

## SHORT COMMUNICATION

# Ticking time bombs – current and potential future impacts of four invasive plant species on the biodiversity of lowland tropical rainforests in south-east Viti Levu, Fiji

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The lowland rainforests of Viti Levu are among the most diverse in the Pacific, having about 100 tree species with a diameter  $\geq 10$  cm per hectare (Keppel *et al.*, 2010; Keppel *et al.*, 2011). Invasive species pose serious threats to native biodiversity in island ecosystems (Denslow *et al.*, 2009; Kueffer, 2010; Kier *et al.*, 2009) and are therefore of considerable concern for the biota of Fiji's lowland rainforests. Here we focus on four species that we recently observed invading lowland rainforests in south-east Viti Levu. We report, for the first time, the occurrence of *Pinanga coronata* (Arecaceae), *Schefflera actinophylla* (Endl.) Harms (Araliaceae), *Spathodea campanulata* P.Beauv. (Bignoniaceae) and *Swietenia macrophylla* King in Hook. (Meliaceae) in primary lowland rainforest. For each species, we report current levels of invasiveness outline likely ecological impacts and suggest appropriate control measures.

The African Tulip Tree, *Spathodea campanulata*, is a fast-growing tree with low wood density and has been identified as one of the most important invasive species found in the Pacific Islands (Meyer, 2000). The species is native to tropical Africa. was introduced to Fiji in the 1930s as an ornamental, and is now widely naturalised (Smith, 1991). *Spathodea campanulata* has become the dominant tree in secondary forest on abandoned farmland in south-east Viti-Levu and is now found throughout the lowlands of Viti Levu. In Papua New Guinea it has invaded similar post-cultivation habitats (Bito, 2007). Occasionally, the species is also found in primary forest, where it is mostly restricted to relatively open, naturally disturbed habitats, such as the banks of streams. However, we have also noted, the odd individual growing in dense, primary forest in the remote Sovi Basin. Native birds and bats have been observed near the flower and are presumably involved in pollination. Because of the copious amounts of light, winged seeds produced, dispersal distances and propagule pressure are likely high.

The wide distribution, high propagule pressure, likely pollination by native species and fast growth rate, make *Spathodea campanulata* a good competitor. However, because the species generally does not seem to regenerate under closed canopy it is likely to stay mostly restricted to an early-successional niche. While this will prevent the species from becoming dominant in close canopy primary forest, a cyclone may create the disturbance required for a

large-scale invasion of primary forests. The species appears to have important ecological benefits, assisting in the quick return of fallow agricultural land to forested landscapes. Further, long-term studies of mono-dominant stands of *Spathodea campanulata* are urgently needed to determine the ability of native species to regenerate under *Spathodea* canopies.

Being native to tropical Central and South America, the large-leaved mahogany, *Swietenia macrophylla*, was introduced to Fiji in 1911 as a potential timber tree (Smith, 1985). It is a large, tree (to 40m high) that is reported to live for centuries (Pennington, 1981). Between the 1950s and 1980s timber plantations of large-leaved mahogany totalling about 40,000 ha were established through native forest conversion in six locations in southern and eastern Viti Levu (Varmola, 2002). Although species of *Swietenia* are often considered non-invasive (Richardson, 1998), we have observed saplings of the species in primary rainforest, several kilometres away from plantations. This parallels reports about the potential invasiveness in another island rainforest on Dominica in the Caribbean (Norghauer *et al.*, 2011). Flowers of mahogany are pollinated by insects (bees, moths and thrips) and are mostly outcrossed (Bawa *et al.*, 1985). Therefore the species must have some adopted pollinators, possibly generalist pollinators of native canopy Meliaceae in Fiji. The winged seeds of *Swietenia macrophylla* have limited dispersal ability of up to 80 m (Gullison *et al.*, 1996) but are produced in large quantities, creating high propagule pressure. *Swietenia macrophylla* regenerates best under closed canopy, meaning it establishes well in primary forest (Grogan *et al.*, 2010).

In the absence of detailed studies, the long-term impact of *Swietenia macrophylla* on native biodiversity is difficult to predict. However, the species is already establishing in Fiji's lowland tropical rainforest and is likely to become a permanent component. The fact that the species was introduced because it has faster growth rates than native species (Varmola, 2002), implies that it could be a better competitor. As a result, *Swietenia macrophylla* could, over many generations, become a dominant rainforest tree, a process which could be accelerated by cyclones dramatically increasing dispersal distances.

Known as the umbrella or octopus tree and native to northern Queensland and New Guinea, *Schefflera*

*actinophylla* can grow as a tree, epiphyte or strangler and was introduced to Fiji in the 1950s as an ornamental (Smith, 1985; Whistler, 2000). The invasive potential of *Schefflera actinophylla* in Fiji was identified more than 10 years ago (Meyer, 2000) and it is now established along the corridor between the urban centres of Suva and Navua. We have also observed the species as a canopy epiphyte in

primary rainforests of the Savura/Vago Forest Reserves. We have observed native wasps and introduced honeybees hovering around the flowers as likely pollinators and native and introduced birds consuming the fruits, hence acting as potential dispersal agents.

**Table 1.** Distribution, ecological characteristics, predicted impact and suggested control measures for four invasive species in the lowland tropical rainforests of South-east Viti Levu, Fiji.

Species	Distribution in SE Viti Levu	Ecological niche in primary forest	Pollination	Dispersal	Prediction without intervention	Suggested measures
<i>Spathodea campanulata</i>	Throughout	Fast-growing, early-successional tree, dependent on light for establishment	Bats and birds	Winged seeds are wind-dispersed	Dominant early-successional tree	Identify long-term dynamics of stands, possibly biocontrol
<i>Swietenia macrophylla</i>	In mahogany plantations and 20 km radius around them	Moderate growth-rate, late-successional, establishes in shade	Insects	Winged seeds are wind-dispersed	Rare or common component of primary rainforest	Prohibit conversion of native forest for plantation establishment, efficient and sustainable production
<i>Schefflera actinophylla</i>	Along the SE coast up to 30km inland	Epiphyte in the canopy	Insects, including native wasps	Birds (native & introduced) disperse seeds	Common epiphyte of primary and secondary rainforest	Attempt immediate eradication, verify strangling habit
<i>Pinanga coronata</i>	Colo-i-Suva & Savura, SE Viti Levu	Understorey shrub	Unknown	Birds disperse seeds, asexual reproduction	Mono-dominant stands in understorey of primary/secondary rainforest	Immediate eradication

*Schefflera actinophylla* achieved its present distribution from urban sources in and around Suva and Navua within a few decades, attesting to its immense dispersal potential. The species has established as a common canopy epiphyte in primary rainforest, suggesting that it will spread throughout the lowland rainforests on Viti Levu. The fact that the species can start out as an epiphyte but turn into a strangler by forming a network of thickening roots around the host tree (Whistler, 2000) is of concern. While we have not observed this behaviour in Fiji, urgent investigations into this issue are needed.

The ivory cane palm, *Pinanga coronata* (Arecaceae), is native to Java and Sumatra (Daehler and Baker 2006) and was brought to Fiji as an ornamental in the 1970s. Spreading from a single garden, its invasive potential was first recognised as a serious threat in the early 1990s (Watling and Chape 2003) and recently highlighted as the species forms dense undergrowth in mahogany plantations of Colo-i-Suva and Savura (Watling, 2005). We recently found a population of about 30 m diameter in primary forest in the Savura/Vago Reserve. Similar mono-dominant stands have been observed in disturbed habitats in Hawaii (Daehler and Baker, 2006) and Tahiti (Meyer *et al.*, 2008).

The palm is one of the most dominant species in its native habitat and this has been attributed to growth form,

effective dispersal and asexual reproduction by clonal growth (Kimura and Simbolon, 2002). These attributes are likely to make it an extremely efficient invader. The tendency to form mono-dominant stands (no native understorey species were observed in the Savura/Vago population), implies that *Pinanga coronata* will outcompete and displace native understorey species.

*Pinanga coronata* poses the biggest threat to the native biodiversity of rainforests in Fiji (Table 1). Its ability to form mono-dominant stands and exclude native species means that quick action is required. Because the species is still restricted to a relatively small area, immediate and total eradication should be attempted before this becomes impossible. Similarly, the spread of *Schefflera actinophylla* is still limited and total eradication could still be attempted. However, achieving this is considerably more difficult because of its wider spread and epiphytic habit. *Spathodea campanulata* has already spread throughout Viti Levu and Vanua Levu with countless populations and millions of adult individuals. The only realistic possibility of controlling this species is via a biological control agent. Halting the spread of *Swietenia macrophylla* would require harvesting all plantations and removing all existing regeneration outside them to reduce the propagule pressure, an impossible scenario because of their extensiveness, perceived economic value and political

complexities. Control of the planting of mahogany to their current plantation localities, efficient and sustainable production, and prohibiting additional forest conversion for mahogany establishment are the most practical and feasible measures to minimise the spread of mahogany.

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