Abstract

Insect-plant interactions are one of the most complex in nature and perhaps the most common, yet only a limited number of studies have focused on this interaction in mangrove systems. This study examined the influence of insects on four species of mangroves in Darwin Harbour, Australia; *Avicennia marina*, *Ceriops australis*, *Rhizophora stylosa* and *Sonneratia alba*. The insect guild composition of the four mangroves was assessed to determine their abundance and species richness. The influence of these insects on mangrove reproduction and recruitment was assessed using mensurative and manipulative experiments. In addition, insect leaf herbivory, leaf characteristics and their susceptibility to herbivory was investigated.

The diversity of insects collected from the four mangrove species included 11 insect orders, totalling 249 species. Insect fauna was comprised of a large number of rare species, with many species collected only once or twice (83.8%). Many insects recorded in this study were undescribed, and may be located only within the Darwin Harbour mangrove environment. Large variations in insect guild composition were detected between mangrove species, with *A. marina* exhibiting the greatest species richness of the four mangroves (109 species), 63 of these phytophagous insects. Species richness of insects declined with distance away from the terrestrial borders of the mangrove community. In contrast to the other mangroves, *S. alba* supported a greater proportion of non-phytophagous species (58.7%), particularly generalists (37.0%). *S. alba* also contained the greatest proportion of exclusive insect species (66.7%). Insect guild composition and abundance may have been influenced by the tidal regimes, in combination with plant characteristics. Seasonality in insect abundance was also likely, with an increase in numbers during the wet season.

Insects were influential as pollinators in the reproductive process of *A. marina* and *S. alba*, as well as flower predators in *S. alba*. Insect flower visitors were abundant in *A. marina* and were important for pollination as no evidence of autogamy was recorded. Fruit set in *A. marina* was unlikely to be pollinator limited as there was no significant difference in fertilisation of manually cross pollinated flowers (19.4%) compared to control flowers (15.0%). Fruit set was likely to be resource limited, as many developing propagules were aborted (81.6%). Insect flower visitors, as well as bats and birds, were also important to *S. alba,* although this species also showed evidence of autogamy. *S. alba* however exhibited pollinator limited fruit set, with significantly higher fruit set in manually cross pollinated flowers (81.8%) compared to controls flowers (50.0%), indicating that there were an insufficient number of insect and bat pollinators. Many *S. alba* buds were bored by insects, reducing the number of reproductive units available for pollination. Insects did not

appear to be as influential in *C. australis* and *R. stylosa* reproduction. Autogamy was recorded in *C. australis*, and although a range of insects were observed visiting flowers of both species, they were also not able to successfully pollinate many flowers (*C. australis* 7% and *R. stylosa* 3.4%). *R. stylosa* exhibited pollinator limited fruit set, as a greater number of cross pollinated flowers were successfully fertilised compared to controls. *R. stylosa* also exhibited resource limited fruit set, as few fertilised flowers become propagules (14.3%).

Eleven species of insect propagule frugivores were recorded in *A. marina*, four in *S. alba*, but only one in *R. stylosa* and *C. australis*. On average, greater than 75% of fruit/propagules of *A. marina*, *R. stylosa* and *S. alba* showed evidence of propagule frugivory, with significant differences in attack rate between sites. Survival rate and growth of *R. stylosa* propagules was significantly less in propagules attacked by insect frugivores, as was the germination rate of *S. alba* seeds. Insect frugivory may also have contributed to the high rate of abortion of developing propagules in *A. marina*. *C. australis* propagules were not significantly influenced by insect frugivory.

Although insect leaf herbivory in the four mangrove species was not as high as in terrestrial systems, it may still have influenced mangrove productivity in Darwin Harbour. Leaves attacked by insects were lost earlier than non-attacked leaves, the rate of loss significantly related to the extent of damage. These leaves entered the detrital pathway earlier than would normally occur, and may influence nutrient dynamics of the mangrove community. *A. marina* and *S. alba* exhibited high proportional leaf area loss to insect herbivores and *R. stylosa* the lowest. Immature leaves were targeted in all species with the exception of *R. stylosa*, consequently periods of leaf flush coincided with higher rates of insect attack in these species. The extent of insect leaf herbivory appeared to be related to the leaf nutrient content, and physical and chemical defences of the leaves. *C. australis* and *R. stylosa* both had high total phenolics and tannin concentrations, and limited nutritive value in comparison to *A. marina* and *S. alba*. The only deterrent in *S. alba* was the toughness of mature leaves, and in *A. marina* the higher fibre content. Tidal inundation also influenced insect herbivory with the upper canopy of *R. stylosa* and *S. alba* showing more evidence of attack, and a significantly greater insect herbivory in the lower canopy of *A. marina*.

The extent and importance of insect-plant interactions varied between the four mangrove species in Darwin Harbour, influencing the mangroves at different periods of their life history. Further research investigating the dynamics of plant-insect interactions in mangroves is required in order to expand our understanding of this important relationship, and particularly to document the remarkable range of insects supported by mangrove communities.