Natural variation in south-eastern South Australian small mammal communities through the Late Quaternary

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For my grandma, Jean Le Cornu, who inspires me to persist against all odds,
and the memory of my late grandpa, Deane Le Cornu,
from whom I draw the strength to do so.

Declaration

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

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List of publications:

Macken, A.C., McDowell, M.C., Bartholomeusz, D.H. & Reed, E.H. (2013) Chronology and stratigraphy of the Wet Cave vertebrate fossil deposit, Naracoorte, and relationship to paleoclimatic conditions of the Last Glacial Cycle in south-eastern Australia. *Australian Journal of Earth Sciences* **60,** 271–281.

Macken, A.C., Staff, R.A. & Reed, E.H. (2013) Bayesian age-depth modelling of Late Quaternary deposits from Wet and Blanche Caves, Naracoorte, South Australia: a framework for comparative faunal analyses. *Quaternary Geochronology* **17,** 26–43

Macken, A.C & Reed, E.H. (2013) Late Quaternary small mammal faunas of the Naracoorte Caves World Heritage Area. *Transactions of the Royal Society of South Australia* **137,** 53–67.

Signed .....

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Date .....

Abstract

Natural variation is characterised as the normal types of change that occurs within ecosystems in response to disturbances at different spatial and temporal scales. Such changes may be expressed across a range of ecological attributes including community structure and composition. Changes in these attributes are often argued to provide the basis of ecosystem resilience to disturbance; that is, the ability of communities to adapt and reorganise whilst retaining their functional and structural traits. Consequently, the maintenance of natural variation within ecological systems has emerged as a primary biodiversity conservation strategy. However, our understanding of what normal patterns of variation may be expected in different ecosystems and the constraints on resilience within them, remains limited.

Palaeoecological deposits have increasingly been used to fill knowledge gaps about the range, type and extent of natural variation and resilience expressed by ecosystems over long time scales in response to disturbances such as climate change. Using two owl-pellet derived fossil assemblages of the Naracoorte Caves in south-eastern South Australia, this thesis examined patterns of natural variation and resilience of a small mammal palaeocommunity in terms of richness, composition, structure and relative abundances through the last glacial cycle (*c*. 51.4 to 10.2 kyr BP). More specifically, this thesis addressed the following questions:

(a) Did the small mammal palaeocommunity reorganise in response to climate change associated with the last glacial cycle?
(b) How did variation in different ecological variables contribute to the persistence or reorganisation of the palaeocommunity, and
(c) How did sampling variation within and between sites, and temporal resolution, impact patterns detected in the fossil assemblages?

To address these questions, the stratigraphic and chronological contexts of the fossil assemblages were defined using sedimentary principles and age-depth modelling of radiocarbon data. Both deposits were found to be composed of five un-reworked sedimentary units which were statistically correlated between the two sites based on modelled ages. These units provided a coarse temporal scale corresponding to the major climatic phases of the last glacial cycle. Sedimentary layers were identified

within the stratigraphic units, providing a finer temporal scale for evaluating the faunal assemblage.

Faunal analyses showed that the two small mammal assemblages were statistically similar and exhibited very little compositional or structural change through the early glacial period and last glacial maximum (LGM). However, two episodes of significant palaeocommunity reorganisation were revealed at the finer temporal scale through the deglaciation/late glacial period. These changes were associated with (a) sea-surface temperatures (SSTs) warming past 16°C, post-dating the onset of warming following the LGM by *c.* 1 to 3 kyrs and (b) continued warming of mean SSTs past 18°C.

The relative abundances of individual species were sensitive to sampling effects and were variable through time at both temporal scales. The whole-palaeocommunity metrics were more robust and showed that a palaeocommunity can be stable for thousands of years, despite variable climatic conditions. Palaeocommunity change during the deglaciation shows that it is not disturbance per se that led to shifts between community states, but disturbance beyond palaeoclimatic thresholds within which particular states were able to persist. Further study of environmental thresholds for the palaeocommunity and individual species will be valuable for assessing the variability of species-environmental associations through time and the potential for their adaptation into the future.

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