THE ROLE OF INSECT LEAF HERBIVORY ON THE MANGROVES *AVICENNIA MARINA* AND *RHIZOPHORA STYLOSA*

Thesis submitted by

Damien Wayne BURROWS

2003

for the degree of Doctor of Philosophy in Zoology and Tropical Ecology within the School of Tropical Biology, James Cook University

ELECTRONIC COPY

I, the undersigned, the author of this work, declare that the electronic copy of this thesis provided to the James Cook University Library, is an accurate copy of the print thesis submitted, within the limits of the technology available.

_____ _____

Signature Date

STATEMENT OF ACCESS

I, the undersigned, the author of this thesis, understand that James Cook University will make it available for use within the University Library and, by microfilm or other means, allow access to users in other approved libraries. All users consulting this thesis will have to sign the following statement:

In consulting this thesis I agree not to copy or closely paraphrase it in whole or in part without the written consent of the author; and to make proper public written acknowledgment for any assistance which I have obtained from it.

Beyond this, I do not wish to place any restriction on access to this thesis.

……. …..…….

Damien Wayne Burrows

ABSTRACT

This thesis examines insect leaf herbivory and the insect herbivore community on two common mangrove species – *Avicennia marina* and *Rhizophora stylosa*, at two sites near Townsville, northern Queensland. Despite its widely recognised importance in other forested ecosystems, the role of insect herbivory in mangrove ecosystems is often downplayed and remains relatively unexplored. It is generally considered that mangroves lack a diverse and specialised insect herbivore fauna, and are populated with insects from adjoining habitats. It is also commonly believed that mangrove leaves are less palatable and nutritious than leaves of other tree species, and that herbivory levels are less than those found in other forest ecosystems.

Sixty-one insect species were confirmed feeding upon *A. marina* and *R. stylosa* at the study sites, more than doubling the number of published host records for Australian mangroves. Herbivore diversity on the two mangrove species was similar, but only four of the 61 herbivore species were in common between them and the composition of the two faunas was substantially different. The two faunas show a high degree of host-specificity and adaptation to their mangrove hosts and there were substantial similarities between the faunas found in this study and those of other *Avicennia* and *Rhizophora* species elsewhere in the world. The diversity of folivores on these two mangrove species was similar to that of other nearby non-mangrove trees and to that reported for other trees elsewhere in the tropics.

Nearly all mangrove herbivory studies have measured damage on discrete leaf samples collected at one point in time. This approach fails to detect entirely consumed leaves, or partly damaged leaves that have been abscised. These leaves can be accounted for by an alternative long-term method that makes repeated herbivory estimates on tagged leaves. Application of the long-term method in this study found herbivory to be 3-6 times higher than estimated by discrete measurements. *R. stylosa* had only 2-3% loss of leaf area in discrete samples but 7-13% loss in the long-term study. *A. marina* had 6-7% loss of leaf area in discrete samples but 28-36% loss in the long-term study. For both species, most herbivory occurred whilst the leaves were young. Once past the juvenile phase, *R. stylosa* leaves were rarely attacked. In contrast, mature *A. marina* leaves suffered significant insect damage and leaf loss. Herbivory reduced average leaf longevity of all leaves by 4-5% for *R. stylosa* and 12-13% for *A. marina*.

In mangroves, loss of entire leaves is reported to be rare, but in *R. stylosa* and *A. marina* in this study, 4-5% and 19-29% of leaves, respectively, were either entirely consumed, or aborted due to insect damage. For both species, loss of leaf material through premature abscission of damaged leaves was as great as that actually consumed by insects, indicating a role for herbivory in promoting leaf fall.

Destruction of developing leaf buds by insects resulted in greater leaf losses than that suffered by emerged leaves. This was especially important for *R. stylosa*, which can only produce leaves from the apical bud. Damage to *R. stylosa* apical buds was common, frequently resulting in the loss of leaves before they emerged or, where damage resulted in the destruction of the apical bud, cessation of leaf production and death of that shoot. In some cases, new apical buds regenerated from suppressed lateral buds immediately below the destroyed apical bud. Death of existing shoots and regeneration from suppressed laterals are potentially major sources of architectural change to tree growth form. Damage to apical buds also resulted in the loss of developing inflorescences and lateral branches.

The chemical and physical nature of leaves changed significantly as they aged. Young leaves had a higher nutrient and chlorophyll concentration, but lower leaf thickness and leaf mass per unit area. Thus they were more nutritious and less tough for herbivores. These young leaves were especially prone to premature leaf fall because of insect damage. Leaves re-translocated over half of their nutrients prior to senescence but consumption or premature abscission of leaves before this process is complete may increase nutrient loss from the trees to microbial and detrital food chains on the forest floor. Thus herbivore-mediated leaf fall may also impact upon nutrient dynamics in mangrove forests.

This thesis demonstrates that: mangroves support a diverse and distinctive insect herbivore community; leaf herbivory is much higher than previously reported; there are additional mechanisms (eg, apical bud damage) by which herbivores affect leaf loss and other aspects of tree performance; and insects significantly affect leaf longevity, the timing of leaf fall and the quality of leaf litter. These results indicate that the role of herbivorous insects in mangrove ecosystems is more important than previously thought and that its evaluation needs to go well beyond simple static measures of leaf area missing from mature leaves.

ACKNOWLEDGEMENTS

I would like to thank my original supervisor, Dr. Chris Hill and my subsequent supervisors Professors Rhondda Jones and Richard Pearson for all their assistance over several years.

I am very grateful to the Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management for funding much of this work and Theresa Leijten from that organisation for her assistance. I also thank Jan Tilden (Coastal CRC) and Dr. Norm Duke (University of Queensland) for reviewing the final draft of this thesis.

I thank my parents who have always wholeheartedly supported all my educational and environmental pursuits.

Special thanks to my girlfriend (now wife) Sandra, who trudged through the mud, sandflies and humidity of tropical mangroves nearly every weekend for 18 months during the peak period of my fieldwork and then waited innumerable nights whilst this thesis was written.

Finally, to my wonderful kiddies, Caitlin and Matthew – both born during this process (as if I wasn't busy enough) – I hope you are proud.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

STATEMENT ON SOURCES

DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

…… ……

Damien Wayne Burrows