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Forum—

Invasive and Toxic Camphor Laurel: A Potential Threat to Native Australian Birds

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Summary

Camphor Laurel *Cinnamomum camphora* is a toxic, alien invasive plant in coastal eastern Australia. Its toxicity profile is reviewed, and observations on its impacts on domestic livestock and wild birds are presented. Given its apparent effects on individual birds and possibly on populations, it would be prudent to eradicate it by a phasing-out process, with phasing in of replacement stands of locally indigenous, fruiting rainforest plants. There is an urgent need for relevant research, and for consideration of Camphor Laurel invasion as potentially a threatening process for native birds.

Introduction

Camphor Laurel *Cinnamomum camphora* is a highly invasive introduced tree in subtropical eastern Australia, where it is supplanting native bushland, particularly the wetter types. It rapidly becomes dominant in disturbed areas where native rainforest is trying to regenerate.

There are up to 36 known chemotypes of Camphor Laurel, with seasonal variation between individual trees (Friend 1999, 2005). Within the tree's parts there are at least 18 known biocidal compounds. These include narcotic molecules such as camphor, benzene, naphthalene and vanillin (Overton 1901, in US EPA 1991), which are currently not known to be made by, or present in, any southern Australian plant species (the 'Gondwanan flora'). Therefore, most of our fauna, including bird species, may not have evolved to deal with the seasonally harsh, volatile defence chemistry of trees like Camphor Laurel. That is, most of our sensitive fauna are not adapted to a wide range of Northern Hemisphere toxins, especially camphor which is the principal narcotic found in all these trees, and in all their parts (Cronin 1989; Wilson 1997).

Toxicity

Camphor is a botanical insecticide and repellent, is moderately powerful in effect, and it can volatilise for years from cut Camphor Laurel wood, a fact widely known internationally since the advent of 'camphor box' industries in East Asia in the period 1750–1880, and their popularity in Europe (Donkin 1999). Also, camphor can cause long-term chronic toxicity (Sittig 1985; Briggs 1992), and is a cumulative poison to higher orders of animals, including humans. Camphor Laurel seeds contain two cytotoxic (ribosome-inactivator) or sterilising compounds (Ling Jung, Lin Wang *et al.* 1995). The most toxic chemotypes in Australia appear to be derived from hybrid Taiwanese × Japanese subspecies via the English Kew Botanical Gardens.

Camphor is confirmed internationally as a hazardous chemical (Sittig 1985; Weiss 1986), yet is being disseminated by tree weeds spreading widely on three continents, with very little remedial action, because most people cannot see the chemical damage or the colourless chemicals being expelled. Many Camphor Laurel populations in New South Wales now consist mainly of the more-toxic chemotypes, since the less-toxic chemotypes have been largely logged over the past 50 or more years.

It is not yet known how hazardous camphor and its various related narcotic and sterilising compounds are, and how cumulative they are in the environment. Camphor (naturally derived or artificially produced) has no or incomplete material safety datasheets for its safe handling or disposal. That is, there are no international safety standards for the sale and dissemination of camphor-containing products, or for the control of the spread of plants that disseminate the toxin into the air and soil, or into waterways with the aid of saponins and similar compounds exuded by neighbouring plants.

Camphor is the most common active constituent in Camphor Laurel trees. There are also many other active toxins in most chemotypes of Camphor Laurel (Duke 1998). The tree's chemistry appears to be 'cryptic', as fauna can be attracted to the trees by some compounds, yet seasonally poisoned by some others, including highly toxic alkaloids (Ellis *et al*. 1972; Rastogi & Mehotra 1990). The trees appear to produce more toxin, and modify their flowering phenology, in response to damage, defoliation or climatic stress (author's unpublished data). For instance, on 99 of 100 Camphor Laurel trees monitored photographically for over five years 1999–2005, previously healthy elkhorn ferns *Platycerium*, mistletoes (Loranthaceae) and flowering orchids *Dendrobium* died off during drought, except for the elkhorns on one tree of known less-toxic chemotype on a dry (non-irrigated) site at Lismore.

Effects on livestock

Since droughts of the 1940s, a range of livestock has been recorded as being killed after eating the bark, leaves or fruits of Camphor Laurel (Everist 1974; Queensland Dept Primary Industries, Brisbane, and New South Wales Agriculture Veterinarians, Wollongbar, personal communications 2001–2004). On-farm experiments, using free-range and confined birds and 'control' flocks with full access to Camphor Laurel trees through the fruiting season, have established the reversible sterility of gamefowl, poultry and domestic geese after they have eaten Camphor Laurel seeds. Results for separate farms at Corndale, Murwillumbah and Mallanganee (NSW, 1998–2002), from independent observers, have been published (e.g. *Tweed Times* 18.04.1998; *Northern Star* Rural Supplement Oct. 1998). After anecdotal reports of egg and fowl infertility, and inedible flesh, when free-range poultry ate fallen Camphor Laurel berries, penning of geese (to prevent access to Camphor Laurels) restored fertility although their flesh remained 'camphorated' and inedible.

Observed effects on wild birds

There is compelling evidence, albeit circumstantial at this stage, that the Camphor Laurel may be adversely affecting the populations of many species of native birds in north-eastern NSW. As well as poisoning or sterilising birds via consumption of toxic fruits and seeds, camphor may also volatilise in high concentrations from trees in hot weather, and the resulting aerosols may narcotise

Emerald Dove *Chalcophaps indica* **found dead under Camphor Laurel tree, dissected to show ingested Camphor Laurel fruits**

Plate 2 Photo: J.A. Friend

or repel birds in the vicinity. Because of its significant, albeit low, solubility in surface waters at above 25°C, camphor is believed to be capable of cumulatively poisoning waterbirds via surface-water intake. Camphor also kills aquatic organisms, and hence poisons or depletes the food resources of waterbirds.

Long-time residents in the area of concern believe that many frugivorous and aquatic birds have declined greatly in areas with dense infestations of the identifiable more-toxic Camphor Laurel chemotypes. There have been mass bird deaths beneath the trees, and birds otherwise inexplicably dead have been found, on dissection, to contain Camphor Laurel fruits or seeds, especially in the hot, humid early summer. Some examples follow.

Native pigeons

From 1955 onwards in Byron and Lismore Shires, various species were found dead or dying beneath, or sometimes seen falling dead after taking flight from, Camphor Laurel trees where they had been eating the fruits. The first mass death was in March 1955, of White-headed Pigeons *Columba leucomela,* Brown Cuckoo-Doves *Macropygia amboinensis* and Rose-crowned Fruit-Doves *Ptilinopus regina* (per botanist Dr Alex Floyd and local landholders). In 1980–1995, flocks of Emerald Doves *Chalcophaps indica* were regularly found dead, 'drunk' or unable to fly, under an old Camphor Laurel tree after eating the berries (same shires, per D. Gourlay). From 1980 to 2002, in Byron Shire, White-headed Pigeons and other pigeon species with crops full of ripe Camphor Laurel fruit, were observed vomiting some berries then falling dead from overhead flocks; only some individuals were

affected (per Dr B. Summers and local landholders). In 2002 a White-headed Pigeon found dead under a Camphor Laurel tree had its gut full of Camphor Laurel fruits and seeds (per I. Tinker, Dorroughby Field Studies Centre). In 2002, at Wollongbar, a White-headed Pigeon 'heavy' with Camphor Laurel fruit glided to its death from an area of ripe Camphor Laurels. At The Channon, an Emerald Dove asphyxiated after trying to vomit a large Camphor Laurel berry from its throat; its stomach contained partly ground Camphor Laurel berries (per M. Humphries). At Koonorigan in 2003 a Common Bronzewing *Phaps chalcoptera* was found dead under Camphor Laurel trees, after having eaten the berries. At Lismore in 2004 Mark Lumsdaine (of the Lismore TAFE Institute) witnessed three Brown Cuckoo-Doves falling out of a large grove of Camphor Laurels, frothing at the mouth and convulsing on the ground, before dying within half an hour, on a sunny day. Previously, I had witnessed individuals on the ground apparently unable to fly, beneath Camphor Laurels, before the species became scarce around The Channon. Historically, native pigeons were known by shooters (personally interviewed) until the 1960s to seasonally gorge on Camphor Laurel berries, which rendered their flesh inedible. The flesh of the various pigeon species was prized until 1980, when it became 'camphorated' throughout, with all reported 'game' species contaminated from Camphor Laurel berry consumption. In December 2005, panting Wonga Pigeons *Leucosarcia melanoleuca* were found unable to move on the forest floor, under a dense canopy of Camphor Laurels in the Tweed catchment. When given water, they convulsed and died; only green Camphor Laurel berries were found in their stomachs.

Parrots

A mass bird death at Coraki in 1987/88 involved Galahs *Cacatua roseicapilla*, lorikeets *Trichoglossus* and rosellas *Platycercus* observed falling dead in a summer heatwave after consuming Camphor Laurel berries (per NSW Agriculture and landholders). In Lismore city parks a similar mass bird death occurred among Galahs and lorikeets near Camphor Laurels, where they had been seen feeding the day before (per Lismore City Council). An entire captive colony of Budgerigars *Melopsittacus undulatus* was found dead after they chewed fresh green Camphor Laurel branches and leaves placed in the aviary (Fuller & McClintock 1982); a Californian Government veterinarian certified the cause of death. The endangered Coxen's Fig-Parrot *Cyclopsitta diophthalma coxeni* was last seen consuming Camphor Laurel berries in the region in 1989. Given the strong superficial likeness of native fig trees and Camphor Laurel trees, and their similar geographic range, eating of Camphor Laurel berries may be a factor in the Fig-Parrot's demise in NSW.

Passerines

In southern Queensland in the 1940s, many Pied Currawongs *Strepera graculina* (formerly shot and eaten as game) were discarded when their flesh was found to be camphorated and inedible. In 2002 at Lismore, two Lewin's Honeyeaters *Meliphaga lewinii* were found dead in a heatwave under a known extremely toxic Camphor Laurel tree (leaves analysed by the Kew Botanic Gardens) that carried green berries. Two Olive-backed Orioles *Oriolus sagittatus* were found dead under a known (analysed) extremely toxic Camphor Laurel tree in Lismore in February 2002, in hot conditions. A juvenile Figbird *Sphecotheres viridis* (a species that eats Camphor Laurel berries) was also found displaying paralysis symptoms, then died, under a known (analysed) more-toxic type of Camphor Laurel in Lismore. In

winter 2005, under a Camphor Laurel tree heavily browsed by Common Brushtail Possums *Trichosurus vulpecula* in Brisbane, Queensland, was found a dead thrush (Bassian or Russet-tailed *Zoothera* sp.), a bird rarely seen in Camphor Laurel-infested areas of north-eastern NSW.

Waterbirds

The effect of Camphor Laurel on macroinvertebrates may affect waterbird populations in the aquatic food chain. The breakdown of leaf-litter into nutrients is achieved by different functional feeding groups of invertebrates, each of which has a different role and is found in different stages in the river between the source and the mouth (Vannote *et al*. 1980). In the headwater streams, bacteria and fungi break down the cell walls of the litter (Boulton & Brock 1999, Canhoto & Graça 1999). This action enables the breakdown of leaves by a group of invertebrates known as shredders, which dominate the upper reaches (Prochazka *et al*. 1991). The shredders convert large organic fragments to smaller particles that become a food source for another feeding group—the collectors (Cummins *et al*. 1989). This process provides the food link between the upper reaches and the lower sectors of a river (Graça *et al*. 2001), the feeding and breeding grounds for many waterbirds. However, fungal colonisation of litter can be deterred by the presence of terpenes (Canhoto & Graça 1999). Shredders prefer leaves that are not tough, have a high nutrient content and do not contain compounds that act as a chemical defence (Graça *et al*. 2001). If the riparian zone is dominated by Camphor Laurel, the main source of litter in the stream will be Camphor Laurel leaves, which are tough and contain certain terpenes such as camphor and α-pinene. Camphor is an ingredient in insect repellent, and α-pinene in insecticide (Brown 1997). In streams dominated by Camphor Laurel trees, the supply of suitable food for shredders will either be lacking or limited to species of litter transported from upstream. In streams infested by Camphor Laurel trees in the riparian zone, the abundance of shredders is low (Davies 2004). In these streams the decomposition rate is depressed by the lack of shredders, and there are low dissolved oxygen levels because of the rotting vegetation. These effects can lead to a decrease in the health of upland streams, and to impacts on the habitats in the lower reaches of river systems where the larger invertebrates and vertebrates, such as waterbirds, are found. These processes may help to account for the observed decline of many waterbird and native fish species in the region.

Discussion

Camphor Laurel stands have been extolled as interim 'stepping stones' or movement corridors, and food sources, for frugivorous birds (including threatened fruit-doves) in northern NSW, until native rainforest regenerates. My surveys of weed species growing within and under or adjacent to roadside Camphor Laurels across three NSW Northern Rivers shires reveal a wide range of other toxic weeds of Northern Hemisphere origin (e.g. Broad-leaved Privet *Ligustrum lucidum* and *Rhus*), all proven capable of chemical defences and, also, capable of withstanding the severe chemistry of the shading Camphor Laurel canopy. More than twice as many exotic weed species readily seed under Camphor Laurel trees, compared with a limited range of native plants that are usually stunted, or in 'locked succession', under Camphor Laurel canopies. Camphor Laurel stands appear to be devoid of most of the native bird species expected in local rainforest, and to be killers of frugivorous birds as well as some seed-eating species.

It has been known for decades that Camphor Laurel is poisonous (Smith 1905; Pammel 1911; Hirst 1942; Sittig 1985), but the information was apparently suppressed because Camphor Laurel was deliberately promoted and provided as a shade tree by many NSW Government agencies or departments. Only in recent years has it become understood that the many narcotic compounds in various parts of the tree are cumulative, long-acting toxins (Overton 1901, in US EPA 1991).

For the many sick, dead or euthanased native birds found on dissection to contain nothing but Camphor Laurel fruits or seeds in their gut, no Lismore veterinarian has yet performed an autopsy, nor is a cause of death being surmised; nor is there any chemical analysis or pathological examination. No introduced Northern Hemisphere bird species have been found dead, sick or paralysed under Camphor Laurels, or suspected of camphor poisoning. Exacting research, to investigate the role of camphor in deaths and population declines of native birds, is long overdue. Meanwhile, the precautionary principle should be invoked and Camphor Laurel eradicated and replaced by native vegetation. Camphor Laurel deserves urgent consideration for nomination as a threatening process, given that it is likely to be already adversely affecting threatened bird species.

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Editor's note: This article is presented as a 'forum' piece, to encourage debate on, and research into, the topic.