Rural dieback: restoring a balance

Picture an Australian paddock with a flock of sheep and a small homestead — the whole scene enhanced by a sprinkling of noble eucalypts. Sadly, much of the beauty in sights such as these may disappear within a few decades.

The unique 'Australianness' of our pastoral lands depends in large part on *Eucalyptus* trees, and in rural areas many of these are dying prematurely and are not being replaced. The problem is more than an aesthetic worry. Trees are a vital resource providing enormous benefits — in agricultural regions as much as in rainforests.

Although the early settlers had to clear much of their land in order to make a living, many deliberately left some trees as windbreaks, as shelter for stock, as sources of timber, and as an aid in controlling erosion. We now know that trees can bestow other benefits as well. For example, they provide a habitat both for birds that may eat various pests, such as grasshoppers, and for insects that may be parasitic or predatory on pests. They can help prevent salinity by keeping the water table down, and they also have the potential to take (from deep underground) nutrients unavailable to shallow-rooted pasture plants and release these to the topsoil through their leaf litter.

When European settlers arrived here, open eucalypt woodland dominated much of the southern two-thirds of Australia. Now, most of this occurs only in small patches on pastoral lands, and many such remnants are dying. (Furthermore, this type of woodland is poorly represented in our national parks, perhaps because it is deemed uninteresting or not in need of conservation.)

When talking about this mysterious widespread death of trees we often use the term dieback. But dieback — like death itself — can be brought about by a multitude of factors. Sometimes the word refers to specific diseases with known pathogens, such as the death of forest trees in Western Australia caused by the fungus *Phytophthora cinnamomi* (see *Ecos* 15), but in the case of relatively isolated trees on farmland no obvious infectious disease exists.

A better term for the situation there is 'rural tree decline'. (However, this article will still use the more familiar and less long-winded term 'dieback' for the premature death of trees on rural land.) The problem does not have a single cause, and hence we're not likely to find a single cure that could simply put things right.

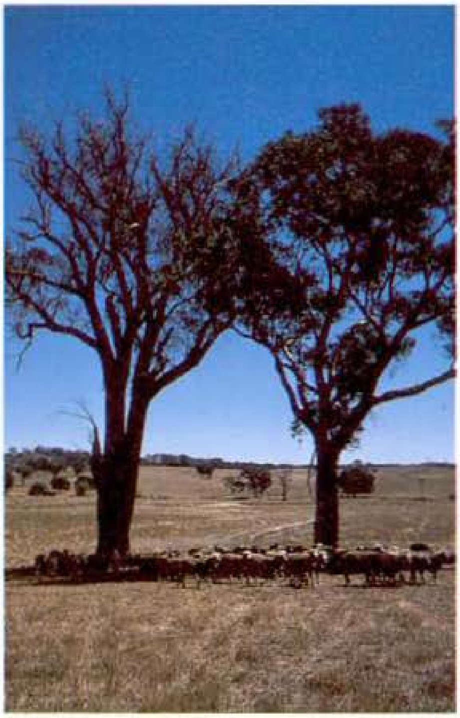
We do know that various environmental factors, such as salinity or drought, can kill trees, but rural tree decline is occurring in areas where these two factors by themselves cannot account for the problem. Instead, scientists have unravelled a complex array of different factors, some more important than others and varying from region to region, that can be distilled into one single issue: how we manage the land.

Healthy woodland. The understorey helps maintain an ecological balance.

The right sort of insect can be useful: here scoliid wasps, which parasitise scarab grubs, rest on twigs of the blackthorn, or Christmas bush — one of the few shrubs that provide a good source of nectar for the adult wasps in the summer.

While other trees can be stricken, it is the decline of eucalypts that has received the most attention. The problem, although it occurs in patches throughout the country, is particularly severe on the Northern and Southern Tablelands of New South Wales, especially in the New England region.

A healthy tree can sometimes exist close to a dying neighbour, as in this case where shade-seeking sheep congregate at the base of two trees.



Scientists now believe that rural tree decline coincides with the changes that agriculture has wrought, but it would be wrong to give the impression that the problem has only arisen recently. In the Nineteenth Century graziers noticed dieback of trees in their pastures and were puzzled by its cause, although they were probably grateful that it helped clear the land!

Old photographs show that, at the beginning of this century, areas of healthy eucalypt woodland existed around gullies or between properties. Now that the proportion of cleared land has become so much greater, dieback is a problem on a far larger scale. Furthermore, the severity of tree decline increased greatly in the 1970s — an increase probably connected with changes in agricultural practice in the 1950s such as the aerial application of fertiliser and the improvement of pasture by means of sowing with sub clover, white clover, and introduced grasses. The greater numbers of sheep and cattle carried on these improved patures had a devastating effect on farm trees.

The symptoms of rural tree decline are similar to those of the known dieback diseases of forest eucalypts — namely, loss of leaves and apparent death of the crown, starting at the tips of branches and so leaving the dead ends protruding beyond the live foliage lower down. As damage to the crown becomes more and more severe, the tree will probably send out new shoots from the trunk or main branches (termed epicormic growth) in a bid to replace lost foliage.

If the tree recovers at this stage, the epicormic shoots grow to replace the lost crown and all should be well. If not, the shoots will, in time, also die, and the tree will once again produce a new batch of epicormic leaves, by drawing upon its stored food reserves. Such cycles of defoliation and refoliation may continue until the reserves are exhausted and death of the whole tree ensues.

It can take a long time for trees to die in this fashion. Partial remissions may occur in particular areas during 'good' years, giving the false impression that the trouble is over and the landscape saved. But, over the years, the decline continues. It could well be that if we knew more about the factors influencing rural dieback we could somehow arrest the attack during one of the periods of partial recovery.

Accordingly, scientists in many organisations have been studying the problem for years (for example, see *Ecos* 19), and they have put forward a number of theories. Most agree that defoliation by a range of insects is what is actually removing the leaves from the branches. But insects are clearly not the whole cause because plenty of woodland eucalypts are prone to attentions of insects yet survive in the long term. Insect attack is an important link in a long chain of events. Unravelling the myriad other factors, and how they may affect insects, is the challenge facing rural dieback research now.

The nectar connection

Dr Rob Davidson — formerly an ecologist with the CSIRO Divisions of Plant Industry, Animal Production, and Entomology in Armidale, but now retired — has studied dieback in New England for many years, with an emphasis on the ecology of the whole problem. He noted work of Dr James Ridsdill-Smith, of the Division of Entomology, showing that nectar is an essential food source for many parasitic wasps and flies. (It's also a useful addition to the diet of various birds.)

More than ten wasp species parasitise the larvae of scarab beetles — a group of avid leaf-eaters that includes the well-known Christmas beetle. So too do tachinid flies, which lay their eggs in many insect pests. The adults of the parasitic wasps drink nectar from native trees and shrubs, such as eucalypts, tea-trees, blackthorn, or sticky daisy bushes. (Parasitic wasps also feed on honeydew secreted by leafhoppers that feed on eucalypts.) Without the large amount of energy continuously provided by nectar, from which they will not fly very far, the adult female wasps cannot dig to find the scarab grubs underground and place the eggs within them.

To sample the insect population naturally present on trees in her study sites, Dr Landsberg (shown here) fogged trees with insecticide and collected the dead insects.

As well as such parasites, scarab beetles have many native predators. The larvae and adults of other beetles and flies feed on scarab grubs, but require the shelter by day of leaf and bark litter on the ground and do not thrive in open cleared pastures. So an isolated tree in a paddock may attract a bevy of leaf-eating scarabs that wreak an unsustainably high level of damage because the predators and parasites that normally keep a check on their numbers cannot live in the cleared field.

Birds are also very important in the dieback equation. Dr Hugh Ford of the Department of Zoology in the University of New England, Armidale, has shown that birds in a healthy woodland consume as much as 60% of the insects that feed on eucalypts. All the usual defoliating and sap-sucking insects still make a living off the trees that are not victims of rural dieback, but provide a food source for an array of other creatures that together make up the ecosystem.

Dr Ford counted birds over a long period, and found more than 20 per hectare in healthy woodland, 10 per hectare where dieback was moderate, two in severely stricken areas, and an average of less than one bird per hectare in pastures with few trees. Some birds were more numerous in small woodland remnants than in continuous forest, presumably because they feed in adjacent pasture.

The trees can tolerate a certain amount of energy loss to insect attack and the system remains in a rough sort of balance, with any increase in leaf-eaters merely meaning more food for their predators. In most parts of the world, trees in their natural state grow in association with shrubs and herbs of many species. Within this framework live various animals — predator, prey, and parasite alike — tied into complex food webs that hold the whole system in balance and usually prevent any one component either dying out or increasing too drastically at the expense of others.

A roam among the gum trees

Clearing the ground to leave only a few isolated mature trees greatly modifies the balanced ecosystem. At the same time, if stock enter the picture their excessive grazing can greatly reduce the understorey in any unfenced remnants of woodland that do remain on a property, thus removing nectar sources for parasitic insects and habitat for many insect-eating birds in one swoop.

And our animals have another effect: if left to have a 'roam among the gum trees' they will end up killing the young eucalypt seedlings (eaten by sheep) and saplings (trampled by cattle). As Dr Davidson and others have pointed out, trees will die naturally of a multitude of factors — environmental stress and insect attack among them — but, provided seed is continually set, mortality is balanced by new growth. There is little doubt that stock prevent this regeneration, so the remaining trees, as they inevitably die, are not replaced.

Even without severe environmental stresses most trees seem to 'age' and after 100–300 years many eucalypts are moribund. With the best care in the world such senescent trees may fail to produce viable seed and will eventually die. Many trees in rural Australia, left standing by the first settlers, may be reaching this state, without having left behind a range of offspring of various ages to replace them.

Another side of dieback research focuses on the dynamics of insect populations. Dr Jill Landsberg, an ecologist formerly with the CSIRO Division of Forestry and Forest Products and now at the Australian National University, has recently completed a comprehensive study measuring and comparing several critical factors in stands of trees with and without livestock. She was particularly intrigued by the observation of several workers that in a dieback area one tree may be the focus for intense insect attack — with little foliage left on it, and a halo of scarab bettles around it — while another nearby may remain relatively healthy.

In Dr Landsberg's study, leaves regrew strongly on branches of *Eucalyptus blakelyi* protected from insect attack.

Dr Landsberg wanted to try to help explain this anomaly and to test a number of rural dieback theories. Working with technician Mr Jock Morse and soil scientist Dr Partap Khanna, she selected a number of sites in the Southern Tablelands of New South Wales, within 2 hours' drive of Canberra.

Each site covered less than 50 hectares and was isolated within a sea of pasture, being more than a kilometre from the nearest forest or woodland. For the purpose of the experiment, the stands designated as 'controls' also had to contain an understorey of shrubs, to help test Dr Davidson's ecosystem-simplification theory.

The team found eight suitable control stands and matched them with eight 'pasture' stands of similar size and — as far as possible — similar geology, degree of isolation, position, and species composition of the overstorey. The crucial difference was that the understorey was not shrubby, but was used for pasture.

The manager of each site completed a detailed questionnaire about stocking rates, fertiliser application, and other aspects of land use. The scientists then assessed tree health by studying the vitality of the crowns and taking into account any dead branches or epicormic shoots. They identified plant species in the areas and assessed their abundance, and carried out bird observations for about 40 hours per site — including during the important time of daybreak.

Using traps and insecticides, they collected and weighed large samples of insects. To measure the extent of defoliation Dr Landsberg used metre-long insect-proof bags to cover four branches on two trees on every site. Each protected branch was matched with a similar adjacent unprotected one and, by comparing the differences in leaf areas, the scientists inferred the extent of leaf destruction brought about by insects.

Dr Khanna carried out chemical analyses of soil samples from all the sites, while Dr Landsberg analysed samples of newly flushed and mature leaves taken from the trees used in another series of insect experiments. These sought to find out whether predation and parasitism on the one hand or food quality on the other was the more important in affecting the growth and survival of a common defoliating insect — a chrysomelid beetle.

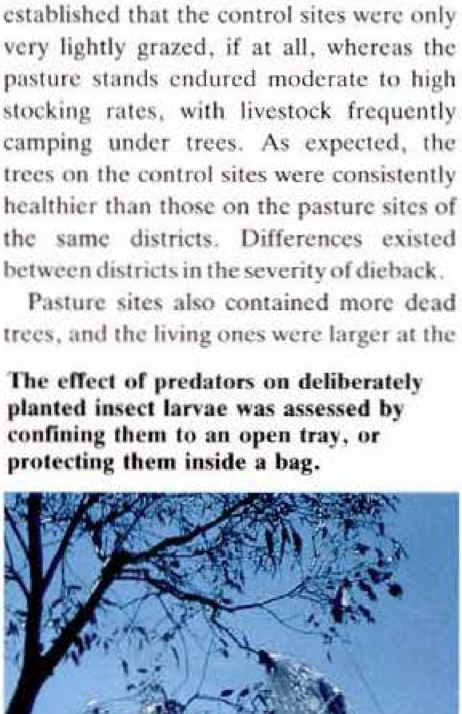
To do this, the scientists attached laboratory-reared insect eggs, ready to hatch, to the leaves, which they protected from predation and the entry of other parasites by enclosing the entire branch within a mesh bag. On similar branches nearby they again placed insect eggs, leaving the foliage open but confining any emerging insects to that area by a slippery-sided tray fitted across the branch. Each day, they counted the larvae and adults that developed.

Results

Several of Dr Landsberg's findings confirmed scientists' existing ideas about rural tree decline. Information from the farmers established that the control sites were only very lightly grazed, if at all, whereas the pasture stands endured moderate to high stocking rates, with livestock frequently camping under trees. As expected, the trees on the control sites were consistently healthier than those on the pasture sites of the same districts. Differences existed between districts in the severity of dieback.

Pasture sites also contained more dead trees, and the living ones were larger at the base. Little regeneration of eucalypts was occurring in these areas, suggesting that the figure for a high proportion of large trees came about because few younger ones were present.

The effect of predators on deliberately planted insect larvae was assessed by confining them to an open tray, or protecting them inside a bag.



Analyses of understorey vegetation and of bird diversity and abundance confirmed the idea that remnants of woodland used for pastoralism are indeed biologically 'degraded' in comparison with otherwise similar treed areas. The understorey contained far fewer shrubs and tree health was inferior in heavily grazed sites.

But one of the most exciting and significant findings was that the pasture sites contained about ten times the mass of insects present in the control sites. As might be expected, the rates of defoliation there were also much higher. Interestingly, the soil in the pasture sites contained much more nitrogen (about four times the concentration of ammonium and forty times that of nitrate) than the controls. The leaves, especially the mature foliage, of the red gums growing there were also richer in nitrogen, phosphorus, and potassium compared with those from trees on the ungrazed sites.

Testing theories

Dr Landsberg's study clearly disproved any idea that dieback of rural trees is a periodic natural phenomenon unrelated to land use. But what if tree sickness merely reflects soil conditions? One result in the experiment belies this: leaves grew in abundance on all branches that were protected from insects, regardless of the site on which they occurred. Thus, although the pastoral sites had far higher levels of nitrates, which can cause soil acidity and thereby stress plants, the trees were evidently still quite capable of a healthy amount of leaf production.

Dr Khanna and Dr Landsberg speculate that soil acidity could be one of many

Choose your trees

Some eucalypt defoliators hard at work. Clockwise from top: Christmas beetles (some of the worst offenders); the very well camouflaged eucalypt-eating larva of a moth; and young cup moth larvae skeletonising a eucalypt leaf.

If your land were afflicted with dieback, what could you do about it? Unfortunately, no easy cure exists — nevertheless, it is possible to help tip the balance back a little in favour of the trees.

Work by Dr Roger Farrow and Dr Penny Edwards, at the CSIRO Division of Entomology in Canberra, has confirmed that tree species vary in their tolerance to insect pests. The scientists are working on a project to re-establish trees in dieback-stricken areas, and aim at developing a strategy for the control of the herbivorous insects that damage eucalypts in pastures.

Many land-owners are now planting eucalypts on farmland suffering from rural tree decline. However, leaf-eating insects quickly colonise new plantations, slowing growth and sometimes killing many trees. In fact, in the Southern Tablelands of New South Wales, it is rare for new plantations of eucalypts to become properly established without some control of insect pests.

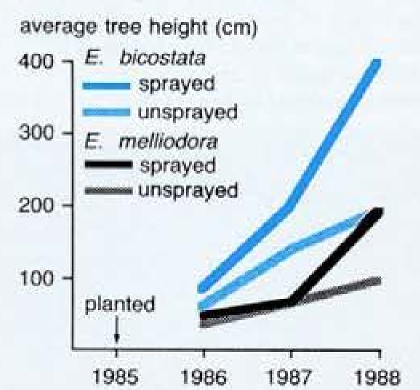
Using 12 eucalypt species in experimental plantations near Canberra, the CSIRO scientists found that protection from insect attack can double the yearly growth rates of young trees. Interestingly, they observed that, despite the absence of a complex shrub community, the natural enemies of the leaf-eaters also colonised the plantations in sufficient abundance to have a regulating effect on most of these. Only a few herbivore species occasionally escaped from their control and so became pests.

Incidentally, identifying the insect pests concerned is no easy task, as many are well camouflaged or feed only at night. The scientists are therefore collecting the droppings — called frass — from which they can pinpoint the insect down to the genus level. By weighing the frass they can deduce the quantity of plant matter consumed by a given number of herbivores.

In the study, trees that appeared 'unhealthy' and showed less growth also attracted more herbivorous insects and, of course, were less able to withstand their attack. Hence, a vicious circle whereby insect damage leads to more insect attention can build up in certain individual trees. It is likely that such victims will eventually die.

Differences between species in their susceptibilities to insects may be due to such factors as leaf structure. For example, those whose juvenile leaves are broad and waxy (such as blue gums introduced to the area) fall prey to the caterpillar of the autumn gum moth, which constructs protective shelters from the soft leaves, whereas most chrysomelid beetles avoid any leaves like this. The reason, Dr Edwards has found, is the inability of the beetles' feet to get a grip on the wax. (However, they will eat the non-waxy adult leaves.) By contrast, applebox (*Eucalyptus bridgesiana*), which is the main indigenous host of the moth, is less susceptible to the insect's effects because its juvenile leaves are more resistant to being folded into shelters.

Insect impact varies



In tests by Dr Farrow and his colleagues with various eucalypt species planted near Goulburn, N.S.W., spraying identified those that suffered most from insect attack; these species benefited most from the treatment.

Differences in susceptibility between individual trees of the same species are harder to explain — although variations exist within a species in, for example, the quantity of juvenile foliage produced. Changes in soil structure and composition, and varying microclimates, may also affect both the eucalypts and the insects that feed on them.

Dr Farrow recommends that farmers plant more trees in stands rather than as isolated individuals scattered here and there. He thinks land managers should choose species that are known to be vigorous growers in the local environment and that are relatively tolerant to attacks from the insect pests commonest in the region. Where Christmas beetles are concerned, they should plant sufficient trees to dilute or spread the load of insects coming from the pastures, where their larvae feed on grass roots. Along with Dr Davidson and Dr Landsberg, he agrees that stock must be excluded from the treed areas, in order to retain a dense layer of low branches and foliage.

predisposing factors in rural tree decline — an environmental stress that further weakens trees. But even the ungrazed sites in their study, despite their lower levels of nitrogen, still had quite acid soils and yet tree health there was good. So while acidity may be unhelpful, none of the trees in the study suffered sufficient stress to interfere with their leaf growth, provided the herbivorous insects were excluded.

It seems that a high rate of insect attack is indeed the decisive factor in rural dieback — at least in the area studied. But why did the pasture sites harbour a far greater mass of insects than the control sites? Was it because, as Dr Davidson believes, their degraded ecosystem — lacking the right understorey — could not support enough insect predators and parasites to keep a check on the defoliators' abundance?

In fact, Dr Landsberg found that the proportion of experimental insects lost to predation differed little between control and pasture sites. It was about 30% in both areas — half the figure for all insects that Dr Ford had found in his study in New England. The level of parasitism she detected was also small: only nine adults of larval parasites emerged, and of particular note was that all of these came from insect larvae reared at two of the pasture sites, with a poor nectar-providing understorey. The study did not assess parasitism in other insects.

But the situation becomes a little more complex because many of the common parasites of the beetle used in the experiment oviposit directly into eggs, rather than into larvae. Hence, this experiment, where the scientists attached the eggs just prior to hatching, offered less chance for many of the parasites to do their work. Dr Landsberg concedes that her results probably underestimate the importance of parasitism. The influence of birds, she feels, may also be greater, as her study did not examine their feeding on insects during the spring, when parents take on more food to rear their nestlings.

The control sites definitely harboured more birds, so how could it be that birds took roughly equal numbers of insects in both types of site? The explanation, Dr Landsberg reasoned, is that a variety of birds nest in the controls, but they may choose to forage elsewhere as well, including within the pasture sites.

What's in a leaf?

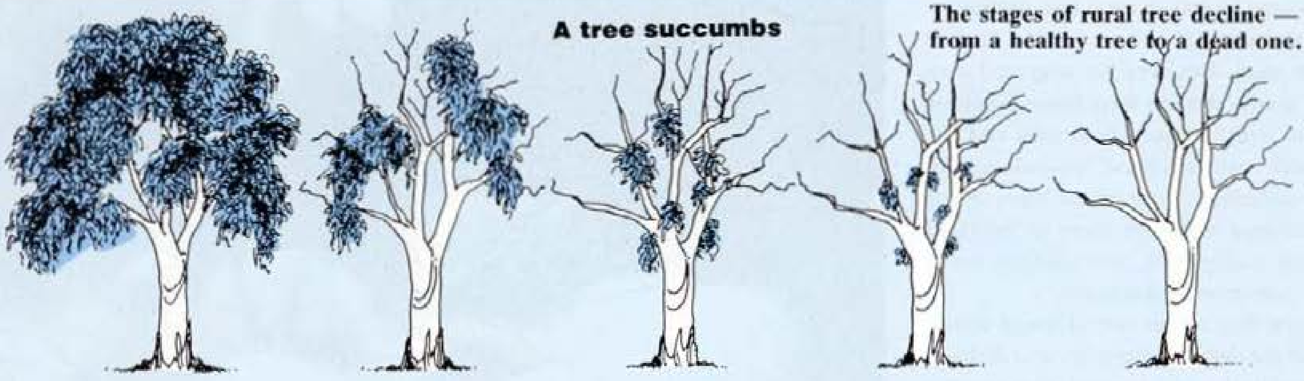
One of the most interesting findings of the study concerned the growth of the chrysomelid beetle larvae that were deliberately protected from predation and parasitism. Those on the trees in the pasture sites grew faster and developed into larger pupae than their fellows munching on the leaves of trees in the controls. Dr Landsberg believes that the difference is mainly due to the nutrient content of the leaves.

The level of nitrogen in the young foliage averaged 1·44% in all the control sites but 1·88% for the pasture sites. Likewise, the figures for phosphorus were 0·16% against 0·21%. A similar range existed for nutrients in mature leaves. These are averages; in one of the control sites the value for nitrogen in the leaves was as low as 0·97% and, presumably as a direct result of this poor nutrition, 59% of the protected larvae died there, compared with only 24% at the paired pasture site. In addition, the survivors were far smaller.

The higher levels of nitrogen and phosphorus in the leaves are almost certainly a direct consequence of the increased amounts of these elements in the soils of the pasture sites. The improved nutritional quality of the leaves directly helps the insects in their battle to survive and reproduce. Work by Dr Cliff Ohmart, also of the Division of Forestry and Forest Products, has shown that the fecundity of female chrysomelids (of the same species used by Dr Landsberg) is influenced both by the nitrogen content of their diet and by their weight. It's quite probable, therefore, that female pupae that develop on the pasture sites would grow into more fecund adults, giving rise by positive feedback to a spiralling increase in the numbers of this particular defoliator.

But what causes the nutrient enrichment of the soil? Although most farmers deliberately avoid spreading fertiliser under trees,

Flower wasps — like the one here feeding on a daisy — parasitise the grubs of scarab beetles, as shown in this series of photos. From top to bottom: the scarab grub underground with a tiny wasp larva attached and feeding on it; the parasitic larva grows while the scarab grub shrinks; and finally the flower wasp larva has pupated and the scarab grub is dead.



The fungal factor

Why do trees defoliated by insect attack actually die? Of course, defoliation removes the leaves, but usually plenty of epicormic buds remain under the bark ready to replace the lost foliage. So the question becomes 'why do the epicormic buds eventually stop producing?'

A possible answer is provided by cankers caused by fungi. Although the type of dieback discussed in the main article (rural tree decline) is not associated with a specific pathogen, cankers are often present on the branches of trees suffering from it.

Such cankers are dead areas of bark and wood that may girdle branches and main stems. Dr Ken Old of the Division of Forestry and Forest Products has isolated fungi from eucalypt cankers. He sampled trees from around the Southern Tablelands of New South Wales, and from Dr Landsberg's study areas in particular. He found that several fungal species were nearly always associated with trees suffering from rural dieback.

That does not mean, of course, that the fungi are causing the dieback. The species involved are common and widespread, growing as saprophytes on dead branches and only becoming pathogens incidentally, if an opportunity — such as the appearance of a wound resulting from insect attack or wind damage — arises. Work from the Northern Hemisphere has shown that these fungi have most effect on trees already stressed. Dr Old therefore decided to carry out test inoculations of the fungi on eucalypts on farms and woodland reserves near Canberra, which were suffering a severe outbreak of Christmas beetles in the summer of 1987/88.

As mentioned in the article, some trees can become completely defoliated because of beetle attack, whereas others nearby escape relatively unscathed. This fact was fortunate for Dr Old, as it enabled him to test the effects of defoliation on fungal growth using pairs of red gums, matched according to their similar size and close proximity, where one was unaffected while its nearby pair had but few remaining leaves. He made small circular cuts into the bark, and then inoculated these wounds with one of three species of fungi.

After 4 weeks, wounds on the defoliated trees that had been inoculated with a fungus by the name of *Endothia gyrosa* formed cankers more than 50% larger than infected wounds in the leafy trees. One year later, the non-inoculated wounds used as controls had healed up — or remained only as small areas of dead bark — in both defoliated and leafy trees.

Dr Old also performed experiments with glasshouse-grown seedlings and plantation saplings (4–6 m tall) of several eucalypts. Some tree species were sensitive to defoliation, whereas others were far less so and their cankers healed despite the removal of leaves.

In rural dieback, the severe levels of defoliation that occur obviously rob the tree of much of its ability to make food. Eventually it will use up its starch reserves, and at that point, Dr Old suggests, the weakened tree will not be able to mount the necessary expensive defence against a fungus. (The defence is expensive in terms of energy requirements because it involves cell division and often the production of compounds, such as polyphenols, that are toxic to fungi.) Common fungi that cause minor infections in transient wounds of all trees then deliver the final *coup de grace* by spreading relentlesly when the host defences are down, killing entire branches.

The scenario resembles a weakening of the immune system in humans — brought on by stress such as malnutrition — where opportunistic infections by usually harmless micro-organisms commonly associated with us take hold when our guard is lowered.

adjacent paddocks are usually fertilised and inadvertent drift may occur. However, the scientists selected pasture and control sites to ensure that they were roughly equal distances from paddocks. Any slow movement of nutrients through the soils from paddock to woodland remnant would also be about the same.

(Of course isolated trees in paddocks would receive the full effect of fertiliser directly; furthermore, the roots of crops in enriched paddocks constitute better-than-usual food for the underground larvae of the defoliating scarab beetles — another way in which agricultural practice has tipped the balance in favour of dieback-associated insects.)

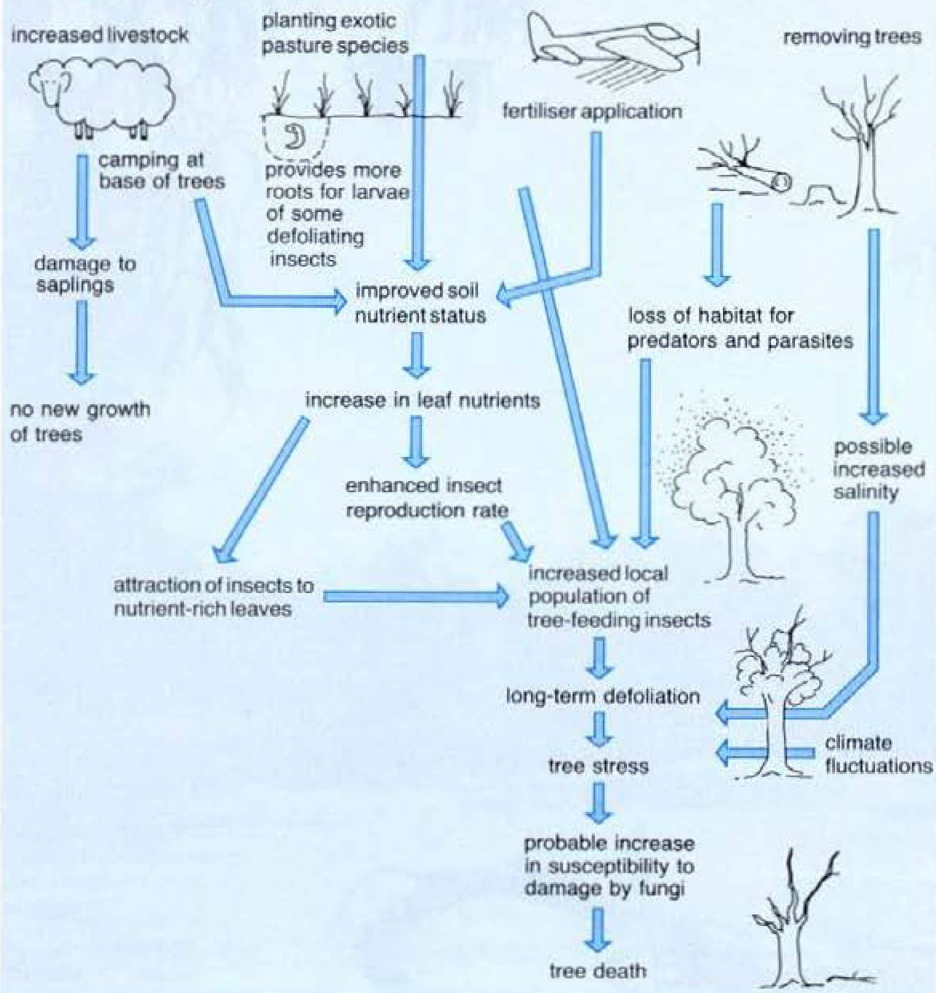
The only difference between the two types of site that Dr Landsberg believes could account for the inequality in soil and leaf nutrients is the presence of livestock. The average stocking rate in the pasture sites was the equivalent of 4·2 sheep per hectare over a 10-year period, whereas in control sites, which suffered occasional grazing, it came to only 0·6 per hectare for the same period.

Particularly interesting was the obervation by the land managers that stock frequently camp under trees in the pasture sites. If they do this regularly their excretion could constitute a substantial addition to the nutrients in the area, and thereby to the leaves of the trees. And what's in a leaf one day will determine the number of insects feeding on local trees next.

Not black and white

Dr Landsberg would be the first to admit that rural tree decline is a multi-faceted problem. In some parts of the country, such as around Tamworth, N.S.W., grazing and eucalypts coexist well and dieback is not a serious problem. A little further north it becomes one. Clearly, therefore, soil enrichment by stock cannot be the only factor operating everywhere. However, in her study area, ecosystem simplification probably had less influence on controlling

How one thing leads to another...



Some of the more important links in the dieback chain.

the numbers of defoliating insects than did nutrient enrichment.

Obviously different parts of the country have various levels of nutrients naturally present in the soil, and the plants are adapted to that. In soils that were originally nutrient-poor, any addition would represent a greater perturbation than the same disturbance in naturally rich soils.

Now although grazing can occur without damaging woodland in some areas, there have been no reports of extensive dieback in the few ungrazed woodlands that remain. Where the studies of Dr Landsberg and Dr Davidson agree, therefore, is in pointing the finger of suspicion at current practices of animal husbandry.

Plenty of other factors also affect whether trees live or die. The stresses of droughts — or even too much water — salinity, and poor soils can all weaken trees and 'push them over the edge' into a state where they cannot tolerate the normal level of insect attack. Fungal infection can have a similar effect, and indeed such infections may be what finally kills a tree weakened by continuous defoliation. (For more on this, see the box on page 14.) Then, too, the populations of insects can be subject to periodic natural fluctuations. High soil temperatures and dry soils kill many scarab eggs and larvae, and very wet soils in spring can kill pupae. Adult Christmas beetles can't emerge from underground in dry, compacted soil.

Moreover, the geology and soil profile of a region, by determining nutrient status and pH, clearly affect the health of plants. It may be that with better mapping we could relate the distribution of dieback to soil types, and perhaps identify high-risk areas in need of special care.

And what is the care that we should apply to minimise tree decline? The main action, the scientists agree, is to fence off remaining wooded areas to exclude stock — at least, for much of the time — and so prevent trampling as well as the possible nutrient enrichment of leaves. (Dr Landsberg's sites were occasionally grazed, without apparent harm.) These 'core' areas should have some shrubs present — if not, they are probably already degraded.

The next step is to plant tree seedlings that, with no stock to trample them, should grow to replace dying trees. Research in the Division of Entomology and elsewhere is identifying eucalypt species that are more resistant to attacks by particular insect pests in certain regions (see the box on page 12). So for regeneration we need to choose species that are well suited to the local climate and insects, plant them in large numbers — so that the insects do not focus on one or two trees — and encourage shrubs and birds to establish themselves. We should try to minimise the drift of fertiliser into the woodland.

Such a prescription need not mean economic loss. Many areas that are not suitable as grazing land, such as gullies and rocky shallow soils, can be left in their naturally wooded state with a fence thrown around them. The New South Wales Department of Agriculture recommends that graziers take steps to encourage birds and parasitic insects to help control pasture pests.

Above all, attitudes must change. We need to realise that on agricultural land we must manage the great resource of native trees as we do crops, pastures, and grazing animals. If done properly, all parties will benefit; and our 'land of sweeping plains' will maintain, for far longer, its productivity and its beauty.

Roger Beckmann

More about the topic

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