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# Future scientific research directions – pests and diseases

Ian Abbott

*Department of Conservation and Land Management, Locked Bag 104, Bentley Delivery Centre, Bentley WA 6983*

**Abstract**

The sustainable management of tuart forest and woodland should rely on a cross-disciplinary, co-ordinated, and integrated approach. *Ad hoc* surveys and general collecting of fungi, bacteria, viruses and invertebrates in the existing forest and woodland are unlikely to contribute to the resolution of how to care for the tuart community on a long-term basis.

A more pro-active focus on establishing a variety of relevant treatments, including thinning of tuart, thinning of wonil, and more frequent low intensity burning, should provide a useful arena for study. In determining knowledge goals, clear thinking is essential in order to avoid producing knowledge that is intellectually gratifying but tangential to understanding mechanisms and patterns of decline. We need to be mindful of causation chains and attempt to distinguish factors that are not relevant from those that are indirect/secondary/contributing or direct/primary/inciting. Important cross-linkages have to be worked out. An appropriate first hypothesis is that pest insects and diseases are secondary, not primary, factors in the current decline of tuart.

Major research gaps include the apparent unavailability of basic information on groundwater levels (both current and before the decline became evident) and soil fertility gradients, together with uncertainty about the appropriate scale at which to apply the treatments listed previously (perhaps several hundreds of hectares). Highest priority research should investigate the effect of these treatments on activity/population size of potential insect pests and disease-causing organisms. Tuart should be included in a more comprehensive sampling program for the Mundulla Yellows virus/viroid.

**Introduction**

In defining a strategy for managing the tuart forest in an ecologically sustainable manner, a pro-active approach is to be preferred to a reactive approach. A team of specialists needs to work together, to a common plan, on the same set of plots. An adaptive approach, through which one learns from error, is to be preferred to the more conventional benign neglect model (based on tenural category). The entomologist and mycologist involved in this team should focus on identifying potential pest and disease species. This is not easy, as *c.* 99% of the biodiversity in tuart forest and woodland is likely to comprise insects and fungi.

Pitfalls to avoid include: *ad hoc*, unstructured surveys; general collecting of fungi, bacteria, viruses and invertebrates; ignoring historical context, particularly indigenous and European information; and not considering the full range of relevant environmental disturbances.

**A way forward**

The first step would be to replace the current passive management model with an active management model. Park managers could impose a variety of relevant disturbances (treatments) to provide a greater variety of learning opportunities. These disturbances could include thinning of tuart, thinning of wonil (peppermint), thinning of both species in the same locality, and a range of fire intensities and fire frequencies.

Clear thinking needs to be applied if the mechanism and pattern of decline are to be understood. Podger in Old *et al.* (1981) has suggested the suitability of Ockham's razor. This entails making the fewest possible assumptions in devising an explanation, and then proceeding to the next level of complexity, not by inclination, but only by the force of inadequacy of the simpler argument. Particularly unhelpful is the adoption of the 'Everything is connected to everything else' generalization of Commoner (1972: 33, because it results in an uninformative diagram with many arrows connecting most boxes (e.g. Wylie & Landsberg 1987).

More effort needs to be put into identifying causation chains, as some factors are more important ('direct', 'primary' or 'inciting') than others ('indirect', 'secondary', 'contributing'). Wherever possible, we should simplify by setting aside second and higher order interactions. Major cross-linkages between factors should not be neglected. A diagram published by Andrewartha and Birch (1954: 402) demonstrates the value of this clear thinking approach.

**An appropriate working hypothesis**

All of the information available to me about diseases and insect pests, together with general theory (e.g. Barbosa & Wagner 1989, Old 2000), leads me to formulate the following basic hypothesis:

*Pest insects and diseases are secondary, not primary, factors in the current decline of tuart.*

**Research gaps**

There is a need to acquire or collate basic environmental information relevant to understanding the reasons for the current decline of tuart. These factors include groundwater levels (both current and before decline became evident) and soil fertility gradients.

There is uncertainty about the appropriate scale at which to apply disturbance treatments in order to obtain a mosaic, adequate replication, a range of thinning intensities of tuart and/or wonil, and a range of fire intensities and frequencies. Should treated areas be tens or several hundreds of hectares? It is important, however, that managers do not apply the same management treatment everywhere.

Finally, it is not established whether the current decline of tuart represents a natural phenomenon. Dendrochronological studies are needed to clarify whether such events occurred only after European settlement, or if they did not, whether there has been a change in their frequency. This technique has provided valuable insights with other tree species/pest insects (e.g. Anderson *et al.* 1987, Krause 1997).

**Highest priority pest and disease research**

The major need is to investigate the effect of the treatments outlined earlier on the activity/population size of potential insect pests and disease-causing organisms.

**Case studies**

It is instructive to examine a number of case studies, as these provide insight into many of the issues raised in this paper. The first case study concerns eucalypt dieback in the 1970s in New England, New South Wales (See the papers by Clark *et al.*, Williams & Nadolny, Roberts & Sawtell, Trenbath & Smith, Richards, Duggin, and Ford in Old *et al.* 1981). The major weakness of this project was that no common set of plots was established, the studies were single discipline-based and thus there was no genuine integration and little chance of ascertaining whether one synchronizing factor had triggered dieback.

The second case study is of outbreaks by Jarrah leafminer and Gumleaf skeletonizer in the forests of south-west WA in the 1980s. It proved difficult to establish historical precedents for these outbreaks (Abbott *et al.* 1999). Research demonstrated that planned burning (usually in spring) and logging were not causal (Abbott *et al.* 1993, 1995; Farr *et al.* 2002). It is suspected that climate change and weather were important, but the data available are insufficient to address these factors. Long time series of abundances are required.

The final case study relates to Jarrah dieback (Shearer & Tippett 1989). This was first described in 1921, and there was much speculation as to the causal agent. A research officer was appointed in 1959 to investigate numerous factors. No progress with managing the problem was possible until 1965, when Podger established that the causal agent is an introduced water mould. Subsequently, there was considerable research into the ecology of *Phytophthora cinnamomi* and ways of disfavouring the pathogen and enhancing the resistance of the host. This led to the development of hygienic procedures, risk assessment and hazard rating.

## Conclusions

Collaboration is important so that all accumulated facts and relevant data sets are available for scientific analysis. Clear and rigorous thinking, together with a willingness to set aside strongly held preconceived ideas and any prejudices, is indispensable in formulating a set of hypotheses to guide data collection. An active approach, using adaptive management, is likely to advance understanding much more rapidly than a passive approach. Pest insects and fungi are probably not primary factors in the current decline of tuart.

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