Ancient DNA in the Australian context: Investigating evolutionary and ecological responses to environmental change.

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Abstract

This thesis investigates how ancient DNA (aDNA) can provide insight into past (and potentially lost) genetic diversity, and how this information can be used to reconstruct evolutionary history. Specifically, it examines how the combination of aDNA data with other analytical techniques can reveal information unavailable from modern genetic studies of mitochondrial DNA, and help to refine models and test hypotheses about the history of individual species through time. Understanding 'patterns' of past genetic diversity and the 'processes' involved in forming these patterns at different temporal and spatial scales is of critical importance in the management of biodiversity, and for predicting future impacts of on-going environmental changes.

This thesis has particular significance for the ancient DNA community in Australia as it demonstrates how DNA may be preserved even in sub-optimal environmental conditions, such as tropical, sand-blown, and arid environments. The genetic information successfully extracted from these sub-optimal samples has allowed a range of phylogeographic questions to be addressed. The overarching question I ask in these studies is: what insights can aDNA provide into evolutionary history and, where these insights contrast with existing models, which additional analytical techniques help clarify or refine these models?

Chapter 2 (Methods) details the optimisation of extraction methods for the isolation of ancient DNA from sub-optimal samples (where often only minimal sample volumes are available for study). I then review the analytical techniques used to investigate the evolutionary history of the three species described in the following chapters.

The first species examined (chapter 3), is the Australian Emu species complex (*Dromaius novaehollandiae*, *D. baudinianus*, *D. ater*, and *D. novaehollandiae diemenensis*). I use both morphological methods and coalescent analysis to investigate the evolutionary history of emu, and the basis for separate taxonomic designations of the Tasmanian Emu, and the dwarf Kangaroo Island and King Island Emus. The morphological differences of the latter two species are first used to investigate potential causes of their dwarfism. Based on this assessment, I use genetic data to examine the demographic/dispersal history and phylogeographic structuring of the mainland Emu across its range.

In chapter 4, I investigate the range restricted and vulnerable Australian Ghost Bat (*Macroderma gigas*). Ancient DNA from subfossil cave deposits is used to describe the genetic relationship between extinct southern and extant northern populations and highlight how ancient DNA is essential in examining ancient patterns of gene flow. I then use species distribution modelling to test whether changing climates are responsible for the isolation and extirpations of these southern populations. I approximated the ecological niche currently occupied by Ghost Bats and then hindcast to the last glacial maximum (LGM) and last interglacial (LIG) to examine potential dispersal opportunities in the past, and forecast using models of projected future climates to investigate likely responses to anthropogenic climate change.

In chapter 5, I explore the use of chicken (*Gallus gallus*) genetic diversity as a record of the migration of early Polynesians across the Pacific. The genetic analysis of commensals allows identification of population bottlenecks and examination of potential source populations, and also a separate means to establish the route that their human-counterparts travelled. I incorporate archaeological models of Polynesian history into patterns of chicken diversity across the Pacific, and test hypotheses of potential dispersal routes of this human-commensal dyad using statistical significance testing.

Thesis declaration

I, Vicki Thomson certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by any other person, except where due reference has been made in the text.

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