New Zealand Isopollen and Isochrone Maps: An Integrative Approach to Reconstructing the Paleoenvironment since the Last Glacial Maximum

A thesis presented in partial fulfilment of the requirements for the degree of

Master of Science
in
Geography

at Massey University, Palmerston North, New Zealand

Robert John Tinkler
2002

Abstract

A series of isopollen and isochrone maps for New Zealand since the Last Glacial Maximum (LGM) is presented; these maps suggest likely paleovegetation patterns in New Zealand since the LGM. To the best of my knowledge, they are the first constructed for any region in the Southern Hemisphere. The procedure used to construct the maps was unique in a number of ways. Contouring was predominantly acheived using kriging techniques on a computer package rather than manual contouring, which has been the norm in other regions. An integrative approach was used; marine microfossil data was utilised to derive paleo-sea surface temperatures which, when combined with faunal freezing temperatures, yielded *a priori* theoretical altitudinal limits for selected taxa to augment the fossil pollen data. Terrestrial macrofossil data was used to evaluate the resultant maps. Paleo-shorelines, also derived from macrofossil studies, are shown. Paleo-shorelines are important in that coastal areas may have served as refugia during, and migration routes after, the LGM.

The resultant maps show that an integrative approach was generally successful. The maps give a more holistic view of New Zealand's paleoenvironment than is possible from studying individual fossil pollen diagrams, and some interesting conclusions are reached. The southern limit of continual forest in the late glacial period may have been 2° south of commonly accepted limits. The existence of a Younger Dryas–synchronous cooling in New Zealand is shown to be unlikely from a palynological perspective.

Errata

page i line 9 should read "...when combined with *floral* freezing temperatures..."

page 17 caption should read "Figure 1. The Hemisphere Centred on New Zealand. Note the isolation of New Zealand, with Australia, our nearest sizeable neighbour, being 2000 km to the *west*."

Table *of* Contents

4. Interpretation of the Maps & Conclusion

5. Appendices

List of Figures

List of Tables

Preface

Quaternary research in the Southern Hemisphere has historically received less emphasis than research north of the equator (Partridge *et al* 1999) yet there are clear differences in the mechanisms and patterns of climate and paleovegetation change between the two hemispheres. It follows that the Southern Hemisphere's paleoclimate is not particularly well understood; typically researchers extrapolate climate reconstructions from Europe and North America to the Southern Hemisphere (eg COHMAP members 1988; Diaz & Graham 1996; Peteet *et al* 1997). Unfortunately, according to Iriondo (1999) "Such a methodological tendency is permanent and often risky," given, for example, "...both extremes of the global climate system (Antarctica and the Pacific Warm Pool) are located in the Southern Hemisphere. It is hardly probable that both regions play a passive role in climatic changes driven by North Atlantic factors."

New Zealand is rather uniquely situated in this regard as it is the only sizeable landmass in the Southern Hemisphere free from continental influences, is proximal to western boundary currents and the subtropical convergence, and is relatively well studied. Furthermore, New Zealand provides "...virtually unparalleled opportunities to examine postglacial environmental changes without the veiling effects of human influences." (Newnham & Lowe 1999) given that anthropogenic impacts on vegetation cannot be unequivocally demonstrated before 700-800 years before present.

Fossil pollen analysis provides one method of paleovegetation and paleoclimate reconstruction. Fossil pollen data has been used in New Zealand to reconstruct paleoclimate and climate change (McGlone 1973; Shulmeister *et al* 1999), and related processes such as changes in paleovegetation composition (Moar 1970); anthropogenic impact (Hume & McGlone 1986; Wilmshurst 1997; Empson *et al* 1999) including dating the first arrival of Maori in New Zealand (Ogden *et al* 1998; McGlone & Wilmshurst 1999a); the impact of cataclysmic events such as vulcanism and fire on vegetation (McGlone *et al* 1988; Bussell 1988), testing succession models (Bray 1989) and to assist with revegetation programs (Chester 1991). Palynology has

also been used to reconstruct Holocene sea level change (Pocknall *et al* 1989; Mildenhall 1994).

In New Zealand, however, palynological research typically focuses at the regional level and there has been considerably less effort to systematically synthesise the results into a coherent picture of the paleoenvironment for the country as a whole. At the same time palynological researchers typically operate in isolation, to some extent under-utilising other paleoenvironment reconstruction techniques. Because palynology is fairly imprecise due to faulty representation of some taxa and complex terrain (Markgraf *et al* 1992), vegetation and climate reconstruction is best effected utilising multiple sources of evidence, including ocean cores, tephras and macrofossils to augment the pollen data. The purpose of this thesis, therefore, is to synthesise as much fossil pollen data as possible in a series of isopollen and isochrone maps for selected New Zealand taxa since the Last Glacial Maximum (*c* 22,000 years ago), at the same time integrating fossil data other than pollen. A secondary objective is to interpret these maps in terms of vegetation and climate change.

Acknowledgments

Thank you to the following people:

Associate Professor John Ogden, School of Geography & Environmental Science, University of Auckland for helpful comments on a draft of this thesis.

Mr Greg Arnold, Institute of Information Sciences & Technology, Massey University for reviewing the statistical methodology in this thesis.

Dr Rodger Sparks, Rafter Radiocarbon Laboratory for providing corrected ^{14}C dates.

Dr James Shulmeister and Dr Bill McLea, School of Earth Sciences, Victoria University for making available unpublished pollen core information for sites in NW Nelson.

Li Xun, Geography Program Massey University for making available unpublished pollen core information for Sponge Swamp and Lake Tiniroto.

Kevin Butler, Geography Program Massey University for stimulating discussions about wives, kids and palynology.

Leighanne Empson, Geography Program, Massey University for stimulating discussions about the New Zealand Quaternary, kids and palynology.

Finally a special thank you to my thesis supervisor Professor John Flenley, Geography Program, Massey University for his encouragement and support over the years, and for being an inspiring teacher.

Dedication

Dedicated to my wife Lesley, and my children Sarah, Rachel, Aimee, and Kate.