ASPECTS OF THE DYNAMICS OF RAINFORESTS IN NORTH-EAST AUSTRALIA

by

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Declaration of Originality

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged.

Preface

The studies described in this thesis were carried out while I was employed by the CSIRO Division of Forest Research and I gratefully acknowledge the encouragement and support provided by the immediate past Chief of the Division, Dr M.F. Day, and the present Chief, Dr J.J. Landsberg. The forests in which the studies were carried out, were nearly all controlled by the Queensland Forestry Department and I thank members of that Department for valuable advice and conscientiously protecting my experimental sites.

I extend my gratitude to many members of the Division for their tolerance and help. Special thanks go to Anthony Irvine for assistance with the sorting and identification of diaspores during the study of dispersal of rainforest plants by Cassowaries; Don Fitzsimons, Tom Risley, Keith Sanderson and Greg Unwin for help with the establishment and maintenance of the study plots; Don Fitzsimons and Ron Knowlton for assistance in the glasshouse and laboratory; Keith Sanderson for preparing most of the line drawings; Bernard Hyland for checking many of the botanical collections and identifying unfamiliar species and Ludeck Wolf for writing the computer programs providing the initial analysis of the plot data. Greg Unwin and Dr Philip West deserve particular mention for their contributions to the analysis of the permanent plot data. Greg Unwin also provided many helpful comments on the final draft. Drs Margaret Anderson and Wesley Taylor are to be thanked for their advice on aspects of the quantification of the light environment in forests.

Headquarters based library staff, especially Heather Howard and Murial Hord, helped locate many obscure references. Roslyn Solly ably undertook the typing of the first draft, while Les Gampe reduced my administrative load to a minimum enabling me to spend more time on my studies. Finally I thank my supervisor, Dr R.B.D. Whalley for his enthusiasm, support and assistance and my wife, Jacquie and daughters, Lucia and Elise, for their help and tolerant understanding during periods when I was away from home either undertaking field studies or using library or laboratory facilities in Armidale and Canberra.

Summary

The aims of this study were to show that the structural and floristic features of some tropical rainforests in north-east Australia appear to be largely the result of characteristics of the individual plant species available at each site and the history and nature of disturbance at that site.

Features of the present environment of the region are the marked winter/spring dry season, the periodic occurrence of tropical cyclones and the absence of shifting cultivation by the indigenous inhabitants. Studies of the vegetational history suggested that the floristics of many sites could be a reflection of differences in dispersal efficiency for, during the Quaternary, the rainfall seems to have fluctuated greatly and rainforests may have been confined to small refuge areas during dry periods. Lower sea levels during the ice ages would have often linked Australia and New Guinea. Given a favourable regional climate this corridor could have permitted the ready migration of rainforest plants in both directions. It was observed that many rainforest patches had recently expanded. Most of this expansion was attributed to a change in the fire regime of adjacent open forests following European settlement.

A series of 19 plots, each of 0.5 ha, was established in unlogged rainforests to provide data on their structural and floristic features. These plots also yielded information on species regeneration, growth rates and mortality. A relationship was found between plot basal area and elevation. This was tentatively explained by the growth and mortality characteristics of the species occurring in the more frequently disturbed, lowland rainforests. Stand diversity did not seem to be greatly influenced by any measured environmental parameter. The regeneration of some canopy tree species appeared to be continuous while that of others was intermittent.

Field observations indicated that gaps created by the death of a canopy level or larger tree were important in rainforest regenerative processes. The role of gaps was more closely examined using a theoretical model and field and glasshouse

experiments. The model predicted the temporal and spatial distribution of sunlight on the floors of gaps of various sizes at different latitudes. It showed that there were important differences in the light environments on floors of gaps in temperate and tropical environments. An hypothesis that these differences could help to account for observed latitudinal trends in diversity, was formulated. A simple integrating solarimeter was developed to quantify the light environments of artificial gaps in which seeds of selected rainforest species had been sown. "Small gap" species (shade tolerants) survived in gaps of all sizes and grew taller in gaps than under an intact forest canopy. Although "large gap" species (shade intolerants) only survived in the large gaps, they grew much more rapidly than the "small gap" species. A glasshouse shading trial supported these trends and indicated that "large gap" species tended to use more of their dry matter production to increase their height than did "small gap" species. Arboretum records and observations of the regeneration on an area which had been felled and burnt, yielded additional information on the relative height growth of a large number of rainforest species. The felling and burning experiment also indicated that vegetative modes should not be overlooked in studies of rainforest regeneration.

Seed was usually produced by rainforest tree species at intervals of two or more years. A few species, notably those characteristic of regeneration in large gaps, produced annual seed crops. Interspecific differences in seed predation were considerable. Overall, predation appeared to extend considerably the interval between effective seed crops for many species. The seeds of most species were dispersed by birds. The Cassowary was particularly important in dispersing large seeds. The absence of frugivorous mammals from this region and adjacent Papua New Guinea, provides an interesting contrast between the dispersal characteristics of trees in the rainforests of these regions and those of the remainder of the tropics. Viable seeds of most species appeared to germinate soon after they fell. Only a few species appeared to produce seed capable of lying dormant in the soil from one seed crop to the next. Although all medium to large sized seeds seemed to be recalcitrant, those examined appeared able to withstand

for at least a few days, the range of temperature and humidity conditions likely to be encountered on the floors of large gaps. However, the environments of large gaps often appeared to limit seedling establishment.

The niche characteristics of rainforest plants were examined in relation to potential establishment environments and some conclusions were drawn concerning the nature of succession, diversity and stability in rainforests. Many basic processes such as those involved in regeneration, growth and competition appeared to be the same as those in temperate forests. The important differences in the tropics seemed to be the greatly increased role of stochastic events in determining the spatial and temporal patterning of opportunities for establishment and growth, and the availability of a particular species at an appropriate time and place.

From a forest management viewpoint, studies of processes associated with regeneration in gaps suggested that there might be important limitations to the maximum growth rates which can be achieved by the restricted silvicultural modification of tropical rainforests. Nevertheless, the development of improved techniques for managing these forests is essential. This goal might be best achieved by continuing to develop an understanding of rainforest dynamics through studies of the regeneration, growth and mortality characteristics of their component species.

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