Fire and rainforest in Tasmania

Tasmanians are the custodians of most of this country's temperate rainforest, which covers some 7% of their island. For the cool, wet, western half of the State, though, a reasonable question is 'why not 100%?' How can the plant ecologist explain the mosaic of vegetation — rainforest, eucalypt forest, scrub, and sedgeland — actually displayed?

A number of researchers believe that fire is the dominant factor, while others regard soil fertility as more important. There is no doubt, however, that fire is a major factor, and this article will look at its effects on rainforest in two localities in Tasmania — one on poor soil in the lowlands of the south-west; the other on good soil in the mountains of the north-east.

Our ubiquitous eucalypts have evolved to cope with fire. Most species actually depend on it for regeneration. On the other hand, fire is an infrequent visitor to rainforest and can do it much harm.

The first well-documented account of the effects of fire on Tasmanian forest was given by Dr Max Gilbert of the Tasmanian Forestry Commission more than 20 years ago. He worked in the Florentine Valley, a high-rainfall area in central Tasmania, and concluded that, if fire could be excluded for about 400 years, then all but the poorest soils would be taken over by rainforest. The eucalypts would disappear.

He thought fires lit by man were mainly responsible for perpetuating the eucalypts, although he noted that lightning caused some fires. More recent studies confirm that more than 98% of fires are man-made.

Further studies since in high-rainfall areas have shown that, where a destructive fire occurs at intervals of 100–400 years, a 'mixed forest' will probably be found. These range from a eucalypt canopy up to 90 m high towering over 40-m-high rainforest (on good sites) to teatrees mixed with rainforest less than 30 m high (on poorer soils).

Where wildfire recurs more frequently, at intervals of 20 to 100 years, we can expect eucalypts standing over a wet scrub

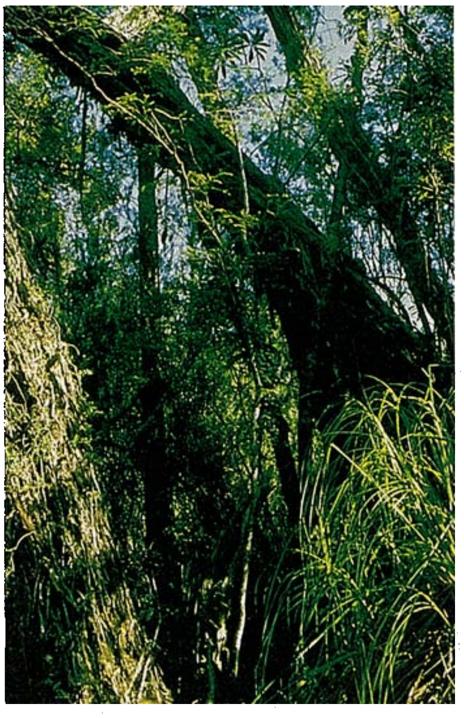
of teatrees, paperbarks, and some rainforest shrubs.

The picture can be extended, and where fire occurs at 10- to 20-year intervals, rainforest species virtually disappear and treeless communities dominate. What's left is generally sedgeland heath — or, in the idiom, button grass plain — with some patches of low eucalypt woodland.

Working out the relation between fire frequency and vegetation is rather like trying to determine which comes first: the chicken or the egg. Fire frequency affects vegetation composition, and the vegetation influences fire frequency. Rainforest is difficult to set alight, while sedgeland can carry fire within 2–3 years of its last burn. Open eucalypt forest burns easily once a litter layer has built up following the last fire. In other words, a feedback process operates between fire frequency and vegetation.

Conceivably, the feedback could lead to a stable balance between fire and vegetation; alternatively, it could produce a 'runaway' situation where fire begets more fire-prone vegetation. What actually happens?

The south-western study area. The researchers found that the boundaries between open country and forest could alter.



Undamaged rainforest above Hoggs Back Plain.

Stability

Mr Tony Mount of the Tasmanian Forestry Commission suggests that the different vegetation types are relatively stable, and that the type of vegetation in any area is determined mainly by environmental factors such as soil fertility, drainage, and topography.

Mr Mount worked in the Florentine Valley in the early 1960s. He agreed with Dr Gilbert's assessments, but questioned whether fire could be excluded for 400 years. He also wondered how fire had maintained a presence in the large areas of mixed forest that Aborigines had probably avoided for many centuries. He concluded that lightning, even at very low frequency, was sufficient to maintain the eucalypts in mixture with rainforest in most areas of high rainfall.

This thought led to his 'fire cycle' theory: each plant community allows a fire frequency suited to maintaining itself. In other words, fire frequency is determined mainly by the vegetation, so the vegetation pattern is stable. For example, after a fire a rainforest may take 80 years to produce enough fuel to sustain a repeat. This gives the plants the time needed to produce the seed required for forest regeneration. The equivalent cycle in a eucalypt forest is shorter, and that in sedgeland much shorter again.

Mr Mount points to the extensive sedgeland in western Tasmania as providing the best evidence for his theory of fire cycles based on relative fuel-accumulation rates. They exist side by side with rainforest over more than a million hectares, yet they are at opposite ends of the fire-frequency scale.

Ecological drift

Professor Bill Jackson of the Botany Department of the University of Tasmania has put forward an 'ecological drift' theory that suggests the vegetation types are less stable. He has extended Dr Gilbert's theories to a range of forest types and claimed that, if fire frequency changed sufficiently, then the vegetation would change.

For example, he argues that, once burnt, a wet forest is likely to dry out more easily and this increases the chances of a repeat burn before it has had time to recover its balance. The new fire may destroy regenerating saplings before they are old enough to produce seed, leaving more open vegetation.

Fire-damaged rainforest near Hoggs Back Plain. Another fire could eliminate it.

Professor Jackson argues that practically all the grassland and open vegetation in Tasmania is the product of repeated firing by Aborigines, who used fire for hunting, to allow easy travel, and for clearing of dense vegetation. They may even have used it to favour useful game and plants. The early navigators and explorers often mentioned sightings of smoke.

Now, although these two theories apparently conflict, Dr Bob Ellis of the CSIRO Division of Forest Research considers that perhaps Mr Mount and Professor Jackson can both be right. He

A feedback process operates between fire frequency and vegetation.

Dr Mick Brown leans against a dead stag of celery-top pine amid button grass plain. Neighbouring stags of *A. odorata* reveal that the vegetation change has occurred this century.

Evidence of fire 3, 7, and 17 years ago resides in the living and dead twigs of *Agastachys odorata*.

believes Mr Mount's ideas are probably correct generalizations for the practical short term (up to 100 years), but in the long term ecological drift is inevitable, whether it's due to fire or to other factors such as climatic change.

However, Dr Frank Podger, also of the Division of Forest Research, is strongly of the opinion that — for the south-west of Tasmania at least — Professor Jackson is right. Dr Podger used to hold to Mr Mount's thesis, but his studies at Hoggs Back Plain and at Mt McCall in Tasmania have convinced him that repeated fire can turn dense tangled rainforest into button grass plain in less than 100 years.

No simple generalization can be expected to hold true throughout a complex forested area like Tasmania, of course. In ecotones — the transitional areas between plant communities — two recent studies have shown ecological drift occurring over quite short time scales.

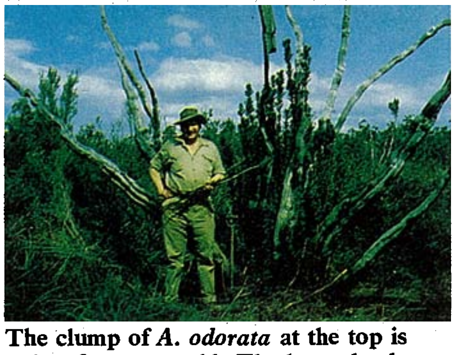
The aftermath of fire.

The rest of this article describes these studies, which were carried out in strips between rainforest and more open vegetation types. The first, on poor soil, was carried out by Dr Mick Brown of the Tasmanian National Parks and Wildlife Service and Dr Podger. The second, on good soil, was done by Dr Ellis.

In both areas, marked changes in fire frequency have occurred in recent times. Ecotones such as these provide an interesting subject for study because they hint at the nature of possible long-term changes due to ecological drift.

The south-west study

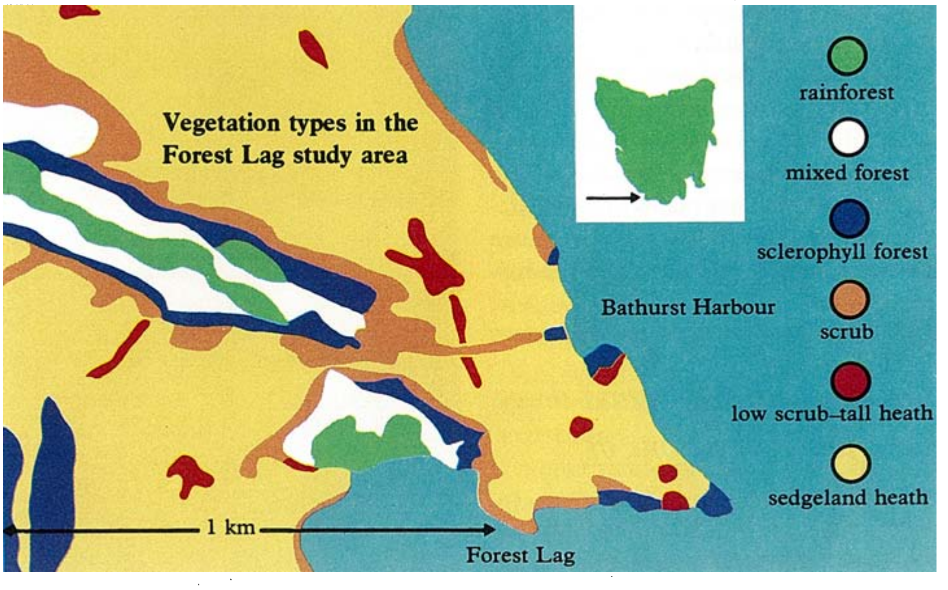
The work by Dr Brown and Dr Podger revealed evidence of ecological drift in three localities in the lowlands of south-western Tasmania. The scientists found that, on the humic soils of these areas, recent alterations in the pattern of fire have considerably shifted the equilibrium of the plant communities.

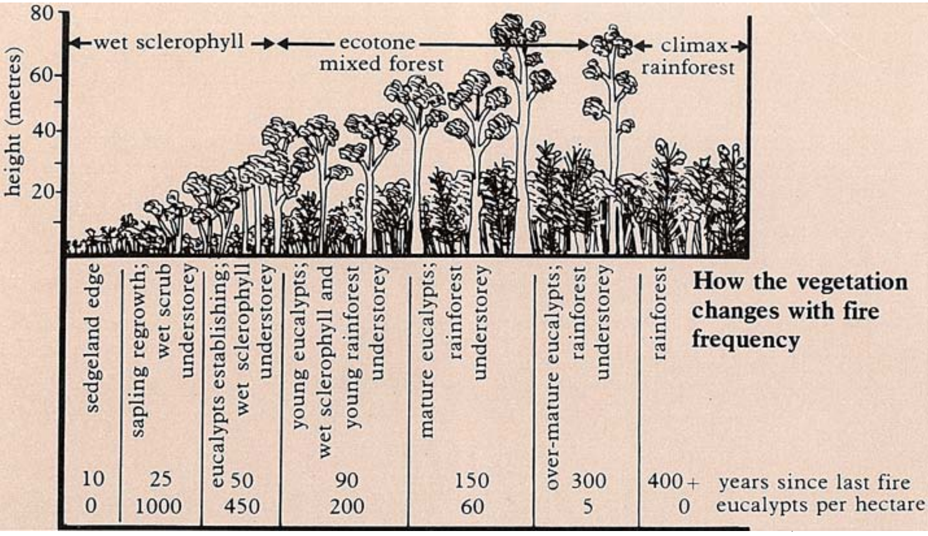


The clump of *A. odorata* at the top is only a few years old. The large dead branches on the still-living specimen below it show more than 200 annual growth rings. Other smaller dead twigs record more recent fires.

The key to testing the ecological drift argument is to document the fire history of a site.

The area was chosen for study because it had a good mixture of vegetation types.





The relation between fire frequency and vegetation type in the wetter regions of Tasmania, as recorded by Professor Jackson.

They emphasize that this conclusion should, for the moment, be restricted to environments of this type, which have shallow, relatively infertile, humic soil. Such areas are extensive in the south-west.

The key to testing the ecological drift argument is finding a way of documenting the fire history of a given site. Conventional methods of dating past fires require the felling of long-lived trees and looking for fire scars among their growth rings.

Such an approach is slow and difficult. Dr Brown's and Dr Podger's work was speeded by their recognition that some shrubs, in particular white waratah (*Agastachys odorata*), can be used to determine a site's fire history.

White waratah shows clear annual growth rings — uncommon for its Proteaceae family — and age can also be simply determined (up to about 25 years) by counting bud and leaf scars on the bark. These scars arise every year as the plant puts out new growth.

Furthermore, the stems are very sensitive to fire, dying whenever fire scorches them. However, the underground rootstock is very resistant and new stems shoot up, mallee-like, after the old have died.

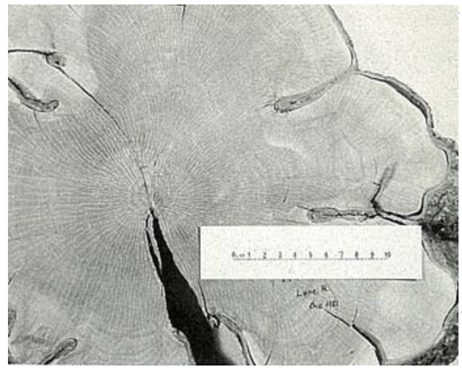
In this way the plant can sometimes survive up to 300 years, with its fire history written into the dead stems. Although the stems resist decay, the older ones appear more weathered than more recently killed ones and this factor allows proper fire dating. Because of the plant's mallee habit, living and dead stems can be removed for dating without killing it.

As a trump card, *A. odorata* is widespread in south-western Tasmania, occurring across the whole range of plant communities from heath and sedgeland to rainforest. *Banksia marginata* and *Cenarrhenes nitida* share some of *A. odorata*'s attributes and can provide fire dating in a similar way, but to a more limited extent, the researchers found.

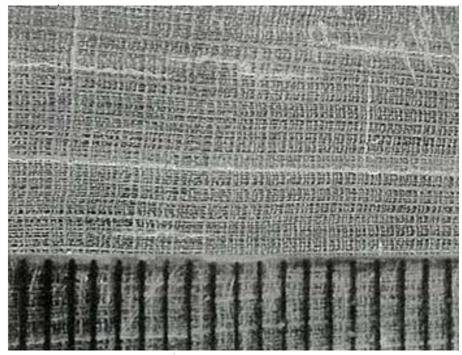
Among the button grass they have found skeletons of celery-top pine.

Stages along a continuum

Dr Brown and Dr Podger conducted their research at Forest Lag on Bathurst Harbour, at Hoggs Back Plain near Hastings Caves, and on Mt McCall near the Franklin River. The Forest Lag study area covered several square kilometres of country, encompassing 12 types of plant community that ranged from rainforest to sedgeland heath (see the map).



This stem of *A. odorata* is more than 300 years old. Magnification reveals annual growth rings (below).



The aim of the study was to quantify the differences between plant communities of different ages as measured by the time since the last fire.

Examination of stems of *A. odorata* and other shrubs revealed that fire occurred around Forest Lag 6, 9, 12, 14, 17, 19, 24, and 30 or more years before the 1980 field study. Some sedgeland heath caught as many as four of these fires, which were lit from 1950 onwards to protect a local cottage.

Prior to 1950, and as far back as 1934, there appears to have been virtually no fire in the area. In 1934, however, a major wildfire had obliterated most of the evi-

Sedgeland is subject to frequent fire.

Lack of fire causes alpine ash to die, and rainforest to take its place.

dence that might have allowed dating to earlier fires.

Aborigines passed through the area frequently in early days, so fires were probably common there then. The signs, though, are that the mixed forest hasn't been burnt for about 250 years, except at its edges, and in the same way the rainforest hasn't been touched for more than 300 years.

When the scientists compared the species composition of 86 sampling sites with the time since each was burnt, it was clear that the two are strongly related.

Some species restricted themselves to the oldest communities, while some herbs were found only in the most recently burnt area. Between these extremes, a large group of species showed a more-or-less steady gradation in numbers from one end of the spectrum to the other. In other words, the transition from sedgeland heath to rainforest was a continuum, in which the stage of the transition strongly correlated with the time since the last fire.

Interestingly, the total number of species was highest on the most recently burnt sites and generally decreased as the period of fire-free time increased.

A most important finding was that the plant community boundaries were not strictly maintained. Some small patches of rainforest burnt by the 1934 wildfire now contain a tangled mass of shrubs among the trees, some dead, some alive. Dry fuel abounds, and a further fire could turn these patches to scrub, the researchers believe.

They observed two cases where a burn 12 years ago had overrun mixed forest from scrub on its margins. In one case, fire has not recurred and the forest is regenerating. However, in the second, fire returned after 6 years. Here, the tall shrubs of the scrub buffer zone were killed and have since fallen. Now, species typical of the sedgeland heaths have invaded the burnt forest.

On the other hand, shifts from sedgeland heath to scrub are apparent, and in several places young rainforest trees (celery-top pine and myrtle) can be seen in the woodlands abutting mixed forest.

One of the research pair's observations that gives cause for concern is the drastic change that a single fire can exert when it sets alight the peat commonly found in Tasmania. Peat fires, widespread in the south-west, completely wipe out the characteristic peat-dwelling species, unlike a normal fire that leaves rootstocks to regenerate.

The scientists found that if the peat fire is confined to the upper layer, the original species may — through seed dispersal, and given sufficient time — reclaim their territory. However, if the peat burns to bedrock, or is subsequently eroded, the damage can take a very long time to repair.

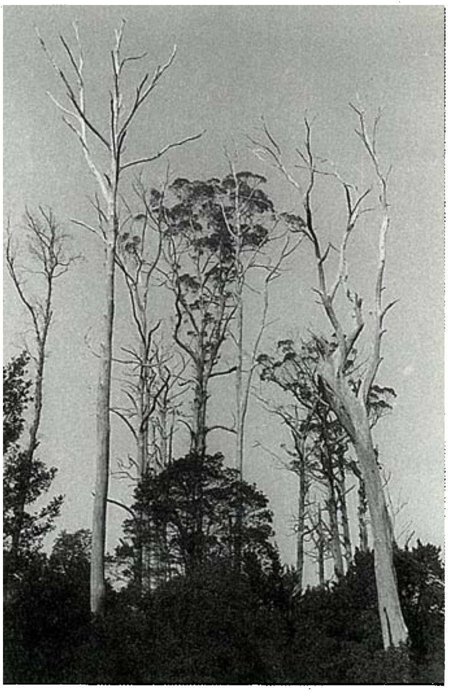
Dynamic boundaries

The Forest Lag site provides good evidence supporting the idea that the vegetation patterns in south-western Tasmania are not fixed. Instead, they appear dynamic and may shift in either direction, towards rainforest or sedgeland.

However, direct evidence to show that plant community boundaries can change comes from the research pair's more recent work at Hoggs Back Plain and Mt McCall.

Among the button grass on Hoggs Back Plain, Dr Brown and Dr Podger have found fallen and standing skeletons of celery-top pine and the gnarled and twisted framework of dead *A. odorata*. At Mt McCall, wood of long-dead King Billy pine and living mallee forms of myrtle have been found among button grass on the ridges. Plainly, those sites once carried rainforest.

This site on the Mt Maurice Plateau in north-eastern Tasmania once carried rainforest. Fire has cleared the area, and eucalypts have moved in. Rainforest logs lie on the ground beneath the eucalypts.



High-altitude dieback of eucalypts in the north-east, caused by lack of fire. Rainforest is reclaiming the area from the eucalypts, which are dying from lowered root temperatures brought about by the increasing rainforest vegetation.

The *A. odorata* provides evidence that the change took place this century. The researchers are continuing their investigations to obtain estimates of the area of Hoggs Back Plain that once carried rainforest, and of the fire frequency that precipitated the change.

The north-east study

The study in the fertile highlands of the northern part of the State by Dr Ellis also shows ecological drift. It indicates that lack of fire causes alpine ash to die, and rainforest to take its place.

For more than 50 years, natural stands of alpine ash (*Eucalyptus delegatensis*) on the Camden Plateau and similar highland areas in northern Tasmania have been observed to be declining in vigour. Many stands contain a large proportion of trees of all ages that are either dead or dying. In nearly all cases, the dieback is associated with the invasion of a rainforest understorey.

Some rainforest areas more than 200 years old contain on the forest floor the remains of eucalypts that have been slowly decaying for what looks like a hundred

Each year, the branches of *Banksia marginata* divide (arrows) and a flower forms in the cleft. This behaviour reveals the plant's age.

years or more. So dieback is not a new phenomenon on the Plateau.

Dr Ellis has been studying its cause. He believes it is a natural result of a reduction in frequency of fire, particularly since the Aborigines ceased burning the region early last century.

Probably rainforest once covered much larger areas than the restricted patches now found. Repeated Aborigine-set fire turned the rainforest to grassland, upon which eucalypts established themselves. (At some sites, beneath the eucalypts, the old trunks of rainforest trees occur.)

Dr Ellis has examined aerial photographs and made many visits to the area. He has found that the degree of dieback strongly depends on fire history.

European settlement evicted the Aborigines. The new settlers on the Camden Plateau did not use fire as much, and rainforest began a resurgence. At the same time, 140–50 years ago, the density of many eucalypt stands increased, as Dr Ellis' ring-counting has shown.

Some 50–100 years later, dieback began at higher elevations (about 1000 m) as rainforest took the upper hand. Now, at many elevations above 800 m, the rainforest invasion is complete. It is proceeding more slowly at lower elevations (above 600 m), where the young eucalypts die first; but Dr Ellis believes that eventually all the eucalypt trees will succumb — unless, of course, fire is re-introduced. He notes that dieback is absent where frequent burning, associated with sheep grazing, has maintained a cover of grass. Felling and burning the understorey has promoted the recovery of stands of alpine ash that were suffering dieback.

In 1963 and 1964, he marked off four plots containing vegetation that ranged from no dieback to severe dieback. Each quarter of each plot received one of four experimental treatments: none (a control); understorey felled; understorey felled and burnt (once); understorey felled and burnt three times since 1964.

The most significant result was that felling and burning the understorey promoted an increase of 60–70% in the rate of growth of badly affected trees (relative to the control).

The most frequently burnt plot (three burns in 12 years) had its rainforest shrubs virtually eliminated. A sparse grass cover appeared and so did fire-tolerant shrubs. The understorey changed from one commonly associated with eucalypt dieback to one normally associated with their healthy growth.

Since 1964 large areas of the Plateau have been harvested, the debris burnt, and the ground then seeded with eucalypts. Vigorous eucalypt growth has resulted, and the oldest stands, now 18 years old, are still growing well.

Dr Ellis attributes the eucalypts' demise to the effects on their roots of a cooling produced by the thickening understorey. He found that the development of a rainforest understorey probably caused the average summer temperature of soil around the eucalypt roots to fall by about 5°C and the average annual temperature by 3°C. This has an equivalent effect to an increase in altitude of about 500 m. Since the temperature of the tall crowns would be little affected, the cooled roots probably could not support the warm crowns and dieback resulted.

He considers that controlled burning at intervals of 30–50 years will be necessary to maintain the eucalypts in good health.

The burning question

Fire is a potent force, and an increase or decrease in its frequency or intensity can change the composition of the vegetation in diverse parts of Tasmania. The problem is to know how to recognize the effects of man's use or non-use of fire for his own purposes.

Fire may be necessary for preserving valuable alpine ash in some places, but the Tasmanian rainforest faces the danger that too much fire may considerably reduce its already small domain.

Andrew Bell

More about the topic

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