THE ECOLOGY OF TROPICAL LOWLAND PLANT COMMUNITIES WITH PARTICULAR REFERENCE TO HABITAT FRAGMENTATION AND *MELALEUCA VIRIDIFLORA* SOL. EX GAERTN. DOMINATED WOODLANDS

Dissertation submitted by

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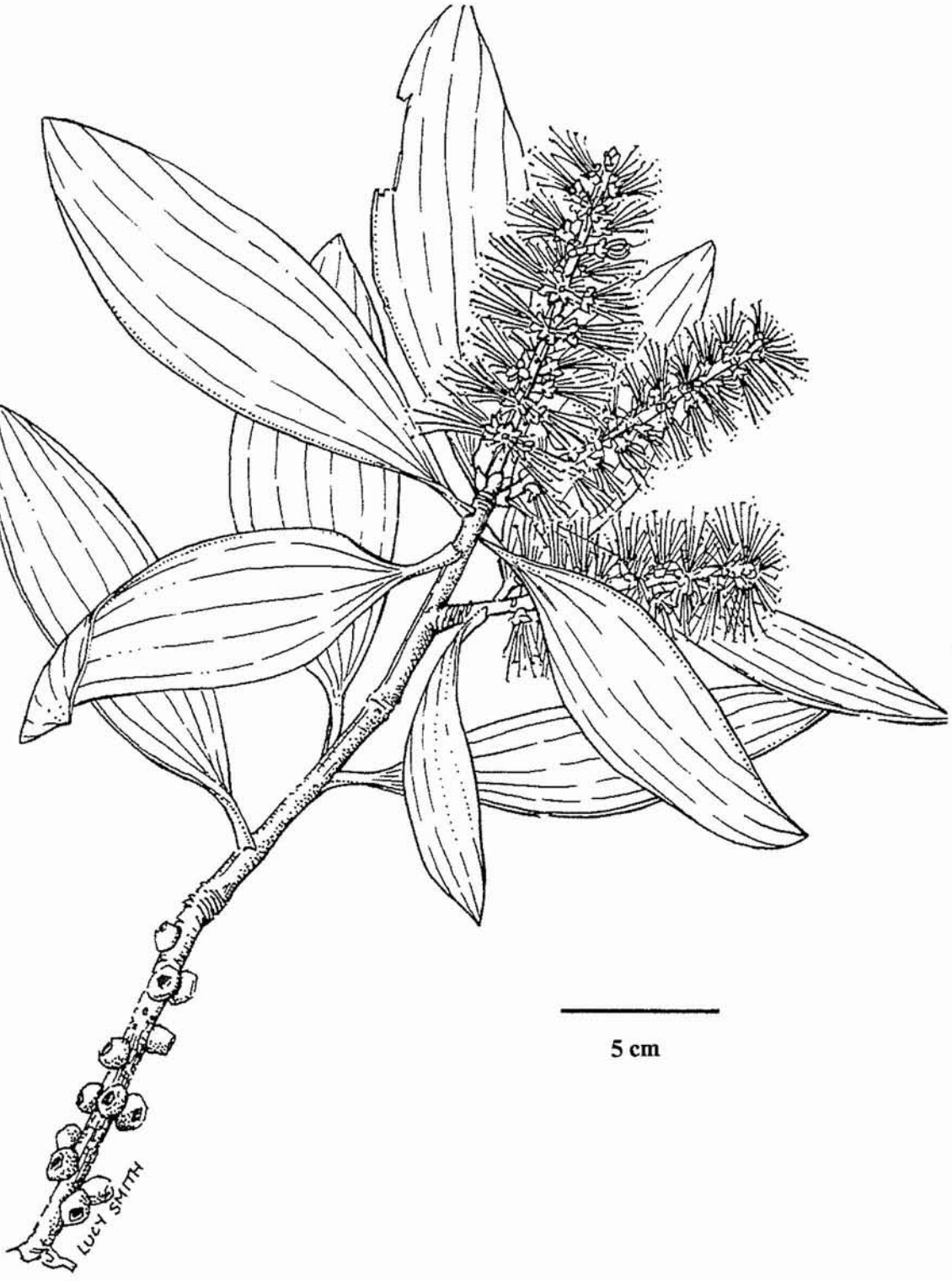
for the degree of Doctor of Philosophy
in the Department of Tropical Plant Sciences at the
James Cook University of North Queensland.

Frontispiece **The Broad-leaved tea-tree: *Melaleuca viridiflora* (Myrtaceae).** Drawing by Lucy Smith taken from Skull (1995).



DEDICATION

I dedicate this thesis to my late grandfather, Mr William H. Cleverly,
a noted goldfield geologist and naturalist who,
even from the red bull dust streets of Kalgoorlie,
encouraged the completion of this project in a remarkable manner.

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STATEMENT OF SOURCES

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 Information derived from the published and unpublished work of others has been acknowledged in the text, and a list of references is given.

S.D. Skull 1st June 1998

ABSTRACT

Tropical lowland plant communities in north-eastern Queensland are under enormous pressure from continuing clearing, fragmentation, exotic species invasion, inappropriate fire regimes, and altered hydrological patterns. Few accurate figures with respect to past clearing patterns exist, and comparatively little scientific research has been conducted on the highly diverse and ecologically significant range of remnant vegetation types. Additionally, most plant communities remain very poorly represented in the existing conservation reserve system. The initial focus of this thesis was, therefore, to provide the first detailed assessment of clearing and fragmentation for an area of the tropical lowland environment (between Townsville and Cairns) widely recognised for its ecological significance.

In the area examined, approximately 140 ha yr^{-1} of remnant vegetation has been cleared over a 50 year period (1942-1992). This is more than double the rate recorded by any other study in the wet-tropics, but well below clearing rates calculated for more populated regions of the state. Dramatic changes in the size class (area) distribution of remnants were recorded for all vegetation types, particularly in the smaller size classes. A range of landscape indices were used to assess patterns of habitat fragmentation. Remnant shape, perimeter length and dispersion across the landscape all varied significantly for certain vegetation types, and the management implications associated with these changes are considered. The need for a "fine-scale" approach to landscape analysis in conservation planning exercises is discussed, with three vegetation types utilised as case studies.

Melaleuca viridiflora open woodlands were selected for further investigation, based on their relatively simple structure, the fact that opportunities arose to assess prescribed burns conducted by management agencies, and the large extent to which they have been affected by past clearing patterns. Their current conservation status as described within the literature was also reviewed. To assess this status fully, a detailed analysis of community structure and composition was conducted at 24 sites throughout the wet-tropics coastal region between Townsville and Cooktown. A high diversity of structural and floristic types was recorded. Many of these types are not adequately included (some not at all) in the existing conservation reserve system. A synthesis of previous research highlighted the significant level of biodiversity associated with these woodlands, adding weight to the argument for increased levels of protection in reserves.

A total of 127 species were recorded from the 24 sites, with classification analyses of species presence/absence data separating seven or eight main groups of sites, essentially related to a gradient of latitude and (predicted) rainfall. The groups were not well explained by either species richness, past fire frequencies or soil types. Structural classification analyses based upon DBH data identified six or seven main groups, the singularly most striking of which was sites with annual fire histories. Ordinations based on both the DBH and species presence/absence data produced groupings that supported those detected by the classification techniques. In a closer examination of sites with similar fire histories, soil moisture and soil type were both found to have significant effects on community structure and composition.

The effects of single prescribed burns were examined at several sites. Moderately intense fire dramatically affected individuals in the understorey and intermediate size classes, with reductions in the latter of up to 58%. The effects of repeated fires (i.e. an annual fire regime) on these size classes were also examined and suggest that two consecutive fires are sufficient to exhaust the regenerative ability of *M. viridiflora* saplings, even though the species is widely considered to be adapted to fire. The simplification of community structure (fewer strata with insufficient recruitment to maturity) as a result of subsequent high frequency fires is considered likely, and recommendations (adopted by management agencies) for longer fire-free intervals than those currently prescribed are proposed. The effects of fires on the fine fuel loads of these communities were also examined, with an average loss of 97% of fine fuel in moderate intensity fires. Even two to three years after fire, fuel loads remained well below pre-fire levels.

The spatial pattern of Caribbean pine (*Pinus caribaea* var. *hondurensis* Barrett & Golfari (Pch)) invasion (from plantations adjacent to high conservation value remnants) into *M. viridiflora* woodlands was also documented. Pines dispersed more than 400 m, with densities ranging widely between the remnants studied. At a site examined in detail, the distribution of pines was poorly correlated with that of the dominant native species in the community. Growth rates of the exotic pine were, at times, more than twenty-fold those of *M. viridiflora*, whilst mortality was substantially lower. Differences in the germination responses of the two species to varying temperature and soil moisture treatments were also examined, with *M. viridiflora* germinating more readily at higher temperatures and elevated soil moisture levels. A relatively intense prescribed fire was used to assess its effectiveness as a management tool for the control of exotic pines. Although successful in controlling juveniles (less than 1.5

m tall), little effect was observed on larger trees. Other potential management techniques (hand removal, localised chemical treatment and the development of sterile plantation species) are considered essential for a successful integrated control program that minimises the potential for invasion into other significant remnant *M. viridiflora* habitats.

Finally, the results of this study are assessed within the context of the sustainable management and development of these woodland communities at the landscape level. The opportunities for future research relevant to each section of the thesis are also outlined.

ACKNOWLEDGMENTS

A lot of water has flowed under the bridge (although not much of it in Townsville) since I first had the notion of tackling a PhD. A great many people have helped me hobble over the finishing line and a brief mention is made of some of these below.

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And a final word of thanks to all the friends who have helped take my mind well and truly off the job.

TABLE OF CONTENTS

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ACF	Australian Conservation Foundation
ACG	Australian Commonwealth Government
AMG	Australian Metric Grid
ANCA	Australian Nature Conservation Agency
ANCOVA	Analysis of Co-variance
ANOVA	Analysis of Variance
AUSLIG	Australian Survey and Land Information Group
BIOCLIM	Bioclimatic Prediction System (Software program)
CSIRO	Commonwealth Scientific Industry Research Organisation
DBH	Diameter at Breast Height
DEST	Department of Environment, Sport and Territories
DNR	Department of Natural Resources
FI	Fragmentation Index
GIS	Geographic Information System
GPS	Geographic Positioning System
HSD	Honestly Significant Difference
HINP	Hinchinbrook Island National Park
PATN	Pattern Analysis (Software program)
QDE	Queensland Department of Environment
QDEH	Queensland Department of Environment and Heritage
QDPI	Queensland Department of Primary Industries
QSFS	Queensland State Forest Service
QNPWS	Queensland National Parks and Wildlife Service
RAKES	Rapid Selection and Appraisal of Key and Endangered Sites
SAS	Statistical Analysis System (Software program)
SI	Shape Index
SIIP	Sugar Industry Infrastructure Package
SPSS	Statistical Package Trade Name (Software program)
SSH	Semi-strong Hybrid Multi-dimensional Scaling
TWINSPAN	Two-Way Species Indicator Analysis (Software program)
UPGMA	Unweighted Pair Group Arithmetic Averaging
WTBR	Wet Tropics Biogeographic Region
WTMA	Wet Tropics Management Authority
WTWHA	Wet Tropics World Heritage Area

LIST OF PLATES

LIST OF FIGURES

LIST OF FIGURES (cont.)

LIST OF TABLES

LIST OF TABLES (cont.)

LIST OF APPENDICES