PHYLOGENETIC AND MORPHOMETRIC ANALYSIS OF A NEW ORNITHUROMORPH FROM THE BARUN GOYOT FORMATION, SOUTHERN MONGOLIA

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Despite the abundance of dinosaur fossils that have been discovered from the Late Cretaceous of the Mongolian Gobi Desert, those belonging to birds have remained elusive. While diverse avifaunas representing coastal environments have been discovered in several localities across the globe, very few continental deposits with bird fossils are known. Of these sites, the Gobi is becoming the most productive in terms of avian diversity, however, this abundance of diversity comes from only a handful of Gobi bird fossils. Therefore the discovery of additional avian taxa is of significance to our understanding of Late Cretaceous avian evolution and in particular of terrestrial avian diversity.

This study provides evidence of a new taxon of primitive ornithuromorph bird from the Late Cretaceous Barun Goyot Formation at Khermeen Tsav in the southern Mongolia Gobi Desert. Anatomical characteristics unique to this bird include an elongate hind limb with an extremely long tarsometatarsus and relatively short toes. This unusual morphology provides the basis for a morphometric analysis with the goal of testing the hypothesis that this taxon was specialized for a ground-dwelling ecology such as wading or running. A phylogenetic analysis was also carried out to test the hypothesis that the new taxon is more closely related to modern birds than to enantiornithines, the other group of birds known from the Gobi. The results of this study provide insight into the evolution of basal ornithuromorph birds as well as the ecological and biological diversity of the Late Cretaceous Gobi Desert.

AN IDENTIFICATION KEY FOR THE REMAINS OF DOMESTIC BIRDS IN EUROPE

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The goal of the project is to create a dichotomous key to distinguish domesticated species (goose *Anser anser*, duck *Anas platyrhynchos*, turkey *Meleagris gallopavo*, peacock *Pavo cristatus*, chicken *Gallus gallus*, helmeted guineafowl *Numida meleagris*, and pigeon *Columba livia*) that are found in archaeological sites in Europe from all other wild species that nest, winter or migrate in Europe. Because most avian bones from archaeological sites are broken, we decided to develop separate identification keys for proximal and distal ends of long bones. This is probably the first time that such an attempt has been undertaken, as other keys use features of complete bones, which makes it often problematic to identify a fragment. In addition, the two independent identifications of each bone end verify each other. ***[poster]***

A REVISION OF C.W. DE VIS' FOSSIL CORMORANTS (AVES: PHALACROCORACIDAE)

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C.W. De Vis named two species of cormorant, *Phalacrocorax gregorii* and *P. vetustus*, from Cooper Creek and Warburton River, central Australia, based on specimens mainly collected by J.W. Gregory in 1901-2. The material of each nominal species consists of extensive, syntypic series of mixed elements. It was subsequently regarded that each series comprised specimens from several living species. One of these species, *P. fuscescens*, is an exclusively marine species, raising questions about its purported presence in central Australian deposits. Re-examination of the fossil material confirms that all specimens complete enough for identification can be referred to either of two living species, *P. carbo* or *P. varius*, or occasionally the darter *Anhinga melanogaster*. There is no unequivocal evidence of the occurrence of *P. fuscescens*. Selections of lectoypes are made to synonymise *P. gregorii* with *P. carbo* and *P. vetustus* with *P. varius*.

BONE GROWTH MARKS IN RATITES (AVES, NEORNITHES, PALAEOGNATHAE)

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Skeletochronology aims to infer life history traits in tetrapods by utilizing bone growth marks (BGMs). In Neornithes, however, the presence of BGMs and their use for individual aging remains controversial. Because most living birds achieve their complete skeletal development in less than one year, BGMs are either absent or scarce and restricted to the outer part of bone cortices. A BGM pattern similar to that of non avian reptiles is known in some non-ornithurine birds and in extinct New Zealand moas (Dinornithiformes). Till recently, BGMs were regarded as unknown in living ratites [Turvey et al., 2005]. This is now contradicted by the discovery of BGMs in the long bones of 3 species of *Apteryx* (Apterygidae).

We have found 7 or 8 well-marked lines of arrested growth (LAGs) in hind limb bone cortices of an adult, the 4 outer LAGs being closer to each other and located in bone periphery. This LAG pattern suggests that *Apteryx*, in contrast to other living birds, does not reach its adult body size until up to 4 years of age and subsequently shows a prolonged periostic osteogenesis during at least 4 more years. Further, we provide evidence that BGMs are absent in the extinct giant *Aepyornis* from Madagascar. Previous osteohistological evidence and new data presented herein are interpreted in the context of the phylogenetic relationships among ratites [Bourdon et al., this volume]. ***[poster]***

QUANTIFICATION OF THE PHYLOGENETIC SIGNAL IN BONE MICROSTRUCTURE IN RATITES (AVES, PALAEOGNATHAE) USING A NEW MORPHOLOGICAL PHYLOGENY

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Phylogenetic relationships among ratites (Aves, Palaeognathae) have perplexed avian systematists for well over a century and have been the subject of conflicts between recent morphological and molecular studies. A new pattern of diversification of ratites is presented herein. The phylogenetic analysis is based on 130 morphological characters and includes all subfossil (Aepyornithidae and Dinornithidae) and living ratite taxa. In the single most parsimonious tree obtained, the Apterygidae plus Dinornithidae are sister to all other ratites. Within this clade, the Aepyornithidae and Struthionidae are successive sister taxa to a new well-supported clade comprising the Rheidae, Dromaiidae and Casuariidae. This novel grouping agrees with current knowledge on Gondwana breakup, which suggests that Australia and South America remained in contact across Antarctica until the earliest Tertiary.

It has long been debated whether bone microstructure either includes diagnostic phylogenetic information or reflects ontogenetic/functional factors. We provide some preliminary results of a study aimed at deciphering the causes explaining the variation of bone histological features in ratites. Firstly, we are quantifying several bone histological variables (vascular density, vascular orientation, density and shape of periosteocytic lacunae) for all ratite genera plus the Tinamidae. Secondly, we are assessing the percentages of the variation of these histological features that are explained either by phylogeny or by functional factors. For this purpose, we use two statistical methods [Mantel, 1967; Legendre et al., 1994; Desdevises et al., 2003] and the new phylogenetic framework presented here.

A NEW GENUS FOR THE EXTINCT LATE PLEISTOCENE OWL (AVES: STRIGIFORMES) FROM RANCHO LA BREA, CALIFORNIA

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A review of the strigiform specimens from the upper Pleistocene Rancho La Brea asphalt deposits previously referred to the extinct owl *Strix brea*, and all newly identified specimens referrable to that species, has provided a clearer picture of this extinct owl. This review and redescription of *Strix brea* reveals that it is more appropriately placed in a new genus whose affinities remain unclear. A variety of morphometric data is provided along with the more detailed osteological descriptions of this extinct species. A total of 138 specimens from the Rancho La Brea collections in the George C. Page Museum, representing a minimum of 23 individuals, are referred to this extinct owl. An additional seven specimens of this extinct species were confirmed in collections from the upper Pleistocene asphalt deposits of Carpinteria, California.

THE AUTOMATED BALANCE SYSTEM OF BIRDS

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Birds maintain balance during bipedal terrestrial locomotion through a heretofore undescribed automated system involving the entire musculoskeletal system of the pelvic girdle and hindlimb, the center of which is the knee joint. As the knee begins to flex in early stance phase of a stride, the proximal end of the femur begins to experience yaw mediad relative to the proximal end of the tibiotarsus. Yaw is controlled by the combination of a rigid osteological contact between the femur and fibula and sliding movements of the lateral and medial menisci of the knee joint. The yaw brings the bird's center of mass over the planted foot, which allows the bird to maintain balance. Slight long-axis rotation of the femur exerts lift on the pelvis, resulting in body roll toward the planted foot. As the knee joint begins to extend in late stance phase the direction of yaw is reversed and the bird's center of mass swings over the opposite foot as it is planted and that knee then begins to flex and exert control over the yaw. At initiation of the swing phase of a stride the knee and tarsal joints flex to raise the foot, and prior to initiation of the next stance phase the extension of the knee joint completes the reversal of the previous yaw and returns the tibiotarsus, and foot, to a forward position, completing the cycle. The automated balance system in birds explains why certain muscles are active at seemingly incongruous periods during the stride cycle.

INSIGHT INTO DIVERSITY, BODY SIZE, AND MORPHOLOGICAL EVOLUTION FROM THE LARGEST EARLY CRETACEOUS ENANTIORNITHINE BIRD

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Most of Mesozoic bird diversity is comprised of species that are part of one of two major lineages: Ornithurae, including living birds, and Enantiornithes, a major radiation traditionally referred to as « opposite birds ». Here we report the largest Early Cretaceous enantiornithine bird from northeast China, which provides evidence that basal parts of Enantiornithes share more morphologies with ornithurine birds than previously thought. Morphological evolution in these two groups has been thought to be largely parallel with derived parts of Enantiornithes convergent on the « advanced » flight capabilities of « advanced » ornithurine birds. The presence of an array of morphologies previously thought to be derived for ornithurine and enantiornithine birds in a basal enantiornithine species informs both the complex character evolution in these two major lineages. Cranial morphologies are also among the best preserved for Mesozoic avialans. The new species extends the size range known for Early Cretaceous Enantiornithes significantly and evidences forelimb to hind limb proportions distinct from all other known parts of the clade. As such, it sheds new light on avialan body size evolution, diversity, and previously proposed putative competitive exclusion in the Early Cretaceous.

UNRESTRICTED EGG SIZE AND THE EVOLUTION OF OBLIGATORY PARENTAL CARE IN BIRDS

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Parental care in birds ranges from nest-mound monitoring in megapodes to extended periods of chick provisioning in albatrosses. Avian neonates also vary from being able to run, even fly, within a few hours of hatching ('precocial') to those emerging blind, naked, and entirely dependant on their parents ('altricial'). We document the evolution of avian developmental strategies using a morphology-based phylogeny, present new correlations between strategies, egg weight and body mass, and examine reproduction in a number of Cretaceous fossil birds. Sequencial loss of precocial features in hatchlings characterizes the evolution of birds. Altriciality is derived within Neoaves, while a set of precocial strategies are seen in earlier diverging lineages, including basal Neornithes and their Mesozoic counterparts (confuciusornithines, enantiornithines, ornithurines). Our data is particularly significant because we show that this evolutionary transition encompasses an increase in relative egg size: fully altricial taxa produce significantly larger eggs compared to female body mass while those of precocial birds are smaller. Anatomical constraints on egg size, seen in Jurassic and Early Cretaceous birds (*Archaeopteryx*, *Confuciusornis*, Enantiornithes), are absent from later diverging lineages. We suggest that the evolution of unrestricted egg size precipitated subsequent diversification of reproductive strategies in living birds.

POSTNATAL GROWTH AND LOCOMOTOR MATURATION IN THE ENANTIORNITHINES: A REAPPRAISAL

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As far as known, the skeletons of perinatal enantiornithines have the shoulder girdle and wing skeleton highly ossified and nearly complete, which indicates the use of flight soon after hatching. This results in a slow rate of postnatal growth, as revealed by the presence of slow-growing, poorly vascularized lamellar-zonal bone tissue in the limbs of adults. The inference of superprecocial flight from the advanced development of flight apparatus has been called into question because no correlation between the timing of flight maturation and the ossification of the wing exists in modern birds. However, this reasoning represents a temporal converse of Julian Huxley's (1942) "refrigerator fallacy", i.e., the false reasoning that fridges are not really useful because people managed without them before. The temporal converse of this reasoning is here termed *tinder-and-flint fallacy*: the fact that tinder-and-flint technology has not been used for many centuries is not a good reason for denying that they were once useful.

The principal and primary function of the wings in all flying birds including the Enantiornithes is flight. Therefore, a nearly complete ossification and the adult relative size of the wing skeleton in their hatchlings demonstrates that they were superprecocial fliers. Precocial flight re-evolved as a juvenile antipredatory adaptation in a few groups of birds (such as the tinamous and some galliforms including the superprecocial megapodes) that nest on the ground in upland habitats. However, the juvenile flight of these birds relies on the accelerated development of the proximal primary flight feathers rather than the accelerated ossification and development of the entire wing. In accord with the predominance of irreversibility and multiple pathways of evolution, the modern precocial fliers evolved a novel adaptive response because their flight apparatus is very different from and much more advanced than that of the Enantiornithes.

EVOLUTION OF THE UNIQUE QUADRATE OF GALLOANSERINE BIRDS

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The quadrate in all extant anseriforms and galliforms has a compact, bicondylar mandibular articulation that is narrower than half the height of the quadrate, and the entire lateral process directed laterocaudally. With a few exceptions, the otic process bears an adductor tubercle and there are two widely separated quadratojugal facets, rostral and caudal. In all extant anseriforms the caudal quadratojugal facet is supported by a dorsomedial buttress and there is a single medial pneumatic foramen (except for *Chauna* that varies in the number and location of these foramina). However, the presbyornithids, which are placed in crown anseriforms in all cladistic reconstructions, differ from extant anseriforms in the state of both pneumatic foramina and quadratojugal facet. The morphology of the presbyornithid quadrate approaches the conditions found in a small Cretaceous galloanserine quadrate (UCMP 53969) that was assigned by Brodkorb (1963) to a charadriiform (*Cimolopteryx*). This raises the question of whether this quadrate belongs to an early presbyornithid or a primitive galloanserine.

Based on the current consensus on the phylogeny of gallonserines, their quadrate provides striking cases of homoplasy (convergence) which evolved despite dramatic differences in feeding modes. The dorsomedial buttress is present in all extant anseriforms and the cracids which also share with the anatids alone the tendency toward the merger of the pterygoid condyle with the medial (mandibular) condyle. The two capitula (otic and squamosal) become fused in some phasianids and some anatids.

GLOBAL BIOGEOGRAPHIC PATTERNS OF BIRDS

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Despite their unique dispersal abilities birds exhibit distributional patterns that often can be explained by large scale vicariance events, e.g., plate tectonics. Here are presented some results that have emerged in a recent investigation of higher-level relationships in Neoaves, a taxonomic group that includes ca 95% of all birds.

DIVERSIFICATION OF NEOAVES: INTEGRATION OF MOLECULAR SEQUENCE DATA AND FOSSILS

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It is a much debated issue whether modern birds began to evolve already early in the Cretaceous, which is suggested by some DNA analyses, or considerably later as indicated by the massive Tertiary fossil record. Incomplete understanding of the patterns of diversification and systematic relationships of the large group Neoaves, which include almost 95% of all bird species, has complicated the picture. In this paper we present the first well-resolved molecular phylogeny for Neoaves, together with divergence times estimates calibrated with a large number of stratigraphically and phylogenetically well-documented fossils. The results suggest that Neoaves diversified around or soon after the K/T boundary, and that the difference between molecular and paleontological data may be less than usually perceived. ***[poster]***

A REVIEW OF THE CAINOZOIC FOSSIL RECORD OF THE DIURNAL RAPTORS OF AUSTRALIA

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This study reviewed and described the fossil material of accipitrids and falconids from the Cainozoic fossil material found in Australia, in order to clarify the evolutionary change and biostratigraphic relationships of the Australian diurnal raptors compared to those from the rest of the world. Although the fossil record for these groups was limited, the fossils provided some important new information. A new genus and species of falconid was identified, represented by a distal tarsometatarsus, dating back to the Miocene, which places it among the oldest members of the Falconidae. A new species of Aquila, represented by a distal humerus, was identified from Mid-Miocene deposits. This distal humerus is the oldest evidence for the genus *Aquila* in Australia. It was also found that the avian diurnal carnivore guild in Australia during the Quaternary was more diverse compared to that of today, with evidence of two distinct and new species of extinct large accipitrids, both of which show affinities to the Old World Vultures. The largest of these extinct accipitrids was comparable in size to Haast's Eagle from New Zealand, although it was clearly a separate species because, rather than being a 'flapping predator' like Haast's Eagle, the morphology of the sternum and the claws suggests that it was a 'gliding killer'.

BIRD SKELETON COLLECTION AT THE NATURAL HISTORY MUSEUM OF VIENNA, AUSTRIA

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With about 8500 skeletons, the bird collection at the Museum of Natural History of Vienna (NMW) is one of the largest in Europe. It contains mostly complete, disarticulated skeletons; only 25% are partial skeletons or skulls and a small proportion (1.6%) of them are mounted. Altogether the collection comprises 1021species in 390 genera and.131 bird families. In recent years the collection has increased annually by up to 300 (currently 3%) specimens. All are recorded in a computer database and on index cards.

Most specimens are of Palaearctic origins, although the collection is also rich in specimens from New Zealand, parts of Africa and North America. It is of particular value as almost all specimens are well documented, predominantly available in both sexes and different age classes, and some taxa are represented in large series. Particular treasures are several extinct (e.g., Aepyornithidae, Dinornithidae, *Raphus cucullatus, Xenicus longipes, Turnagra capensis, Heteralocha acutirostris*) and endangered species.

The current collection strategy is focused on collecting new taxa, enlargement of series, inclusion of representatives from different parts of species´ distribution ranges, preparing partial skeletons from birds skins, and exchanging skeletal material internationally. The collection is regularly used for studies in systematics, taxonomy of extant, subfossil and fossil avifaunas, phylogeography, evolution, food remains of avian and mammalian predators, ecomorphology, DNA analyses, etc. ***[poster]***

UNTANGLING PELECANIFORMES: THE PHYLOGENY OF PELECANIFORMES USING MITOCHONDRIAL DNA

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The phylogeny of Pelecaniformes is currently not well resolved. It has been shown that the order Pelecaniformes is probably not monophyletic, as molecular phylogenies have suggested tropicbirds probably do not group with other Pelecaniformes genera. Additionally, it appears pelicans may also not group with the 'core Pelecaniformes', which include cormorants, darters, boobies, gannets and frigatebirds. A potential sister group for pelicans may be the shoebill (*Balaeniceps*). Within the core Pelecaniformes, there is conflict about the consensus of sister genera. Morphological studies have traditionally placed darters and cormorants together, and the recent nuclear DNA paper of Hackett et al. (2008) also supports this. However, a study by Kennedy et al. (2005) using short mitochondrial sequences showed the effect of long branch attraction on Pelecaniformes genera, and also found no signal for darters and cormorants grouping together. Their results suggested darters and gannets may be sister genera. I will be presenting the results of analyses of complete mitochondrial genome sequences (11kb alignment) comprising representatives of all Pelecaniformes genera, as well as further avian species as putative outgroups. The general consensus on the evolutionary relationships of all birds as found by nuclear and mitochondrial data will also be discussed.

REGIONAL COMPARISONS OF MOA EGGSHELL FRAGMENTS (AVES: DINORNITHIFORMES)

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Eight samples of moa eggshell fragments from palaeontological (Late Holocene) and archaeological sites throughout New Zealand show a strong positive correlation between mean thickness and latitude in accordance with Bergmann's Rule. A frequency histogram of shell thicknesses for each site correlates well with the incidence and relative abundance of moa species at the site (known from bones). At North Cape and Tokerau Beach the distribution of thicknesses is broadly bimodal. Abundant thin shell (mode at 0.90-0.94 mm) was probably produced by *Euryapteryx* "*curtus-gravis*" and *Pachyornis geranoides*, and rarer thick shell (mostly 1.2-1.7 mm) by *Dinornis novaezealandiae*. At both Puketitiri and Castle Point there is essentially one spread of thin to medium-thickness shell, with thick shell almost absent. At Puketitiri the shell is assumed to be mainly from *Anomalopteryx didiformis*, and is thicker overall than at Castle Point where the assumed identity of the shell lies with slightly smaller species (*P. geranoides* with some *Eu.* "*curtus-gravis*"). At the four South Island sites the shell is generally thicker than in the North Island but interpretation is less clear. The modal thicknesses at Wairau Bar, Oamaru, Chatto Creek and Shag River are all in the range 1.15-1.44 mm and probably largely attributable to *Eu.* "*curtus-gravis*" which dominates the bones at all four sites. However, *Emeus crassus*, *A. didiformis* and *Megalapteryx didinus* could have contributed the thinnest shells in most of the South Island samples, and *P. elephantopus* and *D. robustus* were present at most sites to contribute the thickest shell fragments. This study demonstrates the potential usefulness of histograms of moa eggshell thicknesses at particular sites as an adjunct to, or surrogate for, information on the relative abundance of moa bone.

A NEW CORMORANT (AVES, PHALACROCORACOIDEA) FROM THE LOWER MIOCENE OF SOUTHEASTERN GERMANY

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Cormorants are aquatic, piscivorous birds of the Old and New World. Today they are most diversified in the Southern Hemisphere, where they inhabit both marine and freshwater environments. The fossil record of Phalacrocoracoidea (cormorants and anhingas), which starts in the Early Oligocene and possibly goes back to the Eocene of Europe, indicates the European origin of the group.

We present a new species of the genus *Borvocarbo* which has been known from the Late Oligocene of France and Germany. The new species comes from the brackish deposits of the Early Miocene (border Ottnang/Karpatian, MN4b) locality Rauscheröd near Passau (southeastern Germany) in the North Alpine Foreland Basin. These brackish sediments (Ortenburg Schotter) are interpreted as delta deposits in the late central Paratethys. The new species is represented only by a few isolated bones (tibiotarsus, ulna, radius). However, even if the osteological information is limited, a number of plesiomorphic features support the affiliation with *Borvocarbo*, but the new species is distinctly larger than both fossil species, ?*B. stoeffelensis* and *B. guilloti*. With this new record, the stratigraphical range of *Borvocarbo* extends from the Late Oligocene to Early Miocene of Europe.

A DIVERSITY OF STEM LINEAGE PENGUINS FROM THE LATEST CRETACEOUS TO EARLY PALEOCENE OF CHATHAM ISLAND, SW PACIFIC

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Laterally extensive, fossil-rich horizons are preserved in the Takatika Grit of the Tioriori Group, on the north shore of Chatham Island (Rekohu). This is one of only a few recorded formations in the Southern Hemisphere spanning the latest Cretaceous into the early Paleogene (ca. 75-64 Mya), with preserved macrofossil remains, including vertebrates, macroinvertebrates, palynomorphs, and Foraminifera. We report stem penguins from a richly fossiliferous layer exposed recently by changing tides and erosion. Two to four new species distinguished by size are represented by two partial skeletons and an isolated humerus and massive femur. Given the excellent preservation and association of remains, the bones were evidently covered quickly. Little else but bird remains is preserved in the most fossiliferous horizon, suggesting this site was a nesting or feeding ground. Proximity to the K/Pg boundary suggests also an association with the end-Cretaceous event, but ash layers adequate for more precise dating have not been found. The fossils have been dated by associated remains. Non-avian dinosaur remains are present both above and below the bird horizon. This find dates the fossil evidence for origin of the sphenisciform lineage to 64 - 66 Mya, several million years earlier than previously confirmed by associated remains.

THE COLIIFORM AFFINITIES OF *PALAEOSPIZA BELLA* AND A NEW MOUSEBIRD FROM THE GREEN RIVER FORMATION

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Palaeospiza bella was described as an oscine songbird in the late nineteenth century. The Eocene age of this fossil would make it the oldest Northern Hemisphere record of the Passeriformes. However, few later workers have accepted the placement of *Palaeospiza bella* within Passeriformes and the higher relationships of this fossil have remained controversial. Restudy of the holotype specimen reveals that *Palaeospiza bella* is a stem member of the Coliiformes (mousebirds) and represents the latest North American occurrence of a clade with an exclusively African extant distribution. A new fossil mousebird from the Eocene Green River Formation, represented by a nearly complete, articulated skeleton, is identified as another North American occurrence of Coliiformes. We undertook a new phylogenetic analysis of fossil and living Coliiformes based on a matrix including 51 morphological characters and 19 ingroup taxa. The results of this analysis place *Palaeospiza bella* in Colii, the clade comprising taxa more closely related to the crown clade Coliidae than to the extinct Sandcoleidae. The new Green River mousebird is identified as a second North American representative of Colii. This taxon demonstrates the co-occurrence of Colii and Sandcoleidae (represented by *Anneavis anneae*) in the Green River Formation. Phylogenetic results imply a minimum of three mousebird dispersals from Europe to North America occurred during the Early Cenozoic. At present, no fossil taxon can be confidently placed within the crown clade Coliidae.

RECONSTRUCTING THE HABITS OF *JEHOLORNIS PRIMA*

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The habits of *Jeholornis* are reconstructed based on measurements of pedal claw arcs, reexamination of the reversed hallux and statistic analysis of the major hindlimb bone proportion. The average curvature of the pedal claw of digit III in five specimens of *Jeholornis* is 113.1°, similar to that of extant perching birds. Since early avians were usually two dimensionally preserved, the recognition of the reversed hallux in the most basal birds, e.g., *Archaeopteryx* and *Jeholornis*, is often controversial. Our observation shows that during the evolution of a reversed hallux, the first phalanx of pedal digit I had undergone some morphological changes to enable the initial reversal of the hallux, prior to the medial rotation of metatarsal I as seen in most modern birds. The orientation of the phalanx I-1 is assumed to have contributed to the reversal of the hallux. Three-dimensional reconstruction method is also applied in the identification and reconstruction of the disputed orientation of the hallux in *Jeholornis*. By comparing the feet in various individuals of *Jeholornis*, we notice that the observed direction of the hallux seems to be related to the preservational process of the pedal digits to some extent. The hallux tends to be preserved as opposed in ventral view, but not opposed in dorsal view. We conclude that *Jeholornis* generally possessed a reversed hallux, though not well developed as in more advanced birds. Ternary diagrams are used to analyze the relative contribution of the three main segments (femur, tibiotarsus, tarsometatarsus) to the total hindlimb length in *Jeholornis* and other basal birds, indicating a pattern of progressively increased arboreality and change in locomotion style in early avian evolution. In conclusion, the above-mentioned evidence suggests that *Jeholornis* was arboreal or mainly arboreal in habit.

PHYLOGENETIC AND PALEOENVIRONMENTAL SIGNIFICANCE OF THE PASSERINE BIRDS FROM THE EARLY PLIOCENE OF LANGEBAANWEG, SOUTH AFRICA

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The site Langebaanweg is famous for is richness in vertebrate fossils. Intensive studies of the mammalian fossil record already allow detailed reconstructions of the paleoenvironment of the Western Cape 5 Million years ago – for a period of dramatic climate and ecological changes, i.e. decrease of forests contemporary with increasing aridity and spread of grasslands during the Miocene/Pliocene transition. The fossil record of birds are also exceptionally rich, but so far no morphological comparisons and systematic classifications of the Passeriformes of Langebaanweg were published leaving almost the total African pre-Pleistocene fossil record for these groups of birds virtually unexplored. Passeriform species, however, should have been particularly effected by the environmental changes during Miocene and Pliocene. Here I present the first results of my systematic analyses of as yet undescribed fossil specimens of passerine birds in the collections of South African Museum, Cape Town.

AN EXCEPTIONAL NEW AVIAN SPECIES WITH TUBERCLE-BEARING CERVICAL VERTEBRAE FROM THE MIDDLE EOCENE OF MESSEL (GERMANY)

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A new avian species is reported from the Middle Eocene of Messel in Germany, which is most unusual in that the cervical vertebrae of three of the five known specimens bear numerous bony tubercles. Such tubercles were also reported from another species from the Messel deposits, which is a representative of the extinct taxon Idiornithidae. Although the osteology of the new species is not known well enough for a definitive phylogenetic assignment, it clearly does not belong to the Idiornithidae. Compared to extant birds, it agrees with New World vultures (Cathartidae) in some skull features and in overall morphology of the wing skeleton, but distinctly differs in other characters, most notably the small skull and the morphology of the feet. Compared to other fossil taxa, the new species is most similar to the contemporaneous *Masillaraptor parvunguis* Mayr, 2006, which also occurs in Messel and whose phylogenetic affinities are likewise uncertain. The fact that vertebral tubercles are now known from two unrelated avian taxa supports previous assumptions, that these structures are of pathologic origin and possibly represent systemic disorders.

DATABASE COMPILATION OF AVIAN FOSSILS FROM NEOGENE LOCALITIES

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Many localities that are well known for mammalian fossil assemblages also contain fossil bird remains. The paleoecological and paleoclimatological interpretations of these localities might be refined by inclusion of avian taxa in faunal lists. Moreover, the compilation of avian taxa from these localities into a computer database could reveal significant patterns in diversity and spatial and temporal distribution of birds.

In order to test this concept, two Holocene localities in Iowa that were collected in the late 1970s by University of Iowa (UI) researchers and processed by screenwashing for micromammals were examined and found to contain fossils of small birds. Preliminary identification of these remains revealed two passerine birds and one small sandpiper (cf. *Calidris bairdii*). Baird's Sandpiper currently breeds far to the north, and the inclusion of this bird in the faunal list lends support to the periglacial interpretation of the locality.

Information regarding bird fossils from these and other Neogene localities will be entered into the FAUNMAP database (soon to be renamed NEOTOMA). The database is also being expanded from a concentration on North American mammalian taxa over the past 40,000 years to a global scope including multiple fossil groups (pollen, plant macrofossils, insects, reptiles, amphibians, and fish as well as birds) from the past 5 million years. As avian records are added to the database, additional questions regarding avian evolution, biogeography and extinction through the Pliocene, Pleistocene and Holocene will be formulated and addressed.

A NEW SPECIES OF GIANT MARABOU FROM LATE PLEISTOCENE DEPOSITS AT LIANG BUA, FLORES

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Liang Bua, a cave on the western part of Flores (Indonesia), received worldwide fame through the find of a new species of diminutive hominines, *Homo floresiensis* from Late Pleistocene deposits. The fauna associated with *H. floresiensis* includes *Stegodon florensis insularis*, the giant rat *Papagomys*, insectivores, Komodo dragons and birds. It represents a typical unbalanced endemic island fauna characterized by an absence of mammalian predators. Here we present the first description of Late Pleistocene avian fossils from Liang Bua representing a new species of extinct giant marabou, *Leptoptilos robustus* nov.sp. With an estimated weight of 16 kg and a height of 1.8m, this giant carnivorous bird is larger and more robust than any species of marabou living today, and towered over tiny *Homo floresiensis*. Its large size and thick bones point towards a limited ability to fly. Both the robustness and flightlessness of this giant marabou are adaptations to an insular environment, and emphasize the extraordinary nature of the *H. floresiensis* fauna. Moreover, our findings show that large-bodied insular birds do not decrease in body size, as is the case in insular mammals. Instead, they display an increase in body size in response to size changes of food items (large rodents and small *Stegodon*) in an unbalanced insular fauna. Carnivorous bird taxa in particular show a tendency for gigantism as they move into the empty niche of dominant predator.

THE LATE PLIOCENE AVIFAUNA OF AHL AL OUGHLAM, OROCCO

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The locality of Ahl al Oughlam, situated at the southeastern limit of the city of Casablanca (Morocco) at about 34° north, is dated by biochronology of its rich mammalian fauna at about 2.5 Ma. At the present time it is 6.5 km from the Atlantic Ocean but it was on the seashore at the time of the deposition of the fossil material. Among the seabirds are *Phoebastria anglica*, *Phoebastria* cf. *albatrus*, *Phoebastria* cf. *nigripes*, *Pelagornis* n. sp., *Calonectris* cf. *diomedea*, *Morus peninsularis*, *Morus* cf. *bassanus*, *Alca ausonia*. Among the landbirds are *Struthio asiaticus*, *Geronticus* n. sp., several Anseriformes, *Plioperdix* n. sp., several Otididae, *Agapornis* n. sp., *Tyto balearica*, *Tyto alba*, *Surnia robusta*, and a few unidentified Passeriformes. The recent species of albatrosses *P. albatrus* and *P. nigripes* live in the North Pacific but were also present in the North Atlantic until the Middle Pleistocene. Unlike the mammals, which include many genera in common with the African faunas, the land birds have more affinities with the Palaearctic region than with the Ethiopian region. They include several extinct genera or species which have been described, or identified, in the Pliocene of the Palaearctic region. This avifauna is very different from those which have been described in the Late Miocene and Pliocene of Central, Eastern, and Northern Africa. ***[poster]***

THE FOSSIL BIRDS AND OTHER EARLY CRETACEOUS VERTEBRATES FROM LIGHTNING RIDGE, NEW SOUTH WALES

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The Lightning Ridge opal-mining region of New South Wales has produced vertebrate, invertebrate and plant fossils for over 100 years. Most of these fossils are recovered as opalised pseudomorphs or casts of the original fossil bones. Lightning Ridge sediments are part of the Early Cretaceous (middle Albian) Griman Creek Formation, representing an estuarine/freshwater depositional environment near the epicontinental Eromanga Sea. Here we review probable avian remains from Lightning Ridge described by Ralph Molnar and put these into the context of the site's terrestrial vertebrate assemblage. Four fragmentary?avian tibiotarsi and an incomplete vertebral centrum have been recovered. Two distal tibiotarsi may represent archaic, crow-sized, non-enantiornithine birds. These elements exhibit morphologies seen in some diving birds but have unique features suggesting that they may be Australian endemics. A third distal tibiotarsus is larger in size but is too poorly prepared to allow confident identification, as is a proximal tibiotarsus. A partial vertebral centrum resembles that of the gull-like *Ichthyornis* (otherwise known only from the Late Cretaceous of Kansas); alternatively, it may be that of an advanced non-avian theropod. Other Early Cretaceous avian fossils from Australia include a small enantiornithine, *Nanantius eos* from the Early Cretaceous of Queensland, and three feathers from Koonwarra, Victoria. These discoveries suggest that birds were diverse and widely distributed in the Early Cretaceous of Australia and are globally significant because of the general rarity of Early Cretaceous birds (skeletal remains are otherwise restricted to Eurasia)[1]. These Lightning Ridge birds may have occupied piscivorous or diving niches. Plant fossils (primarily araucarian conifers) suggest a forested environment, and invertebrate fossils (freshwater crayfish, bivalve molluscs and gastropods) are indicative of freshwater and/or estuarine waterbodies. Other vertebrate taxa comprising the Lightning Ridge Local Fauna include teleosts; ceratodontid lungfish; small crocodilians; turtles; non-avian theropod, sauropod and ornithopod dinosaurs; and two types of possibly semi-aquatic mammals, an assemblage that supports the interpretation of the palaeoecological environment of Lightning Ridge.

NEW MATERIAL OF THE DROMORNITHID *BARAWERTORNIS TEDFORDI* FROM THE OLIGO-MIOCENE OF AUSTRALIA

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Barawertornis tedfordi is one of the oldest and least known members of the Dromornithidae, an extinct family of large flightless birds from the Tertiary and Pleistocene of Australia. Based on fragmentary and anatomically limited remains, previous phylogenetic studies of this family have placed *B. tedfordi* as the sister group to all other dromornithids.

New fossil material of *B. tedfordi* from Riversleigh, northwestern Queensland described here provides a sounder basis for understanding this enigmatic dromornithid. Phylogenetic analysis of this material challenges the generally accepted sister group relationship between *B. tedfordi* and all other dromornithids, with the precise phylogenetic position of *B. tedfordi* unresolved. However, the intrafamilial relationships among the other dromornithid taxa are consistent with previous studies. A formal revision of dromornithid nomenclature that reflects these relationships is presented here.

B. tedfordi is similar in size to the unrelated Southern Cassowary, *Casuarius casuarius.* Like the Southern Cassowary, it may have been a rainforest dweller that exhibited similar cursorial abilities. A tooth puncture wound and transverse gouges in the fossil material suggests that *B. tedfordi* may have been preyed upon by crocodiles or scavengers.

A PRELIMINARY STUDY OF THE PASSERIFORMES FROM THE TERTIARY OF AUSTRALIA

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The Passeriformes is the most specious order of birds, comprising about 60% of all extant avian species. These birds were traditionally thought to have originated in the northern hemisphere, before spreading to Australasia. However, the lack of passerines in extensive early Tertiary avifaunas in the north has led to the proposal that passerines originated in the southern hemisphere. Molecular studies also suggest that passerines arose on the Australian continental plate, and then dispersed north. The Australian fossil record of passerines can thus provide additional insight into the biogeographical history of this order.

One of the richest Tertiary sites in Australia for passerine material is the Riversleigh World Heritage Area, northwestern Queensland. Numerous remains of passerines have been recovered from fossil sites at Riversleigh, dating from the late Oligocene to the Pliocene, but have not been examined in detail. This preliminary study aims to describe passerine material from Riversleigh and other Australian sites. Morphological information from this material will be used to analyse the phylogenetic relationships among Australian passerines. ***[poster]***

SKULL MORPHOLOGY OF ENANTIORNITHES (AVES: ORNITHOTHORACES)

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Enantiornithines are the most specious avian clade in the Mesozoic, however with less than half of known taxa preserving skull material, our understanding of their cranial morphology remains incomplete. Here we present a comprehensive overview of the current knowledge of enantiornithine skull anatomy and discuss the range of morphologies known for the main cranial elements. The typical enantiornithine skull retains numerous ancestral features such as the lack of fusion among bones, the presence of a postorbital, a primitive quadrate, an unforked dentary, and teeth. The rostrum is well known and shows considerable variation; the premaxilla varies in degree of fusion and the relative lengths of the nasal and maxillary processes. The nasals range from broad to narrow, with the maxillary process reduced or absent. The relative lengths of the premaxillary, jugal, and nasal processes of the maxilla vary considerably; in no taxa is a second accessory maxillary fenestra known. The bones of the braincase are typically unfused. The foramen magnum in all taxa in which preserved is directed caudally, not ventrally. Typically the dentaries are incompletely fused rostrally, and the lower jaw is imperforate. Enantiornithine teeth show considerable diversity in numbers, size, morphology and placement ranging from taxa with large teeth found throughout the jaws to taxa with small, anteriorly restricted teeth to the fully edentulous. Despite limited preservation of skull material, a number of trophic specializations can be deduced from the range of preserved morphologies further hinting at the diversity of the Cretaceous Enantiornithes.

INDEPENDENT EVOLUTION OF FLIGHTLESS PALAEOGNATHS FOLLOWED THE EXTINCTION OF DINOSAURS

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Ratites are widely believed to have a flightless common ancestor that evolved on Gondwana and which dispersed largely in concert with the final break-up of that supercontinent during the mid-late Cretaceous (≈100-65 million years ago). Here we report from moa, the first long (3.4 kilobases) avian ancient nuclear DNA sequences. Phylogenetic analyses of *Rag*1 and *cmos* plus mitochondrial genomes from moa and members of each extant ratite family (ostrich, rhea, emu, cassowary and kiwi) conclusively group moa with tinamous, which were thought to have been the flying sister group of all ratites. This tinamous-moa grouping is nested well within ratites, which considered alongside our molecular dating estimates suggests that large size and loss of flight occurred several times in temporally close association with the Cretaceous-Tertiary extinction event (65 million years ago). Flight can explain anomalies with the vicariance model for ratite dispersal, while niche-filling associated with the extinction of cursorial, herbivorous/omnivorous dinosaurs, such as ornithomimids is consistent with independent losses of flight among ratites.

USING NEOTAPHONOMIC OBSERVATIONS TO UNDERSTAND PLIO-PLEISTOCENE FOSSIL BIRD BONE ASSEMBLAGES AT OLDUVAI GORGE, TANZANIA

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Current taphonomic analyses of fossil avifaunal assemblages are limited by a paucity of neotaphonomic information on bird bone preservation. Analyses instead typically rely on data either from neotaphonomic studies of mammalian bone assemblages or from interpretations of patterning seen at other fossil avifaunal sites. This can lead to misdiagnoses of the cause of death and other processes involved in assemblage formation. Likewise, reliance on taxonomic profiles in the absence of taphonomic analysis may result in the misinterpretation of the paleoenvironmental setting in which the bird bone accumulated. This study looks at one commonly explored pattern observed in fossil avifaunal accumulations: the apparent bias towards wing bone survivorship. Controlled neotaphonomic observations of carnivores feeding on bird carcasses, bird bone exposed to subaerial weathering for a known period of time, and taphonomic data on modern bird bone accumulations, are used to derive expected trends in the differential survivorship of avian skeletal elements. Results are then applied to a fossil bird assemblage from a single stratigraphic horizon (Olduvai Hominin 56 level) at DK, a middle Bed I site (~1.85Ma) at Olduvai Gorge, Tanzania. This assemblage (NISP = 435) includes 165 specimens of the limb bone elements most commonly used in the study of wing abundance. It shows an abundance of wings over leg elements from taxa representing a wide range of body sizes. Fragmentation is low, with many elements retaining at least one epiphysis to allow for later taxonomic identification. Surface preservation is excellent, retaining marks made by a range of taphonomic agents including carnivores. These factors make the OH56 assemblage ideal to test the effects of taphonomic agents on differential skeletal part representation for fossil birds using data collected from neotaphonomic observations.

PHYLOGEOGRAPHY OF THE EXTINCT NEW ZEALAND MOA *PACHYORNIS*: INSIGHTS FROM ANCIENT DNA AND MORPHOLOGY

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Geological factors and climate mediated habitat change can have significant effects on the phylogeography of a species. Using data from ancient DNA, we show how geological and climate changes have affected the phylogeography of the three species within the extinct New Zealand moa genus *Pachyornis*. The results indicate that there is significant phylogeographic structuring within North Island's Mappin's moa (*P. geranoides*) and the South Island heavy footed moa (*P. elephantopus*), but not in crested moa (*P. australis*). The causes of the phylogeographic structuring are hypothesized to be the impact of volcanism on preferred habitat for *P. geranoides*. In South Island, barriers to dispersal, in the form of the Clutha River and associated mountain barriers, resulted in dichotomous clades for for *P. elephantopus* being present in the Holocene along the eastern regions Large *Pachyornis* bones of Otiran glaciation (last glacial maximum) age in North West Nelson/West Coast regions have previously been explained as range expansion of *P. elephantopus* into shrubland habitats during the glacial period. However, we show that such bones are *P. australis*. The resultant non-overlapping bimodal size distribution of *P. australis* bones is explained by sexual dimorphism, as it is in *P. mappini*. There is no phylogeographic structure in haplotype diversity of *P. australis* over its range in West Coast – northwest Nelson, but more southern specimens are not available for analysis.

A HERON (ARDEIDAE: AVES) FROM THE MIOCENE OF SOUTHERN NEW ZEALAND

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Here we describe a proximal coracoid, an almost entire tarsometatarsus, two quadrates and an axis vertebra of an ardeid from Saint Bathans in northern Central Otago, New Zealand from strata in the Bannockburn Formation of the Manuherikia Group which is considered to be early Miocene (ca. 19-16 mya). We present phylogenetic parsimony analyses that show that this heron is basal to most living subfamilies of Ardeidae and has plesiomorphic features formerly considered diagnostic of Nycticoracinae, Tigrisomatinae and Botaurinae. We discuss whether the traditionally accepted subfamilies of Ardeidae are useful and suggest an alternative taxonomy.

FOSSIL EVIDENCE OF MOA IN THE EARLY MIOCENE AND ITS IMPLICATIONS FOR NEW ZEALAND'S 'OLIGOCENE DROWNING'

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From the Late Oligocene to the Early Miocene (about 26-23 MYA), the New Zealand continent (Zealandia) was largely submerged. Differing theories suggest that either all land was drowned, causing the total extinction of the terrestrial fauna and flora, or that some land remained but the reduced area resulted in a genetic bottleneck for some surviving lineages. Fossil remains from the Early Miocene (19-16 MYA) at St Bathans in southern New Zealand, indicate that ratites (assumed to be ancestors of the recently extinct flightless moa (Dinornithiformes)), were present perhaps only 4 million years after this drowning event. Thick eggshell and fragmentary bones suggest that these Miocene ratites were already very large and probably flightless. Until work at St Bathans, the oldest known moa fossils were only 2.5 million years old. Kiwi (Apterygiformes), the other lineage of New Zealand ratites, have a fossil record still restricted to the last 1 million years. The Miocene ratite fossils, together with other vertebrate remains, support the idea that an emergent landmass was present throughout the Oligocene and Miocene.

AVIFAUNAL RESPONSES TO INTERGLACIAL HIGH TEMPERATURES

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The possible effect on avifaunas of a hypothetical future warmer climate has recently caused much speculation, usually ill-founded. On the other hand the actual effects of past warmer interglacials on avifaunas have strangely enough attracted no interest. This paper is an effort to remedy this, by reviewing the avifaunas of the previous interglacial (MIS 5e, 117-130 Ka BP). This interglacial was significantly warmer than the present one, about 2° C in the North Temperate zone and 5° C or more in the Arctic, and may have been the warmest interval since the Pliocene.

Most of the known Last Interglacial avifaunas are from the temperate parts of North America and Europe. The scarcity of avifaunas from other areas is due both to a scarcity of Pleistocene avifaunas in general and to rudimentary quaternary chronologies which makes it difficult to date faunas older than the last glaciation. In North America the largest materials are from California and Florida. The Californian faunas are similar to modern faunas, both for seabirds and land birds, while the Floridian faunas contain a number of extralimital Central- and South American species. A small fauna from Arctic Canada (Old Crow Basin) is also similar to modern faunas. In Europe several faunas from Central Europe show few differences when compared to extant faunas in the same areas, while faunas from Great Britain contain some southern (Iberian) species. Material from the southern hemisphere is very limited, and consists of one small fauna from each Argentina and New Zealand. Both are similar to modern faunas from the same areas.

The only Last Interglacial avifauna that shows dramatic differences from present-day conditions is from southwestern Egypt. This area is now extreme desert but had a rich afrotropical avifauna during the Last Interglacial, presumably due to a northward expansion of the African Monsoon. In general it seems that a temperature rise in the order of two degrees does not have a very dramatic impact on temperate avifaunas, while in the tropics changes in precipitation patterns may be more important than temperatures.

THE EOCENE AVIFAUNA OF THE GREEN RIVER FORMATION

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Fossil birds from the Lower Eocene Green River Formation (USA) are described. Ten additional specimens of *Messelornis nearctica* (Messelornithidae) are reported. New species include a fossil swift, which is tentatively referred to the Apodidae due to characters of the wing, especially the position of the processus musculi extensor metacarpi radialis. It is one of only a few complete fossil apodiform skeletons, including feather preservation. Furthermore, two species of the Primoscenidae are described, which both exhibit the zygodactyl foot and the large processus intermetacarpalis of the carpometacarpus typical for the primoscenids. Further members of the Green River avifauna include two species of putative Leptosomidae, a member of the Primobucconidae, a stem-group representative of Galliformes, a fossil eurypygid species as well as "caprimulgiform" birds and a possible trogon.

THE OLIGOCENE–PLIOCENE FOSSIL RECORD OF WATERFOWL (ANSERIFORMES: ANATIDAE, ANSERANATIDAE) IN AUSTRALIA

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The Tertiary record of Anseriformes, excluding Dromornithidae, in Australia is reviewed. Temporal coverage is restricted to the Late Oligocene – Miocene and Pliocene periods with most Oligo-Miocene fossil anseriforms derived from the Lake Eyre Basin, South Australia, Etadunna and Namba Formations (26-24 Ma). Sixty-one identifiably anseriform fossils reveal a new anatid genus containing three new species and a new genus and species of tadornine. A phylogenetic analysis of the three non-tadornines reveal them to be basal oxyurines. The palaeontologically rich karstic deposits in Riversleigh have provided few anseriforms, but notably, a Faunal Zone A (Late Oligocene) site contains an anseranatid closer to *Anseranas* than to those of equivalent age in the Northern Hemisphere. A single mid-Miocene (*c.* 8 Ma) site, Alcoota, has just three bones of anseriforms other than dromornithids, but they reveal another undescribed tadornine and a small indeterminate anatid. The Pliocene fauna derived from the Lake Eyre Basin, Tirari Formation (Kanunka, Toolapinna faunas) is described. It contains nine modern anseriforms and one extinct oxyurine taxon. Taken with other described Pliocene faunas (Chinchilla, Bluff Downs), these data show that the modern waterfowl fauna was established by the Pliocene, suggesting that major faunal turnover took place in the late Miocene.

FIRST RECORD OF *PALAELODUS* FROM NEW ZEALAND

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The Lower Bannockburn Formation, Manuherikia Group, of Central Otago, New Zealand has in recent years produced a very rich fossil avifauna termed the St. Bathans Fauna. Over 30 taxa of birds are now known from this fauna which is considered to be of early Miocene age (19-16 mya). Here we report the first occurrence of a palaelodid (Aves: Palaelodidae), based on a distal tibiotarsus, and compare it to Australian taxa.

EARLY ADAPTIVE RADIATION OF BIRDS: EVIDENCE FROM THE LOWER CRETACEOUS OF CHINA

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The earliest avian radiation has been well documented by the extreme discoveries of well preserved birds from the Lower Cretaceous of Liaoning, northeast China. In addition to significant taxonomic and morphological differentiations, the Chiense materials have also shown great variations in body size, flight, locomotion, diet and ecological nich. The Chinese Early Cretaceous birds comprise mainly basal enantiornithines, basal ornithurines and a number of more basal taxa that are only slighly more derived than *Archaeopteryx*. Although a general body size decrease is observed among the evolution of Early Cretaceous birds, possibly related to the the initial acquirement of flight, size increase also seemed common among various groups, particular in Ornithurae, correponding to a near modern flight capability and near shore adaptation. Early Cretaceous birds are predominantly arboreal or scansorial as descended from their Jurassic ancestors, and adapted well to the environment of flourishng forests in the warm Early Cretaceous. As a result, some of them became herbivores or specialized seed-eaters, and many others were probably insectivorous or omnivorous, Although some enantiornithines are shown to be fish-eaters by dwelling in trees near the lake, only ornithurines became specialized ground-dweller, well adapted to niches near the lake shore. The early evolution of birds in the Early Cretaceous of China was accompanied by an equally significant radiation of dinosaurs and pterosaurs, and these three vertebrate groups constitute the major competitors at the top of the food chain of the paleoecosystem. The success of the early avian radiation in the Early Cretaceous of China benefitted from both the rich food chain in the bottom and middle of the Jehol ecosystem, and the competitions among vertebrates including birds, dinosaurs, pterosaurs and mammals.

EARLIEST GONDWANAN BIRD FROM THE CRETACEOUS OF SOUTHEASTERN AUSTRALIA

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Our knowledge of Mesozoic bird evolution in Laurasia has advanced rapidly in recent years, fuelled by discoveries at rich sites in China and Spain. The avian Gondwanan record, however, remains sparse, and almost exclusively restricted to the Late Cretaceous (Chiappe, 1996; Dalla Vecchia and Chiappe, 2002). In fact, only a handful of sites in eastern Australia have produced osteological remains dating from the Early Cretaceous. These Australian localities have yielded a small number of isolated elements; the Albian (Early Cretaceous) Toolebuc Formation in western Queensland yielded the tibiotarsus of an enantiornithine, Nanantius eos, along with an additional tibiotarsus and a vertebra (Molnar, 1986; Kurochkin and Molnar, 1997). Further fragmentary material representing Enantiornithes and possibly Ichthyornithiformes comes from the near-contemporaneous Griman Creek Formation of Lightning Ridge, New South Wales (Molnar, 1999). New avian material from the austral supercontinent, therefore, has significant potential to shed light on the evolution of birds in Gondwana, and is critical for testing recent hypotheses on the evolution of crown clade Aves (Cracraft, 2001). Here we describe an avian furcula from Aptian (Early Cretaceous) sediments of coastal Victoria that represents the oldest osteological evidence for birds in Australia, and Gondwana as a whole. Aside from a few small feather impressions found at Koonwarra, Victoria (Vickers-Rich, 1991), Mesozoic birds have, until now, been unknown from southeastern Australia. The new element shares several synapomorphies with Enantiornithes, and thus expands the geographic and temporal range of that clade. This would appear to strengthen the current view that Gondwanan avian assemblages were dominated in the Early Cretaceous by more primitive forms (Molnar, 1986; Kurochkin and Molnar, 1997; Molnar, 1999), a picture at odds with current hypotheses (e.g., that of Cracraft, 2001) placing the origin of Neornithes in the southern supercontinent during this period.