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Dieback: Death of an Australian Landscape

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Visitors entering the New England region by highway from the south are greeted by billboards proclaiming the area as 'Glorious New England', a description that in times past was apt and accurate. Now, beyond those billboards lies a dying landscape. The muted, delicate colours of the Australian countryside have given way to the whitened skeletons of trees with dead branches raised toward the sky as if in supplication. Cattle stand beneath trees which have lost their leaves and can no longer cast shade. There is a harshness to the exposed landscape.

The sickness of the trees is known as 'dieback'. Giving the malady a name merely provides a means of talking about it; it does not cure it nor make it more easily understood. Neither the cause nor the treatment of this ecological disaster is currently well understood despite considerable attention paid to it. It is an exceedingly complex problem and one which will require a long time, much money, and sustained, intensive scientific effort before there is an effective understanding. It is a race against time.

Change in the landscape is inevitable. If one were to take any part of the world's surface and employ time lapse photography over millions of years one would find that a particular

region changes from forest to desert, is covered by a shallow sea, is raised into mountains which subsequently weather away, and so on. These changes are on a very long term scale and are scarcely perceptible within a lifetime, and may even go nearly undetected during such a short period of time as human history on this planet. Change becomes alarming however when within just a few decades, a few years, one witnesses the death of the vegetation clothing an area and sees the quality of the landscape deteriorate markedly. The very fact that the causes often are unknown and hence uncontrollable makes such a situation even more disturbing. This is especially true if the ability of the region to provide food and other natural resources for the human population is impaired.

What has come to be known as dieback is not merely the dying of trees. Rather it is a protracted decline in health and vigour of trees that can be identified by a particular set of symptoms. Dieback does not inevitably lead to the death of the whole tree, as recovery sometimes occurs. However, with progressive or repeated stress from dieback, death eventually follows.

Dieback probably is best defined by the symptoms that can be observed. Those symptoms can be grouped into stages of increasing severity. The first stage is decline and thinning of the crown, beginning at the tips of the twigs and progressing along the branches towards the trunk. As the outer parts die, the dead ends of branches protrude beyond the live remaining foliage. Once there has been considerable decline of the crown, new shoots may be produced directly from the trunk or main branches. These shoots, called epicormic shoots, give the tree a distinctive, compact appearance. If recovery occurs, the epicormic shoots may eventually produce a new, healthy crown. If not, they in turn may begin to die. There may be several cycles of production of epicormic shoots followed by their decline and death. As long as the tree has sufficient reserves of energy to produce new shoots, it can continue to

fight the malady. However, once those reserves are exhausted, no further epicormic shoots can be produced; this leads to the third and final stage of dieback, death of the whole tree. Isolated trees or whole forests can be affected.

Dieback is not a single phenomenon. Dieback in some areas is caused by one particular factor and is reasonably well understood. For example, jarrah dieback in Western Australia is caused by a fungus disease of the roots, and in some areas of South Australia increased soil salinity has been identified as the cause of local dieback. In many cases, however, and especially in New England dieback, perhaps the most complex and least understood type, many theories have been advanced as to the causes. They include (1) insect defoliation, (2) fungal diseases, (3) drought, (4) alteration of water tables, (5) nutrient imbalances in the soil caused by application of fertilisers (especially superphosphate), (6) soil erosion and reduced soil aeration, (7) clearing of land, with retention of old trees but not saplings, (8) overstocking with grazing animals, and (9) salinity.

It is unlikely that any one of these suggested causes is the sole factor responsible for New England dieback. It is more probable that combinations of several are involved, or even all of them in concert. There may be undetected causes not yet suggested, even as an hypothesis. A further complicating factor is that the cause or combination of causes may vary from year to year. For example, at one time drought may be important, but insect grazing at another. A particular cause may only be expressed once in many years. Thus, for some types of dieback, several years of intensive study may be required before all of the important causes can be assessed.

Another complication is that two different causes may interact with each other and produce effects different from the sum of their effects when acting independently, a phenomenon known as 'synergism'. For example, a particular amount of insect grazing in drought years may have a very different influence on the health of trees than the same

amount during wetter years. On the other hand, drought may kill many insects and reduce the intensity of grazing. One year's study cannot unravel the effects of a single factor and certainly cannot lead to insights into the synergistic effects of several factors.

One of the expressions of year to year variation in dieback is that at times the landscape appears to recover. True, dead trees still stand as a reminder of ecological ill health, but many trees that in previous years appeared moribund, vigorously produce new foliage and appear on the way to recovery. And they might recover if the cause or causes of dieback were permanently removed. Unfortunately such recoveries often merely inspire false hope, and subsequent conditions lead to a continued decline and eventual death of trees. This situation is somewhat analagous to the periods of remission, or apparent well-being, experienced by persons afflicted with terminal cancer.

What should be done in the future?

There are two approaches that need to be taken into account in the study of dieback. These differ in emphasis and in their time scale.

One is a long term approach leading to a better understanding of how ecosystems in general function. It is especially important to know more about how different factors interact, that is, to know more about synergistic effects. The study of dieback has revealed over and over again that a particular malady cannot be understood or controlled merely by studying what superficially appears to cause it. The entire ecosystem must be studied. An understanding of such a complex system with its many species, its changes in weather over time, and its alteration at the hands of humans as their activities change, cannot be achieved in a short period. Ecosystems are poorly understood at present, and it is that lack of understanding that has led to many ecological illnesses, of which dieback is merely one example. Once broad principles are

known they can be applied to specific problems, like dieback, as they arise.

This approach has sometimes been labelled as pure research in contrast to applied research which is seen to deal with particular problems of immediate practical significance. That is a misnomer. Pure research provides the fundamental understanding essential for making specific applications and for designing research into particular applied topics. Consequently, one of the important areas of future research is the study of ecosystems and how they function. It is important to discover more about the ways different factors interact and how one event may, through a series of chain reactions, trigger others. We need to know enough about ecosystems to be able to predict what will happen if certain changes in land use take place, not wait to see what *does* happen and then try to rectify the damage. That day is a long way in the future, but is a goal to work towards. Research in that direction should be given the priority it deserves. One of the advantages of pure research is that it may lead to the prevention of ecological disasters and make their treatment unnecessary. A cure is temporary; understanding is permanent.

The second approach is to take immediate measures to lessen the effects of dieback in particular regions. This is a short term approach. One cannot wait until an ecosystem is fully understood before one attempts a cure. It is essential to apply whatever knowledge is available, however imperfect it may be, and to use it to best advantage. If an outbreak of insects is associated with dieback it is important to investigate ways to control the insect. If a fungus disease threatens, its treatment must be attempted, the apparent causes must be dealt with immediately, because an emergency exists. Later, the subtleties can be worked out, to achieve a more complete understanding or to analyse why treatments were not as successful as expected.

Mistakes will inevitably be made, but much will be learned from them. What works at one time or in one place may not

be effective under other circumstances; comparisons of results in different situations can lead to a more effective control. In this regard, the term applied research is also a misnomer. Although it is directed towards the solution of a particular problem of immediate economic significance, it contributes information that leads to a better overall understanding. There is, in fact, a spectrum from pure research on the one hand to applied research on the other, with most projects having elements of both.

The specific directions that future research into dieback should take are as follows:

(1) There should be more cooperation among scientists from different disciplines. One specialist working in his own particular area of research is likely to overlook the importance of other factors outside his own topic of expertise. In a sense, an entomologist may overemphasise insects as the cause of dieback, a mycologist may lay too much stress on the role of fungi, a plant physiologist may view the significance of drought with a particular bias, and so on. It is difficult to see the forest for the trees. Cooperation of specialists in different disciplines should give a broader ecological perspective and lead to a degree of understanding not possible from only one vantage point.

(2) Synergistic effects must be carefully evaluated. Experimental work which deliberately mixes factors in different combinations to find out how they interact is necessary.

(3) Techniques enhancing natural regeneration need to be investigated. Fencing off areas from stock, and alternate use of fenced areas that allows regeneration, should be developed.

(4) Much more work needs to be carried out on artificial regeneration of native species. Research into the tolerance of different species to individual factors and to combinations of factors is necessary for selecting the best species to plant in areas suffering from dieback. Salt resistant species may be needed in some places, insect resistant ones in another, and drought resistant ones in still others. More trials dealing with

several characteristics and employing trees from different areas are needed. Selection of genetic strains after cloning experiments may prove fruitful.

(5) The physiology of eucalypt trees needs further investigation. How they use phosphate, water and salt, and the levels they can tolerate requires study. The effect of ageing needs experimental investigation.

(6) Long term ecosystem studies of forests and rural lands should be launched, so that the fluctuations in weather and other factors on ecosystems can be evaluated.

(7) Specific control measures must be evaluated, not only in terms of their effect on target organisms, but on other members of the ecosystem.

(8) Much attention should be devoted to the development of natural controls. Not only should the insects that parasitise or prey on eucalypt pests be considered; there are a number of fungal, bacterial and viral diseases of insects that may also be effective. Predatory insects should be studied. Given the importance of ants in other parts of the world in the control of forest pests, they should receive more attention in Australia.

(9) Current research into the population ecology of pest insects and fungi should be continued, and expanded to other species as needed.

(10) The feeding and nesting behaviour of birds is an important topic of study. Research into the kinds of shrubs that best fulfil the nesting and cover requirements of a variety of insectivorous species is required, and extensive planting programmes should be initiated.

Dieback is an ecological illness of great magnitude, enormous complexity and a variety of causes. It was not deliberately brought about by human activity, but in many cases the pattern and intensity of land use appears to be an ultimate cause, abetted by secondary ones such as insects, fungi and drought. The malady should not be considered as an act of God for which we have no responsibility, and against which we are powerless. Each of us has a share of blame for having

neglected and abused our environment and ignored signs of its deterioration until it reached disastrous proportions. Together, we all — scientists, graziers, farmers, economists, foresters, land managers, politicians and taxpayers — share the responsibility of finding a cure for dieback, preventing its further occurrence, and regenerating a dying landscape.

Harold Heatwole and Margaret Lowman, *Dieback: Death of an Australian Landscape* (extract from chapter one and conclusion), Reed Books Pty Ltd, Sydney, 1986.