The Heart of Borneo Series 20

Monocotyledons Series 5

Monocotyledon Plants of

PEAT SWAMP FOREST

of Sarawak

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The Heart of Borneo Series 20: Monocotyledons Series 5 - Monocotyledon Plants of Peat Swamp Forest of Sarawak

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Cover: *Cryptocoryne longicauda,* in its natural habitat, peat swamp forest in Samarahan.

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FOREWORD

The Heart of Borneo (HoB) Initiative is a voluntary transboundary conservation project that spans three nations (Malaysia, Brunei, and Indonesia) and covers approximately 220,000 square kilometers. The conservation of Borneo's unique biodiversity is a vital component of the HoB Initiative effort, as the region is home to numerous habitats and native species that are rare and often indigenous to the region. Among the habitats that depict the rich biodiversity in Sarawak are peat swamp forests. The peat swamp forests are one of the most threatened and vulnerable ecosystems which are poorly studied and least understood. Peat swamp forests which thrive on tropical peatlands store huge amounts of carbon as soil organic matter. Their stability is crucial for climate change being the largest near-surface reserves of terrestrial organic carbon.

The plant species richness of the peat swamp forests within the HoB area is reflected in the diversity of the numerous plant species depicted in this magnificent work, which is vital for conservation. The preliminary documentation recorded a total of 28 families, 90 genera, and more than 130 species have been documented in the peat swamp forests in Sarawak. I believe that with more work, the number of plant families and species in the peat swamp forests might be higher.

Special appreciation to the authors. They deserve much credit for the time and effort put into the success of this book published.

YBhg Datu Haji Hamden Bin Haji Mohammad
Director of Forests
Forest Department Sarawak

PREFACE

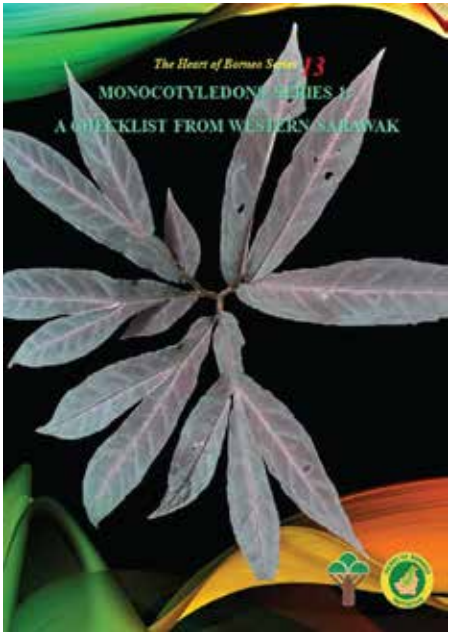
This is the fifth book in The Sarawak's Monocotyledon Plant Series publication under the Monocotyledon Plant Project. The Monocotyledon Plants of Peat Swamp Forests is a book that specifically on the selected common monocot plants found in the peat swamp forests of Sarawak, particularly in the Heat of Borneo areas. Other books in this Monocotyledons Series are, (1) A Checklist From Western Sarawak, (2) Gingers of Sarawak's Heart of Borneo, (3) The Genus Zingiber, and (4) Palms of Sarawak.

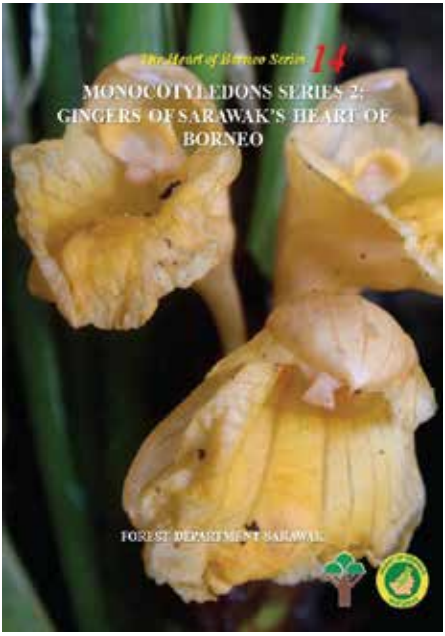
Preliminary documentation recorded a total of 28 families, 90 genera, and more than 130 species have been recorded in the peat swamp forests in Sarawak. The families Orchidaceae, Arecaceae, Araceae, Zingiberaceae, and Cyperaceae are very dominant.

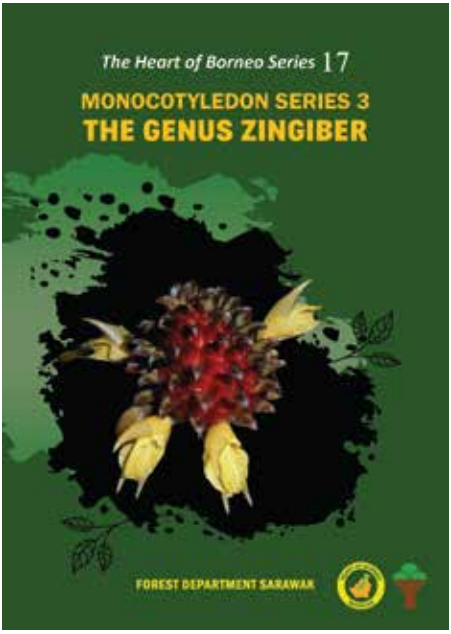
Our documentation on the Monocotyledon plants in Sarawak is beyond complete. Many works are needed, especially on the field excursions and sample collections.

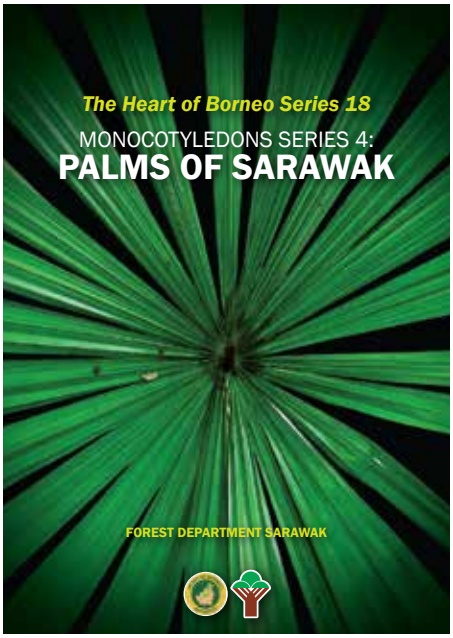
Authors.

The Heart of Borneo Series
(Monocotyledons Series)










HEART OF BORNEO SARAWAK
HEART OF BORNEO INITIATIVE
LEGEND
HOB BOUNDARY
DIVISION
BETONG
BINTULU
KAPIT
KUCHING
LIMBANG
MIRI
MUKAH
SAMARAHAN
SARIKEI
SERIAN
SIBU
SRI AMAN

What Is Heart of Borneo Initiative

Heart of Borneo (HoB) Initiative is a voluntary transboundary cooperation between Brunei Darussalam, Indonesia, and Malaysia to enable conservation and environmental protection while enhancing sustainable developments that improve the welfare of those living on the islands.

The three ASEAN nations cooperation was officially launched in Brazil on 27 March 2006. On 12 February 2007 the Minister of Natural Resources and Environment, Malaysia, Minister of Forestry, Republic of Indonesia, and the Minister of Industry and Primary Resources, Brunei Darussalam, signed and jointly issued a Declaration in Bali, Indonesia.

Because of the global concerns and controversy about tropical forest development, the long-term objectives of the HoB Initiative, as enshrined in the Bali Declaration are as follows:

“With one conservation vision and to promote peoples’ welfare, we will cooperate in ensuring the effective management of forest resources and conservation of the network of protected areas, productive forests, and other sustainable uses”.

FIVE PILLARS OF THE HEART OF BORNEO SARAWAK

Sustainable Forest Management

Focusing on maintaining the balance between forest and environmental protection

Conservation of Biological Diversity

Focusing on the implementation of Conservation and Biological Diversity initiatives within the HoB areas

Community-Based/ Rural Poverty Eradication Program

Focusing on the welfare of rural communities through effective management of TPAs, production, forest and agriculture

Ecotourism Based on Culture, Adventure & Nature

Focusing on developing the ecotourism living involving the local communities to promote conservation and enhance socio-economic well-being

Sustainable Land Use/Agriculture

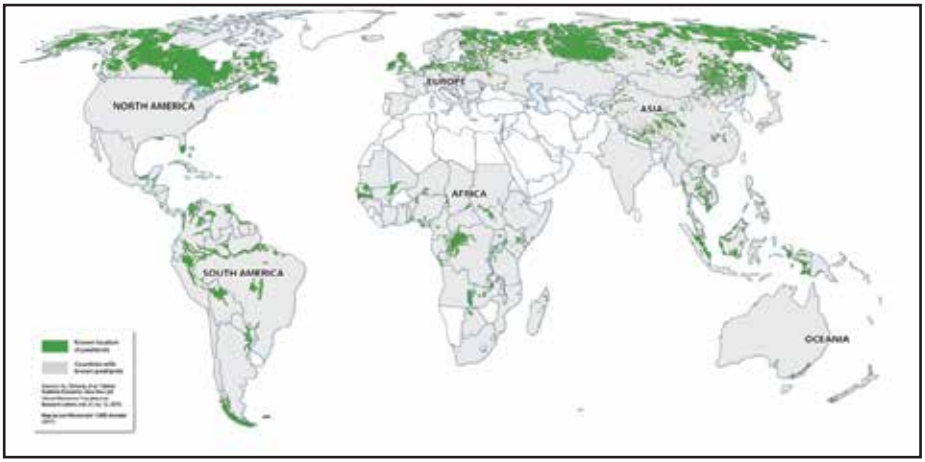
Focusing on sustainable development of rural communities through wise management of natural resources and agriculture

ABOUT PEAT SWAMP FORESTS

The peatlands of Malaysia encompass around 2.6 million hectares (Mutalib et al. 2002). Sarawak has the largest peatland (65% organic matter by definition) in Malaysia, covering around 1.66 million hectares and accounting for 13% of the state's total geographical area (Wong, 1991; Ipor, 2006). They make up almost 70% of all the peatlands in Malaysia. The soil is spread coarse (basin peats) and poorly drained inner valleys (valley peats) in the lower stretches of the primary river and generally occurs between the lower courses of the main rivers such as Batang Saribas, Batang Lupar, Batang Baram, Batang Rajang, and its distributaries. The largest peat swamp forest areas are contributed by the Sibu Division, followed by Sri Aman, Miri, Kota Samarahan, Sarikei, and Bintulu. Kuching Division has the smallest peat area with a total of 23,049 ha.

Peat swamp forest is the most heavily exploited and least studied forest type in Sarawak (Whitmore, 1995), owing to its easy access and the presence of highly valuable timber species such as Ramin (*Gonystylus bancanus*), Alan (*Shorea albida*), Jongkong (*Dactylocladus stenostylus*), Meranti buaya (*Shorea uliginosa*), and many more (Lee, 1991; Ipor, 2006).

Distribution of lowland peatlands in Malaysia (Source: Department of Agriculture Malaysia, 2002; Department of Irrigation and Drainage Sarawak, 2014; Melling, 2016)



Global distribution of peatlands (Source: https://www.grida.no/resources/12546)

Peat swamp forests are important ecosystems that help regulate the climate. Peatlands (areas with peat substance) are projected to encompass 400 million hectares, or 3% of the earth's land surface (Strack, 2008) but are potent carbon sinks that store more carbon than all of the world's forests combined (IUCN, 2021). Waterlogged characteristics of peatlands limit plant deterioration, allowing dead plant material to be collected as peat and storing the carbon absorbed from the atmosphere. This process has a net cooling effect on temperature, making peatlands critical for mitigating environmental problems. They also help with water regulation by lowering the risk of flooding and drought and limiting seawater intrusion.

Peat swamp forests help local economies by providing food, fiber, and other resources that help communities thrive. They also have a high biodiversity, including many endangered species, making them ideal for tourist ventures. Peatland environmental services, including water filtration and flood control, are critical to the well-being of local inhabitants and their livelihoods.

The preservation and restoration of peat swamp forests are critical to worldwide efforts to mitigate climate change and meet Sustainable Development Goals (IUCN, 2021). Initiatives, such as the UN REDD+ program, try to protect the remaining forests by incentivizing conservation and sustainable management (Page & Rieley, 2018). Furthermore, the international community has recognized the value of peatlands, with organizations such as the United Nations Environment Programme and the RAMSAR Convention committing to goals and activities to protect these ecosystems (IUCN, 2021).

PEAT SWAMP FORESTS

Sarawak, a Malaysian state on Borneo Island, is known for its outstanding biodiversity, which includes a unique peat swamp forest habitat. These forests are part of the Borneo peat swamp forest ecoregion and are distinguished by waterlogged soils that prevent the full decomposition of dead plant material, resulting in acidic peat formation. Sarawak's peat swamp forests, such as those in Kalimantan, Indonesia, and Belait Districts, Brunei are found in coastal lowlands, often behind mangrove forests and close to lowland rainforests in better-drained soils. This ecoregion provides a crucial habitat for a diverse range of plant and animal species, contributing to Borneo's position as one of the most important biodiversity and carbon storage centers worldwide.

Peat swamp forests are wetlands found in tropical and subtropical areas. They are distinguished by soil composed of organic matter, primarily peat, which accumulates over time as dead plant material decomposes under the damp conditions of the forest. These forests are home to numerous plant and animal species, some of which are rare and endangered. Peat swamp forests, on the other hand, are a substantial source of carbon dioxide and other greenhouse gases, and their destruction and conversion for agriculture and other purposes have been identified as a key contributor to global climate change.

Peat swamp forests in Southeast Asia have been systematically cleared for agriculture and development, making them one of the world's most vulnerable ecosystems. Vast swaths of peat swamp forest have already been degraded (Mietten et al. 2011), and if current rates of deforestation continue, Southeast Asia's peat swamp forests may be gone by 2030 (Posa et al. 2011).

Malaysia has about 11% of tropical peatlands, second only to Indonesia, which had 80% coverage of tropical peatlands until recently (Rieley et al., 1996; Page et al., 2006). Peat swamp forests are the largest wetland area in Malaysia, accounting for 75% of the total area (UNDP, 2006). Sarawak has the most peat swamp forest coverage in Malaysia, accounting for approximately 64% of the total 2.6 million hectares (Hon, 2011). Sarawak's peat swamp forests are extensively scattered in the deltaic plains, stretching along the Samarahan-Sadong, Lupar-Saribas, Rajang, Baram, and Limbang river systems, as well as the lowland and coastal plains of Mukah (Sawal, 2004). The peatland area of Sarawak is estimated to be 1,657,600 ha, accounting for 13% of the total land area of the state (Tawan et al. 2008) and approximately 60% of Sarawak's total peatlands (Sime Darby Services, 1999).

The majority of Malaysia's lowland peatlands have formed near the coast, behind accreting mangrove coastlines, where sulphides in mangrove mud and water inhibit bacterial action, which leads to the accumulation of organic matter as peat. Many peatlands that are now far inland evolved along the previous coastline, with some reaching 100 kilometres inland, like the peatlands near Marudi in Sarawak. The earliest inland peat patches are thought to be 4,000-5,000 years old. The peatlands that occur along the coast are not continuous; rather, they develop as separate units on the alluvial plains between rivers that go to the sea.

Sarawak peat swamp forests support a diverse range of life, with as many as 927 species of flowering plants and ferns. This diversity is vital not only for biological balance but also for the region's carbon sink and storage capacity. The flora and wildlife found in these forests are equally amazing, with gibbons, orangutans, and crocodiles relying on this habitat. The existence of these species demonstrates the complexity and interdependence of peat-swamp ecosystems.

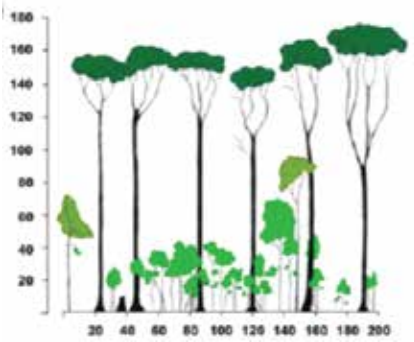
Traditional dominant tree species in peat swamp forests include *Gonystylus bancanus* (Ramin) and *Shorea albida* (Alan batu and Alan bunga), both of which are now uncommon in disturbed ecosystems. The extinction of these species illustrates the vulnerability of peat swamp ecosystems to human activity, highlighting the need for more effective conservation methods to conserve these essential forests and their function in carbon sequestration.

Despite their ecological importance, swamp forests are under severe threat. Large portions of these forests have been drained in recent years for agricultural use, such as the establishment of oil palm plantations, which have been aggravated by the use of fires to clear land. This not only resulted in habitat damage but also contributed to the release of stored carbon, thereby increasing the region's carbon footprint (Alamgir et al., 2020). Conservation efforts have been inadequate in comparison to the magnitude of the devastation, with continuing commercial logging and plans for greater exploitation in Sarawak and Brunei.

The Pan-Borneo Highway and various hydropower dams in Sarawak are significant threats to peat swamp forests and their biodiversity (Alamgir et al., 2020). With approximately 161 km of highway passing forested landscapes and 55 km crossing carbon-rich peatlands, these projects will have an impact on protected areas and crucial habitats for threatened species. The development of 13 hydroelectric dams is expected to affect 1.7 million hectares of forest, resulting in detrimental environmental, economic, and social consequences. Protected areas such as the Loagan Bunut National Park, Maludam National Park, and Pulau Bruit Wildlife Sanctuary serve as havens for remnant peat swamp forests, but they are isolated and face developmental pressures (Tawan et al. 2008).

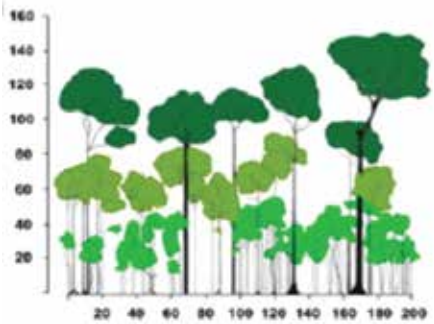
The Forest Department of Sarawak has classified PSF into five distinct sub-types for management purposes. The sub-types are Mixed Swamp Forest (MSF), Alan Batu Forest, Alan Bunga Forest, Padang Alan Forest and Padang Paya Forest. The sub-type MSF occurs on the outskirts of swamps and covers extensive areas of comparatively undeveloped coastal bogs. The canopy is irregular with dominants reaching 40 to 45 m in height, and the floristic structure of all stories are a mix of various plant families. Among the common plant genera in the sub-type are *Gonystylus, Dactylocladus, Shorea, Neoscortechinia, and Alangium.*

Mixed Peat Swamp Forest (Melling, 2016)

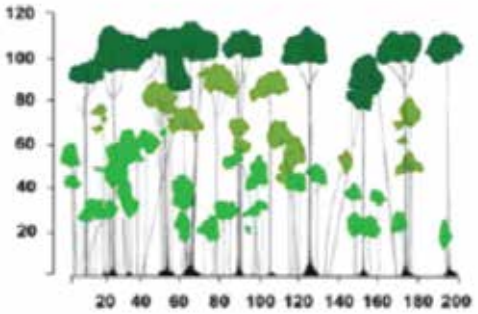


Alan Batu Forest (Melling, 2016)

The sub-type Alan Batu Forest occurs as a transitional zone, often of considerable depth, between sub-types MSF and Alan Bunga Forest. The canopy is uneven, and large trees, often exceeding 1.7 m DBH, of *Shorea albidadominate* the forest. The moderately dense middle and lower storeys are composed of a mix of species that are similar to sub-type MSF. *Stemonurus umbellatus Becc.* (Semburok) is a characteristic species of this sub-type.



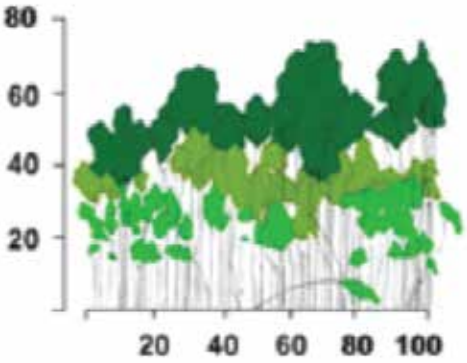
Alan Bunga Forest (Melling, 2016)



Padang Alan Forest (Melling, 2016)

The sub-type Alan Bunga Forest covers very extensive areas of peat swamp forests in the south and east of Sarawak. The emergent layer of the forest canopy is composed of a pure even canopy, ranging in height between 50 – 60m of *Shorea albida* (Alan bunga). The canopy layer is regularly absent and the lower canopy layer is often dominated by one or two species. *Benstonea andersonii* Callm. & Buerki commonly forms dense thickets in the understorey layer. The Padang Alan Forest sub-type occurs as a transitional zone. The canopy is unbroken and even at heights ranging from 30 to 35 m. All trees are relatively small in girth, with only a few individuals exceeding 80 – 90 cm DBH,while the rest are pole-liked trees. *Shorea albida, Litsea palustris* Kostermans (Medang padang), *Parastemon urophyllus* (Wall. ex A.DC.) A. DC. (Ngilas padang), *Combretocarpus rotundatus* (Miq.) Danser (Perepat darat) and *Calophyllum obliquinervum* Merr. (Dangkalan) are common in this sub-type.

The fifth sub-type, Padang Paya Forest (refers to a combination of Phasic Community 5 and 6 in Anderson's PSF ecological terms (Anderson, 1963). This sub-type occurs only in the most highly developed raised bogs. The canopy is dense and even, with few emergent and average height of between 5 – 10 m,rarely reaching 20 m tall. Most of the trees are pole sizes and only a few exceed 30 cm DBH. Among the common species in this sub-type viz. *Parastemonurophyllus, Palaquium cochleariifolium P. Royen* (Nyatoh jelutong), *Dactylocladusstenostachys*, *Garcinia rostrata* (Hask.) Miq (Manggis hutan), *Litsea palustris* and *Tristaniopsis obovata* (Benn.) Peter G. Wilson & J.T. Waterh. (Pelawan merah).

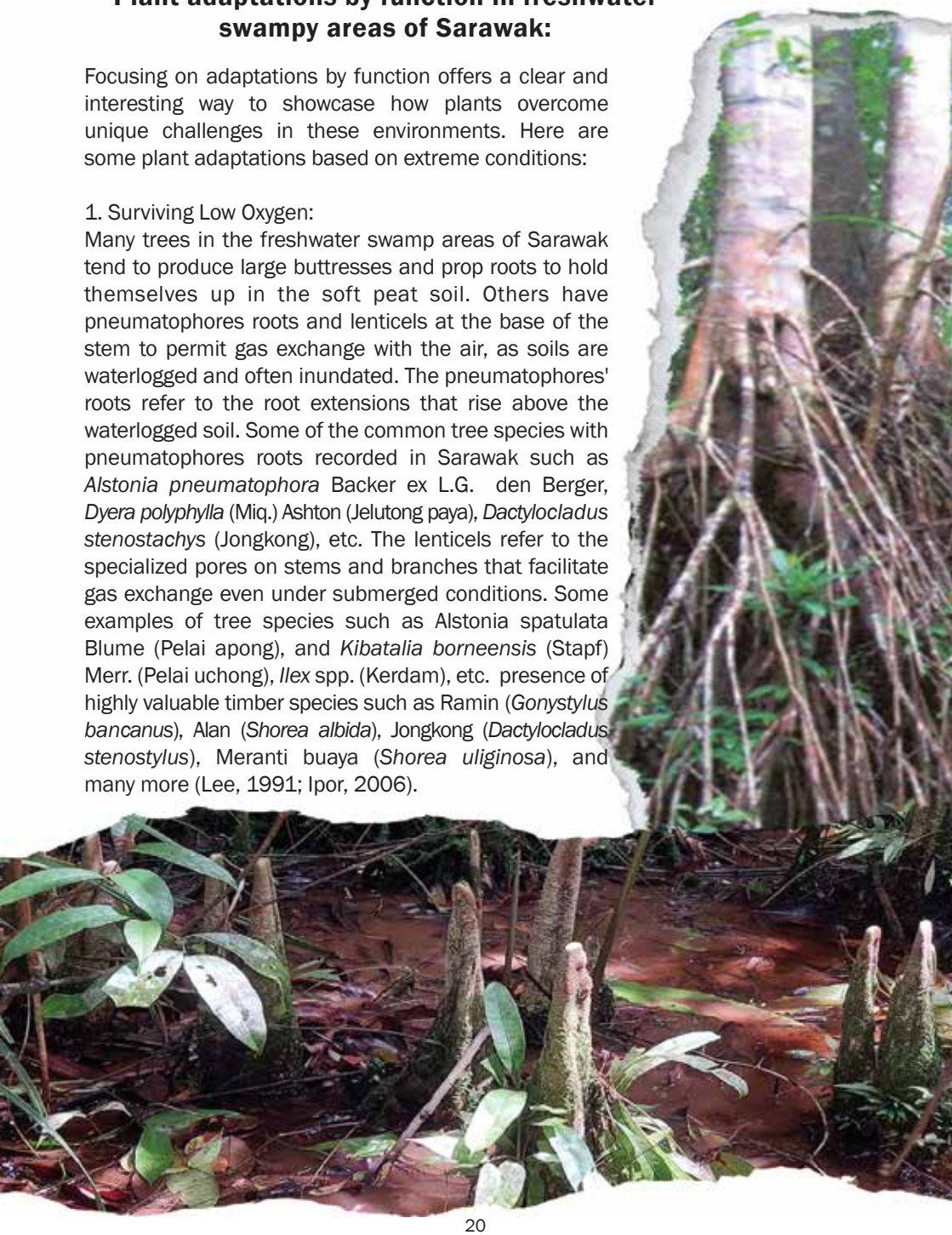


Padang Paya Forest (Melling, 2016)

Plant adaptations by function in freshwater swampy areas of Sarawak:

Focusing on adaptations by function offers a clear and interesting way to showcase how plants overcome unique challenges in these environments. Here are some plant adaptations based on extreme conditions:

1. Surviving Low Oxygen:
Many trees in the freshwater swamp areas of Sarawak tend to produce large buttresses and prop roots to hold themselves up in the soft peat soil. Others have pneumatophores roots and lenticels at the base of the stem to permit gas exchange with the air, as soils are waterlogged and often inundated. The pneumatophores' roots refer to the root extensions that rise above the waterlogged soil. Some of the common tree species with pneumatophores roots recorded in Sarawak such as *Alstonia pneumatophora* Backer ex L.G. den Berger, *Dyera polyphylla* (Miq.) Ashton (Jelutong paya), *Dactylocladus stenostachys* (Jongkong), etc. The lenticels refer to the specialized pores on stems and branches that facilitate gas exchange even under submerged conditions. Some examples of tree species such as Alstonia spatulata Blume (Pelai apong), and *Kibatalia borneensis* (Stapf) Merr. (Pelai uchong), *Ilex* spp. (Kerdam), etc. presence of highly valuable timber species such as Ramin (*Gonystylus bancanus*), Alan (*Shorea albida*), Jongkong (*Dactylocladus stenostylus*), Meranti buaya (*Shorea uliginosa*), and many more (Lee, 1991; Ipor, 2006).



The monocotyledon plants, somehow have different adaptations to survive in extreme conditions of freshwater peatlands compared to the trees. To survive in the low oxygen level, many of the monocotyledon plants tend to produce aerial roots and spongy tissues.Some species such as *Amydrium medium, Rhapidophoratenuis, Scindapsus pictus, orchid* spp., etc develop the sea above ground roots for gas exchange and support.Other species, mostly members from the Araceae (aroids), Hanguanaceae, and Orchidaceae have spongy tissues in their parts. These tissues (internal air channels in leaves and stems) facilitate oxygen transport throughout the plant.

2. Acquiring Nutrients:

Due to extreme conditions, where nutrients are limited, many of the trees in the freshwater swamp forests (such as *Shorea spp.,* and *Mangifera spp.*) acquire nutrients through mycorrhizal partnerships, where their relationships with fungi help them access nutrients from the nutrient-deficient soil. Some of the trees produce large buttress roots (e.g. *Dialium spp., Koompasia malaccensis, Shoreaalbida,* etc.). These large roots extend beyond the tree canopy, capturing organic matter that decomposes and releases nutrients.

Other plant groups such as herbaceous (mostly the monocotyledon) and perennial shrubs have specialized root structures, that are adapted to efficiently absorb nutrients from flooded soil. Some plants become carnivorous (e.g. *Nepenthes* and *sundew*), and develop their parts into structure-like traps. These parts trap and digest insects, supplementing their nutrient intake from the poor soil.

MONOCOTYLEDON PLANT

Angiosperms can be divided into several groups: Basal clades, Magnoliids, Monocots and Eudicots. Most angiosperm families fall into the monocots and eudicots groups. Monocotyledons, often known as monocots, are a large group of flowering plants distinguished by the presence of a single cotyledon or leaf in their seeds. This category comprises a wide range of plants including grasses, lilies, palms, and bananas. Eudicots, which typically have two cotyledons, are distinguishable from monocots. Monocots range in size from small herbaceous plants (e.g., duckweed plants) to large woody plants (e.g., *Pandanus* species).They frequently have short stems with basal leaves, which form dense tussocks.The leaves are normally venation-parallel, and the floral elements are usually organized in multiples of three. Perianths can be reduced or absent in several families, such as grasses, sedges, and rushes.

Several anatomical features can be used to differentiate monocots from eudicots. They will not be visible to the naked eye, but if you have a microscope, they may be used to distinguish between plant groups. Monocots, for example, have vascular bundles distributed throughout the stem, where as eudicots have them organized in a ring around the stem. These vascular bundles are found throughout the stem tissue of monocots such as maize. Eudicots, such as beans, are more complicated. The stems of eudicots are herbaceous or woody in nature. Vascular bundles of herbaceous or immature woody eudicots form a ring around the stem. In older stems, bundles tend to fuse to form concentric rings. Pollen grains in eudicots have three apertures, whereas monocots have only one.

	Dicotyledons	**Monocotyledons**
	Morphological features	**Morphological features**
1.	Reticulate venation is present in the leaves.	Parallel venation is present in the leaves.
2.	Presence of two cotyledons in seed.	Presence of single cotyledon in seed.
3.	Primary root radicle persists as tap root.	Radicle doesn't persist and fibrous root is present.
4.	Flowers tetramerous or pentamerous.	Flowers trimerous .
5.	Tricolpate (3 furrow) pollen is present.	Monocolpate (1 furrow) pollen is present.
	Anatomical features	**Anatomical features**
1.	Vascular bundles are arranged in the form of a ring in stem.	Vascular bundles are arranged in the stem.
2.	Vascular bundles are open (Cambium present).	Vascular bundles are open (Cambium present).
3.	Secondary growth is present.	Secondary growth is present.

The Monocotyledon plants are a diverse group of flowering plants characterized by several distinctive features. Some of the main categories of monocot plants include:

- Poales: This order includes economically important plant families such as Poaceae (grasses) and Cyperaceae (sedges).
- Asparagales: This order includes prominent families like Orchidaceae (orchids), Amaryllidaceare (amaryllis), and Asparagaceae (asparagus).
- Arecales: This order includes the Arecaceae family, which consists of palms.
- Liliales: This order includes families like Liliaceae (lilies) and Melanthiaceae (trillium family).
- Alismatales: This order includes families such as Alismataceae (water plantain family) and Araceae (arum family).

They encompass approximately 60,000 species, including economically important plant families and a wide variety of flowering plants. Monocot cropsplay a crucial role in global agriculture. They include economically important crops such as rice, maize, sugarcane, and bananas, which are staple foods for many populations around the world. The monocot crops contribute immensely to the global economy. They are essential for food security, trade,and livelihoods, making them a vital component of agricultural economies.

shelter for animals

source for nectaries

food for wildlife

SPECIES SELECTION

Agloanema nitidum

Family: Araceae
Scientific name: *Agloanema nitidum* (Jack) Kunth.
Local name:

Description: An erect herb with stout stems. Petiole 10-25 cm long. Young leaves and petiole light green to creamy. Matured leaves elliptic-oblong, base cuneate, pointed at apex, veins pinnately arranged and closed together, dark green and usually white, thickly textured. Inflorescence stalk 3- 15 cm long; spathe boat-shaped, white or light green, 4-5 cm long on green stalk. Fruit berries, white or red, c. 1 cm long.

Ecology: widespread in damp lowland forests, often in peat swamp forests.

Alocasia longiloba

Family: Araceae
Scientific name: *Alocasia longiloba* Miq.
Local name: Keladi muka rusa, Keladi rimau, Keladi ular, Birah kijang, Birah hitam
Synonym: *Alocasia denudata* Engl., *Alocasia lowii* Hook. f., *Alocasia singaporensis* Linden., *Alocasia veitchii* (Lindl.) Schott., *Caladium veitchii* Lindl.

Description: Herb up to 1 m tall with striped leaves. Petiole to about 50 cm long, attached to the margin of the leaf blade or close to it. Leaves 1–3 (sometimes up to 5) per plant, large 30–50 x 20–25 cm, triangular in outline with hastate at the base like a heart, margin wavy, surface glossy green with white to light yellow veins. Inflorescence stalk mottled grey, spathe 8–12 cm long, creamy; spadix light orange or yellow. Fruit berry, orange or red.

Distribution: South Yunnan, Guangdong to the west, and central Malesia. Widespread in Sarawak, particularly in lowland habitats.

Ecology: widespread in the lowland forests o near forest margins of peat swamp forests.

Notes: the specific epithet, “longiloba” refers to the long lobes that are the characteristic of this species.

Alpinia aquatica

Family: Zingiberaceae
Scientific Name: *Alpinia aquatica* (Retz) Roscoe
Local Name: Tepus, Teben, Halia air
Synonym: *Alpinia cornu-cervi* Ridl.; *Alpinia exostylis* K. Schum.; *Alpinia fraseriana* Oliv.; *Heritiera aquatica* Retz.; *Hellenia aquatica* (Retz.) Willd.; *Martensia aquatica* (Retz.) Raeusch.

Description: Herb with leafy shoots, 50–170 cm tall. Leaves 30–55 x 4–6 cm, elliptic-lanceolate, smooth above, margin entire, base cuneate, apex acuminate or with long cauda. Inflorescence terminal on the leafy shoot, 10–20 cm long, flowers white or pinkish white. Fruits globose, green turning to orange and blackish when ripe.

Ecology: this species can be found from lowland to hill forests, up to 200 m altitudes. Commonly found at the coastal and swampy areas near streams and rivers.

Distribution: this species is native to India, Peninsular Malaysia, Sumatra, Java, Borneo and southern Philippines.

Notes: the specific epithet names, aquatica, refer to the habitat. It is claimed that this species has medicinal values, parts of the plants are boiled and used to relief stomach-aches.

Alpinia ligulata

Family: Zingiberaceae
Scientific name: *Alpinia ligulata* K. Schum.
Local name: Tepus, Teben, sibudog

Description: This species usually forms a short-creeping rhizome or in clump of leafy shoots, about 1.2 - 2 m tall. Leaves are large (up to 110 x 35 cm), with narrowly attenuate at the base. A common species in lowland habitats, including peat swamp forest, kerangas, and limestone, prefer wet places near river banks or streams.

The small flowers are closely similar to *Alpinia nieuwenhuizii* but distinct by long brown ligules (the epithet name for this species) and the inflorescences are simple branches.

Endemic to Borneo. Locally known as "Sibodug" by the Bidayuh in Bau, the ripe yellow fruits are edible, and the large leaves are often used to wrap foods.

This species is one of the important food sources for animals (birds, rodents, tortoises and reptiles).

Amischotolype hispida

Family: Commelinaceae
Scientific name: *Amischotolype hispida* (A. Rich) D.Y. Hong
Local name: -
Synonym: F*orrestia hispida* A. Rich.; *Forrestia nigricans* A. Rich ex Steud.

Description: Stem ascending from long rhizome; erect part 45–250 cm long, often trailing or scrambling. Leave blades 19-48 x 4-10.5 cm, lower surface purplish tinged. Inflorescence on erect stem, sessile, 3–6 cm diam., dense with branches obscure, 20– many-flowered. Flowers are pink to pale purple. Capsule 5–8 × 3.5–6.5 mm, ovoid, shorter than sepals by 4–9 mm, pale purple or red. Seeds 2 per locule, aril orange.

Habitat: Primary or secondary forests, on ridges, (steep) slopes, in periodically inundated or riverine areas, gullies, or swamps.

Distribution: Borneo, Sulawesi, Maluku, New Guinea and the Philippines.

Notes: This species is fairly variable concerning indument of vegetative parts, sepals, and capsules.

Amischotolype mollissima

Family: Commelinaceae
Scientific name: *Amischotolype marginata* (Blume) Hassk.
Local name: Segambut merah
Synonym: *: Amischotolype mollissima* var. *marginata* (Blume) R.S. Rao; *Campelia marginata* Blume; *Forrestia marginata* (Blume) *Hassk.; Forrestia mollissima f. marginata* (Blume) *Backer; Tradescantia marginata* (Blume) *Bouche*

Description: Stem ascending from creeping and branched, up to 3 m long rhizome; erect part 30–100 cm long. Inflorescence on rhizome and knee, peduncle 2–15 mm long, dense to very lax with branches obscure or longest 3–30 mm long, up to 20 flowers (or more). Capsule 6–8.5 × 3.5–4.5 mm, narrowly obovoid.

Distribution: this species is native to Borneo, Jawa, Malaya, Myanmar, Philippines, Sulawesi, Sumatera, and Thailand.

Habitat: lowland dipterocarp, peat swamp or montane primary, disturbed or old secondary, in deep to partly shaded or open vegetation in the valley, along streams, in forest clearings or margins, or on roadsides.

Amydrium medium

Family: Aracaee
Scientific name: Amydrium medium (Zoll. & Moritzi) Nicolson
Local name: Sakat galah
Synonym: *Anadendrum medium* (Zoll. & Moritzi) Schott; *Epipremnopsis huegelii* (Schott) Engl.; *Epipremnum medium* (Zoll. & Moritzi) Engl.

Description: Climbing herb.

Distribution: native to southeast Asia and Indo-China regions. A climber aroid commonly found in wet places, particularly near river banks or streams in lowland forests (incl. peat swamp forest).

Notes: ornamental plant.

Apostasia nuda

Family: Orchidaceae
Scientific name: *Apostasia nuda* R. Br.
Local name: Naked Apostasia, Anggerik rumput, Nuda
Synonym: *Apostasia brunonis* Griff; *Apostasia lobbii* Rchb. f.; *Adactylus brunonis* (Griff.) Cretz.; *Adactylus lobbii* Rolfe; *Adactylus nudus* Rolfe

Description: Terrestrial, with many leaves, up to 50 cm tall (sometimes to 80 cm), leaves are linear-lanceolate, 11-20.5 x 3-5 cm. Inflorescences are terminal, and flowers are arranged in spikes. The bases of the spikes are covered with linear bracts. The flowers are sepals and the petals are white in colour

Distribution: Native to Southeast Asia (Thailand, Peninsular Malaysia, Cambodia, Laos, Sumatra, and Borneo) India, and Bangladesh. Lowland forests.

Notes: This species is used for its medicinal properties, such as treating fever, wounds, and skin diseases. It is also used as an ornamental plant in gardens and for landscaping.

Areca triandra

Family: Arecaceae
Scientific name: *Areca triandra* Roxb. ex Buch.-Ham.
Local name: Pinang hutan
Synonym: *Areca aliceae* W.Hill ex F.Muell.; *Areca borneensis* Becc.; *Areca humilis* Blanco ex H. Wendl.; Areca laxa Buch.-Ham.; Areca nagensis Griff.; *Areca polystachya* (Miq.) H.Wendl.; *Nenga nagensis* (Griff.) Scheff.; P*tychosperma polystachyum* Miq.

Description: Palm up to 5 m tall, solitary, but more often suckering at the base. Green crown shaft with prominently ridge green. Inflorescence creamy green, simple branched.

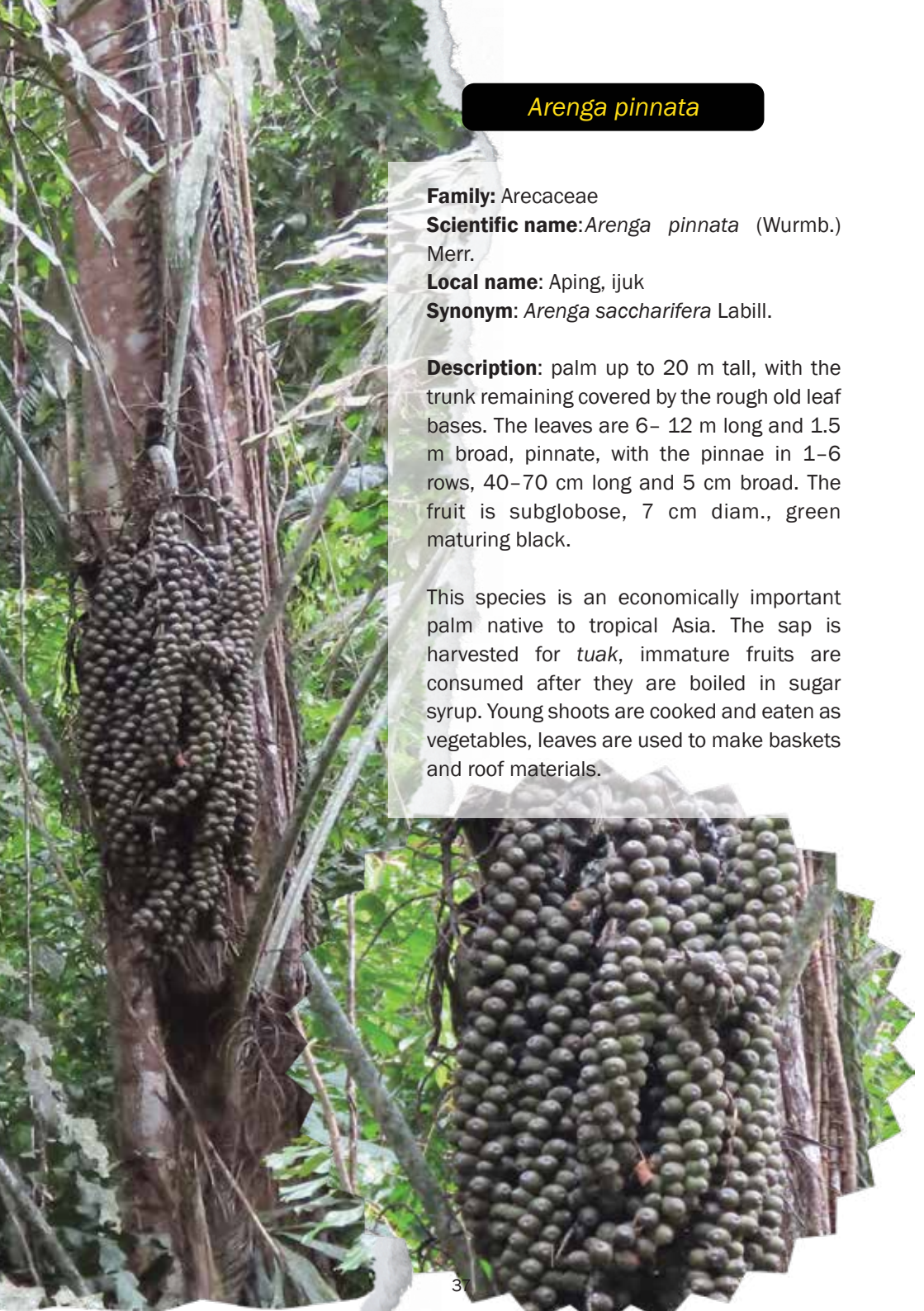
Habitat and Distribution: Often found in the lowland forests (incl. peat swamp), in humid places, particularly near streams or rivers. *Areca triandra* is found in the Andaman Islands, Assam, Bangladesh, Cambodia, south China, Laos, Myanmar, the Philippines, Sumatra, Thailand, Vietnam, Borneo, and Peninsular Malaysia.

Arenga pinnata

Family: Arecaceae
Scientific name:*Arenga pinnata* (Wurmb.) Merr.
Local name: Aping, ijuk
Synonym: *Arenga saccharifera* Labill.

Description: palm up to 20 m tall, with the trunk remaining covered by the rough old leaf bases. The leaves are 6– 12 m long and 1.5 m broad, pinnate, with the pinnae in 1–6 rows, 40–70 cm long and 5 cm broad. The fruit is subglobose, 7 cm diam., green maturing black.

This species is an economically important palm native to tropical Asia. The sap is harvested for *tuak*, immature fruits are consumed after they are boiled in sugar syrup. Young shoots are cooked and eaten as vegetables, leaves are used to make baskets and roof materials.



Barclaya motleyii

Family: : Nymphaeaceae
Scientific name: *Barclaya motleyi* Hook. f.
Local name: Kelekatai,

Description: Submerged aquatic herb. Leaf-blades 3 - 9 x 3 - 8 cm, broadly ovate, apex round, base cordate, subcoriaceous when dry, finely punctate above and coarser on midrib, greyish tomentose and brownish yellow tomentose on midrib and veins below; margin undulate. Flowers 1.5 - 5 cm long, pinky and orangish- yellow, emerging above the water.

This species is widely distributed in Southeast Asia (incl. Sumatra, Southern Thailand, Peninsular Malaysia, and Borneo) and New Guinea.

Benstonea affinis

Family: Pandanaceae
Scientific name: *Benstonea affinis* (Kurz) Callm. & Buerki.
Local name: Mengkuang bunga, Pandan ikan, Mengkuang perah
Synonym: P*andanus aurantiacus* Ridl.; *Pandanus affinis* Kurz

Description: Erect pandan, branching shrub or small tree, up to 5 m tall with slender stems and prop roots. Leaves are spirally arranged, up to 1 m long, with spines along the edges and upper surface. The species is dioecious, producing either male or female flowers on different individuals.

Habitat: Lowland (swamp forest and riverine) and shoreline (incl. mangrove).

Distribution: Widespread in Southeast Asia (Vietnam, Singapore, Indonesia, Brunei, Malaysia and the Philippines).

Bromheadia finlaysoniana

Family: : Orchidaceae
Scientific name: *Bromheadia finlaysoniana* (Lindl.) Miq.
Local name: Pale reed orchid
Synonym: *Bromheadia palustris* Lindl.; *Bromheadia pulchra* Schltr.

Description: This species is a terrestrial orchid, evergreen with flattened yellowish stems, and stiffly spreading elliptic leaves. Inflorescence terminal, zig- zag with many flowers (up to 20 flowers) that open one at a time in succession. Flowers are large and showy, whitish and pinkish on the outside, labellum yellow with purplish on the margin.

Habitat: It grows in wet areas, usually near streams, at 0–200 meters altitude.

Distribution: This species is native to areas from Indo-China to northern Australia (incl. Myanmar, Thailand, Cambodia, Laos, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, the Moluccas, New Guinea, the Cape York Peninsula in Queensland, the Anambas Islands and possibly the Philippines)

Notes: The flower buds are harvested by the locals and cooked as a vegetable

Bulbophyllum gracillimum

Family: Orchidaceae
Scientific name: *Bulbophyllum gracillimum* (Rolfe) Rolfe
Local name: Wispy umbrella orchid
Synonym: *Cirrhopetalum gracillimum* Rolfe

Description: an epiphytic orchid that has a creeping rhizome with olive green pseudobulbs 10–18 mm long and 10–15 mm wide, well-spaced along it. Each pseudobulb has a single thick, leathery, olive green, oblong to narrow egg-shaped leaf 50–80 mm long and 30–35 mm wide on its end. Between six and ten flowers are arranged in a spreading, semi-circular umbel 150–250 mm long. The flowers are purplish red, resupinate, 30–50 mm long and 5–8 mm wide.

Habitat: It grows in wet areas, usually near streams, up to 400 m altitude.

Bulbophyllum lasianthum

Family: Orchidaceae
Scientific name: *Bulbophyllum lasianthum* Lindl.
Local name: Shaggy orchid
Synonym: A*nisopetalon lasianthum* Kuhl ex Hook. f.; *Phyllorkis lasiantha* (Lindl.) Kuntze

Description: Plants are slightly flattened, cylindrical pseudobulbs carrying a single, apical, elliptical, bluntly pointed, conduplicate below leaf, stout, 10 to 44 cm long, basally enveloped by numerous acuminate sheaths, inflorescence up to 40 cm long, produce many flowers (up to 15 flowers). Flowers each measured about 1 cm across, carrying foul-smelling, and not opening well.

Habitat: Epiphytic on trees or lithophytic on rock, in wet areas, usually near streams, from lowland forests (incl. swamp forests) to sub-montane, at elevations up to 1200 m from sea level.

Distribution: Peninsular Malaysia. Sumatera, Sulawesi, and Borneo.

Bulbophyllum macranthum

Family: Orchidaceae
Scientific name: *Bulbophyllum macranthum* Lindl.
Local name: Orkid
Synonym: *Sarcopodium macranthum* (Lindl.) Lindl. & Paxton; *S. purpureum* Rchb. f.; *Bulbophyllum purpureum* Náves; *Phyllorkis macrantha* (Lindl.) Kuntze; *B. cochinchinense* Gagnep.; *Carparomorchis macrantha* (Lindl.) M.A. Clem. & D.L. Jones

Description: Epiphyte with a stout hairy rhizome with well-spaced ovate-elliptic unifoliate pseudobulbs and a single oblong fleshy petiolate leaf. Solitary non- resupinate flower on a long stalk (c. 5 cm long or more), fragrant flower.

Habitat: Grows in a very wide range of habitats, in primary and secondary, forests, from lowland altitudes up to 1500 meters.

Distribution: A widely distributed species, can be found in India, Indo-China, and throughout southeast Asia.

Bulbophyllum medusae

Family: Orchidaceae
Scientific name: *Bulbophyllum medusae* Lindl.
Local name: Orkid medusa
Synonym: *Cirrhopetalum medusae* Lindl.; *Phyllorkis medusae* (Lindl.) Kuntze

Description: This species is an epiphytic orchid with a creeping rhizome with a single leaf (up to 10 cm long) emerging from the top of each of the pseudobulbs. Inflorescence head with more than 15 flowers, and flowers are arranged in clusters. The flowers have thread-like lateral sepals about 120 mm long, giving each cluster the appearance of Medusa. The flowers have an unpleasant smell.

Habitat: Lowland forest (incl. swamp forests, secondary forests, mangroves, and riverine.

Distribution: This species is native to Thailand, Peninsular Malaysia, Sumatra, Borneo, and the Lesser Sunda Islands.

Bulbophyllum vaginatum

Family: Orchidaceae
Scientific name: *Bulbophyllum vaginatum* (Lindl.) Rchb. f. Local name: Orkid
Synonym: *Cirrhopetalum vaginatum* Lindl.; *Phyllorkis vaginata* (Lindl.) *Kuntze; Bulbophyllum whiteanum* (Rolfe) J.J.Sm.

Description: An epiphytic orchid, with a creeping and freely branching sympodial growth habit. Rhizome bears pseudobulbs, each with one shortly- stalked leaf. The leaves are borne as one leaf per pseudobulb which are spaced 3 to 5 cm apart; shortly-stalked, leaves are oblong, 2.5–12 x 1.2–2.5 cm, thick, with a bilobed leaf tip and obtuse leaf lobes. The yellow flowers are borne on umbels which originate from the base of the pseudobulbs. Each flower cluster consists of up to 18 flowers.

Habitat: Epiphyte (primary rainforest, secondary forests, freshwater swamp forest, riverine)

Distribution: This species is native to Thailand, Peninsular Malaysia, Singapore, Borneo, Java and Maluku.

Calamus fissus

Family: Arecaceae
Scientific name: *Calamus fissus* (Blume) Miq.
Local name: Rotan
Synonym: *Daemonorops fissa* Blume

Description: Clustering moderate to robust rattan climbing to 30 m, frequently producing thickets. Stem densely armed with shiny flattened black spines (10 - 20 mm long), solitary or grouped, brown indumentum abundant between the spines.

Habitat: Widespread throughout Sarawak, particularly frequent in the secondary forests on alluvial sites, or wet swampy areas, found in lowland up to hill at 800 m altitude.

Notes: This species produces a coarse medium-sized cane.

Calamus maculatus

Family: Arecaceae
Scientific name: *Calamus maculatus* (J. Dransf.) W.J. Baker.
Local name: Rotan, Spotted rattan, Spotted cane
Synonym: *Daemonorops maculata* J. Dransf.

Description: Slender to moderate solitary rattan with stems rarely longer than 5 m long. Sheaths bright green when fresh, bearing scattered, straight black spines (c. 15 mm long) with yellowish bases and abundant deciduous scales. Leaf rachis sparsely armed, bright green, conspicuously blotched with yellow.

Habitat: This species is confined to the lowland forests (incl. swamp areas) and kerangas.

Notes: The fruits are harvested (produce rich dragon's blood). Endemic to Sarawak.

Caryota mitis

Family: Arecaceae
Scientific name: Caryota mitis Lour.
Local name: Dudur, Rabok, Apeng

Description: A clustered palm with 2–5 stems and easily distinguishable from the fish-tail appearance of leaflets. Stem straight, 3–5 m tall with elongated internodes. The sheath is triangular, disintegrating into black fibres. Leaflets are numerous, like a fish-tail in shape. The inflorescence is axillary, on large stalks hanging downward in a large heavy bunch of spikes, with yellow flowers. Fruits a globose drupe, c. 1.5 cm across, green turning reddish-black when ripe.

Ecology: This species is characteristic of secondary forests and peat swamp forests. Regularly found on the river bank or streams.

Conamomum xanthophlebium

Family: Zingiberaceae
Scientific name:
Conamomum xanthophlebium (Baker) Skornick & A.D. Poulsen
Local name: Firebird ginger, Tepus, Teben
Synonym: *Amomum xanthophlebium* Baker; *Amomum stenoglossum* Baker

Description: This species usually forms a clump of leafy stems (up to 20 plants per clump), about 1.5 - 2.5 m tall (sometimes more than 3 m tall, especially in kerangas forest), and the inflorescences are round at the base of the plant, have large red bracts with a cream yellow flower, reddish veins on creamy yellow labellum. Anther crest shaped like two horns.

Habitat: Lowland forest (incl. swamp forests, secondary forests, mangroves, and riverine.

Distribution: This species is native to Peninsular Malaysia, Sumatra, and Borneo.

Notes: The flowers are eaten, as an ingredient of curries, and fruits are eaten raw. The species epithet name means yellow-veined.

Cryptocoryne cordata var. zonata

Family: Araceae
Scientific name: *Cryptocoryne cordata* Griff. var. *zonata*
Local name: Kelakatai, Trompet air

Description: A submerged herb, with rather flat-looking leaves. Leaves c. 8 – 12 x 3 – 5 cm, broadly elliptic, base obtuse, apex acute, dark green above and reddish-brown beneath. Inflorescence c. 15 cm long. Flowers c. 5 cm long, purple but sometimes yellow under shade, funnel-shaped with wide-mouth, usually purple to brown inside.

Ecology: Shady places in clear and slightly acidic water of peat swamp forests.

Distribution: Peninsular Malaysia, Sumatra, Riau and Borneo.

Notes: Almost all the Cryptocoryne species are sensitive to disturbances (pH, turbidity, BoD, etc), therefore, they are often used as plant species environment indicator (PSEI).

Cryptocoryne fusca

Family: Araceae
Scientific name: *Cryptocoryne fusca*
Local name: Kelakatai, Trompet air
Synonym: *Cryptocoryne johorensis* Engler

Description: A submerged herb in slow- moving streams and rivers. It has a rosette-like growth form, about 10-20 cm in height, with elliptic and pointed leaves.

Distribution: Borneo, Sumatra, Peninsular Malaysia (Johor and Pahang).

Notes: The epithet name means “with the long tail” referring to the long appendage at the top of the limb of the spathe. This species was described by Adolf Engler in 1879 based on a specimen collected by Odoardo Beccari in Sarawak.

Cryptocoryne longicauda

Family: Araceae
Scientific name: *Cryptocoryne longicauda* Engler
Local name: Kelakatai, Trompet air
Synonym: *Cryptocoryne johorensis* Engler

Description: A submerged herb in slow- moving streams and rivers. It has a rosette-like growth form, about 10-20 cm in height, with elliptic and pointed leaves.

Ecology: Shady places in clear and slightly acidic water of peat swamp forests.

Distribution: Borneo, Sumatra, Peninsular Malaysia (Johor and Pahang).

Notes: The epithet name means "with the long tail" referring to the long appendage at the top of the limb of the spathe. This species was described by Adolf Engler in 1879 based on a specimen collected by Odoardo Beccari in Sarawak.

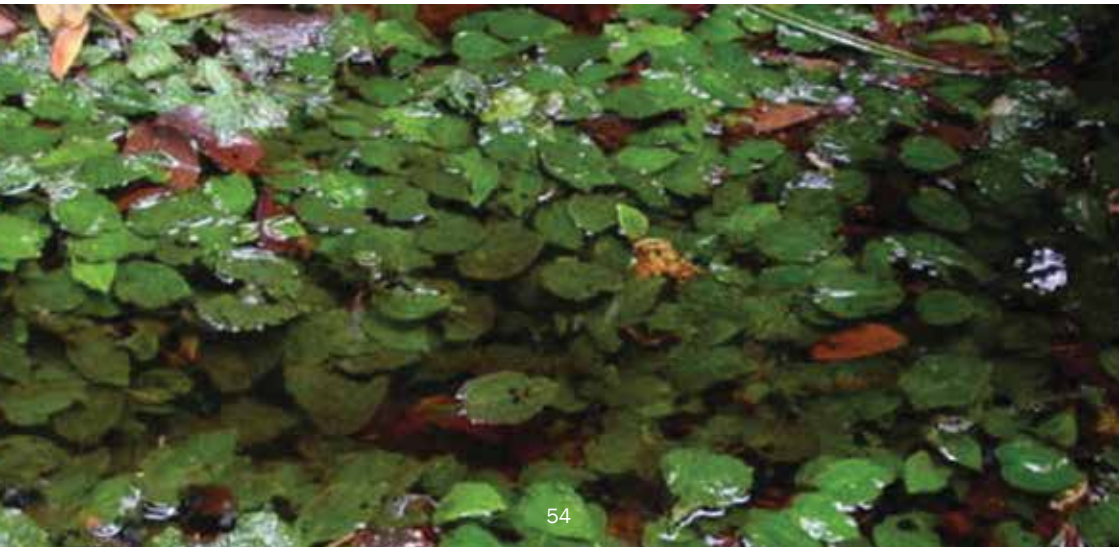
Cryptocoryne pallidinervia

Family: Araceae
Scientific name: *Cryptocoryne pallidinervia* Engler
Local name: Kelakatai, Trompet air, Timun amun
Synonym: *Cryptocoryne venemae* de Wit

Description: A submerged herb in slow-moving streams and rivers. It has a rosette-like growth form, with long, narrow, pointed leaves that are green in color. The flower is pale yellow-green spathe with a white limb. Sometimes the spathe-leave is not closed to form a tube. The leaves are cordate, more or less bullate. The spathe has a long tube and the limb is red with protuberances. Its collar zone is yellowish with small red spots that become smaller towards the throat. The spadix has male and female flowers with very short naked parts of the spadix, situated adjacent to each other. The kettle is black-purple inside. The seeds are small, ovoid-shaped, dark brown.

Ecology and Distribution: this species grows in the peat swamp forests of Sarawak and West Kalimantan (Indonesia), under extremely acid conditions (pH 4 or lower), in slow-moving streams and rivers. According to Anderson (1963), this species is very common in the peat swamp forests of Sarawak. Endemic to Borneo (Sarawak and Kalimantan).

Notes: The plants are sometimes harvested and eaten raw, as “ulam”



Cyrtosperma merkusii

Family: Araceae
Scientific name: *Cyrtosperma merkusii* (Hassk.) Schott
Local name: Keladi pari

Description: Medium-sized herb up to 2 m tall. Stem stout c. 10–15 cm or longer, covered with thorns. Petiole to c. 1 m long, thorny, mottled purplish at base. Leaf blade large, triangular in shape, margin entire, apex pointed with long cauda, base hastate, midrib thorny beneath. Inflorescence stalk to c. 70 cm long, fleshy and thorny; spathe 15–30 cm long, ovate-elliptic with caudate apex, striated brownish-purple outside, pale green or creamy-pink inside; spadix c. 15 cm long, pink, with closely arranged flowers. Fruits green with purple tips.

Ecology: open or shady swampy places in the lowlands.

Dendrobium crumenatum

Family: Orchidaceae
Scientific Name: *Dendrobium crumenatum* Sw.
Local Name: Pigeon orchid; Anggerik merpati, Tepasik; Daun sepulah tulang; Sepuleh rumah; Anggerik bawang Selected
synonym: Onychium crumenatum (Sw.) Blume; *Dendrobium papilioniferum* J.J.Sm.; *Ceraia saaronica* (J.Koenig) M.A.Clem. & D.L.Jones

Description: This species is commonly called pigeon orchid, is an epiphytic orchid, and is a widespread species within South and Southeast Asia, recorded in Taiwan, Cambodia, the Andaman and Nicobar Islands (India), Indonesia, Laos, Malaysia, Myanmar, Sri Lanka, Thailand, Vietnam, the Philippines. It has two rows of leaves along its pseudobulb. Inflorescences arising from the distal leafless part of the stem, usually solitary; floral bracts elliptic, ca. 6 × 2.5 mm. Pedicel and ovary pale red, ca. 15 mm. Flowers are large and showy, pure white with a yellow band on the central part of the labellum, and flowers only last for 1 day.

Notes: The Pigeon orchid is one of the most common species in Sarawak. It usually grows in exposed locations, often in lowland rainforest or coastal scrub; on the branches or tree trunks of ornamental plants by the roadsides. More than 20 names have been registered as synonyms for this species.

Dendrobium secundum

Family: Orchidaceae
Scientific Name: *Dendrobium secundum* (Blume) Lindl.
Local Name: Toothbrush orchid; Anggerik semut.
Synonyms: *Pedilonum secundum Blume; Dendrobium bursigerum* Lindl.; D. heterostigma Rchb. f.; *Callista bursigera* (Lindl.) Kuntze; C. *secunda* (Blume) *Kuntze; Pedilonum bursigerum* (Lindl.) Rauschert

Description: A sympodial, epiphytic orchid. Stems are upright but turn pendulous as they age. Flowers are waxy, borne on an inflorescence that grows at the apex or old, leafless stems and is arranged, facing a single direction, and is usually purple or pink in colour.

Distribution: This species is native to Myanmar, Laos, Thailand, Vietnam, Cambodia, Malaysia, Singapore, Sumatra, Java, Borneo, Sulawesi and Philippines. This species can be found in many habitats; from coastal areas, swamp forests, limestone, hill, and submontane forests, at elevations from 15 m to 700 m above sea level.

Notes: This species is often used as an ornamental plant in gardens and indoor decoration plants. It has a long flowering period and is known for its fragrant flowers. It is also used as a source of food and medicine in some cultures. Although there many variants are reported, only two varieties are recognized; var *alba* and *secundum.*