Mangrove plants

Mangroves — coping with salt

Mangroves are plants which live between the sea and the land. A mangrove is not a species, but rather the name given to a community of unrelated plants living in areas which are inundated by tides. Thus a mangrove may be a tree but (like a 'rainforest plant') may also be a shrub, palm, fern, climber, grass or epiphyte — all of them sharing the ability to live in salt water.

Do all mangroves *need* salt? It seems that the answer is no. Some species have been kept in pots where they have grown happily and flowered regularly when given only fresh water. However, experiments have also shown that the best growth occurs where the plants live in sea water diluted by about 50 percent with fresh water.

*Crystals of salt can be seen on the leaves of the river mangrove (*Aegiceras corniculatum*).*

One particular advantage to growing in a salty environment is the lack of competition! Only a limited number of plants have invested evolutionary energy into adapting to such harsh conditions. In the optimum conditions of a tropical rainforest, diversity is great and competition fierce. On the edge of the sea (in Australia) about 30 species of mangroves have exclusive occupancy.

So how do mangroves manage to flourish in an environment which would kill most other plants?

The first line of defence, for many mangroves, is to **stop** much of the salt from entering at all by filtering it out at root level. Some species can exclude more than 90 percent of salt in sea water. (*Rhizophora, Ceriops, Bruguiera* and *Osbornia* species are all 'salt-excluders'.)

Another trick, is to quickly **excrete** salt which has entered the system. The leaves of many mangroves have special salt glands which are among the most active salt-secreting systems known. It is quite possible to see and/or taste the salt on the leaf surfaces of species which choose this method. ('Salt-secreters' include *Aegiceras, Avicennia, Sonneratia* and *Acanthus*.)

A third method of coping with salt is to **concentrate** it in bark or in older leaves which carry it with them when they drop. (*Lumnitzera, Avicennia, Ceriops* and *Sonneratia* species all use this trick.)

As can be seen from the examples given, some mangroves use only one of these methods but many use two or more.

In addition, a number of features serve to **conserve** water. These include a thick waxy cuticle (skin on the leaf) or dense hairs to reduce transpiration — the loss of water. Most evaporation loss occurs through stomata (pores in the leaves) so these are often sunken below the leaf surface where they are protected from drying winds. Mangrove leaves are also frequently succulent, storing water in fleshy internal tissue.

Marvellous mangroves

Many people don't like mangroves, regarding them as muddy, mosquito- and crocodile-infested swamps. Their removal is seen as a sign of progress. So what is the point of preserving them? For a start, it has been estimated that up to 75 percent of fish caught commercially either spend some time in the mangroves or are dependent on food chains which can be traced back to these coastal forests.

Mangroves also protect the coast by absorbing the energy of storm-driven waves and wind. The only two yachts undamaged by Cyclone Tracy in 1974 had sheltered in a mangrove creek. While providing a buffer for the land on one side, mangroves also protect the sea on the other. Sediments trapped by roots prevent siltation of adjacent marine habitats where cloudy water may cause the death of corals. In addition, mangrove plants and sediments have been shown to absorb pollution, including heavy metals.

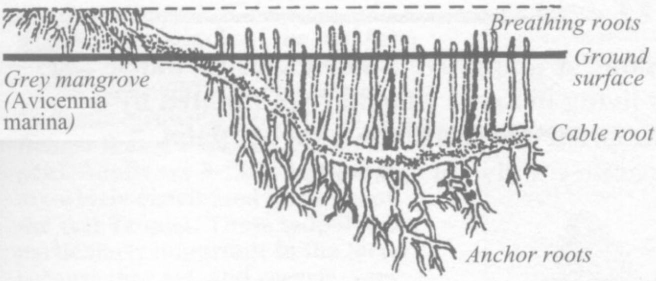
Worldwide, vast tracts of mangroves have been destroyed so we are lucky to have relatively large areas of Australia's tallest and best-developed mangroves still existing on our doorstep. A token preservation of small parts of these, however, would be similar to preserving just a few reefs. Now that their economic and ecological importance has been recognised we carry the responsibility to look after our mangroves.

Roots and shoots

Apart from coping with salt, mangroves also face common problems of water-logged, unstable and oxygen-deficient soils. Despite belonging to many different families mangrove plants have come up with surprisingly similar solutions.

Roots

Roots perform a number of functions for a plant. They support it and they obtain essential nutrients and oxygen.

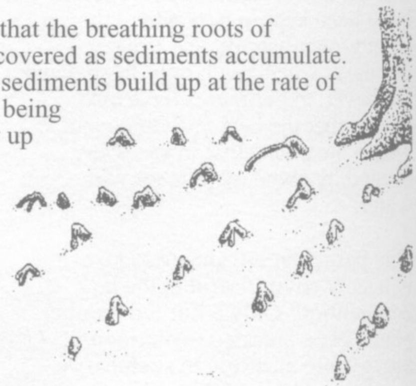


In unstable, sometimes semi-fluid, soil an extensive root system is necessary simply to keep the trees upright. As a result, most mangroves have more living matter below the ground than above it. The main mass of roots, however, is generally within the top two metres — mangroves do not seem to grow deep tap roots, probably because of the poor oxygen supply below the surface.

There are three types of roots with different functions. Radiating cable roots, punctuated by descending anchor roots, provide support. From this framework sprout numerous little nutritive roots which feed on the rich soil just below the surface. The third type of roots collects the oxygen.

Little oxygen is available in fine, often waterlogged, mud. The solution which many mangroves have come up with, is to raise part of their roots above the mud. These roots are covered with special breathing cells, called lenticels, which draw in air. They are connected to spongy tissue within the roots. When *the roots* are submerged in water, the pressure within these tissues falls as the internal oxygen is used up by the plant. The resulting negative pressure means that when the root is re-exposed, as the tide drops, more air is drawn in through the lenticels.

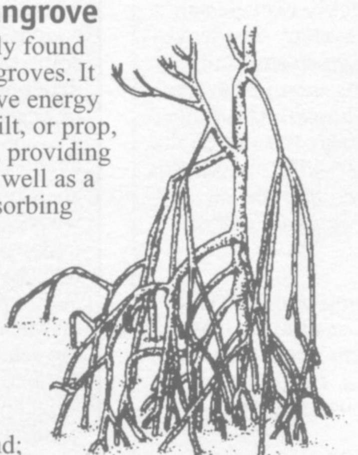
There is always a danger that the breathing roots of mangroves may become covered as sediments accumulate. Under normal conditions sediments build up at the rate of 1.5-2cm a year. To avoid being buried the roots can grow up vertically. Oil, however, can be fatal. Once covered with it the lenticels can no longer draw in air and the plant may suffocate.



Different mangrove species have developed different architectural designs to keep their roots in the air. The species shown here typify the different root arrangements.

Red (stilt or spider) mangrove

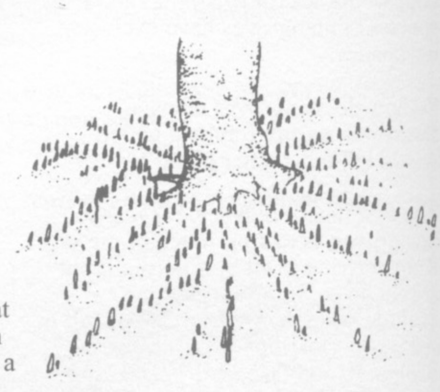
(*Rhizophora stylosa*) is commonly found close to the seaward side of mangroves. It is therefore subjected to high wave energy and has developed a system of stilt, or prop, roots. These spread far and wide, providing numerous anchors for the tree as well as a large surface area for oxygen-absorbing lenticels.



In common with other species, this mangrove also grows aerial roots, extra stilts which arise from the branches or trunk. Studies have shown that these aerial roots alter dramatically in structure when they reach the mud; above it they have about 5 percent air spaces but below this changes to 50 percent.

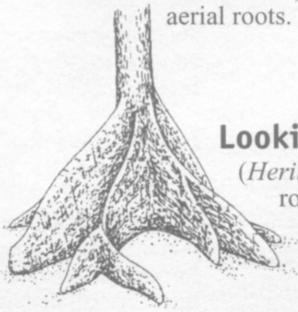
Grey mangrove

(*Avicennia marina*) grows a series of snorkels, or peg/pencil roots, known as pneumatophores. Experiments with a related *Avicennia* species have shown that those plants growing in coarse coral sand, with a good air supply to the roots, were able to survive after their pneumatophores were removed. However, those living in poorly aerated soil died when the pneumatophores were covered. In one situation, where they were covered with oil, the plants responded by growing aerial roots.



Orange mangrove

(*Bruguiera gymnorrhiza*) develops knee roots. These are cable roots which have grown above the surface of the mud and then down into it again.

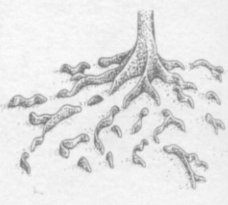


Looking glass mangrove

(*Heritiera littoralis*) produces buttressed roots which are like flattened, blade-like stilt roots.

Cannonball mangrove

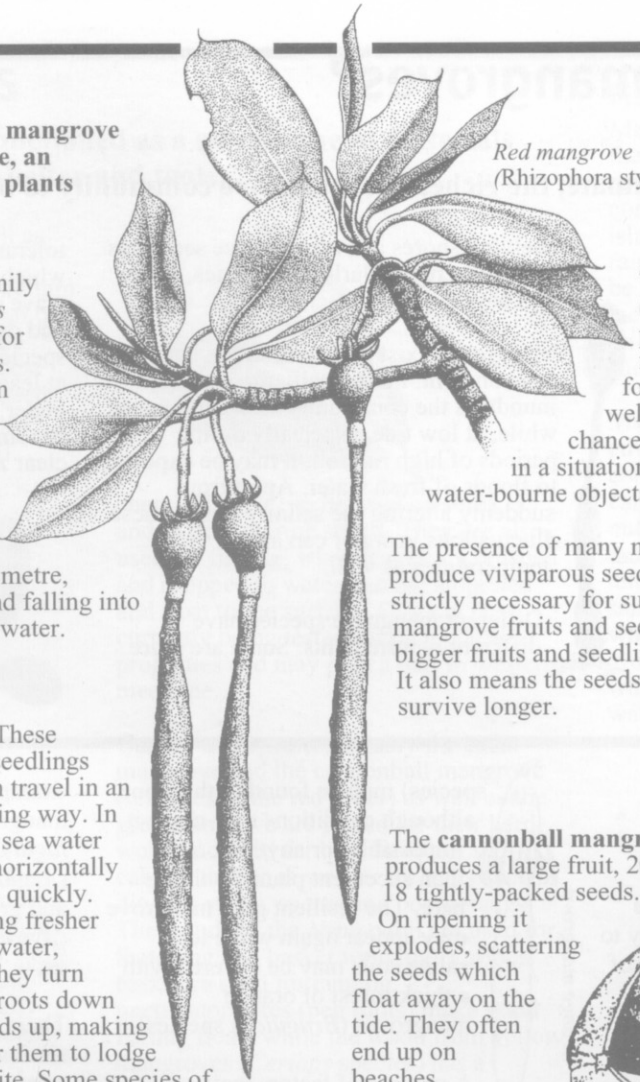
(*Xylocarpus granatum*) is buttressed but the cable roots also appear above the ground in the fashion of knee roots.



Shoots

The fruits and/or seed(ling)s of all mangrove plants can float, which is, of course, an excellent dispersal mechanism for plants which live in water.

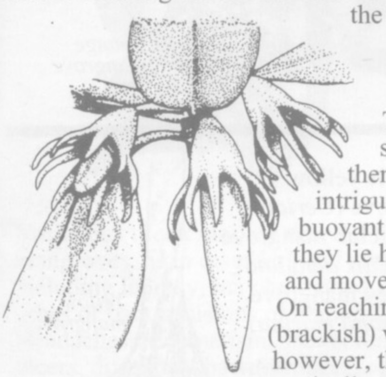
Members of the Rhizophoraceae family (*Rhizophora, Bruguiera* and *Ceriops* species) have an intriguing method for successfully reproducing themselves. The fertilised seeds do not drop from the plants but begin to germinate, growing out from the base of the fruits to form long, spear-shaped stems and roots, called propagules. They may grow in place, attached to the parent tree, for one to three years, reaching lengths of up to one metre, before breaking off from the fruit and falling into the water.



Red mangrove
(Rhizophora stylosa)

The production of live seedlings (known as vivipary) is very rare in plants other than mangroves and a few seagrass species and the reason for it is unclear. It is possible that the well-developed seedling has a greater chance of surviving, once it has taken root, in a situation where it is likely to be battered by water-bourne objects.

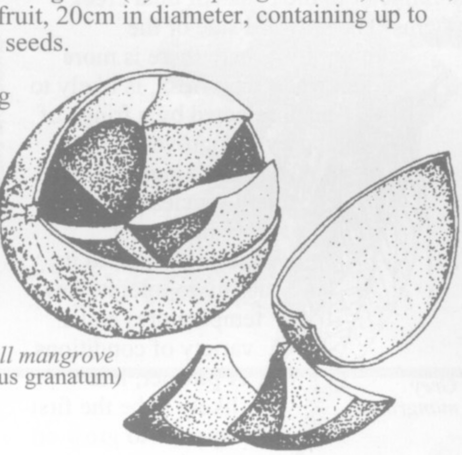
The presence of many mangrove species which do not produce viviparous seedlings shows that this strategy is not strictly necessary for successful reproduction. However, all mangrove fruits and seeds are large, which suggests that bigger fruits and seedlings have a better chance of survival. It also means the seeds with a big storage capacity may survive longer.



Orange mangrove
(Bruguiera gymnorrhiza)

These seedlings then travel in an intriguing way. In buoyant sea water they lie horizontally and move quickly. On reaching fresher (brackish) water, however, they turn vertically, roots down and leaf buds up, making it easier for them to lodge in the mud at a suitable, less salty, site. Some species of these floating seedlings (*Rhizophora*) can survive, in a state of suspended animation, for up to a year in the water. Once lodged in the mud they quickly produce roots and begin to grow.

The **cannonball mangrove** (*Xylocarpus granatum*) (below) produces a large fruit, 20cm in diameter, containing up to 18 tightly-packed seeds. On ripening it explodes, scattering the seeds which float away on the tide. They often end up on beaches.



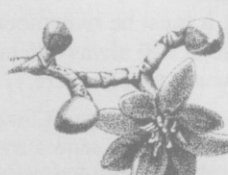
Cannonball mangrove
(Xylocarpus granatum)

Some other species (*Avicennia, Aegialitis* and *Aegiceras*) also produce live seedlings but these are still contained within the seed coat when it drops from the plant. The seed of *Avicennia* floats until this coat drops away. Interestingly the speed with which this happens depends on the temperature and salinity of the water. In water of high or low salinity the seed coat is slow to drop off but in brackish water it is shed quickly allowing the seedling to lodge in the favoured habitat of this species. Higher temperatures also favour faster action. *Avicennia* seeds can stay alive for only four days in the water.

Grey mangrove
(Avicennia

The seed of the **looking-glass mangrove** (*Heritiera littoralis*) has a prominent ridge on one side. This may act as a sail when the seed is in the water.

Mangrove history



Red mangrove

It is thought that mangroves evolved somewhere between Australia and New Guinea, about 50-60 million years ago, and spread out from there to tropical regions worldwide. In warmer periods of the earth's history they probably covered a much larger area than they do now — mangroves currently growing in cool areas such as in Victoria and South Australia are probably relicts of that warmer time.

Desert plants of central Australia may also be seen as relict mangroves from the days when a vast inland sea covered the area. As it dried up, the plants which had adapted to those wet salty conditions found it relatively easy to adapt to a dry situation; salinity, in essence, causes drought by making it difficult to obtain water. As a result the water-conserving strategies of the two groups of plants, although separated by great distances, are remarkably similar.

Orange mangrove

Where are the mangroves?

The necessities of life

The warmer and wetter the climate, the richer the mangrove community to be found there.

The most diverse mangroves occur in tropical areas where the water temperature is greater than 24deg. in the warmest month, where the annual rainfall exceeds 1250mm and mountain ranges greater than 700m high are found close to the coast. (The proximity of mountains tends to ensure the rainfall.) In addition, they need protection from high waves which can erode the shore and prevent seedlings from becoming established. In north Queensland the Great Barrier Reef performs this function while to the south a chain of sand islands provide shelter. Shallow, gently-shelving shores allow mangrove seedlings to anchor, particularly in estuaries, rivers and bays.

Mangroves exist in a constantly changing environment. Periodically the sea inundates the community with salty water while, at low tide, especially during periods of high rainfall, it may be exposed to floods of fresh water. Apart from suddenly altering the salinity levels, these fluctuations in water can alter temperatures as well.

Different mangrove species have different requirements. Some are more tolerant of salt than others. Other factors which affect their distribution include wave energy, soil oxygen levels, drainage and differing nutrient levels. Where one species finds its preferred conditions — or at least those which it is able to tolerate better than other plants — it tends to become dominant. This has led to quite clear zones among mangroves.

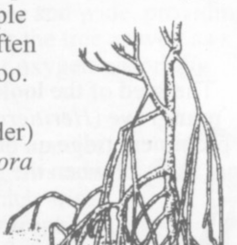
Orange mangrove

Zones in the mangroves

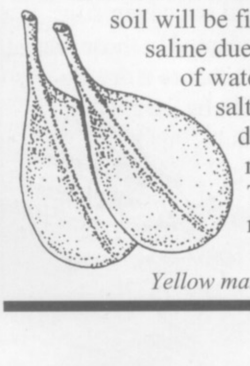
As a general rule bands of dominant mangrove species run parallel to the shoreline or to the banks of tidal creek systems. The seaward side of the community, where there is more salt water than fresh, is likely to be dominated by a fringe of grey mangroves (*Avicennia marina*). This tough species is Australia's most widespread due to its ability to tolerate low temperatures and a variety of conditions. A pioneer, it is likely to be the first species to grow on newly-emerged mud banks, putting up its distinctive peg roots. Mangrove apple (*Sonneratia alba*) often grows in this zone too.

Grey mangrove

The red (stilt or spider) mangrove (*Rhizophora stylosa*) is usually found behind this zone where its long prop roots give it a firm foothold in wind and waves.



The next zone may be inundated only by periodic spring tides at the time of the new and full moon. As a result the soil will be firmer but more saline due to the evaporation of water leaving behind salt which will not be diluted until the next spring tide. The tough yellow mangrove (*Ceriops* species) may be found in this zone, although conditions may make it impossible for anything other than succulent plants to thrive here. The resilient grey mangrove may appear again while less saline soils may be covered with a thick forest of orange mangroves (*Bruguiera* species).



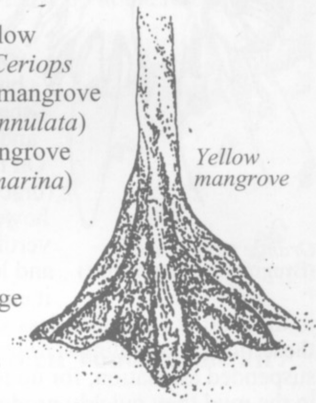
Yellow mangrove

Orange mangrove

A number of factors may determine what happens to the landward side of this zone. In conditions of high rainfall, such as exist in north Queensland, particularly in the Daintree, regular flooding may lead to freshwater swamp areas dominated by the less salt-tolerant mangrove species (such as freshwater mangrove (*Barringtonia acutangula*) and cottonwood (*Hibiscus tiliaceus*). Behind this may be a zone of paperbarks and the beautiful flaky-barked red beech or golden guinea tree (*Dillenia alata*), as littoral (shore) vegetation merges into rainforest.

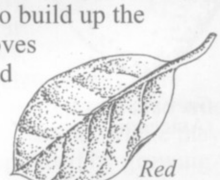
In areas of very seasonal rainfall, such as those in the Gladstone to Townsville region, the reverse may be the case, evaporation and little fresh water input leading to an increase in salinity. This may be a salt marsh or salt flat zone where only the toughest mangroves (for example yellow mangrove (*Ceriops tagal*), club mangrove (*Aegialitis annulata*) and grey mangrove (*Avicennia marina*) grow.

Cottonwood



Yellow mangrove

There is a similar change of species along rivers, the zones corresponding roughly to decreasing salinity levels and ranges of salinity (among other factors). The ever-adaptable grey mangrove tends to be found throughout river systems, including the upper limit of tidal influence where fresh water is abundant. The greatest concentration of mangrove species is usually at the mouth of tidal creeks and rivers where salt and fresh water mix in ideal proportions and floodwaters deposit plenty of material to build up the banks. Red mangroves are frequently found here.



Red mangrove

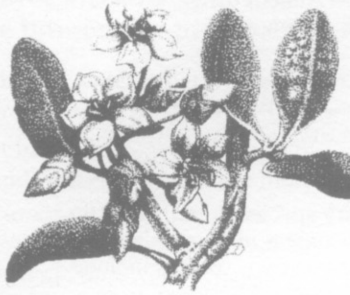
While there are certain patterns to the development of mangrove zones, it must be remembered that local conditions will always dictate which mangroves are found where.

Grey mangrove

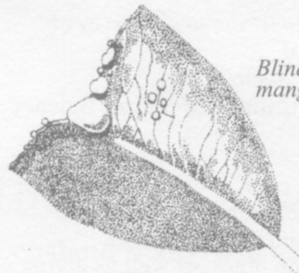
Mangrove uses

The mangroves have long functioned as a storehouse of materials providing food, medicines, shelter and tools.

Fish, crabs, shellfish, prawns as well as edible snakes and worms are found among the mangroves. The fruit of certain species, including the *Nypa* palm, can be eaten after preparation along with the nectar of some of the flowers. The best honey is considered to be that produced from mangroves, particularly the river mangrove (*Aegiceras corniculatum*) (below).



Numerous medicines are derived from mangroves. Skin disorders and sores, including leprosy, may be treated with ashes or bark infusions of certain species. Headaches, rheumatism, snakebites, boils, ulcers, diarrhoea, haemorrhages... and many more conditions are traditionally treated with mangrove plants. The latex from the leaf of the blind-your-eye mangrove (*Excoecaria agallocha*) can indeed cause blindness but the powerful



Blind-your-eye mangrove

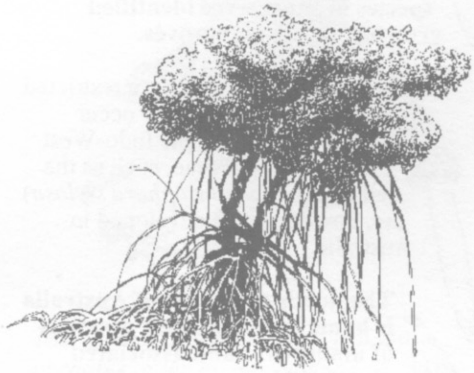
chemicals in it can be used on sores and to treat marine stings. They are also used for fishing; when leaves are crushed and dropped in water fish are stupefied and float to the surface. This sap is currently being tested for its medical properties and may play a part in western medicine.

Certain tree species, notably the cedar mangrove and the cannonball mangrove (relatives of the red cedar) as well as the grey mangrove are prized for their hard wood and used for boat building and cabinet timber as well as for tools such as digging sticks, spears and boomerangs. The fronds of the *Nypa* palm are used for thatching and basket weaving. Various barks are used for tanning, pneumatophores (peg roots) make good fishing floats while the wood from yellow mangroves (*Ceriops* species) has a reputation for burning even when wet.

Mangroves at sea

Mangroves occur not just on the coast of the mainland. They also pop up, where conditions are suitable, on the fringes of continental islands and on wooded coral islands of the reef. In these situations rainfall and nutrient levels are likely to be low so these communities generally lack the diversity and luxuriance of those on the mainland. (Very large islands, such as Hinchinbrook, are an exception.)

Mangroves of coral islands grow in an environment where the main sediment comes from coral and is thus high in calcium carbonate but low in the nutrients which come from the land. The more mature mangrove communities tend to become established on the sandier lee side, usually the northwest, while stunted forms of some species may grow elsewhere. Naturally, those species which require a greater degree of fresh water, are absent at sea.



More plants of the mangroves

Like all ferns the **mangrove fern** (*Acrostichum speciosum*) has a relatively complicated means of reproduction. Spores are produced underneath the fronds in reddish-brown sacs. They are dispersed by wind and then develop into tiny plants (prothalli). These, in turn, produce reproductive structures which, in this species, depend on water for fertilisation. The result is a mature fern plant.

A number of **mistletoe** species live on mangrove trees, parasitising their hosts by sending special roots into their living tissue and robbing them of nutrients. Mistletoes also gain nourishment by photosynthesising, so grow well where sunlight is available. Some species grow only on mangroves while others may be found on other types of trees as well (and some species are never found on mangroves). Since all mangroves contain a high salt content in their sap those mistletoes which choose them for hosts have had to adapt themselves appropriately.

Known as **cottonwood** or river mangrove, this native hibiscus (*Hibiscus tiliaceus*) is a marginal mangrove species, growing on the landward side of mangroves where fresh water is abundant. The underside of its leaves are densely covered with hairs which may help to conserve precious water by reducing loss through transpiration.

Facts and stats

on mangrove plants

Worldwide there are 69 recognised species of mangrove plants belonging to 20 families. Up to 34 mangrove species and three hybrids are known to occur in Queensland — although figures may change as the definition of a mangrove is not clearcut and some plants, such as cottonwood, may be regarded as a mangrove by some and not by others.

A study of Cairns mangroves found 24 mangrove tree and shrub species while a further 18 species of flowering plants were growing among the mangroves or on salt marshes. An additional 42 species of epiphytic plants and 25 species of fungi were identified growing on the mangroves.

No mangrove species are restricted only to Australia. Many occur widely throughout the Indo-West Pacific region. Some, such as the red mangrove (*Rhizophora stylosa*) are, however, best developed in Australia.

The north-east coast of Australia is home to the greatest diversity of mangroves and associated plants. This is because this region was close to the centre of origin and dispersal of mangroves, because the climate is similar to that under which they first evolved and because the sheltered shallow waters of numerous estuaries are ideal for growth.

Mangrove forests occupy approximately 11,600 square kilometres in Australia, 4,600 of these being in Queensland.

The origin of the name 'mangrove' is not certain. It may be a combination of the Portuguese 'mangue', meaning an individual mangrove tree, with the English 'grove', although early versions were 'mangrowe' and 'mangrave'. It may also be derived from the Malay 'manggi-manggi' or 'mangin'.

The colours included in the common names of many mangrove trees often refer either to the bark (for example, grey mangrove) or to the blaze — the colour which shows when the bark is scraped — (for example, the red mangrove).

Bookshelf

Field Guide to the Mangroves of Queensland
Catherine Lovelock
Australian Institute of Marine Science (1993)

This useful pocket-sized guide shows 22 species of mangrove plants illustrated in full colour, with identification notes, as well as giving some good background information.

Mangroves in Focus
Dave Claridge and John Burnett
Wet Paper Publications (1993)

This book presents a great deal of information, in an easy-to-read format, on the mangrove environment, its values and threats. One chapter gives species descriptions while the final section is full of activities, games and ideas for excursions and projects making it particularly useful for schools.

Ecology of Mangroves
Patricia Hutchings and Peter Saenger
University of Queensland Press (1987)

Intended for the scientist this very comprehensive book is packed with information.

Mangroves of Australia
Richard Lear and Tom Turner
University of Queensland Press (1977)

Although out of print now this excellent little book is still available in libraries.

Mangrove Boardwalk to Myall Beach, Cape Tribulation
Esther Cullen (1994)

This useful and thorough guide is available from the Department of Environment office at Cape Tribulation.

Mangroves of the Northern Territory
Glenn M. Wightman
Conservation Commission of the Northern Territory (1989)

Many species described in this book also appear in Queensland. Many of the notes on each species include interesting Aboriginal uses.

Mangroves in New South Wales and Victoria
Christopher Harty
Vista Publications (1997)

Although not covering Queensland, there is also good general mangrove information in this book.

Tourist talk

ENGLISH	GERMAN	JAPANESE	
mangrove	Mangrove	mangrove	マングローブ
salt water	Salzwasser	en sui	塩水
fresh water	Süßwasser	tan sui	淡水
exclude	ausschließen	shya dan suru	遮断する
secrete	absondern	bun pi suru	分泌する
air	Luft	ku ki	空気
leaf	Blatt	ha	葉
root	Wurzel	ne	根
seedling	Samen, Trieb	waka gi	若木
float	treiben	ukabu	浮かぶ