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Birds in a tree: A journey through avian phylogeny,  
with particular emphasis on the birds of  
New Zealand

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## ABSTRACT

Two main themes to the avian research presented in this thesis are,

1. Deep resolution of birds generally, and
2. Investigation of specific aspects of the New Zealand avifauna.

More specifically, this thesis covers phylogeny, and predictions about palaeognaths, pigeons, peleciforms and passerines.

Significant progress is made in resolving the basal branches of Neoaves. This thesis examines whether the six-way basal Neoavian split of Cracraft (2001) is, in principle, resolvable. New mitochondrial genomes are added to improve taxon sampling, break up long branches, and allow testing of the prior assumptions of six Neoavian groups. This research shows the six-way split is resolvable, although more work is required for specific details. From a life-history perspective, it is interesting that the two bird-of-prey groups (falcons and buzzards) are very divergent, and may not be sister groups. Molecular dating supports major diversification of at least 12 Neoavian lineages in the Late Cretaceous. Additionally, novel avian mitochondrial gene orders are investigated and a hypothesis put forward suggesting gene conversion and stable intermediate forms allows an apparently rare event (gene rearrangement) to occur multiple times within Neoaves.

One of Cracraft's six groups, informally called the 'Conglomerati', is particularly difficult to resolve. The pigeons (Columbiformes) lie within the 'Conglomerati', and this chapter examines two aspects along the continuum of pigeon evolution. Firstly the large South Pacific fruit pigeon radiation is examined with mid-length mitochondrial sequences. This clade contains a third of all pigeon species, and has been very successful in island colonisation throughout South East Asia and the Pacific. Secondly, candidates for the closest relative of pigeons are tested using analysis of whole mitochondrial genomes. Highest support was found for the grouping of sandgrouse and pigeon, although they are clearly very divergent.

Also within the 'Conglomerati' is the traditional order Pelecaniformes, and their close allies the Ciconiiformes. These orders (the P&C) are part of an adaptive radiation of seabird water-carnivores, including loons, penguins, petrels and albatrosses. This group is separate from the large shorebird water-carnivore group; although both appear to have begun radiating about 70 million years ago. The

tropicbird represents a separate, convergent life history and is not part of the Pelecaniformes, nor within the larger seabird water-carnivore group.

Resolution of the basal phylogeny of oscine passerines is important for interpreting the radiation of this group out of the Australasian region. Many endemic New Zealand oscine passerines belong to 'basal corvid' lineages, but have not previously been investigated with mitochondrial DNA. This chapter shows that many 'basal corvid' lineages are actually 'basal passerine' lineages, and there is a discrepancy between nuclear Rag-1 phylogenies (the most commonly used gene in passerine phylogenetics) and other phylogenies, including mitochondrial, that requires further investigation.

Taken as a whole, this thesis adds significantly to our understanding of the evolution of birds, and provides a foundation for future research, not only of phylogenetic relationships, but also of avian life history, long-term niche stability and macroevolution.

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