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

Trevor H. Worthy

Environmental Biology
School of Earth and Environmental Sciences
The University of Adelaide
South Australia

A thesis submitted for the degree of Doctor of Philosophy
at The University of Adelaide

23 May 2008

Table of contents

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.

The author consents to this thesis being made available for photocopying and loan when deposited in the University Library.

The author acknowledges that copyright of published works contained within this thesis resides with the copyright holder/s of those works.

……

Trevor H. Worthy

Date 23 May 2008

Acknowledgements

First and foremost, I thank Robert Hill and Tim Flannery who encouraged and facilitated my candidature for a Doctor of Philosophy at the University of Adelaide, and I thank the School of Earth and Environmental Sciences and the South Australian Museum for my Divisional Scholarship. I am particularly grateful for the encouragement and support of my supervisors Alan Cooper, Michael S. Y. Lee, and Walter Boles. I especially thank Michael Lee for guidance in the phylogenetic analyses. I am especially thankful and grateful for an understanding partner and wife Jennifer, whom embraced the move from New Zealand to Australia that allowed me to follow my palaeontological passion.

Entry into a university system after so many years was facilitated by the efficiency of Maria Lekis who helped solve many day to day issues and, whom throughout the last three years, has always been available to give advice. My time here has been made more enjoyable by the camaraderie of my fellow lab-group members, particularly Sarah Bray, Nicolas Rawlence, Marta Kasper, Gaynor Dolman and Jeremy Austin.

I am pleased to acknowledge my coauthors, Alan J. D. Tennyson, Craig Jones, Jim A. McNamara, Barry J. Douglas, Michael S. Y. Lee, Suzanne J. Hand, R. Paul Scofield, John D. Scanlon and Neville S. Pledge, for their contributions to the following works that constitute this thesis. Without their help, clearly, this work may not have eventuated at all. I am extremely grateful to the following institutions and their curators and collection managers for enabling access to fossil specimens or reference material in their care and facilitating loans: **AM**, Australian Museum, Sydney, New South Wales: Walter Boles. **AMNH**, Fossil Amphibian, Reptile, and Bird Collections, Division of Paleontology, American Museum of Natural History, New York, United States of America: Carl Mehling. **ANWC**, Australian National Wildlife Collection, CSIRO, Canberra, Australia: Robert Palmer. **BMNH**, The Natural History Museum, London, United Kingdom: Joanne Cooper. **CM**, Canterbury Museum, Christchurch, New Zealand: Paul Scofield. **FU**, Flinders University of South Australia, Adelaide, South Australia: Rod Wells. **MV**, Museum Victoria, Melbourne, Victoria: Palaeontology Dept. - David Pickering, Tom Rich; Vertebrates Dept. - Rory O'Brien, Wayne Longmore. **NMNZ**, Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand: Alan Tennyson, Sandy (J.A.) Bartle, and Gillian Stone. **NTM**, Museums & Art Galleries of the Northern Territory, Darwin, NT: Dirk Megirian. **SAM**, South Australian Museum, Adelaide, South Australia: Palaeontology

Dept. - Jim McNamara, Neville Pledge, and Dennis Rice; and in the Bird Dept., I especially thank Philippa Horton. **QM**, Queensland Museum, Brisbane, Queensland: Kristen Spring and Heather Janetzki. **USNM**, Division of Birds, Smithsonian Institution, Washington D.C., USA; Storrs Olson, James Dean, & Christopher Milensky. **Université Claude Bernard**, Lyon 1, Centre des Sciences de la Terre, Villeurbanne, Cedex, France: Cécile Mourer-Chauviré.

I particularly wish to acknowledge the detailed knowledge Richard Tedford, Neville Pledge, Tom Rich and Rod Wells readily shared with me concerning fossil sites they had worked. Special thanks are due Rod and Richard for inviting me on their expedition to the Warburton River (2006), enabling me to visit some of the sites first hand that have produced fossil birds. I thank Aaron Camens for his enthusiastic help in field work, and providing a palaeontological ear in a research group otherwise dominated by DNA interests.

Fieldwork in New Zealand excavating the St Bathans Fauna was greatly aided by my colleagues, particularly Alan Tennyson, Paul Scofield, Michael Archer, Suzanne Hand, Henk Godthelp, Jennifer Worthy and Jamie Wood. Numerous other folk helped on the excavation over the years whom all contributed to revealing the St Bathans Fauna: Zoe & Nicky Archer, Rex Austin, Robin Beck, Aaron Camens, Phil Creaser, Travis Cross, Barry Douglas, Peggy Eby, Rachael Fischer, Ian Graham, Jamila Gurovich, Graeme Halliday, Zoe Hill, Rachael Ines, Craig Jones, Lizard, Robert Lohr & Dawn Bell, Julian Louys, Dave Matthews, Jacqueline Nguyen, Kristen Ramsdale, Karen Roberts, Silvia & Millie Ross, Colin & Jenny Sutherland, Barney Tennyson, Kenny Travouillon, Aaron & Rowan Worthy. Excavation of the St Bathans Fauna was made possible by the generosity of the landowners, of whom Ann and Euan Johnstone derive special mention for their welcome hospitality and providing and operating the digger in the quarries. Jack Enright also made us welcome on his land. The excavations of the St Bathans Fauna were supported by grants from the Australian Research Council, and supported by the University of New South Wales, Canterbury Museum and Museum of New Zealand. The South Australian Museum kindly provided facilities to process and prepare excavated materials.

This thesis is dedicated to my wife

Jennifer P. Worthy