

The tolerance of island plant–pollinator networks to alien plants

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Summary

1. Invasive alien plant species pose a severe threat to native plant communities world-wide, especially on islands. While many studies focus on the direct impact of alien plants on native systems, indirect effects of plant invaders on co-flowering natives, for example through competition for pollination services, are less well studied and the results are variable.
2. We used six temporally and taxonomically highly resolved plant–pollinator networks from the island of Mahé, Seychelles, to investigate the indirect impact of invasive alien plant species on remnant native plant communities mediated by shared pollinators. We employed fully quantitative network parameters and information on plant reproductive success, and pollinator diversity and behaviour, to detect changes in plant–pollinator networks along an invasion gradient.
3. The number of visits to and fruit set of native plants did not change with invasion intensity. Weighted plant linkage and interaction evenness, however, was lower at invaded sites than at less invaded sites. These patterns were primarily driven by shifts in interactions of the most common pollinator, the introduced honey bee *Apis mellifera*, while weak interactions and strong native interactions remained unchanged.
4. *Synthesis.* The implications of these findings are twofold: first, quantitative network parameters are important tools for detecting underlying biological patterns. Secondly, alien plants and pollinators may play a greater role in shaping network structure at high than low levels of invasion. We could not show, however, whether the presence of invasive plants result in a simplification of plant–pollinator networks that is detrimental to native plants and pollinators alike.

Key-words: Indian Ocean, indirect interactions, inselbergs, interaction connectance, invasion ecology, invasive alien species, plant communities, pollination webs, Seychelles Islands

Introduction

The introduction of alien species into native ecosystems constitutes one of the major threats for the persistence and integrity of ecosystem functioning (Mack *et al.* 2000; Sala *et al.* 2000). Pollination interactions play a vital role in the reproduction of most plant species, and empirical studies have shown that alien plant species alter pollination of neighbouring, mostly native, plants through shared pollinators (reviewed in Traveset & Richardson 2006; Bjerknes *et al.* 2007). The effects of indirect interactions between plant species range from mutually benefi-

cial (Moeller 2004; Moragues & Traveset 2005; Molina-Mon-tenegro, Badano & Cavieres 2008), to neutral (Aigner 2004; Jones 2004; Kaiser-Bunbury & Müller 2009) and competitive (reviewed in Mitchell *et al.* 2009). Alien plants can compete for pollination with native plants through changes in pollinator visitation and shifts in quantity and quality of pollen delivered to flowers, thus affecting plant reproductive success of native species (Chittka & Schürkens 2001; Brown, Mitchell & Graham 2002; Kandori *et al.* 2009) or causing shifts in foraging behaviour of native pollinators (Ghazoul, Liston & Boyle 1998; Cunningham 2000; Ghazoul 2004). So far, however, no clear and consistent general pattern has emerged (Traveset & Richardson 2006) and thus it is difficult to predict the consequences of invasion on native flora and fauna (Strayer *et al.* 2006). A recent synthesis found an overall slightly negative impact on plant fitness and pollinator visitation rate resulting

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