HOW DO THREATS TO CANTERBURY PLANTS POTENTIALLY LEAD TO EXTINCTION

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How do threats operate on plant species and can we take a more predictive approach to assessing their effects? To answer this I want to talk initially about ships. Just after the film *Titanic* went on show, I started to read about other marine disasters. Out of curiosity I picked up a book about another marine tragedy, the loss of the *Andrea Doria* almost 50 years ago. The most interesting part of the book for me was a detailed analysis of the various factors that led to the disaster. The relevance of this to conservation is that marine disasters and extinction of biological species both involve similar risk situations. There is, in fact, much that conservation can learn from analysis of accidents whether at sea, on the highway or in the mountains.

One of the first things that we learn from such tragedies is that there are both intrinsic and extrinsic factors at work. Intrinsic factors are those that are ever-present in an object, whether a plant species or a ship, and which make it susceptible to deleterious effects of external pressures. To take the *Titanic* as an example, the ship had flaws in its design that meant that a major tear in the hull would allow water to enter at an uncontrollable rate. This is an example of an intrinsic factor that in this instance predisposed the ship to sink in the event of a major collision. In the case of the *Andrea Doria* intrinsic factors included the particular technique used for plotting movement of other ships on the radar screen.

Intrinsic factors in plants that predispose them to extinction events include very small natural population sizes, occupation of very small geographic ranges, reliance on specific pollinators, irregular flowering or fruiting, susceptibility to periodic stress and having a very narrow habitat range. As an example of the first factor, one of the largest populations known of *Iphigenia novae-zelandiae* probably consists of at least 30,000 individual plants but in a patch less than 10 – 30 metres in extent. A site such as this could be eliminated with the single sweep of a bulldozer blade. Mistletoes provide a good example of species with obligate pollination systems, with birds having to learn how to trigger the flowers to open them for nectar and also ensure pollination. A number of Canterbury plants are limestone endemics and these are plants that have very marrow habitat preferences. Dioecism is a further intrinsic factor that can pre-dispose to extirpation of small populations, actual New Zealand examples being provided by *Gunnera hamiltonii* and *Fuchsia procumbens*, both of which have populations that contain only one sexual state (see e.g., Given 1981).

A second lesson is that threats can be divided into those that are proximal primary threats and those that are secondary. In the case of a maritime disaster the first includes those factors such as the fundamental design of a ship, the course being steered and the position of another ship (or iceberg) that may be in its path. Secondary threats include such matters as the procedures for manning lifeboats that may not avert a disaster but can lessen its severity. For plant species secondary threats can include such matters as protection of sites, recovery programmes and management responses to decline.

A third lesson is that some threats are deterministic while others are stochastic. Deterministic threats are those for which trend data can be readily calculated while stochastic threats are literally "a throw of the dice". In the case of the *Andrea Doria* deterministic factors included the velocity of the ship, its bearing and the general visibility at the time of the accident. Stochastic factors included the movements of other ships and the responses of individual crewmembers to impending disaster. For plants deterministic factors include grazing and browsing, rate of spread of a disease and mean seed reproduction, while stochastic factors include seasonal climate, landslides and earthquakes, and unforeseen developments such as housing estates or a change in farming systems that unexpectedly eliminate habitat.

A further lesson is that tragedies rarely have a single cause. The analysis of the *Andrea Doria* loss indicates that there were more than ten factors that contributed to the sinking. In this instance, had any one of those factors not operated, the sinking might have been averted, or at the very most there would have been significantly less loss of life. Yet, when it comes to extinction of plants (and animals) there is often a tendency to look for single causes, whether habitat loss, predation or competition with exotic species.

The English ecologist J. P. Grime (1979) provides another perspective on decline and extinction. He suggested that all species may be placed within a triangular matrix based on the three factors: competition, stress and disturbance. Good competitors include climax species and very few rare or endangered species. Stress tolerant species includes large number of very locally distributed endemic taxa. Such species are threatened by habitat removal, elimination of natural stress factors such as soil infertility, or change in the nature of a stress e.g. from moa browsing to deer and possum browsing. Disturbance tolerant species include most weeds, but also very many rare species and especially those in decline. Species that are attuned to disturbance are often vulnerable both to competition with invasive species that can outcompete for resources, and to changes in disturbance regimes, especially towards greater landscape stability that is often brought on by a wish to make the world 'safer' for humans.

This brings us to the role of processes in nature and the vulnerability of processes to threats. A threat does not have to operate directly on a plant but can act indirectly by affecting key processes that are vital to the continued existence of the species. Such processes may be physical and include natural erosion, storms, and water or air movement. They may also be biological interactions between organisms. Very important examples are provided by 'mutualisms'. These literally involve "two or more organisms helping each other out". For plants among the most important are animal pollinators. The pollinator such as a bird or a bee gets nectar in exchange for ensuring fertilization of the flower's egg cell.

A key aspect of processes is that there is often a lag time between loss of a process and loss of those species affected by this. Woody species of plants provide particularly good examples. Even in the absence of seed production and recruitment of new individuals because essential pollination or dispersal processes no longer operate, aging cohorts of individuals may survive. This is sometimes known as the 'living dead' phenomenon and a good example is provided by shrubby pohuehue (*Muehlenbeckia astonii*).

Canterbury has 132 species that are listed as nationally threatened (Head and Given 2001). These provide examples that illustrate some points about threat, decline and extinction and the role of some major threats. The critically endangered lianoid shrub, *Helichrysum dimorphum*, is an interesting example of a species that has a number of inbuilt factors that pre-dispose it towards decline. Only a few hundred exist in the wild of which most are concentrated into two populations. It has a very narrow habitat range and its pollination appears to be largely by moths that rely on a very specific adjacent habitat. It is prone to summer drought stress, and flowers and fruits in late summer when the risk of such stress is probably greatest. Mistletoes have already been mentioned as having some pre-disposition towards risk of decline. Limestone endemics such as *Ischnocarpus exilis, Carmichaelia hollowayi,* and *Australopyrum calcis* provide further examples of plants that display intrinsic threat factors.

The poor competitiveness of many species under threat is well shown with coastal plants such as *Desmoschoenus spiralis* (pingao), *Euphorbia glauca, Austrofestuca littoralis* and *Sebaea ovata* all of which are threatened by the influx of invasive exotic plants that take over their sand dune and sand swale habitats. A very rarely seen fern that may well be succumbing to the shading effects of exotic grasses is *Anogramma leptophylla* or Jersey fern. Over a number of years it has disappeared from sites on the Port Hills where it was formerly common, usually as a result of growth of tall species of pasture grass.

It seems likely that a significant number of Canterbury plants are dependent on dynamic processes for their continued existence. New Zealand is a land of heterogeneous landscapes where there is change over both short distances and short periods of time. Plants growing here have had to evolve to cope with frequent catastrophes. In the interests of soil stability and safety we strive to create landscapes that are stable and predictable with minimal change. *Leptinella nana,* pygmy daisy, is an example of a species that is probably dependent on small-scale disturbance for its survival. Disturbance creates bare areas that can be colonized by the daisy. The same was probably true of *Carmichaelia juncea,* now extinct in the wild in Canterbury (although it is at the present time being reintroduced). This was a plant of pebbly lake shores in the Waimakariri basin, a habitat that has been shown by studies by the Canadian ecologist Paul Keddy, to be especially rich in rare, disturbance-tolerant species (e.g., Keddy 1985). Other disturbance dependent species include *Crassula peduncularis, Teucridium parvifolium* and *Lepidium oleraceum.*

Habitat loss may be the biggest single factor that is leading to decline in plants found in Canterbury. The Canterbury Plains display an extraordinary level of indigenous habitat loss and replacement with exotic species (see e.g., Molloy 1971; Meurk 1995). It is little wonder that the Plains have seen the severe decline and loss of many species both rare and common. It is, though, not only the lowlands and plains that are affected by habitat loss, but increasingly hill country as well. Extensive land use changes such as conversion of grazing land to exotic forestry increasingly puts pressure on plant species that until now might have been considered comparatively safe. Especially under threat are many shrubs characteristic of divaricating scrub or scrub wetlands, including *Carmichaelia crassicaule, C. kirkii, C. torulosa, Coprosma obconica, C. wallii, C. intertexta, Muehlenbeckia astonii* and potentially even widespread species such as *Sophora prostrata.* Ironically, some of these species such as *Muehlenbeckia astonii* have considerable potential as shelterbelt plants in Canterbury's more arid hill country.

The situation facing many of Canterbury's dry 'grey' shrub components may be especially bleak, not only because of the primary threats of habitat loss and reproductive failure (leading to the 'living dead' phenomenon mentioned earlier) but also because of secondary threats in the form of poor public support for conservation. New Zealand conservation suffers, in common with many other countries, from the problem of icons. Our icons are forest, wetlands, birds and marine mammals. While acknowledging the important place that these occupy in the conservation consciousness, in contrast scrub, lowland grasslands, shrubs, herbaceous plants and most invertebrates constitute a silently suffering majority. Yet, if there were an iconic plant group that deserved far more attention in Canterbury it should be our unique divaricating shrubs. Increasingly they are under threat from the effects of habitat change, loss of key physical and biotic processes and exotic invasion. However, being under-valued means that they frequently get scant attention from official or community sources.

A final point is that whereas initial decline is often caused by several deterministic factors working together, final extinction often seems to be caused by a single stochastic event. This has important implications for management of our botanical heritage. It means that we need to ensure that in the early stages of decline we need to be vigilant and doing everything possible to minimize the collective effects of deleterious factors. This may not require addressing every threat but it does mean that we need to select those that have greatest influence and about which we can do something. This may at least buy time for a more complete addressing of all significant threats.

The terminal role of stochastic events means that for species that are critically endangered and whose populations are small, exceedingly fragmented, affected by missing processes or in suboptimal habitat, we need to be ready to act instantly when the unexpected occurs. At this level, mitigation must be decisive, swift and sometimes radical, possibly involving removal of all wild plants to a safe haven. The challenge for conservation of plants in Canterbury is to ensure that we take remedial action when decline is at an early stage, while having in place rapid response systems that can evaluate and deal with those unexpected and unpredictable events that may be the precursor to extinction.

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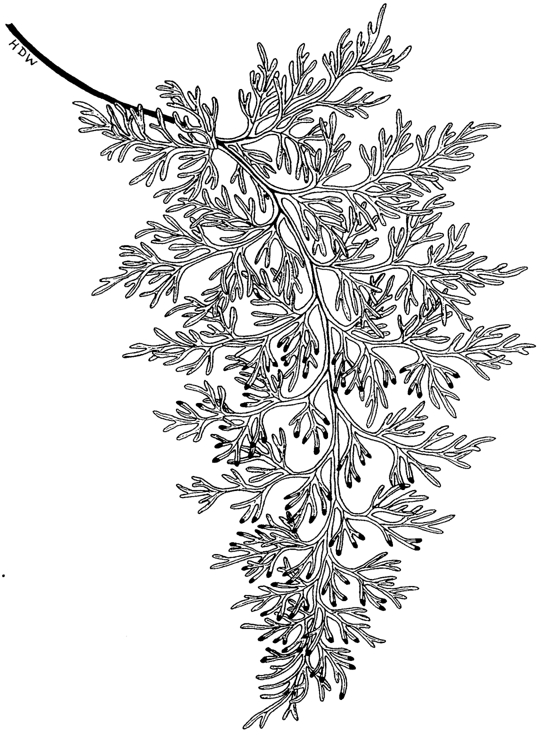

Hymenophyllum dilatatum, large filmy fern, rediscovered on Banks Peninsula after an interval of 100 years. Rare and local in Canterbury. (del. Hugh Wilson).