

**Tertiary fossil waterfowl (Aves: Anseriformes)
of Australia and New Zealand**

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Abstract

Anseriformes, or waterfowl, are related to Galliformes (chickens and kin), together forming the most basal sister of Neoaves. The order is generally considered to comprise four families: Presbyornithidae (Late Cretaceous - Eocene); Anseranatidae (Paleocene-present); Anhimidae (Oligocene-present); Anatidae (Oligocene-present), but the giant Tertiary flightless taxa Dromornithidae (Australia), Gastornithidae (Eurasia) and Diatrymidae (North America) have also been referred to the order. Australasia presently has a unique waterfowl fauna characterized by low species diversity but high phylogenetic diversity: the Magpie Goose *Anseranas* (the sole surviving anseranatid), several monotypic endemic anatid genera of uncertain relationships (Cape Barren Goose *Cereopsis*, Freckled Duck *Stictonetta*, Pink-eared Duck *Malacorhynchus* and Musk Duck *Biziura*), several relatively primitive taxa (the aforementioned plus whistling ducks *Dendrocygna* and Blue-billed Duck *Oxyura*). The evolutionary history of this fauna has, until now, not been examined via the fossil record.

In this thesis, the literature for the global fossil record of Anseranatidae and Anatidae is reviewed. The Neogene (Oligocene-Pliocene) fossil record of Anseriformes, exclusive of dromornithids, is studied from both New Zealand and Australia. For New Zealand, all materials derive from the St Bathans Fauna, Early Miocene (19-16 Ma), Otago. Herein, the first description of this fauna is provided, with four anatid genera (*Manuherikia*, *Dunstanetta*, *Matanas* and *Miotadorna*) established for five species, with a sixth taxon reported (Chapter 2). The phylogenetic affinities of *Manuherikia*, *Dunstanetta* and *Miotadorna* are examined using parsimony analysis of morphological data (133 characters) in Chapter 3. *Miotadorna* is a shelduck related to tadornines, perhaps sister to *Tadorna*, and *Manuherikia* and *Dunstanetta* are oxyurines related to the *Stictonetta*, *Malacorhynchus*, *Oxyura* and *Biziura*). A further species of *Manuherikia* and the existence of definite anserines, probably related to *Cereopsis*, are described in Chapter 4.

The fossil record of Australian anseriforms is described in Chapters 5-8. The Oligo-Miocene record derives principally from the Etadunna and Namba Formations (26-24 Ma) in the Lake Eyre and Frome Basins, respectively, in South Australia. Four taxa are described, with all occurring both in the Namba and Etadunna Formations: a single genus, *Pinpanetta*, is established for three species and another, *Australotadorna*, for a tadornine. Phylogenetic analyses (parsimony and Bayesian) of a dataset (150 characters, 61 taxa) show *Pinpanetta* is an oxyurine and confirm the previously found oxyurine affinity of *Manuherikia* and *Dunstanetta*. A monophyletic clade with moderate support is found for an

expanded Oxyurinae that has *Stictonetta* basal, followed successively by *Mionetta* (Oligo-Miocene of Europe), *Malacorhynchus*, *Pinpanetta*, *Manuherikia*, *Dunstanetta*, *Oxyura* and *Nomonyx*, *Biziura* and *Thalassornis*. This same analysis finds anserines the most basal group in Anatidae, so changing position with *Dendrocygna*, considered by recent authors to be the most basal anatid.

A new genus and species of anseranatid is described from a Faunal Zone A (System A, Late Oligocene) deposit at Riversleigh, northwestern Queensland (Chapter 6). This first pre-Pliocene record of the family in Australia is of equivalent age to the youngest European fossil anseranatid, *Anserpica* from France, but younger than the Eocene *Anatalavis* of England. Only one of three other waterfowl bones known from Riversleigh deposits is identifiable and is referred to a species of *Pinpanetta* found in the Etadunna Formation.

Mid-Late Miocene deposits containing waterfowl are restricted in Australia to just the Waite Formation (c. 8 Ma) at Alcoota in the Northern Territory. Three bones indicate an undetermined tadornine and an undetermined anatid, different from any known species.

The Pliocene record of anseriforms in South Australia is described from the Tirari Formation (Kanunka and Toolapinna Faunas) (Chapter 7). Nine modern species (*Anseranas semipalmata*, *Cereopsis novaehollandiae*, *Cygnus atratus*, *Tadorna tadornoides*, *Biziura lobata*, *Oxyura australis*, *Anas* cf *A. castanea*, *A.* cf *A. gracilis* and *Aythya australis*) are represented. A single extinct species, *Tirarinetta kanunka*, is described and referred to Oxyurinae. From the Parilla Sands, Late Pliocene, at Bookmark Cliffs on the Murray River, a single humerus is described (Chapter 8) and referred to *Tadorna* cf. *T. tadornoides*.

A total of 11 anatid taxa is described from latest Oligocene-Early Miocene deposits in Australasia, which considerably adds to the global record of seven species previously reported for this period. Considering also the anseranatids, the Late Oligocene – Early Miocene fauna of Australia is thus established as having equivalent diversity to that from similar-aged deposits in Europe, but by the late Early Miocene, the New Zealand fauna was more diverse than any other Oligo-Miocene fauna known. The more limited samples available, compared to those from New Zealand, probably explain the lack of a similar diversity being revealed for Australia from this period. In both Australia and New Zealand, the Oligo-Miocene faunas are dominated by oxyurine taxa, as were those in Europe. The presence of a tadornine in Australia in the latest Oligocene and another in New Zealand in the Early Miocene precede the appearance of this subfamily in the Northern Hemisphere by 10 Ma, implying a southern origin for this group. The Late Oligocene presence of *Mionetta* in Europe and of *Pinpanetta* in Australia, and their referral to Oxyurinae, establishes a

minimum age for the origin of this subfamily in the latest Oligocene. The establishment of a fauna comprised of modern species by the Pliocene indicates substantial faunal turnover probably in the Late Miocene. This turnover is due in part to immigration of taxa (*Cygnus*, *Anas*, *Aythya*) and *in situ* evolution (all endemic genera), as occurred in other Australian vertebrates (rodents, snakes, bats). Thus faunal composition in Australia appears to have been more affected by attainment of some threshold in proximity to Asia being breached by the northward continental drift of Australia, than by aridification, which has been ongoing since the Middle Miocene.

Declaration

This thesis 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 another person, except where due reference is made in the text.

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Trevor H. Worthy

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