Tropical Topics

An interpretive newsletter for the tourism industry

Forest fruit dispersal

No. 35 April 1996

Notes from the Editor

Writing some of this issue at home, I was frequently distracted by the squawking of metallic starlings feeding on the fruits of the buttonwood tree in my garden. Closer to the window, preparations are in hand for the October fruit feast, as buds appear on the corky bark tree.

In temperate climates there is an autumn glut of fruit but animals must include other foods in their diets if they are to survive the rest of the year. In the tropics fruit is produced all year and as a consequence there are many animals, particularly birds, which eat nothing, or little, else.

Since so many animals depend on these fruits and so many trees depend on the animals, it is a good idea to help keep the cycle going by planting those native trees which provide food. You can find a list of some on page 7.

I would like to thank the following people for their assistance with this issue: Andrew Dennis, JCU; Stephen Comport, CSIRO; Graham Harrington, CSIRO; Bernie Hyland, CSIRO; Rosemary Lott, JCU; Mike Trenerry, DoE.

Unexpected dispersers

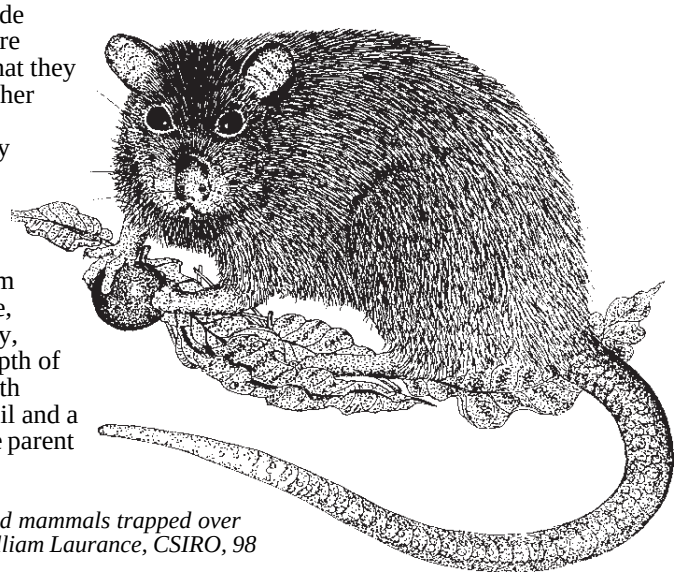
Wind, gravity and water can move seeds away from the parent plant, but a very high percentage of rainforest species employ animals, paying them with a dispensable fruit layer for their seed dispersal services.

While the plant is prepared to supply a certain degree of nutrition in this fruity packaging, it invests the lion's share of nutrients in its seeds for the benefit of the next generation. Many of these seeds are protected by a hard shell — but a number of rainforest animals have realised that it is worth the effort of penetrating this defence.

Giant white-tailed rats are among the most voracious of these, using their exceedingly strong teeth to break into even the hardest nuts. Given the sheer numbers of rats in the rainforests* and the thoroughness of their seed predation (see below) it is actually surprising that any of their favourite trees survive.

However, it seems that white-tailed rats have a habit which works in the trees' favour. They hide seeds. Perhaps they are unable to eat all of what they find and hide them rather than share them with others or perhaps they are looking ahead to lean times. Whatever the reason, this results in seeds being taken from below their parent tree, carried up to 60m away, buried, singly, at a depth of 1-2cm and covered with lightly compressed soil and a layer of leaf litter. The parent tree could hardly wish for a better fate for its offspring.

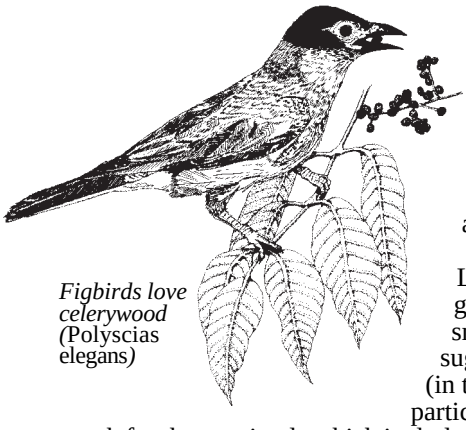
Unfortunately for the seeds, white-tailed rats are good at finding the buried seeds. Perhaps they can smell them or perhaps they remember where they buried them — no one knows. Of 1244 seeds whose fate was followed by CSIRO researchers, 20 percent were hidden but all were eventually eaten. However, although none of the seeds studied ever got a chance to germinate, one remained uneaten for 20 weeks which would have been long enough for seeds of many species to sprout and grow. It would appear that one seed, carefully buried and then forgotten, probably makes up for the multitudes that are sacrificed for the cause.



**Of 10 000 small ground mammals trapped over the past ten years by William Laurance, CSIRO, 98 percent were rats.*

WET TROPICS MANAGEMENT AUTHORITY

QUEENSLAND GOVERNMENT Department of Environment



*Figbirds love celerywood (*Polyscias elegans*)*

Quality or quantity?

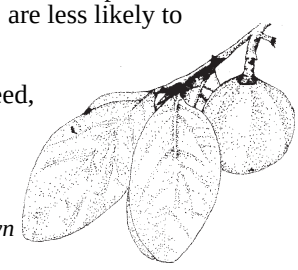
When producing fruits to attract animals, plants have a number of options. One plant may produce a large number of small 'poor quality' fruits while another opts for a smaller number of 'top quality' fruits.

Lilly pillies (*Syzygium* spp.) are in the former group. They produce abundant crops of small fruits which are high in water and sugar content and thus 'cheap' to produce (in terms of energy and resources used). Not particularly high in nutrients, they may be a snack for those animals which include fruits in a mixed diet — but the plant is taking a risk. A number of the consumers are likely to also be seed eaters or to have grinding gizzards which would also destroy ingested seeds. A significant proportion of the seeds from these plants are certain to be doomed.

Fruits in the second group, such as some of those in the Lauraceae family, are particularly sought after by those animals which depend on fruit. They need a more nutritious diet and are offered fruits with a higher content of protein, fat and oil. Requiring more of the plant's energy for production, fewer are produced, but their consumers, such as cassowaries and fruit pigeons*, are less likely to destroy the seeds.

Fruits in the second category are likely to have a large seed, perhaps encased in a hard shell. The large seed has less chance of being carried far from the parent plant than a small one, but is more likely to produce a strong sapling.

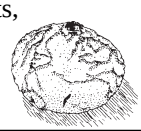
**Not all fruit pigeons are soft on seeds. Some, notably the brown cuckoo-dove, have stones in their gizzards and can reduce the seeds of the fruits they eat to a paste.*



*The hairy walnut (*Endiandra insignis*), a nutritious Lauraceae fruit .*

Fatal attractions

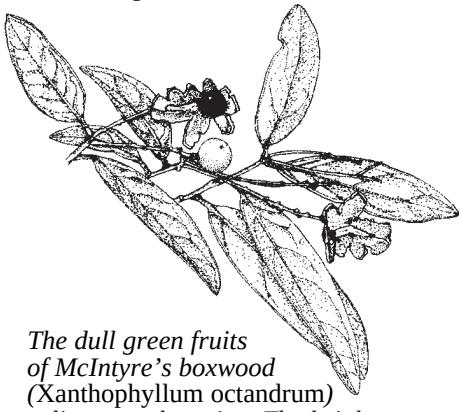
Just because cassowaries and other birds, or even mammals like rats, can eat rainforest fruits, it does not mean that we can also. A very large proportion are very poisonous so please remember — the bright attractive colours are strictly for the birds (and some non-human mammals).



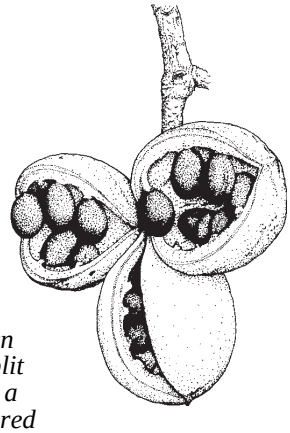
Coming attractions

Plants do not want their fruit to be picked before it is ripe. To prevent this some are covered with spines, others lack the attractive scent of the ripe version and many are colour-coded. Greens and browns camouflage unripe fruits which may turn to red, yellow, black or blue when ripe to advertise their readiness for plucking. It has been said that it is the fruits of the rainforest, rather than the flowers, which produce many of its most vivid colours.

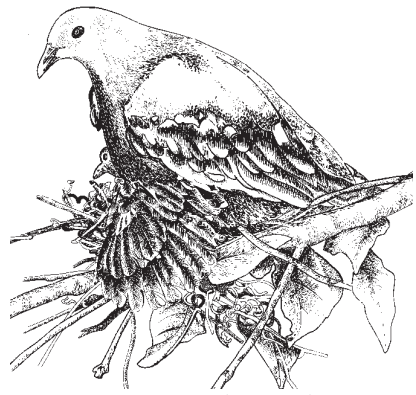
A familiar strategy for rainforest plants is to conceal their seeds in a dull coloured capsule which splits open when ripe to display a bright red or orange interior with contrasting black seeds or seeds with colourful arils.



*The dull green fruits of McIntyre's boxwood (*Xanthophyllum octandrum*) split open when ripe. The bright yellow inner lining thus revealed puts the black seed on display for the birds.*



*Peanut tree (*Sterculia quadrifida*) pods have a greenish-brown exterior but split open to reveal a strongly coloured orange to vermilion interior, contrasting with half a dozen shiny black seeds.*



Wompoo pigeon at its nest

Feeding the youngsters

Most animals which eat fruit have to supplement their diet with insects, nectar, pollen and so on. Cassowaries are known to sometimes eat snails, insects, fungi, flowers and dead animals. Only a few animals, mainly birds which can easily move as supplies fluctuate, eat nothing but fruit.

When raising young, which require protein to develop, mammals are able to provide protein-rich milk. Birds do not have mammary glands — but those strict frugivores, the fruit pigeons, are able to produce a milk-like substance in their crops to feed to their chicks. Other fruit-eating birds, unable to perform this feat, may break with their vegetarianism and give insects to their chicks, even if only for a few days.

The fruitfly connection

When the papaya fruit fly was found in north Queensland there were fears that it would spread into the forests of the wet tropics so, in January, DPI staff began a rainforest trapping program. They plan to continue until the end of May to cover the peak of the fruiting season.

A total of 148 traps have been placed in rainforest sites from Noah Creek, near Cape Tribulation, to Josephine Falls and East Palmerston. Happily, very few papaya fruit flies have been found in these traps, most of them in traps located close to roads at Lake Morris, Kuranda and Rex Range. No breeding populations were found. Even better, of 3000 rainforest fruit samples collected none contained the fruit fly. It appears that the flies are attracted primarily to commercial fruits, where they are much more easily controlled.

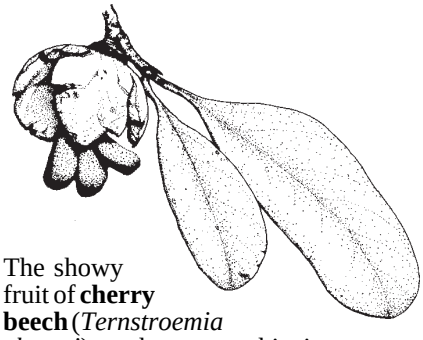
Unfortunately the feral flies are attracted to the equally feral guava trees which grow in the wild. DPI staff are targetting the trees with a herbicide program.

Out and about

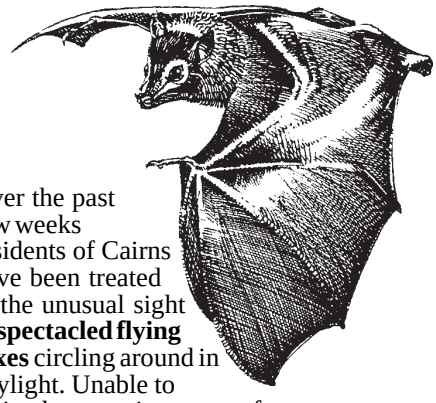
The **Great Barrier Reef Marine Park Information Manual**, and associated videos, have been produced by GBRMPA and will be available very soon.

The manual is in four components. *Reef Essentials* provides a basic understanding of how the World Heritage Area is managed and how to conduct activities in the most environmentally responsible manner. It is accompanied by a 60min. video. *Reef Understandings* is about the ecology and biology of the Reef and has an associated 1hr 30min. video. *Reef Communication* deals with skills and ideas needed to effectively communicate information and *Reef Learning Guide* outlines the main concepts in the manual as a whole.

A copy of the kit will be mailed to each permitted tour operator in the GBRMP and additional copies will soon be available from GBRMPA. Tel: (077) 500 700 for details.

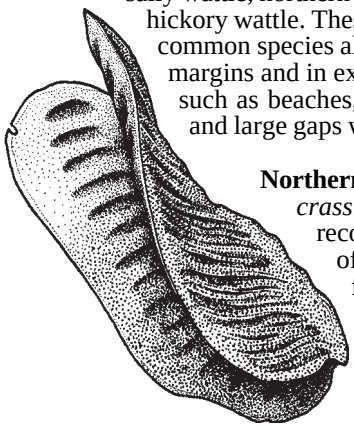


The showy fruit of **cherry beech** (*Ternstroemia cherryi*) can be seen at this time of year. Yellow oval fruits split open when ripe allowing seeds clothed in bright pink-red arils to dangle out and attract the attention of passing birds.

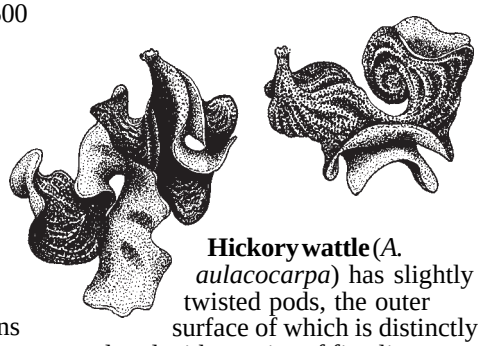


Over the past few weeks residents of Cairns have been treated to the unusual sight of **spectacled flying foxes** circling around in daylight. Unable to resist the tempting scent of their favourite food, melaleuca nectar, the bats are throwing caution to the wind and taking their chances with falcons and sea eagles which could attack them. Melaleuca trees put on two courses of nectar, a daytime feast for honeyeaters and other birds and a nocturnal one for bats and moths. Efficient pollinators as well as fruit dispersers, the bats reward the melaleucas by fertilising their flowers.

April is usually **wattle-blossom** time for several species found in the wet tropics. Flowers can be expected from brown salwood or sally wattle, northern wattle and hickory wattle. These three are common species along rainforest margins and in exposed situations such as beaches, steep ridges and large gaps within rainforest.

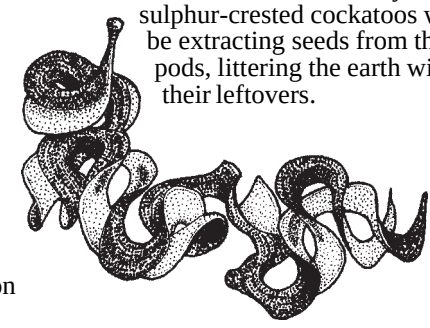


Northern wattle (*Acacia crassicarpa*) is easily recognised because of its very broad, flat pods.



Hickory wattle (*A. aulacocarpa*) has slightly twisted pods, the outer surface of which is distinctly sculpted with a series of fine lines.

Brown salwood (*A. mangium*) develops tightly coiled seed pods. About the middle of the year sulphur-crested cockatoos will be extracting seeds from these pods, littering the earth with their leftovers.



Please note that **permits** are required for commercial activities carried out on conservation parks and resources reserves as well as national parks. Local examples of these include Mount Whitfield Conservation Park, Cairns, Jumrum Creek Conservation Park, Kuranda, Malanda Falls Conservation Park, Keatings Lagoon Conservation Park near Cooktown, Chillagoe (Smelter) Resources Reserve, Heathlands Resources Reserve, Iron Range Resources Reserve, Jardine River Resources Reserve, and Palmer River Goldfields Resources Reserve.

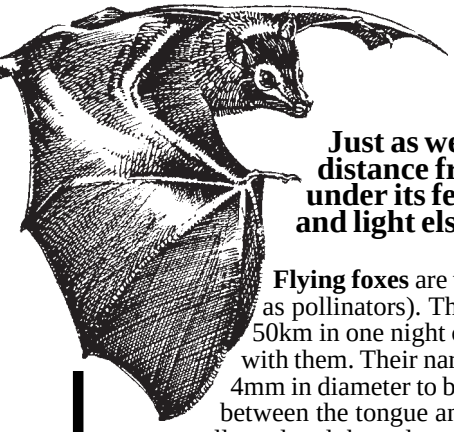
Mastering the Tropical Environment
The Tropical Environment Vacation School is providing professional development courses for resource managers, academic staff and industry personnel. Three intensive training courses on contemporary planning and management of Australia's tropical coast will be held at Townsville's James Cook University this year. Each 10-day course is run by leaders in their field and involves extensive lectures, case study workshops and tutorials.

Environmental law in the tropics
Coordinator: Peter James
Dates: 24 May-3 June 1996
Venue: JCU Cairns campus
Cost: $1000

Integrated coastal management: Ecologically sustainable use of Australia's coastal zone
Coordinator: Richard Kenchington
Dates: 8-19 July 1996
Venue: JCU Townsville campus
Cost: $1000

Caring for country: Recognition of indigenous people's interests in managing Australia's tropical environments
Coordinator: Dermot Smyth
Dates: 9-20 July 1996
Venue: JCU Townsville campus with a field trip to Aboriginal communities
Cost: $1000

For further information and bookings contact Tropical Environmental Studies and Geography, JCU, Townsville, Tel: (077) 81 4325; Fax (077) 81 5581.

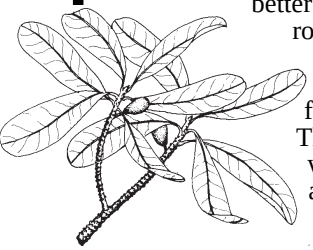


Agents of dispersal

Just as we expect grown children to leave home and produce their families at some distance from us, so also a parent tree strives to prevent its seedlings from growing up under its feet. It is better for the saplings to take their competition for soil nutrients, water and light elsewhere. Movement for a stationary tree, however, requires an agent.

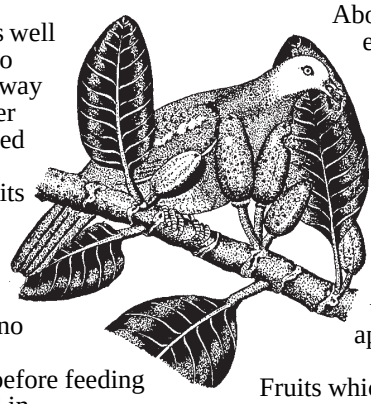
Flying foxes are very important seed dispersers (as well as pollinators). They visit tree tops and can fly up to 50km in one night carrying seeds at least part of the way with them. Their narrow gullets allow only seeds under 4mm in diameter to be swallowed. Most fruit is squashed between the tongue and the ridged palate, the juice swallowed and the pulp and intact seeds spat out. Large fruits are often carried some distance, the fruit consumed and seeds dropped elsewhere.

The greater the number of flying foxes seeking fruit from a tree the better it is for the tree since those for which there is no room on the branches may perform daring raids, snatching fruit and carrying it some distance before feeding — and depositing the seed. Some are dropped in flight thus introducing saplings to cleared areas. The same good fortune awaits small seeds which were ingested as they are also defecated while the animal is flying. This puts these seeds at an advantage over those eaten by birds which are usually dropped from perches in trees, not in open areas.



Fruits which appeal to bats tend to be pale brown, green or yellow, like this pale yellow pencil cedar (Palaquium galactoxylum).

The Queensland tube-nosed bat feeds on fruit and is known to disperse whole fruits, such as figs.



About 40 species of rainforest **birds** eat fruit as a major part of their diet. The most important of these as far as dispersal is concerned are the pigeons; Australia has a particularly large number of pigeon species (which perhaps compensates for the lack of those important dispersal agents found in most other tropical forests — monkeys and apes).

Fruits which attract birds are usually brightly coloured and frequently employ contrasting combinations of red, yellow and black when ripe. Small fruits may be swallowed whole and the seeds passed through the bird's digestive system, ideally intact, but often birds regurgitate the seeds from their crops, spitting them out rather than allowing them to pass right through. Otherwise the fleshy fruit, or an attractive covering around the seed called the aril, is eaten and the seed discarded without being swallowed.

*When the dull green capsules of the fire vine (*Tetracera nordtiana*) are ripe they split open to release bright red filigreed discs (arils) in the centre of which are shiny black seeds, the size of a matchhead. The red attracts birds, particularly metallic starlings, which devour the aril, rejecting the seed.*

Over 1500 Australian plant species produce seeds with a small appendage called an elaiosome. This part of the seed is rich in fats and attracts **ants**. They carry the seed back to their nests where they feed the elaiosomes to their larvae before discarding the seed — which is to all intents and purposes neatly planted in a nutrient-rich environment (the ants' waste heap) at a distance from the parent plant and out of sight of seed predators. This is particularly common among plants in dry areas but also in acacias in disturbed rainforest areas.

Evidence is emerging from research done by JCU student Andrew Dennis that **musky rat-kangaroos** may be extremely important seed dispersers. These little marsupials feed primarily on fruits and seeds of rainforest plants, as well as invertebrates and mushrooms. The fruits they eat range from tiny ones to those weighing 100g. Sometimes only the flesh is eaten and sometimes the seed as well.

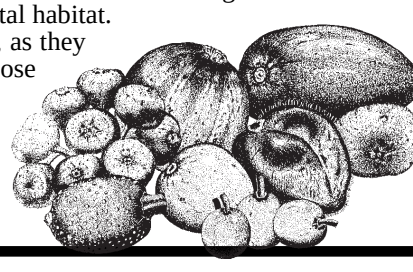
Musky rat-kangaroos do not like to share their food so, if another one appears at a fruit-fall, the first animal will usually pick up a fruit and run away to feed. In cases where only the flesh is eaten, the seed is dropped, in the leaf litter, away from the parent plant where it has a greater chance of survival. This process is likely to happen a number of times at a fruit-fall.

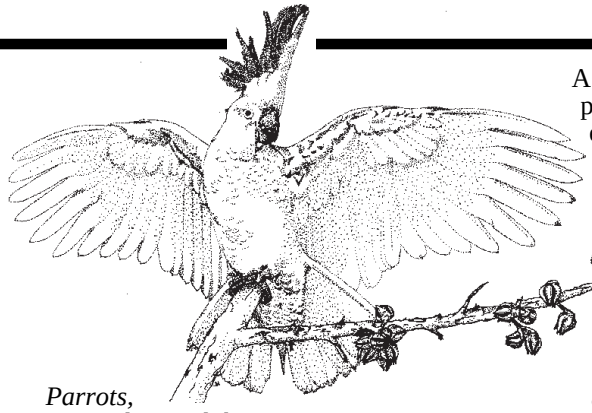
Like white-tailed rats, musky rat-kangaroos also scatterhoard — they take single fruits and seeds and hide them at different locations throughout the forest in buttresses, under logs, in the leaf litter or buried in the soil so that competitors — including rats — are unlikely to find them.

As with those hidden by white-tailed rats, some fruits and seeds are eventually overlooked and are well-placed to germinate. However, in contrast to the white-tailed rats, even when the musky rat-kangaroos do return to recover their booty, they may eat only the flesh of the fruit, dropping the intact seed. Musky rat-kangaroos are thus important dispersers for forest fruits and may indeed handle as many species as the cassowary.

The parents of seeds larger than a plum are in trouble when it comes to getting their progeny to leave home. No birds are able to move such large seeds — apart from one giant, the **cassowary**. Sometimes called an 'honorary mammal' for a lifestyle which scarcely resembles that of a bird, the cassowary eats the fruits of over 70 rainforest trees. Its gentle digestive system passes the seeds, unharmed and often with flesh still attached, into what is, in effect, a pile of compost. While keeping the seeds moist, it is thought that this compost also protects the seeds from predators such as the white-tailed rat. It is also thought that something in the cassowary's digestive system stimulates germination of certain seeds.

Cassowaries numbers are decreasing in the wild as they lose vital habitat. Unfortunately, as they disappear we lose a very important agent of distribution.



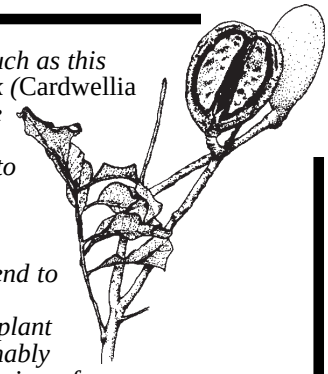


Parrots, particulary sulphur-crested cockatoos, destroy a great number of seeds with their strong beaks. However, being messy eaters, they may unintentionally help the plants by dropping a proportion of the seeds and knocking fruits to the ground where cassowaries and other forest floor animals pick them up and continue the dispersal process.

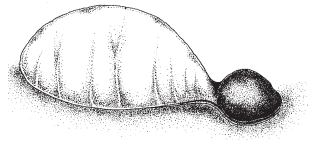
A number of large trees, particularly high canopy and emergent trees rely on **wind** for dispersal.

*The woody cones of brush cyprus pine (*Callitris macleayana*) (left) contain winged seeds. Sulphur-crested cockatoos consume large numbers of them but allow others to escape on wind currents.*

*Various 'oaks', such as this northern silky oak (*Cardwellia sublimis*) produce woody capsules which split open to free the light flattened seeds within. Wind-dispersed seeds tend to be brown or grey, resembling dead plant tissue and presumably avoiding the attention of predators.*



The spore-like seeds of orchids and epiphyte ferns are so light they can be carried aloft by the lightest breeze to treetop branches where new plants can develop.



*Seeds of red tulip oak (*Argyrodendron peralatum*) are wind bourne.*

Although they feed mainly on leaves, **possums**, particularly brushtails, sometimes take advantage of the fruit on offer and can carry large ones, even the size of an apple. Bad-tasting fruits may also benefit from possum distribution, being spat out when the animal discovers how unpleasant they are!

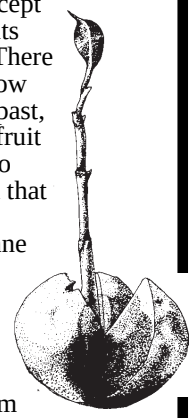
Tree-kangaroos too may act as part-time agents.

Recent floods would have done some plants a favour by moving their seeds to suitable spots for germination and growth. Some fruits are destroyed by immersion in **water** but others are buoyant. Many seaside plants, including mangroves, seek water transport (see *Tropical Topics* 26) but some rainforest trees, particularly those which thrive along riverbanks, such as creek satinash (*Syzygium australe*) also use this as one of their options. Seeds of the blue quandong (*Elaeocarpus angustifolius*) and black bean (*Castanospermum australe*) float well and survive periods in water.

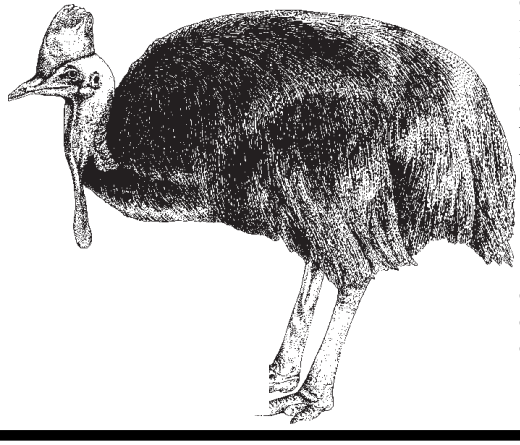
Blue quandong

Black bean

Some rainforest trees produce huge seeds which are too big for even a cassowary to tackle. Ribbonwood (*Idiospermum australiense*) is a rare tree found only in small areas of the wet tropics. With a fruit the size of a billiard ball and a seed which is highly toxic to mammals (except for musky rat-kangaroos), currently its only option for dispersal is **gravity**. There is no way this plant can, naturally, now move uphill! Perhaps, in the distant past, it had an animal disperser. Since the fruit would have to be swallowed whole to remain viable, it has been postulated that its primitive disperser (if it had one) would have been as big as a five-tonne truck!



Without human intervention, ribbonwood will eventually have nowhere to go except the sea — and extinction. This illustrates the problem faced by many plants if their disperser (or pollinator) disappears. We still know little about the intricacies of these relationships. It is likely that certain seeds could not germinate if a particular animal is not able to remove an aril or crack a hard shell or remove a germination inhibitor. Then, slowly but surely, the forest composition would be irreversibly changed.



Apart from their role as seed predators and dispersers (see page 1), **white-tailed rats** also perform a very important function by spreading the spores of certain mycorrhizal fungi. In common with northern bettongs, they dig up and eat the underground fruiting bodies, the truffles, dispersing the spores in their faeces. These fungi form important symbiotic relationships with both rainforest and sclerophyll trees. They attach themselves to the roots and, in return for sugars extracted from the trees, transfer nutrients and water from the soil to their hosts. Some tree species are unable to survive without these fungi so the rats' role in dispersing the spores is an important contribution to the forest's wellbeing.

Other rodents also feed on fruits. Bush rats have been observed carrying large fruits, such as figs, to 'feeding tables' where they are eaten over a few days, some seeds being left intact. They are also thought to hide and store seeds. Melomys also feed on rainforest fruits.

Questions & Answers

Q What is the latest on the declining frogs of the wet tropics?

A Seven wet tropics frog species have declined since the mid-1980s. Four of these appear to be extinct and three species remain only in lower altitude fringes of their former distributions. The declines have moved through Queensland in a wave, at a rate of 100km per year on average, from south to north. In some cases frogs which were abundant vanished in only one season.

Despite the efforts of a number of scientists to either rediscover the frogs or discover the reason for their disappearance, there have been no dramatic breakthroughs. In November and December 1994, 39 people combed Thornton Peak — without success. In June 1995 searchers were lifted into a remote part of the North Johnstone River, west of Innisfail, hoping to find some traces of the frogs in a pristine area remote from human contact — but found none. Bellenden Ker and Bartle Frere have similarly been scoured without result.

A number of theories for the disappearances have been suggested. Glyphosate herbicides are known to kill frogs and tadpoles but pollutants such as these are less likely to affect pristine upland habitats, the scene of the disappearances, than the lowlands, where some species still survive. An increase in ultraviolet rays, due to holes in the ozone layer, sounds like a good theory — but most of the declining frogs are nocturnal, hiding away during the day, and in any case the ozone hole affects temperate, not tropical latitudes.

A favourite theory is that a virus is sweeping through frog populations. One which cannot survive in the warmer temperatures of the lowlands would explain why only upland frogs have been affected. If this virus was spread in water, it would explain why stream-dwelling frogs, which breed in water, have been the only species affected. It could also possibly be spread by mosquitoes or black flies which bite frogs and move between catchments. However, the big problem with the virus theory is that none has been isolated from the dead frogs analysed.

One common feature of those frogs which have disappeared is that they produce only low numbers of eggs. If hit by a disease they would be likely to take much longer to recover their numbers than the more fecund species. Possibly the problem is a combination of effects — perhaps pollution carried in rainfall weakens a population which is then devastated by a disease it would normally be better able to resist, the low numbers of eggs produced preventing it from making a recovery.

Scientists are continuing their research. If there are any breakthroughs, we will let you know.

Q Do fish vocalise?

A Many fish are not silent. Angelfish have been heard to thump loudly and certain damsels make chirping noises to communicate. Sweetlips are also sometimes known as grunts because of the grinding noise made by the teeth in their throat and amplified by their swim bladders. Jewfish are known as croakers in America because of the sound created by them drumming their swim bladders and toadfish are presumably named for the resemblance of their mating calls to those of toads and frogs. Dwellers in houseboats on the coast of the United States are kept awake at night by the extremely loud noises made by one of these species, the oyster toadfish. More locally, our noisy fish include saltwater grunters, trumpeters and freshwater blackbream.

Tourist talk

ENGLISH	GERMAN	JAPANESE	
fruit	Frucht	kajitsu	果実
seed	Samen	tane	種
disperse	verbreiten	chirasu	散らす
white-tailed rat	Weißschwänzige Ratte	shiro o nezumi	白尾鼠
cassowary	Casuar	hikui dori	火食い鳥
flying fox	Flughund	o o koumori	オオコウモリ
bird	Vogel	tori	鳥
pigeon	Taube	hato	鳩
wind	Wind	kaze	風
gravity	Schwerkraft, Gewicht	juryoku	重力

Facts and Stats

About 80 percent of Australian rainforest trees produce fleshy fruits attractive to vertebrates, a much higher percentage than in other vegetation types. Rainforests have a correspondingly higher percentage of fruit-eating animals.

Some animals, such as squirrels, *larderhoard*, storing nuts in one place. *Scatterhoarding* animals hide the food items singly, in different places.

Mace, the spice, is the aril from around the nutmeg nut. Both of these are encased in a capsule which splits open when ripe. Sometimes native nutmegs, with a scarlet filigreed mace, are seen on the rainforest floor. Curiously, the edible part of the lychee is also an aril.

The eggs of many stick insect species resemble seeds with a nutrient-rich elaiosome-like appendage attached (see p4). This attracts ants and, like the seeds, the eggs are carried to the nest, stripped of their food packages and left underground in peace and safety to hatch, a process which sometimes takes years.

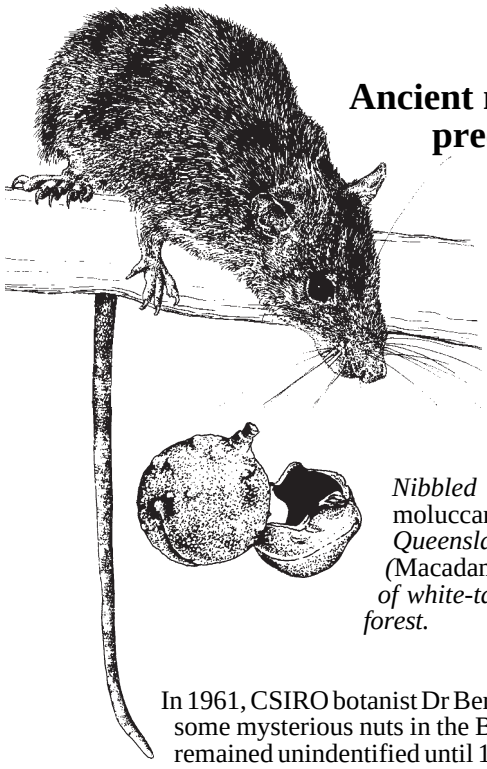
The teeth of white-tailed rats are strong enough to open tin cans and rainforest residents swear that these rodents can read the labels. A favourite is condensed milk. One rat was observed to unscrew the lid of a jar of jam.

Mistletoe fruits are extremely sticky and remain so after they have passed through the mistletoe bird — a process which takes only about half an hour from beak to bottom. The voided seed remains stuck by a gluey thread to the bird which has developed a characteristic dance to wipe it off on to a branch — exactly where the mistletoe seed needs to be. The procedure was wonderfully captured on film for the recent TV series *Secret Life of Plants*. A small mistletoe plant has been photographed sprouting on a telephone line, presumably wiped off there by a mistletoe bird.

Feral pigs, for all their faults including seed predation, may be distributors for some large-fruited forest plants — although this includes the terrible weed, pond apple (*Annona glabra*).

Seed dispersal on the fur or feathers of animals is rare in rainforest — except for the pisonias (*P. umbellifera*) (and the seaside *P. grandis*) which are so sticky that birds and even snakes have been unable to free themselves, sometimes dying as a result.

Plants manipulate animals to disperse their seeds for them — and humans are no exception. We collect fruit and throw away or deliberately plant the seeds. We even spread plants because they look good!



Ancient nuts and modern predators

*Nibbled candlenuts (*Aleurites moluccana*) (above) and Queensland macadamia nuts (*Macadamia whelanii*) are a sign of white-tailed rat activity in the forest.*

In 1961, CSIRO botanist Dr Bernie Hyland collected some mysterious nuts in the Bartle Frere area. They remained unindentified until 1994 when it was noticed that they resembled an old drawing of fossil nuts which had been set in rock 50-60 million years ago. They were identified as belonging to *Eidothea zoexylocarya*, a primitive member of the Proteaceae family.

Since the fossils came from central Victoria, this tree was obviously once widespread — in the days when rainforest covered much of the continent. Now, however, it is rare; it has been found only in five small groups within the wet tropics.

Interestingly, the majority of the nuts from the living trees have been opened and the seed stolen, presumably by rats. The fossil nuts, however, were intact. Conditions which led to their fossilisation, for example being buried in silt during a flood, may have prevented any predators from reaching them but it is also likely to be due to the lack of rodents in Australia at that time. They are certainly comparatively new arrivals; the oldest fossil rodents found in this region were no more than 4.5 million years old.

It is difficult to tell if predation by rats is the reason for the restricted distribution of this tree. After all, although most of the candlenuts found on the forest floor have been opened and robbed of their seeds by rats, there are still plenty of candlenut tree saplings so this species presumably benefits from the animal's tendency to scatterhoard — or, at least, is surviving the predation.

Similarly, despite the scarcity of intact nuts, there are some *Eidothea zoexylocarya* saplings in the forests, so hopefully this tree too will continue to survive predation.

Rats as agents of invasionary forces

It is thought that white-tailed rats contribute to the invasion of wet sclerophyll by rainforest. This process, which is diminishing the area of a rare and important habitat, is estimated to be proceeding at the rate of 1.25m per year.

In one experiment Steve Comport, Masters student with CRC TREM, attached reels of cotton to 50 yellow walnut (*Beilschmiedia bancroftii*) seeds on the rainforest floor. Two of the 50 were carried out of the rainforest and buried in neighbouring wet sclerophyll. It would seem that white-tailed rats act as agents for invasionary forces.

Plants for wildlife

Certain plant species are particularly beneficial for wildlife and are ideal for including in gardens and revegetation projects. Some of the best are listed below — but this is by no means a comprehensive list.

Acknowledgements to Mike Trenerry, Dept Env.

Particularly *useful characteristics are indicated — but please note that this is not the limit of the plant's benefits. Especially useful species are marked *.*	Good for: lowlands	Good for: uplands	Nectar eaten by: birds	Nectar eaten by: fruit bats	Nectar eaten by: insects	Fruit eaten by: birds	Fruit eaten by: fruit bats	Leaves eaten by: possums	Leaves eaten by: caterpillars	Leaves eaten by: other animals
Pandanus species (*P. tectorcoris/whitei/soms-lobachii*) Nesting sites of crimson finch	■		■	■		■	■			■
Native passionfruit vine (*Adenia heterophylla*) *Red lacewing, orange cruiser, glasswing	■	■				■	■		*	
***White mulberry** (*Pipturus argenteus*) *White nymph *Giant spiny stick insect	■			■	■	■			*	*
***Corky bark** (*Caralia brachiata*) *Four o'clock moth	■			■	■	■	■		*	
Fig species ([1]*Ficus racemora/* [1]*opposita/*[2]*leptoclada/pleurocarpa*) *Green ringtail *Red-legged pademelon	[1] ■	[2]				■	■	*		*
***Pink euodia** (*Melicope elleryana*) *Ulysses butterfly host plant	■	■	■	■	■	■	■		*	
Alexandra palm (*Archontophoenix alexandrae*)	■	■	■	■	■	■	■	■		
Dutchman's pipe vine (native *Aristolochia*) *Cairns birdw'g, red-bodied swallowtail, big greasy	■								*	
***Damson trees** (*Terminalia sericocarpa/meulleri*) Large volumes of fruit	■	■				■	■			
***Paperbarks** (*Melaleuca leucodendra/dealbata*) Large amounts of nectar	■	■	■	■	■	■	■			■
Fish poison tree (*Barringtonia racemosa*)	■		■	■	■					■
Trema orientalis *Moth caterpillars *Grasshoppers, crickets, stick insects, beetles	■			■	■	■			*	*
Quandongs (*Elaeocarpus* spp) (*E. angustifolius/*[2]*ruminatus/*[2]*largiflorens*) *Herbert R. ringtail, lemuroid	[2] ■	■	■	■	■	■	■	*		
Gum trees (*Eucalyptus* spp.)*Many insects; trees are good mistletoe hosts	■	■	■	■	■	■	■	■		*
Umbrella tree (*Schefflera* spp.) *Tree-kangaroos (both species)	■	■	■	■	■	■	■	■		*
Bleeding heart (*Omolanthus novo-guineensis*) * Herbert R. ringtail*Hercules moth	■			■	■	■	■	*		*
Lilly pillies/satinashes (*Syzygium* spp.)	■	■	■	■	■	■				■
Walnuts (*Endiandra* spp.) (*E. sankeyana/ E. monothyra*) *Green ringtail, lemuroid (fruit also)	■	■	■	■	■	■	■	■		
Walnuts (*Beilschmedia* spp.) (*B. bancroftii/ B. oligandra*) *Also lemuroid and musky rat-kangaroo	■					■		*		
Bollywood (*Litsea leefeana*) *Green ringtail, lemuroid. *Blue triangle	■	■	■	■	■	■	■	*		*
Ashes (*Alphitonia whitei/petrei*) *Green, Herbert R. ringtails *Red-legged pademelon		■		■	■	■	■	*		*
Celery top (*Polyscias* spp.) *Favourite of Herbert R. ringtail	■	■	■	■	■	■		*		

Other useful species

White beech (*Gmelina dalrympleana*)
Pepperwood (*Cinnamomum laubati*)
White cedar (*Melia azedarach*)
Nutmeg (*Myristica insipida*)
Solitaire palm (*Ptychospermum elegans*)
Neolitsea dealbata
Laurels (*Cryptocarya* spp.)
Oak (*Helicia nortoniana*)
Black wattle (*Acacia aulacocarpa*)
Black bean (*Castanospermum australe*)
Buff beech (*Gomphandra australiana*)
Acid berries (*Acronychia* spp.)
Native olives (*Chionanthus* spp.)
Ebony (*Diospyros* spp.)
Jitta (*Halfordia scleroxyla*)

Bookshelf

Fruits of the Rainforest
William Cooper and Wendy Cooper
GEO Productions Pty Ltd (1994)

Anyone who is interested in rainforest fruits will fall for this book in a big way! William Cooper's illustrations of the fruits of 626 plant species are breathtakingly realistic, even down to the nibblings of insects on the skin. Most illustrations are life size, often with a cross section, and are accompanied by a short text giving details of fruit and leaf size (plus leaf sketch) fruiting season, distribution and so on.

Regeneration of large-seeded trees in Australian rainforest fragments: a study of higher order interactions.
G.N. Harrington, A.K.Irvine, F.H.J.Crome and L.A.Moore
In: **Tropical Forest Remnants: ecology, genetics and management of fragmented communities**
Eds W.F. Laurance and R. Bierregaard
University of Chicago Press
To be published later this year

This was the first study to show that Australian rodents scatterhoard.

Australian Rainforests
Paul Adam
Oxford University Press

There is a short section on seed dispersal on pages 117-119.

Australian Rainforest Plants Vols I-V
Nan and Hugh Nicholson
Terania Rainforest Publishing
(1990-94)

Although not dealing specifically with fruits, this series of books, with good photos and text, is very useful for anyone interested in local plants.

Growing Australian Tropical Plants
Peter and Ann Radke & Garry and Nada Sankowsky
Firth and Frith Books (1993)

Similar in layout and size to the above books, the emphasis here is on gardening with rainforest plants. There are useful notes on height and spread, cultivation requirements and suitabilities as well as distribution, flowers, fruits, etc.

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WET TROPICS MANAGEMENT AUTHORITY

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Environmental Protection Agency
Queensland Parks and Wildlife Service