (one or both pairs) arising from the midrib away from the base of the leaf-blade, *flat on the upper side*, elevated on the lower side; *intercostal veins forming a loose network* of fine veins; *glabrous*; stalk 4–7 mm long. Inflorescence and flower not known. **Fruit** globose, 5–5.5 cm across, irregularly rough-lumpy on the surface when dry.

Distribution. Probably endemic to Sabah, known only from the type collection from Bengkoka in Kudat district.

Ecology. Open secondary vegetation at edge of steep gully, lowlands at 50 m.

7. **Anisophyllea impressinervia** Madani

(Latin, *impressus* = sunken, *nervus* = veins; the impressed leaf veins)

l.c. 53. **Type:** *Shea & Minjulu SAN 76094*, Sabah, Kudat, Bengkoka Peninsula (holotype SAN; isotypes A, K, L, SAR, SING).

Medium-sized tree to 26 m tall, 30 cm diameter. **Bark** irregularly rough-cracking, finely flaky at the base; inner bark red grading to yellow-orange. **Sapwood** pale yellow. **Leaves** of one form mainly, in two distinct ranks along the branches, elliptic or ovate, 4–4.5 x 2–3 cm, *chartaceous to thinly coriaceous*, drying matt on upper surface, lower side with scattered tiny but conspicuous dot-glands; base cuneate to rounded, *apex acute*; *midrib similar to lateral veins in thickness*, *sunken on the upper side*; *lateral veins (one or both pairs) arising from the midrib away from the base of the leaf-blade*, *sunken on the upper side*, elevated on the lower side; *intercostal veins forming a loose network* of fine veins; *glabrous*; stalk 3–6 mm long. Inflorescence and flower not known. **Fruit** globose, *c.* 4.5–5 cm across, irregularly rough-lumpy on the surface when dry.

Distribution. Possibly endemic to Sabah, known only from the type collection from Bengkoka in Kudat district.

Ecology. Secondary forest, lowlands at *c.* 30 m.

8. *Anisophyllea nitida* Madani

(Latin, *nitidus* = polished; the shiny dry upper leaf surface)

l.c. 53. **Type:** *Ampuria SAN 40249*, Sabah, Kuala Penyu (holotype SAN).

Medium-sized tree to 23 m tall, 25 cm diameter. **Bark** smooth to scaly. **Sapwood** brownish. **Leaves** of one form mainly, in two distinct ranks along the branches, *broadly elliptic-ovate to almost round*, 5.5–10 x 4–5.6 cm, *thickly coriaceous, drying glossy on upper surface*, lower side without conspicuous dot-glands; base obtuse-rounded, apex acute to slightly cuspidate; midrib slightly to conspicuously thicker than lateral veins, raised on the upper side; *lateral veins arising from the very base of the leaf-blade*, raised on both sides; *intercostal veins forming a loose network of fine veins*; glabrous; stalk 10–15 mm long. Inflorescence and flower not known. *Infructescence axis covered in persistent velvety purple-brown hairs*. **Fruit** broadly ellipsoid, to 5 x 2.5 cm, smooth on the surface when dry.

Vernacular name. Sabah—*engkop engkop* (Kedayan Bundu).

Distribution. Possibly endemic to northwest Borneo and highly localised. Known only from Kuala Penyu in SW Sabah and the Niah area in NE Sarawak.

Ecology. Lowland secondary and disturbed mixed dipterocarp forest on sandy soils.

9. *Anisophyllea rhomboidea* Baill.

(Latin, *rhomboideus* = rhombic; the leaf shape)

l.c. (1875) 310; Merrill *l.c.* 422; Masamune *l.c.* 515. **Type:** *Beccari PB 1514*, Sarawak (lectotype here chosen: G). **Synonyms:** *A. disticha sensu* Ding Hou *l.c.* 479, *pro parte, sensu* Ashton *l.c.* 347, *pro parte, non* (Jack) Baill.

Shrub or small tree to 4 m tall. **Leaves** of two forms, in four distinct ranks along the branches, those of the lower 2 ranks oblong-rhomboid, those of the upper 2 ranks much smaller and falcate-elliptic to falcate-ovate, *the larger leaf form 3.5–10 x 1.2–3.5 cm*, the smaller leaf form 0.6–1.4 x 0.3–0.8 cm, chartaceous to thinly coriaceous, drying matt on upper surface, lower side without conspicuous dot-glands; base cuneate to right-angled, apex acute; midrib slightly or not thicker than lateral veins, flat on the upper side; lateral veins one pair arising from the very base of the leaf-blade and a third (unpaired) lateral vein arising from the midrib away from the base of the leaf-blade on the acroscopic side of the midrib, flat on upper side, elevated on lower side; intercostal veins scalariform or forming a loosely tessellated network of flat to slightly raised pale fine-veins or obscure; glabrous to slightly hairy on the main veins on the lower side; stalk none or very short, 0–3 mm long. **Inflorescence** a raceme or panicle with short side-branches, *1.5–8(–10) cm long*, in the axils of the large leaves, axes rusty to pale brown fine-hairy. **Flowers** unisexual; calyx pubescent outside, lobes 4; petals 1.5–2 mm long; stamens in male 1–1.5 mm long, replaced by staminodes in the female; pistil in female 1–1.5 mm long, with 1 style, replaced by pistil rudiments in the male. **Fruit** usually several per raceme, ellipsoid, 1.5–2.5 x 0.5–1 cm, smooth on the surface when dry, ripening pinkish.

veins forming a loose network of veins, often obscure; glabrous; stalk 7–14 mm long. **Inflorescence** of one or more panicles to 9 cm long arising from the leaf-axil, the base becoming tuberculate with age. **Flowers** yellow; *calyx-cup conical with 3 sides*, 2.5–4 x 2 mm, glabrous, lobes ovate, 2.5–3 x 1.5–2 mm, outside glabrous, inside scantily pale long-hairy; *petals* c. 2 mm long, *linear*, entire or lacinate (the divisions also linear); stamens with filaments 2–2.5 mm long, anthers ovoid, c. 0.3 mm long; styles 1–1.5 mm long. **Fruit** 3(–4)-winged, 2–3 cm long, 1.5–2 cm wide; wings semicircular, membranous. **Seed** solitary in each fruit, elongate to spindle-shaped.

Vernacular names. Sabah—*perepat paya* (Brunei Malay), *perepat perepat* (Bajau). Sarawak—*kayu tom* (Kayan, Kenyah), *keruntum* (Iban), *mutun* (Pusa Malay), *perepat paya* (Kayan, Kenyah), *sabutun* (Melanau Oya). Brunei—*balak bekatan* (Iban), *keruntum* (Dusun, Iban), *perepat hutan* (Brunei Malay, Belait, Kedayan).

Distribution. As for genus. In Sabah and Sarawak found in all types of peat swamp forest. Also in Brunei and Kalimantan.

Ecology. It is often found in *alan* (*Shorea albida*) swamp forest in Sarawak and Brunei and mixed peat swamp forest in general. In the more open conditions on the domed centres of the largest swamps, and on *kerangas* (heath forest) sites on groundwater podsols it occurs as small trees, whereas in the wetter swampy sites truly big trees occur. In the periodically drier sites in the centre of the big peat swamp complexes, gregarious stands of small *Combretocarpus* trees have been called “*padang keruntum*”. *Keruntum* trees coppice easily. Medium-sized or large trees of it are often stag-headed (with sparse, large-limbed crown portions) and hollow (Browne *l.c.*).

Uses. The timber is suitable for railway sleepers and heavy construction if impregnated with preservative. When well-seasoned, it can be used for flooring and panelling. The wood is moderately hard and moderately heavy (*keruntum* logs sink in water). The texture is coarse and uneven, due to broad rays which produce an oak-like figure (Burgess *l.c.*; Wong (1982) DMT).

ARAUCARIACEAE

P.C. Yii

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Kuching, Malaysia

Hooker *f.*, Fl. Br. Ind. 5 (1890) 650; Merrill, EB (1921) 32; Ridley, FMP 5 (1925) 277; Masamune, EPB (1940) 2; Backer & Bakhuizen *f.*, FJ 1 (1963) 87; Keng, OFMSP (1969) 12, TFM 1 (1972) 39; de Laubenfels, Philip. J. Biol. 7, 2 (1978) 143, FM 1, 10 (1988) 419; Kochummen, Mal. For. Rec. 17 (1979) 54; Cockburn, TS 2 (1980) 2; Anderson, CLTS (1980) 347; Corner, WSTM 2 (1988) 762; Whitmore, Tantra & Sutisna, CLK 1 (1989) 27.

Monoecious trees or rarely shrubs. Exudate resinous, colourless or slightly whitish. **Leaves** simple, spiral, opposite, sub-opposite or in whorls, scale- or needle-like or broad leathery blades with many faint closed longitudinal veins. Male and female cones on separate branches. **Male cones** solitary, lateral or rarely terminal, cylindrical, consisting of numerous spirally arranged microsporophylls, each bearing a few to numerous microsporangia at the abaxial or lower side of an enlarged shield-like apex. **Female cones** solitary, terminal on robust shoots or pedunculate with bracts at the base, ovoid or round, consisting of an axis with numerous spirally arranged seed-scales (megasporophylls), each bearing a solitary seed (ovule) on the adaxial (upper) surface; mature female cones large, woody; cone-scales wedge-shaped. **Seed** winged or not; cotyledons either in 2 fused pairs or of 4 independent units.

Distribution. 2 genera (*Agathis* and *Araucaria*) and 40 species, chiefly in countries bordering the South Pacific Ocean (Indo-China, Malesia, New Caledonia, Australia, New Zealand, Melanesia, and South America). In Sabah and Sarawak represented by a single genus (*Agathis*) with 5 species.

AGATHIS Salisb.

(Greek, *agathis* = a clew; the shape of the cone)

Trans Linn. Soc. London 8 (1807) 311; Hooker *f. l.c.* 650; Merrill *l.c.* 32; Ridley *l.c.* 277; Meijer Drees, Bull. Jard. Bot. Btzg. 3, 16 (1940) 455; Backer & Bakhuizen *f. l.c.* 87; Keng *l.c.* (1969) 12, *l.c.* (1972) 39; Cockburn *l.c.* 2; Anderson *l.c.* 347; Whitmore, Pl. Syst. Evol. 41 (1980) 46, New Phytol. 84 (1980) 407; de Laubenfels, Blumea 24 (1978) 499, Blumea 25 (1979) 531, *l.c.* (1988) 419; Whitmore, Tantra & Sutisna *l.c.* 27. **Synonym:** *Dammara* Link, Enum. Hort. Berol. Alt. 2 (1822) 411.

Usually large trees. *Bole straight and cylindrical, often swollen at the base or with large superficial roots.* **Bark** light-grey to greyish brown, usually smooth and lenticellate when young, gradually peeling off into thin irregular flakes, leaving behind irregular pock-marks on larger trees; inner bark granular, reddish brown. Twigs glabrous, greenish. *Terminal*

buds globular, usually covered with several pairs of overlapping scales. Petioles usually very short, hardly distinguishable from the blades, slightly channelled above. Leaves entire, spirally arranged on the older branches and decussate on the young twigs, size and shape extremely variable, lanceolate, ovate, to elliptic, without distinct midrib; juvenile leaves distinctly larger than the adult leaves and often have more acuminate apices. Male cones subtended by several pairs of bracts, sessile or shortly pedunculate. Female cones with numerous closely appressed more or less triangular seed-scales. Seed flattened ovoid, with 2 unequal lateral wings; cotyledon 2, opposite and leaf-like.

Distribution. About 21 species; Indo-China, Malesia, Australia, New Zealand and Melanesia (except Solomon Islands). 5 species occur in Sabah and Sarawak.

Ecology. Large and emergent trees with 2 species, *Agathis borneensis* and *A. endertii*, widely distributed from lowland peat swamp, *kerangas* (heath), mixed dipterocarp and montane forest to about 2400 m. Young trees often produce female cones several years ahead of males.

Uses. *Agathis* produces a beautiful softwood which fetches a very good price. Its pleasing yellow timber has a natural sheen which is very suitable for furniture and cabinet making, wall and ceiling panelling. It is not durable for outdoor use. The white crystalline resin is also collected for sale as copal. For more information, see Whitmore, *Econ. Bot.* 34 (1980) 1.

Taxonomy. The species of *Agathis* occurring in Sabah and Sarawak are characterised by the decussate leaves with close faint longitudinal veins without prominent midrib, and by the male and female cones which are borne on separate branches. For a detailed account of the systematy of the genus see papers by de Laubenfels, *Blumea* 24 (1979) 531 and Whitmore, *New Phytol.* 84 (1980) 407 and *Pl. Syst. Evol.* 41 (1980) 41.

Key to *Agathis* species

1. Leaf lower surface glaucous.....2
 Leaf lower surface not glaucous.....4
2. Adult leaves distinctly convex-lens-shaped, asymmetric; apex and base sharply acute4. **A. lenticula**
 Adult leaves not so.....3
3. Adult leaves ovate or orbicular, apex obtuse or rounded, usually less than 4 cm. Male cone usually less than 6 mm in diameter, shortly pedunculate. Seed-scales without distinct lip.....5. **A. orbicula**
 Adult leaves elliptic, apex acute or rarely blunt, usually longer than 5 cm. Male cones about 10 mm in diameter, sessile. Seed-scales with distinct protruding lips at the apical margin.....2. **A. endertii**
4. Adult leaves elliptic, usually longer than 5 cm, apex acute. Male cones oblong, pedunculate, usually larger than 20 mm in diameter.....1. **A. borneensis**

Adult leaves ovate, usually less than 5 cm long, apex usually acuminate or round and blunt with a distinct tip. Male cones about 10 mm in diameter.....**3. A. kinabaluensis**

1. Agathis borneensis Warb.
(of Borneo)

Fig. 1.

Monsunia 1 (1900) 184; Merrill *l.c.* 32; Masamune *l.c.* 2; Meijer Drees *l.c.* 459; de Laubenfels *l.c.* (1979) 532, *l.c.* (1988) 433; Whitmore *l.c.* (1980) 54. **Type:** *Beccari* 491 (B) & 596 (B, K), Sarawak (syntypes). **Synonyms:** *Pinus dammara* Lamb., Descr. Pinus 1 (1803) 61; *A. dammara* (Lamb.) Richard, Comm. Bot. Conif. & Cycad. (1826) 83; *A. loranthifolia* Salisb. *l.c.* 312; *Dammara loranthifolia* (Salisb.) Link *l.c.* 411; *A. beccarii* Warb. *l.c.* 184; *A. macrostachys* Warb. *l.c.* 183; *A. rhomboidalis* Warb. *l.c.* 184; *A. alba* Foxw., Philip. J. Sc. 4 (1909) 442; *A. latifolia* Meijer Drees *l.c.* 459.

Emergent tree to 55 m tall and 100 cm diameter. **Bark** warty lenticellate, papery scaly or flaky, maurish grey; inner bark granular, pale brown. **Leaves** when juvenile ovate to lanceolate, up to 14 x 4 cm; when adult *elliptic to ovate*, 6–12 x 2–3.5 cm, *leathery, glabrous*; base cuneate rounded, *apex acute*. **Male cones** *oblong*, 4–7 cm long, 20–25 mm across, on short peduncles, 2–10 mm long; *microsporophylls* 6–7 x 4.5–5 mm, *with broad, rounded apex*. **Female cones** ovoid, 6–8.5 x 5.5–6.5 cm; seed-scales 30–40 x 25–28 mm, *roughly triangular in shape with well rounded apical margin*. **Seeds** flattened ovoid, *c.* 12 x 9 mm, with one well-developed wing, *c.* 20 x 16 mm.

Vernacular names. Sabah—*manggilan* (Dusun), *salang* (Kedayan). Sarawak—*bindang* (Malay), *bulu* (Iban), *kayu jadi* (Malay, Iban). Brunei—*tulong* (Brunei, Malay, Dusun).

Distribution. Sumatra, Peninsular Malaysia and throughout Borneo. In Sabah and Sarawak widespread; also in Brunei and Kalimantan.

Ecology. Infrequent in the lowlands, although found in sandy margins of some peat swamps and *kerangas*, and lower montane forests to 1200 m. Generally prefers more acidic soils; often forming dense, nearly pure stands on certain areas of low-lying wet *kerangas* forest and dry *kerangas* forest on sandstone formations at higher altitude, elsewhere uncommon and scattered.

2. Agathis endertii Meijer Drees

(F.H. Ender, 1891–1953, forester at the Forest Research Institute, Bogor, Indonesia)

l.c. 470; Masamune *l.c.* 3; de Laubenfels *l.c.* (1979) 534, *l.c.* (1988) 439. **Type:** *bb.* 21694, Southern Borneo (holotype BO).

Emergent tree to 60 m and 100 cm diameter. **Bark** smooth with shallow pock-marks and scales, grey-purplish brown; inner bark granular, straw-brown. Exudate whitish, opaque. **Leaves** when juvenile lanceolate, with blunt or acute apex; when adult *elliptic*, 5–9 x 1.8–3.5 cm, *leathery and slightly glaucous on undersurface*; base cuneate rounded, *apex broadly acute or rarely blunt*. **Male cones** *cylindrical*, 2.6–3.8 cm long, 7–10 mm across, *sessile*; *microsporophylls* *spoon-shaped*, *c.* 25 x 20 mm, with spreading and slightly angled

apical margin. **Female cones** shortly ovoid, *c.* 4.5 x 7 cm; seed-scales *c.* 32 x 42 mm, *more or less triangular with well rounded apical margin, and a distinct protruding lip (c. 8 x 3 mm) at the apical margin.* **Seed** flattened ovoid, *c.* 11 x 8 mm; wing one, *c.* 18 x 14 mm.

Vernacular names. Sarawak—*bulok* (Iban).

Distribution. Endemic to Borneo. In Sabah and Sarawak scattered.

Ecology. Scattered throughout lowland rain forests from sea-level to sandstone *kerangas* forest at 1600 m.

3. *Agathis kinabaluensis* de Laub.

(of Mt. Kinabalu)

l.c. (1979) 535, *l.c.* (1988) 439. **Type:** *de Laubenfels P625*, Sabah, Mt. Kinabalu (holotype L; isotypes A, K, SAN).

Tree up to 36 m tall, becoming relatively stunted on exposed ridges and summits. **Bark** dark brown, with numerous lenticels, peeling off into irregular flakes; inner bark granular, reddish brown. Exudate white. **Leaves** when juvenile ovate, up to 9 x 4.4 cm, apex strongly acuminate; when adult *ovate*, 3.5–7 x 1.8–3.2 cm; *base cuneate rounded, apex slightly acuminate or more or less round and blunt with distinct tips on smaller leaves.* **Male cones** cylindrical, 1.8–3 cm long, 8–10 mm across, nearly sessile or on very short peduncles; *microsporophylls spoon-shaped, c. 1.7 x 1.4 mm, with very slightly angled apical margin.* **Female cones** ovoid, *c.* 8 x 11 cm; seed-scales 28–32 x 40–45 mm, *with distinct narrow ridges along apical margin and broadly rounded at the upper end.* **Seed** *c.* 11 x 7 mm, distinctly acute at one end and with a broad wing *c.* 20 x 12 mm at the other.

Vernacular name. Sarawak—*tumu* (Kelabit, Murut).

Distribution. Only known from Mt. Kinabalu, Sabah, and Mt. Murut in Sarawak.

Ecology. Upper mossy montane forest at 1500–2400 m.

4. *Agathis lenticula* de Laub.

(Latin, *lenticularis* = a double convex lens; the leaf shape)

l.c. (1979) 537, *l.c.* (1988) 436. **Type:** *de Laubenfels P619*, Sabah, Mt. Kinabalu, Park HQ (holotype L; isotypes A, K, SAN).

Tree to 45 m tall. **Bark** greyish brown, with numerous small lenticels; young bark distinctly covered with thin exfoliating flakes, gradually breaking into irregular plates; inner bark granular, reddish brown. *Exudate whitish, gradually turning yellow.* **Leaves** when juvenile lenticular, up to 11 x 4.7 cm, tapering toward both ends; when adult lenticular, 5–7 x 1.7–2.4 cm, *leathery, glaucous on the undersurface, apex and base more or less acute.* **Male cones** cylindrical, 3–4 cm long, 9–10 mm in diameter, on short peduncles,

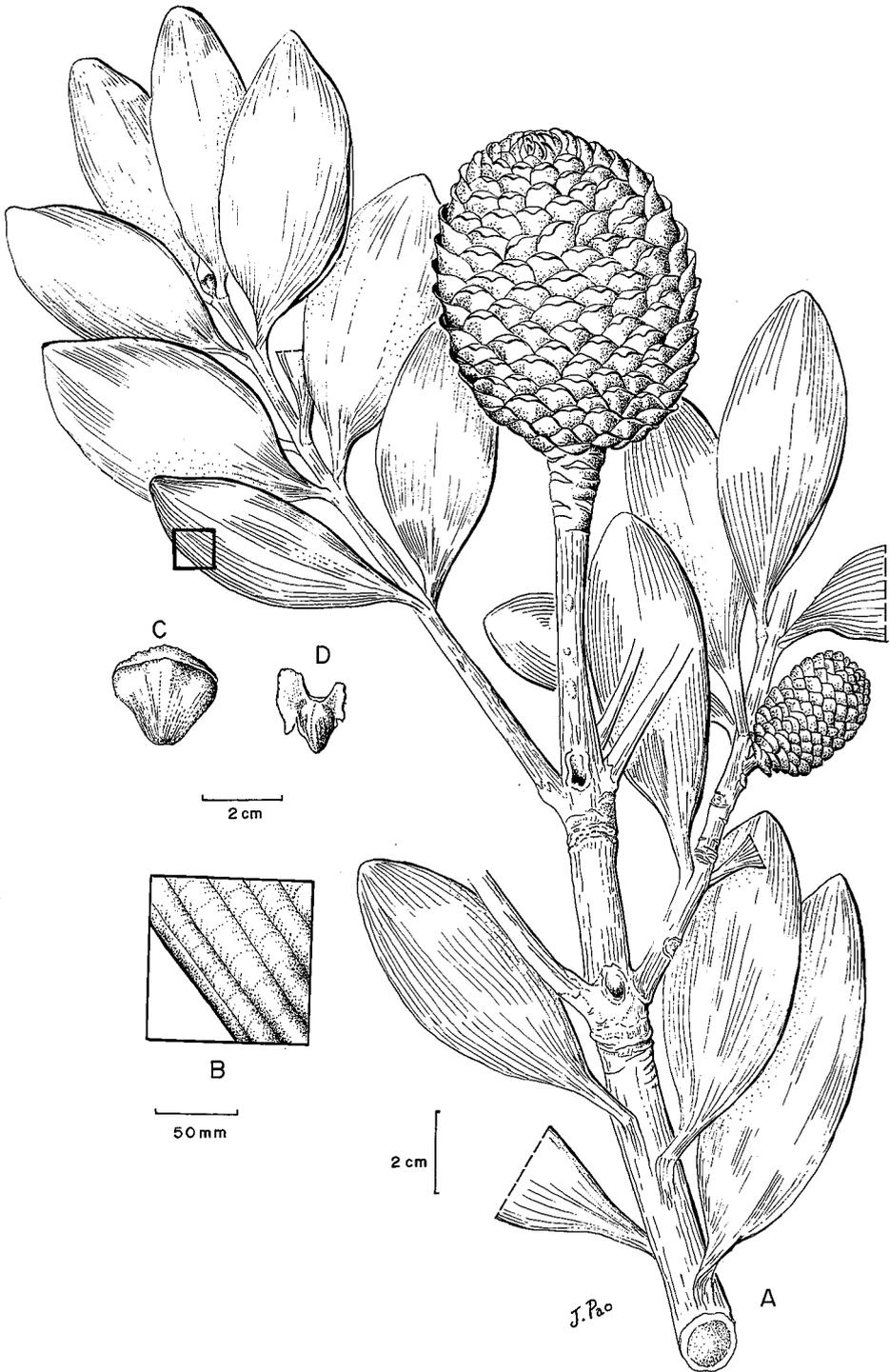


Fig. 1. *Agathis borneensis*. A, leafy branch with lateral male cone and terminal female cone; B, detail of leaf venation; C, seed-scale; D, winged seed. (All from S. 9633.)

2–6 mm long; *microsporophylls* spoon-shaped, 2–2.5 x 1.5–2 mm, with blunt spreading apical margin. **Female cones** spherical, c. 7 x 6 cm; seed-scales c. 40 x 27 mm. **Seeds** c. 11 x 7 mm, with a broadly rounded wing, c. 8 x 14 mm at one end.

Vernacular names. Sabah—*tangilan*, *tungilan* (Dusun).

Distribution. So far only known from the Crocker Range, including Mt. Kinabalu in Sabah.

Ecology. Emergent trees in mossy montane rain forest, at 1140–1680 m.

5. *Agathis orbicula* de Laub.

(Latin, *orbicularis* = circular; the leaf shape)

I.c. (1979) 540, *I.c.* (1988) 437. **Type:** *de Laubenfels P614*, Sarawak, Lawas (holotype L; isotypes A, K, SAN, SAR).

Tree to 40 m tall. **Bark** dark brown, peeling off into irregular flakes, exposing scattered lenticels; inner bark granular, reddish brown. *Exudate* resinous, light yellow and produced in abundance. **Leaves** when juvenile ovate, up to 6.5 x 2.8 cm; apex bluntly acute; when adult ovate to orbicular, 2.4–4 x 1.2–2.4 cm, broadly rounded to slightly angled at the apex, tapering toward the base. **Male cones** minute, cylindrical, 0.8–1.4 cm long, 4–6 mm through; *microsporophylls* helmet-shaped, 1.2–1.5 x 1–1.2 mm, with blunt apex. **Female cones** ovoid, c. 7 x 4.5 cm; seed-scales ovate, c. 20 x 33 mm. **Seeds** similar to that of *A. lenticula*.

Vernacular names. Sarawak—*bulok* (Tban), *tubu* (Kenyah & Kayan), *tumuh* (Murut).

Distribution. Endemic to Borneo; known from southern parts of Sabah to Central Sarawak.

Ecology. Scattered in sandstone *kerangas* forest at 450–1050 m.

BIGNONIACEAE

A. Berhaman

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Merrill, EB (1921) 525; van Steenis, Rec. Trav. Bot. Neerl. 24 (1927) 787, Bull. Jard. Bot. Btzg. 3, 10 (1928) 173, FM 1, 8 (1977) 114; Masamune, EPB (1942) 652; Kochummen, TFM 3 (1978) 36; Anderson, CLTS (1980) 152; Cockburn, TS 2 (1980) 19; Santisuk, Flora of Thailand 5 (1987) 32; Corner, WSTM 1 (1988) 172; Whitmore, Tantra & Sutisna, CLK 1 (1989) 28.

Trees, shrubs or woody climbers; *twigs often lenticellate*; stipules absent. **Leaves** generally *opposite* and *1–2–4-times pinnate*, or *simple and whorled*, often with glands on the lower surface of the leaflets; domatia sometimes present. **Inflorescences** generally terminal, sometimes borne on the trunks and branches. **Flowers** *bisexual*, usually *very showy*; calyx tubular, subtruncate or with 5 lobes or teeth, closed in bud and later splitting into lobes, often glandular outside; *corolla in most genera bilaterally symmetrical*, in some genera somewhat radially symmetrical, basally tubular, upper part expanded, generally campanulate or salver-shaped, with 5 lobes, 2 on the upper side, 3 on the lower; *stamens 5, almost equal, or (mostly) 4 and didynamous (2 long and 2 short), attached to the corolla (epipetalous)*; *ovary superior, 2-celled*, style long, stigma 2-lobed, nectary usually present and ring-like; ovules several to many per cell, arranged longitudinally in 1–2 rows on the septum. **Fruit** *a pod* divided by a longitudinal partition into 2 compartments, *splitting open when ripe*. **Seeds** *many, flat*; embryo near the centre; peripheral wing very thin and transparent or thickened and opaque; germination epigeal.

Distribution. About 120 genera and 650 species in the tropics and subtropics. In Sabah and Sarawak, 10 species in 5 genera including 5 apparently unnamed species (4 woody climbers and 1 tree). A number of exotic species have been introduced as ornamental plants: *Arrabidaea magnifica*, *Jacaranda rhombifolia* (*Jambul merah*, formerly *J. filicifolia*), *Mansoa hymensala*, *Millingtonia hortensis*, *Spathodea campanulata* (African tulip tree), *Tabebuia rosea*, and *Tecoma stans* (Yellow bells).

Ecology. Mostly evergreen but *Oroxylum indicum* and *Dolichandrone spathacea* have been noted as leafless for many months during the dry season of seasonal parts of Asia. *Dolichandrone spathacea* is confined to the mangroves, *Deplanchea bancana* is found in *kerangas* (heath) and peat swamp forest, some woody climber species appear restricted to limestones, and some *Radermachera* species may be restricted to ultramafic soils. In many species, the flowers open at night, and some have fragrant white flowers with long tubes which are pollinated by moths. *O. indicum* has flowers with lurid colour, musky odour, fleshy funnel-shaped corollas, which are pollinated by nectarivorous bats. The winged seeds are dispersed by wind.

1. DEPLANCHEA Vieill.

(E.F. Deplanche 1824–1874, French physician & naturalist)

Bull. Soc. Linn. Normand. 7 (1862) 96; van Steenis *l.c.* (1927) 906, *l.c.* (1977) 135; Kochummen *l.c.* 37; Anderson *l.c.* 152; Cockburn *l.c.* 19; Corner *l.c.* 175; Whitmore, Tantra & Sutisna *l.c.* 28.

Small to medium-sized trees. **Bark** often lenticellate. **Sapwood** soft. **Leaves** simple, in whorls, quite large, elliptic to obovate, chartaceous to coriaceous; base with two large saucer-shaped glands on upper surface. **Inflorescence** terminal, a thyrses with a somewhat flat-topped structure, the branches many (more than 20) and held horizontally at almost right angles to the main inflorescence axis, large and conspicuous. **Flowers** large; calyx 5-lobed; corolla irregular (zygomorphic), funnel-shaped, tube with a short constricted basal part and a flared upper part, lobes 5, yellow; stamens strongly exserted, 4 (rarely 5), didynamous; disc annular to lobed; ovary 2-celled; style long exserted; stigma 2-lobed. **Fruit** a 2-valved capsule. **Seeds** many, thinly winged.

Distribution. 5 species, Malesia to N Australia. 1 species in Borneo (Sabah, Sarawak, Brunei, and Kalimantan).

Ecology. Being light-demanding, species of the genus are mainly found in secondary rain forests (including *kerangas* forest), woodland savannahs, and grasslands, from sea-level to 1000 m.

Deplanchea bancana (Scheff.) Steenis (of Banka Island)

Fig. 1.

l.c. (1927) 921, *l.c.* (1928) 221, *l.c.* (1977) 137; Kochummen *l.c.* 37; Anderson *l.c.* 152; Cockburn *l.c.* 19; Corner *l.c.* 175; Whitmore, Tantra & Sutisna *l.c.* 28. **Basionym:** *Diplanthera bancana* Scheff., Nat. Tijds. Ned. Ind. 31 (1870) 334. **Type:** *Teijsmann, H.B. 9666*, Banka (BO). **Synonym:** *Deplanchea coriacea* Steenis *l.c.* 224.

Small to large trees 10–45 m tall, 25–70 cm diameter; bole fluted at base, buttresses small or large. **Bark** white to brown, lenticellate and slightly fissured; inner bark yellow to pale brown. **Sapwood** white to pale yellow, soft. Young twigs lenticellate, glabrous to pale hairy, pale brown to yellow. **Leaves** obovate to elliptic, 9–34 x 5.5–20 cm, chartaceous to coriaceous; base cordate to cuneate, apex rounded, rarely acuminate-acute; midrib glabrous to yellow-hairy on lower surface; lateral veins 7–8 pairs, raised and glabrous to yellow-hairy on the lower surface; stalk 3–6 cm long, glabrous to yellow-hairy. **Inflorescences** showy, stalk 5–20 cm long. **Flowers** showy; calyx 12–16 mm long, with scattered glands, teeth 5; corolla c. 3.5 x 2.5 cm, yellow, 5-lobed, the upper 2 lobes recurved; stamens 4, filaments erect and curved over the upper corolla-lobes, base glandular hairy; ovary sessile, each locule with two placentas; style greenish yellow, exserted and curved like the stamens; stigma bilobed. **Fruits** oblong, 10–14 x 3.5 cm. **Seeds** flat, c. 3 x 2 cm; wing broad, very thinly transparent, irregularly lobed.

Distribution. Sumatra, Peninsular Malaysia and Borneo. In Sabah and Sarawak uncommon.

Ecology. In Sabah and Sarawak, it occurs in heath forests on white sands or in peat swamps, in primary and secondary forests, from sea-level to 1000 m.

2. DOLICHANDRONE Seemen

(Greek, *dolichos* = long, *andron* = male; the long stamens)

Ann. Mag. Nat. Hist. Ser. 3, 10 (1862); van Steenis *l.c.* (1927) 928, *l.c.* (1928) 227, *l.c.* (1977) 141; Kochummen *l.c.* 39; Anderson *l.c.* 152; Cockburn *l.c.* 19; Corner *l.c.* 176; Whitmore, Tantra & Sutisna *l.c.* 28.

Medium-sized trees. **Leaves** *once pinnate*, leaflets elliptic, entire. **Inflorescence** *a terminal raceme*. **Flowers** fragrant, nocturnal; calyx spathaceous, somewhat curved; corolla funnel-shaped, equally 5-lobed; *stamens* 4, didynamous, included; disc annular; ovary with many ovules in many rows; style slender. **Fruit** a subcylindric capsule. **Seeds** hyaline-winged.

Distribution. 9 species, from East Africa through tropical Asia to Australia; 4 species in tropical SE Asia; 1 species in Sabah and Sarawak.

Dolichandrone spathacea (L. f.) K. Schum.

Fig. 2.

(Latin, *spathaceus* = resembling a spathe; the calyx form)

Fl. Kais. Wilh. Land. (1889) 123; Merrill, *l.c.* (1921) 525; van Steenis *l.c.* (1927) 937, *l.c.* (1928) 227, *l.c.* (1977) 142; Masamune *l.c.* 652; Kochummen *l.c.* 39; Anderson *l.c.* 152; Cockburn *l.c.* 19; Santisuk *l.c.* 56; Corner *l.c.* 176; Whitmore, Tantra & Sutisna *l.c.* 28. **Basionym:** *Bignonia spathacea* L. f., Suppl. (1781) 283. **Type:** *Konig, Herb. Linn. No. 776. 8* (LINN). **Synonyms:** *Dolichandrone rheedii* Seemen, J. Bot. 8 (1870) 380; *Dolichandrone longissima* K. Schum. in Engl. & Prantl, Pfl. Fam. 4, 3b (1894) 240.

Tree to 25 m tall, 10–40 cm diameter. **Bark** pale brown, smooth to fissured; inner bark laminated, reddish pink. **Sapwood** white, soft. Young twigs lenticellate. **Leaves** *once pinnate*, opposite; rachis smooth, brown; leaflets usually 3–4 pairs with one terminal leaflet, ovate-oblong to lanceolate, 5.5–15 x 2.5–6 cm, drying dark to brown-black; base oblique, apex acuminate pointed; lateral veins 5–8 pairs, lower surface with hairy domatia; stalks short in lateral leaflets but 2–4 cm in terminal leaflet. **Inflorescences** 2–8-flowered, with one flower opening at a time. **Flowers** fragrant; calyx conical, closed and with hooked apex in bud, with scattered glands, splitting along one side; *corolla white, with a tube to 14.5 cm long*, bell-shaped near the mouth, 3–4 cm wide, with many scattered glands outside, *lobes 5 with frilled margin*; stamens 4, didynamous with a fifth rudiment, included; style long, exerted, persistent in young fruit; anthers glabrous, bilocular. **Fruits** 20–33.5 x 1.5–3 cm, generally curved, hanging in clusters from the ends of the branches. **Seeds** many, dark grey, in many rows, *c.* 15 x 9 mm including the thick corky wings.

Vernacular names. Sabah—*kelaju*, *tui* (Dusun). Sarawak—*tuih* (Iban).

Distribution. From the coasts of Malabar to tropical SE Asia and the whole of Malesia.

Ecology. Restricted to the back mangroves and along banks of tidal rivers and estuaries. In Sabah, common in the mangrove forests of the west coast; in Sarawak occasional on clay soils at inland limits of mangroves.

Uses. The wood is soft and light with density of about 480 kg/m³, easy to saw and work with and seasons well although it must be protected against sapstains. So far, there is no record of its use in Sabah and Sarawak but in various parts of its geographical range, the wood is used for wooden clogs, net-floats, scabbards and household utensils. Due to its anatomical and physical characteristics the wood may also be suitable for pattern making and matches.

3. OROXYLUM Vent.

(Greek, *oros* = mountain, *xylon* = wood or tree; the natural habitat of the tree)

Dec. Gen. Nov. (1808) 8; van Steenis, *l.c.* (1927) 816, *l.c.* (1928) 181, *l.c.* (1977) 128; Masamune *l.c.* 652; Kochummen *l.c.* 40; Anderson *l.c.* 152; Cockburn *l.c.* 19; Corner *l.c.* 178; Whitmore, Tantra & Sutisna *l.c.* 28.

Small to medium-sized trees. **Leaves** opposite, 2–4-times pinnate; leaflets with 4–5 pairs of lateral veins, glands on the lower surface present only in young and some mature leaves, and then only at the basal part of leaflets. **Inflorescence** a terminal raceme, erect, long. **Flowers** fragrant, showy; calyx closed in bud, with an apical pore opening as a somewhat bell-shaped structure; *corolla purplish*, with 5 subequal lobes; stamens 5; ovules in many rows in each cell. **Fruit** a long, flattened woody capsule. **Seeds** quite large, with thin wings all around, in many rows.

Distribution. Monotypic genus distributed in India, Sri Lanka, and throughout SE Asia.

Oroxylum indicum (L.) Vent. (of India)

Fig. 3.

l.c. 8; van Steenis *l.c.* (1927) 816, *l.c.* (1928) 181, *l.c.* (1977) 128; Masamune *l.c.* 652; Kochummen *l.c.* 40; Anderson *l.c.* 152; Cockburn *l.c.* 19; Santisuk *l.c.* 36; Corner *l.c.* 166; Whitmore, Tantra & Sutisna *l.c.* 28. **Basionym:** *Bignonia indica* L., Sp. Pl. (1753) 625. **Type:** *Herb. Hermann No. 236; vol. 5: Icon. 28, 29, 72* (BM). **Synonyms:** *Bignonia pentandra* Lour., Fl. Coch. 2 (1970) 379; *Bignonia tripinnata* Noronha, Verh. Bat. Gen. 5 (1790) 8; *Calosanthos indica* Blume, Bijdr. (1826) 760; *Hippoxylum indicum* Rafin., Tellur. (1838) 78.

Medium-sized tree, partly deciduous, 20–40 m tall, 10–40 cm diameter. **Bark** smooth, whitish; inner bark pale yellowish. **Sapwood** pale whitish, soft. **Leaves** 3–4-times pinnate, up to 2 m long, tufted at the branch ends; petioles long, rachis swollen at points of articulation; leaflets ovate to oblong, 6–9.5 × 2.5–5 cm, terminal one always bigger; base cuneate or mostly oblique, apex acute to acuminate; lateral veins 4–5 pairs; intercostal veins reticulate; glands scattered on the flower surface. **Inflorescence** 25–100 cm long. **Flowers** nocturnal, c. 9 cm long; calyx coriaceous, 2.5–3.5 cm long, 1.5–2 cm across, containing



Fig. 2. *Dolichandrone spathacea*. A, leafy twig; B, flower; C, fruit; D, seed. (A from SAN 31498, B from FRI 12490, C & D from SAN A 1771.)

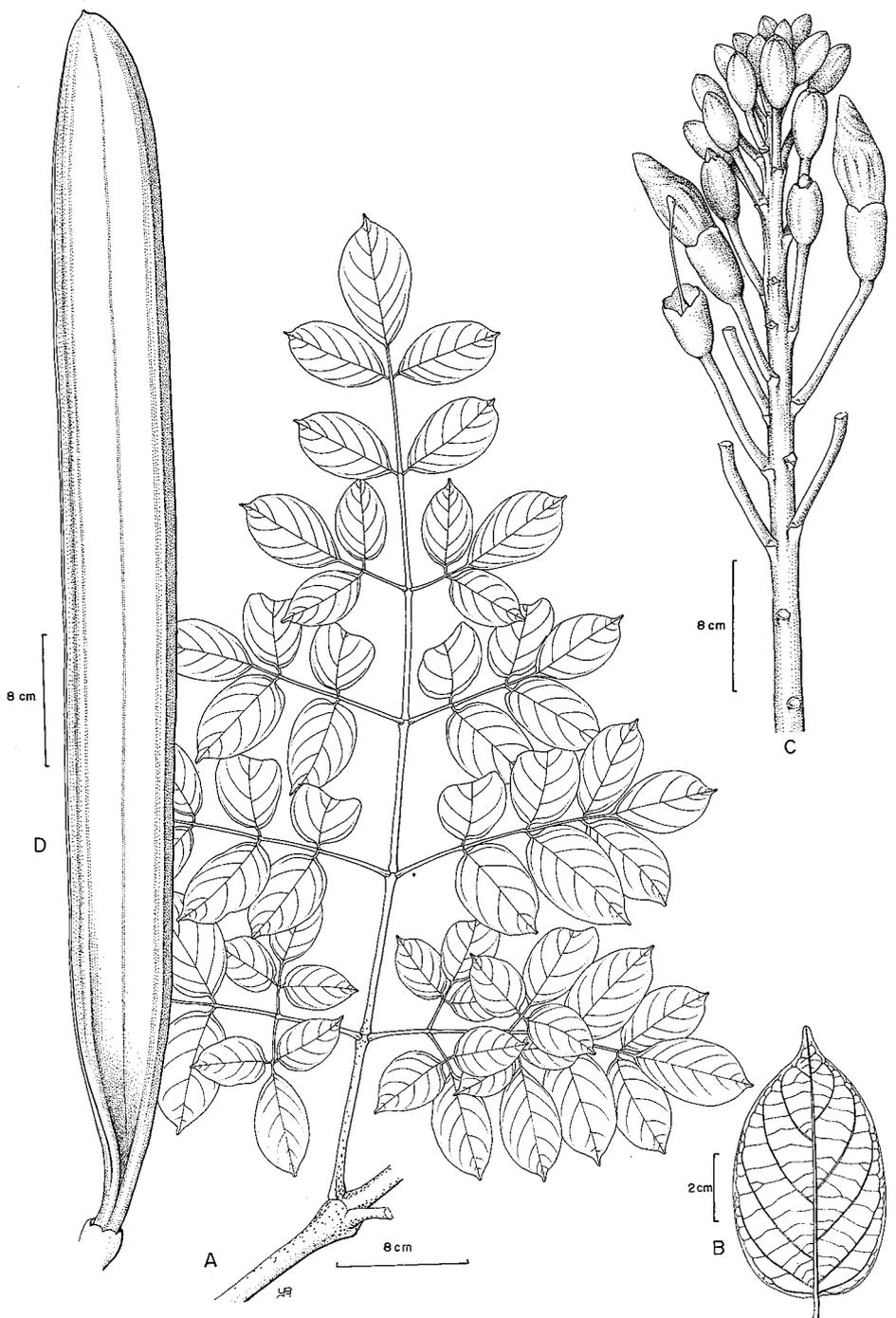


Fig. 3. *Oroxylum indicum*. A, part of compound leaf; B, detail of leaflet; C, part of inflorescence; D, pod. (From SAN 89947.)

water in bud, campanulate, dirty brown-violet, becoming almost woody in the fruit; corolla c. 10 cm long, reddish outside, yellowish to pinkish inside, fleshy, funnel-shaped, the 5 unequal lobes with wrinkled margin; stamens all fertile, hairy at the base, included. **Fruit** 25–100 x 5–10 cm, hanging conspicuously resembling the big flat blade of a slash-knife. **Seeds** numerous, 4–8 x 2.5–4 cm including the membranous and transparent wing.

Vernacular names. Sabah—*parang pamol* (colloquial Malay). Sarawak—*binkuli* (Iban), *gimurai*, *murai* (Padawan Bidayuh), *parang nyabor* (Iban).

Distribution. As for genus.

Ecology. Secondary forest, mostly below 1000 m.

4. **RADERMACHERA** Zoll. & Moritz

(J.C.M. Radermache, 1741–1783, patron of science in the Netherlands Indies)

in Zollinger, Syst. Verz. Pfl. Ind. Arch. 3 (1855) 53; Merrill *l.c.* (1921) 525; van Steenis *l.c.* (1927) 953, *l.c.* (1928) 238, *l.c.* (1977) 149, Blumea 23 (1976) 121; Masamune *l.c.* 652; Kochummen *l.c.* 42; Anderson *l.c.* 152; Cockburn *l.c.* 20; Corner *l.c.* 180; Whitmore, Tantra & Sutisna *l.c.* 29.

Trees or shrubs. Twigs lenticellate. **Leaves** 1–3-times pinnate, opposite; leaflets often with gland-fields on the lower surface. **Inflorescence** a raceme or thyrse, terminal on branches or borne on the trunk and branches (plant cauliflorous or ramiflorous). **Flowers** white, pink or greenish yellow; *calyx* 2–5-lobed, often glandular; *corolla* 5-lobed, slightly two-lipped; stamens 4 or 5; ovary elongate, glabrous or covered with tiny scales or tubercles. **Fruit** a straight or twisted capsule with a corky central placenta. **Seeds** many, tiny and narrow, the ends winged.

Distribution. 15 species; tropical Asia, from India and south China to Malesia; 3 species in Sabah and Sarawak.

Key to *Radermachera* species

1. Leaves typically once pinnate, sometimes 1–2-times pinnate. Inflorescences always borne on leafy shoots..... **1. R. pinnata**
 Leaves 2–3-times pinnate. Inflorescences borne directly on main branches or on trunk and branches (plant cauliflorous or ramiflorous)..... 2
2. Leaves 3-times pinnate, the secondary rachises never winged; leaflet tips caudate **2. R. ramiflora**
 Leaves 2–3-times pinnate, the secondary rachises with 1–2-mm-wide wings; leaflet tips acuminate to cuspidate..... **3. Radermachera sp. A.**

1. *Radermachera pinnata* (Blanco) Seemen
(Latin, *pinnatus* = feathery; the pinnate leaves)

Fig. 4.

J. Bot. 8 (1870) 147; Merrill, *Sp. Blanc.* (1918) 350; van Steenis *l.c.* (1927) 973, *l.c.* (1928) 248, *l.c.* (1976) 129, *l.c.* (1977) 153; Kochummen *l.c.* 42; Corner *l.c.* 181; Whitmore, Tantra & Sutisna *l.c.* 29. **Basionym:** *Millingtonia pinnata* Blanco, Fl. Filip. (1827) 501. **Type:** Merrill *Sp. Blanc.* 834, Philippines, Luzon, Rizal Province (neotype A; isoneotypes BO, K, L). **Synonym:** *R. whitfordii* Merr., Philip. J. Sc. 75 (1912) 352.

subsp. ***acuminata*** (Steenis) Steenis

l.c. (1976) 129, *l.c.* (1977) 154; Whitmore, Tantra & Sutisna *l.c.* 29. **Basionym:** *R. lobbii* (Teijsm. & Binn.) Miq. subsp. *acuminata* Steenis *l.c.* (1928) 247. **Type:** *Endert E 1309*, S Sumatra, Lampong, Tandjong Karang (holotype BO; isotype L). **Synonyms:** *R. lobbii* Teijsm. & Binn., Nat. Tijd. Ned. Ind. 25 (1863) 413; *R. corymbosa* Steenis *l.c.* (1928) 249.

Tree 8–40 m tall, 30 cm diameter; buttresses to 2 m high. **Bark** scaly to flaky, light brown to grey; inner bark pale yellow. **Sapwood** white. **Leaves** 1–2-times pinnate, petioles 8–10 cm long; leaflets obovate to obovate-elliptic, 7–9 x 2.5–4 cm, coriaceous to chartaceous; base cuneate, apex acute to rounded; lateral veins 7–9 pairs. **Inflorescence** a terminal *thyrs*e. **Flowers** mildly fragrant; calyx purple, *c.* 1.5 cm long, *c.* 1–1.5 cm across, with a few scattered glands outside, lobes 3; corolla about 1.5 cm long, *c.* 1–1.2 cm across, basal part narrow tubular and white, upper inflated portion pale lilac, throat and medium inner surface of the lobes orange, lobes 5 with pale, minute hairs on the margin; stamens 4, didynamous; ovary glabrous, style glabrous, 1.2–2 cm long. **Fruit** a capsule, hanging in clusters at the end of branches, 16–27.5 x 0.5–1 cm; persistent calyx *c.* 1.8 cm long. **Seeds** *c.* 2.5 x 0.5 cm, winged.

Vernacular names. Sarawak/Kalimantan—*binutan*, *kujuk langit* (Kapuas Dayak).

Distribution. Peninsular Thailand, Sumatra, Peninsular Malaysia, Borneo, and the Philippines. In Sabah and Sarawak, generally uncommon but localised populations may be encountered in ultramafic and limestone areas in the northern, eastern and southern parts of Sabah, and around the Niah Caves and Kuching areas in Sarawak.

Ecology. Primary and secondary forest, to 800 m, associated with ultramafic soils (Sabah) or limestones (Sarawak). Flowering in May, July–March; fruiting in May–November.

Taxonomy. This species consists of two subspecies, according to van Steenis *l.c.* (1977) 153, *l.c.* (1976) 129. The other subspecies, *R. pinnata* subsp. *pinnata*, is restricted to Celebes, the Moluccas and the Philippines. The main difference is that in subsp. *pinnata* the intercostal veins on the lower leaflet surface form a dense and prominent network, whereas in subsp. *acuminata* the veins are not conspicuous or prominent. Subsp. *acuminata* is slightly variable in leaflet shape and texture.

2. *Radermachera ramiflora* Steenis
(Latin, *ramiflorus* = flowering on the branches)

J. Bot. 74 (1934) 5, *l.c.* (1976) 130, *l.c.* (1977) 152; Masamune *l.c.* 653; Whitmore, Tantra & Sutisna *l.c.* 29. **Type:** *Clemens 28672*, British North Borneo, Mount Kinabalu (holotype BO; isotypes K, L).

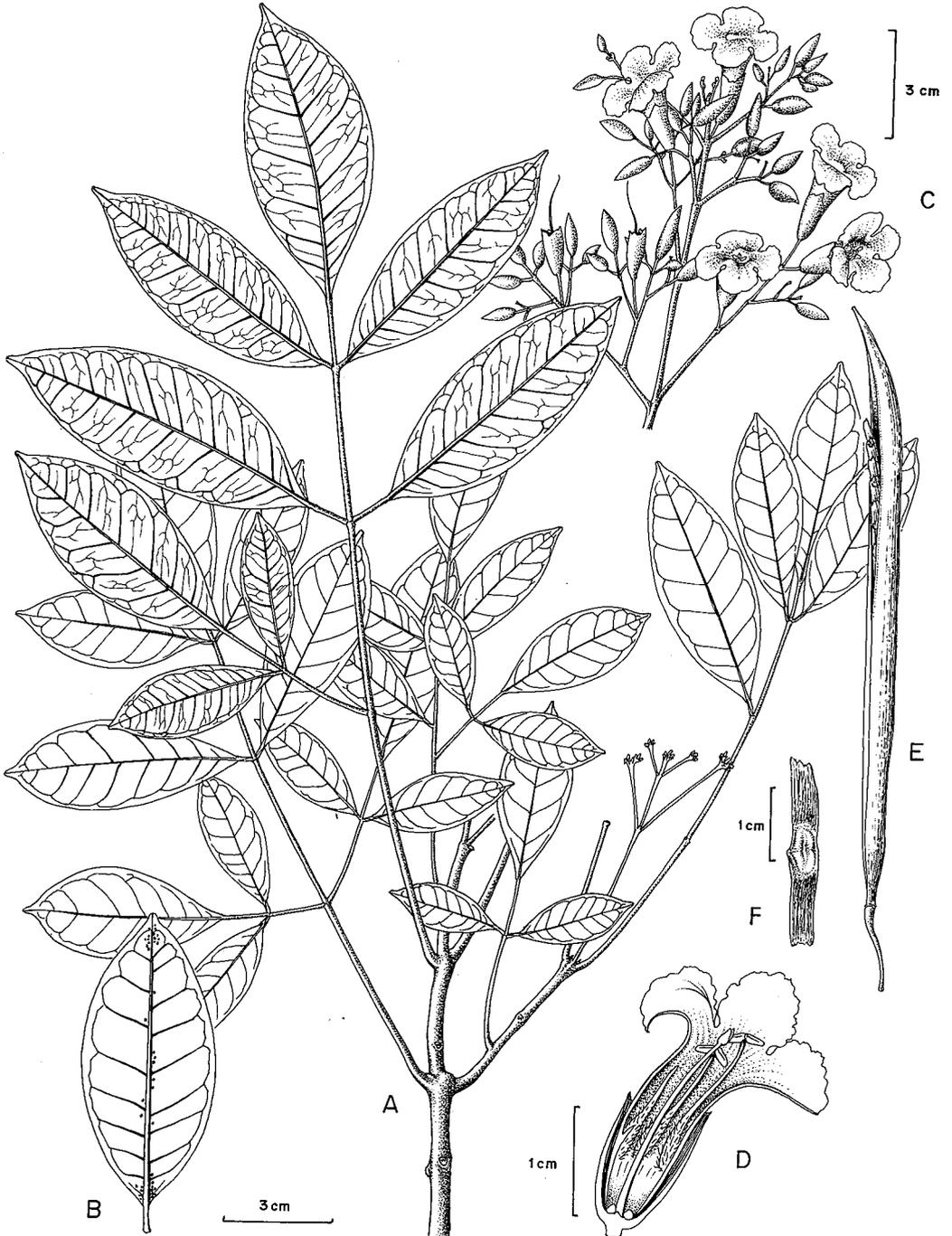


Fig. 4. *Radermachera pinnata* subsp. *acuminata*. A, leafy twig; B, lower leaf surface showing glands; C, part of inflorescence; D, longitudinal section through flower; E, fruit; F, seed. (A & B from SAN 57414, C & D from SAN 96675, E & F from SAN 109532.)

Medium-sized tree, 30–45 m tall, 30–50 cm diameter; trunk fluted at base. **Bark** greyish, fissured; inner bark whitish, turning yellowish on exposure. **Sapwood** yellowish white. Twigs with corky bark. **Leaves** 3-times pinnate, crowded at the branch-tips; leaflets 4–6 pairs, elliptic-lanceolate, coriaceous, 3.5–8.5 x 1.5–3.5 cm; apex caudate; lateral veins 5–7 pairs and raised below, lower surface with scattered small glands near the base. **Inflorescence** a raceme, borne on the trunk and branches (plants cauliflorous or ramiflorous), 11–14 cm long. **Flowers** yellow, erect on curved pedicels of c. 20 cm long; calyx dull reddish green to dark brown when dry, in the bud pear-shaped with many scattered glands outside especially near the base, 18–21 x 6–8 mm, lobes 3; corolla deep ochre-yellow, the limb red, narrowly salver-shaped with scattered 2–4 glands outside, slightly curved, the narrow basal part 3–5 cm long, lobes 5; stamens 4, exserted, didynamous, hairy at the base; ovary ribbed, style to 3–3.5 cm long. **Fruit** straight or twisted, 35–70 cm long. **Seeds** 4–5 x 2.4 mm, the wing 6–7 mm.

Vernacular name. Sabah—*tuik-tuik hutan* (Malay).

Distribution. Endemic to Sabah, known from Mt. Kinabalu, Ranau, Kota Marudu, and Mt. Rara.

Ecology. Rainforest, also in disturbed forest on hill sides, to 1500 m, associated with ultramafic soils. Flowering in January to March and around August; fruiting recorded in April and December.

van Steenis *l.c.* (1977) noted that the calyx is eglandular, but the specimen *Chew & Corner RSNB 4290*, examined by him, has a few scattered glands outside the calyx.

3. *Radermachera* sp. A.

van Steenis *l.c.* (1977) 152 included the only collection of this undescribed species (*Nooteboom & Aban 1603*, Sabah, Kinabalu, at Kampong Kiau) in *R. ramiflora*, a conclusion we disagree with. The species is poorly known; the young flower buds are not sufficient for describing it properly, but the winged secondary rachis and cuspidate leaflet tips clearly distinguish it from *R. ramiflora*.

BURSERACEAE

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A.W. Bennett in Hooker *f.*, Fl. Brit. Ind. 1 (1875) 527; King, J. As. Soc. Beng. 62, 2 (1893) 235; Merrill, EB (1921) 316, PEB (1929) 116; Ridley, FMP 1 (1922) 368; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 281; Masamune, EPB (1942) 362; Browne, FTSB (1955) 70; Leenhouts, FM 1, 5 (1956) 208, FM 1, 6 (1972) 917, FM 1, 7 (1976) 820; Backer & Bakhuizen *f.*, FJ 2 (1965) 112; Smythies, CST (1965) 30; Burgess, TBS (1966) 60; Kochummen, TFM 1 (1972) 121; Cockburn, TS 1 (1976) 34; Anderson, CLTS (1980) 155; Wong, DMT (1982) 30; Corner, WSTM 2 (1988) 199; Whitmore, Tantra & Sutisna, CLK 1 (1989) 34; Ng, Mal. For. Rec. 34, 1 (1991) 35.

Medium-sized to large buttressed trees, rarely shrubs; dioecious or occasionally monoecious; *crushed living parts with strong resinous smell*. **Bark** pale grey to brown, smooth or scaly, often lenticellate, *surface sometimes with black or white resinous gum; inner bark pinkish, or creamy, laminated or mottled, with droplets of clear or white resinous gum, with strong resinous smell* in most species (especially those of *Canarium* and *Triomma*). **Sapwood** often whitish, shiny, sometimes pinkish or yellowish brown, vessels usually visible to the unaided eye. Pith of twigs, petioles and petiolules often with vascular strands and resin ducts. **Leaves** spiral, usually crowded at the tips of twigs, *pinnately compound with opposite leaflets and a terminal leaflet, rarely trifoliolate; petiolules of leaflets with distinct swellings at both ends in most species* (leaflets subsessile in *Garuga*), margin entire except in some *Canarium* and *Garuga* species. Stipules present in all species of *Garuga* and in most species of *Canarium*. **Inflorescences** usually axillary or terminal panicles, sometimes spikes, racemes or thyrses. **Flowers** unisexual (except in *Garuga*), *male and female on different trees*, 3- or 5-merous, usually greenish to cream, the remains of the other sex persisting; sepals valvate, mostly united; petals valvate, free; stamens usually twice as many as petals, filaments free or united, sometimes fused to the disc, anthers dehiscent inwards; disc intrastaminal (except in *Triomma*), nectariferous, brightly coloured; ovary superior, with 3–5 cells, each cell with 2 ovules; style simple, stigma globular, often slightly lobed. **Fruit** a drupe with a fleshy or leathery resinous rind and a more-or-less woody stone (pyrene) or in *Triomma* a woody capsule; stone 3-celled or less. **Seed** one; cotyledons fleshy, variously folded, rolled and convoluted; endosperm absent; germination epigeal or hypogeal, mostly rapid; cotyledons divided into 3, 5 or more lobes (entire in *Scutinanthe*). **Seedling** with first 2 leaves opposite or alternate, subsequent leaves alternate, spiral, simple for several nodes, then pinnate (in some *Santiria* the leaves are pinnate from start); sapling leaflets thinner, with long drawn-out tips, longer petioles and more distantly spaced when compared to the adult leaves.

Distribution. 16 genera and about 550 species; tropics and subtropics. In Sabah and Sarawak, 8 genera and 59 species are known.

Ecology. Burseraceae are common constituents of the main storey of mixed dipterocarp and *kerangas* forests; they also occur in submontane forests to 1800 m. The drupaceous fruits are dispersed by animals. In *Triomma* the winged seeds are dispersed by wind.

Timber. The standard Malaysian name for the timber of Burseraceae is *kedondong* (Malay). It is a very homogeneous group except for slight colour differences, and a light hardwood, moderately hard and moderately heavy; in strength Class 'C', strong; working quality variable, some easy, others difficult and blunting tools excessively. Not durable in tropical conditions. Moderately susceptible to powder post-beetles. Difficult to treat with preservatives. Seasoning without serious degrade, with low shrinkage. Sapwood pale, not sharply defined; heartwood yellow-brown, pink-brown or red-brown, only slightly darkening on exposure, surface mostly glossy, without figure; grain interlocked. Texture moderately fine and even. Most species of *Dacryodes*, *Santiria* and *Scutinanthe* have siliceous timbers while *Canarium* (except *C. apertum*) and *Triomma* have no silica in the timber.

Uses. Timber suitable for general building construction and carpentry work, plywood and weather boarding. The family abounds in fragrant balsams and resins (e.g., balsam from *Commiphora opobalsamum*; frankincense from *Boswellia* species especially *B. sacra*; myrrh from *Commiphora myrra*). The resins are used in traditional medicine in Peninsular Malaysia. The resin from *Canarium luzonicum*, the "Manila-elemi" is used in pharmacy in ointments and plasters. The oil from the kernel is used locally. Commercial quantities of the oil are now being produced in the Solomon Islands from *Canarium* species for industrial use in the manufacture of skin- and hair-care products under the trade name "Solomon Nut Oil". The seeds of *Canarium album*, *Canarium indicum* (*ngali-nut*, Solomon Islands), *C. ovatum* and *C. vulgare* (*kenari*, Indonesian) are eaten. Certain species, e.g., *C. album*, *C. ovatum* and *C. vulgare*, are planted as avenue trees, or for wind-breaks and also as shade-trees for nutmeg plantations.

Taxonomy. Although the Burseraceae is taxonomically closely related to the Meliaceae and Simaroubaceae it is liable to be confused with the pinnate-leaved species of the Anacardiaceae. The sole distinguishing character is the number of ovules per cell which is two in every cell in the Burseraceae and one in the Anacardiaceae. Vegetatively, the swollen petiolule is a good diagnostic feature for most members of the Burseraceae. The family is divided into 3 tribes. Except for *Triomma* which belongs to tribe *Bursereae* with capsular fruit, all the genera in Borneo belong to the tribe *Canarieae* with a drupaceous fruit. *Triomma* retains a capsular fruit which must be the primitive fruit of the family and which is perhaps to be regarded as an ancient relic character.

Key to genera

1. Flowers 4–5-merous. Fruit with 1 or more pyrenes.....2
 Flowers 3-merous. Fruit with 1 pyrene.....5
2. Flowers bisexual. Stipellae present. Leaflet margin toothed.....3. **Garuga**
 Flowers unisexual. Stipellae absent. Leaflet margin entire or occasionally toothed.....3
3. Stamens 5; disc extrastaminal. Fruit a 3-winged capsule. Leaflets withering yellow,
 with pink veins.....8. **Triomma**

- Stamens 8 or 10; disc intrastaminal. Fruit a globular or ellipsoid drupe. Leaflets not so.....4
4. Receptacle of flower cup-shaped; ovary 3-celled.....7. **Scutinanthe**
Receptacle flat; ovary 4–5-celled.....5. **Protium**
5. Fruit thick-walled, bony, seated on enlarged calyx. Leaves often stipulate, leaflet margin often toothed.....1. **Canarium**
Fruit thin-walled, calyx not enlarged in fruit. Leaves without stipules, leaflet margin entire.....6
6. Remains of stigma on the fruit always distinctly off-centre. Fruit surface smooth when dry.....6. **Santiria**
Remains of stigma on the fruit not off-centre. Fruit smooth or coarsely wrinkled when dry.....7
7. Dry fruits smooth. Cotyledons entire. Inflorescences axillary, to 10 cm long...4. **Haplobolus**
Dry fruits coarsely wrinkled. Cotyledons divided. Inflorescences axillary and terminal, much longer.....2. **Dacryodes**

1. CANARIUM Stickman

(from the Moluccan name *kenari*)

kedondong (Malay)

Herb. Amb. (1754) 10 (erroneously *Cenarium*); King *l.c.* 236; Ridley *l.c.* (1922) 369; H.J. Lam, Bull. Jard. Bot. Btze. 3, 12 (1932) 422; Burkill, EPMP 1 (1935) 424; Browne *l.c.* 70; Leenhouts *l.c.* (1956) 249, *l.c.* (1972) 92, Blumea 9 (1959) 275; Backer & Bakhuizen *f. l.c.* 114; Kochummen *l.c.* (1972) 126, Sandakania 5 (1994) 73; Cockburn *l.c.* 37; Anderson *l.c.* 155; Corner *l.c.* 200; Wong *l.c.* 30; Whitmore, Tantra & Sutisna *l.c.* 34; Ng *l.c.* 37.

Medium-sized to large buttressed trees, rarely shrubs. **Bark** grey-fawn or light yellow-brown, smooth, scaly or dippled, with many small lenticels; *inner bark pinkish or reddish, laminated*, soft, aromatic, with clear sticky exudate, rarely with non-sticky exudate, which becomes dark brown on exposure. **Sapwood** whitish, darkening inwards. Twigs usually round, *the pith nearly always with vascular strands*. **Leaves** often with stipules of various shapes and sizes, at base of rachis or on it, soon falling off; leaflets generally with pointed tips, *the margin entire, dentate, or serrate*, basal pair of leaflets usually smaller; petiole rounded, flattened or channelled especially towards base, often swollen at base. **Inflorescences** axillary or terminal panicles, spikes, racemes, or thyrses, female ones often reduced and smaller. **Flowers** unisexual, male and female on separate trees, *3-merous*; receptacle flat or concave; calyx cup-shaped, *lobes* deltoid, outside glabrous or hairy, *inside always densely silky-hairy*; petals 3, creamy, free, usually overlapping in bud, nearly always ovoid-oblong, *the tip inflexed, fleshy and thick* with thin margins, outside hairy in the centre, inside usually glabrous; stamens 6 in one whorl, rarely only 3, free to entirely connate, sometimes adnate to the disc, in female flowers sterile and often less-developed, filaments flattened,

anthers opening by a longitudinal slit; disc inside to the stamens (intrastaminal), 6-lobed, strongly developed in male flowers; ovary in female flowers stalked if receptacle is concave, ovoid to ellipsoid, style cylindrical, stigma globular, slightly 3-lobed; in the male much reduced, often fused to disc. **Fruit** a drupe seated on persistent enlarged calyx, with apical stigma, blue black when ripe (rarely ivory white or red), hairy especially near base and apex, or glabrous; pericarp fleshy or fibrous, wrinkled when dry; stone hard, woody, round or triangular in cross-section, with 3 cells, often reduced to 2 or 1, containing woody intrusions of the placenta, penetrating between cells as wings, often visible as surface ribs. **Seed** 1 per cell; testa brown; without endosperm; cotyledons oily, 3-lobed in most species but 5-lobed in *C. megalanthum*.

Distribution. c. 100 species; tropical W and E Africa, Madagascar, Mauritius, Sri Lanka, SE Asia from S Deccan to S China and Hainan, Malesia, NE Australia and Melanesia; 23 species in Sabah and Sarawak.

Ecology. Common in the lowland mixed dipterocarp forests, rare in submontane forests to 1800 m.

Uses. *Canarium* species produce general utility timber. Burkill (*l.c.*) documents some of the uses. *C. pimela* is cultivated in SE China as an ornamental and as a fruit tree. The fruits are highly esteemed by the Chinese. *C. indicum*, *C. ovatum* and *C. vulgare* are planted for their nuts. They are an important constituent of the diet in the Solomon Islands. In Malaysia and China they are a valued titbit. In Sarawak *C. odontophyllum* is widely cultivated for the edible fruits. *C. pseudodecumanum* has edible fruits; the oil pressed out of the seeds is locally used. The resin is used in pharmacy in ointments and plasters, mainly from *C. luzonicum*, the "Manila-elemi". It is also a constituent of cellulose lacquers. The shell of the nut is used as fuel substitute in the Solomon Islands. Very little is known about the economic value of the other species.

Taxonomy. The genus can be subdivided into 3 subgenera: subgenus *Canarium* consisting of sections *Canarium* and *Pimela* is centred in Malesia, subgenus *Africanarium* in W Africa, and subgenus *Canariellum* restricted to E Queensland and New Caledonia. In Sabah and Sarwak, section *Canarium* can be recognised by its foliaceous or pectinate (comb-like) stipules, its leaflets which dry brown, its stamens that are free or adnate to the disc, the usually glabrous disc and pistil, and the larger fruit (5–7 cm long) with frequently tomentose calyx. In contrast, section *Pimela* has lanceolate or narrow stipules, leaflets which dry greyish green, stamens that are often partly or entirely connate, a disc and pistil that are mostly pilose, and smaller fruit (often 2.5–3.5 cm long) with usually glabrous calyx.

Key to *Canarium* species

- | | |
|--------------------------------|----|
| 1. Leaflets glabrous..... | 2 |
| Leaflets hairy..... | 16 |
| 2. Leaflet margin toothed..... | 3 |
| Leaflet margin entire..... | 6 |

3. Leaflets distinctly whitish below.....**13. C. littorale**
 Leaflets not so, rarely faintly whitish below.....4
4. Stipules absent. Leaflet base rounded, margin faintly toothed.....**20. C. pseudodecumanum**
 Stipules present. Leaflet base not rounded, margin distinctly toothed.....5
5. Stipules deeply irregularly lobed. Rachis yellowish.....**5. C. denticulatum**
 Stipules suborbicular, not lobed. Rachis brownish.....**10. C. kinabaluensis**
6. Leaflets sessile, lateral veins perpendicular to midrib. Trees with stilt-roots
**4. C. decumanum**
 Leaflets stalked, lateral veins not so. Trees without stilt-roots.....7
7. Plants without stipules.....8
 Plants with stipules.....10
8. Lateral veins 5–7 pairs. Leaflet apex with 1–2-cm-long tip.....**22. C. pseudopimela**
 Lateral veins 7–14 pairs. Leaflet apex without such long tips.....9
9. Twigs with prominent leaf-scars. Petals clawed.....**21. C. pseudopatentinervium**
 Twigs without prominent leaf-scars. Petals not clawed.....**19. C. pilosum**
10. Stipules needle-like.....11
 Stipules broad and flat.....13
11. Rachis black. Flowers reddish when fresh.....**6. C. dichotomum**
 Rachis not black. Flowers not reddish when fresh.....12
12. Leaflet stalk about 5 mm long; lateral veins 15–18 pairs.....**11. C. kostermansii**
 Leaflet stalk longer, to 20 mm long; lateral veins 6–11 pairs.....**2. C. asperum**
13. Leaves faintly glaucous below.....**14. C. littorale**
 Leaves not glaucous below.....14
14. Lateral veins and reticulations invisible.....**18. C. patentinervium**
 Lateral veins and reticulations visible.....15
15. Lateral veins prominently raised above; leaflet base usually rounded.....**7. C. divergens**
 Lateral veins not raised; leaflet base cuneate.....**3. C. caudatum**
16. Leaflet margin toothed.....17
 Leaflet margin entire.....24
17. Leaflets sessile, margin minutely toothed.....**20. C. pseudodecumanum**
 Leaflets stalked, margin coarsely and distinctly toothed.....18
18. Stipules absent.....19
 Stipules present.....21

19. Apex of leaflet blunt, rounded or notched.....1. *C. apertum*
 Apex of leaflet pointed.....20
20. Leaflet margin curled inwards.....9. *C. grandifolium*
 Leaflet margin not so.....23. *C. sarawakanum*
21. Stipules linear. Twigs woolly.....19. *C. pilosum*
 Stipules broad and flat. Twigs not woolly.....22
22. Stipules deeply incised.....17. *C. odontophyllum*
 Stipules not deeply incised.....23
23. Stipules kidney-shaped with wavy margin.....14. *C. littorale*
 Stipules rounded to ovate, margin not wavy.....13. *C. latistipulatum*
24. Stipules 3–4-lobed. Leaflet base rounded.....15. *C. megalanthum*
 Stipules linear, not lobed. Leaflet base not rounded.....25
25. Leaflet margin curled inwards.....8. *C. fusco-calycinum*
 Leaflet margin not curled inwards.....26
26. Ultimate leafy twigs stout, more than 1 cm thick. Leaflets (except basal ones) subsessile, base rounded or subcordate.....10. *C. hirsutum*
 Ultimate leafy twigs slender, less than 1 cm thick. Leaflets distinctly stalked, base cuneate.....16. *C. merrillii*

1. *Canarium apertum* H.J. Lam

(Latin, *apertus* = open or unshielded; the basal gaps between petals)

Ann. Jard. Bot. Btzg. 42 (1932) 214, Bull. Jard. Bot. Btzg. 3, 12 (1932) 491; Masamune *l.c.* 362; Leenhouts *l.c.* (1956) 275, *l.c.* (1959) 386; Burgess *l.c.* 60; Kochummen *l.c.* (1972) 128; Anderson *l.c.* 155; Whitmore, Tantra & Sutisna *l.c.* 34. **Type:** *Beccari PB 1630*, Sarawak, Matang (holotype FI; isotypes K, L). **Synonym:** *Santiria serrulata* Engl. in DC., Mon. Phan. 4 (1883) 160; *non C. serrulatum* Miq., Fl. Ind. Bat. 1, 2 (1859) 646.

Very large tree to 40 m tall, 80 cm diameter; buttresses to 2 m high. **Bark** grey-brown, lenticellate, scaly; inner bark yellow-brown. Twigs angled, powdery reddish brown hairy when young. *Stipules absent*. **Leaves** with 3–4 pairs of leaflets; rachis and petiole powdery brown-hairy; blade oblong, elliptic or ovate, 4.5–10.5 x 3–5.5 cm, sparsely rough-hairy below and on midrib above; base rounded to subcordate, margin finely toothed towards apex, *apex blunt or rounded*; midrib flattened above; *lateral veins* 8–15 pairs, prominently raised below, *giving a bullate appearance to the blade*, flat above; intercostal veins reticulate, raised below, faint above; petiolules 2–3 mm long, powdery hairy. **Flowers** (female) yellow-brown, in terminal broadly thyrsoid panicles; *petals clawed*. **Fruits** ovoid, pointed, hairy, circular in cross-section, 4–5 x 2–2.5 cm.

Distribution. Sumatra, Peninsular Malaysia and Borneo. Uncommon in Sabah, recorded from Beaufort, Keningau, Sandakan, Tawau and Tenom. In Sarawak, reported from Belaga, Lundu, Miri and the Sabal Forest Reserve. Also occurs in Kalimantan.

Ecology. In lowland mixed dipterocarp forests to 500 m, on clay-rich and yellow sandy soils and alluvium. Flowers collected in January and April and fruits in May and October.

2. *Canarium asperum* Benth.

(Latin, *asper* = rough, uneven; possibly the rough-hairy inflorescence)

in Hooker, Lond. J. Bot. 2 (1843) 215; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 461; Masamune *l.c.* 362; Leenhouts *l.c.* (1956) 293, *l.c.* (1959) 439; Backer & Bakhuizen *f. l.c.* 115; Whitmore, Tantra & Sutisna *l.c.* 34. **Type:** *Hinds, s.n.*, New Guinea (K).

subsp. *asperum* var. *asperum*

Synonyms: *Canariopsis aspera* (Benth.) Miq., Fl. Ind. Bat. 1, 2 (1859) 653; *Canarium villosum* Benth. & Hook. *f. ex F.-Vill.*, Nov. App. (1880) 40; *C. molle* Engl. in DC. *l.c.* 109 (for a complete list of synonyms, *cf.* Leenhouts *l.c.* (1956)).

Small to medium-sized tree to 30 m tall, 50 cm diameter. **Bark** pale brown, scaly with large flakes; inner bark dull brown with white sticky exudate. **Sapwood** cream. *Stipules* needle-like, inserted near the base of petiole. **Leaves** with up to 6 pairs of leaflets; rachis glabrous, rarely hairy; petiolules of lateral leaflets 0.5–2 cm long, swollen towards apex (only 2 mm long on collections from Pulau Gaya), rarely hairy; blade elliptic to lanceolate, 7.5–16 x 4–6.5 cm; base rounded to broadly cuneate, slightly unequal, *margin entire*, apex pointed; midrib raised above; lateral veins 6–11 pairs, raised below, faintly raised above; intercostal veins scalariform-reticulate, raised below, faint above. **Flowers** in axillary spikes or racemes. **Fruits** ovoid to subglobose, 9–14 x 4–11 mm.

Distribution. E Java, Borneo, Lesser Sunda Islands, Philippines, Celebes, Moluccas, New Guinea and the Solomon Islands. In Sabah uncommon, recorded only from Pulau Selipol, P. Gaya, P. Banggi, Lahad Datu and Kudat. Not yet recorded from Sarawak. Also known from Kalimantan.

Ecology. Rocky coasts and inland lowland mixed dipterocarp forests.

Leenhouts *l.c.* (1956 & 1959) recognised two subspecies, *viz.* subsp. *asperum* and *papuanum*, of which only subsp. *asperum* occurs in Sabah and Sarawak. Of subsp. *asperum*, he distinguished two varieties, namely var. *asperum* and var. *clementis* with the latter endemic to the Philippines.

3. *Canarium caudatum* King

(Latin, *caudatus* = tailed; the gradually tapering leaflet apex)

l.c. 240; Ridley *l.c.* (1922) 370, Kew Bull. (1930) 81; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 443; Masamune *l.c.* 362; Leenhouts *l.c.* (1956) 259, *l.c.* (1959) 343; Kochummen *l.c.* (1972) 129. **Type:** *King's collector 10227*, Perak (holotype CAL; isotypes A, BM, G, L).

Medium-sized to large tree to 36 m tall, 40 cm diameter. **Bark** grey, cracking and scaly; *inner bark with strong resinous smell*. Stipule usually falling off early, kidney-shaped.

Leaves with 2–4 pairs of leaflets; petiolules of lateral leaflets *c.* 1 cm long, swollen at both ends; blade elliptic or ovate, 5.5–16.5 x 3–8 cm; base rounded or broadly cuneate, margin entire, apex pointed, tip *c.* 1 cm long; midrib raised above; lateral veins 8–11 pairs, distinct on both surfaces; intercostal veins reticulate, visible on both sides. **Flowers** in terminal thyrsoïd inflorescences; *stamens 3 in male flowers and 6 in female flowers*. **Fruits** spindle-shaped, 5.5–8 x 2–3.5 cm, with saucer-shaped persistent calyx.

Key to forms

Stipules small, kidney-shaped, inserted partly on the twig.....

forma **caudatum**

Synonym: *C. pauciflorum* Ridl. *l.c.* (1930) 80.

Sumatra, Peninsular Malaysia and Borneo. Of scattered distribution in Sabah and Sarawak.

Stipules auricle-shaped, inserted on the petiole.....

forma **auriculiferum** Leenh.

Blumea 8 (1955) 181. Type: *Haviland 2877*, Sarawak (holotype SING; isotype BM, K, L, SAR).

Sumatra, Peninsular Malaysia, and Borneo. In Borneo uncommon, known by a few collections from Sabah (*SAN 33828*), Sarawak (e.g., *S. 5840*, *S. 12032* and *S. 46003*), and Kalimantan.

Ecology. Lowland mixed dipterocarp and *kerangas* forests to 230 m.

4. **Canarium decumanum** Gaertn.

(Latin, *decumanus* = the largest or greatest; the size of the fruit and tree)

Fruct. 2 (1791) 99; H.J. Lam, *Bull. Jard. Bot. Btzig.* 3, 12 (1932) 435; Leenhouts *l.c.* (1956) 276, *l.c.* (1959) 389; Burgess *l.c.* 60; Cockburn *l.c.* 39; Whitmore, *Tantra & Sutisna l.c.* 34. **Type:** *Hort. Bot. Bog. VI E 5* (= Pl. Bog. Exsicc. 116), Moluccas (neotype L; isoneotypes B, BO, BRSL, G, K, L, NY).

Very large tree to 54 m tall, 150 cm diameter; buttresses to 5 m tall, *stilt-roots present*. **Bark** grey, smooth to scaly or dippled; inner bark orange-red, granular, with strong mango smell, exudate brownish and sticky. **Sapwood** white. Twigs pale white with prominent leaf-scars. *Stipules inconspicuous*. **Leaves** closely spirally arranged, with 4–5 pairs of *almost sessile leaflets*; rachis powdery yellowish hairy; blade oblong, elliptic or ovate, 6–15.5 x 3–7 cm; base rounded or subcordate, *margin entire*, apex pointed; midrib flattened above; *lateral veins 12–23 pairs, almost perpendicular to midrib, forking and forming reticulations a few millimeters away from margin*, visible on both surfaces; intercostal veins scalariform-reticulate, very faint; *petiole flattened above with sharp edges*. **Flowers** hairy, in axillary thyrsoïd inflorescences. **Fruits** ellipsoid, 7–8.5 x 4.5–6 cm, rough hairy.

Vernacular name. Sabah—*pamatudon* (Malay, Dusun).

Distribution. Borneo, Moluccas, New Guinea. In Sabah uncommon, recorded from Lahad Datu and Sandakan; not yet reported from Sarawak; also known in Kalimantan.

Ecology. Lowland forests.

5. *Canarium denticulatum* Blume

(Latin, *denticulatus* = with very small teeth; the leaflet margin)

Bijdr. (1826) 1162; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 521; Masamune *l.c.* 362; Leenhouts *l.c.* (1956) 272, *l.c.* (1959) 367; Backer & Bakhuizen *f. l.c.* 115; Burgess *l.c.* 60; Kochummen *l.c.* (1972) 129; Cockburn *l.c.* 41; Whitmore, Tantra & Sutisna *l.c.* 34. **Type:** *Blume 743*, Java (L, lectotype).

Medium-sized tree to 30 m tall, 50 cm diameter; buttresses short. **Bark** grey-white, smooth; middle bark green; inner bark pinkish. **Sapwood** white. Twig pale whitish. *Stipules persistent, yellowish, inserted on petiole, deeply irregularly lobed.* **Leaves** with 2–6 pairs of leaflets; rachis pale yellow; petiolules of lateral leaflets 8–15 mm long, yellowish (rachis hairy in saplings); blade elliptic or oblong, 6–23.5 x 3–9 cm; base unequal, rounded or cuneate, margin faintly toothed towards apex, apex pointed; midrib raised above; lateral veins 9–13 pairs, curving and joining near margin, visible on both surfaces; intercostal veins reticulate, faintly visible on both surfaces; glabrous or reddish brown-hairy on the lower side. **Flowers** white, hairy, in an axillary thyrsoid inflorescence. **Fruits** ellipsoid, 2.5–3 x 1.5 cm.

Key to subspecies

Leaflets reddish brown-hairy below, margin toothed.....

subsp. **kostermansii** Leenh.

Blumea 8 (1955) 181. Type: *Kostermans 5226*, E Borneo, Sg. Menubar region (holotype L; isotypes BM, BO, K).

Endemic to Borneo. Uncommon, in Sabah only known from several collections, all from the east coast districts; also in Kalimantan.

Leaflets glabrous, margin entire or faintly toothed.....

subsp. **denticulatum**

Synonyms: *C. fissistipulum* Miq., Fl. Ind. Bat. Suppl. (1861) 521; *C. kunstleri* King *l.c.* 184; *C. laciniatum* Elmer, Leafl. Philip. Bot. 3 (1911) 1084.

Andamans, Burma, Sumatra, Peninsular Malaysia, Borneo, and the Philippines. In Sabah reported from Ranau, Kalabakan, Kinabatangan, Lahad Datu, Sandakan, Tawau. In Sarawak known from Batu Laga, Bt. Mersing, Ulu Tinjar, Bt. Raya, Ulu Rajang, Segam FR, Lambir NP and Marudi; also known in Kalimantan. Common in the lowlands, rarely to 750 m, in mixed dipterocarp forest on friable fertile soils, particularly on basic volcanic rocks.

6. *Canarium dichotomum* (Blume) Miq.

(Latin, *dichotomus* = having divisions always in pairs; branching of the inflorescence)

l.c. (1859) 648; Merrill *l.c.* (1929) 116; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 447; Masamune *l.c.* 363; Leenhouts *l.c.* (1956) 283, *l.c.* (1959) 423; Burgess *l.c.* 60; Anderson *l.c.* 155; Whitmore, Tantra & Sutisna *l.c.* 34. **Basionym:** *Pimela dichotoma* Blume, Mus. Bot. Lugd. Bat. 1 (1850) 222. **Type:** *Korthals 957*, Sumatra (holotype L; isotype U). **Synonym:** *C. endertii* H.J. Lam, Ann. Jard. Bot. Btzg. 42 (1932) 210.

Medium-sized tree to 27 m tall, 25 cm diameter. **Bark** brownish to reddish, smooth to scaly; inner bark reddish brown. **Sapwood** pale white. Twigs 0.5–2(–2.5) cm thick, grey or dark brown to blackish, powdery brown-hairy when young. *Stipules* linear, hairy, on the base of rachis, *persistent*. **Leaves** with 1–4 (rarely 6–8) pairs of leaflets; rachis black, powdery brown-hairy; petiolules of lateral leaflets 0.5–2 cm long, hairy; blade elliptic to lanceolate or oblong, 8–20 x 4–9.5 cm, sparsely hairy below or glabrous; base broadly cuneate, unequal, margin entire, apex pointed, tip *c.* 1 cm long; midrib raised above; lateral veins 9–15 pairs, raised below, distinct above; intercostal veins reticulate, faintly visible on both surfaces. **Flowers** in terminal and axillary thyrsoid inflorescences, main branches in male inflorescences repeatedly dichotomously branched, axis reddish. **Fruits** oblong, 3–4 x 1.2–1.5 cm, triangular; calyx funnel-shaped.

Distribution. Sumatra, Borneo. Of scattered distribution in Sabah and Sarawak. Also known in Kalimantan.

Ecology. Lowland forest, rarely in submontane forest to 1200 m.

7. *Canarium divergens* Engl.

(Latin, *divergium* = going different ways; the laxly branched inflorescence)

in DC. *l.c.* 143; Merrill *l.c.* (1921) 316; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 503; Masamune *l.c.* 363; Leenhouts *l.c.* (1956) 260, *l.c.* (1959) 346; Anderson *l.c.* 155. **Type:** *Beccari PB 2237*, Sarawak, Matang (holotype P; isotypes FI, K).

Medium-sized tree to 30 m tall, 45 cm diameter; buttresses short. **Bark** grey-white, lenticellate, scaly. Twigs brownish, glabrous. *Stipules* deciduous. **Leaves** with 2–4 pairs of leaflets; petiolules of lateral leaflets 7–15 mm long; blade elliptic, ovate or obovate, 7–18 x 3.5–9.5 cm, glabrous; base cuneate to rounded, margin entire to faintly toothed, apex pointed, tip *c.* 1 cm long; midrib raised above; lateral veins 7–13 pairs, raised below, faint above, curving and joining near margin; intercostal veins scalariform-reticulate, raised below, faint above. **Inflorescences** thyrsoid, terminal and axillary; male to 37 cm long, hairy. **Fruits** yellowish green when fresh, ellipsoid, 6–8.5 x 2.5–3.5 cm; calyx funnel-shaped with wavy margin.

Distribution. Endemic to Borneo. Uncommon in Sabah, known by a single collection *SAN 50076* from Beaufort; more common in Sarawak, (Semengoh, G. Buri, Matang, Lambir National Park, Bintulu and Ulu Anap); also recorded from Brunei.

Ecology. Mixed dipterocarp forests on deep sandy humult ultisols, to 450 m.

8. *Canarium fusco-calycinum* Stapf ex Ridl.

(Latin, *fuscus* = dark or dark brown, *calycinus* = calyx; the colour of the calyx)

l.c. (1930) 82; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 499; Masamune *l.c.* 363; Leenhouts *l.c.* (1956) 283, *l.c.* (1959) 424; Anderson *l.c.* 155. **Type:** *Haviland 1981*, Sarawak, Kuching (holotype K; isotypes BM, SAR).

Medium-sized tree to 20 m tall, 50 cm diameter. *Twigs rusty brown-hairy*. *Stipules linear, falling off early*. **Leaves** with 2 pairs of leaflets; rachis hairy; petiolules of lateral leaflets 2–3 mm long, hairy; *blade hairy below*, ovate to oblong, 4.5–15 x 3–9 cm; base broadly cuneate, margin entire, incurled, apex pointed, tip *c.* 1 cm long; midrib raised above, hairy; lateral veins 12–17 pairs, raised below, visible above, curving and joining near margin; intercostal veins scalariform-reticulate, raised below, faint above. **Flowers** (male) in terminal thyrsoid inflorescences, hairy; stamens united. **Fruits** ellipsoid, 3–3.5 x 1.2–1.5 cm, triangular in cross-section; calyx red-brown hairy, with distinct lobes.

Distribution. Endemic to Sarawak. Uncommon, reported from the 1st, 4th and 7th Div.

Ecology. Lowland mixed dipterocarp forest.

9. *Canarium grandifolium* (Ridl.) H.J. Lam

(Latin, *grandis* = large; *folium* = leaf)

Ann. Jard. Bot. Btzig. 42 (1932) 215, Bull. Jard. Bot. Btzig. 3, 12 (1932) 527; Leenhouts *l.c.* (1956) 275, *l.c.* (1959) 386; Kochummen *l.c.* (1972) 129. **Basionym:** *Trigonochlamys grandifolia* Ridl., J. Str. Br. R. As. Soc. 54 (1916) 31, *l.c.* (1922) 381. **Type:** *Cantley's collector, s.n.*, Singapore (lectotype SING).

Medium-sized to large tree to 40 m tall, 60 cm diameter; buttresses tall. **Bark** greyish, dippled and scaly. *Twigs densely fulvous tomentose*. *Stipules absent*. **Leaves** with 5–7 pairs of leaflets, leaflet stalks glabrous to hairy; *blade elliptic to obovate, 10–17 x 5–8 cm, densely hairy beneath and on midrib above*; base cuneate to rounded, *margin recurved, minutely toothed* to entire, apex rounded with short tip; *midrib sunken above*; *lateral veins 9–14 pairs, prominently raised below*; *intercostal veins equally prominent, sunken above*. **Inflorescences** terminal, rarely lateral, densely red-tomentose; male thyrsoid, female racemose to spicate. **Flowers** pubescent; *petals clawed*; stamens free. **Fruits** ellipsoid, *c.* 5 x 3.5 cm, slightly hairy at apex.

Distribution. Peninsular Malaysia and Borneo. In Sabah and Sarawak very uncommon, known only from two collections (*SAN 44553* and *S. 36641*); also known from Brunei.

Ecology. Lowland mixed dipterocarp forest.

10. *Canarium hirsutum* Willd.

(Latin, *hirsutus* = covered with rough hairs; the fruit)

Sp. Pl. 4 (1805) 760; Ridley *l.c.* (1922) 374; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 466; Masamune *l.c.* 363; Leenhouts *l.c.* (1956) 287, *l.c.* (1959) 424; Backer & Bakhuizen *f. l.c.* 115; Burgess *l.c.* 60; Kochummen *l.c.* (1972) 130; Cockburn *l.c.* 42; Anderson *l.c.* 155; Whitmore, Tantra & Sutisna *l.c.* 35. **Type:** *bb. 33772*, Moluccas (neotype L; isoneotypes A, BO, SING). **Synonyms:** *C. hispidum* Blume, Cat. (1823) 109; *C. subcordatum* Ridl. *l.c.* (1922) 374.

Medium-sized tree to 25 m tall, 60 cm diameter. *Twigs very stout, 1.5–3.5 cm thick*, reddish brown-hairy near tip, pith large with many small vascular strands. *Stipules* present (except in two varieties), caducous, inserted on the petiole, *subulate*, 4–12 mm long. **Leaves** to 2 m long, with 4–13 pairs of leaflets; *blade sessile* except basal ones, glabrous or hairy, ovate to lanceolate, 5–45 x 2.5–15 cm; base rounded to cordate, margin entire, apex pointed; midrib raised above; lateral veins 12–30 pairs, visible on both surfaces; intercostal veins finely reticulate, visible; *petiole to 2 cm thick near base with sharp edges*. **Inflorescences** axillary, male thyrsoid, female subracemose. **Flowers** c. 1 cm long, shortly stalked. **Fruits** with *irritant reddish brown hairs*, oblong to ovoid, 2.8–3.5 x 2–2.5 cm.

Distribution. Throughout Malesia (except Lesser Sunda Islands), Carolines and Solomon Islands. In Sabah rather common, but in Sarawak very uncommon and represented by a single collection (*S. 25192*). Also known in Kalimantan.

Ecology. Mixed dipterocarp forest, rarely to 1800 m.

Two subspecies and a few varieties are recognised for this species. In Sabah and Sarawak only subspecies *hirsutum* is present with its variety *hirsutum* and forma *scabrum* (Blume) Leenh.

11. *Canarium kinabaluensis* Leenh.

(of Mt. Kinabalu)

l.c. (1955) 182, *l.c.* (1956) 260, *l.c.* (1959) 346; Burgess *l.c.* 60; Whitmore, Tantra & Sutisna *l.c.* 35. **Type:** *Ramos 1698*, North Borneo, Sandakan (holotype L; isotypes A, BO, BM, K, P).

Medium-sized tree to 25 m tall, 50 cm diameter; buttresses steep, to 1 m high. **Bark** grey, smooth; inner bark orange with strong resinous smell. **Sapwood** white. Twigs blackish. *Stipules* suborbicular, inserted on the base of the petiole. **Leaves** with 2–4 pairs of leaflets; rachis black, cracking; petiolule black on drying; blade drying to reddish brown, thickly leathery, elliptic-ovate or lanceolate, 8–20 x 3.5–10 cm; base broadly cuneate, margin very faintly toothed, apex pointed; midrib raised above, sharply keeled below; lateral veins 11–13 pairs, raised below; intercostal veins scalariform. **Inflorescences** and **flowers** unknown. **Fruits** spindle-shaped, green drying brown, strongly wrinkled, 6–8 x 2–4 cm. **Seeds** one.

Distribution. Endemic to Borneo. Uncommon, collected from Papar, Sandakan and Mt. Kinabalu in Sabah; also known from Kalimantan.

Ecology. Lowland to submontane forests at 300–1500 m.

12. *Canarium kostermansii* Leenh.

(A.J.G.H. Kostermans, 1907–1994, botanist at the Forest Research Institute Bogor and the Herbarium Bogoriense, Indonesia)

l.c. (1955) 191, *l.c.* (1956) 281, *l.c.* (1959) 398; Burgess *l.c.* 61; Whitmore, Tantra & Sutisna *l.c.* 35. **Type:** *Kostermans 5315*, E Borneo (holotype L; isotypes BM, K).

Medium-sized to large tree reaching 35 m tall, 60 cm diameter. **Bark** brown, smooth. Twigs slender, to 1 cm thick, pith with 2 concentric cylinders of vascular strands. Stipules subulate, caducous. **Leaves** with 4–7 pairs of leaflets; leaflet stalk about 0.5 cm long; blade lanceolate, 10–22 x 3–7 cm; base unequal, broadly cuneate, margin entire, apex pointed; midrib raised above; lateral veins 15–18 pairs, faintly curving towards the margin, raised above; intercostal veins reticulate, distinct on both surfaces. **Inflorescences** (female) axillary, racemose. **Fruits** spindle-shaped, 3 x 1–1.5 cm, glabrous; calyx funnel-shaped.

Distribution. Endemic to Borneo. Uncommon in Sabah and Sarawak; also found in Kalimantan.

Ecology. Lowlands and hill forests to 900 m.

13. *Canarium latistipulatum* Ridl.

(Latin, *latus* = broad, wide, *stipula* = stipule)

l.c. (1930) 81; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 508; Masamune *l.c.* 364; Leenhouts *l.c.* (1956) 258, *l.c.* (1959) 341; Whitmore, Tantra & Sutisna *l.c.* 35. **Type:** *Haviland & Hose 2245*, Sarawak, Kuching (holotype K; isotype SAR).

Small to medium-sized tree to 27 m tall. *Young twigs powdery brown-hairy*. Stipules sub-persistent, *rounded to ovate*, 1–2 x 1–1.7 cm, inserted on the base of petiole. **Leaves** with 3 pairs of leaflets; rachis powdery brown-hairy; petiolule of lateral leaflets 5–10 mm long, hairy; *blade sparsely hairy below*, drying reddish brown, oblong or elliptic, 6–15 x 3.5–6 cm; base broadly cuneate, margin toothed, apex pointed, tip *c.* 1.5 cm long; midrib raised above; lateral veins 7–10 pairs, raised below, curving and joining near margin; intercostal veins scalariform-reticulate, distinct below, faint above. **Flowers** (male) hairy, in terminal thyrsoid inflorescences. **Fruits** oblong, 6.2–7.2 x 2.2–3 cm, with tapered base; calyx funnel-shaped, powdery brown-hairy.

Distribution. Endemic to Borneo. Common in Sabah but uncommon in Sarawak and known only by 2 other collections (*S. 3458* & *S. 52998*) beside the type.

Ecology. Lowland forests.

14. *Canarium littorale* Blume

(Latin, *littoralis* = of the seashore; its main habitat)

l.c. (1826) 1164; Merrill *l.c.* (1929) 116; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 498; Masamune *l.c.* 364; Leenhouts *l.c.* (1956) 256, *l.c.* (1959) 337; Backer & Bakhuizen *f. l.c.* 115; Burgess *l.c.* 61; Kochummen *l.c.* (1972) 130; Cockburn *l.c.* 42; Anderson *l.c.* 155; Whitmore, Tantra & Sutisna *l.c.* 35. **Type:** *Blume 1736*, Java, Nusa Kambangan (holotype L; isotypes BO, MEL, U).

Medium-sized to large tree to 40 m tall, 60 cm diameter. **Bark** grey, smooth to scaly; inner bark orange-red or brownish. **Sapwood** pale white. Twigs glabrous or hairy. Stipules dropping off early or semi-persistent, kidney-shaped with wavy to deeply lobed margins.

Leaves with 2–6 pairs of leaflets; rachis glabrous or softly hairy; petiolules of lateral leaflets 1–2 cm long, glabrous or hairy, often swollen at both ends; *blade* ovate to oblong or lanceolate, 3–25 x 2–9 cm, glabrous or sparsely to densely hairy below, *sometimes white waxy below*; base cuneate to subcordate, margin entire to faintly or prominently toothed, apex pointed; midrib raised above; lateral veins 9–20 pairs, sometimes curving and joining near margin, raised below, faint or sunken above; intercostal veins scalariform-reticulate or reticulate, distinct below, faint above, rarely sunken above. **Flowers** usually in terminal thyrsoid (male) or subracemose (female) inflorescences. **Fruits** ellipsoid or ovoid, 4.5–7 x 1.5–3 cm, sparsely hairy or glabrous with rugose and wrinkled surface when dried.

An extremely variable species in vegetative and floral characters. Leenhouts (*l.c.* 1959) recognises 5 forms (*littorale*, *pruinsum*, *purpurascens*, *rufum*, and *tomentosum*), of which 3 occur in Sabah and Sarawak.

Key to forms

1. Leaflets whitish beneath.....
 forma **pruinsum** (Engl.) Leenh.
l.c. (1956) 258. Basionym: *C. pruinsum* Engl. in DC. *l.c.* 106, Merrill *l.c.* (1921) 317, Masamune *l.c.* 365. Type: *Beccari PB 1970*, Sarawak (holotype K; isotype FI).
 Confined to Sabah and Sarawak, common in secondary forest, especially on periodically flooded sandy alluvium.

- Leaflets not whitish beneath.....2

2. Leaflets densely hairy below; margin prominently toothed; lateral veins sunken above.....
 forma **rufum** (A.W. Benn.) Leenh.
l.c. (1959) 339. Basionym: *C. rufum* A.W. Benn. in Hooker *f. l.c.* 533, Masamune *l.c.* 365. Type: *Maingay 1434*, Malacca (holotype K; isotypes CAL, L).
 Widely distributed in Sabah, less common in Sarawak. Also in Indo-China, Sumatra, Peninsular Malaysia, and Java.

- Leaflets glabrous below; margin faintly toothed; lateral veins not sunken above.....
 forma **littorale**
 Synonyms: *C. glaucum* Blume *l.c.* (1850) 219; *C. serricuspe* Miq. *l.c.* (1859) 649; *C. serrulatum* Miq. *l.c.* (1859) 646; *C. acutum* Engl. in DC. *l.c.* 113; *C. giganteum* Engl. in DC. *l.c.* 106; *C. flavum* Ridl. *l.c.* (1930) 81.
 Sumatra, Peninsular Malaysia, Java and Borneo. In Sabah and Sarawak common in the lowland mixed dipterocarp to submontane forests to 1100 m. Also found in Kalimantan.

15. **Canarium megalanthum** Merr.

(Greek, *mega* = large, *anthos* = flower)

Philip. J. Sc. 30 (1926) 81; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 446; Masamune *l.c.* 324; Leenhouts *l.c.* (1956) 274, *l.c.* (1959) 370; Burgess *l.c.* 61; Kochummen *l.c.* (1972) 131; Anderson *l.c.* 155; Whitmore, Tantra & Sutisna *l.c.* 35. Type: *Wood 1213*, British North Borneo (holotype UC; isotypes A, K, L).

Emergent tree to 35 m tall, 50 cm diameter; buttresses present. **Bark** grey, smooth to dippled and scaly; inner bark reddish brown. **Sapwood** yellowish white. *Stipules* sub-persistent, inserted on the petiole near base, *3-4-lobed*. **Leaves** with 4-5 pairs of leaflets; rachis powdery yellowish hairy; petiolules of lateral leaflets 1-1.5 cm long, powdery hairy; blade powdery hairy, oblong to lanceolate, 8-17 x 4-7 cm; *base rounded*, margin entire, apex pointed; midrib flattened above; lateral veins 10-12 pairs, raised on both surfaces; intercostal veins scalariform-reticulate, visible below. **Flowers** hairy, in terminal thyrsoid inflorescences. **Fruits** ellipsoid, sparsely hairy, 5-7.5 x 2.8-4.5 cm.

Distribution. Sumatra, Peninsular Malaysia, Borneo; uncommon in Sabah and Sarawak. Also known in Kalimantan.

Ecology. Ridges in mixed dipterocarp forest to 360 m. Flowering in May and fruiting in May and September.

Uses. In Brunei this species is cultivated for its edible fruits which are among the largest in the genus.

16. *Canarium merrillii* H.J. Lam

(E.D. Merrill, 1876-1954, American botanist)

in Merrill *l.c.* (1929) 117; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 489; Masamune *l.c.* 364; Leenhouts *l.c.* (1956) 282, *l.c.* (1959) 402; Burgess *l.c.* 61; Anderson *l.c.* 156; Whitmore, Tantra & Sutisna *l.c.* 35. **Type:** *Elmer 20326*, British North Borneo, Sandakan (holotype PNH; isotypes A, BM, G, K, L, NY, P, SING, U, Z).

Small to medium-sized tree to 25 m tall, 30 cm diameter. **Bark** grey, scaly; inner bark brownish. **Sapwood** white. Twigs pale grey, rough hairy. *Stipules* linear, to 5 mm long, inserted at base of petiole, semi-persistent. **Leaves** with 4-5 pairs of leaflets; rachis hairy; petiolules of lateral leaflets 2-5 mm long, hairy; *blade rough hairy below* (like sandpaper to the touch), elliptic, oblong or obovate, 5.5-16 x 3-5.5 cm; base cuneate, unequal, margin entire, apex pointed, tip *c.* 1 cm long; midrib faintly sunken above; lateral veins 6-14 pairs, curving and joining near margin, raised below, visible above; intercostal veins reticulate, distinct below, faint above. **Flowers** yellow, in terminal or axillary thyrsoid inflorescences. **Fruits** ellipsoid, pointed, 3-4.2 x 1.2-1.5 cm.

Distribution. Endemic to Borneo. Of scattered distribution in Sabah, Sarawak and Kalimantan.

Ecology. Mixed dipterocarp to submontane forests to 1400 m.

17. *Canarium odontophyllum* Miq.

(Greek, *odontos* = toothed, *phyllon* = leaf; the toothed leaflets)

l.c. (1861) 521; Merrill *l.c.* (1929) 118; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 519; Masamune *l.c.* 364; Leenhouts *l.c.* (1956) 271, *l.c.* (1959) 365; Burgess *l.c.* 60; Cockburn *l.c.* 43; Anderson *l.c.* 156; Whitmore, Tantra & Sutisna *l.c.* 35. **Type:** *Teijsmann HB 692*, Sumatra (holotype U; isotype L). **Synonyms:** *C. beccarii* Engl. in DC. *l.c.* 107; *C. palawanense* Elmer, Leaflet. Philip. Bot. 5 (1913) 1754; *C. multifidum* H.J. Lam, Ann. Jard. Bot. Btzig. 42 (1932) 215.

Fig. 1.

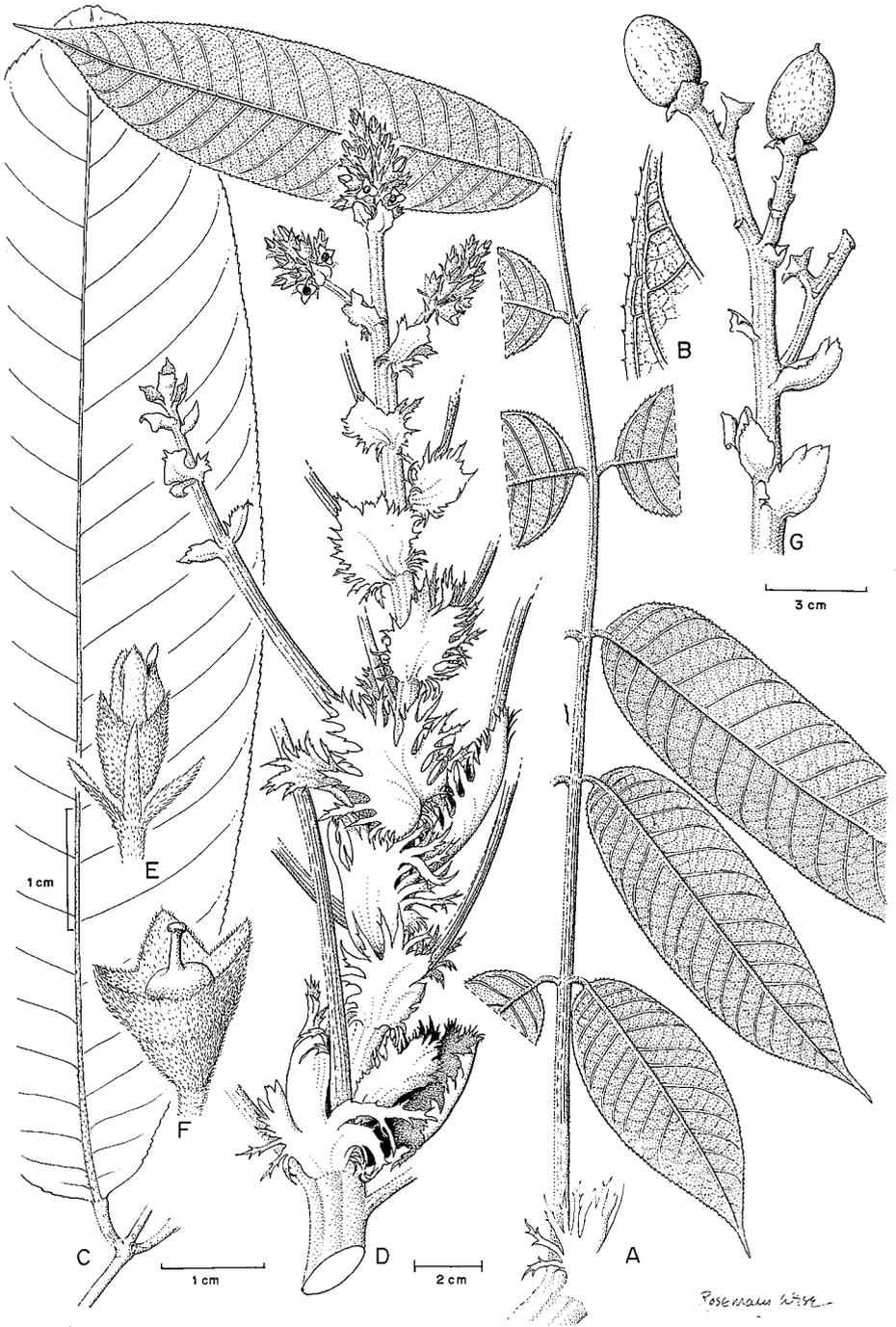


Fig. 1. *Canarium odontophyllum*. A, mature leaf; B, details of leaflet venation and margin; C, young leaflet; D, young shoot with stipules and inflorescences; E, flower bud; F, female flower; G, infructescence. (A, B from SAN 106079; C, D, E & F from SAN 37543; G from SAN 106079.)

Tree to 30 m tall, 30 cm diameter. **Bark** grey-brown; inner bark brownish. **Sapwood** pale. Twigs stout, whitish, 1.5–2 cm thick, rusty hairy. *Stipules persistent, irregularly toothed or lobed, c. 6 x 3 cm.* **Leaves** with 3–8 pairs of leaflets; rachis yellowish hairy; petiolules of lateral leaflets 3–10 mm long, hairy; *blade densely velvety hairy below*, oblong to lanceolate, 9.5–28 x 4–11 cm; base broadly cuneate to rounded, margin toothed, apex pointed; midrib raised above, hairy; lateral veins 12–23 pairs, raised below, faint to sunken above; intercostal veins scalariform-reticulate, raised below, faint to sunken above. **Flowers** hairy, in axillary or terminal thyrsoid inflorescences. **Fruits** ovoid to ellipsoid, 3–4 x 2.5–3 cm.

Distribution. Sumatra, Borneo, and the Philippines. Widely distributed in Sabah, uncommon in Sarawak. Also known in Kalimantan.

Ecology. Mixed dipterocarp forests on fertile clay soils to 500 m. Flowering in May, June and November and fruiting in March and August.

Uses. Widely cultivated in Sarawak and Brunei for its fruits.

18. *Canarium patentinervium* Miq.

(Latin, *patens* = spreading, *nervus* = nerves; the leaflet venation)

l.c. (1861) 526; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 506; Masamune *l.c.* 365; Leenhouts *l.c.* (1956) 258, *l.c.* (1959) 342; Burgess *l.c.* 61; Kochummen *l.c.* (1972) 134; Whitmore, Tantra & Sutisna *l.c.* 36. **Type:** *Teijsmann HB 3736*, Sumatra, Palembang (holotype U; isotype L). **Synonyms:** *C. nitidum* A.W. Benn. in Hooker *f. l.c.* 533; *C. parvifolium* A.W. Benn. in Hooker *f. l.c.* 536.

Tree to 24 m tall, 25 cm diameter. **Bark** grey, smooth. Twigs brownish, lenticellate. Stipules falling off early, kidney-shaped. **Leaves** with 2–4 pairs of leaflets; petiolules of lateral leaflets 1–1.5 cm long, cracking; blade thickly leathery, glabrous, drying to dark brown, ovate to oblong, 7–12.5 x 2.5–6 cm; base cuneate, margin entire, apex pointed; midrib flattened above, rarely sunken; lateral veins 7–10 pairs, raised below, faint above, curving and joining near margin; intercostal veins reticulate, faintly visible on both surfaces, sometimes inconspicuous. **Flowers** hairy, usually in terminal thyrsoid inflorescences. **Fruits** ellipsoid, 6–6.5 x 2.2–3 cm, apex pointed.

Distribution. Sumatra, Peninsular Malaysia, and Borneo. Widespread, collected from Tenom, Tawau and Tuaran in Sabah, and from Lundu, Semengoh to Bukit Lambir in Sarawak. Also found in Kalimantan.

Ecology. Mixed dipterocarp forest on yellow sandy and leached clay soils, and *kerangas* forest, to 450 m.

19. *Canarium pilosum* A.W. Benn.

(Latin, *pilosus* = having soft and distinct hairs; the twigs and leaves)

in Hooker *f. l.c.* 533; King *l.c.* 243; Ridley *l.c.* (1922) 372; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 472; Masamune *l.c.* 365; Leenhouts *l.c.* (1956) 281, *l.c.* (1959) 398; Burgess *l.c.* 61;

Kochummen *l.c.* (1972) 134; Anderson *l.c.* 156; Whitmore, Tantra & Sutisna *l.c.* 36. **Type:** *Maingay 3103*, Malacca (holotype K; isotype CAL).

Small to medium-sized tree to 27 m tall, 25 cm diameter. **Bark** pale brown, smooth; inner bark pink. **Sapwood** white. *Twigs densely woolly hairy. Stipules persistent, linear, inserted at the base of petiole or on the petiole, rarely absent. Leaves with 2–3 pairs of leaflets; rachis densely hairy, rarely glabrous; petiolules of lateral leaflets 2–3 mm long, densely hairy, rarely glabrous; blade densely hairy below, sparsely hairy above, rarely completely glabrous, elliptic, oblong or obovate, 7–19 x 3.5–9 cm; base cuneate or rounded, margin faintly to distinctly toothed, rarely entire, apex pointed, tip c. 1 cm long; midrib raised above; lateral veins 7–14 pairs, raised on both surfaces, curving and joining near margin; intercostal veins scalariform-reticulate, raised below, faint above. Flowers hairy, in axillary or terminal panicles. Fruits oblong, 2–3 x 1–1.5 cm.*

Key to subspecies

Stipules present. Leaflets hairy below, margin toothed.....

subsp. **pilosum**

Synonyms: *C. grandifolium* A.W. Benn. in Hooker *f. l.c.* 533; *C. hirtellum* A.W. Benn. in Hooker *f. l.c.* 533; *C. pilosum* var. *hirtellum* (A.W. Benn.) Ridl. *l.c.* (1922) 372; *C. motleyanum* Engl. in DC. *l.c.* 133.

Sumatra, Peninsular Malaysia and Borneo. In Sabah and Sarawak uncommon, recorded from Beaufort, Beluran, Papar, and Sandakan (Sabah), and from Kapit, Marudi, Miri (Sarawak). Also known in Kalimantan. Lowland forest.

Stipules absent. Leaflets glabrous below, margin entire.....

subsp. **borneensis** Leenh.

l.c. (1955) 193. **Type:** *Clemens 40163*, British North Borneo, Mt. Kinabalu (holotype L; isotypes A, BM, BO, G, NY). **Synonym:** *Dacryodes scandens* Husson, *Blumea* 7 (1952) 164.

Uncommon, known from Mt. Kinabalu, Lahad Datu and Sandakan in Sabah, and G. Lambir in Sarawak. Also found in Kalimantan.

20. **Canarium pseudodecumanum** Hochr.

(Latin, *pseudo* = false; resembling *C. decumanum*)

Pl. Bog. Exs. (1904) 61; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 438; Leenhouts *l.c.* (1956) 275, *l.c.* (1959) 388; Burgess *l.c.* 61; Kochummen *l.c.* (1972) 135; Whitmore, Tantra & Sutisna *l.c.* 36. **Type:** *Hort. Bot. Bog. VI E 6a*, Sumatra, Lampong (holotype L; isotypes B, BO, BRSL, G, K, L, WY, P). **Synonym:** *Canarium decumanum* (*non* Gaertn.) Engl. in Merrill *l.c.* (1929) 116.

Tree to 40 m tall and 120 cm diameter; buttresses to 6 m high. **Bark** grey-white, smooth to scaly; inner bark pale. **Sapwood** yellowish white. *Twigs stout, 1–1.5 cm thick, with large leaf-scars. Terminal bud 4–5 cm long, densely brown tomentose. Stipules absent. Leaves with 4–6 pairs of leaflets; petiole stout, light brown pubescent, swollen at base and flattened above; blade almost sessile, lanceolate or oblong, 17–23 x 7–11 cm, glabrous above except the midrib and lateral veins, densely minutely woolly tomentose below; base rounded or*

subcordate, margin minutely toothed, apex pointed; midrib flattened to raised above; lateral veins 17–23 pairs, distinctly arching near margin, prominent below; intercostal veins prominent giving pitted appearance to the lower surface, veins and reticulations raised above. Inflorescences (male) axillary thyrses. Flowers pubescent. Fruits ellipsoid, 7–8 x 4–6 cm, densely tomentose when young.

Distribution. Sumatra, Peninsular Malaysia, and Borneo. In Sabah recorded from the Ranau, Sandakan and Tawau districts; not recorded from Sarawak. Also known in Kalimantan.

Ecology. Lowland forest to 280 m.

Uses. The resin is used for caulking boats. The fruit is edible. An edible oil is extracted from the seeds.

Closely related to *C. decumanum* but differing in the absence of stipules and by the toothed and densely woolly tomentose lower surface of the leaflets.

21. *Canarium pseudopatentinervium* H.J. Lam

(resembling *C. patentinervium*)

Ann. Jard. Bot. Btzig. 42 (1932) 214, Bull. Jard. Bot. Btzig. 3, 12 (1932) 490; Masamune *l.c.* 365; Leenhouts *l.c.* (1956) 274, *l.c.* (1959) 385; Burgess *l.c.* 61; Anderson *l.c.* 155; Whitmore, Tantra & Sutisna *l.c.* 36. **Type:** *bb.* 153, *T.* 3P. 336, Sumatra, Palembang, Lamatang Ilir near G. Megang (lectotype BO).

Medium-sized to large tree to 45 m tall, 100 cm diameter; buttresses to 5 m tall. **Bark** pale yellow-brown, irregularly scaly to dippled. Twigs whitish, with prominent leaf-scars, pith with many peripherally arranged vascular strands and often with a central cavity. *Stipules absent.* **Leaves** with 1–4 pairs of leaflets; *blade drying greenish*, ovate to elliptic, 5–12 x 2–7 cm; base asymmetric, rounded to broadly cuneate, *margin entire*, apex blunt to pointed; midrib flattened above; lateral veins 7–14 pairs, curving near margin; intercostal veins reticulate, prominent on both surfaces; petiolules of lateral leaflets 5–9 mm long, not swollen at both ends. **Inflorescences (female)** in terminal panicles. **Flowers (female)** subsessile, densely tomentose, *petals distinctly clawed*, apex inflexed, stamens free. **Fruits** ellipsoid, 5–7 x 2–3 cm; calyx triangular, hairy inside.

Distribution. Sumatra, Borneo. In Sarawak uncommon, known only by a single collection *S. 18215* from Belaga; not yet found in Sabah. Also occurs in Kalimantan.

Ecology. Lowland forest at *c.* 100 m.

22. *Canarium pseudopimela* Kochummen

(resembling *C. pimela*)

l.c. (1994) 73. **Type:** *Ding Hou 489*, Sarawak, G. Raya (holotype SAR; isotype L).

Small tree to 12 m tall, 15 cm diameter. Twigs brown, *c.* 3 mm thick, rounded. *Stipules absent.* **Leaves** with 2–3 pairs of leaflets; blade thinly leathery, elliptic to narrowly obovate,

6–13 x 2.5–5 cm, slightly falcate; base cuneate, margin entire, apex cuspidate, tip 1.5–2 cm long; midrib raised above; lateral veins 5–7 pairs, arching and joining near margin, visible below, faint above; intercostal veins finely reticulate, distinctly visible below, faint above; petiolules of lateral leaflets 4–5 mm long, petiolules of terminal leaflet 2–3.5 cm long. **Inflorescences** (female) in racemes, *terminal*, glabrous, *c.* 23 cm long, with 13–14 cm long branches in few-flowered racemes, buds obovate. **Flowers** (female) *c.* 9 mm long, stalk *c.* 5 mm long; calyx funnel-shaped, with obtuse lobes, fleshy, with few irregular lines towards base; petals fleshy, irregularly wrinkled on drying; rudimentary stamens 6, connected into a cup-shaped staminal ring; disc undulate, *c.* 1 mm high; *ovary hairy*, faintly ridged, stigma capitate. **Infructescences** *c.* 13 cm long. **Fruits** ellipsoid, 3 x 1–1.5 cm, triangular, apex narrowed to sharp point; calyx almost flat; stalk *c.* 1.5 cm long.

Distribution. Endemic to Borneo. Uncommon, known by two collections only from G. Lambir (*S. 16613*) and G. Raya (*Ding Hou 489*) in Sarawak.

Ecology. Lowland forests.

Very close to *C. pimela* but differing in the terminal inflorescences, hairy ovary and in the long-pointed leaflets.

23. *Canarium sarawakanum* Kochummen

l.c. (1994) 75. **Type:** *Au S. 24802*, Sarawak, Kapit (holotype SAR; isotypes A, BO, K, KEP, L, SAN, SING).

Small tree to 8 m tall, 10 cm diameter. Twigs reddish brown hairy when young. *Stipules absent*. **Leaves** with 1–2 pairs of leaflets; rachis finely reddish brown hairy; blade thinly leathery, drying to reddish brown, glabrous above, sparsely reddish brown hairy below, elliptic to narrowly obovate, 8–20 x 3.5–8.5 cm; base cuneate, margin sub-entire to faintly toothed, apex acuminate, tip 1–2 cm long; midrib raised above; lateral veins 6–8 pairs, distinct below, faintly raised above, curving and joining near margin; intercostal veins reticulate, visible below, faint above; petiolules of lateral leaflets swollen near the apex, 1–1.5 cm long, that of terminal leaflet to 5 cm long. **Inflorescences** (female) axillary or terminal, thyrsoid, to 22 cm long, with few side branches; rachis brownish hairy. **Flowers** (male) with the calyx hairy outside, margins wavy to lobed; petals oblong, *c.* 4.5 mm long, hairy outside; *stamens* 3, joined at the base, filaments to 2.5 mm long; rudimentary ovary and style present. **Fruits** (immature) ellipsoid, 4.5–5.5 x 1.7–2 cm.

Distribution. Endemic to Borneo. Uncommon, known from a few collections from Kapit, Lubok Antu, G. Penrissen and Simanggang in Sarawak.

Ecology. Lowland to low submontane forests to 900 m.

Close to *C. latistipulatum* but that species has semi-persistent stipules.

2. DACRYODES Vahl

(Greek, *dakruon* = a tear; the resin droplets on the bark surface)

kedondong (Sabah and Sarawak Malay), *kimayau* (Bidayuh in Sarawak)
kembayau (Sabah Dusun), *seladah* (Sarawak Iban)

Skrift. Dansk. Nat. Hist. Selsk. 4 (1810) 116; H.J. Lam, Bull. Jard. Bot. Btztg. 3, 12 (1932) 334; Kalkman, Blumea 7 (1954) 500; Leenhouts *l.c.* (1956) 219, *l.c.* (1972) 917, *l.c.* (1976) 820; Backer & Bakhuizen *f. l.c.* 114; Kochummen *l.c.* (1972) 136; Cockburn *l.c.* 43; Anderson *l.c.* 156; Wong *l.c.* 42; Whitmore, Tantra & Sutisna *l.c.* 36; Ng *l.c.* 37. **Synonyms:** *Pachylobus* G. Don, Gen. Syst. 2 (1832) 89; *Canarium* section *Tenuipyrena* Engl. in DC. *l.c.* 104; *Curtisiana* Ridl., J. Str. Br. R. As. Soc. 82 (1920) 180; *Hemisantiria* H.J. Lam in Merrill *l.c.* (1929) 118.

Small to medium-sized, dioecious trees; buttresses small, short; sometimes with stilt-roots. **Bark** smooth to scaly; *inner bark orange, yellowish white or pink*, exudate often clear, rarely white. **Sapwood** pale. *Stipules absent* (in *D. laxa* the first pair of leaflets are smaller and stipule-like). **Leaflets** *entire*, the base often strongly unequal; *stalks (petiolules) strongly swollen at both ends*. **Inflorescence** an axillary or terminal panicle. **Flowers** unisexual, 3-merous; sepals free or united; *petals usually with thickened inflexed apex*; stamens 6, filaments free, bases united with the disc; disc intrastaminal, glabrous; ovary 3(-2)-celled, usually moderately reduced in male flowers; stigma sessile. **Fruit** a drupe, oblong or ellipsoid, 1-seeded; stigma usually apical; *pericarp fleshy and thick, coarsely wrinkled when dry*, glabrous; stone containing one fertile and two reduced cells; calyx persistent or caducous. **Seeds** round in cross-section; cotyledons 9-11-lobed in *D. rostrata*, and 5-lobed in *D. costata*, *D. laxa* and *D. rugosa*.

Distribution. About 40 species; tropical America, Africa and Asia. In Malesia mainly centred in Sumatra, Peninsular Malaysia and Borneo; 11 species in Sabah and Sarawak.

Ecology. Lowland (including swamp) to submontane forests to 1500 m.

Uses. The timbers of *Dacryodes* are essentially similar to that of *Canarium* in anatomical structure but they are on the whole heavier and the rays contain silica which makes them difficult to saw. Fruits of *Dacryodes rostrata* f. *cuspidata*, known in Sarawak as *keramah* (Malay) and *kembayau* (Murut and Iban), are eaten.

Key to *Dacryodes* species

1. Rachis and young twigs hairy.....2
Rachis and young twigs glabrous.....7
2. Rachis and young twigs covered with long stiff hairs.....5. **D. laxa**
Rachis and young twigs powdery, hairy.....3
3. Ultimate leafy twigs c. 1 cm thick. Terminal bud c. 1.5 cm long.....2. **D. elmeri**
Ultimate leafy twigs to 0.5 cm thick. Terminal bud to 1 cm long.....4

4. Intercostal veins prominently raised below. Hairs not yellowish.....5
Intercostal veins not raised, but visible below. Hairs yellowish.....10. **D. rubiginosa**
5. Intercostal veins scalariform. Leaflets densely hairy below.....8. **D. nervosa**
Intercostal veins reticulate. Leaflets sparsely hairy below.....6
6. Petiolules strongly swollen at both ends; rachis glabrous.....11. **D. rugosa**
Petiolules not strongly swollen at both ends; rachis hairy.....1. **D. costata**
7. Adaxial side of petiole flattened with sharp edges, petiolules of lateral leaflets 2.5–3.5
cm long.....3. **D. expansa**
Petiole and petiolules not so.....8
8. Midrib below sharply keeled; petiole strongly grooved or flattened above.....
.....6. **D. longifolia**
Midrib below not keeled; petiole rounded or flattened above.....9
9. Reticulations fine and more distinct on the upper than on the lower leaflet surface.
Inner bark reddish; cut bark and twigs with white sap.....9. **D. rostrata**
Reticulations more distinct on the lower surface. Inner bark yellowish; cut bark and
twigs without white sap.....10
10. Leaflets usually of 2 pairs only. Trees with stilt-roots.....7. **D. macrocarpa**
Leaflets more than 2 pairs. Trees without stilt-roots.....11
11. Lateral veins sunken above; intercostal veins raised below. Petiolule strongly swollen
at both ends.....11. **D. rugosa**
Lateral veins not sunken above; intercostal veins faintly visible below. Petiolule not
prominently swollen.....4. **D. incurvata**

1. **Dacryodes costata** (A.W. Benn.) H.J. Lam

(Latin, *costatus* = ribbed; probably the prominent veins on the lower leaflet surface)

Ann. Jard. Bot. Btzig. 42 (1932) 204, Bull. Jard. Bot. Btzig. 3, 12 (1932) 359; Masamune *l.c.* 366; Kalkman *l.c.* (1954) 508; Leenhouts *l.c.* (1956) 222; Burgess *l.c.* 61; Kochummen *l.c.* (1972) 140; Anderson *l.c.* 156; Whitmore, Tantra & Sutisna *l.c.* 36. **Basionym:** *Santiria costata* A.W. Benn. in Hooker *f. l.c.* 537. **Type:** *Maingay* 313/3295, Malacca (holotype K; isotype CAL). **Synonym:** *Canarium costatum* (A.W. Benn.) Ridl. *l.c.* (1930) 82.

Medium-sized to large tree to 45 m tall, 45 cm diameter; buttresses short. **Bark** grey-brown, smooth to flaky; inner bark yellow-brown, with droplets of white sap. **Sapwood** whitish. Ultimate leafy twigs to 0.5 cm thick, rusty-brown velvety hairy when young. **Leaves** with 1–3 pairs of leaflets; *rachis powdery rusty hairy; petiole hairy, flattened above*; petiolules of lateral leaflets 5–15 mm long, powdery hairy to glabrous, slightly swollen at both ends; *blade sparsely hairy on midrib and veins below*, elliptic to oblong, 6–15 x 2.5–6 cm; base cuneate, often unequal, apex pointed, tip 1–2 cm long; midrib raised above; lateral veins 10–14 pairs, prominently raised below, faint above, looping and joining

near margin; intercostal veins reticulate, distinct below, faint above. **Inflorescences** terminal or from upper leaf axils, axes densely hairy. **Flowers** pubescent; petals whitish, glabrous; *stamen filaments free from the disc; disc annular to 6-lobed*. **Fruits** ellipsoid or ovoid, 1.7–2.2 x 1–1.2 cm; stalk *c.* 1 cm long.

Distribution. Sumatra, Peninsular Malaysia, Borneo, and the Philippines. In Sabah reported from Ranau, Sandakan and Tawau; in Sarawak, known only from the Lambir National Park and Semengoh FR. Also known in Kalimantan.

Ecology. Widely distributed from lowland to hill forests to 540 m, mainly on ridges and hillsides. Flowering in May and September, and fruiting in July, October and November.

This species is very similar to *D. rugosa* from which it can be distinguished by the hairy petioles, and the less swollen leaflet stalks. The flowers of both species are quite distinct, in *D. costata* the disc is annular to 6-lobed and the stamen filaments free from disc, while in *D. rugosa* the disc is cup-shaped and stamen filaments adnate to disc.

2. *Dacryodes elmeri* H.J. Lam

(A.D.E. Elmer, 1870–1942; plant collector with the Bureau of Science, Manila, the Philippines)

Ann. Jard. Bot. Btzig. 42 (1932) 203, Bull. Jard. Bot. Btzig. 3, 12 (1932) 344; Kalkman *l.c.* (1954) 521; Leenhouts *l.c.* (1956) 225. **Synonym:** *Hemisantria ?n. sp.* H.J. Lam in Merrill *l.c.* (1929) 199. **Type:** *Elmer 21573*, British North Borneo, Tawau (holotype L; isotypes A, BKH, BM).

Tree, to 75 cm in diameter. *Ultimate leafy twigs c. 1 cm thick*, densely minutely villous; pith with many scattered vascular strands. Terminal bud *c.* 1.5 cm long, densely pubescent. **Leaves** with 3–4 pairs of leaflets; rachis strongly flattened at base, hairy at first becoming glabrous; blade oblong, 12–22 x 5–8.5 cm, chartaceous; base oblique-cuneate, on one half rounded, apex pointed; lateral veins 13–18 pairs, prominent beneath. Inflorescence and flower unknown. **Fruits** ovoid, 4–4.7 x 2.25 cm, with rounded apex and base.

Distribution. Endemic to Borneo. Very uncommon, known from the type collection (Sabah) and from Brunei.

Ecology. Lowland forest.

3. *Dacryodes expansa* (Ridl.) H.J. Lam

(Latin, *expansus* = spread out, diffuse; the thin, spread out petals)

Ann. Jard. Bot. Btzig. 42 (1932) 204, Bull. Jard. Bot. Btzig. 3, 12 (1932) 366; Masamune *l.c.* 366; Kalkman *l.c.* (1954) 510; Leenhouts *l.c.* (1956) 228, *l.c.* (1972) 919, *l.c.* (1976) 821. **Basionym:** *Canarium expansum* Ridl. *l.c.* (1930) 83. **Type:** *Haviland 2271*, Sarawak, Kuching (K).

Small tree. Buds reddish brown, hairy. **Leaves** with 4 pairs of leaflets; adaxial side of petiole flattened with sharp edges; petiolules of lateral leaflets 2.5–3.5 cm long, strongly swollen at both ends; blade oblong to oblong-lanceolate, 17–23 x 6–7.5 cm, brownish when dried; base cuneate, apex pointed; midrib raised above; lateral veins 10–12 pairs, prominent below; intercostal veins faint. **Inflorescences** (male) probably lateral on axillary shoots, to 24 cm long, glabrous; *pedicels* 3–7 mm long, *articulated*. **Flowers** (male) glabrous; calyxlobes deltoid; *petals* very thin, *spreading*; stamens free from disc; disc annular, thick; ovary in male flowers reduced. Infructescence and fruit unknown.

Distribution. Endemic to Borneo. Uncommon, known from the type collection only and from Brunei.

Ecology. Lowland forest.

4. *Dacryodes incurvata* (Engl.) H.J. Lam (Latin, *incurvatus* = bending inward; the leaflet margin)

Ann. Jard. Bot. Btzg. 42 (1932) 204, Bull. Jard. Bot. Btzg. 3, 12 (1932) 362; Kalkman *l.c.* (1954) 506; Leenhouts *l.c.* (1956) 224; Burgess *l.c.* 61; Kochummen *l.c.* (1972) 140; Anderson *l.c.* 156; Whitmore, Tantra & Sutisna *l.c.* 36. **Basionym:** *Canarium incurvatum* Engl. in DC. *l.c.* 138. **Type:** *Beccari PB 2937*, Sarawak (holotype P; isotype FI). **Synonyms:** *Santiria nitida* Merr., Publ. Govt. Lab. Philip. 35 (1906) 29; *Canarium nitens* Merr., Philip. J. Sc. 10 (1915) Bot. 24; *Hemisantiria nitida* H.J. Lam in Merrill *l.c.* (1929) 118; *Canarium angulatum* Ridl., Kew Bull. (1931) 493; *Dacryodes angulata* (Ridl.) H.J. Lam, Ann. Jard. Bot. Btzg. 42 (1932) 204.

Medium-sized to large tree to 35 m tall, 30 cm diameter; buttresses steep to 2 m high. **Bark** grey-brown, smooth, with horizontal rings; inner bark pink with droplets of white sap. **Sapwood** pale white. Twigs dark brown. **Leaves** with 1–4 pairs of leaflets; petiole strongly flattened at base; petiolules of lateral leaflets 1–2 cm long, swollen at both ends; blade thinly to thickly leathery, shiny above, elliptic, oblong or lanceolate, 6–16 x 2–9 cm; base rounded, subcordate or cuneate, apex pointed; midrib raised or flattened above; lateral veins 10–16 pairs, raised on both surfaces; intercostal veins reticulate, faintly visible on both surfaces. **Flowers** hairy, usually in terminal panicles. **Fruits** ovoid or ellipsoid, 2.5–3 x 1.7–2 cm, ripening to yellow and then purplish.

Distribution. Sumatra, Peninsular Malaysia, Borneo, and the Philippines. Common in Sabah, recorded from Beaufort, Sipitang and Tawau. In Sarawak recorded from Bintulu, Lambir National Park, Serian and Kuching. Also found in Brunei and Kalimantan.

Ecology. Mixed dipterocarp forests to 860 m; uncommon in mixed peat swamp forest. Flowering in April, June and September, and fruiting in March and June–November.

5. *Dacryodes laxa* (A.W. Benn.) H.J. Lam (Latin, *laxus* = loose or distant; the inflorescence)

Ann. Jard. Bot. Btzg. 42 (1932) 204, Bull. Jard. Bot. Btzg. 3, 12 (1932) 355; Kalkman *l.c.* (1954) 503; Leenhouts *l.c.* (1956) 224; Kochummen *l.c.* (1972) 141; Cockburn *l.c.* 45; Anderson *l.c.* 156; Whitmore, Tantra & Sutisna *l.c.* 37. **Basionym:** *Canarium laxum* A.W. Benn. in Hooker *f. l.c.* 535.

Type: *Maingay 366*, Malacca (holotype K; isotypes CAL, L). **Synonyms:** *Canarium fragile* Engl. in DC. *l.c.* 138; *Santiria laxa* (A.W. Benn.) King, *l.c.* 254.

Small to medium-sized tree to 30 m tall, 30 cm diameter. **Bark** grey, smooth to scaly; inner bark pale yellow. **Sapwood** pale white. *Twigs with long rough hairs when young.* **Leaves** with up to 5 pairs of leaflets; *rachis rough-hairy*; petiolules of lateral leaflets 3–10 mm long, hairy; blade drying greenish, oblong, lanceolate or oblanceolate, 8.5–34 x 4.5–9 cm; base cuneate, apex pointed, tip to 1.5 cm long; midrib raised above; lateral veins 9–30 pairs, raised on both surfaces, curving and joining near margin; *intercostal veins* reticulate, raised below, *sunken above*; petiole strongly swollen at base. **Flowers** in branched, long (c. 80 cm) *terminal panicles*; petals glabrous. **Fruits** pink ripening to blue, oblong or ovoid, 2.5–4.5 x 1–2 cm, apex pointed; stalk 2–2.5 cm long, slender.

Distribution. Sumatra, Peninsular Malaysia, and Borneo. Widely distributed in Sabah. In Sarawak reported only from Bako National Park, Semengoh Arboretum and Lundu. Also known in Brunei.

Ecology. Common in mixed dipterocarp forests on yellow sandy clay soils, to 700 m. Flowering from April to June, and fruiting from June to November.

6. *Dacryodes longifolia* (King) H.J. Lam

(Latin, *longus* = long, *folium* = leaf)

Ann. Jard. Bot. Btzig. 42 (1932) 202, Bull. Jard. Bot. Btzig. 3, 12 (1932) 340; Kalkman *l.c.* (1954) 509; Leenhouts *l.c.* (1956) 228, *l.c.* (1972) 919; Kochummen *l.c.* (1972) 141. **Basionym:** *Santiria longifolia* King *l.c.* 258. **Type:** *King's collectors 6838*, Perak (holotype K; isotype L). **Synonyms:** *Curtisiana penangensis* Ridl. *l.c.* (1920) 180; *Dacryodes longifolia* var. *penangensis* (Ridl.) H.J. Lam, Ann. Jard. Bot. Btzig. 42 (1932) 202.

Medium-sized to large tree to 40 m tall. **Bark** dark grey, smooth; inner bark orange-yellow. Twigs brown, with scattered white lenticels. **Leaves** with 2–6 pairs of leaflets; *petiole strongly grooved or flattened above*; petiolules of lateral leaflets 1–2 cm long, strongly swollen at both ends; blade oblong to lanceolate, 6.5–18 x 2.5–4.5 cm; base usually unequal, broadly cuneate to rounded, apex pointed; *midrib* raised above, *sharply keeled below*; lateral veins 7–12 pairs, distinct below, faint above; intercostal veins reticulate, faintly visible on both surfaces. **Flowers** (male) in axillary panicles, glabrous. **Fruits** ellipsoid, 2.5–3.5 x 1.5–2.5 cm, much wrinkled on drying; stalk c. 7 mm long.

Distribution. Sumatra, Peninsular Malaysia, Borneo and the Philippines. Common and widely distributed in Sabah; less common in Sarawak.

Ecology. Lowland to submontane forests to 1500 m.

7. *Dacryodes macrocarpa* (King) H.J. Lam

(Greek, *makros* = large, *karpos* = fruit)

Ann. Jard. Bot. Btzig. 42 (1932) 203, Bull. Jard. Bot. Btzig. 3, 12 (1932) 342; Masamune *l.c.* 366; Kalkman *l.c.* (1954) 514; Leenhouts *l.c.* (1956) 228, *l.c.* (1972) 919, *l.c.* (1976) 820; Burgess *l.c.* 61;

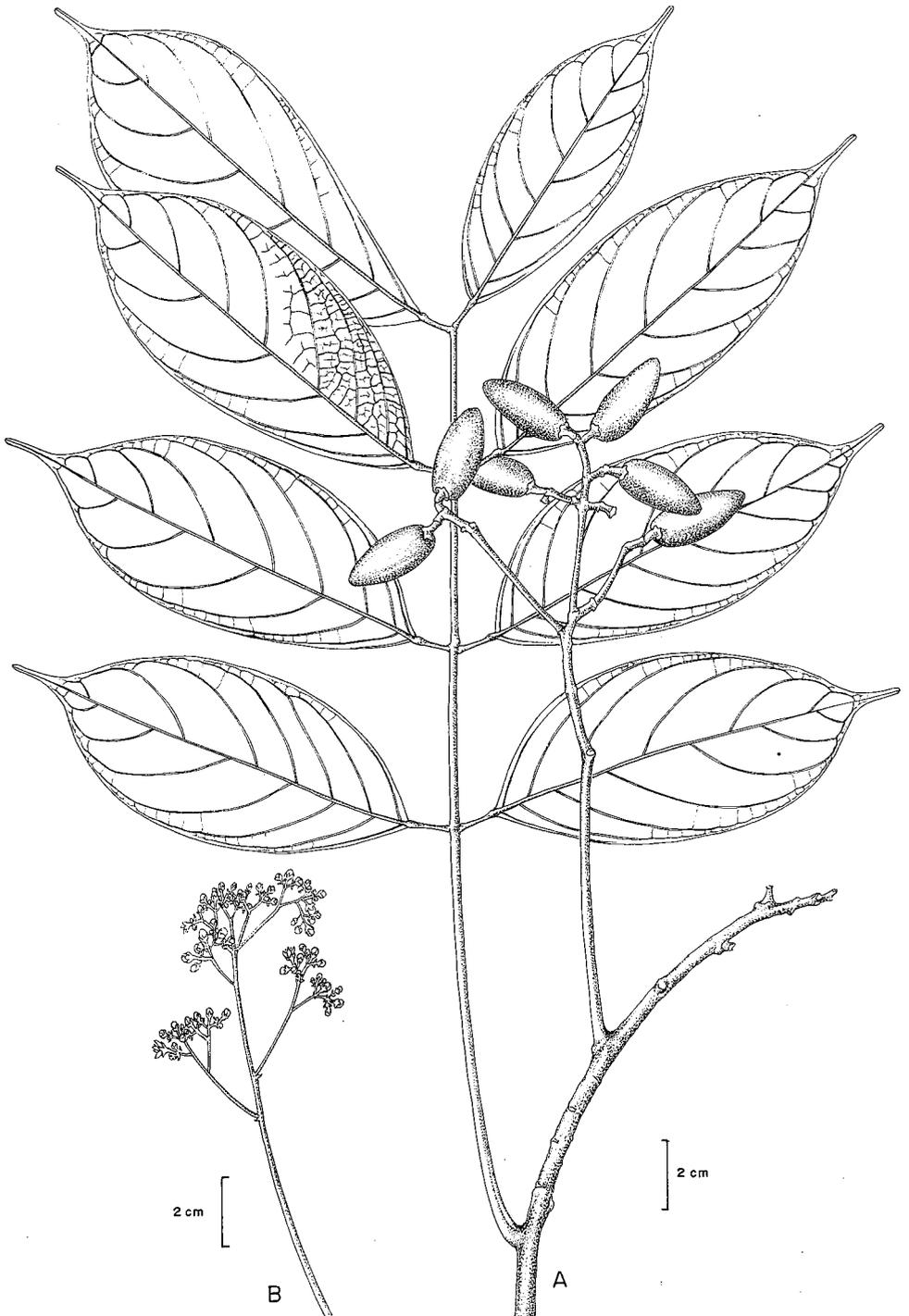


Fig. 2. *Dacryodes rostrata*. A, fruiting leafy twig; B, part of inflorescence. (A from SAN 39742, B from SAN 30412.)

Kochummen *l.c.* (1972) 142; Anderson *l.c.* 156; Whitmore, Tantra & Sutisna *l.c.* 37. **Basionym:** *Santiria macrocarpa* King *l.c.* 256. **Type:** *King's collectors 7298*, Perak (holotype K; isotypes CAL, SING).

Medium-sized to tall tree; stilt-roots and buttresses present. **Bark** reddish brown, cracking. Twigs dark brown to blackish when dry. **Leaves** with 1–2 pairs of leaflets; petiolules of lateral leaflets 0.7–2 cm long, swollen at both ends; blade elliptic, obovate or ovate, 6–12 x 3–6 cm; base often unequal, rounded to broadly cuneate, apex blunt, rounded or shortly pointed; midrib flattened above; lateral veins 6–9 pairs, visible on both surfaces; intercostal veins scalariform-reticulate, faintly visible on both surfaces. **Flowers** glabrous, in axillary panicles. **Fruits** ovoid or ellipsoid, 2.5–4 x 2.5 cm.

Key to varieties

1. Leaflets widest around the middle, equal-sided at base; lateral veins at right angle to midrib.....

var. **patentinervia** Leenh.

l.c. (1976) 821. Type: *Sinclair & Kadim 10492*, Brunei, Bt. Labi FR (holotype L; isotypes K, SAR, SING).

Endemic to Borneo. In Sabah uncommon, known only from Bt. Hampuan, Ranau district (*SAN 25331*). In Sarawak scattered through 3rd, 4th and 5th Div. in the lowland to submontane forest to 1500m. Also in Brunei. Vernacular names: Sarawak—*seladah* (Iban). Brunei—*sabal* (Iban), *sibut* (Tutong, Dusun).

- Leaflets widest in the lower half, oblique at base; lateral veins at acute angle with midrib.....2

2. Twigs blackish when dry. Midrib and veins not prominent beneath.....

var. **macrocarpa**

Synonym: *D. macrocarpa* var. *genuina* H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 343.

Sumatra, Peninsular Malaysia, and Borneo. Uncommon in Sabah, more common in Sarawak. Also in Brunei and Kalimantan. Vernacular names: Sabah—*asam-asam* (Dusun). Sarawak—*icerawas burung*, *keruas* (Malay). Brunei—*kedondong*, *pasoh-pasoh* (Malay).

- Twigs and rachis scaly to powdery hairy and brown when dry. Midrib and veins prominent below.....

var. **kostermansii** (Kalkman) Kalkman

in Leenhouts *l.c.* (1956) 228. Synonym: *D. kostermansii* Kalkman *l.c.* (1954) 515. Type: *Kostermans 6725*, SE Borneo, Loa Djanan, W Samarinda (holotype L; isotypes BO).

Endemic to Borneo. In Sabah known by a single collection (*SAN 25572*) from the Silam FR, Lahad Datu district; not recorded in Sarawak. Also found in Kalimantan.

Ecology. Coastal and mixed swamp forests. Flowering in September and fruiting in March–April and November.

8. *Dacryodes nervosa* (H.J. Lam) Leenh.

(Latin, *nervosus* = prominently nerved; the leaves)

Blumea 12 (1964) 19, *l.c.* (1972) 919. **Basionym:** *Santiria nervosa* H.J. Lam, Ann. Jard. Bot. Btzg. 42 (1932) 206, Bull. Jard. Bot. Btzg. 12, 3 (1932) 387. **Type:** *Grashoff 960*, Sumatra (L.).

Medium-sized tree to 30 m tall, 35 cm diameter; buttresses to 1.5 m tall. **Bark** smooth to scaly, dark brown. Ultimate leafy twigs to 0.5 cm thick. Terminal bud 0.5–1 cm long. **Leaves** with 1–4 pairs of leaflets; blade oblong to ovate, 5.5–17 x 3–7.5 cm, upper surface greenish when dried, lower surface pubescent to glabrous; base broadly cuneate, asymmetric, apex pointed; midrib raised above; lateral veins 10–15 pairs, prominent below; intercostal veins scalariform, raised below; petiolule 8–11 mm long, hairy. **Inflorescences** axillary. **Flowers** sessile or shortly stalked. **Fruits** pink when fresh, ellipsoid, 1.6–1.7 x 1.1 cm.

Distribution. Sumatra, Peninsular Malaysia, and Borneo. Uncommon, in Sarawak so far recorded only from Bako National Park, Bintulu and Sadong (*S. 13389*, *S. 16228*, *S. 18192*, *S. 37488*); not yet found in Sabah. Also occurs in Kalimantan.

Ecology. Lowland forest to 350 m.

9. *Dacryodes rostrata* (Blume) H.J. Lam

Fig. 2.

(Latin, *rostratus* = with a beak or narrowed tip; the leaves)

Ann. Jard. Bot. Btzg. 42 (1932) 203, Bull. Jard. Bot. Btzg. 3, 12 (1932) 349; Masamune *l.c.* 366; Kalkman *l.c.* (1954) 519; Leenhouts *l.c.* (1956) 225; Burgess *l.c.* 161; Kochummen *l.c.* (1972) 143; Cockburn *l.c.* 45; Anderson *l.c.* 156; Whitmore, Tantra & Sutisna *l.c.* 37. **Basionym:** *Santiria rostrata* Blume *l.c.* (1850) 213. **Type:** *Korthals, s.n.* (= *Leiden no. 898.321–228*), Borneo (L.). **Synonym:** *Hemisantiria rostrata* (Blume) H.J. Lam in Merrill *l.c.* (1929) 119.

Small to very large tree to 45 m tall, 200 cm diameter. **Bark** dark grey, smooth to scaly or diphled; inner bark reddish or pinkish with droplets of white sap. **Sapwood** whitish. Twigs thin to very thick (0.4–2.5 cm), dark brown, lenticellate. **Leaves** with 2–8 pairs of leaflets; petiolules of lateral leaflets 1–2 cm long, swollen at both ends; blade thinly to thickly leathery, glabrous or (sometimes) with tiny inconspicuous hairs below, ovate to oblong, 8–30 x 3.5–11 cm; base strongly unequal, apex pointed, tip *c.* 2 cm long; midrib raised above; lateral veins 5–15 pairs, raised on both surfaces; intercostal veins reticulate, faint to distinct on both surfaces or sometimes more distinct above than below; petioles strongly flattened at base in those with thick twigs. **Flowers** densely hairy, in axillary panicles 5–35 cm long. **Fruits** ovoid to oblong, 2–3.5 x 1–2 cm, often strongly wrinkled on drying, ripening to blue, with white sap.

Key to forms

Ultimate leafy twigs 1.5–2.5 cm thick. Leaflets at least 10 cm long, drying greenish grey; reticulations more distinct on the upper than on lower surface.....

forma **cuspidata** (Blume) H.J. Lam

Bull. Jard. Bot. Btztg. 3, 12 (1932) 351. Basionym: *Dracontomelon cuspidatum* Blume l.c. (1850). Type: *Korthals, s.n.* (= *Leiden no. 897. 363–270*), Borneo (L). Synonym: *Canarium minahassae* Koord. l.c. 96; *Santria samarensis* Merr. l.c. (1915) 315; *C. crassifolium* Merr. l.c. (1915) 274; *C. cuspidatum* (Blume) Merr. l.c. (1921) 316; *C. reticulatum* Ridl. l.c. (1930) 83.

Indo-China, Sumatra, Borneo, Philippines, and N Celebes. In Sabah, known from a few collections from Labuan FR (*FDBNB 44236*), Bt. Batangan, Sipitang district (*SAN 16612*), and Nabutan, Ranau district (*SAN 100230*). In Sarawak recorded from Bt. Rawan (*S. 45575*) and Semengoh Arboretum (*S. 32406*) in 1st Div., Ulu Balleh, Kapit, 3rd Div. (*S. 29100*); and Ulu Dapoi, Marudi (*S. 23056 & S. 23474*), Kebulu Protected Forest (*S. 49126*), and Dulit Range (*S. 46672*) in the 4th Div. Vernacular names: Sabah—*kedondong, salong banggi* (Malay). Sarawak—*seladah* (Iban).

Ultimate leafy twigs to 0.5 cm thick. Leaflets smaller, drying reddish brown; reticulations not so.....

forma **rostrata**

Synonyms: *D. rostrata* f. *genuina* H.J. Lam, Bull. Jard. Bot. Btztg. 3, 12 (1932) 351; *Santiria montana* Blume l.c. (1850) 212; *C. montanum* (Blume) Korth. ex Miq. l.c. (1859) 649; *C. kedondon* A.W. Benn. in Hooker f. l.c. 535.

Sumatra, Peninsular Malaysia, and Borneo. Common and widely distributed in Sabah and Sarawak. Vernacular names: Sabah—*kedondong, kambayau* (Dusun).

Ecology. Very common in mixed dipterocarp forest to 800 m. Flowering in February–September, and fruiting in April and June–December.

10. **Dacryodes rubiginosa** (A.W. Benn.) H.J. Lam

(Latin, *rubiginosus* = of rusty colour; the tomentum)

Ann. Jard. Bot. Btztg. 42 (1932) 204, Bull. Jard. Bot. Btztg. 3, 12 (1932) 361; Masamune l.c. 367; Kalkman l.c. (1954) 521; Leenhouts l.c. (1956) 225; Kochummen l.c. (1972) 143; Whitmore, Tantra & Sutisna l.c. 37. **Basionym:** *Canarium rubiginosum* A.W. Benn. in Hooker f. l.c. 535, non *C. rubiginosum* Miq. l.c. (1859) 651 (= *Santiria rubiginosa* Blume). **Type:** *Maingay 309*, Malacca (holotype K; isotypes CAL, L).

Medium-sized tree to 20 m tall, 20 cm diameter. *Ultimate leafy twigs to 0.5 cm thick, yellowish brown velvety hairy* when young. **Leaves** with 2–3 pairs of leaflets; rachis appressed hairy; petiolules of lateral leaflets 0.5–1 cm long, swollen at both ends; *blade sparsely hairy below*, elliptic or oblong, 9.5–19.5 x 2.5–6.5 cm; base cuneate, unequal, apex pointed, tip *c.* 1.5 cm long; midrib raised above; lateral veins 8–12 pairs, prominently raised below, faintly raised above; intercostal veins scalariform-reticulate, visible below. **Flowers** (male) tomentose, in terminal inflorescences, *axes densely yellowish brown hairy*. **Fruits** ellipsoid, 2–2.5 x 1 cm.

Distribution. Peninsular Malaysia and Borneo. In Sabah scattered. In Sarawak uncommon, known only from two collections (*S. 43194* and *S. 43377*) from Samunsam Wildlife Sanctuary and Ulu Sg. Semawat respectively. Also found in Kalimantan.

Ecology. Lowland forest to 200 m.

11. *Dacryodes rugosa* (Blume) H.J. Lam

(Latin, *rugosus* = wrinkled; the bullate leaflets)

Ann. Jard. Bot. Btzig. 42 (1932) 203, Bull. Jard. Bot. Btzig. 3, 12 (1932) 345; Masamune *l.c.* 367; Kalkman *l.c.* (1954) 505; Leenhouts *l.c.* (1956) 221; Backer & Bakhuizen *f. l.c.* (1972) 114; Burgess *l.c.* 62; Kochummen *l.c.* 144; Cockburn *l.c.* 47; Anderson *l.c.* 157; Whitmore, Tantra & Sutisna *l.c.* 37. **Basionym:** *Santiria rugosa* Blume *l.c.* 212. **Type:** *Korthals, s.n.* (= *Leiden no. 898.321-232*), Java (L). **Synonyms:** *Canarium rugosum* (Blume) Miq. *l.c.* (1859) 649 (including var. *sumatranum*); *Hemisantiria rugosa* (Blume) H.J. Lam in Merrill *l.c.* (1929) 119.

Small to medium-sized tree, rarely to 30 m tall and 40 cm diameter. **Bark** grey-white, smooth to scaly; inner bark yellowish. **Sapwood** pale. Ultimate leafy twigs 0.3–0.5 cm thick. **Leaves** with 1–4 pairs of leaflets; rachis flattened above; *petiole glabrous; petiolules of leaflets strongly swollen at both ends*; blade glabrous or appressed pubescent below or with erect hairs on midrib and veins below (var. *virgata*), elliptic, ovate to oblong-lanceolate, 6–22 x 2.5–11 cm, sometimes bullate; base cuneate, apex pointed with long tip; midrib raised above; lateral veins 7–12 pairs, raised below, flattened above (sunken in var. *rugosa*), often curving and joining near margin; intercostal veins reticulate, raised below, faint or sunken above. **Flowers** in axillary panicles, glabrous (var. *virgata*) or hairy; *stamen filaments adnate to the disc; disc cup-shaped*. **Fruits** ovoid, slightly oblique, 1.5–2.5 x 1–1.5 cm.

Key to varieties

Lateral veins sunken on upper leaflet surface. Leaflets glabrous or appressed-hairy on lower surface. Flowers densely hairy.....

var. *rugosa*

Synonyms: *Dacryodes rugosa* var. *genuina* H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 347; *Santiria fasciculata* A.W. Benn. in Hooker *f. l.c.* 539.

Sumatra, Peninsular Malaysia, Java, and Borneo. Widespread in Sabah and Sarawak in mixed dipterocarp forest on yellow sandy clay soils. Also in Kalimantan.

Lateral veins not sunken on upper leaflet surface. Leaflets with scattered erect hairs on midrib and veins on lower side. Flowers glabrous.....

var. *virgata* (Blume) H.J. Lam

Bull. Jard. Bot. Btzig. 3, 12 (1932) 348. **Basionym:** *Santiria virgata* Blume *l.c.* (1850) 213. **Synonym:** *Canarium virgatum* (Blume) Miq. *l.c.* (1959) 650. **Type:** *Korthals, s.n.*, W Borneo, G. Pamaton (holotype L; isotype BO).

Widely distributed in Sabah and Sarawak; also in Kalimantan.

Ecology. Lowland to hill mixed dipterocarp forests to 900 m. Flowering in April–November, and fruiting in March–December.

3. GARUGA Roxb.

(an Indo-Malayan plant name, origin uncertain)

Pl. Corom. 3 (1811) 5; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 325; Kalkman *l.c.* (1954) 459; Leenhouts *l.c.* (1956) 215; Kochummen *l.c.* (1972) 144; Whitmore, Tantra & Sutisna *l.c.* 37.

Deciduous trees. *Pith of branches and petioles without vascular strands. Leaves with stipules, stipellae* (stipule-like outgrowths at the base of leaflets) *often present; margin of leaflets toothed. Inflorescence* an axillary panicle. **Flowers** *bisexual, 5-merous; receptacle concave, globose or cup-like; sepals free; stamens 10; disc adnate to the receptacle, glabrous with 10 lobes between the stamens; ovary 5-celled. Fruit* drupaceous; pericarp fleshy; pyrenes 1–5, furrowed, bony. Cotyledons twisted and folded.

Distribution. 4 species; continental SE Asia, with a variety of one species in Malesia, Melanesia, N Australia, and the Solomon Islands.

Ecology. Lowland forest to 200 m.

Garuga floribunda Decne. var. **floribunda**

Fig. 3.

(Latin, *floribundus* = with abundant flowers)

Nouv. Ann. Mus. Hist. Nat. Paris 3 (1834) 477; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 326; Kalkman *l.c.* (1954) 463; Leenhouts *l.c.* (1956) 215; Kochummen *l.c.* (1972) 144, Whitmore, Tantra & Sutisna *l.c.* 37. **Type:** *sine coll., s.n.*, Timor (holotype G; isotype NY). **Synonyms:** *Guaiacum abilo* Blanco, Fl. Filip. (1837) 364; *Garuga abilo* (Blanco) Merr., Publ. Govt. Lab. Philip. 35 (1905) 73; *Garuga littoralis* Merr. *l.c.* (1915) 27; *Garuga clarkei* Merr. *l.c.* (1915) 29.

Small to medium-sized tree to 12 m tall, 10 cm diameter. **Bark** grey, smooth. Twigs covered with many leaf-scars, minutely tomentose at tips. Stipules inserted at base of petioles, caducous. **Leaves** crowded at ends of twigs, leaflets 4–10(–15) pairs; blade subsessile, elliptic to oblong or lanceolate, 5–19 x 2–5.5 cm; base oblique, cordate or rounded, *margin toothed*, apex pointed; midrib raised above; lateral veins 10–20 pairs, distinct on both surfaces; intercostal veins reticulate, visible on both surfaces. **Flowers** with cup-shaped receptacle; petals tomentose inside. **Fruits** obliquely pear-shaped, 5–9 x 5–12 mm.

Distribution. Peninsular Malaysia, Java, Borneo, Philippines, Celebes, Lesser Sunda Islands, Moluccas, New Guinea, Melanesia, and W Australia. In Borneo uncommon, known only from some islands (Gaya and Sipadan) in Sabah.

Ecology. Coastal forests at low altitude.

A second variety, var. *gamblei*, is known from E India, Sikkim, Bangladesh, W China and Hainan.

4. HAPLOLOBUS H.J. Lam

(Greek, *haplos* = single, *lobus* = lobe; the single-lobed seed)

Ann. Jard. Bot. Btzig. 42 (1932) 25, Bull. Jard. Bot. Btzig. 3, 12 (1932) 404, Blumea 9 (1958) 237; Husson & H.J. Lam, Blumea 7 (1953) 413; Leenhouts *l.c.* (1956) 239, Blumea 20 (1972) 283 & 311; Whitmore, Tantra & Sutisna *l.c.* 37; Kochummen, Sandakania 5 (1994) 75.

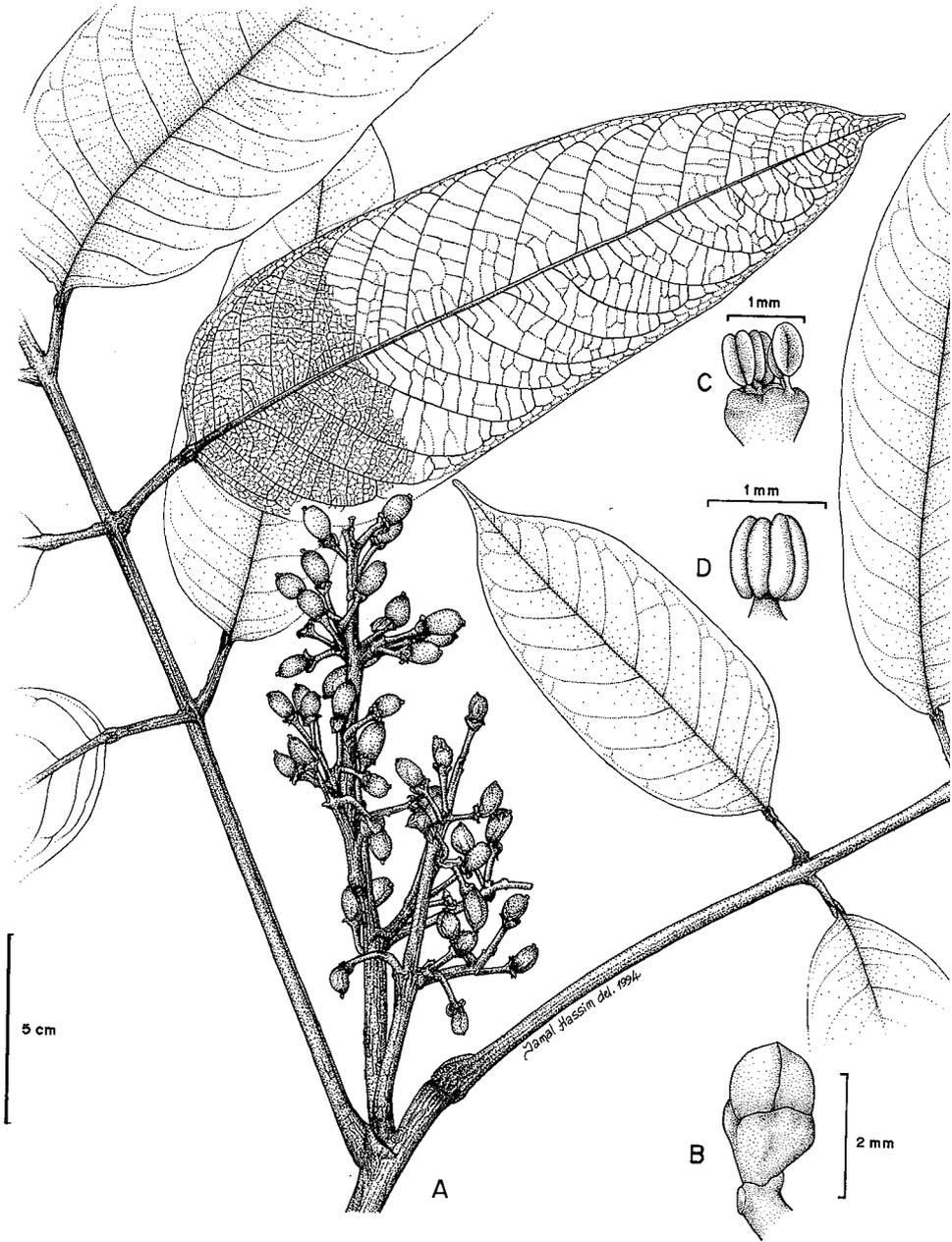


Fig. 4. *Haplolobus leenhoutsii* (A) and *H. kapitensis* (B–D). A, fruiting leafy twig; B, flower bud; C, male flower with sepals and petals removed; D, stamen. (A from S. 41304, B–D from S. 23966.)

Tree. Twigs stout to 2.5 cm diameter, lenticellate. **Leaves** with 6 pairs of leaflets; pith of petioles with 15–20 vascular strands; *rachis* to 23 cm long; *blade* lanceolate-oblong, 21–36 x 7.5–10 cm, *densely hairy on the under surface*; base cuneate, apex pointed; lateral veins 25–30 pairs, arching near margin; *petiole flattened on the upper side, and distinctly striate on the lower side*. Inflorescences and flowers unknown. **Infructescences** borne on leafless twigs or stems. **Fruits** oblong, with pointed tip, 13–15 x 12 mm.

Distribution. Endemic to Sarawak. Uncommon, known only from the type specimen from Mt. Matang.

Ecology. Lowland forest.

2. *Haplolobus bintuluensis* Kochummen

(of Bintulu in Sarawak)

l.c. (1994) 75. **Type:** *Sibat S. 24562*, Sarawak (holotype SAR; isotypes A, K, L, SAN, SING).

Treelet to 3 m tall, 5 cm diameter. Twigs *c.* 7 mm thick, greyish, with white lenticels. Terminal bud oblong, *c.* 10 x 3 mm, rusty hairy. **Leaves:** *rachis c.* 23 cm long, slightly swollen at base, *dark brown-hairy* with 2–3 pairs of leaflets; *petiolules of lateral leaflets* 8–15 mm long, *dark brown hairy*, swollen at both ends, *petiolules of terminal leaflets* 3.5–4.5 cm long; *blade* thinly leathery, glabrous above except midrib, *dark brown hairy on the midrib and veins below*, 10.5–17 x 5.5–7 cm; base cuneate, apex long-pointed, tip narrow, 1–2 cm long; midrib flattened above; lateral veins 7–9 pairs, distinct below, faint above, curving and joining near margin; intercostal veins reticulate, faintly visible below. Inflorescences and flowers unknown. **Infructescence** *c.* 2 cm long. **Fruits** oblong, reddish when fresh, yellowish brown on drying, 16–20 x 11–12 mm, with pointed tip.

Distribution. Endemic to Sarawak. Uncommon, known from the type collection only, from the Nyabau Catchment area, Bintulu.

Ecology. Mixed dipterocarp forest on yellow-red sandy humult ultisol, at about 100 m.

3. *Haplolobus inaequifolius* Kochummen

(Latin, *inaequalis* = unequal, *folium* = leaf; the asymmetric leaflets)

l.c. (1994) 78. **Type:** *Yii S. 40756*, Sarawak (holotype KEP; isotypes K, L, MO, SAN, SAR).

Small tree to 15 m tall, 10 cm diameter. Twigs brownish, *c.* 5 mm thick with whitish lenticels. Terminal bud oblong, *c.* 12 mm long, rusty hairy. **Leaves** glabrous, with 2 pairs of leaflets; *rachis* grey, not swollen at base; *petiolules of lateral leaflets* 8–15 mm long, of terminal leaflet *c.* 4.5 cm long, *the ends black on drying*; *blade* greenish brown on drying, leathery, with 1-mm-wide circular galls, elliptic to ovate or oblong, 7.5–15.5 x 2.5–6 cm, *strongly asymmetric*; base broadly cuneate, apex pointed; *midrib* flattened above, *sharply keeled below*; lateral veins 10 pairs, faint on both surfaces; intercostal veins finely reticulate, visible on both surfaces. **Inflorescence** (male) glabrous, axillary, 4–8 cm long, often

terminating in a vegetative shoot. **Flowers** (male): calyx-lobes triangular with pointed tip; petals oblong; stamens 6 with short stout filaments; disc with wavy margin; rudimentary ovary with 3 distinct stigma. Fruits unknown.

Distribution. Endemic to Borneo. Uncommon, known only by the type specimen from the Sabal Forest Reserve in Sarawak.

Ecology. Hill forest at about 360 m.

4. **Haplolobus kapitensis** Kochummen
(of Kapit, Sarawak)

Fig. 4B–D.

l.c. (1994) 78. **Type:** *Wright S. 23966*, Sarawak, Kapit (holotype KEP; isotypes A, BO, K, L, SAN, SAR, SING).

Emergent tree to 40 m tall, 80 cm diameter. *Twigs* greyish white or grey-brown, *c.* 1 cm thick, lenticellate, *youngest strongly angled*. **Leaves** glabrous, with 2–3 pairs of leaflets; *rachis c.* 26 cm long, *channelled above near base*; petiolules of lateral leaflets 1.5–2 cm long, of terminal leaflets *c.* 4.5 cm long, strongly swollen at both ends; *blade* thickly leathery, *drying to reddish brown below and greenish brown above*, oblong to lanceolate, 11.5–20 x 4.5–9 cm; *base asymmetric*, almost rounded to broadly cuneate, apex pointed; midrib raised above; lateral veins 9–12 pairs, distinctly looping near margin, distinct on both surfaces; intercostal veins reticulate, more distinct above than below. **Inflorescence** (male) axillary, to 21 cm long, on leafless vegetative shoot. **Flowers** (male): calyx cup-shaped with truncate apex; petals yellow, oblong; stamens 3 or 6, with short filaments; disc cup-shaped with wavy margin; pistil rudimentary. Fruits unknown.

Distribution. Endemic to Borneo. Uncommon, known by four collections, *S. 23966* and *S. 29162* from Kapit, Sarawak, and *SAN 22391* and *SAN 62657* from Ranau in Sabah.

Ecology. Lowland and hill forests to 600 m.

5. **Haplolobus leenhoutsii** Kochummen

Fig. 4A.

(P.W. Leenhouts, botanist at Rijksherbarium, Leiden, the Netherlands)

l.c. (1994) 81. **Type:** *Othman et al. S. 41304*, Sarawak, Kapit (holotype SAR; isotypes K, KEP, L, MO, SAN).

Small tree to 20 m tall, 20 cm diameter. **Bark** brownish green, scaly. *Twigs* brown, *c.* 1 cm thick. **Leaves** with 3 pairs of leaflets; *rachis c.* 23 cm long; *petioles channelled with incurled edges above, with many shallow grooves on the remaining part*; petiolules of lateral and terminal leaflets *c.* 2 cm long, strongly swollen at both ends and with horizontal cracks; *blade* drying to greenish brown, glabrous, leathery, lanceolate to elliptic, 14–23 x 4.5–7.5 cm, *with many circular (3-mm-diameter) domatia holes*; base rounded or broadly cuneate, apex pointed; midrib raised above, channelled below; lateral veins 14–17 pairs, distinct below, faint above; intercostal veins reticulate, visible on both surfaces. Inflorescences and

flowers unknown. **Infructescences** axillary, *c.* 15.5 cm long, with many branches. **Fruits** (immature) red when fresh, black on drying, oblong, *c.* 1 cm long, with prominent apical stigma, surface slightly rugose, with remains of floral parts at base, stalk *c.* 1 cm long.

Distribution. Endemic to Borneo. Uncommon, known only from the type specimen from Ulu Balleh, Kapit, Sarawak.

Ecology. Mixed dipterocarp forest at about 500 m, on ridge.

6. *Haplolobus sarawakanus* Kochummen

(of Sarawak)

l.c. (1994) 81. **Type:** *Othman et al. S. 41339*, Sarawak (holotype SAR; isotypes K, KEP, L, SAN, MO).

Small tree to 11 m tall, 15 cm diameter. **Bark** greyish brown, scaly. Twigs *c.* 5 mm thick, pale brown, shallowly grooved, with pale lenticels. **Leaves** glabrous, with 3–4 pairs of leaflets; rachis *c.* 25 cm long, slightly swollen at base; petiolules of lateral leaflets *c.* 1 cm long, of terminal leaflet *c.* 3 cm long, the ends swollen and whitish or blackish; blade thinly leathery, drying to yellowish brown, elliptic or oblong, 12–15 x 3.5–5 cm; base cuneate, slightly asymmetric, apex pointed; midrib flattened above; lateral veins 8–9 pairs, distinct below, faint above, curving and joining near margin; intercostal veins reticulate, very faint on both surfaces. Inflorescences and flowers unknown. **Infructescences** *c.* 4 cm long. **Fruits** (immature) *c.* 8 x 5 mm, calyx funnel-shaped.

Distribution. Endemic to Borneo. Uncommon, known only by the type from Ulu Balleh, Kapit, Sarawak. A collection from Sabah, *SAN 97191*, probably belongs to this species but better material is needed to confirm this.

Ecology. Mixed dipterocarp forest at about 500 m, on ridge.

5. *PROTIUM* Burm. *f.*, *nom. cons.*

(Greek, *proteion* = first-class; probably referring to the hardness and strength of the wood)

Fl. Ind. (1768) 88; H.J. Lam, *Bull. Jard. Bot. Btzg.* 3, 12 (1932) 318; Leenhouts *l.c.* (1952) 154, *l.c.* (1956) 213; Backer & Bakhuizen *f. l.c.* 113.

Trees or shrubs. *Pith of branchlets and petioles withouts vascular strands.* **Leaves** without stipules, *tips of the leaflets usually distinctly mucronulate.* **Inflorescences** paniculate, axillary, rarely pseudo-terminal. **Flowers** 4–5-merous, structurally not always completely unisexual; sepals united; petals valvate with inflexed margins, glabrous; *stamens double the number of petals*, free; disc intrastaminal, annular, truncate to undulate, glabrous; ovary 3–5-celled, stigma subsessile. **Fruits** drupaceous, pericarp fleshy, calyx persistent, not enlarged, with reflexed lobes. Cotyledons plicate, lobed to palmatifid.

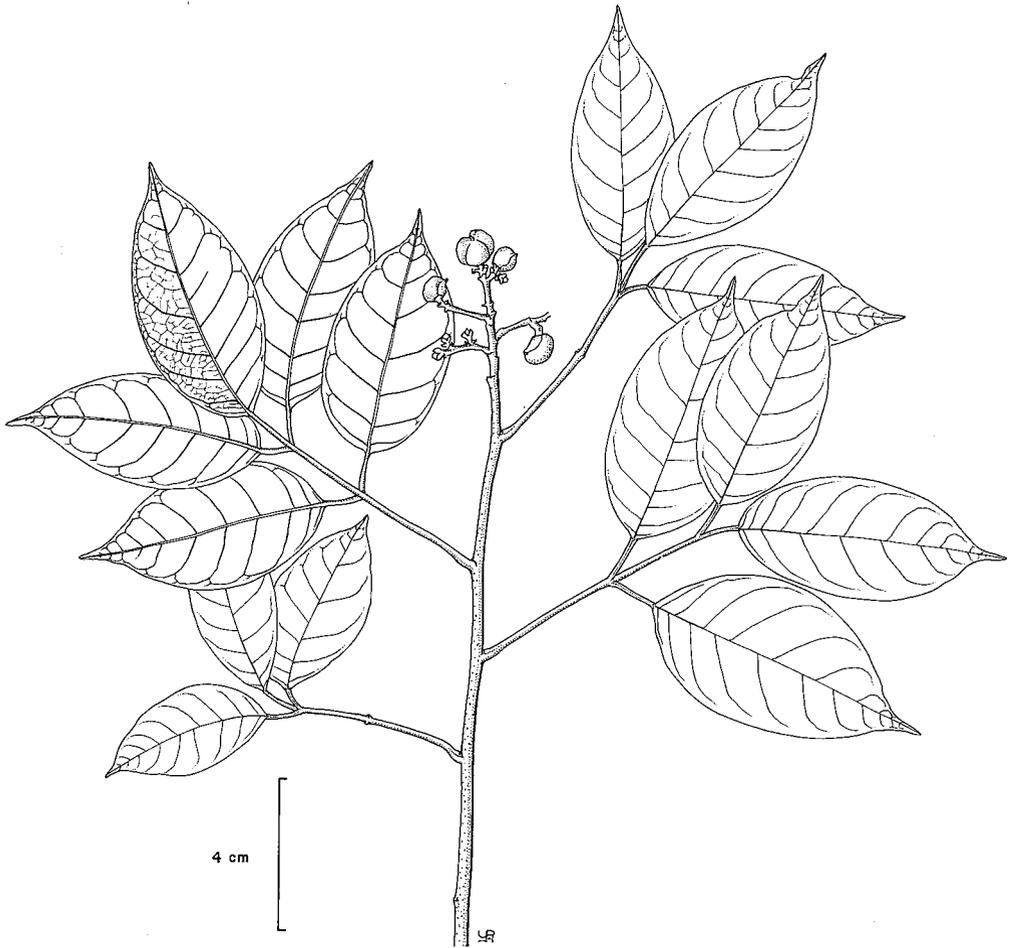


Fig. 5. *Protium connarifolium*. Fruiting leafy twig. (From SAN 89964.)

Distribution. About 85 species; mainly in the American tropics, Madagascar, Mascarenes, India and Malasia. Only one species has been recorded in Sabah; not yet found in Sarawak.

Ecology. Lowland forests.

Protium connarifolium (Perkins) Merr.

Fig. 5.

(with the leaflets resembling those of *Connarus*)

l.c. (1915) 30; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 320; Leenhouts *l.c.* (1952) 155, *l.c.* (1956) 215. **Basionym:** *Canarium connarifolium* Perkins, Fragm. Fl. Philip. 2 (1904) 92. **Type:** Merrill 787, Philippines, Palawan (GH, K, L). **Synonym:** *P. philippinensis* Elmer, Leafl. Philip. Bot. 7 (1915) 2571.

Small tree. **Leaves** with up to 3 pairs of leaflets; petiolules of lateral leaflets to 2 cm long, swollen at both ends; blade ovate to elliptic, 3–11 x 2–5 cm; base cuneate, margin entire, apex pointed with mucronate tip; midrib slightly sunken above; lateral veins 5–7 pairs, looping, visible below, faint above; intercostal veins reticulate, very faintly visible on both surfaces. **Inflorescences** axillary, or female inflorescences sometimes pseudo-terminal. **Flowers** tomentose. **Fruits** 7–8 x 5–13 mm, sparsely pubescent to glabrous, with 1–4 pyrenes.

Distribution. Borneo, Philippines (Palawan). Very uncommon, known by a single collection SAN 89964 from Semporna in Sabah. According to Leenhouts *l.c.* (1956), this species is rather isolated taxonomically from the rest.

Ecology. Lowland forests.

6. SANTIRIA Blume

(Santir, Blume's native guide to G. Salak, Java)

kerantai (Sabah), *seladah* (Sarawak)

l.c. (1850) 209; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 367; Ridley *l.c.* (1922) 376; Kalkman *l.c.* (1954) 522; Leenhouts *l.c.* (1956) 229; Kochummen *l.c.* (1972) 145, Sandakania 5 (1994) 83; Cockburn *l.c.* 47; Anderson *l.c.* 157; Wong *l.c.* 212; Whitmore, Tantra & Sutisna *l.c.* 38; Ng *l.c.* 38. **Synonyms:** *Trigonochlamys* Hook. f., Trans. Linn. Soc. 23, 1 (1860) 170; *Icicaster* Ridl., J. Str. Br. R. As. Soc. 75 (1917) 15.

Medium-sized to large dioecious trees. **Bark** brown, fawn or grey, smooth to fissured, scaly or flaky, with many small or large lenticels; inner bark either pink, soft, and laminated or yellowish white, hard mottled and granular (*S. griffithii*, *S. rubiginosa*), with white to colourless exudate darkening on drying. *Pith of twigs and petioles with or without vascular strands.* **Leaves** without stipules, imparipinnate; leaflets entire, petiolules only slightly swollen at both ends; petiole usually flat or channelled on the upper surface. **Inflorescences** usually axillary, rarely terminal panicles. **Flowers** unisexual, 3-merous; sepals free or united; petals usually with thickened inflexed apex; stamens 6 or 3, anthers basifixed or

dorsifixed; disc intrastaminal, glabrous; ovary 3-celled, glabrous, in male flowers reduced; stigma (sub)-sessile. **Fruits** brightly coloured drupes, irregularly globose or ellipsoid, *more or less oblique*, in big bunches, usually seated on persistent calyx; *stigma off-centre, sometimes nearly basal*; rind thin and firm, *almost smooth when dry*; stone thinly woody containing one fertile and two sterile cells. **Seeds** almost round, not angled; germination in *S. laevigata* and *S. oblongifolia* epigeal, cotyledons 5-lobed, fleshy, first two leaves opposite, subsequent leaves alternate, leaves in young seedling simple; in *S. griffithii* and *S. rubiginosa* germination hypogeal, first two leaves opposite, subsequent leaves alternate and then spiral, leaves in young seedlings pinnate.

Distribution. About 22 species, with 6 species restricted to W Africa and the rest in Malesia (mainly Sumatra, Peninsular Malaysia, Borneo). 15 species in Sabah and Sarawak.

Ecology. Lowland forest, including swamp forest, to submontane forest to 1650 m.

Uses. The timber is commonly grouped together with other members of the family and sold as *kedondong*. The wood is light hardwood. It is essentially similar in anatomical structure to the timber of *Canarium* and *Dacryodes* but is more variable in colour, weight and hardness. Silica is present in all species. *S. laevigata* and *S. tomentosa* are important sources of *kedondong*-timber in Peninsular Malaysia. The buttresses of *S. tomentosa* are interlocked and frequently used for *parang* sheaths.

Taxonomy. The genus is sub-divided into two sections: section *Santiria* and section *Icicopsis*. Apart from the differences in floral characters by which these sections were established, evidence from wood anatomy and germination supports the distinction of these sections. In Sabah and Sarawak, section *Icicopsis* is represented by *S. griffithii* and *S. rubiginosa*.

Key to *Santiria* species

1. Leaflets hairy on the lower side, at least on the midrib.....2
 Leaflets glabrous.....6
2. Leaflets densely velvety or woolly hairy on the lower side.....3
 Leaflets sparsely hairy on the lower side.....5
3. Intercostal veins scalariform.....15. **S. tomentosa**
 Intercostal veins reticulate.....4
4. Leaflets concave, hairs dark brown; petiolule not swollen at ends. Twigs covered with lenticels. Stigma on fruit more than 90° excentric.....10. **S. mollis**
 Leaflets not concave, hairs yellowish brown; petiolule swollen at ends. Twigs not so. Stigma prominently excentric, near pedicel.....1. **S. apiculata**
5. Twigs stout, *c.* 1.5 cm thick. Terminal bud *c.* 2 cm long. Petiole strongly channelled above with deep groove.....4. **S. grandiflora**
 Twigs slender, *c.* 6 mm thick. Terminal bud up to 0.5 cm long. Petiole not channelled or grooved14. **S. sarawakana**

6. Lateral veins sunken above.....**6. S. impressinervis**
Lateral veins not sunken above.....7
7. Twigs stout, 1.5–3 cm thick.....8
Twigs slender, to 1 cm thick.....9
8. Terminal bud *c.* 6 cm long with curved tip. Leaflets 7–9 cm wide; petiolules of lateral leaflets to 2.5 cm long. Stigma of fruit more than 90° excentric.....**7. S. kalkmaniana**
Terminal bud *c.* 1.5 cm long, tip not curved. Leaflets 13–22 cm wide; petiolules of lateral leaflets 4–5 cm long. Stigma of fruit near pedicel.....**9. S. megaphylla**
9. Stigma of fruit more than 90° excentric, near pedicel.....10
Stigma of fruit less than 90° excentric.....12
10. Terminal bud *c.* 2 cm long. Petiole strongly channelled at base with sharp edges. Midrib raised above.....**2. S. conferta**
Terminal bud up to 1 cm long. Petiole not so. Midrib flattened to slightly sunken above.....11
11. Midrib below channelled. Leaflet margin not curled inwards; intercostal veins distinct below.....**1. S. apiculata**
Midrib below not channelled. Leaflet margin curled inwards; intercostal veins invisible below.....**3. S. dacryodifolia**
12. Terminal bud 0.5–2.5 cm long, often resin-coated. Leaflets drying reddish brown or dark brown.....**8. S. laevigata**
Not this combination of characters.....13
13. Rachis blackish, oily, shiny. Lateral veins of leaflets very faint. Stigma on fruit only slightly excentric.....**11. S. nigricans**
Rachis not so. Lateral veins of leaflets distinct. Stigma in fruit 90° excentric.....14
14. Lateral veins distinctly looping near margin; intercostal veins parallel to lateral veins. Fruits to 1.3 cm long.....15
Lateral veins faintly looping near margin; intercostal veins not parallel to lateral veins. Fruit to 3 cm long.....**12. S. oblongifolia**
15. Leaflets not asymmetric at base, petiolules of lateral leaflets to 5 mm long, not swollen at ends.....**5. S. griffithii**
Leaflets asymmetric at base, petiolules of lateral leaflets to 2 cm long, swollen at both ends.....**13. S. rubiginosa**

1. *Santiria apiculata* A.W. Benn.

(Latin, *apiculatus* = furnished with a little point; the pointed leaflets)

in Hooker *f. l.c.* 537; Ridley *l.c.* (1922) 378; H.J. Lam, Bull. Jard. Bot. Btztg. 3, 12 (1932) 375; Masamune *l.c.* 367; Kalkman *l.c.* (1954) 538; Leenhouts *l.c.* (1956) 234; Burgess *l.c.* 62;

Kochummen *l.c.* (1972) 146; Cockburn *l.c.* 48; Anderson *l.c.* 157; Whitmore, Tantra & Sutisna *l.c.* 38. **Type:** *Maingay 303*, Malacca (holotype K; isotype L).

Small to medium-sized tree rarely more than 30 m tall. **Bark** grey or brown, smooth to scaly; inner bark pinkish with droplets of white sap and with strong resinous smell. **Sapwood** pale yellow. Twigs pale or whitish, glabrous or densely brownish hairy (var. *pilosa*). **Leaves** trifoliolate or with 2–5 pairs of leaflets; blade glabrous, drying greenish or hairy below and drying brownish (var. *pilosa*), elliptic or lanceolate, 3.5–16 x 1.5–7 cm; base broadly cuneate, apex pointed with long tip; *midrib* flattened to slightly sunken above, *distinctly grooved below*; *lateral veins* 5–14 pairs, distinct below, faint above, *curving and joining a few millimeters away from margin*; intercostal veins reticulate, faintly visible below, faint to invisible above; with a strong resinous smell when freshly crushed; petiolules usually whitish, glabrous or hairy, 0.5–3 cm long. **Flowers** yellow or reddish, usually in short axillary inflorescences, glabrous or hairy (var. *pilosa*). **Fruits** globose or ellipsoid, 1–2 x 1 cm, *stigma usually more than 90° excentric, sometimes near the pedicel*.

Key to varieties

Twigs, leaflets and flowers densely hairy.....

var. ***pilosa*** (Engl.) Kalkman

in Leenhouts *l.c.* (1956) 236. Basionym: *Santiria pilosa* Engl. in DC. *l.c.* 159.

Endemic to Borneo. In Sabah and Sarawak widely distributed from lowland to submontane forest but less common compared to var. *apiculata*.

Twigs, leaflets and flowers glabrous.....

var. ***apiculata***

Synonyms: *S. beccarii* Engl. in DC. *l.c.* 159; *S. glabra* Merr. *l.c.* (1915) 30; *S. minutiflora* Ridl. *l.c.* (1922) 377; *S. brachystachys* Ridl. *l.c.* (1925) 79; *Canarium pauciflorum* Ridl. *l.c.* (1930) 80; *Haplolobus borneensis* H.J. Lam, Bull. Jard. Bot. Btztg. 3, 12 (1932) 418.

Sumatra, Peninsular Malaysia, Borneo, Philippines, Celebes, Moluccas. Common and widely distributed throughout Sabah and Sarawak. Mixed dipterocarp to submontane forests to 1300 m.

2. *Santiria conferta* A.W. Benn.

(Latin, *confertus* = crowded; the flowers)

in Hooker *f. l.c.* 537; H.J. Lam, Bull. Jard. Bot. Btztg. 3, 12 (1932) 381; Kalkman *l.c.* (1954) 528; Leenhouts *l.c.* (1956) 233; Burgess *l.c.* 62; Kochummen *l.c.* (1972) 146; Whitmore, Tantra & Sutisna *l.c.* 38. **Type:** *Griffith 1150*, Malacca (holotype K; isotype P). **Synonyms:** *S. wrayi* King *l.c.* (1893) 259; *S. conferta* var. *wrayi* (King) H.J. Lam, Bull. Jard. Bot. Btztg. 3, 12 (1932) 381.

Small to medium-sized tree to 30 m tall, 50 cm diameter. **Bark** grey-brown; inner bark yellow. Terminal bud *c.* 2 cm long. Twigs greyish yellow, *c.* 1 cm thick. **Leaves:** petiole strongly channelled with sharp edges; leaflets thickly leathery, oblong, ovate or elliptic, sometimes glaucous below, 11–17 x 5.5–8.5 cm; base rounded to broadly cuneate, apex

pointed; midrib raised above; lateral veins 11–14 pairs, arching near margin, raised on both surfaces; intercostal veins reticulate, faintly visible on both surfaces. **Flowers** in axillary inflorescences. **Fruits** reddish when fresh, subglobose, 1.5–2 x 1.2–1.5 cm, stigma strongly excentric, near pedicel; surface warty.

Distribution. Sumatra, Peninsular Malaysia, Borneo. In Borneo uncommon, known from a few collections from Sabah and Sarawak.

Ecology. Submontane forest at 1200–1650 m. Fruiting in November and December.

3. *Santiria dacryodifolia* Kochummen

(with leaves resembling those of *Dacryodes*)

l.c. (1994) 83. **Type:** *Tong & Jugah S. 32944*, Sarawak (holotype KEP; isotypes K, L, SAN, SAR, SING).

Small tree to 12 m tall, 25 cm diameter; bole fluted. **Bark** light brown, flaky. Twigs brownish, finely lenticellate, *c.* 7 mm thick. **Leaves** with 2 pairs of leaflets; rachis pustular, rounded, not swollen at base; blade coriaceous, glabrous, drying to brownish, elliptic to rhomboid, 8.5–10.5 x 3.5–5.5 cm; base cuneate, *margin curled inwards, apex pointed; midrib sunken above*; lateral veins 5–7 pairs, faintly visible on both surfaces; intercostal veins reticulate, visible above, invisible below; *petiolules* of lateral leaflets 1–1.5 cm long, of terminal leaflet *c.* 4.5 cm long, *strongly swollen at both ends*. Inflorescences and flowers unknown. **Infructescence** axillary and terminal, *c.* 14 cm long. **Fruits** yellowish to deep red when fresh, drying to dark brown, obliquely oblong, 7–8 x 5–6 mm, surface slightly rugose, *stigma more than 90° excentric, near the pedicel*.

Distribution. Endemic to Sarawak. Uncommon, known from the type only from Ulu Sg. Maria, Lawas.

Ecology. Ridge tops at about 1400 m.

Appears close to *S. apiculata* differing in the stout twigs, thick leaflets with recurved margins and in the petiolules with strongly swollen ends.

4. *Santiria grandiflora* Kalkman

(Latin, *grandis* = large, *florus* = flower)

l.c. (1954) 525; Leenhouts *l.c.* (1956) 232; Anderson *l.c.* 157; Whitmore, Tantra & Sutisna *l.c.* 38. **Type:** *Richards 1278*, Sarawak (holotype K; isotype SING).

Medium-sized tree to 30 m tall. **Bark** grey-brown, scaly; inner bark pink, with droplets of white sap. **Sapwood** pale. Twig stout, *c.* 1.5 cm thick, lenticellate, dark brown powdery hairy towards the tip. *Terminal bud c. 2 cm long*. **Leaves** with 4–6 pairs of leaflets;

petiolules of lateral leaflets 1–2 cm long, powdery hairy; *blade glabrous above except the midrib, powdery hairy below*, oblong-elliptic, 16–29 x 5–9 cm; base rounded or broadly cuneate, apex pointed; midrib raised below, flat and faint above; lateral veins 15–24 pairs; intercostal veins scalariform-reticulate, distinct below, faint above; *petiole strongly channelled above with deep groove*, powdery brown-hairy. **Flowers** (male) in axillary inflorescences. **Infructescences** 9–18 cm long. **Fruits** obliquely ellipsoid, yellowish green, ripening pink, with white waxy bloom on drying, 1.5–1.9 x 1.1–1.3 cm, with faintly wrinkled surface; stigma slightly excentric; persistent calyx reflexed.

Distribution. Endemic to Borneo. Uncommon, recorded from Mt. Dulit, Mulu National Park, and Lambir Hills in Sarawak. Also known from Brunei.

Ecology. Mixed dipterocarp forest to 300 m, on ridges or yellow sandy clay soils. Fruiting in March and April.

This species is somewhat similar to *S. tomentosa* but the strongly channelled petiole will distinguish it.

5. *Santiria griffithii* (Hook. f.) Engl.

(W. Griffith, 1810–45, surgeon at Malacca)

Bot. Jahrb. 1 (1881) 43; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 394; Masamune *l.c.* 368; Kalkman *l.c.* (1954) 545; Leenhouts *l.c.* (1956) 236; Kochummen *l.c.* (1972) 147; Burgess *l.c.* 62; Anderson *l.c.* 157; Whitmore, Tantra & Sutisna *l.c.* 38. **Basionym:** *Trigonochlamys griffithii* Hook. f. *l.c.* (1860) 170. **Type:** *Griffith 1148*, Malacca (holotype K; isotype L). **Synonym:** *Santiria borneensis* Engl. *l.c.* 43.

Medium-sized tree to 30 m tall, 55 cm diameter; buttresses to 2 m tall. **Bark** grey-brown, smooth to scaly; inner bark brownish. **Sapwood** pale. Twigs reddish brown-hairy when young. **Leaves** with 5–11 pairs of opposite or subopposite leaflets; rachis minutely hairy; petiolules of leaflets *c.* 5 mm long, hairy, not swollen; blade glabrous or sparsely hairy below, lanceolate or elliptic, 5–10.5 x 1.5–3 cm; base broadly cuneate to rounded, slightly unequal, apex pointed with long tip; midrib flattened above; *lateral veins* 15–18 pairs, faintly visible below, faint to inconspicuous above, *distinctly curving and joining near margin*; intercostal veins reticulate, visible below, faint above. **Inflorescences** axillary, pubescent. **Flowers** tomentose; calyx deeply divided; petals pubescent; stamens 6, filaments adnate to disc, pistil in male flowers reduced. **Fruits** obliquely globose, 8–13 x 8–16 mm; stigma almost 90° excentric.

Distribution. Sumatra, Peninsular Malaysia, Borneo. In Sabah uncommon, recorded from Keningau and Tawau only. In Sarawak more common and widely distributed. Also occurs in Brunei and Kalimantan.

Ecology. Mixed dipterocarp forest on yellow sandy soils to 300 m. Flowering in March–November and fruiting in September–October.

6. *Santiria impressinervis* Kochummen

(Latin, *impressus* = pressed in, *nervus* = nerve; the sunken veins on the upper leaflet surface)

l.c. (1994) 83. **Type:** *Nooteboom & Chai 2113*, Sarawak (holotype KEP; isotype SAR).

Small tree to 15 m tall, 15 cm diameter. **Bark** yellowish, smooth. Twigs *c.* 4 mm thick, brownish, with small lenticels. **Leaves** with 2–3 pairs of leaflets; rachis slender, slightly flattened above towards the base; *petiolules* of lateral leaflets 0.8–1.5 cm long, that of terminal leaflet *c.* 2 cm long, *strongly swollen at both ends*; blade glabrous, coriaceous, drying to yellowish brown, ovate to lanceolate, 6–9 x 2–4 cm; base broadly cuneate, slightly asymmetric, apex pointed, tip 5–10 mm long; midrib faintly sunken above; *lateral veins* 7–9 pairs, *sunken above*, curving and joining near margin; *intercostal veins invisible*. Inflorescences and flowers unknown. **Infructescences** axillary, to 11 cm long. **Fruits** glaucous green when fresh, drying to brownish, smooth, ovoid, *c.* 10 x 7 mm, *stigma prominently off-centre, near pedicel*.

Distribution. Endemic to Sarawak. Uncommon. known only from the type from the Pamerario river at Bario in the Kelabit Highlands.

Ecology. Old secondary forest at 1000 m.

Appears close to *S. apiculata* but differing in the thickly coriaceous leaflets with invisible intercostal veins and in the sunken lateral veins.

7. *Santiria kalkmaniana* Kochummen

Fig. 6.

(C. Kalkman, former director of the Rijksherbarium, Leiden, Netherlands)

l.c. (1994) 86. **Type:** *Saikeh SAN 72293*, Sabah (holotype SAN; isotypes A, K, SAR, SING).

Medium-sized tree to 30 m tall, 45 cm diameter; buttresses to 3 m tall. **Bark** greyish, smooth, lenticellate; inner bark yellowish. **Sapwood** pale yellow. Twigs very stout, 1.5–2 cm thick, grey-brown, lenticellate. *Terminal bud lanceolate, rusty brown, c. 6 cm long with curved tip*. **Leaves** with 5 pairs of leaflets, glabrous; rachis *c.* 54 cm long, petiole channelled above; *petiolules* of lateral leaflets 2–2.5 cm long, slightly swollen at both ends, *petiolules* of terminal leaflets 5–8.5 cm long; blade thinly leathery, oblong to lanceolate, 18–35 x 7–9 cm; base rounded or broadly cuneate, asymmetric, apex pointed; midrib raised above; *lateral veins* 16–19 pairs, raised below, faint above; *intercostal veins reticulate*, more distinct on the upper surfaces. **Inflorescences** (male) axillary, glabrous, panicles to 27 cm long, axes sharply angled. **Flowers** (male) glabrous; calyx red, cup-shaped; petals deep scarlet, oblong; stamens 6, inserted on rim of disc; disc annular; ovary rudimentary. **Infructescences** *c.* 6 cm long, with short branches. **Fruits** light yellow when fresh drying black, subglobose or hemispherical, 1.7–2 x 1.0–1.8 cm, flattened above; stigma more than 90° excentric.

Distribution. Endemic to Borneo. Uncommon, known from few collections from Sabah (SAN 72293, Sipitang; SAN 49754, Ranau), and Sarawak (S. 14727, Kapit; S. 39782, G. Mulu, and S. 4030 from Baram).

Ecology. Lowland and hill forests to 450 m.

This species appears close to *S. laevigata* but differs in the long rusty brown curved terminal bud and in the fruit stigmas that are more than 90° off-centre.

8. *Santiria laevigata* Blume

(Latin, *laevigatus* = smooth and polished; the leaflets)

l.c. (1850) 211; King *l.c.* 257; Ridley *l.c.* (1922) 378; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 382; Masamune *l.c.* 368; Kalkman *l.c.* (1954) 535; Leenhouts *l.c.* (1956) 232; Burgess *l.c.* 62; Kochummen *l.c.* (1972) 147; Cockburn *l.c.* 48; Anderson *l.c.* 157; Whitmore, Tantra & Sutisna *l.c.* 38. **Type:** *Korthals, s.n.* (= *Leiden no. 898.321-201*), Sumatra (L). **Synonym:** *Canarium laevigatum* (Blume) Miq. *l.c.* (1859) 648.

Medium-sized tree to 30 m tall, 80 cm diameter; buttresses to 4 m tall. **Bark** grey-brown, fissured and scaly, lenticellate; inner bark pinkish, laminated, with droplets of white sap. **Sapwood** pale white. *Terminal bud* 0.5–2.5 cm long, often resin-coated. Twigs c. 1 cm thick, lenticellate, dark brown. **Leaves** with 1–4 pairs of leaflets; petiole flattened above with sharp edges (forma *laevigata*) or not flattened (forma *glabrifolia*); petiolules of lateral leaflets 1–1.5 cm long, slightly swollen at both ends, sometimes the swollen parts drying black; *blade drying reddish or dark brown*, elliptic, ovate or oblong, 7–12 x 2.5–6.5 cm; base rounded to broadly cuneate, sometimes unequal, apex pointed; midrib raised above; lateral veins 7–15 pairs, fairly raised on both surfaces, curving and joining near margin; intercostal veins reticulate, very faintly visible on both surfaces. **Flowers** glabrous, in axillary inflorescences. **Fruits** rounded to oblong, 1–2 cm across; stigma less than 90° excentric.

Key to forms

Petiole flattened above, at base with sharp edges.....

forma *laevigata*

Synonyms: *Santiria laevigata* forma *typica* H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 384; *S. violacea* H.J. Lam, Ann. Jard. Bot. Btzig. 42 (1932) 205.

Sumatra, Peninsular Malaysia, Borneo, and Celebes. In Sarawak uncommon, known from two collections (S. 32817 and S. 41457). Not yet recorded from Sabah.

Petiole rounded at base, without sharp edges.....

forma *glabrifolia* (Engl.) H.J. Lam

Ann. Jard. Bot. Btzig. 42 (1932) 205. Basionym: *Santiria glabrifolia* Engl. in DC. *l.c.* 164. Type: *Beccari PB 3756*, Sarawak (FI).

Sumatra, Peninsular Malaysia, and Borneo. Common and widely distributed in Sabah and Sarawak.

Ecology. Mixed dipterocarp, mixed peat swamp and *kerangas* forests on low-nutrient soils to submontane forests to 1200 m.



Fig. 6. *Santiria kalkmaniana*. A, Leafy shoot with infructescences; B, inflorescence with flower buds; C, flower bud; D, flower bud with sepals and petals removed. (A from SAN 72293, B from S. 39782, C & D from S. 4030.)

9. *Santiria megaphylla* Kalkman

(Greek, *mega* = large, *phyllon* = leaf)

l.c. (1954) 533; Leenhouts *l.c.* (1956) 236; Burgess *l.c.* 62; Anderson *l.c.* 157; Whitmore, Tantra & Sutisna *l.c.* 38. **Type:** *Beccari PB 3059*, Sarawak (FI).

Medium-sized tree to 25 m tall. *Twigs very stout, c. 3 cm thick, grey with circular lenticels and with stipule-like undeveloped leaves. Terminal bud c. 1.5 cm long. Leaves with 3–5 pairs of leaflets; petiole stout, strongly channelled at base; petiolules of lateral leaflets 4–5 cm long, petiolules of terminal leaflets c. 11 cm long, strongly swollen at both ends; blade thickly leathery, very large, oblong, 25–61 x 13–22 cm; base broadly cuneate, apex pointed; midrib raised above; lateral veins 8–14 pairs, raised on both surfaces, curving and joining near margin; intercostal veins reticulate, faintly visible on both surfaces. Flowers in axillary inflorescences. Fruits pink when fresh, asymmetric, ellipsoid, 1.5–1.7 x 1–1.25 cm; stigma excentric, near pedicel.*

Distribution. Endemic to Borneo. Uncommon, known from few collections from Sabah (*SAN A 1746*, Beaufort; *SAN 15152*, Sipitang) and Sarawak (*S. 38747* and *S. 43958* from Semengoh Arboretum and Mt. Dulit), and ecological plots at Bako and Lambir NP, and Segam FR. Also known from Brunei.

Ecology. Mixed dipterocarp forests on deep sandy humult ultisols.

The stout twigs and very large leaflets are good diagnostic features for the species.

10. *Santiria mollis* Engl.

(Latin, *mollis* = soft-hairy; the indumentum of young twigs, leaves and flowers)

in DC. *l.c.* 156; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 388; Masamune *l.c.* 368; Kalkman *l.c.* (1954) 530; Leenhouts *l.c.* (1956) 231; Burgess *l.c.* 62; Anderson *l.c.* 157; Whitmore, Tantra & Sutisna *l.c.* 38. **Type:** *Beccari PB 3497*, Sarawak (FI). **Synonym:** *Canarium hirtipetalum* Ridl. *l.c.* (1930) 84.

Medium-sized tree to 24 m tall, 70 cm diameter; buttresses to 3 m high. **Bark** brown, smooth; inner bark reddish brown, with white latex. **Sapwood** pale yellow. Twigs densely reddish brown-hairy with abundant small lenticels when young. Terminal bud stout, *c. 1 x 0.5 cm, hairy as the twig. Leaves with 2–4 pairs of leaflets; rachis densely reddish brown-hairy; petiolules of lateral leaflets to 1 cm long, not swollen at both ends, hairy; blade densely velvety hairy below and on midrib above, obovate, oblong or elliptic, often concave, 7.5–15.5 x 3–7 cm; base cuneate or rounded, often unequal, margin curled inwards, apex pointed with long tip; midrib raised above; lateral veins 10–13 pairs, raised below, faint to sunken above; intercostal veins reticulate, raised below, faint to invisible above. Flowers (male) in hairy axillary inflorescences; sepals almost free, sparsely hairy outside; petals densely hairy on both sides. Fruits subglobose, 1.5–1.8 cm across; stigma more than 90° excentric.*

Distribution. Endemic to Borneo. Uncommon, in Sabah recorded from Beaufort and Tawau. In Sarawak collected from Semengoh Arboretum and Lambir National Park. Also known from Brunei and Kalimantan.

Ecology. Mixed dipterocarp forest to 200 m, often by streams. Flowering in March and November and fruiting in February and March.

Very atypical of *Santiria* in vegetative features.

11. *Santiria nigricans* Kochummen

(Latin, *nigricans* = becoming black; the leaf rachis)

l.c. (1994) 89. **Type:** *Ilias & Yeo S. 38319*, Sarawak (holotype KEP; isotypes K, L, MO, SAN, SAR).

Large tree to 30 m tall, 100 cm diameter. **Bark** brownish, scaly; inner bark reddish brown. **Sapwood** whitish. Twigs brown or greyish brown, 3–4 mm thick. **Leaves** with up to 3 pairs of leaflets, glabrous; *rachis* slender, dark brown, *surface oily*, slightly swollen at the very base; petiolules of lateral leaflets slender, 1–1.5 cm long, of the terminal leaflets to 4 cm long, slightly swollen at both ends, drying to dark brown; blade thinly leathery, drying to grey-brown, elliptic to lanceolate, 6.5–11.5 x 2.8–4.7 cm; *base cuneate, strongly asymmetric*, apex pointed; midrib raised above; lateral veins 7–11 pairs, very faint on both surfaces; intercostal veins reticulate, faintly visible on both surfaces. **Inflorescences** (male) axillary and terminal, glabrous. **Flowers** (male) with green calyx and white petals. **Fruits** green, ripening deep purple to blackish, drying to pale brownish, subglobose, 11–14 mm across, surface with shallow reticulate veins; stigma only slightly off-centre.

Distribution. Endemic to Sarawak; of scattered distribution in Lambir National Park (*S. 38319* and *S. 46599*), Mulu National Park (*S. 42406*), Balingian (*S. 23687*), Selampit (*S. 24939*) and Sg. Jelalong (*S. 48804*).

Ecology. Mixed dipterocarp forest from lowlands to 1600 m.

Somewhat close to *S. oblongifolia* but the dark brown rachis, very faint lateral veins and the subglobose fruits distinguish this species.

12. *Santiria oblongifolia* Blume

(Latin, *oblongus* = rather long, *folium* = leaf; the leaflet shape)

l.c. (1850) 211; H.J. Lam, Bull. Jard. Bot. Btzig. 3, 12 (1932) 372; Masamune *l.c.* 369; King *l.c.* 257; Ridley *l.c.* (1922) 379; Kalkman, *l.c.* (1954) 537; Leenhouts *l.c.* (1956) 233; Burgess *l.c.* 62; Kochummen *l.c.* (1972) 150; Anderson *l.c.* 157; Whitmore, Tantra & Sutisna *l.c.* 39. **Type:** *Praetorius, s.n.* (= *Leiden no. 898.321–221*), Sumatra (L). **Synonyms:** *S. caesia* Engl. in DC. *l.c.* 166; *S. latifolia* Stapf. ex Ridl. *l.c.* (1930) 86.

Medium-sized tree 30 m tall, very rarely to 50 m tall, 80 cm diameter; buttresses to 1.5 m high. **Bark** grey-brown, smooth, lenticellate, rarely scaly or flaky; inner bark pink, laminated. **Sapwood** pale white. **Leaves** with 2–4 pairs of leaflets; petiolules of lateral leaflets 1–3.5 cm long, swollen at both ends; blade thinly to thickly leathery, oblong to lanceolate, 8–21.5 x 3–7.5 cm; base broadly cuneate, apex pointed; midrib raised above; lateral veins 8–10 pairs, visible on both surfaces, curving and joining near margin; intercostal veins reticulate,

faint on both surfaces. **Flowers** in axillary or terminal inflorescences, glabrous or sparsely hairy. **Fruits** oblong-ellipsoid, 1.2–3 x 1.1–2.2 cm; stigma slightly excentric.

Distribution. Sumatra, Peninsular Malaysia, Borneo. Widely distributed in Sabah. In Sarawak collected mainly from the Bako National Park and Semengoh Forest Reserve area. Also found in Kalimantan.

Ecology. Mixed dipterocarp forest on yellow sandy and clay soils, heath forest and submontane forest to 1000 m. Flowering in March, May and September and fruiting in January, March–May and September.

13. *Santiria rubiginosa* Blume

(Latin, *rubiginosus* = rusty coloured; the indumentum)

l.c. (1850) 213; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 399; Masamune *l.c.* 369; Kalkman *l.c.* (1954) 542; Leenhouts *l.c.* (1956) 237; Burgess *l.c.* 62; Kochummen *l.c.* (1972) 151; Anderson *l.c.* 158; Whitmore, Tantra & Sutisna *l.c.* 39. **Type:** *Praetorius*, *s.n.* (=Leiden no. 898.321–229), Sumatra (L). **Synonym:** *Canarium rubiginosum* (Blume) Miq. *l.c.* (1859) 651.

Medium-sized tree to 28 m tall, 40 cm diameter; buttresses to 1.5 m high. **Bark** grey, smooth, lenticellate. Twigs brownish, glabrous, except the tip. **Leaves** with 1–4 pairs of leaflets, sometimes mixed with simple leaves; petiolules of lateral leaflets 0.5–2 cm long, either rounded or strongly flattened, swollen at both ends; blade glabrous or very sparsely powdery hairy below, elliptic to lanceolate, 4.5–13.5 x 1.5–6 cm; base cuneate, often unequal, apex pointed with long tip; midrib raised above; lateral veins 9–13 pairs, visible below, faint above, arching and joining near margin; intercostal veins reticulate, faintly visible on both surfaces. **Flowers** in axillary inflorescences, glabrous; sepals almost free; stamens 3. **Fruits** globular or ellipsoid, 10–14 x 8–10 mm; stigma less than 90° excentric.

S. rubiginosa is very similar to *S. griffithii* in vegetative characters but the asymmetric leaflets of *S. rubiginosa* are distinctive.

Key to varieties

1. Pedicels 1–3 mm long, shorter or as long as the flowers.....2
 Pedicel 2–8 mm long, longer than the flowers.....
 var. **pedicellata** (Ridl.) Kalkman
 l.c. (1954) 544. Basionym: *Santiria pedicellata* Ridl. *l.c.* (1930) 86. Synonym: *S. minimiflora* Ridl. *l.c.* (1930) 87. Type: *Haviland 1866*, Sarawak, Sibul, Rejang (SING).
 Endemic to Borneo. Common in Sarawak but not yet reported from Sabah. Fresh-water, heath and peat swamp forest.
2. Leaflet apex caudate-acuminate, more than 1 cm long; petiolule flattened, the ends blacken on drying.....
 var. **latipetiolata** Kochummen
 l.c. (1994) 89. Type: *George S. 40254*, Sarawak (holotype KEP; isotypes E, K, L, MO, SAN, SAR).

Endemic to Sarawak, known from two collections from the Lambir National Park (*S. 40254* and *S. 47190*). Mixed dipterocarp forest on ridges at 250 m.

Leaf apex not so, petiole not flattened.....

var. **rubiginosa**

Synonyms: *Santiria planchonii* A.W. Benn. in Hooker *f. l.c.* 536; *C. planchonii* (A.W. Benn.) King *l.c.* 240; *Icicaster planchonii* (A.W. Benn.) Ridl. *l.c.* (1917) 15; *S. havilandii* Ridl. *l.c.* (1930) 85.

Sumatra, Peninsular Malaysia, Borneo, and New Guinea. Common and widely distributed in Sarawak in mixed dipterocarp forest but uncommon in Sabah and known only by a single collection, *SAN 16678*, from Sipitang at 750 m.

14. *Santiria sarawakana* Kochummen

(of Sarawak)

l.c. (1994) 91. **Type:** *Tong et al., S. 34287*, Sarawak (holotype SAR; isotypes K, KEP, L, MO, SAN).

Medium-sized tree to 26 m tall, 30 cm diameter. **Bark** dark brown, flaky. *Twigs whitish*, powdery brown-hairy. Terminal bud ovate, *c.* 5 x 3 mm. **Leaves** with 3 pairs of leaflets; rachis hairy as the twig, rounded; petiolules of lateral leaflets 7–15 mm long, of terminal leaflets 1.5–3 cm long, hairy and swollen at both ends; *blade* leathery, glabrous above except the midrib, *densely hairy on midrib and lateral veins below*, ovate to oblong or elliptic, 6–14 x 3–5 cm; base broadly cuneate, asymmetric, *margin curled inwards*, apex pointed; midrib raised above; lateral veins 9–12 pairs, curving and joining near margin, raised below, visible above; intercostal veins scalariform-reticulate, visible on both surfaces. Inflorescences and flowers unknown. **Infructescences** axillary, to 11.5 m long, axes hairy. **Fruits** glaucous black when fresh, black on drying, oblong, 11–13 x 7–10 mm; stigma less than 90° excentric.

Distribution. Endemic to Sarawak. Uncommon, known only from Miri and the Sabal Forest Reserve (*S. 24119* and *S. 34287*).

Ecology. Lowland forest to 120 m.

Close to *Santiria tomentosa* but the sparsely hairy leaflets and short terminal buds are quite distinct.

15. *Santiria tomentosa* Blume

(Latin, *tomentosus* = densely pubescent with matted, woolly or short hairs; the young twigs, buds and leaflets)

l.c. (1850) 211; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 391; Masamune *l.c.* 369; Kalkman *l.c.* (1954) 529; Leenhouts *l.c.* (1956) 231; Burgess *l.c.* 62; Kochummen *l.c.* (1972) 151; Cockburn *l.c.* 49; Anderson *l.c.* 158; Whitmore, Tantra & Sutisna *l.c.* 39. **Type:** *Korthals, s.n.* (= *Leiden no.*

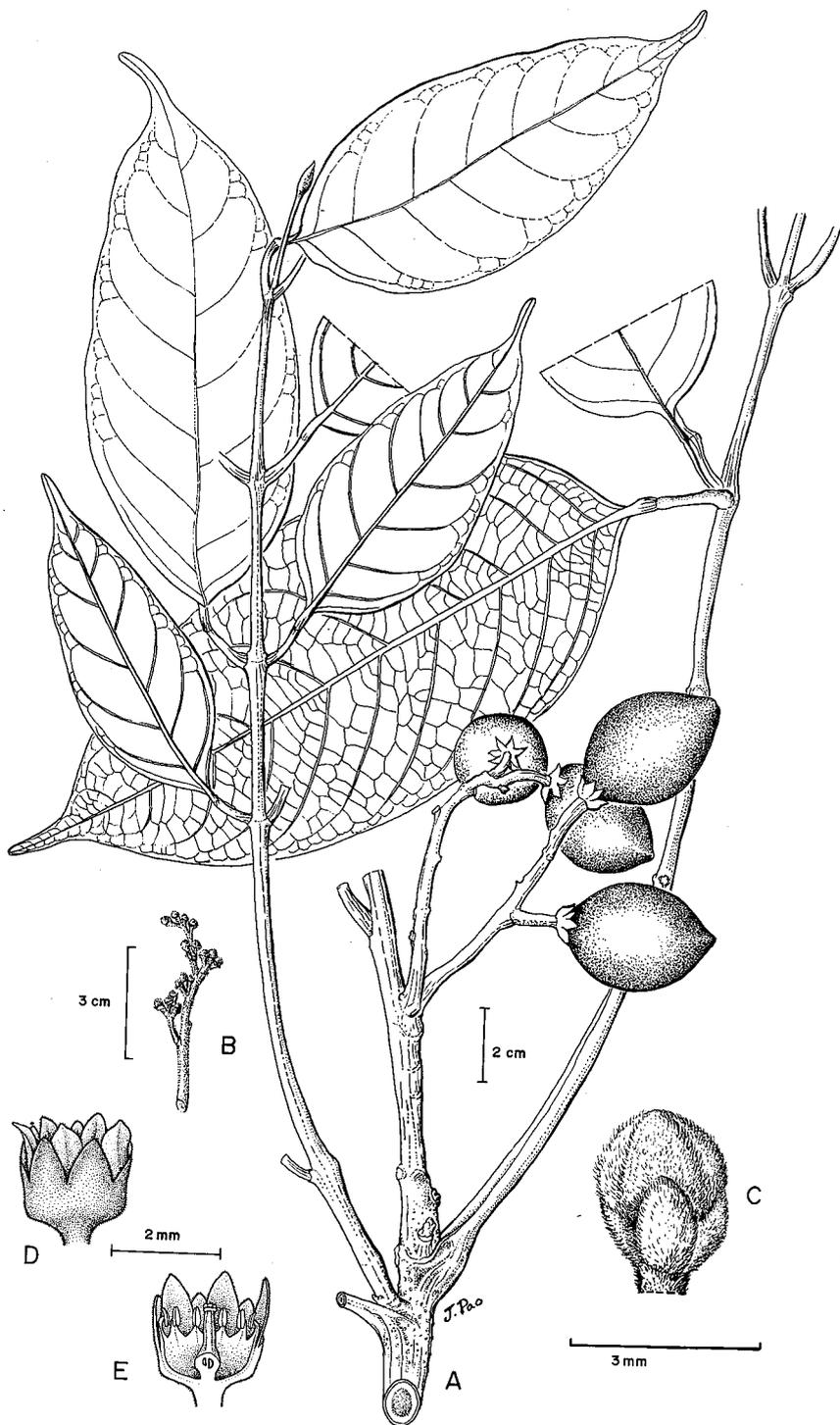


Fig. 7. *Scutinanthe brunnea*. A, fruiting leafy twig; B, inflorescence; C, flower bud; D, open flower; E, longitudinal section of flower. (A from S. 43904, B & C from S. 21666, D & E after FM 1, 5 (1956) 247, fig. 18.)

898.321–245), Sumatra (L). **Synonyms:** *Canarium korthalsii* Miq. *l.c.* (1859) 645; *Santiria multiflora* A.W. Benn. in Hooker *f. l.c.* (1875) 538; *C. micrantherum* Stapf *ex Ridl. l.c.* (1930) 82; *S. mollissima* Ridl. *l.c.* (1930) 85.

Medium-sized tree to 30 m tall, 50 cm diameter; buttresses to 2 m high. **Bark** grey-brown, scaly; inner bark pinkish with droplets of white sap. **Sapwood** pale yellow. Twigs 5–15 mm thick, slightly angled, woolly hairy. Terminal bud to 2 cm long, hairy. **Leaves** with 1–4 pairs of leaflets; *rachis woolly hairy*; petiolules of lateral leaflets 0.5–2 cm long, hairy; *blade woolly hairy below and on midrib above*, ovate to oblong, 11–27 x 4–12 cm; base rounded or cuneate, sometimes unequal, apex pointed; midrib raised above; lateral veins 10–20 pairs, raised on both surfaces, curving and joining near margin; intercostal veins scalariform-reticulate, distinct below, faint above. **Flowers** hairy, in axillary inflorescences. **Fruits** globose or oblong, 2–2.7 x 1.5–2 cm; stigma less than 90° excentric.

Distribution. Sumatra, Peninsular Malaysia, Borneo. Common and widely distributed in Sabah and Sarawak. Also in Brunei and Kalimantan.

Ecology. Mixed dipterocarp forests, rarely in swamps, to 300 m. Flowering in May–October and fruiting in March, April, June, October and November.

There is great variation in the size of leaflets and in the degree of pubescence.

7. SCUTINANTHE Thwaites

(Latin, *scutum* = shield, *anthus* = flower; the shape of the flower)

in Hooker *f.*, *J. Bot. Kew Misc.* 8 (1856) 266; H.J. Lam, *Bull. Jard. Bot. Btzg.* 3, 12 (1932) 420; Leenhouts *l.c.* (1952) 160, *l.c.* (1956) 246; Kochummen *l.c.* (1972) 152; Anderson *l.c.* 158; Wong *l.c.* 215; Ng *l.c.* 38; Whitmore, Tantra & Sutisna *l.c.* 39.

Diococious trees; *bole smooth with horizontal ring or occasionally scaly; inner bark raspberry-red with large beads of creamy to colourless exudate. Pith of branchlets and petioles without vascular strands. Leaves without stipules; leaflets entire. Inflorescences axillary, paniculate. Flowers unisexual, 5-merous, receptacle cup-shaped; sepals free; petals free with slightly thickened apex; stamens 10, confluent at base, episepalous ones longer, in female flowers slightly reduced in size, sterile; disc intrastaminal, adnate to receptacle; ovary hairy, 3-celled, only slightly reduced in male flowers. Fruits drupaceous, stigmatic scar nearly apical, pericarp fleshy; pyrene hard and bony, usually 2 cells strongly reduced; persistent calyx not enlarged. Seeds one; germination in *S. brunnea* epigeal; cotyledons leafy, entire; leaves of young seedling simple, alternate to spiral.*

Distribution. Two species in Sri Lanka, S Burma, W Malesia and Celebes. One species in Sabah and Sarawak.

Ecology. Lowland forests to 100 m.

Uses. The light hardwood timber is commonly grouped together with other members of the family and sold as *kedondong*.

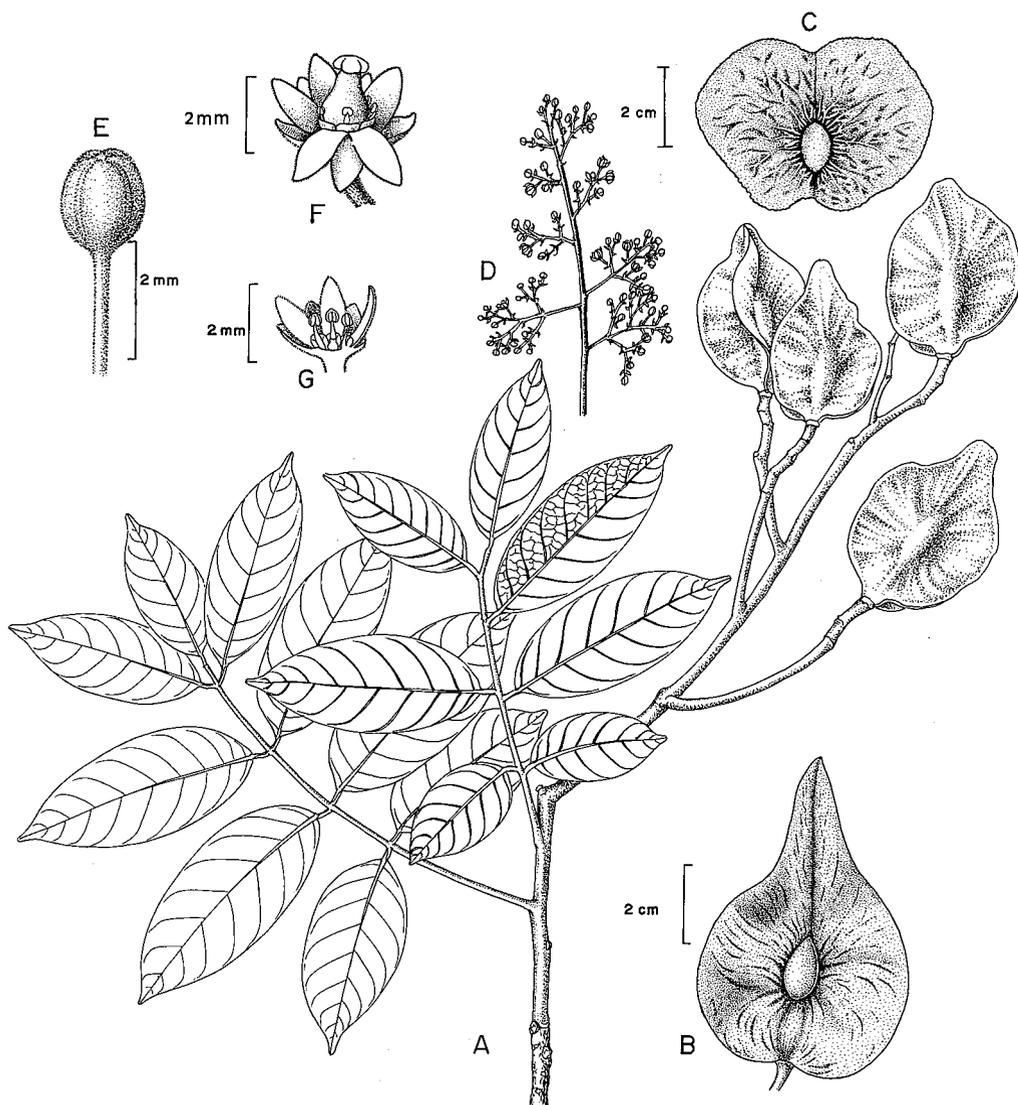


Fig. 8. *Triomma malaccensis*. A, fruiting leafy twig; B, dehisced fruit; C, seed; D, part of inflorescence; E, flower bud; F, female flower; G, section through male flower. (A from SAN 37050, B-C from FRI 21209, D-E from SAN 40617, F-G after FM 1, 5 (1956) 219, fig. 8.)

Scutinanthe brunnea Thwaites

Fig. 7.

(Latin, *brunneus* = brown; the indumentum on the inflorescence)

in Hooker *f. l.c.* (1856) 267; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 420; Leenhouts *l.c.* (1952) 162, *l.c.* (1956) 247; Burgess *l.c.* 62; Kochummen *l.c.* (1972) 152; Anderson *l.c.* 158; Whitmore, Tantra & Sutisna *l.c.* 39. **Type:** *Thwaites 1149*, Ceylon (K). **Synonyms:** *Garuga brunnea* (Thwaites) Marchand, *Adansonia* 8 (1867) 34, 66; *Canarium brunneum* (Thwaites) Beddome, Fl. Sylv. 1 (1868) t. 127.

Medium-sized tree to 30 m tall, 30 cm diameter. **Sapwood** pale. Twigs brownish, lenticellate. **Leaves** with 3–6 pairs of leaflets; petiolules of lateral leaflets 1–2.5 cm long, swollen at both ends; blade elliptic to obovate, 8–21 x 4–8 cm; base broadly cuneate, unequal, apex pointed; *midrib sunken above*; lateral veins 8–10 pairs, raised below, faint above, curving and joining near margin; intercostal veins reticulate, visible on both surfaces. **Inflorescences** *rusty red-pubescent*. **Flowers** densely pubescent with greenish white inner face. **Fruits** ellipsoid, 4–6.5 x 2–3 cm, green, ripening yellow, with persistent calyx.

Distribution. Sri Lanka, Sumatra, Peninsular Malaysia, and Borneo. In Sabah and Sarawak uncommon, known only by a few collections. Also in Brunei and Kalimantan.

Ecology. Lowland forests to 100 m.

8. TRIOMMA Hook. *f.*

(Greek, *tri* = 3, *omma* = eyes or openings;
the triangular seed showing 3 openings in cross-section)

Trans. Linn. Soc. 23 (1860) 171; Ridley *l.c.* (1922) 369; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 331; Kalkman *l.c.* (1954) 499; Leenhouts *l.c.* (1956) 218; Burgess *l.c.* 62; Kochummen *l.c.* (1972) 154; Cockburn *l.c.* 49; Anderson *l.c.* 158; Wong *l.c.* 248; Ng *l.c.* 38; Whitmore, Tantra & Sutisna *l.c.* 39.

Dioecious trees. *Pith of branchlets without vascular strands. Stipules absent. Leaflets* with entire margin, *strongly asymmetrical at base; stalk not swollen. Inflorescences* axillary panicles. **Flowers** unisexual, 5-merous; sepals and petals free; stamens 5, episepalous, base of filaments adnate to disc; *disc extrastaminal*, 5-lobed, lobes emarginate; ovary triangular, 3-celled, in male flowers entirely reduced. **Fruits** 3-winged, dry, woody capsule, splitting into 3 valves. **Seeds** 3, broadly winged; germination epigeal; cotyledons shallowly 5-lobed, leafy; leaves of young seedling alternate to spiral, simple for the first few nodes, later with 3 and 5 leaflets, margin initially toothed becoming entire later.

Distribution. One species confined to W Malesia:

Ecology. Lowland forests.

Uses. The timber is commonly grouped with other members of the family and sold as *kedondong*. The wood is light hardwood, and used for indoor construction. The resin is sometimes used for torches.

Triomma malaccensis Hook. *f.*
(of Malacca)

Fig. 8.

l.c. (1860) 171; King *l.c.* 236; Ridley *l.c.* (1922) 369; Merrill *l.c.* (1929) 119; H.J. Lam, Bull. Jard. Bot. Btzg. 3, 12 (1932) 332; Kalkman *l.c.* (1954) 499; Leenhouts *l.c.* (1956) 218; Burgess *l.c.* 62; Kochummen *l.c.* (1972) 154; Cockburn *l.c.* 49; Anderson *l.c.* 158; Whitmore, Tantra & Sutisna *l.c.* 39. **Type:** *Maingay 299*, Malacca (holotype K; isotype L).

Tree to 60 m tall, 100 cm diameter; buttresses to 5 m high, spreading. **Bark** smooth to scaly, grey-brown; inner bark pink or reddish brown, with a strong mango smell. **Sapwood** pale yellow. Twigs dark brown. **Leaves** with 2–5 pairs of leaflets; *petiolules of leaflets not swollen; blade withering yellow with pink midrib and veins*, oblong or ovate, 4–12 x 2–8 cm; *base strongly unequal with one half rounded*, apex pointed; midrib raised above; lateral veins 6–11 pairs, raised on both surfaces; intercostal veins reticulate, distinct on both surfaces. **Inflorescences** many-branched, hairy. **Flowers:** sepals and petals densely tomentose. **Fruits** 5–7 x 2–2.5 cm. **Seeds** 3 with broad membranous wing. Saplings with densely hairy rachis and leaflets.

Vernacular name. Sabah—*kedondong asam* (Malay).

Distribution. Sumatra, Peninsular Malaysia, Borneo. In Sabah a common emergent tree of the lowland forests, especially by streams. Widespread but not common in Sarawak, known from only two collections from Lambir National Park (*S. 46465*) and Limbang district (*S. 42833*). Also occurs in Kalimantan.

Ecology. Mixed dipterocarp forest on yellow sandy clay soils. Flowering in April–September and fruiting in May–December.

CAPPARACEAE

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Merrill, EB (1921) 280; Masamune, EPB (1940) 318; Jacobs, FM 1, 6 (1960) 61, FM 1, 7 (1976) 822; Whitmore, TFM 2 (1973) 25; Anderson, CLTS (1980) 158; Ashton, MNDTS 2 (1988) 83; Corner, WSTM 1 (1988) 201; Whitmore, Tantra & Sutisna, CLK 1 (1989) 40.

Trees, shrubs, woody climbers, or herbs. **Leaves** simple and entire, or trifoliolate or deeply 5–7-lobed, alternate or spirally arranged, petioled; stipules thorny, minute or absent. **Inflorescences** racemose or paniculate, terminal or lateral, sometimes individual flowers axillary or serial; bracts, if present, small and caducous, rarely with stipular bracteoles. **Flowers** bisexual, regular or slightly irregular, sometimes big and showy, mostly in bud until anthesis but in *Crateva* opening at a very early stage; sepals 4, either equal or in two whorls of 2, free; petals 4 or (in *Stixis*) absent, equal or sometimes 2 of the petals slightly asymmetric and joined at the base, often free, usually stalked; receptacle more or less conical; stamens (4–)6 to many, all fertile, either free or their bases connate with the stalk of the ovary (gynophore) and forming an androgynophore; anthers dorsifixed; ovary superior, 1–6-loculed, generally on a long gynophore, sometimes sessile, ovoid to cylindrical, with a small, simple sessile stigma. **Fruit** a leathery berry or a capsule. **Seeds** many, rarely 1 (*Stixis*), mostly kidney-shaped; endosperm scanty.

Distribution. Approximately 45 genera and 700 species in tropical and subtropical regions. In Sabah and Sarawak represented by 4 genera; *Crateva* with 2 species of trees, the other 3 genera are mainly shrubs, woody climbers, and herbs.

Ecology. Mostly in open places in the lowlands, a few ascend to 1000 m. Although species of the Capparaceae are usually found in dry regions, both Bornean species of *Crateva* are riverine trees. The flower of this family is characterised by long-radiating stamens, suggesting pollination by butterflies and moths. Several species are known to be night-flowering. Birds, bats, and ants have all been cited as dispersal agents. Trees of *Crateva*, however, have water-dispersed fruits.

Uses. The familiar capers are from *Capparis spinosa* originating in the Mediterranean region. Several species are noted for their medicinal properties (*cf.* Perry, MPESA (1980) 68–70). Some tree species of *Crateva* are deemed to have religious significance and are planted for ornamental purposes as well.

Taxonomy. The link between Capparaceae and Brassicaceae (the cabbage family) has long been recognised. The distinct mustard-like taste common in Brassicaceae is also present in

many Capparaceae, e.g. in the capers. Recent cladistic studies (Judd *et al.*, Harvard Papers in Botany 5 (1994) 1–51) based on morphological and genetic data strongly suggest that the Capparaceae is paraphyletic, and the subfam. Cleomoideae is more closely related to the Brassicaceae than to the Capparaceae.

Key to genera

1. Trees. Leaves trifoliolate..... **Crateva**
 Shrubs, woody climbers, or herbs. Leaves simple or deeply 3–7-lobed.....2

2. Herbs. Leaves palmately, deeply 3–7-lobed. Fruit a long capsule.....
Cleome L.
 Gen. Pl. ed. 5 (1754) 302; Jacobs *l.c.* (1960) 99; Whitmore *l.c.* 25.
 A pantropical and subtropical genus with over 150 species, well represented in America; 4 species in Sabah and Sarawak.
 Annual or perennial herbs. Flowers in leafy, terminal racemes or panicles; sepals 4, free; petals clawed, normally 4; stamens 6 to many. Capsule linear and cylindrical. Seeds many.

 Shrubs or woody climbers. Leaves simple. Fruit a leathery berry3

3. Plants with stipular thorns. Flowers on long stalks. Fruit with one to many seeds.....
Capparis Tourn. *ex* L.
 Gen. Pl. ed. 5 (1753) 222; Jacobs *l.c.* (1960) 70, Blumea 12, 3 (1965) 405; Whitmore *l.c.* 25.
 About 250 species in the tropics and subtropics, half of which are in the New World; 7 species in Sabah and Sarawak.
 Shrubs, woody climbers, or rarely small trees. Leaves simple, spiral, with a pair of stipular thorns which are occasionally wanting. Flowers single or in small, sessile groups just above the leaf axils, feathery with long stamens; sepals biseriata, mostly imbricate; petals 4; stamens many, rarely (7–)8(–12), free, radiating, longer than the petals; ovary 1-locular. Berry globular to ellipsoid with a corky or leathery pericarp. Seeds 1 to many, kidney-shaped.

 Plants without thorns. Flowers on short stalks. Fruit with 1 seed
Stixis Lour.
 Fl. Coch. (1790) 295, ed. Willdenow (1793) 361; Jacobs *l.c.* (1960) 95, Blumea 12 (1964) 5; Whitmore *l.c.* 25.
 7 species distributed throughout India, Burma, Cambodia, Hainan, and W Malasia. One species endemic to Borneo, *S. ovata*, occurs in Sabah and Sarawak.
 Rather small unarmed, woody climbers. Branches lenticellate. Leaves simple, rather large. Inflorescences racemose or paniculate. Flowers many, axillary or terminal; petals absent; sepals mostly 6, in two whorls of 3; stamens 20–50(–100), about as long as sepals; ovary subglobular. Fruits few, on a thick woody stalk, ellipsoid, 2.5–5 cm long. Seed one, large.

CRATEVA L.

(Kratevas, 132–63 B.C., an ancient Greek medicine man or root gatherer)

l.c. (1754) 203; Jacobs *l.c.* (1960) 63, *l.c.* (1964) 186; Whitmore *l.c.* 26; Anderson *l.c.* 158; Corner *l.c.* 203; Whitmore, Tantra & Sutisna *l.c.* 40.

Small to medium-sized trees. **Bark** grey or brown, smooth. Twigs round, glabrous, with distinct leaf-scars, stipules small, not persistent; axillary buds small. **Leaves** spiral, palmately lobed or trifoliolate, sessile to shortly stalked, base of stalks bearing small appendages to 1 mm. **Racemes** terminal, corymbiform, either with arrested growth or growing through and developing into a leafy twig with lateral flowers; pedicels leaving distinct scars on the rachis. **Flowers** large and showy, to 5 cm across, opening while green and young, subtended by bracts; sepals 4, clawed, green; petals 4, clawed, first white then cream-coloured; stamens (8–)12–30, filaments at the very base connate with the gynophore, 5–7 cm, thread-like, pinkish violet; gynophore approximately as long as the stamens; receptacle dish-shaped, floral parts not persistent. **Fruits** large, round or oblong berries, with tough, sometimes papillate skin, hanging on a thickened woody pedicel and androgynophore, together to 14 cm long; torus leaving a distinct scar. **Seeds** numerous, heart- or horseshoe-shaped, embedded in pulp.

Distribution. About 6 species distributed throughout the tropics, except in Australia and New Caledonia. Two species in Sabah and Sarawak.

Ecology. Found mostly in periodically flooded lowland forest near rivers, usually below 700 m. Fruits are dispersed by water, possibly also by fish.

Key to *Crateva* species

Leaflets with 10–15 pairs of lateral veins, paler beneath than above.....1. *C. magna*

Leaflets with 5–11 pairs of lateral veins, same colour beneath as above.....2. *C. religiosa*

1. *Crateva magna* (Lour.) DC.

Fig. 1A–C.

(Latin, *magnus* = great, large; referring to the stature)

Prod. 1 (1824) 243; Merrill, Comm. Lour. (1935) 172; Masamune *l.c.* 318; Jacobs *l.c.* (1964) 206, *l.c.* (1976) 822; Whitmore *l.c.* 26; Corner *l.c.* 203; Whitmore, Tantra & Sutisna *l.c.* 40. **Basionym:** *Capparis magna* Lour., Fl. Cochinch. 1 (1790) 331. **Type:** Loureiro, *s.n.*, “Indochina” (BM). **Synonyms:** *Crateva nurvala* Buch.-Ham., Trans. Linn. Soc. 15 (1827) 121; *C. lophosperma* Kurz, J. Bot. 12 (1874) 195, t. 147, f. 4–6.

Tree to 20 m tall, 40 cm diameter. Twigs terete, lenticellate. Petiole 3–11 cm. **Leaflets** firmly herbaceous to slightly coriaceous, paler beneath, mostly lanceolate; apex gradually acuminate with an acute tip; lateral leaflets symmetrical, 8–17 x 2–6 cm, usually sessile, sometimes with stalk 3–6 mm long; lateral veins 10–15 pairs, prominent beneath. **Inflorescences** terminal on leafy twigs to 12 cm, bearing 20 to 100 flowers; pedicels 4–7

cm long; petals 4, ovate-spathulate with a 5–12 mm stalk, lobes 15–30 x 15–22 mm; sepals 4, ovate, 2–3.5 x 1–1.5 mm; stamens 15–25, 3.5–4.5 cm long, filaments purple; ovary oblong to cylindrical, gynophore 3.4–4.5 cm. **Fruits** *ellipsoid*, sometimes *globose*, c. 5 x 4 cm; *pericarp covered with a yellow-greyish crust which eventually breaks off*. **Seeds** horseshoe-shaped, 6–9 mm across, dull dark-brown.

Vernacular names. Sabah—*mempulak* (Murut), *pangos* (Dusun Kinabatangan). Sarawak—*serang* (Iban, in confusion with *Melicope*). Brunei—*kebulan* (Iban). Kalimantan—*sasgah*, *sebelu*, *tigarun* (Iban).

Distribution. India, Burma, China, Hainan, Indo-China, Thailand, Sumatra, Peninsular Malaysia, Java and Borneo. In Sabah, recorded from the Kalabakan, Lahad Datu, Lamas, Sandakan and Telupid districts. In Sarawak from the 3rd, 4th and 7th Div., in all cases near limestone or basalt exposures. Also in Brunei and Kalimantan.

Ecology. Found along streams and rivers or the edge of swamps; rarely found on ridges although it can occur up to 1000 m. Flowering and fruiting irregular.

Uses. In Sabah and Sarawak, poultices made from the root, leaf, or bark are used externally for *sakit angin* (“wind”), poultices made from the bark alone are used externally to reduce high fever. The wood is sometimes used as timber. Elsewhere, the juice from the bark has been used to increase the appetite and as a laxative. The fruits are used in Thailand as fish bait.

2. *Crateva religiosa* G. Forst.

Fig. 1D.

(alluding to its common cultivation around temples in Tahiti)

Pl. Escul. Ins. Oc. Austral. (1786) 45; Masamune *l.c.* 318; Jacobs *l.c.* (1960) 65, *l.c.* (1964) 191; Whitmore *l.c.* 26; Anderson *l.c.* 158; Corner *l.c.* 203; Ashton *l.c.* 84; Whitmore, Tantra & Sutisna *l.c.* 40. **Type:** G. Forster, *s.n.*, Pacific Society Isl. (K). **Synonyms:** *C. membranifolia* Miq., Fl. Ind. Bat., Suppl. (1861) 387; *C. brownii* Korth. ex Miq., Illustr. (1870) 21; *C. macrocarpa* Kurz *l.c.* 195, t. 148, f. 8–10.

Shrub or tree, to 30 m tall and 30 cm diameter. Twigs with many large lenticels. Petiole (3–)6–10 cm. **Leaflets** thin herbaceous, oblong to ovate, top rather abruptly acuminate, (5–)8–16(–27) x (3–)4–10 cm, mostly sessile, sometimes stalked to 5 mm, *concolorous when dried; lateral veins 7–11 pairs*. **Flowers** few to 25, toward the end of leafy twigs which do not grow through; pedicels 2–9 cm; sepals ovate, 4–7 x 1–3 mm; petals 4, ovate, upper pair 2–3 x 1–2 mm, lower pair smaller, 5–20 mm stalked; sepals ovate, 4–7 x 1–3 mm; stamens 10–30, to 11 cm long; ovary subcylindrical to ovoid. **Fruits** *subglobose* to *ovoid*, 6–20 x 5–9 cm; *pericarp papillate*. **Seeds** embedded in cream-coloured pulp, somewhat heart-shaped, 10–19 x 5–17 mm.

Distribution. India, Burma, China, Indo-China, Thailand, Sumatra, Peninsular Malaysia, Java and Borneo. In Sabah, recorded in the Kudat, Sandakan and Kinabatangan districts, and once on a rocky beach on Pulau Tiga off the southwest coast. In Sarawak, collections are known from Sibiu district in the 3rd Div., near limestone.

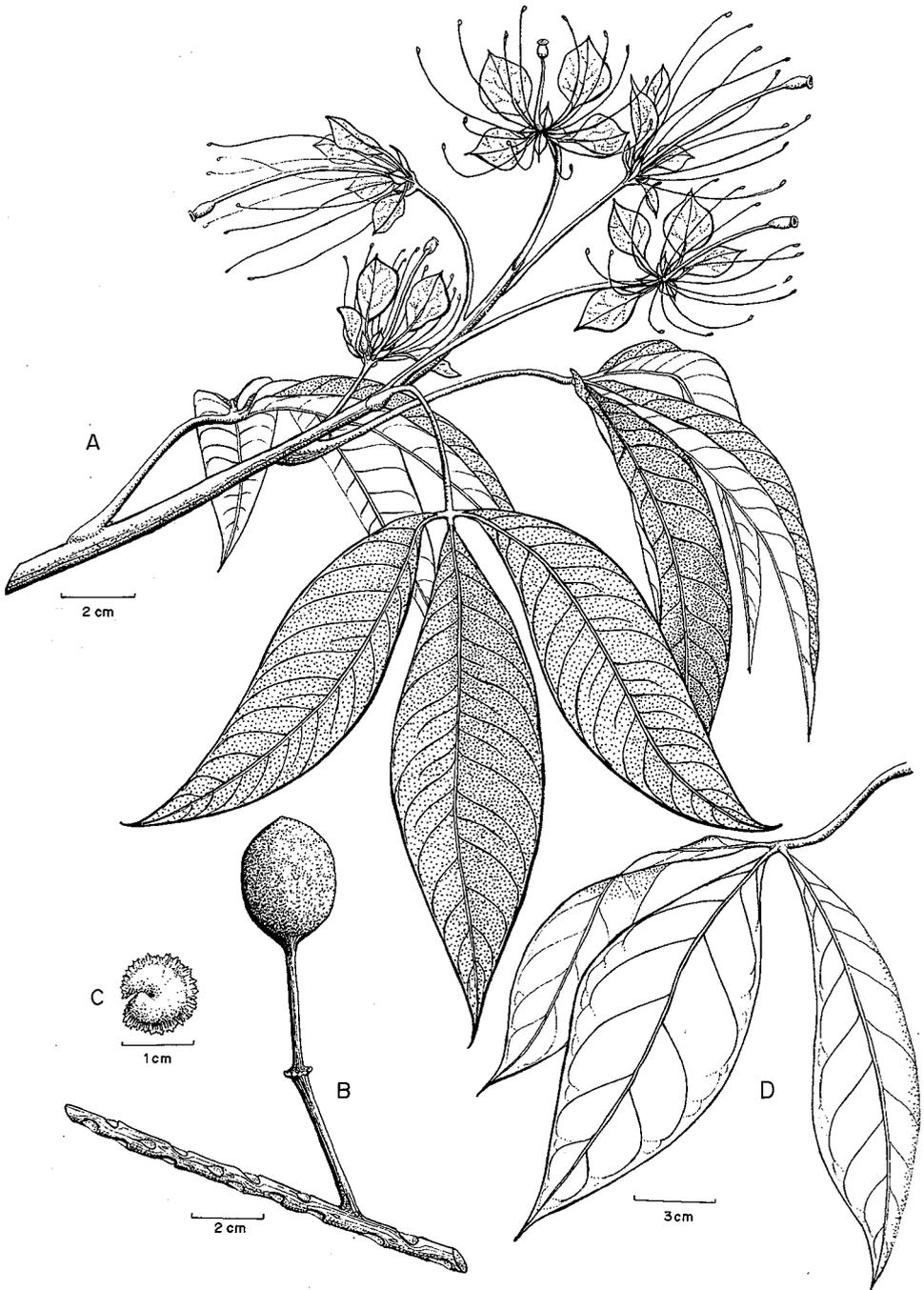


Fig. 1. *Crateva magna* (A–C) and *C. religiosa* (D). A, flowering leafy twig; B, fruit on thickened pedicel and androgynophore; C, seed; D, single leaf. (Drawn from fresh material from Danum Valley Conservation Area, Sabah.)

Ecology. Common in periodically inundated forest along rivers; rarely in secondary or primary dryland forest. Mostly found below 100 m but occasionally also at about 700 m. Flowering and fruiting irregular.

Uses. Occult power has been ascribed to *C. religiosa* in India and Polynesia where it is planted around temples. In the Solomon Islands the leaves are used for ear-ache and the fruit is used to relieve constipation. In Borneo, *C. religiosa* is occasionally planted for ornamental purposes, and the fruits are also used for fish bait.

CELASTRACEAE

K.M. Kochummen

Forest Research Institute Malaysia,
Kepong, Malaysia

Merrill, EB (1921) 354; Ridley, FMP 1 (1922) 443; Masamune, EPB (1942) 417; Browne, FTSB (1955) 76; Ding Hou, FM 1, 6 (1962) 227, FM 1, 6 (1964) 389, FM 1, 6 (1972) 930, Blumea 17 (1969) 97; Backer & Bakhuizen *f.*, FJ 2 (1965) 53; Smythies, CST (1965) 38; Burgess, TBS (1966) 73; Kochummen & Whitmore, TFM 1 (1972) 156; Cockburn, TS 1 (1973) 51; Anderson, CLTS (1980) 159; Wong, DMT (1982) 33; Corner, WSTM 1 (1988) 212; Ashton, MNDT 2 (1988) 87; Whitmore, Tantra & Sutisna, CLK 1 (1989) 42; Ng, MFR 34 (1991) 41.

Trees, erect or scandent shrubs or woody climbers; bole sometimes buttressed, rarely with pneumatophores. **Leaves** simple, decussate, opposite, sub-opposite, spiral or rarely alternate, sometimes black-dotted especially beneath, margin faintly toothed, wavy or entire. Stipules small, falling off early or absent. Incipient bracts absent except in *Microtropis*. **Inflorescences** axillary and/or terminal, sometimes extra-axillary or borne on the branches, thyrsoid, paniculate, racemose, cymose or fasciculate, usually with bracts. **Flowers** regular, bisexual or unisexual (plants dioecious, rarely polygamous); *calyx* 4–5-lobed, *lobes* imbricate, rarely valvate, *persistent*; *petals* 4 or 5, imbricate, contorted or rarely valvate, falling off early, rarely persistent, *free or united at base*, sometimes united with the staminal ring, always larger than calyx-lobes except in *Perrottetia*; stamens 2–5, alternate with petals, filaments inserted on or on the inner side of the disc or on a basal ring (*Microtropis*), *anthers* 2-celled, longitudinally or laterally dehiscent, introrse or extrorse; *disc* often conspicuous, fleshy or membranous, cup-shaped, saucer-shaped or flat, entire, toothed, angled or lobed, extrastaminal or intrastaminal, rarely absent (*Microtropis*); *ovary superior or rarely semi-inferior*, partly or fully immersed in the disc, usually glabrous, sometimes with a tuft of hairs at top (*Bhesa*), rarely with papilla-like or fleshy subulate processes at the base (*Euonymus*), (1–)2–5-celled, rarely many-celled (*Siphonodon*), very rarely hollow at the top (*Siphonodon*), style distinct, or obscure or lacking, simple or divided to the base (*Bhesa*), stigmas simple or lobed; *ovules usually 2 in each cell*, sometimes 1 or 3–18, *anatropous*. **Fruits** drupes, capsules, or berries, surface smooth or spiny. **Seeds** erect or pendulous, sometimes winged, aril present or absent, when present usually partly or entirely enveloping the seed or forming a cushion-like structure situated at the base of seed or with *long, filamentous appendages* (*Sarawakodendron*), often orange or orange-red, rarely white; endosperm present or absent; cotyledons flat, foliaceous.

Distribution. About 90 genera and over 1000 species distributed in both hemispheres, predominant in the tropics and subtropics. In Malesia, 18 genera and *c.* 115 species, of which 15 genera and 70 species are recorded in Sabah and Sarawak.

Ecology. From lowland including mangrove and peat swamp, to montane forests to about 3200 m. Most members of the family have nectariferous disc in the flowers which are

visited by various kinds of insect-pollinators. Seeds of species having brightly coloured arils are dispersed by birds; the winged seeds of *Kokoona*, *Lophopetalum* and other taxa are dispersed by wind. The fruits of the mangrove tree, *Cassine viburnifolia*, have a corky mesocarp that facilitates dispersal by sea water.

Uses. Timbers of the genera *Kokoona*, *Lophopetalum*, and *Siphonodon* have commercial value. Some species contain alkaloids. Aborigines in Peninsular Malaysia make use of the bark of *Lophopetalum pallidum* in the preparation of dart poison. The ochre yellow middle bark of some *Lophopetalum* and *Kokoona* species burn readily and is useful tinder in the forest.

Key to genera

1. Woody climbers or scandent shrubs.....2
 Trees, or erect shrubs.....6
2. Leaves spirally arranged.....3
 Leaves opposite, decussate, or rarely spiral.....4
3. Woody climber. Ovary free from the disc.....

Celastrus L.

Gen. Pl. ed. 5 (1754) 91; Ridley *l.c.* 450; Ding Hou *l.c.* (1963) 233.

About 30 species, tropics and subtropics; 2 species in Sabah and Sarawak.

Leaves spirally arranged, margin toothed. Inflorescences cymose or paniculate. *Flowers unisexual*, 5-merous, pedicel articulated; calyx bell-shaped; disc membranous or fleshy, cup-shaped; ovary superior, 3-celled; style columnar, stigma 3-lobed; *ovules 2 in each cell*. *Fruit* a 3-valved capsule, tipped by persistent style. Seeds 1–6, enveloped by crimson aril.

Scandent shrubs. Ovary partially immersed in the disc.....

Maytenus Molina

Saggio Chile (1782) 177; Ding Hou *l.c.* (1962) 238.

About 225 species; tropics and subtropics of both the Old and New World. In Malesia 5 species, one of which, *M. emarginatus* (Willd.) Ding Hou, is present in Sabah; uncommon, known only by a single collection (*Sugau 34*) from Balambangan island.

Scandent shrubs with spines on leafy shoots. Leaves spirally arranged, margin toothed. Flowers in fascicles, unisexual, 4–5-merous; calyx-lobes deltoid; petals obovate or oblong, entire; disc rounded; stamens inserted on the margin of the disc; ovary partly immersed in the disc, 3-celled, style cylindrical, stigma 3. Fruits a capsule. Seeds ellipsoid, red, subtended by white fleshy aril at the base.

4. Flowers with distinct disc.....5
 Flowers without or with inconspicuous disc.....

Reissantia Hallé

Mus. Hist. Nat. Paris 30 (1958) 466; Ding Hou *l.c.* (1964) 400.

7 species, Old World tropics; 4 species in Sabah and Sarawak.

Leaves decussate, rarely subopposite. Inflorescences axillary. Flowers bisexual; calyx-lobes 5, imbricate; petals 5, imbricate; disc inconspicuous; stamens 3; ovary semi-superior, 3-celled; style short; stigma obscure; ovules 2 (rarely 4–8) in each cell. Fruits capsular consisting of 3 divergent separate follicles which split into 2 valves. Seeds with basal more or less transparent membranous wing.

5. Fruits capsular with 3 follicles. Seeds winged. Petals with inflexed tip.....
- Loeseneriella** A.C. Smith
 Am. J. Bot. 28 (1941) 438; Ding Hou *l.c.* (1964) 397.
 26 species, Tropical Africa, Asia, Malesia, New Hebrides. In Malesia, 4 species of which 2 are present in Sabah and Sarawak.
Leaves decussate. Inflorescences axillary, cymose. Flowers bisexual; calyx deeply 5-lobed; petals 5, thick with inflexed tip; disc fleshy; stamens 3; ovary superior or semi-inferior. Fruits capsular, with 3 divergent follicles, each dehiscing into 2 valves. Seeds usually with basal membranous wing.
- Fruits drupaceous. Seeds embedded in pulp. Petals without inflexed tip.....
- Salacia** L.
 Mant. (1767) 159; Ridley *l.c.* (1922) 456; Ding Hou *l.c.* (1964) 404.
 About 150 species, pantropical; 33 species in Malesia of which 17 are found in Sabah and Sarawak. *Leaves decussate, subopposite or rarely spiral. Flowers bisexual, axillary, in clusters or organised in cymes or panicles; calyx deeply 5-lobed or 3–5-lobed in apical part, and circumscissile at the base or lengthwise splitting or not lobed; petals usually 5, rarely 4 or 7; disc fleshy, ring-like, truncate-conical or flattened, occasionally cup-like; stamens 3, rarely 2; ovary semi-inferior, 3-celled, rarely 2-celled, ovules 2–8 in each cell; style distinct or obscure; stigma obscure. Fruits drupaceous, 1–3-celled. Seeds 1 to several, embedded in mucilaginous pulp.*
6. Leaves alternate or spirally arranged.....7
 Leaves decussate, opposite, subopposite, or very rarely alternate or spiral.....10
7. Leaf margin toothed.....8
 Leaf margin entire.....9
8. Petals usually similar in size to calyx-lobes. Ovary not hollow in apical part...**8. Perrottetia**
 Petals always larger than calyx-lobes. Ovary hollow in apical part.....**10. Siphonodon**
9. Leaves and twigs with pustules; petiole to 1.5 cm long, not swollen towards apex; stipules not prominent, leaving no stipular scars on twigs.....**9. Sarawakodendron**
 Leaves and twigs without pustules; petioles longer than 1.5 cm, swollen at the apex or both ends; stipules prominent, leaving scars on twigs.....**1. Bhesa**
10. Incipient bracts prominent. Disc absent.....**7. Microtropis**
 Incipient bracts absent. Disc present.....11
11. Trees confined to tidal rivers and mangroves. Ovary 2-celled.....**2. Cassine**
 Trees or shrubs of inland forests. Ovary 3 or 4–5-celled.....12

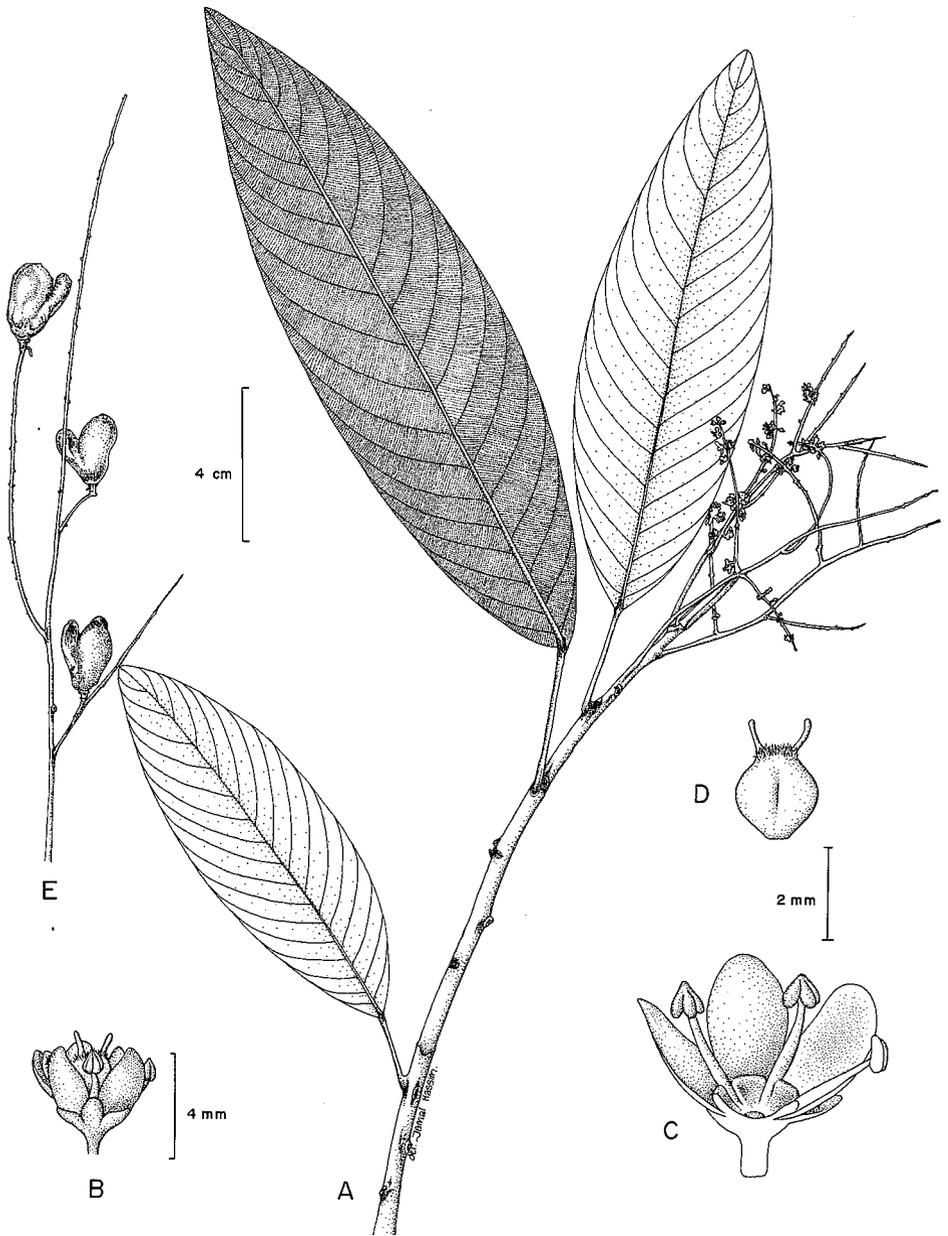


Fig. 1. *Bhesa paniculata*. A, flowering leafy twig; B, flower; C, flower with pistil removed; D, pistil; E, part of infructescence. (A from SAN 79200, B-D after FM 1, 6 (1962) 281, fig. 16, E from SAN 82521.)

12. Ovary 4–5-celled. Seeds not winged.....13
 Ovary 3-celled. Seeds winged.....14
13. Ovules 2 in each cell.....**3. Euonymus**
 Ovules 1 in each cell.....**4. Glyptopetalum**
14. Petals twisted and overlapping. Wing attached to the apex of seed.....**5. Kokoona**
 Petals imbricate. Wing surrounding seed.....**6. Lophopetalum**

1. BHESA Buch.-Ham. *ex* Arn.

(origin unknown, probably an English plant name)

Edin. New Phil. J. (1834) 315; Ding Hou, Blumea Suppl. 4 (1958) 149, *l.c.* (1962) 280; Kochummen & Whitmore *l.c.* 158; Cockburn *l.c.* 54; Anderson *l.c.* 159; Wong *l.c.* 22; Corner *l.c.* 213; Ashton *l.c.* 89; Whitmore, Tantra & Sutisna *l.c.* 42; Ng *l.c.* 43. **Synonym:** *Kurrimia* Wall. *ex* Arn., Nov. Act. Ac. Caes. Leop.-Car. 18 (1836) 328.

Medium-sized to tall trees; bole with buttresses, often fluted at base. **Bark** grey-brown, smooth to cracking and scaly; inner bark mottled cream and orange. **Sapwood** pale yellow. *Twigs* smooth, with distinct stipular scars. Stipules prominent, lanceolate, soon falling off and leaving scars on the twigs. **Leaves** spiral, entire, with silky sheen; intercostal veins fine, scalariform; petioles slender, longer than 1.5 cm, swollen at both ends or at the apex only. **Inflorescences** axillary, solitary or paired, paniculate or racemose; bracts falling off early; pedicels jointed. **Flowers** bisexual, 5-merous (rarely 4-merous); calyx deeply lobed, lobes imbricate or valvate; petals twisted; disc fleshy, entire or lobed; stamens 4–5, seated on or just below the disc; ovary superior, usually with terminal tuft of hairs, 2-celled, with 2 ovules in each cell, styles 2. **Fruit** a capsule, entire or 2-lobed, splitting into 2 valves or on one side only. **Seeds** 1–2 per cell, with bright orange-red or pink basal aril; endosperm copious; germination epigeal.

Distribution. 5 species; Sri Lanka and Malesia; 2 species in Sabah and Sarawak.

Ecology. Widely distributed from lowland to submontane forests to 1500 m.

Key to Bhesa species

Stipules to 3 cm long. Petioles strongly swollen at both ends. Intercostal veins distinct. Inflorescences usually paniculate. Disc deeply 5-lobed. Fruits two-lobed.....**1. B. paniculata**

Stipules to 1 cm long. Petioles only slightly swollen at apex. Intercostal veins faint to invisible. Inflorescence racemose. Disc entire or obscurely notched. Fruits not lobed, with pointed tip.....**2. B. robusta**

1. **Bhesa paniculata** Arn.

Fig. 1.

(Latin, *paniculatus* = having a loose, branched flower-cluster or inflorescence)

l.c. (1834) 315; Ding Hou *l.c.* (1958) 151, *l.c.* (1962) 282; Burgess *l.c.* 73; Kochummen & Whitmore *l.c.* 160; Cockburn *l.c.* 55; Anderson *l.c.* 159; Corner *l.c.* 213; Ashton *l.c.* 92; Whitmore, Tantra & Sutisna *l.c.* 42. **Type:** *Wallich no. 4336*, Penang (BO, K). **Synonyms:** *Kurrimia paniculata* Wall. ex Arn. *l.c.* 328; *K. luzonica* Vidal, Rev. Pl. Vasc. Filip. (1886) 88; *K. minor* Ridl., Kew Bull. (1938) 235.

Medium-sized tree to 35 m tall, 50 cm diameter; bole often fluted at base. **Bark** grey-brown, smooth to cracking; inner bark orange-yellow. **Sapwood** pale white. *Twigs* pale brown to dark brown, 5–10 mm thick, with prominent stipular and leaf scars. *Stipules* lanceolate, *c.* 3 cm long. **Leaves** elliptic to oblong, rarely obovate, 5.5–27 x 2.2–13 cm; base cuneate or rounded, apex pointed or blunt; midrib flattened or raised above; lateral veins 5–20 pairs, prominently raised below, visible above; *intercostal veins scalariform, very close, faint above, distinct beneath; petioles* 1–9.5 cm long, strongly swollen at both ends. **Inflorescences** panicles, 10–37 cm long or racemes to 20 cm long, from axils of upper leaves. **Flowers** greenish yellow or dark purplish red, pedicels 2–3 mm long; calyx-lobes hairy outside; *disc deeply 5-lobed*; petals oblong or ovate, hairy inside; stamens 1.5–2 mm long, anthers triangular; ovary ellipsoid, styles free, about half as long as ovary. **Fruits** 2-lobed, red when fresh, drying dark brown, 1–2 cm long, with the biggest lobe *c.* 0.5 cm wide. **Seeds** 2–4, more than half covered with pink aril; cotyledons leafy.

Vernacular names. Sabah—*biku-biku* (Malay). Sarawak—*simun* (Iban). Brunei—*serunai* (Malay).

Distribution. S India, S Thailand, Sumatra, Peninsular Malaysia, Borneo and the Philippines. Common and widely distributed in Sabah and Sarawak. Also in Brunei and Kalimantan.

Ecology. Lowland, including mixed dipterocarp, heath, and peat swamp, to submontane forests to 1500 m. Submontane samples have comparatively smaller and thicker leaves. Flowering in March–May and August–October, fruiting in April–December.

2. **Bhesa robusta** (Roxb.) Ding Hou

(Latin, *robustus* = strong-growing, robust; the habit)

l.c. (1958) 152, *l.c.* (1962) 283; Kochummen & Whitmore *l.c.* 161; Anderson *l.c.* 159; Corner *l.c.* 214; Ashton *l.c.* 93; Whitmore, Tantra & Sutisna *l.c.* 42. **Basionym:** *Celastrus robustus* Roxb., Fl. Ind. 2 (1824) 395. **Type:** *Roxburgh, Icones no. 2185* (K). **Synonyms:** *Kurrimia pulcherrima* Wall. ex Laws. in Hooker f., Fl. Br. Ind. 1 (1875) 622; *Kurrimia maingayi* Laws. in Hooker f. *l.c.* 622.

Medium-sized tree to 18 m tall and 40 cm diameter. **Bark** grey-brown; inner bark yellow. **Sapwood** pale. *Stipules* lanceolate, 5–10 mm long. **Leaves** elliptic or oblong, 7–9 x 3–4 cm; base cuneate, apex blunt or pointed; midrib raised above; lateral veins 11–15 pairs; *intercostal veins very faint to invisible; petioles* 1–3 cm long, slightly swollen at apex. **Flowers** in racemes, subsessile; calyx lobed, lobes broadly ovate to rounded; petals oblong

to elliptic; *disc* cup-shaped, *subentire* or *obscurely notched*; stamens *c.* 2 mm long, attached beneath the outer margin of disc, anthers deltoid; ovary subglobose with tuft of hairs at apex, styles free, longer than ovary. **Fruits** ovoid, *not lobed*, *c.* 2 x 1 cm, *apex pointed*. **Seeds** 1, enveloped by aril, sometimes only the lower half; cotyledons fleshy.

Distribution. NE India, Bhutan, Chittagong, Burma, Andaman Islands, Thailand, Indo-China, Sumatra, Peninsular Malaysia, and Borneo. In Sabah and Sarawak, uncommon; in Sabah, known from 3 collections (*SAN A 6613*, *SAN 50057*, and *SAN 76690*) from Beaufort and Sandakan districts, and in Sarawak by one collection (*Beccari 2624*).

Ecology. Mixed dipterocarp forests at 300–600 m, on clay-rich soils.

Uses. Though of no commercial importance in Sabah and Sarawak, the timber is used in house-building in other countries where it occurs.

2. CASSINE L.

(origin and meaning unknown)

Gen. Pl. (1737) 338; Ding Hou *l.c.* (1962) 284; Backer & Bakhuizen *f. l.c.* 55; Kochummen & Whitmore *l.c.* 161; Anderson *l.c.* 159; Kostermans, Gard. Bull. Sing. 39 (1986) 177; Ashton *l.c.* 93. **Synonym:** *Elaeodendron* Jacq. *f. ex* Jacq., Ic. Pl. Rar. 12 (1782) t. 48.

Shrubs or small trees. **Leaves** *decussate*. **Inflorescences** axillary or extra-axillary cymes, with distinct peduncles. **Flowers** *bisexual*, 4–5-merous; calyx-lobes imbricate; petals free, imbricate; stamens 4–5, inserted on the disc or on its outer margin, filaments subulate, anthers introrse; disc prominent, fleshy, flat, orbicular or lobed; *ovary semi-inferior*, 2-celled, conical or flask-like, the base slightly united with the disc or partly immersed in it; *style very short or obscure*, stigma obscure or 2-lobed; *ovules 2 in each cell*, erect, attached at the base. **Fruit** a drupe, 1–2-celled. **Seeds** 1–2, not winged, without aril, with endosperm.

Distribution. About 80 species throughout the tropics, mainly in Africa; 2 species in Malesia of which only one is present in Sabah and Sarawak.

Ecology. In Sabah and Sarawak, confined to mangroves and banks of tidal rivers.

Cassine viburnifolia (Juss.) Ding Hou

Fig. 2.

(with leaves resembling those of *Viburnum*)

l.c. (1962) 286; Kochummen & Whitmore *l.c.* 161; Cockburn *l.c.* 54; Anderson *l.c.* 159; Ashton *l.c.* 93. **Basionym:** *Aegiphila viburnifolia* Juss., Ann. Mus. Hist. Nat. Paris 7 (1806) 76. **Type:** *Sine coll.*, *s.n.*, Philippines (P). **Synonyms:** *Euonymus viburnifolius* (Juss.) Merr., Philip. J. Sc. 9 (1914) Bot. 312; *Elaeodendron subrotundum* King, J. As. Soc. Beng. 65, 2 (1896) 356.

Shrub or small tree to 10 m tall, 20 cm diameter. **Bark** yellowish grey, smooth. Twigs black. **Leaves** broadly obovate, 4–10 x 2–6 cm; base cuneate, *margin curled inwards*,

remotely minutely toothed, apex blunt to rounded; lateral veins 4–6 pairs, faint; intercostal veins reticulate, equally prominent as the lateral ones; petioles 8–13 mm long. **Inflorescences** cymose, axillary. **Flowers** white, 4-merous; calyx-lobes broadly ovate to rounded, almost free; petals oblong to ovate-oblong. **Fruits** obovoid, often rhomboid in cross-section; mesocarp thick and corky. **Seed** 1, *c.* 6 x 3 mm, obovate to oblong.

Vernacular name. Sarawak—*barat-barat* (Malay).

Distribution. Andaman Islands, Thailand, Sumatra, Peninsular Malaysia, Borneo, Philippines, and Celebes. In Sabah known from Kudat, Sandakan and Tawau districts, and in Sarawak from the Rejang delta in 3rd. Div. Also in Brunei.

Ecology. Common on the banks of tidal rivers and mangrove channels near the inland limits of salinity. The fruits are dispersed by water.

3. EUONYMUS Tourn. *ex* L.

(Greek, *eu* = good, *onuma* = name; a plant name)

Gen. Pl. ed. 5 (1754) 91; Ridley *l.c.* (1922) 445; Masamune *l.c.* 417; Blakelock, Kew Bull. (1951) 232; Ding Hou *l.c.* (1962) 245; Backer & Bakhuizen *f. l.c.* 53; Kochummen & Whitmore *l.c.* 162; Cockburn *l.c.* 55; Anderson *l.c.* 159; Ashton *l.c.* 94; Whitmore, Tantra & Sutisna *l.c.* 42.

Shrubs or small trees. **Leaves** *opposite-decussate* sometimes with dark spots on the under surface; stipules lanceolate, falling off early. **Inflorescences** axillary, cymose; rarely flowers in fascicles (*E. javanicus*); pedicels jointed. **Flowers** *bisexual*, 5- or 4-merous; calyx deeply lobed, lobes imbricate, entire or minutely toothed; petals free, imbricate, spreading or reflexed; *disc prominent*, fleshy or thin, flat, 5- or 4-angled or 5- or 4-lobed or rounded, smooth or covered with fleshy papilla-like or subulate processes; stamens 4–5, inserted on the disc, *anthers* 2-celled, lateral or introrse, *dehiscence apical*, filaments obscure or distinct; *ovary semi-inferior* 4–5-celled, partly or wholly immersed in the disc, stigma obscure or discoid, *ovules mostly 2 in each cell*. **Fruits** *capsules*, usually (3–)4–5-angular or lobed, smooth or armed with rigid prickles, apex obtuse, acute, truncate or concave. **Seeds** usually black, not winged, partly or completely covered by orange aril.

Distribution. About 180 species, mainly in the tropics and subtropics. In Malasia, 12 species of which 5 are recorded in Sabah and Sarawak.

Ecology. In primary and secondary forests from lowlands to mountains to 3200 m.

Key to *Euonymus* species

(based on inflorescences and flowers)

1. Flowers 5-merous. Leaves without black gland-dots below.....2
- Flowers 4-merous. Leaves with black gland-dots below.....4

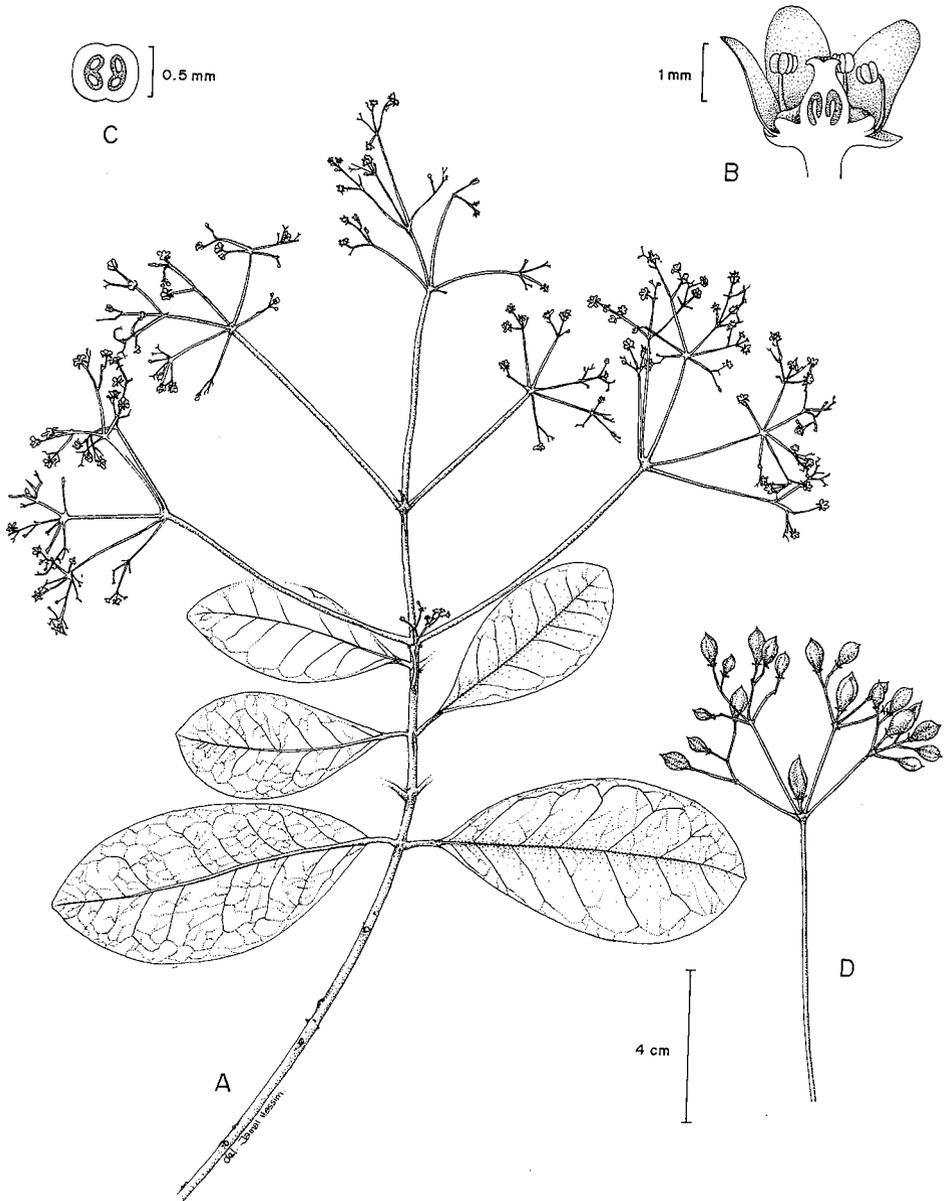


Fig. 2. *Cassine viburnifolia*. A, flowering leafy twig; B, half-flower; C, transverse section through ovary; D, infructescence. (A from SAN 61255, B & C after FM 1, 6 (1962) 285, fig. 18, D from SAN 38943.)

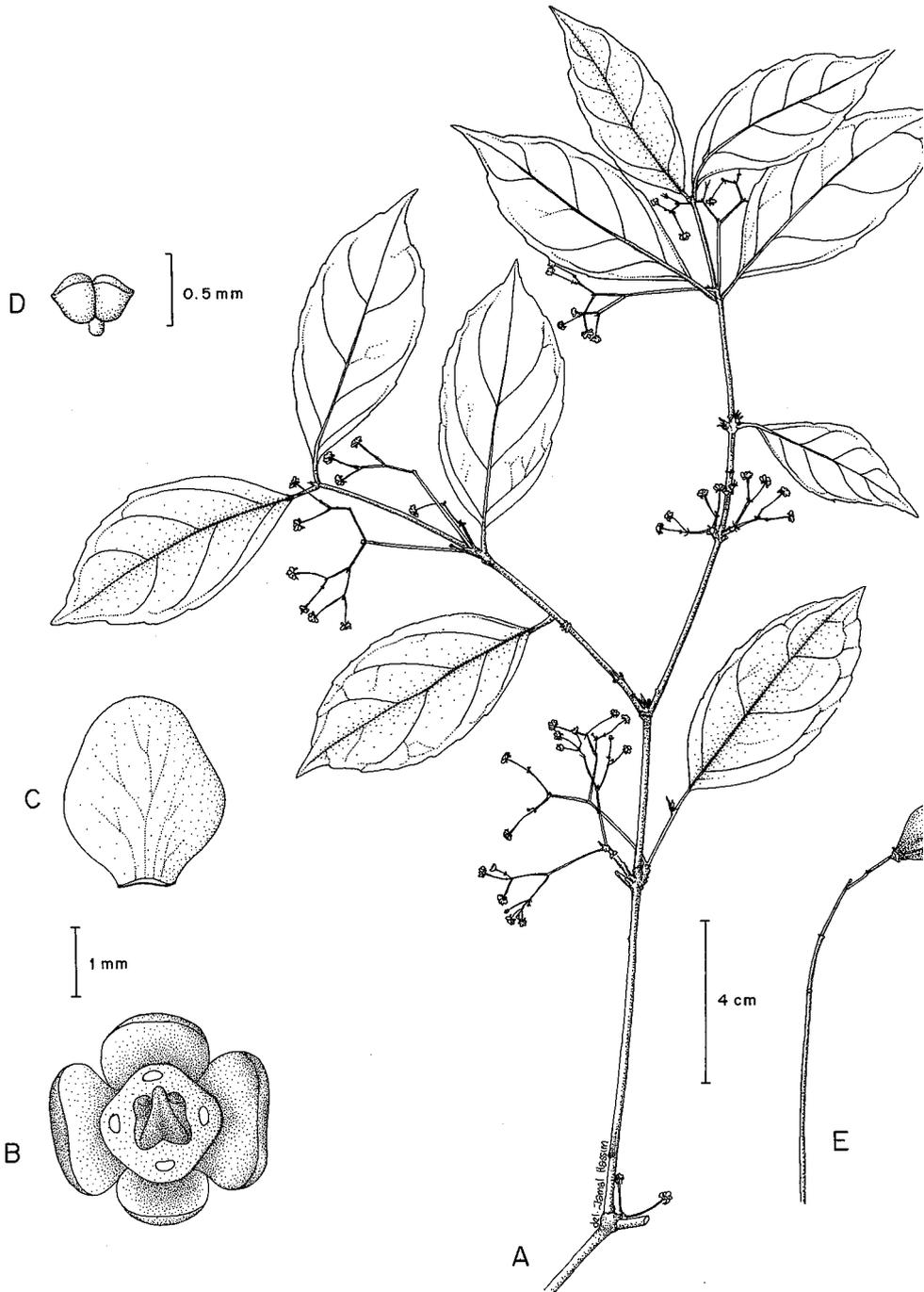


Fig. 3. *Euonymus castanaefolius*. A, flowering leafy twig; B, flower with petals and stamens removed; C, petal; D, young stamen; E, part of infructescence. (A from SAN 93113, B-D after FM 1, 6 (1962) 246, fig. 4, E from S. 47567.)

2. Petals fimbriate.....3
 Petals entire.....1. *E. acuminifolius*
3. Peduncles distinct.....3. *E. cochinchinensis*
 Peduncles obscure.....5. *E. javanicus*
4. Lateral veins of the leaves sunken above.....2. *E. castaneifolius*
 Lateral veins of the leaves not sunken above.....4. *E. glandulosus*

Key to *Euonymus* species

(based on leaves and twigs)

1. Leaf margin toothed.....2
 Leaf margin entire (sometimes faintly toothed in *E. cochinchinensis*).....3
2. Leaf lower surface with scattered black gland-dots. Lateral veins sunken above.....
2. *E. castaneifolius*
 Leaf lower surface without black gland-dots. Lateral veins not sunken above.....
1. *E. acuminifolius*
3. Twigs usually 4-angled. Leaf lower surface with scattered black gland-dots; margin strongly recurved.....4. *E. glandulosus*
 Twigs not 4-angled. Leaf lower surface without scattered black gland-dots; margin not strongly recurved.....4
4. Leaf margin entire. Peduncle obscure.....5. *E. javanicus*
 Leaf margin faintly toothed. Peduncle distinct.....3. *E. cochinchinensis*

1. *Euonymus acuminifolius* Blakelock

(Latin, *acuminatus* = long-pointed, *folius* = leaves)

l.c. 253; Ding Hou *l.c.* (1962) 251; Whitmore, Tantra & Sutisna *l.c.* 43. **Type:** *Bunnemeijer 581*, Sumatra, Ophir district, NW slopes of Mt. Talamau (BO). **Synonym:** *E. acuminifolius* Blakelock var. *borneensis* Blakelock *l.c.* 253.

Shrub to 4 m tall. Twigs 4-angled. **Leaves** membranous to chartaceous, ovate-oblong to lanceolate or elliptic to oblong, 7–10.5 x 2–4 cm, *lower surface without black gland-dots*; base cuneate, *margin toothed*, apex pointed, tip *c.* 2 cm long; *lateral veins* 4–6 pairs, arching near margin, *not sunken above*; petioles 2–6 mm long. **Flowers** in cymes, purplish red, *5-merous*; calyx-lobes rounded, inner two usually larger; petals almost rounded, entire; disc obscurely 5-angular; stamens with very short filaments, anthers *c.* 0.5 mm long; ovary faintly 5-angled, stigma discoid, obscurely 5-angled. **Fruits** obcordate, distinctly 5-lobed, 1.5–2 x 1–1.7 cm. **Seeds** with aril at base.

Distribution. Sumatra, Borneo and Celebes. In Sabah uncommon, known only from Mt. Kinabalu (*Clemens 30350*, type of *E. acuminifolius* var. *borneensis*, and *Clemens 34478*). Not recorded from Sarawak.

Ecology. Montane forest at about 2700 m.

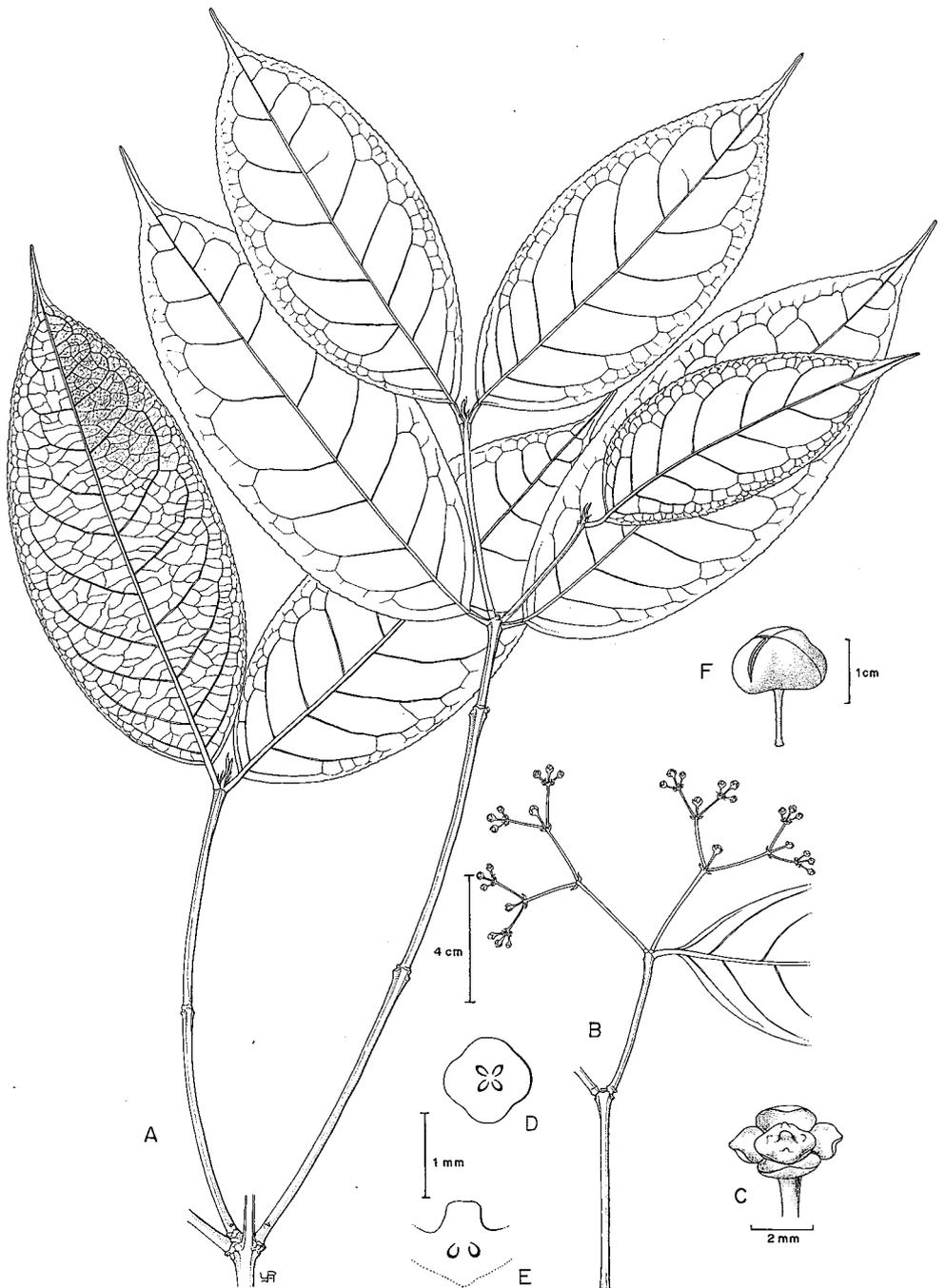


Fig. 4. *Glyptopetalum quadrangulare*. A, leafy twig; B, inflorescence; C, flower with stamens removed; D & E, ovary in longitudinal and transverse sections; F, fruit. (A from S. 16363, B from S. 34185, C-F after FM 1, 6 (1962) 255, fig. 7.)

Distribution. Nicobar Is., Burma, Thailand, Indo-China, Java, Borneo, Natuna Is., Philippines, Celebes, Lesser Sunda Isl., Moluccas, and New Guinea. In Sabah, known from Lahad Datu, Ranau, Tawau and Tenom districts. In Sarawak, uncommon, recorded from the Bukit Numpang and Tai Ton forests.

Ecology. Lowland (including limestone) to montane forests to 2400 m.

4. GLYPTOPETALUM Thwaites

(Greek, *glypto* = incised, *petalum* = petals)

in Hooker, J. Bot. Kew Misc. 8 (1856) 267; Ridley *l.c.* (1922) 446; Ding Hou *l.c.* (1962) 254; Kochummen & Whitmore *l.c.* 162; Anderson *l.c.* 160; Ashton *l.c.* 95.

Shrubs or small trees. **Leaves** opposite. **Inflorescences** cymose, axillary or extra-axillary. **Flowers** bisexual, 4-merous; calyx spreading, inner pair larger; petals free, fleshy with small appendage or depression inside; disc conspicuous, fleshy; stamens 4, inserted on the disc, near base of ovary, anthers opening apically; ovary semi-inferior, immersed in the disc, 4-celled, style obscure, stigma obscure, ovule one in each cell. **Fruits** capsules, when splitting leaving a persistent central columella. **Seeds** with fleshy aril at lower half.

Distribution. c. 20 species; India, Sri Lanka, Burma to Hainan, and Malesia. 8 species are present in Malesia; 2 in Sabah and Sarawak.

Ecology. Lowland to submontane forests to 1400 m.

Taxonomy. The genus is closely allied to *Euonymus* from which it differs in having only one ovule per ovary-cell.

Key to *Glyptopetalum* species

Leaf apex blunt or rounded. Twigs rounded.....1. *G. palawanense*

Leaf apex pointed. Twigs sharply 4-angled.....2. *G. quadrangulare*

1. *Glyptopetalum palawanense* Merr.

(of Palawan)

Philip. J. Sc. 26 (1925) 466; Ding Hou *l.c.* (1962) 257. **Type:** Forestry Bureau 29181, Philippines, Palawan (BO, K).

Small tree to 5 m tall. Twigs grey-green, rounded. **Leaves** leathery, drying to greenish yellow, obovate or elliptic, 10–14 x 5–8 cm; base cuneate, margin distantly toothed towards the upper half, apex blunt or rounded; midrib raised above; lateral veins 6–8 pairs, almost invisible below, faintly raised above; intercostal veins invisible; petioles 8–12 mm long. Flowers unknown. **Fruits** globose to depressed globose, c. 15 x 8 mm, 1–4-celled.

Distribution. Borneo and Philippines (Palawan). Uncommon in Borneo, known only from a sterile collection (*Wong & Payne, s.n.*, 27 April 1993) from Balambangan Island, off Kudat Peninsula, Sabah.

Ecology. Coastal limestone ridge.

2. *Glyptopetalum quadrangulare* Prain ex King (Latin, *quadrangularis* = 4-angled; the twigs)

Fig. 4.

l.c. 345; Ridley *l.c.* (1922) 446; Ding Hou *l.c.* (1962) 257; Kochummen & Whitmore *l.c.* 162; Anderson *l.c.* 160; Ashton *l.c.* 95. **Type:** *King's collector 7106*, Perak (lectotype K; isolectotype BO).

Shrub or small tree to 5 m tall, 5 cm diameter. *Twigs strongly 4-winged.* **Leaves** elliptic-lanceolate, 9–30 x 3–14 cm; base cuneate to rounded, *margin toothed from base to apex*, apex pointed; *lateral veins* 8–12 pairs, raised below, *sunken above*; intercostal veins reticulate; petioles 5–10 mm long. **Flowers** greenish yellow, in 12 cm long cymes; calyx almost divided to base, lobes reniform; petals suborbicular, fleshy, margin thinner, wavy; disc flat; stamens inserted near the base of ovary; ovary pyramidal, style and stigma obscure. **Fruits** c. 2 x 1–1.3 cm, depressed globose, sulcate, 3–4-celled.

Distribution. Burma, Sumatra, Peninsular Malaysia, and Borneo. In Sarawak uncommon, known only by two collections (*S. 16363* from Serian, and *S. 12549* from Bekup); not yet recorded from Sabah. Also known from Kalimantan.

Ecology. Lowland forests on limestone.

5. KOKOONA Thwaites

(*kokoon* = a Ceylonese plant name)

mata ulat (Malay), *bajan* (Iban)

in Hooker, *J. Bot. Kew Misc.* 5 (1853) 379; King *l.c.* 346; Merrill *l.c.* (1921) 354; Masamune *l.c.* 417; van Steenis, *Sarawak Mus. J.* 8 (1958) 437; Ding Hou *l.c.* (1962) 258, *l.c.* (1969) 105; Balan Menon, *MF* 17 (1964) 18; Backer & Bakhuizen *f. l.c.* 54; Smythies *l.c.* 38; Kochummen & Whitmore *l.c.* 163; Jansen *et al.*, *Blumea* 21 (1973) 153; Cockburn *l.c.* 56; Anderson *l.c.* 160; Wong *l.c.* 109; Ashton *l.c.* 97; Whitmore, Tantra & Sutisna *l.c.* 43; Ng *l.c.* 43; Kochummen, *Sandakania* 5 (1994) 51.

Small to very large trees; bole often with short buttresses. **Bark** grey to chocolate-brown, often with horizontal rings, smooth, cracking or fissured, *with large lenticels; middle bark ochre or orange*; inner bark pinkish or yellowish, fibrous. **Sapwood** white to yellow-brown with prominent pale bands. Twigs flattened at nodes, drying black. Stipules small. **Leaves** *decussate, occasionally subopposite or alternate*, margin entire, wavy or toothed. **Flowers** *bisexual*, in axillary panicles or racemes, *pedicels jointed*; sepals 5; petals 5, free, overlapping and twisted (contorted); disc conspicuous, fleshy, cup-shaped, corrugated or 5-lobed; stamens 5, inserted on the inner edge of the disc, *filaments abruptly narrowed*

towards the apex and transparent at the upper end, anthers usually with prominent connective; ovary superior or semi-inferior, 3-celled, style obscure, stigma capitate, ovules 6–16 in each cell, in two rows down the central axis. **Fruits** capsules, 3-angled, 3-valved, splitting loculicidally. **Seeds** overlapping, flat, with conspicuous membranous wing at the apical end; endosperm absent; germination durian-type; cotyledons fleshy; seedlings with opposite leaves, without or with fine hair-like, deciduous stipules.

Distribution. 10 species; Southern India, Sri Lanka, Burma, Malesia. 8 species in Malesia of which 7 are present in Sabah and Sarawak.

Ecology. Found scattered in a wide range of inland forests including swamps to 1500 m.

Uses. The timber is a medium hardwood. It is easy to saw and cross-cut; suitable for heavy construction if treated and can be used as posts, beams, joints and railway sleepers. Also suitable for heavy-duty furniture, parquet-flooring, veneers, window and door-frames.

Taxonomy. The genera *Kokoona* and *Lophopetalum* are difficult to distinguish on vegetative characters alone. However, some species of *Kokoona* have wavy to toothed leaf margins and they dry with greenish tinge, while in *Lophopetalum* the leaves have entire margins and they usually dry to a dark brown colour. The important diagnostic character is in the seed which is surrounded by a membranous wing in *Lophopetalum*, while in *Kokoona* the wing is apical. There is a sharp difference in pollen grains between the two genera; pollen grains of *Kokoona* are single while that of *Lophopetalum* are in tetrads or polyads.

Key to *Kokoona* species (based on flowers and fruits)

1. Fruit surface with abundant pustules. Twigs whitish.....**2. K. leucoclada**
Not this combination of characters.....2
2. Anthers with distinctly prolonged connective.....3
Anthers without or with obscure connective.....5
3. Connective longer than anther-cells.....**4. K. ochracea**
Connective shorter or as long as anther-cells.....4
4. Flower buds ovoid to globose; apex of calyx-lobes rounded or truncate....**3. K. littoralis**
Flower buds broad-ellipsoid; apex of calyx-lobes acute.....**1. K. coriacea**
5. Stamen filaments not broadened at base. Leaf margin strongly wavy and toothed toward apex.....**6. K. reflexa**
Stamen filaments with broad thickened base. Leaf margin recurved, entire or only slightly wavy.....6
6. Inflorescences many-branched. Stigmas not papillose. Leaf margin recurved; intercostal veins equally prominent as the lateral ones.....**5. K. ovatolanceolata**

Inflorescences with few short branches only. Stigmas papillose. Leaf margin entire or slightly wavy; intercostal veins very faint.....7. **K. sabahana**

Key to *Kokoona* species
(based on leaves and twigs)

1. Leaf-margin entire to faintly wavy.....2
Leaf-margin toothed.....5
2. Twigs whitish. Leaves 6.5–10 cm wide; lateral veins 10–12 pairs.....2. **K. leucoclada**
Twigs blackish or dark-brown. Leaves to 6 cm wide; lateral veins 5–9 pairs.....3
3. Leaf-base almost rounded; margin strongly recurved. Common trees of peat and freshwater swamp forests.....5. **K. ovatolanceolata**
Leaf-base not rounded; margin not recurved. Except for *K. sabahana*, usually not found in swamp forests.....4
4. Small pole-sized tree. Petiole to 7 mm long, channelled above.....7. **K. sabahana**
Medium-sized tree. Petiole to 2 cm long, wrinkled on drying.....3. **K. littoralis**
5. Twigs strongly 4-angled. Leaves drying to dark brown above and purplish below.....
.....1. **K. coriacea**
Twigs not angled. Leaves drying pale yellow on both surfaces or pale greyish below....6
6. Leaves when dry pale yellow on both surfaces; margin strongly wavy and distinctly toothed toward the apex.....6. **K. reflexa**
Leaves when dry pale greyish below; margin shallowly toothed from the base to apex
.....4. **K. ochracea**

1. *Kokoona coriacea* King

(Latin, *coriaceus* = leathery; the leaves)

l.c. 347; Ding Hou *l.c.* (1962) 261; Kochummen & Whitmore *l.c.* 164. **Type:** *Kunstler 4226*, Perak (holotype K; isotype BO). **Synonym:** *Lophopetalum coriacea* (King) Ridl. *l.c.* (1922) 450.

Medium-sized tree to 25 m tall, 35 cm diameter. **Bark** grey-white. *Twigs 4-angled* (some-what like that of *Glyptopetalum quadrangulare*). **Leaves** leathery, *drying to dark brown above, and purplish below*, oblong, 11–13 x 5–7.5 cm; base cuneate, *margin toothed*, slightly recurved, apex pointed; midrib sharply keeled below; lateral veins 5–7 pairs, faint; intercostal veins invisible below; petioles *c.* 1 cm long. **Flowers** 5-merous, greenish yellow, fragrant; buds broad ellipsoid; calyx-lobes triangular, apex acute; petals with pale margin; *connective of anthers prolonged, almost as long as anthers*; free part of the ovary ovoid, gradually narrowed into an obscure style, stigmas globose. Fruits unknown.

Distribution. Peninsular Malaysia, Borneo. In Sarawak uncommon, known by a single collection (*S. 40130*) from Niah Cave National Park. Not yet recorded from Sabah.

Ecology. Lowland forest below 100 m.

This is the second collection of this species and a new record for Borneo. This species was until now known only from the type collected from Perak in Peninsular Malaysia.

2. *Kokoona leucoclada* Kochummen

(Greek, *leuco* = white, *cladus* = branch)

l.c. (1994) 51. **Type:** *Amin & Francis SAN 129399*, Sabah, Ranau (holotype SAN; isotypes K, L).

Medium-sized to large tree to 35 m tall, 20 cm diameter. **Bark** grey, smooth; inner bark pale brown. **Sapwood** ochre. *Twigs whitish*, youngest flattened, *grooved in the centre*. **Leaves** leathery, drying to grey-brown, elliptic to oblong, 16.5–20 x 6.5–10 cm; base cuneate, *margin faintly wavy*, slightly recurved, apex pointed; midrib raised above, keeled below; lateral veins 10–12 pairs, visible on both surfaces, distinctly looping near margin; intercostal veins reticulate, very faint; petioles 1–1.5 cm long. **Inflorescences** axillary, to 14 cm long, rachis rectangular, greyish. **Flowers** (immature) sessile, subtended by 5 bracteoles. **Fruits** *c.* 16 x 6 cm, with large pustules outside, on 20 cm long stalk. **Seeds** *c.* 12 x 2.5 cm.

Distribution. Endemic to Sabah. Uncommon, and known only from two collections, *SAN 129399* (the type) from Ranau and *SAN 61073* from Sandakan.

Ecology. Lowland forest.

The flowers are too young to give details of anther and ovary characters. The pustulate fruits and the white twigs distinguish this species from the others.

3. *Kokoona littoralis* Laws.

(Latin, *littoralis* = of the sea-shore)

in Hooker *f. l.c.* 617; Ding Hou *l.c.* (1962) 261; Burgess *l.c.* 73; Kochummen & Whitmore *l.c.* 164; Cockburn *l.c.* 57; Anderson *l.c.* 160; Ashton *l.c.* 100; Whitmore, Tantra & Sutisna *l.c.* 43. **Type:** *Maingay 396/2*, Malacca (holotype K; isotype BO).

Medium-sized tree to 27 m tall, 30 cm diameter, or rarely pole-sized treelet to 6 m tall and 2 cm diameter; bole slightly fluted with irregular hoops. **Bark** greyish or grey-brown with yellowish tinge, smooth to scaly. Twigs blackish on drying, slightly swollen at the nodes, youngest ones rectangular. **Leaves** thickly leathery, drying to dark green with purplish blotches above and pale yellowish below, elliptic-lanceolate to oblong or narrowly obovate, 5–20 x 1.5–6.5 cm; base broadly cuneate to rounded, apex pointed; *midrib faintly raised above*; lateral veins 6–9 pairs, very faint below, faint to inconspicuous above, looping and joining near margin; intercostal veins visible or invisible; petioles 0.5–2 cm long, wrinkled on drying. **Flowers** with yellow petals, pedicels 1–2.5 mm long; flower buds ovoid-subglobose, *calyx-lobes* semi-orbicular, *apex rounded or truncate*; petals broadly ovate, elliptic or suborbicular; *anthers with protruding connective to 1 mm long, slightly shorter*

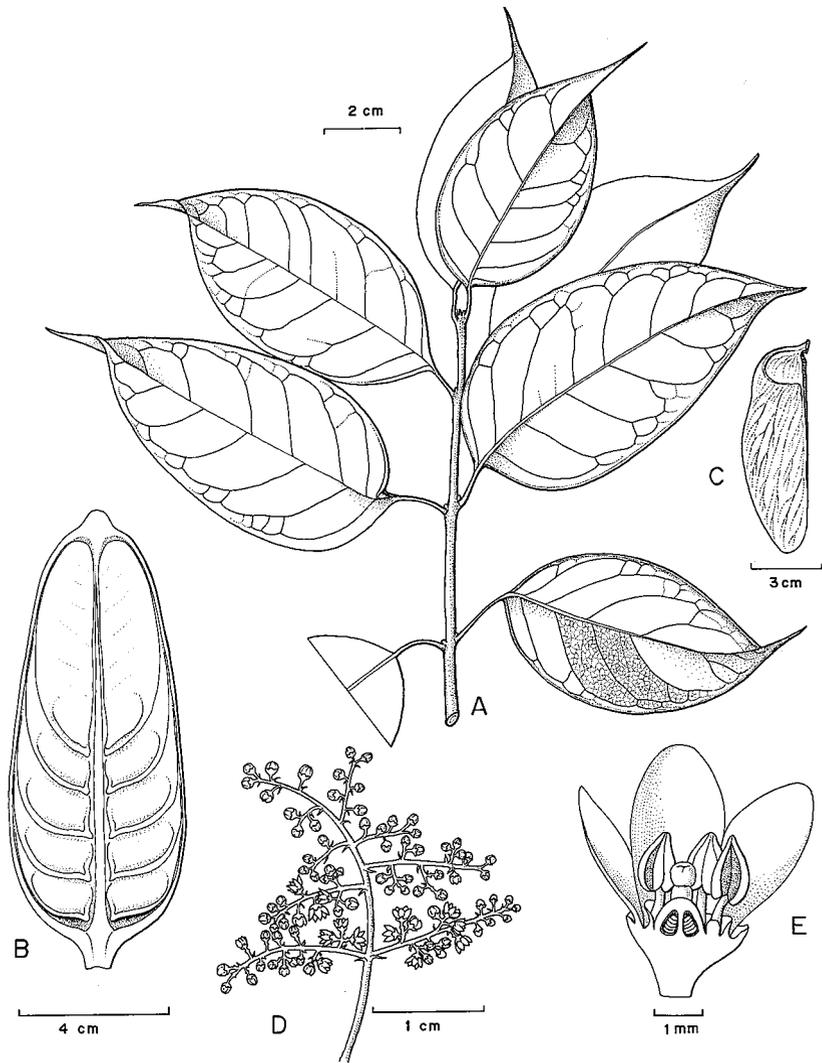


Fig. 5. *Kokoona ovatolanceolata*. A, leafy twig; B, longitudinal section through fruit; C, seed; D, inflorescence; E, longitudinal section through flower. (A from *SAN A 1756*, B & C from *Anderson 9291* (22 November 1957), D & E after *FM 1, 6* (1962) 259, fig. 8.)

than the anthers; ovary triangular, style obscure, stigma capitate. **Fruits** 13–18 x 3–5.5 cm, base tapered. **Seeds** 7.5–12.5 x 2.5 cm (including wing).

Key to varieties

1. Leaves *c.* 20 x 6.5 cm, margin pinkish.....
 var. **longifolia** Kochummen
l.c. (1994) 53. Type: *Wright & Ismawi S. 32289*, Sarawak, Limbang (holotype SAR; isotype K).
 Small tree to 18 m tall, 20 cm diameter. Bark greyish, smooth to scaly. Leaves thick-leatherly, elliptic to lanceolate, *c.* 20 x 6.5 cm; petiole *c.* 2 cm long, channelled above; base cuneate, margin pinkish, apex pointed; midrib raised above; lateral veins 7–9 pairs, faint on both surfaces; intercostal veins laxly reticulate, very faint. Uncommon, known by a single collection (*S. 32289*) from Limbang, Sarawak. Lowland forest.
 Leaves to 11 x 6 cm, margin not pinkish.....2
2. Leaf apex blunt or rounded; intercostal veins invisible.....
 var. **bakoensis** Kochummen
l.c. (1994) 53. Type: *Ding Hou 534*, Sarawak, Kuching (holotype SAR; isotype L).
 Small pole-sized tree to 6 m tall, 2 cm diameter. Leaves coriaceous, oblong with rounded or blunt apex, 5–11 x 1.5–4 cm; lateral and intercostal veins invisible. Locally frequent, known only from Bako National Park, Sarawak. Heath forest.
 Leaf apex pointed; intercostal veins visible.....
 var. **littoralis**
 Synonyms: *Lophopetalum dubium* Laws. in Hooker *f. l.c.* 616; *L. maingayi* Ridl. *l.c.* (1922) 450; *L. littoralis* (Laws.) Ridl. *l.c.* (1922) 450; *K. scortechinii* King *l.c.* 347; *K. lanceolata* Ridl., Kew Bull. (1938) 237, Masamune *l.c.* 417; *Solenospermum littorale* (Laws.) Loes., Notizbl. Berl. Dahl. 13 (1936) 223.
 Sumatra, Peninsular Malaysia, Borneo. In Sarawak, known from Semengoh Arboretum, Balingian, Belaga and Lundu. One sample was collected from G. Matang at 1000 m. Uncommon in Sabah with only 4 collections.

Ecology. Mixed dipterocarp forest on leached soils and heath forest to submontane forest to 1000 m, including limestone. Flowering in August–October and fruiting in May–July.

4. Kokoona ochracea (Elmer) Merr.

(Latin, *ochraceus* = yellow or yellowish brown; the colour of the flowers)

En. Philip. 2 (1923) 484, PEB (1929) 171; Masamune *l.c.* 417; van Steenis *l.c.* 438; Ding Hou *l.c.* (1962) 260; Burgess *l.c.* 74; Cockburn *l.c.* 57; Anderson *l.c.* 160; Ashton *l.c.* 101; Whitmore, Tantra & Sutisna *l.c.* 43. **Basionym:** *Ardisia ochracea* Elmer, Leafl. Philip. Bot. 5(1913) 1819. **Type:** *Elmer 12881*, Philippines, Palawan (holotype K; isotype BO).

Medium-sized tree to 30 m tall, 50 cm diameter. Twigs black, terete. **Leaves** elliptic to ovate or lanceolate, 7–13.5 x 3.5–6 cm, *drying pale greyish below*; base broadly cuneate, *margin*

shallowly toothed, apex pointed; midrib raised or flattened above; lateral veins 5–8 pairs, slightly raised on both surfaces; petioles *c.* 1 cm long. **Flowers** *almost sessile*, in 12 cm long panicles; calyx-lobes semi-orbicular; petals fleshy, ovate or elliptic, margin thin and transparent; anthers subglobose, *connective prolonged, longer than the anthers*; ovary conical, style obscure, stigma cylindrical. Fruits unknown.

Vernacular name. Sabah—*perupok kuning* (Dusun, Malay).

Distribution. Peninsular Malaysia, Borneo, and Palawan Is. In Sabah, reported from Kinabatangan, Lahad Datu, Tenom and Tawau districts. In Sarawak, collections were made from northeastern parts.

Ecology. Scattered in mixed dipterocarp forests at low altitude.

5. *Kokoona ovatolanceolata* Ridl.

Fig. 5.

(Latin, *ovatus* = egg-shaped, *lanceolatus* = tapering toward both ends; the leaf shape)

l.c. (1938) 236; Masamune *l.c.* 417; Ding Hou *l.c.* (1962) 261; Smythies *l.c.* 39; Cockburn *l.c.* 57; Anderson *l.c.* 160; Ashton *l.c.* 100; Whitmore, Tantra & Sutisna *l.c.* 43. **Type:** *Beccari PB 3471*, Sarawak (holotype FI; isotypes BO, K). **Synonym:** *K. scortechinii* (*non* King) Steenis *l.c.* 438.

Tree to 36 m tall. **Bark** smooth to scaly, hoop-marked. **Twigs** dark brown to blackish. **Leaves** ovate to ovate-lanceolate or elliptic, 7–11.5 x 4–5 cm; base rounded to broadly cuneate, *margin strongly recurved*, apex pointed; midrib flattened above; *lateral veins 5–6 pairs*, very faint on both surfaces and hardly distinguishable from the equally prominent reticulate intercostal veins; petioles 1–1.5 cm long, wrinkled and yellowish on drying. **Inflorescences** many-branched panicles, to 14 cm long. **Flowers** yellowish, fragrant, buds globose, *c.* 2 mm across; calyx-lobes suborbicular or reniform; petals ovate; anthers ovoid, *connective not prolonged*, filaments with broad thickened base; ovary ovoid, *style distinct*, stigma obtuse, not papillose. **Fruits** narrow-oblong, 10–17 x 3–5 cm. **Seeds** 7–11 x 2–2.5 cm (including wing).

Vernacular name. Sarawak—*bajan paya* (Iban, Malay).

Distribution. Endemic to Borneo. In Sabah, collected from Papar district and in Sarawak from Baram, Marudi and Sibul. Common in Brunei.

Ecology. Known from heath, peat and freshwater swamp forests.

6. *Kokoona reflexa* (Laws.) Ding Hou

(Latin, *reflexus* = recurved; the leaf tip)

l.c. (1962) 262; Burgess *l.c.* 74; Kochummen & Whitmore *l.c.* 164; Cockburn *l.c.* 57; Anderson *l.c.* 40; Ashton *l.c.* 101; Whitmore, Tantra & Sutisna *l.c.* 44. **Basionym:** *Lophopetalum reflexum* Laws. in Hooker *f. l.c.* 616. **Type:** *Maingay 383/2*, Malacca (holotype K; isotype BO). **Synonym:** *Hippocratea maingayi* Laws. in Hooker *f. l.c.* 625.

Emergent tree, to 50 m tall and 130 cm diameter; bole with stout buttresses. **Bark** dull grey-brown, smooth, hoop-marked, becoming scaly. **Leaves** elliptic to lanceolate, 5.5–11 x

2.5–4 cm; base cuneate, *margin strongly wavy and toothed towards the apex*; apex pointed; midrib raised above; lateral veins 5 pairs, slightly raised on both surfaces; *petioles* slender, 7–15 mm long, *pale yellow on drying*. **Flowers** pale yellowish green; calyx suborbicular; petals ovate, or broadly elliptic; anthers oblong, *connective not protruding*, filaments not broadened at base; ovary ovoid, narrowed to an obscure style, stigma rounded with flat top. **Fruits** *c.* 12 x 3 cm. **Seeds** 9–11 x 2.5 cm including the wing.

Distribution. Sumatra, Peninsular Malaysia, and Borneo. Uncommon in Sabah, known from a single collection (*SAN 64149*) from Ranau. In Sarawak, locally frequent, recorded from Lundu, Semengoh, G. Gaharu, G. Matang, and Bako National Park.

Ecology. Mixed dipterocarp forests.

7. *Kokoona sabahana* Kochummen (of Sabah)

l.c. (1994) 55. **Type:** *Asik SAN 129928*, Sabah, Nabawan (holotype *SAN*; isotypes A, BO, K, L, OX, SAR, SING).

Small tree to 12 m tall, 10 cm diameter. **Bark** pale grey; inner bark brownish. **Sapwood** yellowish. Twigs dark brown to black, swollen at the nodes. **Leaves** elliptic to oblong, 7–11 x 4–6 cm, shiny, drying to yellowish brown; base broadly cuneate, *margin entire or slightly wavy, apex pointed or blunt*; midrib very faintly visible above; lateral veins 6–7 pairs, looping near margin, visible below, faint above; intercostal veins reticulate, faintly visible below; *petioles* 5–7 mm long, channelled above. **Inflorescences** axillary or terminal panicles, to 6 cm long, with a few branches. **Flowers** 5-merous; buds subglobose, *c.* 3 mm across; pedicels *c.* 2 mm long, articulated; sepals triangular; petals slightly obovate with pale margin; disc 5-lobed; stamens inserted within the disc, filaments broad and flat below, tapering towards the apex, *anthers without protruding connective*; ovary immersed in the disc, style distinct, *stigma capitate, with papillae at the top*. Fruits unknown.

Distribution. Endemic to Borneo. Uncommon, known only from 3 collections from Sabah, *SAN 129928* (the type) from Nabawan, *SAN 61465* from Tawau, and *SAN 43778* from Sandakan.

Ecology. Lowland (including swamp) to hill forests to 600 m.

Close to *K. ovatolanceolata* from which it differs by the few-branched, short panicles, larger flowers, papillose stigma, and shorter petiole.

6. *LOPHOPETALUM* Wight *ex* Arn. (Greek, *lophos* = crested, *petalum* = petal)

perupok (Malay, Iban)

Ann. Mag. Nat. Hist. 1, 3 (1839) 150; Merrill *l.c.* (1921) 354; Ridley *l.c.* (1922) 447; Masamune *l.c.* 418; Browne *l.c.* 77; Ding Hou *l.c.* (1962) 262, *l.c.* (1969) 108; Backer & Bakhuizen *f. l.c.* 54; Balan Menon *l.c.* 18; Smythies *l.c.* 38; Burgess *l.c.* 76; Kochummen & Whitmore *l.c.* 165; Jansen *et al. l.c.*

153; Cockburn *l.c.* 58; Anderson *l.c.* 160; Wong *l.c.* 121; Ashton *l.c.* 102; Whitmore, Tantra & Sutisna *l.c.* 44; Ng *l.c.* 44. **Synonym:** *Solenospermum* Zoll., Nat. Tijd. Ned. Ind. 14 (1857) 168, Masamune *l.c.* 419.

Small to very large trees to 45 m tall and 180 cm diameter; bole with or without buttresses, occasionally with pneumatophores. **Bark** similar to *Kokoona*. Twigs pale whitish, dark brown to blackish, often flattened at the nodes. **Leaves** *opposite* or *subopposite*, *margin entire*. **Inflorescences** axillary, peduncles distinct or obscure, *pedicels jointed*. **Flowers** *bisexual*, 5-merous (except ovary); calyx-lobes spreading, inflexed or reflexed; petals free, imbricate, inner surface partly covered with appendages or without; disc conspicuous, usually fleshy and flat, surface smooth or denticulate, 5-angular, rounded or 5-lobed; stamens 5, inserted on the disc, anthers introrse, pollen grains in clusters of fours (tetrads); *ovary* usually *semi-inferior*, 3-celled, style short, stigma obscure, *ovules 4–18 in each cell*, arranged in two series. **Fruit** a *capsule*, 3-angled. **Seeds** flat, surrounded by membranous wing; endosperm absent; germination as in *Kokoona*; cotyledons very thin, seedlings leaves minutely bistipulate, the first two leaves opposite, subsequent leaves alternate on the leader shoots but opposite on the branches.

Distribution. About 18 species; India, Burma, Thailand, Indo-China, Malesia, and Australia. In Malesia 15 species, 10 of which are in Sabah and Sarawak.

Ecology. Lowland (including swamp) to submontane forests to 1500 m.

Uses. The timber is a light hardwood. It is suitable for interior finishing, panelling, partitioning, furniture, veneers, plywood, boxes, crates and mathematical instruments.

Key to *Lophopetalum* species

(based on leaves and twigs)

1. Leaves short-petioled or almost sessile.....2
 - Leaves with distinct petioles.....3
2. Twigs rounded, not winged. Lateral veins 5–7 pairs, sunken above.....2. **L. glabrum**
 Twigs winged, lateral veins 10–15 pairs, not sunken above.....8. **L. sessilifolium**
3. Leaves drying to greenish brown above, lower surface with black gland-dots.....
1. **L. beccarianum**
 Not this combination of characters.....4
4. Intercostal veins invisible below.....5
 Intercostal veins faint to distinctly visible below.....7
5. Blade thinly leathery, apex rounded or notched; lateral veins 4–6 pairs.....
9. **L. subovatum**
 Blade thickly leathery, apex pointed, blunt or rounded; lateral veins 4–11 pairs.....6

6. Petioles 2–2.5 cm long. Blade densely papillose below, margin curled inwards.....**5. L. pachyphyllum**
 Petiole 3–8 mm long. Blade not papillose below, margin not curled inwards.....**7. L. rigidum**
7. Intercostal veins prominently raised below.....**10. L. wightianum**
 Intercostal veins faint below.....8
8. Leaves pale whitish below. Twigs pale whitish.....**6. L. pallidum**
 Leaves not pale whitish below. Twigs dark brown to blackish.....9
9. Lateral veins 8–10 pairs. Petiole 1–1.5 cm long.....**3. L. javanicum**
 Lateral veins 10–15 pairs. Petiole 1.5–3 cm long.....**4. L. multinervium**

Key to *Lophopetalum* species

(based on flowers and leaves)

1. Flower buds almost flat, or wider than long; petals without appendages on the inner surfaces.....2
 Flower buds conical or subglobose, longer than wide; petals with appendages on the inner surfaces.....5
2. Twigs distinctly 4-angled to winged. Inflorescences 18–50 cm long; pedicels 7–15 mm long.....**8. L. sessilifolium**
 Twigs usually rounded. Inflorescences to 15 cm long; pedicels to 9 mm long.....3
3. Disc dish-shaped, 5-lobed.....4
 Disc suborbicular, flat or obscurely 5-angled.....**7. L. rigidum**
4. Petioles 7–15 mm long. Leaves with black gland-dots below; lateral veins not sunken above.....**1. L. beccarianum**
 Petioles to 3 mm long. Leaves without black gland-dots below; lateral veins sunken above.....**2. L. glabrum**
5. Disc 4.5–9.5 mm in diameter at anthesis.....6
 Disc 1–3 mm in diameter at anthesis.....7
6. Leaves densely papillose beneath, intercostal veins invisible.....**5. L. pachyphyllum**
 Leaves not papillose beneath, intercostal veins prominent below.....**10. L. wightianum**
7. Disc with fleshy subulate processes around the base of filaments. Leaves pale whitish below.....**6. L. pallidum**
 Disc smooth or minutely papillose. Leaves not pale whitish below.....8
8. Leaf-apex rounded or notched; lateral veins 4–6 pairs.....**9. L. subovatum**
 Leaf-apex pointed; lateral veins 8–15 pairs.....9

9. Petals 1–1.5 cm long. Lateral veins 8–10 pairs.....**3. *L. javanicum***
 Petals 1.5–3 cm long. Lateral veins 10–15 pairs.....**4. *L. multinervium***

1. *Lophopetalum beccarianum* Pierre

Fig. 6A–D.

(Odoardo Beccari, Italian explorer and botanist, 1843–1920)

Fl. For. Coch. 4 (1894) sub *t.* 307; Merrill *l.c.* (1921) 354; Masamune *l.c.* 418; Ding Hou *l.c.* (1962) 266; Smythies *l.c.* 39; Kochummen & Whitmore *l.c.* 165; Cockburn *l.c.* 59; Anderson *l.c.* 160; Ashton *l.c.* 103; Whitmore, Tantra & Sutisna *l.c.* 44. **Type:** *Beccari PB 2475*, Sarawak (holotype FI; isotypes BO, K). **Synonyms:** *Lophopetalum scortechinii* King *l.c.* 350; *L. havilandii* Ridl. *l.c.* (1931) 37, Masamune *l.c.* 418.

Small to medium-sized tree, rarely to 36 m tall and 60 cm diameter. **Bark** grey-brown, smooth, hoop-marked; inner bark pale brown. **Sapwood** pale yellow. Twigs dark brown to black, rounded. **Leaves** ovate, elliptic or oblong, drying to greenish brown above, with abundant black gland-dots below, 4–30 x 2.5–9 cm; base cuneate, apex pointed or blunt; midrib raised above; lateral veins 5–8 pairs, visible below, faint above, often pinkish when dried; intercostal veins very faint; petioles 7–15 mm long. **Flowers** yellowish, in axillary panicles to 15 cm long; buds flat; pedicels *c.* 5 mm long; calyx-lobes triangular or suborbicular; petals suborbicular or broadly ovate, usually without appendages on inner side, sometimes with distinct veins; disc dish-shaped, 5-lobed; stamen filaments with cushion-like thickening at base; ovary pyramidal, style and stigma obscure. **Fruits** 5 2–11 x 3–3.2 cm. **Seeds** 4.5 x 1.5–1.2 cm (including wing).

Distribution. Peninsular Malaysia and Borneo. In Sabah and Sarawak frequent.

Ecology. Mixed dipterocarp forest to submontane forest to 1800 m, mainly on ridges and hillsides on clay-rich soils. Flowering in February–November.

2. *Lophopetalum glabrum* Ding Hou

Fig. 6E.

(Latin, *glabrus* = smooth; without pubescence)

l.c. (1962) 266; Anderson *l.c.* 160; Ashton *l.c.* 105; Whitmore, Tantra & Sutisna *l.c.* 44. **Type:** *Rutten 83*, E Borneo (holotype U; isotype BO).

Small tree to 15 m tall, 15 cm diameter. **Bark** grey-white; inner bark yellowish. **Sapwood** white. Twigs grey-brown, rounded. **Leaves** elliptic or oblong, 8–16 x 2.5–5.5 cm, without black gland-dots below; base cuneate, apex pointed; midrib raised above; lateral veins 5–7 pairs, raised below, usually sunken above, curving and joining near margin; intercostal veins reticulate, faint below, visible above; petioles to 3 mm long, cracking. **Flowers** yellowish, in branched panicles, to 9 cm long; buds flat; pedicels 5–7 mm long; calyx-lobes deltoid with pointed tips; petals suborbicular, without appendages inside; disc dish-shaped, 5-lobed; anthers suborbicular; ovary pyramidal, style and stigma obscure. **Fruits** reddish brown when fresh, obovoid, 10–12.5 x 3 cm, apex rounded, drying brownish, surface pustulate. **Seeds** 4 in each locule, *c.* 7.5 x 1.5 cm.

Distribution. Endemic to Borneo. Widespread in Sabah and Sarawak, also found in Brunei and Kalimantan.

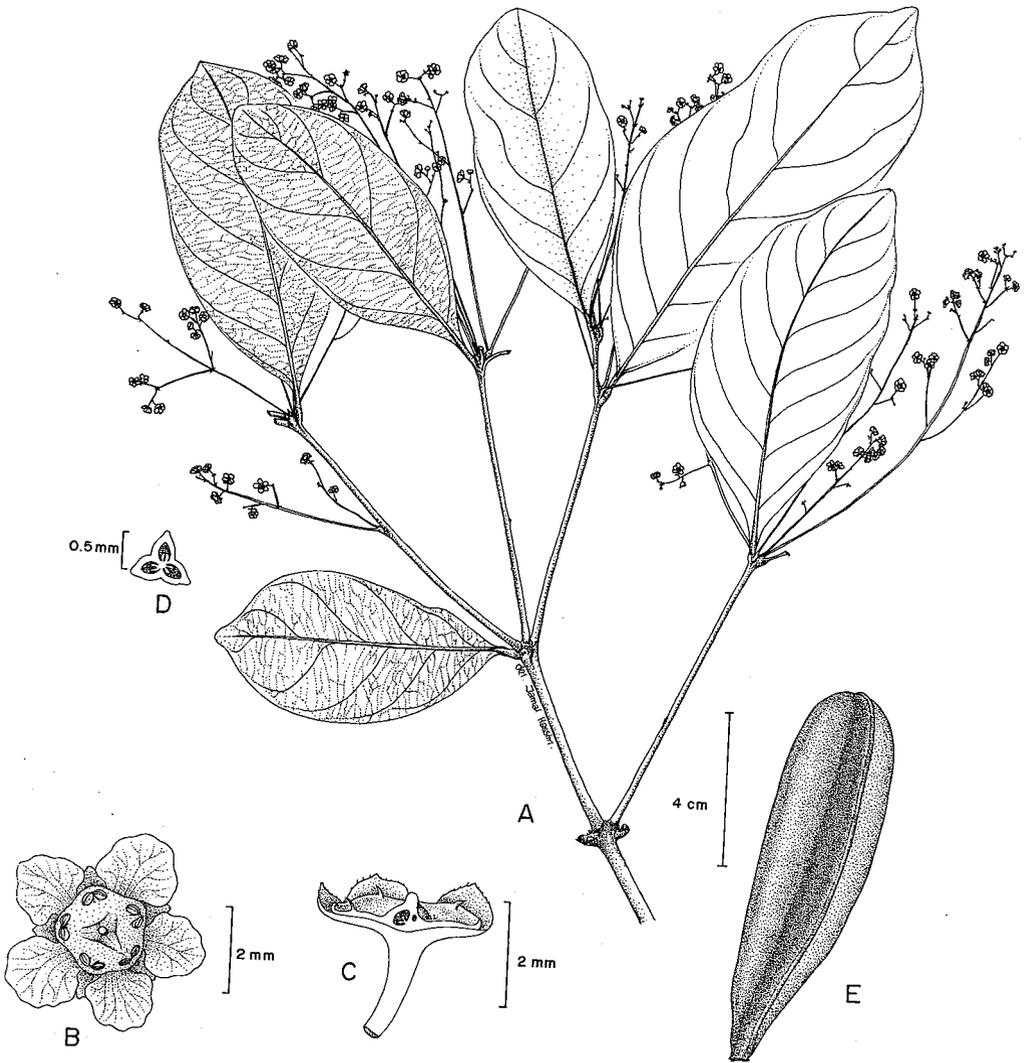


Fig. 6. *Lophopetalum beccarianum* (A–D) and *L. glabrum* (E). A, flowering leafy twig; B, flower, top view; C, longitudinal section through flower, with petals removed; D, transverse section through ovary; E, fruit. (A from SAN 16022, B–D after FM 1, 6 (1962) 263, fig. 10, E from SAN 91886.)

Tree to 45 m tall, 80 cm diameter. **Bark** grey, scaly; inner bark orange-brown. **Sapwood** whitish. *Twigs pale whitish.* **Leaves** *thinly leathery, glaucous below*, elliptic to narrowly obovate, 7–11 x 2.5–6.5 cm; base cuneate, apex cuspidate with short tip; midrib raised above, *pale whitish below*; lateral veins 8–10 pairs with short intermediate veins, very faint on both surfaces; intercostal veins very faint; *petioles* 1.5–2 cm long, *pale whitish.* **Flowers** in panicles; buds short-conical or subglobose; calyx semi-orbicular or triangular; petals with fleshy lobed processes in the central part inside; disc 1–3 mm across at anthesis; *stamens surrounded by fleshy subulate processes of the disc*; ovary triangular, style cylindrical. **Fruits** *c.* 15 cm long. **Seeds** *c.* 9 x 2.3 cm.

Distribution. Sumatra, Peninsular Malaysia, Borneo. In Sabah uncommon, known by only two collection (*SAN 74348* and *SAN 65428*) from Sandakan and Tawau respectively. In Sarawak known from Bintulu, Bt. Mersing, Bt. Raya, and Kapit.

Ecology. Mixed dipterocarp forests on clay soils.

Uses. In Peninsular Malaysia the bark is used as an ingredient in making dart poison by the aborigines.

7. *Lophopetalum rigidum* Ridl.

(Latin, *rigidus* = stiff; the leaf texture)

l.c. (1931) 38; Masamune *l.c.* 418; Ding Hou *l.c.* (1962) 267; Smythies *l.c.* 39; Burgess *l.c.* 77; Cockburn *l.c.* 58; Anderson *l.c.* 161; Ashton *l.c.* 106; Whitmore, Tantra & Sutisna *l.c.* 44. **Type:** *Haviland 2236*, Sarawak, Kuching (BO, K). **Synonym:** *L. subsessile* Ridl. *l.c.* (1931) 37, Masamune *l.c.* 418.

Shrub or small tree, very rarely reaching 30 m tall and 40 cm diameter. **Bark** grey-brown, smooth, hoop-marked with vertical line of lenticels; inner bark purplish brown. **Sapwood** yellow-brown. *Twigs dark brown, rounded.* **Leaves** thickly leathery, drying to greenish brown or reddish brown, not papillose below, ovate-oblong, 4.5–21 x 2–4 cm; base broadly cuneate to rounded, margin not curled inwards, apex pointed or rounded; midrib raised above; lateral veins 4–11 pairs, visible below, faint to invisible above, looping near margin; intercostal veins invisible; petioles stout, 3(–8) mm long. **Flowers** yellowish green, in 10 cm long panicles, pedicels to 5 mm long; buds almost flat, suborbicular or obscurely 5-angled; calyx-lobes ovate or triangular, pointed, with small papilla-like processes outside; petals triangular or suborbicular, without appendages inside, with papilla-like processes outside; disc suborbicular, flat or obscurely 5-angled; stamens with small short-apiculate anthers; ovary pyramidal, style cylindrical. **Fruits** to 11 cm long, surface shortly tuberculate. **Seeds** *c.* 5.5 x 1.5 cm, including wing.

Distribution. Endemic to Borneo. In Sabah, recorded from Lahad Datu (common), Keningau and Ranau. In Sarawak, locally frequent.

Ecology. Freshwater swamps, peat swamps, *kerangas* swamps and also in montane forests to 2400 m.

8. *Lophopetalum sessilifolium* Ridl.

(Latin, *sessile* = stalkless, *folium* = leaves)

l.c. (1931) 37; Masamune *l.c.* 418; Ding Hou *l.c.* (1962) 265; Anderson *l.c.* 161; Ashton *l.c.* 107; Whitmore, Tantra & Sutisna *l.c.* 44. **Type:** *Haviland 1744*, Sarawak, Kuching (BO, K).

Small tree, rarely reaching 20 m tall, 20 cm diameter. *Twigs* dark brown, *strongly 4-angled to winged*. **Leaves** elliptic to oblong or lanceolate, 22–50 x 4.5–12 cm, drying to dark brown *with brown gland-dots below* and grey-brown above; base broadly cuneate to rounded, apex pointed, acumen to 2 cm long; midrib raised above; lateral veins 10–15 pairs, raised on both surfaces, with short intermediate veins; intercostal veins reticulate (rarely scalariform-reticulate), distinct below, faint above; petioles very short to almost absent, rarely to 1 cm long. **Flowers** yellow, in 18–50 cm long panicles, pedicels 7–15 mm long; buds wider than long; calyx-lobes triangular, pointed; petals suborbicular or deltoid with blunt apex, without appendages on the inner side; anthers obtuse; ovary immersed in disc without distinct style or stigma. **Fruits with tuberculate surface**, 7.5–10.5 x 3 cm. **Seeds** 3.8–4.5 x 1–1.3 cm.

Distribution. Endemic to Borneo. In Sarawak, locally abundant in the W Baram valley; also known from Bau, Kapit, Samunsam Wild Life Sanctuary, Semengoh Arboretum, Sg. Jeong, Sg. Kelawit and Sg. Temulan. Not yet reported from Sabah.

Ecology. Lowland forests by rivers. Flowering in February, September and October and fruiting in August and September.

9. *Lophopetalum subovatum* King

(Latin, *sub* = somewhat, *ovatus* = egg-shaped; the leaf shape)

l.c. 349; Ridley *l.c.* (1922) 448; Ding Hou *l.c.* (1962) 271; Burgess *l.c.* 77; Kochummen & Whitmore *l.c.* 169; Cockburn *l.c.* 59; Anderson *l.c.* 161; Ashton *l.c.* 109; Whitmore, Tantra & Sutisna *l.c.* 45. **Type:** *Curtis 1501*, Penang (BO, K). **Synonym:** *Solenospermum apiculatum* Ridl. *l.c.* (1938) 235.

Medium to large-sized tree to 36 m tall, 75 cm diameter. **Bark** pale brown, cracking to scaly, hoop-marked; inner bark pinkish brown. **Sapwood** pale yellow. **Leaves** thinly leathery, drying to brownish, not pale whitish beneath, obovate to elliptic, 4.5–13 x 2.5–7 cm; base tapered, *apex rounded to notched*; midrib raised above; lateral veins 4–6 pairs, curving and joining near margin, faintly visible below, faint to inconspicuous above; intercostal veins invisible; petioles 5–15 mm long. **Flowers** in axillary panicles; buds short-conical or subglobose; calyx-lobes spreading, triangular; petals inside with small appendage on the upper half; disc 1–3 mm across at anthesis, smooth or minutely papillose; anthers deltoid, obtuse; ovary triangular, narrowed towards apex, style cylindrical. **Fruits** to 7 cm long. **Seeds** *c.* 4 x 0.6 cm.

Distribution. Sumatra, Peninsular Malaysia and Borneo. Frequent in Sabah and Sarawak.

Ecology. In mixed dipterocarp forests on leached clay-rich soils, on periodically inundated alluvium, undulating lands and ridges to 900 m.

10. *Lophopetalum wightianum* Arn.

(R. Wight, 19th Century botanist in India)

l.c. (1839) 151; Ding Hou *l.c.* (1962) 267; Kochummen & Whitmore *l.c.* 169; Cockburn *l.c.* 59; Whitmore, Tantra & Sutisna *l.c.* 45. **Type:** *Wight (Icon. t. 162)*, S India, Malabar (K). **Synonyms:** *L. fimbriatum* Wight in Ridley *l.c.* (1922) 448; *L. winkleri* Loes. *l.c.* 221.

Emergent tree to 40 m tall, 100 cm diameter. **Bark** dark grey, fissured; middle bark whitish; inner bark purplish brown. **Leaves** elliptic to ovate, 10–18 x 5–7 cm, not papillose beneath; base rounded to wedge-shaped, *slightly peltate*, apex pointed; midrib raised above; lateral veins 6–12 pairs, pale below; intercostal veins prominent below; petioles 1.5–2.5 cm long. **Flowers** yellow, in panicles, pedicels 5–9 mm long; buds short-conical or subglobose; calyx distinctly 5-lobed; petals broadly ovate to rounded with wavy margin, appendages lamellate to cristate and attached to the lower half of petals; disc 4.5–9.5 mm across at anthesis; stamens with oblong apiculate anthers; ovary triangular, narrowed into style. **Fruits** to 15 cm long. **Seeds** c. 6 x 1.5 cm.

Distribution. India, Indo-China, Sumatra, Peninsular Malaysia, and Borneo. In Sabah, uncommon and recorded from Sandakan and Tawau only. Not yet recorded from Sarawak.

Ecology. Lowland forests to 200 m.

7. *MICROTROPIS* Wall. *ex* Meisn., *nom. cons.*

(Greek, *micro* = small, *tropis* = keel; a small keel on the inner side of the petal)

Pl. Vasc. Gen. Tabul. Diagn. (1837) 68; Ridley *l.c.* (1922) 443; Merrill *l.c.* (1921) 354; Merr. & Freem., Proc. Am. Acad. Arts. Sc. 73 (1940) 276; Masamune *l.c.* 418; Ding Hou *l.c.* (1962) 272; Backer & Bakhuizen *f. l.c.* 54; Kochummen & Whitmore *l.c.* 170; Cockburn *l.c.* 61; Anderson *l.c.* 161; Ashton *l.c.* 109; Kochummen, Sandakaniana 5 (1994) 55. **Synonyms:** *Microtropia* Reichb., Nomencl. (1841) 190; *Paracelastrus* Miq., Fl. Ind. Bat. 1, 2 (1859) 590.

Shrubs or small trees. *Terminal node with one or two pairs of prominent, subpersistent, reduced leaves (incipient bracts).* **Leaves** opposite, glabrous, entire. **Inflorescences** axillary or extra-axillary, dichotomous or paniculate cymes, sometimes in sessile clusters. **Flowers** bisexual, 5- or 4-merous; calyx-lobes almost free, imbricate, persistent, unequal in size, the outer 2 or 3 usually smallest, margin often thinner, transparent, entire, gnawed, irregularly split or fimbriate; *petals free or united*, imbricate; *disc absent*; stamens 4–5, filaments united at base into a ring or a short tube, the united part free from the petals or adnate to it, sometimes the stamens inserted in the mouth of corolla, anthers dorsifixed, usually introrse; *ovary superior*, cylindrical, conical or flask-shaped, 2-celled, ovules 2 in each cell, style very short or cylindrical, stigma obscure, rarely 2–4-lobed. **Fruit** a capsule, striated lengthwise, splitting along one side, apex with short beak, *calyx persistent*. **Seeds** usually 1, erect on a knob-like thickened hilum enveloped by aril, with endosperm.

Distribution. About 80 species, C America, SE to E Asia and Malesia. 20 species in Malesia, of which 14 are in Sabah and Sarawak.

Ecology. Lowland to montane forests to 2700 m, more common in montane forests.

Key to *Microtropis* species
(based mainly on leaves)

1. Leaves thickly leathery, margin distinctly curled inwards.....2
 Leaves thickly or thinly leathery, margin not distinctly curled inwards (except in *M. grandifolia* and *M. sarawakensis*).....4
2. Leaves greyish below; lateral veins and intercostal veins faintly sunken above.....**1. *M. argentea***
 Leaves not greyish below; lateral veins and intercostal veins not sunken above.....3
3. Petioles 7–10 mm long. Intercostal veins invisible below.....**2. *M. borneensis***
 Petioles absent or to 2 mm long. Intercostal veins visible below.....**9. *M. rigida***
4. Leaves drying to greenish yellow. Incipient bracts greenish.....5
 Leaves drying brownish. Incipient bracts brown.....7
5. Incipient bracts needle-like, *c.* 5 x 1 mm.....**10. *M. sabahensis***
 Incipient bracts elliptic, lanceolate or oblong, at least 4 mm broad.....6
6. Intercostal veins equally prominent as the faint lateral veins. Incipient bracts oblong or lanceolate.....**6. *M. kinabaluensis***
 Intercostal veins invisible or very faint. Incipient bracts elliptic or lanceolate.....**11. *M. sarawakensis***
7. Leaves to 4 cm long; base usually rounded to subcordate, apex blunt or rounded.....8
 Leaves longer than 4 cm; base cuneate, apex usually pointed.....9
8. Ovary ovoid-oblong.....**7. *M. ovata***
 Ovary conical.....**14. *M. wallichiana***
9. Incipient bracts foliaceous, 1.7–3 cm long.....**4. *M. grandifolia***
 Incipient bracts stiff, not foliaceous, to 12 mm long.....10
10. Leaves uniformly papillose below with scattered pustules.....**5. *M. keningauensis***
 Leaves not papillose, without pustules.....11
11. Inflorescences in sessile clusters.....**3. *M. fascicularis***
 Inflorescences distinctly stalked.....12
12. Petioles 0.7–1 cm long.....**12. *M. sumatrana***
 Petioles 1–2 cm long.....13
13. Ovary cylindrical, slightly constricted in the middle.....**13. *M. valida***
 Ovary conical, without constriction in the middle.....**8. *M. platyphylla***

Key to *Microtropis* species
(based mainly on flowers)

1. Inflorescences or infructescences in sessile clusters or condensed cymes; peduncle if present to 1 cm long.....2
 Inflorescences and infructescences with peduncle more than 1 cm long.....6
2. Lower surface of leaf uniformly papillose and with scattered pustules...**5. *M. keningauensis***
 Lower surface of leaf not papillose, without pustules.....3
3. Ovary cylindrical or ovoid-oblong.....4
 Ovary conical or gradually tapered to apex.....5
4. Ovary cylindrical with slight constriction in the middle. Petioles 1–2 cm long.....
**13. *M. valida*** (in part)
 Ovary ovoid-oblong. Petioles absent or very short, to 2 mm long.....**7. *M. ovata***
5. Stigmas 4-lobed; ovary gradually tapered towards apex.....**3. *M. fascicularis***
 Stigmas not lobed; ovary conical.....**14. *M. wallichiana***
6. Leaves thickly leathery; margin distinctly curled inwards.....7
 Leaves thinly to thickly leathery; margin not distinctly curled inwards (faintly so in *M. grandifolia* and *M. sarawakensis*).....10
7. Petioles very short, to only 2 mm long or almost absent.....**9. *M. rigida***
 Petioles distinct, at least 7 mm long.....8
8. Lower surface of leaf greyish; lateral veins and intercostal veins sunken above.....
**1. *M. argentea***
 Lower surface of leaf greenish brown; lateral veins and intercostal veins invisible above.....9
9. Incipient bracts 1.7–3 x 1.2–2 cm; petioles 2.3–6 cm long...**4. *M. grandifolia*** (in part)
 Incipient bracts to 5 mm long. Petioles 7–10 mm long.....**2. *M. borneensis***
10. Petals distinctly united, at least up to lower half.....**10. *M. sabahensis***
 Petals free or only slightly united at the very base.....11
11. Ovary cylindrical.....**13. *M. valida*** (in part)
 Ovary conical, flask-shaped or gradually narrowed towards apex.....12
12. Ovary flask-shaped.....13
 Ovary conical or gradually narrowed towards apex.....14
13. Incipient bracts ovate, 1.7–3 x 1.2–2 cm. Leaves 20–30 x 8.5–14.5 cm; petiole 2.3–6 cm long.....**4. *M. grandifolia*** (in part)

- Incipient bracts lanceolate or oblong, to 1.5 cm long. Leaves 11–24.5 x 3.5–9 cm; petiole 1–2 cm long.....**6. M. kinabaluensis**
14. Stigmas 4-lobed; ovary gradually narrowed towards apex.....**12. M. sumatrana**
 Stigmas or apex of ovary not lobed; ovary conical..... 15
15. Leaves thinly leathery. Incipient bracts green, lanceolate or elliptic.....**11. M. sarawakensis**
 Leaves thickly leathery. Incipient bracts brown, lanceolate.....**8. M. platyphylla**

1. Microtropis argentea Kochummen

(Latin, *argenteus* = silvery; the lower leaf surface)

l.c. (1994) 55. **Type:** *Lee S. 39980*, Sarawak, Belaga (holotype SAR; isotypes E, K, KEP, L, SAN).

Small tree to 5 m tall. *Incipient bracts lanceolate, stiff, brown, c. 5 mm long. Twigs swollen at nodes, grey, rounded. Leaves thickly leathery, drying to pale green above, greyish below, elliptic, 10.5–12 x 5.5 cm; base cuneate, margin prominently recurved, with thick rim, apex shortly pointed, incurved; midrib prominently raised above; lateral veins 6–7 pairs, invisible below, faintly sunken above; intercostal veins invisible below, reticulate and faintly sunken above; petioles 0.7–1 cm long, wrinkled on drying. Inflorescences in cymes to 1.5 cm long; peduncles c. 1 cm long; buds globose, c. 2 mm across. Flowers white, 5-merous; sepals rounded with gnawed margins, wrinkled outside; petals united to more than half the length, lobes oblong; stamens at mouth of corolla tube, filaments very short, anthers globose; ovary conical, apical part ridged with no distinct style or stigma. Fruit unknown.*

Distribution. Endemic to Borneo. Uncommon, known only from the type specimen from Belaga, Sarawak.

Ecology. *Kerangas* forest on plateau at 700 m.

2. Microtropis borneensis Merr. & Freem.

(of Borneo)

l.c. 296; Masamune *l.c.* 418; Kochummen *l.c.* (1994) 63. **Type:** *Clemens 31742*, British North Borneo, Mt. Kinabalu (holotype A; isotypes B, BO, GE, N, UC).

Shrub or small tree. Twigs grey, youngest ones reddish brown and slightly angled. *Incipient bracts triangular, stiff, c. 5 mm long. Leaves thickly leathery, drying to greenish brown on both surfaces, elliptic, 5.5–9 x 2.5–4.5 cm; base cuneate, margin with thick rim, wavy and strongly recurved, apex pointed; midrib prominently raised above; lateral veins 5–7 pairs, very faintly visible below only; intercostal veins invisible; petioles 7–10 mm long, wrinkled on drying. Inflorescences and flowers unknown. Infructescences with a peduncle c. 2 cm long. Fruits when fresh oblong, c. 2 x 1.5 cm, yellow, drying black.*

Distribution. Endemic to Borneo. Locally abundant on Mt. Kinabalu in Sabah. In Sarawak, known from a single collection (*S. 40412*), from Lambir National Park.

Ecology. *Kerangas* and montane forests to 2400 m.

Taxonomy. Ding Hou *l.c.* 279 considered this a synonym of *M. platyphylla* Merr. After studying the types and other recently collected specimens of both species, I have come to the conclusion that *M. borneensis* should be reinstated as a distinct species.

3. *Microtropis fascicularis* Kochummen

Fig. 7.

(Latin, *fascicularis* = in a small bundle; the flower clusters)

l.c. (1994) 57. **Type:** Lee S. 44277, Sarawak, Lingga (holotype KEP; isotypes A, K, L, SAN, SAR).

Treelet to 2 m tall. *Incipient bracts stiff, brown, lanceolate, c. 7 x 1 mm, with sharp tip.* Twigs dark brown, rounded. **Leaves** leathery, *surface not papillose nor pustulate*, elliptic or oblong, 10.5–20.5 x 4–8.5 cm; base cuneate, margin slightly recurved, apex pointed; midrib raised above; lateral veins 10–12 pairs, looping near margin, very faint on both surfaces; intercostal veins reticulate, very close, visible on both surfaces; petioles 0.5–2.2 cm long, wrinkled on drying. **Flowers** in *sessile fascicles, 4-merous; sepals rotund, margin gnawed, c. 2 x 1.5 mm; petals free*, oblong to obovate, *c. 1.5 x 1.2 mm*; stamens free, anthers oblong, *c. 1 mm* long; ovary gradually tapered towards apex, striate, stigma 4-lobed. **Fruits** green when fresh, drying black, oblong or ellipsoid, 15–18 x 4–6 mm, with pointed tip.

Distribution. Endemic to Borneo. Uncommon, known by 5 collections from Sarawak.

Ecology. Mixed dipterocarp forest and *kerangas* forest, to 500 m, usually by streams. Flowering in December and fruiting in March–May.

4. *Microtropis grandifolia* Kochummen

(Latin, *grandis* = large, *folius* = leaf)

l.c. 1994) 59. **Type:** Awa & Ilias S. 47380, Sarawak, Lundu (holotype KEP; isotypes K, SAR).

Small tree to 5 m tall. **Twigs** brownish, youngest ones flattened. *Incipient bracts prominent, foliaceous, ovate to elliptic, 1.7–3 x 1.2–2 cm.* **Leaves** thinly to thickly leathery, elliptic, drying greenish brown on both surfaces, 20–30 x 8.5–14.5 cm; base broadly cuneate, margin faintly wavy, faintly curled inwards, apex pointed; midrib flattened to raised above; lateral veins 10–12 pairs, looping near margin, faintly raised on both surfaces with short intermediate veins; intercostal veins reticulate, faintly visible above; petioles 2.3–6 cm long, wrinkled on drying. **Inflorescences** paniculate cymes, *c. 6–7 cm* long; peduncles 2–3 cm long; bracteoles triangular, transparent. **Flowers** 4-merous; outer two sepals larger than inner 2, rotund; petals slightly united at base; anthers sessile, jointed at base on a staminal ring, connective slightly prolonged; *ovary flask-shaped*, style ridged, stigma 2–4-lobed. Fruits unknown.

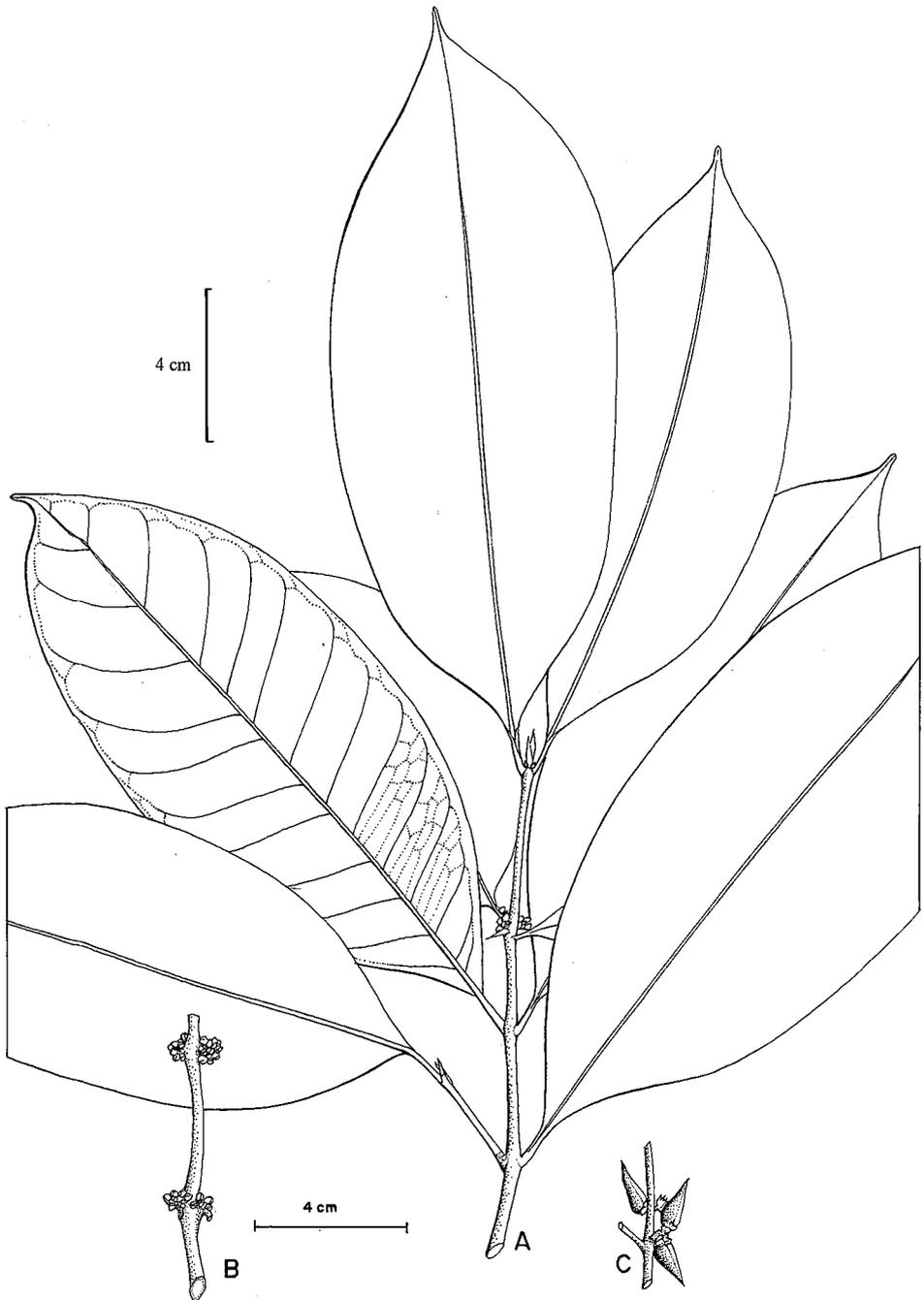


Fig. 7. *Microtropis fascicularis*. A, flowering leafy twig; B, fascicled inflorescence; C, fruits. (A & B from S. 44277, C from S. 36677.)

Key to varieties

Leaves thinly leathery, margin slightly incurved. Petioles *c.* 3 cm. Stigmas 4-lobed.....

var. **grandifolia**

Endemic to Sarawak. Uncommon, known only by two collections (*S.* 47380 from Bukit Panjo, Lundu, and *S.* 34033 from Lubok Antu). Lowland and hill forests to 600 m. Flowering in May.

Leaves thickly leathery, margin strongly incurved. Petioles *c.* 6 cm. Stigma 2-lobed.....

var. **longipetiolatus** Kochummen

l.c. (1994) 59. Type: *Chai S.* 34033, Sarawak, Lanjak Entimau (holotype SAR; isotypes K, KEP, L, MO, SAN). Uncommon, known only from the type collection.

5. *Microtropis keningauensis* Kochummen

(of Keningau, in Sabah)

l.c. (1994) 61. Type: *Fidilis SAN 118405*, Sabah, Keningau (holotype SAN).

Shrub or small tree. Twigs grey-brown. *Incipient bracts* brown, lanceolate, *c.* 10 x 2 mm, with distinct median ridge. **Leaves** leathery, drying brownish, uniformly papillose below with scattered pustules, elliptic, 11.5–23.5 x 4.5–8.5 cm; base cuneate, margin not curled inwards, apex pointed; midrib flattened above; lateral veins 9–12 pairs, looping near margin, distinct below, faintly visible above; intercostal veins reticulate, distinct below, almost invisible above; petioles 8–15 mm long, drying black. Inflorescences and flowers unknown. **Infructescences** almost sessile to 1-cm-stalked. **Fruits** yellowish green when fresh, black on drying, oblong, 2–2.3 x 0.7–0.8 cm, apex with distinct point.

Distribution. Endemic to Borneo. Uncommon, known by two collections only (*SAN 118364* and *SAN 118405*), from Lanau, Keningau in Sabah.

Ecology. Lowland forest by stream and ridge top. Fruiting in October.

6. *Microtropis kinabaluensis* Merr. & Freem.

(of Mt. Kinabalu, Sabah)

l.c. 304; Masamune *l.c.* 418; Ding Hou *l.c.* (1962) 277. Type: *Clemens 29518*, British North Borneo, Mt. Kinabalu (holotype A; isotypes B, BO, GE, K, L, N, UC). **Synonyms:** *M. kinabaluensis* var. *acuminata* Merr. & Freem. *l.c.* 305, Masamune *l.c.* 418; *M. sterrophylla* Merr. & Freem. *l.c.* 305, Masamune *l.c.* 419.

Shrub or small tree to 5 m tall. *Incipient bracts* pale green, to 1.5 cm long, 0.5 cm broad, lanceolate or oblong. Young twigs slightly angled. **Leaves** greenish yellow on drying, leathery, elliptic-oblong, 11–24.5 x 3.5–9.5 cm; base cuneate to tapered, margin slightly recurved, apex pointed; midrib raised above; lateral veins 6–12 pairs, looping near margin, very faint on both surfaces; intercostal veins reticulate, equally prominent as lateral veins;

petioles 1–2 cm long, drying wrinkled and yellowish. **Inflorescences** cymose panicles, to 5.5 cm long, peduncles 1.5–2.5 cm long. **Flowers** white; *calyx-lobes with 3–5 longitudinal veins; petals free, ovate or broadly elliptic; stamen filaments united at base; ovary flask-shaped.* **Fruits** red when ripe, oblong or ovoid to ellipsoid, 1.5–2 x 0.7–1 cm, faintly furrowed, crowned by the persistent style.

Distribution. Endemic to Borneo. Widely distributed in Sabah and Sarawak.

Ecology. Lowland to submontane forests to 1500 m.

7. *Microtropis ovata* Merr. & Freem.

(Latin, *ovatus* = egg-shaped; the leaf shape)

l.c. 297; Masamune *l.c.* 419; Ding Hou *l.c.* (1962) 279. **Type:** *Clemens 40046*, British North Borneo, Mt. Kinabalu (BM, BO).

Shrub to 3 m tall. *Twigs 4-angled. Leaves thickly leathery, under surface not papillose nor pustulate, ovate to ovate-oblong, 4.5–10 x 2–7 cm; base rounded to cordate, margin not curled inwards, apex acute; lateral veins 5–9 pairs; petioles very short to 2 mm long or leaves sessile. Flowers in condensed cymes, peduncle very short; calyx-lobes suborbicular; petals free, ovate or ovate-oblong; stamen filaments united at the lower half; ovary ovoid-oblong, not constricted at the middle. Fruits unknown.*

Distribution. Endemic to Sabah. Uncommon, known from Mt. Kinabalu only.

Ecology. Submontane forests at 1200–1500 m.

8. *Microtropis platyphylla* Merr.

(Greek, *platus* = broad, *phyllon* = leaf; broad-leaved)

Philip. J. Sc. 10 (1915) Bot. 319; Ding Hou *l.c.* (1962) 279. **Type:** *Loher 5779*, Philippines (BO, L).

Shrub or small tree to 10 m tall, 10 cm diameter. *Incipient bracts brown, 4–12 mm long, lanceolate. Leaves thickly leathery, not papillose nor pustulate beneath, elliptic to lanceolate or ovate-lanceolate, 4.5–24 x 4.5–11 cm; base cuneate, margin not curled inwards, apex blunt to pointed; lateral veins 6–12 pairs; petioles 1–2 cm long. Inflorescences paniculate, peduncles 1–1.5 cm long. Flowers (4–)5-merous; calyx-lobes suborbicular or subreniform with gnawed margins; petals free, elliptic or broadly ovate, obtuse; stamen filaments united at base; ovary conical, not constricted at the middle, apex obtuse or notched. Fruits ovoid or ellipsoid, 1–2.5 x 1 cm.*

Distribution. Borneo and the Philippines. Common in Sabah, but uncommon in Sarawak.

Ecology. Hill and montane forests to 2700 m.

9. *Microtropis rigida* Ridl.

(Latin, *rigidus* = stiff; the thick leaves)

l.c. 36; Merr & Freem. *l.c.* 297; Masamune *l.c.* 419; Ding Hou *l.c.* (1962) 278. **Type:** *Beccari PB 1702*, Sarawak (holotype FI; isotypes BO, K).

Small tree to 20 m tall, 15 cm diameter. *Incipient bracts lanceolate, c.* 0.5 cm long, brown, stiff. Twigs swollen at nodes. **Leaves** thickly leathery, elliptic-oblong, 7–12 x 2.5–6 cm, pustulate below; base obtuse, rarely cuneate, margin curled inwards, apex pointed; midrib raised above; lateral veins 5–7 pairs, very faint; intercostal veins reticulate, visible below, invisible above; *petioles very short to 2 mm long to almost absent*. **Inflorescences** to 2.5 cm long, peduncles 1–1.5 cm long. **Flowers** white; calyx-lobes suborbicular, sometimes irregularly split; petals free, oblong, obtuse; stamen filaments subulate, lower half united; ovary globose, narrowed towards apex, style very short, *stigmas obscurely 4–6-lobed*. **Fruits** oblong, 12–15 x 7–9 mm, apex rounded with short persistent style.

Distribution. Endemic to Sarawak; uncommon and known only from Bako National Park, G. Santubong and Mulu National Parks.

Ecology. Lowland to submontane forests to 1000 m, including *kerangas*.

10. *Microtropis sabahensis* Kochummen

(of Sabah)

l.c. (1994) 61. **Type:** *Banang SAN 51915*, Sabah (holotype KEP; isotype SAN).

Treelet to 5 m tall. Youngest twigs reddish brown. *Incipient bracts greenish, needle-like, c.* 5 x 1 mm. **Leaves** thinly leathery, elliptic, 13.5–20.5 x 3.5–7 cm; base cuneate, margin slightly wavy, apex pointed; midrib raised above; lateral veins 8–10 pairs, looping and joining near margin, faint on both surfaces; intercostal veins reticulate, very faint; *petioles 1–1.5 cm long, drying greenish yellow*. **Inflorescences** axillary, 3–4.5 cm long, cymose panicles, *peduncles 1–1.5 cm long*; bracteoles triangular, transparent. **Flowers** 4-merous; *sepals ovate, transparent, wrinkled outside; petals united half-way, lobes oblong with transparent margins; stamens seated on the mouth of corolla-tube, filaments flat; ovary gradually tapered towards apex, slightly ridged towards apex, style indistinct, stigma distinct, 4-lobed*. Fruits unknown.

Distribution. Endemic to Sabah. Uncommon, known only from the type collection from Kinabatangan.

Ecology. Lowland and seasonal swamp forests. Flowering in June.

Very similar to *M. kinabaluensis* but differing in the united petals, shape of ovary and the prominent stigma.

11. *Microtropis sarawakensis* Kochummen

(of Sarawak)

l.c. (1994) 63. **Type:** *Ilias S. 36501*, Sarawak (holotype KEP; isotypes K, L, MO, SAN, SAR).

Small tree to 5 m tall, 10 cm diameter. *Incipient bracts green, elliptic or lanceolate, c. 10 x 4 mm.* Twigs reddish brown, rounded, youngest ones angular. **Leaves** thinly leathery, drying to greenish yellow, elliptic or oblong, 10–17 x 7.5 cm; base cuneate, margin wavy and slightly recurved, apex pointed; midrib raised above; lateral veins 7–9 pairs, very faint on both surfaces; *intercostal veins invisible to very faint*; petioles 1–1.5 cm long, channelled above, wrinkled and yellowish on drying. **Inflorescences** cymose panicles, 2–5 cm long, peduncles 1–1.5 cm long. **Flowers** 4- or 5-merous; *calyx-lobes suborbicular, transparent with few fine veins in the middle; petals free, imbricate, oblong, transparent; stamens with short filaments which are joined at the bottom by a staminal ring, connective slightly prolonged*; ovary short conical, without distinct style, with wavy surfaced, and unlobed stigma. **Fruits** (immature) green when fresh, ovoid, 7–10 x 4–5 mm, apex with short style and stigma, calyx persistent.

Distribution. Endemic to Sarawak. Uncommon, known only by the type collection.

Ecology. Lowland forests by streams. Flowering in April and June, and fruiting in October.

The leaves are somewhat similar to those of *M. sabahensis*, but the shape and size of incipient bracts of *M. sarawakensis* distinguishes it from *M. sabahensis*. Furthermore, in *M. sabahensis* the stigma is distinctly lobed, and the corolla is united almost half way. In contrast, in *M. sarawakensis* the stigma is unlobed and the petals are free.

12. *Microtropis sumatrana* Merr.

(of Sumatra)

Pap. Mich. Acad. Sc. 19 (1934) 164; Merr. & Freem. *l.c.* 304; Ding Hou *l.c.* (1962) 279. **Type:** *Rahmat 214*, Sumatra (A, BO).

Small tree to 20 m tall and 20 cm diameter. **Bark** grey, smooth; inner bark pale grey. **Sapwood** pale white. *Incipient bracts lanceolate, to 12 mm long.* Twigs greyish. **Leaves** thinly leathery, pale below, dark brown on drying, *not papillose nor pustulate beneath*, elliptic, 6.5–11 x 3.5–5.5 cm; base cuneate, apex pointed; midrib flattened above; lateral veins 5–7 pairs, faint to distinct below, curving and joining near margin; intercostal veins laxly reticulate, faint; *petioles 0.7–1 cm long.* **Inflorescences** dichotomously branched, *peduncles 1–3 cm long.* **Flowers** with calyx-lobes irregularly split; petals free, oblong, obtuse; stamens united at the lower half; ovary gradually narrowed towards apex, stigma 4-lobed. **Fruits** oblong, 1.5–1.7 x 0.7–1.0 cm, with pointed tip, calyx persistent at base.

Distribution. Sumatra and Borneo. Uncommon, in Sabah known only from Sipitang, Tawau, and Mostyn.

Ecology. Lowland to submontane forests to 1050 m.

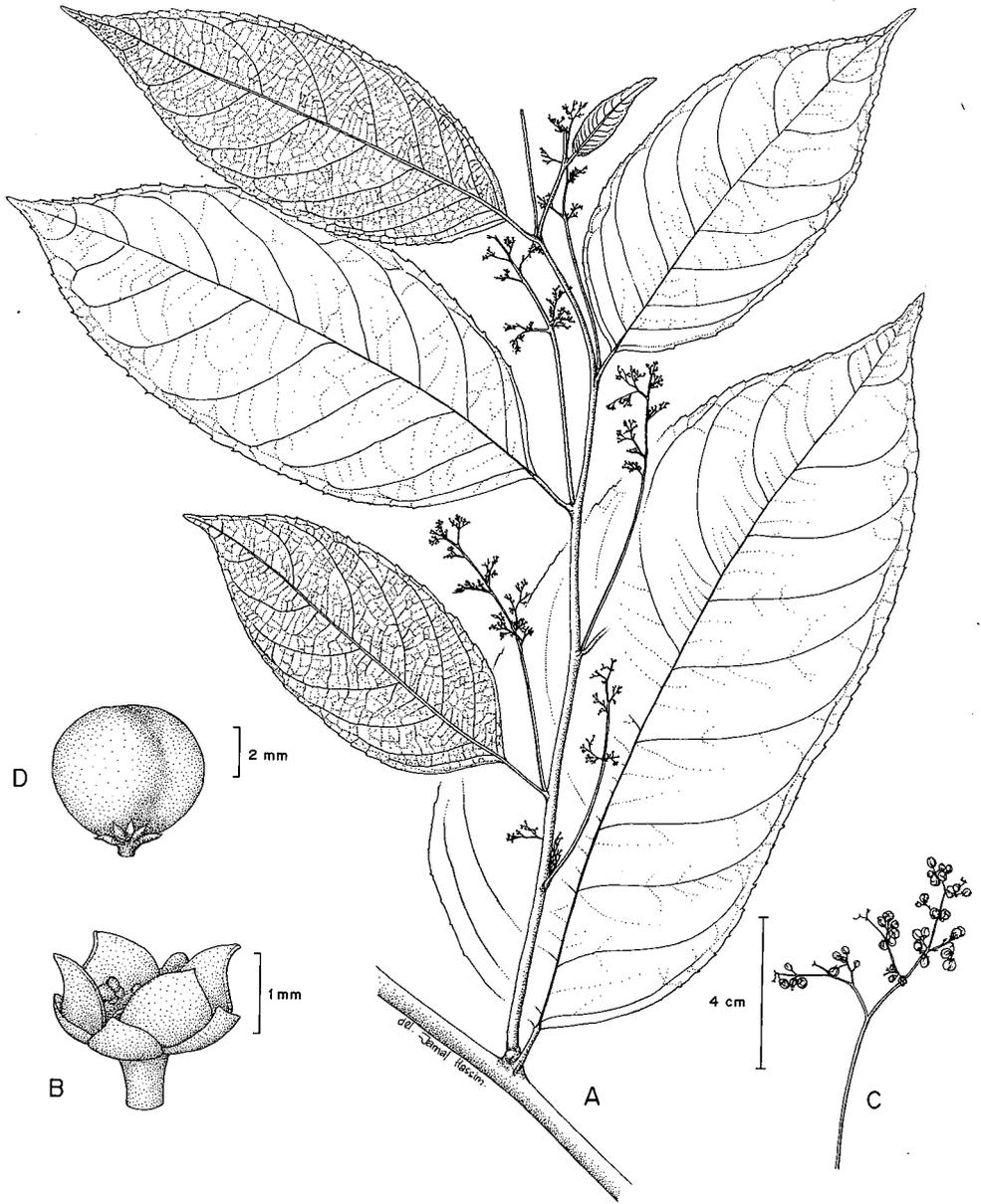


Fig. 8. *Perrottetia alpestris* subsp. *philippinensis*. A, flowering leafy twig; B, flower, C, infructescence; D, fruit. (A from S. 34060, B after FM 1, 6 (1962) 289, fig. 21, C & D from S. 43345.)

13. *Microtropis valida* Ridl.

(Latin, *validus* = robust-growing)

J. Str. Br. R. As. Soc. 75 (1917) 19, *l.c.* (1922) 445; Merr & Freem. *l.c.* 304; Ding Hou *l.c.* (1962) 276; Kochummen & Whitmore *l.c.* 170. **Type:** *Curtis 1331*, Perak (holotype K; isotype BO). **Synonyms:** *M. bicolor* Merr. & Freem. *l.c.* 298; *M. pauciflora* Boerl. ex Merr. & Freem. *l.c.* 303.

Shrub or small tree to 5 m tall. *Incipient bracts brown, stiff, 3–12 mm long. Leaves leathery, under surface not papillose nor pustulate, ovate to lanceolate or elliptic, 11–27 x 4.5–12 cm; base rounded to cuneate, margin not curled inwards, apex acute or acuminate; midrib raised above; lateral veins 6–14 pairs; intercostal veins reticulate, distinct on both surfaces; petioles 1–2 cm long. Inflorescences usually paniculate, rarely a simple cyme or fascicle, peduncles 1–4 cm long. Flowers 4(–5)-merous; calyx-lobes suborbicular, slightly wrinkled outside, margin transparent; petals free, elliptic or oblong, obtuse; stamen filaments united at base; ovary cylindrical, slightly constricted at the middle, truncate or discoid at the top. Fruits ellipsoid, c. 2 x 1 cm, apex pointed and furfuraceous with persistent style.*

Distribution. Sumatra, Peninsular Malaysia and Borneo. In Sabah and Sarawak uncommon, known by only two collections (*SAN 75680* and *SAN 44667*) in Sabah, and three (including the type of *M. bicolor* by Beccari) collections in Sarawak.

Ecology. Lowland to submontane forests to 1350 m.

14. *Microtropis wallichiana* Wight ex Thwaites

(N. Wallich, 1786–1854, Superintendent, Calcutta Botanic Gardens)

En. Pl. Zeyl. (1858) 71; Ding Hou *l.c.* (1962) 279. **Type:** *Wight 528*, Ceylon (BO, K). **Synonym:** *M. suborbiculata* Merr. & Freem. *l.c.* 282, Masamune *l.c.* 419.

Shrub or small tree. *Incipient bracts brown, 3–8 mm long. Twigs rounded to slightly angled. Leaves thickly leathery, elliptic, lanceolate or rounded, 3–18 x 1–6 cm, lower surface not papillose nor pustulate; base cuneate to rounded, margin not curled inwards, apex pointed, blunt or rounded and notched; midrib raised above; lateral veins 4–9 pairs, invisible above; intercostal veins reticulate, faint to invisible; petioles to 1.5 cm long, rarely very short. Inflorescences condensed cymes, less than 1 cm long, peduncles very short or absent. Flowers yellowish; calyx-lobes subreniform; petals free, fleshy; stamen filaments united at the lower part; ovary conical, longitudinally striate, stigma not lobed. Fruits oblong-ellipsoid or oblong-obovoid, c. 1 x 0.5 cm, furfuraceous, crowned by persistent style.*

Distribution. Sri Lanka, Sumatra and Borneo. In Sabah, known from Mt. Kinabalu only; not recorded from Sarawak.

Ecology. Submontane to montane forests at 1250–2500 m.

The types of *M. wallichiana* and *M. suborbiculata* have some differences which require to be substantiated by examining more material. There is no conclusive evidence for their distinction, although it is doubtful if they are the same species.

8. PERROTTETIA Kunth

(G.S. Perrotet, 1793–1870, French botanist)

Nov. Gen. Sp. 7 (1824) 73; Merrill *l.c.* (1921) 354; Ridley *l.c.* (1922) 454; Masamune *l.c.* 419; Ding Hou *l.c.* (1962) 288; Backer & Bakhuizen *f. l.c.* 55; Kochummen & Whitmore *l.c.* 171; Anderson *l.c.* 161; Ashton *l.c.* 112. **Synonym:** *Caryospermum* Blume *l.c.* (1850) 175.

Shrubs or small trees. **Leaves** *alternate*. **Inflorescences** cymose, axillary. **Flowers** *bisexual*, rarely unisexual; calyx-lobes 5 or 4; *petals similar to calyx-lobes in size and shape*; stamens 5 or 4, inserted on the margin of the disc; *ovary semi-inferior*, mostly 2-celled, style 1; ovules two in each cell. **Fruit** a *berry*, globose, 2–4-seeded. **Seeds** covered with thin aril; endosperm thin; embryo small.

Distribution. About 15 species; China, Formosa, Malesia and America. Only one species in Sabah and Sarawak.

Ecology. Primary and secondary hill and montane forests to 2600 m.

Perrottetia alpestris (Blume) Loes.

Fig. 8.

(Latin, *alpestris* = growing above the limit of forest growth; its habitat)

in Engler & Prantl *l.c.* 220; Merrill *l.c.* (1921) 354; Ridley *l.c.* (1922) 454; Masamune *l.c.* 419; Ding Hou *l.c.* (1962) 288; Kochummen & Whitmore *l.c.* 171; Ashton *l.c.* 161. **Basionym:** *Celastrus alpestris* Blume, Bijdr. (1826) 1145. **Type:** *Blume, s.n.*, Java (BO, L).

subsp. **philippinensis** (Vidal) Ding Hou

l.c. (1962) 291. **Basionym:** *Caryospermum philippinensis* Vidal, Rev. Pl. Vasc. Philip. (1886) 89. **Type:** *Beccari PB 7770*, Sarawak (FI).

Shrub or small tree to 12 m tall. *Young twigs and petioles purplish when fresh, blackish on drying*. **Leaves** thinly leathery, elliptic or oblong, 10–20 x 4–8 cm; base cuneate or rounded, sometimes subcuneate, *margin prominently toothed*, apex pointed; midrib flattened above; lateral veins 8–12 pairs, raised below, sunken or flattened above; intercostal veins reticulate, distinct below, faint above; petioles 7–15 mm long, not swollen. **Flowers** white or light greenish, *4-merous*; calyx-lobes sparsely puberulous on both surfaces; petals puberulous on both surfaces; disc cup-shaped; stamen filaments longer than the disc; ovary conical, style short, stigma distinctly 2-lobed. **Fruits** globose or subglobose, 2.5–3.5 mm diameter, red. Seeds 3–4.

Distribution. Borneo, Philippines and Celebes. In Sabah, collected from Kinabalu National Park, Kalabakan and Lamag. In Sarawak, reported from Dulit Range, Mulu National Park, Bt. Rawan, Kapit and Lubuk Antu.

Ecology. Hill and montane forests to 2700 m, in open screes, usually on moist soils.

This subspecies differs from the other two (*alpestris* and *moluccana*) by its 4-merous instead of 5-merous flowers.

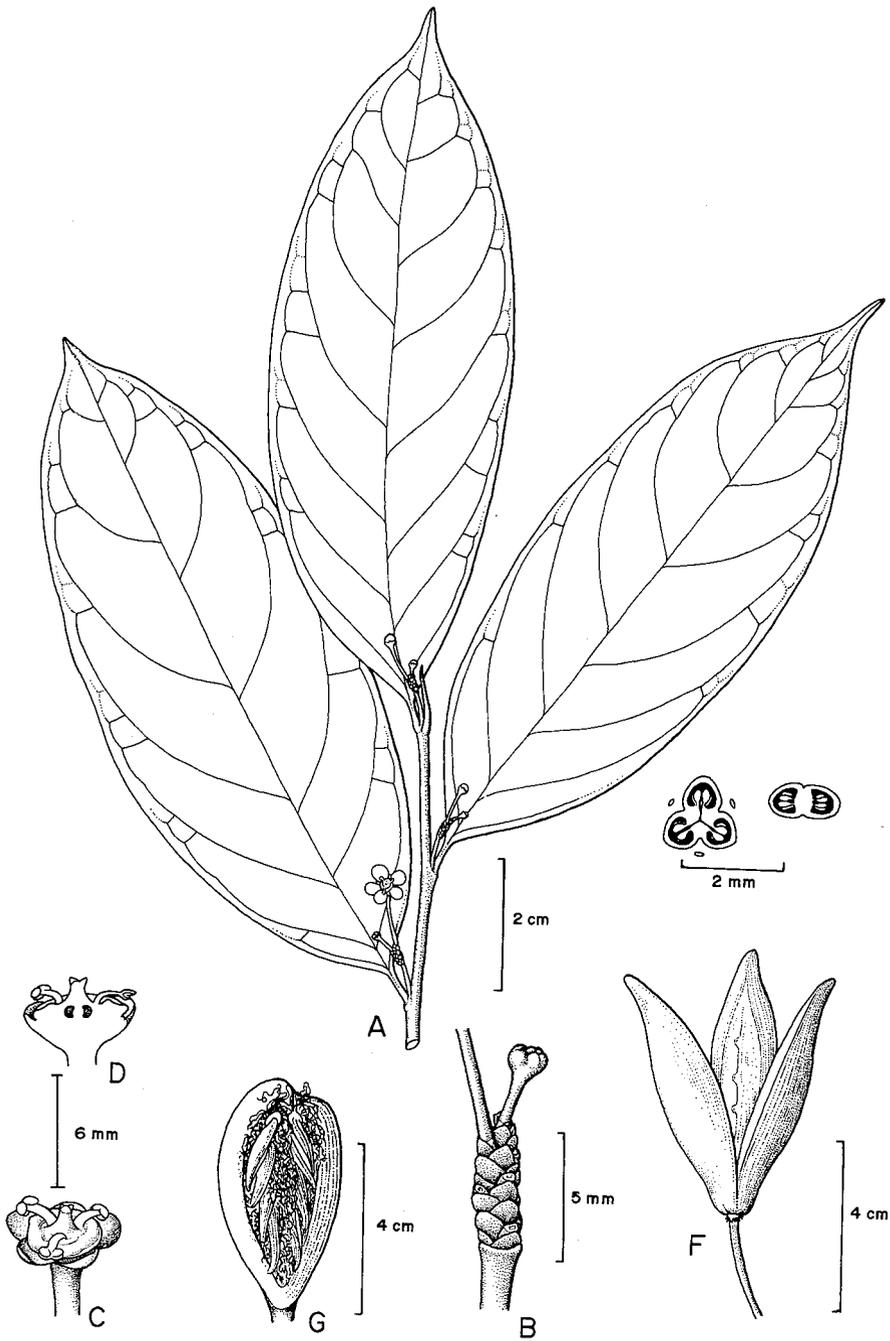


Fig. 9. *Sarawakodendron filamentosum*. A, flowering leafy twig; B, inflorescence; C, flower with petal removed; D, longitudinal section through flower; E, cross section (left) and longitudinal section (right) of ovary; F, dehiscent fruit; G, fruit valve with attached seeds. (All after FM 1, 6 (1962) 931, fig. 4.)

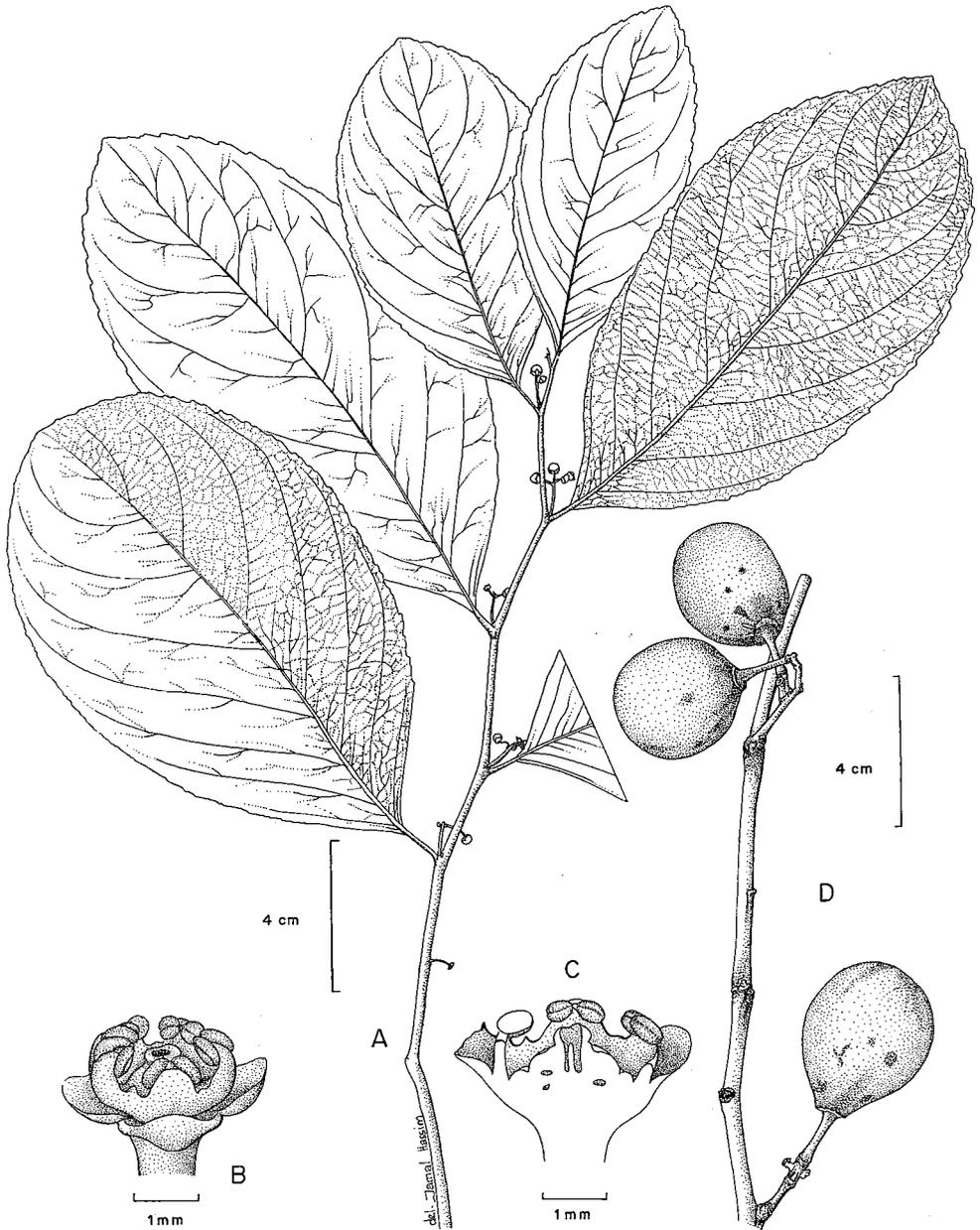


Fig. 10. *Siphonodon celastrineus*. A, flowering leafy twig; B, young flower with petals removed; C, longitudinal section through flower, with petals removed; D, fruiting twig. (A from SAN 55718, B-C after FM 1, 6 (1962) 395, fig. 24, D from S. 39801.)

9. SARAWAKODENDRON Ding Hou

(Greek, *dendron* = a tree; Sarawak tree)

Blumea 15 (1967) 139, *l.c.* (1969) 97, *l.c.* (1972) 930; Anderson *l.c.* 162.

Small trees. *Young twigs, petioles, midrib, leaf blades and floral parts with yellow pustules.* Twigs without distinct stipular scars. **Leaves** *alternate, entire*; petioles not swollen. Stipules inconspicuous. **Inflorescences** axillary, with condensed decussate bracts. **Flowers** *bisexual*; calyx 5-lobed, lobes imbricate; petals 5, imbricate; disc slightly 5-angular; *stamens* 3, inserted at the base of ovary, anthers extrorse, transversely dehiscent; *ovary semi-inferior, 3-celled, 3-angled*, stigma 3, ovules 8 in each cell, in 2 series, placentation axile. **Fruit** a capsule, dehiscing loculicidally into 3 valves. **Seeds** 6–8 in each cell, with endosperm; aril fleshy, cushion or caruncle-like at the chalazal end *which bears 1.5–2-cm-long simple or dichotomously branched, thread-like appendages arising from the base of funicle.*

Distribution. A monotypic genus, endemic to Sarawak.

Ecology. Lowland forests.

Sarawakodendron filamentosum Ding Hou

Fig. 9.

(Latin, *filamentosus* = thread-like; the appendages of the seed aril)

l.c. (1967) 141, *l.c.* (1969) 103, *l.c.* (1972) 932. **Type:** *Ding Hou* 333, Sarawak (holotype L; isotypes BO, SAR).

Small tree to 10 m tall, 15 cm diameter. **Leaves** drying to greenish yellow, elliptic to oblong or oblanceolate, 10.5–29 x 4–10.5 cm; base cuneate, apex pointed; midrib flattened above; lateral veins 4–8 pairs, faintly raised on both surfaces; intercostal veins reticulate, faintly visible below; petioles 0.5–1.5 cm long. **Inflorescences** 1–2.5 cm long, unbranched, few-flowered, peduncles to 1.3 cm long, pedicels 1.5–2 cm long, articulated near base. **Flowers** pale orange, floral parts fleshy; calyx-lobes semi-orbicular, slightly toothed along the margin; petals suborbicular with distinct reticulate venation and light brownish stripes or dots; disc flat, slightly 5-angular; stamens reflexed at anthesis. **Fruits** narrow ellipsoid, 3-angled, 6–8.5 x 2–3.5 cm, gradually narrowed towards both ends. **Seeds** 6–8 in each cell, 2–2.5 x 0.5 cm; embryo narrow-lanceolate, *c.* 18 x 4 mm; cotyledons foliaceous, free.

Distribution. Endemic to Sarawak. Uncommon, known by the following few collections: *Ding Hou* 133, *S.* 24506, *S.* 24897 and *S.* 24898 from the Nyabau FR, Bintulu; *S.* 18685 from Bako National Park; *S.* 42715 from Sri Aman, and *S.* 51508 from Bayai, 2nd Div.

Ecology. In mixed dipterocarp forest on yellow sandy humult ultisol soils and in *kerangas* forest.

The genus has similar floral characters as that of *Salacia* and in fruit characters it has similarities with *Kokoona* and *Lophopetalum*.

10. SIPHONODON Griff.

(Greek, *siphonos* = tube, *odontos* = tooth;
the hollow, columnar, toothed upper part of the ovary)

Calc. J. Nat. Hist. 4 (1844) 246; Ding Hou, Blumea 12 (1963) 36, *l.c.* (1964) 394; Backer & Bakhuizen *f. l.c.* 561; Kochummen & Whitmore *l.c.* 171; Cockburn *l.c.* 62; Anderson *l.c.* 162; Ashton *l.c.* 112; Whitmore, Tantra & Sutisna *l.c.* 45. **Synonym:** *Capusia* Lecompte, Bull. Mus. Hist. Nat. Paris 32 (1926) 95.

Trees. **Leaves** *spiral* or *alternate*. **Inflorescences** axillary, cymose, sometimes only one-flowered. **Flowers** 5-merous; *calyx-lobes imbricate*; petals imbricate, larger than calyx-lobes; stamens 5, sometimes alternating with 5 staminodes, united at lower part, anthers latrorse, connective distinct and broad; ovary *semi-inferior*, 3-celled, *upper half hollow* and with a style-like column arising from the bottom, *ovules 1 in each cell*, oblique or pendulous. **Fruits** drupaceous, with numerous bony 1-seeded pyrenes. **Seeds** flat, with endosperm; cotyledons flat, free.

Distribution. 7 species; SE Asia through Malesia to Australia; one species in Sabah and Sarawak.

Siphonodon celastrineus Griff. (resembling *Celastrus*)

Fig. 10.

l.c. 247; Ding Hou *l.c.* (1964) 394; Backer & Bakhuizen *f. l.c.* 561; Kochummen & Whitmore *l.c.* 171; Cockburn *l.c.* 62; Anderson *l.c.* 162; Ashton *l.c.* 112; Whitmore, Tantra & Sutisna *l.c.* 45. **Type:** Griffith 9019, Penang (BO, K). **Synonyms:** *S. pyriformis* Merr. *l.c.* (1908) 240; *Xanthophyllum subglobosum* Elmer *l.c.* (1913) 1676.

Tree to 35 m tall, 70 cm diameter; buttresses to 2 m high. **Bark** usually grey-brown, smooth to scaly; inner bark yellowish. **Sapwood** pale. **Twigs** brownish, *zig-zag*. **Leaves** *drying greenish yellow*, lanceolate to elliptic or oblong, 8–15 x 3.5–7 cm; base cuneate, *margin toothed*, apex pointed; *midrib flattened above, yellowish below on drying*; lateral veins yellowish on drying; intercostal veins reticulate, distinct below, faint above; *petioles* 5–8 mm long, *drying yellowish*. **Flowers** cream-white; calyx-lobes almost rounded, 1–2 mm long; petals ovate with obtuse apex; stamens *c.* 1 mm long, filaments flat, united near base; ovary subglobose to conical, occasionally with 5 ridges towards the apex. **Fruits** subglobose to obovoid, 3–6.5 x 2–6 cm.

Distribution. India, Burma, Thailand, Indo-China, and Malesia. In Sabah, recorded from Lahad Datu, Ranau, Sandakan and Tawau. In Sarawak, collected from Belaga, Bau, Bt. Mersing, and Ulu Melinau.

Ecology. Mixed dipterocarp forests on fertile clay soils, especially near limestone and on basic volcanic rock. Uncommon. Fruiting in March–November.

This species can be confused with those of *Xanthophyllum* (Polygalaceae) but the toothed leaves at once distinguish this.

CHRYSOBALANACEAE

Ghilleen T. Prance

Royal Botanic Gardens, Kew, England

R. Brown in Tuckey, Narr. Exp. Congo (1818) 433; King, J. As. Soc. Beng. 66, 2 (1897) 275 (under Rosaceae); Ridley, FMP 1 (1922) 665 (under Rosaceae); Merrill, EB (1921) 287, PEB (1929) 92 (under Rosaceae); Masamune, EPB (1942) 324 (under Rosaceae); Backer & Backhuizen *f.*, FJ 1 (1964) 521 (under Rosaceae); Prance & Whitmore, TFM 2 (1973) 321 (under Rosaceae); Anderson, CLTS (1980) 292 (under Rosaceae); Cockburn, TS 2 (1980) 79 (under Rosaceae); Corner, WSTM 2 (1988) 615 (under Rosaceae); Prance & White, Phil. Trans. Roy. Soc. B. 320 (1988) 1; Prance, FM 10, 4 (1989) 635; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 298.

Trees or shrubs. **Leaves** simple, entire, alternate, often coriaceous. Stipules small and caducous to large and persistent. **Inflorescences** racemose, paniculate or cymose; flowers bracteate and usually 2-bracteolate. **Flowers** actinomorphic (with a regular symmetry) to zygomorphic (with an irregular symmetry), bisexual or unisexual (in *Parastemon*, plant sometimes polygamo-dioecious), markedly perigynous; receptacle short to elongate; disc always present, forming a lining to the receptacle; calyx-lobes 5, imbricate, often unequal, erect or reflexed; petals 5, imbricate, usually caducous; stamens variable, 2–60, inserted on the margin of the surface of the disc, or basally adnate to it, forming a complete circle or, in zygomorphic flowers, unilateral, all fertile or some without anthers and then often reduced to small staminodes; filaments filiform, free, connate at the base or ligulately connate, included to far exserted; anthers small, dorsifixed, longitudinally dehiscent; gynoecium (ovary) basically of three carpels and gynobasic (inferior), but usually with only one carpel fully developed, attached to the base, middle or mouth of the receptacle-tube, sessile or with a short gynophore (stalk), pubescent or villous; carpel unilocular with two ovules or bilocular with one ovule in each locule, style filiform, *arising from the receptacle at the base of the carpel*, stigma distinctly or indistinctly 3-lobed, *ovules erect, epitropous* (with micropyle directed towards the base), tenuinucellate (with thin nucellus). **Fruit** a dry or fleshy drupe; endocarp various, thick or thin, fibrous or bony, often with a special mechanism for seedling escape, often densely hairy inside. **Seeds** erect, almost without endosperm; cotyledons plano-convex, fleshy, sometimes ruminant.

Distribution. A pantropical family of 17 genera and 520 species, of which over 400 in the Neotropics, 60 in Africa and 39 in Asia and the Pacific. In Sabah and Sarawak, the family is represented by 6 genera and 15 species all of which are trees.

Ecology. Found mainly in lowlands both in swamp and well-drained forests, to 1500 m. The flowers are pollinated mainly by insects and in a few cases by bats, and the fruits are dispersed by birds, mammals and water.

Uses. The wood is extremely hard and difficult to cut due to the presence of silica; therefore it is resistant to decay and to marine borers and is used for posts and marine piles. The

wood of some species is used for general construction and firewood. The fruit of some species is edible. The fruit of *Atuna racemosa* subsp. *racemosa* is used as a putty for caulking boats and the oil from this species is used in the Pacific in hair dressings.

Taxonomy. Although the family Chrysobalanaceae was described by Robert Brown in 1818 (In: J.K. Tuckey, Narrative of an expedition to explore the River Zaire, Appendix 5: 433–434) it has been placed as a tribe or subfamily of Rosaceae in most of the older and widely used systems of classification such as those of Bentham and Hooker, Engler and Prantl and Hutchinson. This is in marked contrast to the opinions of nearly all workers with a detailed knowledge of the group, especially of its anatomy. The Chrysobalanaceae differs from the Rosaceae in the gynobasic style, the basal, erect ovules which are tenuinucellate, in the presence of abundant deposits of silica in the wood, stem and leaf and in many wood anatomical characters such as the large oblique vessels, the banded oblique vessels, the banded parenchyma which is composed of long strands. The authors of modern evolutionary systems such as Cronquist, Thorne and Takhtajan consider the Chrysobalanaceae to be a separate family but still placed in the Rosales. Dahlgren and Thorne (Ann. Missouri Bot. Gard. 71 (1984) 633–699) suggested a relationship between Chrysobalanaceae and Myrtales. Although the resemblances between Rosaceae and Chrysobalanaceae are superficial, the family is best left in the Rosales until further evidence such as molecular studies show that it should be placed elsewhere. Further details about the taxonomy of the group can be found in Prance and White's paper (*l.c.*).

Key to genera
(based on flowers)

1. Flowers actinomorphic with ovary inserted in centre of receptacle; stamens included...2
Flowers zygomorphic with ovary inserted laterally on receptacle; stamens exerted (except in *Parinari*).....3
2. Stamens 7–10, all fertile.....3. **Licania**
Stamens 5, all fertile or 2 fertile and 3 sterile.....5. **Parastemon**
3. Stamens 6–10, included. Leaves usually with stomatal crypts.....6. **Parinari**
Stamens 10–40, exerted. Leaves never with stomatal crypts.....4
4. Stamens united into a ligule. Ovary unilocular.....2. **Kostermanthus**
Stamens free to base. Ovary bilocular.....5
5. Stamens 10–20. Inflorescence a raceme or sparsely branched contracted panicle.....1. **Atuna**
Stamens 25–40. Inflorescence a many-flowered corymbose panicle.....4. **Maranthes**

Key to genera
(based on fruits)

1. Fruits dehiscent by two lateral plates.....2
Fruits indehiscent or dehiscent by two basal stoppers.....3

2. Fruits bilocular (sometimes only 1 locule developing), 3–4 cm long.....**4. Maranthes**
Fruits unilocular, usually 1–1.5 cm long (2.5–3 cm in *P. grandifructus*).....**5. Parastemon**
3. Fruits dehiscent by two basal stoppers; exocarp lenticellate. Leaves usually with stomatal crypts beneath.....**6. Parinari**
Fruits indehiscent or opening by longitudinal lines. Leaves without stomatal crypts.....4
4. Fruits 1–1.3 cm long, unilocular, breaking open by longitudinal lines of weakness; exocarp smooth.....**3. Licania**
Fruits 3–6 cm long, uni or bilocular, indehiscent; exocarp verrucose-crustaceous.....5
5. Fruits unilocular. Stamens united into a ligule.....**2. Kostermanthus**
Fruits bilocular. Stamens free.....**1. Atuna**

1. ATUNA Rafin.

(an Amboinese vernacular name)

merbatu (Malay)

Sylva Tellur. (1838) 153; Kostermans, Reinwardtia 7, 5 (1969) 421; Prance & Whitmore *l.c.* 323; Anderson *l.c.* 292; Cockburn *l.c.* 81; Prance *l.c.* (1989) 665; Whitmore, Tantra & Sutisna *l.c.* 298.

Synonyms: *Cyclandrophora* Hassk., Flora Beibl. 1 (1842) 47; *Parinari* subg. *Cyclandrophora* (Hassk.) Blume, Mélang. Bot. 2 (1855) 10; *Parinari auct. non Aubl.*, Ridley *l.c.* (1922) 666.

Small to large trees, *ultimate shoots with complicated system of divaricate branching*. Stipules large, prominently keeled, lateral, persistent or subsistent. **Leaves almost glabrous on both surfaces, often with minute papillae on venation giving beaded appearance, without stomatal crypts, with a pair of glands on midrib at or near base of lower surface; petioles eglandular. Inflorescence a raceme, or sparsely branched, contracted panicle; bracts and bracteoles persistent, eglandular, not enclosing groups of flower-buds. Flowers bisexual; receptacle obconical to cylindrical, as long as or exceeding calyx-lobes, hollow, hairy inside throughout, throat blocked by retrorse hairs; calyx-lobes 5, broadly ovate to lanceolate, tomentellous on both surfaces; petals 5, glabrous, exceeding calyx-lobes; stamens 10–20, posterior, inserted unilaterally on margin of disc, filaments free, exerted; staminodes forming a barely visible denticular margin to throat; ovary inserted at mouth of receptacle tube, pilose on exterior, carpel bilocular with 1 ovule in each loculus. Fruits large; epicarp glabrous, densely verrucose-crustaceous; mesocarp transversely fibrous; endocarp hard, thick, shortly and sparsely hairy inside, breaking up irregularly at germination; cotyledons large and strongly ruminant; germination cryptocotylar (with hidden cotyledon), eophylls alternate.**

Distribution. 8 species from Southern India throughout Malesia and to Fiji and Samoa in the Pacific. 3 species occur in Sabah and Sarawak.

Ecology. Usually found on well-drained mixed dipterocarp forest to 600 m.

Uses. Little used as a timber.

Key to *Atuna* species

1. Leaves broadly ovate, thickly coriaceous, cordate at base. Stamens *c.* 10... **1. *A. cordata***
 Leaves elliptic or oblong-lanceolate, chartaceous, rounded at base. Stamens 13–20.....2
2. Receptacle tube narrowly cylindrical. Leaves oblong-lanceolate. Stamens purple.....
 **2. *A. nannodes***
 Receptacle turbinate-campanulate. Leaves elliptic to oblong-ovate. Stamens white.....
 **3. *A. racemosa***

1. ***Atuna cordata*** Cockburn *ex* Prance
 (Latin, *cordatus* = heart-shaped; the leaf base)

Fig. 1.

Brittonia 39 (1987) 364; Cockburn *l.c.* 82; Prance *l.c.* (1989) 667. **Type:** *Ahmad Talip SAN 47687*, Sabah, Lahad Datu (holotype K; isotypes L, SAN).

Tree to 40 m tall, the trunk often with thick buttresses. **Bark** smooth, grey-green, mottled white; inner bark hard, reddish brown. **Sapwood** ochre to red-brown, hard. Young branches glabrescent, inconspicuously lenticellate. *Stipules to 1.7 cm long, very early caducous.* **Leaves** coriaceous, *broadly ovate*, 4.5–12 x 3–9.5 cm; *cordate at base*, abruptly acuminate at apex, the acumen 1–3 mm long; glabrous and shiny above, glabrous beneath; midrib prominulous above, prominent beneath; lateral veins 9–12 pairs, lightly prominulous above, prominulous and glabrous beneath; petioles 1–3 mm long, thick, glabrous. **Inflorescences** of terminal and subterminal racemes, 4–8 cm long, borne in single or more often in paired branches, densely tomentellous on exterior, puberulous within; bracts and bracteoles ovate, tomentellous, early caducous. **Flowers** with *receptacles 5–7 mm long, conical to campanulate*, tomentellous on exterior, sessile; calyx-lobes slightly unequal, tomentellous on both surfaces; petals *c.* 7 mm long, obovate, glabrous; stamens 10, inserted on one side of ring, the filaments 10–12 mm long; ovary densely pilose, style slender, hirsutulous on lower portion. **Fruits** *c.* 6 x 5 cm, ovoid; epicarp verrucose-crustaceous; mesocarp *c.* 5 mm thick, fibrous, hard; endocarp thin.

Distribution. Endemic to Sabah; recorded from Lahad Datu, Karamuak, Mt. Tawai and Mt. Silam.

Ecology. Confined to hills and locally common on ultramafic rock to 1200 m.

2. ***Atuna nannodes*** (Kosterm.) Kosterm.

(Greek, *nanno* = dwarf; the comparatively small size of the tree)

Reinwardtia 7, 5 (1969) 422; Prance & Whitmore *l.c.* 325; Prance *l.c.* (1989) 667. **Basionym:** *Parinari nannodes* Kosterm., Reinwardtia, 7, 1 (1965) 50. **Type:** *Beccari PB 2955*, Sarawak, Mt. Matang (BO, K). **Synonym:** *Cyclandrophora nannodes* (Kosterm.) Kosterm. & Prance, Candollea 20 (1965) 122.

Tree to 20 m, usually smaller, unbuttressed. **Bark** smooth, dark grey. Young branches sparsely appressed hirsutulous-strigose, soon glabrous, obscurely lenticellate. *Stipules narrowly lanceolate, acute, 6–12 mm long, strigose to glabrous, subsistent.* **Leaves** thinly coriaceous, *oblong-lanceolate*, 6.7–19 x 2.5–6 cm, glabrous on both surfaces, sometimes slightly

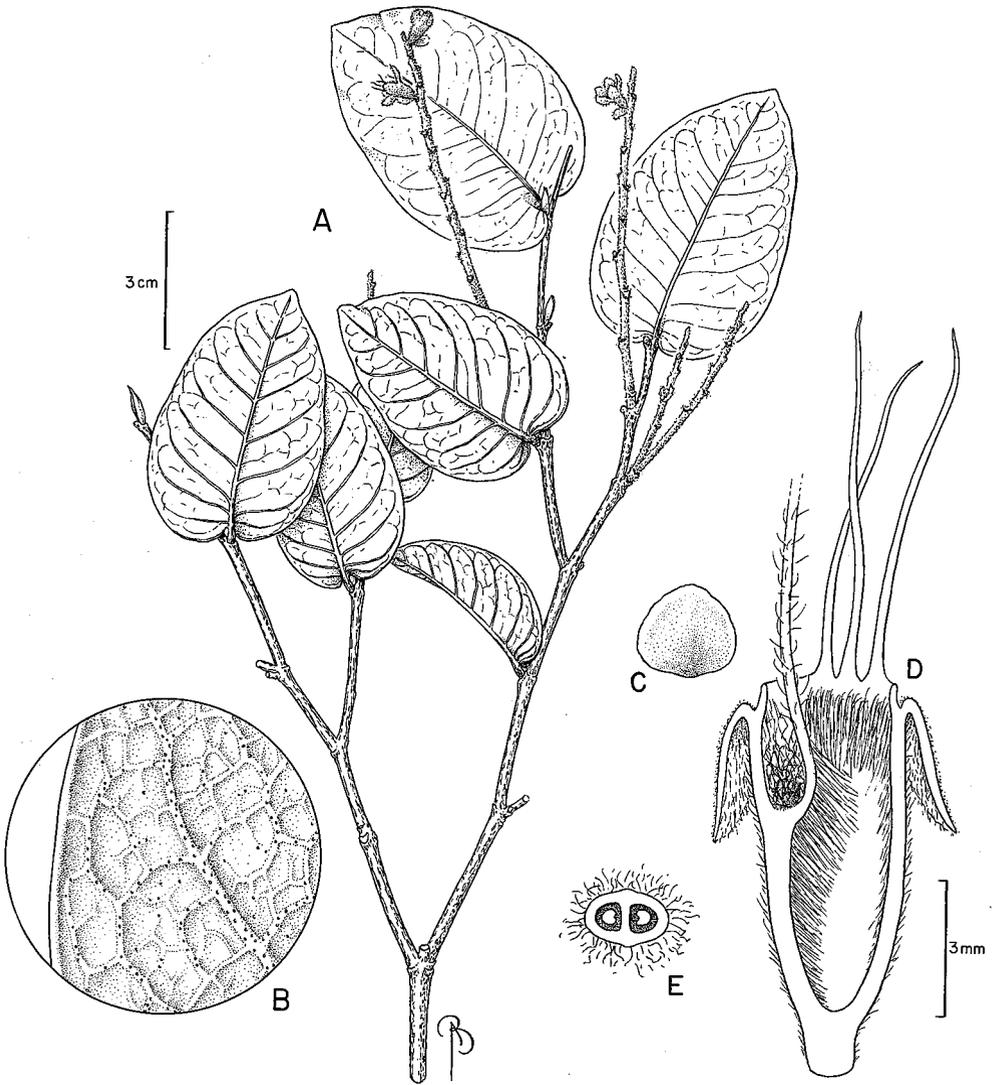


Fig. 1. *Atuna cordata*. A, flowering leafy twig; B, leaf lower surface; C, petal; D, flower in longitudinal section; E, ovary in cross section. (From SAN 47687.)

bullate above; rounded at base, long slender acuminate at apex, the acumen 7–22 mm long; midrib prominulous above, prominent beneath; lateral veins 10–12 pairs, arcuate, prominulous on both surfaces or sometimes prominent beneath; petioles 2–4 mm long, glabrescent, eglandular, the lower part swollen, usually curved. **Inflorescences** axillary racemes, 3–7 cm long, the rachis densely sericeous-tomentellous; bracts and bracteoles lanceolate, 3–7(–13) mm long, persistent, sericeous. **Flowers** with *cylindrical receptacle*, 8–13 mm long, *densely sericeous on exterior*, sessile; calyx-lobes to 6 mm long, unequal, acute, sericeous on exterior; petals white, spatulate to ovate, 8–12 mm long, narrowed to the base; *stamens 18–20, black to purple*, the filaments 10–15 mm long, slightly unilateral with tooth-like staminodes opposite; ovary pilose, style to 15 mm long, glabrous, stigma capitate. **Fruits** ellipsoid, 3–4 x 1.5 cm, slightly tapered to the base, crustaceous-verrucose on exterior; mesocarp 2–2.5 mm, fibrous, hard; endocarp thin.

Distribution. Peninsular Malaysia, Borneo (Sabah, Sarawak, Kalimantan). In Sabah known by collections from localities in the Sandakan, Semporna, Tawau and Tongod districts. In Sarawak, recorded from Bau and Kuching areas, 1st Div.

Ecology. Forest on well-drained soils to 500 m.

3. *Atuna racemosa* Rafin.

(Latin, *racemosus* = with a raceme-like inflorescence)

l.c. 153; Kostermans *l.c.* (1969) 422; Anderson *l.c.* 293; Cockburn *l.c.* 84; Prance *l.c.* (1989) 669.
Type: *Rumphius Herb. Amb. 1 (1741) pl. 66.*

Tree to 35 m tall often with short buttresses. **Bark** smooth, grey to black, mottled; inner bark orange-brown, red-brown to brown, hard. **Sapwood** white, ochre to red-brown; heartwood red-brown. Young branches glabrous, dark red-brown, smooth or obscurely lenticellate when dry. *Stipules lanceolate, stiff, to 8–20 mm long, acute, glabrous to strigose, sub-persistent.* **Leaves** usually chartaceous, more rarely stiffly coriaceous, broadly ovate, elliptic, ovate-oblong, oblong or even lanceolate, 4.5–25(–35) x 2–11 cm; rounded, subcordate or subcuneate at base, acuminate at apex, the acumen 3–25 mm long; glabrous on both surfaces when mature, sometimes sparsely strigose beneath on lower portion when young; midrib prominent on both surfaces; lateral veins 9–13 pairs, prominulous above, prominent beneath, straight or arcuate; the venation conspicuously papillose and often giving leaf a scabrous or beaded appearance; petioles slender or thick, 3–7 mm long, pilose or puberulous, glabrescent or glabrous. **Inflorescences** of axillary racemes or little-branched with 2–3 racemose branches on short main peduncle, 5–15 cm long, the rachis and branches tomentellous or densely short sericeous; bracts and bracteoles ovate to oblong, acute, 3–8 mm long, persistent or caducous. **Flowers** with *receptacle turbinate-campanulate*, 4–10 mm long, tomentose to sericeous on exterior; pedicels 0.5–1 mm long; calyx-lobes ovate to ovate-oblong, 4–7 mm long, densely tomentellous on both surfaces or sericeous on exterior, tomentellous within; petals equal, ovate-oblong, *c.* 10 mm long, blue or white, caducous; stamens 13–20, pale blue, 8–15 mm long with tooth-like staminodes opposite; ovary pilose to densely villous, style equalling filaments, glabrous above, stigma small. **Fruits** *ellipsoid, subglobose to slightly pyriform, 5–7.5 x 3.5–4.5 cm*; epicarp crustaceous-verrucose; mesocarp fibrous, 5–11 mm thick; endocarp thin, 1–3 mm, densely pilose within.

Key to subspecies

Leaves 10–25 (–35) cm long, usually elliptic, oblong or lanceolate but sometimes ovate, chartaceous or thickly coriaceous, the apex long finely acuminate, acumen 6–25 mm long; petioles thick. Flowers 10–17 mm long. Medium-sized to large tree often with fluted bole....

subsp. **racemosa**

Synonyms: *Cyclandrophora glaberrima* Hassk. *l.c.* 47; *Parinarium glaberrimum* (Hassk.) Hassk., *Tijd. Nat. Ges. Phys.* 10 (1843) 147, Merrill *l.c.* (1921) 290, *l.c.* (1929) 92, Masamune *l.c.* 321; *P. scabrum* Hassk. *l.c.* (1843) 147; *P. elatum* King *l.c.* 280; *C. elata* (King) Prance in Kosterm., *Candollea* 20 (1965) 122; *Atuna elata* (King) Kosterm. *l.c.* (1969) 421.

Thailand to Sumatra, Peninsular Malaysia, Singapore, Borneo (Sabah, Brunei, Sarawak), Philippines, Celebes, Moluccas, New Guinea, New Britain, and the Pacific (Admiralty, Caroline, Solomon Islands, Fiji, Samoa). In Sabah common and has been recorded in most districts. In Sarawak uncommon and collected only from Baram district, and known from ecological plots at Bt. Raya, Rejang, Bt. Iju, Balingian, and Bintulu. Found mainly in well-drained mixed dipterocarp forests, to 600 m, but also occurs on riverbanks and freshwater and brackish water swamps, can be very common.

Leaves 4.5–12 cm long, usually ovate or oblong-ovate, subcoriaceous or coriaceous, the apex bluntly acuminate, acumen 3–10 mm long; petioles thin. Flowers 8–11 mm long. Large trees with cylindrical bole.....

subsp. **excelsa** (Jack) Prance

l.c. (1989) 670. Basionym: *Petrocarya excelsa* Jack, *Mal. Misc.* 2 (7) (1822) 66. Type: *Kostermans & Anta 1136*, Bangka, Lobok Besar (neotype K; isoneotypes A, BO, L, SING).

Synonyms: *Parinarium asperulum* Miq., *Fl. Ind. Bat., Suppl.* (1861) 307; *Cyclandrophora asperula* (Miq.) Prance ex Kosterm., *Candollea* 20 (1965) 130; *Cyclandrophora excelsa* (Jack) Kosterm., *Candollea* 20 (1965) 128; *Atuna excelsa* (Jack) Kosterm. *l.c.* (1969) 422; *P. villamilii* Merr., *Philip. J. Sc.* 10 (1915) Bot. 308, Anderson *l.c.* 294; *C. villamilii* (Merr.) Prance ex Kosterm., *Candollea* 20 (1965) 126; *A. villamilii* (Merr.) Kosterm. *l.c.* (1969) 422.

Sumatra, Peninsular Malaysia, Java, Borneo (Sabah, Sarawak, Kalimantan), N Celebes. In Sabah known from Beaufort, Lahad Datu, Lamag, Sandakan and Tawau districts. In Sarawak has been recorded in Lundu, Kuching, Serian, Miri and Kapit districts. Usually occurring in well-drained mixed dipterocarp forest, to 750 m, on ridges and hillsides, uncommon.

Uses. The fruit (cotyledon) of subsp. *racemosa* is grated and made into a putty for caulking canoes, widely used in the Pacific islands. An oil extracted from the seeds is used variously in different areas, e.g., to scent coconut oil and for hairdressing. The leaves are used to thatch the outside walls of houses in Fiji. The wood is used locally for posts and poles but is not of good quality.

2. KOSTERMANTHUS Prance

(A.J.G.H. Kostermans, 1907–1994, botanist of the

Forest Research Institute and Herbarium Bogoriense, Bogor, Indonesia)

Brittonia 31 (1979) 91; Prance & Whitmore *l.c.* 327; Anderson *l.c.* 293; Cockburn *l.c.* 85; Prance *l.c.* (1989) 675; Whitmore, Tantra & Sutisna *l.c.* 299. **Synonyms:** *Acioa auct. non* Aubl., Kostermans, Reinwardtia 7, 1 (1965) 9; *Parinari auct. non* Aubl.: *quoad P. heteropetala et P. myriandra, tantum.*

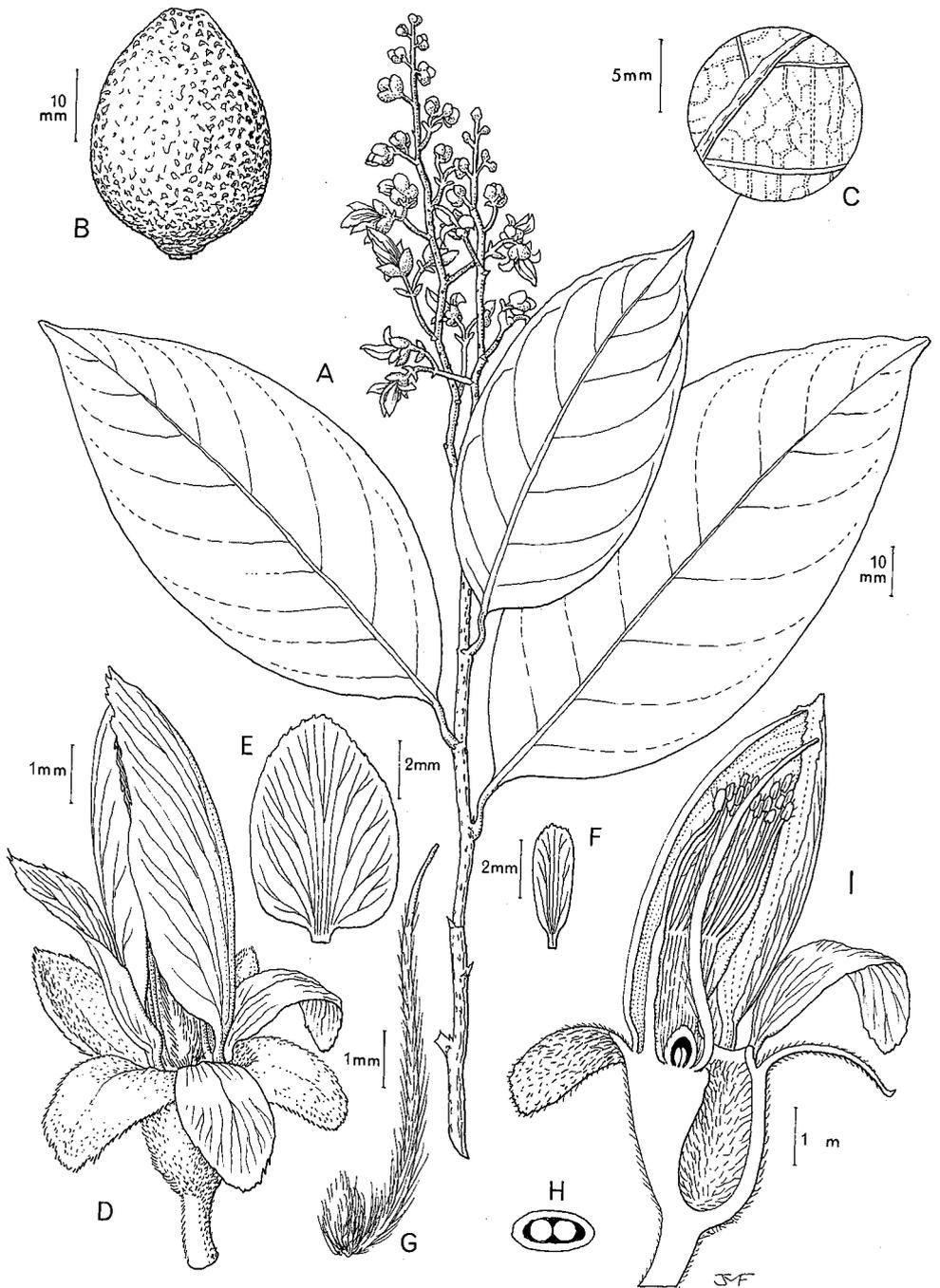


Fig. 2. *Kostermanthus heteropetalus*. A, flowering leafy twig; B, fruit; C, leaf lower surface; D, flower; E, large petal; F, small petal; G, ovary and style; H, ovary in cross section; I, flower in longitudinal section. (A & C from *Kostermans 13630*, B from *Elmer 21848*, D–I from *KEP 105046*.)

Large trees, ultimate shoots not divaricate. Stipules to 7 mm long, foliaceous, persistent, lanceolate to ovate. **Leaves** glabrous on both surfaces with *minute papillae on veins giving a beaded appearance*; petioles eglandular. **Inflorescence** an unbranched or little-branched terminal or axillary raceme with shortly stalked congested cymes proximally and singly inserted flowers distally; bracts and bracteoles small, suborbicular, persistent, eglandular, not enclosing groups of flower buds. **Flowers** bisexual, strongly zygomorphic; receptacle broadly obconic-campanulate, shorter than calyx-lobes, asymmetric, hollow, hairy on both surfaces, but throat not blocked by retrorse hairs; calyx-lobes 5, markedly unequal, suborbicular to ligulate, strongly imbricate; *petals 5, unequal in size and shape, the 2 posterior larger than the others, markedly unguulate and enclosing stamens in bud*; stamens 8–30, inserted unilaterally on margin of disc; *filaments united for half to three quarters of length into a strap*; staminodes 5–8, inserted opposite stamens; ovary inserted laterally at mouth of receptacle, unilocular with 2 ovules. **Fruits** large, hard; epicarp glabrous, crustaceous-verrucose; endocarp hard, thick, glabrous within, breaking irregularly on germination. *Cotyledons slightly ruminatae.*

Distribution. 2 species, one (*K. malayanus*) is confined to Peninsular Malaysia, the other (*K. heteropetalus*) is known from Sumatra, Borneo, the Philippines, and Celebes.

Kostermanthus heteropetalus (Scort. ex King) Prance
(Greek, *hetero* = uneven, *petalon* = petal; the unequal petals)

Fig. 2.

L.c. (1979) 91, *L.c.* (1989) 677; Anderson *L.c.* 293; Cockburn *L.c.* 85; Prance & White *L.c.* (1988) 152; Whitmore, Tantra & Sutisna *L.c.* 299. **Basionym:** *Parinari heteropetalum* Scort. ex King *L.c.* 283. **Type:** *Scortechini 2040*, Perak (BO, SING). **Synonyms:** *Parinarium myriandrum* Merr. *L.c.* (1929) 93; *Acioa heteropetala* (Scort. ex King) Kosterm., *Reinwardtia* 7, 1 (1965) 11.

Tree to 35 m tall, 2 m diameter, often with low small buttresses. **Bark** with small fissures and brittle flakes, grey-brown; inner bark pale red-brown to ochre. **Sapwood** pale yellow; heartwood red-brown with a wavy junction between it and sapwood. Young branches glabrous, lenticellate. Stipules 6–7 mm long, partly intrapetiolar, carinate, ovate, foliaceous, acute to acuminate, persistent to subsistent. **Leaves** coriaceous, usually elliptic-subovate to rarely lanceolate, 5–20 x 2.5–6 cm; cuneate to rounded at base, bluntly acuminate at apex; glabrous on both surfaces, *minutely papillose on venation of both surfaces giving a bead-like appearance*; midrib prominulous above, prominent beneath; lateral veins 6–10 pairs, arcuate, slender, prominent beneath; petioles 6–12 mm long, sometimes lightly alate from decurrent leaf margins, slightly flattened above, eglandular. **Inflorescences** little-branched, to 10 cm long, the rachis and branches lightly tomentellous; bracts and bracteoles ovate, acute, to 3 mm long, caducous. **Flowers** with a receptacle broadly campanulate, 2–3 mm long, tomentose on both surfaces; calyx-lobes fleshy, unequal, acute, to 7 mm long, pilose on both surfaces, reflexed in open flowers; *petals white-tinged pink, fleshy, elliptic, concave, largest up to 15 mm long, tomentellous on exterior, enveloping staminal ligule, the others much smaller to 6 mm long*; stamens 25–30 united into a unilateral ligule for two thirds of their length, to 12 mm long, glabrous; anthers pubescent; ovary densely pilose, style densely appressed pilose, stigma truncate. **Fruits** ovoid, unilocular, c. 4 x 3 cm; epicarp glabrous, crustaceous; endocarp hard, thick. *Cotyledons slightly ruminatae, c. 1.5 x 3 cm.*

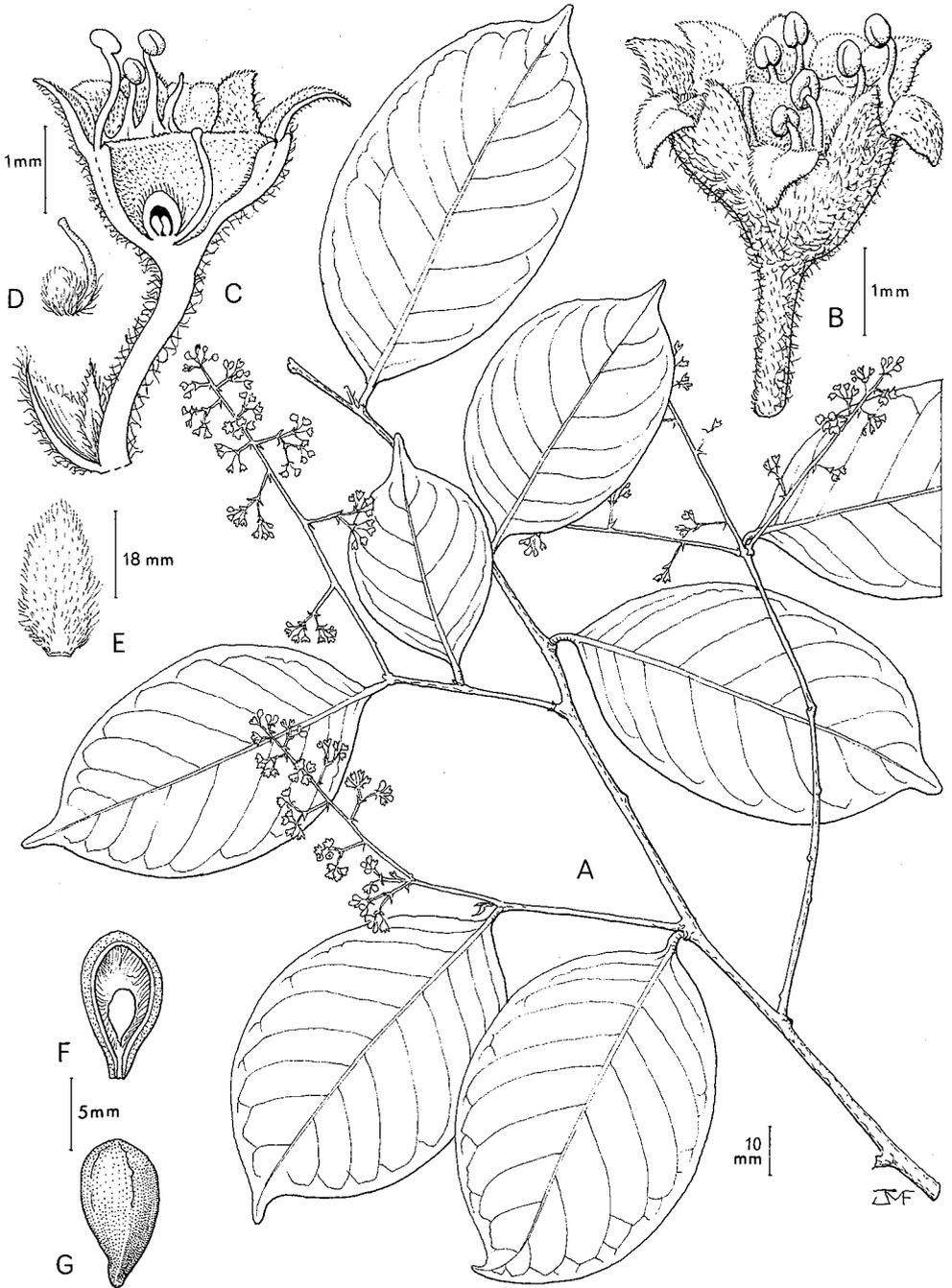


Fig. 3. *Licania splendens*. A, flowering leafy twig; B, flower; C, flower in longitudinal section; D, ovary and style; E, petal; F, fruit in longitudinal section; G, fruit. (A-E from *S. 14958*, F-G from *Kostermans 6353*.)

Vernacular names. Sabah and Sarawak—*merbatu*, *rasak batu* (Malay).

Distribution. Sumatra, Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei and Kalimantan), the Philippines (Mindanao), and Celebes. In Sabah found in Beaufort, Keningau, Kota Marudu, Mostyn, and Tongod districts in the west, and in Lahad Datu, Sandakan, and Tawau districts in the east. In Sarawak widespread.

Ecology. Mixed dipterocarp forest on sandy clay soils, to 500 m.

Uses. The fruit is eaten in Celebes and Sumatra. The timber is easy to cut and is red when freshly cut turning brown with age. It is little used because of its tendency to rot.

3. LICANIA Aubl.

(intended to be an anagram of the local name in French Guiana—*caligni*)

Hist. Pl. Guiane Fr. 1 (1775) 119; Prance & Whitmore *l.c.* 328; Anderson *l.c.* 293; Cockburn *l.c.* 86; Prance *l.c.* (1989) 645. **Synonym:** *Angelesia* Korth., Ned. Kruidk. Arch. 3 (1854) 384.

Small to large trees. Stipules small, free, caducous. **Leaves** glabrous on both surfaces, *without stomatal crypts*; petioles eglandular. **Inflorescence** a panicle of cymules; bracts and bracteoles to 1.5 mm long, membranous, eglandular, not enclosing groups of flower buds. **Flowers** bisexual; receptacle campanulate, slightly asymmetric, tomentose on exterior and interior; calyx-lobes 5, acute, unequal; petals 5, small, not exceeding the calyx-lobes, not clawed; *stamens 7–10, all fertile*, inserted on margin of disc; *filaments glabrous, included, slightly united at base*; *ovary inserted at or near base of receptacle*, pilose on exterior; carpel unilocular, with 2 ovules, style pubescent at base, the stigma capitate. **Fruit** a small, fleshy drupe, narrowed to a shortly stipitate base; *epicarp smooth, not ridged, glabrous, not lenticellate*; mesocarp thin, fleshy; endocarp thin, hard, bony, breaking up in longitudinal lines during germination, tomentose within.

Distribution. 200 species in Neotropics, 1 species in West Africa and 3 species in Thailand and Malesia (Sumatra, Java, Borneo, the Philippines, and Papua New Guinea). In Sabah and Sarawak only 1 species recorded.

Licania splendens (Korth.) Prance

Fig. 3.

(Latin, *splendens* = shining; the shiny surface of the dried leaves)

Fl. Neotropica 9 (1972) 172, *l.c.* (1989) 646; Prance & Whitmore *l.c.* 328; Anderson *l.c.* 293; Cockburn *l.c.* 86. **Basionym:** *Angelesia splendens* Korth. *l.c.* 384, Merrill *l.c.* (1921) 290, *l.c.* (1929) 92, Masamune *l.c.* 324. **Type:** *Korthals, s.n.*, Sumatra (L).

Tree to 25 m tall. **Bark** smooth to scaly, flaking by small scales when old; inner bark red-brown. **Sapwood** pink, hard. Young branches sparsely lanate, soon glabrous. Stipules linear-lanceolate, to 3 mm long, caducous. **Leaves** 4–11 × 1.8–4.2 cm, oblong; cuneate at

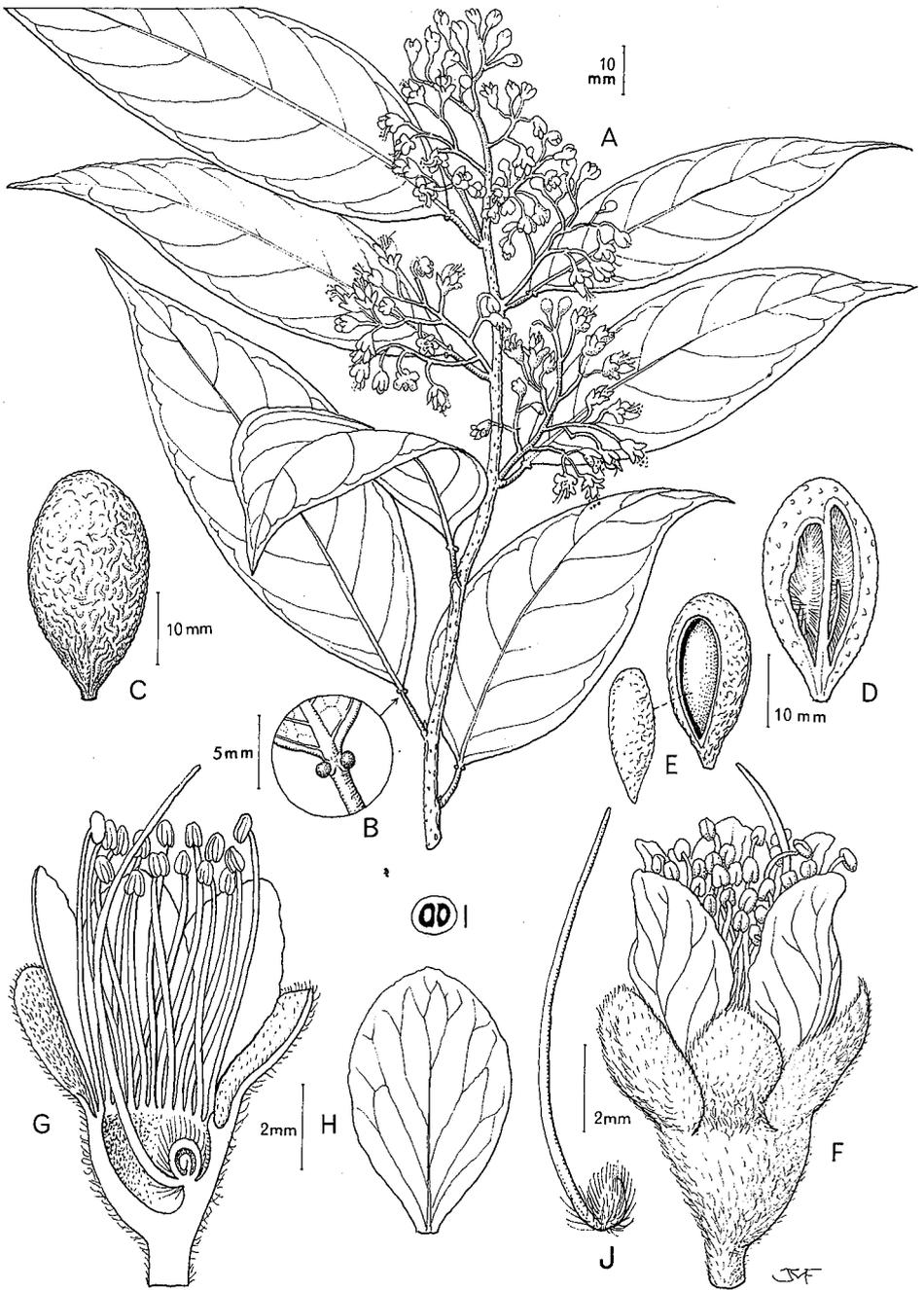


Fig. 4. *Maranthes corymbosa*. A, flowering leafy twig; B, leaf-base with glands; C, fruit; D, fruit in longitudinal section; E, fruit dehiscence; F, flower; G, flower in longitudinal section; H, petal; I, cross-section of ovary; J, ovary and style. (A-B and F-J from SAN A 1888, C-E from Podzorski SMHI 816.)

base, usually acuminate at apex; glabrous beneath; petioles 2–5 mm, canaliculate, glabrous when mature. **Inflorescences** terminal and axillary panicles of cymules, 1.5–14 cm long, the rachis and branches grey-puberulous. **Flowers** *c.* 2 mm long; receptacle campanulate, slightly swollen to one side, grey-tomentellous on exterior, tomentose within; pedicels *c.* 1 mm long; calyx-lobes acute, tomentellous on both surfaces; petals pubescent on exterior; stamens 7–10, slightly unilateral, the filaments glabrous; ovary at or near base of receptacle, unilocular, pilose on exterior. **Fruits** ellipsoid, 1–1.3 cm long; epicarp smooth, glabrous; mesocarp thin, fleshy; endocarp thin, hard, bony, breaking open by longitudinal lines of weakness, tomentose within.

Vernacular names. Sabah—*sampaluan*, *tampaluan* (Dusun).

Distribution. Thailand, Peninsular Malaysia, Java, Borneo (Sabah, Sarawak, Brunei, Kalimantan), the Philippines. In Sabah common, recorded in most districts. In Sarawak, known from Bintulu, Kuching, Lundu and Serian districts.

Ecology. Common tree of primary and secondary mixed dipterocarp forests in well-drained usually sandy soils on slopes and also in peat swamp and on seashores and in rocky places below 400 m.

Uses. The timber is strong, durable and resistant to marine borers and is used for saltwater piles, railroad ties, etc. However, it is extremely hard to work and requires special tools because of silica. The fruit is edible but is not widely used.

4. MARANTHES Blume

(Greek, *maraino* = to wither; the long-persistent withered calyx and stamens below the fruit)

Bijdr. (1825) 89; Kostermans, Candollea 20 (1965) 196; Prance, Bol. Soc. Brot. Ser. 2, 40 (1966) 183, *l.c.* (1989) 671; Prance & Whitmore *l.c.* 329; Anderson *l.c.* 293; Cockburn *l.c.* 88; Whitmore, Tantra & Sutisna *l.c.* 299. **Synonyms:** *Parinari auct. non* Aubl.; *Parinari* sect. *Sarcostegia* Benth. in Hooker, Niger Fl. (1849) 335, *pro parte*; *Parinari* subg. *Sarcostegia* (Benth.) Miq., Fl. Ind. Bat. 1, 1 (1855) 355, *pro parte*; *Parinari* subg. *Exitelia* Blume *l.c.* (1855) 10.

Medium-sized to large trees. Stipules deltate, intrapetiolar, stiff, caducous. **Leaves** glabrous on both surfaces when mature, with dense caducous cobweb-like indumentum when young, without stomatal crypts; *with paired glands at junction of lamina and petiole*; petioles eglandular. **Inflorescence** *a many-flowered corymbose panicle*; bracts and bracteoles eglandular, caducous, not enclosing flower buds in small group. **Flowers** bisexual; *receptacle* obconical, narrowed into pedicel, solid, *almost completely filled with nectariferous tissue*, short-tomentose to glabrous on exterior, glabrous within; calyx-lobes suborbicular, deeply concave, unequal; petals 5, not clawed; *stamens* 25–40, inserted on margin of disc, unilateral with tooth-like staminodes opposite to almost in a complete circle, filaments far exerted beyond calyx-lobes, in a tangled mass; ovary inserted laterally at mouth of receptacle, *carpel bilocular* with 1 ovule in each locule, style pubescent at base only, curved upwards, exerted. **Fruit** a large fleshy drupe; epicarp smooth, glabrous, not lenticellate; mesocarp fleshy; *endocarp very hard, fibrous with a rough exterior, densely tomentose*

within, with 2 lateral plates which break away on germination; germination phanero-cotylar (with exposed cotyledons); cotyledons fleshy, pale green; cataphylls absent; first 2 eophylls opposite, the others alternate or opposite.

Distribution. 10 species in tropical Africa, 1 in Central America, and 1 (*Maranthes corymbosa*) widespread in Malesia, Australia and the western Pacific.

Ecology. Lowland forest.

Uses. Wood hard and durable, used for posts and house building. Fruits of most species edible.

Maranthes corymbosa Blume

Fig. 4.

(Greek, *corymbos* = a cluster; the clustered inflorescences)

l.c. (1825) 89; Kostermans, *Candollea* 20 (1965) 107; Prance & Whitmore *l.c.* 330; Anderson *l.c.* 295; Cockburn *l.c.* 88; Prance & White *l.c.* 127; Prance *l.c.* (1989) 673; Whitmore, Tantra & Sutisna *l.c.* 299. **Type:** Blume, *s.n.*, Java, Prov. Krawang, near Tjiradja (L). **Synonyms:** *Parinarium corymbosum* (Blume) Miq. *l.c.* (1855) 356, Merrill *l.c.* (1921) 290, Masamune *l.c.* 325; *Exitelia corymbosa* (Blume) Blume, *Fl. Jav.* 1, Praef. (1828) 7; *Parinarium griffithianum* Benth. in Hooker *l.c.* (1849) 334.

Tree to 30 m tall, 1.5 m diameter, unbuttressed. **Bark** smooth, grey-brown, lenticellate, often mottled with patches of lichen; inner bark red, thin. **Sapwood** pale white to pink; heartwood red-brown. Young branches red-brown, minutely white-lenticellate, glabrous. Stipules lanceolate, acute, 5–10 mm long, sparsely pilose on exterior, glabrous within, early deciduous. **Leaves** coriaceous, usually oblong-lanceolate to oblong-elliptic, 6.5–14 x 2.5–8 cm; cuneate at base, acuminate at apex, the acumen 8–20 (–30) mm long; glabrous when mature but often sparsely caducous arachnoid-lanate when young, usually with 2 conspicuous prominent glands at junction of petiole and decurrent lower surface; lateral veins 7–10 pairs, arcuate, prominulous on both surfaces; midrib plane above, prominulous beneath; petioles 4–9 mm long, glabrous when mature, flattened above. **Inflorescences** of flattened many-flowered corymbose panicles; rachis and branches sparsely pilose, glabrescent; bracts and bracteoles ovate to lanceolate, sparsely pubescent, caducous. **Flowers** with receptacle turbinate, tapering into pedicels, 2–4 mm long, grey-tomentose to glabrous on exterior, glabrous within; calyx-lobes fleshy, ovate to elliptic, obtuse, 2.5–4 mm long, unequal; petals white-tinged pink, glabrous, 3–6 mm long, caducous; stamens 25–35, inserted in several rows on one side of throat, with tooth-like staminodes opposite; ovary densely lanate and villous; stigma truncate. **Fruits** ellipsoid, 3–4 x 1.5–2 cm, tapered towards base; epicarp thin, glabrous on exterior when mature, sometimes lanate when young; endocarp c. 5 mm thick, densely lanate within, bilocular usually with seed in one locule only. Cotyledons plano-convex.

Vernacular names. Sabah—*bangkawang* (Dusun, Malay). Sarawak—*merbatu* (Malay).

Distribution. S Thailand extending east to Solomon and Caroline Islands and Australia. In Malesia: Sumatra, Peninsular Malaysia, Java, Borneo (Sabah, Sarawak, Brunei, Kalimantan),

the Philippines, Celebes, Moluccas, New Guinea, New Britain and Admiralty Islands. In Sabah, widespread but in Sarawak, uncommon in mixed dipterocarp forest in the northern parts.

Ecology. In primary and secondary forests from the sea-coast to 1500 m on Mt. Kinabalu, Sabah. The fruit is eaten by many birds which probably disperse the seed and account for the wide distribution of this species.

Uses. The wood is used for house building and for posts and the fruit is edible.

5. PARASTEMON A. DC.

(Greek, *para* = near, *stemon* = stamen; both fertile and sterile stamens are located near one another at one side of the flower)

Ann. Sci. Nat. Bot. Ser. 2, 18 (1842) 28; Miquel *l.c.* (1855) 359; Merrill *l.c.* (1921) 290; Ridley *l.c.* (1922) 672; Corner *l.c.* 617; Masamune *l.c.* 324; Anderson *l.c.* 293; Cockburn *l.c.* 90; Prance *l.c.* (1989) 648; Whitmore, Tantra & Sutisna *l.c.* 299. **Synonyms:** *Diemenia* Korth. *l.c.* (1854) 388; *Trichocarya* Miq. *l.c.* (1855) 537, *pro parte*.

Trees or shrubs. Stipules small and triangular, caducous. **Leaves** glabrous on both surfaces, without stomatal crypts, with 2 small discoid glands at base of lamina; petioles eglandular. **Inflorescences** axillary or rarely terminal simple or sparsely branched racemes; bracts and bracteoles small, eglandular, not enclosing groups of flower buds. **Flowers** bisexual or unisexual; *receptacle* patelliform or shallowly cupuliform, shortly hairy within; calyx-lobes 5, acute, subequal; petals 5, not exceeding calyx-lobes, not clawed; *stamens* either 5 and all fertile or 2 fertile with 3 staminodes, the filaments glabrous, shorter than the calyx-lobes; ovary centrally inserted at base of receptacle, glabrous or densely hairy on exterior, *carpel* unilocular, with 2 ovules, style filiform, puberulous towards the base, with 3 large undivided lobes at apex or 1 obscure lobe and 2 large, sometimes deeply divided lobes. **Fruit** a drupe, 1.5–3 cm long, with 2 large lateral plates which break away on germination to allow seedling escape; epicarp smooth, not lenticellate; *endocarp* thin, hard, bony, smooth on exterior, glabrous within.

Distribution. 3 species in the Nicobar Islands, Sumatra, Peninsular Malaysia, Borneo, Moluccas, New Guinea, and Admiralty Islands. 2 species in Sabah and Sarawak.

Ecology. Lowland and swamp forests.

Key to *Parastemon* species

Leaves with 5–6 pairs of lateral veins. Fruit 2.3–3.5 cm long.....1. ***P. grandifructus***

Leaves with 8–11 pairs of lateral veins. Fruit 1–1.5 cm long.....2. ***P. urophyllus***

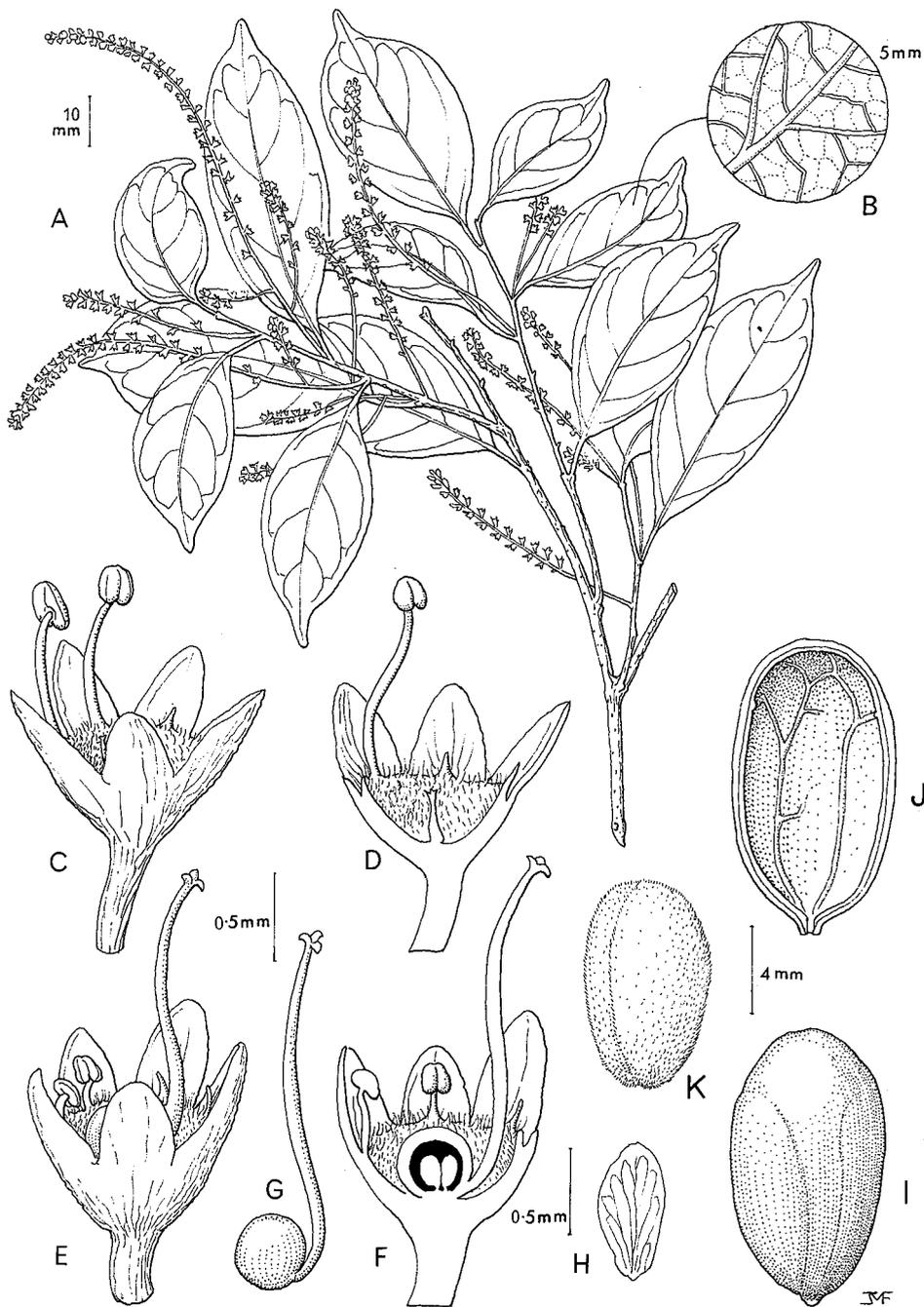


Fig. 5. *Parastemon urophyllus*. A, flowering leafy twig; B, leaf lower surface; C, male flower; D, male flower in section; E, female flower; F, female flower in section; G, ovary and style; H, petal; I fruit showing plate of dehiscence; J, interior of fruit; K, cotyledons. (A-B and E-H from Anderson S. 9803, C-D from Carrick et al. JC/42, I-K from SAN 67203.)

1. *Parastemon grandifructus* Prance

(Latin, *grandis* = large, *fructus* = fruit)

Brittonia 39 (1987) 366, *l.c.* (1989) 650. **Type:** *Wright & Ismawi S. 32320*, Sarawak (L).

Tree to 30 m tall, 30 cm diameter; trunk lightly buttressed to 1 m high. Young branches glabrous. Stipules caducous. **Leaves** coriaceous, glabrous on both surfaces, elliptic to narrowly elliptic-oblong, 5–8.5 x 1.8–3.2 cm; cuneate at base, with a long-cuspidate acumen at apex, the tip 10–16 mm long; midrib prominent above, prominulous or plane beneath; lateral veins 5–6 pairs, prominulous above, plane beneath; petioles 5–8 mm long, glabrous, slightly canaliculate, slightly swollen at base. **Inflorescences** of axillary and terminal racemes, the rachis glabrous. **Flowers** (seen in fruiting specimens): calyx-lobes 5, acute, glabrous on exterior, glabrous within except for a few hairs around base; receptacle glabrous on exterior in fruiting condition; style persistent below fruits, the stigma bifid or trifid. **Fruit** ellipsoid, 2.3–3.5 x 1.3–1.5 cm; epicarp smooth, glabrous; mesocarp thin, *c.* 0.25 mm; endocarp thin, hard, bony, *c.* 0.25 mm thick, glabrous within, opening by 2 lateral plates 1.9–2 cm long.

Vernacular names. Sabah—*kayu ajung*, *mandailas* (Dusun). Sarawak—*ngilas* (Iban, in common with *Xanthophyllum*).

Distribution. Endemic to Borneo (Sabah and Sarawak). In Sabah known from Beaufort Hill and Lumat Estate in the Beaufort district. In Sarawak found in Bau, Kapit, Kuching and Limbang districts.

Ecology. Lowland forests, including swamp and heath forests, to 150 m.

2. *Parastemon urophyllus* (Wall. ex A. DC.) A. DC.

Fig. 5.

(Greek, *aura* = tail, *phyllon* = leaf; the cuspidate apex of the leaf)

l.c. 208; Miquel *l.c.* (1855) 359; Merrill *l.c.* (1921) 290; Ridley *l.c.* (1922) 672; Corner *l.c.* 617; Masamune *l.c.* 324; Browne, FTSB (1955) 308; Anderson *l.c.* 293; Cockburn *l.c.* 90; Prance & Whitmore *l.c.* 331; Prance *l.c.* (1989) 649; Whitmore, Tantra & Sutisna *l.c.* 300. **Basionym:** *Embelia urophylla* Wall. ex A. DC., Trans. Linn. Soc. Lond. 17 (1837) 131. **Type:** *Griffith, s.n.*, Malacca (K). **Synonym:** *Parastemon spicatum* Ridl., J. Str. Br. R. As. Soc. 75 (1917) 29, Merrill *l.c.* (1921) 290, Masamune *l.c.* 324.

Tree to 35 m tall often with small buttresses. **Bark** brownish, smooth, becoming slightly cracked and fissured with age. Young branches glabrous, waxy resinous when young. Stipules triangular, *c.* 1 mm long, caducous. **Leaves** thinly coriaceous, narrowly oblong, 2.5–8 x 1.4–2.5 cm; cuneate at base, *cuspidate-acuminate at apex, the tip 5–15 mm*; midrib plane above, prominulous beneath; lateral veins 8–11 pairs; petioles 4–5 mm long, canaliculate, glabrous. **Inflorescences** of axillary and rarely terminal racemes or occasionally slightly branched, 4–14 cm long, the rachis glabrous. **Flowers** unisexual (*plant polygamodioecious*), *c.* 1.5 mm long; *receptacle broadly cupuliform to flattened saucer-shaped*, glabrous on exterior, tomentose within; pedicels to 2 mm long; calyx-lobes acute, glabrous on exterior; petals 5; *stamens 2-fertile and 3 sterile staminodes opposite; ovary inserted at*

base of receptacle, pilose on exterior, unilocular, style pilose at base, glabrous above, the stigma trifold. **Fruits** *ellipsoid*, 1–1.5 cm long; epicarp smooth, glabrous; mesocarp thin, hard; endocarp thin, hard, bony, glabrous within, *opening by 2 lateral plates*.

Vernacular names. Sabah—*mendailas* (Dusun). Sarawak—*mengilas*, *gilas* (Bidayuh).

Distribution. Nicobar Islands, Sumatra, Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei, Kalimantan). In Sabah found in Beaufort, Keningau, Papar and Sipitang districts in the west, and in Lahad Datu and Sandakan districts in the east. In Sarawak widespread and recorded in most districts.

Ecology. Characteristic component of peat swamp forest where it is a common large tree, but also wide-ranging into *kerangas*, more open scrub forest, and secondary forest on poor soils.

Uses. The wood is hard and very heavy; grain straight or interlocked. It is used for general construction, posts and as a firewood.

6. PARINARI Aubl.

(a vernacular name in French Guiana)

merbatu (Malay)

l.c. 204; Merrill *l.c.* (1921) 290, *l.c.* (1929) 92; Masamune *l.c.* 325; Backer & Bakhuizen *f. l.c.* 521; Kostermans, *Reinwardtia* 7, 1 (1965) 147; Prance & Whitmore *l.c.* 332; Anderson *l.c.* 294; Cockburn *l.c.* 90; Prance *l.c.* (1989) 654; Whitmore, Tantra & Sutisna *l.c.* 300. **Synonym:** *Parinarium* Juss., Gen. Pl. (1789) 342; *Petrocarya* Schreb. in Linnaeus, Gen. Pl. ed. 8, 1 (1789) 245; *Parinarium* subg. *Petrocarya* (Schreb.) Miq. *l.c.* (1855) 352.

Small or large trees or rarely shrubs. Stipules small to large, persistent or caducous. **Leaves** usually with stomatal crypts, filled with pubescence on lower surface or rarely glabrous, or lanate pubescent without crypts; *petioles* usually with 2 circular glands above. **Inflorescence** a many-flowered complex cyme or cymose panicle; *bracts* and *bracteoles* eglandular, usually concealing flower buds individually and in small groups. **Flowers** bisexual; *receptacle* subcampulate to cupuliform, slightly swollen to one side, tomentose on both surfaces; calyx-lobes 5, deltate, acute, densely hairy on both surfaces; petals 5, as long as or shorter than sepals, caducous; *stamens* 6–10, unilateral, the filaments glabrous, included, with c. 6 minute staminodes opposite; ovary inserted on upper half of receptacle-tube below mouth, pilose on exterior, carpel bilocular with 1 ovule in each locule, style arcuate, included. **Fruit** a fleshy drupe; epicarp verrucose; endocarp thick, with a rough fibrous surface, with 2 basal obturators for seedling escape.

Distribution. Pantropical with 18 species in the Neotropics, 6 in Africa and 15 in tropical Asia, Malesia and the Pacific. 7 species in Sabah and Sarawak.

Ecology. A wide range of lowland forest and one species in submontane forest.

Uses. The wood is hard and heavy and is little used, the fruits of most species are edible.

Key to *Parinari* species

1. Stomatal crypts absent from leaf underside; leaf underside glabrous or with a persistent lanate pubescence and then with large persistent stipules 7–20 mm.....2
Stomatal crypts present on leaf underside; leaf underside lanate or at least pubescent in crypts; stipules usually small or if larger then early caducous.....4
2. Leaf underside glabrous; stipules small and caducous.....3
Leaf underside densely lanate pubescent, but when removed no stomatal crypts present; stipules large and persistent, 7–18 mm long.....4. **P. elmeri**
3. Leaves elliptic to oblong or obovate-elliptic, 9.5–20.5 x 4.5–8.5 cm; lateral veins 11–16 pairs. Panicles large and silvery pubescent.....1. **P. argenteo-sericea**
Leaves ovate, 5–9 x 2–4.5 cm; lateral veins 7–11 pairs. Panicles small and subsericeous brown pubescent.....2. **P. canarioides**
4. Leaves with 20–33 pairs of lateral veins.....6. **P. oblongifolia**
Leaves with 10–19 pairs of lateral veins.....5
5. Petioles 14–20 mm long. Leaves with metallic sheen above.....5. **P. metallica**
Petioles 3–10 mm long. Leaves without a metallic sheen.....6
6. Leaves rigidly coriaceous, often broadest well below middle point; midrib and often lateral veins lightly impressed on upper surface. Receptacle *c.* 5 mm. Fruits ovoid, 7–8 cm long.....7. **P. rigida**
Leaves chartaceous, broadest at or above middle; midrib and lateral veins prominent above. Receptacle 3–3.5 mm. Fruits ellipsoid, 3.5–4.5 cm long.....3. **P. costata**

1. *Parinari argenteo-sericea* Kosterm.

(Latin, *argenteus* = silvery, *sericeus* = silky; the pubescence of the flowers and inflorescence)

Reinwardtia 7, 1 (1965) 47, 158; Cockburn *l.c.* 91; Prance *l.c.* (1989) 656; Whitmore, Tantra & Sutisna *l.c.* 300. **Type:** *Wood SAN 16175*, British North Borneo, Lahad Datu (holotype BO; isotypes A, BRI, K, KEP, L, SING).

Tree to 35 m tall. **Bark** brown, lenticellate, hard; inner bark red, hard, *c.* 1.2 mm thick. **Sapwood** yellow. Young branches glabrous, dark purplish brown, with numerous lenticels. Stipules lanceolate, to 8 mm long, tomentose on exterior, early caducous. **Leaves** chartaceous, oblong, elliptic to subovate-elliptic, 9.5–10.5 x 4.5–8.5 cm, *glabrous on both surfaces, without stomatal crypts beneath, usually 2 glands beneath at base near junction with midrib*; rounded at base, acute to shortly acuminate at apex, the tip 7–10 mm long; midrib lightly impressed above except near base, prominent beneath; lateral veins 11–16 pairs, plane above, prominent beneath, erect-patent; petioles 5–9 mm long, eglandular, glabrous, rugulose. **Inflorescence** a lax, much-branched, terminal panicle, 9–15 cm long, the rachis and branches densely grey sericeous-tomentose; bracts and bracteoles ovate, acute, densely tomentellous on exterior, glabrous within except near apex, caducous. **Flowers** with

receptacle campanulate, markedly gibbous, densely grey-tomentellous on exterior, 2–3 mm long, narrowly ovate, densely grey-tomentose on exterior, tomentellous within; petals spathulate, *c.* 2 mm long, caducous; fertile stamens 7–8, base forming a conspicuous fused ring with opposite tooth-like staminodes; ovary densely pilose, style pilose, stigma truncate. **Fruits** ovoid, 7–8 x 4.5–5.5 cm; epicarp densely lenticellate; mesocarp thin, fleshy; endocarp extremely hard and thick (1–8 cm thick), woody, granular, and very irregularly ridged, with 2 small locules in centre, densely lanate within.

Distribution. Endemic to Sabah, known from a few collections from the Lahad Datu, Sandakan, and Tawau districts.

Ecology. Lowland forest to 100 m and forest along rivers.

2. *Parinari canarioides* Kosterm.

(resembling the genus *Canarium*)

New & Crit. Mal. Pl. (For. Dept. Bur. of Planning Bogor, Indonesia) 3 (1955) 25; Reinwardtia 7, 2 (1965) 159; Anderson *l.c.* 294; Cockburn *l.c.* 93; Prance *l.c.* (1989) 656; Whitmore, Tantra & Sutisna *l.c.* 300. **Type:** *Kostermans 7152*, Kalimantan, Tanjung Bangko (holotype BO; isotypes A, BISH, BRI, CAL, CANB, K, L, LAE, MEL, NY, P, PNH, SAN, SING).

Tree to 60 m tall, trunk often buttressed to 1.5–2.5 m. **Bark** smooth, irregularly fissured and flaking, dark red-brown; inner bark pale red-brown. **Sapwood** dull yellow to pink; heartwood brownish red. Young branches sparsely puberulous soon becoming glabrous, grey-brown. Stipules linear, acute to 5 mm, hirsute, early caducous, present on very young leaves only. **Leaves** chartaceous, ovate, 5–9 x 2–4.3 cm, glabrous on both surfaces when mature, without stomatal crypts beneath; rounded to subcordate at base, acuminate at apex, the tip 5–12 mm long; midrib lightly impressed above, prominent beneath, sparsely pubescent when young; lateral veins 7–11 pairs, plane to prominulous above, prominent beneath, arcuate; petioles 3–7 mm, glabrous when mature, eglandular or with small rather inconspicuous central glands. **Inflorescences** dense-flowered axillary panicles to 4.5 cm long, the rachis and branches tomentose; bracts and bracteoles persistent, ovate, puberulous on exterior, caducous. **Flowers** with receptacle campanulate, *c.* 3 mm long, tomentose on exterior; pedicels 1–2 mm long; calyx-lobes elliptic, concave, *c.* 2 mm, acute, sparsely puberulous on exterior, densely tomentellous on interior; petals elliptic, obtuse, *c.* 2 mm, tapered to the base; fertile stamens 7–8. **Fruits** ellipsoid, 3.5–5 x 1.5–2.5 cm; epicarp densely to sparsely lenticellate; mesocarp fleshy, *c.* 1 mm thick; endocarp *c.* 5 mm thick, hard, marbled, densely lanate within.

Distribution. Sumatra, Borneo (Sabah, Sarawak, Brunei, Kalimantan), the Philippines (Palawan), and Celebes. In Sabah found in Kunak and Sandakan districts; widespread but scattered in Sarawak and Brunei.

Ecology. Primary and secondary mixed dipterocarp forests on well-drained clay-rich soils to 800 m.

Uses. Fruit edible.

3. *Parinari costata* (Kunth) Blume

(Latin; *costatus* = ribbed; the strongly veined leaf)

l.c. (1855) 10; Miquel *l.c.* (1855) 354; Merrill *l.c.* (1921) 290; Ridley *l.c.* (1922) 666; Masamune *l.c.* 325; Kostermans, Reinwardtia 7, 2 (1965) 179; Prance & Whitmore *l.c.* 333; Anderson *l.c.* 294; Prance *l.c.* (1989) 663; Whitmore, Tantra & Sutisna *l.c.* 300. **Basionym:** *Lepidocarpa costata* Korth. *l.c.* 387. **Type:** *Korthals, s.n.*, Sumatra (L).

Tree to 60 m tall, 90 cm diameter; trunk buttressed up to 2 m. **Bark** smooth to roughish, cracked, grey or brown, *c.* 0.5 mm; inner bark pale reddish to reddish brown with pale spots, 6–10 mm thick. **Wood** pale brown, darker towards centre. Young branches densely yellow-brown, appressed tomentellous becoming glabrous, with numerous small conspicuous lenticels. Stipules lanceolate, membranous, 3–7 mm long, pilose on exterior, early caducous. **Leaves** rigidly chartaceous, elliptic, subovate-elliptic, oblong-elliptic to oblong-lanceolate, 4–11.5 x 1.6–4.3 cm, glabrous above when mature but with sparse lanate covering when very young, *with stomatal crypts filled with grey lanate pubescence beneath*; rounded to subcuneate at base; acuminate at apex, the tip 3–5 mm long; midrib prominulous above, tomentellous towards base, prominent beneath; *lateral veins 10–19 pairs, arcuate, prominulous above, prominent beneath*; intercostal veins rounded or only slightly flattened; *petioles* 4–9 mm long, slender, thickly tomentose or tomentellous when young, soon glabrous, usually *eglandular or with 2 inconspicuous median glands*. **Inflorescences** of predominantly axillary or terminal few-flowered lax or dense panicles to 8 cm long, *the rachis and branches grey to brown appressed tomentellous or ferruginous-villous pubescent*; bracts and bracteoles lanceolate, *c.* 2 mm long, caducous. **Flowers** with receptacle campanulate, slightly gibbous, grey-brown pubescent on exterior, 3–3.5 mm long; pedicels 0.5–1 mm long; calyx-lobes ovate, acute, 1.5–2 mm long, grey tomentellous on exterior; petals white, spathulate, 1.5–2 mm long, caducous, glabrous; stamens 7–8, with small tooth-like staminodes opposite, slightly unequal; style glabrous, stigma capitate. **Fruits** ellipsoid, to 3.5 x 4.5 cm; *epicarp* usually sparsely verrucose or *lenticellate*; mesocarp *c.* 2 mm, fleshy; endocarp hard, marbled, 3–5 mm thick, fibrous, densely lanate within.

Key to subspecies

Inflorescences and flowers sparsely to densely grey or brown appressed pubescent. Lowland plants.....

subsp. *costata*

Sumatra, Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei, Kalimantan). Mixed dipterocarp forests on well-drained soils, to 300 m. In Sabah and Sarawak uncommon.

Inflorescences and flowers densely ferruginous-villous pubescent. Usually at high altitudes

subsp. *rubiginosa* (Ridl.) Prance

Brittonia 39 (1987) 368, *l.c.* (1989) 663. Basionym: *Parinarium costatum* var. *rubiginosum* Ridl. *l.c.* (1915) 143; *Parinarium rubiginosum* (Ridl.) Ridl. *l.c.* (1917) 29, *l.c.* (1922) 668. Type: *Ridley 16016*, Malaya, Padang (holotype K; isotype SING). Synonym: *Parinari bicolor* Merr., Philip. J. Sc. 10 (1915) Bot. 309.

Burma, Peninsular Malaysia, Borneo (Sabah, Sarawak, Kalimantan). Submontane forests at 750–1000 m. Uncommon; in Sabah known from Mt. Kinabalu (*Clemens*

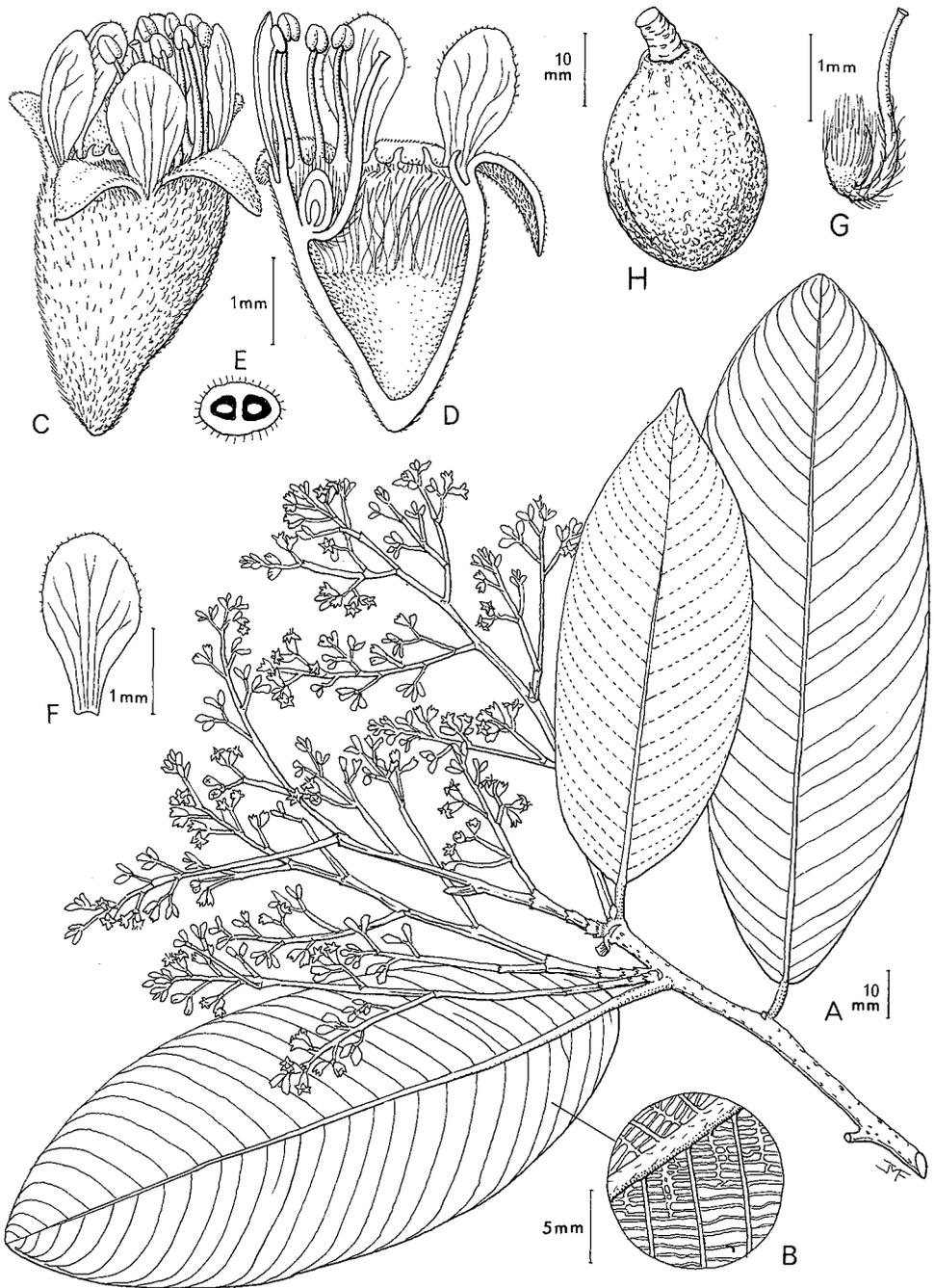


Fig. 6. *Parinari oblongifolia*. A, flowering leafy twig; B, leaf lower surface; C, flower; D, longitudinal section of flower; E, cross-section of ovary; F, petal; G, ovary and style; H, fruit. (A–G from Enggoh 7249, H from SAN 69261.)

50081), Sandakan district (*Puasa 669*), and in Sarawak from Similajau and Segan FR, Bintulu, 4th Div.

Distribution. Burma, Sumatra, Peninsular Malaysia, Borneo (Sabah, Sarawak and Kalimantan), and the Philippines.

Ecology. Mixed dipterocarp to submontane forests on well-drained soils at 300–1000 m.

Taxonomy. Three subspecies are recognised, two of which occur in Sabah and Sarawak (as above), and a third in the Philippines.

4. *Parinari elmeri* Merr.

(A.D.E. Elmer, plant collector with the Bureau of Science, Manila, the Philippines)

l.c. (1929) 92; Masamune *l.c.* 325; Kostermans, *Reinwardtia* 7, 2 (1965) 161; Prance & Whitmore *l.c.* 335; Anderson *l.c.* 294; Cockburn *l.c.* 91; Prance *l.c.* (1989) 657; Whitmore, Tantra & Sutisna *l.c.* 300. **Type:** *Elmer 20806*, British North Borneo, Tawao, Elphinstone Province (holotype UC; isotypes BISH, BO, BR, C, DC, DS, F, GH, L, M, MO, P, S).

Tree to 30 m usually much smaller; trunk unbuttressed. **Bark** pale cream or grey and white mottled, roughened by green excrescences, soft, thin; inner bark orange, hard, *c.* 2.5 mm thick. **Sapwood** white, thin; heartwood straw coloured, hard. Young branches densely tomentellous soon becoming glabrous, obscurely lenticellate. *Stipules lanceolate, acute, to 18 mm long and 3 mm broad at base, lateral, tomentellous, persistent.* **Leaves** oblong to oblong-lanceolate, 5–18 x 1.5–7 cm, chartaceous to thinly coriaceous, glabrous above, *densely pubescent beneath, without stomatal crypts*; subcuneate at base, acuminate at apex, the tip 5–13 mm long; *midrib plane or slightly impressed* and pubescent above when young, prominent beneath; lateral veins 14–21 pairs, prominent beneath, curved at margin; *intercostal veins more or less parallel forming ladder-like reticulation*; petioles 1.5–6 mm long, tomentellous, glandular, *but glands often obscured.* **Inflorescences** of raceme-like reduced terminal and axillary panicles or cymules, 1.7–3 cm long, the rachis and branches densely brown-tomentose; bracts and bracteoles large, *c.* 2 mm long, ovate, persistent. **Flowers** with receptacle conical, gibbous, to 3 mm long, brown-lanate on exterior, pedicels 0.5–2 mm long; calyx-lobes ovate, acute, 2–3 mm long, lanate on exterior; petals white, oblong-ovate, 2–3 mm long, narrowed to the base; fertile stamens 7–9, with tooth-like staminodes opposite. **Fruits** oblong-ellipsoid, *c.* 6.7 x 3.7 cm; epicarp sparingly lenticellate.

Distribution. Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei, Kalimantan), and the Philippines. Uncommon; in Sabah known from the type collection and from Kelumpang Hill, Lahad Datu district (*SAN 29329*), and Tawau district. In Sarawak only two collections from G. Silantek, 85th mile, Simanggang Rd., 2nd Div. (*S. 42636*) and Mt. Matang (*Clemens s.n.*) are known, but has been recorded from ecological plots at Bt. Mersing, Anap, and Nyabau FR.

Ecology. Mixed dipterocarp forests on well-drained soils to 900 m, including areas on ultramafic rock.

Uses. The wood is used for supports of Iban long houses.

5. *Parinari metallica* Kosterm.

(Latin, *metallicus* = metal-like; the metallic sheen on the upper surface of dried leaves)

Reinwardtia 7, 1 (1965) 49, 160; Cockburn *l.c.* 91; Prance *l.c.* (1989) 660. **Type:** Ashton BRUN 3267, Brunei, Andulau FR (holotype SAR; isotypes BO, K, L).

Tree to 20 m tall, unbuttressed. Young branches *appressed strigose* soon becoming glabrous, conspicuously lenticellate. Stipules ovate-lanceolate, acute, 8–15 mm long, densely brown-tomentose, membranous, early caducous. **Leaves** *thickly coriaceous*, elliptic, 8–17 x 4–9 cm, glabrous and *shiny with metallic sheen above when dry*, with dense stomatal crypts filled with hairs; rounded or subcuneate at base, apex rounded to shortly blunt-acuminate, the tip to 3 mm long; midrib plane above, prominent beneath; lateral veins 10–15 pairs, prominulous to plane above, prominent beneath, erect, curved only at margin; *petioles 14–20 mm long*, glabrescent, with inconspicuous glands near to lamina base, puberulous, glabrescent. **Inflorescences** of axillary little-branched panicles, 4–10 cm long, the rachis and branches densely brown tomentellous; bracts and bracteoles ovate, early caducous. **Flowers** with receptacle campanulate, slightly gibbous, 2–3 mm long, ferruginous, pubescent on exterior; pedicels *c.* 0.5 mm long; calyx-lobes lanceolate, acute, *c.* 1 mm long, tomentellous; petals lanceolate, glabrous; stamens *c.* 8 with short tooth-like staminodes opposite; ovary densely pilose, style glabrous, equalling stamens, stigma truncate. Fruits not seen.

Distribution. Endemic to Borneo (Sabah, Sarawak, Brunei). In Sabah found in Beaufort Hill FR, and in Sarawak in Semengoh Arboretum, Kuching, 1st Div., and Lambir Hills, Miri district, 4th Div.

Ecology. Mixed dipterocarp forests on deep sandy humult ultisol soils, to 300 m.

6. *Parinari oblongifolia* Hook. f.

Fig. 6.

(Latin, *oblongus* = rather long, *folius* = leaves; the leaf-shape)

l.c. 309; Ridley *l.c.* (1922) 335; Anderson *l.c.* 294; Cockburn *l.c.* 93; Prance *l.c.* (1989) 659; Whitmore, Tantra & Sutisna *l.c.* 301. **Type:** Griffith, *s.n.*, Malacca (K). **Synonyms:** *Parinarium borneense* Merr. *l.c.* (1929) 93, Masamune *l.c.* 325; *Parinari gigantea* Kosterm., Reinwardtia 7, 2 (1965) 182; Prance *l.c.* (1989) 660; **syn. nov.**

Tree to 40 m tall, trunk with low thick buttresses to 2 m. **Bark** smooth, grey to pale brown, very thin; inner bark reddish brown to brown, 6–12 mm thick. **Sapwood** white to pale yellow; heartwood reddish, hard. Young branches minutely tomentellous, with numerous pale, small, roundish lenticels. Stipules ovate to lanceolate, acute, 3–5 mm, pilose on exterior, early caducous. **Leaves** coriaceous, elliptic to *oblong*, 14–23 x 4–9 cm, glabrous above, *with stomatal crypts, filled with grey lanate pubescence beneath*; rounded to subcordate at base, shortly acuminate at apex, the tip 3–13 mm long; midrib plane above, glabrous when mature except at base, prominent, glabrescent beneath; *lateral veins 23–35 pairs, erect*, plane above, flattened and prominent beneath; intercostal veins prominulous, parallel and more or less ladder-like beneath; *petioles 9–17 mm long, thick-tomentellous when young, glabrescent, eglandular or glandular.* **Inflorescences** of large, spreading

terminal panicles, 10–21 cm long, 7–12 cm broad, the rachis and branches yellow-grey tomentellous; bracts and bracteoles ovate, c. 3 mm long, early caducous. Flowers with receptacle campanulate, slightly gibbous, c. 3 mm long, densely grey-tomentose on exterior; pedicels 1–3 mm long; calyx-lobes ovate, acute, 1.5–2 mm long, unequal, grey-tomentose; petals white to bluish, lanceolate to spatulate; narrowed towards the base, c. 2 mm long, glabrous; stamens 7–10, with tooth-like staminodes opposite; ovary pilose, style glabrous, stigma truncate. Fruits ellipsoid, 5–9 x 3–4 cm; epicarp densely lenticellate; mesocarp 1.5–2 mm thick; endocarp hard, marbled, 7–13 mm thick, fibrous, densely lanate within.

Distribution. Sumatra, Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei, Kalimantan). In Sabah found in Lahad Datu, Sandakan, Semporna, and Tawau districts; in Sarawak only recorded from sterile ecological collections from Santubong to Miri.

Ecology. Lowland rainforest, on river banks or in valleys, to 450 m.

7. *Parinari rigida* Kosterm.

(Latin, *rigidus* = stiff, the thick coriaceous leaves)

Reinwardtia 7, 1 (1965) 53, 163; Prance *l.c.* 660. **Type:** *Sinclair & Kiah SFN 40773*, Malay Peninsula, Trengganu (SING). **Synonym:** *Parinari ashtonii* Kosterm., Reinwardtia 7, 1 (1965) 53, Anderson *l.c.* 294.

Tree to 30 m tall. **Bark** smooth. Young branches tomentellous soon becoming glabrous, obscurely lenticellate. Stipules caducous (not seen). **Leaves** rigidly coriaceous, elliptic to oblong-ovate, 7.5–23 x 3–8 cm, those near to inflorescence much smaller than others, broadest below mid point, glabrous and shiny above, sometimes slightly bullate, *the lower surface with stomatal crypts filled with pubescence, with 2 glandular areas at junction of midrib and petiole below*; rounded or subcordate at base, shortly and broadly acuminate at apex, the tip 3–17 mm long; midrib plane or impressed for upper portion above, prominent and appressed pilose beneath when young; *lateral veins 13–20 pairs, slightly impressed above, prominent beneath, slightly curved at margins only*; intercostal venation flattened or rounded, parallel; *petioles thick, 3–10 mm long, grey-pilose pubescent, rugose, with 2 small glands on mid-point of upper side*. **Inflorescences** of narrow terminal panicles to 13 cm long, the rachis and branches tomentose; bracts and bracteoles lanceolate, to 2 mm long, early caducous. **Flowers** with receptacle campanulate, slightly gibbous, *c. 5 mm long, densely villous-tomentose on exterior*; pedicels *c. 1 mm long*; calyx-lobes elongate triangular, 2–2.5 mm long; petals spatulate; stamens 6–8; ovary densely villous, style equalling stamens, stigma capitate. **Fruits** irregularly ellipsoid, *c. 5 x 4 cm, tapered towards the base almost into a stipe*; epicarp densely lenticellate; mesocarp thin, fleshy; endocarp thick, woody, marbled, lanate within.

Distribution. Sumatra, Peninsular Malaysia, Borneo (known only from Lundu, Kuching and Miri districts in Sarawak).

Ecology. Heath and swamp forests, lowlands to 1400 m.



CLETHRACEAE

A. Berhaman

Forest Research Centre,
Sabah Forestry Department,
Sandakan, Malaysia

Merrill, EB (1921) 460; Masamune, EPB (1942) 567; Sleumer, FM 1, 7 (1971) 139; Whitmore, TFM 2 (1973) 27; Anderson, CLTS (1980) 162; Whitmore, Tantra & Sutisna, CLK 1 (1989) 45.

A small monogeneric family in the Ericales of about 65 species distributed in the temperate, tropical American and Asiatic-Malesian regions.

CLETHRA Gronov. *ex* L.

(Latinised old Greek word — *klethra* = alder tree)

kolintuhan (Dusun Ranau, Sabah)

Gen. Pl. ed. 5 (1753) 188, Sp. Pl. (1753) 396; Merrill *l.c.* (1921) 460; Masamune *l.c.* 567; Sleumer, Bot. Jahrb. 87 (1967) 85, *l.c.* (1971) 139; Whitmore *l.c.* 27; Anderson *l.c.* 162; Whitmore, Tantra & Sutisna *l.c.* 45.

Trees or shrubs. **Leaves** simple, spiral, crowded towards the end of the shoots; margin serrate with glandular teeth, more rarely entire; lateral veins and midrib sunken on upper side, prominent on the lower side; stipules none. **Inflorescence** a solitary terminal raceme, or (usually) a terminal raceme and several lower approximate racemes, from the axils of reduced or caducous leaves; bracts mostly caducous during anthesis, rarely subpersistent. **Flowers** bisexual; calyx-lobes 5(-6), persistent, alternate with the petals; petals 5(-6), generally free; stamens 10(-12) in 2 whorls of 5(-6), filaments adnate to the corolla at base, anthers dorsifixed, opening by apical valves; ovary superior, 3-celled, with axile placentation; ovules many, small, anatropous; style simple, projecting out of the flower, sometimes divided into three apical lobes, each lobe stigmatic at the top. **Fruit** a capsule, 3-loculed, enclosed by the persistent calyx. **Seeds** many, small; endosperm fleshy; embryo cylindrical.

Taxonomy. A monograph of the genus has been published by Sleumer *l.c.* (1967). There are 10 species recorded for South East Asia. Only 3 species occur in Sabah and Sarawak; they are closely related species differing mainly in the details of their hair and flower size.

Key to species

1. Leaf lower surface with stellate hairs only on the midrib and veins, glabrous on the intervenium. Calyx-lobes 1.5-2 mm long.....1. *C. canescens*

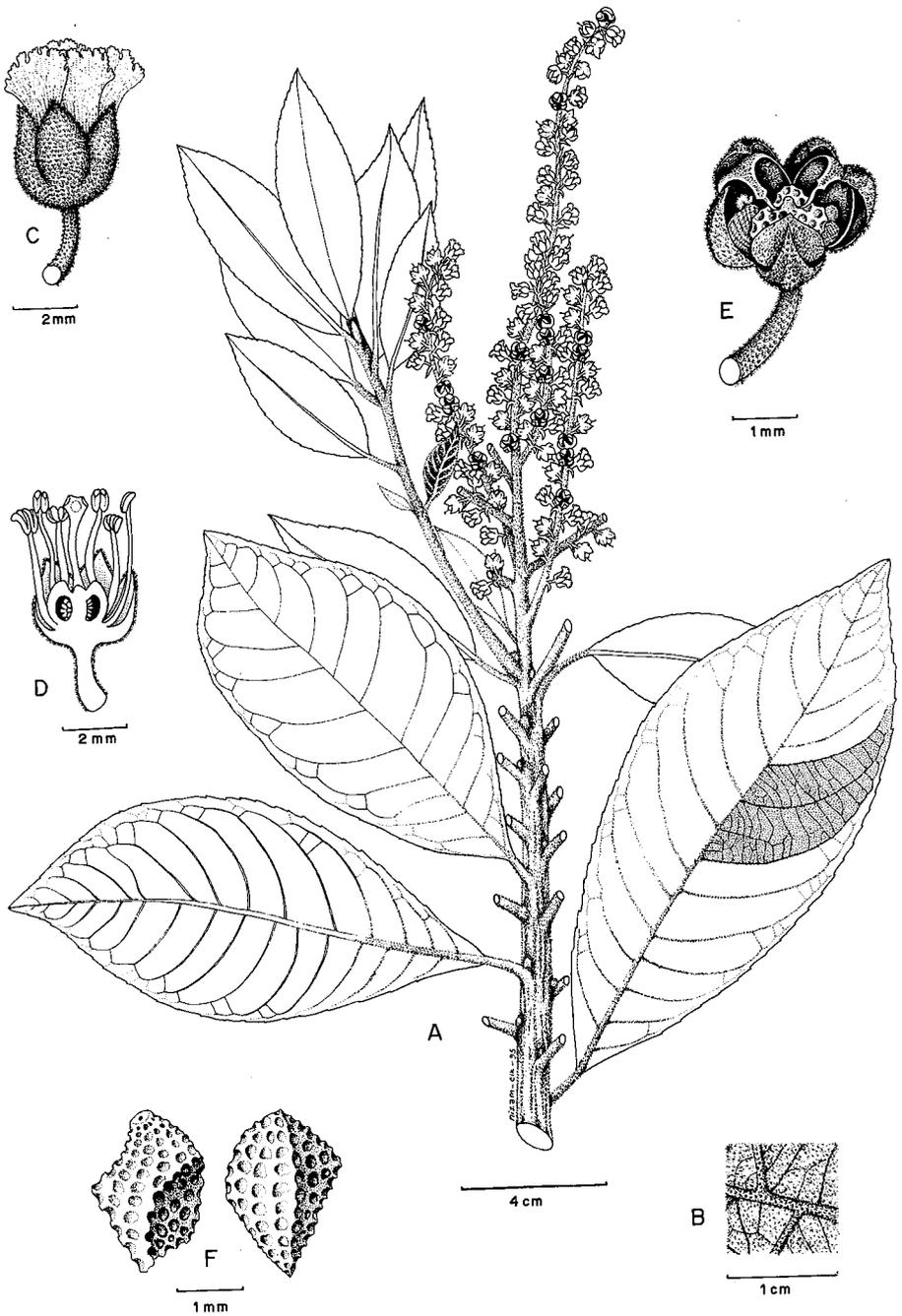


Fig. 1. *Clethra pachyphylla*. A, fruiting leafy twig; B, detail of lower leaf surface; C, flower; D longitudinal section through flower; E, fruit; F, seeds. (All from SAN 65004 except C & D, from Nootboom & Chai 2267.)

- Leaf lower surface with stellate hairs on the midrib and veins, and a fine pale tomentum covering the entire surface of the intervenium. Calyx-lobes 2 mm or longer..... 2
2. Raceme slender (1–1.5 mm thick), axis covered by a mixture of large and tiny stellate hairs (the hairs shorter than 0.5 mm). Calyx-lobes 2–3 mm long..... 2. **C. longispicata**
 Raceme more robust (1.5–2 mm thick), axis covered by a mixture of tufts of long hairs (typically 0.5–1 mm long) and tiny stellate hairs. Calyx-lobes 3–4 mm long.....
 3. **C. pachyphylla**

1. *Clethra canescens* Reinw. ex Blume

(Latin, *canescens* = turning grey; the pubescent leaves)

Bijdr. (1826) 863; Sleumer *l.c.* (1967) 85, *l.c.* (1971) 145; Anderson *l.c.* 162; Whitmore, Tantra & Sutisna *l.c.* 46. **Type:** *Reinwardt, s.n.*, 1821, Celebes, Minahasa, Mt. Klabat (L).

var. **clementis** (Merr.) Sleumer

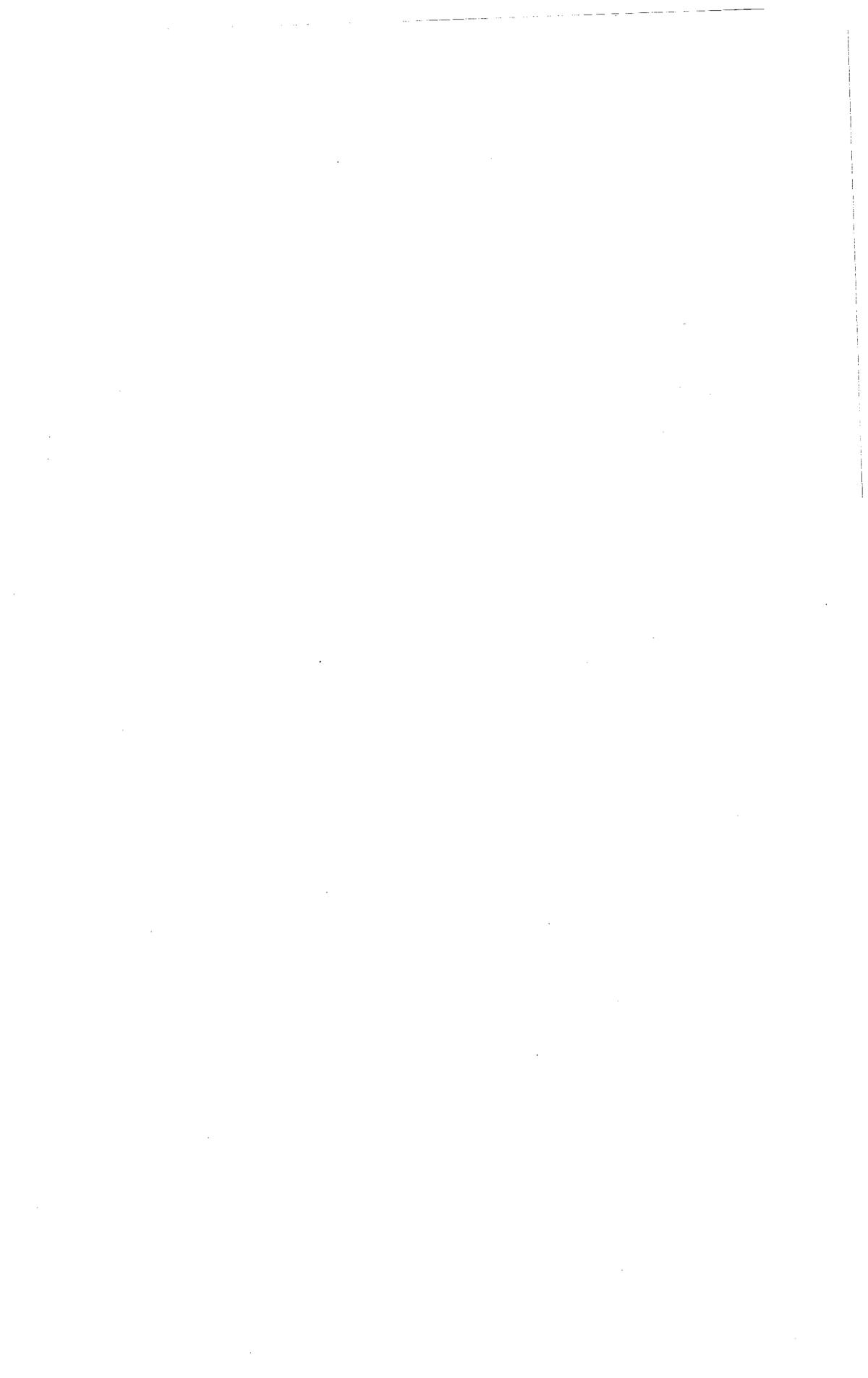
l.c. (1967) 86, *l.c.* (1971) 145. **Basionym:** *Clethra clementis* Merr., Philip. J. Sc. Bot. 13 (1918) 104, *l.c.* (1921) 460; Masamune *l.c.* 567; Anderson *l.c.* 162. **Type:** *Clemens 11148*, British North Borneo, Mt. Kinabalu (PNH, destroyed). **Synonym:** *Clethra canescens* (*non* Reinw. ex Blume) Stapf, Trans. Linn. Soc. Bot. 42 (1914) 105.

Small tree to 10 m. **Bark** smooth, pale brown; inner bark pale yellow. **Sapwood** yellowish. **Leaves** chartaceous to thinly coriaceous, upper surface smooth and shiny, lower surface with stellate hairs only on the midrib and veins, glabrous on the intervenium, oblong to elliptic-obovate, 3–13(–15) x 1–3(–5.5) cm; base cuneate, apex acute to acuminate pointed; lateral veins 10–14 pairs, looping towards the margin; midrib sunken on upper side, glabrous to sparsely covered with stellate hairs and rusty tomentum on lower side; stalk 1–1.5(–2.2) cm long, glabrous to sparsely stellate-hairy. **Inflorescence** axis slender, 1–2 mm thick, covered with a fine rusty tomentum of both smaller and larger stellate or fascicled hairs, flowers densely arranged along the rachis; bracts subulate, hairy, c. 5 mm long. **Flowers** white, scented; calyx-lobes 1.5–2 mm, covered with stellate and fascicled hairs; petals white, spatulate, glabrous, fimbriate, 4–5 mm long; filaments glabrous, 3–3.5 mm long; anthers obovate, 0.5–0.8 mm long; ovary densely covered with straight hairs; style glabrous, 2.5–3.7 mm long. **Fruit** subglobose, 2–3 mm diameter. **Seed** irregularly ovoid-angular, 0.6–1 mm across.

Distribution. Endemic to Borneo (Sabah, Sarawak and Kalimantan). In Sabah, var. *clementis* is locally common on Mt. Kinabalu; in Sarawak it has been recorded from Mt. Dulit (*Richards 1772 & 1804*) and the Baram River (*Haviland 1828*).

Ecology. In montane forest, rarely in lowland forest.

Taxonomy. Sleumer (1967 & 1971) recognises 5 varieties, viz. var. *canescens*, *clementis*, *ledermannii*, *luzonica*, and *novoguineensis*, of which only var. *clementis* occurs in Sabah and Sarawak.



CONNARACEAE

Lesmy Tipot

Forest Research Institute Malaysia,
Kepong, Malaysia

Hooker *f.*, Fl. Brit. Ind. 2 (1879) 46; King, J. As. Soc. Beng. 66, 2 (1897) 1; Ridley, FMP 1 (1922) 544; Merrill, EB (1921) 291, PEB (1929) 94; Masamune, EPB (1942) 328; Leenhouts, FM 1, 5 (1958) 495; Kochummen, TFM 3 (1978) 47; Keng, OFMSP (1978) 211; Anderson, CLST (1980) 163; Ashton, MNDTS 2 (1988) 223; Whitmore, Tantra & Sutisna, CLK 1 (1989) 49.

Mostly woody climbers or shrubs, rarely small trees. **Leaves** alternate or spirally arranged, *without stipules*, *pinnate with terminal leaflet (imparipinnate)*, rarely unifoliolate; *base of petioles and petiolules swollen*; *leaflets not always opposite, pinnately veined or 3-veined, base often slightly peltate*. **Inflorescences** paniculate, axillary or terminal, rarely on branches. **Flowers** 4–5-merous, bisexual or unisexual; sepals free or joined at base; petals free; stamens free or joined at base, in two whorls, inner (epipetalous) rudimentary; ovary superior, usually 5-carpellate (in *Connarus* and *Ellipanthus* only 1-carpellate), ovules 2 in each carpel, orthotropous or anatropous, placentation basal or axillar. **Fruits** follicular, smooth, finely striate, or warty, reddish, stalked, with persistent calyx, splitting ventrally or dorsally, rarely circumscise at the base or indehiscent. **Seeds** one per carpel, with an arillode or sarcotesta, with or without endosperm; cotyledons thick, flat.

Distribution. A pantropical family with 16 genera and *c.* 300–350 species, predominantly African. In Sabah and Sarawak, represented by 6 genera with at least 27 species.

Ecology. Frequent in open areas, forest fringes and river banks in lowland rain forests.

Taxonomy. The Connaraceae was placed under the Dilleniales by Hutchinson (Fam. Fl. Pl. 1, ed. 2 (1959) 329). Keng (*l.c.*), however, included the Connaraceae in the Rosales, considered a more primitive order than the Dilleniales. The Connaraceae was once thought to be the link between the Rosales and Leguminosae but many recent workers believed an affinity to the Sapindaceae is more natural. Some species of the Connaraceae are often confused with those of Leguminosae, especially *Derris*. However, the absence of stipules in the former distinguishes them from the latter.

Uses. Generally of no commercial value. Only the wood of *Ellipanthus* species is sometimes used locally for house posts and bridges. Some species are said to have medicinal properties. For instance, the roots of *Agelaea macrophylla* or *akar malam*, when boiled together with roots of *tapang* (*Koompassia malaccensis*), are used traditionally to treat weakness in infants, while young leaves of *Rourea mimosoides* are used for treating wounds and boils.

Key to genera

1. Trees or treelets.....2
 Woody climbers or shrubs.....3

2. Leaves trifoliolate or pinnate..... **1. Connarus** (in part)
 Leaves unifoliolate..... **2. Ellipanthus**

3. Leaves trifoliolate, upper surface of leaflets with minute pits. Fruits usually warty.....
Agelaea Sol. ex Planch.
 Linnaea 23 (1850) 437; Ridley *l.c.* 552; Merrill *l.c.* (1929) 95; Leenhouts *l.c.* 500; Kochummen *l.c.* 48. Synonym: *Cantanola* Llanos, Mem. R. Ac. Cienc. Madr. 3, 2 (1859) 505, Masamune *l.c.* 328.
 50 species, Africa, Madagascar and Malesia; 4 species in Sabah and Sarawak.
 Woody climbers, rarely scrambling shrubs. Flowers bisexual, 5-merous; petals much longer than sepals; stamens usually 10. Fruit papillose or rugulose to warty. Seeds shiny black, partly covered with orange or yellow arilode.
 Mainly in lowland primary and secondary forests. *A. borneensis* is widely distributed in Sabah and Sarawak; *A. insignis* is very uncommon and in Sarawak is represented by a few collections from Baram and Kuching areas but in Sabah is recorded only from Tawau; *A. macrophylla* is endemic to Sarawak, whereas *A. trinervis* is endemic to Sabah.

 Leaves imparipinnate, upper surface of leaflets not pitted. Fruits smooth.....4

4. Leaflets with emarginate apex.....
Roureopsis Planch.
l.c. 423; Masamune *l.c.* 331; Leenhouts *l.c.* 505; Kochummen *l.c.* 52. Synonym: *Taeniochlaena* Hook. f. in Bentham & Hooker f., Gen. Pl. 1 (1862) 433, Masamune *l.c.* 332.
 10 species, West Africa, Northern Burma, Southern China, Sumatra, Peninsular Malaysia, Java, and Borneo; 2 species in Sabah and Sarawak, viz. *R. acutipetala* and *R. emarginata*.
 Woody climbers, sometimes scandent shrubs. Inflorescences axillary, racemose or paniculate; bracts lanceolate, densely appressed hairy. Flowers bisexual, long-stalked, usually 5-merous; petals linear; stamens usually 10. Fruits oblique-ellipsoid, opening by a ventral slit, red, with persistent calyx. Seeds ellipsoid, hilum partly or entirely covered by a yellow fleshy arilode.

 Apex of leaflets not emarginate.....5

5. Fruits velvety hairy, pear-shaped. Leaflets usually more than 10 pairs.....
Cnestis Juss.
 Gen. (1789) 374; Ridley *l.c.* 553; Merrill *l.c.* (1929) 96; Masamune *l.c.* 329; Leenhouts *l.c.* 497; Kochummen *l.c.* 48.
 About 40 species, predominantly tropical Africa and Madagascar. Two species in Sabah and Sarawak.
 Woody climbers or scandent shrubs. Inflorescences axillary or in fascicles from knobs on branches. Flowers 5-merous; stamens 10; carpels 5. Fruits velvety brown,

pear-shaped, stipitate. Seeds flattened bean-shaped, partially covered by a sarcotesta at the base. Found mainly in a primary and secondary mixed dipterocarp forests to 500 m.

Fruits glabrous, finely striate, pod-like or ellipsoid to ovoid. Leaflets less than 10 pairs
.....6

6. Carpel only one per flower; calyx in fruit accrescent and hard. Fruit ellipsoid, base not stipitate.....6

Rourea Aubl.

Hist. Pl. Guiane 1 (1775) 467, t. 187; Ridley *l.c.* 549; Merrill *l.c.* (1929) 95; Leenhouts *l.c.* 510; Kochummen *l.c.* 51. Synonym: *Santaloides* L. ex Kuntze, Rev. Gen. Pl. 1 (1891) 155 (as *Santalodes*), Merrill *l.c.* (1921) 291, Masamune *l.c.* 331.

About 100 species; Central and South America, Malesia, NE Australia and Melanesia; 4 species in Sabah and Sarawak.

Woody climbers, shrubs, very rarely small trees. Leaves very variable in size and shape. Inflorescences axillary. Flowers 5-merous; sepals ovate, imbricate, margin ciliate; petals twice or more longer than sepals; stamens 10, joined at base. Fruits usually 1 per flower, ellipsoid to ovoid, splitting ventrally. Seeds with the testa partly or almost entirely fleshy or seeds enveloped by fleshy arillode.

Mainly found in low altitude, in primary and secondary mixed dipterocarp rainforests, along forest edges, river banks, and roadsides.

Carpels more than one per flower. Calyx in fruit not accrescent. Fruit pod-like, base narrowly stipitate.....1. **Connarus** (in part)

1. CONNARUS L.

(Greek, *konaros*, a plant name)

Sp. Pl. 2 (1753) 675, Gen. Pl. ed. 5 (1754) 305; Bentham & Hooker *f. l.c.* (1862) 432; King *l.c.* (1897) 2; Ridley *l.c.* 544; Merrill *l.c.* (1921) 291, *l.c.* (1929) 94; Masamune *l.c.* 329; Leenhouts *l.c.* 525; Kochummen *l.c.* 49; Anderson *l.c.* 163; Ashton *l.c.* 223.

Usually woody climbers, rarely shrubs or small trees. **Leaves imparipinnate, sometimes trifoliolate**, rarely unifoliolate; leaflets almost always pellucid-glandular punctate. **Inflorescences** terminal or axillary rarely on the branches or stems. **Flowers bisexual, fragrant, 5-merous; sepals, petals, stamens punctate**, seen as dark gland-dots in herbarium materials; sepals thick and fleshy, not accrescent in fruit; petals nearly always hairy; stamens 10, joined at base; ovary 1-carpellate, stigma capitate. **Fruits pod-like**, opening lengthwise, base narrowed into a stipe, with small persistent calyx, apex short-beaked or curved. **Seed** 1, shiny black, basal part partially enveloped by a fleshy, yellow arillode.

Distribution. About 100 species, pantropical. 13 species in Sabah and Sarawak, including two unnamed taxa (indicated as *Connarus* sp. A and *Connarus* sp. B in the key given below). Of these only one species, *C. agamae*, is a small tree.

Key to *Connarus* species

- 1. Small trees..... *Connarus agamae* 2
 Climbers, scandent or erect shrubs..... 2
- 2. Inflorescences on stems or on leafless twigs..... 3
 Inflorescences terminal or almost so on leafy shoots..... 4
- 3. Leaflets oblong-elliptic, apex shortly acuminate; all veins distinctly raised below, intercostal veins scalariform.....

C. impressinervis B.C. Stone

Malays. For. 43, 2 (1980) 255.

Usually shrub, rarely small tree reaching 5 m tall and 5 cm diameter. Inflorescences on short condensed panicles, peduncles stout. Fruits obliquely obovoid, glabrous, stipitate, sparsely tomentose, slightly compressed, bright orange-red, drying brown, apex rounded.

Primary mixed dipterocarp forest; collected several times from Bukit Raya, Kapit District, Sarawak.

Leaflets narrowly lanceolate, apex distinctly emarginate; veins not raised below, intercostal veins not scalariform.....

Connarus sp. A.

A climber. Leaves trifoliolate, blade distinctly swollen at base, leatherly. Fruits borne on branches, smooth, drying chestnut brown. Seed 1, arillode covering mostly the lower part.

Mixed dipterocarp forest at 740 m. Collected once (S. 36403) from Bt. Goram, Song, Kapit District, Sarawak.

- 4. Leaflets glabrous..... 5
 Leaflets hairy at least on the midrib below or at young stage..... 9
- 5. Leaflet attachment distinctly peltate; lateral veins 16-18 pairs, straight and close together; petiolule 2.5-4 cm long.....

Connarus sp. B.

A climber. Leaflets 1-2 pairs, broadly ovate. Inflorescences terminal.

One collection (S. 44912) from kerangas forest in Bukit Sadok, Ulu Sekrang, Sri Aman, Sarawak.

Leaflet attachment not peltate; lateral veins less than 10 pairs, usually curved; petiolules much shorter..... 6

- 6. Leaflets drying reddish brown. Fruits obovoid; pericarp coarse, thick and woody, c. 2 mm thick.....

C. grandis Jack

Mal. Misc. 2, 7 (1822) 40; Masamune l.c. 329; Leenhouts l.c. 529. Synonym: *Connarus ellipticus* King l.c. 7, Merrill l.c. (1929) 95.

Woody climber, rarely shrub. Branches glabrous. Leaflets 1-2 pairs, obovate to lanceolate. Inflorescences usually densely fulvous-tomentose.

Primary and secondary mixed dipterocarp forests, also in open areas and along river banks. Distributed widely in Sabah and Sarawak, fairly common.

Leaflets not drying as above. Fruits ellipsoid or spindle-shaped; pericarp thin, not coarse.....7

7. Leaflets drying pale green and purplish brown on midrib and lateral veins. Fruits not stipitate.....

C. lucens Schellenb.

Bot. Jahrb. 59 (1924) 36; Leenhouts *l.c.* 539.

Glabrous climber. Leaflets 3–4 pairs, obovate to oblong-lanceolate; lateral veins drying purplish brown. Inflorescences broadly branched. Fruits trapezoid to oblique-ellipsoid, slightly flattened, not stipitate, drying purplish brown.

Recorded from Saribas and Kapit, Sarawak.

Leaflets not drying as above. Fruit stipitate.....8

8. Fruits obliquely spindle-shaped, shortly stipitate. Reticulation of intercostal veins conspicuous.....

C. monocarpus L.

Sp. Pl. (1753) 675; Leenhouts *l.c.* 538 (ssp. *malayensis*). Synonyms: *C. falcatus* Blume, Mus. Bot. Lugd. Bat. 1 (1850) 266, Masamune *l.c.* 329; *C. densiflorus* Merr., Philip. J. Sc. 13 (1918) Bot. 70, Merrill *l.c.* (1921) 292, *l.c.* (1929) 95.

Woody climber. Leaflets 2–4 pairs. Inflorescences many-flowered. Sepals usually distinctly keeled, pubescent outside, glabrous inside.

Uncommon; in Sabah once found along the seashore in Lahad Datu; in Sarawak, collected from forest edges and river banks, and once on limestone.

Fruits ellipsoid, more or less bulging, stipe 0.5–1 cm long. Reticulation of intercostal veins not conspicuous.....

C. winkleri Schellenb.

l.c. (1924) 38; Masamune *l.c.* 330; Leenhouts *l.c.* 540. Synonym: *C. pachyphyllus* Merr. *l.c.* (1918) 71, *l.c.* (1921) 292, Masamune *l.c.* 330.

Woody climber, to 20 m high. Leaflets 2–3 pairs. Inflorescences to 5 cm long, laxly branched. Sepals ovate; petals ovate-lanceolate, thinly tomentose on both surfaces.

Generally lowland forests. Few collections from Sabah, and only one from Sarawak.

9. Leaflet attachment usually subpeltate, lateral veins 10–18 pairs, straight to slightly curved at margin.....

C. euphlebium Merr.

J. Str. Br. R. As. Soc. 85 (1922) 200, *l.c.* (1929) 94; Masamune *l.c.* 329; Leenhouts *l.c.* 527.

Woody climber to 25 m high, sometimes a scandent shrub. Branchlets, petioles, rachises and petiolules densely ferruginous hairy. Leaflets 1–4 pairs, petiolules 2–5 mm long. Inflorescences densely ferruginous-tomentose. Fruits obovoid and rather flattened, shortly stipitate; pericarp densely minutely ferruginous-tomentose.

Generally lowland forests. Uncommon in Sabah and Sarawak, represented by only three collections.

- Leaflet attachment not subpeltate, lateral veins less than 10 pairs, curved and looped at margin..... 10
10. Leaflets progressively increasing in size from basal pair upwards. Fruits glabrous.....
C. odoratus Hook. f.
 Trans. Linn. Soc. 23 (1860) 72; Merrill *l.c.* (1921) 292, *l.c.* (1929) 95; Leenhouts *l.c.* 533.
 Synonym: *C. hebephyllus* King *l.c.* (1897) 5, Merrill *l.c.* (1921) 292.
 Climber or scandent shrub. Branches, leaves, petioles, rachis and petiolules densely tomentose when young, later glabrescent. Inflorescences to 20 cm long, widely branched and densely tomentose. Fruits oblique-ellipsoid, glabrous; pericarp thin, minutely wrinkled outside, densely pubescent inside.
 Lowland forests and thickets. Widespread in Sabah and Sarawak.
- Leaflets equal in size. Fruits thinly or densely ferruginous-tomentose..... 11
11. Leaflets densely ferruginous-pubescent beneath. Fruits not compressed.....
C. villosus Jack
l.c. 38; Masamune *l.c.* 330; Leenhouts *l.c.* 531. Synonym: *C. plumoso-stellatus* Merr. *l.c.* (1918) 72, *l.c.* (1921) 292.
 Woody climber or scandent shrub. Branches, leaves and inflorescences densely pubescent. Leaflets 1-4 pairs. Inflorescences 10-30 cm long, few-flowered. Fruits ellipsoid, not stipitate; pericarp rather thin, outside densely orange-brown pubescent, inside glabrous.
 Primary mixed dipterocarp and *kerangas* forests at low altitudes. Found mainly in the Kuching and Samarahan Divisions in Sarawak but only one record from Sabah.
- Leaflets not so. Fruit compressed..... 12
12. Fruits oblique-ellipsoid, shortly stipitate; hairs branched, usually stellate.....
C. cullionensis Merr.
 Philip. J. Sc. 4 (1909) Bot. 120; Leenhouts *l.c.* 531. Synonym: *C. stellatus* Merr. *l.c.* (1909) 119, Masamune *l.c.* 330.
 Woody climber or scandent shrub. Branchlets densely ferruginous-tomentose, later glabrous. Leaflets 2-5 pairs, tomentose.
 Usually occurs in open areas in the lowland mixed dipterocarp forests.
- Fruits oblique-pyriform, stipitate, stipe to 1.5 cm long; hairs simple, not stellate.....
C. semidecandrus Jack
l.c. 39; Leenhouts *l.c.* 534. Synonyms: *C. mutabilis* Blume *l.c.* 269; *C. borneensis* Merr. *l.c.* (1918) 69, *l.c.* (1921) 292, Masamune *l.c.* 329; *C. jackiana* Schellenb. *l.c.* 40, Masamune *l.c.* 329.
 Large woody climber or scandent shrub. Leaflets 1-3 pairs, sometimes 5 pairs. Inflorescences terminal, to 35 cm long, broadly branched, many-flowered, minutely tomentose. Fruits compressed; pericarp thin, minutely ferruginous-pubescent, glabrescent outside, inside densely pubescent.
 Primary and secondary mixed dipterocarp forests especially in open areas along forest edges and river banks, also in clearings along beaches and sometimes in swampy habitats, on granite and limestone. Widely distributed in Sabah and Sarawak.

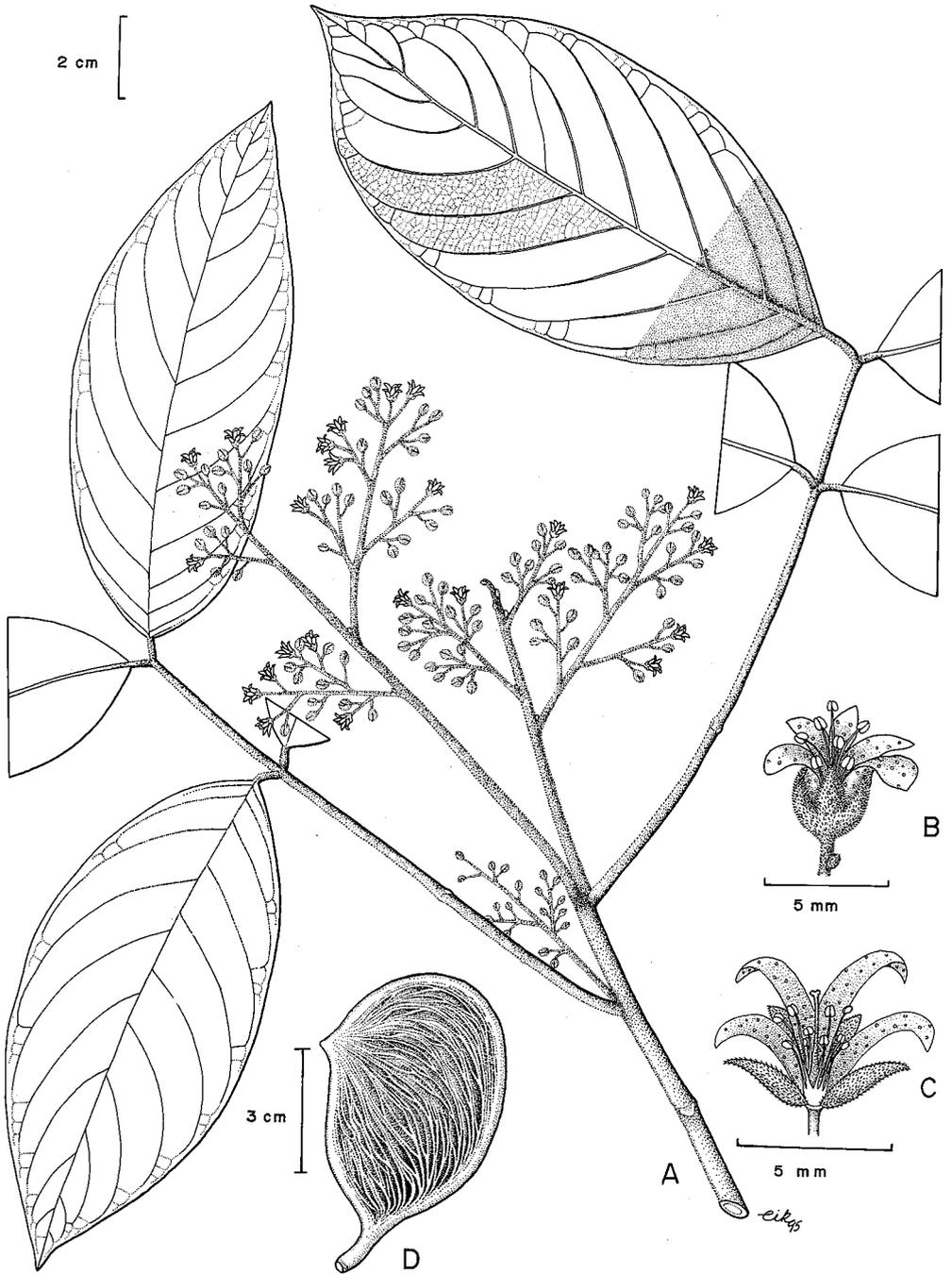


Fig. 1. *Connarus agamae*. A, flowering leafy twig; B, flower, C, flower with one sepal and one petal removed; D, fruit. (A–C from SAN 16882, D from SAN 57255.)

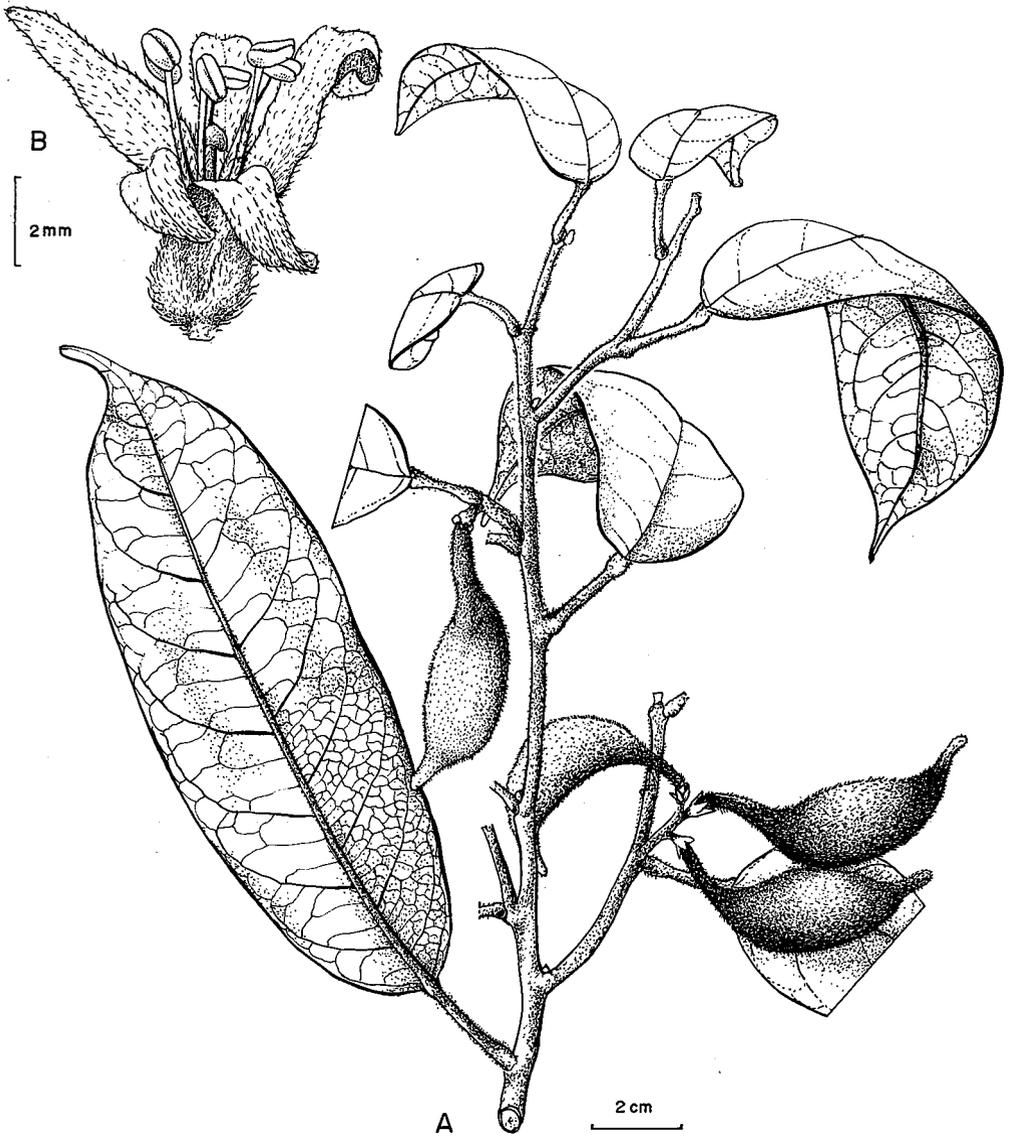


Fig. 2. *Ellipanthus tomentosus*. A, fruiting leafy twig; B, flower. (A from S. 42098, B from SAN 50543.)

Connarus agamae Merr.

Fig. 1.

(José Agama, Deputy Conservator of Forests, British North Borneo, 1889–1982)

L.c. (1918) 68, *L.c.* (1921) 291, *L.c.* (1929) 94; Masamune *L.c.* 329; Leenhouts *L.c.* 527. **Type:** *Agama* 422, British North Borneo, Tawau (holotype K).

Small tree, rarely reaching 20 m high and 20 cm diameter; sometimes shrub, rarely climber. Twigs thinly pubescent, glabrescent. **Leaves** with 1–2 pairs of leaflets, sometimes *unifoliolate* especially below the inflorescence; leaflets oblong, slightly oblique, 11–20 x 4–10 cm, terminal ones ovate, thinly papery, glabrous above, drying reddish brown, *densely ferruginous-pilose beneath especially on midrib*; base rounded to acute, apex blunt; lateral veins 8–15 pairs, straight, strongly looped and closed toward the margin but not joining; intercostal veins reticulate, inconspicuous above. **Inflorescences** densely ferruginous-pubescent. **Flowers:** sepals ovate, brown-pilose on both sides; petals linear, punctate on both sides; stamens all fertile, connate at base. **Fruits** obovate, 5 x 2–3.5 cm, beak acute at 4/5 of the height; pericarp glabrous, shiny and slightly wrinkled, woody, densely fulvous-tomentose inside; stipe 1–1.5 cm long.

Distribution. Endemic to Borneo. In Sabah, recorded from Sandakan and Mostyn, but not yet recorded from Sarawak.

Ecology. In primary mixed dipterocarp forest to 300 m.

2. ELLIPANTHUS Hook. *f.*(Greek, *ellipes* = defective; *anthos* = flower;

referring to the defective or imperfect development of 5 of the 10 stamens)

L.c. (1862) 434, *L.c.* (1879) 55; King *L.c.* 8; Ridley *L.c.* 548; Merrill *L.c.* (1921) 291, *L.c.* (1929) 96; Masamune *L.c.* 330; Leenhouts *L.c.* 520; Kochummen *L.c.* 50; Anderson *L.c.* 163; Ashton *L.c.* 224; Whitmore, Tantra & Sutisna *L.c.* 49. **Synonym:** *Pseudellipanthus* Schellenb. in Mez, Bot. Arch. 1 (1922) 314, Masamune *L.c.* 331.

Shrubs or small trees reaching 25 m tall and 25 cm diameter. Twigs tomentose, at least when young. **Leaves** *alternate, unifoliolate, with a prominent joint at the base*. **Inflorescences** axillary, paniculate or clustered; bracts caducous, lanceolate, small. **Flowers** *4–5-merous, protandrous, unisexual* (and then plants dioecious) *or bisexual*; sepals densely hairy outside, valvate in bud; petals free, imbricate in bud; stamens twice as many as petals, connate at base, episepalous ones well-developed, epipetalous ones rudimentary; ovary 1-carpellate, flattened ovoid, style slender, stigmas disk-shaped to bilobed. **Fruits** *densely tomentose*, apex shortly pointed, base stipitate; pericarp woody; persistent calyx not accrescent. **Seed** one, ellipsoid, shiny black, covered by a yellowish orange arillode at base.

Distribution. About 10 species; Africa, Madagascar, Sri Lanka, continental SE Asia and Malesia. 2 species in Sabah and Sarawak.

Ecology. Lowland mixed dipterocarp forest and mixed swamp forest.

Key to *Ellipanthus* species

Flowers predominantly 4-merous, unisexual. Leaf-blade usually glabrous above, densely ferruginous-tomentose beneath, base rounded..... **1. *E. beccarii***

Flowers predominantly 5-merous, usually bisexual. Leaf-blade usually tomentose above (at least on the midrib), glabrous or thinly fulvous-tomentose beneath, base cuneate or subcordate..... **2. *E. tomentosus***

1. *Ellipanthus beccarii* Pierre

(Odoardo Beccari, Italian explorer and botanist, 1843–1920)

Fl. Coch. 5 (1898) t. 378; Merrill *l.c.* (1921) 291; Leenhouts *l.c.* 524; Anderson *l.c.* 164; Ashton *l.c.* 225; Whitmore, Tantra & Sutisna *l.c.* 49. **Type:** *Beccari PB 296*, Sarawak, Matang (K).

Small *dioecious* tree or shrub, rarely reaching 10 m tall, 15 cm diameter. **Leaves** elliptic to ovate, sometimes lanceolate, *glabrous above, densely ferruginous-tomentose beneath*, 7–15 x 3–5 cm; *base rounded, peltate or not*, apex acuminate; lateral veins 8–10 pairs, curved, looped and joined; petiole jointed at leaf-base, *c.* 1 cm long. **Flowers** *unisexual, 4-merous*. **Fruits** shortly stipitate, stipe to 1 cm long. **Seed** with a small cupular ariloid.

Key to varieties

Leaf-base not peltate.....

var. **beccarii** Leenh.

l.c. 524; Anderson *l.c.* 164; Whitmore, Tantra & Sutisna *l.c.* 49. Synonyms: *E. mindanaensis* (non Merr.) Merr., J. Str. Br. R. As. Soc. 76 (1917) 84, *l.c.* (1921) 291, *l.c.* (1929) 96; *Pseudellipanthus beccarii* (Pierre) Schellenb. *l.c.* (1922) 314; *Dichapetalum tetramerum* Ridl., Kew Bull. (1938) 234.

Known only in the Kuching area, Sarawak on leached yellow soils in mixed dipterocarp forest, and Kalimantan.

Leaf-base peltate.....

var. **peltatus** (Schellenb.) Leenh.

l.c. 524; Anderson *l.c.* 164; Whitmore, Tantra & Sutisna *l.c.* 49. Basionym: *Pseudellipanthus peltatus* Schellenb. *l.c.* (1922) 314.

Endemic to Borneo (Sabah, Sarawak, Brunei, Kalimantan). In Sabah uncommon; in Sarawak frequent in mixed dipterocarp forest on fertile clay soils, particularly on basic volcanic rocks.

Vernacular names. Sarawak—*kelana* (Kenyah), *merinang* (Iban).

2. *Ellipanthus tomentosus* Kurz

(Latin, *tomentosus* = thickly and evenly covered with short matted hairs; the leaves)

Fig. 2.

J. As. Soc. Beng. 41, 2 (1872) 305; Hooker *f. l.c.* 56; Leenhouts *l.c.* 521; Kochummen *l.c.* 50; Anderson *l.c.* 164; Ashton *l.c.* 225; Whitmore, Tantra & Sutisna *l.c.* 49. **Type:** *Wallich Cat. 8551*, Lower Burma, Moulmain (holotype K).

subsp. **tomentosus** var. **luzoniensis** (Vidal) Leenh.

l.c. 524; Whitmore, Tantra & Sutisna *l.c.* 49. **Basionym:** *E. luzoniensis* Vidal, Rev. Pl. Vasc. Filip. (1886) 104. **Synonyms:** *Connarus urdanetensis* Elmer, Leafl. Philip. Bot. 7 (1915) 2594; *E. burebidensis* Elmer *l.c.* 2596; *E. vidalii* Elmer *l.c.* 2596; *E. longifolius* Merr., Philip. J. Sc. 17 (1921) Bot. 262; *E. urdanetensis* (Elmer) Merr., En. Philip. 2 (1923) 241; *E. sarawakensis* Schellenb., Pfl. R. Heft 103 (1938) 185.

Shrub or tree to 20 m tall, 25 cm diameter. **Bark** smooth, greyish brown; inner bark reddish brown. **Sapwood** pale yellow. **Leaflets** elliptic to lanceolate, 7–20 x 4–9 cm, chartaceous, *glabrous or thinly fulvous-tomentose below; base cuneate*, sometimes rounded or subcordate, *apex acuminate; midrib tomentose above*; lateral veins 5–7 pairs, looping near margin; intercostal veins conspicuous below, very faint above; petiole jointed at base, 0.5–3 cm long. **Flowers** white, *bisexual, 5-merous*. **Fruits** stipitate, stipe *c.* 3.5 cm long, apex pointed. **Seeds** *c.* 5 mm long, covered with faintly lobed arilloid.

Vernacular name. Sarawak—*kelin* (Melanau).

Distribution. Borneo, the Philippines and Central Celebes. In Sarawak uncommon, distributed around Miri, Bintulu, Sibuluan, Sarikei and Kuching. In Sabah, recorded from Lahad Datu and Tawau.

Ecology. Locally frequent in primary mixed dipterocarp forest and peat swamp forest.

Uses. The wood is considerably hard and durable, used for local construction works such as bridges and house posts.

CORNACEAE

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Ridley, FMP 1 (1922) 889 (excluding *Alangium*, *Aralidium* and *Nyssa*); Merrill, EB (1921) 459, PEB (1929) 233; Danser, Blumea 1 (1934) 46; Backer & Bakhuizen f., FJ 2 (1965) 158; Matthew, Blumea 23 (1976) 51, FM 1, 8 (1977) 85; Kochummen, TFM 3 (1978) 53; Anderson, CLTS (1980) 164; Whitmore, Tantra & Sutisna, CLK 1 (1989) 49.

Trees, shrubs, or rarely herbs. **Leaves** opposite, subopposite or alternate, simple, entire or rarely serrate, pinnately veined, *exstipulate*, usually petiolate. **Flowers** regular (*actinomorphic*), 4–5-merous, bisexual or sometimes unisexual, arranged in axillary or terminal cymes, panicles or heads; *calyx-tube* adnate to the ovary, 4–5-lobed or subtruncate, *persistent in fruit*; petals 4–5, free, valvate or imbricate in buds; stamens short and equal in number with the petals, 2-locular, dehiscing lengthwise; *disc large*, cushion-shaped at the top of the ovary, *generally persistent in fruit*; *ovary inferior*, 1–4-locular, *ovule 1 in each locule*, *pendulous*, with dorsal or ventral (in *Curtisia* and *Mastixia*) raphe, style simple or lobed. **Fruit** usually a *drupe*, rarely a *berry* (in *Aucuba* and *Griselinia*). **Seeds** usually 1–2, rarely 4, with small elongate embryo embedded in copious oily endosperm.

Distribution. About 8–15 genera and 100 species; mainly in the temperate zones and in the tropics (rare in Africa and South America). In Sabah and Sarawak, represented by the genus *Mastixia* with 7 species.

Ecology. Insect-pollination is probably a general phenomenon in the family, except in *Griselinia litoralis* which has been reported to be wind-pollinated.

Uses. In Sabah and Sarawak, very little is known about the utilization of members of the family. However, the fruit of *Chamaepericlymenum suecicum* is eaten by the Eskimos. In France, *Cornus mas* (Cornelian cherry) is grown as ornamentals, and the fruit is edible and used as a source of raw material for making "Vin de Cornouille". The Assegay tree or Cape Lance wood (*Curtisia faginea*) produces durable, red to brown timber and used for making furnitures in South Africa. *Aucuba japonica* is a popular evergreen garden shrub widely cultivated in temperate and subtropical countries.

Taxonomy. The taxonomic and systematic status of the Cornaceae remains controversial (Matthew *l.c.* 1976, *l.c.* 1977; Mabberley, The Plant Book (1987) 146; and Brummitt, Vascular Plant Families & Genera (1992) 543). In the Malesian region, Ridley (*l.c.*) and Keng (OFMSP, 1969) included *Alangium*, *Aralidium*, *Mastixia* and *Nyssa* in the Cornaceae, whereas van Steenis (Checklist Gen. Names Mal. Bot. (1987) 50) placed *Alangium* in its own family (Alangiaceae), *Aralidium* in the Araliaceae, and *Nyssa* in the Nyssaceae, leaving *Mastixia* as the sole representative of the family in the Malesian region.

MASTIXIA Blume

(Greek, *mastix* = whip; the whiplike apex of the petals)

Bijdr. (1825) 654, Mus. Bot. Lugd. Bat. 1 (1850) 256; Bentham & Hooker *f.*, Gen. Pl. (1887) 950; Harms in Engl. & Prantl, Pfl. Fam. 3 (1898) 262; Wangerin in Engl., Pfl. Reich. 4, 229, 41 (1910) 19; Ridley *l.c.* 889; Merrill *l.c.* (1921) 459, *l.c.* (1929) 233; Danser *l.c.* 47; Backer & Bakhuizen *f. l.c.* 159; Matthew *l.c.* (1976) 51, *l.c.* (1977) 85; Kochummen *l.c.* 53; Whitmore, Tantra & Sutisna *l.c.* 49; Ng, MFFSS 1 (1991) 47.

Trees, usually without buttresses. **Bark** grey to grey-brown, smooth with horizontal rings, rarely cracked to shallowly fissured, *often exuding white resin when bruised*; inner bark orange-yellow, gritty, granular, *with strong smell of sugarcane water*. **Sapwood** soft, yellowish white or white. **Leaves** alternate, subopposite or opposite, margin entire; midrib sunken on adaxial surface, prominent below; lateral veins usually distinct on the abaxial surface. **Inflorescences** terminal or sometimes axillary cymose-panicles. **Flowers** bisexual, in triads, sessile, subtended by tiny, persistent bracts; *calyx-tube* obconical or barrel-shaped or cup-shaped, lobes spreading or not, broader than long or sometimes appear as minute sharp tips, *persistent in fruit*; petals thick, concave, valvate in bud, inflexed and strongly connate at the upper parts; stamens attached below the disc, abutting on and alternating with disc-lobes, opposite the calyx-lobes, filaments subulate, flattened and tapered toward its upper part, anthers cordate, dorsifixed, introrse-latorse; *ovary turbinate, one-locular, surmounted by a fleshy, lobed and grooved disc which is sometimes persistent in fruit*; style very short, stout, ribbed; *stigma punctiform, sometimes bifid or 4–5-lobed, reflexed, some persistent in fruit*. **Fruit** a drupe, ovoid, ellipsoid or oblong, *surmounted by calyx-tube and crowned by the persistent disc (the exposed part of the fruit)*; pericarp (exocarp and mesocarp) thin or thick, *turning to dark purple or blue when ripe*; fruit-wall formed by calyx-tube and pericarp; endocarp stony. **Seed** 1, ovoid or ellipsoid, with membranous testa; endosperm large and U-shaped in transverse section; embryo small and straight, cotyledons thin and foliaceous; germination epigeal.

Distribution. About 13 species; from the western Ghats and Sri Lanka, NE India, Bhutan, Burma, Thailand, Indo-China, S Yunnan, Hainan, through Malesia to New Britain and the Solomon Islands. 7 species (including 2 endemic) are found in Sabah and Sarawak.

Ecology. Found mainly in valleys, slopes or ridges of primary and secondary mixed dipterocarp forests, often in moist habitats, from sea-level to 2200 m.

Uses. Although the trees may reach a considerable size, the scattered occurrence does not contribute to their general use as timber. In addition the timber has little commercial value and therefore only used for packing cases and temporary constructions.

Taxonomy. *Mastixia* is strictly a SE Asian genus. It was included in the Cornaceae by Bentham & Hooker *f.* (*l.c.*) and Hutchinson (Genera of Flowering Plants 2 (1967) 42), whereas Harms (*l.c.*) and Wangerin (*l.c.*) included it in a distinct subfamily. Wangerin distinguished two subgenera, *viz. Tetramastixia* and *Pentamastixia*. Matthew (1976 & 1977), on the other hand, established two subgenera, *Manglesia* (2 species) and *Mastixia* (11 species). He recognised two series, the *Oppositae* and *Alternae* within the subgenus *Mastixia* based on a single character, *viz. whether the first branches of the inflorescence are*

opposite (or subopposite) or alternate. In the absence of flower and fruit and due to the presence of resin in the bole and on the cut ends of logs, the genus can be easily confused with some species of the Dipterocarpaceae that have smooth or cracked bark, such as *Vatica* species. However, in *Mastixia* the inner bark is thick and gritty with a strong sugarcane smell and the wood is soft. Foresters sometimes confuse this genus with those of the Lauraceae (*medang*) because of the gritty inner bark and strong aromatic smell; however *medang* has no resin.

Key to *Mastixia* species

1. Leaf surface velvety hairy below, if glabrescent then midrib hairy.....2
 Leaf surface glabrous.....3
2. Leaves alternate. Twigs and stalks distinctly grooved.....4. **M. macrocarpa**
 Leaves opposite. Twigs and stalks not so.....7. **M. trichotoma**
3. Leaves glaucous below.....3. **M. glauca**
 Leaves not glaucous below.....4
4. Leaf-margin wavy when dry; stalks 2–3 cm long.....2. **M. eugenioides**
 Leaf-margin not wavy when dry; stalks shorter than 2 cm.....5
5. Leaves thickly leathery; margin curled inwards. Twigs dark brown to black when dry
5. **M. pentandra**
 Leaves thinly leathery; margin not curled inwards. Twigs grey or grey-brown when dry
6
6. Leaf lateral veins looping near margin. Flower buds up to 3 mm diameter; petals
 densely hairy on the abaxial surface.....1. **M. cuspidata**
 Leaf lateral veins not looping near margin. Flower buds up to 2 mm diameter; petals
 glabrous on the abaxial surface.....6. **M. rostrata**

1. *Mastixia cuspidata* Blume

(Latin, *cuspidatus* = sharp-pointed; the leaf apex)

l.c. (1850) 256; Miquel, *Fl. Ind. Bat.* I, 1 (1855) 772; Ridley *l.c.* 891; Merrill *l.c.* (1921) 459; Danser *l.c.* 55 (excl. var. *margarethae*); Matthew *l.c.* (1976) 79, *l.c.* (1977) 95; Kochummen *l.c.* 54; Whitmore, Tantra & Sutisna *l.c.* 49. **Type:** *Korthals, s.n.*, Sumatra, West Coast (lectotype L; isolectotype U). **Synonyms:** *Mastixia pentandra* Blume var. *cuspidata* (Blume) Miq. *l.c.* (1858) 1095; *Mastixia bracteata* Clarke in Hooker *f.*, *Fl. Brit. Ind.* 2 (1879) 746.

Tree to 40 m tall, and 40 cm diameter. **Bark** greyish to chocolate-brown, smooth to shallowly fissured; inner bark yellowish to brownish, mottled. **Sapwood** yellowish to brownish. Twigs subglabrous, grey-brown. **Leaves** *alternate, subopposite or opposite, stalk slender, 0.5–1.5 cm long*; blades narrowly obovate, elliptic or oblong, 3.5–9 x 1.5–3.5 cm, thinly leathery, glabrous; base cuneate, apex cuspidate with a tip 0.5–1(–1.5) cm long,

oblique; lateral veins (4–)5 pairs, curving near the margin and joining with next one to form looped intramarginal veins, sunken above; intercostal veins faint to inconspicuous below, inconspicuous above. **Inflorescences** to 4 cm long, subglabrous to puberulous. **Flowers** 5-merous, green to yellow, buds to 3 mm diameter; calyx-tube densely silky-hairy, with 5 lobes, broader than long, subglabrous; petals 1.5–2 x 0.5–1 mm, densely silky-hairy on abaxial surface; stamens 5, filament 1–3.2 mm long; disc yellowish. **Fruits** oblong, 1.5–3 x 0.5–1.3 cm; fruit-wall thin; persistent disc well-exposed; persistent calyx-lobes inconspicuous. **Seeds** ellipsoid, 1.5–2.5 x 0.4–1 cm.

Vernacular name. Sarawak—*biansu gunong* (Iban).

Distribution. Sumatra, Peninsular Malaysia and throughout Borneo. Uncommon in Sabah and Sarawak. In Sabah, recorded from Sipitang, Sandakan, Lahad Datu, and Tawau. In Sarawak, known from Mt. Matang (1st Div.), Sri Aman (2nd Div.), Mt. Dulit near Long Kapa (4th Div.), and Belaga (7th Div.).

Ecology. In primary and secondary mixed dipterocarp forests, to 900 m. Flowering in February–March and July–October; and fruiting in January, March, July–August and October.

Sterile specimens of small-leaved *M. cuspidata* are difficult to distinguish from *M. rostrata* ssp. *caudatifolia*.

2. *Mastixia eugenioides* Matthew

(leaves resembling that of *Eugenia*)

l.c. (1976) 73, *l.c.* (1977) 93; Whitmore, Tantra & Sutisna *l.c.* 50. **Type:** *Beccari PB 2033*, Sarawak, Mt. Matang (holotype FI, isotype L).

Tree to 30 m tall and 30 cm diameter. **Bark** greyish to yellowish brown, smooth; inner bark yellowish brown. Twigs glabrous. **Leaves** opposite, stalk green to greenish yellow, stout, 1.5–3 cm long; blades elliptic to oblong-elliptic, 4–15 x 2–5.5 cm, thickly leathery, glabrous; base cuneate, margin wavy after drying, apex acuminate to caudate; lateral veins 5–7 pairs, flattened above; intermediate lateral veins and intercostal veins prominent below. **Inflorescences** to 8 cm long, glabrous. **Flowers** 4-merous, buds about 1.5–2 mm diameter; calyx-tube glabrous, with 4 lobes, broader than long, glabrous; petals 4, 1–1.5 x 0.5–0.8 mm, glabrous on abaxial surface; stamens 4, filament 0.6–1 mm. **Fruits** green turning to purple when ripe, ovoid (young stage) to oblong, 2–2.5 x 1–1.5 cm; fruit-wall thin; persistent disc not well-exposed; persistent calyx-lobes inconspicuous. **Seed** ellipsoid, 1.9–2.4 x 0.8–1.1 cm.

Vernacular name. Sarawak—*sempetan* (Kenyah).

Distribution. Endemic to Borneo (Sarawak, Sabah, Brunei, and Kalimantan). In Sarawak, recorded from Bukit Senyandang Lingga (2nd Div.), Lambir Hills National Park; Similajau FR (4th Div.), Lawas (5th Div.), and Kapit (7th Div.). In Sabah, known from Tenom, Sandakan and Tawau.

Ecology. In primary mixed dipterocarp forests, from lowlands up to 1200 m. Flowering in July–August, fruiting in September–December.

3. *Mastixia glauca* Matthew

(Greek, *glaukos* = bluish-grey; the lower surface of the leaves)

l.c. (1976) 76, *l.c.* (1977) 95; Whitmore, Tantra & Sutisna *l.c.* 50. **Type:** *Hj. Bujang S. 13481*, Sarawak, 1st Div., Kuching, G. Santubong East (holotype L; isotypes K, SAR).

Tree to 15 m tall, 25 cm diameter. Twigs yellowish, glabrous. **Leaves** *alternate, stalk stout, 2–3.5 cm long*; blades obovate, 7–16 x 4–8.5 cm, thickly leathery, *glaucous and waxy below, glabrous*; base obtuse, margin wavy when dry, apex apiculate; *lateral veins 4–5 pairs* with intermediate lateral veins faint to inconspicuous; intercostal veins inconspicuous. **Inflorescences** subglabrous to puberulous. **Flowers** 4(–5)-merous, greenish yellow; buds 2.8–3.2 mm diameter; calyx-tube puberulous, with 4(–5) lobes, as long as wide, puberulous; petals 4(–5), 1.6–2.1 x 0.6–1.2 mm, hairy on abaxial surface; stamens 4–5, filament 0.9–1.2 mm long. Fruits & seeds unknown.

Distribution. Endemic to Sarawak, and so far only known from Mt. Santubong.

Ecology. In mixed dipterocarp forest at about 90 m. Flowering in April–May.

4. *Mastixia macrocarpa* Matthew

(Greek, *macros* = large, *carpos* = fruit)

l.c. (1976) 75, *l.c.* (1977) 94; Whitmore, Tantra & Sutisna *l.c.* 50. **Type:** *Benang S. 24745*, Sarawak, Miri, Bakam Road (holotype A; isotypes BO, K, KEP, L, MEL, NY, SAN, SAR, SING).

Tree to 20 m tall, 20 cm diameter. Twigs covered with sticky resin when fresh, rusty brown, rough-hairy and *distinctly grooved*. **Leaves** *alternate, stalk stout, 4–6 cm long, grooved, hairy like the twigs*; blades elliptic-oblong to oblong, 13–26 x 5.5–13 cm, thinly leathery, *villous below*; base *cuneate to asymmetric*, apex acute to acuminate; *lateral veins 7–10 pairs*, flatten above, prominent below; *intercostal veins prominent, scalariform or reticulate*. **Inflorescences** to 9 cm long, densely hairy. **Flowers** 5-merous, densely hairy, buds *c.* 4 mm diameter; calyx-tube densely hairy, with 5 lobes, broader than the length, villous; petals 5, 1.8–2.3 x 0.8–1.2 mm, velvety on abaxial surface; stamen 5, filament 1–1.5 mm long. **Fruits** pale green, oblong-ovoid, *c.* 4 x 2 cm; fruit-wall thin; persistent disc not well-exposed; persistent *calyx-lobes prominent, 4–5 mm long*. **Seeds** ellipsoid, *c.* 3.8 x 1.8 cm.

Distribution. Borneo, Philippines (Luzon). In Sarawak known from Miri, Bakam Road; not yet recorded from Sabah, Brunei, and Kalimantan.

Ecology. In mixed dipterocarp forest, at about 75 m. Flowering in October, fruiting in June.

5. *Mastixia pentandra* Blume

(Greek, *penta* = five, *-andrus* = male; with 5 stamens)

l.c. (1825) 654; Danser *l.c.* 49; Backer & Bakhuizen *f. l.c.* 159; Matthew *l.c.* (1976) 80, *l.c.* (1977) 95; Whitmore, Tantra & Sutisna *l.c.* 50. **Type:** Blume, *s.n.* (= Leiden no. 901, 169–375), Java (lectotype L; isolectotypes NY, W).

subsp. *scortechinii* (King) Matthew

l.c. (1976) 80, *l.c.* (1977) 54. **Basionym:** *Mastixia scortechinii* King, J. As. Soc. Beng. 71, 1 (1902) 72. **Type:** *Scortechini* 1971, Perak (lectotype K; isolectotypes BM, CAL, G, L, P). **Synonyms:** *Mastixia megacarpa* Ridl. *l.c.* 891; *Mastixia parvifolia* Hallier *f.*, Beih. Bot. Centralbl. 34, 2 (1916) 41, Merrill *l.c.* (1921) 459.

Tree to 40 m tall, 80 cm diameter; *buttresses short*. **Bark** grey-brown, smooth to shallowly fissured with horizontal rings and lenticels in rows; inner bark yellowish brown to dark yellow, *with strong smell of sugarcane*. **Sapwood** pale yellow to brownish. **Twigs** glabrous, *dark brown to black*. **Leaves** *alternate, spiral or subopposite, stalk stout, 1–2 cm long*; blades obovate to oblong or elliptic, 5–12 x 2.5–5 cm, *thickly leathery*, glabrous; base cuneate, *margin curled inwards*, apex acute or acuminate but sometimes caudate; *lateral veins 4–6 pairs*, flattened above; *intercostal veins and reticulations faint to inconspicuous on both surfaces*. **Inflorescences** to 8 cm long, puberulous to villous. **Flowers** (4–)5-merous, greenish or yellowish white, buds *c.* 2 mm diameter; calyx-tube puberulous, with (4–)5 lobes, as long as wide; petals (4–)5, 1.2–1.5 x 0.8–1 mm, hairy on the abaxial surface; stamens (4–)5, filament 0.5–0.7 mm long. **Fruits** green, ripening purple to bluish black, ovoid to oblong, 1.6–3.5 x 0.8–1.2 cm; fruit-wall thick; persistent disc well-exposed and sometimes bulging; persistent calyx-lobes inconspicuous. **Seeds** ovoid, 0.9–1.2 x 0.5–0.8 cm.

Vernacular names. Sabah and Sarawak—*kaju wulu, medang surungan* (Malay).

Distribution. Thailand, Sumatra, Peninsular Malaysia, Borneo (Sabah and Kalimantan), and Celebes. In Sabah recorded only from Mt. Kinabalu and Mesilau Hill.

Ecology. Uncommon, distributed from lowland to submontane forests to 1500 m. Flowering and fruiting in January–December

Taxonomy. In Matthew's treatment, *Mastixia pentandra* was segregated into six subspecies, *viz.* *pentandra*, *moluccana*, *chinensis*, *cambodiana*, *philippinensis* and *scortechinii*. Of these, only *M. pentandra* subsp. *scortechinii* is known from Sabah.

6. *Mastixia rostrata* Blume

(Latin, *rostratus* = with a beak, narrowed into a slender tip or point; the leaf apex)

Fig. 1.

l.c. (1850) 258; Danser *l.c.* 52; Backer & Bakhuizen *f. l.c.* 159; Matthew *l.c.* (1976) 73, *l.c.* (1977) 94; Anderson *l.c.* 164; Whitmore, Tantra & Sutisna *l.c.* 50. **Type:** Blume, *s.n.* (= Leiden no. 901, 169–384), Java (lectotype L).

subsp. **caudatifolia** (Merr.) Matthew

l.c. (1976) 74, *l.c.* (1977) 94. **Basionym:** *Mastixia caudatifolia* Merr. *l.c.* (1929) 233. **Type:** Elmer 21584, British North Borneo, Tawau, Elphinstone Prov. (holotype UC; isotypes A, BM, BO, GH, HBG, K, L, NY, P, SING, U, UC, US). **Synonyms:** *M. margarethae* Wangerin, Fedde Rep. 4 (1907) 335; *M. cuspidata* Blume var. *margarethae* (Wangerin) Hallier f. *l.c.* 41.

Tree to 30 m tall and 50 cm in diameter. **Bark** greyish to chocolate-brown, smooth to occasionally shallowly fissured; inner bark yellowish to pale orange-yellow, fibrous, soft. **Sapwood** yellowish. **Twigs** glabrous, grey or grey-brown. **Leaves** alternate, subopposite or opposite, stalk slender, to 1(-1.5) cm long; blades elliptic-oblong to elliptic, 4-8(-10) x 2-5 cm, papery to thinly leathery, glabrous; base cuneate, margin not curled inward, apex caudate with the tip to 1.5 cm long; lateral veins 4-6 pairs, prominent below, sunken above, not looping toward leaf margin; intercostal veins faint to inconspicuous below. **Inflorescences** to 6 cm long, subglabrous. **Flowers** 4-merous, green-yellow, buds to 1 mm diameter; calyx-tube glabrous, with 4 lobes, broader than long, glabrous; petals 4, 1.1-1.3 x 0.7-0.9 mm, glabrous on the abaxial surface; stamens 4, filament 1-1.3 mm long; disc yellowish. **Fruits** ovoid to oblong, 1.5-2.2 x 0.5-1 cm; fruit-wall thick; persistent disc not well-exposed; persistent calyx-lobes inconspicuous. **Seeds** ellipsoid, 1.3-2 x 0.6-0.8 cm.

Vernacular name. Sarawak—*patoli entelit* (Iban).

Distribution. Sumatra, Peninsular Malaysia (new record), and Borneo. Widely distributed in Sabah and the W and C parts of Sarawak.

Ecology. In primary mixed dipterocarp forest on clay-rich soils, from lowland to 1600 m. Flowering in June to October, fruiting in August to March.

Taxonomy. In Matthew's treatment, *Mastixia rostrata* was segregated into two subspecies, viz. *rostrata* and *caudatifolia*. Of these, only *M. rostrata* subsp. *caudatifolia* is known from Sabah and Sarawak.

7. *Mastixia trichotoma* Blume

(Greek, *tri* = three, *tomos* = part; the 3-branched inflorescence)

l.c. (1825) 655, King *l.c.* 72; Wangerin *l.c.* (1910) 24; Merrill *l.c.* (1921) 459; Danser *l.c.* 57; Matthew *l.c.* (1976) 68, *l.c.* (1977) 92; Kochummen *l.c.* 54; Anderson *l.c.* 164; Whitmore, Tantra & Sutisna *l.c.* 50. **Type:** Blume, s.n., West Java, Mt. Salak (lectotype L; isolectotypes BM, W). **Synonyms:** *Mastixia laxa* Blume *l.c.* (1850) 257 (including var. *angustifolia*); *Mastixia acuminatissima* Blume *l.c.* (1850) 258; *Mastixia caesia* Blume *l.c.* (1850) 258; *Mastixia kimanilla* Blume *l.c.* (1850) 258.

Tree to 40 m tall and 50 cm diameter. **Bark** yellowish grey to grey-brown, smooth to shallowly fissured; inner bark yellowish brown to pale brown. **Sapwood** pale white. **Twigs** not distinctly grooved, yellowish brown to pale brown, puberulous to woolly. **Leaves** opposite, stalk stout or slender, 1-3.5 cm; blades ovate, elliptic, lanceolate to oblong, 5-24 x 2.5-12 cm, thinly to thickly leathery, subglabrous to velvety hairy below; base acute,

cuneate, obtuse or attenuate, apex acute to acuminate; *lateral veins* 5–15 pairs, sunken above, prominent below; intercostal veins reticulate, faintly visible to prominent below. **Inflorescences** to 15 cm long, puberulous to woolly. **Flowers** 4–5-merous, green to yellowish green; buds 1–2.5 mm diameter; calyx-tube puberulous to villous, with 4 or 5 lobes, as long as wide, puberulous to villous; petals 4 or 5, puberulous to villous on the abaxial surface; stamens 4 or 5. **Fruits** ovoid to ellipsoid, 1.5–3 x 0.6–1.5 cm, fruit-wall thin; persistent disc well-exposed and bulging or not; persistent calyx-lobes inconspicuous to slightly prominent. **Seeds** ovoid to ellipsoid, 1.3–2.9 x 0.4–1.4 cm.

Key to varieties

1. Inflorescence villous to woolly. Lateral veins looping to form marginal veins; intercostal veins distinct and prominent below.....2
- Inflorescence subglabrous to puberulous. Lateral veins not looping; intercostal veins not prominent below.....3

2. Twigs woolly. Leaves villous to woolly, thickly leathery. Flowers 4-merous.....

var. **maingayi** (Clarke) Danser

l.c. 63; Matthew *l.c.* (1976) 70, *l.c.* (1977) 93; Kochummen *l.c.* 54. Basionym: *M. maingayi* Clarke *l.c.* 746. Type: *Maingay* 2680 = *Kew Distr.* 711, Singapore (holotype K; isotypes BM, GH, L). Synonyms: *M. maingayi* Clarke var. *subtomentosa* King *l.c.* 75; *M. propinqua* Ridl., J. Fed. Mal. St. Mus. 4,1 (1909) 25.

Twigs woolly by short yellowish brown hairs. Leaf-stalk stout, 2–3.5 cm, woolly brown-hairy. Leaves 8.5–22 x 3.5–10.5 cm, thickly leathery, abaxial surface woolly brown-hairy, adaxial surface glabrous except the midrib and veins; lateral veins 5–6 pairs, prominently sunken above and raised below, forming marginal loops below; intercostal veins prominently sunken above and raised below. Inflorescences villous to woolly. Flowers 4-merous. Fruits with well-exposed persistent disc; persistent calyx-lobes 1.5–2 mm long.

Sumatra, Peninsular Malaysia, Borneo. In Sabah recorded from Lahad Datu, Ranau, Sipitang, and Tawau districts. In Sarawak, recorded from only Kapit (3rd Div.) and Ulu Lawas (5th Div.). In primary and secondary mixed dipterocarp forests, to 1500 m.

- Twigs subglabrous to velutinous. Leaves glabrous to subglabrous. Flowers 5-merous.....

var. **korthalsiana** (Wangerin) Danser

l.c. 63; Matthew *l.c.* (1976) 70, *l.c.* (1977) 93. Basionym: *M. korthalsiana* Wangerin *l.c.* (1907) 335. Type: *Korthals, s.n.*, E Borneo, Bandjermasin, G. Sakoembang (L).

Twigs subglabrous to velutinous. Leaf-stalks slender, 1.5–2 cm. Leaves 7–13 x 3–5 cm, glabrous to subglabrous; lateral veins 5–6 pairs, forming looped marginal veins below; intercostal veins prominent below. Inflorescences velutinous to woolly. Flowers 5-merous. Fruits with well-exposed persistent disc; persistent calyx-lobes to 1 mm long.

Sumatra and Borneo (Sabah and Kalimantan). In Sabah, recorded from Kota Belud, Lahad Datu, Sandakan, Sipitang, and Tawau districts. No record from Sarawak. In primary mixed dipterocarp forest, from low altitude to 1100 m.

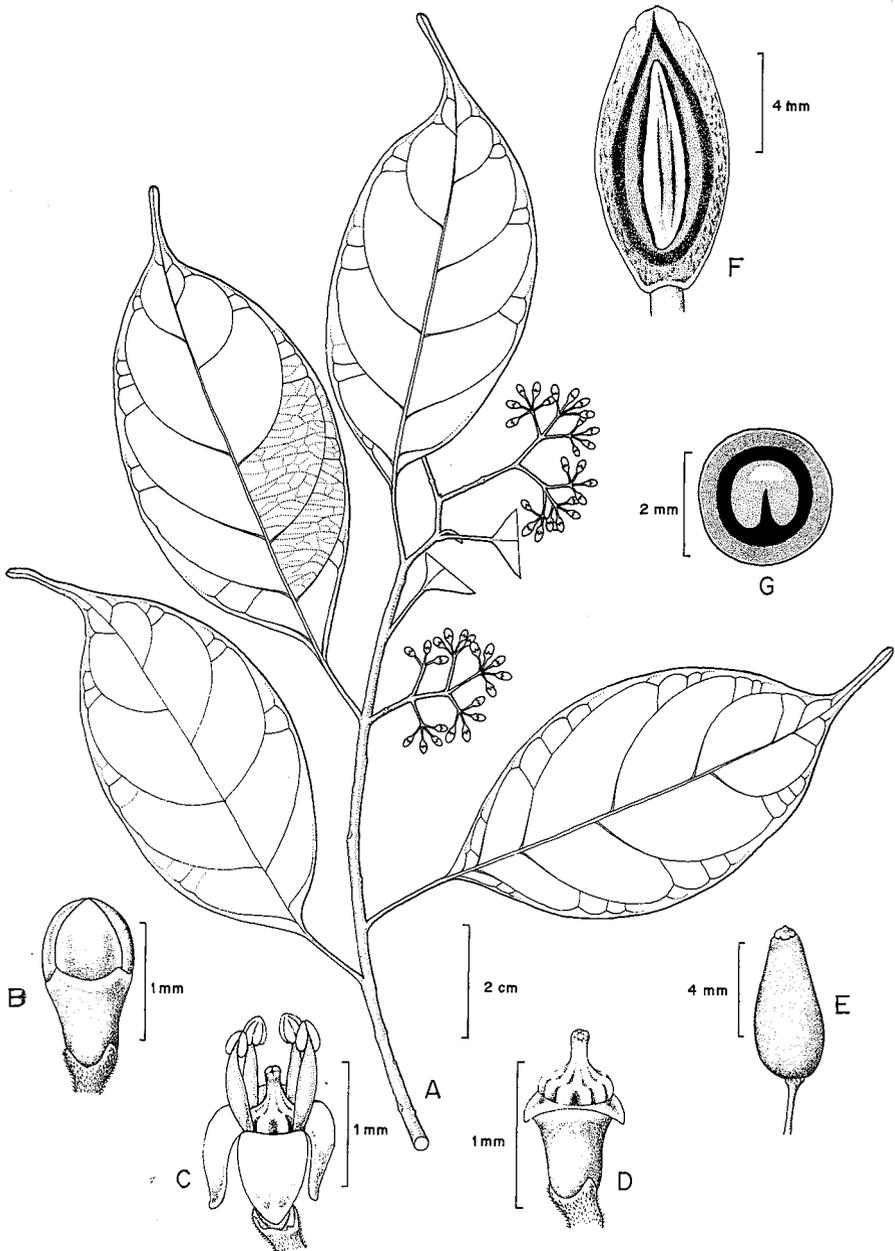


Fig. 1. *Mastixia rostrata* subsp. *caudatifolia*. A, flowering leafy twig; B, flower bud; C, open flower; D, open flower with petals and stamens removed; E, fruit; F, fruit in longitudinal section; G, fruit in cross section. (A–D from SAN 30572, E–G from S. 36376.)

3. Leaves 9–24 x 4–12 cm, margin not wavy after drying, under surface not pale yellow when dry. Twigs and leaves (sub)glabrous. Fruits with persistent disc well-exposed and bulging.....

var. rhynchocarpa Danser.

l.c. 64; Matthew *l.c.* (1976) 71, *l.c.* (1977) 93. Type: *Endert 4769*, E Borneo, East Coast, near Long Hoet, 150 m (lectotype L; isolectotypes A, BO, K). Synonyms: *Mastixia trichotoma* Blume var. *benculuana* Danser *l.c.* 64; *Mastixia trichotoma* Blume var. *simalurana* Danser *l.c.* 65.

Twigs subglabrous. *Leaf-stalks stout, 1.5–2 cm long.* Leaves 9–24 x 4–12 cm, thickly leathery, subglabrous, *under surface not pale yellow when dry; lateral veins 5–15 pairs, not looping near the margin; intercostal veins faintly visible below.* Inflorescences subglabrous to puberulous. Flowers 4-merous. Fruits crowned by bulging, well-exposed *persistent disc*; persistent calyx-lobes to 0.5 mm long.

Sumatra, Java, Borneo, Celebes, and the Moluccas. In Sabah widely distributed. In Sarawak in Ulu Mujong (3rd Div.), Lawas (5th Div.), and Kapit (7th Div.). In primary mixed dipterocarp forests, to 1800 m.

Leaves 7.5–15 x 2.5–6 cm, margin wavy after drying, under surface pale yellow when dry. Twigs and leaves covered with powdery tomentum. Fruits not so.....

var. clarkeana (King) Danser

l.c. 62; Matthew *l.c.* (1976) 72, *l.c.* (1977) 93; Kochummen *l.c.* 54. Basionym: *Mastixia clarkeana* King *l.c.* 72. Type: *Scortechini 869*, Perak (lectotype K; isolectotypes CAL, G, L, P). Synonyms: *Mastixia clarkeana* King var. *macrophylla* King *l.c.* 72; *Mastixia korthalsiana* Wangerin var. *macrophylla* Wangerin *l.c.* (1907) 336; *Vitex premnoides* Elmer *l.c.* 2874; *Mastixia premnoides* (Elmer) Hallier f. *l.c.* 42; *Mastixia trichotoma* Blume var. *tenuis* Danser *l.c.* 61.

Twigs covered with *pale brown powdery tomentum.* *Leaf-stalks slender, 1–1.5 cm long.* Leaves elliptic, 7.5–15 x 2.5–6 cm, *under surface pale yellow on drying; lateral veins 5–7 pairs, not looping near the margin; intercostal veins faintly visible below.* Inflorescences subglabrous to puberulous. Flowers 4-merous. Fruits without well-exposed persistent disc; persistent calyx-lobes prominent, 0.5–1 mm long.

Pattani (Peninsular Thailand), Sumatra, Peninsular Malaysia, Borneo, and Mindanao (Philippines). Uncommon in Borneo, recorded only from Kuching and Mt. Penrissen (1st. Div.) in Sarawak. No record from Sabah. In primary mixed dipterocarp forest, from low altitude to 1100 m.

Vernacular names. Sabah—*bantis* (Dusun Kinabatangan), *medang kanigara* (Malay). Sarawak—*itan beruang* (Kelabit), *medang kanigara* (Malay), *priabu* (Murut).

Taxonomy. Of the five varieties recognised by Matthew *l.c.*, four occur in Sabah and Sarawak.

DATISCACEAE

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Merrill, EB (1921) 414; Masamune, EPB (1942) 507; van Steenis, FM I, 4 (1953) 382; Browne, FTSB (1955) 82; Backer & Bakhuizen *f.*, FJ I (1963) 313; Smythies, CST (1965) 43; Burgess, TS (1966) 86; Whitmore, TFM 2 (1973) 29; Cockburn, TS 1 (1976) 73; Anderson, CLTS (1980) 165; Ashton, MNDTS 2 (1988) 234; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 52.

Trees, shrubs or herbs. **Leaves** spiral, simple, without stipules; blade palmately veined, domatia/glands present. **Flowers** in axillary and/or terminal elongated spikes or panicles, unisexual, regular, parts not overlapping; male: sepals 4–9, free and unequal or connate in a lobed tube; petals 4–9 or 0, free; stamens 4–9 on the sepals, filaments often long, anthers basifixed, 2-celled, longitudinally dehiscent; female: sepals 3–8, often joined above the ovary or free; petals 0; staminodes 0; ovary inferior, 1-celled with 3–8 parietal placentas and numerous ovules; styles 3–8 opposite calyx-lobes, thick, free, mostly adnate to the margin of the calyx, simple or bifid, stigma club-like or capitate. **Fruits** capsular, wall papery, opening at apex with slits and/or splitting laterally. **Seeds** very numerous, minute; endoperm none; embryo straight, cylindrical.

Distribution. 3 genera, with 4 species: *Datisca* (2 species, extra-Malesian), *Octomeles* (1 species, Indomalesian) and *Tetrameles* (1 species, Indomalesian). Only *Octomeles* is found in Sabah and Sarawak.

Taxonomy. The systematic position of the Datisceae remains controversial. Several authors (e.g., Whitmore *l.c.*; Mabberley, PB (1987) 172) maintain the Datisceae as most closely related to the Begoniaceae and Cucurbitaceae, in the Cucurbitales. Mabberley *l.c.* and others (e.g., Willis, DFPP (1973) 1140) suggest that both *Octomeles* and *Tetrameles* should be taken out of the Datisceae and put in the Tetramelaceae (Warb.) Airy-Shaw.

OCTOMELES Miq.

(Greek, *octo* = eight, *melos* = parts, limbs; the 8-merous flowers)

Fl. Ind. Bat., Suppl. (1861) 133, 336; van Steenis *l.c.* 382; Burgess *l.c.* 86; Cockburn *l.c.* 73; Anderson *l.c.* 165; Wong, DMT (1984) 25; Ashton *l.c.* 234; Whitmore, Tantra & Sutisna *l.c.* 53.

Evergreen trees with thick twigs sharply 3-angular at apex. **Leaves** roundish cordate, 5–7(–9)-veined; stalk long, 5-angled; lower surface with domatid glands. **Flowers** sessile, green,

5–8-merous, dioecious, solitary; male: calyx-tube short with free triangular lobes; petals triangular; stamens strongly incurved in bud, filaments thick, anthers large, kidney-shaped, curved; female: sepals joined to form a tube; ovary apex cup-shaped by the thick calyx-tube; styles fleshy, inserted in the calyx-rim opposite the free triangular calyx-lobes, stigma capitate. **Fruit** a barrel-shaped capsule crowned with persistent styles, the styles and exocarp drop away irregularly leaving a pale membranous endocarp behind; *endocarp splitting from the top downwards, the segments spreading stellately, persistent*. **Seeds** spindle-shaped, with narrower tail and thickened head.

Octomeles sumatrana Miq.

(of Sumatra)

Fig. 1.

l.c. 133, 336; van Steenis *l.c.* 382; Browne *l.c.* 82; Smythies *l.c.* 43; Cockburn *l.c.* 73; Anderson *l.c.* 165; Ashton *l.c.* 234; Whitmore, Tantra & Sutisna *l.c.* 53. **Type:** *Teijsmann, s.n.*, Sumatra, Prov. Palembang (holotype L; isotype K).

Tree to 70 m tall and 3 m diameter; bole columnar; *buttresses steep, to 10 m high, spreading to 5 m away from the tree. Branches radial, ascending, pagoda-like; crown monopodial.* **Bark** pale brownish cream or grey, thin, hooped (branch-scars), dot-like lenticels visible; inner bark pinkish cream, soft, fibrous, thick. **Sapwood** cream, exudate slight, clear. *Twigs stout, glabrous, with prominent large round leaf-scars subtended by 5 almost papery sharp ridges.* **Leaves** broadly ovate to round, 12–33 x 16–29 cm, drying rather papery, with scattered white hairs below; base heart-shaped, often deeply to 16 cm, margin toothed or wavy, apex acute to acuminate; midrib raised above and below; lateral veins 7–10 pairs, the basal 1–2 pairs originating from the stalk insertion, giving a somewhat 3-veined or palmately veined appearance, mostly parallel and looping near margin, raised above and below; intercostal veins net-like and flat; midrib and lateral veins dark red on both surfaces; *obscure dark domatia present at apex, at the junctions of the midrib and lateral veins and alongside smaller veins (obvious in dry leaves); stalk glabrous, 3–5 mm thick and 6–32 cm long, smooth on upper side, 5-ridged on lower side, grooved near base for 1–2 cm.* **Male flowers** in spikes 20–60 cm long, *c.* (5–)8 mm across and 7 mm long; sepals connate for most of the length, lepidote, lobes free, triangular, 1.5–2 mm; petals triangular, alternate with calyx-lobes, *c.* 3 mm long; stamens 4–10 mm long, anthers 2–3 mm. **Female flowers** in shorter spikes 8–35 cm long, *c.* 5 mm across and 5–10 mm long; calyx-tube 2–4 mm high; ovary 1–2 mm long, styles fleshy, triangular, 2–3 mm long, stigma thick, 1–2 mm. **Fruits** 8–12 mm long, with pale brown endocarp. **Seeds** thicker in the middle, *c.* 0.8 mm long, numerous.

Vernacular names. Sabah—*binuang* (Malay). Sarawak—*benuang* (Iban), *binong* (Bidayuh), *lemeng* (Berawan, Punan, Tutoh).

Distribution. Sumatra, Borneo, Philippines, Celebes and New Guinea. In Sabah, common on the east coast and interior. In Sarawak, in lowlands and hills in all districts.

Ecology. Often associated with riverine and alluvial deposits but also found in primary and secondary mixed dipterocarp forests on well-drained fertile friable soils below 600 m on the east coast of Sabah and to 800 m on the west coast and in Sarawak. It is more typically

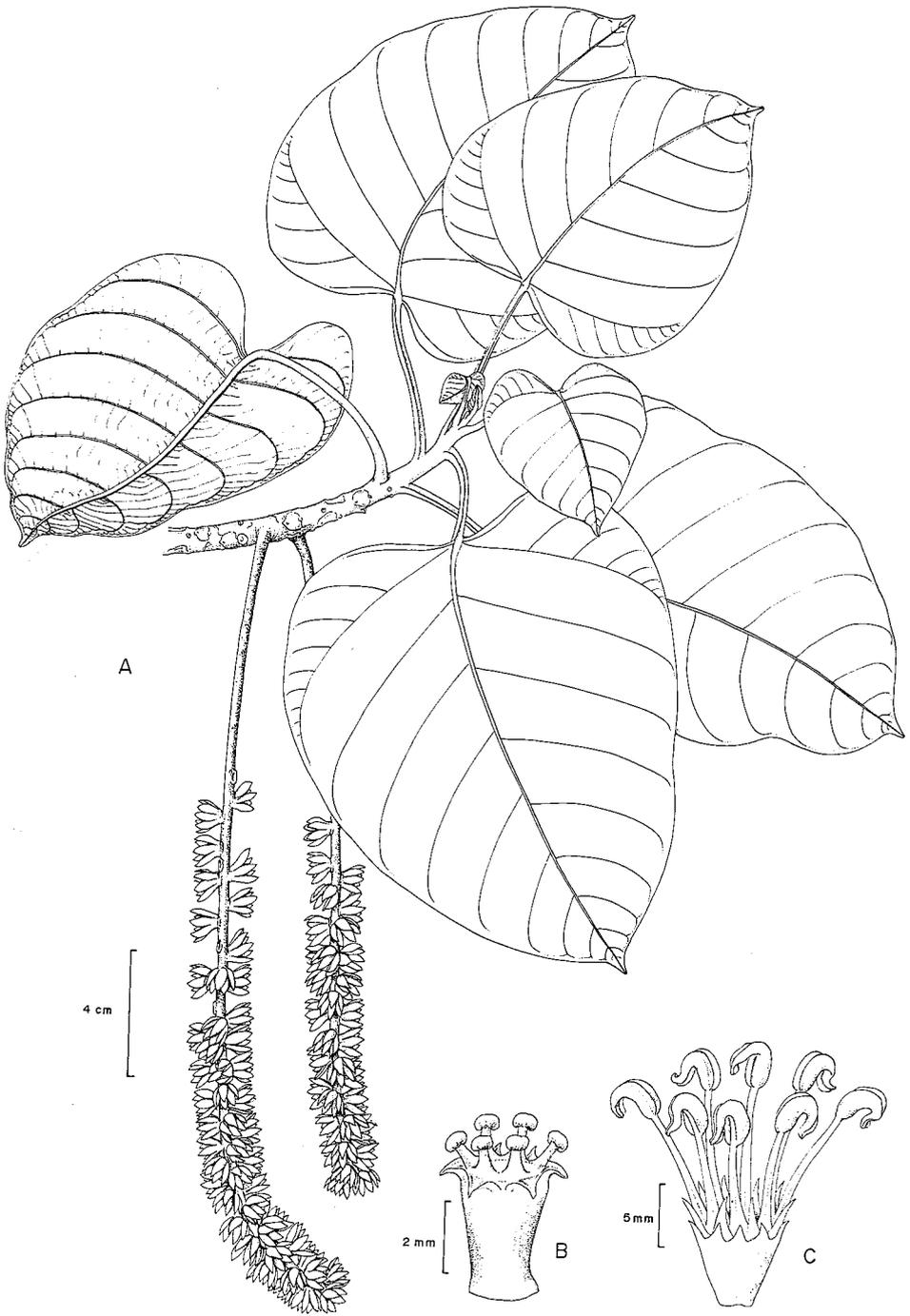


Fig. 1. *Octomeles sumatrana*. A, fruiting leafy twig; B, female flower; C, male flower. (A from SAN 67376, B from Kokawa & Hotta 1426, C from SAN 67406.)

found growing in disturbed habitats such as logged-over forest and after cultivation where it can grow extremely fast, often in gregarious even-aged stands. Flowering and fruiting from November to April in Sabah and Sarawak. Flowers probably wind-pollinated and the seeds probably wind-dispersed.

Silviculture. *Binuang* is one of the fastest growing trees and a strong light-demander. It takes only about 4 months from sowing to planting out in the field. Seed viability, however, soon decreases after collection. Its ability to grow on low hilly sites and in temporarily flooded areas, quick crown development, and self-pruning abilities, make it a suitable plantation tree. For optimal growth, however, the seedlings/saplings would have to be planted at sufficiently wide spacings to accommodate the huge crowns of the mature trees.

Timber strength & wood anatomy. *Binuang* timber is a soft, light hardwood of the obeche (*Triplochiton scleroxylon* – Sterculiaceae) type with long fibres and a low density. The sapwood is almost white but of drab appearance and the heartwood is pale brown or pinkish brown. The wood has an interlocked grain and the texture is coarse (Burgess *l.c.*, Wong *l.c.*). The pores are rather large, oval, mostly open, evenly distributed, with broader rays distinct, almost white and the cut end surfaces are dull (Browne *l.c.*). The dry weight is 270–465 kg/m³ air-dried. The wood seasons slowly and is not durable. There is a tendency for both brittle-heart and fungal stain to develop, and damage by pinhole-borer beetles and powder-post beetles is sometimes present but treatment with preservatives gives moderate resistance (Burgess *l.c.*, Wong *l.c.*).

Uses. The timber works easily with machine and hand tools but the timber can crumble or give a woolly finish if the tool cutters are not kept sharp. It also stains and polishes satisfactorily. Burgess *l.c.* and Wong *l.c.* suggest that the wood can be used for cores, backs to plywood, and is a useful utility timber for packing cases, concrete shuttering, matchboxes and other temporary purposes. It is a potentially important tree for wood chip and pulping and as a shade tree or for stabilising river banks but its potential is not yet exploited in Sabah and Sarawak.

Notes. The seedlings and saplings have usually larger leaves with a cordate base and a few coarse teeth, a distinctly opposite and decussate branching, and characteristically angled twigs which make them easy to identify. Some young *Macaranga* species (Euphorbiaceae) have similar leaves but these can be distinguished easily as the twigs of this genus do not have papery ridges. Older trees can sometimes be confused with *Neolamarckia cadamba* (Roxb.) Bosser (Rubiaceae), but *Octomeles sumatrana* has radial branching in distinct tiers due to its episodic growth pattern whereas *N. cadamba* produces radial branches continuously up the stem. The leaves of *O. sumatrana* are always dotted with holes due to insect damage unlike the leaves of *N. cadamba*. It has been noted by van Steenis *l.c.* as being a “preferred” tree for nesting bees like the other lofty tree species, *Koompassia excelsa* (Becc.) Taub. (Leguminosae).

GOODENIACEAE

K.M. Wong

Forest Research Centre,
Forestry Department, Sabah

Merrill, EB (1921) 586; Masamune, EPB (1942) 724; Leenhouts, FM 1, 5 (1957) 335, FM 1, 5 (1958) 567, FM 1, 6 (1972) 949, FM 1, 7 (1976) 827, FM 1, 9 (1982) 566.

Small trees, shrubs or herbs, or scrambling-climbing plants. **Leaves** spirally arranged or opposite, or whorled, *simple*, pinnately veined; *leaf axils often with hair tufts*; stipules none. **Inflorescences** *cymose*, bracteate. **Flowers** *5-merous*, bisexual, protandrous (male parts maturing first); calyx tubular with distinct lobes; *corolla members fused into one or two broad lip-like structures in the open flower, the lobes with thin membranous margins*; stamens 5, free, borne on the calyx, filaments linear, anthers basifixed and introrse, 2-celled; disc none; ovary 2-celled or imperfectly 1-celled, style cylindrical, *stigma surrounded by a cup-shaped structure (indusium) with ciliate margin*; ovules 1-many, placentation axile or basal. **Fruits** capsular or drupaceous. **Seeds** 1-many, with endosperm.

Distribution. 16 genera, about 430 species, mostly Australian. In Malesia, 5 genera with 11 species. In Sabah and Sarawak, 5 species of *Scaevola* are documented.

Ecology. The family seems confined to or adapted to poor soils. In Malesia its species occur in rather open sites in beach or coastal areas, or on ultramafic soils and in low-stature montane forests.

Taxonomy. The Goodeniaceae are closely related to *Lobelia* and related genera in the Campanulaceae.

SCAEVOLA L.

(the name given to Gajus Mucius around 507 B.C., who burnt his own hand in fearlessness, to which is likened the white, 5-lobed corolla which turns brown)

Mant. (1771) 145; Merrill *l.c.* 586; Masamune *l.c.* 724; Leenhouts *l.c.* (1957) 339, *l.c.* (1958) 567, *l.c.* (1972) 951. **Synonym:** *Temminckia* de Vriese, Ned. Kruidk. Arch. 1, 2 (1851) 141.

Shrubs or small trees, or scrambling-climbing plants. **Leaves** spirally arranged or opposite, or whorled, *entire or crenate to dentate, the margins and tip provided with glands*; leaf-stalks with broad insertion on the shoots. **Flowers** in axillary, bracteate cymes; calyx-tube fused to the ovary; *corolla members all fused to form a broad lip-like structure in the open flower, the free lobes with membranous margins and fimbriate at their base*; ovary inferior

or semi-inferior, 1–2-celled; ovules 1 per ovary cell. **Fruits** drupaceous, with a hard stone. **Seeds** 1 or 2.

Distribution. About 130 species, predominantly Australian, one species reaching to Taiwan and Hainan in south China, a few in east Malesia (New Guinea), and two widely distributed, chiefly littoral species (*S. sericea* in the Indo-Pacific region, *S. plumieri* in the Indo-Atlantic region). In Sabah and Sarawak, 5 species.

Key to *Scaevola* species

1. Leaves in whorls of four.....**5. *S. verticillata***
 Leaves spirally arranged.....2
2. Leaves sessile to subsessile, the blades decurrent more or less all the way to the nodes or the stalks exceedingly short and inconspicuous.....3
 Leaves distinctly stalked, decurrent basal part of the blades very narrow and inconspicuous.....4
3. Plants of sandy, rocky or cliff sites beside the sea or the coast. Leaves exceeding 10 cm long, with long-decurrent bases. Cymes (2–)3–5(–6)-times branched, often 6–10 cm long. Calyx-lobes linear to lanceolate, 2–3 mm long (sometimes elongating to 5–7 mm long); corolla with a fused part 15–20 mm long and free lobes 5–10 mm long. Fruits broad-obovoid to globose, 8–12 mm long, strongly ridged.....**4. *S. sericea***
 Plants of high elevation on mountains (known only on Mt Kinabalu, Sabah). Leaves 1–7 cm long, more or less abruptly sessile. Cymes 1–2-times branched, not exceeding 3 cm long. Calyx-lobes triangular, less than 1 mm long; corolla with a fused part 4–6 mm long and free lobes 4–6 mm long. Fruits narrow-obovoid, 3.5–5 mm long, slightly ridged**1. *S. chanii***
4. Plants of ultramafic substrates (in Borneo known only in Sabah). Leaves 8–15 cm long, distinctly crenate-dentate on the margins. Cymes 3–6-times branched, 5–9 cm long, the first pair of bracts conspicuously larger and leaf-like, peduncle 2–3.5 cm long. Flowers in the forks of cyme branches, stalked.....**2. *S. micrantha***
 Plants so far known only on limestone (in Sarawak). Leaves not exceeding 8 cm long, only minutely and inconspicuously crenate on the margins. Cymes 1–2-times branched, not exceeding 2.5 cm long, the first pair of bracts tiny triangular structures, peduncle to 1 cm long only. Flowers in the forks of cyme branches, sessile.....**3. *S. muluensis***

1. *Scaevola chanii* Wong

Fig. 1.

(C.L. Chan, orchidologist and botanical illustrator)

Sandakan 3 (1993) 12. **Type:** *Chan, Jamal & Wong WKM 2360*, Sabah, Mt. Kinabalu, summit trail, 2900 m alt. (holotype SAN; isotypes K, KEP, L, SAR, SNP).

Shrub or treelet, to 2–3 m high. **Leaves** spirally arranged, obovate, 1–7 x 0.6–3 cm, margin minutely crenate-dentate, coriaceous; glabrous except for small tufts of silvery white hairs

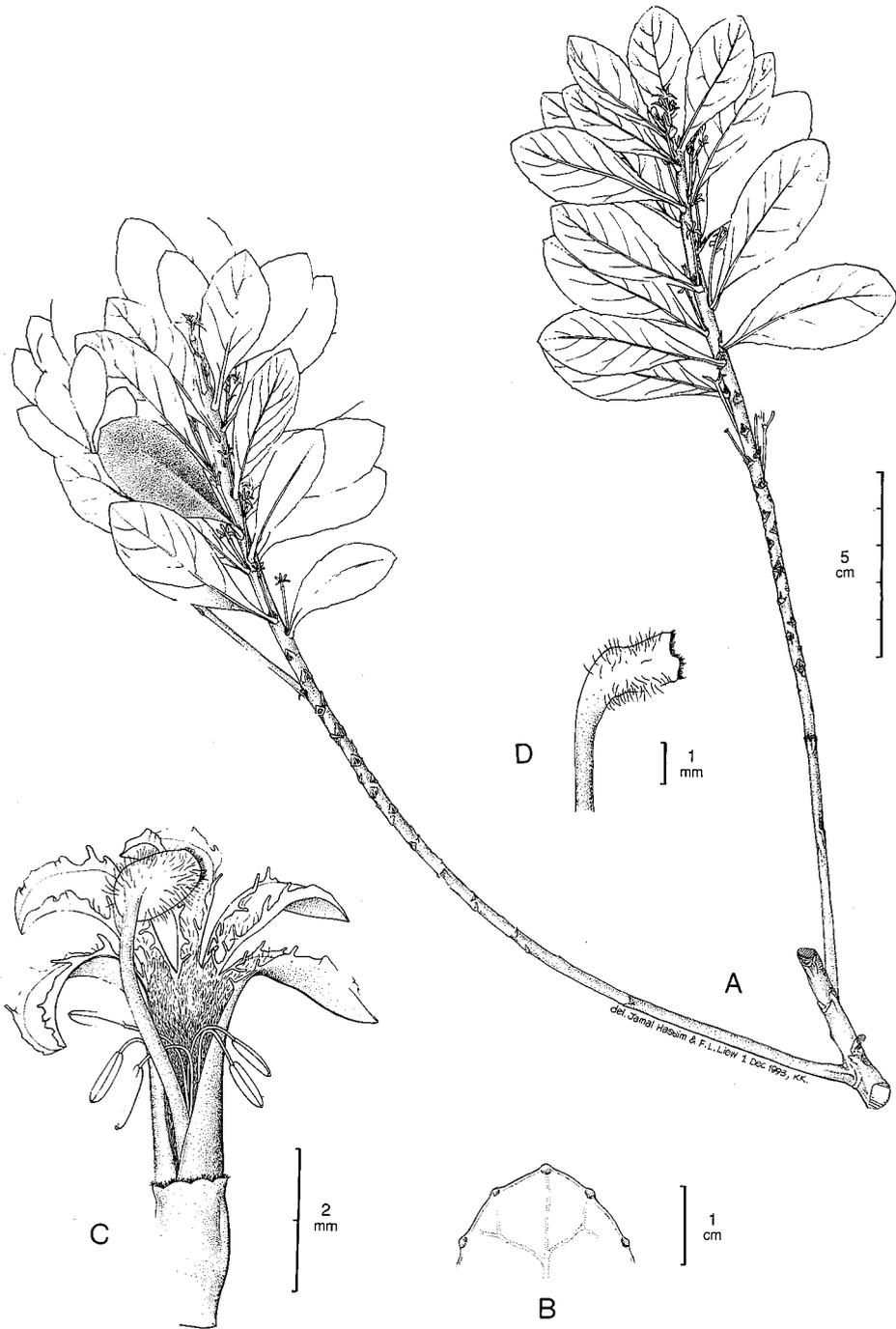


Fig. 1. *Scaevola chanii*. A, flowering leafy twig; B, detail of leaf tip and margin showing glands; C, flower; D, indusiate stigma. (All from Chan, Jamal & Wong WKM 2360.)

in the leaf axils, and tiny silvery round scales all over the young leaves; lateral veins 4–8 pairs, inconspicuous; *stalks* very short, only 1–2 mm long at most, *inconspicuous*. **Inflorescences** 1.5–2.5 cm long, branched only 1–2-times, peduncle 0.7–2 cm long; first pair of bracts triangular-linear, small; glabrous except for tufts of pale hairs in the bract axils. **Flowers** sessile; *calyx* cup obovoid, glabrous, the lobes triangular, less than 1 mm long, pale pilose on the margins; corolla sparsely pale hairy on the outside, the fused part 4–6 mm long, the free lobes 4–6 mm long, pale pilose inside; stamens with filaments *c.* 3 mm long, anthers 0.7–1 mm long; style 6–8 mm long; indusium around the stigma glabrous on the surface, densely pale hairy on the margin. **Fruits** obovoid, 3.5–5 mm long, slightly ridged.

Distribution. Recorded only from Mt. Kinabalu, Sabah. So far endemic.

Ecology. Upper montane forest on ultramafic soil, at 2500–3000 m.

2. *Scaevola micrantha* C. Presl

(Greek, *micros* = small, *anthos* = flower)

Rel. Haenk. 12 (1835) 58; Leenhouts *l.c.* (1957) 342. **Type:** *Haenke 124*, Philippines (W). **Synonyms:** *Temminckia micrantha* (C. Presl) de Vriese *l.c.* (1851) 145; *S. pedunculata* Merr., Philip. J. Sc., Bot. 5 (1910) 251, incl. var. *mollis*, *l.c.* (1921) 586, Masamune *l.c.* 724; *S. merrillii* Elmer, Leaflet. Philip. Bot. 4 (1912) 1491.

Shrub or small tree to 10 m tall, 5 cm diameter. **Bark** dark grey to greenish grey, smooth to slightly flaky. **Leaves** spirally arranged, obovate to oblanceolate, 8–15 x 2–5.5 cm, margin crenate to distinctly dentate, chartaceous to thinly coriaceous; subglabrous (with scattered hairs on the stalk, leaf base and midrib on the lower side) to scantily short-hairy to velvety on the lower side, the leaf axils with tufts of silvery white hairs; lateral veins 6–11 pairs, inconspicuous; *stalks* 4–17 mm long, distinct. **Inflorescences** 5–9 cm long, branched 3–6-times, peduncle 2–3.5 cm long; first pair of bracts ovate and leaf-like, much larger than subsequent bracts; glabrous to pale velvety all over. **Flowers** on stalks 0.5–1.5 mm long; calyx-cup obovoid, glabrous to densely pale pilose, the lobes triangular, *c.* 0.5 mm long, short-hairy on the margins to pale pilose all over; corolla scantily to densely pale pilose all over the outside, the fused part 5–7 mm long, the free lobes 4–5 mm long, pale pilose inside; stamens with filaments *c.* 4 mm long, anthers *c.* 1.5 mm long; style 6–7 mm long; indusium around the stigma scantily hairy to pale pilose on the surface, densely pale-hairy on the margin. **Fruits** obovoid, 5–6 mm long, slightly ridged.

Distribution. Borneo and the Philippines, including Palawan Is. In Borneo, known only from Sabah (Kinabalu-Ranau area, Telupid, Beluran, Mt. Tawai and Mt. Danum). The Celebes collection (*Lam 3266*) from Talaud Is. attributed to this species by Leenhouts *l.c.* (1957) appears to be a different species; it has entirely glabrous leaves, 1-mm-long calyx teeth, linear and longer (6–8 mm) inflorescence bracts, and only 2–3-times branched inflorescences.

Ecology. Recorded only from ultramafic substrates, from the lowlands to submontane forest at *c.* 1500 m.

3. *Scaevola muluensis* Wong

(of Mt. Mulu, Sarawak)

Sandakan 3 (1993) 15. **Type:** *Argent & Jermy 1011*, Sarawak, 4th Division, Gunong Api (holotype SAN; isotypes E, L, SAR).

Shrub or treelet to *c.* 1 m high. **Leaves** spirally arranged, obovate, 4–6.5 x 2–3 cm; margin only minutely and inconspicuously crenate; thinly coriaceous; glabrous except for scattered short pale hairs on the stalk and tufts of short pale hairs in the leaf axils; lateral veins 5–6 pairs, slightly elevated on both surfaces when dry; stalks 5–13 mm long, distinct. **Inflorescences** 1–2 cm long, branched only 1–2-times, peduncle to 1 cm long only; first pair of bracts tiny triangular structures; glabrous except for scanty pale hairs in the bract axils. **Flowers** sessile; calyx-cup obovoid, glabrous, the lobes triangular, *c.* 0.5 mm long, glabrous to sparsely short-hairy on the margins; corolla sparsely pale-hairy on the outside, the fused part 6–6.5 mm long, the free lobes 4.5–5 mm long, pale pilose inside; stamens with filaments *c.* 4 mm long, anthers *c.* 1 mm long; style 6–6.5 mm long; indusium around the stigma with pale long hairs all over, densely pale hairy on the margin. **Fruits** obovoid, 4–5 mm long, slightly ridged, ripening black.

Distribution. Known from two collections (*S.30907* and *Argent & Jermy 1011*) between 1000 m and 1600 m on the limestone of Gunong (Mt.) Api in the Gunong Mulu National Park in Sarawak's 4th Division.

Ecology. Probably restricted to limestone, found on exposed ridges and cliff faces.

4. *Scaevola sericea* Vahl

(Latin, *sericeus* = silky with long hairs; the leaves)

Symb. Bot. 2 (1791) 37; Leenhouts, *l.c.* (1957) 339. **Type:** *G. Forster, s.n.*, Pacific, Niue Is. (C). **Synonyms:** *Lobelia plumieri* (non L.) Burm. f., Fl. Ind. (1768) 189; *S. koenigii* Vahl, Symb. Bot. 3 (1794) 36; *S. taccada* Roxb., Hort. Beng. (1814) 15, Leenhouts *l.c.* (1972) 951; *S. plumieri* (non Vahl) Blume, Bijdr. (1826) 730; *S. leschenaultii* DC., Prod. 7 (1839) 506; *S. macrocalyx* de Vriese *l.c.* (1850) 138; *S. piliplena* Miq., Fl. Ind. Bat. 2 (1857) 581; *S. frutescens* (non *Lobelia frutescens* Mill.) Krause, Pfl. R. Heft 54 (1912) 125, Merrill *l.c.* (1921) 586, Masamune *l.c.* 724.

Shrub or small tree to 10 m tall and 10 cm diameter. **Bark** yellowish green to grey, smooth. **Leaves** spirally arranged, obovate, 12–26 x 5–10 cm; base decurrent to the node, margin crenate to subentire, apex obtuse, rounded; thickly succulent to thinly coriaceous; glabrous to scantily hairy to tomentose on both sides, the leaf axils with dense tufts of pale long-hairs; lateral veins 8–12 pairs, slightly elevated on upper side; stalks nil or very short, hardly 1–2 mm long. **Inflorescences** (4–)6–10 cm long, branched (2–)3–5(–6)-times, peduncle *c.* 1 cm long; first pair of bracts linear-triangular; glabrous to densely short-hairy all over. **Flowers** sessile on the slender cyme branches; calyx cup obovoid-ellipsoid, glabrous to scantily to densely pale hairy, the lobes linear to lanceolate, 2–3 mm, elongating to 5–7 mm long, scantily to densely short-hairy all over; corolla scantily to densely pale-hairy all over the outside, the fused part 15–20 mm long, the free lobes 5–8(–10) mm long, pale pilose inside; stamens with filaments 10–15 mm long, anthers 2–3 mm long; style 15–20

mm long, indusium around the stigma scantily to densely hairy all over, densely pale-hairy on the margin. **Fruits** broadly obovoid to subglobose, 8–12 x 10–15 mm, conspicuously ribbed, fleshy, stone to 8 mm across.

Vernacular name. Sarawak—*butun laut* (Lundu Malay).

Distribution. Madagascar, SE Asia, throughout Malesia, tropical Australia, Micronesia, Melanesia, to Hawaii. In Borneo common along the sea and coast in Sabah, Sarawak, Brunei and Kalimantan.

Ecology. Common on sea-shores and sandy sites behind the shore, on rocky cliffs and even some sandstone hills on the coast (e.g., Trig Hill in Sandakan). Flowers and fruits all year round. The stones, with a corky outer layer, are buoyant and adapted to dispersal by sea currents. The seeds remain viable after long periods in sea water, but will germinate only with fresh water as after being washed ashore on a rainy day (Lesko & Walker, Ecology 50 (1969) 730).

Uses. The pith ("taccada") is used for making Malayan rice-paper and crafting artificial objects of decoration, such as flowers (Burkill *l.c.*). Mamit (*S. 35139*, Sarawak, 1st Division, Lundu) records that the liquid extracted from the fruit can be applied directly to cure sore eyes.

5. *Scaevola verticillata* Leenh.

(Latin, *verticillatus* = whorled; the leaves)

Blumea 12 (1964) 317, f. 1, *l.c.* (1972) 951. **Type:** *Meijer SAN 22818*, Sabah, Ranau, Mt. Tambuyukon (holotype L; isotypes K, SAN, SAR).

Shrub or treelet. **Leaves** in whorls of four, obovate, 2–5.5 x 0.5–2 cm; margin minutely crenate and recurved strongly; thickly succulent to coriaceous; densely tomentose but later glabrescent on upper side, *densely woolly tomentose on lower side* and stalk, leaf axils with tufts of pale long-hair; lateral veins 8–12 pairs, inconspicuous to slightly elevated on upper side; stalks very short, 3–6 mm long. **Inflorescences** 1.5–2 cm long, branched only 2–4-times, peduncle to 0.7–1.2 cm long only, the branches very short; first pair of bracts slightly larger and broader than subsequent bracts; densely hairy all over. **Flowers** sessile; calyx-cup obovoid, scantily to densely short-hairy all over, the lobes of different sizes and shapes (one ovate and *c.* 2.5 mm long, one triangular and *c.* 1 mm long, three rounded and *c.* 0.5 mm long), scantily short-hairy on the surface, densely long-hairy on the margin; corolla densely woolly tomentose on the outside, the fused part 5–6 mm long, the free lobes 5–6 mm long, pale pilose inside; stamens with filaments 4.5–5 mm long, anthers *c.* 1 mm long; style 6.5–7 mm long; indusium around the stigma with pale long hairs around the base, densely pale-hairy on the margin. **Fruits** obovoid-ellipsoid, 3–3.5 mm long, slightly ridged, glabrescent except for the hairy persistent calyx-lobes.

Distribution. Recorded only from Mt. Tambuyukon near Mt. Kinabalu, Sabah. Probably endemic.

Ecology. Found in stunted subalpine vegetation at around 2500 m, on ultramafic substrate.

HYPERICACEAE

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Merrill, EB (1921) 392 (as part of Guttiferae); Masamune, EPB (1942) 477, 482 (as part of Guttiferae); Browne, FTSB (1955) 195; Smythies, CST (1965) 68; Burgess, TBS (1966) 311; Kochummen, TFM 2 (1973) 248; Robson, FM 1, 8 (1974) 1; Shea, TS 1 (1976) 142; Anderson, CLTS (1980) 217; Corner, WSTM 1 (1988) 364; Ashton, MNDTS 2 (1988) 295; Whitmore, Tantra & Sutisna, CLK 1 (1989) 181.

Trees, shrubs or herbs. **Leaves** simple, opposite, entire, without stipules, often with translucent or dark glandular dots. **Inflorescences** terminal and sometimes also axillary, rarely axillary only, cymose, thyrsoïd or paniculate, 1-many-flowered. **Flowers** bisexual, radially symmetrical, in some species with short-styled and long-styled forms; *sepals* 5, free or partially fused, imbricate, often with linear glands, persistent in the fruit; petals 5, free, imbricate, sometimes with scale-like nectar-bearing appendages at the base, glabrous; *stamens* 5-many, fused and grouped into 3-5 fascicles, anthers dorsifixed, staminodal fascicles sometimes present; *ovary* superior, 3-5-celled or just 1-celled, styles (2-)3-5, free or partially fused; ovules 2-many; placentas 2-5, parietal. **Fruits** capsular, splitting septically or loculicidally. **Seeds** 1-many, unwinged or winged; endosperm none.

Distribution. Seven genera and about 550 species, cosmopolitan except for the Arctic regions. In Malesia, including Borneo, only two genera (*Cratoxylum* and *Hypericum*) occur. In Sabah and Sarawak, 6 species of *Cratoxylum* (shrubs and trees) and 2 species of *Hypericum* (herbs) are found.

Ecology. In Sabah and Sarawak, species of *Cratoxylum* are mainly lowland plants; a few species occur also in lower montane areas. In general these are all fast-growing trees commonly found in forest fringes, gaps and disturbed habitats. The light seeds are wind-dispersed. *Hypericum petiolulatum* is a widespread species which in Borneo occurs only on Mount Kinabalu. *H. japonicum* occurs in lowland marshy places and rice fields.

Uses. *Cratoxylum* timber is distinguished into two types, one heavier and classified as *derum* in the trade, the other lighter and known as *geronggang*. *C. cochinchinense*, *C. formosum* and *C. maingayi* produce *derum* timber, which is moderately hard and moderately heavy to heavy; the timber is sometimes known as *serungan batu* (Sabah) or *entemu* (Sarawak). *C. arborescens* and *C. glaucum* produce *geronggang* timber, a light hardwood sometimes called *serungan* in Sabah. *Derum* is suitable for heavy and medium construction under cover, for tool handles and for wooden pallets. *Geronggang* has been found suitable for veneers and plywood, flooring, interior works and light to medium

construction (Wong (1982), DMT). *Geronggang* logs float in water. Browne *l.c.* and Burgess *l.c.* review the wood characteristics.

Taxonomy. Three tribes are recognised within the family: Vismieae (3 genera, Africa and America), Cratoxyleae (3 genera, Madagascar, Indo-Malesia, E Asia, NE America), and Hypericeae (*Hypericum*, mostly montane tropical and temperate areas). Phytochemically, the Hypericaceae are closely related to the Guttiferae; there are also many basic morphological and anatomical similarities between the two families.

Key to genera

Herbs. Bark without resinous sap. Flowers yellow to orange; petals without scale-like appendages. Fruits septicidally dehiscent (splitting along the internal partitions). Seeds without wings.....

Hypericum L.

Gen. Pl. ed. 5 (1754) 341; Robson *l.c.* 14.

About 400 species. Most tropical and temperate regions, but notably absent from the Amazon basin and uncommon in Australasia.

Small trees, shrubs or herbs; in Borneo the two species are herbs. *H. petiolulatum* Hook. f. & Thoms. ex Dyer occurs from Nepal through Indo-China to Sumatra and Borneo; in Borneo it is known only from Mount Kinabalu. *H. japonicum* has naturalised in marshy places and rice fields in Borneo; it is distributed from Japan and Korea through China, Sri Lanka to Malesia, Australasia and Hawaii.

Shrubs or trees. Bark exuding yellow resinous sap which dries black. Flowers white to reddish pink; petals sometimes with basal scale-like appendages. Fruits loculicidally dehiscent (splitting between the internal partitions). Seeds winged..... **Cratoxylum**

CRATOXYLUM Blume

(Greek, *kratos* = strong, *xylon* = wood; referring to the hard and durable timber)

derum, geronggang (Malay)

Verh. Bat. Gen. 9 (1823) 174; Merrill *l.c.* 392; Masamune *l.c.* 477; Browne *l.c.* 195; Smythies *l.c.* 68; Burgess *l.c.* 311; Gogelein, Blumea 15 (1967) 453; Kochummen *l.c.* 248; Robson *l.c.* 4; Shea *l.c.* 144; Anderson *l.c.* 217; Corner *l.c.* 364; Ashton *l.c.* 295; Whitmore, Tantra & Sutisna *l.c.* 181.

Shrubs or small to medium-sized trees. Bark exuding a yellow resinous sap which dries black. Leaves with translucent glandular dots. **Flowers** basically 5-merous; sepals 5 coriaceous, with longitudinal glandular lines or dots, persistent and often elongating in fruit; *petals* 5, white or pink to crimson, with longitudinal glandular lines or dots, in some species with an inner basal nectariferous scale-like appendage; *stamen fascicles* 3, the two larger attached to sepals, the smaller third attached to a petal, each with many stamens filaments white to crimson, anthers white to crimson; (sterile) staminodal fascicles 3, short

and alternating with the stamen fascicles; ovary incompletely 3-celled; styles 3, free, linear; stigma small, knob-like; ovules 4–many, attached to the basal part of the placenta, ascending. **Fruits** ellipsoid, coriaceous to woody, 3-valved, *splitting loculicidally*. **Seeds** 4–many on each placenta, linear to ovoid, *winged* all round or only on one side.

Distribution. 6 species, from India through S China to Malesia (absent in the Moluccas and New Guinea); all present in Borneo.

Ecology. Rare in primary forest, and more common in gaps, forest fringes and disturbed habitats in the lowlands. *C. arborescens* and *C. formosum* can occur on well-drained as well as swampy substrates. *C. glaucum* is found mostly in peat swamps, freshwater swamps, and wet heath forests on white sands. *C. maingayi* is restricted to limestone. The species are deciduous or semi-deciduous except for the evergreen *C. arborescens* and *C. glaucum*. *C. formosum* and *C. maingayi* flower on the bare branches; the other species bear inflorescences with the expanded new foliage or on mature leafy branches.

Key to *Cratoxylum* species

1. Leaf lateral veins inconspicuous, rather straight from midrib to very near the margin where a smooth-running marginal vein occurs. Seeds with wing all round (section *Isopterygium*).....2
 Leaf lateral veins distinct and prominent at least on lower leaf surface, arching at least 2–3 mm away from the margin, not joining at all, or joining to form conspicuous vein-loops. Seeds with wing on one side only.....3
2. Leaves not glaucous beneath, apex with at least a short tip, acuminate or caudate; leaf-stalks at least 4 mm long. Seeds 10–18 in each fruit cell.....1. ***C. arborescens***
 Leaves glaucous beneath, apex rounded, blunt or notched; leaf-stalks 1–3 mm long. Seeds 4–8 per fruit cell.....4. ***C. glaucum***
3. Leaf lateral veins not or only weakly joining to form vein-loops. Inflorescences developing on leafy branches, either terminal panicles or short cymes of a few flowers each at the ends of shoots or in leaf axils. Petals crimson to dark red or orange, without nectary scale (section *Cratoxylum*).....4
 Leaf lateral veins joining strongly to form conspicuous vein-loops towards the margin. Inflorescences developing on leafless parts of branches, of single axillary flowers or on short axillary shoots and so appearing clustered. Petals white to pale lilac, with a basal nectary-bearing scale (section *Tridesmos*).....5
4. Lateral veins on lower leaf-surface distinctly raised and rather coarse. Inflorescence a terminal panicle of many flowers. Persistent sepals less than half the capsule length6. ***C. sumatranum***
 Lateral veins on lower leaf-surface slightly raised and rather fine. Inflorescence a short 1–few-flowered cyme, terminal or axillary. Persistent sepals more than half the capsule length.....2. ***C. cochinchinense***

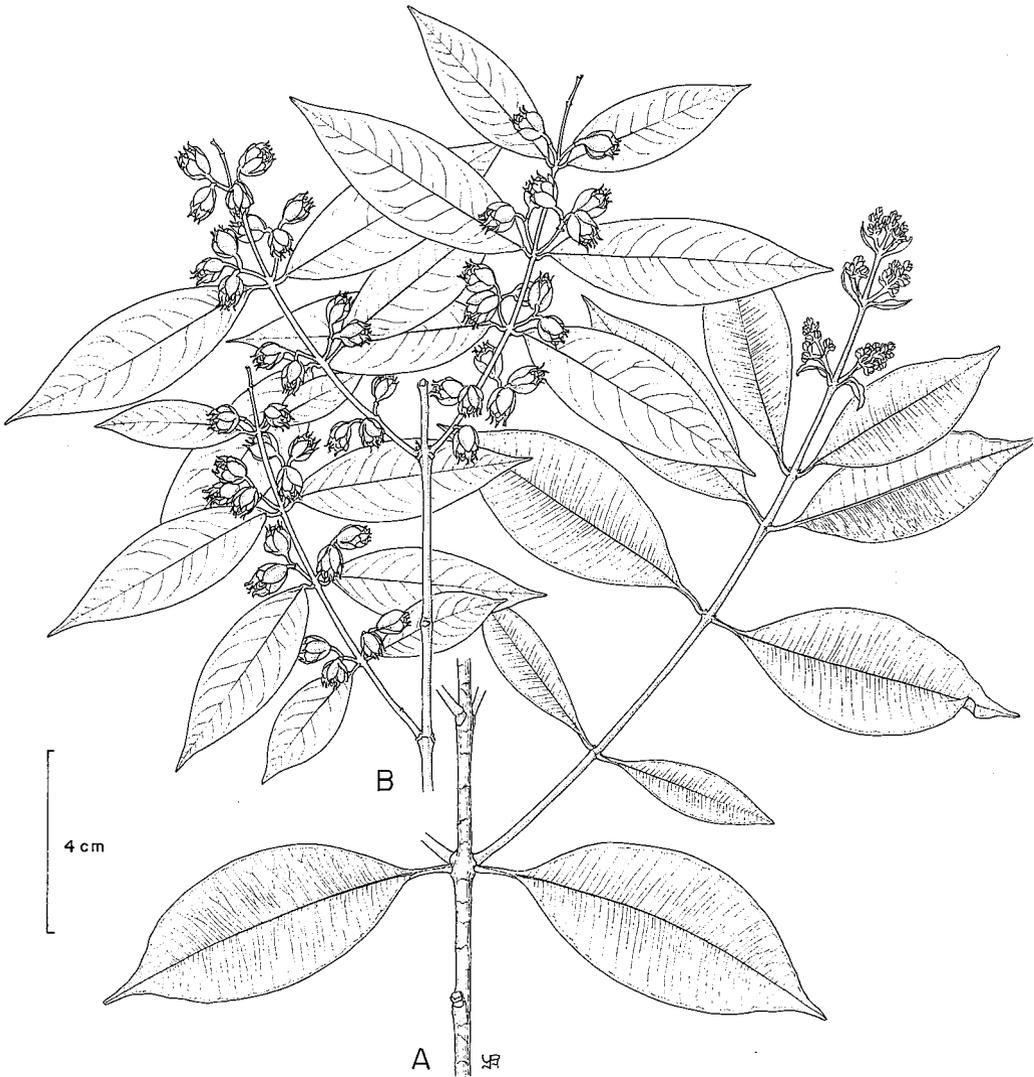


Fig. 1. *Cratoxylum cochinchinense*. A, leafy twig with young inflorescence; B, fruting leafy twig. (A from SAN 89495, B from SAN 134599.)

5. Mature leaves typically at least 6 cm long, lateral veins more than 7 pairs, stalks 6–10 mm long. Persistent sepals to only a third the capsule length.....**3. *C. formosum***
 Mature leaves typically not exceeding 4.5 cm long, lateral veins only 5–6 pairs, stalks to only 5 mm long. Persistent sepals nearly half the capsule length.....**5. *C. maingayi***

1. *Cratoxylum arborescens* (Vahl) Blume

(Latin, *arbor* = tree; the habit)

Mus. Bot. Lugd. Bat. 2 (1852) 17; Merrill *l.c.* 392; Masamune *l.c.* 477; Browne *l.c.* 195; Smythies *l.c.* 68; Kochummen *l.c.* 249; Shea *l.c.* 144; Anderson *l.c.* 217; Corner *l.c.* 365; Ashton *l.c.* 296; Whitmore, Tantra & Sutisna *l.c.* 181. **Basionym:** *Hypericum arborescens* Vahl, Symb. Bot. 2 (1791) 86, t. 43. **Type:** *Konig, s.n.*, 1778, Malacca (C).

Tree, sometimes a shrub, to 60 m tall and 120 cm diameter; buttresses if present to 1 m high. **Bark** grey to dark brown or reddish brown, smooth to fissured-cracking and papery scaly; **inner bark** pink to pale brown, finely laminated. **Sapwood** pale yellow. **Leaves** elliptic to obovate, 5–14 x 2–6.5 cm, coriaceous; base cuneate, *apex cuspidate to slightly caudate*; midrib flat to sunken on upper side; *lateral veins 30–50 pairs, fine, indistinct, running straight to margin where there is a clear marginal vein*; stalk 6–10 mm. **Flowers** arranged in a panicle; petals pink to crimson, with punctate glands, basal scale small. **Fruits** 7–9 x 3–4 mm, persistent sepals to half or more than half the capsule length. **Seeds** 10–18 per locule, each with a wing all round.

Vernacular names. Sabah—*geronggang*, *serungan* (general). Sarawak—*dat* (Kayan, Punan Tutoh), *di'it* (Melanau Oya), *geronggang* (Bidayuh), *idat* (Melanau Oya), *kata mudung* (Kenyah), *labakan* (Kelabit), *manat* (Melanau Rejang), *mertilan* (Iban), *serungan labakan* (Murut, Kenyah), *tat* (Kenyah). Brunei—*geroking* (Belait), *geronggang* (Belait, Dusun, Iban), *labakan* (Murut), *madak* (Tutong). Browne *l.c.* coins the name *geronggang gajah*.

Distribution. S Burma, Sumatra, Peninsular Malaysia, Borneo. In Sabah and Sarawak in all districts. Also in Brunei and Kalimantan.

Ecology. Lowlands principally, also up to lower montane forest at 1400 m. Primary and secondary forests, including *kerangas* (heath) and peat swamp forest, sometimes gregarious, and may form thickets in exploited forest areas.

Uses. The species provides much of the *geronggang* timber in Sabah and Sarawak.

2. *Cratoxylum cochinchinense* (Lour.) Blume

Fig. 1.

(of Indo-China)

l.c. (1852) 17; Masamune *l.c.* 477; Shea *l.c.* 145; Kochummen *l.c.* 251; Anderson *l.c.* 217; Corner *l.c.* 365; Ashton *l.c.* 299; Whitmore, Tantra & Sutisna *l.c.* 181. **Basionym:** *Hypericum cochinchinense* Lour., Fl. Cochin. (1790) 472. **Type:** *Loureiro, s.n.*, "in sylvis Cochinchinae" (BM). **Synonyms:** *C. polyanthum* Korth., Verh. Nat. Gesch. Bot. (1842) 175, t. 36; *C. myrtifolium* Blume *l.c.* (1852) 17; *C. ligustrinum* (Spach) Blume *l.c.* (1852) 16.

Tree, sometimes a shrub, to 30 m tall and 65 cm diameter; trunk sometimes with small buttresses and sometimes spiny. **Bark** pale brown to reddish brown, smooth to flaky or papery; inner bark greenish yellow to pink, thin. **Sapwood** white to yellowish. **Leaves** elliptic, 3.5–11 x 1–4 cm, glaucous beneath, chartaceous to thinly coriaceous; base cuneate, apex acute; midrib sunken on upper side; *lateral veins 9–12 pairs, fine, distinct, not joining to form a marginal vein*; stalks 2–3(–10) mm. **Flowers** 1–several in short axillary cymes; *petals crimson, with linear glands, without basal scale*. **Fruits** 8–12 x 4–5 mm, *persistent sepals more than half the capsule length*. **Seeds** 5–8 per locule, each with a wing only on one side.

Vernacular names. Sabah—*selangan biabas* (Suluk). Brunei—*machit laling* (Belait), *mertilan* (Iban), *serungan* (Brunei Malay), *taikakang* (Kedayan).

Distribution. Burma, Indo-China, South China, Sumatra, Peninsular Malaysia, Borneo, and the Philippines. In Sabah and Sarawak in all districts. Also in Brunei and Kalimantan.

Ecology. Lowland and hill forest, in primary or secondary forest including *kerangas* (heath) forest.

3. *Cratoxylum formosum* (Jack) Dyer

(Latin, *formosus* = beautiful; the flowers)

in Hooker *f.*, Fl. Br. Ind. 1 (1874) 258; Merrill *l.c.* 392; Masamune *l.c.* 477; Shea *l.c.* 146; Browne *l.c.* 197; Anderson *l.c.* 217; Corner *l.c.* 365, Pl. 80; Kochummen *l.c.* 251; Ashton *l.c.* 299; Whitmore, Tantra & Sutisna *l.c.* 181. **Basionym:** *Elodea formosa* Jack, Mal. Misc. 2 (1822) 24. **Type:** *Jack, s.n.*, Sumatra (K).

Tree, sometimes a shrub, to 20 m tall and 30 cm diameter, trunk sometimes spiny. **Bark** grey to red-brown or black, smooth to fissured or scaly; inner bark yellowish. **Sapwood** pale yellowish. **Leaves** broadly elliptic, 4–15 x 2.5–8 cm, glaucous beneath, chartaceous to coriaceous; base cuneate, apex rounded to acute or shortly tipped; midrib sunken on upper side; *lateral veins 8–16 pairs, coarse, raised, distinct, arching and forming vein-loops towards the margin*; stalks 5–10 mm long. **Flowers** *single, axillary, opposite; petals white to pale lilac, with punctate glands, basal scale large*. **Fruits** 10–16 x 4–6 mm, *persistent sepals to only a third of the capsule length*. **Seeds** 7–17 per locule, each with a wing on one side only.

Vernacular names. Sabah—*geronggang, serungan* (generally). Sarawak—*dat tetong* (Punan Tutoh), *entemu* (Iban), *kajo jalan* (Berawan), *melan* (Kenyah), *mirinos* (Bidayoh Sadok), *nyalin bahe* (Kayan), *patok tilan* (Iban), *raja tugag* (Nidayoh Padawan), *sidodot* (Bidayoh Bau).

Distribution. Indo-China, S Andaman Is., Sumatra, Peninsular Malaysia, Java, Borneo, Philippines, Celebes. In Sabah and Sarawak in all districts. Also in Brunei and Kalimantan.

Ecology. Principally lowlands, in primary or secondary forests, including peat swamps. Recorded on sea shores, *kerangas* (heath forest) on white sand, sandstone, alluvium,

limestone and ultramafic soils. Trees of this species can be fully deciduous and the inflorescences develop on bare parts of branches before and as a new flush of leaves develops. Ashton (*BRUN* 5554) noted this species as flowering gregariously in riverbank forest in Brunei.

4. *Cratoxylum glaucum* Korth.

(Latin, *glaucus* = pale blue-green; the lower leaf surface)

l.c. 176; Merrill *l.c.* 392; Masamune *l.c.* 477; Anderson *l.c.* 217; Ashton *l.c.* 298; Whitmore, Tantra & Sutisna *l.c.* 181. **Type:** *Muller L 904*, Karrau, Doeson (lectotype BM; isolectotype W). **Synonym:** *C. procerum* Diels, Bot. Jahrb. (1926) 311.

Small tree or shrub, to 10 m tall, rarely to 25 m tall and 45 cm diameter. **Bark** reddish brown, flaky. **Leaves** broadly elliptic, 2–5 x 1.5–3 cm, *glaucous beneath*, coriaceous; base cuneate, *apex rounded, blunt or notched*; midrib flat to sunken on upper side; *lateral veins 10–14 pairs, fine, indistinct, running straight toward the margin where there is a clear marginal vein*; *stalks 1–3 mm long*. **Flowers** in a panicle or thyrse; petals crimson, with punctate glands, basal scale small. **Fruits** 7–10 x 3–4 mm, *persistent sepals to half the capsule length*. **Seeds** 4–8 per locule, each with a wing all round.

Vernacular names. Sarawak—*geronggang* (Iban), *geronggang lompong* (Iban), *kirap* (Bidayoh), *pidang* (Kenyah), *timau* (Iban). Brunei—*geronggang timau* (Iban). Browne *l.c.* coins the name *geronggang puteh*.

Distribution. Sumatra (Lingga, Bangka and Billiton), Peninsular Malaysia (Johore), Karimata and Natuna Islands, Borneo (W and SE). In Sarawak in coastal areas throughout the state. Also in Brunei and Kalimantan.

Ecology. Found in lowland primary and secondary *kerangas* (heath) forest on white sand, in peat swamps (especially those dominated by the dipterocarps *Dryobalanops rappa* and *Shorea albida*), and also freshwater swamps. Also documented at 1100 m in mossy *kerangas* forest on sandstone ridges.

5. *Cratoxylum maingayi* Dyer

(A.C. Maingay, 1836–1869, botanist of the East India Company)

l.c. 258; Browne *l.c.* 197; Anderson *l.c.* 217; Corner *l.c.* 367; Kochummen *l.c.* 251; Ashton *l.c.* 300; Whitmore, Tantra & Sutisna *l.c.* 181. **Type:** *Maingay, s.n.*, Penang (holotype BM; isotype L). **Synonym:** *C. cochinchinense* var. *calcareum* Ridl., Kew Bull. (1938) 115.

Tree or shrub, to 10 m tall and 10 cm diameter, often crooked. **Bark** brown, smooth to fissured or flaky. **Leaves** broadly elliptic, 1.5–4.5(–5.5) x 0.8–3 cm, coriaceous; base cuneate, apex rounded, notched or obtuse with a short tip; midrib flat to sunken on upper side; *lateral veins 5–6 pairs, raised, distinct, arching and forming vein-loops towards the margin*; *stalks to 5 mm long*. **Flowers** single, axillary, opposite; petals pale pink, with

punctate glands, *basal scale large*. **Fruits** 6–15 x 3–5.5 mm, *persistent sepals nearly half the capsule length*. **Seeds** 5–6 per locule, each with a wing on one side only.

Vernacular names. Sarawak—*gerunggang* (Iban), *patok tilan* (Iban).

Distribution. Indo-China, Sumatra, Peninsular Malaysia, Borneo. In Sarawak, documented from the 1st Div. near Kuching only; also reported in Kalimantan.

Ecology. Lowlands, known only from limestone substrates. Trees of this species are often bare of leaves for a short time, when the inflorescences develop on bare parts of branches.

6. *Cratoxylum sumatranum* (Jack) Blume (of Sumatra)

l.c. (1852) 16; Kochummen *l.c.* 251; Shea *l.c.* 146; Anderson *l.c.* 218; Ashton *l.c.* 301; Whitmore, Tantra & Sutisna *l.c.* 181. **Basionym:** *Elodea sumatrana* Jack *l.c.* 22. **Type:** Jack, *s.n.*, Sumatra, Tello Dalam (K). **Synonyms:** *C. hypericum* (Blume) Merr. *l.c.* 392; *C. celebicum* Blume *l.c.* (1852) 16.

Tree or shrub, to 35 m tall and 60 cm diameter, trunk sometimes with buttresses to 1 m high. **Bark** grey to pale or dark brown, cracking-fissured to scaly; inner bark pale yellow to reddish, soft. **Sapwood** pale yellow to white. **Leaves** ovate-elliptic, 4.5–17 x 1.5–4.5 cm, chartaceous to thinly coriaceous; base cuneate, apex acute; midrib flat to sunken on upper side; *lateral veins 9–22 pairs, coarse, raised, distinct, not joining to form marginal vein*; stalks 2–3 mm long. **Flowers** in a panicle; *petals crimson, with linear glands, basal scale absent*. **Fruits** 7–10 x 3–5 mm, *persistent sepals less than half the capsule length*. **Seed** 3–10 per locule, each with a wing on one side only.

Vernacular names. Sabah—*serungan* (Malay). Brunei—*serungan mampat* (Malay).

Distribution. Southeast Asia, Sumatra, Java, Borneo, Philippines, Celebes, Lesser Sunda Is. In Sabah and Sarawak in all districts. Also in Brunei and Kalimantan.

Ecology. Lowlands, in primary and secondary forest, documented on sandstone, white sand in *kerangas* (heath) forest, and also on ultramafic soils. Rarely found up to 1300 m.

Taxonomy. The Bornean taxon is subsp. *sumatranum*; subsp. *blancoi* (Blume) Gogelein is restricted to the Philippines.

ILLICIAEAE

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A.C. Smith, *Sargentia* 7 (1947) 8; Hutchinson, *Fam. Fl. Pl.* 1, 2nd ed. (1959) 125; *Gen. Fl. Pl.* 1 (1964) 57; Ng, *TFM* 2 (1973) 253.

The family contains only one genus, *Illicium*, which has been the source of considerable discussion regarding its evolutionary relationships. Its affinities with the Magnoliales have long been recognised, and this has been reflected historically by its classification in both the families Magnoliaceae (e.g., Bentham & Hooker, *Gen. Pl.* 1 (1862) 16) and Winteraceae (e.g., Ridley, *FMP* 1 (1922) 18). The most recent comprehensive treatment of the genus is the monograph by A.C. Smith (*Sargentia* 7 (1947) 1), who proposed that it should be isolated as the family Illiciaceae on the basis of various morphological and anatomical criteria, discussed in detail by Bailey & Nast (*J. Arn. Arb.* 26 (1945) 37; *l.c.* 29 (1948) 77), and Keng (*Bot. Bull. Acad. Sin.* 6 (1965) 61). The Illiciaceae bears the closest relationship to the Schisandraceae, a small family of scrambling and twining woody vines. The isolated evolutionary position of these two families has been recognised more recently by their classification as the sole members of the order Illiciales (e.g., Takhtajan, *Bot. Rev.* 46 (1980) 225; Cronquist, *Integr. Syst. Fl. Pl.* 1981); it is generally agreed, however, that the Illiciales are derived from the Magnoliales, and are probably from the same stock as the Winteraceae.

ILLICIUM L.

(Latin, *illicere* = an attractant, probably in reference to the presence of aromatic oils)

Syst. Nat. ed. 10 (1759) 1050; Stapf, *Trans. Linn. Soc. London Ser. 2*, 4 (1894) 128; Ridley, *FMP* 1 (1922) 18 (under Winteraceae); A.C. Smith *l.c.* 10; Ng, *l.c.* 253.

Shrubs or small to medium-sized trees; evergreen, glabrous, aromatic with scattered ethereal oil cells. Leaves simple, entire, alternate often clustered to give appearance of whorls of 3–6 at distal nodes; exstipulate; petioles with groove on adaxial surface; lamina papery to leathery, venation pinnate; base generally attenuate, decurrent, apex generally acuminate. Flowers solitary or in clusters of 2–3, mostly axillary, sometimes borne on the stem; bisexual, regular; perianth not differentiated into sepals and petals, parts numerous (7–33), free, overlapping, spirally arranged, white, cream, pink, red or purplish; androecium of (4–) numerous (up to c. 50) stamens, spirally arranged in one to several series, filaments short, thick; anthers basifixed, introrse-lateral, dehiscing by longitudinal slits; gynoecium of (5–)7–15(–21), free, superior carpels, arranged in a single whorl, obliquely attached to receptacle; carpel unilocular, with single, near-basal, anatropous, bitegmic (with 2 layers of integument), crassinucellar (with a thick nucellus) ovule, stigma dry, nonpapillate, decurrent.

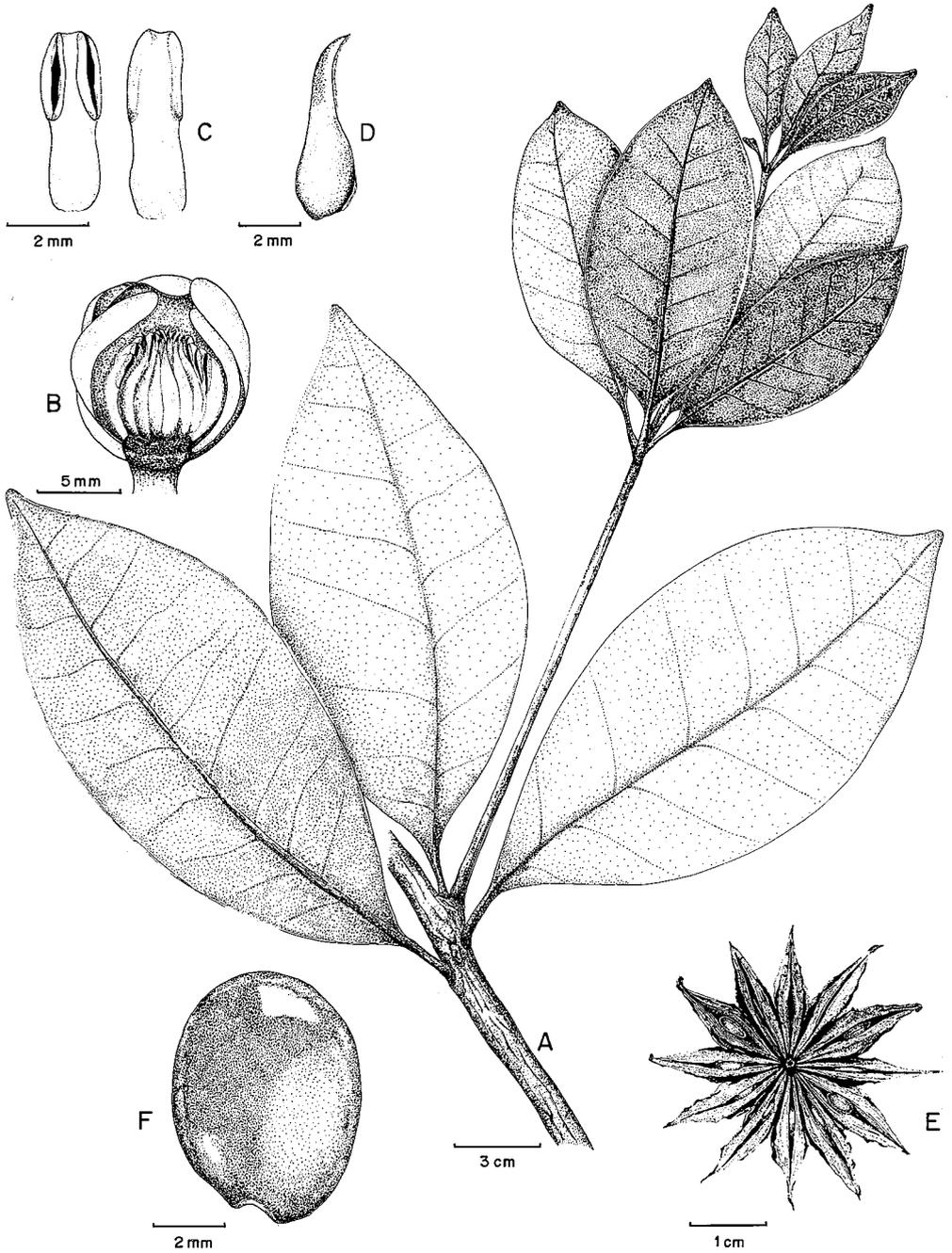


Fig. 1. *Illicium stapfii*. A, leafy twig; B, flower with proximal perianth-parts and stamens removed; C, stamens; D, lateral view of carpel; E, fruit; F, seed. (A from Carr 26441, B from Beaman 9959, C-D from Vermeulen & Duijtermaat 1002, E-F from Anderson 4554.)

Fruits of single-seeded follicles, star-shaped, green (ripening red), splitting along ventral edge of each segment when ripe. **Seeds** solitary in each segment, glossy, brown, with copious oily endosperm.

Distribution. A medium-sized genus, with a disjunct distribution in Southeastern North America (5 species) and eastern Asia (c. 35 species). In Asia the distribution extends from southern Japan to northern Sumatra and Borneo, and from Assam to the Philippines, and the centre of diversity lies in northern Burma and southern China (Yunnan, Guangxi and Guangdong). In Borneo, it is restricted to the cooler montane regions, where two species, *I. kinabaluense* and *I. stapfii*, are known.

Ecology. Vegetative growth is markedly discontinuous, with periods of dormancy of vegetative buds alternating with active growth (Ng *l.c.*). The resumption of growth involves the rapid elongation of a bud to produce a stem several centimetres long, which bears small caducous leaves; apical "pseudowhorls" of leaves are then produced, consisting of alternately arranged normal leaves that are tightly clustered together. Studies in the reproductive biology of North American species have shown that they are pollinated by a wide variety of small insects, but primarily Diptera, and that a gametophytic self-incompatibility system operates (Thien *et al.*, Amer. J. Bot. 70 (1983) 719; White & Thien, J. Elisha Mitchell Sci. Soc. 101 (1985) 15). A system of ballistic seed dispersal (autochory) is apparent in the genus (Roberts & Haynes, Pl. Syst. Evol. 143 (1983) 227), although its efficacy has not been demonstrated in the Bornean species.

Uses. The fruit of *I. verum* Hook. *f.* from China and Indo-China is the source of the spice Chinese Star Anise, used for flavouring food and liqueurs. Although this species does not occur in Borneo, the spice has been imported extensively from China and is traded in Malaysia as *bunga lawang* or *adas china* (Burkill, EPMP 2 (1966) 1244). The fruits of the Japanese species *I. anisatum* L. (syn. *I. religiosum* Sieb. & Zucc.) are poisonous, although small quantities can be used for flavouring, and are sometimes retailed in SE Asia (Burkill *l.c.*). Other *Illicium* species have various reported medicinal properties, often as stomachics, carminatives, stimulants or vermifuges (Perry, MPESE (1980) 180). The timber is of very limited value due to the small size of the trees.

Taxonomy. The last comprehensive revision of the genus was the monograph by A.C. Smith (*l.c.*), in which 42 species were recognised. These species were classified into two sections, *viz.* sect. *Badiana* Spach (which includes the type species and should therefore bear the autonym sect. *Illicium*), and sect. *Cymbostemon* (Spach) A.C. Sm.; the Bornean species belong to the latter section. Smith recognised three species in Borneo (*I. kinabaluense*, *I. stapfii* and *I. cauliflorum*); the acceptance of these species was based on the examination of only 11 herbarium sheets, however, and evidently requires re-evaluation. Only two species are accepted in the present treatment.

Key to *Illicium* species

- Leaves (5-)6-7.5(-11) x (1.5-)2-3(-4) cm. Stamens 7-8. Carpels 8.....1. ***I. kinabaluense***
- Leaves (6-)10-11.5(-16.5) x (2-)4-5(-8.5) cm. Stamens 9-14 (-20). Carpels 8-13.....
-2. ***I. stapfii***

1. ***Illicium kinabaluense*** A.C. Sm.

(of Mt. Kinabalu, Sabah)

l.c. 61. **Type:** *J. & M.S. Clemens 50154*, British North Borneo, Mt. Kinabalu, Penibukan (holotype A; isotype L).

Small tree, to 15 m tall, 45 cm diameter. **Leaves** clustered in "pseudowhorls" of up to 6 leaves; lamina elliptic, *c.* (5-)6-7.5(-11) x (1.5-)2-3(-4) cm; base attenuate, margins slightly revolute, apex (short-)acuminate; midrib slightly impressed above and prominent below; lateral veins 5-8 per side; petioles 9-17 mm long, grooved on adaxial surface. **Flowers** axillary or subterminal, generally solitary; pedicels 10-20 mm long at anthesis; perianth parts 8-10, pink, red or purplish, outermost ones 4.5-6 x 3-3.5 mm, largest 4-7 x 3-5 mm, innermost 3.5-5 x 2 mm; androecium of 7-8 stamens, uniseriate, stamens 1.7-2.5 mm long; gynoecium of 8 carpels, carpels 1.6-2 mm long.

Vernacular name. Sabah—*longugan* (Dusun).

Distribution. Restricted to Mt. Kinabalu, Sabah.

Ecology. Primary forests at 1200-2000 m.

2. ***Illicium stapfii*** Merr.

Fig. 1.

(Otto Stapf, 1857-1933, botanist at Kew in charge of "Indian" collections)

Philip. J. Sci. Bot. 13 (1918) 67, EB (1921) 252; Masamune, EPB (1942) 278; A.C. Smith *l.c.* 65; Anderson, CLTS (1980) 346. **Type:** *M.S. Clemens 10995*, British North Borneo, Mt. Kinabalu, Marai Parai Spur (PNH). **Synonyms:** *Illicium* sp. Stapf *l.c.* 128; *I. cauliflorum* Merr., Sarawak Mus. J. 3 (1928) 522, Masamune *l.c.* 277.

Medium-sized tree, to 25 m tall, 80 cm diameter. **Leaves** clustered in "pseudowhorls" of up to 6 leaves; lamina elliptic, (6-)10-11.5(-16.5) x (2-)4-5(-8.5) cm; base obtuse to attenuate, margins markedly revolute, apex (short-) acuminate, acute or obtuse; midrib markedly impressed above and prominent below; lateral veins 5-12 per side; petioles 10-35 mm long, grooved on adaxial surface. **Flowers** axillary or subterminal, occasionally borne on the bare branches, solitary; pedicels up to 40 mm long at anthesis; perianth parts 9-15, pink, red or purplish, outermost ones 5-8.5 x 4-5 mm, largest 5-9.5 x 3.5-6 mm, innermost (3.5-)7-7.5 x 2.5-4.5 mm; androecium of 9-14(-20) stamens, uniseriate, stamens 2-3.5 mm long; gynoecium of 8-13 carpels, carpels 2-5 mm long.

Vernacular names. Sarawak—*ala* (Iban), *bowlong* (Kenyah).

Distribution. Endemic to Borneo. Montane regions, from Mt. Kinabalu (Sabah) in the north to the Linau-Balui Plateau (Sarawak) in the south; also reported from northern Kalimantan.

Ecology. Primary forests at 800-2000 m.

Taxonomy. Merrill (*l.c.* 1918) and A.C. Smith (*l.c.*) recognised *I. cauliflorum* as a distinct species largely on the basis of its "cauliflorous" habit and greater number of carpels and stamens. Only the holotype was available to these authors for examination (*E. Mjöberg 114*, Mt. Murud, Sarawak (UC)). This specimen is recorded to have flowered at a height of only 1 m, and would more correctly be referred to as "ramiflorous". The study of numerous collections of *I. stapfii* now available indicates that no clear distinction can be drawn between ramiflory and the formation of flowers on young growth, suggesting that it is a poor taxonomic character for the genus. The greater number of carpels and stamens in *I. cauliflorum* is furthermore of little significance, since these characters are considerably more variable in *I. stapfii* than observed by Smith (*l.c.*). There do not appear to be any convincing criteria for retaining *I. cauliflorum* as a distinct species.

JUGLANDACEAE

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Lesch. *ex* Blume, Bijdr. 10 (1825) 528; Blume, Fl. Jav. Jugl. (1829) 5; Merrill, EB (1921) 210, Enum. Philip. Pl. 2 (1923) 23; Ridley, FMP 3 (1924) 368; Masamune, EPB (1942) 231; Dilmy, Rimba Indonesia 4 (1955) 29; Jacobs, FM 1, 6 (1960) 143; Backer & Bakhuizen *f.*, FJ 2 (1965) 158; Burgess, TBS (1966) 321; Manning, Bull. Torrey Bot. Club 93 (1966) 34; Whitmore, TFM 1 (1972) 233; Cockburn, TFS 1 (1976) 151; Anderson, CLTS (1980) 220; Ashton, MNDTS 2 (1988) 303; Corner, WSTM 1 (1988) 367; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 185.

Trees with aromatic tissues; *leaves, young twigs and reproductive parts mostly lepidote* with golden yellow glandular scales. *Stipules none*. **Leaves** spirally arranged, *paripinnate*; leaflet blade often slightly asymmetric. **Inflorescence** a panicle of catkins, axillary or occasionally terminal, with flowers of one sex or both sexes in the same inflorescence; male catkins usually pendulous; female catkins erect at least initially. **Flowers** *unisexual*, in axils of 3-lobed bracts; *perianth 4-lobed*; male: perianth often reduced or irregular, stamens 4–13 (in Asiatic species) and sessile or on short filaments, anthers longitudinally dehiscent; female: perianth lobes in 2 whorls, partly connate with the 2-carpellate ovary; carpels 1-locular with an incomplete transverse septum, ovule 1; style 1, short or absent; *stigmas 2(–4)* in *Engelhardia*, *persistent*, papillose, or 4, sessile. **Fruit** a drupe or in *Engelhardia* a small nut, attached to an enlarged wing-like 3–4-lobed bract. **Seed** 1, without endosperm; cotyledons often much contorted.

Distribution. 7 genera and about 60 species, chiefly in north temperate regions in both the Old and New World, with a few species in the tropics. In Sabah and Sarawak, represented by one genus, *Engelhardia*, with 9 species.

Uses. Walnut (*Juglans*) and hickory (*Carya*) are important north temperate timber genera. The family is also well known as the source of edible nuts, walnuts (*Juglans*) and pecan (*Carya*). In Sabah and Sarawak, the timber of *Engelhardia* is too rare to be of much commercial importance (see under genus).

Taxonomy. The family seems most closely allied to the Myricaceae within the Amentiferae.

ENGELHARDIA Lesch. *ex* Blume

(N. Engelhardt, 1761–1831, a Governor in Java)

sansanglang (Iban, Sarawak), *tansanglang* (Malay, Sarawak)

l.c. (1825) 528, *l.c.* (1829) 5, "*Engelhardtia*"; Merrill *l.c.* (1921) 210, *l.c.* (1923) 23; Ridley *l.c.* 368; Masamune *l.c.* 231; Dilmy *l.c.* 29; Jacobs *l.c.* 143; Backer & Bakhuizen *f. l.c.* 158; Burgess *l.c.* 321;

Manning *l.c.* 34; Whitmore *l.c.* 233; Cockburn *l.c.* 151; Anderson *l.c.* 220; Ashton *l.c.* 303; Corner *l.c.* 367; Whitmore, Tantra & Sutisna *l.c.* 185; Campbell-Gasis, Sandakania 3 (1993) 1. **Synonyms:** "*Engelhardtia*" C. DC., Ann. Sc. Nat. 4, 18 (1862) 35; *Pterilema* Reinw., Syll. 2 (1826) 13; *Oreomunnea* Oerst., Vid. Medd. Nat. For. Kjøbenh. (1856) 52.

Small to medium-sized evergreen trees to 35 m (exceptionally to 50 m) tall, to 150 cm diameter; *bole* columnar at first but *later often of poor form with short flutes*; buttresses thin, small, but sometimes large, steep, thick and branching; crown generally oblong to hemispherical, rather obtuse, with somewhat twisted branches. **Bark** from pale grey through brown-grey to red-brown, smooth to fissured, peeling off in small, rectangular, papery flakes, *often purplish*; *inner bark from yellow to pinkish to brown*, fibrous. **Sapwood** *white to yellow*, soft to hard. Young twigs, leaves and inflorescences covered in golden or orange scurfy scales and pale yellow and orange hairs (visible with a X10 hand lens). *Twigs often with conspicuous leaf-scars and cream to orange lenticels*. **Leaves** *often with a small protuberance at the apex of the rachis*; leaflets 2–7 pairs, alternate to subopposite, sessile or stalked; base often unequal; veins often faintly looping near margin; above glabrous to scaly, below variously scaly and hairy, *vein axils often with tufted domatia* (visible with a X10 hand lens). **Inflorescences** so far known with flowers of only one sex. **Flowers** 4-merous, tiny, often yellow or green, perianth inconspicuous; male: *stamens 4–13, attached to the fused perianth-bract structure*; female: *perianth partly connate with the ovary and fused to a small one-sided 3-lobed bract*, ovule erect and conical with a broad base. **Fruits** *attached to a 3–4-lobed bract; bract membranous, dry; the abaxial and lateral wings with midribs and reticulate venation, the abaxial wing the largest, a smaller adaxial bract often present*; nut small, attached to base of bract; pericarp set with scales or hairs, or both.

Distribution. 12 species, 3 of which are found in the Americas (Mexico, Costa Rica and Guatemala), the other 9 in the Old World from the western Himalayas to south China and extending southwards across Malesia to New Guinea. All 9 species are found in Sabah and Sarawak.

Ecology. Occurring as scattered individuals in lowland mixed dipterocarp forest below 2000 m, on leached acid yellow soils, but becoming common though never dominant at higher elevations (up to 2700 m) in oak-laurel forest on more fertile soils and on ultramafic and basaltic soils. Often shortly deciduous and then flowering. The flowers in catkins suggest wind pollination but the male catkins of *E. roxburghiana* have been noted to have a slight fragrance and may therefore be insect-pollinated also. The fruits are at least partially dispersed by wind. The seedlings often have a terminal leaflet which, as the trees become older, is reduced until all that is left in the adult is a small terminal protuberance. Saplings and pole-sized trees tend to have leaves with more pairs of leaflets, which are usually thinner, longer acuminate, sometimes serrate and often more densely hairy than those of adult trees. Sterile trees may be mistaken for sapindaceous species because of the similarity in their pinnate leaves.

Uses. The wood is locally used for timber but is of inferior quality, being not durable and only of use under cover. The wood is rather soft to moderately hard, light to moderately heavy, with a straight grain, shallowly interlocked, or slightly wavy. The texture is moderately fine to slightly coarse and even. The timber is easy to work. The bark, containing tannin-like compounds, is occasionally used for fish-poison in Sumatra.

Key to *Engelhardia* species
(based on shoot and leaflet characters)

1. Leaflet margins distinctly toothed in some part.....2
Leaflet margins entire or wavy, not toothed.....3
2. Distal leaflets often twice as large as the lower ones; stalk nil to 1 mm, rarely more. Leaflet base acute or wedge-shaped; intercostal veins and areoles mostly invisible on the upper surface in dried specimens.....**8. *E. serrata***
Distal leaflets sometimes larger than lower ones but not up to twice as large; stalk longer, to 4 mm. Leaflet base rounded to subcordate; intercostal veins and areoles distinct on the upper surface in dried specimens.....**1. *E. apoensis***
3. Leaflets coriaceous, elliptic-obovate (or if lanceolate-falcate then with veins impressed on the upper side), and not hairy on the lower side.....4
Leaflets chartaceous, or lanceolate-falcate, or with hairy veins on the lower side (the veins not impressed on the upper side).....6
4. Leaflet intercostal venation coarse, the areolation strongly prominent under X10 magnification.....**3. *E. kinabaluensis***
Leaflet intercostal venation finer, the areolation only faintly visible under X10 magnification.....5
5. Shoot-apices and leaf rachises brown scurfy hairy.....**6. *E. rigida***
Shoot-apices and leaf rachises not scurfy hairy.....**5. *E. mersingensis***
6. Leaflets not decreasing markedly in size from apex to base of leaf rachis; veins on lower side hairy.....**9. *E. spicata***
Leaflets decreasing in size by one third to half from apex of leaf rachis; veins on lower side minutely scaly to subglabrous or apparently glabrous.....7
7. Leaflets elliptic, papery, base only slightly unequal, margin not thickened; stalk almost nil or only to 1 mm long.....**2. *E. danumensis***
Leaflets ovate to lanceolate or falcate, leathery, base very unequal, margin thickened; stalk 1–10 mm long.....8
8. Leaflets to 11 cm long, usually 4–5 pairs per leaf; stalk 1–4 mm long.....**4. *E. mendalomensis***
Leaflets usually larger, to 16 cm long, usually 2–3 pairs per leaf; stalk longer, to 10 mm.....**7. *E. roxburghiana***

Key to *Engelhardia* species
(based on fruit characters)

1. Nut 6–14 mm long with a conspicuously narrowed apex.....**1. *E. apoensis***
Nut shorter, to 6 mm long, apex rounded.....2



Fig. 1. *Engelhardia danumensis*. Fruiting leafy twig. (From SAN 85066.)

2. Adaxial lobe of bract not developed, the nut fully exposed..... 3
 Adaxial lobe of bract well-developed, hiding most of the nut..... 4
3. Nut-stalk 4–8 mm long. Nut covered with scales only. Perianth-lobes broadly ovate
 7. **E. roxburghiana**
 Nut-stalk shorter, to 3 mm long. Nut hairy. Perianth-lobes linear..... 5. **E. mersingensis**
4. Perianth of inconspicuous tiny lobes adnate to the style..... 9. **E. spicata**
 Perianth of ovate to linear lobes at the apex of the nut..... 5
5. Nut set with stiff, loose, irritant long hairs..... 8. **E. serrata**
 Nut indumentum not so..... 6
6. Adaxial lobe of bract cleft in the middle..... 7
 Adaxial lobe of bract not cleft in the middle..... 8
7. Adaxial lobe of bract only shallowly cleft. Perianth-lobes broadly ovate.... 2. **E. danumensis**
 Adaxial lobe of bract deeply cleft to the base. Perianth-lobes linear..... 3. **E. kinabaluensis**
8. Adaxial lobe of bract orbicular..... 6. **E. rigida**
 Adaxial lobe of bract subtruncate, the margin sometimes wavy..... 4. **E. mendalomensis**

1. **Engelhardia apoensis** Elmer *ex* Nagel

(of Mount Apo in the Philippines)

Bot Jahrb. 50 (1914) 477; Elmer, Leaflet. Philip. Bot. 7 (1915) 2693; Merrill *l.c.* (1923) 23; Jacobs *l.c.* 151; Burgess *l.c.* 321; Manning *l.c.* 48; Whitmore *l.c.* 234; Cockburn *l.c.* 152; Ashton *l.c.* 304; Corner *l.c.* 368; Whitmore, Tantra & Sutisna *l.c.* 185. **Type:** *Elmer 11744*, Philippines, Mindanao, Mount Apo (holotype NY; isotypes BM, BO, GH, L, P).

Tree to 50 m tall and 150 cm diameter; bole often straight; buttresses to 4 m tall and 1.5 m out; crown spreading to dense. **Bark** grey-brown to reddish brown; inner bark pink with white wedges to purplish and reddish brown, soft. **Sapwood** pale yellow to white. Twigs, leaves and inflorescences set with golden to orange scales and pale yellow hairs. **Leaf rachis** (8–)13–23(–32) cm long, 3.5–11 cm to first leaflet, *thickened at base*, densely to occasionally covered in scales and occasional hairs; *leaflets* (3–)4–5(–7) pairs, alternate, ovate to lanceolate, (5–)9–13(–16) x (2.2–)3–4(–6) cm, *gradually decreasing a little in size towards base*, drying orange-brown to dark chocolate-brown below, thinly leathery, upper side with occasional scales and hairs, lower side with occasional to dense scales, only midrib and lamina hairy; *base rounded to subcordate*, unequal, *margin toothed irregularly*, at least in lower half, often inrolling, apex acute; *tufted domatia occasional to frequent* in vein axils with midrib; lateral veins 9–16(–18) pairs, above and below visible; intercostal veins net- to ladder-like, above visible, below sometimes invisible; petiolule (1–)2–3(–4) mm long, with dense to occasional scales and hairs. **Inflorescences** axillary, scaly and hairy; male catkins 9–20 cm long, peduncle densely scaly and hairy; stamens 9, anthers scaly and hairy; fruiting catkins (8–)12–19(–30) cm long, peduncle and rachis scaly and hairy. **Fruits** sessile to 3-mm-stalked; bracts with hairs and scales, abaxial wings 55–75 x 12–15 mm, lateral wings 28–35 x 8 mm, adaxial lobes entire to shallowly 4-lobed, hiding top of nut; *nuts ovoid*, 6–14 x 5–6 mm, densely covered in long, soft hairs, *without scales*; *perianth-lobes adnate to the style*, tiny, inconspicuous, not hiding the stigmas.

Distribution. Peninsular Malaysia, Borneo, and the Philippines. In Sabah, an uncommon tree known on Mount Kinabalu only (e.g., *SAN 27565*, *SAN 22408*); uncommon also in Sarawak, known only on Mount Dulit (*Richards 1521*). Also in E Kalimantan.

Ecology. Primary mixed dipterocarp forest from 700 to 1300 m, on fertile and ultramafic soils.

2. *Engelhardia danumensis* Campbell-Gasis (of the Danum Valley area in Sabah)

Fig. 1.

Sandakania 3 (1993) 6. **Type:** *Cockburn SAN 85066*, Sabah, Lahad Datu, Ulu Segama Forest Reserve, Ulu Sungai Segama (holotype SAN; isotypes A, BO, FHO, K, KEP, L, SAR, SING).

Tree to 35 m tall and 60 cm diameter; buttresses thin, plank-like, *c.* 1 m tall and 2 m out. **Bark** dark chocolate-brown; inner bark orange-brown, cut wood and bark smelling like coconut water. **Sapwood** white, hard. Twigs and leaves covered with golden scales but *without hairs*. **Leaf rachis** 4–10 cm long, 2.8–4.2 cm to first leaflet, blackish, *not thickened at base*, scales occasional; **leaflets** 2–3 pairs, alternate to subopposite, elliptic, 2.4–7 x 1.5–1.5 cm, *decreasing to about half the size towards base*, drying dark brown to blackish below, *thin, papery*; upper side glabrous, lower side with occasional to scattered scales all over; base acute to wedge-shaped, subequal, margin entire, undulate, *marginal vein not thickened*, apex acute to shortly acuminate, acumen to 5 mm long; tufted domatia occasional in vein axils with the midrib; lateral veins 8–12 pairs, raised on both sides, conspicuous; intercostal veins net-like, obscure on both sides, areoles obscure; *petiolule absent to 1 mm long*, glabrous or with occasional scales. **Inflorescences** axillary, flowers not known; fruiting catkins 14–18 cm long, peduncle and rachis slender, angular, with golden scales and hairs. **Fruits** sessile to 1-mm-stalked; bracts covered in scales and a few hairs, abaxial wings 19–30 x 6–9 mm, lateral wings 8–11 x 3–4 mm, *adaxial lobe shallowly cleft in the middle*, often hiding the top of the nut; nuts globose *c.* 3 mm across, covered in golden scales and short golden hairs; *perianth-lobes on the nut apex ovate*, free from style, not hiding the stigmas.

Distribution. Endemic to Sabah. Uncommon, and known only from the type collection.

Ecology. Lowland mixed dipterocarp forest.

Vegetatively it approaches *E. rigida* but the leaflets almost blackish on drying, have a thin and papery texture, the lower leaflets decrease in size by half, and the lamina is set with scales but never hairs. Also, the nut in this species differs in being set with both scales and short hairs.

3. *Engelhardia kinabaluensis* Campbell-Gasis (of Mount Kinabalu in Sabah)

l.c. 7. **Type:** *Gibot SAN 66824*, Sabah, Ranau, Mamut Copper Mine (holotype SAN).

Tree to 24 m tall and 35 cm diameter. **Bark** grey to blackish; inner bark yellow to pale white, exudate yellowish. **Sapwood** cream. Twigs, leaves and inflorescences set with golden

scales but without hairs. **Leaf rachis** 3.7–8 cm long, black, 1.5–3.5 cm to first leaflet, *thickened at base*, occasionally with scales; **leaflets** 2–3 pairs, subopposite, elliptic to obovate or *falcate*, 1.5–6.2 x 0.7–2.8 cm, *not decreasing in size towards base*, drying grey-brown to orange-brown below, *leathery*, upper side glabrous, lower side glabrous to sparsely scaly all over; base acute to round, very unequal, margin entire and wavy with thickened marginal vein, apex acute to shortly acuminate, acumen to 2 mm long; *tufted domatia absent to rare in vein axils* with midrib; lateral veins 5–7 pairs, flat to occasionally impressed above, often obscure; *intercostal veins* net-like, *coarse*, *areoles visible and strongly prominent* under X10 magnification; petiolule 2–3 mm, glabrous or occasionally with scales. **Inflorescences** axillary; flowers not known; fruiting catkins 7–10 cm long, the rachis scaly and hairy. **Fruit** stalk 1–2 mm long; bract occasionally scaly, *hairs absent*, abaxial wings 20–24 x 5–6 mm, lateral wings 8–12 x 2–3 mm, *adaxial lobes deeply cleft in the middle*, not hiding the top of the nut; nuts transversely ellipsoid, 2–3 x 3–4 mm, with golden scales and short, golden hairs; *perianth-lobes on the nut apex linear*, free from style, not hiding the stigmas.

Distribution. Uncommon. In Sabah only known on or near Mount Kinabalu (at the Mamut Copper Mine and in the Mesilau Area of Kundasang; e.g., *SAN 74274*, *SAN 111603*, besides the type).

Ecology. Lowland mixed dipterocarp forest and submontane forest from 200 m to 1500 m.

Vegetatively, it approaches *E. rigida* but the leaflets with their thickly, leathery texture, the cover of scales on the leaflets and nuts, and the lack of hairs on the leaflets distinguish it from that species.

4. *Engelhardia mendalomensis* Campbell-Gasis

(of Mendalom Forest Reserve in Sabah)

l.c. 7. **Type:** *Fidilis* *SAN 116714*, Sabah, Tenom District, Mendalom Forest Reserve (holotype *SAN*).

Tree to 35 m tall and 80 cm diameter; buttresses to 3 m high and 4 m out. **Bark** pale brown-grey; inner bark pale yellow to orange-brown. **Sapwood** cream-white to yellowish. **Twigs and leaves** covered in golden scales, *without hairs*. **Leaf rachis** 6–14 cm long, 2.2–6 cm to first leaflet, blackish, *thickened at base*, occasionally with scales and scant hairs; **leaflets** (3–)4–5 pairs, subopposite, ovate to lanceolate or *falcate*, 4–11 x 2–4 cm, *often decreasing to about two-thirds to half the size towards base*, drying dark brown to blackish below, thinly leathery, occasionally with scales but no hairs all over on both sides; base acute or rarely round, very unequal, margin entire, slightly wavy, with thickened marginal vein, apex acute to long-acuminate, acumen to 10 mm long; *tufted domatia occasional to absent in vein axils* with midrib; lateral veins 7–11 pairs, above raised but rather obscure, below raised, conspicuous; *intercostal veins* net-like, *areoles on both sides* obscure; petiolules 1–4 mm long with scattered scales. **Inflorescences** axillary, flowers not known; fruiting catkins 13–30 cm, peduncle and rachis quite stout, angular, drying blackish, scaly and hairy. **Fruits** sessile to 1-mm-stalked; bracts with scales and hairs, abaxial wing 21–50 x 8–10 mm, lateral wings 11–18 x 4–6 mm, *adaxial lobes subtruncate (the margin sometimes wavy)*, often hiding the top of the nut; nuts transversely ellipsoid, 3–4 x 4–5 mm, set with golden scales and scattered, short golden hairs; *perianth-lobes on the nut apex ovate*, free from style, not hiding the stigmas.

Distribution. Uncommon. In Sabah, only known from the type collection.

Ecology. Primary mixed dipterocarp forest from sea-level to 550 m.

Vegetatively it approaches *E. roxburghiana* but differs in having four to five pairs of leaflets drying dark brown to blackish, with fewer pairs of veins and being less densely set with scales. Also, the sessile to 1-mm-pedicellate nuts set with both hairs and scales distinguish it from that species.

5. *Engelhardia mersingensis* Campbell-Gasis (of Mount Mersing in Sarawak)

l.c. 8. **Type:** *Ashton S. 16724*, Sarawak, Bukit Mersing, Ulu Anap (holotype SAR; isotypes A, BO, K, KEP, L, MEL, SAN, SING).

Tree to 30 m tall and 70 cm diameter; buttresses tall, sinuate and branching. **Bark** pale orange-brown, thin, powdery. Twigs, leaves and inflorescences set with golden and orange scales, but without hairs. **Leaf rachis** 4.5–14 cm long, 2.5–4.5 cm to first leaflet, black, thickened at base, occasionally with scales, without hairs; **leaflets** 3–4 pairs, alternate to opposite, elliptic to obovate, 4.5–11 x 2.5–4.8 cm, drying orange-brown to blackish below, chartaceous, upper side glabrous, lower side occasionally scaly all over; base acute to round, subequal to very unequal, margin entire, slightly wavy, with thickened marginal vein, apex acute to acuminate, acumen to 9 mm long; tufted domatia occasionally in vein axils with midrib; **lateral veins** 7–12 pairs, impressed or keeled above, below raised; intercostal veins net-like, areoles only slightly visible under X10 magnification; petiolules 1–2 mm long, with scattered scales. **Inflorescences** terminal or axillary, flowers not known; fruiting catkins 9.5–20 cm long, peduncle and rachis quite stout, angular, drying dark brown or blackish, scaly and hairy. **Fruits** sessile to 0.5-mm-stalked; **bracts** glabrous to scaly, without hairs, abaxial wings 20–31 x 7–10 mm, lateral wings 9–16 x 4–6 mm, adaxial lobes not developed and not hiding the nut; **nuts transversely ellipsoid**, 3 x 4–6 mm, with scales and a few short hairs present; **perianth-lobes on nut apex linear**, free from style, not hiding the stigmas.

Distribution. Uncommon. In Sarawak known only from the type collection. Also in East Kalimantan (on Gunung Beratus).

Ecology. Primary mixed dipterocarp to submontane forest on basaltic soils, at 600–1000 m.

Vegetatively, this species approaches *E. rigida* but the larger leaflets set with scales but not hairs, fewer pairs of lateral veins, and a sessile nut with scales and short hairs distinguish it from that species.

6. *Engelhardia rigida* Lesch. ex Blume (Latin, *rigidus* = stiff; the leaflets)

l.c. (1825) 528, *l.c.* (1829) 13, t. 3; Jacobs *l.c.* 148; Backer & Bakhuizen *f. l.c.* 158; Burgess *l.c.* 321; Manning *l.c.* 40, 45; Cockburn *l.c.* 152; Anderson *l.c.* 220; Ashton *l.c.* 304; Whitmore, Tantra & Sutisna *l.c.* 185. **Type:** *Blume 1958*, Java (holotype L; isotypes K, P). **Synonyms:** *E. subsimplicifolia*

Merr., Govt. Lab. Publ. Philip. 34 (1906) 6, *l.c.* (1923) 24; *E. rigida* var. *subsimplicifolia* (Merr.) Manning *l.c.* 40; *E. lepidota* Schltr., Bot Jahrb. 50 (1913) 66; *E. zambalensis* Elmer *l.c.* 3195.

Tree to 50 m tall, and 90 cm in diameter; buttresses to 3 m high and 2 m out. **Bark** pale brown-grey to reddish brown, soft; inner bark white, orange-yellow to brownish, soft. **Sapwood** white. Twigs, leaves and inflorescences set with golden to orange scales and pale yellow hairs. **Leaf rachis** (1-)2-6(-21) cm long, 1.5-2.5 cm to first leaflet, blackish, *thickened at base*, sometimes *densely scaly and hairy*; *leaflets* typically 2-3 pairs, opposite, ovate to elliptic, 1.5-7.1(-16.5) x 1.4-4(-7.5) cm, often drying orange-brown to brown below, *thickly leathery, often somewhat bullate*; base acute to wedge-shaped, subequal, margin entire, with thickened marginal vein, sometimes inrolled, apex shortly acuminate, acumen 1-2 mm long; tufted domatia occasional to frequent in vein axils with midrib; midrib on upper and lower sides glabrous to densely scaly and hairy; lateral veins 6-9 pairs, distinct on both sides; *intercostal veins* ladder-like, *indistinct on both sides*; petiolules rarely absent to 3(-5) mm long, with scant to dense scales and sometimes hairs. **Inflorescences** axillary on leafy and older leafless twigs, scaly and hairy; male catkins 1.5-6 cm long, perianth-lobes narrowly triangular to completely reduced, stamens (3-)4-6(-7) with anthers equal or unequal, 0.5-1 mm long, more or less white hairy; fruiting catkins (6-)10-15(-22) cm long, peduncle and rachis slender, round, more or less densely scaly and hairy. **Fruits** 0.5-1-mm-stalked; bracts scaly and hairy, abaxial wings 20-60 x 3-8 mm, lateral wings 12-14 x 3-4 mm, *adaxial lobes orbicular or absent* so the top of the nut is sometimes exposed; *nuts* globose, *c.* 3.5 x 4 mm, densely covered by long, soft hairs, but *without scales*; *perianth-lobes on the nut apex ovate*, free from style, not hiding the stigmas.

Distribution. Sumatra, Java, Borneo, the Philippines, Celebes, Moluccas, New Guinea. In Sabah uncommon, known only on Mount Kinabalu; in Sarawak uncommon in lowlands and mountains. Also in Brunei and Kalimantan.

Ecology. Primary mixed dipterocarp forest from sea-level to 2000(-2500)m on both leached yellow, sandy and ultramafic soils.

Uses. The wood is used for canoes and general building work in Sumatra.

Taxonomy. Manning (*l.c.*) distinguished two varieties of this species in Borneo, var. *subsimplicifolia* and var. *rigida*. Var. *subsimplicifolia* was said to differ from the other in having fewer pairs of leaflets and shorter fruiting catkins and fruits. The type specimen of *E. rigida* var. *rigida* unfortunately does not have any fruits but otherwise looks like var. *subsimplicifolia* with one extra pair of leaflets. The other specimens of *E. rigida* var. *rigida* named by Manning had all the characters which Manning ascribed to var. *subsimplicifolia*, including fewer leaflets, shorter fruiting catkins and smaller fruits. It is felt that *E. rigida*, at least in Borneo, cannot be separated into these two varieties.

7. *Engelhardia roxburghiana* Wall.

(W. Roxburgh, 1751-1815, a Scottish botanist)

Pl. As. Rar. 2 (1831) 85, *t.* 199; Jacobs *l.c.* 154; Burgess *l.c.* 321; Manning *l.c.* 38, 48; Whitmore *l.c.* 235; Cockburn *l.c.* 154; Anderson *l.c.* 220; Ashton *l.c.* 305; Corner *l.c.* 369; Whitmore, Tantra &

Sutisna *l.c.* 185. **Type:** *Wallich Cat.* 4942, Malaya (holotype CAL). **Synonyms:** *Juglans pterococca* Roxb., Hort. Beng. (1814) 68; *E. chrysolepis* Hance, Ann. Sc. Nat. 4, 15 (1861) 227; *E. wallichiana* Lindl. ex Wall., Cat. (1831/32) no. 4942; *E. pterococca* (Roxb.) Kuntze, Rev. Gen. Pl. 2 (1891) 637; *E. spicata* var. *formosana* Hay, Fl. Mont. Form. 6 (1908) 199; *E. formosana* Hay, Ic. Pl. Form. 6 (1916) 61; *E. fenzelii* Merr., Lingn. Sc. J. 7 (1931) 300.

Tree to 35 m tall and 70 cm diameter; buttresses to 2 m high, thin, branching; crown dense or spreading. **Bark** fawn to dark chocolate-brown or black; inner bark yellow to reddish brown, soft, moist; exudate clear, white. **Sapwood** white to pale yellow. *Twigs often with crusts of white exudate*, together with leaves and inflorescences set with golden to orange scales and pale yellow to orange hairs. **Leaf rachis** (5.5-)6-14(-17) cm long, 3.4-9.5 cm to first leaflet, *thickened at base*, scantily to densely scaly and hairy; *leaflets* 2-3(-4) pairs, alternate to subopposite, ovate to lanceolate, (5-)10-16(-23) x (1.4-)3.5-5(-8) cm, *gradually decreasing in size towards base, drying greenish to greyish brown or brown below*, leathery; *base* acute to wedge-shaped, very unequal, *often somewhat decurrent*, margin entire, slightly wavy, with thickened marginal veins, sometimes inrolled, apex long-acuminate, acumen 10-17 mm long; *tufted domatia absent to rare in the vein axils* with the midrib; *midrib* and *veins* above with occasional to scattered scales, below with occasional to dense scales but *without hairs*; lateral veins 8-12 pairs, above raised to flat, below raised; intercostal veins ladder-like, distinct above, indistinct below, areoles distinct above and below; petiolules (1-)6-10(-12) mm long thickened at base, sparsely to densely scaly and hairy. **Inflorescences** *terminal* on lateral twigs, paniculate; male catkins 8-10 per inflorescence, 9-10 cm long, peduncle slender, scaly but without hairs; perianth-lobes 1-1.5 mm across; stamens 8-12, inserted (2-)3 at the base of each perianth-lobe, anthers equal, *c.* 0.5 mm long, filaments equal to unequal, 0.3-0.5 mm long, glabrous, faintly sweet scented; fruiting catkins 10-17(-23) cm long, peduncle and rachis slender, scaly and densely hairy. **Fruit** stalk 4-5(-8) mm long; bracts scaly but without hairs, abaxial wings 28-45(-55) x 5-8 mm, lateral wings 21 x 5-6 mm, *adaxial lobes not developed* so nut is visible; *nuts* globose, 4-5 x 4-5 mm, with scales but *without hairs*; *perianth-lobes at the nut apex ovate, enclosing the 4 sessile stigmas.*

Distribution. India to Indo-China, Sumatra, Peninsular Malaysia, and Borneo. In Sabah uncommon, only known from the Crocker Range (*SAN 44313*); in Sarawak scattered throughout mixed dipterocarp and submontane forests (*S. 28588, S. 32811, Nootboom & Chai 2153*), locally abundant as on the summit ridges of the basaltic Bt. Mersing and the Tau Range, where it grows together with *E. mersingensis*. Also in Brunei at Ulu Mendamit.

Ecology. Primary mixed dipterocarp forest in hilly country, to 1750 m, on clay-rich, relatively fertile soils.

8. *Engelhardia serrata* Blume

(Latin, *serratus* = toothed like a saw; the leaflet margin)

l.c. (1829) 14, t. 4; Jacobs *l.c.* 150; Backer & Bakhuizen *f. l.c.* 158; Burgess *l.c.* 321; Manning *l.c.* 40, 45; Whitmore *l.c.* 236; Cockburn *l.c.* 152; Anderson *l.c.* 220; Ashton *l.c.* 305; Corner *l.c.* 370; Whitmore, Tantra & Sutisna *l.c.* 185. **Type:** *Blume 2221*, Java, Mt. Salak (holotype L). **Synonyms:**

E. palernbanica Miq., Fl. Ned. Ind., Suppl. (1861) 346, 139; *E. parvifolia* C. DC. l.c. 34; *E. nudiflora* Hook. f., Fl. Br. Ind. 5 (1888) 596; *E. serrata* Blume var. *nudiflora* (Hook. f.) Manning l.c. 46; *E. permicrophylla* Elmer, Leaflet. Philip. Bot. 9 (1934) 3194.

Tree to 30 (–45) m tall, 120 cm diameter; buttresses to 3–4 m high and 3 m out. **Bark** light to dark grey to reddish brown; inner bark from pinkish brown to orange- and reddish brown, soft. **Sapwood** yellowish to white. Twigs, leaves and inflorescences set with golden and orange scales and pale yellow hairs. **Leaf rachis** (2.6–)5–18(–24) cm long, 1.2–3.1 cm to first leaflet, *slightly thickened at base*, densely to scantily covered with scales and hairs; *leaflets* (2–)3–6(–9) pairs, alternate to subopposite, oblong to lanceolate in young trees to obovate in older trees, (1–)2–15(–20.5) x (0.5–)1–4(–8) cm, *often decreasing to about half the size towards base*, drying from ochre-brown to dark brown below, chartaceous in young trees to leathery in older trees, upper side with only the midrib and veins sparsely to densely scaly and hairy, lower side with scattered to dense scales and sparse hairs all over; base acute to wedge-shaped, rarely rounded, subequal, *margin regularly to irregularly toothed at least in upper third*, apex short- to long-acuminate, acumen 1–5 mm long; *tufted domatia frequent in vein axils* with midrib; lateral veins 4–15 pairs, fewer in older trees, above distinct or not, raised to flat; intercostal veins net-like, above and below distinct or not; *petiolules absent to 1(–3) mm long*, occasionally with dense scales and hairs. **Inflorescences** axillary on leafy or older leafless twigs, scaly and hairy; male catkins 2–3 per inflorescence, 3–13 cm long, perianth-lobes more or less completely reduced, stamens (3–) 5–7, anthers sometimes unequal and 0.5–1 mm long, filaments sessile to 0.3 mm long and sparsely hirsute; fruiting catkins 9–14(–30) cm long, peduncle and rachis stout, angular, densely covered with scales and hairs. **Fruits** sessile to 1-mm-stalked; bracts glabrous or scaly and hairy; abaxial wings 16–40 x 6–11 mm, lateral wings 6–12 x 3–6 mm, *adaxial lobe frilled to shallowly 2–3-lobed*, often hiding the top of the nut; *nuts globose, c. 3 mm across, sometimes with a few scales, densely covered in stiff, long hairs; perianth-lobes on nut apex ovate*, free from style, not hiding the stigmas.

Vernacular names. Sabah—*pusing-pusing* (Malay). Sarawak—*entalun* (Iban), *momon* (Malay), *owl* (Murut), *tepanga* (Kenyah).

Distribution. Burma, Thailand, Indo-China, Sumatra, Peninsular Malaysia, Java, Borneo, Philippines, and the Moluccas. In Sabah, not uncommon in the lowlands but also on the Crocker Range. In Sarawak, scattered in lowland and submontane forests. Also in Brunei and Kalimantan.

Ecology. Primary mixed dipterocarp forest, on sandy or clayey soils from sea-level to 2200 m; rarely in secondary forest.

Taxonomy. Manning l.c. recognised four varieties, viz. var. *serrata*, *parvifolia* (C. DC.) Manning, *nudiflora* (Hook. f.) Manning, and *cambodica* Manning, of which the first three occur in Sabah and Sarawak. These taxa seem to share the characters described above, and with limited material available for study, it is impossible to say whether the varietal status proposed by Manning is truly justified.

9. **Engelhardia spicata** Lesch. ex Blume
(Latin, *spicatus* = bearing a spike; the inflorescence)

l.c. (1825) 528; Merrill *l.c.* (1921) 210, *l.c.* (1923) 24; Ridley *l.c.* 368; Masamune *l.c.* 231; Jacobs *l.c.* 151; Backer & Bakhuizen *f. l.c.* 158; Burgess *l.c.* 321; Manning *l.c.* 41; Whitmore *l.c.* 236; Cockburn *l.c.* 152; Corner *l.c.* 370; Whitmore, Tantra & Sutisna *l.c.* 186. **Type:** Blume, *s.n.*, Java (holotype L; isotypes K, NY, P). **Synonym:** *E. philippinensis* C. DC. *l.c.* 34, t. 2, f. 15.

var. **aceriflora** (Reinw.) Koords. & Valetton

Bijdr. Booms. Java 5 (1900) 167. **Basionym:** *Pterilema aceriflorum* Reinw., Syll. Pl. Nov. Soc. Rolisb. 2 (1826) 13. **Type:** Reinwardt, *s.n.*, Java (holotype L). **Synonyms:** *E. aceriflora* (Reinw.) Blume *l.c.* (1829) 11, t. 2 and 5B; *E. pterococca* Roxb. ex Kuntze var. *aceriflora* (Reinw.) Kuntze *l.c.* 637.

Tree to 40 m tall, 280 cm diameter; buttresses sometimes present, to 3 m tall; crown dense, rounded. **Bark** light brown-grey. Twigs with pale golden scales and hairs. **Leaf rachis** (5.5–)10–30 cm long, to 5.5 cm to first leaflet, *slightly thickened at base*, brown or blackish, glabrous to scaly and hairy; *leaflets* (2–)3–5(–7) pairs, subopposite to opposite, oblong to lanceolate, (6–)4–16(–30) x (3–)1.5–6(–8) cm, *not decreasing in size towards base*, leathery; upper and lower sides glabrous to sparsely scaly to *very hirsute*, or *both scaly and hairy*, especially on the midrib and veins on the lower side; base rounded to *subcordate*, very unequal, margin entire, wavy, apex shortly acuminate, tip obtuse to acute; *tufted domatia* frequent in the vein axils with the midrib and often also in the axils of veins which join near the margin, visible to the unaided eye; lateral veins 11–18 pairs, above distinct, raised, below often indistinct; intercostal veins indistinct above and below; petiolules absent to 3 mm long. **Inflorescences** paniculate, axillary on leafy or older leafless twigs; male (4–)9–17 cm long; perianth-lobes present or reduced, very irregular, lobes to 2 mm long; stamens 6–14, anthers equal or unequal, (sub)sessile, hirsute; fruiting catkins (8–)19–30(–40) cm long, peduncle and rachis angular, glabrous or scaly. **Fruits** sessile to 1-mm-stalked; abaxial wings 20–60 x 7–15 mm, lateral wings 20–25 x 5–8 mm, wings often very irregular, *adaxial lobes frilled to shallowly 4–5-lobed*, often hiding the top of the nut; *nuts globose to transversely ellipsoid*, 3–6 x 3–8 mm, with long, soft, dense hairs, *without scales*; *perianth-lobes tiny, inconspicuous, adnate to style*, not hiding the stigmas.

Distribution. India to Indo-China, Sumatra, Peninsular Malaysia, Java, Borneo, the Philippines, and Lesser Sunda Islands. In Sabah, uncommon on Mount Kinabalu (e.g., SAN 42865, SAN 61785); not reported from Sarawak or Brunei. Also in East Kalimantan.

Ecology. Primary forest, more common on mountains, from sea-level to 2500 m.

Taxonomy. Koorders & Valetton *l.c.* and Manning *l.c.* recognised three varieties, namely var. *acerifolia* (Reinw.) Koord. & Valetton, *colebrookeana* (Lindl. ex Wall.) Kuntze, and *spicata*, of which only var. *acerifolia* is so far found in Sabah.

MONIMIACEAE

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Hooker *f.*, Fl. Br. Ind. 5 (1890) 114; Merrill, EB (1921) 271, PEB (1929) 77; Ridley, FMP 3 (1924) 73; Masamune, EPB (1942) 305; Backer & Bakhuizen *f.*, FJ 1 (1963) 116; Anderson, CLTS (1980) 253; Philipson, Blumea 28 (1982) 77, Blumea 30 (1985) 389, FM 1, 10 (1986) 255; Ng, TFM 4 (1989) 261; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 235.

Trees or shrubs, rarely woody climbers. **Leaves** simple, decussate or rarely alternate or in whorls of three, usually with round oil-cells in the lamina, bearing simple or stellate hairs or glabrous. Stipules absent. **Inflorescences** cymes, solitary or fascicled, terminal or axillary, rarely on the trunk. **Flowers** unisexual or bisexual, regular; receptacles usually well-developed or rarely reduced, round, urceolate or bell-shaped; tepals inconspicuous, rarely developing as distinct sepals and petals, decussate, in whorls or spirals. **Male flowers** with few to many stamens arranged in whorls, spirally or irregularly, filaments strap-shaped, anthers 2–4-loculed, opening through slits or valves. **Female flowers** with or without staminodes; carpels few to many, sessile or stalked (stipitate), free or immersed in the receptacles; ovule solitary, anatropous, erect or pendulous, with a thick nucellus (crassinucellar), bitegmic or unitegmic. **Fruits** achenes or drupes, rarely plumose, usually enclosed by the persistent receptacle, stalked or sessile, set free by splitting of the receptacles. **Seed** one; endosperm copious, oily; embryo straight; cotyledons appressed or divergent.

Distribution. About 33 genera and 320 species, mostly in the warmer parts of the southern hemisphere (Malesia, Australia, SW Pacific, islands in the western Indian Ocean and S America). In Sabah and Sarawak, represented by 2 genera with 3 species.

Taxonomy. The two genera (*Kibara* and *Matthaea*) occurring in Sabah and Sarawak are included by Philipson (*l.c.* (1986) 261) in the subfamily *Mollinedieae* and characterised by the male flowers having globose or flask-shaped receptacles and by drupaceous fruits borne in heads. For a detailed account of the systematic position of the family see Philipson's account (*l.c.* 1986).

Key to genera

Leaves ovate to broadly elliptic; lateral veins diminished and not joined toward the margin. Stamens 6–9, arranged in 2 series, anthers opening by a single longitudinal slit. Fruit-stalk shorter than 8 mm.....1. **Kibara**

Leaves narrowly lanceolate to lanceolate-oblong, lateral veins looped and joined at the margin. Stamens usually 4, free, anthers opening by two longitudinal slits. Fruit-stalk longer than 8 mm.....2. **Matthaea**

1. **KIBARA** Endl.

(a Sundanese plant name).

Gen. Pl. (1837) 314; Hooker *f. l.c.* 114; Merrill *l.c.* (1921) 271, *l.c.* (1929) 77; Ridley *l.c.* 73; Masamune *l.c.* 305; Backer & Bakhuizen *f. l.c.* 117; Anderson *l.c.* 253; Philipson *l.c.* (1985) 389, *l.c.* (1986) 287; Ng *l.c.* 261; Whitmore, Tantra & Sutisna *l.c.* 235. **Synonyms:** *Brongniartia* Blume, *Bijdr.* 9 (1825) 455 (*non* Knuth); *Sciadicarpus* Hassk., *Flora* 25, 3 (1842) 20; *Sarcodiscus* Griff., *Not. Pl. As.* 4 (1854) 380.

Trees or shrubs with aromatic smell. Terminal vegetative buds conical or pyramidal, surrounded by scale leaves. **Leaves** simple, decussate; blades entire or toothed, usually with short, tufted, soft, brown hairs, gradually becoming glabrous; *lateral veins arched and diminishing toward the margins.* **Inflorescences** terminal or axillary cymes (racemose in the non-Bornean *K. streimannii*), paniculate or fasciculate; *pedicels thickening distally into flat or cup-shaped receptacles.* **Male flowers** usually smaller than the females, with a minute opening surrounded by 2–4 decussate pairs of tepals; *stamens 6–9, arranged in 2 series, with an outer series of 4(–5) larger stamens, and an inner series of 4 smaller, often infertile stamens, anthers opening by a single slit, with a filament or sessile.* **Female flowers** with a minute opening surrounded by 5 decussate pairs of tepals, the inner pairs thickened and granular; carpels many, free on the inside of the receptacles; style very short; ovule 1. **Fruit** a sessile or short-stalked drupe enclosed by enlarged receptacle. **Seeds** coniform; seed-coat membranous; embryo small.

Distribution. About 40 species, in Peninsular Thailand, Nicobar Islands, Malesia and Queensland (Australia). Only 2 species occur in Sabah and Sarawak.

Ecology. Mostly understory shrubs and small trees in rain forest from sea-level to 2800 m; occasionally on limestone hills, sandy and coral beaches.

Key to *Kibara* species

Leaves broadly ovate to elliptic-oblong, base rounded or subcordate, margins entire or toothed, apex distinctly acuminate1. **K. coriacea**

Leaves narrowly to broadly elliptic, base narrowly to broadly cuneate, margins entire, apex obtuse.....2. **K. obtusa**

1. **Kibara coriacea** (Blume) Tulasne (Latin, *coriaceus* = leathery; the leaves)

Arch. Mus. Hist. Nat. Paris 7 (1855) 404; Hooker *f. l.c.* 114; Ridley *l.c.* 75; Merrill *l.c.* (1929) 77; Masamune *l.c.* 305; Backer & Bakhuizen *f. l.c.* 117; Philipson *l.c.* (1985) 406, *l.c.* (1986) 298; Ng

l.c. 261; Whitmore, Tantra & Sutisna *l.c.* 235. **Basionym:** *Brongniartia coriacea* Blume *l.c.* (1825) 436. **Type:** Blume, *s.n.*, Java (L). **Synonyms:** *K. blumei* Steud., Nomencl. Bot. (1840) 846; *Sciadicarpus brongniartii* Hassk. *l.c.* 20; *Sarcodiscus chloranthiformis* Griff. *l.c.* 350; *K. chartacea* Blume, Mus. Bot. Lugd. Bat. 2 (1856) 89; *K. cuspidata* Blume *l.c.* (1856) 89, Merrill *l.c.* (1921) 271, Masamune *l.c.* 305; *K. tomentosa* and *macrophylla* J.R. Perkins, Bot. Jahrb. 25 (1898) 571; *K. trichantha* J.R. Perkins *l.c.* (1898) 572; *K. serrulata* J.R. Perkins *l.c.* (1898) 575; *K. angustifolia* J.R. Perkins *l.c.* (1898) 577; *K. motleyi* J.R. Perkins, Bot. Jahrb. 45 (1911) 424, Merrill *l.c.* (1921) 272, Masamune *l.c.* 305; *K. grandifolia* Merr., Philip. Govt. Lab. Bur. Bull. 29 (1905) 15; *K. ellipsoidea* Merr., Philip. J. Sc. 1 (1906) Suppl. 56; *K. mollis* Merr., Philip. J. Sc. 3 (1908) Bot. 225.

Shrub or tree, to 15 m tall, 15 cm diameter. **Bark** smooth, pale grey; inner bark pale yellow. Twigs slightly pubescent, gradually become glabrous. **Leaves** broadly ovate to elliptic-oblong, 6–26.6 x 4–18.5 cm, leathery or papery, glabrous or sparsely to rather densely hairy beneath; base cuneate, rounded or subcordate, margin entire or toothed toward the apex, *apex distinctly acuminate*; midrib and lateral veins prominent beneath; *lateral veins arched, ascending and joining near the margins*; stalk 5–25 mm long, slightly channelled above, pubescent or glabrous. **Inflorescence** a terminal or axillary, simple 3-flowered or compound cyme, with the male flowers at the proximal and the female flowers at the distal parts. **Male flowers** rounded, 1.5–2 mm across, hairy; tepals 6–8 with rounded apex; *stamens 4 in outer series and 4 smaller ones in the inner series*, filaments strap-shaped. **Female flowers** larger than male flowers, rounded, about 3–5 mm across; *tepals about 6 with swollen pendulous glands within the minute opening*. **Fruit** an ovoid drupe, *c.* 2 x 1.5 cm, ripening deep blue, purple or black, on *short swollen orange stalk; in clusters of 3–13*. **Seed** coat membranous, orange when dried.

Vernacular names. Sabah—*ambibiliw, labak* (Dusun).

Distribution. Throughout Malesia; in Sabah and Sarawak widespread.

Ecology. Lowland rain forests including swamp, coral beach, limestone hill, mixed dipterocarp forests, and lower montane forests from sea-level to 1600 m.

Uses. The fruit is said to be edible and the leaves are used as flavouring in meat dishes.

2. *Kibara obtusa* Blume

Fig. 1.

(Latin, *obtusus* = blunt or rounded; the leaf apex)

l.c. (1856) 89; Philipson *l.c.* (1985) 409, *l.c.* (1986) 300. **Type:** Blume, *s.n.*, Celebes (holotype L). **Synonym:** *K. depauperata* Merr., Philip. Govt. Lab. Bur. Bull. 35 (1906) 13.

Tree to 20 m tall, 20 cm diameter. **Bark** scaly to shallowly fissured, pale yellow; inner bark dull orange. Young twigs with short stiff-hairs. **Leaves** narrowly to broadly elliptic, 7–16.5 x 3.3–10 cm; base cuneate, *margin entire, apex obtuse or rounded*; midrib and lateral veins prominent beneath, glabrous or with sparse stiff-hairs; stalk 10–18 mm long, pubescent or glabrous. **Inflorescence** a terminal or axillary, simple or compound cyme, to about 70 mm long, with a pair of small bracteoles. **Male flowers** obovoid, *c.* 2 mm across; tepals 4, minute; *stamens usually 4 in the outer series and 2 smaller, infertile ones in the inner*

series. **Female flowers** larger than male flowers, globose, about 2.5–3 mm across; *tepals* 4, apex obtuse, with 4 swollen glands projecting among the carpels; carpels about 13, hairy, with blunt stigmas. **Fruit** an ovoid drupe, 17–24 x 10–12 mm, ripening black, seated on a short orange stalk. **Seed** coat membranous, orange in colour when dried.

Distribution. Borneo, Philippines, Celebes, and W New Guinea. In Sabah, uncommon and only known from 4 collections, 3 from Lahad Datu (*SAN 29844*, *SAN 31104*, *SAN 33382*) and one from Semporna (*SAN 46055*). Not yet reported in Sarawak.

Ecology. Primary rain forest from sea-level to 700 m.

2. MATTHAEA Blume

(Matteo de S. Guiseppe, 1617–1691, an Italian Missionary and Botanist in India)

l.c. (1856) 89; Hooker *f. l.c.* 115; Merrill *l.c.* (1921) 272; Ridley *l.c.* 73; Masamune *l.c.* 305; Anderson *l.c.* 254; Philipson *l.c.* (1982) 77, *l.c.* (1986) 319; Ng *l.c.* 263.

Trees or shrubs. **Leaves** simple, *opposite*, entire or sub-serrate, leathery. **Inflorescences** axillary, rarely terminal cymes, much shorter than leaves. **Male** receptacle subglobose; *tepals* 4; *stamens* 4, *free*, filaments short, *anthers* opening by 2 longitudinal slits. **Female** receptacle depressed globose; *tepals* 4, without apical pore or gap but upper half abscising as a calyptra at anthesis to reveal numerous carpels. **Fruits** long-stalked drupes, fleshy; one or more on the enlarged receptacle.

Distribution. 6 species, all Malesian: Sumatra, Peninsular Malaysia, Anambas Island, Borneo, Celebes, Philippines, and N Moluccas. Only 1 species has been recorded in Sarawak.

Ecology. Understorey trees in lowland and submontane forests to about 1700 m.

Matthaea sancta Blume

Fig. 2.

(Latin, *sanctus* = holy; alluding to the religious work of Matteo de S. Guiseppe)

l.c. (1856) 90; Hooker *f. l.c.* 115; Merrill *l.c.* (1921) 272; Ridley *l.c.* 73; Masamune *l.c.* 305; Anderson *l.c.* 264; Philipson *l.c.* (1982) 82, *l.c.* (1986) 323; Ng *l.c.* 263. **Type:** Blume, *s.n.*, "Sumatra and Borneo" (holotype L). **Synonyms:** *M. latifolia* J.R. Perkins *l.c.* (1898) 563; *M. calophylla* J.R. Perkins *l.c.* (1898) 563; Merrill *l.c.* (1921) 272, Masamune *l.c.* 305; *M. ellipsoidea* Merr. ex J.R. Perkins *l.c.* (1911) 423.

Shrub or small tree, to 10 m tall, 10 cm diameter. Twigs green, glabrous. **Leaves** papery, glabrous, lanceolate-oblong to oblong, 15.5–29 x 5.5–9.5 cm; base broadly cuneate, truncate or rounded, margins entire or slightly toothed at the upper part, apex acuminate; lateral veins arched, ascending and looping far from the margins, impressed on the upper surface, prominently raised beneath; stalk 1.5–3 cm long, glabrous. **Inflorescences** axillary cymes. **Male flowers** depressed globose, 2–3 mm across, opening by a small gap between a pair of

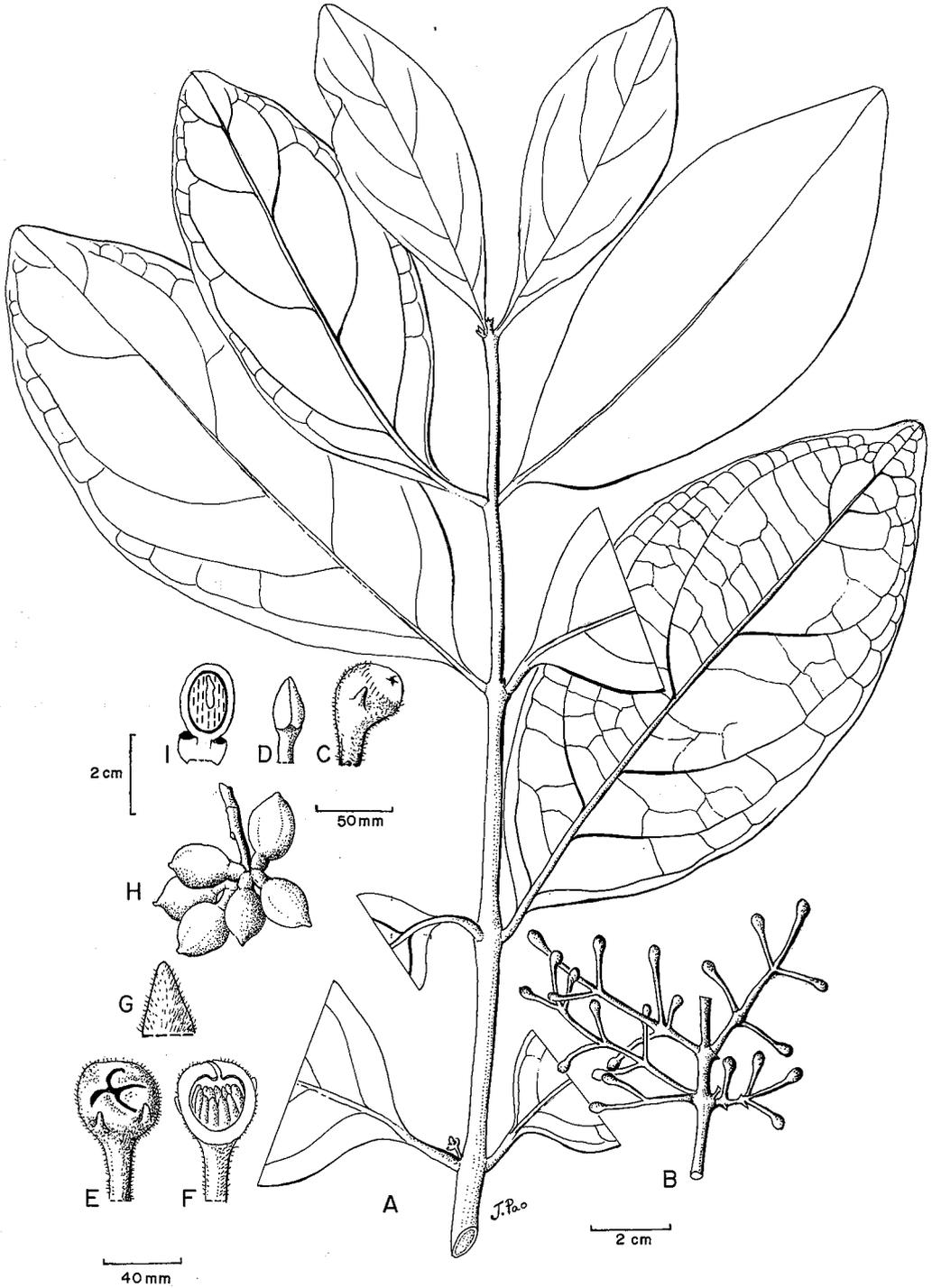


Fig. 1. *Kibara obtusa*. A, leafy twig with young axillary inflorescence; B, inflorescence; C, male flower; D, stamen; E, female flower; F, section of female flower; G, carpel; H, fruits; I, section of fruit. (A–G from SAN 29844, H–I from SAN 31104.)

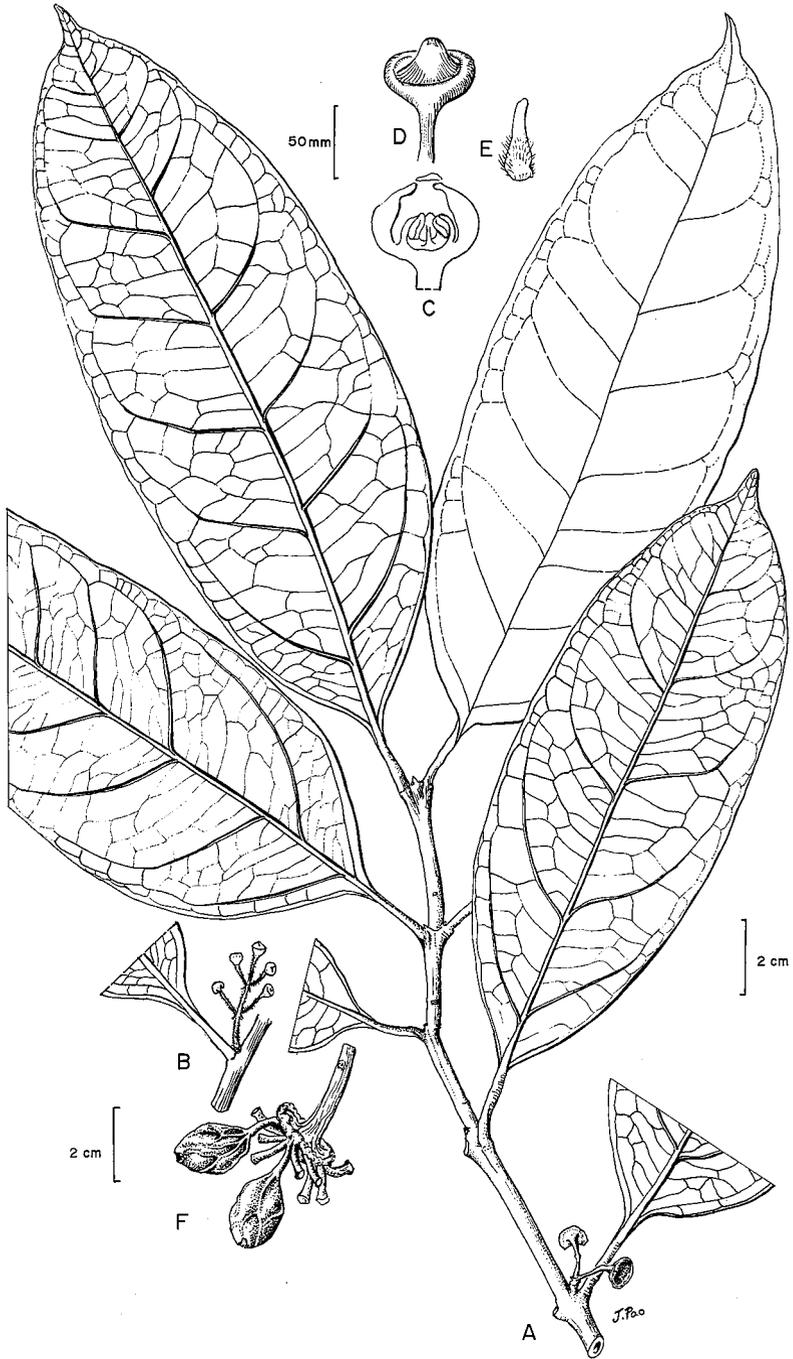


Fig. 2. *Matthaea sancta*. A, leafy twig with female inflorescence; B, male inflorescence; C, male flower in longitudinal section; D, female flower before anthesis; E, carpel; F, fruits. (From Steven 261.)

lip-like perianth-lobes; *stamens* 4. **Female flowers** similar to males but much larger, *c.* 10 mm across, on 1–4 pedicels arising in clusters of 3–5 from short peduncles; without any apical pore or gap but the upper half abscising as a calyptra at anthesis to reveal numerous sessile carpels which are closely packed on a dish-like receptacle. **Fruit** a drupe, ellipsoid, *c.* 2.5 x 1.5 cm, with thin bony endocarp, ripening blue or purple, attached in clusters of up to 18 to an enlarged orange receptacle. **Seed** coat light brown when dried.

Distribution. Sumatra, Peninsular Malaysia, Anambas Is., Borneo, Philippines, and Celebes. Uncommon in Sabah but widespread in Sarawak.

Ecology. Lowland rain forests, including limestone hill and mixed dipterocarp forests on clay-rich soils, and lower montane forest, from sea-level to 1400 m.



NYSSACEAE

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Kuching, Sarawak

Wangerin in Engler, Pfl. R. 41, 2 (1910) 1; Wasscher, Blumea 1 (1935) 343, FM 1, 4 (1948) 29; Masamune, EPB (1942) 517; Hutchinson, Fam. Fl. Pl. 1 (1959) 175, Gen. Fl. Pl. 2 (1967) 50; Eyde, J. Arn. Arb. 44, 1 (1963); Backer & Bakhuizen *f.*, FJ 2 (1965) 161; Kochummen, TFM 1 (1972) 346; Cockburn, TS 2 (1980) 61; Mabberley, PB (1987) 404; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 277.

Trees or shrubs. **Leaves** simple, spirally arranged, without stipules. **Flowers** more or less regular, male or hermaphrodite, solitary or more often in axillary heads or condensed racemes; calyx 5-toothed or absent; corolla composed of 5(-10) imbricate petals; nectary disc present; stamens (8-)10(-15), usually in 2 whorls, the outer whorl opposite the petals in male flowers or as many as and alternate with the petals in hermaphrodite flowers, anthers dorsifixed, dehiscing lengthwise; ovary inferior, 1-2-loculed, with 1-2 basally united styles, ovule 1, pendulous, anatropous. **Fruit** a drupe. **Seeds** with scanty, oily endosperm; embryo straight.

Distribution. 3 genera, with 8-10 species, distributed in N America, Mexico, E and SE Asia. In Sabah and Sarawak, represented by 1 genus (*Nyssa*) with 1 species (*N. javanica*).

Taxonomy. The family is closely related to the Cornaceae with which it has been frequently included in previous publications (Ridley, FMP 1 (1922) 889; Keng, OFMSP (1978) 219; Brummitt, Vasc. Pl. Fam. & Gen (1992) 543). It can be distinguished from the Cornaceae by the following characters: male flowers with tepaloid sepals and petals, stamens 8-10 arranged in two whorls; hermaphrodite flowers solitary or in heads, sepals and petals well developed; style 1, rarely 2, each with 1 stigma; fruit a drupe.

NYSSA L.

(a legendary town in India where Bacchus,
the Greek God of Wine, was brought up by nymphs)

Sp. Pl. (1753) 1058; Ridley *l.c.* 895 (under Cornaceae); Wasscher *l.c.* (1935) 343, *l.c.* (1948) 29; Masamune *l.c.* 517; Backer & Bakhuizen *f. l.c.* 161; Kochummen *l.c.* 346; Cockburn *l.c.* 61; Whitmore, Tantra & Sutisna *l.c.* 277. **Synonyms:** *Agathisanthes* and *Ceratostachys* Blume, Bijdr. (1825) 644; *Agathidanthos* Hassk., Cat. Hort. Bog. (1844) 254; *Daphniphyllopsis* Kurz, J. As. Soc. Beng. 44, 2 (1875) 201.

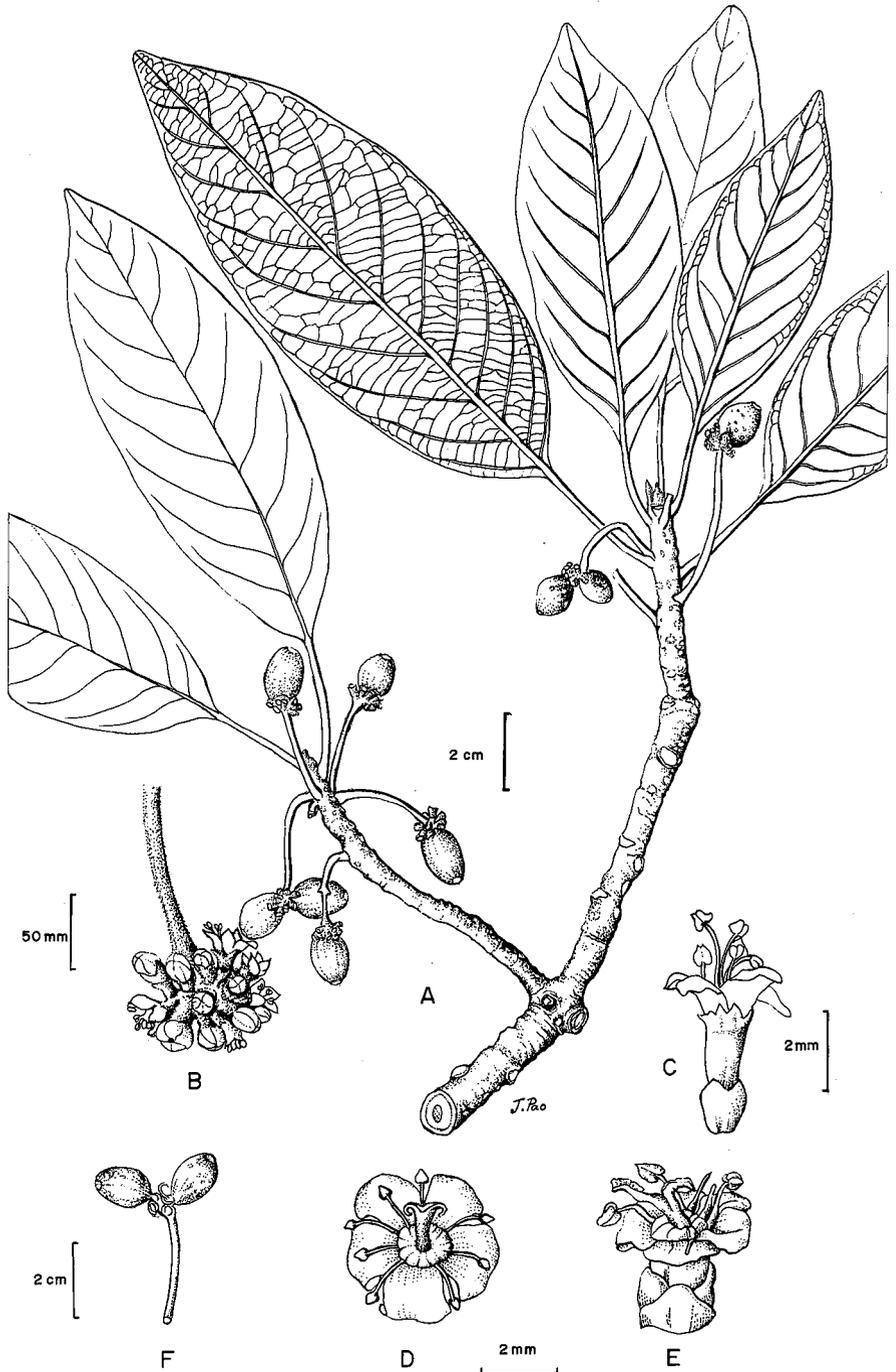


Fig. 1. *Nyssa javanica*. A, fruiting leafy twig; B, inflorescence; C, male flower; D-E, female flowers; F, fruits. (A and F from S. 35531, B-E from SAN 42783.)

Dioecious trees or shrubs. **Leaves** simple, spirally arranged, without stipules. **Flowers** male or hermaphrodite, often in heads, in the axils of a bract and with 2 bracteoles. **Male flowers** in axillary heads or short racemes; calyx campanulate, rim smooth or 5-toothed; petals 5, imbricate in bud, alternate with the calyx-lobes; stamens 8–16, in 2 alternating whorls; anthers dorsifixed, opening lengthwise; disc pulvinate; ovary and style rudimentary. **Hermaphrodite flowers** in 2–10-flowered, axillary, stalked heads; calyx entire or 5-toothed; petals 5–8; stamens of the inner whorl partly sterile; ovary 1-locular, connate with the calyx, style with 2 appressed, curving, often torulose branches, stigmatose inside. **Fruits** drupaceous, ovoid to ellipsoid-oblong.

Distribution. About 6 species, 4 in the Atlantic N America, 1 in China, and 1 (*N. javanica*) widespread from India to W Malesia.

Nyssa javanica (Blume) Wangerin
(of Java)

Fig. 1.

in Engler *l.c.* 15; Wasscher *l.c.* (1935) 344, *l.c.* (1948) 29; Masamune *l.c.* 517; Kochummen *l.c.* 346; Cockburn *l.c.* 61; Whitmore, Tantra & Sutisna *l.c.* 277. **Basionym:** *Agathisanthes javanica* Blume *l.c.* 645. **Type:** *Blume, s.n.*, Java (holotype L; isotype K). **Synonyms:** *Agathidanthus javanica* Hassk. *l.c.* 254; *Nyssa sessiliflora* Hook. f. & Th., Gen. Pl. 1 (1867) 952; *Ilex daphniphyloides* Kurz, J. As. Soc. Beng. 39, 2 (1870) 72; *Daphniphylopsis capitata* Kurz *l.c.* (1875) 201; *Nyssa arborea* Koord., Exk. Fl. Jav. 2 (1912) 731; *Nyssa bifida* Craib, Kew Bull. (1913) 69.

Tree to 50 m tall, 90 cm in diameter, sometimes with very low buttresses. **Bark** grey, smooth to slightly flaky, with prominent corky lenticels; inner bark dull yellow or pale brown, fibrous or laminated, staining dark blue after slash. **Sapwood** heavy, yellowish white. **Twigs** green, with large scattered lenticels and leaf-scars, often covered with brown tomentum when young, gradually turning glabrous. **Leaves** typically crowded toward the end of the twigs; stalk 1.5–4 cm long, hairy; blades slightly glaucous below, thinly leathery, oblong-lanceolate to obovate, 5–19 x 2–7 cm; base gradually narrowed toward stalk, margin entire to slightly wavy, apex abruptly pointed; midrib flushed reddish, slightly hairy; lateral veins 8–11 pairs, hairy. **Flowers** in stalked, roundish, axillary heads 12–18 mm across, stalk slightly angular, 10–50 mm long, glabrous or slightly hairy, bracteate; bracts persistent in hermaphrodite flowers. **Male flowers** in 20–40-flowered heads; calyx bell-shaped, 4–5-toothed; petals 4–5, free, overlapping, recurved, shortly hairy; stamens 8–10 in 2 whorls. **Hermaphrodite flowers** in 3–9(–18)-flowered heads; calyx campanulate, densely appressed-sericeous, lobes 4–5, irregular, rounded or almost absent; petals 4–5; stamens 8–10, inner whorl sterile; ovary 1-chambered, style with 2 curving branches. **Fruits** ellipsoid drupes, slightly flattened, to 22 x 15 mm, crowned by small persistent calyx. **Seed** one, stone-like, grooved on one side and knobby on the other.

Vernacular name. Sarawak—*terang bulu* (Kelabit).

Distribution. Sumatra, Peninsular Malaysia, Java and Borneo. In Sabah, the species is known only from Mt. Kinabalu (*SAN 22427*, *SAN 23507*, *SAN 42755*, *SAN 42785*, *SAN 60599*, *SAN 62216* and *SAN 62220*); in Sarawak, one collection so far (*S. 35531*), from Kelabit Highlands, Bario.

Key to genera

1. Shrubs to medium-sized trees. Stamens 10; carpels 5–10, free. Fruit a 1-seeded drupe.....2
 Shrubs. Stamens 5; carpels 2–5, united. Fruit a capsule or berry with more than one seed.....3
2. Leaves with distinct marginal veins, margin toothed; stipules united. Anthers opening by apical pores.....**3. Gomphia**
 Leaves without marginal vein, margin entire; stipules free. Anthers opening by longitudinal slits.....**1. Brackenridgea**
3. Leaf margin toothed. Ovary 5-celled. Anthers opening by apical pores. Fruit a berry**2. Euthemis**
 Leaf margin entire or toothed. Ovary 1-celled. Anthers opening by longitudinal slits. Fruit a capsule.....4
4. Branches hollow. Leaves shiny, lateral veins invisible. Seeds winged.....**4. Schuurmansia**
 Not as above.....5
5. Stem coarsely bristly with persistent stipules and bracts. Inflorescences axillary, one-flowered.....
Neckia Korth.
 Ned. Kruidk. Arch. 1 (1848) 358; Merrill *l.c.* 388; Ridley *l.c.* 134; Masamune *l.c.* 469; Kanis *l.c.* (1968) 69, *l.c.* (1971) 110.
 Monotypic genus (*N. serrata* Korth.) confined to Sumatra, Peninsular Malaysia, Borneo (Sabah, Brunei, Sarawak, Kalimantan) and the Philippines. Lowland to submontane forests to 1200 m.
 Understorey shrubs. Stipules comb-shaped. Leaves spiral, blade with toothed margin. Inflorescences axillary; rachis thread-like, 1–5 cm long; bracts many; only single flower developing; pedicels jointed. Flowers 5-merous; *stamens* 5, *anthers opening by longitudinal slits*, staminodes many; carpels 3, united, ovary 1-celled, with distinct style and stigma. Fruit a capsule, splitting into 3. Seed not winged, pitted.
 Stem not so. Inflorescences terminal, with many flowers.....6
6. Leaves oblanceolate, subsessile. Staminodes 10.....
Indovethia Boerl.
 Feestbundel P.J. Veth (1894) 89; Merrill *l.c.* 388; Masamune *l.c.* 469; Kanis *l.c.* (1968) 72, *l.c.* (1971) 112; Anderson *l.c.* 283.
 Monotypic genus (*I. calophylla* Boerl.). Central Sumatra and NW Borneo. Uncommon, in moist shady places in lowland forest.
 Shrublets. *Stipules comb-shaped*. Leaves spiral, margin entire or toothed. Flowers: sepals 5, *persistent in fruit*, petals 5, free; stamens 5, *anthers opening by longitudinal slits*, staminodes 10; carpels 3, united, ovary 1-celled, with distinct style and stigma. Fruit a *capsule, splitting into 3 including style*. Seed not winged, surface pitted.
 Leaves linear with distinct petiole. Staminodes many.....**5. Schuurmansia**

1. BRACKENRIDGEA A. Gray

(W.D. Brackenridge, 1810–1893, the Scots-American botanist and horticulturist)

New Gen. Pl. (1853) 5; Merrill *l.c.* 387; Masamune *l.c.* 468; Furtado, Gard. Bull. Sing. 19 (1962) 181; Kanis *l.c.* (1968) 41, *l.c.* (1971) 101; Ng *l.c.* 256; Cockburn *l.c.* 64; Anderson *l.c.* 282; Whitmore, Tantra & Sutisna *l.c.* 278.

Small to medium-sized trees. Stipules small, often divided, falling off early. **Leaves** alternate-distichous, glossy above; *lateral veins strongly curved to the apex, often some of the lower ones parallel to the margin*. **Inflorescences** thyrsoid of condensed cymes; rachis often growing vegetatively after flowering; *bracts many, at base of inflorescences, falling off early leaving distinct ring-like scars*; pedicels jointed at base, filiform. **Flowers** arranged in 1–4 tiers; *sepals 5, accrescent, fleshy and red in fruit*; petals 5(–10), white or yellow; stamens 10 (or many), *anthers dehiscent by longitudinal slits*; *carpels 5(–10), free*, but sharing a common style; ovules campitropous or epitropous; stigma small. **Fruit** a drupe, 1–2(–5), greenish becoming almost black on ripening, surrounded by persistent sepals.

Distribution. About 8 species, tropical E Africa, Madagascar, Malesia; 2 species in Sabah and Sarawak.

Ecology. Everwet tropical areas to 1000 m. Dispersal is mainly by birds because of the conspicuous black fruits on the red torus and calyx. Flowering and vegetative growth tend to occur at alternative intervals during the growth of the stem. After a period of leaf production, the terminal bud is covered with closely spaced scale-leaves, some of which bear inflorescences in their axils. When flowering and fruiting is completed the terminal bud resumes vegetative activity to bear foliage leaves again. This pattern of growth can be traced through the series of alternating leaf-scars and peduncle-bases along the twig.

Taxonomy. Two sections are recognised in the genus. In section *Brackenridgea*, all flowers in a cyme open simultaneously; the corolla is 5-merous, white; there are 10 stamens in one whorl; and 5 carpels. In section *Notochnella*, the flowers of a cyme open successively; the corolla is yellow and irregular; there are many stamens in more than 1 whorl; and 5–10 carpels. Section *Notochnella* is confined to the Philippines.

Key to *Brackenridgea* species

Inflorescence a many-flowered cyme; pedicels in two or more tiers.....1. **B. hookeri**

Inflorescence a 3(–5)-flowered cyme; pedicels in one tier only.....2. **B. palustris**

1. *Brackenridgea hookeri* (Planch.) A. Gray

Fig. 1.

(W.J. Hooker, 1785–1865, sometime Director of the Kew Botanic Gardens)

l.c. 6; Furtado *l.c.* 182; Kanis *l.c.* (1968) 45, *l.c.* (1971) 102; Ng *l.c.* 256; Anderson *l.c.* 283; Whitmore, Tantra & Sutisna *l.c.* 278. **Basionym:** *Gomphia hookeri* Planch. in Hooker, Lond. J. Bot. 6 (1847) 3. **Type:** *Philips, s.n.*, Penang (K). **Synonyms:** *Gomphia corymbosa* (King) Ridl., J. Str. Br. R. As. Soc. 54 (1910) 36 *p.p. excl. typus*, *Brackenridgea denticulata* Furtado *l.c.* 183.

Tree to 30 m tall, 60 cm diameter. **Bark** reddish brown, smooth to slightly fissured and scaly; inner bark reddish brown. **Leaves** elliptic to oblong, rarely obovate, 6–17 x 2.5–7.5 cm; base cuneate, apex pointed; midrib raised above; *lateral veins of lower half of leaf curving upwards to almost to leaf apex, running parallel to margins*; petiole 0.6–1 cm long. **Flowers** clustered in two or more tiers; pedicel 1–2 cm long. **Fruits** 6–9 x 5.5–6 mm.

Distribution. India, Andamans, Thailand, Peninsular Malaysia and Borneo. Uncommon and of scattered occurrence in Sabah and Sarawak.

Ecology. Lowland mixed dipterocarp forest on sandy humult ultisols to submontane forests to 1000 m, including *kerangas* and dry hillocks in swampy forests.

2. *Brackenridgea palustris* Bartelli

(Latin, *palustris* = inhabiting boggy or marshy ground)

Malpigia 15 (1901) 165; Merrill *l.c.* 387; Masamune *l.c.* 468; Furtado *l.c.* 182; Kanis, *l.c.* (1968) 46, *l.c.* (1971) 102; Ng *l.c.* 256; Cockburn *l.c.* 64; Anderson *l.c.* 283; Whitmore, Tantra & Sutisna *l.c.* 278. **Type:** *Beccari PB 3472*, Borneo (holotype FI; isotypes A, K, P). **Synonyms:** *Gomphia hookeri* (Planch.) A. Gray var. *corymbosa* King, J. As. Soc. Beng. 62 (1893) 233; *B. serrulata* Bartelli *l.c.* 163, Merrill *l.c.* 387, Masamune *l.c.* 469; *Gomphia corymbosa* (King) Ridl. *l.c.* (1910) 33, *p.p.*, FMP 1 (1922) 367.

Tree to 30 m tall, 40 cm diameter. **Bark** brown to reddish brown, smooth to scaly, inner bark reddish brown. **Sapwood** white to pale yellow. **Leaves** elliptic to oblong, 5.5–10 x 2–4 cm; base cuneate, apex pointed; midrib raised above; *lateral veins of lower half curving upwards, running parallel to the margin towards apex*; intercostal veins invisible to very faint; petiole 0.5–1 cm long. **Flowers** fascicled in one tier only, pedicel jointed. **Fruits** to 8 x 6 mm.

Distribution. Sumatra, Peninsular Malaysia, Borneo, Philippines, Celebes. Uncommon in Sabah and Sarawak.

Ecology. Usually on lowlands, especially in peat swamp and *kerangas* forests, rarely in submontane forests to 1000 m.

2. *EUTHEMIS* Jack

(Greek, *eu* = good, *themis* = law; the even thickness and symmetry of the leaves)

Mal. Misc. 1, 5 (1821) 5; Merrill *l.c.* 388; Ridley *l.c.* (1922) 367; Masamune *l.c.* 469; Kanis *l.c.* (1968) 62, *l.c.* (1971) 108; Ng *l.c.* 257; Anderson *l.c.* 283; Ashton *l.c.* 62.

Shrubs. Stipules falling off early. **Leaves** spiral, with numerous close, almost parallel *lateral veins; margin thick-rimmed*, distinctly or faintly toothed. **Inflorescences** terminal and axillary racemes. **Flowers:** *sepals persistent in fruit*; petals 5, white or pink; staminodes 0–5; stamens 5, *anthers opening by apical pores*; carpels 5, united, ovary 5-

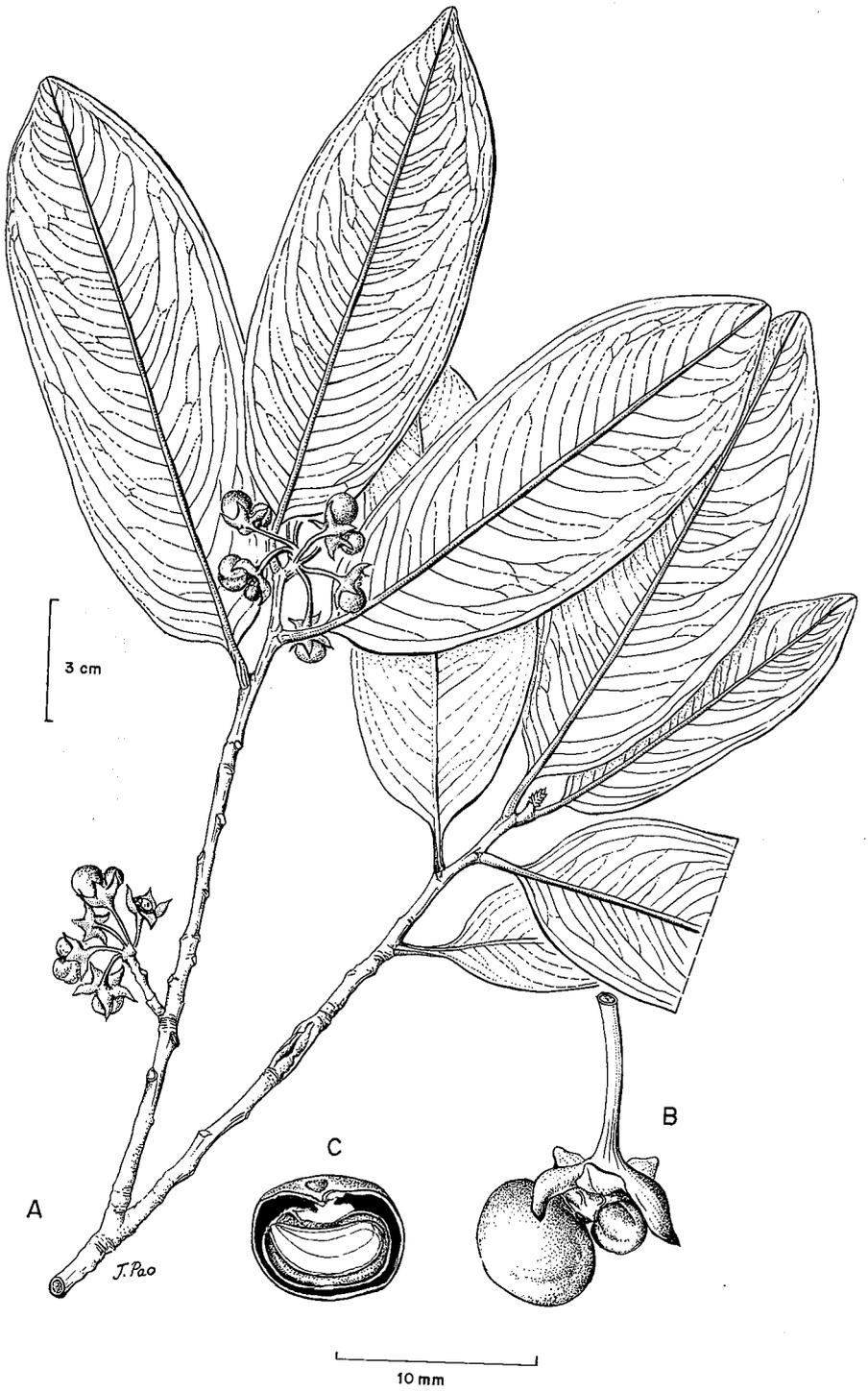


Fig. 1. *Brackenridgea hookeri*. A, fruiting leafy twig; B, fruit; C, fruit in longitudinal section. (All from S. 27231.)

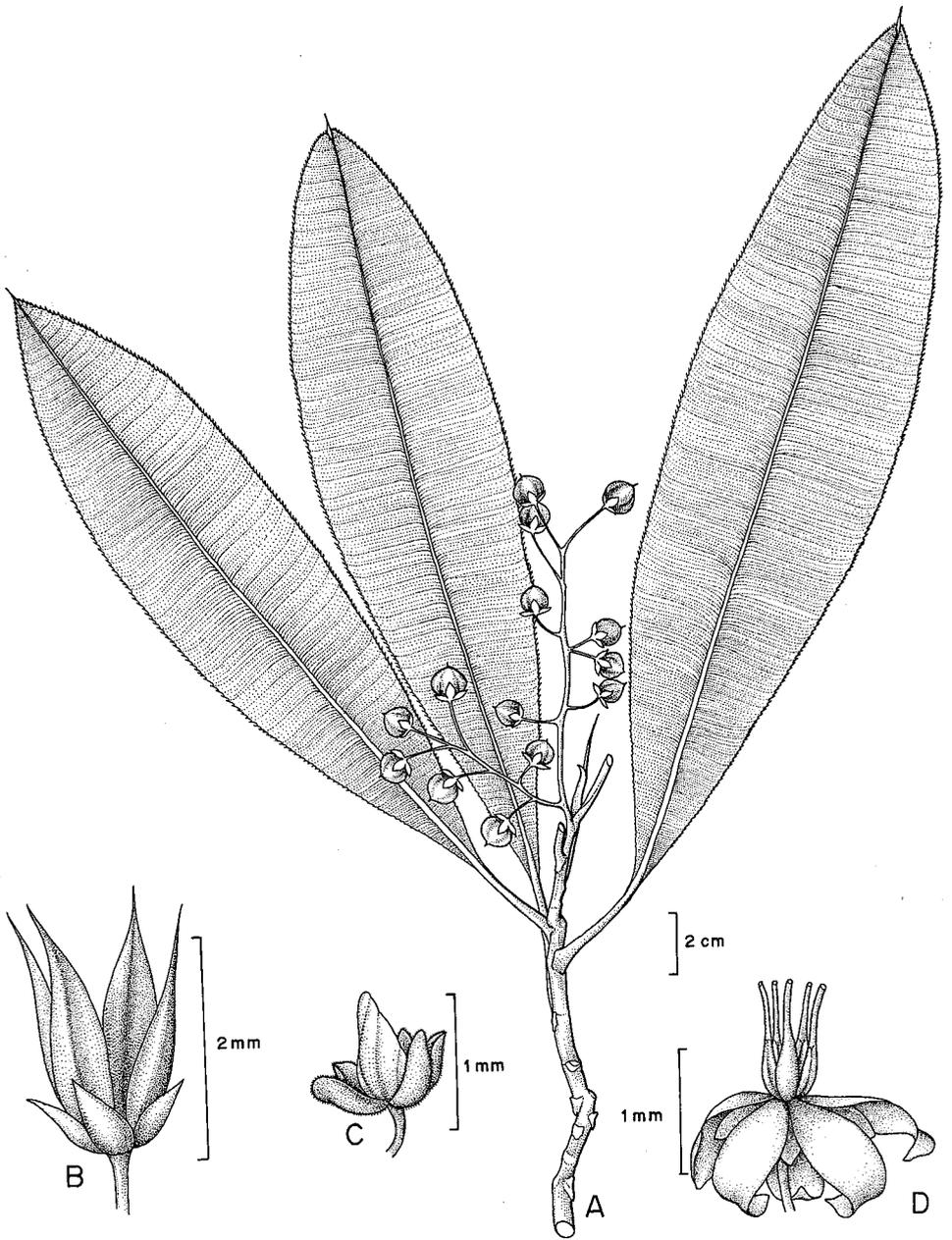


Fig. 2. *Euthemis leucocarpa* (A-B) and *E. minor* (C-D). A, fruiting leafy twig; B, dehiscent fruit; C, flower bud; D, open male flower. (A-B from SAN 84753, C-D after FM 1, 7 (1972) 109, fig. 4.)

celled, ovules 2 per cell, pendulous, axile; style distinct, stigma minute. **Fruit** a berry with 5 pyrenes. **Seeds** 1–2 per cell.

Distribution. 2 species; SW Cambodia, Sumatra, Peninsular Malaysia, Borneo.

Ecology. *Kerangas* forests, on low ridges, in peat swamp forests and also on ridges with poor sandy soils, below 1250 m.

Uses. *E. leucocarpa* roots are used in traditional medicine in Peninsular Malaysia and in Brunei; the fruits are used to treat eye diseases.

Key to *Euthemis* species

- Leaves 8–40 cm long; apex pointed; margin distinctly toothed; petiole 2–5 cm long. Mature fruit white.....1. *E. leucocarpa*
- Leaves 4–15 cm long; apex rounded to slightly notched, with short mucro; margin faintly toothed; petiole to 1.5 cm. Mature fruit red.....2. *E. minor*

1. *Euthemis leucocarpa* Jack (Greek, *leuco* = white, *karpos* = fruit)

Fig. 2A–B.

l.c. 16; Merrill *l.c.* (1921) 388; Ridley, FMP 1 (1922) 368; Masamune *l.c.* 469; Kanis *l.c.* (1968) 62, *l.c.* (1971) 108; Ng *l.c.* 257; Anderson *l.c.* 283. **Type:** *Wallich 2516*, Singapore (K, neotype). **Synonym:** *E. robusta* Hook. f. in Ridley *l.c.* 368.

Shrub to 2 m tall. Stipules ovate. **Leaves** oblong to linear-oblong, 8–40 x 2–10 cm; base tapered, *margin distinctly toothed*, apex acute; midrib raised above; lateral veins numerous, 1–2 mm apart; *petiole winged*, 2–5 cm long. **Inflorescences** in branched racemes. **Fruits** globose, 6–10 mm in diameter, white when mature.

Distribution. Cambodia, Sumatra, Peninsular Malaysia, and Borneo. Widely distributed in Sabah and Sarawak.

Ecology. Lowland to submontane forests to 1000 m, on poor soils. In Sarawak frequent in mixed swamp and *kerangas* forests.

2. *Euthemis minor* Jack (Latin, *minor* = small; the smaller size compared to *E. leucocarpa*)

Fig. 2C–D

l.c. 18; Merrill *l.c.* (1921) 388; Ridley *l.c.* (1922) 368; Masamune *l.c.* 469; Kanis *l.c.* (1968) 65, *l.c.* (1971) 108; Ng *l.c.* 257; Cockburn *l.c.* 62; Anderson *l.c.* 283. **Type:** *Wallich 2517*, Singapore (K, neotype). **Synonyms:** *E. obtusifolia* Hook. f., Trans. Linn. Soc. 23 (1862) 163, Merrill *l.c.* (1921) 389, Masamune *l.c.* 469; *E. ciliata* Pearson, Kew Bull. (1906) 3; *E. hackenbergii* Diels, Bot. Jahrb. 60 (1926) 310.

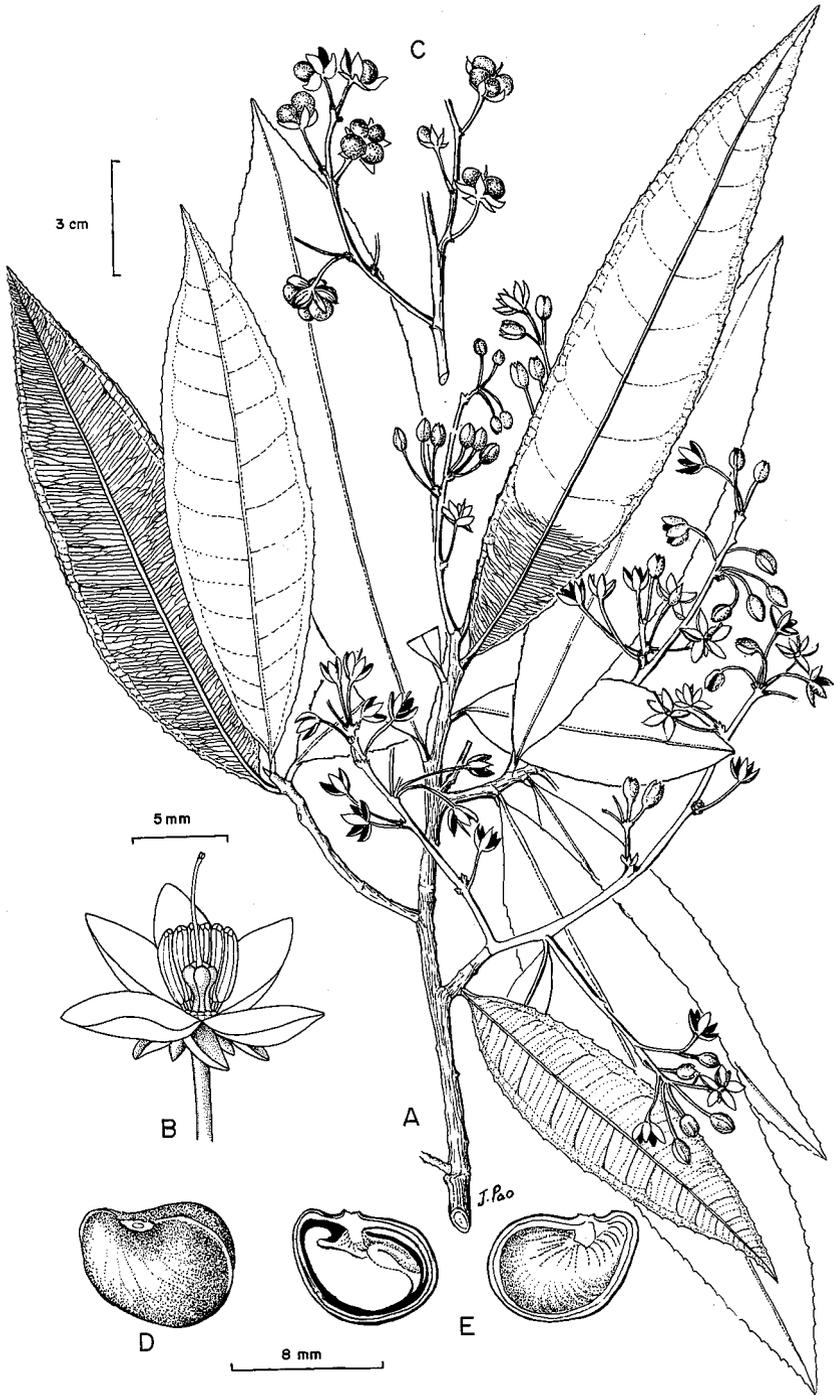


Fig. 3. *Gomphia serrata*. A, flowering leafy twig; B, open flower; C, infructescence; D, fruit; E, fruit in longitudinal section. (A-B from S. 38696, C-E from S. 32942.)

Shrub or treelet to 5 m tall. *Twigs black. Leaves* oblong to oblanceolate, 4–15 x 1.5–4 cm; base tapered, *margin faintly toothed, apex rounded with a short point*; midrib raised above; lateral veins *c.* 1 mm apart, very faint to invisible; petiole 0.5–1.5 cm long. **Inflorescence** usually an unbranched raceme. **Flowers** sepals and petals pinkish when fresh. **Fruits** globose, 4–6 mm in diameter, with 5 prominent ridges.

Distribution. Sumatra, Peninsular Malaysia, Borneo. Common in Sabah and Sarawak.

Ecology. Lowland to submontane forests to 1250 m; locally abundant in Sarawak in *kerangas* and *padang alan* forest.

3. GOMPHIA Schreb.

(Greek, *gomphos* = a thorn or spike;
the form of the flower base during fruit development)

Gen. Pl. ed. 8 (1784) 291; Ridley *l.c.* (1922) 365; Kanis, Taxon 16 (1967) 420, *l.c.* (1968) 51, *l.c.* (1971) 105; Ng *l.c.* 258; Cockburn *l.c.* 65; Anderson *l.c.* 283; Whitmore, Tantra & Sutisna *l.c.* 278. **Synonyms:** *Campylocerum* Tiegh., Bull. Mus. Hist. Nat. Paris (1902) 546; *Meesia* Gaertn., Fruct. & Sem. Pl. 1 (1788) 344.

Shrubs or small to medium-sized trees. Stipules united, falling off early. **Leaves** spiral, *margin firmly toothed; lateral veins numerous, close and almost parallel, with 2–3 distinct intramarginal veins; petiole to 3 mm long. Inflorescences* in terminal and axillary panicles, *peduncle persistent. Flowers: sepals 5, enlarged and persistent in fruit; petals 5; stamens 10, anthers opening by apical pores; gynophore columnar, 5-ribbed; carpels 5, free. Fruit* a drupe. **Seed** one.

Distribution. Mainly African; 1 species in SW India, Sri Lanka, E Thailand, Indo-China, Hainan and W Malesia.

Ecology. Confined to everwet tropical and moderately dry monsoon areas from lowlands to 1500 m. Dispersal is presumed to be by birds.

Gomphia serrata (Gaertn.) Kanis
(Latin, *serratus* = with teeth; the leaf margin)

Fig. 3.

l.c. (1967) 418, *l.c.* (1968) 53, *l.c.* (1971) 105; Ng *l.c.* 258; Cockburn *l.c.* 65; Anderson *l.c.* 283; Whitmore, Tantra & Sutisna *l.c.* 278. **Basionym:** *Meesia serrata* Gaertn. *l.c.* (1788) 344. **Type:** *Koenig 25, Ceylon (L).* **Synonyms:** *Gomphia sumatrana* Jack *l.c.* 29; *G. microphylla* Ridl. *l.c.* (1922) 369; *G. oblongifolia* Ridl., Kew Bull. (1925) 281; *Ouratia angustifolia* (Vahl) Baill. ex Laness, Rev. Gen. Pl. (1891) 106, Merrill *l.c.* 387, Masamune *l.c.* 470; *O. borneensis* Bartelli *l.c.* 158, Merrill *l.c.* 387, Masamune *l.c.* 470; *O. neriifolia* Bartelli *l.c.* 158, Merrill *l.c.* 387, Masamune *l.c.* 470; *O. beccariana* Bartelli *l.c.* 159, Merrill *l.c.* 387, Masamune *l.c.* 470; *O. megacarpa* Ridl., Kew Bull. (1930) 76, Masamune *l.c.* 470.

Shrub or medium-sized tree, to 20 m tall, 40 cm diameter; bole slightly fluted. **Bark** dark grey-brown, scaly; inner bark pink, fibrous. **Sapwood** pale. **Leaves** *shiny above, very*

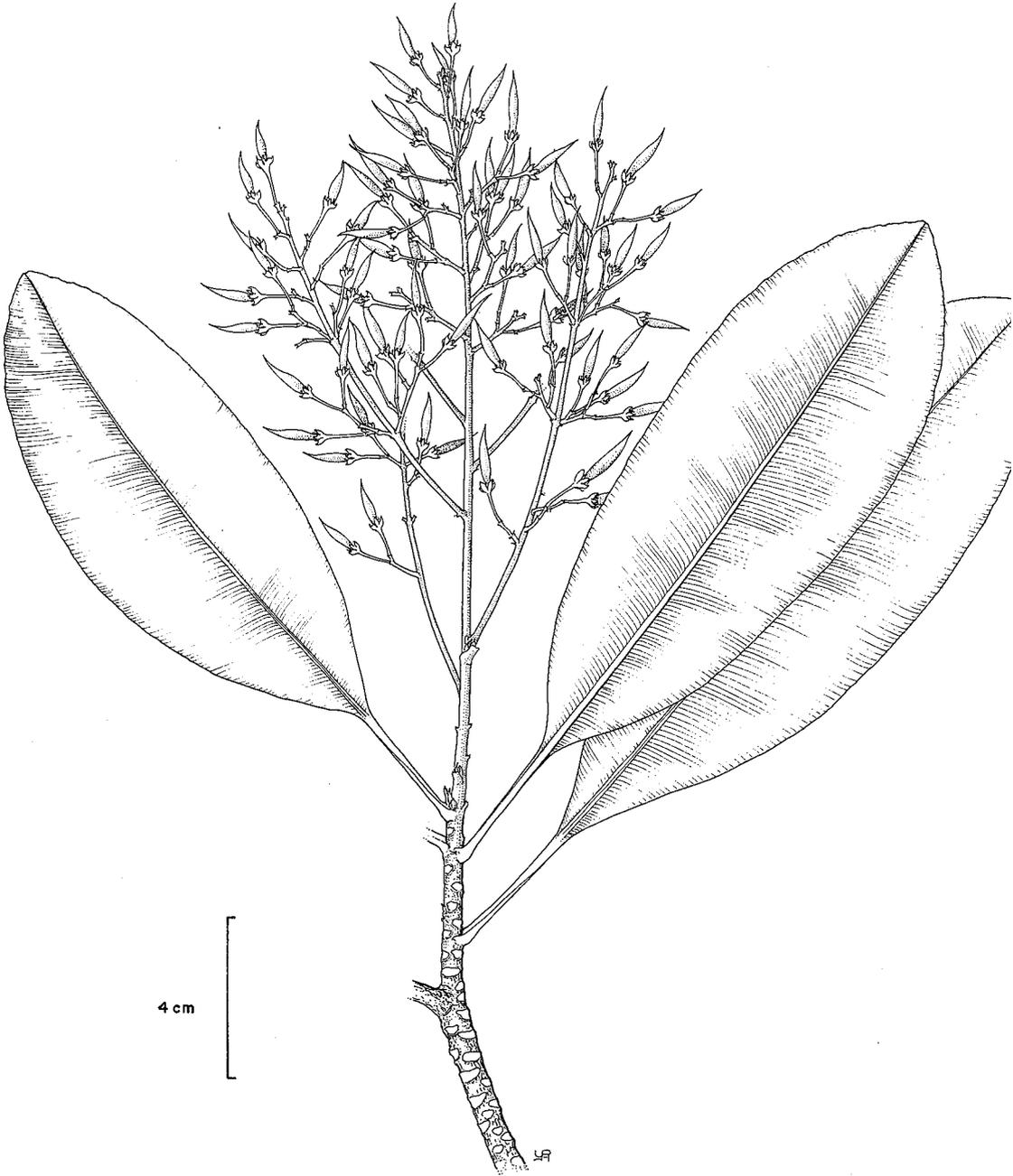


Fig. 4. *Schuurmansia elegans*. Fructing leafy twig. (From SAN 132717.)

variable in shape and size, elliptic, oblong, or obovate, 5.5–33 x 2–7.5 cm; base cuneate, margin faint to distinctly toothed, apex pointed; midrib raised above; *lateral veins* numerous, close, almost parallel, very faint to almost invisible on both surfaces, *forming 1–3 distinct wavy intramarginal veins*; intercostal veins finely reticulate, very faint; *petiole* to 3 mm long. **Inflorescences** axillary and terminal panicles. **Flowers**: pedicel *c.* 1 cm long; sepals 5, tinged pink, enlarged in fruit; petals 5, yellow or cream, obliquely obovate to broadly spatulate; stamens 10, subsessile or with very short filaments, *anthers opening with 2 apical pores*, obovoid; carpels 5, free, with a single style. **Fruits** kidney-shaped, 1–2(–5), yellowish green, ripening purplish, 0.5–1 x 0.4–0.6 cm, with persistent sepals. **Seed** one.

Vernacular names. Sabah—*antimagas gimbaan* (Murut), *kolambang* (Dusun), *majang-majang* (Kadazan), *quintalai* (Kadazan). Sarawak—*aam* (Kenyah), *chinaga-lampong*, *keladang*, *kelutak* (Iban), *ladin* (Malay).

Distribution. SW Peninsular India, Sri Lanka, E Thailand, Indo-China, Hainan, Malesia. Common and widely distributed in Sabah and Sarawak.

Ecology. Lowland forests on well-drained infertile organic soils, including mixed dipterocarp and *kerangas* forests, to submontane forest to 1500 m, sometimes occurring by stream banks, rarely on limestone forests. Flowering and fruiting samples have been collected throughout the year. As this species is found in a number of ecological habitats there is considerable variation in its morphological characters. This variation is more pronounced in Sarawak. In the more exposed habitats, on cliffs and on poor *kerangas* soils, this species has very small leaves.

Uses. Roots and leaves are bitter and are decocted in S India for a stomachic and antiemetic tonic. Young branch tissue is used to treat toothache in Cambodia.

4. SCHUURMANSIA Blume

(J. Schuurmans Stekhoven, 1972–1855,
horticulturist at the Leiden University Botanical Garden)

Mus. Bot. Lugd. Bat. 1 (1850) 177; Masamune *l.c.* 470; Kanis *l.c.* (1968) 74, *l.c.* (1971) 115; Anderson *l.c.* 283; Whitmore, Tantra & Sutisna *l.c.* 278.

Shrubs or small trees. *Twigs hollow*. Stipules entire, narrow, lanceolate. **Leaves** spiral, shiny, margin entire or toothed, glandular; lateral veins invisible. **Inflorescences** in terminal panicles. **Flowers**: sepals 5; petals 5; stamens 5, *anthers opening by longitudinal slits*, staminodes many in one or two whorls; carpels 3, united, ovary 1-celled. **Fruit** a *capsule, splitting into 3*. **Seeds** *winged*.

Distribution. 3 species; Borneo, Philippines, Celebes, Moluccas, New Guinea, Solomon Islands, Bismarks; 1 species in Borneo.

Ecology. Pioneer plants from sea-level to 3000 m.

Schuermansia elegans Blume
(Latin, *elegans* = elegant; the growth habit)

Fig. 4.

l.c. 178; Kanis *l.c.* (1968) 75, *l.c.* (1971) 115; Anderson *l.c.* 238; Whitmore, Tantra & Sutisna *l.c.* 278. **Type:** *Zippelius, s.n.*, Amboina (L). **Synonyms:** *S. parviflora* Ridl., *Trans. Linn. Soc. 2, Bot. 9* (1916) 18; *S. borneensis* Ridl., *Kew Bull.* (1930) 77, Masamune *l.c.* 470.

Small tree to 5 m tall. **Leaves** obovate to oblong, 10–30 x 2.5–10 cm, *shiny, surface of dried leaves finely reticulate*; base tapered, apex rounded to blunt; *lateral veins many, close, almost parallel, very faint on both surfaces*; petiole 5–6 cm long. **Flowers** yellow. **Fruits** fusiform, *c.* 2.5 x 0.5 cm, with pointed tip and persistent sepals. **Seeds** *c.* 3 mm long with slender wings.

Distribution. Borneo, Philippines, Celebes, Moluccas, New Guinea. In Sabah and Sarawak uncommon, known by only 2 collections (Sabah, *SAN A 3636*; Sarawak, *Nooteboom 1517*).

Ecology. Lowlands and hills including limestones, to 900 m.

5. SCHUURMANIELLA Hall. f.

Rec. Trav. Bot. Neerl. 10 (1913) 344; Merrill *l.c.* 387; Masamune *l.c.* 470; Kanis *l.c.* (1968) 73, *l.c.* (1971) 113; Anderson *l.c.* 283.

Shrubs. *Stipules needle-like*. **Leaves** spiral, *margin finely toothed*. **Inflorescences** terminal racemes. **Flowers:** sepals 5, petals 5, *staminodes many*, stamens 5, *anthers opening by longitudinal slits*; carpels 3, united, ovary 1-celled, style short, stigma capitate. **Fruit** a capsule, splitting into 3. **Seeds** hairy.

Distribution. Monotypic, endemic to Borneo (Sarawak).

Ecology. Mainly lowlands, especially in *kerangas* forests on poor soils and on sandstone cliffs near sea, rarely to 600 m.

Schuermansiella angustifolia (Hook. f.) Hall. f.
(Latin, *angustus* = narrow, *folium* = leaf)

Fig. 5.

l.c. 345; Merrill *l.c.* (1921) 387; Masamune *l.c.* 470; Kanis *l.c.* (1968) 73, *l.c.* (1971) 114; Anderson *l.c.* 283. **Basionym:** *Schuermansia angustifolia* Hook. f. *l.c.* 157. **Type:** *Lobb, s.n.*, Sarawak (K).

Shrub to 10 m tall. *Stipules* to 12 x 0.5 mm. **Leaves** *linear-oblong*, 8–17 x 0.7–1.45 cm; base tapered, apex pointed; midrib raised above; *lateral veins invisible to very faint, numerous, close*; petiole 0.5–1 cm long. **Flowers:** petals white with pink base; stamens purplish; ovary ovoid, style short, purplish, stigma capitate. **Fruits** ellipsoid, *c.* 8.5 x 3 mm.

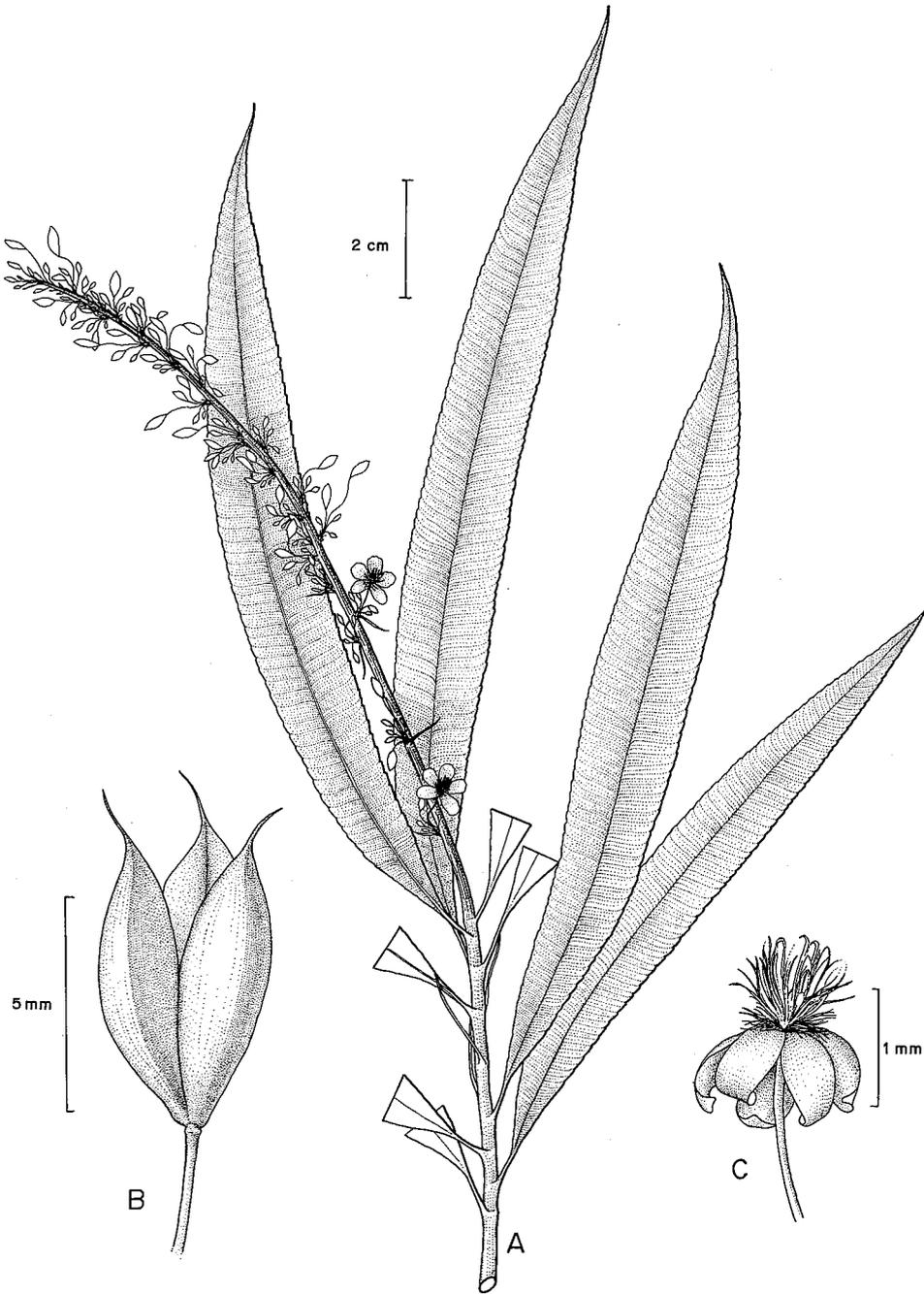


Fig. 5. *Schuurmansiella angustifolia*. A, flowering leafy twig; B, dehiscent fruit; C, open flower. (A & C from *S.* 21431, B from *Anderson* 8368.)

Distribution. Endemic to western Sarawak.

Ecology. Lowlands from sea-level to 600 m, mainly in *kerangas* forest.

OLACACEAE

Lesmy Tipot

Forest Research Institute Malaysia,
Kepong, Malaysia

Hooker *f.*, Fl. Brit. Ind. 1 (1875) 572 (under Olacineae); King, J. As. Soc. Beng. 64, 2 (1895) 108; Merrill, EB (1921) 242; Ridley, FMP 1 (1922) 419; Sleumer in Engler & Prantl, Pfl. Fam. 2, 16b (1935) 5, Blumea 26 (1980) 145, FM 1, 10 (1984) 1; Masamune, EPB (1942) 258; Backer & Bakhuizen *f.*, FJ 2 (1965) 63; Smythies, CST (1965) 113; Whitmore, TFM 2 (1973) 299; Keng, OFMSP (1978) 212; Anderson, CLTS (1980) 284; Cockburn, TS 2 (1980) 65; Corner, WSTM 2 (1988) 600; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 279.

Trees, shrubs or climbers. **Leaves** spirally arranged, rarely distichous, simple, entire, stalked, without stipules, when dry often with parchment-like and/or finely tuberculate surface, pinnately veined with the lateral veins rather distant. **Inflorescences** axillary cymes, racemes or branched spikes. **Flowers** bisexual, rarely unisexual, mostly radially symmetrical, rarely heterostylus; calyx often cup-like, shortly 3-7-lobed or dentate, sometimes accrescent; petals 3-7, free or joined below; stamens as many or twice the number of petals; disc present; ovary mostly superior, rarely inferior, 3-5-loculed, ovule solitary in each locule; style usually 1, stigma 3-5-lobed. **Fruit** a drupe; exocarp thin or fleshy; endocarp crustaceous to woody. **Seeds** one per fruit, with thin testa and abundant endosperm.

Distribution. Pantropical, 27 genera with *c.* 170 species. In Sabah and Sarawak, represented by 8 genera with 9 species of trees, shrubs and climbers.

Ecology. Found in a wide range of habitats, from open and sandy seashores to secondary and primary mixed dipterocarp forests. Occasionally in submontane forests.

Uses. Most species are small to medium-sized trees and are, therefore, commercially not important, except for *Scorodocarpus borneensis* which produces a dark red timber. Species of *Anacolosa*, *Strombosia* and *Ochanestachys* are occasionally used in local construction works. The wood of *Ximenia americana* can be used as a substitute for sandal wood, whereas the fruit kernel is said to have medicinal properties. Fruits of *Scorodocarpus borneensis* are edible and the young leaves are taken as vegetable.

Taxonomy. Engler (Syllabus, 1924) recognised Olacaceae as the most primitive family in the order Santalales. Ridley *l.c.*, following Hooker *f. l.c.*, on the other hand, treated Olacaceae together with Icacinaceae under the order Olacineae. Hutchinson (Fam. Fl. Pl. 1 (1964) 329) placed Olacaceae together with Opiliaceae and a few other families in the Olacales, an order comparatively more primitive than the Santales. Keng *l.c.*, Sleumer *l.c.* and Whitmore *l.c.* followed Engler's classification, a stand accepted in the present account. The Santalales consists of a small group of families showing a tendency toward

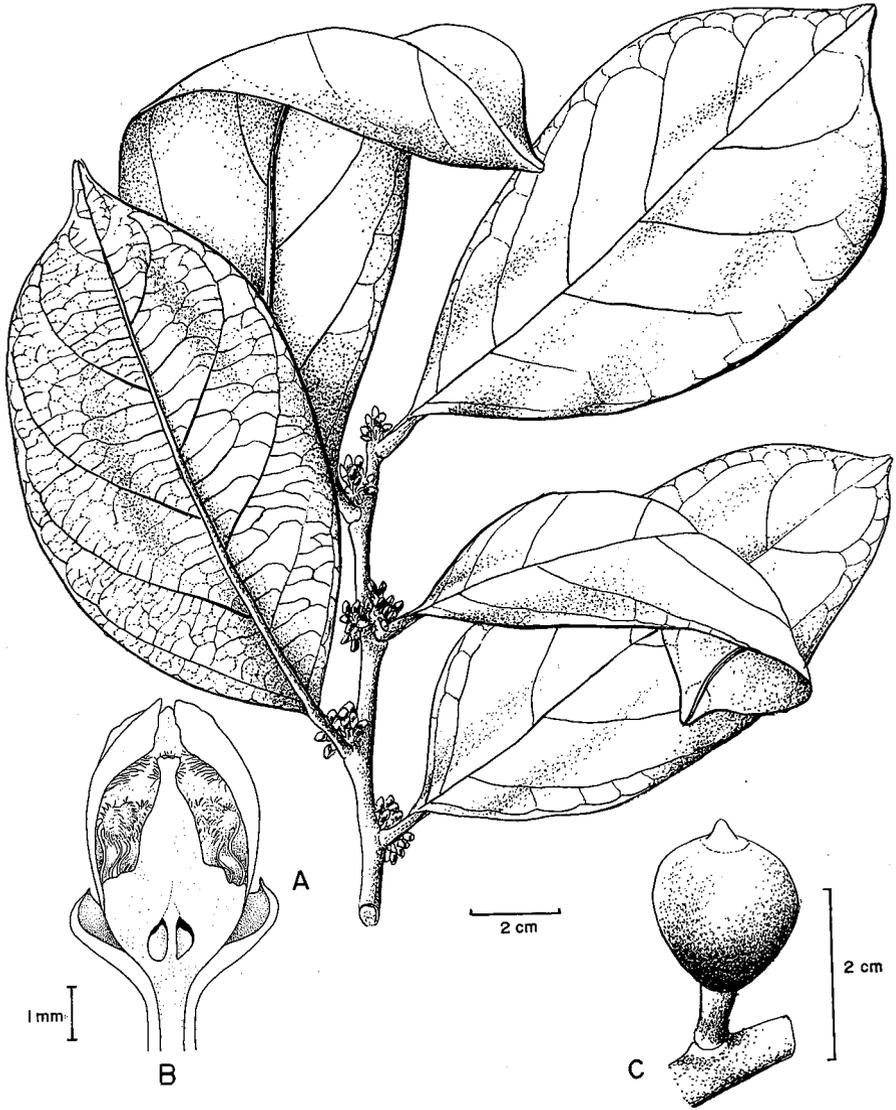


Fig. 1. *Anacolosa frutescens*. A, flowering leafy twig; B, longitudinal section of flower bud; C, fruit. (From S. 29191.)

hemiparasitism, reduction of the flowers and adaptation to the climbing and epiphytic habit. In this account, the nomenclature follows that of Sleumer's revision (1984), in which he has considerably reduced the number of species of *Strombosia* and *Olox* recognised by earlier workers.

Key to genera

1. Slender woody climbers, often with axillary tendrils.....
 - Erythralum** Blume
Bijdr. (1826) 921; Merrill, PEB (1929) 58; Masamune *l.c.* 258; Sleumer *l.c.* (1980) 151, *l.c.* (1984) 17.
One species, *E. scandens* Blume, distributed from the Himalayas to Assam, Bengal, Burma, Indo-China, Thailand and Malesia. In Sabah, recorded from Kinabatangan, Lahad Datu, Ranau, Tambunan, Tawau, Tenom and Mt. Kinabalu at c. 1200 m. In Sarawak, in Melinau and Bukit Jebong in Bau district.
Fruit drupaceous, ellipsoid, ripening reddish, *entirely enclosed by the persistent calyx which finally splits from top downwards into 3–6 reflexed segments*. In open areas and hillsides.
 - Trees, shrubs or scandent shrubs, without axillary tendrils.....2
2. Leaves usually mucronate at apex. Twigs armed with thorns.....
 - Ximenia** L.
Sp. Pl. (1753) 1193; Masamune *l.c.* 259; Sleumer *l.c.* (1980) 166, *l.c.* (1984) 10.
Eight species in the tropics and subtropics. 1 species, *X. americana* L., in Borneo and has been recorded from Teluk Tambak, Santubong near Kuching, Lubok Jayau and Tatau near Bintulu in Sarawak; and from Lahad Datu, Sandakan and Semporna in Sabah.
Low-branching shrub, deciduous in dry season. Usually on sandy seashores and in dry forest fringes, sometimes on stony ground.
 - Leaves not mucronate. Twigs without thorns.....3
3. Leaves distichous or subdistichous. Calyx well-developed, enclosing fruit or flat and fleshy at maturity.....4
 - Leaves not distichous. Calyx not developed as above.....5
4. Leaves elliptic, both surfaces parchment-like. Fruit seated on an enlarged flattish calyx.....
 - 2. Harmandia**
Leaves ovate, elliptic to oblong, surface not parchment-like. Fruit enclosed in the enlarged calyx.....
 - Olox** L.
Sp. Pl. (1753) 34; Merrill *l.c.* (1921) 242; Masamune *l.c.* 259; Sleumer *l.c.* (1984) 8.
About 40 species, Old World Tropics. 1 species, *O. imbricata* Roxb., distributed in India, Sumatra, Peninsular Malaysia, Borneo, Java, New Guinea and Solomon Islands. In Sabah, recorded from Lamag, Mt. Lotung, Bongawan, Papar, Sipitang, and Sandakan. In Sarawak, in Lawas, Limbang, Sibul, Kapit and Kuching.

Scandent shrub or climber. On open sandy ground including coasted areas, and occasionally on rocky ground along streamsides.

5. Leaves usually with fine pellucid-dots visible against strong light.....6
Leaves not so.....7
6. Young twigs zig-zag. Petals entirely free.....**5. Strombosia**
Young twigs not zig-zag. Petals fused in the lower half.....**1. Anacolosa**
7. All parts reeking of garlic smell when fresh. Leaves broadly elliptic, *c.* 20 cm long.
Bark fissured or thinly flaky, inner bark without any sap.....**4. Scorodocarpus**
Garlic smell absent. Leaves elliptic, rather small. Bark dippled, distantly scaly, inner
bark with a slight white sap.....**3. Ochanostachys**

1. ANACOLOSA Blume

(Greek, *anakolos* = knotted; the calyx-cup rim)

Mus. Bot. Lugd. Bat. 1 (1850) 250, *t.* 46; Merrill *l.c.* (1921) 242; Ridley *l.c.* (1922) 424; Sleumer in Engler & Prantl *l.c.* (1935) 20, *l.c.* (1980) 146, *l.c.* (1984) 23; Masamune *l.c.* 258; Whitmore *l.c.* 300; Anderson *l.c.* 283; Whitmore, Tantra & Sutisna *l.c.* 279.

Trees or shrubs. **Leaves** spiral, pinnately veined. **Flowers** bisexual, in axillary cymes or fascicles; calyx cup-shaped, (5-)6(-7)-dentate or minutely toothed; petals (5-)6(-7), inserted on the margin of the cupular disc, fused in the lower part, fleshy and concave below; stamens (5-)6(-7), filaments short, anthers ovoid; disc hypogenous, fused with the ovary-wall, 6-denticulate or furrowed; ovary superior, incompletely 2(-3)-celled below, 1-celled above, style short and thickened at base; ovules 2(-3), unitegmic, pendant, placentation central. **Fruit** a drupe, surrounded by the enlarged disc, tipped by the remains of the style, seated on the small persistent calyx; pericarp thin, fleshy; endocarp thin, crustaceous. **Seeds:** embryo minute; endosperm starchy and oily.

Distribution. 15 species, in the Old World tropics, of which 3 species occur in Malesia. In Sabah and Sarawak, one species.

Anacolosa frutescens (Blume) Blume

Fig. 1.

(Latin, *frutex* = a shrub; the habit)

l.c. (1850) 251, *t.* 46; Masamune *l.c.* 258; Sleumer *l.c.* (1980) 146, *l.c.* (1984) 25; Anderson *l.c.* 283; Whitmore, Tantra & Sutisna *l.c.* 279. **Basionym:** *Stemonurus frutescens* Blume *l.c.* (1826) 649. **Type:** Blume "2168", Java (holotype L; isotypes P, U). **Synonyms:** *Anacolosa heptandra* Maingay ex Mast. in Hooker *f. l.c.* 581; *A. arborea* Koord. & Valetton, Bull. Inst. Bot. Buitz. 2 (1899) 9; *A. luzoniensis* Merr., Philip. J. Sc. 4, Bot. (1909) 253; *Anacolosa* sp. Merr. *l.c.* (1921) 242; *Salacia bartletti* Ridl., Kew Bull. (1938) 239.

Erect shrub or small slender tree, to 30 m tall and 30 cm diameter. **Bark** smooth to papery or mottled, greenish grey; inner bark reddish. **Sapwood** yellow to pale red. Twigs greyish

brown or whitish. **Leaves** very variable in shape, from elliptic to elliptic-oblong or lanceolate, 9–18 x 6–9.5 cm, papery to leathery, glossy above when fresh, brownish and dull in dry state, *usually with tiny warts or tubercles on both surfaces*, or with *fine pellucid-dots* visible against strong light; base cuneate, slightly asymmetric, margin entire, apex acuminate, blunt or rounded; lateral veins 5–7 pairs, ascending, rather distant, lowest pair close to the base, faint on upper surface, conspicuous and slightly raised below; petiole stout, 5–12 mm long. **Flowers** in *axillary clusters* of 5–15, pedicels 2–5 mm; calyx shortly 5–7-lobed, glabrous or pale rusty-puberulous, *c.* 3 mm in diameter; petals 6, ovate-lanceolate, glabrous or rarely puberulous outside, 2–3 x 1–1.5 mm; stamens 6, anthers hairy; ovary with 2–3 pendulous ovules. **Fruits** obovoid to oblong, with persistent calyx, green, ripening yellow to orange, *c.* 1.2 x 0.8 cm. **Seeds:** endosperm copious.

Vernacular names. Sabah—*salangugapit* (Dusun, Tawau). Sarawak—*belian landak* (Malay, Iban), *jerit* (Iban), *ladit* (Melanau).

Distribution. Burma, Andaman and Nicobar Is., Thailand, Sumatra, Peninsular Malaysia, Java, Borneo, Philippines, Celebes and the Moluccas. In Sabah, recorded from Kalabakan, Keningau, Kota Belud, Lahad Datu, Ranau, Sandakan, Sepulut and Tawau. In Sarawak, known from Kuching, Sibul, Sarikei, Kapit, Bintulu, Miri to Baram.

Ecology. Common on hillslopes of primary mixed dipterocarp forests on sandy humult ultisols, sometimes in heath and peat swamp forests. Once recorded from limestone hill, and once from submontane forest at about 1100 m.

Uses. The wood is pale reddish brown, considerably hard and heavy, and sometimes used locally for house-posts though not very durable.

2. HARMANDIA Pierre *ex* Baill.

(Jules Harmans, 1845–1921, French colonial officer)

Bull. Linn. Soc. Paris 2 (1889) 770; Sleumer *l.c.* (1935) 30, *l.c.* (1980), *l.c.* (1984) 9; Whitmore *l.c.* 301; Whitmore, Tantra & Sutisna *l.c.* 279.

Trees *monoecious*. **Leaves** *distichous*, pinnately veined. **Inflorescences** short, axillary racemes. **Flowers** *unisexual*; *calyx at anthesis disc-form, shortly 4-dented, much accrescent at maturity forming a frill below the fruit*; petals 4 in male, 6–8 in female flowers, connate to an urceolate tube at base, free at the upper part; *disc extra-staminal, annular*. **Male flowers:** *stamens 4, epipetalous*, filaments fused into a tube with the free anthers on top; ovary rudimentary. **Female flowers:** *staminodal tube without anthers; ovary pyramidal, 1-celled, with 2 pendant ovules, placentation basal*; style short-conical, stigma 3, sessile. **Fruit** a drupe, *conescent with the much enlarged calyx below*; pericarp fleshy; endocarp thin and woody. **Seeds:** *endosperm oily; embryo excentric*.

Distribution. Monotypic; Indo-China and W Malesia (Sumatra, Peninsular Malaysia and Borneo).

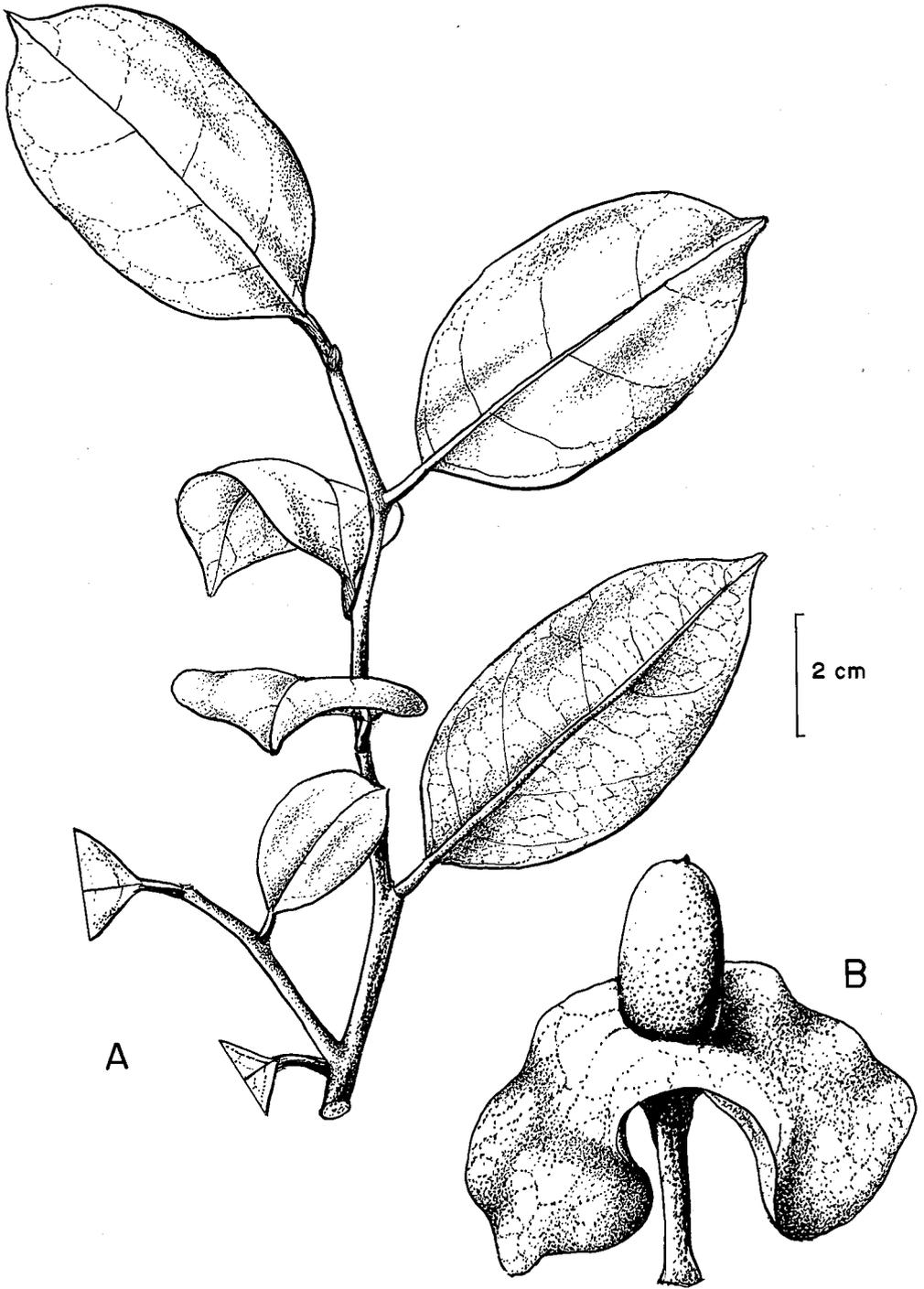


Fig. 2. *Harmandia mekongensis*. A, leafy twig; B, fruit. (From SAN 107911.)

Ecology. Usually found in lowland forests.

Harmandia mekongensis Pierre *ex* Baill.

Fig. 2.

(of Mekong River in Laos)

l.c. 770; Sleumer *l.c.* (1980) 153, *l.c.* (1984) 9. **Type:** *Harmand 1322*, SE Laos (holotype P; isotypes BM, K, L, SING). **Synonym:** *Harmandia kunstleri* King *l.c.* 100.

Medium-sized tree to 30 m tall, 30 cm diameter. **Bark** thin, pale brown to whitish, flaky; inner bark pale yellow, granular. **Sapwood** pale yellow. Twigs slender, dark brown to black, striate and slightly zig-zag. **Leaves** elliptic, 7–8.5 x 3–4 cm, subcoriaceous, *parchment-like* especially on lower surface, deep green when fresh; base cuneate to slightly rounded, margin recurved, apex pointed; lateral veins 4–6 pairs, rather inconspicuous on both surfaces; reticulations very faint; petiole 8–10 mm long. **Flowers** pale green to whitish; *calyx cupular at bud stage, accrescent in fruit*; petals *c.* 2 mm, connate below, forming an *urceolate corolla*. **Male flowers:** stamens 4, filaments connate to a fleshy tube, *c.* 1.5 mm; anthers cordate, *c.* 0.5 mm; pistillodes present. **Female flowers:** staminodal tube without anthers; ovary conical, tapering to a short style; stigmas 3, sessile. **Fruits** ovoid-ellipsoid, green, maturing black, *c.* 3 x 1.5 cm, with an *enlarged pale red and fleshy calyx below*. **Seeds:** pericarp fleshy, *c.* 0.5 mm thick; endocarp woody, *c.* 0.5 mm thick.

Distribution. Indo-China (Laos, Annam) and W Malesia (Sumatra, Peninsular Malaysia and Borneo). In Sabah very uncommon, represented by only two collections from Keningau (*SAN 107911*) and Nabawan (*SAN 118776*). Not yet recorded from Sarawak.

Ecology. In lowland and hill primary and disturbed forests to about 300 m.

3. OCHANOSTACHYS Mast.

(Greek, *okanon* = shield strap, *stachus* = spike; the inflorescence)

in Hooker *f. l.c.* 576; Merrill *l.c.* (1921) 242, *l.c.* (1929) 58; Ridley *l.c.* (1922) 422; Masamune *l.c.* 259; Whitmore *l.c.* 302; Anderson *l.c.* 284; Sleumer *l.c.* (1980) 153, *l.c.* (1984) 12; Whitmore, Tantra & Sutisna *l.c.* 279. **Synonym:** *Petalinia* Becc., Malesia 1 (1883) 257.

Trees. **Leaves** spiral. **Flowers** bisexual, on simple or branched axillary spikes; *calyx* small, cup-shaped, 4–5-lobed, not accrescent; petals 4–5, almost free; stamens 8–15, epipetalous, (1–)2(–3) on each petal, filaments joined at base, anthers globular to subglobular; disc hypogynous, fleshy, rather inconspicuous; ovary superior, incompletely 3–4-chambered, style short, stigma 3-lobed; ovules bitegmic, pendulous, placentation free basal. **Fruit** a drupe; pericarp thin; endocarp woody. **Seeds:** endosperm starchy; embryo small, apical.

Distribution. Monotypic; confined to W Malesian region (Sumatra, Bangka, Lingga Island, Peninsular Malaysia, and Borneo).

Ecology. Lowland rain forest.

Ochanostachys amentacea Mast.

Fig. 3.

(Latin, *amentum* = a catkin; the inflorescence)

in Hooker *f. l.c.* 577; Merrill, *l.c.* (1921) 242, *l.c.* (1929) 58; Ridley, Kew Bull. (1931) 35, incl. var. *rufa* Stapf ex Ridl.; Masamune *l.c.* 259; Browne, FTSB (1955) 251; Smythies *l.c.* 113; Burgess, TBS (1966) 420; Whitmore *l.c.* 302; Anderson *l.c.* 284; Cockburn *l.c.* 67; Sleumer *l.c.* (1980) 153, *l.c.* (1984) 14; Whitmore, Tantra & Sutisna *l.c.* 278. **Type:** *Maingay 384*, Malacca (lectotype K; isolectotype P). **Synonyms:** *Petalinia bancana* Becc. *l.c.* 258; *Ochanostachys bancana* (Becc.) Valetton, Crit. Overz. Olacin. (1886) 104.

Small to medium-sized tree, to 30 m tall, 70 cm diameter; bole straight to (often) rather poorly formed, at base shortly fluted or buttressed. **Bark** grey-brown to reddish brown, *shedding off into thin, irregular scales, exposing lighter coloured patches, giving a dippled appearance; inner bark finely fibrous, yellowish brown, with discrete droplets of white latex.* **Sapwood** hard, brownish yellow. **Leaves** usually glabrous, thinly leathery, ovate-elliptic to elliptic-oblong, 6–13 x 3–7 cm, green and shiny above, yellowish green beneath when fresh, rather dull and brownish when dry, *usually with blackish dots on both surfaces*; base cuneate or rounded, margin entire, apex acute to acuminate; *lateral veins 4–6 pairs, rather distant, sunken above prominent below*; intercostal veins scalariform, very fine and rather faint; stalk slender, 1.5–2.5 cm, with a faint, darker, 5 mm, apical knee. **Inflorescences** *simple or branched spikes to 12 cm long.* **Flowers** green, *in opposite, well-spaced clusters*; calyx 4–5-toothed, *c.* 1 mm; *petals (3–)4(–5)*, ovate to ovate-oblong, *c.* 2.5 x 1.5 mm; *ovary depressed ovoid, striate*, glabrous, style short, cylindrical. **Fruits** subglobose, to 2 cm across, on a slender peduncle of *c.* 2 mm; pericarp thin, *exuding a milky gum*; endocarp woody. **Seeds** subglobose.

Vernacular names. Sabah—*tanggal* (Dusun). Sarawak—*imah* (Bidayuh Bau), *petaling* (Malay), *sagad berauh* (Murud), *santikal* (Iban).

Distribution. Sumatra, Bangka, Peninsular Malaysia and Borneo. Common and widespread throughout Sabah and Sarawak.

Ecology. Main canopy tree in primary and secondary mixed dipterocarp forest, on hillsides and ridges on loamy usually clay-rich soils, to 800 m, occasionally in heath forest.

Uses. Produces a yellowish brown, hard, heavy, and reasonably durable wood, useful for house construction and logging railways.

4. SCORODOCARPUS Becc.

(Greek, *skorodon* = garlic, *karpus* = fruit; the strong garlic smell in the fruit)

Nuov. Giorn. Bot. Ital. 9 (1877) 274, t.11, f.12–17; Merrill *l.c.* (1921) 242; Ridley *l.c.* (1922) 424, Masamune *l.c.* 259; Smythies *l.c.* 113; Whitmore *l.c.* 303; Anderson *l.c.* 284; Cockburn *l.c.* 67; Sleumer *l.c.* (1980) 160, *l.c.* (1984) 15; Whitmore, Tantra & Sutisna *l.c.* 279.

Garlic-smelling tree, with straight bole, without buttresses. **Leaves** *spiral.* **Flowers** *bisexual*, in short racemes; *calyx* small, cup-shaped, *narrowly 4–5-toothed, not enlarged in fruit; petals*

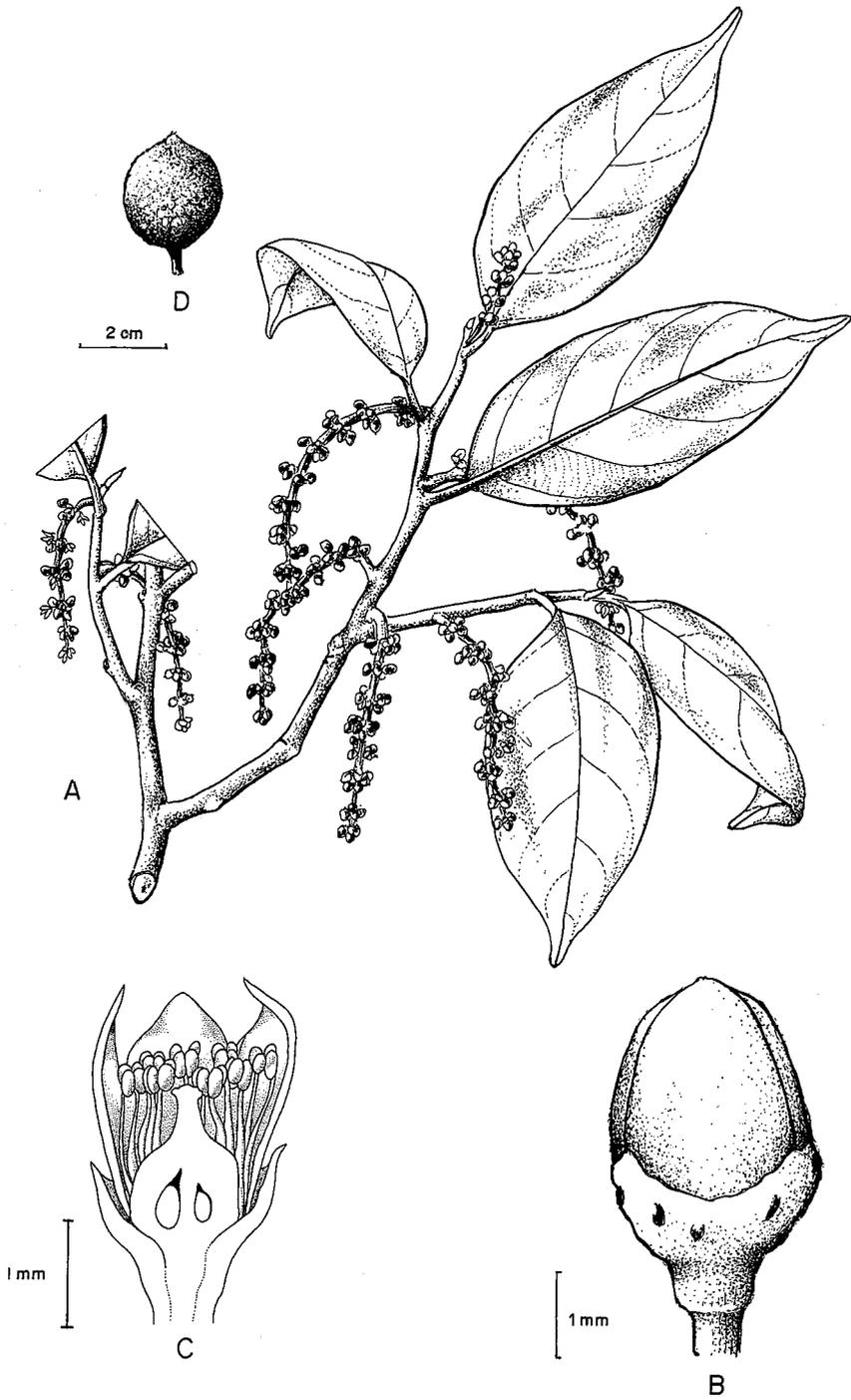


Fig. 3. *Ochanostachys amentacea*. A, flowering leafy twig; B, flower bud; C, flower bud in section; D, fruit. (From SAN 61173.)

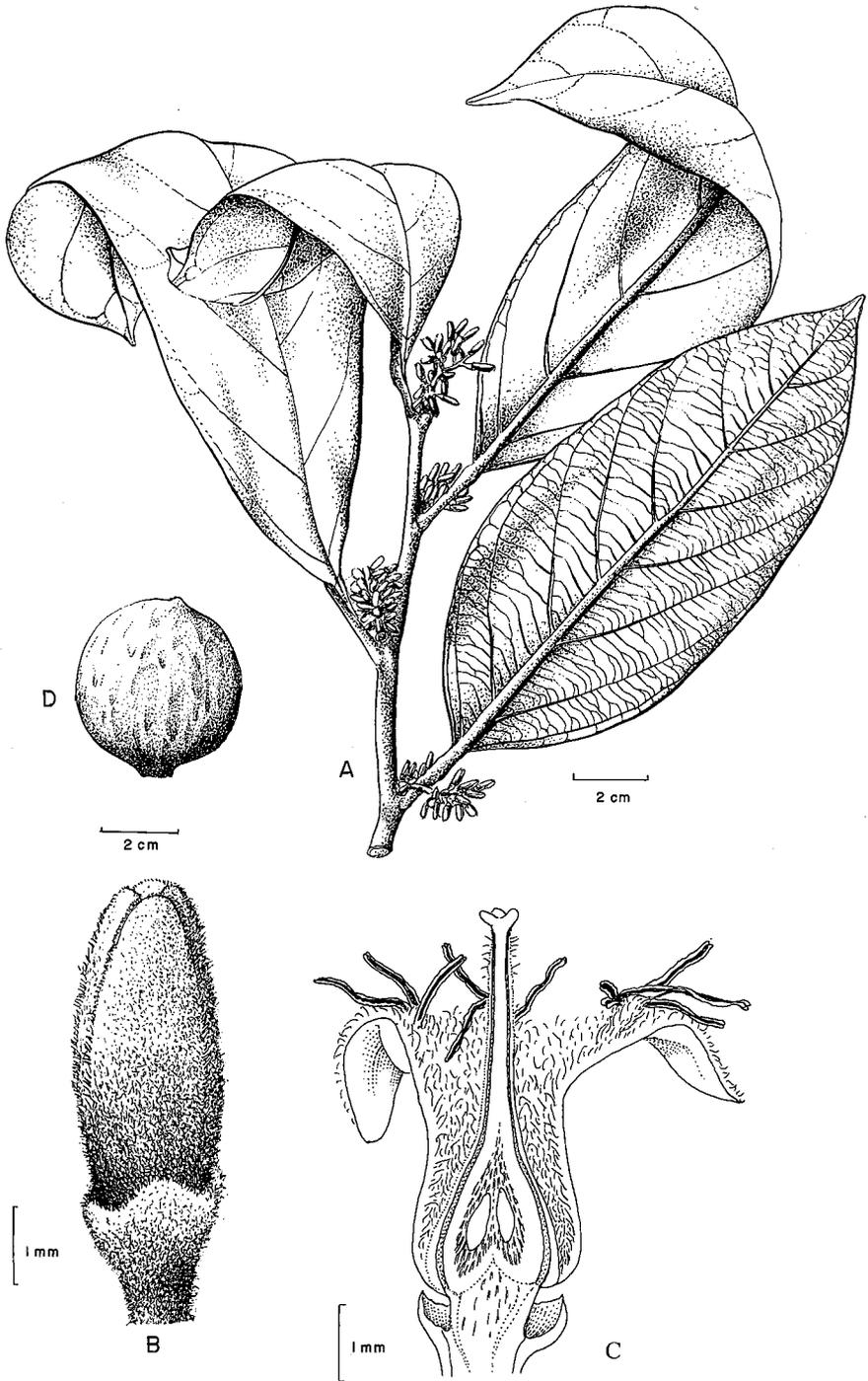


Fig. 4. *Scorodocarpus borneensis*. A, flowering leafy twig; B, flower; C, longitudinal section of flower; D, fruit. (From S. 36079.)

4–5, hairy within; *stamens* 8–10, in pairs, joined halfway down, and attached to the base of petal; *ovary* superior, imperfectly 3–4-celled, style elongate conical, *stigma* 3–4-lobed, *ovule* 1 in each cell, pendant, *placentation* free. **Fruit** a drupe; pericarp thin, fleshy; endocarp woody. **Seeds:** *endosperm* fleshy, containing starch and tannin.

Distribution. Monotypic; S Thailand, Sumatra, Lingga Island, Peninsular Malaysia and Borneo.

Ecology. Common in lowland forest.

Scorodocarpus borneensis (Baill.) Becc.

Fig. 4.

(of Borneo)

L.c. 274, *t.* 11, *f.* 12–17; Merrill *l.c.* (1921) 242; Ridley *l.c.* (1922) 424; Masamune *l.c.* 259; Brown *l.c.* 280; Smythies *l.c.* 422; Whitmore *l.c.* 303; Anderson *l.c.* 284; Cockburn *l.c.* 67; Sleumer *l.c.* (1980) 160, *l.c.* (1984) 15; Whitmore, Tantra & Sutisna *l.c.* 279. **Basionym:** *Ximenia borneensis* Baill., *Andansonia* 11 (1874) 271. **Type:** *Beccari* PB 1581, Sarawak, Mt. Matang (holotype FI; isotypes P, W).

Medium-sized to large tree, to 40 m tall, 80 cm diameter; *all parts with garlic smell especially when crushed or cut*; crown small, dense; bole straight, to 25 m, occasionally with small, low buttresses. **Bark** grey to dark red or brown, fissured and thinly rectangularly flaky; *inner bark purplish red, inwards with coarse orange flecks*. **Sapwood** hard, yellow to reddish brown. **Leaves** coriaceous, shiny green above when fresh, dull olive-green when dry, glabrous, elliptic, 10–22 x 4–9 cm; base cuneate to rounded, margin entire, apex acuminate; lateral veins 5–6 pairs, distant, curving upwards towards margin, flat above, very prominent beneath; reticulation rather faint; petiole 1.5–2 cm, thickened distally or almost at the leaf-base. **Inflorescences** racemose, to 4 cm, rusty to greyish puberulous. **Flowers** white, *c.* 1.5 cm long, solitary or grouped in clusters of 2–3 along the rachis; pedicels *c.* 1.5–2 mm; calyx small with wavy edges; petals white or creamy white, 8–10 x 2 mm, woolly inside, reflexed; anthers 3–4 mm; ovary yellowish green, tapering toward the thickish white style. **Fruits** globose, green, *c.* 5 cm across; peduncle 1 cm; pericarp thin and fleshy; endocarp woody with numerous vertical fibre-like hard strands. **Seeds** subglobose.

Vernacular names. Sabah—*bawang hutan* (Malay). Sarawak—*sagan-berauh* (Murut), *sindok*, *sindu* (Iban), *troduh* (Bidayuh Bau).

Distribution. Peninsular Thailand, Sumatra, Lingga Is., Peninsular Malaysia, Borneo. In Sabah and Sarawak widespread. Also occurs in Brunei and Kalimantan.

Ecology. Commonly found on slopes in primary and secondary mixed dipterocarp forest on clay loam soils, and occasionally in seasonally flooded alluvial forest.

Silviculture. *Bawang hutan* requires well-drained soils for good growth under normal conditions. It is evergreen but slow-growing. Fruiting usually occurs during June–September.

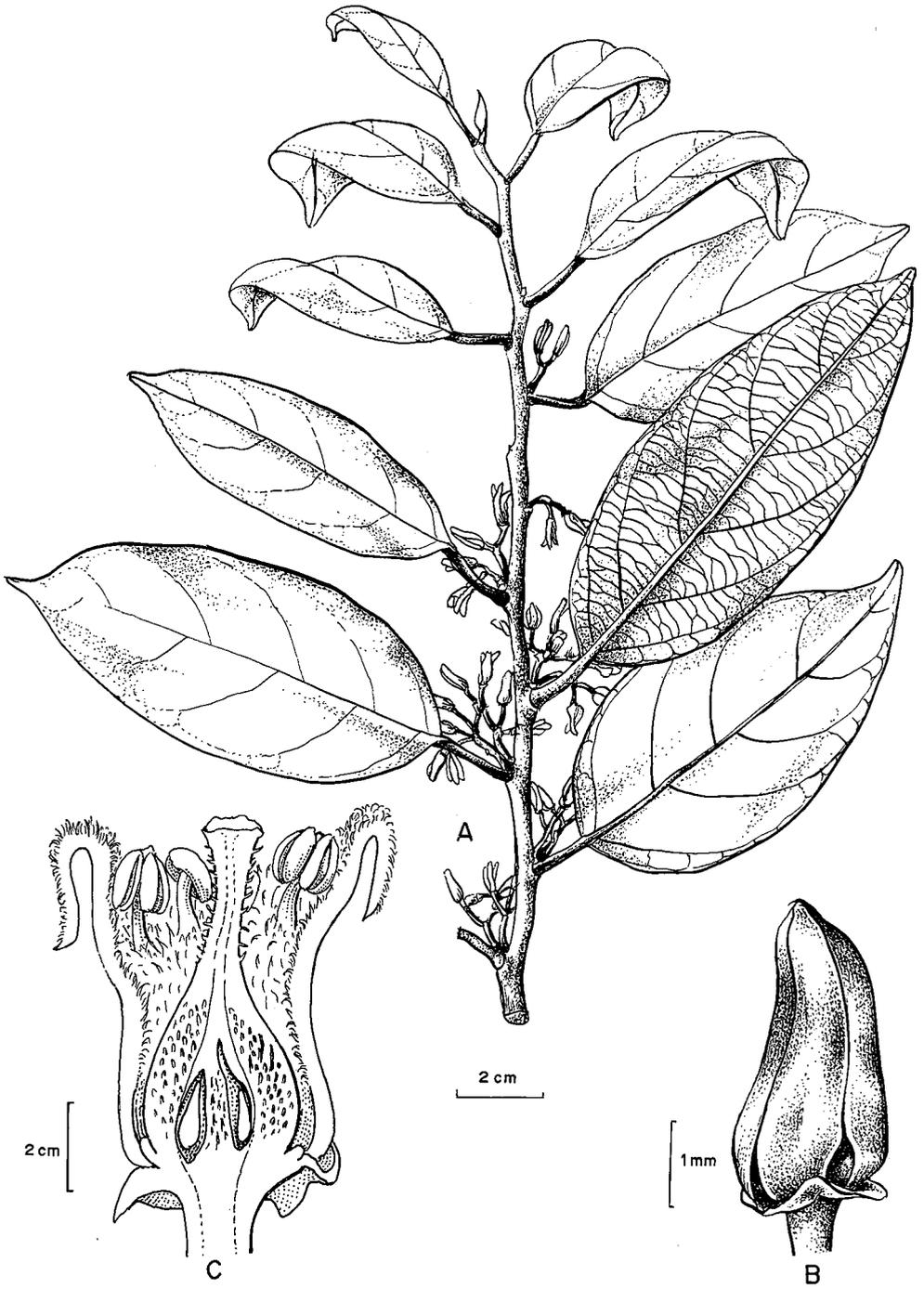


Fig. 5. *Strombosia javanica*. A, flowering leafy twig; B, flowers; C, longitudinal section of flower. (From S. 34250.)

Uses. Produces a dark brown, moderately durable, medium hardwood timber useful for piling, making bridges and house-posts. The fruits are boiled and eaten by many communities in Borneo (*S. 36079* and *SAN 10463*). The young leaves are also cooked as a vegetable in Sarawak.

5. STROMBOSIA Blume

(Greek, *strombos* = conical or pear-shaped; the fruit)

l.c. (1826) 1154; Merrill *l.c.* (1921) 242; Ridley *l.c.* 425; Sleumer in Engler & Prantl *l.c.* (1935) 21, *l.c.* (1980) 163, *l.c.* (1984) 19; Masamune *l.c.* 259; Whitmore *l.c.* 305; Anderson *l.c.* 284; Whitmore, Tantra & Sutisna *l.c.* 280. **Synonym:** *Lavallea* Baill., *Adansonia* 2 (1862) 361.

Shrubs or trees. *Young twigs distinctly zig-zag, smooth, light coloured, old ones often black. Leaves spirally arranged, pinnately veined, glabrous; lateral veins rather distant, ascending. Flowers bisexual, in sessile or shortly stalked cymes or clusters; calyx cup-shaped, 5-lobed, accrescent and adnate to the pericarp almost to the top of the mature fruit; petals 5, free, inner parts hairy; stamens 5, adnate to the petals, filaments flat, with simple hairs, anthers dorsifixed; disc prominent, 5-lobed; ovary partly sunken into the receptacle, almost entirely covered by the 5-lobed fleshy disc, 3-5-chambered; ovules 3-5 per locule, anatropous, placentation free central; style short, stigmas subglobular, obscurely 3-5-lobed. Fruits drupaceous, crowned by the persistent calyx and style base; pericarp thin-fleshy; mesocarp crustaceous or woody. Seeds: embryo small, apical; endosperm fleshy and oily.*

Distribution. About 12 species, *c.* 9 of which are confined to tropical Africa; the rest occur in India, Sri Lanka, Burma, Thailand, and Malesia (Sumatra, Peninsular Malaysia, Java, Borneo, the Philippines and N Moluccas). In Sabah and Sarawak, represented by 2 species.

Ecology. Generally lowland forest.

Key to *Strombosia* species

Leaves smooth on upper surface, not pellucid-punctulate; intercostal veins usually visible. Flowers in cymose inflorescences. Fruits with truncate apex, apiculate by the persistent, hard style-base.....1. *S. javanica*

Leaves parchment-like on both surfaces, distinctly pellucid-punctulate; intercostal veins seldom visible. Flowers in clusters. Fruits with obtuse-rounded apex, remains of style-base inconspicuous.....2. *S. ceylanica*

1. *Strombosia javanica* Blume (of Java)

Fig. 5.

l.c. (1826) 1155; Merrill *l.c.* (1921) 242; Ridley *l.c.* 425; Masamune *l.c.* 259; Browne *l.c.* 282; Whitmore *l.c.* 306; Sleumer *l.c.* (1980) 164, *l.c.* (1984) 21; Whitmore, Tantra & Sutisna *l.c.* 280. **Type:** *Blume, s.n.*, West Java, Mt. Salak (holotype L; isotypes K, P).

Tree to 40 m tall, 100 cm diameter; bole straight, often with knobs; crown dense and narrow. **Bark** yellowish grey, shallowly irregularly fissured; inner bark pinkish, fibrous. **Sapwood** pale yellow. **Leaves** elliptic-oblong, (10-)12-18(-24) x 4-8 cm, thick membranous to subcoriaceous, drying yellowish olivaceous or *brownish, smooth and shiny above*, without pellucid-dots; base obtuse to rounded, margin entire, apex subacuminate; lateral veins 5-7 pairs, conspicuous and raised below, flat above; petiole slightly swollen distally, 1.5-2 cm. **Flowers** solitary or in 3-7-flowered fascicles; *calyx disc-shaped, 4-5 angular*, teeth obscure, *c.* 3 mm; petals greenish white, reflexed at apex, densely hairy inside, glabrous outside, ovate-lanceolate, 8-10 x 2-3 mm; filaments ciliate at the apex, anthers ovate-oblong, *c.* 0.5 mm; *ovary deeply 5-furrowed lengthwise; style columnar; stigma obscurely 5-lobed.* **Fruits** ovoid, 2-3.5 x 1.5-2 cm, green, with thin and fleshy pericarp and woody endocarp, apex *truncate, crowned by the remains of the calyx, disc and style.*

Vernacular name. Sarawak—*belian landak* (Iban).

Distribution. Burma, S Thailand, Sumatra, Peninsular Malaysia, Java and Borneo (Sarawak, Brunei and Kalimantan). In Sarawak uncommon (e.g., *S.* 34250, *S.* 35255 from Mt. Gading, Lundu, and *S.* 1476 from Marudi). Not yet recorded in Sabah.

Ecology. Scattered but locally common in mixed dipterocarp forest and secondary forest to 600 m, on clay-rich fertile soils.

Uses. Produces a moderately hard, durable, light yellowish timber, used locally for house construction.

2. *Strombosia ceylanica* Gardner (of Ceylon)

Calc. J. Nat. Hist. 6 (1845) 350; Sleumer *l.c.* (1980) 165, *l.c.* (1984) 22; Whitmore, Tantra & Sutisna *l.c.* 280. **Type:** *Gardner, s.n.*, Ceylon, Hantane (holotype K, isotype BM). **Synonyms:** *S. lucida* Teijsm. & Binn. ex Valetton *l.c.* 93; *Anacolosa maingayi* Mast. in Hooker *f. l.c.* 580; *S. maingayi* (Mast.) Whitmore, Gard. Bull. Sing. 26 (1973) 285; *S. rotundifolia* King *l.c.* 102; *S. multiflora* King *l.c.* 102; *S. latifolia* Stapf, Kew Bull. (1906) 71, Merrill *l.c.* (1921) 242, Masamune *l.c.* 259.

Small to medium-sized tree, 40 m tall, 60 cm diameter; crown dense; bole straight, closely branched, sometimes buttressed. **Bark** grey to brown, *peeling off in scroll-shaped patches or scales*; inner bark reddish brown. **Sapwood** hard, orange-brown. **Leaves** subcoriaceous, elliptic to ovate-oblong, 8-15(-25) x 3-7(-11) cm, shiny above when fresh, drying dull or greenish brown or glaucous green, *conspicuously parchment-like, distinctly pellucid-punctulate*; base cuneate to rounded, margin entire, apex shortly acuminate; lateral veins 5-8 pairs, ascending, curved, faint above, slightly raised beneath; *intercostal veins invisible.* **Flowers** in clusters or fascicles of 3-6, almost sessile or with 1-2 mm pedicels, arising from small woody-warts; calyx 5-lobed, lobes ovate, obtuse, ciliate; petals 5, greenish white, oblong, hairy inside, glabrous outside; anthers ovate; *ovary semi-inferior, disc conical, faintly 5-lobed*; style filiform, 2-4 mm. **Fruits** roundish to subglobose, *c.* 2-2.5 cm across, attenuate at base at maturity, *apex with the persistent tiny style*; pericarp

thinly fleshy, pink to purple, rugose or tuberculate; endocarp thinly woody. **Seeds** *c.* 1.2 cm across.

Vernacular name. Sarawak—*belian landak* (Iban, Malay, Melanau).

Distribution. SW India, Sri Lanka, Sumatra, Peninsular Malaysia, Java, and Borneo. Widespread in Sarawak, from Limbang, Baram, Miri, Marudi, Bintulu, Kapit, Sri Aman to Kuching. In Sabah, recorded from Beaufort, Beluran, Lahad Datu, Sandakan and Tenom.

Ecology. In lowland mixed dipterocarp and secondary forest on leached sandy humult soils; also collected in hill forest up to 1000 m.

Uses. The timber is hard, heavy but only moderately durable. The wood is yellowish brown, having rather fine and even texture, useful for house construction.

OXALIDACEAE

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Merrill, EB (1921) 311, PEB (1929) 111; Ridley, FMP 1 (1922) 329; Masamune, EPB (1942) 355; Backer & Bakhuizen *f.*, FJ 1 (1963) 244; Veldkamp, FM I,7 (1971) 151; Cockburn, TFM 1 (1972) 347, TS 2 (1980) 69; Anderson, CLTS (1980) 286; Corner, WSTM 2 (1988) 605; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 282.

Trees, shrubs, climbers or herbs. **Leaves** alternate or spiral, compound with a terminal leaflet or simple, pinnately veined, stipules sometimes present, stalk usually with a basal joint. **Inflorescences** axillary, pseudoterminal or on the branches, racemes, panicles or cymes, 1- to many-flowered. **Flowers** bisexual, regular (actinomorphic), 5-merous, heterostylous (with short, medium and long-styled forms), heterodistylous (with short and long-styled forms) or homostylous (with all styles of similar length), stalk jointed; sepals 5, free or fused at the base, persistent; petals 5, clawed, often falling off early; stamens 10, arranged in two whorls, 5 opposite and 5 alternate with petals, connate at the base into an annulus, persistent, of which 5 are sometimes sterile (staminodes); anther dorsifixed, versatile, dehiscing extrorsely by longitudinal slits; *disc absent*; ovary superior, 5-locular; ovules anatropous, bitegmic, tenuinucellate (with a thin nucellus, *Averrhoa*) or crassinucellate (with a thick nucellus, *Oxalis* and *Biophytum*), 1 or more per locule; placentation axile; styles 5, of the same or different length, terminal, free, erect or recurved. **Fruit** a dry 5-valved capsule or a berry. **Seeds** 1 to many per fruit, sometimes arillate (except for species of *Sarcotheca* and *Averrhoa bilimbi*); endosperm fleshy; embryo straight.

Distribution. 6 genera with about 890 species, mostly in tropical or subtropical areas. In Malesia, 5 genera with 29 species, of which 14 are endemic. In Sabah and Sarawak, represented by 5 genera with 12 species, of which only 5 are wild and 2 are cultivated trees.

Ecology. Found in a wide variety of habitats, from lowland primary and secondary forests to montane forests, to about 2200 m.

Uses. Species of *Averrhoa* are cultivated for its edible fruit, and that of *Oxalis* are cultivated as ornamentals. The wood of the ligneous Oxalidaceae is not utilised as timber. In Peninsular Malaysia, the fruits of *Sarcotheca* are edible.

Taxonomy. Hutchinson (Fam. Fl. Pl. 1 (1959) 356, 497; Gen. Fl. Pl. 2 (1967) 610) considered the herbaceous taxa as the Oxalidaceae *sensu stricto* (in the Geraniales), and accommodated the arboreous taxa in the Lepidobotryaceae (Malpighiales) and Averrhoaceae (Rutales) respectively. Recent work indicates that *Sarcotheca* and *Dapania* (in the Lepidobotryaceae) should be associated with *Averrhoa* rather than with *Lepidobotrys*.

Therefore, the Averrhoaceae would be better retained as a group in the Oxalidaceae. Species of *Sarcotheca* have sometimes been confused with that of *Rourea* (Connaraceae). However, *Rourea* differs from *Sarcotheca* in having free carpels, 2-collateral ovules, seeds with an aril, and a dry, indehiscent, 1-celled and 1-seeded fruit.

Key to genera

1. Herbs.....2
 Climbers or trees.....3

2. Leaves trifoliolate.....
 - Oxalis L.**
 Sp. Pl. (1753) 433, Gen. Pl. ed. 5 (1754) 198; Ridley *l.c.* 330; Backer & Bakhuizen *f. l.c.* 245; Veldkamp *l.c.* 153.
 7 species in Malesia; 2 species (*O. corniculata* and *O. corymbosa*) in Sabah and Sarawak.
 Herbs. Leaves trifoliolate; leaflets usually obcordate. Inflorescences cymose to pseudumbellate, one- to many-flowered. Sepals shortly connate at base; petals connivent above the claw. Capsules dehiscent loculicidally, the valves remaining attached to the central axis. Seeds usually few, ejaculatory apparatus and testa smooth.
 - Leaves pinnate, with many leaflets.....
 - Biophytum DC.**
 Prod. 1 (1824) 689; Edgewick & Hooker *f.*, Fl. Br. Ind. 1 (1874) 436; Ridley *l.c.* 330; van Steenis, Bull. Jard. Bot. Btuz 3, 18 (1950) 449; Backer & Bakhuizen *f. l.c.* 246; Veldkamp *l.c.* 159.
 7 species in Malesia; 1 species (*B. sensitivum*) in Sabah & Sarawak.
 Herbs or usually sympodially branched dwarf shrubs. Stipules bristle-like (setaceous). Leaves paripinnate, in tufts at the end of the stems or branches; leaflets opposite. Flowers terminal, usually in pedunculate, bracteate pseudo-umbels, heterodistylous, heterotristylous or homostylous; sepals free; petals twisted, connivent above the claw. Capsules split loculicidally to the base, forming a 5-rayed star-shaped fruit without leaving a columella. Seeds 1-6 per cell, ejaculatory apparatus and aril white, thin.

3. Climbers. Leaves unifoliolate.....
 - Dapania Korth.**
 Ned. Kruidk. Arch. 3 (1854) 381; 2; Ridley *l.c.* 334; Veldkamp, Blumea 15 (1967) 523, *l.c.* (1971) 166.
 2 species in Malesia (Sumatra, Peninsular Malaysia, Borneo) with one species, *D. grandifolia* endemic to NE Sabah and SE Kalimantan.
 Common woody climbers in primary lowland forests. Leaves alternate, estipulate; stalks jointed in the middle. Inflorescences racemose, on the branches or axillary, solitary to fascicled. Flowers androdioecious; sepals 5, connate at the lower half, margins ciliate; petals 5, free, imbricate. Capsules fleshy, loculicidally dehiscent. Seeds hard; aril enveloping the seed.

- Trees. Leaves pinnate, trifoliolate, or unifoliolate.....4

4. Leaves imparipinnate with 3–19 pairs of leaflets. Stalks of leaf and leaflet not jointed...

Averrhoa L.

l.c. (1753) 428, *l.c.* (1754) 196; Ridley *l.c.* 331; Backer & Bakhuizen *f. l.c.* 247; Veldkamp *l.c.* (1971) 174; Corner *l.c.* 605; Whitmore, Tantra & Sutisna *l.c.* 282.

Two species (*A. bilimbi* and *A. carambola*) of unknown origin, currently cultivated throughout the humid tropics and subtropics.

Shrubs or small trees, cultivated as fruit trees. Stipules absent. *Leaves* spirally arranged or clustered at the end of branches, *imparipinnate*; leaflets entire, subopposite, sessile, 3 or more pairs. *Inflorescences* panicles, axillary or borne on the trunk. Flowers heterodistylous or heterotristylous; sepals shortly connate at base; petals twisted, free or connivent above the claw, pink to dark red; stamens all fertile or 5 fertile and 5 sterile; ovary syncarpous with 3–7 superimposed pendulous ovules in each of the 5 locules. *Fruit* a large juicy berry. Seeds numerous, elliptic, flat; aril, if present, fleshy, attached to the entire adaxial placenta, 2-lobed, and enveloping the seed; cotyledons thin, flat; germination epigeal.

Both species prefer a climate with a dry season, but also do well in wetter climates.

A. carambola has been cultivated successfully in frost-free subtropics up to 30°S in Australia and 32°N in Israel. For healthy growth, both species require adequate moisture and well-drained soils. In Malaysia, *A. carambola* has been planted and thrives well in well-drained peat soils. Vernacular name: *belimbing* (Malay).

Leaves unifoliolate or trifoliolate. Stalks of leaf and leaflet jointed.....**Sarcotheca**

SARCOTHECA Blume

(Greek, *sarcos* = fleshy; *theca* = container; the fleshy fruit)

tabarus (Dusun, Sabah), *piang* (Iban, Sarawak)

Mus. Bot. Lugd. Bat. 1 (1850) 241; Ridley *l.c.* 332; Merrill *l.c.* (1929) 111; Veldkamp *l.c.* (1967) 527, *l.c.* (1971) 168; Cockburn *l.c.* (1972) 348, *l.c.* (1980) 70; Anderson *l.c.* 286; Whitmore, Tantra & Sutisna *l.c.* 282; Ng, Mal. For. Rec. 34 (1992) 470. **Synonyms:** *Roucheria* Miq. *l.c.* (1859) 136; *Connaropsis* Planch. *ex Hook. f.*, Trans. Linn. Soc. 23 (1860) 166.

Trees or shrubs; bole *deeply fluted*. **Bark** reddish or reddish brown, scaly or diphloic; inner bark reddish. **Sapwood** pale. Stipules absent. **Leaves** alternate, unifoliolate or trifoliolate; margin entire; leaf-stalks jointed, proximal parts and leaflet stalks swollen and wrinkled. **Inflorescences** axillary or terminal panicles, one to several together. **Flowers** heterodistylous, arranged in more or less stalked cymes, scattered along a simple or sparsely branched rachis; cymes subtended by small caducous bracts; sepals unequal, persistent (except in *S. diversifolia*), imbricate, shortly connate at base, abaxial surface strigose with appressed hairs; petals twisted, imbricate, free at base, usually fused above and falling off as a single unit, adaxial surface with minute papillae in the upper half; stamens all fertile; ovary glabrous to hairy, ovules 2 in each locule. **Fruits** fleshy, red at least when dry, usually 5-ridged. **Seeds** flat, without aril, testa reddish, smooth to wrinkled, hard; cotyledons thin, flat; germination epigeal.

Distribution. 11 species in W Malesia (Sumatra, Peninsular Malaysia, Borneo, Celebes). In Sabah and Sarawak, 5 species are recorded.

Ecology. Primary and secondary forest on poor soils at low altitudes.

Uses. Species of *Sarcotheca* produce a light, easily worked timber, which is sometimes used for roofing and interior work, but it lacks both strength and durability. The fruit, although sour, is eaten in curry dishes, and cooked with vegetables and sweets. It is said to be a remedy for cough.

Key to *Sarcotheca* species

1. Leaves trifoliolate; terminal leaflet larger than lateral leaflets. Mature fruits greenish yellow when fresh, red when dry.....1. *S. diversifolia*
 Leaves unifoliolate. Mature fruits red when fresh.....2
2. Young twigs and abaxial surface of leaf-blades densely brownish velvety hairy; leaflet margin curled inwards.....4. *S. ochracea*
 Young twigs and abaxial surface of leaf-blades glabrous to sparsely hairy; leaflet margin not curled inwards.....3
3. Young twigs 4-angled. Leaves oblong to oblanceolate, 14–27 x 4–8 cm; lateral and intercostal veins distinctly prominent on the lower surface.....3. *S. macrophylla*
 Young twigs terete (rounded). Leaves elliptic, oblong or lanceolate, 4.5–15 x 2–6 cm; lateral and intercostal veins prominent to inconspicuous on the lower surface.....4
4. Leaf blades glaucous below, elliptic or oblong; veins not drying reddish; stalks long (stalk:blade ratio 1:4.5). Panicles short and compact. Sepals dark red to crimson.....
2. *S. glauca*
 Leaf blades not glaucous below, oblong to lanceolate; veins drying reddish; stalks short (stalk:blade ratio 1:10). Panicles long and lax. Sepals rusty.....5. *S. rubrinervis*

1. *Sarcotheca diversifolia* (Miq.) Hallier f.

(Latin, *diversifolius* = with leaves of different shapes)

Med. Rijksherb. Leiden 1 (1911) 2; Veldkamp *l.c.* (1967) 529, *l.c.* (1971) 170; Cockburn *l.c.* (1980) 71; Whitmore, Tantra & Sutisna *l.c.* 282. **Basionym:** *Rourea diversifolia* Miq., Fl. Ind. Bat. 1 Suppl. (1860) 528. **Type:** *Teijsmann HB 707* (= ? 706), West Sumatra, Sibolga, Morsala Island (holotype L; isotypes BO, CAL, K). **Synonyms:** *Connaropsis diversifolia* (Miq.) Kurz, J. As. Soc. Beng. 39, 2 (1870) 69, *excl. syn. C. griffithii*; *Santalodes diversifolium* (Miq.) O. Kuntze, Rev. Gen. Pl. 1 (1891) 155; *Connaropsis acuminata* Pears., Kew Bull. (1906) 2; *S. acuminata* (Pears.) Hallier f., Beih. Bot. Centralbl. 34, 2 (1917) 27; *S. subtriplinervis* Hallier f. *l.c.* (1917) 27; *Connaropsis grandiflora* Ridl., Kew Bull. (1930) 75.

Small to medium-sized tree to 30 m tall, 50 cm diameter, *sometimes with equal buttresses to 2 m tall*. **Bark** smooth, pock-marked or occasionally scaly, reddish brown; inner bark

generally light red or pink. **Sapwood** white, pale yellow or sometimes pinkish. Twigs rounded. **Leaves** *trifoliolate*, stalks 5–17 mm long, 1–2.5 mm thick, rachis 8–31 mm long, 0.75–2 mm thick; leaflets ovate to elliptic or lanceolate, *lateral leaflets* 2.5–10.5 x 1–4 cm, *sometime falling off early but leaving a scar, terminal leaflet often twice the size of the other leaflets*, papery to thinly leathery, glabrous; base acute to broadly rounded, apex acute to caudate; lateral veins 2–5 pairs, prominent on both surfaces; intercostal veins net-like; leaflet stalk 3.5–8 mm long, 0.75–2 mm thick. **Inflorescences** 1–4 panicles together, shorter than the subtending leaf, loosely branched; 1–9 cm long, *rusty hairy, becoming glabrous at mature state*. **Flower** stalk with proximal part 2.5–5 mm long, distal part 1–3 mm long; sepals purplish, ovate to oblong, 2.5–5 x 1.5–3 mm, apex acute to emarginate, abaxially puberulous to glabrous, mostly falling off, seldom persistent in fruit; petals pink to red, obovate-oblong to obovate-lanceolate, 8–10 x 2–3.5 mm, apex rounded to emarginate, 1–2 mm long clawed; filaments in short-styled form 2.5–3.5 mm and 3.5–4.5 mm, in long-styled form 1.5–2.5 mm and 2.5–3 mm; ovary ellipsoid, puberulous to glabrous, styles in short-styled form 0.5–1 mm long, in long-styled form 2.5–4 mm long. **Fruits** green when young, greenish yellow when mature, ellipsoid, glabrous, 12–20 x 9–15 mm. **Seeds** none to 7 per fruit, 6–7.5 x 4.5–5 mm, testa smooth.

Vernacular names. Sabah—*iba jantan* (Suluk), *tabarus* (general). Sarawak—*buah piang* (Iban and Malay), *jiwang* (Punan). Brunei—*kerapa-kerapa, perapan macas, tabaus, tebarus* (Tutong Dusun). General—*belimbing bulat* (Malay).

Distribution. Sumatra and Borneo. Common in the coastal area of Sabah and throughout Sarawak.

Ecology. Primary mixed dipterocarp forest and secondary forest from lowlands to 900 m, on leached yellow, especially humult sandy ultisols, occasionally in mixed swamp forest but very rare in the Rejang delta. Flowering in February–November, fruiting in March–June and September–December.

2. *Sarcotheca glauca* (Hook. f.) Hallier f.

Fig. 1.

(Greek, *glaukos* = bluish grey; the lower leaflet surface)

l.c. (1911) 2; Merrill *l.c.* (1921) 312; Masamune *l.c.* 355; Veldkamp *l.c.* (1967) 535, *l.c.* (1971) 172; Cockburn *l.c.* (1980) 71; Anderson *l.c.* 286; Whitmore, Tantra & Sutisna *l.c.* 282. **Basionym:** *Connaropsis glauca* Hook. f. *l.c.* (1860) 166. **Type:** *Lobb 1857, "Borneo"* (holotype K).

Small to medium-sized tree to 21 m tall, 30 cm diameter; no buttresses. **Bark** smooth to slightly fissured, occasionally scaly, often warty; inner bark yellow-brown, sometimes with a pink tinge. **Sapwood** usually white or pale yellow, rarely pink. Twigs rounded. **Leaves** *unifoliolate*, stalk 7–30 mm long, 0.5–1 mm thick, leaflet stalk 3–6 mm long, 1–1.5 mm thick; *blades* elliptic to oblong, 4.5–11 x 1.5–5 cm, slightly larger on sterile twigs, papery to thinly leathery, glabrous, glaucous, dull, *grey-green on the abaxial surface, sometimes shiny on the adaxial surface*; base broadly cuneate to rounded or subcordate, apex acute, acuminate or caudate; lateral veins 5–7 pairs, more or less looping and joining near the margin; intercostal veins net-like. **Inflorescences** 1–2 panicles together, erect, compact, usually many-flowered, 2–13 cm long, covered with minute rusty scale-like indumentum.

Flower stalk with proximal part 2–5.5 mm long, distal part 1.5–2 mm long; sepals dark red to crimson, ovate to oblong, 1.5–3 x 0.5–1.5 mm, apex rounded, minutely hairy on the abaxial surface, glabrescent in fruit; petals red, darker at apex, oblong to lanceolate, 3.5–6 x 1–2 mm, apex rounded to slightly emarginate, 0.5–1.5-mm-long-clawed; filaments in short-styled form 2–2.5 mm and 2.5–3.5 mm, in long-styled form 1–1.5 mm and 1.5–2 mm long; ovary ellipsoid, rusty hairy, styles in short-styled form 0.5–1 mm long, in long-styled form 2.5–3 mm long. **Fruits** bright pink to dark red, turning black when old, ellipsoid to nearly round, 7.5–12.5 x 5–11 mm. **Seeds** 1–9 per fruit, 6–7 x 3.5–4 mm, testa smooth.

Vernacular names. Sabah—*asam daham* (around Sandakan), *gitan gizu* (Dusun Rungus), *kandis daham* (around Mempakul), *rangkas-rangkas* (Dusun Kinabatangan), *t-izos-izos* (around Papar). Sarawak—*aremajuh* (Dayak), *medang, piang* (Iban), *tulang payung piang* (Malay). Brunei—*asam piai* (Dusun), *kandis daham* (Kedayan).

Distribution. NW Borneo (Sabah, Sarawak and Brunei). Common in Sabah and Sarawak. No record from Kalimantan.

Ecology. Primary and secondary lowland forests, often on hill slopes. In Sarawak, uncommon in mixed swamp forest, occasional or widespread in *kerangas* forest and mixed dipterocarp forest on sandy humult ultisols. Flowering in February–April and September–December, fruiting in October–May.

3. *Sarcotheca macrophylla* Blume

(Greek, *makros* = large, *phullon* = leaf)

l.c. (1850) 242; Merrill *l.c.* (1921) 312; Masamune *l.c.* 355; Veldkamp *l.c.* (1967) 541, *l.c.* (1971) 174; Whitmore, Tantra & Sutisna *l.c.* 282. **Type:** Müller, *s.n.*, “Borneo” (lectotype L; isolectotype BO). **Synonym:** *Roucheria macrophylla* Miq. *l.c.* (1859) 136.

Small tree to 15 m tall, 10 cm diameter; no buttresses. **Bark** smooth, pale brown; inner bark reddish. **Sapwood** white. Twigs 4-angled when young and rounded when old. **Leaves** *unifoliolate*, stalk 5–12 mm long, 1.5–3 mm thick, leaflet stalk 3–9 mm long, 1–3 mm thick; *blades* oblong to oblanceolate, 15–26 x 3–9 cm, thinly leathery, adaxial surface glabrous, abaxial surface puberulous on the veins; base rounded to truncate or subcordate, apex acuminate to cuspidate; *midrib* puberulous, *sunken above*; *lateral veins* 6–13 pairs, *distinctly prominent on the abaxial surface*; *intercostal veins* net-like, *distinctly prominent*. **Inflorescences** 1–4 panicles together, slender, lax, pendulous; 12–85 cm long, brown-puberulous. **Flower** stalk with proximal part to 2 mm long, distal part to 1 mm long; sepals obovate to ovate, 1.5–2.5 x 1–1.5 mm, apex rounded, abaxially rusty hairy, puberulous in fruit; petals dark red, obovate-oblong to oblanceolate, 3–5 x 1–2 mm, apex obtuse to emarginate, to 0.5-mm-long-clawed; filaments in short-styled form 1–2 mm and 2–3 mm long, in long-styled form 1–1.5 mm and 1.5–2.0 mm long; ovary subglobose to ellipsoid, densely hairy, styles in short-styled form 0.25–0.75 mm long, in long-styled form 1–2 mm long. **Fruits** dark red, subglobose, 6–11 x 5–8 mm, glabrescent, glossy. **Seeds** to 9 x 4 mm, testa wrinkled.

Vernacular names. Sarawak—*belimbing manik* (Bakumpai-Dayak), *piang* (Iban).

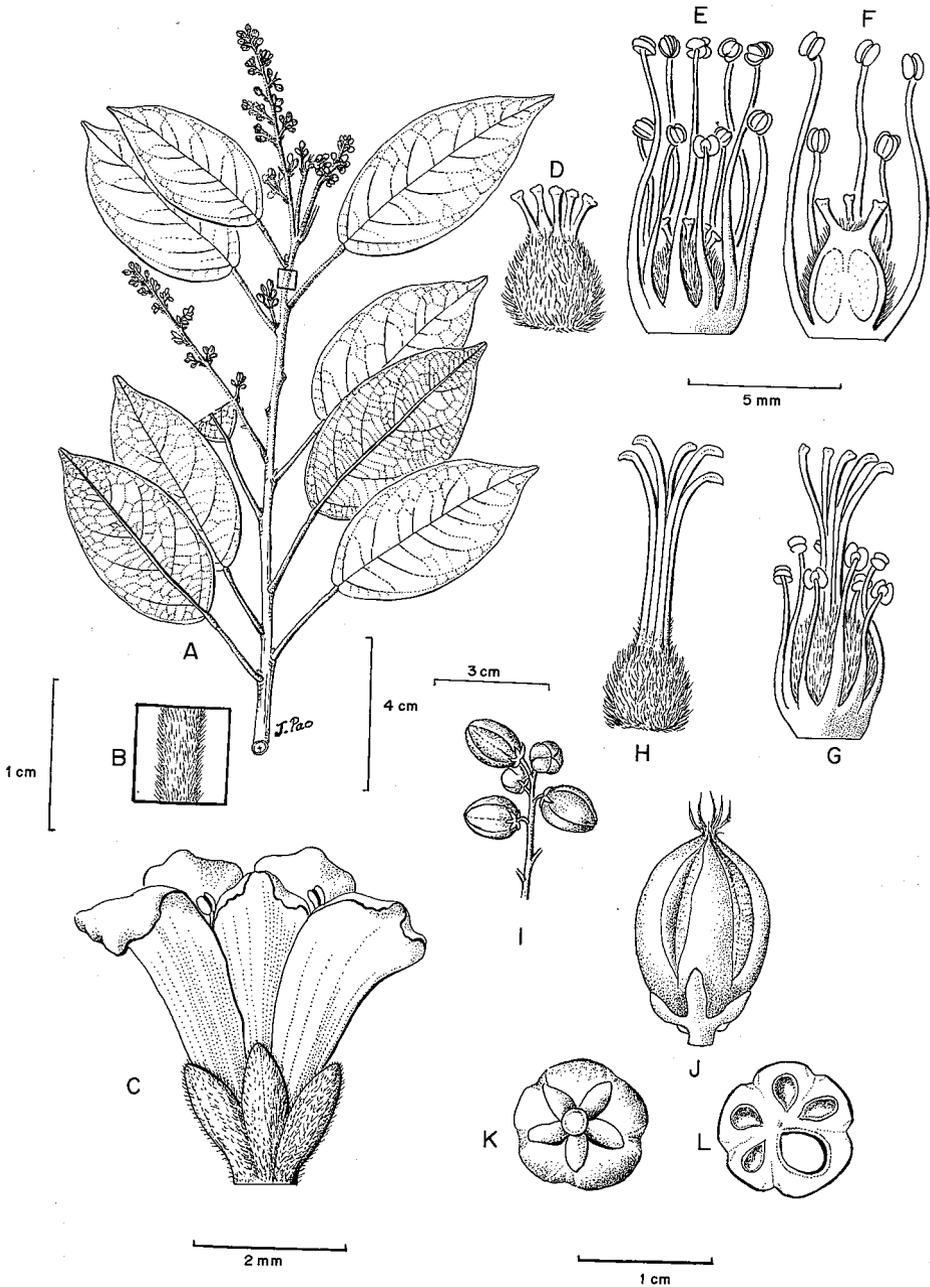


Fig. 1. *Sarcotheca glauca*. A, flowering leafy twig; B, upper portion of twig; C, flower; D, ovary of short-styled flower; E, short-styled flower with sepals and petals removed; F, longitudinal-section of short-styled flower; G, long-styled flower with sepals and petals removed; H, ovary of long-styled flower; I, infructescence; J, dehiscent fruit; K, basal view of mature fruit; L, cross-section of fruit. (A & B from SAN A 1195, C from SAN 72350, D-F from SAN 33562, G-H from SAN 33612, I-L from Chew CWL 1423.)

Distribution. Borneo (Sarawak and Kalimantan). Only one collection, *Beccari PB 3166* reported from Marop, Sarawak.

Ecology. Primary and secondary forest on sandy soils at low altitude. Flowering and fruiting in January–May.

4. *Sarcotheca ochracea* Hallier f.

(Greek, *ochre* = yellow to yellowish brown; the dry leaves)

l.c. (1917) 28; Merrill *l.c.* (1921) 312; Masamune *l.c.* 356; Veldkamp *l.c.* (1967) 541, *l.c.* (1971) 173; Anderson *l.c.* 286; Whitmore, Tantra & Sutisna *l.c.* 282. **Type:** *Haviland 2343*, “Borneo” (holotype L; isotypes K, SING).

Small tree to 10 m tall, 10 cm diameter; no buttresses. **Bark** brownish; inner bark pale brown. Twigs rounded. **Leaves** *unifoliolate*, stalk 8–24 mm long, 1.5–2 mm thick, leaflet stalk 3–6 mm long, 1.5–3 mm thick; *blades elliptic to oblong*, 7.5–19.5 x 4–10 cm, adaxial surface glabrous, abaxial surface rusty-pubescent to velvety; base obtuse to rounded, *margin slightly wavy and curved towards the abaxial surface*, apex acuminate; lateral veins 6–9 pairs, abaxial surface prominent; intercostal veins net-like, prominent. **Inflorescences** 1–2 panicles together, erect to pendulous, compact to elongate, branched in comb-like way, many-flowered, 7–64 cm long, rusty-velvety. **Flower** stalk with proximal part 4–8 mm long, distal part 0.5–1 mm long; sepals reddish brown, obovate, 2.5–3 x 2–3 mm, apex rounded to retuse, rusty-puberulous on the abaxial surface, puberulous in fruit; petals scarlet, darker at apex, obovate to lanceolate, 6–8 x 1.5–2 mm, apex obtuse to rounded, 1.5–2.0-mm-long-clawed; filaments in short-styled form *c.* 2.5 mm and 3.5 mm long, in long-styled form 1.5–2 mm and 2–2.5 mm long; ovary subglobose, rusty hairy, styles in short-styled form 0.5–1 mm long, in long-styled form 2–2.5 mm long. **Fruits** bright red, subglobose to oblong with rounded apex, 8–15 x 6–15 mm. **Seeds** 1–2 per fruit, 5–7 x 3–4.5 mm, testa wrinkled.

Vernacular names. Sarawak—*ikor mata* (Iban), *pechi mata* (general).

Distribution. Borneo. In Sarawak uncommon (Miri, Bintulu and Tatau).

Ecology. In mixed dipterocarp forest on pale yellow infertile clay soils. Flowering and fruiting in April–October.

5. *Sarcotheca rubrinervis* Hallier f.

(Latin, *ruber* = red, *nervus* = nerve)

l.c. (1917) 29; Merrill *l.c.* (1921) 312; Masamune *l.c.* 356; Veldkamp *l.c.* (1967) 539, *l.c.* (1971) 173; Cockburn *l.c.* (1980) 73; Whitmore, Tantra & Sutisna *l.c.* 283. **Type:** *Amdjah 1082*, E Borneo (holotype L; isotype BO). **Synonym:** *S. oblongifolia* Merr. *l.c.* (1929) 111.

Small to medium-sized tree to 20 m tall, 30 cm diameter; no buttresses. **Bark** smooth, thin, reddish to reddish brown; inner bark yellow or yellowish brown, sometimes with a pink

tinge, fibrous. **Sapwood** white or pale yellow. Twigs rounded. **Leaves** *unifoliolate*, stalk 6–20 mm long, 1.5–2 mm thick, leaflet stalk 2–4 mm long, 1.5–2 mm thick; *blades oblong to lanceolate*, 6.5–15 x 2–6 cm, glabrous, abaxial surface not or sometimes slightly glaucous; base obtuse to rounded, apex acute to acuminate; *lateral veins* 4–11 pairs, *often with reddish tinge*, more or less looping and joining near the margin; intercostal veins irregular, the more prominent ones running from vein to vein or from vein to midrib, fainter ones net-like. **Inflorescences** 1–2 panicles together, elongate, lax, pendulous, 6–36 cm long, rusty puberulous. **Flower** stalk with proximal part 3–5 mm long, distal part up to 1 mm long; sepals ovate to lanceolate, 1.5–2.5 x 1–1.5 mm, apex acute to emarginate, minutely rusty hairy at base, puberulous in fruit; petals red or rarely white, lanceolate, twice as long as sepals, apex rounded to emarginate, 0.5–1-mm-long-clawed; filaments in short-styled form 1.5–2 mm and 2.5–3 mm long, in long-styled form 0.5–1 mm and 1–1.5 mm long; ovary subglobose, densely hairy, styles in short-styled form *c.* 0.5 mm long, in long-styled form 1.5–2 mm long. **Fruits** pink to bright red, subglobose, 6–10 x 5–10 mm, glaucous to glossy. **Seeds** to 6.5 x 5 mm, testa smooth to more or less wrinkled.

Vernacular names. Sabah—*asem-asem* (Dusun Kinabatangan), *iba talon* (Bajau), *ira prumpuan* (Suluk), *lampyos* (Dusun Penampang), *pinggoh*, *pinguh* (Kalabakan), *tabarus* (general).

Distribution. Borneo (Sabah and Kalimantan). In Sabah only known from Tawau.

Ecology. Primary and secondary forests near rivers on loamy soils of flat to undulating lands. Flowering and fruiting in March–December.

PITTOSPORACEAE

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Merrill, EB (1921) 287; Masamune, EPB (1942) 324; Bakker & van Steenis, FM 1, 5 (1957) 345; Whitmore, TFM 2 (1973) 309; Anderson, CLTS (1980) 286; Ashton, MNDTS 2 (1988) 325; Corner, WSTM 2 (1988) 607; Sugau, Sandakania 4 (1994) 41.

Small to medium-sized trees, shrubs, or climbers; indumentum if present consisting of simple hairs; bark resinous. **Leaves** *spirally arranged, often crowded towards the end of the twigs, simple, mostly entire, pinnately veined; stipules absent.* **Inflorescence** a few- to many-flowered, axillary or terminal, bracteate corymbose panicle, raceme or thyrse, sometimes on bare branches, often also as fascicles of flowers. **Flowers** *regular, mostly 5-merous, bisexual or functionally unisexual;* bracteoles often 2; sepals 5, free or connate at the base, overlapping; petals 5, often narrowed at the base and loosely joined as a tube, overlapping, caducous; stamens 5, inserted on the sepals, erect, free, or slightly connivent at the base, anthers 2-celled, introrse, basifixed, dehiscent lengthwise (or by pores); *ovary superior, sometimes shortly stalked, mostly 1-chambered, sometimes completely or incompletely 2-chambered, placentas 2–6, basal or on the wall, style simple, stigma simple and thickened, or lobed, ovules numerous; anatropous with one integument.* **Fruit** *a berry or a loculicidal, 2- or 6-valved capsule.* **Seeds** *few to many per fruit, embedded in a resinous or oily pulp or fluid, seldom winged, testa thin, smooth; endosperm copious, hard; embryo small, close to the hilum; cotyledons small, 2–5.*

Distribution. 9 genera restricted to the Old World, chiefly Australian; 6 genera are completely restricted to Australia; and 2 in E Malesia and Australia; 1 (*Pittosporum*) is widely distributed and the sole representative of the family in Sabah and Sarawak.

Ecology. Members of the family can be found in everwet or dry regions, from tropical to warm-temperate areas.

Uses. Several genera have species that are grown as ornamentals; it has been suggested (Bakker & van Steenis *l.c.*) that a few *Pittosporum* species might be used for re-afforestation of bare lands, on account of their adaptability to such sites.

PITTOSPORUM Banks *ex* Sol.

(Greek, *pitta* = resin, *spora* = seed; the resinous seed)

in Gaertner, Fruct. 1 (1788) 286; Merrill *l.c.* 287; Masamune *l.c.* 324; Bakker & van Steenis *l.c.* 345; Whitmore *l.c.* 309; Anderson *l.c.* 286; Ashton *l.c.* 325; Corner *l.c.* 607; Sugau *l.c.* 41.

Trees or shrubs, with rhythmic growth; terminal bud protected by scale leaves. **Leaves** entire, often hairy when young. **Flowers** few to many, in fascicles, thyrses or corymbs, seldom solitary, white or pale yellow, fragrant; sepals free or more or less connate; petals generally ligulate, free or united in the lower part, the free segments spreading or recurved; stamen filaments slender in male flowers, somewhat shorter and slightly broadened at the base in female flowers, anthers generally oblong in male flowers, sagittate and smaller in female flowers; *ovary* sessile or stalked, glabrous or hairy, 1-chambered, slender in male flowers but stout in female flowers; style in female flowers short and with a 2-5-lobed capitate stigma, in male flowers longer and with obscure stigmas; placentas 2-5, basal or on the ovary wall, ovules few to many. **Fruit** a loculicidally dehiscent, 2(-6)-valved capsule, usually ripening orange. **Seeds** 1 to many per fruit, covered by a resinous viscous fluid; germination epigeal.

Distribution. About 100 species, from warm-temperate to tropical areas, from Africa, South and East Asia and Australasia, to the Pacific Islands. 6 species are documented for Borneo, all found in Sabah, while only 2 occur in Sarawak.

Ecology. Species of *Pittosporum* are generally understorey shrubs or trees of the rain forest, occurring from near sea-level to the subalpine zone on Mt. Kinabalu.

Key to *Pittosporum* species

(based mainly on leaf characters)

1. Leaves very narrowly elliptic to linear, to 1.1 cm wide **2. P. linearifolium**
 Leaves elliptic, oblanceolate or obovate, typically more than 1.5 cm wide..... 2
2. Leaves persistently thickly rusty hairy on the lower side, and conspicuously bullate on the upper side; margins markedly recurved when dry..... **6. P. silamense**
 Leaves glabrous or, if hairy, only when very young, and not bullate or only finely so on the upper side; margins not or only weakly recurved when dry..... 3
3. Lateral veins finely impressed above. Sepals 6-7 mm long..... **3. P. longisepalum**
 Lateral veins flat above. Sepals less than 5 mm long..... 4
4. Leaves markedly obovate, the apex abruptly acuminate to cuspidate. Inflorescence borne on bare branches..... 5
 Leaves elliptic, or if oblanceolate or obovate, then the apex gradually acuminate. Inflorescence borne in the leafy portions of branches..... **1. P. ferrugineum**
5. Leaf-stalks 8-18 mm long. Petals 9-12 mm long. Infructescence-stalks not conspicuous or to 0.5 cm long. Mature fruits to 1.7-2 cm long..... **5. P. resiniferum**
 Leaf-stalks, 15-25 mm long. Petals only 4-7 mm long. Infructescence-stalks 1-3 cm long. Mature fruits 1-1.5 cm long..... **4. P. ramiflorum**

Key to *Pittosporum* species
(based on flower and fruit characters)

1. Inflorescences mainly on bare branches.....2
 Inflorescences among leaves on the branches.....3
2. Petals 4–7 mm long. Infructescence-stalks 1–3 cm long. Fruit 1–1.5 cm long.....
 4. ***P. ramiflorum***
 Petals 9–12 mm long. Infructescence-stalks inconspicuous or to 0.5 cm long. Fruits
 1.7–2 cm long.....5. ***P. resiniferum***
3. Seeds attached to the fruit-wall to halfway to the fruit-apex.....1. ***P. ferrugineum***
 Seeds attached to the basal portion of the fruit-wall.....4
4. Fruits, at least when young (and ovary), glabrous, or at most slightly hairy at the base
 2. ***P. linearifolium***
 Fruits, at least when young (and ovary), hairy all over.....5
5. Infructescence-stalks 0.8–1.2 cm long. Seeds to 11 per fruit.....6. ***P. silamense***
 Infructescence-stalks 2–3 cm long. Seeds 1–4 per fruit.....3. ***P. longisepalum***

1. *Pittosporum ferrugineum* Aiton

(Latin, *ferrugineus* = rusty; the brown leaf tomentum)

Hort. Kew ed. 2, 2 (1811) 27; Merrill *l.c.* 287; Masamune *l.c.* 324; Bakker & van Steenis *l.c.* 345; Whitmore *l.c.* 309; Anderson *l.c.* 286; Ashton *l.c.* 322; Corner *l.c.* 607. **Type:** Hort. Kew (from a cultivated plant in the Royal Botanic Gardens Kew; native of New Guinea and introduced before 1787 by the Right Hon. the Earl of Tankerville), *vide* Aiton (BM). **Synonyms:** *Itea javanica* Blume, Bijdr. (1926) 863; *Pseuditea javanica* (Blume) Hassk., Flora 25, 2 (1842) Beibl. 30; *Pittosporum javanicum* (Blume) Blume, Mus. Bot. Lugd. Bat. 1 (1850) 159; *Pittosporum rufescens* Turcz., Bull. Soc. (Imp.) Nat. Mosc. 27, 2 (1854) 367; *Pittosporum nativitatis* Bakker in Andrews, Monogr. Christm. Isl. (1960) 171; *Pittosporum versteeghii* Merr. & Perry, J. Arn. Arb. 21 (1940) 177.

Small to medium-sized tree, to 15 m tall, occasionally reaching 20 m tall, 25 cm diameter. **Bark** brownish; inner bark yellowish. **Sapwood** pale yellow, soft. Young shoot more or less densely covered with caducous rusty brown hairs. **Leaves** typically elliptic, rarely oblanceolate or obovate, 6–12 x 2–4 cm, papery, pale brown on both surfaces; base cuneate, margin plane and slightly undulate, apex narrowly acute to gradually acuminate; midrib sharp on the lower side but depressed on the upper side; *lateral veins* 5–9 pairs, flat above; intercostal veins reticulate, fine; leaf-stalks 8–15 mm long, slender and grooved on the upper side; **Inflorescence** a many-flowered thyrse, 1.5–5 cm long, borne among leaves on the branches, or terminal; peduncle 1–5 cm long, rusty-hairy. **Flowers** pale yellow, sepals lanceolate to linear, 2–4 mm long, generally rusty hairy; petals ligulate, 6–8 x 1 mm; stamens 3–4 mm long, filaments 2.5–3 mm long, anthers 0.5–1 mm long; *ovary* ellipsoid or cylindrical, sessile, densely rusty hairy, style 1–1.5 mm long, glabrous, stigma often scarcely capitate in male flowers, 2-lobed in female flowers. **Fruits** capsular, 1–16 in an infructescence, often broader than long or subglobose, 0.5–1 cm long, 2-valved, generally notched and mucronate apically, narrowed towards the often hairy base, rugose, ripening

on the lower side; not bullate on the upper side; midrib impressed on the upper side, raised on the lower side; *lateral veins* 5–7 pairs, finely impressed on the upper side, raised on the lower side; intercostal veins reticulate, very fine; stalk *c.* 5 mm long, slender. **Inflorescences** 3-flowered cymes, terminal on leafy shoots; peduncle 2–3 cm long, hairy. **Flowers** with *sepals free, linear-lanceolate, 6–7 x 1–1.5 mm*, hairy, acute, longer than the petals in bud; petals narrowly oblanceolate, *c.* 8 x 1–2 mm, acute; stamens 4–5 cm long, filaments *c.* 3 mm long, anthers *c.* 2 mm long, apiculate; ovary ellipsoid, subsessile, densely hairy to 1 mm long from the base, stipe with 5 furrows, *c.* 2 x 1–1.5 mm. **Fruits** subglobose, *c.* 0.7 cm across, 2-valved, mucronate, rugose; *infructescence-stalks 2–3 cm long, hairy*. **Seeds** 1–4 per fruit, *c.* 4 x 3 mm, attached on a placenta at the base of the fruit.

Distribution. Sabah (Mt. Kinabalu) and Central Celebes.

Ecology. Mainly in submontane rain forest, at 1200–1500 m.

4. *Pittosporum ramiflorum* (Zoll. & Moritz) Zoll. ex Miq.

(Latin, *rami* = branches, *florum* = flowers; the inflorescences on the bare branches)

Fl. Ind. Bat. 1, 2 (1858) 122; Bakker & van Steenis *l.c.* 345. **Basionym:** *Glyaspermum ramiflorum* Zoll. & Moritz, Nat. Geneesk. Arch. Ned. Ind. 2 (1845) 11. **Type:** *Zollinger 2139*, Java, Gede (P). **Synonyms:** *Pittosporum ramiflorum* var. *parviflorum* K. Schum. in K. Schumann & Hollrung, Fl. Kais. Wilh. Land (1889) 70; *P. comptum* K. Schum. & Lauterb., Fl. Schutzgeb. (1900) 338; *P. clementis* Merr., Philip. J. Sc. 3 (1908) Bot. 137.

Shrub or tree, (3–)5–20(–30)m tall. **Leaves** spirally arranged or in distinct clusters along the twigs, obovate, 5–18 x 2.5–6 cm, plane, subcoriaceous, glabrous when mature; base broadly cuneate, margin entire, apex abruptly acuminate, acumen for 0.5–1.5 cm long; midrib flattened on the upper side but raised on the lower side; lateral veins 5–8 pairs, flattened on the upper side but somewhat raised on the lower side; intercostal veins reticulate, fine; *stalks 15–25 mm long*, slender and grooved on the upper side. **Inflorescences** densely branched and many-flowered, mainly on the bare parts of branches; peduncles 1–3 cm long, hairy; bracts ovate, *c.* 1–1.5 mm, caducous; pedicels to 6 mm. **Flowers** white, sepals united at their base in a shallow cup, 1.5–2 mm high, otherwise free, with rounded apices; *petals narrowly elliptic, (4–)5–6(–7) x (1–)2(–3) mm*, rounded; stamens 4–5 mm long, filaments 3–5 mm long, anthers oblong, 0.7–2 mm long; ovary ellipsoid or obovoid, 2–3 x 1–1.5 mm, subsessile, brownish hairy, style 1–3 mm long, stigma 2-lobed. **Fruits** varying in number, on woody stalks, ellipsoid to obovoid, compressed, 1–1.5 cm long, 2-valved, with an abrupt tip, valves hard, 1–2 mm thick, wrinkled; *infructescence-stalks 1–3 cm long, hairy*. **Seeds** many per fruit, attached to the fruit-wall from the base up to apex of the fruit, very irregular in shape to roundish, flat, 2–3 mm diameter.

Distribution. Java, Borneo, Southern Philippines (Negros, Cebu, Mindano and Bohol), Celebes, the Moluccas (Ambon, Buru, Ceram), New Guinea, Solomon Islands. In Sabah only found on Mt. Kinabalu; not yet recorded from Sarawak.

Ecology. An understorey tree in rain forest, sometimes also riverine, occasionally to 3200 m in montane forest.

5. *Pittosporum resiniferum* Hemsl.

(Latin, *resinifer* = producing resin; the capsule)

Kew Bull. (1894) 344; Bakker & van Steenis *l. c.* 345. **Type:** *Holmes, s.n.*, Philippines (lectotype K, here designated). **Synonyms:** *P. epiphyticum* Merr. *l. c.* (1908) 138; *P. accuminatissimum* Merr., Philip. J. Sc. 14 (1919) 402.

Small to medium-sized tree, 2–10 m tall, 10–20 cm diameter. **Bark** thin, whitish to dark brown; inner bark creamy pink, exudate sticky. **Sapwood** pale white. **Leaves** spirally arranged, markedly obovate, 9–18 x 2.5–5 cm, glabrous; base narrowly cuneate, margin slightly recurved when dry, rather thick, apex abruptly cuspidate; midrib slender, prominent on the lower side, flattened on the upper side, pale brown; lateral veins 7–10 pairs, flattened on upper side, raised on the lower side; intercostal veins reticulate, fine; *stalks* 8–18 mm long, slender, grooved on the upper side. **Inflorescence** a false umbel, 1–1.5 cm long, borne on bare branches below the leaves; peduncles not conspicuous or only to about 0.5 cm long, slightly hairy. **Flowers** whitish; sepals united at their lower half into a shallow cup, 1–2 mm high, apices rounded, 1–2 mm long; petals narrowly oblong, 9–12 x 1.5–2 mm; stamens 7–9 mm long, filaments slender, 6–7 mm long, anthers 1.5–2 mm long; ovary ellipsoid, 4–5 x 1.5–2 mm, sessile, densely hairy, style 2–2.5 mm long, stigma thickened. **Fruits** 1–6 in an infructescence, ripening orange, capsule globose to ellipsoid, 1.7–2 cm long, very hard when dry, 2-valved, notched and with an abrupt tip, rounded to cordate at the base, glabrous, rugose; *infructescence-stalks* inconspicuous or to about 0.5 cm long, hairy to glabrous. **Seeds** many per fruit, attached to the fruit-wall from the base to the apex of the fruit.

Vernacular name. Sabah—*bedung* (Dusun Ranau).

Distribution. Sabah (Mt. Kinabalu) and the Philippines (Luzon, Mindoro, Panay, Catanduanes, Leyte, and Mindanao).

Ecology. In montane forest, sometimes also at lower localities. It seems to be a light-demanding species.

6. *Pittosporum silamense* J. B. Sugau

(of Mt. Silam, Sabah)

Sandakania 4 (1994) 41. **Type:** *Joseph et al. SAN 120894*, Sabah, Lahad Datu, Mt. Silam (holotype SAN).

Small tree, bole *c.* 5 cm diameter. **Bark** smooth, brownish; inner bark yellowish. **Sapwood** yellowish. **Leaves** generally elliptic, 5.5–10 x 2.5–4 cm, *conspicuously bullate on the upper side, persistently thickly rusty-hairy on the lower side*; base cuneate, margins *markedly recurved when dry, rather thick*, apex narrowly cuneate to acuminate; midrib sunken on the upper side, raised on the lower side; lateral veins 6–9 pairs, deeply impressed on the upper side, raised on the lower side; stalks 8–18 mm long, slender, grooved on the upper side. **Inflorescence** a many-flowered thyrse. Flowers unknown.

Fruits 10–18 in an infructescence, greenish to blue when unripe, black when ripe, capsule subglobose, 0.8–1.1 cm long, 2-valved, notched and with an abrupt tip, base narrowed to about 2 mm long, *covered with rusty hair; infructescence-stalk 0.8–1.2 cm long, hairy.*
Seeds to 11 per fruit, attached to a placenta at the base of fruit, black.

Distribution. Endemic to Sabah. Apparently restricted to Mt. Silam in Lahad Datu district.

Ecology. Hill forest, about 800 m, on ultramafic soil.

RHAMNACEAE

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Ridley, FMP 1 (1922) 461; Masamune, EPB (1942) 434; Suessenguth in Engler & Prantl, Pfl. Fam. 20 d (1953) 7; Backer & Bakhuizen *f.*, FJ 2 (1965) 80; Anderson, CLTS (1980) 289; Keng, OFMSP (1983) 203; Corner, WSTM 2 (1988) 609; Latiff, TFM 4 (1989) 297; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 293.

Deciduous or evergreen, often thorny trees, shrubs, woody climbers or very rarely herbs. **Leaves** *simple, alternate* or rarely *opposite, pinnately veined or 3-veined*. *Stipules* generally present, small, deciduous or *often transformed into straight to recurved spines*. **Inflorescences** basically cymose, cymes mostly axillary, sessile or peduncled, or reduced to many- to few-flowered fascicles. **Flowers** *radially symmetrical, 4- or 5-merous*, rarely 3- or 6- or 7-merous, bisexual or unisexual (plants monoecious and/or dioecious); hypanthium resembling a calyx-tube, patelliform or hemispherical to tubular; sepal 4 or 5, valvate in bud, triangular, erect to more or less recurved during anthesis, often medially keeled within; petals 4 or 5, rarely absent, usually smaller than the alternate sepals, concave or hooded (cucullate), rarely almost flat, often shortly clawed, enfolding the epipetalous stamens; stamens 4 or 5, in a single series opposite the petals, filaments thin, adnate to the base of the petals, anthers minute, versatile, generally 2-thecate, dehiscent by longitudinal slits; disc intrastaminal, nectariferous, thin to more or less fleshy, entire or lobed, glabrous or rarely pubescent, free from the ovary or adnate around the base; *ovary superior or half-inferior, 2-3(-5)-loculate*, with 1 ovule in each locule; *ovules anatropous, basal and erect*. **Fruit** *a capsule or a dry or fleshy drupe* with 1-3 dehiscent or indehiscent stones (endocarps), often winged. **Seeds** with scanty fleshy endosperm or rarely without endosperm; embryo large, oily, straight or rarely bent.

Distribution. A cosmopolitan family of about 45 genera and 800 to 1000 species. In Sabah and Sarawak, represented by 8 native genera with 21 species of which only 4 species in 4 genera are trees, the others are either erect or straggling shrubs or woody climbers.

Ecology. Tropical rain forest to moderately arid areas and from near sea-level to elevation and latitude near the tree limit.

Uses. A rather limited number of Rhamnaceae species furnish useful and valuable timber of local importance. Some West Indian species of *Colubrina*, *Krugiodendron* and *Reynosa* yield a hard and heavy wood sold as "Ironwood". Ornamental plants are restricted to the North American genus *Ceanothus*, of which several species are planted for their showy inflorescences, and the European *Paliurus spina-christi*, which is widely used as protective and ornamental hedge-plants. Edible fruits are furnished by the Mediterranean jujubes

(*Ziziphus*), which are widely cultivated in Africa and Asia. Further economic products of rhamnaceous plants are dyes (*Rhamnus*), laxatives and diuretics (*Frangula*, *Paliurus*, *Rhamnus*), soap (*Colubrina*, *Ziziphus*) and substitute for tea (*Sageretia*). None of these uses is, however, reported for taxa occurring in Sabah and Sarawak.

Taxonomy. Suessenguth (*l.c.*) recognised 58 genera and grouped them into five tribes, mainly distinguished by ovary and fruit characters. The 21 genera of the largest tribe Rhamnaceae extend over nearly the whole area of the family, except extratropical South America. In Sabah and Sarawak, they are represented by *Alphitonia*, *Colubrina* and *Rhamnus*. The tribe Zizipheae comprises 20 genera, and is mainly centered in subtropical and tropical regions of the world, namely in the West Indies and Central America, East Asia and Indo-Malesia. *Berchemia* and *Ziziphus* are the two genera native to Borneo. The tribe Colletieae are mostly restricted to the extratropical South America, with one genus (*Adolphia*) in Mexico and California and another genus (*Discaria*) extending to New Zealand and Australia. The predominantly climbing or even herbaceous tribe Gouanieae are confined to a narrow pantropical belt. Out of the five genera recognised, only *Gouania* is widely distributed throughout Malesia, including Sabah and Sarawak. *Smythea* and *Ventilago*, the only two genera of the tribe Ventilagineae, are restricted to the Paleotropics, and both occur in Sabah and Sarawak.

Key to genera

1. Small to medium-sized trees or shrubs; fruits never winged.....2
 Woody climbers with winged fruits.....6
2. Leaves 3-veined from the base; stipules often transformed into straight or recurved spines.....4. **Ziziphus**
 Leaves pinnately veined; stipules never transformed into spines.....3
3. Fruit a single-stoned fleshy drupe.....
 Berchemia Necker
 Elem. bot. (1790) 122; Backer & Bakhuizen *f. l.c.* 83.
 22 species; North America (1 species), Minor Asia, Indo-China, New Caledonia, Malesia; 1 species in Sabah and Sarawak.
 Erect or straggling shrubs. Leaves membranous, with numerous pairs of slightly curved, parallel lateral veins. Inflorescences raceme-like thyrses. Flowers bisexual or unisexual by abortion. Fruit an ellipsoid to obovoid, single-stoned fleshy drupe.
 Fruit a 2–4-stoned capsule or drupe; epicarp dry or more or less fleshy.....4
4. Fruit a 3-locular, capsule.....2. **Colubrina**
 Fruit indehiscent.....5
5. Epicarp mealy or corky; endocarpids splitting ventrally. Seeds distinctly arillate.....
 1. **Alphitonia**
 Epicarp fleshy; endocarpids indehiscent. Seeds never arillate.....3. **Rhamnus**

6. Branches often with tendrils. Fruit with three rounded commissural wings.....
Gouania Jacq.
 Select. Stirp. Amer. Hist. (1763) 263; Ridley *l.c.* 468; Masamune *l.c.* 434; Backer & Bakhuizen *f. l. c.* 85.
 About 50 species; tropical America and Africa, Madagascar, India, Indo-China, Malesia, Australia, Polynesia; 3 species in Sabah and Sarawak.
 Woody climbers with solitary tendrils. Leaves membranous to coriaceous, ovate or cordate, pinnately veined, rarely 3-veined, margin entire to serrate. Inflorescence a multiflowered, axillary or terminal, spike- or raceme-like thyrse. Flowers bisexual or polygamous. Fruit a 3-locular schizocarp, splitting septicidally into three 2-winged indehiscent endocarps.
- Branches never with tendrils. Fruit with one apical wing.....7
7. Fruit a globose indehiscent structure, bearing a long (at least twice as long as the fruit) apical wing.....
Ventilago Gaertn.
 Fruct. Sem. Pl. 1, 1 (1788) 233; Ridley *l.c.* 465; Masamune *l.c.* 434; Backer & Bakhuizen *f. l.c.* 81.
 About 40 species; Africa, Madagascar, India, Indo-China, Malesia, Australia; 4 species in Sabah and Sarawak.
 Leaves chartaceous to coriaceous, elliptic to oblong-ovate, pinnately veined, margin entire to serrate. Inflorescences axillary clusters or shortly stalked cymes which are often combined into racemes or panicles. Flowers bisexual, rarely apetalous.
- Fruit a compressed, septicidally dehiscing capsule bearing a small apical wing.....
Smythea Seem.
 Bonplandia 9 (1861) 255; Ridley *l.c.* 468; Masamune *l.c.* 434; Backer & Bakhuizen *f. l.c.* 81.
 7 species; Indo-China, Malesia, Polynesia; 1 species in Sabah and Sarawak.
 Leaves membranous to chartaceous, elliptic to ovate, pinnately veined, often somewhat asymmetric. Flowers in axillary fascicles, bisexual.

1. ALPHITONIA Reiss. *ex* Endl.

(Greek, *alphiton* = baked barley meal; the mealy nature of the ripe fruit exocarp)

Gen Pl. (1840) 1098; Braid, Kew Bull. (1925) 168; Masamune *l.c.* 434; Anderson *l.c.* 289; Whitmore Tantra & Sutsua *l.c.* 293.

Evergreen trees or shrubs; buds and young stems often more or less densely brownish pubescent. Bark and wood of several species with rather strong smell of sarsaparilla. **Leaves** *alternate*, ovate to obovate or elliptic to lanceolate, rarely almost cordate, chartaceous to coriaceous, venation pinnate; *blade* usually glabrous above, *whitish or rusty pubescent underneath*; stipules small, deciduous. **Inflorescences** many-flowered, di- or trichotomous, axillary or rarely terminal cymes. **Flowers** 5-7-merous; hypanthium patelliform to hemi-

spherical; sepals 5, triangular, keeled within; petals 5, clawed, cucullate; stamens 5; disc mainly thick, nectariferous; *ovary inferior*, immersed in the stout disc, 2–3-locular, style short, 2–3-lobed, basally often densely whitish to yellowish pubescent or glabrous. **Fruits** *drupaceous*, globose or broadly ovoid; *mesocarp thick, mealy*; endocarp splitting longitudinally into 2 to 3, hard and coriaceous endocarps, at the base surrounded by the persistent hypanthium. **Seeds** *more or less completely enclosed by a loose, membranous, reddish brown aril*; testa smooth, crustaceous; embryo straight; endosperm cartilaginous.

Distribution. About 10 species; Malesia, Polynesia and Australia. One species in Sabah and Sarawak.

Uses. The wood of the tree species in Australia, Malesia and most of the Polynesian Island is said to be of considerable value (Braid *l.c.* 170), and used for axe-handles, piling, and cabinet-making.

Alphitonia excelsa (Fenzl) Reiss. *ex* Endl.

Fig. 1.

(Latin, *excelsus* = lofty, high; the tree)

l.c. 1098; Maiden, *For. Fl. N.S.W.* (1903) 38; Braid *l.c.* 177; Masamune *l.c.* 434; Anderson *l.c.* 289; Whitmore, Tantra & Sutisna *l.c.* 293. **Basionym:** *Colubrina excelsa* Fenzl in Endl., *Enum. Pl.* (1837) 20. **Type:** *Cunningham, s.n.*, Australia, Queensland, Brisbane, Moreton Bay (K). **Synonyms:** *Rhamnus incanus* Roxb., *Fl. Ind.* (1832) 603; *Alphitonia incana* (Roxb.) Kurz *ex* Hoogland, *Kew Bull.* 15 (1961) 33; *A. philippinensis* Braid *l.c.* 183.

Small to medium-sized tree rarely to 30 m high; bole straight to 20 m high. *Bark and wood with a rather strong smell of wintergreen.* **Bark** smooth, grey to brownish; inner bark thin, greenish, more or less straw, cambium yellow. **Sapwood** whitish; heartwood reddish brown. Young twigs, axillary buds, stipules, petioles and lower surface of the leaves more or less densely yellowish to whitish pubescent. Stipules minute, acute triangular, early deciduous. **Leaves** alternate, chartaceous to subcoriaceous, ovate-lanceolate or elliptic, 6–20(–30) x 3–6(–10) cm; base acute or obtuse to rounded, rarely cordate, margin entire, apex acute to shortly acuminate; midrib prominent below, impressed above; lateral veins 10–14 pairs; petioles 5–10 mm long. **Inflorescences** *terminal or axillary cymes.* **Flowers** about 4–5 mm in diameter, light green to yellowish, 5-merous, rarely 6- or 7-merous; hypanthium shallow hemispherical; sepals about 1.5 mm long; petals erect to slightly recurved; stamens about 1.5 mm long; disc shallow, lining the hypanthium, ring-shaped, glandulous; ovary obconical, whitish tomentose; style conical. **Fruits** globose to broadly ovoid, to 15 mm in diameter, greenish when young, *black when ripe.* **Seeds** often permanently attached to the receptacle after dehiscence of the fruit.

Vernacular names. Sabah—*balik angin* (Dusun, Malay), *pati yata* (Dusun), *pokudata* (Dusun).

Distribution. A widely distributed species, extending from Borneo, the Philippines, New Guinea to Australia. In Sabah and Sarawak common and widespread in the lowlands. Also in Brunei and Kalimantan.

Taxonomy. Braid (*l.c.*) split the former *A. excelsa* into a group of species poorly differentiated in leaf shape and size. Examination of numerous specimens throughout Malesia and



Fig. 1. *Alphitonia excelsa*. A, flowering leafy twig; B, flower; C, infructescence; D, dehiscent mericarps of a fruit; E, seed almost completely covered with a thin reddish brown aril (A & B from SAN A 364, C-E from Schirarend 5.)



Fig. 2. *Colubrina beccariana*. A, leafy twig; B, flower; C, fruit; D, dehiscent endocarps of a fruit. (A from Sinclair et al. 8946, B from SAN 54539, C from SAN 15374, D from Kostermans 21228.)

Australia supports the conclusion that there is only one highly variable and widely distributed species.

Ecology. Fairly common element of lowland secondary forests or of depauperate, disturbed primary forests throughout the area. Maiden (*l.c.*) reports that the trees grow well on poor sandy soils.

Uses. Braid (*l.c.*) states that the species is used as fodder plant. He also records its medicinal properties and notes that it is valuable for tanning.

2. COLUBRINA Rich. *ex* Brongn.

(Latin, *colubrinus* = like a snake; perhaps from the French name *bois couleuvre*, the snake wood or serpent tree, *C. ferruginosa*, from Martinique Island)

Ann. Sci. Nat. 10 (1827) 61; Ridley *l.c.* 465; Backer & Bakhuizen *f. l.c.* 84; Johnston, Brittonia 23 (1971) 2; Latiff *l.c.* 298; Whitmore, Tantra & Sutisna *l.c.* 293.

Deciduous or evergreen trees and shrubs, rarely scandent. Stipules minute, early deciduous. **Leaves** alternate to rarely opposite, chartaceous to subcoriaceous; margin entire, serrate or crenate; venation pinnate or acrodromous from the base. **Inflorescence** an axillary cyme or *small thyse*, sessile or shortly peduncled, mainly few-flowered. **Flowers** usually 5-merous, bisexual, perigynous; hypanthium hemispherical; sepals 5, triangular, rather densely pubescent outside, conspicuously keeled within, deciduous; petals 5, clawed; stamens 5, about as long as petals, dehiscing introrsely; disc massive, fleshy; *ovary semi-inferior*, 3(-4)-locular, styles 3-lobed to trifid, stigmas 3. **Fruit** a subglobose, 3-lobed capsule; mesocarp thin, dry or rather fleshy; endocarp cartilaginous to woody, *splitting into 3 ventrally dehiscent endocarps*. **Seeds** broadly obovate, shiny, rarely with a minute basal aril, surface smooth or pitted; testa coriaceous to bony; endosperm fleshy, thick.

Distribution. An almost pantropical genus of about 24 species, mainly centered in the Neotropics. Two species (*C. asiatica* and *C. beccariana*) are found in Sabah and Sarawak.

Uses. The very hard and heavy wood of several neotropical species, known as "West Ironwood" (*C. arborescens*, *C. elliptica*) is of some local importance.

Key to *Colubrina* species

Small to medium-sized tree. Leaves subcoriaceous, oblong-elliptic to oblong-obovate, 3-veined from the acute base.....**C. beccariana**

Small coastal shrub. Leaves chartaceous, broadly ovate to cordate, pinnately veined.....
C. asiatica (L.) Brongn.

l.c. 62; Masamune *l.c.* 434. Basionym: *Ceanothus asiaticus* L., Sp. Pl. (1753) 196.

Sprawling shrub. Leaves ovate to cordate, very thin, pinnately veined, margin dentate. Flowers in few-flowered thyrses. Fruit a globose capsule with explosive dehiscence.

India, China, throughout Malasia. In Sabah and Sarawak scattered in coastal area, and collected from Pulau Tiga FR (*FDBNB* 38625) and Timbun Mata FR (*FDBNB* 44652) in Sabah, and Telok Pinang, 1st Div. in Sarawak (*S.* 41941).

Colubrina beccariana Warb.

Fig. 2.

(Odoardo Beccari, Italian explorer and botanist, 1843–1920)

Bot. Jahrb. Syst. 13 (1891) 367; Ridley *l.c.* 465; Johnston *l.c.* 44; Latiff *l.c.* 298; Whitmore, Tantra & Sutisna *l.c.* 293. **Type:** *Warburg* 20187, Dutch New Guinea (holotype B, destroyed; isotype A). **Synonym:** *C. anomala* King, J. As. Soc. Beng. 45 (1896) 377.

Small to medium-sized tree to 25 m high, bole up to 20 m, diameter to 50 cm, sometimes with weak buttresses. **Bark** smooth or slightly dimpled, very brittle, reddish brown to dark brown; inner bark light red, pale yellow near cambium. **Wood** very hard, sapwood pale yellow. Young branches, axillary buds, petioles, major leaf venation, peduncles, pedicels and gynoeceum densely rusty pubescent. Stipules subulate, to 4 mm long, early deciduous. **Leaves** alternate, subcoriaceous, oblong-elliptic to oblong-obovate, 10–22 x 3.5–8.5 cm; base acute, margin slightly revolute, entire to finely serrulate, individual teeth minute, appressed, bearing a black, glandular apex, apex acuminate, acumen 1–2 cm long and 2–3 mm wide, apically rounded; venation pinnate, slightly impressed above, more or less prominent below; *lateral veins* 4–6 pairs, *basal ones extending into the upper half of the lamina*; intercostal veins rectangular to the midrib, strongly percurrent between superadjacent lateral veins; petioles 6–15 mm long. **Inflorescences** axillary fascicles or shortly *peduncled cymes*; pedicels 1–3 mm long. **Flowers** 5(–6)-merous; hypanthium shallow patelliform; sepals triangular to acuminate, distinctly keeled within; petals obovate, cucullate; disc fleshy, slightly grooved; ovary immersed in the fleshy disc, densely brownish pubescent, 2–3-locular; style more or less deeply bi- to tri-fid, stigmas 3, slightly capitate. **Fruits** globose, 10–16 mm in diameter, glabrous; exocarp flaky, black when dry; mesocarp thin; endocarp woody, splitting into 3 explosively dehiscent endocarps when ripe; pedicels to 2 cm long. **Seeds** 8–10 mm across, testa glossy, reddish brown.

Vernacular names. Sabah—*obbar-obbar* (Dusun), *odok-odok* (Kadazan), *udok-udok* (Malay).

Distribution. Peninsular Malaysia and Borneo (Sabah and Kalimantan). In Sabah, collections have been made from Kinabatangan, Lamag, and Sandakan (Kabali-Sepilok FR) districts.

Ecology. A typical lowland species, mainly found in undisturbed primary rainforest.

3. RHAMNUS L.

(after the ancient Greek plant name *rhamnos*)

Sp. Pl. (1753) 193; Masamune *l.c.* 434; Anderson *l.c.* 290; Latiff *l.c.* 298. **Synonym:** *Oreorhamnus* Ridl., J. Fed. Malay. St. Mus. 10 (1920) 131.

Deciduous or evergreen trees and shrubs, rarely climbing, often thorny. Stipules small, caducous. **Leaves** alternate or rarely opposite, glabrous to rather densely pubescent,

membranous to coriaceous, venation pinnate; margin entire to toothed. **Inflorescences** *axillary cymes*, sessile or peduncled, rarely reduced to a solitary flower. **Flowers** perigynous, *bisexual or unisexual by abortion*; hypanthium campanulate to urceolate; sepals 4–5, deltoid, valvate in bud; petals 4–5 or rarely wanting, minute, usually shortly clawed, concave to hooded; stamens 4–5, sterile and rudimentary or completely wanting in female flower; disc nectariferous, lining the floral tube; ovary superior, 2–3(–4)-locular, each locule with one solitary, erect, anatropous ovule; stigma 3-lobed or stigmata 2–3. **Fruit** a *globular to obovoidal drupe with 2–3(–4) endocarpids*; *mesocarp fleshy to coriaceous*, often with tanniferous idioblasts or mucilage cavities; endocarp cartilaginous to woody; endocarpids abaxially convex, adaxially slightly angular to almost flat, dehiscent or indehiscent. **Seeds** narrow ellipsoidal to obovoidal, rarely suborbicular; testa membranous; endosperm fleshy, scanty; embryo large.

Distribution. The genus extends over nearly the whole area of the family, being abundant in Eastern Asia and Southwestern North America, rather scanty in Europe and Africa, and absent from Madagascar, Australia and Polynesia; one species in Sabah and Sarawak.

Ecology. Primarily distributed in the temperate and subtropical regions of both hemispheres, the genus extends into tropical highlands and is found even in semiarid to arid places. Of significance is the obvious avoidance of hot tropical lowlands.

Uses. Several species are grown as ornamentals or hedge-plants, other furnish wood of local importance or drugs (e.g., *R. cathartica*).

Rhamnus borneensis Steenis (of Borneo)

Fig. 3.

J. Bot. 72 (1934) 6; Masamune *l.c.* 434; Anderson *l.c.* 290; Latiff *l.c.* 298. **Type:** *Clemens 27876*, British North Borneo, Mt. Kinabalu (L). **Synonyms:** *R. lancifolia* Steenis *l.c.* 7, Anderson *l.c.* 290; *R. borneensis* Steenis var. *borneensis* Latiff *l.c.* 299.

Small tree to 15 m high; crown small; bole straight, diameter to 20 cm. **Bark** rugulose; inner bark yellow, fibrous, without latex. **Sapwood** silky white, heartwood dark brown. Young twigs, axillary buds, stipules, petioles, pedicels, flower buds and lower surface of the leaves densely yellowish pubescent, *indument composed of stellate hairs*; branches soon glabrescent, with smooth, red to red-brown bark, without lenticels. **Leaves** lanceolate-elliptic to obovate, chartaceous to subcoriaceous, shiny and glabrous above, densely whitish to yellowish pubescent below, 7.5–14 x 3–5.5 cm; base acute, margin slightly revolute, entire to finely serrulate, apex rounded or acute to acuminate, acumen blunt or broadly triangular; lateral veins 7–11 pairs, straight to slightly curved, parallel, ex-medially anastomosing with each forming well-developed marginal loops. **Inflorescences** *axillary fascicles or shortly peduncled, few-flowered cymes*. **Flowers** 4–5 mm in diameter; pedicels 4–7 mm long; hypanthium hemispheric to campanulate; sepals deltoid to acute triangular, 1.5–2 mm long and wide, distinctly keeled within; petals cucullate, clawed, distinctly 2-lobed, 1.5–2 mm long; stamens 1–1.5 mm long; disc thin, lining the hypanthium, glabrous; ovary very small, conical to globose, 3-locular, glabrous; style undivided, cylindrical, stigma

slightly 3-partite, inconspicuously capitate. **Fruits** red, globose to obovoid, with 2–3 *endocarps*; mesocarp coriaceous; *endocarp stony*, *endocarps lenticular*. **Seeds** elliptic to cylindrical.

Distribution. Sumatra, Peninsular Malaysia and Borneo. Uncommon; in Sabah known from a few collections (e.g., *Clemens 27876* and *SAN 56276* from Mt. Kinabalu area), and in Sarawak scattered and confined to montane forest (e.g., *Nooteboom & Chai 1996* from Mt. Murut; *S. 35822* and *S. 38139* from Mt. Mulu; and *S. 47355* from Mt. Berumpit). No record from Brunei and Kalimantan.

Ecology. A species of submontane to montane ridge and mossy forests to 2700 m.

4. ZIZIPHUS Mill.

(from the Persian plant name *zizuf*)

Gard. Dict. Abr. ed. 4 (1754); Ridley *l.c.* 461; Merrill, PEB (1929) 177; Masamune *l.c.* 435; Backer & Bakhuizen *f. l.c.* 81; Anderson *l.c.* 290; Corner *l.c.* 610; Latiff *l.c.* 299; Whitmore, Tantra & Sutisna *l.c.* 293.

Deciduous or evergreen, small to medium-sized trees, erect or straggling shrubs or to 30 m high woody climbers, often armed. *Stipules* small, deciduous or *often transformed into straight or recurved spines*. **Leaves** alternate, usually *distinctly 3-veined from the base*, rarely pinnately veined, *often slightly asymmetric*; margin entire or serrate to crenate. **Inflorescences** axillary fascicles or sessile or peduncled, umbel-like cymes, rarely terminal or axillary thyrses. **Flowers** perigynous, bisexual, yellowish to greenish; hypanthium shallow patelliform to hemispherical; sepals 5, keeled inside, early deciduous; petals 5, cucullate, clawed, rarely absent; disc nectariferous, fleshy, mainly flat, 5- to 10-lobed, lining the hypanthium; ovary 2–3(–4)-locular, styles 2–4, stigma 2–3(–4), very small, slightly capitate. **Fruits** drupaceous, fleshy or almost dry, exclusively one-stoned; mesocarp fleshy to leathery; *endocarp bony to woody*, surface smooth to furrowed. **Seeds** ellipsoid, nearly plano-convex, raphe lateral, testa thin, membranous; endosperm scanty, fleshy; embryo straight.

Distribution. An almost pantropical genus of about 100 species centered in tropical America and in Southeastern Asia. In Sabah and Sarawak, 8 species, which are mostly thorny straggling shrubs or woody climbers of the lowlands.

Ecology. The genus is widely distributed in tropical and subtropical regions of the world, extending locally into temperate or even semi-arid to arid zones.

Uses. Two species, *Z. jujuba* Mill. and *Z. mauritiana* Lam. are widely cultivated for their edible fruits. The wood of some other species is of local importance, e.g., for house-building, furnitures, cabinet-making, and for agricultural tools.

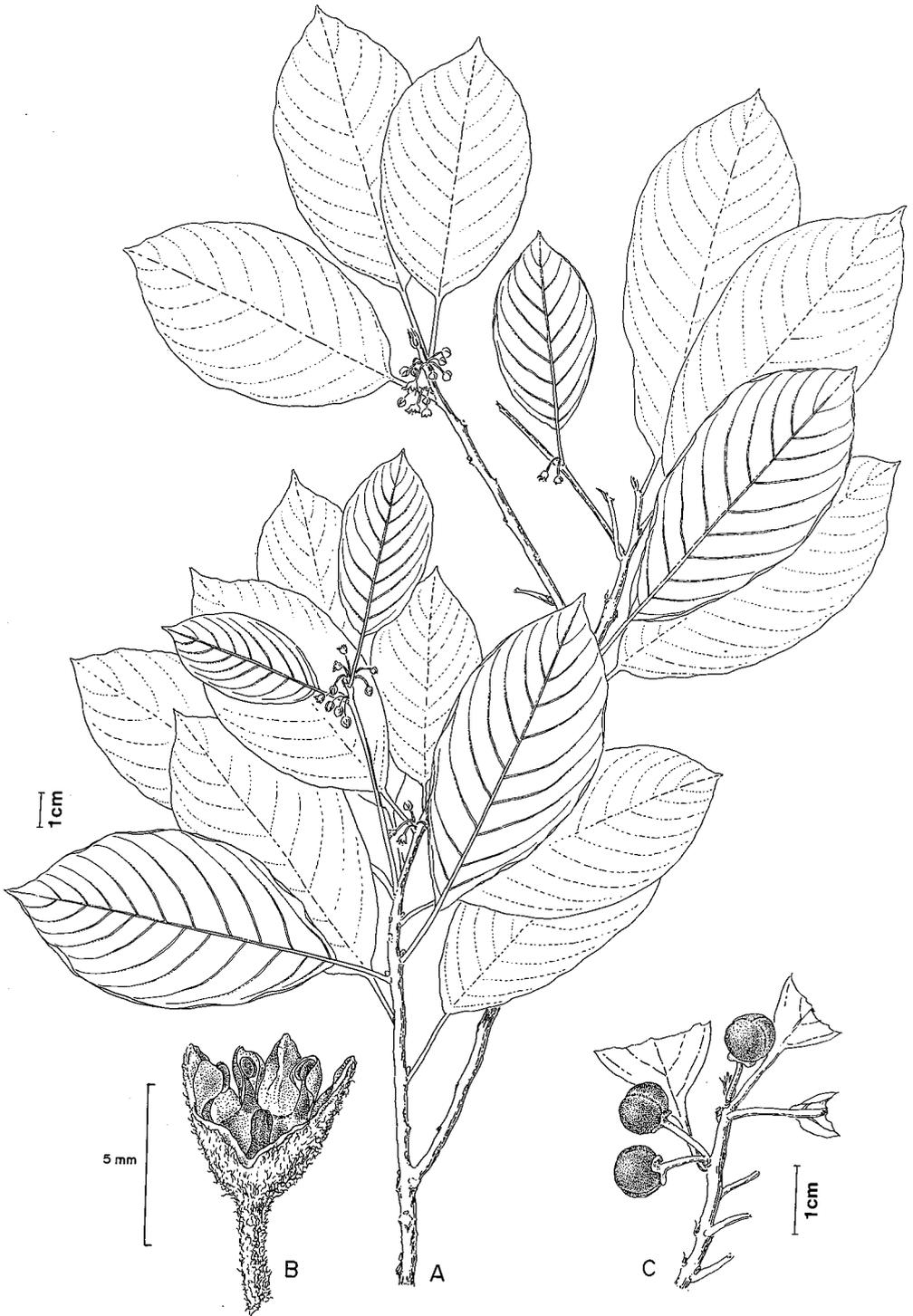


Fig. 3. *Rhamnus borneensis*. A, flowering leafy twig; B, flower with 2 sepals, 2 petals and 2 stamens removed; C, twig with mature fruits. (All from SAN 56276.)

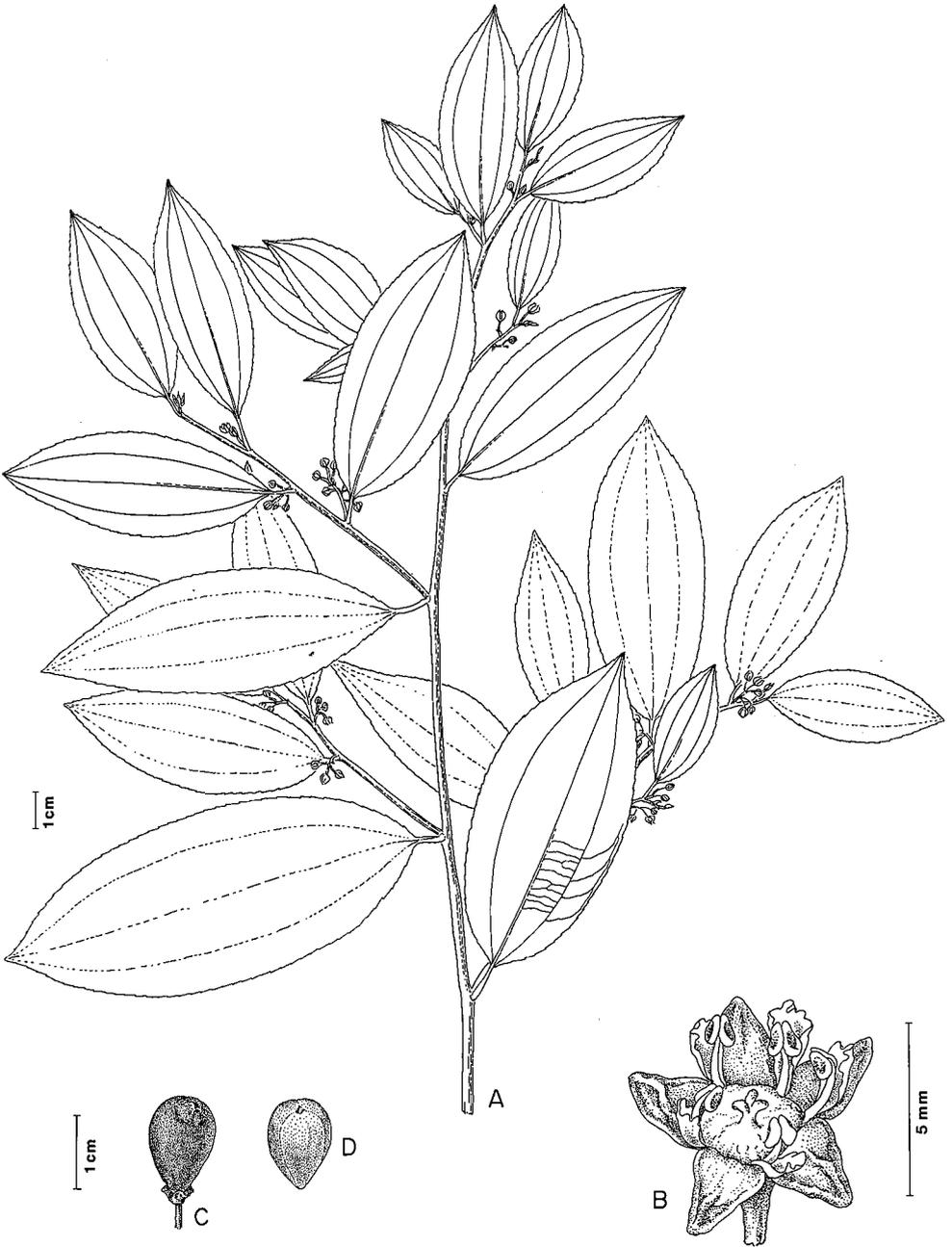


Fig. 4. *Ziziphus angustifolius*. A, flowering leafy twig; B, flower; C, single drupaceous fruit; D, endocarp. (A from van Steenis 3396, B from Ramos 1656, C-D from de Vogel & Vermeulen 6607.)

Key to *Ziziphus* species

1. Small to medium-sized unarmed tree. Leaves to 30 cm long.....**Z. angustifolius**
Erect or straggling shrub or woody climber with stipulary spines. Leaves smaller.....2
2. Leaves less than 10 cm long.....3
Leaves 10–17 cm long.....7
3. Fruits ellipsoid, with flattened base and acuminate apex, to 4 cm long.....
Z. borneensis Merr.
l.c. (1929) 178; Masamune *l.c.* 435; Whitmore, Tantra & Sutisna *l.c.* 294.
Straggling shrub or woody climber with recurved stipulary spines, plant often densely ferruginous-tomentose. Leaves elliptic to oblong-elliptic, chartaceous to subcoriaceous; base often distinctly asymmetric, margin entire to minutely dentate, apex acuminate. Flowers in axillary fascicles. Fruits a very large ellipsoid drupe. Endemic to Borneo (Sabah, Sarawak, Brunei, Kalimantan).

Fruits globose to obovoid, to 1 cm in diameter.....4
4. Leaves very thin, venation pattern of the lower surface dark coloured and typically distinct. Style undivided and glabrous.....
Z. cumingiana Merr.
Philipp. J. Sci. 1, Suppl. 3 (1906) 206.
Erect or straggling shrub with one recurved stipulary spine per node. Leaves ovate, often distinctly asymmetric, very thin; margin finely dentate. Flowers in few-flowered axillary cymes, very small. Drupes glabrous. Borneo (Sabah) and the Philippines.

Leaves chartaceous to coriaceous, venation pattern never distinctly coloured. Styles 2(–3)-lobed, densely pubescent.....5
5. Leaves with distinct arcs of veins diverging from the lateral veins.....
Z. horsfieldii Miq.
Fl. Ned. Ind. 1, 1 (1855) 643; Masamune *l.c.* 435; Latiff *l.c.* 300; Whitmore, Tantra & Sutisna *l.c.* 294.
Straggling shrub with one short stipulary spine per node. Leaves ovate to elliptic, very thin, often somewhat asymmetric; base obtuse, margin minutely dentate, apex shortly acuminate. Flowers in axillary, dichotomously branched cymes. Drupes globose, densely brownish pubescent. Sumatra, Peninsular Malaysia, Java, Borneo (Sabah, Sarawak, Brunei, Kalimantan).

Leaves without such lateral veins.....6
6. Leaves bearing a distinct intra-marginal vein.....
Z. havilandii Ridl.
Kew Bull. (1931) 495; Masamune *l.c.* 435; Whitmore, Tantra & Sutisna *l.c.* 294.
Straggling shrub with one recurved stipulary spine per node, plant more or less densely yellowish pubescent, glabrescent. Leaves ovate, often asymmetric, very thin; base obtuse, margin minutely dentate. Flowers in dichotomously branched,

axillary cymes. Drupes globose to obovoid, densely yellowish to brownish pubescent. Endemic to Borneo (Sabah, Sarawak, Brunei, Kalimantan).

Leaves without any intramarginal vein.....

Z. suluensis Merr.

Philipp. J. Sci. 30 (1926) 408, *l.c.* (1929) 177; Masamune *l.c.* 435; Whitmore, Tantra & Sutisna *l.c.* 294.

Straggling shrub with one recurved stipulary spine per node. Leaves elliptic, subcoriaceous; base obtuse to rounded, often somewhat asymmetric, margin minutely dentate, apex acuminate. Flowers in small, axillary, few-flowered cymes. Drupes globose to obovoid, densely brownish pubescent. Sumatra, Borneo, Philippines and the Moluccas.

7. Leaves chartaceous to subcoriaceous, venation pattern typically prominent on the lower surface. Bark of twigs cream-coloured, densely lenticellate.....

Z. crebrivenosa C.B. Rob.

Philipp. J. Sci. 3 (1908) 201; Whitmore, Tantra & Sutisna *l.c.* 294.

Woody climber with one recurved stipulary spine per node and densely lenticellate branches. Leaves obovate to elliptic, often somewhat asymmetric, chartaceous; base obtuse to rounded, margin faintly denticulate, apex acute to obtusely acuminate and mucronate. Flowers in axillary cymes. Drupes globose, to 3 cm diameter, densely lenticellate. Borneo (Sabah, Sarawak, Kalimantan), Philippines and Celebes.

Leaves coriaceous, venation pattern very delicate, never prominent. Bark of twigs brownish, not lenticellate.....

Z. calophylla Wall.

in Roxb., Fl. Ind. 2 (1824) 366; Merrill *l.c.* (1926) 364, *l.c.* (1929) 177; Ridley, Kew Bull. (1931) 494; Masamune *l.c.* 435; Latiff *l.c.* 300; Whitmore, Tantra & Sutisna *l.c.* 294.

Sturdy straggling shrub, with short, solitary or paired stipulary spines. Leaves coriaceous, elliptic to oblong-elliptic, base usually narrowed, margin minutely dentate, apex acuminate. Flowers in axillary or terminal cymes. Drupes globose, densely brownish tomentose. Sumatra, Peninsular Malaysia and Borneo (Sabah, Brunei, Kalimantan).

Ziziphus angustifolius (Miq.) Hatusima *ex* Steenis

Fig. 4.

(Latin, *angustifolius* = having narrow leaves)

Nova Guinea, Botany 3 (1960) 13; Hatusima, Cat. Hort. Bot. (1957) 242; Merrill & Perry, J. Arn. Arb. 20 (1939) 337; Anderson *l.c.* 290; Latiff *l.c.* 299; Whitmore, Tantra & Sutisna *l.c.* 293.

Basionym: *Solenostigma angustifolium* Miq., Fl. Ned. Ind., Suppl. (1861) 412. **Type:** *Miquel HB 758* and *HB 2501*, Sumatra West Coast (syntypes L). **Synonyms:** *Celtis angustifolia* (Miq.) Planch. in DC., Prod. 17 (1873) 186; *C. grewioides* Warb., Bot. Jahrb. 13 (1891) 287; *Ziziphus inermis* Merr., Govt. Lab. Publ. Philipp. 35 (1906) 37; *Z. forbesii* Baker *f.*, J. Bot. 61, Suppl. (1923) 10; *Z. grewioides* (Warb.) Perry *ex* Steenis, Blumea 7 (1954) 595.

Small to medium-sized, unarmed tree to 30 m high and 40 cm diameter; crown narrow conical; bole straight, rarely crooked, up to 20 m high, sometimes with buttresses of about 1

m high and 1–1.5 m out. **Bark** not fissured, not peeling, with densely spaced lenticels, greyish to brownish, about 0.2 mm thick; inner bark yellow to brownish, blaze straw-coloured, cambium orange. **Sapwood** hard, light to greyish brown, to 15 cm thick; heartwood hard and heavy, dark brown. Young twigs, axillary buds, stipules, petioles, peduncles, pedicels and flower buds rather densely yellowish to brownish pubescent; older branches glabrescent, greyish to brownish, lenticellate. *Stipules* minute, narrow lanceolate, *not transformed into spines*, 1–2 mm long, early deciduous. **Leaves** alternate, chartaceous to subcoriaceous, symmetric, oblong-elliptic to oblong-ovate, 12–20 x 3–7 cm; base obtuse to acute, margin slightly revolute, finely serrate, apex acute to acuminate, acumen about 1–2 cm long, 0.5 cm wide, apically distinctly mucronate; *venation 3-veined from the base*; intercostal veins rectangular to the midrib, strongly parallel between the midrib and the lateral veins, outer intercostal veins anastomosing to form a slightly looped marginal vein. **Inflorescences** axillary, peduncled, branched cymes, to 3 cm long. **Flowers** 4–6 mm in diameter, 5-merous, greenish to yellowish; pedicels 2–4 mm long; hypanthium patelliform; sepals triangular, keeled within; petals clawed, cucullate; stamens about 1.5 mm long, filaments pale greenish, anthers green; disc prominent, glandulous, glabrous, yellow to ochre; ovary immersed in the disc, 2–3-locular, style 2–3-lobed, increasingly diverging during anthesis, stigmas distinctly papillous. **Fruits** globose to obovoid, often 1-seeded, 10–20 mm diameter; mesocarp comparatively thin; *endocarp woody*.

Vernacular names. Sabah—*kayu labu* (Kadazan), *pasil-pasil* (Bajau).

Distribution. India, Burma, Thailand, Sumatra, Peninsular Malaysia, Borneo (throughout), Philippines, Celebes, Moluccas, New Guinea, and Solomon Island. In Sabah recorded from Kinabatangan, Tenom, Tongod, Lahad Datu, and Sandakan districts; and in Sarawak from various localities in the 1st, 4th and 7th Divisions. Also occurs in Brunei and Kalimantan.

Ecology. Lowland mixed dipterocarp forest to c. 600 m.



RHIZOPHORACEAE

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Merrill, EB (1921) 420; Masamune, EPB (1942) 515; Browne, FTSB (1955) 296; Ding Hou, FM 1, 5 (1958) 429; Burgess, TBS (1966) 431; Ashton, MNDTS 2 (1988) 342; Juncosa & Tomlinson, Ann. Missouri Bot. Gard. 75 (1988) 1278; Kochummen, TFM 4 (1989) 302; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 295.

Trees or shrubs, the mangrove species often with characteristic root formations (branching stilt-roots in *Rhizophora*, knee pneumatophore-roots in *Bruguiera*). **Bark** invaginating finely and regularly into the wood in the inland genera (*Carallia*, *Gynotroches*, *Pellacalyx*). Twigs solid or (in *Gynotroches* and *Pellacalyx*) hollow; branch nodes swollen. **Leaves** opposite and decussate, entire or toothed, pinnately veined; stipules interpetiolar, caducous, with colleters on the inner side. **Inflorescences** usually axillary, cymose or a fascicle of flowers or flowers solitary. **Flowers** bisexual or (in *Gynotroches*) unisexual (the plants dioecious), radially symmetrical; calyx-lobes 4–16, valvate; petals 4–16, free, fleshy, 2-fid to fimbriate or fringed with apiculate appendages or lacerate or lobed (rarely entire); stamens free or (in *Pellacalyx*) inserted on the calyx-tube, 1–3 times the number of petals or (in *Kandelia*) many; anthers 4-celled or (in *Kandelia*) many-celled, dorsifixed, splitting lengthwise or (in *Rhizophora*) opening by a ventral valve; ovary superior or semi-inferior or inferior, 2–12-celled (cells often incompletely or not separated at floral maturity and then apparently 1-celled), style simple, stigma capitate or lobed, ovules 2–many per cell, pendulous, placentation axile; disc usually present, fleshy, annular, entire to lobed. **Fruit** a berry, calyx persistent. **Seeds** 1–many per fruit, pendulous, endospermous; embryo with laminar cotyledons; germination epigeal or in the mangrove species viviparous (while the seed still enclosed in the fruit and the fruit still attached to the tree).

Distribution. 15 genera with c. 145 species, pantropical. In Sabah and Sarawak 7 genera with 23 species.

Ecology. The mangrove species occur on coastlines with warm currents, and many also grow in brackish water conditions within the estuaries or along the lowest stretches of rivers. The inland species are mostly of moist (primary or secondary) tropical forests.

Uses. The mangrove species have been exploited for poles used in scaffolding and the construction of large fishing platforms and traps. The bark of almost all mangrove species (in *Bruguiera*, *Ceriops* and *Rhizophora*) are used for tanning. The mangrove species are also important in providing poles for the local charcoal industry, the calorific value of the wood being excellent. In the inland forests, *Carallia* species grow to timber size and are exploited for logs.

Taxonomy. Rhizophoraceae have been traditionally placed in the Myrtales and sometimes with the Cornales. This was based on the incorrect assumption that the Rhizophoraceae typically have an inferior ovary, whereas in fact this is a rare and derived condition. Sometimes, also based on a single character of the presence of interpetiolar stipules, the Rhizophoraceae has been said to be related to the Rubiaceae and Cunoniaceae. Dahlgren (1988) (Ann. Missouri Bot. Gard. 75: 1259), after considering a number of characters, places the Rhizophoraceae in the Celastrales, together with Celastraceae and Elaeocarpaceae. Cronquist (1981) (An Integrated System of Classification of Flowering Plants) separates the Rhizophoraceae *sensu stricto* in its own order, the Rhizophorales.

Although a number of authors have treated the genera *Anisophyllea* and *Combretocarpus* as part of the Rhizophoraceae, it is now well established that these two genera should be separately classified in a family, the Anisophylleaceae (this volume). Within the Rhizophoraceae *s.s.* Juncosa & Tomlinson *l.c.* consider three tribes, Rhizophoreae (*Bruguiera*, *Ceriops*, *Kandelia*, *Rhizophora*), Gynotrocheae (*Carallia*, *Gynotroches*, *Pellacalyx*, *Crossostylis*) and Macarisieae (which includes seven genera not in our area).

Some Rhizophoraceae can be confused with the Rubiaceae at a glance, as both typically have opposite leaves with interpetiolar stipules. The Rubiaceae have fused corolla members and have a corolla-tube, and the stamens are as many as the corolla-lobes. In the Rhizophoraceae, the corolla members (petals) are free, and frequently the stamens are at least twice the number of petals.

Key to genera

1. Plants of mangrove forests. Bark not invaginating into wood. Seeds germinating while still in the fruits and the fruits still attached to the tree (viviparous).....2
 Plants of inland forests. Bark invaginating finely and regularly into wood. Seeds germinating only after the fruits have fallen off the tree.....5
2. Leaf apex pointed.....3
 Leaf apex blunt or rounded.....4
3. Plants developing buttresses and knee pneumatophores (breathing roots). Calyx-lobes 8–16, lanceolate-linear.....**1. Bruguiera**
 Plants developing conspicuous branching stilt-roots. Calyx-lobes 4, broadly ovate**7. Rhizophora**
4. Plants developing only short buttresses, trunk not usually thickened at base. Leaves broadly elliptic to obovate, length at most twice the width. Hypocotyl (first elongating axis) in the germinating fruit with sharp longitudinal ridges.....**3. Ceriops**
 Plants typically without buttresses, trunk developing a conically thickened base. Leaves narrowly elliptic-oblong, length at least 2.5–3-times the width. Hypocotyl in the germinating fruit smooth.....**5. Kandelia**
5. Twigs solid. Leaf-margin distinctly toothed or crenate. Inflorescence cymose, with a distinct main stalk.....**2. Carallia**

Twigs hollow. Leaf-margin faintly toothed to entire. Inflorescence a fascicle of flowers without any distinct main stalk.....6

6. Stipules with overlapping margins. Ovary superior (calyx at the base of the fruit) 4. **Gynotroches**
 Stipules not overlapping, flat to slightly spreading. Ovary inferior (calyx at the apex of the fruit)..... 6. **Pellacalyx**

1. BRUGUIERA Lam.

(J.G. Bruguieres, 1750–1798, who worked for Lamarck's Encyclopaedia Methodica)

beus, lengadai (Malay)

Tab. Enc. Meth. (1797) t. 397; Merrill *l.c.* (1921) 421; Masamune *l.c.* 515; Browne *l.c.* 299; Ding Hou *l.c.* 457; Burgess *l.c.* 431; Ashton *l.c.* 349; Kochummen *l.c.* 309; Whitmore, Tantra & Sutisna *l.c.* 295.

Medium-sized trees with buttresses and *knee pneumatophores*, sometimes with aerial roots when young. **Leaves** usually coriaceous, entire, glabrous, *finely black-dotted on the lower side*; stipules lanceolate. **Inflorescence** a 2–5-flowered cyme or reduced to a solitary flower. **Flowers** bisexual, articulate at the base with the stalk; *calyx thick, 8–15-lobed, lobes lanceolate-linear, acute; petals 2-lobed, falling off early; disc cup-shaped and attached to the calyx-tube; stamens twice the number of petals and paired; ovary inferior, 2–4-celled, ovules 2 per cell, style filiform, stigma obscurely 2–4-lobed.* **Fruits** included in and adnate to the calyx-tube, usually 1-celled, 1(–2)-seeded; *germination viviparous*; hypocotyl rounded or obscurely ribbed, blunt.

Distribution. 6 species, tropical east Africa to Asia, throughout Malesia to Australia and Polynesia. In Sabah and Sarawak, 4 species.

Ecology. In mangroves, usually occurring behind *Rhizophora* stands that are inundated. Forming pure stands in some sites.

Uses. Not suitable for poles and for construction. The wood, however, is used for making charcoal.

Key to *Bruguiera* species

1. Flowers solitary. Bark in mature trees usually fissured-flaky.....2
 Flowers several in a cyme. Bark usually smooth or lenticellate.....3
2. Flower-stalks 10–12 mm long; tips of petal acute, each with 3 or 4 distinct bristles 2. **B. gymnorrhiza**
 Flower-stalks 6–8 mm long; tips of petals obtuse, each with 1–3 bristles..... 4. **B. sexangula**

3. Flowers small, the calyx 3–4 mm long, smooth; stalks 2–3 mm long. Fruit with reflexed calyx-lobes..... **1. *B. cylindrica***
 Flowers larger, the calyx 6–10 mm long, ribbed; stalks 5–8 mm long. Fruit with erect calyx-lobes..... **3. *B. parviflora***

1. *Bruguiera cylindrica* (L.) Blume

(Latin, *cylindricus* = cylindric; the hypocotyl)

En. Pl. Jav. 1 (1827) 93; Browne *l.c.* 300; Ding Hou *l.c.* 467; Burgess *l.c.* 432; Ashton *l.c.* 353; Kochummen *l.c.* 310; Whitmore, Tantra & Sutisna *l.c.* 295. **Basionym:** *Rhizophora cylindrica* L., Sp. Pl. (1753) 443. **Type:** *Kari-kandel* Rheede, Hort. Mal. 6 (1686) 59, t. 33. **Synonyms:** *R. caryophylloides* Burm. f., Fl. Ind. (1768) 109; *R. ceratophylloides* Gmel., Syst. Veg. (1796) 749; *B. caryophylloides* (Burm. f.) Blume *l.c.* (1827) 93; *B. malabarica* Arn., Ann. Mag. Nat. Hist. 1 (1838) 369; *Kanilia caryophylloides* (Burm. f.) Blume, Mus. Bot. Lugd. Bat. 1 (1849) 141.

Tree to 25 m tall, 45 cm diameter; buttresses to 1 m high. **Bark** grey, with many large prominent lenticels; inner bark pink. **Sapwood** yellowish brown. **Leaves** elliptic, 7–17 x 2–8 cm, thinly coriaceous; base cuneate, apex acute; lateral veins *c.* 7 pairs, distinct to obscure on both sides; stalk 1–4.5 cm long; stipules 2.5–3.5 cm long. **Flowers** in 3-flowered cymes; stalks 2–3 mm long; calyx-tube smooth, 3–4 mm long, lobes 8, as long as the tube; petals 4–5 mm long, the lobes $\frac{1}{3}$ the length of the petal, apex obtuse, each with 1–3 bristles to 1.5 mm long, outer margin fringed with white hairs. **Fruits** with calyx-tube 1–1.2 cm long, the calyx-lobes reflexed; hypocotyl cylindric, to 15 cm long, 0.5 cm thick.

Vernacular names. Sabah—*beus* (Malay). Sarawak—*berus ngayong* (Lundu Malay), *berus puteh* (Malay), *ngayong* (Lundu Malay).

Distribution. SE Asia, throughout Malesia to N Queensland. In Sabah recorded from Pulau Gaya and Pulau Tiga in the west coast; in Sarawak recorded at Lundu and the Rejang delta. Also in Brunei and Kalimantan.

Ecology. Often gregarious on newly formed sandy clays and behind *Avicennia* on the seaface; it is succeeded by other species on better drained sites.

Uses. The timber is mainly used for firewood and is not durable in contact with soil, hence it is not favoured as a pole in house construction.

2. *Bruguiera gymnorrhiza* (L.) Lam.

(Greek, *gymnos* = naked, *rhiza* = root; the exposed germinating hypocotyl)

Encycl. Meth. Bot. 4 (1798) 696; Browne *l.c.* 301; Ding Hou *l.c.* 461; Burgess *l.c.* 431; Ashton *l.c.* 350; Kochummen *l.c.* 310; Whitmore, Tantra & Sutisna *l.c.* 296. **Basionym:** *Rhizophora gymnorrhiza* L., Sp. Pl. (1753) 433. **Type:** *Kandel* Rheede, Hort. Mal. 6 (1686) 57, t. 31 & 32. **Synonyms:** *R. palun* DC., Prod. 3 (1828) 33; *B. rheedii* Blume *l.c.* (1827) 92; *R. tinctoria* Blanco, Fl. Filip. (1837) 394; *B. capensis* Blume *l.c.* (1849) 137; *B. wightii* Blume *l.c.* (1849) 138; *B. rumphii* Blume *l.c.* (1849) 138;

B. cylindrica sensu Hance (*non* Blume), J. Bot. 18 (1879) 10; *B. conjugata sensu* Merr. (*non* *R. conjugata* L.), Philip. J. Sc. 9 (1914) Bot. 118, *l.c.* (1921) 421, Masamune *l.c.* 515.

Tree to 35 m tall, 45 cm diameter; often with buttresses to 1 m high. **Bark** dark grey to brown to black, deeply *fissured and roughly flaky*, lenticels conspicuous only when young; inner bark yellowish pink. **Sapwood** pale yellowish brown. **Leaves** elliptic-oblong, 8–20 x 4–7 cm, thinly coriaceous; base cuneate or rarely obtuse, apex acute; lateral veins 9–10 pairs, indistinct on both sides; stalk 2–4.5 cm long; stipules 3–4 cm long. **Flowers** *solitary*; *stalks 10–12 mm long*; calyx-tube distinctly ribbed at upper part, 8–12 mm long, lobes 10–16, 17–22 mm long; *petals 13–15 mm long*, the lobes $\frac{1}{3}$ – $\frac{1}{2}$ the length of the petals, *apex acute, each with 3 or 4 bristles* of 2–3 mm long, outer margin fringed with white silky hairs. **Fruits** with calyx-tube to 2.5 cm long, the calyx-lobes ascending, not reflexed; hypocotyl slightly ribbed, to 25 cm long, 2 cm thick.

Vernacular names. Sabah—*putut* (Malay). Sarawak—*berus kurong, berus merah, kurong* (Malay).

Distribution. Tropical east Africa, S and SE Asia to the Ryukyus, throughout Malesia to Australia, Micronesia and Polynesia. In Sabah and Sarawak all districts with a coastline. Also in Brunei and Kalimantan.

Ecology. One of the largest trees of the mangrove, found at the inland margins.

Uses. The wood is hard, difficult to work and not ornamental, although it is easily impregnated with preservative. It can be used for rail sleepers, and is locally used in charcoal making and for firewood, and the poles are sometimes used in house construction. The bark has been used for the manufacture of cutch but is said to be inferior to that from *Rhizophora*.

3. *Bruguiera parviflora* (Roxb.) Wight & Arn. *ex* Griff.

Fig. 1.

(Latin, *parvus* = little, *flores* = flowers)

Trans. Med. Phys. Soc. Calc. 8 (1836) 10; Merrill *l.c.* (1921) 421; Masamune *l.c.* 515; Browne *l.c.* 301; Ding Hou *l.c.* 464; Burgess *l.c.* 431; Ashton *l.c.* 353; Kochummen *l.c.* 310; Whitmore, Tantra & Sutisna *l.c.* 296. **Basionym:** *Rhizophora parviflora* Roxb., Fl. Ind. ed. Carey 2 (1832) 461. **Type:** Roxburgh no. 1246 (K). **Synonyms:** *R. cylindrica sensu* Roxb. (*non* L.), Hort. Beng. (1814) 36; *Kanilia parviflora* (Roxb.) Blume *l.c.* (1849) 140; *B. ritchiei* Merr., Publ. Govt. Lab. Philip. 6 (1904) 11.

Tree to 30 m tall, 45 cm diameter. **Bark** pale grey mottled, pale brown, smooth with small obscure lenticels; inner bark pinkish red. **Sapwood** pale brown. **Leaves** elliptic-oblong, 8–15 x 2.5–5 cm, thinly coriaceous; base cuneate, apex acute; lateral veins 9–10 pairs, slightly distinct on both sides; stalk 0.6–1.2 cm long; stipules 3–6 cm long. **Flowers** 2–5 in a *cyme*; *stalks 5–8 mm long*; calyx-tube distinctly ridged to the base, 6–10 mm long, lobes 10–12, 2–3 mm long; petals 2–3 mm long, the lobes $\frac{1}{2}$ the length of the petals, apex obtuse and reflexed, each with 1–3 bristles to 1.3 mm long, outer margin fringed with white silky hairs. **Fruits** with calyx-tube to 4 cm long, the *calyx-lobes ascending*, not reflexed; hypocotyl angular, to 6 cm long, 1.5 cm thick.

Vernacular names. Sabah—*beus* (Malay), *langarai* (Idahan, Suluk), *lanjing lanjing* (Kedayan), *lenggadai* (Malay). Sarawak—*berus lenggadai*, *lenggadai* (Malay).

Distribution. Sri Lanka, SE Asia, throughout Malesia, New Britain. In Sabah and Sarawak common in mangroves.

Ecology. Often mixed with *Rhizophora* and occasional along the margins of mangrove channels.

Uses. The wood lasts only a year in contact with soil in the tropics. A minor source of charcoal wood and firewood, unpopular as a pole.

4. *Bruguiera sexangula* (Lour.) Poir

(Latin, *sex* = six, *angulus* = angle; the ridged hypocotyl)

Encycl. Supp. 4 (1816) 262; Merrill *l.c.* (1921) 422; Masamune *l.c.* 515; Ding Hou *l.c.* 463; Burgess *l.c.* 431; Ashton *l.c.* 351; Kochummen *l.c.* 312; Whitmore, Tantra & Sutisna *l.c.* 296. **Basionym:** *Rhizophora sexangula* Lour., Fl. Coch. (1790) 297. **Type:** Loureiro, *s.n.* (BM). **Synonyms:** *B. angularis* Spreng., Syst. Veg. 2 (1825) 602; *B. cylindrica sensu* Blume (*non B. cylindrica* L.) *l.c.* (1827) 93; *R. polyandra* Blanco, Fl. Filip. (1837) 396; *R. plicata* Blanco *l.c.* 398; *B. eriopetala* Wight & Arn. *ex Arn.*, Ann. Mag. Nat. Hist. 1 (1838) 368, Browne *l.c.* 301; *B. australis* A. Cunn. *ex Arn. l.c.* 368; *R. australis* (A. Cunn. *ex Arn.*) Steud., Nomencl. ed. 2, 2 (1841) 449; *R. eriopetala* Steud. *l.c.* 449; *B. parietosa* Griff., Notul. 4 (1854) 670; *B. 10-angulata* Griff. *l.c.* 669; *B. oxyphylla* Miq., Sumatra (1861) 324; *B. malabarica sensu* F.-Vill. (*non Arn.*), Nov. App. (1880) 79.

Tree to 40 m tall, 60 cm diameter; buttresses to 1 m high, stilt-roots sometimes developing. **Bark** pale grey-brown, *conspicuously lenticellate*; inner bark pale brown. **Sapwood** yellowish brown. **Leaves** elliptic-oblong to oblanceolate, 8–14 x 3–6 cm, thinly coriaceous; base cuneate, apex acute; lateral veins 7–11 pairs, slightly distinct to obscure on both sides; stalk 0.7–2.5 cm long; stipules 3–6 cm long. **Flowers** *solitary*; *stalks 6–8 mm long*; calyx-tube distinctly ridged to the base, 10–12 mm long, lobes 10–12, 18–20 mm long; *petals c.* 15 mm long, the lobes $\frac{1}{2}$ the length of the petals, *apex obtuse* and reflexed, *each with 1–3 bristles*, outer margin fringed with white silky hairs. **Fruits** with calyx-tube 15–18 mm long, the calyx-lobes ascending, not reflexed; hypocotyl angular, to 6–8 cm long, 1.5 cm thick.

Vernacular names. Sabah—*mata buaya* (Malay). Sarawak—*berus putut*, *putut* (Malay).

Distribution. Sri Lanka and SE Asia to New Britain and throughout Malesia. In Sabah and Sarawak common in mangroves. Also in Brunei and Kalimantan.

Ecology. Scattered towards the inland margins of mangroves; on wetter soils together with *B. cylindrica* and *B. parviflora*.

Uses. Mainly for charcoal making and firewood, and also in local house construction.

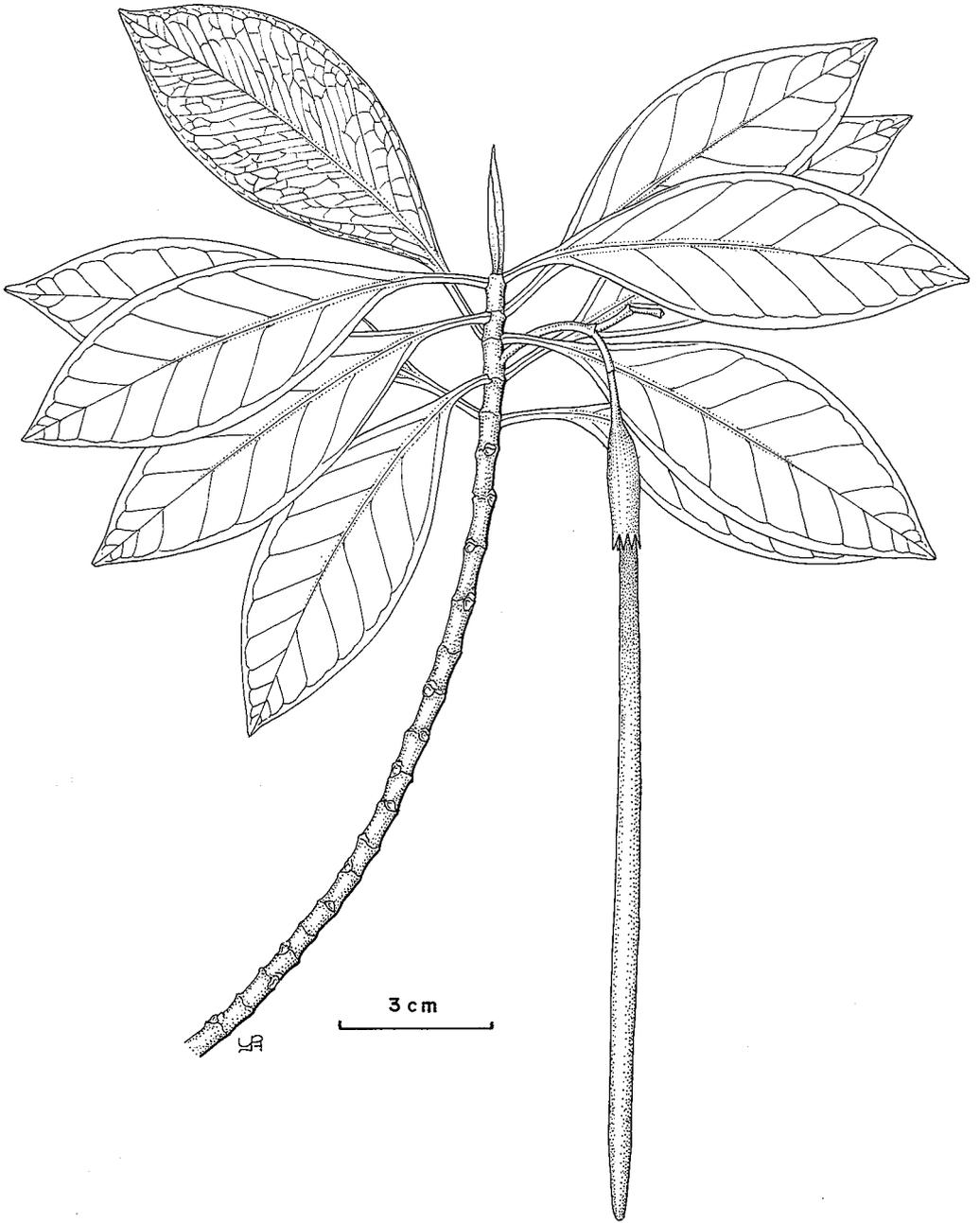


Fig. 1. *Bruguiera parviflora*. Fruiting leafy twig. (From SAN 75544.)

2. **CARALLIA** Roxb., *nom. cons.*

(from *karalli*, an Indian plant name)

Pl. Corom. 3 (1811) 8; Merrill *l.c.* (1921) 421; Masamune *l.c.* 515; Browne *l.c.* 305; Ding Hou *l.c.* 481; Ashton *l.c.* 291; Kochummen *l.c.* 312; Whitmore, Tantra & Sutisna *l.c.* 296. **Synonyms:** *Symmetria* Blume, Bijdr. (1826–27) 1130; *Sagittipetalum* Merr., Philip. J. Sc. 3 (1908) Bot. 247.

Small to medium-sized trees, sometimes with small buttresses or stilt-roots. **Bark** smooth and hoop-marked, becoming roughened by minute longitudinal fissures and transverse cracks, sometimes scaly, grey-brown or pinkish brown; *inner bark invaginating finely and regularly into the wood*. **Sapwood** with conspicuous radiating lines. Stipules lanceolate. **Leaves** often black-dotted on lower side, margin entire or toothed. **Inflorescence** a condensed or lax cyme, or flowers in pairs or solitary. **Flowers** sessile or stalked, calyxlobes 5–8, deltoid, acute to acuminate; petals 5–8, clawed; stamens twice the number of petals, usually free; disc angular, fleshy; ovary inferior, 5–8-celled with 2 ovules per cell, or 1-celled with 10–12 ovules, styles filiform or slightly conical. **Fruits** small, ellipsoid-obovoid, pulpy, 1-celled, usually 1-seeded. **Seeds** ellipsoid or reniform, endospermous; germination epigeal.

Distribution. *c.* 11 species, Madagascar, India, Sri Lanka, SE Asia and Malesia to N Australia. 8 species in Sabah and Sarawak.

Ecology. Mostly lowland forests, sometimes swamps, to hills and ridges to *c.* 2000 m.

Uses. The timber of some species are suitable for making tool-handles and inferior construction such as picture-frames and panelling. It is also sometimes used for firewood and charcoal.

Taxonomy. Four species enumerated here are not named but merely indicated by numbers; their precise naming will depend on the collection of better flowering material and, in one or two cases, will need to be based on a study of wider scope.

Key to *Carallia* species

1. Leaves without conspicuous dark gland-dots all over the blade.....2
 Leaves with conspicuous dark gland-dots all over the blade.....5
2. Leaves not longer than 4 cm; lateral veins 4–6 pairs, intercostal veins inconspicuous on both sides. Flowers solitary in each unbranched inflorescence.....**8. Carallia sp. 5**
 Leaves typically longer than 4 cm; lateral veins 6–11 pairs, intercostal veins conspicuous and often prominent on both sides. Flowers several to many on clearly branched cymes.....3
3. Leaves stiffly leathery, margin coarsely saw-toothed; intercostal veins very prominent on upper side.....**6. Carallia sp. 3**
 Leaves chartaceous to thinly leathery, margin entire to subentire or faintly toothed towards apex; intercostal veins only slightly prominent on upper side.....4

4. Leaf-margin faintly toothed to entire; lateral veins looping towards the margin forming only one clear submarginal vein. Flowers sessile, on an apparently simple axis (actually a cyme with branches reduced), peduncle nil or very short and inconspicuous.....3. **C. coriifolia**
Leaf-margin always slightly but distinctly toothed; lateral veins forming 2–several series of angular loops between midrib and margin. Flowers short-stalked, in a distinctly branched cyme, peduncle 1–1.8 cm long, distinct.....1. **C. borneensis**
5. Leaf lateral veins forming 2–several series of angular loops between midrib and margin; intercostal veins typically net-like; margin typically with distinct fine teeth (rarely shortly toothed to subentire).....4. **Carallia sp. 1**
Leaf lateral veins typically looping to form only one distinct submarginal vein; intercostal veins more or less parallel to the lateral veins; margin either shortly toothed or entire.....6
6. Leaf-margin shortly toothed to subentire. Inflorescence peduncle 1–2.5 cm long. Flowers at least shortly stalked.....2. **C. brachiata**
Leaf-margin entire. Inflorescence peduncle to only 1 cm long at most. Flowers sessile.....7
7. Leaves elliptic to slightly obovate, to 7–8 cm long at most, chartaceous to thinly leathery, veins inconspicuous to slightly prominent on upper side.....5. **Carallia sp. 2**
Leaves broad-obovate, larger, stiffly leathery, veins prominent on upper side.....7. **Carallia sp. 4**

1. **Carallia borneensis** Oliver
(of Borneo)

Fig. 2.

in Hooker, *Ic. Pl.* (1896) *t.* 2459; Merrill *l.c.* (1921) 421; Masamune *l.c.* 515; Ding Hou *l.c.* 484; Burgess *l.c.* 432; Ashton *l.c.* 356; Whitmore, Tantra & Sutisna *l.c.* 296. **Type:** *Creagh, s.n.*, British North Borneo (K). **Synonyms:** *Sagittipetalum mindanaensis* Merr., Philip. J. Sc. 3 (1908) Bot. 247; *S. palawanense* Elmer, Leafl. Philip. Bot. 5 (1913) 1830; *Carallia mindanaensis* (Merr.) Merr., En. Philip. 3 (1923) 146.

Small or medium-sized tree to 25 m tall. **Bark** finely fissured, pale to brownish, inner bark yellowish brown. **Sapwood** yellowish brown. **Leaves** broadly elliptic to obovate, 5.5–10 x 2.5–7 cm, *chartaceous*, without conspicuous dark gland-dots on the blade; base cuneate, margin distinctly densely short-toothed, apex acute to acuminate to cuspidate; lateral veins 6–8 pairs, slightly raised on lower side, obscure or distinct above, forming 2–several series of angular loops between midrib and margin; intercostal veins indistinct to slightly distinct on both sides; stalk 5–8 mm long; stipules 1–1.5 cm long. **Inflorescences** to 3.5 cm long, (di-)trichotomously branched; peduncle 1–1.8 cm long. **Flowers** 4–5 mm long, shortly stalked; calyx-lobes 6, *c.* 4 mm long, shortly white-hairy on inner side; petals sagittate, to 5 mm long; filaments filiform, 3–5 mm long; disc cup-shaped, divided to halfway into deltoid lobes; ovary 1-celled with 12 ovules, style filiform, stigma capitate. **Fruits** oblong-ellipsoid, 8–10 x 4–6 mm, 1-seeded. **Seeds** oblong-ellipsoid, 2–3 mm long.

Vernacular name. Sabah—*kemuning hutan* (Dusun).

Distribution. Borneo, Philippines, New Guinea. In Sabah and Sarawak, common throughout. Also in Brunei and Kalimantan.

Ecology. Primary mixed dipterocarp forest, lowlands to about 1000 m, and secondary forest on sandy soils.

2. *Carallia brachiata* (Lour.) Merr.

(Latin, *brachiatus* = having decussate branches; the inflorescence)

Philip. J. Sc. 15 (1919) 249; Masamune *l.c.* 515; Burgess *l.c.* 432; Ashton *l.c.* 356; Kochummen *l.c.* 313; Whitmore, Tantra & Sutisna *l.c.* 296. **Basionym:** *Diatoma brachiata* Lour., Fl. Coch. (1790) 296. **Type:** Loureiro, *s.n.*, "Habitat in sylvis Cochinchinae" (Merrill, Comm. Lour., 1935, 281, states that this specimen cannot be found in the BM). **Synonyms:** *Symmetria obovata* Blume *l.c.* (1826–27) 1131; *C. celebica* Blume *l.c.* (1849) 131, Merrill *l.c.* (1921) 421; *C. confinis* Blume *l.c.* (1849) 129, Merrill *l.c.* (1921) 421; *C. cuspidata* Blume *l.c.* (1849) 129, Merrill *l.c.* (1921) 421; *C. lucida* Roxb., Corom. Pl. 3 (1811) 8, Merrill *l.c.* (1921) 421; *C. multiflora* Blume *l.c.* (1849) 131; *C. timorensis* Blume *l.c.* (1849) 128; *C. cerisopsifolia* Miq., Analecta Pt. 3 (1852) 8; *C. floribunda* Miq., Fl. Ind. Bat. 1, 1 (1858) 1088; *C. calycina* Benth., J. Linn. Soc. 3 (1859) 75; *Stalagmites lamponga* Miq., Sumatra (1861) 496; *Garcinia cymulosa* Miq., Ann. Mus. Bot. Lugd. Bat. 1 (1864) 208; *C. arguta* Koord. & Valetton, Bijdr. Booms. Java 4 (1896) 301; *C. scortechinii* King, J. As. Soc. Beng. 66, 2 (1897) 319; *C. spinulosa* Ridl., J. Str. Br. R. As. Soc. 82 (1920) 184; *C. cuprea* Ridl., Kew Bull. (1938) 282; *C. viridifolia* Ridl. *l.c.* (1938) 282.

Medium-sized to large tree to 35 m tall, 70 cm diameter, sometimes buttressed and sometimes with stilt-roots. **Bark** smooth or scaly-lenticellate, brownish; inner bark yellowish brown. **Sapwood** pale yellowish to brownish. **Leaves** elliptic to obovate, 5–12.5 x 2–7.5 cm, chartaceous, with conspicuous dark gland-dots on the lower side when dry; base cuneate to obtuse, margin shortly toothed to subentire, apex acuminate to cuspidate; lateral veins 8–12 pairs, faint to slightly raised on both sides; intercostal veins more or less parallel to lateral veins, indistinct on both sides; stalk 1.5–2.5 cm long; stipules 0.8–1.2 cm long. **Inflorescence** a cyme to 2.5–4 cm long, (di-)trichotomously branched, peduncle 1–2.5 cm long. **Flowers** 2.5–3 mm long, shortly stalked; calyx-lobes (4–)6–8, 1–1.5 mm long, glabrous on inner side; petals suborbicular, to 1.5–2 mm long; filaments filiform, 2–3 mm long; disc cup-shaped, divided to halfway into deltoid lobes; ovary 5–8-celled with 2 ovules per cell, style filiform, stigma lobed. **Fruits** globose, to 7 mm across, 1-seeded. **Seeds** globose, c. 2 mm across.

Vernacular names. Sarawak—*rabong*, *radipah* (Melanau Matu and Oya).

Distribution. Widely distributed from Madagascar, Sri Lanka, India, SE Asia and Malesia to N Australia. In Sabah and Sarawak common throughout. Also in Brunei and Kalimantan.

Ecology. Primary and secondary forests, lowlands to 1800 m; on infertile organic soils in mixed dipterocarp forest, heath forest, and on the margins of freshwater swamp forests.

Uses. The wood is good for furniture and other interior finishings such as parquet flooring and panelling, as it is hard and has an attractive oak-like figure; it is, however, difficult to season.

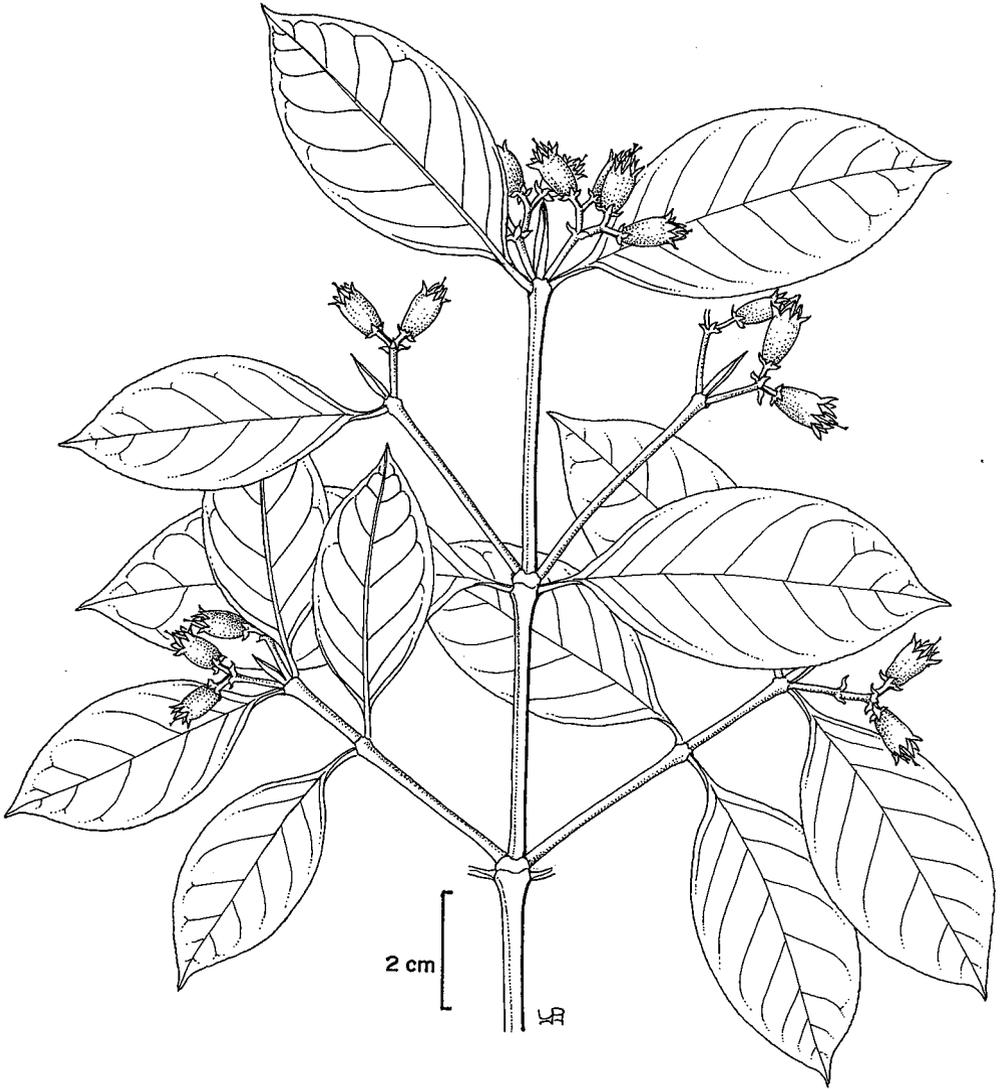


Fig. 2. *Carallia borneensis*. Flowering leafy twig. (From SAN 103017.)

3. *Carallia coriifolia* Ridl.

(Latin, *coriaceus* = leathery, *-folius* = -leaved)

l.c. (1938) 283; Ding Hou *l.c.* 483; Ashton *l.c.* 357; Whitmore, Tantra & Sutisna *l.c.* 296. **Type:** *Haviland 1797*, Sarawak, Kuching (holotype K; isotypes L, SAR).

Small tree to 10 m tall. **Bark** flaky, dark grey; inner bark yellowish. **Sapwood** yellowish. **Leaves** ovate to oblong or elliptic, 7–17 x 3–6 cm, *chartaceous*, without conspicuous dark gland-dots on the lower side when dry; base cuneate or rarely rounded, margin faintly toothed to entire, apex acuminate; lateral veins 8–12 pairs, slightly raised on both sides; intercostal veins slightly prominent on upper side, visible on lower side; stalk 0.5–1 cm long; stipules 1.5–2.5 cm long. **Inflorescence** a cyme to 1.5 cm long with alternate branches reduced, *peduncle nil or inconspicuous*. **Flowers** 4–5 mm long, *sessile*; calyx-lobes 5–6, 1–1.5 mm long, glabrous on inner side; petals sagittate, 2.5–3 mm long; filaments filiform, 2–2.5 mm long; disc cup-shaped, divided to halfway into deltoid lobes; ovary 1-celled with 10–12 ovules, style filiform, stigma capitate. **Fruits** ellipsoid, *c.* 12 mm long, 7 mm wide, 1-seeded. **Seeds** oblong-ellipsoid, 2–2.5 mm long.

Distribution. Endemic to Borneo. In Sabah recorded from the Penampang and Beaufort districts, in Sarawak in Kuching and Serian districts. Also in Kalimantan.

Ecology. Mixed dipterocarp forest to 1000 m.

4. *Carallia* sp. 1

Small tree to 15 m tall, 30 cm diameter. **Bark** smooth, dark grey-brown; inner bark brown. **Sapwood** pale yellowish. **Leaves** broadly elliptic to obovate, 6–7 x 4–8 cm, *chartaceous* to thinly *coriaceous*, with conspicuous dark gland-dots on the lower side when dry; base cuneate, margin finely toothed, apex acuminate to cuspidate; lateral veins 6–12 pairs, raised on both sides, forming 2–several series of angular loops between midrib and margin; intercostal veins net-like, indistinct on upper side, slightly distinct on lower side; stalk 0.5–1 cm long; stipules 1–2 cm long. **Inflorescence** a dense cyme to 2.5 cm long. **Flowers** 2–2.5 mm long; calyx-lobes 5–6, *c.* 1.5 mm long, glabrous on inner side; petals sagittate, to 2 mm long; filaments filiform, 2–2.5 mm long; disc cup-shaped, divided to halfway into rounded lobes; ovary 5-celled with 2 ovules per cell, style filiform, stigma capitate. **Fruits** globose, to 6 mm across, 1-seeded. **Seeds** oblong-ellipsoid, 2–2.5 mm long.

Vernacular names. Sabah—*meransi* (Brunei Malay), *merawai*, *tikolod*, *yulu tambang* (Dusun).

Distribution. Known so far from Sabah, where it is apparently common (all districts) and often confused with *C. borneensis*, and apparently also present in Sarawak (4th Division at Niah National Park, and 7th Division at Ulu Belaga). Also in Brunei (*Niga NN 47*, Belait). Sabah collections include *SAN 124068*, *SAN 85908*, *Nooteboom 1306* (from Tambunan), *SAN 63504* (Sandakan), and *SAN 89461* (Ranau). The Sarawak collections, which have entire leaf margins, are *S. 43802* (Ulu Belaga) and *S. 40118* (Niah).

Ecology. Lowland secondary forest and along rivers, and mixed dipterocarp forest to c. 600 m.

5. *Carallia* sp. 2

Small tree to 25 m tall, 30 cm diameter. **Bark** slightly fissured, brown; inner bark brown. **Sapwood** pale pinkish brown. **Leaves** *oblong-elliptic to slightly obovate*, 2–7 x 2–4 cm, *chartaceous to thinly coriaceous*, with *conspicuous dark gland-dots on the lower side* when dry; base cuneate to obtuse, *margin entire*, apex obtuse, slightly cuspidate; lateral veins 6–10 pairs, raised on both sides; *intercostal veins more or less parallel to lateral veins*, *obscure above*, slightly raised below; stalk 0.5–1 cm long; stipules 0.5–0.7 cm long. **Inflorescence** a cyme to 1.4 cm long, *peduncle to 1 cm* long. **Flowers** known only as young buds, *sessile*. Fruits not known.

Vernacular name. Sarawak—*rabong* (Iban).

Distribution. Recorded only from Sarawak: *S. 39097* (Niah, Ulu Sungai Sah) and *S. 43023* (Limbang, Ulu Medamit).

Ecology. Lowland mixed dipterocarp forest on sandy clay.

6. *Carallia* sp. 3

Small tree to 10 m tall, 15 cm diameter. **Leaves** broadly elliptic to obovate, 5–9 x 4–5 cm, *stiffly coriaceous*, *without conspicuous dark gland-dots on the lower side* when dry; base cuneate, margin coarsely saw-toothed, apex acute; *lateral veins 8–10 pairs*, raised on both sides, forming 2–several series of angular loops between midrib and margin; *intercostal veins prominent* on both sides; stalk 0.5–0.8 cm long; stipules 0.5–1 cm long. **Inflorescence** a cyme, to 2 cm long. Flowers not known. Fruits not known.

Distribution. Recorded only from Sarawak at the Nyabau Catchment area, Bintulu, Miri (*S. 24594*).

Ecology. Lowland mixed dipterocarp forest on yellow red sandy humult ultisols, at about 150 m.

7. *Carallia* sp. 4

Shrub or small tree to 6 m tall, 5 cm diameter. **Leaves** *broadly obovate*, 8–11 x 4–7 cm, *stiffly coriaceous*, with *conspicuous dark gland-dots on the lower side* when dry; base cuneate, *margin entire*, apex obtuse and very slightly cuspidate to rounded; lateral veins 8–10 pairs, raised on both sides; *intercostal veins prominent on both sides*; stalk 0.7–1 cm long; stipules c. 1 cm long. **Inflorescence** a cyme to 1.8 cm long, *peduncle to 1 cm* long. **Flowers** 3–4 mm long, *sessile*; calyx-lobes 5, c. 2 mm long, glabrous on inner side; petals sagittate, to 2.5 mm long; filaments filiform, to 2 mm long; disc cup-shaped, divided to

halfway into deltoid lobes; ovary 5-celled with 2 ovules per cell, style filiform, stigma capitate. Fruits not known.

Distribution. Known only from Bukit Tawai, Telupid in Sabah (*SAN 39321*), on ultramafic soil.

Ecology. Secondary forest.

8. *Carallia* sp. 5

Shrub or small tree 1–2 m tall. **Leaves** oblong-elliptic to obovate, to 2.7 x 2.4 cm, thinly coriaceous, without conspicuous dark gland-dots on the lower side when dry; base cuneate, margin faintly toothed, apex acute; lateral veins 4–6 pairs, slightly raised on both sides; intercostal veins inconspicuous on upper side, slightly prominent on lower side; stalk c. 0.5 cm long; stipules 0.5–1 cm long. **Inflorescences** to 1.2 cm long, with a solitary flower. **Flowers** (buds) with 4 calyx-lobes. **Fruits** (young) ellipsoid, c. 4 mm long.

Distribution. Recorded only from Sarawak at the summit of Batu Lawi in the Kelabit Highlands area (*Nooteboom & Chai 2259*).

Ecology. Forest on sandstone at about 2000 m.

3. *CERIOPS* Arn.

(Greek, *ceras* = horn, *ops* = obscure; alluding to the fruit from which the hypocotyl has yet to elongate)

Ann. Mag. Nat. Hist. 1 (1838) 363; Merrill *l.c.* (1921) 420; Masamune *l.c.* 516; Browne *l.c.* 302; Ding Hou *l.c.* 468; Burgess *l.c.* 432; Ashton *l.c.* 357; Kochummen *l.c.* 315; Whitmore, Tantra & Sutisna *l.c.* 296.

Small or medium-sized trees with stilt-roots to 1 m high; *pneumatophores* prominent. **Leaves** broadly elliptic to obovate, coriaceous, sometimes black-dotted on lower side; margin entire; stipules lanceolate. **Inflorescence** a condensed cyme, shortly stalked or sessile, (2–)4–many-flowered. **Flowers** with calyx deeply 5–6-lobed; petals 5–6, each embracing 2 stamens; ovary semi-inferior, 3-celled, ovules 2 per cell, style simple, stigma simple or obscurely 2–3-lobed. **Fruits** ovoid, almost entirely superior. **Seed germination** viviparous; hypocotyl prominently ridged or grooved.

Distribution. 2 species, tropical east Africa to Malesia, N Australia and the Pacific. Both species in Sabah and Sarawak.

Ecology. At the mouths of estuaries and bays, and behind the sea beach.

Uses. The bark is a source of tannin and a dye for the batik industry, and is used in the manufacture of an alcoholic drink. The wood is used for firewood and charcoal.

Key to *Ceriops* species

Petals fringed with many long narrow processes at the apex; anthers as long as or longer than the filament. Fruit with erect to ascending calyx-lobes; hypocotyl 9–15 cm long when fully extended at fruit-fall.....1. **C. decandra**

Petals with 3 short appendages at the apex; anthers less than half the length of the filament. Fruit with reflexed calyx-lobes; hypocotyl 15–35 cm long when fully extended at fruit-fall.....2. **C. tagal**

1. **Ceriops decandra** (Griff.) Ding Hou

(Greek, *deca* = ten, *-andrus* = male; with ten stamens in the flower)

l.c. 471; Burgess *l.c.* 432; Ashton *l.c.* 357; Kochummen *l.c.* 315; Whitmore, Tantra & Sutisna *l.c.* 296. **Basionym:** *Bruguiera decandra* Griff. *l.c.* (1836) 10. **Type:** Griffith, *s.n.*, Burma (K). **Synonyms:** *C. roxburghiana* Arn. *l.c.* 364, Merrill *l.c.* (1921) 420, Masamune *l.c.* 516, Browne *l.c.* 303; *C. zippeliana* Blume *l.c.* (1849) 143; *Rhizophora glomerulata* Zipp. ex Blume *l.c. pro syn. R. decandra* Roxb. ex Griff. *l.c.* (1854) 663.

Shrub to small tree to 15 m tall, 30 cm diameter. **Bark** smooth to papery-flaky to lenticellate, pale brown; inner bark red. **Sapwood** pale yellowish brown. **Leaves** obovate to elliptic-oblong, 4.5–10 x 2.5–6 cm; base cuneate, margin slightly recurved when dry, apex obtuse, rounded or notched; lateral veins 9–10 pairs, obscure, joining near margin to form a submarginal vein; stalk 1–2.5 cm long; stipules 1.5–2.5 cm long. **Flower petals** white, fringed with many long narrow processes at apex; stamens 1 mm long, anthers ovoid, more than half the length of the filaments; style *c.* 1 mm long, stigma capitate. **Fruits** ovoid-conical, *c.* 1.8 cm long, calyx-lobes erect to ascending; hypocotyl club-shaped, 9–15 cm long, sharply ridged.

Vernacular names. Sabah—*tengar* (Brunei Malay). Sarawak—*bakau lali*, *tengar tikus* (Malay).

Distribution. India, Indo-China, Peninsular Malaysia, Banka, Java, Borneo, Philippines, Celebes, Moluccas and New Guinea. In Sabah recorded from Kudat (Balambangan Island also), Sandakan and Lahad Datu; in Sarawak from Selabat to the Rejang delta. Also in Kalimantan

Ecology. Edges of mangrove swamps and along tidal creeks.

2. **Ceriops tagal** (Pers.) C.B. Rob.

Fig. 3.

(a Philippine plant name)

Philip. J. Sc. 3 (1908) 306; Merrill *l.c.* (1921) 420; Masamune *l.c.* 516; Browne *l.c.* 302; Ding Hou *l.c.* 469; Burgess *l.c.* 432; Ashton *l.c.* 360; Kochummen *l.c.* 316; Whitmore, Tantra & Sutisna *l.c.* 297. **Basionym:** *Rhizophora tagal* Pers., Mem. Soc. Linn. Paris 3 (1824) 138. **Type:** Perrottet, Philippines, Zamboanga (No specimen seen by Merrill, see En. Philip. Fl. Pl. 3, 1923, 144). **Synonyms:** *Rhizophora timorensis* DC., Prod. 3 (1828) 32; *C. candolleana* Arn. *l.c.* 364; *C. pauciflora* Benth. in Hooker *f.*, Lond. J. Bot. 2 (1843) 218; *C. fosteniana* Blume *l.c.* (1849) 143; *C.*

boviniana Tul., Ann. Sc. Nat. 4, 6 (1856) 112; *C. lucida* Miq., Sumatra (1861) 325; *C. timoriensis* Domin, Bibl. Bot. 8 (1928) 444.

Small to medium-sized tree, to 25 m, 45 cm diameter, with small stilt-roots. **Bark** smooth to flaky or dippled, grey-brown; inner bark pale yellowish white to pinkish. **Sapwood** yellowish white to pale brown. **Leaves** obovate to obovate-oblong or elliptic-oblong, 5–12 x 2–7 cm; base cuneate, margin slightly recurved when dry, apex obtuse to slightly notched; lateral veins 9–12 pairs, faint, joining at margin to form a submarginal vein. **Flower petals** white, with 3 club-shaped appendages at the apex; stamens 3–5 mm long, anthers sagittate, less than half the length of the filaments; style c. 2 mm long, simple. **Fruits** ovoid, 1.5–2.5 cm long, calyx-lobes recurved; hypocotyl club-shaped, 15–35 cm long, sharply ridged.

Vernacular names. Sabah—*tagal* (Suluk), *tangal* (Suluk), *tanug* (Bajau) *tengar* (Brunei Malay), *tenug* (Ilanun). Sarawak—*tengar samak* (Malay).

Distribution. East Africa, Madagascar, Seychelles, Sri Lanka, India, Indo-China, Taiwan, throughout Malesia to Micronesia and Australia. In Sabah, recorded from the southwest part around Sipitang to Kota Kinabalu, and the Sandakan and Lahad Datu mangroves. In Sarawak, recorded from the Sarawak and Rejang deltas. Also in Brunei and Kalimantan.

Ecology. In brackish water environments, on relatively well-drained sites within the reach of tides in the inner fringes of mangroves. It is much more common than the preceding species.

Uses. A most durable mangrove wood. The bark is used for tanning fishing lines, nets and sails. The trunk is used in house-building. It is also used for charcoal and known as an excellent firewood.

4. GYNOTROCHES Blume

(Greek, *gune* = woman, *trochos* = wheel; alluding to the shape of the stigma)

Bijdr. (1825) 218; Merrill *l.c.* (1921) 420; Masamune *l.c.* 516; Ding Hou *l.c.* 488; Ashton *l.c.* 362; Kochummen *l.c.* 317; Whitmore, Tantra & Sutisna *l.c.* 297.

Small trees; *young branches hollow*. **Leaves** with entire to faintly toothed margin; stipules lanceolate, margins overlapping. **Flowers** very small, solitary on short stalks or fascicled in dense axillary clusters, stalks jointed; calyx deeply 4–5-lobed; petals 4–5, obovate to elliptic; stamens 8–10, free; ovary superior, slightly ridged, 4–6-celled, ovules 3–8 per cell, style simple, stigma a 4–8-lobed discoid structure or slender with spreading lobes. **Fruit** a berry, globose to oblong, few- to many-seeded.

Distribution. One species, from Upper Tenasserim, throughout Malesia, to the Western Pacific.

Taxonomy. Although the wider concept of Ding Hou *l.c.* is followed here, there is some suggestion (Juncosa & Tobe, Ann. Missouri Bot. Gard. 75 (1988) 1410) that the material

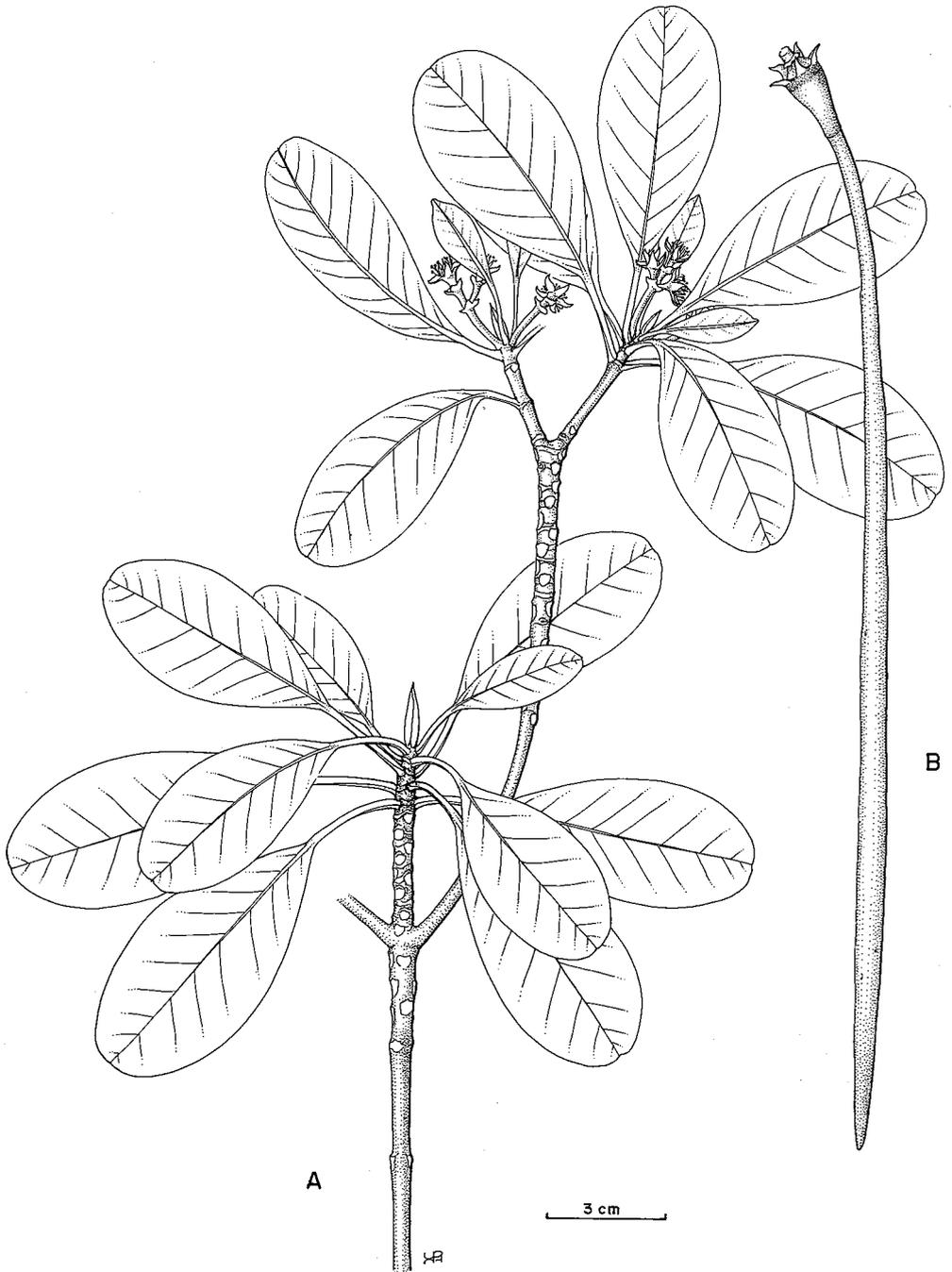


Fig. 3. *Ceriops tagal*. A, flowering leafy twig; B, germinating fruit. (From SAN 84104.)

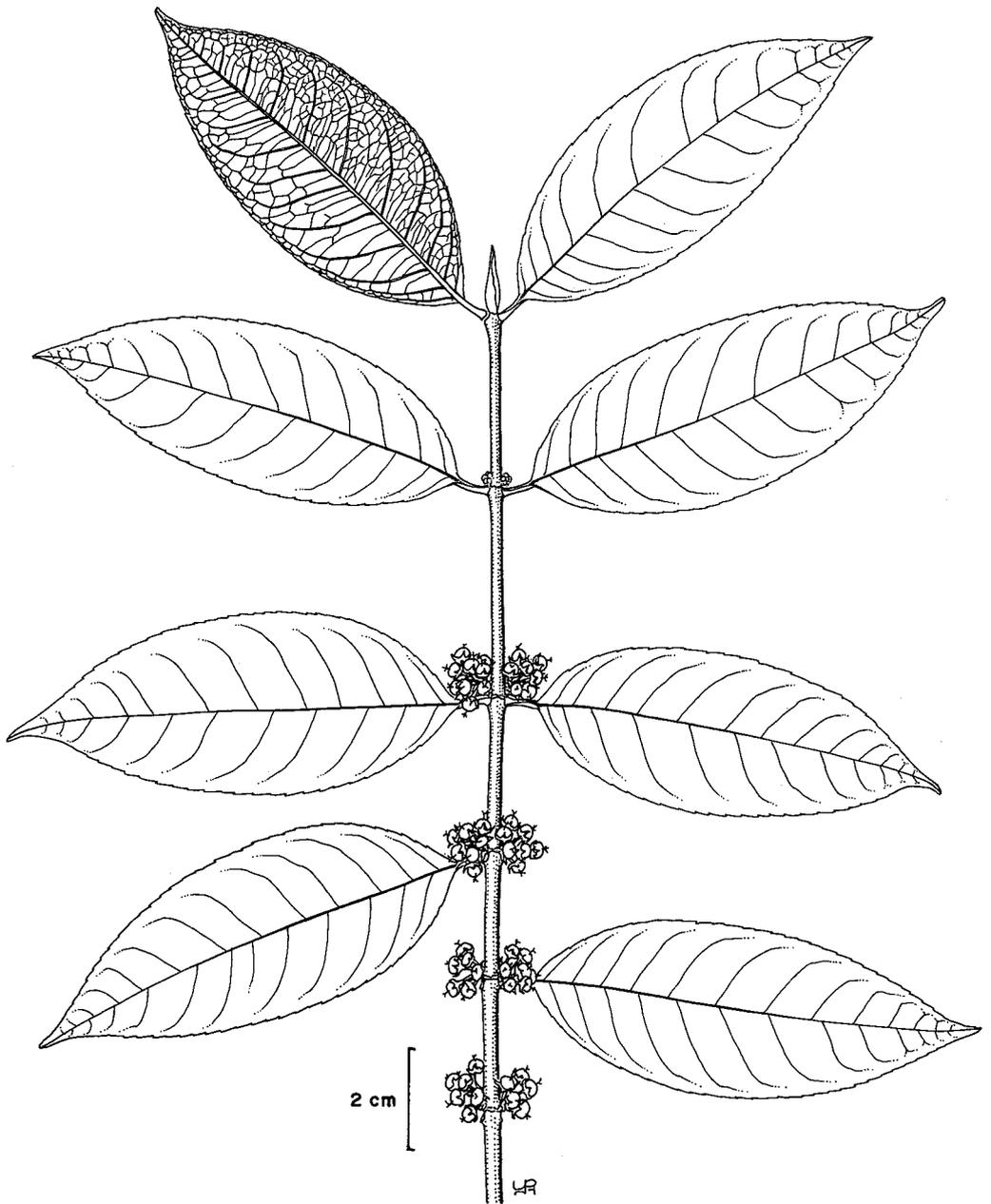


Fig. 4. *Gynotroches axillaris*. Fruiting leafy twig. (From SAN 55769.)

from Sarawak may represent at least two ecotypes which probably constitute distinct species.

Gynotroches axillaris Blume

Fig. 4.

(Latin, *axillaris* = axillary; the flowers)

l.c. (1825) 219; Merrill *l.c.* (1921) 420; Masamune *l.c.* 516; Ding Hou *l.c.* 488; Ashton *l.c.* 362; Kochummen *l.c.* 317; Whitmore, Tantra & Sutisna *l.c.* 297. **Type:** *Blume, s.n.*, Java (L). **Synonyms:** *Dryptopetalum coriaceum* Arn. *l.c.* 373; *G. dryptopetalum* Blume *l.c.* (1849) 127; *G. micrantha* Blume *l.c.* (1849) 127, Masamune *l.c.* 517; *G. reticulata* A. Gray in Wilkes, Bot. U.S. Expl. Exped. 1 (1854) 607; *G. parvifolia* Merr., Publ. Gov. Lab. Philip. 35 (1905) 46; *G. puberula* Merr., Philip. J. Sc., Bot. 10 (1915) 333; *G. lanceolata* Merr., Philip. J. Sc., Bot. 11 (1916) 21.

Small or medium-sized tree, to 35 m tall, 70 cm diameter. **Bark** smooth, often hoop-marked, grey to blackish; *inner bark* yellowish to reddish brown, fibrous, *finely and regularly invaginating into the wood*. **Sapwood** yellowish brown to pale reddish brown. **Leaves** ovate to elliptic-oblong or lanceolate, 5–15 x 3–7.5 cm, usually coriaceous, glabrous or (rarely) pubescent on the midrib and lateral veins below; base cuneate, apex acute to acuminate; midrib flat on upper side, raised on lower side; lateral veins 8–12 pairs, flat on upper side, raised on lower side, forming distinct loops just behind the margin; intercostal veins net-like, flat on upper side, distinctly prominent on lower side; stalks 0.5–1.5 cm long; stipules to 1.5 cm long. **Flowers** greenish white, 1–16 in each leaf axil, bisexual but sometimes male by abortion; calyx-lobes with tufts of hairs at apex; petals clawed, divided into appendages towards the apex; stamens 1–2 mm long; disc cup-shaped or nearly flat, 8–10-lobed; ovary ovoid; style to 2 mm long. **Fruits** usually globose, *c.* 3 mm across, green ripening red to shiny black, persistent calyx-lobes erect or reflexed.

Vernacular names. Sabah—*bulu bulu* (Malay), *kandis batu* (Malay), *kupi kupi* (Brunei Malay), *pahau pahau* (Murut). Sarawak—*kelalud* (Melanau), *sawar bubu* (Iban). Brunei—*kerakas payau* (Kedayan), *kerakas payoh* (Dusun), *sawar bubu* (Iban).

Distribution. Burma, Thailand, Malesia except the Lesser Sunda Islands, to Melanesia and Micronesia. In Sabah and Sarawak, in all districts. Also recorded for Brunei and Kalimantan.

Ecology. Lowlands to about 2200 m, in marshy places especially along rivers, and also well-drained sandy sites. Occasionally also in secondary forests.

5. KANDELIA Wight & Arn.

(from a Malabar (Indian) plant name)

Prod. (1834) 310; Merrill *l.c.* (1921) 421; Masamune *l.c.* 517; Ding Hou *l.c.* 473; Ashton *l.c.* 363; Kochummen *l.c.* 319.

Small trees. **Leaves** with linear stipules. **Inflorescence** a peduncled cyme bearing 4–9 flowers. **Flowers** with *calyx deeply 5(–6)-lobed; petals 5(–6), bilobed, with a long bristle*

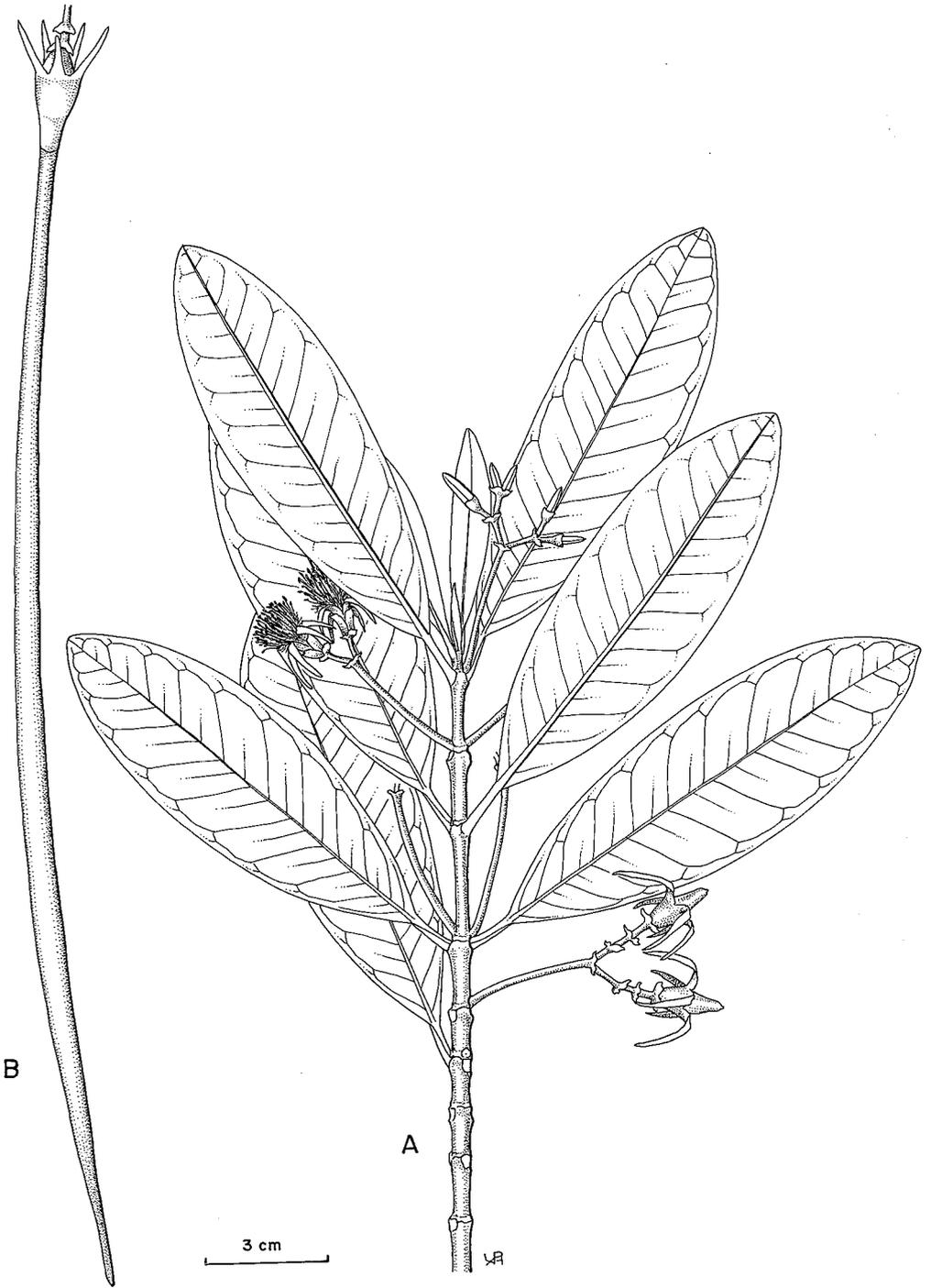


Fig. 5. *Kandelia candel*. A, flowering leafy twig; B, germinating fruit. (A from S. 30640, B from SAN 102906.)

between lobes, each lobe *lacinate to fimbriate*; *stamens many*, free, of unequal length, exserted, anthers many-celled; *ovary 1-celled*, *ovules 6*, apically attached, style simple. **Fruit** ovoid. **Seed** solitary; *germination viviparous*; hypocotyl cylindrical to spindle-shaped.

Distribution. One species; India, Indo-China to S China and western Malesia (NE Sumatra, Peninsular Malaysia, N and W Borneo).

Kandelia candel (L.) Druce
(a Malabar plant name)

Fig. 5.

Rep. Bot. Exch. Club. Br. Isl. 3 (1914) 420; Merrill *l.c.* (1921) 421; Masamune *l.c.* 517; Ding Hou *l.c.* 473; Ashton *l.c.* 363; Kochummen *l.c.* 319. **Basionym:** *Rhizophora candel* L., Sp. Pl. (1753) 443.

Shrub or small tree, to 10 m tall; *trunk with swollen conical base* but no buttresses. **Bark** flaky, lenticellate, greyish to reddish brown; inner bark thin, pink. **Sapwood** pale yellowish brown. **Leaves** *narrowly oblong-elliptic* to obovate-oblong, 6–13 x 2–6 cm, coriaceous; base cuneate, margin frequently recurved, *apex acute-blunt to rounded*; lateral veins 6–7 pairs, inconspicuous on both sides; stalks 1–1.5 cm long; stipules 0.5–1.5 cm long. **Flowers** *c.* 2 cm long, white; calyx 5–6-lobed, reflexed after anthesis; petals *c.* 14 mm long; stamens with small narrow anthers on slender filaments; style filiform, stigmas 3. **Fruits** ovoid, 1–2.5 cm long, 1-seeded; *hypocotyl* to 40 cm long, terete, smooth.

Vernacular names. Sabah—*berus berus* (Malay), *beus* (Bajau, Malay), *linggayong*, *linggayong laut* (Brunei Malay). Sarawak—*bakau aleh aleh* (Malay).

Distribution. India, Burma, Thailand, Indo-China, China, Ryukyus, S Japan, NE Sumatra, Peninsular Malaysia, W and N Borneo. In Sabah, recorded so far from the Papar and Sandakan areas; in Sarawak from the Kuching, Sajingkat and Kelepu mangroves. Also in Brunei and W Kalimantan

Ecology. Scattered along the banks of brackish water (tidal) rivers and channels in mangrove areas.

6. PELLACALYX Korth.

(Greek, *PELLA* = hide, *KALUX* = calyx; the hair-covered calyx)

merbuloh (Iban, Malay; Sarawak), *sawar (sambar) bubu* (Iban, Sarawak)

Tijd. Nat. Gesh. Phys. 3 (1836) 20; Merrill *l.c.* (1921) 422; Masamune *l.c.* 517; Ding Hou *l.c.* 490; Ashton *l.c.* 363; Kochummen *l.c.* 320; Whitmore, Tantra & Sutisna *l.c.* 297. **Synonyms:** *Plaesiantha* Hook. *f.* in Benth. & Hooker *f.*, Gen. Pl. 1 (1865) 861; *Craterianthus* Valetton *ex* Heyne, Nutt. Pl. Indon. 4 (1917) 196.

Small to medium-sized trees; *young branches hollow*. **Bark** *invaginating finely and regularly into the wood*. **Leaves** oblong to ovate; sparsely to densely pubescent with stellate

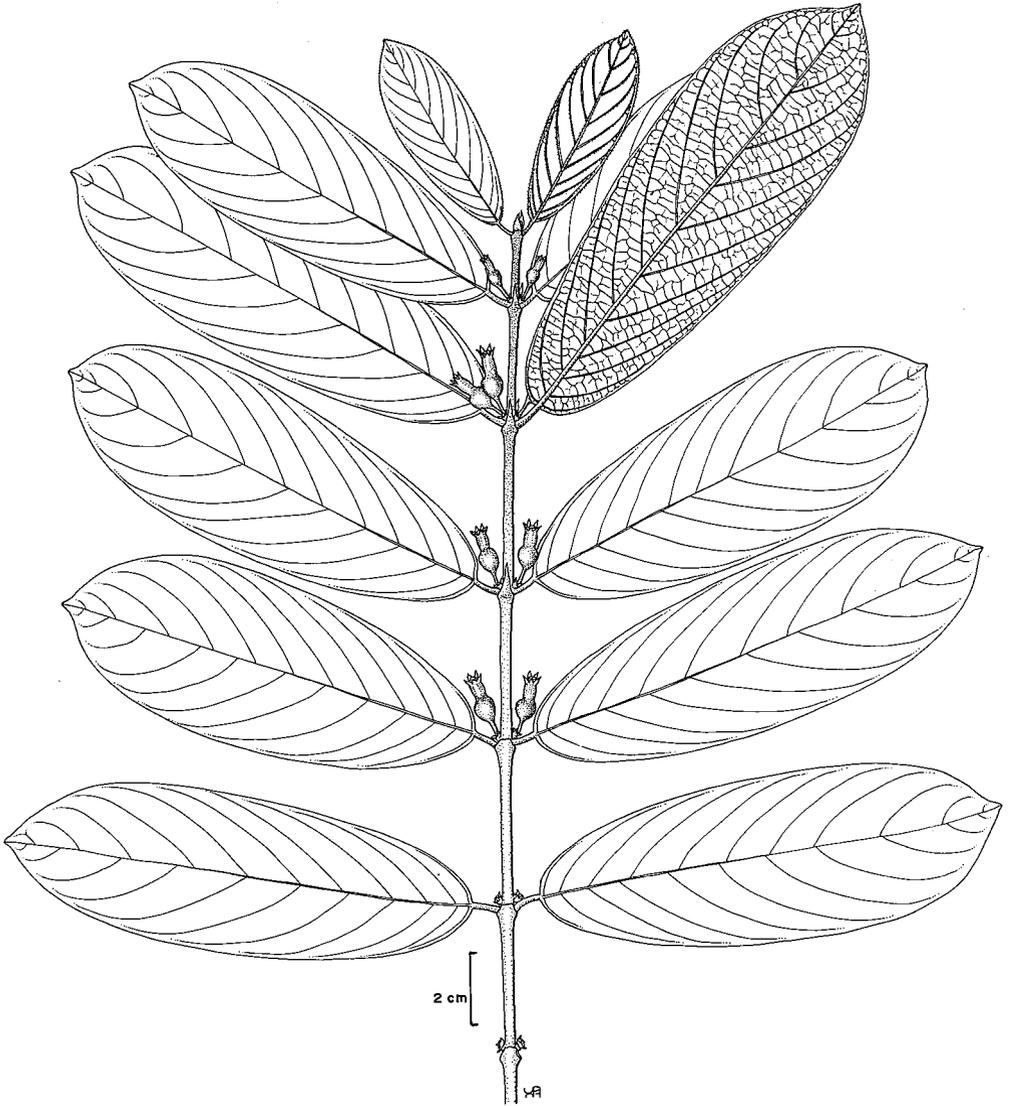


Fig. 6. *Pellacalyx axillaris*. Fruiting leafy twig. (From SAN 75981.)

or simple hairs (rarely a mixture of the two), sometimes glabrescent to glabrous; *margin entire or obscurely to distinctly serrulate; stipules with margins not overlapping. Flowers fasciated, 2–8 in a leaf axil, or on short dense inflorescences; calyx tubular, lobes (3–)4–5(–6), tube hairy inside at the lower part; petals 4–5, inserted on the margin of the calyx-tube, densely short-hairy outside; stamens twice as many as petals, inserted on the margin of the calyx-tube, filaments connate at the base or free, in 1 or (rarely) 2 series, unequal, anthers suborbicular; ovary inferior, 9–10(–12)-celled, ovules 8–25 per cell, style columnar and usually hairy, stigma discoid or capitate, obscurely 8–10-lobed. Fruit a berry, subglobose. Seeds few to many.*

Distribution. 7 or 8 species; Burma and S China to Sumatra, Borneo, Philippines, and Celebes. In Sabah and Sarawak, 4 species.

Ecology. In Sabah and Sarawak in mixed dipterocarp forest to 1300 m.

Key to *Pellacalyx* species

1. Leaf lateral veins 5–7 pairs. Calyx 4-merous, the outside covered in very minute hairs not easily visible to the unaided eye (appearing glabrous).....**3. P. lobbii**
 Leaf lateral veins 9–12 pairs. Calyx 5-merous, the outside conspicuously hairy.....2
2. Lower leaf surface with a mixture of simple hairs and stellate hairs, both types similarly abundant. Inside of calyx-tube with scanty short straight hairs at the base. Stamens in two series.....**4. P. symphiodiscus**
 Lower leaf surface with predominantly stellate scales (mixed with a few simple hairs) or predominantly simple hairs (mixed with a few stellate scales). Inside of calyx-tube with either a band of woolly hairs and scanty short straight hairs below the band, or a zone of villous hairs at the base. Stamens in one series.....3
3. Lower leaf surface with predominantly stellate scales mixed with a few simple hairs. Calyx-lobes reflexed at floral maturity; inside of calyx-tube with a band of woolly hairs and scanty short straight hairs below the band. Petal tips fringed with linear segments attenuating into fine processes.....**1. P. axillaris**
 Lower leaf surface with predominantly simple hairs mixed with a few stellate scales. Calyx-lobes ascending at floral maturity; inside of calyx-tube with a zone of villous hairs near the base. Petal tips with very fine hair-like processes.....**2. P. cristatus**

1. *Pellacalyx axillaris* Korth.

Fig. 6.

(Latin, *axillaris* = axillary; the inflorescences)

l.c. 20, *t.* 2; Ding Hou *l.c.* 493; Ashton *l.c.* 364; Kochummen *l.c.* 320; Whitmore, Tantra & Sutisna *l.c.* 297. **Type:** *Korthals, s.n.*, Sumatra (L).

Small to medium-sized tree, to 25 m tall, 60 cm diameter; buttresses if present to 60 cm high. **Bark** pale reddish brown, finely cracked to rough-fissured; inner bark pinkish yellow. **Sapwood** yellow. **Leaves** oblong to obovate-oblong, 8–17 x 3.5–7 cm, *lower side* densely or sparsely covered with *stellate scales mixed with a few simple hairs*; base broadly cuneate to rounded, margin entire or toothed (with a tuft of short hairs on each tooth), apex acute to

acuminate; *lateral veins* 9–12 pairs, flat on upper side, raised on lower side; stalk 5–8 mm long; stipule 1–1.5 cm long. **Flower** calyx conspicuously hairy outside, the tube 5–6 mm long, inside with a few short hairs at the base and a band of woolly hairs above these, lobes 5, 2–2.5 mm long, reflexed at anthesis; petals 1.5–2.5 mm long, the apices fringed with linear segments attenuating into fine processes; stamens in one series; style 1.5–2 mm long. **Fruits** ovoid or subglobose, c. 10 mm across.

Vernacular name. Sarawak—*danguh* (Bidayuh).

Distribution. Sumatra, Peninsular Malaysia, Borneo and Mindanao (Philippines). In Sabah recorded from Kudat, Beaufort and Telupid. In Sarawak recorded from the Padawan area (1st Div.) and Sg. Beria in the Kapit District (7th Div.). Also in Brunei and Kalimantan.

Ecology. Common where it occurs in lowland primary mixed dipterocarp forest and secondary forest, usually in valleys and moist sites.

2. *Pellacalyx cristatus* Hemsl.

(Latin, *cristatus* = crested; the persistent calyx crowning the fruit)

in Hooker *f.*, Ic. Pl. 16 (1886) *sub t.* 1546; Masamune *l.c.* 517; Ding Hou *l.c.* 493; Ashton *l.c.* 364; Whitmore, Tantra & Sutisna *l.c.* 297. **Type:** *Beccari PB 1258*, Sarawak (G, K).

Small tree to 10 m tall, 10 cm diameter. **Bark** yellowish brown, smooth; inner bark pale brown. **Sapwood** pale yellow. **Leaves** narrowly oblong to ovate-oblong, 10–17 x 3–5 cm, lower side densely or sparsely covered with simple hairs mixed with a few stellate scales, or glabrescent; base obtuse to rounded, margin toothed (with a tuft of short hairs on each tooth), apex acuminate; *lateral veins* 9–12 pairs, flat on upper side, raised on lower side; stalk 7–10 mm long; stipule 1–1.5 cm long. **Flower** calyx conspicuously hairy outside, the tube 9–10 mm long, inside with a few short hairs at the base and a zone of villous hairs above these, lobes 5, 1.5–2 mm long, ascending at anthesis; petals 2.5–3.5 mm long, the apices fringed with fine hair-like processes; stamens in one series; style 2.5–3 mm long. **Fruits** subglobose, to 10 mm across.

Distribution. Endemic to Borneo. In Sabah, recorded from Nabawan northwards to Mt. Kinabalu; in Sarawak from the Kuching area, Belaga and Mt. Api, Mulu National Park. Also in Kalimantan.

Ecology. Hills and mountain ridges to c. 900 m.

3. *Pellacalyx lobbii* (Hook. *f.*) Schimp.

(Thomas Lobb, 1820–1894, plant collector)

in Engl. & Prantl, Pfl. Fam. 3, 7 (1893) 54; Masamune *l.c.* 517; Ding Hou *l.c.* 491; Ashton *l.c.* 365; Whitmore, Tantra & Sutisna *l.c.* 297. **Basionym:** *Plaesiantha lobbii* Hook. *f.* in Benth. & Hooker *f.*, Gen. Pl. 1 (1865) 145. **Type:** *Lobb, s.n.*, Brunei (K).

Medium-sized tree, to 45 m tall, 65 cm diameter; stilt-roots at times present. **Bark** medium brown, cracking-fissured; inner bark pale brown. **Sapwood** yellow. **Leaves** obovate to obovate-oblong, 7–17 x 2–6 cm, lower side sparsely covered with stellate hairs; base

cuneate, margin entire or faintly toothed (glabrous on each tooth), apex acute to abruptly acuminate; *lateral veins* 5–7 pairs, flat on upper side, raised on lower side; stalk 5–8 mm long; stipule 0.5–1 cm long. **Flower** *calyx* very minutely hairy outside (appearing glabrous to the unaided eye), the tube 6–7 mm long, inside with a few short hairs at the base, *lobes* 4, 2.5–3 mm long, ascending at anthesis; petals 1.5–2 mm long, the apices finely serrulate; stamens in one series; style 1–1.5 mm long. **Fruits** subglobose, to 8 mm across.

Vernacular names. Sarawak—*paserujan gunugo, rasu* (Iban).

Distribution. Sumatra and Borneo. In Sabah and Sarawak, in most districts. Also in Brunei and Kalimantan.

Ecology. Primary and secondary forests.

4. *Pellacalyx symphiodiscus* Stapf

(Greek, *sumphuein* = fused, *discus* = disc; of fused parts forming the floral disc)

Kew Bull. (1898) 224; Merrill *l.c.* (1921) 422; Masamune *l.c.* 517; Ding Hou *l.c.* 492; Ashton *l.c.* 365; Whitmore, Tantra & Sutisna *l.c.* 297. **Type:** *Haviland 2206*, Sarawak (K).

Small to medium-sized tree, to 25 m tall, 40 cm diameter. **Bark** pale brown, smooth; inner bark pale brown. **Sapwood** yellow. **Leaves** ovate-oblong to obovate-oblong, 9–19 x 3.5–7 cm, *lower side* densely or sparsely covered with a mixture of stellate hairs and simple hairs (both types similarly abundant); base acute or rounded, margin toothed (with a tuft of short hairs on each tooth), apex acute to shortly acuminate; *lateral veins* 9–12 pairs, flat on upper side, raised on lower side; stalk 6–10 mm long; stipule 0.8–1.2 cm long. **Flower** *calyx* conspicuously hairy outside, the tube 4–5 mm long, inside with a few short hairs at the base, *lobes* 5, 1.5–2 mm long, reflexed at anthesis; petals 1.5–2.5 mm long, the apices fringed with fine hair-like processes; *stamens* in two series; style 1.5–2 mm long. **Fruits** subglobose, to 9 mm across.

Distribution. Endemic to Borneo. In Sabah, known only from the Penampang and Lamag districts; in Sarawak from the Kuching, Selang and Pengkalan Ampat areas. Also in Brunei and Kalimantan.

Ecology. Mixed dipterocarp forest to c. 650 m.

7. RHIZOPHORA L.

(Greek, *rhiza* = root, *pherein* = bearing; the stilt-roots)

bakau (Malay)

Gen. Pl. ed. 5 (1754) 202; Merrill *l.c.* (1921) 420; Masamune *l.c.* 517; Browne *l.c.* 296; Ding Hou *l.c.* 448; Burgess *l.c.* 433; Tomlinson & Womersley, *Contrib. Herb. Austr.* 19 (1976) 1; Ashton *l.c.* 366; Kochummen *l.c.* 321; Whitmore, Tantra & Sutisna *l.c.* 298. **Synonyms:** *Mangium* Rumph. *ex Scop.*, *Introd. Hist. Nat.* (1777) 218.

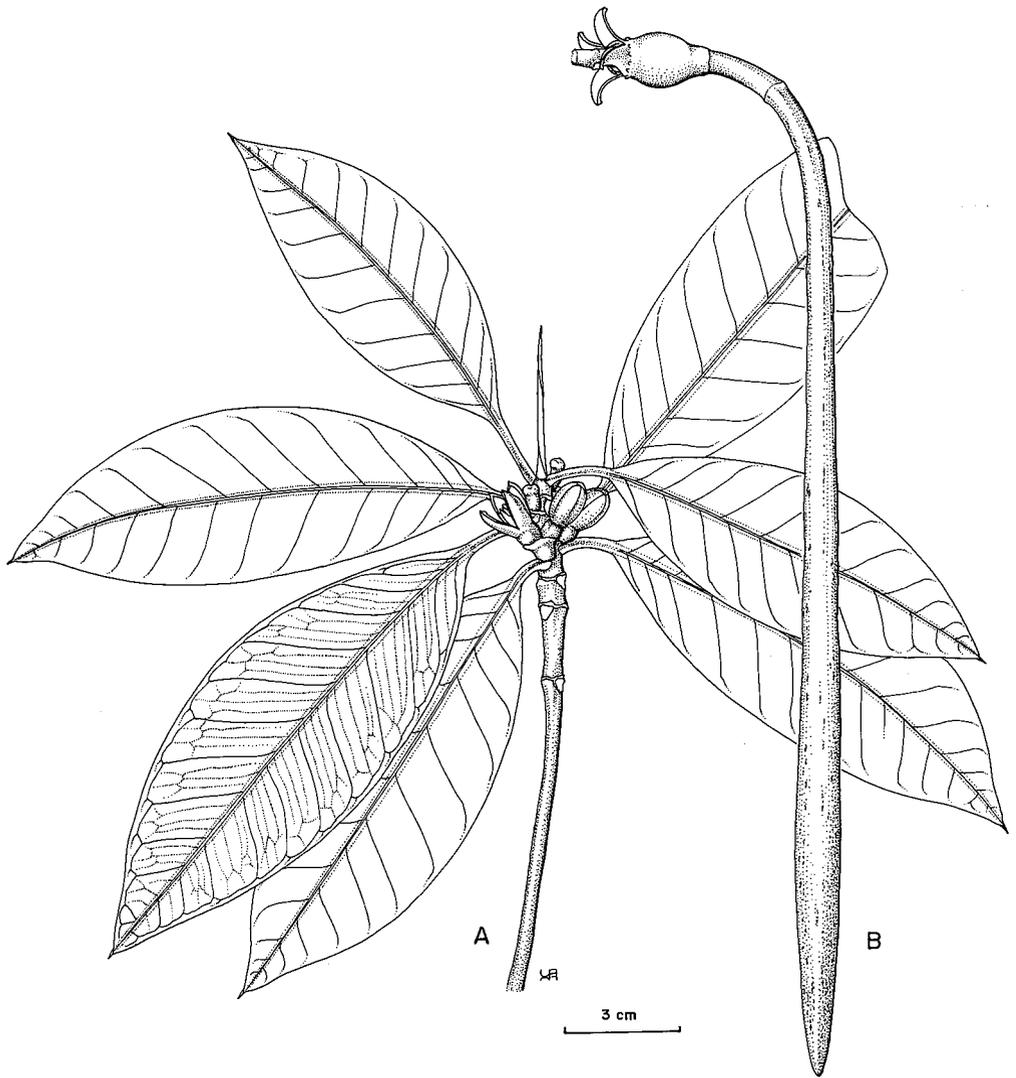


Fig. 7. *Rhizophora apiculata*. A, flowering leafy twig; B, germinating fruit with long hypocotyl. (A from SAN 75507, B from SAN 81950.)

Small to medium-sized trees with *conspicuous branching stilt-roots* but no pneumatophores. **Leaves** succulent, entire, *apex acute*, lower side usually black-dotted; stipules lanceolate, conspicuous. **Inflorescence** a cyme, 2–3-branched. **Flowers** bisexual; *calyx* leathery, *deeply 4-lobed*, *lobes broadly ovate*, ascending but reflexed in the fruit; petals 4, falling off early; stamens 8–12, filaments very short or hardly distinct; ovary semi-inferior, 2-celled, ovules 2 per cell, style obscure or to 6 cm long, stigma simple or somewhat 2-lobed. **Fruits** ovoid, usually 1-seeded; *germination viviparous*.

Distribution. 7 species, mainly along tropical coasts and throughout Malesia. In Sabah, 3 species and in Sarawak, 2.

Ecology. Mangrove swamps and tidal parts of rivers; the most widespread mangrove genus.

Uses. The poles are used in fishing platforms, traps and house frames. The wood is durable as piling timber and is also used in concrete foundations for buildings. Excellent as firewood and for making charcoal. The bark is also used for tanning.

Key to *Rhizophora* species

1. Inflorescences 2-flowered, shorter than the leaf-stalks, mostly in the axils of leaf-scars on the branches just below the current cluster of leaves. Petals glabrous save for the occasional presence of a few scattered short-hairs.....1. **R. apiculata**
 Inflorescences 2–16-flowered, longer than the leaf-stalks, in leaf axils within the current cluster of leaves. Petals long-hairy on the margins and inner side.....2
2. Leaves typically 11–18 x 5–10.5 cm. Style obscure or very short, not exceeding 1.5 mm.....2. **R. mucronata**
 Leaves typically 6–12 x 3–6 cm. Style filiform, 4–6 mm long.....3. **R. stylosa**

1. *Rhizophora apiculata* Blume

Fig. 7.

(Latin, *apiculatus* = with a short abrupt point; the leaf apex)

l.c. (1827) 91; Ding Hou *l.c.* 452; Burgess *l.c.* 433; Ashton *l.c.* 366; Kochummen *l.c.* 322; Whitmore, Tantra & Sutisna *l.c.* 298. **Type:** *Pee-Kandel* Rheede, Hort. Mal. 6 (1686) 61, t. 34. **Synonyms:** *R. candelaria* DC., Prod. 3 (1828) 32, Merrill *l.c.* (1921) 420, Masamune *l.c.* 517; *R. conjugata* Arn. (*non L.*) *l.c.* 363, Browne *l.c.* 298.

Medium-sized tree to 30 m tall, 75 cm diameter. **Bark** pinkish grey to grey, smooth to shallowly fissured. **Sapwood** pale brown. **Leaves** narrowly elliptic to sublanceolate, 7–16 x 3–7 cm, coriaceous; base cuneate, apex acute to pointed, with a short mucro; stalk 1.5–3 cm long; stipules 4–8 cm long. **Inflorescences** 2-flowered, shorter than the petioles, peduncle 0.5–1.5 cm long, mostly in the axils of leaf-scars on the branches just behind the current cluster of leaves. **Flowers** sessile, calyx-lobes 10–14 x 6–8 mm; petals 8–11 x 1.5–2 mm, glabrous except for the occasional presence of a few scattered short-hairs; stamens

10–12, sessile; style 0.5–1 mm long. **Fruits** obpyriform (inverted pear-shaped), 2–2.5 cm long, hypocotyl to 33 cm long.

Vernacular names. Sabah—*bangkita* (Malay). Sarawak—*bakau minyak* (Malay).

Distribution. Tropical SE Asia, Sri Lanka, throughout Malesia to Micronesia and New Britain, the Solomons and New Hebrides. In Sabah, the largest stands occur between the Bay of Brunei and Klias in the SW, but generally common in mangroves. In Sarawak, with good stands at the Sarawak River Delta, the Lower Rejang and generally elsewhere. Also in Brunei and Kalimantan.

Ecology. Dominant species of the mangroves, forming pure stands on soft recent muddy substrates, immediately behind the river banks or up to them, in the lower parts of major river deltas.

2. *Rhizophora mucronata* Lam.

(Latin, *mucronatus* = with an abrupt short point; the leaf apex)

Encycl. 6 (1804) 189; Merrill *l.c.* (1921) 421; Masamune *l.c.* 517; Browne *l.c.* 298; Ding Hou *l.c.* 453; Burgess *l.c.* 433; Ashton *l.c.* 367; Kochummen *l.c.* 322; Whitmore, Tantra & Sutisna *l.c.* 298. **Type:** *Commerson, s.n.*, isle de France (Mauritius) (P). **Synonyms:** *R. mangle* Roxb. (*non* L.), Hort. Beng. (1814) 36; *R. macrorrhiza* Griff. *l.c.* (1836) 8; *R. lingissima* Blanco, Fl. Filip. (1837) 398.

Medium-sized tree to 30 m tall, 210 cm diameter. **Bark** grey to black, roughly grid-cracked. **Sapwood** pale brown. **Leaves** broadly elliptic to oblong, 11–18 x 5–10.5 cm, coriaceous; base cuneate, apex acute to slightly obtuse, with a short mucro; stalk 2.5–5.5 cm long; stipules 5.5–8.5 cm long. **Inflorescences** 2–5(–12)-flowered, longer than the petioles, peduncle 2.5–5.5 cm long, in leaf axils within the current cluster of leaves. **Flowers** with stalks 4–8 mm long, calyx-lobes 13–15 x 5–7 mm; petals 8–10 x 2–3 mm, long-hairy on the margins and inner side; stamens 8, subsessile; style 0.5–1.5 mm long. **Fruits** narrowly ovoid, 5–7 cm long, hypocotyl to 62 cm long.

Vernacular name. Sabah and Sarawak—*bakau kurap* (Malay).

Distribution. E Africa through S and SE Asia to Queensland, Melanesia and Micronesia, also in Tonga. In Sabah and Sarawak, common in mangrove areas. Also in Brunei and Kalimantan.

Ecology. Usually in small stands or scattered groups along the lower parts of tidal rivers, both on clay-rich and sandy deposits.

3. *Rhizophora stylosa* Griff.

(Latin, *stylosus* = with a conspicuous style; the flower)

l.c. (1854) 665; Ding Hou *l.c.* 456; Kochummen *l.c.* 323. **Type:** *Griffith, s.n.*, Malacca, Pulo Bissar (K). **Synonym:** *R. mucronata* var. *stylosa* Schimp., Bot. Mitt. Trop. 3 (1891) 92.

Small tree to 15 m tall, 25 cm diameter. **Bark** dark brown to black, fissured. **Sapwood** pale yellowish brown. **Leaves** elliptic to sub lanceolate, 6.5–12 x 3–6 cm, coriaceous; base cuneate, apex acute to pointed, with a short mucro; stalk 1.5–2.5 cm long; stipules 4–6 cm long. **Inflorescences** 4–8(–16)-flowered, longer than the petioles, peduncle 2.5–5 cm long, in leaf-axils within the current cluster of leaves. **Flowers** with stalks 0.5–1 mm long, calyx-lobes 9–12 x 3–5 mm; petals 7–8 x 2.5–3.5 mm, long-hairy on the margins and inner side; stamens 8, filaments short but distinct; style 4–6 mm long. **Fruits** ovoid to obpyriform, 2.5–4 cm long, hypocotyl to 54 cm long.

Distribution. Taiwan, Peninsular Malaysia, Java, Borneo, Philippines, Celebes, Moluccas, New Guinea to Melanesia, New Britain and Queensland. In Sabah, recorded only from the Lahad Datu area (SAN 26145) and Pulau Balambangan in the north (SAN 85589). Not recorded for Sarawak, Brunei and Kalimantan.

Ecology. Exclusively along sandy shores and coral terraces facing open sea.

RUTACEAE

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Hooker *f.*, Fl. Brit. Ind. 1 (1875) 484; Kurz, For. Fl. Brit. Burma 1 (1877) 178; Merrill, EB (1921) 313, PEB (1929) 113; Ridley, FMP 1 (1922) 340; Craib, Fl. Siam Enum. 1 (1931) 215; Masamune, EPB (1942) 357; Browne, FTSB (1955) 315; Backer & Bakhuizen *f.*, FJ 2 (1965) 94; Swingle, Citrus Industry 1 (1967) 190; Stone, TFM 1 (1972) 367; Anderson, CLTS (1980) 307; Perry, MPESA (1980) 361; Corner, WSTM 2 (1988) 656; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 304; Ng, MFFSS 2 (1992) 493.

Aromatic trees, shrubs, or woody climbers, or seldom herbs; *twigs and branches sometimes armed with spines or thorns; tissues usually dotted with lysigenous oil-glands containing volatile essential oils.* **Leaves** pinnate or trifoliolate or unifoliolate, less commonly simple; opposite, alternate or spirally arranged, rarely whorled, *often conspicuously pellucid-dotted; petioles sometimes winged*, usually articulated with the blade, without stipules. **Inflorescences** terminal or axillary panicles, cymes or racemes, or flowers seldom solitary, rarely epiphyllous. **Flowers** *bisexual or (in dioecious plants) unisexual, regular or rarely somewhat irregular*; sepals 4–5, rarely 2–3, usually imbricate, free or fused basally to form a cup-like calyx; petals 4–5, rarely 2–3 or 6, alternate with the sepals, imbricate or valvate, free or fused basally, rarely united to form a tube; stamens 4–5 or 8–10 or more (to 60), equal or unequal, sometimes intermixed with staminodes, filaments free or fused basally, rarely united to form a tube; anthers 2-celled, often gland-tipped; *disc surrounding base of ovary, intrastaminal, usually annular, nectariferous, sometimes modified into a gynophore*, rarely lacking; ovary superior, carpels 4–5, rarely 1–3 or 6 or more, completely to partially fused or free except for the united styles, ovules 1–2 per locule, rarely more, placentation axile, stigma small or broad, sometimes lobed. **Fruit** *a capsule, follicle, samara, drupe, berry or hesperidium (Citrus), dry or fleshy; hesperidia composed of juice-filled pulp-vesicles*, with or without oil-droplets; pericarp leathery to woody or fleshy, usually glandular. **Seeds** usually 1 per carpel, ovoid to ellipsoid or oblong, with or without endosperm, sometimes winged, sometimes hairy; testa firm or membranous; monoembryonic or polyembryonic; embryo straight or curved; cotyledons white or green, flat or folded.

Distribution. A cosmopolitan family comprising approximately 160 genera and 1650 species, distributed largely in tropical and subtropical parts of the world, with good representation in arid areas of the warm temperate zone (Australia and S Africa). In Sabah and Sarawak, 23 genera with about 75 species, of which 17 genera and 43 species are native trees and shrubs. The remaining taxa are scandent shrubs (15 species), or are cultivated (*c.* 17 species). The genera *Fortunella* (2–3 species), *Limonia* (1 species), and *Triphasia* (1 species) are represented only by introduced species found under cultivation and are excluded from this treatment.

Ecology. Native species are found in a wide range of natural habitats occurring in the lowlands, hills, and mountains, along coastal areas, and on offshore islands. These habitats include primary and secondary forests (flat or undulating lands, ridges, hillsides), forest margins, open places and disturbed sites, mangrove forest (*Merope*), heath forest, swamp (freshwater, peat) forest, streamsides and riverbanks, and beach forest (*Severinia*). Some species show affinities for specific soil types such as ultramafic (*Lunasia*) and limestone (some *Clausena*, *Glycosmis*, *Murraya* and *Micromelum*). The majority of species are found below 1300 m elevation, and a few ascend to higher altitudes (*Citrus* and *Tetractomia* to 1800 m, and *Melicope* to 2400 m). Thirteen tree and shrub taxa are endemic to Sabah and/or Sarawak, four of which are found in each of the genera *Glycosmis* and *Melicope*, followed by *Maclurodendron* (2 species), *Clausena*, *Monanthocitrus*, and *Pleiospermium*. Abundance varies among species, ranging from widespread and common to infrequent and rare. *Merrillia* is very rare in Sabah, and *Burkillanthus* is endangered, if not already extinct, in Sarawak.

The typically small size and drab colour (white or cream to greenish or yellowish) of the flowers of the Rutoideae (*Melicope*, *Tetractomia*, *Zanthoxylum*) and Toddalioidae (*Acronychia*, *Maclurodendron*), and the larger, often fragrant flowers of the Aurantioideae (*Citrus*, *Murraya*, *Pleiospermium*, etc.), suggests insect pollination. The watery nectar secreted through stomata in the outer portions of the floral disc serves as both an attractant and food source. Fruit and seed dispersal is by birds (*Melicope*, *Zanthoxylum*), wind (*Tetractomia*), water (*Merope*), and fruit- and seed-eating animals (*Citrus*, *Clausena*, *Glycosmis*, *Micromelum*, *Severinia*, and most other Aurantioideae).

Uses. The family includes the wild and cultivated citrus fruits of the subfamily Aurantioideae (chiefly from *Citrus* and *Fortunella*) which serve as a source of food and flavourings, essential oils, and medicines. A number of other genera provide lesser known edible fruits (*Clausena*, *Limonia*, and *Triphasia*), flavours (*Murraya*), and traditional medicines and poisons (*Glycosmis*, *Merope*, *Micromelum*, *Murraya*, *Paramignya*, *Severinia*). Although few of the species reach timber size, the wood of some is valued for its special qualities such as grain, colour, or hardness (*Citrus*, *Merrillia*, *Micromelum*, and *Murraya*). A number of species are prized as ornamentals or hedge-plants due to their attractive foliage and fragrant flowers (*Citrus*, *Fortunella*, *Glycosmis*, *Luvunga*, *Murraya*, and *Triphasia*). Certain species of *Pleiospermium* and *Severinia* have been suggested as a source of rootstock material for *Citrus* breeding and improvement programmes.

More than half the species of the non-aurantioid genera (subfamilies Rutoideae and Toddalioidae) attain timber size, yet only *Acronychia* (1 species), *Maclurodendron* (1 species) and *Melicope* (1 species) have reportedly been used for construction purposes. All of the genera (except *Maclurodendron*), including *Toddalia*, are said to have minor medicinal importance. Lesser-known uses are as a source of resin (*Melicope*), food and flavouring (*Acronychia* and *Melicope*), and fish poison (*Acronychia*).

Taxonomy. The Rutaceae is generally accepted as closely allied to the Meliaceae, Simaroubaceae, and in some characters to other families included in the order Sapindales, e.g., the Anacardiaceae, Burseraceae, and Sapindaceae. From the Meliaceae and Simaroubaceae (its closest allies), the family differs by its glandular-punctate leaves and the presence of secretory cavities containing aromatic esthereal oils in the parenchymatous and pericarp

tissues. In the most detailed treatment of the family, Engler (in Engler & Prantl, Pfl. Fam. 19 a (1931) 187–359) recognised 7 subfamilies. Airy-Shaw (in Willis, Dict. Fl. Pl. & Ferns 8th ed. (1973) 1014), however, raised the subfamily Flindersioideae and Rhabdodendroideae to family status, thus reducing the number of subfamilies to 5. Of these 5 or 7 subfamilies, only the Aurantioideae, Rutoideae and Toddalioidae are represented by native species in Sabah and Sarawak. More recently, Da Silva *et al.* (Pl. Syst. Evol. 161 (1988) 97–134), on the basis of phytochemical, morphological and geographical evidence, proposed the inclusion of the subfamily Toddalioidae in the Rutoideae, and the reorganisation of tribes and genera in the subfamily Aurantioideae.

Key to subfamilies

1. Carpels usually 3–5, usually joined only by the styles, separated in fruit. Fruits follicular, woody, dehiscent along the upper suture.....subfam. **Rutoideae**
(Genera: *Lunasia*, *Melicope*, *Tetractomia*, *Zanthoxylum*)
Carpels 2–20, joined completely or nearly so. Fruit a drupe or berry, dry or fleshy, indehiscent.....2
2. Carpels 2–5, rarely 1, rarely completely joined. Fruit a single, several-loculed drupe, or 2–4 drupelets joined at the base. Seeds with endosperm, cotyledons obscure.....
.....subfam. **Toddalioidae**
(Genera: *Acronychia*, *Maclurodendron*, *Toddalia*)
Carpels usually 4–20, completely joined. Fruit a dry or fleshy berry or hesperidium, with or without pulp-vesicles. Seeds lacking endosperm, cotyledons well-developed
.....subfam. **Aurantioideae**
(Genera: *Burkillanthus*, *Citrus*, *Clausena*, *Fortunella*, *Glycosmis*, *Limonia*, *Luvunga*, *Merope*, *Merrillia*, *Micromelum*, *Monanthocitrus*, *Murraya*, *Paramignya*, *Pleiospermium*, *Severinia*, *Triphasia*).

Key to native tree and shrub genera

1. Twigs, branchlets, and older branches unarmed. Leaves opposite.....2
Twigs and branchlets and/or older branches armed with spines or prickles, or unarmed. Leaves alternate or spirally arranged.....5
2. Leaves trifoliolate and/or unifoliolate, rarely bifoliolate; petioles 1–30 cm long, not swollen apically.....**8. Melicope**
Leaves strictly unifoliolate; petioles not longer than 5 cm, generally swollen apically.....3
3. Leaves generally leathery. Fruit a group of 1–4 dehiscent follicles.....**16. Tetractomia**
Leaves thinly leathery. Fruit a 4-loculate, indehiscent drupe.....4
4. Younger branchlets glabrous to finely hairy. Leaflets usually elliptic; lateral veins and reticulations conspicuous below. Flowers bisexual.....**1. Acronychia**

- Younger branchlets brown- to rusty-hairy. Leaflets usually obovate to oblanceolate; lateral veins and reticulations inconspicuous below. Flowers unisexual.....
7. **Maclurodendron**
5. Twigs and branchlets unarmed (or with spine-like paraphylls in some *Severinia*).....6
 Twigs and branchlets and/or older branches armed with spines or prickles (or unarmed or nearly so in some *Pleiospermium*).....12
6. Leaves simple; blades often rigid when older, not articulated at the base.....7
 Leaves pinnate and/or unifoliolate; leaflet blades not as above, articulated at the base.....8
7. Leaf-margins sinuate or coarsely dentate. Petioles swollen apically. Fruit a group of ribbed follicles.....6. **Lunasia**
 Leaf-margins subentire to obscurely crenulate. Petioles not as above. Fruit a fleshy berry.....15. **Severinia**
8. Young branch-tips densely rusty-hairy. Leaves pinnate and/or unifoliolate, often leathery5. **Glycosmis**
 Young branch-tips glabrous or hairy (if hairy, not as above). Leaves pinnate, thinly leathery.....9
9. Leaf-rachis narrowly winged. Leaflets alternate to subopposite. Fruit a large berry, 7 cm in diameter or more; pericarp thick, leathery.....10. **Merrillia**
 Leaf-rachis wingless. Leaflets alternate. Fruit a small berry, 1–2 cm in diameter or less; pericarp thin.....10
10. Leaflets generally 3–7 (or more in some of the cultivated species); bases not obliquely asymmetric (or asymmetric in some of the cultivated species). Inflorescence an axillary panicle (or terminal and/or corymbose in some of the cultivated species)...13. **Murraya**
 Leaflets generally 5–15 (or more in some *Clausena*); base obliquely asymmetric. Inflorescence a terminal panicle or corymb.....11
11. Leaflets 9–15. Inflorescence a flat-topped corymb. Petals valvate in bud....11. **Micromelum**
 Leaflets 5–31. Inflorescence a panicle. Petals imbricate in bud.....4. **Clausena**
12. Trees or scandent to erect shrubs. Twigs and branchlets and/or older branches armed with numerous thick spines or small (sometimes hollow or recurved) prickles. Leaves pinnate. Fruit of 1–4 follicles.....17. **Zanthoxylum**
 Trees or erect shrubs. Twigs and branchlets and/or older branches armed with straight, terete, axillary spines, or unarmed or nearly so. Leaves 2–3-foliolate and/or unifoliolate, or simple. Fruit a fleshy berry or hesperidium.....13
13. Leaves 2–3-foliolate (or unifoliolate in juvenile growth), rather stiff when older2. **Burkillanthus**
 Leaves strictly unifoliolate or simple.....14
14. Shrubs or small trees. Petioles wingless. Fruits lacking pulp-vesicles.....15
 Shrubs or small to large trees. Petioles narrowly to broadly winged, or rarely wingless. Fruits containing pulp-vesicles.....16

15. Leaves oblong-ovate, thick, fleshy; lateral veins inconspicuous. Petiole articulated with the blade. Mangrove swamp plants.....**9. Merope**
 Leaves oblong-oblongate, thin, not fleshy; lateral veins conspicuous. Petiole not articulated with the blade. Inland lowland forest plants.....**12. Monanthocitrus**
16. Spines solitary or paired, generally only on older branches, or branches unarmed or nearly so. Fruits 1.5–2.5 cm in diameter.....**14. Plciospermium**
 Spines solitary, predominantly on younger branches and twigs, older branches often unarmed. Fruits mostly 4 cm in diameter or larger.....**3. Citrus**

Key to native genera

1. Carpels 3–4, seldom 2, often joined by the styles but separated in fruit. Fruits follicular, leathery or woody, dehiscent along the upper suture; endocarp sometimes detaching... 2
 Carpels 2–18, incompletely or completely united. Fruit an indehiscent, dry or fleshy drupe or berry..... 5
2. Flowers 4–5-merous, unisexual or bisexual. Branches armed with spines or prickles, or unarmed..... 3
 Flowers 3–4-merous, unisexual (or bisexual in some *Melicope*). Branches unarmed... 4
3. Ovary 4-carpellate. Follicles boat-shaped; exocarp leathery, not glandular. Seeds winged, testa parchment-like. Flowers bisexual. Branches unarmed.....**16. Tetractomia**
 Ovary 2–4-carpellate. Follicles subglobose; exocarp conspicuously glandular. Seeds un-winged, testa black, glossy. Flowers unisexual. Branches armed with spines or prickles**17. Zanthoxylum**
4. Flowers 3-merous, unisexual. Follicles flattened laterally, ribbed, with a short beak. Leaves simple, alternate.....**6. Lunasia**
 Flowers 4-merous, unisexual or bisexual. Follicles subglobose, not ribbed, without beak. Leaves trifoliolate and/or unifoliolate, opposite.....**8. Melicope**
5. Carpels rarely completely united; ovary usually shallowly lobed. Fruit a drupe..... 6
 Carpels always completely united; ovary not lobed. Fruit a berry or hesperidium..... 8
6. Scandent shrubs, armed with prickles. Leaves trifoliolate, alternate or spiral. Flowers unisexual.....

Toddalia Juss.

Gen. Pl. 3 (1789) 371; Hooker *f. l.c.* (1875) 497; Kurz *l.c.* (1877) 183; Craib *l.c.* 220; Backer & Bakhuizen *f. l.c.* 101; Perry *l.c.* 368.

1 species; Africa, Madagascar, India, Sri Lanka, S China, Indonesia, Borneo (Sabah and Sarawak), and the Philippines.

Climbers with prickly branchlets. Leaves trifoliolate; leaflets with prickly midrib and toothed margin. Inflorescence an axillary or terminal panicle. Flowers 4–5-merous, unisexual; sepals small; petals to 5 mm long, oblong; stamens 4–5, female flowers with staminodes; ovary 4–5-carpellate, on short stalk. Fruit a small, round drupe. Seeds smooth, angular; embryo curved, embedded in fleshy endosperm.

- Erect shrubs or trees, unarmed. Leaves unifoliolate, opposite. Flowers unisexual or bisexual7
7. Flowers unisexual; buds globose; petals imbricate; filaments glabrous; ovaries and fruits glabrous..... **7. Maclurodendron**
 Flowers bisexual; buds cylindrical; petals valvate; filaments ciliate at base; ovaries and fruits hairy or sparsely so..... **1. Acronychia**
8. Twigs and branchlets unarmed. Ovary 2–5-carpellate (or rarely 6-carpellate in *Merrillia*); ovules 1–2 per locule (or 8–10 in *Merrillia*). Fruits rather small (or large in *Merrillia*), without pulp-vesicles, dry or slightly juicy (or mucilaginous in *Merrillia*)9
 Twigs and branchlets (especially in young plants) and/or older branches armed (or unarmed or with spine-like paraphylls in some *Severinia*; unarmed or nearly so in some *Pleiospermium*). Ovary 2–5-carpellate (or 6–18-carpellate in *Citrus*), ovules 2 per locule or more (or rarely 1). Fruits small to large, with or without pulp-vesicles, usually juicy or mucilaginous..... 13
9. Inflorescence a terminal, flat-topped corymb. Petals valvate in bud. Cotyledons thin, folded..... **11. Micromelum**
 Inflorescence a terminal or axillary panicle, raceme or cyme, or 1–2-flowered. Petals imbricate in bud. Cotyledons thick, flat..... 10
10. Inflorescence 1–2-flowered. Petals *c.* 2.5 cm long. Ovary 5–6-carpellate. Fruits 9 cm or more in diameter; pericarp thick, leathery..... **10. Merrillia**
 Inflorescence a many-flowered panicle, raceme or cyme. Petals rarely exceeding 2 cm long. Ovary 2–5-carpellate. Fruits less than 2.5 cm in diameter; pericarp thin, glandular 11
11. Style persistent, thick, shorter than the ovary. Locules 1–2-ovulate. Young growth densely reddish hairy..... **5. Glycosmis**
 Style deciduous or persistent, shorter than the ovary or as long or longer. Locules 2-ovulate (rarely 1-ovulate). Young growth not as above..... 12
12. Petals 10–21 mm long or more. Style as long as or longer than the ovary, stigma capitate. Floral buds cylindrical or oblong..... **13. Murraya**
 Petals 3–6 mm long. Style shorter than the ovary, stigma flattened. Floral buds globose or ovoid..... **4. Clausena**
13. Stamens twice as many as the petals. Fruits 1–3 cm in diameter; locules containing mucilage or scant flesh, pulp-vesicles lacking. Erect or scandent shrubs or trees..... 14
 Stamens 2–4 times as many as the petals or more. Fruits variable in size, to 20 cm in diameter; locules containing juice-filled pulp-vesicles. Erect shrubs or trees..... 17
14. Scandent shrubs armed with solitary, recurved or straight spines. Leaves trifoliolate and/or unifoliolate..... 15
 Erect shrubs or small trees armed with solitary or paired, straight spines. Leaves unifoliolate or simple..... 16

15. Leaves trifoliolate (or unifoliolate on juvenile stems). Petioles 7–30 cm long, rarely shorter.....
- Luvunga** Buch.-Ham. in Wall. *ex* Wight & Arn.
 Prodr. 1 (1834) 90; Hooker *f. l.c.* (1875) 508; Kurz *l.c.* (1877) 193; Merrill *l.c.* (1921) 315, *l.c.* (1929) 115; Ridley *l.c.* (1922) 354; Craib *l.c.* 235; Masamune *l.c.* 360; Backer & Bakhuizen *f. l.c.* 105; Burkill, EPMP (1966) 1396; Swingle *l.c.* (1967) 265; Anderson *l.c.* 308; Perry *l.c.* 371; Stone, Proc. Ac. Nat. Sc. Phil. 137 (1985) 221.
c. 12 species; India, Sri Lanka, Burma, Indo-China, Malesia; 7–8 species in Sabah and Sarawak.
 Woody climbers with hook-like or (in juvenile plants) straight axillary spines. Leaves trifoliolate or (in juveniles) unifoliolate. Leaflets coriaceous; margin entire; petiolules pulvinate. Inflorescence an axillary panicle or raceme. Flowers 4–5-merous; calyx cup-like, slightly lobed; petals oblong-linear; stamens usually 8 or 10; ovary 2–4-carpellate, on short stalk, style thick. Fruit a glandular berry, thick-walled. Seeds 1–3 per fruit.
- Leaves unifoliolate. Petioles to 2.5 cm long, usually shorter.....
- Paramignya** Wight
 Ill. Ind. Bot. 1 (1840) 108, 110; Hooker *f. l.c.* (1875) 509; Kurz *l.c.* (1877) 193; Ridley *l.c.* (1922) 355; Burkill, Gard. Bull. S.S. 5 (1931) 213, *l.c.* (1966) 1691; Craib *l.c.* 235; Swingle *l.c.* (1967) 270; Stone *l.c.* (1972) 384; Perry *l.c.* 371; Corner *l.c.* 669.
c. 12 species; India, Sri Lanka, Burma, S China, Indo-China, Thailand, Malesia, Australia; 3–4 species in Sabah and Sarawak.
 Woody climbers or (rarely) shrubs, with hook-like or short straight axillary spines. Twigs zigzag. Leaves unifoliolate, margins entire; petioles short, pulvinate. Inflorescences axillary, often solitary. Flowers 4–5-merous, often large; calyx cup-like, lobed; petals lanceolate-oblong; stamens 8 or 10; ovary 3–5-carpellate, stalked. Fruits round or lobed, glandular, resinous. Seeds 1 to several per fruit, ovoid or flattened.
16. Ovary ovoid, glabrous. Fruits ovoid to ellipsoid, angular, green when ripe. Seeds flattened. Leaves unifoliolate..... **10. Merope**
 Ovary bottle-shaped, sparsely hairy. Fruits obovoid to pyriform, yellow-orange when ripe. Seeds thick. Leaves simple..... **12. Monanthocitrus**
17. Stamens 4–8 times as many as the petals. Pulp-vesicles tapered at both ends (fusiform), on slender stalks..... **13. Citrus**
 Stamens twice as many as the petals. Pulp-vesicles cylindrical or conical or irregular in shape, stalkless or nearly so..... 18
18. Ovary 5-carpellate, locules 22–26-ovulate. Fruits 8–11 cm in diameter, obovoid to oblong **2. Burkillanthus**
 Ovary 2- or 4–5-carpellate, locules 1–2-ovulate. Fruits to 2.5 cm in diameter, usually less, round or nearly so..... 19
19. Disc small, annular to cup-like. Fruits 15–25 mm in diameter, pericarp rough-glandular. Petioles winged or narrowly so, articulated with the leaf-blades..... **14. Pleiospermium**
 Disc cup-like, enclosing the base of the ovary. Fruits 6–15 mm in diameter, pericarp smooth. Petioles wingless, not articulated with the leaf-blades..... **15. Severinia**

1. **ACRONYCHIA** J. R. Forst. & G. Forst. (Greek, *akron* = tip, *onychos* = claw; the claw-like tip of the petals)

Char. Gen. Pl. ed. 1 (1775) 27; Hooker *f. l.c.* (1875) 498; Kurz *l.c.* (1877) 183; King, J. As. Soc. Beng. 62, 2 (1893) 214; Ridley *l.c.* (1922) 347; Merrill *l.c.* (1929) 113; Craib *l.c.* 221; Masamune *l.c.* 357; Backer & Bakhuizen *f. l.c.* 101; Burkill *l.c.* (1966) 40; Stone *l.c.* (1972) 371; Hartley, J. Arn. Arb. 55 (1974) 469; Anderson *l.c.* 307; Perry *l.c.* 361; Whitmore, Tantra & Sutisna *l.c.* 304.

Shrubs or trees or rarely climbers. Branches unarmed. **Leaves** opposite, trifoliolate or unifoliolate, petioles wingless; leaflets pinnately veined, margin entire, articulated at the base. **Inflorescences** axillary, paniculate, subcorymbose, or 1- to few-flowered. **Flowers** bisexual, 4-merous; sepals 4, free or fused at base, imbricate; petals 4, free, valvate, pellucid-dotted, white or cream to greenish or yellowish, becoming reflexed; stamens 8, unequal, alternately long and short, *filaments* flattened and tapering to a sharp apex, *usually densely ciliate at the base*, becoming reflexed, anthers ovoid to ellipsoid, basifixed; disc shallowly 8-lobed; *ovary 4-carpellate, with septicial fissures or without*, ovules 2 per locule, style twisted, stigma shallowly 4-lobed. **Fruit** a 4-loculate drupe, *with septicial fissures or without; epicarp semi-fleshy, spongy or woody when dry, with or without evident mesocarp; endocarp cartilaginous to parchment-like*. **Seeds** 1–2 per locule, narrowly ellipsoid, slightly bent; testa dull to shiny, smoothish to finely rugose; endosperm fleshy; embryo straight.

Distribution. 42 species; from India to SW China, and throughout Malesia to E Australia and New Caledonia. The greatest number are found in Australia, Irian Jaya (Indonesia) and Papua New Guinea, including several rare and endemic species. One species, *A. pedunculata*, occurs in Sabah and Sarawak.

Ecology. Found in primary and secondary rain forests, from the lowlands and hills to cloud forests and subalpine habitats above 3000 m and in coastal scrub.

Acronychia pedunculata (L.) Miq.

Fig. 1.

(Latin, *pedunculatus* = slender-stalked; the inflorescence)

Fl. Ned. Ind., Suppl. (1861) 532; Merrill *l.c.* (1929) 113; Craib *l.c.* 221; Masamune *l.c.* 357; Stone *l.c.* (1972) 371; Hartley *l.c.* 549; Perry *l.c.* 361; Whitmore, Tantra & Sutisna *l.c.* 305. **Basionym:** *Jambolifera pedunculata* L., Sp. Pl. 1 (1753) 349. **Type:** *Jambolifera* L., Fl. Zeyl. (1747) 139. **Synonyms:** *Acronychia laurifolia* Blume, Cat. (1823) 63; *A. arborea* Blume, Bijdr. (1825) 244; *Melicope conferta* Blanco, Fl. Filip. ed. 2 (1845) 205; *Acronychia apiculata* Miq. *l.c.* (1861) 532.

Shrub or small to large tree to 30 m tall and 50 cm in diameter; bole to 23 m tall. Younger branchlets glabrous to finely hairy. **Leaves** unifoliolate; *leaflet usually elliptic* or elliptic-oblong to obovate or oblanceolate, 3.5–24.5 x 2–8.5 cm, thinly leathery; base cuneate or occasionally rounded, apex acuminate or occasionally blunt or rounded; lateral veins 7–14 pairs; *reticulations conspicuous above and below*; petioles 0.5–5 cm long. **Inflorescences** few- to many-flowered, 2–25 cm long, axes glabrous or nearly so, pedicels 2–12 mm long. **Flowers** 4–12 mm long; sepals triangular or rounded, minute; petals linear or oblanceolate, glabrous to sparsely hairy; disc glabrous; ovary hairy, rarely only at apex; style hairy at base. **Fruits** to 15 mm in diameter, usually subglobose to ellipsoid or conical, *more or less*

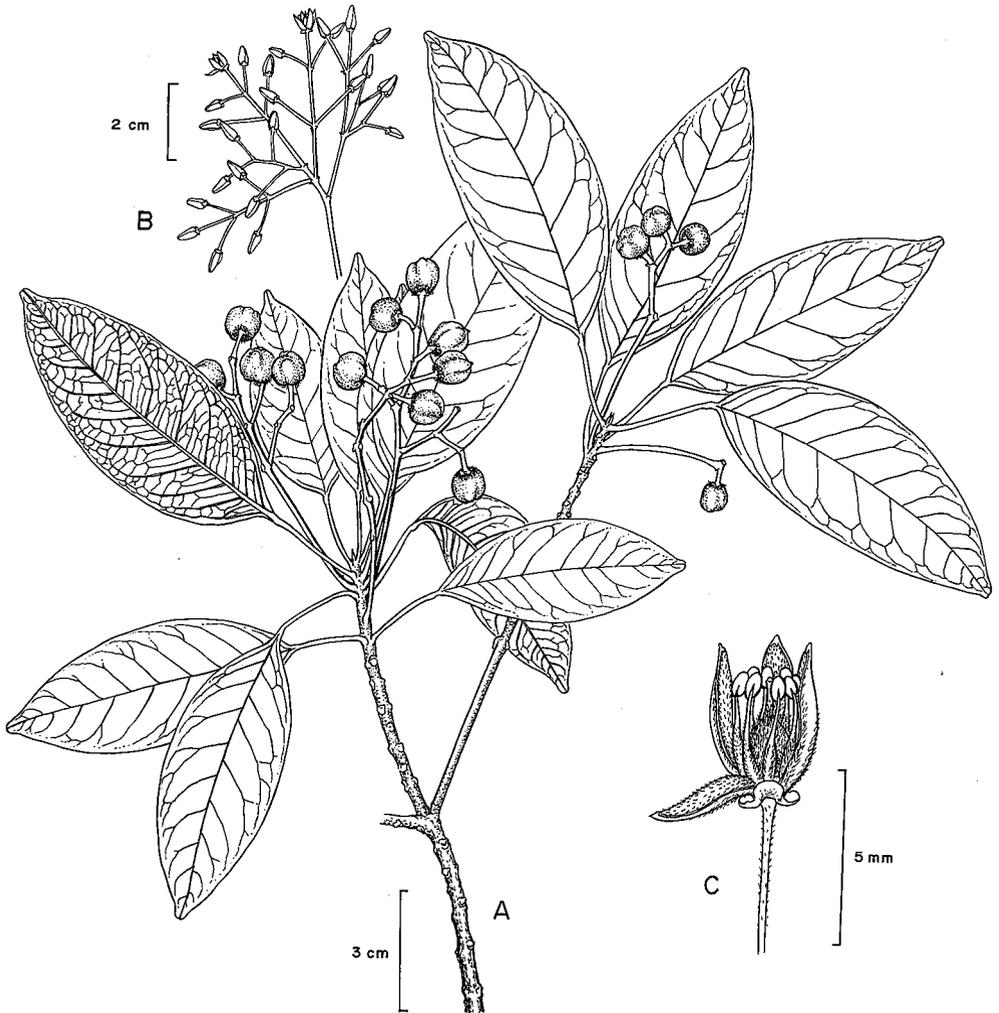


Fig. 1. *Acronychia pedunculata*. A, fructing leafy twig; B, part of inflorescence; C, flower with one petal removed. (From SAN 85676.)

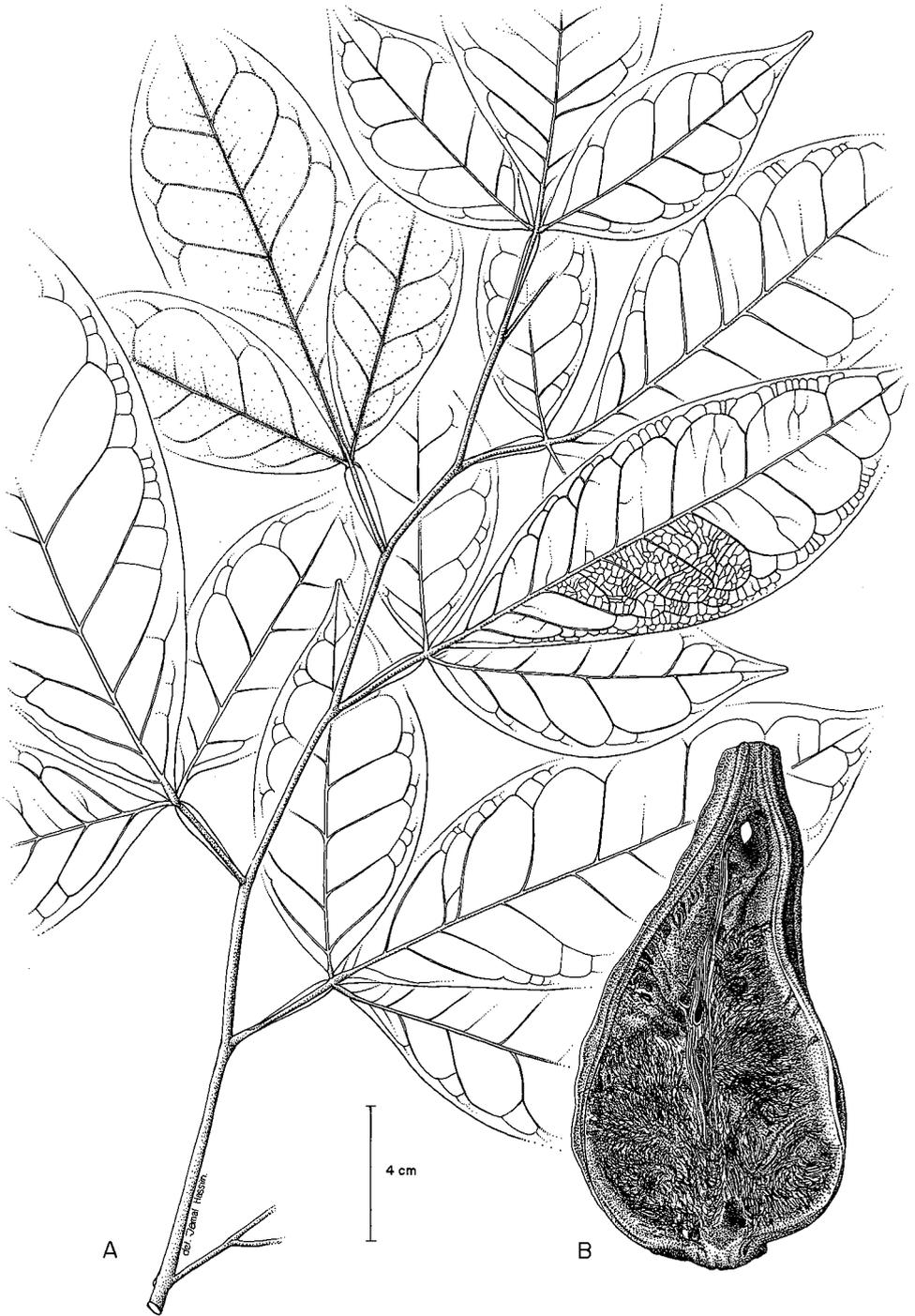


Fig. 2. *Burkillanthus malaccensis*. A, leafy twig; B, dried fruit in longitudinal section. (From S. 15848.)

4-lobed or longitudinally ribbed, usually sparsely hairy, base with a ring of dense hairs, apex rounded to shortly tipped; epicarp when dry to 3 mm thick; mesocarp woody or nearly so; endocarp cartilaginous. Seeds reddish black to black, 3–7 mm long.

Distribution. India, Sri Lanka, eastward to Taiwan and throughout Malesia to Papua New Guinea. In Sabah, frequent in primary and secondary forests, often on hill-sides, from near sea-level to 1500 m. In Sarawak, collected only twice (Baram and Lundu Districts). Also occurs in Brunei and Kalimantan.

Uses. The wood, roots, bark and leaves are used medicinally to treat rheumatism, scabies and colic, and as pain reliever (China, Indo-China, Indonesia). The roots are used as a fish poison (Indo-China). The wood is rarely used in construction and for making charcoal, and its young leaves are eaten as a condiment (Java).

2. BURKILLANTHUS Swingle

(I. H. Burkill, 1870–1965, one time director of the Singapore Botanic Gardens)

J. Arn. Arb. 20 (1939) 255, *l.c.* (1967) 294; Stone *l.c.* (1972) 373; Whitmore, Tantra & Sutisna *l.c.* 305.

Trees; crown broad, dense. Branches armed, drooping in older trees. **Leaves** alternate, 1–3-foliolate; petioles narrowly winged to nearly wingless, pulvinoid at base; leaflets thinly leathery, becoming stiff when older, glabrous, articulated at the base. **Inflorescences** axillary, few-flowered clusters, pedicels short. **Flowers** bisexual, large, 5-merous; sepals 5, nearly free to the base, with large oil-glands; petals 5, gland-dotted distally; stamens 10, free, slender, anthers small, oblong; disc cylindrical; ovary 5-carpellate, obovoid, sparsely hairy, glandular on upper half, fluted with 5 grooves; ovules 22–26 per locule in 2 rows, style slender, glabrous, stigma globose. **Fruit** a large, obovoid to oblong berry; exocarp thick, leathery, light green becoming pale yellow, roughened with numerous oil-glands; endocarp thin, woody; pulp-vesicles sessile, cylindrical, tips acute, pale yellow. **Seeds** numerous, large, cream with brown cap, embedded in mucilage; monoembryonic.

Distribution. 1 species, restricted to N Sumatra, Peninsular Malaysia and Sarawak. Uncommon, and possibly endangered.

Ecology. Found as solitary trees or small populations of several trees, on stream banks, slopes, and ridge tops in primary and secondary forest, on rocky and sandy soils, from 5 to 200 m.

Burkillanthus malaccensis (Ridl.) Swingle (of Malacca)

Fig. 2.

l.c. (1939) 257, *l.c.* (1967) 295; Whitmore *l.c.* 373; Stone *l.c.* (1972) 373, Fed. Mus. J. 23 (1978) 114; Whitmore, Tantra & Sutisna *l.c.* 305. **Basionym:** *Citrus malaccensis* Ridl. *l.c.* (1922) 359. **Type:** Goodenough 1273, Malacca, Nyalas (holotype SING; isotypes K, US).

Small tree to 15 m tall and 40 cm in diameter; *bole* to 4 m tall, *fluted*. Branches generally armed with stout, straight, usually paired spines. **Leaves** unifoliolate (on juvenile growth) or 2–3-foliolate; terminal leaflets lanceolate or elliptic-lanceolate, 12.5–27 x 4.5–11.5 cm; base broadly cuneate, margins subentire to slightly coarse-crenate, apex acute or acuminate; *lateral veins* 12–18 pairs, *deeply sunken above*; petioles 4–5 cm long; petiolules 2–2.5 mm long, *pulvinoid*; lateral leaflets to 8 x 4 cm, petioles 1–4 cm long, otherwise similar to terminal leaflet. **Inflorescences** 1–4-flowered, pedicels 5–7 mm long. **Flower** 5–6 cm across; sepals lanceolate-acuminate; petals 2–2.5 cm long, subspathulate; ovary 6.5–7 mm long. **Fruits** 10–8 x 8–11 cm; *exocarp c. 1 cm thick*; endocarp 2–3 mm thick, pulp-vesicles 1.5–3 cm long. **Seeds** broadly obovoid, tapering to an acute base, 2.2–2.7 cm long and *c. 8 mm thick*; testa thin, slightly wrinkled; cotyledons pale buff.

Vernacular name. Sarawak—*limau hantu* (Malay).

Distribution. Throughout the range of the genus. In Sarawak very uncommon, collected once in 1961 (*S. 15848*) from primary riparian forest in the Labang FR, Bintulu.

3. CITRUS L.

(Latin name for the citron tree)

Sp. Pl. 1 (1753) 401; Hooker *f. l.c.* (1875) 514; Kurz *l.c.* (1877) 195; Merrill *l.c.* (1921) 315; Ridley *l.c.* (1922) 358; Burkill *l.c.* (1931) 220, *l.c.* (1966) 568; Craib *l.c.* 236; Masamune *l.c.* 357; Santiago, Bull. Mal. Div. Agr. 111 (1962) 1; Backer & Bakhuizen *f. l.c.* 107; Swingle *l.c.* (1967) 358; Stone *l.c.* (1972) 374, *l.c.* (1985) 226; Perry *l.c.* 361; Corner *l.c.* 659; Whitmore, Tantra & Sutisna *l.c.* 305; PROSEA 2 (1991) 119, 325.

Shrubs or small to large trees. Branches generally armed with axillary, solitary spines, older branches often unarmed. *Young twigs angular, flattened, becoming terete*. **Leaves** alternate, simple or unifoliolate, blades thinly leathery to leathery, glabrous or short-hairy below; margins entire to serrate or crenulate; *petioles often winged or emarginate*, usually articulated with the blade. **Inflorescences** axillary, short corymbose racemes or cymes, or solitary. **Flowers** bisexual or male only, 4–5-merous, fragrant or not; calyx cup-like; sepals 4–5; petals 4–8, commonly 5, oblong-linear, thick; stamens about 4–8 times the number of petals, free or fused at the base and in bundles; disc annular; *ovary subglobose, (6–)8–18-carpellate*, usually glabrous, ovules (1–)4–8(–12) per locule in 2 rows, style cylindrical, stigma globose-capitate. **Fruit** a *fleshy hesperidium*; *pericarp leathery, outer layer (exocarp or flavedo) densely glandular and pigmented, middle layer (mesocarp or albedo) white, dry, inner layer (endocarp) membranous, thin, flesh of stalked fusiform, pulp-vesicles filled with watery, sweet or bitter juice*, with or without distinct oil-droplets. **Seeds** few to many, angular-obovoid, often flattened, pale; mono- or polyembryonic; embryo white or green.

Distribution. 17 species; from India, Sri Lanka and Burma to Japan, China, Taiwan and Indo-China, and throughout Malesia eastward to the Pacific Islands. Two species, *C. halimii* and *C. macroptera*, are native to Sabah, the latter species also occurs in Sarawak. In addition, a number of species have long been introduced and are cultivated in Sabah and Sarawak. Numerous hybrids and variants of these species exist, many having unknown origins which makes classification difficult.

Stone (*l.c.* 1985) reported a collection of *Citrus grandis* from Ulu Segama, Sabah (SAN 75565) and suggested that it might be indigenous there, although he admitted that the species could have been introduced into that area by early gold prospectors. On this basis and until more specimens are available, this species is excluded from the present treatment.

Uses. Citrus fruits are eaten fresh, canned, preserved or candied. The juice is extracted and made into drinks or concentrates. Pectin and essential oils are made from the rind, while waste fruit-pulp is processed into cattle-feed. Citric acid is manufactured from certain species. The leaves, flowers, and fruits of some species are sources of expensive essential oils (oil of neroli, bergamot oil) used in perfumery. Various plant parts (leaves, flowers, fruits, and seeds) are used to flavour foods and often enter into native medicinal remedies. Some species are reported to show insecticidal and germicidal activity. Flavonoids from the inner cortex are said to have anti-tumour properties. Some species are utilised as rootstock for the cultivation of commercially important citrus because of their resistance to certain diseases. Citrus is less commonly used as a source of wood for cabinetry. In Malaysia, the plants have reportedly been used for occult purposes.

Taxonomy. The taxonomic delimitation of species, subspecies, and forms of *Citrus* is complicated by the peculiar reproductive behaviour found in the genus including hybridisation, polyembryony (asexual seed production), the spontaneous production of autotetraploids, and mutations. Two widely opposing systems of classification exist. That of Tanaka (Revisio Aurantiacearum - IX, Jap. Soc. Prom. Sci., Ueno, Tokyo, 1954) proposes 145 species (increased to 157 a few years later), while that of Swingle (*l.c.* 1967) recognises only 16 species. This difference reflects a lack of agreement on what constitutes a species and whether supposed hybrids should be assigned the rank of species. Swingle, whose system is followed in this treatment, did not consider valid many of Tanaka's species which were clearly horticultural forms, and mostly the result of interspecific hybridisation. Several other systems of classification put forward by various authors are intermediate. Recent studies employing numerical taxonomy, chemosystematics, and other experimental methods have attempted to elucidate relationships among taxa and clarify the "species" problem in *Citrus*. Several such studies support the notion that the genus centres around three basic species or "biotypes", *viz.* *C. grandis*, *C. medica*, and *C. reticulata*.

Key to *Citrus* species

1. Petioles narrowly winged or wingless, or if broadly winged, never as broad as the leaf blades. Flowers large, usually 2.5–4.5 cm wide, fragrant. Stamens free or united in bundles.....2
 Petioles broadly winged, often as broad as the leaf-blades. Flowers small, usually less than 2 cm wide, not fragrant. Stamens free.....9
2. Petioles wingless, not articulated with the leaf-blade. Flowers perfect or staminate. Fruits usually oblong, pericarp thick. Cultivated.....

***C. medica* L.**

Sp. Pl. 2 (1753) 782. Synonym: *C. aurantium* var. *medica* Wight & Arn. *l.c.* 98.

Probably native to NE India and upper Burma. Cultivated widely in the tropics and subtropics for its fruits. Vernacular names: citron, *limau susu*.

- Petioles winged, often narrowly so, articulated with the leaf-blade. Flowers all perfect (except in *C. limon*). Fruits ovoid or globose or pear-shaped, pericarp thin (except in *C. grandis*).....3
3. Petioles very narrowly winged. Flowers perfect or staminate; stamens usually more than 4 times the number of petals. Fruits ovoid. Cultivated.....
- C. limon** (L.) Burm. f.
Fl. Ind. (1768) 1/3. Basionym: *Citrus medica* var. *limon* L. l.c. (1753) 782. Synonym: *Citrus limonum* Risso, Ann. Mus. Hist. Nat. Paris 20 (1813) 201.
Probably native to S Asia and now widely cultivated in the tropics and subtropics for its fruits. Vernacular names: lemon, *limau mata kerbau*.
- Petioles narrowly to broadly winged. Flowers usually perfect; stamens usually 4 times the number of petals. Fruits globose or pear-shaped, sometimes slightly flattened.....4
4. Fruits with loose pericarp, easily detached. Seeds small, plump. Embryo green.....5
Fruits with adherent pericarp, not easily detached. Seeds various. Embryo not green....6
5. Leaves somewhat rhomboid, tips acute. Fruits small to medium-sized, sometimes flattened. Cultivated.....
- C. reticulata** Blanco
Fl. Filip. (1837) 610. Synonyms: *Citrus nobilis* Andrews, Bot. Repos. 9 (1809) 608, *non* Lour. (1790); *Citrus deliciosa* Tenore, Ind. Sem. Hort. Neap. (1840) 9.
Native to SE Asia. Widely grown for its edible fruits. Vernacular names: mandarin, *limau manis*.
- Leaves elliptic, tips rounded. Fruits small, globose. Cultivated.....
- C. microcarpa** Bunge
Mem. Ac. Imp. Sc. St. Petersburg. 2 (1833) 84. Synonyms: *Citrus mandurensis* Lour., Fl. Cochinch. 2 (1790) 467; *Citrus mitis* Blanco l.c. (1837) 610.
Originated in China as a natural hybrid between *Citrus reticulata* var. *austera* Swingle (sour mandarin) and a species of *Fortunella* (kumquat); currently classified as *xCitrofortunella microcarpa* (Bunge) Wijnands, Baileya 22 (1984) 134. Widely grown in SE Asia for its acid juice. Vernacular names: calamondin, *limau kesturi*.
6. Petioles broadly winged. Fruits large to very large, usually 10–20 cm in diameter, round to pear-shaped. Seeds large, rough, monoembryonic. Cultivated.....
- C. grandis** (L.) Osbeck
Dagb. Ostind. Resa (1757) 98. Basionym: *Citrus aurantium* var. *grandis* L. l.c. (1753) 783. Synonyms: *Citrus decumana* L., Syst. ed. 12 (1767) 508; *Citrus maxima* (Burm. f.) Merr., Interp. Rumph. Herb. Amb. (1919) 296.
Native to Malesia; widely cultivated in SE Asia for its edible fruits. Vernacular names: pummelo, *limau besar*.
- Petioles narrowly winged to nearly wingless. Fruits small to medium-sized, generally 4–9 cm in diameter. Seeds various, usually polyembryonic (except in *C. halimii*).....7
7. Fruits medium-sized, 5–9 cm in diameter; pulp orange. Cultivated.....

C. sinensis (L.) Osbeck

Reise Ostind. China (1765) 250. Basionym: *Citrus aurantium* var. *sinensis* L. *l.c.* (1753) 782.

Probably native to the region between China and Vietnam. Cultivated widely in the subtropics and tropics for its edible fruits. Vernacular names: sweet orange, *limau manis*.

Fruits small, 4–7 cm in diameter; pulp greenish to yellowish. Cultivated or wild.....8

8. Leaves small, mostly 5–7.5 cm long. Stamens 20–25. Fruits globose to ovoid, sometimes with apical papilla; pericarp thin, smooth. Cultivated.....

C. aurantifolia (Christm. & Panz.) Swingle

J. Wash. Ac. Sc. 3 (1913) 465. Basionym: *Limonia aurantifolia* Christm. & Panz., Pfl. Syst. 1 (1777) 618. Synonym: *Citrus acida* Roxb., Fl. Ind. ed. 2, 3 (1832) 390.

Native to N India and Burma, or N Malesia. Cultivated throughout the tropics and warm subtropics for its fruits. Vernacular names: lime; *limau nipis*.

Leaves large, 8–15 cm long or more. Stamens 18–20. Fruits subglobose to slightly pyriform; pericarp thick, smooth to bumpy. Hills and mountains.....1. **C. halimii**

9. Petiolar wings with subentire margins. Fruits large, 8–15 cm in diameter; pericarp smooth.....2. **C. macroptera**

Petiolar wings with serrate-crenulate margins. Fruits small, 5–7 cm in diameter; pericarp irregularly bumpy. Cultivated.....

C. hystrix DC.

Cat. Pl. Hort. Bot. Monsp. (1813) 97. Synonym: *Citrus torosa* Blanco *l.c.* (1832) 609; *Citrus papeda* Miq., Fl. Ned. Ind. 1 (1859) 530.

Of unknown origin but widely naturalised in Malesia, Sri Lanka and Burma. Cultivated for its fruits. Vernacular names: Mauritius papeda, *limau purut*.

1. Citrus halimii Stone

(Sultan Abdul Halim Nu'azzam Shah Ibni Almarhum Sultan Badlishah, Sultan of Kedah and former King of Malaysia)

Biotropica 5 (1973) 102, *l.c.* (1978) 114; Stone & Jones, Proc. Ac. Nat. Sc. Phil. 140 (1988) 267; Ng *l.c.* 495; Whitmore, Tantra & Sutisna *l.c.* 305; PROSEA 2 (1991) 119. **Type:** *Stone 9550*, Peninsular Malaysia, Pahang, G. Nuang (holotype KLU; isotypes KEP, L, SING, US).

Medium-sized or large tree to 25 m tall and 60 cm in diameter; trunk straight, cylindrical; crown meagre, of few ascending branches. Spines on youngest branches of saplings straight to 2.5 cm long, absent on adult plants. **Leaves** *unifoliolate, elliptic or slightly ovate, 8–15 x 3.5–7.5 cm* (larger on vigorous young shoots), thinly leathery; margin subentire or subcrenulate, apex acute to shortly acuminate and emarginate; lateral veins 7–11 pairs; **petioles** usually 1–2 cm long, *very narrowly winged or wingless*, articulated with the blade. **Inflorescences** solitary, pedicels 1–3.5 mm long. **Flowers** 5-merous; sepals deltoid; petals ovate-elliptic, white; stamens 18–20, free or in 2–3 bundles; disc thin; **ovary** (6–)9–10-

carpellate, ovules 1–3(–5) per locule, style columnar, stigma flat, angled. Fruits subglobose to slightly pyriform, 5–7 cm in diameter, green ripening glossy deep yellow, smooth or bumpy; pericarp c. 6 mm thick, glandular; pulp-vesicles pale greenish to yellowish, juicy, acrid oil-droplets absent. Seeds numerous, to 2.1 cm long, testa veiny-reticulate; monoembryonic; cotyledons white.

Vernacular name. Sabah—*limau hutan* (Malay).

Distribution. S Thailand, Peninsular Malaysia, and Borneo. In Sabah, uncommon (Kota Marudu, Ranau and Tambunan districts), occurring as solitary trees on slopes and ridges in primary submontane forest, at 900–1800 m. Not reported from Sarawak, Brunei and Kalimantan.

Uses. The fruits are eaten as a condiment (rinds?), and are said to be thirst-quenching (Peninsular Malaysia). The flesh is said to be acidic and pleasant to taste.

2. *Citrus macroptera* Montr.

Fig. 3.

(Greek, *makros* = large, *pteron* = wing; the leaf-stalk)

Mem. Ac. R. (Imp.) Lyon Sc. 10 (1860) 187; Burkill *l.c.* (1931) 220, *l.c.* (1966) 576; Santiago *l.c.* 131; Swingle *l.c.* (1967) 395; Stone *l.c.* (1972) 374; Corner *l.c.* 661; PROSEA 2 (1991) 326. **Type:** *Montrouzier, s.n.*, New Caledonia, Ile Art (LY). **Synonyms:** *Citrus papuana* F.M. Bail., Contr. Fl. Brit. N. Guin. (1903) 1; *C. aurantium* subsp. *saponacea* Safford, Contr. US. Nat. Herb. 9 (1905) 226; *C. hystrix* (non DC.) Ridl. *l.c.* (1922) 358.

var. *macroptera*

Small or medium-sized tree to 20 m tall and 50(–100) cm diameter, generally much smaller; crown broad, dense. Branches and twigs armed with straight spines to 1.5 cm long, longer on juvenile growth. **Leaves** *unifoliolate, to 30 cm long, blade ovate-lanceolate, 5–15 x 3–6.5 cm; base rounded, margin shallowly crenate, apex acuminate; petioles broadly winged, with wing as large as the blade, obovate to nearly spatulate, margin subentire to crenate in the upper half, articulated with the blade. Inflorescence* a few-flowered cluster. **Flowers** 1.3–2 cm in diameter; buds subglobose; sepals triangular, small; petals oblong, concave; stamens *c.* 20, free; *ovary 10–12-carpellate, slightly hairy, style thick, stigma depressed. Fruits globose to pyriform, sometimes depressed, 8–15 cm in diameter or larger, smooth, green turning pale yellow; pericarp to 2.5 cm thick, segments 10–12, pulp-vesicles greenish yellow, juice scant, bitter, acrid oil-droplets present. Seeds 1–2 per segment, flattened, to c. 2 cm long; monoembryonic.*

Vernacular names. Sabah and Sarawak—*limau hantu, limau hutan* (Malay).

Distribution. The species and the variety are distributed in Indo-China, Malesia, New Caledonia, and Polynesia. Three varieties are known to occur, only one of which (var. *macroptera*) is in Sabah and Sarawak. Found occasionally in SW Sabah (Pinangah, Kinabatangan, Lahad Datu, and Tawau districts) as solitary trees along the banks of streams and on forested ridges and hills in primary forest, at 150–600 m. In Sarawak,

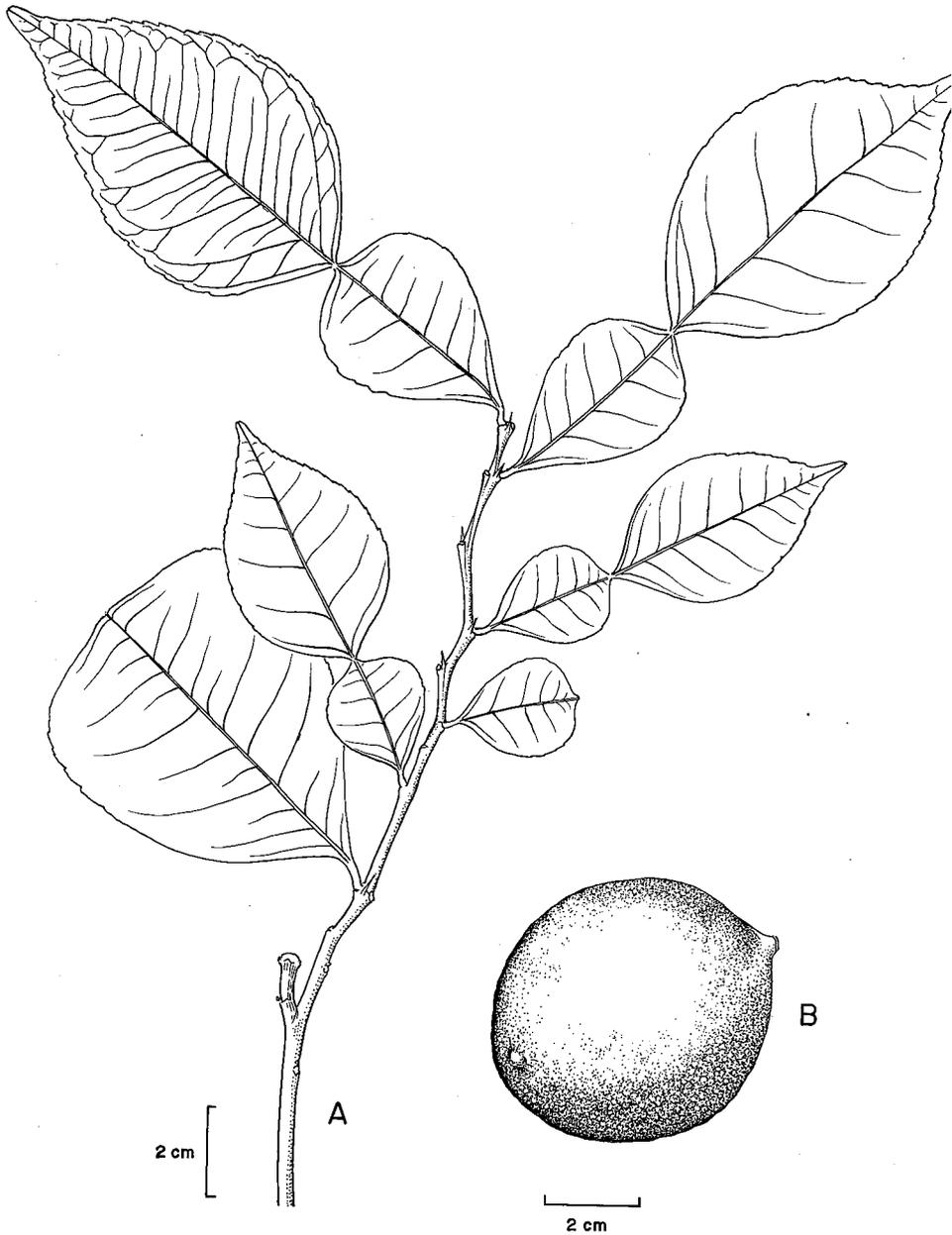


Fig. 3. *Citrus macroptera* var. *macroptera*. A, leafy twig; B, fruit. (From SAN 71072.)

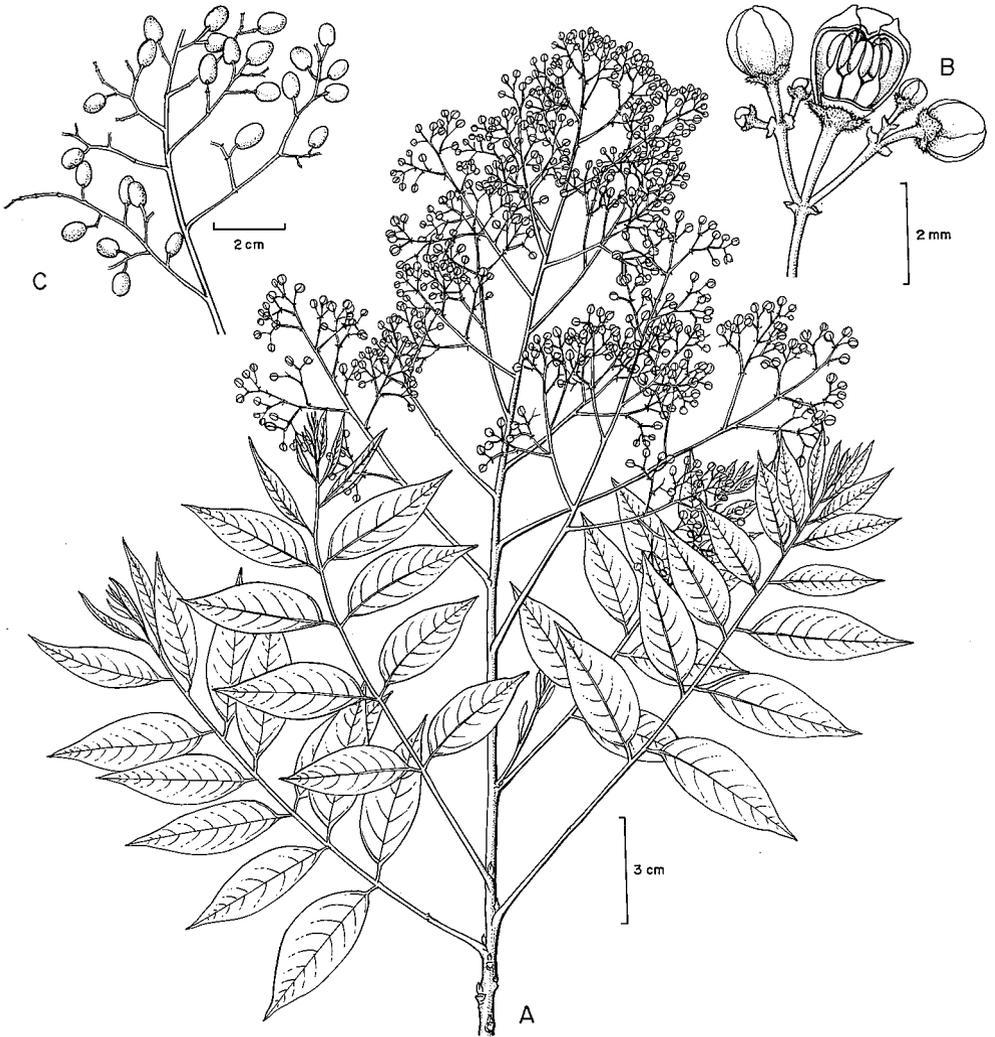


Fig. 4. *Clausena excavata*. A, flowering leafy twig; B, part of inflorescence (one flower with two petals removed); C, part of infructescence. (A & B from SAN 89309, C from SAN 56188.)

known only from a single collection made from lowland riverine forest (*Taufik, s.n.*, Kg. Bedup, Serian; KLU).

Uses. The fruits are reported to be edible (Philippines, Indonesia, Sabah), and are said to cause impotence (Indonesia). The leaves are eaten as a vegetable and used medicinally (Indonesia). Sticks are made from its wood (Papua New Guinea).

4. *CLAUSENA* Burm. f.

(Clausen, a botanist known to Burmann)

Fl. Ind. (1768) 243; Hooker *f. l.c.* (1875) 503; Kurz *l.c.* (1877) 187; Merrill *l.c.* (1921) 314, *l.c.* (1929) 115; Ridley *l.c.* (1922) 352; Craib *l.c.* 231; Masamune *l.c.* 358; Backer & Bakhuizen. *f. l.c.* 103; Burkill *l.c.* (1966) 584; Swingle *l.c.* (1967) 209; Stone *l.c.* (1972) 375; Anderson *l.c.* 307; Perry *l.c.* 363; Corner *l.c.* 662; Ng *l.c.* 495; Whitmore, Tantra & Sutisna *l.c.* 305; PROSEA 2 (1991) 141.

Shrubs or small trees. Branches unarmed; branchlets short-hairy. **Leaves** *alternate, pinnate, rachis sometimes winged*; leaflets alternate, usually 5–9(–31), often with asymmetric base, articulated with the petiolules. **Inflorescences** *lax* panicles or racemes, terminal or axillary. **Flowers** bisexual, small, 4–5-merous; buds small, subglobose or ovoid; sepals 4–5, calyx cup-like, lobed; petals elliptic or oval, free, imbricate; stamens (7–)8 or 10, free, unequal, in 2 whorls, the outer opposite the sepals and longer, filaments inflated or flattened at base, often narrowed at apex, glabrous, anthers ovate or elliptic, dorsifixed; disc annular, glabrous; ovary 2–5-carpellate, sometimes obscurely lobed, usually hairy, glandular, *seated on a glabrous, hourglass-shaped gynophore*, ovules (1–)2 per locule, style short, stout, deciduous or persistent, usually narrowed where it joins the ovary, stigma flattened, obscure. **Fruit** an ovoid or oblong berry. **Seed** usually 1 per fruit; cotyledons green.

Distribution. *c.* 29 species; from tropical Africa to India, S China, Taiwan, Indo-China, throughout Malesia and N Australia. Two species, *C. calciphila* and *C. excavata*, are in Sabah, the latter occurring also in Sarawak, Brunei and Kalimantan. A third species, *C. lansium*, is sparingly cultivated.

Key to *Clausena* species

1. Leaves 15–31-foliolate. Flowers mostly 4-merous. Stamens 8.....2. ***C. excavata***
Leaves 5–11-foliolate. Flowers 5-merous. Stamens 10.....2
2. Leaves 5–7-foliolate. Stigma flat. Fruits oblong-ellipsoid, to 1.5 cm long.....1. ***C. calciphila***
Leaves 9–11-foliolate. Stigma 5-lobed. Fruits ovoid-globose, to 2.5 cm long. Cultivated
C. lansium (Lous) Skeels
USDA Bur. Pl. Ind. Bull. 168 (1909) 31. Basionym: *Quinaria lansium* Lour., Fl. Cochinch. (1790) 272. Synonyms: *Cookia wampi* Blanco *l.c.* 358; *Clausena wampi* (Blanco) Oliv., J. Linn. Soc. Bot. 5, Suppl. 2 (1861) 34.
Native to S China and Indo-China. Widely cultivated in the tropics and subtropic for its edible fruits. Vernacular names: *wampee*, *wampi*.

1. *Clausena calciphila* Stone

(Latin, *calx* = chalk, Greek, *philos* = loving; referring to its preference for limestone habitats)

l.c. (1978) 111. **Type:** *Erwin & Paul S. 27430*, Sarawak, Kuching, Bukit Pa'it (SAR).

Small tree to 10 m tall. **Leaves** to 60 cm long, commonly 5–7-foliolate; leaflets elliptic-ovate, the lowest ones 7–13 x 4–7 cm, the lateral and terminal ones larger, 15–25 x 12–16 cm; base rounded, obliquely asymmetric, margin entire to subentire, apex acuminate; lateral veins 5–8(–10) pairs, together with midrib raised below; petioles 10–12 cm long, rachis glabrescent, wingless; petiolules 5–9 mm long. **Inflorescence** a loose, terminal panicle, 20 cm long or more during flowering, to 40 cm long in fruit; buds subglobose, c. 2 mm long. **Flowers** 5-merous; sepals 5, broadly triangular, minute, margin ciliate; petals 5, elliptic, c. 3 mm long, glabrous, margin hyaline; stamens 10, alternately long and short, filaments narrowly elliptic, anthers oblong-ovoid, connectives 1-glandular; disc annular, yellowish; ovary 5-carpellate, globose, glabrous, papillate-glandular, style shortly cylindrical. **Fruits** oblong-ellipsoid, 1.5–1.6 cm long, gland-dotted.

Distribution. Endemic to Sarawak. Uncommon, known from only three localities in Kuching (Bt. Pa'it, Bt. Bra'ang) and Baram (Bt. Mentagai) districts; on rocky limestone slopes, at 150–300 m.

2. *Clausena excavata* Burm. f.

Fig. 4.

(Latin, *excavatus* = to make hollow; the bases of the filaments)

l.c. 243; Hooker *f. l.c.* (1875) 504; Kurz *l.c.* (1877) 188; Merrill *l.c.* (1921) 314, *l.c.* (1929) 115; 314; Ridley *l.c.* (1922) 352; Craib *l.c.* 231; Masamune *l.c.* 358; Backer & Bakhuizen *f. l.c.* 104; Burkill *l.c.* (1966) 585; Swingle *l.c.* (1967) 212; Stone *l.c.* (1972) 375; Anderson *l.c.* 308; Perry *l.c.* 363; Corner *l.c.* 662; Whitmore, Tantra & Sutisna *l.c.* 306. **Type:** *Burmans 29*, India, Dauhon Kongeere (L). **Synonyms:** *Clausena javanensis* Raeusch. ex DC., Prodr. 1 (1824) 538; *Murraya burmanni* Spreng., Syst. Veg. 2 (1825) 315; *Amyris graveolens* Buch.-Ham. ex Steud., Nom. Bot. ed. 2, 1 (1840) 81.

var. *excavata*

Small tree to 15 m tall and 20 cm diameter. Branchlets softly hairy. **Leaves** 20–50 cm long, rachis slender, cylindrical, not winged; leaflets 15–31, oblong-ovate to lanceolate or slightly crescent-shaped, 2–9 x 1.5–4 cm, thinly leathery, glabrous above, sparsely hairy below; base rounded, obliquely asymmetric, margins toothed, apex tapered or acuminate; petiolules short. **Inflorescence** a much-branched panicle, terminal, 10–30 cm long, pyramid-shaped, branches hairy. **Flowers** 4(–5)-merous, buds round; calyx minute, hairy; petals oval, 3.5–5 mm long, glabrous, yellowish or greenish; stamens 8, filaments inflated and concave at base; ovary ovoid to ellipsoid, hairy or hirsute, slightly lobed, style cylindrical, persistent, not narrowed where it joins the ovary. **Fruits** broadly ellipsoid, 1–1.8 cm long, smooth, glabrous; peel green ripening pink, translucent. **Seed** 1 per fruit, oblong.

Distribution. India, Burma, S China, Taiwan, Indo-China, and throughout Malesia. Two varieties exist with only the widespread var. *excavata* in Sabah and Sarawak. Widespread

and common in Sabah and parts of Sarawak (Kuching and Baram districts). Also occurs in Brunei and Kalimantan.

Ecology. In forests and open places in the lowlands and hills, especially disturbed areas around villages and forest margin, and on limestone, from sea-level to 1500 m.

Uses. The leaves are reported to have insecticidal properties, and the roots, stems, leaves and flowers are used to treat paralysis, stomach disorders, intestinal worms, and fever (Taiwan, Indo-China, Peninsular Malaysia, Indonesia). Its wood has been used to make axe-handles (Java).

5. GLYCOSMIS Corrêa

(Greek, *glukus* = sweet, *osme* = scent; sweet-smelling plant)

Ann. Mus. Hist. Nat. Paris 6 (1805) 384; Hooker *f. l.c.* (1875) 499; Kurz *l.c.* (1877) 184; Merrill *l.c.* (1921) 314, *l.c.* (1929) 113; Ridley *l.c.* (1922) 348; Craib *l.c.* 222; Narayanaswami, Rec. Bot. Surv. Ind. (1941) 1; Masamune *l.c.* 359; Backer & Bakhuizen *f. l.c.* 102; Burkill *l.c.* (1966) 1103; Swingle *l.c.* (1967) 206; Stone *l.c.* (1972) 380, *l.c.* (1978) 75, *l.c.* (1985) 1; Anderson *l.c.* 308; Corner *l.c.* 665; Whitmore, Tantra & Sutisna *l.c.* 306.

Shrubs or trees. Branches unarmed. *Shoot tips and young inflorescences densely hairy, the hairs reddish.* **Leaves** alternate or opposite, pinnate or unifoliolate, rarely simple, petioles wingless; leaflets 1–5(–15), alternate or sometimes opposite, chartaceous or leathery, margin entire or obscurely toothed, articulated at the base. **Inflorescences** axillary or pseudoterminal racemes or cymose panicles. **Flowers** bisexual, 4–5-merous; sepals fused at base, imbricate, glandular; petals ovate to elliptic, imbricate, greenish to whitish; stamens 8 or 10, usually unequal, filaments abruptly narrowed at the apex, *anthers* small, ovate to elliptic, *generally with a terminal gland, often with 1 or several glands on the connective*; disc annular, with small lobes; ovary 2–5-carpellate, club- to flask-shaped to nearly conical, often raised on a stout gynophore, ovules 1–2 per locule, style short, thick, persistent, stigma slightly broadened, faintly lobed. **Fruits** globose to oblong or ellipsoid berries, dry or fleshy, outer wall glandular, white to pink or purplish. **Seeds** 1–2(–3) per fruit, round to plano-convex, thin-walled, cotyledons green, fleshy.

Distribution. *c.* 40 species; India, Sri Lanka, SE Asia, S China, Taiwan, Malesia, and Australia. Seven species occur in Sabah and Sarawak, two of which (*Glycosmis chlorosperma* and *G. macrantha*) are widespread and common. *Glycosmis parviflora* is occasionally cultivated in Sabah and possibly also in Sarawak.

Taxonomy. Although readily distinguished from its closest relatives (*Clausena* and *Murraya*), the chaotic state of its constituent species (65 names have been published to date) has persisted due to lack of any critical taxonomic and nomenclatural review. Stone (*l.c.* 1978 and 1985), whose interpretation of the genus is followed here, admits that *Glycosmis* is still imperfectly known and several taxonomic problems remain to be solved.

Key to *Glycosmis* species

1. Leaves predominantly pinnate, never uniformly unifoliolate. Ovary smooth.....2
 Leaves predominantly unifoliolate, or some of them 2–3-foliolate. Ovary papillate-glandular.....3. ***G. lanceolata***
2. Ovary glabrous, 4–5-carpellate.....3
 Ovary densely hairy, 2–3-carpellate.....6. ***G. sapindoides***
3. Inflorescences pseudoterminal.....4
 Inflorescences axillary.....7
4. Flowers large, 7–11 mm long; petals glabrous.....5
 Flowers medium-sized to small, rarely over 6 mm long; petals hairy, at least below....6
5. Leaves alternate; leaflets not over 15 cm long, lateral veins 5–9, petiolules to 7 mm long.....5. ***G. macrantha***
 Leaves sometimes opposite, leaflets over 15 cm long, lateral veins 10–14, petiolules 10–20 mm long.....7. ***G. superba***
6. Lateral veins not prominently raised below. Sepals narrowly triangular, *c.* 2.5 mm long. Fruits subellipsoid, *c.* 7.5 mm long.....4. ***G. longisepala***
 Lateral veins prominently raised below. Sepals deltoid-ovoid, 1–1.5 mm long. Fruits globose, over 10 mm long.....1. ***G. chlorosperma***
7. Leaflets predominantly entire. Inflorescences corymbose. Fruits ellipsoid, usually purplish to black.....2. ***G. cyanocarpa***
 Leaflets sometimes obscurely toothed. Inflorescences narrow, somewhat elongate. Fruits globose, white to yellowish or pinkish. Cultivated.....

***G. parviflora* (Sims) Little**

Phytologia 2 (1948) 463. Basionym: *Limonia parviflora* Sims, Bot. Mag. (1823) *t.* 2416. Synonym: *Glycosmis citrifolia* (Willd.) Lindl., Trans. Hort. Soc. Lond. 6 (1826) 72. Native to S China and Indo-China. Introduced to horticulture and botanical gardens in various parts of the World.

1. *Glycosmis chlorosperma* (Blume) Spreng.

(Greek, *khloros* = green, *sperma* = seed)

Syst. Veg. ed. 16, 4 (1827) 162; Narayanaswami *l.c.* 40; Masamune *l.c.* 359; Backer & Bakhuizen *f. l.c.* 102; Swingle *l.c.* (1967) 207; Stone *l.c.* (1972) 382, *l.c.* (1978) 93, *l.c.* (1985) 2; Anderson *l.c.* 308; Corner *l.c.* 666; Whitmore, Tantra & Sutisna *l.c.* 306. **Basionym:** *Cookia chlorosperma* Blume. *l.c.* (1825) 135. **Type:** *Blume, s.n.*, Java, Mt. Salak (L). **Synonyms:** *Glycosmis monticola* Ridl., J. Str. Br. R. As. Soc. 75 (1917) 14; *G. malayana* Ridl. *l.c.* (1917) 12.

Shrub or small tree. **Leaves** pinnate, rarely unifoliolate, *opposite or alternate*, glabrous, with or without axillary lanceolate paraphylls to 2.5 cm long; leaflets (1–)3–5(–7), ovate to

oblong-lanceolate, or narrowly so, 5–20(–30) x 2–9(–14) cm, leathery; base acute, margin entire, apex acuminate; *lateral veins* 5–11 pairs, rather distant, strongly inarching near the margin, depressed above, conspicuously raised below; petiolules 3–5 mm long. **Inflorescences** pseudoterminal cymose-panicles, 2–16 cm long, branches rusty hairy, buds small, minutely hairy. **Flowers** at tips of short branchlets, 5-merous; sepals ovate, to 2 mm long, margin hyaline, ciliate; *petals* whitish, obovate-oblong, to 6 mm long, *rusty hairy below*, margin membranous; stamens 10, alternating long and short, anthers ovate-cordate, sometimes minutely gland-tipped; disc ring-like, yellow; ovary (4–)5-carpellate, glabrous, flask-shaped, on a thick gynophore, style short, equalling the ovary in length. **Fruits** globose, 10–12.5 mm long.

Key to varieties

1. Leaflets ovate, 5–7 cm long, lateral veins 5 pairs. Inflorescences 2–3 cm long.....

var. **bidiensis** Stone

l.c. (1985) 3. Type: *J. & M.S. Clemens 20663*, Sarawak, Kuching, Bidi Cave (holotype K). Small tree. *Leaves* 3–5-foliolate; *leaflets* ovate, 5–7 x 2–2.3 cm; *lateral veins* 5 pairs. *Inflorescences* 2–3 cm long. *Flowers* small; *buds* 2–3 mm long; *anthers* glandular; *disc* distinctly constricted, 0.8–0.9 mm wide; *ovary* 4–5-carpellate. Endemic to Sarawak, where it is known only from the type locality, on limestone.

Leaflets oblong-lanceolate to elliptic, 5–30 cm long, lateral veins 9–11 pairs. Inflorescences longer than 5 cm.....2

2. Leaflets oblong-lanceolate, mostly less than 15 cm long. Inflorescences 7.5–11 cm long.....

var. **chlorosperma**

Shrub or small tree to 10 m tall and 15 cm diameter. *Leaves* 3–6-foliolate; *leaflets* oblong-lanceolate, 5–15(–20) x 2–8.5 cm; *base* sometimes slightly asymmetric; *lateral veins* 9–10 pairs. *Inflorescences* 7.5–11 cm long. *Flowers* small; *sepals* c. 1 mm long; *petals* c. 2.5 mm long; *ovary* 5-carpellate, *style* almost lacking. Vernacular name: *segera* (Malay). Throughout the range of the species. Widespread in Sabah and Sarawak, in mixed dipterocarp forest on fertile clay loam soils, especially on basic volcanic substrates, occasionally on limestone, from near sea-level to 800 m.

Leaflets oblong-elliptic, 15–30 cm long. Inflorescences generally larger, to 16 cm long.....

var. **elmeri** (Merr.) Tanaka

Med. Rijksherb. 69 (1931) 3; Stone *l.c.* (1978) 94, *l.c.* (1985) 3. Basionym: *Glycosmis elmeri* Merr., Philip. J. Sc. 30 (1926) Bot. 400, Merrill *l.c.* (1929) 113, Masamune *l.c.* 359. Type: *Ramos & Edano 44150*, Philippines, Sulu Archipelago, Tawitawi (UC).

Shrub or small tree to 10 m tall and 20 cm diameter. *Leaves* 3–4-foliolate; *leaflets* oblong-elliptic, 15–20(–30) x 6–9(–14) cm; *base* broadly acute; *lateral veins* 9–11 pairs. *Inflorescences* 6–16 cm long, *side branches* to 5 cm long. *Flowers* sessile, *buds* brownish. Philippines (Sulu Archipelago), Borneo. Common in Sabah and Sarawak, occurring in lowland and hill forest, usually on ridges and slopes, and occasionally on limestone, from near sea-level to 1280 m.

Distribution. S Burma, S Thailand, Peninsular Malaysia, Sumatra, Java, Borneo (Sabah, Sarawak, Kalimantan) and S Philippines. A variable species with seven recognised varieties, three of which occur in Sabah and Sarawak.

2. *Glycosmis cyanocarpa* (Blume) Spreng.

(Greek, *kuanos* = dark blue, *karpos* = fruit)

l.c. (1827) 161; Kurz *l.c.* (1877) 184; Masamune *l.c.* 359; Backer & Bakhuizen *f. l.c.* 102; Swingle *l.c.* (1967) 207; Stone *l.c.* (1978) 97, *l.c.* (1985) 5; Whitmore, Tantra & Sutisna *l.c.* 306. **Basionym:** *Cookia cyanocarpa* Blume *l.c.* (1825) 136. **Type:** Blume, *s.n.*, Java, Mt. Salak (L). **Synonyms:** *Glycosmis longifolia* Tanaka, Bull. Soc. Bot. Fr. 75 (1928) 709; *G. cymosa* (Kurz) Narayanaswami *l.c.* 26

var. **platyphylla** (Merr.) Stone

l.c. (1978) 98, *l.c.* (1985) 6. **Basionym:** *Glycosmis platyphylla* Merr., Philip. J. Sc. 12 (1917) Bot. 273. **Type:** Wenzel 1611, Philippines, Leyte (US). **Synonym:** *Glycosmis clemensii* Tanaka *l.c.* (1931) 4.

Shrub or small to medium-sized tree to 15 m tall and 30 cm diameter. **Leaves** 3–4-foliolate, alternate, 11–20 cm long; leaflets (1–)3–9, elliptic or lanceolate, 4–30 x 1–10 cm, glabrous or rusty-scurfy, sometimes only on midrib, below; base acute, margin usually entire or sometimes finely toothed, apex caudate-acuminate; *lateral veins* 5–10(–20) pairs, *sometimes strongly raised below*, inarching near the margin; petiolules 2–4 mm long. **Inflorescences** *predominantly axillary corymbs*, 1–12 cm long, open-branched, branches spreading, hairy, with linear, leaf-like bracts. **Flowers** 4–5-merous; buds glabrous, *c.* 5 mm long; sepals broad, rounded, *c.* 1.3 mm long, hairy, especially towards apex, margin rusty-ciliate; petals oblong to oblong-obovate, 3.5–4 mm long, hairy, especially towards apex; *stamens* 10, nearly equal to unequal, filaments broad, narrowed at apex, anthers ovate, glandular-apiculate; disc elevated, minutely lobed or glandular; ovary 4–5-carpellate, ellipsoid, constricted at base and in the middle, glabrous, not glandular, seated on a well-developed gynophore, style short, stigma broad. **Fruits** oblong or ellipsoid, 1–1.5 cm long, *purplish*. **Seed** 1 per fruit.

Distribution. India, Nepal, SW China, Burma, Indo-China, and throughout W Malesia (Sumatra, Peninsular Malaysia, Java, Borneo and the Philippines). A variable species comprising 10 varieties, one of which (var. *platyphylla*) occurs in Borneo, Philippines, and the Talaud Islands. In Sabah and Sarawak (Lundu district), var. *platyphylla* occurs on flat and undulating land in primary and secondary lowland forest, from near sea-level to 200 m; also in Kalimantan.

3. *Glycosmis lanceolata* (Blume) Spreng.

(Latin, *lanceolatus* = spear-shaped; the leaves)

Cat. Hort. Bog. (1866) 208; Narayanaswami *l.c.* 61; Stone *l.c.* (1985) 10; Whitmore, Tantra & Sutisna *l.c.* 306. **Basionym:** *Sclerostylis lanceolata* Blume *l.c.* (1825) 134. **Type:** Blume, *s.n.*,

Batavia (L.). **Synonyms:** *Glycosmis simplicifolia* Spreng. *l.c.* (1827) 162; *G. montana* Pierre, Fl. For. Cochinch. 4 (1893) 285; *G. greenei* var. *simplex* Stone *l.c.* (1978) 90.

Shrub or small to medium-sized tree to 18 m tall and 25 cm diameter. Branches with shiny and cracked bark. **Leaves** 1–5-foliolate, alternate; leaflets, oblong-ovate or oblanceolate, 8.5–17 x 3–8 cm; base rounded, margin entire, apex shortly acuminate or emarginate; lateral veins 8–12 pairs; petiolules 3–4 mm long, 7–9 mm long in unifoliolate leaves. **Inflorescences** short, axillary cymose-panicles, 1–3 cm long, branches short, rusty scurfy-hairy. **Flowers** small, 5-merous; sepals 1–1.5 mm long, glabrous below; *petals* longer, oblong-ovate, *rusty scurfy-hairy below*, margins hyaline; stamens 10, alternating long and short, anthers oblong-cordate, *connectives obscurely glandular*; *ovary* (2–)3-carpellate, ellipsoid-ovoid, glabrous, *distinctly papillate glandular*, seated on a well-developed gynophore, tapering into style, stigma 3-lobed. **Fruits** globose.

Distribution. Indo-China, Hainan, Sumatra, Java, Borneo, S Philippines, and the Lesser Sunda Islands. Widespread in Sabah on ridges and slopes in lowland forest, occasionally on limestone, from near sea-level to 240 m. In Sarawak, known from only one locality in Kuching district (Stone 13739, Padawan, Bt. Pa'it). Also known from Kalimantan.

4. *Glycosmis longisepala* Stone

(Latin, *longus* = long, *sepalum* = sepal)

l.c. (1985) 11; Whitmore, Tantra & Sutisna *l.c.* 306. **Type:** *J. & M.S. Clemens 20001*, Sarawak, Mt. Pueh (holotype K).

Small tree. **Leaves** 5–7-foliolate, to 30 cm long; leaflets ovate-lanceolate or elliptic, 7–16 x 2.8–6 cm; base acute, margin entire, apex acuminate; lateral veins 6–8 pairs; petiolules 3–8 mm long. **Inflorescences** pseudoterminal cymose-panicles, elongate or pyramid-shaped, to 13 cm long. **Flowers** 5-merous; *sepals narrowly triangular*, *c. 2.5 mm long*, surfaces hairy, margin ciliate; *petals c. 3 mm long*, hairy below; stamens 10, anthers *c. 1 mm long*, glandular-apiculate, connective glandular dorsally; *ovary* (4–)5-carpellate, to 2 mm long, glabrous, glandular, seated on a well-developed gynophore. **Fruits** *subellipsoid*, *c. 7.5 mm long*. **Seeds** 2 per fruit.

Distribution. Endemic to Sarawak; known only from the type locality, in forest, at 1000–1400 m.

5. *Glycosmis macrantha* Merr.

(Greek, *makros* = large, *anthos* = flower)

Fig. 5.

l.c. (1929) 114; Masamune *l.c.* 360; Swingle *l.c.* (1967) 207; Stone *l.c.* (1978) 92, *l.c.* (1985) 11; Whitmore, Tantra & Sutisna *l.c.* 306. **Type:** *Elmer 21456*, British North Borneo, Tawau (holotype UC; isotypes MO, US). **Synonym:** *Glycosmis oliveri* Stapf ex Ridl., Kew Bull. (1930) 80, Masamune *l.c.* 360.

Small to medium-sized tree to 20 m tall and 20 cm diameter; bole to 12 m tall. **Leaves** 5–9-foliolate, 17–30 cm long, alternate; leaflets oblong to elliptic, 7–14 x 3–6 cm, glabrous,

chartaceous; base acute, apex acuminate, acumen 1–2 cm long; *lateral veins* 5–9 pairs, *strongly raised below*; petiolules 4–7 mm long. **Inflorescences** terminal or axillary cymes. **Flowers** large, 4–5-merous, whitish, on short stalks or nearly sessile; sepals orbicular, 2.5–3 mm long, sparsely hairy or glabrous; petals 5, oblong, glabrous, *c.* 7 x 3 mm; stamens 10, equal, filaments thick, *c.* 4 mm long, anther connectives dorsally glandular; ovary 5-carpellate, glabrous, seated on a well-developed gynophore, style cylindrical. **Fruits** ovoid, *c.* 1 cm long.

Distribution. Endemic to Borneo. In Sabah, widespread and abundant in primary and secondary forest, predominantly on hillsides and ridges, and often in disturbed habitats, to 1400 m. In Sarawak, uncommon and rarely collected. Also in Kalimantan.

6. *Glycosmis sapindoides* Lindl. in Wall. ex Oliver (resembling the genus *Sapindus*)

J. Linn. Soc. Bot. 5, Suppl. 2 (1861) 38; Hooker *f. l.c.* (1875) 501; King *l.c.* 217; Ridley *l.c.* (1922) 351; Craib *l.c.* 225; Narayanaswami *l.c.* 55; Backer & Bakhuizen *f. l.c.* 102; Swingle *l.c.* (1967) 207; Stone *l.c.* (1972) 381, *l.c.* (1985) 18; Whitmore, Tantra & Sutisna *l.c.* 307. **Type:** *Wallich Cat.* 6376, Penang (lectotype K). **Synonyms:** *Glycosmis cyanocarpa* var. *sapindoides* (Lindl.) Kurz, J. Bot. 14 (1876) 34; *G. elata* Ridl., J. Fed. Mal. St. Mus. 10 (1920) 130; *G. macrophylla* (Blume) Miq., Fl. Ind. Bat. 1, 2 (1859) 522.

var. *sapindoides*

Shrub or small tree to 10 m tall and 10 cm diameter. *Young branches yellow, shiny.* **Leaves** pinnate, alternate; *leaflets* (3–)5–9, *oblanceolate*, 14–22 x 4–8 cm; base acute, margin entire, apex acuminate; *lateral veins* 9–11 pairs, *prominently raised below*; petiolules to 3 mm long. **Inflorescences** axillary cymose-panicles, 1.5–2(–7.5) cm long; buds rusty hairy. **Flowers** small, 5-merous, in clusters at tips of short branchlets; *sepals* broadly ovate, *to 0.5 mm long*, hairy below, margin ciliolate; petals oblong-elliptic, *c.* 2.5 mm long, hairy below; stamens 10, alternating long and short, *filaments slender*, *c.* 1.5 mm long, glabrous, *anthers* crescent-shaped, *gland-tipped*; *ovary* (2–)3-carpellate, *ellipsoid, densely rusty hairy, stigma broad.* **Fruits** ellipsoid.

Distribution. Mainland SE Asia and W Malesia, to Papua New Guinea and Australia. Of the three known varieties, only the commonest (var. *sapindoides*) occurs in Sabah. This variety occurs in the western and central parts of the range of the species, as far east as Papua New Guinea. In Sabah, known only from Kota Kinabalu district (Pulau Sipanggar) where it is found on ridge tops and hillsides in primary forest, to 200 m. Also in Kalimantan.

7. *Glycosmis superba* Stone

(Latin, *superbus* = splendid; the large, attractive leaves)

l.c. (1978) 95, *l.c.* (1985) 20; Anderson *l.c.* 308. Whitmore, Tantra & Sutisna *l.c.* 307. **Type:** *Anderson, Tan & Wright S. 26059*, Sarawak, Ulu Sg. Sekaloh (SAR).

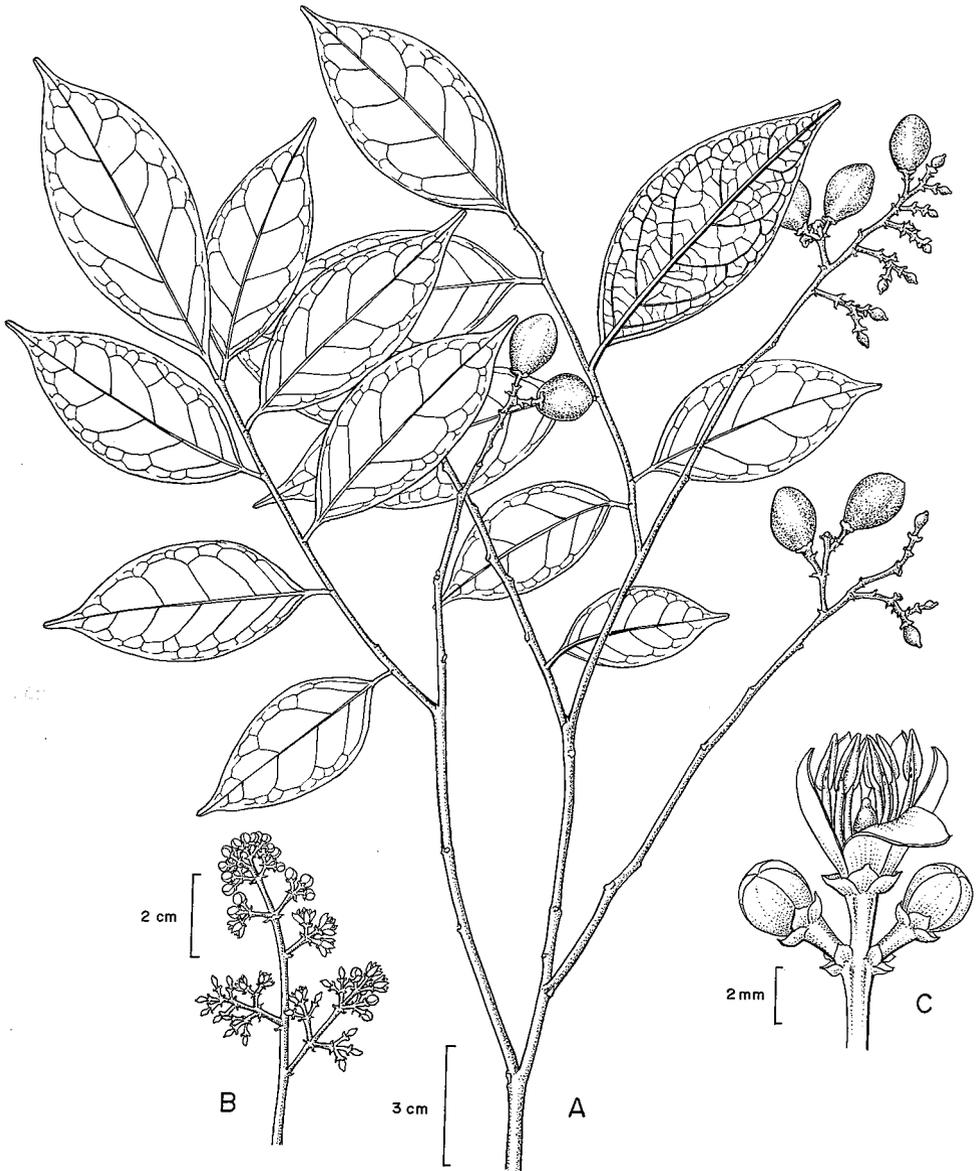


Fig. 5. *Glycosmis macrantha*. A, fruiting leafy twig; B, part of inflorescence; C, flowers. (A, from SAN 57109, B & C from SAN 44669.)



Fig. 6. *Lunasia amara*. Fruiting leafy twig. (From SAN 92007.)

Shrub or small tree to 10 m tall and 10 cm diameter. **Leaves** large, opposite, 3–6-foliolate, to 33 cm long; leaflets elliptic-oblongate, 20–31 x 8–12 cm, leathery; base cuneate, margin obscurely wavy to subentire, apex acuminate-caudate; lateral veins 10–14 pairs; *petiolules* 1–2 cm long. **Inflorescences** pseudoterminal, pyramid-shaped, densely cymose-paniculate, subglabrous, 33–45 mm long. **Flowers** 5-merous; *sepals* broadly orbicular-ovate, c. 3 mm long, glabrous below, margin hyaline; petals at least 6 mm long, glabrous, glandular; stamens 10, anther connectives 4–6-glandular, apex glandular-apiculate; disc 5-lobulate; ovary 5-carpellate, cylindrical, glabrous, stigma 5-lobed, style glandular.

Distribution. Endemic to Sarawak (Kuching, Bintulu and Miri districts) and Brunei.

Ecology. Found on ridges and undulating ground in primary mixed dipterocarp forest and secondary forest on sandy humult ultisols, from near sea-level to 100 m.

6. LUNASIA Blanco

(Tagalog, *lunas*; a native name for *L. amara*)

Fl. Filip. ed. 1 (1837) 783; Merrill *l.c.* (1929) 113; Masamune *l.c.* 360; Backer & Bakhuizen *f. l.c.* 99; Hartley, J. Arn. Arb. 48 (1967) 460; Anderson *l.c.* 308; Perry *l.c.* 366.

Erect shrubs or small trees; dioecious. Branches unarmed. *All vegetative and reproductive parts with grey to reddish brown scale-like and/or star-shaped hairs.* **Leaves** alternate, simple; leaf blades pinnately veined, leathery, becoming stiff when older; petioles wingless, swollen at apex. **Inflorescences** axillary panicles, *flowers in small globose-clusters, 3–6 mm in diameter.* **Flowers** unisexual, 3-merous, fragrant; sepals 3, free, valvate; petals 3, free, valvate, white to greenish or yellowish; stamens 3, opposite the sepals, rudimentary in female flowers, anthers dorsifixed; ovary 3-carpellate, carpels fused at base, rudimentary in male flowers, ovules 1 per locule; styles 3. **Fruits** of 1–3 dehiscent follicles, the undeveloped follicles persistent in fruit; pericarp dry at maturity; endocarp cartilaginous, discharged when the follicle dehisces. **Seeds** 1 per locule; endosperm lacking; cotyledons oily.

Distribution. One species; E Java, Borneo, Philippines, Celebes, Papua New Guinea and Australia (Queensland).

Ecology. Occurs in well-drained, primary and secondary rain forests, thickets, and garden regrowth, from near sea-level to 900 m.

Lunasia amara Blanco

(Latin, *amarus* = bitter; referring to the alkaloid content)

Fig. 6.

l.c. 783; Merrill *l.c.* (1929) 113; Masamune *l.c.* 360; Backer & Bakhuizen *f. l.c.* 99; Hartley *l.c.* (1967) 464; Anderson *l.c.* 308; Perry *l.c.* 366. **Type:** *Escritor BS 20776*, Philippines, Luzon Island (neotype A). **Synonyms:** *Pilocarpus amara* (Blanco) Blanco *l.c.* (1845) 540; *Lunasia reticulata* Elmer, *Leafl. Philip. Bot.* 4 (1912) 1511; *L. gigantifolia* Merr., *Philip. J. Sc.* 21 (1922) Bot. 519.

var. **amara**

Shrub or small tree to 15 m tall (usually smaller), 30 cm diameter, sparsely branched. **Leaves** crowded toward the branchlet tips; blades oblanceolate to obovate or elliptic, 6–60 x (up to) 18 cm; base cuneate to narrowly rounded or cordate, margin subentire to sinuate or coarsely dentate, apex rounded to acuminate; lateral veins 9–35 pairs, strongly raised below; petioles 1.5–15 cm long. **Male inflorescences** to 28 cm long and 8 cm wide; sepals ovate, minute; petals obovate-acuminate, c. 1 mm long; staminal filaments glabrous. **Female inflorescences** to 25 cm long and 2 cm wide; sepals broad ovate, 1–1.5 mm long; petals ovate-acuminate, c. 2 mm long; staminodes 3; styles fused at base, stigmas flattened and spreading over the tops of the carpels. **Fruits** obovate follicles, 6–15 x 5–10 mm, flattened laterally, ribbed on the sides, with a beak to 5 mm long, densely hairy. **Seeds** nearly obovoid; testa dark brown to reddish, papery.

Distribution. One variety (var. *amara*) with the same range of distribution as that of the genus and species, occurs in Sabah and Sarawak. The other known variety, *babuyanica* (Merr.) Hartley, is endemic to the Babuyan Islands in the Philippines. In Sabah, var. *amara* is widespread and found in a variety of habitats, including offshore islands, ridges and slopes in primary forest, and forest on ultramafic soils, from near sea-level to 900 m. In Sarawak, frequent on limestone cliffs and slopes at low elevations (Miri and Baram districts).

Uses. Bark, leaves, and seeds have been used medicinally to treat skin diseases, swollen limbs, snake bite, and stomach ailments (Philippines, Indonesia). A number of alkaloids are reported from the plant. Lunasin and lunacrin, two alkaloids extracted from the bark, were shown to have negative effects on the voluntary and smooth muscles, blood vessels, and hearts of laboratory animals (Wirth, J. Am. Pharm. Assoc. 20 (1931) 1254), causing death due to the simultaneous cessation of the respiratory and circulatory systems.

7. MACLURODENDRON T.G. Hartley

(Floyd A. McClure, 1897–1970, American botanist and plant explorer)

Gard. Bull. Sing. 35 (1982) 1.

Small to medium-sized trees; dioecious. Branches unarmed. Young branchlets hairy, trichomes brownish to rust-coloured. **Leaves** opposite, unifoliolate; blade pinnately veined, margin entire; petioles wingless, swollen at the apex, articulated with the blades. **Inflorescences** axillary, paniculate or racemose. **Flowers** unisexual, 4-merous, round in bud; sepals 4, triangular, fused at base, valvate; petals 4, ovate, free, imbricate, white or greenish or yellowish; stamens 8, unequal, alternately long and short, filaments glabrous, nearly linear, curved inward, anther ovoid to ellipsoid, dorsifixed, pollen lacking in female flowers; disc irregularly 8-lobed; ovary 4-carpellate, shallowly 4-lobed, glabrous, rudimentary in male flowers, 2 ovules per locule, style straight, stigma capitate, 4-lobed. **Fruit** a 4-loculate drupe, glabrous; exocarp somewhat leathery, glandular; mesocarp spongy, thin when dry; endocarp parchment-like, shiny. **Seeds** ovoid to kidney-shaped, dark brown to black, shiny,

1–2 per locule; outer testa usually spongy, inner testa bony; endosperm fleshy; embryo straight or bent.

Distribution. 6 species; Thailand, Sumatra, Peninsular Malaysia, Borneo, the Philippines, Vietnam, and Hainan Island. One species (*M. porteri*) commonly occur in Sabah and Sarawak, while *M. parviflorum* is endemic to Sarawak and *M. pubescens* to Sabah.

Ecology. Mainly in well-drained primary rain forests and occasionally in secondary forests and heath forests, from near sea-level to 1500 m.

Taxonomy. Several species were previously described under *Acronychia* (e.g., *A. porteri*). The two genera are similar in a number of characters including the opposite leaves, 4-merous flowers, 2-ovulate locules, and drupaceous fruits. However, *Maclurodendron* differs in its exclusively unifoliolate leaves (sometimes trifoliolate in *Acronychia*), unisexual flowers, imbricate petals, glabrous staminal filaments, and glabrous ovaries and fruits, never with septicial fissures.

Key to *Maclurodendron* species

1. Fully developed leaf-blades hairy below, especially on the midrib and lateral veins **3. *M. pubescens***
Fully developed leaf-blades glabrous or nearly so..... 2
2. Inflorescences 1–3 cm long. Petals *c.* 1.5 mm long. Seed surface irregularly roughened **1. *M. parviflorum***
Inflorescences 2–15 cm long. Petals 2–2.5 mm long. Seed surface minutely reticulate **2. *M. porteri***

1. *Maclurodendron parviflorum* T.G. Hartley

(Latin, *parvus* = small, *flos* = flower)

l.c. (1982) 14. **Type:** *Anderson S. 25426*, Sarawak, Kuching district (holotype L; isotype SAR).

Small tree to 5 m tall. Branchlets glabrous or nearly so. **Leaves** elliptic or obovate to oblanceolate, 9–16 x 3–9 cm, thinly leathery, *drying pale green, glabrous or nearly so*; base narrow, apex acuminate or occasionally rounded; lateral veins 7–11 pairs; intercostal veins and reticulations faint; petioles 1–2 cm long. **Inflorescences** 1–3 cm long; peduncle axis and branches sparsely hairy to glabrous, pedicels sparsely hairy, 1–3 mm long. **Flowers** 1–1.5 mm wide in bud; sepals nearly 1 mm long, sparsely hairy; petals *c.* 1.5 mm long, glabrous. **Fruits** *c.* 7 mm in diameter, nearly round to ovoid, shallowly 4-lobed, acute at the apex. **Seeds** *c.* 5 mm long, *surface irregularly roughened; outer testa not spongy.*

Distribution. Endemic to Sarawak, where it is known from only four collections in Kuching district.

Ecology. In primary heath (*kerangas*) forest and secondary forest on podzolised soils, at low elevations.

2. **Maclurodendron porteri** (Hook. f.) T.G. Hartley
(G. Porter, first Curator of Waterfall Garden, Penang)

Fig. 7.

l.c. (1982) 8. **Basionym:** *Acronychia porteri* Hook. f. (1875) 498; Anderson *l.c.* 307. **Type:** Maingay Kew Distr. No. 280, Penang (lectotype K; isolectotypes BM, GH, L). **Synonyms:** *Jambolifera porteri* (Hook. f.) Kuntze, Rev. Gen. Pl. 1 (1891) 102; *Melicope unifoliolata* Merr., Philip. J. Sc. 13 (1918) Bot. 74, *l.c.* (1921) 314, Masamune *l.c.* 360.

Small to medium-sized tree to 25 m tall and 40 cm diameter; bole to 12 m tall. Branchlets glabrous or nearly so. **Leaves** obovate to oblanceolate or elliptic, 5–24 x 2–10 cm, thinly leathery, *drying pale brown to dark brown, glabrous or nearly so*; base narrow or acute, apex abruptly acuminate or occasionally rounded or acute; lateral veins 6–11 pairs; intercostal veins and reticulations faint; petioles 0.7–5 cm long **Inflorescences** 2–15 cm long; peduncle axis and branches sparsely hairy to glabrous, pedicels nearly glabrous, 1–7 mm long. **Flowers** 1.5–2 mm wide in bud; sepals 0.5–1 mm long, glabrous to hairy; *petals* 2–2.5 mm long, glabrous to hairy. **Fruits** 6–11 mm in diameter, nearly round to ovoid, often shallowly 4-lobed, often tipped. **Seeds** 4–8 mm long, *surface minutely reticulate, outer testa spongy*.

Vernacular name. Sarawak—*rawang* (Malay).

Distribution. Burma, Peninsular Thailand, Sumatra, Peninsular Malaysia, Singapore, Borneo, and the Philippines. Widespread in Sabah and Sarawak. Also in Brunei and Kalimantan.

Ecology. Locally on hillsides and ridges in primary mixed dipterocarp forest and occasionally in secondary forest and heath (*kerangas*) forest (in Sarawak), on low nutrient organic soils, from near sea-level to 1400 m.

Uses. The timber, while not durable, has been used for building purposes (Peninsular Malaysia).

3. **Maclurodendron pubescens** T. G. Hartley
(Latin, *pubescens* = hairy; the leaves and floral parts)

l.c. (1982) 11. **Type:** Patrick SAN 26359, Sabah, Sandakan district (holotype L; isotype K).

Small to medium-sized tree to 30 m tall and 35 cm diameter; bole to 18 m tall. *Branchlets hairy, becoming glabrous*. **Leaves** obovate to oblanceolate or elliptic, 11–23 x 5–11 cm, thinly leathery, *drying pale greenish brown to brown, pubescent below especially on the midrib and veins*, glabrous above; base narrow, apex acuminate to rounded; lateral veins 8–11 pairs; intercostal veins and reticulations faint; petioles 1.5–5 cm long. **Inflorescences** 3–11 cm long; peduncle axis and branches sparsely to densely hairy; pedicels hairy, 3–5 mm long. **Flowers** 1.5–2 mm wide in bud; sepals *c.* 7 mm long, hairy; petals *c.* 2 mm long, hairy below, glabrous to sparsely hairy above. **Fruits** 10–12 mm in diameter, nearly round to ovoid, shallowly 4-lobed, acute at the apex. **Seeds** 5–7 mm long, *surface minutely reticulate; outer testa spongy*.

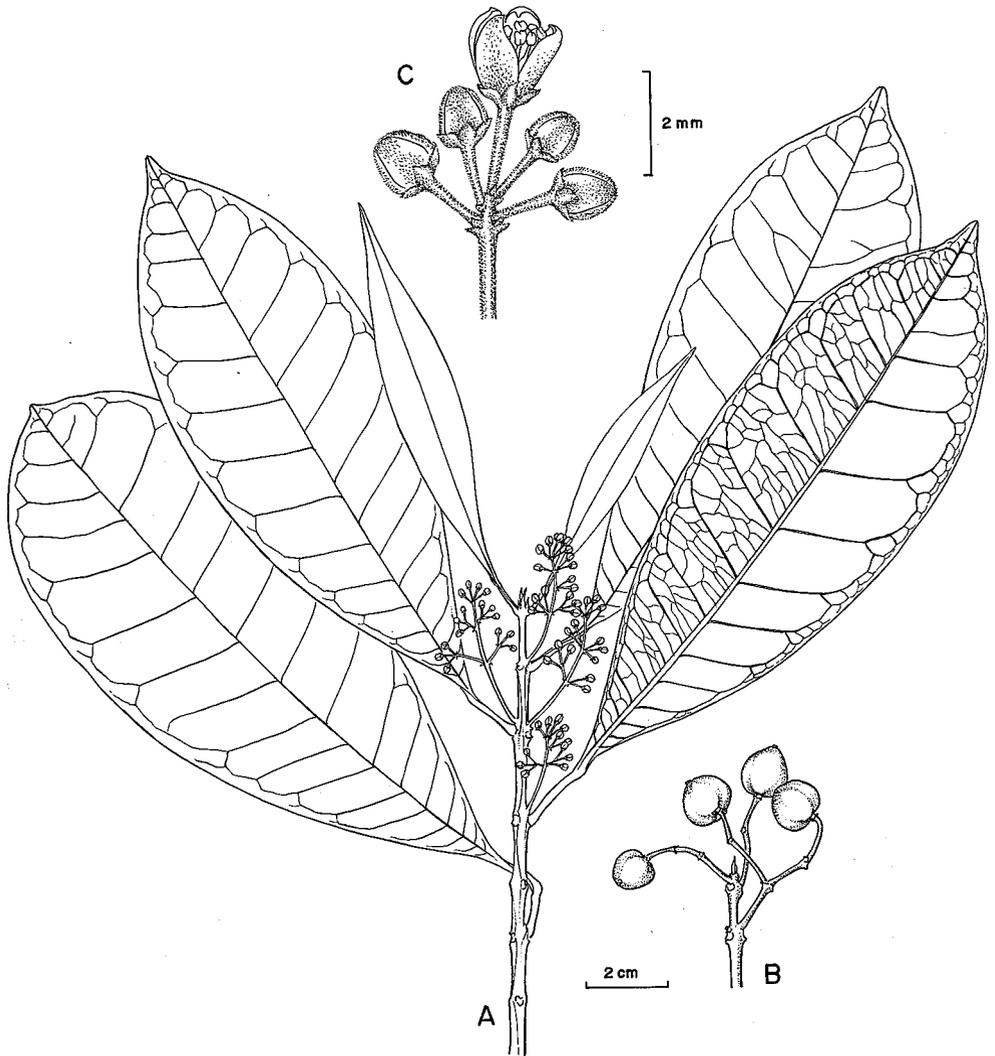


Fig. 7. *Macclurodendron porteri*. A, flowering leafy twig; B, part of inflorescence; C, fruits. (A & B from SAN 34008, C from SAN 55734.)

Distribution. Endemic to Sabah, where it is found in Sandakan (especially common in Leila and Sepilok-Kabili FR), Keningau, and Lamag districts.

Ecology. On ridges and hillsides in primary forest, from near sea-level to 140 m.

8. MELICOPE J.R. Forst. & G. Forst.

(Greek, *meli* = honey, *kope* = a cutting;
the emarginate lobes of the nectar-secreting disc)

serang (Malay)

Char. Gen. Pl. (1776) 55; Hooker *f. L.c.* (1875) 491; Kurz *L.c.* (1877) 181; King *L.c.* 212; Anderson *L.c.* 308; Hartley, Gard. Bull. Sing. 34 (1981) 91, Sandakania 4 (1994) 47; Hartley & Stone, Taxon 38 (1989) 199.

Shrubs or small to tall trees; dioecious in unisexual plants. Branches unarmed. **Leaves** *opposite or whorled, trifoliolate and/or unifoliolate*, petioles wingless; leaflets leathery or thinly so, margin mostly entire, articulated at the base. **Inflorescences** cymes or densely flowered panicles or solitary, axillary or on branchlets below leaves, rarely terminal or on stems. **Flowers** *small, bisexual or unisexual, 4-merous*; sepals 4, fused at base; petals 4, free, valvate or imbricate, white or cream to greenish or yellowish, rarely pink; stamens 4 or 8, rarely 4–8, free, rudimentary in female flowers; disc cushion- to ring-like or cupular; *ovary 4-carpellate, carpels fused completely or only at base*, rudimentary in male flowers, ovules (1–)2 per locule, styles united, rarely stylar branches divergent, stigma small to capitate or peltate, often lobed, or 4-branched. **Fruits** *of 1–4 basally fused follicles, erect or spreading at maturity, grading to a 4-locular capsule; endocarp cartilaginous, remaining attached in the dehisced follicle, fused to or separate from epicarp*. **Seeds** 1–2 per locule, not expelled from mature fruit at dehiscence; testa thick, hard, covered by a *shiny, black epidermis*; endosperm abundant; embryo straight or nearly so; cotyledons flat.

Distribution. About 230 species ranging from Madagascar to India, S China, throughout Malesia, Polynesia, the Hawaiian Islands, Australia and New Zealand. 14 species in Sabah and Sarawak.

Taxonomy. In his revision of the genus *Tetradium* Lour., Hartley (*L.c.* 1981) redefined *Melicope* and suggested transferring to it many of the species placed in the genus *Euodia* J. R. Forst. & G. Forst. As characterised by Hartley, *Melicope* and *Euodia* are largely differentiated on the basis of their seeds (smooth, shiny and remaining attached in the dehisced follicle in *Melicope*, and dull, rough and discharged from the follicle in *Euodia*), floral characteristics (bisexual or unisexual flowers with 4 or 8 stamens in *Melicope*, and bisexual flowers with 4 stamens in *Euodia*), and geographical ranges (*Euodia* has a narrower distribution, occurring in New Guinea, NE Australia, and east to Samoa and Hawaii). As a consequence of this new generic delimitation, there are no representatives of the genus *Euodia* in Sabah or Sarawak.

Key to *Melicope* species

1. Stamens 8. Seeds attached to dehiscent fruit by a partially detached strip of pericarp and/or raphe. Leaves trifoliolate and/or unifoliolate.....2
 Stamens 4. Seeds attached to dehiscent fruit by a funiculus. Leaves mostly trifoliolate, or (in *M. subunifoliolata*) sometimes uniformly unifoliolate.....4
2. Sepals shorter than 1 mm. Follicles 2–5 mm long. Leaves mostly trifoliolate.....**14. *M. triphylla***
 Sepals 1–2 mm long. Follicles 10–13 mm long. Leaves trifoliolate and/or unifoliolate.....3
3. Terminal bud glabrous. Petiolules 1–2 mm long.....**9. *M. jugosa***
 Terminal bud hairy. Petiolules 3–15 mm long.....**12. *M. sororia***
4. Flowers bisexual; stigma not lobed or wavy. Inflorescences axillary and/or on branchlets below leaves.....5
 Flowers usually unisexual; stigma lobed or wavy. Inflorescences axillary.....6
5. Leaflet-margin entire. Pedicels 4–8 mm long. Petals densely hairy above. Follicles 4–6 mm long.....**2. *M. bonwickii***
 Leaflets-margin entire or (in cultivated forms) lobed or wavy. Pedicels less than 3 mm long. Petals glabrous. Follicles 2–3 mm long.....**5. *M. denhamii***
6. Trichomes mostly simple.....7
 Trichomes mostly in bundles or star-shaped.....13
7. Leaflet-base cordate to rounded; petiolules lacking.....**10. *M. latifolia***
 Leaflet-base rounded or acute to narrowly tapered; petiolules lacking or up to 20 mm long.....8
8. Petals 1.3–1.8 mm long. Leaflets 1.5–5.5 cm wide.....9
 Petals 1.5–3 mm long. Leaflets 2.5–21 cm wide.....10
9. Leaflets glabrous or midrib sparsely hairy below. Follicles 7–9 mm long; epicarp subfleshy, becoming glabrous.....**3. *M. clemensiae***
 Leaflets glabrous above; midrib hairy to velvety below. Follicles 10–10.5 mm long; epicarp dry, hairy.....**13. *M. subunifoliolata***
10. Petals silky-hairy above. Raphe of seeds contorted.....**4. *M. confusa***
 Petals glabrous or sparsely hairy to hairy above, especially on lower half. Raphe of seeds not contorted.....11
11. Terminal leaflets obovate to broadly obovate, 7.5–16.5 cm long; apex abruptly acuminate; lateral veins 9–15 pairs. Follicles 3–4 mm long.....**6. *M. glabra***
 Terminal leaflets elliptic to obovate, 3.5–46 cm long; apex usually acuminate; lateral veins 8–24 pairs. Follicles 3–12 mm long.....12

2. **Melicope bonwickii** (F. Muell.) T.G. Hartley
(J. Bonwick, student of Australian geography)

l.c. (1994) 56. **Basionym:** *Euodia bonwickii* F. Muell., *Fragm.* 5 (1865) 56. **Type:** *Dallachy, s.n.*, Australia, Queensland, Rockingham Bay (holotype MEL). **Synonyms:** *Euodia speciosa* Rchb. f. & Zoll. *ex* Teijsm. & Binnen., *Nat. Tijds. Ned. Ind.* 29 (1867) 255; *E. villamilii* Merr., *Philip. J. Sc.* 9 (1914) Bot. 296.

Tree to 40 m tall. *Young branchlets glabrous or rarely sparsely hairy; terminal bud appressed hairy.* Trichomes simple. **Leaves** opposite, trifoliolate, petioles 2–14.5 cm long; leaflets elliptic to obovate, 10–30 x 5–15 cm, glabrous or sparsely hairy on veins below; base acute or narrowly tapered and sometimes asymmetric, apex acuminate; *lateral veins* 14–24 pairs, sometimes raised above, *sometimes with axillary cavities below*; petiolules lacking or to 4 mm long. **Inflorescences** on branchlets below leaves, rarely axillary, glabrous to sparsely hairy, 3.5–10 cm long; *pedicels 4–8 mm long.* **Flowers** bisexual; sepals nearly round, to 2 mm long, glabrous to sparsely hairy below; *petals pink or rarely white, ovate to elliptic or elliptic-oblong, 4–5.5 mm long, densely hairy above*; stamens 4, filaments glabrous; disc and ovary hairy to densely hairy, style glabrous, stigma capitate. **Fruits** of nearly round to obovoid follicles, 4–6 mm long; *epicarp dry, sparsely hairy to almost glabrous; endocarp glabrous.* **Seeds** nearly round to ellipsoid or nearly hemispherical, 3–4.5 mm long; *funiculus 1–3 mm long.*

Distribution. Java, Borneo, Philippines, and east to Papua New Guinea and Australia. In Sabah, in primary and secondary forest, from near sea-level to 750 m; also occurs in Kalimantan.

Uses. The bark is reported to be used in the treatment of leech bites (Indonesia).

3. **Melicope clemensiae** T.G. Hartley
(Mary S. Clemens, 1873–1968, plant collector of the Malesian region)

l.c. (1994) 64. **Type:** *Aban Gibot SAN 60767*, Sabah, Mt. Kinabalu Park (holotype L; isotype SAN).

Shrub or tree to 15 m tall. *Young branchlets and terminal buds glabrous, or nearly so, to velvety.* Trichomes mostly simple. **Leaves** opposite, trifoliolate (rarely unifoliolate); petioles 1.5–8 cm long; leaflets elliptic to obovate or oblanceolate, 5–16 x 2–5.5 cm, glabrous or midrib sparsely hairy below; base acute to narrowly tapered and often asymmetric, apex acuminate; *lateral veins* 11–18 pairs, raised above; petiolules 1.5–12 mm long. **Inflorescences** *axillary, laxly flowered*, 2.5–16 cm long, glabrous to somewhat velvety; *pedicels 2–5 mm long.* **Flowers** unisexual; sepals round to ovate-triangular, less than 1 mm long, hairy or glabrous below; petals ovate to elliptic, *c.* 1.5 mm long, glabrous; stamens 4, filaments glabrous; disc and ovary nearly glabrous to hairy, style glabrous, stigma weakly 4-lobed. **Fruits** of round to obovoid follicles, 7–9 mm long; *epicarp subfleshy, becoming glabrous; endocarp glabrous.* **Seeds** round, ovoid or ellipsoid, slightly compressed, 5–7 mm long; *funiculus 1.5–2 mm long.*

Distribution. Endemic to Sabah and Sarawak; in primary and secondary forest, on ridges and slopes, sometimes on limestone, from 650 to 1800 m.

4. *Melicope confusa* (Merr.) Liu

(Latin, *confusio* = disorder; referring to this taxon's long confusion with *Euodia glabra*)

Ill. Native Introd. Lign. Pl. Taiwan 2 (1962) 876; Hartley *l.c.* (1994) 59. **Basionym:** *Euodia confusa* Merr., Philip. J. Sc. 20 (1922) Bot. 391. **Type:** *Ramos BS 15055*, Philippines, Luzon, Laguna Province (A).

Tree to 30 m tall. Young branchlets glabrous to sparsely hairy; *terminal buds hairy to velvety*. Trichomes simple. **Leaves** opposite, trifoliolate; petioles 2.5–18.5 cm long; leaflets elliptic to obovate or ovate, 12–35 x 5–8 cm, glabrous to hairy below; base acute to narrowly tapered, rarely asymmetric, apex acuminate; lateral veins 11–24 pairs, raised to depressed above; petiolules 3–15 mm long. **Inflorescences** axillary, 6–30 cm long, peduncle glabrous to hairy, pedicels 1–3 mm long. **Flowers** *unisexual*; sepals nearly round or ovate, to 1 mm long, hairy below; *petals elliptic, 2.5–3 mm long, silky hairy above*; stamens 4, filaments sparsely hairy towards base or glabrous; disc and ovary hairy, style hairy at least basally, stigma weakly 4-lobed. **Fruits** *of round to ellipsoid follicles, 4.5–6 mm long, fused basally and erect or diverging; epicarp subfleshy, sparsely hairy or glabrate; endocarp glabrous. Seeds round to ovoid or ellipsoid, 3.5–4 mm long; funiculus 1–1.5 mm long, raphe contorted.*

Distribution. Borneo, Philippines, Celebes and Moluccas. In Sabah, found mainly in primary and secondary forest, from near sea-level to 90 m; no record from Sarawak.

Uses. The bark is used medicinally for treating enlargement of the spleen (Philippines); a decoction of the root or leafy shoot with liquor is ingested to treat hives (Taiwan).

5. *Melicope denhamii* (Seemen) T.G. Hartley

(H. M. Denham, the 19th century British sea captain)

l.c. (1994) 57. **Basionym:** *Picrasma denhamii* Seemen, Fl. Vit. (1865) 33. **Type:** *McGillivray 46*, New Hebrides, Aneitum (holotype BM). **Synonyms:** *Euodia tenuistyla* Stapf, Trans. Linn. Soc. Bot. 4 (1894) 137, Merrill *l.c.* (1921) 314, Masamune *l.c.* 359; *E. ridleyi* Hochr., Icon Bog. 2 (1905) 151; *E. schullei* var. *ridleyi* (Hochr.) Lauterb., Bot. Jahrb. 55 (1918) 230; *E. suaveolens* var. *ridleyi* (Hochr.) Bakhuizen f., Blumea 6 (1950) 365.

Shrub or tree to 25 m tall. *Young branchlets and terminal buds glabrous to densely hairy or velvety*. Trichomes simple, star-shaped or in bundles. **Leaves** opposite, trifoliolate (occasionally unifoliolate); petioles 1–16 cm long; leaflets elliptic, 10–19 cm long, sparsely hairy to hairy on midrib and veins below; base cuneate to narrowly tapered, apex acuminate; lateral veins 15–22 pairs, raised or depressed above; petiolules lacking or up to 1 cm long. **Inflorescences** axillary and/or on branchlets below leaves, 2–7 cm long, hairy, pedicels 0.2–2.3 mm long. **Flowers** *bisexual*; *sepals ovate to triangular, to 0.8 mm long, glabrous to hairy below; petals ovate-elliptic or elliptic, 1.2–2.2 mm long, glabrous*; stamens 4, filaments glabrous; disc glabrous; ovary hairy, style glabrous to sparsely hairy, stigma capitate. **Fruits** *of nearly round follicles, 2–3 mm long; epicarp dryish, glabrous to sparsely hairy; endocarp glabrous. Seeds nearly round or hemispherical, 1.5–2.5 mm long; funiculus to 1.5 mm long.*

rounded or abruptly acuminate, lateral veins 7–11 pairs, sometimes raised above; petiolules 1–2 mm long; leaflets of unifoliolate leaves elliptic or rarely elliptic-obovate, to 13.5 x 6 cm, base rounded or rarely acute, lateral veins 9–13 pairs; petiolules lacking, or similar to that of trifoliolate leaves. **Inflorescences** axillary, glabrous to sparsely hairy, 1–2 cm long; pedicels to 3.5 mm long. **Flowers** unisexual; sepals nearly round or ovate, to 2 mm long, sometimes ciliolate; petals elliptic, to 4 mm long; *stamens* 8; stigma capitate, weakly 4-lobed. **Fruits** glabrous, follicles ellipsoid, c. 10 mm long; *epicarp* dry. **Seeds** ellipsoid, c. 8 mm long.

Distribution. Endemic to Sabah, in forest from 2250 to 2400 m.

10. *Melicope latifolia* (DC.) T.G. Hartley

(Latin, *latus* = broad, *folium* = leaf)

l.c. (1994) 72. **Basionym:** *Euodia latifolia* DC. *l.c.* 724, Merrill *l.c.* (1921) 314, Masamune *l.c.* 358, Anderson *l.c.* 308. **Type:** *Doleschall 335*, Moluccas, Ambon (neotype W).

Shrub or tree to 30 m tall. *Young branchlets and terminal buds glabrous to softly hairy.* Trichomes simple. **Leaves** opposite, trifoliolate (occasionally unifoliolate); petioles 4–29 cm long; leaflets elliptic to ovate or obovate, 8–37 x 3–19 cm, glabrous to hairy above and below; base cordate to rounded, sometimes asymmetric, apex acuminate; *lateral veins 14–31 pairs*, raised to slightly depressed above; petiolules lacking. **Inflorescences** axillary, often densely flowered, 5–24 cm long, *glabrous to softly hairy*; pedicels lacking or to 3 mm long. **Flowers** unisexual, sometimes bisexual; *sepals* ovate to triangular or rounded, to 1.5 mm long, *softly hairy below*; petals ovate to elliptic, 2–4 mm long, glabrous to hairy below; *stamens* 4, filaments glabrous; disc more or less glabrous; ovary glabrous to hairy, style glabrous, stigma 4-lobed or wavy. **Fruits** of elliptic follicles, 3.5–4.5 mm long, *sometimes fused up to full length*; *epicarp* dry, glabrous to sparsely hairy; *endocarp* glabrous. **Seeds** round to ellipsoid or hemispherical, 2–3 mm long; funiculus 0.5–1.5 mm long.

Distribution. Peninsular Malaysia, Java, Borneo, Phillipines, Papua New Guinea and east to Samoa. In Sabah, in primary and secondary forest and open places, from near sea-level to 600 m. No record from Sarawak.

Uses. The leaves have been used for treating fever and cramps (Peninsular Malaysia, Indonesia). Resin collected from the trunk has been used as a varnish and adhesive (Indonesia).

11. *Melicope lunu-ankenda* (Gaertn.) T.G. Hartley

(the Sri Lankan name for this species)

l.c. (1994) 61. **Basionym:** *Fagara lunu-ankenda* Gaertn., *Fruct. Sem. Pl.* 1 (1788) 334. **Type:** *Koenig, s.n.*, Ceylon (holotype L). **Synonyms:** *Euodia aromatica* Blume *l.c.* (1825) 246; *Zanthoxylum aromaticum* (Blume) Miq. *l.c.* (1859) 670; *Ampacus aromatica* (Blume) Kuntze *l.c.* 98; *Zanthoxylum roxburghianum* Cham., *Linnaea* 5 (1830); *E. roxburghiana* (Cham.) Benth., *Fl. Hongk.* (1861) 59; *Ampacus roxburghiana* (Cham.) Kuntze *l.c.* 98; *E. lunu-ankenda* (Gaertn.) Merr., *Philip. J. Sc.* 7

(1912) Bot. 378, Merrill *l.c.* (1921) 314, Anderson *l.c.* 308; *E. arborea* Elmer, Leaflet. Philip. Bot. 8 (1915) 2806; *E. malayana* Ridl. *l.c.* (1922) 342, Masamune *l.c.* 358, Anderson *l.c.* 308; *E. punctata* Merr., J. Str. Br. R. As. Soc. 86 (1922) 315, *l.c.* (1929) 113, Masamune *l.c.* 358, Anderson *l.c.* 308; *E. triphylla* var. *pubescens* Ridl. *l.c.* (1930) 77, Masamune *l.c.* 359; *E. concinna* Ridl. *l.c.* (1930) 78, Masamune *l.c.* 358; *E. obtusifolia* Ridl. *l.c.* (1930) 78, Masamune *l.c.* 358.

Shrub or tree to 30 m tall. Young branchlets glabrous to velvety; *terminal buds sparsely hairy to velvety*. Trichomes mostly simple. **Leaves** opposite, trifoliolate (occasionally unifoliolate); petioles 1.5–15 cm long; leaflets elliptic to obovate, 3.5–23 x 2.5–7 cm, glabrous or nearly so; base rounded to narrowly tapered and often asymmetric, apex acute to acuminate, rarely rounded or emarginate; lateral veins 8–17 pairs, sometimes raised above; petiolules 0.5–15 mm long. **Inflorescences** axillary, 2–32 cm long with main branches ascending, glabrous to velvety; pedicels 0.3–3 mm long. **Flowers** unisexual, rarely bisexual; sepals round to ovate-triangular, 0.5–1.2 mm long, glabrous to hairy below; petals ovate to elliptic, 1.5–3 mm long, glabrous to sparsely hairy below, hairy above on lower half or glabrous; stamens 4, filaments hairy at base or glabrous; *disc glabrous to densely hairy or velvety*; ovary nearly glabrous to densely hairy, style glabrous to hairy, stigma weakly 4-lobed. **Fruits** of ellipsoid to obovoid follicles, 6–10 mm long (9–12 mm long in montane plants); *epicarp subfleshy, glabrous*; endocarp glabrous. **Seeds** round to ovoid or ellipsoid, sometimes compressed, 3–6 mm long; funiculus 0.5–3 mm long.

Distribution. Himalayas, Sri Lanka, Java, Borneo, SW Philippines, and Celebes. In Sabah and Sarawak, common in primary and secondary well-drained or swampy forest and montane shrubbery, from near sea-level to 2200 m. Also known from Brunei and Kalimantan.

Taxonomy. Hartley (*l.c.* 1994) recognises lowland and montane variants of this species. Plants from montane habitats have larger follicles and more leathery leaflets, usually with rounded to abruptly tipped apices. Because the two intergrade, they are treated as a single taxon.

Uses. The roots are reportedly used to treat colds and rheumatism (Taiwan), and the leaves and flowers for menstrual disorders and fever (Peninsular Malaysia). Its timber is weak but used in construction. The leaves are eaten as a condiment and have been used to flavour food.

12. *Melicope sororia* T.G. Hartley

(Latin, *sororius* = sisterly; referring to its close relationship to *Melicope jugosa*)

l.c. (1994) 53. **Type:** *J. & M.S. Clemens 29477*, British North Borneo, Mt. Kinabalu, Tenompok (holotype NY; isotypes A, B, BO, L, UC).

Shrub or small tree to 5 m tall. *Young branchlets glabrous, rather corky; terminal bud hairy*. Trichomes mostly simple. **Leaves** opposite, trifoliolate and/or unifoliolate, *rarely bifoliolate*, glabrous, petioles 1–10 cm long; leaflets of trifoliolate leaves elliptic to obovate, 6.5–14 x 3–6 cm, base acute to narrowly tapered and somewhat asymmetric, *margin entire or less commonly toothed toward apex*, apex acuminate or rarely rounded, lateral veins 7–

11 pairs, sometimes raised above, petiolules 3–15 mm long; leaflets of unifoliolate leaves to 16 x 8 cm, petiolule to 1 cm long, otherwise similar to leaflets of trifoliolate leaves. **Inflorescences** axillary, glabrous, 2.5–10 cm long; pedicels to 3.5 mm long, sparsely hairy. **Flowers** unisexual; sepals nearly round or ovate or elliptic, to 1.5 mm long, sometimes ciliate; petals elliptic, to 2.5 mm long; *stamens* 8; stigma capitate, weakly 4-lobed. **Fruits** glabrous, *follicles ellipsoid, 10–13 mm long; epicarp dry. Seeds ellipsoid, 9–10 mm long.*

Distribution. Endemic to Sabah, occurring in forest from 1500 to 2400 m.

13. *Melicope subunifoliolata* (Stapf) T.G.Hartley

(Latin, *sub* = nearly, *unus* = one, *folium* = leaf; the almost unifoliolate leaves)

l.c. (1994) 66. **Basionym:** *Euodia subunifoliolata* Stapf *l.c.* 138, Merrill *l.c.* (1921) 314, Masamune *l.c.* 359. **Type:** *Haviland 1193*, British North Borneo, Mt. Kinabalu (holotype K).

Shrub or tree to 15 m tall. *Young branchlets hairy to velvety; terminal buds velvety.* Trichomes mostly simple. **Leaves** opposite, trifoliolate and/or unifoliolate, glabrous above, *hairy to velvety on midrib* (sparsely hairy on veins) below; petioles 1–9 cm long; leaflets of trifoliolate leaves elliptic to obovate, 5–15.5 x 1.5–5.5 cm, base acute to narrowly tapered, apex acuminate, lateral veins 10–20 pairs, sometimes raised above, petiolules 0.5–10 mm long; leaflets of unifoliolate leaves elliptic-obovate, to 8.5 x 3.5 cm, base acute, lateral veins 11–14 pairs, otherwise similar to leaflets of trifoliolate leaves. **Inflorescences** axillary, *laxly flowered*, 3–13 cm long, hairy to velvety; pedicels 1–2.5 mm long. **Flowers** unisexual; sepals ovate to triangular, 0.7–1.5 mm long, hairy below; petals elliptic to ovate, 1.3–1.8 mm long, glabrous; *stamens* 4, filaments glabrous; ovary and top of disc hairy, style hairy at base, stigma weakly 4-lobed. **Fruits** *of ellipsoid follicles, 10–10.5 mm long; epicarp dry, hairy; endocarp glabrous. Seeds round to ovoid, sometimes compressed, 5–6.3 mm long; funiculus 0.5–1.5 mm long.*

Distribution. Endemic to Sabah, occurring in primary montane forest, often on ridges and slopes, from 1200 to 2600 m, and sometimes descending to 180 m.

14. *Melicope triphylla* (Lam.) Merr.

(Greek, *treis* = three, *phyllon* = leaf; having trifoliolate leaves)

l.c. (1912) 375; Anderson *l.c.* 309; Hartley *l.c.* (1994) 54. **Basionym:** *Fagara triphylla* Lam., *Encycl.* 2 (1788) 375. **Type:** *Sonnerat, s.n.*, Philippines (holotype P). **Synonyms:** *Euodia triphylla* (Lam.) DC. *l.c.* 724; *Zanthoxylum triphyllum* (Lam.) G. Don, *Gen. Hist.* 1 (1831) 804; *Ampacus triphylla* (Lam.) Kuntze *l.c.* 98.

Shrub or tree to 15 m tall. *Young branchlets glabrous to hairy, sometimes glaucous; terminal bud glabrous to velvety hairy.* Trichomes, if present, simple. **Leaves** opposite, mostly trifoliolate, petioles 3–11 cm long; *leaflets* elliptic to oblanceolate, 8–25 x 2.5–6 cm, *glabrous*; base acute to narrowly tapered and sometimes asymmetric, apex acuminate; lateral veins 7–19(–25) pairs, sometimes raised above; petiolules 2–15 mm long. **Inflorescences** axillary and/or on branchlets below leaves, glabrous to hairy, 1–11 cm long.

pedicels lacking or to 4 mm long. **Flowers** unisexual; sepals ovate-triangular, to 0.8 mm long, apex sometimes sparsely hairy; petals lanceolate to ovate or elliptic, to 3.5 mm long; *stamens* 8, *filaments sparsely hairy or glabrous*; disc hairy or glabrous; ovary glabrous, stigma capitate, 4-lobed. **Fruits** *glabrous, follicles ellipsoid or nearly round, 2.5–5 mm long; epicarp subfleshy*. **Seeds** *nearly round to ellipsoid, 2.4–4.5 mm long*.

Distribution. Taiwan and Ryukyu Islands, south to Borneo, and east to Papua New Guinea. In Sabah and Sarawak, in primary and secondary forest, from near sea-level to 1300 m. Also in Kalimantan.

9. MEROPE Roem.

(Merope of Greek mythology, one of the Heliades)

Syn. Hesper. 1 (1846) 44; Backer & Bakhuizen *f. l.c.* 106; Swingle *l.c.* (1967) 258; Stone *l.c.* (1972) 382, *l.c.* (1978) 115.

Shrubs or small trees. Branches armed with axillary, solitary or paired spines. **Leaves** alternate, unifoliolate, *leathery*; petioles short, stout, wingless, articulated with the blade. **Inflorescences** 1(–2)-flowered, rarely few-flowered, axillary. **Flowers** bisexual, 4–5-merous; calyx cup-like, 5-lobed; petals 5(–6), free, imbricate in bud; stamens 10, free, equal; ovary ovoid, 3(–4)-carpellate, on a tall gynophore, ovules 2–4 per locule, style short, thick, stigma flat. **Fruit** *an ovoid, angular berry, with 3–4-flattened sides; pericarp thick, glandular, strongly aromatic when crushed, filled with sticky clear fluid*. **Seeds** *few to many per fruit, oblong, flattened, overlapping*.

Distribution. One species, ranging from Burma to Indo-China and throughout Malesia. Found in Sabah and Sarawak.

Ecology. A widely scattered, highly specialised genus which thrives in the saline soil of tidal forests and mangrove swamps, often on the banks of streams. The tides aid in the dispersal of the buoyant fruits.

Merope angulata (Willd.) Swingle

Fig. 9.

(Latin, *angulatus* = angled; the fruit)

J. Wash. Ac. Sc. 5 (1915) 420, *l.c.* (1967) 258; Backer & Bakhuizen *f. l.c.* 106; Stone *l.c.* (1972) 382, *l.c.* (1978) 115. **Basionym:** *Citrus angulata* Willd., Sp. Pl. ed. 4, 3 (1800) 1426. **Type:** *Limonellus angulosus* Rumph., Herb. Amboin. 2 (1741) 110. **Synonyms:** *Sclerostylis spinosa* Blume *l.c.* (1825) 134; *Paramignya longispina* Hook. *f. l.c.* (1875) 511; *P. angulata* (Willd.) Kurz, J. As. Soc. Beng. 44 (1875) 135.

Erect shrub or small tree to 3 m tall and 10 cm diameter, often with multiple stems arising from a root crown. Branches sparse, with paired, rarely solitary, stout spines, to 5 cm long on juvenile stems. **Leaves** *oblong-ovate to obovate, 4.5–16 x 2–6 cm, thick, glabrous*; base rounded, margin subentire to faintly notched, apex acute or shortly acuminate; midrib

prominent below; lateral veins and reticulations inconspicuous; petioles 5–7 mm long. **Inflorescences** 1(–2)-flowered, glabrous; pedicels short. **Flowers** small, fragrant, buds ovoid; sepals triangular, c. 1 mm long, glabrous; petals oblong-lanceolate, 7–9 mm long, glabrous, white; filaments glabrous, white, anthers linear-oblong, yellow; ovary slender, glabrous. **Fruits** ovoid to ellipsoid, 3–4.5 cm long, 3–4-sided in cross-section, apex bluntly acuminate, green when ripe. **Seeds** 2–3 cm long, somewhat reniform, tapering to a blunt point; testa rough; cotyledons green.

Vernacular names. Sabah and Sarawak—*limau buaya*, *limau laut* (Malay).

Distribution. Throughout the range of the genus. In Sabah and Sarawak, occurs in rather small but dense populations in inland areas of tidal swamps and mangrove forest, often on the edges of streams and on riverbanks, and usually in association with Nipa palm (*Nypa fruticans*).

Uses. The fruits are used for the treatment of stomach disorders and colic (Peninsular Malaysia).

10. MERRILLIA Swingle

(E. D. Merrill, 1876–1954, American botanist)

l.c. (1918) 337, *l.c.* (1967) 240; Ridley *l.c.* (1922) 353; Craib *l.c.* 231; Burkill *l.c.* (1966) 1481; Stone *l.c.* (1972) 382; Corner *l.c.* 667; Stone & Jones *l.c.* (1988) 268.

Trees; crown rather bushy; trunk and main branches covered with pale fissured bark; branches unarmed. **Leaves** alternate, pinnate; leaflets 5–13, lower ones small, higher ones increasingly larger, terminal leaflet largest, thinly leathery, articulated at the base; rachis flattened, narrowly winged. **Inflorescences** axillary, 1–2-flowered. **Flowers** bisexual, large, slightly irregular, 5-merous; calyx cup-like, sepals 5, small; petals 5, free, long, imbricate; stamens 10, free, unequal; ovary 5(–6)-carpellate, bottle-shaped, on a well-developed gynophore, ovules 8–10 per locule, style long, slender, stigma capitate. **Fruit** a subglobose to oblong or ellipsoid berry; pericarp thick, resinous, 5-chambered, chambers with cartilaginous walls and filled with clear mucilage. **Seeds** numerous, flattened, densely scaly; cotyledons plano-convex.

Distribution. One species; S Thailand, Sumatra, Peninsular Malaysia, and Borneo (Sabah).

Ecology. Scattered as solitary trees on stream banks and slopes of hills and ridges, in moist primary and secondary forest, to 400 m.

Taxonomy. This anomalous genus contains a number of metabolites in common with *Murraya* sect. *Murraya* (Kong *et al.*, Biochem. Syst. Ecol. 16 (1988) 47). One of these metabolites, *yuehchukene*, is of particular interest because of its anti-implantation effect in rats. Swingle (*l.c.* 1967) suggested a possible origin of the genus from a *Murraya*-like ancestor. Morphologically, there are a number of similarities between *Merrillia* and

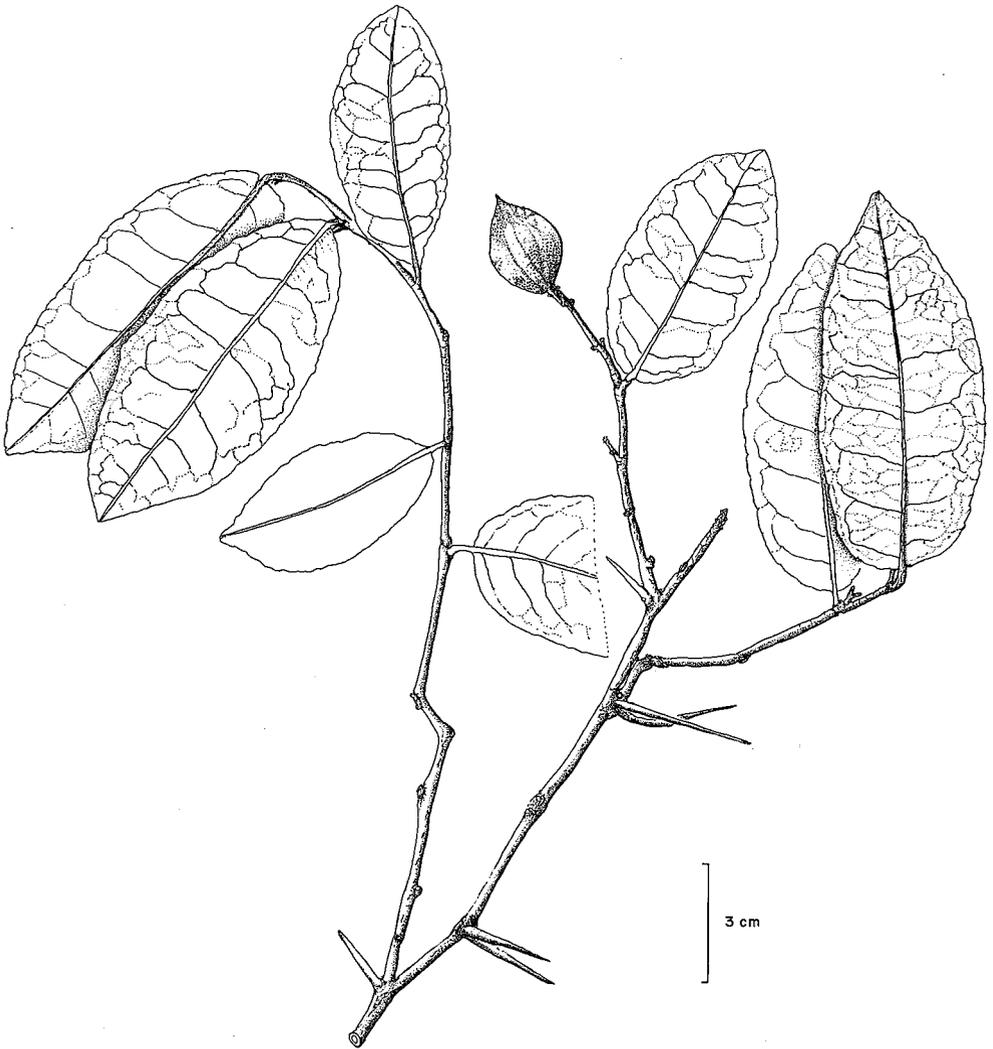


Fig. 9. *Merope angulata*. Fruiting leafy twig. (From S. 34375.)

Murraya sect. *Murraya*. Both have yellowish stem- and root-bark, and some species of sect. *Murraya* possess a winged leaf-rachis and densely villous seeds, characteristics found also in *Merrillia caloxylon*. The two differ markedly, however, in the size and shape of their flowers and fruits.

Merrillia caloxylon (Ridl.) Swingle
(Greek, *kalos* = beautiful, *xylon* = wood)

Fig. 10.

l.c. (1918) 338, *l.c.* (1967) 241; Ridley *l.c.* (1922) 354; Craib *l.c.* 231; Burkill *l.c.* (1966) 1481; Stone *l.c.* (1972) 383; Corner *l.c.* 667; Stone & Jones *l.c.* 68; Ng *l.c.* 495. **Basionym:** *Murraya caloxylon* Ridl., J. Str. Br. R. As. Soc. 50 (1908) 113. **Type:** *Wray & Robinson 5548*, Upper Perak, Kenering (holotype BM; isotypes SING, US).

Small to medium-sized tree to 20 m tall and 25 cm diameter; bole short. **Leaves** to 20 cm long; leaflets usually 7–9, alternate to subopposite, *lowest leaflets stipule-like, larger laterals elliptic, 7.5–9 x 4 cm*; base triangular and slightly asymmetric, margin wavy to slightly toothed, apex acuminate; petiolules nearly lacking. **Inflorescences** usually 1-flowered. **Flowers** *pendulous, trumpet-shaped*; sepals triangular or ovate, to 2.5 mm long; petals oblanceolate, gradually tapering to a narrow base, 2.5–5.5 cm long, greenish-white; ovary and style hairy. **Fruits** *c. 11 x 9 cm or larger; pericarp c. 13 mm thick, leathery, warty, greenish becoming yellow*. **Seeds** 8–10 per chamber, lens-shaped, *c. 13 x 3 mm, scales membranous, flattened, slightly fimbriate*.

Distribution. Throughout the range of the genus. In Sabah, collected only once from the bank of a stream in secondary forest at 20 m (*Junaidi Payne, s.n.*, Sandakan, Ulu Gum Gum; SAN).

Uses. In Peninsular Malaysia, the durable, handsome wood, which is yellow with dark brown streaks, has been used to make walking sticks, smoking pipes, *parang* handles and sheaths, and other small objects.

11. MICROMELUM Blume

(Greek, *mikros* = small, *melon* = apple; the shape of the fruits)

l.c. (1825) 137; Hooker *f. l.c.* (1875) 501; Kurz *l.c.* (1875) 136; King *l.c.* 218; Ridley *l.c.* (1922) 351; Merrill *l.c.* (1929) 114; Craib *l.c.* 227; Masamune *l.c.* 360; Backer & Bakhuizen. *f. l.c.* 103; Burkill *l.c.* (1966) 1492; Swingle *l.c.* (1967) 197; Stone *l.c.* (1972) 383; Anderson *l.c.* 309; Perry *l.c.* 366; Corner *l.c.* 667; Whitmore, Tantra & Sutisna *l.c.* 307.

Shrubs or trees; branches unarmed. **Leaves** alternate, pinnate, rachis wingless; leaflets (1–) 7–15(–23), laterals alternate, subchartaceous to thinly leathery, *usually obliquely asymmetric and articulated at the base*. **Inflorescences** *terminal, flat-topped paniculate corymbs*, often very large, flowers numerous. **Flowers** bisexual, 5-merous; calyx cup-like,



Fig. 10. *Merrillia caloxylon*. A, leafy twig; B, flowering shoot; C, fruit. (All from fresh material from a cultivated tree at the Forest Research Institute Malaysia; Non-Dipterocarp Arboretum D13 – Tree No. 213.)

sepals triangular, small; petals oblong-linear, free, valvate; stamens 10, alternately long and short, filaments linear, glabrous, anthers ovate, sub-basifixed; disc annular; ovary 2–6-carpellate, glabrous to densely hairy, radial walls often twisted, one oil-gland over each locule, ovules 2 per locule, style slender, constricted at the base, detaching from ovary, stigma flattened to subglobose. **Fruit** a subglobose or oblong berry, dryish; pericarp thin, glandular, glabrate to hirsute. **Seeds** ellipsoid; *cotyledons thin, folded*.

Distribution. About 10 species; from W Pakistan, India and Sri Lanka to S China, and south through Indo-China and Malesia to Australia, New Caledonia and S Pacific. One species, *M. minutum*, in Sabah and Sarawak.

Micromelum minutum (G. Forst.) Wight & Arn.
(Latin, *minutus* = small; the flowers)

Fig. 11.

l.c. (1834) 93; Craib *l.c.* 227; Masamune *l.c.* 360; Backer & Bakhuizen *f. l.c.* 103; Burkill *l.c.* (1966) 1493; Swingle *l.c.* (1967) 203; Stone *l.c.* (1972) 383; Anderson *l.c.* 309; Perry *l.c.* 366; Corner *l.c.* 668; Whitmore, Tantra & Sutisna *l.c.* 307; Ng *l.c.* 496. **Basionym:** *Limonia minuta* G. Forst., Prodr. (1786) 33. **Type:** *Forster, s.n.*, Friendly Islands (BM). **Synonyms:** *Micromelum pubescens* Blume *l.c.* (1825) 138, Merrill *l.c.* (1929) 114, Masamune *l.c.* 361, Anderson *l.c.* 309; *M. glabrescens* Benth. in Hooker, Lond. J. Bot. 2 (1843) 212.

var. **minutum**

Shrub or small to medium-sized tree to 20 m tall and 15 cm diameter. Young branchlets densely short-hairy, the trichomes greyish. **Leaves** to 30 cm long or more; leaflets 9–15, ovate-lanceolate, 3–12 x 1.5–6 cm, thinly leathery, *sometimes drying almost black*, subglabrous to shortly hairy on veins below; *base obtuse and asymmetric*, margin entire or wavy to shallowly dentate-crenate, apex attenuate-acuminate; lateral veins 5–8 pairs; petiolules to 5 mm long. **Inflorescences** 13–20 cm long, hairy; bracts short deltoid-linear; pedicels to 5 mm long. **Flowers** small; sepals shortly hairy, sometimes glabrate; petals to 5–8 mm long, spreading, hairy below, pale green or yellowish-white; staminal filaments to 9 mm long, narrowed at apex, white; ovary cylindrical, 5-carpellate, *c.* 1.5 mm long, hairy becoming glabrous, style glabrous or sparingly hairy, stigma flattened to subcapitate. **Fruits** ellipsoid-oblong, to 1 cm long, glabrate, yellow or red when ripe. **Seeds** *with green, wrinkled cotyledons*.

Distribution. Sri Lanka, Indo-China, Peninsular Malaysia, Borneo, Philippines, Papua New Guinea, NE Australia and the Pacific. A variable species with four varieties, the most widespread of which, var. *minutum*, occurs in Sabah and Sarawak. The var. *minutum* is scattered in Sabah and Sarawak, in primary and secondary forest on low undulating ground, disturbed open sites, and forest margins, and frequently on limestone outcrops and sandy coasts of the mainland and islands, from near sea-level to 600 m.

Uses. The roots and leaves are used in treating scabies, intermittent fever, headache, and menstrual disorders (Indo-China, Peninsular Malaysia, Philippines). Its light, durable timber is used for construction purposes (Peninsular Malaysia).



Fig. 11 *Micromelum minutum* var. *minutum*. Fruting leafy twig. (From SAN 93274.)

12. **MONANTHOCITRUS** Tanaka

(Greek, *monos* = single, *anthos* = flower)

J. Arn. Arb. 9 (1928) 138; Swingle *l.c.* (1967) 252; Stone *l.c.* (1985) 216; Stone & Jones *l.c.* (1988) 268.

Erect shrubs to small trees. Branches slender, armed, *spines axillary and paired or single, unequal in length*, rarely unarmed. **Leaves** *alternate, simple*; petioles short, wingless, not articulated with the blade. **Inflorescences** *axillary, usually solitary*. **Flowers** *small, bisexual, 5-merous*, buds ovoid or ellipsoid; calyx cup-like, slightly lobed, sepals 5, imbricate; petals 5, ovate, imbricate; stamens 10, equal, free, anthers oblong-linear; disc annular; ovary 3-5-carpellate, globose to oblong, glabrous to sparsely hairy, ovules 2-10 per locule, style stout, stigma 3-5-lobed. **Fruit** a globose to ovoid or pyriform berry; pericarp somewhat leathery, thin, glandular. **Seeds** 6-10 per fruit, *tightly packed in the locules and embedded in mucilage or scant pulp*, flattened to concave or plano-convex, with or without thin membranous margin; testa sometimes spotted.

Distribution. 4 species; Borneo, Irian Jaya, and Papua New Guinea. One species, *M. oblanceolata*, in Sabah.

Taxonomy. Proposed by Tanaka in 1928, the genus remained monotypic until 1985, when Stone described a new species, *M. bispinosa*, and transferred one other from *Wenzelia* Merr., a related genus occurring in the Philippines, Irian Jaya, Papua New Guinea, and Fiji. The two genera were originally distinguished chiefly on the character of the seeds (margin laciniate-membranous and testa spotted in *Monanthocitrus*, and margin thin-membranous and testa not spotted in *Wenzelia*). These differences do not hold up between the genera as here understood, and their distinctness now remains somewhat problematical. The size of the flowers (generally smaller in *Monanthocitrus*) and nature of the spines (generally paired and subequal in *Monanthocitrus*) may be more significant characters, but conclusive analysis will depend upon the availability of new material.

Monanthocitrus oblanceolata Stone & Jones
(Latin, *ob* = reversed, *lancea* = spear; the leaf shape)

Fig. 12.

l.c. 268. **Type:** *Abu Bakar SAN 36203*, Sabah, Sandakan, Labuk Road (holotype SAN; isotypes K, L).

Shrub or small tree to 5 m tall. Bark smooth, dark brown. Spines paired, 5-40 mm long or more. *Leafy stems zig-zag*. **Leaves** *oblong-oblanceolate* or narrowly subelliptic, 4-20 x 1.5-7 cm, thinly leathery; base subcuneate or obtuse or subcordate, margin entire, *apex acuminate-caudate*, tip to 26 mm long; midrib below prominent, sparsely hairy; lateral veins clearly visible, 8-10 pairs; reticulations obscure; petioles 2.5-7 mm long. **Inflorescences** 1(-2)-flowered; pedicels to 5 mm long. **Flowers** with calyx *c.* 2 mm wide, sepals ovate-triangular, *c.* 1 mm long, margin minutely ciliate; petals subelliptic, *c.* 5 mm long, glabrous, whitish; staminal filaments *c.* 1.5 mm long, anthers with a minutely glandular-apiculate apex; ovary narrowly bottle-shaped, 3-4-carpellate, sparsely hairy, style cylindrical,

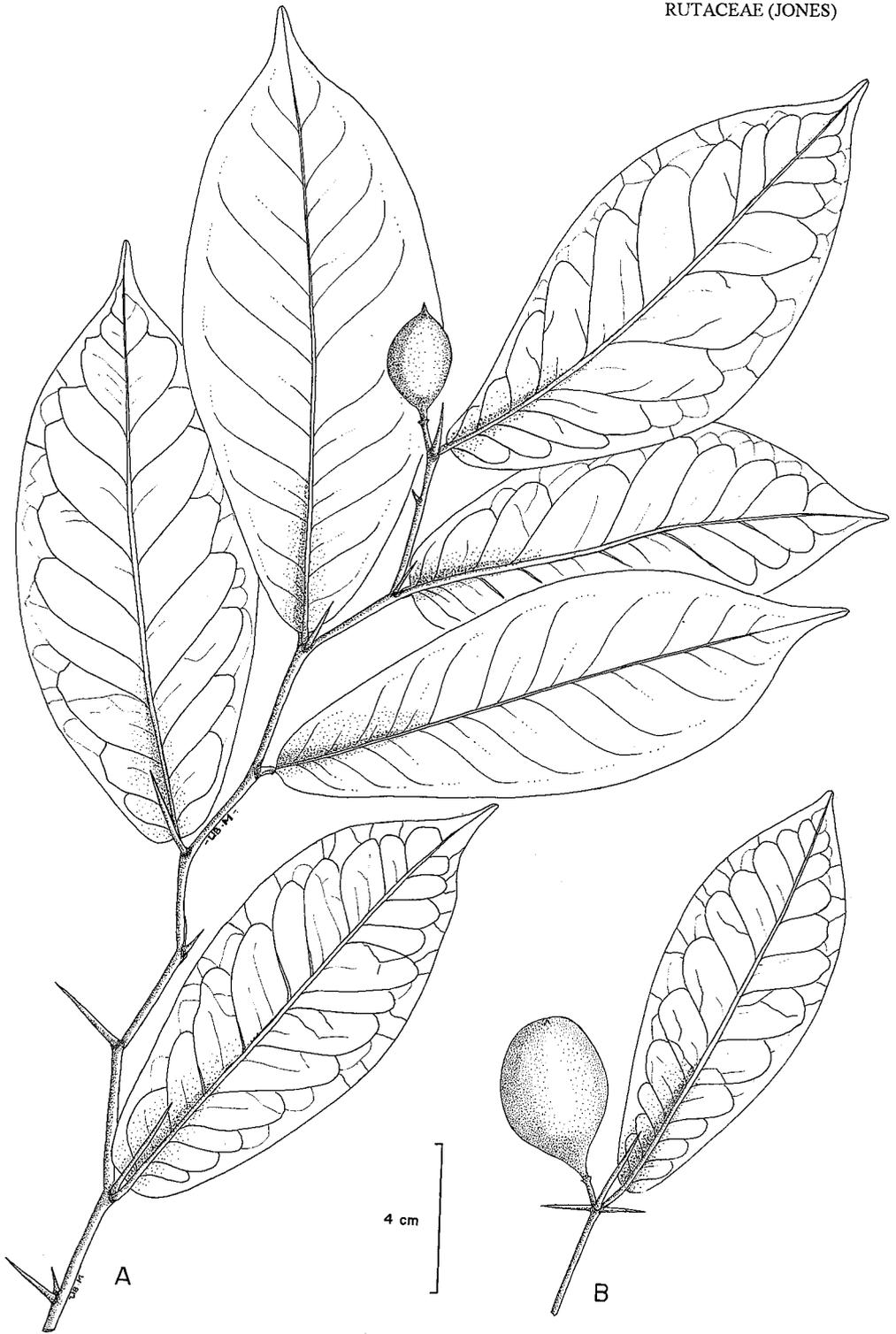


Fig. 12. *Monanthocitrus oblanceolata*. A, fruting leafy twig; B, detail of shoot with three spines. (A from SAN 57242, B from SAN 87022.)



Fig. 13. *Murraya paniculata*. A, fruiting leafy twig; B, inflorescence; C, flower. (From SAN 50299.)

stigma minutely lobed. **Fruits** obovoid or pyriform, to 5 x 2.8 cm, beaked; pericarp yellow-orange, smooth, on pedicels to 1 cm long. **Seeds** 8–10 per fruit, embedded in whitish, sweet-tasting flesh; testa thin; cotyledons plano-convex, thick, green, obscurely glandular.

Distribution. Endemic to Sabah and rather uncommon in Kota Belud, Beluran and Sandakan districts, south to Lahad Datu and Tawau.

Ecology. Found as solitary trees or small populations in the understorey of lowland forests, usually occurring on slopes and ridges of low hills, and sometimes bordering streams on flat land, to 600 m.

Taxonomy. The species superficially resembles *Merope angulata*. However, the more conspicuous leaf venation, smaller flowers, obovoid fruits, and different habitat conditions readily distinguish this from *Merope angulata* which is associated with mangrove swamps. The two species are very similar in size and habit.

13. MURRAYA Koenig ex L.

(J. A. Murray, 1740–1791, student of Linnaeus)

Mant. 2 (1771) 554, 563; Hooker *f. l.c.* (1875) 502; Kurz *l.c.* (1877) 190; King *l.c.* 219; Ridley *l.c.* (1922) 353; Craib *l.c.* 230; Browne *l.c.* 315; Backer & Bakhuizen *f. l.c.* 103; Burkill *l.c.* (1966) 1531; Swingle *l.c.* (1967) 231; Stone *l.c.* (1972) 384; Perry *l.c.* 367; Corner *l.c.* 668.

Shrubs or trees, deciduous or evergreen. Branches unarmed. *Bark usually smooth, often pale.* **Leaves** alternate, pinnate or rarely unifoliolate, rachis wingless; leaflets usually 3–9 (to as many as 25), articulated at the base. **Inflorescences** axillary or terminal panicles, cymes or corymbs. **Flowers** bisexual, medium-sized to large (over 1 cm long), 5-merous, buds cylindrical or oblong; sepals ovate or lanceolate, fused at base; petals linear to oblanceolate, imbricate; stamens 10, free, nearly equal or alternately long and short, filaments slightly flattened, glabrous, anthers ovate to elliptic, nearly basifixed; disc annular to cylindrical; ovary 2–5-carpellate, ovoid to ellipsoid, glabrous or sometimes finely hairy, on a gynophore, ovules (1–)2 per locule, style slender, not persistent, stigma capitate. **Fruit** an ovoid to round berry, pulp mucilaginous, peel thin, glandular. **Seeds** 1 to several per fruit, smooth or hairy; testa thin; cotyledons green, plano-convex.

Distribution. About 15 species; from India to S China, Indo-China and Taiwan, and throughout Malesia, eastward to NE Australia and New Caledonia. One native species (*Murraya paniculata*) occurs in Sabah. Two additional species, *M. exotica* and *M. koenigii*, are occasionally cultivated in Sabah and Sarawak.

Taxonomy. A study by Kong *et al.* (Biochem. Syst. Ecol. 14 (1986) 491) on the distribution of the alkaloids *yuehchukene* and *girininbine* in the roots of eight species of *Murraya* has revealed a division within the genus between species producing one or the other of these alkaloids. This division is supported by morphological differences which have long been recognised. However, the most recent classification of the genus (Swingle *l.c.* 1967) does

not adequately reflect this information. One group (section *Murraya*) is characterised by species containing *yuehchukene* (no *girinimbine*) and possessing yellowish stems and roots, larger petals (1–2 cm long), and red, ovoid to ellipsoid fruits. Plants in the second group (section *Bergera*) contain *girinimbine* (no *yuehchukene*) and possess brown stems and roots, smaller petals (4–7 mm long), and purplish-black, globose to ellipsoid fruits. Of the species occurring in Sabah and Sarawak, *M. paniculata* and *M. exotica* represent section *Murraya*, and *M. koenigii* represents section *Bergera*.

Key to *Murraya* species

1. Leaf stalks hairy. Inflorescences many-flowered corymbs. Fruits blackish when ripe. Cultivated.....
M. koenigii (L.) Spreng.
l.c. (1825) 315. Basionym: *Bergera koenigii* L. *l.c.* 563. Synonym: *Murraya foetidissima* Teijsm. & Binn., Nat. Tijd. Ned. Ind. 27 (1864) 41; *Chalcas koenigii* (L.) Kurz *l.c.* (1875) 132.
 India, Sri Lanka, Burma, Indo-China, Hainan and S China. Commonly cultivated in tropical countries, including in Sabah and Sarawak, for its leaves (Curry leaves; *daun kari*).

- Leaf stalks glabrate. Inflorescences few-flowered panicles or cymes. Fruits red when ripe.....2

2. Leaflets obovate, less than 4 cm long, apex somewhat obtuse. Inflorescences terminal. Fruits elliptic to subglobose. Cultivated.....
M. exotica L.
l.c. (1771) 563. Synonym: *Murraya paniculata* var. *exotica* (L.) Huang, Act. Phytotax. Sinica 8 (1959) 100.
 Native to China and Taiwan (?). Commonly cultivated throughout the tropics.

- Leaflets ovate or elliptic to rhomboid, 3–7 cm long, apex acuminate. Inflorescences axillary. Fruits ovoid with acuminoid apex. Wild species.....**M. paniculata**

***Murraya paniculata* (L.) Jack**

Fig. 13.

(Latin, *paniculatus* = tufted; the inflorescence)

Mal. Misc. 1 (1820) 31; Ridley *l.c.* (1922) 353; Crajb *l.c.* 230; Browne *l.c.* 315; Backer & Bakhuizen *f. l.c.* 103; Burkill *l.c.* (1966) 1531; Swingle *l.c.* (1967) 232; Stone *l.c.* (1972) 384; Perry *l.c.* 367; Corner *l.c.* 669; Ng *l.c.* 496. **Basionym:** *Chalcas paniculata* L., Mant. 1 (1767) 68. **Type:** "India" (LINN); based partly on *Camunium* Rumph., Herb. Amboin. 6. **Synonyms:** *Limonia lucida* G. Forst. *l.c.* (1786) 33; *Murraya sumatrana* Roxb., Fl. Ind. ed. 2, 2 (1832) 375; *M. odorata* Blanco *l.c.* (1845) 256.

var. ***paniculata***

Shrub or small to medium-sized tree to 20 m tall, 25 cm diameter. Bark thin, pale to whitish. Young shoots, twigs, sepals, petals, and ovary glabrous to slightly hairy. **Leaves**

pinnate, to 17 cm long; leaflets 3–7, rarely unifoliolate, *ovate or ovate-elliptic to rhomboid*, 3–7 x 2–3.5 cm, chartaceous or thinly leathery, *glossy and darker above*, glabrous; base cuneate to rounded, margin entire or faintly crenulate, apex acuminate; lateral veins 5–8 pairs; petiolules 2–6 mm long. **Inflorescences** axillary panicles or cymes, few-flowered; peduncle 1–4 cm long; pedicels 2–9 mm long. **Flowers** *large*; sepals (4–)5, narrowly deltoid, *c.* 1 mm long, glandular; petals (4–)5, elliptic to oblong-obovate, to 15–21 mm long or more, white; stamens alternately long and short, the longer to 12 mm long, filaments dilated below; ovary 2-carpellate, glandular, style columnar, nearly 1 cm long, stigma enlarged, bilobed. **Fruit** *an ovoid berry, c. 12 mm long, apex acuminate; peel shiny red, gland-dotted*, glabrous. **Seeds** *densely hairy*; cotyledons thick, fleshy.

Vernacular name. Sabah—*kemuning* (Malay).

Distribution. Throughout the range of the genus. Of the four known varieties, only var. *paniculata* occurs in Sabah, where it is occasionally found in lowland and hill forests, usually on rocky soils or limestone, from near sea-level to 600 m.

Taxonomy. *M. exotica* has usually been placed in synonymy with this species or as a variety of it. In this treatment, *M. paniculata* is restricted to the wild form found locally, with comparatively larger leaflets and flowers. *M. exotica*, locally found only in cultivation, differs in the shape of its leaflets (obovate to subelliptic) and fruits (ellipsoid to subglobose), in having terminal inflorescences, and in its more restricted natural geographical range (coastal areas of Hong Kong and China).

Uses. The leaves, fruits and bark of both *M. paniculata* and *M. exotica* have been used for treating venereal disease, intestinal worms, skin disorders, and dysentery, among others (China, Philippines, Peninsular Malaysia, Indonesia). Their heavy, yellow wood has been used to make walking sticks, *kris* handles, and various small objects (Peninsular Malaysia, Thailand). A face powder has been made from its bark and roots (Burma), and the fragrant flowers are used in cosmetics (Java). The leaves contain an unidentified, water-soluble toxin that has been shown to kill eggs and nymphs of the Asian citrus blackfly, *Aleurocanthus woglumi* Ashby, with topical exposure (Dowell, Pan-Pacific Entomol. 65 (1989) 163).

14. PLEIOSPERMIUM (Engl.) Swingle

(Greek, *pleio* = few, *sperma* = seed)

J. Wash. Ac. Sc. 6 (1916) 426, *l.c.* (1939) 258, *l.c.* (1967) 290; Merrill *l.c.* (1929) 115; Masamune *l.c.* 361; Backer & Bakhuizen *f. l.c.* 104; Anderson *l.c.* 309.

Shrubs or small trees. Branches armed with axillary, solitary or paired spines, or unarmed or nearly so. *Young twigs angular*, becoming terete. **Leaves** alternate, 1–3-foliolate; *petioles winged or wingless*; leaflets thinly leathery, glabrous, margin entire, articulated at the base. **Inflorescences** axillary or pseudoterminal panicles or racemes, often few-flowered, hairy. **Flowers** small, bisexual, 4–5-merous, *fragrant, buds cylindric*; sepals triangular to linear-

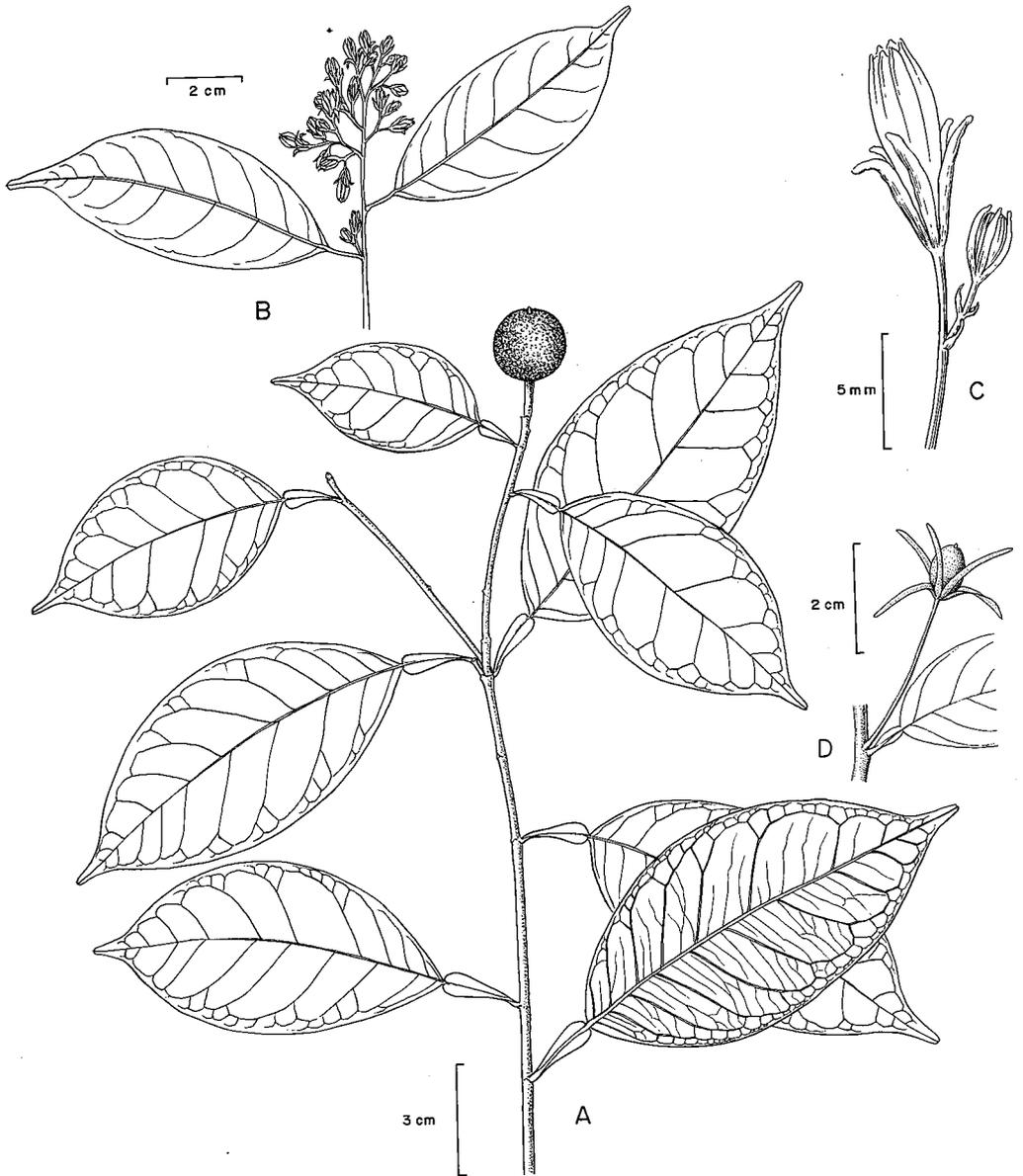


Fig. 14. *Pleiospermium longisepalum*. A, fruting leafy twig; B, flowering twig; C, mature flower with bud. (From SAN 90784.)

lanceolate, glabrous to finely hairy; petals linear-oblong, glabrous or finely hairy below, white to greenish, imbricate in bud; stamens 8 or 10, free, alternately long and short, filaments glabrous, anthers oblong to linear-oblong; disc annular to shortly cup-like; ovary 4–5-carpellate, cylindrical or ovate, glabrous or hairy, on a short gynophore or nearly sessile, ovules 2 per locule, style slender or stout, stigma subcapitate. **Fruit** a globose to oblong berry, 1.5–2.5 cm in diameter; pericarp rough-glandular; pulp-vesicles slender, to 1 cm long; juice oily-resinous. **Seeds** ovoid, flattened, to 1 cm long; testa smooth or wrinkled; monoembryonic; cotyledons plano-convex, thick, green.

Distribution. 6 species; S India, Sri Lanka, Vietnam, Sumatra, Java, and Borneo. Two species, *P. latialatum* and *P. longisepalum*, are found in Sabah. The former species also occurs in Sarawak.

Key to *Pleiospermium* species

Petioles broadly winged, 10–20 mm wide. Sepals 4–6 mm long, triangular.....1. *P. latialatum*

Petioles narrowly winged, 3–5 mm wide. Sepals 9–12 mm long, linear.....2. *P. longisepalum*

1. *Pleiospermium latialatum* Swingle

(Latin, *latus* = broad, *ala* = wing; the petiole)

l.c. (1939) 261, *l.c.* (1967) 293; Masamune *l.c.* 361; Anderson *l.c.* 309. **Type:** *Elmer 21542*, British North Borneo, Tawau (holotype AA; isotypes BO, K, L, P, PNH, US).

Shrub or small to medium-sized tree to 25 m tall, 30 cm diameter; bole to 15 m tall; trunk, bole, and main branches armed with paired spines to 3 cm long, generally unarmed on upper branches. **Leaves** unifoliolate, oblong-elliptic or lanceolate, 9–15 x 3.5–7 cm; base rounded or cuneate, apex acute-caudate, acumen 4–6 mm long and emarginate; lateral veins 10–13 pairs; petioles 1.5–2.5 cm long, broadly winged, obcordate, top 1–2 cm wide, narrower at base and pulvinoid. **Inflorescences** axillary clusters or pseudoterminal panicles. **Flowers** with sepals triangular, (2–)4–6 x 2–4 mm, glabrous, persistent and spreading at right angles below the fruit; petals glabrous; ovary hairy. **Fruits** globose, 1.5–2.5 cm in diameter; pericarp greenish yellow, with numerous raised oil-glands; pulp-vesicles slender, conical, 3–4.5 mm long, tips acute. **Seeds** 2–3 per fruit.

Vernacular names. Sarawak—*limo antu* (preferred common name), *limo to'* (Kayan), *limo bali* (Kenyah), *para bileh* (Berawan).

Distribution. Endemic to Borneo. Widespread and common in Sabah and Sarawak, occurring in the lowlands and hills and along streams and rivers in primary mixed dipterocarp and secondary forests on fertile clay-rich loam soils, and (in Sarawak) on limestone slopes and ridges, from near sea-level to 300 m.

2. *Pleiospermium longisepalum* Swingle (Latin, *longus* = long, *sepalum* = sepal)

l.c. (1939) 259, *l.c.* (1967) 293. **Type:** *Castro & Melegrito 1348*, British North Borneo, Banguay Is. (holotype NA; isotypes K, US).

Shrub or small tree to 15 m tall, 40 cm diameter; trunk sometimes fluted. *Branches unarmed or nearly so.* **Leaves** unifoliolate, elliptic, 7.5–11.5 x 3–5.5 cm; base rounded or cuneate, apex acuminate, acumen rounded or retuse; lateral veins 8–10 pairs; *petioles* 1–1.5 cm long, *narrowly winged (wing 3–5 mm wide at top), tapering to a wingless, pulvinoid base.* **Inflorescences** axillary clusters or pseudoterminal panicles. **Flowers** with *sepals linear, 9–12 x 2–3 mm, chartaceous, apex rounded or emarginate, persistent and reflexed below the fruit.* **Fruits** globose, tipped by the short persistent style, 2–2.5 cm in diameter; pericarp 1.5–2 mm thick, pimply from numerous raised oil-glands, ripening pale brownish yellow, pulp-vesicles 4–6 mm long, tapering to a blunt point. **Seeds** 1–2 per fruit, c. 1 cm long.

Vernacular names. Sabah—*limau hutan, limau limau* (Malay).

Distribution. Endemic to Sabah where it is not uncommon in the foothills and low mountainous areas of Kota Marudu, Ranau, and Tambunan districts, and occasionally on off-shore islands (Pulau Banggi = Banguay Is., Pulau Bohayan).

Ecology. Usually found on the slopes of hills and adjacent to streams in primary and secondary inland forests, and on high ground near the sea, to 1300 m.

15. SEVERINIA Tenore

(Severinus, 6th Archbishop of Rome, 640 A.D.)

Ind. Sem. Hort. Neap. 3 (1840); *Masamune l.c.* 357; *Swingle l.c.* (1967) 283; *Stone l.c.* (1978) 116; *Perry l.c.* 371.

Shrubs or small trees. Branches spreading, armed with stout axillary spines, or unarmed. **Leaves** *alternate, simple, often rigid, conspicuously parallel-veined; petioles short, wingless, not articulated with the blade.* **Inflorescences** densely flowered, axillary or terminal panicles or racemes, or few-flowered clusters. **Flowers** bisexual, small, 3–5(–7)-merous; calyx cup-like, sepals imbricate, glabrous or hairy; petals valvate, glabrous or nearly so; stamens 5–15, free, filaments dilated or flattened, anthers small, *disc cup-like, enclosing base of ovary;* ovary subglobose or oblong, 1–5-carpellate, on a short gynophore, ovules 1 per locule, style short, stigma ovoid. **Fruit** *a small berry, round, juicy or semi-dry; pericarp dotted with oil-glands, smooth; pulp-vesicles irregular in size and shape, lacking stalks.* **Seeds** small, ovoid, thick; testa thin; monoembryonic.

Distribution. 6 species; from S China, Taiwan, and Indo-China, south to Java, N Borneo, the Philippines, Moluccas, and Irian Jaya. Two species (*S. disticha* and *S. paniculata*) occur in Sabah.

Taxonomy. The genus has been confused with *Atalantia* Corr. which resembles in its leaf characters (shape, size, and venation) and habit. All species of *Severinia* have at one time been placed in *Atalantia*. *Atalantia* differs, however, in having leaf-blades articulated with the petioles, larger flowers, filaments more or less fused, well-formed pulp-vesicles, and small, orange-like fruits. Its 11 species are distributed from India to W Malesia and is represented in Peninsular Malaysia by two species. The relationship of *Severinia* to *Atalantia* needs to be examined more critically.

Key to *Severinia* species

Leaves ovate-lanceolate, apex acute-acuminate. Inflorescences axillary or terminal, racemose or paniculate. Ovary 2-carpellate.....1. *S. disticha*

Leaves oblong-ovate, apex rounded. Inflorescence terminal, paniculate. Ovary 4-carpellate
.....2. *S. paniculata*

1. *Severinia disticha* (Blanco) Swingle
(Latin, *distichus* = of two rows; the leaf arrangement).

Fig. 15.

J. Wash. Ac. Sc. 28 (1938) 533, *l.c.* (1967) 287; Masamune *l.c.* 357; Stone *l.c.* (1978) 116.
Basionym: *Limonia disticha* Blanco *l.c.* (1837) 356. **Type:** Merrill, *Sp. Blancoanae* No. 594, Philippines, Luzon (L). **Synonyms:** *Limonia corymbosa* Blanco *l.c.* (1845) 251; *Atalantia nitida* Oliv. *l.c.* 24; *A. disticha* (Blanco) Merr., Bull. Gov. Lab. Philip. 27 (1905) 28, Masamune *l.c.* 357.

Shrub or small tree to 10 m tall, 15 cm diameter. Branches unarmed, occasionally with paired spine-like paraphylls. **Leaves** 3–8(–11) × (1.5–)2.5–4 cm or more, ovate or ovate-lanceolate, wavy in dried specimens; base cuneate to obtuse, margin subentire, sometimes faintly crenulate, apex acute or acuminate, acumen usually blunt, often emarginate; lateral veins parallel, straight, numerous, 15–20 pairs, prominent below; petioles 3–9 mm long, flattened above, glabrous to hairy. **Inflorescences** many-flowered, axillary or (rarely) terminal panicles or racemes, 3–9 cm long; pedicels 3–5 mm long. **Flowers** 5-merous; sepals 5, broadly rounded, margins ciliate; petals 5, oblong, minutely tipped, to 7 mm long, white; stamens 10, alternately long and short, filaments to 5 mm long, flattened, narrowed at apex and base, anthers ovate, apiculate-glandular; ovary 2-carpellate, oblong, glabrous to sparsely hairy, style cylindrical, stout, stigma slightly lobed. **Fruits** subglobose, to 1.5 cm wide, blackish-purple when ripe; pulp greenish, juicy. **Seeds** 1–2 per fruit, greenish white.

Distribution. Borneo (Sabah), E Java, Philippines, Moluccas, Flores, and Irian Jaya. In Sabah, not uncommon in the understorey of beach strand vegetation, and in primary and secondary forest on hills and ridges near the coast, frequently on offshore islands, usually on sandy or rocky soil, rarely on limestone, from near sea-level to 90 m.

Uses. The ripe, juicy fruits are rather sweet and eaten fresh (Sabah, Indonesia). The roots are said to be used medicinally, and its fruits made into glue (Philippines). The timber has been used in construction (Indonesia, Philippines).

2. *Severinia paniculata* (Warb.) Swingle (Latin, *paniculatus* = tufted; the inflorescence)

l.c. (1938) 533, *l.c.* (1967) 288; Stone *l.c.* (1978) 116. **Basionym:** *Atalantia paniculata* Warb., Bot. Jahrb. 13 (1891) 340. **Type:** *Warburg 20132*, Moluccas, Ceram Laut (B). **Synonyms:** *Atalantia maritima* Merr., *l.c.* (1914) 293; *A. disticha* (Blanco) Merr. var. *paniculata* (Warb.) Tanaka *l.c.* (1928) 141.

Shrub or small tree. Branches unarmed. **Leaves** *oblong-ovate*, 9–12 x 3–5 cm, or larger; base gradually tapered, margin obscurely crenulate, apex rounded or emarginate; lateral veins numerous, parallel, more or less prominent below; petioles *c.* 8 mm long, terete, hairy. **Inflorescences** *terminal panicles*, 4–6 cm long or more, hairy; pedicels 2–4 mm long. **Flowers** 5-merous; sepals 5, *c.* 1 mm long, tips blunt, margins ciliate; petals 5, 4–7 mm long, lanceolate, tips rounded, subglabrous; stamens 10, alternately long and short, filaments 4–5 mm long, glabrous, anthers broadly cordate; ovary 4-carpellate, style deciduous. **Fruits** globose, to 12 mm in diameter. **Seeds** 2–4 per fruit.

Distribution. Borneo (Sabah), S Philippines, Moluccas, and Sumbawa (the Lesser Sunda Is.). In Sabah, less widespread than the related species *S. disticha*, and found in many of the same habitats, particularly beach forest and offshore islands, at sea level.

Taxonomy. This species is very closely related to *S. disticha* and Tanaka (*l.c.* 1928) considered it to be a variety. Many of their morphological characters appear to overlap. Swingle (*l.c.* 1967) distinguished it from *S. disticha* based upon its larger leaves, smaller, paniculate inflorescences, and ovaries with four carpels instead of two. A re-evaluation of the taxonomic status of this species (and most other *Severinia*) would be useful.

16. TETRACTOMIA Hook. f.

(Greek, *tetra* = four, *tome* = a separation; the four carpels which split in fruit)

l.c. (1875) 490; King *l.c.* 211; Merrill *l.c.* (1921) 314; Ridley *l.c.* (1922) 345; Craib *l.c.* 215; Masamune *l.c.* 361; Burkill *l.c.* (1966) 2182; Stone *l.c.* (1972) 385; Hartley, J. Arn. Arb. 60 (1979) 127; Anderson *l.c.* 309; Whitmore, Tantra & Sutisna *l.c.* 307. **Synonym:** *Terminthodia* Ridl., J. Fed. Mal. St. Mus. 6 (1915) 141.

Shrubs or small to large trees. Branches unarmed. **Leaves** *opposite, unifoliolate*, margins entire, pinnately veined; petioles wingless, articulated with the blade. **Inflorescences** axillary panicles, sometimes 1- to few-flowered. **Flowers** *bisexual, 4-merous*; sepals 4, fused at base, valvate or partially imbricate; petals 4, free, usually valvate, triangular, spreading and becoming recurved; stamens 4, free, opposite the sepals, filaments flattened, tapered, glabrous, elongating after anthesis, anthers ellipsoid, dorsifixed; staminodes 4, alternating with the stamens, anthers minute, without pollen; disc broad, glabrous, rounded to 4-angled; ovary 4-carpellate, carpels erect, free or fused at the base, joined near the apex by a single style, locules 2-ovulate; *style straight, composed of 4 elements twisted together*, stigma capitate. **Fruits** of 1–4 erect follicles, undeveloped carpels persistent in fruit, *follicles boat-shaped*, free or fused at the base; exocarp and mesocarp leathery; endocarp

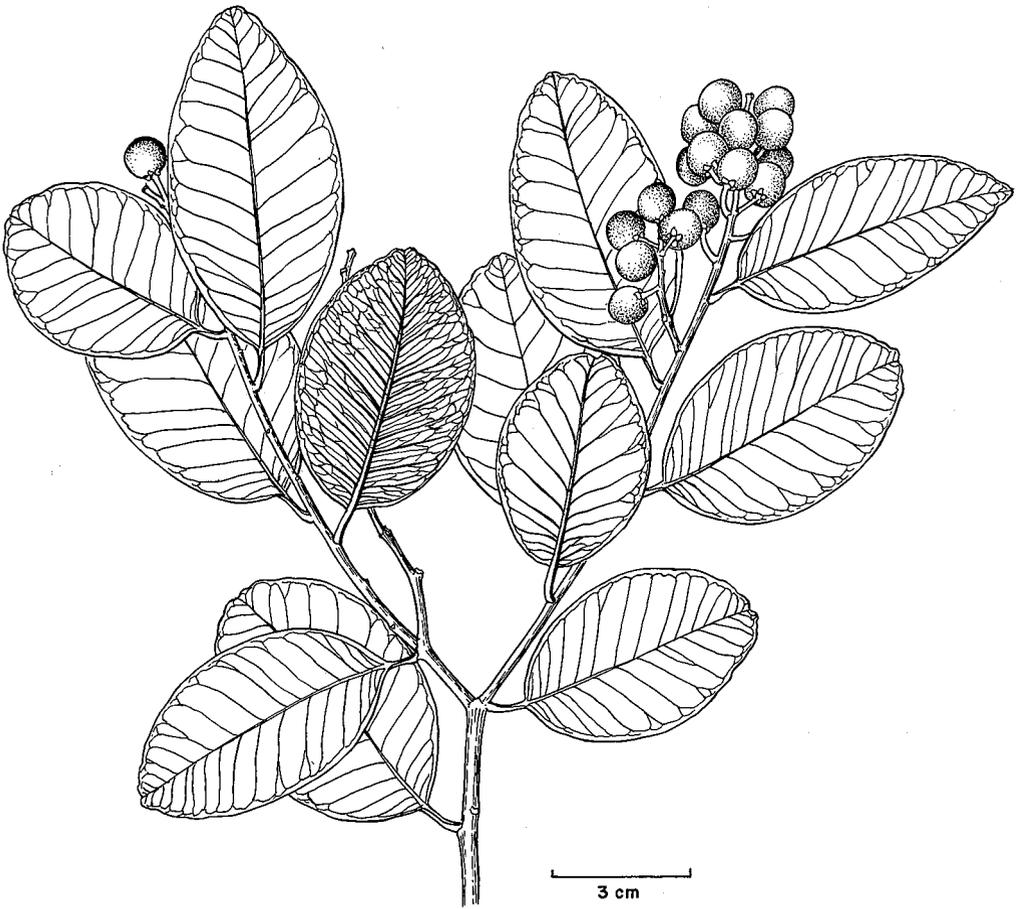


Fig. 15. *Severinia disticha*. Fruiting leafy twig. (From SAN 36104.)

cartilaginous, separating from the mesocarp. **Seeds** 1–2 per follicle, *winged*; *testa papery*; endosperm fleshy; embryo straight.

Distribution. 6 species; S Thailand, Sumatra, Peninsular Malaysia, Borneo, Philippines, Celebes, Papua New Guinea, and the Solomon Islands. The widely distributed *T. tetrandrum* occurs in Sabah and Sarawak. The remaining species are localised endemics in other parts of the range.

Ecology. Lowland to montane forests, peat swamp forests, heath forests, and subalpine habitats, from near sea-level to 3300 m.

***Tetractomia tetrandrum* (Roxb.) Merr.**

Fig. 16.

(Greek, *tetra* = four, *andros* = male; the number of stamens)

J. Str. Br. R. As. Soc. 76 (1917) 87, *l.c.* (1921) 314; Ridley *l.c.* (1922) 346; Craib *l.c.* 215; Masamune *l.c.* 361; Burkill *l.c.* (1966) 2182; Stone *l.c.* (1972) 385; Hartley *l.c.* (1979) 132; Anderson *l.c.* 309; Whitmore, Tantra & Sutisna *l.c.* 308. **Basionym:** *Melicope tetrandra* Roxb., Hort. Bengal. (1814) 88. **Type:** *Roxburgh, Icones 1411*, Penang (K). **Synonyms:** *Tetractomia beccarii* Hook. f. *l.c.* (1875) 489, Merrill *l.c.* (1921) 314, Masamune *l.c.* 361, Anderson *l.c.* 309; *Terminthodia viridiflora* Ridl. *l.c.* (1915) 141; *Tetractomia obovata* Merr. *l.c.* (1917) 86, *l.c.* (1921) 314, Masamune *l.c.* 361; *Tetractomia holttumi* Ridl., J. Bot. 62 (1924) 295; *Tetractomia latifolia* Ridl. *l.c.* (1930) 79, Masamune *l.c.* 361, Anderson *l.c.* 309; *Tetractomia montana* Ridl. *l.c.* (1930) 79, Masamune *l.c.* 361, Anderson *l.c.* 309; *Tetractomia parviflora* Ridl. *l.c.* (1930) 78, Masamune *l.c.* 361, Anderson *l.c.* 309.

Shrub or small to large tree to 30 m tall, 50 cm diameter; bole to 18 m tall. Branchlets glabrous. **Leaves** sometimes clustered at branch ends, blades glabrous, leathery, obovate to oblanceolate or elliptic, (2.5–)7.5–22(–32) x 1–14 cm; base rounded to attenuate, apex emarginate or rounded to acuminate or mucronate; lateral veins 4–11 pairs; petioles 0.3–5 cm long, *swollen at both ends*. **Inflorescences** 1- to many-flowered, (0.8–)4–16 cm long, glabrous to sparsely hairy; pedicels 0.5–4 mm long. **Flowers** 2.5–10 mm wide; sepals rounded to triangular, 0.4–1.5 mm long, glabrous to sparsely hairy, ciliolate when young; *petals green to yellowish*, ovate-triangular, 1–4.5 mm long, usually glabrous; carpels free at the base, glabrous or sparsely hairy, style glabrous. **Fruits** with free follicles, 4–11 mm long, glabrous or nearly so.

Vernacular names. Sabah and Sarawak—*jampang*, *jampang rusa*, *medang rawang* (preferred common name), *rawang mata*, *rawang paya* (Malay).

Distribution. Throughout the range of the genus. In Sabah and Sarawak widespread; also in Brunei and Kalimantan.

Ecology. Common in secondary forests and open places on infertile organic soils, and also mixed dipterocarp forest on humult ultisols, lowland peat swamp and heath forests, from near sea-level to 1900 m.

Taxonomy. An extremely variable species in habit, leaf size and shape, and inflorescence, flower and fruit size. In Sabah and Sarawak, this variation is characterised by a widespread,

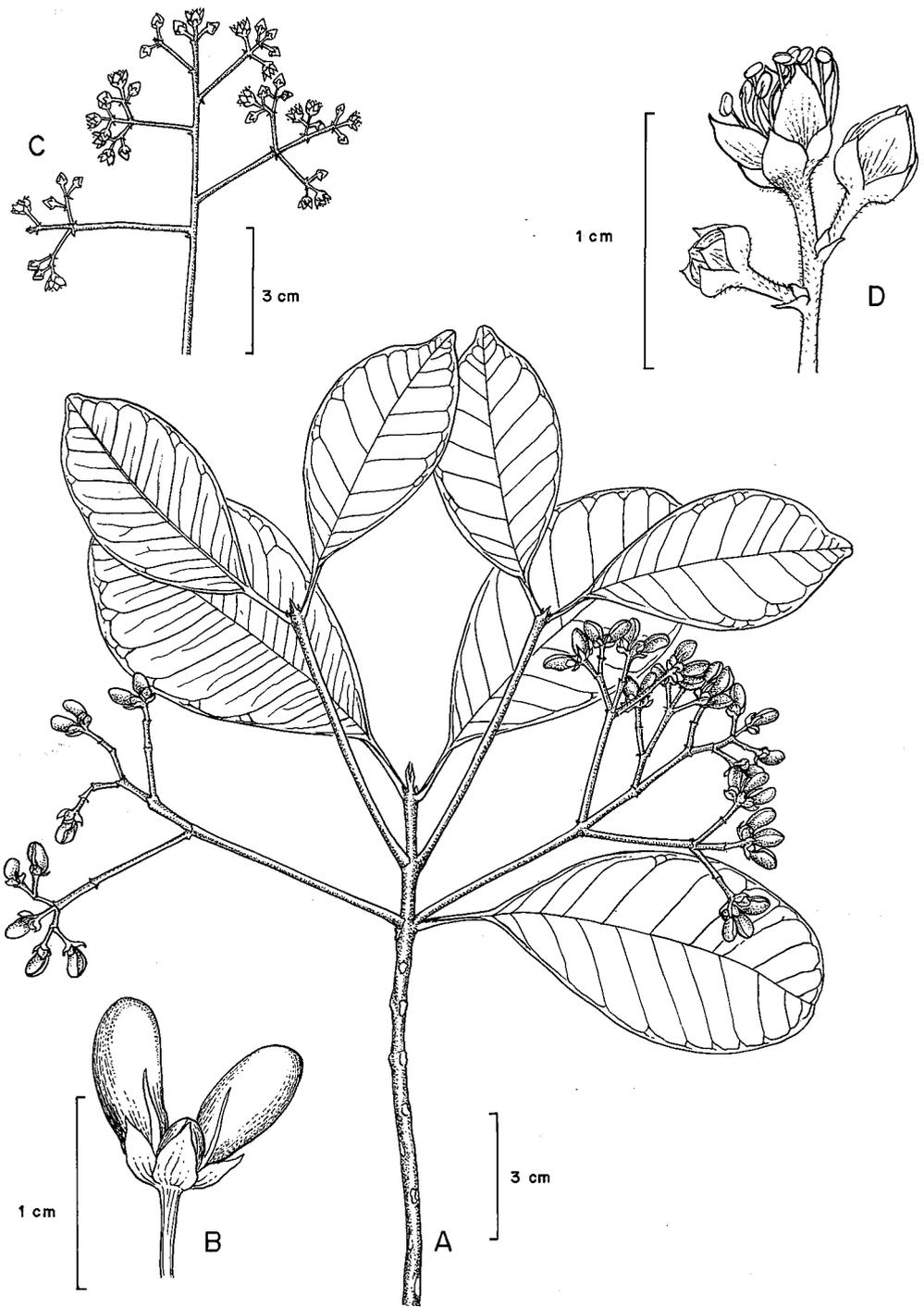


Fig. 16. *Tetractomia tetrandrum*. A, fruiting leafy twig; B, fruit; C, part of inflorescence; D, detail of cluster of flowers. (A & B from SAN 65010, C & D from SAN 22689.)

generalised form and several specialised forms or races which reflect the distribution of certain habitats, *i.e.*, lowland peat swamp forest, heath forest, lower montane forest, and lowland dipterocarp forest. Hartley (*l.c.* 1979) describes these races and provides the names of relevant previously described taxa assigned to these entities.

17. ZANTHOXYLUM L.

(Greek, *xanthos* = yellow, *xulon* = wood)

l.c. (1753) 270; Hooker *f. l.c.* (1875) 492; Kurz *l.c.* (1877) 180; King *l.c.* 213; Ridley *l.c.* (1922) 346; Craib *l.c.* 218; Backer & Bakhuizen *f. l.c.* 96; Burkill *l.c.* (1966) 2326; Hartley, *J. Arn. Arb.* 47 (1966) 171, 51 (1970) 423; Stone *l.c.* (1972) 386; Anderson *l.c.* 309; Perry *l.c.* 369; Corner *l.c.* 670; Whitmore, Tantra & Sutisna *l.c.* 308. **Synonym:** *Fagara* L., *Syst. ed.* 10 (1759) 897.

Scandent or erect shrubs or trees; dioecious or rarely monoecious, evergreen or deciduous. Twigs and branches armed with spines or prickles. Leaves alternate, unifoliolate, trifoliolate or pinnate with up to 15 pairs of leaflets, with or without a terminal leaflet, leaflets articulated at the base, leaf rachis sometimes winged. Inflorescences terminal or axillary racemes, panicles or cymes. Flowers small, unisexual, rarely bisexual; sepals 4–5; petals 4–5; or perianth segments 6–8 and undifferentiated; stamens 4–6, opposite the sepals, rudimentary in female flowers; disc flat or cushion-like; ovary 1–5-carpellate, rudimentary in male flowers, carpels free or fused at base, ovules 2 per locule, styles fused to divergent, stigma capitate. Fruits of 1–5 follicles, free or basally fused; outer wall glandular, red to black; endocarp cartilaginous. Seeds ovoid to round, 1 per follicle, often hanging from the dehisced follicle at maturity; testa black or reddish, glossy; endosperm white, fleshy.

Distribution. A large genus comprising approximately 200 or more species of mainly pantropical distribution, with a few representatives in temperate eastern Asian and North America. In Sabah and Sarawak, 4 species occur, two of which are trees or shrubs, and the remaining two being scandent shrubs.

Ecology. Most of the species generally grow in rain forests and thickets at low and medium elevations. The attractive seeds are dispersed by birds, accounting for the often wide and sometimes discontinuous distribution of some of the species.

Uses. Various species are sources of spices and condiments, and local medicines. The attractive wood of some is used for cabinetry and other fine work.

Key to *Zanthoxylum* species

1. Erect shrubs or trees. Branchlets armed with straight prickles. Ovary 2–3-carpellate...2
 Scandent or suberect shrubs. Branchlets and/or leaf axes armed with recurved prickles
 or unarmed. Ovary 4-carpellate.....3
2. Inflorescences paniculate. Leaflets 8–18 cm long. Carpels 3.....2. **Z. myriacanthum**
 Inflorescences cymose. Leaflets 1–8 cm long. Carpels 2.....1. **Z. avicennae**

3. Lateral leaflets subopposite to alternate. Midribs of leaflets not armed.....

Z. scandens Blume

l.c. (1825) 249; Backer & Bakhuizen *f. l.c.* 96; Hartley *l.c.* (1966) 177; Whitmore, Tantra & Sutisna *l.c.* 308.

India, China, Taiwan, Ryukyu Islands, Sumatra, Java, Borneo; uncommon in Sabah and Sarawak, known only from montane forest.

Climbing (occasionally suberect) shrub, dioecious. Leaves pinnate; leaflets 2–12 pairs, with margins finely glandular toothed. Inflorescences axillary, or axillary and terminal panicles. Flowers 4-merous; petals occasionally purple-margined; ovary 4-carpellate. Follicles in groups of 1–4, 4–5 mm in diameter.

Lateral leaflets opposite. Midribs of leaflet usually armed.....

Z. nitidum (Roxb.) DC.

l.c. (1824) 727; Ridley *l.c.* (1922) 1347; Burkill *l.c.* (1966) 2327; Hartley *l.c.* (1966) 180, *l.c.* (1970) 423; Stone *l.c.* (1972) 386; Whitmore, Tantra & Sutisna *l.c.* 308.

India, Thailand, Vietnam, Malesia, Solomon Is., Australia. In Sabah (Ranau and Pinangah districts), in forest to 1100 m.

Climbing (occasionally suberect) shrub, dioecious or (rarely) monoecious. Leaves pinnate, leaflets 2–4 pairs, with margin entire to glandular toothed. Inflorescences terminal and/or axillary, racemes or panicles. Flowers 4-merous; ovary 4-carpellate. Follicles in groups of 1–4, 5–7 mm in diameter.

1. **Zanthoxylum avicennae** (Lam.) DC.

(Ibn Sina, or Avicenna, 980–1037, Arabian medical writer and philosopher)

l.c. (1824) 726; Hartley *l.c.* (1966) 190, *l.c.* (1970) 423; Perry *l.c.* 370. **Basionym:** *Fagara avicennae* Lam. *l.c.* 445. **Type:** *d'Incarville 179*, China, Kwangtung (P). **Synonyms:** *Zanthoxylum diversifolium* Warb. *l.c.* 339; *Z. iwahigense* Elmer, *Leafl. Philip. Bot.* 5 (1913) 1833.

Scandent or erect shrub or small tree to 15 m tall; dioecious, evergreen. *Smaller branches and twigs with straight or recurved prickles. Leaves* pinnate, to 30 cm long, axis often narrowly winged; *leaflets 2–11 pairs, subopposite, ovate to elliptic-lanceolate, 1–8 x 1–3 cm, glabrous, thinly leathery; base rounded to cuneate, margin nearly entire to finely glandular toothed, apex rounded to acuminate; lateral veins 4–11 pairs; petiolules 2–5 mm long. Inflorescences* terminal (occasionally axillary), *flat-topped cymes, to 20 cm long, axis glabrous. Flowers* unisexual, 5-merous; sepals 5, triangular or rounded, under 1 mm long; petals 5, elliptic, 1–2.5 mm long, white to greenish; stamens 5, rudimentary in female flowers; disc flat or cushion-like; ovary 2-carpellate, rudimentary in male flowers, styles and stigmas united, peltate. **Fruits** of 1–2 nearly round follicles, *c.* 4.5 mm in diameter, the undeveloped carpels (if any) persistent in fruit.

Distribution. China, Vietnam, Thailand, Java, Borneo, Philippines, Celebes, Lesser Sunda Islands and the Moluccas. In Sabah, reported only from Ranau district.

Ecology. Found locally on flat sites and hillsides in primary and secondary forest, occasionally on ultramafic soil, to 1500 m.

Uses. The stems and bark are used medicinally as a tonic and for treating snake bite (Indo-China, Philippines).



Fig. 17. *Zanthoxylum myriacanthum*. A, flowering leafy twig; B, detail of lower leaflet surface; C, detail of upper leaflet surface; D, part of infructescence; E, dehiscent fruit. (A-C from *SAN 87166*, D & E from *SAN 116158*.)

2. **Zanthoxylum myriacanthum** Wall. ex Hook. f.
(Greek, *myrios* = numberless, *akantha* = thorn)

Fig. 17.

L.c. (1875) 496; King *L.c.* 214; Ridley *L.c.* (1922) 347; Burkill *L.c.* (1966) 2327; Hartley *L.c.* (1966) 185; Stone *L.c.* (1972) 386; Anderson *L.c.* 309; Perry *L.c.* 371; Corner *L.c.* 671. Whitmore, Tantra, Sutisna *L.c.* 308. **Type:** *Porter* (*Wallich Cat. No. 1214*), Malacca (K). **Synonyms:** *Fagara myriacantha* (Wall. ex Hook. f.) Engl. in Engler & Prantl *L.c.* (1896) 118.

Small to large tree to 30 m high, 35 cm diameter; dioecious, evergreen; bole to 15 m tall. *Stems with thick spines to 3 cm long; smaller branches and twigs with straight, hollow prickles usually housing ants.* **Leaves** pinnate, to 60 cm long; leaflets 4–11 pairs, opposite or subopposite, elliptic, 8–18 x 3–8 cm, glabrous or shortly hairy below, leathery; base blunt to nearly cordate and slightly asymmetric, *margin finely glandular toothed*, apex acuminate; lateral veins 8–18 pairs; petiolules to 5 mm long. **Inflorescences** terminal and axillary panicles, 15–25 cm long, axes mostly glabrous. **Flowers** unisexual, 5-merous; sepals 5, triangular, minute; petals 5, elliptic, 1.5–2.5 mm long, white or yellowish, sometimes purplish; stamens 5; disc flat; ovary 3(–4)-carpellate, rudimentary in male flowers, styles and stigmas united, peltate. **Fruits** of 1–3 nearly round follicles, 3–6 mm in diameter, the undeveloped carpels (if any) persistent in fruit.

Distribution. E India, N Vietnam, SW China, Sumatra, Peninsular Malaysia, Borneo, Philippines. In Sabah, occurs scattered in Ranau, Tambunan and Keningau districts. In Sarawak, collected once (*Omar, s.n.*, Ulu Lawas).

Ecology. Locally found in primary and secondary forest in the hills and low mountains, to 1200 m.

Uses. The smoke of burning seeds is said to be inhaled for treating ulcerated syphilitic nose (Peninsular Malaysia).

SIMAROUBACEAE

Julius Kulip & K.M. Wong

Forest Research Centre,
Sabah Forestry Department,
Sandakan, Malaysia

Merrill, EB (1921) 315; Ridley, FMP 1 (1922) 360; Masamune, EPB (1942) 361; Nooteboom, FM 1, 6 (1962) 193, FM 1, 6 (1972) 968, Blumea 11 (1962) 509; Keng, OFMSP (1969) 178; Kochummen, TFM 2 (1972) 345; Cockburn, TS 1 (1976) 217; Anderson, CLTS (1980) 322; Corner, WSTM 2 (1988) 696; Whitmore, Tantra & Sutisna, CLK 2,1 (1990) 329.

Trees or shrubs (some sprawling), usually *containing very bitter substances*. Hairs mostly simple and unicellular, sometimes with a glandular head. **Leaves** spirally arranged, simple or pinnate, sometimes (in *Ailanthus*, *Brucea* and *Soulamea*) with pitted, concave, or flattish glands on the lower surface; stipules usually absent except in *Allantospermum*, *Irvingia* and *Picrasma*. **Inflorescences** usually compound, axillary, rarely terminal; *plants monoecious or dioecious*. **Flowers** usually small, regular, unisexual or bisexual; *sepals* 3–5, almost always partly united; *petals* 3–5, free; stamens inserted at the base of the disc, sometimes arranged in two whorls, with the inner whorl alternate with the petals and the outer whorl (if present) opposite the petals, anthers 2-celled, opening lengthwise; disc intrastaminal, sometimes rather inconspicuous; *ovary superior, 2–5-lobed, with 1–5 chambers*, or with free carpels; *ovule one* in each carpel, *anatropous*, placentation axile. **Fruits** usually not splitting, often *drupe-like*, sometimes a *samara* or in *Allantospermum* septicidally splitting into 5 valves. **Seeds** with scant or no endosperm.

Distribution. Some 30 genera and 200 species, distributed in the tropics and subtropics and some in temperate Asia. In Sabah and Sarawak, represented by 9 genera with 11 species of which only one (*Harrisonia*) includes scrambling shrubs.

Ecology. Simaroubaceae species are found mostly in lowland forest. *Quassia indica* shows preference for temporarily inundated areas while *Eurycoma longifolia* has a distinct preference for acidic, leached, well-drained soils. *Soulamea amara* occurs in the *Barringtonia*-formation of the coastal vegetation and prefers calcareous or rocky beaches. Pollination is probably by insects as the flowers are often reported to be fragrant.

Uses. *Ailanthus*, *Allantospermum* and *Irvingia* are the only genera reaching timber size. All the bitter-tasting genera are used locally in the preparation of traditional medicines, especially as tonics, antidiarrhetics and antihelminthics, and the roots of *Eurycoma longifolia* has been reported to contain biologically active compounds useful as anti-malaria drugs (Chan *et al.*, *Planta Medica* 52 (1986) 105).

Taxonomy. The Simaroubaceae are closely related to the Burseraceae, Meliaceae and Rutaceae. While the genera are quite distinctly recognised, the limits of these families overlap somewhat. Forman (Kew Bull. 19 (1965) 517) placed *Irvingia* in the Irvingiaceae

and *Allanthospermum* in the Ixonanthaceae but Nootboom (*l.c.* (1972) 970) concluded that the morphological, phytochemical and palynological evidence favoured including these genera in the Simaroubaceae.

Key to genera

1. Sprawling or scrambling spiny shrubs.....
 - Harrisonia** R. Brown *ex* A. Juss.
 Mem. Mus. Hist. Nat. Paris 12 (1825) 517; Masamune *l.c.* 362; Nootboom, FM 1,6 (1962) 207.
 3–4 species in the Old World Tropics. 1 species, *H. perforata* (Blanco) Merr., occurs in Sabah. Scandent prickly shrub; branches with thorns; leaf-stalk winged. Lowlands to 400 m, also on Banggi island. Vernacular names: Sabah—*bogua* (Dusun Banggi), *kait-kait* (Tenom Murut), *kukualang* (Malay).
- Shrubs or trees, unarmed..... 2
2. Leaflets margin toothed..... **3. Brucea**
 Leaves or leaflets margin entire..... 3
3. Leaves simple 4
 Leaves pinnate 7
4. Leaves spirally arranged, densely clustered at shoot tips, obovate, stalks 3–8 cm long **8. Soulamea**
 Leaves spiral to alternate and well-spaced along the shoots, elliptic, stalks 0.5–2 cm long..... 5
5. Leaves with pitted glands. Stipules absent..... **7. Quassia** (in part)
 Leaves without such glands. Stipules either conspicuous conical structures or present only in leaf buds on young shoots and falling off early..... 6
6. Twigs with annular stipule-scars, not swollen at leaf insertion. Leaf-stalks 10–20 mm long..... **5. Irvingia**
 Twigs without annular stipule-scars, swollen at points of leaf insertion. Leaf-stalks 5–44 mm long..... **2. Allantospermum**
7. Leaflets sessile..... **4. Eurycoma**
 Leaflets distinctly stalked..... 8
8. Leaflets very unequal at base. Fruits winged..... **1. Ailanthus**
 Leaflets symmetric at base. Fruit a drupe..... 9
9. Veins sunken on both upper and lower leaflet surfaces; stipules absent..... **7. Quassia** (in part)
 Veins prominent on both upper and lower leaflet surfaces; stipules present, sub-orbicular..... **6. Picrasma**

1. **AILANTHUS** Desf., *nom. cons.*(from the Amboinese plant name *aylanto*)

Mem. Phys. Math. Ac. R. Sc. Paris (1786) 270, t. 8; Nooteboom, FM 1,6 (1962) 215; Kochummen *l.c.* 346; Whitmore, Tantra & Sutisna *l.c.* 329.

Dioecious trees with straight bole but without buttresses. **Bark** pale grey, smooth or lenticellate; inner bark yellowish brown. **Sapwood** pale white. Twigs thick, with large leaf-scars. **Leaves** more or less tufted at the ends of twigs, *pinnate*, to 60 cm long, *without a terminal leaflet*; leaflets 10–13 pairs, 7.5–12.5 x 2.5–5 cm, hairy below, *with scattered glands* in the forks of the veins on the underside; *base very unequal, margins entire, apex pointed*; the leaves eventually drooping with bowed stalk. **Flowers** 5–6-merous; calyx small, 5–6-lobed, closed in bud and later irregularly splitting (often 2-lobed) to the base, rarely cupular; petals 5–6, induplicate-valvate in bud, concave; stamens 10, in male flowers inserted below the outer margin of the disc, in female flowers either of subnormal size (but without pollen), or vestigial, or absent, anthers opening laterally or externally, the 2 cells free in their lower half; ovary 2–5-carpellate, carpels free, flat, in the male flower vestigial or absent; styles 2–5, free or united; ovule 1 in each carpel. **Fruit** a *samara*, elliptic or oblong-lanceolate. **Seeds** flat, orbicular or obovate or somewhat triangular, without endosperm.

Distribution. 5 species in tropical and subtropical SE Asia from Turkestan and India to China, through Malesia to Solomon Islands, Queensland and northern New South Wales in Australia. In Sabah and Sarawak, 2 species are known.

Ecology. In Sabah and Sarawak, both species are uncommon and found mainly in lowland forests below 1000 m, in valleys, along streams, and open places.

Key to *Ailanthus* species

Leaflets with lower surface glabrous and with a pair of large glands.....1. **A. integrifolia**

Leaflets with lower surface hairy or sparsely hairy and with scattered small glands.....
.....2. **A. triphysa**

1. **Ailanthus integrifolia** Lam.

(Latin, *integer* = entire, *folia* = leaves or leaflets; the leaflet margins)

Dict. 3, 2 (1792) 417; Merrill, Interpr. Rumph. (1917) 299; Nooteboom, FM 1, 6 (1962) 218; Kochummen *l.c.* 346; Cockburn *l.c.* 219; Whitmore, Tantra & Sutisna, *l.c.* 229. **Type:** *Rumphius Herb. Amb. 3:205, t. 132*. **Synonyms:** *A. blancoi* Merr., Sp. Blanc. (1918) 205; *A. peekelii* Melch., Notizbl. Berl. Dahl. 10 (1930) 893; *Dysoxylum dasyphyllum* Miq., Ann. Mus. Bot. Lugd. Bat. 4 (1868) 19.

Tree to 55 m tall, 65 cm diameter. **Bark** smooth, light brown or grey. **Sapwood** white, yellow, pale brown or creamish, very soft; heartwood absent. **Leaves** 30–200 cm long,

stalks 5–20 cm long; *leaflets* 2–9 pairs, 3.5–14 x 3.3–6.2 cm, *glabrous on both surfaces*; base very oblique or sickle-shaped, apex blunt-acute; stalks 0.5–1.5 cm long; lateral veins 6–13 pairs; *glands on lower surface large*, black, flat, oblong, 0.5–5.0 mm diameter, mostly *paired* near the base. **Inflorescences** to c. 40 cm long, glabrous, pedicels to c. 15 mm long. **Flowers** with calyx more or less pubescent, closed in bud, rupturing and toothed irregularly, rarely cupular, 1–4 mm high, rarely caducous; petals puberulous, acute or bluntish, to c. 9 x 3 mm; filaments with many long spreading hairs to glabrous, usually thickened downwards, c. 0.5 mm in female flowers, to 4 mm long in male flowers; anthers c. 1 mm in female flowers, to 2.5 mm long in male flowers; ovary 5, usually densely puberulous; styles 5, connate at the base, including the long, stellately spreading stigmas, to c. 6 mm long. **Fruits** of (1–)3–5 samaras, each somewhat elliptic, 11–22 x 2.5–5 cm, the vein reticulations distinct on the outside, pale green; stalk 2.5–5 cm long. **Seeds** flat; testa thin; cotyledons 2.

Distribution. Malesia: all islands, except Java and the Lesser Sunda Islands, and Melanesia (Bismarcks and Solomons). In Sabah, the species has been recorded from the Sandakan and Beaufort districts. In Sarawak, once collected at Suai, Miri, 4th Div. (S. 39203). Also in Kalimantan.

Ecology. In primary rain forest or rarely secondary forest, very rare.

Uses. In New Guinea and the Bismarcks, the timber is made into planks for house construction (Nootboom *l.c.*).

2. *Ailanthus triphysa* (Dennst.) Alston

(Greek, *tri* = 3-partite, *physis* = in character; the calyx-tube)

Fig. 1.

Handb. Fl. Ceyl. 6, Suppl. (1931) 41; Nootboom, FM 1,6 (1962) 219; Kochummen *l.c.* 346; Cockburn *l.c.* 219; Whitmore, Tantra & Sutisna *l.c.* 329. **Basionym:** *Adenantha triphysa* Dennst., Schluss. Hort. Mal. (1818) 32. **Type:** *Dennst.*, *Schluss. Hort. Mal.* (1818) t. 32. **Synonyms:** *A. philippinensis* Merr., Publ. Gov. Lab Philip. 35 (1906) 25; *Hebonga obliqua* Radlk., Philip. J. Sc. 6 (1911) Bot. 366.

Tree to 60 m tall and 50 cm diameter. **Bark** pale brown, smooth to lenticellate; inner bark yellowish brown, mottled. **Sapwood** white. Twigs thick, reddish brown hairy. **Leaves** to 30 cm long, rachis slightly pubescent; *leaflets* almost sickle-shaped, c. 18 pairs, 7.5–11.7 x 3–4 cm, membranous, upper surface glabrous, *lower surface densely hairy*; base distinctly unequal (one side sharply acute, the other side rounded), margin wavy, apex pointed; lateral veins 8–20 pairs, more or less sunken above; *glands small, scattered over the whole surface especially on the midrib and veins*. **Inflorescences** many-flowered, more or less pubescent, c. 20–60 cm long; bracts small, ovate to triangular, falling early; pedicels to c. 4 mm. **Flowers** with calyx pubescent, less than 1 mm high, the triangular acute lobes as long as the tube or a little longer; petals glabrous or nearly so, 3–5 x 1–1.5 mm; filaments twisted-folded in bud, filiform or sometimes attenuating from the base to the top; anthers c. 1.2 mm long, 1 mm wide in male flowers, smaller in female flowers. **Fruits** of 1–3(–4) samaras, each somewhat obovate, 4.5–8 x 1.5–2.5 cm, ripening red; stalk 0.8–2 cm long.



Fig. 1. *Ailanthus triphysa*. A, leafy twig; B, inflorescence. (A from SAN 59251, B from SAN 49456.)



Fig. 2. *Allantospermum borneense* subsp. *borneense*. A, fruiting leafy twig; B, infructescence. (All from S. 15016.)

Distribution. India, Sri Lanka, Burma, Thailand, Vietnam, through Malesia (except Sumatra, Peninsular Malaysia, Lesser Sunda Is., and New Guinea) to Queensland and the northern parts of New South Wales. In Sabah uncommon, recorded from the interior parts at Sook, Keningau and Tenom, and in the east coasts at Lahad Datu. Not yet recorded in Sarawak. Also in Kalimantan.

Ecology. In primary lowland and hill forests.

Uses. The resin is tapped and used as incense and traditional medicine in India. In Indo-China the bark is burned as incense. The bark and the leaves are used for making a tonic, especially for post-childbirth. They also possess febrifuge properties and are used for treating dyspeptic complaints. The wood is used for making wooden shoes in Luzon (the Philippines), for fishing floats, catamarans, sword-handles, and spear-sheath in India, and for tea-boxes in Sri Lanka (Nootboom *l.c.*).

2. ALLANTOSPERMUM Forman

(Greek, *ala* = wing, *sperma* = seed; the winged seeds)

Kew Bull. 19 (1965) 516; Nootboom *l.c.* (1972) 968; Kochummen *l.c.* 347; Cockburn *l.c.* 217; Whitmore, Tantra & Sutisna *l.c.* 329.

Trees. Twigs *without annular stipular scars, swollen at points of leaf insertion. Leaves simple, entire. Inflorescence* a panicle. **Flower** *bisexual, 5-merous; sepals 5; petals 5; stamens 10, free, anthers versatile; disc 10-lobed, intrastaminal; ovary superior, shallowly 5-lobed, stigma with a tiny papillose head. Fruit* a capsule, broadly ellipsoidal, twisted after *splitting into 5 valves* along the septa, leaving a central columella. **Seeds** cylindrical, ellipsoid, shiny and waxy.

Distribution. 2 species, 1 in Malesia (Peninsular Malaysia and Borneo) and the other in Madagascar (*A. multicaule* (Capuron) Noot.).

Allantospermum borneense Forman

(of Borneo)

Fig. 2.

l.c. 517, t. 1; Nootboom *l.c.* (1972) 972; Kochummen *l.c.* 347; Cockburn *l.c.* 217; Whitmore, Tantra & Sutisna *l.c.* 329. **Type:** *Galau S. 15262*, Sarawak, 1st Div., Semengoh Forest Reserve (holotype K; isotypes L, SAN, SAR).

Tree, to 90 m tall and 60 cm diameter; bole fluted and often crooked; buttresses sharp and spreading, to 3 m high. **Bark** pale brown with grey patches, smooth or with distant, adherent, large, thinnish scales, minutely lenticellate; inner bark pink, mottled white. **Sapwood** yellowish brown. *Twigs* brown, slender, *more or less zig-zag. Leaves* elliptic to oblong, 6.5–15 x 1.7–3.3 cm, glossy above, dull beneath; base cuneate to broadly rounded, apex blunt-acuminate; midrib and veins prominent on both surfaces; lateral veins 5–10 pairs, intermediate veins extending about half-way to the margin; stalks blackish, channelled

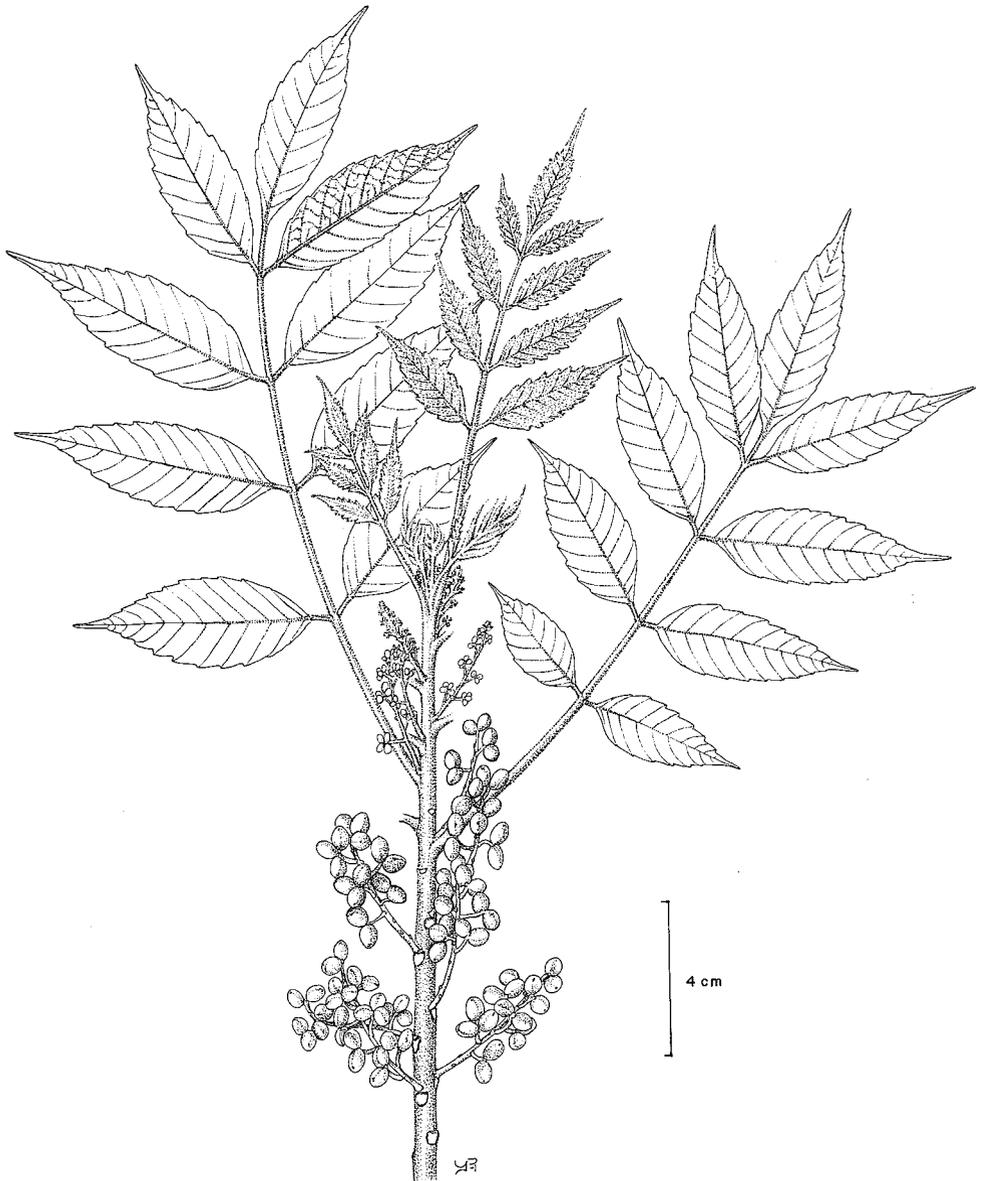


Fig. 3. *Brucea javanica*. Fructing leafy twig. (From Zainuddin 1713.)

above, 0.5–4.4 cm long. **Inflorescences** (1–)3.3–5.9 cm long, bearing the scars of early caducous bracts. **Flowers** with a stalk 7–9 cm long; sepals white, boat-shaped, 3–4 x 2 mm, rounded at the apex, reflexed at anthesis; petals white, elliptic to obovate, 4–5 x 2.5–3 mm, membranous, reflexed at anthesis, caducous; stamens to 6 mm long, anthers *c.* 1 mm long; disc *c.* 1.5 mm diameter and 0.5 mm thick; ovary 5-lobed, *c.* 1.5 x 2 mm, style filiform, 3–4 mm long, purple, stigma knob-like. **Fruits** broadly ellipsoid, 5-lobed, 2.8–4.2 x 1–3.5 cm, apical beak 2–10 mm long. **Seeds** cylindrical, often slightly curved, 2–2.5 x 4–6 mm.

Key to subspecies

Leafy branches conspicuously zig-zag. Inflorescences 3.3–5.9 cm long, laxly branched. Fruits 2–3.5 cm wide, apical beak 2–4 mm long.....

subsp. **borneense**

Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei, Kalimantan). In primary mixed dipterocarp forest on sandy humult ultisols; in Sabah also on ultramafic soils. Apparently gregariously flowering and fruiting at several year intervals.

Leafy branches only slightly zig-zag. Inflorescences 1–2 mm long, condensed. Fruits about 1.1 cm wide, apical beak 6–10 mm long.....

subsp. **rostratum** Noot.

l.c. (1972) 972; Cockburn *l.c.* 217; Whitmore, Tantra & Sutisna *l.c.* 330. Type: *Agama SAN 36068*, Sabah, Lahad Datu, Pulau Sakar (holotype L; isotypes K, SAN).

Known only from Sabah (Sandakan and Lahad Datu areas).

Vernacular names. Sarawak—*nyalin* (Iban). Brunei—*kayu tulang* (Malay), *tulang* (Iban).

3. BRUCEA J.F. Mill., *nom. cons.*

(J. Bruce, 1730–1794, a Scottish scholar and explorer)

Icon. (1779) *t.* 25; Merrill *l.c.* (1921) 316; Ridley *l.c.* 361; Masamune *l.c.* 361; Corner *l.c.* 697; Nootboom, FM 1, 6 (1962) 209; Kochummen *l.c.* 348; Cockburn *l.c.* 219; Anderson *l.c.* 322.

Shrubs or small trees. **Leaves** pinnate, with a terminal leaflet; leaflets with toothed margins; stipules none. **Flowers** unisexual, in axillary inflorescences; *sepals* 4, united at base; *petals* 4, free; disc thick with 4 lobes; *stamens* 4, with short filaments, vestigial or absent in female flowers; ovary 4-carpellate, carpels free, styles free or united at base; ovules 1 in each carpel, attached above the middle. **Fruit** a drupe, hardly fleshy, with a stone. **Seeds** with very thin endosperm.

Distribution. 6 species in tropical Africa and Asia, including 2 in Malesia. In Sabah and Sarawak one species.

Brucea javanica (L.) Merr.
(of Java)

Fig. 3.

J. Am. Arb. 9 (1928) 3; Kochummen *l.c.* 348; Cockburn *l.c.* 219; Nootboom, FM 1, 6 (1962) 210; Anderson *l.c.* 322. **Basionym:** *Rhus javanica* L., Sp. Pl. (1753) 265. **Type:** *Osbeck, s.n.*, Java (L).



Fig. 4. *Eurycoma longifolia*. A, flowering leafy twig; B, lower side of leaf; C, flower bud; D, open flower; E, infructescence. (A–D from SAN 88096, E from SAN 73999.)

Synonyms: *Lussa radja* Rumph., Herb. Amb. (Auct.) 7 (1755) 27, t. 15; *Brucea sumatrana* Roxb., Hort. Beng. (1814) 12; *Brucea sumatrensis* Spreng., Pl. Min. Cogn. 2 (1815) 90; *Brucea amarissima* Desv. ex Gomes, Mem. Acad. Sc. Lisb. n.s. 4, 1 (1872) 30.

Shrub or small tree to 5 m high. **Leaves** 20–40 cm long; leaflets ovate to oblong-lanceolate, 3–15, 4.5–11 x 1.5–4 cm, sparsely hairy above, more or less pubescent below, sometimes glabrous; stalks 2–5 mm, the terminal one much longer. **Flowers** greenish white to greenish red or purple. **Fruits** 1–4 together, 4–5 mm long.

Vernacular names. Sabah—*kuinin* (Dusun/Kadazan Tambunan), *mara* (Maga), *pait-pait* (Dusun/Kadazan Kinabatangan), *payas* (Dusun/Kadazan Ranau), *tongkat ali* (Papar Malay; in common with *Eurycoma*). Sarawak—*jaloat* (Murut).

Distribution. From Sri Lanka and the Deccan Peninsula through SE Asia to S China and S Formosa, throughout Malesia and N Australia. In Sabah, it is found all over the state. In Sarawak, it has been recorded from the 1st, 2nd, 4th and 7th Div. Also in Brunei.

Ecology. A common, light-tolerant plant, preferring open sites and secondary forest and thickets, forest edges and ridges, even occurring in sunny places in sandy dunes and on limestone rock. Flowering and fruiting throughout the year.

Uses. The roots and fruits contain bitter principles which possess medicinal value and used as concoctions in the treatment of dysentery, diarrhoea and fever.

4. EURYCOMA Jack

(Greek, *eurus* = broad, *kome* = tuft or crust; the leaves crowded at the ends of branches)

Mal. Misc. 2 (1822) 45; Merrill *l.c.* (1921) 316; Ridley *l.c.* 361; Burkill, EPMP (1935) 984; Masamune *l.c.* 361; Corner *l.c.* 698; Nooteboom, FM 1, 6 (1962) 203; Kochummen *l.c.* 349; Cockburn *l.c.* 219; Anderson *l.c.* 323.

Trees, treelets or shrubs. Twigs stout with large leaf-scars. **Leaves** *pinnate*, with terminal leaflet, crowded at branch ends; leaflets *sessile*, opposite or subopposite; base slightly oblique, attached to the rachis with a prominent joint; *lateral veins inconspicuous* above and below. **Inflorescence** a downturned axillary panicle; plants monoecious or dioecious. **Flowers** *unisexual*, female always with large sterile stamens, males always with a pistillode; calyx small, 5–6-lobed; petals 5–6; stamens 5–6, on the sepals alternating with 5–6 small staminodes, stamens and staminodes sometimes united with the base of petals; disc inconspicuous; carpels 5–6, each with 1 ovule, free, the styles slightly united, stigma peltate, 5–6-lobed. **Fruit** a nut, to 5 per flower, each on a short stalk *c.* 3 mm long, ellipsoid or ovoid. **Seeds** without endosperm.

Distribution. 3 species in tropical SE Asia, Sumatra, Borneo and S Philippines. In Sabah and Sarawak, only 1 species.

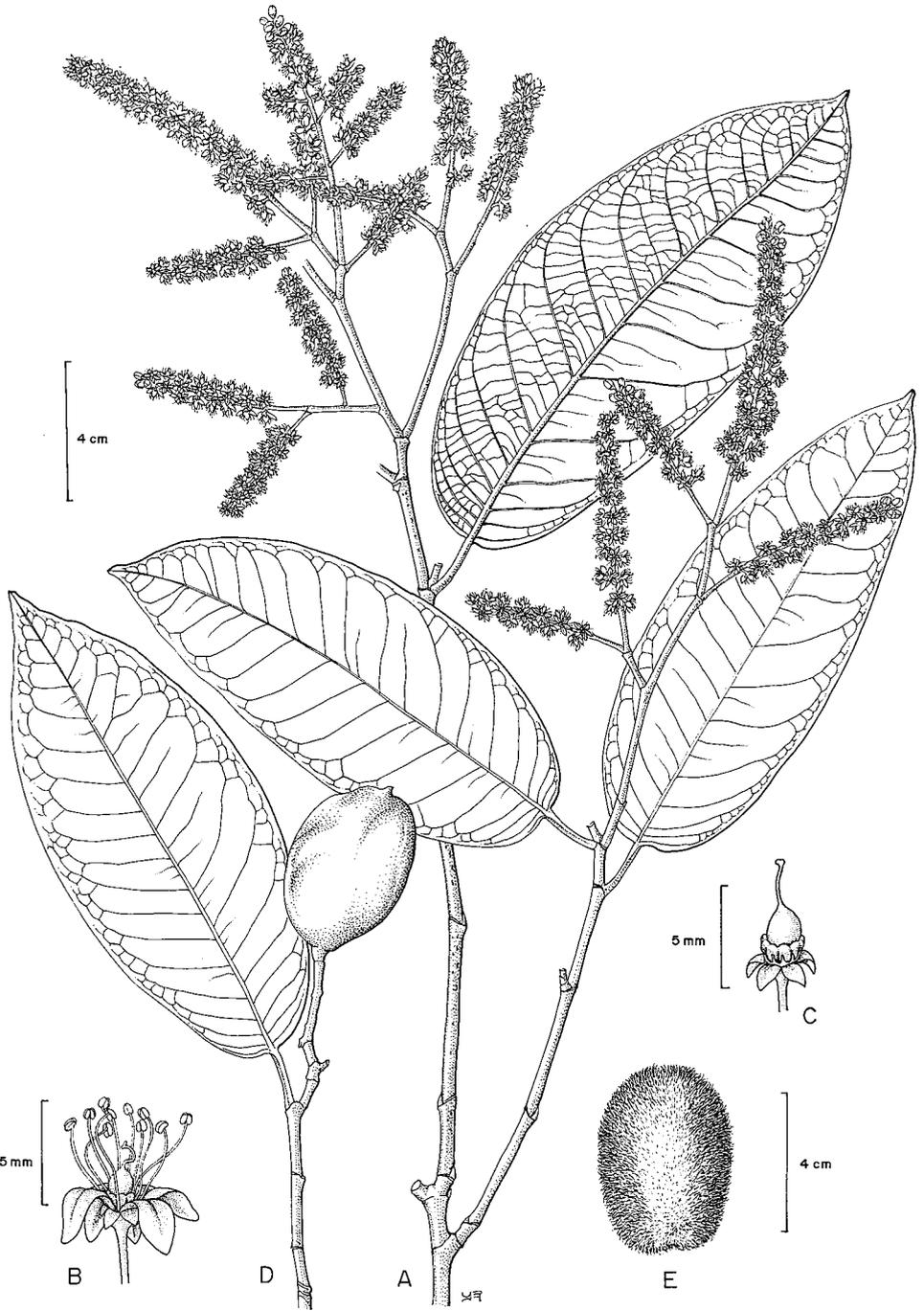


Fig. 5. *Irvingia malayana*. A, flowering leafy twig; B, flower; C, flower with petals and stamens removed; D, twig with young fruit; E, fibrous mesocarp of fruit. (A-C from SAN 43118, D from SAN 63884, E from SAN 74993.)

Eurycoma longifolia Jack

Fig. 4.

(Latin, *longus* = long, *folium* = leaves)

l.c. 45; Ridley *l.c.* 362; Merrill *l.c.* (1921) 316, PEB (1929) 116; Masamune *l.c.* 361; Burkill *l.c.* 984; Corner *l.c.* 604; Nooteboom, FM 1, 6 (1962) 205; Kochummen *l.c.* 349; Cockburn *l.c.* 219; Anderson *l.c.* 323. **Type:** *Jack s.n.*, Sumatra (holotype K). **Synonyms:** *E. merguensis* Planch. in Hooker, Lond. J. Bot. 5 (1846) 584; *Picroxylon siamense* Warb., Fedde Rep. 16 (1919) 256; *Manotes asiatica* Gagn., Bull. Soc. Bot. Fr. 98 (1951) 207.

Spindly unbranched tree or shrub, to 8 m tall and 15 cm diameter, or with a few upright branches, each crowned by an umbrella-like rosette of leaves. **Bark** greyish brown, smooth. **Leaves** to 100 cm long; leaflets lanceolate to obovate-lanceolate, rarely oblong, 5–20 x 1.5–6 cm; base oblique, apex blunt to slightly acuminate; midrib raised on both surfaces; lateral veins inconspicuous above and sunken below. **Flowers** reddish; petals hairy on both sides, *c.* 4.5–5.5 x 1.5–2.5 mm; styles rather long, stigma *c.* 1 mm above the ovaries. **Fruits** 10–17(–20) x 5–12 mm.

Vernacular names. Sabah—*ionadiandau*, *nuad-mandau* (Runggus), *tombuid* (Dusun/Kadazan Tambunan), *tongkat ali* (Malay), *tongkat langit* (Kuala Penyu Malay). Sarawak—*bedara* (Semantan Malay), *sengkanyat* (Iban), *sengkayap* (Iban), *tongkat ali* (Santubong & Miri), *tungkat ali* (Lundu).

Distribution. Lower Burma, Thailand, Laos, Cambodia, Indo-China; Malesia: Sumatra, Peninsular Malaysia, and Borneo. Common throughout both Sabah and Sarawak; also in Brunei and Kalimantan

Ecology. Abundant on well-drained sandy soils below 1200 m, in primary and secondary mixed dipterocarp, heath and submontane forests.

Uses. In Sabah the roots are mixed with other medicinal plants, e.g., *Cinnamomum* species, and used to prepare a health tonic. In Brunei, the bark is used as a blood coagulant in complication during childbirth. The young leaves can be eaten raw to cure stomach-aches. In Peninsular Malaysia, Chan *et al.* (Planta Medica 52 (1986) 105) reported that methanol-extracts of roots contained biologically active compounds showing a strong antiplasmodial activity against a multi-drug resistant K1 strain of *Plasmodium falciparum* from Thailand. The putative aphrodisiac properties of the roots have, as yet, been substantiated by rigorous experiment.

5. IRVINGIA Hook.f.

(E.G. Irving, 1816–1855, Scottish botanist)

pauh kijang

Trans. Linn. Soc. 23 (1860) 167; Ridley *l.c.* 363; Corner *l.c.* 699; Nooteboom, FM 1, 6 (1962) 223; Kochummen *l.c.* 350; Cockburn *l.c.* 221; Anderson *l.c.* 323; Whitmore, Tantra & Sutisna *l.c.* 330.

Large trees; buttresses steep, to 6 m high. **Bark** fawn, smooth with distant loose scales, minutely lenticellate; inner bark mottled, cream-yellow. **Sapwood** orange-brown. *Twigs*

with stipules forming a narrow, conical cap surrounding the terminal buds, soon falling, leaving conspicuous annular scars. **Leaves** simple, glabrous, entire. **Inflorescences** axillary and terminal panicles. **Flowers** (4–)5-merous, *bisexual*; sepals connate (united) at the base; petals overlapping in buds; stamens twice as many as petals, inserted beneath the large, cushion-shaped, intrastaminal disc; ovary 2-chambered, conical or somewhat flattened, sessile; style 1, stigma inconspicuous; ovules solitary. **Fruit** a *drupe*, large, 1–2-seeded, resembling a mango.

Distribution. 3 species in tropical Africa and 1 species in tropical SE Asia and W Malesia.

Ecology. Frequent in lowland forests.

Uses. The fruit of all species is edible, but usually only the seeds are eaten.

Irvingia malayana Oliv. *ex* A.W. Benn.
(of Malaya)

Fig. 5.

in Hooker *f.*, Fl. Brit. Ind. 1 (1875) 522; Ridley *l.c.* 364; Corner *l.c.* 699; Nooteboom, FM 1, 6 (1962) 223; Kochummen *l.c.* 350; Cockburn *l.c.* 221; Burgess TBS (1966) 455; Anderson *l.c.* 323; Whitmore, Tantra & Sutisna *l.c.* 330. **Type:** *Maingay* 298, Malacca (holotype K). **Synonyms:** *Irvingia oliveri* Pierre, Fl. For. Coch. 4 (1892) t. 263 B; *Irvingella malayana* van Tiegh., Ann. Sc. Nat. 9, 1 (1905) 276; *Irvingella oliveri* (Pierre) van Tiegh. and *Irvingella harmandiana* van Tiegh. *l.c.* 279; *Irvingia harmandiana* (van Tiegh.) Pierre *ex* Lecomte, Fl. Gen. I.-C. 1 (1911) 701; *Irvingia longipedicellata* Gagnep., Fl. Gen. I.-C. Suppl. 1 (1946) 670.

Medium-sized to large tree reaching 50 m tall and 50 cm diameter, with big limbs; buttresses steep, plank-like and spreading, to 3 m high. **Bark** greyish to whitish, scaly to flaky, sometimes smooth, minutely lenticellate. **Leaves** elliptic-oblong to lanceolate, 8–20 x 2.5–9 cm, upper surface shiny, lower surface slightly glaucous especially when fresh; base often rounded, apex usually pointed; midrib raised above; lateral veins 10–16 pairs, looping and joining at margin, prominent on both surfaces; stipule-cap 3–4 cm long. **Flowers** greenish white or yellowish, small. **Fruits** ellipsoid, c. 6 x 4 cm, slightly glaucous. **Seedling** with first two leaves opposite; germination epigeal.

Vernacular names. Sabah—*mengkudu* (Dusun/Kadazan Tuaran/Ranau; doubtful, as this name normally refers to *Morinda* in the Rubiaceae), *pauh kijang* (Malay), *selangan tandok* (Malay), *tenghilan* (Dusun/Kadazan Tuaran). Sarawak—*patok entilit* (Iban).

Distribution. Thailand, Indo-China, and Malesia (Sumatra, Peninsular Malaysia, Borneo and Bawean). Widespread in Sabah and Sarawak. Also in Brunei and Kalimantan.

Ecology. Scattered in mixed dipterocarp forest on clay-rich soils, to 300 m.

Timber. Burgess (*l.c.* 455) summarises the timber properties of this species. *Pauh kijang* produces a very strong and springy timber, hard to saw and work, due to the high density. It takes a very fine finish, and requires very little filling, and turns very well. In Sandakan, furniture of this timber glued with synthetic resin glues has tended to fail at the glue-line.

Uses. The yellow wood is too hard to work with and not very durable. In Peninsular Malaysia, it has been used for making *kris*-handles and handles of tapping knives (Nootboom, *l.c.*). The seeds contain a creamy yellow, nice-smelling fat known as "dika" fat in Europe, used for making soap, wax, and candles. The seeds can also be eaten (Nootboom, *l.c.*).

6. PICRASMA Blume

(Greek, *pikros* = bitter, *osme* = smell or taste; the bark and other parts)

Bijdr. 5 (1825) 247; Ridley *l.c.* 361; Burkill *l.c.* 1723; Nootboom, FM 1, 6 (1962) 212; Kochummen *l.c.* 351; Anderson *l.c.* 323; Whitmore, Tantra & Sutisna *l.c.* 330.

Trees or shrubs. **Leaves** *pinnate*, with terminal leaflet, stalk base and rachis nodes usually swollen; leaflets opposite or subopposite, entire, veins prominent on both upper and lower surfaces; stipules present, suborbicular and falling off early. **Inflorescences** axillary, long-peduncled, compound-cyme, unisexual (plants monoecious or dioecious). **Flowers** 4–5-merous, female usually twice as large as male; sepals small, free to united half way up; petals persistent in female, much longer than the sepals; stamens 4–5; disc thick; carpels up to 7, free, each with 1 ovule, vestigial or absent in male; styles united except at base, sometimes 1 or 2, free; stalks jointed in the lower half. **Fruit** 1–4, drupe-like; exocarp thin, fleshy, wrinkled when dry; endocarp hard. **Seeds** without endosperm.

Distribution. About 8 species, 6 in tropical America, 2 species in Asia including 1 in Malasia.

Uses. *Picrasma* species contain alkaloids, the source of quassia chips used in insecticide.

Picrasma javanica Blume

Fig. 6.

(of Java)

l.c. 248; Ridley *l.c.* 361; Burkill *l.c.* 1723; Nootboom, FM 1, 6 (1962) 213; Kochummen *l.c.* 351; Anderson *l.c.* 323; Whitmore, Tantra & Sutisna *l.c.* 330. **Type:** *Blume, s.n.*, Java (holotype L). **Synonyms:** *P. nepalensis* A.W. Benn., Pl. Jav. Rar. (1844) 201; *P. andamanica* Kurz ex A.W. Benn. in Hooker *f. l.c.* (1875) 520; *P. philippinensis* Elmer, Leaflet. Philip. Bot. 5 (1913) 1837.

Tree to 24 m tall and 25 cm diameter; bole fluted. **Bark** dark, smooth, brittle; inner bark dull yellow. **Sapwood** with clearly visible vessels. **Leaves** with 5–7 leaflets, stalk 2–6 cm long; leaflets entire, 4–20 x 1–10 cm; base wedge-shaped, margin wavy or wrinkled, apex acuminate; lateral veins 3–8 pairs, petiolules to 7 mm long; stipules leafy, nearly rounded, 7–25 x 5–20 mm, usually falling off early leaving a large scar. **Inflorescences** to 20 cm long. **Flowers** 4-merous, white to yellow or green; sepals glabrous to puberulous, triangular to ovate, *c.* 1 mm; petals ovate-oblong or oblong, often acute-acuminate to mucronate, glabrous, or sparsely hairy, with a conspicuous midrib; stamens usually longer than petals in male flowers, shorter than petals in female flowers, filaments gradually thinner towards the top, hairy at base, 0.5–2 mm long in female flowers and 1–5 mm in male flowers, anthers 1–2 mm long in male and to 1 mm and empty in female flowers; ovary 4-lobed, 4-

carpellate, glabrous to hairy, styles 1–1.5 mm long, stigmas *c.* 2 mm. **Fruits** green to red or blue, ovoid to depressed globose, 9–10 x 7–12 mm. **Seeds** with a broad hilum; testa rather thick and hard.

Vernacular names. Sabah—*balimbing*, *panguban* (Dusun/Kadazan Tambunan). Sarawak—*kayu pahit* (Malay).

Distribution. Tropical SE Asia (from Sikkim, Assam, Burma and Tonkin southward to Malesia). In Borneo, recorded in Sarawak only at about 400 m on the Gunung (Mt.) Api limestone, at Mulu, and in Sabah on the west coasts.

Ecology. Uncommon, usually scattered in rainforests from near sea-level to 1500 m.

Uses. The bark contains quassin, which gives its bitter taste. In Java, the leaves have been applied for treating sores (Nooteboom *l.c.*). The trunk is too small for timber and the wood is not durable (Burkill *l.c.*).

7. QUASSIA L.

(named after a slave in Surinam who reported
the medicinal properties of the wood to Dalberg, friend of Linnaeus)

Sp. Pl. ed. 2 (1762) 553, *l.c.* (1763) 1679; Merrill *l.c.* (1921) 315 (as *Samadera*); Ridley *l.c.* 363; Burkill *l.c.* 1945; Masamune *l.c.* 362 (as *Samadera*); Nooteboom, FM 1, 6 (1962) 198, Blumea 11 (1982) 514; Kochummen *l.c.* 352; Cockburn *l.c.* 217.

Trees or shrubs. **Leaves** pinnate or simple, with pitted glands on the upper surface along the margin and especially at the apex; stipules and scars absent. **Inflorescence** a simple or branched raceme, a panicle, or an umbel. **Flowers** 4–6-merous, unisexual or bisexual, or polygamous; petals imbricate or contorted in bud, longer than the calyx, sometimes very long; stamens hairy, adaxial scale with a shorter or longer free apex; disc cylindrical or subglobose; carpels free, more or less puberulous; style 1, with a terminal, inconspicuous stigma. **Fruits** 1–6 per flower, drupaceous or woody, often compressed laterally, with a narrow, unilateral, sharp-edged thinner part in the apical half. **Seeds** with a thin testa, without endosperm.

Distribution. Pantropical, *c.* 25 species in tropical and subtropical America, 5–10 species in Africa, 2 species in lower Burma and Cambodia (one of which is found almost throughout Malesia), 1 species endemic to Borneo and Sumatra, and 2 species in Queensland.

Ecology. In lowland rain forests.

Key to *Quassia* species

Leaves pinnately compound. Flowers in panicles. Fruits 1–5 from each flower, drupaceous, slightly flattened, ellipsoid.....1. *Q. borneensis*

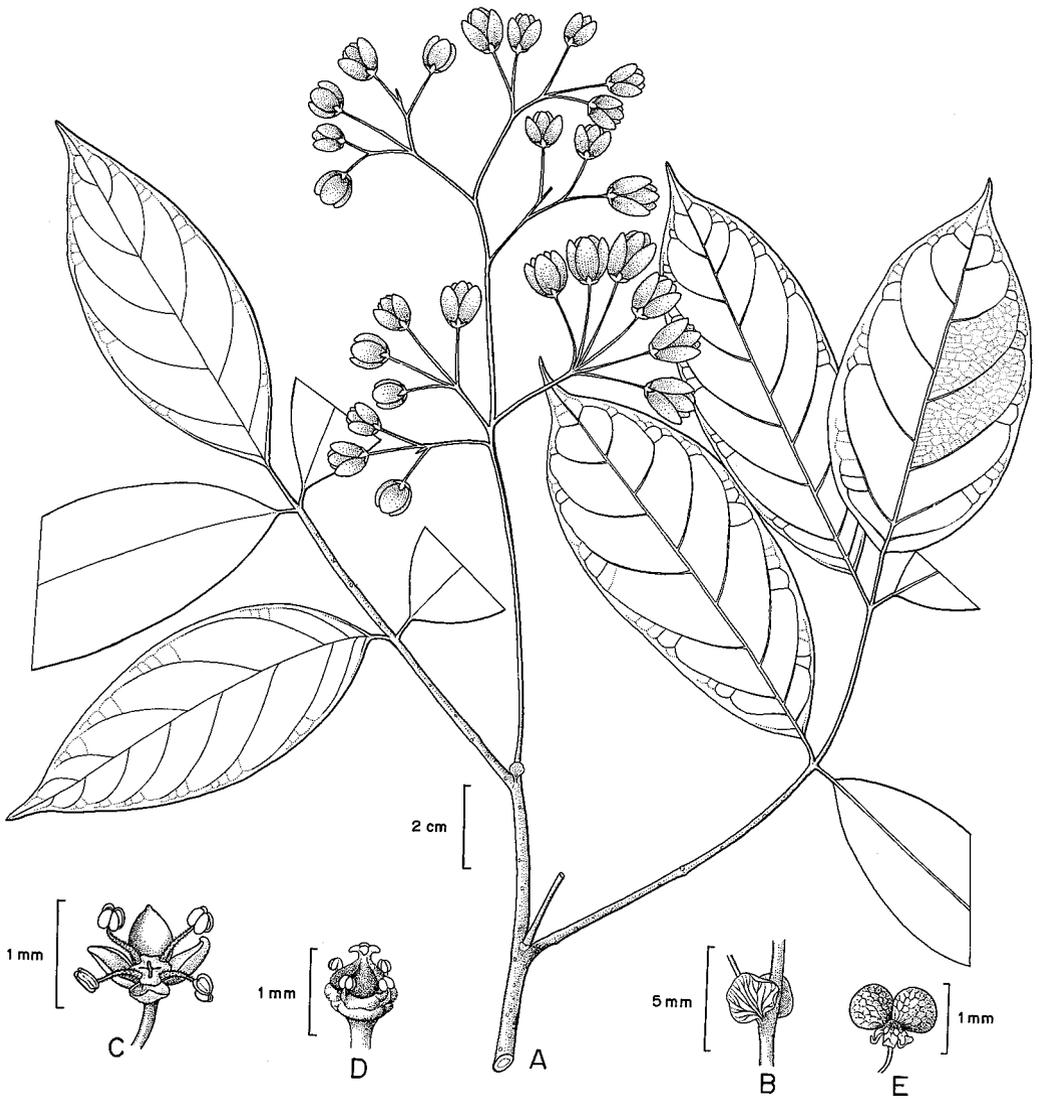


Fig. 6. *Picrasma javanica*. A, flowering leafy twig; B, stipules; C, male flower; D, female flower; E, fruits. (A from de Wilde & de Wilde-Duyffes 14843, B-E after FM 1, 6 (1962) 213, fig. 15.)



Fig. 7. *Quassia indica*. A, fruiting leafy twig, B, inflorescence. (A from S. 42968, B from S. 16407.)

Leaves simple. Flowers in umbel-like clusters. Fruits 1–4 from each flower, strongly flattened, with straight inner and semicircular outer margin.....2. *Q. indica*

1. *Quassia borneensis* Noot.

(of Borneo)

FM 1, 6 (1962) 203, Blumea 11 (1962) 518; Cockburn *l.c.* 219; Anderson *l.c.* 323; Whitmore, Tantra & Sutisna *l.c.* 330. **Type:** *Meijer SAN 20499*, Sabah (holotype L; isotypes K, SAN).

Tree to 25 m tall and 25 cm diameter; buttresses low. **Bark** pale yellow to greyish brown, densely fissured-corky. **Sapwood** white. **Leaves** *pinnate, spirally arranged; leaflets 2–4 pairs, elliptic to obovate-oblong, 8–12 x 4–4.5 cm, glabrous, upper surface shiny, lower surface dull; with small pitted glands along the margins and in the acumen on the upper surface; base cuneate, apex shortly rounded to acuminate; lateral veins sunken on both surfaces, obscure, ending in a marginal vein; stalk c. 5 cm long, rachis terete, petiolules 1–1.5 cm long, articulated at the base. Inflorescences* puberulous all over, shorter than the leaves. **Flowers** (male) *4–5-merous, pedicels to 7 mm long; calyx c. 1 mm high; petals contorted or imbricate in bud, glabrous, elliptic to ovate-oblong, 3–4 x 2 mm; stamens slightly shorter than the petals, anthers oblong; disc c. 0.5 mm high, at the base c. 2 mm wide and at the apex c. 1 mm wide, the upper half distinct from the lower half and folded around the barren ovaries. Fruits 1–5 in each flower, drupaceous, prune-shaped, dark purple-red when ripe, slightly flattened-ellipsoid, with a faint dorsal and ventral ridge, 2–3 x 1.5 cm; pericarp thin but hard. Seeds with a thin testa; cotyledons large, green, plano-convex.*

Vernacular names. Sabah—*mamungal* (Malay), *pait-pait* (Malay). Sarawak—*medang pahit* (Malay).

Distribution. Malesia: Sumatra (Indragiri), Borneo (Sabah and Sarawak). Uncommon.

Ecology. Primary mixed dipterocarp forest on humult ultisols; also, rarely, in peat swamp and *kerangas* (heath) forests.

2. *Quassia indica* (Gaertn.) Noot.

Fig. 7.

(of the Indies)

FM 1, 6 (1962) 199, Blumea 11 (1962) 517; Kochummen *l.c.* 352; Cockburn *l.c.* 217; Anderson *l.c.* 323; Whitmore, Tantra & Sutisna *l.c.* 330. **Basionym:** *Samadera indica* Gaertn., *Fruct.* 2 (1791) 352, *t.* 156, *f.* 3. **Type:** *Gaertner, Fruct.* 2 (1791) 352, *t.* 156, *f.* 3. **Synonyms:** *Manungala pendula* Blanco, *Fl. Filip.* (1837) 306; *Samadera brevipedata* Scheff., *Nat. Tijds. Ned. Ind.* 32 (1871) 410.

Tree or shrub, to 20 m and 8 cm diameter. **Bark** brownish green, smooth; inner bark pinkish. **Sapwood** pale yellow; cambium yellow. Branchlets with small pith, with several stiff persistent scales at the base of each shoot. **Leaves** simple, elliptic-oblong to lanceolate, 12–13 x 4–12 cm; base acute or sometimes rounded, or subcordate, apex blunt or acuminate or sometimes rounded; midrib, lateral and intercostal veins prominent on both

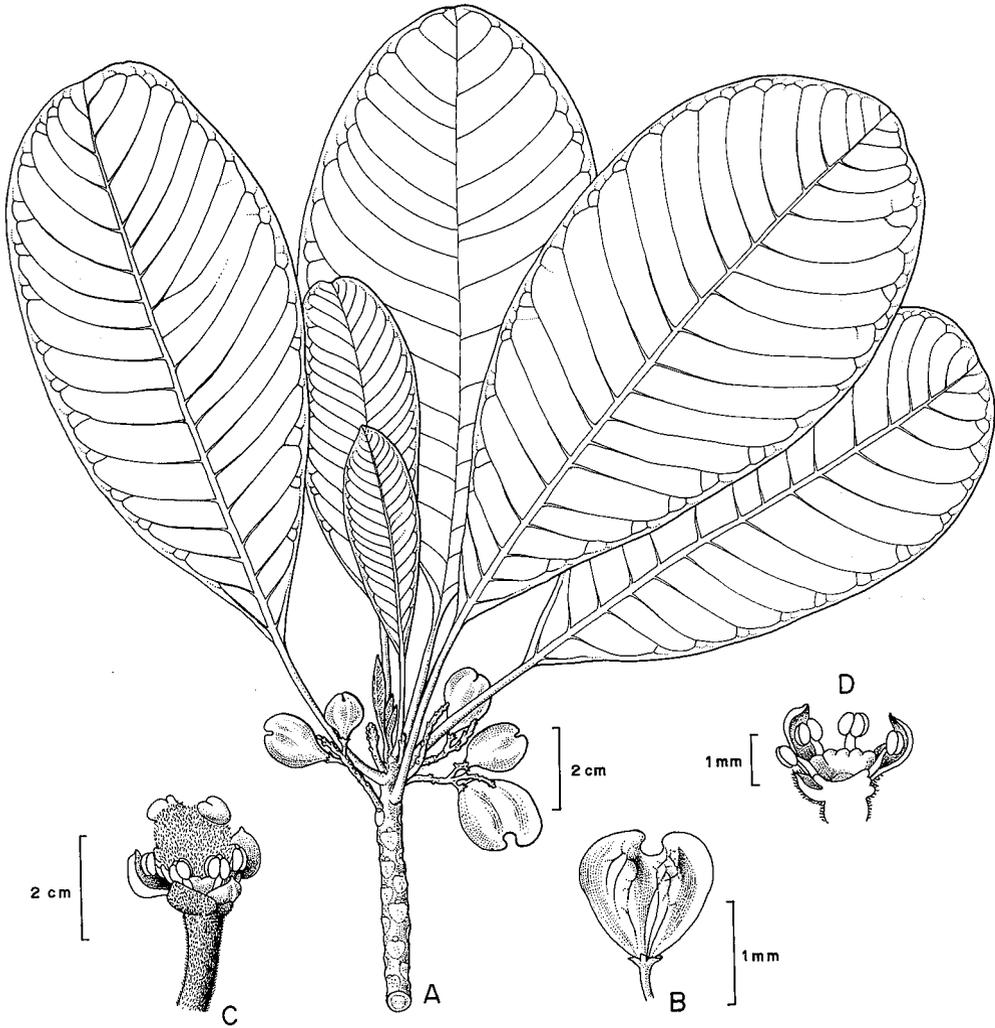


Fig. 8. *Soulamea amara*. A, fruiting leafy twig; B, fruit; C, flower; D, longitudinal section of flower with pistil removed. (After FM 1, 6 (1962) 222, fig. 21.)

surfaces; stalks 1–2.5 cm long. **Inflorescences** jointed at the lower half, 0.5–2.5 cm, growing during anthesis; bracts minute. **Flowers** to 20 or more; calyx 4-lobed, 2–3 mm long, lobes about as long as or longer than the tube, puberulous outside; petals 4, free, dorsally puberulous, obtuse, usually narrowed to the base, creamy green to violet, to 3 x 1 cm; filaments puberulous, hairy except toward the apex, to 2.5 cm long, inserted at the base of the disc, anthers lanceolate to oblong, *c.* 4 x 2 mm; styles to 2 mm long. **Fruits** 1–4 together, flattened, with straight inner and semicircular outer margin, which is sharp and thinner in the upper half, the apex more or less overtopping the subapical styler scar, 4–9 x 2.5 cm.

Vernacular names. Sabah—*kacang-kacang* (Malay), *kelapahit* (Sook Murut). Sarawak—*manuggal* (Iban).

Distribution. Madagascar, Sri Lanka, S Concan, Malabar, Lower Burma (Martaban, Tenasserim), Andamans, and Cochinchina, through Malesia to the Bismarcks and Solomons. In Sabah, it is found mainly in the east coast (Sandakan & Lahad Datu districts), with only a few records from the west coast (Sipitang district). In Sarawak, it is found throughout the state.

Ecology. Locally abundant in tidal swamp forests below 150 m, sometimes in localities which are periodically inundated by fresh or salt water, for example on the edge of mangroves. Occasional in freshwater swamp forest; also occurs in mixed dipterocarp forest.

Uses. In Sarawak, the wood is used for making knife-handles. The seeds are given as an emetic and purgative, and sometimes in bilious fevers (Nooteboom *l.c.*).

8. SOULAMEA Lam.

(*soelamoe*, a Ternatean name for the plant)

Dict. Enc. Meth. 1 (1783) 449; Masamune *l.c.* 362; Nooteboom, FM 1,6 (1962) 221; Cockburn *l.c.* 217.

Shrubs or small trees. **Leaves** simple, obovate, spirally arranged, densely clustered at shoot tips, sometimes with few glands underneath. **Flowers** in axillary racemes or narrow thyrses, 3(–4–5)-merous, bisexual; floral parts persistent; sepals more or less connate at the base, slightly imbricate in bud; petals longer than sepals; stamens twice as many as petals, in 2 distinct rows, inserted under the lower outer margin of the disc, anthers versatile; disc 3(–4–5)-lobed, each lobe forked; ovary (1–)2–3-carpellate, styles horizontally adnate to their carpels, stigmas small; ovules sessile. **Fruits** dry, (1–)2(–3)-celled, indehiscent, flattened, distinctly winged, more or less emarginate, rarely flattened, ovoid, acute. **Seeds** attached adaxially nearly halfway down; testa thin; cotyledons plano-convex.

Distribution. 9 species. One species is endemic to the Seychelles, 6 species occur in New Caledonia, and one species in Fiji. One species is widely distributed in Malesia and Polynesia, and it occurs in Sabah and Sarawak.

Soulamea amara Lam.

Fig. 8.

(Latin, *amarus* = bitter; the taste of the tissues)

l.c. (1783) 449; Miquel, *Fl. Ind. Bat.* 1, 2 (1859) 129; Masamune *l.c.* 362; Nooteboom, *FM* 1, 6 (1962) 221; Cockburn *l.c.* 217. **Type:** *Rumphius Herb. Amb. t. 415* (L). **Synonyms:** *Rex amaroris* Rumph., *Herb. Amb.* 2 (1743) 129, *t. 41*; *Cardiocarpus amarus* Reinw., *Syll. Ratisb.* 2 (1826) 14; *Cardiophora hindsii* Benth. & Hook. *f.*, *Lond. J. Bot.* 2 (1843) 216.

Shrub or small tree to 5(–15) m tall; young shoots and buds rusty tomentose. **Leaves** crowded at the apex of the branchlets, on dropping leaving large scars; blade obovate-oblong, 10–35 x 4–12 cm; base cuneate, apex blunt but sometimes mucronate; midrib and veins hairy below; midrib slightly immersed or inconspicuous above, strongly prominent beneath; lateral veins straight, parallel, ending in an intramarginal looped vein, sulcate, slightly prominent or inconspicuous above; intercostal veins finely dense-reticulate beneath; *stalks* pithy, shrunken at the base when dry, sometimes also at apex, hairy, 3–8 cm long. **Inflorescences** erect, shorter than the leaves, 3–12 cm long. **Flowers** *c.* 2 mm long; pedicels to 5 mm long; sepals puberulous, erect, appressed, 0.5–1.0 mm long; petals concave, spreading, finally reflexed, sparsely hairy to glabrous, accrescent, to 2.5 x 1 mm; stamens with glabrous filaments to 1 mm long, anthers *c.* 0.75 mm long; ovary 2–3-carpellate, never with more than 2 carpels fertile, carpels connate except at the top. **Fruits** obcordate, to 2 x 2.5 cm, strongly emarginate; pericarp hard and corky; wings often nearly touching near the inward curved style-bases. **Seeds** round, 0.5–1 cm across.

Distribution. From Borneo eastwards to Micronesia (West and East Carolines and Marshalls) and Melanesia (New Britain, Solomons, New Hebrides); in Malesia: Borneo (Sabah, Sarawak, Karimata Is.), Moluccas, and New Guinea.

Ecology. A typical constituent of the *Barringtonia*-formation of the beach vegetation, but much rarer than most of the species belonging to that formation, though locally common on the sandy beaches and behind coral reefs.

Uses. None known in Sabah and Sarawak. The roots and the fruits of this very bitter plant have been used to treat cholera, pleurisy, and other fevers; a beverage prepared from powdered leaves is taken against colic and cough, and the fruits have been used to induce vomiting in treating snake bites (Nooteboom *l.c.*).

SONNERATIACEAE

Othman Bojo

Universiti Malaysia Sarawak,
Kota Samarahan, Malaysia

Merrill, EB (1921) 418; Holthuis & Lam, *Blumea* 1, 5 (1942) 216; Backer & van Steenis, FM 1, 4 (1951) 280, FM 1, 5 (1958) 557, FM 1, 6 (1972) 973; Whitmore, TFM 1 (1973) 442; Cockburn, TS 1 (1976) 223; Anderson, CLTS (1980) 323; Ashton, MNDTS 2 (1988) 374; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 331.

Trees. **Bark** cream to grey, smooth or shallowly irregularly flaky; inner bark soft, brown. **Sapwood** soft, pale yellow. **Leaves** simple, opposite, biseriate, entire, coriaceous, short-stalked, without stipules. **Inflorescences** terminal corymbs or 1–3-flowered fascicles. **Flowers** bisexual, pedicelled, rather large, regular; sepals persistent, thickly leathery, connate at base to form a tube or cup with 4–8 triangular lobes, segments valvate in bud, often reddish inside; petals absent or as many as sepals, broad and wrinkled or very narrow and smooth, alternating with the sepals; stamens 12 to many, inserted on the sepals, 1–many seriate, inflexed in bud, filaments filiform to subulate; anthers 2-celled, kidney-shaped or oblong, opening lengthwise; ovary superior, sessile and with a broad base, enclosed by the calyx-base until it expands, 4–20-celled, septa thin; style 1, long, stout, stigma 1, capitate or slightly lobed; ovules anatropous many, placentation axile. **Fruits** many-seeded berries (in *Sonneratia*) or dehiscent capsules (in *Duabanga*), subtended by the persistent calyx-tube. **Seeds** small, without endosperm; embryo straight.

Distribution. 2 genera with 7 species distributed in the Old World Tropics from East Africa to the Pacific islands. In Sabah and Sarawak, 2 genera with 4 species.

Ecology. Whereas *Sonneratia* is a mangrove genus found mainly on sandy and muddy tidal flats, estuaries, brackish streams and coral terraces at tide level, *Duabanga* is a component of lowland and hill forests, and being light-demanding, is frequently found in secondary forests, forest-edges and river-banks. The flowers produce a mild sour to musty odour, expand at sunset, last for only one night and are pollinated by nectarivorous bats. The fruits/seeds are dispersed either by water (*Sonneratia*) or by wind (*Duabanga*).

Uses. The soft pale wood of the Sonneratiaceae is not durable and its only known use is as firewood. However, timber of *Duabanga* is occasionally used for boat-building. Fruits of some species (*S. caseolaris* and *S. ovata*) are edible, and the leaves and pneumatophores of *S. caseolaris* are reported to have medicinal value.

Taxonomy. Previous authors such as Ridley (FMP 1 (1922) 819), Watson (MFR 6 (1928) 50), Browne (FTSB (1955) 248), Hsuan Keng (OFMSP (1978) 155), Corner (WSTM 1 (1988) 470) and Brummitt (Vasc. Pl. Fam. & Gen.—Dicot. (1992) 607) included *Duabanga*

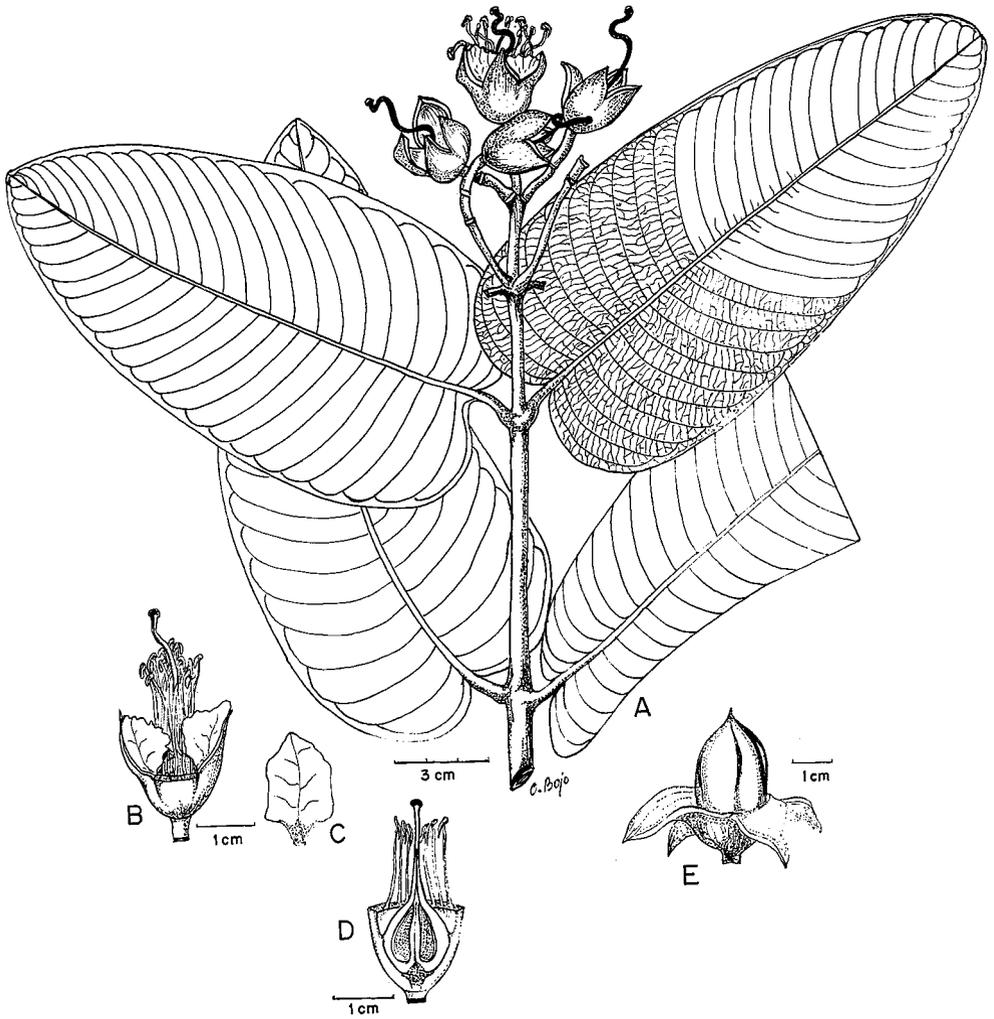


Fig. 1. *Duabanga moluccana*. A, flowering leafy twig; B, flower with some sepals and petals removed; C, petal; D, longitudinal section of flower with sepals and petals removed; E, fruit. (A-D from UNIMAS/OB 82, E from Hansen 207.)

and *Sonneratia* in the Lythraceae. This contention seems to be supported by anatomical (Metcalf & Chalk, *Anat. Dicot.* 1 (1964) 6), embryological (Venkateswarlu, *Proc. Indian Acad. Sci. Ser. B*, 5 (1937) 206), and palynological evidence (Erdtman, *Poll. Morph. & Pl. Tax.* 1 (1952) 412; Thanikaimoni & Jayaweera, *Tran. Sect. Sci. & Techn., Inst. Princ. Pondichery* 5, 2 (1966) 1; Muller, *Pollen et Spores* 2 (1969) 223; Germeraad, Hopping & Muller, *Rev. Palaeobot. & Palyn.* 6 (1968) 189). However, accounts by Backer & van Steenis (*l.c.*), Cockburn (*l.c.*), Ashton (*l.c.*), Maberley (PB (1987) 546), and van Steenis (*Checkl. Gen. Names Males. Bot., Sperm.* (1987) 115) include the two genera in the Sonneratiaceae, a view which is adopted here. For anatomical information on the family, the work of Reinders-Gouwentak (FM 1, 4 (1951) 513) should be consulted.

Key to genera

Monopodial trees of inland forests, without breathing roots; branches drooping. Leaves coriaceous, glaucous below, with many prominent lateral veins and intra-marginal veins, base heart-shaped. Flowers in terminal corymbs; petals broad, wrinkled. Fruits 4–8-valved capsules. Seeds tailed at each end by the protracted testa.....1. **Duabanga**

Sympodial trees of mangroves and sea-coasts, with breathing roots; branches not drooping. Leaves succulent, not glaucous, venation obscure; base not heart-shaped. Flowers in clusters of 1–3 at the ends of the branchlets; petals absent or very narrow. Fruits indehiscent berries. Seeds not tailed.....2. **Sonneratia**

1. DUABANGA Buch.-Ham.

(from *duyabangga*, an Indian vernacular name)

Trans. Linn. Soc. Lond. 17 (1893) 177; Ridley, *FMP* 1 (1922) 824 (under Lythraceae); Burkill, *EPMP* (1935) 868; Backer & van Steenis *l.c.* 288; Jayaweera, *J. Arn. Arb.* 48 (1967) 89; Ashton *l.c.* 375; Kochummen & Wyatt-Smith, *MFR* 17 (1964) 271; Cockburn *l.c.* 223; Corner, *WSTM* (1988) 476 (under Lythraceae); Whitmore, *Tantra & Sutisna l.c.* 331.

Medium-sized to big trees; *crown monopodial, rather open, ultimate branches drooping*; bole with insignificant concave buttresses at base. **Bark** smooth, pale ochreous-cream or grey; inner bark pale yellow, soft, fibrous. **Sapwood** white, soft. *Twigs 4-angled or winged, often with an interpetiolar ridge*. **Leaves** oblong-ovate, base heart-shaped, glaucous beneath, coriaceous; *lateral veins prominent beneath, looped at the margin forming intra-marginal veins*; petioles short. **Flowers** 5–many, *in terminal corymbs, 4–8-merous*; *calyx fleshy, green, cup-shaped with triangular segments*; *petals shortly clawed*, white or yellowish, *broad, wrinkled*; *stamens 12 or many, 1-seriate*; anther recurved over one end of the connective; *ovary 4–8-celled*; stigma stout, lobed. **Fruits** 4–8-valved, *loculicidally dehiscent*. **Seeds** *tailed at both ends by the extended testa*.

Distribution. 2 species, from eastern Himalaya to New Guinea. Only 1 species (*D. moluccana*) is found in Sabah and Sarawak and is common.

Ecology. Mainly in mixed evergreen and deciduous forests at 15–1200 m. Usually occurring as scattered individuals on brownish yellow sandy clay loam soils or yellow podsols. The seeds are readily dispersed by wind.

Taxonomy. Based on the revision of Sonneratiaceae by Backer & van Steenis (*l.c.* 288), *Duabanga* consists of two species, *D. grandiflora* and *D. moluccana*. In 1967, Jayaweera (*l.c.* 89), added one new species, *D. taylorii* Jayaweera. However, detailed study of *D. taylorii* by Geesink (*Blumea* 2, 18 (1970) 454) reveals that this species is a primary hybrid between *D. grandiflora* and *D. moluccana* which is believed to have originated in the Bogor Botanic Garden in the 1850s.

Uses. In Sabah and Sarawak, its non-durable and soft wood has no commercial value. However, in other regions, the wood is used for house and boat-building and also for firewood.

Duabanga moluccana Blume (of the Moluccas islands)

Fig. 1.

Mus. Bot. Lugd. Bat. 1 (1849) 109; Merrill, PEB (1929) 212; Holthuis & Lam *l.c.* 216; Backer & van Steenis *l.c.* 288; Jayaweera *l.c.* 91; Cockburn *l.c.* 223; Anderson *l.c.* 323; Ashton *l.c.* 375; Corner *l.c.* 476; Whitmore, Tantra & Sutisna *l.c.* 331. **Type:** *Forstein, s.n.*, Moluccas, Ambon (holotype L). **Synonym:** *D. borneensis* R. Knuth, Fedde Rep. 38 (1935) 121.

Tree to 45 m tall and 100 cm diameter, with or without buttresses; trunk columnar. **Bark** smooth becoming fissured or scaly with age, lenticellate, grey or brownish; inner bark yellowish or pale brown, soft and fibrous. **Sapwood** cream, darkening purplish on exposure. **Twigs** 3–8 mm diameter, slender, 4-angled, becoming terete with age, hairy when young, glabrescent. **Leaves** ovate, oblong or oblanceolate, 10–26 x 4–13 cm, dark green above, paler beneath, leathery; base shallowly heart-shaped, apex acuminate; midrib prominent beneath; lateral veins 11–26 pairs, joined near the margin to form an intramarginal vein; petioles 5–10 mm long. **Inflorescences** few to many-flowered, dense or rather lax, pubescent at first, becoming glabrous. **Flower-buds** 2 x 1.5 cm, ovoid, ribbed, acute. **Flowers** 4-merous, with musty odour; calyx-tube c. 2 cm across at anthesis, lobes 4, c. 1–2 cm deep; petals 4, c. 2 x 1.2 cm, yellowish or cream, falling off early; stamens 12, anthers yellow turning to pale brown; style c. 40 mm long, dark red, stigma dark green. **Fruits** ovoid or oblong, 4-valved, 1.5–3 x 1–2 cm. **Seeds** c. 0.7 mm long.

Vernacular names. Sabah—*magas* (Kadazan). Sarawak—*benung kasung* (Bidayuh), *sawih* (Iban).

Distribution. Java, Borneo (Sabah, Sarawak, Brunei, Kalimantan), Celebes, Moluccas, and New Guinea.

Ecology. In Sabah and Sarawak, widely distributed at 15–750 m, on damp clay-rich fertile soils, especially in high light intensity areas such as river-banks, forest-edges, logged-over forests, road-sides, abandoned cultivation sites and also on limestone hills.

Uses. The timber is little used at present. Recorded uses include temporary light construction, floaters for extracting timber logs, fish-net floats and dug-out boats. It grows

fast and may have potential to be planted for pulping materials or for core-stock in plywood manufacturing.

2. SONNERATIA L. f., *nom. cons.*

(Pierre Sonnerat, 18th century French explorer-naturalist)

Suppl. Pl. Syst. Veg. (1781) 38; Merrill *l.c.* (1921) 416; Ridley *l.c.* 825; Watson *l.c.* 121; Burkill *l.c.* 2051; Backer & van Steenis *l.c.* 282; Wyatt-Smith, MF 16 (1953); Kochummen & Wyatt-Smith *l.c.* 315; Whitmore *l.c.* 444; Cockburn *l.c.* 224; Anderson *l.c.* 323; Duke & Jackes, *Blumea* 32 (1987) 277; Ashton *l.c.* 375; Corner *l.c.* 476 (under Lythraceae); Whitmore, Tantra & Sutisna *l.c.* 331.

Synonyms: *Blatti* Adans., *Fam.* 2 (1763) 88; *Pagapate* Sonnerat, *Voy. Nouv. Guin.* (1776) 16.

Small to medium-sized glabrous trees, with sympodial crown and low branching; bole fluted at base, surrounded by spindle-shaped breathing roots (pneumatophores), buttresses absent. **Bark** smooth, becoming scaly or finely fissured with age, lenticellate, pale grey-green to dark brownish grey; inner bark pinkish or brownish, rather watery. *Young twigs* (branchlets) drooping or erect, distinctly jointed above the nodes, 4-angled, becoming terete with age. **Flowers** in terminal clusters of 1-3, 4-8-merous; calyx cup-shaped, 4-8-lobed, segments ovate or triangular, often reddish within; petals absent or 4-8, narrow, and falling off early; stamens many, falling off early; ovary 10- to many-celled; style slender, sinuous in bud. **Fruits** indehiscent berries, depressed-globose, tipped by the persistent style and seated on the persistent star-like calyx-cup, pericarp leathery. **Seeds** many, embedded in foul-smelling pulp, not tailed at both ends; embryo straight.

Distribution. 5 species distributed along sea-shores of tropical East Africa, Asia, Malesia, Australia and Pacific Islands. 2 species occur in Sabah and three in Sarawak.

Ecology. Mangrove trees, found on sandy and muddy tidal flats, estuaries, brackish water-courses, river-banks and creeks and coral-terraces at tide level. The flowers are ephemeral and pollinated by nectar-feeding bats and birds. The fruits are water-dispersed. Hybrids have been recorded between *S. alba* x *S. caseolaris* and *S. alba* x *S. ovata* along the Brunei coasts, and their status has been substantiated by palynological (Muller, *Ancient Pacific Floras* (1964) 33), morphological and cytological (Muller & Hou-Liu, *Blumea* 14 (1966) 337) evidence.

Uses. The timber is classified as moderately hard to hard and moderately heavy to heavy. However, it is only locally used for firewood and occasionally for house-posts. Burgess (TBS (1966) 461) claimed that the wood of *S. caseolaris* could be pulped by the sulphate process to give a pulp with similar strength properties to commercial eucalypt pulp. The fruits of some species are edible. In Sarawak, fruits of *S. caseolaris* and *S. ovata* are edible.

Key to *Sonneratia* species

1. Leaves elliptic to elliptic-ovate. Young twigs drooping. Petals linear-lanceolate, dark red; filaments bright pink at base, upper part white.....2. *S. caseolaris*
- Leaves obovate, broadly ovate to suborbicular. Young twigs erect. Petals (if present) linear, white; filaments white2

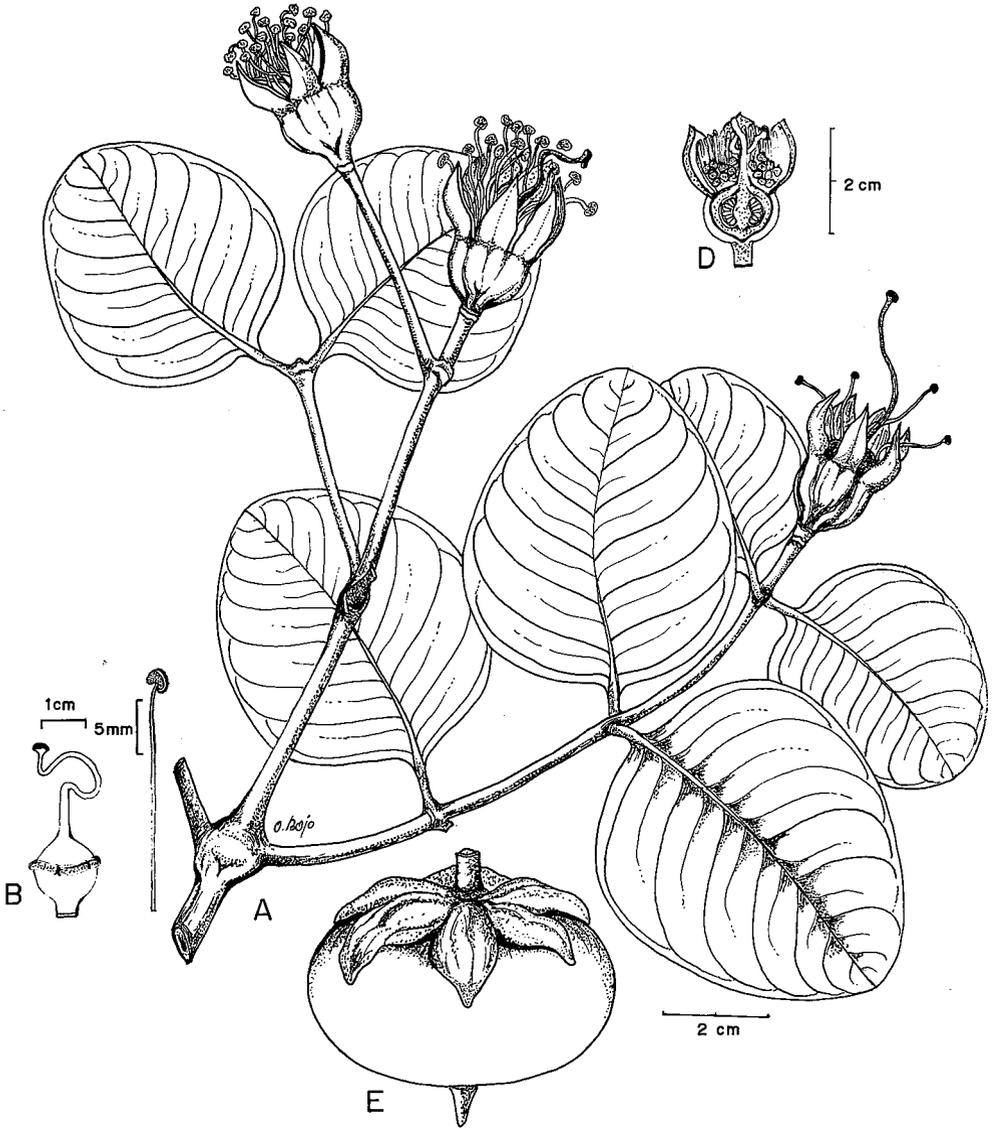


Fig. 2. *Sonneratia ovata*. A, flowering leafy twig; B, pistil with other floral parts removed; C, stamen; D, longitudinal section of flower; E, fruit. (All from living specimens.)

2. Leaves obovate, base cuneate. Petals linear, white.....1. *S. alba*
 Leaves broadly ovate to suborbicular, base rounded or subcordate. Petals absent.....
3. *S. ovata*

1. *Sonneratia alba* J. Smith

(Latin, *albus* = white; the flowers)

in Rees, Cycl. 33 (1819) 2; Beccari, Nelle For. di Borneo (1902) 579; Merrill, Interp. Rumph. Herb. Amb. (1917) 383, *l.c.* (1921) 418; Backer & van Steenis *l.c.* 285; Wyatt-Smith *l.c.* 214; Browne *l.c.* 323; Duke & Jackes *l.c.* 286; Ashton *l.c.* 379; Corner *l.c.* 476; Whitmore, Tantra & Sutisna *l.c.* 331. **Type:** Rumph. Herb. Amb. 3 (1754) 111, t. 73, Ambon. **Synonyms:** *Rhizophora caseolaris* L. in Stickman, Herb. Amb. (1754) 13, *in part*; *Blatti alba* (J. Smith) Kuntze, Rev. Gen. 1 (1891) 238.

Tree to 40 m tall and 70 cm diameter; stems usually crooked; *crown* rather open, more or less broadly oblong, *low-branching*. *Young twigs erect*. **Bark** slightly cracked to fissured, *grey to brownish above normal tide mark*, lenticels usually present; inner bark not laminated, mottled cream and pinkish brown. **Leaves** fleshy, broadly obovate to rarely ovate, 3.5–10 x 2–7.5 cm; base cuneate, apex broadly rounded; *lateral veins 7–9 pairs, thin, inconspicuous*; petioles 7–13 mm, stout. Flower-buds oblong, 2–2.5 x 1.5 cm. **Flowers** solitary or in terminal clusters of 2–3, 6–7(–8)-merous; *calyx 1.5–2.5 cm long, cup obconical, ribbed or angular, angles as many as segments and alternating with them, segments 6–7, ovate-oblong, 1.3–2 cm long, inner surface red, especially at base; petals 6–7, linear, inconspicuous and almost resemble the filaments, white, pink at base; filaments white*; ovary 14–18-celled. **Fruits** 4–5 cm long, 3–4 cm across, dark green, subtended by the ribbed calyx-cup.

Vernacular names. Sabah—*pedada* (Malay, Kadazan). Sarawak—*perepat* (Malay, Iban).

Distribution. Tropical East Africa, N Madagascar, Seychelles, Sri Lanka, Andamans, continental SE Asia, throughout Malesia to Australia and the W Pacific Islands. In Sabah, a common component of mangroves in Kudat, Sandakan, Lahat Datu and Semporna. In Sarawak, very common in Buntal Bay from Santubong to Bako National Park and elsewhere such as the Lawas mangroves. Also in Brunei and Kalimantan.

Ecology. A pioneer mangrove species found on muddy and shallow parts of calm sea-shores and along the mouths of tidal creeks, forming dense pure stands on intertidal sites. Rarely found far from river mouths and sandy beaches.

Uses. In Sabah and Sarawak, the wood is used as firewood. Elsewhere, such as in Minahasa (NE Celebes), the wood is valued for ship and house-building.

2. *Sonneratia caseolaris* (L.) Engl.

(Latin, *caseus* = cheese; the fruit which resembles a small, depressed rounded piece of cheese)

in Engler & Prantl, Nachtr. (1897) 261; Merrill *l.c.* (1917) 383, *l.c.* (1921) 418; Backer & van Steenis *l.c.* 283; Wyatt-Smith *l.c.* 213; Browne *l.c.* 248; Whitmore *l.c.* 445; Cockburn *l.c.* 225;

Anderson *l.c.* 323; Duke & Jackes *l.c.* 289; Ashton *l.c.* 379; Corner *l.c.* 476; Whitmore, Tantra & Sutisna *l.c.* 331. **Basionym:** *Rhizophora caseolaris* L., *p.p.* in Stickman, *Herb. Amb.* (1754) 13. **Type:** *Rumph. Herb. Amb.* 3 (1754) 112, *t.* 74–75, Ambon. **Synonyms:** *S. acida* L., *Suppl.* 252; *Aubletia caseolaris* (L.) Gaertn., *Fruct.* (1788) 379; *Blatti caseolaris* (L.) Kuntze, *l.c.* 238; *Blatti acide* (L.) Lam., *Enc.* 1 (1789) 429; *S. pagatpat* Blanco, *Fl. Filip.* (1837) 424; *Blatti pagatpat* (Blanco) Niedenzu in Engler & Prantl, *Pfl. Fam.* 3, 7 (1891) 21; *S. ovalis* Korth., *Ned. Kruidk. Arch.* 1 (1846) 198; *S. evenia* Blume, *Mus. Bot. Ind. Bat.* 1 (1851) 337; *S. lanceolata* Blume *l.c.* (1851) 337; *S. obovata* Blume *l.c.* (1851) 337; *S. neglecta* Blume *l.c.* (1851) 338.

Tree to 20 m tall and 30 cm diameter; *stems frequently leaning and crooked; crown rather open.* **Bark** smooth, greenish grey and lenticellate when young, becoming irregularly fissured and pale brown with age; inner bark cream or pinkish brown, faintly laminated; *exudate watery.* *Young twigs drooping, yellowish brown turning to greenish brown with age.* **Leaves** elliptic to elliptic-ovate, 3.8–9.5 x 2–8 cm; base cuneate, apex blunt or subacuminate; *lateral veins 8–12 pairs, thin and inconspicuous; petiole 7–11 mm long, reddish.* Flower buds broadly ovoid or oblong to subglobose, 2–2.5 x 1–1.5 cm. **Flowers** 6–8-merous; *calyx at anthesis shallowly cup-shaped, smooth, segments 6–8, usually longer than the tube, cream or pale yellow inside, base crimson, forming a crimson ring around the fruit; petals linear-lanceolate, 6–8, 20–25 x 1.5–2 mm, dark red; filaments white, bright pink at base; ovary 16–21-celled.* **Fruits** *c.* 4 cm long, 7.5 cm across, dark green, *crowned with persistent conically thickened style base, subtended by the flattened, green calyx-tube with horizontally spreading lobes.*

Vernacular names. Sabah—*perepat* (Malay, Kadazan). Sarawak—*pedada* (Iban, Malay).

Distribution. Sri Lanka, tropical SE Asia to New Guinea, Northern Australia, the Solomon Island, and New Hebrides. In Sabah and Kalimantan, very common in mangrove front. In Sarawak and Brunei, common along tidal river-banks and mangroves, especially on deep muddy river-banks, and from the limit of brackish water down to the lower end of the *Nypa*-zone near the river-mouths.

Ecology. Individual trees of *S. caseolaris* are usually found scattered among other mangrove species (e.g., *Avicennia* species) rather than forming a pure stand.

Uses. The young, sour-tasting berries are edible and are also used in traditional medicine, chiefly externally but also internally (Burkill *l.c.* 2088). Burkill & Haniff (*Gard. Bull. S.S.* 6 (1930) 204) reported that leaves pounded with rice were applied for small-pox. Pectin is locally extracted from the fruits. The wood is used as fuel, and the pneumatophores, after boiling in water, furnish an inferior substitute for cork.

3. *Sonneratia ovata* Backer (Latin, *ovatus* = oval; the leaf shape)

Fig. 2.

Bull. Jard. Bot. Btzig. 3, 2 (1920) 329; van Steenis, *Bull. Jard. Bot. Btzig.* 3, 12 (1931) 162; Backer & van Steenis *l.c.* 162; Wyatt-Smith *l.c.* 214; Whitmore *l.c.* 445; Anderson *l.c.* 323; Duke & Jackes *l.c.* 299; Ashton *l.c.* 380; Corner *l.c.* 476; Whitmore, Tantra & Sutisna *l.c.* 331. **Type:** *Backer 21422*, Java (lectotype L).

Tree to 20 m tall and 20 cm diameter; *stems* short and *usually twisted*. **Bark** grey, smooth to slightly fissured, lenticellate; inner bark pale brown to reddish, faintly laminated. *Young twigs erect, greyish brown*. **Leaves** usually ovate to orbicular or broadly ovate, 2.5–7.5 x 3–9 cm; base rounded or subcordate, apex broadly rounded; *adaxial surface slightly corrugated by the fine but conspicuous 9–10 pairs of lateral veins*; petioles 4–11 mm long. **Flowers** usually in terminal clusters of 2–3(–4), occasionally solitary; buds broadly ovoid, apex rounded or obtuse, *finely verruculose*, 1.5–2 x 1–1.5 cm; *calyx cup-shaped, tapering abruptly into a stalk-like base, ribbed, segments usually 6, ovate-triangular*, 13–15 mm long, *inner surface tinged reddish at base*; petals absent; filaments white; ovary 13–15-celled. **Fruits** c. 4 cm long, 7 cm across, *dark green when young, turning to yellowish green when ripe*.

Vernacular name. Sarawak—*rogam* (Malay).

Distribution. China, Thailand and throughout Malesia. In Sarawak, Brunei and Kalimantan very local. In Sabah, has not been recorded with certainty.

Ecology. Occasionally found on banks of tidal rivers and muddy soils inundated only by spring tides.

Uses. In Sarawak, the mature fruit is edible and eaten as *ulam* (a salad) by the Malays.

STAPHYLEACEAE

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Merrill, EB (1921) 355; Ridley, FMP 1 (1922) 511; van Steenis, Nova Guinea 10,2 (1959) 211; van der Linden, FM 1, 6 (1960) 49; Airy-Shaw, Kew Bull. 18, 2 (1965) 252; Backer & Bakhuizen *f.*, FJ 2 (1965) 145; Sponberg, Journ. Arn. Arb. 52 (1971) 196; Whitmore, TFM 1 (1972) 446; Anderson, CLTS (1980) 324; Dickison, Journ. Arn. Arb. (1984) 149; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 332; Webster, Ann. Missouri Bot. Gard. 81 (1994) 54.

Trees or shrubs, non-laticiferous. **Leaves** simple to compound (*imparipinnate to paripinnate*), *opposite or alternate*, leaflet margin toothed; stipules usually falling off early. **Inflorescences** terminal, subterminal or axillary panicles or racemes. **Flowers** bisexual, sometimes unisexual, actinomorphic (with regular symmetry); sepals 5, imbricate; petals 5, imbricate; *stamens* 5, *alternating with the petals outside the disc*; anthers 2-celled, longitudinally dehiscent, dorsifixed; disc present or absent; ovary superior, 2–4-celled, styles 2–4, free or fused together, stigmas capitate or coherent, forming a peltate structure; ovules one or more per cell, placentation axile or basal. **Fruit** an indehiscent berry, *follicle or inflated capsule*. **Seeds** one to several, arillate or exarillate; embryo straight; cotyledons flat; endosperm fleshy or horny.

Distribution. 5 genera with about 60 species. *Staphylea* (11 species), *Tapiscia* (1 species) and *Euscaphis* (1 species) are found in the north temperate region. *Huertea* (4 species) occurs from West Indies to Peru. *Turpinia* has 30–40 species distributed from the Indo-malesian region to Japan and tropical America. In Sabah and Sarawak, *Turpinia* is represented by 6 species all of which occur in Sabah, although only 2 species are found in Sarawak.

Uses. Some species of the temperate *Staphylea* and *Euscaphis* are cultivated as ornamental plants. Timbers of a few species of *Turpinia* are occasionally utilised locally. The fruit of *Euscaphis japonica*, a common tree or shrub in Japan and Central China, is used for preparing a drug.

Taxonomy. In early publications, the family was considered closely affiliated to the Rhamnaceae. Later authors (*cf.* van Steenis *l.c.* 211, van der Linden *l.c.* 49, Sponberg *l.c.* 196) placed it near to the Aceraceae, Celastraceae, Cunoniaceae, and Sapindaceae. Its affinity to the Cunoniaceae was based on the evidence derived from morphology, anatomy and embryology (Hallier, 1908; Whitmore *l.c.* 446; Thorne, 1976; Dickison *l.c.* 149). Anatomically, there are major differences between the Staphyleaceae and the Sapindaceae (Metcalf & Chalk, Anat. Dicot. 1 (1957) 443) although the Staphyleaceae have some

similarities to the woody Saxifragaceae in terms of nodal and leaf anatomy (Dickinson, Bot. Gaz. 148,4 (1987) 475). Whitmore (*l.c.* 446) included *Bischofia* under the Staphyleaceae, which had been initially placed in the Euphorbiaceae by Decaisne (1842) and later isolated as a separate family, the Bischofiaceae, by Airy-Shaw (1965). However, evidence from embryology and anatomy appears to support its inclusion in the Euphorbiaceae (Webster, 1994). The Indochinese *Tricaphis* was also included in the Staphyleaceae by Gagnepain (Not. Syst. 13 (1948) 190) but van Steenis (1960) excluded it, and suggested that it belonged to either the Anacardiaceae or Sapindaceae. Hence, the taxonomic status of this family, particularly the position of certain genera, remains controversial.

TURPINIA Vent., *nom. cons.*

(P.J.Fr. Turpin, 1775–1840, an eminent French botanical artist)

Choix (1803) 31, *t.* 31; Ridley *l.c.* (1922) 511; Merrill & Perry, Journ. Arn. Arb. 22 (1941) 543; Metcalfe & Chalk *l.c.* 443; van Steenis *l.c.* 211; van der Linden *l.c.* 49; Backer & Bakhuizen *f. l.c.* 145; Burkill, EPMP 2 (1966) 2234; Grey-Wilson, Kew Bull. 26, 1 (1972) 141; Whitmore *l.c.* 446; Anderson *l.c.* 324; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 332; Pereira, Sandakania 5 (1994) 15. **Synonyms:** *Triceros* (*non* Griff.) Lour., Fl. Coch. 1 (1790) 184; *Dabrympelea* Roxb., Pl. Corom. 3 (1820) 76, *t.* 279; *Ochranthe* Lindl., Bot. Reg. 8 (1836) *t.* 1819; *Hasskarlia* Meisn., Pl. Vasc. Gen. 2 (1843) 348; *Kaernbachia* (*non* O. Kuntz.) Schltr., Bot. Jahrb. 52 (1914) 151.

Trees or shrubs. Twigs smooth, terete, pithy, glabrous or hairy. Stipules interpetiolar, entire or bifid at apex, falling off early (except in *T. stipulacea*), leaving prominent scars. Leaves *opposite-decussate, unifoliolate, trifoliolate to pinnate (imparipinnate or paripinnate), petioles wrinkled at base; glands present at base of leaflets and at the insertion of petioles to the rachis;* leaflets chartaceous to coriaceous, margin serrate to crenate, midrib prominent. **Inflorescences** axillary, terminal to subterminal panicles or racemes. **Flowers** *bisexual;* outer sepals broader than the inner ones, ovate, margin ciliate; petals of equal size, longer than sepals, margin ciliate; stamens of equal size, broad at the base, glabrous, anthers oval, apex sometimes apiculate; disc lobed, fleshy; ovary superior, (2–)3(–4)-celled; *styles closely adnate together forming a peltate stigma;* ovules one to numerous in each cell, in axile placentation in 2 rows. **Fruit** a globose to subglobose or trilobed, indehiscent, *fleshy berry, typically crowned by three radial lines or horn-like structures (remains of the styles) on top;* fruit wall thin to thick, fleshy. **Seeds** mostly angular, one to a few in each cell, pale to dark brown; cotyledon flat, roundish.

Distribution. About 30–40 species from Sri Lanka to southern Japan, southward and eastward to Malesia, west Pacific and the central and south American tropics (West Indies, Columbia, Ecuador, Peru). In Sabah and Sarawak, the genus is represented by 6 species, 2 of which are endemic to Sabah, *viz.*, *Turpinia nitida* and *Turpinia stipulacea*.

Ecology. Evergreen understory trees or shrubs of lowland tropical to subtropical rain forests to montane zones reaching *c.* 2400 m in New Guinea and Mt. Kinabalu and to 3000 m in the Himalayas and Yunnan. Fruits are probably dispersed by birds and other animals and the hard-coated seeds can probably withstand acidity and digestion in intestines during dispersal by animals.

Uses. *Turpinia* species produce timber of a low durability, hence usage in construction is exceptional. The wood is used for packaging cases in Indonesia (Burkill *l.c.* 2234). *Turpinia nepalensis*, common in western China, produces a useful tough wood. Most *Turpinia* species are grown as pioneer trees for reforestation due to their rapid growth on eroded mountain slopes in central Java.

Key to *Turpinia* species
(based mainly on leaf characters)

1. Stipules 14–25 mm long, conspicuous and persistent on apices of leafy twigs.....**6. *T. stipulacea***
Stipules not exceeding 10 mm in length, not very conspicuous, falling off early from leafy twigs.....2
2. Lower surface of leaflets sparsely to densely short-hairy on the midrib, lateral veins and blade.....**3. *T. grandis***
Lower surface of leaflets glabrous.....3
3. Intercostal veins pseudoscalariform (with many almost straight cross-veins between the lateral veins).....**5. *T. sphaerocarpa* (in part)**
Intercostal veins reticulate (with wide areoles, or obscurely or distinctly tessellate, with no or very few straight cross-veins between the lateral veins).....4
4. Leaflets thickly coriaceous, margin strongly recurved when dry.....**4. *T. nitida***
Leaflets chartaceous or coriaceous, margins not strongly recurved when dry.....5
5. Leaflets narrowly acuminate to caudate, acumen usually 1–2 cm.....**1. *T. borneensis***
Leaflets shortly acuminate to cuspidate, acumen to *c.* 1 cm long, often shorter.....6
6. Leaves typically 20–46 cm long (rachis 10–18 cm long)....**5. *T. sphaerocarpa* (in part)**
Leaves often less than 20 cm long (rachis less than 10 cm long).....7
7. Stipules 2.5–3.5 x 2–2.5 mm. Leaflets coriaceous and slightly shiny on lower or both surfaces. Fruit globose to subglobose, without short apical horns, but with radial lines at the apex. (Plants restricted to limestone habitats.).....**2. *T. calciphila***
Stipules 5–7 x 3–4 mm. Leaflets chartaceous and not shiny. Fruit slightly trilobed at the apex, with short apical horns. (Plant of non-limestone habitats.).....
.....**5. *T. sphaerocarpa* (in part)**

Key to *Turpinia* species
(based mainly on fruits and flowers)

1. Fruits slightly to distinctly trilobed at the apex, typically with short apical horns.....2
- Fruits globose to subglobose, without short apical horns.....3

2. Petals 2–4 x 1.5–2 mm; anthers 0.8–1 mm long; pistils 2.5–3.5 mm long. Seeds 5–8 mm across. Leaflets oblong, elliptic-oblong to lanceolate or ovate, typically shiny above, coriaceous, margin strongly recurved..... **4. T. nitida**
 Petals 1.8–2 x 1–1.1 mm; anthers 0.5 mm long; pistils 2–2.2 mm long. Seeds 2–4 mm across. Leaflets ovate-elliptic to elliptic, not shiny above, chartaceous, margin not recurved..... **5. T sphaerocarpa** (in part)
3. Fruit-wall brittle, 0.1–0.3 mm thick (Plants restricted to limestone habitats)..... **2. T. calciphila**
 Fruit-wall not brittle, thicker than 0.5 mm (Plants not restricted to limestone habitats)..... 4
4. Ovules (2–)3–4 per cell..... 5
 Ovules (4–)6–8(–9) per cell..... 6
5. Petals 2.5–4.5 mm long; stamens 2–3 mm long; pistils 2–3 mm long, ovary 1–1.5 mm across. Stipules 14–25 mm long, conspicuous and persistent on apices of leafy twigs..... **6. T. stipulacea**
 Petals 1.2–2 mm long; stamens 0.8–1.8 mm long; pistils 1–2 mm long, ovary 0.6–1 mm across. Stipules 3–8 mm long, not very conspicuous, falling off early from leafy twigs..... **1. T. borneensis**
6. Seeds 5–14 per fruit. Lower surface of leaflets sparsely to densely short-hairy on the midrib, lateral veins and blade. Leaf rachises 3–8 cm long..... **3. T. grandis**
 Seeds 1–7 per fruit. Lower surface of leaflets completely glabrous. Leaf rachises 10–18 cm long..... **5. T. sphaerocarpa** (in part)

1. Turpinia borneensis (Merr. & Perry) B.L. Linden
 (of Borneo)

l.c. 49; Anderson *l.c.* 324; Whitmore, Tantra & Sutisna *l.c.* 332. **Basionym:** *Turpinia montana* var. *borneensis* Merr. & Perry *l.c.* 549. **Type:** *J. & M. S. Clemens 29391 bis*, British North Borneo, Kinabalu, Tenompok (holotype UC; isotypes BO, K).

Tree to 20 m tall and 20 cm diameter. **Bark** shallowly fissured, pale brown; inner bark greyish. **Sapwood** brownish. *Stipules* 3–8 x 2–4 mm, not very conspicuous, falling off early from leafy twigs, glabrous, margin sparsely hairy to entire. **Leaves** 3–5(–7)-foliolate, (13–) 16–35(–40) cm long; petioles 3–11 cm long, 1–2 mm thick, glabrous; leaf-rachis 4.5–13 cm long, glabrous; petiolules of lateral leaflets 2–15 mm long, glabrous; *leaflets* drying pale green above, *chartaceous, glabrous*, not shiny, ovate-elliptic to lanceolate, 5–18 x 2–7 cm; base cuneate, sometimes rounded or oblique, margin finely serrate, not recurved, *apex narrowly acuminate to caudate, acumen (0.5–)1–2 cm long*; lateral veins 7–11 pairs, distinctly looping at the margin, prominent on lower surface; *intercostal veins reticulate or distinctly tessellate and prominent, with no or very few straight cross-veins between the lateral veins on both surfaces*. **Inflorescences** axillary panicles, to 30 cm long, rachis subglabrous. **Flowers** cream to pale yellow, sepals ovate, thin, 1.2–2 x 1–1.8 mm; *petals* obovate, 1.2–2 x 0.8–1.5 mm; *siamens* 0.8–1.8 mm long, glabrous, filaments 0.5–1.5 mm

long, glabrous, anthers 0.4–0.5 mm long, apiculate or not; *pistils* 1–2 mm long, styles 0.6–1.8 mm long; *ovary* 0.6–1 mm across, 3(–4)-celled, each cell with 3–4 ovules. **Fruits** globose, 8–18 mm diameter, without short apical horns but with three radial lines at the apex, wrinkled; wall thin, not brittle, 0.5–1 mm thick. **Seeds** pale to dark brown, 4–10 x 6–10 mm, 1–4 in each fruit.

Distribution. Borneo (Kalimantan and Sabah) and the Philippines; not yet recorded in Sarawak.

Ecology. Primary and secondary mixed dipterocarp forest to 1800 m. Flowering has been recorded from November to March whereas fruiting has been noted from May to October.

2. *Turpinia calciphila* J. T. Pereira

(Latin, *calx* = lime; Greek, *philos* = loving; referring to the habitat)

Sandakania 5 (1994) 18. **Type:** *Anderson S. 4710*, Sarawak, Baram, Gunung Api (holotype SAR; isotypes BO, K, L, SING).

Tree to 25 m tall and 50 cm diameter. **Bark** creamy yellow, slightly flaky. *Stipules* 2.5–3.5 x 2–2.5 mm, not very conspicuous, falling off early from leafy twigs, glabrous, margin hairy. **Leaves** 1–3-foliolate, 9–16(–25) cm long, petioles 1.5–4(–7.5) cm long, 1–2 mm thick, glabrous; *leaf-rachis* 1.5–4 cm long, glabrous; petiolules of the lateral leaflets 5–14 mm long, glabrous; *leaflets* drying pale green to brown above, coriaceous, glabrous, slightly shiny on lower or both surfaces, ovate to ovate-elliptic, 6.5–15 x 3.5–6.5 cm; base rounded to slightly cuneate, sometimes oblique, margin shallowly serrate, sometimes slightly undulate, not recurved, apex shortly acuminate, acumen 0.4–1 cm long; midrib and lateral veins raised and distinct on lower surface; lateral veins 6–8 pairs, ascending, parallel, open or looping towards the margin; *intercostal veins* reticulate or distinctly tessellate beneath, with no or very few straight cross-veins between the lateral veins. **Inflorescences** axillary panicles to 25 cm long, rachis densely hairy at the distal end. Flowers not known in mature state. **Fruits** globose to subglobose, 5–10 mm diameter, without short apical horns but with three radial lines at the apex, smooth; wall 0.1–0.3 mm thick, brittle. **Seeds** dark brown to reddish brown, 4–8 x 5–8 mm, 1–6 in each fruit.

Vernacular name. Sarawak—*laba* (Iban).

Distribution. Endemic to Sarawak (4th Division, Baram, Gunung Api and Gunung Buda; 1st Division, near Bau, Bt. Buan and Bt. Gebung).

Ecology. So far only known from the lower, mesic slopes of limestone screes, to 900 m.

3. *Turpinia grandis* B.L. Linden

(Latin, *grandis* = large, big; the leaves)

l.c. 49; Whitmore, Tantra & Sutisna *l.c.* 332. **Type:** *Endert 4669*, E Borneo, W Koetai, Kiau River, 700 m alt. (holotype L; isotypes BO, K).

Tree to 20 m tall and 30 cm diameter. **Bark** smooth, greyish; inner bark yellowish. **Sapwood** pale white. *Stipules* 4 x 3–5 mm, not very conspicuous, falling off early from

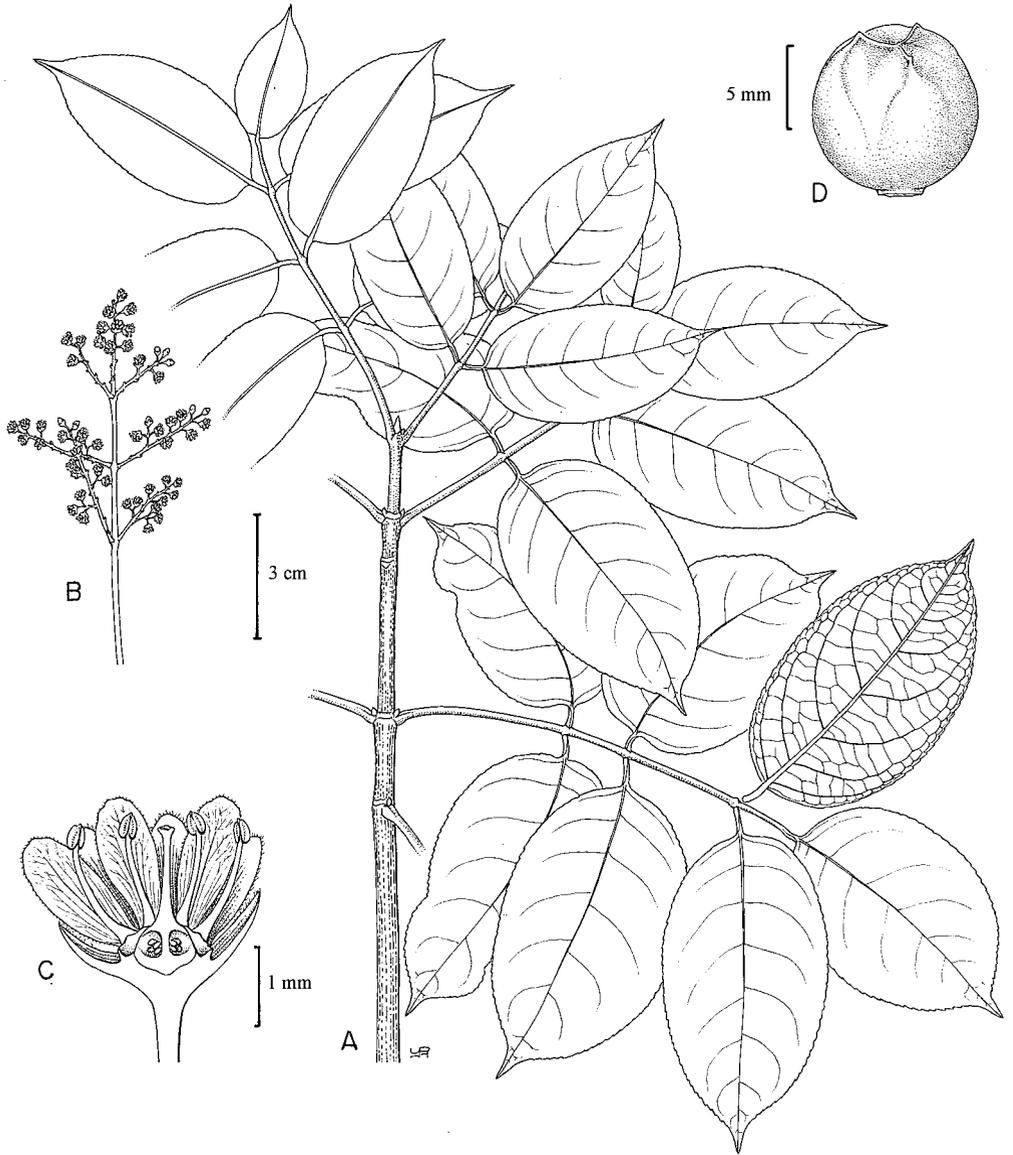


Fig. 1. *Turpinia sphaerocarpa* var. *microcerotis*. A, leafy twig; B, part of inflorescence; C, flower in longitudinal section; D, fruit. (A & D from J. & M.S. Clemens 28707, B & C from Kostermans 10409.)

leafy twigs, densely hairy, margin hairy. **Leaves** 1–3-foliolate, 20–39 cm long, petioles 2.5–9 cm long, 2–4 mm thick, minutely hairy; leaf-rachis 3–8 cm long, short-hairy; petiolules of lateral leaflets 5–15 mm long, minutely hairy; leaflets drying dark brown above, ovate to ovate-oblong, 14–25 x 7–13 cm, thickly chartaceous, sparsely to densely short-hairy beneath; base narrowly rounded to cuneate, sometimes asymmetric, margin sharply serrate, not recurved, apex shortly acuminate, acumen 0.5–1 cm; *midrib sparsely to densely short-hairy; lateral veins* 7–12 pairs, ascending, parallel, open or sometimes looping towards the margin, distinct beneath, sparsely to densely short-hairy; *intercostal veins pseudo-scalariform (with many almost straight cross-veins between the lateral veins)*. **Inflorescences** axillary or terminal panicles to 35 cm long, rachis densely to sparsely hairy. **Flowers** pale yellowish; sepals ovate, thin, 1.8–2.5 x 1–2 mm; petals linear obovate, 2–3 x 1–1.5 mm; stamens 2.5–3 mm long, glabrous, filaments 2–3 mm long, anthers 0.5–0.6 mm long, not apiculate; pistils 2–3 mm long, styles 1.5–2 mm long, *ovary* 1–1.1 mm across, 3-celled, *each cell with (5–)6–8(–9) ovules*. **Fruits** globose, 10–20 mm diameter, *without short apical horns* but with three radial lines at the apex, wrinkled, *wall not brittle*, 1.5–2 mm thick. **Seeds** pale brown, 5–8 x 5–8 mm, 5–14 in each fruit.

Distribution. Endemic to Borneo (Kalimantan, Sabah, Sarawak). In Sabah, collected from Tambunan (SAN 113560 and SAN 113536) and Gunung Lotung, Lamag (SAN 83167) and in Sarawak from the 4th Division, Baram, Kelabit Highlands (S. 35520).

Ecology. Scattered on ridges, forested river-banks and deep ravines. Flowers recorded around May and fruits from October to November.

4. *Turpinia nitida* Merr. & Perry

(Latin, *nitidus* = shiny or polished; the leaf surface)

l.c. 543; B.L. Linden *l.c.* 49; Whitmore, Tantra & Sutisna *l.c.* 33. **Type:** J. & M. S. Clemens 30840, British North Borneo, Mt. Kinabalu, Penibukan (holotype UC; isotypes BO, K).

Tree to 15 m tall and 40 cm diameter. **Bark** fissured or lenticellate, greyish brown to black; inner bark reddish brown. **Sapwood** pale yellow. *Stipules* 3.5–10 x 2–5 mm, *not very conspicuous, falling off early from leafy twigs*, glabrous, margin entire to sparsely hairy. **Leaves** 1–3–5–7-foliolate, (15–)18–35(–39) cm long; petioles 3–13 cm long, 2–4(–6) mm thick, glabrous; leaf-rachis 2–18 cm long, glabrous; petiolules of lateral leaflets 1–25 mm long, glabrous; *leaflets*, drying pale green, sometimes pale brown, *oblong, elliptic-oblong to lanceolate or ovate*, 6–21 x 3–11 cm, *thickly coriaceous, glabrous, typically shiny on upper surface*; base rounded to acute, sometimes asymmetric, *margin* sharply to shallowly serrate, *strongly recurved*, apex acuminate to cuspidate, acumen 0.5–1.5(–2) cm long; lateral veins 6–11 pairs, ascending arcuately half way, parallel, open or sometimes looping towards the margin, *obscure on upper surface; intercostal veins reticulate or distinctly tessellate, with no or very few straight cross-veins between the lateral veins on lower surface*. **Inflorescences** axillary or terminal panicles, to 45 cm long, rachis glabrous or sparsely hairy. **Flowers** yellowish to pink-tinged, sepals oblong to ovate, 1.5–3.5 x 1.5–2.5 mm, thin; *petals* spatulate, 2–4 x 1.5–2 mm; stamens 1.8–4 mm long, filaments 1.5–8

mm long, *anthers* 0.8–1 mm long, slightly to distinctly apiculate; *pistils* 2.5–3.5 mm long, styles 2–3 mm long; ovary 1–2 mm across, (2–)3(–4)-celled, each cell with (3–)4–7(–8) ovules. **Fruits** 3-lobed, typically with three short apical horns at the apex, smooth, woody, 8–20 mm diameter, wall not brittle, 1.5–5 mm thick. **Seeds** pale brown, 5–8 mm across, 1–7 in each fruit.

Distribution. Endemic to Sabah (Ranau, Sandakan, Kudat and Lahad Datu), not yet known in Sarawak.

Ecology. Montane forest to 2400 m and also in primary and secondary forest on hills near streams. Frequently found on ultramafic soils. Flowers documented around November to May, fruits mostly during July to September.

5. *Turpinia sphaerocarpa* Hassk.

Fig. 1.

(Greek, *sphaero* = globose, spherical, *karpos* = fruit; the fruit shape)

Flora 25, 2 (1842) Beibl. 1, 42; Ridley, J. Str. Br. R. As. Soc. 82 (1920) 179, J. Mal. Br. R. As. Soc. 1 (1923) 58; Merrill & Perry *l.c.* 543; B.L. Linden *l.c.* 49; Whitmore *l.c.* 448; Anderson *l.c.* 324; Whitmore, Tantra & Sutisna *l.c.* 332; Pereira *l.c.* 21. **Type:** *s. coll.*, *s.n.*, Herbarium Reinwardtianum in Acad. Lugduno-Batavo (holotype L). **Synonyms:** *Dalrymplea javanica* Hassk., Pl. Jav. Rar. (1848) 439; *Turpinia latifolia* Wall. ex Ridl. *l.c.* (1920) 178; *T. laxiflora* Ridl. *l.c.* (1920) 179.

Tree to 35 m tall and 90 cm in diameter; buttresses to 6 m high. **Bark** slightly fissured, flaky to smooth, greyish brown, yellowish brown to pale brown; inner bark yellowish to brown. **Sapwood** yellow to white. *Stipules* 4–7 x 3–5 mm, not very conspicuous, falling off early from leafy twigs, glabrous to minutely hairy, margin entire to sparsely hairy. **Leaves** 3–5–7–9-foliolate, 9–46 cm long; petioles (2–)4–11 cm long, 1–5 mm thick, glabrous; leaf-rachis 2–18 cm long, glabrous; petiolules of the lateral leaflets 1–15 mm long, glabrous; leaflets drying greenish brown to dark purplish brown, ovate-elliptic, elliptic, ovate, sometimes lanceolate to oblanceolate, 5 19 x 22.5 11 cm, chartaceous to coriaceous, glabrous, not shiny to shiny above; base rounded to cuneate sometimes asymmetric, margin shallowly to deeply serrate, not recurved, apex shortly acuminate to cuspidate, acumen 0.4–1 cm long; midrib raised and distinct on lower surface; lateral veins 5–10 pairs, ascending, parallel, open or looping towards the margin; intercostal veins pseudoscalariform (with many almost straight cross-veins between the lateral veins) to reticulate with wide areoles, obscurely or distinctly tessellate (with no or very few straight cross-veins between the lateral veins). **Inflorescences** axillary to terminal panicles, 17–40 cm long, rachis sparsely to densely hairy at the distal end. **Flowers** with sepals ovate, thin, 1–2 x 1–2 mm; petals spathulate to linear obovate, 1.7–3.5(–4) x 0.8–1.5 mm, thin; stamens 1.5–3.5 mm long, filaments 1–3 mm long, anthers 0.4–0.6 mm long, apiculate or not; pistils 1.5–3.5 mm long, styles 1–3 mm long, ovary 0.8–1.2(–1.5) mm across, (2–)3-celled, each cell with (4–)5–7(–9) ovules. **Fruits** 5–18 mm diameter, slightly trilobed at the apex and with three short apical horns, or globose and without short apical horns but sometimes with three radial lines at the apex, smooth to wrinkled upon drying; wall not brittle, 0.5–3 mm thick (rarely 0.1–0.3 mm). **Seeds** pale brown to dark brown, 2–9 x 2–9 mm, 1–7 in each fruit.

Key to varieties

Leaf-rachises 10–18 cm long. Leaves typically 20–46 cm long. Leaflets (7–)10–19 x (3–)5–11 cm. Fruits globose, without short apical horns.....

var. **sphaerocarpa**

Synonym: *Dalrymplea javanica* Hassk., *l.c.* 439; *Turpinia latifolia* Wall. ex Ridl. *l.c.* (1920) 178; *Turpinia laxiflora* Ridl. *l.c.* (1920) 179.

Sumatra, Peninsular Malaysia, Singapore, Borneo, Java, Philippines, Lesser Sunda Islands & Moluccas. Common in Sabah and Sarawak and scattered in primary and secondary lowland to submontane forests to 1500 m, near river banks, also occurring in limestone forest. Found on various types of high nutrient soils. Vernacular names: Sarawak—*maba* (Iban), *entrang* (Sg. Sinjan, Kuching), *tait berak* (Kelabit).

Leaf-rachises 2–8 cm long. Leaves 9–18(–20) cm long. Leaflets 5–10 x 2.5–5 cm. Fruits slightly trilobed at the apex, with three short horns.....

var. **microcerotis** J. T. Pereira

Sandakanian 5 (1994) 21. Type: *J. & M. S. Clemens* 28707, British North Borneo, Ranau, Kinabalu, Tenompok (holotype SING; isotypes BO, K).

Borneo (Sabah and Kalimantan). In Sabah collected from Tenompok and Mt. Kinabalu, Ranau. Not yet recorded for Sarawak. Lowlands, on sandy loam soils (Kalimantan) to montane forest to *c.* 1500 m (Sabah). Vernacular name: Sabah—*tapong-tapong* (Dusun).

6. *Turpinia stipulacea* B.L. Linden

(Latin, *stipula* = stipule; the conspicuous stipules)

l.c. 49; Whitmore, Tantra & Sutisna *l.c.* 332. Type: *Carr SFN* 27516, British North Borneo, Mt. Kinabalu, near Tibabah River (holotype SING).

Tree to 10 m tall and 10 cm diameter. **Bark** thin, greyish, slightly fissured; inner bark dull pale brownish. **Sapwood** pale yellow. *Stipules* 14 25 x 4 15 mm, conspicuous and persistent on apices of leafy twigs, woody, glabrous, margin entire. **Leaves** 7–9–11-foliolate, 20–43 cm long; petioles 5–8 cm long, stout, glabrous; leaf-rachis 20–30 cm long; petiolules of lateral leaflets 3–11 cm, stout, glabrous; leaflets drying reddish brown to greenish brown above, ovate-elliptic, 7–14 x 2–7 cm, chartaceous to thinly coriaceous, glabrous; base cuneate to rounded, margin shallowly undulate to deeply serrate, apex shortly acuminate, acumen 0.5–0.8 cm long; lateral veins 8–11 pairs, ascending, parallel, or open towards the margin, distinct on lower surface; intercostal veins pseudoscalariform (with many almost straight cross-veins between the lateral veins). **Inflorescences** axillary panicles, to 35 cm long, rachis subglabrous. **Flowers** with sepals oblong to ovate, 2–3.5 x 1.5–2.5 mm, thick; petals linear to elliptic, 2.5–4.5 x 1–1.5 mm, thin; stamens 2–3 mm long, glabrous, filaments 1.8–2.8 mm, anthers 0.4–0.7 mm long, distinctly apiculate; pistils 2–3 mm long, styles *c.* 2 mm long; ovary 1–1.5 mm across, 3-celled, each cell with (2–)3–4 ovules. **Fruits** globose, (6–)10–16 mm diameter, without short apical horns but with three radial lines at the apex, wrinkled, wall not brittle, 0.5–1.5 mm thick. **Seeds** dark brown, 6–10 x 6–10 mm, 1–4 in each fruit.

Distribution. Endemic to Sabah (Ranau only).

Ecology. Occurs along streams or ridges on montane forest to 2100 m. This species superficially resembles *Turpinia sphaerocarpa* in some vegetative characters. It can be distinguished by the larger and more persistent stipules and smaller number of ovules.

STYRACACEAE

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Merrill, EB (1921) 485; Backer & Bakhuizen *f.*, FJ 2 (1965) 203; van Steenis, FM 1, 4 (1949) 49, FM 1, 6 (1972) 976; Cockburn, TS 2 (1980) 103; Anderson, CLTS (1980) 327; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 340.

Trees or shrubs. **Leaves** simple, spirally arranged or pseudo-alternate, margin entire or toothed, mostly with stellate or lepidote indumentum, without stipules. **Inflorescences** racemes or panicles, axillary or terminal. **Flowers** regular; calyx tubular more or less adnate to the ovary, lobes if present valvate; corolla mostly joined into a basal tube (rarely of free petals), lobes 4–7, valvate or imbricate; stamens equal and alternate or double the number of petals, mostly adnate to the tube; ovary superior (rarely semi-inferior), 3–5-celled, style 1, stigma punctiform to 3–5-lobed. **Fruits** capsules (rarely berries), dehiscent or not, pericarp often thick and woody or corky, calyx persistent. **Seeds** 1 to many per locule, with endosperm.

Distribution. 12 genera and *c.* 190 species, mostly in the northern hemisphere, especially E Asia (absent from Australia and the Central Pacific). In Malesia, represented by 2 genera, *Bruinsmia* and *Styrax*, with the greatest diversity in Sumatra and no species as yet being found in the Philippines, C and E Java and the Lesser Sunda Islands. Two species are known from Borneo, one, *Styrax agreste*, occupies the southern half of the island and has not yet been collected from Sabah and Sarawak, although it may be expected; the other, *Bruinsmia styracoides*, is less collected from Sarawak than from Sabah.

Ecology. Lowland and submontane forests to 1600 m.

Uses. *Styrax benzoin* is the source of benzoin resin (*kemenyan*), which is used for medicinal and a variety of other purposes.

Taxonomy. *Symplocos* is treated as a separate family as it does not have the stellate hairs, nor fasciculate stamens, linear anthers and the half or wholly superior ovary characteristic of the Styracaceae.

BRUINSMIA Boerl. & Koord.

(A.E.J. Bruinsma, 1852–1943, Dutch East India Forest Service)

Nat. Tijd. Ned. Ind. 53(1893) 68; Perkins, Pfl. R. 30 (1907) 14, 88; van Steenis, Bull. Jard. Bot. Btzg. 3, 12 (1932) 215, *l.c.* (1949) 49; van Steenis & Bakhuizen *f.*, Bot. Jahrb. 86 (1967) 393; Cockburn, TS 2 (1980) 103.

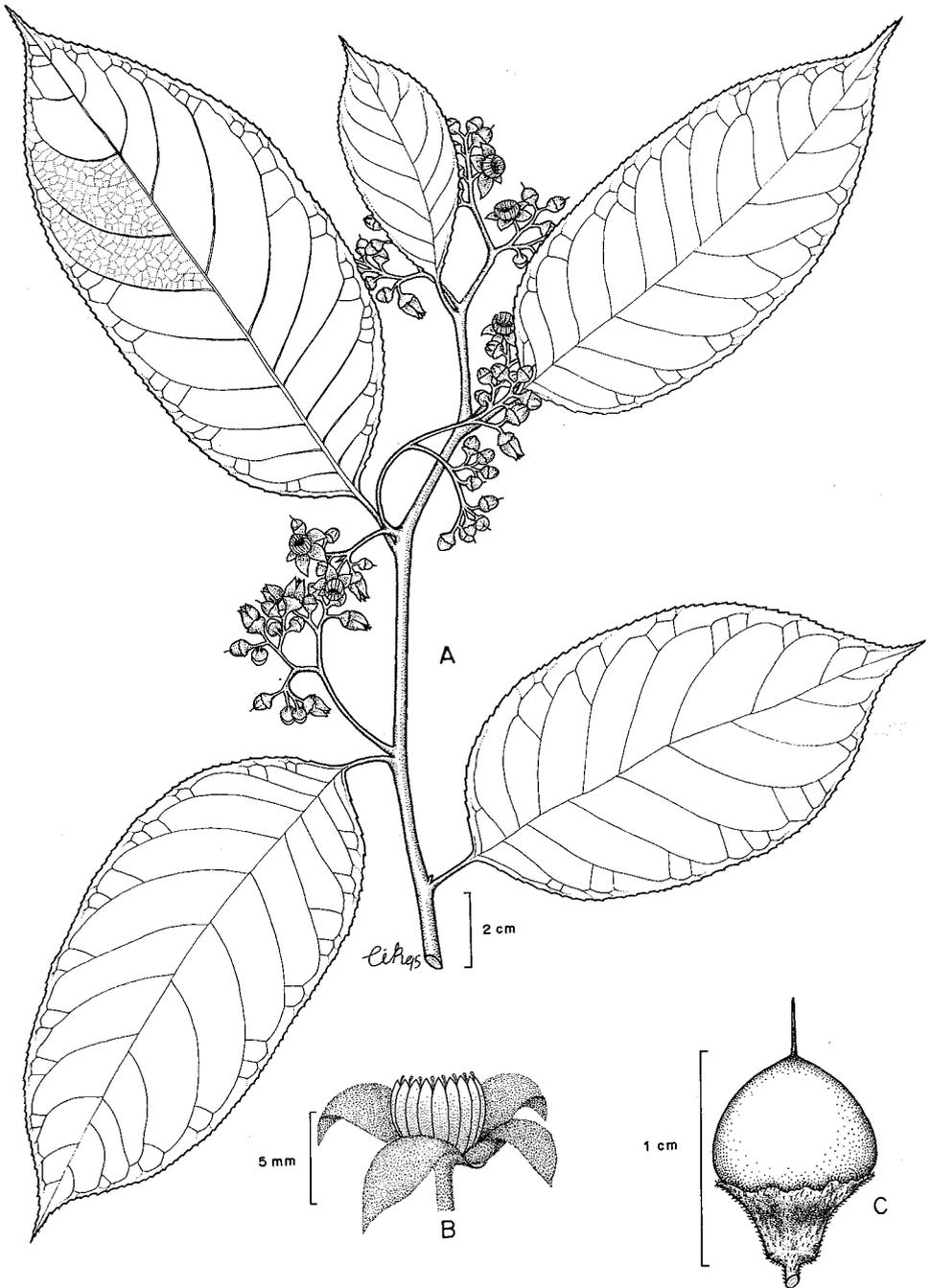


Fig. 1. *Bruinsmia styracoides*. A, flowering leafy twig; B, flower; C, fruit. (All from van Balgooy 5182.)

Glabrate trees with flattened-angular twigs. Leaf margin entire to coarsely crenate. **Inflorescences** compound, dichotomous, terminal or axillary panicles; pedicels articulated at apex. **Flowers** dull green or white; corolla-lobes free without a staminal tube; ovary glabrous, 3–5(–6)-loculed. **Fruits** fleshy, indehiscent, style base persistent. **Seeds** minute, 1–many per locule.

Distribution. 2 species, one in Borneo; the other, *B. polysperma* (Clarke) Steenis, is known from India (Assam), Burma and Thailand (Chiangmai).

Taxonomy. *Bruinsmia* is distinguished from *Styrax* by the leaves, which are glabrescent or sparsely stellate hairy, by the compound dichotomous inflorescences (as opposed to racemose-paniculate), the articulate flower-stalks, the 3- to 5-celled ovary and fruit, and by the many seeds in the fruit.

***Bruinsmia styracoides* Boerl. & Koord.**

Fig. 1.

(resembling the classic Greek tree, *Styrax officinalis*, which yields the resin storax)

l.c. 68; Perkins *l.c.* 14, 88; van Steenis *l.c.* (1932) 215, *l.c.* (1949) 49; Cockburn *l.c.* 103; Anderson *l.c.* 327; Whitmore, Tantra & K. Sutisna *l.c.* 340. **Type:** *Koorders 8529β and 8530β* (1893), Java (syntypes BO, K, L).

Tree to 45 m tall and 30–200 cm diameter; clear bole 23 m; crown large and spreading, flowering at 5 m; trees over 25 m with buttresses *c.* 65–100 cm high, 5–7 cm thick and 65–80 cm out. **Bark** smooth becoming slightly fissured with age, grey to grey-brown; inner bark soft and stringy, pale brown becoming reddish brown on exposure with a jelly-like exudate that reddens on exposure. **Sapwood** white. Twigs flattened-angular at nodes. Indumentum of young twigs, lower leaf surface and panicle dense, comprising stellate hairs, persisting only on inflorescences. **Leaves** ovate to oblong, 7.5–19 x 3–10 cm, chartaceous; base usually rounded, *margin serrate*, apex acute to acuminate; lateral veins 6–10 pairs; stalk grooved, 0.5–1.5 cm long. **Panicles** terminal and 4.5–25 cm long or axillary and 2.5–7 cm long, with dense yellow-brown pubescence; *pedicels c.* 1 mm, lengthening to 2–3 mm in fruit, *articulated*; bracteoles narrow, 1–2.5 mm long. **Flowers:** calyx broadly cup-shaped, entire or shortly 5-toothed, 1.2–3 mm long and 5 mm wide; corolla lobes 5(–6), free, ovate-oblong, 9–10 x 4–4.5 mm, imbricate, pale yellow, silvery hairy on both sides; stamens yellow-orange, 10(–12), 5 longer (6–6.5 mm) alternate, 5 shorter (5–5.5 mm) epipetalous, or 10 subequal (3.5–4 mm), joined to the base of corolla; *ovary* 2–3 x 2.5–3.5 mm, *imperfectly 5(–6)-locular*; style 3–7 mm long, stigma capitate; ovules many. **Fruits** dark green, on dish-like calyx 7 mm wide, *globular to pear-shaped*, 6–10 x 6–9 mm, attenuated to persistent style base 0.7–6 mm long; fruit-wall indehiscent, *thick and pulpy*. **Seeds** many per locule, *c.* 1.5 mm long, black, *4-angular and very finely corrugated*.

Vernacular names. Sabah—*tingo-tingo* (Dusun Kundasan). Sarawak—*empudu* (? Iban).

Distribution. Sumatra, W Java, Borneo, Philippines (Mindanao), Celebes, Moluccas (Bacan Is.) and New Guinea. In Sabah and Sarawak, widely distributed but more common in Sabah.

Ecology. On steep hill sides or ridges in primary, occasionally in disturbed forest, from the lowland at 450 m to montane forest at 2000 m. Most flowering and fruiting occurs between May and November, buds and mature fruits develop simultaneously.

TRIGONIACEAE

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Merrill, PEB (1929) 132; Masamune, EPB (1942) 378; van Steenis, FM 1, 4 (1949) 59; Kochummen, TFM 1 (1972) 449; Anderson, CLTS (1980) 340; Ashton, MNDTS (1988) 469; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 361.

Trees or shrubs. **Leaves** simple, entire; stipules small, caducous. **Inflorescences** racemose or paniculate, axillary and terminal. **Flowers** bisexual, bilaterally symmetrical; sepals 5, free or joined at the base, imbricate, unequal; petals 3–5, free, imbricate, unequal; stamens 3–12, grouped to one side opposite the anterior petals, filaments fused at the base, anthers 2-celled and dehiscing lengthwise; ovary superior, 3-locular, woolly; style simple; ovules 1–several per locule, placentation axile. **Fruit** a 3-lobed structure splitting into 3 flat, winged fruit portions (*samaras*). **Seeds** compressed, hairy, endosperm none.

Distribution. 3 genera and 44 species, in tropical South America and Malesia. In Malesia, only the monotypic genus *Trigoniastrum* is found.

Taxonomy. Trigoniaceae is generally accepted as most closely related to the Polygalaceae.

TRIGONIASTRUM Miq.

(Latin, *trigonus* = 3-angled, *aster* = star; the fruit form)

Fl. Ind. Bat. Suppl. (1860) 394; Merrill *l.c.* 132; Masamune *l.c.* 378; van Steenis *l.c.* 59; Kochummen *l.c.* 449; Anderson *l.c.* 340; Ashton *l.c.* 469; Whitmore, Tantra & Sutisna *l.c.* 361.

Trees. **Leaves** alternate and distichous on branches. **Flowers** with 5 petals, the posterior one largest and saccate and with a concave gland at the mouth of the sac, the lateral ones spatulate and spreading, the anterior two closer together and obliquely held; stamens 6; ovules solitary in each locule.

Distribution. Monotypic, confined to Sumatra, Peninsular Malaysia and Borneo.

Trigoniastrum hypoleucum Miq.

(Greek, *hypo* = lower side, *leuco* = white or glaucous; the leaf surface)

Fig. 1.

l.c. 394; Merrill *l.c.* 132; Masamune *l.c.* 378; van Steenis *l.c.* 59; Kochummen *l.c.* 449; Anderson *l.c.* 340; Ashton *l.c.* 469; Whitmore, Tantra & Sutisna *l.c.* 361. **Type:** *Teijsmann, s.n.*, Sumatra,

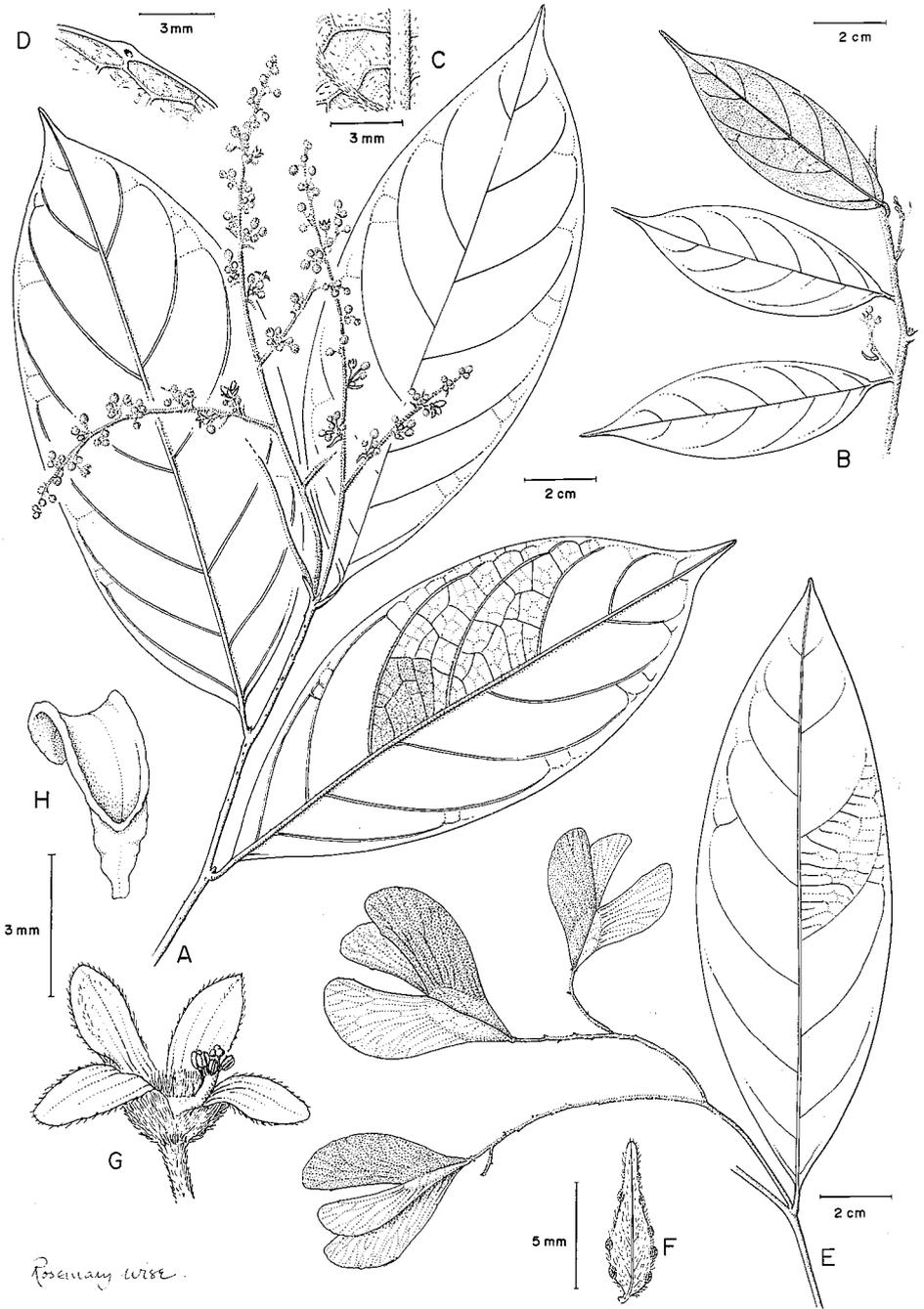


Fig. 1. *Trigonistram hypoleucum*. A, flowering twig with larger leaf form; B, twig with smaller leaf form; C, detail of lower leaf surface; D, gland on leaf margin; E, fruiting twig; F, detail of inflorescence bract; G, flower with petals removed; H, posterior petal with pouch-like base. (A, C, D, F, G, H from SAN 89752; B from SAN 84757; E from SAN 83338.)

Lamong, Mengala (holotype L; isotype K). **Synonym:** *Isopterys penangiiana* Wall. ex A.W. Benn. in Hooker *f.*, Fl. Br. Ind. 1 (1872) 208.

Small to medium-sized tree, to 30 m tall and 50 cm diameter, sometimes with buttresses up to 1 m high. **Bark** pale greenish grey to brown, *smooth to lenticellate*; *inner bark* pale greenish yellow to yellowish brown, *exuding a yellowish sticky sap which turns reddish* on exposure. **Sapwood** yellowish ochre, hard. **Leaves** elliptic, 5–20 x 1.5–8 cm, chartaceous to thickly coriaceous, *glaucous beneath*, glabrous or yellow-hairy on the veins below and midrib on upper surface; base cuneate to rounded, apex acute to cuspidate; midrib sunken to flat on upper side, prominent on lower surface, drying pale brown to dark purplish; *lateral veins 5–8 pairs*, distinct, *looping coarsely* towards the margin; intercostal veins reticulate, prominent on the lower leaf-surface and sometimes the upper surface; stalks 5–9 mm long. **Inflorescences** 7–15 cm long, paniculate, the axes scantily to densely yellow *short-hairy all over*. **Flowers** fragrant; sepals ovate-acute, *c.* 2.5 x 1.5 mm, pale green, yellow short-hairy; *posterior petal white with a yellowish basal sac-like part c.* 2 mm across and a reflexed distal part *c.* 2.5 mm long and 2 mm wide, the concave gland at the mouth of the sac to 0.8 mm across; lateral petals spatulate, 3.5–4 x 1.5 mm, creamy yellow; anterior petals oblong, oblique, 4–5 mm long, white; staminal tube *c.* 1 mm long, anthers *c.* 0.5 mm long; ovary pale yellow woolly, to 0.5 mm across, style *c.* 1.5 mm long and subglabrous. **Fruit** a 3-lobed structure; *each lobe a samara*, ovate, flattened and wing-like, the inner basal portion straight and fused with the other 2 lobes, the whole lobe to 6 cm long and 2.5 cm wide, yellowish green ripening pale brown.

Vernacular names. Sabah—none generally, but once (SAN 32418) documented as *miapa* (Dusun Bundu Tuhan). Sarawak—*atap* (Kenyah), *lia* (Iban), *ngilis* (Iban), *nyalin* (Iban: in common with *Xanthophyllum* which it resembles), *nyalin bintek* (Iban), *tulang kwe* (Kenyah). Brunei—*mengilas babi* (Iban).

Distribution. As for genus. In Sabah and Sarawak in all districts. Also in Brunei and Kalimantan.

Ecology. Although widespread in Borneo, the species is nowhere common. It has a wide ecological amplitude and has been collected from peat swamp, freshwater swamp, heath (*kerangas*), alluvial and mixed dipterocarp forests in the lowlands and hills, to submontane forest at about 1200 m. Ashton (*l.c.*) points out there may be two ecotypes, one a small tree with thick leaves found in peat swamp, heath and mixed dipterocarp forests on poor sandy soils, and the other a larger tree with thinner, narrower leaves in mixed dipterocarp forest on richer sites. Van Steenis (*l.c.*) records flowering and fruiting specimens collected in every month of the year; it is possible, though, that there are local variations in the phenology of the species. The winged fruits are wind-dispersed.

Uses. None recorded, but the wood has been tested and is listed as being hard or very hard and heavy or very heavy, with a moderately fine texture (Wong (1982) DMT).

The leafy twigs alone are easily confused with those of *Xanthophyllum* (Polygalaceae), although the flowers and fruits readily distinguish it. In many *Xanthophyllum* species, the leaf blades have distinct glands and the ultimate leafy twigs are green, and so are different.



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COMMONLY USED ABBREVIATIONS FOR LOCALITIES

English		Malay	
Word	Abbreviation	Word	Abbreviation
Central	C	Bukit	Bt.
Division	Div.	Gunung	G.
East	E	Kampung	Kg.
Forest Reserve	FR	Sungai	Sg.
Island	Is.	Tanjung	Tg.
Mount	Mt.		
National Park	NP		
North-East	NE		
North-West	NW		
River	R.		
South	S		
South-East	SE		
South-West	SW		
West	W		

GLOSSARY

abaxial	the side of an organ facing away from the distal portion of the axis which bears it
accrescent	increasing in size with age, e.g., the calyx of some plants after flowering
achene	a small, hard, dry, non-splitting fruit
acrid	sharp, irritating to the taste
acrodromous	with veins converging and uniting at the apex of the leaf
acroscopic	towards the apex or distal part of an organ; e.g., flowers in an inflorescence
actinomorphic	(flowers) radially symmetrical
acumen	a tapering point or tip
acuminate	drawn out into a long point; having a gradually tapering point; pointed; e.g., leaf apex
acute	ending in a sharp tapering point; e.g., leaf apex
adaxial	the side of an organ facing the distal portion of the axis which bears it
adherent	in contact but not fused together; e.g., floral parts
adnate	attached to some other organ
alate	winged; as a stem or petiole
anastomosing	joining of veins to form a network
anatropous	(ovules) with hilum and micropyle close together and chalaza at the other end
androdioecious	plants with male or hermaphrodite flowers
androecium	male reproductive organs of a plant
androgynophore	common structure or stalk that supports androecium and gynoecium
anisophylly	the occurrence of leaves with distinct form and size
annular	ring-like
annulus	ring
anterior	frontal
anther	the part of a stamen which contains pollen
anthesis	(flowers) that period between the opening of the bud and the withering of the stigma and/or stamen
antidysenteric	against dysentery
antiemetic	preventing vomiting
antihelminthic	working against worms
apetalous	without petals
apiculate	with an abrupt small tip, as a leaf
arachnoid	like a cobweb
arboreous	with the habit of a tree; tree-like
arcuate	curved or shaped like a bow; arc-shaped
areolation	of fine veins anastomosing and enclosing tiny spaces
areole	a tiny space marked on a surface; e.g., on leaves
aril	a fleshy expansion of the funicle, arising from the placenta, and enveloping a seed

arillate	having / bearing an aril
arillode	a false aril
arilloid	resembling an aril
articulated	jointed
attenuate	gradually narrowing to a tip or base; e.g., leaf-blade
auricle	ear-like lobe or appendage
auriculate	with auricles; e.g., leaf with expanded bases surrounding stem
axile	(ovule placentation) with ovules attached to central axis within the ovary
axillar/axillary	(inflorescence; bud) borne in the axil, i.e. the junction between leaf-stalk and stem
ballistic	(seed dispersal) referring to the fruit which discharges its seeds elastically
basal	at or near the base of an organ
basifixed	(stamens) having filament attached to anther base
berry	non-splitting pulpy fruit with many seeds
bifid	forked; divided nearly to middle line
bifoliate	with two leaflets
bilocular	having two cavities or chambers; eg., anther or ovary
biseriate	in two series
bisexual	having both male and female reproductive organs; hermaphrodite
bistipulate	with two stipules
bitegmic	(ovules) with two layers of integuments
bract	a modified leaf in whose axil a flower or branch axis arises
bracteate	having bracts
bracteolate	with bracteoles
bracteole	a secondary bract as one on a pedicel of a flower, usually smaller than bract
bud	a rudimentary state of a stem or branch; an unexpanded flower
bullate	blistered like a savoy-cabbage leaf
caducous	fall off very early; deciduous; e.g., stipules
calcareous	growing on soil derived from decomposition of calcareous rocks; limy
calyptra	a cap-shaped structure
calyx	the outer whorl of floral envelope; collective name for sepals
campanulate	bell-shaped
camptotropous	(ovule) curved or bent like a horse-shoe
canaliculate	longitudinally channelled or grooved
capitate	enlarged or swollen at tip; arranged into a mass at apex, as some inflorescences
capsular	possessing fruit of capsule-type
capsule	a dry, dehiscent fruit
carinate	having a ridge or a keel
carminative	relieving flatulence
carpel	a simple pistil formed by a single leaf-like, ovule-bearing structure; a basic ovule-bearing chamber of the ovary
carpellate	with carpels

cartilaginous	firm and tough but elastic like cartilage
caruncle	a wart or protuberance near the hilum of a seed
cataphyll	the early leaf-forms of a plant or shoot, as cotyledons, bud-scales, rhizome scales, etc.
catkin	a deciduous spike, consisting of unisexual apetalous flowers
caudate	with a slender tail-like appendage
cauliflorous	having flowers on the main stem
chalaza	that part of an ovule or a seed where the nucellus joins the integuments
chartaceous	papery
ciliate	fringed with hairs
ciliolate	ciliate but hairs minute
circumscissile	dehiscing in transverse circular line, the top separating like the lid of a pill box; e.g., in fruits
coherent	the incorporation of one part with another, as the petals to form a tubular corolla
colic	a severe spasmodic abdominal pain
collateral	positioned side by side
colleter	mucilaginous hairs on the buds of many flowering plants which secrete gum
columella	a persistent central axis around which the carpels of some fruits are arranged
columnar	having a form of a column; pillar-like
commissure	the face by which one carpel joins another as in the Umbelliferae (cabbage family)
concave	having an outline or surface curved like the interior of a circle or sphere
concolorous	uniform in tint
concreescent	growing together
cone	a dry multiple fruit- or seed-bearing structure; e.g., in pine tree
conical/ coniform	cone-shaped
connate	united to similar structures
connective	the portion of a stamen distinct from the filament which connects the two halves of an anther
connivent	coming in contact; converging
contorted	twisted
convex	having a more or less rounded surface
convolute	rolled around
cordate	heart-shaped
coriaceous	leathery in texture
corolla	the inner series of floral envelope, composed of petals; collective name for petals
corymb	a flat-topped or convex and open flower-cluster of the indeterminate or centripetal order
corymbiform/corymbose	arranged in corymbs
crassinucellate	(ovule) having a thick nucellus
crenate	toothed with the teeth rounded at apex

crenulate	crenate with small teeth
crenate	a structure having a shape like the moon as seen in the first or the last quarter of the month.
cristate	crested; having a tesselled margin
crustaceous	brittle in texture
crypts	stomatal pits; also applied to sunken glands, receptacles for secretions in a plant with dotted leaves
cryptocotylar	(seed) with hidden cotyledons during germination
cucullate	hooded or hood-shaped
cuneate	wedge-shaped
cupular	furnished with, or subtended by a cup-like structure
cupuliform	cup-shaped
cuspidate	tipped with a sharp, rigid point
cyme	a flower-cluster of determinate or centrifugal type, often convex or flat-topped
cymose	bearing cymes; cyme-like
cymules	a small cyme or portion of one
deciduous	falling off, as petals fall after flowering or leaves in autumn or dry season
decurrent	running down, as when leaves are prolonged beyond their insertion, and thus run down the stem
decussate	in pairs that alternate at right angle, thus in four rows
dehisce	gape or burst open spontaneously when ripe, as seed capsules or anthers
dehiscent	opening by definite pores or slits at maturity to release the content; as in fruits or anthers
deltate/deltoid	shaped like a Greek letter Delta; equilaterally triangular
dentate	toothed
denticulate	minutely toothed
dichotomous	two-forked, the branches equal or nearly so
didynamous	(flower) having four stamens arranged in pairs, two long and two short
dimorphic	in two forms
dioecious	(plant) having unisexual flowers, with the staminate and pistillate flowers borne on separate individuals
discoid	resembling a disk
dispersal	the various ways by which seeds or fruits are scattered away from the mother-trees
distichous	disposed in two vertical ranks, as in leaves
distylous	having two styles
diuretic	promoting the secretion of urine
divaricate	extremely divergent
divergent	separated or turning in different directions
domatia	dome-like, usually hairy projections sheltering parasites
dorsifixed	(stamen) having filament attached to the back of an anther
drupaceous	resembling a drupe
drupe	one-seeded, indehiscent fruit with the pericarp fleshy or leathery and the seed-coat hard and stony

druplet	a diminutive drupe
dyspeptic	stomach discomfort; e.g., indigestion
eglandular	without glands
ejaculatory apparatus	a structure that forcibly throws out endogenously formed content; e.g., in fruit
ellipsoid	a tridimensional structure elliptic in outline; e.g., seeds
elliptic	shaped like an ellipse, oblong with regularly rounded ends; e.g., leaf-blade
emarginate	having a notch cut out, usually at the extremity
emetic	that causes vomiting
endocarp	the inner layer of a pericarp
endocarpid	indehiscent kernel or pyrene embedded in certain fruits
endosperm	albumen deposited within the embryo-sac of a seed
entire	having an even margin, without lobes or teeth; e.g., leaf-blade
eophyll	early form of leaf
ephemeral	lasting for a day or less
epicarp	the external layer of a pericarp
epigeal	(seed germination) with the cotyledons lifted above the ground surface by an elongating axis
epipetalous	(stamens) borne upon the petals
epiphyllous	borne upon the leaves
epiphytic	relating to epiphytes
episepalous	borne upon the sepals
epitropous	denotes an anatropous ovule with its raphe averse when ascending, adverse when suspended
estipulate	without stipules
exarillate	without aril
excentric	out of the centre; one-sided
excrecence	growing in an unnatural way, as a wart or other outgrowth
exfoliate	to come away in scales or flakes
exocarp	the outer layer of a pericarp
exserted	projecting beyond the surrounding organ, as stamens beyond the tube of the corolla
exstipulate	without stipules
extra	outside or beyond
extrastaminal	arising or situated outside the stamens
extrorse	directed outwards, as the dehiscence of an anther
exudate	discharge from incision or pore; e.g., gum, latex, moisture, resin, etc.
falcate	sickle-shaped
fascicle	a close bundle or cluster of flowers, leaves, etc.
fasciculate	connected or drawn into a fascicle
febrifuge	a medicine that reduces fever
ferruginous	rust-coloured
filament	the stalk of an anther
filamentous	having a form of a filament
filiform	thread-shaped

fimbriate	with the margin bordered by long slender processes
fissured	deeply grooved or furrowed
flavedo	yellowness
foliaceous	having the texture or shape of a leaf
follicle	a fruit of one carpel, opening by a ventral suture to which the seeds are attached
follicular	shaped like a follicle
fulvous	dull yellow; tawny
funicle/funiculus	the cord or thread which connects the ovule or seed to the placenta
furfuraceous	scurfy; having soft scales
fusiform	spindle-shaped
gametophyte	the generation of a plant that bears the sexual organs, producing gametes, in turn giving rise to the sporophyte
germicidal	ability to destroy germs
germicide	a substance that destroys germs
gibbous	enlarged, humped or swollen on one side
glabrate/ glabrous	smooth; without pubescence
glabrescent	becoming glabrous, or slightly so
glandulous	possessing glands
glaucous	bluish green
globose/globular	rounded or spherical in shape
granular	like grains or granules
gynobasic	denotes a style that adheres by its base to a prolongation upwards of the torus between carpels
gynoecium	an organ in which female cells are formed
gynophore	a stalk supporting the ovary/pistil/carpel
herbaceous	having the texture, colour and properties of a herb
hermaphrodite	(flower) with both stamens and pistils; having the characteristics of both sexes
hesperidium	many-celled, few-seeded indehiscent fruit, having the epicarp and mesocarp joined together, and the endocarp projecting into the interior as membranous partitions which divide the pulp into chambers; such as the orange
heterostylous	(flowers) with different types (length) of styles
hilum	the scar left on a seed where formerly attached to the funicle or placenta
hirsute	coarse-hairy
hirsutulous	minutely hirsute
homostylous	with uniform styles
hyaline	colourless or translucent
hypanthium	an enlargement or elongation of the torus or floral axis below the calyx
hypocotyl	the portion of the axis below cotyledons in an embryo
hypogeal/hypogeous	(seed germination) with cotyledons not lifted above the ground surface by an elongating axis
hypogynous	free from but inserted below the gynoecium or pistil; e.g., petals and sepals

idioblast	a special cell in a tissue that markedly differs from the rest in form, size, or contents
imbricate	overlapping
imparipinnate	pinnate with an odd terminal leaflet
incipient bract	bract in an initial stage of development
indehiscent	not opening by valves or along regular lines
indumentum	hairy covering
induplicate	with the margins bent inwards, and the external face of these edges, applied to each other, without twisting
indusium	an epidermal outgrowth covering and protecting another structure; a ring of collecting hairs below the stigma
inferior	(ovary) arising or growing at a level below the insertion of other floral parts
inflexed	turned abruptly or bent inwards
inflorescence	the deposition of the flowers on the floral axis; flower cluster
infructescence	the inflorescence in a fruiting stage; collective fruits
insecticidal	ability to destroy insects
intercostal	between veins of a leaf
interpetiolar	between the petioles
intervenium	a portion of parenchyma between the veins of a leaf
intra	within
intramarginal	placed within the margin near the edge
intrapetiolar	within the petiole or between it and the stem
intrastaminal	within the stamens, as the disc of Anacardiaceae (the mango family)
introrse	turned inwards, towards the axis
invaginating	involuting or drawn into a sheath
juvenile	young stage of growth
lacerate	torn or irregularly cleft
lacinate	incised or slashed into narrow lobes
lamellate	made up of thin plates
lamina	the blade of a leaf
laminata	consisting of plates or layers
lanate	clothed with woolly and intergrown hairs
lanceolate	lance-shaped; narrow and tapering to each end
laticiferous	latex-bearing
latrorse	turned or directed towards the side of an organ; e.g., anthers of a flower
laxative	tending to stimulate or facilitate evacuation of the bowel
lenticel	lenticular corky spots on young bark, corresponding to epidermal stomata
lenticellate	having lenticels
lenticular	like a doubly convex lens
lepidote	beset with small scurfy scales
ligulate	furnished with a ligule
ligule	a strap-shaped body/structure, such as the limb of the ray florets in Compositae (sun-flower family)

linear	narrow, several times longer than wide
lobulate	having small lobes
locular/loculate	divided into locules or cavities
locule/loculus	the cell or cavity of an ovary or an anther
loculicidal	dehiscence of a fruit down the center of a compartment or a locule
lysigenous	a state when a cavity is formed by a degeneration or dissolving of cells
megasporophyll	seed- or ovule-bearing leaf-like structure
membranous	thin and semi-transparent
merism	repetition of parts to form a symmetry or pattern
mesocarp	the middle layer of a pericarp
micropyle	aperture at the apex of an ovule through which pollen-tube enters the embryo-sac
microsporangium	a microspore- or pollen-bearing structure or organ
microsporophyll	a leaf-like structure bearing microsporangium
monoecious	(plant) having stamens and pistils in separate flowers, but borne on the same plant
monoembryonic	with only one embryo
monogeneric	a family having a single genus
monopodial	(tree) with the branches or appendages arising from a simple axis
monotypic	a genus with a single species
mucilaginous	slimy, composed of mucilage
mucre	a sharp point abruptly terminating an organ
mucronate	abruptly terminated by a short and straight point
mucronulate	tipped by a diminutive mucre
multiflorous	many-flowered
nectariferous	nectar-bearing
nectarivorous	nectar-feeding
nocturnal	(flowers) night-blooming
nucellus	the body of the ovule containing the embryo-sac; the kernel of an ovule
obcordate	inversely heart-shaped
oblanceolate	inversely lanceolate; tapering towards the base more than towards the apex
oblong	much longer than broad, with nearly parallel sides
obovate	inversely egg-shaped, with narrow end attached to stalk
obpyriform	inversely pear-shaped
obturator	a wart-like protuberance of the placenta covering the micropyle
obtuse	with blunt end
ochraceous	yellow with a tinge of red
olivaceous	olive-coloured
orbicular	of a flat body with a circular outline
orthotropic	assuming a vertical position
orthotropous	(ovule) having a straight axis, the chalaza being at the insertion and the micropyle at the opposite end

ovary	that part of the pistil which contains the ovules
ovate	egg-shaped (two dimensional), the broad end attached to the stalk
ovoid	somewhat egg-shaped (three dimensional)
ovule	the female gamete- or egg-cell-bearing tissue of seed-bearing plants; the organ which after fertilization develops into a seed
palmate	(leaf-blade) divided into lobes which arise from a common centre
palmatifid	(leaf-blade) cut in a palmate fashion nearly to the petiole
palynological	pertaining to pollen and spores
panicle	a loose flower-cluster, as a branched raceme or corymb
paniculate	having flowers clustered in a panicle
papilla	soft superficial glands or protuberances
papillate/papillose	having papillae
paraphyll	leaf-like expansion produced near the leaves
parenchyma	soft, succulent tissue in plant composed of more or less isodiametric, thin-walled cells
parenchymatous	consisting of parenchyma
parietal	(ovules) borne on or belonging to the inner wall of an ovary
paripinnate	pinnate, with an equal number of leaflets, that is without a terminal one
patelliform	shaped like a small flat dish
pedicel	the ultimate stalk of a single flower in an inflorescence
peduncle	the stalk of a solitary flower or an inflorescence
pedunculate	borne upon a peduncle
pellucid	wholly or partially transparent
peltate	shaped like a small shield; fastened to stalk at a point within margin
pendulous	hanging or pendent
percurrent	extending throughout the entire length
perennial	persisting throughout the year or for a number of years
perianth	the floral envelopes of which calyx and corolla cannot be distinguished
pericarp	fruit-wall
perigynous	(flowers) having sepals, petals and stamens adnate with the lower part of the pistil
petal	one of the leafy expansions in the floral whorl constituting the corolla
petiole	leaf-stalk
petiolule	stalk of a leaflet in a compound leaf
phanerocotylar	(germination) with exposed cotyledons
pilose	having soft distinct hairs
pinnate	compound leaf with the leaflets arranged on each side of the midrib or rachis
pistil	the female organ of a flower, consisting of ovary, style and stigma
pistillode	rudimentary pistil

placenta	the organ which bears ovules in an ovary
placentation	the manner by which ovules are attached to the ovary
plagiotropic	having oblique or horizontal direction of growth
pleurisy	inflammation of the pleura
pligate	folded into plaits, usually lengthwise
plumose	feathery; feather-like
pneumatophore	an aerating root; e.g., in Rhizophoraceae
polyadelphous	having stamens grouped into several bundles
polyembryonic	having more than one embryo in a seed
polygamodioecious	(plant) having bisexual flowers and unisexual flowers on different individuals of the same species
polygamous	(plant) having bisexual flowers and unisexual flowers on the same, or on different individuals of the same species
posterior	on the side next or close to the axis
prominulous	slightly raised, standing out a little from the surface
protandrous	(flowers) having anthers mature before the pistils in the same flower
proximal	the part nearest to the axis
pseudo-	false or resembling
puberulous	slightly hairy
pubescence	hairiness
pubescent	clothed with soft hair
pulp-vesicle	air cavity or small bladder in the pulp of a fruit; e.g., <i>Citrus</i> fruit
pulpy	with juicy or fleshy tissue
pulvinate	cushion-shaped
pulvinus	the swollen base of a leaf-stalk
punctate	marked with dots, depressions or translucent glands
punctiform	in the form of a point or a dot
punctulate	with minute dots
purgative	strongly laxative
pustular	having slight elevation like blisters
pustule	a blister-like prominence; pimple
pyrene	a stone or kernel of a fruit; nutlet
pyriform	pear-shaped
raceme	an indeterminate or centripetal inflorescence with lengthened axis and equally stalked flowers
racemose	raceme-like or having racemes
rachis	the central elongated axis of an inflorescence or a compound leaf
radicle	the rudimentary root of a plant embryo
ramiflorous	flowering on the branches
raphe	a ridge of fibrous vascular tissue connecting the base of nucellus with the placenta
receptacle	that part of flower stalk (usually fleshy) which bears other floral organs
reniform	kidney-shaped

resinous	producing resin or covered with resin
reticulate	netted like net-work, as venation of a leaf
retrorse	(anther) turned or directed backwards
retuse	with a shallow notch at a rounded apex
revolute	rolled back from the margin or apex
rheumatism	any disease marked by inflammation and pain in the joints , muscles or fibrous tissue
rhomboid	approaching a rhombic outline; quadrangular with the lateral angles obtuse
rosette	arranged in a condensed circular fashion
rugose	covered with wrinkles
rugulose	somewhat wrinkled
ruminate	(endosperm) having a mottled appearance through infolding of inner seed-coat
saccate	sac-shaped or pouch-shaped
sagittate	shaped like the barbed head of an arrow
samara	a winged, non-splitting, flat, one-seeded fruit
sarcotesta	the fleshy outer portion of seed-coat
sarcotheca	fleshy pollen case or theca
scabies	a contagious skin disease causing severe itching
scabrous	rough to the touch due to the presence of stiff hairs, scales, or points
scalariform	having markings suggestive of a ladder
scale	any thin scarios body, usually a degenerate leaf, sometimes of epidermal origin
scandent	climbing
schizocarp	a dry fruit which splits into two or more one-seeded portions
scurfy	covered with bran-like scales
semi-inferior	partially inferior
semi-superior	partially superior
sepal	leaf-like divisions of a calyx
septicidal	dehiscing through the dissepiments or lines of junction
seriate	disposed in series of rows, either transverse or longitudinal
sericeous	clothed with close-pressed soft and straight pubescence
serrate	beset with sharp teeth directed upwards on the margin
serrulate	serrate but the teeth minute
sessile	without stalk
setaceous	bristle-like
sinuate/sinuuous	with a deep wavy margin
spathaceous	resembling or bearing a spathe
spathe	a large bract sheathing or enclosing an inflorescence or a flower cluster
spathulate	oblong, with the basal end attenuate like a druggist's spatula
spicate	disposed in or resembling a spike
spike	an indeterminate inflorescence, with sessile flowers seated along a common axis
stamen	the male organ of a flower, consisting of a stalk or a filament and an anther containing pollen

staminate	having stamens
staminode	rudimentary sterile stamen
stellate	star-like or star-shaped with slender segments radiating out from a common centre
stigma	that portion of a pistil or style which receives the pollen
stigmatic	relating to or having the function of a stigma
stigmatose	provided with stigmas or having conspicuous stigmas
stimulant	a stimulus-producing agent
stipe	stalk
stipellae	a minute stipule on a partial petiole of a compound leaf
stipitate	having a stipe or a special stalk
stipular	having stipules or relating to stipules
stipulary	occupying the place of stipules
stipule	an appendage of a leaf on each side of the leaf-insertion
stomatal crypts	simple glandular pits or cavities on stomata
strand	a bundle of vascular tissue, resembling a cord
striate	marked with fine longitudinal parallel lines, as grooves or ridges
strigose	beset with sharp-pointed appressed straight and stiff hairs or bristles
style	the slender upper part of an ovary supporting a stigma
subulate	awl-shaped; narrowing and tapering from the base to a fine point
sulcate	grooved or furrowed
superior	(ovary) with all the floral envelopes inserted below it, on the torus
suture	a line or a junction of two parts immovably connected; line of dehiscence
syncarpous	composed of two or more united carpels
tanniferous	producing tannin
tendrill	a slender stem or leaf-outgrowth which functions as a climbing apparatus
tenuinucellate	(ovule) with a thin nucellus
tepal	free segment of a perianth not differentiated into sepals and petals
terete	cylindrical and usually tapering, rounded in cross-section
tessellate	checkered
testa	the outer coat of a seed, usually hard and brittle
tetrad	a group of four; a body formed of four cells, as in the formation of pollen in the pollen-mother-cells
theca	a pollen-case
thyrsse	a mixed inflorescence with the main axis indeterminate, and the secondary and ultimate axes cymose
thyrsoid	resembling a thyrsse
tomentellous	sparingly or minutely tomentose
tomentose	densely pubescent with matted wool, or short hairs
tomentum	pubescence of matted interwoven hairs

torulose	cylindrical with swollen portions at intervals; beaded
torus	same as receptacle
translucent	transmitting rays of light without being transparent
trapezoid	having a shape of a trapezium
triad	group of three
trichome	hair-like outgrowth of the epidermis
trichotomous	three-forked, branching into three divisions
trifid	three-cleft
trifoliolate	with three leaflets
tristylous	with three styles
truncate	squared at the tip or base as if cut off with a straight blade
tubercle	a small rounded protuberance
tuberculate	having tubercles
turbinate	top-shaped; inversely conical
umbel	an indeterminate inflorescence in which a cluster of pedicels spring from the same point, like the ribs of an umbrella
undulate	wavy
ungulate	hoofed; clawed
uniseriate	in one horizontal row or series
unisexual	(flower) with either stamens or pistils only, not both
unitegmatic	(ovule) having one layer of integument
urceolate	pitcher-shaped, hollow and contracted at the mouth like an urn or a pitcher
valvate	opening by valves, as in most dehiscent fruits or anthers; when parts of a flower-bud meet exactly without overlapping
vein	a thread or strand of vascular tissue in a flat organ, as a leaf
velutinous	velvety due to a coating of fine soft hairs
velvety	densely covered with fine short soft erect hairs
venation	the disposition of veins; the mode of veining
vermifuge	that expels intestinal worms
verrucose	warty
verruculose	very warty; much covered with warts
versatile	swinging freely on its support, as many anthers on their filaments
vessel	any tube or canal with properly defined walls in which fluids circulate
vestigial	small and imperfectly developed; the remaining trace of an organ which fully developed in some ancestral form
villous	covered with long fine hairs
viviparous	germinating or sprouting from seed or bud while still attached to the parent plant
zygomorphic	not radially symmetrical

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(compiled by Rusea Go)

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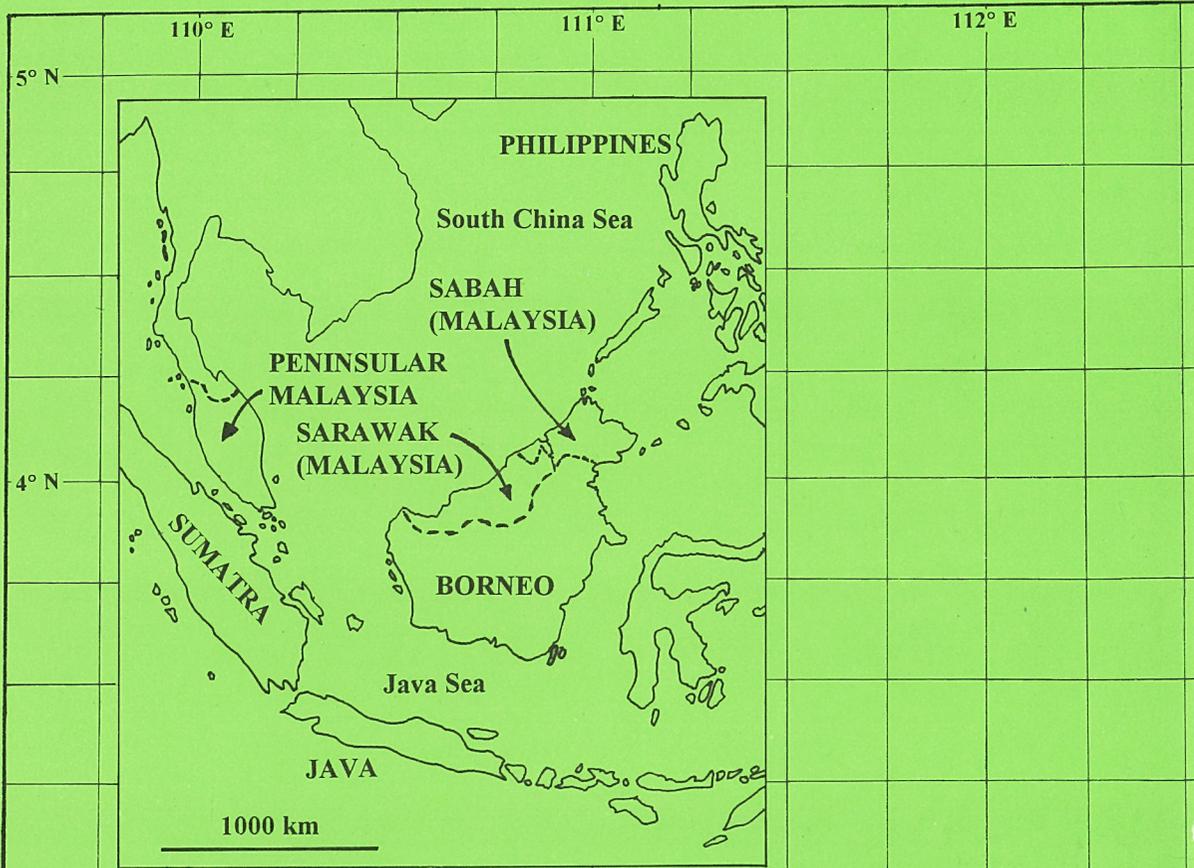
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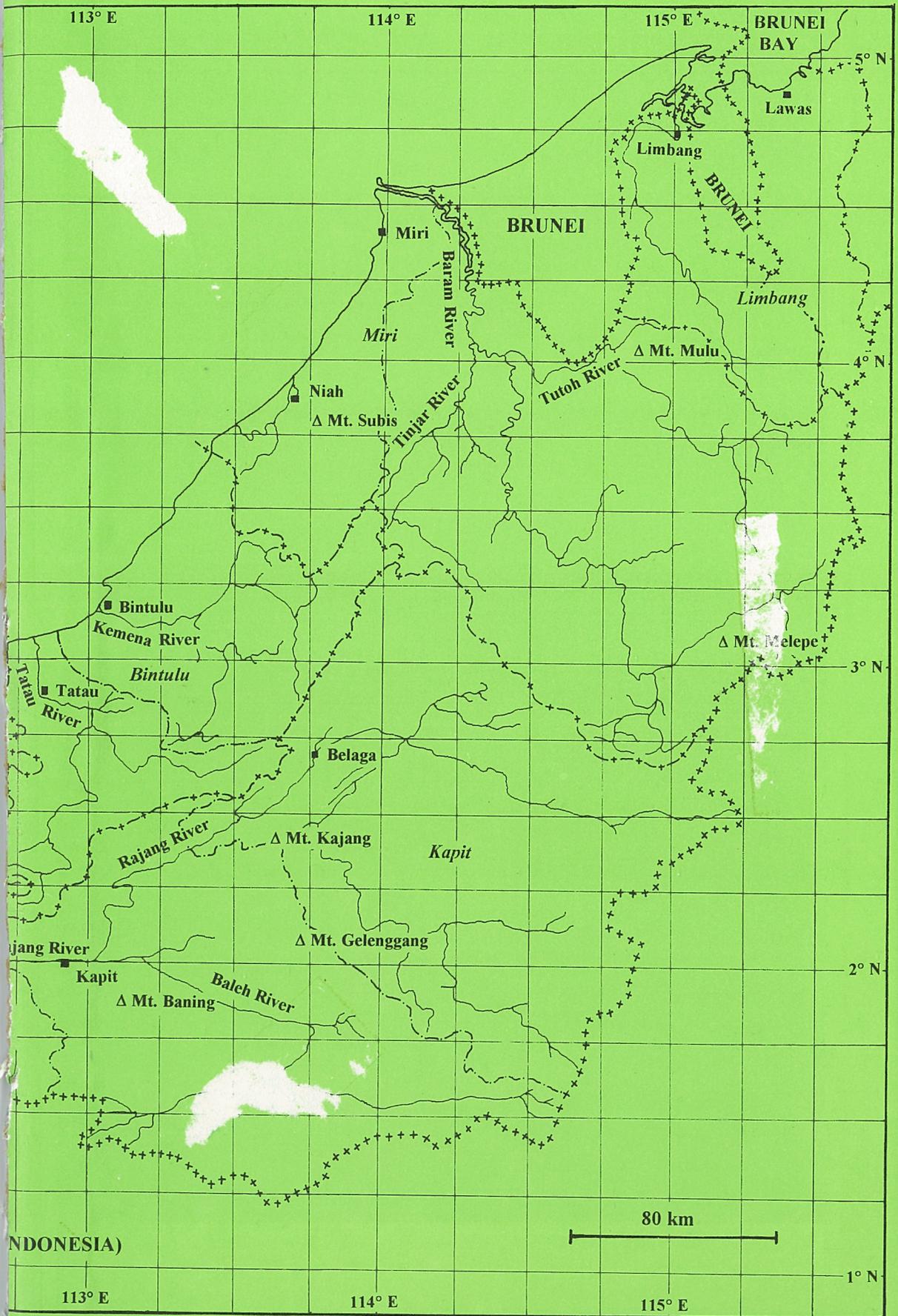
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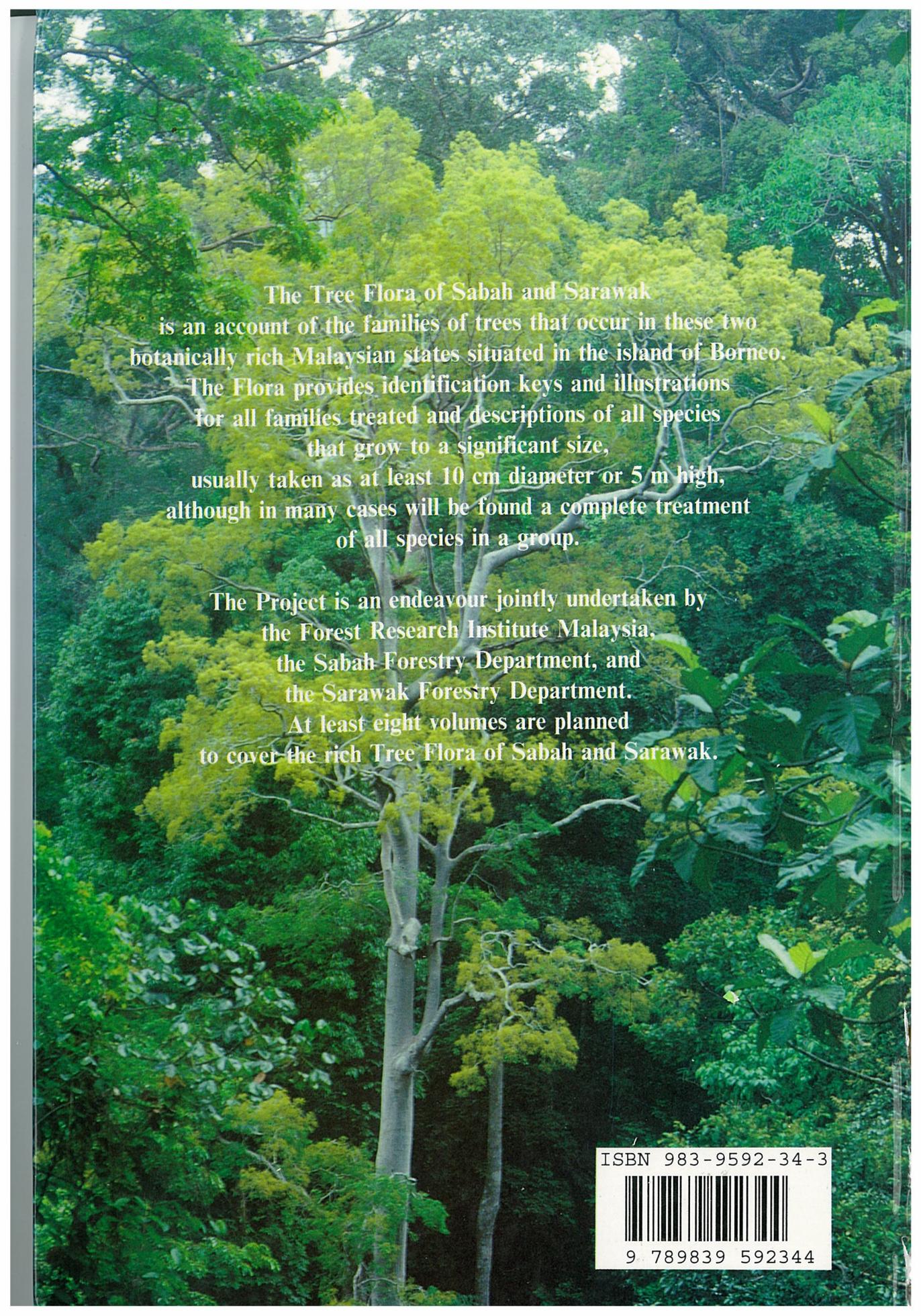
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The Tree Flora of Sabah and Sarawak
is an account of the families of trees that occur in these two
botanically rich Malaysian states situated in the island of Borneo.
The Flora provides identification keys and illustrations
for all families treated and descriptions of all species
that grow to a significant size,
usually taken as at least 10 cm diameter or 5 m high,
although in many cases will be found a complete treatment
of all species in a group.

The Project is an endeavour jointly undertaken by
the Forest Research Institute Malaysia,
the Sabah Forestry Department, and
the Sarawak Forestry Department.
At least eight volumes are planned
to cover the rich Tree Flora of Sabah and Sarawak.

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