



Australia's **MANGROVES**

The Australian coastline is 18% occupied by a very special and beneficial habitat of extraordinary trees and larger shrubs bathed regularly by flooding tides and washing waves. This practical guide describes each of these highly adapted plants.

THE AUTHORITATIVE GUIDE TO AUSTRALIA'S MANGROVE PLANTS

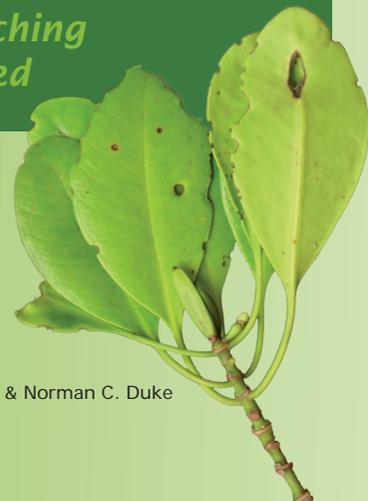
- descriptions of 41 Australian species, 57% of the world's
- illustrated keys for easy identification
- more than 500 colour photographs
- feature artworks by Fran Davies
- State & Territory sections with local specialist contributions
- a manual for community awareness

*For research, teaching
and the eco-minded*



THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA

Published by University of Queensland & Norman C. Duke
Designed by Diana Kleine



Australia's **MANGROVES**

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INCLUDES A WATER-PROOF IDENTIFICATION KEY FOR FIELD USE

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AUTHOR
NORM DUKE

DESIGNED BY
DIANA KLEINE

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Foreword

The phrase 'the lucky country' is lodged deep in the Australian psyche. Its original ironic context has long been forgotten but for mangroves Australia is indeed a paradise. Over half of the global mangrove species reside here and they represent six percent of the world's mangrove area. As a result of Australia's low population density and developed economy, mangroves generally enjoy a relatively protected and non-threatening environment. However, vigilance is still required as they can occupy prime land for development.

Over the years, Australian scientists have written numerous books and papers on mangroves but 'Australia's Mangroves' must be considered the definitive text on the taxonomy and identification of mangroves in Australia. The author, Norman Duke is an internationally recognised expert on mangrove taxonomy and ecology. He has waded through mangrove swamps around the world with a burning enthusiasm to understand the biology of mangroves. Not content with this understanding, Norman has a mission to convert unbelievers to appreciate the beauty and importance of these often misrepresented ecosystems.

This elegantly produced book will be of immense value to professional scientists, students and conservation groups. At one level it can be used as a simple key to identify mangroves in the field. At another level, it provides a detailed scholarly description of every species of mangrove found in Australia. Above all it is the distillation of one person's detailed knowledge of those mysterious forests that lie between the land and the sea around the coast of Australia.

Emeritus Professor Colin Field

Contributors

MANGROVE HABITAT SPECIALISTS

The following mangrove and coastal habitat specialists have generously contributed ideas, information and photographs for the State and Territory section in particular:

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Preface

For a long time, people living by the sea have appreciated the breath-like rhythm of watery tides regularly rising and pulsing back across the coastal margin.

“as man has within him a pool of blood wherein the lungs as he breathes expand and contract, so the body of the earth has its ocean, which rises and falls every six hours with the breathing of the world;” Leonardo da Vinci (1501). Leicester Codex ‘Treatise on Water’,

In this, I empathise also with the comparison of the human life force as a reminder and thoughtful metaphor of our intimate relationship and total dependence on our unique planet. In light of the drastic risk this implies, as we unwittingly alter earthly processes, I am further reminded of my affable eccentric past student, Lloyd Godson. He will submerge himself in a steel box filled with life-giving plants in a Victorian weir to demonstrate this point, aided by Australian Geographic. Notwithstanding the outcome of Lloyd’s demonstration, when I look to my own discipline of three decades, I ask myself - what can be seen in the tea-cup of mangroves? The most effective answer lies in our recognition of the overwhelming influence of people on those earthly processes. Outcomes like environmental sustainability will be achieved only with the greater awareness and responsibility of a better-informed community. This is a community better able to weigh up the facts and potential consequences, and to prioritise everyday socio-economic needs with those of natural ecosystems like mangroves.

A chief objective with this book therefore has been to help demystify an often maligned group of plants, and to share my enduring fascination for them. I do this, I trust, with practical, state-of-the-art information on all of Australia’s mangrove plants, and aided by contributions from local colleagues and friends focussing on each State. In particular, I include the latest descriptions of species and variants, plus a summary of current data on their regional distributions, along with respective geographic and climatic limitations. I further add supportive innovations like my re-invention of the ‘wheel’ – a separate water-proof field key. Let me know what you think! With all this, I hope you enjoy your mangrove experience, even better.

Norm Duke

12th June 2006, University of Queensland, Centre for Marine Studies, n.duke@uq.edu.au



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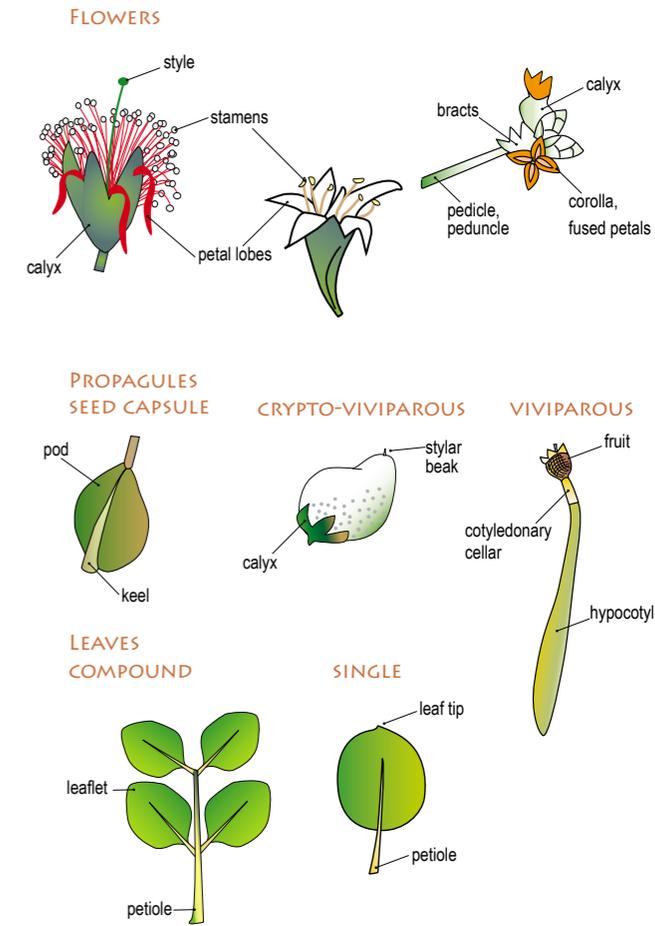
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GLOSSARY

Abaxial	the leaf surface facing away from the stem of the plant	Carpel	a simple pistil or single-celled ovary or seed vessel, or one of the parts of a compound pistil, ovary, or seed vessel	Entire	continous or undivided, continuous simple margin	Imbricate	overlapping in regular order, as the scales on a snake
Abscission	process by which leaves, stems or fruits are separated from the parent plant	Cartilaginous	firm and tough, yet flexible	Ephemeral	flowers that last for a short duration, of 1-2 days	Indented	with very irregular edge, as if broken into with teeth
Accreting	build up of sediment or other matter	Catkins	a slender, spikelike flower cluster, sometimes drooping	Epicalyx	a series of bracts subtending and resembling a calyx	Inflorescence	arrangement of flowers or flower cluster
Actinomorphic	a flower that is radially symmetrical	Chartaceous	papery in texture	Epicarp	outermost layer of the pericarp of fruits as the skin	Interpetiolar	of stipules inserted on the stem between opposite leaves
Acuminate	a leaf shape that gradually tapers to a long point	Ciliate	fringed with hairs	Epigeal	referring to plants growing above ground, or the emerging cotyledon during the germination process	Intertidal	land zone affected by tides, between high and low levels
Acute	sharp, ending in a point	Circumscissile	splitting or opening along a circumference, with the top coming off as a lid	Erect	vertical or upright	Intrapetiolar	between petioles
Adaxial	the leaf surface facing the stem of the plant	Clavate	club shaped	Estuarine	of, relating to, or found in an estuary	Involute	rolled inward or toward the upper surface
Adventitious roots	roots arising from the plant above the ground, able to absorb oxygen from the air	Columnar	column like	Evergreen	a plant that retains its leaves year-round	Jugate	joined in, or forming, pairs or a pair
Aerial root	a root descending from a branch but not penetrating into the soil	Compound leaf	leaf divided into 2 or more leaflets on a single leaf stalk or petiole	Exserted	projecting beyond, such as stamens projecting from the corolla	Juvenile	immature, not yet adult
Alternate	one leaf, or other structure, per node	Connate	like a cone	Exude	to flow out of, or to bleed slowly, describes the sap of a plant	Keel	projecting ridge on a surface, like the keel of a boat
Angular	sharp cornered	Coriaceous	leathery	Facultative	optional, not obligatory	Knee roots	above ground roots shaped like a knee
Annular	in the form of a ring	Corolla	the petals, either free or united	Family	major unit of taxonomic classification comprising related genera	Laciniate	shaped, or formed, like a fringe, as a ligament, slashed into narrow pointed lobes
Anomalous	unusual, abnormal	Cotyledons	the seed-leaves or embryonic leaf	Filament	the stalk of the stamen which supports the anther	Lamina	the leaf blade
Anther	the portion of a stamen which bears the pollen	Cotyledonary collar	extended tube formed by fusion of cotyledons, remains on plant after seedling drops, in Rhizophoraceae	Filiform	thread like	Lanceolate	lance-shaped, much longer than wide with broad base tapering to the apex
Anthesis	the act of a flower opening; the period of coming to full bloom	Crenulate	a leaf margin shaped in rounded waves	Fissure	long, narrow, sometimes deep cracks on a surface	Leaflet	one of the blades of a compound leaf, several leaflets form a leaf on a common petiole
Apetalous	without petals	Crypto-viviparous	a germinated seedling attached to the parent plant but covered by the intact fruit wall, called the pericarp	Fissured bark	bark that splits or cracks	Leathery	tough, leather-like structure
Apex	tip of leaf, root or shoot	Cuneate	wedge shaped at base	Flaky bark	barks that falls off in flakes or thin sheets	Lenticel	brown corky spots on the bark, used for gas exchange
Apices	plural of apex	Cuneiform	shaped like a wedge	Flower	the organ bearing the reproductive parts of a plant	Lepidote	covered in small scaly leaves
Apiculate	Ending as an abrupt tip which is not stiff	Cupulate	shaped like a cup	Foliaceous	like a leaf in shape	Linear	long and very narrow
Axillary	arising from the axil, as in an axillary bud	Cupuliform	like a cup	Friable	crumbly	Lobe	division of a leaf
Basal	arising from the base of a stem	Cylindrical	long and tubular	Froned	palm leaf	Loculus	having small compartments
Bifurcate	forked in two	Cymes	a flat topped inflorescence in which the centre flower opens first	Fungiform	shaped like a mushroom	Medial constriction	narrow wasted, middle diameter smaller than overall diameter
Bilobed	two lobes	Deciduous	leaves shed at the end of the growing, or dry, season	Genus	unit in the taxonomic hierarchy, subordinate in rank to the family, but above species level	Medifixed	attached in the middle
Bilocular	two compartments in the ovary, anther, or fruit	Decussate	growing in pairs, each of which is at right angles to the next pair above or below	Germination	the beginning of growth by a seed, or a pollen grain	Mesocarp	the middle, usually fleshy layer of a fruit wall
Bithecate	double or paired container	Dehisce	the action of a plant naturally releasing its seed as a method of scattering its offspring further abroad	Glabrate	almost glabrous or becoming glabrous with age or maturity	Midrib	large central vein of a leaf
Blade	the expanded, flattened part of the leaf	Deltoid	shaped like a triangle	Glabrous	smooth, without hairs	Monococious	male and female flowers separate but on the same plant
Bract	a small modified leaf which subtends a flower or a cluster of flowers	Dentate	sharply toothed, with the points sticking straight out from the margin	Gland	group of cells which secrete special chemical substances like nectar or resin	Mucilage	slimy, glue
Bracteoles	a small bract, often scaly, borne on the pedicel	Dichasia	a cyme having two lateral flowers or branches originating from opposite points beneath a terminal flower	Glaucous	covered with a waxy bloom or whitish material that rubs off easily	Mucronate	leaf apex usually broad, terminated by a short stiff point called a mucro
Bristle	relatively stiff, hairs on top of petal lobes, in <i>Bruguiera</i>	Dioecious	with male and female flowers on different plants	Globose	almost globular or spherical	Neap tide	a tide of minimum range occurring at the time of quarter and three quarter moon
Buttress	flattened projection or outgrowth from lower trunk which joins lateral roots to stem	Dorsal	the back	Glossy	smooth and shining	Nectariferous	having nectar
Buttress root	a stout vertically flattened root growing from near the base of the stem and helping to support the tree	Drupe	a soft covered fruit, like a stone fruit	Gnarled	twisted, knobby, contorted	Node	point where leaves or branched arise from a stem
Cable root	a slender root which spreads horizontally outwards from the plant just below the soil surface, often giving rise to pneumatophores	Ellipsoidal	elliptic in outline, but solid	Habit	the general appearance of a plant	Ob lanceolate	leaf shape that is broader at the apex gradually narrowing to the base, opposite of lanceolate
Caducous	falling off early	Elliptic	oval-shaped, longer than wide and widest in the middle, usually with pointed apex and base	Hairs	fine hairs, like those along sides of petal lobes, in <i>Bruguiera</i> and <i>Rhizophora</i>	Oblong	elongated, two or four times longer than broad
Calyx	the outer covering of a flower base, often called sepals	Emerginate	notched at the tip or apex	Halophyte	a plant which grows in saline soil, adapted to highly saline habitat	Obovate	inversely egg-shaped, with the broader end upward
Campanulate	shaped like a bell	Endemic	native only to one small area or one country and found nowhere else as a native	Hyaline	resembling glass, as in translucence or transparency, glassy	Obovoid	pear shaped
Canopy	the uppermost layer of branches and leaves of a single tree or forest	Endosperm	a tissue containing stored food, surrounding and nourishing the embryo	Hybrid	individual produced as a result of cross between two different species, often infertile and expressing vigorous growth	Obtuse	blunt at the end, forming greater than right angle
Capitate	forming a head, rounded and compact			Hypocotyl	the portion of the stem of a seedling below the cotyledons	Opposite	two leaves borne on either side of a branch at a single node
Capsular	shaped like a capsule			Hypogeal	of, or relating to, seed germination in which the cotyledons remain below the surface of the ground	Orbicular	a leaf that is nearly circular
Capsule	a single, or many seeded fruit with a hard case that dries at maturity and often bursts to release seeds					Ovary	the portion of the flower which contains the ovules, matures to a fruit and bears seeds

Ovate	shaped like an egg, broader at the base	Raceme	an inflorescence having stalked flowers arranged singly along an elongated unbranched axis
Ovoid	like an egg	Radicle	the embryonic root
Ovule	the immature seed	Recurved	bent or curved backwards
Panicle	an inflorescence divided into branches, compound	Reflexed	a sharp bend downward or backward
Pan-tropical	occurring throughout the tropics	Reticulate	like a net
Paraphyses	one of the erect sterile filaments often occurring among the reproductive organs of certain fungi, algae, and mosses	Revolute	rolled downwards or to the lower side
Paripinnate	having pairs of leaflets opposite each other along a central stem, with a single leaf at the end	Rhizome	an underground, horizontal stem
Pedicel	the stalk of a flower in a cluster	Ridge	angular with lengthwise lines
Pedicellate	a stalk that supports a fruiting or spore-bearing organ	Rosette	a radiating cluster of leaves as in a dandelion
Peduncle	a single inflorescence stalk bearing a cluster of flowers	Rugose	wrinkled
Peltate	a leaf with the stalk usually attached centrally beneath the leaf blade	Scales	small dry flakes covering leaf or fruit surface
Pendulous	having branches or flower heads that bend downward, drooping or weeping	Scarious	scratched surface
Pentamerous	five parts, or 5 lobed	Semi-orbicular	semi-circular, usually a leaf
Perennial	a plant that will live for three years or more under normal conditions	Sepal	outermost part of a flower, collectively called the calyx
Pericarp	the wall of the ripe ovary	Sericeous	silky
Persistent	remaining attached for a long time	Serpentine	snake like
Petiole	the leaf stalk	Sessile	without a stalk
Petiolar	of, relating to, or growing on a petiole, a petiolar sheath	Sheath	a tubular covering that surrounds part of a plant
Petiolar scales	scales on the petiole	Sickle-shaped	shaped like a sickle, a curved knife
Phenology	occurrence of flowering and fruiting events	Simple	single, undivided piece, applied to leaves
Pilose	hairy, usually with long and distinct hairs	Sinuous	curving like a meandering stream
Pin	dominant pistil with knob like stigma, a counter to 'Thrum'	Sinus	the base of a gap between lobes
Pinnae	a leaflet on the second division of a bipinnate leaf	Smooth	leaf texture not rough
Pinnate	having leaflets growing in rows on both sides of a petiole, or leaf stem, as in a fern, feather like in appearance	Spathe	a bract or pair of bracts, often large, enclosing the flowers
Pistillate	a flower that has only female reproductive components	Spathulate	like a small spathe, a flat spoon
Plank roots	vertically flattened, lateral extensions of buttress root	Species	a naturally occurring population of individuals which are reproductively isolated from similar species
Plumular	shaped like a plumule	Spicate	like ears of corn
Plumule	the embryonic shoot	Spike	elongated, unbranched inflorescence like a raceme, but flowers are sessile
Pneumatophore	a respiratory root which rises above the soil surface, spongy or corky aerial roots arising from cable roots, variable in shape including peg, conical, pencil, knee, 'breathing roots'	Spine	relatively stiff, needle like thread between petal lobes, in <i>Bruguiera</i>
Prop roots	aerial roots that form on the stem above ground, also called stilt roots	Sporangia	specialized spore cases found on the underside of fern fronds
Propagule	seed or seedling capable of producing a new plant, often applied to Rhizophoraceae, e.g. <i>Rhizophora</i> , <i>Bruguiera</i> , <i>Ceriops</i>	Spore	the reproductive structures of ferns
Puberulent	covered with fine soft hairs or down; synonym: pubescent	Spring tide	tides of maximum range occur during both new and full moon
Pubescent	softly hairy, covered with short, soft fine hairs	Stalk	petiole, peduncle or stem
Pulvinate	a swelling at the base of the petiole, often facilitating leaf motion	Stamen	the male organ of the flower consisting of the pollen-bearing anther and its stalk the filament
Pustular	covered in pustules, raised lumps, often flaking	Staminate	like a stamen
		Staminodes	a sterile stigma, often modified in shape and size
		Stellate	star shaped
		Sterile	infertile, non-reproductive, not able to reproduce
		Stigma	the portion of the style which receives the pollen

Stilt root	a root arising from the stem some distance above the ground and affording support to the plant, often called prop roots
Stipule	a leaf-like or scale-like appendage, often in pairs at the base of the leaf petiole
Stomata	openings of the leaf connected to internal air spaces
Strigose	with pointed, rigid, hair-like scales or bristles
Stylar beak	pointed end of a fruit formed from the spent style
Style	an often slender portion of the pistil which arises from the ovary and supports the stigma
Subtended	joined to
Subterminal	near terminal shoots or buds
Succession	the order in which one vegetation type or ecological community replaces another following some change or disturbance
Succulent	juicy or fleshy, thick
Superior	above the part
Suture	line where two parts are joined, and often split apart
Taproot	central main root evident in deep rooted species
Terete	circular in transverse section, cylindrical and usually tapering
Terminal	borne at the end or apex
Testa	hard shell
Tetrahedral	angular shaped, often 4 sided
Tetramerous	4-part shape
Thecate	like a container
Thicket	dense growth of shrubs and small trees
Thrum	a threadlike part of a flower, a stamen, a counter to 'Pin'
Tomentose	densely woolly, the hairs are soft and matted
Translucent	allows light through
Tree	higher woody plant, usually with one major trunk
Tri-locular	having three compartments
Turbinate	shaped like a turbin
Umbel	an inflorescence consisting of a number of flower stalks or pedicels, nearly equal in length and spreading from a common centre, like umbrella ribs
Umbelliform	shaped like an umbel
Unilocular	single compartment
Urceolate	shaped like a pitcher or urn
Valvate	shaped like a valve
Variety	taxonomic unit within the species
Venation	patterns in the veins of a leaf blade, typically parallel veined or net-veined
Vestige	remnant piece
Viviparous	a germinated seedling that has developed while still attached to the parent plant
Zygomorphic	a flower that is bilaterally symmetrical

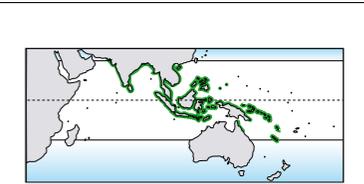


Species pages are standardised to make identification easier. Scientific and common names are listed along with special features and distinguishing characters. Background text describes family affinities and closest relatives. Selected photographs show key attributes. Margin icons and descriptive charts provide further reference.

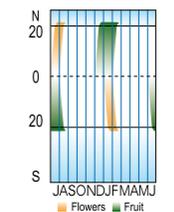
Sonneratia caseolaris

Nine icons show the key attributes that characterise each species.

	GROWTH FORM	Plant Structure	Distinctive plant, stem, roots
	FOLIAGE	Leaf Position	OPPOSITE or ALTERNATE
		Leaf Structure	SIMPLE or COMPOUND
		Leaf Shape	Distinctive leaf, margin, tip
	REPRODUCTIVE PARTS	Inflorescence	TERMINAL AXILLARY BOTH
		Flower	Distinctive flower, petals, stamens
		Fruit	Distinctive fruit, propagule
	LOCAL DISTRIBUTION	Tidal Position	HIGH MID LOW
		Position Upriver	DOWNSTREAM INTERMEDIATE UPSTREAM



DISTRIBUTION MAP
Map shows Australian and Indo-West Pacific distributions for each species and its close relatives.



PHENOLOGY CHART
The chart shows months of flowering and fruiting at different latitudes. There is a shift to later months with higher latitude and cooler climate. Flowering and fruiting in the northern hemisphere differs by 6 months.

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