The Heart of Borneo Series 11:

A Pictorial Guide to the Mangrove Flora of Sarawak

A Pictorial Guide to the

MANGROVE FLORA OF SARAWAK

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FOREWORD

Datu Haji Hamden bin Haji Mohammad
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Mangrove forests are incredibly important ecosystems that are found at the interface between marine and terrestrial ecosystems. Home to an incredible array of species, it hosts a rich diversity of flora and fauna.

Realising the importance of mangrove ecosystems for economic and environmental benefits, the Forest Department Sarawak has gazetted 11,084 hectares of mangrove forest under Permanent Forest Estates (PFEs) throughout Sarawak.

This publication aims to serve as a user-friendly and practical guidebook for individuals engaged in the field management of mangroves, as well as for students and the general public who are fascinated by mangrove plants. By offering photographs and concise descriptions of each species, we aim to assist readers in identifying various mangrove species. It is our aspiration that this book will not only introduce readers to the captivating beauty of mangrove flora but also foster a deeper appreciation for the invaluable resources offered by mangrove ecosystems.

DATU HAJI HAMDEN BIN HAJI MOHAMMAD

PREFACE

The Research and Development Division (RDD) of the Forest Department Sarawak plays a pivotal role in conducting forest research such as, generating knowledge for conservation and sustainable management, documentation of flora and fauna, and the dissemination of information pertaining to forest research.

Over the years, RDD has undertaken extensive research across various regions of Sarawak, encompassing a diverse range of forest types, including Mangrove Forests. Mangroves harbour a remarkable diversity of flora and fauna, showcasing unique and extraordinary adaptations to thrive in the challenging coastal and muddy environments. As we deepen our understanding and appreciation of this exceptional ecosystem, we enhance its resilience and longevity.

This book serves as an initiative to share the beauty of mangrove flora with others, shedding light on their remarkable adaptations and ecological significance. Through education and awareness, we aim to foster greater recognition of the value inherent in mangrove ecosystems.

RUNI SYLVESTER PUNGGA
Senior Assistant Director
Research and Development Division

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INTRODUCTION

Mangrove Forests

The mangrove ecosystem is a unique type of forest characterized by its highly specialized vegetation and limiting environment. Mangrove forests grow at the interface between land and sea in tropical and subtropical latitudes. Therefore, mangrove ecosystems harbour a rich diversity of both terrestrial and aquatic flora and fauna. Asia has the largest mangrove areas and are exceptional for their high biodiversity with more than 50 species of plants recorded. Malaysia alone has recorded 41 species of mangrove plants (FAO, 2007 and Shah *et al.*, 2015).

Mangrove plants are typically classified into two groups: true mangrove species and mangrove associated species. True mangrove species predominantly inhabit mangrove environments and typically do not extend into terrestrial plant communities and are morphologically, physiologically and reproductively adapted to saline, waterlogged and anaerobic conditions (Shin *et al.*, 2015).

Meanwhile, mangrove associated species are mainly found at the landward edge of mangrove ecosystems, along riverbanks or in beach forests. However, they do not possess all the highly specific adaptations developed in true mangrove species (FAO, 2007).

The mangrove ecosystem offers a multitude of ecological services, which makes it one of the most important ecosystems. Its existence mitigates coastal erosion and flooding, facilitates nutrient supply and regeneration, regulates solutes discharged into the sea, stores water, and effectively traps sediments and carbon.

Highlighting the significance of wetlands to inhabitants, mangroves offer crucial protection and breeding grounds for fishes and other aquatic organisms, while also serving as habitats for numerous flora and fauna. Moreover, the goods and services derived from mangrove forests are invaluable to humankind, including a source of timber for construction, firewood, charcoal, food, and various other necessities.

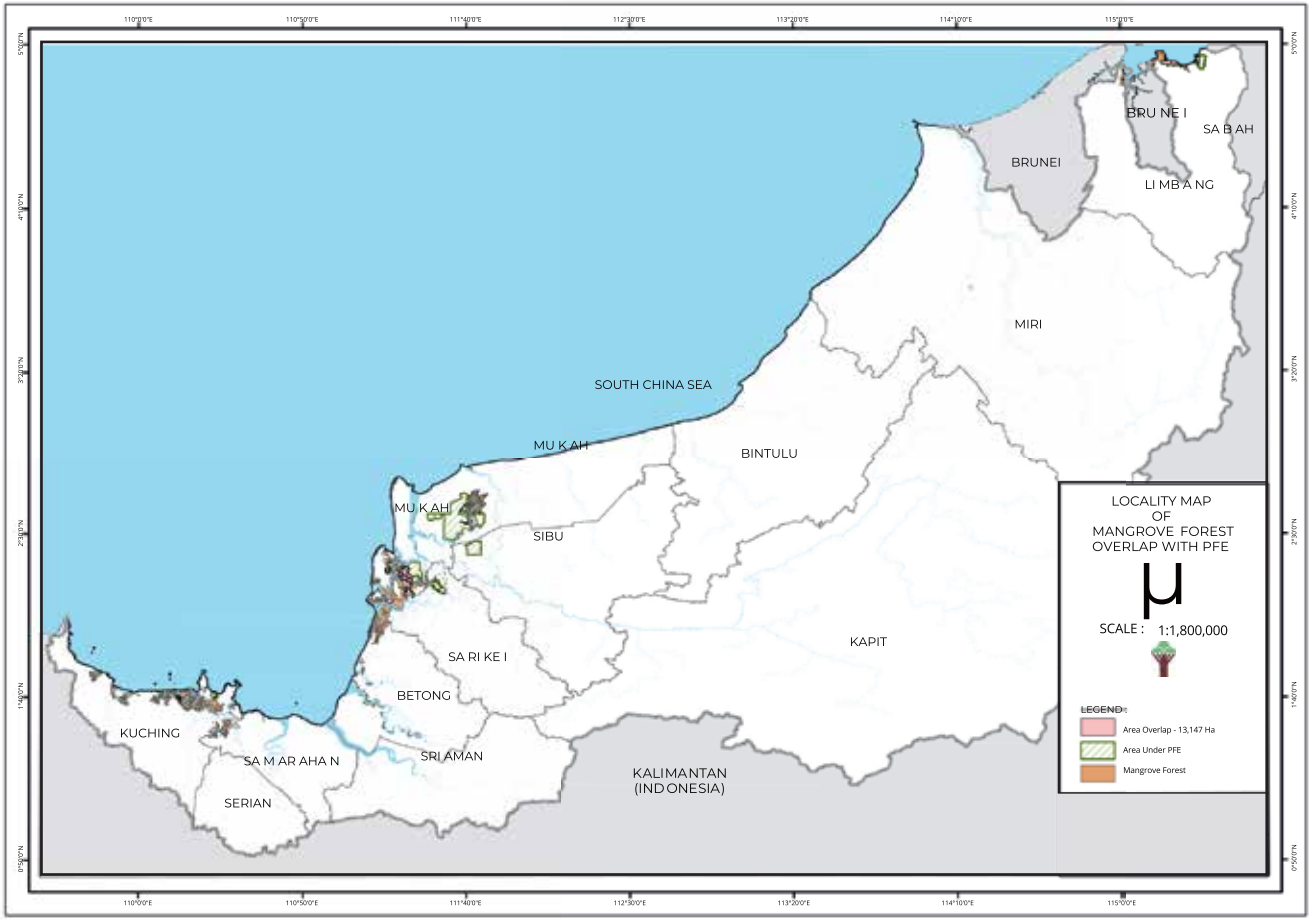
Challenges and losses facing mangroves persist as a significant concern. Nonetheless, there is a growing recognition of the importance of mangrove ecosystems, leading to various afforestation and rehabilitation initiatives, particularly aimed at protection and conservation. Several Asian nations have designated mangrove areas as Ramsar sites or established them as National Parks, Reserve Forests, Protected Forests, and Wildlife Sanctuaries, underscoring the commitment to their preservation and safeguarding.

A dense *Rhizophora mucronata* stands.

Sarawak Mangroves

Mangrove in Sarawak encompass approximately 126,400 hectares, constituting 26% of the total mangrove coverage in Malaysia, making it the second largest area in the country. Remarkably, it is considered one of the least affected areas, as stated by Latiff and Faridah-Hanum (2014) and Shah et al. (2015). The primary habitats are situated in the Kuching Division, Sarikei Division within the Rejang Delta, and Limbang Division (Chai, 2009). Among the most commonly recorded plant species are *Rhizophora* spp., *Sonneratia* spp. and *Avicennia* spp.

Mangroves are renowned for their valuable resources for both economic and non-economic reasons such as forestry, fisheries, wildlife conservation, eco-tourism, and physical environment protection. Realizing the importance of these functions, and mindful of potential over exploitation and threats to mangrove ecosystems, Forest Department Sarawak (FDS) is dedicated to their conservation. A total of 11, 084 hectares of mangrove areas are conserved under the gazettement of Permanent Forest Estates (PFEs) (FDS, 2022). The gazettement serves not only for timber production, but also for conservation, research, recreation opportunities and other ecosystem services. Additionally, FDS has initiated rehabilitation efforts in abandoned coastal lands through replanting of mangrove species, aiming to restore the ecological balance of the ecosystem to a favorable state.



Mangrove areas conserved under Permanent Forest Estates (PFEs) in Sarawak

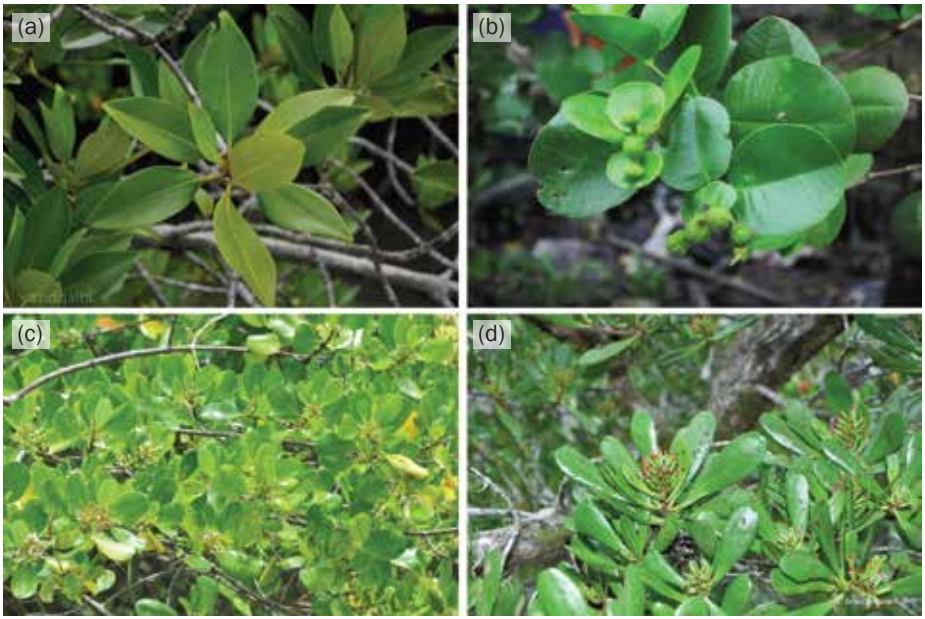
Mangrove forest at Sg. Daun, Santubong

General Characteristics of Mangrove Flora

The term ‘mangrove’ is commonly used to identify trees and shrubs species that have developed morphological adaptations to the tidal environment such as the form of aerial roots, salt excretion glands and vivipary of seeds.

01 Succulent leaves

Think voluminous sleeves and bold prints. This fashion trends gears towards more drama than usual everyday dresses.



(a) Leaves of *Rhizophora mucronata* (Bakau kurap); (b) S*onneratia ovata* (Rogam); (c) *Scyphiphora hydrophyllaceae* (Landing); (d) *Lumnitzera littorea* (Teruntum merah).

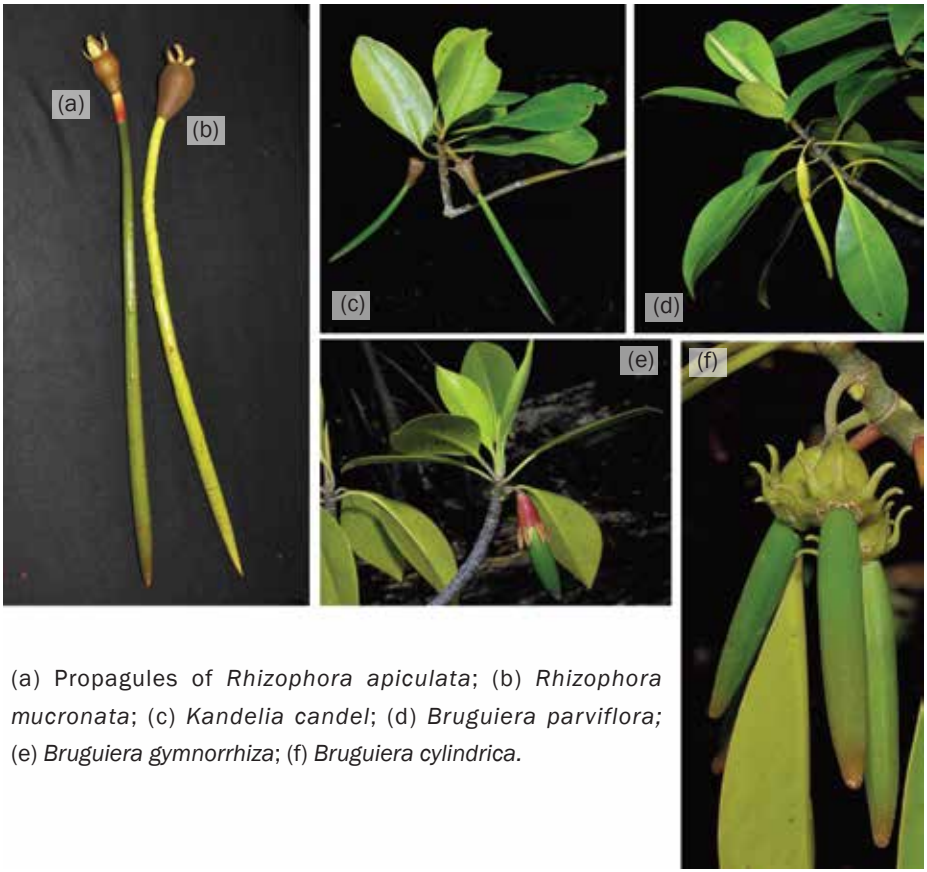
02 Roots for respiration and anchorage

The rooting adaptation of mangroves include stilt roots, various types of pneumatophores, and aerial roots. All these form of roots enabling the plant to absorb sufficient oxygen, providing mechanical support and aiding it in obtaining nutrition.

(a) Pencil-like pneumatophores of *Avicennia alba*; (b) cone-shaped pneumatophores of *Sonneratia alba*; (c) cone-shaped pneumatophores of *Xylocarpus moluccencis*; (d) spreading ribbon-like buttresses of *Xylocarpus granatum*; (e) knee roots of *Bruguiera parviflora*; (f) stilt roots of *Rhizophora mucronata*; (g) aerial roots of *Avicennia officinalis*.

03 Propagules for germination

Many of the mangrove plants show vivipary, that is the fruits germinate while still attached to the plant. Once mature, it will drop into the water. Propagules can survive desiccation and remain dormant for over a year before arriving in a suitable environment.



(a) Propagules of *Rhizophora apiculata*; (b) *Rhizophora mucronata*; (c) *Kandelia candel*; (d) *Bruguiera parviflora;* (e) *Bruguiera gymnorrhiza*; (f) *Bruguiera cylindrica.*

Pure stands of Nypa fruticans (Nipah).

Mangrove Flora

Trees & Shrubs

Aegiceras corniculatum (L.) Blanco

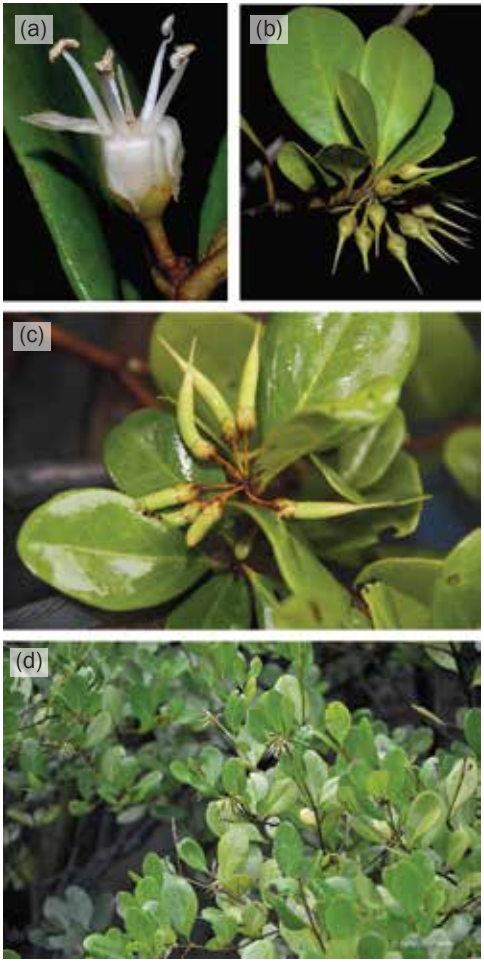
Primulaceae

Sekang mata, Tungkat mata

Aegiceras corniculatum is a mangrove species commonly found along the landward margin of mangroves that are inundated by high tides, and fringes of seasonally brackish waterways. The flower are fragrant.

Botanical features

A shrub or small tree up to 6m tall, with roots sprawling along the soil surface. The leaves are spirally arranged and leathery, often with slightly red midribs below and whitish salt-excretion glands that are covered with salt on the leaf surfaces and stalks. The flowers are in clusters, umbrella-shaped, sweetscented and white. The fruit is strongly curved and pointed, and bears a single seed.



(a) The flower; (b) The flower buds;
(c) The fruits; (d) The leafy twigs

The habit of *Aegiceras corniculatum*

Avicennia alba Blume

Acanthaceae

Api-api hitam

Avicennia alba is a mangrove tree species and grow as a shrub or small tree. It is a pioneer species of mangrove swamps on sheltered shores, also in the more saline parts, along tidal riverbanks and along the seashores.

Botanical features

A shrub or tree, grow up to 10m tall, has a complex system of horizontal roots and pneumatophores. The tree produces a low, dense bushy crown, often branching near the base of the trunk. The thin-hard outer bark is grey or brown, warty or smooth, finely fissured. The leaves are opposite, 15cm long by 5cm wide, oblong or lanceolate with pointed tips and silvery grey lower surfaces. The upper leaf surfaces are covered with numerous sunken, glandular dots. The flowers are orange with a diameter of 3-4mm when expanded. The fruit is greyish green and conical shape and extends into a beak, up to 4cm long.

(a) Silvery grey lower leaves; (b) The fruits; (c) The inflorescence; (d) The pencil-like pneumatophores.

The habit of *Avicennia alba*

Avicennia marina (Forssk.) Vierh.

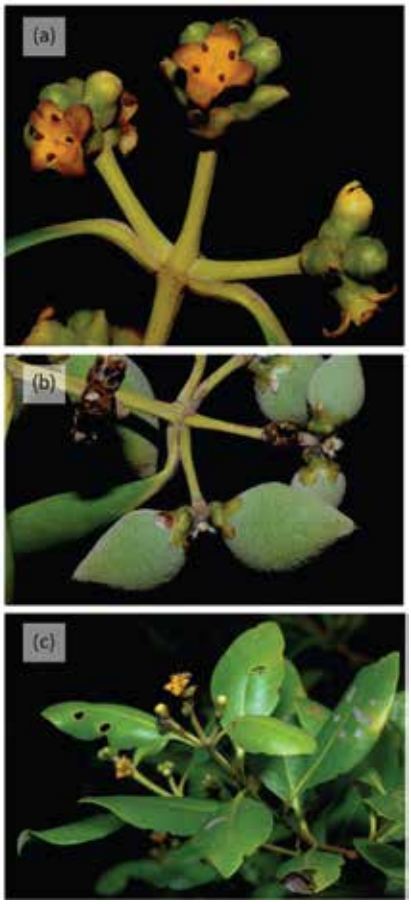
Acanthaceae

Api-api merah

Avicennia marina is a mangrove tree species and grow as a small to medium sized tree. It is a pioneer mangrove species and among the first to colonize open tidal habitats.

Botanical features

A small to medium sized tree with an open branched, rounded crown, usually growing up to 10m tall. The bark is smooth and pale yellowish green. The leaves are opposite, thick and leathery, shiny olive green above with dense grey hairs beneath. Leaf margin entire with narrow base and short petiole, 5mm long. Flower creamy yellow, small, in dense round heads in leaf axils or terminally, on short and square stalks with sweet scented. Fruit green, oval, two-valved capsule 20-25mm diameter. The seed developing on the tree, fruit usually splitting after falling and then dispersed by water. Extensive underground root system (pneumatophores) up to 90mm long, sticking up out of the mud.



(a) The inflorescence; (b) The fruits;
(c) The flowers on leafy twigs

The habit of *Avicennia marina*

Avicennia officinalis L.

Acanthaceae

Api-api sudu

Avicennia officinalis is a mangrove tree species and grow as a small to medium-sized tree. This species is the only species that produces stilt roots in the genus. It is found sporadically on the banks of the rivers that flooded at high tide and is rarely found near the sea.

Botanical features

A tree, usually up to 12m tall with stilt roots. The young tree produces a low, dense bushy crown. While mature tree forms a columnar tree up to 15m and may grow up to 30m tall. The bark is yellowish green to brownish grey, smooth, sometimes covered with lenticels and is slightly fissured. The leaves are opposite, measuring up to 12.5cm long by 5cm wide, shiny green, spathulate with rounded apices and golden brown lower surfaces. The flower is the largest among the genus, has a diameter of 6-10mm when expanded and is orange- yellow to lemon-yellow. The fruit is green, densely covered with soft brown tomentum, with a short beak at the apex.

(a) The fruits; (b) The inflorescence; (c) The aerial roots and pencil-like pneumatophores.

The habit of *Avicennia officinalis*

Bruguiera cylindrica (L.) Blume

Rhizophoraceae

Berus ngayong, Ngayong, Berus putih

Bruguiera cylindrica is a mangrove species, grows into a tree with knee roots. It is frequently found behind the Avicennia zone, on the seaward side of mangrove, with consolidated blackish brown sandy clay soil.

Botanical features

A tree up to 15m tall. The bark surface is greyish to light glaucous, with small, corky lenticels. The leaves are elliptic and with about 7 veins. The flowers are in groups of three; the petals are white with each lobe bearing 2–3 bristles at the top. The fruit bears reflexed calyx lobe and the hypocotyl is green, cylindrical, frequently curved, and measures 8–10cm long.

(a) The flowers; (b) The propagules; (c) The knee roots

The habit of *Bruguiera cylindrica*

Bruguiera gymnorrhiza (L.) Lam. ex Savigny

Rhizophoraceae

Berus kurong, Berus merah, Kurong

Bruguiera gymnorrhiza is a mangrove species with numerous knee roots. It is considered as the largest mangrove tree found at the inland margins, normally occurring in areas of low salinity, with consolidated sticky mud.

Botanical features

A tree up to 30m tall. The bark surface is grey to brown with large lenticels, deeply fissured and roughly flaky. The leaves are leathery, with black dots and often reddish on the lower surfaces. The flowers appear solitary on a pendulous flower stalk, light to bright red; the calyx lobes are pink to red and the petals bear 2-3 white bristles. The fruit bears ascending calyx lobes; the hypocotyl is staright with ridges, green, tinged red at tip and measures 12–25cm long.

(a) The propagules; (b) The flowers;
(c) The knee roots

The habit of *Bruguiera gymnorrhiza*

Bruguiera parviflora (Roxb.) Wight & Arn. ex Griff.

Rhizophoraceae

Berus lenggadai, Lenggadai

Bruguiera parviflora is a mangrove species with numerous knee roots. It is commonly found mixed with Rhizophora and occasionally along the margins of mangrove channels.

Botanical features

A small tree up to 5m tall. The bark surface is pale grey mottled or pale brown, smooth with small obscure lenticels. The leaves are elliptic, with black dots on the lower surfaces. The flowers are in clusters of 3–7 (or sometimes 10) with ridged calyx tubes and straight calyx lobes; the yellowish green petals bear three bristles on each lobe and one bristle in the notch exceeds the length of the lobes. The fruit bears ascending calyx lobes and smooth hypocotyl, measures up to 15cm long.

(a) The calyx lobes;
(b) The propagule on leafy twig.

Bruguiera sexangula (Lour.) Poir.

Rhizophoraceae

Berus putut, Putut

Bruguiera sexangula is a mangrove species, tending to be scattered towards the inland margins of mangroves.

Botanical features

A tall tree that reaches up to 30m tall with buttresses and knee roots, occasionally stilt roots. The bark surface is pale gray with conspicuous lenticels. The leaves are leathery, elliptic to narrowly elliptic. The flowers are solitary with distinctly ridged calyx tube and 10-12 lobed calyx that are yellow to yellowish brown or reddish; the petals are white with 1 or 2 bristles on each lobe. The fruit bears ascending calyx lobes and angular hypocotyl, 6-12cm long and about 1.5cm wide.

(a) The propagule;
(b) The calyx lobe;
(c) The standing tree;
(d) The bark.

Casuarina equisetifolia L.

Casuarinaceae

Rhu laut

Casuarina equisetifolia is an evergreen conifer-like angiosperm. It is an associate mangrove tree that occurs in open coastal strand habitats, including sandy beaches, rocky coasts, sand dunes, and estuarine or mangrove habitats. The tree serve as a control to coastal erosion and as a windbreak.

Botanical features

A tree up to 35m tall. The trunk straight, cylindrical, usually branchless for up to 10m. Bark is greyish brown, rough, furrowed and flaking. Branchlets pine-needle like, greyish green, jointed, thin. Leaves reduced to tiny scales, six to eight in whorls, whorls encircle joints of branchlets. Flowers unisexsual, inconspicuous, female in small axillary clusters, male in small terminal spikes. Fruit tiny, oneseeded, winged nutlet (samara), formed in woody, brown cone-like clusters (fruiting heads) with 2cm long and 13mm wide.

(a) The bark; (b) The needlelike branchlets; (c) The cones; (d) The seeds.

Casuarina equisetifolia

Ceriops decandra (Griff.) W.Theob.

Rhizophoraceae

Bakau Lali, Tengar tikus

Ceriops decandra is a mangrove species with pneumatophores. It occurs on the landward side of mangrove, beside stream and prefers sand or mud substrates.

Botanical features

A shrub or small tree up to 5m tall. The bark surface is light glaucous brown, smooth with scanty lenticels. The leaves are elliptic-oblong to obovate. The flowers are in a condensed head with 2-4 flowers, borne in the axils of the upper branches; the petals are white, fringed with many long hairs at the apices. The fruit is ovoid-conical, with erect of ascending calyx lobes and club-shaped hypocotyl that is ridged and 9-15cm long.

(a) The propagules on leafy twigs;
(b) The propagules

Ceriops tagal (Perr.) C.B. Rob

Rhizophoraceae

Tengar samak

Ceriops tagal is a mangrove species that can co-exist with *Ceriops decandra* but is usually more abundant. It forms dense stands on the landward edge of tidal forests and prefers clay substrates.

(a) The propagules on leafy twigs;
(b) The flowers; (c) The bark.

Botanical features

A shrub or small tree, up to 6m tall, with small stilt roots, sometimes developing knee roots. The bark is grey-brown, smooth to flaky or dippled. The leaves are obovateelliptic with inwardly curved margins. The flowers are in pendulous heads of 5-10 flowers, occuring at the ends of new shoots or in the leaf axils on older ones; the calyx lobes are erect; the petals are white. The fruit is ovoid with recurved calyx lobes and club-shaped hypocotyl that is ridged, 15-35cm long. This speciescan be distinguished from *Ceriops decandra* by having recurved calyx lobes (erect or ascending in *Ceriops decandra*); three appendages at the apices of each petals (many long hair or appendages at the petal apices in Ceriops decandra); longer hypocotyls, 15-25cm long (shorter hypocotyls, 9-15cm long in *Ceriops decandra*).

The habit of *Ceriops tagal*

Cynometra cauliflora L.

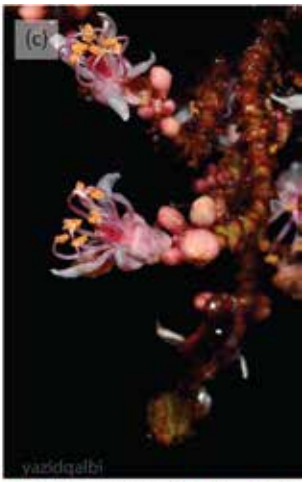
Fabaceae

Nam-nam

Cynometra cauliflora, an associate mangrove species grows well in wet tropical lowlands. The young fruit is very sour but when mature, it can be eaten fresh.

Botanical features

A shrub or small tree up to 10m tall, with dense crown and distinctly zig-zag twigs. Bark smooth. Leaves with a pair of ovate to oblong leaflets, surface glabrous. Inflorescence cauliflorous, pinkish white, 4-5 small racemes crowded together on hard knots on the trunk right down to the ground. Fruits kidney-shaped, fleshy, rugose brownish green, hanging from the trunk. Seeds flattened kidney-shaped, brown.



(a) The trunk with cauliflorous flower; (b) The leaves; (c) The inflorescence; (d) The fruit.

Excoecaria agallocha L.

Euphorbiaceae

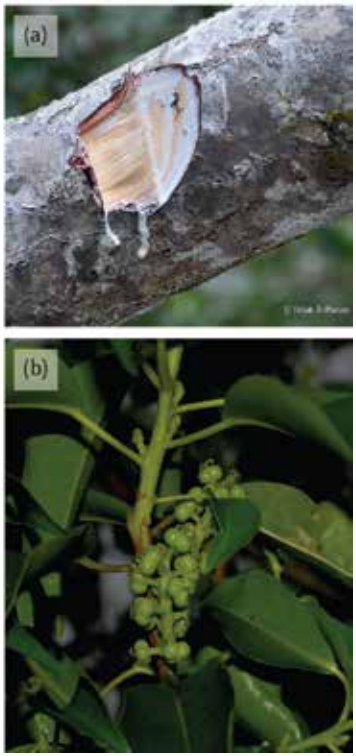
Buta-buta

Excoecaria agallocha is a small deciduous mangrove tree that commonly found in the landward margins of mangrove swamps, occasionally on river banks influenced by tides or along sandy seashores. The white sap causes blistering and blindness to humans (the vernacular name refers to this property).

Botanical features

A small deciduous tree up to 10m tall. The bark is grey, smooth, but somewhat warty. A large quantity of highly irritating white latex is present in the trunk, stems and leaves. The leaves are arranged alternately, measuring 5–10cm long, ovate or elliptic, with entire to shallowly crenulate leaf margins. There are two glands at the base of each leaf. The leaves turn orange to a bright shade of red before they are

shed, and this gives the entire tree a reddish appearance. Trees bear either female or male flower. The 3-lobed fruit is a capsule.



(a) The present of white sap; (b) The 3-lobed fruits; (c) The male flowers.

The habit of *Excoecaria agallocha*

Heritiera littoralis Aiton

Malvaceae

Dungun kelabu, Dungun

Heritiera littoralis is classified as a mangrove associate species. This species is commonly found in the landward margin of mangroves with environment of sandy and rocky coasts.

Botanical features

A medium-sized tree, grow up to 25m tall. The bark is greyish, smooth but becoming fissured of flaky on older trees. The leaves are thin but stiff, slightly heart-shaped at the bases and rounded at the apices, covered with overlapping silvery white scales on the lower surfaces, turning dull orange-yellow when older. The flowers are tiny, bell- shaped, dull purple and clustered at the leaf axils or branch tips. The fruit is boat-like, woody, shiny brown to purplish, with a short flange on one side.

(a) The bark; (b) The leaves; (c) The fruit; (d) The inflorescence; (e) The flowers.

The habit of *Heritiera littoralis*

Kandelia candel (L.) Druce

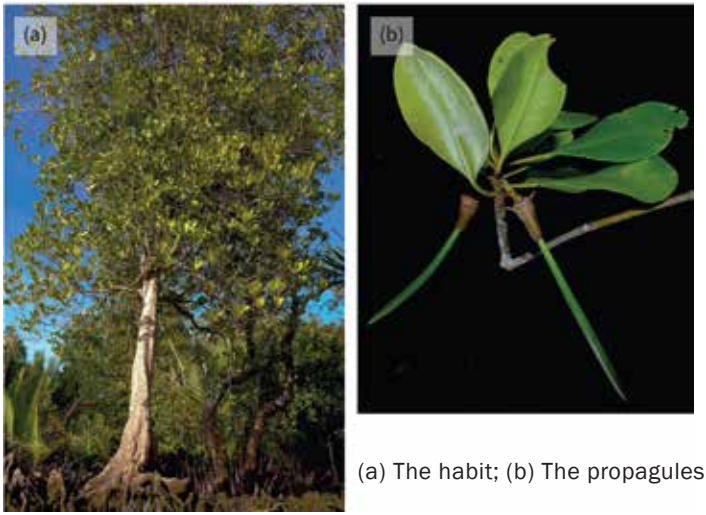
Rhizophoraceae

Bakau aleh-aleh, Aleh-aleh

Kandelia candel is a mangrove species that can be found scattered along the banks of tidal rivers among other mangroves and prefers mud flat.

Botanical features

A shrub of small tree, up to 7m tall with swollen conical base of the trunk. The bark surface dull brown, lenticellate, flaky towards base. The leaves are narrowly oblong elliptic to obovate-oblong with recurved margins. The flowers are in clusters of 4-9 white flowers with linear calyx lobes that are recurved after the flowers have expanded. The fruit is brownish green, ovoid with a long club-shaped hypocotyl that may tinged reddish, 15-40cm long.



(a) The habit; (b) The propagules

Lumnitzera littorea (Jack) Voigt

Combretaceae

Teruntum merah

Lumnitzera littorea is a mangrove species and may grow as a large tree. It can be found along the river bank at landward margin of mangroves, where tidal inundation is rare. This species is listed as protected plant under Wildlife Protection Ordinance, 1998 in Laws of Sarawak.

Botanical features

A medium-sized tree up to 10m tall or more, bole often twisted, with slender, knee-shaped and dark brown pneumatophores. The bark is brown, fissured and flaking. The leaves are simple, succulent, narrowly obovate-elliptic, measuring 2–8cm by 1–2.5cm, clustered at the ends of the twigs, with very short leaf stalks. The flowers are in compact terminal racemes, red, and the stamens are twice as long as the petals. The fruit is green, ellipsoid, somewhat corky, slightly compressed and ribbed.

(a) The bark; (b) Flowering of *L. littorea*; (c) The inflorescence

The habit of *Lumnitzera littorea*

Lumnitzera racemosa Willd.

Combretaceae

Teruntum puteh

Lumnitzera racemosa is a shrub or tree, and a mangrove species. It occurs on the landward fringe of mangrove swamps, usually on sandy portions. A substrate of consolidated mud is preferred. The white, slightly scented and nectar-rich flowers are pollinated by insects.

Botanical features

A shrub or small tree up to 8m tall, with a reddish-brown, longitudinally fissured rough bark, and without pneumatophores. Young branchlets are reddish or grey, sometimes slightly hairy at first, later smooth. Leaves are leathery, narrowly obovate measuring 2-10cm by 1-2.5cm, crowded towards the ends of twigs, and has small notch at the tip of each leaf . The stalkless white flowers occur in clusters, located in the axils, and the stamens are about the same length with petals.

(a) The habit; (b) The leaves; (c) The longitudinally fissured rough bark.

Pluchea indica (L.) Less.

Asteraceae

Beluntas

Pluchea indica is a mangrove associated species. Often found in brackish marshes and other saline habitats including mangroves, occasionally found in forested area at low elevations, preferably in sunny or slightly shaded localities.

(a) The inflorescence; (b) The habit

Botanical features

Erect shrub up to 2m tall. Leaves are obovate with tapering base, alternate, stalkless or shortly- stalked leaves, have membranous leaf blades that are toothed, aromatic when crushed. Its tubular flowers develop in pinkish purple heads, found together in cluster or on branched shoots, at the leaf axils or the end of leafy twigs. Fruits indehiscent, brown, dry, one- seeded, cylindrical, five-ribbed and 1mm long..

Rhizophora apiculata Blume

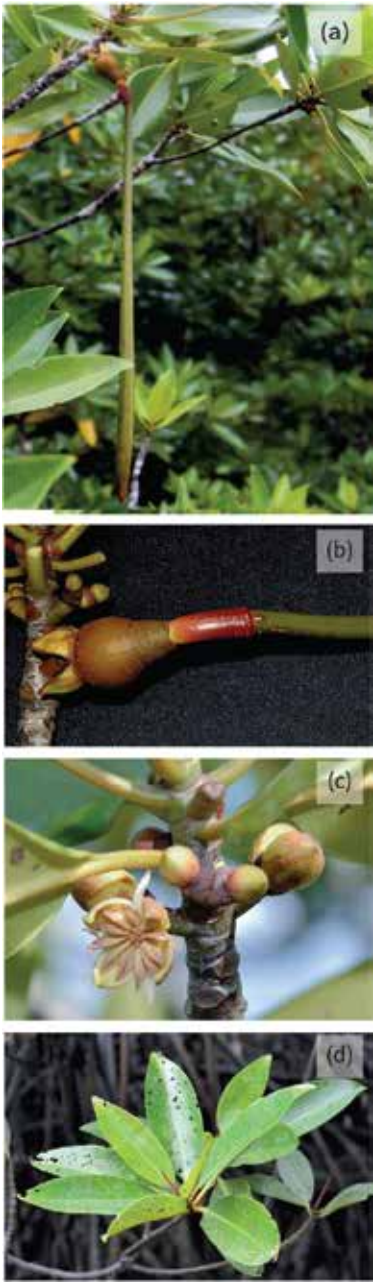
Rhizophoraceae

Bakau minyak

Rhizophora apiculata is a dominant mangrove species, forming pure stands behind riverbanks and prefers deep, soft, muddy soils that are inundated by normal high tides.

Botanical features

A medium-sized tree up to 30m tall. It is readily recognized by its arching stilt roots and sometimes aerial roots from the branches. The bark surface dark brown, slightly fissured. The stipules are usually red. The leaves are leathery and narrowly elliptic with light green zones along the midrib and tinged reddish on the lower surfaces, small black glands present on the undersurface. The flowers occur in pairs, in the axils of leaves and are shorter that the petioles; the petals are yellowish to whitish and very thin and glabrous; stamens sessile, yellowish grey. The fruit is inverted pear-shaped with a long club-shaped hypocotyl that is green with a purple tinge, 18-38cm long. The calyx is brownish yellow to reddish and recurved.



(a) The propagule; (b) The hypocotyl;
(c) The flower and flower buds; (d) The leaves

The habit of *Rhizophora apiculata*

Rhizophora mucronata Poir.

Rhizophoraceae

Bakau kurap

Rhizophora mucronata is a mangrove species that usually occurs in the same localities with *R. apiculata*. The difference is *R. mucronata* prefers more at sandy and firmer substrates. It can be found in small stands or scattered along the lower parts of tidal rivers and is regarded as the most important and widespread mangrove species.

Botanical features

A medium-sized tree, up to 30m tall, with silt and aerial roots. The bark is grey to black, grid-cracked. The leaves are leathery and broadly elliptic to oblong. The flowers are in groups of 2-5, and located within the axils of leaves, longer that the petioles. The calyx is deeply lobed and pale yellow, and the petals are white with densely hairy margins. The fruit is narrowly ovoid, brownish green, with rough and warty hypocotyl, 36-40cm long and up to 2cm wide.

(a) The propagule; (b) The stilt roots; (c) The leaves; (d) The flower and flower buds

The habit of *Rhizophora mucronata*

Scyphiphora hydrophylacea C.F.Gaertn.

Rubiaceae

Landin, Kayu hujan, Sabar bubu laut

Scyphiphora hydrophyllaceae is a mangrove species commonly found on mud, sand and rocky substrates on riverbanks, and inland edges of mangrove.

Botanical features

A bushy shrub or small tree, up to 3m tall. The twigs and leaf stalks are reddish when young. The leaves are fleshy, leathery, obovate, shiny green on the upper surfaces but paler beneath, measuring 4-9cm long and 2-5cm wide with blunt tips. The flowers are whitish pink, fragrant, about 3.5cm wide, in clusters on short stalks. The fruit is a capsule, with 6-8 ridges, green, in tight bunches in the leaf-axils, turning to whitish when mature.

(a) The inflorescence; (b) The infructescence;
(c) The bushy leaves of *S. hydrophyllacea*.

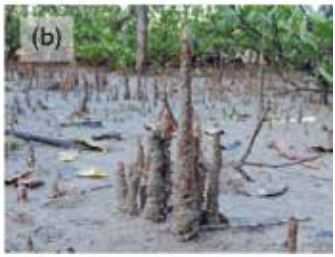
The habit of *Scyphiphora hydrophyllacea*

Sonneratia alba Sm.

Lythraceae

Perepat

Sonneratia alba is a mangrove species commonly found on the seaward side of the mangroves. It is a pioneer species, prefers muddy and sandy soils. The leaves form main source of food for Proboscis monkey (*Nasalis larvatus*). This species is listed as protected plant under Wildlife Protection Ordinance, 1998 in Laws of Sarawak.



(a) Proboscis monkey eat the young leaves of *S. alba;*
(b) The cone-shaped pneumatophores;
(c) The flower and flower bud;
(d) The fruits

Botanical features

A tall tree, up to 20m tall. The bark is cream to light grey, finely fissured. The leaves are thick, leathery, broadly obovate with rounded apices. The flowers are solitary or in a terminal cluster, reddish at the inner part of the petals, with prominent whitish stamens in the central part of the corolla. The fruit is greenish, 3-4cm in diameter and subtended at its base by persistent sepals that are usually reflexed.

The habit of *Sonneratia alba*

Sonneratia alba at hide tide

Sonneratia caseolaris (L.) Engl.

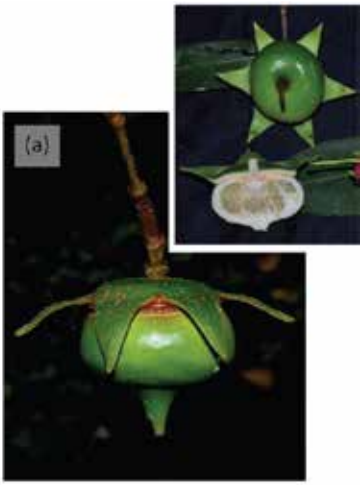
Lythraceae

Pedada

Sonneratia caseolaris is a mangrove species, occurs in less saline parts of mangrove forests on deeply muddy soil, along tidal creeks with slow-moving water. The young fleshy fruit is sour and edible. This species is listed as protected plant under Wildlife Protection Ordinance, 1998 in Laws of Sarawak.

Botanical features

A small tree, up to 15m tall with vertical pneumatophore. Crown rounded, spreading but not dense, and the ends of the branches are droop. The leaves are elliptic. The flowers are borne in terminal clusters, petals are dark red, filaments whitish, bright pink at the bases. The green fleshy fruit occurs on the flattened calyx tube with its nearly horizontally-spreading lobes. It is flattened-round, measuring 3-4cm by 5-7.5cm.



(a) The fruits; (b) The leaves;
(c) The blooming flower

The sour young fleshy fruit of *Sonneratia caseolaris* is edible

The habit of *Sonneratia caseolaris*

Sonneratia ovata Backer

Lythraceae

Pedada rogam

Sonneratia ovata is a mangrove species commonly found on the landward edge of the mangrove swamps, preferring brackish water and muddy soil. The fruits are edible, though they taste very sour.

Botanical features

A small tree up to 5m tall. The leaves are shiny dark green, thick, leathery, broadly ovate, usually not narrow at the base. The flowers large, 10cm in diameter, petals absent, only many long white stamens forming a powder-puff shaped. Stiff cup-shaped calyx with sepals broadly triangular and reddish on the inside. The fruit is greenish, globular, 7.5cm in diameter, leathery with calyx lobes that clasp the fruit.

(a) The flower and flower buds; (b) The fruits

Xylocarpus granatum J. Koenig

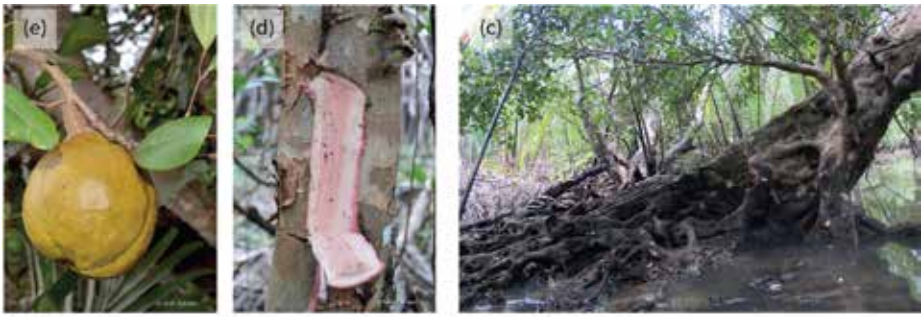
Meliaceae

Nyireh bunga, Nyireh air, Nyireh jambu

Xylocarpus granatum is a mangrove species commonly found along tidal banks, the landward margin of mangroves, and other back mangrove zones that are less saline. It is usually associated with *Nypa* and *Sonneratia.*

Botanical features

A tree up to 20m tall and produces thin, branched, ribbon-like buttresses that spread out from the base. Bark surface yellowish brown, thin and flaking. The leaves are compound, usually containing 1-2 pairs of leaflets and without a terminal leaflets; the leaflets are round to oval with usually rounded apices. The flowers are borne in clusters in the axils of the leaves, creamy white or pinkish. The fruit is big, 12–25cm across, depressed rounded, bright orange and consist of four compartments filled with large, woody tetrahedrally shaped seeds.



(a) The flower; (b) The leaves; (c) The ribbon-like roots;
(d) The outer and inner bark; (e) The fruit

The habit of *Xylocarpus granatum*

Xylocarpus moluccensis (Lam.) M. Roem.

Meliaceae

Nyireh batu, Nyireh peti

Xylocarpus moluccensis is a mangrove species frequently occurs in mangrove swamps, most commonly in brackish water.

Botanical features

A tree up to 20m tall with small buttresses and many pointed, conical- and saucer-shaped pneumatophores. Bark surface pinkish brown, flaky, layered inner bark. The leaves are compound, arranged spirally with typically 2-3 pairs of leaflets. The flowers are borne in clusters in the axils of leaves and the calyx lobes are rounded and white, petals are yellowish. The fruits are broadly ellipsoid, 6–11cm across, brown and bear 5–10 seeds. This species can be distinguished from *X. granatum* by having pneumatophores (absent in *X. granatum*), pointed leaf apices (usually rounded leaf apices in *X. granatum*), and smaller fruit diameter (larger fruit diameter in *X. granatum*).

(a) The stem cross section; (b) The leaves;
(c) The cone- shaped pneumatophores;
(d) The bark; (e) The fruit

The habit of *Xylocarpus moluccensis*

Mangrove Flora

Palms

Nypa fruticans Wurmb

Arecaceae

Nipah

Nypa fruticans is a mangrove species. This palm is usually found naturally in pure stands. The inflorescence produces large quantity of sweet syrup which contained a high concentration of sucrose.

Botanical features

A clump-forming and stemless palm. The leaves are erect or slightly recurved and strongly flanged at the bases. Leaflets 100–120 per leaf, shiny green on the upper surfaces and glaucous on the lower surfaces. The bisexual flower yellow, clusters sprout out from near the top of the stem. The fruiting body is spherical, each individual fruit is brownish, angular, fibrous and contains one egg-shaped seed.

(a) The inflorescence;
(b) The infructescence;
(c) The split fruit, with white fleshy edible kernel of seed;
(d) The fruit

The habit of *Nypa fruticans*

Oncosperma tigillarium (Jack) Ridl.

Arecaceae

Nibong

Oncosperma tigillarium is a spiny palm and a mangrove associated species. This species grows in transitional forest on landward or freshwater swamp forest margins of mangroves.

Botanical features

An erect palm up to 25m tall, very spiny. The leaf stalk is brown-scaly and very thorny. The leaflet blades are slightly grayish covered with dense scales, strongly drooping, pointed and without spines at the margins. The flower clusters are bisexual, located below the leaf- crown, up to 60cm long and branched. The male flowers are thicker and shorter than the female flowers. The fruit is round, with a remnant of the style, dark green and turn to dark purple when matured.

(a) The inflorescence; (b) The sharp needle-like thorns on stem

The habit of *Oncosperma tigillarium*

Mangrove Flora

Herbaceous

Acanthus ebracteatus Vahl

Acanthaceae Neruju,

Jeruju hitam

Acanthus ebracteatus is a mangrove species commonly found in landward edges of mangrove just above the high tide mark, and also occur in inner mangroves as understory herbaceous.

Botanical features

Erect shrubby herb with decumbent and grayish stems, up to 2m tall. *Acanthus ebracteatus* resembles *A. ilicifolius*, but all parts are smaller. Inflorescence terminal, flowers measure 2-3cm usually white, have only one main developing leaflets, as the secondary ones are usually rapidly shed. The leaves are simple, opposite and margin spiny. The fruit shorter than 2cm, green, shiny smooth.

(a) The spines at the leaf node; (b) The inflorescence;
(c) The fruits; (d) The spiny margin of leaves

Acanthus ilicifolius L.

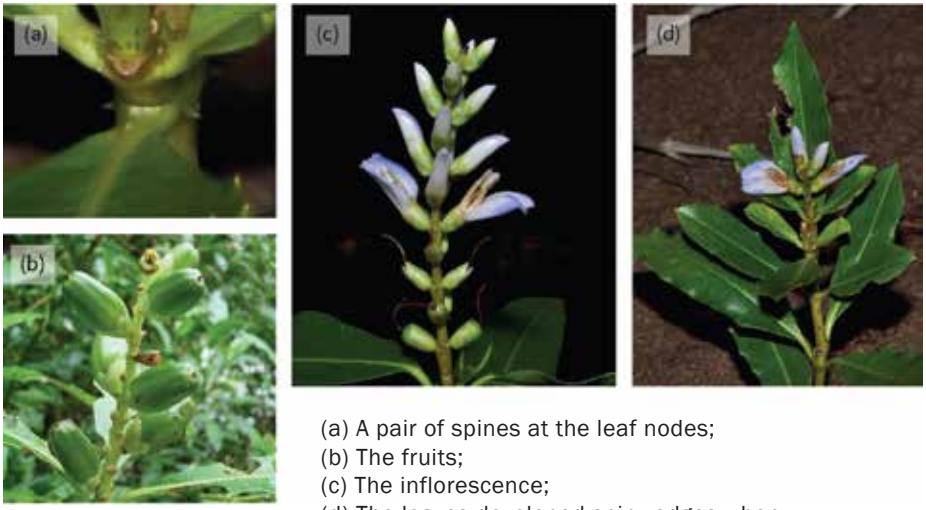
Acanthaceae Neruju,

Jeruju putih

Acanthus ilicifolius is a mangrove species commonly found in or near mangrove area, seldom found further inland. This species is often confused with *A. ebracteatus.* However, when both species occur together, the two species seem distinct in the characters.

Botanical features

A sprawling herb, grow up to2 m tall. Stems are green with speckles, and a pair of spines at the leaf nodes. Shoots are initially erect but tend to lean or sprawl with age. Leaf simple, opposite decussate, smooth, broadly lanceolate, have spiny edges when the plants are growing in an open position but can be totally spineless when growing in the shade. Flowers occur in terminal spikes, usually pale mauve or violet. Flowers have one main enveloping leaflet subtended by two secondary ones and remain attached throughout the life of the plant. Fruits are nut-like with small light-yellow seeds.



(a) A pair of spines at the leaf nodes;
(b) The fruits;
(c) The inflorescence;
(d) The leaves developed spiny edges when growing in open space.

Cryptocoryne ciliata (Roxb.) Schott

Araceae

Keladi payau

Cryptocoryne ciliata is an erect aquatic herb, and a mangrove associated species. This species is widely distributed, and naturally in the tropical regions, from India, Indo-China, throughout southeast Asia, northern Australia to New Guinea. Typically found in brackish swamp and in back mangrove zone (Zone III and IV), often in Nypa association. This species also cultivated as an aquarium decoration plant.

Botanical features

Herb grows up to 60cm tall with short greenish brown rhizomes. Leaves lanceolate, 12-40 x 4-12cm, smooth, glossy above, cordate base and entire margins. The flowers are solitary, with short peduncle (up 5cm long), spadix is curled up and tubular, spathe is spread out and has a frilled margin. Fruits are fleshy, rounded, black (matured), about 3cm in diameter, and breaks open into 6-8 parts.

(a) The spathe limb with whitish tube opening;
(b) The fruits;
(c) The habit

Mangrove Flora

Ferns

Acrostichum aureum L.

Pteridaceae

Piai raya

Acrostichum aureum is the most common ground dwelling fern that found on the inland side of mangroves. This mangrove species does not tolerate as much inundation by sea-water as *A. speciosum*. It prefers in bright and sunny areas.

Botanical features

Herb grows up to 60cm tall with short greenish brown rhizomes. Leaves lanceolate, 12-40 x 4-12cm, smooth, glossy above, cordate base and entire margins. The flowers are solitary, with short peduncle (up 5cm long), spadix is curled up and tubular, spathe is spread out and has a frilled margin. Fruits are fleshy, rounded, black (matured), about 3cm in diameter, and breaks open into 6-8 parts.

(a) The habit;
(b) The leaflets and the sporangia underneath

Acrostichum speciosum Willd.

Pteridaceae

Piai laut

Acrostichum speciosum, the mangrove fern species occurs in part of mangroves that are more frequently inundated by tides. Unlike *A. aureum*, it usually prefers in shaded areas.

Botanical features

Terrestrial fern, forming coarse clumps up to 1.5m tall. The fertile leaflets at the top are rusty, dark brown undersides and uniformly covered with sporangia. The tips of the smaller, sterile leaflets are narrowly pointed. Leaf venation is net-like. Spores are large and tetrahedral in shape.

(a) The leaf venation;
(b) The leaflets and the sporangia underneath;
(c) The habit

Asplenium nidus L.

Aspleniaceae

Paku sarang burung, Sakat-sakat, Langsuyar

Asplenium nidus occurs in shaded and not too dry localities. The nest- shaped rosette of fronds traps dead leaves. This forms a spongy humus, which is effective in holding a lot of water after rains. This ferns are considered as mangrove associated species.

Botanical features

Epiphytic fern with a stout, erect rhizome, bearing a rosette of leaves at the top with large mass of roots. The leaf is simple up to 150cm long, 20cm wide. Veins are straight, slightly at an angle to the midrib. The sori (containing spores) occur on every vein of the top half of the frond. Spores are light brown, transparent when fresh and opaque when old.

(a) The habit;
(b) Brownish sori underside leaf

Platycerium coronarium (Konig) Desv.

Polypodiaceae

Paku tanduk rusa

Platycerium coronarium are commonly found on old trees and also upper branches of tall trees in primary forest, and in many types of lowland forest including mangroves. It is considered as mangrove associated species. The branching fronds resemble the antlers of deer, thus giving rise to the plant's common name '*Tanduk rusa'*.

Botanical features

Large epiphytic fern. There are two types of leaves: sterile nest-leaves and fertile leaves. Sterile nest-leaves are erect when living. New nest-leaves successively produced on the outside to replace old leaves, which die and curl up to grip the leaf litter inside. Fern's roots grow into this mass of decaying leaves for moisture and nutrients. Fertile leaves are narrowly linear, up to 2m long, pendulous, and hang beneath the nest leaves but consists of many repeatedly dichotomously branching parts. Underside of frond holds semicircular ear-like lobes densely coated with brown sporangia.

The habit of *Platycerium coronarium*

DISTINCT CHARACTERISTICS OF SOME MANGROVE PLANT SPECIES

AVICENNIACEAE

Avicennia spp.

INFLORESCENCE

FRUITS

Avicennia alba

Avicennia officinalis

Avicennia marina

LYTHRACEAE

Sonneratia spp.

FLOWERS | LEAVES | FRUITS



Sonneratia alba



Sonneratia ovata



Sonneratia caseolaris

MELIACEAE

Xylocarpus spp.

Xylocarpus moluccensis

Xylocarpus granatum

BARK

ROOTS

LEAVES

RHIZOPHORACEAE

Bruguiera spp.

PROPAGULES

Bruguiera parviflora

Bruguiera cylindrica

Bruguiera gymnorrhiza

Bruguiera sexangula

RHIZOPHORACEAE

Ceriops spp.

PROPAGULES

Ceriops decandra

Ceriops tagal

RHIZOPHORACEAE

Rhizophora spp.

Rhizophora apiculata

LEAVES & PROPAGULES

Rhizophora mucronata

FLOWERS

LEAVES

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FASCINATING ANIMALS THAT LIVE IN MANGROVE FORESTS

Mangrove ecosystems are specify by a unique assemblage of plants and animals that are adapted to the challenging conditions of the intertidal zone, where the land meets the sea. Here are some of the fascinating animals found living in mangrove habitats.

mangrove

FLORA OF SARAWAK

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