

TROPICAL TOPICS

AN INFORMATIVE NEWSLETTER ABOUT THE ENVIRONMENT



Light in the Rainforest

September 2011

Notes from the Editor

Sunlight is food. Without it no plant can live. The abundance of sunlight in the tropics produces more living plant material per hectare than anywhere else on the planet.

Ideal growing conditions have also produced one of the most diverse ecosystems on Earth (it is possible to find 120 tree species per hectare in Queensland's tropical forests compared with only 30 per hectare in temperate forests). Much scientific research has been done in an attempt to understand what produces such diversity. One theory is that different gaps - openings in the forest canopy - producing different amounts of light (see page 2) is responsible.

The forest may need some disturbance but one thing is certain; human impact on tropical forests does nothing to maintain diversity. Clearing affects the nutrient balance (by removing trees, increasing soil erosion, fires, etc.) and the ability of the forest to regrow (by crushing saplings and compacting soil). Not least, these gaps encourage growth of a limited number of hardy, lightloving species such as lawyer cane and stinging trees.

Research has shown that full regeneration of a forest can take 800 years - even longer if the disturbance is more severe. With this in mind we can be thankful that the forests of the Australian Wet Tropics are now protected. The long process of regeneration can begin.

The solar panel canopy

When we look down from an aeroplane on to the rainforest canopy we see a green roof – an almost solid mass of vegetation obscuring the ground below. What we are seeing are billions of leaves feeding. They are guzzling sunlight.

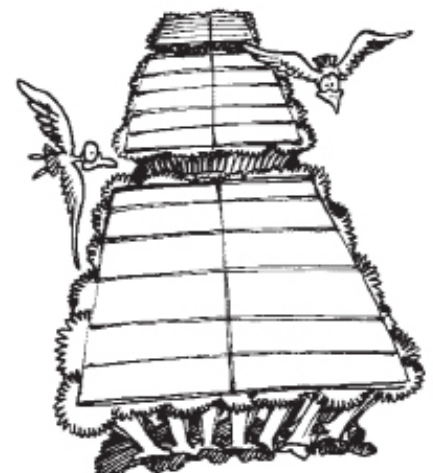
Animals eat other organisms, living or dead - a pre-prepared meal of nutrients. Plants, on the other hand, make their own food. They are the only living things that can capture energy from the sun and use it (through the process of photosynthesis) to produce sugars and other materials from which they build their own structures. Each leaf is a solar cell. The canopy is a vast solar panel.

The architecture of the forest is determined by a hunger for sunlight. There is fierce competition for this vital energy. Stretching high on tall, straight trunks, trees don't waste energy on producing branches until they reach the canopy and are able to compete successfully with their neighbours for available light. Trunks can be branchless to heights of 30m or more. On the other hand, the same trees, grown in full light - for example in a park or garden without competition from neighbours - will branch early in life and grow into shorter, bushy trees with completely different shapes.

The canopy is an interlocking network of sun-hungry leaves. It is so efficient that only between three and 15 percent of sunlight penetrates. Not all of the light is caught by the topmost leaves. Studies of mangrove (Rhizophoraceae family) forests have shown that leaves at the top of the canopy tend to be inclined so that they are When we look down from an aeroplane on to the rainforest canopy we see a green roof – an almost solid

mass of vegetation obscuring the ground below.

What we are seeing are billions of leaves feeding. They are guzzling sunlight. not fully exposed to the sun. This probably prevents them from being damaged by the intensity of the tropical sun. (Leaves held up to receive the full force of the sun were recorded to be 10oC hotter than those at their natural, inclined, angle.) This arrangement also allows sunlight to be shared by leaves lower in the canopy. There the leaves, unlike those at the top, grow horizontally and can capture all the rays reaching them. Researchers also discovered that, like the best solar panels, leaves move into the most efficient positions; leaf angles in these mangrove trees alter with changes in light between wet (cloudy) and dry (sunny) seasons.





Menu at the Photosynthesis Cafe

Chlorophyll

Essential for digestion of your meal, this tadpole-shaped molecule is tastefully arranged around a single atom of magnesium.

Sunlight

Strong, hot and spicy. A real energy booster after a long dark night.

Hydrogen

Tastefully combined with oxygen and presented in a crystal clear beverage.

Carbon and oxygen

Irresistibly combined in a heady concoction of carbon dioxide and wrapped in an invisible (and disposable) mix of nitrogen, oxygen, argon and water vapour.

A story of Oskars

Although it looks stable, rainforest is continually changing. Old trees fall and others take their place.

Look around the forest floor. In the gloom, where only one to five percent of available light falls, vegetation is sparse. Apart from ferns, palms and other plants which have adapted to low light levels, there are some spindly saplings with few leaves.

Astonishingly, these unimpressive plants may be 20-year-old trees. Botanists have nicknamed these little saplings 'Oskars'. Oskar, a character in the novel *The Tin Drum* by German author Gunter Grass, was a little boy who didn't grow up. That is what has happened to these saplings. Deprived of sunlight they are unable to reach their potential as magnificent rainforest trees. But there is hope. All they need is a gap in the canopy. Perhaps an old tree or even a branch will fall and give them a chance.

That increase in light is enough. Suddenly energy is available for growth — and the race is on. Generally the largest Oskar wins. Once it reaches the canopy its shade will kill competitors. If, however, there is no gap, Oskars eventually die after a couple of pointless decades of waiting while more germinate, taking their place.

If the gap is large, different types of trees join the race — pioneer species. Unlike the Oskars (otherwise known as climax species) pioneers cannot germinate or grow in low light. Instead their seeds, which remain viable (able to germinate) for much longer than those of climax species, wait for a burst of sunlight. Then they sprout and take off. These pioneer saplings grow much faster in bright light. They are sprinters whereas climax Oskars are long distance runners.

This is not all bad news for the climax species. Pioneers are able to grow in dry hot sunny conditions which Oskars dislike. Some have deep tap roots and can reach nutrient and water stores beyond the reach of shallowrooted climax species. They prevent soil erosion and create shady damp conditions where more little Oskars can germinate. Usually fast-growing pioneers live for just 20-50 years. Eventually a small gap opens and a patient Oskar on the forest floor has a chance at last. Although slowergrowing, these trees live much longer — for hundreds of years. It is these climax species, the long distance runners, which comprise a mature, well-established rainforest.





More light notes



Greedy leaves

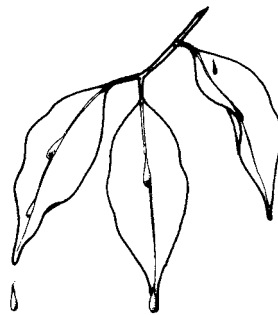
For a young sapling the bigger its leaves, the better are its chances of gathering light. Some forest trees produce young leaves which are very different from the mature leaves. *Darlingia darlingiana* produces large, lobed leaves (left) at first. Gradually they become less lobed and the mature leaves (right) are a conventional 'leafy' shape.

Angling for light

When competition for light is as intense as it is in the rainforest, the last thing you want to do is shade your own leaves. Next time you see a sapling, look at the way its leaves are arranged to gain maximum exposure. Many spiral out from the trunk — you can count five or more leaves before you find two growing at the same angle. Others produce their leaves at right angles, each new layer growing out further to avoid shading previous layers.

Drip tips

Many rainforest leaves have a glossy upper surface and pointed leaf tips — known as 'drip tips' — so water runs off quickly. This helps to prevent the growth of algae and lichens which are more likely to take hold on a damp surface. By covering the surface of the leaf, they would cut out light and, therefore, decrease its ability to photosynthesise. Quick rainwater runoff may also prevent the leaf from becoming too cool, which would slow down the activities of the living cells.



Red leaves in the rainforest


New growth on many rainforest plants, notably *Syzygium* species, is often a very attractive red colour, but the reason for this is a long-standing puzzle. The red or pink is caused by the pigment anthocyanin, (which also gives beetroot its colour). Its actual colour varies from red to brown and purple depending on the pH of the fluid in the leaf cells. Research by Dr Sharon Robinson of the Australian National University suggests that the red colour may act to protect the photosynthetic mechanism inside the new leaves. New red leaves are not yet photosynthetically active — they are still developing the internal organs (chloroplasts) responsible for capturing the sun's energy and converting it to stored energy. Anthocyanin pigment reflects red light like a mirror and absorbs light from the blue end of the spectrum. Anthocyanin can therefore act as a sunscreen, reducing the amount and type of light penetrating the leaf until the chloroplasts mature and can use the light photosynthetically. We see the red colouration because anthocyanin reflects red light away from the leaf and absorbs blues and greens.





Gathering sunflecks


Few plants can survive in the very dim light of the forest floor. Those that do depend on sunflecks — patches of sunlight which dodge the leaves above and reach parts of the floor for as little as a few seconds a day. Dark green forest leaves are very efficient at capturing sunlight. In addition, these plants seem to respond very quickly when they are lit up. With most plants there is a time lag after exposure to light, before photosynthesis begins. Then, as soon as the light is 'switched off', the rate of photosynthesis begins to decline. However, research indicates that forest floor plants switch on quicker — as soon as the sunfleck hits them — and continue to photosynthesise longer after the light has gone.


Facts and stats on light and leaves


 During a day, a hectare of forest can cycle 500 000 litres of carbon dioxide. With all plants on the earth doing this our atmosphere is completely recycled about every 250 years.


 Chlorophyll, the green matter in leaves, has existed for at least two billion years. Its decomposition products have been found in rocks containing algae of that age.

 Almost all the oxygen in the earth's atmosphere (20 percent) has been derived from photosynthesis over the past two billion years.

 The long red and short blue wavelengths of visible light are absorbed more easily by chlorophyll than medium wavelengths. Most of these are reflected and enter our eye producing the effect we recognise as green.

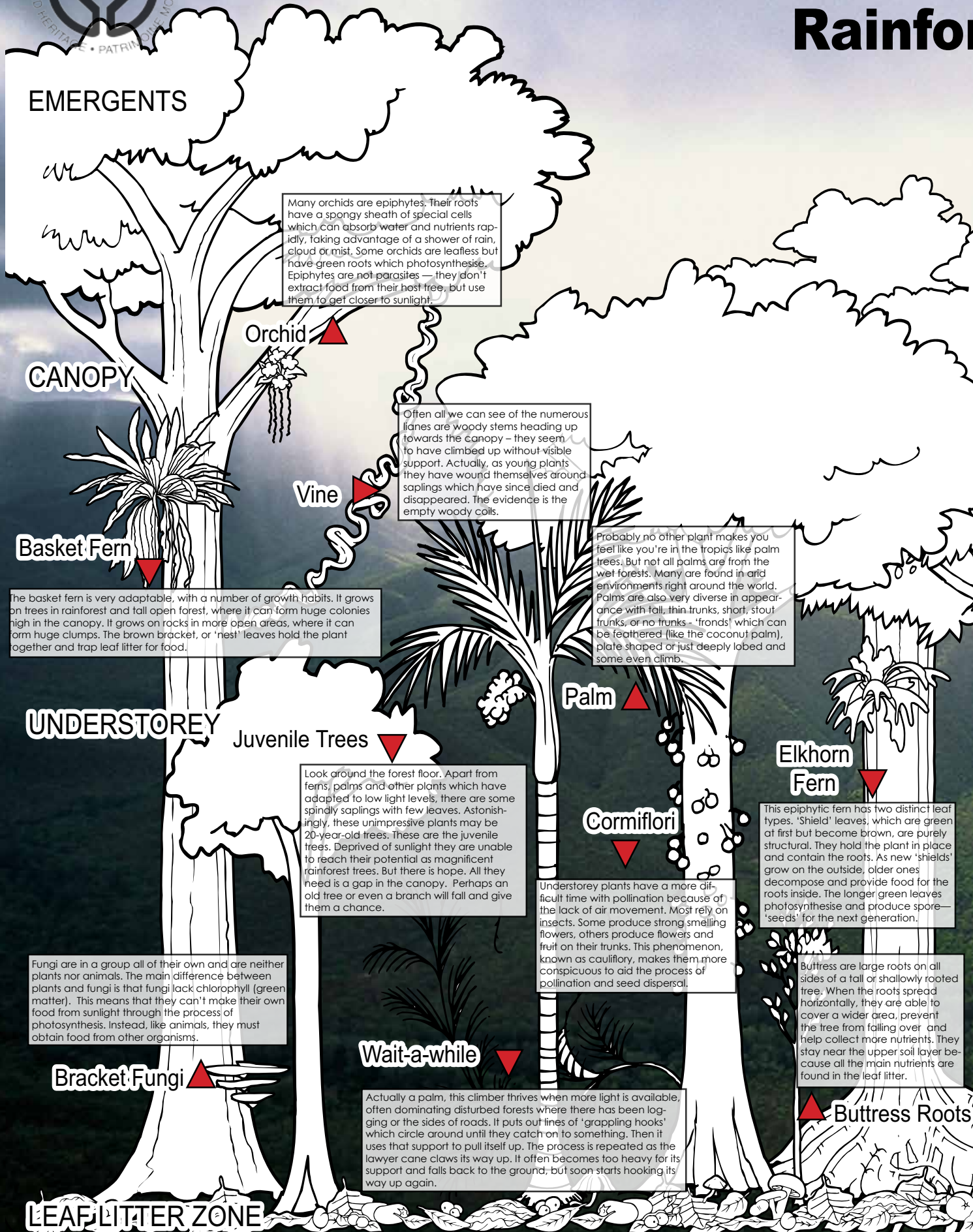
 Although 75-80 percent of the sunlight falling on a leaf is absorbed, only about 10 percent is actually captured by the chlorophyll and turned into energy.

 Almost all twiners twist themselves in an anticlockwise direction — whether in the northern or southern hemispheres. Scientists are still trying to understand why.

 Epiphytic ferns can become very heavy and break branches off trees. Some trees have defence mechanisms against epiphytes. Very smooth bark discourages them from gaining a foothold. Others have flaky bark which pulls away from the tree with the epiphyte's weight. It is thought that some trees may produce a toxin to inhibit epiphyte growth.



Reach for the Sky Rainforest



EMERGENTS

Many orchids are epiphytes. Their roots have a spongy sheath of special cells which can absorb water and nutrients rapidly, taking advantage of a shower of rain, cloud or mist. Some orchids are leafless but have green roots which photosynthesise. Epiphytes are not parasites — they don't extract food from their host tree, but use them to get closer to sunlight.

Orchid

CANOPY

Often all we can see of the numerous lianes are woody stems heading up towards the canopy — they seem to have climbed up without visible support. Actually, as young plants they have wound themselves around saplings which have since died and disappeared. The evidence is the empty woody coils.

Vine

Basket Fern

The basket fern is very adaptable, with a number of growth habits. It grows on trees in rainforest and tall open forest, where it can form huge colonies high in the canopy. It grows on rocks in more open areas, where it can form huge clumps. The brown bracket, or 'nest' leaves hold the plant together and trap leaf litter for food.

Probably no other plant makes you feel like you're in the tropics like palm trees. But not all palms are from the wet forests. Many are found in arid environments right around the world. Palms are also very diverse in appearance with tall, thin trunks, short, stout trunks, or no trunks - 'fronds' which can be feathered (like the coconut palm), plate shaped or just deeply lobed and some even climb.

UNDERSTOREY

Juvenile Trees

Look around the forest floor. Apart from ferns, palms and other plants which have adapted to low light levels, there are some spindly saplings with few leaves. Astonishingly, these unimpressive plants may be 20-year-old trees. These are the juvenile trees. Deprived of sunlight they are unable to reach their potential as magnificent rainforest trees. But there is hope. All they need is a gap in the canopy. Perhaps an old tree or even a branch will fall and give them a chance.

Palm

Corniflori

Elkhorn Fern

This epiphytic fern has two distinct leaf types. 'Shield' leaves, which are green at first but become brown, are purely structural. They hold the plant in place and contain the roots. As new 'shields' grow on the outside, older ones decompose and provide food for the roots inside. The longer green leaves photosynthesise and produce spore-'seeds' for the next generation.

Fungi are in a group all of their own and are neither plants nor animals. The main difference between plants and fungi is that fungi lack chlorophyll (green matter). This means that they can't make their own food from sunlight through the process of photosynthesis. Instead, like animals, they must obtain food from other organisms.

Bracket Fungi

Understorey plants have a more difficult time with pollination because of the lack of air movement. Most rely on insects. Some produce strong smelling flowers, others produce flowers and fruit on their trunks. This phenomenon, known as cauliflory, makes them more conspicuous to aid the process of pollination and seed dispersal.

Wait-a-while

Actually a palm, this climber thrives when more light is available, often dominating disturbed forests where there has been logging or the sides of roads. It puts out lines of 'grappling hooks' which circle around until they catch on to something. Then it uses that support to pull itself up. The process is repeated as the lawyer cane claws its way up. It often becomes too heavy for its support and falls back to the ground, but soon starts hooking its way up again.

Buttress are large roots on all sides of a tall or shallowly rooted tree. When the roots spread horizontally, they are able to cover a wider area, prevent the tree from falling over and help collect more nutrients. They stay near the upper soil layer because all the main nutrients are found in the leaf litter.

Buttress Roots

LEAF LITTER ZONE



Forest Structure Diagram

Whether they are stretchers, climbers, jumpers, hitchhikers or sunfleck gatherers, all plants are aiming to capture the sun's rays.

Here are some different strategies they use to reach for the sky.

Rainforest Types

Wet Tropics Rainforests have three major landscape types:

- The uplands/tablelands
- The coastal hills
- The lowland coastal plains

The region is recognised as the most bio-diverse of any area in Australia.

The Canopy

The canopy consists of the tree tops. The canopy keeps the rainforest below cool, moist and shady. The canopy is an interlocking network of sun-hungry leaves. It is so efficient that only 3 - 15 per cent of sunlight penetrates this uppermost tree canopy to reach the lower undergrowth.

Emergents

Emergents are the tallest trees in the rainforest overtopping the canopy layer. They grow as high as 60 m above the forest floor with trunks that measure up to 5m around.

Understorey

Below the canopy we find the understorey. This area gets only 2-5% of the sunlight available to the canopy. This limited light encourages the resident plants to devise unique ways to survive, such as the solar-collecting dark green leaves. This level is comprised of vines, smaller trees, ferns and palms.

Leaf Litter Zone

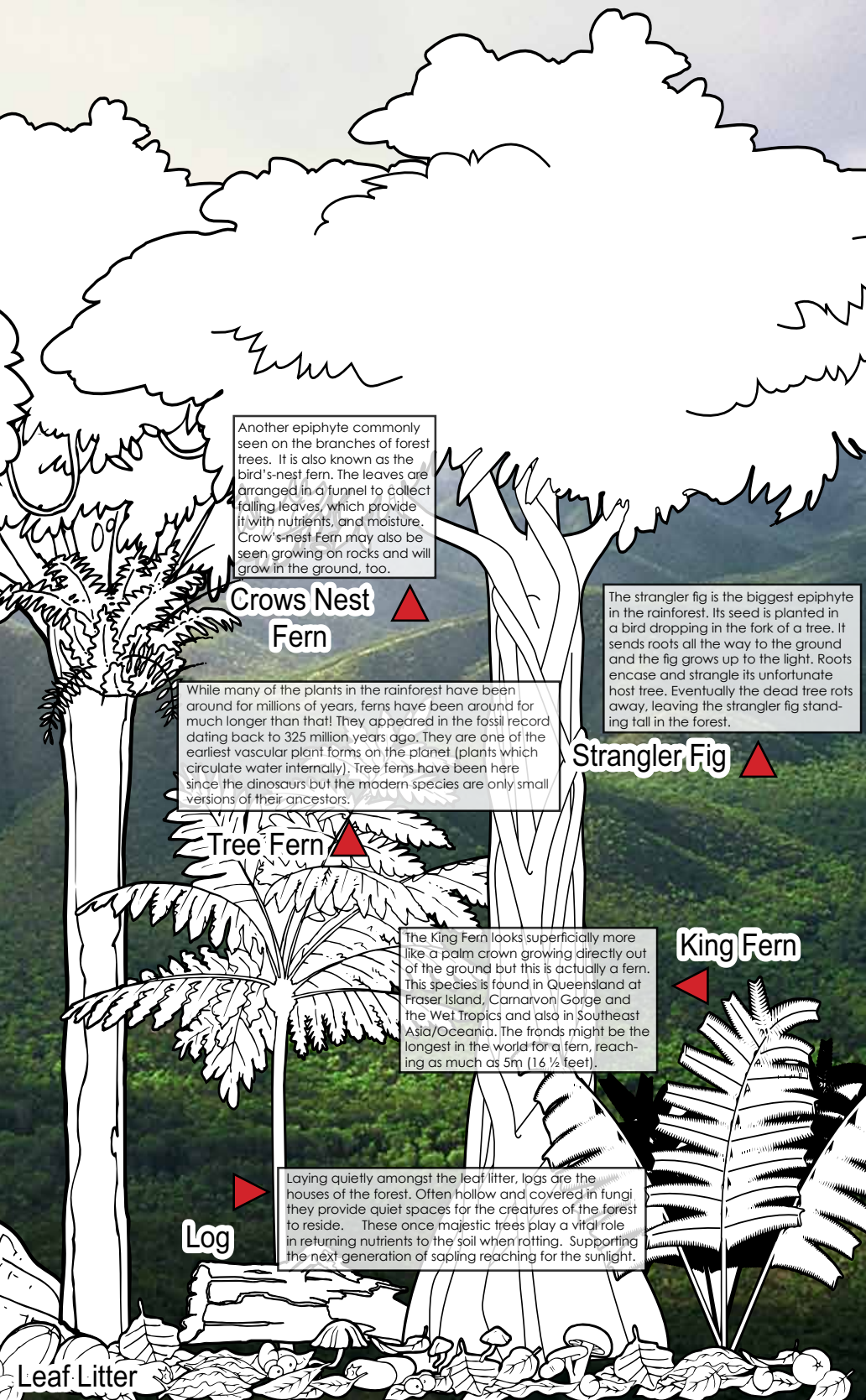
The leaf litter provides a healthy compost to feed the rainforest plants and keep the soil moist. Very little sunlight filters through to this area. Mosses, herbs and fungi grow here. There is much decay on this level, which sends nutrients back into the soil.

To learn more about the Wet Tropics contact:

Ph: 4052 0555

Email: wtma.records@derm.qld.gov.au or go to:

www.wettropics.gov.au



Another epiphyte commonly seen on the branches of forest trees. It is also known as the bird's-nest fern. The leaves are arranged in a funnel to collect falling leaves, which provide it with nutrients, and moisture. Crow's-nest Fern may also be seen growing on rocks and will grow in the ground, too.

Crows Nest Fern

The strangler fig is the biggest epiphyte in the rainforest. Its seed is planted in a bird dropping in the fork of a tree. It sends roots all the way to the ground and the fig grows up to the light. Roots encase and strangle its unfortunate host tree. Eventually the dead tree rots away, leaving the strangler fig standing tall in the forest.

Strangler Fig

While many of the plants in the rainforest have been around for millions of years, ferns have been around for much longer than that! They appeared in the fossil record dating back to 325 million years ago. They are one of the earliest vascular plant forms on the planet (plants which circulate water internally). Tree ferns have been here since the dinosaurs but the modern species are only small versions of their ancestors.

Tree Fern

The King Fern looks superficially more like a palm crown growing directly out of the ground but this is actually a fern. This species is found in Queensland at Fraser Island, Carnarvon Gorge and the Wet Tropics and also in Southeast Asia/Oceania. The fronds might be the longest in the world for a fern, reaching as much as 5m (16 1/2 feet).

King Fern

Laying quietly amongst the leaf litter, logs are the houses of the forest. Often hollow and covered in fungi they provide quiet spaces for the creatures of the forest to reside. These once majestic trees play a vital role in returning nutrients to the soil when rotting. Supporting the next generation of sapling reaching for the sunlight.

Log

Leaf Litter



Nature notes

A diary of natural events creates a pleasing journal which grows richer with the passage of time. Watching for the recurrence of an event after noting it in a previous year, and trying to understand what could have caused changes in timing, is intriguing. These notes are from the author's own notebook, or were offered by researchers and fellow naturalists.

Readers will, inevitably, note variations between their observations and those appearing here. If you do not keep a nature diary perhaps



Spring in Wet Tropics rainforests will see the blossoming of a plant known as 'native guava' (*Eupomatia laurina*). These flowers are thought to show some primitive characteristics. For example, what look like numerous white petals are, in fact, sterile stamens, revealed after the united petals are pushed off as a cap, similar to the process in eucalypt flowers. The sterile stamens are food for a small weevil which lives in close association with this flower, assisting in its pollination.

A small, glossy-leaved beach tree known as the sea hearse (*Hernandia nymphaeifolia*) should carry ripe fruit this month. The gloomy name is an allusion to its unusual fruit, a dark, ridged seed case, partially concealed within 'a loose smooth cream envelope with a circular opening at the top through which the black fruit can be seen ... the fruit's structure apparently suggesting a carved coffin surrounded by a pale shroud.' (Cribb, A.B. and J.W., 1985: *Plant Life of the Great Barrier Reef and Adjacent Shores*.)

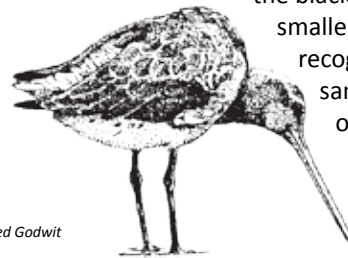


Numbers of migratory waders will also be reaching a peak during September, returning to our hemisphere after a busy breeding season in far-off nations to the north, during their summer. Most numerous of about 30 species of waders recorded on the Cairns mudflats are sharp-tailed and curlew sandpipers and red-necked stint.

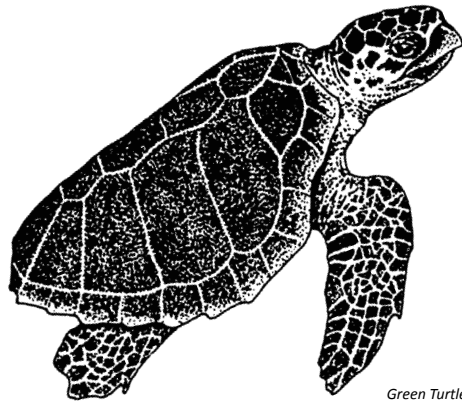


Whimbrel

Relatively easy to identify are the large eastern curlew, its smaller relative, the whimbrel, and two species of godwit - the blacktailed and bar-tailed. Of the smaller species, two of the most recognisable may be the Terek sandpiper with its squat body on orange legs and the greenshank, with dark green legs. (Acknowledgements to John Crowhurst, Cairns Regional Council.)



Bar-Tailed Godwit



Green Turtle

Female green turtles may begin mating during September, accepting and storing sperm from several males. During mating, which takes place at the surface, the shell of the male can be seen as an almost immobile lump on the water.

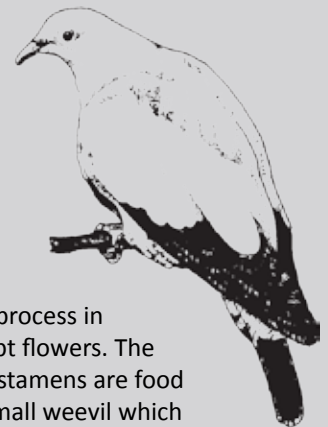
Fertilised green turtles may begin egg laying at traditional beach sites about November, producing several clutches of up to 150 eggs at intervals until about March next year. (Acknowledgments to Mark Simmons of GBRMPA.)

Pied imperial - pigeons

September marks the start of the period when our skies are enlivened by Pied imperial-pigeons. These striking white and black birds return from New Guinea to nest offshore, on islands such as Hinchinbrook and Low Isles, as well as in trees on the mainland, including some lucky urban backyards.

Rainforest fruits which feature prominently in their diet include many of the laurel family (*Cryptocarya* spp), lawyer palms (*Calamus* spp), figs and woodland trees of the *Canarium* family (*Canarium vitiense* and others).

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to the process in eucalypt flowers. The sterile stamens are food for a small weevil which lives in close association with this flower, assisting in its pollination.

Pied imperial-pigeons raise one young at a time, the parents taking turns to feed the nestling on 'pigeon milk' secreted from glands in the crop, a procedure common to all pigeons. Birds may raise a second offspring after the first fledges, but this has not been confirmed. (Acknowledgments to Francis Crome, CSIRO Wildlife, Atherton.)