# Inside our rainforests

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**Our continent never was well endowed with rainforest. Today we have much less. Dairy pastures and sugar cane cover the ground where not so long ago forest grew. 'Rainforest' evokes a mental picture of lush, deep-green, dimly lit jungle consisting of tall evergreen trees from which hang rope-like vines. This is in fact true tropical rainforest. Not all Australian rainforests are like that.**

You could say that we have three types —tropical, subtropical, and temperate. All are patchy in their distribution, and in many ways can be regarded as archipelagos of islands each surrounded by a sea of eucalypts.

Tropical rainforest is found between the northern tip of Cape York and Ingham, just north of Townsville. The large belt between Cooktown and Ingham most nearly approaches the popular conception. In this region, rain falls all the year round, although more usually does fall during the tropical wet season. The forest contains robust, woody vines and many types of epiphytes—orchids or other plants that grow on the trunks and branches of the trees.

Smaller patches of tropical rainforest that occur all the way up the eastern side of Cape York tend to look rather different. Here nearly all of the yearly rainfall comes during the monsoonal wet season. Cape York's 'monsoonal' rainforest seldom grows as tall as that found in areas with a more even rainfall, and many of its trees and vines drop their leaves in the dry season. Bottle-shaped trees capable of storing water also occur. In fact, even in the forests in the wettest areas behind Tully some trees drop their leaves for parts of the year.

Areas of subtropical rainforest stretch from behind Mackay to about Kiama, south of Sydney. Like the wettest tropical forests, these are evergreen. They too contain lianes and epiphytes, but the trees usually have smaller leaves than those in tropical rainforest. Unlike the tropical rainforests they are often dominated by the coniferous genus *Araucaria*—the hoop pines and bunya pines. To the south, lianes become scarcer and less robust, and ferns take over from the orchids and aroids.

The scattered Antarctic beech forests of Victoria, and the much more extensive ones in western Tasmania, are the temperate rainforests. Unlike the tropical and subtropical ones, the Antarctic beech forests contain few tree species. Vines are rare, and often absent altogether. Mosses, lichens, and ferns line the trunks and branches, and ferns may cover the forest floor.

### Cutting them down

Our forbears saw rainforest as a source of agricultural wealth to be cleared to make way for other crops, or at least to be logged for timber. For example, our most extensive area of this forest—the belt roughly between Ingham and Cooktown —originally covered about 1·2 million hectares. Now only about half remains.

Australia is not alone in clearing her

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Strangler fig—a common feature of lowland rainforest.

1 **Herbert River ringtailed possum—it occurs only in rainforest between Ingham and Cooktown.**

2 **Male lovely wren.**

3 **Tropical 'montane' rainforest on the Atherton Tableland.**

4 **Colour in the shadows—toadstools in the forest.**

5 **Fruit-sucking moth.**

6 **Tree kangaroo—we have two species.**

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rainforests. The 'developing nations' of the tropics are also levelling their forests or heavily logging them at an extremely rapid rate—to provide food for their expanding populations, and foreign currency by selling off the timber.

Of course, clearing rainforest to plant crops or pastures is only one option—and one to which many Australians now object. Anyway, much of our remaining rainforest is in rugged country where our

*Our forbears saw rainforest as a source of agricultural wealth.*

type of agriculture would be unsuitable. Some of these areas are or could be logged, but more and more the community is insisting that extensive areas be preserved in perpetuity in national parks.

In fact, for many years the Queensland Forestry Department has been putting areas aside for this purpose. Of the 550 000 or so hectares of rainforests remaining on Crown land in northern Queensland, 108 000 ha are within national parks. More, presumably, will be declared now that management of these areas has passed to the State's newly created National Parks and Wildlife Service.

But what criteria do you use when dedicating a piece of rainforest as a national park? And how big does a piece of rainforest have to be to remain viable? If the purpose is to preserve representative examples of all existing forest types, then it is essential to have fairly detailed knowledge of what these are.

Tropical rainforests are unbelievably complicated, and we don't know much about them. They contain a mass of tree and plant species—too many by far for one person to identify without years of experience, and a great deal of time at his disposal.

### Judging by their looks

Because of this, Dr Len Webb, leader of the Division of Plant Industry's Rainforest Ecology Section at the CSIRO Long Pocket Laboratory near Brisbane, developed a completely different approach. He classified the forests on their structure, not on the species they contain—in other words he graded them on what they look like.

This idea isn't as outlandish as it may sound. In fact different vegetations in similar climates in different parts of the world often do look similar. Thus the alpine areas around Mount Kosciusko are covered with grassland and very low bushes, as are the mountains of Scotland. The semi-arid tropical grassy woodlands of northern Australia and central Africa also resemble one another. However, in both cases the actual plant species in the two climatically similar regions are completely different.

Rainforests too tend to resemble one another in similar environments, regardless of their location or the species they contain. Thus highland 'montane' tropical rainforest looks rather like the lowland subtropical type—since both live in much the same climate.

Nearly 10 years ago, Dr Webb used this structural classification of rainforests and associated vegetation to recommend 20 areas in the wet tropical lowlands between Ingham and Cairns—the most threatened region—for preservation as representative of the various types of vegetation there. About half of these areas have since been included in national parks or reserves.

But rainforests don't only contain vegetation. Cassowaries, brush turkeys, and a host of other birds live in them, as well as tree kangaroos, possums, other mammals, reptiles, and insects. We still know very little about the habitat requirements of rainforest fauna. Also we still know equally little about how the fauna affect the rainforest vegetation.

Dr Jiro Kikkawa of the University of Queensland has collaborated with Dr Webb over the past 8 years to try to correlate the habitat needs of wildlife with Dr Webb's classifications of the vegetation. At present, these two are collaborating, along with Mr Geoff Tracey of the Rainforest Ecology Section and a number of researchers from university and State government departments, on a project to establish detailed criteria for the selection and management of national parks in northern Queensland. Their project considers aesthetic, educational, and recreational criteria as well as scientific ones.

It also attempts to assess what impact people will have on national parks. Even if an area is preserved as a national park, parts of it at least will not remain virgin, since people wandering through on paths, having picnics, or driving their cars along tracks within the forest affect it.

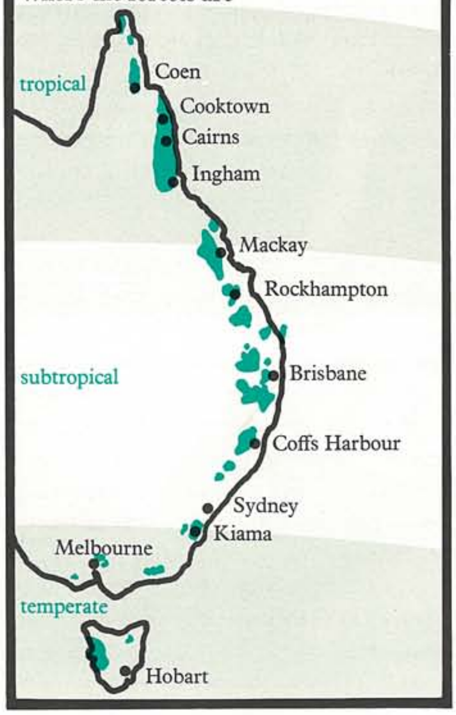
**Does it change?**

Before we can understand that problem, we really do need to come to terms with the forests and all the incredible variety within them, and discover how disturbance changes them. Is rainforest something that is unchanging and fragile, or can it survive considerable disturbance?

Dr Mike Hopkins of the CSIRO Division of Land Use Research is studying rainforest regrowth. He works alongside Dr Webb and Mr Tracey at the Long Pocket Laboratory. At last, after many years of research by these scientists and others all over the tropics, a picture is emerging. Dr Hopkins, Dr Webb, and Mr Tracey see it like this.

*Is rainforest something that is unchanging and fragile, or can it survive considerable disturbance?*

**Where the forests are**




*Even if an area is preserved as a national park, people within the forest bring their own problems.*

To us the rainforest seems fixed and unchanging, but this is because each of us lives only for a relatively short time. We also have preconceived ideas, stemming from the fact that most of our knowledge about forests comes from cooler lands. Thus we assume that the combination of tree species that make up the canopy of a mature forest is a 'climax' that, if undisturbed, will remain the same for a very long time indeed.

This may well be true in the cooler temperate forests where the climax community consists of relatively few species. But the mature tropical rainforest canopy consists of a huge number of different patchily distributed species in all sorts of combinations, apparently without rhyme or reason. Are all these combinations fixed for all time? It seems not.

On a longer time scale of say 1000 years, rather than Man's three score years and ten, the species combinations at any one place will change, often considerably. What any individual person sees is the product partly of the particular environmental conditions of the forest, and partly of chance.

Any combination of a large group of suitable mature canopy species can grow under the conditions existing at a particular site. But by no means all of these

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## Where it came from

Not only do the southern rainforests look different from the tropical ones, in fact the trees and other plants within them have a completely different ancestry. Australian tropical forest is often said to have 'Indo-Malaysian affinities', which means that its ancestors spread from south-east Asia through New Guinea. Australia and New Guinea were joined as one land mass until about 10 000 years ago. Most of the subtropical rainforest species derived from the same stock, so the southern limit of the subtropical rainforest near Kiama represents the southern limit of colonization by the Indo-Malaysian stock.

Antarctic beech, the hoop and bunya pines, and one or two other genera represent a much more ancient 'Antarctic' stock, whose descendants are today found mainly in southern Australia, New Zealand, and South America. These trees far pre-date the eucalypts—Australia's most characteristic tree type. The Antarctic and Indo-Malaysian stocks intermingle in the subtropical rainforests—the areas of hoop-pine-dominated subtropical rainforest being a good example. A few remnants of hoop pine also remain on the Atherton Tableland, and both hoop pine and Antarctic beech have also spread against the tide of Indo-Malaysian rainforest across the land bridge into New Guinea.

All Australian rainforest, regardless of its ancestry, is unusual in that it is surrounded by completely unrelated vegetation—the eucalypts—and the border between the two types is usually very sharp. Elsewhere in the tropics rainforest is usually surrounded by related vegetation that is adapted to drier conditions.

In the less wet areas, fire seems to be the major factor that controls the location of the boundary between the rainforest and the eucalypts. Eucalypts can tolerate fire; rainforest cannot. During dry periods therefore, when wildfires are common, eucalypts tend to encroach on the rainforest, while in the wetter times the rainforest takes over from the eucalypts—provided the soils are fertile enough. Areas of rainforest that contain eucalypts represent an intermediate stage.

# Birds, mammals, and insects

Rainforest isn't only trees and plants. It also contains birds, mammals, and insects, as well as a host of other organisms. Many people don't realize, for example, that two species of tree kangaroo are quite common in northern Queensland rainforests, which also have a bird and insect fauna all of their own.

Some 167 bird species seem to inhabit the rainforests between the tip of Cape York and Victoria, although authorities do differ a bit about this. Probably 25 of these species live only in Australian rainforests. A further 37, including the cassowary, also live only in rainforest, but in other countries as well as Australia. Another 87 bird species seem to need this forest type, or adjacent wet sclerophyll forests or mangroves, to survive. The rest —like the crimson rosella, kookaburra, and pied currawong—appear at home both inside and far away from rainforest.

Not all of the 25 bird species found only in Australian rainforest occur throughout. Twelve of them have only been seen in the extensive areas between Cairns and Ingham, and another, the yellow-spotted honeyeater, is known to live both here and at the tip of Cape York. The paradise rifle-bird, rufous scrub-bird, and Albert's lyrebird live only in subtropical rainforests. Only the topknot pigeon can be found in all the types between Cape York and Victoria.

Tropical and subtropical rainforests also support some 49 species of native Australian mammals. Of these, nine bats, four marsupials, and the dingo may be found in rainforests anywhere between Cape York and Kiama in southern New South Wales. The remaining 35 species cover a part of this range. The two tree kangaroo species already mentioned live in the belt between Cairns and Ingham, and the sugar glider probably occurs southwards from Cooktown.

In general, the mammals and birds of the northern part of Cape York are very similar to those of Papua New Guinea. The mammals in particular become progressively more different further south.

We still know very little about the insects of the rainforests. Many of them derive from very ancient insect stocks. In many ways their distribution mirrors that of the rainforest itself, in that to the north the great majority derive from Indo-Malaysian stock, while in the more southern forests most insects have Antarctic ancestry. As with the vegetation, the subtropical rainforests generally contain a mixture. The insect group with northern ancestry contains some of our largest and most spectacular species.

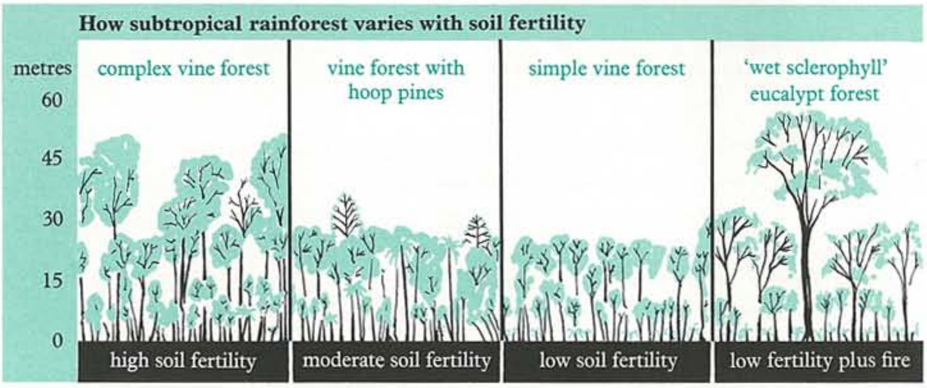
For most insects the edge of the rainforest is too great a barrier to be crossed. As a rule, those in the drier eucalypt woodlands are not closely related to the rainforest insects. This isn't so surprising, since the damp rainforests provide a very different environment from the dry eucalypt woodlands. To survive in these woodlands, insects had to develop ways of preventing themselves from dehydrating, and few can now tolerate the moist coolness of the rainforest. In addition, few of the herbivorous rainforest insects can tolerate a diet containing eucalyptus oil.

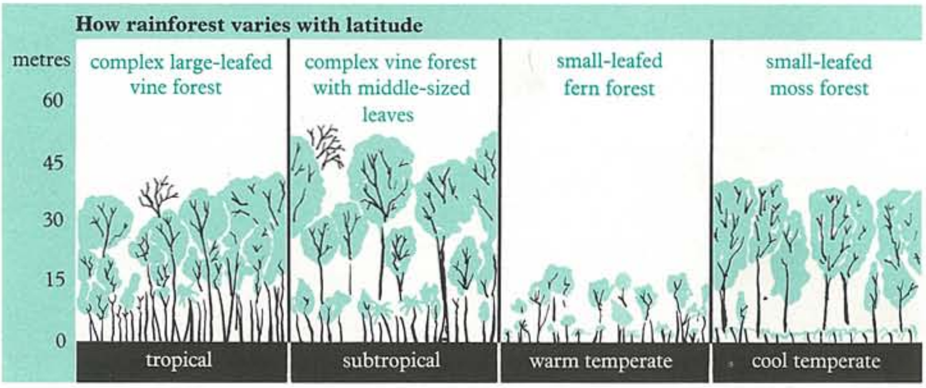
The archipelago-like distribution of our rainforests has meant that insect populations have been isolated on each 'island' for a very long time. Little migration goes on between them, since few rainforest insects can tolerate the harsh conditions of the intervening open woodland. Consequently evolution has gone on independently in each isolated patch, thus making the situation even more confusing for entomologists who study the distribution of rainforest insects.

Rainforest mammals. J. W. Winter. *Wildlife in Australia*, 1973, **10**, 84–6.

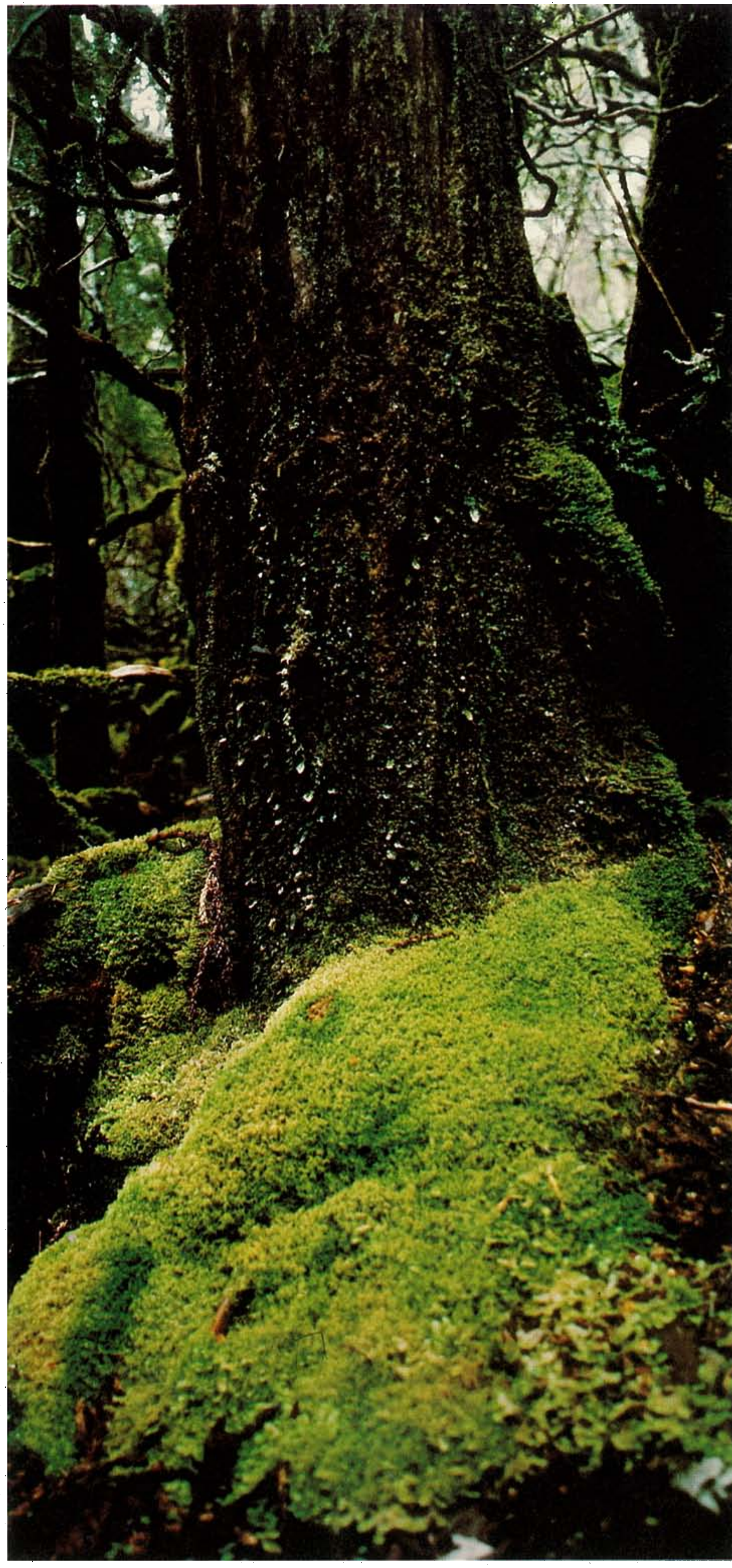
Australian rainforest insects. G. Monteith. *Wildlife in Australia*, 1973, **10**, 88–90.

**One of many diagrams prepared by Dr Webb to illustrate vegetation changes along environmental trends—here, for subtropical rainforest, from fertile to infertile soils.**




**Another of Dr Webb's vegetation trend diagrams—this time representing changes in lowland rainforest from the tropical north to the temperate south.**



species will be there. Which ones are depends largely on chance. Old trees die leaving gaps in the canopy. Landslips occur from time to time and passing cyclones uproot trees. New trees can grow in the gaps created by these disturbances.

If a gap appears in the rainforest for any reason, it may first be taken over by a whole succession of shorter-lived trees that are not normally found in the mature canopy. (We'll hear more about these later in this article.) However, in the long run, seedlings of the mature canopy species will take over once more. But the seeds of the mature canopy species frequently don't get moved far from their parents, as they tend to be heavy. So mature canopy species that finally fill the gap will often be those already growing in the nearby undamaged forest.

Nevertheless, the gap will not necessarily be filled with seedlings from the nearest available mature canopy tree. Many rainforest species seem to have mechanisms that prevent seedlings from thriving close to the parent tree. For example, silky oak (*Grevillea robusta*) produces a chemical in its roots that suppresses its own seedlings and nearby young trees—which explains why this tree doesn't grow well in timber plantations.

Factors like this may also account for the fact that in any particular area the number of trees of any one species is often very small. Insects and fungi seem to play their part in limiting the number of individuals of any one species too.

Historically, occasional landslips and cyclones would have been the main disturbances that caused gaps in the canopy in Australian rainforests. In other countries such as New Guinea, where the geologically young hillsides are much more prone to large landslips, and where Man has been practising slash-and-burn agriculture for centuries, the rainforest has received much more disturbance than in Australia. Nevertheless, it has been able to recover. Studying what happens after such events should reveal how practices like logging or clear-felling affect the ecosystem, and even indicate how features like permanent roads will affect the forest in a national park.

### 'Scab' forms

It seems that a rainforest can be likened to a living organism. When it is damaged, mature canopy species don't immediately begin to fill the gap. First the forest forms

**Moss on the floor of an Antarctic beech forest in Tasmania.**

a 'scab' over the wound. The scab consists of shrub and tree species completely different from the original cover. Only after a number of years do these different species finally give way to mature canopy seedlings.

Which species will make up the scab depends at least partly on the size of the wound. In an extreme case, as after a landslip, bare soil will be exposed. Species of the undisturbed canopy cannot colonize bare soil, since their seedlings cannot tolerate the harsh conditions. Instead, pioneers take over. These pioneers cannot tolerate shade, and they are followed by other more shade-tolerant species, so the damaged area passes through a series of stages before it reverts back to the mature canopy. Where the disturbance has less dramatic effects, the succession may start at a later stage.

Different rainforest ecologists have divided the succession process into a variable number of stages. The Long Pocket researchers have divided it into four—pioneer, early secondary, late secondary, and mature canopy. They freely admit that their classification is somewhat arbitrary, and even some widespread species don't fit into it too well. Nevertheless, it does provide a useful framework on which to hang ideas about how rainforests work.

The pioneers, which include both woody and non-woody weeds, live for between 1 and 3 years. They regularly produce very large numbers of very light seeds, which can be carried over great distances by birds and the wind. These seeds remain viable in the soil for many years, and the seedlings will not tolerate any shade at all.

Early secondary canopy species will tolerate some shade, and their seeds are similar to those of the pioneers in that they are regularly produced in vast quantities, and are very effectively dispersed. They tend to be fast-growing trees that live for between 15 and 50 years. Many can also propagate themselves by root suckers.

Late secondary canopy species tend to be a bit hard to define. They are intermediate between the early secondaries and the mature canopy species. They will tolerate considerable shade. They tend to be fairly fast-growing, but produce seed less regularly and of lower viability than the early secondary species. Wind still plays a part in their dispersal. This group, incidentally, contains many of our commercial timber trees.

Seedlings of the mature canopy species are very tolerant of shade. Seeds of the mature canopy trees rarely remain viable for very long.

*National parks will have to be large to maintain all the species in their kaleidoscopic profusion.*

### Practical implications

So much for how rainforests react to disturbance. What are the practical implications as far as managing them is concerned? For one thing, the CSIRO researchers point out, national parks will have to be large if we want to maintain within them all the species of the forest mosaic in their kaleidoscopic profusion. Small areas are likely to become simpler over a period of many years. Within a small area many species will be poorly represented, if at all, because of their patchy distribution. Since their long-term survival depends on chance disturbances of the forest canopy, time will be on the side of the commoner species.

The researchers also warn against putting in too many roads and other permanent openings in the forest canopy. Such openings will be permanently lined with species of the earlier succession stages, which have easily distributed seeds. The effect of having these earlier succession species permanently rather than temporarily growing within the forest will probably be to inundate it with seeds of these stages. In time the forest must change, since these long-lived seeds will flood every break that develops in the canopy. Under normal circumstances only a few would reach these breaks.

Of course, not all remaining tropical and subtropical rainforests will be maintained as national parks. Other areas will be logged, and possibly some will still be cleared for planting tree plantations, pastures, or crops. But the experience of farmers all over the world has shown that pastures or annual crops planted on cleared rainforest sites do not always do well. Hopefully, we now have the means to avoid repeating their mistakes.

*Experience all over the world has shown that pastures or annual crops planted on cleared rainforest sites do not always do well.*

Rainforests appear very lush, so one might assume that they grow on fertile soils. In fact, some rainforests grow on very poor soils. Practically all the nutrients required to maintain the lush growth are above ground in the vegetation, or in the top 15 cm of the soil. As the trees and other rainforest vegetation die, or their leaves fall, insects, fungi, and bacteria rapidly break them down and their nutrients are quickly recycled back into the vegetation. Thus, on poor soils, rainforests represent accumulations of nutrients from elsewhere. Remove this rainforest, and the finely balanced recycling system breaks down and the accumulated nutrients wash away.

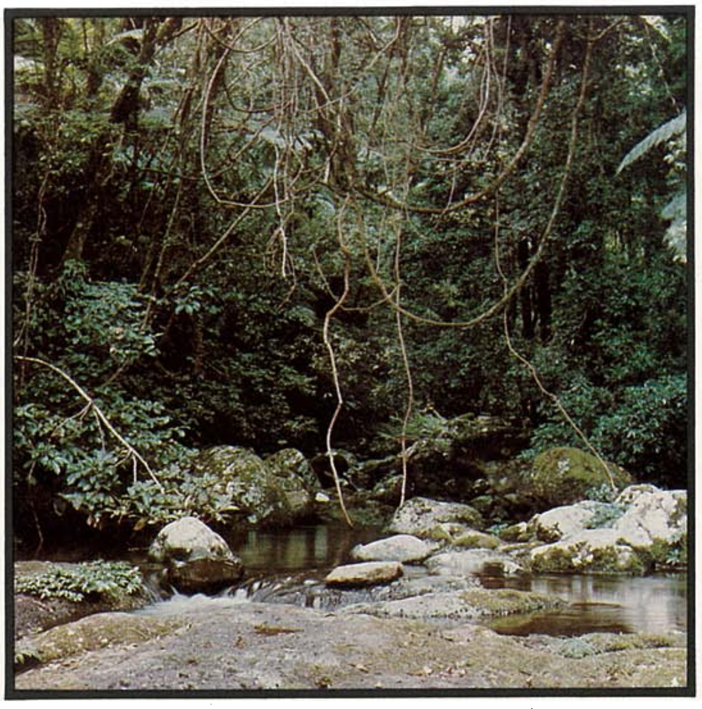
### Cutting them over

Selective logging represents the least disruptive productive use of rainforest. Timber-cutters merely take out the more valuable trees. 'Cutting over' forests has been a common practice for very many years all over Australia. In the northern Queensland rainforests, logging of this type began in the 1880s, and it has supported several local timber mills since the early 1930s.

Northern Queensland rainforests yield a number of high-priced cabinet woods like maple, silkwood, and northern silky oak, as well as other less valuable ones. Currently, these forests yield about 270 000 cubic metres of wood each year. About a quarter of this is converted into veneer and plywood. The remainder is sawn. The Queensland Forestry Department marks all trees to be cut, and only trees with a trunk diameter more than 40 cm at breast height are logged. Some large trees remain, along with the younger trees, as a source of seed. Thus more are ready for further logging some 20–30 years later.

Most of the valuable timber trees belong to the late secondary stage in the rainforest succession. The slight disturbance caused by selective logging tends to favour them, since they can grow quickly in the brighter light. Foresters have found that they can successfully plant young seedlings along 'snig' tracks (made when pulling out the timber) and along lines cut through the undergrowth of logged forest, and thus 'enrich' it.

Removing logs does, of course, take out nutrients. Researchers at the CSIRO Division of Forest Research's Atherton Laboratory (formerly part of the Forest Research Institute) have calculated likely



**Hanging vines in subtropical rainforest on the Lamington Plateau.**

**If mishandled, some rainforest soils erode very easily.**

losses. They came to the conclusion that present selective logging practices can be continued on most of the soils near Atherton, at least into the near future, without fear of doing irreparable damage.

For example, their calculations suggest that a normal, but comparatively heavy, logging that yields 70 cu m of timber from each hectare results in a direct nutrient loss of 1 kg of phosphorus, 10 kg of potassium, 90 kg of calcium, and 20 kg of magnesium. They consider these amounts to be low in comparison with the total nutrient store typically found in even the poorer granite-derived soils on most rainforest sites near Atherton.

## Fauna affected

Selective logging does of course alter the forest, and this must affect the fauna. Some will be adversely affected, but not all. Disturbing the vegetation tends to bring more plant species into flower and fruit. Working in the lowland rainforests around Mission Beach near Tully, Mr Frank Crome of the CSIRO Division of Wildlife Research has shown that logging may actually favour some fruit pigeons, since they prefer the fruits of secondary species whose growth is stimulated by forest disturbance (see *Ecos* 4).

Cutting relatively few trees over a large area means high costs. In southern Australia the usual response to this situation is to clear the original forest and to plant single-species plantations in their place. But in the tropical northern areas the danger of attack by diseases and insects, particularly on native species, as well as the greater likelihood of devastation by cyclones, makes this a much more risky venture. In the past, commercial plantations of valuable native timbers like maple, red cedar, and kauri pine on cleared rainforest sites have had problems with root rot and other diseases, as well as with insect and rat attack.

Similar problems have been encountered in other countries. For example, the rubber tree is a native of Brazilian rainforests, yet it has not proved possible to successfully grow rubber there in single-species plantations. But Malaysia, far away from the insect predators and diseases of Brazil, depends on rubber plantations for much of its wealth.

A less drastic approach to increasing the numbers of useful timber trees in rainforests is to carry out what's called 'silvicultural treatment'. The usual practice is to clean out all the larger specimens of species that do not yield usable timber, and also defective examples of timber-producing species. Thus this technique favours the healthiest examples of the most valuable timber trees at the expense of all others. The Queensland Forestry Department has been investigating such practices for many years, but so far has only used them over very limited areas.

Obviously, silviculturally treating a rainforest alters its species composition, and it could be regarded as permanently maintaining the forest in the late secondary phase. It probably has the advantage over clear-felling and replanting that the nutrient recycling process of the forest is not brought to a standstill, so less nutrients would be lost. However, it must affect the forest fauna, since many food-producing tree and shrub species would become scarcer.

Clearing rainforest and replanting with pastures or annual crops can create the worst problems. Tropical downpours on cleared slopes that are too steep can cause serious erosion, and nutrients leach out very rapidly from tropical soils.

## Re-establishment possible?

On the Atherton Tableland, and elsewhere, farmers have in the past cleared rainforest areas unsuitable for pasture or crop production, and then abandoned them. What happens to those abandoned areas—can the rainforest come back?

Most of the unsuitable land on the Tableland that was cleared and quickly abandoned appears to be reverting to rainforest. In southern Queensland, Dr Hopkins from the Long Pocket Laboratory has studied a small area of once-cleared forest on the Lamington Plateau. Detailed records of this area have been kept for many years. Some 50–60 years after clearing, the species in the canopy and understorey of the secondary forest now growing there are very similar to those in nearby untouched forests, but the canopy height is very much lower.

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# Rainforest and computers

At first, tropical rainforests give an impression of confusion. In eucalypt forests you can walk through and meet perhaps a dozen species of tree and a limited number of other plants, but tropical rainforest contains a huge number of species. In northern Queensland, Dr Webb, Mr Tracey, and Dr Bill Williams found no less than 818 species at 18 collecting sites.

It takes years of experience to be able to identify such a large number of species. Surveying these 18 sites took a year, and Mr Tracey then spent another year in the herbarium identifying all the trees and plants. So if you want to understand fairly quickly how a piece of rainforest works, you have to find some other way than by identifying the vegetation. To be able to do this without the aid of an experienced taxonomist would be particularly useful for the 'developing countries'.

With this in mind, Dr Webb and Mr Tracey teamed up with Dr Williams to develop Dr Webb's ideas about classifying rainforest by using computer techniques. Dr Williams was formerly Professor of Botany at Southampton University in England, and more recently with CSIRO, first at the Division of Computing Research, and later at the Division of Tropical Agronomy.

Their approach depends on observing the forests' structure and appearance, and relating these features to the environment. They have used the Queensland rainforests as a model for all others.

Dr Webb had already been applying his ideas to rainforests for a number of years. By using features of appearance and structure only, he classified the Australian rainforests into 12 sub-formations. He found that he could broadly correlate these sub-formations to environmental factors such as the rainfall and fertility of the soil. By increasing the breakdown to 20 sub-formations, he then improved the fit considerably.

But correlating the forest structure at various sites with these and other environmental factors raises enormous difficulties, and there are limits to how far one can take this approach without being swamped with information.

Here Dr Williams' extremely broad knowledge of computer techniques came in. With the assistance of CSIRO's Control Data 3600 computer in Canberra, Dr Webb, Mr Tracey, and Dr Williams selected what they believed to be the 24 most useful structural features of the rainforests of eastern Australia and listed these on a form. They then got independent observers who had little knowledge of rainforest species or structure to fill in the forms at 70 sites between Cape York and the Bellangry State Forest near Port Macquarie, N.S.W. At the same time they used the standard forester's technique of preparing spot lists of the commoner tree species at each site, so that they could compare the results from the two methods.

When the structural information on the forms was submitted to the Canberra computer for classification, the results, as hoped, generally reflected combinations of major environmental factors, irrespective of the location. Thus cool upland habitats bore similar forests with small leaves and slender wiry vines, regardless of whether the site was in the Bellangry Forest or the Atherton Tableland. (The individual species at these climatically similar sites were almost completely different.)

In addition (leaving aside the question of whether we should clear rainforest), it seemed likely that, simply by choosing the right set of forest features, we should be able to predict how any site in a particular area may behave under different forms of land use.

The scientists therefore decided to take this line of study a stage further. They chose 38 sites in subtropical southern Queensland that carried a large number of rainforest types. They paired each one off with a cleared site close by, which had originally carried the same sort of rainforest. These sites had all been cleared within the last 15–60 years, and were being used for a variety of purposes such as dairy-farming and growing hoop pine plantations.

Once again, the scientists collected spot lists of the vegetation from each of the paired sites. They also recorded the major environmental factors and the condition of the cleared land.

Using advanced statistical techniques with the aid of the Canberra computer, they were then able to show that a number of the features on the intact and cleared sites corresponded strikingly.

The corresponding features on the intact and cleared sites were in fact a series of trends. By combining these trend patterns it was possible to confidently predict whether any site that carried the natural vegetation would be suitable for a particular agricultural use. Moreover, the scientists found that they could predict suitable forms of rehabilitation for derelict cleared sites that carried only weeds and regrowth.

For example, in one trend series on the uncleared sites, the trend went from high-rainfall eucalypt forest (wet sclerophyll forest) at one end to complex rainforest containing a great many vines at the other. This series corresponded on the cleared sites with successful hoop pine plantations at one end and good dairy pastures at the other. It turned out that the fertility of the soil was the dominant factor in the environment that underlay these two trends —wet sclerophyll forest and hoop pine plantations needing only relatively infertile soils, and vine forest and dairy pastures needing very fertile soils.

Any site, therefore, in subtropical Queensland or New South Wales (but not northern Queensland) supporting that type of complex vine forest might be expected to support good dairy pastures after clearing. For each particular site, studies of features from other trends reflecting such environmental factors as the rainfall either confirmed or contradicted the prediction.

Sites suitable for growing hoop pines, or others that should not be cleared under any circumstances, could be located in the same way.

Could this technique for predicting the agricultural potential of rainforest areas be adapted for use in other countries? The researchers don't see why not; but cleared sites already successfully supporting agriculture and corresponding uncleared ones would have to be available.


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**Huge plank buttresses, like those on this Moreton Bay fig, are particularly a feature of lowland tropical and subtropical rainforests.**

However, these two areas have three things in common—they were abandoned almost immediately after clearing, the regrowth has remained comparatively undisturbed, and adjacent areas of untouched forest have been able to act as seed sources for trees of the later successional stages. What happens when large tracts of unsuccessful farmland are allowed to become derelict after years of use?

Dr Hopkins is studying such a situation on the Army's Land Warfare Centre at Canungra in southern Queensland. Much of the landscape of the Land Warfare Centre is covered by rainforests that have been heavily logged in the past. Some of these disturbed forests are regenerating well. Other areas that have been heavily fired have been taken over by fire-tolerant eucalypt species.

But the Army also acquired a number of dairy farms, which had been maintained under pasture for 50–60 years. These pastures were weed-infested and degraded. Mr Hopkins is now looking into the possibility of re-establishing on them forests similar to those that covered them in the past.

However, the cleared areas at Canungra are somewhat unusual in that their management can be carefully controlled. More often, derelict farmland is subjected to frequent burning and grazing. The effect that these influences have depends to some extent on the soils. On poor soils, fire-tolerant eucalypt forest tends to take over. Elsewhere thick 'scrubs' consisting of early secondary species may develop, especially if the cleared areas are so large that no seed trees of the mature canopy species remain nearby. Under these conditions the succession back to rainforest takes a very long time indeed. Large areas of such scrub exist behind Cairns on sites that were once cleared for coffee-growing.

As a final cautionary tale it's worth considering what technologically advanced tree-harvesting methods for such operations as wood-chipping do to rainforests. A plan to wood-chip the forests behind Cairns was considered recently, but was dropped. However, in many 'developing' countries, rainforests are being cleared at a rapid rate. For example, operations planned near Madang in New Guinea will result in 4000 ha being cleared each year. Plantations of kamerere—a local eucalypt—are being planted on most of the cleared areas and various forms of agriculture are proposed for the rest. However, there is no guarantee that these uses for the cleared land will succeed.

Can such cleared areas revert back to rainforest? Frequently, the researchers at the Long Pocket Laboratory suspect, even on the most fertile soils, the answer is 'no'. If the coupes (the units of land being clear-felled) are too big, and their shapes and arrangements are wrong, then rapid reversion cannot take place. The prospect seems to be for a landscape of pioneer and secondary canopy species.

For the late secondary canopy species to come in, and, more especially, the mature canopy ones, frequent pockets of mature forest must be left within the cleared areas as sources of seed. Just how big these pockets should be, and how far apart they can be to function effectively as seed sources, is anybody's guess.

### More about the topic


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