The Evolution and Phylogeny of Early Telluraves ("Land Birds")

Mhairi Lesley Reid



Department of Earth Sciences
Kellogg College
University of Oxford

A thesis submitted for the degree of
Doctor of Philosophy
Trinity 2025

Supervised by: Prof. Roger B. J. Benson

Declaration

The contents of this thesis are all my own work, except where otherwise stated. The views and opinions expressed herein are mine and not necessarily those of any other person or body unless so attributed.

Mhairi L. Reid

Abstract

Telluraves (landbirds) are a clade of birds defined by their arboreality and contain some of the most species-rich avian groups. Although recent phylogenomic analyses have clarified the interrelationships among crown-group birds, the results of these studies show notable incongruities with each other and with morphology-based hypotheses, raising questions about the affinities of key fossil groups, and their implications for bird evolution. Furthermore, existing morphological datasets for telluravian birds are frequently limited by restricted taxon or character sampling, inconsistent character construction, or a combination of several of these factors. The objective of my research is to establish a new and comprehensive morphological dataset for extant Telluravian taxa in order to test core hypotheses of early telluravian evolution and the factors underlying their early evolution. My approach aims to address the following questions: (1) Are morphological data adequate to robustly resolve deep phylogenetic divergences within Telluraves? (2) Are the topologies supported by these data congruent with previous hypotheses based on morphological or molecular signals, or neither? (3) Do fossil taxa have a significant impact on the topology, potentially reconciling morphological and molecular signals? And (4) what does phylogenetic analysis of morphological data, constrained by a molecular backbone topology, suggest about the affinities of extinct groups? In this thesis I reviewed all previously published characters relevant to relationships of living and fossil Telluraves and provided a more complete scoring of morphological data using high-resolution μCT data of extant birds, combined with the study of key fossil taxa. The new dataset is comprised of 550 characters, of which 328 are new and were scored for 57 extant avian taxa and 50 telluravian Palaeogene fossils. The analyses were run using both maximum parsimony and Bayesian inference. Three different analyses were performed: Analysis A1 included extant taxa only and was left unconstrained; Analysis A2 included both extant and fossil taxa, left unconstrained; Analysis A3 included both extant and fossil taxa constrained by molecular scaffolds. Additional tests on the dataset were also performed in which I evaluated the effect of

alternative outgroup choices and the effect of removing “raptorial” characters from the dataset. The morphological data successfully recovered many of the intra-clade relationships within orders, including within Accipitriformes, Falconiformes, Psittaciformes, and Passeriformes, with topologies closely mirroring those from molecular studies. However, my results affirm that morphological data for living species significantly rejects current molecular phylogenetic hypotheses of the deeper inter-relationships among Telluraves, suggesting substantial morphological homoplasy during the early evolution of the group. Morphological analyses alone often recover a “raptorial” clade (Accipitriformes, Falconiformes, Strigiformes) inconsistent with molecular phylogenies, reflecting convergence in predatory adaptations. The inclusion of fossil taxa improves resolution, particularly supporting the monophyly of Psittacopasseres (parrots + passerines) and the ancestral presence of a zygodactyl foot condition. Molecularly constrained analyses further refine fossil placements, though some uncertainty remains, particularly among early pan-Psittaciformes. Overall, my work highlights the critical role of fossils in bridging morphological and molecular data, providing new insights into the evolutionary history and early diversification of Telluraves.

Acknowledgements

Firstly, I would like to express my deepest gratitude to my supervisor Roger Benson, who has the most unique way of looking at things and has a surprising number of nuggets of wisdom to give. Thank you for always being enthusiastic on hearing my latest bird fact at each meeting.

I would like to thank all the curators and museum-affiliated researchers who helped make this work possible: Judith White at the NHM Tring, Krister Smith at the Senchenberg Nature Museum, Susie Maidment at the NHM London, Matthew Miller and Helen James at the Smithsonian, Laura Vietti and Whiteney Worrell at UW in Laramie, Jennifer Alexander at the Wyoming State Museum, Cheyenne, Levi Shinkle at the Wyoming Dinosaur Centre… oh and I almost forgot, Roger Benson at the AMNH. And finally, my biggest thanks go to Arvid Aase, at the Fossil Butte National Monument, thank you for letting us into your home and hosting us in Wyoming, it was truly an unforgettable experience.

Thank you to Stuart Robinson (and Ronny) for all the fun undergraduate sedimentary practicals and field work, without which I would have honestly gone crazy due to having zero actual rocks to look at in my thesis.

To everyone in the “Benson lab logo” group chat – Duhita, Ben and Stephanie, and to my office mates Alice, Gawain and Bridgit, it has been a wonderful experience sharing all the ups and downs of this journey and you have all made it a little easier.

Thank you to my family for their unquestionable support through my many many years of studies, and never really knowing what I actually do other than looking at rocks (wait until they read this thesis though).

And finally, Kevin – I do not know how to adequately express the gratitude I feel towards your endless love and support. Even when I was feeling down on all things bird, you decided to pick up bird photography to join in on all things bird with me. This thesis would not have been possible without you.

Table of Contents

Declaration ..... **i**

Abstract ..... **ii**

Acknowledgements ..... **iv**

..... **1**

Chapter 1 An Introduction to Telluraves and Their Evolutionary History **2**

1.1. A brief history of morphological classification of groups now included in Telluraves 6
1.1.2 The contribution of morphology to the phylogenetic classification of Telluraves *9*

1.2. Current knowledge of Telluraves intrarelationships: the uncertainty within core landbirds 12
1.2.1 Telluraves monophyly *12*
1.2.2 Afroaves *16*
1.2.3 Australaves *20*

1.3 Overview of the Palaeogene fossil record and their phylogenetic affinities. 25
1.3.1 Stem members of Afroaves *26*
1.3.1 Stem members of Australaves *31*

1.4 Aims and objectives 37

Chapter 2 Morphological Character Dataset **41**

2.1 Introductory note 41

2.2 Compiling previous morphological character datasets 41

2.2 Character coding 43

2.4 Extant taxon sampling 46

2.5 The character list 47

Chapter 3 The Phylogenetic Inter-relationships of Telluraves **265**

3.1 Introduction 265

3.2 Methods 267
3.2.1 Taxon list *267*
3.2.2 Character list & Data matrix *273*
3.2.3 Phylogenetic analyses *274*
3.2.4 Assessing the impact of ordered characters *278*
3.2.5 Assessing the impact of outgroup selection *278*
3.2.6 Assessing alternative hypotheses using statistical tests *280*
3.2.7 Assessing the phylogenetic influence of raptorial characters *282*

3.3 Results 285
3.3.1 Analysis 1: extant taxa only, unconstrained *285*
3.3.2 Analysis 2: combined extant and extinct taxa, unconstrained *296*
3.3.3 Analysis 3: combined extant and extinct taxa, constrained *308*
3.3.4 Outgroup selection tests *326*
3.3.5 Tree topology tests *328*
3.3.6 Excluding "raptorial" characters *330*

3.4 Discussion 331
3.4.1. The significant homoplasy within Telluraves *331*
3.4.2 Higher-level synapomorphies of Telluraves *335*

Chapter 4 Conclusions and future research **349**

4.0 Synthesis of Research Aims 349

4.1 Discrepancy between intra- and inter-clade relationships 350

4.2 Convergent raptoriality in Telluraves 352

4.3 Future considerations 359
Appendix 1 Supplementary tables and figures 390
Appendix 2 Anatomical features referenced within this study 413
Appendix 3 Character/taxon matrix, PAUP*/MrBayes scripts and character optimisation for all analyses 423
Appendix 4 List of characters not included in present study. 534



Southern double-collared sunbird (Cinnyris chalybeus), Kirstenbosch National Botanical Garden, Western Cape, South Africa. Photo by Kevin S. Olsen with bird-guide Mhairi Reid.

Chapter 1 An Introduction to Telluraves and Their Evolutionary History

Telluraves or "core landbirds" are a speciose, monophyletic group of predominantly arboreal and terrestrial birds, which belong to the hyperdiverse clade Neoaves (Hackett *et al.* 2008; Yuri *et al.* 2013) (Fig. 1.1). Telluraves comprises taxa from 12 orders: **Accipitriformes**, diurnal raptors that include the New World vultures (Cathartidae), the secretary bird (Sagittariidae), ospreys (Pandionidae), hawks, eagles, and kites (Accipitridae); **Strigiformes**, nocturnal predators that include barn owls (Tytonidae) and true owls (Strigidae); **Coliiformes**, containing only one family restricted to sub-Sahara Africa, the mousebirds (Coliidae); **Leptosomiformes,** an endemic Madagascan order only containing one species in its own family, the cuckoo-roller (*Leptosomus discolor*); **Trogoniformes**, containing one family found in tropical and subtropical forests around the world, the trogons (Trogonidae); **Bucerotiformes**, containing three families that are found primarily in the Old World tropics, hornbills (Bucerotidae), hoopoes (Upupidae) and woodhoopoes (Phoeniculidae); **Coraciiformes**, a diverse order of brightly coloured birds that are found worldwide, bee-eaters (Meropidae), rollers (Coraciidae), ground rollers (Brachypteraciidae), todies (Todidae), motmots (Momotidae) and kingfishers (Alcedinidae); **Piciformes**, containing nine families that are found in a wide variety habits, e.g., jacamars (Galbulidae), honeyguides (Indicatoridae), woodpeckers (Picidae) and toucans (Ramphastidae); **Cariamiformes**, containing only one family found in central South America, the seriemas (Cariamidae); **Falconiformes**, containing one family, the falcons and caracaras (Falconidae); **Psittaciformes**, containing three families that are mostly restricted to tropical and subtropical regions, the New Zealand parrots (Strigopidae), cockatoos (Cacatuidae) and parrots (Psittacidae); and finally, **Passeriformes**, a huge order of 137 families, including more than half the bird species in the world, that can be divided into three suborders, New Zealand wrens (Acanthisitti), suboscines (Tyranni), and oscines or songbirds (Passeri). Members of Telluraves exhibit extensive

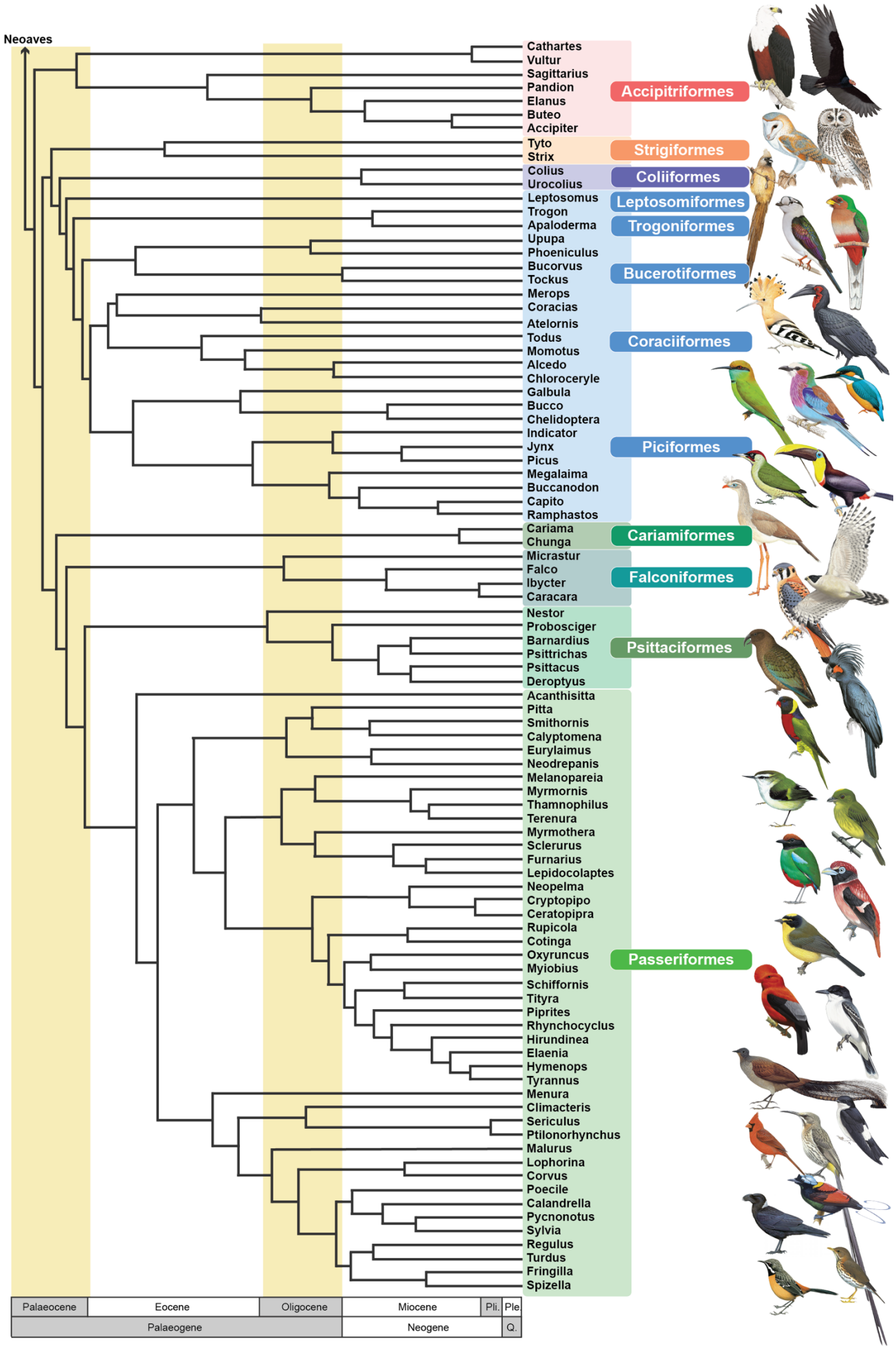
ecological versatility, occupying a wide range of habitats around the world. Their ability to adapt to a variety of ecological niches is evident in their specialised morphologies and behaviours. For instance, advanced vocalisation and song-learning in oscines (songbirds) (e.g., Opaev 2022), the specialised feeding behaviours in Picidae (woodpeckers) (e.g., Jung *et al.* 2019), the grasping abilities of the zygodactyl foot in Psittaciformes (parrots) (e.g., Dickinson *et al.* 2024), the adaptation to predation by large claws and strong feet in Accipitridae (hawks, eagles and kites) (e.g., Ward *et al.* 2002), or the high-speed, high-altitude attack strategy of Falconidae (falcons) (e.g., Tucker 1998).

Over the last 20 years, fossil discoveries and molecular clock analyses have provided strong evidence that the earliest known stem-group representatives of extant Neoaves orders most likely first appeared in the Paleocene (66 Ma to 56 Ma), a crucial time period for understanding the history of diversification of birds (Yuri *et al.* 2013; Jarvis *et al.* 2014; Prum *et al.* 2015; Kuhl *et al.* 2021; Mayr 2022a; Stiller *et al.* 2024) (Fig. 1.1). By the early-to-middle Eocene (approx. 55-37 Ma), the fossil record of modern birds (Neornithes) is well represented and abundant (Mayr 2022a). Among Telluraves, fossils that are clearly assignable to crown group orders and their stem lineages for example stem-Coliiformes (Ksepka *et al.* 2017), stem-Cariamiformes (Mayr 2016), stem-Falconiformes (Mayr & Kitchener 2022), stem-Psittaciformes and stem-Passeriformes (Smith *et al.* 2018), generally date to the Palaeocene and Eocene epochs, and fossils assignable to the crown groups of living orders, including members of extant families and genera mostly appear by the Oligocene Epoch (33.9-23 Ma). The considerable diversity of stem group representatives present in the Palaeogene most likely resulted from a rapid evolutionary diversification, which filled the many vacant ecological niches after the Cretaceous-Paleogene (K-Pg) extinction event 66 million years ago (Feduccia 2003; Field *et al.* 2018). Climate change throughout the Eocene and cooling during the middle Eocene–Oligocene are may also have played a major role (Lindow & Dyke 2006; Mayr 2011b). It is clear that the Eocene was an important time for bird evolution, and that the bird fossils from this time are abundant, diverse and well-preserved (e.g., London Clay Formation, UK; Messel Formation, Germany; Fur Formation,

Denmark, and Green River Formation, USA). Nevertheless, the identities of many specimens and the affinities of these species, in general, remain controversial and poorly understood, particularly for less complete remains. New fossils are continuously being found and described from localities around the world, many of which have not been included into phylogenetic analyses yet.

Despite a relatively intensive research focus on extant and extinct birds, there are still many questions relating to their early evolutionary history, particularly the affinities of extinct, fossil groups with distinct ecomorphologies, their implications for the evolution of ecological traits, and the extent to which morphological character states support key nodes in the molecular phylogeny of Telluraves. Many parts of the tree remain poorly resolved, notably for the deep intrarelationships of Telluraves with no clear synapomorphies uniting these bird clades.

Figure 1.1. Phylogeny of Telluraves. Redrawn from Prum *et al.* (2015), time-calibrated phylogeny from a concatenated, Bayesian analysis. Background colours mark geological periods; Pli, Pliocene; Ple, Pleistocene. Illustrations of representative bird species are depicted by their linages, sourced from Birds of the World (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.


Neoaves
Cathartes
Vultur
Sagittarius
Pandion
Elanus
Buteo
Accipiter
Accipitriformes
Tyto
Strix
Strigiformes
Colius
Urocolius
Coliiformes
Leptosomus
Leptosomiformes
Trogon
Apaloderma
Trogoniformes
Upupa
Phoeniculus
Bucorvus
Tockus
Bucerotiformes
Merops
Coracias
Atelornis
Todus
Momotus
Coraciiformes
Alcedo
Chloroceryle
Galbula
Bucco
Chelidoptera
Indicator
Jynx
Picus
Megalaima
Buccanodon
Capito
Ramphastos
Piciformes
Cariama
Chunga
Cariamiformes
Micrastur
Falco
Ibycter
Caracara
Falconiformes
Nestor
Prosobsciger
Barnardius
Psittrichas
Psittacus
Deroptyus
Psittaciformes
Acanthisitta
Pitta
Smithornis
Calyptomena
Eurylaimus
Neodrepanis
Melanopareia
Myrmornis
Thamnophilus
Terenura
Myrmothera
Sclerurus
Furnarius
Lepidocolaptes
Neopelma
Cryptopipo
Ceratopipra
Rupicola
Cotinga
Oxyruncus
Myiobius
Schiffornis
Tityra
Piprites
Rhynchocyclus
Hirundinea
Elaenia
Hymenops
Tyrannus
Menura
Climacteris
Sericulus
Ptilonorhynchus
Malurus
Lophorina
Corvus
Poecile
Calandrella
Pycnonotus
Sylvia
Regulus
Turdus
Fringilla
Spizella
Passeriformes
Palaeocene
Eocene
Oligocene
Miocene
Pli.
Ple.
Palaeogene
Neogene
Q.

1.1. A brief history of morphological classification of groups now included in Telluraves

Many classical morphological works attempted to understand bird interrelationships, before the molecular phylogenetic revolution of the early 2000s. These efforts, which began in the 19th century, relied on morphological traits without explicit evolutionary hypotheses, but were quick to embrace Darwinism, a search for evidence of common ancestry, and the recognition of convergent evolution. Homology became the guiding principle for character evaluation, with internal structures like the skeleton and musculature providing the most reliable genealogical information. *Classification of Birds* by Huxley (1867) exemplifies this shift. In this work, Huxley recognized the close relationships of Cathartidae (New World vultures) and Accipitridae (though acknowledged they had morphological differences), grouping them within the traditional "Falconiformes" ("Aetomorphae"), which included Accipitridae, Falconidae and Strigidae. This grouping was based on a number of morphological characteristics but mainly on "raptorial" features such as forward-facing eyes, hooked beak, strong grasping feet and long talons. Furthermore, Huxley recognised the close relationships among many of the Coraciimorphae ("Coccygomorphae"), uniting both "Falconiformes", "Coccygomorphae" and "Psittacomorphae" (Psittaciformes) under the "suborder" "Desmognathae", based on a number of morphological characteristics of the palate structures, sternum and toe arrangements (zygodactyl foot condition). Several birds that are not now considered as being related to these taxa were also included in this "suborder" including Anseriformes (waterfowl), Pelecanimorphae (storks and allies) and Cuculiformes (cuckoos). Passeriformes were recognised as a separate order based on their unique palate structures, sternum and the hypotarsus. Psittaciformes were also at this time recognised as a separate order due to their highly apomorphic morphology but did not place them close to other Telluraves.

Garrod (1874) focused on functional anatomy, particularly the musculature of the syrinx and hind limb to classify birds. For instance, oscines (songbirds, a subset of Passeriformes) were

identified based on their complex syringeal musculature, which allowed for varied vocalisation. While the absence of the ambiens muscle (a small muscle that plays a role in flexing the toes) was used to define the "Anomalogonatae", which included Passeriformes (which included many Eucavitaves), Piciformes, Cuculiformes (cuckoos), Caprimulgiformes (nightjars and allies) and Apodiformes (swifts and hummingbirds). Later studies showed that the loss of the ambiens muscle occurred multiple times independently (e.g., Raikow 1978; Livezey & Zusi 2007; Jarvis *et al.* 2014). In Garrod (1875) demonstrated that the presence of Type 6 flexor tendons in birds with zygodactyl feet supported the close relationship between Piciformes and "Galbuliformes" (Galbuli), whereas Psittaciformes, despite also possessing zygodactyl feet, exhibit Type 1 flexor tendons.

The work of Fürbringer (1888) on avian anatomy and classification laid the foundation for future studies of avian comparative anatomy. Extensive anatomical data was used to infer evolutionary relationships among birds, particularly the separation of Palaeognathae (ratites and tinamous) from Neognathae (all other modern birds), recognising Passeriformes as a distinct and highly derived group (again) and a close relationship between birds of prey (Accipitriformes and Falconiformes). Many more ornithologists continued this line of thinking like Gadow (1893), who's work would become the basis of the following century avian systematists. Gadow recognised the close relationships between most of the Coraciimorphae, even placing owls (Strigiformes) within the same order "Coraciiformes". However, the relationships of Passeriformes and Psittaciformes remained uncertain, and both were placed within separate orders. Cathartidae, Accipitridae and Falconidae were all placed in the order "Falconiformes" but placed in a "legion" together with many other non-Telluravian birds like Anseriformes and Pelecanimorphae.

Mayr & Amadon (1951) used skeletal, muscular, and ecological features to distinguish between major groups. For instance, raptors (Accipitriformes and Falconiformes) were considered closely related based on their anatomical adaptations to predatory lifestyle though considered them to be closely related to Ciconiiformes (storks and allies), Cariamidae (and

Sagittariidae) were thought to be Gruiformes (cranes and allies) based on their broad anatomical similarities. Passerines were considered a relatively derived group, whereas Piciformes and Coraciiformes were viewed as more "primitive" due to their shared morphological traits, albeit closely related to each other. Discussions towards the end of the 19th century often focussed on how to distinguish between derived characters and "primitive" traits, but also which specific characters should be used in classification. Many ornithologists were moving towards using more myological data in conjunction with other soft tissue data (e.g., George & Berger 1966b).

The mid-20th century witnessed a shift toward hierarchical classifications and evolutionary systematics, exemplified by the classification system of Wetmore (1960), whose work was heavily influenced by Fürbringer (1888) and Gadow (1893). Wetmore retained many traditional groupings from the above-mentioned studies of the 19th century ornithologists but sought to organize avian orders into an evolutionary framework informed by fossil data and comparative anatomy. Wetmore (1960) did not explicitly unite telluravian birds into a single clade but rather recognised shared morphological and ecological traits that linked many of these groups. Psittaciformes, Passeriformes and Strigiformes at this time were still maintained as a separate orders not close to any telluravian bird likely due to their highly specialized morphology. Wetmore did recognise that passerines were not "morphologically uniform" and so included the oscine-suboscine division.

Cracraft (1981) provided one of the earlier attempts at cladistic analyses of Neoaves, proposing a monophyletic "Division 9" clade that included Piciformes, Coliiformes, Coraciiformes and Passeriformes. Strigidae were now placed within "Falconiformes" and maintained being grouped with Ciconiiformes. Relationships within these clades still remained poorly resolve, with few-to-no synapomorphies provided for uniting many of the birds within this study. Cracraft's biggest critic Olsen (1985) also contributed significantly to the understanding of higher land bird evolution, particularly through the integration of fossil evidence. Olsen (1985) proposed a "basal land bird" assemblage that included Accipitriformes (that included falconidae) and Psittaciformes. The "higher land bird" assemblage very much retained subsequent classifications

of Garrod (1874) "Anomalogonate" and Beddard (1898) which included Strigiformes and Coliiformes originally not include by Garrod (1874). Subsequently, monophyly of the above hypothesised "basal" and "higher land bird" assemblages has not been supported by any recent phylogenetic analysis based on molecular or morphological data and the composition of many taxa within the "higher land birds" remained controversial. Despite these advances, this period was also characterized by the recognition of pervasive challenges in inferring evolutionary history from morphological data. Homoplasy, especially in traits such as zygodactyly (present in Piciformes, Coraciiformes, Trogoniformes and Psittaciformes) and the predatory adaptations of Strigiformes, Falconiformes and Accipitriformes, confounded efforts to establish robust phylogenies. Though many studies throughout the ages (e.g., Gadow 1893; Beddard 1898; Sibley & Ahlquist 1972; Jollie 1976; Raikow 1978; Cracraft 1981) increasingly recognised the role of convergence in shaping the similarities between falcons and other raptors.

1.1.2 The contribution of morphology to the phylogenetic classification of Telluraves

By the 1990s, comprehensive studies synthesized large morphological datasets in an attempt to untangle neornithine phylogeny, providing some resolution for inter-ordinal relationships within Neoaves (e.g., Livezey & Zusi 1990; Mckitrick 1991; Mayr & Clarke 2003; Livezey & Zusi 2006, 2007). Mayr & Clarke (2003) performed a comprehensive phylogenetic analysis to clarify the evolutionary relationships of Neornithes using osteology, musculature and other soft tissues. This analysis recovered the monophyly of Neoaves, but did not support a monophyletic grouping of Telluraves as currently recognised (Fig. 1.2A). Though resolution within certain telluravian clades were somewhat congruent with future phylogenomic results. For example, the traditional taxon "Falconiformes" (including Cathartidae, Sagittariidae, Accipitridae, and Falconidae) was not found to be monophyletic (e.g., Livezey & Zusi 2001); Cathartidae, Sagittariidae, and Strigidae were shown to be successive sister taxa of a clade including Falconidae and Accipitridae; and

Passeriformes were closely associated with Coraciidae and Coliidae. Monophyly of (Strigiformes + (Falconidae + Accipitridae)) was previously supported in some studies like Cracraft (1981), but was not supported in other morphological analyses such as that of Livezey & Zusi (2001). Mayr *et al.* (2003) conducted an integrative phylogenetic analysis using both morphological and molecular data. Analysis of the morphological data and of the combined data set supported the monophyly of (Strigiformes, (Falconidae + Accipitridae)), a sister group relationship between Pici (Ramphastidae, Indicatoridae and Picidae) and Galbulidae (Galbulidae and Bucconidae) and support for the monophyly of (Upupidae + Bucerotidae). While Psittacidae were recovered as sister to an assemblage that included Coliidae, Picidae and Galbulidae, Leptosomidae were recovered as sister to Podargidae (frogmouths), and Passeriformes were recovered as sister to Cuculidae, but closely associated with the Psittacidae assemblage.

Livezey & Zusi (2006, 2007) undertook one of the most extensive morphological phylogenetic analyses of Neornithes, whose work resulted in two publications that constitute a major contribution to the knowledge of morphological variation in birds. The first publication gave a detailed description of the 2954 morphological characters identified and observed using 150 avian taxa (Livezey & Zusi 2006). This huge dataset included 2451 osteological, 256 myological, and 247 miscellaneous (ligaments, soft tissues, neuroanatomy and integument) characters. These characters were then analysed phylogenetically in their second publication, Livezey & Zusi (2008). This work revealed a general clustering of taxa within what is now considered Telluraves but with significant differences in topology compared to molecular-based phylogenies, approximating more closely to the "Anomalogonate" of Garrod (1874) and Fürbringer (1888) (Fig. 1.2B). In their phylogeny, taxa were dispersed across multiple, unrelated clades: Passeriformes were recovered as monophyletic with high bootstrap support, but their sister relationships were unresolved, though closely aligned with Piciformes; Psittaciformes were recovered as monophyletic but not closely associated with Passeriformes and positioned closer to Accipitriformes. Piciformes and Coraciiformes have strong support as sister groups with Trogoniformes and Coliiformes, being basal to this grouping. Cathartidae were recovered to be

sister to Accipitriformes (Sagittariidae + Pandionidae + Accipitridae + Falconidae). Strigiformes were not recovered as part of a monophyletic "raptorial" clade but rather sister to Cathartiformes + Accipitriformes, which, at the time, was supported by previous analyses (e.g., Mayr & Clarke 2003; Mayr *et al.* 2003). The momentous work of Livezey & Zusi (2006, 2007) was not met without criticism. Mayr (2008a, p. 64) assessed multiple aspects of the methodology and regarded the study to be "flawed by incorrect or doubtful character scorings, and unacceptable generalisations on character distribution based on unverified assumptions". Mayr (2008a) suggested that the characters used by Livezey & Zusi (2007) were prone to homoplasy, where convergent features could artificially group unrelated taxa. This is prevalent problem in Neoaves, where ecological and functional convergences are widespread.

There have been numerous attempts to resolve the intrarelationships of Neoaves. With each new method comes new disagreement between and among studies, whether that data type be morphology (e.g., Livezey & Zusi 2006, 2007), DNA-DNA hybridisation (e.g., Sibley & Ahlquist 1990) or mitochondrial genes (e.g., Mayr *et al.* 2003). However, with the inclusion of nuclear loci, particularly those derived from protein-coding genes, ultra conserved elements (UCEs), and other non-coding regions, these methods have generally recovered a similar set of relationships, which consistently differ from those derived from morphological phylogenetics in recovering a monophyletic Telluraves that was not otherwise suggested.

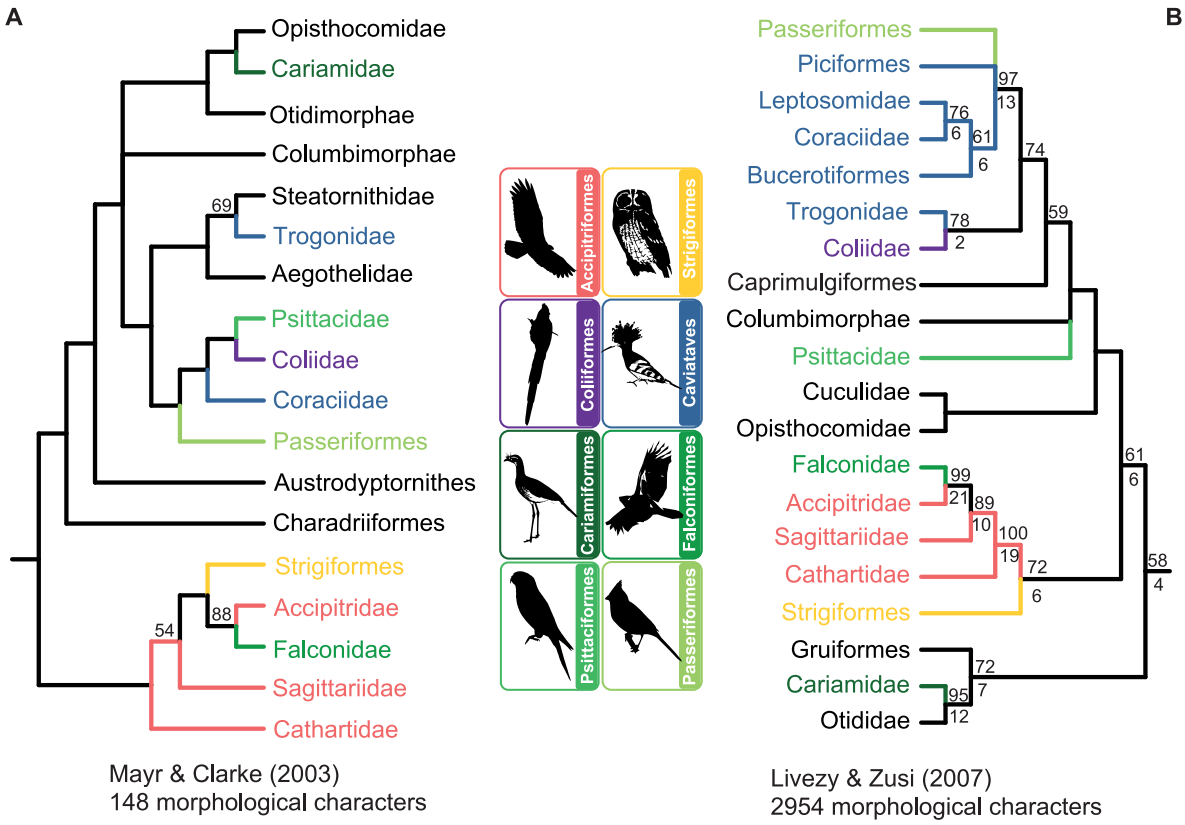


Figure 1.2. Higher level phylogeny based on morphological datasets. (A) Topology recovered in the parsimony analysis of 148 morphological characters, simplified after Mayr & Clarke (2003); (B) Topology recovered in the parsimony analysis of 2954 morphological characters, simplified after Livezey & Zusi (2007). Bootstrap support values above 50% are given.

1.2. Current knowledge of Telluraves intrarelationships: the uncertainty within core landbirds

1.2.1 Telluraves monophyly

As of today, Telluraves (sensu Yuri *et al.* 2013) is well-supported as a monophyletic clade by molecular phylogenetics and phylogenomics (Ericson *et al.* 2006; Hackett *et al.* 2008; McCormack *et al.* 2013; Kimball *et al.* 2013; Yuri *et al.* 2013; Jarvis *et al.* 2014; Burleigh *et al.* 2015; Prum *et al.* 2015; Suh *et al.* 2015; Reddy *et al.* 2017; Liu *et al.* 2018; Kimball *et al.* 2019; Kuhl *et al.* 2021; Stiller *et al.* 2024) (See Table S1.1 for summary of studies). The advent of molecular phylogenetics has significantly refined Telluraves phylogeny, including deeper intrarelationships within this clade.

Aspects of these analyses have been very broadly congruent with earlier hypotheses based on morphological studies, namely the close relationships between Piciformes, Coliiformes, Coraciiformes and Passeriformes, but significantly different to morphological studies in that Falconidae, Cariamiformes, Psittaciformes are recovered in a clade together with Passeriformes. Close affinities of these taxa had not been recognised by earlier systematists and there are currently no universally accepted diagnostic morphological synapomorphies (shared derived traits) that unequivocally unite Telluraves (Sangster *et al.* 2022). The monophyly of Telluraves is predominantly supported by molecular phylogenetics with morphological evidence being inconsistent, and often subject to homoplasy or convergence.

The majority of recent analyses favour a topology that divides Telluraves into two major subclades, the Afroaves (Accipitriformes, Strigiformes, Coliiformes, Leptosomiformes, Trogoniformes, Bucerotiformes, Piciformes and Coraciiformes) and the Australaves (Cariamiformes, Falconiformes, Psittaciformes and Passeriformes), each of which has two raptorial lineages at their base (e.g., Jarvis *et al.* 2014; Reddy *et al.* 2017; Kimball *et al.* 2019; Kuhl *et al.* 2021) (Fig. 1.3A). Some analyses have found Afroaves as a paraphyletic grade outside of Australaves, with Accipitriformes sister to other Telluraves (Kimball *et al.* 2013; Prum *et al.* 2015; Braun & Kimball 2021) (Fig. 1.3B). Prum *et al.* (2015) named this new clade of landbirds, excluding Accipitriformes, Eutelluraves. A third possibility exists, a "core" raptorial clade (Accipitriformes + Strigiformes) sister to the remaining Afroaves was recovered by Stiller *et al.* (2024) (Fig. 1.3C) and later named Hieraves (Wu *et al.* 2024). A recent study by Wu *et al.* (2024) recovered a topology significantly different from previous studies where Coraciimorphae (Coliiformes, Leptosomiformes, Trogoniformes, Bucerotiformes, Coraciiformes, Piciformes) were recovered as the most basal clade to the rest of landbirds. This study however was critiqued by Springer & Gatesy (2024) who highlighted potential issues with misalignment and homology in the dataset, particularly regarding the novel clade "Aquateraves". It is clear that there is uncertainty within the deeper branches and at the root of core landbirds, especially regarding the

positions of Accipitriformes, Coliiformes and Strigiformes, which currently have been resolved in almost every configuration (e.g., Jarvis *et al.* 2014; Suh *et al.* 2015; Kuhl *et al.* 2021).

Divergence times for Telluraves

Estimates of Telluraves' divergence vary widely depending on methodological approaches and data integration. Molecular phylogenies, such as Prum *et al.* (2015), often infer post-Cretaceous radiation for the majority of the deep divergences within avian crown groups, relying on genomic data but limited by sparse fossil calibrations. However, other studies, such as Crouch *et al.* (2019) employed a total-evidence tip-dating approach, integrating 782 morphological characters from 122 extinct and 258 extant taxa with molecular sequence data. This method, using Telluravian fossil taxa, yielded a Telluraves crown age of ~75.6 Ma, supporting a pre-K-Pg diversification. Despite a sparse matrix (94.8% missing data), their approach mitigated node-calibration biases, though limited taxon sampling (e.g., excluding Strigiformes) reduced resolution. This integrative approach recovered Coliiformes as sister to Psittaciformes, challenging molecular placements within Coraciimorphae, while relationships like Trogoniformes-Leptosomiformes showed weak support.

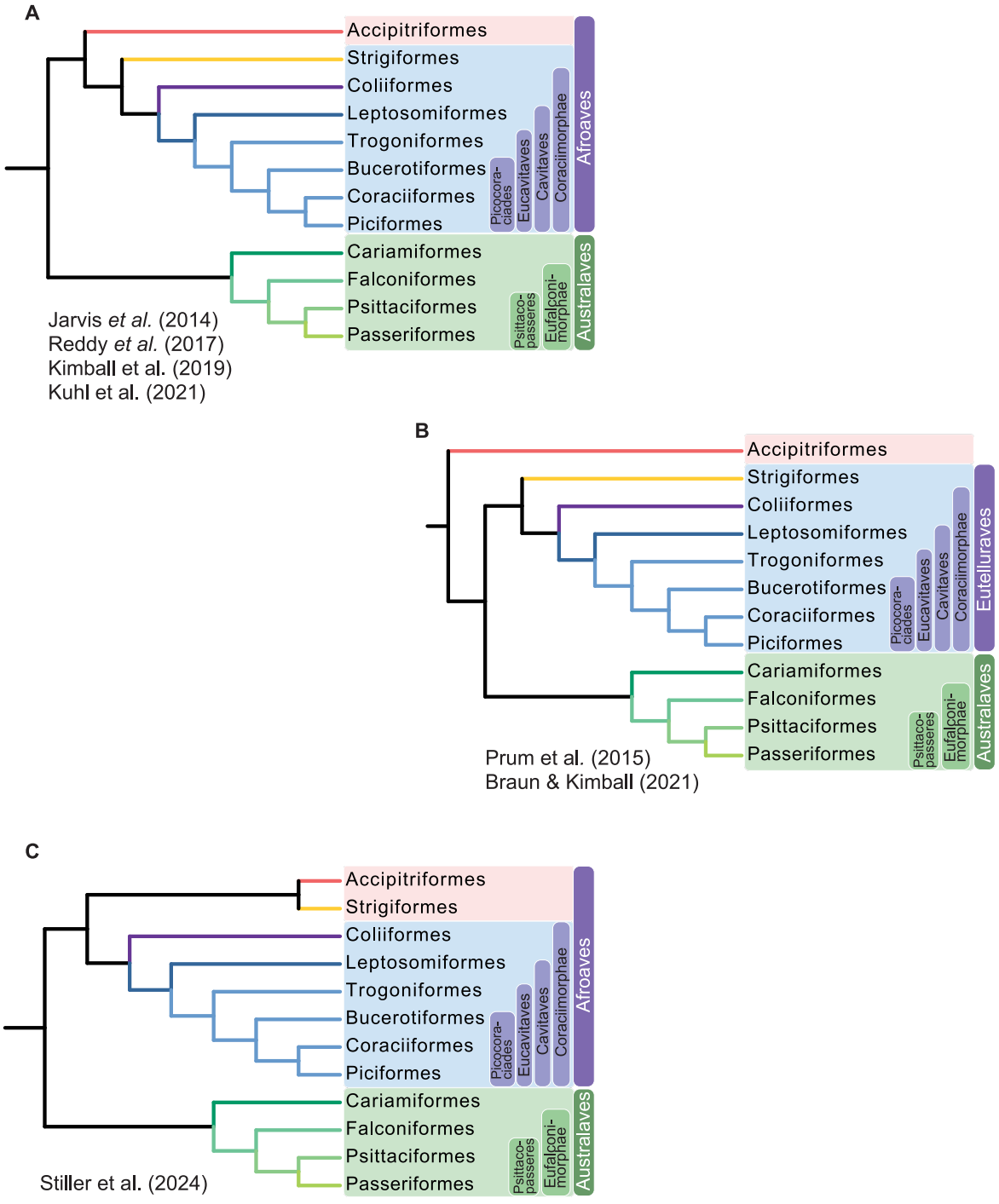


Figure 1.3. Example alternative hypotheses for the molecular phylogenetic topology of Telluraves. (A) Afroaves is monophyletic and sister to Australaves, e.g., Jarvis *et al.* (2014), Reddy *et al.* (2017), Kimball *et al.* (2019) and Kuhl *et al.* (2021); (B) Accipitriformes sister to remaining members of landbirds, "Afroaves" not monophyletic in this hypothesis, e.g., Prum *et al.* (2015) and Braun & Kimball (2021); (C) Afroaves is monophyletic but Strigiformes are not sister to Coraciimorphae but grouped with Accipitriformes in a "core" raptorial clade, e.g., Stiller *et al.* (2024).

1.2.2 Afroaves

Afroaves (Ericson *et al.* 2006) (sometimes) includes the orders Cathartiformes and Accipitriformes, which, together as a clade, are in turn sister to Strigiformes and all other Coraciimorphae (Fig. 1.3A & C). Coraciimorphae contains the order Coliiformes and the clade Cavitaves, an assemblage of birds that includes Leptosomiformes, Trogoniformes, Bucerotiformes, Coraciiformes, and Piciformes. Afroaves has since been recovered by majority-supported phylogenomic data (see Table S1.1). The basal dichotomy differs among recent molecular analyses as mentioned above but most studies support a dichotomy between Accipitriformes and all other Afroaves (Hackett *et al.* 2008; Jarvis *et al.* 2014; Burleigh *et al.* 2015; Reddy *et al.* 2017; Kimball *et al.* 2019; Kuhl *et al.* 2021). No morphological apomorphies are known for this clade (Sangster *et al.* 2022).

Accipitriformes

Accipitriformes includes Cathartidae (New World vultures, sometimes split off into a separate order Cathartiformes), Sagittariidae (secretary birds), and Pandionidae (ospreys) which are successive sister taxa of Accipitridae (hawks, eagles, and allies) (Griffiths *et al.* 2007; Prum *et al.* 2015). Accipitriformes are mainly carnivorous and are colloquially referred to as "raptors" but are highly diverse in their specialisations such as by the obligate vertebrate scavenging of Cathartidae, the cursorial lifestyle of Sagittariidae, or the feet-first plunging method of Pandionidae. Historically, Accipitridae and Falconidae were grouped together alongside Strigiformes and Cathartidae in an order named "Falconiformes" (e.g., Brandt 1853; Wetmore 1960), though there were doubts about these relationships with recognition that Strigiformes form a separate clade (e.g., Fürbringer 1888; Jollie 1977; Cracraft 1981). Cathartidae were also thought to be placed in a separated order, the Cathartiformes, due to their notably different ecology and morphology, by some earlier authors (e.g., Friedman 1950). Ultimately, they were placed as sister to or a suborder of Ciconiiformes (storks), based on certain morphological and physiological similarities, and this

relationship was even supported in early molecular studies (Mayr & Amadon 1951; Ligon 1967; Sibley & Ahlquist 1972, 1990). The superficial resemblance of New World vultures (Cathartidae) and Old World vultures (Accipitridae) was also problematic and the non-monophyly of Old World vultures or their inclusion within Accipitriformes was established only through more recent analyses of molecular data.

Recent molecular studies have firmly placed Cathartidae (or Cathartiformes) as sister to Accipitriformes (Hackett *et al.* 2008; Jarvis *et al.* 2014 etc.), diverging from the latter in the early Paleogene (61.1 Ma) (De Panis *et al.* 2021). Sagittariidae diverged from the rest of Accipitriformes at 60.7 Ma, and Pandionidae diverged from Accipitridae at 50.2 Ma, with Elaninae splitting from the rest of Accipitridae at 44.7 Ma (Catanach *et al.* 2024). Within the traditional composition of "Falconiformes", Accipitridae and Falconidae were usually thought to have a close relationship, though often times doubted (e.g., Olsen 1985). Cladistic morphological analyses also resulted in a sister group relationship between these birds (Mayr & Clarke 2003; Livezey & Zusi 2007) but phylogenomic analyses has now confirmed that these birds are not in any way closely related and that Falconidae are far outside Accipitriformes, in Australaves (see explanation of Falconiformes below) (Ericson *et al.* 2006; Hackett *et al.* 2008 etc.).

Strigiformes

Strigiformes (owls), the nocturnal predatory birds, are placed into two monophyletic families Tytonidae (Barn owls) and Strigidae (typical owls) (see Salter *et al.* 2020 for review). Historically owls were placed within "Falconiformes" based on their "raptorial" lifestyle but were quickly recognised as distinct from diurnal birds of prey and placed into a separate order due to their highly modified cranium, binocular vision, binaural hearing (in most taxa), and specialised feathers for silent flight (e.g., Wetmore 1960). Some ornithologists suggested that owls were likely related to nightjars due to their nocturnal habits, large eyes and camouflaged plumage (e.g., Fürbringer 1888; Gadow 1893; Mayr & Amadon 1951; Sibley & Ahlquist 1990) while some anatomists like Cracraft (1981) assumed a closer relationship with "Falconiformes" due to their

derived tarsometatarsus and pelvic morphology that is also shared with pandionids and acciptrids. Cladistic analyses of morphological characters generally found owls either as sister to "falconiforms" (Livezey & Zusi 2007) or nested within them (Mayr & Clarke 2003).

In most recent phylogenomic studies Strigiformes are placed as the sister group to the diverse clade Coraciimorphae (Coliiformes + (Leptosomiformes + (Trogoniformes + (Bucerotiformes + (Coraciiformes + Piciformes))))). However, Stiller *et al.* (2024) (and some other molecular studies e.g., Jarvis *et al.* 2014; Houde *et al.* 2019; Braun & Kimball 2021) found Accipitriformes and Strigiformes in a group, as sister to the remaining Afroaves. Stiller *et al.* (2024) found that the support for the monophyletic relationship between Accipitriformes and Strigiformes increased with additional passeriform taxa included in the analysis, whereas sampling fewer taxa of each order favoured Accipitriformes as the sister to the remaining Afroaves. The position of owls within Afroaves is not secure, with a number of different configurations resolved in a variety of ways, even in some studies placed as a sister group to Psittaciformes (Pacheco *et al.* 2011). Many authors have suggested this instability is likely due to introgressive hybridisation near the base of Afroaves (e.g., Kuritzin *et al.* 2016; Gatesy & Springer 2022).

Coraciimorphae

The monophyly of a clade formed by Coliiformes (mousebirds), Leptosomiformes (cuckoo-rollers), Trogoniformes (trogons), Bucerotiformes or Bucerotes (hornbills and allies), Coraciiformes (rollers and allies) and Piciformes (woodpeckers and allies) is well supported by multiple phylogenomic studies (e.g., Hackett *et al.* 2008; Yuri *et al.* 2013; Prum *et al.* 2015 etc.). Historical morphological studies did not recognise this monophyly but did group Bucerotiformes, Coraciiformes and Piciformes under a broader "Coraciiform assemblage", largely based on shared features of the skull, particularly the structure of the palate and zygomatic process (e.g., Cracraft 1981). However other groups, such as Coliiformes, were not always included in this assemblage. Coliiformes comprise only six species that are restricted to sub-Saharan Africa. They are rather

unique in their behaviour and ecology, often highly gregarious, feeding on fruit and nectar, and have the ability to hang upside down due to their long claws, pamprodactyl feet (all four toes point forward) and stiffened tail feathers. The phylogenetic position of these birds has long been controversial, but generally they have been associated with the rest of Cavitaves and identified as a separate order owing to their highly derived morphology and lack of clear synapomorphies with other groups. In some cases, mousebirds were placed within passerines (e.g., Cracraft 1981; Berman & Raikow 1982) due to their shared, unique morphology of the deep flexor tendons. However, an affinity with Coraciiformes or Piciformes was more often argued for (e.g., Olsen 1985), and some early phylogenetic analyses suggested a sister relationship of mousebirds to Trogoniformes (Sibley & Ahlquist 1990; Livezey & Zusi 2007). Even with the more recent phylogenomic studies, Coliiformes are still unstable but generally favour (higher support values) a position sister to Cavitaves (see Table S1.1).

Cavitaves (sensu Yuri *et al.* 2013) is a clade including Leptosomiformes, Trogoniformes, Bucerotiformes (Bucerotidae + Upupiformes), Coraciiformes and Piciformes. They were aptly named after the fact that they all nest in tree cavities or, in some cases, self-excavated burrows. Leptosomiformes (cuckoo-rollers) are a carnivorous forest-dwelling bird of Madagascar and surrounding islands. Historically these birds were consistently assigned to Coraciiformes by being closest to Coraciidae (true rollers) and Brachypteraciidae (ground rollers), mostly based on similarities of the skull (e.g., Cracraft 1971a), though this was questioned by these authors and others (Cracraft 1981; Mayr 2008a). The morphological phylogenetic analysis by Livezey & Zusi (2007) found Leptosomidae to be sister to Brachypteraciidae, but with no further explanation of possible apomorphies, the results of which were criticized by Mayr (2008a). Phylogenomic studies have now firmly placed Leptosomiformes as the sister taxon to Eucavitaves, a clade including Trogoniformes, Bucerotiformes, Coraciiformes and Piciformes (e.g., Hackett *et al.* 2008; Yuri *et al.* 2013; Prum *et al.* 2015 etc.). Trogoniformes are frugivorous birds with a unique foot morphology in that they are the only birds to have the heterodactyl foot condition, where the second toe is permanently reversed (instead of the fourth, zygodactyl foot). Like cuckoo-rollers

they have a long and complex classification history, often being assigned within Coraciiformes (e.g., Maurer 1981; Gadow 1893), a separate order between mousebirds and passerines (e.g., Fürbringer 1888); with nightjars and owls (Verheyen 1956); or as sister to Steatornithidae (oilbirds) (Mayr & Clarke 2003). Nonetheless, and despite conflicting morphological phylogenetic hypotheses, trogons were generally accepted as a separate order (Trogoniformes), close to or near Coraciiformes. Bucerotiformes and Upupiformes were similarly treated, as being close to Coraciiformes, with morphological analysis generally agreeing that these birds formed a sister group with other Coraciiformes (Livezey & Zusi 2007). Other morphological analyses found Bucerotes to be sister to Piciformes (Manegold 2005). These birds, along with Coraciiformes and Piciformes, termed Picocoraciades (sensu Sangster *et al.* 2022), are one of the few groupings with morphological synapomorphies, such as having a well-defined sulcus for the tendon of m. extensor longus alulae on the radial carpal (Mayr 2014). And finally, the Picodynastornithes (sensu Sangaster *et al.* 2022) which includes Coraciiformes and Piciformes, there is strong molecular support for a sister relationship between these two groups (see table S1.1), which was not previously recognised in historical morphological descriptions but a close relationship was acknowledged due to a number of cranial and foot morphology similarities (e.g., Wetmore 1960).

1.2.3 Australaves

One of the more unexpected results of modern sequence-based analyses of avian interrelationships is the recognition of a sister-group relationship between Psittaciformes and Passeriformes (Psittacopasseres). These are closely related to Cariamiformes and Falconiformes, and form the clade Australaves (Fig. 2). This clade was first reported by Ericson *et al.* (2006) and now further supported by robustly-supported independent nuclear gene loci and retroposon insertions (see Table S1). Molecular clock analysis suggested that Australaves diverged at 55-65 Ma, likely within the Palaeocene boundary (Jarvis *et al.* 2014; Prum *et al.* 2015).

Morphological studies did not recognize the close affinities between members of Australaves, which not only differ in anatomy but also ecology. There are currently no morphological apomorphies that unite Australaves (Sangster *et al.* 2022).

Cariamiformes

Living Cariamiformes (seriemas) comprise the single family Cariamidae (*Chunga* + *Cariama*), they are large, long-legged, mainly terrestrial birds (though they build their nests in trees) confined to the sparsely wooded grasslands of South America. Cariamidae were traditionally classified as a Gruiformes (cranes and allies) (e.g., Wetmore 1960; Cracraft 1986; Stegmann 1978; Cracraft 1981; Sibley & Ahlquist 1990; Livezey & Zusi 2007) and at times even placed in the same order as Sagittariidae (Stresemann 1959). This was largely based on the structure of the pelvis and hind limbs that are adapted for terrestrial locomotion and their somewhat "raptorial" behaviour (Redford & Peters 1986), superficially similar to secretary birds. However, this interpretation was challenged as more detailed comparative analysis revealed significant differences in these birds' anatomy and were often placed with Opisthocomidae (hoatzins) due to the similarities in the strongly bowed carpometacarpus (e.g., Olsen 1985; Mayr & Clarke 2003). Phylogenomic studies now firmly place Cariamiformes (*Chunga* + *Cariama*) as basal to Falconiformes, Psittaciformes and Passeriformes (Eufalconimorphae) (Jarvis *et al.* 2014 etc.). Though in one study unpartitioned coding exons supported a sister group relationship between Cariamiformes and Falconiformes (Braun & Kimball 2021). Cariamiformes and Falconiformes share only a few derived features, such as the long processus supraorbitalis of the lacrimal, abbreviated phalanges on the fourth digits and raptor-like ungual phalanges, all features that are also present in Accipitridae.

Falconiformes

Living Falconiformes comprise the single family Falconidae, that is divided into three subfamilies (Herpetotherinae + (Polyborinae + Falconinae) and are widely recognised as a clade, with well

established relationships (e.g., Griffiths *et al.* 2004; Fuchs *et al.* 2015). Falconidae are diurnal birds of prey that have a range of hunting styles and habitats, from ambush predators in dense forests (forest falcon), diving at high speeds in urban settings (peregrine falcon) or simply walking on the ground in search for food (crested caracara). Older studies consistently placed Falconidae within the historical "Falconiformes", a clade comprising Sagittariidae, Pandionidae and Accipitridae (e.g., Garrod 1874; Wetmore 1960), due to their "raptorial" appearance (forward facing eyes, hooked beak and long sharp talons) and lifestyle as predators (predominantly carnivorous diet). Though Falconidae have at times been recognised as distinct from these birds with the possibility of convergence through raptorial morphology, the relationship with Accipitridae was rarely questioned (e.g., Jollie 1976; Olsen 1985). For example, the killing style of falcons is to use their beaks to sever the spinal cord, unlike in Accipitridae that primarily use talons; or the differences in flight style that are reflected in their flight musculature, sternum, and coracoid, allowing for rapid powerful flight (Jollie 1977). Morphological phylogenies have consistently recovered Falconidae within Accipitriformes or sister to Accipitridae (Mayr & Clarke 2003; Mayr *et al.* 2003; Livezey & Zusi 2007).

Recent molecular phylogenies strongly contradict previous morphological results, consistently finding that Falconidae instead are sister to Psittacopasseres (Psittaciformes + Passeriformes) (see Table S1.1), and that similarities between Falconidae and Accipitridae are due to convergence. Molecular data has yielded a 34.2 Ma maximum time estimate for the earliest divergences within crown group Falconiformes, with stem Falconiformes likely diverging from Psittaciformes around 50-55 Ma, in the early Eocene (Fuchs *et al.* 2015). Though these dates are mainly based on the earliest putative falconiform fossil taxa *Antarctoboenus carlinii* Cenizo *et al.* (2016) from Antarctica, which could be problematic due to the fragmentary nature of the fossil (Mayr 2009).

Eufalconimorphae (Falconiformes + (Psittaciformes + Passeriformes)) have no morphological apomorphies (Sangster *et al.* 2022). However, Pyle (2013) observed that falcons and parrots shared a distinctive wing molt sequence, while Razmadze *et al.* (2018) noted the

general similarity of wing musculature between these birds (though additionally similar to pigeons).

Psittaciformes

Extant parrots are characterized by their distinctive hooked beak with large cere, zygodactyl feet (i.e. outer toe permanently reversed), which makes them adept at accessing hard-shelled seeds and nuts. Psittaciformes were recognised very early on as a distinct clade owing to these unique morphologies, and as Sibley & Ahlquist (1990, p. 380) said "there has been little doubt about which birds are, and are not, parrots". Despite this, their relationship with other birds has always been uncertain (e.g., Huxley 1897; Wetmore 1960; Olsen 1985). For example, DNA hybridisation analysis by Sibley & Ahlquists (1990, p. 390) concluded that "parrots have no close relatives". Ornithologists have associated parrots with a range of birds, including hawks and owls due to their hooked beaks (e.g., Fitzinger 1856), cuckoos due to their zygodactyl feet (e.g., Cabanis 1847) and even pigeons due their large cere (e.g., Garrod 1874; Fürbringer 1888). Some ornithologists like Beddard (1898) recognised the close affinities of parrots with passerines, and it is clear that parrots also shared traits with the above groups, which is now recognised as convergent evolution. Morphological phylogenetic analyses have sometimes grouped parrots with Coliiformes (mousebirds) (e.g., Mayr & Clarke 2003), but these phylogenies are weakly supported and this clade isn't recovered in other morphology-based analysis (Livezey & Zusi 2007).

Molecular analyses consistently support a sister relationship between Psittaciformes and Passeriformes, this clade is termed Psittacopasseres (sensu Sangster *et al.* 2022). Psittaciformes and Passeriformes are remarkedly different in their morphology. Besides the highly derived skull of parrots, their tarsometatarsus and feet morphology are also very different. Parrots have short legs with zygodactyl feet while passerines are long-legged with anisodactyl feet (three toes facing forward). No morphological apomorphies have been found for Psittacopasseres though a study by Mayr (2015b) found a possible synapomorphy in the separation of the accessory trochlea of the fourth toe from the main body of the corresponding trochlea by a furrow, a character state

that is observed between Psittaciformes and candidate stem Passeriformes but not observed in crown Passeriformes.

Passeriformes

Passeriformes ("perching birds") account for approximately 60% of all living bird species and have diversified on all continents within nearly all terrestrial ecosystems. Most passerines are small, feeding primary on insects, seeds, fruit or nectar. They are characterized by a foot specialized for perching, with three forward-pointing toes and an elongated hind toe (anisodactyl). Most classical ornithologists concentrated on the debate as to whether passerines should be divided into suborders or not, with very little agreement on even the family level designations. Though there was agreement on two primary divisions, "tyranni" (suboscines) and "passeri" (oscines), this is largely based on the specialised syrinx in oscines that allows for complex vocalisation (Ames 1971). A third order, the Acanthisitti which only includes the New Zealand Acanthisittidae, was only recognised as the basal-most passerine and sister to all other passerines through molecular phylogenetics (Barker *et al.* 2004). Acanthisitti likely diverged from other passerines approximately 47-55 Ma, coinciding with the radiation of land birds in the Southern hemisphere (Ericson *et al.* 2002). Passeriformes were generally included in orders that encompassed Piciformes, Coliiformes and Coraciiformes (e.g., Cracraft 1981; "Division 9"). Early morphological phylogenetic analyses also recovered passerines in a polytomy with Piciformes and Coraciiformes (Mayr & Clarke 2003; Livezey & Zusi 2007), whereas all current molecular relationships congruently support a sister group relationship between Passeriformes and Psittaciformes (see Table S1.1).

1.3 Overview of the Palaeogene fossil record and their phylogenetic affinities.

The following sections provide a brief overview of the current understanding of the intrarelationships of stem Telluravian fossil taxa from the Palaeocene and Eocene. Phylogenomic and fossil studies provided strong evidence that the earliest known stem-group representatives of extant telluravian orders appeared in the early Paleogene (65.5 Ma to 33.9 Ma) (Yuri *et al.* 2013; Jarvis *et al.* 2014; Prum *et al.* 2015; Kuhl *et al.* 2021; Mayr 2022a; Stiller *et al.* 2024) (Fig. 1.1). For more comprehensive reviews and detailed discussions on the fossil taxa refer to Mayr (2009a, 2017a, 2022a), who has published over 70 papers on Paleogene birds since 1998.

Most Palaeogene fossil land birds are found in several Konservat- Lagerstätten from the Northern Hemisphere. The most famous of these is the Middle Messel Formation. The fossils are located at the Messel Pit Fossil site in Hesse, central Germany. The Middle Messel Formation consists of finely laminated bituminous shales deposited into a maar lake during the earliest middle Eocene (MP 11; 48 Ma) (Lenz *et al.* 2015). During this time the area around the Messel was likely covered by subtropical to tropical vegetation (Grein *et al.* 2011; Smith, Schaal*, et al.* 2018). Due to the anoxic conditions of the lake and very rapid burial of the recently deceased birds, they are often preserved fully articulated with soft tissues, including feathers (Vinther *et al.* 2010) and stomach contents (Mayr & Wilde 2014). The fossils are, however, mostly flattened and crushed, with finer details often obscured.

Another critical European fossil locality is the Phosphorites du Quercy of southern France, which provides a complementary record of Palaeogene avian diversity. The Quercy Phosphorites Formation consists of phosphate-rich sediments in karstic cavities, formed by the dissolution of limestone and infilled with clay, phosphatised nodules and other sediments, that infilled and formed over the late Eocene to late Oligocene (~ 38-25 Ma) (Legendre *et al.* 1992). An abundance of bird fossils have been found in the karstic fillings of Quercy. See Mourer-Chauviré (2006) for a compressive list of fossil found within this formation.

Undoubtedly the next most widely-renowned locality is the Fossil Butte Member of the Green River Formation of Wyoming in North America. The Green River Formation comprises organic-rich calcareous shales deposited in a series of stratified lake systems spanning over 5 million years and dating between 53.5 and 48.5 Ma (Smith *et al.* 2003). The fossil birds of the Fossil Butte Member would have lived in a subtropical environment with more temperate highland flora than what is observed at Messel (Grande 2013). The preservation of these fossils is very similar to Messel fossils, though generally less crushed.

Additional prolific fossil sites are in Southern England, specifically two localities of the London Clay Formation, the Isle of Sheppey (e.g., Andrews 1899; Mayr 2008d) and Walton-on-the-Naze (e.g., Mayr & Daniels 1998; Mayr & Kitchener 2024a). The London Clay Formation comprises shallow marine sediments deposited during the early Eocene (approx. 55-49 Ma) (Aldiss 2012). Fossil birds from this formation are often disarticulated and fragmentary but can have perfect 3D preservation that often have partial to near-complete skeletons (e.g., Mayr & Kitchener 2024a). There are many more important fossil sites in the Northern Hemisphere that have not been mentioned here. For a full review see Mayr (2022a). The record of Palaeogene Telluraves from the southern hemisphere is sparse. Other than the cariamiform Phorusrhacidae (terror birds) from South America (Alvarenga 2014), there are only fragments of a possible stem-Falconiformes from Antarctica (Acosta Hospitaleche *et al.* 2019) and a stem-Psittaciformes from Namibia (Mourer-Chauviré *et al.* 2015).

1.3.1 Stem members of Afroaves

Stem Accipitriformes

The most well-known putative Cathartiformes fossil is the Teratornithidae, which includes one of the largest volant birds to have ever existed, *Argentavis magnificens* Campbell Jr & Tonni, 1983 from the early Miocene of Brazil. The early possible stem representatives of this taxon are not as well known and generally comprise fragmentary fossils. Two such representatives are

Diatropornis ellioti (Milne-Edwards 1892) and *Parasarcoramphus milneedwardsi* Mourer-Chauviré, 2002 from the middle Eocene to late Oligocene Quercy fissure fillings in France (Mourer-Chauviré 2002). However, Mayr (2009; 2022) noted that the fossils used to describe these species were only compared to members of Cathartidae, and there is a possibility that these fossils instead represent members of the stem group that forms (Cathartidae + Teratornithidae), though no formal phylogenetic analysis has been made. Other possible stem group representatives of Cathartidae are *Phasmagyps patritus* Wetmore, 1927 from the late Eocene (Chadronian) of Colorado, USA and *Brasilogyps faustoi* Alvarenga, 1985 from the late Oligocene/early Miocene of Brazil.

The fossil record of Sagittariidae is very poor, with only one genus described, *Pelargopappus schlosseri* Gaillard, 1908 and *P. magnus* Milne-Edwards, 1867 from the late Oligocene to early Miocene of the Quercy fissure fillings (Mourer-Chauviré *et al.* 1983). Based on molecular divergence estimates, Sagittariidae split from (Accipitridae + Pandionidae) at least 40 Ma during the Eocene; and possibly even earlier according to some studies (Mindell *et al.* 2018). Until more fossils are found from this period the evolutionary history of these birds cannot be assessed.

There are a number of possible fossil Pandionidae specimens from the late Eocene to early Oligocene. These specimens consist of ungual phalanx, a fragmentary tarsometatarsus, distal humerus and an incomplete carpometacarpus (Harrison & Walker 1976; Rasmussen *et al.* 1987; Mayr 2006c). As of today, the oldest described osprey is *Pandion pannonicus* Kessler, 2018 from the late Oligocene of Hungry. Given that Pandionidae diverged from Accipitridae around 42 Ma (Mindell *et al.* 2018) it is likely that other Accipitriformes fossil specimens from the Eocene are unrecognised members of stem Pandionidae and that character traits in early species of *Pandion* were plesiomorphic for all Accipitriformes.

There is a solid record of crown accipitrids from the Oligocene of Europe and North America, with very few from the Eocene (see Mayr 2022a for full summary of Oligocene and younger accipitrids). Unfortunately, the nature of the fossil specimens, fragmentary or single

isolated specimens, does not allow for definitive identification or any phylogenetic affinities. The oldest described representative of Accipitridae is *Milvoides kempi* from the middle Eocene of the UK and only known from a distal tarsometatarsus (Harrison & Walker 1979). A complete tarsometatarsus is known from the late Eocene of Wyoming, *?Palaeoplancus dammanni* Mayr & Perner, 2020. Other, older accipitrids all come from the early Oligocene such as *Aquilavus corroyi* (Gaillard 1939) and *Aquilavus hypogaeus* (Milne-Edwards A. 1892), found in the early Oligocene fissure fillings of Quercy (Mourer-Chauviré 2006); and the nearly complete, though poorly preserved, *Aviraptor longicrus* Mayr & Jurum, 2020 from the early Oligocene of Poland. Another well represented species from the early Oligocene of Wyoming is *Palaeoplancus sternbergi* Wetmore, 1933b which, according to Mayr (2022a), could possibly be placed outside crown Accipitridae due to the long and slender acromial process of the furcula which is observed in Sagittariidae and Pandionidae but not Accipitridae. Several species were described from the early Oligocene of the White River Group in North America, notably a skull "*Buteo*" *grangeri* and a distal tarsometatarsus *"B". fluviaticus* (Wetmore & Case 1934; Miller & Sibley 1942). Given the age of the specimens, it is unlikely that they formally belong within *Buteo*. However, *B. grangeri* is remarkably similar to *Buteo* and *Accipiter* in the cerebellar prominence and the convex shaped os nasal (personal observation).

Finally, the Horusornithidae from late Eocene of the Quercy fissure fillings of France were described by Mourer-Chauviré (1991). Currently restricted to a single species, *Horusornis vianeyliaudae* exhibits a number of features that distinguish it from other Accipitriformes but shares many derived morphologies observed in Pandionidae, Accipitridae and Falconidae. For example, the two crests exhibited in the hypotarsus, a derived morphology of the coracoid, and ungual phalanges (Mayr 2022a). Overall, early Accipitriformes have not been thoroughly examined in a phylogenetic context mainly due to the isolated and fragmentary fossil record and there is potential for future revisions.

Stem Strigiformes

Unlike Accipitriformes, the Palaeogene record of strigiform birds is extensive and diverse despite being mostly comprised of single elements. The oldest representatives include the late Palaeocene North American Ogygoptyngidae which includes the single taxon *Ogygoptynx wetmorei* Rich & Bohaska, 1981 and the European *Berruornis orbisantiqui* Mourier-Chauvire, 1994. The bulk of Eocene species (and all North American birds) are placed into the Protostrigidae established by Wetmore (1933a). This includes the middle and late Eocene taxa *Minerva* ("*Protostrix*") and the Oligocene *Oligostrix* (Mourer-Chauviré & Shufeldt 1983; Fischer 1983). Another taxon traditionally placed into the protostrigid owls is *Eostrix* from the early Eocene, which comprises of a number of different species from North America, England and Mongolia. Other representatives of stem owls include Necrobyinae, Palaeoglaucidae and Selenornithidae which were named by Mourer-Chauviré (1987) for Strigiformes from the Quercy fissure fillings. The only articulated postcranial skeleton of Paleogene owls is *Palaeoglaux artophoron* (Paleoglaucidae) from the middle Eocene of Messel, though these specimens are severely crushed, losing any finer details (Peters 1992; Mayr 2009a).

The most complete and best preserved stem fossil owls are the recently described *Primoptynx poliotauros* from the early Eocene Willwood Formation in the USA (Mayr *et al.* 2020) and *Ypresiglaux* from the early Eocene London Clay Formation in England (Mayr & Kitchner 2023d). The only study to attempt to place stem Strigiformes into a phylogenetic context is by Mayr & Kitchener (2023d). In this study, it was found that *Eostrix* likely does not belong within Protostrigidae as it does not form a clade with *Minerva* and *Oligostrix,* this assignment was already proposed based on a number of morphological differences in the tibiotarsus and tarsometatarsus in Mayr (2022a). A sister group relationship was found to be well-supported between *Primoptynx* and (*Oligostrix* + *Minerva*) and *Ypresiglaux* is likely closer to crown group owls than *Primoptynx.* The interrelationships of other stem group Strigiformes were not resolved. These stem owls differ distinctly from extant owls in a number of features that suggest they likely evolved as diurnal

predators before evolving specialised features adapted to nocturnal activity (Mayr & Kitchener 2023d).

Stem Coraciimorphae

There are a large number of specimens assigned to *Plesiocathartes*, from the almost complete yet compressed fossils of the Messel and Green River Formation (*P. kelleri*, *P. wyomingensis*, *P. major*) to the 3D preserved fossils of the London Clay Formation (*P. insolitipes, Waltonavis*) (Mayr 2002a; Mayr & Kitchener 2022b). Only a few studies have included stem Leptosomiformes in a phylogenetic analysis, namely Ksepka *et al.* (2017) and Ksepka *et al.* (2019), in which *Plesiocathartes kelleri* and P*. wyomingensis* were recovered as sister to Leptosomiformes. Coliiformes are likely one of the most well studied Palaeogene taxa owing to their abundance in well preserved specimens. Coliiformes are divided into two major subclades, the Sandcoleidae and Coliidae (all crown group members). Sandcoleidae are morphological distinctive stem group representatives of Coliiformes that include *Sandcoleus copiosus*, *Anneavis anneae*, *Eoglaucidium pallas* and *Tsidiiyazhi abini* (Houde & Olson 1992; Ksepka *et al.* 2017; Mayr 2018). Coliidae are distinguished from Sancoleidae by their proportionally longer legs and a large disk-like pygostyle observed in extant Coliiformes (Mayr 2022a), and include *Selmes*, *Chascacocolius, Masillacolius, Celericolius, Primocolius, Palaeospiza* (see Mayr 2022a and references therein). The interrelationships of stem coliiform birds is well established, with Sandcoleidae as sister to all other Collidae (Mayr & Peters 1998b; Mayr & Mourer-Chauviré 2004; Ksepka & Clarke 2009b; Ksepka & Clarke 2010; Mayr 2013, 2015a, 2018).

The Palaeogene fossil record of stem Trogoniformes is limited to a few specimens. Notably the oldest members *Septentrogon madseni* from the early Eocene Fur Formation (Kristoffersen 2002), *Masillatrogon pumilio* from the latest early or earliest middle Eocene of Messel in Germany (Mayr 2005c, 2009b) and *Eotrogon stenorhynchus* from the early Eocene London Clay of Walton-on-the-Naza, UK (Mayr *et al.* 2023). There are number of younger stem

Trogoniformes such as *Primotrogon wintersteini* from the and early Miocene that are not mentioned here, refer to Mayr (2022a).

Messelirrisoridae are the more abundant (yet crushed) avian taxa in the Middle Eocene deposits of Messel in Germany. Mayr (1998a; Mayr 2000d, 2006b) originally considered messelirrisorids to be stem group Upupiformes. In an analysis by (Mayr 2006b) Messelirrisoridae were found to be sister to crown group Upupiformes but with low bootstrap support.

1.3.1 Stem members of Australaves

Stem Cariamiformes

Stem group Cariamiformes include the Phorusrhacidae, Idiornithidae, and Bathornithidae, occurring in the Paleogene of South America, Europe and North America. The interrelationships of fossil Cariamiformes are not well understood and have sometimes been contentious (e.g., Worthy *et al.* 2017; Agnolin 2021). A derived characteristic of Cariamiformes is the presence of the os lacrimale communicans (Mayr 2022c), the ossification of the lacrimojugal ligamentum, which is present as an independent bone that contacts the processus orbitalis of the lacrimal. This extra ossification is observed in all Cariamidae and Phorusrhacidae skulls that preserve the lacrimal. Phorusrhacidae, also known as “terror birds”, existed from the Eocene to the Pliocene (3.3 Ma) of South America. They are characterized by their long hind limbs, narrow pelvis, reduced forelimbs and huge narrow skulls (e.g., Degrange *et al.* 2010; Degrange 2015, 2020). They have often been depicted as the top predators in the Cenozoic likely hunting in dense vegetation (e.g., Alvarenga & Höfling 2003). Alvarenga & Höfling (2003) recognized five subtaxa, of which only the Psilopterinae, Patagornithinae, and Brontornithinae have a Paleogene fossil record (see also Alvarenga *et al.* 2011). It is well-supported that Phorusrhacidae compose the crown group with Cariamidae (Degrange 2015; Mayr 2016a, 2022a) and has been widely recognised in the past as such (Brodkorb 1967; Cracraft 1968, 1971b; Mourer-Chauviré *et al.* 1983; Alvarenga & Höfling 2003; Alvarenga *et al.* 2011). Mayr (2016a) and Mayr & Kitchener (2022a) found a number of

synapomorphies that support this clade: a reduced acrocoracoid process of the coracoid, carpometacarpus with a wide intermetacarpal space, a short hallux, an abbreviated penultimate phalanx of the fourth toe, and the presence of the os lacrimale communicans as previously mentioned.

Idiornithidae are a medium sized birds that occur from the middle Eocene to late Oligocene deposits of the Quercy fissure fillings in France and the Geisel Valley in Germany (Mourer-Chauviré *et al.* 1983; Mourer-Chauviré 2006; Mayr 2020c; Mourer-Chauviré 2013). Mourer-Chauviré *et al.* (1983) and Mourer-Chauviré (2013) included the taxa *Dynamopterus* (*"Idiornis"*), *Elaphrocnemus, Oblitavis, Occitaniavis, and Propelargus* as Idiornithidae. *Dynamopterus* was a small species of bird with long slender legs and was very similar to extant Cariamidae in the block-like hypotarsus of the tarsometatarsus and the osseus connection between the acrocoracoid and procoracoid process of the coracoid (Mayr 2022). *Elaphrocenemus* has traditionally been placed within Idiornithidae but in a more recent analysis by Mayr (2016), it was found to be in a polytomy together with Opisthocomiformes and *Paracrax* (Bathornithidae). These two birds were suggested as tentative cariamiform-like birds by Mayr (2022).

Bathornithidae was established by Wetmore (1933c) and subsequently revised by (Cracraft 1968, 1971b). Nine species were recognised from the middle Eocene to late Oligocene of North American localities (see Mayr 2016 for list of species). The monophyly of bathornithids has not been satisfactorily established, and even a diagnosis covering all currently recognized taxa does not exist. Mayr (2016) suggested that Bathornithidae should be restricted to only *Bathornis*. The oldest (Eocene) and best known North American cariamiform is *Bathornis grallator* (Wetmore 1944). Wetmore (1944) originally described this taxon as a flightless relative of New World vultures. This, however, was later recognised as stem group representatives of Cariamiformes (e.g., Olsen 1985). This species of extinct birds was likely was flightless due to the reduced acrocoracoid process of the coracoid (same as extant seriemas). Agnolin (2009) proposed a sister group relationship between *Bathornis* and Phorusrhacidae. This was contested by Mayr (2016) whose analysis recovered *Bathornis* and *Dynamopterus* (Idiornithidae) outside a

clade including the Phorusrhacidae and Cariamidae. A recent study by LaBarge *et al.* (2024) found *Bathornis* to be closer to Cariamidae than to Phorusrhacidae, which are shown to be sister to a clade comprising *Cariamidae, Paracrax, Idriornis, Bathornis* and *Strigogyps*. They do state that this is not conclusive as the inclusion of these taxa in their analysis was intended only to constrain the distinctive morphology of Phorusrhacidae.

Another putative stem cariamiform is *Strigopys*, recognised by Gaillard (1908) from the Quercy fissure fillings in France. This specimen and subsequent discoveries have long been a subject of phylogenetic uncertainty (see Mayr 2022a for full review). While originally compared to Strigiformes (hence the genus name), Mourer-Chauviré (1981) reassigned *Strigogyps minor* to *Ameghinornis minor*, linking it to other Phorusrhacidae. However, Mayr (2005d) challenged this association and suggested *Strigogyps* is likely outside of *Phorusrhacidae*, *Idiornithidae*, and *Cariamidae* based on the two distinct crests observed in hypotarsus of tarsometatarsus (as opposed to block-like in Cariamiformes). The analysis of Mayr (2016) found *Ameghinornis* in a polytomy with *Bathornis*, *Dynamopterus* and the clade (Cariamidae + Phorusrhacidae).

Finally, there are a number of cariamiform-like Palaeogene taxa, e.g., *Elaphrocnemus, Paracrax*, Eleutherornithidae, Salmilidae, and *Gradiornis*, that have all been assigned to Cariamiformes by various authors but are notably different in their morphology to Cariamiformes or are very fragmentary to make any conclusive assignments (see Mayr 2022a for full review on these taxa). Analysis by Mayr (2016a) did not resolve the affinities of *Paracrax* and *Elaphrocnemus*, which are placed in a polytomy together with Opisthocomiformes. The Salmilidae from the latest early or earliest middle Eocene of Messel comprise a single species, *Salmila robusta* Mayr (2000c) and have recently been recovered as sister to Leptosomiformes though this result was doubted on inadequate character scoring (Musser & Clarke 2020). The rest of these problematic taxa have not been resolved or examined in a phylogenetic context.

Stem Falconiformes

The fossil record of Paleogene Falconiformes is poorly represented, other than the Eocene Masillaraptoridae, which are represented by several articulated skeletons. There are currently two species, *Masillaraptor parvunguis* Mayr (2006a) from the latest early or earliest middle Eocene of Messel in Germany (Mayr 2006a, 2009c) and *Danielsraptor phorusrhacoides* Mayr & Kitchener (2022a) from the early Eocene London Clay Formation in England. *Masillaraptor parvunguis* was considered to be either an Accipitriformes or Falconiformes when first described (Mayr 2006a) but was later considered to be a stem falconid (Mayr 2009c; Mayr & Kitchener 2022a). The analysis of Mayr & Kitchener (2022a) established support for a sister group relationship between *Danielsraptor* and *Masillaraptor* as well as a sister group relationship between Masillaraptoridae and Falconiformes, albeit with low bootstrap values. Masillaraptoridae were previously also considered to be related to Cariamiformes due to the block like hypotarsus (Daniels 1995), however, Mayr & Kitchener (2022a) confirmed that these birds are outside Cariamiformes. A number of synapomorphies shared by Masillaraptoridae and Falconiformes were recovered by Mayr & Kitchener (2022a), mainly those found in most "raptorial" birds such as a hooked beak but also some uniquely shared with Falconiformes such as tomial grooves in the upper beak, and a dorsal projection rostral to the cotyla lateralis on the mandible.

Other candidate stem Falconiformes are more fragmentary. Potentially the oldest is *Antarctoboenus carlinii* (Cenizo *et al.* 2016) from early Eocene of La Mesta Formation of Seymour Island, Antarctica based on the distal end of the tarsometatarsus. Harrison (1982, 1984) described two putative Falconiformes from the London Clay Formation *Parvulivenator watteli* and *Stintonornis mitchelli.* None of these birds have been examined in a phylogenetic context, likely because of their fragmentary nature.

Stem Psittacopasseres

Candidate stem Psittacopasseres were comparatively abundant during the Eocene, the current recognised diversity spans the Halcyornithidae, Messelasturidae, Vastanavidae, Quercypsittidae, Psittacopedidae, Morsoravidae and the Zygodactylidae. Many Paleogene taxa originally proposed as stem Psittaciformes have undergone re-interpretation in light of the recent molecular evidence for a sister relationship between Psittaciformes and Passeriformes, with many of these taxa now placed outside Psittaciformes and even Psittacopasseres. One taxon has remained with Psittaciformes affinities, the Quercypsittidae, which are known from the late Eocene Quercy fissure filings (Mourer-Chauviré 1992). Their close affinities with Psittaciformes have been confirmed in many recent phylogenetic analyses (e.g., Mayr & Kitchener 2023c-b). They show a number of differences from crown group Psittaciformes, particularly in the shorter accessory trochlea of the tarsometatarsus and a cup-like articular facet for the scapula (Mourer-Chauviré 1992; Mayr 2022).

Halcyornithidae, Messelasturidae and Vastanavidae were orginally assigned to the stem group of Psittaciformes (Mayr 2009a; Mayr *et al.* 2010; Mayr 2011c). The messelasturids and halcyornithids were also originally compared to Accipitridae and other raptors, like Strigiformes, due to a number of features, such as exhibiting a long caudally directed supraorbital processes or owl-like ungual phalanges (Peters 1994; Mayr 2005b, 2022a). More recent analyses of morphological data using a molecular backbone constraint have returned Halcyornithidae, Messelasturidae and Vastanavidae as successive sister taxa to Psittacopasseres (Mayr 2015b; Ksepka *et al.* 2019; Mayr & Kitchener 2023a). The Hacyornithidae comprise the *Cyrilavis* from the Green River Formation (Ksepka *et al.* 2011), the *Pseudasturides* ("*Pseudastur*") and *Serudaptus* (Mayr 1998b; Mayr 2000a) from Messel, and the London Clay *Pulchrapollia* (Dyke & Cooper 2000). There are a number of differences in morhology between halcyornithids and parrots, but they do have a short parrot-like tarsometatarsus, which exhibits a somewhat similar accessory trochlea to parrots (Mayr 2022). Messelasturidae include *Tynskya* (Mayr 2000b; Mayr 2021d;

Mayr & Kitchener 2023a) from the Green River and London Clay, and *Messelastur gratulator* from Messel (Peters 1994; Mayr 2005b, 2011c).

Psittacopedidae include *Psittacopes lepidus* Mayr & Daniels, 1998 from the Messel, *Parapsittacopes bergdahli* Mayr, 2020a from the London Clay and *Psittacomimus eos* Mayr & Kitchener, 2023c from the London Clay. Psittacopedidae were initially hypothesised to be stem Psittaciformes due to their short parrot-like tarsometatarsus (Mayr & Daniels 1998) but are now recovered as stem group representatives of Passeriformes (Ksepka *et al.* 2019; Mayr & Kitchener 2023c-b). There are number taxa that are allied with Psittacopidae, such as *Pumiliornis tessellatus* Mayr, 1999 from the Messel, *Morsoravis sedilis* Bertelli *et al*., 2010 from the Danish Fur Formation, *Sororavis solitarius* Mayr & Kitchener, 2023b from the London Clay and *Eofringillirostrum* Ksepka *et al.*, 2019 from the Green River Formation. An analysis by Ksepka *et al.* (2019) resulted in clade that includes the above mentioned birds (except *Sororavis*) but this was not found in the analysis of Mayr & Kitchener (2023c-b), in which *Eofringillirostrum* was found to be outside this clade.

The Zygodactylidae Brodkorb (1971), are comparatively the most species rich Eocene clade within Telluraves, with members also known from the Oligocene and early Miocene (Ballmann 1969b, 1969a; Mayr 2008b). They are characterised by a long and slender tarsometatarsus and a zygodactyl foot condition; a retroverted fourth toe and associated accessory trochlea of the distal end of the tarsometatarsus. The Zygodactylidae comprise *Zygodactylus*, *Primoscens*, *Primozygodactylus* and *Eozygodactylus* (Mayr 2022). Multiple phylogenetic analyses support a sister group relationship with crown Passeriformes (Mayr 2008b, 2015b, 2020b; Smith, DeBee*, et al.* 2018; Hieronymus *et al.* 2019; Ksepka *et al.* 2019), termed Parapasseres (Mayr 2015). Zygodactylids and Passeriformes share a number of synapomorphies, mostly in the carpometacarpus (Mayr & Kitchener 2023c).

1.4 Aims and objectives

It is now apparent that the interrelationships of these birds are determined by a complex suite of characters and it is sometimes difficult to distinguish between plesiomorphic, apomorphic and homoplastic characters, presenting a difficult phylogenetic challenge that remains to be addressed (Livezey & Zusi 2007; Mayr 2009, 2020). Phylogenies represent the evolutionary relationships of species and are central to addressing evolutionary hypotheses (Felsenstein 2003). However, palaeontological research on telluravian phylogeny, including enigmatic and ecologically diverse extinct groups, has tended to focus on subsets of taxa, centred on a single clade (Mayr & Mourer-Chauviré 2004; Mayr 2005b; Ksepka & Clarke 2012; Smith, DeBee*, et al.* 2018; Mayr & Kitchener 2022a, 2023). This narrow-focus approach, together with a limited character list, has produced relatively well-resolved phylogenetic hypotheses for specific bird groups such as the Zygodactylidae (Smith *et al.* 2018) and the stem passeriform group Psittacopedidae (Ksepka *et al.* 2019). However, it has not yet provided a consensus about the relationships of such groups among wider Telluraves. Although some researchers have attempted to consider early bird phylogeny in a broader sense (e.g., Ksepka *et al*. 2017, 2019; Mayr & Kitchener 2023a,b,c), notably Mayr's (2005) review on Paleogene bird fossils from Europe, few have attempted a much-needed comprehensive overview of early telluravian evolution.

Currently, many fossil telluravian birds have poorly resolved phylogenetic affinities, statistical support for phylogenetic hypotheses is generally low, and the results are sensitive to character/taxon sampling as well as molecular backbone constraints. For example, the identification of Vastanavidae, Halcyornithidae and Messelasturidae as representatives of pan-Psittaciformes (the total clade including stem and crown group Psittaciformes) is often recovered in unconstrained analysis (Ksepka *et al.* 2011; Mayr & Kitchener 2023a). However, when a molecular constraint is applied (generally using Prum *et al.* 2015 as a molecular backbone) the positions of these taxa shift to stem group representatives of the Pisttacopasseres (Mayr & Kitchener 2023a). The Vastanavidae have further been shown to be more distantly related to

Psittaciformes in other recent studies (Mayr 2015b; Mayr & Kitchener 2022c) and Halcyornithidae possible sister to Coraciimorphae (Ksepka *et al.* 2017). The interrelationships between and among these birds, as well as other psittacopasserines, are not well established nor are they strongly supported in the phylogenies. For instance, *Eofringillirostrum* is well established as a stem Passeriformes, but there is still uncertainty as to whether it is more closely related to Zygodactylidae and crown Passeriformes than other Psittacopedidae taxa (Ksepka *et al*. 2019). Further stem Telluravian taxa (outside of Psittaciformes and Passeriformes) have not been tested in a larger phylogenetic context. For example, the stem Falconiformes Masillaraptoridae (Mayr & Kitchener 2022a), the stem Cariamiformes Bathornithidae (Mayr 2016a), the stem Accipitriformes Horusornithidae (Mourer-Chauviré 1991) and the stem Strigiformes *Ypresiglaux* and *Primoptynx* (Mayr *et al.* 2020; Mayr & Kitchener 2023).

Other challenges reflect broader methodological issues in avian phylogenetics, where molecular phylogenies (e.g., Prum *et al.* 2015) and morphology-based cladistics (e.g., Livezey & Zusi 2007) often yield conflicting results and node-calibrated clocks may underestimate divergence times. Total-evidence tip-dating, as employed by Crouch *et al.* (2019) integrates fossil and molecular data to estimate a Late Cretaceous Telluraves origin (~75.6 Ma), but with sparse morphological matrices limit resolution. This obscures the implications of the avian fossil record for key hypotheses of the early diversification of Telluraves. Therefore, the overall aim of this thesis is to evaluate support for the hypotheses of Telluravian relationships, and especially the affinities of fossil groups, using a comprehensive sample of anatomical characters.

The objective of my research is to establish a new phylogenetic dataset, based on synthesis of all previous character lists and personal observations; to resolve phylogenetic issues of early telluravians; and to study the patterns of their phenotypic evolution in a phylogenetic context. This has been achieved using high-resolution, three-dimensional anatomical datasets from micro-CT scans of extant Telluraves, combined with the study of key fossil taxa. I have revised and expanded on previous phylogenetic character datasets and provided more complete scoring of morphological data from extant species. The morphological component of the data matrix was

assembled using a combination of previously published character matrices, as well as primary literature descriptions of fossil material. This work focused on the morphological assessment of bird specimens representing key fossil taxa whose anatomy were previously poorly characterized. The resulting phylogenetic analysis will test core hypotheses of early telluravian evolution and the factors underlying their early diversification. I also analysed patterns of phenotypic evolution in light of phylogeny using the rate of evolutionary changes in discrete morphological characters in my phylogenetic dataset.

In Chapter 2 of my thesis, I present a detailed character list and descriptions that include anatomical figures, providing a comprehensive morphological dataset for extant Telluravian taxa. These characters, form the foundation for subsequent phylogenetic analyses.

In Chapter 3 of my thesis, I present the results of the phylogenetic analysis of Telluraves using the dataset presented in Chapter 2. This investigation produced clearer synapomorphies of the Telluraves. In this chapter, I also investigate whether morphological data is adequate to robustly resolve phylogenetic divergences and whether these topologies are congruent with previous morphological hypotheses, molecular data or neither. I also assess the impact of fossil taxa on the topology and examine the effect of “raptorial” characters on their inter-relationships. These questions were investigated using parsimony and Bayesian inference methods, providing a robust framework to evaluate Telluravian phylogenetics.

In Chapter 4 of my thesis, I synthesize the phylogenetic results from Chapter 3 and discuss their implications for understanding Telluraves’ early diversification and the role of fossil taxa in shaping phylogenetic hypotheses, while introducing feature considerations.



Rock kestrel (Falco rupicolus), Hermanus, Western Cape, South Africa. Photo by Kevin S. Olsen with bird-guide Mhairi Reid.

Chapter 2 Morphological Character Dataset

2.1 Introductory note

This chapter encompasses the morphological character list, which is typically placed in an appendix, but instead is presented as a chapter. This is often considered a critical component of the analysis, directly supporting the main arguments and interpretations within a study, rather than supplementary information that can be skipped over, thereby emphasising its importance, and allowing for detailed discussion and explanation. A character list is fundamental to understanding the methodology and the results of a morphological study, particularly when discussing character evolution and relationships between taxa. The character list encompasses explanations for character states, coding rational, and justification for character selection.

2.2 Compiling previous morphological character datasets

In an attempt to collate and capture all morphological variation documented so far in telluravian birds, all characters previously published were critically reviewed, overlapping characters combined and reconciled, and, in some cases, extensively rewritten with additional detail to enhance repeatability in scoring. The focus was mainly on previously published stem Telluraves (Palaeocene and Eocene) as they are important for solving the mosaic of features present in telluravian early interrelationships. Key morphological phylogenetic studies of extinct Palaeogene telluravian taxa are summarised in Table 1. Additional studies that focused on morphological descriptions of extant and more recent extinct Telluraves are used to supplement in the review and the creation of characters. These specific studies are referenced in the character list where necessary. Only three of the studied matrices are more “global” in scope, i.e., focused on all extant Aves (Mayr & Clarke 2003; Mayr *et al.* 2003; Livzey & Zusi 2007), while the rest have different

foci, mainly on the fossil specimens in question, where the characters and chosen taxa are designed to test specific relationships within a clade. The main source of previously published characters come from Mayr & Kitchener (2023a; 2023b; 2023c; 2023d) and Ksepka *et al.* (2017, 2019). All of these matrices are modified versions of previous studies and can be traced back to either Mayr & Clarke (2003), Mayr *et al*. (2003) or Livezey & Zusi (2007). Though in most cases there is lack of transparency as to where the included characters come from and little to no explanation of character selection criteria or of the feature itself.

Table 1. List of phylogenetic analyses used in this thesis.

Author (s)	Focus	No. of taxa	No. of characters
Mayr & Clarke 2003	Neoaves	43	148
Mayr e*t al.* 2003	Telluraves	29	89
Mayr & Mourer-Chauvire 2004	Stem Coliiformes	12	19
Mayr 2004	Stem Coraciiformes	17	56
Mayr *et al.* 2004	Stem Coraciiformes	16	36
Mayr 2005a	Stem Psittaciformes	35	96
Mayr 2005b	Stem Falconiformes	22	110
Mayr 2006	Stem Coraciiformes	34	122
Livezey & Zusi 2007	Aves	150	2954
Zelenkov & Dyke 2008	Stem Coliiformes	15	27
Clarke *et al.* 2009	Stem Coraciiformes	49	133
Ksepka & Clarke 2009	Stem Coliiformes	31	50
Ksepka & Clarke 2010	Stem Coliiformes	30	60
Mayr *et al.* 2010	Stem Psittaciformes	35	25
Ksepka *et al.* 2011	Stem Psittaciformes	25	101
Mayr 2011c	Stem Psittaciformes	35	100
Ksepka & Clarke 2012	Stem Psittaciformes	28	106
Mayr 2013	Stem Coliiformes	15	34
Mayr 2015b	Stem Psittacopasserine	27	70
Bourdon *et al.* 2016	Stem Coraciiformes	21	78
Mayr 2016	Stem Cariamiformes	13	40
Ksepka *et al.* 2017	Stem Coliiformes	48	111
Smith *et al.* 2018	Stem Passeriformes	26	50
Hieronymus *et al.* 2019	Stem Passeriformes	17	*39*
Ksepka *et al.* 2019	Stem Passeriformes	34	146
Mayr 2020b	Stem Psittacopasserine	34	84
Riamon *et al.* 2020	Stem Passeriformes	35	36
Mayr 2021c	Stem Psittaciformes	27	77
Mayr 2022b	Stem Coraciiformes	19	58
Mayr & Kitchener 2022a	Stem Falconiformes	10	42
Steell *et al.* 2022	Crown Passeriformes	154	49
Mayr & Kitchener 2023a	Stem Psittaciformes	38	98
Mayr & Kitchener 2023b	Stem Passeriformes	38	96
Mayr & Kitchener 2023c	Stem Psittacopasserine	40	92
Mayr & Kitchener 2023d	Stem Strigiformes	28	26

2.2 Character coding

Phylogenetic analyses utilising morphological data rely fundamentally on the concept of homology, defined as the hypothesis that similarities shared between species are attributable to

common ancestry (e.g., Platnick 1979; Eldredge & Cracraft 1980; De Pinna 1991). This implies that homologous traits serve as reliable indicators of evolutionary relationships. The delimitation of these traits into characters and character states forms the cornerstone of morphological phylogenetic studies. Early hypotheses of homology (termed "primary homology" by De Pinna 1991) are typically established through observation of topographic, ontogenetic, and compositional correspondence (Patterson 1982; De Pinna 1991). The validity of these primary homology hypotheses is subsequently assessed through congruence with a phylogenetic framework, traditionally by using parsimony. This method favours phylogenetic trees that uphold these initial hypotheses as true homology rather than the result of convergent evolution (Patterson 1982; De Pinna 1991). Therefore, characters, in this sense, are equivalent to homologous traits, while character states represent the different variations that a particular trait can assume across taxa at a single hierarchical level (Platnick 1979; De Pinna 1991). The classic example, often used as an analogy, is an aligned nucleotide site in a DNA sequence. This site constitutes a character, while the specific nucleotides (A, T, C, or G) at that site represent character states (Pleijel 1995). Morphological character coding can be more subjective, as it relies on human observation and interpretation, as opposed to the objective reading of a sequence. Nonetheless, rigorous adherence to homology criteria and careful documentation of observation can help mitigate this issue.

A critical assumption in character coding is that character states are independent of each other (e.g., Pimentcl & Riggins 1987). Violations of this assumption can result in a single observation being inadvertently given greater weight, leading to inaccurate phylogenetic inference (Wilkinson 1995b; Strong & Lipscomb 1999). Logical dependence exists when the coding of one character state directly affects the scoring of another within the same taxon, a problem readily avoided with careful character definition (Wilkinson 1995). However, biological dependence is a greater challenge. It arises when character states of different characters are linked through functional or developmental pathways (Wilkinson 1995), often reflecting

biological amalgamation. Information on the underlying causes of these linkages is often limited; thus, this type of dependence can be difficult to avoid.

The application of parsimony, while historically dominant in morphology-based phylogenetics, has been re-evaluated in light of alternative methods such as maximum likelihood (ML) and Bayesian inference (Felsenstein 2004). These methods allow incorporation of different models of character evolution and are increasingly being applied to morphological datasets. Furthermore, recent research has highlighted the dynamic nature of homology, emphasizing the importance of accounting for developmental and genetic context when assessing character equivalence across taxa (Brigandt 2002). The choice of characters and their coding can also lead to significant biases in tree reconstruction. Studies by Brazeau (2011) and Wiens (2000) demonstrate the potential for different interpretations of the same morphological trait to result in drastically different phylogenetic outcomes. These studies highlight the importance of detailed documentation of character coding criteria, along with sensitivity analyses to explore the impact of alternative coding schemes. As for the issue of linked characters, some studies have suggested that, where possible, data from developmental genes could be used to help discern independence (e.g., Abouheif 1999). However, this type of information is not available for many taxa.

While the principles of homology and character independence remain central to morphological phylogenetics, it is important to acknowledge the challenges inherent in this approach. These challenges encompass not only the subjective nature of character coding, but also the complexities of character independence and the need to explore alternative analytical methods such as assessing the sensitivity of phylogenetic results to different character sets, coding schemes, and phylogenetic methods. Morphological data is essential for studying extinct species, particularly where fossils can provide critical insights into the traits of ancestral species and the sequence of evolutionary changes. While studying extant species, morphology reflects adaptations to environmental pressures, offering insights into how species interact with their ecosystems, providing context for interpreting evolutionary changes at the genetic level.

Character revision

Previously utilised characters were sampled according to the following criteria: 1) character states had to vary within the ingroup; 2) characters and individual character states were independent of each other; 3) homology of the character and character states across the ingroup was clear and relatively uncontroversial; 4) distinctions between character states were well-defined. Morphological traits were also coded into binary or multistate characters.

In previous studies of bird phylogeny, morphological characters are often combined into complex observations across multiple hierarchical levels of similarity or combined independently into varying character states. To avoid this, morphological variation is coded in separate characters.

2.4 Extant taxon sampling

The compilation of an inclusive taxon list, encompassing a broad range of extant Telluraves, was central to the current analysis. My objective is not to resolve the in-group relationships of extant Telluraves but to elucidate the relationships among higher taxonomic groupings given the disparate typologies between morphological and molecular phylogenies. My final data set is not designed to test the global relationships of Telluravian taxa within Aves as a whole. Therefore, the focus was on likely basal or earlier diverging members of each clade defined within current molecular topology (see Table S1.1). In total, 57 extant telluravian taxa were selected with at least one representative of each of the families within a clade, excepting of Passeriformes, where only 15 of the over 140 families were utilised. See Table S1.2 for full list of specimens examined and associated depositories.

All osteological characters were based on first hand examination of dry osteological specimens and predominantly by μCT (micro computed tomography) scanned dry osteological collections or μCT scanned fluid preserved specimens. All μCT scanned specimens were previously collected from the TEMPO project library on morphosource

(https://www.morphosource.org/projects/00000C420/about), see also Bjarnason & Benson (2021). All CT image volumes and virtually reconstructed 3D meshes are publicly available on MorphoSource (see Table S1.2 for links to specific specimens). All 3D meshes or models were visualised and studied in MeshLab v2023.12. Scorings from previous published matrices were re-examined where possible. In some cases, the exact species used in previously published material was not available for direct examination, so comparisons were made within the same genus or family.

2.5 The character list

This resulted in a phylogenetic data matrix of 550 characters of which 222 are from the combined previous studies, and 106 were modified for the reasons given under each character description; 328 were new characters where either a previously described characters definition was significantly changed, from previously published morphological studies (that are not placed in a phylogenetic context), or from my own observations. Almost all characters are osteological in nature, with only one character as soft tissue. See Figure 1.4 for a summary of characters per anatomical region.

Some characters were dismissed if they: 1) were poorly defined or could not be sufficiently quantified; 2) exhibited overlapping variation that cannot be separated; 3) were redundant with other characters; 4) were only informative for birds outside Telluraves. In total, 17 osteological characters were excluded, presented in Appendix 4.

An illustrated character list with discussion of character modification and additions, and justifications for modified scorings is presented below. “Modified from study X” refers to modified version of the characters presented by others and “new character” describes characters based on my own observations or from other morphological based studies. References with no pre-text indicates that the character has not changed in the previously described definition.

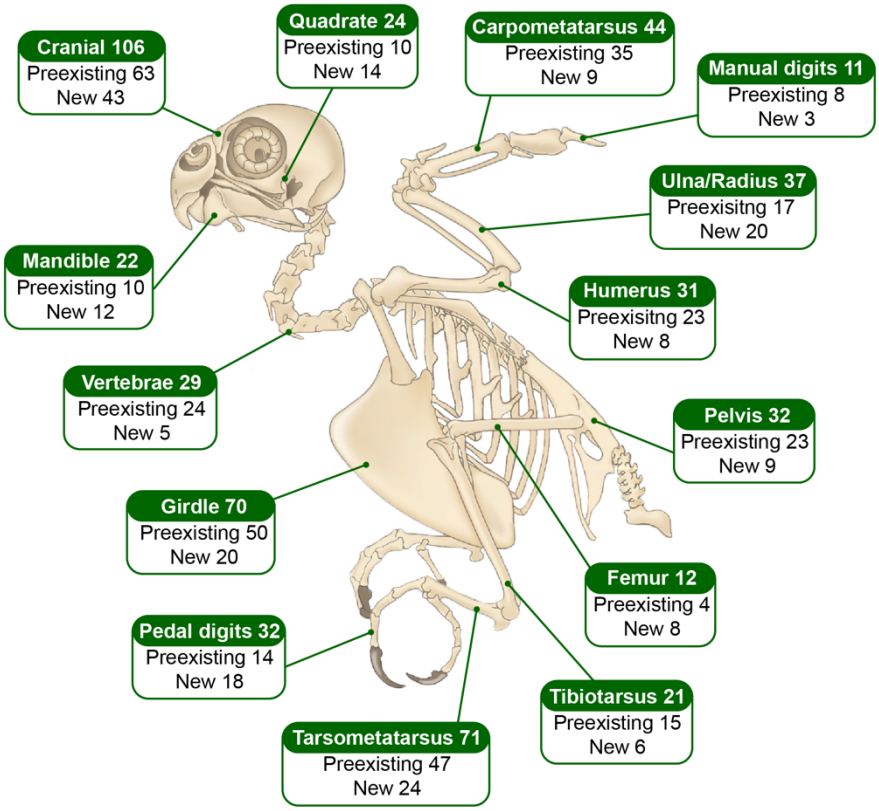


Figure 1.4. Summary of characters per anatomical region.

Anatomical nomenclature

Anatomical terminology follows Baumel & Witmer (1993). The following terms are also included: “processus dentiformis” (Lambrecht 1914), “fovea ligamentalis ventralis” (Livezey & Zusi 2007), and “processus cranialis” (Manegold 2008), “fossa distalis ventralis” and “processus craniodistalis” (Steell *et al.* 2023). See Appendix 2 for all anatomical features discussed in this study. Where applicable, taxon names for major bird clades follow the phylogenetic definitions of Sangster & Mayr (2021) and Sangster *et al.* (2022). Additionally, Cathartidae is accepted within the order Accipitriformes according to the North American Classification Committee (NACC) and International Ornithological Community (IOC). Note, the South American Classification Committee (SACC) do accept Cathartidae as a separate order, Cathartiformes, distinct from Accipitriformes.

CRANIUM

1. Upper beak (maxillary rostrum), length: less than total cranium length (0); equalling or exceeding total cranium length (1).

Modified from Zelenkov & Dyke (2008, ch. 1), (Ksepka *et al.* 2011, ch. 1), Ksepka & Clarke (2009a, ch. 5), Ksepka & Clarke (2010, ch. 2), Ksepka & Clarke (2012, ch. 2) , Mayr (2013, ch. 2).

In most Cavitaves the upper beak is equal to or longer than the cranium, this is also observed in Cariamiformes and the outgroup taxa. See Table S1.5 for rostrum and skull measurements. In all previous work, state 0 is stated as one-third or less than the total length of skull. This, however, was found to not be highly informative given that only a few birds have a beak length less than one-third of the skull in the current dataset (e.g. *Indicator parchyrhynchus* and *Falco sparverius*). Measurements of beak length were taken in a straight line from cranial frontal hinge to tip of beak (ignoring the curve of the culmen).

2. Upper beak, bifurcated groove running from region of nasal to premaxilla: absent (0); present (1) (Fig. 2.2I).

(Ksepka *et al.* 2011, ch. 2), Ksepka & Clarke (2012, ch. 2).

A distinctly bifurcated groove was considered diagnostic for Psittaciformes by Boles (1993). These grooves often hold neurovascular structures for enhanced sensory input (Boles 1993). Deep canals that run parallel along the rostrum are observed in some Accipitriformes (e.g. *Sagittarius*), Falconiformes (e.g. *Falco sparverius*), Cavitaves (e.g. *Atelornis pittoides*) and many birds outside Telluraves (e.g. *Charadris vociferus*). These observations have not been added as a character in this thesis.

3. Upper beak, clearly defined tomial "tooth" or notch on the maxillary bone: absent (0); present (1) (Fig. 2.1K, M).

Modified from (Ksepka *et al.* 2011), Ksepka & Clarke (2012, ch. 3), Mayr & Kitchener (2022a, ch. 9).

In most morphological descriptions of extant taxa, the tomial “tooth” or notch is a feature on the tomial edge of the rhamphotheca (keratinous beak). This can be observed in most Psittaciformes, Falconiforms, some Accipitridae (*Buteo*), Lybiidae (Piciformes) and Laniidae (Passeriformes). In

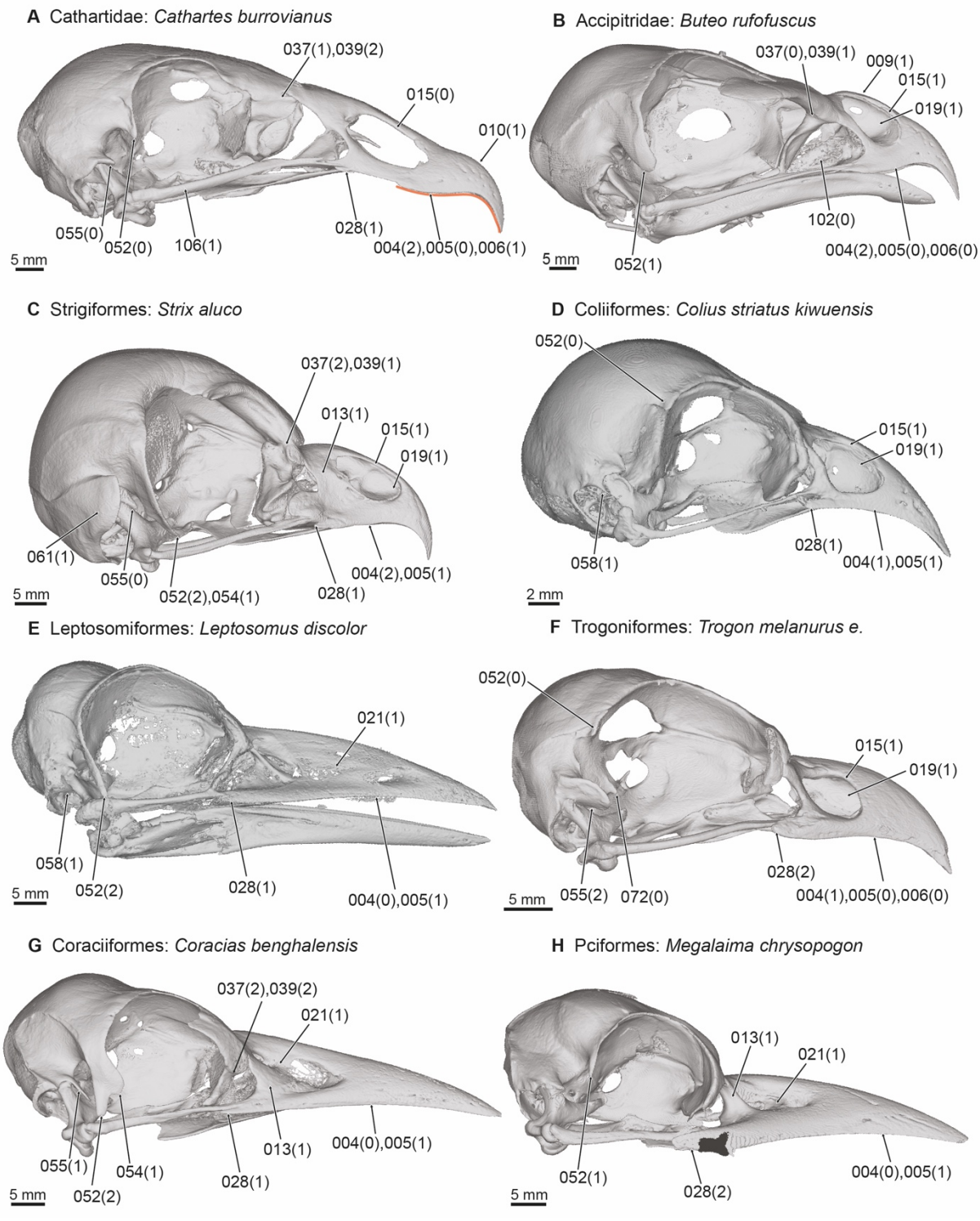
Falconiformes the tomial tooth is used to help aid in immobilising prey by severing the spinal cord, and this is likely the case in Shirkes (Laniidae). The character here refers to a tomial "tooth" defined by a notch on the maxillary bone, which is present only in Psittaciformes (Fig. 2.1M; except *Nestor* and *Strigops*) and some Falconidae, in which it is generally smaller (e.g. *Falco*; Fig 2.1K). The morphology of this structure varies among parrots, with a notch-like structure present in *Barnardius*, *Psittacus* and *Deroptyus*, in which there is a deep concavity before the tip (See Boles 1993); whereas in *Probosciger* the tomium is otherwise smooth with a tooth-like projection near the middle of the tomial margin (Fig. 2.1M).

4. Upper beak, premaxilla, rostral apex curvature: straight (0); curved (de-curved) (1); sharply ventrally hooked, extending far over the rostral tip of the mandible (2) (Fig. 2.1).

Modified from Mayr & Clarke (2003, ch. 3), Mayr (2005a, ch. 2), Mayr (2005b, ch. 1), Mayr (2006b, ch. 2), Mayr (2011c, ch. 2), Mayr (2016a, ch. 8), Mayr *et al.* (2010, ch. 2), Ksepka *et al.* (2017, ch. 2), Ksepka *et al.* (2019, ch. 1), Mayr & Kitchener (2022a, ch. 8).

Ksepka *et al.* (2019, ch. 1) was a complex, multistate character, including 5 states that describe overall beak shape as either "finch-like", in which it is deep, conical and abbreviated, "raptorial", in which the tip is sharply hooked, "parrot-like", in which the nasofrontal hinge is downturned, "long and slender", in which the narial openings are elongated and finally "spatulate". However, the approach fails to capture the similarities between some beak shapes, for example Psittaciformes have variation in their beak shape, *Nestor* and *Strigops* have a decurved beak much like in Trogoniformes (Fig. 2.1F, L) and the rest of Psittaciformes have ventrally hooked beaks (Fig. 2.1M). I therefore used separate characters to capture distinct aspects of similarity among upper beaks: beak length overall (Ch. 1), a downturned nasofrontal hinge (Ch. 7) and size of the narial openings in relation to beak length (Ch. 17).

Figure 2.1. Skulls in right lateral view showing characters 3, 4, 5 ,6, 9, 10, 13, 15, 19, 20, 21, 28, 33, 37, 38, 41, 42, 43, 52, 53, 54, 55, 57, 58, 60 and 72. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Buteo rufofuscus* (Jackal buzzard, NHMUK zoo 1862.1.18.1), (C) *Strix aluco* (Tawny owl, NHMUK zoo S/2001.38.1); (D) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (E) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (F) *Trogon melanurus eumorphus* (Black-tailed trogon, FMNH birds 290496); (G) *Coracias benghalensis* (Indian roller, NHMUK zoo S/1987.19.15); (H) *Megalaima chrysopogon* (Golden-whiskered barbet, NHMUK zoo 1850.8.15.28); (I) *Cariama cristata cristata* (Red-legged seriema, FMNH birds 105635); (J) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (K) *Falco sparverius* (American kestrel, UMMZ birds 154462); (L) *Nestor notabilis* (Kea, FMNH birds 23530); (M) *Probosciger aterrimus* (Palm cockatoo, NHMUK zoo S/2006.15.5; (N) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (O) *Melanopareia torquata bitorquata* (Double-collared crescentchest, FMNH birds 335140); (P) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.


A Cathartidae: Cathartes burrovianus
037(1),039(2)
015(0)
010(1)
055(0)
052(0)
106(1)
028(1)
004(2),005(0),006(1)
5 mm
B Accipitridae: Buteo rufofuscus
037(0),039(1)
009(1)
015(1)
019(1)
102(0)
052(1)
004(2),005(0),006(0)
5 mm
C Strigiformes: Strix aluco
037(2),039(1)
013(1)
015(1)
019(1)
061(1)
055(0)
052(2),054(1)
028(1)
004(2),005(1)
5 mm
D Coliiformes: Colius striatus kiwuensis
052(0)
015(1)
019(1)
028(1)
058(1)
004(1),005(1)
2 mm
E Leptosomiformes: Leptosomus discolor
021(1)
058(1)
052(2)
028(1)
004(0),005(1)
5 mm
F Trogoniformes: Trogon melanurus e.
052(0)
015(1)
019(1)
028(2)
055(2)
072(0)
004(1),005(0),006(0)
5 mm
G Coraciiformes: Coracias benghalensis
037(2),039(2)
021(1)
055(1)
052(2)
054(1)
028(1)
013(1)
004(0),005(1)
5 mm
H Pciformes: Megalaima chrysopogon
013(1)
021(1)
052(1)
028(2)
004(0),005(1)
5 mm

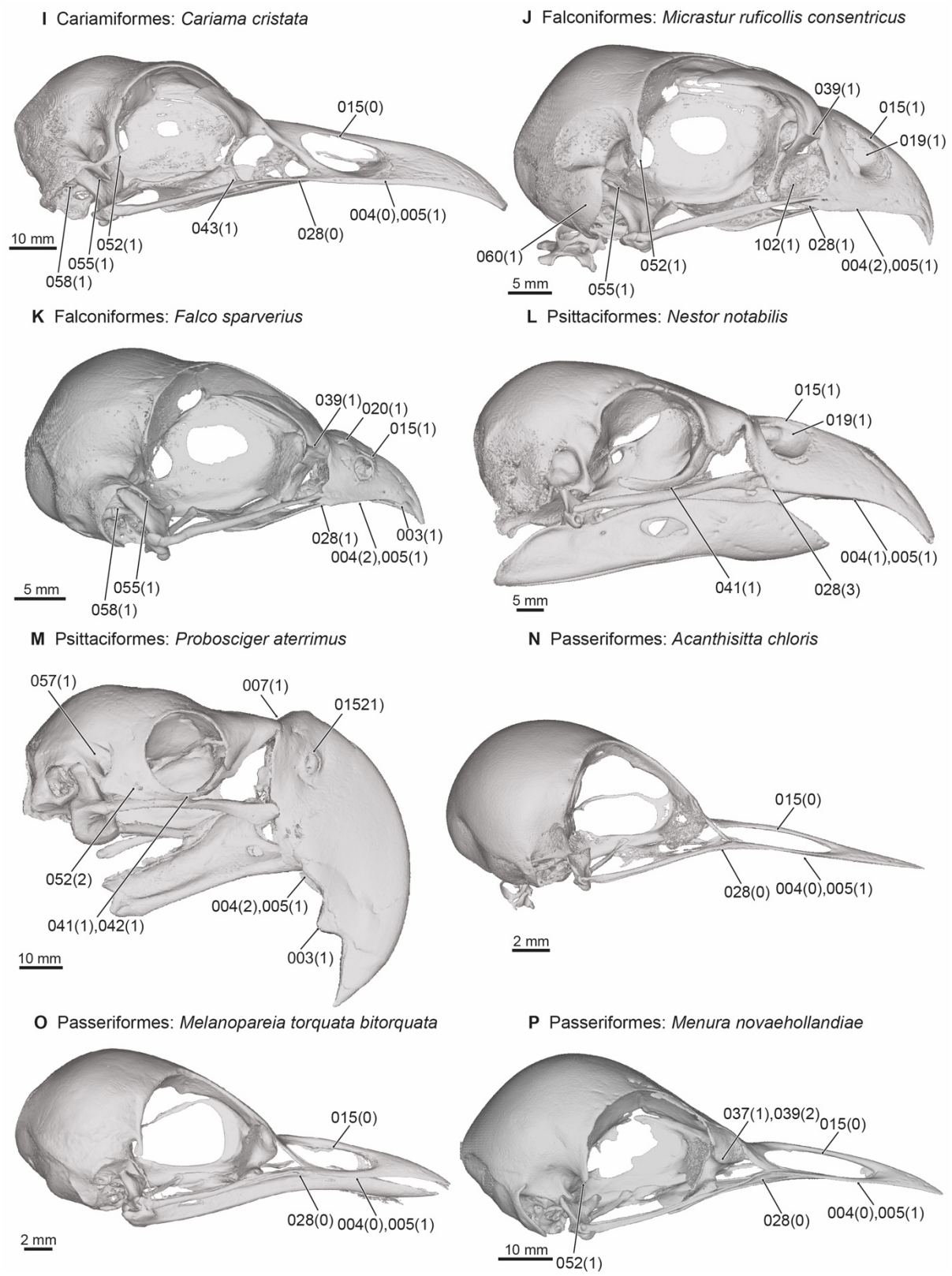


Figure 2.1. (Continued from previous page).

5. Upper beak, shape of tomial ridge (crista tomialis) in lateral view: sigmoid, caudal section convex (recurved superiorly) (0); straight to gradual curvature towards the tip (1) (Fig. 2.1).

Modified from Claramunt & Rinderknecht (2005, ch. 5).

The tomial crest or ridge (crista tomialis) on the lateral edge of the maxilla contributes to the shape of the lower beak. The shape of the tomial ridge as either straight (Fig. 2.1E) to gradually decurved (Fig. 2.1D) shows a large amount of variation in curvature among species of Telluraves, which is difficult to score objectively. For this study, a binary character is used to show that all Accipitriformes (except Sagittariidae) have a tomial ridge that is caudally convex or sigmoidal (Fig. 2.1A, B). And, to a lesser extent, is also observable in the Trogoniformes (*Trogon m. eumorphus* and *Apaloderma narina*) of this study and so scored as (0) (Fig. 2.1F). In some birds the tomial crest is completely absent (e.g. *Gypaetus barbatus*, see Migotto (2013) and in Cathartidae the position or extension is only rostral (Fig. 2.1A, orange line) (see list of characters not included in this study).

6. Upper beak, position of the caudally convex tomial ridge: in line with maxillary bar/process of nasal (0); rostral to maxillary bar/process of nasal (1); inapplicable, convex caudal region of tomial ridge absent [ch. 5: 0] (NA) (Fig. 2.1A, B).

New character.

7. Upper beak, recurved (abruptly downturned at frontonasal hinge): not recurved (0); recurved (1) (Fig. 2.1M).

Modified from Ksepka *et al.* (2017, ch. 2), Ksepka *et al.* (2019, ch. 1) (see description of ch. 4 for explanation of modification).

An abruptly downturned beak at the nasal frontal hinge is observed only in Psittaciformes. There is some amount of degree to which the beak is recured, notably that *Nestor notabilis* and *Psittrichas fulgidus* have far less of a degree of re-curvature than other parrots. However, for the purpose of this study both have been scored (1).

8. Upper beak, nasofrontal hinge, transverse groove: absent/indefinite region (0); caudal part of beak markedly set off by a furrow against rostral part of cranium (frontals/frontalia) (1) (Fig. 2.2A, F, I).

Modified from Mayr & Clarke (2003, ch. 5), Mayr (2005b, ch. 2), Mayr (2013, ch. 3).

The frontal region (Os frontale) is articulated rostrally to the nasal bone by the nasal-frontal suture or hinge. Also known as the craniofacial flexion zone, "zona flexoria craniofacialis" Zusi (1984), composed of the lacrimals, nasals, frontals and premaxillae. In some birds the caudal part of the beak is markedly set off by a furrow against the rostral portion of the cranium (Fig. 2.2C, F, I). Psittaciformes have the most developed and distinctive nasal-frontal hinge (Fig. 2.2I).

9. Upper beak, supranarial bar (os nasale) shape: straight (0); strongly convex (1) (Fig. 2.1B).

New character.

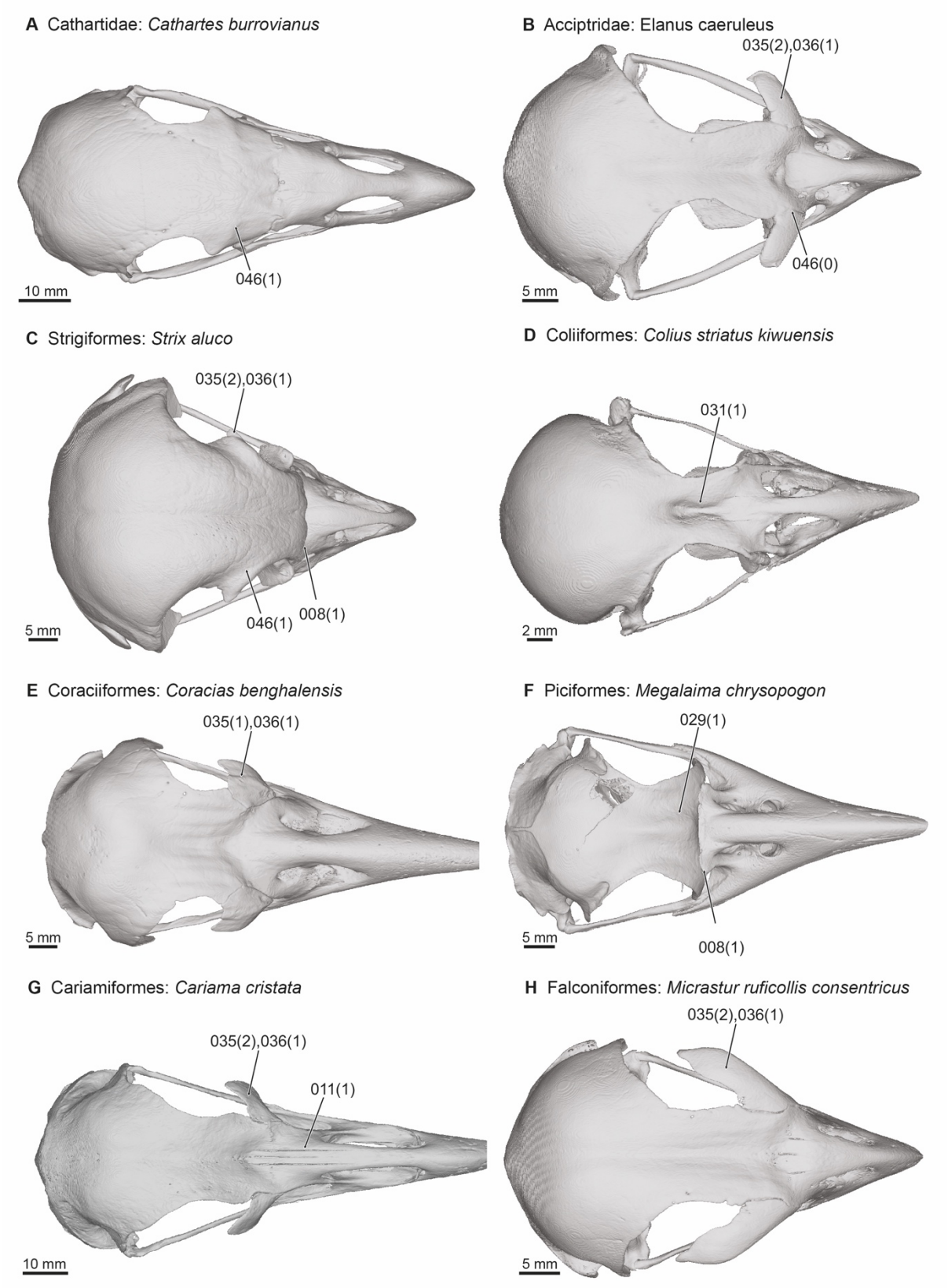
A strongly convex supranarial bar is observed in nested Accipitridae like *Buteo rufofuscus* (Fig. 2.1B) and nested Falconiformes like *Daptrius ater* and *Caracara cheriway*.

10. Upper beak, premaxillary shape: smooth curve (0); "bulbous" strongly convex/dorsally inflated in lateral view (1) (Fig. 2.1A).

New character.

In the present study a bulbous dorsal margin of the premaxilla (state 1) is only observed in Cathartidae but is also present in some Old World vultures (e.g. *Gyps fulvus*; personal observation).

Figure 2.2. Skulls in dorsal view showing characters 2, 8, 11, 29, 30, 35 and 36. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (C) *Strix aluco* (Tawny owl, NHMUK zoo S/2001.38.1); (D) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (E) *Coracias benghalensis* (Indian roller, NHMUK zoo S/1987.19.15); (F) *Megalaima chrysopogon* (Golden-whiskered barbet, NHMUK zoo 1850.8.15.28); (G) *Cariama cristata cristata* (Red-legged seriema, FMNH birds 105635); (H) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (I) *Strigops habroptilus* (Kākāpō, NHMUK zoo 1881.1.17.71); (J) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146). Numbers denote characters and character states as listed.


A Cathartidae: *Cathartes burrovianus*
046(1)
10 mm
B Acciptridae: Elanus caeruleus
035(2),036(1)
046(0)
5 mm
C Strigiformes: *Strix aluco*
035(2),036(1)
046(1)
008(1)
5 mm
D Coliiformes: *Colius striatus kiwuensis*
031(1)
2 mm
E Coraciiformes: *Coracias benghalensis*
035(1),036(1)
5 mm
F Piciformes: *Megalaima chrysopogon*
029(1)
008(1)
5 mm
G Cariamiformes: *Cariama cristata*
035(2),036(1)
011(1)
10 mm
H Falconiformes: *Micrastur ruficollis consentricus*
035(2),036(1)
5 mm

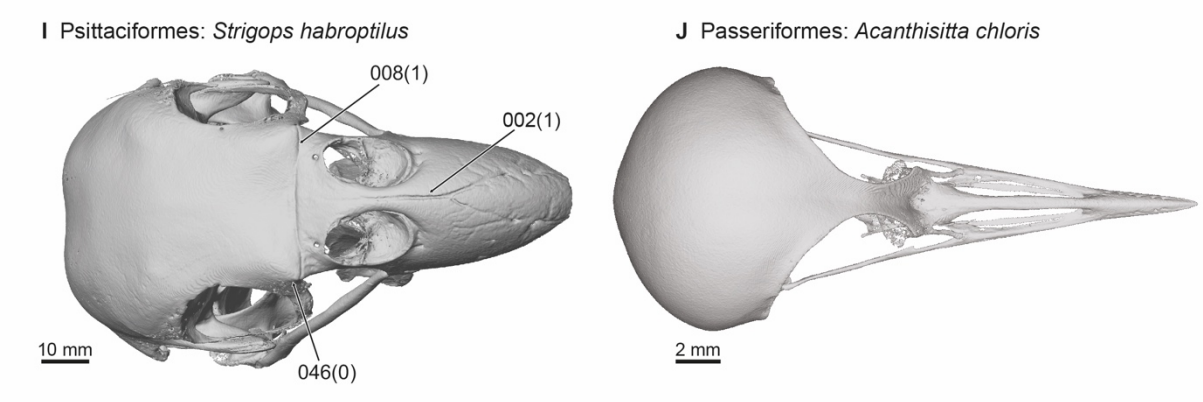


Figure 2.2. (Continued from previous page).

11. Upper beak, frontal processes (processus frontales) of premaxilla: fully fused/not extensively unfused (0); extensively unfused (1) (Fig. 2.2G).

New character.

The frontal processes of the premaxillae are fused in most Telluraves (state 0) while in many non-Telluraves, including the outgroups used in this study, the frontals tend to be distinctly separate with a visible gap or suture between them (state 1). However, Cariamiformes as well as their extinct members such as the Phorusrhacidae *Llallawavis scagliai* are extensively unfused compared to most other Telluraves (see Degrange 2020).

12. Upper beak, ventral surface, distinct median ridge that projects further than tomial ridge: absent (0); present (1) (Fig. 2.3B).

Mayr & Kitchener (2022, ch. 9).

In the ventral concavity just proximal of the bill tip of many birds, the tomial ridge is flat or slightly convex (Fig. 2.3A, state 0). In state 1, the tomial ridge forms a distinct median ridge, the tomial ridge, in this case, does not form a sharp cutting edge but bear shallow tomial grooves. This feature is observed in all Falconiformes including the Masillaraptoridae *Danielsraptor phorusrhacoides* and *Masillaraptor parvunguis* (Mayr & Kitchener 2022).

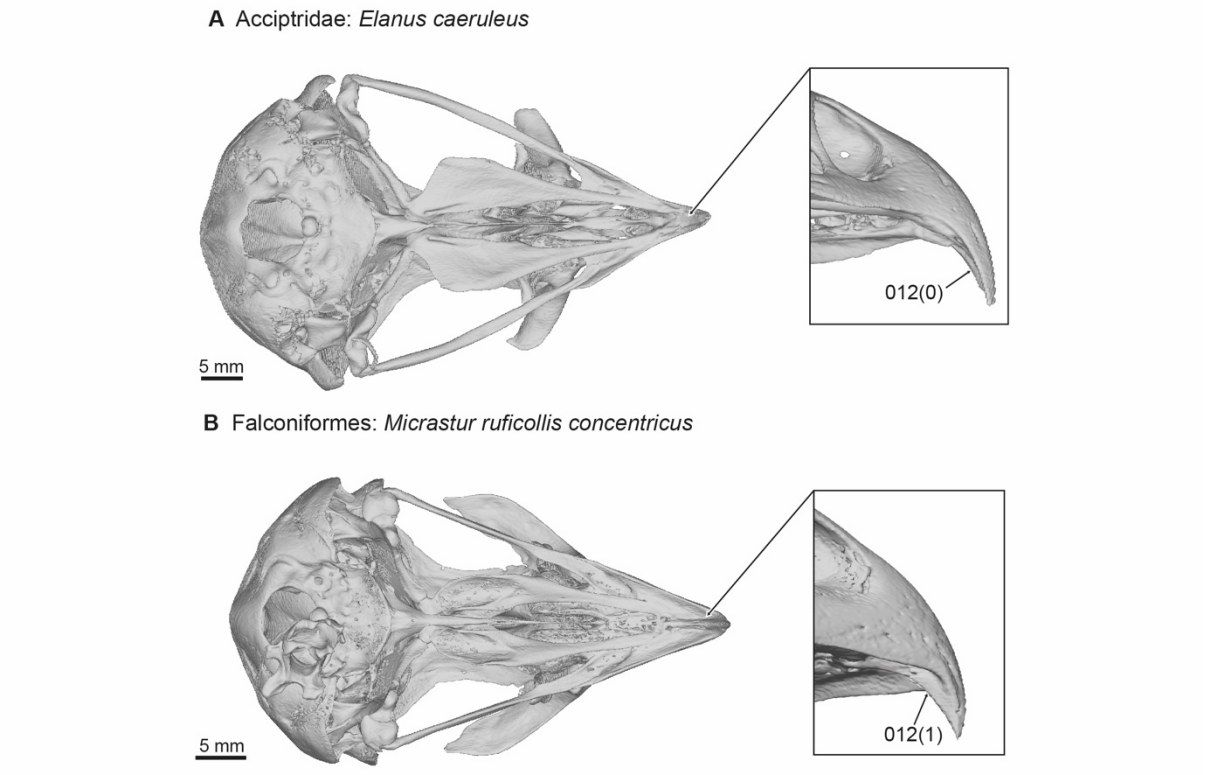


Figure 2.3. Skulls in ventral view, with right ventrolateral view of distal portion of rostrum in box showing character 12. (A) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (B) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226). Numbers denote characters and character states as listed.

13. Upper beak, lateral narial bar (fused maxilla and nasals): narrow (0); wide (1) (Fig. 2.1C, G, H).

New character.

A wide narial bar is a feature observed in Cavitaves such as *Coracias benghalensis* (Fig. 2.1G), *Momotus momota* and *Galbula dea*. The narial bar in some cases like in *Tockus, Ramphastos* and *Psittaciformes* are exceptional large due to the reduction in the nasal cavity and overall major ossification of the upper beak, these birds have been scored as (?). There are birds that do show an intermediate size for example in *Pseudasturides_macrocephalus* (Mayr 1998, fig. 3), in these cases they have been scored as (0).

14. Upper beak: mediolaterally narrow (mediolateral width of nasofrontal hinge/ width of cranium <0.625 (0) mediolaterally wide (width of nasofrontal hinge/ width of cranium>0.650) (1).

New character.

A mediolaterally wide upper beak (state 1) is observed in early diverging Cavitaves such as Leptosomiformes, Trogoniformes and Bucerotiformes. Trogoniformes have exceptionally wide beaks that likely help them to dig nesting sites into rotten wood (Collar 2001), this has not been accounted for in the present study. See Table S1.5 for measurements of the nasofrontal hinge width and cranium width.

15. Nares, shape in lateral view: subrounded (0); ovoid (1); round (2) (Fig. 2.1).

Modified from Ksepka *et al.* (2011, ch. 1), Ksepka & Clarke (2012, ch. 1), Smith, DeBee*, et al.* (2018, ch. 1), Hieronymus *et al.* (2019, ch. 1).

Subrounded nares are nearly circular but slightly flatted, this observed in most members of Cariamiformes and Passeriformes (Fig. 2.1I, N, O, P). Ovoid nares are elongate, tear drop shaped this is observed in most other Telluraves. Perfectly rounded nares are only observed in nested Psittaciformes such as *Probosciger* (Fig. 2.1M). In some cases, a thin osseous sheet is covering the proximal portion of the nasal opening, for e.g. in *Falco*, the shape of the nasal opening is still considered ovoid (Fig. 2.1K).

16. Nares, shape in lateral view, triangular with a flat ventral margin: absent (0); present (1).

Clarke *et al.* (2009, ch. 2), Bourdon *et al.* (2016, ch. 2).

In Clarke *et al.* (2009), *Eocoracias* is placed as the sister taxon to a clade comprising *Paracoracias, Geranopterus*, and "Coracioidea". This recovered position for *Paracoracias*, as more closely related to "Coracioidea" than *Eocoracias*, is supported by one unambiguous synapomorphy: external nares triangular with a flat ventral margin. In the present study however, only *Atelornis pittoids* (Brachypteraciidae) and *Alcedo atthis* (Alcedinidae) was found to have this feature (state 1).

17. Nares, size: anteroposterior length less than half the length of the rostrum (0); equal to or greater than half the length of the rostrum (1).

Modified from Hieronymus *et al.* (2019, ch. 2), Riamon *et al.* (2020, ch. 4), Smith *et al.* (2018, ch. 2).

See Table S1.5 for nares and rostrum measurements.

18. Upper beak, well-defined cere surrounding narial openings: absent (0); present (1).

Mayr & Clarke (2003, ch. 143) ch.143, Mayr *et al.* (2003, ch. 4), Mayr (2005a, ch. 4), Mayr (2005b, ch. 106), Mayr (2006, ch. 4), Mayr *et al.* (2010, ch. 4), Mayr (2011, ch. 4), Mayr (2015b, ch. 2), Ksepka *et al.* (2017), Mayr (2020b, ch. 2), Mayr (2021c, ch. 2), Mayr & Kitchener (2023a, ch. 2), Mayr & Kitchener (2023b, ch. 2), Mayr & Kitchener (2023c-b, ch. 2).

The cere, a soft tissue structure at the base of the upper beak, is typically waxy in life and serves multiple functions, including protection of the nares and facilitation of respiratory efficiency, with possible roles in sexual display in some taxa (e.g. Ferguson-Lees & Christie 2001; Bortolotti *et al.* 2003). The cere is observed mainly in Accipitriformes, Strigiformes, Coliiformes, Psittaciformes and Falconiformes. This feature is also commonly found in many birds outside of Telluraves such as Cracidae (curassow) and Columbidae (pigeons). In Strigiformes the cere is not found around the nares but rather more distal. Scorings taken from the above studies as well as personal observation.

19. Nares, largely or completely ossified nasal septum that extends the length of the narial opening: absent (0); present (1) (Fig. 2.1).

Mayr & Clarke (2003, ch. 8), Mayr *et al.* (2003, ch. 1), Mayr (2004, ch. 1), Mayr *et al.* (2004, ch.1), Mayr (2005a, ch. 1), Mayr (2005b, ch. 3), Mayr (2006, ch. 1), Zelenkov & Dyke (2008, ch. 3), Clarke *et al.* (2009, ch. 7), Ksepka & Clarke (2009, ch. 1), Ksepka & Clarke (2010, ch. 1), Mayr *et al.* (2010, ch. 1), Ksepka *et al.* (2011, ch. 4), Mayr (2011, ch. 1), Ksepka & Clarke (2012, ch. 6), Mayr (2013, ch. 1), Mayr (2015, ch. 1), Bourdon *et al.* (2016, ch. 7), Ksepka *et al.* (2019, ch. 2), Mayr (2020, ch. 1), Mayr (2021, ch. 1), Mayr (2022b, ch. 1), Mayr & Kitchener (2023a, ch. 1), Mayr & Kitchener (2023b, ch. 1), Mayr & Kitchener (2023c, ch. 1).

The nasal septum (septum nasi osseum) extends from the distal narial opening to the proximal narial opening as an osseous sheet. The amount of ossification of the nasal septum (septum nasale) in Neognathae varies significantly and is rarely found in Palaeognathae (Ericson 1997). Within Telluraves, total ossification is found in many birds of this study mainly Accipitriformes (Fig. 2.1B), Strigiformes Fig. 2.1C), Coliiformes (Fig. 2.1K), many of the Eucavitaves (Fig. 2.1F), Falconiformes (Fig. 2.1J) and Psittaciformes (Fig. 2.1L). This feature however is only found in a few Passeriformes (e.g. *Rupicola* sp. and in some Passerida). In the above listed references, *Leptosomus* and *Merops* have been scored as possessing a largely ossified nasal septum (state 1 here). However, after examination of specimens using CT scanned images, it is clear that the ossification of the nasal septum is not complete in *Leptosomus* and *Merops* and for this reason

they have been scored as state 0 here. Cavitaves in general show the most variation in the amount of ossification, with birds like *Merops* showing a small amount of ossification, but no true separation of the nasal cavity. Juvenile Meropidae do have a cartilaginous nasal septum, but this does not appear to become ossified (Brusaferro & and Simonetta 1998). In some cases, the nasal septum is fused with the os maxillare (see ch.23).

20. Narial opening: completely open (0); proximodorsal part partially covered by nasal bone (1) (Fig. 2.1K).

New character.

The presence of a partially covered nasal opening (state 1) was observed in all Falconiformes except Herpetotherinae (*Micrastur* and *Herpetotheres*, Fig. 2.1J). The bone covers about two thirds of the nasal opening and results in a circular or oblong nasal opening shape. This has also been observed in *Aquila rapax* (Acciptridae) (see Migotto 2013 ch.37) but is absent in other birds. It is possible that this covering also occurs in parrots, resulting in small, rounded nostrils, however it is difficult to make out any clear sutures similar to what is observed in falcons.

21. External naris, division by a thin bony septum: undivided (0); divided (1) (Fig. 2.1E).

Clarke *et al.* (2009, ch. 6), Bourdon *et al.* (2016, ch. 6).

An osseous lamella subdivides the external naris into a rostral and a caudal opening in some Cavitaves namely in Bucerotiformes, including *Upupa epops*, Coraciidae, Brachypteraciidae (though not observed in this study) and Megalaimidae, see discussion in Mayr & Clarke (2003); Cracraft (1971a). In the present study it was also found to be observed in *Leptosomus discolor* (Fig. 2.1E). This so-called "amphirhinal condition" is also widespread within Passeriformes however not observed in any of the taxa in this study.

22. Nares, extensively ossified turbinates: absent (0); present, with scroll-like morphology (1) (Fig. 2.4).

New character.

In birds, the respiratory turbinate is generally a cartilaginous, scroll-like structure within the nasal cavity (Zusi 1993). There are many cases where the turbinate ossifies on the nasal, maxilla or both and the degree to which it ossifies varies greatly within and among clades. (Tada & Tsuihiji 2021) found extensive ossification as a scroll structure in some Accipitriformes such as *Aegypius monachus*, while some Falconiformes, Psittaciformes and Passeriformes had only a ridge. In the present study, the turbinate was found to be ossified as a scroll-like structure in *Vultur gryphus*, Upupidae, *Indicator pachyrhynchus* (Fig. 2.4A), *Megalaima chrysopogon*, Falconiformes (Fig. 2.4B) and *Rupicola peruvianus*. And as a ridge in *Leptosomus discolor, Probosciger aterrimus*, *Psittacus Erithacus* and *Nestor notabilis* (scored as absent for this study).

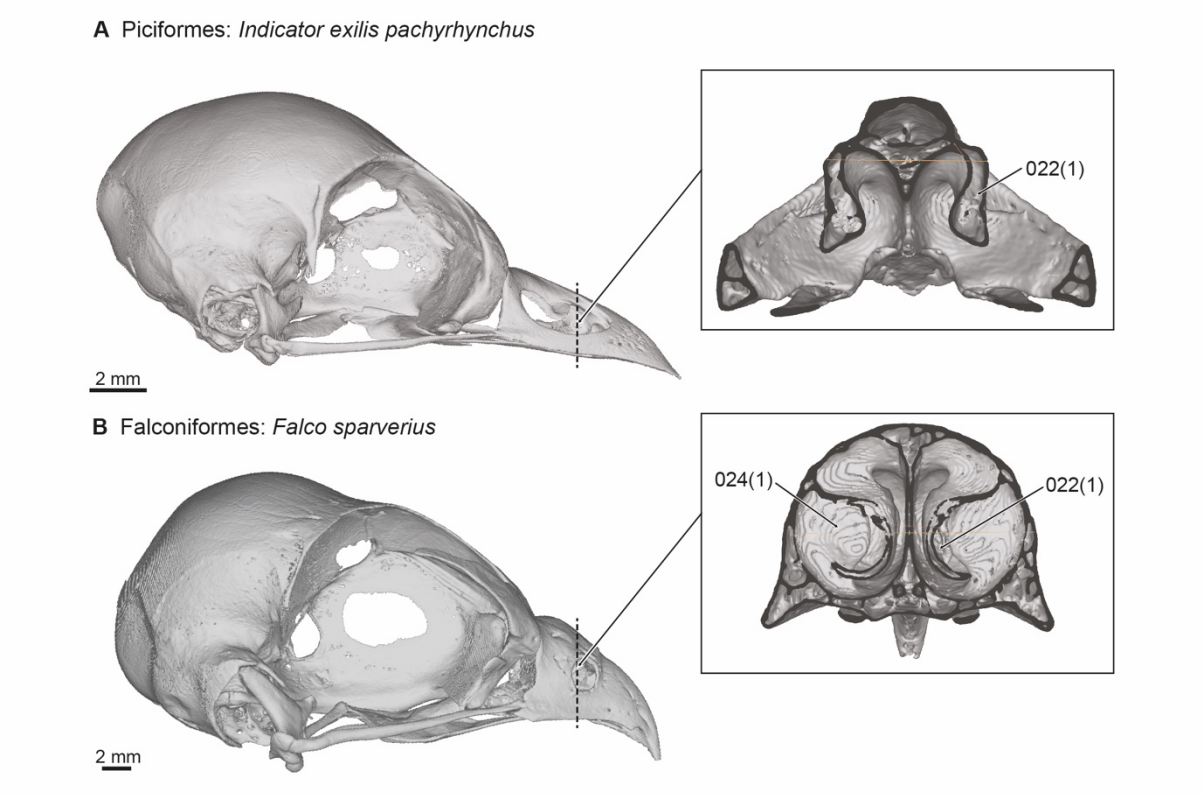


Figure 2.4. Skulls in lateral view with frontal cross-section of rostrum in box showing characters 22 and 24. (A) *Indicator exilis pachyrhynchus* (Least honeyguide, FMNH birds 429726); (B) *Falco sparverius* (American kestrel, UMMZ birds 154462). Numbers denote characters and character states as listed.

23. Nasal septum, if present: unfused (0); fused with maxilla (os maxillare) (1); inapplicable, nasal septum absent [ch.19] (NA) (Fig. 2.5).

New character.

In birds with robustly ossified beaks such as Falconiformes, the maxilla (os maxillare) often co-ossifies with surrounding bones, specifically the nasals and, if present, the nasal septum (Fig. 2.5C). In Coliiformes the nasal septum and maxilla are not completely fused but rather touching Fig. 2.5B), for this reason they have been scored as unfused (0).

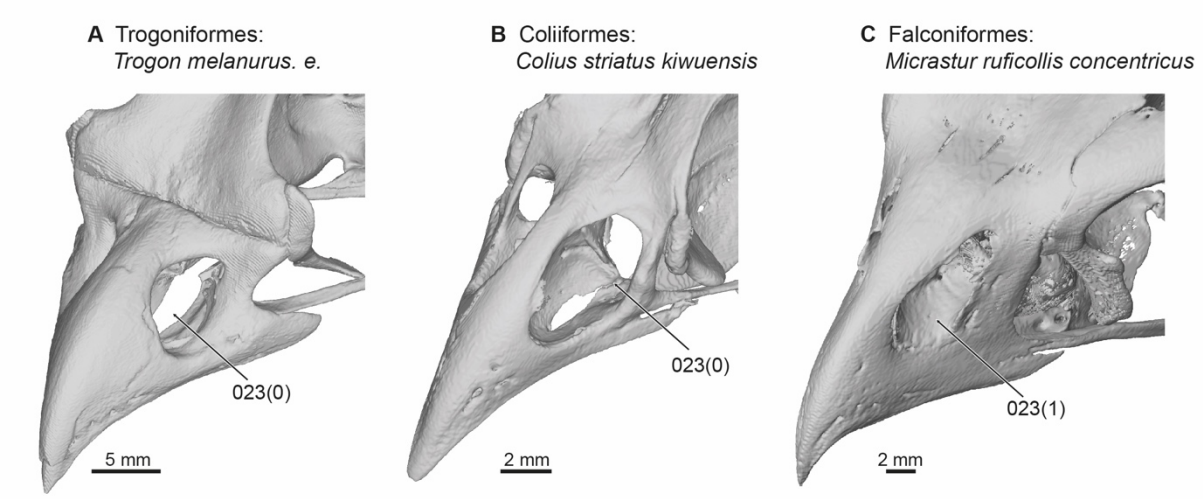


Figure 2.5. Rostrum in left anterodorsolateral view showing character 23. (A) *Trogon melanurus eumorphus* (Black-tailed trogon, FMNH birds 290496); (B) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (C) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226). Numbers denote characters and character states as listed.

24. Narial opening, extra bony tubercle interior to the nasal openings: absent (0); present (1) (Fig. 2.4B).

New character.

An extra bony tubercle (state 1) is only present in Falconidae (Fig. 2.4B), except in the basal subfamily Herpetotherinae (laughing and forest falcons) where it is absent (state 0). This bony tubercle is regarded as an aid for breathing at high speeds during aerial dives (Kesel *et al.* 2019).

25. Relationship of external naris and fenestra antorbitalis: do not overlap in lateral view (0); caudal border of the nares overlaps fenestra antorbitalis posteriorly (extends rostrally) (1).

Clarke *et al.* (2009, ch. 1), Bourdon *et al.* (2016, ch. 1).

26. Upper beak, cranial kinesis: holorhinal naris (0); schizorhinal naris (1) (Fig. 2.6).

Modified from Mayr & Clarke (2003, ch. 6).

Cranial kinesis in birds is characterised by the ability to move the upper bill relative to the cranium. This movement occurs in bending zones and can be categorised according to the position of the zone of bending (Zusi 1984). Most Telluraves are able to move the upper bill as a whole, a condition known as prokinetic (Bock 1964), where the bending zone is situated at the nasal-frontal hinge. Prokinesis is generally associated with a holorhinal naris, in which the nasal bones are contiguous and are not deeply cleft (state 0). The second most common bending type is ryhnochokinetic, where the bending zones are positioned further rostrally, within the upper bill. Rhynchokinesis is generally associated with a schizohinal naris where the lateral bar is flexible and the narial opening extends caudally beyond the naso-frontal hinge, as a slit that emarginates the nasal bone (Zusi 1984). There are a number of sub-divisions characterized between prokinetic and rhynochokinetic skulls but for the purpose of this study it is simplified to what can only be observed in the osteological configuration of the nares and not the position of the bending zone. For a more in-depth discussion on these types see Zusi (1984) and (Gussekloo & Bout 2005). In the present study, a schizorhinal naris was found to be present in the Passeriformes *Acanthisitta chloris* (also confirmed in Zusi (1984) study) (Fig. 2.6B). The schizorhinal condition was also identified and discussed in the Zygodactylidae *Primozygodactylus quintus* (Mayr 2017b, fig. 3), *P. danielsi* (Mayr 2017b, fig. 3) and the morsoavid *Pumiliornis tessellatus* (Mayr 2008c). And finally, many outgroup taxa like *Charadris* possess this condition (Fig. 2.6A).

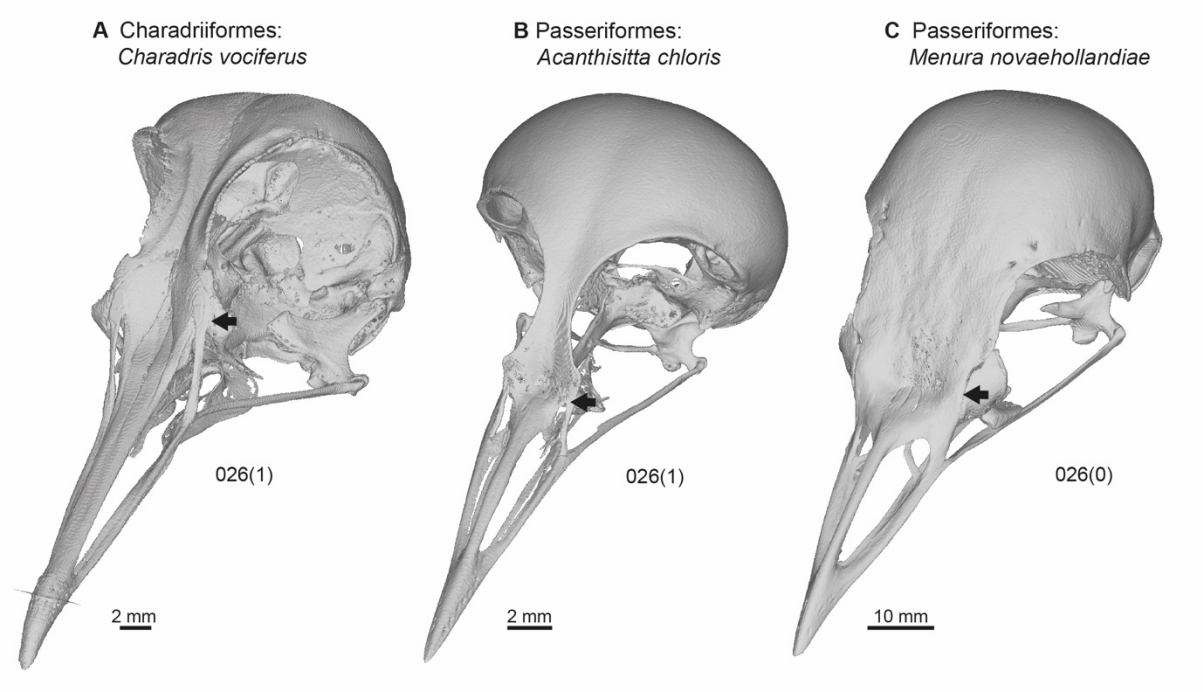


Figure 2.6. Skulls in left anterodorsolateral view showing character 26. Black arrow indicates craniofacial hinge. (A) Schizorhinal type naris, *Charadris vociferus* (Killdeer, FMNH birds 470173); (B) Schizorhinal type naris, *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (C) Holorhinal type naris, *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

27. Antorbital fenestra (fenestra antorbitalis), the proportional size compared to that of the skull: developed (0), reduced (1).

Riamon *et al.* (2020, ch. 5).

Scorings taken from the above study.

28. Angulus tomialis maxillaris: continuous (fused) with jugal bar (0); discrete projection ventral to jugal (1); discrete projection lateral to jugal (2); unfused (no projection) (3) (Fig. 2.1).

New character.

In many birds, the tomial ridge forms a caudally directed process that extends ventral to the jugal process (processus jugalis), which was termed "angulus tomialis" by (Livezey & Zusi 2006, pg. 84), it is also known as the maxillary process of the praemaxilla. In Telluraves this extension is a

flattened process that can either be completely fused to the jugal bar (state 0; Fig. 2.1I, N, O, P), ventral to the jugal (state 1; Fig. 2.1A, C, D, E, G, J, K), lateral to the jugal (state 2; F, H) or no projection (Fig. 2.1L).

29. Frontal region, bony elevation: absent (0); present (1) (Fig. 2.2F).

New character.

A bony elevation in the frontal region (os frontale) was originally described by Burt (1930) as the "frontal overhang". Bock (1964) suggested that in woodpeckers this structure functions as a "bony stop", preventing an excessive protraction of the maxilla during hammering. This has been corroborated by mechanical studies that show the effect of the frontal overhang (uneven spongy bone), and hyoid bone designed to limit the stresses away from the braincase and towards the body (e.g. Wang *et al.* 2011). However, this elevation is also found in many other Piciformes that do not drum heavily on tree bark, such as *Megalaima chrysopogon* (Golden-whiskered barbet), see Donatelli (2012) for more examples (Fig. 2.2F).

30. Frontals, interorbital region (bridge): much narrower than skull at level of quadrate (0); wide, interorbital region subequal to skull width at level of quadrate (1) (Fig. 2.2).

Ksepka *et al.* (2011, ch. 8), Ksepka & Clarke (2012, ch. 9).

A relatively narrower interorbital region is observed in most Telluraves except in Psittaciformes where it is exceptionally wide (Fig. 2.2I). Passeriformes have an exceptionally narrow interorbital region but is not accounted for in the present study. See Table S1.5 for measurements of interorbital width and width of cranium.

31. Frontal region: convex or flat (0); furrowed along the midline between orbits, concave (1) (Fig. 2.2).

New character.

The degree of depression is highly variable within Telluraves, but for the most part the frontals are relatively flat except in basal Coraciimorphae such as Coliiformes (Fig. 2.2D), Leptosomiformes and Trogoniformes, in which there is a very deep furrow along the midline of

the interorbitals. To a lesser extent this feature is seen in Cariamiformes and has been scored as present (state 1). This feature has also been found in some Accipitriformes such as *Leptodon cayanensis* (Gray-headed kite) but none of this study, see Migotto (2013) for more examples within Accipitriformes.

32. Orbits, size relative to skull (rostral-caudal length): more than half (0); less than half (1).

Raimon *et al.* (2020, ch. 2).

See Table S1.5 for measurements of orbit length and cranium length.

33. Orbits, shape: dorsolateral side is flatter (0); rounded (1) (Fig. 2.1).

Modified from Raimon et al (2020, ch. 3).

34. Lacrimal: present, and more or less individualised or "free" (0); indiscernible due to loss or fusion (1) (Fig. 2.7F).

Modified from Mayr *et al.* (2003, ch. 6), Mayr (2005, ch. 6), Mayr (2006, ch. 7), Clarke *et al.* (2009, ch. 12), Mayr *et al.* (2010, ch. 6), Mayr (2011, ch. 6), Bourdon *et al.* (2016, ch. 10), Ksepka *et al.* (2017, ch. 5), Ksepka *et al.* (2019, ch. 5), Raimon *et al.* (2020, ch. 6).

In previous character statements the phrase "greatly reduced" or "absent" are used to describe state 1. Indiscernible is used herein because the lacrimal (os lacrimale) is not always completely lost but fused to an expansive ectethmoid (Fig. 2.7F). This is likely the case in Bucerotiformes based on a study of young individuals (Pascotto & Donatelli 2003; Pascotto *et al.* 2006), a condition also observed outside Telluraves such as in Columbidae (Andrela & Donatelli 1995). In *Momotus* (Motmots) it is clear that the lacrimal is completely absent, given that the ectethmoid is reduced, so it is not likely to be fused, Korzun *et al.* (2004) suggested that the lacrimal could possibly be incorporated into the upper jaw of these birds. To answer such questions further embryological studies are needed. In all passerines (with a few exceptions) the lacrimal is fused to the ectethmoid (Ch. 48) but the fusion point of contact is clearly visible and so the lacrimal is very much discernible (Fig. 2.7I).

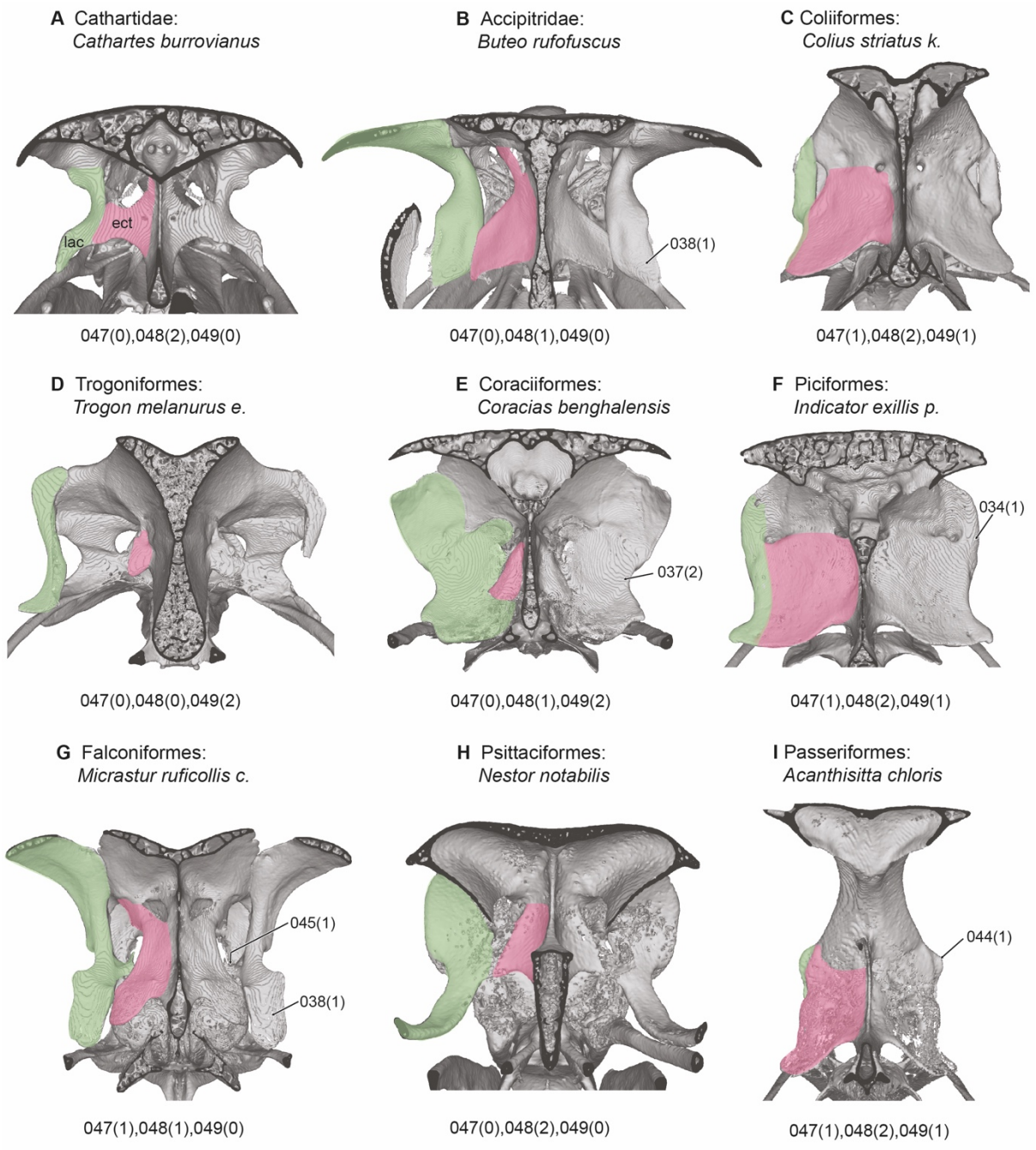


Figure 2.7. Frontal cross-section through orbit, looking rostrally showing ectethmoid (pink; 'ect') and lacrimal (green; 'lac') showing characters, 34, 38, 44, 47, 48 and 49. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Buteo rufofuscus* (Jackal buzzard, NHMUK zoo 1862.1.18.1); (C) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (D) *Trogon melanurus eumorphus* (Black-tailed trogon, FMNH birds 290496); (E) *Coracias benghalensis* (Indian roller, NHMUK zoo S/1987.19.15); (F) *Indicator exilis pachyrhynchus* (Least honeyguide, FMNH birds 429726); (G) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (H) *Nestor notabilis* (Kea, FMNH birds 23530); (I) , *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146). Numbers denote characters and character states as listed.

35. Lacrimal, size of supraorbital process: unexpanded (narrow) (0); medially expanded (1); greatly expanded (caudally long/pointed) (2) (Fig. 2.2).

Modified from Mayr *et al.* (2004, ch. 3), Clarke *et al.* (2009, ch. 10), Bourdon *et al.* (2016, ch. 8), Ksepka *et al.* (2019, ch. 4), Mayr & Kitchener (2023c-a, ch. 1).

The supraorbital process (processus supraorbitales) is a projection of the lacrimal that originates at the rostrodorsal margin of the orbit and extends posteriorly at the level of the lateral edge of the frontal bone (sensu Cracraft 1968). A long and well-developed supraorbital process of the lacrimal (state 2) is found in most members of Sagittariidae, Accipitridae (Fig. 2.2B), Cariamiformes (Fig. 2.2G) and Falconiformes (Fig. 2.2H). The development of this process is variable within Strigiformes. They are, for example, well developed in *Aegolius funereus*, *Athene noctua* and *Surnia ulula* but narrow and small in *Strix aluco*, *Tyto alba* and some larger species. However, a well-developed supraorbital process is present in juveniles of *Strix aluco* and so was scored as present in Mayr *et al.* (2004) and Mayr & Kitchener (2023d). In work by Ksepka *et al.* (2019) owls have not been scored as having enlarged supraorbital processes. I think the problem is specifically with the owls *Tyto* and *Strix* in that the supraorbital process has become fused within the orbital rim, making it difficult to decern the shape (Fig. 2.2C). However, I agree with Mayr *et al.* (2004) and have scored owls as having a greatly expanded process (state 2). Additionally, a free lacrimal is observed in the early Eocene *Ypresiglaux michaeldanielsi* (Mayr & Kitchener 2023d). An additional state has been added (state 1) in this study, to account for the highly variable size of the supraorbital process observed in Coraciiformes such as *Coracias* (Fig. 2.2E).

36. Lacrimal, supraorbital process caudally projecting over orbit: absent (0); present (1) (Fig. 2.2).

Mayr & Clarke (2003, ch. 13), Mayr *et al.* (2003, ch. 5), Mayr (2005a, ch. 5) 5, Mayr (2005b, ch. 6), Mayr (2006, ch. 6), Mayr *et al.* (2010, ch. 5), Ksepka *et al.* (2011, ch. 10), Mayr (2011, ch. 5), Ksepka & Clarke (2012, ch. 8), Mayr (2015, ch. 3), Mayr (2016, ch. 1), Ksepka *et al.* (2017, ch. 4), Mayr (2020, ch. 3), Mayr (2021, ch. 3), Mather *et al.* (2022, ch. 5), Mayr & Kitchener (2022a, ch. 1), Mayr & Kitchener (2023a, ch. 3), Mayr & Kitchener (2023b, ch. 3), Mayr & Kitchener (2023c, ch. 3).

A caudally projecting supraorbital process is observed in most members of Accipitridae (Fig. 2.2B), Cariamiformes (Fig. 2.2G) and Falconiformes (Fig. 2.2H), as well as all Coraciidae e.g. *Coracias benghalensis* (Fig. 2.2E).

37. Lacrimal, shape of descending process from lateral view: unexpanded (narrow) (0); stout (1); greatly expanded medially (2); inapplicable, lacrimal indiscernible [ch.34] (NA) (Fig. 2.1; Fig. 2.7E).

Modified from Mayr *et al.* (2003, ch. 7), Mayr (2004, ch. 2), Mayr *et al.* (2004, ch. 4), Mayr (2005, ch. 7) 7, Mayr (2006, ch. 8), Clarke *et al.* (2009, ch. 11), Mayr *et al.* (2010, ch. 7), Mayr (2011, ch. 7), Bourdon *et al.* (2016, ch. 9), Ksepka *et al.* (2017, ch. 6), Ksepka *et al.* (2019, ch. 6), Mayr (2022, ch. 2).

The "descending process" of the lacrimal passes ventrally from the head, toward the jugal bar (sensu Cracraft 1968). Cracraft (1981, pg. 702) originally described the presence of a medially expanded descending process (state 1) as a synapomorphy of a taxon that includes Coraciidae (Fig. 2.7E), Brachypteraciidae and Alcedinidae. In the present study, this feature was also found to be present in *Todus mexicanus*. In Ksepka *et al.* (2019) ch.6 and Ksepka *et al.* (2017) ch.6 a state was included to describe a very specific condition only seen in Strigiformes (Fig. 2.1C) where the descending process of the lacrimal is inflated and bulbous in appearance. However, the lacrimal in Owls is still very much expanded medially (state 2). Falconiformes and Psittaciformes tend to have stout descending processes of the lacrimal (Fig. 2.1J, K, L)

38. Lacrimal, shape of ventral end (orbital process): narrow, same width as descending process (0); expanded rostroventrally (1) (Fig. 2.7).

New character.

The ventral portion of the descending process is also known as the "lacrimal foot" (sensu Cracraft 1968). A rostroventrally expanded lacrimal foot is observed in Accipitridae (Fig. 2.7B) and Falconiformes (Fig. 2.7G).

39. Lacrimal, lateral concavity (fossa nasolacrimalis) of the descending process: absent (0); shallow (1); deep concavity (2) (Fig. 2.1).

Mather *et al.* (2022, ch. 11).

The lateral margin of the orbital process can exhibit a distinct inicisura ductus nasolacrimalis (fossa nasolacrimalis) as a deep concavity (Fig. 2.1B, C, G, J, K).

40. Lacrimal, orbital process (processus orbitalis): short, terminates far from jugal bar (0); well developed, contacting or nearly contacting jugal bar (1); inapplicable, lacrimal indiscernible [ch.34] (NA) (Fig. 2.1).

Mayr & Clarke (2003, ch. 12), Mayr (2005b, ch. 5).

State 0 is found in non-telluravian birds, as well as Cariamiformes, in which the descending process is short, but is extended by a separate bone called the communicans (see ch. 43). In the previous works cited above, Coliiformes were also scored as having a short orbital process. This could be the case for *Colius striatus kiwuensis* but difficult to determine in *Urocolius macrourus pulcher* where the lacrimal appears fused with the expanded ectethmoid. Therefore, I have tentatively scored only *Colius striatus kiwuensis* as having a short (0) lacrimal.

41. Lacrimal, orbital process projects posteriorly to form a "suborbital arch": absent (0); present (1) (Fig. 2.1).

Modified from Ksepka *et al.* (2011, ch. 12), Ksepka & Clarke (2012, ch. 12).

The "suborbital arch" is a bony structure where the orbital process/anterior end/ foot of the lacrimal projects posteriorly in an arch. In the references cited above, a multistate character was used to define the contact between the suborbital arch (bony ring) and zygomatic process (processus zygomaticus) as either absent (state 0 here; in all non-Psittaciformes), "nearly complete" where the projecting lacrimal foot is not fused to the zygomatic process but forms a suborbital arch (state 1 of Ksepka & Clarke 2012) or "complete" where the lacrimal foot projects and is fused to the zygomatic process (state 3 of Ksepka & Clarke 2012). The "complete" state where the Lacrimal is fused to the zygomatic process in Ksepka & Clarke (2012) is only observed in some Cacatuidae like *Probosciger aterrimus* (Fig. 2.1M) and the budgerigar *Melopsittacus undulatus*. In the present study the character has been modified by merging states 1 and 2 of Kspeka & Clarke (2012) into a single state (1). In some Psittaciformes the lacrimal fuses to the postorbital process to form the suborbital arch, they are scored as state 1 herein (see Ch. 42).

42. Lacrimal, suborbital arch formed by fusion between postorbital process and lacrimal: absent (0); present (1) (Fig. 2.1).

Ksepka *et al.* (2011, ch. 11), Ksepka & Clarke (2012, ch. 11).

As described above in some Psittaciformes the lacrimal fuses to the postorbital process to form the suborbital arch for e.g. *Strigops habroptilus*. In *Probosciger aterrimus* the lacrimal is fused to both the zygomatic process and postorbital process (Fig. 2.1M).

43. Lacrimal, communicans: absent (0); present (1) (Fig. 2.1I).

Mayr (2016, ch. 6), Mayr & Kitchener (2022a, ch. 6).

A rod-shaped ossicle situated between the lacrimal and the jugal bar of Cariamiformes was originally described by Burmeister (1854) as "os lacrymale communicans". This ossicle is present in both extant species of Cariamiformes, *Cariama cristata* and *Chunga burmeisteri* (Fig. 2.1I). It has also been identified in the extinct cariamiform group, Phorusrhacidae (Degrange *et al.* 2015; Degrange 2021). See (Mayr 2022c) for more details on the uncinate bones of Neornithes (of which there are many).

44. Lacrimal, supraorbital process: fully developed (0); reduced (1) (Fig. 2.7I).

New character.

The lacrimal in Passeriformes is not only reduced but also the supraorbital process does not extend past the frontal suture (Fig. 2.7I).

45. Lacrimal, anterior process around mid-height of the descending process: absent (0); present (1) (Fig. 2.7G).

New character.

Cracraft (1968) described an anterior process of the lacrimal passing from the descending process to the maxillopalatines in Trogoniformes and Musophagidae (turacos). In the present study it was only found to be present in *Apaloderma narina* (Trogoniformes) and *Micrastur ruficollis concentricus* (Falconiformes, Fig. 2.7G) and *Daptrius ater*. The shape and size of the anterior process does vary between species.

46. Lacrimal, supraorbital process, type of articulation with the frontal: sutured (0); fused (1) (Fig. 2.2A, C, I).

Mather *et al.* (2022, ch. 4).

In most Telluraves, the dorsomedial portion of the lacrimal bone (supraorbital process) is articulated predominantly with the lateral margin of the frontal and nasal bones through the facies articularis frontonasalis. This articulation surface is generally clearly defined by a suture (state 0). However, in some taxa this suture is closed by fusion (state 1) e.g. *Cathartes burrovianus* (Fig. 2.2A) and all Psittaciformes.

47. Ectethmoid, relationship with frontals/naso-frontal hinge: unfused (0); fully fused with frontals (1) (Fig. 2.7).

Modified from Mayr & Clarke (2003, ch. 14), Mayr *et al.* (2003, ch. 8), Mayr (2004, ch. 3), Mayr (2005, ch. 8), Mayr (2005b, ch. 7), Mayr (2006, ch. 9), Clarke *et al.* (2009, ch. 14), Mayr *et al.* (2010, ch. 8), Mayr (2011, ch. 8), Bourdon *et al.* (2016, ch. 12), Mayr (2016, ch. 2), Ksepka *et al.* (2017, ch. 7), Ksepka *et al.* (2019, ch. 7), Mayr & Kitchener (2022a, ch. 2).

The ectethmoid is a lateral, plate-like projection of the anterior end of the interorbital septum. This bone has a complex relationship with the frontal and lacrimal bones, with a large amount of variation within Aves. Previous descriptions of this character (from the above references) state the absence/presence of the ectethmoid "greatly expanded, plate-like, with dorsal margin largely fused with frontals". While this condition, in which an expanded ectethmoid is fused to the frontals, is present many Coraciimorphae (e.g. *Colius striatus*; Fig. 2.7C) and Passeriformes (e.g. *Acanthisitta chloris*; Fig. 2.7I), in Falconiformes and some Passeriformes the ectethmoid is expanded, but there is only partial or no even fusion to the frontals (Fig. 2.7G). Moreover, Mayr & Kitchener (2022a) ch. 2 "Lacrimal, ectethmoid, and frontal fused: no (0), yes (1)" does not account for the different relationship combinations between these three bones. Therefore, I use three separate characters to account for fusion of the ectethmoid–frontal suture (ch. 47), fusion of the ectethmoid–lacrimal suture (ch. 38), and expansion of the ectethmoid (ch. 39). Birds with partial fusion such as in *Cathartes burrovianus* (Fig. 2.7A), *Buteo rufofuscus* (Fig. 2.7B) and *Nestor notabilis* (Fig. 2.7H), are scored as state (0). In *Daptrius ater* and *Caracara cheriway* the partial fusion is not fully ossified, with the connection made of soft tissue.

48. Ectethmoid: separated from lacrimal (0); contacting lacrimal (1); fused to lacrimal (2) (Fig. 2.7).

New character.

In state 0, the ectethmoid and lacrimal are distinctly separate, with no direct contact. This state is observed in Cathartiformes, Leptosomiformes, Trogoniformes (Fig. 2.7D). In state 1, the ectethmoid is contacting or articulates with the lacrimal, this state is observed Accipitriformes (Fig. 2.7B) and in some members of Cavitaves (Fig. 2.7E). In state 2 the ectethmoid and lacrimal are fused into a single bony structure in Cathartidae (Fig. 2.7A), Coliiformes (Fig. 2.7C), Psittaciformes (Fig. 2.7H) and Passeriformes (Fig. 2.7I).

49. Ectethmoid-lacrimal complex: narrow plate on ventromedial part of antorbital wall, enclosing a wide, circular opening (0); wide plate that covers most of the antorbital wall (narrow hole) (1); ectethmoid completely reduced (only a small bony projection) (2) (Fig. 2.7).

New character.

In state 0 the ectethmoid-lacrimal complex forms a slender, ventromedially positioned plate, leaving a large, semi-circular opening in the antorbital wall, this is observed in all outgroup taxa, Accipitridae (Fig. 2.7A, B), Strigiformes, Falconiformes (Fig. 2.7G) and Psittaciformes (Fig. 2.7H).In state 1 the complex forms a wide plate, occupying much of the antorbital wall and reducing the opening to only the foramen orbitonasale medialis, this is observed in Coliiformes (Fig. 2.7C), Bucerotiformes, Piciformes (Fig. 2.7F) and Passeriformes (Fig. 2.7I). In state 2 the ectethmoid is nearly absent, reduced to a small bony projection, this is observed in Leptosomiformes, Trogoniformes (Fig. 2.7D) and Coraciiformes (Fig. 2.7E).

50. Cranium, anterior wall of braincase: largely ossified (0); almost completely unossified (1) (Fig. 2.8).

Clarke *et al.* (2009, ch. 5).

The anterior wall of the braincase refers to the bony structure separating the orbits and nasal cavity from the cranial cavity. In most members of Telluraves the anterior wall is predominately bony (Fig. 2.8A, B, D; state 0). In Passeriformes however, the anterior wall is largely unossified (Fig. 2.8C; state 1), with the exception in *Menura novaehollandiae* (Fig. 2.8D). There are cases outside Passeriformes where the anterior wall is not fully ossified, particularly in Todidae. In Clarke *et al.* (2009, ch. 5) only *Todus* and *Palaeotodus* are scored as having a unossified anterior wall, however, it is evident that this is the same for most members of Passeriformes. The amount

of ossification seen in the cranium does vary widely within Telluraves, affecting the size of the orbitocranial fontanelle and optic foramen (see list of characters not included in this study).

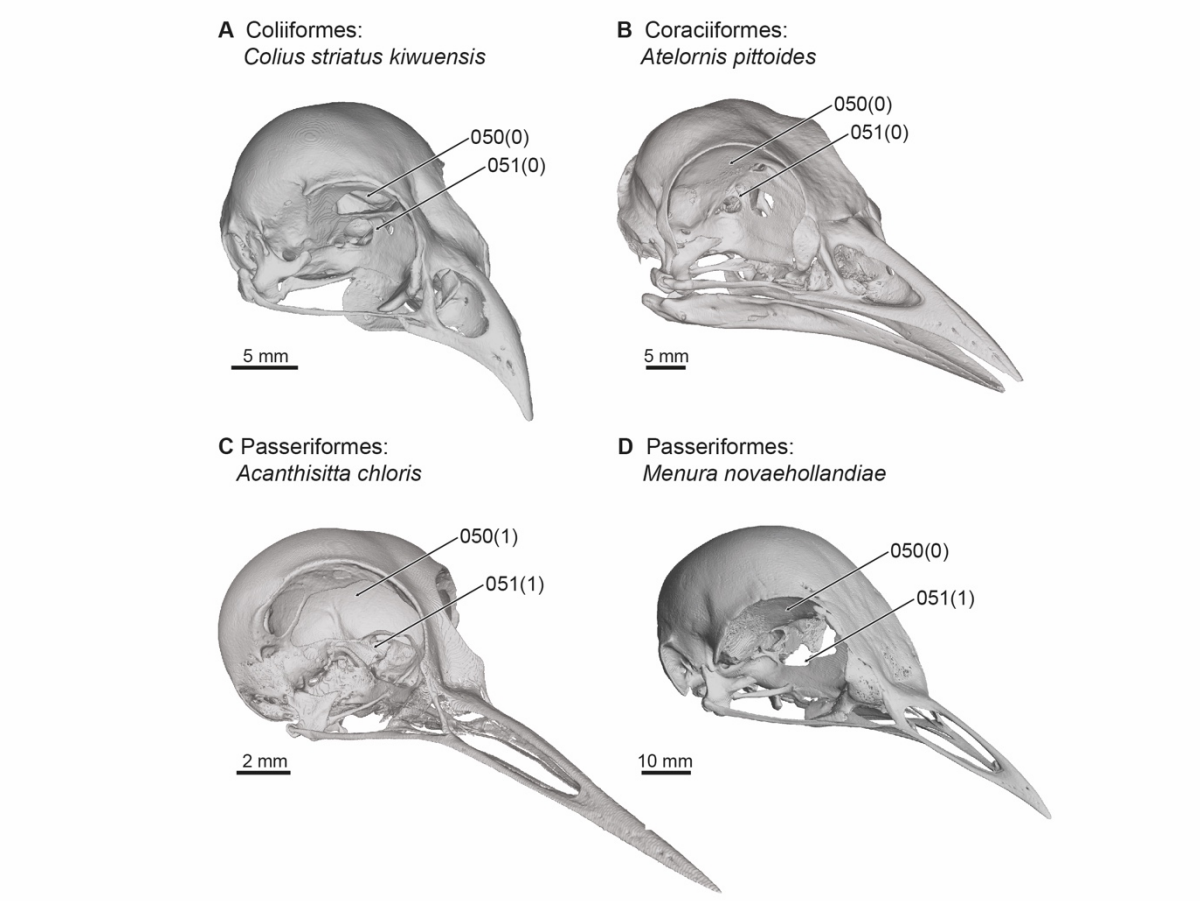


Figure 2.8. Skulls in right anterodorsolateral view showing characters 50 and 51. (A) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (B) *Atelornis pittoides* (Pitta-like ground roller, NHMUK zoo 1870.5.5.10); (C) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (D) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751. Numbers denote characters and character states as listed.

51. Optic foramen: separated into discrete foramen (0); one central optic foramen (1) (Fig. 2.8).

New character.

In state 0, each optic nerve passes through its own discrete foramen, separated by ossification. This is observed in most Telluraves (Fig. 2.8A, B) as well as the outgroup taxa *Eudromia elegans* and *Chauna chavaria*. In state 1, decreased ossification in the anterior wall of the braincase has likely led to a single centralised optic foramen, this is observed in most members of Passeriformes, even in cases where there is more ossification of the anterior wall e.g. *Menura*

novaehollandiae (Fig. C, D). This state is also observed in the outgroup taxa *Charadris vociferus* and *Eurypyga helias.*

52. Postorbital process (processus postorbitalis), length: poorly developed/ short/ truncate (almost absent) (0); elongate, but well separated from jugal bar (1); extremely elongate, touching or nearly touching jugal bar (2) (Fig. 2.1).

Mayr *et al.* (2003, ch. 11), Mayr (2004, ch. 4), Mayr *et al.* (2004, ch. 5), Mayr (2005, ch.1 1), Mayr (2006, ch. 14), Clarke *et al.* (2009, ch. 15), Mayr *et al.* (2010, ch. 11), Mayr (2011, ch. 11), Bourdon *et al.* (2016, ch. 13), Ksepka *et al.* (2017, ch. 8), Ksepka *et al.* (2019, ch. 8), Mayr (2022, ch. 3).

The postorbital process is a bony extension of the frontal bone that forms part of the orbits' posterior boundary. A short, almost truncate postorbital process (state 0) is present in most members of Coraciimorphae (Fig. 2.1D, F), some members of Psittaciformes (Fig. 2.1L), most members of Passeriformes (Fig. 2.1N) and all outgroup taxa. An elongate postorbital process is well separated from and does not touch the jugal (state 1) is present in Cathartidae (Fig. 2.1A), Accipitridae (Fig. 2.1B), Piciformes (Fig. 2.1H), Cariamiformes (Fig. 2.1I) and Falconiformes (Fig. 2.1J, K). An elongate postorbital process that approaches and nearly contacts the jugal (state 2) is present in Strigiformes (Fig. 2.1C), Leptosomiformes (Fig. 2.1E) and some Psittaciformes (Fig. 2.1M).

53. Postorbital process, development of a rostral projection: absent (0); present (1) (Fig. 2.1G).

Mayr *et al.* (2004, ch. 6), Clarke *et al.* (2009, ch. 16), Bourdon *et al.* (2016, ch. 14), Ksepka *et al.* (2017, ch. 9), Ksepka *et al.* (2019, ch. 9), Mayr (2022, ch. 4).

A small rostral projection from the postorbital process (state 1) is present in most extant Coraciidae (Fig. 2.1G) and Brachypteraciidae (though none in this study).

54. Postorbital process, orientation of the dorsal part of the ventral tip, main plane being parallel to the frontal axis of the skull: absent (0), present (1) (Fig. 2.1C).

Modified from Mayr (2016, ch. 5), Mayr & Kitchener (2022a, ch. 5).

The dorsal part of the ventral tip of the postorbital process is aligned parallel to the frontal axis in Strigiformes (Fig. 2.1C).

55. Zygomatic process: present, relatively small (0); developed (1), highly developed (2) (Fig. 2.1).

Modified from Mayr & Clarke (2003, ch. 33), Mayr (2005b, ch. 21), Clarke *et al.* (2009, ch. 17), Bourdon *et al.* (2016, ch. 15), Ksepka *et al.* (2019, ch. 10).

The zygomatic process of the squamosal is highly variable in shape and size within Telluraves. A noticeable zygomatic process, where it is present but relatively small (state 0) is observed in many Telluraves, e.g. Cathartidae (Fig. 2.1A), Accipitridae (Fig. 2.1B) and Strigiformes (Fig. 2.1C). A developed zygomatic process that extends about one-third of the distance from the base of the squamosal to the jugal arch (state 1) is observed in many different clades e.g. Coraciiformes (Fig. 2.2G), Cariamiformes (Fig. 2.2I) and Falconiformes (Fig. 2.2J, K). Highly developed (state 2) is defined here as extending more than half the distance and can abut the quadrate, this is observed in Trogoniformes (Fig. 2.1F) and Psittaciformes (Fig. 2.1M; except *Nestor notabilis*). Within clades there are differences in the length of the zygomatic process. For example, Momotidae, Todidae, and Brachypteraciidae all have longer processes than Coraciidae but for the purpose of this study they are all scored as state 1.

56. Zygomatic process relative angle to quadrate: parallel (0); horizontally oriented (1) (Fig. 2.1F, M).

New character.

The zygomatic process extends in a direction aligned to the long axis of the quadrate (typically oriented dorsoventrally or slightly angled, this is observed in almost all Telluraves, with the few exceptions of where the zygomatic process is horizontally orientated, roughly perpendicular to the quadrates long axis, this is overserved in Trogoniformes (Fig. 2.1F) and some members of Psittaciformes (Fig. 2.1M).

57. Postorbitalis/zygomaticus, temporal fenestra formed by fusion of the zygomaticus process, postorbitalis process and suborbital arch of the lacrimal: absent (0); present (1) (Fig. 2.1M).

Ksepka *et al.* (2011, ch. 13), Ksepka & Clarke (2012, ch. 13).

Derived feature observed in some members of Psittaciformes for example, *Probosciger aterrimus* (Fig. 2.1M).

58. Suprameatic process: absent/small (0); present as a variably prominent process (1) (Fig. 2.1).

New character.

The suprameatic process of the squamosal is a rostrally pointed projection, located caudoventral to the zygomatic process. Together, these processes are important insertion points for the muscles and aponeurosis of the *m. adductor mandibular* system. In some birds, notably in Falconiformes, the suprameatic process is exceptionally prominent (state 1; Fig. 2.1K) (although it is still a very small process in comparison to the zygomaticus). Throughout Telluraves this process varies considerably in size and shape. However, for the purpose of the present study a binary character is made to denotate only the absence or presence (Fig. 2.1D, E, I, K) of the suprameatic process.

59. Temporal fossa (fossae temporales): widely separated from one another on skull roof (0); extending close to midline on dorsal surface of skull or contact to form a crest (1) (Fig. 2.9).

Modified from Clarke *et al.* (2009, ch. 3), Ksepka & Clarke (2012, ch. 10), Ksepka *et al.* (2011, ch. 9), Bourdon *et al.* (2016, ch. 3), Ksepka *et al.* (2017, ch. 10), Mayr (2022, ch. 5).

The temporal fossa is a depression or concavity on the lateral and dorsal surface of the cranium, in most Telluraves the fossa are positioned far apart (state 0; Fig. 2.9A, D, E). The temporal fossa in Piciformes and Coraciiformes, however, extend close the midline of the cranium (state 1; Fig. 2.9B, C). In most of these taxa, the temporal fossa are so deep and close set that a sagittal crest is formed. This sagittal crest is the basis of a separate character here (Ch. 64) because it is not clear what the relationship is between the deep fossa and the formation of the crest as they can be mutually exclusive.

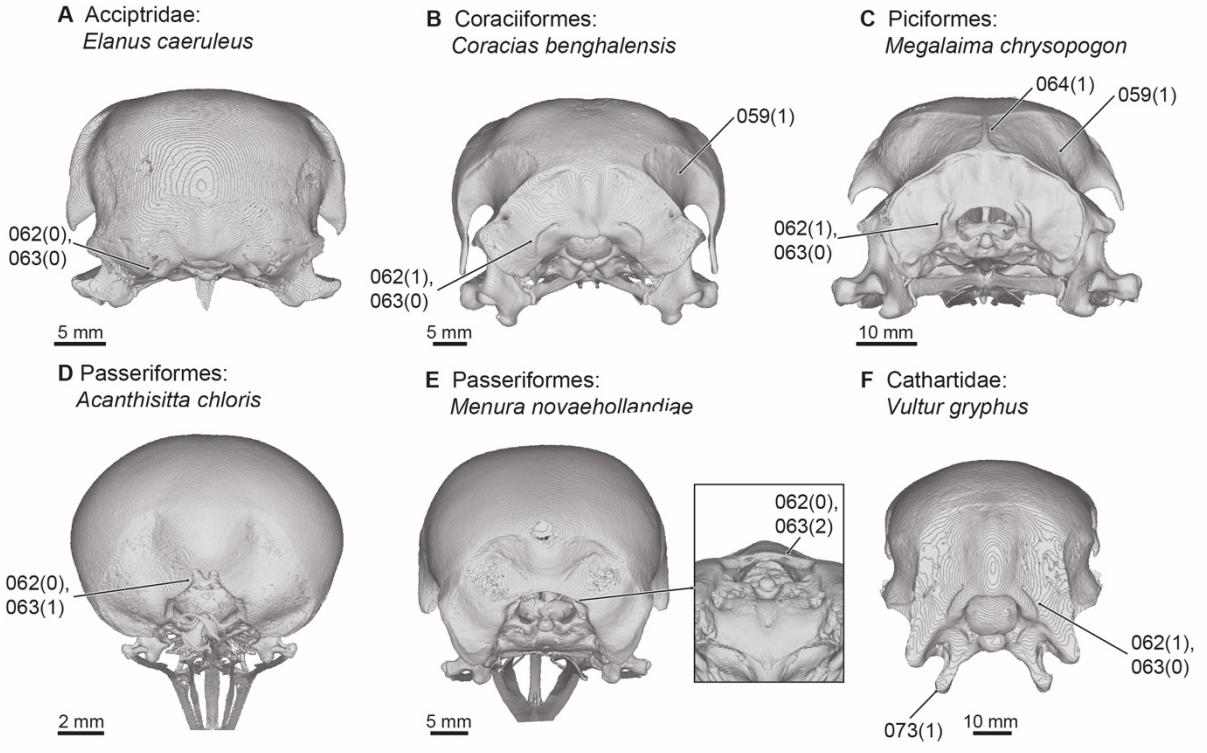


Figure 2.9. Skulls in posterior view showing characters 59, 62, 63 and 64. (A) *Elanus caeruleus* (black-winged kite, NHMUK zoo 1850.8.15.159); (B) *Coracias benghalensis* (Indian roller, NHMUK zoo S/1987.19.15); (C) *Megalaima chrysopogon* (Golden-whiskered barbet, NHMUK zoo 1850.8.15.28); (D) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (E) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751), close up of ventral portion of foramen magnum in box; (F) *Vultur gryphus* (Andean condor, NHMUK zoo1955.5.11. Numbers denote characters and character states as listed.

60. Squamosal dorsal-ventrally expanded and extending far rostrally: absent (0); present, forming a "tympanic wing" (1) (Fig. 2.1C, J).

New character.

The squamosal of neornithine birds differs in shape, size and interactions with surrounding bones, and closely related taxa often show very disparate morphologies, see Mayr & Manegold (2021) for a detailed study on the comparative morphology of the squamosal shape in juvenile avian skulls. In Strigiformes the squamosal (os squamosum) overlaps the zygomatic process creating a deep recess and partially covering the caudal margin of the ear hole (external acoustic meatus) (Fig. 2.1C). While this feature has historically only been said to be observed in owls where it is called the tympanic wing (Elzanowski & Mayr 2018), it is also present among Falconiformes, specifically in Herpetotherinae , for example *Micrastur ruficollis* (Fig. 2.1G). Given that both birds are known for their acute hearing abilities (Kelber 2022) it is possible that the tympanic wing of the squamosal aids in directional hearing. The tympanic wing is small in other

falconiforms but is still more expanded than in the rest of Telluraves, they have however been scored as (0).

61. Foramen magnum, angle relative to parasphenoid rostrum: opens ventrally >135° (0); opens caudally <135° (1).

New Character.

This character was scored using measurements of the internal angle between the parasphenoid rostrum and the foramen magnum in (Chiappe *et al.* 2022). The threshold of 135° was chosen based on comparative measurements across Telluravian taxa.

62. Supraoccipital bone, length of canalis semicircularis: absent/ short (0); long (1) (Fig. 2.9).

New character.

The path of the posterior semicircular canal is visible externally as a curving ridge on the caudal surface of the supraoccipital and is visible in most Telluraves except *Cathartes burrovianus* (Fig. 2.10A) and Strigiformes (Fig. 2.10D) in which only the external occipital vein foramen is visible. This canal, when present generally extends from the ventrolateral region of the cerebellar prominence to the dorsolateral portion of the foramen magnum. There is a large variation in the length of the canals and seems to be in part related to the position of the occipital foramen (see Ch. 63). For this reason, a binary character is made to demonstrate the prominence and long length observed in Coraciiformes (Fig. 2.9B) and Piciformes (Fig. 2.9C). In the outgroup taxa like *Eudromia elegans*, the canal is as long and deep, but it is perfectly straight and not bowed like in Telluraves.

63. Supraoccipital bone, position of external occipital vein foramen (foramen veni occipitalis externae), relative to the foramen magnum: dorsolateral (0); dorsal (1); internal of the lateral margins of the foramen magnum (2).

New character.

In state 0 the external occipital vein foramen (foramen veni occipitalis externae) is positioned lateral to and slightly above the foramen magnums dorsal margin, this is observed in most

Telluraves for example Accipitridae (Fig. 2.9A), Coraciiformes (Fig. 2.9B) and Piciformes (Fig. 2.9C). In state 1 the foramen is located directly dorsal to the foramen magnum and positioned along the midline or near the midline of the dorsal surface, in which the canalis semicircularis originates from the dorsal edge of the foramen magnum. This is observed in most members of Passeriformes (Fig. 2.9D). In state 2 the foramen is not external but rather internal of the lateral margins of the foramen magnum or within the deep occipital grooves that surround the foramen magnum, this is observed in all Oscines (Fig. 2.9E). Outside Passeriformes this feature is only observed in *Strigops habroptilus* (kākāpō).

64. Supraoccipital bone, crista nuchalis sagittalis/transverse nuchal crest/occipital crest, dorsal portion: absent/barely visible (0); present and prominent, raised dorsally (1).

New character.

A sagittal crest (crista nuchalis sagittalis) is observed Bucerotiformes, Coraciiformes and Piciformes (Fig. 2.9C). This is likely related to the very deep temporal fossa observed in these birds (Ch. 59).

65. Otic region, canaliculus cochlea forming large window-like opening: absent (0); present (1) (Fig. 2.10).

New character. Based Mayr (2019).

In some taxa, the canaliculus cochlea forms a large opening (state 1), which reaches the size of the fenestra cochleae. Mayr (2019) reported in *Cathartes* and some Psittacidae (*Ara*), though none of the Psittacidae included here exhibit such a feature. In the present study state 1 was only apparent in *Cathartes burrovianus* (Fig. 2.10A) and *Charadris vociferus.* See Mayr (2019, fig. 2) for more details on an open canaliculus cochlea.

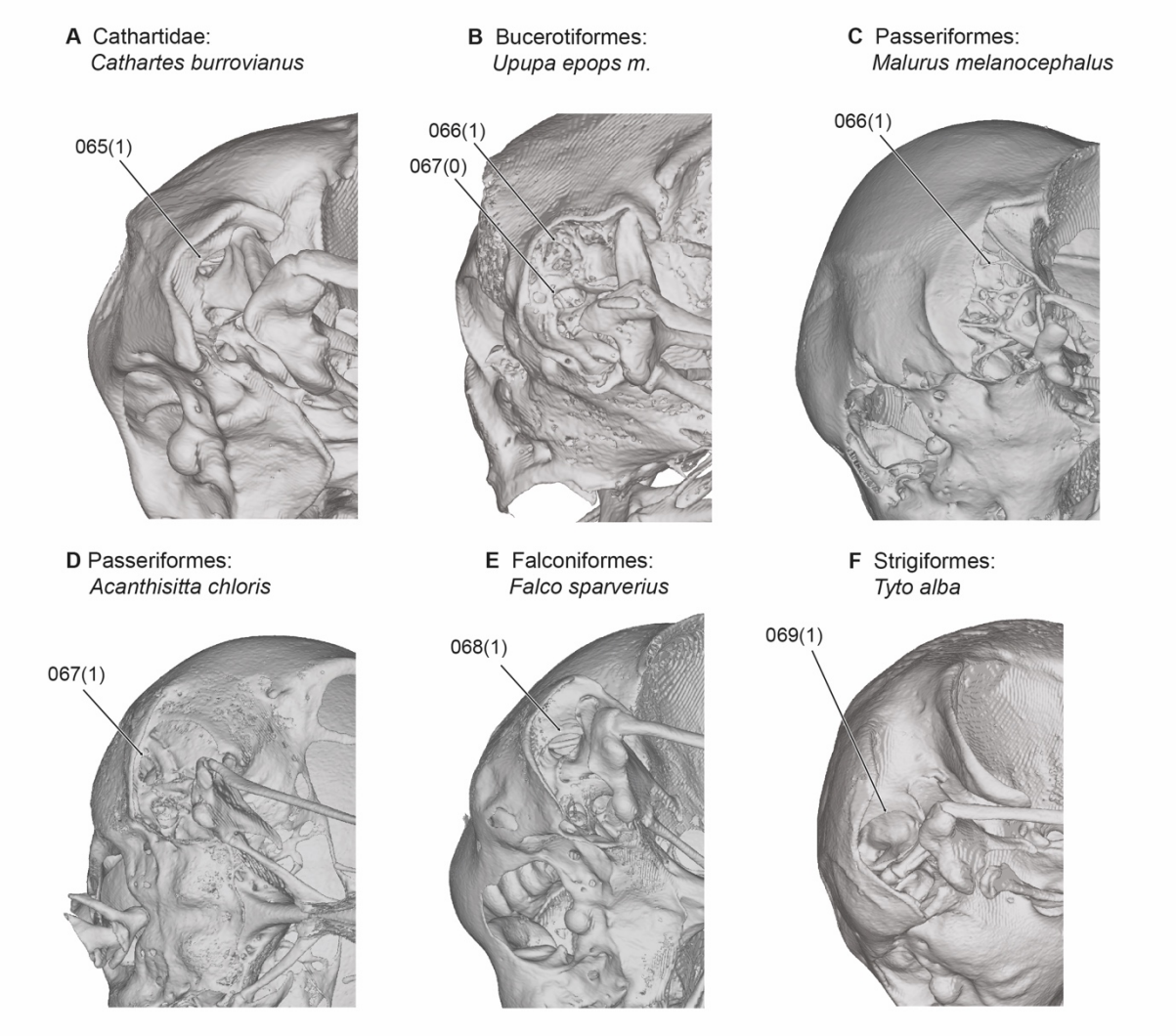


Figure 2.10. Close-up view of the otic region in rostrolater view showing characters 65, 66, 67, 68 and 69. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Upupa epops marginata* (Madagascar hoopoe, FMNH birds 352821); (C) *Malurus melanocephalus* (Red-backed fairywren, UMMZ birds 224775); (D) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (E) *Falco sparverius* (American kestrel, UMMZ birds 154462); (F) *Tyto alba* (Barn owl, NHMUK zoo 1989.22.1). Numbers denote characters and character states as listed.

66. Otic region, pila otica with trabeculate lateral surface: absent (0); present (1) (Fig. 2.10)

New character. Based Mayr (2019).

Mayr (2019) describes the cotyla quadratica otici, which articulates with the otic condyle of the quadrate, as being situated on a peduncle-like structure termed pila otica. In Mayr (2019) it was suggested that “most” passerines pila otica has a reticulate structure with numerous small bony struts and fenestrae (Fig. 2.10B, C; state 1). However, after reviewing the Passeriformes in the

present study state 1 is only present in oscines (except *Menura novaehollandiae*), in which a deep recess forms within the pila otica, much deeper than in Coraciimorphae with similar structures. This deep recess also results in the semicircular canals of the bony labyrinth to be exposed. See Mayr (2019, fig. 5) for more details on a trabeculate surface in Coliidae and Upupidae.

67. Otic region, opening of recessus tympanicus dorsalis located: dorsal of the articulation facets for the quadrate (0); caudodorsally of the articulation facets for the quadrate (1) (Fig. 2.10)

New character. Based Mayr (2019).

A more caudodorsally positioned opening for the recessus tympanicus is observed most members of Passeriformes (state 1; Fig. 2.10D), otherwise throughout Telluraves the recessus tympanicus dorsalis is located dorsally of the articulation facets for the quadrate (state 2; Fig. 2.10B). Scorings based on discussion in Mayr (2019).

68. Otic region, very large foramen for the ramus occipitalis of the arteria ophthalmica externa: absent (0), present (1) (Fig. 2.10E).

Mayr (2022, ch. 6).

Mayr & Walsh (2018) suggested that a large foramen for the ramus occipitalis is a derived characteristic of extant rollers (and some extinct). However, in the present study it was also found to be present in Accipitridae and Falconiformes (Fig. 2.10E).

69. Otic region, very large recessus tympanicus dorsalis: no (0) yes (1) (Fig. 2.10F)

New character.

A very large recessus tympanicus dorsalis is only observed in Strigiformes (Fig. 2.10F).

70. Columella, footplate: flat and disk-like (0); bulbous or bullate (asymmetrical expansion) (1).

Mayr & Clarke (2003, ch. 39), Mayr *et al.* (2003, ch. 18), Mayr (2004, ch. 6), Mayr *et al.* (2004, ch. 7), Mayr (2005, ch. 20), Mayr (2005b, ch. 25), Mayr (2006, ch. 22), Clarke *et al.* (2009, ch. 19), Mayr *et al.* (2010, ch. 20), Mayr (2011, ch. 20), Mayr (2015, ch. 7), Bourdon *et al.* (2016, ch. 16),

Ksepka *et al.* (2017, ch. 21), Ksepka *et al.* (2019, ch. 26), Mayr (2020, ch. 10), Mayr (2021, ch. 9), Mayr (2022, ch. 7), Mayr & Kitchener (2023, ch. 10), Mayr & Kitchener (2023c, ch. 10).

The footplate of the columella is the broadened distal portion that contacts the fenestra vestibuli of the inner ear. Mayr & Clarke (2003) suggested that a bulbous columellar footplate (state 1) is present in some suboscine Passeriformes and was considered to be a derived feature of those birds, since the columella of Acanthisittidae (the sister taxon of Passeriformes) has a flat footplate (state 0). Scorings were derived from the above references and Peacock *et al.* (2024).

71. Columella, basal end: unfenestrated (0); distinct oval shaped fenestra (1) fenestrated (struts) basal end (2); bulbous with one large fenestra (3).

New character.

In state 0 the basal end of the columella is solid, lacking any perforations of fenenstra. In state 1 the basal end features a well-defined oval shaped fenestra; this is observed most members of Accipitriformes. In state 2 the basal end is perforated with multiple fenestrae, this is observed in Some members of Falconiformes and Strigiformes. In state 3 the basal end is bulbous in shape, this is observed in some members of Coraciiformes, Trogoniformes and Passeriformes. Scorings and descriptions of each state described from Peacock *et al.* (2023).

72. Orbitosphenoid process: absent (0); present (1) (Fig. 2.1F).

New character.

The orbitosphenoid process is found on the caudal wall of the orbit, medial to the zygomatic process. There is considerable variation in the shape and size of this process, from very small points (e.g. *Leptosomus discolor* and *Trogon melanurus*; Fig. 2.1F) to a large, flattened process seen in *Ramphastos ambiguous*. In *Passer domesticus* there are three orbital crests on each side, which has been suggested as a synapomorphy of Passerida (Gómez & Lois-Milevicich 2024). However, in the present study it was only observed in *Sylvia borin.* Generally, when this process is present, it is associated with pseudotemporal swelling (Gómez & Lois-Milevicich 2024).

73. Lamina parasphenoidalis processus medialis: absent (0); short (1); long (2) (Fig. 2.9F)

Mayr & Clarke (2003, ch. 30), Mayr (2005b, ch. 18), Migotto (2013, ch. 19).

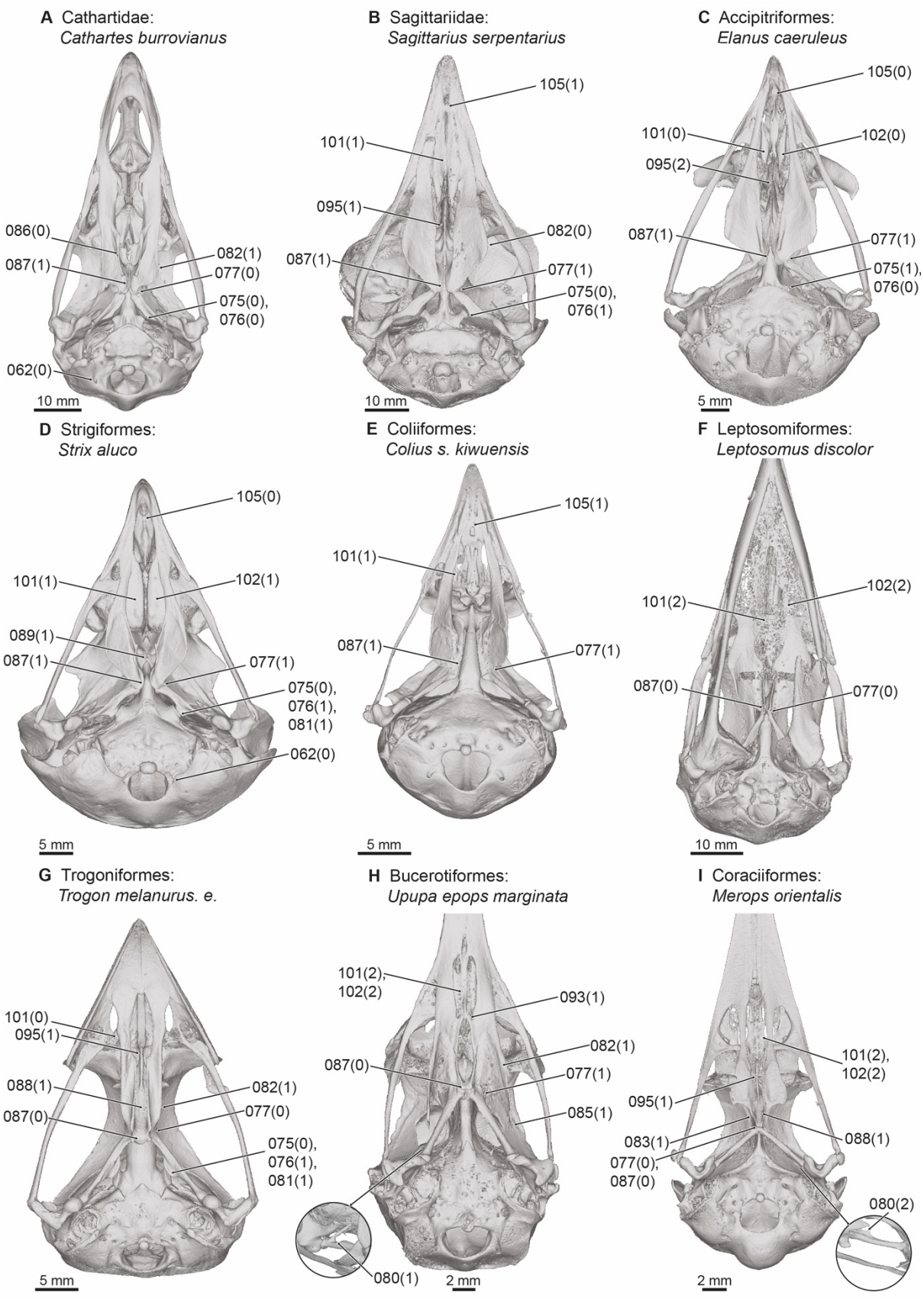
In most Telluraves the lamina parasphenoidalis lacks any visible medial process (state 0). In a few Telluraves for example in Cariamiformes there is a short process (state 1). In Cathartiformes this process is exceptionally long (Fig. 2.9F; state 2).

74. Lateral fusion of lamina parasphenoidalis to base of rostrum parasphenoidale: present (0); absent (1).

Migotto (2013, ch. 20).

Of the taxa studied here, all most all have the medial portion of the parasphenoidal lamina not fused to the base of the parasphenoid rostrum (state 1). State (0) is present in *Pandion haliaetus carolinensis* and *Leptosomus discolor*. See Migotto (2013) for more detailsand images.

Figure 2.11. Skulls in ventral view showing characters 75, 76, 78, 80, 81, 82, 83, 84, 85, 87, 88, 89, 90,91, 92, 93, 95, 96, 97, 101, 102, 105 and 108. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Sagittarius serpentarius* (Secretary bird, NHMUK zoo 1898.5.7.1); (C) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (D) *Strix aluco* (Tawny owl, NHMUK zoo S/2001.38.1); (E) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (F) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (G) *Trogon melanurus eumorphus* (Black-tailed trogon, FMNH birds 290496); (H) *Upupa epops marginata* (Madagascar hoopoe, FMNH birds 352821); (I) *Merops orientalis* (Asian green bee-eater, UMMZ birds 216577); (J) *Galbula dea* (Paradise jacamar, FMNH birds 376705); (K) *Chunga burmeisteri* (Black-legged seriema, FMNH birds 106731); (L) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (M) *Deroptyus accipitrinus* (Red-fan parrot, NHMUK zoo S/2002.14.2); (N) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (O) *Melanopareia torquata bitorquata* (Double-collared crescentchest, FMNH birds 335140); (P) *Corvus brachyrhynchos* (American crow, FMNH birds 441515). Numbers denote characters and character states as listed.


A Cathartidae:
Cathartes burrovianus
086(0)
087(1)
082(1)
077(0)
075(0),
076(0)
062(0)
10 mm
B Sagittariidae:
Sagittarius serpentarius
105(1)
101(1)
095(1)
087(1)
082(0)
077(1)
075(0),
076(1)
10 mm
C Accipitriformes:
Elanus caeruleus
105(0)
101(0)
102(0)
095(2)
087(1)
077(1)
075(1),
076(0)
5 mm
D Strigiformes:
Strix aluco
105(0)
101(1)
102(1)
089(1)
087(1)
077(1)
075(0),
076(1),
081(1)
062(0)
5 mm
E Coliiformes:
Colius s. kiwuensis
105(1)
101(1)
087(1)
077(1)
5 mm
F Leptosomiformes:
Leptosomus discolor
102(2)
101(2)
087(0)
077(0)
10 mm
G Trogoniformes:
Trogon melanurus. e.
101(0)
095(1)
088(1)
087(0)
082(1)
077(0)
075(0),
076(1),
081(1)
5 mm
H Bucerotiformes:
Upupa epops marginata
101(2),
102(2)
093(1)
087(0)
082(1)
077(1)
085(1)
080(1)
2 mm
I Coraciiformes:
Merops orientalis
101(2),
102(2)
095(1)
083(1)
077(0);
087(0)
088(1)
080(2)
2 mm

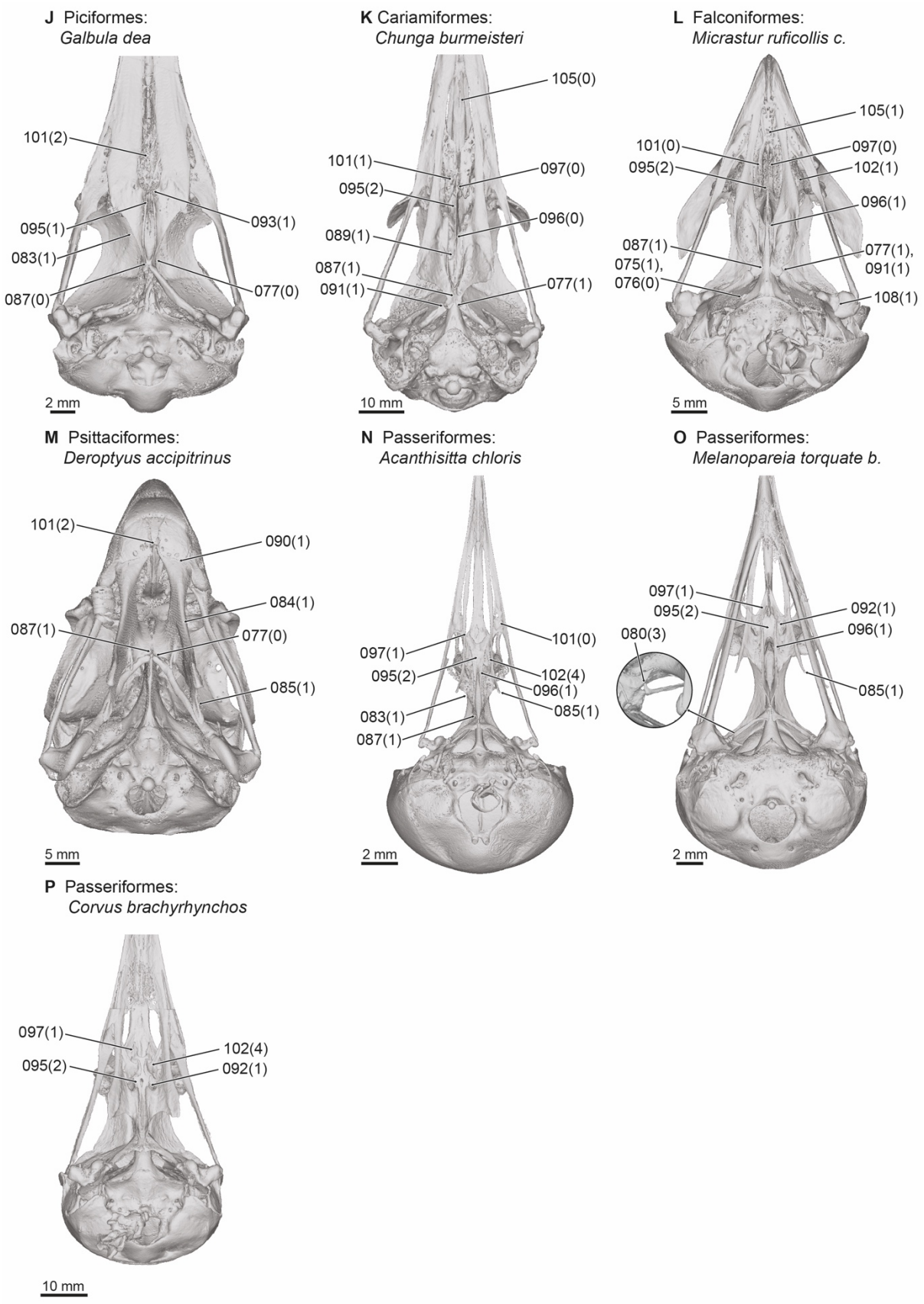


Figure 2.11. (Continued from previous page).

75. Basipterygoid process: present and well-developed (0); present but small (1); absent (2) (Fig. 2.11).

Modified from Mayr (2016, ch. 3), Ksepka *et al.* (2017, ch. 11), Mayr & Kitchener (2022a, ch. 3), Ksepka *et al.* (2019, ch. 12), Mayr & Kitchener (2023a, ch. 5).

The basipterygoid process (processus basipterygoideus) is a structure at the base of the parasphenoidal rostrum. The occurrence of the development of these processes varies widely among Aves, in such a way that homology of the basipterygoid articulation within Galloanseres and other neornithine birds has been considered uncertain (Weber 1993). For the taxa included in the present study, a well-developed process (state 0) is found in Cathartidae (Fig. 2.11A), Sagittariidae (Fig. 2.11B), Strigiformes (Fig. 2.11D) and Trogoniformes (Fig. 2.1G). A small process is observed in *Micrastur ruficollis concentricus* (Fig. 2.11L), *Strigops habroptilus* and Accipitridae (Fig. 2.11C). It is likely in these birds that the process is reduced during development but remain small in adults (state 1) (Jollie 1976).

76. Basipterygoid process articulates with pterygoid: absent (0); present (1) (Fig.2.11).

Mayr & Clarke (2003, ch. 23), Mayr *et al.* (2003, ch. 12), Mayr (2005a, ch. 13), Mayr (2005b, ch. 16), Mayr (2006, ch. 16), Mayr *et al.* (2010, ch. 13), Mayr (2011, ch. 13), Mayr (2015, ch. 5), Mayr (2020, ch. 5), Mayr & Kitchener (2023c, ch. 5).

When present and well-developed, the basipterygoid process has an articulation surface that connects to the pterygoid bone.

77. Pterygoid-palatine joint articulation: pterygoid articulates/abuts to parasphenoid and palatine (0); pterygoid articulates/abuts only to palatine (1) (Fig. 2.11).

New character. Based on Zusi & Livezey (2006).

The pterygoid (pterygoides) articulates to the palatine pterygoid process (processus pterygoides palatini of the palatine). In state 0 pterygoid-palatines joint abuts to both the parasphenoid and palatine, this is observed in Cathartidae (Fig. 2.11A), Leptosomiformes (Fig. 2.11F), Bucerotiformes (Fig. 2.11H), Coraciiformes (Fig. 2.11I), Piciformes (Fig. 2.11J), Psittaciformes (Fig. 2.11M) and Passeriformes (Fig. 2.11N-O). In state 1 the pterygoid-palatines joint abuts only to the palatine, this is observed in Sagittariidae (Fig. 2.11B), Accipitridae (Fig. 2.11C), Strigiformes (Fig. 2.11D), Falconiformes (Fig. 2.11L), Coliiformes (Fig. 2.11E) and Trogoniformes (Fig. 2.11G).

78. Pterygoid-palatine joint articulation forms an oblique, rectilinear syndesmosis: absent (0); present (1).

New character. Based on Zusi & Livezey (2006).

This feature is discussed in Zusi & Livezey (2006, fig. 14D) as a synapomorphy of passerines, in which the pterygoid-palatine joint forms an oblique, rectilinear syndesmosis, characterised by a straight, diagonally oriented connection stabilized by ligaments. This syndesmosis creates a rigid, linear articulation that aligns at an angle relative to the skulls midline, securely binding the pterygoid and palatine.

79. Pterygoid, caudal end dorsoventrally expanded: no (0), yes (1) (Fig. 2.11K).

Mayr (2016, ch. 7), Mayr & Kitchener (2022a, ch. 7).

A feature only observed in Cariamiformes (Fig. 2.11K) and *Bathornis grallator* (Mayr 2016, fig. 4).

80. Pterygoid, dorsomedial margin: no projection (0); rounded projection (1); craniocaudally elongate crista (2); long pointed dorsal projection (3) (Fig. 2.11)

New character.

The dorsomedial margin of the pterygoid can exhibit a number of different projections. A rounded projection is observed in Bucerotiformes (Fig. 2.11H) and Trogoniformes, a craniocaudally elongate crista is observed in *Colius striatus* and some members of Coraciiformes (Fig. 2.11I). A long and pointed projection (state 3) is observed in most members of Passeriformes (Fig. 2.11O) except for example *Acanthisitta*.

81. Pterygoid, robust process for articulation with basipterygoid processes (facies articularis basipterygoidea), projecting from medial margin of pterygoid medially towards basisphenoid: absent (0); present (1) (Fig. 2.11).

New character.

The pterygoid features a robust process that articulates with the basipterygoid in Strigiformes (Fig. 2.11D), and Trogoniformes (Fig. 2.11G), otherwise even if the basiptyergoid is robust the

pterygoid will not necessarily have a robust process for the articulation for example in Cathartidae and Sagittariidae (Fig. 2.11A, B).

82. Palatine, pars lateralis (lateral portion): present and well developed (0); reduced, equal in width to the rostral palatine process (1) (Fig. 2.11).

Modified from Mayr & Clarke (2003, ch. 16), Mayr (2005b, ch. 9).

Each palatine (os palatinum) consists of two structural parts: a lateral part (pars lateralis) and a choanal part (pars choanalis). The pars lateralis articulates with the maxillae through long maxillary process of the palatines. In previous studies (cited above) this feature was described as either absent/very small or present/well developed, with Trogoniformes being scored lacking the pars lateralis. While this is true comparatively, many other Cavitaves (e.g. Fig. 2.2H) have a very similar shape to that seen in trogons, albeit the most extreme reduction is observed in Trogoniformes (Fig. 2.11G). For this reason, absent was changed here to "equal in width to the rostral palatine process" (state 1) in which the pars lateralis has been somewhat reduced giving a rectangular shape to the palatine. Otherwise, all other Telluraves are observed with well-developed pars lateralis (e.g. Fig. 2.11B). A complete reduction of the pars lateralis in the character bellow (ch.83).

83. Palatine, reduction of pars lateralis posteriorly: unreduced (0); reduced (1) (Fig. 2.11).

Modified from Mayr & Clarke (2003, ch. 16), Mayr (2005b, ch. 9).

Reduction of the pars lateralis (state 1) is mostly observed in Passeriformes (Fig. 2.11N-O), some members of Coraciiformes (Fig. 2.11I) and Piciformes (Fig. 2.11J), where the position of the angulus caudo-lateralis has become more rostral in position.

84. Palatine, orientation of pars lateralis: horizontal (0); vertical (1) (Fig. 2.11M).

Ksepka *et al.* (2011, ch. 14), Ksepka & Clarke (2012, ch. 14), Ksepka *et al.* (2017, ch. 13), Ksepka *et al.* (2019, ch. 14).

The derived condition (state 1) is present in crown group Psittaciformes (Fig. 2.11M).

85. Palatine, accessory palatine processes: absent (0); present (1) (Fig. 2.11H, M, N, O).

Mayr (2006, 12) ch., Clarke *et al.* (2009, ch.4), Bourdon *et al.* (2016, ch.5).

State (1) describes the presence of a posteriorly directed spine-like process on the caudolateral margin of the palatine (os palatinum), this is observed in most members of Psittaciformes (Fig. 2.11M; except *Nestor notabilis*) and most members of Passeriformes (Fig. 2.11N, O). Additionally, these processes are also observed in *Upupa epops* (Fig. 2.11H). The size and shape of these process does vary greatly between these clades but is not accounted for in the present study.

86. Palatine, crista ventralis: present (0); absent (1) (Fig. 2.11)

Mayr & Clarke (2003, ch. 15), Mayr (2005b, ch. 8), Mayr *et al.* (2010, ch. 98), Mayr (2011, ch. 100), Mayr (2015, ch. 4), Ksepka *et al.* (2017, ch. 12), Ksepka *et al.* (2019, ch. 13), Mayr (2020, ch. 4), Mayr (2021, ch. 4), Mayr & Kitchener (2023a, ch. 4), Mayr & Kitchener (2023b, ch. 4), Mayr & Kitchener (2023c, ch. 4).

The presence of the crista ventralis is a ventral rise or crest on the palatine and typically runs along the midline or lateral edge. The above cited studies considered this feature as a synapomorphy of all Neoaves. While in the present study all Telluraves have been scored as present (e.g. Fig. 2.11A), there are examples where a crest is not present, for example in Sagittariidae (Fig. 2.11B). This feature likely needs more investigation.

87. Palatines, median contact caudal to the pterygoid process: co-ossified (0); separated across the midline, either touching or separated widely (1) (Fig. 2.11).

New character.

The palatines either meet along their respective medial margins at the sutura interpalatine, ventral to the midline of rostrum parasphenoid (state 1) or are partially or wholly separated (state 1) or even co-ossified fully (state 0) (Zusi & Livezey 2006). There is a large amount of variation among species in which the palatines do not contact each other (state 1), from widely separated, for example Strigiformes (Fig. 2.11D), to touching or nearly touching, for example Accipitriformes (Fig. 2.11C). Within these instances it is difficult to truly know the position in the CT scans as these parts are moveable to some degree. For example, in Figure 2.11A *Cathartes burrovianus,* the medial margins are touching but this is not the case in other dried osteological specimens of the same species, albeit the medial margins are very close together. For the purpose of this study, birds that have the margins fully co-ossified are scored as state 0, for example

Trogoniformes (Fig. 2.11G), Bucerotiformes (Fig. 2.11H), Coraciiformes (Fig. 2.11I) and Piciformes (Fig. 2.11J). In Coliiformes the palatines are extremely widely separated (Fig. 2.11E), this is likely due to the inflated parasphenoid (a feature also seen Trogoniformes but with no separation of the palatines).

88. Palatine, choanalis dorsal lamella: remain separated (0); complete medial fusion (1) (Fig. 2.11)

Modified from Mayr & Clarke (2003, ch.17), Mayr (2005b, ch.10).

Complete fusion of the choanalis dorsal lamella (state 1) is observed in Trogoniformes (Fig. 2.11G), some members of Coraciiformes like Merops orientalis (Fig. 2.11I).

89. Palatine, lamella dorsalis choanalis palatini fused/ossified: absent (0); present (1).

New character.

Ossification of the lamella dorsalis choanalis palatini is observed in Strigiformes (Fig. 2.11D), Cariamiformes (Fig. 2.11K) and some members of Cavitaves.

90. Palatine, maxillary process (processus maxillaris), articulation with premaxilla: maxillary process fuses with maxilla at rostral end (0); rostral end of maxillary process condyle-like, articulating with socket in premaxilla (1) (Fig. 2.11M).

Ksepka *et al.* (2011, ch. 15), Ksepka & Clarke (2012, ch 15), Ksepka *et al.* (2017, ch. 14), Ksepka *et al.* (2019, ch. 15).

The derived condition (state 1) is present in crown Psittaciformes (state 1; Fig. 2.11M).

91. Palatine, pterygoid process: short, does not project substantially from palatine (0); extensive, separate process extending caudolaterally from palatine (1) (Fig. 2.11).

New character.

In state 1 the pterygoid process is well developed and prominent, forming a distinct elongated projection that extends caudolaterally from the palatine, this is observed in Cariamiformes (Fig. 2.11K) and Falconiformes (Fig. 2.11L).

92. Palatine, rostromedial process: reduced (0); elongated (1) (Fig. 2.11).

New character.

The rostromedial process of the palatine is present and elongated in Passeriformes (state 1; Fig. 2.11O). This is also observed in many members of Coraciiformes and Piciformes though to not such an exaggerated length, though still scored as state 1 in the present study. This is also complicated by the fact that passerines have a very reduced palatine that makes it unclear what features could be congruent with others outside Passeriformes (i.e. "aegithognathous" type palate; Zusi & Livezey 2006). It is to be noted that elongated rostromedial process on the palatine are observed in birds outside Telluraves such as *Caprimulgus* (nightjars).

93. Palatine, rostromedial processes contacting one another: absent (0); present (1) (Fig. 2.11J).

New character.

In state 1, the rostromedial process of the palatine (processus rostromedialis palatini) articulates with the palatine process of the maxilla (proccessus palatus of os maxillare). This contact is only observed in Cavitaves with excessively long beaks e.g. *Galbula dea* (Fig. 2.11J).

94. Palatine and pterygoid fused: fused (0), un-fused (1).

Mayr & Clarke (2003, ch.22), Mayr (2004, ch.5), Mayr (2005a, ch.12), Mayr (2005b, ch.15), Mayr (2006, ch.15), Mayr (2011, ch.12), Mayr *et al.* (2010, ch.12).

Separated palatines and pterygoids are an apomorphy of Neognathae. In the current dataset, fused palatine and pterygoid are observed only in the outgroup taxa *Chauna* and *Eudromia* (state 0).

95. Vomer: absent (0); small (1); developed (2) (Fig. 2.11).

Modified from Mayr & Clarke (2003, ch.18), Mayr (2005b, ch.11).

In state 0 the vomer is completely absent, with no bony structure, this is observed in Cathartidae, Leptosomiformes, Coliiformes, Bucerotiformes and Strigiformes. In state 1 (modified from cited

refences above), the vomer is present but reduced, is observed in Sagittariidae (Fig. 2.11B), Trogoniformes (Fig. 2.11G), most members of Coraciiformes (Fig. 2.11I) and most members of Piciformes (Fig. 2.11J). Finally, a developed vomer, where it forms a long bone along the midline, is observed in all remaing Telluraves.

96. Vomer, caudal ends: fused/single flange fused to the dorsal lamella of the palatine choanalis (0) "deeply cleft"/ margins diverging into caudo-laterally orientated flanges (1); inapplicable, vomer absent [ch.95] (NA) (fig. 2.11).

Modified from Mayr & Clarke (2003, ch. 19), Mayr (2005b, ch. 12).

In the "cleft" condition (state 1) the caudal margin of the vomer diverges into caudolaterally orientated flanges and is observe in Passeriformes (Fig. 2.11N, O), Falconiformes (Fig. 2.11L), and *Indicator* and *Picus.* Traditionally, Falconiformes were designated as "desmognathos" palate type by Zusi & Livezey (2006). However, through my own observations and work from the above sources it is clear that the vomer is not fused to the palatines choanal lamella but rather is cleft like in Passerines or the "aegithognathous" palate type.

97. Vomer, rostral end: pointed (0); bifurcated and inflated (1) truncated and inflated (2); inapplicable, vomer absent [ch.95] (NA) (Fig. 2.11).

Modified from Mayr *et al.* (2003, ch. 9), Mayr (2005a, ch. 9), Mayr (2006, ch. 10), Mayr *et al.* (2010, ch. 9), Mayr (2011, ch. 9).

The rostral end of the vomer tapers to a point (state 0) in most members of Telluraves (e.g. Fig. 2.11K) except for Piciformes and Passeriformes. A bifurcated or forked shaped rostral end of the vomer is observed in Passeriformes (Fig. 2.11N, O), the size and shape of the bifurcation is highly variable within Passeriformes but is not accounted for in this study. In Claramunt & Rinderknecht (2005) the bifurcated condition (state 1) was attributed to the ossification of the nasal turbinals. Plateau & Foth (2021) suggested that vomer shape is not a good proxy for taxonomy, because shape differences are affected by size, and neither should be used to differentiate between different types of cranial kinesis. State 2, a truncated vomer is only observed in *Menura* and *Climacterus*.

98. Vomer, shape: narrow (0); mediolaterally expanded (1); inapplicable, vomer absent [ch.95] (NA).

Mayr & Clarke (2003, ch.20), Mayr (2005b, ch.13).

In the work cited above state 1 was not scored for any Telluraves. However within in Telluraves Passeriformes do have a mediolaterally expanded vomer and were scored as such here.

99. Vomer, dorsoventrally high lamella: absent (0); present (1).

Mayr & Clarke (2003) ch.21, Mayr (2005b) ch.14.

100. Maxillopalatine process of the maxillare: present (0); reduced or absent (1).

Mather *et al.* (2022, ch. 42), Migotto (2013, ch.42).

The maxillopalatine process (processus maxillopalatinus) of the maxillare arises on the level of the contact zone between the maxillary and nasal bones and typically extends caudomedially towards the tip of the vomer, which it contacts in some taxa , see Mayr (2020a) for comparative morphology of the maxillary bone. A reduced maxillopalatine process (state 1) is obserevd in Indicatoridae and Picidae, and this process is completely absent in Jynginae. Mayr (2020a) suggested that in these birds, the ossification of the nasal turbinates has a functional correlation with the reduction of the maxillopalatine process. This has yet to be tested. In the above referenced work, Cathartidae were scored having a reduced maxillopalatine process.

101. Maxillopalatine, contact between processes along the midline: widely separated (0); adjacent/touching (1); fused/co-ossified (2) (Fig, 2.11).

Mayr & Clarke (2003, ch. 11), Mayr (2005b, ch. 4), Mayr (2006, ch. 5), Migotto (2013, ch. 43), Mather *et al.* (2022, ch. 43).

Complete fusion of the maxilliopalatine process of the maxillare (state 2) is observed in several Coraciimorphae for example *Leptosomus discolor* (Fig. 2.11F), *Upupa epops* (Fig. 2.11H), Galbula dea (Fig. 2.11J) some members of Cariamiformes, and Psittaciformes (Fig. 2.11M). In the above references, Coliiformes were also scored as having fused maxillopalatine processes. However, in *Colius striatus kiwuensis*, studied here, the processes were found to only touching (state 1; Fig. 2.11E). The same condition occurs in some Cariamiformes, among which *Cariama cristata* has fused maxillopalatine processes, but *Chunga burmeisteri* has unfused maxillopalatine processes (state 1; Fig. 2.11K) (see also Degrange *et al.* 2015)

102. Maxillopalatine process shape: vertically oriented shell-shaped structure (0) bulge-like lamella (1); sheet-like lamella (2); craniocaudally narrow (3), horizontally orientated rod or lamella (4) (Fig. 2.11).

New character. Based on Mayr (2020a).

In state 0 the maxillopalatine process of the maxillary takes on a vertically oriented shell-shaped structure, with a concave lateral or ventrolateral surface (Mayr 2020a), this is observed in Sagittariidae, Accipitridae (Fig. 2.1B; Fig. 2.11C), Cariamiformes and the outgroup taxa. In state 1, the maxillopalatine process is a bulge-like lamella, this is observed in Strigiformes (Fig. 2.11D), Falconiformes (Fig. 2.1L; Fig. 2.11L), Coliiformes (Fig. 2.11E), Piciformes, some members of Coraciiformes and Psittaciformes. The most exaggerated inflated bulge shape (state 1) is observed in Strigidae, in which the maxillopalatine process has a trabeculate structure (Mayr 2020a). In state 2, the maxillopalatine process is a sheet-like lamella, this is observed Leptosomiformes (Fig. 2.11F), Bucerotiformes (Fig. 2.11F) and some members of Coraciiformes (Fig. 2.11I). State 3, where the maxillopalatine process is craniocaudally narrow, is only observed in Trogoniformes (Fig. 2.11G). In state 4, the maxillopalatine process is rod shaped, this is observed in Passeriformes (Fig. 2.11N, P) in which the shape can vary in the amount of caudal expansion. See Mayr (2020a) for more detailed discussion on the various shapes of the maxillopalatine process.

103. Maxillopalatine process of the maxillary, contacts the vomer: absent (0); present (1).

New character.

Sate 1 is only observed in Passeriformes. There is a large amount of variation in the form of this contact, in some cases the maxillopalatine process is fused to the vomer (e.g. *Climacterus melanurus wellsi*) and in others the vomer touches the elongated rostromedial angle of the palatine (e.g. *Melanopareia torquate bitorquata*).

104. Maxillopalatine process of the maxillary, ventral foramina: absent (0); present (1).

New character.

The ventral foramina are a set of openings or fenestra that occur on the midsection of the maxillopalatine process (see Mayr 2020a for more details and figures).

105. Rostrum maxillae covered ventrally by medially co-ossified palatine processes (processus palatini) of premaxillae: absent (0), present (1) (Fig. 2.11).

Mayr (2016, ch. 4), Mayr & Kitchener (2022a, ch. 4).

A medially co-ossified palatine processes (processus palatini) of premaxillae is observed in some members of Accipitridae (Fig. 2.11B), Leptosmiformes, Coliiformes (Fig. 2.11E), Bucerotiformes (Fig. 2.11H), some members of Coraciiformes and Piciformes, Falconiformes (Fig. 2.11L) and Psittaciformes.

106. Jugal, robust: no (0), yes (1).

Mayr (2016, ch. 9), Mayr & Kitchener (2022a, ch. 20).

In the above references, only various fossil taxa such as *Bathornis grallator, Danielsraptor phorusrhacoides, Masillaraptor parvunguis*, were scored as having a robust jugal (state 1). The size of jugal in these fossils is of similar size to what it is seen Cathartiformes (Fig. 2.1A), therefore scored as state 1.

107. Quadrate, dorsally projecting process on lateral condyle (condylus lateralis): absent (0); present (1).

Mayr & Clarke (2003, ch. 38), Ksepka & Clarke (2009, ch. 4), Ksepka & Clarke (2010, ch. 3), Ksepka *et al.* (2017, ch. 16), Ksepka *et al.* (2019, ch. 17).

A dorsally projecting lateral condyle (state 1) is observed in crown Coliidae. In previous studies such as Ksepka *et al.* (2019), this feature was also observed in *Tyrannus* (Passeriformes) and *Upupa* (Upupiformes), however this was not observed in the specimens of the present study.

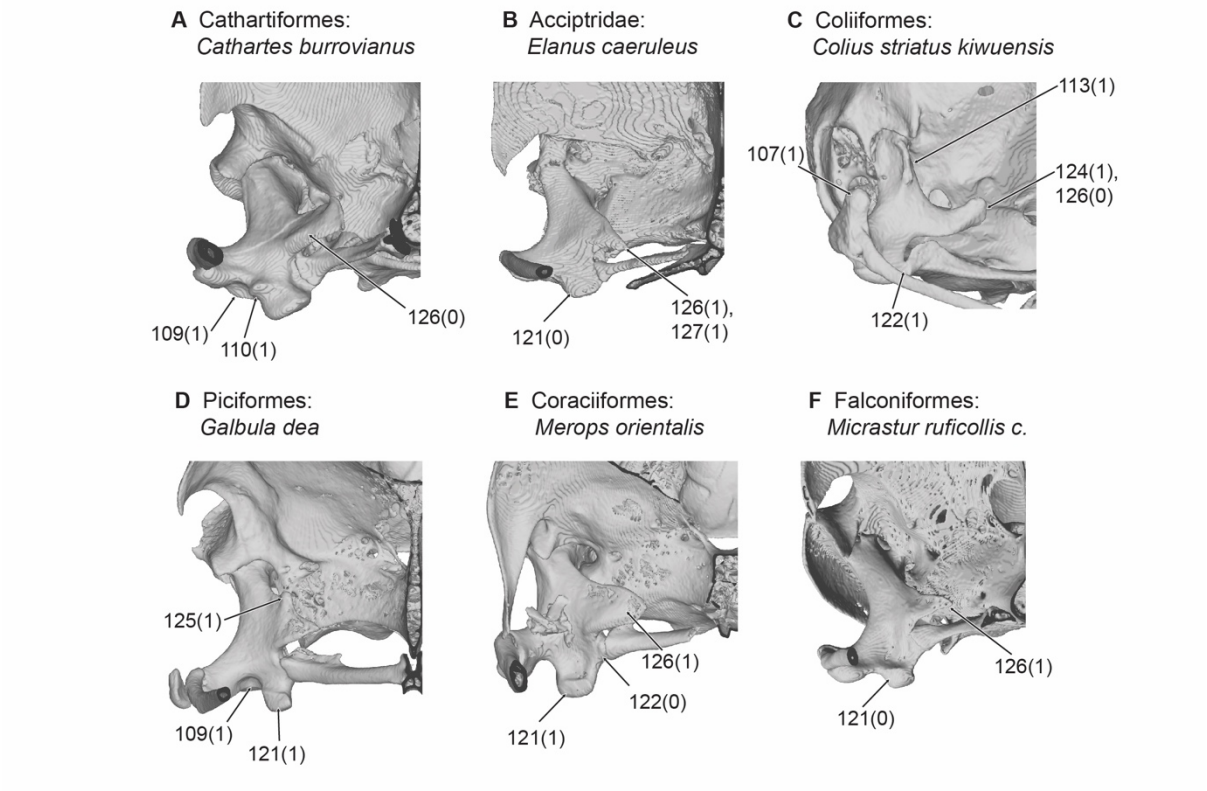


Figure 2.12. Quadrates in rostral view showing characters 107, 109, 110, 113, 121, 122, 124, 125 and 126. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (C) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (D) *Galbula dea* (Paradise jacamar, FMNH birds 376705); (E) *Merops orientalis* (Asian green bee-eater, UMMZ birds 216577); (F) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226). Numbers denote characters and character states as listed.

108. Quadrate, medial condyle (condylus medialis) of the mandibular process with concave lateral articular surface: absent (0), present (1) (Fig. 2.11).

Mayr & Clarke (2003, ch. 37), Mayr *et al.* (2004, ch. 8), Mayr (2005, ch. 24), Mayr (2020, ch. 11), Mayr (2021, ch. 10), Mayr & Kitchener (2023a, ch. 11), Mayr & Kitchener (2023b, ch. 11), Mayr & Kitchener (2023c, ch. 11).

In state 1, the lateral portion the articular surface of the medial condyle exhibits a markedly concave articulation facet for the mandible that extends across the quadrate. This feature is only observed in Falconiformes (Fig. 2.11L) but not apparent in *Caracara cheriway* (as previously scored in the above cited references). *Parapsittacopes* and *Tynskya* are also scored as present (state 1) in the above cited references, I however was not able to observe this in person but have scored as present based on the above references.

109. Quadrate, intercondylar sulcus (sulcus intercondylaris): shallow (0); deeply excavated (1) (Fig. 2.12)

New character.

A deeply excavated intercondylar sulcus (state 1) is observed in Cathartidae (Fig. 2.12A), Some members of Coraciimorphae for example *Galbula dea* (Fig. 2.12D) and most members of Falconiformes.

110. Quadrate, process between medial and lateral condyles: absent (0); present (1) (Fig. 2.12).

New character.

State 1 is only present in Cathartiformes (Fig. 2.12A) and outgroup taxa.

111. Quadrate, caudal view, distal end of medial condyle (condylus mediali) of the mandibular process forming a marked shelf: absent, uniformly convex (0); present (1) (Fig. 2.13).

New character.

State 1 the distal end of the medial condyle forms a marked shelf, characterised by a distinct, flattened, or ledge like projection, is observed in Cariamiformes (Fig. 2.13B) and Falconiformes (Fig. 2.13C). State 0, where the medial condyle is uniformly convex is observed in all other Telluraves (fig. 2.13A).

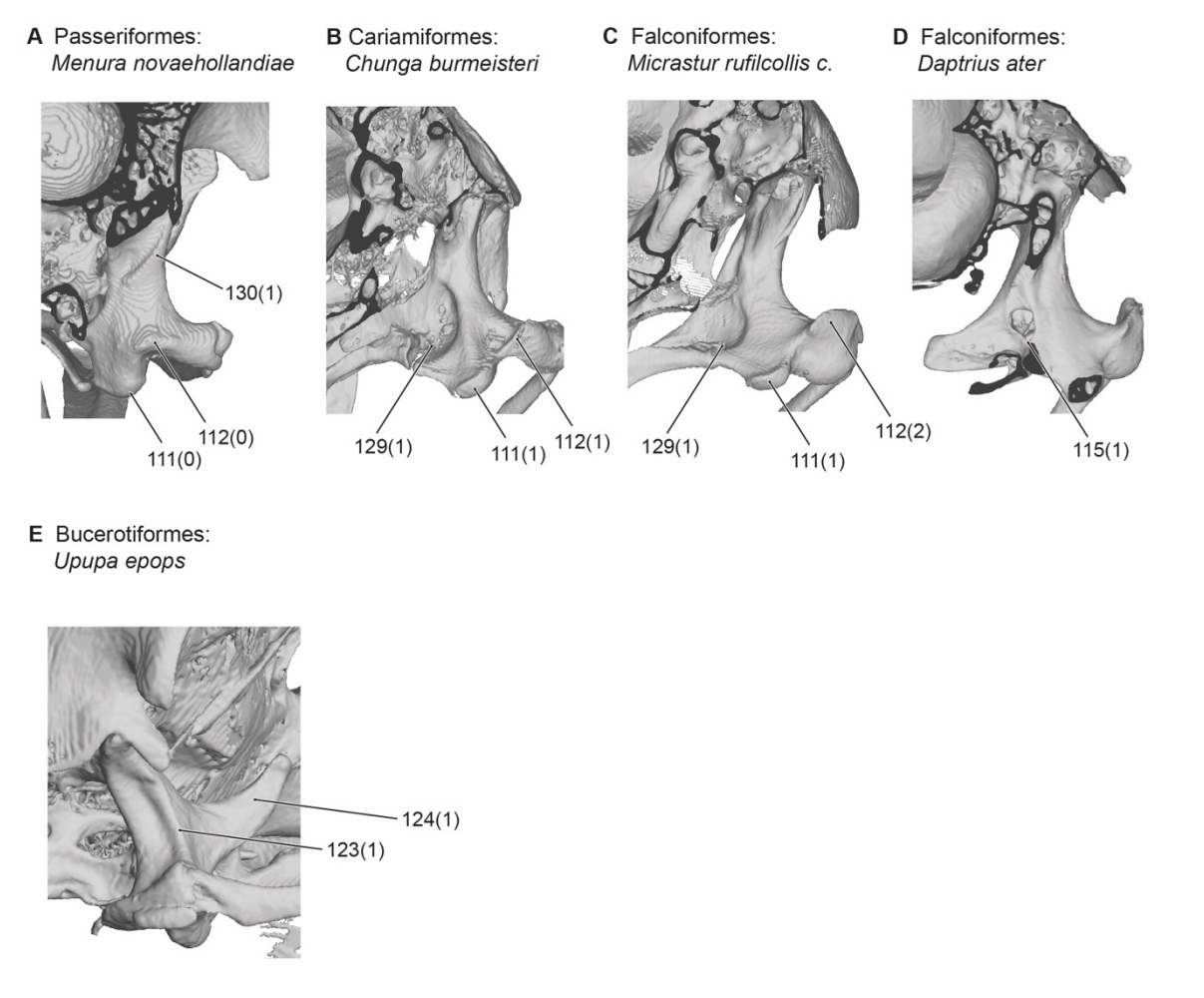


Figure 2.13. Right quadrates in medial view showing characters 111, 112, 123, 124, 129 and 130. (A) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751); (B) *Chunga burmeisteri* (Black-legged seriema, FMNH birds 106731); (C) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226). Numbers denote characters and character states as listed; (D) *Daptrius ater* (Black caracara, UMMZ birds 157622); (E) *Upupa epops marginata* (Madagascar hoopoe, FMNH birds 352821), in lateral view.

112. Quadrate, caudal condyle (condylus caudalis): reduced (smooth/ small rise) (0); prominent (lip) (1) extensive (shelf) (2).

New character.

In state 0, the caudal condyle is smooth or has a small rise, this is observed in most members of Accipitridae, Leptosomiformes, most members of Coraciiformes and Psittaciformes. State 1, the caudal condyle is more developed forming a lip-like projection, this is observed in Strigiformes, Pandionidae, most members of Coraciimorphae and Passerines (Fig. 2.13A). In state 1, an extensive shelf on the caudal condyle (condylus caudalis) is observed in Falconiformes (Fig. 2.13C).

113. Quadrate, eminentia articularis: absent (0); present (1) (Fig. 2.12C).

Mayr (2013, ch. 4), Ksepka *et al.* (2017, ch. 15), Ksepka *et al.* (2019, ch. 16).

In state 1, a dorsoventrally oriented ridge is present on the lateral surface of the otic process, for the origin of m. adductor mandibulae externus profundus (Andors 1992). This ridge is present in extinct and extant Coliiformes (Fig 2.13C), and *Picus viridis*.

114. Quadrate, otic process (processus oticus), caudal surface with pneumatic foramen (foramen pneumaticum) under capitulum: absent (0); present (1).

Modified Mayr & Clarke (2003, ch. 36), Mayr *et al.* (2003, ch. 17), Mayr (2005a, ch. 19), Mayr (2005b, ch. 23), Mayr *et al.* (2010, ch. 19), Mayr (2011, ch. 19), Mayr (2020, ch. 12), Mayr (2022, ch. 12), Mayr & Kitchener (2023a, ch. 12), Mayr & Kitchener (2023b, ch. 12), Mayr & Kitchener (2023c, ch.12).

This character is modified from the above cited refences in that "large" pneumatic foramen has been removed, as the size varies within Telluraves.

115. Quadrate, medial pneumatic foramen (foramen pneumaticum mediale): absent (0); present (1) (Fig. 1.13D).

Modified from Mayr (2022, ch. 11).

A medial pneumatic foramen is present on the medial surface of the otic process (Fig. 2.13D). See Mayr (2021d) figure 2 for detailed descriptions on the quadrate.

116. Quadrate, position of medial pneumatic foramen (foramen pneumaticum mediale): caudomedial (0); dorsally (1); inapplicable, medial pneumatic foramen absent (NA) (Fig. 1.13D).

New character.

The position of the medial pneumatic foramen, if present, does vary. For examply it is more dorsally positioned in Daptrius ater (Fig. 2.13D). See Mayr (2021b, fig 2) for detailed descriptions.

117. Quadrate, orbital process (processus orbitalis), distance from interorbital septum: long process (more than half the distance) (0); half/less than half this distance (1); greatly reduced (1/3 of the distance) (2).

Modified from Mayr *et al.* (2003, ch. 15), Mayr (2005a, ch. 17), Mayr (2006, ch. 20), Mayr *et al.* (2010, ch. 17), Mayr (2011, ch. 17).

A greatly reduced orbital process (state 2) is observed in Psittaciformes and a few Accipitridae, for example Elanus caeruleus (Fig. .212B).

118. Quadrate, otic process (processus oticus) in caudal view: mediolaterally wide (0); narrow and pillar-like (capitulum squamosum and capitulum oticum close together) (1).

Ksepka *et al.* (2011, ch. 16), Ksepka & Clarke (2012, ch. 16).

A narrow and pillar-like otic process (state 1) was considered to be a synapomorphy of crown Psittaciformes by Mayr & Daniels (1998). See Mayr (2021; fig. 2) for detailed description.

119. Quadrate, otic capuitulum (capitulum oticum) greatly elongated: absent (0), present (1).

Mayr & Kitchener (2023b, ch. 2).

A greatly elongated otic capitulum (state 1) is only present in crown Strigiformes. See Mayr (2021, fig. 2) for detailed description. Mayr & Kitchener (2023b) suggested that the large and extended capitulum oticum may be functionally related to the otic region likely improving auditory capabilities.

120. Quadrate, medial end of otic process (processus oticus), position of capitulum oticum relative to capitulum squamosum: equal heights (0); unequal heights (capitulum oticum projecting more dorsally) (1).

Mayr & Kitchener (2023a, ch. 13.)

See Mayr (2021, fig. 2) for detailed description.

121. Quadrate, rostral view, medial condyle (condylus mediali): slightly protruding, approximately level with the lateral condyle (condylus lateralis) (0); strongly protruding ventrally, past lateral condyle (1) (Fig. 2.12).

Modified from Mayr (2022, ch. 10).

A strongly protruding medial condyle is observed in many Telluraves for example *Merops orientalis* (Fig. 2.12E).

122. Quadrate, pterygoid condyle (condylus pterygoideus) and medial condyle (condylus mediali): distally separated (0); super-imposed (1) (Fig. 2.12).

New character. Based on Elzanowski & Boles (2015).

A super-imposed pterygoid and medial condyle are superimposed or aligned, this is observed in Coliiformes (Fig. 2.12C) and some members of Piciformes.

123. Quadrate, otic process (processus oticus) with distinct fossa along the caudal surface: absent (0); present (1) (Fig. 2.13).

New character. Based Elzanowski & Boles (2015)

The lateral surface of the otic process with a deep lateral crest is observed in *Upupa epops* (Fig. 2.13E). This feature is also observed in the extinct Strigiformes *Ypresiglaux michaeldanielsi* Mayr & Kitchener (2023d).

124. Quadrate, orbital process (processus orbitalis), strongly curved dorsally: absent (0); present (1) (Fig. 12).

New character. Based on Elzanowski & Boles (2015)

A dorsally curved orbital process is observed in Coliiformes (Fig. 2.12C) and *Upupa epops* (Fig. 2.13E).

125. Quadrate, large, dorsally projecting process on orbital process (processus orbitalis): absent (0); present (1) (Fig 2.12).

New character.

A large dorsally projecting process of the orbital process is observed in most members of Coraciiformes and Galbula dea (Fig. 2.12D).

126. Quadrate, shape of orbital process (processus orbitalis): rod-like (0); triangular (width of base of orbital subequal to or longer than length of orbital) (1) (Fig, 2.12).

New character.

The shape of the orbital process is defined by two shapes, either as a rod (state 0) which is observed in many Telluraves for example Cathartidae (Fig, 2.12A) or triangular shaped (state 1) for example Accipitridae (Fig. 2.12B)

127. Quadrate, orbital process (processus orbitalis) orientation: "directed rostrally / rostrodorsally (0); inclined rostroventrally (1) (Fig. 2.12B).

New character.

In a few members of Accipitridae the orbital process is orientated rostroventrally (state 1; Fig. 2.12B)

128. Quadrate, lateral condyle (condylus lateralis) length: approximately same rostrocaudal length (condylus medialis) (0); substantially longer than medial condyle (1).

New character.

129. Quadrate, caudal view, deep fossa between orbital process (processus orbitali) and medial condyle (condylus mediali): absent (0); present (1) (Fig. 2.13).

New character.

A deep fossa between the orbital process and medial condyle is observed in Cariamiformes (Fig. 2.13B) and Falconiformes (Fig. 2.13C) In Cariamiformes this fossa encompasses the foramen pneumaticum mediale.

130. Quadrate, fossa caudalis: absent/shallow (0); deep/distinctive (1) (Fig. 2.13A)

New character.

See figure 2.13A for example of a distinctive sharp ridge that delimits the fossa caudalis.

MANDIBLE

131. Mandible, caudal mandibular fenestra (fenestra caudalis mandibulae): small, foramen-sized perforation (0); large, ovate fenestra (1) (Fig. 2.14).

Zelenkov & Dyke (2008, ch. 2), Ksepka & Clarke (2009, ch. 5), Ksepka & Clarke (2010, ch. 5), Ksepka *et al.* (2011, ch. 21), Ksepka & Clarke (2012, ch. 21), Mayr (2015, ch. 6), Ksepka *et al.* (2017, ch. 19), Mayr (2020, ch. 6), Mayr (2021, ch. 6), Smith *et al.* (2018, ch. 5), Ksepka *et al.* (2019, ch. 23), Mayr & Kitchener (2023a, ch. 6), Mayr & Kitchener (2023b, ch .6), Mayr & Kitchener (2023c, ch. 6).

In cases where the caudal mandibular fenestra (fenestra caudalis mandibulae) is absent (state 0), it takes the form of a small foramen instead of a large, ovoid opening (Fig. 2.14A, C). In Mayr & Kitchener (2023a,b,c) only Passeriformes and Coliidae are scored as possessing the caudal fenestra (state 1), while in Ksepka *et al.* (2019) only *Colius striatus*, Trogoniformes and passerines are scored as state 1. In older works, such as Ksepka *et al.* (2017), *Cariama cristata*, and Strigiformes are scored as having a caudal fenestra, however in later works this was changed to a rostral fenestra (see Ch. 132). In the present study I found that the size of the foramen to be highly variable, with the largest observed in Passeriformes (Fig. 2.14D) and *Trogon melanurus eumorphus* (Trogoniformes) and somewhat smaller in *Apaloderma narina* (Trogoniformes) and *Micrastur ruficollis concentricus* (Falconiformes; Fig. 2.14B), which have all been scored as state 1.

132. Mandible, rostral mandibular fenestra: absent (0); present (1) (Fig. 2.14).

Clarke *et al.* (2009, ch. 22), Ksepka *et al.* (2011, ch. 20), Ksepka & Clarke (2012, ch. 20), Ksepka *et al.* (2019, ch. 22).

The rostral mandibular fenestra is found at the confluence of the dentary and surangular and is present (state 1) in Strigiformes, Cariamiformes, Falconiformes (Fig. 2.14B), *Colius striatus* and Nestor notabilis (Fig. 2.14C). It can be difficult to discern between the caudal mandibular fenestra and the rostral mandibular fenestra because the caudal foramen can be completely absent, and the sutures between bones of the mandible are often closed in Telluraves.

133. Mandible, rostral and caudal mandibular fenestra when both present: separate (0); confluent (1); inapplicable, only one fenestra is present (NA).

New character.

A confluent rostral and caudal mandibular fenestra is observed in Strigiformes and Coliiformes.

134. Mandible, number of fenestrae: zero (0); one (1); two (2) (Fig. 2.14).

New character.

Two clearly defined fenestra (caudal and rostral mandibular fenestra) is observed in *Micrastur ruficollis* (Fig. 2.14B) and *Chunga burmeisteri*.

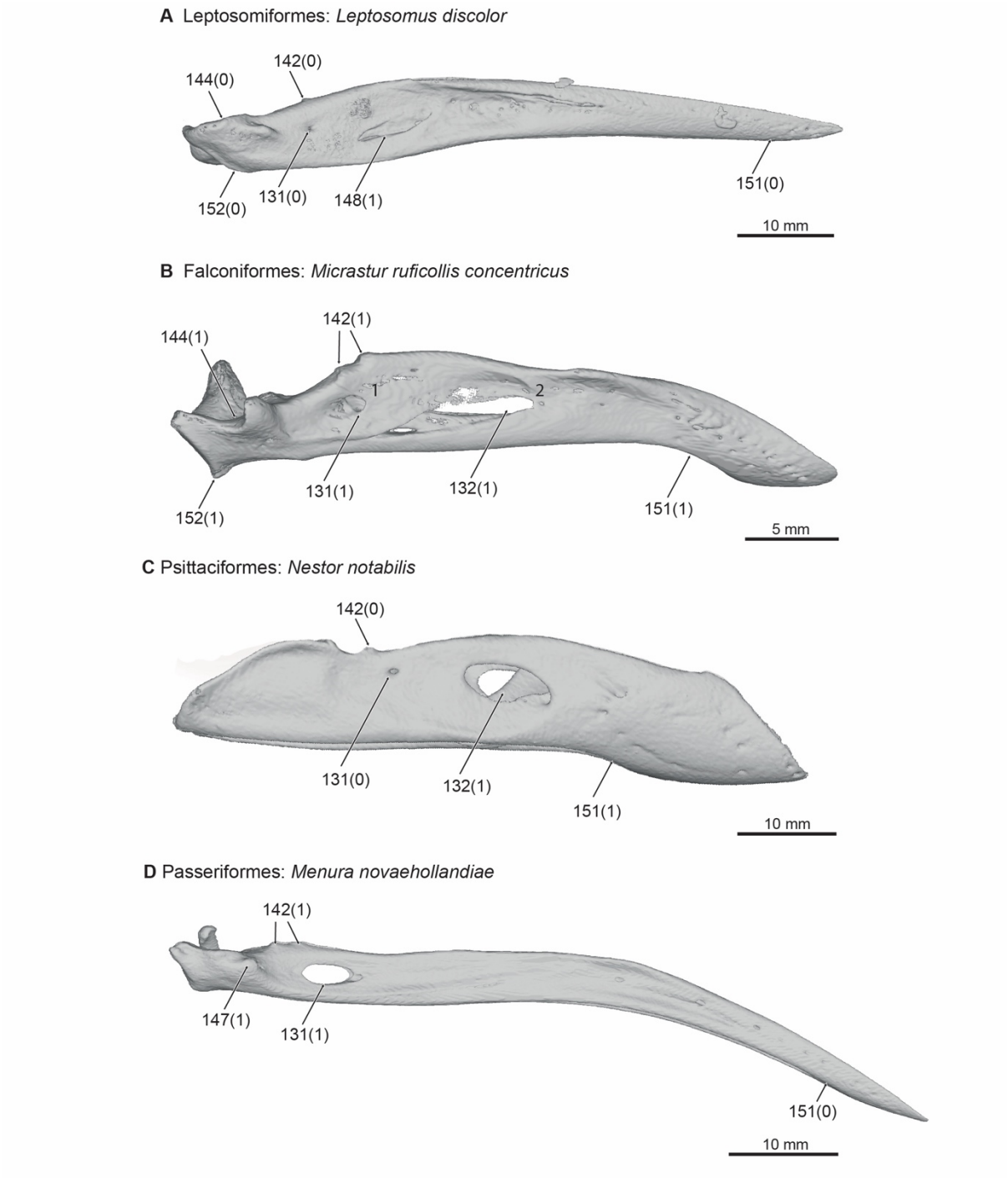


Figure 2.14. Mandibles in right lateral view showing characters 131, 132, 142, 144, 146, 148, 151 and 152. (A) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (B) *Caracara cheriway* (crested caracara, UMMZ birds 133664); (C) *Nestor notabilis* (Kea, FMNH birds 23530); (D) *Menura novaehollandiae* (superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

135. Mandible, dorsal surface of mandibular symphysis (pars symphysialis): concave (0); flat (1) (Fig. 2.16).

Mayr & Clarke (2003, ch. 43), Mayr (2006, ch. 24), Ksepka *et al.* (2019, ch. 20).

The mandibular symphysis is formed by the anterior fusion of the dentary bones. In most Telluraves the dorsal surface of mandibular symphysis is concave (state 0; Fig. 2.16A, B) while in Bucerotiformes, *Alcedo atthis* and *Merops orientalis* the symphysis is level or flat (state 2).

136. Mandible, mandibular symphysis/pars symphysialis: short (0); extensive, accounting for one-third or more of total mandible length (1).

Mayr *et al.* (2003, ch. 19), Mayr (2005, ch. 21), Mayr (2006, ch.23,), Clarke *et al.* (2009, ch. 20), Mayr *et al.* (2010, ch. 21), Mayr (2011, ch. 21), Bourdon *et al.* (2016, ch. 17), Smith *et al.* (2018, ch. 4), Ksepka *et al.* (2017, ch. 18), Ksepka *et al.* (2019, ch. 19).

An extensive mandibular symphysis (state 1) is observed in Bucerotiformes, and many members of Coraciiformes and Piciformes.

137. Mandible, retroarticular process (processus retroarticularis): short (not extended) (0); caudally extending (1) (Fig. 2.15).

Modified from Mayr & Clarke (2003, ch. 44), Mayr (2005b, ch. 26), Mayr (2006, ch. 28), Ksepka & Clarke (2009, ch. 2), Ksepka & Clarke (2010, ch. 6), Mayr (2013, ch. 5), Ksepka *et al.* (2017, ch. 20), Ksepka *et al.* (2019, ch. 25), Mayr (2020, ch. 9), Mayr & Kitchener (2023a, ch. 9), Mayr & Kitchener (2023b, ch. 9), Mayr & Kitchener (2023c, ch. 9).

The retroarticular process (processus retroarticularis) serves as an attachment site for the depressor mandibulae muscle, which also the lower jaw to be opened. An enlarged process likely enhances its leverage and efficiency in jaw depression while foraging in soil or tree crevices (Zusi 1959). An elongated and caudally extending retroarticular process (processus retroarticularis) (state 1) is present in Coliiformes (Fig. 2.15G), Bucerotiformes (Fig. 2.15H) and Psittaciformes (Fig. 2.15I). It is also present in the stem mousebirds *Masillacolius brevidactylus* and *Oligocolius psittacocephalon* (Ksepka *et al.* 2019). This feature was also considered autapomorphic in some Passeriformes (Mayr & Clarke 2003), but the feature is not present in any passerines in the present study. In Mayr & Kitchener (2023a,b,c), Psittaciformes were left blank , so it is unknown as to what the score should be but in older studies as listed above, some characters had a third

state describing the condition seen only in Psittaciformes where an "elongate, but not blade-like processus retrarticularis is present". I have made this into a separate character 138.

138. Mandible, transverse crest of the fossa (crista transversa fossae) extends with processus retroarticularis: absent (0); present (1) (Fig. 2.15I).

New character.

See above comments and Figure 2.15I.

139. Mandible, medial process of the mandible (processus mandibulae medialis): elongated (0); completely reduced (1) (Fig. 2.15).

New character.

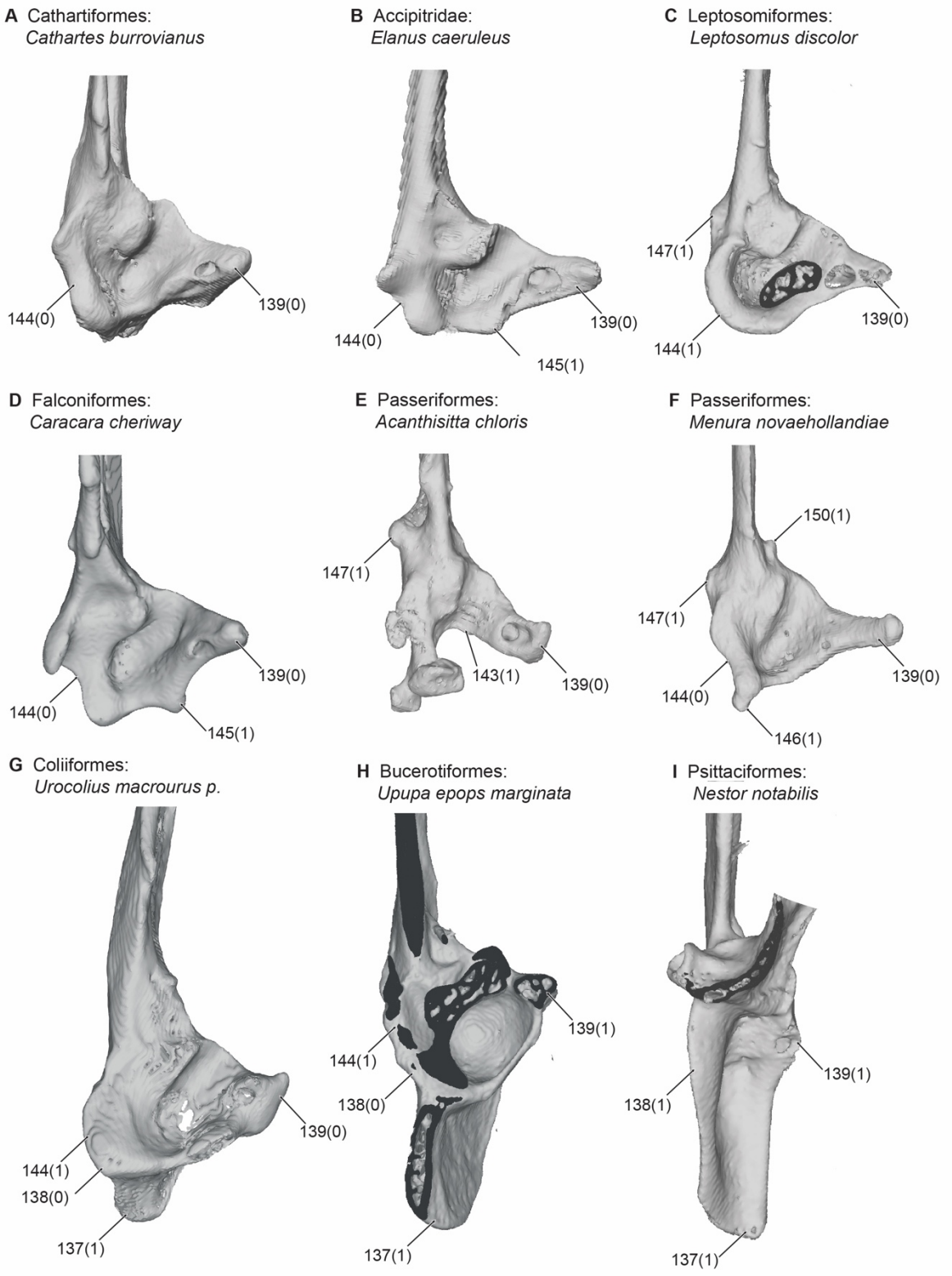
A completely reduced medial process of the mandible is present in Psittaciformes (Fig. 2.15I) and Bucerotiformes (Fig. 215H). Otherwise, the size and shape is considerably variable within Telluraves (state 0). In passerines the process tends to be narrower than in other birds (Fig. 2.15E).

140. Mandible, rami dorsoventrally deep across the entire mandibular length (ratio mandible length to maximum dorsoventral depth): <0.2 (0), >0.2 (1) (Fig. 2.14).

Ksepka *et al.* (2011, ch. 19), Ksepka & Clarke (2012, ch. 19), Mayr (2020, ch. 7), Mayr (2021, ch. 7), Mayr & Kitchener (2023a, ch. 7), Mayr & Kitchener (2023c, ch. 7).

The presence of a dorsoventrally deep mandible (state 1) is observed in Psittaciformes (Fig. 2.14C) and also some possible stem Psittaciformes such as *Messelastur gratulator* and *Tynskya* (ratio above 0.2). The ratio of max depth to length is 0.1 in Falconiformes, higher than in other non-psittaciform Telluraves but not accounted for in the present study. See Table S1.5 for mandible length measurements.

Figure 2.15. Posterior part of mandibular ramus in dorsal view showing characters 137, 138, 139, 143, 144, 147 and 150. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (C) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (D) *Caracara cheriway* (Crested caracara, UMMZ birds 133664); (E) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (F) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751); (G) *Urocolius macrourus pulcher* (Blue-naped mousebird, FMNH birds 368959); (H) *Upupa epops marginata* (Madagascar hoopoe, FMNH birds 352821); (I) *Nestor notabilis* (Kea, FMNH birds 23530). Numbers denote characters and character states as listed.


A Cathartiformes:
Cathartes burrovianus
144(0)
139(0)
B Accipitridae:
Elanus caeruleus
144(0)
139(0)
145(1)
C Leptosomiformes:
Leptosomus discolor
147(1)
144(1)
139(0)
D Falconiformes:
Caracara cheriway
139(0)
144(0)
145(1)
E Passeriformes:
Acanthisitta chloris
147(1)
143(1)
139(0)
F Passeriformes:
Menura novaehollandiae
150(1)
147(1)
144(0)
139(0)
146(1)
G Coliiformes:
Urocolius macrourus p.
139(0)
144(1)
138(0)
137(1)
H Bucerotiformes:
Upupa epops marginata
139(1)
144(1)
138(0)
137(1)
I Psittaciformes:
Nestor notabilis
139(1)
138(1)
137(1)

141. Mandible, length: markedly longer than upper beak (0); approximately equal to upper beak (1).

Ksepka *et al.* (2011, ch. 18), Ksepka & Clarke (2012, ch. 18).

A mandible shorter than the upper beak is a major feature contributing to the ''parrot shaped'' beak of extant Psittaciformes (Mayr & Daniels 1998). This, however, is not the case in the most basal parrots *Nestor notabilis* and *Strigops habroptilus*. Additionally, a considerably shorter mandible compared to the upper beak is observed in the passerine *Neodrepanis coruscans*. See Table S1.5 for mandible length measurements.

142. Mandible, coronoid process (processus coronoideus): indistinct (0); strongly developed, forming two cristae (1) (Fig. 2.14).

Ksepka *et al.* (2019) ch. 24.

A strongly developed coronoid process (state 1) is observed mostly in Cathartidae, Falconiformes (Fig. 214B) and Passeriformes (Fig. 2.14D).

143. Mandible, posterior wall of articular cavity developed (0); poorly developed, deep incision between medial process and retroarticular process (1) (Fig. 2.15)

Modified from Clarke *et al.* (2009, ch. 21), Bourdon *et al.* (2016, ch. 18).

The posterior wall of articular cavity is poorly developed and completely reduced in the Cavitaves *Todus mexicanus* and *Momotus momota*, and the Passeriformes *Acanthisitta chloris* (Fig. 2.15E).

144. Mandible, lateral mandibular process (processus mandibulae lateralis): the lateral and caudal cotylae prominent creating a saddle shaped appearance (0); lateral and caudal cotylae are rounded and smooth (1) (Fig. 2.14; 2.15).

New character.

The lateral and caudal cotylae on the dorso-lateral border of the quadratic articular fossa are indistinguishable due to the absence of the intercondylar process separating them (state 1), this is observed in early diverging Coraciimorphae like Coliiformes (Fig. 2.15G), Leptosomiformes

(Fig. 2.14A; 2.15C), Trogoniformes and Bucerotiformes (Fig. 2.25H). In Falconiformes the caudal cotylae is exceptionally large creating a very deep saddle shape (state 0; Fig. 2.14B), similar to what is observed in Accipitridae.

145. Mandible, caudal articular end with marked dorsal projection, which borders caudal fossa: absent (0), present (1) (Fig. 2.15B).

Mayr & Kitchener (2022a, ch. 13).

In Mayr & Kitchener (2022a) the Falconiform *Caracara plancus* and *Danielsraptor parvunguis* are scored as having this dorsal projection present (state1) and was suggested that this feature is found in crown group Falconiformes and absent in extant and fossil Cariamiformes suggesting this feature as a diagnostic apomorphy for Pan-Falconiformes. In the present study, however, this feature was not observed (state 0) in the basal most falconiforms Herpetotherinae and only observed in later diverging crown group Falconiformes (Fig. 2.15D). This projection is also observed in the accipitriform *Elanus caeruleus* (Fig. 2.15B).

146. Mandible, lateral mandibular process (processus mandibulae lateralis) with large and caudally extending separate process: absent (0); present (1) (Fig. 2.15F).

New character.

A caudally extending process on the lateral condyle (state 1) is mainly observed in Passeriformes (Fig. 2.15F) and some Cavitaves. As well as *Parapsittacopes bergdahli* and *Cyrilavis colburnorum.*

147. Mandible, rostrolateral process of the lateral cotyle: absent (0); present (1) (Fig. 2.15).

New character.

A large tuberculum extending rostrolaterally from the lateral cotyle (state1) and is observed in many Telluraves (Fig. 2.15C, E, F). The process is likely a stop for the jugal. It can be variable in the shape, size and position within Telluraves but not accounted for in the present study.

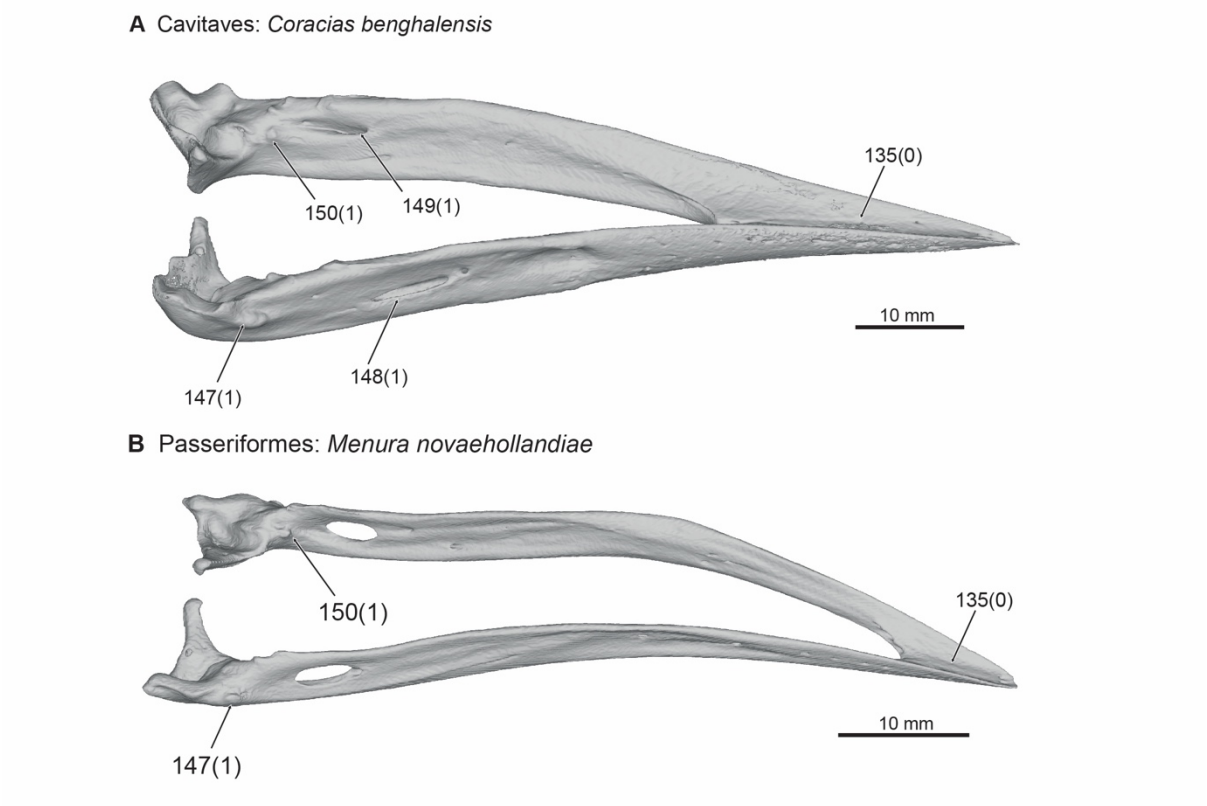


Figure 2.16. Mandibles in right dorsolateral view showing characters 147, 148, 149 and 150, mandible in caudal lateral view. (A) *Coracias benghalensis* (Indian roller, NHMUK zoo S/1987.19.15); (B) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

148. Mandible, lateral pseudotemporale: absent (0); present (1) (Fig. 214A).

New character.

A pseudotemporale on the lateral surface of the mandible is observed in for example Leptosomiformes (Fig. 214A).

149. Mandible, fossa aditus canalis mandibulae enclosed forming a pseudotemporale: absent (0); present (1) (Fig. 2.16A).

New character.

An enclosed fossa aditus canalis mandibulae is observed in mostly Coraciiformes (Fig. 2.16A).

150. Mandible, pterygoid tubercle (tuberculum pterygoidem): small/ inconspicuous (0) large and rounded (1) (Fig. 2.15F; 2.16A, B).

New character.

A large and rounded pterygoid tubercle is ventrocaudally to the base of the fossa aditus canalis mandibulae in Passeriformes (Fig. 2.15F; 2.16A, B) and some members of Coraciiformes.

151. Mandible, rostral portion, lateral surface of ventral mandibular margin at level of symphysis: straight or slightly down-curved (0); strongly down-turned, with distinct angle of deflection at the gonys (1) (Fig. 2.14B, C).

New character.

A strongly down-turned mandible is observed in Accipitriformes, Strigiformes, Falconiformes (Fig. 2.14B) and Psittaciformes (Fig. 2.14D).

152. Mandible, ventral surface of the articular fossa: smooth and rounded (0); rectangular (1) (Fig. 2.17).

New character.

In most birds ventral surface of the articular fossa is smooth and rounded (state 0), likely due to a retroarticular process (Ch. 137) giving a smooth and rounded appearance to the ventral surface of the articular fossa (Fig. 2.17A). In Cariamiformes, Falconiformes (Fig. 2.17B) and Accipitridae, a triangular aspect to the region where the caudal margin of the mandible exhibits a rectangular aspect (state 1).

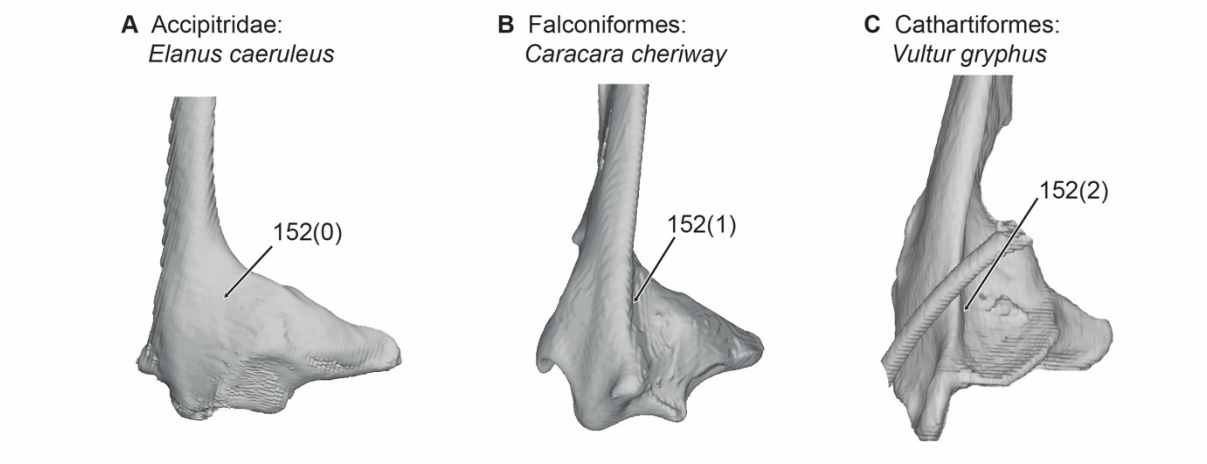


Figure 2.17. Posterior part of mandibular rami in ventral view showing character 152. (A) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (B) *Caracara cheriway* (Crested caracara, UMMZ birds 133664). (C) *Vultur gryphus* (Andean condor, NHMUK zoo S/1955.5.11). Numbers denote characters and character states as listed.

VERTEBRAE

153. Atlas, transverse foramen: absent (0); present (1).

Mayr & Clarke (2003, ch. 47), Mayr (2005b, ch. 29), Clarke *et al.* (2009, ch. 24).

A transverse foramen (state 1) is observed in Sagittariidae, Leptosomiformes and *Picus viridis*. Scorings partially based on Mayr (2005b) and Mayr & Clarke (2003), Sagittariidae are scored as having transverse foramen in these studies, however the specimen in the present study did exhibit such foramen where only a small extension is observed that does not fully join with the transverse foramina, none the less, it has been scored as present (state 1).

154. Atlas, processus ventralis: short (0); elongated and caudally projected (1).

Mayr & Clarke (2003, ch. 46), Mayr (2005b, ch. 28), Ksepka *et al.* (2011, ch. 22), Ksepka & Clarke (2012, ch. 22).

An elongated and caudally projected ventral process of the atlas is observed in Psittaciformes and *Pseudasturides macrocephalus.*

155. Atlas, processus ventralis: dorso-ventrally short (0); dorso-ventrally expanded (1).

New character.

156. Atlas, incisura fossae: open (0), closed (1).

Mayr *et al.* (2003, ch. 23), Mayr (2005a, ch. 25), Mayr (2006, ch. 29), Mayr *et al.* (2010, ch. 25), Mayr (2011, ch. 25).

157. Atlas, reduced torus dorsalis: absent (0); present (1).

New character.

A reduced torus dorsalis of the atlas is only observed in Coliiformes and *Galbula dea*.

158. Atlas and axis: separate (0); fused into single element in adult (1).

Clarke *et al.* (2009, ch. 23).

A fused atlas and axis is only observed in *Tockus nasutus*.

159. Axis, transverse foramen: absent (0); present (1).

Mayr & Clarke (2003, ch. 49), Mayr *et al.* (2003, ch. 24), Mayr (2005a, ch. 26), Mayr (2005b, ch. 31), Mayr (2006, ch. 30), Clarke *et al.* (2009, ch. 25), Mayr *et al.* (2010, ch. 26), Mayr (2011, ch. 26).

Differing in scoring between above cited references, notably in Clarke (2009) where a transverse foramen is present in Cathartidae and absent in Leptosomiformes and Cariamiformes. I am in agreement that a transverese foramen is present (state 1) in Cathartiformes, but also *Sagittarius serpentarius.*

160. Axis, corpus strongly shortened in craniocaudal direction: no (0), yes (1).

Mayr & Kitchener (2023d, ch. 4).

In the above cited reference a shortened axis in the craniocaudal direction is observed in Strigiformes. However in the present study it was found only in *Tyto alba*.

161. Axis, corpus with pneumatic foramina on lateral sides: no (0), yes (1).

Mayr & Clarke (2003, ch. 48), Mayr (2005b, ch. 30).

Scorings taken from the above cited references.

162. Third cervical vertebra, osseous bridge from processus transversus to processus articularis caudalis: absent (0), present (1).

Mayr & Clarke (2003, ch. 52), Mayr (2005b, ch. 34).

Scorings taken from the above cited references.

163. At least 7th and 8th cervical vertebra, osseous bridge from processus costalis to midsection of corpus vertebrae: absent (0), present (1).

Mayr & Clarke (2003, ch.53), Mayr (2005b, ch.35), Mayr (2006, ch.31).

Scorings taken from the above cited references.

164. Fourth cervical vertebra, processus ventralis long and well defined: no (0), yes (1).

Mayr (2020, ch. 16), Mayr (2021, ch. 14), Mayr & Kitchener (2023b, ch. 16), Mayr & Kitchener (2023c, ch. 16).

Scorings taken from the above cited references.

165. Fourth cervical vertebra, processus spinosus long and well defined: no (0), yes (1).

Mayr (2020, ch. 15), Mayr (2021, ch. 13), Mayr (2022, ch. 16), Mayr & Kitchener (2023a, ch. 16), Mayr & Kitchener (2023b, ch. 15), Mayr & Kitchener (2023c, ch. 15).

Scorings taken from the above cited references. However, I disagree that all Trogoniformes and Bucerotiformes should be scored as state 1. In the present study neither *Trogon melanurus eumorphus* or *Upupa epops marginata* were found to exhibit a long and well defined processus spinosus of the fourth cervical vertebrae.

166. Fourth cervical vertebra, osseous bridge connecting the processus transversus with the processus articularis caudalis: absent (0), present (1).

Scorings taken from the above cited references as well as my own observations. I disagree that all Alcedinidae (e.g. *Alcedo atthis*) exhibit an osseous bridge that connects the processus transversus with the processus articularis caudalis (state 1). Additionally, an osseous bridge (state 1) was found in *Cariama cristata cristata*.

167. Thoracic vertebrae, hyper-elongated processus ventralis: absent (0); present (1).

Ksepka & Clarke (2009, ch. 6), Ksepka & Clarke (2010, ch. 7), Ksepka *et al.* (2017, ch. 22), Ksepka *et al.* (2019, ch. 29).

In the above cited references a hyper-elongated processus ventralis (state 1) is scored only for Coliiformes; this, however, was also found to be the case in the Coraciiformes *Alcedo atthis.*

168. Several thoracic vertebrae fused to a notarium: no (0), yes (1).

Mayr & Clarke (2003, ch. 56), Mayr (2005b, ch. 37), Ksepka *et al.* (2017, ch. 23), Ksepka *et al.* (2019, ch. 30).

The notarium is where any group of thoracic vertebrae are fused to each other and to the synsacrum, and sometimes the caudalmost cervical vertebrae (Baumel & Witmer 1993). This can occur in many ecologically disparate non-Telluravian birds, and its likely function is either allowing for strong take off from the ground or functional movement of the neck by anchoring the neck muscles (James 2009; Aires *et al.* 2022). Within Telluraves, the predominant form is four fused thoracic vertebrae and one free presynsacral. A notrium (state 1) occurs mostly in Falconiformes except for the basal Herpetotherinae (*Micrastur* and *Herpetotheres*). A notarium also occurs in some Passeriformes and Psittaciformes (James 2009; Aires *et al.* 2021), though the members of these groups included in the present study do not have a notarium (state 0).

169. Corpus of thoracic vertebrae pleurocoelous, that is, with distinct ovate fossae on lateral surfaces: no (0), yes (1).

Mayr (2015, ch. 10), Ksepka *et al.* (2019, ch. 28), Mayr (2020, ch. 17), Mayr (2021, ch. 15), Mayr (2022, ch. 17), Mayr & Kitchener (2023a, ch. 18), Mayr & Kitchener (2023b, ch. 17), Mayr & Kitchener (2023c, ch. 17), Mayr & Kitchener (2023d, ch. 5).

Scorings taken from the above cited references. Pleurocoels are deep ovoid depressions on the lateral surfaces of the corpus of the caudal thoracic vertebrae (state 1). Among extant birds this

feature is considered to be primitive within neognathous birds ((Ericson 1997; Mayr 2007). See (Mayr 2021b) for a more detailed study on the occurrence of the pleurocoels.

170. Caudal thoracic vertebrae: heterocoelous (0), platycoelous (1), opisthocoelous (2).

Mayr & Clarke (2003, ch. 57), Mayr (2020, ch. 18), Mayr (2021, ch. 16), Mayr & Kitchener (2023a, ch. 19), Mayr & Kitchener (2023b, ch. 18), Mayr & Kitchener (2023c, ch. 18).

Scorings taken from the above cited references.

171. Uncinate processes: unfused to ribs (0); fully fused to ribs (1).

Mayr & Clarke (2003, ch. 74), Ksepka *et al.* (2019, ch .31).

The presence of fused uncinate processes was proposed as a synapomorphy of Neornithes by (Cracraft & Prum 1988).

172. Presacral vertebrae (all vertebrae cranial to synsacrum): twenty or more (0); 18 or 19 (1).

Modified from Mayr & Clarke (2003, ch. 55), Mayr *et al.* (2003, ch. 26), Mayr (2004, ch. 8), Mayr (2005a, ch. 29), Mayr (2005b, ch. 36), Mayr (2006, ch.3 4), Clarke *et al.* (2009, ch. 26), Mayr *et al.* (2010, ch. 29), Ksepka *et al.* (2011, ch. 24), Mayr (2011, ch. 29), Ksepka & Clarke (2012, ch. 24), Mayr (2015, ch. 9), Smith *et al.* (2018, ch. 6), Ksepka *et al.* (2019, ch. 27), Mayr (2020, ch. 13), Mayr (2021, ch. 11), Mayr (2022, ch. 14), Mayr & Kitchener (2023a, ch. 14), Mayr & Kitchener (2023b, ch. 13), Mayr & Kitchener (2023c, ch. 13).

Almost all Telluraves (and outgroup taxa) have 19 presacral vertebrae (state 1). only the Accipitriformes were found to have twenty presacral vertebrae (state 0) namely *Vultur gryphus*, *Sagittarius serpentarius, Buteo rufofuscus* and *Accipitriter nisus*.

173. Caudal vertebrae, dorsal view, transverse processes: roughly all equal in length and width (0); expand in width and length towards the pygostyle (1) (Fig. 2.18A).

New character.

Expanded transverse processes of the caudal vertebrae are observed in all “raptorial” birds of this study, for example Accipiter nisus (Fig. 2.18A).

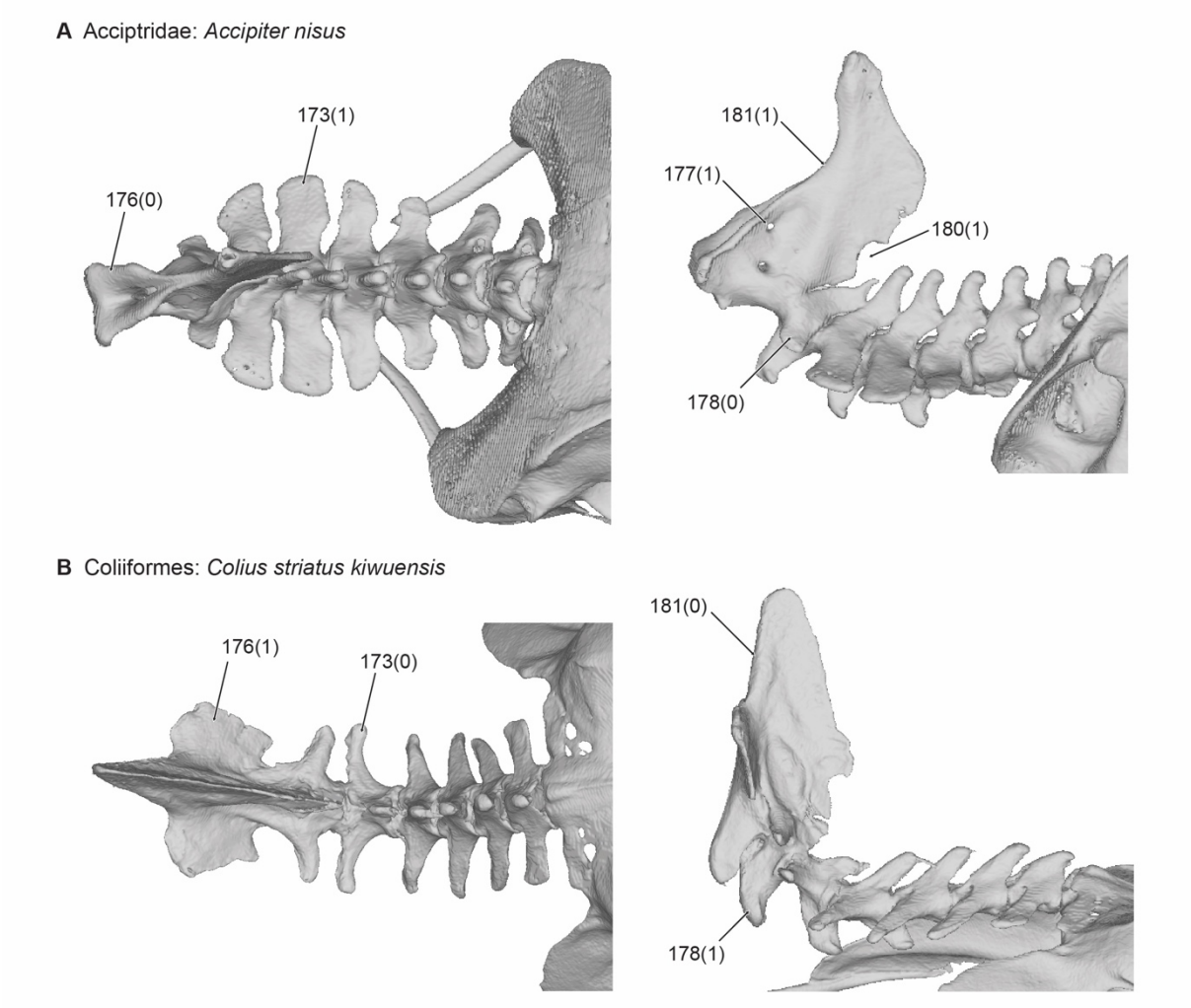


Figure 2.18. Caudal vertebrate, including pygostyle in dorsal (left) and right lateral (right) views showing characters 173, 176, 177, 178, 180 and 181. (A) *Accipiter nisus* (Eurasian sparrowhawk, NHMUK zoo S/1982.149.1); (B) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817). Numbers denote characters and character states as listed.

174. Caudal vertebrae, number of free vertebrae including pygostyle: 8 or more (0); 7 or less (1).

New character.

The taxa with highest number of free vertebrae in the present study is observed *Todus mexicanus* and *Charadris vociferus* (nine free caudal vertebrae), while the least number of free caudal vertebrae (three) is observed in *Opisthocomus hoazin* but also possibly in the psittacopedid *Eofringillirostrum boudreauxi* (Ksepka et al. 2019, fig. 1) and the zygodactylid *Primozygodactylus quintus* (Mayr 2017, fig. 2).

175. Caudal vertebrae, spinous processes: extensive (0); reduced (small) (1).

Mayr & Clarke (2003, ch. 59), Mayr (2005b, ch. 38).

176. Pygostyle, caudal margin: not markedly expanded (0); forming expanded, shield-like discus pygostyli (1) (Fig. 2.18).

Mayr & Clarke (2003, ch. 60), Mayr *et al.* (2003, ch. 25), Mayr (2004, ch. 7), Mayr *et al.* (2004, ch. 11), Mayr (2005a, ch. 28), Mayr (2005b, ch. 39), Mayr (2006, ch. 33), Zelenkov & Dyke (2008, ch. 4), Clarke *et al.* (2009, ch. 28), Ksepka & Clarke (2009, ch. 8), Ksepka & Clarke (2010, ch. 10), Mayr *et al.* (2010, ch. 28), Mayr (2011, ch. 28), Mayr (2013, ch. 6), Mayr (2015, ch. 11), Bourdon *et al.* (2016, ch. 21), Ksepka *et al.* (2017, ch. 24), Smith *et al.* (2018, ch.7), Ksepka *et al.* (2019, ch. 33), Mayr (2020, ch. 19), Mayr (2021, ch. 17), Mayr (2022, ch. 18), Mayr & Kitchener (2023a, ch. 20), Mayr & Kitchener (2023b, ch. 19), Mayr & Kitchener (2023c, ch. 19).

Mousebirds possess the most expansive discus pygostyli, with sharply defined, ridge-like margins or shield-like (state 1; Fig. 2.18B). A number of other Coraciimorphae included in the present study also have a large discus pygostyli (state 1) though not as large as in mousebirds, are scored as state 1. A large shield-like pygostyle on Coliiformes serves as the attachment area for well-developed depressor muscles of the tail and also allows for the attachment of long tail feathers (Baumel & Witmer 1993). This is likely related to Coliiformes being able to use their stiffened tail feathers as a prop when hanging.

177. Pygostyle, caudoventral portion of corpus perforated: yes (0); no (1) (Fig. 2.18).

Mayr & Clarke (2003, ch. 61), Mayr (2005a, ch. 27), Mayr (2005b, ch. 40), Mayr (2006, ch. 32), Mayr *et al.* (2010, ch. 27), Mayr (2011, ch. 27).

A perforated caudal margin of the pygostyle is observed in Cathartidae and Accipitridae (Fig. 2.18A).

178. Pygostyle, bears processus transversus from one incorporated caudal vertebra: absent (0); present (1) (Fig. 2.18B).

Ksepka & Clarke (2010, ch. 9).

The pygostyle can incorporate a single caudal vertebra, this is observed in Coliiformes (Fig. 2.18B), *Picus viridis*, *Ramphastos ambiguous* and *Menura noaehollandiae*.

179. Pygostyle: short, height approximately equal to the length of the preceding two-three free caudal vertebrae (0); large, height approximately equal to length of proceeding four free caudal vertebrae (1).

Modified from Ksepka & Clarke (2012, ch. 25), Ksepka *et al.* (2019, ch. 32).

A pygostyle allows for the structural support for the rectrices (tail feathers), providing a broader attachment surface for the musculus levator caudae and musculus depressor caudae, which are critical for tail movement and stability during flight, perching, or display behaviours (Gatesy & Dial, 1996; Baumel & Witmer, 1993). In birds such as Accipitriformes and Falconiformes a large pygostyle (state 1) may improve tail manoeuvrability for ariel predation or in birds such as Coliiformes and Psittaciformes allow for the attachment of long or more expanded tail feathers (Ksepka et al. 2012).

180. Pygostyle, anterior border of lamina: notch absent (0); notch present (1) (Fig. 2.18A).

Clarke *et al.* (2009, ch. 27), Bourdon *et al.* (2016, ch. 20).

A notch present on the anterior border of the pygostyle lamina is observed in a number of Telluraves for example *Accipiter nisus* (Fig. 2.18A).

181. Pygostyle, posterior edge of lamina: straight (0); convex (1) (Fig. 2.18).

New character.

A convex posterior edge of the pygostyle lamina is observed in some members of Falconiformes, Accipitriformes (Fig. 2.18A) and Leptosomiformes.

STERNUM

182. Sternum, lateral view, cranial edge of carina sterni or keel: concave curve or straight (0); deeply concave (1); convex (2) (Fig. 2.19).

Modified from Ksepka *et al.* (2011, ch. 31), Ksepka & Clarke (2012, ch. 32).

The above cited references described this character as the shape of the apex carinae / keel apex as either rounded or pointed. However, this shape can be ambiguous and is dependent on the shape of the cranial edge of the keel. For example, when the cranial edge of the keel is more concave than straight (state 1), the apex is pointed (Fig. 2.19D). A convex cranial edge of the keel (state 2) is observed in Psittaciformes (Fig. 2.19C).

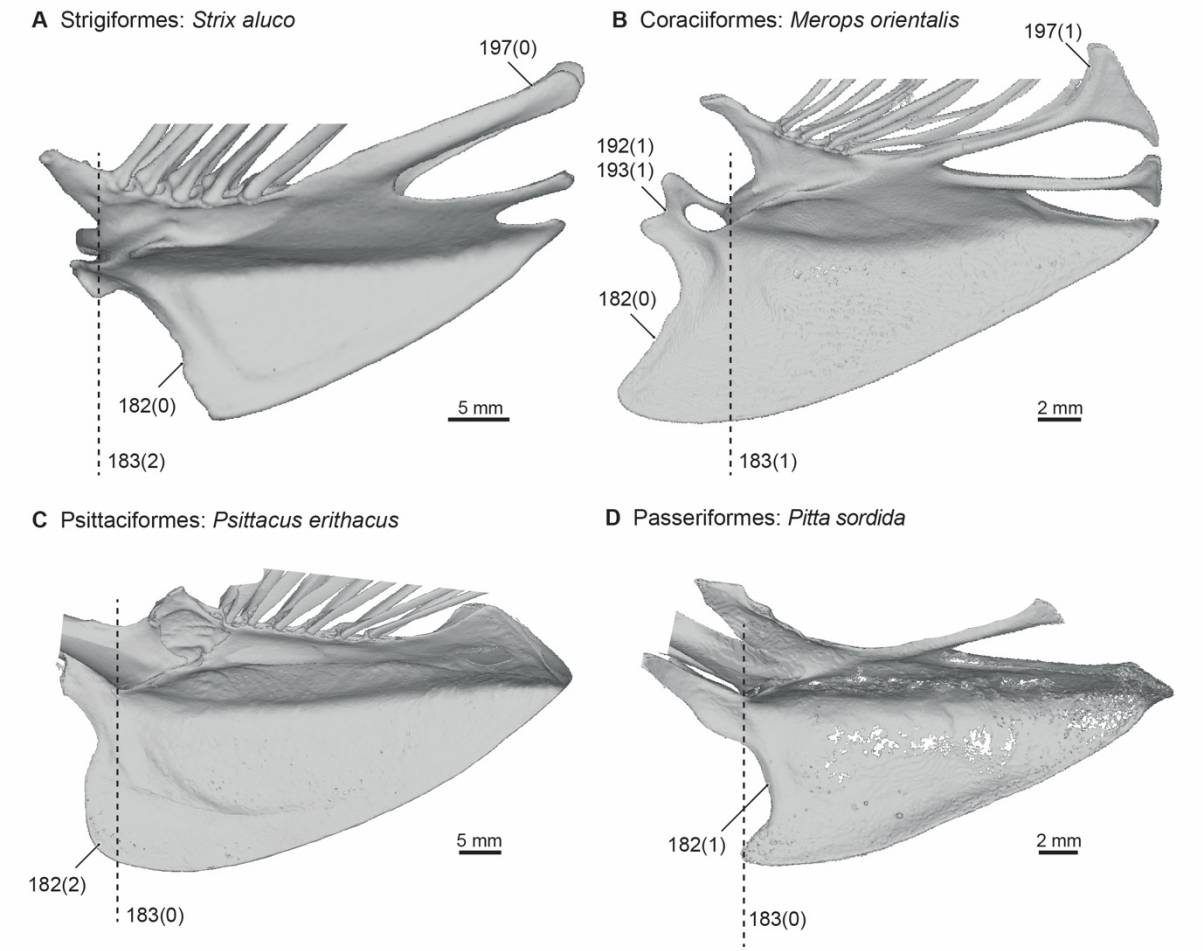


Figure 2.19. Sterna in left lateral view showing characters 182, 183, 192, 193 and 197. Vertical dashed line indicates position of keel apex. (A) *Strix aluco* (Tawny owl, NHMUK zoo S/2001.38.1); (B) *Merops orientalis* (Asian green bee-eater, UMMZ birds 216577); (C) *Psittacus erithacus* (African grey parrot, NHMUK zoo S/1992.41.60); (D) *Pitta sordida* (Western hooded pitta, NHMUK zoo S/1956.20.14). Numbers denote characters and character states as listed.

183. Sternum, lateral view, position of keel apex (apex carinae) relative to the sulcus sellaris medialis on a dorsoventral axis: roughly adjacent (0); projecting cranially (1); displaced caudally (2) (Fig. 2.19).

Modified from Mayr (2020, ch. 29), Mayr & Kitchener (2023a, ch. 30), Mayr & Kitchener (2023b, ch. 30), Mayr & Kitchener (2023c, ch. 29).

The anteroposterior position of the apex carinae varies among Telluraves. Mayr (2020, ch. 29) noted that the keel apex extends far beyond the sternal rostrum (rostrum sterni) in Burcerotidae (state 1, here in). While these birds display the most exaggerated example of state 1, this state is also present in many other Coraciimorphae (Fig. 2.19B). I have amended this character to include all positions of the apex carina as either adjacent (state 0; Fig. 2.19C), extended beyond/ cranially (state 1; Fig. 2.19B) or in some rarer cases displaced caudally in relation to the sternal rostrum (state 2; Fig. 2.19A). State 2 is present in the earlier diverging groups like Cathartiformes, Strigiformes, Cariamiformes and Acanthisittidae (Fig. 2.19A).

184. Sternum, caudal incisurae/fenestrae: none (0); two (1); four (2).

Mayr & Clarke (2003, ch. 73), Mayr *et al.* (2003, ch. 35), Mayr (2004, ch. 15), Mayr (2005a, ch. 38), Mayr (2005b, ch. 50), Mayr (2006, ch. 46), Clarke *et al.* (2009, ch. 40), Mayr *et al.* (2010, ch. 38), Ksepka *et al.* (2011, ch. 32), Mayr (2011, ch. 38), Ksepka & Clarke (2012, ch. 33), Mayr (2015, ch. 22), Bourdon *et al.* (2016, ch. 30), Ksepka *et al.* (2017, ch. 29), Ksepka *et al.* (2019, ch. 41), Mayr (2020, ch. 31), Mayr (2021, ch. 28), Mayr (2022, ch. 29), Mayr & Kitchener (2023b, ch. 32), Mayr & Kitchener (2023a, ch. 33), Mayr & Kitchener (2023c, ch. 32).

During ontogeny, the sternum is formed by fusion of three trabeculae: trabeculae caudo-lateralis, intermedia and median. The ossification of these trabeculae occurs through distinct processes between the different groups of birds, forming between the trabecular spaces, incisions or fenestra, which exhibit very varied patterns in terms of number, but mainly of form. In some cases, only one open lateral fenestra is present, often seen in Cathartidae, Accipitridae or Psittaciformes, this however varies on the individual level (personal observations). The ossification of the incisura or fenestra is likely related to the stage of bone development of the specimen (Jollie 1977).

185. Sternum, incisura/fenestra medialis: open caudally forming incisura (0); closed caudally forming fenestrae (1) (Fig. 2.20).

Modified from Ksepka *et al.* (2011, ch. 33), Ksepka & Clarke (2012, ch. 34).

Medial fenestrae (state 1) are present in only a few Telluraves, namely *Acanthisitta chloris* (Fig. 2.20D)

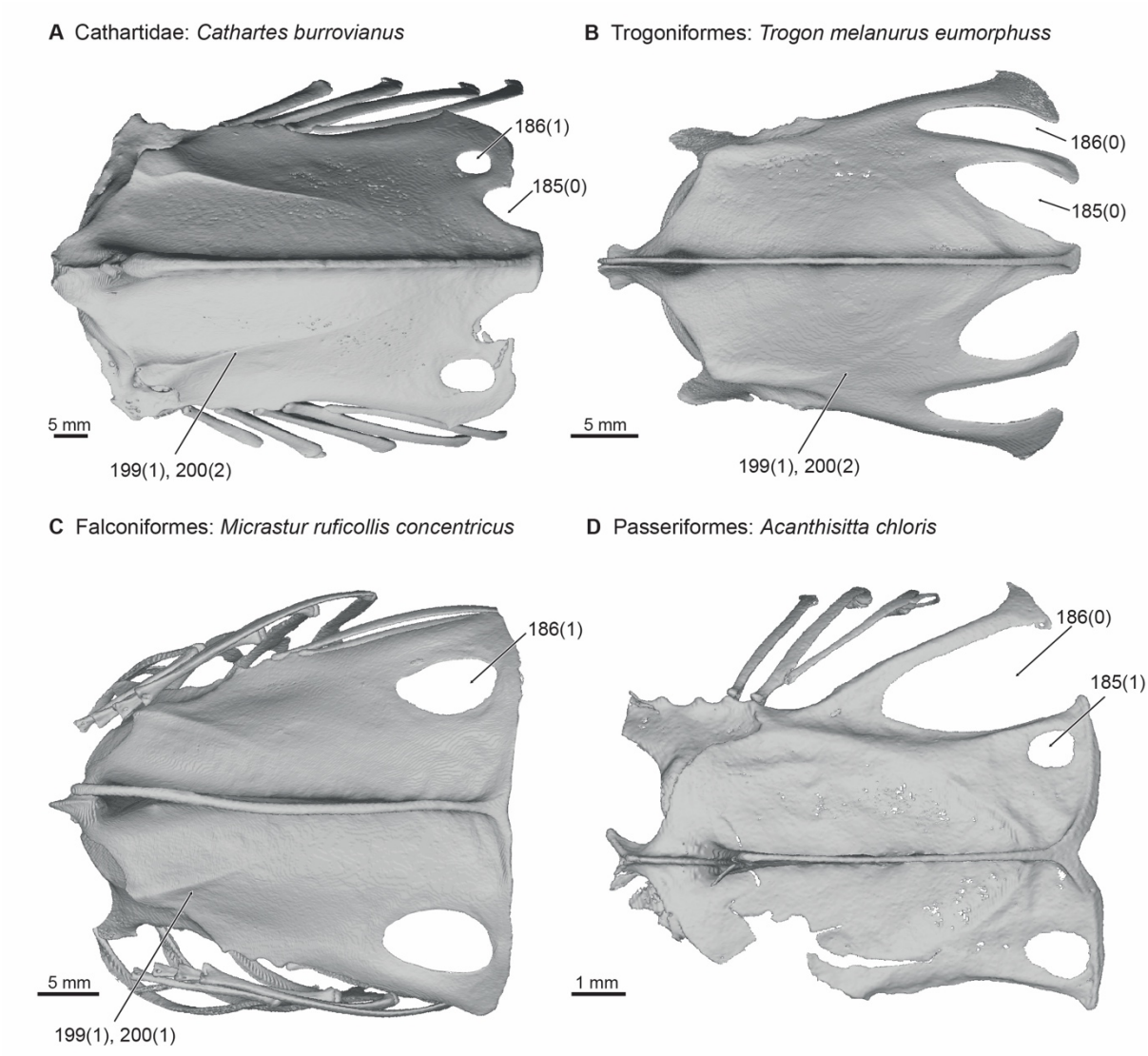


Figure 2.20. Sterna in ventral view showing characters 185, 186, 199 and 200. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Trogon melanurus eumorphus* (Black-tailed trogon, FMNH birds 290496); (C) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (D) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146). Numbers denote characters and character states as listed.

186. Sternum, incisura/fenestra lateralis: open caudally (0); closed caudally forming fenestrae (1) (Fig. 2.20).

Modified from Ksepka *et al.* (2011, ch. 33), Ksepka & Clarke (2012, ch. 34).

Lateral fenestrae (state 1) are present in a few members of Accipitriformes (Fig. 2.20A), a few members of Falconiformes (Fig. 2.20B) and Psittaciformes.

187. Sternum, facies visceralis of the keel with pneumatic foramina along midline and lateral margins: absent (0), present (1).

Mayr & Clarke (2003, ch. 72), Mayr (2005b, ch. 49).

Pneumatic foramina along the lateral margins are only present in Sagittariidae.

188. Sternum, external spine (spina externa rostri): absent/under-developed (0); present/well-developed (1) (Fig. 2.21).

Mayr *et al.* (2003, ch. 32), Mayr *et al.* (2004, ch. 17), Mayr (2005a, ch. 35), Mayr (2005b, ch. 47), Mayr (2006, ch.42), Clarke *et al.* (2009, ch. 38), Mayr *et al.* (2010, ch. 35), Mayr (2011, ch. 35), Mayr (2015, ch. 21), Ksepka *et al.* (2017, ch. 27), Ksepka *et al.* (2019, ch. 37), Mayr (2020, ch. 30), Mayr (2021, ch. 27), Mayr (2022, ch. 28), Mayr & Kitchener (2023a, ch. 31), Mayr & Kitchener (2023b, ch. 30), Mayr & Kitchener (2023c, ch. 30).

The external spine is never truly absent in Telluraves except in Cathartiformes (state 0; Fig. 2.21A). Otherwise, a reduced and short spine (state 0) is observed in most Accipitriformes, Leptosomiformes and the outgroup taxa.

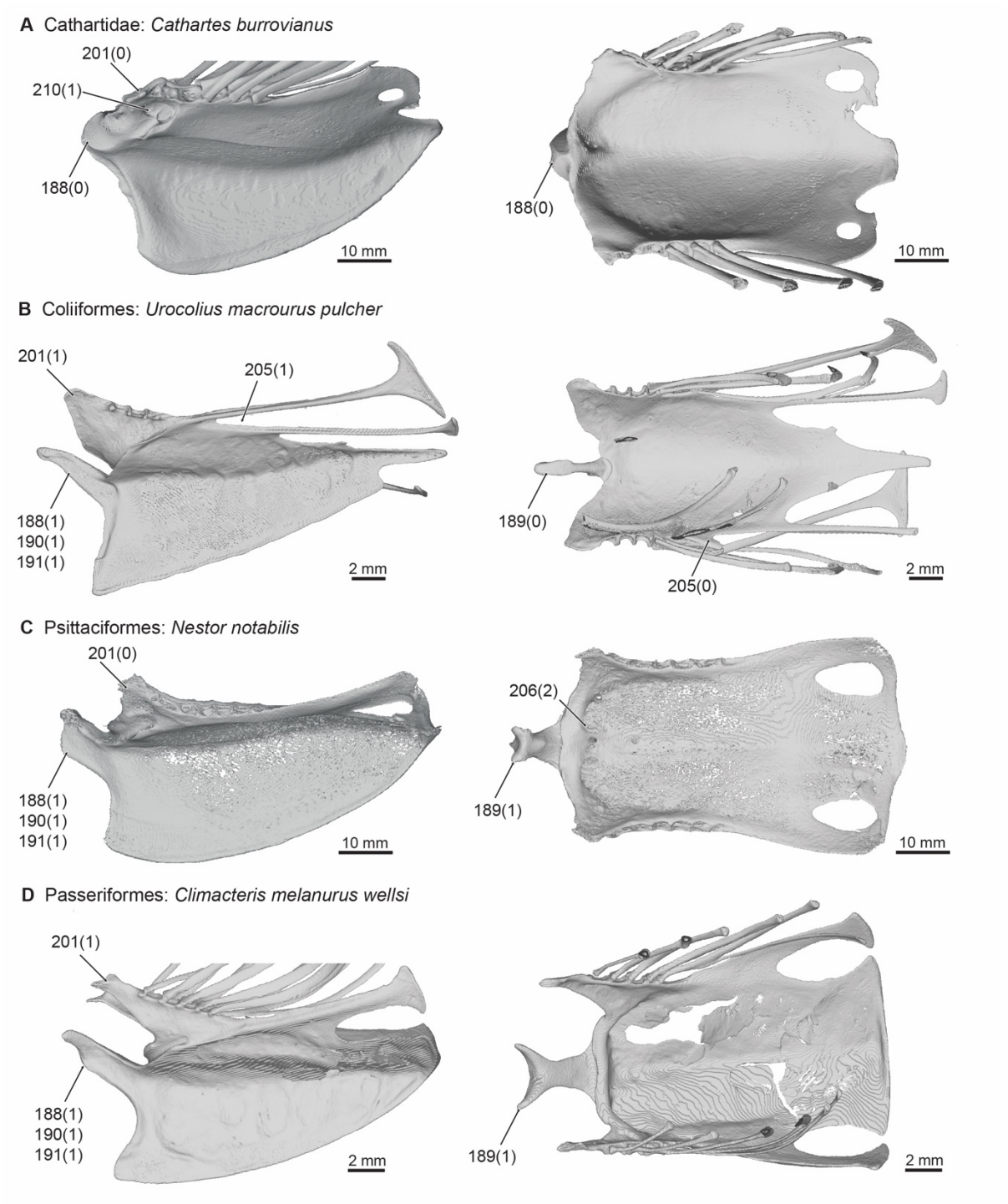


Figure 2.21. Sterna in left lateral (left) and dorsal (right) views showing characters 188, 189, 190, 191, 201 and 205. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Urocolius macrourus pulcher* (Blue-naped mousebird, FMNH birds 368959); (C) *Nestor notabilis* (Kea, FMNH birds 23530); (D) *Climacteris melanurus wellsi* (Black-tailed treecreeper, UMMZ birds 214303). Numbers denote characters and character states as listed.

189. Sternum, external spine (spina externa): single blade/single external spine (0); bifurcated blades/bifurcated external spine (1) (Fig. 2.21).

Modified from Mayr & Clarke (2003, ch. 70), Ksepka *et al.* (2011, ch.29), Ksepka & Clarke (2012, ch. 30), Ksepka *et al.* (2017, ch. 28), Ksepka *et al.* (2019, ch. 38), Ksepka *et al.* (2019, ch. 40), Mayr & Kitchener (2023a, ch. 32), Mayr & Kitchener (2023b, ch. 31), Mayr & Kitchener (2023c, ch. 31).

In some previously cited work (e.g. Mayr & Kitchener 2023a,b,c) only Passeriformes and Trogoniformes are scored as having a bifurcated external spine (state 1), while in other cited refences from above (e.g. Ksepka et al. 2017) state 1 is present in Psittaciformes and many other members of Cavitaves. In the present study Trogoniformes, some members of Coraciiformes, Psittaciformes (Fig. 2.21C) and Passeriformes (Fig. 2.21D). In passerines the cranial apex of the bifurcated process is strongly widened, more so than in any other non-passerine Telluraves except in *Merops orientalis*, this variation has not been accounted for.

190. Sternum, external spine (spina externa) amount of projection: short (less than half the length of the keel) (0) long (more than half the length keel) (1); inapplicable, spina externa rostri absent [ch.138] (NA) (Fig. 2.21).

New character.

A long external spine (state 1) occurs in most Coraciimorphae (Fig. 2.21B; except *Leptosomus discolor*), Psittaciformes (Fig. 2.21C) and Passeriformes (Fig. 2.21D).

191. Sternum, spina externa position: cranially directed (0); dorsally deflected (1); inapplicable, spina externa rostri absent [ch.138] (NA) (Fig. 2.21).

Ksepka & Clarke (2012, ch. 29), Ksepka *et al.* (2011, ch. 28), Ksepka *et al.* (2019, ch. 39).

A dorsally deflected external spine (state 1) was considered synapomorphic for Psittaciformes (Fig. 2.21C) by (Mayr & Daniels 1998) however, this state 1 is also present in Passeriformes (Fig. 2.21D) and a few members of Cavitaves (Fig. 2.21B).

192. Sternum, internal spine (spina interna): absent/underdeveloped (0); present/ well-developed (1) (Fig. 2.19B).

Mayr *et al.* (2003, ch. 33), Mayr (2005a, ch. 36), Mayr (2006, ch. 43), Clarke *et al.* (2009, ch. 37), Mayr *et al.* (2010, ch. 36), Mayr (2011, ch. 36), Bourdon *et al.* (2016, ch. 29), Ksepka *et al.* (2017, ch. 26), Smith *et al.* (2018, ch. 15), Ksepka *et al.* (2019, ch. 36).

A present and well-developed internal spine (state 1) is present in only a few Telluraves such as *Merops orientalis* (Fig. .2.19B). In the outgroup taxa Tinamiformes, internal spine can be variable in development. In *Eudromia* this process in comparatively short to other Tinamiformes, however it is much larger than what is seen in the few Telluraves that possess this feature (state 1)

193. Sternum, spina externa and spina interna fused to form spina communis: absent (0); present (1); inapplicable, spina externa and spina interna absent [ch.138, ch.192] (NA) (Fig. 2.19B).

New character.

In Mayr (2000a) Upupidae and Phoeniculidae are united on several derived characters one of them being that the external and internal spines are fused to form a spina communis (state 1). This feature however is also observed in *Merops orientalis* (Fig. 2.21B).

194. Sternum, coracoid sulci (sulci articularis coracoidei) separated by libram (extension of the external spine): absent (0); present (1) (Fig. 2.22).

New character.

The coracoid sulci (sulcus articularis coracoideus) are a groove or set of grooves on the margo cranialis sterni, which serves for the articulation of the coracoid bone. In some cases, the sulci are separated by a libram (state 1), this is mainly observed in Cathartidae (Fig. 2.22A), Sagittariidae and Cariamiformes. The grooves can also be seperated by a deep foramen (ch. 195, state 1), which is seen in most members of Cavitaves (Fig. 2.22B) and in some members of Passeriformes like *Melanopareia bitorquata*. There are no studies on the particular function these differences serve but it is likely that a stop between the sulci helps in stabilisation of the shoulders for soaring flight while a deep foramen allows for more flexible movement of the shoulders, good for taking off from the ground or branch rapidly.

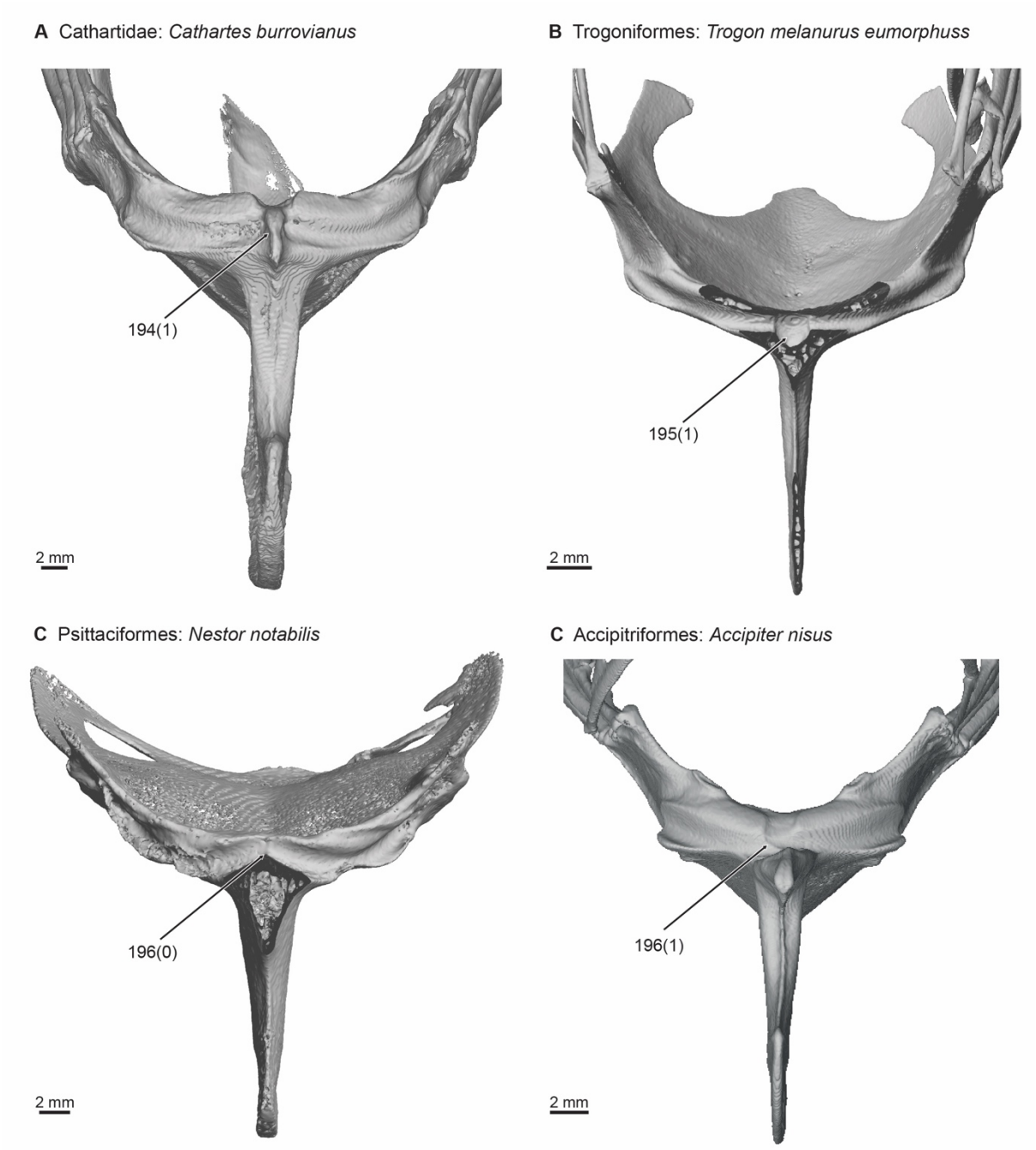


Figure 2.22. Sterna in cranial view showing characters 194, 195 and 196. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Trogon melanurus eumorphus* (Black-tailed trogon, FMNH birds 290496); (C) Nestor notabilis (Kea, FMNH birds 23530); (D) *Accipiter nisus* (Eurasian sparrowhawk, NHMUK zoo S/1982.149.1). Numbers denote characters and character states as listed.

195. Sternum, coracoid sulci (sulci articularis) separated by a deep foramen: absent (0); present (1) (Fig. 2.22).

New character.

See above comments.

196. Sternum, position of coracoid sulci (sulci articularis coracoidei): separate (0); overlapping (1) (Fig. 2.22).

Modified from Mayr & Clarke (2003, ch. 69), Mayr (2005b, ch. 46), Mayr (2006, ch. 44), Mayr (2013, ch. 10).

The articulation grooves for the coracoids, right and left, can be arranged symmetrically or separate (state 0), or overlapping (state 1), where the medial crest that separates them is incongruent to the dorsoventral axis. In the above references, Falconiformes and Psittaciformes are scored as having overlapping sulci. Whether right overlaps left or visa vera, tends to be highly variable and might be on the individual level. This is particularly difficult to see in Psittaciformes as the boundaries for the sulci are subtle and not as deep as in Falconiformes. I however disagree with the above references in that Psittaciformes do not have overlapping sulci (Fig. 2.22C) and only Falconiformes and Accipitridae (Fig. 2.22C) have this feature. Birds that have a libram or deep sulcus are scored as not overlapping (state 0).

197. Sternum, lateral trabecula (trabecula lateralis), distal end: maintains width (0); moderate to wide terminal expansion, generally creating inverted "T" shape (1); inapplicable, incisura lateralis absent [185] (NA) (Fig. 2.19).

Modified from Zelenkov & Dyke (2008, ch. 5), Ksepka & Clarke (2009, ch. 12), Ksepka & Clarke (2010, ch. 14), Ksepka *et al.* (2017, ch. 31), Ksepka *et al.* (2019, ch. 43).

There is a large amount of variation on the amount of expansion (state 1) seen in Telluraves, where it becomes very subjective as to when it is expanded or not. For this reason, I have amended state 1 so that it encompasses all expanded trabecula lateralis and not just the extreme case where it makes a "T" shape (e.g *Colius striatus*). My scores for this character differ from those of the above references, in that passerines and some Cavitaves (Fig. 2.19B) are scored as state 1.

198. Sternum, intermediate trabecula and median trabecula (trabecula intermediana and mediana), relative caudal extent: subequal (0); intermediana<mediana (1); intermediana>mediana (2).

Modified from Smith *et al.* (2018, ch. 17), Hieronymus *et al.* (2019, ch. 8).

199. Sternum, dorsolateral intermuscular line: absent (0); present (1) (Fig. 2.20).

Clarke *et al.* (2009, ch. 36).

A visible and present dorsolateral intermuscular line is observed in most Telluraves (Fig. 2.20A, B, C).

200. Sternum, caudal extension of dorsolateral intermuscular line down the body of the sternum: extends to cranial third of body (0); extends to middle third of body (1); extends to caudal third of body (2) (Fig. 2.20).

Mather *et al.* (2022, ch. 88).

The dorsolateral intermuscular line corresponds to the place of origin of part of the supracoracoid muscle ligaments and its extension along the sternum bone can vary, for example an intermuscular line that extends to the caudal third of the body (state 2) is observed in Cathartidae (Fig. 2.20A) and Trogoniformes (Fig. 2.20B), while an intermuscular line that extends to the cranial third of the body is observed in Falconiformes (Fig. 2.20C).

201. Sternum, craniolateral process (processus craniolateralis): weak or moderate projection (0); elongate with prominent projection (1) (Fig. 2.21).

Modified from Clarke *et al.* (2009, ch. 36), Ksepka & Clarke (2009, ch. 10), Ksepka & Clarke (2010, ch. 12).

The process craniolateral process greatly in length between taxa. In the above studies this character was used to describe the similarities (or differences) within Coliiformes and stem taxa, where *Colius* is only scored as having a elongate projection but other mousebirds are not. In some past studies the process length would be compared to the length of the internal spine (e.g. Clarke *et al*. 2009). However, within Telluraves the length of the internal spine is also highly variable. It

is then best to judge length of the craniolateral process by comparison to the last adjoining processus costales. The craniolateral process is typically elongated (state 1) in Strigiformes, Coraciimorphae (Fig. 2.21B) and Passeriformes (Fig. 2.21D; except *Acanthisitta chloris*).

202. Sternum, craniolateral process, angle from major axis of carina: craniolaterally directed (0); laterally directed (1).

Ksepka & Clarke (2012, ch. 31).

203. Sternum, number of processus costales (articular surfaces for sternal ribs): 3-4 (0), 5-6 (1), 7-8 (2).

Mayr & Clarke (2003, ch. 71), Mayr (2005b, ch. 48).

204. Sternum, maximum length: longer than humerus (0); shorter than humerus (1).

Ksepka *et al.* (2019, ch. 44).

See table S1.16 for measurements of the sternum and humerus length.

205. Sternum, depth of fenestrae/incisurae roughly equal to/ more than half the length of sternum: absent (0); present (1) (Fig. 2.21).

New character.

Incisurae that equal to or more than half the length of sternum is observed in a few members of Coraciimorphae (Fig. 2.21B) and many members of Passeriformes for example *Pitta sordid*.

206. Sternum, dorsal surface, medial sulcus of the sternum (sulcus medianus sterni) immediately caudal to cranial margin, pneumatic foramen (foramen pneumaticum) (exclusive of pneumatic pores): shallow foramen/absent (0); present, undivided (1); present, divided medially (2) (Fig. 2.21).

Livezey & Zusi (2006, ch. 1108).

A divided pneumatic foramen of the medial sulcus of the sternum (state 2) is observed in Psittaciformes (Fig. 2.21C) and *Cariama cristata*.

207. Sternum, external labial tubercle (processus labrum internum): absent or small (0); robust (1).

Modified from Mather *et al.* (2022, ch. 77).

An external labial tubercle (processus labra internum or processus supralabraris) is located dorsally to the coracoid sulcus (sulcus articularis coracoideus) and medially to the craniolateral process, (see Migotto 2013 for more detailed description). The processus labra internum is present (state 1) in some extinct and extant Accipitridae (Mather *et al.* 2022), though none were found in the chosen Accipitridae of this study. While state 1 is mostly observed in outgroup taxa groups, it was also observed in Piciformes.

208. Sternum, caudolateral extremity of sternocoracoid fossa: little differentiation of the caudolateral margin (0); distinct, with thick caudolateral margin (1).

Mather *et al.* (2022, ch. 78.)

The sternocoracoid fossa is a laterally continuous groove for the articulation of the coracoid. In Cathartiformes and Sagittariidae the fossa is caudally delimited by a distinct edge (state 1).

209. Sternum, caudolateral extension of sternocoracoid fossa: reaches 2nd costal process (0); reaches 3rd-4th costal process (1); extends caudally past all costalis (2).

Mather *et al.* (2022, ch. 80).

The sternocoracoid fossa occupies the rostrolateral portion of the sternum at varying lengths. This can be compared in relation to the number of costal processes.

210. Sternum, foramen in sternocoracoid fossa: absent (0); present (1) (Fig. 2.21).

Mather *et al.* (2022, ch. 81).

Foramen in the sternocoracoid fossa (state 1) is observed in Cathartidae (Fig. 2.21A), Sagittariidae and the outgroup taxon *Eudromia elegans.*

211. Sternum, pneumatic foramen on dorsal face of craniolateral process (processus craniolateralis): absent (0); present (1).

Mather *et al.* (2022, ch. 83).

Pneumatic foramen in the medial portion of the craniolateral process is observed in Cathartiformes and Sagittariidae.

212. Sternum, keel greatly reduced, especially in its midsection: absent (0), present (1).

Mayr (2016, ch. 16).

The hight of the sternal keel is related to flight capability as it is the main site of attachment for the flight muscles (Lowi-Merri *et al.* 2021). Birds with powered flight have a larger keel and birds that spend most of the time on ground like *Strigops habroptilus*, have a reduced keel. This correlation however is not clear in birds like the *Opisthocomus hoazin*, which are capable of sustained flight yet have a reduced keel.

213. Sternum, keel connected to internal spine: absent (0); present (1).

New character.

A connected keel and internal spine is only present in some Piciformes like *Picus viridis* (Fig. 2.23)

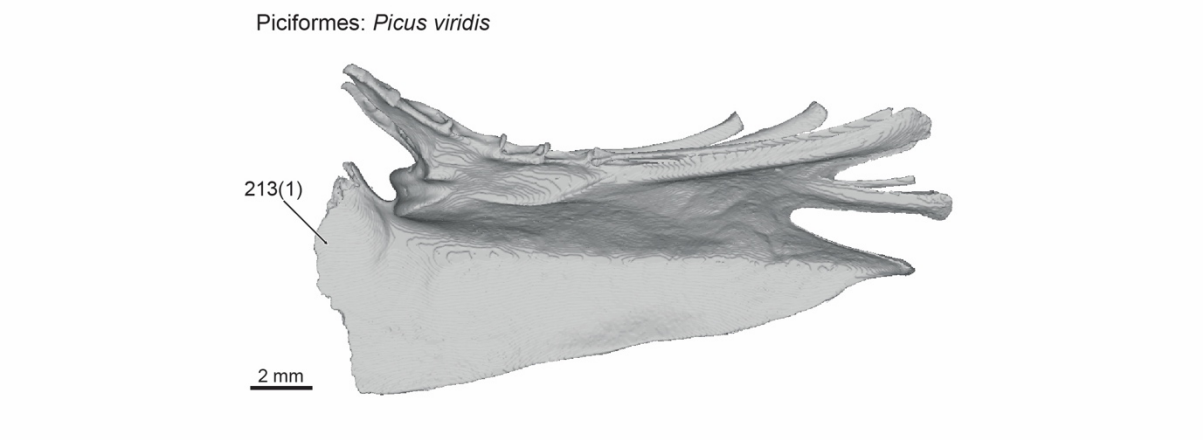


Figure 2.23. Sternum of *Picus viridis* (European green woodpecker, NHMUK zoo S/1982.5.1) in left lateral view showing character 213. Numbers denote characters and character states as listed.

CORACOID

214. Coracoid, pneumatic foramen in the infra-acrocoracoid recess (recessus infra-acrocoracoideus): absent (0); present (1) (Fig. 2.24B).

Ksepka *et al.* (2011, ch. 35), Ksepka & Clarke (2012, ch. 36).

A pneumatic foramen is located in the sulcus supracoracoideus (state 1), the groove for the supracoracoid muscle. It can vary in position, where, for e.g., in *Sagittarius,* Falconiformes and Psittaciformes it is ventrally located and the rest of Accipitridae (Fig. 2.24B) and Strigiformes it is dorsally located.This variation has not been accounted for in the present study. There are accounts of this foramen being present in Cathartidae (Migotto 2013) but not observed in the taxa of the current study.

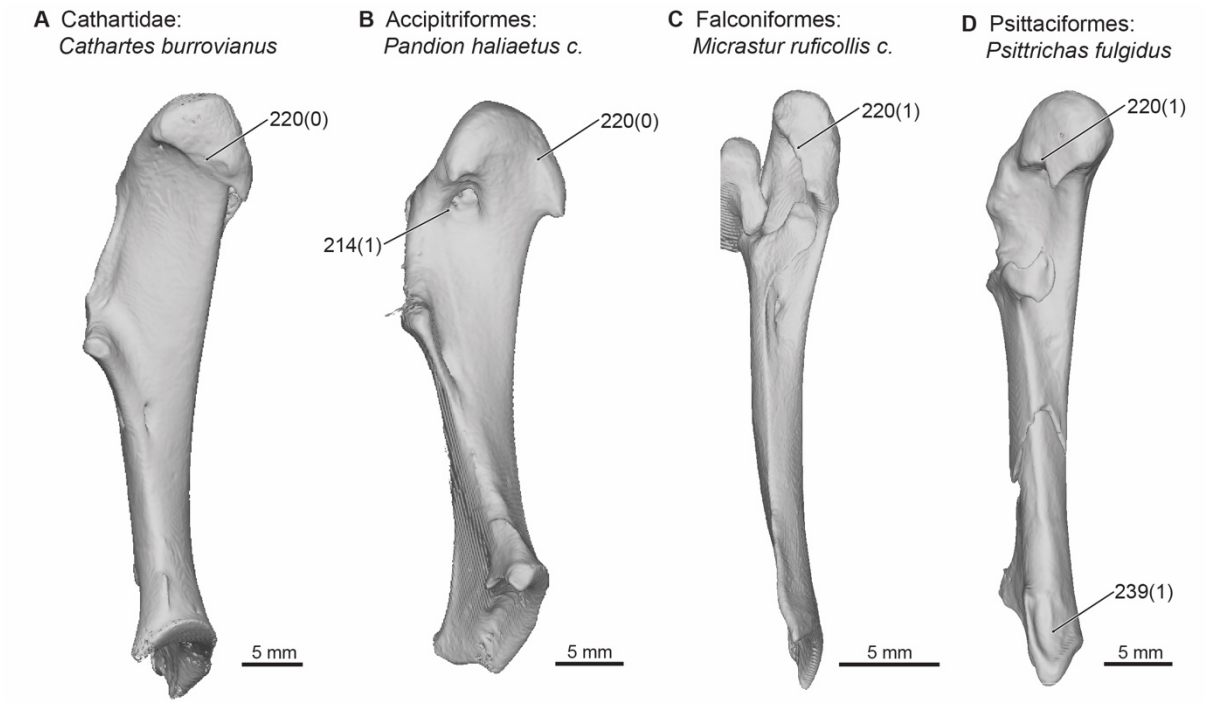


Figure 2.24. Coracoids in medial view showing characters 214, 220 and 239. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Pandion haliaetus* carolinensis (Osprey, FMNH birds 437336); (C) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); *Psittrichas fulgidus* (Pesquet's parrot, YPM orn 141821). Numbers denote characters and character states as listed.

215. Coracoid, procoracoid process (processus procoracoideus): reduced (0); developed but moderate size, projecting approximately ¼ to approximately half the width of the coracoid shaft (1); projecting more than the width of the coracoid shaft (2) (Fig. 2.25).

Modified from Mayr (2004, ch. 11), Mayr *et al.* (2004, ch. 15), Clarke *et al.* (2009, ch. 34), Ksepka & Clarke (2009, ch. 14), Ksepka & Clarke (2010, ch. 16), Ksepka & Clarke (2012, ch. 39), Bourdon *et al.* (2016, ch. 28), Ksepka *et al.* (2017, ch. 34), Smith *et al.* (2018, ch. 13), Hieronymus *et al.* (2019, ch. 6), Ksepka *et al.* (2019, ch. 47), Raimon *et al.* (2020, ch. 11), Mayr (2022, ch. 24).

A reduced procoracoid process (state 0) is observed in Coliiformes, most members of Piciformes, a few members of Coraciiformes and almost all Passeriformes (Fug. 2.25H, except oscines). See Table S1.5 for measurements of the procoracoid and width of shaft.

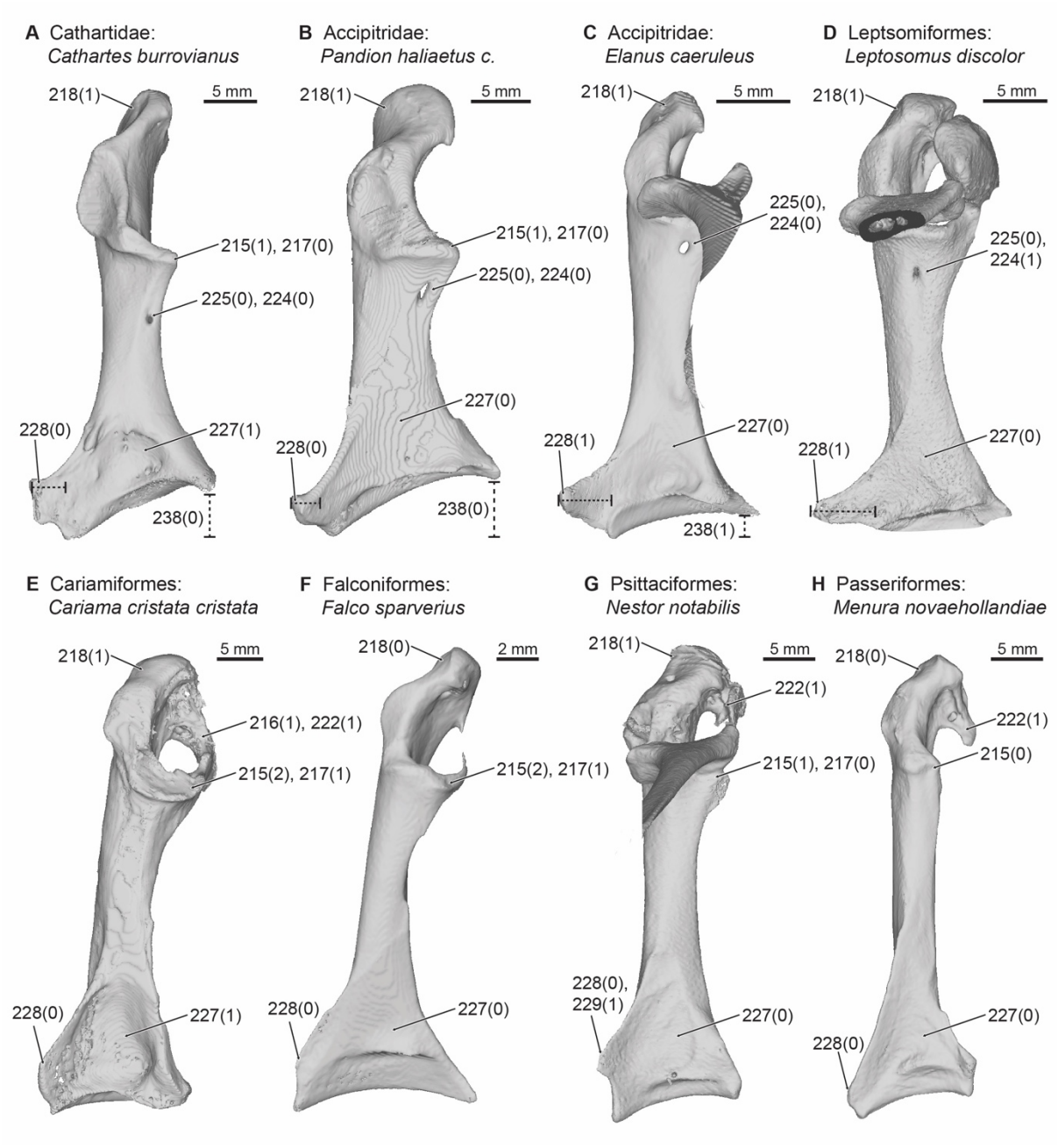


Figure 2.25. Coracoids in dorsal view showing characters 215, 216, 217, 218, 222, 224, 225, 227, 228, 229 and 238. Dashed lines indicates the of projection of the processus lateralis. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Pandion haliaetus carolinensis* (Osprey, FMNH birds 437336); (C) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (D) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (E) *Cariama cristata cristata* (Red-legged seriema, FMNH birds 105635); (F) *Falco sparverius* (American kestrel, UMMZ birds 154462); (G) *Nestor notabilis* (Kea, FMNH birds 23530); (H) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

216. Coracoid, ossified connection between acrocoracoid process and procoracoid process: absent (0); present (1) (Fig. 2.25E).

Clarke *et al.* (2009, ch. 33), Bourdon *et al.* (2016, ch. 27), Ksepka *et al.* (2019, ch. 51).

An ossified connection between the acrocoracoid process and procoracoid process is present in Cariamiformes (Fig. 2.25E) and Bucerotiformes.

217. Coracoid, procoracoid process (processus procoracoideus): straight, protruding perpendicular to the longitudinal axis of the coracoid (0); ventrally directed towards acrocoracoid process (processus acrocoracoideus) (1) (Fig, 2.25).

Modified from Mayr (2016, ch. 11), Mayr & Kitchener (2022a, ch. 14).

In Mayr & Kitchener (2022a, ch. 14) the procoracoid process is described as directed towards a hook-like acrocoracoid process and that both processes are in close contact or even fuse. There are a number of independently varying states in this statement in that the procoracoid process can be ventrally directed (state 1; Fig. 2.25E, F) and the acrocoracoid process is not hook-like (see Ch. 222).

218. Coracoid, tip of acrocoracoid process: pointed and projected cranially (0), broadly rounded (1) (Fig. 2.25).

Modified from Mayr (2015, ch. 18), Mayr (2020, ch. 26), Mayr (2021, ch. 24), Mayr & Kitchener (2023a, ch. 27), Mayr & Kitchener (2023b, ch. 26), Mayr & Kitchener (2023c, ch. 26).

In state 0 the tip of the acrocoracoid process is sharp and pointed, extending cranially (anteriorly) in a distinct, tapered projection. This creates a narrow, elongated structure at the coracoid's cranial end (Fig. 2.25F, H). In state 1 the tip of the acrocoracoid process is wide and rounded, forming a blunt, broadly curved end rather than a pointed projection. This results in a more robust, less tapered cranial extremity (Fig. 2.25A, B, C, D, E, G).

219. Coracoid, degree of curvature of the acrocoracoid process: straight to moderately hooked outline (0); expansive hooked outline (1).

Modified from Smith *et al.* (2018, ch. 12), Ksepka *et al.* (2019, ch. 49).

Within Telluraves, Passeriformes have a more hooked-shaped outline of the acrocoracoid process (state 1) compared to other birds. This hook shape however is much more strongly hooked in outgroup taxa (also state 1). In Ksepka *et al.* (2019) *Psittacus erithacus* and *Leptosomus discolor* have been scored as having a hooked outline. However, I disagree and do not think they are as hooked as in Passerines and scored as state 0.

220. Coracoid, facies articularis clavicularis, caudal margin: no overhang over sulcus m. supracoracoidei, not delimited by an edge (0); overhang the sulcus supracoracoideus, delimited by an overhanging ledge or crest (1) (Fig. 2.24).

Modified from Mayr & Clarke (2003, ch. 64), Ksepka *et al.* (2011, ch. 34), Ksepka & Clarke (2012, ch. 35).

The caudal margin of articular face of the clavicle can have a thick edge, connecting the brachial tubercle to the articulation region with the acrocoracoid process or have an overhang that separates the region into dorsal and ventral segments (state 1; Fig. 2.24).

221. Coracoid, processus acrocoracoideus/omal extremity: well developed (0); extremely reduced (1) (Fig. 2.28C).

Mayr (2004, ch. 13), Mayr (2006, ch. 40).

A completely reduced acrocoracoid process (state 1) is observed in some Piciformes (Fig. 2.28C).

222. Coracoid, process overhanging supracoracoid sulcus: absent (0); present (1) (Fig. 2.25).

Clarke *et al.* (2009, ch. 35), Ksepka *et al.* (2019, ch. 50).

A process overhanging the supracoracoid sulcus (state 1) is present in Psittaciformes (Fig. 2.25G) and some Passeriformes (Fig. 2.25H), mainly in oscines. It is difficult to tell if this is the same overhanging process in Cariamiformes (Fig. 2.25E) where there is a ossified connection between acrocoracoid process and procoracoid process, however when observing stem Cariamiformes like *Dynamopterus minor* there is a clear overhang similar to what is observed in Psittaciformes and Passeriformes and so it is likely this is the same case for extant Cariamidae, therefore scored as state 1.

223. Coracoid, clavicular articular surface, laterally extended flat facies on ventral portion: absent (0); present (1) (Fig. 2.27B).

New character.

A flat clavicular articular surface is only observed in Accipitridae (Fig. 2.27B).

224. Coracoid, position of Supracoracoid nerve foramen (foramen nervi supracoracoidei): medial (0); reaching midline of shaft (1); inapplicable, foramen nervi absent [225] (NA) (Fig. 2.25).

New character.

A supracoracoid nerve foramen that is positioned on the midline of the coracoid shaft (state 1) is observed in a few birds namely in Leptosomiformes (Fig. 2.25D) and Falconiformes.

225. Coracoid, foramen nervi supracoracoidei: present (0), absent (1) (Fig. 2.25).

Mayr *et al.* (2003, ch. 29), Mayr & Clarke (2003, ch. 65), Mayr *et al.* (2004, ch. 2), Mayr (2005a, ch. 32), Mayr (2005b, ch. 43), Mayr (2006, ch. 38), Ksepka & Clarke (2009, ch. 13), Ksepka & Clarke (2010, ch. 15), Mayr *et al.* (2010, ch. 32), Mayr (2011, ch. 32), Ksepka *et al.* (2011, ch. 37), Ksepka & Clarke (2012, ch. 38), Mayr (2013, ch. 7), Mayr (2015, ch. 16), Mayr (2016, ch. 14), Ksepka *et al.* (2017, ch. 33), Ksepka *et al.* (2019, ch. 46), Mayr (2020, ch. 24), Mayr (2021, ch. 22), Mayr (2022, ch. 25), Mayr & Kitchener (2022a, ch. 17), Mayr & Kitchener (2023a, ch. 25), Mayr & Kitchener (2023b, ch.24), Mayr & Kitchener (2023c, ch. 24).

The presence of the foramen for the supracoracoid nerve facilitates the passage of the supracoracoideus nerve, supporting the upstroke in flight and enabling the powerful, agile flight behaviours. A foramen nervi supracoraoidei (state 0) is present in all Accipitriformes (Fig. 2.25A, B, C), Strigiformes, Falconiformes (except *Falco sparverius*) and Leptosomiformes (Fig. .2.25D) and the outgroup taxon *Charadris*.

226. Coracoid, coracoscapular joint: deeply excavated and cup-like cotyla scapularis (0); shallow facies articularis scapularis (1).

Mayr *et al.* (2003, ch. 28), Mayr (2005a, ch. 31), Mayr (2006, ch. 37), Mayr *et al.* (2010, ch. 31), Mayr (2011, ch. 31), Ksepka *et al.* (2011, ch. 36), Ksepka & Clarke (2012, ch. 37), Mayr (2015, ch.

15), Mayr (2016, ch. 12), Ksepka *et al.* (2017, ch. 32), Ksepka *et al.* (2019, ch. 45), Mayr (2020, ch. 23), Mayr (2021, ch. 21), Mayr & Kitchener (2022a, ch. 15), Mayr & Kitchener (2023a, ch. 24), Mayr & Kitchener (2023b, ch. 23), Mayr & Kitchener (2023c, ch. 23), Mayr & Kitchener (2023d, ch. 7).

The coracoscapular joint is where the coracoid and scapula articulate, either by a flat facies (state 1) or a cup-shaped articular facies (state 0), see Mayr (2021a) for in-depth review. Mayr (2021a) suggests that the cup-like cotyla scapularis is plesiomorphic for Neornithes and that a flat articularis scapularis (state 0) evolved independently multiple times among subgroups. Among extant Telluraves, state 0 is only observed in Sagittariidae, Leptosomiformes and Cariamiformes, while it is also observed in many fossil Falconiformes and Psittacopasseres. In Ksepka *et al.* (2019) the character describes the coracoscapular joint in three states accounting for the variation in the depth, Leptosomus is scored as having a shallow concavity whereas in Mayr (2021a) this bird is noted as cup-like, I have scored it as state 0 in the present study. Further discrepancies between the two mentioned studies in scores for Cariamiformes, Mayr (2021a) has scored these birds as cup-like, though it would appear that the cotyla is more on the shallow side for these birds. I have scored the same as Mayr (2021a), though tentatively.

227. Coracoid, impression of sternocoracoid muscle, on dorsal surface: shallow, not visible (0); very deep sulcus (1) (Fig. 2.25).

New character.

A very deep sulcus or impression of the sternocoracoid muscle that is located on the dorsal surface of the coracoid (stat 1) is present in Cathartiformes (Fig. 2.25A) and Cariamiformes (Fig. 2.25).

228. Coracoid, lateral process (processus lateralis), projection: non-projecting, barely extends past lateral-most point of facies articularis sternalis (0); well-projecting, extends distinctly lateral of facies articularis sternalis (1) (Fig. 2.25).

Modified from Zelenkov & Dyke (2008, ch. 8), Ksepka & Clarke (2009, ch. 15), Ksepka & Clarke (2010, ch. 17), Ksepka & Clarke (2012, ch. 40), Mayr (2013, ch. 8), Mayr (2015, ch. 19), Ksepka *et al.* (2017, ch. 35), Ksepka *et al.* (2019, ch. 48), Mayr (2020, ch. 27), Mayr (2021, ch. 25), Mayr & Kitchener (2023a, ch. 28), Mayr & Kitchener (2023b, ch. 27), Mayr & Kitchener (2023c, ch. 27).

Ksepka et al (2019) and Mayr & Kitchener (2023a,b,c) use similar character state descriptions, but different scores for this character. The character state description used by both authors is "well-developed" (state 1) which is vague. To account the variation observed throughout

Telluraves, the relative development or projection of the lateral process should be compared to the relative caudal width of the sternal facet, where if the process is longer than half the width of the facet then it is scored as state 1. In Mayr & Kitchener (2023a,b,c) all passerines have been scored as possessing a "well-developed" (state 1) lateral process. However, my observations of Passeriformes indicate that only a few species of Passeriformes, mostly oscines, have this large process (in agreement with Ksepka *et al.* 2019).

229. Coracoid, lateral process, apex, craniocaudal location, extensively cranial to lateral angle: absent (0); present (1) (Fig. 2.25G).

New character.

A cranially placed lateral process is present (state 1) in a number of Telluraves such as Psittaciformes (Fig. 2.25G), Strigiformes, a number of members of Cavitaves.

230. Coracoid, lateral process, apex, orientation: lateral (0); rostral curvature (1) (Fig. 2.26A).

New character.

A curving rostrally lateral process is present in *Galbula dea* (Fig. 2.26A) and *Todus Mexicans*.

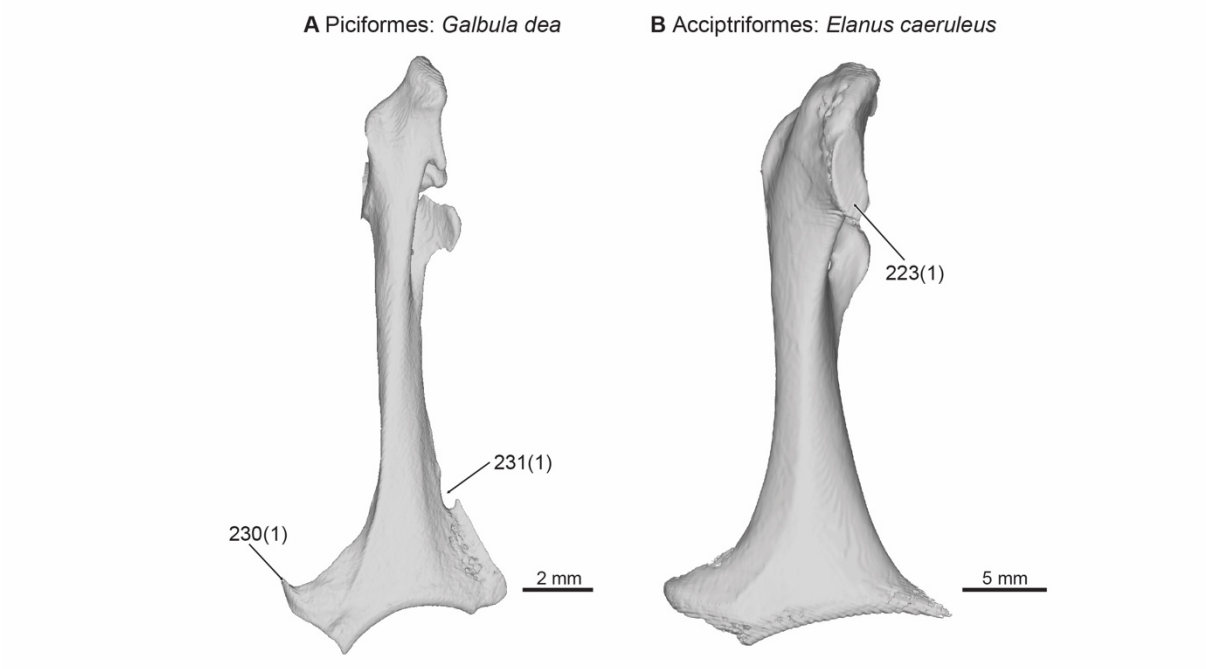


Figure 2.26. Coracoids in ventral view showing characters 230 and 231. (A) *Galbula dea* (Paradise jacamar, FMNH birds 376705); (B) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159). Numbers denote characters and character states as listed.

231. Coracoid, extremitas sternalis with notch in margo medialis: no (0), yes (1) (Fig. 2.26A).

Mayr *et al.* (2003, ch. 30), Mayr (2004, ch. 12), Mayr *et al.* (2004, ch. 16), Mayr (2005a, ch. 33), Mayr (2006, ch. 39), Mayr *et al.* (2010, ch. 33), Mayr (2011, ch. 33), Mayr (2015, ch. 17), Mayr (2020, ch. 25), Mayr (2021, ch. 23), Mayr (2022, ch. 26), Mayr & Kitchener (2023a, ch. 26), Mayr & Kitchener (2023b, ch. 25), Mayr & Kitchener (2023c, ch. 25).

A notch in the margo medialis is present in Piciformes (Fig. 2.26A), where it can be variable in size and shape. For example, in some Ramphastidae it is wide and shallow but indicated by a hook above the angulus medialis , see Höfling & Alvarenga (2001) figure 5. The notch is also present in the early Eocene stem Piciformes, the Primoscenidae (Mayr 1998a).

232. Coracoid, medial side (margo medialis): flange absent, margin straight (0); flange present, margin convex (medial bulge of extremitas sternalis) (1).

Smith *et al.* (2018, ch. 14), Hieronymus *et al.* (2019, ch. 7), Mayr & Kitchener (2022a, ch. 18).

A flange (medial projection) on the medial margin (extremitas sternalis) is rare in extant birds, and is best recognized at the point of inflection where it will be almost at right angles. In extant

Telluraves this feature is observed only in Trogoniformes. In some extinct Telluraves there is a large bulge on the medial margin as seen in the tentatively referred specimen *Danielsraptor phorusrhacoides* (NMS.Z.2021.40.13), this flange is similar to what is seen in *Zygodactylus grandei* and *Psittacomimus eos* (Mayr & Kitchener 2022, figure 3D). In Smith *et al.* (2018) *Primozygodactylus* is scored as having state 1 though this feature is not observable in the photos within the publication. The shape of this margin can be variable, from very straight to almost convex as well as the amount of projection of the flange. A very large process is observed on the medial side of the coracoid in *Upupa epops*, however, this is not a flange but rather a unique projection only seen in this bird and *U. epops* is scored as state 0.

233. Coracoid, medial side (margo medialis) flange present, margin concave: absent (0); present (1) (Fig. 2.28A).

New character.

A concave flange on the medial margin of the coracoid (state 1) is present in Coliiformes (Fig. 2.28A).

234. Coracoid, lateral view, large projection from lateral margin, joining with margo medialis: absent (0); present (1) (Fig. 2.27).

New character.

A large projection from the lateral margin that joins with the margo medialis is to or is the coracobrachial ligament tubercle but very enlarged. This tubercle is seen in many Accipitriformes and Cathartiformes but is often more subtle than in passerines, which are very enlarged and form a connection with the lateral margin. Within Passeriformes this projection can vary in size and projection but is not accounted for in this study. This can also been seen in *Parapsitacopes bergdahli* (Mayr & Kitchener 2022, figure 3A-D) and *Psittacomimus eos* (Mayr & Kitchener 2022, figure 3H) while not as large as in extant passerines, have tentatively scored as present.

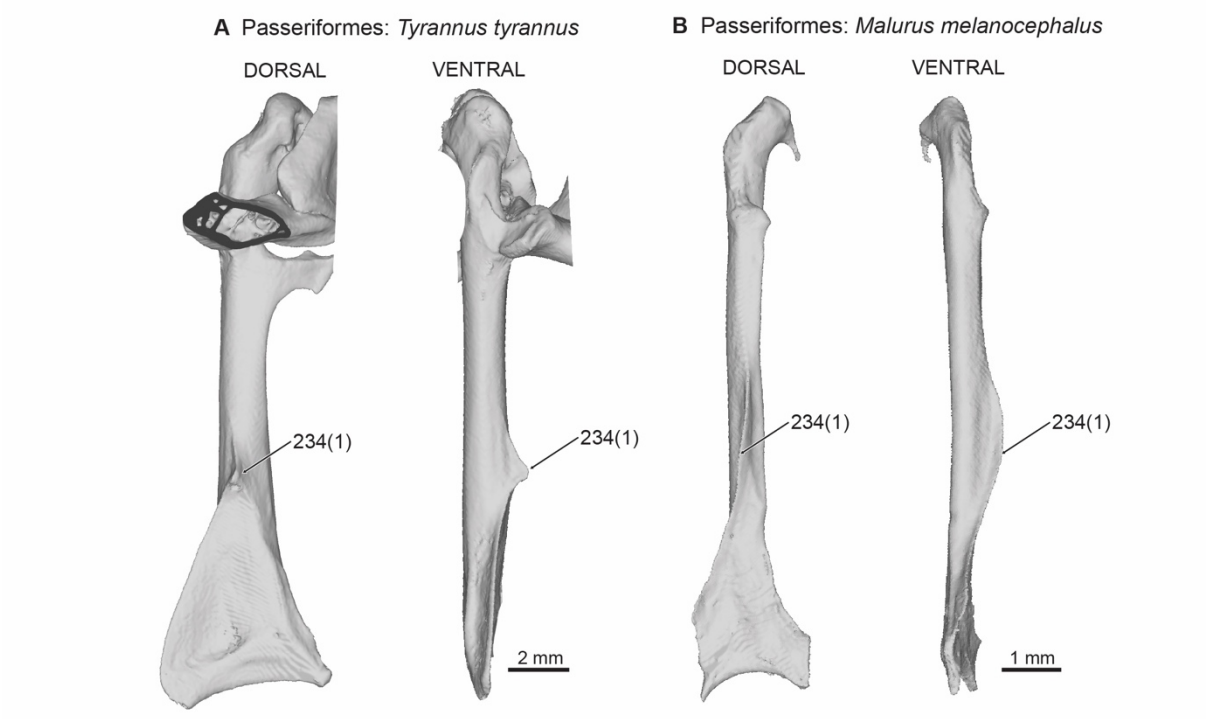


Figure 2.27. Coracoids in dorsal (left) and ventral (right) views showing character 234. (A) *Tyrannus tyrannus* (Eastern kingbird, FMNH birds 487521); (B) *Malurus melanocephalus* (Red-backed fairywren, UMMZ birds 224775). Numbers denote characters and character states as listed.

235. Coracoid, articular facet for sternum (facies articularis sternalis): prominent projection of the internal lip (labrum internum coracoidei) (0); completely reduced (1) (Fig. 2.28).

New character.

A reduced internal lip of the articular facet for the sternum (state 1) is observed in a few members of Telluraves such Coliiformes (Fig. 2.28A). Most Telluraves have a visible labrum (state 0), with varying extents in length and width, with the most prominent is observed in Strigiformes.

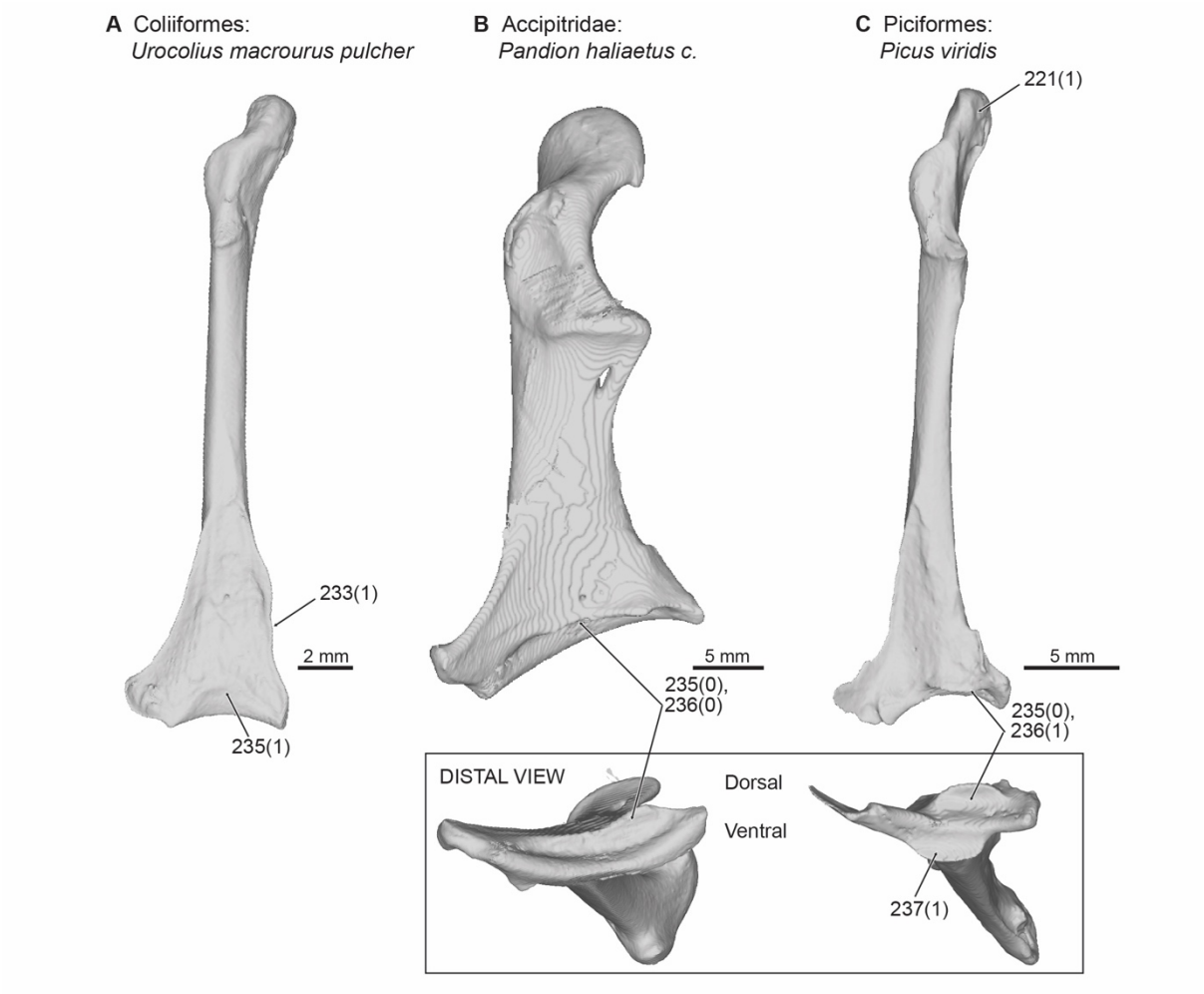


Figure 2.28. Coracoids in dorsal (above) and distal (below) views showing characters 235, 236 and 237. (A) *Urocolius macrourus pulcher* (Blue-naped mousebird, FMNH birds 368959); (B) *Pandion haliaetus carolinensis* (Osprey, FMNH birds 437336); (C) *Picus viridis* (European green woodpecker, NHMUK zoo S/1982.5.1). Numbers denote characters and character states as listed.

236. Coracoid, width of the facet on the articular facet for sternum: narrow, consistent along facies (0); reduced/short and widened dorsoventrally into a flange at medial angle end (1) short and placed midline (2) (Fig, 2.28C).

Modified from Mayr (2004, ch. 13), Mayr (2006, ch. 40).

A reduced/short articular facet for sternum that widens dorsoventrally into a flange at angulus medialis end of the coracoid is observed in most members of Piciformes (Fig. 2.28C) and Coraciiformes. There are also cases where the facies is not on the medial side but rather directly midline of the coracoid (state 2), the labrum tends to be reduced in these birds and not deep, this

is observed in a few Cavitaves like *Atleornis* or *Ramphastos* but mainly in some Passeriformes as well as their extinct relatives such as Primozygodactylidae.

237. Coracoid, articular facet for sternum with facet on ventral side: absent (0); present (1) (Fig. 2.28C).

New character.

A ventral articular facet for sternum is present in Bucerotiformes and Piciformes (Fig. 2.28C).

238. Coracoid, relative angle from medial angle to lateral edge of articular facet for sternum: cranial re-curvature of medial angle (0); horizontal, both on the same plane to sub-horizontal (1) (Fig. 2.25).

New character.

In most Telluraves, the angle of the lateral edge of the articular facet for the sternum is either horizontal to sub-horizontal (state 1), for example in Accipitridae, Leptsomiformes, Cariamiformes, Falconiformes, Psittaciformes and Passeriformes (Fig. 2.25C, D, E, F, G, H). In Cathartiformes (Fig. 2.25A), Pandionidae (Fig. 2.25B) and Sagittariidae the angle is greatly exaggerated and above 20 degrees (state 0).

239. Coracoid, medial view of medial angle with deep depression bordered by a dorsal ridge: absent (0); present (1) (Fog. 2.24D).

New character.

A deep depression on the medial angle is observed in Psittaciformes (Fig. 2.24D).

240. Coracoid, medial angle with cranially projected process: absent (0); present (1).

New character.

A cranially projected process coming from the medial angle (state 1) is present in some members of Cavitaves and some members of Passeriformes.

241. Coracoid, fused with scapula: no (0), yes (1).

Mayr & Clarke (2003, ch. 68).

A fused coracoid and scapula is only present in *Opisthocomus hoazin*.

FURCULA (CLAVICULA)

242. Furcula, omal extremity: outline linear (0); articular facet for the acrocoracoid process (processus acrocoracoideus) and acromial process (processus acromialis) forming a plate-like extremitas omalis of subtriangular shape (1) (Fig. 2.29).

Mayr (2004, ch. 9), Clarke *et al.* (2009, ch. 30), Ksepka *et al.* (2011, ch. 26), Mayr (2015, ch. 12), Bourdon *et al.* (2016, ch. 23), Ksepka *et al.* (2017, ch. 25), Smith *et al.* (2018, ch. 9), Ksepka *et al.* (2019, ch. 35), Hieronymus *et al.* (2019, ch. 4), Mayr (2020, ch. 20), Mayr (2021, ch. 18), Mayr (2022, ch. 19), Mayr & Kitchener (2023a, ch. 21), Mayr & Kitchener (2023b, ch. 20), Mayr & Kitchener (2023c, ch. 20).

The subtriangular shape (state 1) appears when the acrocoracoid process and acromial process are more or less in line with one another creating a subtriangular shape. This feature is observed in many Coraciimorphae (Fig. 2.29B) and all Passeriformes (Fig. 2.29B, C; except *Menura novaehollandiae.*). The degree to which the acrocoracoid process is extended and the position is variable amongst these birds.

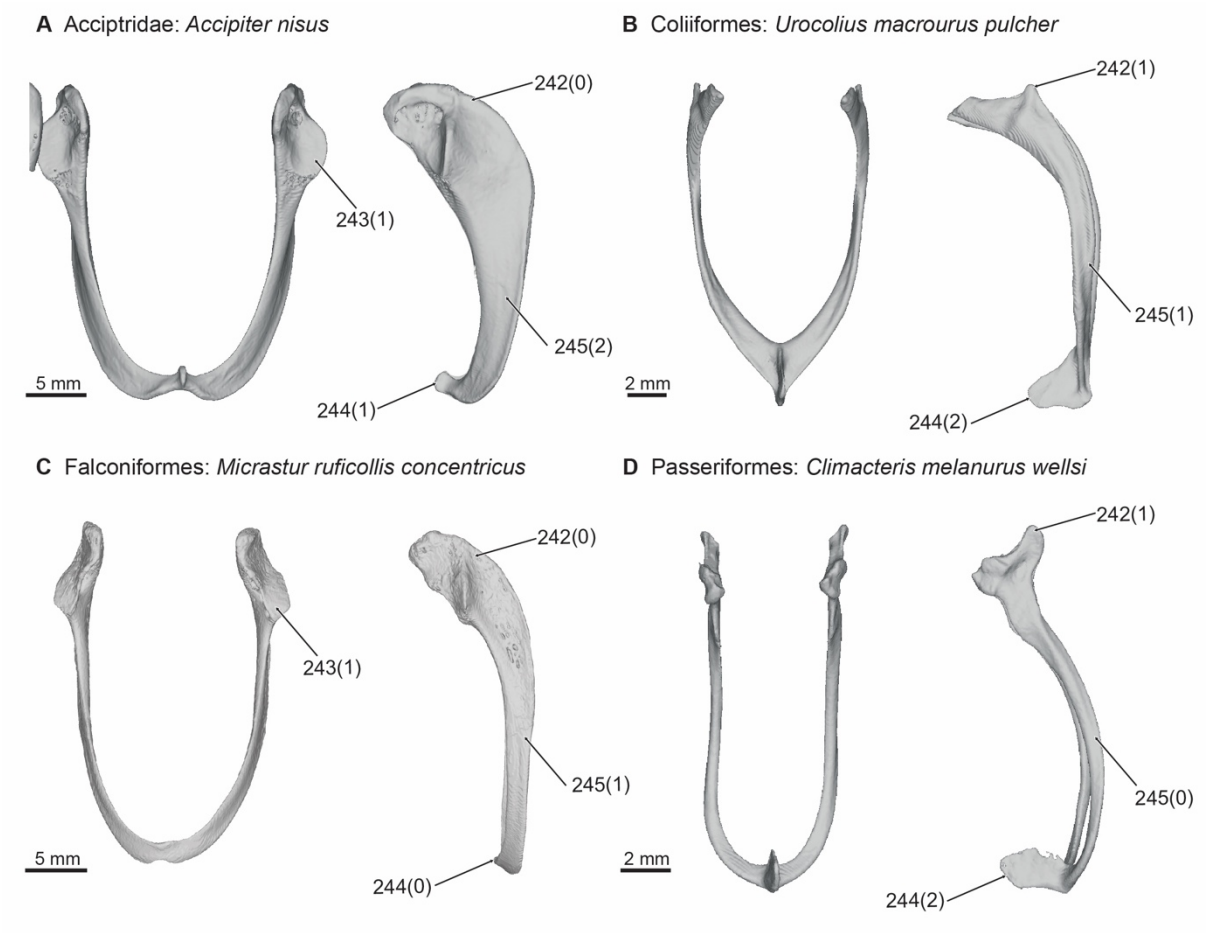


Figure 2.29. Furculae in caudal (left) and right lateral (right) views showing characters 242, 243 and 244. (A) *Accipiter nisus* (Eurasian sparrowhawk, NHMUK zoo S/1982.149.1); (B) *Urocolius macrourus pulcher* (Blue-naped mousebird, FMNH birds 368959); (C) *Falco sparverius* (American kestrel, UMMZ birds 154462); (D) *Climacteris melanurus wellsi* (Black-tailed treecreeper, UMMZ birds 214303). Numbers denote characters and character states as listed.

243. Furcula, omal extremity, processus acrocoracoideus (articular facet for coracoid): mediolaterally flattened (0); with distinct, laterally protruding facies articularis acrocoracoide (1) (Fig. 2.29A, C).

Modified from Mayr & Clarke (2003, ch.62), Mayr *et al.* (2003, ch.27), Mayr (2005a, ch.30), Mayr (2005b, ch.41), Mayr (2006, ch.35), Mayr *et al.* (2010, ch.30), Mayr (2011, ch.30), Ksepka & Clarke (2012, ch.27), Mayr (2015, ch.13), Mayr (2020, ch.21), Mayr (2021, ch.19), Mayr (2022, ch.20), Mayr & Kitchener (2023a, ch.22), Mayr & Kitchener (2023b, ch.21), Mayr & Kitchener (2023c, ch.21).

The articular facet of the acrocoracoid process well developed and laterally protruding (state 1) in mainly Accipitridae (Fig. 2.29A) and Falconiformes (Fig. 2.29C). In a study by Qian *et al.* (2024) it was found that the acrocoracoid process develops independently from the main body of the furcula, suggesting a second ossification centre. The functional role of this process is however

unknown, though a laterally orientated acrocoracoid process (state 1) is observed in flapping-soaring birds like Accipitridae.

244. Furcula, apophysis of the furcula: absent or a barely perceptible ridge (0); small process (1); large, mediolaterally flattened, and blade-like (2) (Fig. 2.28).

Mayr (2004, ch. 10), Mayr *et al.* (2004, ch. 13), Mayr (2006, ch. 36), Clarke *et al.* (2009, ch. 29), Ksepka & Clarke (2009, ch. 9), Ksepka & Clarke (2010, ch. 11), Ksepka *et al.* (2011, ch. 27), Ksepka & Clarke (2012, ch. 28), Mayr (2015, ch. 14), Bourdon *et al.* (2016, ch. 22), Smith *et al.* (2018, ch. 8), Ksepka *et al.* (2019, ch. 34), Mayr (2020, ch. 22), Mayr (2021, ch. 20), Mayr (2022, ch. 22), Mayr & Kitchener (2023a, ch. 23), Mayr & Kitchener (2023b, ch. 22), Mayr & Kitchener (2023c, ch. 22).

The clavicular symphysis is characterised by the region where ankylosis occurs between the caudomedial portions of the right and left clavicles, thus forming the furcula. The apophysis of the furcula is a projection or ridge associated with this region. Within Telluraves, there is a high amount of variation in the size and shape of this process (sometimes called the hypocleidium). An expansive and almost blade-like process (state 2) is observed in most members of Passeriformes (Fig. 2.29D), Coliiformes (Fig. 2.29B), Trogoniformes and *Atleornis pittoides*. In many of the above listed references, the character description of the process is described only as "well-developed", where Trogoniformes and some other Cavitaves would be included. In order to account for the variation in shape and size of the process an additional state (1) was added were only a small process is observably, this includes birds like Accipitriformes (Fig.2.29A), *Coracias benghalensis* and *Acanthisitta chloris*.

245. Furcula, clavicular shaft, mediolateral width: extremely thin (0); intermediate (1); extremely thick (2) (Fig. 2.29).

Modified from Mayr *et al.* (2004, ch. 12), Bourdon *et al.* (2016, ch. 24), Mayr (2016, ch. 15), Smith *et al.* (2018, ch. 8), Mayr (2022, ch. 21), Mayr & Kitchener (2022a, ch. 19).

The above cited references only described a condition for when the clavicular shaft are extremely reduced, a feature observed mostly in Passeriformes (Fig. 2.29C; state 0). However, there is more variation seen within Telluraves. Therefore, I use three states to account for this variation. An extremely thick and robust scapus is observed in all Cathartidae and Accipitridae (Fig. 2.29; state 2) and an intermediate width (state 1) is observed in all other Telluraves, for example Coliiformes (Fig. 2.29B) and Falconiformes (Fig. 2.29C).

246. Furcula, lateral pneumatic recess (recessus pneumaticus lateralis): absent (0); present (1).

New character.

Pneumatisation of the acromial process (state 1) is present only in Cathartidae.

SCAPULA

247. Scapula, acromion: single (0); distinctly bifurcate, with an additional medial process (1) (Fig. 2.30).

Mayr *et al.* (2003, ch. 31), Mayr *et al.* (2004, ch. 14), Mayr (2004, ch. 14), Mayr (2005a, ch. 34), Mayr (2006, ch. 41), Clarke *et al.* (2009, ch. 31), Mayr *et al.* (2010, ch. 34), Mayr (2011, ch. 34), Mayr (2015, ch. 20), Bourdon *et al.* (2016, ch. 25), Ksepka *et al.* (2017, ch. 37), Smith *et al.* (2018, ch. 11), Ksepka *et al.* (2019, ch. 53), Mayr (2020, ch. 28), Mayr (2021, ch. 26), Mayr (2022, ch. 23), Mayr (2022, ch. 27), Mayr & Kitchener (2023a, ch. 29), Mayr & Kitchener (2023b, ch. 28), Mayr & Kitchener (2023c, ch. 28), Mayr & Kitchener (2023d, ch. 8).

A scapula with a distinctly bifurcated acromion (state 1) is present in Passeriformes (Fig. 2.30C, D) and Coraciimorphae, where an additional medial process may be present (and is not the coracoid tubercle of the acromion, Ch. 248).

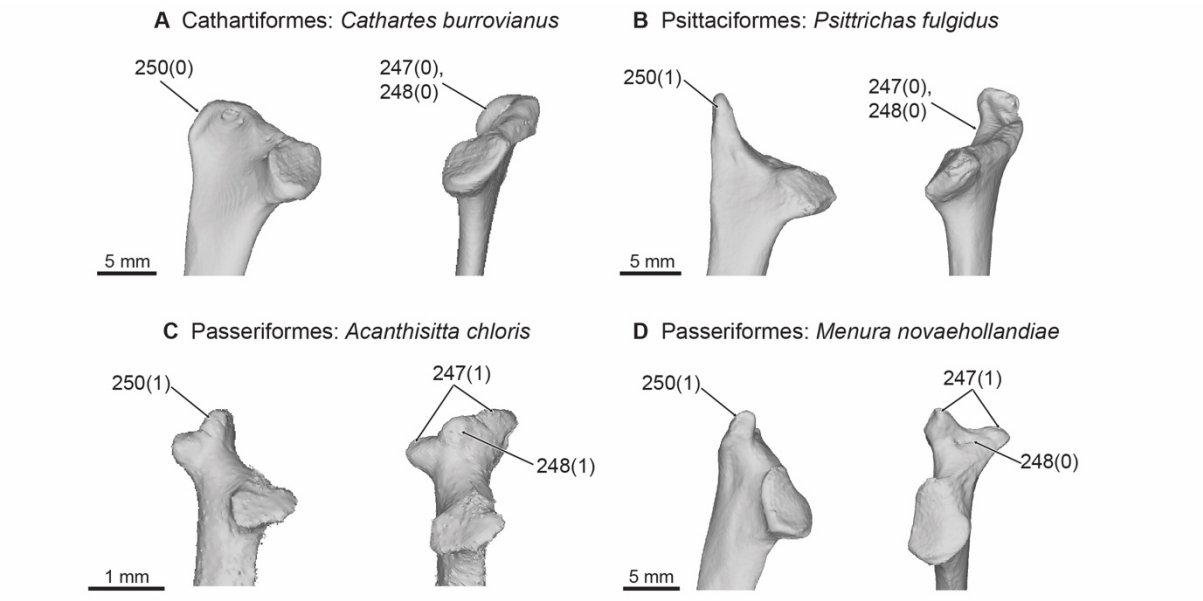


Figure 2.30. Distal ends of scapulae in lateral (left) and medial (right) views showing characters 247, 248, 249 and 250, scapula in lateral and medial view. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Psittrichas fulgidus* (Pesquet's parrot, YPM orn 141821); (C) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (D) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

248. Scapula, coracoid tubercle of the acromion: absent or very small, conforms with sulcus (0); prominent tubercle (1) (Fig. 2.30).

New character.

The coracoid tubercle of the acromion is present and prominent in only a few Telluraves, such as Falconiformes and *Acanthisitta chloris* (Fig. 2.30C).

249. Scapula, pneumatic foramen on dorsal surface between facies articularis humeralis and acromion: absent (0); present (1).

Clarke *et al.* (2009, ch. 32), Ksepka *et al.* (2011, ch. 39), Ksepka & Clarke (2012, ch. 42), Bourdon *et al.* (2016, ch. 26).

250. Scapula, cranial projection of acromion in ventral or medial view: low projection (0); distinctly elongated projection (1) (Fig. 2.30).

Ksepka & Clarke (2010, ch. 19), Ksepka *et al.* (2011, ch. 38), Ksepka & Clarke (2012, ch. 41), Smith *et al.* (2018, ch. 10), Hieronymus *et al.* (2019, ch. 5).

A distinctly elongated projection of the acromion is observed in most members of Telluraves (Fig. 2.30B, C, D), the length to which the acromion is extended varies widely among Telluraves but this variation has not been accounted for in this study.

251. Scapula: shorter than humerus (0); longer than humerus (1).

Ksepka & Clarke (2009, ch. 16), Ksepka & Clarke (2010, ch. 18), Mayr (2013, ch. 9), Ksepka *et al.* (2017, ch. 36), Ksepka *et al.* (2019, ch. 52).

The scapula is much shorter than the humerus in most birds but exceeds the humerus in length in some species of Coliiformes, Cavitaves and Passeriformes. See Table S1.5 for length measurements of the scapula and humerus.

HUMERUS

252. Humerus, bicipital crest (crista bicipitalis), general form: rounded, continuously curving (0); intermediate between squared off and rounded (1); straight to concave, sharp angle into shaft (sickle shaped) (2)(Fig. 2.31).

Modified from Mayr (2005b, ch. 52), Clarke *et al.* (2009, ch. 42), Ksepka *et al.* (2011, ch. 41), Ksepka & Clarke (2012, ch. 44), Bourdon *et al.* (2016, ch. 78), Smith *et al.* (2018, ch. 20), Hieronymus *et al.* (2019, ch. 11).

A character describing the shape of the bicipital crest have been used by many previous authors (cited above). However, there are major discrepancies between their scorings. Smith *et al.* (2018) and Hieronymus *et al.* (2019) scored Passeriformes (except *Acanthisitta chloris*) as having an "exceptionally large, pointed" bicipital crest, whereas Ksepka *et al.* (2011) and Ksepka & Clarke (2012) score passerines as having an "unexpanded" bicipital crest. In Mayr (2005b) Psittaciformes are scored as "unexpanded" while in Ksepka *et al.* (2011) and Ksepka & Clarke (2012) Psittaciformes were scored as having an "inflated and proximodistally expanded" bicipital crest. It is clear that there is complex shape variation within the bicipital crest that might be causing these differences. In most Telluraves the bicipital crest is rounded and continuously curving (state 0; Fig 2.31A) or an intermediate between squared off and rounded (e.g. Accipitriformes) (state 1; Fig. 2.31B, D, F, G). Among these birds, the size of the crest varies in its distal expanse for e.g. in *Buteo rufo* (Fig. 2.31B) the crest is distally expansive whereas in *Strix aluco* it is not, but both show a somewhat squared off crest. Passeriformes have a distinctive shape where the distal edge of the crest is almost concave, and angles sharply into the shaft giving a sickle shaped appearance (state 1; Fig. 2.31C, H). In this case, the crest is more reduced in its distal

extent and can even be laterally extensive in some passerines (e.g. *Pitta sordida*). In Psittaciformes the crest still angles sharply into the shaft but is more proximodistally expanded than in Passeriformes. Variations of all the above-described shapes can be found in Coraciimorphae but have not been accounted for in this present study. In fossil taxa, Ksepka *et al.* (2011) and Ksepka & Clarke (2012) scored *Psittacopes Lepidus* as "inflated and proximodistally expanded", same as Psittaciformes, however this is not evident in the photos of this fossil specimen therefore scored as state 0. Smith *et al.* (2018) scored all *Primozygodactylus* species as having an "exceptionally large, pointed" bicipital crest. While this is possibly true for *P. quintus* (Smith *et al.* 2018), it is not so evident in the other species described in Smith *et al.* (2018) and so been scored as '?' here. Note that *Sagittarius_serpentarius*, *Alcedo atthis* and *Cariama c. cristata* (Fig. 2.31E) have very small and reduced bicipital crests and so have been scored as (?).

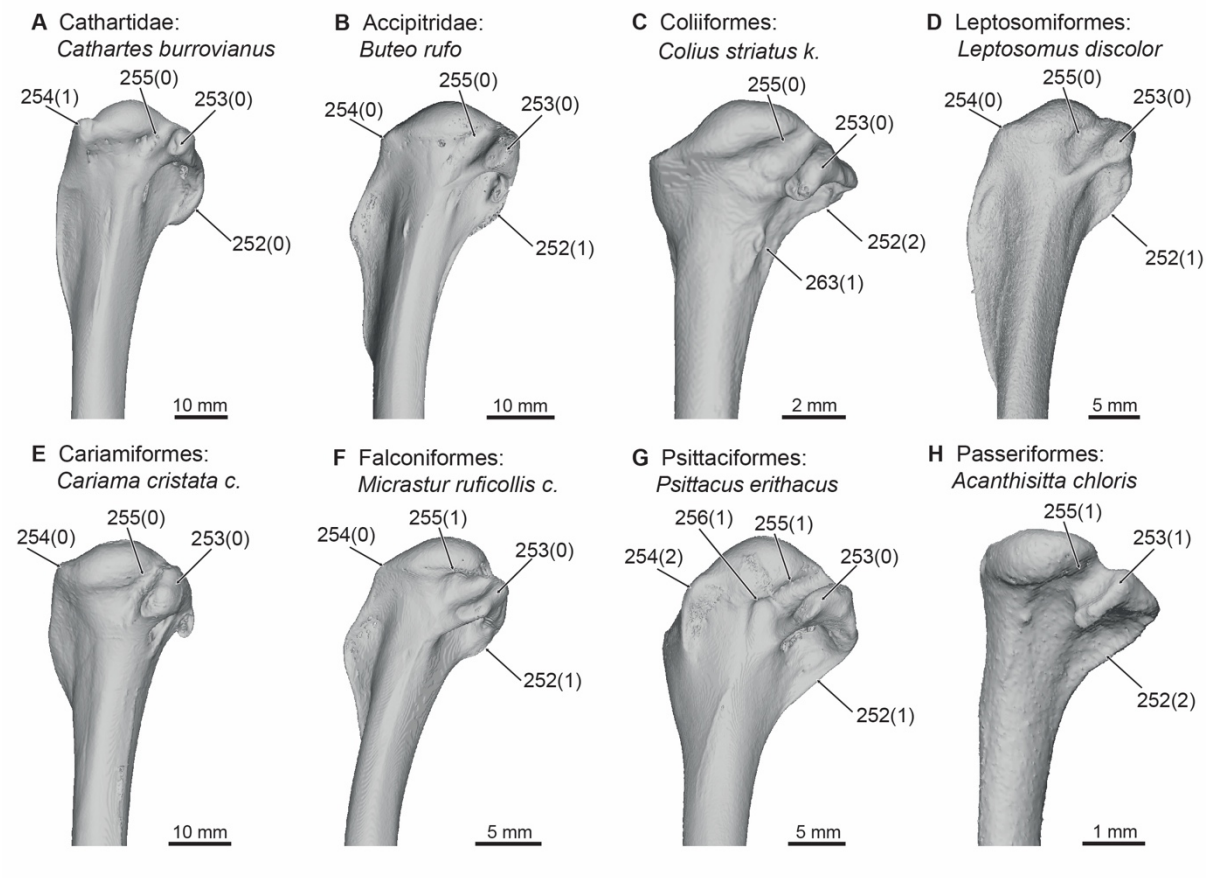


Figure 2.31. Proximal part of humeri in caudal view showing characters 252, 253, 254, 255, 256 and 263. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Buteo rufofuscus* (Jackel buzzard, NHMUK zoo 1862.1.18.1); (C) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (D)*Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38; (E) *Cariama cristata cristata* (Red-legged seriema, FMNH birds 105635); (F) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (G) *Psittacus erithacus* (African grey parrot, NHMUK zoo S/1992.41.60); (H) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146). Numbers denote characters and character states as listed.

253. Humerus, ventral tubercle (tuberculum ventral): distinct rounded knob (0); distinct elongated tubercle forming a ridge (1) (Fig. 2.31).

New character.

An elongated ventral tubercle is observed in Passeriformes and Piciformes, where the tuberculum ventral no longer looks like a tubercle but rather a crescent shaped ridge (state 1; Fig. 2.31H)

254. Humerus, dorsal tubercle (tuberculum dorsale): non-distinct (0); moderately distinct, round tubercle (1); distinct, elongated ridge, oriented proximodistally (2) (Fig. 2.31).

Modified from Mayr & Clarke (2003, ch. 76), Mayr (2005b, ch. 54).

The dorsal tubercle is a distinctive elongated ridge (state 2) in Psittaciformes (Fig. 2.31G). Otherwise, in the rest of Telluraves, the tubercle is either a small rise on the dorsal surface (completely absent in Coliiformes Fig. 2.31C and Passeriformes Fig. 2.31H) (state 0; Fig. 2.31B, D, E, F) or a more prominent tubercle (state1; Fig. 2.31A).

255. Humerus, Capital incisure (incisura capitis), depth: shallow (0); deep (1) (Fig. 2.31).

Modified from Raimon *et al.* (2020, ch. 20).

A deep capital incisure is present in for example Falconiformes (Fig. 2.31F) and Psittaciformes (Fig. 2.31G).

256. Humerus, a deep caudal part of the latissimus dorsi muscle impression (m. latissimus dorsi pars caudalis): absent or very shallow (0); present (1) (Fig. 2.31).

Raimon *et al.* (2020, ch.15).

There are varying degrees of depth of this fossa where “absent” is not truly absent but shallow (state 0). A deep impression is associated with the dorsal crest of the pneumatic fossa of the humerus (state 1; Fig. 2.31G).

257. Humerus, pneumatic foramen within the pneumotricipital fossa (fossa pneumotricipitalis): absent (0); present, small (1); present, large (2).

Mayr & Clarke (2003, ch. 77), Mayr (2005b, ch.53), Ksepka & Clarke (2009, ch. 18), Ksepka & Clarke (2010, ch. 21), Ksepka *et al.* (2011, ch. 43), Mayr (2011, ch. 40), Ksepka & Clarke (2012, ch. 46), Mayr (2013, ch. 13), Mayr (2015, ch. 25), Ksepka *et al.* (2017, ch. 40), Ksepka *et al.* (2019, ch. 56), Mayr (2020, ch. 34), Mayr (2021, ch. 31), Mayr & Kitchener (2023a, ch. 36), Mayr & Kitchener (2023b, ch. 35), Mayr & Kitchener (2023c, ch. 35).

The presence of pneumatic foramina within the pneumotricipital fossa was proposed as a synapomorphy of Neornithes by Cracraft (1988, pg. 344). It is possibly absent (state 0) in *Acanthisitta chloris*.

258. Humerus, humeral head (caput humeri), dorsal view, inclination: caudally inflected (0); proximal inflected (1) (Fig. 2.32).

Modified from Ksepka *et al.* (2011, ch. 40), Ksepka & Clarke (2012, ch. 43).

This character is best viewed best viewed in dorsal or lateral view. A proximally inflected capital humerus is present in Psittaciformes (Fig. 2.32B), Leptosomiformes and Accipitriformes (except Sagiitariidae).

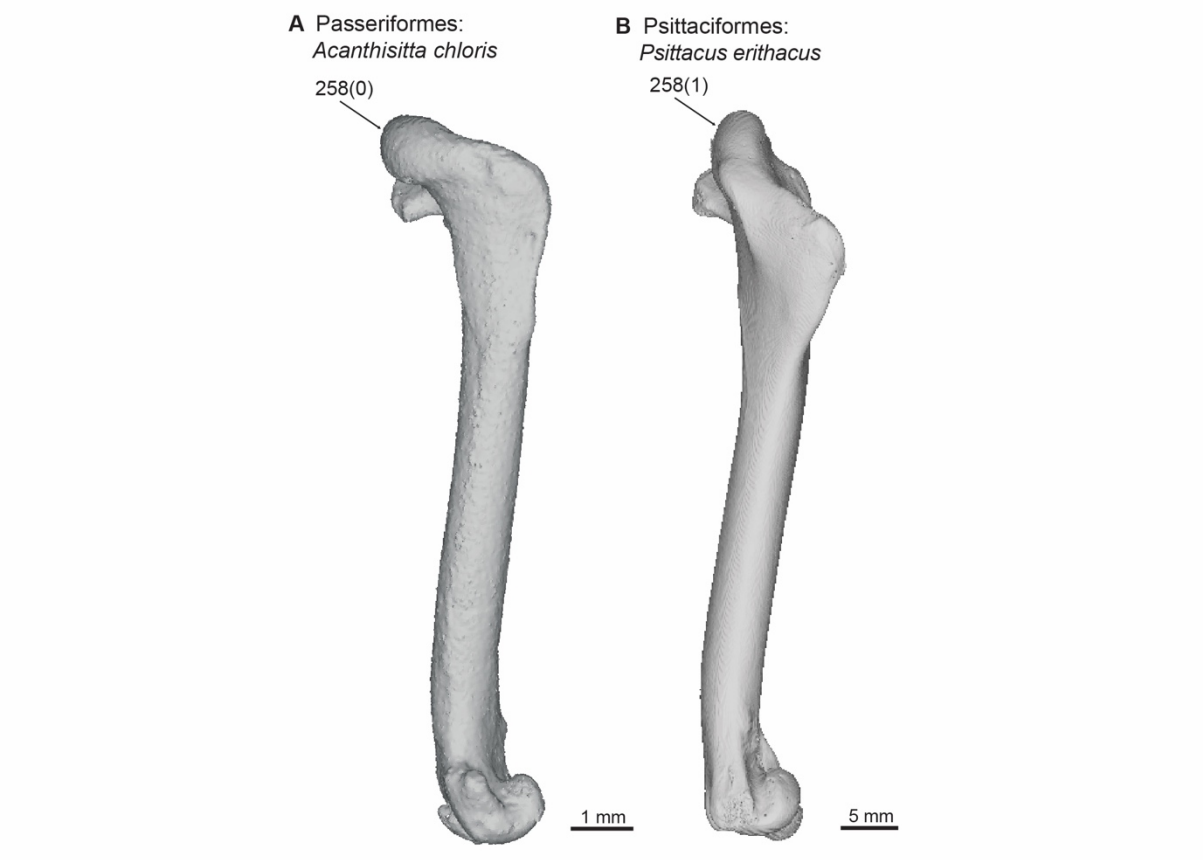


Figure 2.32. Right humeri in dorsal view showing character 258. (A) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (B) *Psittacus Erithacus* (African grey parrot, NHMUK zoo S/1992.41.60). Numbers denote characters and character states as listed.

259. Humerus, deltopectoral crest (crista deltopectoralis): smoothly curving (0); angular at its midlength (1); angular proximal to midlength (pronounced cranial projection) (2) (Fig. 2.33).

Modified from Dyke & Cooper (2000, ch. 27), Mayr & Clarke (2003, ch. 75), Mayr (2005b, ch. 51), Ksepka *et al.* (2011, ch. 42), Ksepka & Clarke (2012, ch. 45), Bourdon *et al.* (2016, ch. 65).

The dorsal angle of the deltopectoral crest can vary three distinct ways. Either the dorsal angle is not apparent, making a smooth curve (state 0), or the dorsal angle is accentuated where its position can vary from either being at its midlength (state 1) or more proximally (state 1). In previous work only Psittaciformes are scored as having a "pronounced cranial projection" (state 2; Fig. 2.33D). However, this condition is also observed in Passeriformes. A new state (1) has been added to distinguish between a smooth curving crest (Fig. 2.33A) versus a crest with a accentuated dorsal angle (Fig. 2.33B, C)

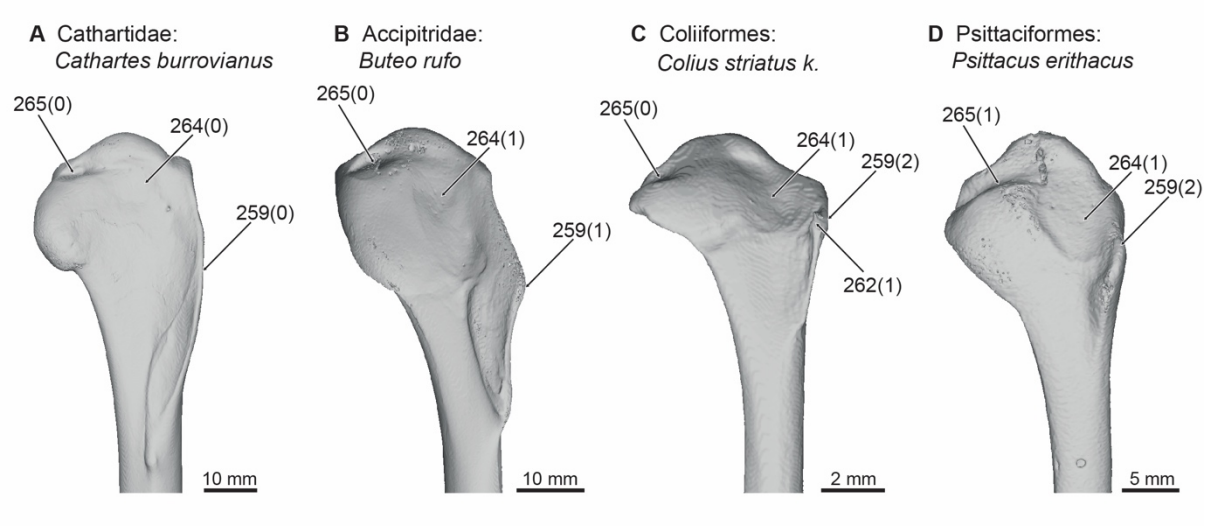


Figure 2.33. Proximal part of left humeri in cranial view showing characters 259, 262, 264 and 265. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Buteo rufofuscus* (Jackel buzzard, NHMUK zoo 1862.1.18.1); (C) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (D) *Psittacus erithacus* (African grey parrot, NHMUK zoo S/1992.41.60). Numbers denote characters and character states as listed.

260. Humerus, crista deltopectoralis: measuring approximately one-third the total length of the humerus (0); measuring approximately one-quarter the total length of the humerus (1).

Mayr *et al.* (2004, ch. 4), Zelenkov & Dyke (2008, ch. 9), Ksepka & Clarke (2009, ch. 19), Ksepka & Clarke (2010, ch. 22), Mayr (2013, ch. 11), Bourdon *et al.* (2016, ch. 77), Ksepka *et al.* (2017, ch. 41), Ksepka *et al.* (2019, ch. 57), Raimon *et al.* (2020, ch. 16).

The studies cited above did not describe how this measurement was taken. For reference herein the length of the deltopectoral crest is taken from the dorsal tubercle to the distal angle where the crest aligns with the shaft. In Ksepka *et al.* (2019, ch. 57) Psittaciformes and Strigiformes are scored as having longer crests (state 0). In the present study it was found that Strigiformes and Psittaciformes have relatively short crests, along with Passeriformes and many Coraciimorphae (state 0). See table S1.16 for measurements.

261. Humerus, dorsal view, distal end of deltopectoral crest has a prominent tubercle: absent (0); present (1).

New character.

A deltopectoral crest with dorsal tubercle is present only observed in Oscines.

262. Humerus, deltopectoral crest with large tubercle on lateral edge: absent (0); present (1) (Fig. 2.33C).

New character.

A large tubercle on the deltopectoral crest is only observed in Coliiformes (Fig. 2.33C).

263. Humerus, caudal surface, round tubercle located slightly distal to the fossa pneumotricipitalis/ located at m. latissimus dorsi pars caudalis: absent (0); present (1) (Fig. 2.31C).

Ksepka & Clarke (2010, ch. 20), Ksepka *et al.* (2017, ch. 39), Ksepka *et al.* (2019, ch. 55).

A round tubercle located slightly distal to the pneumotricipital fossa only observed in Coliiformes (Fig. 2.31C).

264. Humerus, coracobrachial impression: non-distinct (0); deep or sharply delimited (1) (Fig. 2.33).

New character.

A noticeably deep or sharply distal delimitation of the impression (state 1) is observed in Psittaciformes (Fig. 2.33D), Accipitriformes (Fig. 2.33B) Strigiformes, Falconiformes and Coliiformes (Fig. 2.33C). In all fossil specimens observed in this study, none have a distinct coracobrachial impression except for in *Pulchrapollia eximia* (NMS.Z.2021.40.64), where there is a small but deep impression, however scored as state 0. The size and depth of the coracobrachial impression varies within Telluraves. The distal extent of the impression appears to be related to the shape and size of the bicipital crest, except in some Cavitaves and Passeriformes where the basin is small (by relative extent) and rounded, this variation has not been accounted for in the present study.

265. Humerus, transverse ligamental sulcus (sulcus ligamentosus transversus), dorsoventral length: abbreviated, non-distinct small round sulcus (0); elongated, deep, and rectangular-shaped (at least half the width of the humeral head) (1) (Fig. 2.33).

Mayr *et al.* (2003, ch. 36), Mayr (2005a, ch. 39), Mayr (2006, ch. 47), Mayr *et al.* (2010, ch. 39), Mayr (2011, ch. 39), Bourdon *et al.* (2016, ch. 64).

An elongated deep furrow that transverses the humeral head (state 1) is observed in Psittaciformes (Fig. 2.33D).

266. Humerus, ventral supracondylar tubercle (tuberculum supracondylare ventrale): small indistinct tubercle (0); massively enlarged tubercle (1) (Fig. 3.34).

New character.

Most members of Telluraves have an enlarged tubercle (state 1; Fig. 2.34B, C, D) except Accipitriformes (Fig. 2.34A).

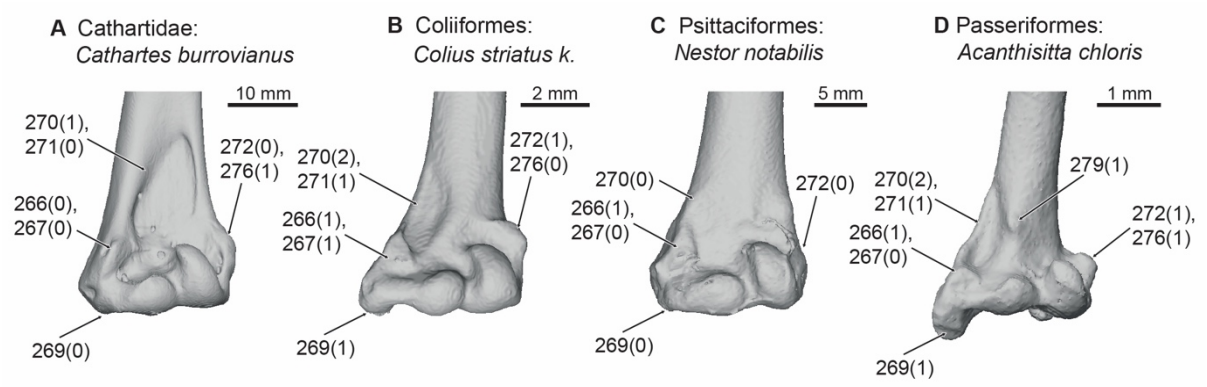


Figure 2.34. Proximal part of left humeri in cranial view showing characters characters 266, 267, 269, 270, 271, 272, 276, 279, distal portion of left humerus in cranial view. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (C) *Nestor notabilis* (Kea, FMNH birds 23530); (D) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146). Numbers denote characters and character states as listed.

267. Humerus, ventral supracondylar tubercle: moderately developed (0); expanded, forming large triangular platform approximately equal in width to condylus ventralis and in dorsal extent to condylus dorsalis (1) (Fig. 2.34B).

Ksepka *et al.* (2017, ch. 46), Ksepka *et al.* (2019, ch. 63).

The ventral supracondylar tubercle is expanded, forming a large triangular surface adjacent to the condylus ventralis in Coliiformes (state 1; Fig. 2.34B). In Ksepka *et al.* (2017) this morphology

was considered diagnostic for Sandcoleidae and Coliiformes, and a similar degree of development is seen in some songbirds as well (though none of the current study).

268. Humerus, ventral supracondylar tubercle, position: cranial (0); ventral border/ cranioventral margin (1).

New character.

A ventral supracondylar tubercle on the cranioventral margin is observed in most outgroup taxa of the current study.

269. Humerus, flexor process (processus flexorius): weakly developed only slightly or in line with ventral condyle (0); strongly projected reaching distally beyond margin of ventral condyle (1) (Fig. 2.34).

Modified from Mayr *et al.* (2003, ch. 38), Mayr (2005a, ch. 41), Mayr (2006, ch. 49), Zelenkov & Dyke (2008, ch. 12), Ksepka & Clarke (2009, ch. 21), Ksepka & Clarke (2010, ch. 24), Mayr *et al.* (2010, ch. 41), Mayr (2011, ch. 42), Mayr (2013, ch. 15), Mayr (2015, ch. 24), Ksepka *et al.* (2017, ch. 46), Smith *et al.* (2018, ch. 24), Hieronymus *et al.* (2019, ch. 15), Ksepka *et al.* (2019, ch. 64), Mayr (2020, ch. 33), Raimon *et al.* (2020, ch. 21), Mayr (2021, ch. 30), Mayr (2022, ch. 30), Mayr & Kitchener (2023a, ch. 35), Mayr & Kitchener (2023b, ch. 34), Mayr & Kitchener (2023c, ch. 34).

In the most recent studies (Mayr & Kitchener 2023a,b,c) Coliiformes (Fig. 2.24B), Bucerotiformes, Piciformes (except *Galbula dea*) and Passeriformes (Fig. 2.24D) were all scored as having a projected flexor process that extends distally beyond the margin of the ventral condyle (state 1). Passeriformes poses the most ventrally expanded process of all Telluraves, this is not accounted for in the present study. A weakly developed flexor process that does not project ventrally (state 0) is observed in Cathartiformes (Fig. 2.24A), Trogoniformes, Strigiformes and Psittaciformes (Fig. 2.34C). My scores differ from those of previous studies (listed above) in that *Accipiter nisus, Urocolius m.* and early diverging Falconiformes are scored as state 1, which were scored as state 0 in previous studies.

270. Humerus, brachial fossa (fossa musculi brachialis): non distinct (0); weakly delimited, wide and open (1); sharply delimited, ovate depression (2) (Fig. 2.34).

Modified from Mayr *et al.* (2003, ch. 37), Mayr & Clarke (2003, ch. 79), Mayr & Clarke (2003, ch. 80), Mayr (2005a, ch. 40), Mayr (2005b, ch. 55), Mayr (2005b, ch. 56), Mayr (2006, ch. 48), Mayr *et al.* (2010, ch. 40), Mayr (2011, ch. 41), Bourdon *et al.* (2016, ch. 68).

The brachial fossa (fossa musculi brachialis) serves as the origin for the musculus brachialis, a key flexor of the elbow joint that facilitates wing folding and maneuverability during flight (George & Berger 1966a; Baumel & Witmer 1993). An exceptionally deep and sharply delimited brachial fossa (state 2) is observed in *Indicator,* this was considered an autopomorphy of this taxon by Mayr *et al.* (2003). This feature was also proposed as a synapomorphy of Trogonidae and Steatornithidae (oil birds) by Mayr *et al.* (2003). While these birds do have exceptionally deep fossa, for the purpose of this study, the shape of fossa is rather noted here. There are two distinct shapes observed in Telluraves, something that looks like the delta insignia of Star Trek (state 1; Fig. 2.24A) and an ovate depression where the distal border is clear and delimited (state 2; Fig. 2.24B &D). State 2 is observed in most Coraciimorphae (Fig. 2.34B) and most members of Passeriformes (Fig. 2.34D), as well as *Tyto alba*. A weakly delimited, wide, and open morphology (state 1) is observed in Cathartidae (Fig. 2.34A), Accipitridae, Cariamiformes and Falconiformes. This more open morphology likely provides a broader attachment area for the musculus brachialis, enhancing the muscle's leverage and allowing for more flexible wing movements, which is advantageous for the diverse flight styles.

271. Humerus, fossa musculi brachiallis, position: medially situated (centrally) (0); laterally situated (1) (Fig. 2.34).

Mayr (2004, ch. 16), Bourdon *et al.* (2016, ch. 67), Mayr (2016, ch. 19), Smith *et al.* (2018, ch. 22), Hieronymus *et al.* (2019, ch. 13).

In Passeriformes (Fig. 2.24D) and Coliiformes (Fig. 2.34B) the brachial fossa is situated along the lateral margin (state 1).

272. Humerus, dorsal supracondylar process (processus supracondylaris dorsalis): weakly developed tubercle (0); strongly projected/discrete (1) (Fig. 2.34).

Modified from Ksepka *et al.* (2011, ch. 46), Ksepka & Clarke (2012, ch. 49), Mayr (2015, ch. 26), Ksepka *et al.* (2017, ch. 44), Smith *et al.* (2018, ch. 18), Hieronymus *et al.* (2019, ch. 9), Ksepka *et al.* (2019, ch. 61), Mayr (2020, ch. 35), Raimon *et al.* (2020, ch. 23), Mayr (2021, ch. 32), Mayr & Kitchener (2023a, ch. 37), Mayr & Kitchener (2023b, ch. 36), Mayr & Kitchener (2023c, ch. 36).

A blunt process or weakly developed tubercle (state 0) is found in most Telluraves except for Strigiformes, Coliiformes (Fig. 2.34B), some members of Cavitaves and Passeriformes (Fig. 2.34D) where the process is strongly projected (state 1). The dorsal supracondylar process is does vary from being completely absent like in Psittaciformes (Fig. 2.34C) to being a small ridge or lump

like in *Galbula dea*, both scored as state 0. In the character description of Mayr & Kitchener (2023a,b,c) the direction of the process is also included. Here, this has been made into a new character (ch. 274).

273. Humerus, dorsal supracondylar process (processus supracondylaris dorsalis) separated from shaft by a small notch: absent (0); present (1).

Modified from Smith *et al.* (2018, ch. 18), Hieronymus *et al.* (2019, ch. 9).

A small notch separating the dorsal supracondylar process from the shaft is only observed in Zygodactylidae, see above references for more explanation.

274. Humerus, dorsal supracondylar process (processus supracondylaris dorsalis), direction: dorsally directed process (0); proximodorsally projected process (1).

New character**.**

See character 272 discussion.

275. Humerus, dorsal supracondylar process (processus supracondylaris dorsalis): single (0); bifurcated (1).

Ksepka *et al.* (2019, ch. 62), Raimon *et al.* (2020, ch. 22).

276. Humerus, dorsal supracondylar process (processus supracondylaris dorsalis), position: proximally positioned away from dorsal condyle (0); distally positioned and approximately in line with dorsal condyle (1) (Fig. 2.34).

New character.

A distally positioned dorsal supracondylar process that is approximately in line with the dorsal condyle is observed in Cathartidae (Fig. 2.34A), Pandionidae, Sagittariidae and Cariamiformes and all Passeriformes (Fig. 2.24D).

277. Humerus, humeral head (caput humeri), proximal end: head positioned so it is largely aligned with the shaft (0); head deflected so as to be situated almost entirely ventral to the ventral margin of the shaft (1).

Ksepka *et al.* (2017, ch. 38), Ksepka *et al.* (2019, ch. 54).

a humeral head that is deflected so as to be situated almost entirely ventral to the ventral margin of the shaft (stat 1) is observed in Coliiformes, as scored in Ksepka *et al.* (2017) and Kspeka *et al.* (2019). In the above references it is likely that this interpretation was based on observation the humerus in cranial or caudal views.

278. Humerus, shaft in cranial view: curved (0); straight (1).

Zelenkov & Dyke (2008 ch. 10), Ksepka & Clarke (2009, ch. 20), Ksepka & Clarke (2010, ch. 23), Ksepka *et al.* (2011, ch. 45), Ksepka & Clarke (2012, ch. 48), Ksepka *et al.* (2017, ch. 42), Ksepka *et al.* (2019, ch. 58), Raimon *et al*. (2020, ch. 19).

A straight shaft (state 1) is observed in Coliiformes, Psittaciformes and Passeriformes.

279. Humerus, dorsal, cranial surface, tubercle placed at centre of shaft, proximal to condylus dorsalis: absent (0); present (1) (Fig. 2.34).

Ksepka *et al.* (2019, ch. 60).

A tubercle placed at the centre of the shaft proximal to the dorsal condyle is observed in Passeriformes (Fig. 2.34D).

280. Proportions of humerus and femur: humerus longer than femur (0); femur longer than humerus (1).

Smith *et al.* (2018, ch. 21), Hieronymus *et al.* (2019, ch. 12).

See Table S1.5 for measurements of the humerus and femur.

281. Proportions of humerus and ulna: humerus longer than ulna (0); ulna longer than humerus (1).

Ksepka & Clarke (2009) ch.23, Ksepka & Clarke (2010) ch.26, Mayr (2013) ch.14, Ksepka *et al.* (2017) ch.47, Ksepka *et al.* (2019) ch.65, Mayr & Kitchener (2023b) ch.37, Mayr & Kitchener (2023c) ch.37.

See Table S1.5 for measurements of the humerus and Ulna.

282. Humerus, crescent-shaped depression proximal to dorsal condyle: absent (0); present (1).

Mayr *et al.* (2004, ch. 5), Ksepka & Clarke (2009, ch. 22), Zelenkov & Dyke (2008, ch. 11), Ksepka & Clarke (2010, ch. 25), Mayr (2013, ch. 12), Ksepka *et al.* (2017, ch. 43), Ksepka *et al.* (2019, ch. 59).

Scorings taken from the above cited references.

RADIUS

283. Radius, radial bicipital tubercle (tuberculum bicipitale radii): rounded/bulbous (0); concave (1); straight crest-like projection (pinched) (2) (Fig. 2.35).

Modified from Ksepka *et al.* (2017, ch. 51), Ksepka *et al.* (2019, ch. 66).

There are three distinct forms that the radial bicipital tubercle can take. In state 0, it forms a small tubercle that can proceed caudally as a marked ridge on the caudal edge joining the facies articularis ulnaris. In state 1, it forms a depression where the distal edge of facet is slightly projecting and curved (Fig. 2.35C). In state 2, it forms a straight crest orientated proximodistal (Fig. 2.35B).

284. Radius, radial bicipital tubercle (tuberculum bicipitale radii), distance from radial head: distal (0); proximal (1) (Fig. 2.35).

New character.

A distally position radial bicipital tubercle is observed in most Telluraves (Fig. 2.35A), in Psittaciformes and Passeriformes the tubercle is positioned more proximal to the radial head (Fig. 2.35B, C).

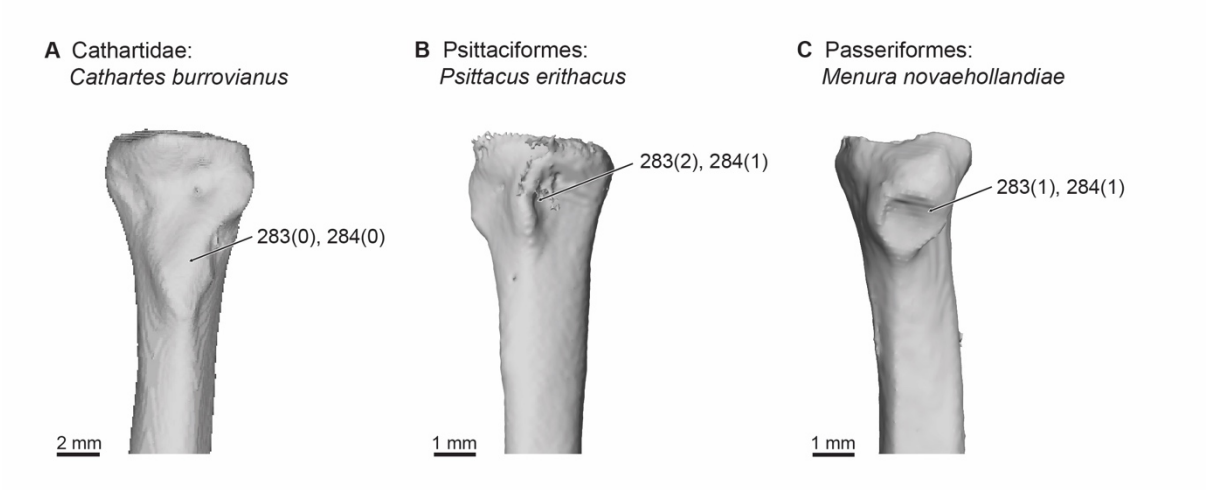


Figure 2.35. Proximal part of left radii in ventral view showing characters 283, 284, 294. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Psittacus erithacus* (African grey parrot, NHMUK zoo S/1992.41.60); (C) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

285. Radius, tuberculum bicipitale radii (radial tuberosity/bicipital tubercle) does not extend beyond the shaft (0); projects beyond radial head (1) (Fig. 2.36).

Modified from Ksepka *et al.* (2017, ch. 51), Ksepka *et al.* (2019, ch. 66).

A proximally projected radial bicipital tubercle (state 1) is present in Bucerotiformes (Fig. 2.36) and Passeriformes.

286. Radius, proximal ulnar articular surface (proximal facies articularis ulnaris): small/absent, does not expand prominently past the lateral surface of shaft (0); prominent expanse past the shaft (1) (Fig 2.36).

New character.

An expansive proximal ulnar articular surface is observed in many Telluraves for example Accipitridae (Fig. 2.36B) and Bucerotiformes (Fig. 2.36C).

287. Radius, proximal ulnar articular surface curving cranially: no (0); yes (1) (Fig. 2.36).

New character.

A proximal ulnar articular surface that curves cranially is observed in Bucerotiformes (Fig. 2.36C) and Passeriformes.

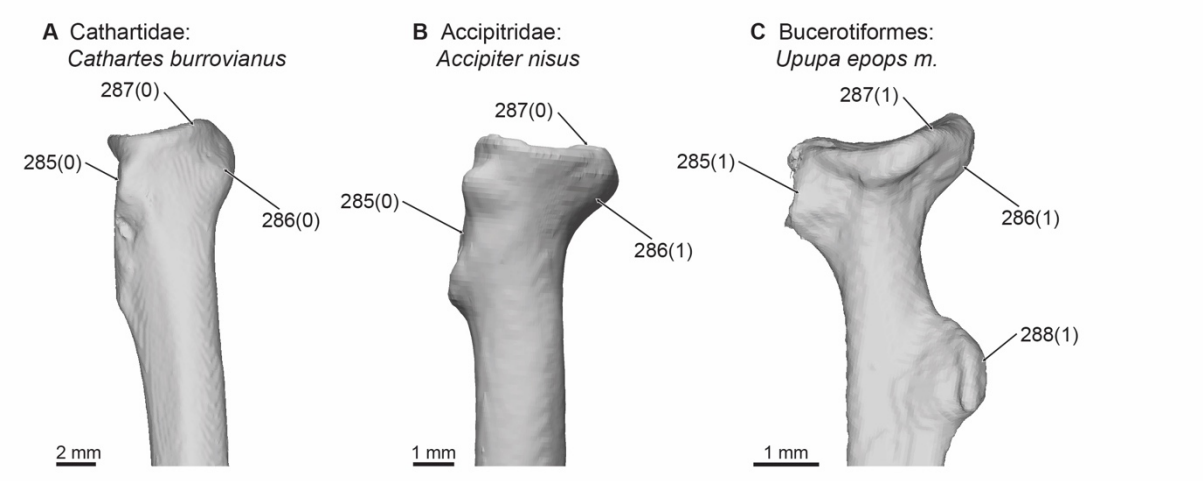


Figure 2.36. Proximal part of left radii in cranial view showing characters 285, 286, 287, 288. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Accipiter nisus* (Eurasian sparrowhawk, NHMUK zoo S/1982.149.1); (C) *Upupa epops marginata* (Madagascar hoopoe, FMNH birds 352821). Numbers denote characters and character states as listed.

288. Radius, proximal end, lateral side, prominent raised process: absent (0); present (1).

New character.

A prominent raised process (state 1) is only present in *Upupidae*.

289. Radius, distal ulnar articular surface (distal facies articularis ulnaris): rounded, not medially expanding (0); pointed, medially expanded generally past the most proximal portion of the radius (1) (Fig. 2.37).

New character.

A medially expanded distal ulnar articular surface (state 1) is observed in only a few Telluraves such as *Accipiter* (Fig. 2.37B) and *Strix* (Fig. 2.37D).

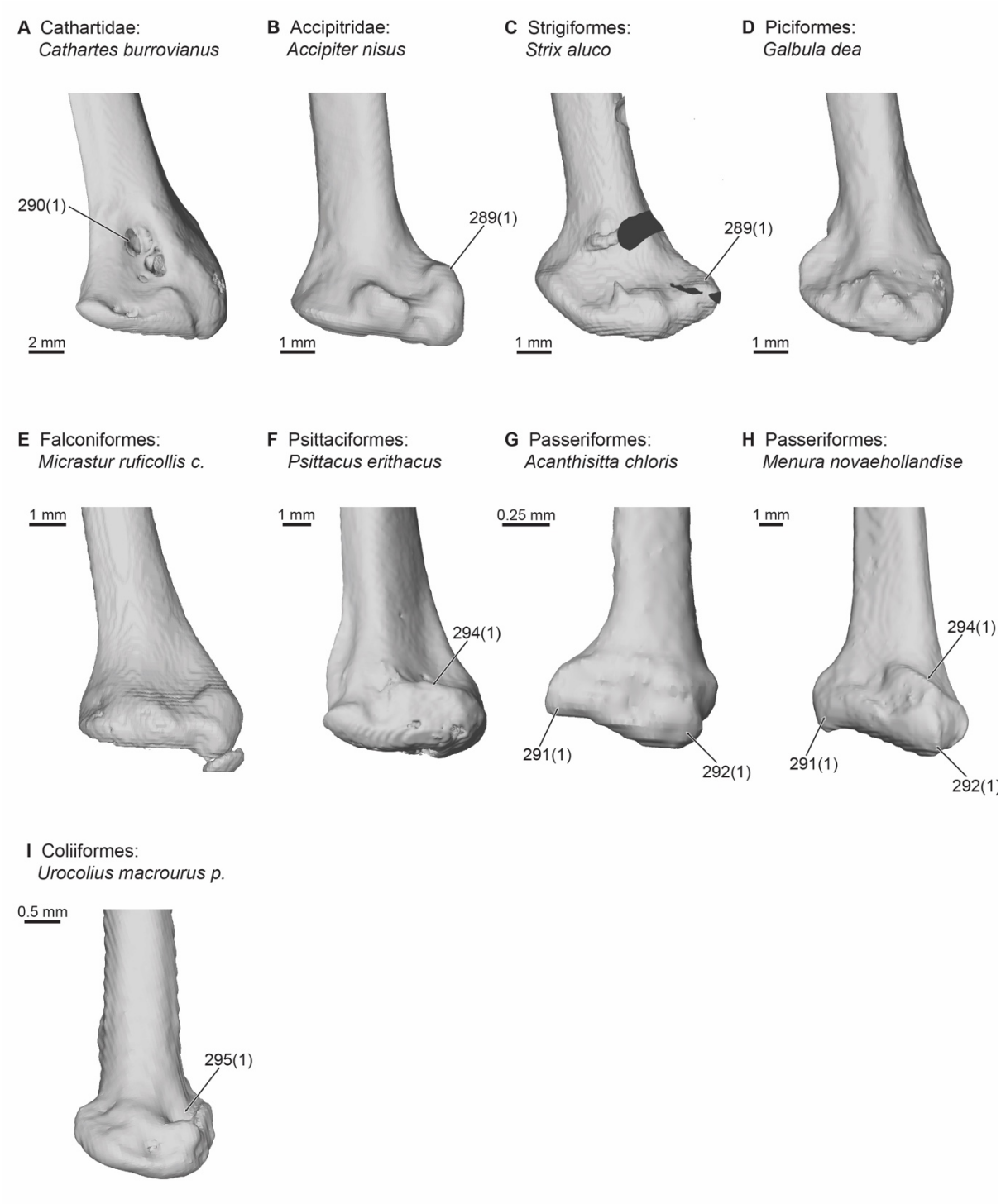


Figure 2.37. Distal portion of left radii in ventral view showing characters 289, 290, 291, 292, 294, 295. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Accipiter nisus* (Eurasian sparrowhawk, NHMUK zoo S/1982.149.1); (C) *Strix aluco* (tawny owl, NHMUK zoo S/2001.38.1); (D*) Galbula dea* (Paradise jacamar, FMNH birds 376705); (E) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (F) *Psittacus erithacus* (African grey parrot, NHMUK zoo S/1992.41.60); (G) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (H) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751); (I) *Urocolius macrourus pulcher* (Blue-naped mousebird, FMNH birds 368959). Numbers denote characters and character states as listed.

290. Radius, ventral, ligamental depression (depression ligamentosa): indistinct/ small depression/ shallow (0); deep depression (1) (Fig. 2.37A).

New character.

The caudal surface of the distal end of the radius bears a marked muscular depression, the depression ligamentosa. This can be delimited ventrally by a prominent and robust ridge. Among Telluraves, this feature (state 1) only observed in Cathartiformes (Fig. 2.27A), in which the pneumatic foramen is located in the medial portion of the depression.

291. Radius, distal end, dorsal portion forming a proximally directed hook: absent (0); present (1).

Mayr (2020, ch. 40), Mayr & Kitchener (2023a, ch. 42), Mayr & Kitchener (2023b, ch. 41), Mayr & Kitchener (2023c, ch. 41).

Terminology and scoring taken from the above cited reference. A hook-like process (state 1) is observed in most Passeriformes (Fig. 2.37G,H) and many extinct taxa like *Parapsittacopes* (Mayr & Kitchener 2022c; fig. 3)*, Primoscens* and *Psittacomimus* (Mayr & Kitchener 2022c; fig. 3). Within Passeriformes and these extinct taxa, the size and shape of this process varies greatly. However, this variation is not recorded in the current study.

292. Radius, distal end, ventral aponeurosis tubercle (tuberculum aponeurosis ventralis) strongly developed and distoventrally protruding: no (0); yes (1).

Mayr (2020, ch. 41), Mayr & Kitchener (2023a, ch. 43), Mayr & Kitchener (2023c, ch. 42).

Terminology and scoring taken from the above cited references. A strongly developed ventral aponeurosis tubercle (state 1) is observed in Passeriformes (Fig. 2.37G, H), where the amount of protrusion of the ventral aponeurosis tubercle is highly variable (most exaggerated in *Myrmornis torquate*) but is not recorded for the current analysis. State 1 is also observed in *Picus*.

293. Radius, radiocarpal articular surface (facies articularis radiocarpalis): indistinct from the tendinous groove (0); crescent shaped basin (1) (Fig. 2.38).

New character.

State 1 is observed in Coraciiformes (Fig. 2.38B) and Piciformes, in which a deep crescent shaped basin in the distal portion of the tendinous groove forming the radiocarpal articular surface (state 1). This facies is generally less distinct (state 0) in other Telluraves.

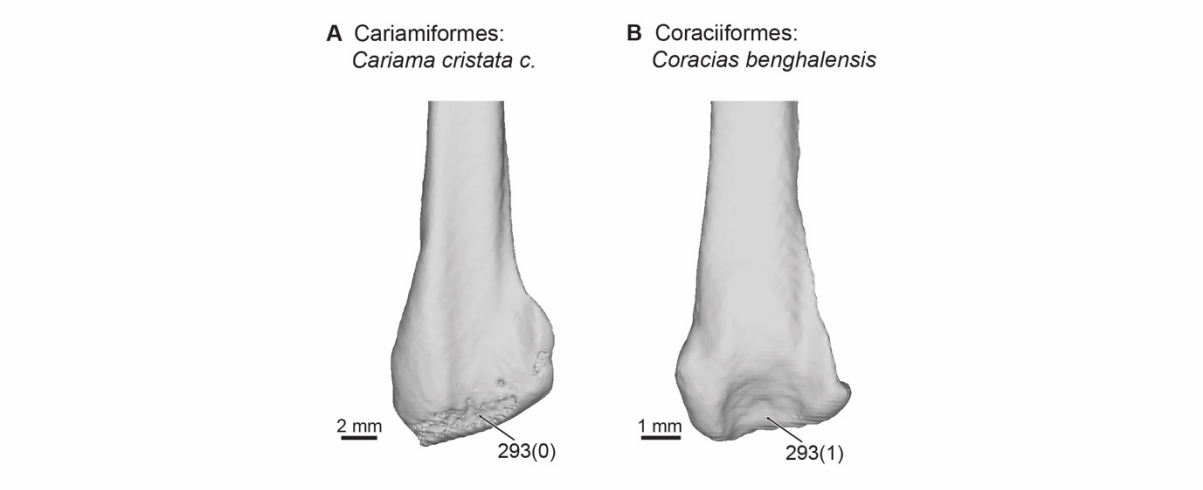


Figure 2.38. Distal part of left radii in dorsal view showing character 293. (A) *Cariama cristata cristata* (Red-legged seriema, FMNH birds 105635); (B) *Coracias benghalensis* (Indian roller, NHMUK zoo S/1987.19.15). Numbers denote characters and character states as listed.

294. Radius, ulna articular surface (facies articularis ulnaris), forming a large marked shelf on lateral side: absent (0); present (1) (Fig. 2.37).

New character.

An example of the ulna articular surface forming a large marked shelf on the lateral surface is observed in *Menura* (Fig. 2.37H).

295. Radius, ulna articular surface (facies articularis ulnaris) indented making a deep basin: absent (0); present (1) (Fig. 3.37).

New character.

A deep, indented basin within the ulna articular surface is only present Coliiformes (Fig. 2.37I).

296. Radius, extra tubercle above tuberculum aponeurosis ventralis: absent (0); present (1).

New character.

297. Radius: bowed (slightly curved, sigmoidal) (0); straight (1).

New character.

A bowed radius (state 0) is present in Accipitriformes and Strigiformes.

298. Radius flattened along the medial margin (dorsoventrally flattened, craniocaudally wider shaft): absent (0); present (1).

New character.

299. Radius, osseous arch on proximal end of shaft: absent (0); present (1).

Ksepka *et al.* (2019, ch. 67), Mayr & Kitchener (2023d, ch. 11).

The osseous arch is a bony arch located proximally on the shaft of the radius (state 1) only observed in Strigiformes. It is likely that this arch protected blood vessels and nerves (proprioceptive organ) from pressure from the flight muscles according to the flight style of owls (parachuting hunting style) and allows for a greater mass of flight muscles (Lo Coco *et al.* 2020). According to Peters (1992) the Eocene owl *Palaeoglaux perrierensis* has two small elevations 5 mm apart with a slightly flattened space between them and suspects that there might have been an ossified arch originally, that was broken. This is in agreement with the some of the extant owl specimens of this analysis where the arch was also broken.

ULNA

300. Ulna, olecranon process: reduced/absent (0); prominent (1) (Fig. 2.39E).

New character.

The olecranon is a large bony prominence at the proximal end of ulna, which articulates with the olecranon fossa of the humerus. It is only reduced in Cariamiformes (state 1; Fig. 2. 2.39E).

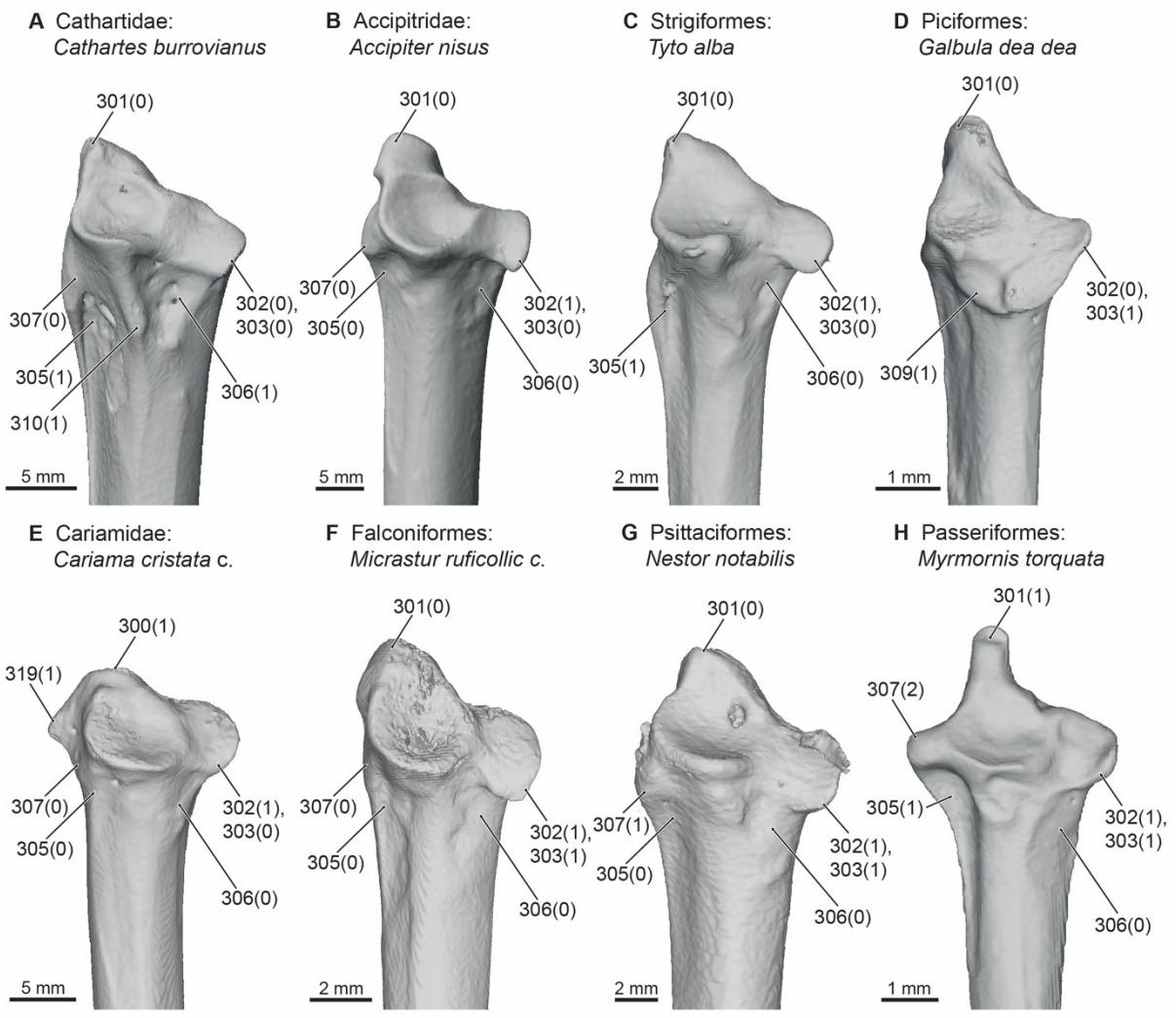


Figure 2.39. Proximal part of left ulnae in cranial view showing characters 300, 301, 302, 303, 305, 306, 309 and 319. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Accipiter nisus* (Eurasian sparrowhawk, NHMUK zoo S/1982.149.1); (C) *Tyto alba* (Barn owl, NHMUK zoo S/1989.22.1); (D) *Galbula dea dea* (Paradise jacamar, FMNH birds 376705); (E) *Cariama cristata cristata* (Red-legged seriema, FMNH birds 105635); (F) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (G) *Nestor notabilis* (Kea, FMNH birds 23530); (H) Myrmornis torquate (Wing-banded antbird, YPM orn 106157). Numbers denote characters and character states as listed.

301. Ulna, olecranon: blunt and rounded (0); narrow, long and sharply projected (1) (Fig. 2.39H).

Modified from Mayr (2004, ch. 19), Bourdon *et al.* (2016, ch. 32), Clarke *et al.* (2009, ch. 44), Mayr (2011, ch. 46), Ksepka *et al.* (2017, ch. 48), Smith *et al.* (2018, ch. 26), Ksepka *et al.* (2019, ch. 68), Mayr (2021, ch. 35), Mayr & Kitchener (2023a, ch. 41).

An exceptionally long and narrow olecranon (state 1) is observed mostly in Passeriformes (Fig. 2.29H) and Piciformes.

302. Ulna, dorsal cotylar process (cotyla dorsalis): continuous with incisura radialis (0); projecting distally (separated) from radial incisure (incisura radialis) (1) (Fig. 3.29A).

New character.

A dorsal cotylar process that is continuous with the incisura radialis (state 0) is present in Accipitriformes such as Cathartidae (Fig. 2.39A).

303. Ulna, dorsal cotylar process size: does not extend past rim of ventral cotyla (0); extends distally past the rim of ventral cotyla (1) (Fig. 3.39).

Modified from Ksepka *et al.* (2011, ch. 48), Ksepka & Clarke (2012, ch. 51).

A dorsal cotyla process that is expanded distally pas the rim of the ventral cotyla is present in only a few Telluraves such as Piciformes (Fig. 2.39D), Falconiformes (Fig. 2.39F), Psittaciformes (Fig. 2.39G) and Passeriformes (Fig. 2.39H).

304. Ulna, ventral cotyle: moderate size (unexpanded offset from olecranon) (0); greatly expanded (into the olecranon) (1).

Mayr (2004, ch.1 8), Mayr *et al.* (2004, ch. 6), Mayr (2005a, ch. 44), Mayr (2006, ch. 52), Zelenkov & Dyke (2008, ch. 13), Ksepka & Clarke (2009, ch. 24), Ksepka & Clarke (2010, ch. 27), Ksepka *et al.* (2011, ch. 49), Mayr (2011, ch. 45), Mayr (2015, ch. 28), Ksepka *et al.* (2017, ch. 49), Ksepka & Clarke (2012, ch. 52), Ksepka *et al.* (2019, ch. 69), Mayr (2020, ch. 37), Mayr (2021, ch. 34), Mayr & Kitchener (2023a, ch. 39), Mayr & Kitchener (2023b, ch. 38), Mayr & Kitchener (2023c, ch. 38).

The ventral cotyle can expand proximally into the olecranon (state 1). This feature is observed in Coliiformes, Trogoniformes, Bucerotiformes and Sandcoleidae.

305. Ulna, impression of m. brachialis (impressio brachialis): shallow (0); deeply excavated (1) (Fig. 2.39).

New character.

There is a considerable amount of variation in the depth, size and shape of the impression brachialis throughout Telluraves, a deeply excavated impression of the m. brachialis (state 1) is

mostly present Passeriformes (Fig. 2.39H), Coliiformes and Cathartidae (Fig. 2.39A) in which pneumatisation occurs within the impression.

306. Ulna, radial incisure (incisura radialis): indistinct (0); distinct concave pit (1).

New character.

The radial incisure (incisura radialis) can be defined as a concave pit or face distal to the cotyla ventralis of the ulna. In Cathartidae (Fig. 2.39A), Pandionidae and Accipitridae (Fig. 2.39B) the concave basin is deep and distinct (state 1). The basin in Cathartiformes and Pandionidae is also delimited medially by a prominent crest (Migotto 2013). However, that distinction has not been recorded in the present study.

307. Ulna, ventral collateral ligamental tubercle (tuberculum ligamenti collateralis ventralis): shallow/absent/not projecting (0); moderately projecting (1); strongly protruding (2) (Fig. 2.39).

Modified from Mayr *et al.* (2003, ch. 42), Mayr (2005a, ch. 45), Mayr (2006, ch. 53), Mayr *et al.* (2010, ch. 45), Mayr (2015, ch. 29), Ksepka *et al.* (2019, ch. 72), Mayr (2020, ch. 39), Raimon *et al.* (2020. ch. 24), Mayr (2022, ch. 31), Mayr & Kitchener (2023c, ch. 40).

Mayr & Kitchener (2023) original version of this character combines two features that can vary independently of each other: "olecranon very long, narrow, and pointed; tuberculum ligamenti collateralis ventralis strongly protruding". A long and narrow olecranon (see Ch. 301) may not necessarily have an extended ventral collateral ligamental tubercle (TLC). According to Mayr & Manegold (2006) a well-developed and strongly developed TLC (state 2) is present in suboscine passerines (Fig. 2.39H) but not oscines. An additional state is added to account for the variability in size throughout Telluraves (state 1).

308. Ulna, dorsal view, very deep pit distal to rim of cotyla ventralis: absent (0); present (1) (Fig. 2.40).

Mayr (2013, ch. 16), Ksepka *et al.* (2019, ch. 71).

In some members of Passeriformes there is a very shallow pit at the insertion area of musculus biceps brachii (state 1; Fig. 2.40). This pit, which was considered to be a characteristic feature of

Passeriformes by (Ballmann 1969a), is very distinct in oscines but shallow or absent in most examined Suboscines.

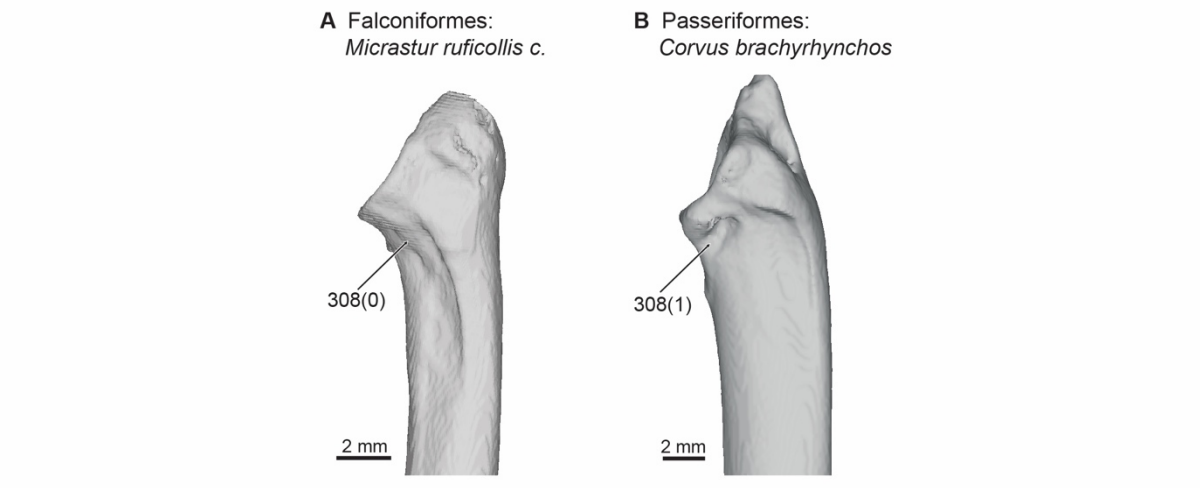


Figure 2.40. Proximal part of right ulnae in ventral view showing character 307. (A) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (B) *Corvus brachyrhynchos* (American crow, FMNH birds 441515). Numbers denote characters and character states as listed.

309. Ulna, oblique mediodistal ridge extending from distal end of dorsal cotyle: absent (0), present (1) (Fig. 2.39D).

Mayr (2020, ch. 38), Mayr & Kitchener (2023a, ch. 40), Mayr & Kitchener (2023c, ch. 39).

An oblique mediodistal ridge extending from distal end of dorsal cotyle is only present in *Galbula* (Fig. 2.39D) and *Todus*.

310. Ulna, proximal end, distinct elongate, ridge-like elevation along midline of shaft (tuberculum bicipitale ulnare), distal of ventral cotyle: absent (0), present (1) (Fig. 2.39A).

Mayr *et al.* (2003, ch. 41).

A distinct ridge-like elevation midline of shaft distal to the ventral cotyle is only present in in *Cathartes burrovianus* (Fig. 2.39A) and outgroup taxa.

311. Ulna, quill knobs (papillae remigales caudalus): absent/very faint (0); prominent knob-like projections (1) (Fig. 2.41).

Clarke *et al.* (2009, ch. 43), Bourdon *et al.* (2016, ch. 31), Ksepka *et al.* (2017, ch. 50), Smith *et al.* (2018, ch. 25), Ksepka *et al.* (2019, ch. 70), Raimon *et al*. (2020. ch. 28).

The caudodorsal surface of the ulna features small, rounded projections, the papillae remigales caudalus or quill knobs, and associated transversely oriented troughs, papillae remigales ventralis, which are not always present. Papillae remigales are associated with the attachment of the follicles of the remiges and is thought to be an indication of strongly-attached forelimb feathers and possibly indicate the secondary remiges in a given specimen (Turner *et al.* 2007; Zelenitsky *et al.* 2012). Hieronymus (2015) concluded that quill knobs may actually serve different purposes, that although they are frequently cited as correlating to feather attachment, their link to overall wing shape is problematic and is likely driven by divergent trends in different clades of neoavain birds (homoplasy of prominent ulnar papillae rather than functional signal). There is a considerable amount of variation in shape, size, position, and number of quill knobs throughout Telluraves. This variation has not been recorded in the current study.

312. Ulna, papillae remigalis ventralis: absent/very faint (0); shallow basins/troughs offset from papillae remigalis caudalus (1) (Fig. 2.41).

New character.

See ch. 311 discussion.

313. Ulna, visible secondary remigial papillae: absent (0); present (1) (Fig. 2.41).

New character.

See ch. 311 discussion.

314. Ulna, radial depression (depressio radialis): shallow depression (0); deep and pit-like (1) (Fig. 2.42).

Mayr & Clarke (2003, ch. 84), Mayr (2005b, ch. 60), Ksepka *et al.* (2011, ch. 50), Ksepka & Clarke (2012, ch. 53).

A deep and pit-like radial depression (state 1) is present in a few extant Telluraves for example *Cathartes burrovianus* (Fig. 2.42A).

315. Ulna, caudal surface of distal end with marked depression distal of tendinal incisure: no (0), yes (1) (Fig. 2.43).

Mayr (2011, ch. 47).

The caudal surface of distal end with a marked depression distal of tendinal incisure is present in Falconiformes (Fig. 2.43).

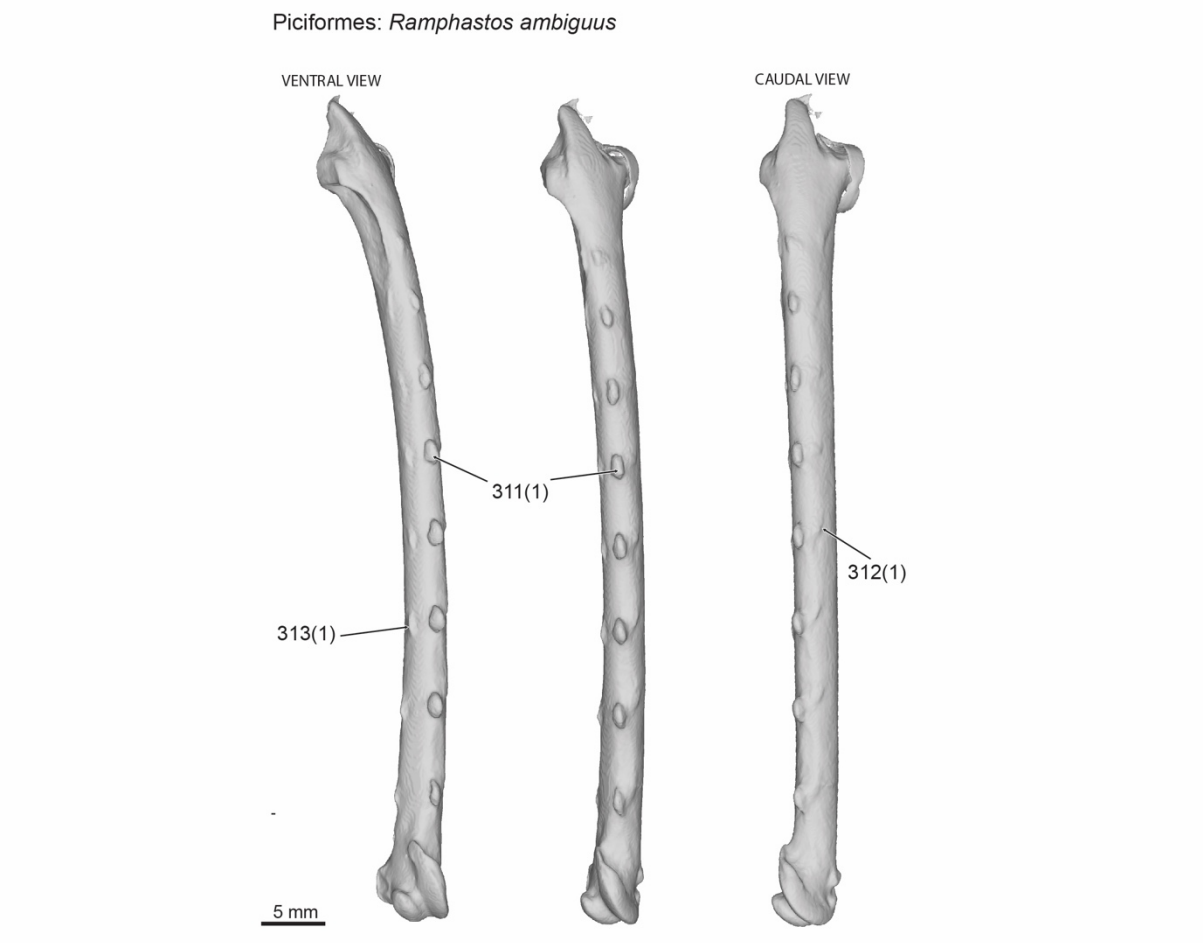


Figure 2.41. Right ulnae showing characters 311 and 313. *Ramphastos ambiguous* (Yellow-throated toucan, NHMUK zoo S/2002.21.2). Numbers denote characters and character states as listed.

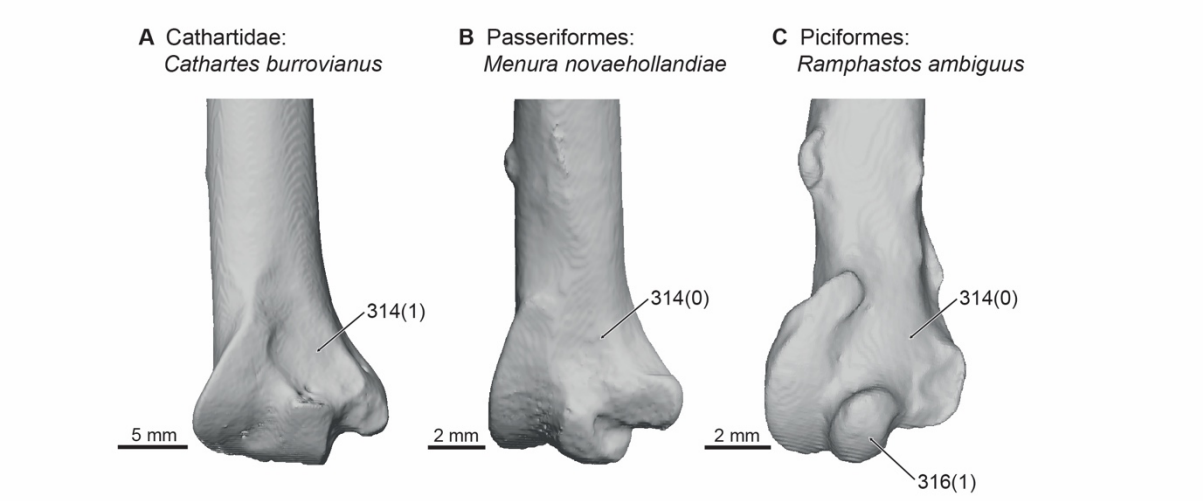


Figure 2.42. Distal part of left ulnae in ventral view showing characters 314 and 315. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751); (C) *Ramphastos ambiguous* (Yellow-throated toucan, NHMUK zoo S/2002.21.2). Numbers denote characters and character states as listed.

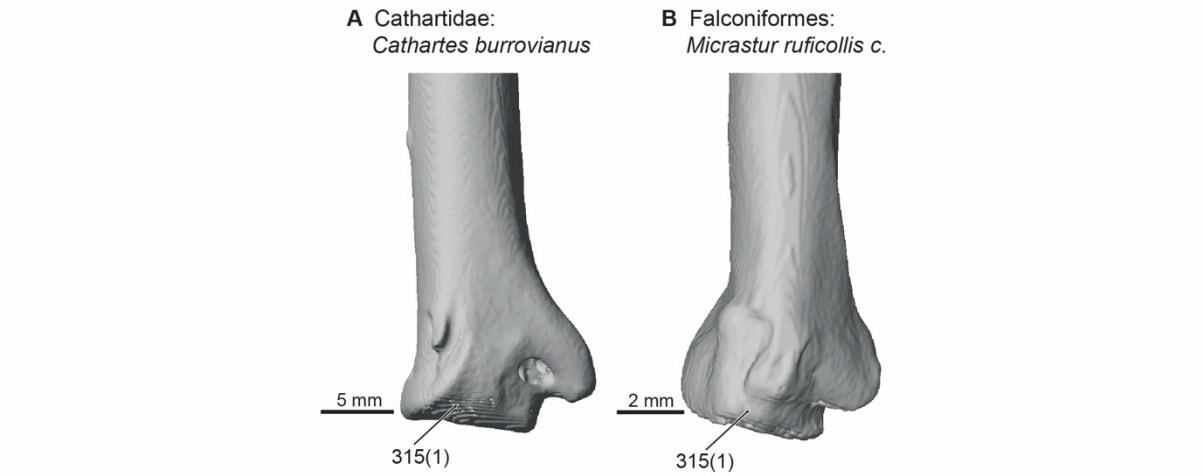


Figure 2.43. Distal part of right ulnae in dorsal view showing character 315, right ulna in dorsal view. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226). Numbers denote characters and character states as listed.

316. Ulna, very large and prominent ventral condyle (condylus ventralus ulnaris): absent (0); present (1) (Fig. 2.42).

New character.

A very large and prominent ventral condyle is present in Piciformes (Fig. 2.42C).

317. Ulna length compared to tarsometatarsus length ratio: ulna shorter than tarsometatarsus (0); ulna longer than tarsometatarsus (1).

Modified from Smith *et al.* (2018, ch. 27), Hieronymus *et al.* (2019, ch. 16).

In the above references a second state "ulna subequal to tarsometatarsus" is used, where the coding was based on "k-means clustering" of the ulna to tarsometatarsus ratio. To simplify I have removed that state as it did not appear to have any significance. Measurements of tarsometatarsus and ulna in Table S1.5.

318. Ulna very short, measuring only about 3/4 of the length of the humerus: no (0), yes (1).

Mayr & Kitchener (2022a, ch. 22).

The ulna in all Telluraves is longer than the humerus and is considered plesiomorphic within neornithine. See Table S1.5 for measurements of ulna and humerus.

319. Ulna, humeral trochlea (trochlea humerus: absent (0); present (large) (1) (Fig. 2.39E).

New character.

A humeral trochlea (state 1) is present in Cariamiformes (Fig. 2.39E)

RADIAL CARPAL

320. Radial carpal, sulcus for the tendon of musculus extensor longus alulae: absent or weakly developed (0); well-defined and narrow (1).

Mayr (2015, ch. 36), Ksepka *et al.* (2017, ch. 52), Ksepka *et al.* (2019, ch. 74), Mayr (2020, ch. 48), Mayr (2021, ch. 42), Mayr (2022, ch. 37), Mayr & Kitchener (2023a, ch. 53), Mayr & Kitchener (2023b, ch. 52), Mayr & Kitchener (2023c, ch. 51).

Where radiale were unavailable for selected specimens of this study, scores for those taxa were based on (Mayr 2014). A proximodistally wide radiale, with well-defined, narrow sulcus for the

tendon of musculus extensor longus alulae (state 1) is considered a synapomorphy of Picocoraciae (Bucerotiformes + Coraciiformes + Piciformes) (Mayr 2014).

321. Radial carpal, shape in cranial view: narrower proximodistally than dorsoventrally (tapers towards dorsal end) (0); dorsal end proximodistally wide (1).

New character. Based on Mayr (2014).

In most Telluraves the radiale narrows in the proximodistally direction (state 0), while in some birds for example Cariamiformes and Falconiformes the dorsal end is wide (more rectangle shaped). See Mayr (2014) for more detail on the comparative morphology of the radiale.

322. Radial carpal, dorsal part of facies articularis radialis forms a marked dorsally projected process: absent (0); present (1).

New character. Based on Mayr (2014).

A marked dorsal projection on the dorsal part of the facies articularis radialis (state 1) is present in all Passeriformes. Scorings based on Mayr (2014) study on the comparative anatomy of the radial carpal bone.

ULNAR CARPAL

323. Ulnar carpal, with crus longum being much longer than crus breve (abbreviated): absent (0); present (1) (Fig. 2.44).

Mayr *et al.* (2003, ch. 45), Mayr (2005a, ch. 49), Clarke *et al.* (2009, ch. 45), Mayr *et al.* (2010, ch. 49), Mayr (2011, ch. 51), Bourdon *et al.* (2016, ch. 33).

A crus longum that is substantially longer than crus breve (state 1) is present in Trogoniformes (Fig. 2.44B) and Psittaciformes.

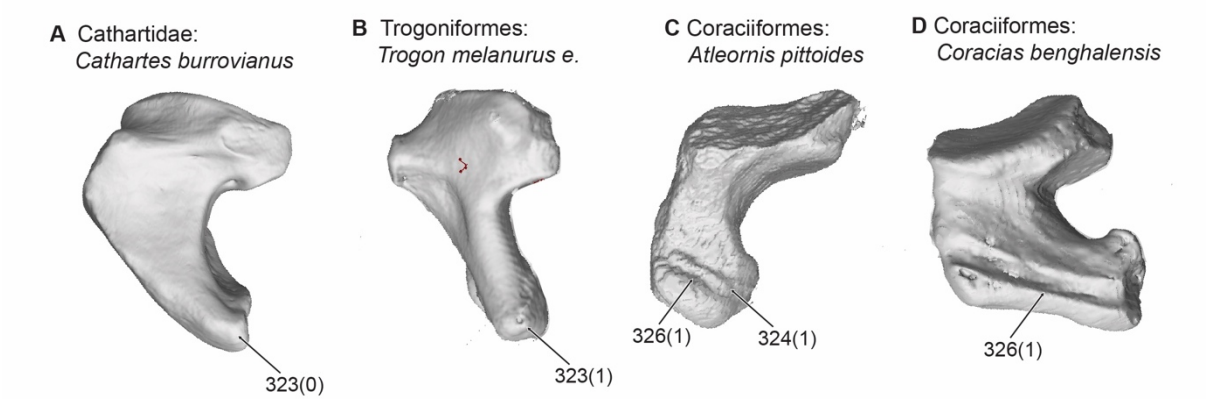


Figure 2.44. Right ulnar carpal in distal view showing characters 323, 324 and 326. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Trogon melanurus eumorphus* (Black-tailed trogon, FMNH birds 290496); (C) *Atelornis pittoides* (Pitta-like ground roller, NHMUK zoo 1870.5.5.10); (D) *Coracias benghalensis* (Indian-roller, NHMUK zoo S/1987.19.15). Numbers denote characters and character states as listed.

324. Ulnar carpal, with crus longum greatly abbreviated: absent (0), present (1) (Fig. 2.44).

Mayr & Clarke (2003, ch. 87), Mayr *et al.* (2003, ch. 46), Mayr (2005a, ch. 50), Mayr (2005b, ch. 63), Mayr (2006, ch. 62), Mayr *et al.* (2010, ch. 50), Mayr (2011, ch. 52).

A greatly abbreviated crus longum (state 1) was originally proposed as a synapomorphy of the taxon (Cuculidae+ Musophagidae) by Hughes (2000). Though this is also seen in a few Telluraves. The above references scored Passeriformes as having an abbreviated crus longum (state 1). Here, this was only found to be true in a few passerines such as *Menura*, *Climacterus* and the Coraciiformes Atleornis pittoides (Fig. 2.44C).

325. Ulnar carpal, tuberculum at area of insertion of ligamentum humerocarpale: absent (0); present (1) (Fig. 2.45).

Mayr & Clarke (2003, ch. 88).

A tuberculum (state 1) is present in *Cathartes burrovianus* (Fig. 2.44A), Accipitridae (Fig. 2.45B) and *Micrastur ruficollis* (Fig. 2.45C).

326. Ulnar carpal, deep ligamental furrow on crus longum: absent (0); present (1) (Fig. 2.44).

New character.

A deep ligamental furrow (state 1) is present in in Coraciiformes (Fig. 2.44C, D).

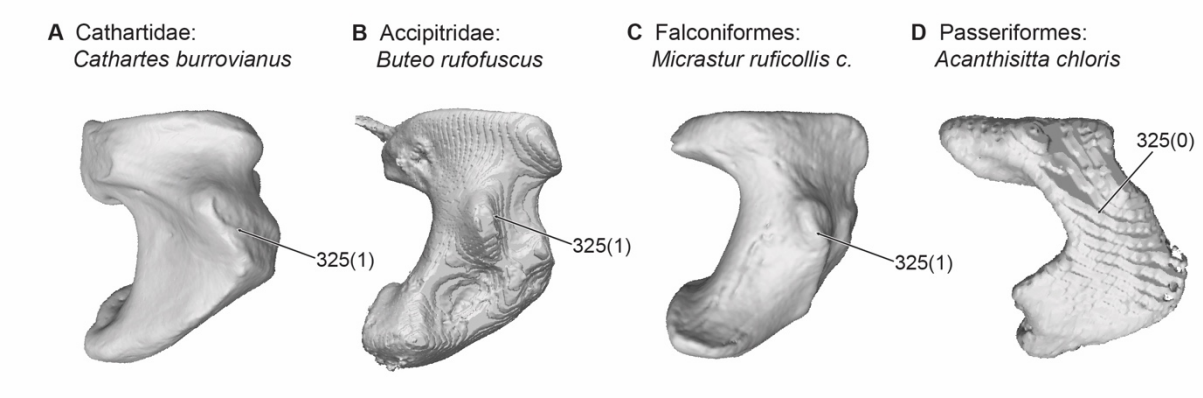


Figure 2.45. Right ulnar carpal in proximal view showing character 325, right ulnare in caudal view. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Buteo rufofuscus* (Jackel buzzard, NHMUK zoo 1862.1.18.1); (C) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (D) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146). Numbers denote characters and character states as listed.

CARPOMETACARPUS

327. Carpometacarpus, processus alularis, position of caudal facet in cranial view: cranial (neutral position) (0); dorsally extended (1); ventrally extended (2) (Fig. 2.46).

New character.

The alular process is made up of two facets that tend to form a saddle shape, in which the more caudal facet can vary in position relative to the ventral facet. All Passeriformes have a ventrally extending "caudal" facet where the aluare process is no longer saddle shaped (state 2: Fig. 2.46D) (see ch. 328). In Cathartidae the processus alularis is more dorsally extended (state 1; Fig. 2.46A), additionally a ridge extends from the caudal to ventral side diagonally, this unique feature has not been accounted for in this study.

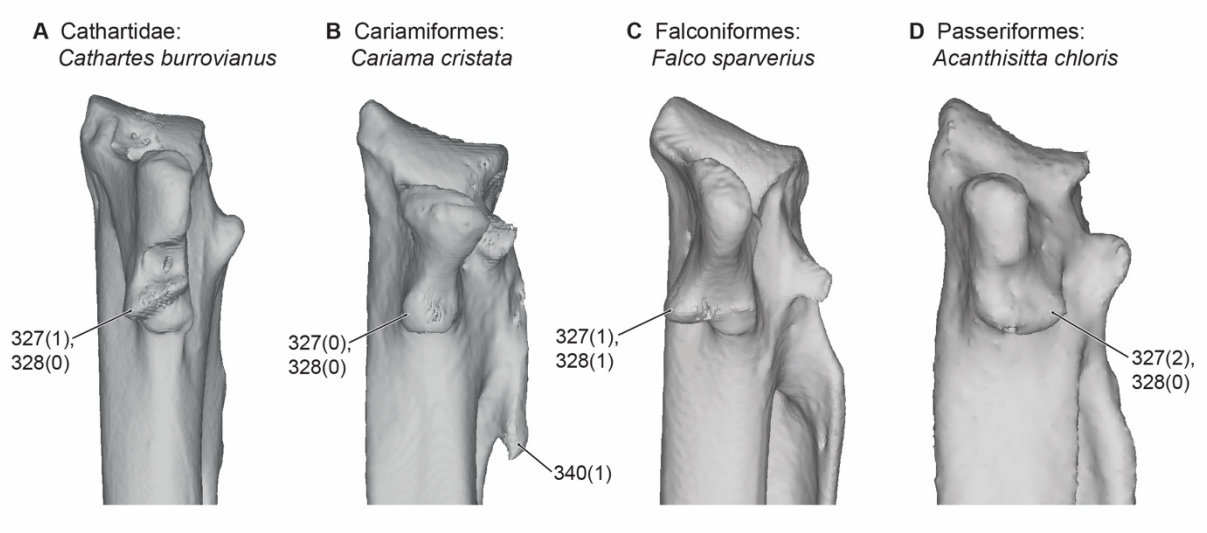


Figure 2.46. Proximal part of right carpometacarpi in cranial view showing characters 327, 328 and 340, proximal portion of right carpometacarpus in cranial view. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Cariama cristata* (Red-legged seriema, FMNH birds 105635); (C) *Falco sparverius* (American kestrel, UMMZ birds 154462); (D) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146). Numbers denote characters and character states as listed.

328. Carpometacarpus, distal surface of facies articularis alularis: markedly convex, ball-shaped (0); saddle-shaped or weakly convex (1) (Fig. 2.46).

Mayr (2016, ch. 25), Mayr & Kitchener (2022a, ch. 26).

See ch. 327 for discussion.

In the above references only Cariamiformes are scored as having a ball shaped articularis alularis (state 0). In the present study Piciformes and Passeriformes are scored as having a ball-shaped processes as well (Fig. 2.46D). The original character by Mayr (2016) is not clear and was only scored for Cariamiformes. The shape of the facies articularis alularis is generally rounded in all birds, so my interpretation of this character could be incorrect as I did not observe this feature specifically in Cariamiformes. The processus extensorius however is unique in Cariamiformes as well as their stem relatives, the extension is directly perpendicular to the x plane of the carpometacarpus giving the appearance of a wide triangle, this has not been made into a new character.

329. Carpometacarpus, alular process (processus alularis), position of distal margin relative to fovea carpalis caudalis: distal (0); in line (1); proximal (2) (Fig. 2.47).

Modified from Steell *et al.* (2023, ch. 18).

In Steell *et al.* (2022) ch.18 the character description had the position of the distal margin relative to the fovea ligamentalis ventralis, a structure that is present throughout Passeriformes, but is absent in most other birds. For this reason, the position of the margin is compared to the proximal region of the caudal carpal fossa (fovea carpalis caudalis).

330. Carpometacarpus, synostosis metacarpalis distalis, ventral view, with deep fossa at distal margin of spatium intermetacarpalis: absent (0); present (1) (Fig. 2.47).

Modified from , Ksepka *et al.* (2019, ch. 83), Steell *et al.* (2022, ch. 51).

A deep fossa within the distal metacarpal synostosis (state 1) is present in *Picus viridis* (Fig. 2.47D) and most oscines except *Menura novaehollandiae*, *Crovus brachyrhynchos* and *Zosterops lateralis.*

331. Carpometacarpus, intermetacarpal process (processus intermetacarpalis): absent or very small (0); present (1) (Fig. 2.48).

Mayr *et al.* (2004, ch. 7), Zelenkov & Dyke (2008, ch. 14), Smith *et al.* (2018, ch. 29), Hieronymus *et al.* (2019, ch. 18), Steell *et al.* (2022, ch. 28).

The intermetacarpal process serves as insertion site of musculus extensor carpi ulnaris, which allows for flexing of the hand, particularly in birds that tend to hover or burst take-offs (Stegmann 1965). The intermetacarpal process is present (state 1) in many Strigiformes, Coliiformes (Fig. 2.48B), Coraciiformes (Fig. 2.48C), Piciformes (Fig. 2.48D) and Passeriformes (Fig. 2.48G, H, I). I observed a small lump of bone in the position of the intermetacarpal process in some taxa, including *Accipiter nisus* and *Micrastur ruficollis* which was scored as absent in the present study (state 0). A small process is also observed in some Eocene trogoniform taxa like *Eotrogon* (Mayr et al. 2023, fig. 6f, g), this bird has been scored as (0).

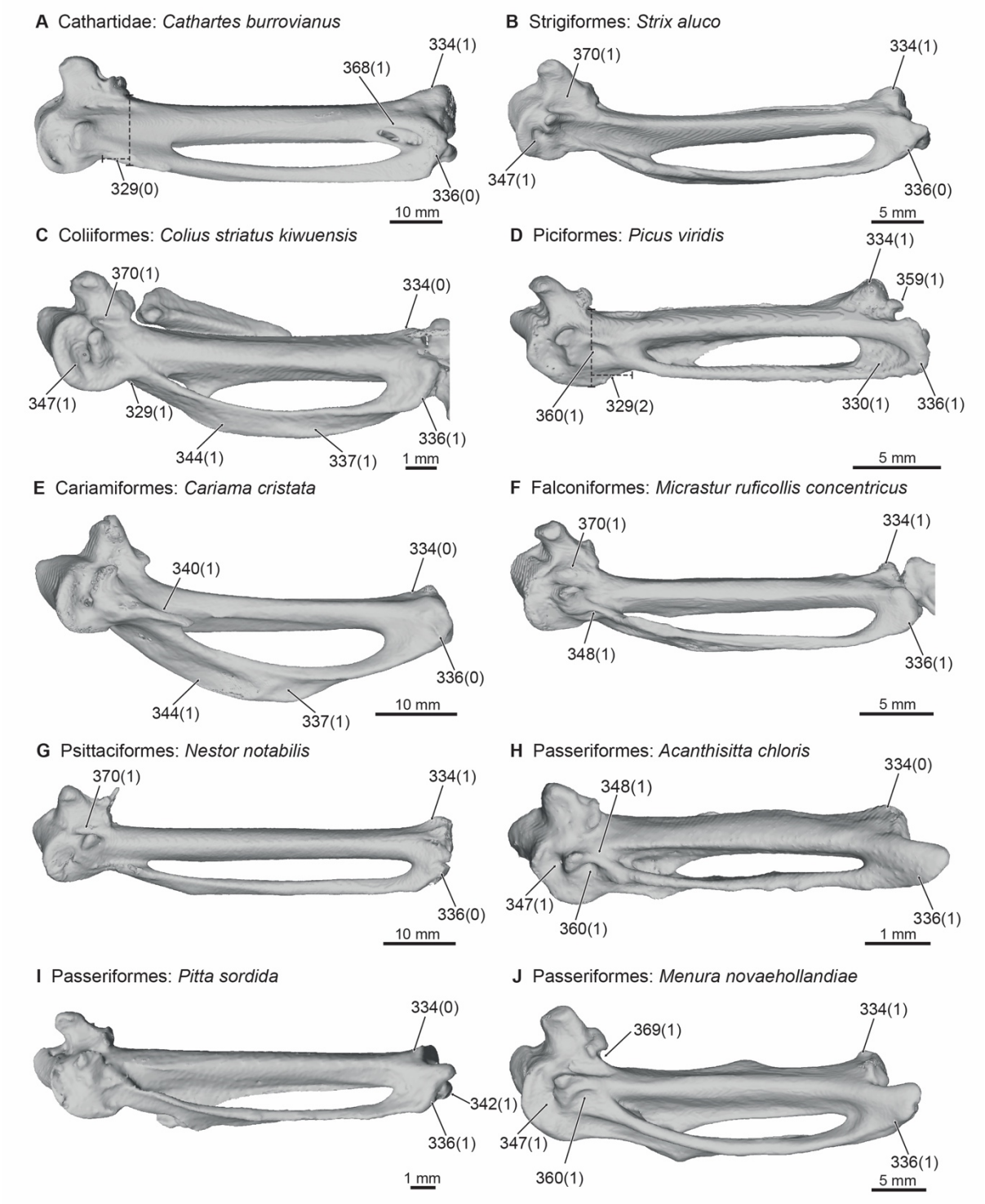


Figure 2.47. Left carpometacarpi in ventral view showing characters 329, 330, 334, 336, 337, 340, 342, 344, 347, 348, 359, 360, 368 and 370. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Strix aluco* (Tawny owl, NHMUK zoo S/2001.38.1); (C) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (D) *Picus viridis* (European green woodpecker, NHMUK zoo S/1982.5.1); (E) *Cariama cristata* (Red-legged seriema, FMNH birds 105635); (F) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (G) *Nestor notabilis* (Kea, FMNH birds 23530); (H) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (I) *Pitta sordida* (Western hooded pitta, NHMUK zoo S/1956.20.14); (J) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751).

332. Carpometacarpus, intermetacarpal process: under-developed (0); well-developed, contacting or nearly contacting minor metacarpal (os metacarpale minus) (1); well-developed, fused with minor metacarpal (2) (Fig. 2.48)

Mayr *et al.* (2003, ch. 44), Mayr (2004, ch. 22), Mayr *et al.* (2004, ch. 19), Mayr (2005a, ch. 47), Mayr (2006, ch. 58), Clarke *et al.* (2009, ch. 47), Ksepka & Clarke (2009, ch. 25), Ksepka & Clarke (2010, ch. 28), Mayr *et al.* (2010, ch. 47), Mayr (2011, ch. 49), Mayr (2013, ch. 17), Mayr (2015, ch. 33), Bourdon *et al.* (2016, ch. 35), Ksepka *et al.* (2017, ch. 55), Smith *et al.* (2018, ch. 30), Hieronymus *et al.* (2019, ch. 19), Ksepka *et al.* (2019, ch. 77), Mayr (2020, ch. 45), Mayr (2021, ch. 39), Mayr (2022, ch. 34), Steell *et al.* (2022, ch. 29), Mayr & Kitchener (2023a, ch. 50), Mayr & Kitchener (2023b, ch. 49), Mayr & Kitchener (2023c, ch. 49).

A fused minor metacarpal and intermetacarpal process (state 2) was considered a characteristic feature in Passeriformes (Fig. 2.48G, H, I), however it is also observed in Piciformes (Fig. 2.48D). The intermediate state where the process is well developed but not completely fused to the minor metacarpal (state 1) is observed in Coraciiformes (Fig. 2.48C) and Coliiformes (Fig. 2.48B).

333. Carpometacarpus, intermetacarpal process, caudal margin, if fused: does not protrude or only slightly protrudes beyond caudal edge of proximal part of metacarpal III (os metacarpale III) (0); protrudes clearly beyond caudal edge of metacarpal III (os metacarpale III) (1) (Fig. 2.48).

Steell *et al.* (2022, ch. 30).

An example of state 1 in Figure 2.48D.

334. Carpometacarpus, metacarpal II, cranial margin of craniodistal region in relation to proximal region: approximately level (0); moderately expanded cranially (1) (Fig. 2.47).

Steell *et al.* (2022, ch.37).

An expanded cranial margin (state 1) is not an easily discernible feature throughout Telluraves. It would appear that most birds have some amount of expansion of the distal region but in some birds, it is flat or level (state 0) like in *Cariama cristata* (Fig. 2.47E), *Colius s. kiwuensis* (Fig. 2.47C) and according to Steell *et al.* (2022), suboscines.

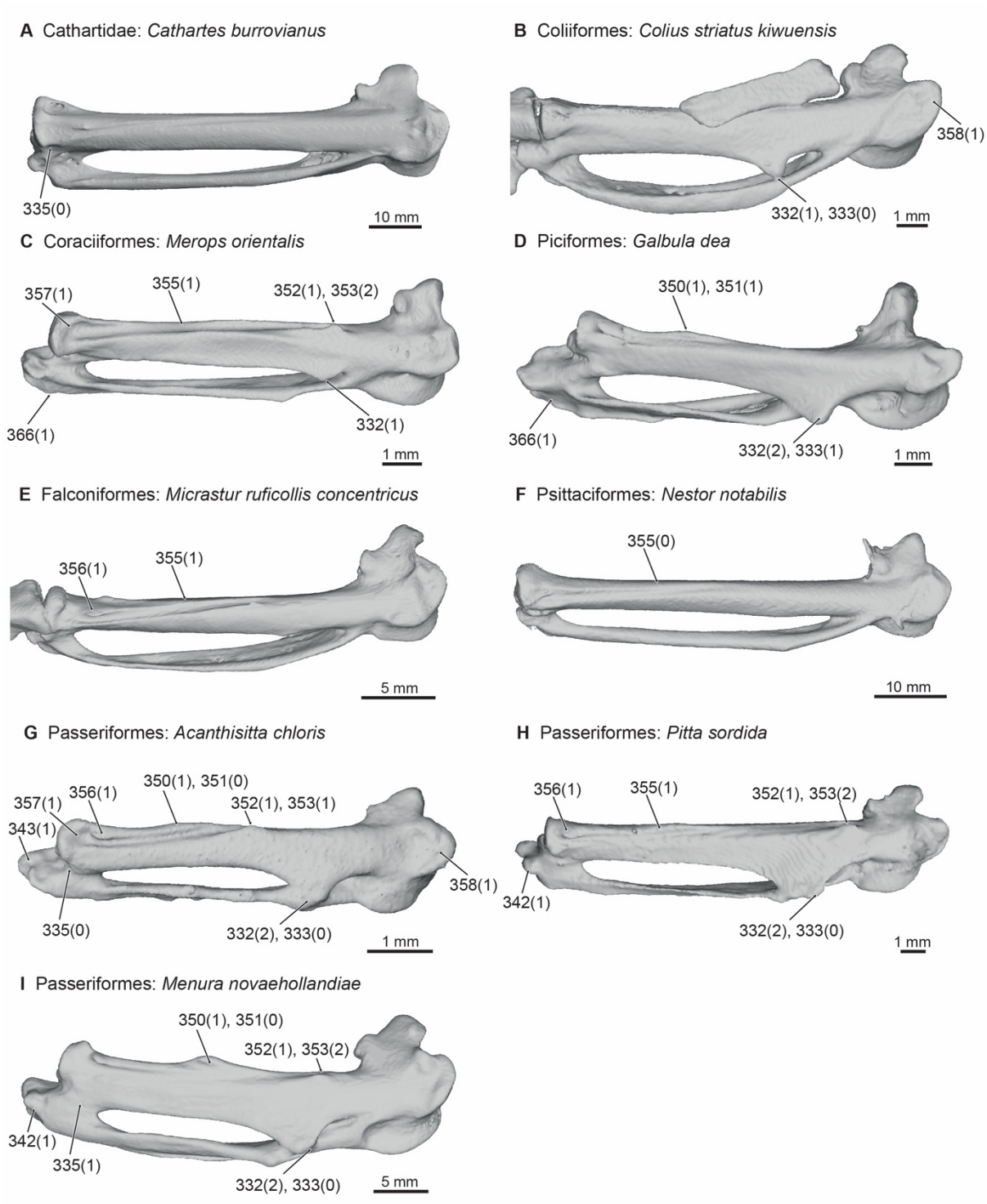


Figure 2.48. Left carpometacarpi in dorsal view showing characters 332, 333, 335, 342, 343, 350, 351, 352, 353, 355, 356, 357, 358 and 366. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (C) *Merops orientalis* (Asian green bee-eater, UMMZ birds 216577); (D) *Galbula dea* (Paradise jacamar, FMNH birds 376705); (E) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (F) *Nestor notabilis* (Kea, FMNH birds 23530); (G) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (H) *Pitta sordida* (Western hooded pitta, NHMUK zoo S/1956.20.14); (I) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

335. Carpometacarpus, metacarpal II, dorsal surface of caudodistal region: protrudes dorsally (0); is planar (1) (Fig. 2.48).

Steell *et al.* (2022, ch.38)

Manegold (2008) suggested that state 0 is plesiomorphic and state 1 is an apomorphy for oscines (Fig. 2.48I). State 1 was also observed in Piciformes and Cariamiformes in this study.

336. Carpometacarpus, metacarpal II and III, relative distal projection: subequal (0); metacarpal III projects substantially beyond metacarpal II (1) (Fig. 2.47).

Mayr (2004, ch. 24), Mayr *et al.* (2004, ch. 22), Mayr (2005a, ch. 48), Mayr (2006, ch. 59), Clarke *et al.* (2009, ch. 50), Ksepka & Clarke (2009, ch. 26), Mayr *et al.* (2010, ch. 48), Ksepka & Clarke (2010, ch. 29), Mayr (2011, ch. 50), Mayr (2015, ch. 35), Bourdon *et al.* (2016, ch. 38), Ksepka *et al.* (2017, ch. 57), Smith *et al.* (2018, ch. 32), Hieronymus *et al.* (2019, ch. 21), Ksepka *et al.* (2019, ch. 79), Mayr (2020, ch. 47), Mayr (2021, ch. 37), Mayr (2021, ch. 41), Mayr (2022, ch. 36), Steell *et al.* (2022 ch. 46), Mayr & Kitchener (2023a, ch. 52), Mayr & Kitchener (2023b, ch. 51).

There are discrepancies in scorings between the above cited references. In Ksepka *et al.* (2019) Strigiformes are scored as having a distally-projected metacarpal III (state 1), likely because the articulation facet for digit minoris (digitalis II) is large and extended. In Mayr *et al.* (2023a,b) Strigiformes are scored as instead as state 0, but Trogoniformes as state 1. However, Trogoniformes show the same morphology as in Strigiformes, in which the articulation facet for digit minoris (digitalis II) is large and extended. Here, I scored both Strigiformes (Fig. 2.47B) and Trogoniformes as state 0 and Leptosomiformes, Bucerotiformes, Piciformes (Fig. 2.47D). Coraciiformes and Passeriformes (Fig. 2.47H,I, J) as state 1.

337. Carpometacarpus, metacarpal III, intermetacarpl space: straight, narrow intermetacarpl space (0); bowed (concave dorsally), wide intermetacarpl space (1) (Fig. 2.47).

Mayr & Clarke (2003, ch. 85), Mayr *et al.* (2003, ch. 43), Mayr (2005a, ch. 46), Mayr (2005b, ch. 61), Mayr (2006, ch. 56), Zelenkov & Dyke (2008, ch. 15), Clarke *et al.* (2009, ch. 52), Ksepka & Clarke (2010, ch. 30), Ksepka *et al.* (2011, ch. 53), Mayr (2011, ch. 48), Mayr *et al.* (2010, ch. 46), Mayr (2013, ch. 19), Ksepka & Clarke (2012, ch. 56), Mayr (2015, ch. 31), Bourdon *et al.* (2016, ch. 39), Mayr (2016, ch. 22), Smith *et al.* (2018, ch. 31), Hieronymus *et al.* (2019, ch. 20), Mayr (2020, ch. 43), Mayr & Kitchener (2022a, ch. 23), Steell *et al.* (2022, ch. 26), Mayr & Kitchener (2023a, ch. 45), Mayr & Kitchener (2023b, ch. 44), Mayr & Kitchener (2023c, ch. 44).

The most exaggerated bowed shaped metacarpal III (state 1) is observed in Coliiformes (Fig. 2.47C) and Cariamiformes (Fig. 2.47E). There are more intermediate forms of bowing observed in Trogoniformes and Bucerotiformes, they have been scored as (1), same as in the above citied refences.

338. Carpometacarpus, metacarpal III, ventral edge: smooth/no protrusions (0); distinct protrusions causing undulated edge (1) (Fig. 2.49).

Mayr (2006, ch. 60), Clarke *et al.* (2009, ch. 54), Bourdon *et al.* (2016, ch. 41), Steell *et al.* (2022, ch. 27).

An undulating ventral edge of the metacarpal III is present in Bucerotiformes (Fig. 2.49C) and some members of Passeriformes (Fig. 2.46E).

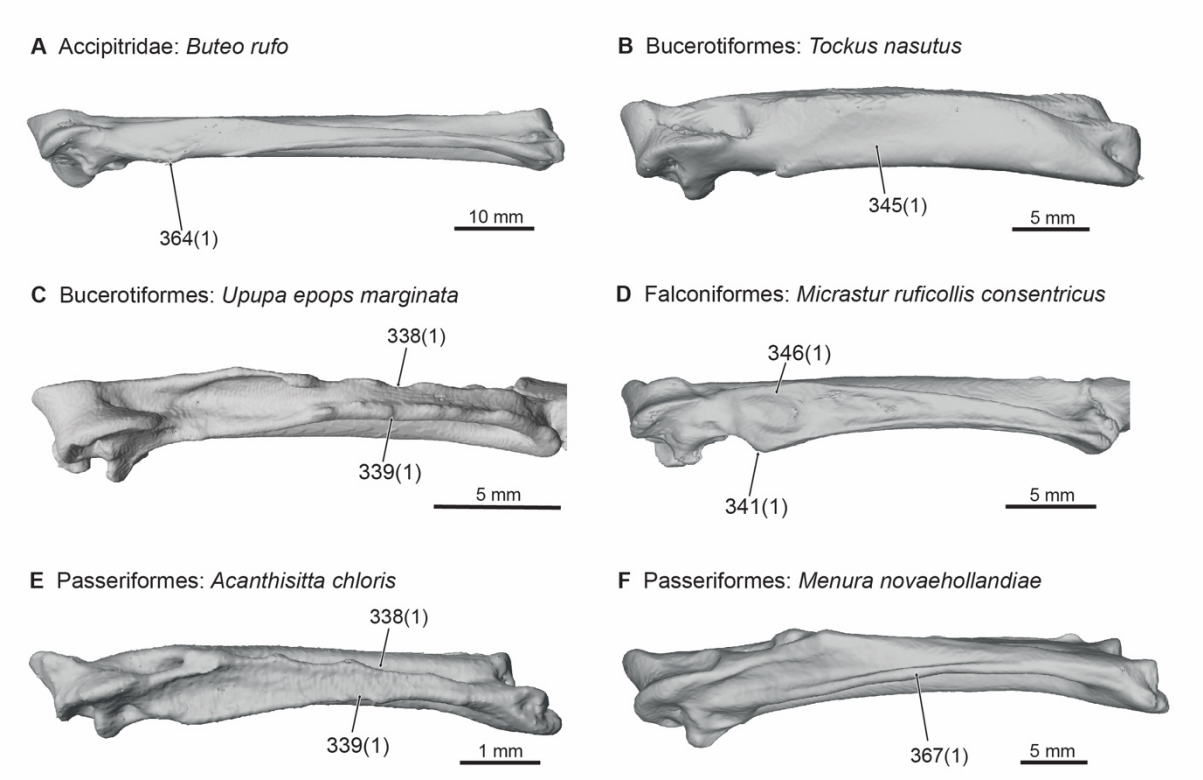


Figure 2.49. Left carpometacarpi in caudal view showing characters 338, 339, 341, 345, 346, 364 and 367. (A) *Buteo rufofuscus* (Jackel buzzard, NHMUK zoo 1862.1.18.1); (B) *Tockus nasutus* (African grey hornbill, NHMUK zoo S/1989.2.2); (C) *Upupa epops marginata* (Madagascar hoopoe, FMNH birds 352821); (D) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (E) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (F) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

339. Carpometacarpus, metacarpal III, dorsal edge: smooth/no protrusions (0); distinct one or multiple protrusions (1).

Steell *et al.* (2022, ch.31.)

An undulating dorsal edge of the metacarpal III is present in Bucerotiformes (Fig. 2.49C) and some members of Passeriformes (Fig. 2.46E).

340. Carpometacarpus, metacarpal III, ventral surface, tuberculum intermetacarpalis: absent (0); present (1) (Fig. 2.46).

Mayr (2016, ch. 24), Mayr & Kitchener (2022a, ch. 24).

A portion of trochlea carpalis between processus pisiformis and the metacarpal III is distinctly raised and form the intermetacarpal tubercle (state 1) in Cariamiformes (Fig. 2.46B).

341. Carpometacarpus, metacarpal III, proximal end, caudal view, ventrally protruding flange on ventral edge: absent (0); present (1) (Fig. 2.49).

Mayr (2004, ch. 23), Mayr *et al.* (2004, ch. 20), Mayr (2006, ch. 61), Clarke *et al.* (2009, ch. 48), Ksepka & Clarke (2009, ch. 27), Ksepka & Clarke (2010, ch. 31), Mayr (2013, ch. 20), Bourdon *et al.* (2016, ch. 36), Ksepka *et al.* (2017, ch. 59), Ksepka *et al.* (2019, ch. 81), Mayr (2022, ch. 33), Mayr & Kitchener (2022a, ch. 25).

State 1 is present in for example Falconiformes (Fig. 2.46D).

342. Carpometacarpus, ventral view, "finger-like" process (processus craniodistalis) projecting from cranio-distal margin of metacarpal III and clearly separated from the articulation facet for digit III: absent (0); present (1) (Fig. 2.48).

Ksepka *et al.* (2017, ch. 58), Ksepka *et al.* (2019, ch. 80), Steell *et al.* (2022, ch. 49).

The processus craniodistalis (sensu Steell et al. 2022; state 1) is considered an apomorphy of suboscines (Manegold 2008). Note that this "finger-like" process (sensu Mourer-Chauviré *et al.* 1989) is not the articulation facet for digit III as seen in other birds. In subocines the "finger-like" process is clearly set off from the rest of the distal end of mt III and protrudes cranially off the articular facet for digit III (Fig. 2.48H, I). It is clear that this process like facet serves a different

function as it inserts into digit II and not digit III, whether this is the case for oscines, it is not described or studied.

343. Carpometacarpus, metacarpal III, dorsal view, craniodistal edge clearly extends further distally than caudodistal edge: absent (0); present (1).

Raimon et al (2020, ch. 31), Steell *et al.* (2022, ch. 48).

Scorings taken from the above citied references. See *Acanthisitta chloris* Figure 2.48I for example.

344. Carpometacarpus, metacarpal III, orientation of proximal part: faces caudally (0); ventrally deflected where the caudal surface is visible in ventral view (1) (Fig. 2.47C, E).

Modified from Mayr (2005b, ch. 62), Mayr & Clarke (2003, ch. 86), Steell *et al.* (2022, ch. 24).

345. Carpometacarpus, metacarpal III: tapering in width distally (0); distal end of metacarpal III dorsoventrally wide (more or less equal width of mt III from proximal to distal end) (1) (Fig. 2.49B).

Modified from Mayr (2004, ch. 25).

In Mayr (2004, ch. 25) metacarpal III is described as being "strap-like" in some birds, which likely means that the mt III is equal in width from the distal to proximal ends (state 1, here). In Mayr's (2004) version of this character the strap-like mt III is then described as also being "more or less strongly tilted dorso ventrally". Here, this second aspect is already in a separate character (Ch. 344). A more or less equal width of mt III from proximal to distal end (state 1) is observed in Bucerotiformes (Fig. 2.49B) and Piciformes.

346. Carpometacarpus, sulcus m. flexor digiti III, proximal margin: barely or not distinguishable (0); clearly defined (1) (Fig. 2.49D).

Steell *et al.* (2022, ch.23).

A clearly defined sulcus m. flexor digiti III (state 1) is observed in Cavitaves, Passeriformes, and Falconiformes (Fig. 2.49D).

347. Carpometacarpus, fossa infratrochlearis, deeply recessed proximal to proc. pisiformis: absent (0); present (1) (Fig. 2.47).

Steell *et al.* (2022, ch. 15), Mayr & Kitchener (2023a, ch. 46), Mayr & Kitchener (2023b, ch. 45), Mayr & Kitchener (2023c, ch. 45).

A deep fossa infratrochlearis (state 1) was originally used in Steell *et al.* (2022) for Passeriformes (Fig. 2.47H) but it applies across Telluraves and is observed in many Coraciiformes (Fig. 2.47C) as well, where it can be exceptionally deep, though in a more caudal position from the processus pisiformis (not recorded in the present study). In some birds like Cariamiformes and *Acanthisitta* a large foramen is observed within the fossa.

348. Carpometacarpus, ventral view, distinct ridge from the caudal end of metacarpal III to the processus pisiformis: absent (0), present (1).

Mayr (2006, ch. 57), Clarke *et al.* (2009, ch. 53), Bourdon *et al.* (2016, ch. 40), Ksepka *et al.* (2019, ch. 84).

This character was discussed by Mayr (2000, fig 3) where a distinct ridge from the caudal end of the mt III to the process pisiformis (state 1) was suggested to be synapomrphic for Upupidae. However, state 1 is also present in *Micrastur concentricus* (Fig. 2.47F) and some Passeriformes.

349. Carpometacarpus, processus pisiformis: centrally placed (0); shifted cranially (1).

Ksepka *et al.* (2011, ch. 51), Ksepka & Clarke (2012, ch. 54).

The processus pisiformis is centrally placed (state 0) in all Telluraves.

350. Carpometacarpus, metacarpal II, processus dentiformis (protuberentia metacarpalis): absent (0); present (1) (Fig. 248).

Mayr (2004, ch. 21), Mayr (2006, ch. 55), Clarke *et al.* (2009, ch. 46), Mayr (2015, ch. 32), Bourdon *et al.* (2016, ch. 34), Ksepka *et al.* (2017, ch. 56), Hieronymus *et al.* (2019, ch. 17), Ksepka *et al.* (2019, ch. 78), Mayr (2020, ch. 44), Mayr (2021, ch. 38), Steell *et al.* (2022, ch. 35), Mayr & Kitchener (2023a, ch. 47), Mayr & Kitchener (2023b, ch. 46), Mayr & Kitchener (2023c, ch. 46).

The processus dentiformes (sensu Mayr 1998) is a protuberance that guides major digit tendon of m. extensor digitorum communis along the dorsal surface of carpometacarpus. This process is

present mainly in Passeriformes (Fig. 2.48G, I) but a number of Cavitaves (Fig. 2,48D) also exhibit this feature, varying greatly in size. There are major discrepancies in the scoring between the above references likely because the processus dentiformis can be a subtle feature e.g. in *Acanthisitta chloris* (Fig. 2.48I).

351. Carpometacarpus, processus dentiformis, position along os metacarpale II: arises at about the proximodistal midpoint (0); arises distally of the proximodistal midpoint (1); inapplicable processus dentiformis absent [ch. 350] (NA) (Fig. 2.48G, H, I).

Smith *et al.* (2018, ch. 28), Raimon et al (2020, ch. 29), Steell *et al.* (2022, ch. 36).

352. Carpometacarpus, cranial process (rocessus cranialis), dorsal view: absent (0); present (1) (Fig. 2.48).

Steell *et al.* (2022, ch. 8), Mayr & Kitchener (2023a, ch. 48).

A cranial process was noted in Worthy *et al.* (2010) and Manegold (2008), the protuberance is a small process at the proximal end of the sulcus tendinosus. Worthy *et al.* (2010) describe this feature (state 1) as present in all passerines (Fig. 2.48G, H, I) with differing positions of the process (except for *Acanthisitta*), however they noted that several Coraciiformes may have this feature as well. This is indeed true for Bucerotiformes and most Coraciiformes (Fig. 2.48C).

353. Carpometacarpus, cranial process (processus cranialis), position relative to approximate midpoint of proc. intermetacarpalis: distal (0); opposite (1); proximal (2); inapplicable, processus cranialis absent [ch. 352] (NA) (Fig. 2.48C, G, H, I).

Steell *et al.* (2022, ch. 9).

354. Carpometacarpus, extensor process (processus extensorius): moderately projected (0); elongate and sharply projected (1).

Ksepka *et al.* (2011, ch. 52), Ksepka & Clarke (2012, ch. 55), Ksepka *et al.* (2019, ch. 85.)

The extensor process be measured by the distance of the cranial edge of the extensor to the cranial edge of the alurare.

355. Carpometacarpus, tendinal sulcus (sulcus tendinous): barely perceptible/ shallow (0); well-delimited, distinct with a high ridge (1) (Fig. 2.48).

Ksepka & Clarke (2009, ch. 28), Ksepka & Clarke (2010, ch. 32), Mayr (2016, ch. 26), Ksepka *et al.* (2017, ch. 60), Ksepka *et al.* (2019, ch. 82), Mayr & Kitchener (2022a, ch. 27), Steell *et al.* (2022, ch.39).

According to Ksepka *et al.* (2019) and Mayr (2006) the sulcus tendinous is distinct in all birds except Coliiformes and Cariamiformes. There is however a clear distinction between Passeriformes and all other Telluraves in that the sulcus creates a deep furrow that extends from the most distal to the most proximal part of the carpometacarpus in Passeriformes (Fig, 2,48G, H, I). However, a distinct sulcus (state 1) is also observed in many other Telluraves such Coraciiformes (Fig. 2.48C)

356. Carpometacarpus, sulcus tendinous, dorsal view, distal region, cranial margin delimited by a discernible ridge (sometimes hangs over sulcus): small/absent (0); present (1) (Fig 2.48).

Steell *et al.* (2022, ch. 41), Mayr & Kitchener (2023b, ch. 47), Mayr & Kitchener (2023c, ch. 47).

This character refers only to the region of sulcus on dorsal surface of the mt II. My scores differ from those of the above references in that Falconiformes are scored as having a clear ridge delimiting the sulcus tendinous (state 1; Fig. 2.48G).

357. Carpometacarpus, sulcus tendineus, distal end broadens into a fossa on distal os metacarpale II: continuous (0); ends in fossa (1) (Fig. 2.48C, G).

Steell *et al.* (2022, ch.40).

358. Carpometacarpus, dorsal carpal trochlea (trochlea carpalis dorsalis), labrum dorsalis, proximal terminus of dorsal rim of trochlea: rounded (0); craniocaudally narrow and proximodistally elongate (1) (Fig. 2.48).

Modified from Mayr (2004, ch. 20), Mayr (2015, ch. 34), Mayr (2020, ch. 46), Mayr (2021, ch. 40), Mayr (2022, ch. 35), Mayr & Kitchener (2023a, ch. 51), Mayr & Kitchener (2023b, ch. 50), Mayr & Kitchener (2023c, ch. 50), Mayr & Kitchener (2023d, ch. 12).

A narrow and elongate dorsal carpal trochlea (state 1) is present in all Passeriformes (Fig. 2.48G, H, I) and some members of Piciformes (Fig. 2.48D) and Coraciiformes.

359. Carpometacarpus, digital articular surface II (facies articularis digitalis II): absent, small protrusion (0); prominent distally protruding tubercle (discrete) (1) (Fig. 2.47D).

Modified from Steell *et al.* (2022, ch. 45).

A prominent distally protruding digital articular surface II (state 1) is present in Piciformes (Fig. 2.47D). This may be a different tubercle that was being referred to in Steell *et al.* (2022).

360. Carpometacarpus, ventral ligamentous fovea (fovea ligamentalis ventralis), ventral view: absent (0); present (1).

New character.

A ventral ligamentous fovea is present in Passeriformes (Fig. 2.47H, J) and some memerbs of Piciformes (Fig. 2.47D). For more detail on the fovea see Steell *et al.* (2022).

361. Proportions of carpometacarpus and coracoid: coracoid longer than carpometacarpus (0); carpometacarpus longer than coracoid (1).

Mayr (2015, ch. 30), Ksepka *et al.* (2017, ch. 53), Ksepka *et al.* (2019, ch. 75), Mayr (2020, ch. 42), Mayr (2021, ch. 36), Mayr (2022, ch. 32), Mayr & Kitchener (2023a, ch. 44), Mayr & Kitchener (2023b, ch. 43), Mayr & Kitchener (2023c, ch. 43).

See Table S1.5 for measurements on the carpometacarpus and coracoid.

362. Carpometacarpus, portion of trochlea carpalis between processus pisiformis and os metacarpale minus distinctly raised: no (0), yes (1).

Mayr & Kitchener (2022a, ch.24).

363. Carpometacarpus, foramen in ventrally protruding projection from minor metacarpal: absent (0); present (1).

Bourdon *et al.* (2016, ch.37).

364. Carpometacarpus, proximal end, small tubercle on ventral side of mc III: absent (0); present (1).

New character.

A small tubercle on the ventral side of the mt III is present in Cathartidae, and a few members of Accipitridae (Fig. 2.49A).

365. Carpometacarpus, trochlea carpalis ventralis, large, raised ridge on proximal portion: absent (0); present (1).

New character.

366. Carpometacarpus, metacarpal III, caudodistal edge clearly extends further caudally: no (0); yes (1) (Fig. 2.48).

New character.

A caudally extending distal edge of the mt III (state 1) is present in most Coraciimorphae (Fig. 2.48C) and some members of Passeriformes.

367. Carpometacarpus, ventral view, mc III ventral edge upturned into a ridge: absent (0); present (1) (Fig. 2.49).

New character.

An upturned ventral edge of the mt III (state 1) is present many members of Passeriformes (Fig. 2.49F) and Eucavitaves.

368. Carpometacarpus, proximal end, pneumatic foramina in fossa carpal cranial: absent (0); present (1) (Fig. 2.47A).

New character.

Pneumatic foramina in fossa carpal cranial (state 1) is present in Cathartidae (Fig. 2.47A) and outgroup taxa.

369. Carpometacarpus, proximal end, contiguity between facies articularis digiti alulae and proximal region of os metacarpale majus: present, connected to os metacarpale majus (0); absent, not connected, far apart (1) (Fig. 2.47J).

New character.

In some birds, the articular face for the alular digit is differentiated from the metacarpal and, therefore, not contiguous (state 1). This is mostly observed in oscines (Fig. 2.47J).

370. Carpometacarpus, proximal end, ventral facies, deep sulcus separating the processus pisiformis and the processus extensorius: absent (0); present (1) (Fig. 2.47).

New character.

The sulcus between the processus pisiformis and the processus extensorius is exceptionally deep (state 1) in Falconiformes (Fig. 2.47F).

MANUAL DIGITS

371. Phalanx digiti alulae, claw: present (0); absent (1).

Mayr *et al.* (2004, ch. 24), Mayr (2005a, ch. 51), Mayr (2006, ch. 63), Mayr *et al.* (2010, ch. 51), Ksepka *et al.* (2011, ch. 55), Mayr (2011, ch. 53), Ksepka & Clarke (2012, ch. 58), Bourdon *et al.* (2016, ch. 42), Smith *et al.* (2018, ch. 34), Hieronymus *et al.* (2019, ch. 23).

Scorings are taken from the above cited references as well as observations from Stephan (1992). I have added scorings from my own personal observations as well, though the small claw is often lost during maceration of specimens. In previous work Psittacidae are scored as having this claw absent (state 1). However, the alular claw is present (state 0) in other groups of Psittaciformes, Strigopidae (*Nestor notabilis*, *Strigops habroptilus*), Cacatuidae and Psittaculidae (Wein & Schwing (2017), confirmed by my personal observations. Other Telluraves observed with an alular claw are Falconiformes, Cathartiformes, *Sagittarius* and some outgroup taxa.

Unfortunately, Cariamiformes have not been studied previously for this feature and no appropriate specimens were observable during the current study.

372. Manual phalanx II-1: large proximally directed process on ventral side of proximal end: absent (0); present (1) (Fig. 2.50D).

Mayr *et al.* (2003, ch. 49), Mayr (2004, ch. 26), Mayr *et al.* (2004, ch. 23), Mayr (2005a, ch. 54), Mayr (2006, ch. 65), Clarke *et al.* (2009, ch. 55), Mayr *et al.* (2010, ch. 54), Mayr (2011, ch. 56), Mayr (2015, ch. 37), Bourdon *et al.* (2016, ch. 43), Ksepka *et al.* (2017, ch. 61), Ksepka *et al.* (2019, ch. 86), Mayr (2020, ch. 49), Mayr (2021, ch. 43), Mayr (2022, ch. 38), Mayr & Kitchener (2023a, ch. 54), Mayr & Kitchener (2023b, ch. 53), Mayr & Kitchener (2023c, ch. 52).

Mayr *et al.* (2003) considered a large proximally directed process on the ventral side of the manual phalanx II-1 (state 1) as a synapomorphy for Piciformes (Fig. 2.50D). Scorings taken from the above cited references.

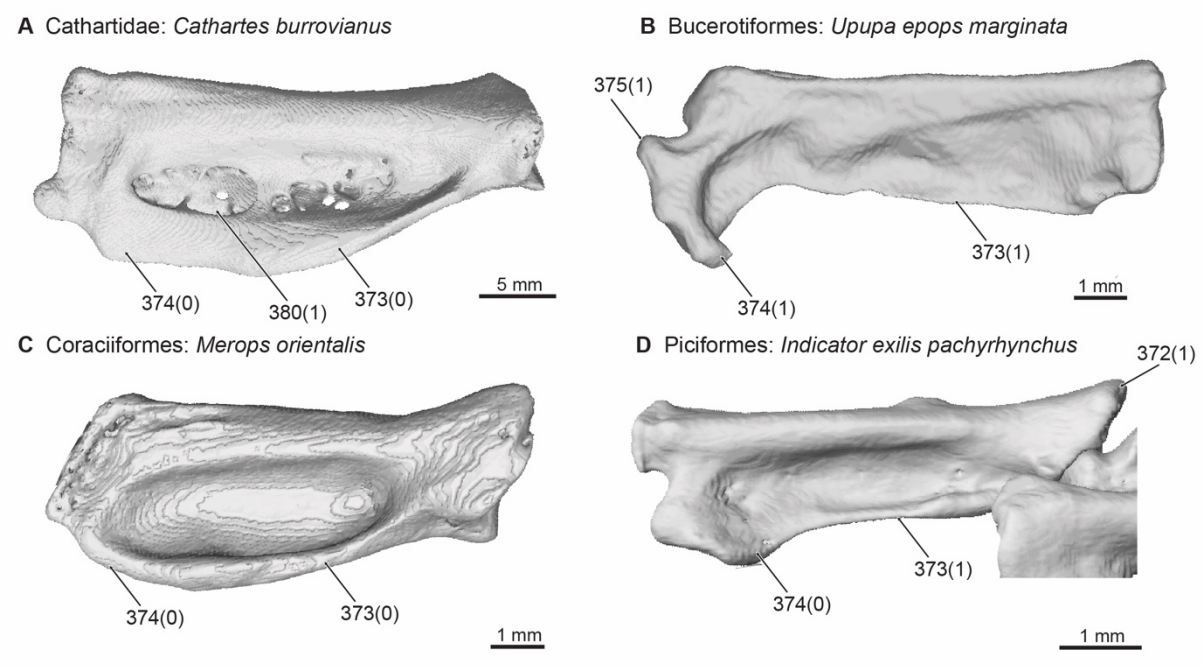


Figure 2.50. Right manual phalanx II-1 in ventral view showing characters 372, 373, 374, 375 and 380. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Upupa epops marginata* (Madagascar hoopoe, FMNH birds 352821); (C) *Merops orientalis* (Asian green bee-eater, UMMZ birds 216577); (D) *Indicator exilis pachyrhynchus* (least honeyguide, FMNH birds 429726). Numbers denote characters and character states as listed.

373. Manual phalanx II-1, caudal margin: reaching pila cranialis in regular curve (0); reduced caudal margin (lobe) (1) (Fig. 2.50).

New character.

The caudal margin of the manual phalanx II-1 is reduced in all Piciformes (Fig. 2.50D) and Bucerotiformes (Fig. 2.50B).

374. Manual phalanx II-1, caudal margin: smooth and linear ventrally (0); hooked ventrally (1) (Fig. 2.50B).

Modified from Mayr (2006, ch. 66), Ksepka *et al.* (2017, ch. 62), Smith *et al.* (2018, ch. 35), Hieronymus *et al.* (2019, ch. 24), Ksepka *et al.* (2019, ch. 87), Mayr & Kitchener (2023d, ch. 13).

The hooked caudal margin of the manual phalanx II-1 is likely apparent due to the reduced caudal margin and is present in (state 1) Bucerotiformes (Fig. 2.50B)

375. Manual phalanx II-1, proximally hooked process projects from caudal edge of distal end: absent (0); present (1) (Fig. 250B).

Clarke *et al.* (2009, ch. 56), Bourdon *et al.* (2016, ch. 44).

A proximally hooked process that projects from caudal edge of the distal end (state 1) is present in Upupidae (Fig. 2.50B)

376. Manual phalanx II-1, dorsal view, dorsal fossa (fossa dorsalis): continuous smooth fossa (0); divided into two depressions by a distinctly raised oblique ridge (1) (Fig. 2.51).

Mayr *et al.* (2003, ch. 47), Mayr (2005a, ch. 52), Mayr *et al.* (2010, ch. 52), Mayr (2011, ch. 54).

A smooth fossa with no clear divisions (state 0) is present in Cathartidae, Cariamiformes (Fig. 2.51A), and Passeriformes (Fig. 2.51D). The remaining Telluraves all have a distinctly divided dorsal fossa (Fig. 2.51B, C).

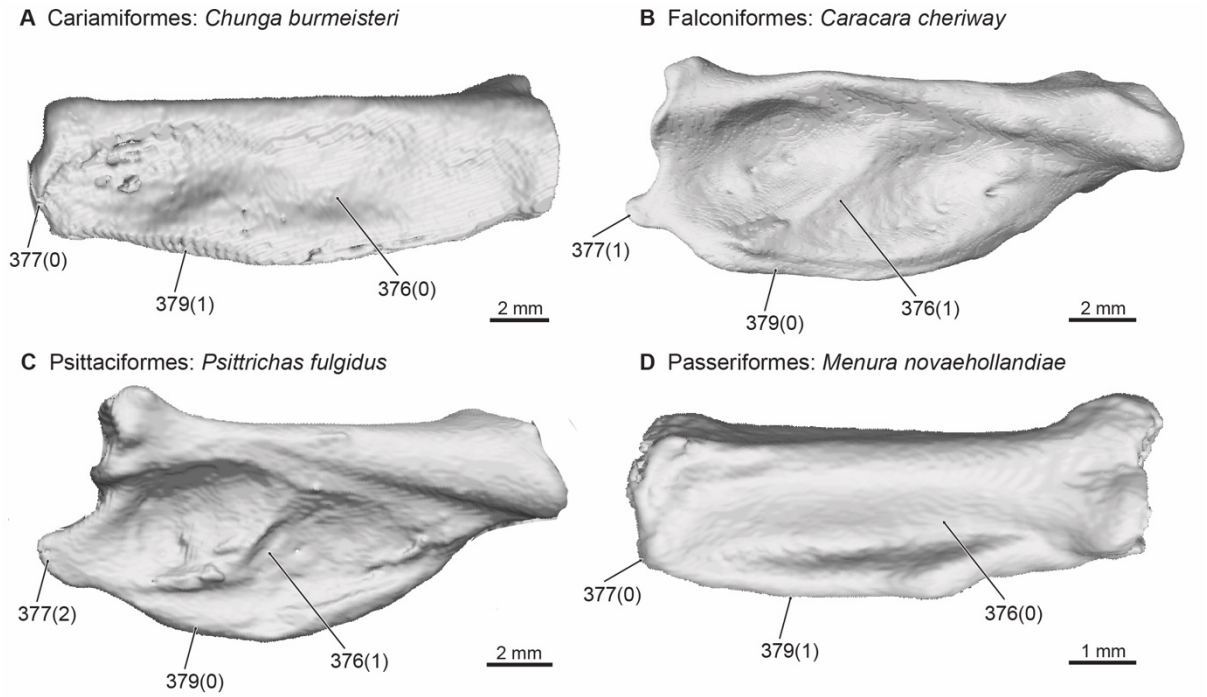


Figure 2.51. Right manual phalanx II-1 in dorsal view showing characters 376, 377 and 379. (A) *Chunga burmeisteri* (black-legged seriema, FMNH birds 106731); (B) *Caracara cheriway* (Crested caracara, UMMZ birds 133664); (C) *Psittrichas fulgidus* (Pesquet's parrot, YPM orn 141821); (D) *Menura novaehollandiae* (superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

377. Manual phalanx II-1, internal indicus process: weak or absent (0); projects past phalangeal articular facet (1); strongly projected and wide (2) (Fig. 2.51).

Modified from Mayr *et al.* (2003, ch. 48), Mayr (2005a, ch. 53), Mayr (2006, ch. 64), Clarke *et al.* (2009, ch. 57), Mayr *et al.* (2010, ch. 53), Mayr (2011, ch. 55), Ksepka *et al.* (2011, ch. 54), Ksepka & Clarke (2012, ch. 57), Bourdon *et al.* (2016, ch. 45), Raimon *et al.* (2020, ch. 34).

The internal indicus process that is strongly projected and wide (state 2) is present in Psittaciformes (Fig. 2.51B). An additional state was added (state 1) to the original character in order to account for birds that have also have a internal indicus process that projects past the phalangeal articular facet (Fig. 2.51B) but not as large as what is observed in Psittaciformes.

378. Manual phalanx II-1, cranial view, pila cranialis with deep furrow: absent (0); present (1).

New character.

A deep and furrowed pila cranialis (state 1) is present in Leptosomiformes and Upupidae. In Upupidae an ossified tendon is observed within the furrow.

379. Manual phalanx II-1: ovoid, with convex caudal margin (0); rectlinear, with straight caudal margin (cranial-caudally narrow) (1) (Fig. 2.51).

Mayr & Clarke (2003, ch. 89), Bourdon *et al.* (2016, ch. 70), Raimon *et al.* (2020, ch. 33).

A rectangular (state 1) shaped manual phalanx is present in many Telluraves, for example Cariamiformes (Fig. 2.51A) and some members of Passeriformes (Fig. 2.51D).

380. Manual phalanx II-1: not perforated (0); perforated (1) (Fig. 2.50A).

New character.

A perforated (state 1) manual phalanx II-1 is present in Cathartidae (Fig. 2.50A) and Strigiformes.

381. Manual phalanx III-1, shape of flexor process: widened into a small tubercle/rise (triangular in shape) and inconspicuous (0); distinct and separated tubercle (straight margin) pronounced flexor tubercle (1) (Fig. 2.52).

Smith *et al.* (2018, ch. 33), Hieronymus *et al.* (2019, ch. 22).

There is a large amount of variation in the shape and position of the flexor process within Telluraves. A wide and triangular shaped flexor process (state 0) is present in most Telluraves (Fig. 2.52A) while a distinct and separated tubercle (state 1) is present in Strigiformes and Coraciimorphae (Fig. 2.52B).

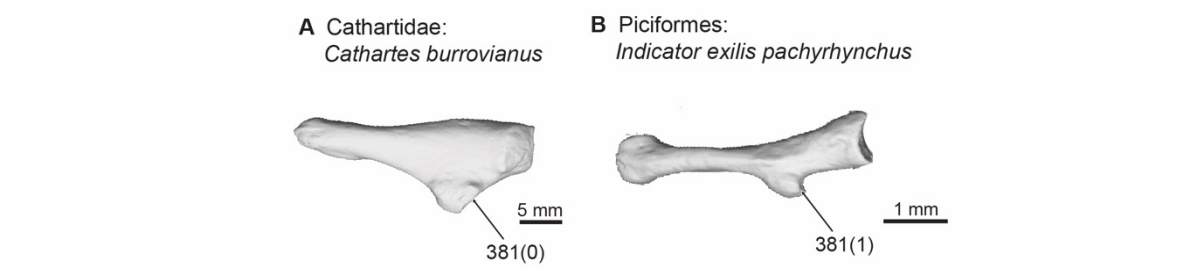


Figure 2.52. Right manual phalanx III-1 in dorsal view showing character 381. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Indicator exilis pachyrhynchus* (least honeyguide, FMNH birds 429726). Numbers denote characters and character states as listed.

SYNSACRUM (PELVIS)

382. Pelvis, ilia co-ossified with synsacrum: yes (0), no (1).

Ksepka *et al.* (2019, ch. 89), Mayr (2020, ch. 50), Mayr & Kitchener (2023a, ch. 55), Mayr & Kitchener (2023b, ch. 55), Mayr & Kitchener (2023c, ch. 53).

The ilium is fused to the synsacrum in all extant Telluraves (state 0) and has only been found to be unfused (state 1) in the extinct taxa *Parapsittacopes* and *Morsoravis*, see above references for more details.

383. Pelvis, ilioischial foramen (foramen ilioischiadicum): incompletely closed due to lack of contact between ilium and ischium at caudal border/unfused posteriorly (0); fully enclosed/fused posteriorly (1).

Mayr & Clarke (2003, ch. 94), Mayr (2004, ch. 27), Mayr (2005a, ch. 55), Mayr (2005b, ch. 67), Mayr (2006, ch. 68), Mayr *et al.* (2010, ch. 55), Mayr (2011, ch. 57), Ksepka *et al.* (2017, ch. 64), Ksepka *et al.* (2019, ch. 91).

A caudally closed ilioischial foramen **(**foramen ilioischiadicum) (state 1) is an apomorphy of Neognathae birds (Mayr 2004).

384. Pelvis, dorsal iliac crests (cristae iliacae dorsalis): fused with synsacral spinous crest (crista spinosa synsacra), creating fully enclosed iliosynsacral canal (canalis iliosynsacralis) (0); remain separated from synsacral spinous crest (crista spinosa synsacra) (1) (Fig. 2.54).

Mayr & Clarke (2003, ch. 92), Mayr (2005b, ch. 65), Clarke *et al.* (2009, ch. 59), Ksepka *et al.* (2011, ch. 57), Ksepka & Clarke (2012, ch. 60), Ksepka *et al.* (2017, ch. 63), Ksepka *et al.* (2019, ch. 90).

The dorsal iliac crests are largely or completely fused cranially with crista spinosa of the synsacrum, thus forming a closed iliosynsacral canal (state 0). This is observed in all Cathartidae (Fig. 2.53A), Accipitridae, Strigiformes (Fig. 2.53B), Cariamiformes (Fig. 2.53E), Falconiformes (Fig. 2.53E) and Psittaciformes (Fig. 2.53G).

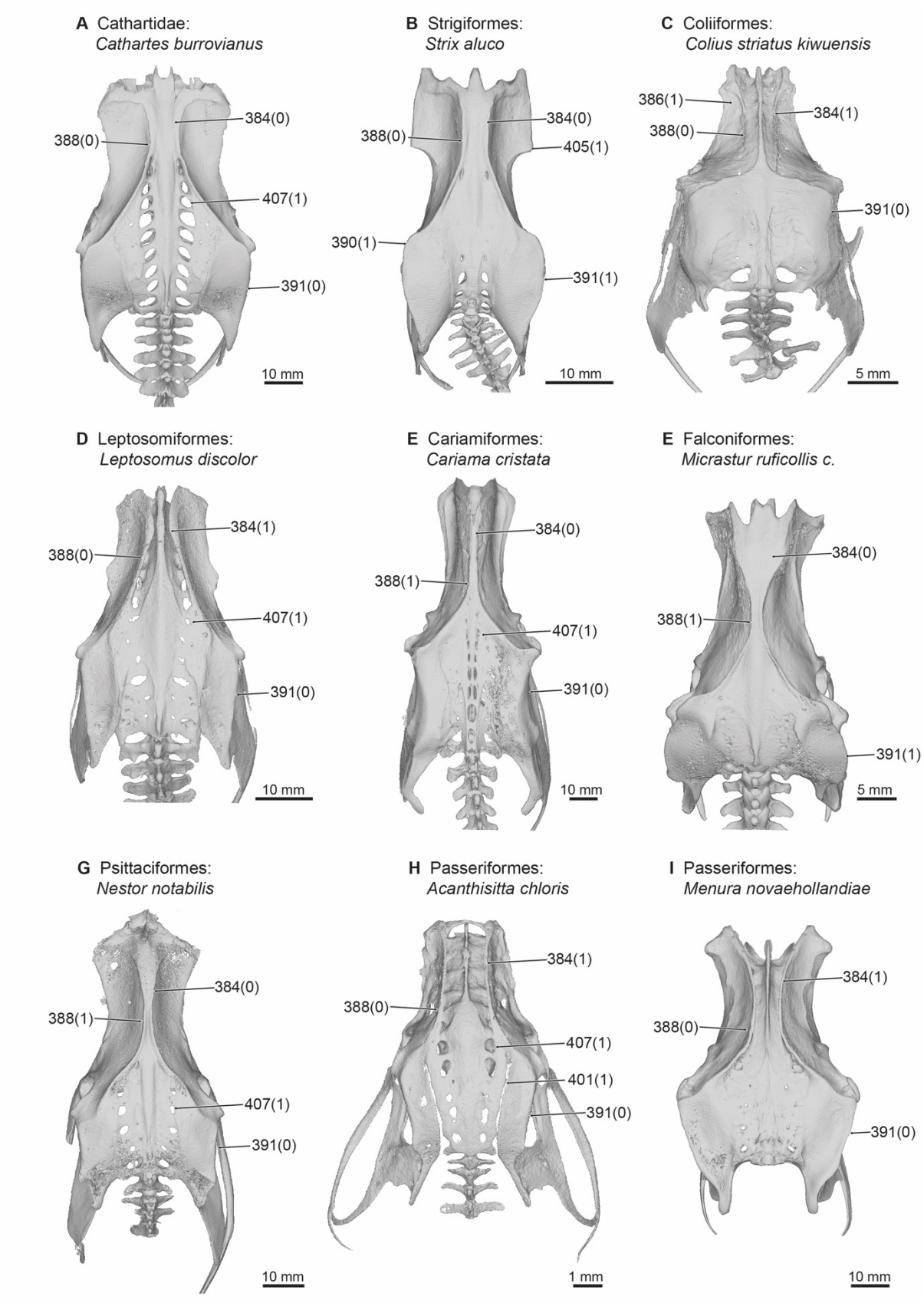

A Cathartidae:
Cathartes burrovianus
384(0)
388(0)
407(1)
391(0)
10 mm
B Strigiformes:
Strix aluco
384(0)
388(0)
405(1)
390(1)
391(1)
10 mm
C Coliiformes:
Colius striatus kiwuensis
386(1)
384(1)
388(0)
391(0)
5 mm
D Leptosomiformes:
Leptosomus discolor
384(1)
388(0)
407(1)
391(0)
10 mm
E Cariamiformes:
Cariama cristata
384(0)
388(1)
407(1)
391(0)
10 mm
E Falconiformes:
Micrastur ruficollis c.
384(0)
388(1)
391(1)
5 mm
G Psittaciformes:
Nestor notabilis
384(0)
388(1)
407(1)
391(0)
10 mm
H Passeriformes:
Acanthisitta chloris
384(1)
388(0)
407(1)
401(1)
391(0)
1 mm
I Passeriformes:
Menura novaehollandiae
384(1)
388(0)
391(0)
10 mm

Figure 2.53. Synsacra in dorsal view showing characters 384, 388, 390, 391 and 407. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Strix aluco* (Tawny owl, NHMUK zoo S/2001.38.1); (C) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (D) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (E) *Cariama cristata* (Red-legged seriema, FMNH birds 105635); (F) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (G) *Nestor notabilis* (Kea, FMNH birds 23530); (H) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146); (I) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

385. Pelvis, dorsal iliac crests (cristae iliacae dorsalis), lateral view, preacetabular edge: straight/ subequal in dorsoventral height with postacetabular (0); convexly bowed/ dorsally prominent, elevated above the level of the postacetabular synsacrum (1) (Fig, 2.54).

Modified from Derange *et al.* (2015, ch. 57), Musser & Cracraft (2019, ch. 257), Livezey & Zusi (2006, ch. 1819).

A strongly convexly bowed dorsal iliac crests (state 1) is observed in Cariamiformes (Fig. 2.54E). A somewhat lesser degree in curvature is observed in Sagittariidae and has also been scored as (state 1).

386. Pelvis, mid-section of dorsal iliac crests/ preacetabular ilium: prominently projecting ridges, sub-rectangular (0); reduced, narrows cranially (1) (Fig. 2.53 & 2.54).

Mayr *et al.* (2003, ch. 51), Mayr (2004, ch. 28), Mayr (2005a, ch. 57), Mayr (2006, ch. 70), Mayr *et al.* (2010, ch. 57), Mayr (2011, ch. 59).

A reduced mid-section of the preacetabular ilium (state 1) is present in Coliiformes (Fig. 2.53C & 2.54C). State 1 is best viewed from dorsal view as the preacetabular ilium can look like they are reduced when viewed in lateral view as the angle of the preacetabular ilium can be horizontal (Ch. 387).

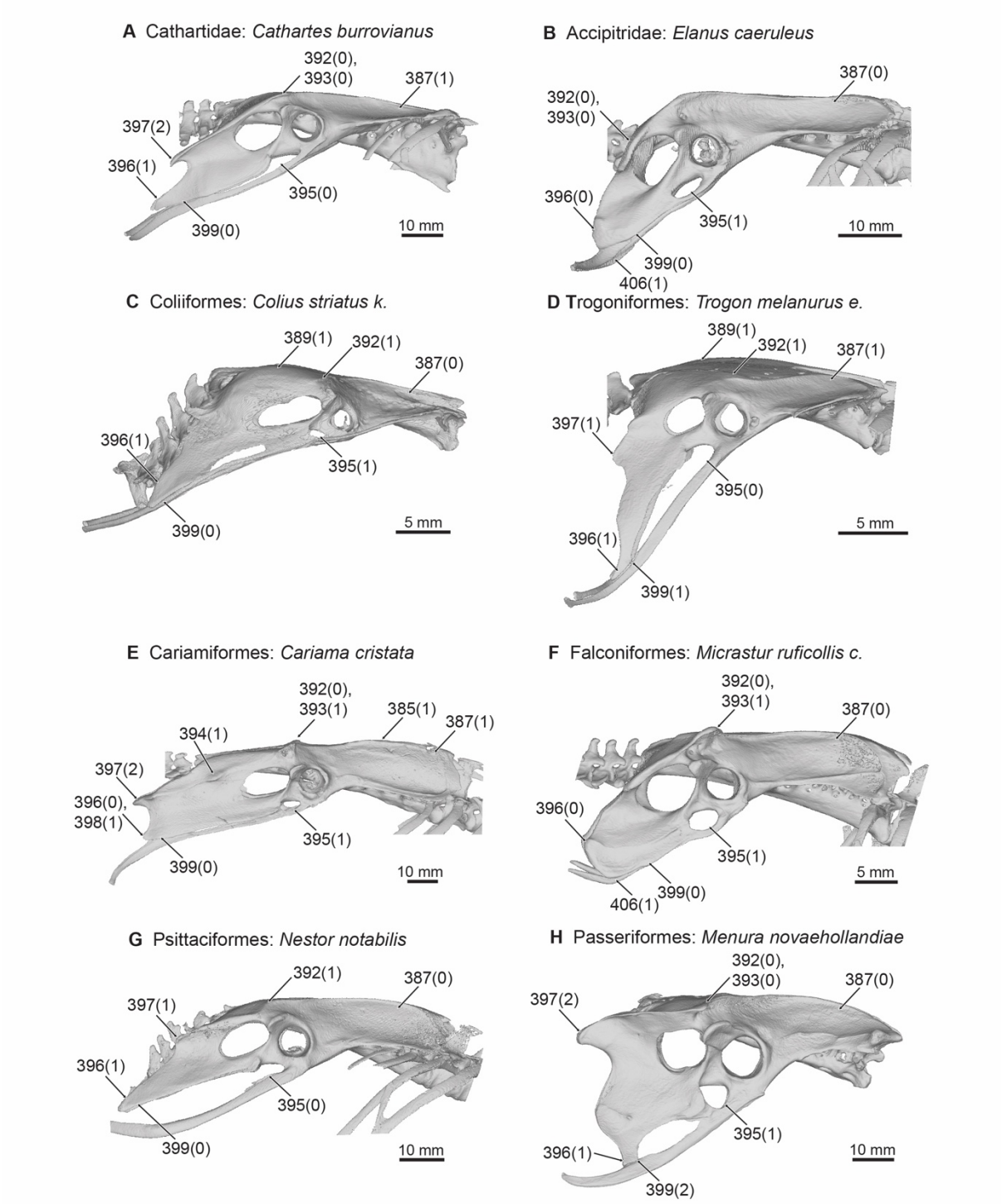


Figure 2.54. Synsacra in right lateral view chowing characters 385, 387, 392, 393, 394, 395, 396, 397, 398, 399 and 405. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (C) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817), (D) *Trogon melanurus eumorphus* (Black-tailed trogon, FMNH birds 290496); (E) *Cariama cristata* (Red-legged seriema, FMNH birds 105635); (F) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (G) *Nestor notabilis* (Kea, FMNH birds 23530); (H) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

387. Pelvis, preacetabular ilium, lateral face, angle respective to transverse plane of synsacrum: oblique or subvertical (0); sub horizontal (1) (Fig. 2.54).

Musser & Cracraft (2019, ch 258); Livezey & Zusi (2006, ch. 1823).

A sub-horizontal preacetabular ilium in respect to the transverse plane of synsacrum (state 1) is observed in Cathartidae (Fig. 2.54A) and Trogoniformes (Fig. 2.54D).

388. Pelvis, dorsal view, proximity of dorsal iliac crests (cristae iliacae dorsalis) in preacetabular zone: separated (0); close set or touching (1) (Fig. 2.53).

Migotto (2013, ch. 124), Mather *et al.* (2022, ch. 193).

Medially, the dorsal iliac crests can be closely set or in some cases touching (state 1), as observed mainly in Falconiformes (Fig. 2.53E) and Psittaciformes (Fig. 2.53G). In other Telluraves, the crests are clearly separated from each other and never meet medially (state 0).

389. Pelvis, dorsolateral iliac crest (crista dorsolateralis ilii): laterally expanded (0); absent or retracted, dorsolateral corner of ilium forms a smooth curve instead of a crest (1) (Fig. 2.54).

Modified from Ksepka & Clarke (2009, ch. 29), Ksepka & Clarke (2010, ch. 33).

In the above cited references only Coliiformes (Fig. 2.54C) are scored as having a bulbous crista dorsolateralis ilii (state 1). However, this is also present in the Trogoniformes (Fig. 2.54D), as observed during the current study.

390. Pelvis, dorsolateral iliac crest (crista dorsolateralis ilii), lateral extremity, overhanging antitrochanter: absent (0); present (1) (Fig. 2.53).

Modified from Mayr *et al.* (2003, ch. 52), Mayr (2005a, ch. 58), Mayr (2006, ch. 71), Mayr *et al.* (2010, ch. 58), Mayr (2011, ch. 60), Mayr (2015, ch. 38), Mayr (2020, ch. 51), Mayr (2021, ch. 44), Mather *et al.* (2022, ch. 196), Mayr & Kitchener (2023a, ch. 56), Mayr & Kitchener (2023c, ch. 54).

The lateral extremity of the dorsolateral iliac crest can be laterally expansive and can dorsally cover the the antitrochanter in dorsal view (state 1). In the present study this condition was only

observed in Strigiformes (Fig. 2.53B). The original character, used in the references cited above, described this character as "crista dorsolateralis ilii strongly developed, overhanging a marked concavitas infracristalis and a marked sulcus antitrochantericus and convexly bowed if pelvis is viewed from its dorsal side, praeacetabular part much longer than postacetabular part, spina dorsolateralis ilii reduced: no (0), yes (1)". This description combines a number of independent morphological conditions into each character state, including information on whether the crista dorsolateralis ilii is straight or convexly bowed, which is the subject of a separate character in the present study (Ch. 391).

391. Pelvis, dorsolateral iliac crest (crista dorsolateralis ilii), dorsal view, postacetabularis edge: straight (0); convexly bowed (greatly laterally expanded) (1) (Fig. 2.53).

New character.

A convexly bowed dorsolateral iliac crest (state 1) is present in Accipitridae, Strigiformes (Fig. 2.53B) and Falconiformes (Fig. 2.53E). In Sagittariidae the dorsolateral iliac crest is only slightly convexly bowed, and has been scored as (0).

392. Pelvis, supratrochanteric crest (cristae supratrochanterica): present (0); reduced/absent (1) (Fig. 2.54).

New character.

A reduced supratrochanteric crest (state 1) is observed in many Telluraves such as in Trogoniformes (Fig. 2.54D) and Psittaciformes (Fig. 2.54G). Terminology from Degrange *et al.* (2015).

393. Pelvis, cristae supratrochanterica (supratrochanteric crest), lateral projection: weakly projected (less than antitrichanter) (0); strongly laterally projected (1); inapplicable, cristae supratrochanterica absent (N/A).

New character.

Terminology from Derange *et al.* (2015). See Figure 54.

394. Pelvis, lateral process located caudally to foramen ilioischiadicum: absent (0); present (1) (Fig. 2.54).

Mayr (2016, ch. 28), Mayr & Kitchener (2022a, ch. 29).

A lateral process located caudally to the foramen ilioischiadicum (state 1) is present in *Cariama cristata* (Fig. 2.54E)

395. Pelvis, caudal margin of obturator foramen (foramen obturatum): open, confluent to ischiopubica fenestra (0); closed (1) (Fig. 2.54).

Ksepka & Clarke (2009, ch. 31), Ksepka & Clarke (2010, ch. 35), Mayr (2013, ch. 21), Ksepka *et al.* (2017, ch. 66), Smith *et al.* (2018, ch. 37), Ksepka *et al.* (2019, ch. 93), Hieronymus *et al.* (2019, ch. 26), Mather *et al.* (2022, ch. 200).

The obturator foramen can be open and confluent to the ischiopubica fenestra (state 0; Fig. 2.54B, C, E, F, H) or caudally closed by ankyloses of the pubis and ischium region (state 1; Fig. 2.54A, D, G). There are discrepancies between scoring in the above references and the scorings in the present study. I suspect that the closure can vary on an individual basis and ontogenetic processes.

396. Pelvis, processus terminalis ischii: broad, blunt, sub-rectangular (0); narrow and slender/acuminate (1) (Fig. 2.54).

Modified from Mayr *et al.* (2003, ch. 55), Mayr (2004, ch. 29), Mayr (2005a, ch. 60), Mayr (2006, ch.74), Mayr *et al.* (2010, ch. 60), Mayr (2011, ch. 62), Mayr (2015, ch. 39), Mayr (2020, ch. 52), Mayr (2021, ch. 45), Mayr (2022, ch. 39), Mayr & Kitchener (2023a, ch. 57), Mayr & Kitchener (2023b, ch. 56), Mayr & Kitchener (2023c, ch. 55).

The original character description, used in the reference cited above, is: "the Pelvis, processus terminalis ischii very narrow and slender, touching pubis at an angle of 45°–90°, fenestra ischiopubica very wide: no (0), yes (1)". This combines a few variables, such as the angle at which the processus terminalis ischii contacts the pubis is the subject of a separate character here (Ch. 399) as this process can be narrow (state 1; Fig. 2.54A, D, G, H) but not necessarily deflected in all birds.

397. Pelvis, spina dorsolateral illi (processus terminalis illi), lateral surface: absent (0); blunt/rounded (1); very narrow and slender (2) (Fig. 2.54).

Modified from Mayr *et al.* (2003, ch. 54), Mayr (2006, ch. 67).

398. Pelvis: processus terminalis ischii extends further than processus terminalis ilii (0); terminal processus aligned (1) (Fig. 2.54).

New character.

An aligned terminal process of the ischium with the terminal process of the ilium is present in Sagittariidae, Pandionidae and Cariamiformes (Fig. 2.54E).

399. Pelvis, contact between ischium and pubis: ischium and pubis subparallel to one another (0); ischium ventrally deflected at distal end (45°), with narrow distal tip contacting pubis (1); ischium sharply ventrally deflected (90°) at distal end, with narrow distal tip contacting pubis (2) (Fig. 2.54).

Ksepka & Clarke (2009, ch. 30), Ksepka & Clarke (2010, ch. 34), Ksepka *et al.* (2017, ch. 68), Ksepka *et al.* (2019, ch. 94).

In *Acanthisitta chloris* and suboscines the terminal process of the ischium is strongly deflected at 90° (state 1; Fig. 2.54H). Previous authors included Trogoniformes in this state as well, however I observed that the process is not as strongly deflected in Trogoniformes (Fig. 2.54D) and so scored them instead as state 1.

400. Pelvis, preacetabular tubercle (tuberculum praeacetabulare): present/developed (0); absent/poorly developed (1).

Mayr & Clarke (2003, ch. 93), Mayr *et al.* (2003, ch. 53), Mayr (2005a, ch. 59), Mayr (2005b, ch. 66), Mayr (2006, ch. 72), Clarke *et al.* (2009, ch. 58), Mayr *et al.* (2010, ch. 59), Mayr (2011, ch. 61), Ksepka *et al.* (2017, ch. 65), Ksepka *et al.* (2019, ch. 92).

All Telluraves have an absent preacetabular tubercle (state 1) except in *Cariama cristata* and *Tockus nasutus* in which a very small projection is observed, they have however been scored as (state 1).

401. Pelvis, iliosynsacral suture (sutura iliosynsacralis): obliterated (0); incompletely fused (1) (Fig. 2.53).

Ksepka *et al.* (2011, ch. 58), Ksepka & Clarke (2012, ch. 61).

An incompletely fused iliosynsacral suture (state 1; Fig. 2.53H) can be a very subtle feature that does not show up well on the 3d models of the CT scans and is better observed in dried specimens. For this reason, scoring has been taken from the above cited references. Some amount of caution is to be advised as the age of the specimens may affect the amount of fusion observed.

402. Pelvis, number of thoracic vertebrae ankylosed in synsacrum: 9-10 (0), 11-12 (1), 13-14 (2), 15-16 (3), 17-18 (4).

Mayr & Clarke (2003, ch. 91), Mayr (2005b, ch. 64).

Scorings taken from the above cited references as well as personal observation.

403. Pelvis, synsacrum, ventral view, costal processes (processus costales): developed, clearly separate from transvers process (processus transversus), and contacting ilia (0); indistinct (1) (Fig. 2.55).

Ksepka & Clarke (2009, ch. 7), Ksepka & Clarke (2010, ch. 8), Bourdon *et al.* (2016, ch. 62).

This character captures variation in the degree of fusion of transverse processes of thoracic vertebrae to the iliac blades. In Telluraves, the transverse processes of the 1-2 caudalmost thoracic vertebrae are incompletely fused to preacetabular iliac blades (state 0; Fig. 2.55A). In some other Neognathae, such as *Chauna*, all vertebrae are fused to the iliac blades. My scores differ from those of the above references in that Strigiformes are not considered having indistinct processus costales (state 0), and only indistinct in Coliiformes (Fig. 2.55B).

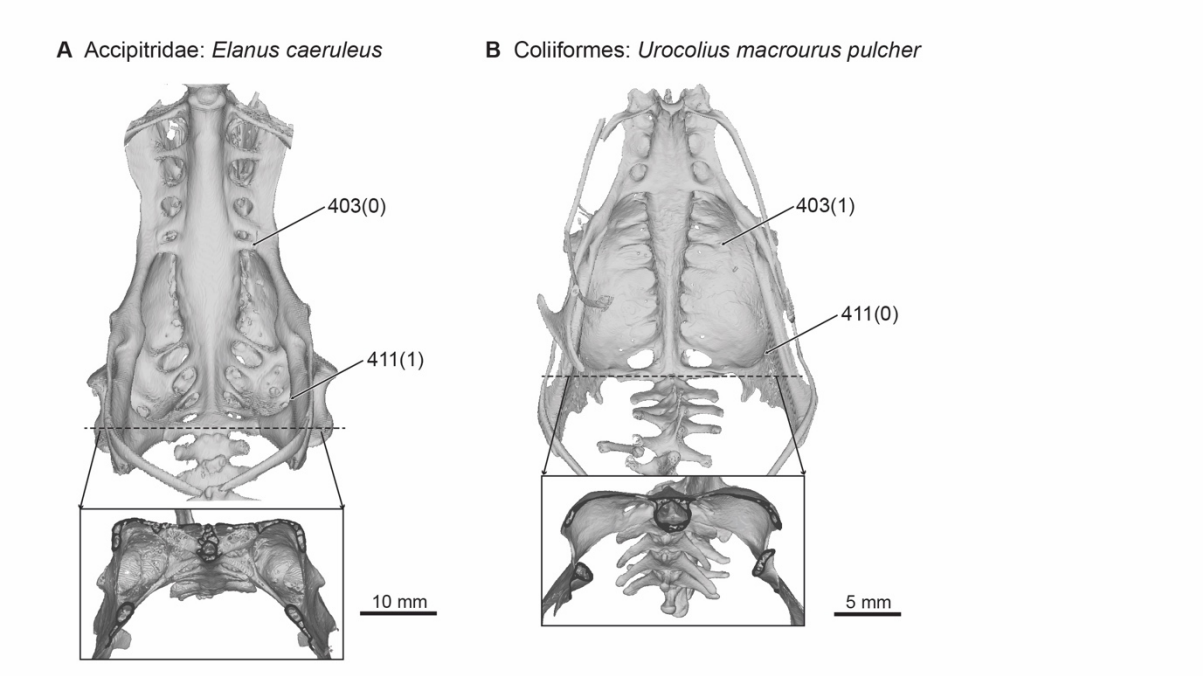


Figure 2.55. Synsacra in ventral view, frontal cross section of caudal section in a square box showing characters 403 and 411. (A) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (B) *Urocolius macrourus pulcher* (Blue-naped mousebird, FMNH birds 368959). Numbers denote characters and character states as listed.

404. Pelvis, ankylosis of acetabular transverse process to acetabular area, ankyloses limited to synsacrum (0); ankyloses to dorsal margin of acetabulum (1) (Fig. 2.56).

Modified from Musser & Cracraft (2019, ch. 280), Mather *et al.* (2022, ch. 204).

State 0 is present mostly in *Cathartes burrovianus* (Fig. 2.56A), Coraciimorphae, Psittaciformes and Passeriformes. State 1 is observed in *Vultur gryphus*, Cariamiformes (Fig. 2.556B), Falconiformes, *Strix aluco*, Accipitridae and outgroup taxa.

405. Pelvis, craniolateral edge of alae praeacetabulares ilii pointed and protruding: absent (0), present (1) (Fig. 2.53B).

New character.

A pointed and protruding preacetabular wings of the ilium (alae praeacetabulares ilii) is observed in Strigiformes (Fig. 2.53B).

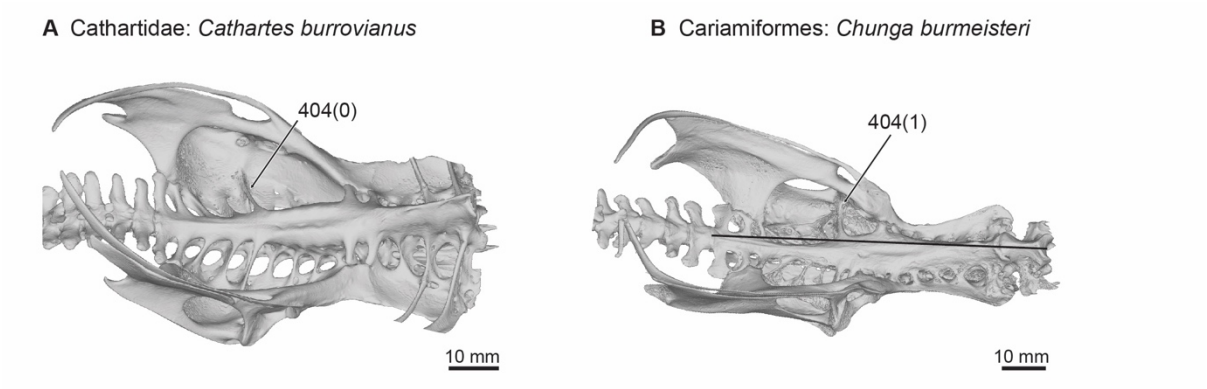


Figure 2.56. Synsacra in right ventrolateral view showing character 404. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Chunga burmeisteri* (Black-legged seriema, FMNH birds 106731). Numbers denote characters and character states as listed.

406. Pelvis, pubis ankyloses to the ventral margin of the ischium and completely eliminates the fenestra ischiopubica: absent (0); present (1) (Fig. 2.54).

New character.

The middle portion of the pubis ankyloses to the ventral margin of the ischium and completely eliminates the ischiopubic fenestra in Falconiformes (Fig. 2.54F), Pandionidae and Accipitridae (state 1).

407. Pelvis, dorsal view, intertransverse foramina (foramina intertransversia): partially or completely closed by osseous sheet (0); open (1) (Fig. 2.53).

Migotto (2013, ch. 125), Mather *et al.* (2022, ch. 194).

The intertransverse foramina (foramina intertransversia) occur on the dorsal surface of the synsacrum, and in most cases these foramina are covered by an osseous sheet (state 0). This can however vary on the age of the specimen. In a few Telluraves, the foramina remain open (state 1; Fig. 2.53A, D, E, G, H).

408. Pelvis, interacetabular width relative to synsacral length: narrow (1.9 or above) (0); elongated (below 1.9) (1); broad in mediolateral direction (1.0 or below) (2).

Modified from Mayr & Clarke (2003, ch. 90), Mayr *et al.* (2003, ch. 50), Mayr (2005a, ch. 56), Mayr (2006, ch. 69), Mayr (2006, ch. 73), Mayr *et al.* (2010, ch. 56), Ksepka *et al.* (2011, ch. 56), Mayr (2011, ch. 58), Ksepka & Clarke (2012, ch. 59), Mayr (2016, ch. 27), Ksepka *et al.* (2019, ch. 88).

The pelvis is exceptionally broad (state 2) in Pandionidae and Trogoniformes.

409. Pelvis, renal fossa (fossa renalis), pneumatic foramen between foramen ilioischiadicum and foramen acetabuli: present (0); absent (1) (Fig. 2.57).

New character.

A pneumatic foramen between the ilioischial foramen and the acetabular foramen (state 0) is present in many Telluraves such as Cathartidae (Fig. 2.57A).

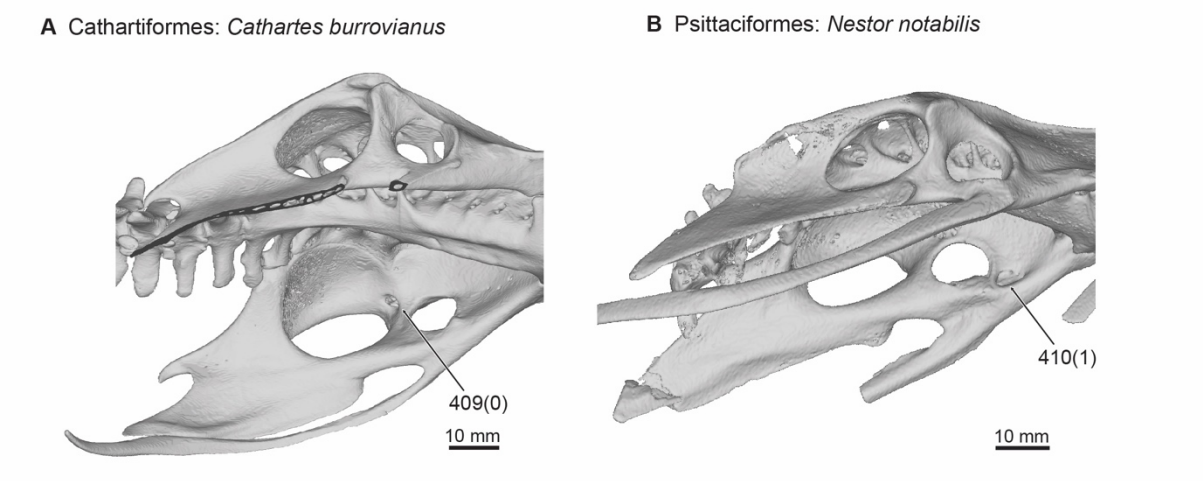


Figure 2.57. Synsacra in right ventrolateral view showing character 409. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); *Nestor notabilis* (Kea, FMNH birds 23530). Numbers denote characters and character states as listed.

410. Pelvis, fossa renalis, pneumatic foramen caudal to foramen acetabuli: absent (0); present (1) (Fig. 2.57).

New character.

A pneumatic foramen between caudal to the acetabular foramen (state 1) is present in Psittaciformes (Fig. 2.57B) and *Acanthisitta chloris*.

411. Pelvis, caudal recess of the fossa (recessus caudalis fossae): shallow/absent (0); deep (1) (Fig. 2.55).

Mayr & Clarke (2003, ch. 95), Mayr (2005b, ch. 68).

The caudal recess of the fossa results from the presence of an ischial lamina that is anteriorly extensive and occur in many Telluraves such as Accipitridae (Fig. 2.55A) (state 1).

412. Pelvis, dorsal view, foramina intertransversia closely set to midline, pseduotemporale: absent (0); present (1).

New character.

413. Pelvis, preactabulare region and postactabulare relationship: <0.6 (0); 0.7 (1); ala preactabulare longer than post (0.8/0.9) (2).

Degrange *et al.* (2015, ch. 55).

FEMUR

414. Femur, pneumatic foramen on craniolateral surface of trochanteric crest (crista trochanterica): absent (0), present (1) (Fig. 2.58).

Mayr *et al.* (2003, ch. 56), Mayr & Clarke (2003, ch. 98), Mayr *et al.* (2004, ch. 25), Mayr (2004, ch. 31), Mayr (2005a, ch. 61), Mayr (2005b, ch. 70), Mayr (2006, ch. 75), Clarke *et al.* (2009, ch. 60), Mayr *et al.* (2010, ch. 61), Mayr (2011, ch. 63), Mayr (2015, ch. 40), Mayr (2016, ch. 29), Ksepka *et al.* (2017, ch. 69), Ksepka *et al.* (2019, ch. 95), Mayr (2020, ch. 53), Mayr (2021, ch. 46), Mayr (2022, ch. 40), Mayr & Kitchener (2022a, ch. 30), Mayr & Kitchener (2023a, ch. 58), Mayr & Kitchener (2023b, ch. 57), Mayr & Kitchener (2023c, ch. 56).

A pneumatic foramen on the medial surface of the trochanteric crest (state 1) and is observed Cathartidae (Fig. 2.58A), Accipitridae, Falconiformes and some Cavitaves. The number and size of the foramen also varies among these birds but is not accounted for in the current study.

415. Femur, proximal end, large crest on lateral surface: absent (0); present (1) (Fig. 2.58).

New character.

A large crest of the lateral surface of the proximal end of the femur is present only in the oscines *Menura novaehollandiae* (Fig. 2.58D) and *Climacterus melanurus wellsi*.

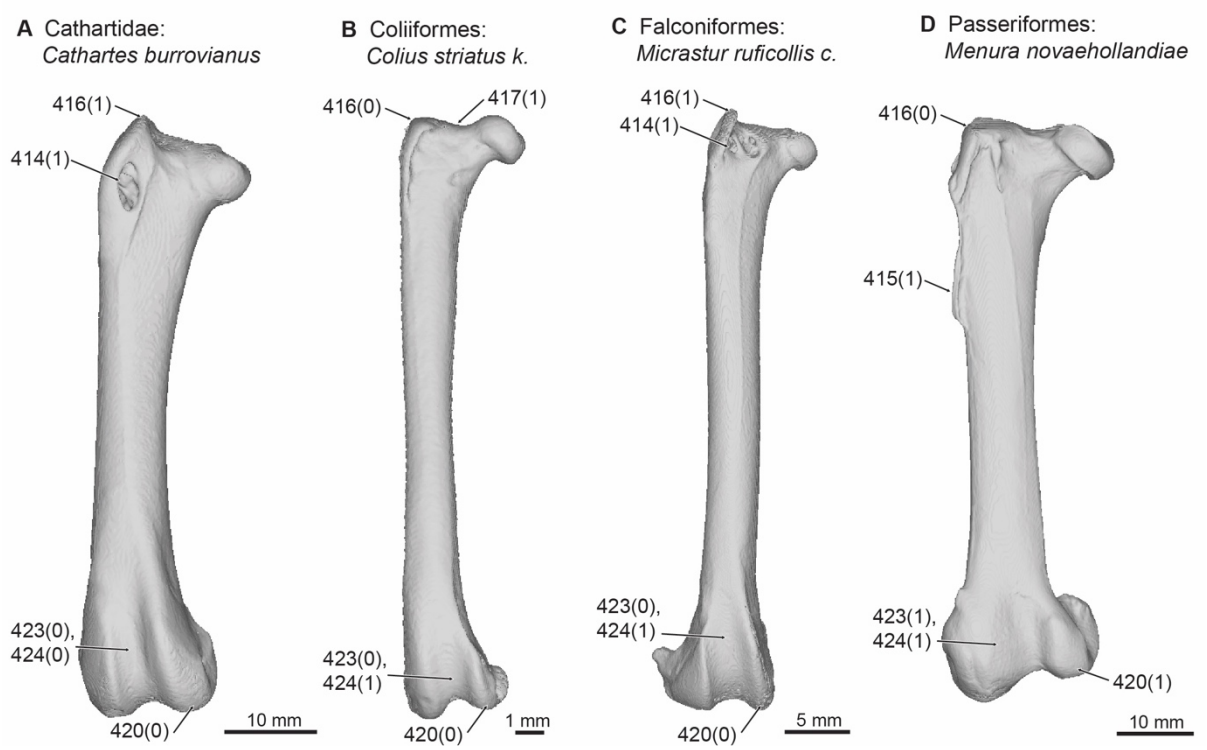


Figure 2.58. Right femora in cranial view showing characters 414, 415, 416, 417, 420, 423 and 424. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (C) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (D) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

416. Femur, trochanteric crest (crista trochanterica): well developed, markedly projected cranially proximal (0); undeveloped, does not surpass level of the femoral head (1) (Fig. 2.58).

Mayr & Clarke (2003, ch. 97), Mayr (2005b, ch. 69), Ksepka & Clarke (2010, ch. 36), Mayr (2016. ch. 30), Ksepka *et al.* (2017, ch. 70), Ksepka *et al.* (2019, ch. 96), Mayr & Kitchener (2022a, ch. 31).

The trochanteric crest (crista trochanterica) projects proximally from the lateral edge of the proximal femur (state 0) in Cathartidae (Fig. 2.58A), Accipitridae, Cariamiformes and Falconiformes (Fig. 2.58).

417. Femur, articular surface for antitrochanteric articular surface (facies articularis antitrochanteria): flat (0); deeply convex (1) (Fig. 258A).

New character.

The antitrochanteric articular surface, located on the proximal femur, forms part of the hip joint, and its non-convex (flat) morphology (state 0) in Telluraves suggests a relatively broad and stable articulation with the antitrochanter, potentially facilitating a wider range of femoral motion during locomotion (Baumel & Witmer 1993; Hutchinson 2001). A deeply convex antitrochanteric articular surface (state 1) is observed in the outgroup taxa and Coliiformes (Fig. 2.58B). A slightly convex antitrochanteric articular surface is observed in some oscines like *Menura novaehollandiae* but has been scored as state 0.

418. Femur, distal end, caudal view, tubercle for the lateral gastrocnemius muscle (tuberculum m. gastrocnemius lateralis): moderately developed (0); greatly expanded (1) (Fig. 2.59).

Mayr (2004, ch. 30), Mayr (2005a, ch. 62), Mayr (2006, ch. 76), Mayr *et al.* (2010, ch. 62), Mayr (2011, ch. 64), Ksepka & Clarke (2009, ch. 32), Ksepka & Clarke (2010, ch. 37), Ksepka *et al.* (2011, ch. 59), Ksepka & Clarke (2012, ch. 62), Mayr (2015, ch. 41), Ksepka *et al.* (2017, ch. 71), Ksepka *et al.* (2019, ch. 97), Mayr (2020, ch. 54), Mayr (2021, ch. 47), Mayr & Kitchener (2023a, ch. 59), Mayr & Kitchener (2023b, ch. 58), Mayr & Kitchener (2023c, ch. 57).

A greatly expanded tubercle for the lateral gastrocnemius muscle (state 1) is present in Coliiformes (Fig. 2.59B).

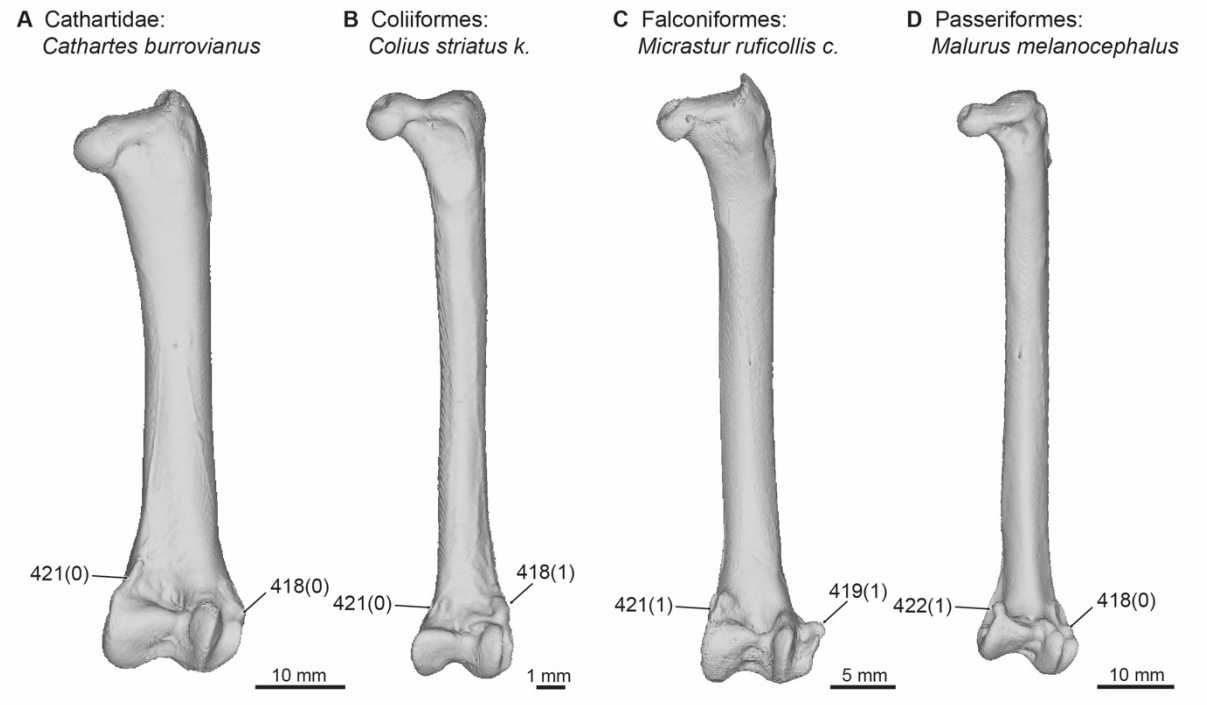


Figure 2.59. Right femora in caudal view showing characters 418, 419 and 422. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (C) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (D) *Malurus melanocephalus* (Red-backed fairywren, UMMZ birds 224775). Numbers denote characters and character states as listed.

419. Femur, distal end, caudal view, fibular condyle (condylus fibularis): not elevated, grading smoothly (0); elevated, extending far laterally (1) (Fig. 2.59).

Migotto (2013, ch. 135), Musser & Cracraft (2019, ch. 311), Livezey (1998, ch. 308).

The fibular condyle (articulation site for the fibula) of Falconiformes exhibits a uniquely extensive process that extends laterally (state 1; Fig. 2.59C).

420. Femur, distal end, position of medial condyle (condylus medialis): horizontal to sub-horizonal (in line with shaft) (0); curved, condyle extends far medial to shaft (1) (Fig. 2.58).

New character.

In state (1) the medial condyle is in a more proximal position relative to the lateral condyle. This is observed in all Passeriformes (Fig. 2.58D) and Cariamiformes.

421. Femur, distal end, medial supracondylar crest (crista supracondylaris medialis): not developed (0); greatly expanded/developed (1) (Fig. 2.59)

New character.

A greatly expanded and developed medial supracondylar crest (state 1) is present in Falconiformes (Fig. 2.59 C).

422. Femur, distal end, large tubercle extending proximally on medial condyle: absent (0); present (1) (Fig 2.59D).

New character.

A large proximally extending tubercle on the medial condyle (state 1) is present in *Melanopareia torquata bitorquata* and *Malurus melanocephalus* (Fig. 2.59D).

423. Femur, intercondylar sulcus (sulcus intercondylaris/patellaris): deep (0); shallow (1) (Fig. 2.58).

New character.

A shallow intercondylar sulcus is present in mainly members of Eucavitaves and Passeriformes (Fig. 2.58D).

424. Femur, width of intercondylar sulcus (sulcus intercondylaris/patellaris): narrow (0); wide (1) (Fig. 2.58).

New character. See Figure 2.58.

425. Femur, length compared to tibiotarsus: over 1/2 length of tibiotarsus (0); less than 1/2 length of tibiotarsus (1).

New character.

See Table S1.5 for length measurements of tibiotarsus.

TIBIOTARSUS

426. Fibula, length: short, less than half the length of the tibiotarsus (0); elongate, reaching almost to the distal end of the tibiotarsus (1).

Mayr *et al.* (2003, ch. 60), Mayr (2005a, ch. 66), Mayr (2006, ch. 81), Mayr *et al.* (2010, ch. 66), Mayr (2011, ch. 69), Ksepka *et al.* (2011, ch. 63), Ksepka & Clarke (2012, ch. 67), Ksepka *et al.* (2017, ch. 77), Ksepka *et al.* (2019, ch. 104).

In Cathartiformes, Accipitriformes and Falconiformes the fibula is proportionally much longer (state 1) than it is in other Telluraves. Within these birds the fibula can extend to, and be fused to, the most distal portion of the tibiotarsus (e.g. *Pandion haliaetus carolinensis*).

427. Fibular crest, proximodistal location: proximal to head of tibiotarsus (0); close to midshaft of tibiotarsus (1) (Fig. 2.60).

Musser & Cracraft (2019, ch. 330), Livezey & Zusi (2006, ch. 2085).

A fibular crest that is close to the midshaft of the tibiotarsus (state 1) is mostly present in Psittaciformes (Fig. 2.60D) and Passeriformes (Fig. 2.60E).

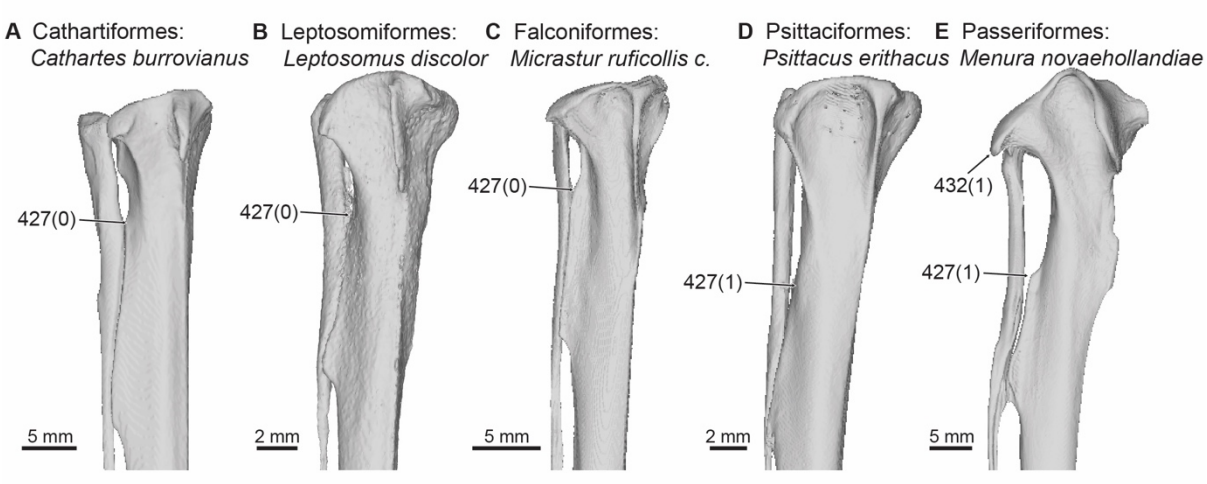


Figure 2.60. Proximal portion of Left tibiotarsi in cranial view showing characters 427 and 432, proximal portion of left tibiotarsus in cranial view. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (C) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (D) *Psittacus erithacus* (African grey parrot, NHMUK zoo S/1992.41.60); (E) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

428. Tibiotarsus, cranial cnemial crest (crista cnemialis cranialis), apex, proximodistal height relative to head of tibiotarsus: at same height of fossae retropatellares or only slightly elevated above fossae (0); well projected proximally to fossae (1) (Fig. 2.61).

Mayr & Clarke (2003, ch. 99), Mayr (2004, ch. 39), Clarke *et al.* (2009, ch. 61), Mayr (2016, ch. 31), Mayr & Kitchener (2022a, ch. 32).

A well projected cranial cnemial crest (state 1) is present in Coliiformes, most members of Piciformes (Fig. 2.61B), Cariamiformes (Fig. 2.61C), some members of Psittaciformes, and some members of Passeriformes (*Acanthisitta*, suboscines; Fig. 2.61E).

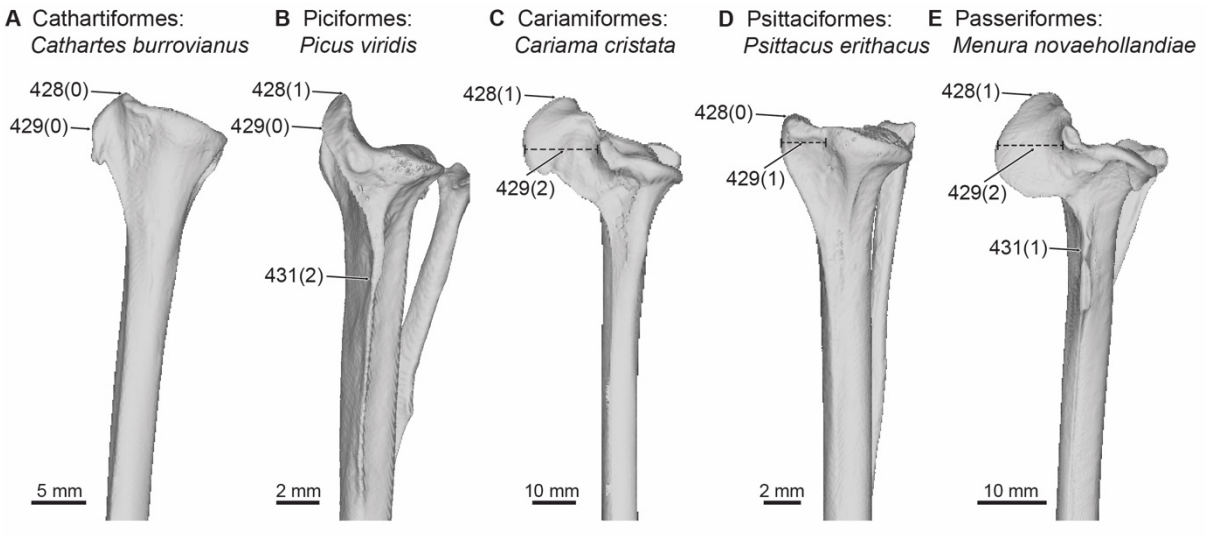


Figure 2.61. Proximal portion of left tibiotarsi in medial view showing characters 428, 429 and 431, proximal portion of left tibiotarsus in medial view. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Picus viridis* (European green woodpecker, NHMUK zoo S/1982.5.1); (C) *Cariama cristata cristata* (Red-legged seriema, FMNH birds 105635); (D) *Psittacus erithacus* (African grey parrot, NHMUK zoo S/1992.41.60); (E) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

429. Tibiotarsus, cranial cnemial crest (crista cnemialis cranialis) extent of (anterior) projection from shaft: less than width of shaft (0); subequal to width of shaft (1); greater than width of shaft (2) (Fig. 2.61).

Smith *et al.* (2018, ch. 38), Hieronymus *et al.* (2019, ch. 27).

See figure 2.61 for variations in the extent of the projection anteriorly.

430. Tibiotarsus, both cristae cnemiales and crista patellaris forming a ridge, which circumscribes a groove on the cranial side of the bone: absent (0), present (1) (Fig. 2.62).

Mayr *et al.* (2003, ch. 57), Zelenkov & Dyke (2008, ch. 17), Ksepka & Clarke (2009, ch. 34), Ksepka & Clarke (2010, ch. 39), Mayr *et al.* (2010, ch. 63), (2013, ch. 23), Mayr (2015, ch. 42), Ksepka *et al.* (2019, ch. 99), Ksepka *et al.* (2017, ch. 73), Mayr (2020, ch. 55), Mayr (2021, ch. 48), Mayr & Kitchener (2023a, ch. 60), Mayr & Kitchener (2023b, ch. 59), Mayr & Kitchener (2023c, ch. 58).

Mayr & Kitchener (2023a,b,c) scored only Picidae and Coliidae as state 1, whereas Ksepka *et al.* (2019) scored Coliiformes and Passeriformes as state 1. The discrepancy in scoring is likely due to the character description not being very clear. In many birds the cristae cnemiales and crista

patellaris form a slightly raised ridge, but only in Coliiformes (Fig. 2.62A) and *Picus* (Fig. 2.62B) does this ridge become a shelf bounded distally by a deep grove is visible.

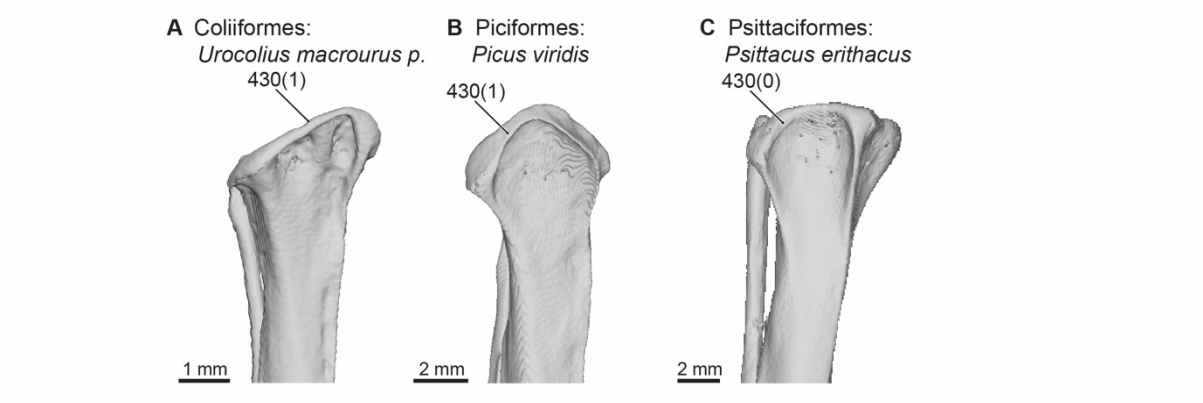


Figure 2.62. Proximal portion of left tibiotarsi in cranial view showing character 430. (A) *Urocolius macrourus pulcher* (Blue-naped mousebird, FMNH birds 368959); (B) *Picus viridis* (European green woodpecker, NHMUK zoo S/1982.5.1); (C) *Psittacus erithacus* (African grey parrot, NHMUK zoo S/1992.41.60). Numbers denote characters and character states as listed.

431. Tibiotarsus, medial view of proximal end: no ridge (0); low ridge opposite to fibular crest (1); crista cnemialis cranialis continuous with a marked crest opposite to fibular crest (2) (Fig. 2.61).

Mayr (2004, ch. 33), Mayr *et al.* (2004, ch. 8), Mayr (2005a, ch. 64), Mayr (2005b, ch. 71), Mayr (2006, ch. 78), Ksepka & Clarke (2009, ch. 33), Clarke *et al.* (2009, ch. 62), , Ksepka & Clarke (2010, ch. 38), Mayr *et al.* (2010) ch. 64, Ksepka *et al.* (2011) ch. 61, Mayr (2011) ch. 66, Ksepka & Clarke (2012) ch. 64, Mayr (2013, ch. 22), Mayr (2015, ch. 43), Bourdon *et al.* (2016, ch. 47), Ksepka *et al.* (2017, ch. 72), Ksepka *et al.* (2019, ch. 98), Mayr (2020, ch. 56), Raimon *et al.* (2020, ch. 36), Mayr (2021, ch. 49), Mayr & Kitchener (2023a, ch. 61), Mayr & Kitchener (2023b, ch. 62), Mayr & Kitchener (2023c, ch. 59).

Mayr & Kitchener (2023a,b,c) scored all Passeriformes as state 1. However, in the present study this morphology was found to be much more variable among Passeriformes, with some taxa showing state 2 (Fig. 2.61E) as well as state 0.

432. Tibiotarsus, crista cnemialis lateralis, apex, proximodistal height relative to head of tibiotarsus: approximately at the level of fossae retropatellares (0); extremely distally projected (hooked) (1) (Fig. 2.60).

Ksepka *et al.* (2011, ch. 60), Ksepka & Clarke (2012, ch. 63), Mayr (2015, ch. 44), Ksepka *et al.* (2019, ch. 100), Mayr (2020, ch. 57), Mayr (2021, ch. 50), Mayr & Kitchener (2023a, ch. 62), Mayr & Kitchener (2023b, ch. 61), Mayr & Kitchener (2023c, ch. 60).

A distally projected and hook-like lateral cnemial crest (state 1) is present in Cariamiformes, and Passeriformes (Fig. 2.60E) .

433. Tibiotarsus, distal end, cartilaginous trochlea (trochlea cartilaginis) caudal margin deeply concave, creating a wide H-shaped outline: absent (0); present (1) (Fig. 2.63).

Ksepka *et al.* (2017) ch.76, Ksepka *et al.* (2019) ch.103.

The cartilaginous trochlea forming a wide H-shaped outline (state 1) is a derived condition that characterises Strigiformes (Fig. 2.63B)

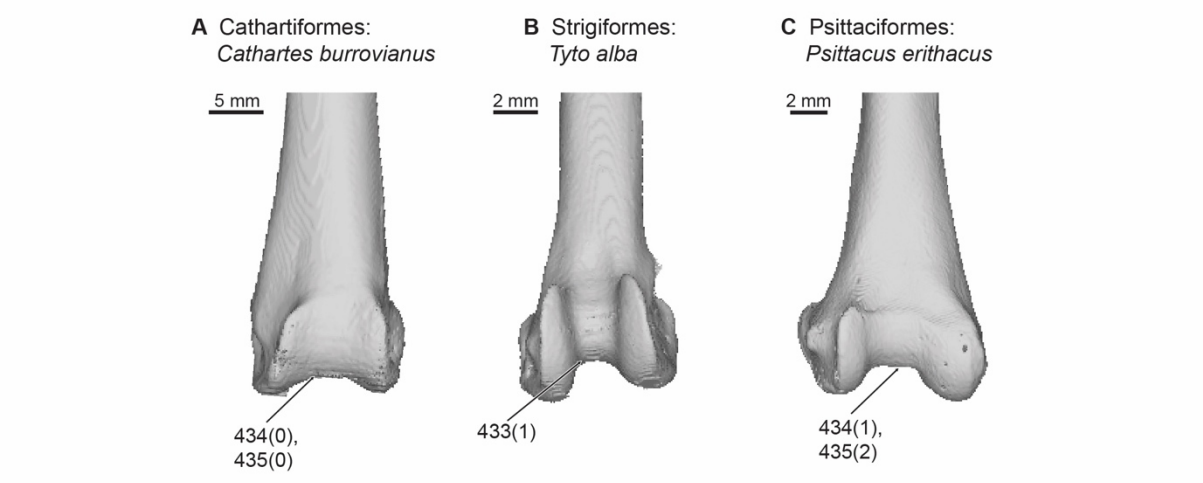


Figure 2.63. Distal portion of left tibiotarsi in caudal view showing characters 433, 434 and 435, distal portion of left tibiotarsus in caudal view. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Tyto alba* (Barn owl, NHMUK zoo S/1989.22.1); (C) *Psittacus erithacus* (African grey parrot, NHMUK zoo S/1992.41.60). Numbers denote characters and character states as listed.

434. Tibiotarsus, depth of distal groove in cartilaginous trochlea (trochlea cartilaginus tibialis): shallow (0); deep (1) (Fig. 2.63).

Ksepka *et al.* (2011) ch.62, Ksepka & Clarke (2012) ch.66.

The tibial cartilage trochlea (trochlea cartilaginus tibialis) is located on the posterior face of the tibiotarsus between the medial and lateral condyles. In most Telluraves this surface is relatively flat (state 0; Fig. 2.63A) except in Psittaciformes (Fig. 2.63B) and Passeriformes (state 1; Fig. 2.63C).

435. Tibiotarsus, caudal view, ratio of tibial cartilage trochlea (trochlea cartilaginis tibialis) height (proximodistal) to width (mediolateral) of condyles: subequal (0.9) (0); trochlea cartilaginis tibialis subequal compressed and condyles mediolaterally wide (1); exceptionally mediolaterally wide (>1.9) (2).

Modified from Mayr *et al.* (2003, ch. 59), Mayr (2006, ch. 79), Mayr (2011, ch. 67), Mayr (2015, ch. 45), Ksepka *et al.* (2017, ch. 75), Ksepka *et al.* (2019, ch. 102), Mayr (2020, ch. 58), Mayr (2021, ch. 51), Mayr (2022, ch. 41), Mayr & Kitchener (2023a, ch. 63), Mayr & Kitchener (2023b, ch. 62), Mayr & Kitchener (2023c, ch .61).

See Table S1.5 for measurements.

436. Tibiotarsus, ossified supratendinous bridge (pons supratendineus): present (0), absent (1) (Fig. 2.68).

Mayr & Clarke (2003, ch. 100), Mayr *et al.* (2003, ch. 58), Mayr (2005a, ch. 65), Mayr (2005b, ch. 72), Mayr (2006, ch. 80), Mayr *et al.* (2010, ch. 65), Mayr (2011, ch. 68), Ksepka & Clarke (2012, ch. 65), Ksepka *et al.* (2017, ch. 74), Ksepka *et al.* (2019, ch. 101), Raimon *et al.* (2020, ch. 39), Mayr & Kitchener (2023d, ch. 14).

The presence of an ossified supratendinous bridge (state 0) was proposed as a synapomorphy of Neornithes relative to *Ichthyornis* by Gauthier (1986) and Cracraft (1988, p. 344). However, there is no ossification (state 1) observed in Strigiformes (Fig. 2.64B) and some Psittaciformes (Cacatuidae).

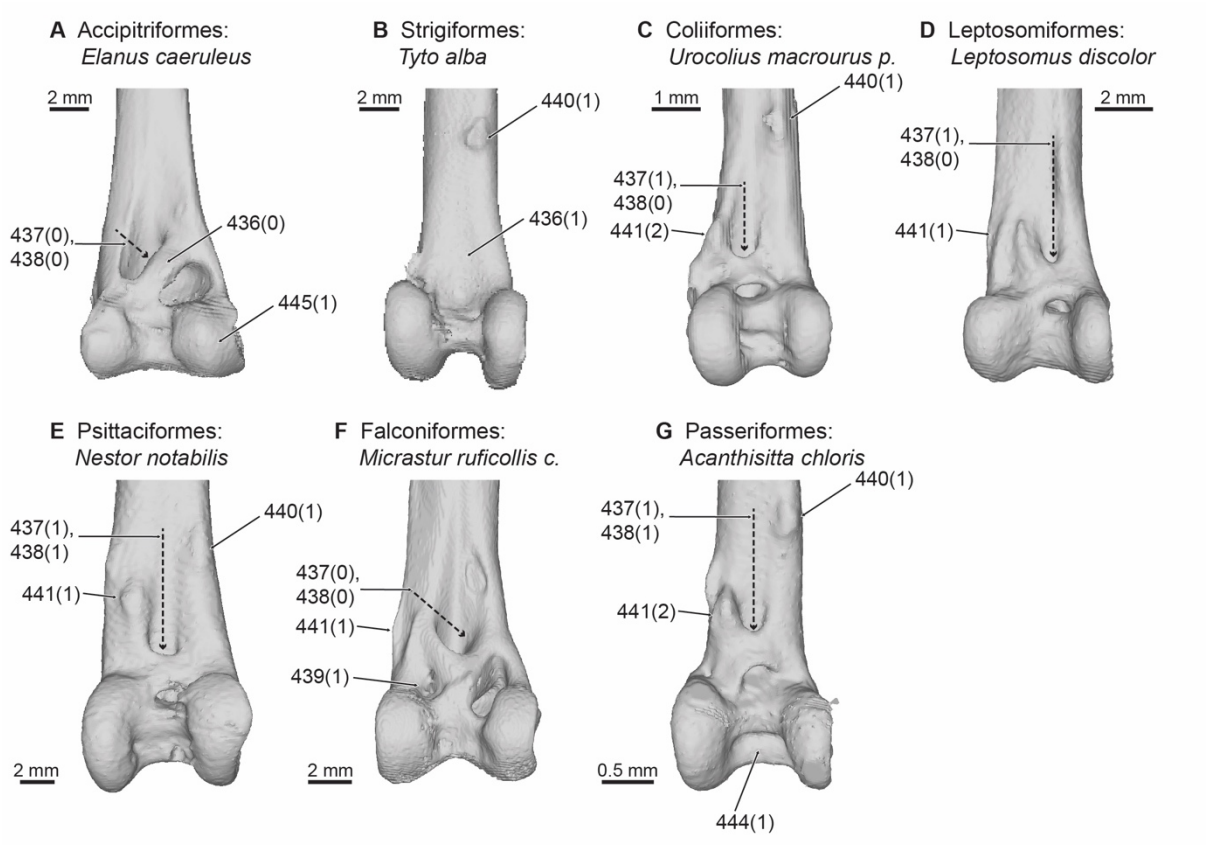


Figure 2.64. Distal portion of left tibiotarsi in cranial view showing characters 436, 437, 438, 440, 441 and 444. (A) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (B) *Tyto alba* (Barn owl, NHMUK zoo S/1989.22.1); (C) *Urocolius macrourus pulcher* (Blue-naped mousebird, FMNH birds 368959); (D) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (E) *Nestor notabilis* (Kea, FMNH birds 23530); (F) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (G) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146). Numbers denote characters and character states as listed.

437. Tibiotarsus, alignment of supratendinous bridge (pons supratendineus) in relation to long axis of shaft: oblique, oriented proximolaterally-to-distomedially (0); perpendicular, oriented mediolaterally (1); inapplicable, ossified pons supratendineus absent [ch.436] (N/A) (Fig. 2.64).

New character.

An oblique supratendinous bridge in relation to the long axis of the shaft (state 0) is observed in Cathartidae, Accipitridae (Fig. 2.64A), Cariamiformes and Falconiformes (Fig. 2.64). Within these groups there is variation on the exact angle at which the bridge is oblique but for the purpose of these studies it is generalised to account for the two extreme conditions of either orientated mediolaterally or proximolaterally-to-distomedially orientated.

438. Tibiotarsus, sulcus extensorius position: medial margin (0); centrally placed (1) (Fig. 2.64).

New character.

The groove that houses the extensor muscles of the digits can be located more centrally (state 1) or placed along the medial margin (state 0). See figure 2.64 for examples.

439. Tibiotarsus, distal end, number of openings to canalis extensorius: 2 (0); 3 (1) (Fig. 2.64).

New character.

In Falconiformes an additional opening is observed lateral to the canalis extensoris (state 1; Fig. 2.64F).

440. Tibiotarsus, distal end, cranial view, prominent tubercle/ridge (apophysis interna ligamenti obliqui) on medial margin of shaft, proximal of pons supratendineus: absent (0); present (1) (Fig. 2.64).

New character.

A prominent tubercle located on the medial margin of the shaft, proximal to the supratendineus bridge (state 1) is present in Strigiformes (Fig. 2.64B), Coliiformes (Fig. 2.64E), Piciformes, some members of Psittaciformes (Fig. 2.64E) and Passeriformes (Fig. 2.64G). There are cases where there might be a tubercle but is difficult to discern, for example in *Micrastur* there is a shallow depression on the medial margin of shaft, proximal of pons supratendineus , this has been scored as absent and should likely be made into a new character.

441. Tibiotarsus, lateral tuberositas retinaculi extensori: absent (0); weakly developed (groove) (1); forming a prominent projection on medial edge (2) (Fig. 2.64).

Modified from Mayr (2022, ch. 42).

An additional state was added to account for the condition in which the lateral tuberositas retinaculi extensori forms a lateral groove (state 1; Fig. 2.64D, E, F), otherwise a prominent lateral tuberositas retinaculi extensori is a rounded projection (state 2; Fig. 2.64C, G)

442. Tibiotarsus, epicondylus medialis tubercle: absent/small projection (0); projects markedly from condyle (1).

Modified from Mather *et al.* (2022, ch. 230).

443. Tibiotarsus, epicondylus lateralis tubercle: absent/small projection (0); projects markedly from condyle (1).

Mather *et al.* (2022, ch. 238).

444. Tibiotarsus, distal end, cranial view, deep, mediolaterally broad depression within intercondylar sulcus: absent (0); present (1) (Fig. 2.64).

New character.

A deep and mediolaterally broad depression within the intercondylar sulcus (state 1) is present in most members of Passeriformes (Fig. 2.64G).

445. Tibiotarsus, condylus medialis much wider than condylus lateralis: no (0), yes (1) (Fig. 2.64).

Mayr & Kitchener (2023d) ch.15.

This character was originally described for the stem Strigiformes *Minerva* and *Oligostrix* (Mayr *et al.* 2020). It would however appear that extant Accipitridae also have wide medial condyle (Fig. 2.64A).

446. Tibiotarsus, deep and distinct ovate fossa distal to incisura intercondylaris: absent (0); present (1).

New character.

Only observed in *Vastanavis*, see Mayr *et al.* (2013, fig. 1P).

TARSOMETATARSUS

447. Tarsometatarsus, lateral cotyle, depth: deep, concave (0); flat or slightly concave (1).

Musser & Clarke (2022, ch. 645).

448. Tarsometatarsus, lateral cotyle, proximal view, dorsal margin, crista-like margin and/or subtending angle: absent, dorsal margin of cotyle essentially absent and cotyla is coplanar with and almost indistinguishable from cotyla corpus (0); present (1) (Fig. 2.65).

Modified from Musser & Clarke (2022, ch. 644), Mayr & Kitchener (2023b, ch. 67).

State 1 is present in Strigidae (Fig. 2.65D) and Coliiformes (Fig. 2.65E).

449. Tarsometatarsus, medial portion of proximal end forming a prominent dorsal projection: no (0); yes (1) (Fig. 2.65).

Mayr & Kitchener (2023a, ch. 68).

This prominent dorsal projection on the medial portion of the medial condyle (state 1) is likely related to the retinaculum extensorium, see Ch. 452. In Mayr & Kitchener (2023a) for extant birds, only Coliidae are scored as state 1 (Fig. 2.65E). This feature is also however, present in many Strigiformes (Fig. 2.65D), Piciformes and some Coraciiformes (Fig. 2.65H), as well as many Pan-Psittaciformes like *Tynskya* (Mayr & Kitchener 2023a, fig. 8P, Q).

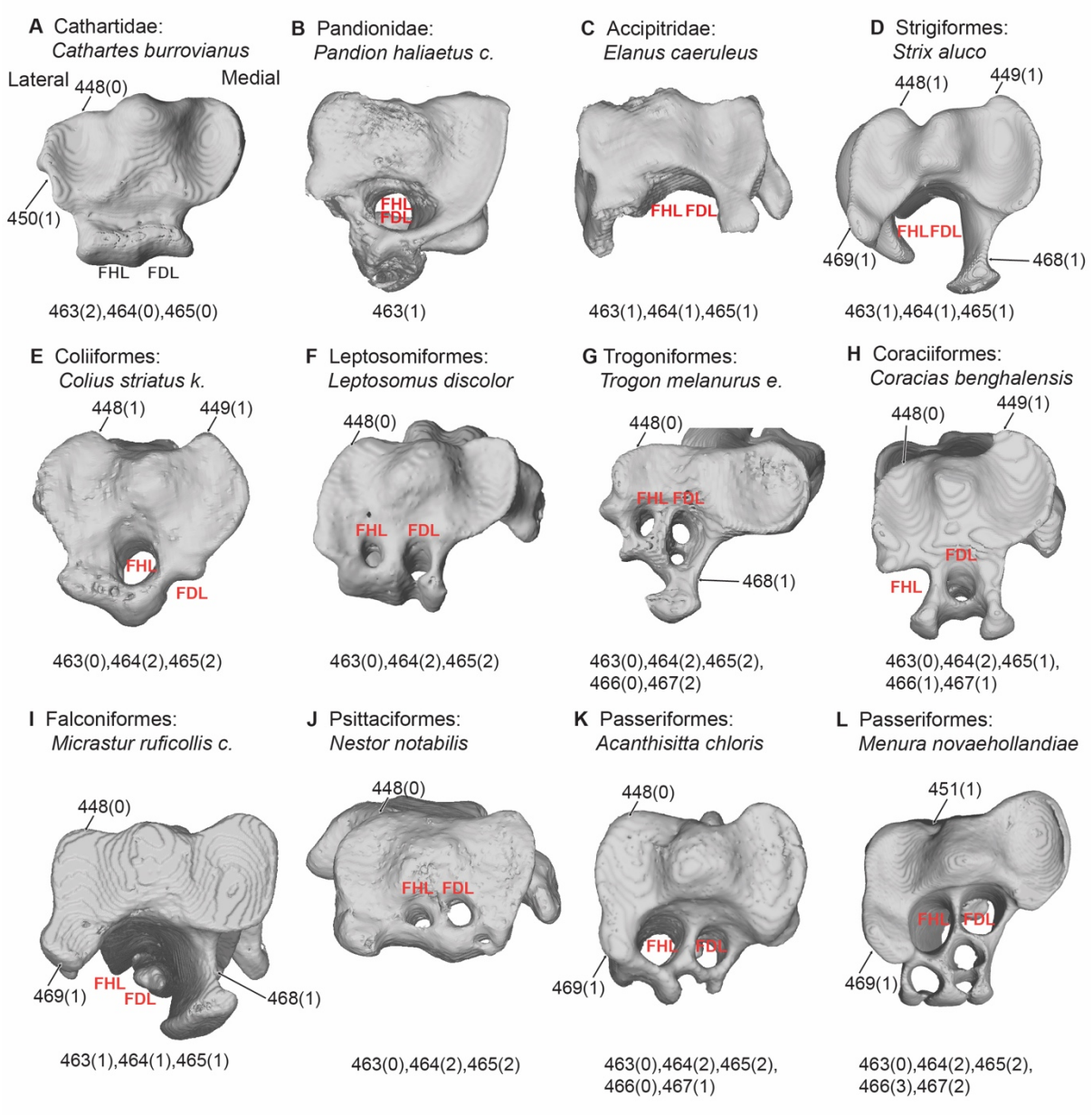


Figure 2.65. Right tarsometatarsi in proximal view showing characters 448, 449, 450, 451, 463, 464, 465, 466, 467, 468 and 469. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Pandion haliaetus* carolinensis (Osprey, FMNH birds 437336); (C) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (D) *Strix aluco* (Tawny owl, NHMUK zoo S/2001.38.1); (E) B) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (F) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (G) *Trogon melanurus eumorphus* (Black-tailed trogon, FMNH birds 290496);(H) *Coracias benghalensis* (Indian roller, NHMUK zoo S/1987.19.15); (I) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (J) *Nestor notabilis* (Kea, FMNH birds 23530); (K) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146).; (L) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

450. Tarsometatarsus, notch on lateral crest of the lateral condyle: absent (0); present (1) (Fig. 2.65A).

New character.

A notch on the lateral condyle (state 1) is only present in Cathartidae (Fig. 2.65A).

451. Tarsometatarsus, small depression proximal to intercotylar eminence (eminentia intercotylaris), on dorsal crest of lateral condyle: absent (0); present (1) (Fig. 2.65L).

New character.

The small depression (state 1) is present in some members of Passeriformes (Fig. 2.65L).

452. Tarsometatarsus, arcus extensor (retinaculum extensorium): not apparent/open (0); deep open furrow denoted by lateral ridges (1); completely ossified forming arcus extensorius (2) (Fig. 2.66).

Modified from Mayr *et al.* (2003, ch. 65), Mayr (2004, ch. 35), Mayr (2005a, ch. 70), Mayr (2006, ch. 86), Ksepka & Clarke (2009, ch. 36), Clarke *et al.* (2009, ch. 64), Mayr *et al.* (2010, ch. 70), Ksepka & Clarke (2010, ch. 41), Mayr (2011, ch. 72), Mayr (2015, ch. 53), Bourdon *et al.* (2016, ch. 49), Ksepka *et al.* (2017, ch. 81), Ksepka *et al.* (2019, ch. 108), Mayr (2020, ch. 66), Mayr (2021, ch. 59), Mayr & Kitchener (2023a, ch. 73), Mayr & Kitchener (2023b, ch. 71), Mayr & Kitchener (2023c, ch. 69), Mayr & Kitchener (2023d, ch. 18).

Previous authors only denoted the absence or presence of the arcus extensor, an ossified retinaculum that holds the m. tibialis cranialis in place. However, there is variation on the amount of ossification seen throughout Telluraves. A deep furrow with lateral ridges known as the impressio retinaculi extensori (Baumel & Witmer, 1993) is observed in many Cavitaves (Fig. G, H), Psittaciformes (Fi. 2.66J) and some Accipitridae (see Migotto 2006) (state 1). This is likely the site of ossification of the tendon insertion sites of the extensor muscle of digit III. In some Piciformes a very thin incomplete arcus is apparent, they are however scored as (1). State 2, where a fully ossified retinaculum occurs in Pandionidae (Fig. 2.66B), Strigiformes (Fig. 2.66D), Coliiformes (Fig. 2.66E) and Passeriformes.

453. Tarsometatarsus, intercotylar eminence (eminentia intercotylaris), proximal projection in cranial view: low and gently rounded (0), proximally projected (1); strongly proximally projected (2) (Fig. 2.66).

Modified from Ksepka *et al.* (2017, ch. 79), Ksepka *et al.* (2019, ch. 106).

This character was modified by adding a new state that accommodates for an almost double in size intercotylar eminence seen in Piciformes (Fig. 2.66H).

454. Tarsometatarsus, proximal vascular foramina (foramina vascularia proximalia): both lateral and medial foramina present (0); only medial foramen present (1); only lateral foramen present (2) (Fig. 2.66).

Mayr *et al.* (2004, ch. 11), Zelenkov & Dyke (2008, ch. 19), Ksepka & Clarke (2009, ch. 39), Ksepka & Clarke (2010, ch. 44), Ksepka *et al.* (2011, ch. 73), Ksepka & Clarke (2012, ch. 77), Mayr (2013, ch. 26), Ksepka *et al.* (2017, ch. 84), Ksepka *et al.* (2019, ch. 111), Mayr & Kitchener (2023b, ch. 68).

A single medial foramen (state 1) is observed in Coliiformes as well as *Cyrilavis* (Ksepka *et al.* 2011; Ksepka & Clarke 2012), though the medial foramen could possibly be obscured in *Cyrilavis*. A single lateral foramen (state 2) is observed in extant Psittaciformes (Fig. 2.66L) and possibly in some *Trogon* species (Mayr *et al.* 2023) though not observed in the species of the current study.

455. Tarsometatarsus, proximal vascular foramina (dorsal openings), relative position: at same level as each other (0); lateral foramen more proximal than medial foramen (1); medial foramen more proximal than lateral foramen (2); inapplicable, medial or lateral foramina vascularia proximalia absent [ch. 454] (N/A) (Fig. 2.66).

Mayr *et al.* (2010, ch. 99), Ksepka *et al.* (2011, ch. 74), Ksepka & Clarke (2012, ch. 78), Mayr (2015, ch. 50), Mayr (2020, ch. 63), Mayr (2021, ch. 56), Mayr & Kitchener (2023c, ch. 66), Mayr & Kitchener (2023a, ch. 70).

Best observed in plantar view, it is to be noted that the lateral foramen is always slightly more proximal than the medial in most birds, so state (1) is when there is a much larger difference in distance. State (2) is only observed in Trogoniformes (Fig. 2.66G) and *Alcedo atthis*. The previous characters were modified for a number of reasons, for example in Mayr & Kicthener (2023a) ch. 70 it is stated " foramin vascularia proximalia widley separated, with lateral foramen situated

farther proximally than medial", the distance between the foramen are now in a new character (ch. 456) as these features are independently varying.

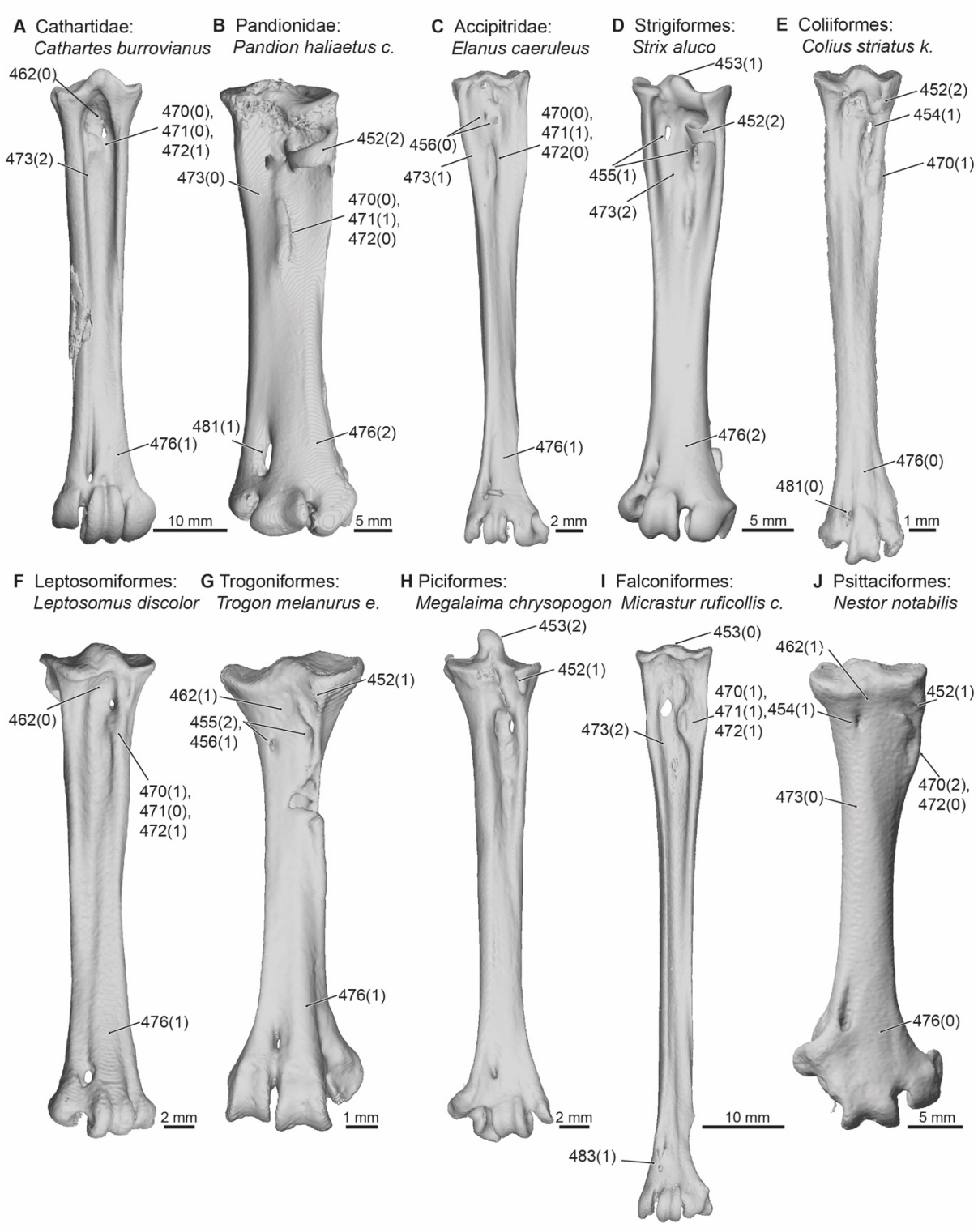


Figure 2.66. Right tarsometatarsi in dorsal view showing characters 454, 455, 458, 462, 470, 471, 472, 476, 482 and 483. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Pandion haliaetus* carolinensis (Osprey, FMNH birds 437336); (C) *Elanus caeruleus* (Black-winged kite,

NHMUK zoo 1850.8.15.159); (D) *Strix aluco* (Tawny owl, NHMUK zoo S/2001.38.1); (E) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (F) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (G) *Trogon melanurus eumorphus* (Black-tailed trogon, FMNH birds 290496);(H) *Megalaima chrysopogon* (Golden-whiskered barbet, NHMUK zoo 1850.8.15.28); (I) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (J) *Nestor notabilis* (Kea, FMNH birds 23530). Numbers denote characters and character states as listed.

456. Tarsometatarsus, dorsal proximal vascular foramina: closely placed (0); widely separated from one another (1) (Fig. 2.66).

Modified from Ksepka et al. (2019, ch. 112).

457. Tarsometatarsus, dorsal proximal vascular foramina enclosed in ovoid depression that is plantar to plane of sulcus extensorius: absent, foramina coplanar with sulcus extensorius (0); present (1).

Musser & Clarke (2022, ch.664)

The dorsal proximal vascular foramina enclosed in ovoid depression (state 1) is only observed in Cariamiformes within Telluraves.

458. Tarsometatarsus, proximal vascular foramina size: small (0); very large (1).

New character.

In extant Telluraves, exceptionally large proximal vascular foramina (state 1) are observed in for example *Tockus nasutus*. In *Micrastur concentricus* only the lateral foramen is very large, this character was scored as state 1 (Fig. 2.66I). Very large foramina are mainly observed in fossil taxa such as *Pulchrapolia* and *Vastanavis*.

459. Tarsometatarsus, proximal vascular foramina unequal in size, medial foramen very large and lateral diminutive: absent (0); present (1).

New character.

A medial foramen larger than the lateral foramen is present in of halycornithids (Ksepka & Clarke 2012).

460. Tarsometatarsus, medial plantar crest (crista medioplantaris): absent (0); short crista, restricted to proximal third of tarsometatarsus (1); distally extensive, extending nearly to midpoint of tarsometatarsus (2) (Fig. 2.67).

Modified from Mayr *et al.* (2004, ch. 26), Clarke *et al.* (2009, ch. 66), Ksepka & Clarke (2009, ch. 37), Ksepka & Clarke (2010, ch. 42), Ksepka *et al.* (2011, ch. 76), Ksepka & Clarke (2012, ch. 80), Mayr (2015, ch. 48), Bourdon *et al.* (2016, ch. 51), Ksepka *et al.* (2017, ch. 82), Ksepka *et al.* (2019, ch. 109), Mayr (2020, ch. 61), Mayr (2021, ch. 54), Mayr (2022, ch. 43), Mayr & Kitchener (2023a, ch. 66), Mayr & Kitchener (2023b, ch. 65), Mayr & Kitchener (2023c, ch. 64).

I added an additional state 1 to account for the variation seen throughout Telluraves, as the above references have differing scores. The hypotarsus passes into a well-developed medial plantar crest, which can be short, restricted to the proximal third of the tarsometatarsus (state 1), for example Leptosomiformes (Fig. 2.67E). Other Telluraves, mainly Coraciiformes have a distally extensive crest (state 2; Fig. 2.67H).

461. Tarsometatarsus, medial parahypotarsal fossa (fossa parahypotarsalis medialis) marked and proximal part of margo medialis forming a sharp ridge: absent (0), present (1) (Fig. 2.67).

Mayr *et al.* (2003, ch. 61), Mayr (2004, ch. 36), Mayr *et al.* (2004, ch. 27), Mayr (2005a, ch. 67), Mayr (2006, ch. 83), Mayr (2011, ch. 70), Mayr *et al.* (2010, ch. 67), Mayr (2015, ch. 49), Bourdon *et al.* (2016, ch. 50), Mayr (2020, ch. 62), Mayr (2021, ch. 55), Mayr (2022, ch. 44), Mayr & Kitchener (2023a, ch. 67), Mayr & Kitchener (2023b, ch. 66), Mayr & Kitchener (2023c, ch. 65).

A marked medial parahypotarsal fossa (state 1) is present in Leptosomiformes and Coraciiformes (Fig. 67H).

462. Tarsometatarsus, dorsal infracotylar fossa (fossa infracotylaris dorsalis): concave (0); absent, where the cranial surface is flattened or convex (1) (Fig. 2.66).

Ksepka *et al.* (2011, ch. 72), Ksepka & Clarke (2012, ch. 76), Bourdon *et al.* (2016, ch. 71).

In most Telluraves a concave fossa is present proximally, on the cranial surface of the tarsometatarsus (state 0; Fig. 2.66). In Psittaciformes (Fig. 2.66J) and Trogoniformes (Fig. 2.66G) the fossa is absent, where the cranial surface is flattened or convex (state 1).

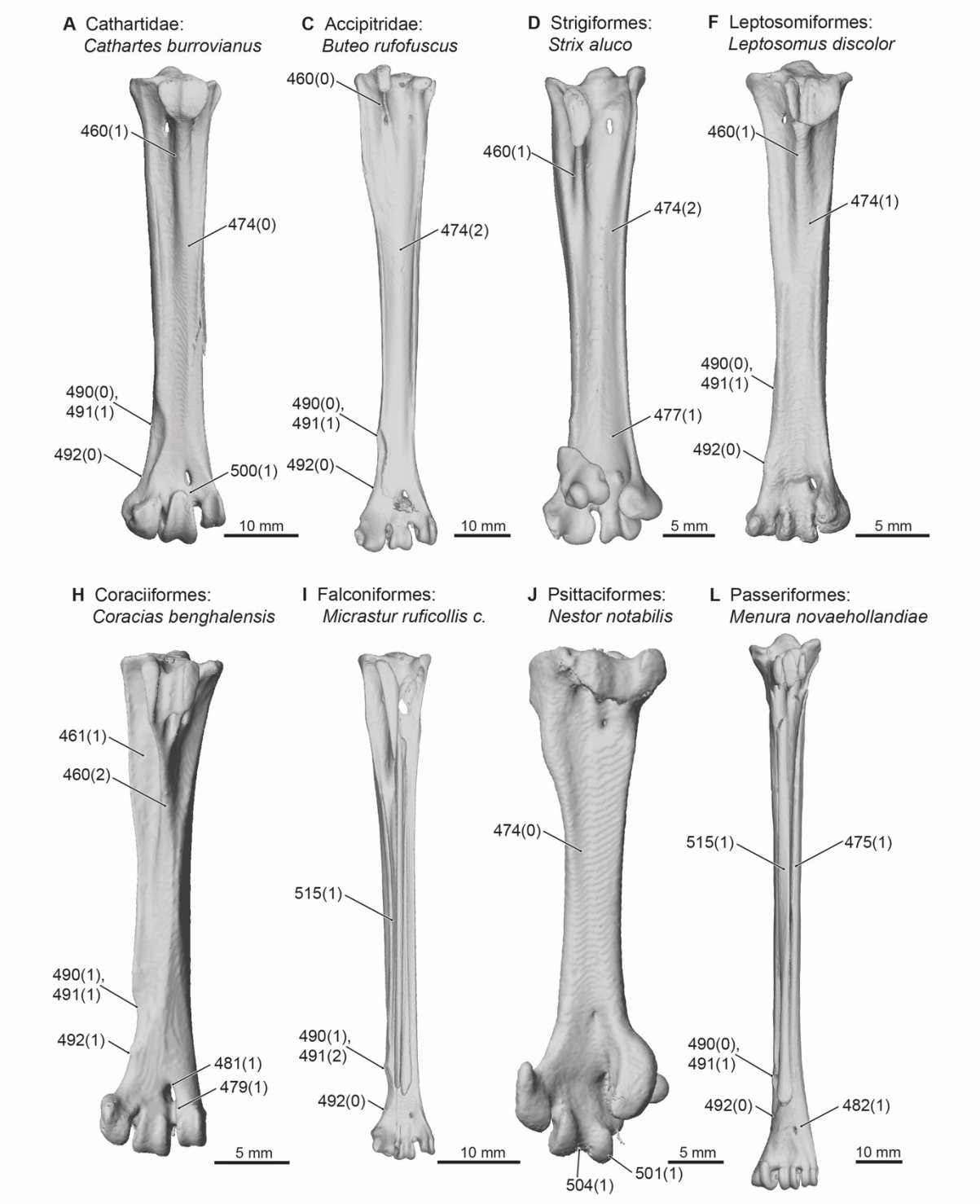


Figure 2.67. Right tarsometatarsi in caudal view showing characters 460, 461, 474, 475, 479, 482, 481, 490, 491, 492, 501, 504 and 515. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Buteo rufofuscus* (Jackal buzzard, NHMUK zoo 1862.1.18.1), (C) *Strix aluco* (Tawny owl, NHMUK zoo S/2001.38.1); (D) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (E) *Coracias benghalensis* (Indian roller, NHMUK zoo S/1987.19.15); (F) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (G) *Nestor notabilis* (Kea, FMNH birds 23530); (H) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.

463. Tarsometatarsus, hypotarsus, sulcus/canal for tendon of musculus flexor hallucis longus (FHL) and sulcus/canal for tendon of musculus flexor digitorum longus (FDL): multiple crests that enclose individual flexor tendons in sulci/canals (0); two separated crests or common canal, which encompass all flexor tendons (1); block-like, with flat plantar surface, which guides all plantar tendons (2) (Fig. 2.65).

New character.

Terminology for the hypotarsus from (Mayr 2016b). Within Telluraves there are three conditions or types of hypotarsus. In the "asulcate" hypotarsus type (state 2; Fig. 2.65A) the hypotarsus is block-like, no canals and only shallow furrows for the flexor tendons. This is observed in Cathartidae, Sagittariidae and Cariamiformes. In extinct taxa it is observed in *Danielsraptor phorusrhacoides* (NMS.Z.2021.40.12, Mayr & Kitchener 2022a, fig. 5) and *Masillaraptor parvunguis* (SMF-ME 1065, Mayr 2006, no figure only in text). In Mayr (2016) *Bathornis sp.* is scored as having a block-like hypotarsus but not for *B. Grallator* as the hypotarsus is missing but for *B. veredus* see Olsen (1985, fig. 6). In the "monosulcate" type (state 1; Fig. 2.65B, C,D,I) only a single sulcus is present, which usually encompasses all or most flexor tendons. In extinct taxa this is observed in *Tynskya* (see Mayr 2011, fig. 6; Mayr 2021d , fig. 7; Mayr & Kitchener 2023a) and *Messelastur gratulator* (SMF-ME 11348, Mayr 2011, fig. 5). This type is observed in Accipitridae and Falconiformes. In some rare cases the crests have ankylosed where both tendons are enclosed (for e.g. Pandionidae), they have been scored as state 1. The last type (state 0; Fig. 2.65E, F, G, H, J, K, L) is a combination of "bisulcate" where there are separate sulci for the FDL and FHL tendons, "trisulcate" where there are three sulci, "monocanaliculate" where a single canal, centrally or medially placed, can include the FDL tendon and "bicanaliculate" where there are two canals for the FHL and FDL tendons. These last combinations are better served in separate characters (Ch. 464, Ch. 465, Ch. 466 and Ch. 467) with a focus on each of the tendons as there are a number of different combinations observed in Telluraves.

464. Tarsometatarsus, hypotarsus, pathway of FDL: not indicated by a discrete bony structure (0); well-defined groove/open furrow/sulcus, two widely separated crests, which encompass all flexor tendons (1); enclosed or nearly enclosed in a canal (2) (Fig. 2.65).

Modified from Mayr & Clarke (2003, ch. 105), Mayr *et al.* (2003, ch. 64), Mayr *et al.* (2004, ch.1 2), Mayr (2004, ch. 37), Mayr (2005a, ch. 69), Mayr (2005b, ch. 74), Zelenkov & Dyke (2008, ch. 20), Mayr *et al.* (2010, ch. 69), Ksepka & Clarke (2009, ch. 40), Ksepka & Clarke (2010, ch. 45), Ksepka *et al.* (2011, ch. 66), Ksepka *et al.* (2011, ch. 67), Mayr (2011, ch. 71), Ksepka & Clarke (2012, ch.

70), Ksepka & Clarke (2012, ch. 71), Mayr (2013, ch. 28), Mayr (2015, ch. 51), Mayr (2016, ch. 34), Ksepka *et al.* (2017, ch. 85), Ksepka *et al.* (2019, ch. 113), Mayr (2020, ch. 64), Mayr (2021, ch. 57), Mayr (2022, ch. 45), Mayr & Kitchener (2022a, ch. 35), Mayr & Kitchener (2023a, ch. 71), Mayr & Kitchener (2023b, ch. 69), Mayr & Kitchener (2023c, ch. 67), Mayr & Kitchener (2023d, ch. 16).

Character description is based on Ksepka et al (2019, ch. 113). An enclosed (or nearly enclosed) canal for the FDL (state 2) is observed in Cavitaves (Fig. 2.65E, F, G, H), Psittaciformes (Fig. 2.64J) and Passeriformes. State 1 is observed in Strigiformes (Fig. 2.65D), Falconiformes (Fig. 2.6C), and Accipitridae (Fig. 2.65B). State 0 is observed in Cathartidae (Fig. 2.65A) and Cariamiformes. Scores were taken from the above references as well as my own observations.

465. Tarsometatarsus, hypotarsus, pathway for tendon of m. flexor hallucis longus (FHL): not indicated by a discrete bony structure (0); well-defined groove/open furrow/sulcus (1); enclosed canal (2) (Fig. 2.65).

Modified from Mayr & Clarke (2003, ch. 106), Mayr *et al.* (2003, ch. 63), Mayr (2004, ch.38), Mayr *et al.* (2004, ch. 13), Mayr *et al.* (2004, ch. 28), Mayr (2005b, ch. 75), Mayr (2006, ch. 85), Zelenkov & Dyke (2008, ch. 21), Clarke *et al.* (2009, ch. 63), Ksepka & Clarke (2009, ch. 41), Ksepka & Clarke (2010, ch. 46), Ksepka *et al.* (2011, ch. 65), Ksepka & Clarke (2012, ch. 69), Mayr (2013, ch. 27), Mayr (2015, ch. 52), Bourdon *et al.* (2016, ch. 48), Ksepka *et al.* (2017, ch. 86), Ksepka *et al.* (2019, ch. 114), Mayr (2020, ch. 65), Mayr (2021, ch. 58), Mayr (2022, ch. 46), Mayr & Kitchener (2023a, ch. 72), Mayr & Kitchener (2023b, ch. 70), Mayr & Kitchener (2023, ch. 68).

Character description is based on Ksepka et al (2019, ch. 114). The single large hypotarsal canal that is present in extant mousebirds was originally presumed to house the tendon of m. flexor digitorum longus (FDL). However, in mousebirds this canal does not house the tendon of m. flexor digitorum longus (FDL), but instead houses the tendon of m. flexor hallucis longus (FHL) (Mayr 2016). See Figure 2.65 for all state examples.

466. Tarsometatarsus, hypotarsus, pathways of m. flexor perforans digiti III (FPIII), m. flexor perforans et perforatus digiti III (FPPIII) and m. flexor perforans digiti IV (FPIV): not indicated by a discrete bony structure (0); pathway bounded on medial and lateral margins by caudally projecting bony flanges (1); single large canal encloses all three tendons (2); individual small canals enclose each tendon (3) (Fig. 2.65).

Modified from Ksepka *et al.* (2011, ch. 68), Ksepka *et al.* (2011, ch. 71), Ksepka *et al.* (2019, ch. 115), Ksepka *et al.* (2017, ch. 87), Ksepka & Clarke (2012, ch. 72), Ksepka & Clarke (2012, ch. 75).

Fully enclosed canals for individual tendons or combinations of tendons (state 2 & 3) are present in some Piciformes (state 2), Coraciiformes (state 1; Fig. 2.65H), and Passeriformes (state 3; Fig. 2.65L).

467. Tarsometatarsus, hypotarsus, pathway for tendon of m. flexor perforatus digiti II (FPII): no bony pathway (0); in a sulcus (1); enclosed in a canal (2) (Fig. 2.65).

Ksepka *et al.* (2011, ch. 69), Ksepka *et al.* (2011, ch. 70), Ksepka & Clarke (2012, ch. 73), Ksepka & Clarke (2012, ch. 74).

Scorings taken from the above cited references. See Figure 2.65G, H, K & L for examples of all states.

468. Tarsometatarsus, hypotarsus, medial crest (crista medialis, ML), relative plantar prominence: cristae subequal in plantar prominence (0); crista medialis more plantarly prominent than crista lateralis hypotarsi (1) (Fig. 2.65).

Musser & Cracraft (2019, ch. 349); Livezey (1998, ch. 336).

The hypotarsus medial crest is plantarly prominent in Falconiformes (Fig. 2.65I).

469. Tarsometatarsus, hypotarsus, lateral crest (crista lateralis, CL), greatly enlarged and extensive: absent (0); present (1) (Fig. 2.65I & L).

New character.

See Mayr (2016b) for terminology explanation. An extensive and enlarged lateral crest is present in Falconiformes (Fig. 2.65I) and Passeriformes (Fig. 2.65L).

470. Tarsometatarsus, tuberosity of the cranial tibial muscle (tuberositas musculi tibalis cranialis), position: near the midline of the dorsal face of the tarsometatarsus (0); adjacent to the medial margin of the tarsometatarsus (1); directly on craniomedial margin of tarsometatarsus (2) (Fig. 2.66).

Modified from Ksepka *et al.* (2011, ch. 75), Ksepka & Clarke (2012, ch. 79), Ksepka *et al.* (2017, ch. 80), Ksepka *et al.* (2019, ch. 107), Mayr & Kitchener (2023a, ch. 74), Mayr & Kitchener (2023b, ch. 72), Mayr & Kitchener (2023c, ch. 70).

Character description based on Ksepka *et al.* (2019, ch. 107). The tubercle of the cranial tibial muscle is mostly prominent in Accipitriformes where in the rest of Telluraves it can be ambiguous and in some cases only a rough surface, none the less, the position of the tubercle can vary greatly between clades. In the characters of Mayr & Kitchener (2023a,b,c) the tubercle is described as being large and medial to the margin of the bone, unlike in Ksepka *et al*. (2017; 2019) the tubercle is further differentiated into either being medial, adjacent to the medial margin or directly on the craniomedial margin. This has led to differing in scores between these two authors. In both cases Psittaciformes have been scored as either "medial to the bone" or "directly on the craniomedial margin". It is clear that in Psittaciformes the tubercle is no longer on the dorsal surface of the tarsometatarsus but rather on the margin (state 2; Fig. 2.66J) and contributing to a bulge on the medial margin. The position of the tuberosity of the cranial tibial muscle midline of the shaft (state 0) is present in Accipitriformes (Fig. 2.66A, B, C, D).

471. Tarsometatarsus, tuberosity of the cranial tibial muscle, shape: roughly circular or semi-ovular (0); elongate ridge (1) (Fig. 2.66).

Modified from Mather *et al.* (2022, ch. 264).

In Pandionidae (Fig. 2.66B), Accipitridae (Fig. 2.66C), Strigiformes (Fig. 2.66D) and Falconiformes (Fig. 2.66I) the tubercle of the cranial tibial muscle is very developed and resembles a longitudinal ridge rather than a tubercle (state 1).

472. Tarsometatarsus, tuberosity of the cranial tibial muscle relative to foramina vascularia proximalia: distal to medial foramen (0); proximal to medial foramen (1) (Fig. 2.66).

Modified from Mather *et al.* (2022, ch. 266).

The tuberosity of the cranial tibial muscle is proximal to the medial foramen through out Telluraves for example Cathartidae (Fig. 2.66A), Leptosomiformes (Fig. 2.66F) and Falconiformes (Fig. 2.66I).

473. Tarsometatarsus, extensor sulcus (sulcus extensorius): shallow (0); deep (1); cavernous (2) (Fig. 2.66).

New character.

The extensor sulcus varies from shallow (state 0; Fig. 2.66D, G, J), deep (state 1; Fig. 2.66C, E, F) to cavernous (state 2; Fig. 2.66A, I).

474. Tarsometatarsus, flexor sulcus (sulcus flexororius): shallow (0); deep (1); cavernous (2) (Fig. 2.67).

New character.

The flexor sulcus is defined by the medioplantar margin of the shaft. In cases where it is shallow and almost absent (state 0), as in Psittaciformes (Fig. 2.67J), the margin is gently rounded. In *Avolatavis tenens* the flexor sulcus does have small ridges on the margins but has been scored absent/ shallow as the sulcus itself is flat. A cavernous flexor sulcus (state 2) is present in for example Accipitridae (Fig. 2.67C) and Strigiformes (Fig. 2.67D).

475. Tarsometatarsus, well-developed lateral plantar crest (crista plantaris lateralis): absent, same level as crista plantaris medialis (0); present, dorsally more prominent than crista plantaris medialis (1) (Fig. 2.67L).

Mayr (2004, ch. 39), Mayr (2015, ch. 47), Ksepka *et al.* (2017, ch. 83), Ksepka *et al.* (2019, ch. 110), Mayr (2020, ch. 60), Mayr (2021, ch. 53), Mayr & Kitchener (2023a, ch. 65), Mayr & Kitchener (2023b, ch. 64), Mayr & Kitchener (2023c, ch. 63).

A dorsally more prominent lateral plantar crest (state 1) is present in Passeriformes (Fig. 2.67L).

476. Tarsometatarsus, dorsal surface of shaft (facies dorsalis) proximal to trochleae: nearly flat (0); slightly convex (1); strongly convex (2).

Ksepka *et al.* (2019. ch. 117).

A strongly convex dorsal surface of the shaft (state 1) is present in Pandionidae (Fig. 2.66B) and Strigiformes (Fig. 2.66D).

477. Tarsometatarsus, plantar supratrochlear fossa (fossa supratrochlearis plantaris): absent/ indistinct (0); present, distinctly concave (1) (Fig. 2.67)

New character.

A distinctly concave plantar supratrochlear fossa (state 1) is present in Strigiformes (Fig. 2.67D).

478. Tarsometatarsus, distal interosseous canal (canalis interosseus distalis): absent (0); present (1) (Fig. 2.68).

Modified from Mayr & Clarke (2003, ch. 107), Mayr *et al.* (2003, ch. 66), Mayr *et al.* (2004, ch. 30), Mayr (2004, ch. 43), Mayr (2005a, ch. 71), Mayr (2005b, ch. 76), Mayr (2006, ch. 87), Clarke *et al.* (2009, ch. 68), Ksepka & Clarke (2009, ch. 43), Ksepka & Clarke (2010, ch. 48), Mayr *et al.* (2010, ch. 71), Mayr (2011, ch .73), Ksepka *et al.* (2011, ch. 87), Ksepka & Clarke (2012, ch. 91), Mayr (2015, ch. 54), Bourdon *et al.* (2016, ch.53), Ksepka *et al.* (2017, ch.94), Ksepka *et al.* (2019, ch. 125), Mayr (2020, ch. 67), Mayr (2021, ch. 60), Mayr (2022, ch. 48), Mayr & Kitchener (2023a, ch. 75), Mayr & Kitchener (2023a, ch. 76), Mayr & Kitchener (2023b, ch. 73), Mayr & Kitchener (2023b, ch. 74), Mayr & Kitchener (2023c, ch. 71).

The m. extensor brevis digit IV passes through the canalis interosseous distalis, a fully enclosed canal between trochlea IV and III. This canal is observed in Eucavitaves (Fig. 2.68F), Psittaciformes and Passeriformes (state 1). Birds scored as absent (state 0), either have no visible canal at all or, in some cases, have an open sulcus between the foramen vasculare distale and the incisura intertrochlearis lateralis. This sulcus may or may not be related to the canalis interosseus distalis, and so for this reason is separated into a different character (Ch. 479).

479. Tarsometatarsus, distal interosseous canal: not as follows (0); caudally open sulcus between foramen vasculare distale and incisura intertrochlearis lateralis (1); dorsally open sulcus between foramen vasculare distale and incisura intertrochlearis lateralis (2) (Fig. 2.67).

Modified from Mayr & Clarke (2003, ch. 107), Mayr *et al.* (2003, ch. 66), Mayr *et al.* (2004, ch. 30), Mayr (2004, ch. 43), Mayr (2005a, ch. 71), Mayr (2005b, ch. 76), Mayr (2006, ch. 87), Clarke *et al.* (2009, ch. 68), Ksepka & Clarke (2009, ch. 43), Ksepka & Clarke (2010, ch. 48), Mayr *et al.* (2010, ch. 71), Mayr (2011, ch. 73), Ksepka *et al.* (2011, ch. 87), Ksepka & Clarke (2012, ch. 91), Mayr (2015, ch. 54), Bourdon *et al.* (2016, ch. 53), Ksepka *et al.* (2017, ch. 94), Ksepka *et al.* (2019, ch. 125), Mayr (2020, ch. 67), Mayr (2021, ch. 60), Mayr (2022, ch. 48). Mayr & Kitchener (2023a, ch. 75), Mayr & Kitchener (2023a, ch. 76), Mayr & Kitchener (2023b, ch. 73), Mayr & Kitchener (2023b, ch. 74), Mayr & Kitchener (2023c, ch. 71).

A caudally open sulcus between the vasculare distale and incisura intertrochlearis lateralis (state 1) is present in a few Coraciiformes (Fig. 2.67H) and Psittaciformes. State (2) is only observed in *Galbula* among extant birds, but is also present in many extinct taxa such as *Psittacopes, Pseudasturides, Cyrilavis* and *Tynskya* (Mayr & Daniels 1998; Mayr & Kitchener 2024a; Mayr & Kitchener 2023a).

480. Tarsometatarsus, lateral margin of the distal interosseous sulcus, dorsal view, forms a marked projection: absent (0); present (1).

New character.

Characteristic feature seen in many halycornithids (Mayr 2016c, fig. 3).

481. Tarsometatarsus, distal vascular foramen (foramen vasculare distale), size: small to moderate (0); greatly enlarged (1) (Fig. 2.66)

Modified from Mayr *et al.* (2004, ch. 29), Clarke *et al.* (2009, ch. 67), Bourdon *et al.* (2016, ch. 52), Mayr (2022, ch. 47).

The distal vascular foramen varies in size among Telluraves. The foramen is exceptionally small (state 0) in some birds, such as Coliiformes (Fig. 2.66E), this variation has not been accounted for in this study. An enlarged foramen (state 1) is visible in many Halcyornithidae, where this enlargement is on both surface of the tarsometatarsus (see Mayr & Kitchener 2023 fig.5), otherwise in extant birds it is present in Pandionidae (Fig. 2.66B)

482. Tarsometatarsus, distal vascular foramen,: placed distally (0); placed far proximally (1) (Fig. 2.67).

New character.

A proximally placed distal vascular foramen is present in Passeriformes (Fig. 2.67L).

483. Tarsometatarsus, dorsal surface, osseous bridge covering distal vascular foramen: absent (0); present (1) (Fig. 2.66).

New character.

An osseous bridge covering the distal vascular foramen is present in extant Falconiformes (Fig. 2.66I). Ksepka & Clarke (2012) describe *Avolatavis tenens* appearing to have a "distal bridge of bone separating the foramen vasculare distale from the incisura intertrochlearis lateralis on the

dorsal surface". Unfortunately, the dorsal surface of the tarsometatarsus is on the latex peel so I was unable to observe this in person. Nevertheless, I tentatively scored *Avolatavis* as state 1.

484. Tarsometatarsus: viewed from posterior, metatarsal trochleae arranged in an arc, such that plantar surface is concave (0); arranged linearly from medial to lateral, forming approximately straight plantar surface (1) (Fig. 2.68).

Mayr & Clarke (2003, ch. 104), Mayr (2005b, ch. 77), Bourdon *et al.* (2016, ch. 74), Hieronymus *et al.* (2019, ch. 32), Smith *et al.* (2018, ch. 43).

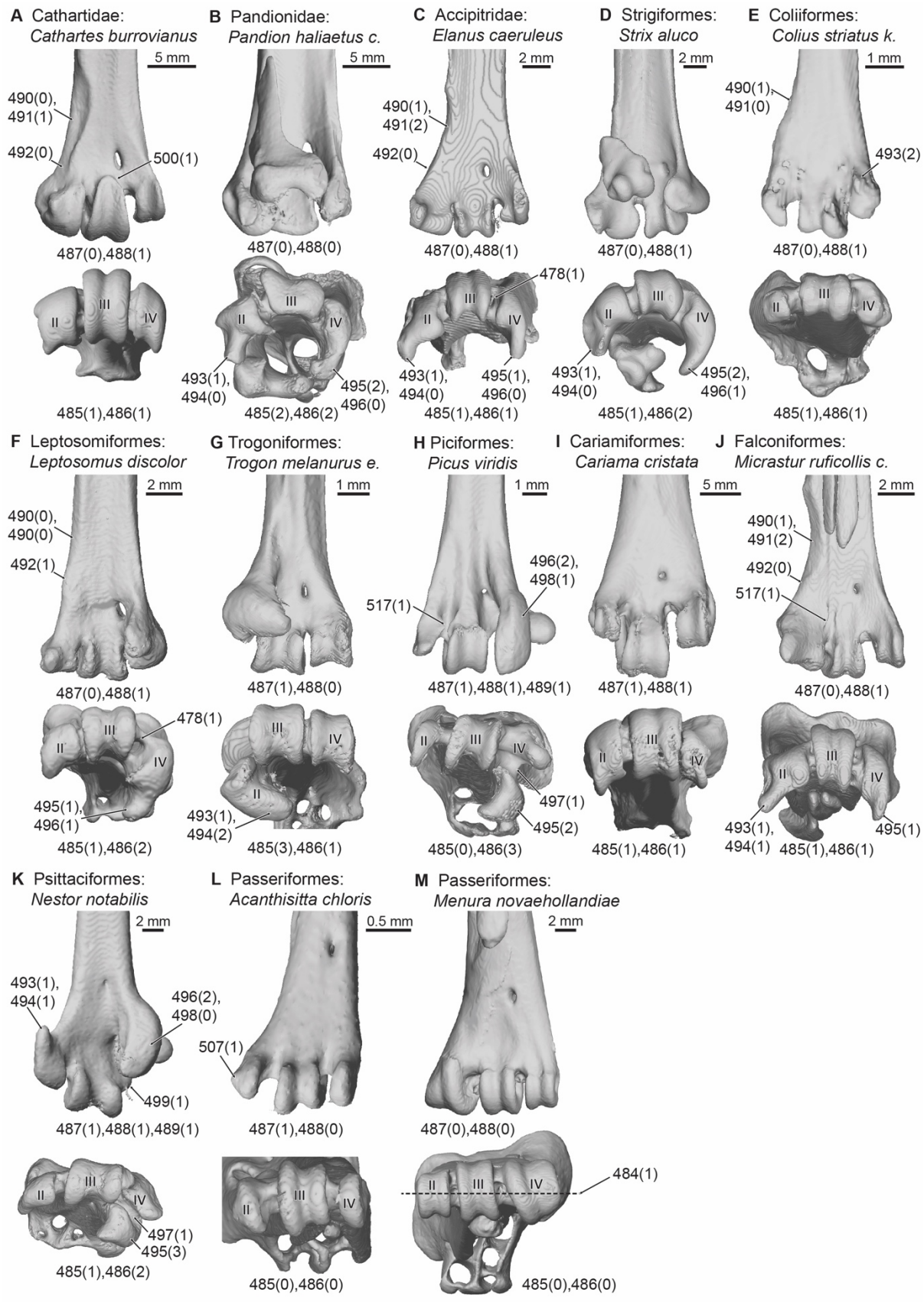
Metatarsal trochleae are best viewed plantarly. The concavity is decided from a mid-point on the metatarsals, with a mediolaterally-oriented line drawn from this midpoint. In state 0, the trochleae of mt III and mt IV are located plantar to the trochlea of mt II. In state 1, the trochleae of mt III and mt IV are line with the trochlea of mt II (Fig. 2.68M). Smith *et al.* (2018) noted that the metatarsal trochleae in Zygodactylidae are concave (state 0). Some exceptions found in extant taxa are *Probosciger aterrimus* and *Trogon melanurus* in which mt II and mt III are in line with one another but mt IV is reflected inwards, scored here as state 0.

485. Tarsometatarsus, posterior view, position of trochleae metatarsi II relative to trochleae metatarsi III: medial (0); slightly plantomedial (20 degrees) (1); strongly plantomedial (<35 degrees) (2); almost directly plantar (reverted/reversed) (3)(Fig. 2.68).

New character.

A reverted or reversed mt II (state 3) is a diagnostic apomorphy of Trogoniformes (Fig. 2.68G), the only birds to have heterodactyl feet (second is permanently reversed). This feature is also observed in stem Trogoniformes such as the early Eocene *Eotrogon* and *Masillatrogon* (Mayr *et al.* 2023). See Figure 2.68 for all state change examples.

Figure 2.68. Left tarsometatarsi in posterior (above) and distal (below) views Characters 484, 485, 486, 487, 488, 490, 491, 492, 495, 496, 497, 498 and 499. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Pandion haliaetus* carolinensis (Osprey, FMNH birds 437336); (C) *Elanus caeruleus* (Black-winged kite, NHMUK zoo 1850.8.15.159); (D) *Strix aluco* (Tawny owl, NHMUK zoo S/2001.38.1); (E) B) *Colius striatus kiwuensis* (Speckled mousebird, FMNH birds 384817); (F) *Leptosomus discolor* (Cuckoo-roller, NHMUK zoo 1968.30.38); (G) *Trogon melanurus eumorphus* (Black-tailed trogon, FMNH birds 290496); (H) *Picus viridis* (European green woodpecker, NHMUK zoo S/1982.5.1); (I) *Cariama cristata cristata* (Red-legged seriema, FMNH birds 105635); (J) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (K) *Nestor notabilis* (Kea, FMNH birds 23530); (L) *Acanthisitta chloris* (Rifleman, NHMUK zoo 1940.12.8.146).; (M) *Menura novaehollandiae* (Superb lyrebird, FMNH birds 336751). Numbers denote characters and character states as listed.


A Cathartidae:
Cathartes burrovianus
5 mm
490(0),
491(1)
492(0)
500(1)
487(0),488(1)
II
III
IV
485(1),486(1)
B Pandionidae:
Pandion haliaetus c.
5 mm
487(0),488(0)
493(1),
494(0)
495(2),
496(0)
485(2),486(2)
C Accipitridae:
Elanus caeruleus
2 mm
490(1),
491(2)
492(0)
487(0),488(1)
478(1)
493(1),
494(0)
495(1),
496(0)
485(1),486(1)
D Strigiformes:
Strix aluco
2 mm
487(0),488(1)
493(1),
494(0)
495(2),
496(1)
485(1),486(2)
E Coliiformes:
Colius striatus k.
1 mm
490(1),
491(0)
493(2)
487(0),488(1)
485(1),486(1)
F Leptosomiformes:
Leptosomus discolor
2 mm
490(0),
490(0)
492(1)
487(0),488(1)
478(1)
495(1),
496(1)
485(1),486(2)
G Trogoniformes:
Trogon melanurus e.
1 mm
487(1),488(0)
493(1),
494(2)
485(3),486(1)
H Piciformes:
Picus viridis
1 mm
496(2),
498(1)
517(1)
487(1),488(1),489(1)
497(1)
495(2)
485(0),486(3)
I Cariamiformes:
Cariama cristata
5 mm
487(1),488(1)
485(1),486(1)
J Falconiformes:
Micrastur ruficollis c.
2 mm
490(1),
491(2)
492(0)
517(1)
487(0),488(1)
493(1),
494(1)
495(1)
485(1),486(1)
K Psittaciformes:
Nestor notabilis
2 mm
493(1),
494(1)
496(2),
498(0)
499(1)
487(1),488(1),489(1)
497(1)
495(3)
485(1),486(2)
L Passeriformes:
Acanthisitta chloris
0.5 mm
507(1)
487(1),488(0)
485(0),486(0)
M Passeriformes:
Menura novaehollandiae
2 mm
487(0),488(0)
484(1)
485(0),486(0)

486. Tarsometatarsus, posterior view, position of trochlea metatarsi IV relative to trochlea metatarsi III: medial (0); slightly plantomedial (120 degrees) (1); strongly plantomedial (>140 degrees) (2).

New character.

A strongly plantomedially deflected trochlea metatarsi IV (state 2) is present in Pandionidae (Fig. 2.68B), Strigiformes (Fig. 2.68D) and Piciformes (Fig. 2.68H).

487. Tarsometatarsus, relative extension of trochlea metatarsi II: trochlea metatarsi II projects to the same level as trochlea metatarsi III (0); II retracted proximal to trochlea metatarsi III (1); trochleae metatarsi II projecting distally further than trochlea metatarsi III (2) (Fig. 2.68).

Modified from Mayr (2004, ch. 41), Mayr *et al.* (2004, ch. 15), Mayr *et al.* (2004, ch. 32), Ksepka & Clarke (2010, ch. 49), Mayr (2013, ch. 30), Bourdon *et al.* (2016, ch. 55), Ksepka *et al.* (2017, ch. 89), Ksepka *et al.* (2019, ch. 119), Raimon *et al*. (2020, ch. 41), Raimon *et al*. (2020, ch. 42), Mayr & Kitchener (2023d, ch. 21), Zelenkov & Dyke (2008, ch. 23).

There is a number of different combinations of relative lengths of the metatarsi in Telluraves, in some previous works for example Ksepka *et al.* (2019, ch. 119), a multistate character is used to with a varying number of combinations of lengths of all the metatarsi. In this analysis I have opted for using two separate characters to describe the relative extension of metatarsi compared with the mt III. In some rare cases the mt II projects distally further than mt III in some Passeriformes (see Raimon *et al.* 2020). See Figure 2.68 for all combinations of the character states.

488. Tarsometatarsus, relative extension of trochlea metatarsi IV: trochlea metatarsi IV projects to the same level as trochlea metatarsi III (0); IV retracted proximal to trochleae metatarsi III (1); trochleae metatarsi IV projecting distally further than trochleae metatarsi III (2) (Fig. 2.68)

Modified from Clarke *et al.* (2009, ch. 70), Ksepka & Clarke (2009, ch. 44).

See Figure 2.68 for all combinations of the character states.

489. Tarsometatarsus, rotation of trochlea metatarsi IV: aligned in the same direction as the other trochlea (0); splayed/rotated anteriorly (retroverted position) where it is retracted proximal to II and III (1) (Fig. 2.68).

Ksepka *et al.* (2019, ch. 17).

A splayed anteriorly metatarsi IV (state 1), where it is orientated more obliquely to the longitudinal axis is present in Piciformes (Fig. 2.68H) and Psittaciformes (Fig. 2.68K), in which the zygodactyl condition occurs.

490. Tarsometatarsus, fossa metatarsi I: located on plantar or plantomedial margin of tarsometatarsus (0); located on medial margin of tarsometatarsus (1) (Fig. 2.68).

Modified from Mayr (2004, ch. 44), Mayr *et al.* (2004, ch. 14), Ksepka & Clarke (2009, ch. 42), Ksepka & Clarke (2010, ch. 47), Ksepka *et al.* (2011, ch. 77), Zelenkov & Dyke (2008, ch. 22), Ksepka & Clarke (2012, ch. 81), Mayr (2013, ch. 29), Ksepka *et al.* (2017, ch. 88), Ksepka *et al.* (2019, ch. 116).

A medially placed metatarsal I fossa (state 1) is present in Psittaciformes though this is not always apparent as there is no clear convex cut on the medial margin of the distal tarsometatarsus. A very obvious medial metatarsal I fossa is present in *Micrastur ruficollis* (Fig. 2.68J).

491. Tarsometatarsus, fossa metatarsi I: flat or shallow facet (0); deep cavity on plantar surface (1); deeply incised concavity on medial margin (2) (Fig. 2.68).

Amended from Ksepka *et al.* (2011, ch. 78), Ksepka & Clarke (2012, ch. 82).

See discussion in Ch. 490.

492. Tarsometatarsus, fossa metatarsi I: distal portion, facet extends distally/ past foramen (0); distal portion, facet does not extend distally (1) (Fig. 2.68).

New character.

493. Tarsometatarsus, flange/projection on trochlea metatarsi II: absent (0); very large and present (1) (Fig. 2.68).

Modified from Mayr (2004, ch. 40), Mayr *et al.* (2004, ch. 16), Zelenkov & Dyke (2008, ch. 24), Ksepka & Clarke (2009, ch. 45), Ksepka & Clarke (2010, ch. 50), Ksepka *et al.* (2011, ch. 80), Ksepka & Clarke (2012, ch. 84), Mayr (2013, ch. 31), Ksepka *et al.* (2017, ch. 90), Smith *et al.* (2018., ch. 41), Hieronymus *et al.* (2019, ch. 30), Ksepka *et al.* (2019, ch. 121).

A projection on the trochlea metatarsi II (state 1) is present in Pandionidae (Fig. 2.68B), Accipitridae (Fig. 2.68C), Strigiformes (Fig. 2.68D), Psittaciformes (Fig. 2.68K) and Falconiformes (Fig. 2.68J). This projection was considered present in *Cariama cristata* in some previous work (Kspeka *et al.* 2019). However, it was clearly absent in the specimens of *Cariama* examined in this study (state 0). *Leptosomus* has conflicting scores between the above authors as well, it is possible that the morphology is variable on the specimen level. There does appear to be a small rise on the mt II of the examined specimen of the current study, but it is significantly smaller than what is observed in Accipitriformes, Falconiformes and Psittaciformes and so it is coded as absent (state 0). There is a clear distinction is the shape of the projection in Psittaciformes in that they exhibit a medially directed projection (with exception in *Nestor notabilis*). Whereas in all other birds with a projection or flange (state 1), the flange pinches in the middle creating an oblong shape with a clear distinction and deep sulcus. I have not accounted for this variation in these analyses but is worth noting and could possibly be made into a separate character. Here, variation in the direction of the flange has been coded in a separate character (Ch. 494)

494. Tarsometatarsus, flange/projection on trochlea metatarsi II: plantarly directed projection (0); medially directed projection (1); laterally directed projection (2); inapplicable, flange/projection on trochlea metatarsi II absent (N/A). (Fig. 2.68)

Modified from Mayr (2004, ch. 40), Mayr *et al.* (2004, ch. 16), Zelenkov & Dyke (2008, ch. 24), Ksepka & Clarke (2009, ch. 45), Ksepka & Clarke (2010, ch. 50), Ksepka *et al.* (2011, ch. 80), Ksepka & Clarke (2012, ch. 84), Mayr (2013, ch.31), Ksepka *et al.* (2017, ch. 90), Smith *et al.* (2018, ch. 41), Hieronymus *et al.* (2019, ch. 30), Ksepka *et al.* (2019, ch. 121).

This amended character incorporates the different directions of the flange separately from the presence or absence of a flange or projection formed by trochlea metatarsi II. See above comments. Trogoniformes are the only birds to have the projection laterally directed (state 2; Fig. 2.68G), this is likely due to the strongly plantarly deflected Trochlea metatarsi II. See Figure 2.68 for different states of this character.

495. Tarsometatarsus, trochlea metatarsi IV: unmodified (0); lateral edge of the condyle is extended into a flange (1); projected "wing-like" flange (2); with fully developed trochlea accessoria (condyle defined by being mediolaterally expanded) (3) (Fig. 2.68).

Modified from Mayr & Clarke (2003, ch. 109), Mayr *et al.* (2003, ch. 68), Mayr (2004, ch. 42), Mayr (2005a, ch. 75), Mayr (2005b, ch. 79), Mayr (2006, ch. 91), Clarke *et al.* (2009, ch. 69), Mayr *et al.* (2010, ch. 75), Ksepka & Clarke (2010, ch. 53), Ksepka *et al.* (2011, ch. 85), Mayr (2011, ch. 76), Ksepka & Clarke (2012, ch. 89), Mayr (2015, ch. 60), Bourdon *et al.* (2016, ch. 54), Ksepka *et al.* (2017, ch. 93), Smith *et al.* (2018, ch. 44), Hieronymus *et al.* (2019, ch. 33), Ksepka *et al.* (2019, ch. 124), Mayr (2020, ch. 73), Mayr (2021, ch. 66), Mayr (2022, ch. 50), Mayr & Kitchener (2022a, ch. 36), Mayr & Kitchener (2023a, ch. 83), Mayr & Kitchener (2023b, ch. 81), Mayr & Kitchener (2023c, ch. 78), Mayr & Kitchener (2023d, ch. 22).

Trochlea accessoria or "schnenhalter" is a ventral hook-shaped outgrowth of the trochlea metatarsi IV observed in zygodactyl type feet (rotation of digit IV), a condition observed in Psittaciformes (state 3; Fig. 2.68K) and Piciformes (state 3; Fig. 2.68H). Similar to the trochlea accessoria is a "wing-like" flange (state 2), where the entire condyle is medio-lateral widened into a projection, this is observed in many semi-zygodactyl (facultatively change orientation of dIV) birds like Musophagidae (turacos), Strigiformes (Fig. 2.68D) and Pandionidae (Fig. 2.68B). This flange is clearly different from Psittaciformes and Piciformes as there is no distally projecting outgrowth but rather the condyle is mediolaterally expanded and projects more medial. Leptosomatidae are also zygodactylous (though not always thought as so), the "wing-like" flange on these birds is not as large as in Strigiformes or Pandionidae but similar in shape. A much smaller flange is also observed in Accipitriformes and Falconiformes, the shape of this flange is different to what is observed in other birds, only the lateral edge of the condyle is extended creating a narrow flange (state 1; Fig. 2.68C & J) .These birds have a anisodactyl foot condition where this thin flange is thought to help in spreading or widening the toes to assist in catching prey (with the addition of the very large flange on trochlea metatarsi II). While it is clear to distinguish between the traditional "schnenhalter" or trochlea accessoria and other types of flanges seen throughout extant Telluraves, this is not as clear in many extinct Telluraves such as the Halcyornithidae. In Mayr & Kitchener (2023a,b,c,d) and older works by this author include whether the trochlea accessoria is separated by a deep furrow or not. For example, a parrot will have the trochlea accessoria separated by a deep furrow but halcyornithids have a trochlea accessoria but separated by a furrow. It is not always clear the difference between this latter case and what is observed in Strigiformes. For this reason, state (3) in this analysis is described as the trochlea accessoria being present when the condyle is mediolaterally expanded, and in a separate character whether this expanded flange is separated by a furrow or not (Ch. 496) as well as the directional projection of this flange (Ch. 497). In Mayr & Kitchener (2023a) they state that Messelasturidae have a flange-like trochlea accessoria that resembles Strigiformes, and so likely that these birds are not fully zygodactyl. These birds were scored as state (2) of that study "with large trochlea accessoria that is not separated by a furrow from the main trochlea", however Strigidae are scored as state (1) "with plantarly-directed wing-like flange". I do not see a

significant difference in flange of Strigiformes and the Messelasturidae and functionally they are likely both semi-zygodactyl,. Halcyornithidae and Psittacopedidae are scored as also having a trochlea accessoria but with no deep furrow, in this case the flange does look significantly different to what is observed in Messelasturidae and Strigiformes, see Mayr & Kitchener (2023a, fig. 3T-AA). No extant birds have a trochlea accessoria without a deep furrow. In older work by Mayr (2021), *Tynskya waltonensis* (Messelasturidae) is scored as (state 1) "with plantarly-directed, wing-like flange", same as Strigidae. This "wing-like" flange is also observed in many extinct Strigiformes like *Ypresiglaux* but also in putative stem Psittaciformes like *Avolatavis*. Coliiformes are another bird that tend to be are scored as having flange or projection, they are in the above refences always scored the same as Strigiformes, the flange on mousebirds are significantly smaller than what is seen in owls and in some specimens they are absent but I have scored (2) in accordance to previous work.

496. Tarsometatarsus, projecting flange on trochlea metatarsi IV: plantarly directed projection (0); curved medially (1); distally (trochlea accessoria) (2); inapplicable, trochlea metatarsi IV flange/ trochlea accessoria absent (N/A) (Fig. 2.68).

New character.

See above comments and Figure 2.68.

497. Tarsometatarsus, trochlea metatarsi IV separated from trochlea accessoria by deep furrow: absent (0); present (1); inapplicable, trochlea accessoria absent (N/A)(Fig. 2.68).

Modified from Ksepka *et al.* (2011, ch. 86), Ksepka & Clarke (2012, ch. 90), Mayr (2020, ch. 73), Mayr (2021, ch. 66), Mayr (2022, ch. 50), Mayr & Kitchener (2022a, ch. 36), Mayr & Kitchener (2023a, ch. 83), Mayr & Kitchener (2023b, ch. 81), Mayr & Kitchener (2023c, ch. 78), Mayr & Kitchener (2023d, ch. 22).

See above (ch.495) comments. A trochlea accessoria seperated by a deep furrow is observed in Piciformes (Fig. 2.68H) and Psittaciformes (Fig. 2.68K).

498. Tarsometatarsus: trochlea accessoria: does not extend to (midline of) trochlea metatarsi III (0); more or less on level with trochlea metatarsi III (distally elongated) (1), inapplicable, trochlea accessoria absent (N/A) (Fig. 2.68).

Smith *et al.* (2018, ch. 45), Hieronymus *et al.* (2019, ch. 34).

A distally elongated trochlea accessoria (state 1) is observed in Piciformes (except in *Galbula*) (Fig. 2.68H).

499. Tarsometatarsus, tubercle at the lateral edge of the neck of trochlea metatarsi III: absent (0); present (1) (Fig. 2.68).

Ksepka *et al.* (2011, ch. 84), Ksepka & Clarke (2012, ch. 88), Mayr (2015, ch. 59), Ksepka *et al.* (2017, ch. 91), Smith *et al.* (2018, ch. 46), Ksepka *et al.* (2019, ch. 122), Mayr (2020, ch. 72), Mayr (2021, ch. 65), Mayr & Kitchener (2023a, ch. 81), Mayr & Kitchener (2023b, ch. 79), Mayr & Kitchener (2023c, ch. 77).

A tubercle at the lateral edge of the neck of trochlea metatarsi III (state 1) is present in in extant Psittaciformes (Fig. 2.68K) and Pan-Psittaciformes such as *Parapsittacopes*, *Pseudasturides*, *Pulchrapollia*, *Tynskya* and *Quercypsitta* and also Psittacopasseres such as *Psittacopes.*

500. Tarsometatarsus, trochlea metatarsi III, plantar view, prominent ridge denotating the proximal border of the trochlea: absent (0); present (1) (Fig. 2.68).

New character.

A prominent ridge denotating the proximal border of trochlea metatarsi III (state 1) is present in Cathartidae (Fig. 2.68A) and Cariamiformes.

501. Tarsometatarsus, trochlea metatarsi III, symmetry in distal view: symmetrical (0); asymmetrical, medial rim projects farther plantarly than lateral rim (1); asymmetrical, lateral rim projects farther plantarly than medial rim (2) (Fig. 2.67).

Mayr *et al.* (2004, ch. 17), Ksepka & Clarke (2009, ch. 46), Ksepka & Clarke (2010, ch. 51), Ksepka *et al.* (2011, ch. 83), Ksepka & Clarke (2012, ch. 87), Ksepka *et al.* (2017, ch. 92), Ksepka *et al.* (2019, ch. 123).

502. Tarsometatarsus, depression on dorsal surface of shaft immediately proximal to neck of trochlea metatarsi III: absent (0); present (1).

Ksepka *et al.* (2019, ch. 118), Mayr & Kitchener (2023a, ch. 82), Mayr & Kitchener (2023b, ch. 80).

503. Tarsometatarsus, trochlea metatarsi II, articular face: smooth or weakly grooved (0); with well-developed sulcus at midline (1).

Ksepka *et al.* (2011, ch .81), Ksepka & Clarke (2012, ch. 85), Ksepka *et al.* (2019, ch. 120).

504. Tarsometatarsus, trochlea metatarsi III with a wide, deeply incised groove between the trochlear rims (plantar surface mainly): absent (0), present (1).

Mayr (2015, ch. 58), Mayr (2020, ch. 71), Mayr (2021, ch. 64), Mayr & Kitchener (2023a, ch. 80), Mayr & Kitchener (2023b, ch. 78), Mayr & Kitchener (2023c, ch. 76).

A deeply incised trochlea metatarsi III (state 1) is present in Psittaciformes (Fig. 2.67J).

505. Tarsometatarsus, anterior end of trochlea metatarsal IV: marked convexity on lateral tarsometatarsal margin: absent (0); present (1).

Smith *et al.* (2018) ch.39, Hieronymus *et al.* (2019) ch.28.

According to Mayr (2008, fig. 7E) this character is an autapomorphy of *Zygodactylus*.

506. Tarsometatarsus: marked sulcus on plantar surface of proximal end of trochlea metatarsi IV bordering on lateral tarsometatarsal convexity: absent (0); present (1).

Smith *et al.* (2018, ch. 40), Hieronymus *et al.* (2019, ch. 29).

State 1 only scored for Zygodactylids in the above citied references.

507. Tarsometatarsus, trochlea metatarsi II: aligned in the same direction as the other trochlea (0); splayed/rotated anteriorly (1).

New character.

A splayed trochlea metatarsi II is present in Passeriformes (Fig, 2.68L)

508. Tarsometatarsus, trochlea metatarsi III, shape in distal view: mediolateral and dorsoplantar dimensions subequal (0); much wider mediolaterally (1).

Mayr (2005a, ch. 73), Mayr (2005b, ch. 78), Mayr (2006, ch. 89), Mayr (2011, ch. 75), Mayr *et al.* (2010, ch. 73), Ksepka & Clarke (2010, ch. 52), Ksepka *et al.* (2011, ch. 82), Ksepka & Clarke (2012, ch. 86), Mayr (2015, ch. 57), Mayr (2020, ch. 70), Mayr (2021, ch. 63), Mayr & Kitchener (2023a, ch. 79), Mayr & Kitchener (2023b, ch. 77), Mayr & Kitchener (2023c, ch. 75).

A much wider mediolateral trochlea metatarsi III (state 1) is present in extant Psittaciformes.

509. Tarsometatarsus, size of trochlea metatarsi II: not as follows (0); trochlea metatarsi II reduced, width less than half the width (mediolateral) of trochlea metatarsi III (1).

Ksepka & Clarke (2012) ch.83.

510. Tarsometatarsus, size of mt IV: not as follows (0); trochlea metatarsi IV reduced, width less than half the width (mediolateral) of trochlea metatarsi III (1).

New character.

511. Tarsometatarsus, shape: distal mediolateral width across all the trochleae less than one third of proximodistal length (slender) (0); distal width approximately/more than one third length (short and stocky) (1).

Modified from Zelenkov & Dyke (2008, ch. 18), Ksepka *et al.* (2011, ch. 64), Mayr (2020, ch. 59), Mayr (2021, ch. 52), Mayr & Kitchener (2023a, ch. 64), Mayr & Kitchener (2023b, ch. 63), Mayr & Kitchener (2023c, ch. 62).

512. Tarsometatarsus, length: very short, less than half of humerus length (0); moderate length, equal to or more than humerus half length (1); elongated, exceeding humerus in length (2).

Mayr (2004, ch. 34), Mayr *et al.* (2004, ch. 9), Mayr (2006, ch. 82), Clarke *et al.* (2009, ch. 65), Ksepka & Clarke (2009, ch. 35), Ksepka & Clarke (2010, ch. 40), Mayr (2013, ch. 24), Mayr (2015, ch. 46), Mayr (2016, ch. 33), Ksepka *et al.* (2017, ch. 78), Smith *et al.* (2018, ch. 42), Hieronymus *et al.* (2019, ch. 31), Ksepka *et al.* (2019, ch. 105), Mayr & Kitchener (2022a, ch. 34), Mayr & Kitchener (2023d, ch. 17).

This character is widely variable within Passeriformes and even throughout Telluraves, though the tarsometatarsus is uniformly longer than the humerus in Zygodactylidae. Measurements for tarsometatarsus and humerus in Table S1.5.

513. Tarsometatarsus, length: very short, less than half of tibiotarsus length (0); moderate length, equal to or more than tibiotarsus half length (1); elongated, exceeding Tibiotarsus in length (2).

Modified from Bourdon *et al.* (2016, ch. 75).

A very short Tarsometatarsus (compared to the tibiotarsus) is present in Psittaciformes as well as a number of fossil taxa such as *Pumillornis, Avolatavis, Eurofluvioviridavis* and *Cyrilaves*. Measurements for tarsometatarsus and tibiotarsus in Table S1.5.

514. Tarsometatarsus, incisurae intertrochleares very short/absent: no (0); yes (1).

Mayr *et al.* (2003, ch. 67), Mayr *et al.* (2004, ch. 31), Mayr (2005a, ch. 72), Mayr (2006, ch. 88), Mayr *et al.* (2010, ch. 72), Mayr (2011, ch. 74), Mayr (2015, ch. 55), Mayr (2020, ch. 68), Mayr (2021, ch. 61), Mayr (2022, ch. 49), Mayr & Kitchener (2023a, ch. 77), Mayr & Kitchener (2023b, ch. 75), Mayr & Kitchener (2023c, ch. 73).

Very short incisurae intertrochleares (state 1) is only observed in Bucerotiformes.

515. Tarsometatarsus, ossified tendons within the plantar sulcus flexorius: absent (0); present (1) (Fig. 2.67).

New character.

The ossification of tendons (FDL, FHL etc.) within the plantar sulcus of the tarsometatarsus is observed in in extant Falconiformes (Fig. 2.67I) and Passeriformes (Fig. 2.67L). The amount of ossification varies within these clades. Bledsoe *et al.* (1993) found extensive ossification in the hindlimb tendons of woodcreepers and suggested that this adaptation is likely to help resist increased forces that act to extend the limb during vertical climbing. Harcourt-Brown (2001) found ossified tendons in various falcon species (e.g American Kestrel) and none in Accipitridae. There is also suggestion that there are ossified tendons in the hindlimbs of owls such as *Ninox odiosa* (personal observation) though not seen in the owls studied in this work (Rack & Ross 1984). It is possible these ossified tendons help to assist in greater control over individual digits during foot closure, or more likely help in overcoming large forces from various foot use (Rack & Ross 1984). Possible ossified tendons are also observed in many Sandcoleidiae and considered characteristic of this group (Mayr 2018, fig 5).

516. Tarsometatarsus, pronounced ovoid tubercle on the plantar surface of the base of trochlea II: absent (0); present (1).

New character.

An ovoid tubercle on the plantar surface of the base of trochlea II autapomorphy of *Avolatavis tenes* (Ksepka & Clarke 2012). A pronounced ovoid tubercle occurs on the plantar surface of the base of trochlea II, starting at the distal margin of fossa mt I and extending to the level of the dorsal border of the foramen vasculare distale. The feature has not been observed in other species of Pan-Psittaciformes.

517. Tarsometatarsus, furrow for the tendons of the flexor muscles of the second toe on plantar surface of the bone: absent (0); present (1) (Fig. 2.68).

New character.

A furrow for the tendons of the flexor muscles of the second toe on plantar surface of the bone is observed *in Micrastur ruficollis* (Fig. 2.68J).

PEDAL DIGITS

518. Pedal phalanx I-1 proximal end: unexpanded (0); widened due to lateral expansion (1) (Fig. 2.69).

Mayr *et al.* (2003, ch. 69), Mayr *et al.* (2004, ch. 33), Mayr (2004, ch. 45), Mayr (2005a, ch. 76), Mayr (2006, ch. 92), Clarke *et al.* (2009, ch. 71), Mayr *et al.* (2010, ch. 76), Mayr (2011, ch. 77), Mayr (2015, ch. 61), Bourdon *et al.* (2016, ch. 56), Ksepka *et al.* (2017, ch. 95), Ksepka *et al.* (2019, ch. 127), Mayr (2020, ch. 74), Mayr (2022, ch. 51), Mayr & Kitchener (2023a, ch. 85), Mayr & Kitchener (2023b, ch. 83), Mayr & Kitchener (2023c, ch. 79).

A widened proximal pedal phalanx I-1 is mostly present in Falconiformes (Fig. 2.69) and Accipitridae.

519. Pedal phalanx I-1 length relative to digit III: shorter than 50% of total length (0); longer than 50% of total length (1).

New character.

A long pedal phalanx I-1 length relative to digit III is observed in all Passeriformes and the Coraciiformes *Todus mexicanus* (Todidae).

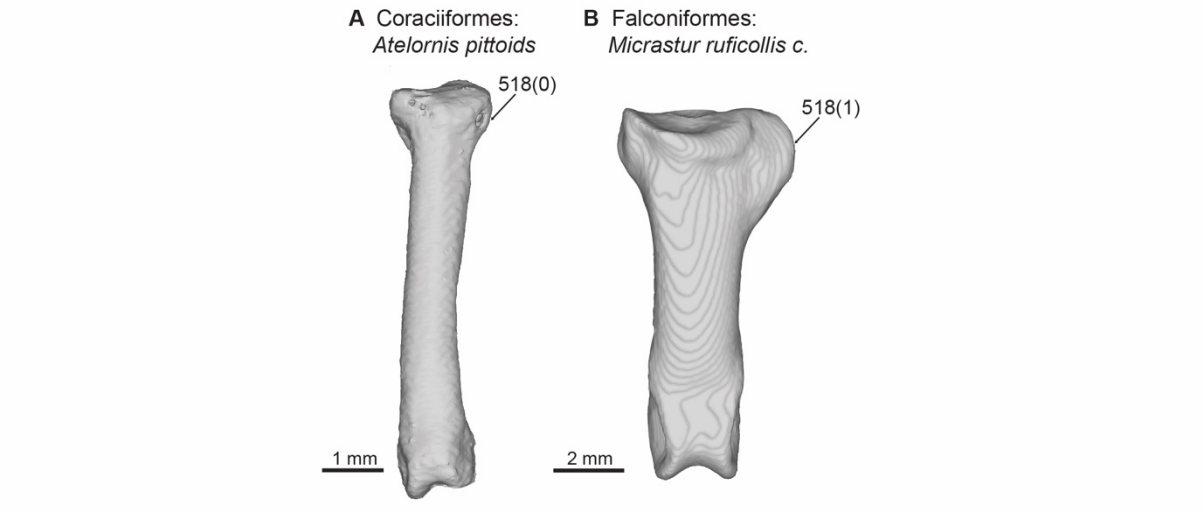


Figure 2.69. Pedal phalanx I-1 in dorsal few showing character 518. (A) *Atelornis pittoides* (pitta-like ground roller, NHMUK zoo 1870.5.5.10); (B) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226). Numbers denote characters and character states as listed.

520. Pedal phalanx I-1 length greatly reduced, measuring less than half of the length of the proximal phalanx of the third toe: absent (0), present (1).

New character.

The reduction of pedal; phalanx I-1 is generally present in several walking (fowl, quail, tinamou etc.) and swimming (ducks, grebes) birds. This feature is only observed in crown Cariamiformes this includes the Phorusrhacida *Psilopterus, Patagornis* and *Llallawavis* (Mayr 2016).

521. Pedal phalanx II-1 length relative to II-2: subequal in length to phalanx II-2 (0); reduced, measuring less than one-half the length of phalanx II-2 (1); abbreviated to one-third the length of phalanx II-2 (2).

Modified from Mayr *et al.* (2004, ch. 18), Zelenkov & Dyke (2008, ch. 25), Ksepka & Clarke (2009, ch. 47), Ksepka & Clarke (2010, ch. 54), Mayr (2011, ch. 79), Mayr (2013, ch. 32), Mayr (2015, ch. 63), Mayr (2016, ch. 36), Ksepka *et al.* (2017, ch. 96), Smith *et al.* (2018, ch. 47), Ksepka *et al.* (2019, ch. 128), Mayr (2020, ch. 76), Mayr (2021, ch. 69), Mayr & Kitchener (2022a, ch. 38), Mayr & Kitchener (2023a, ch. 87), Mayr & Kitchener (2023b, ch. 85), Mayr & Kitchener (2023c, ch. 81).

Additional states were added to accommodate the variation seen throughout Telluraves. A reduced digit II phalanx I (state 1) is observed in Accipitriformes (except Sagittariidae and

Cathartidae) and Falconiformes. A greatly reduced digit II phalanx I (state 2) is observed in Accipitridae. A reduced digit II phalanx I is also observed in the stem Strigiformes *Ypresiglaux michaeldanielsi* and *Primoptynx poliotauros*, this however is not the case in the extant owls within this study *Tyto alba* and *Strix aluco*, though this is true for earlier diverging owls like *Ninox odiosa* (personal observation).

522. Pedal phalanx II-1 longer than II-2: absent (0); present (1).

New character.

State 1 is mostly observed in the outgroup taxa but also in Cathartidae and Sagittariidae.

523. Pedal digit III: equal in development/robustness to digit II (0); markedly more robust than digit II (1) (Fig. 2.70).

Ksepka *et al.* (2011, ch. 88), Ksepka & Clarke (2012, ch. 92), Ksepka *et al.* (2019, ch. 129).

The most exaggerated size difference in pedal digit III and digit II is observed in Psittaciformes, this is however also observed in Piciformes (Fig. 2.70B).

524. Pedal digit II and III coalescent along the proximal portion: absent (0); present (1) (Fig. 2.71).

Modified from Clarke *et al.* (2009, ch. 73), Ksepka *et al.* (2017, ch. 101), Ksepka *et al.* (2019, ch. 135).

The original characters described whether the condition of syndactyly is present or absent in the digits II and III. The term syndactyly is found in avian literature to describe the foot with a skin connection uniting the forward three toes (Bock & Miller 1959). Syndactyly does not involve the same proportion of the toes in all species of bird (Abourachid *et al.* 2017) and most often connects the first phalanges on two forward-facing toes. Where this condition occurs the portion of the toes linked by the skin, that is, the proximal phalanx of the toe II, is much more narrow and even coalescent along the digits (state 1). This condition is mainly observed in Piciformes (Fig. 2.71C). This condition also occurs between pedal digit IV and III, see Ch 536 See Höfling & Abourachid (2021) for further details on syndactyly condition in birds.

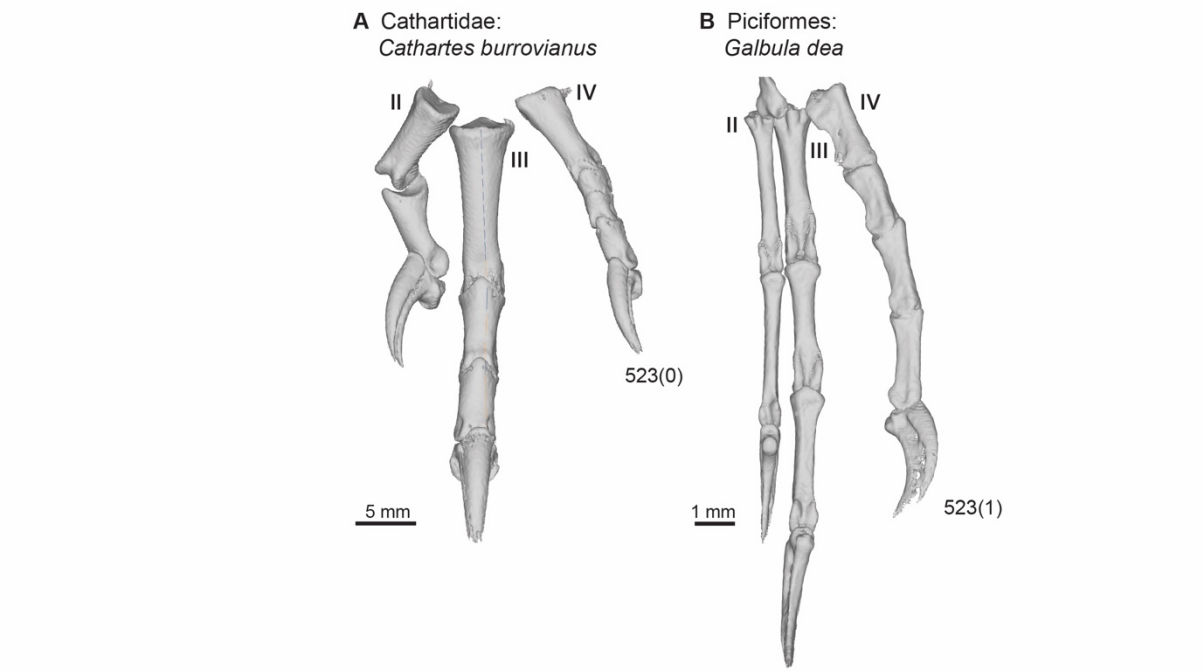


Figure 2.70. Left pedal digits in dorsal view showing character 523. (A) *Cathartes burrovianus* (Lesser yellow-headed vulture, UMMZ birds 227466); (B) *Galbula dea* (Paradise jacamar, FMNH birds 376705). Numbers denote characters and character states as listed.

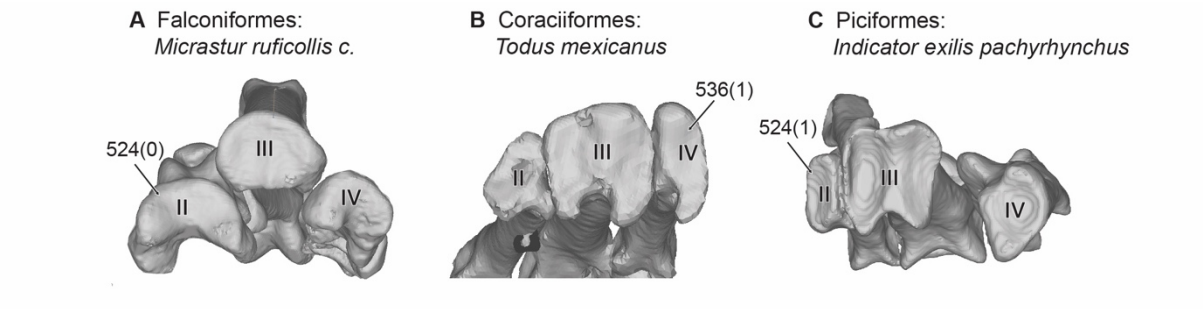


Figure 2.71. Pedal digits in anterior view showing characters 524 and 536. (A) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (B) *Todus mexicanus* (Puerto Rican tody, FMNH birds 351174); (C) *Indicator exilis pachyrhynchus* (least honeyguide, FMNH birds 429726). Numbers denote characters and character states as listed.

525. Pedal phalanx III-2 proximal portion, with large extension on tuberculum extensorium: absent (0); present (1) (Fig. 2.72).

New character.

A strongly proximo-dorsally projected tuberculum extensorium of the second phalanx of the third toe (state 1) is observed in Strigiformes and most other Coraciimorphae (Fig. 2.72).

526. Pedal phalanx III-2 relative to III-1 and III-3: subequal or longer (0); reduced, shorter than both (cube shaped) (1).

New character.

A cubed shaped phalanx III-2 is present in Accipitridae.

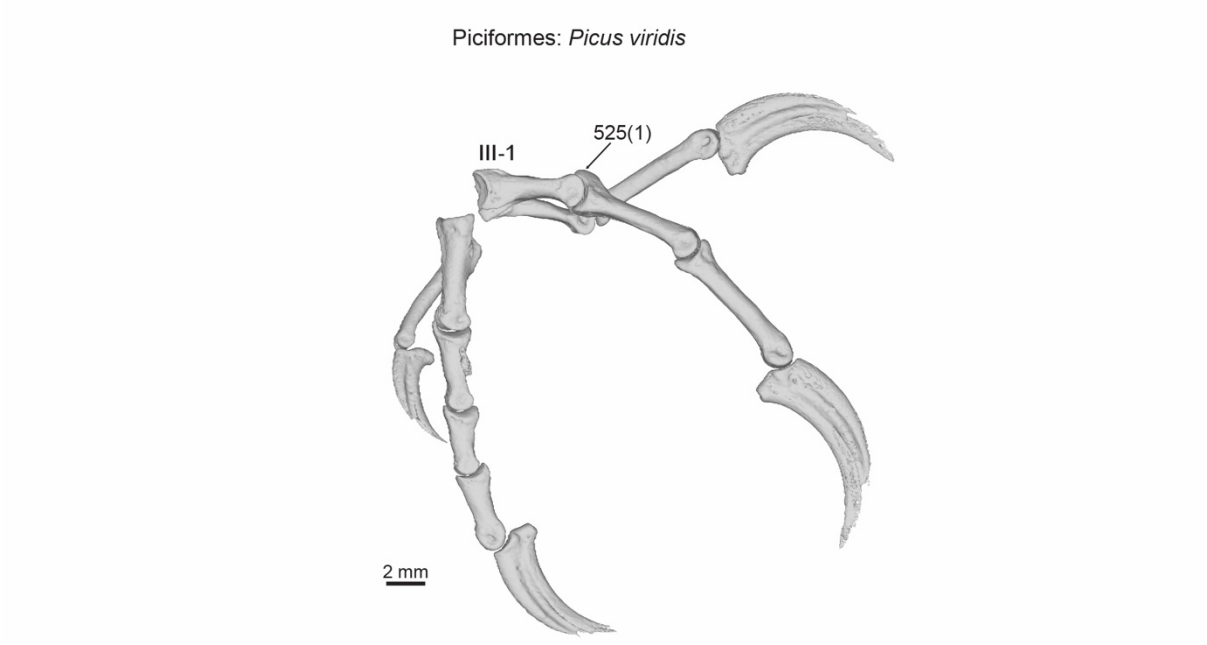


Figure 2.72. Pedal digits in lateral view showing character 525. *Picus viridis* (European green woodpecker, NHMUK zoo S/1982.5.1). Numbers denote characters and character states as listed.

527. Pedal phalanx III-2 and III-3 size difference: subequal (0); III-3 longer than III-2 (1); III-2 longer than III-3 (2).

New character.

528. Pedal phalanx IV-1, IV-2 and IV-3 amount of reduction compared to phalanx IV-4: subequal (0); proximal three phalanges individually shorter in length compared to penultimate (1); greatly reduced, measuring less or equal to half the length of phalanx IV-4 (2).

Amended from Mayr *et al.* (2003, ch. 70), Mayr (2004, ch. 47), Mayr *et al.* (2004, ch. 19), Mayr (2005a, ch. 78), Mayr (2005b, ch. 82), Mayr (2006, ch. 94), Zelenkov & Dyke (2008, ch. 26), Ksepka

& Clarke (2009, ch. 48), Ksepka & Clarke (2010, ch. 55), Mayr *et al.* (2010, ch. 78), Ksepka *et al.* (2011, ch. 89), Mayr (2011, ch. 80), Ksepka & Clarke (2012, ch. 93), Mayr (2013, ch. 33), Mayr (2015, ch. 64), Ksepka *et al.* (2017, ch. 97), Ksepka *et al.* (2019, ch. 131), Mayr (2020, ch. 77), Mayr (2021, ch. 70), Mayr & Kitchener (2023a, ch. 89), Mayr & Kitchener (2023b, ch. 87), Mayr & Kitchener (2023c, ch. 82), Mayr & Kitchener (2023d, ch. 23).

Characters 528, 529, 530 and 531 are all combinations of relative length of the phalanges of pedal digit 4. Shortening of pedal phalanges allow for a higher degree of curvature of the toes, increasing the grasping function of the foot. This is most often observed in birds that manipulate food items such as owls, diurnal birds of prey and parrots. Shortened phalanges is also observed in Coliiformes, this was likely an adaption to clinging to vertical slopes or hanging from branches (Mayr 2015). Characters 528, 529, 530 and 531 are all combinations of relative length of the phalanges of pedal digit IV. Greatly reduced pedal phalanges enhances grasping efficiency for perching or prey capture by reducing the length of proximal phalanges while maintaining a longer distal phalanx for leverage, a trait advantageous for the diverse locomotor strategies within Afroaves, such as the perching adaptations of Coliiformes or the grasping talons of raptorial Cathartidae and *Sagittarius* (Hutchinson, 2001)

529. Pedal phalanx IV-2 and IV-3 relative shortening to IV-4: subequal (0) shorter, IV-2 and IV-3 individually half the length of IV-4 (1); greatly reduced, length of both IV-2 and IV-4 combined is less than half the length of IV-4 (2).

Modified from Mayr *et al.* (2003, ch. 70), Mayr (2004, ch. 47), Mayr *et al.* (2004, ch. 19), Mayr (2005a, ch. 78), Mayr (2005b, ch. 82), Mayr (2006, ch. 94), Zelenkov & Dyke (2008, ch. 26), Ksepka & Clarke (2009, ch. 48), Ksepka & Clarke (2010, ch. 55), Mayr *et al.* (2010, ch. 78), Ksepka *et al.* (2011, ch. 89), Mayr (2011, ch. 80), Ksepka & Clarke (2012, ch. 93), Mayr (2013, ch. 33), Mayr (2015, ch. 64), Ksepka *et al.* (2017, ch. 97), Ksepka *et al.* (2019, ch. 131), Mayr (2020), ch. 77, Mayr (2021, ch. 70), Mayr & Kitchener (2023, ch. 89), Mayr & Kitchener (2023b, ch. 87), Mayr & Kitchener (2023c, ch. 82), Mayr & Kitchener (2023d, ch. 23).

530. Pedal phalanx IV-1 length relative to phalanx IV-4: subequal or longer (0); slightly shorter (2/3) (1); considerably shorter (1/2 or less) (2).

Modified from Mayr *et al.* (2003, ch. 70), Mayr (2004, ch. 47), Mayr *et al.* (2004, ch. 19), Mayr (2005a, ch. 78), Mayr (2005b, ch. 82), Mayr (2006, ch. 94), Zelenkov & Dyke (2008, ch. 26), Ksepka & Clarke (2009, ch. 48), Ksepka & Clarke (2010, ch. 55), Mayr *et al.* (2010, ch. 78), Ksepka *et al.* (2011, ch. 89), Mayr (2011, ch. 80), Ksepka & Clarke (2012, ch. 93), Mayr (2013, ch. 33), Mayr (2015, ch. 64), Ksepka *et al.* (2017, ch. 97), Ksepka *et al.* (2019, ch. 131), Mayr (2020), ch. 77, Mayr (2021, ch. 70), Mayr & Kitchener (2023, ch. 89), Mayr & Kitchener (2023b, ch. 87), Mayr & Kitchener (2023c, ch. 82), Mayr & Kitchener (2023d, ch. 23).

531. Pedal phalanx IV-3 greatly reduced in length relative to phalanx IV-1 and IV-2: absent (0); present (1).

Modified from Mayr *et al.* (2003, ch. 70), Mayr (2004, ch. 47), Mayr *et al.* (2004, ch. 19), Mayr (2005a, ch. 78), Mayr (2005b, ch. 82), Mayr (2006, ch. 94), Zelenkov & Dyke (2008, ch. 26), Ksepka & Clarke (2009, ch. 48), Ksepka & Clarke (2010, ch. 55), Mayr *et al.* (2010, ch. 78), Ksepka *et al.* (2011, ch. 89), Mayr (2011, ch. 80), Ksepka & Clarke (2012, ch. 93), Mayr (2013, ch. 33), Mayr (2015, ch. 64), Ksepka *et al.* (2017, ch. 97), Ksepka *et al.* (2019, ch. 131), Mayr (2020), ch. 77, Mayr (2021, ch. 70), Mayr & Kitchener (2023, ch. 89), Mayr & Kitchener (2023b, ch. 87), Mayr & Kitchener (2023c, ch. 82), Mayr & Kitchener (2023d, ch. 23).

532. Pedal phalanx IV-4, abbreviated, not significantly longer than second and third: absent (0), present (1).

Mayr (2016, ch. 37), Mayr & Kitchener (2022a, ch. 39).

Abbreviated pedal phalanx IV-4 is present in crown group Cariamidae, this includes the Phorusrhacidae *Psilopterus, Patagornis* and *Llallawavis* (Mayr 2016).

533. Pedal phalanx IV-1, fully closed or nearly closed bony canal for flexor tendon on ventral surface: absent (0); present (1) (Fig. 2.73).

Ksepka *et al.* (2011, ch.90), Ksepka & Clarke (2012, ch.94).

A fully or nearly closed bony canal for the flexor tendon is present in Psittaciformes (Fig 2.73).

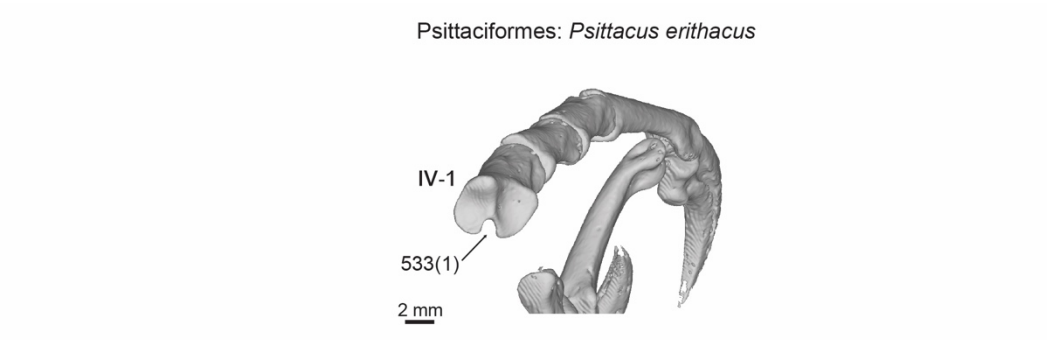


Figure 2.73. digit IV in proximal view showing character 533. *Psittacus erithacus* (African grey parrot, NHMUK zoo S/1992.41.60). Numbers denote characters and character states as listed.

534. Pedal phalanx III-1, foveae ligamentorum collateralia: shallow (0); deep (1).

New character.

535. Pedal phalanx IV-1: unexpanded (0); greatly widened at base (1) (Fig. 2.75).

Ksepka *et al.* (2019, ch. 130), Mayr & Kitchener (2023a, ch. 88), Mayr & Kitchener (2023b, ch. 86).

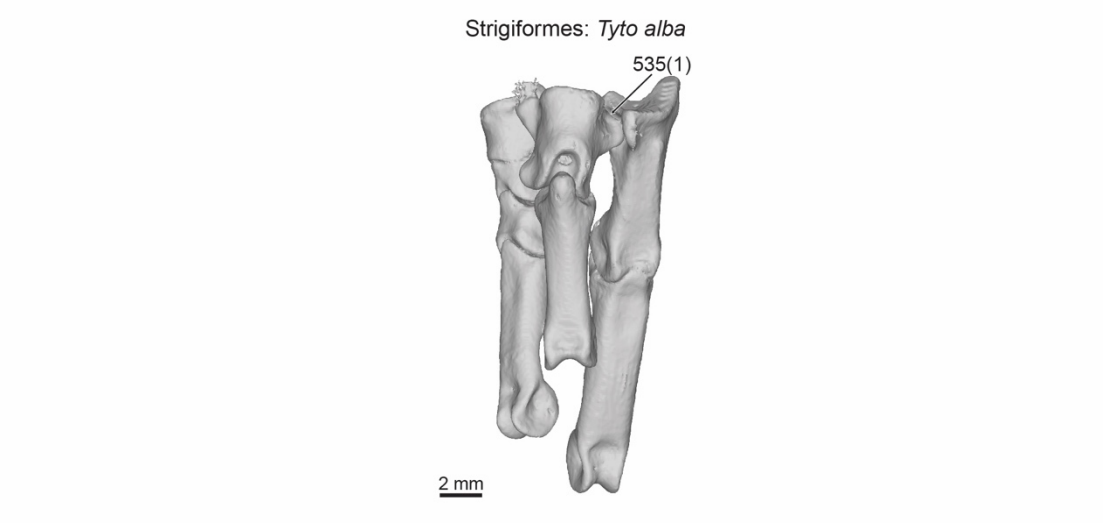


Figure 2.74. Pedal digits in dorsal view showing character 535. *Tyto alba* (Barn owl, NHMUK zoo S/1989.22.1). Numbers denote characters and character states as listed.

536. Pedal digit III and IV coalescent at least over length of proximal phalanx of pedal digit III: absent (0), present (1) (Fig. 2.71).

Mayr *et al.* (2003, ch. 71), Mayr *et al.* (2004, ch. 34), Mayr (2004, ch. 48), Mayr (2005a, ch. 77), Mayr (2006, ch. 93), Mayr *et al.* (2010, ch. 77), Mayr (2011, ch. 78), Mayr (2015, ch. 62), Bourdon *et al.* (2016, ch. 58), Mayr (2020, ch. 75), Mayr (2021, ch. 75) , Mayr (2022, ch. 53), Mayr & Kitchener (2023a, ch. 86), Mayr & Kitchener (2023b, ch. 84), Mayr & Kitchener (2023c, ch. 80).

See character 524 discussion. This condition (state 1) is mostly observed in Eucavitaves (Fig. 2.71B) except in Piciformes. This does occur in some passerines such as *Acanthisitta chloris.*

537. Pedal digits relative lengths: IV shorter than III (0); IV equal in length to III (1); IV longer than III (2).

New character.

538. Pedal digits relative lengths: II shorter than III (0); II equal in length to III (1); II longer III (2).

New character.

539. Pedal digits relative lengths: II shorter than IV (0); II equal to IV (1); II longer than IV (2).

New character.

540. Pentultimate phalanx on each pedal digit is the longest or equal to the other phalanx on each toe: no (0); yes (1).

New character.

The penultimate phalanx of each pedal digit is the longest phalanx, as in most extant arboreal birds.

541. Pedal digit IV-1: marked plantar projection on the proximal end: absent (0); present (1).

New character.

This feature was discussed in Mayr & Kitchener (2023a, fig. 8A,B) for *Messelastur gratulator* and *Tynskya sp.,* and identified as a autapomorphic feature of the Messelasturidae. However, a very similar feature is also observed in Picidae, though the direction of the projection is more plantarly projected. This feature in Picidae has not been scored in this analysis, see unused characters list.

542. Pedal unguals: degree of curvature: slight to straight (0); moderate (1); pronounced curve (2) (Fig. 2.75).

Mayr & Clarke (2003, ch. 114), Mayr (2016, ch. 38), Hieronymus *et al.* (2019, ch. 37), Mayr (2020, ch. 79), Mayr (2021, ch. 72), Mayr & Kitchener (2022a, ch. 40), Mayr & Kitchener (2023a, ch. 91), Mayr & Kitchener (2023d, ch. 24), Mayr & Kitchener (2023c, ch. 84), Mayr & Kitchener (2023b, ch. 89).

See figure 2.75 for varying degrees of curvatures of the unguals (Fig. 2.75).

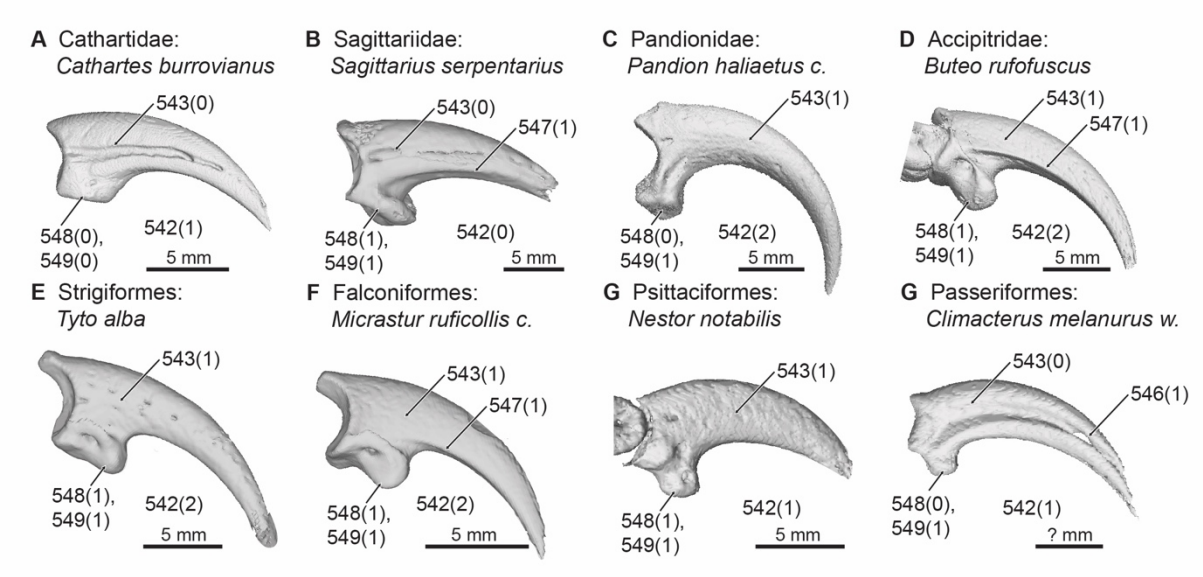


Figure 2.75. Pedal unguals in lateral view Characters 542, 543, 548 and 549. (A) *Cathartes burrovianus* (lesser yellow-headed vulture, UMMZ birds 227466); (B) *Sagittarius serpentarius* (secretary bird, NHMUK zoo 1898.5.7.1); (C) *Pandion haliaetus carolinensis* (Osprey, FMNH birds 437336); (D) *Buteo rufofuscus* (jackel buzzard, NHMUK zoo 1862.1.18.1); (E) *Tyto alba* (barn owl, NHMUK zoo S/1989.22.1); (F) *Micrastur ruficollis concentricus* (Barred forest-falcon, FMNH birds 330226); (G) *Nestor notabilis* (Kea, FMNH birds 23530); (H) *Climacteris melanurus wellsi* (black-tailed treecreeper, UMMZ birds 214303). Numbers denote characters and character states as listed.

543. Pedal unguals, sulci neurovascularis: laterally open sulcus (0); closed to form a canal that opens proximal to the tuberculum flexorium (ventral foramina) (1) (Fig. 2.75).

Mayr *et al.* (2003, ch. 72), Mayr & Clarke (2003, ch. 113), Mayr (2005a, ch. 79), Mayr (2005b, ch. 83), Mayr (2006, ch. 95), Ksepka & Clarke (2009, ch. 49), Ksepka & Clarke (2010, ch. 56), Mayr *et al.* (2010, ch. 79), Ksepka *et al.* (2011, ch. 92), Mayr (2011, ch. 81), Ksepka & Clarke (2012, ch. 96), Ksepka *et al.* (2017, ch. 98), Ksepka *et al.* (2019, ch. 132), Mayr (2020, ch. 78), Mayr (2021, ch. 71), Mayr & Kitchener (2022a, ch. 41), Mayr & Kitchener (2023a, ch. 90), Mayr & Kitchener (2023b, ch. 84).

544. Pedal digit III ungual with longitudinal ridge along medial surface: absent (0), present (1).

Mayr & Clarke (2003, ch. 114), Mayr (2016, ch. 38), Hieronymus *et al.* (2019, ch. 37), Mayr (2020, ch. 79), Mayr (2021, ch. 72), Mayr & Kitchener (2022a, ch. 40), Mayr & Kitchener (2023a, ch. 91), Mayr & Kitchener (2023b, ch. 89), Mayr & Kitchener (2023c, ch. 84), Mayr & Kitchener (2023d, ch. 24).

A longitudinal ridge along the medial surface of the third ungual is only present in Strigiformes, this ridge serves part of the “comb” feature on the keratin sheath.

545. Pedal digit III ungual to non-ungual phalanges length ratio: > 25% (0); < or equal to 25% (1).

Smith *et al.* (2018, ch. 50), Hieronymus *et al.* (2019, ch. 38).

546. Pedal unguals, apex phalanx with large foramen: absent (0); present (1).

New character.

A large foramen on the apex of the pedal ungual (1) is present in Passeriformes (Fig. 2.75G)

547. Pedal unguals, plantar surface of the corpus phalangis: convex surface (oval shaped cross section) (0); latero-medially compressed and delimited by lateral and medial ridges (arc shaped cross section) (1) (Fig. 2.75).

New character.

See Wertz *et al.* (2022) for more details on comparative morphology of ungual phalanges.

548. Pedal unguals, position of tuberculum flexorium: proximally oriented (0); distally oriented (1) (Fig. 2.75).

New character.

See Wertz *et al.* (2022) for more details on comparative morphology of ungual phalanges.

549. Pedal unguals, size of tuberculum flexorium: plantarly un-expanded (0); ventrally expanded (1) (Fig. 2.75)

New character.

See Wertz *et al.* (2023) for more details on comparative morphology of ungual phalanges.



Fiscal shrike (Lanius collaris), Hermanus, Western Cape, South Africa. Photo by Kevin S. Olsen with bird-guide Mhairi Reid.

Chapter 3 The Phylogenetic Inter-relationships of Telluraves

3.1 Introduction

Phylogenetic studies of Telluraves have historically been complicated by the convergent evolution of shared morphological traits in some groups, especially among raptorial birds (Accipitriformes, Strigiformes and Falconiformes), leading to conflicting topologies between morphological and molecular data. Molecular phylogenies, such as those by Jarvis *et al.* (2014) and Stiller *et al.* (2024), consistently support a division of Telluraves into two primary subclades: Afroaves (including Accipitriformes, Strigiformes, and others) and Australaves (including Falconiformes, Psittaciformes, and Passeriformes). These studies suggest a phylogenetically dispersed distribution of "raptorial" orders (Fig. 1.3A, C). Other molecular analyses found Afroaves as a paraphyletic grade outside of Australaves, with Accipitriformes sister to other Telluraves, implying that the common ancestor of Telluraves may have been raptorial or predatory (e.g., Prum *et al*. 2015) with subsequent diversification into non-raptorial lineages like parrots and songbirds (Fig. 1.3B). However, morphological analyses often group raptorial birds together, forming a "raptorial" clade, which contradicts molecular findings and may reflect homoplasy due to convergent evolution (e.g., Mayr & Clarke 2003; Livezey & Zusi, 2007).

Fossil birds from the Paleogene, particularly from the Eocene, are essential to understanding early telluravian evolution, and may help to resolve their deep phylogenetic divergences. Previous phylogenetic studies on stem Telluraves have predominantly focused on specific subgroups within established clades, rather than exploring broader systematic issues. For instance, studies on Sandcoleiformes (Houde & Olson 1992), Primobucconidae (Mayr *et al.* 2004), Halcyornithidae (Ksepka *et al.* 2011), Zygodactylidae (Smith, DeBee, *et al.* 2018),

Masillaraptoridae (Mayr & Kitchener 2022a), Psittacopedidae (Mayr & Kitchener 2022c), Vastanavidae and Messelasturidae (Mayr & Kitchener 2023a), and Picocoraciades (Mayr & Kitchener 2024c) have provided detailed insights into individual lineages. However, these analyses typically included only a few terminal taxa outside the group of interest, prioritizing intragroup relationships over intergroup connections. A few studies, such as those by Ksepka *et al.* (2017), Ksepka *et al.* (2019) and Mayr & Kitchener (2023a,b,c), have attempted to resolve relationships across stem Telluraves, offering a more comprehensive overview. These studies provide valuable insights into specific clades such as the placement of *Eofringillirostrum* as a stem Passeriformes (Ksepka *et al.* 2019), the potential affinity of Halcyornithidae to Coraciimorphae (Ksepka *et al.* 2017), and Vastanavidae and Messelasturidae as potential stem group memeber of Psittacopasseres (Mayr & Kitchener 2023a). These studies emphasise that phylogenetic placements are generally weakly supported and there exist some character evidence for alternative phylogenies. Figure 3.1 summarizes the phylogenetic hypotheses recovered in these previous studies, highlighting the fragmented nature of current knowledge (refer to Chapter 1 for more details on specific fossil taxa).

Given these limitations in previous analyses, particularly their subgroup focus and limited integration of fossils, the current study establishes a new morphological dataset to re-examine the phylogenetic intra and inter-relationships of Tellurave. My approach aims to address the following questions: (1) Are morphological data adequate to robustly resolve deep phylogenetic divergences within Telluraves? (2) Are the topologies supported by these data congruent with previous hypotheses based on morphological or molecular signals, or neither? (3) Do fossil taxa have a significant impact on the topology, potentially reconciling morphological and molecular signals? And (4) what does phylogenetic analysis of morphological data, constrained by a molecular backbone topology, suggest about the affinities of extinct groups? By collating all previous subgroup analyses into a single large-scale framework, this study seeks to provide a holistic view of Telluraves evolution, utilising both extant and extinct taxa to enhance resolution and test the robustness of phylogenetic inferences.

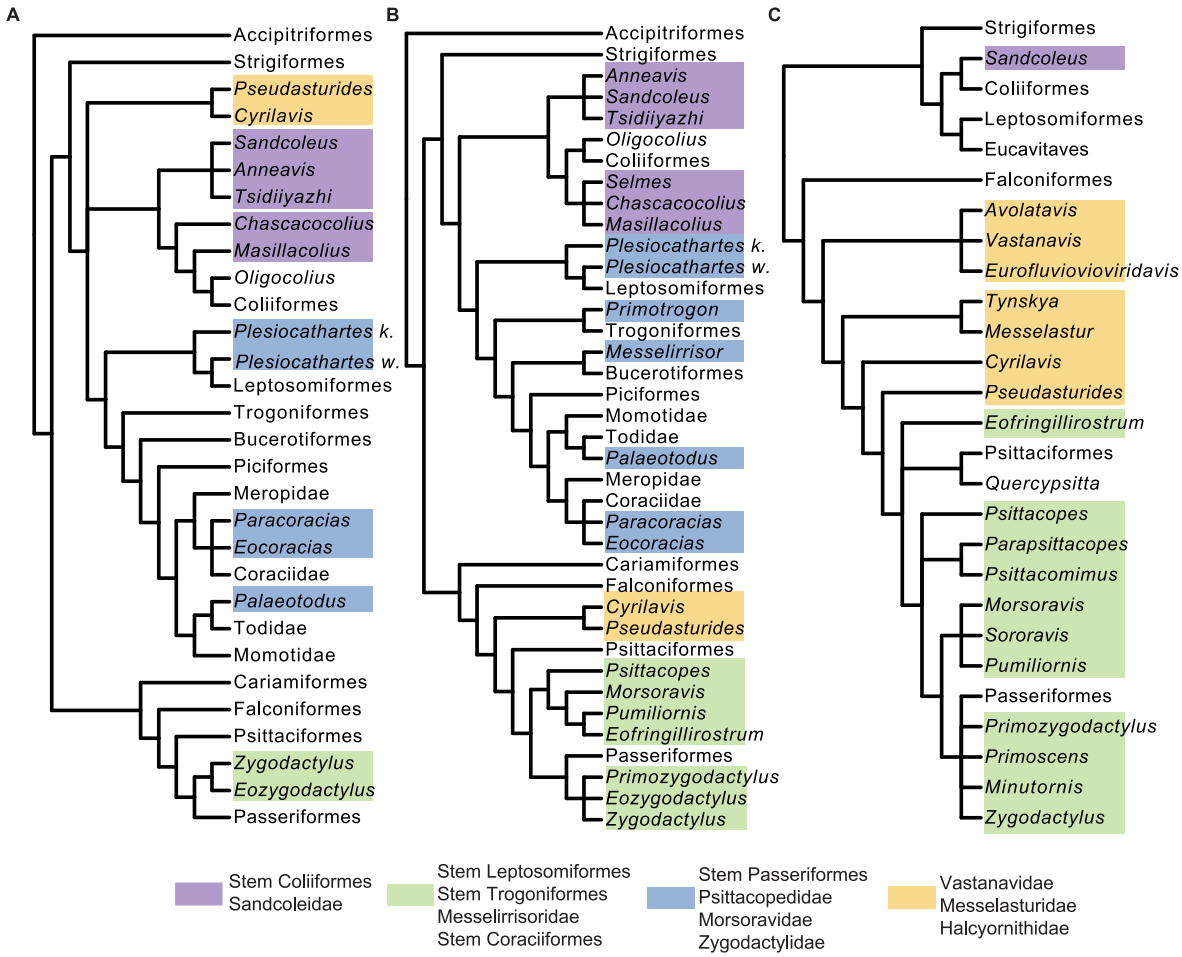


Figure 3.1. Simplified phylogenetic hypotheses of selected previous studies which include a wider range of fossil taxa, all studies use Prum *et al.* (2015) as the backbone constraint. (A) Ksepka *et al.* (2017); (B) Ksepka *et al.* (2019); (C) Mayr & Kitchener (2023b).

3.2 Methods

3.2.1 Taxon list

The aim of this study is to synthesize data relevant to all deeper Telluravian relationships and produce a large, taxon-rich topology encompassing members of all higher clades, both living and extinct. For my fossil sample, I focussed on Palaeocene and Eocene taxa because phylogenomic and fossil studies provided strong evidence that the earliest known stem-group representatives of extant telluravian orders appeared in the early Paleogene (65.5 Ma to 33.9 Ma) (Yuri *et al.* 2013; Jarvis *et al.* 2014; Prum *et al.* 2015; Kuhl *et al.* 2021; Mayr 2022a; Stiller *et al.* 2024) (Fig. 1.1). A

comprehensive taxon list was compiled encompassing a broad range of 57 extant telluravian birds. The full list of extant taxa examined in this study are listed in Table S1.2, with links to relevant CT scan data in Morphosource. All μCT scanned specimens were previously collected from the TEMPO project library on morphosource, see also Bjarnason & Benson (2021). Choice of extant taxa is discussed in Chapter 2 of this thesis. Four taxa were chosen as outgroups: *Eudromia elegans* (Tinamiformes), *Chauna chavaria* (Anseriformes*), Eurypyga helias* (Eurypygiformes) and *Charadrius vociferus* (Charadriiformes) (see section 3.2.5 for discussion of outgroup taxa).

Sampled fossil taxa focused on early members of each probable assigned clade within Telluraves. In total, 50 early telluravian taxa were chosen (Table 3.1), based on their morphology being clearly and adequately documented in published literature with good quality photos available for character scoring. Where possible, they were directly observed and detailed photographs were taken. An important criterion in selecting fossil taxa was the completeness of the specimens to ensure that the entire mosaic of features is realised. Taxa were also chosen to represent groups that collectively span the stem lineages of many living groups. Most fossil specimens were scored at species level, with two taxa (*Waltonavis* and *Dynamopterus*) considered at the generic level to improve scoring completeness. Refer to Chapter 1 for more in-depth discussion of fossil taxa.

Stem Accipitriformes are represented by *Diatropornis ellioti* Milne-Edwards, 1892 a putative stem Cathartidae, the horunsornithid *Horusornis vianeyliaudae* Mourer-Chauviré, 1991 and *Palaeoplancus sternbergi* Wetmore, 1993. According to Mayr (2022), the assignment of *Horusornis vianeyliaudae* to Accipitriformes should be provisional. However, given that well preserved and complete Accipitriformes fossils from the Palaeocene and Eocene are scarce, this taxon is included in the analysis. *Palaeoplancus sternbergi* is the youngest (early Oligocene) fossil included in this analysis and was originally described by Wetmore (1933) as a stem representative of Accipitridae. Stem Strigiformes are represented by *Primoptynx poliotauros* Mayr *et al.*, 2020 and *Ypresiglaux michaeldanielsi* Mayr & Kitchener, 2023d.

Stem Coliiformes are represented by the Sandcoleidae *Eoglaucidium* cf. *pallas* (Mayr 2018) and stem group Collidae *Masillacolius brevidacylus* Mayr & Peters, 1998. Stem Leptosomiformes are represented (though tentatively assigned) by *Plesiocathartes insolitipes* (Mayr & Kitchener 2022b), *Plesiocathartes kelleri* (Mayr 2002a) and *Plesiocathartes wyomingensis* (Weidig 2006). *Waltonavis paraleptosomus*, *W. danielsi* and *W.* sp. are also considered in this analysis even though their designation to Leptosomiformes is uncertain (Mayr & Kitchener 2022b). Stem Trogoniformes are represented by the Trogonidae *Eotrogon stenorhynchus* Mayr *et al.,* 2023, one the oldest (early Eocene) and most complete pan-trogoniform. Stem Bucerotiformes is represented by the Messelirrisoridae *Messelirrisor halcyrostris* (Mayr 1998a). Other stem Coraciiformes (most derived stem Cavitaves) are well represented in the fossil record but due to time constraints could not be examined in this study.

The Bathornithidae *Bathornis grallator* Wetmore, 1944, redescribed by (Mayr 2016a), the Idiornithidae *Dynamopterus gallicus* (Milne-Edwards 1892), *D. minor* (Mourer-Chauviré *et al.* 1983; Mourer-Chauviré 2013) and *D. velox* (Mourer-Chauviré 2013) represent stem Cariamiformes. Stem Falconiformes are represented by the Masillaraptoridae *Danielsraptor phorusrhacoides* Mayr & Kitchener, 2022a, *Masillaraptor parvunguis* Mayr, 2006 and *Masillaraptor cf. parvunguis* Mayr & Kitchener, 2022a.

Stem Psittaciformes are represented by the Quercypsittidae *Quercypsitta sudrei* Mourer-Chauviré, 1992, the only known family from the Paleogene to have definitive psittaciform affinities. Stem Passeriformes are represented by the Zygodactylidae *Zygodactylus grandei, Eozygodactylus americanus* and *Primozygodactylus* Mayr, 1998b. The Zygodactylidae and crown group Passeriformes form a clade termed Parapasseres (Mayr 2015b). Other stem Passeriformes included are the Psittacopedidae *Psittacopes Lepidus, Parapsittacopes bergdahli Psittacomimus eos* and the closely associated taxa *Eofringillirostrum boudreauxi* and the Morsoravidae *Pumiliornis tessellatus* (Mayr 2015b; Mayr & Kitchener 2023b). Other more controversially resolved taxa included in this analysis are: the Vastanavidae *Vastanavis eocaena*, *V. cambayensis*, *Avolatavis tenens*, *A. europaeus* and *Eurofluvioviridavis robustipes*; the Messelasturidae

Messelastur gratulator, *Tynskya waltonensi*, *T. eocaena*, *T. brevitarsus*, and *T. crassitarsu*; and the Halcyornithidae *Pulchrapollia gracilis*, *P. eximia*, *Cyrilavis colburnorum*, *C . olsoni*, *Serudaptus pohli* and *Pseudasturides macrocephalus* (Mayr 2005b; Mayr *et al.* 2010).

Table 3.1. List of taxa included in Analysis 2 & 3 with associated primary refences used for scoring. Asterisks indicate taxa scored entirely from published descriptions (i.e. specimens not examined).

Family	Taxon	Specimen(s) used for character scoring	Primary reference used for character scoring
Horusornithidae	*Horusornis vianeyliaudae**	BFI 1974 (holotype)	Mourer-Chauviré (1991)
Teratornithidae	*Diatropornis ellioti*	MNHM QU 1554D (holotype), FSL 330 501	Cracraft & Rich (1972); Mourer-Chauviré (1988)
Accipitridae	*Palaeoplancus sternbergi*	USNM 12479 (holotype)	Wetmore (1933)
Strigiformes	*Primoptynx poliotauros**	UMMP 96195 (holotype)	Mayr *et al.* (2020)
Strigiformes	*Ypresiglaux michaeldanielsi**	NMS.Z.2021.40.26 (holotype); NMS.Z.2021.40.27	Mayr & Kitchener (2023d)
Sandcoleidae	*Eoglaucidium cf. pallas*	WDC-C-MG 148/149b; SMF-ME 11110a,b; SMF-ME 3544; SMF-ME 10795a,b	Fischer (1987); Mayr & Peters (1998); Mayr (2002b, 2018, 2020)
Coliidae	*Masillacolius brevidactylus**	HLMD-Me 10472 (holotype); SMF-ME 11322	Mayr & Peters (1998); Mayr (2015)
Leptosomidae	*Plesiocathartes insolitipes**	NMS.Z.2021.40.36 (holotype); SMF Av 656	Mayr & Kitchener (2022a)
Leptosomidae	*Plesiocathartes wyomingensis*	WDC-2001 -CGR-021	Mayr (2002b, 2002c, 2020); Mourer-Chauviré (2002); Weidig (2006)
Leptosomidae	*Plesiocathartes kelleri**	SMF-ME 3639 (holotype)	Mayr (2002b, 2002c, 2020); Mourer-Chauviré (2002); Weidig (2006)
Leptosomidae	*Waltonavis paraleptosomus**	NMS.Z.2021.40.16 (holotype); NMS.Z.2021.40.17; NMS.Z.2021.40.18; NMS.Z.2021.40.19	Mayr & Kitchener (2022a)
Leptosomidae	*Waltonavis danielsi & sp.**	NMS.Z.2021.40.20 (holotype); NMS.Z.2021.40.21 (holotype)	Mayr & Kitchener (2022a)
Trogonidae	*Eotrogon stenorhynchus**	NMS.Z.2021.40.83 (holotype); NMS.Z.2021.40.84-90	Mayr *et al*. (2023)
Messelirrisoridae	*Messelirrisor halcyrostris**	SMF-ME 1883 (holotype); SMF-ME 10987a,b	Mayr (1998, 2000c, 2006a)
Bathornithidae	*Bathornis grallator**	CM 9377 (holotype)	Wetmore (1944); Cracraft (1968,1971,1973); Mayr (2016a)
Idiornithidae	*Dynamopterus velox*	MNHN QU 16225	Milne-Edwards (1892); Mourer-Chauviré (2013)
Idiornithidae	*Dynamopterus gallicus*	MNHN QU 15502; MNHM QU 16966	Milne-Edwards (1892); Mourer-Chauviré (2013)
Idiornithidae	*Dynamopterus minor*	MNHN QU 15504; NHMW 2013/0093/0001a,b,; NHMW 2013/0094/0001; NHMW 2013/0094/0002	Milne-Edwards (1892); Mourer-Chauviré (2013)
Masillaraptoridae	*Masillaraptor parvunguis*	SMF-ME 1065 (holotype); SMF-ME 11042	Mayr (2006b, 2009b, 2020c)
Masillaraptoridae	*Masillaraptor cf. parvunguis**	NMS.Z.2021.40.14	Mayr & Kitchener (2022a)
Masillaraptoridae	*Danielsraptor phorusrhacoides**	NMS.Z.2021.40.12 (holotype); NMS.Z.2021.40.13	Mayr & Kitchener (2022a)
Halcyornithidae	*Pulchrapollia gracilis*	NHMUK A6207 (holotype)	Dyke & Cooper (2000); Mayr & Kitchener (2023c)
Halcyornithidae	*cf. Pulchrapollia*	SMF Av 628; SMF Av 629; SMF Av 630; SMF Av 631; USNM PAL 771600; USNM PAL 771605	Mayr (2016); Mayr *et al.* (2021)
Halcyornithidae	*cf. Pulchrapollia gracilis**	NMS.Z.2021.40.63	Mayr & Kitchener (2023a)
Halcyornithidae	*? Pulchrapollia eximia**	NMS.Z.2021.40.64	Mayr & Kitchener (2023a)

Halcyornithidae	*Pseudasturides macrocephalus*	WDC-C-MG 94 (holotype); SMNK-PAL.2373a; SMF-ME 2086a,b; 727a,b; SMF Av 508	Dyke (2001); Mayr (1998,2002, 2007);
Halcyornithidae	*Cyrilavis colburnorum*	FMNH PA 754 (holotype),766,722	Ksepka *et al.* (2011)
Halcyornithidae	*Cyrilavis cf. colburnorum**	NMS.Z.2021.40.67	Mayr & Kitchener (2023a)
Halcyornithidae	*Serudaptus pohli**	WDC-C-MG 201a,b (holotype)	Mayr (2000); Mayr (2011)
Messelasturidae	*Messelastur gratulator*	SMF-ME 2024 (holotype), 11080, 11348	Peters (1994); Mayr (2005, 2011)
Messelasturidae	*Tynskya eocaena**	SNSB-BSPG 1997 I 6 (holotype), WN 96939	Mayr (2000, 2021)
Messelasturidae	*Tynskya waltonensis**	SMF Av 652 (holotype)	Mayr (2021)
Messelasturidae	*Tynskya brevitarsus**	NMS.Z.2021.40.78 (holotype)	Mayr & Kitchener (2023a)
Messelasturidae	*Tynskya crassitarsus**	NMS.Z.2021.40.73 (holotype)	Mayr & Kitchener (2023a)
Vastanavidae	*Vastanavis eocaena**	GU/RSR/VAS 441 (holotype), 1245,1255,1256, 1802	Mayr *et al.* (2007, 2010, 2013); Mayr & Kitchener (2023a)
Vastanavidae	*Vastanavis cambayensis*	GU/RSR/VAS 1251 (holotype) 442,1252, 1253, 1802	Mayr *et al*. (2007, 2010, 2013); Mayr & Kitchener (2023a)
Vastanavidae	*Avolatavis tenens*	UWGM 39876 (holotype)	Ksepka and Clarke (2012)
Vastanavidae	*Avolatavis europaeus**	NHS.Z.2021.40.76	Mayr & Kitchener (2023a)
Vastanavidae	*Eurofluvioviridavis robustipes**	SMNK.PAL.3835 (holotype), SMF-ME 10783a + 10783b	Mayr (2015b)
Quercypsittidae	*Quercypsitta sudrei**	BFI 1903 (holotype)	Mourer-Chauviré (1992)
Psittacopedidae	*Psittacopes lepidus*	SMF-ME 1279 (holotype), SMF-ME 1089a,b	Mayr & Daniels (1998); Mayr (2015)
Psittacopedidae	*Parapsittacopes bergdahli**	SMF Av 653 (holotype)	Mayr (2020b)
Psittacopedidae	*Psittacomimus eos**	NMS.Z.2021.40.38	Mayr & Kitchener (2022c)
Morsoravidae	*Pumiliornis tessellatus**	SMF-ME 2092A+B (holotype); SMF-ME 11414a,b	Mayr (1999, 2008a); Mayr & Wilde (2014)
Psittacopedidae	*Eofringillirostrum boudreauxi*	FMNH PA 793	Ksepka *et al*. (2019)
Zygodactylidae	*Zygodactylus grandei*	FMNH PA 726; UWGM40705	Weidig (2010); Smith *et al.* (2018)
Zygodactylidae	*Primozygodactylus danielsi*	SMF-ME 2522A (holotype), SMF-ME 10835A	Mayr (1998)
Zygodactylidae	*Primozygodactylus major*	SMF–ME 799a,b	Mayr (1998); Mayr (2017)
Zygodactylidae	*Primozygodactylus eunjooae*	SMF–ME 1074 (holotype)	Mayr & Zelenkov (2009)
Zygodactylidae	*Primozygodactylus quintus*	SMF-ME 11091a,b (holotype)	Mayr (2017)
Zygodactylidae	*Primozygodactylus longibrachium*	SMF-ME 11171a,b (holotype)	Mayr (2017)
Zygodactylidae	*Eozygodactylus americanus*	USNM 299821, WDC-C-GR 014, FMNH PA770	Weidig (2010); Smith *et al*. (2018)

Institutional abbreviations

BFI, Université des Sciences et Techniques du Languedoc, Montpellier, France; **BSPG**, Bayerische Staatssammlung fur Palfiontologie und Historische Geologie, Munich, Germany; **CM**, Carnegie Museum of Natural History, Pittsburgh, USA; **FSL**, Faculté des Sciences de Lyon, Lyon, France; **FMNH**, Field Museum of Natural History, Chicago, USA; **GU/RSR/VAS**, Garhwal University, Department of Geology, Uttarakhand, India; **HLMD**, Hessisches Landesmuseum Darmstadt, Dramstadt, Germany; **NHMUK**, British Museum of Natural History, London, UK; **NMS**, National Museums Scotland, Edinburgh, UK; **NHMW**, Naturhistorisches Museum, Vienna, Austria; **MNHN**, Muséum National d'Histoire naturelle, Paris, France; **SMNK**, Staatliches Museum für Naturkunde Karlsruhe, German; **SMF**, Senckenberg Research Institute, Frankfurt am Main, Germany; **SNSB-USNM**, National Museum of Natural History, Washington DC, USA; **UMMP**, University of Michigan, Museum of Paleontology, Ann Arbor, USA; **UWGM**, University of Wyoming Geological Museum, Laramie, USA; **WDC**, Wyoming Dinosaur Center, Thermopolis, USA.

3.2.2 Character list & Data matrix

The character list used in all analyses included 550 characters complied from a thorough review of previous extant and extinct Telluraves analyses, which are discussed in more detail in Chapter 2 of this thesis (see Table 1.1). All characters were critically assessed for inclusion, a total of 222 are from combined previous studies and 328 are new.

Approximately 65% of the dataset comprises missing entries, denoted as "?" in the matrix. Most are from incomplete preservation of fossil taxa. Inapplicable character states are noted as "-" in the matrix and are a consequence of coding strategy used for characters 6, 37-40, 63, 77, 96-99, 101-104, 116, 133, 171, 182, 183, 185, 186, 189-191, 197, 200, 224, 236 , 271, 333, 351, 353, 393, 437, 439, 455, 471, 494, 496-498, and 519.

The study set contains high amounts of missing data within the fossil taxa, see Table S1.3 for a list of the percentage of missing postcranial and cranial data, or the proportions of characters

in the dataset. Much of the missing data is concentrated in the cranial characters of extinct taxa with only four taxa that are highly incomplete in both cranial and post-cranial data (>80%). While missing data has been shown to reduce phylogenetic accuracy (e.g., Wiens 2003), the quantity of missing data does not directly correlate with the information content of a taxon. A highly incomplete taxon may still increase resolution if it contains informative synapomorphies (e.g., Wiens 2003).

3.2.3 Phylogenetic analyses

Three main phylogenetic tests were performed using both maximum parsimony and Bayesian inference. Within each analysis a number of iterations are analysed: the effect of ordered characters, varying outgroup selections and effect of raptorial characters (described below in more detail):

- **Analysis A1** includes extant taxa only, left unconstrained.
- **Analysis A2** includes both extant and fossil taxa, left unconstrained.
- **Analysis A3** includes both extant and fossil taxa constrained by a molecular scaffold from Prum *et al.* (2015) and Stiller *et al.* (2024).

Maximum parsimony

All phylogenetic analyses (A1-3) were performed in PAUP* v.4.0 (Swofford 2003). Characters were equally weighted and treated as unordered (see below for ordered character tests). Trees were rooted with outgroups forming a polytomy at the base of the tree. An heuristic search was performed with 100,000 random addition sequence replicates to obtain the most parsimonious trees for the datasets. Tree bisection and reconnection (TBR) was utilized as the branch-swapping algorithm for the heuristic search. Zero-length branches were collapsed if they lacked support under any of the most parsimonious reconstructions (“Rule 3”). The maximum number

of trees saved for each random addition sequence replicate was set to 100 to prevent searches from becoming stuck on large islands of MPTs during any particular random addition sequence replicate. The character-taxon matrix used in PAUP* (and all other analyses) is provided in Appendix S3.1.

The analyses were also performed in TNT v.1.6 *Willi Henning Society Edition* (Goloboff & Morales 2023), using the new technology-driven search with Sectorial Search, Ratchet, Drift and Tree Fusing algorithms using default parameters, with 1000 random additional replicates (RAS) and 10 trees saved per replicate. The resulting MPTs were then subjected to a Traditional Search, with tree bisection reconnection (TBR) branch swapping, using 1,000 replications and 10 trees saved per replication. The collapsing rule set to "Rule 3" to match settings in PAUP*, general RAM set to 900 MB and the maximum number of trees to be held set to 9,999. Nodal support was assessed using Bremer support (values of 100) and Bootstrap analyses (100 replicates, full heuristic search, absolute frequences) in TNT v.1.6.

In order to understand the morphological character transitions implied by the phylogeny, as well as the morphological support for internal nodes of the tree, character state optimization was performed in PAUP* v.4.0 (heuristic search settings discussed above). PAUP* allows specification of the optimization criterion where ACCTRAN (accelerated transformation) and DELTRAN (delayed transformation) agree, while TNT only returns unambiguous synapomorphies. ACCTRAN favours earlier transformation, placing character state changes closer to the root, which can result in a higher number of inferred reversals while DELTRAN delays transformations, positioning changes nearer to the terminal branches, therefore favouring parallelism or independent acquisitions of character states (Agnarsson & Miller 2008). Only relying on unambiguous character optimisation may lead to underestimation of synapomorphies within a clade, especially in groups with substantial missing data and uneven character representation among taxa (Agnarsson & Miller 2008). Character transformations were also visualised using the "trace character history" option in Mesquite (Maddison & Maddison 2007),

as this often allows more detailed evaluation of transitions. Both the ensemble and individual character diagnostics were calculated in PAUP*.

In Analysis 3, a molecular backbone constraint is applied on the combined matrix of both extant and extinct morphological data. This was performed in PAUP*, using molecular scaffolds from Prum *et al.* (2015) and Stiller *et al.* (2024) as partial constraints (NEXUS constraints provided in Appendix S3.2). In backbone constraints, the fossil taxa (i.e., unlisted taxa) are left unconstrained and so are allowed to fall anywhere within the constrained topology of the extant taxa.

Bayesian inference

The dataset was additionally analysed under Bayesian inference using MrBayes v3.2.7a (Ronquist, Teslenko, *et al.* 2012). Telluraves monophyly was assumed and enforced as a topological constraint to focus on intra-relationships, and to help aid in faster convergence and accurate rooting by reducing computational complexity (Huelsenbeck & Ronquist 2001). I used the Mkv model of morphological character state evolution, accounting for rate heterogeneity among characters (gamma distribution), improving the fit to morphological data with potential homoplasy (Lewis 2001). The analyses were conducted using Markov Chain Carlo (MCMC) sampling to estimate the posterior distribution. Parameter states and trees were printed and sampled every 10,000 generations to balance computational efficiency through sampling. Relative burn-in was enabled, discarding the first 50% of samples to remove early, non-converged states. The temperature parameter for heated chains was set to 0.9 to optimise swapping between chains and improve mixing, this was executed with two independent runs with four chains each and three swap attempts per generation. The analysis was stopped when the average standard deviation of split frequencies fell below 0.01 (stopval = 0.01), ensuring convergence between runs, which generally occurred around 30 million generations. All analyses were summarised as 50% majority rule trees (contype= halfcompat) as well as adding all compatible groups to the tree (i.e. the consensus tree; contype= allcompat). In Analysis 3, where a molecular scaffold was

applied to the combined extant and extinct data matrix, MrBayes constraints were generated using the package *paleotree* v. 3.4.7 (Bapst 2012) in RStudio v. 2022.07.1 (R Core Team 2021).

Additionally, a time-calibrated relaxed-clock Bayesian inference analyses were performed (Lepage *et al.* 2007). The base clock rate was given an informative prior based on non-clock analysis, following Simões *et al.* (2020): the median value of the tree height in substitutions from posterior trees (calculated in Tracer v.1.7.2) divided by the age of the tree based on the median of the distribution of the root prior, in natural log scale. I chose to use the exponent of the mean to provide a broad standard deviation as previously recommended (Pyron 2017). The sampling strategy was set to diversity, which is more appropriate when extant taxa are sampled in a manner that maximises diversity and fossils are sampled randomly (Ronquist, Klopfstein*, et al.* 2012; Zhang *et al.* 2016). The time-calibrated tree was produced using the R package Strap (Bell & Lloyd 2015) based on the 'equal' method and the function geoscalePhylo was used to plot the time-scaled tree against a geological time scale. The fossil ages used for tip dating correspond to the uniform prior distributions on the age range of the stratigraphic occurrence of the fossils, details of age sources are provided in Table S1.4. The age of the root was set using a uniform prior distribution, with hard minimum and maximum bounds, this was preferred over an exponential offset prior because preliminary runs consistently produced unrealistically deep divergence times for Telluraves. The minimum bound (62 Ma) corresponds to the age of the oldest fossil assigned to Telluraves in this analysis, the mousebird *Tsidiiyazhi abini* from the Nacimiento Formation in New Mexico, USA (Ksepka *et al.* 2017). This provides a conservative estimate for the earliest appearance of the clade, ensuring that the most recent common ancestor of Telluraves cannot postdate this record. The maximum bound (66 Ma) was chosen based on molecular divergence date estimates from Prum *et al.* (2025) which place the origin of Telluraves around the K-Pg boundary, additionally no Telluravian fossils are known from the Cretaceous. The MrBayes script as well as the constraint scripts are provided in Appendix S3.3.

3.2.4 Assessing the impact of ordered characters

In all analyses, characters were initially treated as unordered. Analysis 1 and 2 were then subject to a second round of testing where ordered characters, suggested by previous studies, are used (denoted with an * in Chapter 2). Ordering character states reflects an *a priori* hypothesis that transitions between character states follow a specific sequence (Wilkinson 1992, 1995a). Generally, only multistate characters are ordered where one state is clearly intermediate in form, size, or number. Though, many of the ordered characters from previously published analyses do not have clear evidence for this. Ordering characters can have a significant influence on phylogenetic outcomes (e.g., Brady *et al.* 2024). So unless there is strong evidence (developmental or functional) for support of a specific transition sequence, unordered characters provide a more neutral approach to character evolution.

3.2.5 Assessing the impact of outgroup selection

Global phylogenetic studies of Telluraves have used various different outgroups, either from Anseriformes, Tinamiformes, or both (e.g., Mayr *et al.* 2003; Ksepka *et al.* 2017; Ksepka *et al.* 2019). Most notably, Livezey & Zusi (2007) used 35 outgroup taxa encompassing Crocodylia, theropod Dinosauria, and Mesozoic birds to root Neornithes. While broader outgroup sampling might stabilize higher order relationships, it may not be optimal for resolving relationships within more derived clades like Telluraves.

To evaluate the effect of outgroup selection, I tested the effects of alternative choices of outgroups. The choice and number of outgroup taxa affects character polarisation, which determines the ancestral-versus-derived states of traits (Farris 1982; Lyons-Weiler *et al.* 1998). Outgroup selection can therefore influence the inferred relationships among ingroup taxa, affecting both the stability and accuracy of the resulting tree. If the outgroup is too distantly related, and no intermediate taxa are included, it may exhibit plesiomorphic states that

misrepresent the ingroups ancestral condition. Incorporating outgroups that are phylogenetically distant from Telluraves, without including intermediate taxa, can provide a more stringent test of ingroup relationships by challenging assumed sister group affiliations, but it may also destabilize the topology if homoplasy accumulates over long evolutionary distances (Nixon & Carpenter 1993; Graham *et al.* 2002). Smith (1994) recommended that sampling taxa from the closest successive sister group is best in order to minimize phylogenetic noise and ensure accurate character polarization. Molecular phylogenetics have shown that Aequorlitornithes (Charadriiformes, Mirandornithes, Phaethoquornithes) as possibly sister to Telluraves (e.g., Prum *et al*. 2015), though other molecular studies have found alternate possible sister relationships such as Elementaves (Aequornithes, Pathaethontimorphae, Strisores, Opisthocomiformes, Cursorimorphae) (Stiller *et al.* 2024). I represented these groups using the outgroups *Charadrius vociferus (Charadriiformes)* and *Eurypyga helias (*Eurypygiformes). Choosing the appropriate outgroups from within the above mentioned clades is difficult because they are highly disparate groups, with many derived members, and it isn't clear which groups represent the plesiomorphic condition. I also selected more distantly related taxa as outgroups: *Eudromia elegans (Palaeognathae)* and *Chauna chavaria (Galloanserae)*. These taxa appear to be less derived than the chosen waterbirds, but are not closely-related to Telluraves, which may increase the risk of homoplasy and long branch attraction artifacts as these taxa may share fewer relevant character states with the ingroup (Barriel & Tassy 1998).

I varied outgroup choice by conducting separate phylogenetic analyses using: (1) only closely related groups (*Charadris* and *Eurypyga);* (2) only distantly related groups *(Eudromia* and *Chauna)*; and (3) a combination of both closely and distantly related outgroups. This test is mainly focused on the relatedness of the outgroup taxa to Telluraves. Using more than one outgroup is a good test for monophyly of the ingroup, though this can be assumed due to the substantial evidence from molecular results that Telluraves is monophyletic (Table S1.1). Tree topologies resulting from different outgroup selections were statistically compared in PAUP*, and tree length

variations were recorded to assess stability. To determine whether different outgroup choices significantly affected tree topology, the analyses were unrooted.

3.2.6 Assessing alternative hypotheses using statistical tests

To assess whether molecular constrained topology provides a statistically worse explanation of the morphological character data compared to the unconstrained morphological topology, pairwise Templeton tests were conducted, complemented by Kishino-Hasegawa (KH) and winning-sites tests. The Templeton test, based on the Wilcoxon signed-rank test for phylogenetic comparisons, evaluates whether two competing topologies, one derived from morphology alone and one constrained by molecular data, are significantly different in terms of parsimony score (i.e. tree length) (Templeton 1983). A one-tailed *p*-value less than 0.05 indicates a significant difference in tree length, allowing rejection of the null-hypothesis that the molecular topology is not significantly worse than the unconstrained morphological topology. A *p*-value greater than 0.05 indicates a non-significant difference in tree length, indicating that the molecular constrained tree cannot be statistically distinguished from the most parsimonious morphological tree. The KH test assesses maximum likelihood differences between trees, comparing the likelihood scores of the topologies under a probabilistic model, with *p*-values below 0.05 indicating a significant difference (Kishino & Hasegawa 1989). The winning-sites test (sign test) compares the number of characters favouring one topology over another, offering a parsimony-based assessment of character support, where a *p*-value below 0.05 indicates significant incongruence (Prager & Wilson 1988). Additionally, tests were performed on the topological results of the differing outgroup tests. All tests were performed in PAUP* v.4.0. These tests do have limitations when applied to morphological datasets, mainly how homoplasy can lead to longer tree lengths, reduced consistency indices and introduce bias in overestimating or underestimating differences between topologies (Swofford *et al.* 1996; Nixon & Carpenter 1996). Previous morphological works (e.g., Smith 2010) have also pointed out that these tests requires

that the topologies being compared are specified *a priori*, independent of the data used for the test. In practice, nearly all applications of these tests involve comparing alternative topologies to the optimal topology estimated from the same data. This violates the assumptions of the test, because the optimal topology is inherently expected to have a better fit, guaranteeing a non-zero difference in optimality scores and potentially skewing the distribution of differences, which is assumed to be normal under the null hypothesis (Goldman *et al.* 2000; Shimodaira & Hasegawa 1999). Goldman *et al.* (2000) expanded on this issue in detail, demonstrating that the K-H test is invalid when applied to topologies chosen a posteriori, such as the maximum likelihood or most-parsimonious tree derived from the same dataset used for testing, because the test's expectation that likelihood differences are cantered around zero no longer holds. They cautioned that many published applications of the KH test may therefore be biased and should be treated with scepticism.

To evaluate the fit of the morphological dataset to the inferred phylogenetic topologies, both the ensemble and individual character diagnostics are calculated in PAUP*, alongside the retention index (RI), consistency index (CI), and rescaled consistency index (RC). CI is an indication of how consistent a character change is or the fit in the given tree (i.e., degree of homoplasy Kluge & Farris 1969). This is calculated by dividing the minimum number of steps or changes the character can make by the actual observed number of steps taken. A CI of 1 indicates no homoplasy (all characters evolve without reversal or convergence), while values closer to 0 reflect increased homoplasy. RI assess the retention of synapomorphies, calculated as RI = (h - s) / (h - m), where s is the maximum possible number of character state changes (i.e., the number of steps if all characters were maximally homoplastic), h is the observed number of steps, and m is the minimum number of steps as defined above (Farris 1989). RI values range from 0 to 1, with higher values indicating greater retention of shared derived characters (synapomorphies) and less homoplasy. RC is simply CI multiplied by RI, scaling the consistency of CI by RI giving a more comprehensive assessment of the phylogenetic signal.

3.2.7 Assessing the phylogenetic influence of raptorial characters

The term “raptorial” specifically refers to vertebrate eating predators or “birds of prey” and is traditionally applied to three orders: Accipitriformes (including Cathartidae), Falconiformes, and Strigiformes (McClure *et al.* 2019). These birds share a suite of features that correlate with their predatory lifestyle such as a short, hooked beak, elongated toes with long curved talons and robust skulls adapted for powerful biting forces. Additionally, their hindlimbs are particularly adapted to catch, hold and carry prey items. Both Australaves and Afroaves include a basal distribution of “raptorial” orders, implying that the ancestral lineage of Telluraves was raptorial or at least likely exhibited predatory characteristics (Hackett *et al.* 2008, Jarvis *et al.* 2014, Prum *et al.* 2015). Jarvis *et al.* (2014) and Prum *et al.* (2015) proposed that this “raptorial” condition may have served as an evolutionary foundation, giving rise to non-raptorial lineages and resulting in a paraphyletic assemblage defined by the predatory lifestyle. This however is not reflected in the fossil record, raptorial lifestyle likely evolved independently within each of the three raptorial clades (and also in the extinct groups such as Masillaraptoridae, Messelasturidae and Halcyornithidae) (Mayr 2021c; Mayr & Kitchener 2022a, 2023a).

“Raptorial” bird groups are consistently grouped together in previous morphological phylogenetic studies, indicating that shared predatory adaptions may obscure true phylogenetic relationships due to homoplasy (e.g., Livezey & Zusi 2007). The discrepancy between morphological and molecular hypotheses highlights the need to test the impact of these characters on phylogenetic inference, as homoplasy can lead to erroneous topologies, particularly in morphological datasets where functional convergence is prevalent (Wiley & Lieberman 2011). To investigate the impact of raptorial adaptions on phylogenetic relationships within Telluraves, the characters were partitioned into two subsets: (1) characters associated with “raptoriality” and (2) all remaining characters, where characters that might be functionally linked to a raptorial lifestyle are removed from the analysis.

Raptorial birds exhibit a diverse array of morphological adaptions with notable differences in "raptorial" modifications among Accipitridae, Cathartidae, Strigiformes, and Falconiformes, as defined by McClure *et al.* (2019). For example, Accipitridae are characterised by enlarged talons on digits I and II, which enhance their ability to restrain and immobilise prey through a powerful grip (Fowler *et al.* 2009). In contrast, Falconidae display moderate enlargement, relying instead on a strong bite force and specialised tomial 'tooth' to break the necks of their prey (Sustaita & Hertel 2010; Sustaita 2008). Additionally, both Pandionidae and Strigiformes employ a semi-zygodactyl foot condition to aid in prey capture, with Strigiformes having particularly unique adaptions, such as asymmetrical ears and specialised feathers for silent flight etc. While these specific, derived traits highlight the adaptive diversity among raptorial families, only shared features between these birds were categorised as being related to raptoriality and omitted from test analyses.

The character optimisation from each analysis, implemented in PAUP* was used to identify which unambiguous synapomorphies are driving the grouping of these birds. The full list of ACCTRAN/DELTRAN optimisations for each analysis is given in Appendix 3. There are extensive studies on raptorial predatory functional morphology which include skull morphometrics (e.g., Hertel 1995), pes tendon systems (Einoder & Richardson 2006), myology of the hindlimb (e.g., Liang *et al*. 2022), musculoskeletal mechanics (e.g., Sustaita 2008; Ward *et al.* 2002), talon size variation (Fowler *et al.* 2009) and tarsometatarsus morphometrics (Tronrud 2022). While some of these studies highlight osteological features that arise from predatory adaptations, many do not describe the specific osteological features that arise from certain muscle attachment sites. Characters that define adaptations to a predatory lifestyle are as follows:

- The rostral apex curvature of the upper beak is sharply ventrally hooked, extending far over the rostral tip of the mandible (Ch. 4:2; Fig. 2.1). The curvature of the upper beak allows predatory birds to render flesh, grip prey effectively and deliver a powerful bite.

- The supraorbital process is long and caudally projecting over the orbits (Ch. 35:1; Ch. 36:1; Fig. 2.2). The projection likely protects the eyes from debris and prey retaliation, as well as acting as a sun-shade.
- The rostral portion of the mandible is strongly downturned, with distinct angle of deflection at the gonys (Ch. 151:1; Fig. 2.15). The downturned mandible likely facilitates a scissor like action with the upper beak.
- An expanded transverse process of the caudal vertebrae (Ch. 173:1). This feature likely supports flight dynamics in raptors, supporting larger tail muscles, enhancing control and balance.
- A notch present in the anterior border of the pygostyle (Ch. 180:1; Fig. 2.18). Possibly something to do with the attachment of tail feathers, aiding in steering and braking during flight. Not observed in Strigiformes.
- A convex-shaped pygostyle (Ch. 181:1; Fig. 2.18). Convex shape likely allows for the wider spread of tail feathers, improving lift and manoeuvrability. Not observed in Strigiformes.
- Overlapping coracoid sulcus of the sternum (Ch. 196:1; Fig. 2.22). The sulci are the articular surface where the coracoids attach, forming part of the shoulder girdle. Overlapping sulci could possibly enhance stability for sustained flight or manoeuvring while carrying prey.
- A distinct, laterally protruding processus acrocoracoideus of the furcula (Ch. 243:1; Fig. 2.29). This joint stabilises the shoulder girdle.
- No fenestra ischiopubica of the pelvis (Ch. 406:1; Fig. 2.54). The hip potentially plays an important role in lifting prey after a strike (Frank *et al.* 2022). Not observed in Strigiformes.
- The hypotarsus with two separate crests or a common canal, which encompasses all flexor tendons (Ch. 463:1; Fig. 2.65). A study by Tronrud (2022) identified that a deep, monosulcate hypotarsus is a statistically significant indicator of raptoriality in birds, and that this feature arose independently in Accipitridae, Falconiformes and Strigiformes. The

hypotarsus holds the flexor digitorum longus and flexor hallucis longus muscles which are responsible for talon closure and grip force (Liang *et al.* 2022).

- An elongated tuberositas m. tibialis cranialis of the tarsometatarsus (Ch. 471:1; Fig. 2.66). The crest that anchors the tibialis cranialis muscle plays a role in grasping and manipulating prey (Goslow 1972).
- Pedal phalanx II-1 reduced, measuring less than one half the length of phalanx II-2 (Ch. 521:1). A shorter proximal phalanx allows for a more powerful, concentrated force at the claw tip. Not observed in Strigiformes.
- Pedal phalanx IV-1, IV-2 and IV-3 greatly reduced, length of both IV-2 and IV-4 combined is less than half of the length of IV-4 (Ch. 528:1; Ch. 529:2).
- Sharply hooked pedal unguals (Ch. 542:2; Fig. 2.75). A curved talon is important for maintaining grip forces on prey, though the degree of curvature is variable throughout these birds (Fowler *et al.* 2009; Tsang *et al.* 2019), they all serve similar functions.
- The sulci neurovascularis of the pedal unguals closed to form a canal that opens to the tuberculum flexorium (Ch. 543:1; Fig. 2.75). A closed canal likely ensures that blood vessels and nerves are protected during high impact strikes and prey capture.
- The plantar surface of the corpus phalangis is latero-medially compressed and delimited by lateral and medial ridges creating an arc shaped cross-section (Ch. 547:1; Fig. 2.75). This feature is not observed in Pandionidae and Strigiformes, though still included here.

3.3 Results

3.3.1 Analysis 1: extant taxa only, unconstrained

Maximum Parsimony

Analysis 1, using unordered characters of equal weight, recovered one most parsimonious tree (MPT) of 2670 steps, with a consistency index (CI) of 0.236, retention index (RI) of 0.683 and a

rescaled consistency index (RC) of 0.161 (Fig. 3.2A). The ACCTRAN/DELTRAN optimisations of nodes and character states are detailed in Appendix 3 (S3.4), and a discussion of supporting unambiguous synapomorphies recovered for selected assemblages are in section 3.4.1. The single MPT is well-resolved, recovering several higher-level clades that correspond to recognised molecular clades. However, the deeper inter-relationships among these clades are incongruent with recent molecular analyses. The monophyletic clades Australaves (Cariamiformes + Falconiformes + Psittaciformes + Passeriformes) and Afroaves (Accipitriformes + Strigiformes + Coraciimorphae) as defined by molecular analyses (Table S1) are not recovered in the morphological analysis. Instead, a monophyletic "raptorial clade", encompassing Accipitriformes, Strigiformes and Falconiformes, is recovered, with high Bremer support (7) but low bootstrap support (<50%). Accipitriformes are recovered as paraphyletic, with Strigiformes and Falconiformes nested within this group. Strigiformes are placed as the sister group to Falconiformes, supported by low Bremer support (3) and moderate bootstrap support (52%). Within this group, Strigiformes (*Tyto alba*, *Strix aluco*) are resolved as sister to Falconiformes, supported by low Bremer support (3) and moderate bootstrap support (52%). This contrasts with molecular studies, which consistently recover Accipitriformes as monophyletic and place Strigiformes as a separate linage, either sister to Accipitriformes (+ Cathartidae) or Coraciimorphae, distinct from Falconiformes, which are nested within Australaves (e.g., Prum *et al.* 2015; Stiller *et al.* 2024). However, the internal relationships within Accipitriformes (+ Cathartidae) are relatively consistent with molecular findings: Cathartidae (*Cathartes burrovianus*, *Vultur gryphus*) is recovered as sister to Accipitriformes, Pandionidae (*Pandion haliaetus*) is resolved as the sister taxon to Accipitridae, and Sagittariidae (*Sagittarius serpentarius*) as basal within Accipitriformes. Within Accipitridae, the relationships among *Elanus*, *Buteo* and *Accipiter* are broadly aligned with recent molecular analyses (Mindell *et al.* 2018; Catanach *et al.* 2024). Falconiformes (*Micrastur ruficollis concentricus, Falco sparverius, Daptrius ater, Caracara cheriway*), is resolved as monophyletic within the "raptorial clade" with

the internal relationships aligned with molecular analyses: Herpetotherinae as basal followed by Falconinae sister to Polyborinae (Fuchs *et al.* 2015).

This "raptorial" clade is found to be sister to a larger monophyletic group encompassing all other Telluraves, supported by moderate Bremer support (6) and low bootstrap support (<50%). Within this larger group Passeriformes are nested within a Coraciimorphae assemblage where Cariamiformes and Psittaciformes are basal to this grouping. Coliiformes (*Colius striatus kiwuensis, Urocolius macrourus pulcher*) are found to be sister to Passeriformes and not the basal-most Coraciimorphae, as observed in most molecular studies. Cavitaves is recovered as a paraphyletic assemblage comprising Leptosomiformes (*Leptosomus discolor*), Trogoniformes and Bucerotiformes as successively more closely related to Piciformes and Coraciiformes. Picodynastornithes (Coraciiformes + Piciformes) is recovered with medium Bremer support (6) but low bootstrap support (<50%). However, the interrelationships of these orders are not fully consistent with molecular studies in that *Todus mexicanus* is sister to Coraciidae (*Coracias benghalensis* and *Atelornis pittoides*) instead of Momotidae (*Momotus momota*) and Alcedinidae (*Alcedo atthis*). Inter-relationships within Piciformes are consistent with molecular analyses.

Psittaciformes is recovered as monophyletic, with high bootstrap and Bremer supports. The internal relationships of this clade closely align with molecular analyses (Smith *et al.* 2022) except where *Strigops habroptilus* is not sister to *Nestor notabilis*.

Passeriformes is resolved as monophyletic, with high bootstrap and Bremer support. The inter-relationships of this clade are fairly aligned with molecular phylogenies in that *Acanthisitta chloris* (Acanthisittidae) is sister (high Bremer and bootstrap support) to the monophyletic subclades Tyranni (suboscines) and Passeri (oscines) (Oliveros *et al.* 2019). Inter-relationships within the subclades however are not consistent with molecular phylogenies (Oliveros *et al.* 2019). Within Tyranni: *Pitta sordida* is grouped with Tyrannida taxa (*Neopelma chrysocephalum, Rupicola peruvianus, Piprites chloris tschudii, Tyrannus tyrannus*) forming a paraphyletic assemblage, and with Furnariida (*Myrmornis torquata*, *Myrmothera campanisona minor*) nested within this group. Within Passeri: this group is paraphylectically associated with a non-oscine

bird (*Melanopareia bitorquata*); *Menura novaehollandiae and Climacterus melanurus wellsi* are not in the most basal position but rather nested within a group including *Malurus melanocephalus*. Outgroup relationships were not consistent with molecular placements, although characters were not included to specifically resolve the placement of these taxa.

In general, deeper intra-relationships between clades exhibit high Bremer support, indicating robustness to additional steps (high parsimony robustness), but low bootstrap support, suggesting that these clades are supported by a few characters with strong signal, but those characters are not consistently resampled or influential across data subsets, potentially due to homoplasy. Additionally, the distribution of CI and RI values reveals significant homoplasy. For example, only 34 characters (6.18% of the total) have an RI of 1.00, representing uniquely derived characters.

Analysis 1, using ordered characters, recovered two MPTs of 2691 steps, with an ensemble consistency index (CI) of 0.236, retention index (RI) of 0.683 and a rescaled consistency index (RC) of 0.161 (Fig. 3.2B). The strict consensus tree is well-resolved and differs from the unordered analysis in that Cathartidae, Sagittariidae and Cariamiformes for a successive sister assemblage at the base of a larger monophyletic assemblage that includes a "raptorial" clade (Strigiformes + Pandionidae + Accipitridae + Falconiformes) and the rest of Telluraves. Strigiformes have shifted to being sister to (Pandionidae + Accipitridae + Falconiformes) assemblage. Both Leptosomiformes and Coliiformes are now in more basal positions, where Leptosomiformes is sister to an assemblage that includes Psittaciformes, Coraciimorphae and Passeriformes. Coliiformes are now sister to an assemblage that includes (Eucavitaves + Passeriformes). Support values throughout the inter-nodes are very low. Otherwise, most recognised molecular clades within Telluraves are recovered, similar to the unordered analysis. However, the inter-relationships differ from the unordered analysis and remain incongruent with molecular studies, most notably the intra-relationships within Passeriformes are not congruent with molecular analyses nor the unordered analysis.

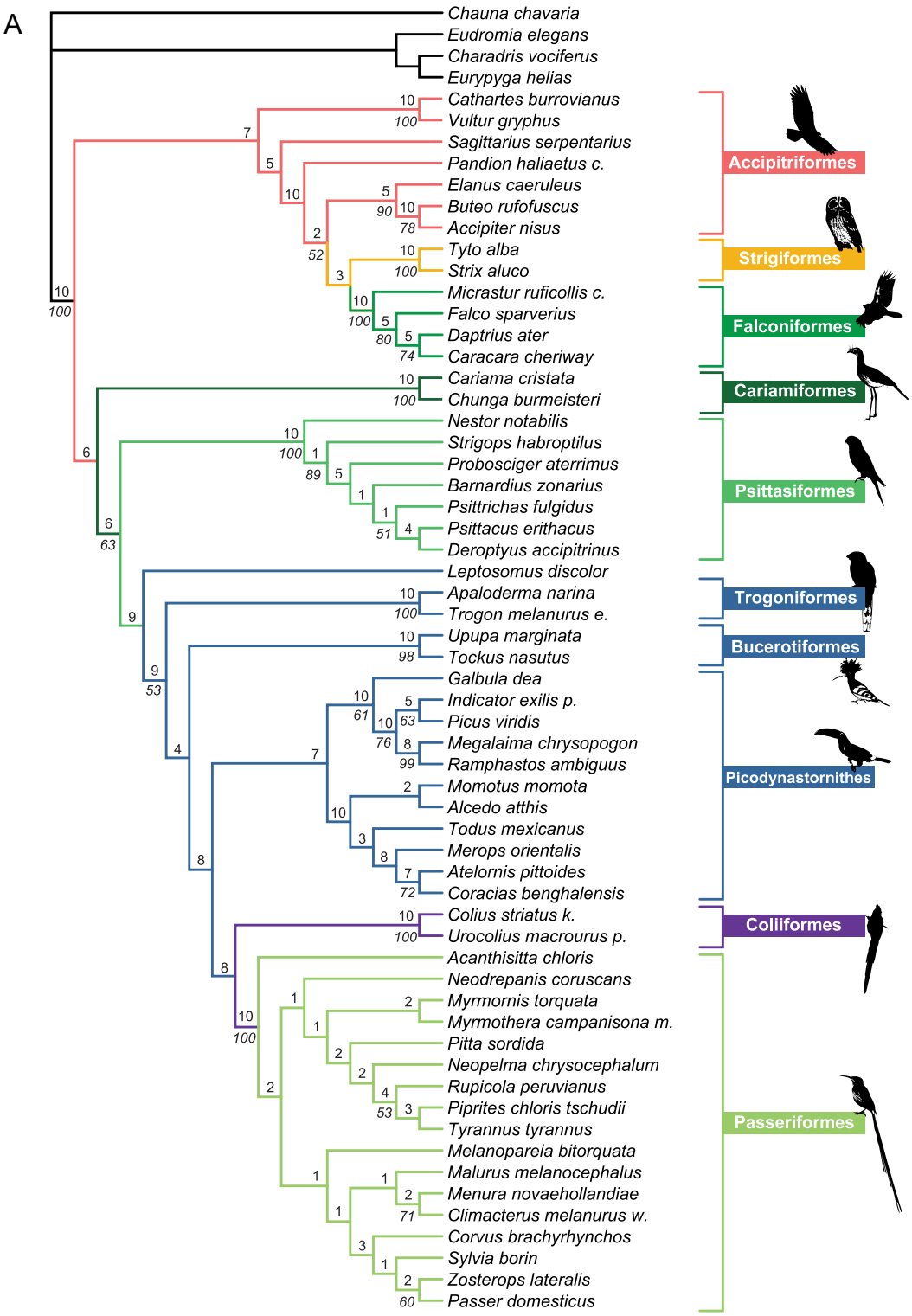


Figure 3.2. (A) Strict consensus of a single parsimonious tree obtained from Analysis 1 (extant taxa only, unordered). Length = 2670, CI = 0.236, RI = 0.683; (B) Strict consensus of 2 parsimonious tree from the ordered characters of Analysis 1, using only extant taxa, unconstrained. Length = 2691, CI = 0.236, RI = 0.683. Support values shown at nodes: Bremer indexes greater than 1 are shown above nodes, bootstrap values greater than 50% shown below nodes in italics.

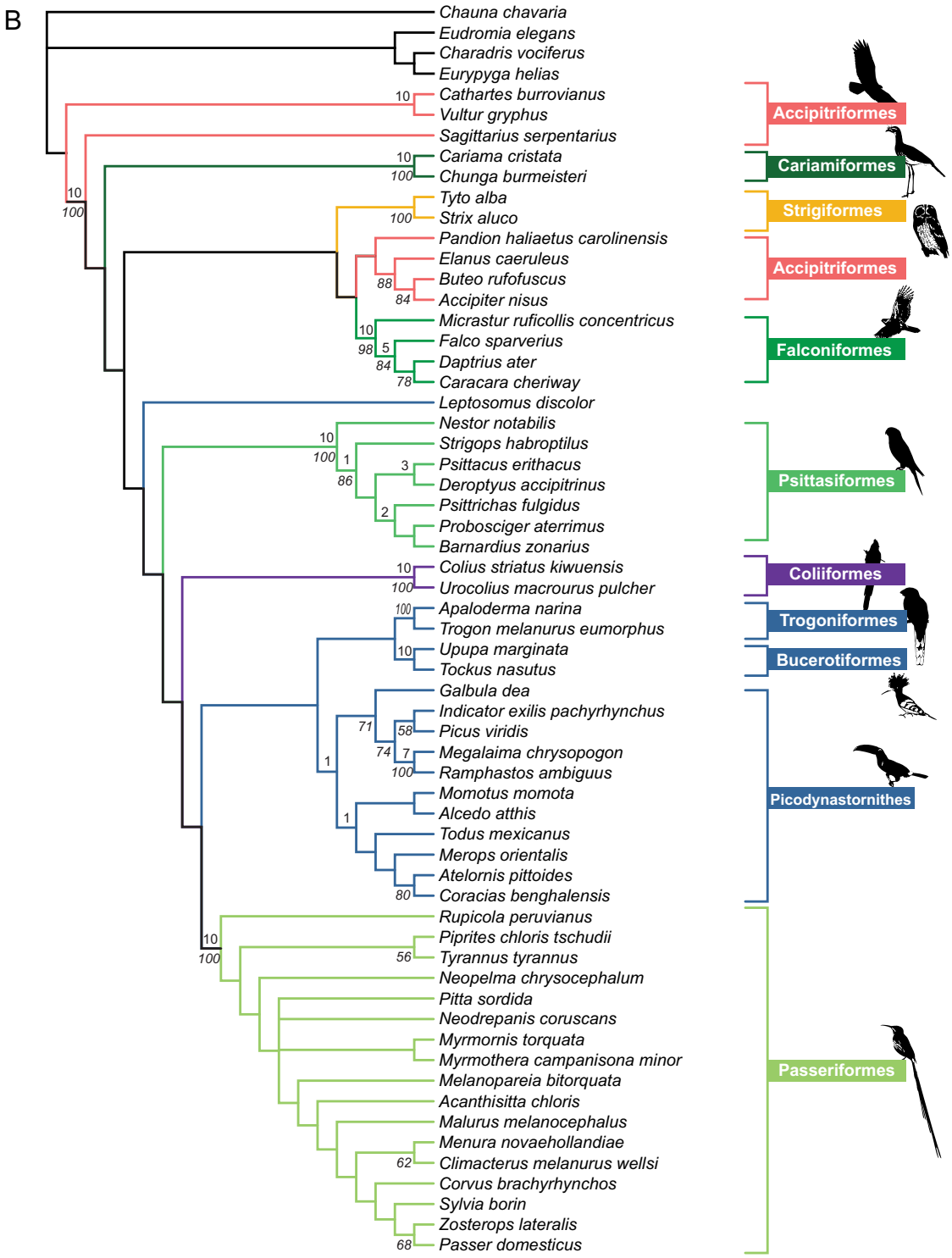


Figure 3.2. (continued).

Bayesian inference (none-time-calibrated)

The results of the unordered Bayesian inference analysis are summarised as both an "allcompat" (strict consensus) tree and a "halfcompat" (majority rule) tree that collapses partitions with a posterior probability lower than 50% (Fig. 3.3A & B). Only two nodes have posterior probabilities less than 50% (Fig. 3.3B) and would not appear in the "halfcompat" (majority rule) tree. High posterior probabilities (PP) are returned for many of the intra- and inter-relationships. This Bayesian topology largely agrees with the parsimony results in recovering a monophyletic "raptorial" clade (PP = 90%) except Strigiformes are sister to an assemblage that includes Pandionidae, Accipitridae and Falconiformes. Additionally, Cathartidae and Sagittariidae are monophyletic, which does not correspond to the paraphyletic relationship observed in the parsimony analysis and molecular analyses. The remaining Telluraves constitute a monophyletic assemblage (PP = 50%) in which Coliiformes, unlike in the unordered parsimony results, is sister to an assemblage that includes Coraciiformes, Piciformes, which in turn are sister to Passeriformes (PP = 36%). While most clade inter-relationships generally correspond to molecular hypotheses, passerine inter-relationships are not congruent with molecular analysis, unlike in the unordered parsimony analysis.

The results of the ordered Bayesian topology (Fig. 3.4A & B) mostly agree with the ordered parsimony results except Cathartidae are placed in a monophyletic grouping with Sagittariidae (PP = 88%) and Psittaciformes are sister to an assemblage that includes Coraciimorphae and Passeriformes (PP = 91%). In general, the intra-ordinal posterior probabilities are high except where Passeriformes are sister to Picodynastornithes (Coraciiformes + Piciformes) (PP = 40%).

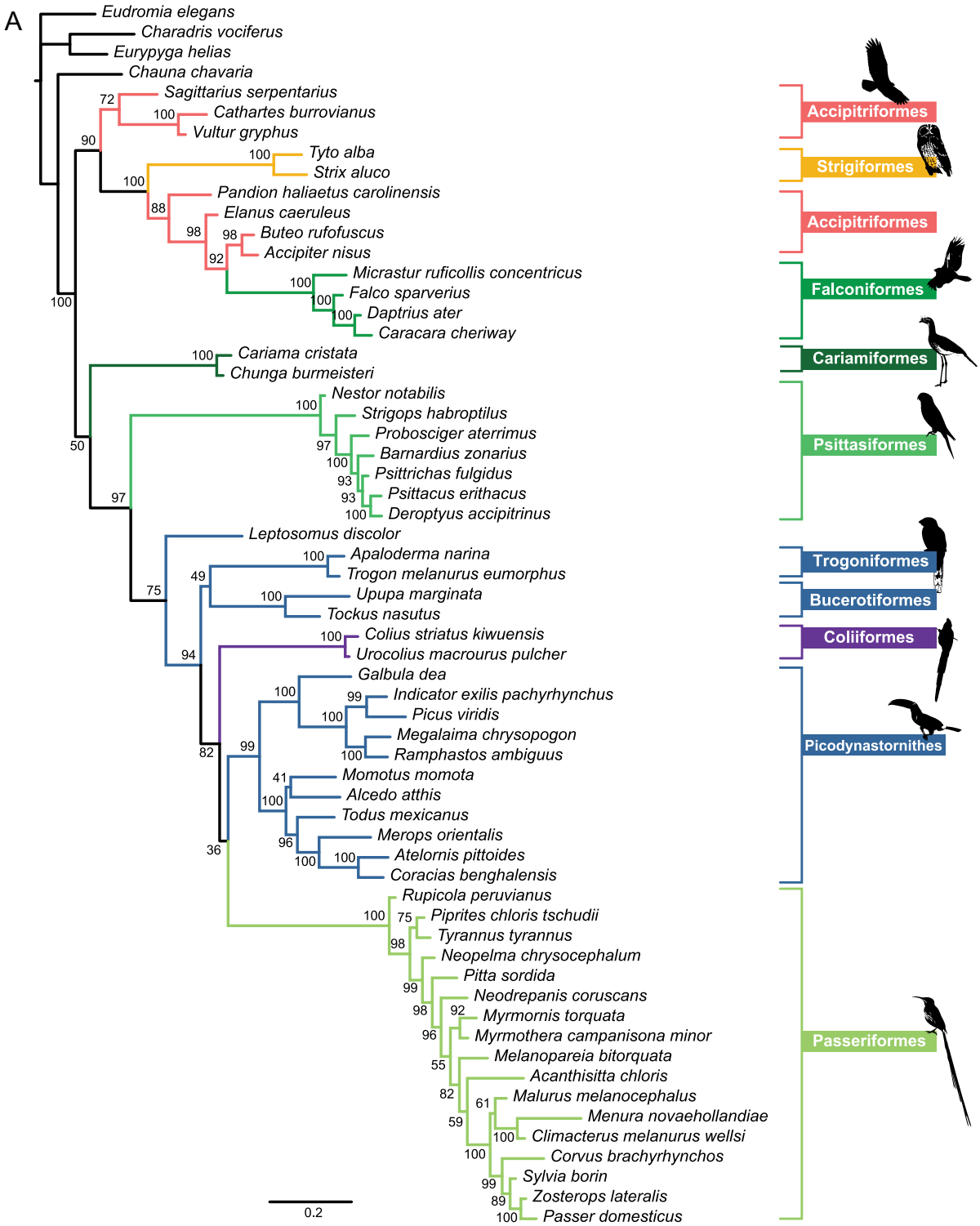


Figure 3.3. (A) The "allcompat" consensus tree resulting from Bayesian Analysis 1 (unordered, extant taxa only); (B) The "halfcompat" majority rule tree recovered from Bayesian Analysis 1, unordered. Numbers on nodes represent posterior probabilities. Scale bar indicates 0.2 expected changes per site.

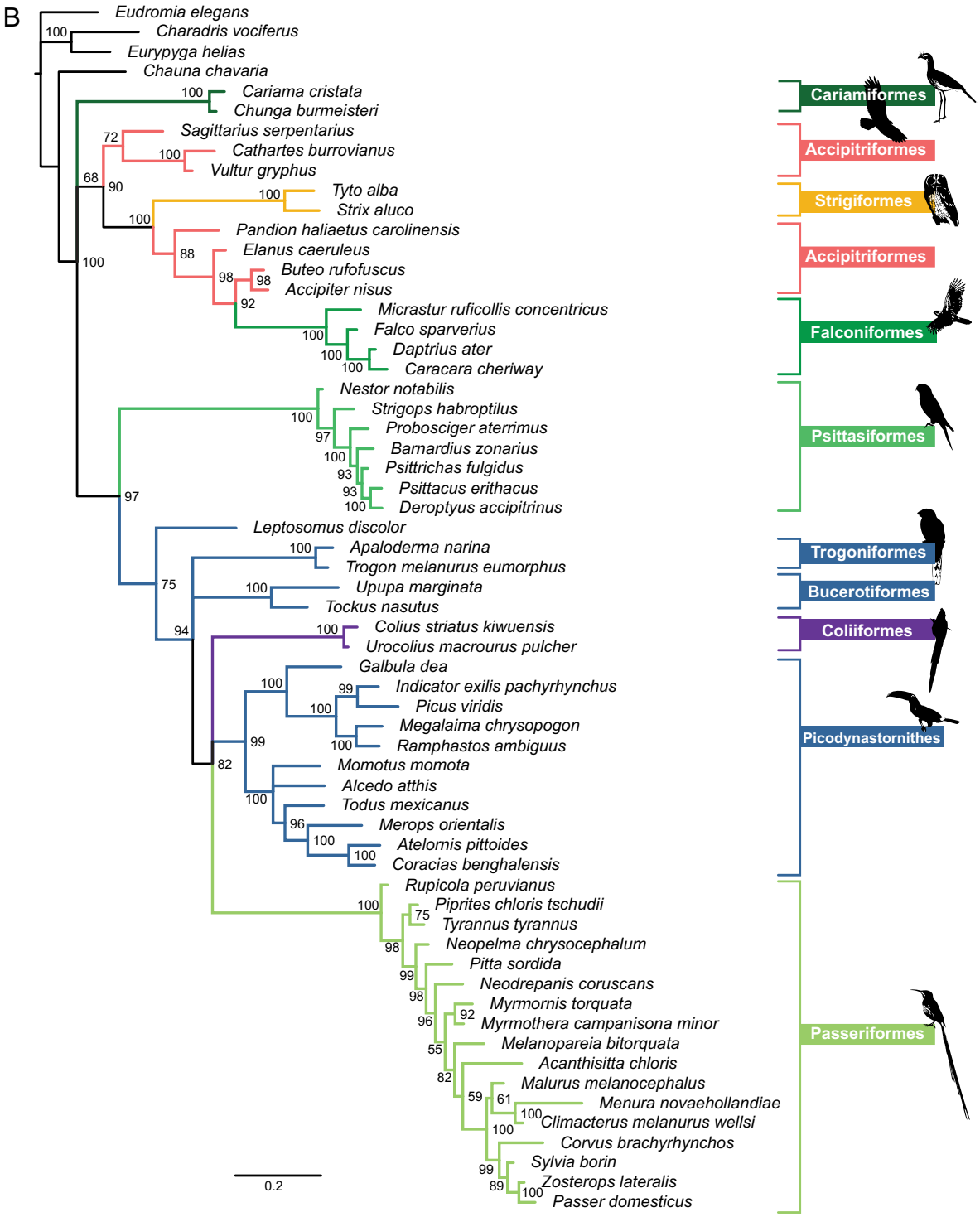


Figure 3.3. (Continued).

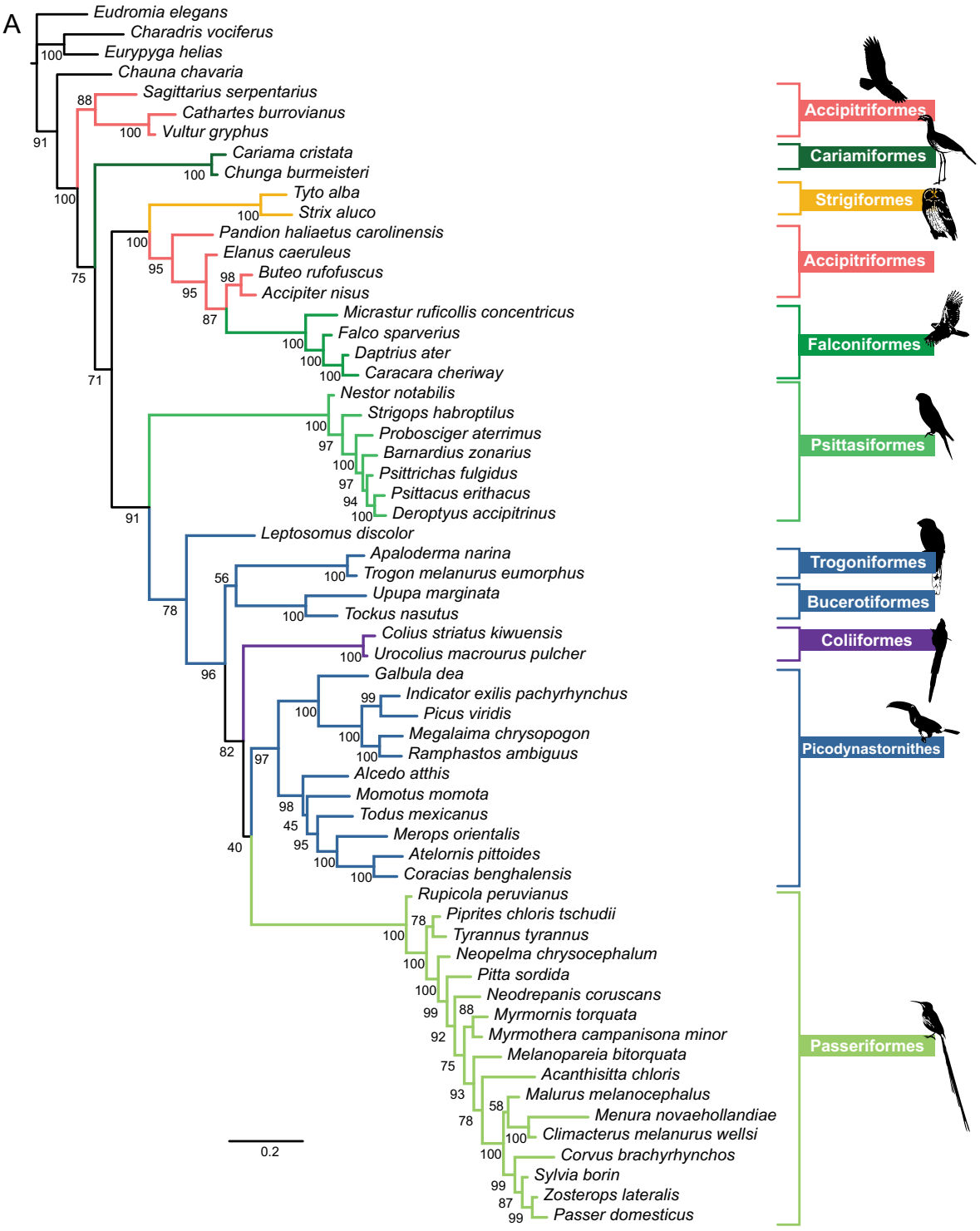


Figure 3.4. (A) The "allcompat" consensus tree resulting from Bayesian Analysis 1 (ordered, extant taxa only); (B) The "halfcompat" majority rule tree recovered from Bayesian Analysis 1, ordered. Numbers on nodes represent posterior probabilities. Scale bar indicates 0.2 expected changes per site.

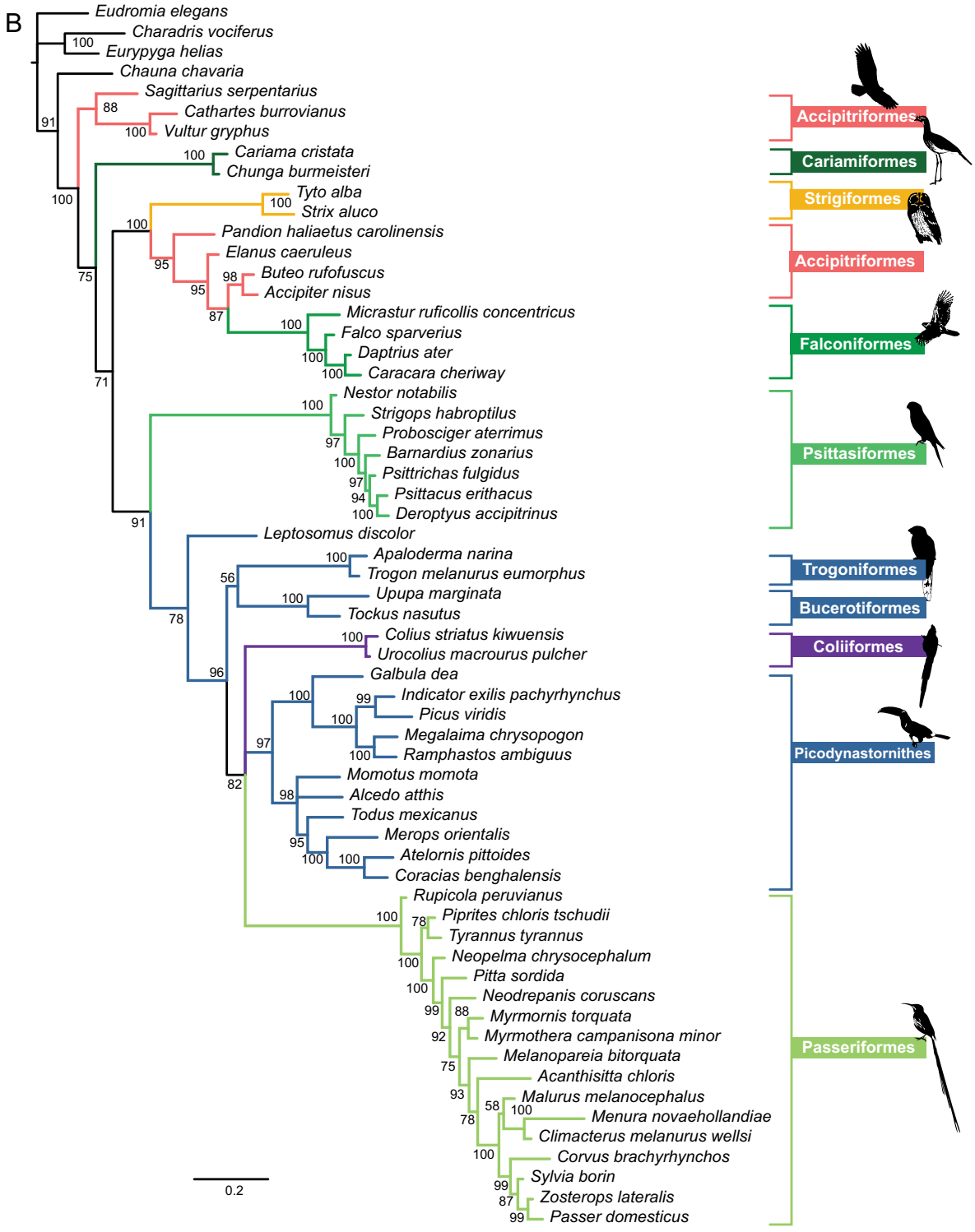


Figure 3.4. (Continued).

3.3.2 Analysis 2: combined extant and extinct taxa, unconstrained

Maximum parsimony

Analysis 2, using unordered characters of equal weight, recovered 183 MPTs of 3528 steps, with an ensemble consistency index (CI) of 0.183, retention index (RI) of 0.660 and a rescaled consistency index (RC) of 0.121 (Fig. S1.1). While certain major extant and extinct clades are recognisable, deeper intra-relationships form a polytomy. Poor resolution is evident in several taxa with unstable positions across the MPTs, including Leptosomiformes (*Plesiocathartes* and *Waltonavis sp.*), the putative cathartid *Diatropornis ellioti*, and the Vastanavidae *Eurofluvioviridavis robustipes.* These 'wildcard' taxa were identified as rogues by their variable placement in the Adams consensus tree (Fig. S1.2A & B). Four taxa were identified as potential rogue taxa: *Diatropornis ellioti*, *Plesiocathartes insolitipes, Plesiocathartes wyomingensis* and *Eurofluvioviridavis robustipes.* Pruning *Diatropornis ellioti*, using the Strict Reduced Consensus method, discarded six MPTs due to redundancy, while sequentially pruning the remaining three taxa had no effect. Thus, *Diatropornis ellioti* was excluded from subsequent analyses as the amount of missing data is significantly high (87.8%), having only been described from a tarsometatarsus and the distal portion of a tibiotarsus (Cracraft & Rich 1972). The phylogenetic position of *Diatropornis ellioti* varies significantly across the MPTs, falling as either sister to an assemblage including Accipitriformes and Falconiformes, closer to the base of the tree, or even nested within Masillaraptoridae, reflecting both incomplete data and possible character conflict. The affinities of *Diatropornis ellioti* are not well understood, while the tarsometatarsus closely resembles that of Cathartidae, its original description lacked comparison to a broader range of taxa, suggesting that re-examination could clarify its affinities.

Reanalysis of the reduced version of the dataset recovered 205 MPTs of 3520 steps, with an ensemble CI of 0.184, RI of 0.660 and RC of 0.123 (Fig. 3.5A). MPTs differ only in the relationships among extant Passeriformes. The 50% majority rule and Adams consensus trees are presented in Appendix 1 (Fig. S1.2C & D). The full optimisation of characters is given in

Appendix 3 (S3.5), and the discussions of supporting unambiguous synapomorphies recovered for selected assemblages are in sections 3.4.1 & 3.4.2. Many of the recognised stem taxa of individual families are recovered congruent with previous studies on those specific taxa. However, many have not been tested in a larger phylogenetic context or in a phylogenetic context at all, and so it is worth mentioning their topological positions.

As in Analysis 1, a monophyletic "raptorial clade" is returned, which includes Strigiformes, Falconiformes, Pandionidae and Accipitridae, similar to other studies that combined both extant and extinct taxa (e.g., Ksepka *et al.* 2017, fig. S2; Ksepka *et al.* 2019, fig. S3). However, Cathartidae, Sagittariidae and Cariamiformes form a paraphyletic assemblage at the base of the tree in this analysis. Cariamiformes shift notably from Analysis 1, where they were sister to a Psittaciformes, Coraciimorphae and Passeriformes assemblage. Their monophyly is however well supported, where *Bathornis* (Bathornithidae) and *Dynamopterus* (Idiornithidae) are recovered as successively more-crownwards members of the cariamiform stem lineage. This is consistent with previous studies, which consider these taxa to be along the stem lineage for Cariamiformes (Mayr 2016a). This analysis departs from Mayr (2016) in that *Bathornis* and *Dynamopterus* are recovered in a polytomy together. In this analysis, *Dynamopterus* is recovered closer to crown group Cariamidae. *Horusornis vianeyliaudae* is recovered as sister to *Pandion haliaetus* (osprey). This taxon from the late Eocene (La Bouffie locality of the Quercy fisser fillings, France, 37 Ma) was originally described by Mourer-Chauviré (1991) as likely Accipitriformes, though she notes a similarity to Sagittariidae and Pandionidae. Additionally, Mayr (2006a) also noted a number of derived features that it shares with Accipitridae and recovered Horusornithidae in a polytomy with Falconidae and Accipitridae, though Pandionidae was not included in that study. *Palaeoplancus sternbergi* is recovered nested within Accipitridae, sister to *Buteo* and *Accipiter*, though weakly supported. Given that Elaninae (represented here by *Elanus caeruleus*) diverged from the rest of Accipitridae around 44.7 Ma (Catanach *et al.* 2025), it is possible that the early Oligocene (Whitneyan Poleslide Member of the Brule Formation; 30-32 Ma) *Palaeoplancus sternbergi* is an accipitrid. Given the plesiomorphic morphology, a slender acromial process of the

furcula, observed in Sagittariidae and Pandionidae, it could be outside crown Accipitridae as suggested by Mayr (2022). *Ypresiglaux michaeldanielsi* and *Primoptynx poliotauros* were recovered as successively closer sister taxa to crown Strigiformes, consistent with Mayr & Kitchener (2023), though with low support values. Strigiformes are recovered as sister to Falconiformes + (Pandionidae + Accipitridae) instead of nested within Accipitriformes as in Analysis 1. Surprisingly, the stem Falconiformes Masillaraptoridae are not recovered as sister to crown group Falconiformes but rather sister to the remaining non-raptorial telluravian birds. The study by Mayr & Kitchener (2022a) that recovered Masillaraptoridae as sister to Falconiformes only included a limited sub-set of taxa from Cariamiformes and Falconiformes.

The analysis obtained a monophyletic, but poorly-supported, Psittacopasseres (sensu Suh *et al.* 2011), which includes crown group Psittaciformes, Psittacopedidae, Zygodactylidae and crown group Passeriformes. This clade is, however, sister to a Coraciimorphae assemblage (instead of sister to Falconiformes). This position of Passeriformes here contrast with most previous unconstrained morphological analysis of global phylogenetic scope (e.g., Mayr 2015; Ksepka *et al.* 2017; Mayr & Kitchener 2023a), in which passerines have been recovered closely aligned with Coraciimorphae with Psittaciformes sister to that assemblage. A monophyletic Parapasseres (sensu Mayr 2015) is recovered, in which the Zygodactylids *Zygodactylus grandei*, *Eozygodactylus americanus* and *Primozygodactylus* are sister to crown Passeriformes, which is consistent with previous studies (Smith, DeBee*, et al.* 2018; Mayr & Kitchener 2022c). However, *Primozygodactylus* is not recovered as part of the monophyletic Zygodactylidae here, but rather basal to the remaining Zygodactylidae and crown Passeriformes, forming a paraphyletic assemblage which is not consistent with most previous studies but was hinted at by Mayr (2017a).

Psittacopedidae (*Psittacopes* + *Parapsittacopes* + *Psittacomimus*) are recovered at the base of a clade including Zygodactylidae and crown Passeriformes and pan-Passeriformes, consistent with previous analyses (Mayr 2015, 2020; Mayr & Kitchener 2022b; Ksepka *et al.* 2019). *Pumiliornis tessellatus* is recovered as sister to Psittacopedidae, unlike in Mayr & Kitchener

(2023b), where the Morsoravidae are recovered as sister to a clade formed by Zygodactylidae and crown group Passeriformes. It is likely that with the inclusion of the other morsoravids *Morsoravis* and *Sororavis* in the analysis the topology could change. *Eofringillirostrum boudreauxi* is not recovered within Psittacopedidae, contrary to Ksepka *et al.* (2017, 2019). These authors do note that *Eofringillirostrum* could possibly be more closely related to Zygodactylidae and crown Passeriformes congruent with this study. In Mayr & Kitchener (2022c) *Eofringillirostrum* is recovered basal to Psittacopedidae, Morsoravidae and Zygodactylidae and crown Passerinformes.

Plesiocathartes kelleri + *P. wyomingensis* are recovered as sister to *Leptosomus discolor*, consistent with their tentative assignment to Leptosomidae in Mayr (2002a) and Weidig (2006), but with very low support. This topology is slightly different to that of Ksepka *et al.* (2017, 2019), in which *Plesiocathartes wyomingensis* is recovered as sister to *Leptosomus discolor*. *Waltonavis* was not found to be sister to Leptosomidae, contrary to Mayr & Kitchener (2022b), but rather sister to an assemblage that includes Halcyornithidae and Messelasturidae. The placements of other Coraciimorphae however, are consistent with previous hypotheses: the Sandcoleidae *Eoglaucidium cf. pallas* and stem group Collidae *Masillacolius brevidacylus* are recovered as a successive sister group to crown Coliiformes (Ksepka *et al.* 2017; Mayr & Kitchener 2024b)*; Eotrogon stenorhynchus* is recovered as sister to crown Trogoniformes and the Messelirrisoridae *Messelirrisor halcyrostris* is recovered as sister to crown Bucerotiformes (Mayr 2006b; Mayr & Kitchener 2024c).

Halcyornithidae and Messelasturidae form a monophyletic clade that is unexpectedly recovered as outside pan-Psittaciformes. Furthermore, Vastanavidae are nested within a Coraciimorphae assemblage. This is not congruent with most other studies, which have recovered these taxa as pan-Psittaciformes, generally, as successive sister taxa of a clade including the Psittacopedidae, Morsoravidae and crown Psittaciformes (e.g., Ksepka *et al.* 2011; Ksepka *et al.* 2012; Ksepka *et al.* 2019; Mayr & Kitchener 2023a). Nevertheless, Vastanavidae was recovered outside of an assemblage including Coraciimorphae, Psittaciformes and Passeriformes by Mayr &

Kitchener (2022) and Mayr & Kitchener (2023b), while in the unconstrained analysis of Ksepka *et al.* (2017) Halcyornithidae are recovered as sister to Coliiformes.

Analysis 2, using ordered characters, recovered 183 MPTs of 3528 steps, with an ensemble consistency index (CI) of 0.183, retention index (RI) of 0.660 and a rescaled consistency index (RC) of 0.121 (Fig. 3.5B). The main difference from the ordered analysis is that Cariamiformes are recovered as sister to Sagittariidae and that Strigiformes as sister to a larger assemblage containing Coraciimorphae, Psittaciformes and Passeriformes. In general, the inter-relationships of the individual fossil families are not as well resolved as in the unconstrained analysis.

Overall, the clade support values are very low in both the unordered and ordered analyses. Similar to Analysis 1, most major molecular clades are not recovered, such as Afroaves (the clade including Accipitriformes, Strigiformes and Coraciimorphae) or Australaves (the clade including Cariamiformes, Falconiformes, Psittaciformes and Passeriformes). However, unlike in Analysis 1, Eucavitaves (the clade including Trogoniformes, Bucerotiformes, Coraciiformes and Piciformes) and Psittacopasseres (the clade including Passeriformes and Psittaciformes) are recovered.

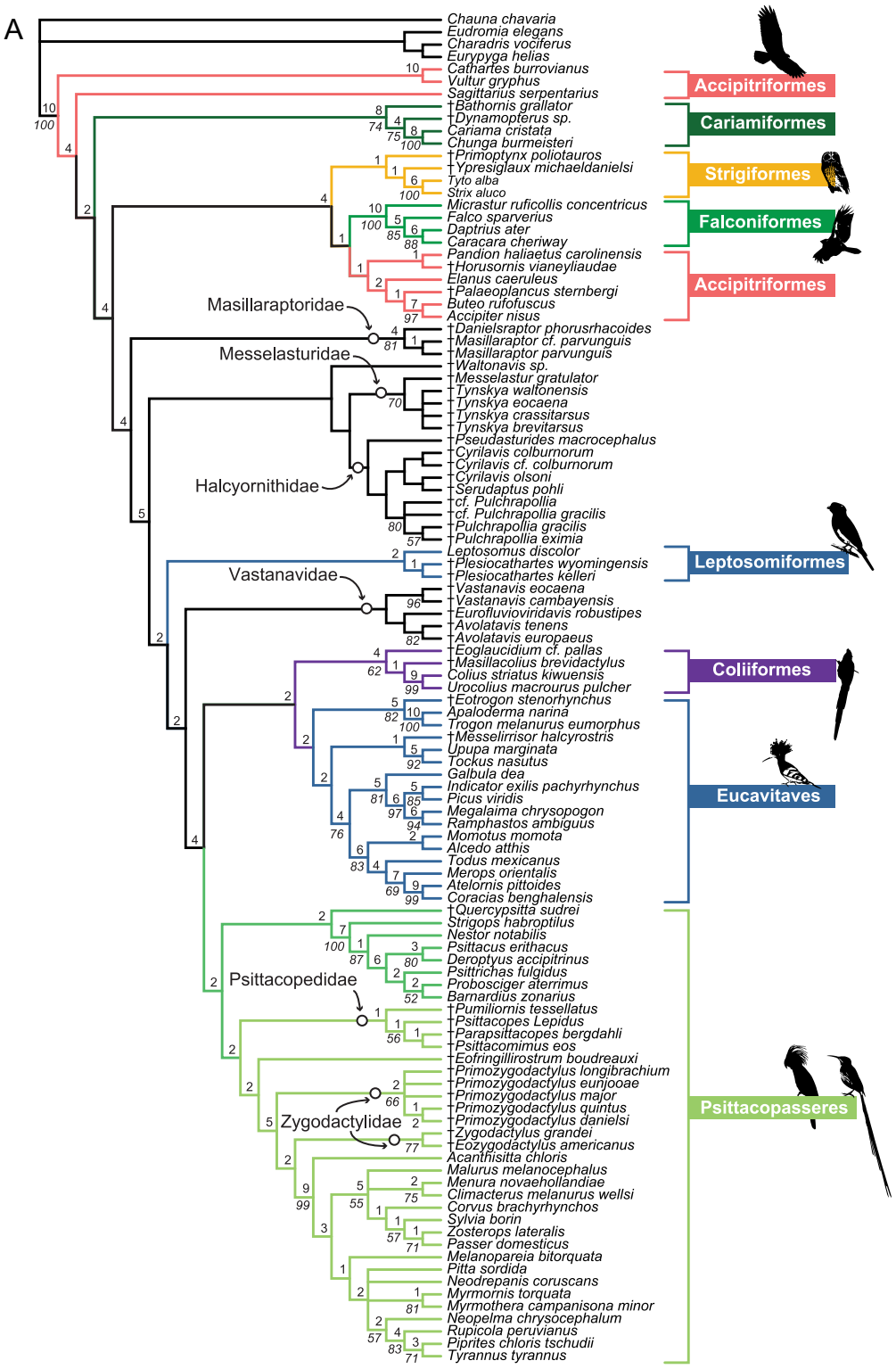


Figure 3.5. (A) Reanalysis of Analysis 2 (extant and extinct taxa, unconstrained, unordered) with *Diatropornis ellioti* removed, strict consensus of 205 MPTs. Length = 3520, CI = 0.184, RI = 0.660; (B) Strict consensus of 183 MPTs from the ordered characters of Analysis 2 (extant and extinct taxa). Length = 3528, CI = 0.1834, RI = 0.6603. Support values shown at nodes: Bremer indexes greater than 1 are shown above nodes, bootstrap values greater than 50% shown below nodes (italics). Extinct taxa denoted with a dagger.



Figure 3.5. (Continued).

Bayesian inference

The results of the unordered Bayesian inference analysis are summarised as both an "allcompat" (strict consensus) tree and a "halfcompat" (majority rule) tree that collapses partitions with a posterior probability lower than 50% (Fig. 3.6A & B). The Bayesian topology largely agrees with the parsimony results in recovering a "raptorial" assemblage except Masillaraptoridae are now sister to a group that includes Strigiformes, Accipitridae and Falconiformes. There are, however, some major differences: Psittacopasseres (Passeriformes and Psittaciformes) is not recovered and Vastanavidae, Halcyornithidae and Messelasturidae form a monophyletic clade (PP = 65%) basal to an assemblage that includes Psittaciformes, Coraciimorphae and Passeriformes. *Diatropornis ellioti* is not removed in this analysis and is recovered in a more basal position closer to Cathartidae and Sagittariidae. Other smaller differences in topology compared to the parsimony analysis are as follows: *Horusornis vianeyliaudae* is recovered as sister to stem Strigiformes (PP = 87%); *Palaeoplancus sternbergi* is recovered as basal to Accipitridae (PP = 77%); *Primozygodactylus* is recovered as sister to the other Zygodactylidae (PP = 49%) and *Waltonavis sp.* is recovered as nested within Leptosomiformes. The ordered analyses have identical topology except with slightly lower posterior probabilities (Fig. 3.7A & B). Overall, there is generally high posterior probabilities (PP) for many of the intra- and inter-relationships.

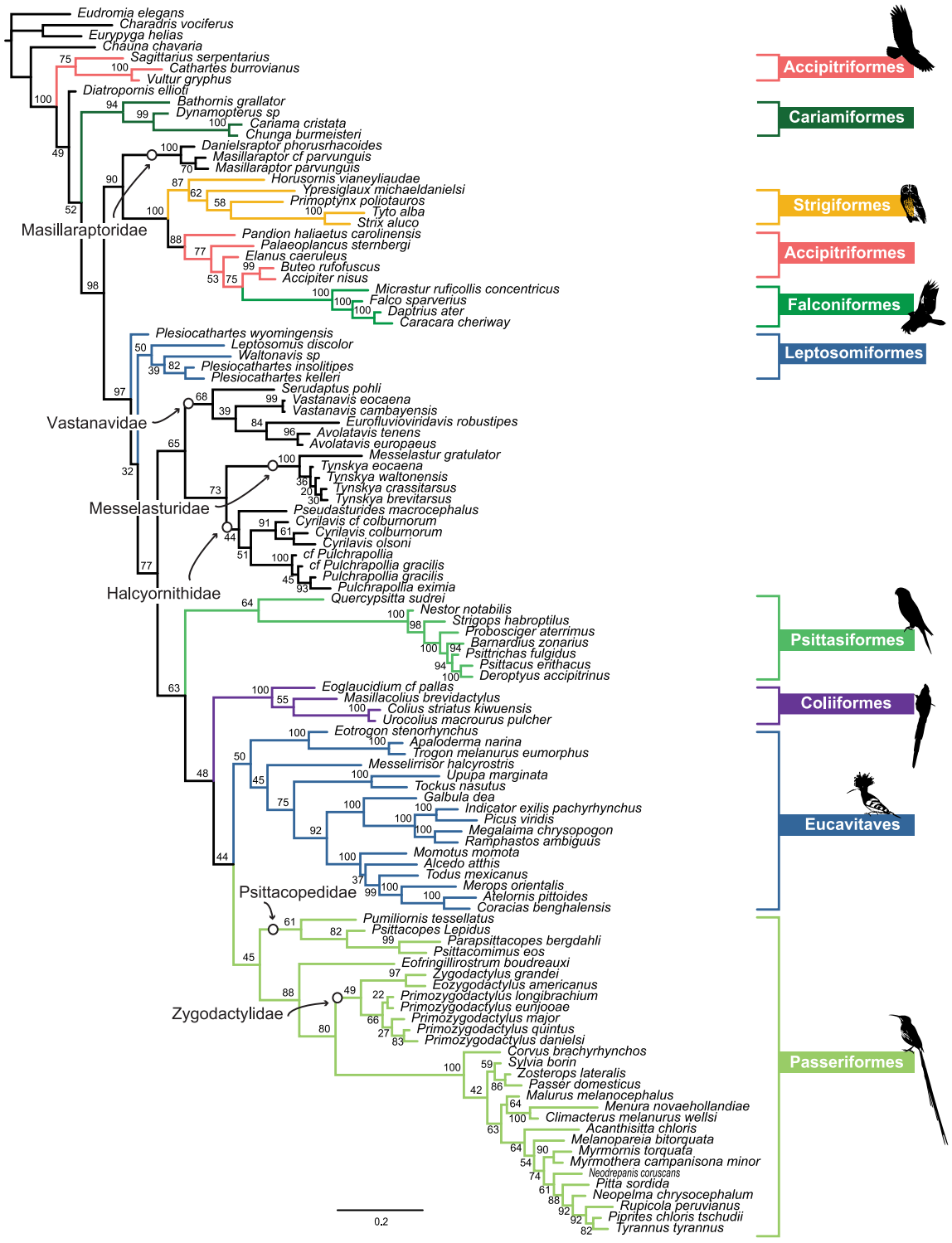


Figure 3.6. (A) The "allcompat" consensus tree resulting from Bayesian Analysis 2 (unordered, extant and extinct taxa). (B) "Halfcompat" MCC tree recovered from Bayesian Analysis 2 (extant and extinct taxa, unordered). Numbers on nodes represent posterior probabilities. Numbers on nodes represent posterior probabilities. Scale bar indicates 0.2 expected changes per site.

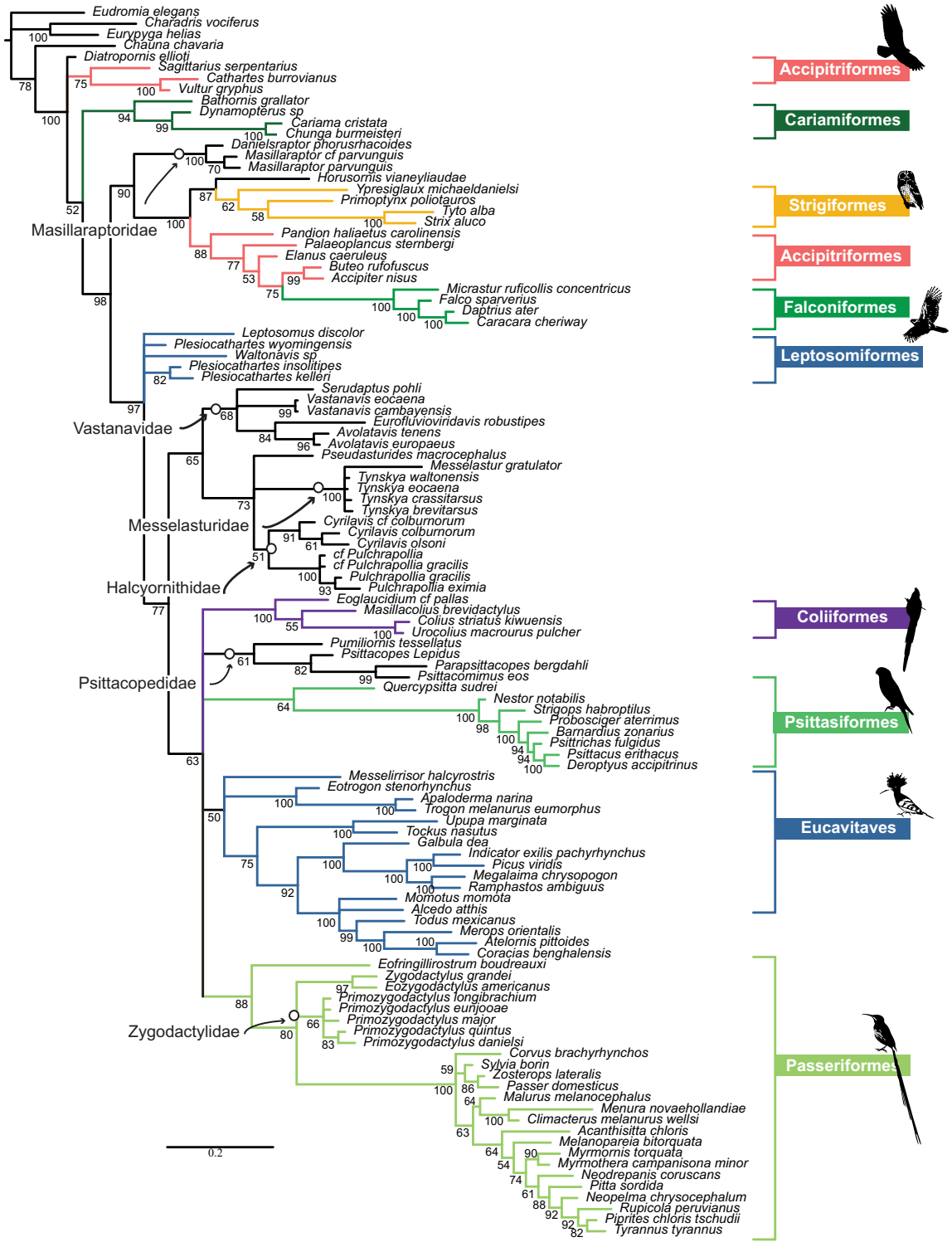


Figure 3.6. (Continued).

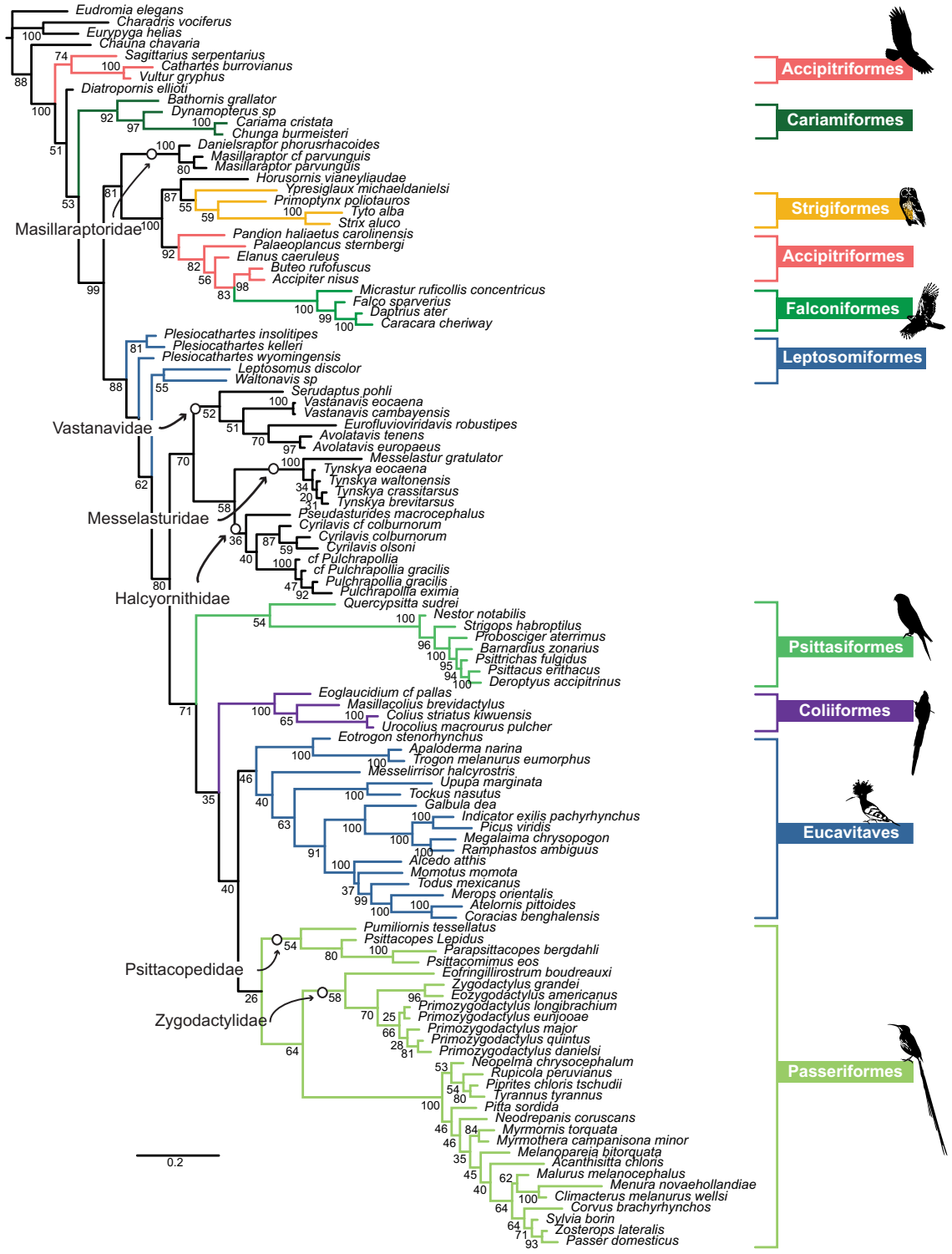


Figure 3.7. (A) The "allcompat" consensus tree resulting from Bayesian Analysis 2 (ordered, extant and extinct taxa). (B) "Halfcompat" MCC tree recovered from Bayesian Analysis 2 (extant and extinct taxa, ordered). Numbers on nodes represent posterior probabilities. Numbers on nodes represent posterior probabilities. Scale bar indicates 0.2 expected changes per site.

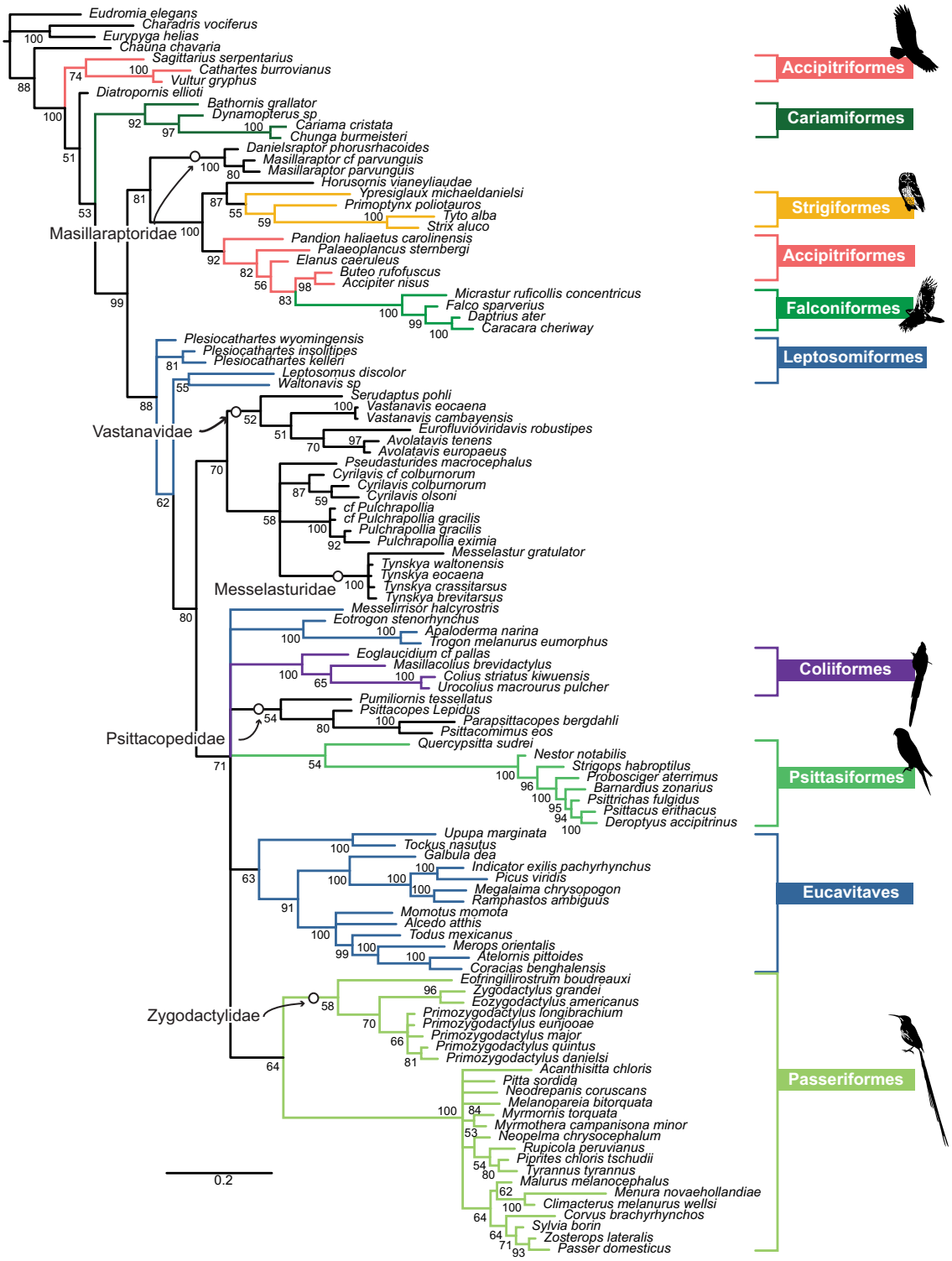


Figure 3.7. (Continued).

3.3.3 Analysis 3: combined extant and extinct taxa, constrained

Maximum parsimony

Analysis 3 used unordered characters of equal weight, and applied two distinct molecular constraints based on the phylogenomic analyses of Stiller *et al.* (2024) and Prum *et al.* (2015) to explore their effects on the fossil placement. The "Stiller" constraint, which enforces a topology where Telluraves diverges into two separate monophyletic clades Afroaves (Accipitriformes + Strigiformes + Coraciimorphae) and Australaves (Cariamiformes + Falconiformes + Psittaciformes + Passeriformes), in the unordered analysis recovered 425 MPTs of 3630 steps, with an ensemble consistency index (CI) of 0.178, retention index (RI) of 0.647 and a rescaled consistency index (RC) of 0.115 (Fig. 3.8). Variability among the MPTs was primarily restricted to the relationships within Messelasturidae and Halcyornithidae. The "Prum" constraint, which enforced a topology where Accipitriformes are sister to the remaining core landbirds, in the unordered analysis recovered 535 MPTs of 3622 steps, with an ensemble CI of 0.181, RI of 0.651 and RC of 0.118 (Fig. 3.9). The shorter tree length (=18 steps shorter) under the "Prum" constraint suggests a slightly better fit to the morphological data, this is also corroborated by the slightly higher CI, RI and RC values. However, both constrained analyses produced longer trees than the unconstrained analysis (A2; 3520 steps). The 50% majority rule and Adams consensus trees are presented in Appendix 1 (Fig. S1.3). The full optimisation of characters is given in Appendix 3 (S3.6 & S3.7), and supporting unambiguous synapomorphies for each of the major clades is discussed in more detail in section 3.4.2.

Both constraints resulted in a number of shifts in the positions of several extinct taxa, both relative to unconstrained analyses and between the two constraints. Under the "Stiller" constraint *Waltonavis* and *Plesiocathartes* were resolved as successively closer to Eucavitaves. This placement somewhat contrasts with prior studies in which Mayr & Kitchener (2022b) recovered *Waltonavis* as sister to Leptosomiformes, and Ksepka *et al.* (2019) similarly aligned

Plesiocathartes as sister to Leptosomiformes. In the "Prum" constraint these taxa form a polytomy at the base of Coraciimorphae and Strigiformes.

Masillaraptoridae exhibited further variability: under the "Prum" constraint they are positioned as sister to crown Falconiformes, consistent with Mayr & Kitchener (2022a), though with very low support. Whereas the "Stiller" constraint placed them as sister to Accipitriformes.

In both constraint analyses *Horusornis vianeyliaudae* is recovered as basal to crown Falconiformes, though with low support, which is not congruent with previous hypotheses that the Horusornithidae are more closely related to Accipitridae than Falconidae (Mayr 2006a). An unexpected outcome of the "Stiller" constraint recovered Quercypsittidae within a clade comprising Vastanavidae, Halcyornithidae, and Messelasturidae, rather than basal to crown Psittaciformes. In the original descriptions of *Vastanavis*, they were likened to Quercypsittidae due to their similar overall proportions of the tarsometatarsus, asymmetrically placed foramina vascularia proximalia, two hypotarsal sulci/canals, and a large trochlea metatarsi II (Mayr 2010; Mayr & Kitchener 2023a). Additionally, in a study by Ksepka & Clarke (2012), *Qucerypsitta* was recovered as sister to *Avolatavis*, though supported by a single unambiguous synapomorphy.

Vastanavidae, Halcyornithidae and Messelasturidae consistently showed affinities with Strigiformes across analyses using both constraints, though with low support values (Figs. 3.8; 3.9). Interestingly, these findings partially align with the results of Mayr (2005), which tentatively linked Messelasturidae to Strigiformes, as well as some of the original descriptions of halcyornithids and messelasturids, which suggested similarities with Falconiformes and Strigiformes. However, this result diverges from that of Mayr (2015), in which Halcyornithidae and Vastanavidae were recovered in close association with Psittaciformes in the constrained analysis of that study, and Vastanavidae formed a clade outside of Eufalconimorphae (Falconiformes + Psittaciformes + Passeriformes). The intra-relationships of the monophyletic Vastanavidae (*Vastanavis* + *Eurofluvioviridavis* + *Avolatavis*) are fairly consistent throughout my analyses, with *Vastanavis* as sister to *Eurofluvioviridavis* + *Avolatavis*, consistent with Mayr (2015). In more recent studies, they often form a polytomy (e.g., Mayr & Kitchener 2023a). The

monophyly of Vastanavidae is not recovered in the "Stiller" constraint, where *Avolatavis*, *Eurofluvioviridavis,* and *Vastanavis* form a successively closer sister taxa to a clade comprising Quercypsittidae, Messelasturidae, and Halcyornithidae. The monophyly of Messelasturidae (*Messelastur* + *Tynskya*) and Halcyornithidae (*Pulchrapollia* + *Cyrliavis* + *Serudaptus* + *Pseudasturides*) together in a clade is recovered consistently throughout all the analyses, as also recovered in the unconstrained analysis of Mayr (2021). This sister relationship between Messelasturidae and Halcyornithidae is generally not retained when a molecular scaffold is applied, often becoming paraphyletic with respect to the Messelasturidae or crown group Psittaciformes (Mayr 2021; Mayr & Kitchener 2023a).

Most other extinct taxa maintained stable positions, with minor intra-clade variations. Notably, under the "Stiller" constraint, *Primozygodactylus* is sister to *Zygodactylus* + *Eozygodactylus*, which is more consistent with previous studies on these birds (e.g., Smith *et al*. 2018), though this was not the case under the "Prum" constraint, for which the positions remained unchanged from the unconstrained analysis and remain paraphyletic with respect to crown Passeriformes. The support for most major clades, such as Afroaves and Australaves, under both the "Stiller" and "Prum" constraints is weak, due to the placement of fossil taxa within specific groups.

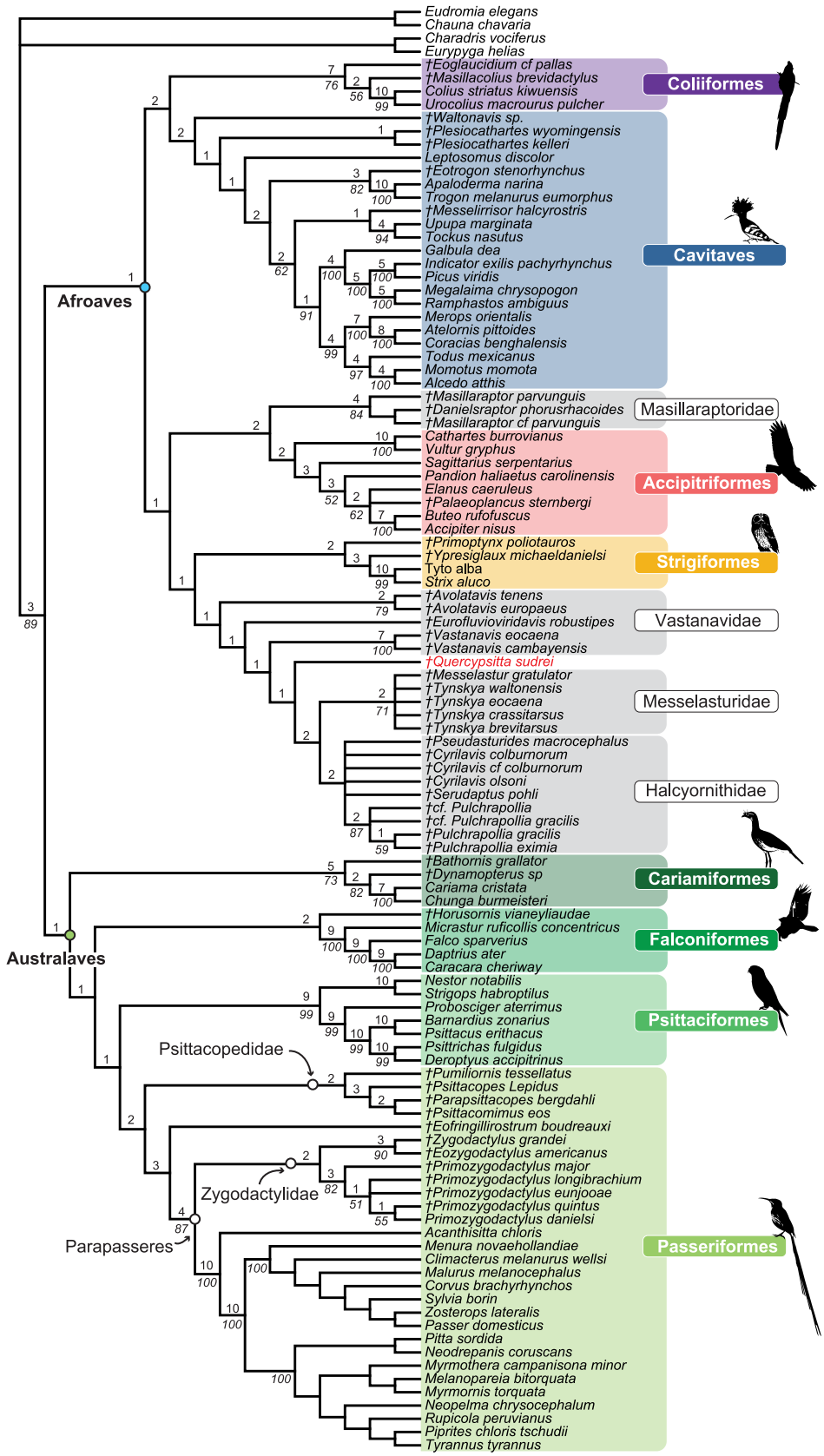


Figure 3.8. Strict consensus of 425 MPTs obtained from Analysis 3 using Stiller *et al.* (2024) as the backbone constraint. Length = 3630, CI = 0.178, RI = 0.647. Support values shown at nodes: Bremer indexes greater than 1 are shown above nodes, bootstrap values greater than 50% shown below nodes (italics). Extinct taxa denoted with a dagger.

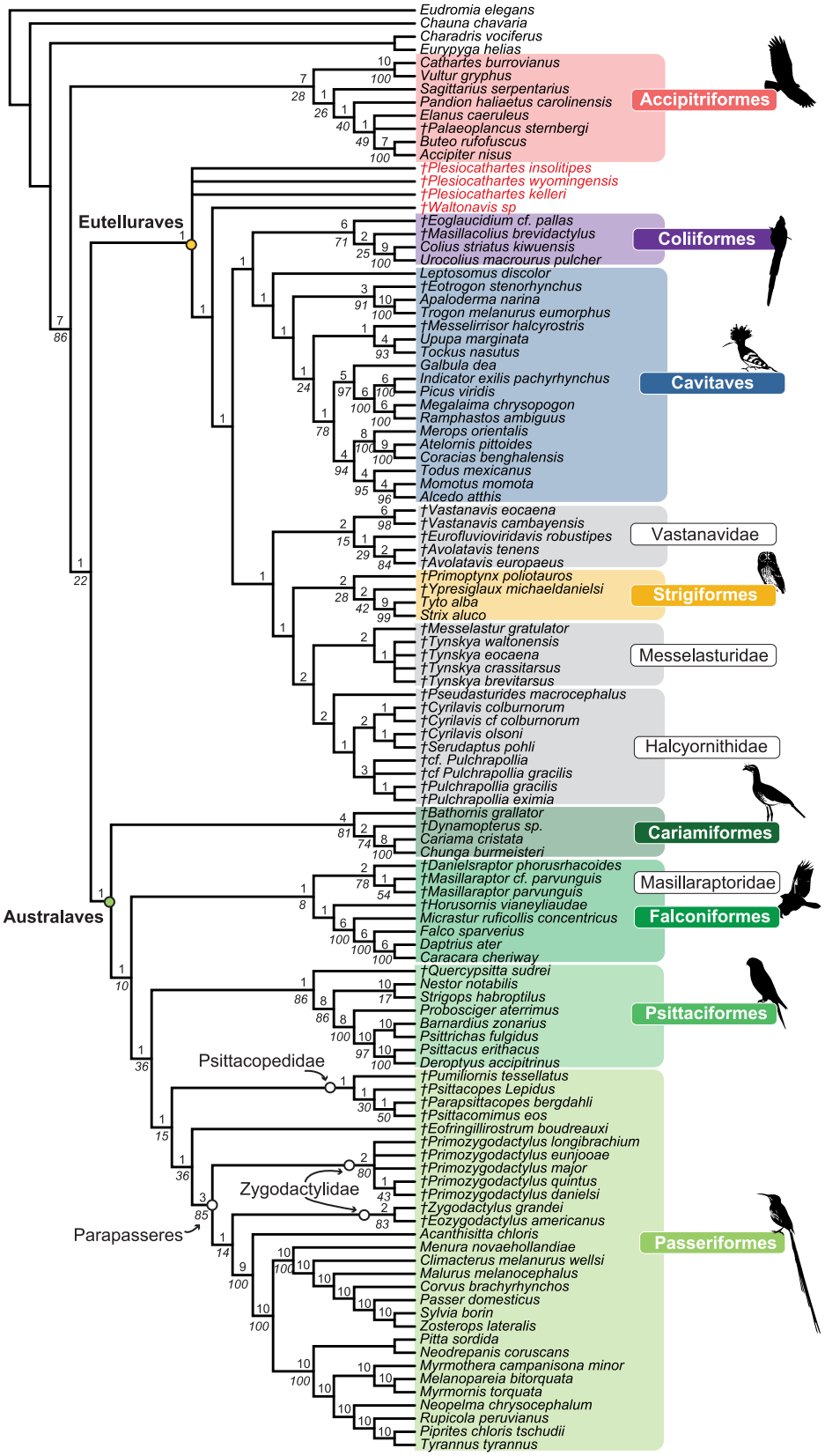


Figure 3.9. Strict consensus of 535 MPTs obtained from Analysis 3 using Prum *et al.* (2015) as the backbone constraint. Length = 3622, CI = 0.181, RI = 0.651. Support values shown at nodes: Bremer indexes greater than 1 are shown above nodes, bootstrap values greater than 50% shown below nodes (italics). Extinct taxa denoted with a dagger.

Bayesian inference (non-time calibrated)

The results of the unordered Bayesian inference analysis, using both Stiller *et al.* (2024) and Prum *et al.* (2015), constraints are summarised as both an "allcompat" (strict consensus) tree and a "halfcompat" (majority rule) tree that collapses partitions with a posterior probability lower than 50% (Fig. 3.8A & B; Fig. 3.9A & B). Analyses with the inclusion of the rogue taxon *Diatropornis ellioti* are presented in Appendix 1 (Figs. S1.4 & S1.5).

Several extinct taxa have retained their positions from Analysis 2. Notably, in both constraint analyses (whether *Diatropornis ellioti* is included or not), Masillaraptoridae are recovered as sister to crown Falconiformes (PP = 99%), agreeing with Mayr & Kitchener (2022a) and contrasting with the maximum parsimony results. Vastanavidae, Halcyornithidae, and Messelasturidae form a monophyletic clade sister to Psittacopasseres (PP = 39%) under the "Stiller" constraint, consistent with most recent studies, as discussed already (e.g., Ksepka *et al.* 2011; Ksepka *et al.* 2012; Ksepka *et al.* 2019; Mayr & Kitchener 2023a). Under the "Prum" constraint, this assemblage is recovered as sister to Coraciimorphae (PP = 35%). In both analyses these taxa are consistently recovered as monophyletic whether the "Stiller" (PP = 49%) or the "Prum" (PP = 50%) constraints are used. However, excluding *Diatropornis ellioti* (previously identified as a rogue taxon) caused Vastanavidae, Halcyornithidae, and Messelasturidae to shift to being sister to Falconiformes (PP = 33%), under the "Stiller" constraint, while remaining consistent under the "Prum" constraint. The position of *Diatropornis ellioti* varied significantly, recovered either as sister to Accipitriformes or basal to Australaves + Coraciimorphae.

Unexpectedly, under both the "Prum" and "Stiller" constraints *Ypresiglaux* and *Primoptynx,* previously aligned with Strigiformes in Analysis 2, are closely associated with Accipitriformes and not recovered as sister to Strigiformes. However, under the "Prum" constraint when *Diatropornis ellioti* is removed *Ypresiglaux* and *Primoptynx* shift to being sister to Strigiformes. The position of *Horusornis* is consistently recovered as sister to *Ypresiglaux* and *Primoptynx* in all constraint analyses, which is in contrast to both Analysis 1 and Analysis 2. The position of Quercypsittidae in the "Prum" constraint is also unexpected, being nested within

Psittacopedidae. Additionally, in the "Stiller" constraint the Coliiformes *Masillacolius* and the Bucerotiformes *Messelirrisor* are recovered as nested within stem Passeriformes. This, however, is not the case when the rogue taxon is included. The stem Leptosomiformes *Plesiocathartes* and *Waltonavis* are also unexpectedly recovered as either basal to Psittacopasseres under the "Stiller" constraint or the basalmost Coraciimorphae in the "Prum" constraint, with low posterior probabilities indicating uncertainty. In the trees with *Diatropornis ellioti* removed, *Plesiocathartes* and *Waltonavis* shift to being sister to Leptosomiformes in both constraints.

The support for most major clades, including Afroaves and Australaves, is weak in the Bayesian analysis under both the "Stiller" and "Prum" constraints, again suggesting a conflict between the morphological dataset and the molecular constraints (Fig. 3.8C & D; Fig. 3.9 C & D).

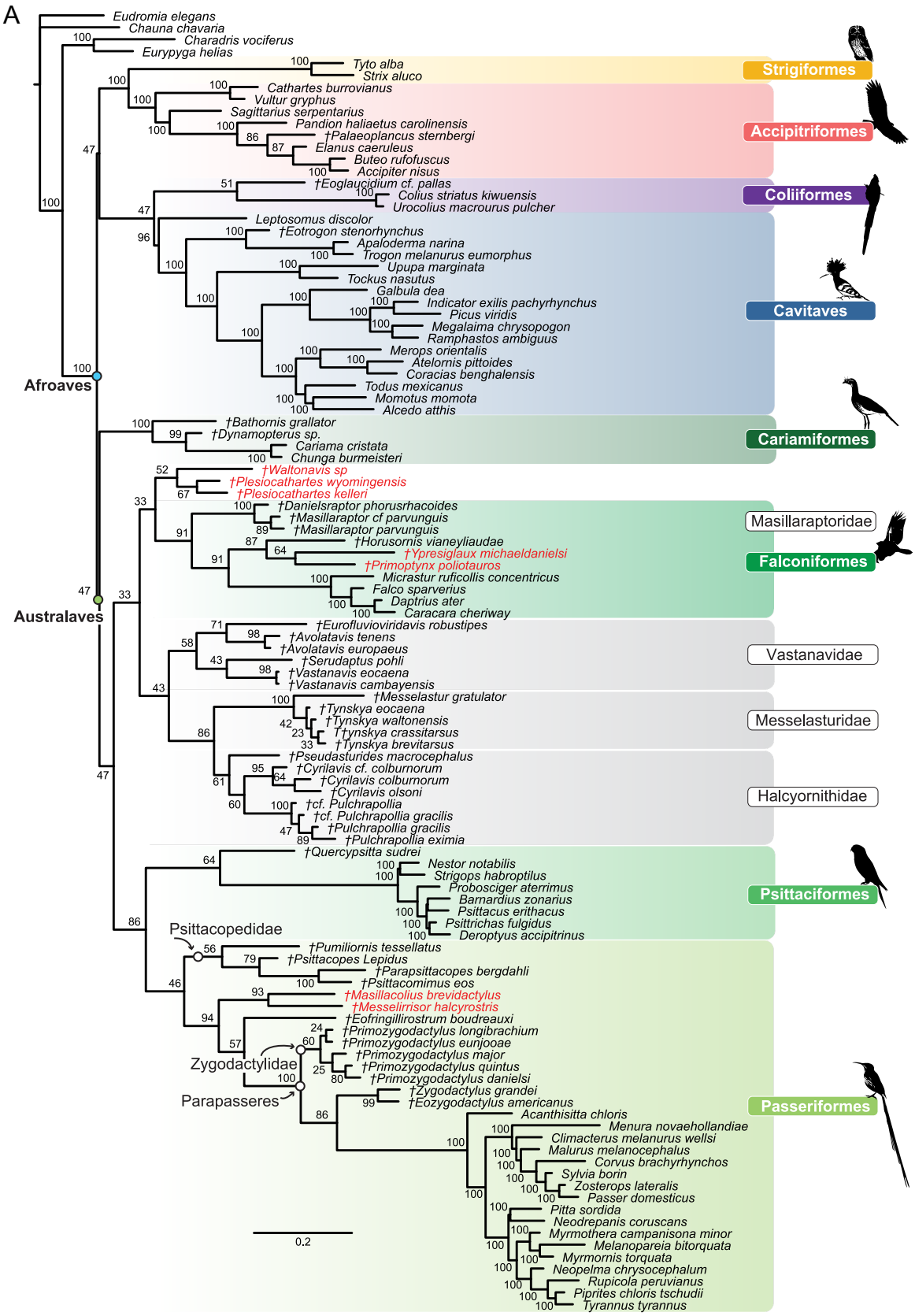


Figure 3.8. Bayesian Analysis 3 results using Stiller *et al.* (2024) as the backbone constraint. (A) The "allcompat" consensus tree, unordered; (B) "Halfcompat" MCC tree, unordered; (C) The "allcompat" consensus tree, ordered; (D) "Halfcompat" MCC tree, ordered. Numbers on nodes represent posterior probabilities.Scale bar indicates 0.2 expected changes per site.

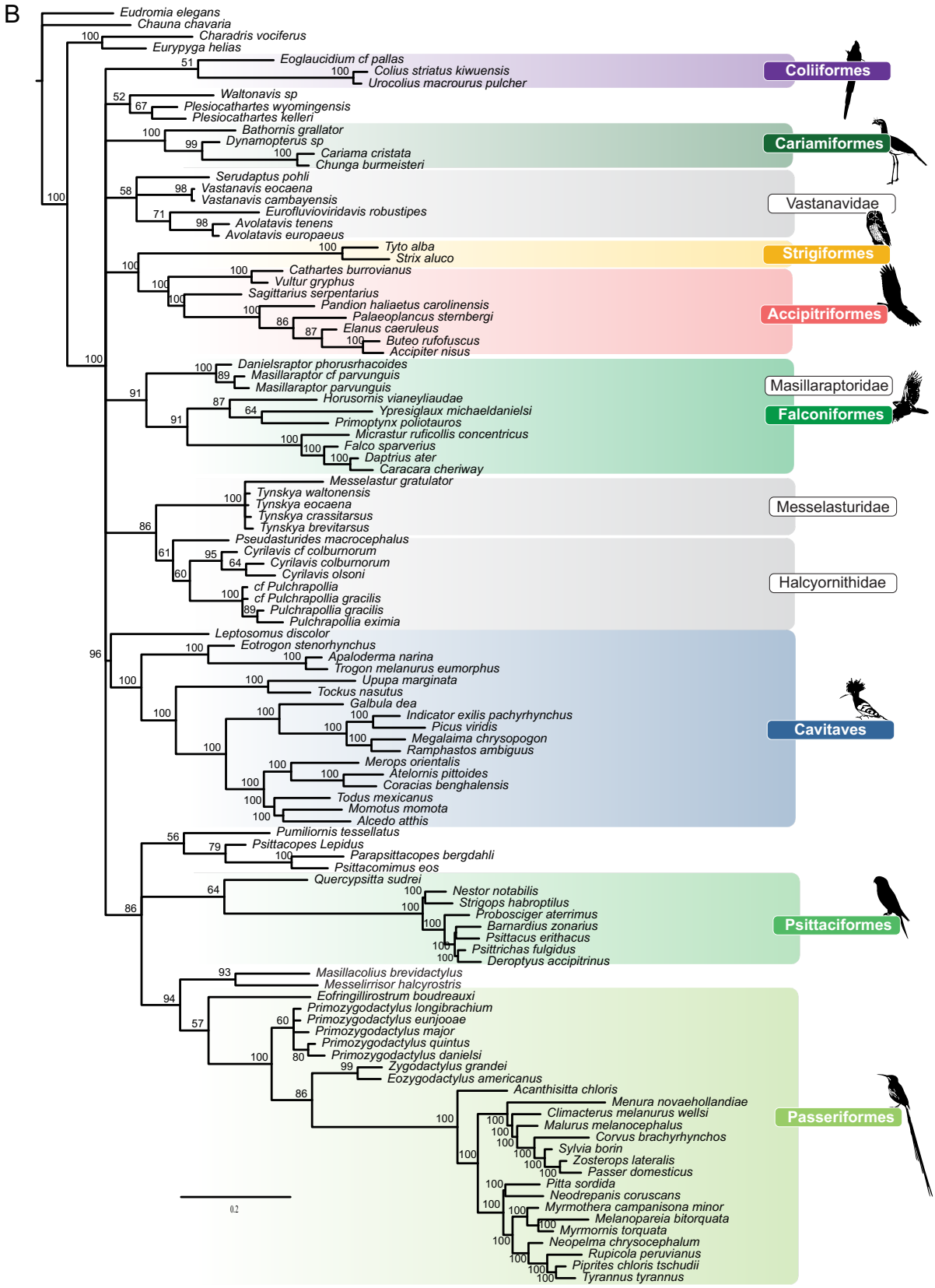


Figure 3.8. (Continued).

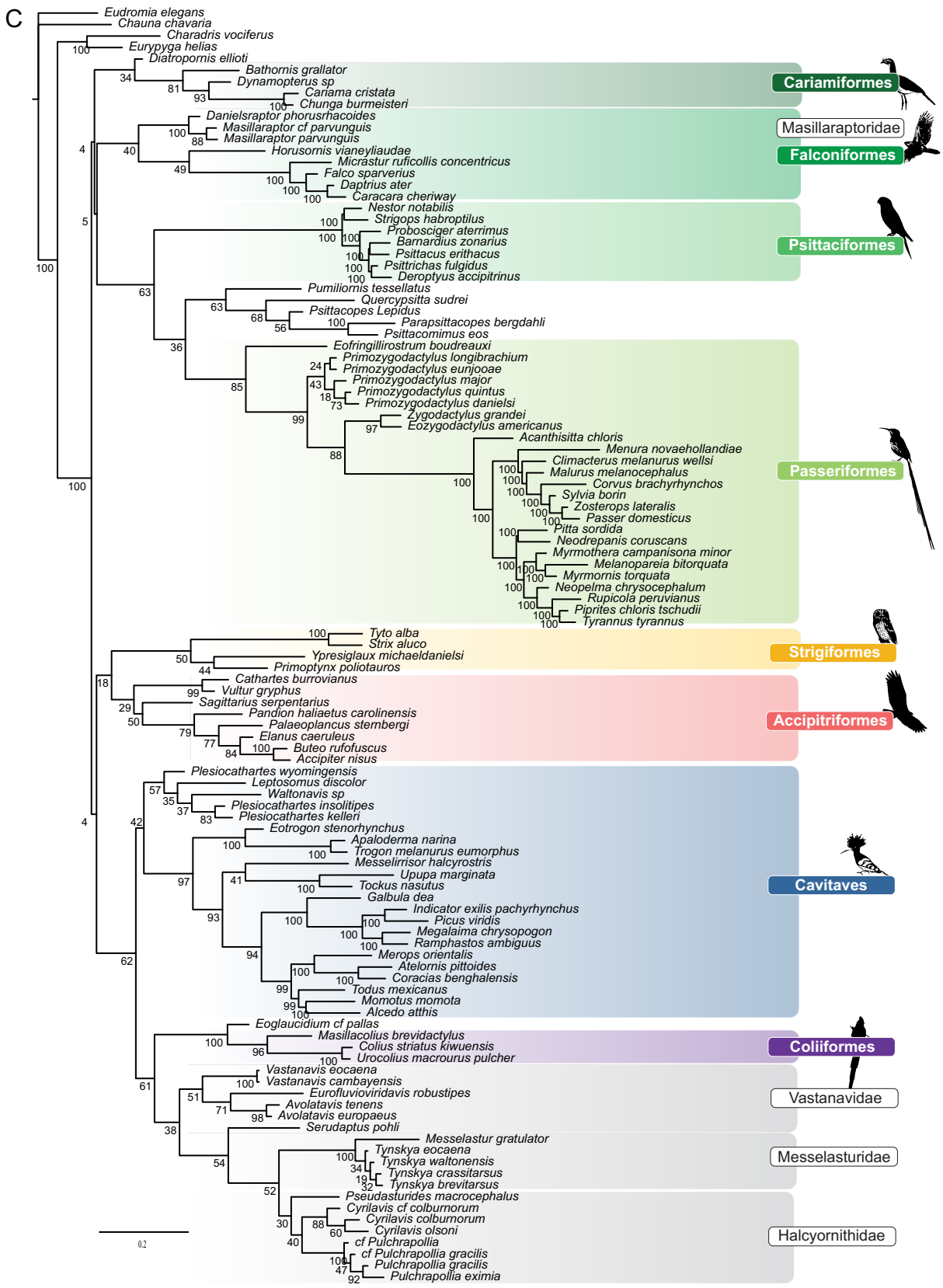


Figure 3.8. (Continued).

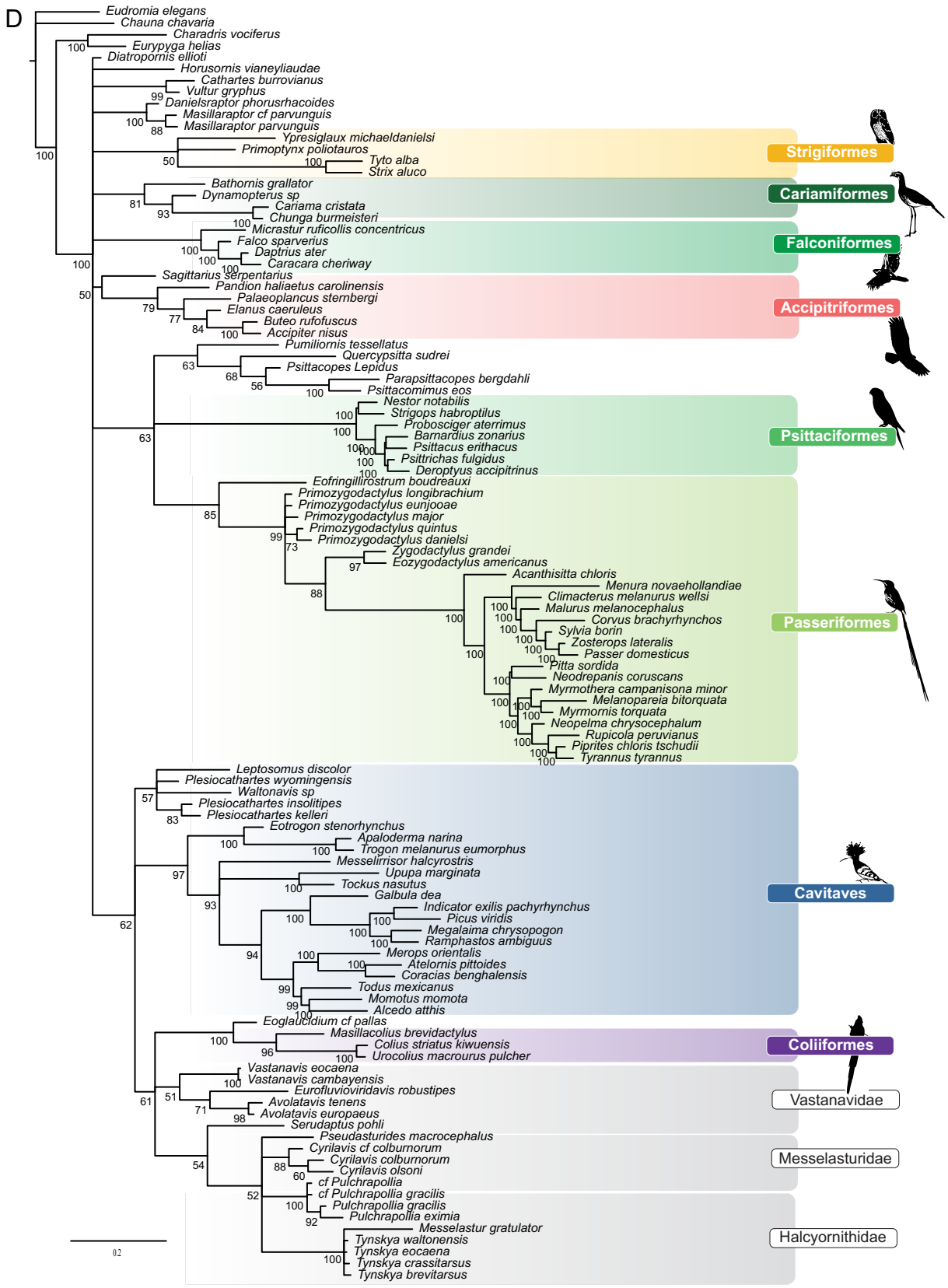


Figure 3.8. (Continued).

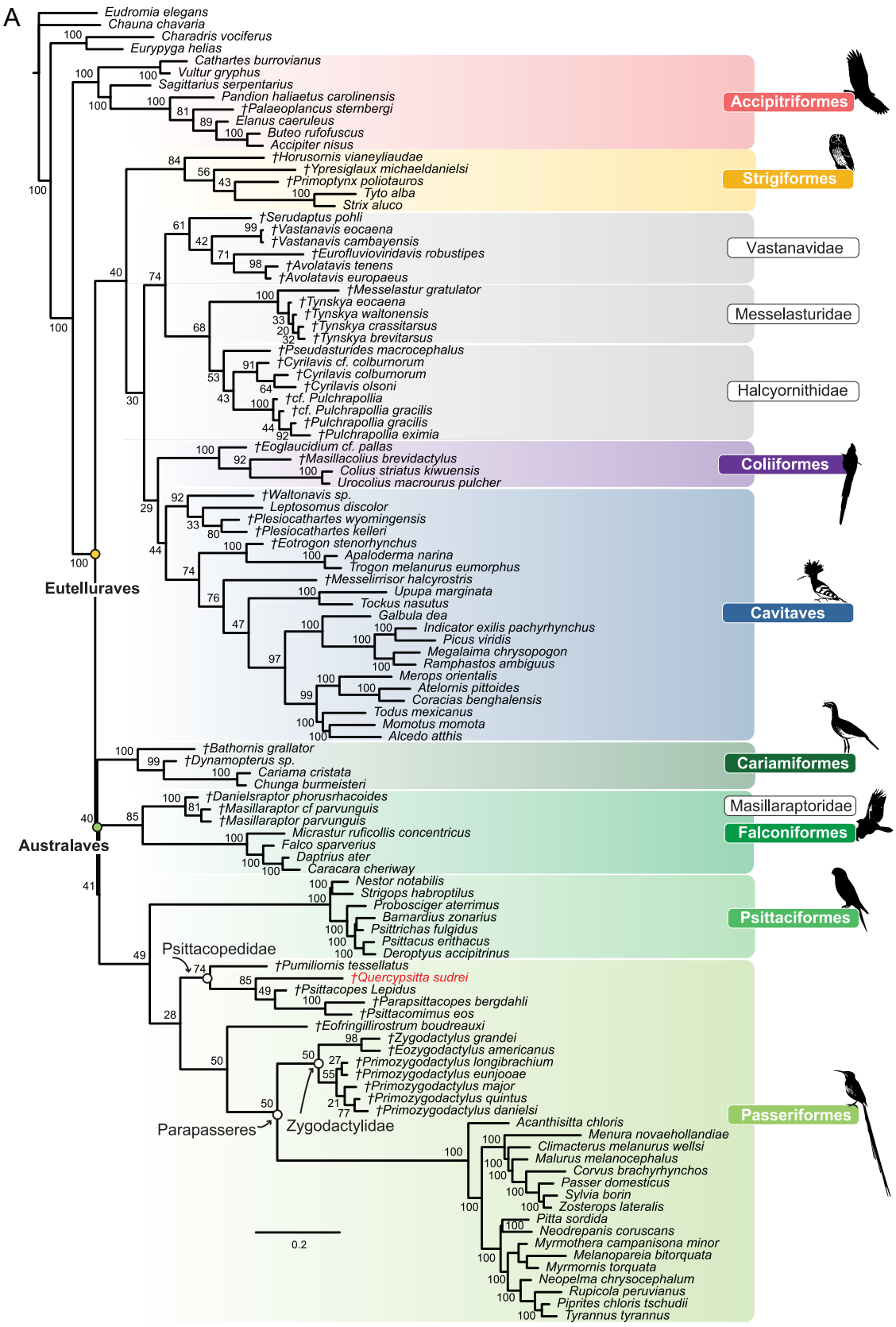


Figure 3.9. Bayesian Analysis 3 results using Prum *et al.* (2015) as the backbone constraint. (A) The "allcompat" consensus tree, unordered; (B) "Halfcompat" MCC tree, unordered; (C) The "allcompat" consensus tree, ordered; (D) "Halfcompat" MCC tree, ordered. Numbers on nodes represent posterior probabilities. Scale bar indicates 0.2 expected changes per site.

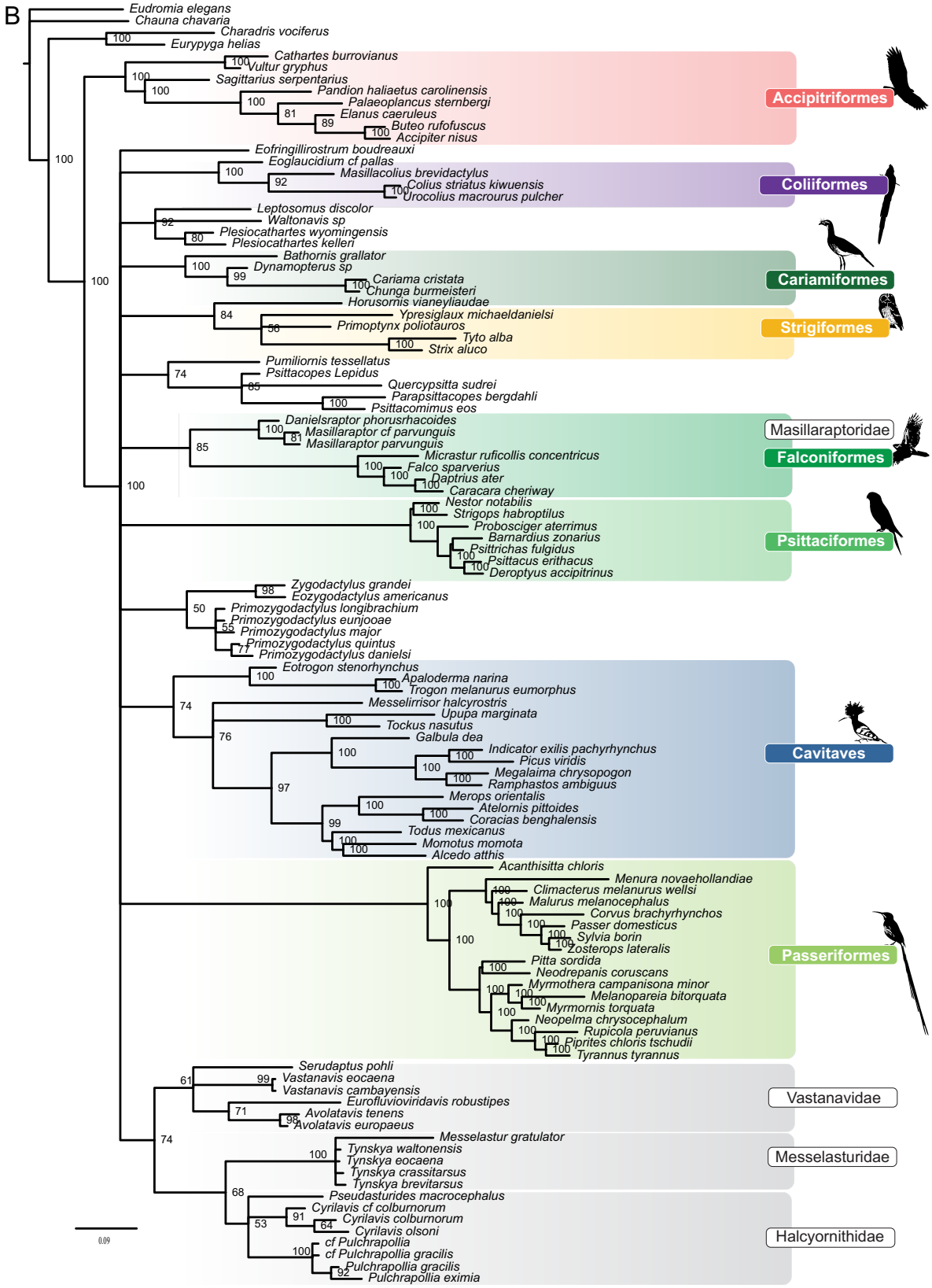


Figure 3.9. (Continued).

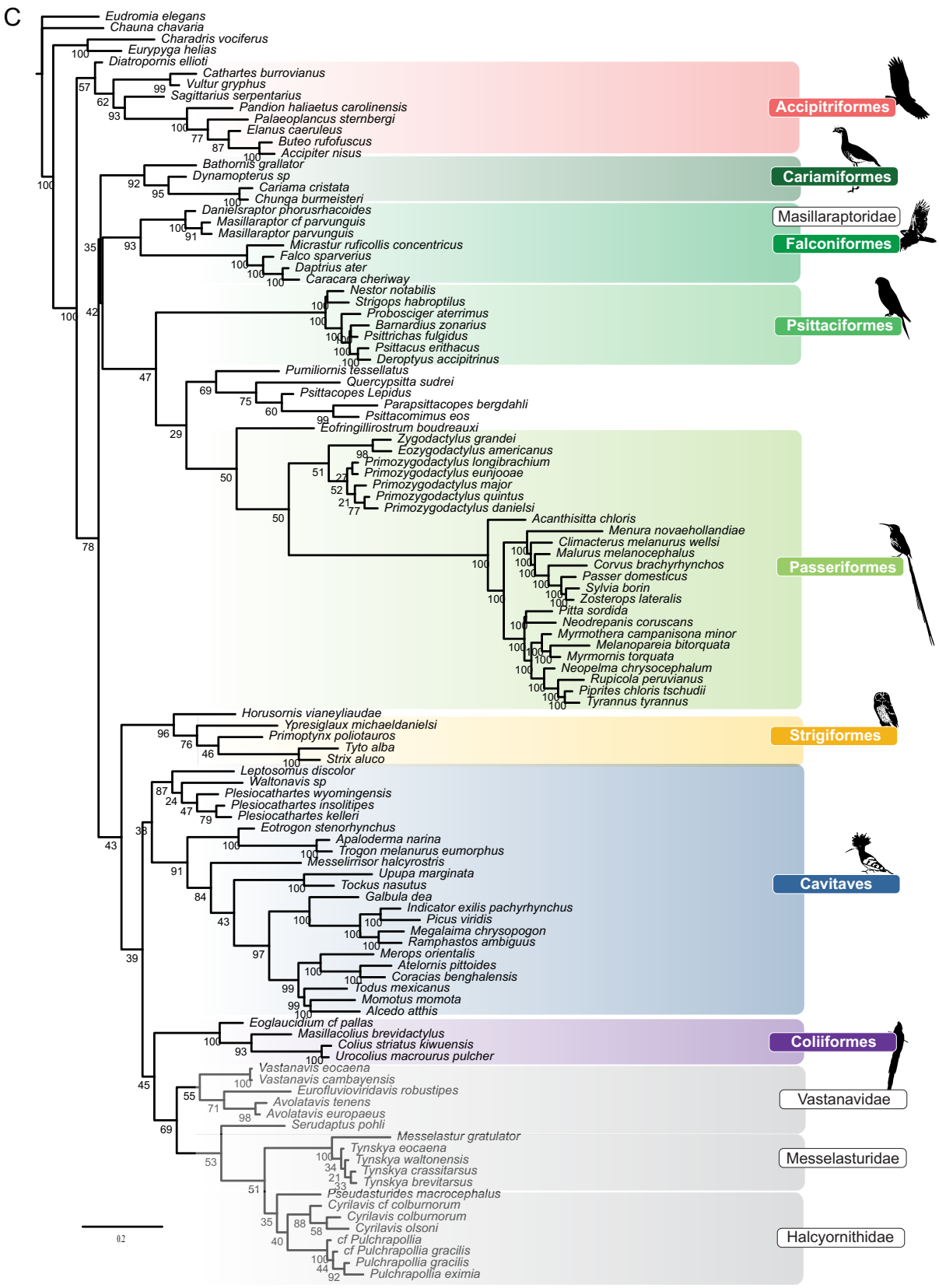


Figure 3.9. (Continued).

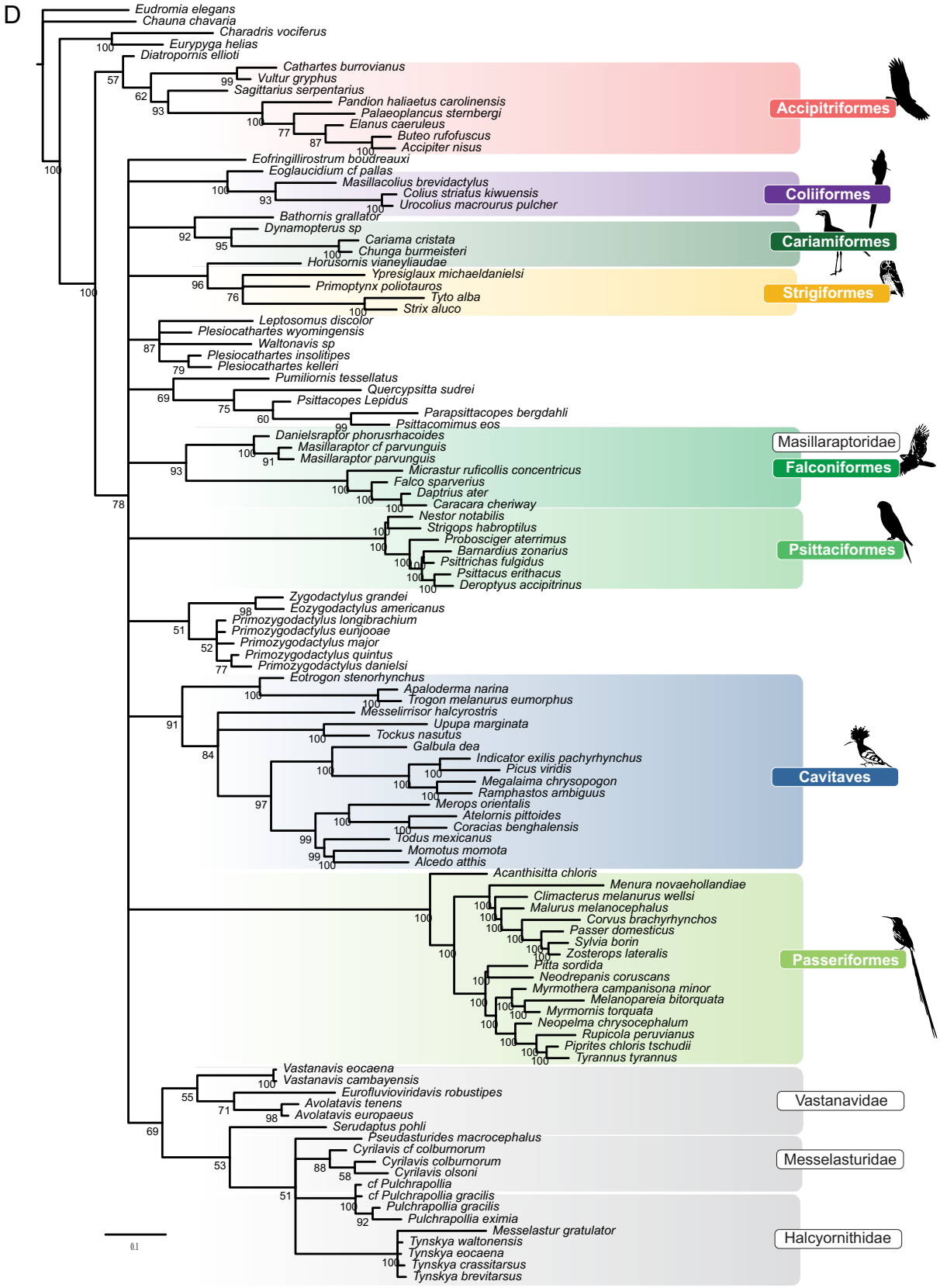


Figure 3.9. (Continued).

Bayesian inference (time-calibrated)

The results of the time-calibrated ordered Bayesian inference analysis using the FBD model, with both Stiller *et al.* (2024) and Prum *et al.* (2015) constraints are shown as MCC trees (majority rule) that collapses partitions with a posterior probability lower than 50% (Fig. 3.10 & Fig. 3.11). Additional unordered analyses were performed for each constraint and summarised as majority rule trees (Fog. S1.11 & S1.12). The tree topologies defined by both constraints (unordered and ordered) are very similar to that recovered by the non-time calibrated analyses: *Bathornis* and *Dynamopterus* as sister to Cariamiformes; Masillaraptoridae as sister to crown Falconiformes; *Horusornis, Ypresiglaux* and *Primoptynx* as sister to crown Strigiformes; Quercypsittidae nested within Psittacopedidae; *Plesiocathartes* and *Waltonavis* sister to Leptosomiformes; *Eoglaucidium* and *Masillacolius* sister to crown Coliiformes; *Eotrogon* as sister to sister to crown Trogoniformes; *Messelirrisor* as sister to Eucavitaves; Vastanavidae, Halcyornithidae, and Messelasturidae as sister to either Coliiformes or Cavitaves; and Zygodactylidae does not form a monophyletic group and forms part of Parapasseres.

The main difference between the results of the time and non-time calibrated Bayesian analyses (unordered and ordered) are that Psittacopedidae is recovered as sister to crown Psittaciformes with relatively low support (P = 59%). This is in contrast to all other analyses as well as previous studies (e.g., Mayr 2020) where they are allied with Zygodactylidae and crown Passeriformes. Overall, the support for most major clades, including Afroaves and Australaves, is a lot higher than in non-time calibrated analyses. However, the support for Vastanavidae, Halcyornithidae, and Messelasturidae as a monophyletic group is very low (PP = 34), in contrast to all other analyses in this thesis. In previous studies (e.g., Mayr & Kitchener 2022) these birds do not form a monophyletic group and can be found in many different configurations.

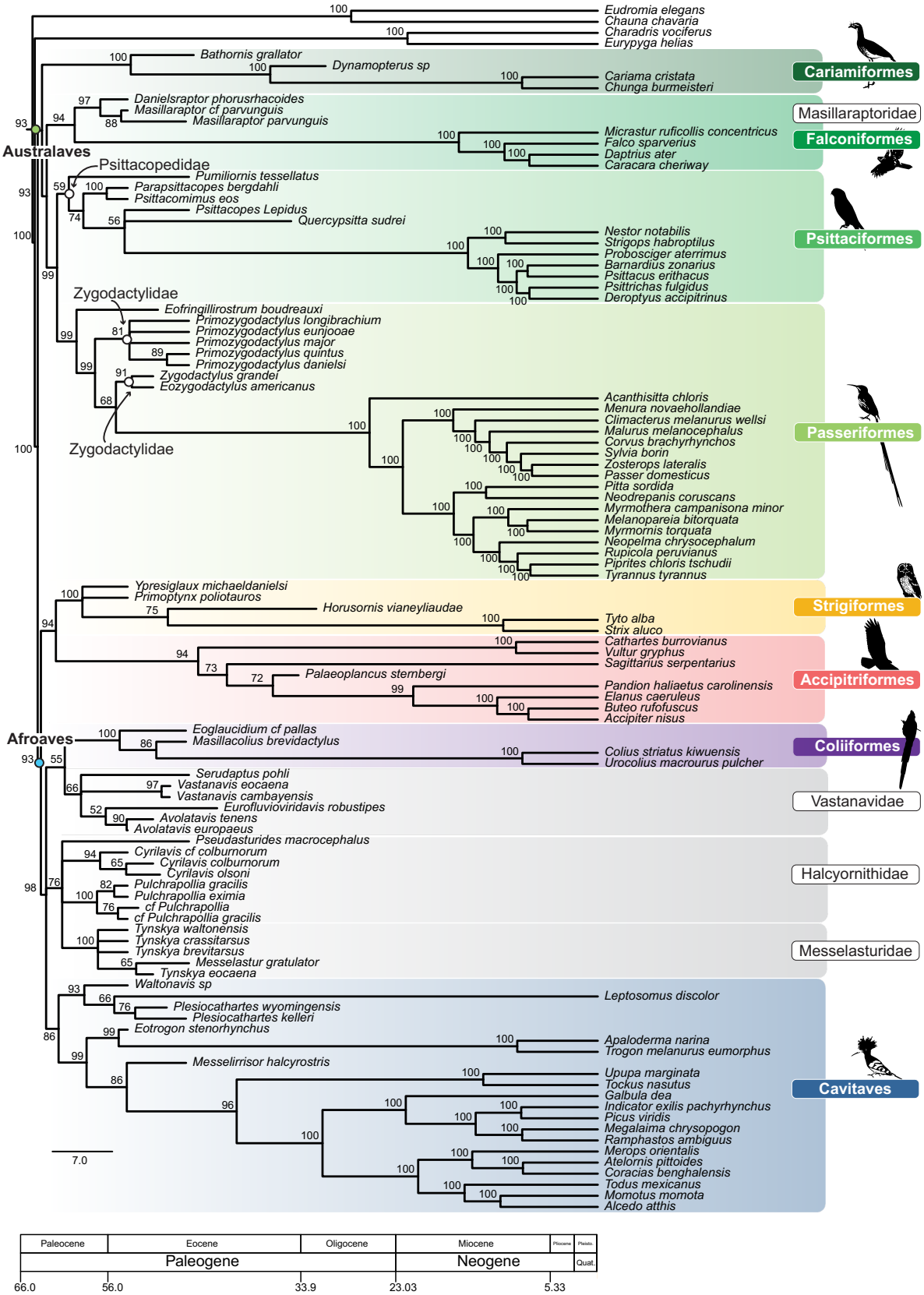


Figure 3.10. "Stiller" constraint majority rule consensus tree recovered from Bayesian analysis with FDB model, ordered characters. Numbers on nodes represent posterior probabilities. Scale bar indicates 7.0 expected changes per site.

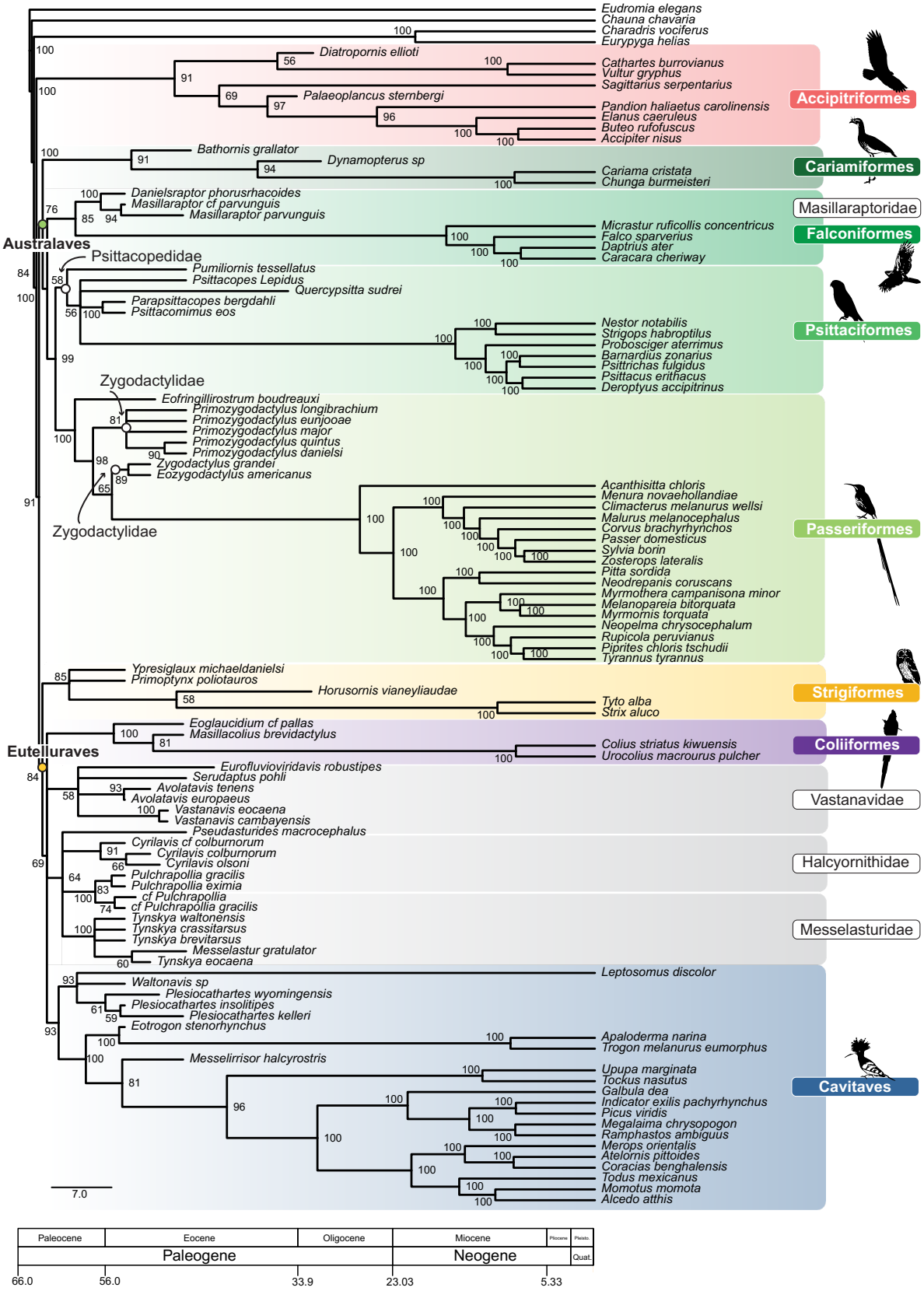


Figure 3.11. "Prum" constraint majority rule consensus tree recovered from Bayesian analysis with FDB model, ordered characters. Numbers on nodes represent posterior probabilities. Scale bar indicates 7.0 expected changes per site.

3.3.4 Outgroup selection tests

Analysis 1: Maximum parsimony

Analysis of the unordered datasets was conducted using alternating outgroup configurations. The data set that included *Charadris vociferus* and *Eurypyga helias* only recovered three MPTs of 2561 steps, with an ensemble CI of 0.244, RI of 0.689 and RC of 0.168 (Fig. S1.6A). The MPTs are generally well resolved except with variability in the resolution of passerine suboscines. Overall, deeper (e.g., intra-ordinal) node support Bremer and bootstrap support values. Similar to the initial analysis with all four outgroup taxa, a "raptorial" clade is recovered, though with key differences: the position of Cariamiformes is now resolved as sister (low support values) to an Accipitriformes, Strigiformes, and Falconiformes assemblage; and Psittaciformes as sister to Passeriformes uniting them into a single monophyletic clade (very low support values), congruent with molecular results.

Analysis of a dataset including *Eudromia elegans* and *Chauna chavaria* only recovered two MPTs of 2579 steps, with an ensemble CI of 0.244, RI of 0.693 and a rescaled consistency index (RC) of 0.169 (Fig. S1.6B). Overall, the tree is no longer split into two monophyletic assemblages, but rather members of Cathartidae, Sagittariidae, and Cariamiformes are found in a grade with respect to all other Telluraves and a group comprising Strigiformes (Accipitridae + Falconiformes); and Leptosomiformes as successively closer sister taxa to Psittacopasseres (Psittaciformes + Passeriformes). Overall, resolution is lost (polytomy) among Strigiformes and Accipitriformes + Falconiformes within Coraciimorphae and within Passeriformes.

Analysis 1: Bayesian inference (none-time-calibrated)

The results of the Bayesian inference analysis including *Charadris vociferus* and *Eurypyga helias* only, is summarised in Figure S1.7A. The Bayesian topology overall does not differ from the initial Bayesian analysis (four outgroup taxa) except for one exception, Psittaciformes are now sister to

a Cariamiformes + Accipitriformes + Strigiformes + Falconiformes assemblage (PP = 58%). In the ordered dataset Psittaciformes are sister to coraciimorphae + Passerine assemblage (PP = 57%).

Bigger changes in the topology are observed when *Eudromia elegans* and *Chauna chavaria* are included only. Psittaciformes retain being sister (PP = 98%) to an assemblage that includes Coraciimorphae + Passeriformes, observed in the initial analysis, however the base of the tree is now a paraphyletic grade, with Cariamiformes basal to Strigiformes + Accipitridae + Falconiformes (Fig. S1.7B). The topology is exactly the same for the ordered dataset, but with slightly higher posterior probabilities for the deeper nodes.

Overall, the Bayesian results are notably different from the parsimony outgroup iterations in that a sister relationship between Psittaciformes and Passeriformes is not recovered.

Analysis 2: Maximum parsimony

The data set including *Charadris vociferus* and *Eurypyga helias* only recovered 391 MPTs of 3415 steps, with an ensemble CI of 0.189, RI of 0.664 and RC of 0.125 (Fig S1.8A). The intra-clade relationships are largely unresolved. Nonetheless, the general topology, particularly concerning Cavitaves, Coliiformes, Psittaciformes, and Passeriformes, is almost identical to the initial analysis with all outgroup taxa included.

The data set including *Eudromia elegans* and *Chauna chavaria* as the only outgroup taxa recovered 415 MPTs of 2561 steps, with an ensemble CI of 0.190, RI of 0.666 and RC of 0.127 (Fig. S1.8B). The topology is identical to the initial analysis with all outgroup taxa included.

Analysis 2: Bayesian inference (none-time-calibrated)

Both iterations of the Bayesian inference analyses recovered almost identical topologies to the original analysis (Fig. S1.9). Except in the iteration with *Eudromia elegans* and *Chauna chavaria* removed, Leptosomiformes, Vastanavidae, Halcyornithidae, and Messelasturidae are monophyletic (PP = 77%).

3.3.5 Tree topology tests

To evaluate the fit of the molecular constrained topologies to the morphological data, the unconstrained maximum parsimony tree from Analysis 1 (extant taxa only, Fig. 3.2) was compared with a constrained iteration of Analysis 1 (extant taxa only, constrained by molecular topologies Prum *et al.* 2015; Stiller *et al.* 2024) using maximum parsimony in PAUP*. The constrained tree under the Prum *et al.* (2015) topology is 104 steps longer (length = 2774 steps) than the unconstrained tree from Analysis 1 (length = 2670 steps), while the constrained tree under the Stiller *et al*. (2024) topology is 186 steps longer (length = 2856 steps). The results of the Templeton (Wilcoxon signed-ranks) test assessing the statistical significance of these differences are presented in Table 3.2. These indicate a significant difference between the two topologies ($p < 0.0001$), rejecting the null hypothesis that they are equally parsimonious as explanations of the morphological character data. The winning-sites (sign) test further supports this result, with 121 more characters favouring the unconstrained tree over the "Prum" tree and 164 more characters favouring the unconstrained tree over the "Stiller" tree (Table 3.2). Similarly, the Kishino-Hasegawa test found that enforcing the molecular constraint topology results in a significantly worse fit to the morphological data. These results collectively indicate strong incongruence between the morphological and molecular topologies, suggesting that the signal in the morphological dataset does not support the molecular constraint tree.

To examine the effects of incorporating fossil taxa on the positions of extant groups, during unconstrained analysis of morphological data, I compared the results of Analysis 2 (unconstrained analysis of extant + fossil taxa; Fig. 3.5), pruned to include only extant taxa, to Analysis 1 (unconstrained analysis of only extant taxa), and the trees returned under both the "Stiller" and "Prum" constraints. Results of these comparisons are shown in Table 3.2. The Templeton test indicates no significant difference between Analysis 1 and Analysis 2 (extant topology only) ($p = 0.189$), suggesting that the addition of fossil taxa does not substantially alter the fit of the topology of extant taxa to the morphological dataset. This is in contrast to both

constraint trees which show significant differences ($p < 0.0001$). Both the Winning-sites test and KH test corroborates these findings, with no significant difference. Analysis 2 topology constrained to the topology of Analysis 1 shows only a modest increase in tree length (17 steps). However, the non-significant *p*-values across all tests suggest that this increase within expected variation.

Table 3.2. Results of pairwise tests of topologies.

			Templeton test			Winning-sites test	
Tree	**Length**	**Rank sums**	**N**	***z***	***p***	**Count**	***p***
A1	2670	(best)					
Prum *et al.* 2015	2774	11940.5	180	–5.706	<0.0001	121	<0.0001
		–4349.5				–59	
Stiller *et al*. 2024	2856	19265.5	217	–8.414	<0.0001	164	<0.0001
		–4387.5				–53	
A1	2670	(best)					
A2 (extant topology)	2687	5655	142	–1.313	0.189	76	0.450
		–4498.0				–66	
Prum *et al*. 2015	2774	11940.5	180	–5.706	<0.0001	121	<0.0001
		–4349.5				–59	
Stiller *et al.* 2024	2856	19265.5	217	–8.414	<0.0001	164	<0.0001
		–4387.5				–53	
Eudromia-Chauna	2559	(best)					
A1	2670	15023	202	-6.182	<0.0001	146	<0.0001
		-5480				-56	
Prum *et al*. 2015	2774	20584.5	221	-9.154	<0.0001	182	<0.0001
		-3946.5				-39	
Stiller *et al*. 2024	2856	25493.5	-236	11.357	<0.0001	208	<0.0001
		-2472.5				-28	
Charadrius-Eurypyga	2561	7138.5	167	-0.221	0.8254	89	0.439
		-6889.5				-78	

When comparing trees returned from analyses with different outgroup selection (Table 3.2), the Templeton test show that using either the *Eudromia-Chauna* pair (tree length = 2559) or the *Charadris-Eurypyga* pair (tree length = 2561) produced statistically indistinguishable topologies ($z = –0.221$, $p = 0.825$). This indicates that both outgroup pairs yield comparable character optimisations and robust intra-relationships within Telluraves, with *Eudromia-Chauna* outgroup being slightly more parsimonious. In contrast, incorporating all four outgroup taxa,

resulted in a significantly worse topology (z = –6.182, p < 0.0001), suggesting that the additional taxa introduced conflicting phylogenetic signals or possibly increased homoplasy. The winning-sites test identified the *Charadris-Eurypyga* outgroup as the best scoring topology, possibly due to their closer relationship to Telluraves, though the Templeton test shows no significant difference between the pairs. This is corroborated by the KH tests where the reduced outgroups produce the highest CI, RI, and RC, and the lowest HI, as well as a best G-fit score.

3.3.6 Excluding "raptorial" characters

Excluding "raptorial" characters from Analysis 1 resulted in 42 MPTs of 2554 steps (Fig. S1.10A). This analysis resulted in some notable changes to the topology such as that Falconiformes and Strigiformes are no longer within a monophyletic "raptorial" clade. Cathartidae, Sagittariidae, Accipitridae, Falconiformes and Cariamiformes form a paraphyletic grade as successively closer sister taxa to the remaining Telluraves, where Strigiformes are now sister to an assemblage that includes Coraciimorphae + Psittaciformes + Passeriformes. Psittaciformes are found as sister to Passeriformes. The position of Coliiformes is unresolved, either as sister to Eucavitaves or sister to Psittaciformes and Passeriformes. Additionally, the internal relationships of Passeriformes are largely unresolved. Excluding "raptorial" characters from Analysis 2 resulted in 1883 MPTs of 3400 steps (Fig. S1.10B). This analysis resulted in a number of polytomies, though mostly still similar to the initial test from Analysis 1 in that Strigiformes are still sister to Coraciimorphae + Psittaciformes + Passeriformes, and Psittaciformes are sister to Passeriformes. Fossil taxa remain in similar positions from the original Analysis 2. Incongruence length difference tests (ILD) tests were also performed, comparing "raptorial" characters to non-raptorial characters. The ILD test recovered a p-value of 1, indicating that the partitions are congruent, suggesting that the raptorial clade is supported by a combination of homoplastic characters from both partitions, not just "raptorial" ones, even though the topologies do show a clear change in relationships.

3.4 Discussion

3.4.1. The significant homoplasy within Telluraves

The tree topologies returned by Analyses 1 and 2 (unconstrained analyses) of my morphological dataset support the monophyly of most major extant orders of Telluraves (Figs 3.2-3.5). The intra-relationships within telluravian orders match those recovered in molecular hypotheses. However, the deeper relationships between orders conflict with molecular phylogenies, likely due to morphological convergence between the "raptorial" groups (Accipitridae, Falconiformes, and Strigiformes) and possibly between Coraciimorphae and Passeriformes. The discordance could also be due to the retention of plesiomorphic traits in Psittaciformes, as well as in their stem representatives (pan-Psittaciformes), relative to Strigiformes and other "raptorial" groups. These deep relationships between orders exhibit high Bremer support from morphological character data, indicating robustness to additional steps (high parsimony robustness), but low bootstrap support, suggesting that these clades are supported by a few characters with strong, but likely misleading, signal.

The monophyly of the "raptorial" clade (Strigiformes + Accipitriformes + Falconiformes) recovered in Analysis 1 & 2, is supported by 23 unambiguous synapomorphies in Analysis 1: 30 (1 -> 0), 81 (1 -> 0), 173 (0 -> 1)*, 188 (0 -> 1), 194 (1 -> 0), 196 (0 -> 1)*, 243 (0 -> 1)*, 371 (0 -> 1), 391 (0 -> 1)*, 406 (0 -> 1), 453 (1 -> 0), 463 (2 -> 1), 471 (0 -> 1)*, 472 (1 -> 0), 487 (1 -> 0), 493 (0 -> 1), 521 (0 -> 1)*, 527 (0 -> 1), 528 (0 -> 2)*, 530 (0 -> 2)*, 540 (0 -> 1), 542 (0 -> 2), 543 (0 -> 1)*; and 12 unambiguous synapomorphies in Analysis 2: 19 (0 -> 1)*, 38 (0 -> 1), 151 (0 -> 1)*, 173 (0 -> 1)*, 397 (2 -> 0), 463 (2 -> 1), 464 (0 -> 1), 465 (0 -> 1), 487 (1 -> 0), 529 (1 -> 2)*, 542 (0 -> 2)*, 543 (0 -> 1)*. A large number of these synapomorphies are functionally related to a "raptorial" lifestyle (denoted with *), as discussed in section 3.2.7. The "raptorial" clade is similarly observed in many other studies such as Mayr & Clarke (2003) and Livezey & Zusi (2007), as well as studies that include fossil taxa such as Ksepka *et al.* (2017, 2019).

The removal of “raptorial” characters had only a moderate impact on the topology (Fig. S1.9) with the loss of the monophyletic “raptorial” clade and recovery of a sister group relationship between Psittaciformes and Passeriformes, both of which bring the topology somewhat closer to molecular hypotheses. Accipitriformes, Strigiformes, and Falconiformes are recovered as a paraphyletic grade in this analysis (Fig. S1.9), differing from molecular phylogenies in which they are a polyphyletic assemblage, with Falconiformes as sister to Psittaciformes + Passeriformes (Table S1.1). This suggests that there are still likely many characters that indirectly reflect adaptions for predation that overlap in phylogenetic signals. This is common in morphological datasets where functional complexes are represented by multiple correlated traits (Wiley & Lieberman 2011). Additionally, there may be a number of non-raptorial characters that have as big an impact on the relationships in the unconstrained analyses. Given the low support values for the inclusion of Falconiformes within Accipitriformes in Analysis 1 and 2, the topology may not be supported by any particular subset of characters, including raptorial ones.

In Analysis 1, Passeriformes are recovered as nested within the paraphyletic Coraciimorphae assemblage, with Coliiformes sister to Passeriformes, which in turn are sister to Picodynastornithes (Figs. 3.2 & 3.3). This is supported by 15 unambiguous synapomorphies: 15 (1 -> 0), 102 (2 -> 1), 204 (0 -> 1), 205 (0 -> 1), 215 (2 -> 0), 242 (0 -> 1), 247 (0 -> 1), 250 (0 -> 1), 252 (1 -> 2), 271 (0 -> 1), 331 (0 -> 1), 332 (0 -> 1), 365 (1 -> 0), 377 (1 -> 0), 440 (0 -> 1), 473 (0 -> 1). A number of these characters are likely related to convergence in adaptions to arboreality, perching, agile flight and general small size. For example, deep sternal fenestrae or incisurae help reduce the sternum’s weight, likely an adaption for light-weight, manoeuvrable flight (Lowi-Merri *et al.* 2021) (Ch. 205:1; Fig. 2.21), a reduced processus procoracoideus decreases leverage for the m. supracoracoideus, a muscle that elevates the wing during upstroke, possibly allowing for rapid flapping (Baumel & Witmer 1993) (Ch. 215:0; Fig. 2.25) and the presence of a processus intermetacarpalis likely strengthens the hand section for powerful take offs (also observed in birds outside Telluraves, like chickens) (Stegmann 1965). Many of the above mentioned traits are

not immediately obvious nor thoroughly studied, highlighting a need for deeper investigation into their significance.

The addition of fossil taxa in Analysis 2 (Fig. 3.5) introduced minor topological differences compared to Analysis 1 (Fig. 3.2), primarily in the recovery of a monophyletic Psittacopasseres (Psittaciformes + Passeriformes), though the parsimony scores between the two analyses were not significantly different (Table 3.2). In a previous study by Ksepka *et al.* (2019) a monophyletic Psittacopasseres was also recovered in the unconstrained extant and extinct analysis. This suggests that fossils may provide a somewhat valuable phylogenetic signal that helps refine relationships, particularly between Passeriformes and Psittaciformes, which is supported by molecular studies (e.g., Prum *et al.*, 2015; Stiller *et al.*, 2024). These fossils are a possible case of "character extinction", where many character state combinations were present in the earliest members of a group, but disappeared since, due to either extinction of that taxa or extensive subsequent morphological evolution. This is likely the case for Psittacopedidae, Zygodactylidae, and Morsoravidae which share character combinations that are present in both Psittaciformes and Passeriformes. The clade including *Eofringillirostrum*, Psittacopedidae, Zygodactylidae, Morsoravidae (represented by *Pumiliornis*), and crown Passeriformes is supported by 15 unambiguous: 17(0 -> 1), 101(2 -> 0), 130(0 -> 1), 146(0 -> 1), 169(0 -> 1), 179(1 -> 0), 236(0 -> 2), 269(0 -> 1), 297(1 -> 0), 307(1 -> 0), 360(0 -> 1), 370(1 -> 0), 432(0 -> 1), 529(1 -> 0), 534(1 -> 0). One of these characters has been previously suggested as an apomorphy for this clade (Mayr & Kitchener 2023b): the flexor process of the humerus is strongly projected and reaching distally beyond the distal margin of the ventral condyle (Ch. 269:1). Additionally, one character represents a reversal into the plesiomorphic condition (Mayr & Kitchener 2023b): the proximal three phalanges of the fourth toe are not abbreviated (Ch. 529:0). The recovered unambiguous synapomorphies of Psittacopasseres (Psittaciformes + stem and crown Passeriformes) are discussed further in the next section.

The removal of "raptorial" characters from the dataset for Analysis 2 resulted in the recovery of Psittacopasseres (Fig. S1.9). Considering that the removed raptorial characters (Ch. 4,

Ch. 151, Ch. 543) are also observed in Psittaciformes it is likely that Psittaciformes share notionally "raptorial" features with Falconiformes + Cariamiformes, that may have been plesiomorphic for Australaves and lost in Passeriformes. Including fossil groups such as Psittacopedidae and Zygodactylidae, which share features with both Psittaciformes and Passeriformes adds data on ancestral character state combinations that seem to be important in supporting Psittacopaseres based on morphological data.

The effect of outgroup selections

The alternative outgroup selections resulted in changes in character polarity, as the reference for inferring ancestral-versus-derived states is altered. This is reflected in the topological differences that may affect interpretations of deep divergences among orders within Telluraves. In Analysis 1, reducing the number of outgroup taxa in both parsimony iterations resulted in Psittaciformes and Passeriformes as sister to one another but the relationships within the other clades shifted between the iterations (Fig. S1.6). However, in Analysis 2, with the addition of fossil taxa, there were no substantial changes to the topology (Fig. S1.8). The inclusion of fossil taxa likely provides additional character states that stabilise rooting and polarisation of characters, reducing dependency on the outgroup taxa. Additionally, the statistical results strongly suggests that outgroup selection influences the inferred intra-relationships of the extant dataset and not the dataset with both extant and extinct taxa included. When outgroups more closely allied to the ingroup (*Charadris vociferus* and *Eurypyga helias*) are used, the resulting topologies are nearly identical to those derived from the alternative outgroup pair (*Eudromia elegans* and *Chauna chavaria*). However, incorporating all four taxa as outgroups leads to significantly longer trees.

3.4.2 Higher-level synapomorphies of Telluraves

The phylogenetic analyses conducted in the present study reveal a complex picture of morphological support for telluravian intra-relationships, with several major clades recovered across the unconstrained and constrained analyses (e.g., Eucavitaves, Picocoraciades, Picodynastornithes, and Psittacopasseres). However, the synapomorphies supporting these clades, particularly under the molecular constraints of Stiller *et al.* (2024) and Prum *et al.* (2015), differ significantly from those in the unconstrained analyses, reflecting the influence of molecular scaffolds on morphological character optimization. The "Prum" constraint generally provides a better fit to the morphological data, as seen by the shorter tree length and higher CI, RI, and RC values, possibly because its topology (Accipitriformes as sister to core landbirds) is more similar to what is recovered in the unconstrained analysis. While the "Stiller" constraint, which divides Telluraves into two monophyletic groups (Afroaves and Australaves), appears to be less parsimonious, with more unexpected fossil placements like Masillaraptoridae shifting away from Falconiformes.

Focusing on unambiguous synapomorphies that are consistent across both constraints, where applicable, Analysis 2, should represent a more robust evolutionary signal revealing synapomorphies that are less sensitive to the specific molecular scaffold. Specific characters optimised as unambiguous synapomorphies for major clades and their phylogenetic distributions are summarised in Table 3.3 and detailed below. The full optimisation lists for each analysis is given in Appendix 3.

Table 3.3: Unambiguous synapomorphies recovered in Analysis 2 and Analysis 3 for all telluravian clades defined by molecular hypothesis (Prum *et al*. 2015; Stiller *et al*. 2024). Synapomorphies recovered across all analyses in bold.

Telluraves	
A2	4(2), **17(0)**, **18(1)**, 28(1), **40(1)**, **52(1)**, 94(1), 161(0), **179(1)**, 225(0), 260(0), 268(0), **270(1)**, 329(0), **402(2)**, **417(0)**, 473(2), 492(0)
A3 Stiller	**17(0)**, 172(1), **179(1)**, 188(1), 254(0), **270(1)**, **417(0)**, 473(1), 540(1), 545(1)
A3 Prum	**17(0)**, **18(1)**, **40(1)**, **52(1)**, **179(1)**, **270(1)**, **402(2)**, **417(0)**
Afroaves (Accipitriformes + Strigiformes + Coraciimorphae)	
A2	*not recovered*
A3 Stiller	28(1), 91(0), 133(1), 184(2), 225(0), 370(1), 528(1), 529(1), 530(1)
A3 Prum	*not recovered*
Eutelluraves (Strigiformes + Coraciimorphae)	
A2	*not recovered*
A3 Stiller	*not recovered*
A3 Prum	58(1), 75(2), 81(0), 188(1), 276(0), 297(1), 306(0), 347(1), 361(0), 377(0), 426(0), 437(1), 540(1)
Hieraves (Strigiformes + Accipitriformes)	
A2	*not recovered*
A3 Stiller	13(1), 17(1), 169(1), 174(0), 305(1), 453(0), 465(1), 472(0), 543(1)
A3 Prum	*not recovered*
Coraciimorphae	
A2	*not recovered*
A3 Stiller	31(1), 47(1), **101(2)**, **105(1)**, 115(0), **144(1)**, **156(1)**, 200(2), 270(2), **376(0)**, **384(1)**, **392(1)**, 416(1), **447(0)**, 465(2), 525(1)
A3 Prum	18(0), **101(2)**, **105(1)**, **144(1)**, **156(1)**, **376(0)**, **384(1)**, **392(1)**, **447(0)**
Cavitaves	
A2	*not recovered*
A3 Stiller	**180(1)**, **188(0)**, **220(1)**, **224(1)**, **549(0)**
A3 Prum	**180(1)**, **188(0)**, **220(1)**, **224(1)**, 361(1), **549(0)**

Eucavitaves	
A2	**62(1)**, 87(0), **89(1)**, 195(1), **229(1)**, **355(1)**, 460(1), 472(1), **527(0)**, 529(0), 548(0)
A3 Stiller	**58(0)**, **62(1)**, **89(1)**, **176(1)**, **180(0)**, **188(1)**, **197(1)**, **203(0)**, **225(1)**, **229(1)**, **323(1)**, **355(1)**, **361(0)**, **423(1)**, **478(0)**, **527(0)**, **528(0)**, **530(0)**
A3 Prum	25(0), 52(0), **58(0)**, **62(1)**, **89(1)**, **176(1)**, **180(0)**, **188(1)**, **197(1)**, **203(0)**, **225(1)**, **229(1)**, **323(1)**, **355(1)**, **361(0)**, **423(1)**, **478(0)**, **527(0)**, **528(0)**, **530(0)**, 536(1)
Picocoraciades	
A2	**64(1)**, **311(1)**, **320(1)**, **321(1)**, **356(1)**, 370(0), 487(0)
A3 Stiller	**64(1)**, **142(1)**, **311(1)**, **320(1)**, **321(1)**, **356(1)**, **409(1)**, **413(0)**, **476(0)**
A3 Prum	**64(1)**, 136(1), **142(1)**, **311(1)**, **320(1)**, **321(1)**, **356(1)**, **409(1)**, **413(0)**, **476(0)**
Picodynastornithes	
A2	**13(1)**, **59(1)**, **144(0)**, **271(1)**, **283(0)**, **293(1)**, **312(1)**, 358(1), 441(0), **449(1)**, **465(1)**, 524(1)
A3 Stiller	**13(1)**, **59(1)**, **144(0)**, **205(1)**, **250(1)**, **260(1)**, **271(1)**, **283(0)**, **293(1)**, **312(1)**, **449(1)**, **465(1)**
A3 Prum	**13(1)**, **59(1)**, **144(0)**, **205(1)**, **250(1)**, **260(1)**, **271(1)**, **283(0)**, **293(1)**, **312(1)**, 331(1), 377(0), **449(1)**, **465(1)**
Australaves (Cariamiformes + Falconiformes + Psittaciformes + Passeriformes)	
A2	*not recovered*
A3 Stiller	228(0), 321(1), 361(0), **388(1)**, 395(1)
A3 Prum	215(2), **388(1)**
Eufalconimorphae (Falconiformes + Psittaciformes + Passeriformes)	
A2	*not recovered*
A3 Stiller	**1(0)**, **25(0)**, **48(1)**, **96(1)**, 226(1), 255(1), 347(0), 453(0), 469(1)
A3 Prum	**1(0)**, **25(0)**, **48(1)**, **96(1)**, 115(1)
Psittacopasseres (Psittaciformes + Passeriformes)	
A2	1(0), 31(0), **32(0)**, **85(1)**, 126(1), 228(0), **256(1)**, **284(1)**, 434(1), **489(1)**
A3 Stiller	**32(0)**, **58(0)**, **77(0)**, **85(1)**, 91(0), **190(1)**, **252(2)**, **256(1)**, **284(1)**, 392(1), **396(1)**, **404(0)**, **409(1)**, **429(1)**, 431(1), 440(1), **467(1)**, **470(2)**, **478(0)**, **489(1)**, **496(2)**, **513(0)**
A3 Prum	**32(0)**, 52(0), **58(0)**, **77(0)**, **85(1)**, **190(1)**, 250(1), **252(2)**, **256(1)**, **284(1)**, **396(1)**, **404(0)**, **409(1)**, 424(1), **429(1)**, 460(0), 463(0), 464(2), 465(2), **467(1)**, **470(2)**, 472(0), **478(0)**, **489(1)**, **496(2)**, **513(0)**

Telluraves

Currently, there are no known synapomorphies for Telluraves (Sangster *et al.* 2022) and while the current study does not specifically test their monophyly, it is still worth noting the eight potential unambiguous synapomorphies consistently recovered across two or more analyses (Table 3.3):

- The size of the external nares, which are less than half the length of the rostrum (Ch.17:0). This reflects a "trend" towards increased ossification of the rostrum and cranium in Telluraves compared to outgroup taxa. However, this feature is subsequently modified in Passeriformes (including stem representatives) and Strigiformes, which exhibit elongated nares, exceeding half the rostral length (Ch. 17:1), a feature also observed in stem passerine representatives such as Zygodactylidae and Psittacopedidae. Similarly, fossil taxa with elongated nares, *Messelastur gratulator*, *Tynskya eocaena,* and *Eurofluvioviridavis robustipes*, likely contributed to their phylogenetic affinity with Strigiformes.
- The processus orbitalis, a ventral extension of the lacrimal toward the jugal bar, is well developed: either touching or nearly touching the jugal bar (Ch. 40:1; Fig. 2.1). A well-developed processus orbitalis is present in Falconiformes and Psittaciformes, reflecting the likely convergence with Accipitriformes. Functionally, an elongated processes orbitalis could enhance orbital protection in raptorial birds or support mechanical stresses in Psittaciformes (and even falcons). This synapomorphy is recovered in both Analysis 2 and the "Prum" constraint analysis, but was not recovered in the "Stiller" constraint analysis. This potentially highlights topological variability in Telluraves, reflecting the difference in the phylogenetic placement of Accipitriformes.
- The length of the postorbital process is elongate, but well separated from the jugal bar (Ch. 52:1; Fig. 2.1). Again, this feature was not recovered as a synapomorphy in the "Stiller" constraint analyses as it is observed in Accipitriformes, Cariamiformes (crown and stem) and Falconiformes (crown and stem) but not in most Coraciimorphae

(exception in Piciformes), Psittaciformes and Passeriformes. An elongate postorbital process is also observed in a number of fossil taxa such as *Pseudasturides macrocephalus* and *Messelastur gratulator*.

- The pygostyle is large, with its height approximately equal to the length of the preceding four free caudal vertebrae (Ch. 179:1). The consistent recovery of this character across all analyses suggests that a large pygostyle is a stable synapomorphy for Telluraves. However, variability exists within the clade, mostly in Passeriformes and fossil taxa. For example, a large pygostyle is observed in *Avolatavis tenens*, the previously proposed pan-Psittaciformes, though not observed in halcyornithids and messelasturids (Ksepka *et al.* 2012).
- The fossa musculi brachialis, located on the ventral surface of the humerus, is weakly delimited, wide, and open (Ch. 270:1; Fig. 2.43). Despite being recovered as a synapomorphy across all analyses it is only observed in Accipitriformes, Cariamiformes and Falconiformes while in many other Telluraves like Strigiformes, Coraciimorphae and Passeriformes exhibit a sharply delimited and ovate depression (Ch. 270:2; Fig. 2.34). This likely reflects the highly diverse flight styles within Telluraves. Almost all fossil taxa observed in this study exhibit state 1 except *Waltonavis*, *Pulchrapolia gracilis*, cf. *Pulchrapolia gracilis,* and *Tynskya brevitarsus,* which exhibit state 2.
- Thirteen to fourteen thoracic vertebrae ankylosed in the synsacrum (Ch. 402:2). This synapomorphy is not recovered in the "Stiller" constraint anaylsis as state 2 is mostly observed in Accipitriformes, Cariamiformes, Falconiformes, and Psittaciformes while Coraciimorphae and Passeriformes exhibit fewer ankylosed vertebrae.
- The articular surface of the femur that articulates with the antitrochanter of the pelvis is not deeply convex (Ch. 417:0: Fig. 2.58). A likely plesiomorphic condition observed in almost all Telluraves, except in Coliiformes, where it is deeply convex (Ch. 417:1; Fig. 2.58), and some oscines like *Menura novaehollandiae*.

These synapomorphies should be interpreted with caution, as this study has a limited sampling of outgroup taxa, and there is an absence of a comprehensive analysis of all other avian lineages outside Telluraves.

Afroaves

The clade Afroaves (Accipitriformes + Strigiformes + Coraciimorphae), previously discussed in Chapter 1, is defined by the Stiller *et al.* (2024) constraint only, and is supported by nine potential unambiguous synapomorphies (Table 3.3). Selected characters are discussed below:

- The angulus tomialis maxillaris, a feature of the maxilla near the tomial edge, forms a discrete projection ventral to the jugal bar (Ch. 28:1; Fig. 2.1) in most Afroaves, including Accipitriformes, Strigiformes, Coliiformes, and Leptosomiformes, but is not observed in Eucavitaves where the angulus tomialis maxillaris is continuously fused to the jugal bar (Ch.28:0). A discrete projection is also observed outside Afroaves, such as in Falconiformes, indicating possibly homoplasy. This feature was also observed in many fossil taxa such as *Pseudasturides macrocephalus, Cyrilavis colburnorum*, *Serudaptus pohli,* and *Messelastur gratulator,* which may contribute to their position outside pan-Psittaciformes.
- The sternum has four caudal incisurae or fenestrae (Ch. 184:2). While this is observed in almost all Afroaves, it is not observed in Accipitriformes which only have two caudal incisurae or fenestrae. *Masillaraptoridae* are also observed as having four caudal incisurae or fenestrae, and while previous studies have recovered this group as stem falconiforms, they are recovered sister to Accipitriformes, and so, therefore, likely increasing the perceived support for state 2 as a synapomorphy for Afroaves. Additionally, this character shows variabile/widespread homoplasy throughout. Telluraves, Cariamiformes, Falconiformes, and Psittaciformes have two incisurae or fenestrae, while *Acanthisitta chloris*, Zygodactylidae, Psittacopedidae, and *Pumiliornis tessellatus* have four incisurae or fenestrae.

- A supracoracoid nerve foramen is present in the coracoid (Ch. 225:0; Fig. 2.25) of Accipitriformes, both stem and crown Strigiformes, the Sandcoleiformes *Eoglaucidium,* and stem and crown Leptosomiformes. Additionally, it is present in both stem and crown Falconiformes, most Halcyornithidae, and Messelasturidae, suggesting significant homoplasy and likely a common a feature throughout early neornithine birds (Mayr 2021c). Similarly, the presence of the foramen in stem owls, stem Leptosomiformes, and stem Falconiformes indicates that this character state may be ancestral for a broader clade encompassing both Afroaves and related groups, potentially reducing its specificity as a synapomorphy for Afroaves.
- Reduction of pedal phalanges IV-1, IV-2, and IV-3, and their relative shortening compared to phalanx IV-4 (Ch. 528:1, Ch. 529:1, Ch. 530:1). The pedal phalanges of the fourth toe in Afroaves exhibit a consistent pattern of reduction and shortening, as reflected in the three related characters: the proximal three phalanges (IV-1, IV-2, IV-3) are individually shorter than the penultimate phalanx IV-4; phalanges IV-2 and IV-3 are individually half the length of IV-4; and phalanx IV-1 is slightly shorter (two-thirds the length) than IV-4. Shortening of the phalanges in the above combinations are observed in Cathartidae, Sagittariidae, stem and crown Leptosomiformes, and stem and crown Coliiformes. Likely convergence is observed in Psittaciformes, Masillaraptoridae, and some Halcyornithidae and Messelasturidae.

Fossil taxa and their impact on Afroaves synapomorphies

My analyses returned several possibilities for the phylogenetic affinities of Masillaraptoridae, Messelasturidae, Vastanavidae, and Halcyornithidae. I find (Messelasturidae + Halcyornithidae) as a monophyletic assemblage in all analyses that in turn are sister to either a wider grouping of Coraciimorphae, Psittaciformes and Passeriformes in the unconstrained analyses (Fig. 3.5-3.7). Vastanavidae is a successive sister of a clade including Coliiformes, Eucavitaves, and Psittacopasseres under the parsimony Analysis 2 (Fig. 3.6), as sister to Strigiformes under both

constraints in the parsimony Analysis 3 (Figs. 3.8 & 3.9) or sister to Coliiformes in the time-calibrated Bayesian analyses (Fig. 3.10 & 3.11). These hypotheses differ from most other studies, which have recovered these taxa as pan-Psittaciformes, generally as successive sister taxa to a clade including the Psittacopedidae, Morsoravidae, and crown Psittaciformes (e.g., Ksepka *et al.* 2011; Ksepka *et al.* 2012; Ksepka *et al*. 2019; Mayr & Kitchener 2023a). It is clear from the above listed synapomorphies that unexpected fossil placements, particularly Masillaraptoridae, Messelasturidae, Vastanavidae, and Halcyornithidae have substantial effect on interpretations of Afroavian synapomorphies. The placement of Masillaraptoridae as sister to Accipitriformes (Ch. 184:2), and Messelasturidae, Halcyornithidae, and Vastanavidae as sister to Strigiformes (Ch. 225:0, Ch. 528:1, Ch. 529:1, Ch. 530:1), despite their traditional classifications as stem Falconiformes and stem Psittaciformes, respectively, may increase the support for (Ch. 28, Ch. 91, Ch. 133, Ch. 184, Ch. 225, Ch. 370, Ch. 528, Ch.529, Ch. 530) as synapomorphies of Afroaves. However, if Messelasturidae, Vastanavidae, and Halcyornithidae were found instead as stem or pan-Psittaciformes, then this could reveal these traits as plesiomorphic or convergently evolved, reducing their phylogenetic signal for Afroaves and highlighting the need for further phylogenetic resolution.

I find Masillaraptoridae as sister to a clade including Messelasturidae, Halcyornithidae, Vastanavidae, Coraciimorphae, and Psittacopasseres in the parsimony Analysis 2 (unconstrained; Fig. 3.6 & 3.7), or as sister to Accipitriformes under the parsimony Analysis 3 using the "Stiller" constraint (Fig. 3.8), or as sister to Falconiformes under the Bayesian (time & non-time calibrated) and parsimony Analysis 3 (Fig. 3.10 & 3.11). Most of these hypotheses differ from recent works that regarded Masillaraptoridae as stem Falconiformes (Mayr & Kitchener 2022a). Given the morphological convergence between "raptorial" birds, it is expected that Masillaraptoridae is recovered in close association with Accipitriformes, mainly with Cathartidae, since both share a block-like hypotarsus. Masillaraptoridae are recovered as sister to Falconiformes in the parsimony "Prum" constraint analysis and both constrained Bayesian analyses. The pan-Falconiformes are supported by 13 unambiguous synampomorphies: 12(0 -> 1), 35(0 -> 2), 36(0

-> 1), 39(0 -> 2), 55(0 -> 1), 142(0 -> 1), 180(0 -> 1), 181(0 -> 1), 196(0 -> 1), 248(0 -> 1), 377(0 -> 1), 391(0 -> 1), 521(0 -> 1). One of the listed unambiguous synapomorphies was suggested as an apomorphy for pan-Falconiformes by Mayr & Kitchener (2022a) , the distinct tomial grooves or ridge on the rostrum (Ch. 12:1; Fig. 2.3B). However, a second apomorphy suggested by this study, a mandible with a marked dorsal projection rostral of the cotyla lateralis (Ch. 145:1; Fig. 2.15B), is only obtained in the ACCTRAN optimisation, likely because this feature is also observed in *Elanus caeruleus* and not observed in the basal most extant Falconiformes, the Herpetotherinae (which was not included in Mayr & Kitchener 2022a study). Masillaraptoridae were suggested to be an evolutionary link between Falconiformes and Cariamiformes, given the mosaic features between these birds like the block-like hypotarsus. However, in the unconstrained analysis they are not closely associated, but rather basal to an assemblage of Coraciimorphae, Psittaciformes, and Passeriformes.

The consistent affinity of Vastanavidae, Halcyornithidae, and Messelasturidae with Strigiformes across both constraints is supported by four unambiguous synapomorphies: 13(0 -> 1), 17(0 -> 1), 174(1 -> 0), 453(1 -> 0). Halcyornithidae and Messelasturidae were originally described as resembling Strigiformes and Falconiformes (Mayr 2000b, 2002b, 2005b) and only in more recent analyses were they recovered as pan-Psittaciformes which was mostly supported by derived features of the Zygodactyl foot (Mayr 2011c). The resemblance with Strigiformes (and Falconiformes) was based on many “raptorial” features such as a long supraorbital processes of the lacrimal, a hypotarsus with a single wide sulcus hypotarsus and curved claws and, in messelasturids, a ridge along the medial surface of the ungual phalanx of the third toe (the “comb” in owls). It is therefore likely that this grouping presented here is based on homoplastic traits. Additionally, their variable placement relative to Psittacopasseres or Coraciimorphae under the unconstrained analysis and the Bayesian inference analyses reflects ongoing uncertainty about their position within Telluraves. The monophyly of Messelasturidae and Halcyornithidae, and their stable intra-relationships, suggest that these families are well-defined, but their broader relationships are sensitive to the underlying molecular topology. The shift in their position upon

removal of *Diatropornis ellioti* under the "Stiller" constraint underscores the impact of rogue taxa on phylogenetic stability, particularly in datasets with high missing data.

Australaves

Australaves (Cariamiformes + Falconiformes + Psittaciformes + Passeriformes) is recovered in both "Stiller" and "Prum" constraints, with multiple potential unambiguous synapomorphies identified in each (Table 3.3). However, only one character is consistently recovered across both constraints: the proximity of the cristae iliacae dorsalis in the preacetabular zone of the pelvis being close set or touching (Ch. 388:1; Fig. 2.53). This feature is only observed in Cariamiformes (including *Bathornis grallator*), Falconiformes (unknown in Masillaraptoridae) and Psittaciformes (unknown in Quercypsittidae), but notably absent in Passeriformes (unknown in Zygodactylidae and other stem Passeriformes). There is, however, some amount of homoplasy in that this feature is also observed in the outgroup taxon *Chauna* and some Accipitriformes like *Vultur gryphus* and *Buteo rufofuscus*. To confirm the evolutionary significance of this character, more complete fossil material will be needed.

Eufalconimorphae

Eufalconimorphae (Falconiformes + Psittaciformes + Passeriformes) is supported by four unambiguous synapomorphies across both constraints (Table 3.3):

- The upper beak length is less than the total length of the cranium (Ch. 1:0).
- The external naris and fenestra antorbitalis do not overlap in lateral view (Ch. 25:1).
- The ectethmoid contacting the lacrimal (Ch. 48:1; Fig. 2.7).
- Caudal ends of the vomer being "deeply cleft" with caudo-laterally orientated flanges (Ch. 96:1; Fig. 2.11).

All four synapomorphies exhibit significant homoplasy, reducing their utility as unique diagnostic features for Eufalconimorphae. A shorter beak is observed in Falconiformes,

Masillaraptoridae, Psittaciformes (except *Probosciger*), most Passeriformes (except *Neodrepanis* and *Myrmornis*), most Zygodactylidae, and most Psittacopedidae, but also observed in Accipitriformes, Strigiformes, Halcyornithidae, Vastanavidae, and Messelasturidae, indicating a plesiomorphic state with widespread distribution. The ectethmoid-lacrimal relationship is observed in Falconiformes and stem representatives of passerines like *Eofringillirostrum* and *Pumiliornis*. However, this is also observed in most Accipitridae, *Tyto alba,* and Coraciiformes, suggesting homoplasy, rather than a unique trait, for Eufalconimorphae. A deeply cleft vomer is observed in Falconiformes and Passeriformes, but also in most outgroup taxa, indicating that this derived state is not exclusive to Eufalconimorphae and likely represents a broadly shared trait within Neornithes.

Psittacopasseres

Psittacopasseres (Psittaciformes + Passeriformes) is supported by 17 unambiguous synapomorphies between the two constraint analyses, but only four of the synapomorphies are consistently recovered across all three analyses, as detailed below (Table 3.3):

- Orbits larger than half the skull length (Ch. 32:0) are observed in Psittaciformes, most crown Passeriformes (except *Acanthisitta chloris* and *Pitta sordida*), and the stem passerines Zygodactylidae, Psittacopedidae, and *Eofringillirostrum boudreauxi*.
- The presence of accessory palatine processes on the palatine (Ch. 85:1) is observed in Psittaciformes and most Passeriformes (except most oscines). Unfortunately, the palate is missing in almost all fossil taxa, limiting ancestral state reconstruction. Nonetheless, this feature is only observed in a few birds outside Psittacopasseres, such as *Upupa marginata* and *Alcedo atthis*. These processes or flanges likely contribute to cranial kinesis, possibly adding flexibility for manipulation while feeding (Zusi 1984).
- The presence of a deep fossa pneumotricipitalis dorsalis on the humerus (Ch. 256:1) is observed in Psittaciformes, most Passeriformes, and the stem Passeriformes

Parapsittacopes bergdahli, suggesting a derived trait that likely enhances attachment for the m. latissimus dorsi, improving wing stability during flight or perching (Baumel & Witmer 1993; Mayr 2011a). This feature is however not observed in any suboscines and the stem Passeriformes *Psittacomimus eos.*

- A splayed or rotated trochlea metatarsi IV on the tarsometatarsus (Ch.489:1; Fig. 2.68) is observed in Psittaciformes and stem Passeriformes but not in crown Passeriformes, indicating a derived trait that may facilitate zygodactyl or semi-zygodactyl foot arrangements for grasping. The absence in crown Passeriformes may suggest a reversal, discussed more below.

Zygodactyl foot condition in Psittacopasseres

The remaining 13 synapomorphies of Psittacopasesseres (Table 3.3), which vary across analyses, reflect topological differences in the constraints, as well as the placement of fossil taxa. Nonetheless, a few of these synapomorphies are worth discussing, particularly those pertaining to the zygodactyl foot condition. Psittaciformes are characterised by a zygodactyl foot with a permanently reversed fourth toe. Considering the strong support for passerine/parrot sister taxon relationship, this has opened the possibility that a zygodactyl foot may be ancestral to the entire group Mayr (2009a). This is indeed the case for the Zygodactylidae, an extinct clade of small birds that possess a zygodactyl foot, with two pedal digits that are caudally deflected, a condition that was originally compared to that of Psittaciformes (Ballmann 1969b; Smith, DeBee*, et al.* 2018). This condition is easily recognisable, even in non-articulated fossils, as the trochlea IV exhibits a large bony extension known as the trochlea accessoria or sehnenhalter. The results of several phylogenetic analyses have placed Zygodactylidae as the sister taxon to passerines (e.g., Mayr 2008b, 2015b; Smith, DeBee*, et al.* 2018). In all analyses of this study the positions of Zygodactylidae, Psittacopedidae, Morsoravidae (*Pumilliornis*), and *Eofringillirostrum* are consistently recovered as stem Passeriformes (or pan-Passeriformes), and are supported by 10

unambiguous synapomorphies recovered across all analyses: 17(0 -> 1), 130(0 -> 1), 146(0 -> 1), 169(0 -> 1), 179(1 -> 0), 236(0 -> 2), 269(0 -> 1), 297(1 -> 0), 360(0 -> 1), 432(0 -> 1).

The evidence supporting zygodactyly as the ancestral state in Passeriformes, and the proposed sister-taxon relationship between Passeriformes and Psittaciformes all suggest that a zygodactylid-like foot morphology may represent the plesiomorphic state for a broad clade that includes parrots, passerines, zygodactylids, and allies (Mayr 2008b, 2009a; Botelho *et al.* 2014; Mayr 2015b). Ultimately, this suggests that passerines secondarily regained anisodactyl feet in their evolutionary history, which was previously supported by ancestral state reconstructions (Ksepka *et al.* 2017).

In this study, the "Prum" and "Stiller" constraints recovered two unambiguous synapomorphies for Psittacopasseres related to the zygodactyl condition, Ch. 489:1, already discussed above, and Ch. 496:2 (Fig. 2.68), where the trochlea accessoria (which is present) is distally projecting. Additionally, Ch. 495:3 (Fig. 2.95) is recovered in the ACCTRAN and DELTRAN optimisations; this character state describes the presence of a fully developed trochlea accessoria. These features are all observed in Psittaciformes and the stem Passeriformes, Zygodactylidae, and Psittacopedidae, but not crown Passeriformes. This supports the hypothesis that a zygodactylid foot morphology was plesiomorphic for Psittacopasseres, with a secondary reversal to anisodactyly in Passeriformes, as suggested by many studies (e.g., Mayr 2008b, 2009a; Botelho *et al.* 2014; Mayr 2015b). *Pumilliornis* (Morsoravidae), however, does not exhibit these traits, but rather has a semi-zygodactly foot (Mayr & Kitchener 2023b). In the case of this analysis, it appears to be a reversal to a more plesiomorphic state. If all Morsoravidae were to be included in this analysis this could challenge the hypothesis the zygodactyl foot condition is ancestral to Passeriformes.



Bald eagle (Haliaeetus leucocephalus), Kluane National Park, Yukon, Canada. Photo by Kevin S. Olsen with bird-guide Mhairi Reid.

Chapter 4 Conclusions and future research

4.0 Synthesis of Research Aims

The analyses conducted in this thesis were designed to address four overarching questions concerning the phylogenetic utility of morphological data and the role of fossils in Telluraves systematics:

(1) Are morphological data adequate to resolve deep phylogenetic divergences within Telluraves, and are the resulting topologies congruent with previous morphological or molecular hypotheses? Morphological data proved to be highly informative at shallower levels, successfully recovering many intra-ordinal relationships that were congruent with molecular results. However, at deeper nodes, morphological analyses failed to consistently recover clades supported by molecular phylogenies such as Afroaves and Australaves, instead uniting raptorial groups into a spurious clade driven by convergence. These findings indicate that morphological data are adequate for reconstructing relationships within orders but lack robustness for resolving inter-ordinal divergences, and the resulting topologies are more consistent with earlier morphological hypotheses of raptor unity than with molecular phylogenies.

(2) Do fossil taxa have a significant impact on the topology, potentially reconciling morphological and molecular signals? Fossil inclusion significantly influenced topologies, in some cases improving congruence with molecular expectations. For example, fossil intermediates such as Zygodactylidae and Psittacopedidae supported the monophyly of Psittacopasseres, in line with molecular studies. At the same time, the placement of other fossil groups such as Vastanavidae, Halcyornithidae, and Messelasturidae remained unstable, at times reinforcing and at times conflicting with molecular topologies. Overall, fossils enhanced phylogenetic signal and highlighted transitions otherwise invisible in extant-only analyses.

(3) What does phylogenetic analysis of morphological data, constrained by a molecular backbone topology, suggest about the affinities of extinct groups? When constrained by a molecular scaffold, the analyses stabilized the placement of several fossils, notably Zygodactylidae, Psittacopedidae, and Eofringillirostrum as stem-Passeriformes. Other groups, however, such as Vastanavidae, Halcyornithidae, and Messelasturidae exhibited variable affinities, underscoring both the phylogenetic uncertainty of these lineages and the complexity of character mosaics in Paleogene birds. These outcomes highlight the value of integrating molecular scaffolds with morphological matrices in clarifying fossil affinities.

4.1 Discrepancy between intra- and inter-clade relationships

The phylogenetic analyses conducted in this study reveal significant incongruence between morphological and molecular data, particularly in resolving deep, inter-ordinal relationships within Telluraves. The morphological data successfully recovered many of the intra-clade relationships within orders, including within Accipitriformes, Falconiformes, Psittaciformes, and Passeriformes, with topologies closely mirroring those from molecular studies (e.g., Fuchs *et al.* 2015; Mindell *et al.* 2018; Oliveros *et al.* 2019; Smith *et al.* 2022). At deeper nodes, such as the relationships between Afroaves (Accipitriformes + Strigiformes + Coraciimorphae) and Australaves (Cariamiformes + Falconiformes + Psittaciformes + Passeriformes), morphological analyses fail to consistently recover molecularly supported clades. Instead, Analysis 1 (extant taxa only) united Accipitriformes, Strigiformes, and Falconiformes into a "raptorial" clade, a grouping not supported by molecular phylogenies (Prum *et al.* 2015; Stiller *et al.* 2024), reflecting convergent evolution driven by similar predatory lifestyles despite their independent evolution. Additionally, Passeriformes and Picodynatornithes are recovered as sister groups likely due to their convergent adaptations to perching and grasping as both exploit similar ecological niches, as noted in Mayr (2015b). This discrepancy is further highlighted by low consistency and variable support values, indicating that homoplasy significantly impacts morphological reconstructions at

deeper phylogenetic levels. The congruence within orders suggests that morphological characters are phylogenetically informative at shallower taxonomic levels where homoplasy is less prevalent, and character states are more likely to reflect shared ancestry.

The inclusion of fossil taxa provides additional signal, aligning some morphological results more closely with molecular hypotheses. In Analysis 2 the monophyly of groups like Psittacopasseres (Psittaciformes + Passeriformes), align more closely with with molecular hypotheses. Fossils such as within Zygodactylidae and Psittacopedidae provided morphological intermediates that help support the monophyly of Psittacopasseres. These taxa confirm the zygodactyl foot as a plesiomorphic condition for passerines, supporting a secondary reversal to anisodactyly (e.g., Ksepka *et al*. 2017). Applying molecular constraints in Analysis 3 (Prum *et al.* 2015; Stiller *et al.* 2024) revealed the variable certainty in fossil placements compared to previous studies. Some fossil taxa, such as Zygodactylidae, Psittacopedidae, and *Eofrinigillirostrum* increased in certainty as they were consistently recovered as stem Passeriformes across all constrained and unconstrained analyses. Conversely, Vastanvidae, Halcyornithidae, and Messelasturidae exhibited greater uncertainty. These groups, traditionally resolved as pan-Psittaciformes, are variably placed as sister to Strigiformes or basal to Strigiformes/Coraciimorphae under constrained and unconstrained analyses presented here.

The impact of fossils on phylogenetic inference has been the subject of long-standing interest. Patterson (1981) emphasized that fragmentary and homoplastic fossil data could destabilize higher-level topologies, while Gauthier *et al.* (1988) argued that fossils are essential for rooting character transformations and understanding deep-time evolutionary transitions. In studies that include molecular data, the incorporation of fossils has been shown to have a positive effect on the inference of modes of macroevolution, ancestral character states and patterns of speciation and extinction (Slater *et al.* 2012; Puttick 2016). Recent studies have demonstrated that incorporating fossil taxa into morphological matrices influences phylogenetic results in a manner distinct from simply increasing extant taxon sampling, an effect attributed to the unique character combinations often preserved in fossils (Koch & Parry 2020; Mongiardino Koch *et al.*

2021). Taken together with the results presented here, this underscores that while morphological data can provide strong phylogenetic signal at shallower taxonomic levels, the inclusion of fossils is crucial for bridging morphological gaps, refining hypotheses of trait evolution, and contextualizing conflicts between morphological and molecular evidence in Telluraves.

4.2 Convergent raptoriality in Telluraves

Given that most early-diverging living groups of Telluraves are “raptorial”, whether that resulted from a single origin (e.g., Jarvis *et al.* 2014; Prum *et al.* 2015) or multiple origins (e.g., Hackett *et al*. 2008; Stiller *et al.* 2024), large phylogenomic studies have led to the conclusion that the common ancestor of Telluraves may have been “raptorial” or at least an “apex predator” (Jarvis *et al.* 2014; Prum *et al.* 2015). A molecular phyloecological study by Wu *et al.* (2021) showed that specific fat digestion and absorption for carnivory evolved independently three times in Telluraves, supporting the hypothesis that the presence of carnivory in telluravian ancestry, but also that carnivory is more widespread than in the traditionally “raptorial” groups, as it is also present in some Passeriformes such as Laniidae (shrikes) or in many Eucavitaves such as Bucorvidae (ground hornbills). Much of the apparent disagreement stems from the inconsistent use of the term “raptorial” in molecular studies. The bird groups that typically are identified as being “raptorial” today (Accipitriformes, Strigiformes, Falconiformes) possess a suite of derived features that make them well-suited to a specific predatory lifestyle of catching prey with their feet and only represent a subset of all carnivorous birds.

A ”raptorial” Telluravian ancestor is not evident when examining morphological data, as demonstrated in the current study, where the distribution of “raptorial” traits, as defined in section 3.2.7, are across Telluraves and not recovered as synapomorphies in ancestral state reconstructions (section 3.42). To further investigate if the most recent common ancestor of Telluraves was raptorial, the ancestral reconstruction analysis was conducted in MESQUITE v. 4beta with the “Trace Character History” option and the ML approach using the Markov k-state

one-parameter (Mk1) evolutionary model. Two functionally important traits were selected: a sharply ventrally hooked beak extending over the mandibular tip (Ch. 4:2) and the presence of a monosulcate hypotarsus (Ch. 463:1), which has a strong form-function relationship with raptorial foot use (Tronrud 2022). Reconstructions were performed under both the "Prum" and "Stiller" constraint topologies. In neither constraint did the Telluraves node show meaningful likelihood support for the raptorial conditions (Fig. 4.1& 4.2). A raptorial-like beak showed low likelihood (25%; Fig. 4.1A & B), while a monosulcate state was essentially unsupported (Fig. 4.2A & B), receiving less than one percent proportional likelihood under either topology. Taken together, these reconstructions indicate that neither a hooked beak nor a monosulcate hypotarsus characterized the common ancestor of Telluraves. Rather, both traits appear to have arisen independently in multiple lineages, which being crown Falconiformes, crown Accipitriformes, stem and crown Strigiformes and Messelasturidae. Interestingly, within Australaves, the likelihood reconstructions reveal a complex pattern of repeated gains and losses of raptorial traits. Within Australaves, the likelihood reconstructions reveal a complex pattern of repeated gains and losses of raptorial traits. The most recent common ancestor of Falconiformes, Psittaciformes and Passeriformes show a relatively high likelihood support for a raptorial-like beak in both constraints, suggesting a reversal to a straight beak morphology in Passeriformes.

A previous study by Tronrud (2022) concluded that the perching ability is likely ancestral for Telluraves, marking a shift from the predominantly terrestrial ecologies to a predominantly arboreal ecology. However, in this study the most recent common ancestor of Telluraves is reconstructed with an asulcate hypotarsus a morphology associated with more generalised or terrestrial locomotion observed in stem and crown Cathartiformes and Cariamiformes (Fig. 4.2). This suggests that early Telluraves may have combined arboreal habits with a plesiomorphic, ground-associated hypotarsal condition, highlighting an ecological transition zone at the base of the clade and underscoring a deep ecological split from the mainly terrestrial Aequorlitornithes and Gruiformes. Further study will be needed in-order to test this.

Finally, although “raptorial” traits, including foot-use traits, evolved independently within these lineages, carnivory per se could still have been present in the Telluraves ancestor even if the diagnostic raptorial morphologies were not.

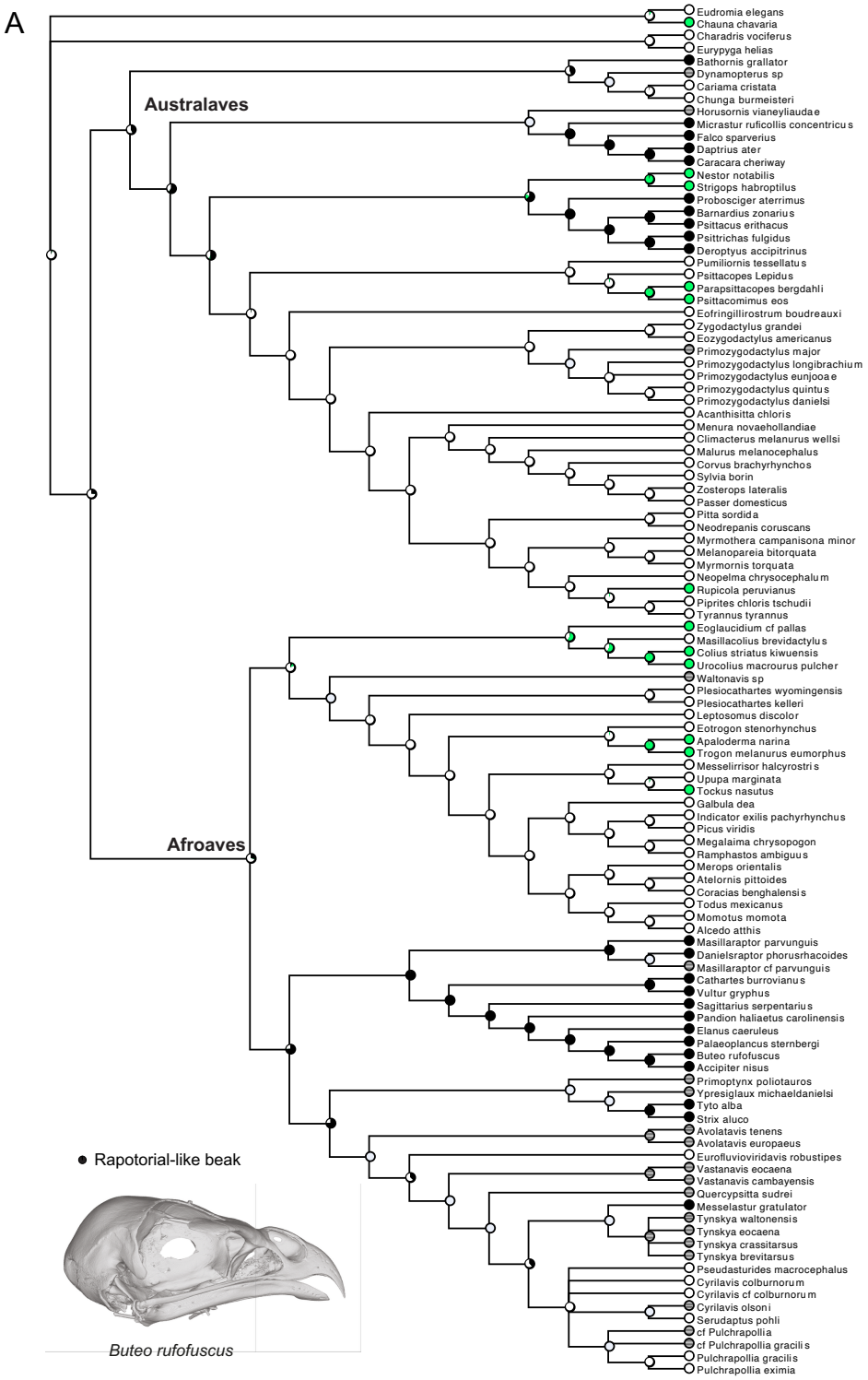


Figure 4.1. Mk1 likelihood optimisation of ancestral state for beak curvature (straight, white; decurved, green; raptorial-like, black). (A) Stiller et al. constraint enforced; (B) Prum et al constraint enforced.

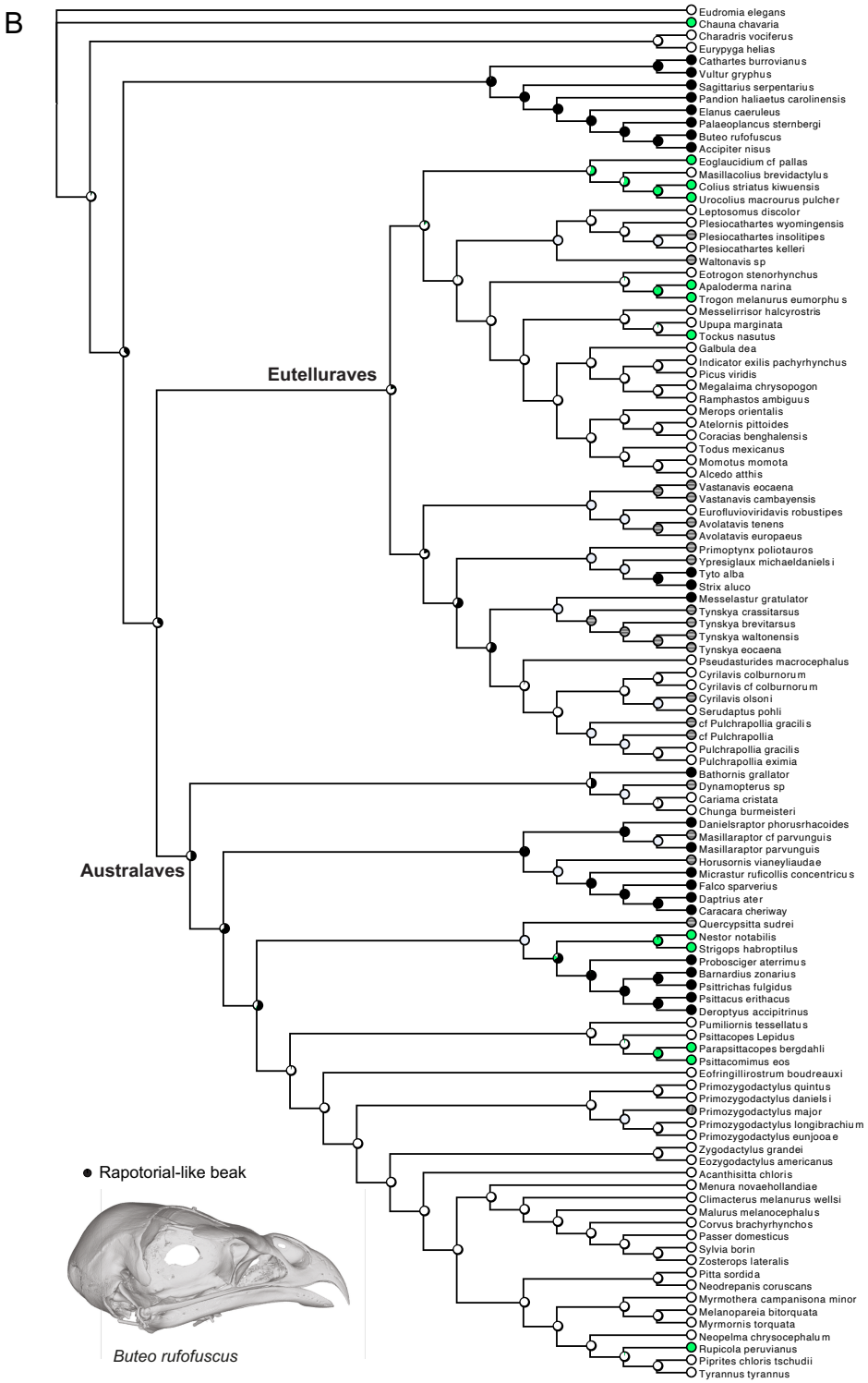


Figure 4.1. (Continued).

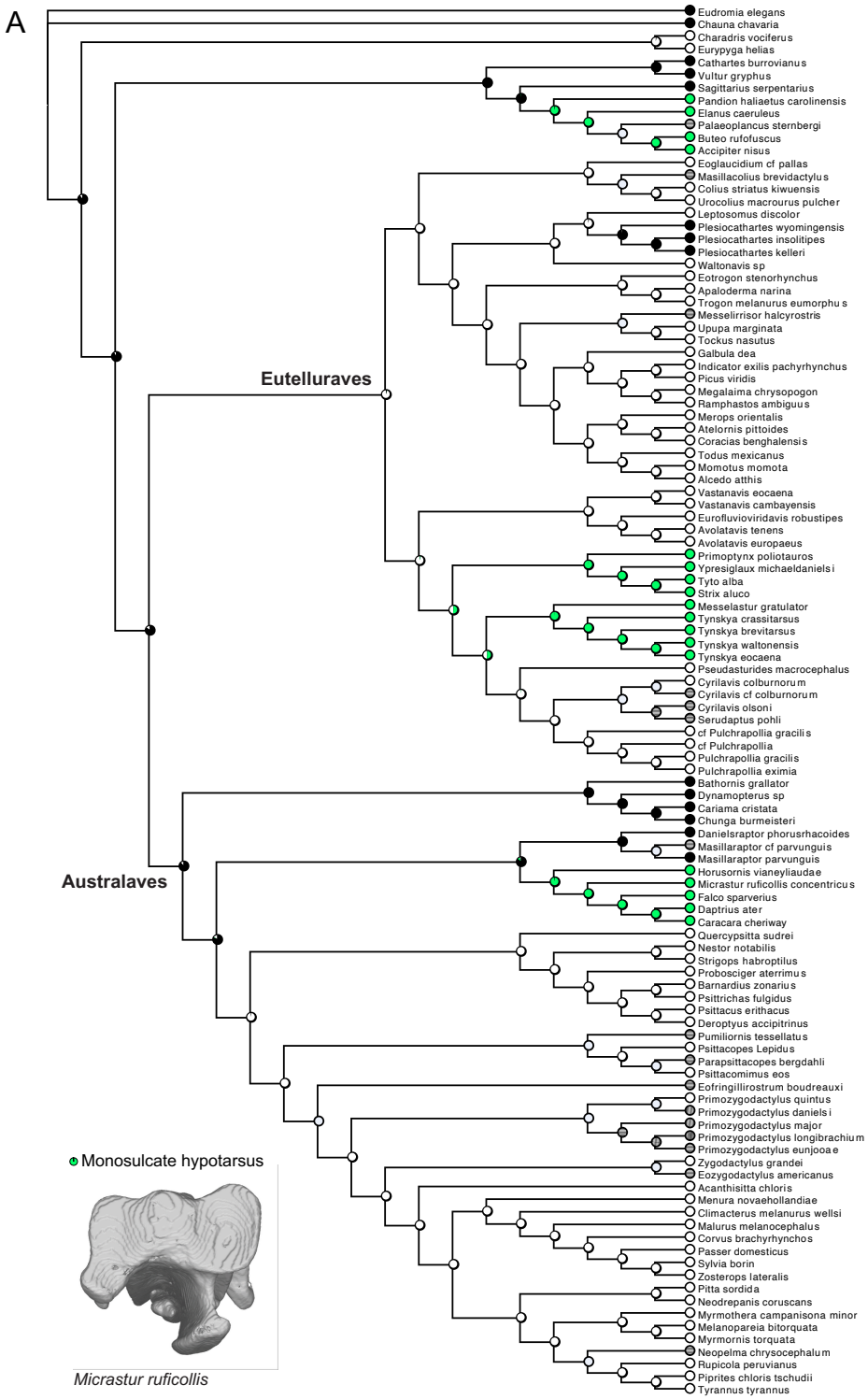


Figure 4.2. Mk1 likelihood optimisation of ancestral state for hypotarsus shape (asulcate, black; monosulcate, green; multisulcate, white). (A) Stiller et al. constraint enforced; (B) Prum et al constraint enforced.

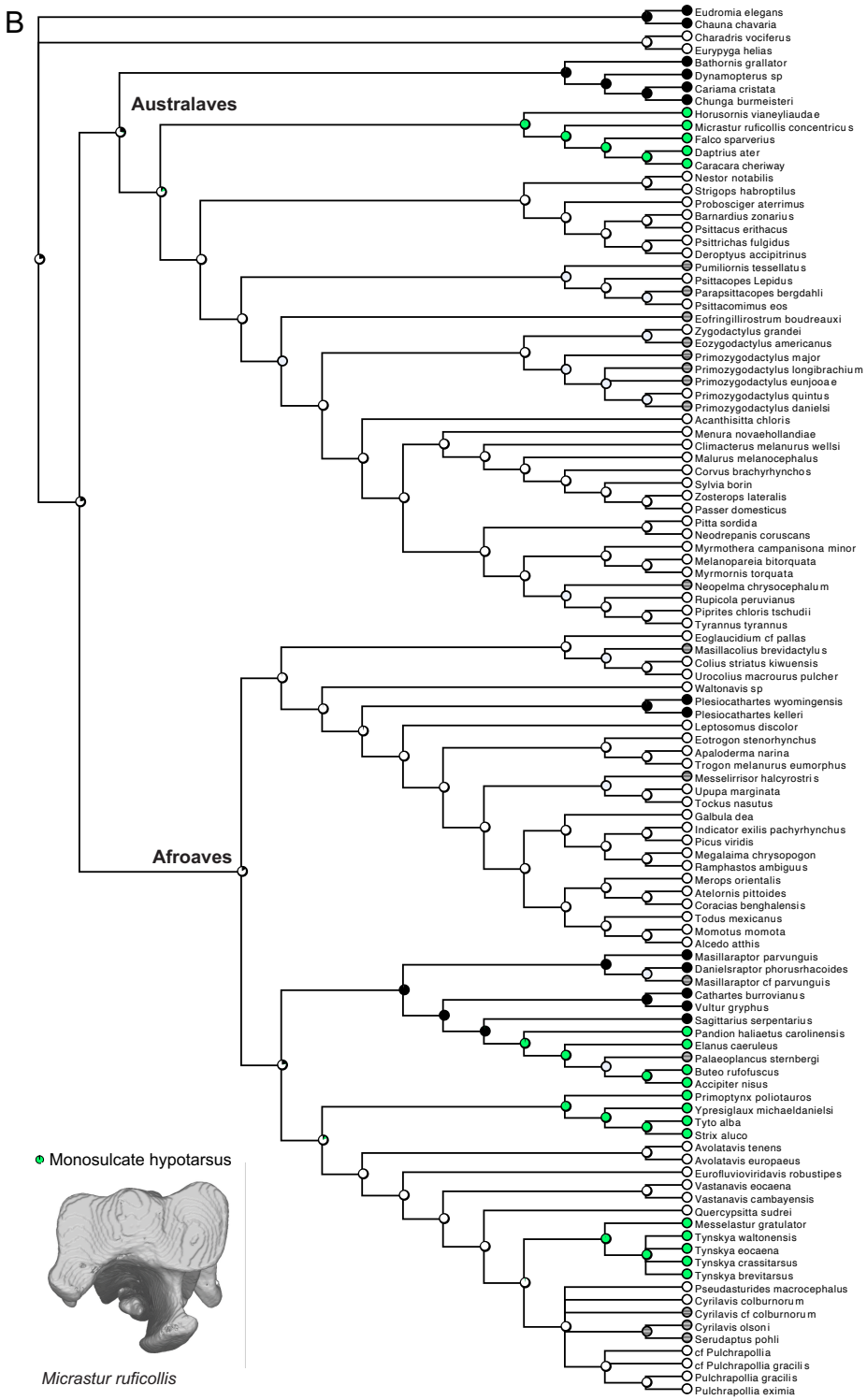


Figure 4.2. (Continued).

4.3 Future considerations

To address the discrepancies observed, future research should expand fossil taxon sampling, particularly for groups like Morsoravidae, to further test the monophyly of Parapasseres, which shifts between monophyletic and paraphyletic in this study and possibly in others (Mayr & Kitchener 2022c).

The discrepancy between the Bayesian and parsimony analyses in this study further illustrates the challenges of resolving Telluravian relationships. This difference may stem from the Bayesian frameworks use of the Mkv model in MrBayes, which accounts for rate heterogeneity and homoplasy more effectively than parsimony, potentially providing a better fit for datasets with missing data (Lewis 2001). For example, the recovery of Vastanavidae, Halcyornithidae, and Messelasturidae as a monophyletic clade basal to Psittaciformes, Coraciimorphae, and Passeriformes, which is more congruent with recent studies on these birds. However, the low posterior probabilities in the constraint analyses also suggest that there is limited phylogenetic signal at deep nodes. Total-evidence dating could provide a more robust framework for modelling character evolution, potentially resolving discrepancies between Bayseian and parsimony results.

Finally, discovering new, well preserved Paleogene birds will be critical for any future studies, potentially filling in morphological gaps and refining Telluravian phylogeny.

REFERENCES

Abouheif, E. 1999. A method for testing the assumption of phylogenetic independence in comparative data, *Evolutionary Ecology Research*, 1: 895-909.

Abourachid, A., A. C. Fabre, R. Cornette, and E. Höfling. 2017. Foot shape in arboreal birds: two morphological patterns for the same pincer-like tool, *Journal of Anatomy*, 231: 1-11.

Acosta Hospitaleche, C. I. A., P. Jadwiszczak, J. A. Clarke, and M. Cenizo. 2019. The fossil record of birds from the James Ross Basin, West Antarctica.

Agnarsson, I., and J. A. Miller. 2008. Is ACCTRAN better than DELTRAN?, *Cladistics*, 24: 1032-38.

Agnolin, F. 2009. Sistemática y filogenia de las aves fororracoideas (Gruiformes: Cariamae), *Fundación de Historia Natural Félix de Azara, Buenos Aires*.

Agnolin, F. L. 2021. Reappraisal on the Phylogenetic Relationships of the Enigmatic Flightless Bird Moreno and Mercerat, 1891, *Diversity-Basel*, 13.

Aires, A. S., L. M. Reichert, R. T. Müller, and M. B. Andrade. 2022. Review of morphology, development, and evolution of the notarium in birds, *The Anatomical Record*, 305: 2079-98.

Aldiss, D. 2012. The stratigraphical framework for the Palaeogene successions of the London Basin, UK.

Alvarenga, H. 2014. South American and Antarctic Continental Cenozoic Birds — Paleobiogeographic Affinities and Disparities.Claudia Tambussi and Federico Degrange . Springer Briefs in Earth Sciences, Dordrecht Heidelberg, Germany, 113 p., ISBN 978-94-007-5466-9, *Ameghiniana*, 51: 266-66.

Alvarenga, H., L. Chiappe, and S. Bertelli. 2011. *Phorusrhacids: the terror birds* (John Wiley & Sons: Chichester).

Alvarenga, H. F. 1985. Notas sobre os Cathartidae (Aves) e descrição de um novo gênero do Cenozóico brasileiro, *Anais da Academia brasileira de Ciências*, 57: 349-57.

Alvarenga, H. M. F., and E. Höfling. 2003. Systematic revision of the Phorusrhacidae (Aves: Ralliformes), *Papéis Avulsos de Zoologia (São Paulo)*.

Ames, P. L. 1971. The morphology of the syrinx in passerine birds, *Peabody Mus. Nat. Hist., Bull.*, 37.

Andors, A. V. 1992. reappraisal of the Eocene groundbird diatryma (Aves: Anserimorphae), *Natural History Museum of Los Angeles County, Science Series*, 36: 109-25.

Andrela, S., and R. Donatelli. 1995. Osteologia e miologia de Columbina squammata (Lesson, 1831)(Aves: Columbiformes), *Naturalia Naturalia, São Paulo*, 20: 107-23.

Andrews, C. W. 1899. On the remains of a new bird from the London Clay of Sheppey. In *Proceedings of the Zoological Society of London*, 776-85. Wiley Online Library.

Ballmann, P. 1969a. *Die vögel aus der altburdigalen Spaltenfüllung von Wintershof (West) bei Eichstätt in Bayern* (Bayer. Staatssamml. für Paläontologie und Historische Geologie).

Ballmann, P. 1969b. Les oiseaux miocènes de La Grive-Saint-Alban (Isère), *Geobios*, 2: 157-204.

Bapst, D. W. 2012. paleotree: an R package for paleontological and phylogenetic analyses of evolution, *Methods in Ecology and Evolution*, 3: 803-07.

Barker, F. K., A. Cibois, P. Schikler, J. Feinstein, and J. Cracraft. 2004. Phylogeny and diversification of the largest avian radiation, *Proceedings of the National Academy of Sciences*, 101: 11040-45.

Barriel, V., and P. Tassy. 1998. Rooting with multiple outgroups: consensus versus parsimony, *Cladistics*, 14: 193-200.

Baumel, J. J., and L. M. Witmer. 1993. Osteologia. in J.J. Baumel, A.S. King and J.C. Vanden Berge (eds.), *Handbook of Avian Anatomy: Nomina Anatomica Avium 2nd ed. Cambridge, Massachusetts: Nuttall Ornithological Society* (Nuttall Ornithological Club: Cambridge, MA).

Beddard, F. E. 1898. *The Structure and Classification of Birds* (Longmans, Green, and Company).

Bell, M. A., and G. T. Lloyd. 2015. strap: an R package for plotting phylogenies against stratigraphy and assessing their stratigraphic congruence. In.: Wiley Online Library.

Berman, S. L., and R. J. Raikow. 1982. The hindlimb musculature of the mousebirds (Coliiformes), *The Auk*, 99: 41-57.

Bertelli, S., B. E. Lindow, G. J. Dyke, and L. M. Chiappe. 2010. A well-preserved 'charadriiform-like'fossil bird from the Early Eocene Fur Formation of Denmark, *Palaeontology*, 53: 507-31.

Bjarnason, A., and R. Benson. 2021. A 3D geometric morphometric dataset quantifying skeletal variation in birds, *MorphoMuseuM*, 7.

Bledsoe, A. H., R. J. Raikow, and A. G. Glasgow. 1993. Evolution and functional significance of tendon ossification in woodcreepers (Aves: Passeriformes: Dendrocolaptinae), *Journal of Morphology*, 215: 289-300.

Bock, W. J. 1964. Kinetics of the avian skull, *Journal of Morphology*, 114: 1-41.

Bock, W. J., and W. D. Miller. 1959. The scansorial foot of the woodpeckers, with comments on the evolution of perching and climbing feet in birds. american museum novitates; no. 1931.

Boles, W. E. 1993. A New Cockatoo (Psittaciformes, Cacatuidae) from the Tertiary of Riversleigh, Northwestern Queensland, and an Evaluation of Rostral Characters in the Systematics of Parrots, *Ibis*, 135: 8-18.

Bortolotti, G. R., K. J. Fernie, and J. E. Smits. 2003. Carotenoid concentration and coloration of American Kestrels (Falco sparverius) disrupted by experimental exposure to PCBs, *Functional Ecology*, 17: 651-57.

Botelho, J. F., D. Smith-Paredes, D. Nuñez-Leon, S. Soto-Acuña, and A. O. Vargas. 2014. The developmental origin of zygodactyl feet and its possible loss in the evolution of Passeriformes, *Proc Biol Sci*, 281: 20140765.

Bourdon, E., A. V. Kristoffersen, and N. Bonde. 2016. A roller-like bird (Coracii) from the Early Eocene of Denmark, *Scientific Reports*, 6.

Brady, P. L., A. Castrellon Arteaga, S. López-Torres, and M. S. Springer. 2024. The effects of ordered multistate morphological characters on phylogenetic analyses of eutherian mammals, *Journal of Mammalian Evolution*, 31: 28.

Brandt, J. 1853. Die Gruppen und Gattungen der Raubvögel Russlands in exomorphischer und craniologischer Beziehung, *Journal für Ornithologie*, 1: 178-95.

Braun, E. L., and R. T. Kimball. 2021. Data Types and the Phylogeny of Neoaves, *Birds*, 2: 1-22.

Brazeau, M. D. 2011. Problematic character coding methods in morphology and their effects, *Biological Journal of the Linnean Society*, 104: 489-98.

Brigandt, I. 2002. Homology and the origin of correspondence, *Biology and Philosophy*, 17: 389-407.

Brodkorb, P. 1967. Catalogue of fossil birds, part 3 (Ralliformes, Ichthyornithiformes, Charadriiformes), *Bulletin of the Florida Museum of Natural History.*, 11: 99-220.

Brodkorb, P. 1971. *Catalogue of fossil birds: Part 4 (Columbiformes through Piciformes)* (University of Florida Gainesville).

Brusaferro, A., and A. M. and Simonetta. 1998. Morphology of the feeding apparatus in nestlings of Merops, *Italian Journal of Zoology*, 65: 249-59.

Burleigh, J. G., R. T. Kimball, and E. L. Braun. 2015. Building the avian tree of life using a large-scale, sparse supermatrix, *Molecular Phylogenetics and Evolution*, 84: 53-63.

Burmeister, H. 1854. *Beiträge zur Naturgeschichte der Seriema: Skelets des Dicholophus cristatus mit dem Skelettypus der Raubvögel, Trappen, Hühner von CL Nitzsch, hg. von H. Burmeister. Mit 2 Tafeln* (Schmidt).

Burt, W. H. 1930. Adaptive modifications in the woodpeckers, *Univ. Calif. Pub. Zool.*, 32: 455-524.

Cabanis, J. L. 1847. *Ornithologische Notizen: I und II*.

Campbell Jr, K. E., and E. P. Tonni. 1983. Size and locomotion in teratorns (Aves: Teratornithidae), *The Auk*, 100: 390-403.

Catanach, T. A., M. R. Halley, and S. Pirro. 2024. Enigmas no longer: using ultraconserved elements to place several unusual hawk taxa and address the non-monophyly of the genus Accipiter (Accipitriformes: Accipitridae), *Biological Journal of the Linnean Society*, 144.

Catanach, T. A., M. R. Halley, and S. Pirro. 2025. Enigmas no longer: using ultraconserved elements to place several unusual hawk taxa and address the non-monophyly of the genus Accipiter (Accipitriformes: Accipitridae), *Biological Journal of the Linnean Society*, 144: blae028.

Cenizo, M., J. I. Noriega, and M. A. Reguero. 2016. A stem falconid bird from the Lower Eocene of Antarctica and the early southern radiation of the falcons, *Journal of Ornithology*, 157: 885-94.

Chiappe, L. M., G. Navalón, A. G. Martinelli, W. Nava, and D. J. Field. 2022. Fossil basicranium clarifies the origin of the avian central nervous system and inner ear, *Proceedings of the Royal Society B*, 289: 20221398.

Claramunt, S., and A. Rinderknecht. 2005. A new fossil furnariid from the Pleistocene of Uruguay, with remarks on nasal type, cranial kinetics, and relationships of the extinct genus, *Condor*, 107: 114-27.

Clarke, J. A., D. T. Ksepka, N. A. Smith, and M. A. Norell. 2009. Combined phylogenetic analysis of a new North American fossil species confirms widespread Eocene distribution for stem rollers (Aves, Coracii), *Zoological Journal of the Linnean Society*, 157: 586-611.

Collar, N. 2001. Family Trogonidae (Trogons), *Handbook of the birds of the world*, 6: 80-127.

Collinson, M. E., N. F. Adams, S. R. Manchester, G. W. Stull, F. Herrera, S. Y. Smith, M. J. Andrew, P. Kenrick, and D. Sykes. 2016. X-ray micro-computed tomography (micro-CT) of pyrite-permineralized fruits and seeds from the London Clay Formation (Ypresian) conserved in silicone oil: a critical evaluation, *Botany*, 94: 697-711.

Cracraft, J. 1968. A review of the Bathornithidae (Aves, Gruiformes), with remarks on the relationships of the suborder Cariamae. American Museum novitates; no. 2326.

Cracraft, J. 1971a. The relationships and evolution of the rollers: families Coraciidae, Brachypteraciidae, and Leptosomatidae, *The Auk*, 88: 723-52.

Cracraft, J. 1971b. Systematics and evolution of the Gruiformes (Class Aves). 2, Additional comments on the Bathornithidae, with descriptions of new species. American Museum novitates; no. 2449.

Cracraft, J. 1981. Toward a Phylogenetic Classification of the Recent Birds of the World (Class Aves), *Auk*, 98: 681-714.

Cracraft, J. 1986. The Origin and Early Diversification of Birds, *Paleobiology*, 12: 383-99.

Cracraft, J., and R. O. Prum. 1988. Patterns and processes of diversification: speciation and historical congruence in some Neotropical birds, *Evolution*, 42: 603-20.

Cracraft, J., and P. V. Rich. 1972. The systematics and evolution of the Cathartidae in the Old World Tertiary, *The Condor*, 74: 272-83.

Crouch, N. M. A., K. Ramanauskas, and B. Igic. 2019. Tip-dating and the origin of Telluraves, *Molecular Phylogenetics and Evolution*, 131: 55-63.

Daniels, M. 1995. Untitled report. In *Society of Avian Paleontology and Evolution, information letter n° 9*, edited by C. Mourer-Chauviré.

De Panis, D., S. A. Lambertucci, G. Wiemeyer, H. Dopazo, F. Almeida, C. Mazzoni, M. Gut, I. Gut, and J. Padró. 2021. Mitogenomic analysis of extant condor species provides insight into the molecular evolution of vultures, *Scientific Reports*, 11: 17109.

De Pinna, M. C. 1991. Concepts and tests of homology in the cladistic paradigm, *Cladistics*, 7: 367-94.

Degrange, F., C. Tambussi, K. Moreno, L. Witmer, and S. Wroe. 2010. Mechanical Analysis of Feeding Behavior in the Extinct ‘‘Terror Bird’’Andalgalornis.

Degrange, F. J. 2015. Hind limb morphometry of terror birds (Aves, Cariamiformes, Phorusrhacidae): functional implications for substrate preferences and locomotor lifestyle, *Earth and Environmental Science Transactions of the Royal Society of Edinburgh*, 106: 257-76.

Degrange, F. J. 2020. A Revision of Skull Morphology in Phorusrhacidae (Aves, Cariamiformes), *Journal of Vertebrate Paleontology*, 40.

Degrange, F. J. 2021. A new species of Dryornis (Aves, Cathartiformes) from the Santa Cruz Formation (lower Miocene), Patagonia, Argentina, *Journal of Vertebrate Paleontology*, 41: e2008411.

Degrange, F. J., C. P. Tambussi, M. L. Taglioretti, A. Dondas, and F. Scaglia. 2015. A new Mesembriornithinae (Aves, Phorusrhacidae) provides new insights into the phylogeny and sensory capabilities of terror birds, *Journal of Vertebrate Paleontology*, 35: e912656.

Dickinson, E., M. W. Young, C. J. Kim, M. Hadjiargyrou, and M. C. Granatosky. 2024. The influence of substrate size upon pulling and gripping forces in parrots (Psittaciformes), *Journal of Experimental Biology*, 227.

Donatelli, R. J. 2012. Cranial osteology of meiglyptini (aves: piciformes: picidae), *Anatomy Research International*, 2012: 951836.

Dyke, G. J., and J. H. Cooper. 2000. A new psittaciform bird from the London Clay (Lower Eocene) of England, *Palaeontology*, 43: 271-85.

Einoder, L., and A. Richardson. 2006. An ecomorphological study of the raptorial digital tendon locking mechanism, *Ibis*, 148: 515-25.

Eldredge, N., and J. Cracraft. 1980. Phylogenetic patterns and the evolutinary process, *Method and Theory in Comparative Biology*, 8: 1-349.

Elzanowski, A., and W. E. Boles. 2015. A coraciiform-like bird quadrate from the Early Eocene Tingamarra local fauna of Queensland, Australia, *Emu-Austral Ornithology*, 115: 110-16.

Elzanowski, A., and G. Mayr. 2018. Multiple origins of secondary temporal fenestrae and orbitozygomatic junctions in birds, *Journal of Zoological Systematics and Evolutionary Research*, 56: 248-69.

Ericson, P. G., L. Christidis, A. Cooper, M. Irestedt, J. Jackson, U. S. Johansson, and J. A. Norman. 2002. A Gondwanan origin of passerine birds supported by DNA sequences of the endemic New Zealand wrens, *Proceedings of the Royal Society of London. Series B: Biological Sciences*, 269: 235-41.

Ericson, P. G. P. 1997. Systematic relationships of the palaeogene family Presbyornithidae (Aves: Anseriformes), *Zoological Journal of the Linnean Society*, 121: 429-83.

Ericson, P. G. P., C. L. Anderson, T. Britton, A. Elzanowski, U. S. Johansson, M. Källersjö, J. I. Ohlson, T. J. Parsons, D. Zuccon, and G. Mayr. 2006. Diversification of Neoaves:: integration of molecular sequence data and fossils, *Biology Letters*, 2: 543-U1.

Farris, J. S. 1982. Outgroups and parsimony, *Systematic Zoology*, 31: 328-34.

Farris, J. S. 1989. The retention index and the rescaled consistency index, *Cladistics*, 5: 417-19.

Feduccia, A. 2003. 'Big bang' for tertiary birds?, *Trends in Ecology & Evolution*, 18: 172-76.

Felsenstein, J. 2004. Inferring phylogenies. in, *Inferring phylogenies*.

Ferguson-Lees, J., and D. A. Christie. 2001. *Raptors of the world* (A&C Black).

Field, D. J., A. Bercovici, J. S. Berv, R. Dunn, D. E. Fastovsky, T. R. Lyson, V. Vajda, and J. A. Gauthier. 2018. Early Evolution of Modern Birds Structured by Global Forest Collapse at the End-Cretaceous Mass Extinction, *Current Biology*, 28: 1825-+.

Fischer, K. 1983. Oligostrix rupelensis n. gen., n. sp., eine neue Ureule (Protostrigidae, Strigiformes, Aves) aus dem marinen Mitteloligozän des Weisselsterbeckens bei Leipzig (DDR), *Zeitschrift für geologische Wissenschaften*, 11: 483-87.

Fowler, D. W., E. A. Freedman, and J. B. Scannella. 2009. Predatory functional morphology in raptors: interdigital variation in talon size is related to prey restraint and immobilisation technique, *PLoS One*, 4: e7999.

Frank, T. M., P. Dodson, and B. P. Hedrick. 2022. Form and function in the avian pelvis, *Journal of Morphology*, 283: 875-93.

Friedman, H. 1950. The birds of North and Middle America. Part XI. Cathartidae to Falconidae, *United States Nafional Museum Bullefin*, 50.

Fuchs, J., J. A. Johnson, and D. P. Mindell. 2015. Rapid diversification of falcons (Aves: Falconidae) due to expansion of open habitats in the Late Miocene, *Molecular Phylogenetics and Evolution*, 82: 166-82.

Fürbringer, M. 1888. *Untersuchungen zur Morphologie und Systematik der Vögel: zugleich ein Beitrag zur Anatomie der Stütz-und Bewegungsorgane* (T. van Holkema: Amsterdam).

Gadow, H. 1893. Vogel. II. Systematischer Theil, *Bronn's Klassen und Ordnungen des Their-Reichs*, 6.

Gaillard, C. 1908. *Les oiseaux des phosphorites du Quercy* (A. Rey).

Gaillard, C. 1939. Contribution à l'étude des oiseaux fossiles, *Publications du musée des Confluences*, 15: 1-100.

Garrod, A. H. 1874. On Certain Muscles of the Thigh of Birds and on Their Value in Classification, *Part II. Zoological Society of London*, 42: 111-23.

Garrod, A. H. 1875. On the disposition of the deep plantar tendons in different birds. In.: Zoological Society of London.

Gatesy, J., and M. S. Springer. 2022. Phylogenomic coalescent analyses of avian retroelements infer zero-length branches at the base of neoaves, emergent support for controversial clades, and ancient introgressive hybridization in afroaves, *Genes*, 13: 1167.

Gauthier, J. 1986. Saurischian monophyly and the origin of birds, *Memoirs of the California Academy of sciences*, 8: 1-55.

Gauthier, J., A. G. Kluge, and T. Rowe. 1988. AMNIOTE PHYLOGENY AND THE IMPORTANCE OF FOSSILS, *Cladistics*, 4: 105-209.

George, J. C., and A. J. Berger. 1966a. Avian myology, *(No Title)*.

George, J. C., and A. J. Berger. 1966b. *Avian myology [by] J.C. George [and] A.J. Berger* (Academic Press: New York).

Goldman, N., J. P. Anderson, and A. G. Rodrigo. 2000. Likelihood-based tests of topologies in phylogenetics, *Systematic Biology*, 49: 652-70.

Goloboff, P. A., and M. E. Morales. 2023. TNT version 1.6, with a graphical interface for MacOS and Linux, including new routines in parallel, *Cladistics*, 39: 144-53.

Gómez, R. O., and J. Lois-Milevicich. 2024. Comparative osteology of the skull of cowbirds (Icteridae: Molothrus), *Journal of Morphology*, 285: e21752.

Goslow, G. E. 1972. Adaptive mechanisms of the raptor pelvic limb, *The Auk*, 89: 47-64.

Graham, S. W., R. G. Olmstead, and S. C. Barrett. 2002. Rooting phylogenetic trees with distant outgroups: a case study from the commelinoid monocots, *Molecular Biology and Evolution*, 19: 1769-81.

Grande, L. 2013. *The lost world of fossil lake: snapshots from deep time* (University of Chicago Press).

Grein, M., T. Utescher, V. Wilde, and A. Roth-Nebelsick. 2011. Reconstruction of the middle Eocene climate of Messel using palaeobotanical data, *Neues Jahrbuch Fur Geologie Und Palaontologie-Abhandlungen*, 260: 305.

Griffiths, C. S., G. F. Barrowclough, J. G. Groth, and L. Mertz. 2004. Phylogeny of the Falconidae (Aves): a comparison of the efficacy of morphological, mitochondrial, and nuclear data, *Molecular Phylogenetics and Evolution*, 32: 101-09.

Griffiths, C. S., G. F. Barrowclough, J. G. Groth, and L. A. Mertz. 2007. Phylogeny, diversity, and classification of the Accipitridae based on DNA sequences of the RAG-1 exon, *Journal of Avian Biology*, 38: 587-602.

Gussekloo, S. W., and R. G. Bout. 2005. Cranial kinesis in palaeognathous birds, *Journal of Experimental Biology*, 208: 3409-19.

Hackett, S. J., R. T. Kimball, S. Reddy, R. C. K. Bowie, E. L. Braun, M. J. Braun, J. L. Chojnowski, et al. 2008. A phylogenomic study of birds reveals their evolutionary history, *Science*, 320: 1763-68.

Harrison, C., and C. Walker. 1976. Birds of the British upper Eocene, *Zoological Journal of the Linnean Society*, 59: 323-51.

Harrison, C., and C. Walker. 1979. Birds of the British Middle Eocene, *Tert Res Spec Pap 5*: 19-27.

Harrison, C. J. O. 1982. A new tiny raptor from the Lower Eocene of England, *ARDEA*, 70: 22-80.

Harrison, C. J. O. 1984. Further additions to the fossil birds of Sheppey: A new falconid and three small rails.

Hertel, F. 1995. Ecomorphological Indicators of Feeding Behavior in Recent and Fossil Raptors, *The Auk*, 112: 890-903.

Hieronymus, T. L. 2015. Qualitative skeletal correlates of wing shape in extant birds (Aves: Neoaves), *Bmc Evolutionary Biology*, 15: 1-12.

Hieronymus, T. L., D. A. Waugh, and J. A. Clarke. 2019. A new zygodactylid species indicates the persistence of stem passerines into the early Oligocene in North America, *Bmc Evolutionary Biology*, 19.

Höfling, E., and A. Abourachid. 2021. The skin of birds' feet: morphological adaptations of the plantar surface, *Journal of Morphology*, 282: 88-97.

Höfling, E., and H. M. Alvarenga. 2001. Osteology of the shoulder girdle in the Piciformes, Passeriformes and related groups of birds, *Zoologischer Anzeiger-A Journal of Comparative Zoology*, 240: 196-208.

Houde, P., and S. L. Olson. 1992. A radiation of coly-like birds from the Eocene of North America (Aves: Sandcoleiformes new order), *Natural History Museum of Los Angeles County, Science Series*.

Huelsenbeck, J. P., and F. Ronquist. 2001. MRBAYES: Bayesian inference of phylogenetic trees, *Bioinformatics*, 17: 754-55.

Hughes, J. M. 2000. Monophyly and phylogeny of cuckoos (Aves, Cuculidae) inferred from osteological characters, *Zoological Journal of the Linnean Society*, 130: 263-307.

Hutchinson, J. R. 2001. The evolution of femoral osteology and soft tissues on the line to extant birds (Neornithes), *Zoological Journal of the Linnean Society*, 131: 169-97.

Huxley, T. H. 1867. On the classification of birds and on the taxonomic value of the modifications of certain of the cranial bones observable in the class, *Proceedings of the Zoological Society of London.*

James, H. F. 2009. Repeated evolution of fused thoracic vertebrae in songbirds, *The Auk*, 126: 862-72.

Jarvis, E. D., S. Mirarab, A. J. Aberer, B. Li, P. Houde, C. Li, S. Y. W. Ho, et al. 2014. Whole-genome analyses resolve early branches in the tree of life of modern birds, *Science*, 346: 1320-31.

Jollie, M. 1976. A contribution to the morphology and phylogeny of the Falconiformes, *Evolutionary Theory*, 1 285-98.

Jollie, M. 1977. A contribution to the morphology and phylogeny of the Falconiformes, *Evolutionary Theory*, 2: 115-208.

Jung, J. Y., A. Pissarenko, A. A. Trikanad, D. Restrepo, F. Y. Su, A. Marquez, D. Gonzalez, S. E. Naleway, P. Zavattieri, and J. McKittrick. 2019. A Natural Stress Deflector on the Head? Mechanical and Functional Evaluation of the Woodpecker Skull Bones, *Advanced Theory and Simulations*, 2.

Kelber, A. 2022. Falconiformes Sensory Systems. in Jennifer Vonk and Todd K. Shackelford (eds.), *Encyclopedia of Animal Cognition and Behavior* (Springer International Publishing: Cham).

Kesel, A. B., F. Hoffmann, A. Baars, and L. Danter. 2019. Flow phenomena in the falcon nose–an interpretation approach. In *Conference: Bionik: Patente aus der Natur. Bremen, Germany*, 224-27.

Kessler, J. E. 2018. Evolution and presence of diurnal predatory birds in the Carpathian Basin, *Ornis Hungarica*, 26: 102-23.

Kimball, R. T., C. H. Oliveros, N. Wang, N. D. White, F. K. Barker, D. J. Field, D. T. Ksepka, et al. 2019. A Phylogenomic Supertree of Birds, *Diversity-Basel*, 11.

Kimball, R. T., N. Wang, V. Heimer-McGinn, C. Ferguson, and E. L. Braun. 2013. Identifying localized biases in large datasets: A case study using the avian tree of life, *Molecular Phylogenetics and Evolution*, 69: 1021-32.

Kishino, H., and M. Hasegawa. 1989. Evaluation of the maximum likelihood estimate of the evolutionary tree topologies from DNA sequence data, and the branching order in Hominoidea, *Journal of molecular evolution*, 29: 170-79.

Kluge, A. G., and J. S. Farris. 1969. Quantitative phyletics and the evolution of anurans, *Systematic Biology*, 18: 1-32.

Koch, N. M., and L. A. Parry. 2020. Death is on Our Side: Paleontological Data Drastically Modify Phylogenetic Hypotheses, *Systematic Biology*, 69: 1052-67.

Korzun, L. P., C. Érard, and J.-P. Gasc. 2004. Morphofunctional study of the bill and hyoid apparatus of Momotus momota (Aves, Coraciiformes, Momotidae): implications for omnivorous feeding adaptation in motmots, *Comptes Rendus Biologies*, 327: 319-33.

Kristoffersen, A. V. 2002. An early Paleogene trogon (Aves: Trogoniformes) from the Fur Formation, Denmark, *Journal of Vertebrate Paleontology*, 22: 661-66.

Ksepka, D. T., and J. A. Clarke. 2009a. Affinities of and the Phylogeny and Biogeography of Mousebirds (Coliiformes), *Auk*, 126: 245-59.

Ksepka, D. T., and J. A. Clarke. 2009b. Affinities of Palaeospiza bella and the phylogeny and biogeography of mousebirds (Coliiformes), *The Auk*, 126: 245-59.

Ksepka, D. T., and J. A. Clarke. 2010. New fossil mousebird (Aves: Coliiformes) with feather preservation provides insight into the ecological diversity of an Eocene North American avifauna, *Zoological Journal of the Linnean Society*, 160: 685-706.

Ksepka, D. T., and J. A. Clarke. 2012. A New Stem Parrot from the Green River Formation and the Complex Evolution of the Grasping Foot in Pan-Psittaciformes, *Journal of Vertebrate Paleontology*, 32: 395-406.

Ksepka, D. T., J. A. Clarke, and L. Grande. 2011. Stem parrots (Aves, Halcyornithidae) from the Green River Formation and a combined phylogeny of Pan-Psittaciformes, *Journal of Paleontology*, 85: 835-52.

Ksepka, D. T., L. Grande, and G. Mayr. 2019. Oldest Finch-Beaked Birds Reveal Parallel Ecological Radiations in the Earliest Evolution of Passerines, *Current Biology*, 29: 657-+.

Ksepka, D. T., T. A. Stidham, and T. E. Williamson. 2017. Early Paleocene landbird supports rapid phylogenetic and morphological diversification of crown birds after the K-Pg mass extinction, *Proc Natl Acad Sci U S A*, 114: 8047-52.

Kuhl, H., C. Frankl-Vilches, A. Bakker, G. Mayr, G. Nikolaus, S. T. Boerno, S. Klages, B. Timmermann, and M. Gahr. 2021. An Unbiased Molecular Approach Using 3′-UTRs Resolves the Avian Family-Level Tree of Life, *Molecular Biology and Evolution*, 38: 108-27.

Kuritzin, A., T. Kischka, J. Schmitz, and G. Churakov. 2016. Incomplete lineage sorting and hybridization statistics for large-scale retroposon insertion data, *PLoS Computational Biology*, 12: e1004812.

LaBarge, T. W., J. D. Gardner, and C. L. Organ. 2024. The evolution and ecology of gigantism in terror birds (Aves, Phorusrhacidae), *Proceedings of the Royal Society B: Biological Sciences*, 291: 20240235.

Legendre, S., B. Marandat, B. Sigé, J.-Y. Crochet, M. Godinot, and J.-L. Hartenberger. 1992. La faune de mammifères de Vielase (phosphorites du Quercy, Sud de la France). Preuve paléontologique d'une karstification du Quercy dès l'Eocène inférieur, *Neues Jahrbuch für Geologie und Paläontologie. Monatshefte*: 414-28.

Lenz, O. K., V. Wilde, D. F. Mertz, and W. Riegel. 2015. New palynology-based astronomical and revised 40 Ar/39 Ar ages for the Eocene maar lake of Messel (Germany), *International Journal of Earth Sciences*, 104: 873-89.

Lepage, T., D. Bryant, H. Philippe, and N. Lartillot. 2007. A general comparison of relaxed molecular clock models, *Molecular Biology and Evolution*, 24: 2669-80.

Lewis, P. O. 2001. A Likelihood Approach to Estimating Phylogeny from Discrete Morphological Character Data, *Systematic Biology*, 50: 913-25.

Liang, X., M. Liu, C. Ying, and Z. Zhang. 2022. Myological variation in the hindlimb of three raptorial birds in relation to foraging behavior, *Avian Research*, 13: 100053.

Ligon, J. D. 1967. Relationships of the cathartid vultures.

Lindow, B. E. K., and G. J. Dyke. 2006. Bird evolution in the Eocene: climate change in Europe and a Danish fossil fauna, *Biological Reviews*, 81: 483-99.

Liu, Y., S. Liu, C. F. Yeh, N. Zhang, G. Chen, P. Que, L. Dong, and S. H. Li. 2018. The first set of universal nuclear protein-coding loci markers for avian phylogenetic and population genetic studies, *Sci Rep*, 8: 15723.

Livezey, B. C. 1998. A phylogenetic analysis of the Gruiformes (Aves) based on morphological characters, with an emphasis on the rails (Rallidae), *Philosophical Transactions of the Royal Society B-Biological Sciences*, 353: 2077-151.

Livezey, B. C., and R. L. Zusi. 1990. Phylogeny of the Neornithes: Relationships of the modern birds, *Smithsonian Contributions to Zoology*, 495: 1-99.

Livezey, B. C., and R. L. Zusi. 2001. Higher-order phylogenetics of modern Aves based on comparative anatomy, *Netherlands Journal of Zoology*, 51.

Livezey, B. C., and R. L. Zusi. 2006. Higher-order phylogeny of modern birds (Theropoda, Aves: Neornithes) based on comparative anatomy: I. – Methods and characters., *Bulletin of the Carnegie Museum of Natural History*, 37: 1-556.

Livezey, B. C., and R. L. Zusi. 2007. Higher-order phylogeny of modern birds (Theropoda, Aves: Neornithes) based on comparative anatomy.: II.: Analysis and discussion, *Zoological Journal of the Linnean Society*, 149: 1-95.

Lo Coco, G. E., M. J. Motta, M. C. Mosto, and M. B. Picasso. 2020. Wing and tail myology of Tyto furcata (Aves, Tytonidae), *Journal of Morphology*, 281: 450-64.

Lowi-Merri, T. M., R. B. Benson, S. Claramunt, and D. C. Evans. 2021. The relationship between sternum variation and mode of locomotion in birds, *BMC Biology*, 19: 1-23.

Lyons-Weiler, J., G. A. Hoelzer, and R. J. Tausch. 1998. Optimal outgroup analysis, *Biological Journal of the Linnean Society*, 64: 493-511.

Maddison, W., and D. Maddison. 2007. Mesquite 2, *A modular system for evolutionary analysis*, 3.

Manegold, A. 2005. Zur Phylogenie und Evolution der "Racken"-, Specht-und Sperlingsvögel ("Coraciiformes", Piciformes und Passeriformes: Aves), *Vogelwarte*: 273.

Manegold, A. 2008. Passerine diversity in the late Oligocene of Germany: earliest evidence for the sympatric coexistence of Suboscines and Oscines, *Ibis*, 150: 377-87.

Mather, E. K., M. S. Lee, A. B. Camens, and T. H. Worthy. 2022. An exceptional partial skeleton of a new basal raptor (Aves: Accipitridae) from the late Oligocene Namba formation, South Australia, *Historical Biology*, 34: 1175-207.

Maurer, D. 1981. Appendicular myology, phylogeny, and classification of the avian order Coraciiformes (including Trogoniformes).

Mayr, E., and D. Amadon. 1951. A classification of recent birds, *American Museum Novitates*, 1496: 1-42.

Mayr, G. 1998a. *" Coraciiforme" und" piciforme" Kleinvögel aus dem Mittel-Eozän der Grube Messel (Hessen, Deutschland)* (Senckenbergische Naturforschende Gesellschaft).

Mayr, G. 1998b. A new family of Eocene zygodactyl birds, *Palaeobiodiversity and Palaeoenvironments*, 78: 199-209.

Mayr, G. 1999. Pumiliornis tessellatus n. gen. n. sp., a new enigmatic bird from the Middle Eocene of Grube Messel (Hessen, Germany), *COURIER-FORSCHUNGSINSTITUT SENCKENBERG*: 75-84.

Mayr, G. 2000a. New or previously unrecorded avian taxa from the Middle Eocene of Messel (Hessen, Germany), *Fossil Record*, 3: 207-19.

Mayr, G. 2000b. A new raptor-like bird from the Lower Eocene of North America and Europe, *Senckenbergiana lethaea*, 80: 59-65.

Mayr, G. 2000c. A remarkable new 'gruiform'bird from the Middle Eocene of Messel (Hessen, Germany), *Paläontologische Zeitschrift*, 74: 187-94.

Mayr, G. 2000d. Tiny hoopoe-like birds from the Middle Eocene of Messel (Germany), *The Auk*, 117: 964-70.

Mayr, G. 2002a. A new species of Plesiocathartes (Aves:? Leptosomidae) from the middle Eocene of Messel, Germany, *PaleoBios*, 22: 10-20.

Mayr, G. 2002b. On the osteology and phylogenetic affinities of the Pseudasturidae - Lower Eocene stem-group representatives of parrots (Aves, Psittaciformes), *Zoological Journal of the Linnean Society*, 136: 715-29.

Mayr, G. 2004. The phylogenetic relationships of the early Tertiary Primoscenidae and Sylphornithidae and the sister taxon of crown group piciform birds, *Journal of Ornithology*, 145: 188-98.

Mayr, G. 2005a. A Fluvioviridavis-like bird from the Middle Eocene of Messel, Germany, *Canadian Journal of Earth Sciences*, 42: 2021-37.

Mayr, G. 2005b. The postcranial osteology and phylogenetic position of the middle Eocene Peters, 1994 : A morphological link between owls (Strigiformes) and falconiform birds?, *Journal of Vertebrate Paleontology*, 25: 635-45.

Mayr, G. 2005c. New trogons from the early Tertiary of Germany, *Ibis*, 147: 512-18.

Mayr, G. 2005d. Old World phorusrhacids, *Aves, Phorusrhacidae): a new look at Strigogyps ("Aenigmavis") sapea*: 11-16.

Mayr, G. 2006a. A new raptorial bird from the Middle Eocene of Messel, Germany, *Historical Biology*, 18: 99-106.

Mayr, G. 2006b. New specimens of the Eocene Messelirrisoridae (Aves: Bucerotes), with comments on the preservation of uropygial gland waxes in fossil birds from Messel and the phylogenetic affinities of Bucerotes, *Palaeontologische Zeitschrift*, 80: 390-405.

Mayr, G. 2006c. An osprey (Aves: Accipitridae: Pandioninae) from the early Oligocene of Germany, *Senckenbergiana lethaea*, 86: 93-96.

Mayr, G. 2007. The renaissance of avian paleontology and its bearing on the higher-level phylogeny of birds, *Journal of Ornithology*, 148: S455-S58.

Mayr, G. 2008a. Avian higher-level phylogeny: well-supported clades and what we can learn from a phylogenetic analysis of 2954 morphological characters, *Journal of Zoological Systematics and Evolutionary Research*, 46: 63-72.

Mayr, G. 2008b. Phylogenetic affinities of the enigmatic avian taxon Zygodactylus based on new material from the early Oligocene of France, *Journal of Systematic Palaeontology*, 6: 333-44.

Mayr, G. 2008c. Pumiliornis tessellatus Mayr, 1999 revisited—new data on the osteology and possible phylogenetic affinities of an enigmatic Middle Eocene bird, *Paläontologische Zeitschrift*, 82: 247-53.

Mayr, G. 2008d. A skull of the giant bony-toothed bird Dasornis (Aves: Pelagornithidae) from the lower Eocene of the Isle of Sheppey, *Palaeontology*, 51: 1107-16.

Mayr, G. 2009a. *Paleogene Fossil Birds* (Springer: Berlin/Heidelberg, Germany).

Mayr, G. 2009b. A well-preserved second trogon skeleton (Aves, Trogonidae) from the middle Eocene of Messel, Germany, *Palaeobiodiversity and Palaeoenvironments*, 89: 1-6.

Mayr, G. 2009c. A well-preserved skull of the "falconiform" bird Masillaraptor from the middle Eocene of Messel (Germany), *Palaeodiversity*, 2: 315-20.

Mayr, G. 2010. Mousebirds (Coliiformes), parrots (Psittaciformes), and other small birds from the late Oligocene/early Miocene of the Mainz Basin, Germany, *Neues Jahrbuch Fur Geologie Und Palaontologie-Abhandlungen*: 129-44.

Mayr, G. 2011a. Metaves, Mirandornithes, Strisores and other novelties – a critical review of the higher-level phylogeny of neornithine birds, *Journal of Zoological Systematics and Evolutionary Research*, 49: 58-76.

Mayr, G. 2011b. Two-phase extinction of "Southern Hemispheric" birds in the Cenozoic of Europe and the origin of the Neotropic avifauna, *Palaeobiodiversity and Palaeoenvironments*, 91: 325-33.

Mayr, G. 2011c. Well-preserved new skeleton of the Middle Eocene Messelastur substantiates sister group relationship between Messelasturidae and Halcyornithidae (Aves, ?Pan-Psittaciformes), *Journal of Systematic Palaeontology*, 9: 159-71.

Mayr, G. 2013. Late Oligocene mousebird converges on parrots in skull morphology, *Ibis*, 155: 384-96.

Mayr, G. 2014. Comparative morphology of the radial carpal bone of neornithine birds and the phylogenetic significance of character variation, *Zoomorphology*, 133: 425-34.

Mayr, G. 2015a. A new specimen of the Early Eocene Masillacolius brevidactylus and its implications for the evolution of feeding specializations in mousebirds (Coliiformes), *Comptes Rendus Palevol*, 14: 363-70.

Mayr, G. 2015b. A reassessment of Eocene parrotlike fossils indicates a previously undetected radiation of zygodactyl stem group representatives of passerines (Passeriformes), *Zoologica Scripta*, 44: 587-602.

Mayr, G. 2016a. Osteology and phylogenetic affinities of the middle Eocene North American Bathornis grallator-one of the best represented, albeit least known Paleogene cariamiform birds (seriemas and allies), *Journal of Paleontology*, 90: 357-74.

Mayr, G. 2016b. Variations in the hypotarsus morphology of birds and their evolutionary significance, *Acta Zoologica*, 97: 196-210.

Mayr, G. 2016c. The world's smallest owl, the earliest unambiguous charadriiform bird, and other avian remains from the early Eocene Nanjemoy Formation of Virginia (USA), *Palz*, 90: 747-63.

Mayr, G. 2017a. *Avian Evolution: The Fossil Record of Birds and Its Paleobiological Significance* (Wiley Blackwell).

Mayr, G. 2017b. New species of Primozygodactylus from Messel and the ecomorphology and evolutionary significance of early Eocene zygodactylid birds (Aves, Zygodactylidae), *Historical Biology*, 29: 875-84.

Mayr, G. 2018. New data on the anatomy and palaeobiology of sandcoleid mousebirds (Aves, Coliiformes) from the early Eocene of Messel, *Palaeobiodiversity and Palaeoenvironments*, 98: 639-51.

Mayr, G. 2019. The otic region of the skull of neognathous birds: on the homology and comparative morphology of some neurovascular and muscular foramina and other external skeletal structures, *Vertebrate Zoology*, 70: 69-85.

Mayr, G. 2020a. Comparative morphology of the avian maxillary bone (os maxillare) based on an examination of macerated juvenile skeletons, *Acta Zoologica*, 101: 24-38.

Mayr, G. 2020b. A remarkably complete skeleton from the London Clay provides insights into the morphology and diversity of early Eocene zygodactyl near-passerine birds, *Journal of Systematic Palaeontology*, 18: 1891-906.

Mayr, G. 2020c. An updated review of the middle Eocene avifauna from the Geiseltal (Germany), with comments on the unusual taphonomy of some bird remains, *Geobios*, 62: 45-59.

Mayr, G. 2021a. The coracoscapular joint of neornithine birds—extensive homoplasy in a widely neglected articular surface of the avian pectoral girdle and its possible functional correlates, *Zoomorphology*, 140: 217-28.

Mayr, G. 2021b. On the occurrence of lateral openings and fossae (pleurocoels) in the thoracic vertebrae of neornithine birds and their functional significance, *Vertebrate Zoology*, 71: 453-63.

Mayr, G. 2021c. A partial skeleton of a new species of Mayr, 2000 (Aves, Messelasturidae) from the London Clay highlights the osteological distinctness of a poorly known early Eocene "owl/parrot mosaic", *Palz*, 95: 337-57.

Mayr, G. 2021d. A partial skeleton of a new species of Tynskya Mayr, 2000 (Aves, Messelasturidae) from the London Clay highlights the osteological distinctness of a poorly known early Eocene “owl/parrot mosaic”, *Palz*, 95: 337-57.

Mayr, G. 2022a. *Paleogene Fossil Birds* (Springer International Publishing).

Mayr, G. 2022b. A partial skeleton of from the early Eocene London Clay reveals derived features of bee-eaters (Meropidae) in a putative stem group roller (Aves, Coracii), *Palaeobiodiversity and Palaeoenvironments*, 102: 449-63.

Mayr, G. 2022c. A survey of the uncinate bone and other poorly known ossicles associated with the lacrimal/ectethmoid complex of the avian skull, *The Anatomical Record*, 305: 2312-30.

Mayr, G., and J. Clarke. 2003. The deep divergences of neornithine birds: a phylogenetic analysis of morphological characters, *Cladistics*, 19: 527-53.

Mayr, G., and M. Daniels. 1998. Eocene parrots from Messel (Hessen, Germany) and the London Clay of Walton-on-the-Naze (Essex, England), *Palaeobiodiversity and Palaeoenvironments*, 78: 157-77.

Mayr, G., V. De Pietri, and R. Paul Scofield. 2022. New bird remains from the early Eocene Nanjemoy Formation of Virginia (USA), including the first records of the Messelasturidae, Psittacopedidae, and Zygodactylidae from the Fisher/Sullivan site, *Historical Biology*, 34: 322-34.

Mayr, G., V. L. De Pietri, and A. C. Kitchener. 2023. Narrow-beaked trogons from the early Eocene London Clay of Walton-on-the-Naze (Essex, UK), *Journal of Ornithology*, 164: 749-64.

Mayr, G., P. D. Gingerich, and T. Smith. 2020. Skeleton of a new owl from the early Eocene of North America (Aves, Strigiformes) with an accipitrid-like foot morphology, *Journal of Vertebrate Paleontology*, 40: e1769116.

Mayr, G., and J. Hurum. 2020. A tiny, long-legged raptor from the early Oligocene of Poland may be the earliest bird-eating diurnal bird of prey, *The Science of Nature*, 107: 48.

Mayr, G., and A. C. Kitchener. 2022a. New fossils from the London Clay show that the Eocene Masillaraptoridae are stem group representatives of falcons (Aves, Falconiformes), *Journal of Vertebrate Paleontology*, 41.

Mayr, G., and A. C. Kitchener. 2022b. New species from the early Eocene London Clay suggest an undetected early Eocene diversity of the Leptosomiformes, an avian clade that includes a living fossil from Madagascar, *Palaeobiodiversity and Palaeoenvironments*, 103: 585-608.

Mayr, G., and A. C. Kitchener. 2022c. Psittacopedids and zygodactylids: The diverse and species-rich psittacopasserine birds from the early Eocene London Clay of Walton-on-the-Naze (Essex, UK), *Historical Biology*, 35: 2372-95.

Mayr, G., and A. C. Kitchener. 2023. Early Eocene fossil illuminates the ancestral (diurnal) ecomorphology of owls and documents a mosaic evolution of the strigiform body plan, *Ibis*, 165: 231-47.

Mayr, G., and A. C. Kitchener. 2023a. The Vastanavidae and Messelasturidae (Aves) from the early Eocene London Clay of Walton-on-the-Naze (Essex, UK), *Neues Jahrbuch Fur Geologie Und Palaontologie-Abhandlungen*, 307: 113-39.

Mayr, G., and A. C. Kitchener. 2023b. A new fossil from the London Clay documents the convergent origin of a “mousebird-like” tarsometatarsus in an early Eocene near-passerine bird, *Acta Palaeontologica Polonica*, 68: 1-11.

Mayr, G., and A. C. Kitchener. 2023c-a. Early Eocene fossil illuminates the ancestral (diurnal) ecomorphology of owls and documents a mosaic evolution of the strigiform body plan, *Ibis*, 165: 231-47.

Mayr, G., and A. C. Kitchener. 2023c-b. Psittacopedids and zygodactylids: The diverse and species-rich psittacopasserine birds from the early Eocene London Clay of Walton-on-the-Naze (Essex, UK), *Historical Biology*, 35: 2372-95.

Mayr, G., and A. C. Kitchener. 2024a. The Halcyornithidae from the early Eocene London Clay of Walton-on-the-Naze (Essex, UK): a species complex of Paleogene arboreal birds, *Geobios*, 83: 45-60.

Mayr, G., and A. C. Kitchener. 2024b. A new mousebird (Aves, Coliiformes) from the early Eocene London Clay of Walton-on-the-Naze (Essex, United Kingdom) constitutes a morphological link between sandcoleids and coliids, *Geodiversitas*, 46: 979-93.

Mayr, G., and A. C. Kitchener. 2024c. The Picocoraciades (hoopoes, rollers, woodpeckers, and allies) from the early Eocene London Clay of Walton-on-the-Naze, *Palz*, 98: 291-312.

Mayr, G., and A. Manegold. 2006. A small suboscine-like passeriform bird from the early Oligocene of France, *The Condor*, 108: 717-20.

Mayr, G., and A. Manegold. 2021. On the comparative morphology of the juvenile avian skull: An assessment of squamosal shape across avian higher-level taxa, *The Anatomical Record*, 304: 845-59.

Mayr, G., A. Manegold, and U. S. Johansson. 2003. Monophyletic groups within 'higher land birds' - comparison of morphological and molecular data, *Journal of Zoological Systematics and Evolutionary Research*, 41: 233-48.

Mayr, G., and C. Mourer-Chauviré. 2004. Unusual tarsometatarsus of a mousebird from the Paleogene of France and the relationships of Selmes Peters, 1999, *Journal of Vertebrate Paleontology*, 24: 366-72.

Mayr, G., C. Mourer-Chauvire, and I. Weidig. 2004. Osteology and systematic position of the eocene primobucconidae (Aves, Coraciiformes), with first records from Europe, *Journal of Systematic Palaeontology*, 2: 1-12.

Mayr, G., and T. Perner. 2020. A new species of diurnal birds of prey from the late Eocene of Wyoming (USA)–one of the earliest New World records of the Accipitridae (hawks, eagles, and allies), *Neues Jahrbuch Fur Geologie Und Palaontologie-Abhandlungen*: 205-15.

Mayr, G., and D. S. Peters. 1998a. Die Mausvögel (Aves: Coliiformes) vom mittleren Eozän der Grube Messel (Hessen, Deutschland), *Senckenbergiana lethaea*, 78: 179-97.

Mayr, G., and D. S. Peters. 1998b. The mousebirds (Aves: Coliiformes) from the Middle Eocene of Grube Messel (Hessen, Germany), *Palaeobiodiversity and Palaeoenvironments*, 78: 179-97.

Mayr, G., R. S. Rana, K. D. Rose, A. Sahni, K. Kumar, L. Singh, and T. Smith. 2010. Quercypsitta-Like Birds from the Early Eocene of India (Aves, ?Psittaciformes), *Journal of Vertebrate Paleontology*, 30: 467-78.

Mayr, G., and S. A. Walsh. 2018. Exceptionally well-preserved early Eocene fossil reveals cranial and vertebral features of a stem group roller (Aves: Coraciiformes), *Palz*, 92: 715-26.

Mayr, G., and V. Wilde. 2014. Eocene fossil is earliest evidence of flower-visiting by birds, *Biology Letters*, 10: 20140223.

McClure, C. J., S. E. Schulwitz, D. L. Anderson, B. W. Robinson, E. K. Mojica, J.-F. Therrien, M. D. Oleyar, and J. Johnson. 2019. Commentary: defining raptors and birds of prey, *Journal of Raptor Research*, 53: 419-30.

McCormack, J. E., M. G. Harvey, B. C. Faircloth, N. G. Crawford, T. C. Glenn, and R. T. Brumfield. 2013. A phylogeny of birds based on over 1,500 loci collected by target enrichment and high-throughput sequencing, *PLoS One*, 8: e54848.

Mckitrick, M. C. 1991. Forelimb Myology of Loons (Gaviiformes), with Comments on the Relationship of Loons and Tubenoses (Procellariiformes), *Zoological Journal of the Linnean Society*, 102: 115-52.

Migotto, R. 2013. Phylogeny of Accipitridae (Aves: Accipitriformes) based on osteological characters, *PhD Dissertation, Universi-dade de São Paulo, Insituto de Biociências, Departmento de Zoologia*.

Miller, A. H., and C. G. Sibley. 1942. An Oligocene hawk from Colorado, *Condor*, 44: 19.

Milne-Edwards A. 1892. Sur les oiseaux fossiles des dépots éocènes de phosphate de chaux du Sud de la France, *C R Second Congr Ornithol Internat*: 60–80.

Mindell, D. P., J. Fuchs, and J. A. Johnson. 2018. Phylogeny, taxonomy, and geographic diversity of diurnal raptors: Falconiformes, Accipitriformes, and Cathartiformes, *Birds of Prey: Biology and conservation in the XXI century*: 3-32.

Mongiardino Koch, N., R. J. Garwood, and L. A. Parry. 2021. Fossils improve phylogenetic analyses of morphological characters, *Proceedings of the Royal Society B: Biological Sciences*, 288: 20210044.

Mourer-Chauvire, C. 1994. A large owl from the Palaeocene of France, *Palaeontology*, 37: 339-48.

Mourer-Chauviré, C. 1981. Première indication de la présence de Phorusracidés, famille d'oiseaux géants d'Amérique du Sud, dans le Tertiaire européen: Ameghinornis nov. gen.(Aves, Ralliformes) des Phosphorites du Quercy, France, *Geobios*, 14: 637-47.

Mourer-Chauviré, C. 1987. Les Strigiformes (Aves) des Phosphorites du Quercy (France): systématique, biostratigraphie et paléobiogéographie, *Travaux et Documents des Laboratoires de Géologie de Lyon*, 99: 89-135.

Mourer-Chauviré, C. 1991. Les Horusornithidae nov. fam., Accipitriformes (Aves) a articulation intertarsienne hyperflexible de l'Eocene du Quercy, *Geobios*, 24: 183-92.

Mourer-Chauviré, C. 1992. Une nouvelle famille de perroquets (Aves, Psittaciformes) dans l'Éocène supérieur des Phosphorites du Quercy, France, *Geobios*, 25: 169-77.

Mourer-Chauviré, C. 2002. Revision of the Cathartidae (Aves, Ciconiiformes) from the Middle Eocene to the Upper Oligocene Phosphorites du Quercy, France. In *Proceedings of the 5th symposium of the Society of Avian Paleontology and Evolution, Beijing, 1–4 June 2000*, 97-111. Science Press.

Mourer-Chauviré, C. 2006. The avifauna of the Eocene and Oligocene Phosphorites du Quercy (France): an updated list, *Strata. Série 1: Communications*, 13: 135-49.

Mourer-Chauviré, C. 2013. Idiornis Oberholser, 1899 (Aves, Gruiformes, Cariamae, Idiornithidae): a junior synonym of Dynamopterus Milne-Edwards, 1892 (Paleogene, Phosphorites du Quercy, France), *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, 270: 13-22.

Mourer-Chauviré, C., L. G. Marshall, C. de Muizon, and B. Sigé. 1983. *Les Gruiformes (Aves) Des Phosphorites Du Quercy (France): 1, Sous-ordre Cariamae (Cariamidae Et Phorusrhacidae): Systématique Et Biostratigraphie* (" Palæovertebrata).

Mourer-Chauviré, C., M. Pickford, and B. Senut. 2015. Stem group galliform and stem group psittaciform birds (Aves, Galliformes, Paraortygidae, and Psittaciformes, family incertae sedis) from the Middle Eocene of Namibia, *Journal of Ornithology*, 156: 275-86.

Mourer-Chauviré, C., and R. W. Shufeldt. 1983. Minerva antiqua (Aves, Strigiformes), an owl mistaken for an edentate mammal. American Museum novitates; no. 2773.

Musser, G., and J. A. Clarke. 2020. An exceptionally preserved specimen from the Green River Formation elucidates complex phenotypic evolution in Gruiformes and Charadriiformes, *Frontiers in Ecology and Evolution*, 8: 559929.

Musser, G. M., and J. Cracraft. 2019. A new morphological dataset reveals a novel relationship for the adzebills of New Zealand (Aptornis) and provides a foundation for total evidence neoavian phylogenetics, *American Museum Novitates*, 2019: 1-70.

Nixon, K. C., and J. M. Carpenter. 1993. On outgroups, *Cladistics*, 9: 413-26.

Nixon, K. C., and J. M. Carpenter. 1996. On simultaneous analysis, *Cladistics*, 12: 221-41.

Oliveros, C. H., D. J. Field, D. T. Ksepka, F. K. Barker, A. Aleixo, M. J. Andersen, P. Alström, et al. 2019. Earth history and the passerine superradiation, *Proc Natl Acad Sci U S A*, 116: 7916-25.

Olsen, S. J. 1985. The fossil record of the birds. in J. R. King D. S. Farner, & K. C. Parkes (ed.), *Avian Biology* (Academic Press).

Opaev, A. S. 2022. The Communicative Value of Complex Singing in Passerine Birds, *Biology Bulletin*, 49: 1750-68.

Pacheco, M. A., F. U. Battistuzzi, M. Lentino, R. F. Aguilar, S. Kumar, and A. A. Escalante. 2011. Evolution of modern birds revealed by mitogenomics: timing the radiation and origin of major orders, *Molecular Biology and Evolution*, 28: 1927-42.

Pascotto, M. C., and R. J. Donatelli. 2003. Cranial osteology in momotidae (Aves: Coraciiformes), *Journal of Morphology*, 258: 32-48.

Pascotto, M. C., E. Höfling, and R. J. Donatelli. 2006. Osteologia craniana de Coraciiformes (Aves), *Revista Brasileira de Zoologia*, 23: 841-64.

Patterson, C. 1981. Significance of Fossils in Determining Evolutionary Relationships, *Annual Review of Ecology and Systematics*, 12: 195-223.

Patterson, C. 1982. Morphological characters and homology, *Problems of phylogenetic reconstruction*: 21-74.

Peacock, J., G. M. Spellman, D. J. Field, M. J. Mason, and G. Mayr. 2024. Comparative morphology of the avian bony columella, *The Anatomical Record*, 307: 1735-63.

Peters, D. S. 1992. A new species of owl (Aves: Strigiformes) from the Middle Eocene Messel oil shale, *Natural History Museum of Los Angeles County Science Series*, 36: 161-69.

Peters, D. S. 1994. Messelastur gratulator n. gen. n. spec., ein Greifvogel aus der Grube Messel (Aves: Accipitridae), *Courier Forschungsinstitut Senckenberg*, 170: 3-9.

Pimentcl, R. A., and R. Riggins. 1987. The nature of cladistic data, *Cladistics*, 3: 201-09.

Plateau, O., and C. Foth. 2021. Common patterns of skull bone fusion and their potential to discriminate different ontogenetic stages in extant birds, *Frontiers in Ecology and Evolution*, 9: 737199.

Platnick, N. I. 1979. Philosophy and the transformation of cladistics, *Systematic Zoology*, 28: 537-46.

Pleijel, P. 1995. On character coding for phylogenetic analysis, *Cladistics*, 11: 309-15.

Prager, E. M., and A. C. Wilson. 1988. Ancient origin of lactalbumin from lysozyme: analysis of DNA and amino acid sequences, *Journal of molecular evolution*, 27: 326-35.

Prum, R. O., J. S. Berv, A. Dornburg, D. J. Field, J. P. Townsend, E. M. Lemmon, and A. R. Lemmon. 2015. A comprehensive phylogeny of birds (Aves) using targeted next-generation DNA sequencing, *Nature*, 526: 569-73.

Puttick, M. N. 2016. Partially incorrect fossil data augment analyses of discrete trait evolution in living species, *Biology Letters*, 12: 20160392.

Pyle, P. 2013. Evolutionary implications of synapomorphic wing-molt sequences among falcons (Falconiformes) and parrots (Psittaciformes), *The Condor*, 115: 593-602.

Pyron, R. A. 2017. Novel approaches for phylogenetic inference from morphological data and total-evidence dating in squamate reptiles (lizards, snakes, and amphisbaenians), *Systematic Biology*, 66: 38-56.

Qian, W., Z. Zhonghe, and L. Zhiheng. 2024. A secondary endochondral ossification centre in the furcula of extant birds and its significance for the evolution of the neornithine acrocoracoclavicular joint, *Historical Biology*: 1-10.

Rack, P., and H. Ross. 1984. The tendon of flexor pollicis longus: its effects on the muscular control of force and position at the human thumb, *The Journal of physiology*, 351: 99-110.

Raikow, R. J. 1978. Functional morphology and the evolution of the avian hand, *Ornithological Monographs*, 26: 1-92.

Rasmussen, D. T., S. L. Olson, and E. L. Simons. 1987. Fossil birds from the Oligocene Jebel Qatrani formation Fayum Province, Egypt.

Razmadze, D., A. A. Panyutina, and N. V. Zelenkov. 2018. Anatomy of the forelimb musculature and ligaments of Psittacus erithacus (Aves: Psittaciformes), *Journal of Anatomy*, 233: 496-530.

Reddy, S., R. T. Kimball, A. Pandey, P. A. Hosner, M. J. Braun, S. J. Hackett, K. L. Han, et al. 2017. Why Do Phylogenomic Data Sets Yield Conflicting Trees? Data Type Influences the Avian Tree of Life more than Taxon Sampling, *Systematic Biology*, 66: 857-79.

Redford, K. H., and G. Peters. 1986. eastern Bolivia, and south to Uruguay, Paraguay, and the Argentinian provinces of San Luis, La Pampa, and Entre Rios (Blake 1977, Frieling 1936). Indeed, the Red-legged Seriema is one of the most frequently seen large birds in central Brazil where KHR spent 2 yrs. It is even more frequently heard than seen because its loud distinctive songs carry for, *J. Field Ornithol*, 57: 261-69.

Riamon, S., N. Tourment, and A. Louchart. 2020. The earliest Tyrannida (Aves, Passeriformes), from the Oligocene of France, *Scientific Reports*, 10.

Rich, P. V., and D. J. Bohaska. 1981. The Ogygoptyngidae, a new family of owls from the Paleocene of North America, *Alcheringa*, 5: 95-102.

Ronquist, F., S. Klopfstein, L. Vilhelmsen, S. Schulmeister, D. L. Murray, and A. P. Rasnitsyn. 2012. A total-evidence approach to dating with fossils, applied to the early radiation of the Hymenoptera, *Systematic Biology*, 61: 973-99.

Ronquist, F., M. Teslenko, P. van der Mark, D. L. Ayres, A. Darling, S. Höhna, B. Larget, L. Liu, M. A. Suchard, and J. P. Huelsenbeck. 2012. MrBayes 3.2: Efficient Bayesian Phylogenetic Inference and Model Choice Across a Large Model Space, *Systematic Biology*, 61: 539-42.

Salter, J. F., C. H. Oliveros, P. A. Hosner, J. D. Manthey, M. B. Robbins, R. G. Moyle, R. T. Brumfield, and B. C. Faircloth. 2020. Extensive paraphyly in the typical owl family (Strigidae), *The Auk*, 137: ukz070.

Sangster, G., E. L. Braun, U. S. Johansson, R. T. Kimball, G. Mayr, and A. Suh. 2022. Phylogenetic definitions for 25 higher-level clade names of birds, *Avian Research*, 13.

Shimodaira, H., and M. Hasegawa. 1999. Multiple comparisons of log-likelihoods with applications to phylogenetic inference, *Molecular Biology and Evolution*, 16: 1114.

Sibley, C. G., and J. E. Ahlquist. 1972. A comparative study of the egg-white proteins of non-passerine birds, *Bulletin of the Peabody Museum of Natural History*, 39.

Sibley, C. G., and J. E. Ahlquist. 1990. *Phylogeny and Classification of Birds: A Study in Molecular Evolution* (Yale University Press).

Simões, T. R., M. W. Caldwell, and S. E. Pierce. 2020. Sphenodontian phylogeny and the impact of model choice in Bayesian morphological clock estimates of divergence times and evolutionary rates, *BMC Biology*, 18: 191.

Slater, G. J., L. J. Harmon, and M. E. Alfaro. 2012. INTEGRATING FOSSILS WITH MOLECULAR PHYLOGENIES IMPROVES INFERENCE OF TRAIT EVOLUTION, *Evolution*, 66: 3931-44.

Smith, A. B. 1994. Rooting molecular trees: problems and strategies, *Biological Journal of the Linnean Society*, 51: 279-92.

Smith, B. T., J. Merwin, K. L. Provost, G. Thom, R. T. Brumfield, M. Ferreira, W. M. Mauck, III, R. G. Moyle, T. F. Wright, and L. Joseph. 2022. Phylogenomic Analysis of the Parrots of the World Distinguishes Artifactual from Biological Sources of Gene Tree Discordance, *Systematic Biology*, 72: 228-41.

Smith, K. T., S. Schaal, and J. Habersetzer. 2018. Messel: an ancient greenhouse ecosystem, *(No Title)*.

Smith, M. E., B. Singer, and A. Carroll. 2003. 40Ar/39Ar geochronology of the Eocene Green River Formation, Wyoming, *Geological Society of America Bulletin*, 115: 549-65.

Smith, N. A., A. M. DeBee, and J. A. Clarke. 2018. Systematics and phylogeny of the Zygodactylidae (Ayes, Neognathae) with description of a new species from the early Eocene of Wyoming, USA, *Peerj*, 6.

Smith, N. D. 2010. Phylogenetic analysis of Pelecaniformes (Aves) based on osteological data: implications for waterbird phylogeny and fossil calibration studies, *PLoS One*, 5: e13354.

Springer, M. S., and J. Gatesy. 2024. A new phylogeny for Aves is compromised by pervasive misalignment and homology problems, *Proceedings of the National Academy of Sciences of the United States of America*, 121.

Steell, E. M., J. M. T. Nguyen, R. B. J. Benson, and D. J. Field. 2023. Comparative anatomy of the passerine carpometacarpus helps illuminate the early fossil record of crown Passeriformes, *Journal of Anatomy*, 242: 495-509.

Stegmann, B. 1965. Funktionell bedingte eigenheiten am metacarpus des vogelflügels, *Journal für Ornithologie*, 106: 179-89.

Stegmann, B. 1978. The avian skeleton and its phylogenetic implications, *Proceedings of the International Symposium on Evolution and Systematics of Birds*: 123-34.

Stephan, B. 1992. Vorkommen und Ausbildung der Fingerkrallen bei rezenten Vögeln, *Journal für Ornithologie*, 133: 251-77.

Stiller, J., S. H. Feng, A. Chowdhury, I. Rivas-González, D. A. Duchêne, Q. Fang, Y. Deng, et al. 2024. Complexity of avian evolution revealed by family-level genomes, *Nature*, 629: 851–60.

Stresemann, E. 1959. Vögel und Vogelforschung: Eine Einführung in die Ornithologie, *Springer*.

Strong, E. E., and D. Lipscomb. 1999. Character coding and inapplicable data, *Cladistics*, 15: 363-71.

Suh, A., L. Smeds, and H. Ellegren. 2015. The Dynamics of Incomplete Lineage Sorting across the Ancient Adaptive Radiation of Neoavian Birds, *Plos Biology*, 13.

Sustaita, D. 2008. Musculoskeletal underpinnings to differences in killing behavior between North American accipiters (Falconiformes: Accipitridae) and falcons (Falconidae), *J Morphol*, 269: 283-301.

Sustaita, D., and F. Hertel. 2010. In vivo bite and grip forces, morphology and prey-killing behavior of North American accipiters (Accipitridae) and falcons (Falconidae), *Journal of Experimental Biology*, 213: 2617-28.

Swofford, D. L. 2003. PAUP* 4.0 : Phylogenetic Analysis Using Parsimony. In.

Swofford, D. L., J. L. Thorne, J. Felsenstein, and B. M. Wiegmann. 1996. The topology-dependent permutation test for monophyly does not test for monophyly, *Systematic Biology*, 45: 575-79.

Tada, S., and T. Tsuihiji. 2021. Ossification of the respiratory turbinate in Aves and its implications for non-avian dinosaurs, *Bull. Natl. Mus. Nat. Sci. Ser. C*, 47: 53-59.

Team, R. C. 2021. *R: a language and environment for statistical computing* (R Foundation for Statistical Computing: Vienna, Austria).

Templeton, A. R. 1983. Phylogenetic inference from restriction endonuclease cleavage site maps with particular reference to the evolution of humans and the apes, *Evolution*: 221-44.

Tronrud, B. 2022. Evolution and ecomorphology of the avian foot: the morphology of the tarsometatarsus in birds and its responses to evolutionary changes in foot use, University of Oxford.

Tsang, L. R., L. A. Wilson, J. Ledogar, S. Wroe, M. Attard, and G. Sansalone. 2019. Raptor talon shape and biomechanical performance are controlled by relative prey size but not by allometry, *Scientific Reports*, 9: 7076.

Tucker, V. A. 1998. Gliding flight: speed and acceleration of ideal falcons during diving and pull out, *Journal of Experimental Biology*, 201: 403-14.

Turner, A. H., P. J. Makovicky, and M. A. Norell. 2007. Feather quill knobs in the dinosaur Velociraptor, *Science*, 317: 1721-21.

Verheyen, R. 1956. La mue de la queue chez les Hiboux et les Chouettes (Striges), *Gerfaut*, 46: 121-25.

Vinther, J., D. E. Briggs, J. Clarke, G. Mayr, and R. O. Prum. 2010. Structural coloration in a fossil feather, *Biology Letters*, 6: 128-31.

Wang, L., J. T.-M. Cheung, F. Pu, D. Li, M. Zhang, and Y. Fan. 2011. Why do woodpeckers resist head impact injury: a biomechanical investigation, *PLoS One*, 6: e26490.

Ward, A. B., P. D. Weigl, and R. M. Conroy. 2002. Functional morphology of raptor hindlimbs: Implications for resource partitioning, *Auk*, 119: 1052-63.

Weber, V. E. 1993. Zur Evolution basicranialer Gelenke bei Vögeln, insbesondere bei Hühner- und Entenvögeln (Galloanseres), *Journal of Zoological Systematics and Evolutionary Research*, 31: 300-17.

Weidig, I. 2006. The first new world occurrence of the Eocene bird Plesiocathartes (Aves:? Leptosomidae), *Paläontologische Zeitschrift*, 80: 230-37.

Wein, A., and R. Schwing. 2017. Claws on the wings of kea parrots (Nestor notabilis), *Notornis*, 64: 31-33.

Wertz, K., T. Tomek, and Z. M. Bochenski. 2023. Whose talon is this? A manual for the identification of ungual phalanges of European birds of prey: Falcons and owls, *International Journal of Osteoarchaeology*, 33: 562-76.

Wetmore, A. 1927. Fossil birds from the Oligocene of Colorado, *Proc Colo Mus Nat Hist*, 7: 1-13.

Wetmore, A. 1933a. Fossil bird remains from the Eocene of Wyoming, *The Condor*, 35: 115-18.

Wetmore, A. 1933b. An Oligocene eagle from Wyoming, *Smithsonian Miscellaneous Collections*.

Wetmore, A. 1933c. A second specimen of the fossil bird Bathornis veredus, *The Auk*, 50: 30.

Wetmore, A. 1944. A new terrestrial vulture from the Upper Eocene deposits of Wyoming, *Annals of the Carnegie Museum*, 30: 57-69.

Wetmore, A. 1960. A classification for the birds of the world, *Smithsonian Miscellaneous Collections*, 139: 1-37.

Wetmore, A., and E. C. Case. 1934. A new fossil hawk from the Oligocene beds of South Dakota.

Wiens, J. J. 2000. Coding morphological variation within species and higher taxa for phylogenetic analysis, *Phylogenetic analysis of morphological data*, 115: 45.

Wiens, J. J. 2003. Missing data, incomplete taxa, and phylogenetic accuracy, *Systematic Biology*, 52: 528-38.

Wiley, E. O., and B. S. Lieberman. 2011. *Phylogenetics: theory and practice of phylogenetic systematics* (John Wiley & Sons).

Wilkinson, M. 1992. Ordered versus unordered characters, *Cladistics*, 8: 375-85.

Wilkinson, M. 1995a. A comparison of two methods of character construction, *Cladistics*, 11: 297-308.

Wilkinson, M. 1995b. Coping with abundant missing entries in phylogenetic inference using parsimony, *Systematic Biology*, 44: 501-14.

Worthy, T. H., F. J. Degrange, W. D. Handley, and M. S. Y. Lee. 2017. The evolution of giant flightless birds and novel phylogenetic relationships for extinct fowl (Aves, Galloanseres) (vol 4, 170975, 2017), *Royal Society Open Science*, 4.

Worthy, T. H., S. J. Hand, J. M. Nguyen, A. J. Tennyson, J. P. Worthy, R. P. Scofield, W. E. Boles, and M. Archer. 2010. Biogeographical and phylogenetic implications of an early Miocene wren (Aves: Passeriformes: Acanthisittidae) from New Zealand, *Journal of Vertebrate Paleontology*, 30: 479-98.

Wu, S. Y., F. E. Rheindt, J. Zhang, J. J. Wang, L. Zhang, C. Quan, Z. H. Li, et al. 2024. Genomes, fossils, and the concurrent rise of modern birds and flowering plants in the Late Cretaceous, *Proceedings of the National Academy of Sciences of the United States of America*, 121.

Yuri, T., R. T. Kimball, J. Harshman, R. C. Bowie, M. J. Braun, J. L. Chojnowski, K. L. Han, et al. 2013. Parsimony and model-based analyses of indels in avian nuclear genes reveal congruent and incongruent phylogenetic signals, *Biology (Basel)*, 2: 419-44.

Zelenitsky, D. K., F. Therrien, G. M. Erickson, C. L. DeBuhr, Y. Kobayashi, D. A. Eberth, and F. Hadfield. 2012. Feathered non-avian dinosaurs from North America provide insight into wing origins, *Science*, 338: 510-14.

Zelenkov, N. V., and G. J. Dyke. 2008. The Fossil Record and Evolution of Mousebirds (Aves: Coliiformes), *Palaeontology*, 51: 1403-18.

Zhang, C., T. Stadler, S. Klopfstein, T. A. Heath, and F. Ronquist. 2016. Total-evidence dating under the fossilized birth–death process, *Systematic Biology*, 65: 228-49.

Zusi, R. L. 1959. The Function of the Depressor Mandibulae Muscle in Certain Passerine Birds, *The Auk*, 76: 537-39.

Zusi, R. L. 1984. A functional and evolutionary analysis of rhynchokinesis in birds.

Zusi, R. L. 1993. Patterns of diversity in the avian skull, *The skull*, 2: 391-437.

Zusi, R. L., and B. C. Livezey. 2006. Variation in the os palatinum and its structural relation to the palatum osseum of birds (Aves), *Annals of Carnegie Museum*, 75: 137-80.

Appendix 1 Supplementary tables and figures

Table S1.1 Summary of main phylogenomic studies and hypotheses. ML, maximum likelihood; PP, posterior probability; MRP, matrix representative with parsimony; SH-aLRT, Shimodaira-Hasegawa approximate likelihood ratio test; UCEs, ultra-conserved elements; CEs, conserved elements. Redrawn and modified from Sangster *et al.* (2022).

	Hackett et al. 2008	**McCormack et al. 2013**	**Yuri et al. 2013**	**Jarvis et al. (2014)**	**Prum et al. (2015)**	**Reddy et al. (2017)**	**Kimball et al. (2019)**	**Kuhl et al. (2021)**	**Stiller et al. (2024)**	**Wu et al. (2024)**
Data type(s)	169 taxa, 19 nuclear loci	32 taxa, 1541 UCEs	169 taxa, 19 nuclear loci	48 taxa, 8251 exon loci, 2516 intron loci, 3769 UCEs	198 taxa, 259 nuclear loci	253 taxa, 54 nuclear loci	supertree	3'UTR sequences	118 taxa, 12449 CEs	118 taxa, 12449 CEs
Telluraves	98% ML bootstrap	100% ML bootstrap	100% ML bootstrap	100% ML bootstrap	1.0 PP	>95% ML bootstrap	100% MRP bootstrap	100% (SH-aLRT)	1.0 PP	>90% ML bootstrap
Afroaves	<70% ML bootstrap (not recovered)	not recovered	<50% ML bootstrap	100% ML bootstrap	not recovered	<70% ML bootstrap	100% MRP bootstrap	100% (SH-aLRT)	1.0 PP	not recovered
Coraciimorphae	not recovered	not recovered	54% ML bootstrap (Coliiformes+ Strigiformes)	100% ML bootstrap	1.0 PP	<70% ML bootstrap	72% MRP bootstrap	100% (SH-aLRT)	1.0 PP	>90% ML bootstrap
Cavitaves	85% ML bootstrap	100% ML bootstrap	92% ML bootstrap	100% ML bootstrap	1.0 PP	<70% ML bootstrap	100% MRP bootstrap	100% (SH-aLRT)	1.0 PP	>90% ML bootstrap
Eucavitaves	71% ML bootstrap	>70% ML bootstrap	100% ML bootstrap	72% ML bootstrap	1.0 PP	>95% ML bootstrap	100% MRP bootstrap	100% (SH-aLRT)	1.0 PP	>90% ML bootstrap
Australaves	64% ML bootstrap	53% ML bootstrap (Coliiform+ Australaves)	67% ML bootstrap	100% ML bootstrap	1.0 PP	>95% ML bootstrap	100% MRP bootstrap	100% (SH-aLRT)	1.0 PP	>90% ML bootstrap
Eufalconimorphae	73% ML bootstrap	>70% ML bootstrap	73% ML bootstrap	100% ML bootstrap	1.0 PP	<70% ML bootstrap	100% MRP bootstrap	100% (SH-aLRT)	1.0 PP	>90% ML bootstrap
Psittacopasserae	77% ML bootstrap	>70% ML bootstrap	78% ML bootstrap	100% ML bootstrap	1.0 PP	>95% ML bootstrap	100% MRP bootstrap	100% (SH-aLRT)	1.0 PP	>90% ML bootstrap

Table S1.2 List of extant taxa observed in this thesis.

Order/Family	**Taxon name**	**Common name**	**Specimen no.**	**Morphosource specimen link**
Tinamiformes				
Tinamidae	*Eudromia elegans*	elegant crested tinamou	UMMZ birds 156966	https://www.morphosource.org/concern/biological_specimens/000S26494
Anseriformes				
Anhimidae	*Chauna chavaria*	nothern screamer	OUMNH ZC 23790	https://www.morphosource.org/concern/biological_specimens/000S32663
Eurypygiformes				
Eurypygidae	*Eurypyga helias*	sunbittern	FMNH Birds 317341	https://www.morphosource.org/concern/biological_specimens/000S26516
Charadriformes				
Charadriidae	*Charadrius vociferus*	killdeer	FMNH Birds 470173	https://www.morphosource.org/concern/biological_specimens/000S29876
Opisthocomiformes				
Opisthocomidae	*Opisthocomus hoazin*	hoatzin	NHMUK ZOO S/1961.6.1	https://www.morphosource.org/concern/biological_specimens/000S26438
Accipitriformes				
Cathartidae	*Cathartes burrovianus*	lesser yellow-headed vulture	UMMZ birds 227466	https://www.morphosource.org/concern/biological_specimens/000S30020
Cathartidae	*Vultur gryphus*	Andean condor	NHMUK ZOO S/1955.5.11	https://www.morphosource.org/concern/biological_specimens/000S30006
Sagittariidae	*Sagittarius serpentarius*	secretary bird	NHMUK ZOO 1898.5.7.1	https://www.morphosource.org/concern/biological_specimens/000S26469
Pandionidae	*Pandion haliaetus carolinensis*	osprey	FMNH Birds 437336	https://www.morphosource.org/concern/biological_specimens/000S26547
Accipitridae	*Elanus caeruleus*	black-winged kite	NHMUK ZOO 1850.8.15.159	https://www.morphosource.org/concern/biological_specimens/000S26408
Accipitridae	*Buteo rufofuscus*	jackel buzzard	NHMUK ZOO 1862.1.18.1	https://www.morphosource.org/concern/biological_specimens/000S29906
Accipitridae	*Accipiter nisus*	Eurasian sparrowhawk	NHMUK ZOO S/1982.149.1	https://www.morphosource.org/concern/biological_specimens/000S29927
Strigiformes				
Tytonidae	*Tyto alba*	barn owl	NHMUK ZOO S/1989.22.1	https://www.morphosource.org/concern/biological_specimens/000S30005
Strigidae	*Strix aluco*	tawny owl	NHMUK ZOO S/2001.38.1	https://www.morphosource.org/concern/biological_specimens/000S26463
Coliiformes				
Coliidae	*Colius striatus kiwuensis*	speckled mousebird	FMNH Birds 384817	https://www.morphosource.org/concern/biological_specimens/000S29880
Coliidae	*Urocolius macrourus pulcher*	blue-naped mousebird	FMNH Birds 368959	https://www.morphosource.org/concern/biological_specimens/000S29879
Leptosomiformes				
Leptosomidae	*Leptosomus discolor*	cuckoo-roller	NHMUK ZOO 1968.30.38	https://www.morphosource.org/concern/biological_specimens/000S29899
Trogoniformes				
Trogonidae	*Apaloderma narina*	narina trogon	FMNH Birds 290897	https://www.morphosource.org/concern/biological_specimens/000S29849

Table S1.2. (Continued).

Trogonidae	*Trogon melanurus eumorphus*	black-tailed trogon	FMNH Birds 290496	https //www.morphosource.org/concern/biological_specimens/000S29838
Bucerotiformes				
Upupidae	*Upupa marginata*	Madagascar hoopoe	FMNH Birds 352821	https //www.morphosource.org/concern/biological_specimens/000S29841
Bucerotidae	*Tockus nasutus*	African grey hornbill	NHMUK ZOO S/1989.2.2	https //www.morphosource.org/concern/biological_specimens/000S30002
Coraciiformes				
Meropidae	*Merops orientalis*	Asian green bee-eater	UMMZ Birds 216577	https //www.morphosource.org/concern/biological_specimens/000S29960
Brachypteraciidae	*Atelornis pittoides*	pitta-like ground roller	NHMUK 1870.5.5.10	https //www.morphosource.org/concern/biological_specimens/000S29914
Coraciidae	*Coracias benghalensis*	Indian roller	NHMUK ZOO S/1987.19.15	https //www.morphosource.org/concern/biological_specimens/000S29909
Todidae	*Todus mexicanus*	Puerto Rican tody	FMNH Birds 351174	https //www.morphosource.org/concern/biological_specimens/000S29835
Momotidae	*Momotus momota*	Amazonian motmot	NHMUK ZOO S/2015.23.4	https //www.morphosource.org/concern/biological_specimens/000S26422
Alcedinidae	*Alcedo atthis*	common kingfisher	NHMUK ZOO s/1994.7.1	https //www.morphosource.org/concern/biological_specimens/000S29893
Piciformes				
Galbulidae	*Galbula dea*	paradise jacamar	FMNH Birds 376705	https //www.morphosource.org/concern/biological_specimens/000S26517
Indicartoridae	*Indicator exilis pachyrhynchus*	least honeyguide	FMNH Birds 429726	https //www.morphosource.org/concern/biological_specimens/000S26520
Picidae	*Picus viridis*	European green woodpecker	NHMUK ZOO S/1982.5.1	https //www.morphosource.org/concern/biological_specimens/000S26453
Megalaimidae	*Megalaima chrysopogon*	golden-whiskered barbet	NHMUK ZOO 1850.8.15.28	https //www.morphosource.org/concern/biological_specimens/000S26419
Ramphastidae	*Ramphastos ambiguus*	yellow-throated toucan	NHMUK ZOO S/2002.21.2	https //www.morphosource.org/concern/biological_specimens/000S26462
Cariamiformes				
Cariamidae	*Cariama cristata*	red-legged seriema	FMNH Birds 105635	https //www.morphosource.org/concern/biological_specimens/000S29875
Cariamidae	*Chunga burmeisteri*	black-legged seriema	FMNH Birds 106731	https //www.morphosource.org/concern/biological_specimens/000S32659
Falconiformes				
Herpetotherinae	*Micrastur ruficollis concentricus*	barred forest-falcon	FMNH Birds 330226	https //www.morphosource.org/concern/biological_specimens/000S30016
Falconinae	*Falco sparverius*	American kestrel	UMMZ Birds 154462	https //www.morphosource.org/concern/biological_specimens/000S26495
Polyborinae	*Daptrius ater*	black cararcara	UMMZ Birds 157622	https //www.morphosource.org/concern/biological_specimens/000S32669
Polyborinae	*Caracara cheriway*	crested caracara	UMMZ Birds 133664	https //www.morphosource.org/concern/biological_specimens/000S32664
Psittaciformes				
Strigopidae	*Nestor notabilis*	Kea	FMNH Birds 23530	https //www.morphosource.org/concern/biological_specimens/000S30016
Strigopidae	*Strigops habroptilus*	Kākāpō	NHMUK ZOO 1881.1.17.71	https //www.morphosource.org/concern/biological_specimens/000S30008
Cacatuidae	*Probosciger aterrimus*	palm cockatoo	NHMUK ZOO S/2006.15.5	https //www.morphosource.org/concern/biological_specimens/000S26452
Psittaculidae	*Barnardius zonarius*	Australian ringneck	NHMUK ZOO S/1983.5.1	https //www.morphosource.org/concern/biological_specimens/000S29904

Table S1.2. (Continued).

Psittaculidae	*Psittrichas fulgidus*	Pesquet's parrot	YPM VZ YPM ORN 141821	https //www.morphosource.org/concern/biological_specimens/000S29980
Psittacidae	*Psittacus erithacus*	African grey parrot	NHMUK ZOO S/1992.41.60	https //www.morphosource.org/concern/biological_specimens/000S26459
Psittacidae	*Deroptyus accipitrinus*	red-fan parrot	NHMUK ZOO S/2002.14.2	https //www.morphosource.org/concern/biological_specimens/000S30061
Passeriformes				
Acanthisittidae	*Acanthisitta chloris*	Rifleman	NHMUK ZOO 1940.12.8.146	https //www.morphosource.org/concern/biological_specimens/000S29907
Pittidae	*Pitta sordida*	Western hooded pitta	NHMUK ZOO S/1956.20.14	https //www.morphosource.org/concern/biological_specimens/000S32001
Philepittidae	*Neodrepanis coruscans*	commonsunbird-asity	FMNH Birds 363807	https //www.morphosource.org/concern/biological_specimens/000S26527
Melanopareiidae	*Melanopareia bitorquata*	double-collared crescentchest	FMNH Birds 335140	https //www.morphosource.org/concern/biological_specimens/000S26522
Thamnophilidae	*Myrmornis torquata*	wing-banded antbird	YPM VZ YPM ORN 106157	https //www.morphosource.org/concern/biological_specimens/000S29979
Grallariidae	*Myrmothera campanisona minor*	thrush-like antbird	FMNH Birds 322348	https //www.morphosource.org/concern/biological_specimens/000S26526
Pipridae	*Neopelma chrysocephalum*	saffron-crested tyrant-manakin	YPM VZ YPM ORN 139662	https //www.morphosource.org/concern/biological_specimens/000S29978
Cotingidae	*Rupicola peruvianus*	Andean cock-of-the-rock	UMMZ Birds 119210	https //www.morphosource.org/concern/biological_specimens/000S22572
Tyrannidae	*Piprites chloris tschudii*	wing-barred piprites	FMNH Birds 290398	https //www.morphosource.org/concern/biological_specimens/000S26549
Tyrannidae	*Tyrannus tyrannus*	Eastern kingbird	FMNH Birds 487521	https //www.morphosource.org/concern/biological_specimens/000S29840
Menuridae	*Menura novaehollandiae*	superb lyrebird	FMNH Birds 336751	https //www.morphosource.org/concern/biological_specimens/000S26523
Climacteridae	*Climacteris melanurus wellsi*	black-tailed treecreeper	UMMZ Birds 214303	https //www.morphosource.org/concern/biological_specimens/000S29957
Maluridae	*Malurus melanocephalus*	red-backed fairywren	UMMZ Birds 224775	https //www.morphosource.org/concern/biological_specimens/000S26499
Corvidae	*Corvus brachyrhynchos*	American crow	FMNH Birds 441515	https //www.morphosource.org/concern/biological_specimens/000S29882
Sylviidae	*Sylvia borin*	garden warbler	FMNH Birds 385185	https //www.morphosource.org/concern/biological_specimens/000S29832
Zosteropidae	*Zosterops lateralis*	silvereye	NHMUK ZOO A/2014.12.10	https //www.morphosource.org/concern/biological_specimens/000S29917
Passeridae	*Passer domesticus*	house sparrow	NHMUK ZOO S/1977.70.3	https //www.morphosource.org/concern/biological_specimens/000S29951

Table S1.3. Proportion of missing data scored in the matrix.

		Missing data %		
Genus	**Species**	**Total**	**Cranial**	**Postcranial**
Horusornis	*vianeyliaudae*	72.0	100.0	61.3
Diatropornis	*ellioti*	87.8	100.0	83.2
Palaeoplancus	*sternbergi*	70.4	73.7	69.1
Primoptynx	*poliotauros*	66.7	100.0	54.0
Ypresiglaux	*michaeldanielsi*	50.0	72.4	41.5
Eoglaucidium	*cf. pallas*	50.7	64.5	45.5
Masillacolius	brevidactylus	68.5	77.6	65.1
Plesiocathartes	*insolitipes*	71.1	84.2	66.1
Plesiocathartes	*wyomingensis*	68.4	86.8	61.3
Plesiocathartes	*kelleri*	71.5	77.0	69.3
Waltonavis	*paraleptosomus*	53.6	95.4	37.7
Waltonavis	*danielsi*	53.6	95.4	37.7
Eotrogon	*stenorhynchus*	50.9	71.7	43.0
Messelirrisor	*halcyrostris*	67.5	72.4	65.6
Bathornis	*grallator*	62.9	46.1	69.3
Dynamopterus	*velox*	71.8	100.0	61.1
Dynamopterus	*gallicus*	71.8	100.0	61.1
Dynamopterus	*minor*	71.8	100.0	61.1
Masillaraptor	*parvunguis*	71.1	71.7	70.9
Masillaraptor	*cf. parvunguis*	62.4	100.0	48.0
Danielsraptor	*phorusrhacoides*	56.0	59.2	54.8
Pulchrapollia	*gracilis*	74.5	98.0	65.6
cf. Pulchrapollia		83.6	100.0	77.4
cf. Pulchrapollia	*gracilis*	69.8	100.0	58.3
? Pulchrapollia	*eximia*	53.5	73.0	46.0
Pseudasturides	*macrocephalus*	44.4	55.3	40.2
Cyrilavis	*colburnorum*	38.0	45.4	35.2
Cyrilavis	*colburnorum cf.*	61.1	74.3	56.0
Serudaptus	*pohli*	78.2	69.7	81.4
Messelastur	*gratulator*	51.5	65.1	46.2
Tynskya	*eocaena*	64.7	97.4	52.3
Tynskya	*waltonensis*	63.5	84.2	55.5
Tynskya	*brevitarsus*	77.5	93.4	71.4
Tynskya	*crassitarsus*	74.2	84.9	70.1
Vastanavis	*eocaena*	65.1	100.0	51.8
Vastanavis	*cambayensis*	65.1	100.0	51.8
Avolatavis	*tenens*	77.5	100.0	68.8
Avolatavis	*europaeus*	81.8	100.0	74.9
Eurofluvioviridavis	*robustipes*	69.8	69.1	70.1

Table S1.3. (Continued).

Quercypsitta	*sudrei*	82.2	100.0	75.4
Psittacopes	*lepidus*	57.1	71.7	51.5
Parapsittacopes	*bergdahli*	54.4	44.7	58.0
Psittacomimus	*eos*	55.8	69.1	50.8
Pumiliornis	*tessellatus*	56.5	59.9	55.3
Eofringillirostrum	*boudreauxi*	61.5	56.6	63.3
Zygodactylus	*grandei*	59.6	60.5	59.3
Primozygodactylus	*danielsi*	77.5	60.5	83.9
Primozygodactylus	*major*	85.3	100.0	79.6
Primozygodactylus	*eunjooae*	70.2	57.9	74.9
Primozygodactylus	*quintus*	29.6	42.1	24.9
Primozygodactylus	*longibrachium*	73.6	62.5	77.9
Eozygodactylus	*americanus*	69.1	57.9	73.4

Table S1.4. List of fossil taxa and ages used for tip-calibrations.

Fossil Taxa	Age	Chronostratigraphy	Source
Horusornis vianeyliaudae	37.71-27.3 Ma	Quercy Phosphorites Formation, Boussac, France; late Eocene to early Oligocene (middle-late Eocene)	Mourer-Chauviré (1991)
Diatropornis ellioti	37.71-27.3 Ma	Quercy Phosphorites Formation, France; late Eocene to early Oligocene	Cracraft & Rich (1972); Paleobiodb.org
Palaeoplancus sternbergi	37-33.7 Ma	"Upper Oreodon beds of the Oligocene", Wyoming; this possibly refers to occurrence of the mammal Oreodont fossils found from the late Eocene to early Oligocene and likley found within the White River Formation or White river Group, possibly the Chadronian	Wetmore (1933)
Primoptynx poliotauros	54.5-55 Ma	McCullough Peaks locality, Willwood Formation, Wyoming, U.S.A.; biochron Wa-3 (early Graybullian, early Eocene)	Gingerich (2010); Mayr *et al.* (2020)
Ypresiglaux michaeldanielsi	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K. ; early Ypresian, early Eocene.	Collinson *et al.* (2016); Mayr & Kitchener (2023d)
Eoglaucidium cf. pallas	48.2-47.8 Ma	Messel, Germany; early Eocene. T	Lenz *et al.* (2015); Mayr (2018)
Masillacolius brevidactylus	48.2-47.8 Ma	Messel near Darmstadt, Germany; early Eocene	Lenz *et al.* (2015); Mayr (2015)
Plesiocathartes insolitipes	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Collinson *et al.* (2016); Mayr & Kitchener (2022a)
Plesiocathartes wyomingensis	53.5-48.5 Ma	Green River Formation, Wyoming, USA; early Eocene	Weidig (2006)
Plesiocathartes kelleri	48.2-47.8 Ma	Messel near Darmstadt, Germany; early Eocene (Mp 11)	Mayr (2002b); Lenz *et al.* (2015)
Waltonavis paraleptosomus	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr & Kitchener (2022a); Collinson *et al.* 2016
Waltonavis danielsi & sp.	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr & Kitchener (2022a); Collinson *et al.* 2016
Eotrogon stenorhynchus	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr et al. (2023); Collinson *et al.* 2016
Messelirrisor halcyrostris	48.2-47.8 Ma	Messel, Germany; early Eocene	Mayr (2006a), Lenz *et al.* (2015)

Table S1.4. (Continued).

Bathornis grallator	47.3-46.9 Ma	Sand Wash Basin, Wyoming, locality 196, Washakie Formation, Colorado, USA; late Bridgerian/early Uintan	Mayr (2016a)
Dynamopterus velox ("Idiornis cursor")	27.3-23.04 Ma	Quercy Phosphorites Formation, France; early to late Oligocene, MP 25	Mourer-Chauviré (2013) ; Paleobiodb.org
Dynamopterus gallicus	47.8-33.9 Ma	Quercy Phosphorites Formation, France; middle to late Eocene	Mourer-Chauviré (2006, 2013)
Dynamopterus minor	38-33.9 Ma	Quercy Phosphorites Formation, France; late Eocene	Mourer-Chauviré (2006, 2013)
Masillaraptor parvunguis	48.2-47.8 Ma	Messel near Darmstadt, Germany; middle Eocene (ca. 47 million years ago).	Mayr (2009b)
Masillaraptor cf. parvunguis	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr & Kitchener (2022); Collinson et al. 2016
Danielsraptor phorusrhacoides	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr & Kitchener (2022); Collinson et al. 2016
Pulchrapollia gracilis	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Dyke & Cooper (2000)
cf. Pulchrapollia	53-54 Ma	Fisher/Sullivan site, Nanjemoy Formation, Virginia, USA; calcareous nannofossil zone NP 11	Mayr et al. (2021)
cf. Pulchrapollia gracilis	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr & Kitchener (2023a); Collinson et al. 2016
? Pulchrapollia eximia	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr & Kitchener (2023a); Collinson et al. 2016
Pseudasturides macrocephalus	47.8-47.5 Ma	Messel near Darmstadt, Germany; lower middle Eocene (MP 11)	Mayr (2007)
Cyrilavis colburnorum	51.66 Ma	Fossil Butte Member, Green River Formation, Wyoming, USA. These deposits are late early Eocene, and multicrystal analyses (sanidine) from a K-feldspar tuff (FQ-1) at the top of the middle unit of the Fossil Butte Member, from Fossil Fowkes Basin (locality: N41º47'32.2" W110º42'39.6") have yielded an age of 51.97 ± 0.16Ma	Smith *et al.* (2018); Ksepka *et al.* (2011)
Cyrilavis cf. colburnorum	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr & Kitchener (2023a)

Table S1.4. (Continued).

Cyrilavis olsoni	48.07-56.0		
Serudaptus pohli	47.8-47.5 Ma	Geiseltalium, Messel, Germany; lower middle Eocene	Mayr (2000); Mayr (2011)
Messelastur gratulator	47.8-47.5 Ma	Messel near Darmstadt, Germany; lower middle Eocene (MP 11)	Mayr (2011)
Tynskya eocaena	51.66 Ma	Fossil Butte Member, Green River Formation; upper Lower Eocene	Mayr (2021); Smith *et al.* (2010)
Tynskya waltonensis	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr (2021); Collinson *et al.* 2016
Tynskya brevitarsus	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr & Kitchener (2023); Collinson *et al.* 2016
Tynskya crassitarsus	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr & Kitchener (2023); Collinson *et al*. 2016
Vastanavis eocaena	52 Ma	Vastan Lignite Mine, Cambay Formation, India; early Eocene (Ypresian)	Mayr *et al*. (2007)
Vastanavis cambayensis	52 Ma	Vastan Lignite Mine, Cambay Formation, India; early Eocene (Ypresian)	Mayr *et al*. (2007, 2010, 2013); Mayr & Kitchener (2023)
Avolatavis tenens	51.66 Ma	Fossil Butte Member, Green River Formation; upper Lower Eocene	Ksepka &Clarke (2012); Smith *et al.* (2008)
Avolatavis europaeus	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr & Kitchener (2023); Collinson *et al.* 2016
Eurofluvioviridavis robustipes	48.07-41.03	Messel near Darmstadt, Germany; lower middle Eocene (MP 11)	Mayr (2015)
Quercypsitta sudrei	*37.71-33.9*	Quercy Phosphorites Formation, France; middle to late Eocene	Mourer-Chauviré (1992)
Psittacopes lepidus	47.8-47.5 Ma	Geiseltalium, Messel, Germany; lower middle Eocene	Mayr & Daniels (1998)
Parapsittacopes bergdahli	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr (2020)
Psittacomimus eos	54.6-55 Ma	Walton-on-the-Naze, Walton Member (previously Division A2), London Clay Formation, Essex, U.K.; early Ypresian, early Eocene	Mayr & Kitchener (2022); Collinson *et al*. 2016

Table S1.4. (Continued).

Pumiliornis tessellatus	47.8-47.5 Ma	Messel near Darmstadt, Germany; lower middle Eocene (MP 11)	Mayr (2008a)
Eofringillirostrum boudreauxi	56-48.07	Locality A [7], ‘‘Sandwich beds’’, Fossil Butte Member, Green River Formation, Wyoming, USA; early Eocene	Ksepka *et al.* (2019)
Zygodactylus grandei	51.66 Ma	Fossil Butte Member, Green River Formation; early Eocene	Smith *et al.* (2010); Smith *et al*. (2018)
Primozygodactylus danielsi	47.8-47.5 Ma	Messel near Darmstadt, Germany; early Eocene (MP 11)	Mayr (1998); Lenz *et al*. (2015)
Primozygodactylus major	47.8-47.5 Ma	Messel near Darmstadt, Germany; early Eocene (MP 11)	Mayr (2017); Lenz *et al.* (2015)
Primozygodactylus eunjooae	47.8-47.5 Ma	Messel near Darmstadt, Germany; early Eocene (MP 11)	Mayr & Zelenkov (2009); Lenz *et al*. (2015)
Primozygodactylus quintus	47.8-47.5 Ma	Messel near Darmstadt, Germany; early Eocene (MP 11)	Mayr (2017); Lenz *et al*. (2015)
Primozygodactylus longibrachium	47.8-47.5 Ma	Messel near Darmstadt, Germany; early Eocene (MP 11)	Mayr (2017); Lenz *et al*. (2015)
Eozygodactylus americanus	51.66 Ma	Fossil Butte Member, Green River Formation; early Eocene	Smith *et al*. (2018)

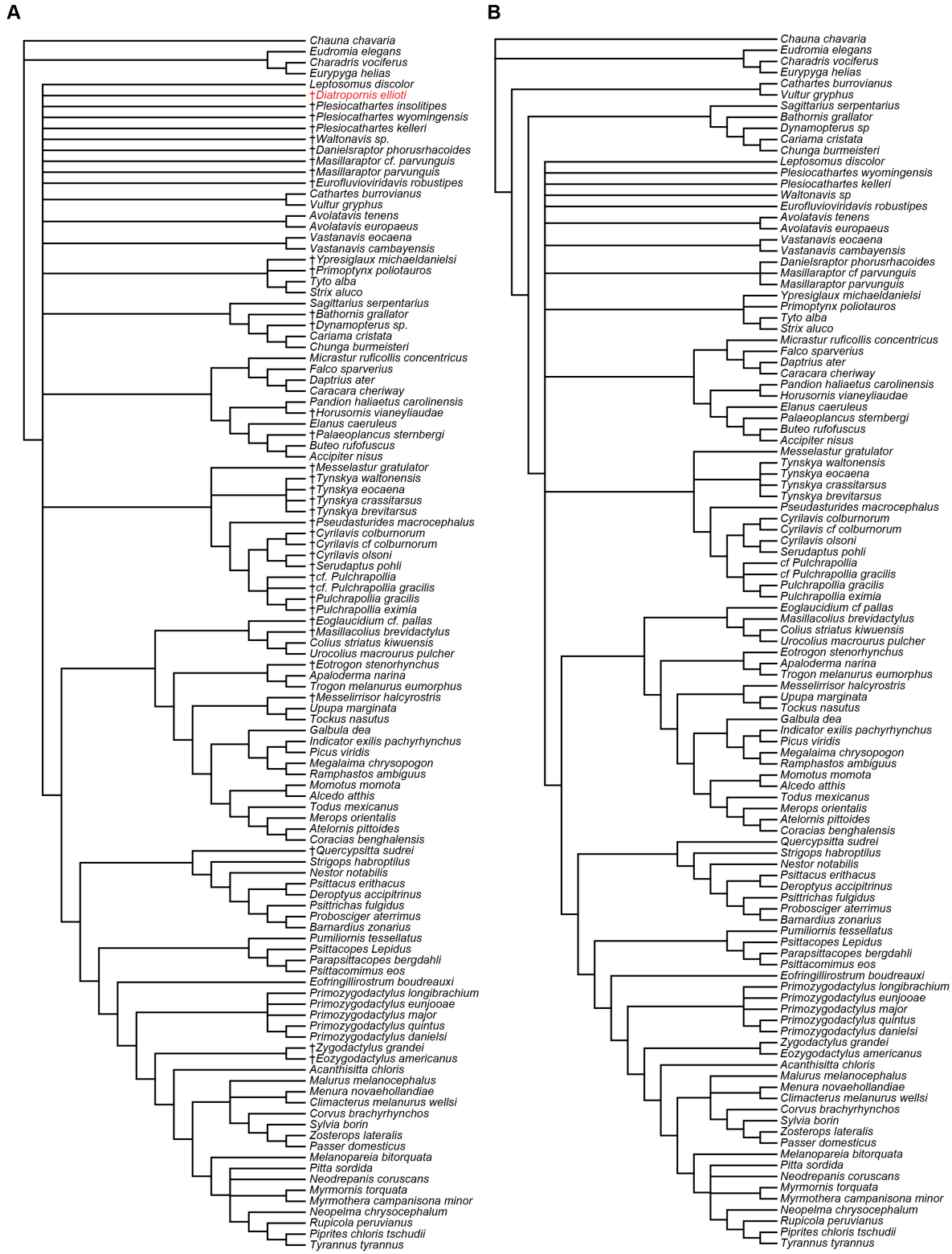


Figure S1.1. (A) Strict consensus of a single parsimonious tree from the Analysis 2 (extant taxa, unconstrained). Length =183, CI = 0.1834, RI = 0.6603; (B) Strict reduced consensus after pruning wildcard taxon highlighted in red from the full set of MPTs.

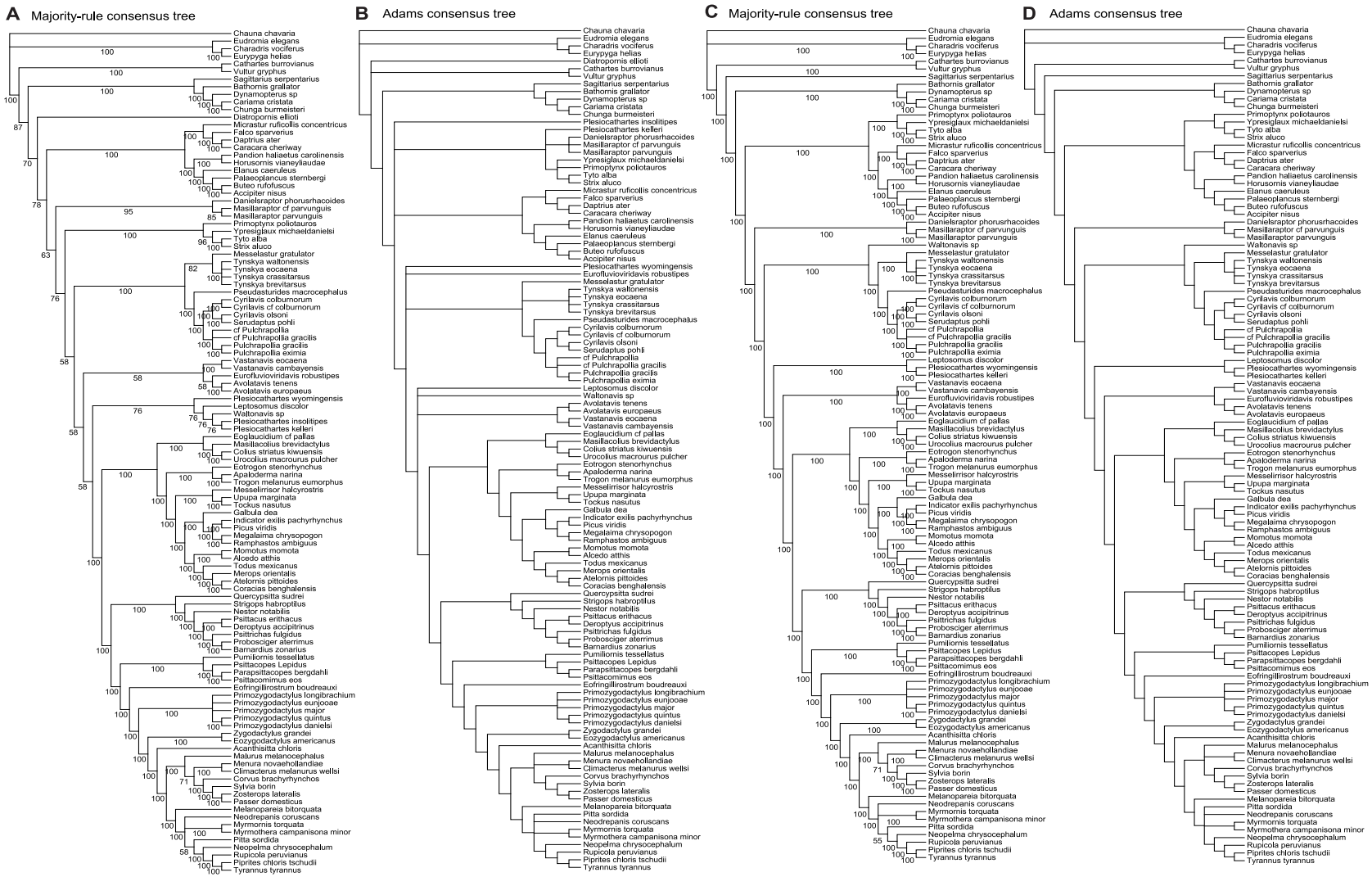


Figure S1.2. 50% majority rule and Adams consensus trees recovered for Analysis 2. (A & B) Before pruning of rouge taxon; (C & D) Reanalysis of the reduced version of the dataset.

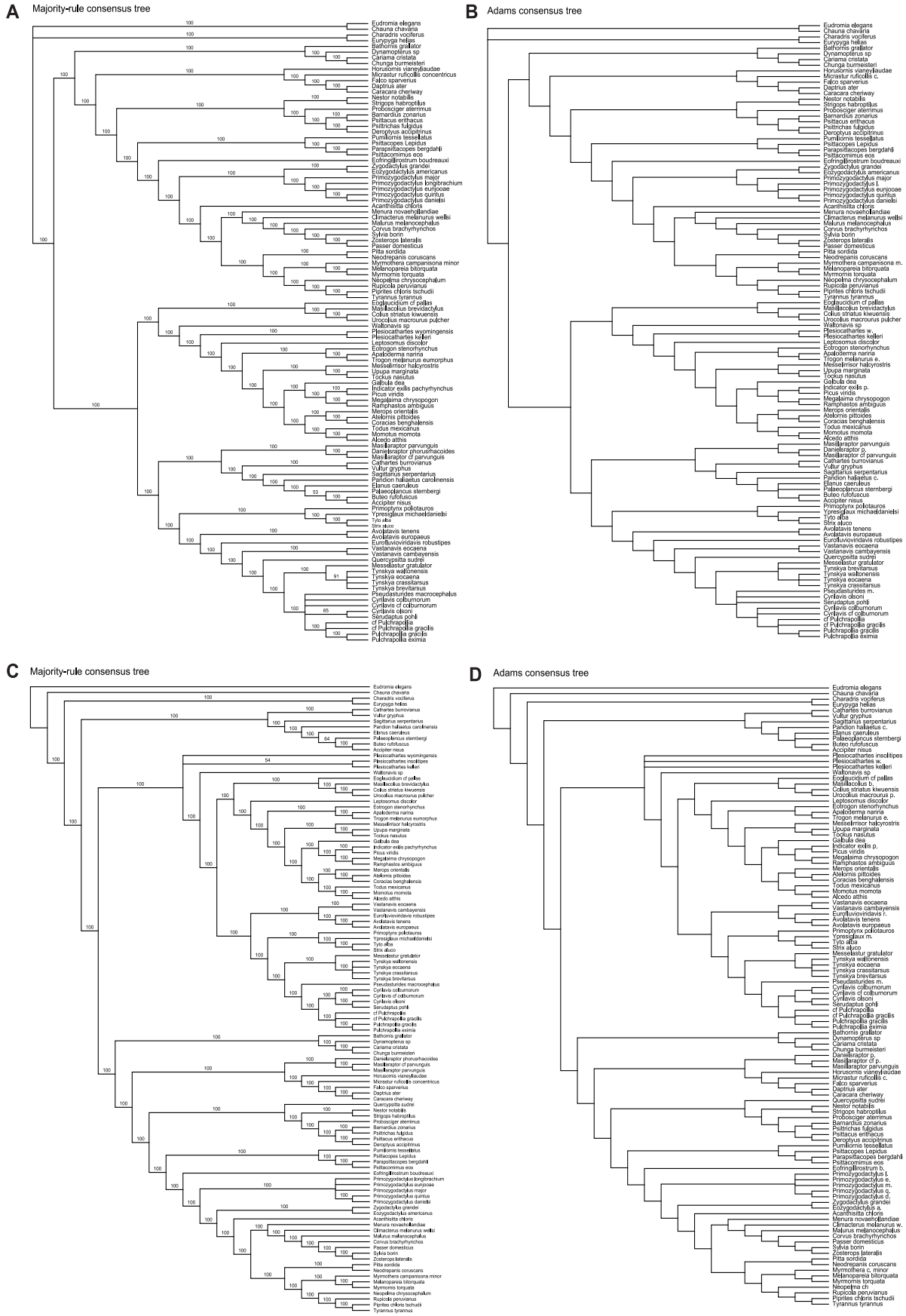


Figure S1.3. 50% majority rule and Adams consensus trees recovered for Analysis 3. (A & B) using Stiller et al. (2024) as the backbone constraint; (C & D) using Prum et al. (2015) as the backbone constraint.

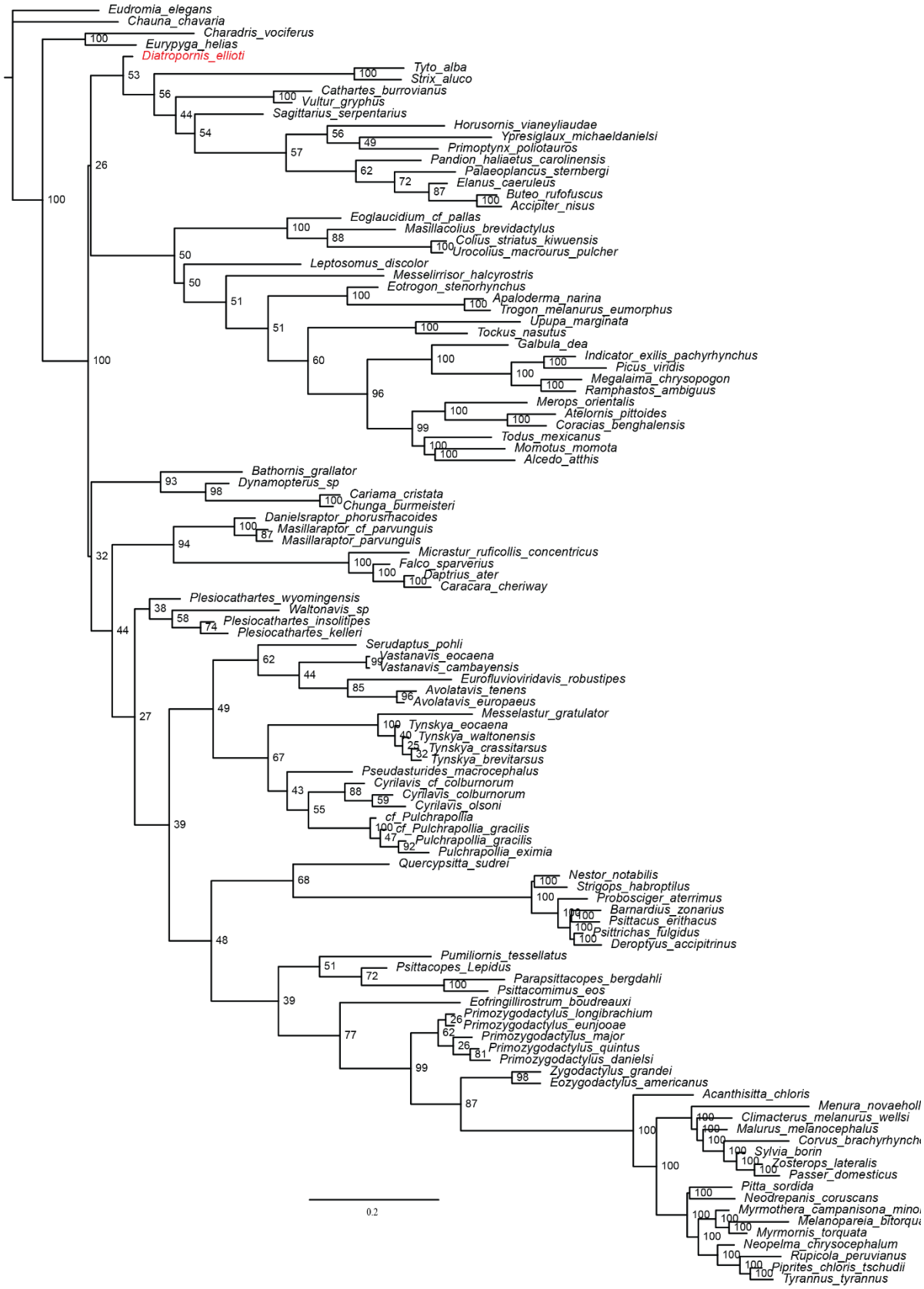


Figure S1.4. The "allcompat" consensus tree resulting from Bayesian Analysis 3 (unordered, extant and extinct taxa, using Stiller et al. (2024) as the backbone constraint). Numbers on nodes represent posterior probabilities. Rogue taxon highlighted in red.

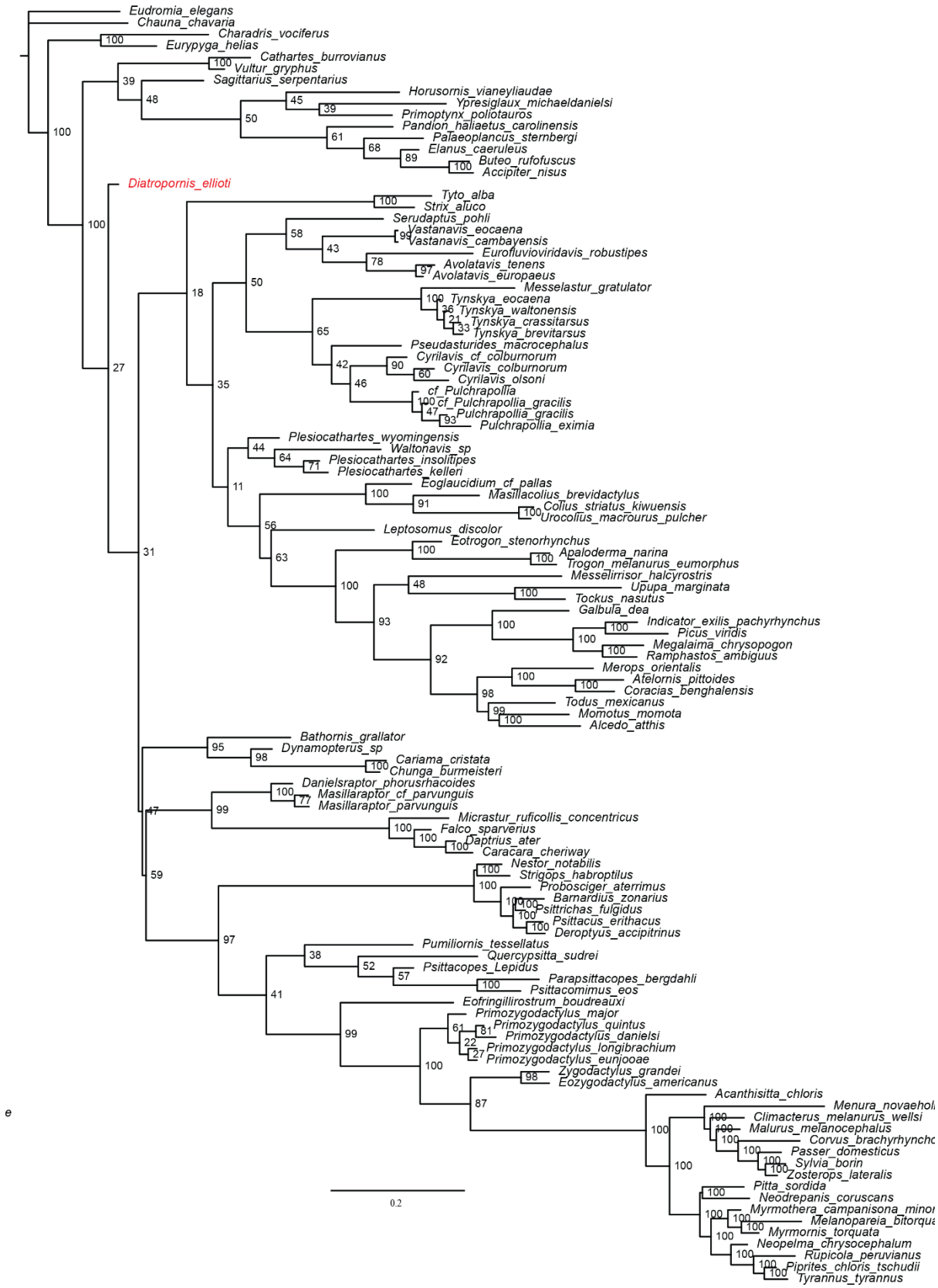


Figure S1.5. The "allcompat" consensus tree resulting from Bayesian Analysis 3 (unordered, extant and extinct taxa, using Prum et al. (2015) as the backbone constraint). Numbers on nodes represent posterior probabilities. Rogue taxon highlighted in red.

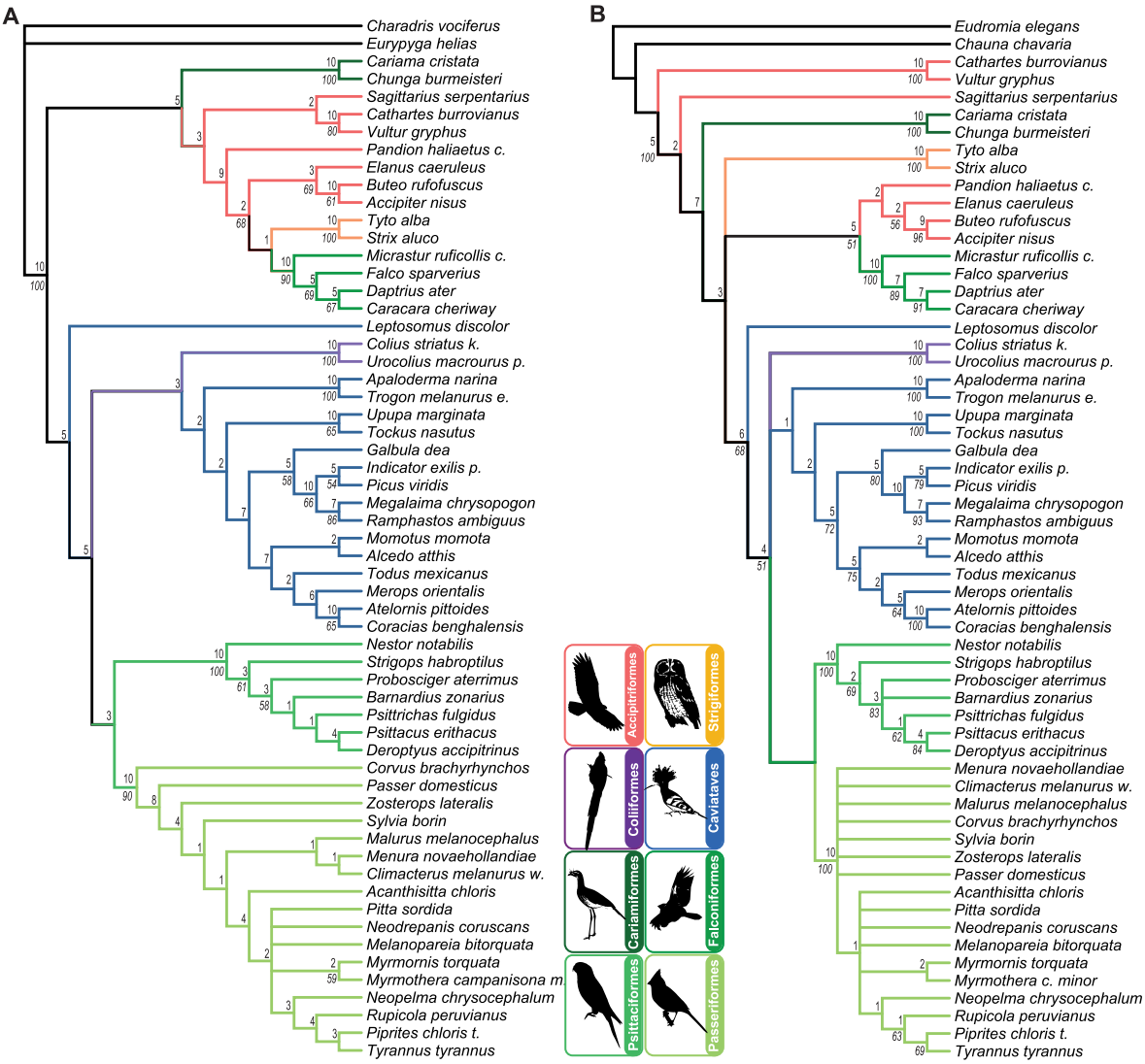


Figure S1.6. (A) Strict consensus of three MPTs of length 2561 when outgroup *Eudromia elegans* and *Chauna chavaris* are excluded from Analysis 1 (extant taxa only); (B) Strict consensus of two MPTs of length 2579 when outgroup *Charadris vociferus* and *Eurypyga cristate* are excluded from Analysis 1 (extant taxa only). Support values shown at nodes: Bremer indexes greater than 1 are shown above nodes, bootstrap values greater than 50% shown below nodes (italics).

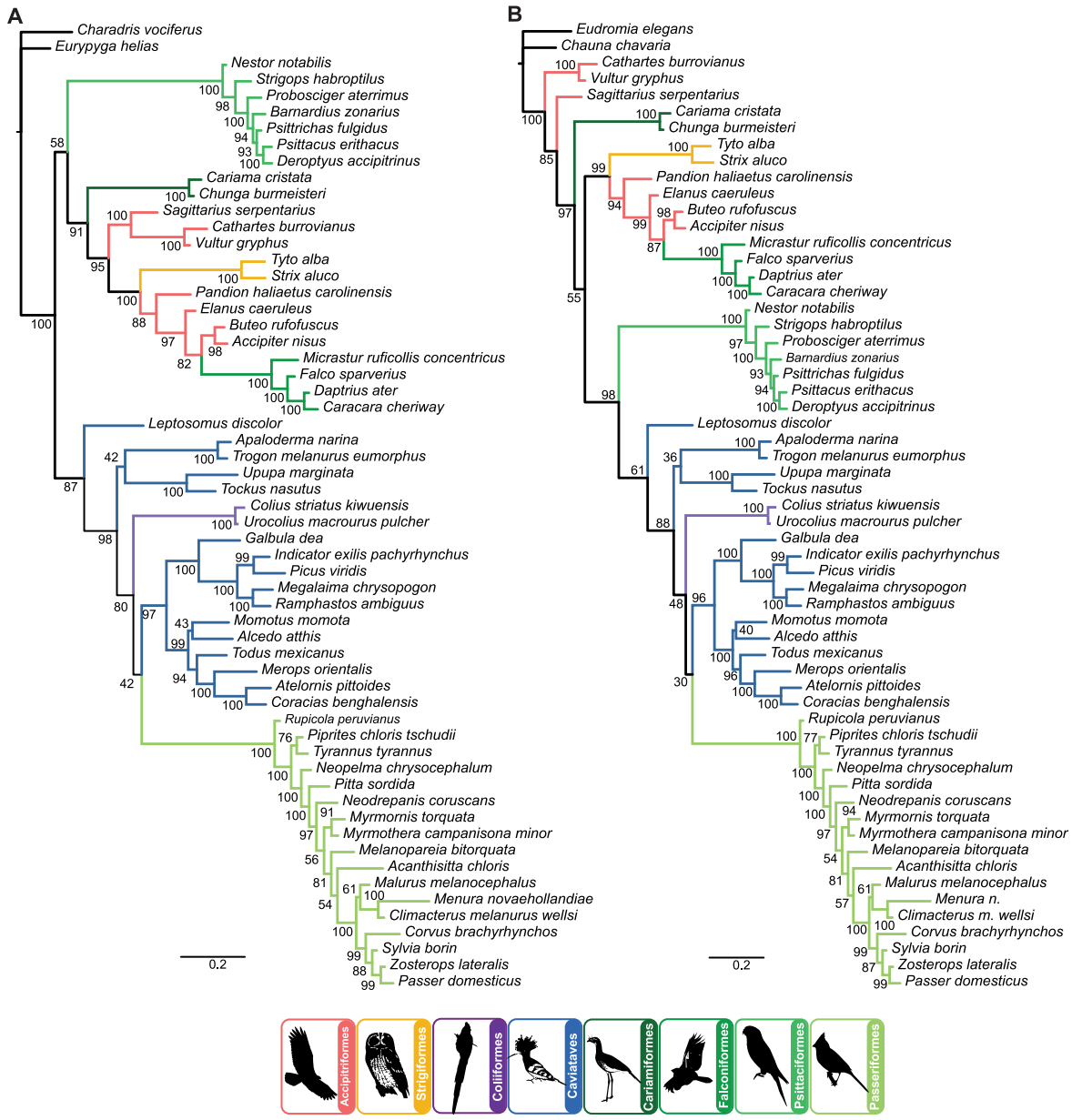


Figure S1.7. (A) The "allcompat" consensus tree resulting from Bayesian Analysis 1 when outgroup *Eudromia elegans* and *Chauna chavaris* are excluded; (B) The "allcompat" consensus tree resulting from Bayesian Analysis 1 when outgroup *Charadris vociferus* and *Eurypyga cristate* are excluded from Analysis 1 (extant taxa only). Numbers on nodes represent posterior probabilities.



Figure S1.8. (A) Strict consensus of 391 MPTs of length 3415 when outgroup *Eudromia elegans* and *Chauna chavaris* are excluded from Analysis 2 (extant and extinct taxa); (B) Strict consensus of 415 MPTs of length 2561 when outgroup *Charadris vociferus* and *Eurypyga cristate* are excluded from Analysis 2. Support values shown at nodes: Bremer indexes greater than 1 are shown above nodes, bootstrap values greater than 50% shown below nodes (italics).



Figure S1.9. (A) The "allcompat" consensus tree resulting from Bayesian Analysis 1 when outgroup *Eudromia elegans* and *Chauna chavaris* are excluded; (B) The "allcompat" consensus tree resulting from Bayesian Analysis 2 when outgroup *Charadris vociferus* and *Eurypyga cristate* are excluded. Numbers on nodes represent posterior probabilities.

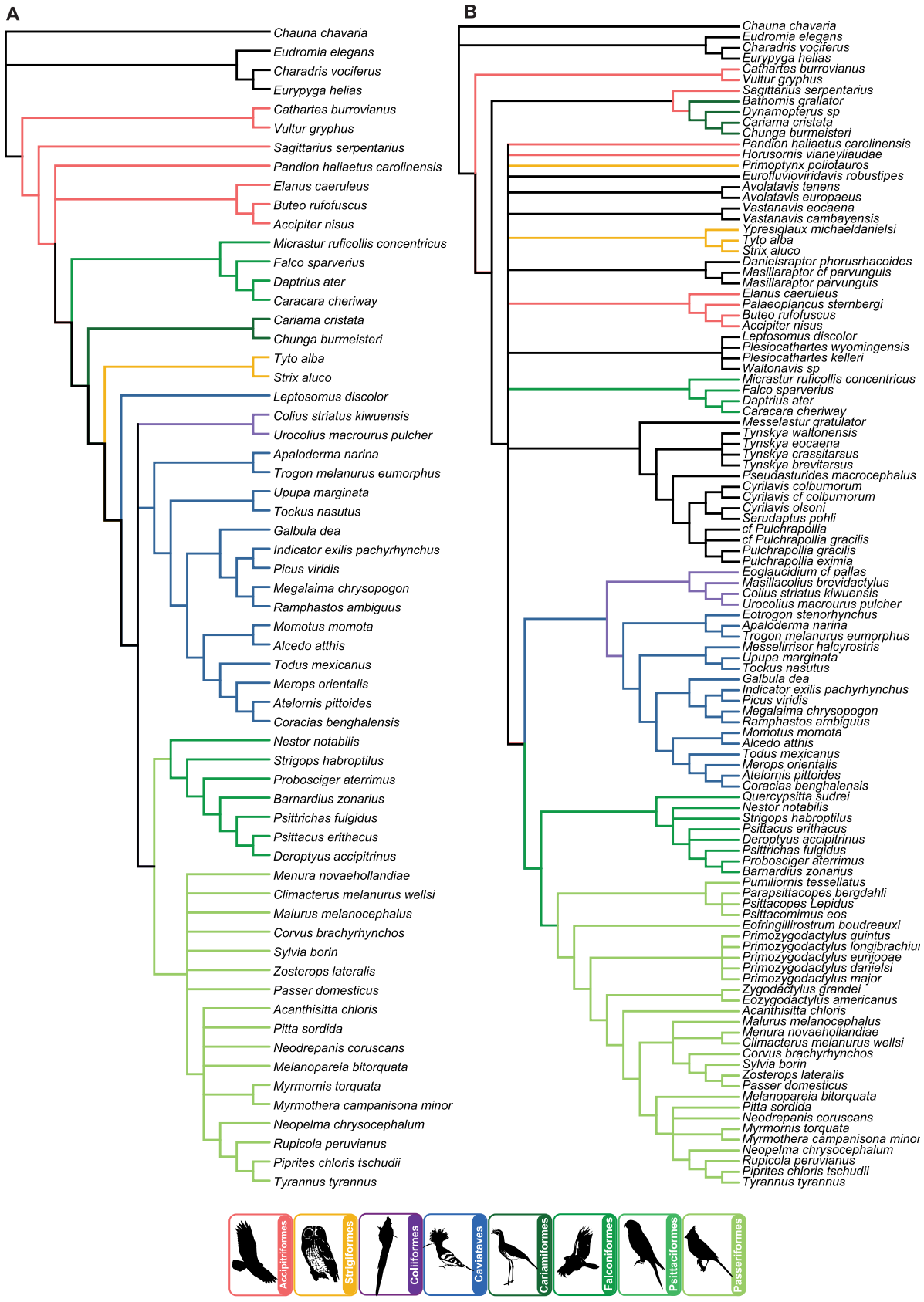


Figure S1.10. Results from a reduced dataset where "raptorial" characters are removed. (A) Analysis 1, strict consensus of 28 MPTs of length 2593; (B) Analysis 2, strict consensus of 1883 MPTs of length 3400.

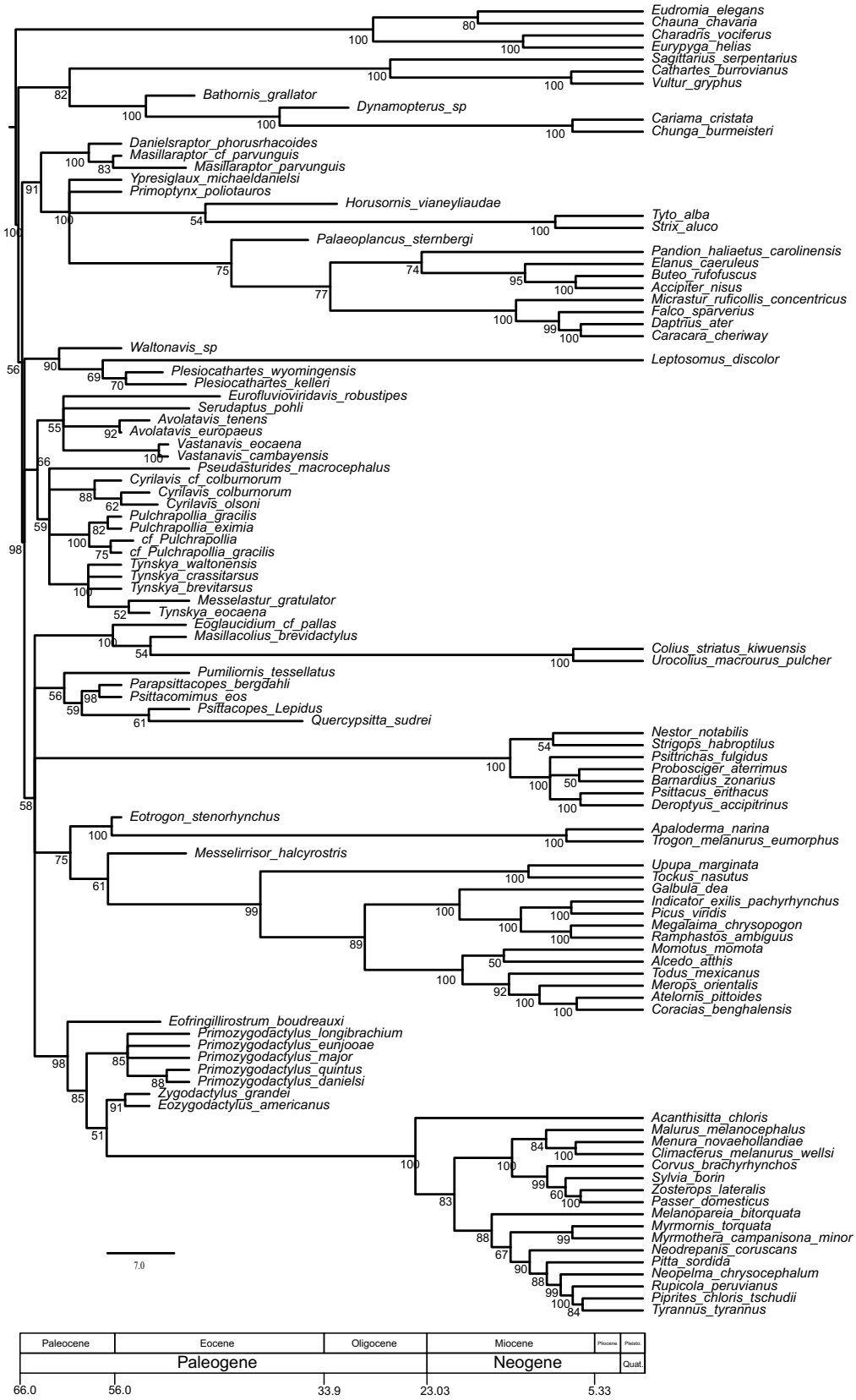


Figure S3.11. "Stiller" constraint majority rule consensus tree recovered from Bayesian analysis with FDB model, unordered characters. Numbers on nodes represent posterior probabilities. Scale bar indicates 7.0 expected changes per site.

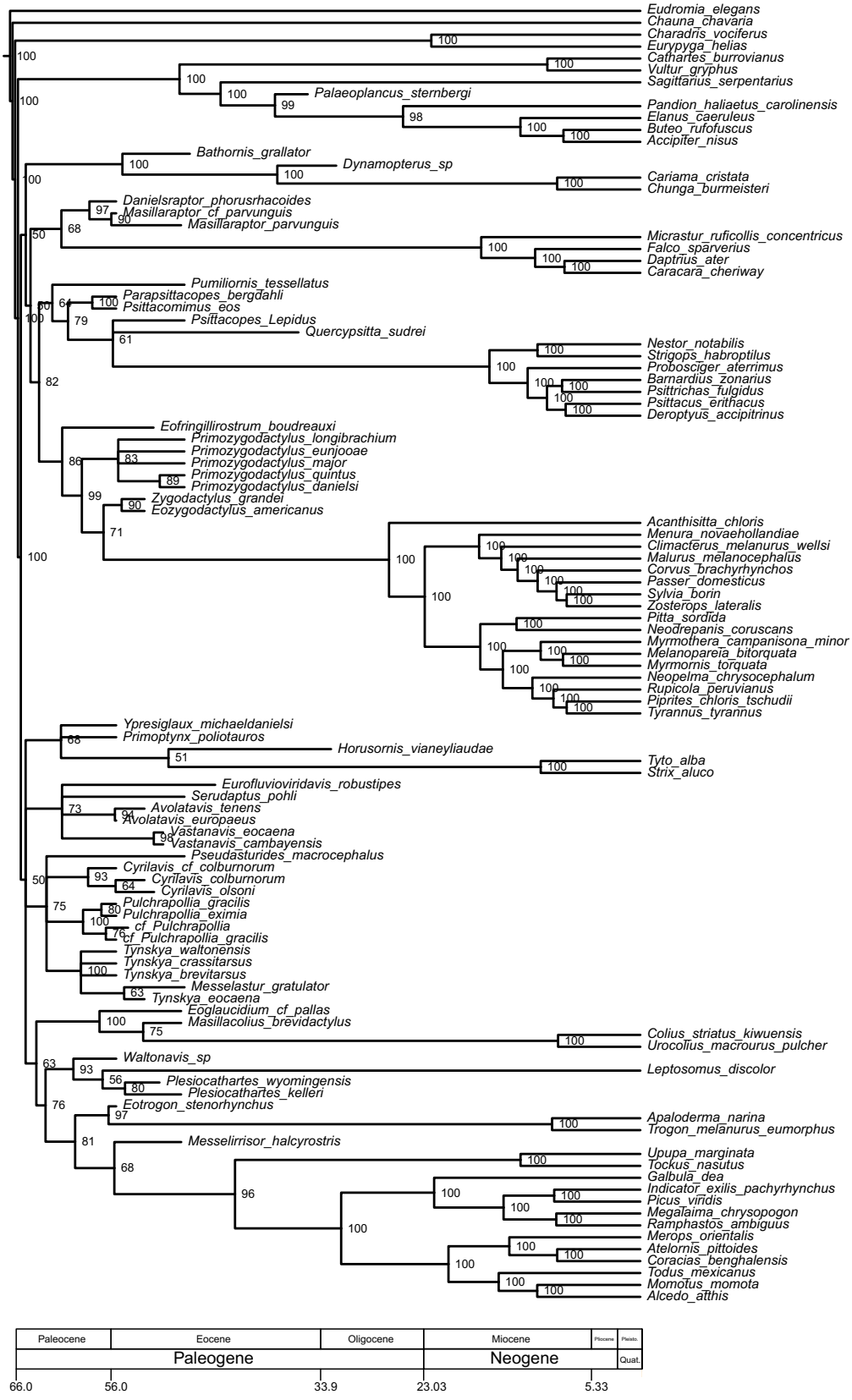
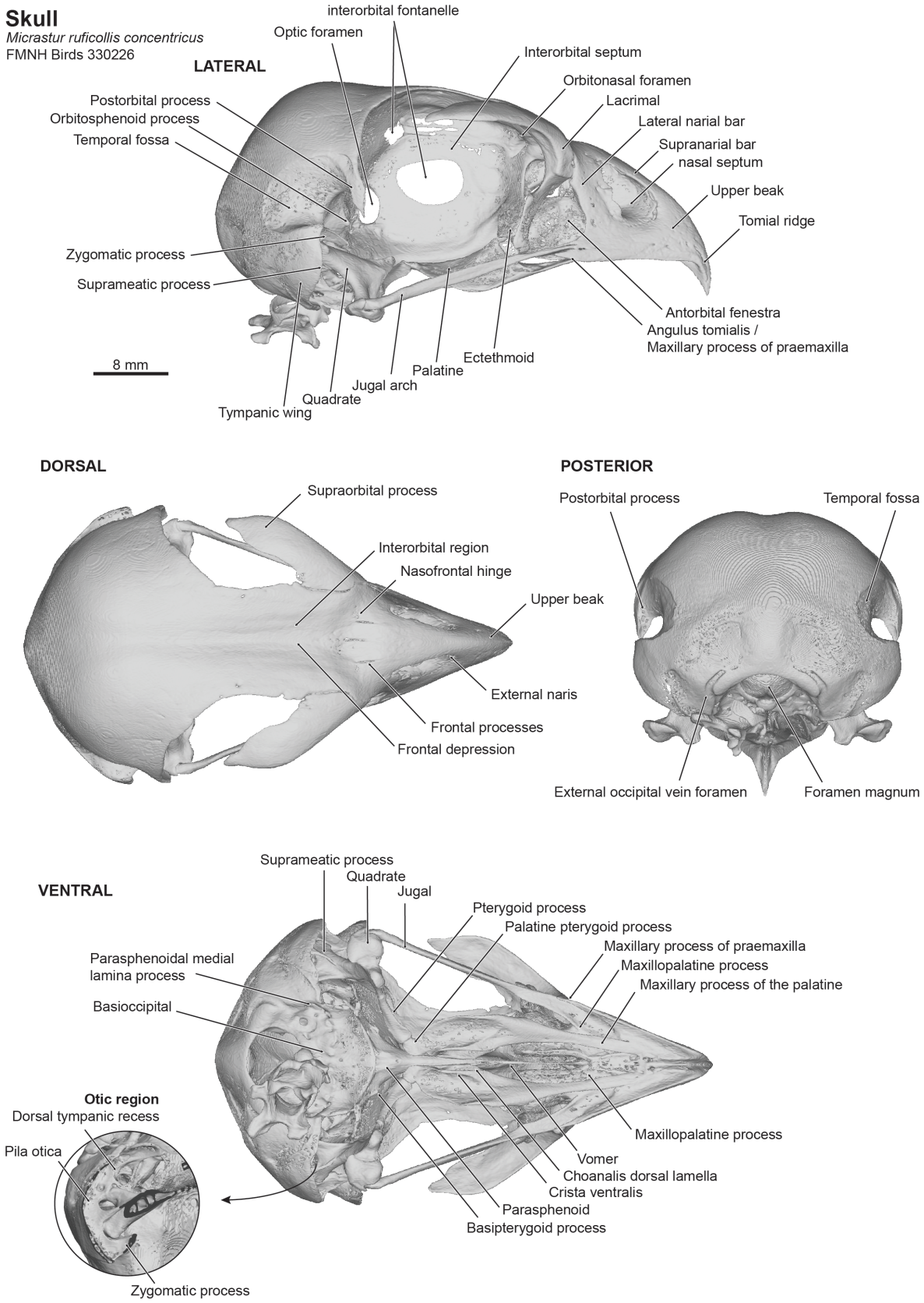


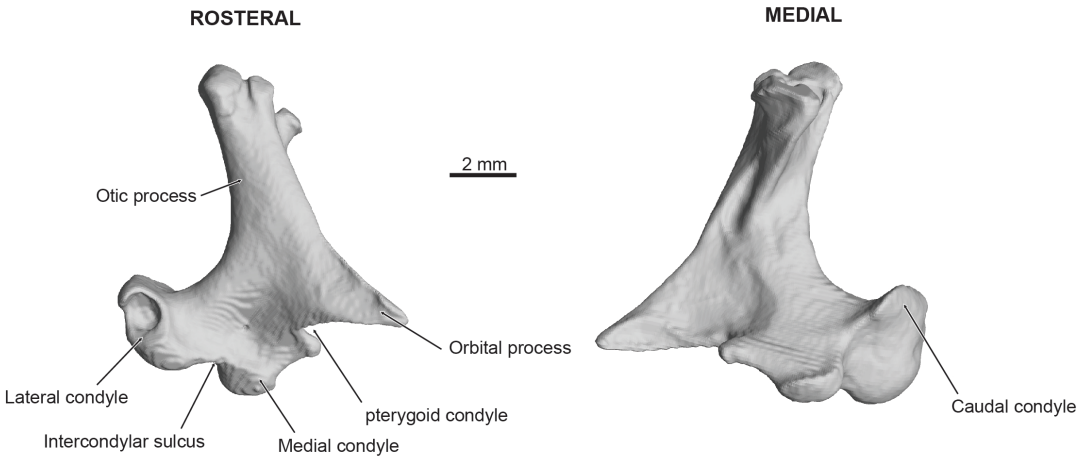
Figure S3.12. "Prum" constraint majority rule consensus tree recovered from Bayesian analysis with FDB model, unordered characters. Numbers on nodes represent posterior probabilities.

Appendix 2 Anatomical features referenced within this study


Skull
Micrastur ruficollis concentricus
FMNH Birds 330226
LATERAL
interorbital fontanelle
Optic foramen
Interorbital septum
Orbitonasal foramen
Lacrimal
Lateral narial bar
Supranarial bar
nasal septum
Upper beak
Tomial ridge
Postorbital process
Orbitosphenoid process
Temporal fossa
Zygomatic process
Suprameatic process
Antorbital fenestra
Angulus tomialis /
Maxillary process of praemaxilla
8 mm
Ectethmoid
Palatine
Jugal arch
Quadrate
Tympanic wing
DORSAL
Supraorbital process
Interorbital region
Nasofrontal hinge
Upper beak
External naris
Frontal processes
Frontal depression
POSTERIOR
Postorbital process
Temporal fossa
External occipital vein foramen
Foramen magnum
VENTRAL
Suprameatic process
Quadrate
Jugal
Pterygoid process
Palatine pterygoid process
Maxillary process of praemaxilla
Maxillopalatine process
Maxillary process of the palatine
Parasphenoidal medial
lamina process
Basioccipital
Otic region
Dorsal tympanic recess
Pila otica
Zygomatic process
Maxillopalatine process
Vomer
Choanalis dorsal lamella
Crista ventralis
Parasphenoid
Basipterygoid process

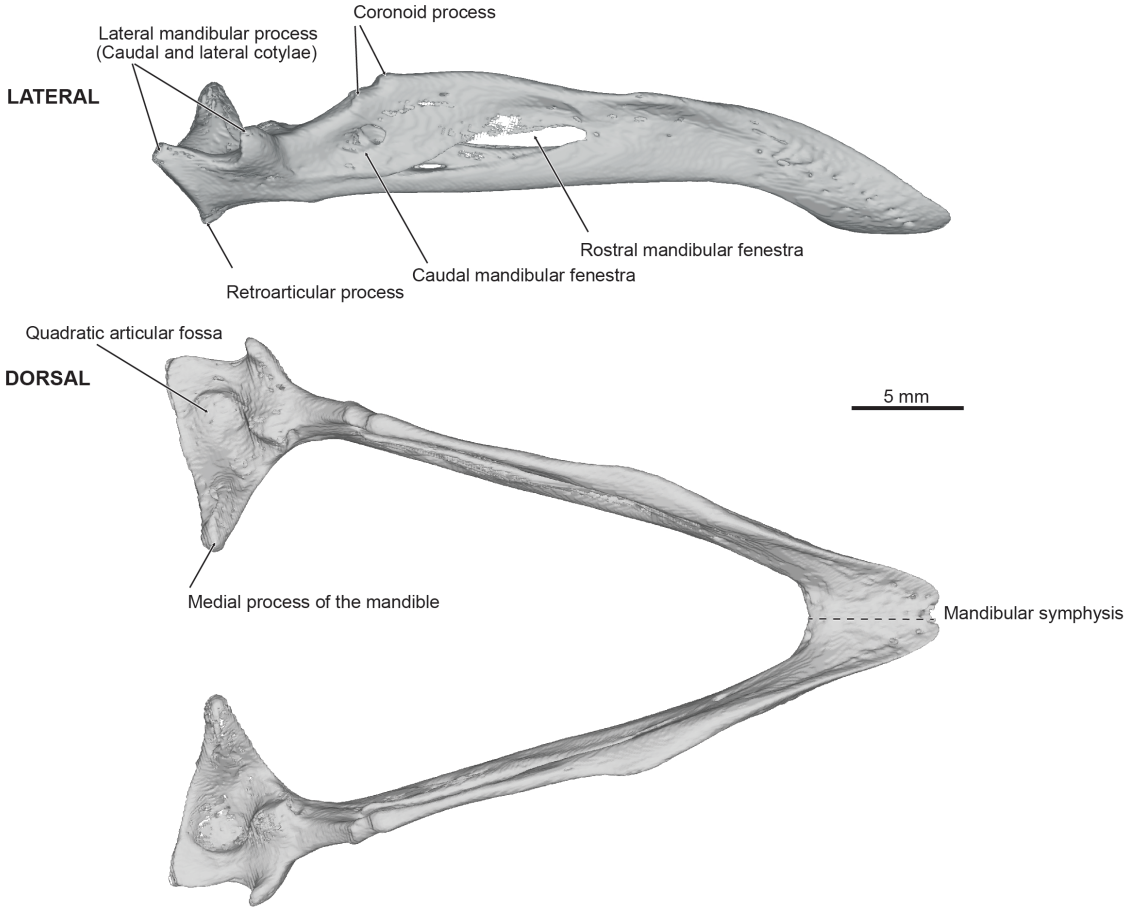
Quadrate

Micrastur ruficollis concentricus
FMNH Birds 330226



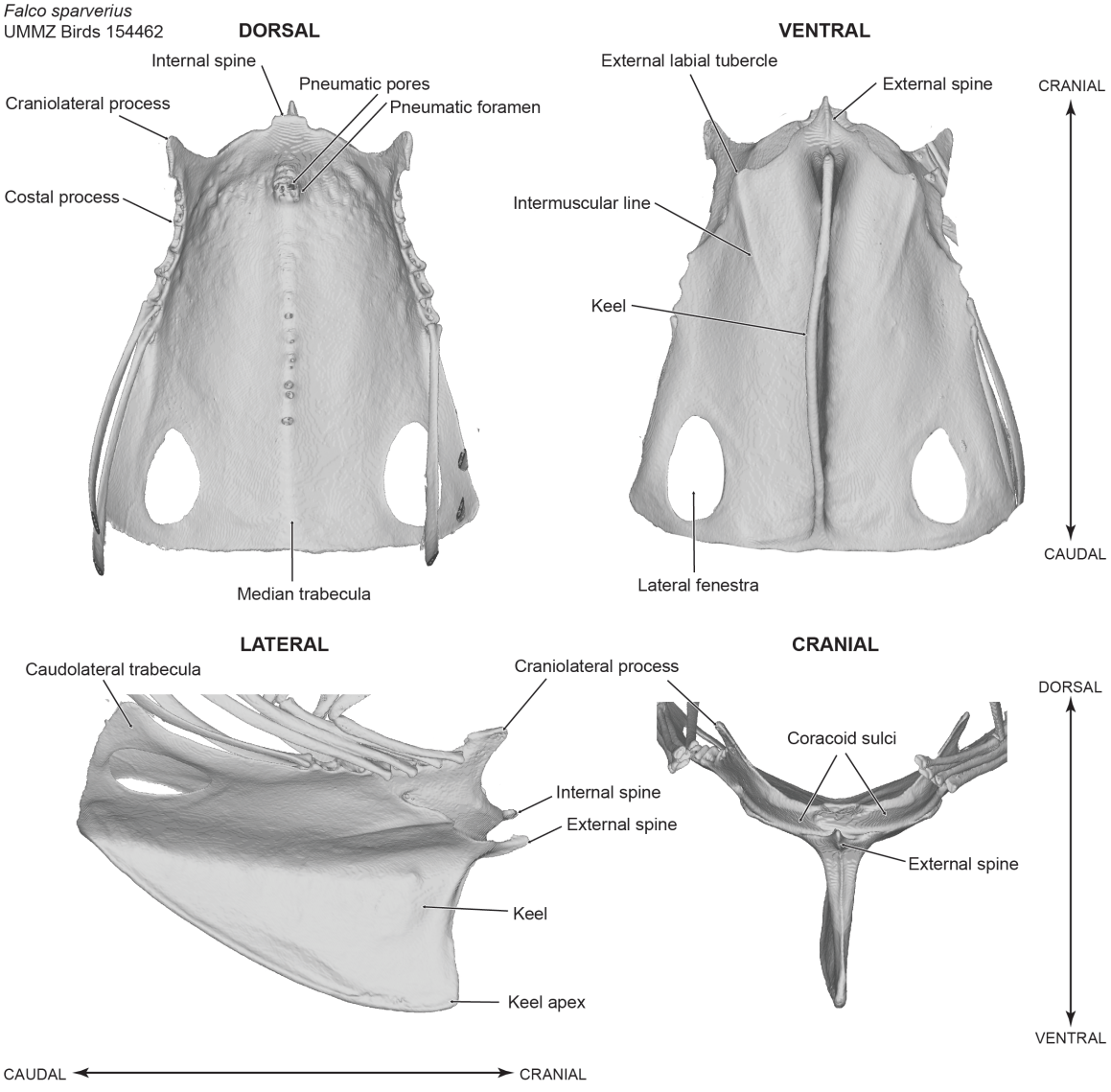
Mandible

Micrastur ruficollis concentricus
FMNH Birds 330226



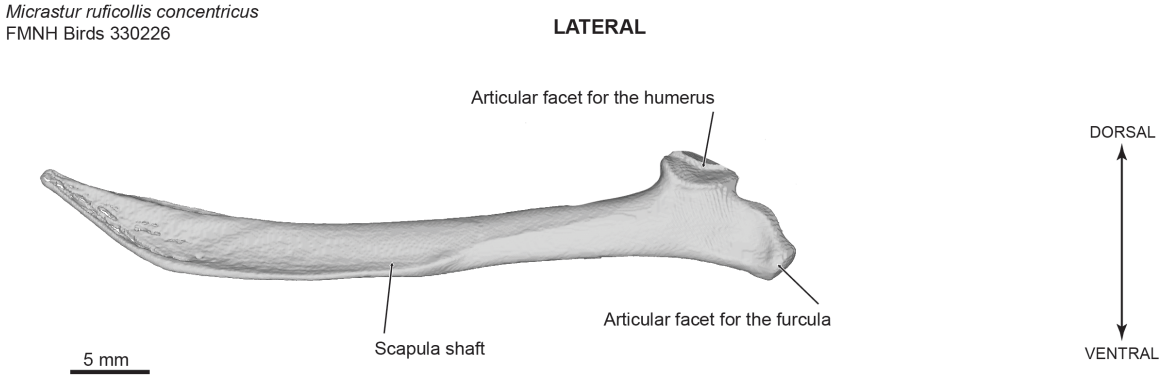
Sternum

Falco sparverius
UMMZ Birds 154462



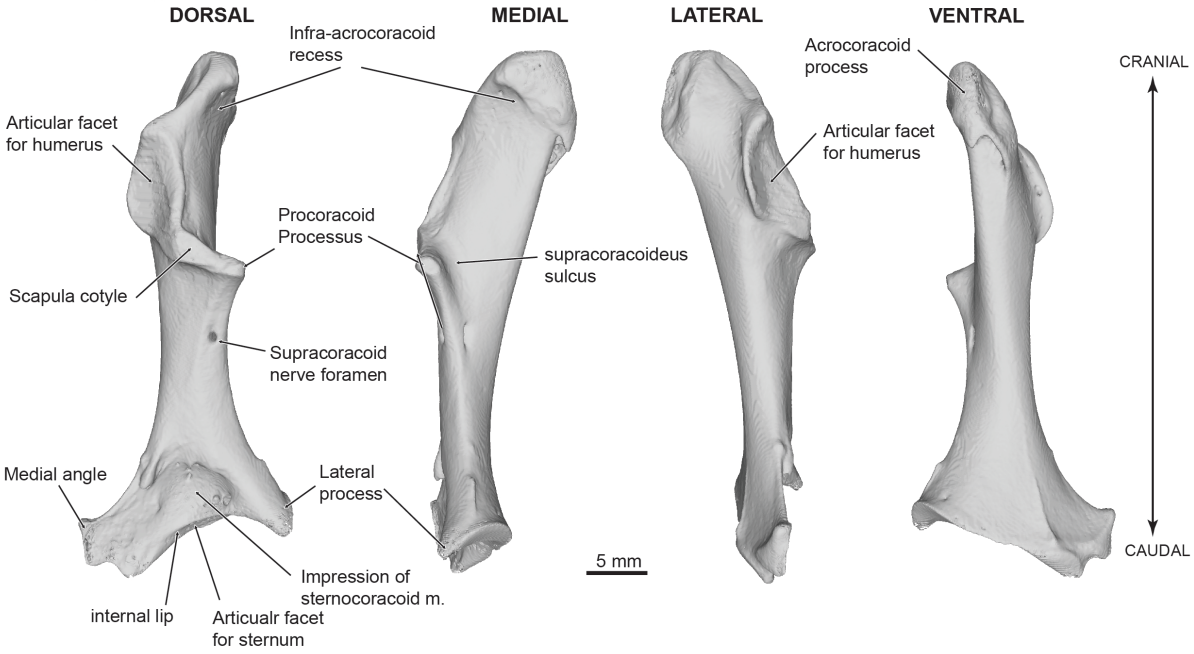
Scapula

Micrastur ruficollis concentricus
FMNH Birds 330226



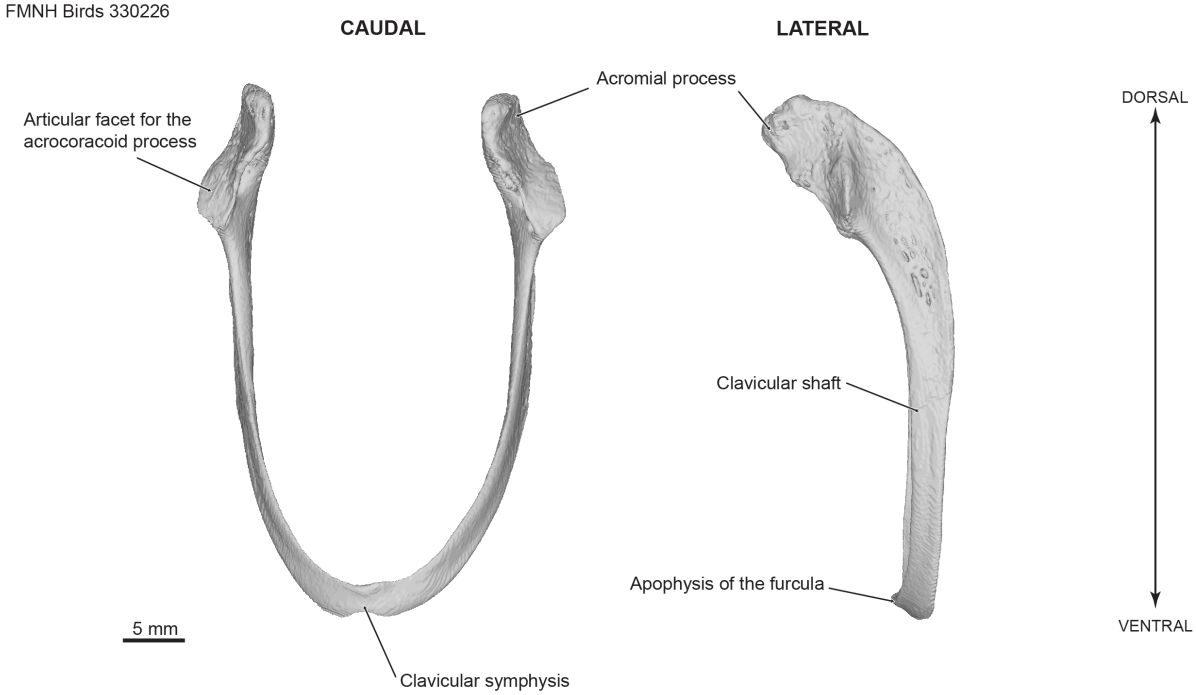
Coracoid

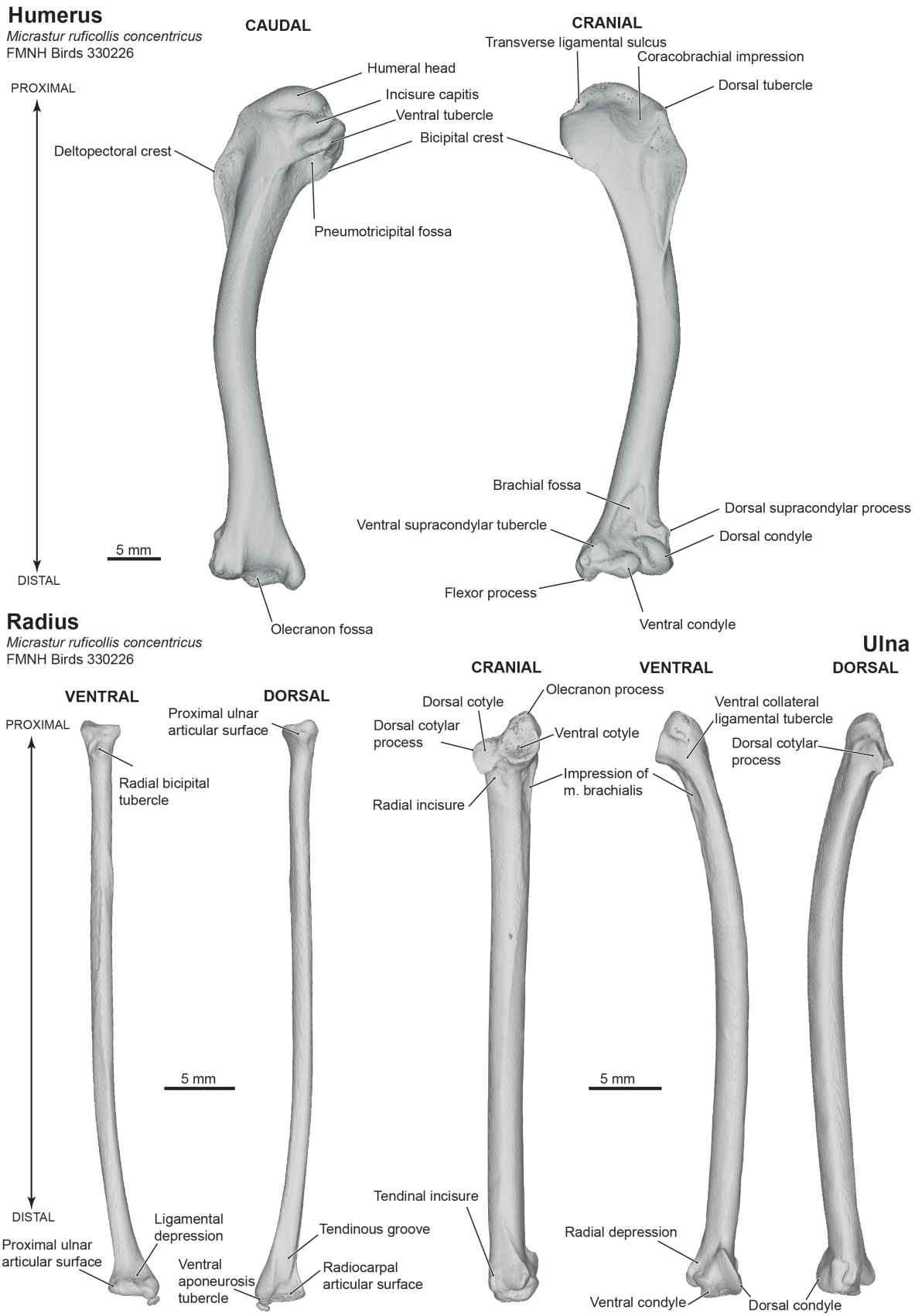
Cathartes burrovianus
UMMZ birds 227466



Furcula

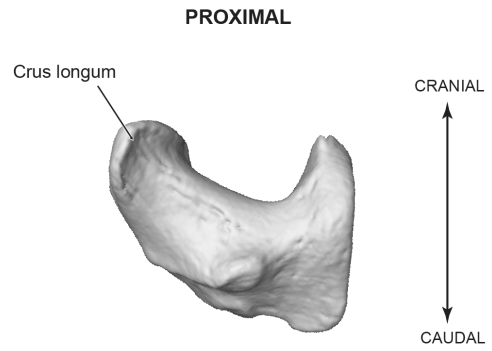
Micrastur ruficollis concentricus
FMNH Birds 330226




Humerus
Micrastur ruficollis concentricus
FMNH Birds 330226
CAUDAL
CRANIAL
PROXIMAL
DISTAL
5 mm
Humeral head
Incisure capitis
Ventral tubercle
Bicipital crest
Deltopectoral crest
Pneumotricipital fossa
Olecranon fossa
Transverse ligamental sulcus
Coracobrachial impression
Dorsal tubercle
Brachial fossa
Dorsal supracondylar process
Ventral supracondylar tubercle
Dorsal condyle
Flexor process
Ventral condyle
Radius
Micrastur ruficollis concentricus
FMNH Birds 330226
VENTRAL
DORSAL
PROXIMAL
DISTAL
5 mm
Proximal ulnar articular surface
Radial bicipital tubercle
Ligamental depression
Proximal ulnar articular surface
Ventral aponeurosis tubercle
Tendinous groove
Radiocarpal articular surface
Ulna
CRANIAL
VENTRAL
DORSAL
5 mm
Olecranon process
Dorsal cotyle
Dorsal cotylar process
Ventral cotyle
Impression of m. brachialis
Radial incisure
Tendinal incisure
Ventral collateral ligamental tubercle
Dorsal cotylar process
Radial depression
Ventral condyle
Dorsal condyle

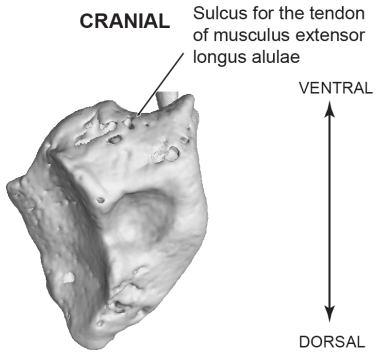
Ulnare

Micrastur ruficollis concentricus
FMNH Birds 330226



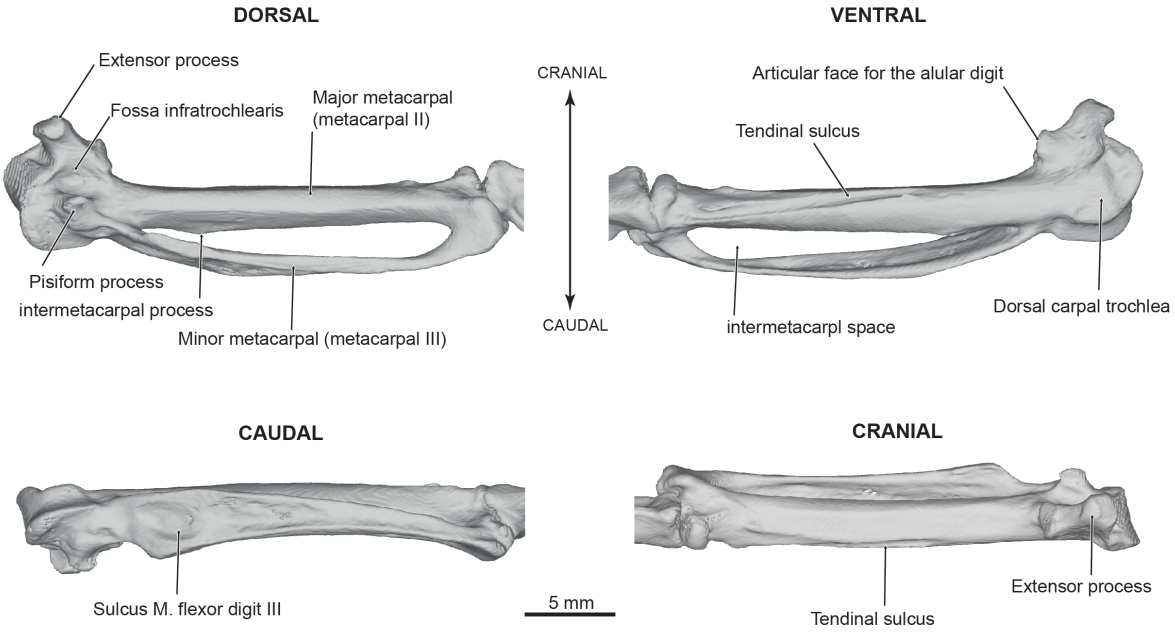
Radiale

Micrastur ruficollis concentricus
FMNH Birds 330226



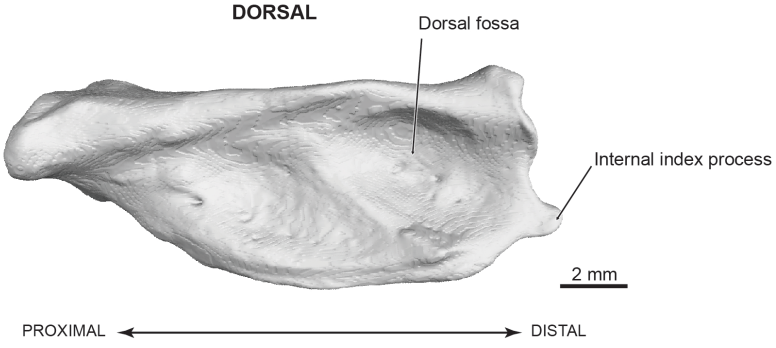
Carpometacarpus

Micrastur ruficollis concentricus
FMNH Birds 330226



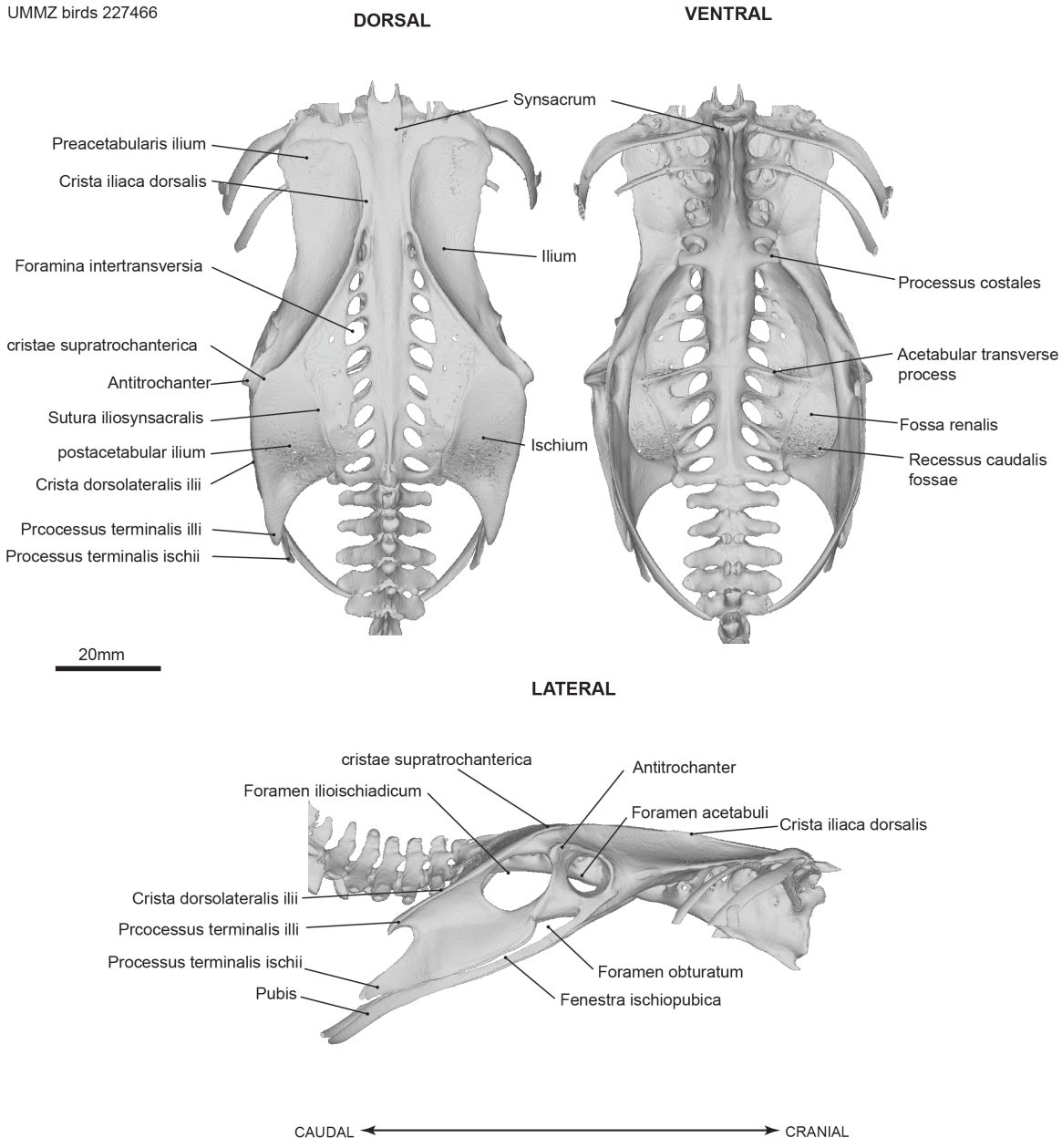
Manual phalanx II-1

Micrastur ruficollis concentricus
FMNH Birds 330226



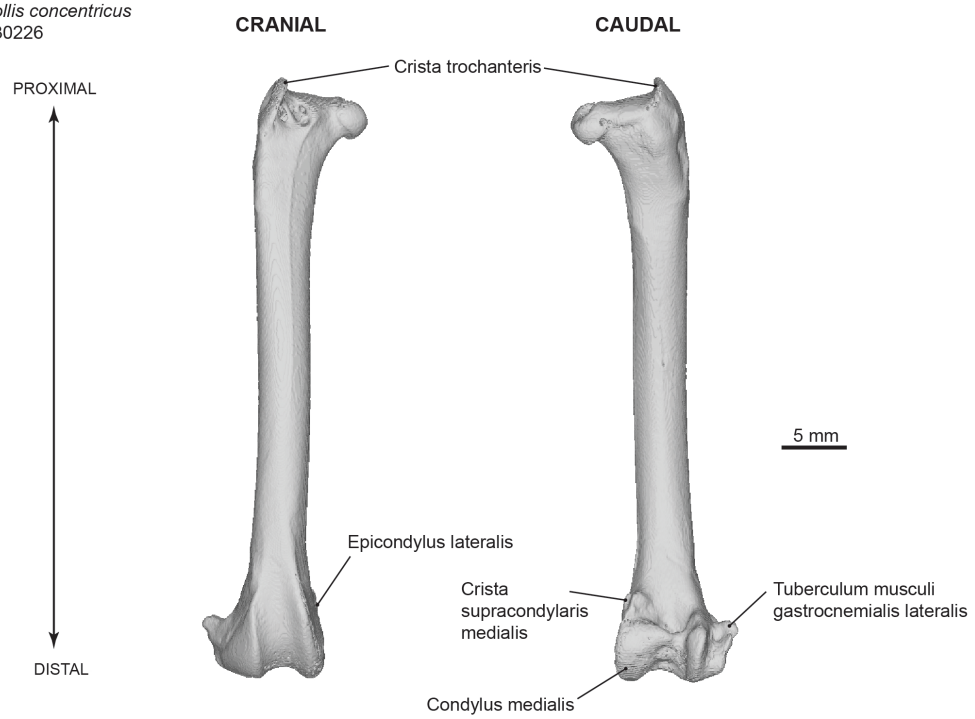
Synsacrum (pelvis)

Cathartes burrovianus
UMMZ birds 227466



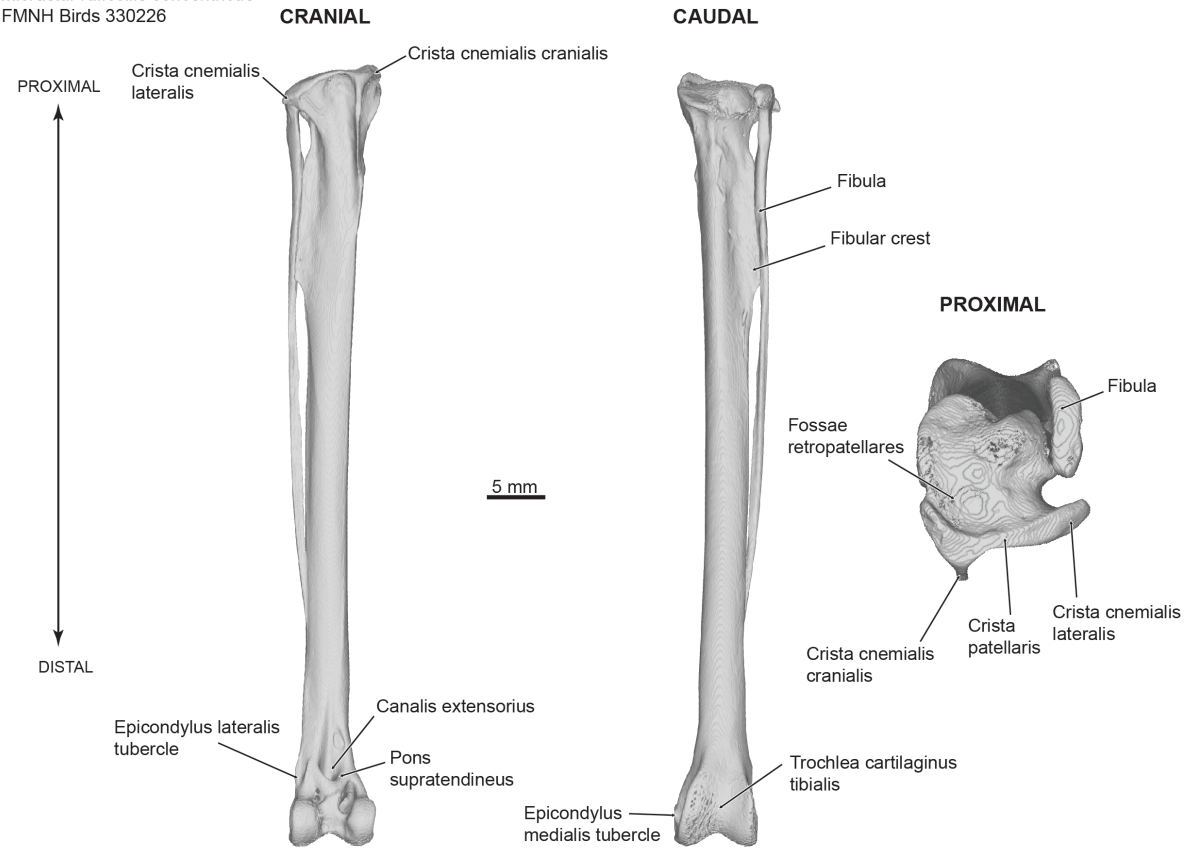
Femur

Micrastur ruficollis concentricus
FMNH Birds 330226



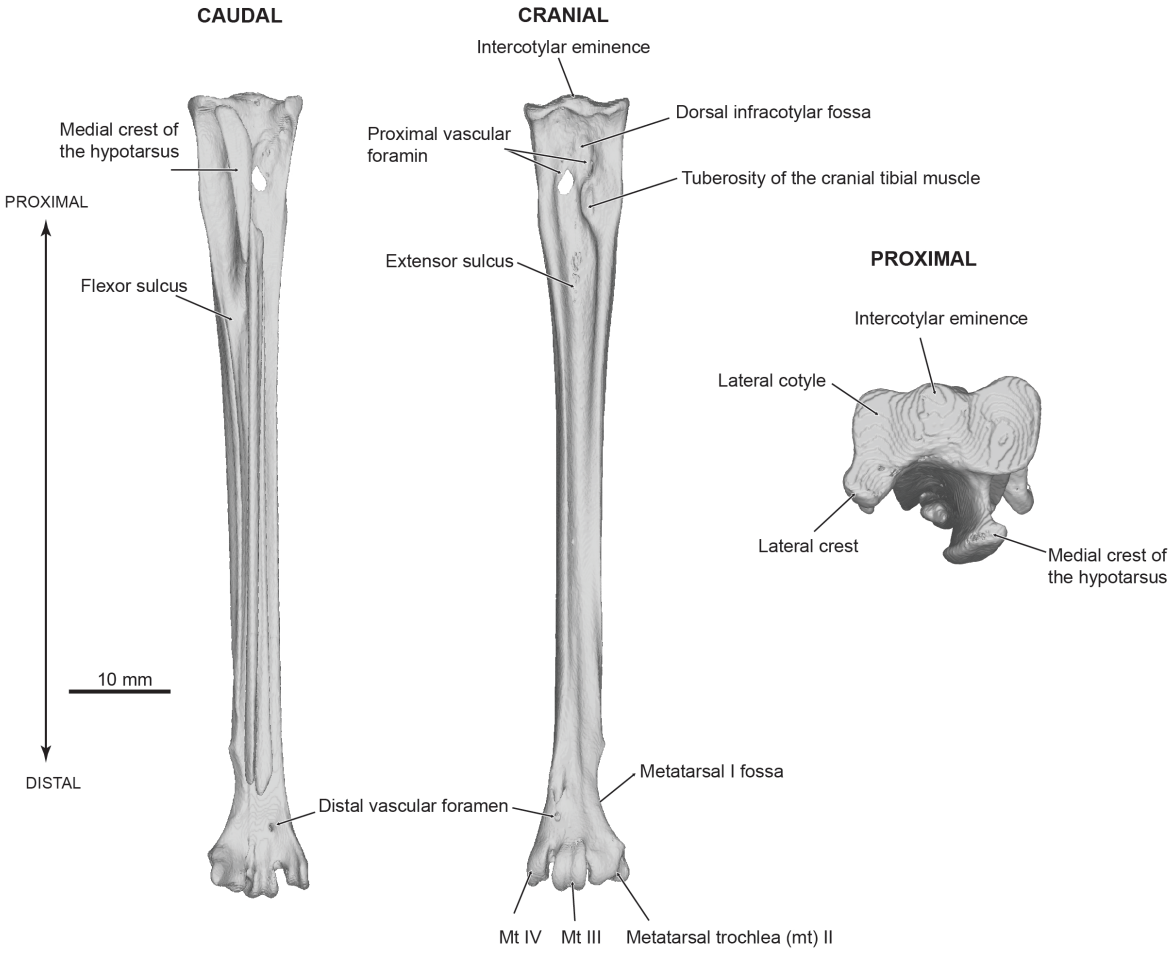
Tibiotarsus

Micrastur ruficollis concentricus
FMNH Birds 330226



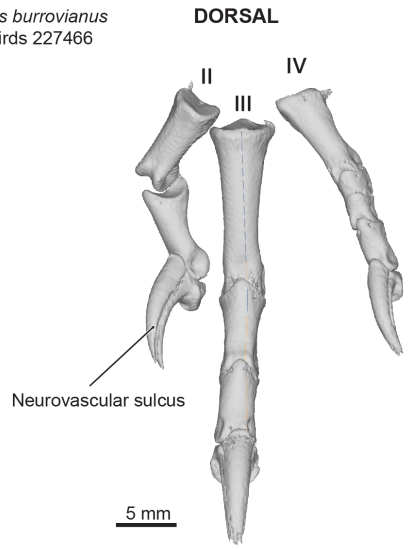
Tarsometatarsus

Micrastur ruficollis concentricus
FMNH Birds 330226



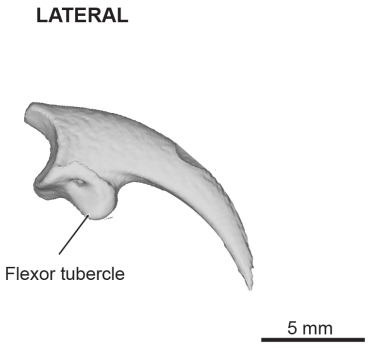
Pedal digits

Cathartes burrovianus
UMMZ birds 227466



Pedal ungual

Micrastur ruficollis concentricus
FMNH Birds 330226



Appendix 3 Character/taxon matrix, PAUP*/MrBayes scripts and character optimisation for all analyses

S3.1 Character matrix used in A1, A2 and A3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Eudromia elegans	1	0	0	0	1	-	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Chauna chavaria	1	0	0	1	0	-	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Charadris vociferus	1	0	0	0	1	-	0	0	0	0	1	0	0	0	?	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	1
Eurypyga helias	1	0	0	0	1	-	0	0	0	0	0	0	0	0	?	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Cathartes burrovianus	0	0	0	2	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0
Vultur gryphus	1	0	0	2	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0
Sagittarius serpentarius	0	0	0	2	1	-	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	1	0	0	1	0	1	0
Pandion haliaetus c.	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	0	1	0	0	0
Elanus caeruleus	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	0	1	0	0	0
Buteo rufofuscus	0	0	0	2	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	1	0	0	1	0	0	0
Accipiter nisus	0	0	0	2	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	1	0	0	1	0	0	0
Tyto alba	0	0	0	2	1	-	0	1	0	0	0	0	1	0	1	0	1	1	1	0	0	0	1	0	0	0	1	1	0	0	0
Strix aluco	0	0	0	2	1	-	0	1	0	0	0	0	1	0	1	0	1	1	1	0	0	0	1	0	0	0	1	1	0	0	0
Colius striatus kiwuensis	0	0	0	1	1	-	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	1
Urocolius macrourus pulcher	0	0	0	1	1	-	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	1
Leptosomus discolor	1	0	0	0	1	-	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	1	0	1	1	0	0	1
Apaloderma narina	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	1
Trogon melanurus e.	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	1
Upupa marginata	1	0	0	0	1	-	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	1
Tockus nasutus	1	0	0	1	1	-	0	0	0	0	0	0	?	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
Merops orientalis	1	0	0	0	1	-	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atelornis pittoides	1	0	0	0	1	-	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	1	0	1	0	0	1	0	0	0
Coracias benghalensis	1	0	0	0	1	-	0	0	0	0	0	0	1	0	?	0	0	0	1	0	1	0	1	0	1	0	0	1	0	0	0
Todus mexicanus	1	0	0	0	1	-	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Momotus momota	1	0	0	0	1	-	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Alcedo atthis	1	0	0	0	1	-	0	0	0	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Galbula dea	1	0	0	0	1	-	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
Indicator exilis p.	0	0	0	0	1	-	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Picus viridis	0	0	0	0	1	-	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0
Megalaima chrysopogon	1	0	0	0	1	-	0	1	0	0	0	0	1	0	?	0	0	0	0	0	1	1	0	0	0	0	0	2	1	1	0
Ramphastos ambiguus	1	0	0	0	1	-	0	1	0	0	0	0	?	1	2	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1	0
Cariama cristata	1	0	0	0	1	-	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1
Chunga burmeisteri	1	0	0	0	1	-	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1
Micrastur ruficollis c.	0	0	0	2	1	-	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0
Falco sparverius	0	0	1	2	1	-	0	0	0	0	0	1	0	0	1	0	0	1	1	1	0	1	1	1	0	0	0	1	0	0	0
Daptrius ater	0	0	0	2	1	-	0	0	1	0	0	1	0	0	1	0	0	1	1	1	0	1	1	1	0	0	0	1	0	0	0
Caracara cheriway	0	0	0	2	1	-	0	0	1	0	0	1	0	0	1	0	0	1	1	1	0	1	1	1	0	0	0	1	0	0	0
Nestor notabilis	0	1	0	1	1	-	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	3	0	1	0
Strigops habroptilus	0	1	0	1	1	-	1	1	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	3	0	1	0
Probosciger aterrimus	1	1	1	2	1	-	1	1	0	0	0	0	0	1	2	0	0	1	1	0	0	0	1	0	0	0	0	3	0	1	0
Barnardius zonarius	0	1	1	2	1	-	1	1	0	0	0	0	0	1	2	0	0	1	1	0	0	0	1	0	0	0	0	3	0	1	0
Psittrichas fulgidus	0	1	1	2	1	-	1	1	0	0	0	0	0	1	2	0	0	1	1	0	0	0	1	0	0	0	0	3	0	1	0
Psittacus erithacus	0	1	1	2	1	-	1	1	0	0	0	0	0	1	2	0	0	1	1	0	0	0	1	0	0	0	0	3	0	1	0
Deroptyus accipitrinus	0	1	1	2	1	-	1	1	0	0	0	0	0	1	2	0	0	1	1	0	0	0	1	0	0	0	0	3	0	1	0
Acanthisitta chloris	0	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Pitta sordida	0	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Neodrepanis coruscans	1	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melanopareia bitorquata	0	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Myrmornis torquata	1	0	0	0	1	-	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Myrmothera campanisona m.	0	0	0	0	1	-	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Neopelma chrysocephalum	0	0	0	0	1	-	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Rupicola peruvianus	0	0	0	1	1	-	0	1	0	0	0	0	?	0	0	0	0	0	1	1	0	1	0	0	0	0	0	1	0	0	0
Piprites chloris tschudii	0	0	0	0	1	-	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Tyrannus tyrannus	0	0	0	0	1	-	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Menura novaehollandiae	0	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Climacterus melanurus wellsi	0	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Malurus melanocephalus	0	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Corvus brachyrhynchos	0	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Sylvia borin	0	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zosterops lateralis	0	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Passer domesticus	0	0	0	0	1	-	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Palaeoplancus sternbergi	0	0	0	2	0	0	0	?	0	0	?	?	0	?	1	0	0	?	?	0	0	?	?	?	1	0	?	1	?	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primoptynx poliotauros	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillacolius brevidactylus	1	?	0	0	1	-	0	?	0	0	?	?	?	?	0	0	0	?	?	0	?	?	?	?	?	0	?	?	0	?	?
Eoglaucidium cf pallas	1	?	0	1	1	-	0	0	0	0	0	?	?	?	0	0	0	?	0	0	0	?	?	?	0	0	?	?	0	?	?
Eotrogon stenorhynchus	?	?	0	0	1	?	0	?	0	0	?	0	?	0	1	0	?	?	0	0	0	?	?	?	0	0	?	?	?	?	?
Messelirrisor halcyrostris	1	?	0	0	1	-	0	?	0	0	?	?	0	?	?	0	?	?	?	?	?	?	?	?	1	?	?	0	0	?	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Plesiocathartes wyomingensis	1	?	0	0	1	?	0	0	0	0	?	0	?	?	?	0	?	0	?	1	?	?	?	?	?	0	?	?	?	?	?

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Plesiocathartes kelleri	1	?	0	0	1	?	0	0	0	0	?	0	0	?	0	0	0	0	1	0	0	?	?	?	1	0	0	?	?	?	?
Waltonavis sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Bathornis grallator	1	?	0	0	1	-	0	0	?	0	?	0	0	0	?	0	0	?	0	0	0	0	-	0	1	0	0	2	0	0	0
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	?	?	0	2	0	?	0	?	0	0	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?
Masillaraptor cf parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor parvunguis	0	?	0	2	?	-	0	?	0	0	?	1	?	?	1	0	0	?	?	0	0	?	?	?	?	0	?	?	?	?	?
Eofringillirostrum boudreauxi	0	?	0	0	1	-	0	1	0	0	0	0	0	?	1	0	1	?	1	0	0	?	?	0	0	0	0	0	0	?	?
Zygodactylus grandei	0	?	0	0	1	-	0	0	0	0	0	0	0	?	0	0	1	?	0	0	0	0	-	0	0	0	0	0	0	?	?
Eozygodactylus americanus	0	?	0	0	1	-	0	0	0	0	0	0	0	?	0	0	1	?	0	0	0	0	-	0	0	0	0	0	0	?	?
Primozygodactylus quintus	0	0	0	0	1	-	0	1	0	0	?	0	0	?	0	0	1	?	0	0	0	0	-	0	1	1	0	0	0	?	0
Primozygodactylus longibrachium	?	0	0	0	1	-	0	1	0	0	?	0	?	?	0	0	1	?	?	0	0	0	?	0	1	?	0	0	0	?	0
Primozygodactylus eunjooae	1	0	0	0	1	-	0	1	0	0	?	0	?	?	0	0	1	?	0	0	0	0	-	0	1	0	0	0	0	?	?
Primozygodactylus danielsi	0	0	0	0	1	-	0	1	0	0	?	0	?	?	0	0	1	?	0	0	0	0	-	0	1	1	0	0	0	?	?
Primozygodactylus major	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	1	?	0	0	1	-	0	0	0	0	1	0	0	0	0	0	1	?	0	0	0	0	-	0	1	1	0	0	0	0	0
Parapsittacopes bergdahli	0	?	0	1	1	-	0	?	0	0	?	0	0	?	0	0	1	?	0	0	0	0	0	0	0	0	0	1	?	0	?
Psittacopes Lepidus	0	?	0	0	1	-	0	1	0	0	?	?	?	?	0	0	0	?	0	0	0	?	?	?	?	0	?	?	?	0	0
Psittacomimus eos	0	0	0	1	1	-	0	0	0	0	0	0	0	0	1	1	1	?	0	0	0	?	?	?	0	0	0	?	?	?	?
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	0	0	0	0	1	-	0	1	0	0	0	0	1	?	0	0	0	?	0	0	0	0	0	0	1	0	0	1	0	0	1
Cyrilavis colburnorum	0	0	0	0	1	-	0	0	0	0	0	0	0	?	1	0	0	?	0	0	0	0	0	0	1	0	0	1	0	0	1
Cyrilavis cf. colburnorum	?	?	?	0	1	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	?	?	0	0	1	-	0	?	0	0	0	0	?	?	1	0	?	?	?	0	0	?	?	?	?	?	?	?	0	0	1
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	0	?	0	2	0	-	0	?	1	0	?	?	1	?	1	0	1	?	1	0	0	?	?	0	0	?	?	1	0	?	?
Tynskya waltonensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya eocaena	0	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	1	?	0	0	1	-	0	0	?	0	?	0	1	?	1	?	1	?	?	0	0	?	?	0	0	?	?	?	?	0	?
Serudaptus pohli	1	?	0	0	1	-	0	?	0	0	?	0	0	?	0	0	0	?	?	0	0	0	?	0	1	?	0	1	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Eudromia elegans	0	1	0	0	0	0	1	2	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Chauna chavaria	1	1	0	0	0	0	?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charadris vociferus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0
Eurypyga helias	1	1	0	0	0	0	?	0	0	0	0	0	0	0	?	0	0	0	0	1	0	0	0	0	0	0	1	0	0
Cathartes burrovianus	1	0	0	0	0	1	0	2	1	0	0	0	0	0	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0
Vultur gryphus	1	0	0	0	0	0	0	2	1	0	0	0	0	0	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0
Sagittarius serpentarius	1	1	0	2	1	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Pandion haliaetus c.	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	?	?	0	0	0	1	0	0	0	0	0	0	0	0
Elanus caeruleus	0	0	0	2	1	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0
Buteo rufofuscus	1	0	0	2	1	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Accipiter nisus	1	0	0	2	1	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Tyto alba	0	0	0	2	0	2	1	2	1	0	0	0	0	0	1	0	1	0	0	0	2	0	1	0	0	0	1	0	1
Strix aluco	0	0	0	2	1	2	1	2	1	0	0	0	0	0	1	0	0	2	0	0	2	0	1	0	0	0	1	0	1
Colius striatus kiwuensis	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	1	0	0
Urocolius macrourus pulcher	0	0	1	0	0	0	0	0	-	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	1	0	0
Leptosomus discolor	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	2	0	0	2	0	0	0	0	0	1	0	0
Apaloderma narina	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	2	0	0	0	0	0	2	1	0	0	0	0
Trogon melanurus e.	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	1	0	0	0	0
Upupa marginata	0	1	1	0	0	-	-	-	-	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0
Tockus nasutus	1	1	1	0	0	-	-	-	-	0	0	0	0	0	0	0	2	0	0	0	1	0	0	1	1	0	0	0	0
Merops orientalis	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	1	0
Atelornis pittoides	1	1	0	1	0	2	1	1	1	0	0	0	0	0	0	0	1	2	0	0	2	1	0	1	0	0	0	1	0
Coracias benghalensis	0	1	0	1	1	2	1	1	1	0	0	0	0	0	0	0	1	2	0	0	2	1	0	1	0	0	0	1	0
Todus mexicanus	1	0	0	0	0	2	1	0	1	0	0	0	0	0	0	0	1	2	1	1	0	0	0	1	0	0	0	0	0
Momotus momota	1	1	1	0	0	-	-	-	-	0	0	0	0	0	0	0	?	2	0	0	1	0	0	1	0	0	0	1	0
Alcedo atthis	0	0	0	1	0	2	1	1	1	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	1	0
Galbula dea	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	2	0	0	0	0	0	1	1	0
Indicator exilis p.	0	1	1	0	0	-	-	-	-	0	0	0	0	0	0	1	2	1	0	0	1	0	0	0	0	0	0	0	0
Picus viridis	0	1	1	0	0	-	-	-	-	0	0	0	0	0	0	1	2	1	0	0	1	0	0	1	0	0	1	0	0
Megalaima chrysopogon	0	1	1	0	0	-	-	-	-	0	0	0	0	0	0	1	2	1	0	0	1	0	0	0	0	0	0	1	0
Ramphastos ambiguus	0	1	1	0	0	-	-	-	-	0	0	0	0	0	0	1	2	1	0	0	1	0	0	1	0	0	0	1	0
Cariama cristata	0	1	0	2	1	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	1	0	0	1	0	0	1	0	0
Chunga burmeisteri	0	1	0	2	1	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	1	0	0	1	0	0	1	0	0
Micrastur ruficollis c.	1	1	0	2	1	1	1	2	1	0	0	0	0	1	0	1	1	0	0	0	1	0	0	1	0	0	1	0	1
Falco sparverius	1	1	0	2	1	1	1	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0
Daptrius ater	0	1	0	2	1	1	1	2	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	0	0	1	0	0
Caracara cheriway	0	1	0	2	1	1	1	2	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	1	0	0
Nestor notabilis	0	1	0	0	0	1	0	1	1	1	0	0	0	0	1	0	2	0	0	0	0	0	0	1	0	0	0	0	0
Strigops habroptilus	0	1	0	0	0	1	0	0	1	1	1	0	0	0	1	0	2	0	0	0	2	0	0	2	1	0	0	0	0
Probosciger aterrimus	0	1	0	0	0	1	0	1	1	1	1	0	0	0	1	0	2	0	0	0	2	0	0	2	1	1	0	0	0
Barnardius zonarius	0	1	0	0	0	1	0	1	1	1	0	0	0	0	1	0	2	0	0	0	0	0	0	2	1	0	0	0	0
Psittrichas fulgidus	0	1	0	0	0	1	0	2	1	1	0	0	0	0	1	0	2	0	0	0	0	0	0	2	1	0	0	0	0
Psittacus erithacus	0	1	0	0	0	1	0	2	1	1	0	0	0	0	1	0	2	0	0	0	0	0	0	2	0	0	0	0	0
Deroptyus accipitrinus	0	1	0	0	0	1	0	2	1	1	1	0	0	0	1	0	2	0	0	0	2	0	0	2	0	1	0	0	0
Acanthisitta chloris	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	1	1	0	0	0	0	0	0	0	0	0
Pitta sordida	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	1	1	1	0	0	0	1	0	0	0	0	0
Neodrepanis coruscans	0	1	0	1	0	0	0	0	1	0	0	0	1	0	0	1	2	1	1	0	0	0	0	1	0	0	0	0	0
Melanopareia bitorquata	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	1	1	0	0	0	1	0	0	0	0	0
Myrmornis torquata	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	1	1	0	0	0	1	0	0	0	0	0
Myrmothera campanisona m.	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	1	1	0	0	0	1	0	0	0	0	0
Neopelma chrysocephalum	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	1	1	0	0	0	0	1	0	0	1	0	0
Rupicola peruvianus	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	0	0	0	0	0	1	0	0	1	0	0
Piprites chloris tschudii	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	1	1	0	0	0	1	0	0	1	0	0
Tyrannus tyrannus	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0	1	1	1	1	0	0	0	0	1	0	0	1	0	0
Menura novaehollandiae	0	1	0	1	0	1	1	2	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0
Climacterus melanurus wellsi	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	0	1	1	0	0	0	0	0	0	0	0
Malurus melanocephalus	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	1	1	0	0	0	1	0	0	0	0	0
Corvus brachyrhynchos	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	0	0	0	0	0	1	1	0	0	0	0
Sylvia borin	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	1	1	0	0	0	0	0	0	0	0	0
Zosterops lateralis	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	1	1	0	0	0	0	0	0	0	0	0
Passer domesticus	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	2	1	1	1	0	0	0	1	1	0	0	0	0
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	?	?	0	1	1	0	?	?	?	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primoptynx poliotauros	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillacolius brevidactylus	?	?	0	0	0	?	?	?	?	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eoglaucidium cf pallas	1	0	0	0	0	?	?	?	1	0	0	0	?	?	?	?	?	1	0	?	0	0	0	1	0	0	?	?	0
Eotrogon stenorhynchus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelirrisor halcyrostris	1	1	0	0	0	?	?	?	?	?	0	0	?	?	?	1	?	?	0	?	0	0	0	0	?	0	?	?	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Plesiocathartes wyomingensis	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Plesiocathartes kelleri	1	?	0	1	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	0	?	?	?	?	?	?	?
Waltonavis sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Bathornis grallator	1	1	0	0	0	1	?	2	?	0	0	?	0	0	1	?	0	0	0	?	1	0	0	0	0	0	1	0	?
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	?	?	0	2	1	0	0	2	1	0	0	0	0	0	0	0	?	?	0	?	1	0	0	?	?	0	?	0	?
Masillaraptor cf parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor parvunguis	?	?	0	2	1	?	?	?	?	0	0	?	?	?	?	?	?	?	?	?	1	0	?	1	?	0	?	?	?
Eofringillirostrum boudreauxi	0	0	0	0	0	0	-	0	0	0	0	0	1	0	0	1	1	1	?	?	?	?	?	?	?	0	?	0	?
Zygodactylus grandei	0	0	?	0	0	0	-	0	0	0	0	0	?	0	0	1	?	1	?	?	0	?	?	?	?	0	?	?	?
Eozygodactylus americanus	0	0	?	0	0	0	-	0	0	0	0	0	1	0	0	1	?	1	?	?	0	?	?	0	?	0	?	0	?
Primozygodactylus quintus	0	?	0	0	0	-	0	0	0	0	0	0	1	0	0	1	2	1	?	?	0	0	0	0	?	0	?	0	?
Primozygodactylus longibrachium	?	?	?	?	?	?	?	?	?	0	0	0	?	0	?	?	?	?	?	?	0	0	0	0	?	0	?	0	?
Primozygodactylus eunjooae	1	1	0	0	0	-	0	0	0	0	0	0	1	0	0	?	2	?	?	?	0	0	0	0	?	0	?	0	?
Primozygodactylus danielsi	1	1	0	0	0	-	0	?	0	0	0	0	0	0	?	?	?	?	?	?	0	0	0	0	?	0	?	0	?
Primozygodactylus major	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	1	0	0	0	0	?	?	?	1	0	0	0	?	?	0	2	1	1	?	?	0	-	-	0	-	-	?	?	?
Parapsittacopes bergdahli	0	0	0	1	0	1	1	0	?	0	0	0	0	0	?	?	?	?	?	?	0	?	?	1	0	0	?	?	?
Psittacopes Lepidus	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Psittacomimus eos	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	1	?	0	2	1	?	?	?	?	0	0	0	?	?	?	?	?	?	?	?	1	0	0	0	0	0	?	2	?
Cyrilavis colburnorum	0	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	?	0	1	0	0
Cyrilavis cf. colburnorum	?	?	0	2	1	?	?	?	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cyrilavis olsoni	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?
Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	0	?	0	?
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	1	?	0	2	1	?	?	?	?	0	0	0	?	?	?	?	?	?	0	?	1	0	0	0	?	0	0	?	0
Tynskya waltonensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Serudaptus pohli	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?	?	1	0	?	0	0	0	?	?	0	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
Eudromia elegans	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0
Chauna chavaria	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	1
Charadris vociferus	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	1	0	0
Eurypyga helias	1	0	0	1	0	1	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	0	0	1	0	0
Cathartes burrovianus	1	0	0	0	1	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0
Vultur gryphus	1	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Sagittarius serpentarius	?	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0
Pandion haliaetus c.	1	1	0	0	0	0	0	0	0	0	1	0	1	1	2	0	1	0	0	0	0	0	0	0	0	0	1	0	1
Elanus caeruleus	?	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Buteo rufofuscus	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Accipiter nisus	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Tyto alba	0	0	0	0	0	0	0	0	1	2	2	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	1	1
Strix aluco	0	0	0	0	0	0	0	0	1	2	2	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	1
Colius striatus kiwuensis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	1	0	0	2	0	0	0	0	0	0	1	0	0
Urocolius macrourus pulcher	?	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Leptosomus discolor	?	0	0	0	0	0	0	0	0	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apaloderma narina	?	1	0	0	0	1	0	0	0	2	3	1	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	1	1
Trogon melanurus e.	0	1	0	0	0	1	0	0	0	2	3	1	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	1	1
Upupa marginata	1	1	0	1	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	1	0	0	1	0	0	0	1
Tockus nasutus	1	0	0	1	0	1	0	0	0	0	0	0	1	0	2	0	-	0	0	0	0	0	1	0	0	0	0	0	1
Merops orientalis	0	0	0	1	0	0	0	0	0	0	3	0	1	0	2	0	0	0	0	2	0	0	1	0	0	0	0	1	1
Atelornis pittoides	0	1	0	1	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	1
Coracias benghalensis	0	1	0	1	0	0	0	1	0	0	0	0	1	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	1
Todus mexicanus	?	0	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	1
Momotus momota	1	1	0	1	0	0	0	0	0	0	3	1	0	0	2	0	0	0	0	0	0	1	0	0	0	0	1	0	1
Alcedo atthis	1	1	0	1	0	0	0	0	0	?	3	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Galbula dea	0	1	0	1	0	0	0	0	0	0	?	0	0	0	2	0	0	0	0	3	0	0	1	0	0	0	0	0	1
Indicator exilis p.	1	1	0	0	0	1	0	0	0	?	?	1	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Picus viridis	?	0	0	1	0	1	0	0	0	?	?	1	0	0	2	0	0	0	0	0	0	0	1	0	0	0	1	0	0
Megalaima chrysopogon	1	1	0	1	0	1	0	0	0	?	?	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Ramphastos ambiguus	1	1	0	1	0	1	0	0	0	0	2	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cariama cristata	1	0	0	1	0	0	0	0	0	0	0	0	1	0	2	0	0	0	1	0	0	0	0	0	0	0	1	0	1
Chunga burmeisteri	1	0	0	0	0	0	0	0	0	?	?	1	1	0	2	0	1	0	1	0	0	0	0	0	0	0	1	0	1
Micrastur ruficollis c.	0	1	0	0	0	0	0	1	0	?	?	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Falco sparverius	0	0	0	0	0	0	0	1	0	0	2	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Daptrius ater	?	1	0	0	0	0	0	1	0	2	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Caracara cheriway	?	1	0	0	0	0	0	1	0	?	?	0	1	0	2	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Nestor notabilis	1	1	0	0	0	0	0	0	0	0	?	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Strigops habroptilus	1	0	2	0	0	0	0	0	0	?	?	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0
Probosciger aterrimus	?	0	?	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	1	0	1	0	0
Barnardius zonarius	?	0	0	0	0	0	0	0	0	?	?	0	0	0	2	0	0	0	0	0	0	0	0	1	1	0	1	0	0
Psittrichas fulgidus	?	0	0	0	0	0	0	0	0	?	?	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Psittacus erithacus	1	0	0	0	0	0	0	0	0	?	?	0	0	0	2	0	0	0	0	0	0	0	0	1	1	0	1	0	0
Deroptyus accipitrinus	?	0	0	0	0	0	0	0	0	?	?	0	0	0	2	0	0	0	0	0	0	0	0	1	1	0	1	0	0
Acanthisitta chloris	?	0	1	0	0	0	1	0	0	0	?	0	0	0	2	0	0	1	0	0	0	0	1	0	1	0	1	0	0
Pitta sordida	1	0	1	0	0	0	1	0	0	0	3	0	0	0	2	0	0	1	0	0	0	0	1	0	1	0	1	0	0
Neodrepanis coruscans	?	0	1	0	0	0	1	0	0	0	3	0	0	0	2	0	0	1	0	0	0	0	1	0	1	0	1	0	0
Melanopareia bitorquata	?	0	1	0	0	0	0	0	0	?	?	0	0	0	2	0	0	1	0	3	0	0	1	0	1	0	1	0	0
Myrmornis torquata	?	0	-	0	0	0	0	0	0	?	?	0	0	0	2	0	0	1	0	3	0	0	1	0	1	0	1	0	0
Myrmothera campanisona m.	?	0	1	0	0	0	1	0	0	?	?	0	0	0	2	0	0	1	0	3	0	0	1	0	1	0	1	0	0
Neopelma chrysocephalum	?	0	1	0	0	0	1	0	0	?	?	0	0	0	2	0	0	1	0	3	0	0	1	0	1	0	1	0	0
Rupicola peruvianus	1	0	1	0	0	0	1	0	0	?	?	0	0	0	2	0	0	1	0	3	0	0	1	0	1	0	1	0	0
Piprites chloris tschudii	?	0	1	0	0	0	1	0	0	?	?	0	0	0	2	0	0	1	0	3	0	0	1	0	1	0	1	0	0
Tyrannus tyrannus	?	0	1	0	0	0	1	0	0	0	3	0	0	0	2	0	0	1	0	3	0	0	1	0	1	0	1	0	0
Menura novaehollandiae	0	0	2	0	0	0	0	0	0	?	?	0	0	0	2	0	0	1	0	3	0	0	1	0	0	0	1	0	0
Climacterus melanurus wellsi	0	0	2	0	0	1	?	0	0	?	?	0	0	0	2	0	0	1	0	3	0	0	1	0	1	0	1	0	0
Malurus melanocephalus	?	0	2	0	0	1	?	0	0	?	?	0	0	0	2	0	0	1	0	3	0	0	1	0	1	0	1	0	0
Corvus brachyrhynchos	0	0	2	0	0	1	?	0	0	0	0	0	0	0	2	0	0	1	0	3	0	0	1	0	0	0	1	0	0
Sylvia borin	?	0	2	0	0	1	?	0	0	?	?	0	0	0	2	0	0	1	0	3	0	0	1	0	0	0	1	0	0
Zosterops lateralis	?	0	2	0	0	1	?	0	0	?	?	0	0	0	2	0	0	1	0	3	0	0	1	0	0	0	1	0	0
Passer domesticus	1	0	2	0	0	1	?	0	0	?	?	1	0	0	2	0	0	1	0	3	0	0	1	0	1	0	1	0	0
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primoptynx poliotauros	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillacolius brevidactylus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eoglaucidium cf pallas	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eotrogon stenorhynchus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	1	?	?	?	?	?	?	?	?
Messelirrisor halcyrostris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	?	?	?	?	?	?	?	?
Plesiocathartes wyomingensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
Plesiocathartes kelleri	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Waltonavis sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	1	?	?	?	?	?	?	?	?
Bathornis grallator	?	?	?	?	?	?	?	?	?	?	?	0	?	?	2	0	?	?	1	0	0	?	?	0	?	?	?	?	1
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	0	?	?	?	?	0	?	?	?	?	?	?	?	?
Masillaraptor cf parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eofringillirostrum boudreauxi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Zygodactylus grandei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eozygodactylus americanus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus quintus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus longibrachium	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus eunjooae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus danielsi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus major	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Parapsittacopes bergdahli	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Psittacopes Lepidus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Psittacomimus eos	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	0	?	?	?	?	0	?	?	0	?	1	?	?	?
Cyrilavis colburnorum	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cyrilavis cf. colburnorum	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya waltonensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	?	?	0	0	0	1	0	0	0	1	1	0	0
Serudaptus pohli	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113
Eudromia elegans	0	1	0	0	0	2	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
Chauna chavaria	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Charadris vociferus	0	1	0	0	1	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Eurypyga helias	0	1	0	0	1	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	1	0
Cathartes burrovianus	0	1	0	0	1	0	-	-	-	-	1	-	-	-	-	0	1	0	0	1	1	0	1	0
Vultur gryphus	0	0	0	0	1	0	-	-	-	-	1	-	-	-	-	0	1	0	0	1	1	0	0	0
Sagittarius serpentarius	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Pandion haliaetus c.	0	0	0	0	1	2	0	0	0	0	0	2	0	0	0	1	0	0	0	1	0	0	1	0
Elanus caeruleus	0	0	0	0	1	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Buteo rufofuscus	0	0	0	0	1	2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Accipiter nisus	0	0	0	0	1	2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Tyto alba	0	0	0	0	1	2	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0
Strix aluco	0	0	0	0	1	0	-	-	-	-	0	1	1	0	1	0	0	0	0	0	0	0	1	0
Colius striatus kiwuensis	0	0	0	0	1	0	-	-	-	-	0	1	1	0	1	1	0	1	0	1	0	0	1	1
Urocolius macrourus pulcher	0	0	0	0	1	0	-	-	-	-	0	2	1	0	1	1	0	1	0	0	0	0	1	1
Leptosomus discolor	0	0	0	0	1	0	-	-	-	-	0	2	2	0	0	1	0	0	0	0	0	0	0	0
Apaloderma narina	0	0	0	0	1	1	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	1	0
Trogon melanurus e.	0	0	0	0	1	1	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	1	0
Upupa marginata	0	0	0	1	1	0	-	-	-	-	0	2	2	0	1	1	0	0	0	0	0	0	1	0
Tockus nasutus	0	0	0	1	1	0	-	-	-	-	0	2	2	0	?	1	0	0	0	1	0	0	1	0
Merops orientalis	0	0	0	0	1	1	0	0	0	0	0	2	2	0	1	1	0	0	0	1	0	0	0	0
Atelornis pittoides	0	0	1	0	1	0	-	-	-	-	0	2	2	0	0	1	0	0	0	1	0	0	0	0
Coracias benghalensis	0	0	0	0	1	1	0	0	0	0	0	2	2	0	0	1	0	0	0	1	0	0	0	0
Todus mexicanus	0	0	1	0	1	0	-	-	-	-	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Momotus momota	0	0	1	0	1	1	0	0	0	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0
Alcedo atthis	0	0	0	0	1	0	-	-	-	-	0	2	1	0	0	1	0	0	0	0	0	0	1	0
Galbula dea	0	0	0	1	1	1	0	0	0	0	0	2	1	0	1	1	0	0	0	0	0	0	1	0
Indicator exilis p.	0	0	1	0	1	1	1	1	1	0	1	-	-	-	-	0	0	0	0	0	0	0	1	0
Picus viridis	0	0	1	0	1	1	1	0	0	0	1	-	-	-	-	0	0	0	0	0	0	0	1	1
Megalaima chrysopogon	0	0	0	0	1	1	0	1	0	0	0	2	1	0	0	1	0	0	0	1	0	0	1	0
Ramphastos ambiguus	0	0	0	1	1	0	-	-	-	-	0	2	1	0	0	1	0	0	0	1	0	0	0	0
Cariama cristata	0	1	0	0	1	2	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	1	1	0
Chunga burmeisteri	0	1	0	0	1	2	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0
Micrastur ruficollis c.	0	1	0	0	1	2	1	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	2	0
Falco sparverius	0	1	0	0	1	2	1	0	0	0	0	0	1	0	1	1	0	0	1	1	0	1	2	0
Daptrius ater	0	1	0	0	1	2	1	0	0	0	0	0	1	0	0	1	0	0	1	1	0	1	2	0
Caracara cheriway	0	1	0	0	1	2	1	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	2	0
Nestor notabilis	1	0	0	0	1	0	-	-	-	-	0	2	1	0	0	1	0	0	0	0	0	0	0	0
Strigops habroptilus	1	0	0	0	1	0	-	-	-	-	0	2	1	0	0	1	0	0	0	0	0	0	0	0
Probosciger aterrimus	1	0	0	0	1	0	-	-	-	-	0	2	1	0	0	1	0	0	0	0	0	0	0	0
Barnardius zonarius	1	0	0	0	1	0	-	-	-	-	0	2	1	0	0	1	0	0	0	0	0	0	0	0
Psittrichas fulgidus	1	0	0	0	1	0	-	-	-	-	0	2	1	0	0	1	0	0	0	0	0	0	0	0
Psittacus erithacus	1	0	0	0	1	0	-	-	-	-	0	2	1	0	0	1	0	0	0	0	0	0	0	0
Deroptyus accipitrinus	1	0	0	0	1	0	-	-	-	-	0	2	1	0	0	1	0	0	0	0	0	0	0	0
Acanthisitta chloris	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Pitta sordida	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	?	0
Neodrepanis coruscans	0	0	?	0	1	2	1	?	1	0	0	?	?	?	?	?	0	0	0	0	0	0	1	0
Melanopareia bitorquata	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Myrmornis torquata	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Myrmothera campanisona m.	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Neopelma chrysocephalum	0	0	1	0	1	?	?	?	?	0	0	?	?	?	?	?	0	0	0	0	0	0	1	0
Rupicola peruvianus	0	0	1	0	1	2	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Piprites chloris tschudii	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Tyrannus tyrannus	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Menura novaehollandiae	0	0	1	0	1	2	1	2	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Climacterus melanurus wellsi	0	0	1	0	1	2	1	2	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Malurus melanocephalus	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Corvus brachyrhynchos	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Sylvia borin	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Zosterops lateralis	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Passer domesticus	0	0	1	0	1	2	1	1	1	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	0	0	0	0
Primoptynx poliotauros	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillacolius brevidactylus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	0
Eoglaucidium cf pallas	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?	0
Eotrogon stenorhynchus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	1	0	0	1	0
Messelirrisor halcyrostris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	1	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	0	0
Plesiocathartes wyomingensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113
Plesiocathartes kelleri	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Waltonavis sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Bathornis grallator	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	0	1	?	?	?	?	?	0	?
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	?	0	0	1	0	0
Masillaraptor cf parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?
Eofringillirostrum boudreauxi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?	0
Zygodactylus grandei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?	0
Eozygodactylus americanus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?	0
Primozygodactylus quintus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	0	1	0
Primozygodactylus longibrachium	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	?	0	?	?	0
Primozygodactylus eunjooae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	0	?	?	?	?	?
Primozygodactylus danielsi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	0	?	?	?	?	?
Primozygodactylus major	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?
Parapsittacopes bergdahli	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	0	0	1	0	0	0	0	0
Psittacopes Lepidus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?	?
Psittacomimus eos	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	0	0	0	0	0
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?
Cyrilavis colburnorum	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	?	0	?	0	0
Cyrilavis cf. colburnorum	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	1	?	1	?
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	1	1	1	0
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	0	0
Tynskya waltonensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	0
Tynskya eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	0
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	0	?	?	?	1	?	?	?	?	?	0	0	?	?	0	0	0	?	?	?	?	?	?	?
Serudaptus pohli	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
Eudromia elegans	1	0	-	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	-	0	1
Chauna chavaria	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0
Charadris vociferus	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-	1	0
Eurypyga helias	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-	1	0
Cathartes burrovianus	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	-	0	0
Vultur gryphus	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	-	0	0
Sagittarius serpentarius	1	0	-	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0
Pandion haliaetus c.	0	0	-	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0
Elanus caeruleus	0	1	1	2	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	-	0	0
Buteo rufofuscus	0	1	1	1	0	0	1	0	0	0	0	0	1	1	0	1	1	0	0	-	0	0
Accipiter nisus	0	1	1	2	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	-	0	0
Tyto alba	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0
Strix aluco	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
Colius striatus kiwuensis	1	0	-	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	1	0
Urocolius macrourus pulcher	1	0	-	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	1	0
Leptosomus discolor	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0
Apaloderma narina	1	0	-	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	-	1	0
Trogon melanurus e.	1	0	-	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	-	1	0
Upupa marginata	1	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	-	0	1
Tockus nasutus	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	1
Merops orientalis	1	1	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	-	0	1
Atelornis pittoides	1	0	-	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	-	0	0
Coracias benghalensis	0	1	1	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	-	0	0
Todus mexicanus	1	0	-	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	-	0	0
Momotus momota	1	0	-	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	-	0	0
Alcedo atthis	1	0	-	2	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	-	1	1
Galbula dea	1	0	-	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	-	0	1
Indicator exilis p.	1	0	-	1	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	-	0	0
Picus viridis	1	0	-	1	0	0	?	0	1	0	0	0	0	0	0	0	0	0	0	-	1	0
Megalaima chrysopogon	1	0	-	0	0	0	?	1	1	0	0	0	0	0	0	0	0	0	0	-	1	0
Ramphastos ambiguus	1	0	-	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	-	0	0
Cariama cristata	1	0	-	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
Chunga burmeisteri	1	0	-	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	2	0
Micrastur ruficollis c.	1	0	-	1	0	0	1	0	0	0	0	0	1	0	0	1	0	1	1	0	2	0
Falco sparverius	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
Daptrius ater	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
Caracara cheriway	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
Nestor notabilis	0	1	0	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	-	1	0
Strigops habroptilus	0	1	0	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	-	0	0
Probosciger aterrimus	0	1	0	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	-	0	0
Barnardius zonarius	0	1	0	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	-	0	0
Psittrichas fulgidus	0	1	0	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	-	0	0
Psittacus erithacus	0	1	0	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	-	1	0
Deroptyus accipitrinus	0	1	0	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	-	0	0
Acanthisitta chloris	1	0	-	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	-	1	0
Pitta sordida	1	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-	1	0
Neodrepanis coruscans	1	0	-	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-	1	0
Melanopareia bitorquata	1	0	-	1	0	0	0	1	0	0	0	1	1	0	0	0	0	1	0	-	1	0
Myrmornis torquata	1	0	-	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	-	1	0
Myrmothera campanisona m.	1	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-	1	0
Neopelma chrysocephalum	1	0	-	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-	1	0
Rupicola peruvianus	1	0	-	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	-	1	0
Piprites chloris tschudii	1	0	-	1	0	0	0	0	1	0	0	0	1	0	1	0	0	1	0	-	1	0
Tyrannus tyrannus	1	0	-	1	0	0	0	0	1	0	0	0	1	0	1	0	0	1	0	-	1	0
Menura novaehollandiae	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	-	1	0
Climacterus melanurus wellsi	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	-	1	0
Malurus melanocephalus	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	-	1	0
Corvus brachyrhynchos	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-	1	0
Sylvia borin	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	-	1	0
Zosterops lateralis	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	-	1	0
Passer domesticus	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	-	1	0
Palaeoplancus sternbergi	?	?	?	?	0	?	0	?	?	?	0	0	1	?	?	?	?	0	0	-	0	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	0	0	-	?	0	0	0	0	0	1	0	0	1	0	0	0	0	0	?	?	?	0
Primoptynx poliotauros	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillacolius brevidactylus	?	?	?	?	0	0	?	?	?	?	?	?	?	?	?	?	?	0	0	?	0	?
Eoglaucidium cf pallas	0	0	?	?	0	0	0	?	?	?	?	?	?	?	?	?	?	0	0	?	0	?
Eotrogon stenorhynchus	0	0	-	?	0	0	0	0	0	0	0	0	0	0	0	0	0	?	?	?	?	?
Messelirrisor halcyrostris	?	?	?	?	0	0	?	?	?	?	?	?	?	?	?	?	?	0	0	?	0	1
Plesiocathartes insolitipes	0	1	1	?	0	0	0	0	0	0	0	0	?	?	0	0	0	?	?	?	?	?
Plesiocathartes wyomingensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
Plesiocathartes kelleri	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	0	?
Waltonavis sp.	?	0	?	?	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Bathornis grallator	?	?	?	2	0	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	0	0
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	0	1	0	?	0	0	0	0	0	0	?	?	?	?	?	0	0	?	?	?	?	0
Masillaraptor cf parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor parvunguis	?	?	?	?	0	?	0	?	?	?	?	?	?	?	?	1	?	0	0	-	0	0
Eofringillirostrum boudreauxi	?	?	?	0	?	0	?	?	?	?	0	0	?	?	?	?	?	0	0	-	0	0
Zygodactylus grandei	?	?	?	1	?	?	?	?	?	?	?	0	?	?	?	?	?	0	0	-	0	?
Eozygodactylus americanus	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	0	0	-	0	0
Primozygodactylus quintus	1	1	0	1	0	0	0	0	0	0	0	0	0	0	?	1	1	0	0	-	0	0
Primozygodactylus longibrachium	1	?	?	1	0	0	0	?	?	?	0	0	0	0	?	?	?	0	0	-	0	?
Primozygodactylus eunjooae	1	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	0	0	-	0	?
Primozygodactylus danielsi	1	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	0	0	-	0	?
Primozygodactylus major	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	0	?
Parapsittacopes bergdahli	1	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	-	1	0
Psittacopes Lepidus	0	?	?	?	0	0	0	?	?	0	0	0	?	?	?	?	?	1	0	-	1	0
Psittacomimus eos	1	1	1	?	0	0	0	0	0	1	?	?	?	?	0	0	1	1	0	-	1	?
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	0	?	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	0	?
Cyrilavis colburnorum	?	?	?	1	0	?	?	?	?	?	0	0	0	?	0	?	?	0	0	-	0	0
Cyrilavis cf. colburnorum	?	?	?	?	?	?	1	0	0	?	?	?	?	?	1	0	0	0	0	-	0	0
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	?	?	0	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	0	0	-	?	0	0	1	0	0	1	?	?	?	?	1	0	0	?	?	?	?	?
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	?	?	?	?	0	0	?	0	?	0	?	?	?	?	?	?	?	0	0	?	?	?
Tynskya waltonensis	0	1	1	?	0	0	1	0	0	0	?	?	?	?	1	1	1	?	0	?	?	0
Tynskya eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya crassitarsus	0	1	1	?	0	0	1	0	0	0	?	?	?	?	1	1	1	?	0	?	?	0
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	0	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?
Serudaptus pohli	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	0	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157
Eudromia elegans	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Chauna chavaria	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0
Charadris vociferus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Eurypyga helias	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0
Cathartes burrovianus	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0
Vultur gryphus	0	1	0	0	0	0	1	0	0	0	0	1	0	0	1	0	2	0	0	1	0	0
Sagittarius serpentarius	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0
Pandion haliaetus c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0
Elanus caeruleus	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Buteo rufofuscus	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0
Accipiter nisus	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0
Tyto alba	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	?	0	0	0	0	0
Strix aluco	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
Colius striatus kiwuensis	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1
Urocolius macrourus pulcher	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	?	?	?	?	?
Leptosomus discolor	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	1	0	0	0	0
Apaloderma narina	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	1	0
Trogon melanurus e.	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	1	0
Upupa marginata	1	1	0	1	0	0	1	0	1	0	0	1	0	0	0	0	2	0	0	0	1	0
Tockus nasutus	1	1	0	1	0	0	1	0	1	0	1	0	0	1	0	0	2	0	0	0	1	0
Merops orientalis	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0
Atelornis pittoides	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	1	0
Coracias benghalensis	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	1	0
Todus mexicanus	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0
Momotus momota	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1	0
Alcedo atthis	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Galbula dea	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Indicator exilis p.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
Picus viridis	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Megalaima chrysopogon	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	?	?	?	?	?
Ramphastos ambiguus	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0
Cariama cristata	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Chunga burmeisteri	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Micrastur ruficollis c.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0
Falco sparverius	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	1	0	0
Daptrius ater	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	1	1	0
Caracara cheriway	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0
Nestor notabilis	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	2	0	1	0	1	0
Strigops habroptilus	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	2	?	?	?	?	?
Probosciger aterrimus	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	2	0	1	0	1	0
Barnardius zonarius	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	2	0	1	0	1	0
Psittrichas fulgidus	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	2	0	1	0	1	0
Psittacus erithacus	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	2	0	1	0	1	0
Deroptyus accipitrinus	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	2	0	1	0	1	0
Acanthisitta chloris	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	1	0
Pitta sordida	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0
Neodrepanis coruscans	1	0	0	0	0	0	1	0	0	0	?	0	0	0	0	0	0	0	0	0	1	0
Melanopareia bitorquata	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Myrmornis torquata	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0
Myrmothera campanisona m.	0	0	0	0	0	0	1	0	0	0	?	1	0	0	1	0	0	0	0	0	1	0
Neopelma chrysocephalum	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0
Rupicola peruvianus	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Piprites chloris tschudii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Tyrannus tyrannus	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
Menura novaehollandiae	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0
Climacterus melanurus wellsi	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0
Malurus melanocephalus	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	1	0
Corvus brachyrhynchos	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0
Sylvia borin	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0
Zosterops lateralis	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0
Passer domesticus	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
Palaeoplancus sternbergi	0	0	0	0	0	0	0	?	0	?	?	0	?	?	?	0	1	0	0	?	0	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	0	0	0	0	0	?	0	?	0	0	0	0	?	0	0	1	?	0	0	0	0	?
Primoptynx poliotauros	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillacolius brevidactylus	0	1	0	?	0	0	?	?	1	?	?	?	?	?	?	0	?	?	?	?	?	?
Eoglaucidium cf pallas	?	0	?	?	0	0	0	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?
Eotrogon stenorhynchus	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?
Messelirrisor halcyrostris	0	1	0	?	0	0	?	?	1	?	?	?	?	?	?	0	?	?	?	?	0	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	0	?
Plesiocathartes wyomingensis	0	0	?	?	0	0	0	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?

	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157
Plesiocathartes kelleri	0	0	?	?	0	0	0	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?
Waltonavis sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	1	?
Bathornis grallator	0	0	0	0	0	0	0	0	0	0	0	0	?	?	?	0	0	0	?	?	0	?
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	1	0	0	1	0	?	1	0	0	1	0	?	?	?	?	?	0	?	?	?	?	?
Masillaraptor cf parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor parvunguis	1	0	0	?	0	0	?	?	0	1	0	0	?	?	?	0	0	?	?	?	?	?
Eofringillirostrum boudreauxi	0	1	?	?	0	0	0	0	0	?	?	0	?	?	?	0	0	?	?	?	?	?
Zygodactylus grandei	0	0	?	?	0	0	0	?	1	?	?	?	?	?	?	0	0	?	?	?	?	?
Eozygodactylus americanus	0	0	?	?	0	0	0	?	1	?	?	1	?	?	?	0	0	?	?	?	?	?
Primozygodactylus quintus	0	0	0	?	0	0	0	?	1	?	?	?	?	?	?	1	0	0	?	?	0	0
Primozygodactylus longibrachium	?	0	0	?	0	?	1	?	1	?	?	?	?	?	?	0	0	0	?	?	0	0
Primozygodactylus eunjooae	?	0	0	?	0	0	0	?	1	?	?	0	?	?	?	0	0	0	?	?	0	0
Primozygodactylus danielsi	?	0	0	?	0	0	0	?	?	?	?	0	?	?	?	1	0	0	?	?	0	0
Primozygodactylus major	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	0	0
Pumiliornis tessellatus	0	0	?	?	0	0	0	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?
Parapsittacopes bergdahli	0	0	0	0	0	?	1	0	1	0	1	0	?	?	?	0	?	0	?	?	0	?
Psittacopes Lepidus	0	0	0	?	0	0	1	?	?	0	?	0	?	?	?	1	0	?	?	?	?	?
Psittacomimus eos	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	0	?
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	0	0	0	0	0	0	?	0	?	0	0	0	?	?	?	0	1	0	1	?	?	?
Cyrilavis colburnorum	0	0	?	?	0	0	0	?	?	0	1	?	?	?	?	0	0	0	0	?	0	0
Cyrilavis cf. colburnorum	0	0	0	0	0	?	1	0	0	0	1	0	1	1	0	0	1	?	?	?	?	?
Cyrilavis olsoni	?	?	?	?	0	0	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	0	0	?	0	1	0	0	?	?	?	?	0	?	?	?	1	0	?	?	?	?	?
Tynskya waltonensis	0	?	?	?	1	?	?	?	?	?	?	?	?	?	?	0	?	0	?	?	0	?
Tynskya eocaena	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya crassitarsus	0	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	?	0	?	?	?	?	?	0	0	0	0	0	0	0	0	0	?	?	?	?	?	?
Eurofluvioviridavis robustipes	0	0	0	0	0	0	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?
Serudaptus pohli	0	0	0	0	0	0	0	0	0	?	0	0	?	?	?	1	1	?	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179
Eudromia elegans	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	?	?	?	0	0	?	?
Chauna chavaria	0	0	0	1	1	0	0	0	0	0	0	0	0	-	0	?	?	?	0	0	0	?
Charadris vociferus	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	?
Eurypyga helias	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0
Cathartes burrovianus	0	1	0	0	1	0	0	0	1	0	0	0	0	1	1	0	1	0	0	1	0	1
Vultur gryphus	0	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	1
Sagittarius serpentarius	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	?	0	0	1	0	?
Pandion haliaetus c.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	0	1
Elanus caeruleus	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	?
Buteo rufofuscus	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1
Accipiter nisus	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1
Tyto alba	0	0	1	1	1	0	0	1	0	0	0	0	0	1	1	1	0	0	0	?	0	?
Strix aluco	0	0	1	0	1	0	0	1	0	0	0	0	0	1	1	1	0	0	0	?	0	?
Colius striatus kiwuensis	0	0	0	0	1	1	0	1	0	1	0	0	0	1	1	0	1	0	1	0	1	1
Urocolius macrourus pulcher	0	?	?	?	?	?	?	?	?	1	?	0	?	1	?	0	1	0	1	0	1	1
Leptosomus discolor	0	0	0	0	1	1	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1
Apaloderma narina	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	1
Trogon melanurus e.	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	?	1
Upupa marginata	0	1	0	0	1	1	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	1
Tockus nasutus	1	0	0	0	1	1	0	0	1	0	0	0	0	1	1	0	1	0	1	0	0	1
Merops orientalis	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	?	?	?	0	0	0	?
Atelornis pittoides	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	?	?	?	0	0	?	?
Coracias benghalensis	0	0	0	1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	?	?
Todus mexicanus	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Momotus momota	0	0	0	0	1	1	0	0	1	0	0	0	0	1	1	?	?	?	0	0	0	?
Alcedo atthis	0	0	0	0	1	0	0	1	0	1	0	0	0	1	1	0	0	0	0	0	0	0
Galbula dea	0	0	0	1	1	1	0	0	1	0	0	0	0	1	1	?	?	?	1	0	0	?
Indicator exilis p.	0	0	0	0	1	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0
Picus viridis	0	1	0	0	1	0	0	1	1	0	0	0	0	1	1	?	?	?	1	0	1	?
Megalaima chrysopogon	0	?	?	?	?	?	?	?	?	?	?	0	0	1	?	?	?	?	1	0	0	?
Ramphastos ambiguus	0	1	0	0	1	0	0	0	1	0	0	0	0	1	1	0	1	0	1	0	1	1
Cariama cristata	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	0	1
Chunga burmeisteri	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	?
Micrastur ruficollis c.	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1
Falco sparverius	0	0	1	0	1	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	1
Daptrius ater	0	0	?	0	1	0	0	0	0	0	1	0	0	1	1	?	?	1	0	0	0	?
Caracara cheriway	0	0	0	1	1	0	0	0	0	0	1	0	0	1	1	?	?	?	0	0	0	?
Nestor notabilis	0	0	0	0	0	1	0	1	0	0	0	0	2	1	1	?	1	0	0	0	0	1
Strigops habroptilus	0	?	?	?	?	?	?	?	?	?	?	0	2	1	?	?	?	?	0	0	?	?
Prosobsiger aterrimus	0	0	0	0	0	1	0	1	0	0	0	0	2	1	1	?	?	?	0	0	0	?
Barnardius zonarius	0	0	0	0	0	0	0	1	0	0	0	0	2	1	1	0	1	1	0	0	0	1
Psittrichas fulgidus	0	0	0	0	0	0	0	1	0	0	0	0	2	1	1	?	?	?	0	0	?	?
Psittacus erithacus	0	0	0	0	0	0	0	1	0	0	0	0	2	1	1	0	1	1	0	0	0	1
Deroptyus accipitrinus	0	0	0	0	0	0	0	1	0	0	0	0	2	1	1	?	?	?	0	0	0	?
Acanthisitta chloris	0	0	0	0	1	0	1	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0
Pitta sordida	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	?	?	?	0	0	?	?
Neodrepanis coruscans	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	1
Melanopareia bitorquata	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	1
Myrmornis torquata	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	?	?	?	0	0	?	?
Myrmothera campanisona m.	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	0	1	0	0	0	0	0
Neopelma chrysocephalum	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	?	?	?	0	0	?	?
Rupicola peruvianus	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	0	?	?	0	0	?	?
Piprites chloris tschudii	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	?	?	?	0	0	?	?
Tyrannus tyrannus	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	1
Menura novaehollandiae	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	?	?	?	0	0	1	?
Climacterus melanurus wellsi	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	?	?	?	0	0	?	?
Malurus melanocephalus	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	?	?	?	0	0	?	?
Corvus brachyrhynchos	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	0	1	0	0	0	0	1
Sylvia borin	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	1
Zosterops lateralis	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	1
Passer domesticus	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	0	1	0	0	0	0	0
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	0	0	0	0	0	?	1	0	1	?	?	1	?	?	?	?	?	?	?	?	?	?
Primoptynx poliotauros	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?
Masillacolius brevidactylus	?	?	?	?	?	?	?	?	?	?	0	?	0	1	1	?	?	?	?	?	?	?
Eoglaucidium cf pallas	?	?	?	?	?	?	?	?	?	0	0	0	?	1	?	?	?	?	0	?	?	1
Eotrogon stenorhynchus	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelirrisor halcyrostris	?	1	?	?	0	0	?	?	?	?	0	?	?	?	?	?	1	?	?	?	?	0
Plesiocathartes insolitipes	0	0	0	0	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?
Plesiocathartes wyomingensis	?	?	?	?	?	?	?	?	?	?	0	?	?	1	?	?	?	?	0	0	0	1

	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179
Plesiocathartes kelleri	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?
Waltonavis sp.	0	0	0	0	1	?	?	?	?	?	?	1	?	?	?	?	?	?	0	0	0	?
Bathornis grallator	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	0	0	0	0	?
Masillaraptor cf parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	1	0	?
Masillaraptor parvunguis	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	0	0	1	0	?
Eofringillirostrum boudreauxi	?	?	?	?	?	?	?	?	?	?	0	1	?	?	1	?	1	?	0	?	?	0
Zygodactylus grandei	?	?	?	?	?	?	?	?	?	?	0	1	?	1	0	?	?	?	0	?	?	?
Eozygodactylus americanus	?	?	?	?	?	?	?	?	?	?	0	?	?	1	1	?	?	?	0	?	?	0
Primozygodactylus quintus	0	0	0	?	?	?	?	?	?	?	0	1	?	1	1	0	1	?	0	0	?	1
Primozygodactylus longibrachium	0	0	0	?	?	?	?	?	?	?	?	1	?	1	1	0	?	?	0	0	?	1
Primozygodactylus eunjooae	0	0	0	?	?	?	?	?	?	?	?	1	?	1	1	0	?	?	0	0	?	1
Primozygodactylus danielsi	0	0	0	?	?	?	?	?	?	?	?	1	?	1	1	0	?	?	0	0	?	1
Primozygodactylus major	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	?	?	?	?	?	?	?	?	?	?	0	1	?	?	0	?	1	?	0	?	?	?
Parapsittacopes bergdahli	0	?	?	?	0	?	0	0	0	?	?	1	?	?	?	?	?	?	?	?	?	?
Psittacopes Lepidus	?	?	?	?	?	?	?	?	?	?	0	1	?	?	0	?	1	?	0	?	0	0
Psittacomimus eos	0	?	?	?	0	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	0	1	0	1
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	?	?	?	?	0	0	?	?	?	0	0	1	?	1	1	?	?	?	0	?	?	?
Cyrilavis colburnorum	0	0	0	?	0	?	?	?	0	0	0	1	?	1	1	0	0	?	0	?	?	0
Cyrilavis cf. colburnorum	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	?	?	?	?	0	0	?	?	?	?	0	0	?	?	1	?	0	?	0	?	?	0
Tynskya waltonensis	0	?	?	?	?	?	1	0	1	?	?	1	1	?	?	?	?	?	?	?	?	?
Tynskya eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	0	0	0	0
Serudaptus pohli	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201
Eudromia elegans	?	?	0	0	1	-	0	0	0	0	0	0	1	0	0	1	0	0	0	0	-	0
Chauna chavaria	?	?	0	1	1	-	0	0	0	-	-	-	0	0	1	0	0	0	2	1	1	0
Charadris vociferus	?	?	1	0	2	0	0	0	1	0	0	0	0	0	1	0	0	0	1	1	2	0
Eurypyga helias	0	0	1	0	2	0	0	0	0	-	-	-	0	0	0	0	1	0	0	1	2	1
Cathartes burrovianus	1	0	0	2	2	0	1	0	0	-	-	-	0	0	1	0	0	-	1	1	2	0
Vultur gryphus	1	0	0	2	1	0	-	0	0	-	-	-	0	0	1	0	0	-	0	1	2	0
Sagittarius serpentarius	?	?	0	0	0	-	-	1	0	-	-	-	0	0	1	0	0	-	?	1	1	0
Pandion haliaetus c.	1	1	0	0	1	0	-	0	1	0	0	0	0	0	0	0	1	-	1	1	1	0
Elanus caeruleus	?	?	0	0	1	-	1	0	0	-	-	-	0	0	0	0	1	-	0	1	1	0
Buteo rufofuscus	1	0	0	0	1	-	1	0	1	0	0	0	0	0	0	0	1	-	0	1	1	0
Accipiter nisus	1	1	1	0	1	-	1	0	1	0	1	0	0	0	0	0	1	-	0	1	1	0
Tyto alba	?	?	0	2	1	-	0	0	0	-	-	-	0	0	0	0	0	0	0	1	1	1
Strix aluco	0	0	0	2	2	0	0	0	1	1	0	0	0	0	0	0	1	0	2	1	2	1
Colius striatus kiwuensis	0	0	0	0	2	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	2	1
Urocolius macrourus pulcher	0	0	0	0	2	0	0	0	1	0	1	1	0	0	0	0	0	1	0	0	-	1
Leptosomus discolor	1	1	0	0	2	0	0	0	0	-	0	0	0	0	0	1	0	0	1	1	2	1
Apaloderma narina	0	1	1	0	2	1	1	0	1	1	1	0	0	0	0	1	0	1	0	1	2	1
Trogon melanurus e.	0	0	0	1	2	1	1	0	1	1	1	1	0	0	0	1	0	1	0	1	2	1
Upupa marginata	0	0	2	1	1	-	0	0	1	0	1	0	1	1	0	1	0	1	0	1	2	1
Tockus nasutus	0	0	0	1	1	-	0	0	1	0	1	0	1	1	1	0	0	0	0	1	2	1
Merops orientalis	0	0	0	1	2	0	0	0	1	1	1	0	1	1	0	0	0	1	0	1	1	1
Atelornis pittoides	?	?	1	0	2	0	0	0	1	1	1	0	0	0	0	1	0	1	0	1	2	1
Coracias benghalensis	?	?	0	0	2	0	0	0	1	0	1	0	0	0	0	1	0	1	0	1	1	1
Todus mexicanus	0	0	1	0	2	0	0	0	1	1	1	0	0	0	0	1	0	1	0	1	2	1
Momotus momota	?	?	0	1	2	1	1	0	1	1	1	0	0	0	0	1	0	0	0	1	2	1
Alcedo atthis	0	0	0	1	2	0	0	0	1	0	1	0	0	0	0	1	0	1	0	0	-	1
Galbula dea	?	?	0	1	2	0	0	0	1	0	1	0	0	0	0	1	0	1	0	1	1	1
Indicator exilis p.	0	0	0	1	2	0	0	0	1	0	1	1	0	0	0	1	0	1	0	1	2	1
Picus viridis	?	?	0	1	2	0	0	0	1	0	1	1	0	0	0	1	0	0	0	1	2	1
Megalaima chrysopogon	?	?	0	1	2	0	0	0	1	0	1	0	0	0	0	1	0	1	0	1	2	1
Ramphastos ambiguus	0	0	0	1	2	0	0	0	1	0	1	1	0	0	0	1	0	0	0	1	2	1
Cariama cristata	0	0	1	2	1	-	0	0	1	0	0	0	0	0	1	0	0	0	1	1	1	0
Chunga burmeisteri	?	?	1	2	1	-	0	0	1	0	0	0	0	0	1	0	0	0	1	1	1	0
Micrastur ruficollis c.	1	1	0	0	1	-	1	0	1	0	0	0	0	0	0	0	1	-	0	1	1	0
Falco sparverius	1	1	0	0	1	-	1	0	1	0	0	0	1	0	0	0	1	-	0	1	1	0
Daptrius ater	?	?	0	0	1	-	0	0	1	0	0	0	1	0	0	0	1	0	2	1	1	0
Caracara cheriway	?	?	0	0	1	-	0	0	1	0	0	0	1	0	0	0	1	0	2	1	1	0
Nestor notabilis	0	0	0	0	1	-	1	0	1	1	1	1	0	0	0	0	0	-	0	1	2	0
Strigops habroptilus	?	?	-	-	1	-	0	0	1	1	1	1	0	0	0	0	0	-	0	1	2	0
Probosciger aterrimus	?	?	2	0	1	-	1	0	1	1	1	1	0	0	0	0	0	-	0	1	2	0
Barnardius zonarius	0	0	2	0	1	-	1	0	1	1	1	1	0	0	0	0	0	-	0	1	2	0
Psittrichas fulgidus	?	?	2	0	1	-	1	0	1	1	1	1	0	0	0	0	0	-	0	1	2	0
Psittacus erithacus	0	0	2	0	1	-	1	0	1	0	1	1	0	0	0	0	0	-	0	1	2	0
Deroptyus accipitrinus	?	?	2	0	1	-	1	0	1	1	1	1	0	0	0	0	0	-	0	1	2	0
Acanthisitta chloris	0	0	0	2	2	1	0	0	1	1	1	0	0	0	0	0	0	1	0	0	-	0
Pitta sordida	?	?	1	0	1	-	0	0	1	1	1	1	0	0	0	1	0	1	0	0	-	1
Neodrepanis coruscans	0	0	1	0	1	-	0	0	1	1	1	1	0	0	0	1	0	1	0	0	-	1
Melanopareia bitorquata	0	0	0	0	2	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	-	1
Myrmornis torquata	?	?	0	0	1	-	0	0	1	1	1	1	0	0	0	0	0	1	0	0	-	1
Myrmothera campanisona m.	0	0	1	0	1	0	0	0	1	1	1	1	0	0	0	0	0	1	0	0	-	1
Neopelma chrysocephalum	?	?	1	0	1	-	0	0	1	1	1	1	0	0	0	1	0	1	0	0	-	1
Rupicola peruvianus	?	?	1	0	1	-	1	0	1	1	1	1	0	0	0	1	0	1	0	0	-	1
Piprites chloris tschudii	?	?	1	0	1	-	0	0	1	1	1	1	0	0	0	1	0	1	0	0	-	1
Tyrannus tyrannus	0	0	1	0	1	-	0	0	1	1	1	1	0	0	0	1	0	1	0	0	-	1
Menura novaehollandiae	?	?	0	0	1	-	0	0	1	1	1	1	0	0	0	0	1	0	0	1	1	1
Climacterus melanurus wellsi	?	?	0	0	1	-	0	0	1	1	1	1	0	0	0	0	0	1	0	0	-	1
Malurus melanocephalus	?	?	0	0	1	-	0	0	1	1	1	1	0	0	0	0	0	1	0	0	-	1
Corvus brachyrhynchos	0	0	1	0	1	-	0	0	1	1	1	1	0	0	0	1	0	1	0	0	-	1
Sylvia borin	0	1	0	0	1	-	0	0	1	1	1	1	0	0	0	1	0	1	0	0	-	1
Zosterops lateralis	0	0	0	0	1	-	0	0	1	1	1	1	0	0	0	0	0	1	0	0	-	1
Passer domesticus	0	0	0	0	1	-	0	0	1	1	1	1	0	0	0	0	0	1	0	0	-	1
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	?	?	?	?	2	0	0	0	1	0	0	0	0	0	0	0	?	0	0	0	-	0
Primoptynx poliotauros	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillacolius brevidactylus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eoglaucidium cf pallas	0	0	?	0	2	0	0	?	?	0	1	?	?	?	?	?	?	1	?	1	2	0
Eotrogon stenorhynchus	?	?	?	?	?	?	?	?	1	1	1	?	?	?	?	?	?	?	?	?	?	?
Messelirrisor halcyrostris	?	?	?	?	2	?	?	?	1	?	?	?	0	?	?	?	?	?	?	?	?	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	0	?	?	?	?	?	0	0	1	?	?	?	?	?
Plesiocathartes wyomingensis	1	0	0	0	2	0	0	?	?	?	?	?	?	?	?	?	?	0	0	?	0	1

	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201
Plesiocathartes kelleri	?	?	?	?	2	?	?	?	0	?	?	?	0	?	?	?	?	?	?	?	?	?
Waltonavis sp.	1	0	?	?	?	?	?	?	0	?	?	?	?	?	0	0	1	?	?	?	?	?
Bathornis grallator	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	1	1	?	?	?	?	?	?	1	1	0	0	0	0	0	0	1	?	?	?	?	?
Masillaraptor cf parvunguis	1	1	?	?	2	0	0	?	?	?	?	?	?	?	?	?	?	0	2	1	1	0
Masillaraptor parvunguis	1	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eofringillirostrum boudreauxi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Zygodactylus grandei	?	?	?	?	2	0	0	?	1	0	0	?	?	?	?	?	?	1	0	?	?	?
Eozygodactylus americanus	0	0	?	?	2	0	0	?	?	?	?	?	?	?	?	?	?	1	1	?	?	?
Primozygodactylus quintus	0	0	0	0	2	0	0	?	1	0	1	0	0	-	0	?	?	0	0	?	?	0
Primozygodactylus longibrachium	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus eunjooae	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus danielsi	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus major	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	?	?	?	2	2	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Parapsittacopes bergdahli	?	?	0	1	?	?	?	?	1	0	1	1	0	0	0	0	1	?	?	?	?	1
Psittacopes Lepidus	?	1	0	0	2	0	0	?	1	0	1	1	?	0	?	?	?	0	?	?	?	?
Psittacomimus eos	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis tenens	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	?	?	?	0	2	0	0	?	1	0	1	0	0	?	?	?	?	0	?	?	?	?
Cyrilavis colburnorum	0	0	?	?	2	0	0	?	?	?	?	?	?	?	?	?	?	1	0	?	?	?
Cyrilavis cf. colburnorum	?	?	0	1	?	?	?	?	1	0	1	0	0	0	?	?	?	?	?	?	?	?
Cyrilavis olsoni	?	?	1	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	1	0	2	0	0	0	1	0	0	1	0	0	?	?	?	0	0	?	?	1
Pulchrapollia eximia	?	?	?	?	?	?	?	?	1	0	?	0	?	?	?	?	?	?	?	?	?	1
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya waltonensis	?	?	?	?	?	?	?	?	1	0	0	0	?	?	?	?	?	?	?	?	?	?
Tynskya eocaena	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya crassitarsus	?	?	?	?	?	?	?	?	1	0	0	0	?	?	0	0	1	?	?	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Serudaptus pohli	?	?	0	1	2	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
Eudromia elegans	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0
Chauna chavaria	0	2	1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Charadris vociferus	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0
Eurypyga helias	0	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Cathartes burrovianus	0	1	1	0	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Vultur gryphus	0	1	1	0	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Sagittarius serpentarius	0	1	1	0	1	0	1	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0
Pandion haliaetus c.	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1
Elanus caeruleus	0	1	1	0	0	0	0	2	0	1	0	0	1	1	0	0	0	0	0	0	0	1
Buteo rufofuscus	0	2	1	0	1	0	0	2	0	1	0	0	1	1	0	0	0	0	0	0	0	1
Accipiter nisus	0	2	1	0	1	0	0	2	0	1	0	0	1	1	0	0	0	0	0	0	0	1
Tyto alba	0	0	1	0	1	0	0	1	0	0	0	0	0	2	0	1	0	0	0	0	0	0
Strix aluco	0	1	1	0	0	0	0	2	0	0	0	0	1	2	0	0	1	0	0	0	0	0
Colius striatus kiwuensis	0	0	1	1	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Urocolius macrourus pulcher	0	0	1	1	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Leptosomus discolor	0	1	1	0	0	0	0	2	0	0	0	0	0	2	0	1	0	0	1	0	1	0
Apaloderma narina	0	0	1	0	0	0	0	2	0	0	0	0	1	2	0	0	0	0	1	0	0	0
Trogon melanurus e.	0	0	1	0	0	0	0	2	0	0	0	0	1	1	0	0	0	0	1	0	0	0
Upupa marginata	0	0	1	0	1	0	0	0	0	0	0	0	0	2	1	1	0	0	?	0	?	0
Tockus nasutus	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	?	0	?	0
Merops orientalis	0	0	1	1	1	0	0	2	0	0	0	0	0	2	0	1	0	0	1	0	0	0
Atelornis pittoides	0	0	1	1	1	0	0	2	0	0	0	0	1	2	0	1	0	0	1	0	0	0
Coracias benghalensis	0	0	1	0	1	0	0	2	0	0	0	0	1	2	0	1	0	0	0	0	0	0
Todus mexicanus	0	0	1	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Momotus momota	0	0	1	0	1	0	0	2	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Alcedo atthis	0	0	1	0	1	0	0	2	0	0	0	0	0	1	1	0	1	0	?	0	?	0
Galbula dea	0	0	1	1	1	1	0	2	0	0	0	0	0	2	0	0	0	0	0	0	1	0
Indicator exilis p.	0	0	1	1	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Picus viridis	0	1	1	0	0	1	0	2	0	0	0	1	1	0	0	0	1	0	0	1	0	0
Megalaima chrysopogon	0	1	1	1	0	1	0	2	0	0	0	1	0	0	0	0	1	0	0	1	0	0
Ramphastos ambiguus	0	1	1	0	0	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Cariama cristata	0	1	1	0	2	0	0	0	0	0	0	0	0	2	1	1	1	0	1	0	1	0
Chunga burmeisteri	0	1	1	0	1	0	0	0	0	0	0	0	0	2	1	1	1	0	1	0	1	0
Micrastur ruficollis c.	0	1	1	0	0	0	0	1	0	0	0	0	1	2	0	1	0	0	1	0	0	0
Falco sparverius	1	1	1	0	1	0	0	1	0	0	0	0	1	2	0	1	0	0	0	0	0	0
Daptrius ater	1	1	1	0	1	0	0	1	0	0	0	0	1	2	0	1	0	0	1	0	0	0
Caracara cheriway	1	1	1	0	1	0	0	1	0	0	0	0	1	2	0	1	0	0	1	0	0	0
Nestor notabilis	0	1	1	0	2	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	1	0
Strigops habroptilus	1	1	1	0	0	0	0	0	0	0	1	0	?	?	?	?	?	?	?	?	?	?
Prosobsiger aterrimus	1	1	1	0	2	0	0	0	0	0	0	0	1	2	0	1	1	0	1	0	1	0
Barnardius zonarius	1	1	0	0	0	0	0	0	0	0	0	0	1	2	1	1	1	0	1	0	1	0
Psittrichas fulgidus	1	1	1	0	2	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	1	0
Psittacus erithacus	1	1	1	0	2	0	0	0	0	1	0	0	1	1	0	0	1	0	1	0	1	0
Deroptyus accipitrinus	1	1	0	0	2	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0
Acanthisitta chloris	0	0	1	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pitta sordida	0	0	1	1	0	0	0	2	0	0	0	0	?	?	?	?	?	1	?	0	?	0
Neodrepanis coruscans	0	1	0	0	1	0	0	2	0	0	0	0	1	2	0	0	0	0	0	0	0	0
Melanopareia bitorquata	0	1	1	1	0	0	0	2	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Myrmornis torquata	0	1	1	1	1	0	0	2	0	0	0	0	1	1	0	0	0	1	1	0	0	0
Myrmothera campanisona m.	0	1	1	1	1	0	0	2	0	0	0	0	1	0	0	0	0	1	1	0	0	0
Neopelma chrysocephalum	0	0	1	0	1	0	0	2	0	0	0	0	1	2	0	0	0	1	1	0	0	0
Rupicola peruvianus	0	0	1	0	1	0	0	2	0	0	0	0	1	2	0	0	0	1	1	0	0	0
Piprites chloris tschudii	0	0	1	0	1	0	0	2	0	0	0	0	1	2	0	0	0	1	1	0	0	0
Tyrannus tyrannus	0	0	1	0	1	0	0	2	0	0	0	0	1	2	0	0	0	1	1	0	0	0
Menura novaehollandiae	0	1	0	0	1	0	0	2	0	1	0	0	1	0	0	0	0	0	1	0	1	0
Climacterus melanurus wellsi	0	1	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	1	0
Malurus melanocephalus	0	1	1	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Corvus brachyrhynchos	0	1	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	1	0
Sylvia borin	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Zosterops lateralis	0	1	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Passer domesticus	0	1	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	1	1	0	0	1	0	0	0	1	0
Ypresiglaux michaeldanielsi	0	1	1	0	?	0	0	?	?	?	0	0	0	1	0	1	0	1	1	0	1	0
Primoptynx poliotauros	?	?	?	?	?	?	?	?	?	?	?	?	1	?	0	0	1	0	0	0	0	0
Masillacolius brevidactylus	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	0	0	0	0	0
Eoglaucidium cf pallas	?	?	1	0	?	?	?	?	?	?	0	0	0	0	0	0	0	0	0	0	0	0
Eotrogon stenorhynchus	?	0	?	?	?	?	?	?	?	?	?	?	0	2	0	0	0	1	1	0	1	0
Messelirrisor halcyrostris	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	?	?	?	?	?	?	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	1	0	0	0	0	0
Plesiocathartes wyomingensis	?	1	1	?	?	?	?	?	?	?	0	0	?	?	?	?	?	?	?	?	?	?

	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
Plesiocathartes kelleri	?	?	1	?	?	?	?	?	?	?	0	0	?	2	0	0	?	?	?	0	?	0
Waltonavis sp.	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	1	0	0	0
Bathornis grallator	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	?	0
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	0	2	1	1	0	0	?	0	1	0
Danielsraptor phorusrhacoides	?	?	?	?	?	?	?	?	?	?	?	0	1	2	0	0	0	0	1	0	0	0
Masillaraptor cf parvunguis	?	?	?	0	?	?	?	?	?	?	?	0	0	2	0	1	0	0	1	0	0	0
Masillaraptor parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?
Eofringillirostrum boudreauxi	?	?	?	?	?	?	?	?	?	?	0	0	?	0	0	-	0	?	?	0	?	0
Zygodactylus grandei	?	?	?	1	?	?	?	?	?	?	0	0	?	0	?	-	0	0	?	0	?	0
Eozygodactylus americanus	?	?	?	?	?	?	?	?	?	?	0	0	?	0	?	-	?	?	?	?	?	0
Primozygodactylus quintus	?	?	1	0	?	?	?	?	?	?	0	0	0	0	0	0	0	0	0	0	0	0
Primozygodactylus longibrachium	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	0	0	0	0	0
Primozygodactylus eunjooae	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	0	0	0	0	0
Primozygodactylus danielsi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?
Primozygodactylus major	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	0	0	0	0	0
Pumiliornis tessellatus	?	?	1	?	?	?	?	?	?	?	?	?	0	2	0	1	0	1	1	0	0	0
Parapsittacopes bergdahli	1	?	?	?	?	?	?	?	?	?	0	0	0	2	0	1	0	1	1	0	0	0
Psittacopes Lepidus	?	?	1	?	?	?	?	?	?	?	0	0	?	1	0	0	0	1	0	0	0	0
Psittacomimus eos	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	1	0	0	0
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	?	?	1	0	?	?	?	?	?	?	0	?	?	1	0	0	0	0	0	0	0	?
Cyrilavis colburnorum	?	?	1	0	?	?	?	?	?	?	0	0	0	2	0	?	0	0	?	0	0	0
Cyrilavis cf. colburnorum	?	?	?	?	?	?	?	?	?	?	0	0	0	2	0	1	0	0	1	0	0	0
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	0	?	1	0	?	?	0	?	?	?	0	0	0	2	0	1	0	0	1	0	0	?
Pulchrapollia eximia	?	0	?	?	?	?	?	?	?	?	?	?	0	2	0	1	0	0	1	0	0	?
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	1	1	0	0	0	0	0
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	1	1	0	0	0	0	0
Messelastur gratulator	?	1	?	?	?	?	?	?	?	?	?	?	?	1	0	0	0	0	1	0	0	?
Tynskya waltonensis	?	?	?	?	?	?	?	?	?	?	?	?	0	2	0	1	0	1	1	0	0	0
Tynskya eocaena	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	?	0	1	1	0	0	0
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	0	?	0	?	0	1	1	0	0	0
Eurofluvioviridavis robustipes	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	0	?	?	?	?	?
Serudaptus pohli	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	0	0	?	0	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	1	0	0	0	0	0

	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245
Eudromia elegans	-	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Chauna chavaria	-	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Charadris vociferus	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0
Eurypyga helias	-	1	0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1
Cathartes burrovianus	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Vultur gryphus	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Sagittarius serpentarius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Pandion haliaetus c.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
Elanus caeruleus	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	2
Buteo rufofuscus	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	2
Accipiter nisus	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	2
Tyto alba	1	0	1	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	2
Strix aluco	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	2
Colius striatus kiwuensis	-	1	1	0	0	0	0	0	0	1	0	1	-	0	1	0	0	0	1	0	1	1
Urocolius macrourus pulcher	-	1	1	0	1	0	0	0	0	1	0	1	-	0	1	0	0	0	1	0	2	1
Leptosomus discolor	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	2
Apaloderma narina	-	1	1	0	1	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	2	1
Trogon melanurus e.	-	1	1	0	1	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	2	1
Upupa marginata	-	1	1	0	1	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1
Tockus nasutus	-	1	1	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1
Merops orientalis	-	1	1	0	1	0	0	0	0	1	0	0	1	0	1	0	0	0	1	1	0	1
Atelornis pittoides	-	1	1	0	1	1	0	0	0	0	1	0	2	0	1	0	0	0	1	0	2	1
Coracias benghalensis	-	1	1	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1	1
Todus mexicanus	-	1	1	0	1	1	1	0	0	0	0	0	1	0	1	0	1	0	1	0	0	1
Momotus momota	-	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1
Alcedo atthis	-	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	1
Galbula dea	-	1	1	0	1	1	1	1	0	0	0	0	1	1	1	0	1	0	0	1	0	1
Indicator exilis p.	-	1	1	0	1	1	1	1	0	0	0	0	1	1	1	1	1	0	1	0	0	0
Picus viridis	-	1	1	0	1	0	0	1	0	0	0	0	1	1	1	1	0	0	1	0	0	0
Megalaima chrysopogon	-	1	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	0	0	0
Ramphastos ambiguus	-	1	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	1	0	0	0
Cariama cristata	-	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Chunga burmeisteri	-	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0
Micrastur ruficollis c.	1	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
Falco sparverius	-	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
Daptrius ater	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	2
Caracara cheriway	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	2
Nestor notabilis	-	1	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
Strigops habroptilus	-	1	1	0	0	1	0	0	0	0	0	?	0	0	?	?	0	0	0	0	0	?
Prosobsciger aterrimus	-	1	1	0	1	1	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1
Barnardius zonarius	-	1	1	0	1	1	1	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1
Psittrichas fulgidus	-	1	1	0	1	1	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1
Psittacus erithacus	-	1	1	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
Deroptyus accipitrinus	-	1	1	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
Acanthisitta chloris	-	1	1	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	1	0	1	0
Pitta sordida	-	1	1	0	0	0	0	0	0	0	1	0	?	0	1	0	0	0	?	?	?	?
Neodrepanis coruscans	-	1	1	0	0	0	0	0	0	0	1	0	?	0	1	0	1	0	1	0	2	0
Melanopareia bitorquata	-	1	1	0	0	0	0	0	0	0	1	0	?	0	1	0	1	0	1	0	2	0
Myrmornis torquata	-	1	1	0	0	0	0	0	0	0	1	0	?	0	1	0	0	0	1	0	2	0
Myrmothera campanisona m.	-	1	1	0	0	0	0	0	0	0	1	0	?	0	1	0	0	0	1	0	2	0
Neopelma chrysocephalum	-	1	1	0	0	0	0	0	0	0	1	0	?	0	1	0	1	0	1	0	2	0
Rupicola peruvianus	-	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	0
Piprites chloris tschudii	-	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	2	0
Tyrannus tyrannus	-	1	1	0	0	0	0	0	0	0	1	1	-	0	1	0	0	0	1	0	2	0
Menura novaehollandiae	-	1	1	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	1
Climacterus melanurus wellsi	-	1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	2	0
Malurus melanocephalus	-	1	1	0	0	0	0	0	0	0	1	1	-	0	1	0	0	0	1	0	2	0
Corvus brachyrhynchos	-	1	1	0	1	1	0	0	0	0	1	0	1	0	1	0	0	0	1	0	2	0
Sylvia borin	-	1	1	0	1	0	0	0	0	0	1	0	2	0	1	0	0	0	1	0	2	0
Zosterops lateralis	-	1	1	0	1	0	0	0	0	0	1	0	2	0	1	0	0	0	1	0	2	0
Passer domesticus	-	1	1	0	1	0	0	0	0	0	1	0	2	0	1	0	0	0	1	0	2	0
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	?	?	0	?	?	?	?
Ypresiglaux michaeldanielsi	1	0	1	0	1	1	1	0	1	0	0	0	0	0	1	?	0	0	1	0	0	1
Primoptynx poliotauros	0	0	0	0	?	?	?	0	0	0	0	0	0	0	1	?	0	0	?	?	?	?
Masillacolius brevidactylus	-	1	1	0	0	0	0	0	0	0	0	?	?	?	1	?	0	0	?	0	0	?
Eoglaucidium cf pallas	0	0	1	0	1	0	0	0	0	0	0	1	?	?	1	?	?	0	0	0	0	?
Eotrogon stenorhynchus	-	1	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2	1
Messelirrisor halcyrostris	-	1	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	0	?
Plesiocathartes insolitipes	0	0	0	0	?	0	0	0	?	?	0	0	0	0	0	?	0	0	0	0	0	1
Plesiocathartes wyomingensis	1	0	0	0	1	0	0	?	?	?	?	?	?	?	?	?	?	0	?	?	0	?

	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245
Plesiocathartes kelleri	?	?	?	?	?	?	?	0	?	?	0	?	?	?	?	?	?	0	0	?	0	?
Waltonavis sp.	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	?	0	0	0	0	1	0
Bathornis grallator	-	1	0	0	0	0	0	0	0	0	0	0	?	0	1	?	?	0	?	?	?	?
Dynamopterus sp.	-	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	?	?	?	0
Danielsraptor phorusrhacoides	0	0	0	0	?	?	?	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1
Masillaraptor cf parvunguis	1	0	0	0	1	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1
Masillaraptor parvunguis	?	0	0	?	?	?	?	?	1	0	?	?	?	?	?	?	?	0	0	0	0	1
Eofringillirostrum boudreauxi	-	1	1	?	?	0	0	?	?	0	0	?	?	?	?	?	0	0	0	0	0	1
Zygodactylus grandei	-	1	1	?	0	0	0	0	1	0	0	?	?	?	?	?	0	0	1	0	1	0
Eozygodactylus americanus	-	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?
Primozygodactylus quintus	-	1	1	0	1	1	0	0	0	?	0	0	2	0	1	?	0	0	1	0	2	0
Primozygodactylus longibrachium	-	1	1	?	1	?	?	0	?	?	?	?	?	?	?	?	?	?	1	0	2	0
Primozygodactylus eunjooae	-	1	1	0	1	1	0	0	1	0	0	0	2	0	1	?	0	0	1	0	2	?
Primozygodactylus danielsi	-	1	1	?	1	?	?	0	?	?	?	?	?	?	?	?	?	?	1	0	2	?
Primozygodactylus major	-	1	1	0	0	1	0	0	1	0	0	0	2	0	1	?	0	0	1	0	2	0
Pumiliornis tessellatus	-	1	1	?	0	?	?	?	0	0	0	?	?	?	?	?	?	0	0	0	1	1
Parapsittacopes bergdahli	-	1	1	0	0	0	0	0	?	?	1	0	2	0	1	?	?	0	?	?	1	1
Psittacopes Lepidus	-	1	1	?	0	1	0	0	?	?	?	?	?	?	?	?	0	0	0	0	1	1
Psittacomimus eos	-	1	1	0	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	1	1
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	1	0	1	?	0	0	0	0	1	0	0	?	?	0	1	?	?	0	0	0	0	1
Cyrilavis colburnorum	1	0	0	0	1	1	1	0	1	0	0	0	0	?	1	?	0	0	0	0	0	2
Cyrilavis cf. colburnorum	1	0	0	0	0	0	0	0	1	0	0	0	0	?	1	?	0	0	0	0	?	2
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	?
Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	1	0	0	0	1	1	1	0	0	0	0	0	0	?	1	?	0	0	0	0	0	1
Pulchrapollia eximia	1	0	0	0	1	1	1	0	0	0	0	0	0	?	1	?	0	0	0	0	0	1
Vastanavis eocaena	-	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	?	?	0	1
Vastanavis cambayensis	-	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	?	?	0	1
Messelastur gratulator	0	0	0	?	0	?	?	0	?	?	?	?	?	?	1	?	?	0	0	0	0	1
Tynskya waltonensis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	?	0	0	0	0	0	1
Tynskya eocaena	0	0	0	?	0	?	?	0	?	?	0	0	?	?	?	?	?	0	0	0	0	1
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	1
Tynskya brevitarsus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	?	0	?	?	?	?	?
Eurofluvioviridavis robustipes	?	0	?	1	1	0	1	?	0	0	?	?	?	?	?	?	?	0	?	?	?	?
Serudaptus pohli	?	?	?	?	0	?	?	0	0	0	?	?	?	?	?	?	?	?	0	0	1	1
Quercypsitta sudrei	-	1	0	0	?	?	?	0	0	0	0	0	0	0	1	?	0	0	?	?	?	?

	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267
Eudromia elegans	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0
Chauna chavaria	1	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0
Charadris vociferus	0	0	0	0	0	0	1	0	1	0	1	1	0	0	1	0	0	0	0	0	1	0
Eurypyga helias	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0
Cathartes burrovianus	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0
Vultur gryphus	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0
Sagittarius serpentarius	0	0	0	0	0	0	?	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
Pandion haliaetus c.	0	0	0	0	0	0	1	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0
Elanus caeruleus	0	0	0	0	1	0	1	0	0	0	0	1	1	1	0	0	0	0	1	0	0	0
Buteo rufofuscus	0	0	0	1	1	0	1	0	0	0	0	2	1	1	0	0	0	0	1	0	1	0
Accipiter nisus	0	0	1	0	1	0	1	0	0	0	0	2	1	1	0	0	0	0	1	0	0	0
Tyto alba	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	1	1	0	0
Strix aluco	0	0	0	1	1	0	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0
Colius striatus kiwuensis	0	0	0	0	1	1	2	0	0	0	0	2	0	1	1	0	1	1	1	0	1	1
Urocolius macrourus pulcher	0	1	0	0	1	1	2	0	0	0	0	2	0	1	1	0	1	1	1	0	1	1
Leptosomus discolor	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Apaloderma narina	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0	0	0	0	1	0
Trogon melanurus e.	0	0	0	0	0	1	0	0	1	0	1	2	0	1	1	0	0	0	0	0	1	0
Upupa marginata	0	0	0	0	0	0	1	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0
Tockus nasutus	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
Merops orientalis	0	1	0	0	1	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0
Atelornis pittoides	0	1	0	0	1	0	1	0	0	0	1	2	0	1	1	0	0	0	0	0	1	0
Coracias benghalensis	0	1	0	1	1	0	1	0	0	0	1	2	0	1	1	0	0	0	0	0	1	0
Todus mexicanus	0	1	0	0	1	0	2	1	0	0	1	2	0	0	1	0	0	0	0	0	1	0
Momotus momota	0	1	0	1	1	0	2	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0
Alcedo atthis	0	1	0	0	1	0	?	0	0	0	1	1	0	0	1	0	0	0	0	0	1	1
Galbula dea	0	0	0	0	1	0	2	1	1	0	0	2	0	0	1	0	0	0	0	0	1	0
Indicator exilis p.	0	1	0	0	1	0	2	1	0	1	0	2	0	0	1	0	0	0	0	0	1	0
Picus viridis	0	1	0	0	1	0	2	1	0	1	0	2	0	0	1	0	0	0	0	0	1	1
Megalaima chrysopogon	0	1	0	0	1	1	2	1	0	1	0	2	0	1	1	0	0	0	0	0	1	0
Ramphastos ambiguus	0	1	0	1	1	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	1	0
Cariama cristata	0	0	0	0	1	0	?	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0
Chunga burmeisteri	0	0	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0
Micrastur ruficollis c.	0	1	1	1	1	0	1	0	0	1	0	2	0	1	0	0	0	0	1	0	1	0
Falco sparverius	0	0	1	1	1	0	1	0	0	1	0	2	0	1	0	0	0	0	1	0	1	0
Daptrius ater	0	0	1	1	1	0	1	0	0	1	0	2	1	1	0	0	0	0	1	0	1	0
Caracara cheriway	0	1	1	1	1	0	1	0	0	1	0	2	1	0	0	0	0	0	1	0	1	0
Nestor notabilis	0	0	0	0	1	0	2	0	2	1	1	2	1	2	1	0	0	0	1	1	1	0
Strigops habroptilus	0	0	?	?	?	?	2	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?
Prosobsiger aterrimus	0	0	0	1	1	0	2	0	2	1	1	2	1	2	1	0	0	0	1	1	1	0
Barnardius zonarius	0	0	0	1	1	0	2	0	2	1	0	2	1	2	1	0	0	0	1	1	1	0
Psittrichas fulgidus	0	0	0	1	1	0	2	0	2	1	1	2	1	2	1	0	0	0	1	1	1	0
Psittacus erithacus	0	0	0	1	1	0	2	0	2	1	1	2	1	2	1	0	0	0	1	1	1	0
Deroptyus accipitrinus	0	0	0	1	1	0	2	0	2	1	1	2	1	2	1	0	0	0	1	1	1	0
Acanthisitta chloris	0	1	1	0	1	1	2	1	0	1	1	0	0	2	1	0	0	0	0	0	1	0
Pitta sordida	0	0	0	0	1	0	2	1	0	1	0	2	0	2	1	0	0	0	0	0	1	0
Neodrepanis coruscans	0	1	0	0	1	1	2	1	0	1	0	2	0	2	1	0	0	0	0	0	1	0
Melanopareia bitorquata	0	1	0	0	1	1	2	1	0	0	0	2	0	2	1	0	0	0	0	0	1	0
Myrmornis torquata	0	1	0	0	1	0	2	1	0	0	0	2	0	2	1	0	0	0	0	0	1	0
Myrmothera campanisona m.	0	1	0	0	1	0	2	1	0	1	0	2	0	2	1	0	0	0	0	0	1	0
Neopelma chrysocephalum	0	1	0	1	1	1	2	1	0	0	0	2	0	2	1	0	0	0	0	0	1	0
Rupicola peruvianus	0	0	0	1	1	0	2	1	0	1	0	2	0	2	1	0	0	0	0	0	1	0
Piprites chloris tschudii	0	0	0	0	1	1	2	1	0	1	0	2	0	2	1	0	0	0	?	0	1	0
Tyrannus tyrannus	0	0	0	0	1	1	2	1	0	0	0	2	0	2	1	0	0	0	0	0	1	0
Menura novaehollandiae	0	1	0	0	1	0	2	0	0	0	1	2	0	2	1	1	0	0	0	0	1	0
Climacterus melanurus wellsi	0	1	0	0	1	1	2	1	0	1	1	2	0	2	1	1	0	0	0	0	1	0
Malurus melanocephalus	0	1	0	0	1	1	2	1	0	1	1	2	0	2	1	1	0	0	0	0	1	0
Corvus brachyrhynchos	0	1	0	0	1	0	2	1	0	0	0	2	0	2	1	1	0	0	0	0	1	0
Sylvia borin	0	1	0	0	1	1	2	1	0	0	1	2	0	2	1	1	0	0	0	0	1	0
Zosterops lateralis	0	1	0	0	1	1	2	1	0	0	1	2	0	2	1	1	0	0	0	0	1	0
Passer domesticus	0	1	0	0	1	0	2	1	0	0	1	2	0	2	1	1	0	0	0	0	1	0
Palaeoplancus sternbergi	1	?	?	?	?	?	?	0	?	0	?	?	?	?	?	?	?	?	?	?	0	0
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	0	1	0	0	?	0	?	0	?	?	1	?	?	?	?	?	?	1	0	1	0
Ypresiglaux michaeldanielsi	0	1	0	0	0	?	2	0	?	0	0	1	?	?	?	?	?	0	0	0	?	?
Primoptynx poliotauros	?	?	?	?	?	?	1	0	0	0	?	1	?	?	?	?	?	0	0	?	1	0
Masillacolius brevidactylus	0	0	0	0	0	0	2	?	0	?	?	?	0	0	1	?	?	?	?	?	?	?
Eoglaucidium cf pallas	?	0	?	?	?	0	?	?	1	0	?	1	?	1	0	?	?	0	?	?	0	?
Eotrogon stenorhynchus	0	0	1	0	1	?	0	0	1	0	0	?	?	0	0	0	0	0	1	0	1	0
Messelirrisor halcyrostris	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?
Plesiocathartes insolitipes	0	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Plesiocathartes wyomingensis	?	?	?	?	?	0	?	?	0	?	?	?	?	1	0	0	0	?	0	?	?	?

	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267
Plesiocathartes kelleri	?	0	0	0	0	0	1	?	0	0	0	?	?	1	0	0	0	0	?	?	?	?
Waltonavis sp.	0	?	?	0	0	0	1	0	0	0	0	0	?	0	0	0	0	0	0	0	0	0
Bathornis grallator	?	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Dynamopterus sp.	?	?	?	?	?	?	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Danielsraptor phorusrhacoides	?	0	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor cf parvunguis	0	?	?	?	?	?	1	?	0	0	0	0	?	1	?	0	0	0	0	0	0	0
Masillaraptor parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?
Eofringillirostrum boudreauxi	?	0	0	?	0	0	2	?	1	?	?	?	?	?	0	?	?	?	?	?	?	0
Zygodactylus grandei	?	0	0	?	1	1	2	?	0	?	?	?	?	?	1	?	?	0	?	?	?	0
Eozygodactylus americanus	?	0	0	1	0	1	2	1	0	1	?	?	?	?	1	?	?	0	?	?	?	0
Primozygodactylus quintus	0	0	0	0	1	1	2	?	0	0	?	0	?	0	1	0	0	?	?	?	0	0
Primozygodactylus longibrachium	0	0	0	0	1	1	?	?	0	0	?	0	?	0	1	0	0	?	?	?	0	?
Primozygodactylus eunjooae	?	0	0	0	1	1	?	?	0	0	?	0	?	0	1	0	0	?	?	?	0	?
Primozygodactylus danielsi	?	0	?	?	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus major	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	0	0	0	0	1	0	0	0	0	?	?	2	?	0	1	0	0	0	?	?	1	0
Parapsittacopes bergdahli	?	0	0	0	1	1	2	0	1	0	1	0	?	2	1	0	0	0	0	0	0	0
Psittacopes Lepidus	0	0	?	?	?	0	0	?	?	?	?	?	?	1	1	0	0	0	?	?	0	0
Psittacomimus eos	0	0	0	0	1	?	0	0	0	0	0	0	?	?	?	?	?	?	0	0	?	?
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	?	0	?	?	1	0	1	?	1	?	?	0	?	0	1	0	0	0	?	0	0	0
Cyrilavis colburnorum	0	0	0	0	0	0	1	0	1	?	0	?	0	0	1	0	0	0	?	?	?	?
Cyrilavis cf. colburnorum	?	0	0	0	0	?	1	0	1	1	0	?	?	0	1	0	0	0	0	0	0	0
Cyrilavis olsoni	?	?	?	?	1	?	?	?	?	?	?	?	0	0	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	0	0
cf. Pulchrapollia	?	?	?	?	?	?	?	0	1	0	0	0	0	?	?	0	?	0	0	0	?	?
cf. Pulchrapollia gracilis	0	0	0	0	0	0	?	?	1	?	?	?	?	?	?	?	?	?	?	0	0	0
Pulchrapollia eximia	0	0	1	0	0	0	2	0	1	0	0	0	?	0	0	0	0	0	0	0	0	0
Vastanavis eocaena	?	0	1	0	1	?	?	?	1	0	?	0	?	0	0	0	0	0	0	0	0	1
Vastanavis cambayensis	?	0	1	0	1	?	?	?	1	0	?	0	?	0	0	0	0	0	0	0	0	1
Messelastur gratulator	0	0	0	?	0	0	1	?	1	?	?	0	0	0	0	0	0	0	?	0	?	?
Tynskya waltonensis	0	0	0	0	0	?	1	0	1	0	0	0	?	2	1	0	0	0	0	0	?	?
Tynskya eocaena	0	0	?	?	0	?	?	0	1	?	?	0	?	2	1	0	?	?	?	?	?	?
Tynskya crassitarsus	0	?	?	?	?	?	1	0	1	0	0	0	?	2	?	0	0	0	0	0	?	?
Tynskya brevitarsus	?	?	?	?	1	?	1	0	?	0	0	0	?	?	?	?	?	?	?	?	1	0
Eurofluvioviridavis robustipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Serudaptus pohli	?	0	?	0	1	0	0	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289
Eudromia elegans	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Chauna chavaria	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Charadris vociferus	0	0	2	0	1	0	0	0	0	0	0	0	0	1	0	2	0	0	1	1	0	0
Eurypyga helias	1	0	2	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Cathartes burrovianus	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Vultur gryphus	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Sagittarius serpentarius	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1
Pandion haliaetus c.	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Elanus caeruleus	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Buteo rufofuscus	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	2	0	0	1	0	0	0
Accipiter nisus	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1
Tyto alba	0	0	2	0	1	0	0	0	1	0	0	0	0	1	0	1	0	0	1	0	0	1
Strix aluco	0	0	0	-	1	0	0	0	1	0	0	0	0	1	0	1	0	0	1	0	0	1
Colius striatus kiwuensis	0	1	2	1	1	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0
Urocolius macrourus pulcher	0	1	2	1	1	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0
Leptosomus discolor	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Apaloderma narina	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0
Trogon melanurus e.	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0
Upupa marginata	0	1	0	-	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1
Tockus nasutus	0	1	2	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	0	0
Merops orientalis	0	0	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0
Atelornis pittoides	0	0	0	-	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0
Coracias benghalensis	0	0	2	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	0	0
Todus mexicanus	0	0	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0
Momotus momota	0	0	0	-	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1
Alcedo atthis	0	0	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0
Galbula dea	0	0	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Indicator exilis p.	0	1	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Picus viridis	0	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1
Megalaima chrysopogon	0	1	2	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1
Ramphastos ambiguus	0	1	2	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0
Cariama cristata	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Chunga burmeisteri	0	0	0	-	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Micrastur ruficollis c.	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Falco sparverius	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0
Daptrius ater	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0
Caracara cheriway	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	2	0	0	0	0	0	0
Nestor notabilis	0	0	0	-	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0
Strigops habroptilus	?	?	?	?	?	?	?	?	0	?	?	?	?	?	0	?	?	?	?	?	0	?
Probosciger aterrimus	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	2	1	0	0	0	0	0
Barnardius zonarius	0	0	0	-	0	0	0	0	0	1	1	0	0	1	0	2	1	0	0	0	0	0
Psittrichas fulgidus	0	0	0	-	0	0	0	0	0	1	1	0	0	1	0	2	1	0	0	0	0	0
Psittacus erithacus	0	0	0	-	0	0	0	0	0	1	1	0	0	1	0	2	1	0	0	0	0	0
Deroptyus accipitrinus	0	0	0	-	0	0	0	0	0	1	1	0	0	1	0	2	1	0	0	1	0	0
Acanthisitta chloris	0	1	2	1	1	0	1	0	1	0	1	1	0	1	0	1	1	1	1	1	0	0
Pitta sordida	0	1	0	1	1	0	1	0	1	0	1	1	0	?	0	?	1	?	?	?	0	?
Neodrepanis coruscans	0	1	2	1	1	0	1	0	1	0	1	1	0	1	0	1	1	1	1	1	0	0
Melanopareia bitorquata	0	1	2	1	1	0	1	0	1	0	1	1	1	0	0	1	1	1	0	1	0	0
Myrmornis torquata	0	1	2	1	1	0	1	0	1	0	1	1	0	1	0	1	1	1	0	1	0	0
Myrmothera campanisona m.	0	1	2	1	1	0	1	0	1	0	1	1	0	1	0	1	1	1	1	1	0	0
Neopelma chrysocephalum	0	1	2	1	1	0	1	0	1	0	1	1	0	1	0	1	1	1	1	1	0	0
Rupicola peruvianus	0	1	2	1	1	0	1	0	1	0	1	1	0	1	0	1	1	1	1	1	0	0
Piprites chloris tschudii	0	1	0	1	1	0	1	0	1	0	1	1	0	1	0	1	1	1	1	1	0	0
Tyrannus tyrannus	0	1	0	1	1	0	1	0	1	0	1	1	1	1	0	1	1	1	1	1	0	0
Menura novaehollandiae	0	1	0	1	0	0	1	0	1	0	1	1	1	1	0	1	1	1	0	1	0	0
Climacterus melanurus wellsi	0	1	2	1	1	0	1	0	1	0	1	1	0	1	0	1	1	1	0	1	0	0
Malurus melanocephalus	0	1	2	1	1	0	1	0	1	0	1	1	1	1	0	1	1	1	0	1	0	0
Corvus brachyrhynchos	0	0	0	1	1	0	1	0	1	0	1	1	0	1	0	1	1	1	0	1	0	0
Sylvia borin	0	1	2	1	1	0	1	0	1	0	1	1	1	1	0	1	1	1	0	1	0	0
Zosterops lateralis	0	1	2	1	1	0	1	0	1	0	1	1	1	1	0	1	1	1	1	1	0	0
Passer domesticus	0	1	2	1	1	0	1	0	1	0	1	1	0	1	0	1	1	1	1	1	0	0
Palaeoplancus sternbergi	0	0	1	0	0	?	?	0	?	?	0	?	?	?	0	1	1	0	0	1	0	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	0	0	0	-	1	0	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	1	0	1	0	0	1
Primoptynx poliotauros	0	0	1	0	1	0	0	0	0	?	?	?	?	?	0	?	0	0	0	0	0	0
Masillacolius brevidactylus	?	1	?	?	1	?	0	0	0	?	1	?	1	0	?	?	?	?	?	?	?	?
Eoglaucidium cf pallas	?	0	?	?	1	?	?	?	?	0	0	?	0	1	0	?	?	0	0	0	0	?
Eotrogon stenorhynchus	0	0	2	0	0	0	0	0	0	?	0	0	?	1	0	?	?	?	?	?	?	?
Messelirrisor halcyrostris	?	0	?	?	0	?	?	0	?	?	?	?	0	1	?	?	?	?	?	?	?	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Plesiocathartes wyomingensis	?	0	?	?	?	?	?	?	?	0	1	0	0	1	?	?	?	?	?	?	?	?

	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289
Plesiocathartes kelleri	?	0	?	?	0	?	?	0	0	0	0	?	0	1	?	?	?	?	?	?	?	?
Waltonavis sp.	0	0	2	0	1	0	0	0	0	0	0	0	?	?	0	?	?	?	?	?	?	?
Bathornis grallator	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Dynamopterus sp.	0	0	1	0	0	0	0	0	0	0	0	0	?	?	0	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor cf parvunguis	0	0	1	0	0	?	0	0	0	1	0	0	?	?	?	?	?	?	?	?	?	?
Masillaraptor parvunguis	?	0	?	?	?	?	?	?	?	?	0	?	?	1	?	?	?	?	?	?	?	?
Eofringillirostrum boudreauxi	?	?	?	?	1	?	?	0	?	1	1	0	0	1	?	?	?	?	?	?	?	?
Zygodactylus grandei	?	1	?	?	1	1	1	0	?	0	1	?	0	1	?	?	?	?	?	?	?	?
Eozygodactylus americanus	?	1	?	?	1	1	1	0	?	0	1	0	?	1	?	?	?	?	?	?	?	?
Primozygodactylus quintus	?	1	?	?	1	?	0	0	0	0	1	0	0	1	?	?	?	?	0	?	?	?
Primozygodactylus longibrachium	?	1	?	?	?	?	?	?	?	0	1	?	0	1	?	?	?	?	0	?	?	?
Primozygodactylus eunjooae	?	1	?	?	?	?	?	?	?	0	1	?	0	1	?	?	?	?	0	?	?	?
Primozygodactylus danielsi	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus major	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	0	1	?	?	0	?	?	0	?	0	0	?	1	1	?	?	?	?	?	?	?	?
Parapsittacopes bergdahli	0	1	1	0	1	0	0	0	0	1	0	0	?	1	0	?	?	0	1	0	0	?
Psittacopes Lepidus	?	1	?	?	1	?	?	0	0	0	1	0	0	1	?	?	?	?	?	?	?	?
Psittacomimus eos	0	?	1	0	1	0	0	0	0	?	?	?	?	?	0	?	?	?	?	?	?	?
Avolatavis tenens	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	?	0	0	?	0	0	?	0	?	0	0	0	0	1	?	?	?	?	0	?	?	?
Cyrilavis colburnorum	?	0	?	?	0	?	?	0	?	0	0	?	0	1	?	?	?	?	?	?	?	?
Cyrilavis cf. colburnorum	0	0	?	0	0	0	0	0	0	?	0	0	0	1	0	?	?	?	?	?	?	?
Cyrilavis olsoni	?	?	?	?	0	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	0	0	2	0	1	0	0	0	0	?	?	0	?	1	0	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	0	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	0	0	2	0	0	0	0	0	?	0	0	0	0	?	0	?	?	?	?	?	?	?
Pulchrapollia eximia	0	0	?	0	1	0	0	0	0	1	0	0	0	1	0	?	?	?	?	?	?	?
Vastanavis eocaena	1	0	1	0	0	?	?	?	?	0	0	0	?	?	0	?	?	0	0	0	0	?
Vastanavis cambayensis	1	0	1	0	0	?	?	?	?	0	0	0	?	?	0	?	?	0	0	0	0	?
Messelastur gratulator	?	0	?	?	0	?	0	0	0	1	0	?	0	1	?	?	?	?	?	?	?	?
Tynskya waltonensis	?	0	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya eocaena	?	0	?	?	0	?	?	?	?	?	0	?	0	1	?	?	?	?	?	?	?	?
Tynskya crassitarsus	?	?	?	?	0	0	0	0	0	?	?	0	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	1	0	2	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	?	0	?	?	0	?	0	?	1	0	0	?	0	1	?	?	?	?	?	?	?	?
Serudaptus pohli	?	0	?	?	0	?	?	?	?	?	1	?	0	1	?	?	?	?	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311
Eudromia elegans	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
Chauna chavaria	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0
Charadris vociferus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
Eurypyga helias	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Cathartes burrovianus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1
Vultur gryphus	0	0	0	0	0	0	0	0	0	0	0	0	?	0	0	1	1	0	0	0	0	1
Sagittarius serpentarius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pandion haliaetus c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Elanus caeruleus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Buteo rufofuscus	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1
Accipiter nisus	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Tyto alba	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0
Strix aluco	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1
Colius striatus kiwuensis	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	1	0	1	0	0	0	0
Urocolius macrourus pulcher	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	1	0	1	0	0	0	0
Leptosomus discolor	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	0	0
Apaloderma narina	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	1	0	0	0	0
Trogon melanurus e.	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	1	0	0	0	0
Upupa marginata	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	1	0	0	0	1
Tockus nasutus	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	1
Merops orientalis	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1
Atelornis pittoides	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Coracias benghalensis	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1
Todus mexicanus	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0	1
Momotus momota	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0
Alcedo atthis	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1
Galbula dea	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	1	0	1
Indicator exilis p.	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	2	0	0	0	1
Picus viridis	0	0	1	1	0	0	0	1	1	0	0	1	1	0	0	1	0	2	0	0	0	1
Megalaima chrysopogon	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	1	0	0	0	1
Ramphastos ambiguus	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	1	0	0	0	1
Cariama cristata	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	1
Chunga burmeisteri	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	1
Micrastur ruficollis c.	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Falco sparverius	0	0	0	0	2	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Daptrius ater	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Caracara cheriway	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Nestor notabilis	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Strigops habroptilus	?	?	?	0	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?
Probosciger aterrimus	0	0	0	0	2	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Barnardius zonarius	0	0	0	0	2	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0
Psittrichas fulgidus	0	0	0	0	2	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Psittacus erithacus	0	0	0	0	2	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Deroptyus accipitrinus	0	0	0	0	2	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Acanthisitta chloris	0	1	1	0	0	0	0	1	1	0	0	1	1	0	0	1	0	1	1	0	0	1
Pitta sordida	?	?	?	0	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?
Neodrepanis coruscans	0	1	1	0	2	0	0	1	1	0	0	1	1	0	0	1	0	2	1	0	0	1
Melanopareia bitorquata	0	1	1	0	2	0	0	1	1	0	0	1	1	0	0	1	0	2	1	0	0	1
Myrmornis torquata	0	1	1	0	2	0	0	1	0	0	0	1	1	1	0	1	0	2	0	0	0	1
Myrmothera campanisona m.	0	1	1	0	2	0	0	1	1	0	0	1	1	1	0	1	0	2	0	0	0	1
Neopelma chrysocephalum	0	1	1	0	2	0	0	1	1	0	0	1	1	1	0	0	0	2	0	0	0	0
Rupicola peruvianus	0	1	1	0	2	0	0	1	1	0	0	1	1	1	0	1	0	2	0	0	0	1
Piprites chloris tschudii	0	1	1	0	2	0	0	1	1	0	0	1	1	1	0	1	0	2	0	0	0	1
Tyrannus tyrannus	0	1	1	0	2	0	0	1	1	0	0	1	1	1	0	1	0	2	0	0	0	1
Menura novaehollandiae	0	1	1	0	2	0	0	1	1	0	0	1	1	1	0	1	0	0	0	0	0	1
Climacterus melanurus wellsi	0	1	1	0	2	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	0	1
Malurus melanocephalus	0	1	1	0	2	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	0	1
Corvus brachyrhynchos	0	1	1	0	2	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	0	1
Sylvia borin	0	1	1	0	2	0	0	0	1	0	0	1	1	1	0	1	0	0	1	0	0	1
Zosterops lateralis	0	1	1	0	0	0	0	0	1	0	0	1	1	1	0	1	0	0	1	0	0	0
Passer domesticus	0	1	1	0	0	0	0	0	1	0	0	1	1	1	0	1	0	0	1	0	0	0
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	0	?	0	?	0	?	0
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	?	0	0	0	?	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0
Primoptynx poliotauros	0	0	0	0	0	0	0	?	0	0	0	0	?	?	?	?	?	?	?	?	?	1
Masillacolius brevidactylus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0
Eoglaucidium cf pallas	?	0	?	?	?	?	?	1	0	0	?	0	?	?	1	?	?	0	?	0	?	0
Eotrogon stenorhynchus	?	?	?	?	?	?	?	?	?	?	0	0	1	1	0	0	0	0	0	0	0	0
Messelirrisor halcyrostris	?	?	?	?	?	?	?	?	?	0	?	?	?	?	0	?	?	1	?	?	?	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?	?	?	?	?	0
Plesiocathartes wyomingensis	?	?	?	?	?	?	?	?	?	0	0	0	?	?	?	?	?	?	?	?	?	0

	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311
Plesiocathartes kelleri	?	?	?	?	?	?	?	?	?	0	0	0	?	?	?	?	?	?	?	?	?	0
Waltonavis sp.	?	?	?	?	?	?	?	?	?	?	0	0	1	1	0	0	0	0	?	0	0	?
Bathornis grallator	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	0	0	0	?	0	?	?
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	1	0	1	0	0	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor cf parvunguis	?	?	?	?	?	?	?	?	?	?	0	0	0	1	0	0	0	0	?	0	0	0
Masillaraptor parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eofringillirostrum boudreauxi	?	?	?	?	?	?	?	0	0	0	0	0	?	?	?	?	?	?	?	?	?	0
Zygodactylus grandei	?	?	?	?	?	?	?	?	?	0	0	0	?	?	?	?	?	?	?	?	?	0
Eozygodactylus americanus	?	?	?	?	?	?	?	0	?	0	0	0	?	?	?	?	?	?	?	?	?	0
Primozygodactylus quintus	0	0	0	0	?	?	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Primozygodactylus longibrachium	?	0	0	?	?	?	?	?	?	0	?	0	?	?	0	?	?	?	?	0	?	?
Primozygodactylus eunjooae	?	0	0	?	?	?	?	?	?	0	?	0	?	?	0	?	?	?	?	0	?	?
Primozygodactylus danielsi	?	0	0	?	?	?	?	?	?	0	?	0	?	?	0	?	?	?	?	0	?	?
Primozygodactylus major	?	0	0	?	?	?	?	?	?	0	?	0	?	?	0	?	?	?	?	0	?	?
Pumiliornis tessellatus	?	?	?	?	?	?	?	0	?	?	0	0	1	0	0	?	1	0	?	1	?	0
Parapsittacopes bergdahli	?	1	1	0	0	?	0	?	?	0	0	0	1	1	0	0	0	0	0	1	0	0
Psittacopes Lepidus	?	?	?	?	?	?	?	0	0	?	0	0	?	?	?	?	?	?	?	?	?	0
Psittacomimus eos	?	1	0	0	0	?	0	?	?	?	0	0	1	1	0	0	0	0	0	1	0	?
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	?	0	0	0	?	?	?	0	?	0	0	0	0	?	0	1	?	1	?	?	0	0
Cyrilavis colburnorum	?	?	?	0	?	?	?	?	?	0	0	0	0	0	?	?	0	?	0	0	?	0
Cyrilavis cf. colburnorum	?	0	0	?	?	?	?	?	?	?	0	0	?	?	?	?	?	?	?	?	?	?
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	0	0	1	1	0	1	0	1	?	0	0	0
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	?	?	?	?	?	?	?	?	?	?	0	0	1	1	0	1	0	1	?	0	0	0
Vastanavis eocaena	0	0	0	?	?	?	0	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	0	0	0	?	?	?	0	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	?	?	?	?	?	?	?	0	0	0	1	0	0	0	0	?	?	?	?	?	0	0
Tynskya waltonensis	?	0	0	?	?	?	?	?	?	?	?	0	?	?	0	?	?	?	?	?	?	?
Tynskya eocaena	?	0	0	?	?	?	?	0	?	?	?	0	?	?	0	?	?	?	?	?	?	?
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0
Serudaptus pohli	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	0	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333
Eudromia elegans	0	0	0	0	0	1	0	0	0	?	0	?	0	?	?	1	1	1	0	0	0	-
Chauna chavaria	0	0	1	0	0	0	0	0	0	?	0	?	?	?	?	1	1	1	0	0	0	-
Charadris vociferus	0	0	0	0	0	1	0	0	0	0	0	?	1	1	0	1	1	1	0	0	0	-
Eurypyga helias	0	0	0	0	0	1	0	0	0	0	0	0	?	?	?	1	1	1	0	0	0	-
Cathartes burrovianus	0	0	1	0	0	1	0	0	0	?	0	0	0	1	0	1	1	0	0	0	0	-
Vultur gryphus	0	0	0	0	0	1	0	0	0	?	0	?	0	0	0	1	1	0	0	0	0	-
Sagittarius serpentarius	0	0	0	0	0	0	0	0	0	?	0	?	?	?	?	1	1	0	0	0	0	-
Pandion haliaetus c.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	-
Elanus caeruleus	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0	-
Buteo rufofuscus	0	0	1	0	0	1	0	0	0	1	0	1	0	1	0	1	1	0	0	0	0	-
Accipiter nisus	0	1	1	0	0	1	0	0	0	1	0	1	0	1	0	1	1	0	0	0	0	-
Tyto alba	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	-
Strix aluco	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	-
Colius striatus kiwuensis	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0	1	1	-
Urocolius macrourus pulcher	0	0	0	0	0	1	0	0	0	?	0	?	0	0	0	0	1	1	0	1	1	-
Leptosomus discolor	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	-
Apaloderma narina	0	0	0	0	0	1	0	0	0	?	0	1	1	0	0	0	1	1	0	0	0	-
Trogon melanurus e.	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	-
Upupa marginata	0	1	0	0	0	1	0	0	1	1	0	1	0	0	0	0	1	2	0	0	0	-
Tockus nasutus	0	1	0	0	0	1	0	0	1	1	0	1	0	0	0	0	1	2	0	0	0	-
Merops orientalis	1	0	0	1	1	1	0	0	1	?	0	1	0	0	1	1	1	2	0	1	1	-
Atelornis pittoides	0	0	0	0	0	0	0	0	1	?	0	1	0	0	1	1	1	1	0	1	1	-
Coracias benghalensis	1	0	0	0	0	1	0	0	1	?	0	1	0	0	1	1	1	1	0	1	1	-
Todus mexicanus	1	1	0	0	0	1	0	0	1	?	0	1	0	0	1	1	1	1	0	1	1	-
Momotus momota	1	0	0	0	0	1	0	0	1	1	0	1	0	0	1	1	1	1	0	1	1	-
Alcedo atthis	1	0	0	0	0	1	0	0	1	?	0	1	0	0	1	1	1	1	0	1	1	-
Galbula dea	1	0	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	1	0	1	2	1
Indicator exilis p.	1	1	0	0	1	1	0	0	1	?	0	1	0	0	0	0	0	2	0	1	2	0
Picus viridis	1	1	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	2	1	1	2	0
Megalaima chrysopogon	1	0	0	0	1	1	0	0	1	?	0	1	0	0	0	0	0	2	0	1	2	1
Ramphastos ambiguus	1	1	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	2	0	1	2	1
Cariama cristata	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	-
Chunga burmeisteri	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	-
Micrastur ruficollis c.	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	1	1	1	0	0	0	-
Falco sparverius	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	-
Daptrius ater	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	-
Caracara cheriway	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	-
Nestor notabilis	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	-
Strigops habroptilus	?	?	?	?	?	?	0	0	0	0	0	0	1	0	0	?	?	?	?	?	0	?
Probosciger aterrimus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	-
Barnardius zonarius	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	-
Psittrichas fulgidus	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	-
Psittacus erithacus	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	-
Deroptyus accipitrinus	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	-
Acanthisitta chloris	0	0	0	0	0	0	0	0	0	?	1	0	0	0	0	2	0	2	0	1	2	0
Pitta sordida	?	?	?	?	?	?	0	0	0	?	1	0	0	0	0	2	0	2	0	1	2	0
Neodrepanis coruscans	0	0	0	0	0	1	0	0	0	?	1	0	?	?	?	2	0	2	0	1	2	0
Melanopareia bitorquata	0	0	0	0	0	0	0	0	0	?	1	0	0	0	0	2	0	2	0	1	2	1
Myrmornis torquata	0	0	0	0	0	1	0	0	0	?	1	0	?	?	?	2	0	2	0	1	2	1
Myrmothera campanisona m.	0	0	0	0	0	0	0	0	0	?	1	0	?	?	?	2	0	2	0	1	2	1
Neopelma chrysocephalum	0	0	0	0	0	1	0	0	0	?	1	0	?	?	?	2	0	2	0	1	2	1
Rupicola peruvianus	0	0	0	0	0	1	0	0	0	?	1	0	?	?	?	2	0	2	0	1	2	0
Piprites chloris tschudii	0	0	0	0	0	1	0	0	0	?	0	0	?	?	?	2	0	2	0	1	2	0
Tyrannus tyrannus	0	0	0	0	0	1	0	0	0	?	1	0	0	0	0	2	0	2	0	1	2	0
Menura novaehollandiae	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2	0	1	0	1	2	0
Climacterus melanurus wellsi	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	2	0	2	1	1	2	0
Malurus melanocephalus	0	0	0	0	0	0	0	0	0	?	1	0	?	?	?	2	0	2	1	1	2	1
Corvus brachyrhynchos	0	0	0	0	0	1	0	0	0	0	1	0	?	?	?	2	0	2	0	1	2	0
Sylvia borin	0	0	0	0	0	0	0	0	0	?	1	0	?	?	?	2	0	2	1	1	2	0
Zosterops lateralis	0	0	0	0	0	0	0	0	0	?	1	0	?	?	?	2	0	2	0	1	2	0
Passer domesticus	0	0	0	0	0	1	0	0	0	?	1	0	?	?	?	2	0	2	1	1	2	0
Palaeoplancus sternbergi	?	?	0	?	?	?	?	?	?	?	?	?	0	1	?	?	?	0	?	0	-	-
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	0	-	-
Ypresiglaux michaeldanielsi	?	?	?	?	0	?	0	0	?	?	?	?	?	?	?	?	?	0	0	0	-	-
Primoptynx poliotauros	?	?	?	?	0	?	0	0	?	?	?	?	0	?	?	?	?	0	0	0	-	-
Masillacolius brevidactylus	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	-
Eoglaucidium cf pallas	0	0	?	?	?	1	0	0	0	0	0	1	0	?	?	?	?	1	0	0	-	-
Eotrogon stenorhynchus	0	0	0	0	0	1	0	0	0	0	0	1	?	?	?	?	?	1	0	0	-	-
Messelirrisor halcyrostris	?	?	?	?	?	1	0	?	?	?	?	?	0	?	?	?	?	?	0	1	1	-
Plesiocathartes insolitipes	0	0	0	0	0	1	0	0	0	0	0	0	0	?	0	?	?	1	?	0	-	-
Plesiocathartes wyomingensis	0	0	?	?	?	1	0	0	?	?	?	?	?	?	?	?	?	?	0	0	-	-

	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333
Plesiocathartes kelleri	0	0	?	?	?	1	0	0	?	?	?	?	?	?	?	?	?	?	0	0	-	-
Waltonavis sp.	?	?	0	0	0	?	0	0	0	0	0	0	0	?	0	?	?	1	0	0	-	-
Bathornis grallator	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	-	-
Dynamopterus sp.	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	0	2	?	?	?	?
Danielsraptor phorusrhacoides	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor cf parvunguis	0	0	?	?	?	?	?	?	0	0	0	0	0	1	0	?	?	1	?	0	-	-
Masillaraptor parvunguis	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	1	?	?	0	-	-
Eofringillirostrum boudreauxi	0	0	?	?	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	1	1	-
Zygodactylus grandei	0	0	?	?	?	0	0	?	0	?	?	?	?	?	?	?	?	?	?	1	1	-
Eozygodactylus americanus	0	0	?	?	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	1	1	-
Primozygodactylus quintus	0	0	0	?	0	1	0	?	0	?	?	?	0	?	?	?	?	1	0	1	1	-
Primozygodactylus longibrachium	?	?	?	?	?	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus eunjooae	?	?	?	?	?	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus danielsi	?	?	?	?	?	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus major	?	?	?	?	?	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	?	?	?	?	?	?	0	?	?	?	?	?	0	?	?	?	?	?	?	0	-	-
Parapsittacopes bergdahli	0	0	1	0	0	?	0	?	?	?	?	?	?	?	?	?	?	0	?	1	0	-
Psittacopes Lepidus	0	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	0	0	0	-	-
Psittacomimus eos	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	1	0	-
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	0	?	1	?	1	1	0	?	?	?	?	?	?	?	?	?	?	?	?	0	-	-
Cyrilavis colburnorum	0	0	?	?	0	1	0	?	0	?	?	?	0	?	?	?	?	?	0	0	-	-
Cyrilavis cf. colburnorum	?	?	1	?	?	?	0	?	?	?	?	?	0	0	0	?	?	0	0	0	-	-
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	0	?	1	?	0	1	0	?	?	?	?	?	?	?	?	?	?	0	?	0	-	-
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?
Pulchrapollia eximia	0	?	1	?	0	1	0	?	?	0	?	?	?	?	?	?	?	1	0	0	-	-
Vastanavis eocaena	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	-	-
Vastanavis cambayensis	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	-	-
Messelastur gratulator	0	0	0	1	0	1	0	?	0	?	?	?	?	?	?	?	?	0	0	0	-	-
Tynskya waltonensis	?	?	0	?	?	0	0	?	0	?	?	?	0	?	?	?	?	0	?	0	-	-
Tynskya eocaena	?	?	0	?	?	0	0	?	0	?	?	?	0	?	?	?	?	0	0	0	-	-
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	?	?	?	?	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	0	-	-
Serudaptus pohli	?	?	1	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0	-	-
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?

	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355
Eudromia elegans	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Chauna chavaria	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	-	0	-	1	0
Charadris vociferus	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	-	0	-	0	0
Eurypyga helias	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Cathartes burrovianus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Vultur gryphus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Sagittarius serpentarius	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Pandion haliaetus c.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Elanus caeruleus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Buteo rufofuscus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	1
Accipiter nisus	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	-	0	-	0	0
Tyto alba	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	-	0	-	0	1
Strix aluco	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	-	0	-	0	0
Colius striatus kiwuensis	0	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	-	0	-	0	0
Urocolius macrourus pulcher	1	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	-	0	-	0	0
Leptosomus discolor	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	-	0	-	0	0
Apaloderma narina	1	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	-	0	-	0	1
Trogon melanurus e.	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	-	0	-	0	1
Upupa marginata	1	1	1	1	1	1	0	0	0	0	0	1	0	1	1	0	1	1	1	2	0	1
Tockus nasutus	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	2	0	1
Merops orientalis	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	-	1	2	0	1
Atelornis pittoides	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	1	2	0	1
Coracias benghalensis	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	-	1	2	0	1
Todus mexicanus	1	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	-	1	1	0	1
Momotus momota	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	1
Alcedo atthis	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	-	0	-	0	1
Galbula dea	1	0	1	1	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	-	1	1
Indicator exilis p.	1	1	1	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	-	0	1
Picus viridis	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	-	0	-	0	1
Megalaima chrysopogon	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	-	0	-	1	1
Ramphastos ambiguus	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	-	0	-	0	1
Cariama cristata	0	1	0	1	0	0	1	0	0	0	1	0	0	1	1	0	0	-	0	-	1	0
Chunga burmeisteri	0	1	0	1	0	0	1	0	0	0	1	0	0	1	1	0	0	-	0	-	0	0
Micrastur ruficollis c.	1	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0	0	-	0	-	1	1
Falco sparverius	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	-	0	-	1	1
Daptrius ater	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	-	0	-	0	1
Caracara cheriway	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	-	0	-	0	1
Nestor notabilis	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	1	0
Strigops habroptilus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Probosciger aterrimus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	1	0
Barnardius zonarius	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	1	0
Psittrichas fulgidus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	1	0
Psittacus erithacus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	1	0
Deroptyus accipitrinus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	1	0
Acanthisitta chloris	0	0	1	0	1	1	0	1	0	1	0	0	0	1	1	0	1	0	1	1	0	1
Pitta sordida	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	2	0	1
Neodrepanis coruscans	0	0	1	1	1	1	0	0	1	1	0	0	0	1	0	0	1	0	1	2	0	1
Melanopareia bitorquata	0	0	1	1	1	1	0	0	0	1	0	0	0	1	0	0	1	0	0	-	0	0
Myrmornis torquata	0	0	1	0	1	0	0	0	0	1	0	0	0	1	1	0	1	0	1	2	0	1
Myrmothera campanisona m.	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0	1	2	0	1
Neopelma chrysocephalum	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	1	2	0	1
Rupicola peruvianus	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	-	1	2	0	1
Piprites chloris tschudii	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	2	0	1
Tyrannus tyrannus	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	1	2	0	1
Menura novaehollandiae	1	1	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	2	0	1
Climacterus melanurus wellsi	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	2	0	1
Malurus melanocephalus	1	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	2	0	1
Corvus brachyrhynchos	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	2	0	0
Sylvia borin	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	1
Zosterops lateralis	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	1
Passer domesticus	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	1
Palaeoplancus sternbergi	0	0	0	0	0	0	0	0	0	0	0	?	?	1	0	0	0	-	0	-	0	0
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	0	1	0	0	?	?	?	?	0	?	?	?	?	0	0	0	0	-	0	-	0	0
Ypresiglaux michaeldanielsi	1	0	0	0	0	0	0	0	0	0	0	?	?	?	0	0	0	-	0	-	0	0
Primoptynx poliotauros	?	0	0	0	0	0	0	0	0	0	?	?	?	1	1	0	0	-	0	-	0	0
Masillacolius brevidactylus	?	?	0	1	?	?	0	1	?	?	?	?	?	?	?	?	0	-	?	-	1	0
Eoglaucidium cf pallas	?	?	0	1	0	0	0	0	0	0	1	0	?	0	?	0	0	-	0	-	?	0
Eotrogon stenorhynchus	?	0	0	1	0	0	0	0	0	0	0	0	?	1	0	0	0	-	0	-	?	1
Messelirrisor halcyrostris	?	1	0	0	1	1	0	0	0	0	0	?	?	1	1	0	0	-	?	-	1	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	0	?	?	?	0	0	0	?	-	-	-	0	?
Plesiocathartes wyomingensis	?	?	0	0	0	0	0	0	0	0	0	?	?	?	0	0	0	-	-	-	0	0

	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355
Plesiocathartes kelleri	?	?	0	0	0	0	0	?	?	0	0	?	?	?	?	0	0	-	-	-	0	1
Waltonavis sp.	1	0	0	0	0	0	0	1	0	0	0	0	?	0	0	0	?	-	-	-	0	0
Bathornis grallator	0	1	0	1	0	0	0	0	0	0	1	0	?	?	?	?	0	-	0	-	?	0
Dynamopterus sp.	?	?	?	1	?	?	1	?	?	0	?	?	?	?	?	?	?	?	?	?	?	1
Danielsraptor phorusrhacoides	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor cf parvunguis	1	?	?	0	0	0	?	0	0	?	?	?	?	1	0	0	0	-	0	-	0	?
Masillaraptor parvunguis	?	?	0	0	0	0	?	0	0	0	0	?	?	?	?	?	?	?	?	?	0	?
Eofringillirostrum boudreauxi	?	?	0	0	0	0	?	0	?	?	?	?	?	?	?	0	0	-	?	?	0	1
Zygodactylus grandei	?	?	1	0	0	0	?	?	?	?	?	?	?	?	?	?	1	1	1	?	1	1
Eozygodactylus americanus	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	1	?
Primozygodactylus quintus	0	?	0	0	0	0	0	0	0	0	1	?	?	0	0	0	1	0	1	?	0	1
Primozygodactylus longibrachium	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	?	?	?
Primozygodactylus eunjooae	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	?	?	?
Primozygodactylus danielsi	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	?	?	?
Primozygodactylus major	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	?	?	?
Pumiliornis tessellatus	?	?	0	0	?	?	?	?	0	?	?	?	?	?	?	0	0	?	0	?	1	?
Parapsittacopes bergdahli	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	0	0	?	0	-	0	?
Psittacopes Lepidus	0	0	0	0	0	0	0	?	0	0	0	?	?	0	0	0	0	-	?	?	0	0
Psittacomimus eos	1	0	0	1	0	0	0	?	0	0	0	?	?	1	0	0	0	-	0	-	0	0
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	0	?	0	0	?	?	?	?	0	?	?	?	?	?	?	0	0	-	0	-	?	0
Cyrilavis colburnorum	1	0	0	0	0	0	0	?	0	0	0	?	?	?	?	?	0	-	0	-	0	1
Cyrilavis cf. colburnorum	1	0	0	0	0	0	0	0	0	0	0	?	?	0	0	0	0	-	0	-	0	?
Cyrilavis olsoni	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	0	?
Pulchrapollia gracilis	?	?	?	0	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	0	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	1	?	0	0	?	?	?	?	?	0	0	?	?	?	0	0	0	-	0	-	0	0
Vastanavis eocaena	0	0	0	0	?	?	?	?	0	?	?	?	?	1	0	0	0	-	0	0	0	0
Vastanavis cambayensis	0	0	0	0	?	?	?	?	0	?	?	?	?	1	0	0	0	-	0	0	0	0
Messelastur gratulator	?	?	0	0	?	?	?	?	?	?	0	?	?	1	0	0	0	?	?	?	?	1
Tynskya waltonensis	?	?	?	?	0	0	0	?	?	?	?	?	?	0	?	0	0	-	0	-	0	0
Tynskya eocaena	?	?	0	0	0	0	0	0	0	0	?	?	?	0	0	0	0	-	0	-	0	0
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	0	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?	0	-	0	-	0	0
Serudaptus pohli	?	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	0	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	0	?	?	?	?	?	?

	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377
Eudromia elegans	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	1	?	?	?	?	?	?
Chauna chavaria	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	?	?	?	?	?	?
Charadris vociferus	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	?	0	0	0	0	1	1
Eurypyga helias	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	?	0	0	0	0	1	1
Cathartes burrovianus	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1
Vultur gryphus	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1
Sagittarius serpentarius	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Pandion haliaetus c.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Elanus caeruleus	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	1	1
Buteo rufofuscus	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0
Accipiter nisus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1
Tyto alba	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0	1	1
Strix aluco	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	1	0	0	1	0
Colius striatus kiwuensis	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0
Urocolius macrourus pulcher	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0
Leptosomus discolor	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	1	0	0	0	0	1	1
Apaloderma narina	0	1	0	0	0	0	0	0	0	1	1	1	0	0	1	1	0	1	0	0	0	1
Trogon melanurus e.	0	1	0	0	0	0	0	0	0	1	1	1	0	0	1	1	0	1	0	0	0	1
Upupa marginata	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	1	1	0	1
Tockus nasutus	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	1	0	0	1
Merops orientalis	0	1	0	0	0	0	0	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0
Atelornis pittoides	1	0	0	0	0	?	0	1	0	1	0	1	0	0	1	1	0	0	0	0	0	0
Coracias benghalensis	1	1	0	0	0	?	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0	1
Todus mexicanus	1	1	1	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0
Momotus momota	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Alcedo atthis	1	0	1	0	0	?	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1
Galbula dea	1	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	0	0	0
Indicator exilis p.	1	0	1	1	1	0	0	0	0	0	1	1	0	0	0	1	1	1	1	0	0	0
Picus viridis	1	0	1	1	1	0	0	0	0	0	1	1	0	0	0	1	1	1	1	0	0	0
Megalaima chrysopogon	1	0	1	1	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	0	0	0
Ramphastos ambiguus	1	0	1	1	0	0	0	0	0	0	1	1	0	1	0	1	1	1	1	0	0	0
Cariama cristata	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	?	0	0	0	0	0	0
Chunga burmeisteri	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	?	0	0	0	0	0	0
Micrastur ruficollis c.	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1
Falco sparverius	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
Daptrius ater	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
Caracara cheriway	0	0	0	0	0	?	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
Nestor notabilis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2
Strigops habroptilus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	1	2
Probosciger aterrimus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	2
Barnardius zonarius	0	0	0	0	0	?	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	2
Psittrichas fulgidus	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	2
Psittacus erithacus	0	0	0	0	0	?	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	2
Deroptyus accipitrinus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	2
Acanthisitta chloris	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Pitta sordida	0	0	1	0	0	?	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1
Neodrepanis coruscans	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
Melanopareia bitorquata	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	?
Myrmornis torquata	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	?
Myrmothera campanisona m.	1	0	1	0	1	?	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1
Neopelma chrysocephalum	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1
Rupicola peruvianus	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	?
Piprites chloris tschudii	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	?
Tyrannus tyrannus	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Menura novaehollandiae	0	0	0	0	1	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	0	0
Climacterus melanurus wellsi	1	0	1	0	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0
Malurus melanocephalus	1	0	1	0	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	?
Corvus brachyrhynchos	0	0	0	0	1	?	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	?
Sylvia borin	1	0	1	0	1	?	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	?
Zosterops lateralis	1	0	1	0	1	?	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	?
Passer domesticus	1	0	1	0	1	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	?
Palaeoplancus sternbergi	0	0	0	0	0	0	0	0	0	?	0	0	0	0	1	?	0	0	0	0	0	0
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	0	0	0	0	0	0	0	0	0	?	0	0	0	0	0	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	0	?	1	0	?	0	?	0	?	?	0	0	?	?	?	?	0	0	0	0	1	0
Primoptynx poliotauros	0	0	0	0	?	?	0	0	?	0	0	0	?	0	1	?	?	?	?	?	?	?
Masillacolius brevidactylus	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eoglaucidium cf pallas	?	?	0	0	?	0	?	0	?	?	?	?	?	0	?	0	0	0	0	0	0	0
Eotrogon stenorhynchus	0	0	0	0	0	?	0	0	0	?	0	?	0	0	1	?	0	0	0	0	0	1
Messelirrisor halcyrostris	?	?	0	0	?	0	?	0	?	?	?	?	?	?	0	0	0	0	0	0	0	0
Plesiocathartes insolitipes	?	?	0	?	0	?	0	?	?	0	?	?	?	0	0	?	0	0	0	0	1	1
Plesiocathartes wyomingensis	0	?	0	0	?	1	0	0	0	?	?	0	0	0	?	0	0	0	0	0	?	1

	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377
Plesiocathartes kelleri	1	1	0	0	?	1	0	0	0	?	?	0	0	0	?	0	?	0	?	?	?	?
Waltonavis sp.	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	?	0	0	0	0	0	0
Bathornis grallator	0	0	?	0	?	0	?	?	0	?	0	0	0	1	?	?	0	0	0	0	0	0
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor cf parvunguis	0	?	0	0	0	1	0	?	?	0	?	0	?	0	1	?	0	0	0	0	?	1
Masillaraptor parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	1	1
Eofringillirostrum boudreauxi	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	1	0	0	0	0	?	0
Zygodactylus grandei	?	?	1	?	?	0	?	?	?	?	?	?	?	?	?	0	0	0	0	0	0	0
Eozygodactylus americanus	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	1	0	0	0	0	0	0
Primozygodactylus quintus	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	?	0
Primozygodactylus longibrachium	?	?	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus eunjooae	?	?	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus danielsi	?	?	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus major	?	?	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	?	?	0	?	?	0	?	?	?	?	?	?	?	?	?	1	0	0	0	0	?	1
Parapsittacopes bergdahli	0	?	0	0	1	0	0	?	?	0	?	?	0	0	0	?	0	0	0	0	1	0
Psittacopes Lepidus	0	0	0	0	?	0	?	?	?	?	0	0	0	0	0	1	0	0	0	0	1	2
Psittacomimus eos	0	0	0	0	1	0	0	?	0	?	0	0	0	0	1	?	0	?	?	?	?	?
Avolatavis tenens	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	0	0	0	0	?	0	?	?	?	?	?	0	?	?	?	1	0	0	0	0	0	1
Cyrilavis colburnorum	0	0	0	0	?	0	0	0	?	?	0	0	0	0	?	0	0	0	0	0	?	0
Cyrilavis cf. colburnorum	0	0	?	0	0	0	0	0	?	0	0	0	0	0	0	?	?	?	?	?	?	?
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	0
Pulchrapollia gracilis	?	?	1	?	1	?	0	?	?	1	?	?	0	0	1	?	0	0	0	0	1	0
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	0	0	1	0	1	0	0	0	?	1	0	?	0	0	1	?	0	0	0	0	1	0
Vastanavis eocaena	0	0	0	0	0	0	0	0	?	0	0	?	0	0	1	?	0	0	0	0	1	1
Vastanavis cambayensis	0	0	0	0	0	0	0	0	?	0	0	?	0	0	1	?	0	0	0	0	1	1
Messelastur gratulator	1	0	0	0	1	0	0	?	0	0	?	0	0	0	0	0	0	0	0	0	0	0
Tynskya waltonensis	?	?	0	?	?	0	0	0	?	0	?	?	0	0	?	?	0	?	?	?	?	?
Tynskya eocaena	0	0	0	0	?	0	0	0	0	0	0	0	0	0	?	0	0	0	0	0	0	0
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	0	?	0	?	?	1	?	?	?	?	?	0	?	1	?	0	0	0	0	0	1	0
Serudaptus pohli	0	?	0	?	?	0	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?
Quercypsitta sudrei	?	?	0	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399
Eudromia elegans	?	?	?	?	0	0	1	0	0	0	0	0	0	0	1	-	0	0	0	0	0	0
Chauna chavaria	?	?	?	?	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0
Charadris vociferus	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	0	0	1	0	0
Eurypyga helias	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	0	1	2	0	0
Cathartes burrovianus	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	2	0	0
Vultur gryphus	0	0	1	0	0	1	0	0	0	1	1	0	0	0	1	-	0	0	1	2	0	0
Sagittarius serpentarius	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	1	0	1	0	0	1	0
Pandion haliaetus c.	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	-	0	1	0	1	1	0
Elanus caeruleus	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
Buteo rufofuscus	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0
Accipiter nisus	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0
Tyto alba	1	0	0	1	0	1	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0
Strix aluco	0	0	1	1	0	1	0	0	0	0	0	0	1	1	0	1	0	1	1	0	0	0
Colius striatus kiwuensis	0	0	0	1	0	1	1	0	1	0	0	1	0	0	1	-	0	1	1	0	0	0
Urocolius macrourus pulcher	0	0	0	1	0	1	1	0	1	0	0	1	0	0	1	-	0	1	1	0	0	0
Leptosomus discolor	1	0	0	1	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	2	0	0
Apaloderma narina	0	0	0	1	0	1	1	0	0	1	0	1	0	0	1	-	0	0	1	1	0	1
Trogon melanurus e.	0	0	0	1	0	1	1	0	0	1	0	1	0	0	1	-	0	0	1	1	0	1
Upupa marginata	1	1	0	1	0	1	1	0	1	0	0	0	0	0	1	-	0	0	1	1	0	1
Tockus nasutus	0	1	0	1	0	1	1	0	0	0	0	0	0	0	1	-	0	0	1	2	0	1
Merops orientalis	0	0	0	1	0	1	1	0	1	0	0	0	0	0	1	-	0	0	1	2	0	0
Atelornis pittoides	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	2	0	0
Coracias benghalensis	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	-	0	0	1	2	0	0
Todus mexicanus	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	-	0	0	1	1	0	1
Momotus momota	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	-	0	0	1	1	0	0
Alcedo atthis	0	1	0	1	0	1	1	0	0	1	0	0	0	0	1	-	0	0	1	1	0	0
Galbula dea	0	1	0	1	0	1	1	0	1	0	0	0	0	0	1	-	0	0	1	2	0	0
Indicator exilis p.	0	1	0	1	0	1	1	0	0	1	0	0	0	0	1	-	0	0	1	2	0	1
Picus viridis	0	1	0	1	0	1	1	0	0	0	0	0	0	0	1	-	0	0	1	2	0	1
Megalaima chrysopogon	0	1	0	1	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	2	0	1
Ramphastos ambiguus	0	1	0	1	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	2	0	1
Cariama cristata	0	1	0	0	0	1	0	1	0	0	1	0	0	0	0	1	1	1	0	2	1	0
Chunga burmeisteri	0	1	0	0	0	1	0	1	0	0	1	0	0	0	0	1	0	1	0	2	1	0
Micrastur ruficollis c.	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0
Falco sparverius	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0
Daptrius ater	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0
Caracara cheriway	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0
Nestor notabilis	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	-	0	0	1	1	0	0
Strigops habroptilus	0	0	0	0	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Probosciger aterrimus	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	-	1	0	1	1	0	0
Barnardius zonarius	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	-	0	0	1	1	0	0
Psittrichas fulgidus	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	-	0	0	1	1	0	0
Psittacus erithacus	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	-	0	0	1	1	0	0
Deroptyus accipitrinus	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	-	0	0	1	1	0	0
Acanthisitta chloris	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	2	0	2
Pitta sordida	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	2	0	2
Neodrepanis coruscans	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	0	1	2	0	2
Melanopareia bitorquata	0	?	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	2	0	2
Myrmornis torquata	0	?	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	0	1	2	0	2
Myrmothera campanisona m.	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	0	1	2	0	2
Neopelma chrysocephalum	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	0	1	2	0	1
Rupicola peruvianus	0	?	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	1	0	1
Piprites chloris tschudii	0	?	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	1	0	1
Tyrannus tyrannus	0	?	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	0	0	1
Menura novaehollandiae	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	2	0	2
Climacterus melanurus wellsi	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	0	1	1	0	2
Malurus melanocephalus	0	?	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	2
Corvus brachyrhynchos	0	?	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	2	0	2
Sylvia borin	0	?	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	2	0	2
Zosterops lateralis	0	?	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	2	0	2
Passer domesticus	0	?	0	0	0	1	1	0	0	0	0	0	0	0	1	-	0	1	1	2	0	2
Palaeoplancus sternbergi	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primoptynx poliotauros	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillacolius brevidactylus	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?
Eoglaucidium cf pallas	?	0	?	0	0	?	?	?	?	?	?	?	0	?	?	?	?	0	1	?	?	?
Eotrogon stenorhynchus	0	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelirrisor halcyrostris	?	1	?	?	?	1	?	?	0	?	?	?	0	?	?	?	?	?	1	?	?	?
Plesiocathartes insolitipes	0	0	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Plesiocathartes wyomingensis	0	0	0	0	0	1	?	?	?	?	?	?	?	?	?	?	?	0	1	2	?	?

	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399
Plesiocathartes kelleri	?	?	?	?	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Waltonavis sp.	0	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Bathornis grallator	0	1	0	?	?	?	?	?	?	?	1	?	?	?	?	?	?	1	?	?	?	?
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	?	?	?	?	0	?	0	0	0	?	?	0	0	1	1	-	0	0	0	?	?	?
Masillaraptor cf parvunguis	?	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor parvunguis	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eofringillirostrum boudreauxi	0	1	0	?	?	?	?	?	?	?	?	?	0	?	?	?	?	1	1	?	0	2
Zygodactylus grandei	0	1	0	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	0	2
Eozygodactylus americanus	0	1	0	1	0	?	?	?	?	?	?	?	?	?	?	?	?	0	1	?	?	?
Primozygodactylus quintus	0	1	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	1	1	?	?	2
Primozygodactylus longibrachium	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?
Primozygodactylus eunjooae	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?
Primozygodactylus danielsi	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	1	1	?	?	?
Primozygodactylus major	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	1	1	?	?	?
Pumiliornis tessellatus	0	1	0	0	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Parapsittacopes bergdahli	0	0	0	?	1	?	?	?	?	?	?	?	0	?	?	?	?	0	?	?	?	?
Psittacopes Lepidus	0	0	0	0	0	1	?	?	0	?	?	?	?	?	?	?	?	1	1	?	?	0
Psittacomimus eos	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	0	?	?	?
Avolatavis tenens	?	?	?	?	0	1	?	?	0	?	?	?	0	?	?	0	?	0	1	1	0	0
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pseudasturides macrocephalus	0	0	0	0	0	?	0	?	?	?	?	?	0	0	?	?	?	?	?	?	?	?
Cyrilavis colburnorum	0	1	0	0	0	1	1	?	?	?	0	0	0	?	0	?	?	?	1	1	0	?
Cyrilavis cf. colburnorum	?	?	?	?	0	1	?	?	0	0	?	?	?	?	?	?	?	?	?	?	?	0
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	0	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	0	1	?	?	?	?	?	0	?	?	?	?	?	?	1	2	0	0
Pulchrapollia eximia	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis eocaena	0	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	0	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	0	0	0	0	0	1	0	?	0	?	0	0	?	0	?	?	?	?	?	?	?	?
Tynskya waltonensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya eocaena	?	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	0	0	0	0	?	0	?	?	?	?	?	?	0	?	?	?	?	?	1	?	0	0
Serudaptus pohli	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	0	?	?	0
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421
Eudromia elegans	0	1	4	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Chauna chavaria	1	0	3	0	1	0	0	0	1	1	1	1	0	1	1	0	0	1	0	0	0	0
Charadris vociferus	1	1	3	0	1	0	0	1	1	1	0	0	0	1	0	0	0	1	0	0	0	0
Eurypyga helias	1	1	3	0	1	0	0	1	1	1	0	1	0	2	0	0	0	1	0	0	0	0
Cathartes burrovianus	1	0	2	0	0	0	0	1	1	0	0	1	0	2	1	0	0	0	0	0	0	0
Vultur gryphus	1	0	2	0	1	0	0	0	1	0	0	1	0	2	1	0	0	0	0	0	0	0
Sagittarius serpentarius	1	0	2	0	1	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0
Pandion haliaetus c.	1	0	2	0	0	0	1	0	2	0	0	1	0	1	0	0	0	0	0	0	0	0
Elanus caeruleus	1	0	2	0	0	0	1	0	1	1	0	1	0	2	1	0	?	0	0	0	0	0
Buteo rufofuscus	1	0	2	0	1	0	0	0	1	1	0	1	0	2	1	0	0	0	0	0	0	0
Accipiter nisus	1	0	2	0	1	0	1	0	1	1	0	1	0	2	1	0	0	0	0	0	0	0
Tyto alba	1	0	1	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
Strix aluco	1	0	1	0	1	1	0	0	1	0	0	1	0	2	0	0	0	0	0	0	0	0
Colius striatus kiwuensis	1	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	0	0	0
Urocolius macrourus pulcher	1	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	0	0	0
Leptosomus discolor	1	0	1	0	0	0	0	1	1	0	0	1	0	1	0	0	1	0	0	0	0	0
Apaloderma narina	1	0	1	0	0	0	0	0	2	0	0	0	0	1	0	0	1	0	0	0	0	0
Trogon melanurus e.	1	0	1	0	0	0	0	0	2	0	0	0	0	1	1	0	1	0	0	0	0	0
Upupa marginata	1	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0
Tockus nasutus	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Merops orientalis	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0
Atelornis pittoides	1	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0
Coracias benghalensis	1	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0
Todus mexicanus	1	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0
Momotus momota	1	1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0
Alcedo atthis	1	1	1	0	0	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0
Galbula dea	1	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0
Indicator exilis p.	1	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Picus viridis	1	0	1	0	0	0	0	0	1	1	0	0	0	0	?	?	?	?	?	?	?	?
Megalaima chrysopogon	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Ramphastos ambiguus	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Cariama cristata	1	0	2	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Chunga burmeisteri	1	0	2	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Micrastur ruficollis c.	1	0	2	0	1	0	1	0	0	0	0	1	0	1	1	0	0	0	0	1	0	1
Falco sparverius	1	0	2	0	1	0	1	0	1	0	0	1	0	2	1	0	0	0	0	1	0	1
Daptrius ater	1	0	2	0	1	0	1	0	1	0	0	1	0	2	1	0	0	0	0	1	0	1
Caracara cheriway	1	0	2	0	0	0	0	0	1	0	0	1	0	2	1	0	0	0	0	1	0	1
Nestor notabilis	1	1	2	0	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
Strigops habroptilus	1	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?
Probosciger aterrimus	1	1	2	0	0	0	0	0	1	1	1	1	0	2	0	0	0	0	0	0	0	0
Barnardius zonarius	1	1	2	0	0	0	0	0	1	1	1	1	0	2	0	0	1	0	0	0	0	0
Psittrichas fulgidus	1	1	2	0	0	0	0	0	1	1	1	1	0	1	0	0	1	0	0	0	0	0
Psittacus erithacus	1	1	2	0	0	0	0	0	1	1	1	1	0	0	0	0	1	0	0	0	0	0
Deroptyus accipitrinus	1	1	2	0	0	0	0	0	1	1	1	1	0	1	0	0	1	0	0	0	0	0
Acanthisitta chloris	1	1	1	1	0	0	0	1	1	1	1	0	0	1	0	0	1	0	0	0	1	0
Pitta sordida	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	1	0
Neodrepanis coruscans	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	1	0
Melanopareia bitorquata	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	1	0
Myrmornis torquata	1	1	1	0	0	0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	1	0
Myrmothera campanisona m.	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	1	0
Neopelma chrysocephalum	1	1	1	0	0	0	0	1	2	0	0	0	0	1	0	0	1	0	0	0	1	0
Rupicola peruvianus	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	1	0
Piprites chloris tschudii	1	1	1	0	0	0	0	1	2	0	0	0	0	1	0	0	1	0	0	0	1	0
Tyrannus tyrannus	1	1	1	0	0	0	0	1	1	0	0	0	0	2	0	0	1	0	0	0	1	0
Menura novaehollandiae	1	0	1	0	0	0	0	0	1	0	0	1	0	1	0	1	1	0	0	0	1	0
Climacterus melanurus wellsi	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	1	0
Malurus melanocephalus	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	1	0
Corvus brachyrhynchos	1	1	1	0	0	0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	1	0
Sylvia borin	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	1	0
Zosterops lateralis	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0
Passer domesticus	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	0	0	?	?	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primoptynx poliotauros	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	?	0	0	1
Masillacolius brevidactylus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eoglaucidium cf pallas	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	1	?	?	?
Eotrogon stenorhynchus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelirrisor halcyrostris	0	?	?	?	?	?	?	?	0	?	?	?	?	?	0	?	?	?	0	?	?	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	0
Plesiocathartes wyomingensis	?	?	?	0	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421
Plesiocathartes kelleri	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Waltonavis sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Bathornis grallator	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	1	?	?	?	?
Dynamopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0	?	?	1	?
Danielsraptor phorusrhacoides	1	0	?	?	?	0	0	?	0	?	?	?	?	?	0	0	0	0	0	0	0	?
Masillaraptor cf parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	0	0	?
Masillaraptor parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	0	?	?	?	?	?
Eofringillirostrum boudreauxi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Zygodactylus grandei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eozygodactylus americanus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus quintus	?	?	?	?	?	?	0	?	?	?	?	1	?	1	0	0	1	0	0	0	0	0
Primozygodactylus longibrachium	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	0	?	?	?
Primozygodactylus eunjooae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	0	?	?	?
Primozygodactylus danielsi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	0	?	?	?
Primozygodactylus major	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	0	?	?	?
Pumiliornis tessellatus	?	?	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?
Parapsittacopes bergdahli	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	?	?	?	?
Psittacopes Lepidus	1	0	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?
Psittacomimus eos	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	0	0	?	?	?
Avolatavis tenens	0	?	?	0	0	0	0	0	1	0	1	1	0	?	0	0	?	0	0	0	0	0
Avolatavis europaeus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	1	0	0	0	0	0
Pseudasturides macrocephalus	?	?	?	0	1	?	?	?	0	?	?	?	?	?	0	?	?	?	0	?	?	?
Cyrilavis colburnorum	1	1	?	?	?	0	?	1	0	?	?	?	?	2	?	0	1	0	0	0	0	1
Cyrilavis cf. colburnorum	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cyrilavis olsoni	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	1	0	0	0	0	0
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	1	?	?	?	?	?	0	1	?	?	?	?	?	?	?	0	1	0	0	0	0	0
Pulchrapollia eximia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	1	0	0	0	0	0
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	1	?	?	?	?	?	?	?	0	?	?	0	?	2	0	?	?	?	?	?	?	?
Tynskya waltonensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	1	0	?	?	?	?
Tynskya eocaena	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?	?
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0	1	0	0	0
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eurofluvioviridavis robustipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Serudaptus pohli	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443
Eudromia elegans	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Chauna chavaria	0	0	0	0	1	?	1	1	0	0	1	0	?	1	0	0	?	0	0	0	0	0
Charadris vociferus	0	0	1	1	0	1	1	2	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Eurypyga helias	0	0	0	0	1	0	0	2	0	0	0	0	0	1	0	1	1	0	0	0	0	0
Cathartes burrovianus	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Vultur gryphus	0	0	0	0	1	?	0	0	0	0	0	0	?	1	0	0	?	0	0	0	0	0
Sagittarius serpentarius	0	0	0	1	1	?	0	0	0	0	0	0	?	2	0	0	?	0	0	0	0	0
Pandion haliaetus c.	0	0	0	0	1	?	0	0	0	0	0	0	?	2	0	0	?	0	0	0	0	0
Elanus caeruleus	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Buteo rufofuscus	0	0	0	0	1	?	0	0	0	0	0	0	?	1	0	0	?	0	0	1	1	0
Accipiter nisus	0	0	0	0	1	?	0	0	0	0	0	0	?	1	0	0	?	0	0	1	1	0
Tyto alba	0	0	0	0	1	0	0	0	0	0	0	1	1	2	1	-	?	-	1	0	0	0
Strix aluco	0	0	1	0	1	?	0	1	0	0	0	1	?	1	1	-	?	-	1	0	0	0
Colius striatus kiwuensis	0	0	1	0	0	0	1	1	1	2	0	0	0	1	0	1	0	0	1	2	0	0
Urocolius macrourus pulcher	0	0	1	0	0	?	1	1	1	2	0	0	?	1	0	1	?	0	1	2	0	0
Leptosomus discolor	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	1	0	0	0	1	0	0
Apaloderma narina	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	2	0	0
Trogon melanurus e.	0	1	1	0	1	1	0	1	0	0	0	0	0	1	0	1	1	0	0	2	0	0
Upupa marginata	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0
Tockus nasutus	0	1	1	0	0	?	0	0	0	0	0	0	?	1	0	1	?	0	0	2	0	0
Merops orientalis	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2	0	0
Atelornis pittoides	0	0	1	0	0	?	0	2	0	0	0	0	?	0	0	1	?	0	0	2	0	0
Coracias benghalensis	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Todus mexicanus	0	0	1	0	0	?	1	1	0	0	0	0	?	2	0	1	?	0	1	0	0	0
Momotus momota	0	0	1	0	0	?	0	0	0	0	0	0	?	1	0	1	?	0	1	0	0	0
Alcedo atthis	0	0	1	0	0	?	0	1	0	0	0	0	?	1	0	1	?	0	0	0	0	0
Galbula dea	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1
Indicator exilis p.	0	1	0	0	0	?	1	1	0	2	0	0	?	1	0	1	?	0	1	1	0	0
Picus viridis	?	?	?	?	0	1	1	0	1	2	0	0	0	1	0	1	0	0	1	1	0	0
Megalaima chrysopogon	0	1	1	0	0	?	1	0	0	2	0	0	?	2	0	1	?	0	1	1	0	0
Ramphastos ambiguus	0	1	1	0	0	?	1	0	0	2	0	0	?	1	0	1	?	0	1	1	1	0
Cariama cristata	0	0	0	1	0	1	1	2	0	0	1	0	0	2	0	0	0	0	0	0	0	0
Chunga burmeisteri	0	0	0	1	1	1	1	2	0	0	1	0	0	2	0	0	0	0	0	0	0	0
Micrastur ruficollis c.	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	1
Falco sparverius	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	1
Daptrius ater	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0
Caracara cheriway	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0
Nestor notabilis	0	0	1	0	0	1	1	1	0	1	0	0	1	2	0	1	1	0	1	1	0	0
Strigops habroptilus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Probosciger aterrimus	0	0	1	0	0	1	1	1	0	1	0	0	1	2	1	-	?	-	1	2	0	0
Barnardius zonarius	0	0	1	0	0	1	1	1	0	1	0	0	1	1	0	1	1	0	1	2	0	0
Psittrichas fulgidus	0	0	1	0	0	1	0	0	0	1	0	0	1	2	0	1	1	0	1	2	0	0
Psittacus erithacus	0	0	1	0	0	1	0	1	0	0	0	0	1	2	1	-	?	-	0	0	1	0
Deroptyus accipitrinus	0	0	1	0	0	1	0	1	0	1	1	0	1	2	0	1	1	0	0	0	0	0
Acanthisitta chloris	0	1	1	1	0	1	1	2	0	1	1	0	1	1	0	1	1	0	1	2	1	0
Pitta sordida	0	1	1	0	0	1	0	2	0	0	0	0	1	1	0	1	1	0	1	2	0	0
Neodrepanis coruscans	0	1	1	0	0	?	1	2	0	2	1	0	?	0	0	1	?	0	1	2	0	0
Melanopareia bitorquata	1	1	1	0	1	?	0	2	0	2	1	0	?	1	0	1	?	0	1	2	0	0
Myrmornis torquata	0	1	1	0	0	1	0	2	0	2	1	0	1	1	0	0	1	0	1	2	0	0
Myrmothera campanisona m.	0	1	1	0	1	?	0	2	0	0	1	0	?	1	0	0	?	0	1	2	0	0
Neopelma chrysocephalum	0	1	1	0	0	?	0	2	0	0	0	0	?	1	0	0	?	0	1	2	0	0
Rupicola peruvianus	0	1	1	0	0	?	1	2	0	0	0	0	?	1	0	1	?	0	1	0	0	0
Piprites chloris tschudii	0	1	1	0	1	?	0	2	0	0	0	0	?	1	1	-	?	0	1	0	0	0
Tyrannus tyrannus	0	1	1	0	1	1	0	2	0	0	0	0	1	1	0	1	1	0	1	1	0	0
Menura novaehollandiae	0	1	1	0	1	1	1	2	0	1	1	0	1	2	0	1	1	0	0	1	1	1
Climacterus melanurus wellsi	0	1	1	0	1	1	1	2	0	2	1	0	1	2	0	1	1	0	1	1	1	1
Malurus melanocephalus	1	1	1	0	0	1	1	2	0	2	1	0	1	1	0	1	1	0	1	1	0	0
Corvus brachyrhynchos	0	1	1	0	0	?	1	2	0	0	1	0	?	1	0	1	?	0	0	0	0	0
Sylvia borin	0	1	1	0	1	?	1	2	0	0	1	0	?	1	0	1	?	0	1	2	0	0
Zosterops lateralis	0	1	1	0	0	?	1	2	0	2	1	0	?	1	0	1	?	0	0	2	0	0
Passer domesticus	0	1	1	0	0	?	1	2	0	2	1	0	?	1	0	1	?	0	0	2	0	0
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	0	0	1	0	1	0	0	?	0	0	0
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	?	0	1	1	1	-	-	-	?	0	?	?
Ypresiglaux michaeldanielsi	?	?	?	?	?	?	?	?	?	?	?	0	0	1	1	-	-	-	1	0	0	0
Primoptynx poliotauros	0	0	0	0	?	0	0	0	?	0	0	1	1	?	1	-	-	-	1	0	0	0
Masillacolius brevidactylus	?	?	?	0	0	?	?	?	?	?	?	0	?	1	?	?	?	?	?	?	?	?
Eoglaucidium cf pallas	?	?	?	0	0	0	?	1	1	2	0	?	?	?	?	?	?	?	?	?	?	?
Eotrogon stenorhynchus	?	?	?	?	?	0	0	0	0	0	0	0	?	1	0	1	0	0	0	1	0	0
Messelirrisor halcyrostris	?	?	?	?	0	?	?	?	0	1	?	?	?	?	0	?	?	?	?	?	?	?
Plesiocathartes insolitipes	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Plesiocathartes wyomingensis	?	?	?	0	0	?	?	?	0	?	0	?	?	?	0	?	?	?	?	?	?	?

	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443
Plesiocathartes kelleri	?	?	?	0	0	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?
Waltonavis sp.	?	?	?	?	?	?	0	?	0	0	0	?	?	?	0	1	?	?	0	0	?	?
Bathornis grallator	?	?	?	?	?	?	?	?	?	?	?	?	1	?	0	?	?	?	?	?	?	?
Dynamopterus sp.	?	?	?	?	?	0	0	0	0	0	0	0	?	?	0	1	0	0	?	?	?	?
Danielsraptor phorusrhacoides	0	1	0	?	?	0	0	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor cf parvunguis	0	1	0	?	?	?	?	?	?	?	?	0	?	?	0	1	0	0	0	?	?	?
Masillaraptor parvunguis	?	?	?	?	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eofringillirostrum boudreauxi	?	?	?	0	0	0	?	?	?	?	?	0	?	1	?	?	?	?	?	?	?	?
Zygodactylus grandei	?	?	?	1	0	?	?	1	0	0	1	?	?	0	?	?	?	?	1	?	?	?
Eozygodactylus americanus	?	?	?	0	?	?	?	1	?	?	0	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus quintus	0	?	?	0	?	0	?	0	0	0	1	0	?	0	0	1	0	0	0	0	0	0
Primozygodactylus longibrachium	?	?	?	?	?	?	?	0	0	0	1	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus eunjooae	?	?	?	?	?	?	?	0	0	0	1	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus danielsi	?	?	?	?	?	?	?	0	0	0	1	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus major	?	?	?	?	?	?	?	0	0	0	1	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	?	?	?	?	?	0	0	1	0	1	1	0	?	1	1	?	?	?	?	?	?	?
Parapsittacopes bergdahli	?	?	?	?	?	0	?	?	0	1	?	?	?	0	?	?	?	?	?	?	?	?
Psittacopes Lepidus	?	?	?	0	0	?	0	?	0	?	1	?	1	0	?	?	?	?	?	?	0	0
Psittacomimus eos	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	?	?	0	?	?	?	?
Avolatavis tenens	0	?	?	0	0	?	0	?	0	0	0	0	1	1	?	?	?	?	?	?	0	?
Avolatavis europaeus	0	1	?	?	?	0	0	?	0	0	0	0	1	1	0	1	?	0	0	0	0	?
Pseudasturides macrocephalus	?	?	?	0	0	0	?	?	0	0	0	0	0	1	0	1	?	0	1	0	0	0
Cyrilavis colburnorum	0	?	?	1	0	?	?	?	0	?	0	0	0	1	?	?	?	?	?	?	0	?
Cyrilavis cf. colburnorum	?	?	?	?	0	0	0	?	?	1	0	?	?	?	?	?	?	?	?	?	?	?
Cyrilavis olsoni	?	?	?	?	0	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	0	1	1	?	?	?	0	?	0	0	0	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	0	0	1	0	1	?	0	0	0	0	0
cf. Pulchrapollia gracilis	0	1	1	0	?	?	0	?	0	0	0	?	?	?	?	?	?	?	0	?	?	?
Pulchrapollia eximia	0	1	1	0	?	?	?	?	?	?	?	0	0	?	0	1	?	0	0	?	0	?
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	?	0	0	1	0	0	?	0	0	0	?	?
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	?	0	0	1	0	0	?	0	0	0	?	?
Messelastur gratulator	?	?	?	1	0	1	?	?	0	0	0	0	0	1	0	1	?	?	?	0	?	?
Tynskya waltonensis	?	?	?	?	?	?	?	?	0	0	0	0	0	?	0	1	?	0	1	?	?	?
Tynskya eocaena	?	?	?	0	0	?	?	?	0	0	0	0	0	?	0	1	?	0	1	?	?	?
Tynskya crassitarsus	0	0	0	?	?	?	?	?	?	?	?	0	0	?	0	1	?	0	1	?	?	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	?	?	0	0	?	0	1	?	0	1	?	?	?
Eurofluvioviridavis robustipes	?	?	?	0	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?
Serudaptus pohli	?	?	?	?	0	?	?	?	0	1	0	?	0	?	?	?	?	?	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	0	1	2	0	1	?	0	0	0	0	0

	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465
Eudromia elegans	0	0	0	1	0	0	0	0	0	1	0	0	0	1	1	0	1	0	0	2	0	1
Chauna chavaria	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0
Charadris vociferus	0	0	0	1	0	0	0	0	0	1	0	0	0	1	1	0	1	0	0	0	2	1
Eurypyga helias	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	1	0
Cathartes burrovianus	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	2	0	0
Vultur gryphus	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	2	0	0
Sagittarius serpentarius	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0
Pandion haliaetus c.	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	1	2	2
Elanus caeruleus	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1
Buteo rufofuscus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Accipiter nisus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Tyto alba	0	0	0	1	0	0	0	0	2	1	0	1	1	0	0	0	1	0	0	1	1	1
Strix aluco	0	0	0	0	1	1	0	0	2	1	0	1	1	0	0	0	1	0	0	1	1	1
Colius striatus kiwuensis	0	0	0	0	1	1	0	0	2	1	1	-	1	0	0	0	0	0	0	0	1	2
Urocolius macrourus pulcher	0	0	0	0	1	1	0	0	2	1	1	-	1	0	0	0	0	0	0	0	1	2
Leptosomus discolor	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	1	1	0	0	2	2
Apaloderma narina	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	1	0	1	0	2	1
Trogon melanurus e.	0	0	0	1	0	0	0	0	1	0	0	2	1	0	0	0	1	0	1	0	2	2
Upupa marginata	0	0	0	0	0	0	0	0	2	1	0	0	1	0	0	0	2	0	0	0	2	2
Tockus nasutus	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	2	0	0	0	2	2
Merops orientalis	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	1	2	1	0	0	2	1
Atelornis pittoides	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	2	1	0	0	2	1
Coracias benghalensis	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	2	1	0	0	2	1
Todus mexicanus	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	2	1	0	0	2	1
Momotus momota	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	2	1
Alcedo atthis	0	0	0	0	0	1	0	0	0	1	0	2	0	0	1	0	2	1	0	0	2	1
Galbula dea	0	0	0	0	0	1	0	0	0	2	0	0	1	0	0	0	1	0	0	0	2	1
Indicator exilis p.	0	0	0	0	0	1	0	0	1	2	0	0	0	0	0	0	1	0	0	0	2	1
Picus viridis	0	0	0	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	2	1
Megalaima chrysopogon	0	0	0	0	0	1	0	0	1	2	0	0	0	0	0	0	1	0	0	0	2	1
Ramphastos ambiguus	0	0	0	0	0	1	0	0	1	2	0	0	0	0	0	0	1	0	0	0	2	1
Cariama cristata	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	2	0	0
Chunga burmeisteri	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2	0	0
Micrastur ruficollis c.	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	1	1
Falco sparverius	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	1	1	1
Daptrius ater	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	1	1
Caracara cheriway	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1
Nestor notabilis	0	0	0	1	0	0	0	0	1	0	2	-	-	0	0	0	0	0	1	0	2	2
Strigops habroptilus	?	?	?	?	?	?	?	?	1	0	2	-	?	?	?	?	?	0	1	0	2	2
Prosobsiger aterrimus	0	0	0	1	0	0	0	0	1	0	2	-	-	0	0	0	0	0	1	0	2	2
Barnardius zonarius	0	0	0	1	0	0	0	0	1	0	2	-	-	0	1	0	0	0	1	0	2	1
Psittrichas fulgidus	0	0	0	1	0	0	0	0	1	0	2	-	-	0	1	0	0	0	1	0	2	2
Psittacus erithacus	0	0	0	1	0	0	0	0	1	0	2	-	-	0	1	0	0	0	1	0	2	2
Deroptyus accipitrinus	0	0	0	1	0	0	0	0	1	0	2	-	-	0	1	0	0	0	1	0	2	2
Acanthisitta chloris	1	0	0	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	2	2
Pitta sordida	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	2	2
Neodrepanis coruscans	0	0	0	1	0	0	0	0	2	1	0	0	1	1	0	0	0	0	0	0	2	2
Melanopareia bitorquata	1	0	0	1	0	0	0	0	2	1	0	0	1	0	0	0	0	0	0	0	2	2
Myrmornis torquata	1	0	0	1	0	0	0	?	2	1	0	0	1	0	0	0	0	0	0	0	2	2
Myrmothera campanisona m.	1	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	2	2
Neopelma chrysocephalum	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Rupicola peruvianus	0	0	0	1	0	0	0	1	2	1	0	0	1	0	0	0	0	0	0	0	2	2
Piprites chloris tschudii	0	0	0	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	2	2
Tyrannus tyrannus	0	0	0	1	0	0	0	1	2	1	0	0	1	0	0	0	0	0	0	0	2	2
Menura novaehollandiae	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	2	2
Climacterus melanurus wellsi	1	0	0	1	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	2	2
Malurus melanocephalus	1	0	0	1	0	0	0	0	2	1	0	0	1	0	0	0	0	0	0	0	2	2
Corvus brachyrhynchos	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	2	2
Sylvia borin	1	0	0	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	2	2
Zosterops lateralis	1	0	0	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	2	2
Passer domesticus	1	0	0	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	2	2
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Diatropornis ellioti	0	0	0	1	0	0	?	0	0	1	0	0	?	0	0	0	?	?	0	2	0	0
Horusornis vianeyliaudae	0	0	0	?	?	?	?	?	0	0	0	0	0	0	0	0	0	0	0	1	?	?
Ypresiglaux michaeldanielsi	0	0	0	?	?	?	?	?	0	0	0	0	1	0	0	0	0	0	0	1	1	1
Primoptynx poliotauros	0	0	0	?	?	?	?	?	?	0	0	?	?	?	?	?	?	?	0	1	1	1
Masillacolius brevidactylus	?	?	?	?	?	?	?	?	0	0	0	?	1	0	0	?	?	?	0	?	?	?
Eoglaucidium cf pallas	?	0	?	?	?	1	?	?	0	1	?	?	1	0	0	?	0	0	0	0	2	1
Eotrogon stenorhynchus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	?	0	0	?	?
Messelirrisor halcyrostris	?	?	?	?	?	?	?	?	0	0	0	?	0	0	0	?	1	1	0	?	?	?
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	?
Plesiocathartes wyomingensis	?	?	?	?	?	?	?	?	0	0	?	?	1	?	?	?	?	?	0	2	?	?

	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465
Plesiocathartes kelleri	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	2	?	?
Waltonavis sp.	?	0	?	0	0	0	0	0	0	?	0	0	1	0	1	1	1	?	0	0	2	2
Bathornis grallator	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	0	?
Dynamopterus sp.	?	?	?	0	0	0	?	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0
Danielsraptor phorusrhacoides	?	?	?	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0
Masillaraptor cf parvunguis	0	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	?	?	?	?	?	?
Masillaraptor parvunguis	?	?	?	?	?	?	?	?	0	1	0	?	?	?	0	?	1	0	0	2	0	0
Eofringillirostrum boudreauxi	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	0	0	?	?	?	?
Zygodactylus grandei	?	?	?	?	?	0	?	?	0	?	0	?	?	0	?	?	0	0	?	0	2	2
Eozygodactylus americanus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus quintus	0	0	?	?	1	0	0	0	0	1	0	2	0	0	1	0	0	0	0	0	2	2
Primozygodactylus longibrachium	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	0	0	?	?	2	2
Primozygodactylus eunjooae	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	0	0	?	?	2	2
Primozygodactylus danielsi	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	0	?	?	2	2
Primozygodactylus major	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	0	?	?	2	2
Pumiliornis tessellatus	?	?	?	?	?	?	?	?	0	0	?	?	1	?	?	?	0	0	?	?	?	?
Parapsittacopes bergdahli	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Psittacopes Lepidus	?	?	?	?	?	?	?	?	0	0	0	0	1	0	0	0	0	0	?	0	2	2
Psittacomimus eos	?	?	?	0	0	0	?	0	0	0	0	0	1	0	0	0	0	0	0	0	2	2
Avolatavis tenens	?	?	?	?	?	?	?	?	0	0	0	1	?	?	0	0	0	0	?	0	?	1
Avolatavis europaeus	0	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	1
Pseudasturides macrocephalus	1	0	0	?	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	1
Cyrilavis colburnorum	?	?	0	0	?	1	?	0	0	1	1	-	-	0	0	-	1	0	0	0	2	1
Cyrilavis cf. colburnorum	?	?	?	?	0	1	?	?	0	1	?	?	?	?	?	?	1	0	0	?	?	?
Cyrilavis olsoni	?	?	0	?	?	1	?	?	?	?	1	-	?	?	?	-	?	?	0	?	?	?
Pulchrapollia gracilis	?	?	?	1	0	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	2	1
cf. Pulchrapollia	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	2	1
cf. Pulchrapollia gracilis	?	?	?	1	0	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	2	1
Pulchrapollia eximia	?	0	0	1	0	1	0	0	1	0	0	0	1	0	1	1	1	0	0	0	2	1
Vastanavis eocaena	?	0	1	1	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	2	1
Vastanavis cambayensis	?	0	1	1	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	2	1
Messelastur gratulator	?	0	0	?	?	?	0	?	0	0	0	?	?	?	0	?	2	0	?	1	1	1
Tynskya waltonensis	0	0	0	?	?	1	?	?	0	0	0	1	1	0	0	0	2	0	0	1	1	1
Tynskya eocaena	0	0	0	?	?	1	?	?	0	0	0	1	1	0	0	0	2	0	0	1	1	1
Tynskya crassitarsus	0	0	0	?	?	1	0	0	0	0	0	1	1	0	0	0	2	0	0	1	1	1
Tynskya brevitarsus	0	0	0	?	?	1	0	0	0	0	0	1	1	0	0	0	2	0	0	1	1	1
Eurofluvioviridavis robustipes	?	?	?	?	?	?	?	?	?	?	1	-	?	?	0	-	0	0	?	0	2	2
Serudaptus pohli	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	1	?	?	0	0	0	1	1	0	0	0	0	0	0	0	2	1

	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487
Eudromia elegans	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1
Chauna chavaria	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	2	1	1
Charadris vociferus	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	1	0	0	0	2	1	1
Eurypyga helias	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	2	1	1
Cathartes burrovianus	0	0	0	0	0	0	1	2	0	0	1	0	1	0	0	0	0	0	0	1	1	0
Vultur gryphus	0	0	0	0	0	0	1	2	0	0	1	0	1	0	0	0	0	0	0	1	1	1
Sagittarius serpentarius	0	0	0	0	0	0	1	2	0	0	1	0	1	0	0	0	0	0	0	1	1	1
Pandion haliaetus c.	0	0	0	0	0	1	0	0	1	0	2	1	1	0	0	1	0	0	0	2	2	0
Elanus caeruleus	0	0	0	0	0	1	0	1	2	0	1	0	1	0	0	0	0	0	0	1	1	0
Buteo rufofuscus	0	0	0	0	0	1	0	1	2	0	1	0	1	0	0	0	0	0	0	1	1	0
Accipiter nisus	0	0	0	0	0	1	0	1	2	0	1	0	1	0	0	0	0	0	0	1	1	0
Tyto alba	0	0	1	1	0	1	0	2	1	0	2	1	1	0	0	0	0	0	0	1	2	0
Strix aluco	0	0	1	1	0	1	0	2	2	0	2	1	1	0	0	0	0	0	0	1	2	0
Colius striatus kiwuensis	0	0	0	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0
Urocolius macrourus pulcher	0	0	0	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0
Leptosomus discolor	0	0	0	0	1	0	1	1	1	0	1	0	1	0	0	0	0	0	0	1	2	0
Apaloderma narina	0	2	1	0	2	0	1	0	0	0	1	0	0	0	0	0	0	0	?	3	1	1
Trogon melanurus e.	0	2	1	0	2	0	1	0	0	0	1	0	0	0	0	0	0	0	?	3	1	1
Upupa marginata	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Tockus nasutus	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Merops orientalis	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Atelornis pittoides	2	2	0	0	1	0	1	1	0	0	0	0	0	1	0	1	0	0	0	1	1	0
Coracias benghalensis	1	1	0	0	1	0	1	1	0	0	0	0	0	1	0	1	0	0	0	1	1	0
Todus mexicanus	1	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Momotus momota	1	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Alcedo atthis	1	1	0	0	1	0	1	1	0	0	0	0	0	1	0	1	0	0	0	1	1	0
Galbula dea	0	1	0	0	1	0	1	1	0	0	0	0	0	2	1	0	0	0	0	0	2	0
Indicator exilis p.	2	2	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Picus viridis	2	2	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Megalaima chrysopogon	2	2	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Ramphastos ambiguus	2	2	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Cariama cristata	0	0	0	0	?	0	1	2	1	0	1	0	1	0	0	0	0	0	0	1	1	1
Chunga burmeisteri	0	0	0	0	0	0	1	2	1	0	1	0	1	0	0	0	0	0	0	1	1	1
Micrastur ruficollis c.	0	0	1	1	1	1	1	1	2	0	1	0	1	0	0	0	0	1	0	1	1	0
Falco sparverius	0	0	1	1	1	1	1	1	?	0	1	0	1	0	0	0	0	1	0	1	1	0
Daptrius ater	0	0	1	1	0	1	1	1	1	0	1	0	1	0	0	0	0	0	0	1	1	0
Caracara cheriway	0	0	1	1	1	1	1	1	1	0	1	0	1	0	0	0	0	1	0	1	1	0
Nestor notabilis	0	2	0	1	2	-	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	1
Strigops habroptilus	0	1	?	?	2	-	0	?	?	0	?	?	?	?	0	1	0	0	0	1	1	1
Probosciger aterrimus	0	1	0	1	2	-	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1
Barnardius zonarius	0	2	0	0	2	-	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	1
Psittrichas fulgidus	0	0	0	0	2	-	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	1
Psittacus erithacus	0	1	0	0	2	-	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	1
Deroptyus accipitrinus	0	1	0	0	2	-	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	1
Acanthisitta chloris	0	1	0	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	1	0	0	1
Pitta sordida	3	2	0	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0
Neodrepanis coruscans	3	2	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0
Melanopareia bitorquata	3	2	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0
Myrmornis torquata	3	2	0	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0
Myrmothera campanisona m.	3	2	0	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0
Neopelma chrysocephalum	?	?	?	?	?	?	?	0	0	?	0	0	0	0	0	0	1	0	1	0	0	0
Rupicola peruvianus	3	2	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Piprites chloris tschudii	3	2	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0
Tyrannus tyrannus	3	2	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0
Menura novaehollandiae	3	2	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0
Climacterus melanurus wellsi	3	2	0	1	1	0	1	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0
Malurus melanocephalus	3	2	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	1
Corvus brachyrhynchos	3	2	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	1
Sylvia borin	3	2	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	1
Zosterops lateralis	3	2	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	1
Passer domesticus	3	2	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	1
Palaeoplancus sternbergi	?	?	?	?	0	1	?	0	?	?	1	?	?	0	?	0	0	0	0	?	?	0
Diatropornis ellioti	?	?	0	0	0	0	1	2	?	0	1	?	?	?	0	0	0	0	0	1	1	1
Horusornis vianeyliaudae	?	?	?	?	0	?	0	1	1	0	1	1	1	0	0	1	0	0	0	1	2	0
Ypresiglaux michaeldanielsi	?	?	0	?	0	1	0	2	2	0	2	1	?	0	0	1	0	0	0	2	2	1
Primoptynx poliotauros	?	?	0	?	1	0	?	0	0	0	1	?	?	?	?	?	?	?	?	0	?	0
Masillacolius brevidactylus	?	?	?	?	1	0	0	1	?	0	?	0	?	0	0	0	0	?	?	?	?	0
Eoglaucidium cf pallas	?	?	?	?	1	0	0	1	1	0	?	0	1	0	0	0	0	?	?	?	?	1
Eotrogon stenorhynchus	?	?	1	?	1	0	1	1	0	0	1	0	?	0	0	0	0	0	?	3	1	1
Messelirrisor halcyrostris	?	?	?	?	1	0	1	0	?	0	0	0	0	?	0	0	0	?	?	?	?	0
Plesiocathartes insolitipes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	?
Plesiocathartes wyomingensis	?	?	?	?	?	?	?	2	?	0	?	?	?	?	?	?	?	?	0	?	?	0

	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487
Plesiocathartes kelleri	?	?	?	?	?	?	?	?	2	0	?	1	?	?	?	0	?	?	?	?	?	?
Waltonavis sp.	?	?	1	0	1	0	1	1	0	0	1	0	?	0	0	0	0	0	0	1	1	0
Bathornis grallator	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?
Dynamopterus sp.	0	0	0	0	0	0	1	1	0	0	1	0	?	?	0	0	0	0	0	1	1	1
Danielsraptor phorusrhacoides	0	0	0	0	0	0	1	2	1	0	1	0	1	0	0	0	0	0	0	1	1	1
Masillaraptor cf parvunguis	?	?	?	?	0	0	1	2	1	0	1	0	1	0	0	0	0	0	0	1	1	1
Masillaraptor parvunguis	0	0	?	?	0	?	?	2	1	0	?	?	?	?	?	0	0	?	?	?	?	1
Eofringillirostrum boudreauxi	?	?	?	?	2	0	0	2	?	0	1	1	?	?	?	0	0	0	0	?	?	?
Zygodactylus grandei	0	?	?	?	?	?	?	?	?	1	?	?	0	?	0	?	?	?	0	?	?	?
Eozygodactylus americanus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?
Primozygodactylus quintus	?	?	0	?	1	0	1	0	1	1	1	1	1	0	0	0	0	0	0	1	1	1
Primozygodactylus longibrachium	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus eunjooae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus danielsi	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus major	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	?	?	?	?	2	0	?	1	0	0	1	0	?	?	0	0	0	0	0	1	1	1
Parapsittacopes bergdahli	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Psittacopes Lepidus	?	?	?	?	2	?	?	?	?	0	?	?	0	2	?	?	?	?	?	?	?	1
Psittacomimus eos	0	?	0	0	2	0	0	1	0	0	0	0	0	2	0	0	0	0	1	0	2	1
Avolatavis tenens	?	?	?	?	?	?	?	?	0	0	?	0	1	?	0	0	0	1	?	1	?	1
Avolatavis europaeus	?	?	?	?	2	0	0	1	0	0	1	0	1	0	0	0	0	1	0	1	1	1
Pseudasturides macrocephalus	?	?	?	?	2	0	0	1	1	0	1	?	0	2	0	1	0	0	0	?	?	1
Cyrilavis colburnorum	?	?	?	?	1	0	0	0	1	0	1	0	0	2	0	1	0	0	0	?	?	1
Cyrilavis cf. colburnorum	?	?	?	?	1	0	0	0	1	0	1	0	0	?	0	1	0	0	0	1	1	1
Cyrilavis olsoni	?	?	?	?	1	?	?	?	?	?	?	?	0	2	0	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	1	0	1	0	0	0	1	0	1	0	0	2	1	1	0	0	?	1	?	1
cf. Pulchrapollia	?	?	1	?	1	0	0	0	1	0	1	0	0	2	1	1	0	0	0	1	1	1
cf. Pulchrapollia gracilis	0	0	1	0	1	?	0	0	1	0	1	0	0	2	1	1	0	0	0	1	1	1
Pulchrapollia eximia	0	0	1	0	1	1	0	0	1	0	1	0	0	2	1	1	0	0	0	1	1	1
Vastanavis eocaena	0	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	1	1
Vastanavis cambayensis	0	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	1	1
Messelastur gratulator	?	?	1	0	1	?	?	?	2	0	?	1	?	?	0	0	0	?	?	?	?	1
Tynskya waltonensis	?	?	1	0	1	0	0	1	1	0	1	0	0	2	0	0	0	0	?	?	?	1
Tynskya eocaena	?	?	?	0	1	?	?	1	1	0	1	0	?	2	0	0	0	0	0	?	?	1
Tynskya crassitarsus	?	1	1	0	?	?	?	1	1	0	1	0	0	2	0	0	0	0	0	1	1	1
Tynskya brevitarsus	?	1	1	0	?	?	?	1	1	0	1	0	0	2	0	0	0	0	0	1	1	1
Eurofluvioviridavis robustipes	?	?	0	?	?	?	?	?	?	0	0	?	?	?	?	?	?	?	?	?	?	?
Serudaptus pohli	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?
Quercypsitta sudrei	?	?	?	?	1	1	?	0	0	0	0	0	0	2	0	1	0	0	1	0	0	1

	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509
Eudromia elegans	1	0	0	0	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Chauna chavaria	1	0	0	0	1	1	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Charadris vociferus	1	0	0	0	1	1	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Eurypyga helias	1	0	0	0	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Cathartes burrovianus	1	0	0	1	0	0	-	0	-	-	-	0	1	0	0	0	0	0	0	0	0	0
Vultur gryphus	1	0	0	0	0	0	-	0	-	-	-	0	1	0	0	0	0	0	0	0	0	0
Sagittarius serpentarius	1	0	0	0	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Pandion haliaetus c.	0	0	0	1	0	1	0	2	0	-	-	0	0	0	0	0	0	0	0	0	0	0
Elanus caeruleus	1	0	1	2	0	1	0	1	0	-	-	0	0	0	0	0	0	0	0	0	0	0
Buteo rufofuscus	1	0	0	1	0	1	1	1	0	-	-	0	0	0	0	0	0	0	0	0	0	0
Accipiter nisus	1	0	0	1	0	1	1	1	0	-	-	0	0	0	0	0	0	0	0	0	0	0
Tyto alba	1	0	0	0	1	1	0	2	1	-	-	0	0	0	0	0	0	0	0	0	0	0
Strix aluco	1	0	0	0	1	1	0	2	1	-	-	0	0	0	0	0	0	0	0	0	0	0
Colius striatus kiwuensis	1	0	1	0	1	0	-	2	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Urocolius macrourus pulcher	1	0	1	0	1	0	-	2	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Leptosomus discolor	1	0	0	0	0	0	-	2	1	-	-	0	0	1	0	0	0	0	0	0	0	0
Apaloderma narina	0	0	0	0	1	1	2	0	-	-	-	0	0	0	0	0	0	0	0	1	0	0
Trogon melanurus e.	0	0	0	0	1	1	2	0	-	-	-	0	0	0	0	0	0	0	0	1	0	0
Upupa marginata	1	0	1	2	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Tockus nasutus	1	0	0	0	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Merops orientalis	0	0	0	0	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Atelornis pittoides	1	0	0	0	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Coracias benghalensis	1	0	1	1	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	1
Todus mexicanus	0	0	0	0	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Momotus momota	0	0	0	1	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	1	0	0
Alcedo atthis	0	0	0	1	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Galbula dea	1	1	0	0	1	0	-	3	2	1	0	0	0	0	0	1	0	0	0	0	0	0
Indicator exilis p.	1	1	0	0	1	0	-	3	2	1	1	0	0	0	0	0	0	0	0	0	0	1
Picus viridis	1	1	0	0	1	0	-	3	2	1	1	0	0	0	0	0	0	0	0	0	0	1
Megalaima chrysopogon	1	1	0	0	1	0	-	3	2	1	1	0	0	0	0	0	0	0	0	0	0	1
Ramphastos ambiguus	1	1	0	0	1	0	-	3	2	1	1	0	0	0	0	0	0	0	0	0	0	1
Cariama cristata	1	0	0	0	1	0	-	0	-	-	-	0	1	0	0	0	0	0	0	0	0	0
Chunga burmeisteri	1	0	0	0	1	0	-	0	-	-	-	0	1	0	0	0	0	0	0	0	0	0
Micrastur ruficollis c.	1	0	1	2	0	1	1	1	0	-	-	0	0	0	0	0	0	0	0	0	0	0
Falco sparverius	1	0	0	0	1	1	1	1	0	-	-	0	0	0	0	0	0	0	0	0	0	1
Daptrius ater	1	0	0	0	1	1	1	1	0	-	-	0	0	0	0	0	0	0	0	0	0	0
Caracara cheriway	1	0	0	1	1	1	1	1	0	-	-	0	0	0	0	0	0	0	0	0	0	0
Nestor notabilis	1	1	1	0	1	1	1	3	2	1	0	1	0	1	0	0	1	0	0	0	1	0
Strigops habroptilus	1	1	1	2	1	1	1	3	2	1	0	1	?	1	0	?	1	0	0	0	1	0
Probosciger aterrimus	1	1	1	2	1	1	1	3	2	1	0	1	0	1	0	0	1	0	0	0	1	0
Barnardius zonarius	1	1	1	2	1	1	1	3	2	1	0	1	0	1	0	0	1	0	0	0	1	0
Psittrichas fulgidus	1	1	1	2	1	1	1	3	2	1	0	1	0	1	0	0	1	0	0	0	1	0
Psittacus erithacus	1	1	1	2	1	1	1	3	2	1	0	1	0	1	0	0	1	0	0	0	1	0
Deroptyus accipitrinus	1	1	1	2	1	1	1	3	2	1	0	1	0	1	0	0	1	0	0	0	1	0
Acanthisitta chloris	0	0	0	1	0	0	-	0	-	-	-	0	0	1	0	0	0	0	0	1	0	1
Pitta sordida	1	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	1	0	0
Neodrepanis coruscans	1	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	1	0	1
Melanopareia bitorquata	1	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	1	0	0
Myrmornis torquata	1	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	1	0	0
Myrmothera campanisona m.	1	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	1	0	0
Neopelma chrysocephalum	1	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	1	0	0
Rupicola peruvianus	0	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	1	0	0
Piprites chloris tschudii	0	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	1	0	0
Tyrannus tyrannus	0	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	1	0	0
Menura novaehollandiae	0	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Climacterus melanurus wellsi	0	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Malurus melanocephalus	0	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Corvus brachyrhynchos	0	0	0	1	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	1
Sylvia borin	0	0	0	1	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	1
Zosterops lateralis	1	0	0	1	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	1
Passer domesticus	1	0	0	1	1	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	1
Palaeoplancus sternbergi	1	0	0	1	0	1	0	?	?	-	-	0	0	0	0	0	0	0	0	0	0	0
Diatropornis ellioti	1	0	?	?	?	0	-	0	-	-	-	0	0	0	?	0	0	0	0	0	0	0
Horusornis vianeyliaudae	1	0	0	0	1	1	0	1	0	-	-	0	1	0	0	0	0	0	0	0	0	0
Ypresiglaux michaeldanielsi	1	0	1	0	0	1	0	2	0	-	-	0	0	0	0	0	1	0	0	0	0	0
Primoptynx poliotauros	0	?	1	0	?	0	-	?	?	?	?	0	0	0	?	0	?	?	?	0	0	0
Masillacolius brevidactylus	0	0	0	0	?	?	?	?	-	-	-	0	0	2	0	0	0	?	?	0	0	?
Eoglaucidium cf pallas	1	0	1	1	?	1	?	2	-	-	-	0	0	0	0	1	0	?	?	0	0	0
Eotrogon stenorhynchus	1	0	0	0	?	1	2	0	-	-	-	0	0	0	0	0	0	0	?	0	0	0
Messelirrisor halcyrostris	0	0	0	0	?	1	0	0	-	-	-	0	0	0	0	0	0	?	?	1	0	0
Plesiocathartes insolitipes	1	0	?	?	?	0	?	1	1	?	?	0	0	?	?	0	0	0	0	0	0	0
Plesiocathartes wyomingensis	1	?	0	0	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?	?

	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509
Plesiocathartes kelleri	?	?	0	0	?	0	?	1	1	?	?	?	?	?	?	0	?	?	?	?	?	?
Waltonavis sp.	1	0	0	1	0	1	0	1	1	?	?	0	0	?	?	?	0	0	0	0	0	0
Bathornis grallator	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Dynamopterus sp.	1	0	0	?	0	1	0	0	-	-	-	0	0	0	0	0	0	0	?	0	0	0
Danielsraptor phorusrhacoides	1	0	0	1	0	1	0	1	0	-	-	0	0	0	0	0	0	0	?	0	0	0
Masillaraptor cf parvunguis	1	0	0	1	0	1	0	1	0	-	-	0	0	0	0	0	0	0	?	0	0	0
Masillaraptor parvunguis	1	0	0	?	?	?	?	0	-	-	-	0	0	0	?	?	0	?	?	0	0	0
Eofringillirostrum boudreauxi	1	1	0	?	?	1	?	3	2	1	?	?	?	?	0	0	?	?	?	?	1	?
Zygodactylus grandei	1	1	?	?	?	1	0	3	2	1	1	0	?	?	1	?	0	1	1	?	0	?
Eozygodactylus americanus	?	?	?	?	?	1	?	3	?	?	1	0	?	?	?	?	?	?	?	?	?	?
Primozygodactylus quintus	1	1	0	0	1	1	0	3	2	1	0	0	0	0	1	0	0	0	0	1	0	0
Primozygodactylus longibrachium	?	?	?	?	?	?	?	3	2	1	?	?	?	?	1	?	0	?	?	?	0	?
Primozygodactylus eunjooae	?	?	?	?	?	0	-	3	2	1	?	?	?	?	1	?	0	?	?	?	0	?
Primozygodactylus danielsi	?	?	?	?	?	1	?	3	2	1	?	?	?	?	1	?	0	?	?	?	0	?
Primozygodactylus major	?	?	?	?	?	?	?	3	2	1	?	?	?	?	1	?	0	?	?	?	0	1
Pumiliornis tessellatus	1	0	0	0	?	1	?	3	?	-	-	0	0	0	1	0	1	?	?	0	0	0
Parapsittacopes bergdahli	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	1	?	?	?	1	?
Psittacopes Lepidus	1	?	0	?	?	0	?	3	?	1	?	1	?	?	0	0	1	?	?	?	1	?
Psittacomimus eos	1	1	0	0	1	0	-	3	2	1	0	1	0	2	0	0	1	0	?	0	1	0
Avolatavis tenens	1	0	0	0	1	1	0	2	?	-	-	0	?	0	0	1	0	?	?	0	0	0
Avolatavis europaeus	1	0	0	0	1	1	0	2	1	-	-	0	1	0	0	1	0	?	?	0	0	0
Pseudasturides macrocephalus	1	1	0	0	?	0	-	3	1	0	0	1	0	0	0	0	0	0	0	0	1	1
Cyrilavis colburnorum	1	?	?	?	?	0	-	3	1	0	0	?	0	0	0	0	0	0	0	?	1	0
Cyrilavis cf. colburnorum	1	1	0	0	1	0	-	3	1	0	0	0	?	0	0	0	0	?	?	0	1	0
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	?	0	0	?	?	?	?	?	?	?	1	0	0	0	0	1	0	0	?	1	0
cf. Pulchrapollia	1	1	0	0	1	0	-	3	1	0	0	1	0	0	0	0	1	0	0	0	1	0
cf. Pulchrapollia gracilis	1	1	0	0	1	0	-	3	1	0	0	1	0	0	0	0	1	0	0	0	1	0
Pulchrapollia eximia	1	1	0	0	1	0	-	3	1	0	0	1	0	0	0	0	1	0	0	0	1	0
Vastanavis eocaena	1	0	1	2	1	0	-	1	1	-	-	0	0	0	0	1	0	?	?	0	0	0
Vastanavis cambayensis	1	0	1	2	1	0	-	1	1	-	-	0	0	0	0	1	0	?	?	0	0	0
Messelastur gratulator	1	0	0	1	0	1	0	3	1	0	0	0	?	0	?	0	1	0	0	0	1	0
Tynskya waltonensis	1	1	0	1	1	1	0	3	1	0	0	1	0	0	0	0	0	0	0	0	1	0
Tynskya eocaena	1	1	0	1	1	1	0	3	1	0	0	1	0	0	0	0	0	0	0	0	1	0
Tynskya crassitarsus	1	1	0	1	1	1	0	3	1	0	0	1	0	0	0	0	0	0	0	0	1	0
Tynskya brevitarsus	1	1	0	1	1	1	0	3	1	0	0	1	0	0	0	0	0	0	0	0	1	0
Eurofluvioviridavis robustipes	1	?	?	?	?	0	-	2	?	-	?	?	?	?	?	1	0	?	?	?	?	0
Serudaptus pohli	?	?	?	?	?	0	?	3	1	0	?	?	?	?	?	?	0	?	?	?	?	?
Quercypsitta sudrei	1	1	0	0	0	0	-	3	2	1	0	1	0	0	0	0	1	?	?	0	0	0

	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531
Eudromia elegans	0	0	1	2	0	0	0	0	0	?	0	0	?	0	?	?	?	?	0	?	?	0
Chauna chavaria	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Charadris vociferus	0	0	1	1	0	0	0	0	0	-	1	?	1	?	0	?	?	?	0	0	?	0
Eurypyga helias	0	0	1	2	0	0	0	0	0	0	0	?	1	?	0	0	?	?	0	?	?	0
Cathartes burrovianus	0	0	0	2	0	0	0	0	?	0	0	0	0	0	0	0	0	0	0	1	0	0
Vultur gryphus	0	0	0	2	0	0	0	0	?	0	0	0	1	0	0	0	0	0	0	0	0	0
Sagittarius serpentarius	0	0	2	2	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0
Pandion haliaetus c.	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	1	2	2	2	0
Elanus caeruleus	0	0	0	2	0	0	0	0	1	0	0	1	0	0	0	0	1	1	2	2	2	0
Buteo rufofuscus	0	0	2	2	0	0	0	0	1	0	0	2	0	0	0	0	1	1	2	2	1	0
Accipiter nisus	0	0	2	2	0	0	0	0	?	?	0	2	0	0	0	0	1	2	2	2	1	0
Tyto alba	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	2	2	2	2	0
Strix aluco	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	2	2	0
Colius striatus kiwuensis	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	1	2	1
Urocolius macrourus pulcher	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	?	?	1	2	1	2	1
Leptosomus discolor	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0
Apaloderma narina	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	?	0	0	?	0	?	0
Trogon melanurus e.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	?	0	0	0	0	0	0
Upupa marginata	0	0	1	2	1	0	0	0	?	?	0	0	0	0	0	0	0	0	0	0	0	0
Tockus nasutus	0	0	1	2	1	0	0	0	0	?	0	0	0	0	0	?	0	0	0	0	0	0
Merops orientalis	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Atelornis pittoides	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coracias benghalensis	0	0	0	2	0	0	0	0	?	?	0	0	0	0	0	?	?	?	?	?	?	0
Todus mexicanus	0	0	1	2	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0
Momotus momota	0	0	1	2	0	0	0	0	?	0	0	0	0	0	1	?	?	?	0	?	?	0
Alcedo atthis	0	0	0	0	0	0	0	0	?	0	0	0	0	0	1	1	?	?	1	?	?	0
Galbula dea	0	0	1	2	0	0	0	0	?	?	0	0	0	1	1	0	0	0	0	0	0	0
Indicator exilis p.	0	0	1	2	0	0	0	0	?	?	0	0	0	1	1	1	0	0	0	0	0	0
Picus viridis	0	0	1	2	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0
Megalaima chrysopogon	0	0	1	2	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0
Ramphastos ambiguus	0	0	1	2	0	0	0	1	?	0	0	0	0	1	1	?	0	0	0	0	0	0
Cariama cristata	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Chunga burmeisteri	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Micrastur ruficollis c.	0	0	2	2	0	1	0	1	1	0	0	1	0	0	0	0	0	1	2	2	2	0
Falco sparverius	0	0	1	2	0	0	0	0	?	?	0	1	0	0	0	0	0	1	2	2	2	0
Daptrius ater	0	0	1	2	0	0	0	0	?	?	0	1	0	0	0	0	0	0	2	2	1	0
Caracara cheriway	0	0	1	2	0	0	0	0	?	?	0	1	0	0	0	0	?	?	2	?	?	0
Nestor notabilis	0	1	1	0	0	0	0	0	?	0	0	0	0	1	0	0	0	1	0	?	1	0
Strigops habroptilus	0	1	1	0	0	?	0	0	?	?	0	?	?	?	0	0	?	?	?	?	?	0
Prosobsiger aterrimus	0	1	0	0	0	0	0	0	?	0	0	0	0	1	0	0	0	1	0	1	1	0
Barnardius zonarius	0	1	1	0	0	0	0	0	?	0	0	0	0	?	0	0	?	?	0	0	?	0
Psittrichas fulgidus	0	1	0	0	0	0	0	0	?	?	0	?	0	?	0	0	?	?	?	?	?	0
Psittacus erithacus	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	1	0
Deroptyus accipitrinus	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	1	0
Acanthisitta chloris	1	0	2	2	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Pitta sordida	1	0	2	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Neodrepanis coruscans	1	0	2	2	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Melanopareia bitorquata	1	0	2	2	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Myrmornis torquata	0	0	1	2	0	0	0	0	?	?	0	?	0	?	?	0	?	?	?	?	?	0
Myrmothera campanisona m.	1	0	2	2	0	1	0	0	0	1	0	0	0	0	0	0	0	?	?	?	?	0
Neopelma chrysocephalum	0	0	?	2	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Rupicola peruvianus	0	0	1	2	0	0	0	0	?	?	0	?	0	?	?	0	?	?	?	?	?	0
Piprites chloris tschudii	0	0	1	2	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Tyrannus tyrannus	0	0	1	2	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Menura novaehollandiae	1	0	2	2	0	1	0	0	?	1	0	?	0	?	?	0	?	?	1	?	?	0
Climacterus melanurus wellsi	1	0	2	2	0	1	0	0	?	?	0	?	0	?	?	0	?	?	?	?	?	0
Malurus melanocephalus	1	0	2	2	0	1	0	0	?	?	0	?	0	?	?	0	?	?	?	?	?	0
Corvus brachyrhynchos	0	0	1	2	0	0	0	0	?	?	0	?	0	?	?	0	?	?	?	?	?	0
Sylvia borin	1	0	2	2	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Zosterops lateralis	1	0	2	2	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Passer domesticus	1	0	2	2	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Palaeoplancus sternbergi	0	0	?	?	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Diatropornis ellioti	0	0	?	?	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	0	0	?	?	0	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?
Ypresiglaux michaeldanielsi	0	0	?	?	0	0	0	0	0	0	0	1	0	0	0	?	?	?	2	2	2	0
Primoptynx poliotauros	?	?	?	?	?	?	?	?	0	0	0	1	0	0	0	?	0	1	2	2	2	0
Masillacolius brevidactylus	?	0	1	?	1	0	0	0	0	0	0	1	0	0	0	?	0	1	2	1	2	1
Eoglaucidium cf pallas	0	0	1	2	0	1	0	0	0	0	0	1	0	0	0	?	0	1	2	1	2	1
Eotrogon stenorhynchus	0	0	0	1	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelirrisor halcyrostris	0	0	1	1	1	0	0	0	0	0	?	?	?	0	0	?	?	?	0	0	0	0
Plesiocathartes insolitipes	0	?	?	?	0	?	0	?	0	0	0	?	0	0	0	0	0	1	?	?	?	?
Plesiocathartes wyomingensis	?	?	0	1	?	0	?	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0

	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531
Plesiocathartes kelleri	?	?	1	1	0	0	?	?	0	0	0	0	0	0	0	?	0	1	?	?	?	0
Waltonavis sp.	0	0	1	?	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0
Bathornis grallator	?	?	1	?	?	?	?	?	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Dynamopterus sp.	0	0	1	?	0	0	0	0	0	?	?	0	?	?	?	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	0	0	1	?	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	1	0
Masillaraptor cf parvunguis	0	0	1	?	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor parvunguis	0	0	1	1	?	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2	1	0
Eofringillirostrum boudreauxi	?	0	1	0	0	1	0	0	0	0	0	1	0	0	?	0	0	1	1	0	2	0
Zygodactylus grandei	?	0	2	1	0	0	?	?	0	0	0	0	0	0	?	0	0	0	0	0	0	0
Eozygodactylus americanus	?	?	2	?	?	?	?	?	?	0	0	0	0	0	?	0	0	0	0	0	0	0
Primozygodactylus quintus	0	0	2	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Primozygodactylus longibrachium	?	?	?	?	0	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus eunjooae	?	?	?	?	0	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus danielsi	?	?	?	?	0	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus major	?	?	?	?	0	?	?	?	0	?	?	?	?	1	?	?	?	?	?	?	?	?
Pumiliornis tessellatus	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parapsittacopes bergdahli	?	?	?	?	?	?	?	?	0	?	?	0	0	1	0	0	?	?	?	?	?	0
Psittacopes Lepidus	?	0	1	1	0	0	?	?	?	0	0	0	0	0	?	0	0	0	0	0	0	0
Psittacomimus eos	0	0	?	?	0	0	0	0	?	?	?	0	?	?	?	?	?	?	?	?	?	?
Avolatavis tenens	0	1	?	0	1	0	1	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0
Avolatavis europaeus	0	1	?	0	1	?	0	0	?	?	?	?	?	0	?	?	0	?	?	?	?	?
Pseudasturides macrocephalus	1	0	1	1	0	0	0	0	0	0	0	0	0	1	?	0	0	1	1	1	1	0
Cyrilavis colburnorum	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	0
Cyrilavis cf. colburnorum	0	0	?	?	0	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cyrilavis olsoni	?	0	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	0	?	?	?	0	?	0	0	?	0	0	0	0	1	0	?	0	1	?	?	?	?
cf. Pulchrapollia	0	0	?	?	0	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	0	?	?	?	0	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	0	1	?	?	0	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis eocaena	0	1	0	?	0	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis cambayensis	0	1	0	?	0	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Messelastur gratulator	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0	1	0	1	1	1	1	0
Tynskya waltonensis	0	0	?	?	0	?	?	0	?	?	?	1	0	?	?	1	?	?	?	?	?	?
Tynskya eocaena	0	0	0	1	0	0	0	0	?	?	?	1	0	0	0	?	0	1	1	1	1	0
Tynskya crassitarsus	0	0	?	?	0	?	?	0	?	?	?	?	?	?	?	1	?	?	?	?	?	?
Tynskya brevitarsus	0	0	?	?	0	?	?	0	?	?	?	?	?	?	?	1	?	?	?	?	?	?
Eurofluvioviridavis robustipes	0	1	0	0	0	0	?	?	0	0	0	1	0	0	0	0	0	1	1	1	2	0
Serudaptus pohli	?	1	0	0	0	?	?	?	0	?	?	1	0	1	?	0	1	1	1	?	?	?
Quercypsitta sudrei	0	0	?	?	0	0	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?

	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550
Eudromia elegans	?	0	?	0	0	?	?	?	?	0	0	0	0	?	0	?	?	?	0
Chauna chavaria	?	0	?	0	0	0	0	1	0	0	0	0	0	0	0	?	?	?	0
Charadris vociferus	?	0	?	?	0	1	0	0	0	0	0	0	0	0	?	?	?	?	0
Eurypyga helias	?	0	?	0	0	?	0	?	0	0	0	0	0	?	?	?	?	?	0
Cathartes burrovianus	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Vultur gryphus	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Sagittarius serpentarius	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	1	1	0
Pandion haliaetus c.	0	0	0	0	0	0	0	1	1	0	2	1	0	1	0	0	0	1	0
Elanus caeruleus	0	0	?	0	0	?	0	?	1	0	2	1	0	1	0	1	1	1	0
Buteo rufofuscus	0	0	?	0	0	0	0	1	1	0	2	1	0	1	0	1	1	1	0
Accipiter nisus	0	0	?	0	0	?	1	?	1	0	2	1	0	1	0	1	1	1	0
Tyto alba	0	0	0	1	0	0	0	2	1	0	2	1	1	1	0	0	1	1	0
Strix aluco	0	0	1	1	0	0	0	2	1	0	2	1	1	1	0	0	1	1	0
Colius striatus kiwuensis	0	0	1	0	0	0	0	2	1	0	2	1	0	1	0	0	1	1	0
Urocolius macrourus pulcher	0	0	?	?	0	?	?	?	?	0	2	1	0	?	?	0	1	1	0
Leptosomus discolor	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1
Apaloderma narina	0	0	?	0	1	?	?	?	?	0	0	0	0	1	?	0	0	0	0
Trogon melanurus e.	0	0	?	0	1	?	1	?	1	0	0	0	0	1	?	0	0	0	0
Upupa marginata	0	0	1	0	1	1	0	?	?	0	0	0	0	1	0	0	0	0	0
Tockus nasutus	0	0	?	0	1	?	?	?	?	0	0	1	0	1	?	0	?	?	0
Merops orientalis	0	0	?	0	1	1	0	?	1	0	1	0	0	1	?	0	0	0	0
Atelornis pittoides	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	0	0	1	0
Coracias benghalensis	0	0	?	0	0	1	?	?	?	0	0	?	0	?	?	0	0	1	0
Todus mexicanus	0	0	1	0	1	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Momotus momota	0	0	?	0	1	1	0	0	1	0	0	0	0	?	?	0	?	?	0
Alcedo atthis	0	0	?	0	1	1	0	0	1	0	0	0	0	?	0	0	?	?	0
Galbula dea	0	0	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0
Indicator exilis p.	0	0	0	0	0	?	?	?	?	0	0	0	0	1	?	0	?	?	0
Picus viridis	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0
Megalaima chrysopogon	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	1	0
Ramphastos ambiguus	0	0	?	0	0	1	0	0	1	0	0	0	0	1	?	0	0	0	0
Cariama cristata	1	0	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0	1	0
Chunga burmeisteri	1	0	0	0	0	?	?	?	1	0	1	1	0	?	0	0	0	1	0
Micrastur ruficollis c.	0	0	0	0	0	0	0	1	1	0	2	1	0	1	0	1	1	1	0
Falco sparverius	0	0	?	0	0	?	0	?	?	0	2	1	0	1	?	1	1	1	0
Daptrius ater	0	0	?	0	0	?	0	?	?	0	2	1	0	1	?	1	1	1	0
Caracara cheriway	0	0	?	?	0	?	?	?	?	0	2	1	0	?	?	1	1	1	0
Nestor notabilis	0	1	1	0	0	?	0	?	?	0	1	1	0	1	0	0	1	1	0
Strigops habroptilus	0	1	?	?	0	?	?	?	1	0	0	1	0	?	0	0	1	0	0
Probosciger aterrimus	0	1	1	0	0	0	0	0	?	0	1	1	0	1	0	?	1	1	0
Barnardius zonarius	0	1	1	?	0	1	0	0	1	0	1	1	0	0	0	?	?	?	0
Psittrichas fulgidus	0	1	1	?	0	?	?	?	?	0	1	1	0	?	0	?	?	?	0
Psittacus erithacus	0	1	1	0	0	?	?	?	?	0	1	0	0	1	0	0	1	0	0
Deroptyus accipitrinus	0	1	1	?	0	1	0	0	1	0	2	0	0	1	0	1	1	1	0
Acanthisitta chloris	0	0	0	0	1	1	0	0	1	0	0	0	0	1	0	0	1	0	0
Pitta sordida	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0
Neodrepanis coruscans	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0
Melanopareia bitorquata	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0
Myrmornis torquata	0	0	?	?	?	?	?	?	?	0	?	0	0	?	?	?	?	?	0
Myrmothera campanisona m.	0	0	0	0	1	?	?	?	?	0	0	0	0	1	1	?	?	?	0
Neopelma chrysocephalum	0	0	?	0	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0
Rupicola peruvianus	0	0	?	?	?	?	?	?	?	0	?	0	0	?	?	?	?	?	0
Piprites chloris tschudii	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0
Tyrannus tyrannus	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0
Menura novaehollandiae	0	0	?	?	?	1	0	0	1	0	1	0	0	?	0	1	1	1	0
Climacterus melanurus wellsi	0	0	?	?	?	?	?	?	?	0	1	0	0	?	?	0	0	1	0
Malurus melanocephalus	0	0	?	?	?	?	?	?	?	0	?	0	0	?	?	?	?	?	0
Corvus brachyrhynchos	0	0	?	?	?	?	?	?	?	0	?	0	0	?	?	?	?	?	0
Sylvia borin	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0
Zosterops lateralis	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	1	0	0
Passer domesticus	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	1	0
Palaeoplancus sternbergi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Diatropornis ellioti	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Horusornis vianeyliaudae	?	?	?	?	?	?	?	?	?	?	1	1	0	?	0	1	1	1	?
Ypresiglaux michaeldanielsi	0	?	?	?	0	?	?	?	?	0	2	1	1	?	0	0	1	1	?
Primoptynx poliotauros	0	?	1	0	0	0	0	2	1	0	2	1	1	1	0	0	1	1	?
Masillacolius brevidactylus	0	?	?	0	0	0	0	0	1	0	2	0	0	1	0	?	1	1	0
Eoglaucidium cf pallas	0	?	?	?	0	0	0	0	1	0	2	0	0	1	0	?	1	1	0
Eotrogon stenorhynchus	?	?	?	?	?	?	?	?	?	?	0	0	?	?	?	0	0	0	0
Messelirrisor halcyrostris	0	?	?	0	0	?	?	?	?	?	?	0	?	?	?	?	?	?	0
Plesiocathartes insolitipes	?	?	?	0	0	?	?	?	1	0	1	0	0	1	0	0	0	0	1
Plesiocathartes wyomingensis	0	?	?	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0

	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550
Plesiocathartes kelleri	0	?	?	0	0	?	?	?	1	?	1	0	0	1	0	0	0	0	?
Waltonavis sp.	0	?	?	0	0	0	?	?	1	0	1	0	0	1	0	0	1	0	1
Bathornis grallator	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	?	0	0	?
Dynamopterus sp.	0	?	?	?	?	?	?	?	?	?	0	0	?	?	?	?	?	?	?
Danielsraptor phorusrhacoides	0	0	?	0	0	?	?	0	1	0	1	0	?	?	0	0	1	0	?
Masillaraptor cf parvunguis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Masillaraptor parvunguis	0	?	?	0	0	0	0	0	1	0	0	0	0	1	0	?	?	0	?
Eofringillirostrum boudreauxi	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	?	1	0	?
Zygodactylus grandei	0	?	?	0	?	0	0	0	1	0	0	0	0	0	0	?	0	0	?
Eozygodactylus americanus	0	?	?	0	?	0	0	0	1	0	0	0	0	1	0	?	0	0	?
Primozygodactylus quintus	0	?	?	0	0	0	0	0	1	0	0	0	0	1	0	?	0	0	?
Primozygodactylus longibrachium	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus eunjooae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus danielsi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Primozygodactylus major	?	?	?	?	?	?	?	?	?	?	0	0	?	1	?	?	0	0	?
Pumiliornis tessellatus	0	0	0	1	0	0	0	1	?	0	0	0	0	1	0	1	0	0	?
Parapsittacopes bergdahli	?	0	0	0	0	?	?	?	?	0	?	0	?	?	?	?	?	?	?
Psittacopes Lepidus	0	?	?	1	0	0	0	1	1	0	0	0	0	1	0	0	2	0	?
Psittacomimus eos	?	?	?	?	?	?	?	?	?	?	0	0	0	?	0	0	1	0	?
Avolatavis tenens	0	0	1	0	0	1	0	0	1	?	0	1	0	1	0	1	1	1	?
Avolatavis europaeus	?	?	?	?	0	?	?	?	?	?	0	1	0	?	0	1	1	1	?
Pseudasturides macrocephalus	0	?	?	0	?	0	0	0	1	?	0	0	0	0	0	0	1	1	?
Cyrilavis colburnorum	0	?	1	0	0	1	0	0	0	?	0	0	0	0	0	0	1	1	?
Cyrilavis cf. colburnorum	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cyrilavis olsoni	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia gracilis	?	0	0	0	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
cf. Pulchrapollia gracilis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Pulchrapollia eximia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Vastanavis eocaena	?	?	?	?	?	?	?	?	?	?	0	0	0	?	0	0	1	0	?
Vastanavis cambayensis	?	?	?	?	?	?	?	?	?	?	0	0	0	?	0	0	1	0	?
Messelastur gratulator	0	0	1	0	0	1	0	0	1	1	1	1	1	1	0	0	1	1	?
Tynskya waltonensis	?	?	?	?	?	?	?	?	?	1	?	1	?	?	?	0	1	1	?
Tynskya eocaena	0	0	?	0	0	0	?	?	1	1	1	1	?	1	0	0	1	1	?
Tynskya crassitarsus	?	?	?	?	?	?	?	?	?	1	1	1	?	?	0	0	1	1	?
Tynskya brevitarsus	?	?	?	?	?	?	?	?	?	1	1	1	?	?	0	0	1	1	?
Eurofluvioviridavis robustipes	0	?	?	0	?	2	0	0	1	?	1	1	?	1	0	1	1	1	?
Serudaptus pohli	?	?	?	0	?	?	?	?	?	?	?	1	0	?	?	?	?	?	?
Quercypsitta sudrei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

S3.2 PAUP* script for backbone molecular constraints used in Analysis 3

```
#NEXUS


BEGIN TAXA;
        TITLE Untitled_Block_of_Taxa; DIMENSIONS NTAX=61;
        TAXLABELS
                Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus
Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus
Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina
Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides
Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus
Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri
Micrastur_ruficollis_concentricus  Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus
Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus
Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata
Myrmothera_campanisona_minor Neopelma_chrysocephalum Rupicola_peruvianus Piprites_chloris_tschudii
Tyrannus_tyrannus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos
Sylvia_borin Zosterops_lateralis Passer_domesticus
        ;

END;


BEGIN TREES;
        Title 'Trees from "Prum2015_constraint.txt"';
    LINK Taxa
TRANSLATE                       = Untitled_Block_of_Taxa;
 [0]        1                   Eudromia_elegans,
[1]         2                   Chauna_chavaria,
[2]         3                   Charadris_vociferus,
[3]         4                   Eurypyga_helias,
[4]         5                   Cathartes_burrovianus,
[5]         6                   Vultur_gryphus,
[6]         7                   Sagittarius_serpentarius,
[7]         8                   Pandion_haliaetus_carolinensis,
[8]         9                   Elanus_caeruleus,
 [9]                        10 Buteo_rufofuscus,
 [10]                       11 Accipiter_nisus,
 [11]                       12 Tyto_alba,
 [12]                       13 Strix_aluco,
 [13]                       14 Colius_striatus_kiwuensis,
 [14]                       15 Urocolius_macrourus_pulcher,
 [15]                       16 Leptosomus_discolor,
 [16]                       17 Apaloderma_narina,
[17]        18                  Trogon_melanurus_eumorphus,
[18]        19                  Upupa_marginata,
[19]        20                  Tockus_nasutus,
[20]        21                  Merops_orientalis,
[21]        22                  Atelornis_pittoides,
[22]        23                  Coracias_benghalensis,
[23]        24                  Todus_mexicanus,
[24]        25                  Momotus_momota,
[25]        26                  Alcedo_atthis,
[26]        27                  Galbula_dea,
[27]        28                  Indicator_exilis_pachyrhynchus,
[28]        29                  Picus_viridis,
[29]        30                  Megalaima_chrysopogon,
[30]        31                  Ramphastos_ambiguus,
[31]        32                  Cariama_cristata,
[32]        33                  Chunga_burmeisteri,
[33]        34                  Micrastur_ruficollis_concentricus,
[34]        35                  Falco_sparverius,
```

```
  [35]      36                  Daptrius_ater,
  [36]      37                  Caracara_cheriway,
  [37]      38                  Nestor_notabilis,
  [38]      39                  Strigops_habroptilus,
  [39]      40                  Probosciger_aterrimus,
  [40]      41                  Barnardius_zonarius,
  [41]      42                  Psittrichas_fulgidus,
  [42]      43                  Psittacus_erithacus,
  [43]      44                  Deroptyus_accipitrinus,
  [44]      45                  Acanthisitta_chloris,
  [45]      46                  Pitta_sordida,
  [46]      47                  Neodrepanis_coruscans,
  [47]      48                  Melanopareia_bitorquata,
  [48]      49                  Myrmornis_torquata,
  [49]      50                  Myrmothera_campanisona_minor,
  [50]      51                  Neopelma_chrysocephalum,
  [51]      52                  Rupicola_peruvianus,
  [52]      53                  Piprites_chloris_tschudii,
  [53]      54                  Tyrannus_tyrannus,
  [54]      55                  Menura_novaehollandiae,
  [55]      56                  Climacterus_melanurus_wellsi,
  [56]      57                  Malurus_melanocephalus,
  [57]      58                  Corvus_brachyrhynchos,
  [58]      59                  Sylvia_borin,
  [59]      60                  Zosterops_lateralis,
 [60]       61          Passer_domesticus;

TREE 'Prum_et_al._2015' = [&U]
(1,(2,((3,4),(((5,6),(7,(8,(9,(10,11))))),(((12,13),((14,15),(16,((17,18),((19,20),(((21,(22,23)),(24,(25,26))),(27,((28,29),(30,31)))))))),(
(32,33),((34,(35,(37,36))),(((38,39),(40,((41,42),(43,44)))),(45,(((46,47),(((48,49),50),(51,((53,54),52)))),(55,((57,(58,((59,60),61))),5
6))))))))))));

TREE 'Stiller_et_al._2024' = [&U]
(1,2,((3,4),(((((5,6),(7,(8,(9,(10,11))))),(12,13)),((14,15),(16,((17,18),((19,20),(((21,(22,23  ,(24,(25,26))),(27,((28,29),(30,31)))))))
),((32,33),((34,(35,(36,37))),(((38,39),(40,((41,43),(42,44)))),(45,(((46,51),(((47,48),49),(50,((5
,53),61)))),(54,(55,(56,(57,(58,(59,60))))))))))))));

   END;
```

S3.3 MrBayes script and backbone molecular constraints used in Analysis 3

Prum et al. (2015) constraint

#NEXUS

begin mrbayes;

[start logfile]
log start filename="A3_Prum_MrBayes";

[close after running]
set autoclose=yes nowarn=yes;

[outgroup]
outgroup Eudromia_elegans; [optional] constraint root = 1-. ;

constraint node1 partial = Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi : Eudromia_elegans;
constraint node2 partial = Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi : Eudromia_elegans Chauna_chavaria;
constraint node3 partial = Charadris_vociferus Eurypyga_helias :
Eudromia_elegans Chauna_chavaria Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;
constraint node4 partial = Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias;
constraint node5 partial = Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida

Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node6 partial = Cathartes_burrovianus Vultur_gryphus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node7 partial = Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node8 partial = Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node9 partial = Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node10 partial = Buteo_rufofuscus Accipiter_nisus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node11 partial = Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum

Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus;

constraint node12 partial = Tyto_alba Strix_aluco

Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node13 partial = Tyto_alba Strix_aluco : Eudromia_elegans

Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node14 partial = Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node15 partial = Colius_striatus_kiwuensis

Urocolius_macrourus_pulcher : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node16 partial = Leptosomus_discolor Apaloderma_narina

Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node17 partial = Apaloderma_narina

Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius

Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node18 partial = Apaloderma_narina

Trogon_melanurus_eumorphus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node19 partial = Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node20 partial = Upupa_marginata Tockus_nasutus :
Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node21 partial = Merops_orientalis Atelornis_pittoides
Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node22 partial = Merops_orientalis Atelornis_pittoides
Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node23 partial = Merops_orientalis Atelornis_pittoides
Coracias_benghalensis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata

Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node24 partial = Atelornis_pittoides Coracias_benghalensis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node25 partial = Todus_mexicanus Momotus_momota
Alcedo_atthis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node26 partial = Momotus_momota Alcedo_atthis :
Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node27 partial = Galbula_dea
Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node28 partial = Indicator_exilis_pachyrhynchus
Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node29 partial = Indicator_exilis_pachyrhynchus Picus_viridis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis

Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node30 partial = Megalaima_chrysopogon

Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node31 partial = Cariama_cristata Chunga_burmeisteri

Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus;

constraint node32 partial = Cariama_cristata Chunga_burmeisteri :

Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node33 partial = Micrastur_ruficollis_concentricus

Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri; constraint node34 partial = Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node35 partial = Falco_sparverius Caracara_cheriway

Daptrius_ater : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis

Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node36 partial = Caracara_cheriway Daptrius_ater :
Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node37 partial = Nestor_notabilis Strigops_habroptilus
Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater;

constraint node38 partial = Nestor_notabilis Strigops_habroptilus
Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node39 partial = Nestor_notabilis Strigops_habroptilus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node40 partial = Probosciger_aterrimus
Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node41 partial = Barnardius_zonarius Psittrichas_fulgidus
Psittacus_erithacus Deroptyus_accipitrinus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides

Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node42 partial = Barnardius_zonarius

Psittrichas_fulgidus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node43 partial = Psittacus_erithacus

Deroptyus_accipitrinus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node44 partial = Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus;

constraint node45 partial = Pitta_sordida Neodrepanis_coruscans

Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris; constraint node46 partial = Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node47 partial = Pitta_sordida Neodrepanis_coruscans :

Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius

Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node48 partial = Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node49 partial = Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node50 partial = Melanopareia_bitorquata Myrmornis_torquata : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node51 partial = Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi;

constraint node52 partial = Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi; constraint node53 partial = Piprites_chloris_tschudii Tyrannus_tyrannus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis

Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi; constraint node54 partial = Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus;

constraint node55 partial = Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus Climacterus_melanurus_wellsi : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae;

constraint node56 partial = Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi;

constraint node57 partial = Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Climacterus_melanurus_wellsi;

constraint node58 partial = Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Climacterus_melanurus_wellsi;

constraint node59 partial = Sylvia_borin Zosterops_lateralis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Caracara_cheriway Daptrius_ater Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittrichas_fulgidus Psittacus_erithacus

Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Malurus_melanocephalus Corvus_brachyrhynchos Passer_domesticus Climacterus_melanurus_wellsi;

[constrain ingroup]

constraint ingroup = 5-.;

[helps to seep up analysis, reach convergence and correct rooting]
prset topologypr =
constraints(node1,node2,node3,node4,node5,node6,node7,node8,node9,node10,node11,node12,node13,node14,node15,node16,node17,node18,node19,node20,node21,node22,node23,node24,node25,node26,node27,node28,node29,node30,node31,node32,node33,node34,node35,node36,node37,node38,node39,node40,node41,node42,node43,node44,node45,node46,node47,node48,node49,node50,node51,node52,node53,node54,node55,node56,node57,node58,node59,ingroup);

[set character evol model]
lset coding=variable rates=gamma; [Mkv+G]

[set prior parameters for rate variation among charatcers] prset ratepr=variable;

[set hyperprior parameters for rate variation among charatcers] prset shapepr=exponential (1.0);

[analysis parameters]
mcmcp ngen= 30000000 relburnin=yes burninfrac=0.5 printfreq=10000 samplefreq=10000 temp=0.9 nruns=2 nchains=4 nswaps=3 savebrlens=yes
stopval = 0.01;

[startrunning] mcmc;

[summarizeparameters] sump;

[summarize trees]
sumt contype=allcompat Outputname=A3_Prum_AllCompCon.t; [MCtree]
sumt contype=halfcompat Outputname=A3_Prum_MRC.t; [MRC tree]

[closelogfile] log stop;

Stiller at al. (2024) constraint

#NEXUS

begin mrbayes;

[start logfile]
log start filename="A3_Stiller_MrBayes";

[close after running]
set autoclose=yes nowarn=yes;

[outgroup]
outgroup Eudromia_elegans; [optional] constraint root = 1-. ;

constraint node1 partial = Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria;
constraint node2 partial = Charadris_vociferus Eurypyga_helias : Eudromia_elegans Chauna_chavaria Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus

Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node3 partial = Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias;
constraint node4 partial = Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node5 partial = Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node6 partial = Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node7 partial = Cathartes_burrovianus Vultur_gryphus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node8 partial = Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri

Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node9 partial = Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node10 partial = Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node11 partial = Buteo_rufofuscus Accipiter_nisus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node12 partial = Tyto_alba Strix_aluco : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node13 partial = Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node14 partial = Colius_striatus_kiwuensis Urocolius_macrourus_pulcher : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea

Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node15 partial = Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node16 partial = Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node17 partial = Apaloderma_narina Trogon_melanurus_eumorphus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node18 partial = Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node19 partial = Upupa_marginata Tockus_nasutus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node20 partial = Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus

Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node21 partial = Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node22 partial = Merops_orientalis Atelornis_pittoides Coracias_benghalensis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node23 partial = Atelornis_pittoides Coracias_benghalensis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node24 partial = Todus_mexicanus Momotus_momota Alcedo_atthis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node25 partial = Momotus_momota Alcedo_atthis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node26 partial = Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus

Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node27 partial = Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus

Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node28 partial = Indicator_exilis_pachyrhynchus Picus_viridis : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node29 partial = Megalaima_chrysopogon Ramphastos_ambiguus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node30 partial = Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus;
constraint node31 partial = Cariama_cristata Chunga_burmeisteri : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node32 partial = Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus

Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri; constraint node33 partial = Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node34 partial = Falco_sparverius Daptrius_ater Caracara_cheriway : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node35 partial = Daptrius_ater Caracara_cheriway : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node36 partial = Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway;
constraint node37 partial = Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node38 partial = Nestor_notabilis Strigops_habroptilus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis

Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node39 partial = Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node40 partial = Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node41 partial = Barnardius_zonarius Psittacus_erithacus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node42 partial = Psittrichas_fulgidus Deroptyus_accipitrinus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node43 partial = Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus;
constraint node44 partial = Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata

Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris; constraint node45 partial = Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node46 partial = Pitta_sordida Neodrepanis_coruscans : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node47 partial = Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node48 partial = Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node49 partial = Melanopareia_bitorquata Myrmornis_torquata : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;

constraint node50 partial = Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node51 partial = Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node52 partial = Piprites_chloris_tschudii Tyrannus_tyrannus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus;
constraint node53 partial = Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus;
constraint node54 partial = Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae;
constraint node55 partial = Malurus_melanocephalus Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae

```
Climacterus_melanurus_wellsi;
constraint node56 partial = Corvus_brachyrhynchos Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans
Chauna_chavaria Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius
Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco
Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina
Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis
Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis
Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus
Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus
Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida
Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor
Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae
Climacterus_melanurus_wellsi Malurus_melanocephalus;
constraint node57 partial = Sylvia_borin Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria
Charadris_vociferus Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius
Pandion_haliaetus_carolinensis Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco
Colius_striatus_kiwuensis Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina
Trogon_melanurus_eumorphus Upupa_marginata Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis
Todus_mexicanus Momotus_momota Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis
Megalaima_chrysopogon Ramphastos_ambiguus Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus
Falco_sparverius Daptrius_ater Caracara_cheriway Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus
Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida
Neodrepanis_coruscans Melanopareia_bitorquata Myrmornis_torquata Myrmothera_campanisona_minor
Neopelma_chrysocephalum Piprites_chloris_tschudii Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae
Climacterus_melanurus_wellsi Malurus_melanocephalus Corvus_brachyrhynchos;
constraint node58 partial = Zosterops_lateralis Passer_domesticus : Eudromia_elegans Chauna_chavaria Charadris_vociferus
Eurypyga_helias Cathartes_burrovianus Vultur_gryphus Sagittarius_serpentarius Pandion_haliaetus_carolinensis
Elanus_caeruleus Buteo_rufofuscus Accipiter_nisus Tyto_alba Strix_aluco Colius_striatus_kiwuensis
Urocolius_macrourus_pulcher Leptosomus_discolor Apaloderma_narina Trogon_melanurus_eumorphus Upupa_marginata
Tockus_nasutus Merops_orientalis Atelornis_pittoides Coracias_benghalensis Todus_mexicanus Momotus_momota
Alcedo_atthis Galbula_dea Indicator_exilis_pachyrhynchus Picus_viridis Megalaima_chrysopogon Ramphastos_ambiguus
Cariama_cristata Chunga_burmeisteri Micrastur_ruficollis_concentricus Falco_sparverius Daptrius_ater Caracara_cheriway
Nestor_notabilis Strigops_habroptilus Probosciger_aterrimus Barnardius_zonarius Psittacus_erithacus Psittrichas_fulgidus
Deroptyus_accipitrinus Acanthisitta_chloris Pitta_sordida Neodrepanis_coruscans Melanopareia_bitorquata
Myrmornis_torquata Myrmothera_campanisona_minor Neopelma_chrysocephalum Piprites_chloris_tschudii
Tyrannus_tyrannus Rupicola_peruvianus Menura_novaehollandiae Climacterus_melanurus_wellsi Malurus_melanocephalus
Corvus_brachyrhynchos Sylvia_borin;

[constrain ingroup] constraint ingroup = 5-.;

[helps to seep up analysis, reach convergence and correct rooting] prset topologypr =
constraints(node1,node2,node3,node4,node5,node6,node7,node8,node9,node10,node11,node12,node13,node14,node15,node16,nod
e17,node18,node19,node20,node21,node22,node23,node24,node25,node26,node27,node28,node29,node30,node31,node32,node33,
node34,node35,node36,node37,node38,node39,node40,node41,node42,node43,node44,node45,node46,node47,node48,node49,nod
e50,node51,node52,node53,node54,node55,node56,node57,node58, ingroup);

[set character evol model]
lset coding=variable rates=gamma; [Mkv+G]

[set prior parameters for rate variation among charatcers] prset ratepr=variable;

[set hyperprior parameters for rate variation among charatcers] prset shapepr=exponential (1.0);

[analysis parameters]
mcmcp ngen= 30000000 relburnin=yes burninfrac=0.5 printfreq=10000 samplefreq=10000 temp=0.9 nruns=2 nchains=4
nswaps=3 savebrlens=yes stopval = 0.01;

[start running] mcmc;

[summarize parameters] sump;

[summarize trees]
sumt contype=allcompat Outputname=A3_Stiller_AllCompCon.t; [MC
tree]
sumt contype=halfcompat Outputname=A3_Stiller_MRC.t; [MRC tree]

[close logfile] log stop;
```

Time-calibrated relaxed-clock Bayesian inference parameters

[Tip Calibrations]

```
CALIBRATE   Palaeoplancus_sternbergi        = uniform (33.7,37.0);
CALIBRATE   Horusornis_vianeyliaudae        = uniform (27.3,37.71);
CALIBRATE   Ypresiglaux_michaeldanielsi     = uniform (54.6,55.0);
CALIBRATE   Primoptynx_poliotauros          = uniform (54.6,55.0);
CALIBRATE   Masillacolius_brevidactylus     = uniform (47.8,48.2);
CALIBRATE   Eoglaucidium_cf_pallas          = uniform (47.8,48.2);
CALIBRATE   Eotrogon_stenorhynchus          = uniform (54.6,55.0);
CALIBRATE   Messelirrisor_halcyrostris      = uniform (47.8,48.2);
CALIBRATE   Plesiocathartes_wyomingensis    = uniform (48.5,53.5);
CALIBRATE   Plesiocathartes_kelleri         = uniform (47.8,48.2);
CALIBRATE   Waltonavis_sp                   = uniform (54.6,55.0);
CALIBRATE   Bathornis_grallator             = uniform (46.9,47.3);
CALIBRATE   Dynamopterus_sp                 = uniform (23.04,38.0);
CALIBRATE   Danielsraptor_phorusrhacoides   = uniform (54.6,55.0);
CALIBRATE   Masillaraptor_cf_parvunguis     = uniform (54.6,55.0);
CALIBRATE   Masillaraptor_parvunguis        = uniform (47.8,48.2);
CALIBRATE   Eofringillirostrum_boudreauxi   = uniform (48.07,56.0);
CALIBRATE   Zygodactylus_grandei            = uniform (51.66,52.0);
CALIBRATE   Eozygodactylus_americanus       = uniform (51.66,52.0);
CALIBRATE   Primozygodactylus_quintus       = uniform (47.5,47.8);
CALIBRATE   Primozygodactylus_longibrachium = uniform (47.5,47.8);
CALIBRATE   Primozygodactylus_eunjooae      = uniform (47.5,47.8);
CALIBRATE   Primozygodactylus_danielsi      = uniform (47.5,47.8);
CALIBRATE   Primozygodactylus_major         = uniform (47.5,47.8);
CALIBRATE   Pumiliornis_tessellatus         = uniform (47.5,47.8);
CALIBRATE   Parapsittacopes_bergdahli       = uniform (54.6,55.0);
CALIBRATE   Psittacopes_Lepidus             = uniform (47.5,47.8);
CALIBRATE   Psittacomimus_eos               = uniform (54.6,55.0);
CALIBRATE   Avolatavis_tenens               = uniform (51.66,52.0);
CALIBRATE   Avolatavis_europaeus            = uniform (54.6,55.0);
CALIBRATE   Pseudasturides_macrocephalus    = uniform (47.5,47.8);
CALIBRATE   Cyrilavis_colburnorum           = uniform (51.66,52.0);
CALIBRATE   Cyrilavis_cf_colburnorum        = uniform (54.6,55.0);
CALIBRATE   Cyrilavis_olsoni                = uniform (48.07,56.0);
CALIBRATE   Pulchrapollia_gracilis          = uniform (54.6,55.0);
CALIBRATE   cf_Pulchrapollia                = uniform (53.0,54.0);
CALIBRATE   cf_Pulchrapollia_gracilis       = uniform (54.6,55.0);
CALIBRATE   Pulchrapollia_eximia            = uniform (54.6,55.0);
CALIBRATE   Vastanavis_eocaena              = uniform (48.07,52.0);
CALIBRATE   Vastanavis_cambayensis          = uniform (48.07,52.0);
CALIBRATE   Messelastur_gratulator          = uniform (47.5,47.8);
CALIBRATE   Tynskya_waltonensis             = uniform (54.6,55.0);
CALIBRATE   Tynskya_eocaena                 = uniform (51.66,52.0);
CALIBRATE   Tynskya_crassitarsus            = uniform (54.6,55.0);
CALIBRATE   Tynskya_brevitarsus             = uniform (54.6,55.0);
CALIBRATE   Eurofluvioviridavis_robustipes  = uniform (41.03,48.07);
CALIBRATE   Serudaptus_pohli                = uniform (47.5,47.8);
CALIBRATE   Quercypsitta_sudrei             = uniform (33.9,37.71);
```

[Fossilised Birth-Death model for extant + fossil tips]
PRSET brlenspr = clock:fossilization;

[Speciation/extinction/fossilisation priors - conservative defaults]
PRSET speciationpr = exponential(10.0); [broad prior on the net diversification rate]
PRSET extinctionpr = beta(1,1); [flat prior on the relative extinction (turnover) rate]
PRSET fossilizationpr = beta(1,1); [flat prior on the relative fossilization rate (sampling proportion)]

[Sampling strategy for extant + fossils]
PRSET samplestrat = diversity; [strategy under which species were sampled = maximize diversity since species were sampled to represent all major lineages/families]
PRSET sampleprob = 0.006; [prior on the fraction of extant species that are sampled in the analysis = 50/8477]

[root age prior places a soft upper bound constrain on the age of the tree]
PRSET treeagepr = uniform(62,66); [latest Cretaceous as soft maximum, no Telluraves are known from the Cretaceous]

[clock model]
[base of clock rate: clockrate informative prior based on previous nonclock analysis = median value for tree height in substitutions from posterior trees/ age of the tree based on the median of the distribution for the root prior]
PRSET clockratepr = lognorm(-0.63827,1.25);

```
[clock model for rate variation among lineages: IGR - relaxed uncorrelated clock with values sampled from a gamma distribution]
PRSET clockvarpr = igr;

[hyperprior on shape of gamma distribution from IGR clock]
PRSET igrvarpr = exp(10);
```

S3.4 Character optimisation for Analysis 1 (unconstrained)

Galbula dea:
Unambiguous: 23(0 -> 1), 35(0 -> 1), 58(0 -> 1), 80(0 -> 3), 93(0 -> 1), 121(0 -> 1), 135(0 -> 1), 147(0 -> 1), 157(0 -> 1), 161(0 -> 1), 163(0 -> 1), 200(2 -> 1), 215(0 -> 2), 222(0 -> 1), 229(0 -> 1), 230(0 -> 1), 242(1 -> 0), 243(0 -> 1), 247(1 -> 0), 254(0 -> 1), 303(0 -> 1), 307(1 -> 0), 309(0 -> 1), 337(0 -> 1), 350(0 -> 1), 354(0 -> 1), 386(0 -> 1), 437(1 -> 0), 443(0 -> 1), 479(0 -> 2), 480(0 -> 1), 503(0 -> 1), 539(0 -> 1), 546(0 -> 1); DELTRAN: 19(0 -> 1), 48(2 -> 1), 52(0 -> 2), 61(1 -> 0), 83(0 -> 1), 126(0 -> 1), 206(0 -> 1), 240(0 -> 1), 333(0 -> 1), 407(0 -> 1), 424(1 -> 0), 534(0 -> 1); ACCTRAN: 52(1 -> 2), 456(0 -> 1), 525(1 -> 0).

(Indicatoridae + Picidae + Megalaimidae + Ramphastidae):
Unambiguous: 34(0 -> 1), 66(0 -> 1), 120(0 -> 1), 122(0 -> 1), 245(1 -> 0), 255(0 -> 1), 269(0 -> 1), 301(0 -> 1), 305(0 -> 1), 329(1 -> 2), 335(0 -> 1), 359(0 -> 1), 399(0 -> 1), 428(0 -> 1), 431(0 -> 2), 441(0 -> 1), 452(0 -> 1), 466(0 -> 2), 467(1 -> 2), 498(0 -> 1), 509(0 -> 1); DELTRAN: 52(0 -> 1), 456(1 -> 0), 525(0 -> 1); ACCTRAN: 19(1 -> 0), 48(1 -> 2), 61(0 -> 1), 72(0 -> 1), 97(0 -> 1), 104(1 -> 0), 126(1 -> 0), 159(0 -> 1), 191(0 -> 1), 203(0 -> 1), 206(1 -> 0), 213(0 -> 1), 221(0 -> 1), 313(0 -> 1), 347(1 -> 0), 407(1 -> 0), 429(1 -> 0), 487(0 -> 1), 517(0 -> 1), 534(1 -> 0), 549(0 -> 1).

Piciformes:
Unambiguous: 27(0 -> 1), 166(0 -> 1), 207(0 -> 1), 231(0 -> 1), 237(0 -> 1), 253(0 -> 1), 316(0 -> 1), 328(1 -> 0), 332(1 -> 2), 345(0 -> 1), 372(0 -> 1), 373(0 -> 1), 374(0 -> 1), 453(1 -> 2), 489(0 -> 1), 495(0 -> 3), 523(0 -> 1), 536(1 -> 0); DELTRAN: 47(0 -> 1), 62(0 -> 1), 95(0 -> 1), 183(0 -> 1), 367(0 -> 1), 379(0 -> 1), 427(0 -> 1), 485(1 -> 0), 486(1 -> 2); ACCTRAN: 52(0 -> 1), 83(0 -> 1), 287(1 -> 0), 424(1 -> 0), 460(2 -> 1), 486(0 -> 2).

Coraciiformes:
Unambiguous: 37(0 -> 2), 38(0 -> 1), 49(1 -> 2), 176(1 -> 0), 256(0 -> 1), 326(0 -> 1), 327(0 -> 1), 401(0 -> 1), 423(1 -> 0), 461(0 -> 1), 466(0 -> 1), 488(1 -> 0), 537(0 -> 1); DELTRAN: 19(0 -> 1), 48(2 -> 1), 71(0 -> 3), 174(1 -> 0), 179(1 -> 0), 206(0 -> 1), 287(0 -> 1), 407(0 -> 1), 460(1 -> 2), 525(0 -> 1); ACCTRAN: 47(1 -> 0), 55(0 -> 1), 71(2 -> 3), 112(1 -> 0), 142(1 -> 0), 149(0 -> 1), 189(0 -> 1), 379(1 -> 0), 397(2 -> 1).

Picodynastornithes:
Unambiguous: 8(0 -> 1), 13(0 -> 1), 59(0 -> 1), 283(1 -> 0), 293(0 -> 1), 312(0 -> 1), 441(2 -> 0), 465(2 -> 1), 524(0 -> 1); DELTRAN: 64(0 -> 1), 136(0 -> 1), 144(1 -> 0), 236(0 -> 1), 320(0 -> 1), 321(0 -> 1), 358(0 -> 1), 449(0 -> 1), 467(0 -> 1); ACCTRAN: 19(0 -> 1), 48(2 -> 1), 71(0 -> 2), 95(0 -> 1), 126(0 -> 1), 174(1 -> 0), 179(1 -> 0), 206(0 -> 1), 240(0 -> 1), 259(1 -> 0), 269(1 -> 0), 333(0 -> 1), 337(1 -> 0), 367(0 -> 1), 403(1 -> 0), 407(0 -> 1), 452(2 -> 0), 456(1 -> 0).

(Coliiformes + Passeriformes):
Unambiguous: 1(1 -> 0), 25(0 -> 1), 87(0 -> 1), 89(1 -> 0), 134(0 -> 1), 165(0 -> 1), 195(1 -> 0), 244(0 -> 1), 251(0 -> 1), 272(0 -> 1), 278(0 -> 1), 305(0 -> 1), 395(0 -> 1), 428(0 -> 1), 431(0 -> 2), 527(0 -> 1); DELTRAN: 47(0 -> 1), 269(0 -> 1), 452(0 -> 2), 460(1 -> 0); ACCTRAN: 33(1 -> 0), 62(1 -> 0), 64(1 -> 0), 96(0 -> 1), 97(0 -> 1), 98(0 -> 1), 136(1 -> 0), 183(1 -> 0), 199(1 -> 0), 228(1 -> 0), 236(1 -> 2), 320(1 -> 0), 321(1 -> 0), 334(1 -> 0), 351(1 -> 0), 460(2 -> 0), 548(0 -> 1).

Tockus nasutus:
Unambiguous: 4(0 -> 1), 15(1 -> 2), 27(0 -> 1), 32(0 -> 1), 49(1 -> 0), 52(0 -> 1), 55(0 -> 1), 56(0 -> 1), 73(0 -> 1), 83(0 -> 1), 109(0 -> 1), 146(0 -> 1), 149(0 -> 1), 158(0 -> 1), 194(0 -> 1), 195(1 -> 0), 197(1 -> 0), 215(2 -> 1), 249(0 -> 1), 306(0 -> 1), 307(1 -> 0), 308(0 -> 1), 347(1 -> 0), 453(1 -> 0), 458(0 -> 1), 484(0 -> 1), 543(0 -> 1); DELTRAN: 117(0 -> 1), 452(0 -> 1), 485(1 ->

0); ACCTRAN: 47(1 -> 0), 62(1 -> 0), 236(1 -> 0), 257(2 -> 1), 259(1 -> 0), 337(1 -> 0), 358(1 -> 0), 452(2 -> 1), 467(1 -> 0).

Upupa marginata:
Unambiguous: 20(0 -> 1), 21(0 -> 1), 22(0 -> 1), 25(0 -> 1), 31(0 -> 1), 80(0 -> 1), 82(0 -> 1), 85(0 -> 1), 122(0 -> 1), 123(0 -> 1), 124(0 -> 1), 130(0 -> 1), 147(0 -> 1), 159(0 -> 1), 172(1 -> 0), 182(0 -> 2), 206(0 -> 1), 266(1 -> 0), 270(2 -> 0), 288(0 -> 1), 289(0 -> 1), 296(0 -> 1), 301(0 -> 1), 335(0 -> 1), 338(0 -> 1), 339(0 -> 1), 348(0 -> 1), 375(0 -> 1), 378(0 -> 1), 386(0 -> 1), 397(2 -> 1), 414(0 -> 1), 426(0 -> 1), 441(2 -> 1), 466(0 -> 1), 490(0 -> 1), 491(0 -> 2); DELTRAN: 47(0 -> 1), 62(0 -> 1), 236(0 -> 1), 257(1 -> 2), 259(0 -> 1), 337(0 -> 1), 358(0 -> 1), 438(0 -> 1), 452(0 -> 2), 467(0 -> 1), 534(0 -> 1), 537(0 -> 1); ACCTRAN: 117(1 -> 0), 485(0 -> 1).

(Picodynastornithes + Coliiformes + Passeriformes):
Unambiguous: 14(1 -> 0), 102(2 -> 1), 205(0 -> 1), 215(2 -> 0), 242(0 -> 1), 247(0 -> 1), 250(0 -> 1), 252(1 -> 2), 271(0 -> 1), 331(0 -> 1), 332(0 -> 1), 365(1 -> 0), 377(1 -> 0), 440(0 -> 1), 473(0 -> 1); DELTRAN: 115(1 -> 0), 117(0 -> 1), 220(1 -> 0), 257(1 -> 2); ACCTRAN: 66(1 -> 0), 144(1 -> 0), 229(1 -> 0), 373(1 -> 0), 399(1 -> 0), 427(0 -> 1), 438(1 -> 0), 449(0 -> 1).

Bucerotiformes
Unambiguous: 30(0 -> 1), 34(0 -> 1), 93(0 -> 1), 135(0 -> 1), 137(0 -> 1), 139(0 -> 1), 152(0 -> 2), 163(0 -> 1), 166(0 -> 1), 184(2 -> 1), 192(0 -> 1), 193(0 -> 1), 209(2 -> 0), 216(0 -> 1), 217(0 -> 1), 237(0 -> 1), 260(1 -> 0), 284(0 -> 1), 285(0 -> 1), 313(0 -> 1), 329(1 -> 2), 345(0 -> 1), 350(0 -> 1), 352(0 -> 1), 374(0 -> 1), 408(1 -> 0), 429(1 -> 0), 514(0 -> 1); DELTRAN: 64(0 -> 1), 66(0 -> 1), 136(0 -> 1), 183(0 -> 1), 229(0 -> 1), 269(0 -> 1), 287(0 -> 1), 320(0 -> 1), 321(0 -> 1), 373(0 -> 1), 379(0 -> 1), 399(0 -> 1), 403(0 -> 1), 460(1 -> 2), 486(1 -> 0); ACCTRAN: 61(0 -> 1), 115(0 -> 1), 525(1 -> 0), 537(0 -> 1).

Apaloderma narina:
Unambiguous: 45(0 -> 1), 162(1 -> 0), 181(0 -> 1), 182(0 -> 1), 231(0 -> 1), 283(1 -> 2), 339(0 -> 1), 429(1 -> 0), 434(0 -> 1), 465(2 -> 1); DELTRAN: 447(1 -> 0); ACCTRAN: 183(1 -> 0), 257(2 -> 1), 286(1 -> 0).

Trogon melanurus eumorphus:
Unambiguous: 191(0 -> 1), 215(2 -> 1), 230(0 -> 1), 251(0 -> 1), 302(1 -> 0), 303(0 -> 1), 414(0 -> 1), 426(0 -> 1), 427(0 -> 1), 452(0 -> 1), 512(1 -> 0); DELTRAN: 61(1 -> 0), 183(0 -> 1), 257(1 -> 2), 286(0 -> 1), 538(0 -> 1); ACCTRAN: 447(0 -> 1).

(Bucerotiformes + Picodynastornithes + Coliiformes + Passeriformes):
Unambiguous: 48(0 -> 2), 49(2 -> 1), 142(0 -> 1), 311(0 -> 1), 356(0 -> 1), 370(1 -> 0), 409(0 -> 1), 413(1 -> 0), 476(1 -> 0); DELTRAN: 286(0 -> 1), 336(0 -> 1), 447(1 -> 0), 487(1 -> 0); ACCTRAN: 31(1 -> 0), 32(1 -> 0), 64(0 -> 1), 72(1 -> 0), 117(0 -> 1), 136(0 -> 1), 148(1 -> 0), 189(1 -> 0), 220(1 -> 0), 269(0 -> 1), 287(0 -> 1), 320(0 -> 1), 321(0 -> 1), 358(0 -> 1), 379(0 -> 1), 403(0 -> 1), 452(0 -> 2), 460(1 -> 2), 486(1 -> 0).

Trogoniformes
Unambiguous: 1(1 -> 0), 4(0 -> 1), 5(1 -> 0), 8(0 -> 1), 19(0 -> 1), 28(0 -> 2), 33(1 -> 0), 55(0 -> 2), 56(0 -> 1), 70(0 -> 2), 71(0 -> 3), 75(2 -> 0), 76(0 -> 1), 77(0 -> 1), 80(0 -> 1), 81(0 -> 1), 82(0 -> 1), 88(0 -> 1), 95(0 -> 1), 101(2 -> 0), 102(2 -> 3), 105(1 -> 0), 128(0 -> 1), 131(0 -> 1), 134(0 -> 1), 146(0 -> 1), 151(0 -> 1), 173(0 -> 1), 185(0 -> 1), 186(0 -> 1), 214(0 -> 1), 232(0 -> 1), 244(0 -> 2), 252(1 -> 0), 254(0 -> 1), 256(0 -> 1), 298(0 -> 1), 304(0 -> 1), 324(0 -> 1), 357(0 -> 1), 367(0 -> 1), 387(0 -> 1), 389(0 -> 1), 397(2 -> 1), 408(1 -> 2), 453(1 -> 0), 455(0 -> 2), 462(0 -> 1), 468(0 -> 1), 470(1 -> 2), 488(1 -> 0), 493(0 -> 1), 507(0 -> 1), 513(2 -> 1); DELTRAN: 31(0 -> 1), 32(0 -> 1), 62(0 -> 1), 66(0 -> 1), 72(0 -> 1), 115(1 -> 0), 148(0 -> 1), 189(0 -> 1), 229(0 -> 1), 259(0 -> 1), 337(0 -> 1), 373(0 -> 1), 399(0 -> 1), 438(0 -> 1), 467(0 -> 2), 485(1 -> 3), 494(0

-> 2); ACCTRAN: 47(1 -> 0), 236(1 -> 0), 336(1 -> 0), 467(1 -> 2), 485(0 -> 3), 487(0 -> 1), 538(0 -> 1).

Leptosomus discolor:
Unambiguous: 21(0 -> 1), 22(0 -> 1), 25(0 -> 1), 27(0 -> 1), 28(0 -> 1), 35(0 -> 1), 52(0 -> 2), 58(0 -> 1), 73(0 -> 1), 74(0 -> 1), 147(0 -> 1), 150(0 -> 1), 153(0 -> 1), 166(0 -> 1), 174(1 -> 0), 180(0 -> 1), 181(0 -> 1), 188(1 -> 0), 198(0 -> 1), 225(1 -> 0), 243(0 -> 1), 245(1 -> 2), 260(1 -> 0), 305(0 -> 1), 341(0 -> 1), 378(0 -> 1), 395(0 -> 1), 407(0 -> 1), 461(0 -> 1), 473(0 -> 1), 474(0 -> 1), 486(1 -> 2), 492(1 -> 0), 495(0 -> 2), 496(2 -> 1), 512(1 -> 0), 528(0 -> 1), 550(0 -> 1); DELTRAN: 31(0 -> 1), 32(0 -> 1), 47(0 -> 1), 72(0 -> 1), 112(1 -> 0), 148(0 -> 1), 163(0 -> 1), 217(0 -> 1), 224(0 -> 1), 236(0 -> 1), 258(0 -> 1), 336(0 -> 1), 487(1 -> 0), 501(0 -> 1), 525(0 -> 1), 527(0 -> 1), 530(0 -> 1); ACCTRAN: 156(1 -> 0), 190(1 -> 0), 226(1 -> 0), 229(1 -> 0), 257(2 -> 1), 424(1 -> 0), 438(1 -> 0), 467(1 -> 0), 478(0 -> 1), 534(1 -> 0).

(Eucavitaves + Passeriformes):
Unambiguous: 89(0 -> 1), 104(0 -> 1), 114(0 -> 1), 176(0 -> 1), 197(0 -> 1), 203(1 -> 0), 222(1 -> 0), 323(0 -> 1), 327(1 -> 0), 355(0 -> 1), 361(1 -> 0), 376(1 -> 0), 411(1 -> 0), 423(0 -> 1), 435(2 -> 1), 441(1 -> 2), 536(0 -> 1); DELTRAN: 156(0 -> 1), 190(0 -> 1), 226(0 -> 1), 424(0 -> 1), 478(1 -> 0); ACCTRAN: 62(0 -> 1), 66(0 -> 1), 112(0 -> 1), 115(1 -> 0), 163(1 -> 0), 183(0 -> 1), 217(1 -> 0), 258(1 -> 0), 259(0 -> 1), 286(0 -> 1), 337(0 -> 1), 373(0 -> 1), 399(0 -> 1), 447(1 -> 0), 485(1 -> 0), 501(1 -> 0), 527(1 -> 0), 530(1 -> 0).

Deroptyus accipitrinus:
Unambiguous: 42(0 -> 1), 52(0 -> 2), 57(0 -> 1), 204(1 -> 0), 222(1 -> 0), 287(0 -> 1), 432(0 -> 1), 542(1 -> 2), 547(0 -> 1); DELTRAN: 312(0 -> 1); ACCTRAN.

Psittacus erithacus:
Unambiguous: 132(0 -> 1), 134(0 -> 1), 189(1 -> 0), 211(0 -> 1), 413(1 -> 0), 431(1 -> 0), 436(0 -> 1), 442(0 -> 1), 549(1 -> 0); DELTRAN; ACCTRAN: 312(1 -> 0).

Psittrichas fulgidus:
Unambiguous: 85(1 -> 0), 358(0 -> 1), 429(1 -> 0), 467(1 -> 0); DELTRAN: 312(0 -> 1); ACCTRAN.

Psittacidae:
Unambiguous: 56(1 -> 0), 235(1 -> 0), 307(1 -> 0), 314(0 -> 1), 440(1 -> 0), 441(2 -> 0), 543(1 -> 0); DELTRAN: 518(0 -> 1), 529(0 -> 1); ACCTRAN.

Barnardius zonarius:
Unambiguous: 204(1 -> 0), 216(0 -> 1), 230(0 -> 1), 256(1 -> 0), 303(0 -> 1), 435(2 -> 1), 465(2 -> 1), 467(1 -> 2), 545(1 -> 0); DELTRAN: 217(0 -> 1), 413(1 -> 2); ACCTRAN: 206(2 -> 0), 512(0 -> 1), 529(1 -> 0).

(Psittacidae + *Psittacus*):
Unambiguous: 39(1 -> 2), 215(2 -> 1), 428(1 -> 0); DELTRAN: 206(0 -> 2), 512(1 -> 0); ACCTRAN: 217(1 -> 0), 312(0 -> 1), 413(2 -> 1).

Probosciger aterrimus:
Unambiguous: 1(0 -> 1), 57(0 -> 1), 136(0 -> 1), 270(0 -> 1), 324(1 -> 0), 394(0 -> 1), 436(0 -> 1), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0); DELTRAN: 42(0 -> 1), 52(0 -> 2), 163(0 -> 1), 206(0 -> 2), 217(0 -> 1), 413(1 -> 2), 469(0 -> 1), 512(1 -> 0), 529(0 -> 1); ACCTRAN.

(Psittacidae + Psittaculidae):
Unambiguous: 296(0 -> 1), 416(0 -> 1), 458(0 -> 1), 537(0 -> 1); DELTRAN: 175(0 -> 1); ACCTRAN: 42(1 -> 0), 52(2 -> 0), 163(1 -> 0), 469(1 -> 0).

Strigops habroptilus:
Unambiguous: 63(0 -> 2), 75(2 -> 1), 212(0 -> 1), 549(1 -> 0); DELTRAN: 42(0 -> 1), 52(0 -> 2); ACCTRAN: 39(1 -> 0), 186(1 -> 0), 206(2 -> 0), 542(1 -> 0).

(Cacatuidae + Psittacidae + Psittaculidae):
Unambiguous: 3(0 -> 1), 4(1 -> 2), 14(0 -> 1), 15(1 -> 2), 141(0 -> 1), 228(0 -> 1), 371(0 -> 1); DELTRAN: 39(0 -> 1), 182(0 -> 2), 186(0 -> 1), 235(0 -> 1), 249(0 -> 1), 277(0 -> 1), 283(0 -> 2), 294(0 -> 2), 441(1 -> 2), 542(0 -> 1); ACCTRAN: 512(1 -> 0).

Nestor notabilis:
Unambiguous: 62(0 -> 1), 132(0 -> 1), 134(0 -> 1), 215(2 -> 1), 328(1 -> 0), 407(0 -> 1); DELTRAN: 39(0 -> 1), 55(0 -> 1), 163(0 -> 1), 186(0 -> 1), 206(0 -> 2), 467(0 -> 2), 469(0 -> 1), 542(0 -> 1); ACCTRAN: 217(1 -> 0), 467(1 -> 2).

(*Strigops* + Cacatuidae + Psittacidae + Psittaculidae):
Unambiguous: 8(0 -> 1), 56(0 -> 1), 85(0 -> 1), 202(0 -> 1), 491(0 -> 2); DELTRAN: 55(0 -> 2), 467(0 -> 1); ACCTRAN: 42(0 -> 1), 52(0 -> 2), 55(1 -> 2), 175(0 -> 1), 182(0 -> 2), 235(0 -> 1), 249(0 -> 1), 277(0 -> 1), 283(0 -> 2), 294(0 -> 2), 413(1 -> 2), 441(1 -> 2).

(Coraciimorphae + Passeriformes):
Unambiguous: 14(0 -> 1), 18(1 -> 0), 30(1 -> 0), 87(1 -> 0), 144(0 -> 1), 184(1 -> 2), 195(0 -> 1), 201(0 -> 1), 209(0 -> 2), 218(1 -> 0), 228(0 -> 1), 270(0 -> 2), 283(0 -> 1), 365(0 -> 1), 366(0 -> 1), 371(0 -> 1), 381(0 -> 1), 384(0 -> 1), 388(1 -> 0), 402(2 -> 1), 416(0 -> 1), 549(1 -> 0); DELTRAN: 49(0 -> 2), 102(0 -> 2), 152(1 -> 0), 347(0 -> 1), 456(0 -> 1), 470(0 -> 1); ACCTRAN: 32(0 -> 1), 47(0 -> 1), 55(1 -> 0), 61(1 -> 0), 72(0 -> 1), 102(1 -> 2), 148(0 -> 1), 206(2 -> 0), 236(0 -> 1), 239(1 -> 0), 250(1 -> 0), 336(0 -> 1), 427(1 -> 0), 428(1 -> 0), 487(1 -> 0), 494(1 -> 2), 525(0 -> 1), 542(1 -> 0), 543(1 -> 0).

Psittaciformes:
Unambiguous: 1(1 -> 0), 2(0 -> 1), 4(0 -> 1), 7(0 -> 1), 19(0 -> 1), 23(0 -> 1), 28(0 -> 3), 37(0 -> 1), 41(0 -> 1), 46(0 -> 1), 48(0 -> 2), 84(0 -> 1), 90(0 -> 1), 117(0 -> 2), 118(0 -> 1), 121(0 -> 1), 126(0 -> 1), 137(0 -> 1), 138(0 -> 1), 139(0 -> 1), 140(0 -> 1), 151(0 -> 1), 154(0 -> 1), 162(1 -> 0), 165(0 -> 1), 170(0 -> 2), 191(0 -> 1), 214(0 -> 1), 252(1 -> 2), 254(0 -> 2), 255(0 -> 1), 256(0 -> 1), 259(0 -> 2), 264(0 -> 1), 265(0 -> 1), 278(0 -> 1), 284(0 -> 1), 324(0 -> 1), 354(0 -> 1), 377(1 -> 2), 397(2 -> 1), 401(0 -> 1), 409(0 -> 1), 410(0 -> 1), 431(0 -> 1), 434(0 -> 1), 440(0 -> 1), 452(0 -> 1), 453(1 -> 0), 454(0 -> 2), 460(1 -> 0), 462(0 -> 1), 472(1 -> 0), 476(1 -> 0), 479(0 -> 1), 481(0 -> 1), 489(0 -> 1), 490(0 -> 1), 493(0 -> 1), 495(0 -> 3), 499(0 -> 1), 504(0 -> 1), 508(0 -> 1), 511(0 -> 1), 513(2 -> 0), 523(0 -> 1), 533(0 -> 1), 548(0 -> 1); DELTRAN: 102(0 -> 1), 112(1 -> 0), 152(1 -> 2), 156(0 -> 1), 189(0 -> 1), 190(0 -> 1), 226(0 -> 1), 229(0 -> 1), 239(0 -> 1), 250(0 -> 1), 257(1 -> 2), 258(0 -> 1), 424(0 -> 1), 427(0 -> 1), 428(0 -> 1), 438(0 -> 1), 470(0 -> 2), 478(1 -> 0), 494(0 -> 1), 501(0 -> 1), 527(0 -> 1), 530(0 -> 1), 534(0 -> 1), 543(0 -> 1); ACCTRAN: 31(1 -> 0), 39(0 -> 1), 49(2 -> 0), 152(0 -> 2), 186(0 -> 1), 347(1 -> 0), 469(0 -> 1), 470(1 -> 2), 518(0 -> 1), 529(0 -> 1).

Cariama cristata:
Unambiguous: 64(0 -> 1), 161(0 -> 1), 166(0 -> 1), 270(0 -> 1), 272(0 -> 1), 323(0 -> 1), 354(0 -> 1), 394(0 -> 1), 459(0 -> 1); DELTRAN: 134(0 -> 1), 206(0 -> 2), 426(1 -> 0); ACCTRAN.

Chunga burmeisteri:
Unambiguous: 72(0 -> 1), 77(0 -> 1), 101(2 -> 1), 174(1 -> 0), 243(0 -> 1), 312(0 -> 1), 460(1 -> 0); DELTRAN: 134(0 -> 2), 206(0 -> 1); ACCTRAN: 134(1 -> 2), 206(2 -> 1), 426(0 -> 1).

(Psittaciformes + Coraciimorphae + Passeriformes):

Unambiguous: 15(0 -> 1), 95(2 -> 0), 105(0 -> 1), 194(1 -> 0), 200(1 -> 2), 245(0 -> 1), 276(1 -> 0), 307(0 -> 1), 370(0 -> 1), 392(0 -> 1), 396(0 -> 1), 404(1 -> 0), 437(0 -> 1), 441(0 -> 1), 463(2 -> 0), 464(0 -> 2), 465(0 -> 2); DELTRAN: 40(0 -> 1), 426(1 -> 0), 429(0 -> 1), 496(0 -> 2); ACCTRAN: 52(1 -> 0), 102(0 -> 1), 112(1 -> 0), 133(0 -> 1), 152(1 -> 0), 156(0 -> 1), 163(0 -> 1), 189(0 -> 1), 190(0 -> 1), 229(0 -> 1), 257(1 -> 2), 329(0 -> 1), 424(0 -> 1), 438(0 -> 1), 467(0 -> 1), 470(0 -> 1), 473(2 -> 0), 478(1 -> 0), 501(0 -> 1), 527(0 -> 1), 530(0 -> 1), 534(0 -> 1).

Cariamiformes:
Unambiguous: 11(0 -> 1), 25(0 -> 1), 35(0 -> 2), 36(0 -> 1), 43(0 -> 1), 58(0 -> 1), 73(0 -> 1), 79(0 -> 1), 89(0 -> 1), 91(0 -> 1), 99(0 -> 1), 111(0 -> 1), 114(0 -> 1), 115(1 -> 0), 129(0 -> 1), 132(0 -> 1), 142(0 -> 1), 182(0 -> 1), 183(0 -> 2), 198(0 -> 1), 216(0 -> 1), 227(0 -> 1), 281(1 -> 0), 296(0 -> 1), 300(0 -> 1), 311(0 -> 1), 317(1 -> 0), 319(0 -> 1), 321(0 -> 1), 327(1 -> 0), 328(1 -> 0), 334(1 -> 0), 335(0 -> 1), 337(0 -> 1), 340(0 -> 1), 344(0 -> 1), 348(0 -> 1), 361(1 -> 0), 362(0 -> 1), 376(1 -> 0), 377(1 -> 0), 379(0 -> 1), 385(0 -> 1), 393(0 -> 1), 395(0 -> 1), 398(0 -> 1), 408(1 -> 0), 412(0 -> 1), 413(1 -> 0), 420(0 -> 1), 425(0 -> 1), 432(0 -> 1), 447(1 -> 0), 457(0 -> 1), 474(0 -> 1), 500(0 -> 1), 512(1 -> 2), 520(0 -> 1), 532(0 -> 1); DELTRAN: 31(0 -> 1), 49(0 -> 2), 52(0 -> 1), 55(0 -> 1), 217(0 -> 1), 239(0 -> 1), 250(0 -> 1), 329(1 -> 0), 347(0 -> 1), 427(0 -> 1), 428(0 -> 1), 429(0 -> 2), 473(0 -> 2), 542(0 -> 1), 543(0 -> 1); ACCTRAN: 40(1 -> 0), 134(0 -> 1), 226(1 -> 0), 258(1 -> 0), 429(1 -> 2), 456(1 -> 0).

(Cariamiformes + Psittaciformes + Coraciimorphae + Passeriformes):
Unambiguous: 5(0 -> 1), 75(0 -> 2), 81(1 -> 0), 117(1 -> 0), 188(0 -> 1), 215(1 -> 2), 220(0 -> 1), 222(0 -> 1), 238(0 -> 1), 254(1 -> 0), 266(0 -> 1), 297(0 -> 1), 302(0 -> 1), 306(1 -> 0), 540(0 -> 1); DELTRAN: 101(0 -> 2), 172(0 -> 1), 435(1 -> 2), 545(0 -> 1); ACCTRAN: 31(0 -> 1), 49(0 -> 2), 55(0 -> 1), 206(0 -> 2), 217(0 -> 1), 224(0 -> 1), 239(0 -> 1), 250(0 -> 1), 347(0 -> 1), 426(1 -> 0), 427(0 -> 1), 428(0 -> 1), 429(0 -> 1), 494(0 -> 1), 496(0 -> 2), 542(0 -> 1), 543(0 -> 1).

(Accipitriformes + Strigiformes + Falconiformes):
Unambiguous: 4(0 -> 2), 28(0 -> 1), 177(0 -> 1), 180(0 -> 1), 186(0 -> 1), 225(1 -> 0), 245(0 -> 2), 260(1 -> 0), 270(0 -> 1), 414(0 -> 1), 492(1 -> 0), 512(1 -> 0), 539(0 -> 1), 547(0 -> 1); DELTRAN: 40(0 -> 1), 52(0 -> 1), 329(1 -> 0); ACCTRAN: 1(1 -> 0), 32(0 -> 1), 33(1 -> 0), 46(0 -> 1), 48(0 -> 1), 159(0 -> 1), 208(0 -> 1), 210(0 -> 1), 413(1 -> 2), 518(0 -> 1), 529(0 -> 1).

Chauna chavaria:
Unambiguous: 4(0 -> 1), 8(0 -> 1), 32(0 -> 1), 73(0 -> 1), 76(0 -> 1), 86(0 -> 1), 89(0 -> 1), 99(0 -> 1), 137(0 -> 1), 144(0 -> 1), 152(1 -> 2), 183(0 -> 1), 198(0 -> 2), 203(1 -> 2), 206(0 -> 1), 208(0 -> 1), 209(0 -> 1), 227(0 -> 1), 245(0 -> 2), 246(0 -> 1), 252(1 -> 0), 255(0 -> 1), 281(1 -> 0), 290(0 -> 1), 305(0 -> 1), 310(0 -> 1), 314(0 -> 1), 317(1 -> 0), 347(0 -> 1), 354(0 -> 1), 360(0 -> 1), 368(0 -> 1), 409(0 -> 1), 410(0 -> 1), 414(0 -> 1), 428(0 -> 1), 429(0 -> 1), 432(0 -> 1), 485(1 -> 2), 493(0 -> 1), 529(0 -> 1), 539(0 -> 1); DELTRAN; ACCTRAN.

Telluraves:
Unambiguous: 17(1 -> 0), 18(0 -> 1), 94(0 -> 1), 161(1 -> 0), 179(0 -> 1), 218(0 -> 1), 268(1 -> 0), 402(3 -> 2), 417(1 -> 0); DELTRAN; ACCTRAN: 40(0 -> 1), 52(0 -> 1), 101(0 -> 2), 172(0 -> 1), 226(0 -> 1), 258(0 -> 1), 329(1 -> 0), 435(1 -> 2), 456(0 -> 1), 473(0 -> 2), 545(0 -> 1).

Outgroup (Eudromia + Charadris + Eurypyga):
Unambiguous: 5(0 -> 1), 25(0 -> 1), 26(0 -> 1), 30(1 -> 0), 91(0 -> 1), 96(0 -> 1), 228(0 -> 1), 238(0 -> 1), 384(0 -> 1), 388(1 -> 0), 392(0 -> 1), 401(0 -> 1), 407(0 -> 1), 458(0 -> 1); DELTRAN; ACCTRAN: 11(0 -> 1), 48(0 -> 1), 114(0 -> 1), 162(1 -> 0), 168(0 -> 1), 194(1 -> 0), 200(1 -> 2), 219(0 -> 1), 220(0 -> 1), 302(0 -> 1), 325(0 -> 1), 371(0 -> 1), 411(1 -> 0), 457(0 -> 1), 465(0 -> 1), 522(0 -> 1), 537(0 -> 1).

Charadris vociferus:

Unambiguous: 31(0 -> 1), 61(1 -> 0), 65(0 -> 1), 74(0 -> 1), 112(1 -> 0), 116(0 -> 1), 132(0 -> 1), 137(0 -> 1), 152(1 -> 2), 161(1 -> 0), 166(0 -> 1), 174(1 -> 0), 188(0 -> 1), 198(0 -> 1), 225(1 -> 0), 232(0 -> 1), 256(0 -> 1), 266(0 -> 1), 268(1 -> 0), 272(0 -> 1), 276(1 -> 0), 283(0 -> 2), 287(0 -> 1), 310(0 -> 1), 347(0 -> 1), 368(0 -> 1), 397(2 -> 1), 424(0 -> 1), 425(0 -> 1), 426(1 -> 0), 427(0 -> 1), 428(0 -> 1), 441(0 -> 1), 481(0 -> 1), 493(0 -> 1), 513(2 -> 1), 520(0 -> 1); DELTRAN: 11(0 -> 1), 48(0 -> 1), 75(0 -> 1), 114(0 -> 1), 219(0 -> 1), 220(0 -> 1), 324(0 -> 1), 325(0 -> 1), 411(1 -> 0), 457(0 -> 1), 464(0 -> 2), 465(0 -> 1), 537(0 -> 1); ACCTRAN: 162(0 -> 1), 168(1 -> 0), 194(0 -> 1), 302(1 -> 0), 464(1 -> 2).

Eurypyga helias:
Unambiguous: 32(0 -> 1), 64(0 -> 1), 66(0 -> 1), 81(1 -> 0), 82(0 -> 1), 99(0 -> 1), 131(0 -> 1), 147(0 -> 1), 148(0 -> 1), 196(0 -> 1), 201(0 -> 1), 207(0 -> 1), 209(0 -> 1), 218(0 -> 1), 236(0 -> 1), 245(0 -> 1), 303(0 -> 1), 306(1 -> 0), 334(1 -> 0), 370(0 -> 1), 396(0 -> 1), 413(1 -> 2), 437(0 -> 1), 438(0 -> 1); DELTRAN: 75(0 -> 2), 162(1 -> 0), 168(0 -> 1), 194(1 -> 0), 302(0 -> 1), 464(0 -> 1); ACCTRAN: 11(1 -> 0), 48(1 -> 0), 75(1 -> 2), 114(1 -> 0), 219(1 -> 0), 220(1 -> 0), 411(0 -> 1), 457(1 -> 0), 465(1 -> 0).

Eudromia elegans:
Unambiguous: 38(0 -> 1), 39(0 -> 2), 40(0 -> 1), 46(0 -> 1), 55(0 -> 1), 62(0 -> 1), 76(0 -> 1), 86(0 -> 1), 98(0 -> 1), 105(0 -> 1), 115(1 -> 0), 121(0 -> 1), 135(0 -> 1), 144(0 -> 1), 152(1 -> 0), 192(0 -> 1), 195(0 -> 1), 199(1 -> 0), 203(1 -> 0), 204(1 -> 0), 205(0 -> 1), 210(0 -> 1), 215(1 -> 0), 305(0 -> 1), 360(0 -> 1), 364(0 -> 1), 383(1 -> 0), 397(2 -> 0), 400(1 -> 0), 402(3 -> 4), 413(1 -> 0), 478(1 -> 0); DELTRAN: 11(0 -> 1), 48(0 -> 1), 114(0 -> 1), 162(1 -> 0), 168(0 -> 1), 194(1 -> 0), 219(0 -> 1), 220(0 -> 1), 302(0 -> 1), 371(0 -> 1), 411(1 -> 0), 457(0 -> 1), 465(0 -> 1); ACCTRAN.

Outgroup (Charadris + Eurypyga):
Unambiguous: 51(0 -> 1), 58(0 -> 1), 77(0 -> 1), 94(0 -> 1), 104(0 -> 1), 110(0 -> 1), 117(1 -> 0), 134(0 -> 1), 182(0 -> 1), 184(1 -> 2), 229(0 -> 1), 244(0 -> 1), 270(0 -> 2), 286(0 -> 1), 409(0 -> 1), 429(0 -> 2), 463(2 -> 0), 477(0 -> 1), 485(1 -> 2); DELTRAN: 200(1 -> 2), 522(0 -> 1); ACCTRAN: 75(0 -> 1), 324(0 -> 1), 464(0 -> 1).

Cathartes burrovianus:
Unambiguous: 37(0 -> 1), 65(0 -> 1), 74(0 -> 1), 82(0 -> 1), 91(0 -> 1), 148(0 -> 1), 184(1 -> 2), 198(0 -> 1), 290(0 -> 1), 310(0 -> 1), 314(0 -> 1), 325(0 -> 1), 388(1 -> 0), 404(1 -> 0), 407(0 -> 1), 487(1 -> 0), 491(0 -> 1), 542(0 -> 1); DELTRAN: 1(1 -> 0), 172(0 -> 1), 529(0 -> 1); ACCTRAN.

Vultur gryphus:
Unambiguous: 62(0 -> 1), 112(1 -> 0), 117(1 -> 0), 130(0 -> 1), 137(0 -> 1), 147(0 -> 1), 150(0 -> 1), 152(1 -> 2), 392(0 -> 1), 522(0 -> 1); DELTRAN; ACCTRAN: 1(0 -> 1), 172(1 -> 0), 529(1 -> 0).

Accipiter nisus:
Unambiguous: 182(0 -> 1), 190(0 -> 1), 248(0 -> 1), 289(0 -> 1), 306(1 -> 0), 313(0 -> 1), 336(0 -> 1), 347(0 -> 1), 527(1 -> 2), 538(0 -> 1); DELTRAN: 117(1 -> 2), 181(0 -> 1), 228(0 -> 1), 283(0 -> 1); ACCTRAN: 127(1 -> 0), 129(1 -> 0), 364(1 -> 0).

Buteo rufofuscus:
Unambiguous: 120(0 -> 1), 249(0 -> 1), 266(0 -> 1), 280(0 -> 1), 311(0 -> 1), 355(0 -> 1), 377(1 -> 0), 406(1 -> 0); DELTRAN: 127(0 -> 1), 129(0 -> 1), 283(0 -> 2), 364(0 -> 1); ACCTRAN: 117(2 -> 1), 181(1 -> 0), 228(1 -> 0), 283(1 -> 2).

Elanus caeruleus:

Unambiguous: 54(0 -> 1), 71(1 -> 0), 105(1 -> 0), 145(0 -> 1), 152(1 -> 0), 188(1 -> 0), 404(1 -> 0), 435(1 -> 2), 455(0 -> 1), 490(0 -> 1); DELTRAN: 117(1 -> 2), 127(0 -> 1), 129(0 -> 1), 228(0 -> 1), 364(0 -> 1), 388(1 -> 0), 491(0 -> 2); ACCTRAN: 23(1 -> 0), 142(1 -> 0), 302(1 -> 0), 491(1 -> 2).

(*Buteo* + *Accipiter*):
Unambiguous: 9(0 -> 1), 32(0 -> 1), 149(0 -> 1), 150(0 -> 1), 172(1 -> 0), 203(1 -> 2), 206(0 -> 1), 257(1 -> 2), 269(0 -> 1), 286(0 -> 1), 307(0 -> 1), 314(0 -> 1), 321(0 -> 1), 441(0 -> 1), 442(0 -> 1), 494(0 -> 1), 512(0 -> 2), 521(1 -> 2), 530(2 -> 1); DELTRAN: 23(0 -> 1), 142(0 -> 1), 302(0 -> 1), 491(0 -> 1); ACCTRAN: 283(0 -> 1), 388(0 -> 1).

Strix aluco:
Unambiguous: 48(1 -> 0), 49(0 -> 2), 95(2 -> 0), 184(1 -> 2), 198(0 -> 2), 200(1 -> 2), 209(1 -> 2), 218(0 -> 1), 303(0 -> 1), 311(0 -> 1), 313(0 -> 1), 373(0 -> 1), 377(1 -> 0), 380(0 -> 1), 424(0 -> 1), 429(0 -> 1), 447(1 -> 0), 448(0 -> 1), 449(0 -> 1), 534(0 -> 1); DELTRAN: 142(0 -> 1), 152(1 -> 0), 180(1 -> 0), 189(0 -> 1), 249(0 -> 1), 270(1 -> 0), 413(1 -> 2); ACCTRAN: 217(1 -> 0), 224(1 -> 0), 255(1 -> 0), 302(1 -> 0), 355(1 -> 0).

Tyto alba:
Unambiguous: 36(1 -> 0), 82(0 -> 1), 87(1 -> 0), 88(0 -> 1), 121(0 -> 1), 161(0 -> 1), 188(1 -> 0), 196(1 -> 0), 203(1 -> 0), 206(0 -> 1), 214(1 -> 0), 236(0 -> 1), 243(1 -> 0), 250(1 -> 0), 265(0 -> 1), 324(0 -> 1), 357(0 -> 1), 378(0 -> 1), 395(1 -> 0), 404(1 -> 0), 435(1 -> 2), 474(2 -> 1), 527(1 -> 2); DELTRAN: 217(0 -> 1), 224(0 -> 1), 255(0 -> 1), 270(1 -> 2), 302(0 -> 1), 355(0 -> 1), 434(0 -> 1); ACCTRAN: 142(1 -> 0), 249(1 -> 0), 270(0 -> 2), 413(2 -> 1).

Caracara cheriway:
Unambiguous: 73(0 -> 1), 108(1 -> 0), 155(1 -> 0), 161(0 -> 1), 247(0 -> 1), 259(1 -> 0), 277(0 -> 1), 311(0 -> 1), 329(1 -> 0), 356(1 -> 0), 391(1 -> 0), 404(1 -> 0), 406(1 -> 0), 491(0 -> 1); DELTRAN; ACCTRAN: 460(2 -> 1).

Daptrius ater:
Unambiguous: 45(0 -> 1), 441(1 -> 0), 470(1 -> 0), 483(1 -> 0); DELTRAN: 70(0 -> 2), 71(2 -> 0), 175(0 -> 1), 460(1 -> 2), 527(1 -> 0), 530(2 -> 1); ACCTRAN.

Falco sparverius:
Unambiguous: 3(0 -> 1), 52(1 -> 0), 104(0 -> 1), 160(0 -> 1), 225(0 -> 1), 509(0 -> 1); DELTRAN: 32(0 -> 1), 245(2 -> 1), 269(0 -> 1), 302(0 -> 1), 354(0 -> 1), 443(0 -> 1), 460(1 -> 2); ACCTRAN: 62(1 -> 0), 70(2 -> 0), 220(1 -> 0).

Polyborinae
Unambiguous: 9(0 -> 1), 117(1 -> 0), 156(0 -> 1), 186(1 -> 0), 198(0 -> 2), 258(0 -> 1), 305(0 -> 1), 456(1 -> 0); DELTRAN: 62(0 -> 1), 220(0 -> 1), 474(2 -> 1); ACCTRAN: 32(1 -> 0), 71(2 -> 0), 175(0 -> 1), 245(1 -> 2), 269(1 -> 0), 302(1 -> 0), 354(1 -> 0), 443(1 -> 0), 527(1 -> 0), 530(2 -> 1).

Micrastur ruficollis concentricus:
Unambiguous: 45(0 -> 1), 47(0 -> 1), 72(0 -> 1), 114(0 -> 1), 115(1 -> 0), 126(0 -> 1), 131(0 -> 1), 134(1 -> 2), 174(0 -> 1), 247(0 -> 1), 287(0 -> 1), 317(1 -> 0), 325(0 -> 1), 336(0 -> 1), 348(0 -> 1), 361(1 -> 0), 367(0 -> 1), 408(1 -> 0), 424(0 -> 1), 458(0 -> 1), 490(0 -> 1), 491(0 -> 2), 515(0 -> 1), 517(0 -> 1); DELTRAN: 32(0 -> 1), 60(0 -> 1), 62(0 -> 1), 75(0 -> 1), 220(0 -> 1), 229(0 -> 1), 245(2 -> 1), 269(0 -> 1), 302(0 -> 1), 346(0 -> 1), 354(0 -> 1), 443(0 -> 1), 512(0 -> 2); ACCTRAN: 413(2 -> 1), 492(1 -> 0), 512(1 -> 2).

(Falconinae + Polyborinae):

Unambiguous: 20(0 -> 1), 22(0 -> 1), 24(0 -> 1), 109(0 -> 1), 145(0 -> 1), 168(0 -> 1), 192(0 -> 1), 202(0 -> 1), 206(0 -> 1), 283(0 -> 2), 294(0 -> 2); DELTRAN: 75(0 -> 2), 116(0 -> 1), 413(1 -> 2), 492(0 -> 1), 512(0 -> 1); ACCTRAN: 60(1 -> 0), 75(1 -> 2), 229(1 -> 0), 346(1 -> 0), 460(1 -> 2), 474(2 -> 1).

Strigiformes
Unambiguous: 8(0 -> 1), 13(0 -> 1), 17(0 -> 1), 27(0 -> 1), 46(0 -> 1), 52(1 -> 2), 54(0 -> 1), 69(0 -> 1), 76(0 -> 1), 81(0 -> 1), 89(0 -> 1), 101(0 -> 1), 105(1 -> 0), 119(0 -> 1), 133(0 -> 1), 147(0 -> 1), 160(0 -> 1), 165(0 -> 1), 183(0 -> 2), 186(1 -> 0), 201(0 -> 1), 259(1 -> 0), 260(0 -> 1), 272(0 -> 1), 283(0 -> 1), 286(0 -> 1), 289(0 -> 1), 299(0 -> 1), 305(0 -> 1), 327(1 -> 0), 331(0 -> 1), 347(0 -> 1), 365(0 -> 1), 381(0 -> 1), 390(0 -> 1), 396(0 -> 1), 402(2 -> 1), 405(0 -> 1), 406(1 -> 0), 414(1 -> 0), 433(0 -> 1), 436(0 -> 1), 440(0 -> 1), 452(0 -> 2), 453(0 -> 1), 455(0 -> 1), 473(1 -> 2), 476(1 -> 2), 477(0 -> 1), 486(1 -> 2), 495(1 -> 2), 496(0 -> 1), 518(1 -> 0), 521(1 -> 0), 525(0 -> 1), 535(0 -> 1), 539(1 -> 2), 544(0 -> 1), 547(1 -> 0); DELTRAN: 37(0 -> 2), 60(0 -> 1), 70(0 -> 2), 104(0 -> 1), 228(0 -> 1), 229(0 -> 1), 346(0 -> 1), 388(1 -> 0), 492(0 -> 1); ACCTRAN: 37(1 -> 2), 68(1 -> 0), 75(1 -> 0), 116(1 -> 0), 129(1 -> 0), 152(1 -> 0), 180(1 -> 0), 181(1 -> 0), 189(0 -> 1), 270(1 -> 0), 276(0 -> 1), 434(0 -> 1).

Falconiformes
Unambiguous: 12(0 -> 1), 33(0 -> 1), 55(0 -> 1), 91(0 -> 1), 96(0 -> 1), 108(0 -> 1), 111(0 -> 1), 112(1 -> 2), 120(0 -> 1), 155(0 -> 1), 244(1 -> 0), 248(0 -> 1), 257(1 -> 2), 266(0 -> 1), 297(0 -> 1), 315(0 -> 1), 321(0 -> 1), 329(0 -> 1), 356(0 -> 1), 371(1 -> 0), 419(0 -> 1), 421(0 -> 1), 427(0 -> 1), 441(0 -> 1), 442(0 -> 1), 470(0 -> 1), 472(0 -> 1), 483(0 -> 1), 494(0 -> 1); DELTRAN: 37(0 -> 1), 68(0 -> 1), 129(0 -> 1), 142(0 -> 1), 177(1 -> 0), 181(0 -> 1), 217(0 -> 1), 224(0 -> 1), 249(0 -> 1), 255(0 -> 1), 276(1 -> 0), 355(0 -> 1), 439(0 -> 1); ACCTRAN: 32(0 -> 1), 62(0 -> 1), 104(1 -> 0), 220(0 -> 1), 228(1 -> 0), 245(2 -> 1), 269(0 -> 1), 354(0 -> 1), 388(0 -> 1), 443(0 -> 1), 512(0 -> 1).

Accipitridae:
Unambiguous: 112(1 -> 0), 126(0 -> 1), 130(0 -> 1), 211(0 -> 1), 236(0 -> 1), 323(0 -> 1), 325(0 -> 1), 409(0 -> 1), 445(0 -> 1); DELTRAN: 39(0 -> 1), 68(0 -> 1), 75(0 -> 1), 104(0 -> 1), 116(0 -> 1), 209(0 -> 2), 223(0 -> 1), 258(0 -> 1), 276(1 -> 0), 413(1 -> 2), 447(1 -> 0), 460(1 -> 0), 526(0 -> 1); ACCTRAN: 117(1 -> 2), 127(0 -> 1), 209(1 -> 2), 226(1 -> 0), 364(0 -> 1), 393(1 -> 0), 456(1 -> 0).

(Strigiformes + Falconiformes):
Unambiguous: 5(0 -> 1), 25(1 -> 0), 58(0 -> 1), 71(1 -> 2), 102(0 -> 1), 132(0 -> 1), 134(0 -> 1), 215(1 -> 2), 306(1 -> 0), 341(0 -> 1), 468(0 -> 1), 469(0 -> 1); DELTRAN: 23(0 -> 1), 39(0 -> 2), 209(0 -> 1), 226(0 -> 1), 393(0 -> 1), 456(0 -> 1); ACCTRAN: 37(0 -> 1), 39(1 -> 2), 60(0 -> 1), 70(0 -> 2), 177(1 -> 0), 217(0 -> 1), 223(1 -> 0), 224(0 -> 1), 229(0 -> 1), 249(0 -> 1), 255(0 -> 1), 258(1 -> 0), 346(0 -> 1), 355(0 -> 1), 439(0 -> 1), 447(0 -> 1), 460(0 -> 1), 491(1 -> 0), 492(0 -> 1), 526(1 -> 0).

Pandion haliaetus carolinensis:
Unambiguous: 35(2 -> 1), 62(0 -> 1), 73(0 -> 1), 74(0 -> 1), 89(0 -> 1), 109(0 -> 1), 155(0 -> 1), 162(1 -> 0), 198(0 -> 1), 392(0 -> 1), 397(0 -> 1), 404(1 -> 0), 408(1 -> 2), 414(1 -> 0), 452(0 -> 2), 476(1 -> 2), 477(0 -> 1), 481(0 -> 1), 485(1 -> 2), 486(1 -> 2), 488(1 -> 0), 513(2 -> 1), 547(1 -> 0); DELTRAN: 75(0 -> 2), 101(0 -> 2), 115(1 -> 0), 181(0 -> 1), 223(0 -> 1), 226(0 -> 1), 258(0 -> 1), 388(1 -> 0), 398(0 -> 1), 435(1 -> 2), 447(1 -> 0), 456(0 -> 1), 460(1 -> 0), 464(0 -> 2), 465(0 -> 2), 474(0 -> 1), 491(0 -> 1), 495(0 -> 2), 526(0 -> 1); ACCTRAN: 23(1 -> 0), 36(1 -> 0), 75(1 -> 2), 413(2 -> 1), 464(1 -> 2), 465(1 -> 2), 495(1 -> 2), 548(1 -> 0).

(Accipitridae + Strigiformes + Falconiformes):

Unambiguous: 38(0 -> 1), 61(1 -> 0), 174(1 -> 0), 218(1 -> 0), 238(0 -> 1), 250(0 -> 1), 254(1 -> 0), 264(0 -> 1), 370(0 -> 1), 473(0 -> 1); DELTRAN: 36(0 -> 1), 464(0 -> 1), 465(0 -> 1), 474(0 -> 2), 495(0 -> 1), 548(0 -> 1); ACCTRAN: 39(0 -> 1), 68(0 -> 1), 101(2 -> 0), 104(0 -> 1), 115(0 -> 1), 129(0 -> 1), 142(0 -> 1), 209(0 -> 1), 228(0 -> 1), 276(1 -> 0), 302(0 -> 1), 398(1 -> 0), 435(2 -> 1), 474(1 -> 2).

Sagittarius serpentarius:
Unambiguous: 5(0 -> 1), 76(0 -> 1), 95(2 -> 1), 112(1 -> 0), 114(0 -> 1), 117(1 -> 2), 149(0 -> 1), 152(1 -> 0), 153(0 -> 1), 184(1 -> 0), 187(0 -> 1), 206(0 -> 1), 289(0 -> 1), 306(1 -> 0), 317(1 -> 0), 377(1 -> 0), 385(0 -> 1), 425(0 -> 1), 512(0 -> 2), 522(0 -> 1); DELTRAN: 23(0 -> 1), 32(0 -> 1), 36(0 -> 1), 46(0 -> 1), 101(0 -> 1), 115(1 -> 0), 159(0 -> 1), 208(0 -> 1), 210(0 -> 1), 244(0 -> 2), 393(0 -> 1), 398(0 -> 1), 413(1 -> 0), 435(1 -> 2), 473(0 -> 2), 529(0 -> 1), 548(0 -> 1); ACCTRAN: 33(0 -> 1), 101(2 -> 1), 172(1 -> 0), 226(1 -> 0), 244(1 -> 2), 258(1 -> 0), 413(2 -> 0), 456(1 -> 0).

(Pandionidae + Accipitridae + Strigiformes + Falconiformes):
Unambiguous: 30(1 -> 0), 81(1 -> 0), 173(0 -> 1), 188(0 -> 1), 194(1 -> 0), 196(0 -> 1), 243(0 -> 1), 371(0 -> 1), 391(0 -> 1), 406(0 -> 1), 453(1 -> 0), 463(2 -> 1), 471(0 -> 1), 472(1 -> 0), 487(1 -> 0), 493(0 -> 1), 521(0 -> 1), 527(0 -> 1), 528(0 -> 2), 530(0 -> 2), 540(0 -> 1), 542(0 -> 2), 543(0 -> 1); DELTRAN: 33(1 -> 0), 172(0 -> 1), 244(0 -> 1), 529(0 -> 2); ACCTRAN: 32(1 -> 0), 46(1 -> 0), 75(0 -> 1), 159(1 -> 0), 208(1 -> 0), 210(1 -> 0), 223(0 -> 1), 388(1 -> 0), 447(1 -> 0), 460(1 -> 0), 464(0 -> 1), 465(0 -> 1), 473(2 -> 0), 474(0 -> 1), 491(0 -> 1), 495(0 -> 1), 526(0 -> 1), 529(1 -> 2).

Cathartidae
Unambiguous: 6(0 -> 1), 10(0 -> 1), 39(0 -> 2), 73(0 -> 2), 95(2 -> 0), 100(0 -> 1), 106(0 -> 1), 109(0 -> 1), 110(0 -> 1), 121(0 -> 1), 142(0 -> 1), 155(0 -> 1), 166(0 -> 1), 183(0 -> 2), 200(1 -> 2), 227(0 -> 1), 246(0 -> 1), 252(1 -> 0), 305(0 -> 1), 311(0 -> 1), 364(0 -> 1), 368(0 -> 1), 376(1 -> 0), 380(0 -> 1), 387(0 -> 1), 396(0 -> 1), 450(0 -> 1), 500(0 -> 1), 549(1 -> 0); DELTRAN: 32(0 -> 1), 33(1 -> 0), 46(0 -> 1), 48(0 -> 2), 159(0 -> 1), 208(0 -> 1), 210(0 -> 1), 226(0 -> 1), 258(0 -> 1), 413(1 -> 2), 456(0 -> 1), 473(0 -> 2); ACCTRAN: 48(1 -> 2), 435(2 -> 1), 545(1 -> 0).

(Sagittariidae + Pandionidae + Accipitridae + Strigiformes + Falconiformes):
Unambiguous: 15(0 -> 1), 19(0 -> 1), 25(0 -> 1), 35(0 -> 2), 71(0 -> 1), 77(0 -> 1), 105(0 -> 1), 151(0 -> 1), 214(0 -> 1), 259(0 -> 1), 395(0 -> 1), 397(2 -> 0); DELTRAN: 1(1 -> 0), 48(0 -> 1), 518(0 -> 1), 545(0 -> 1); ACCTRAN: 23(0 -> 1), 36(0 -> 1), 115(1 -> 0), 116(0 -> 1), 181(0 -> 1), 244(0 -> 1), 393(0 -> 1), 398(0 -> 1), 548(0 -> 1).

Colius striatus kiwuensis:
Unambiguous: 80(0 -> 2), 101(2 -> 1), 109(0 -> 1), 132(0 -> 1), 151(0 -> 1), 247(1 -> 0), 281(1 -> 0), 365(0 -> 1); DELTRAN: 61(1 -> 0), 157(0 -> 1), 163(0 -> 1), 228(1 -> 0), 334(1 -> 0), 525(0 -> 1), 534(0 -> 1), 539(0 -> 2); ACCTRAN: 199(0 -> 1).

Urocolius macrourus pulcher:
Unambiguous: 34(0 -> 1), 191(0 -> 1), 244(1 -> 2); DELTRAN: 199(1 -> 0); ACCTRAN: 228(0 -> 1), 334(0 -> 1).

Piprites chloris tschudii:
Unambiguous: 322(1 -> 0), 408(1 -> 2), 436(0 -> 1), 452(2 -> 1); DELTRAN: 142(1 -> 0), 150(1 -> 0), 343(1 -> 0); ACCTRAN: 17(0 -> 1), 51(0 -> 1).

Tyrannus tyrannus:

Unambiguous: 38(0 -> 1), 48(2 -> 1), 235(0 -> 1), 255(1 -> 0), 280(0 -> 1), 367(1 -> 0), 397(1 -> 0), 413(1 -> 2), 441(0 -> 1), 536(1 -> 0); DELTRAN: 17(1 -> 0), 51(1 -> 0); ACCTRAN: 142(0 -> 1), 150(0 -> 1), 343(0 -> 1).

Rupicola peruvianus:
Unambiguous: 4(0 -> 1), 19(0 -> 1), 20(0 -> 1), 22(0 -> 1), 25(1 -> 0), 28(0 -> 1), 50(1 -> 0), 102(4 -> 1), 103(1 -> 0), 186(0 -> 1), 234(1 -> 0), 251(1 -> 0), 350(1 -> 0), 428(0 -> 1), 475(1 -> 0), 482(1 -> 0); DELTRAN: 17(1 -> 0), 51(1 -> 0), 142(1 -> 0), 150(1 -> 0), 249(0 -> 1), 343(1 -> 0); ACCTRAN: 407(1 -> 0).

Tyrannidae
Unambiguous: 126(0 -> 1), 146(1 -> 0), 270(2 -> 0), 356(1 -> 0), 426(0 -> 1), 515(0 -> 1); DELTRAN: 407(0 -> 1); ACCTRAN: 249(1 -> 0).

Neopelma chrysocephalum:
Unambiguous: 48(2 -> 1), 240(0 -> 1), 255(1 -> 0), 305(1 -> 0), 311(1 -> 0), 333(0 -> 1), 395(1 -> 0), 408(1 -> 2), 437(1 -> 0); DELTRAN: 249(0 -> 1), 407(0 -> 1); ACCTRAN: 247(0 -> 1).

(*Rupicola* + *Piprites* + *Tyrannus*):
Unambiguous: 122(0 -> 1), 128(0 -> 1), 147(1 -> 0), 397(2 -> 1), 441(2 -> 0), 488(1 -> 0); DELTRAN: 247(1 -> 0), 512(2 -> 1); ACCTRAN: 17(1 -> 0), 51(1 -> 0), 142(1 -> 0), 150(1 -> 0), 343(1 -> 0).

Pitta sordida:
Unambiguous: 32(0 -> 1), 33(1 -> 0), 47(1 -> 0), 117(1 -> 0), 206(1 -> 0), 270(2 -> 0), 347(1 -> 0), 350(1 -> 0), 356(1 -> 0), 360(1 -> 0), 379(0 -> 1), 447(1 -> 0), 452(2 -> 0), 527(1 -> 0), 536(1 -> 0); DELTRAN: 247(1 -> 0), 251(1 -> 0); ACCTRAN: 8(1 -> 0), 80(3 -> 0), 409(0 -> 1).

Tyrannidae:
Unambiguous: 58(0 -> 1), 205(1 -> 0), 399(2 -> 1), 444(1 -> 0), 473(1 -> 0), 510(1 -> 0); DELTRAN: 8(0 -> 1), 80(0 -> 3), 215(0 -> 2), 409(1 -> 0); ACCTRAN: 249(0 -> 1), 251(0 -> 1), 407(0 -> 1), 512(2 -> 1).

Myrmornis torquata:
Unambiguous: 1(0 -> 1), 17(1 -> 0), 67(1 -> 0), 121(0 -> 1), 182(1 -> 0), 215(0 -> 1), 255(1 -> 0), 286(1 -> 0), 298(1 -> 0), 356(1 -> 0), 411(0 -> 1), 510(1 -> 0), 512(2 -> 1); DELTRAN; ACCTRAN: 431(0 -> 2).

Myrmothera campanisona minor:
Unambiguous: 117(1 -> 0), 317(1 -> 0), 347(1 -> 0), 426(0 -> 1), 452(2 -> 1), 515(0 -> 1); DELTRAN: 174(0 -> 1), 179(1 -> 0), 431(2 -> 0); ACCTRAN.

(*Pitta* + Tyrannidae):
Unambiguous: 203(1 -> 0), 338(1 -> 0), 432(1 -> 0), 451(0 -> 1); DELTRAN: 195(0 -> 1), 342(0 -> 1), 366(1 -> 0), 431(2 -> 0); ACCTRAN: 247(1 -> 0), 395(0 -> 1).

(*Myrmornis* + *Myrmothera*):
Unambiguous: 333(0 -> 1), 348(0 -> 1), 437(1 -> 0); DELTRAN: 8(0 -> 1), 80(0 -> 3), 251(1 -> 0), 395(1 -> 0), 409(1 -> 0); ACCTRAN: 174(0 -> 1), 179(1 -> 0), 195(1 -> 0), 215(2 -> 0), 342(1 -> 0), 366(0 -> 1).

Neodrepanis coruscans:
Unambiguous: 1(0 -> 1), 17(1 -> 0), 25(1 -> 0), 35(0 -> 1), 51(1 -> 0), 136(0 -> 1), 204(1 -> 0), 205(1 -> 0), 240(0 -> 1), 435(1 -> 0), 444(1 -> 0), 457(0 -> 1), 509(0 -> 1); DELTRAN: 195(0 ->

1), 215(0 -> 2), 337(0 -> 1), 342(0 -> 1), 366(1 -> 0), 395(1 -> 0), 473(1 -> 0); ACCTRAN: 80(3 -> 0), 150(1 -> 0), 219(1 -> 0).

(*Myrmornis* + *Myrmothera* + *Pitta* + Tyrannidae):
Unambiguous: 147(0 -> 1), 220(0 -> 1), 303(0 -> 1), 308(1 -> 0), 339(1 -> 0), 377(0 -> 1), 428(1 -> 0); DELTRAN: 150(0 -> 1), 219(0 -> 1); ACCTRAN: 8(0 -> 1), 251(1 -> 0), 337(1 -> 0), 409(1 -> 0), 431(2 -> 0), 473(0 -> 1).

Climacterus melanurus wellsi:
Unambiguous: 219(0 -> 1), 228(0 -> 1), 280(1 -> 0), 317(0 -> 1), 395(1 -> 0), 413(1 -> 0), 481(0 -> 1), 482(1 -> 0); DELTRAN: 255(0 -> 1), 330(0 -> 1), 347(1 -> 0), 397(2 -> 1); ACCTRAN: 236(2 -> 1), 337(1 -> 0), 392(0 -> 1).

Menura novaehollandiae:
Unambiguous: 25(1 -> 0), 30(0 -> 1), 35(0 -> 1), 37(0 -> 1), 38(0 -> 1), 39(0 -> 2), 44(1 -> 0), 47(1 -> 0), 48(2 -> 1), 66(1 -> 0), 85(1 -> 0), 129(0 -> 1), 196(0 -> 1), 197(1 -> 0), 199(0 -> 1), 204(1 -> 0), 206(0 -> 1), 211(0 -> 1), 214(0 -> 1), 242(1 -> 0), 244(2 -> 0), 245(0 -> 1), 251(1 -> 0), 253(1 -> 0), 270(2 -> 0), 272(1 -> 0), 308(1 -> 0), 312(0 -> 1), 329(2 -> 1), 356(1 -> 0), 358(1 -> 0), 370(0 -> 1), 401(1 -> 0), 409(1 -> 0), 411(0 -> 1), 431(2 -> 1), 440(1 -> 0), 444(1 -> 0), 447(1 -> 0), 547(0 -> 1), 548(0 -> 1); DELTRAN: 178(0 -> 1), 200(2 -> 1), 236(1 -> 2), 337(0 -> 1), 392(1 -> 0), 528(0 -> 1), 537(0 -> 1), 546(1 -> 0); ACCTRAN: 255(1 -> 0), 330(1 -> 0), 347(0 -> 1), 397(1 -> 2).

Malurus melanocephalus:
Unambiguous: 126(0 -> 1), 143(0 -> 1), 235(0 -> 1), 333(0 -> 1), 422(0 -> 1); DELTRAN: 255(0 -> 1), 330(0 -> 1), 337(0 -> 1), 347(1 -> 0), 392(1 -> 0), 397(2 -> 1), 487(0 -> 1); ACCTRAN: 205(0 -> 1).

(*Menura* + *Climacterus*)*:*
Unambiguous: 50(1 -> 0), 52(0 -> 1), 55(1 -> 0), 97(1 -> 2), 234(1 -> 0), 339(1 -> 0), 415(0 -> 1), 426(0 -> 1), 435(1 -> 2), 442(0 -> 1), 443(0 -> 1), 451(0 -> 1), 456(1 -> 0); DELTRAN: 61(1 -> 0), 205(1 -> 0), 321(0 -> 1), 379(0 -> 1), 542(0 -> 1), 549(0 -> 1); ACCTRAN: 487(1 -> 0).

Passer domesticus:
Unambiguous: 9(0 -> 1), 56(0 -> 1), 72(0 -> 1), 85(0 -> 1), 117(1 -> 0), 146(1 -> 0), 174(0 -> 1), 179(1 -> 0), 251(1 -> 0), 280(1 -> 0), 317(0 -> 1), 549(0 -> 1); DELTRAN: 25(1 -> 0), 130(0 -> 1), 330(0 -> 1); ACCTRAN: 55(0 -> 1).

Zosterops lateralis:
Unambiguous: 339(1 -> 0), 548(0 -> 1); DELTRAN: 55(1 -> 0); ACCTRAN: 25(0 -> 1), 130(1 -> 0), 330(1 -> 0).

Sylvia borin:
Unambiguous: 181(0 -> 1), 426(0 -> 1), 515(0 -> 1); DELTRAN: 25(1 -> 0), 55(1 -> 0), 130(0 -> 1), 195(0 -> 1), 205(1 -> 0), 330(0 -> 1), 431(2 -> 0); ACCTRAN: 440(0 -> 1).

(*Zosterops* + *Passer*):
Unambiguous: 121(0 -> 1), 286(0 -> 1), 294(2 -> 0), 311(1 -> 0), 413(1 -> 0), 488(0 -> 1); DELTRAN: 440(1 -> 0); ACCTRAN: 195(1 -> 0), 205(0 -> 1), 431(0 -> 2).

Corvus brachyrhynchos:
Unambiguous: 33(1 -> 0), 50(1 -> 0), 51(1 -> 0), 56(0 -> 1), 117(1 -> 0), 174(0 -> 1), 182(0 -> 1), 229(0 -> 1), 251(1 -> 0), 269(1 -> 0), 270(2 -> 0), 280(1 -> 0), 317(0 -> 1), 339(1 -> 0), 355(1 -> 0), 356(1 -> 0), 358(1 -> 0), 366(1 -> 0), 409(1 -> 0), 411(0 -> 1), 441(2 -> 0), 451(0 -> 1), 452(2

-> 1), 510(1 -> 0), 512(2 -> 1); DELTRAN: 61(1 -> 0), 195(0 -> 1), 205(1 -> 0), 222(0 -> 1), 431(2 -> 0), 440(1 -> 0); ACCTRAN: 130(1 -> 0), 236(2 -> 1), 256(1 -> 0), 330(1 -> 0), 347(0 -> 1).

(*Sylvia* + *Zosterops* + *Passer*):
Unambiguous: 204(1 -> 0), 297(1 -> 0), 456(1 -> 0), 492(0 -> 1); DELTRAN: 236(1 -> 2), 256(0 -> 1), 347(1 -> 0), 539(0 -> 1); ACCTRAN: 25(1 -> 0), 55(1 -> 0), 61(0 -> 1), 222(1 -> 0).

(*Malurus* + *Menura* + *Climacterus*)*:*
Unambiguous: 147(0 -> 1), 441(2 -> 1); DELTRAN: 130(0 -> 1), 222(0 -> 1), 256(0 -> 1), 515(0 -> 1); ACCTRAN: 178(0 -> 1), 219(1 -> 0), 255(0 -> 1), 321(0 -> 1), 392(1 -> 0), 397(2 -> 1), 528(0 -> 1), 537(0 -> 1), 539(1 -> 0), 542(0 -> 1), 546(1 -> 0), 549(0 -> 1).

(*Corvus* + *Sylvia* + *Zosterops* + *Passer*):
Unambiguous: 17(1 -> 0), 85(1 -> 0), 228(0 -> 1), 343(1 -> 0), 367(1 -> 0), 509(0 -> 1); DELTRAN: 219(0 -> 1), 487(0 -> 1); ACCTRAN: 195(0 -> 1), 337(1 -> 0), 431(2 -> 0), 440(1 -> 0), 515(1 -> 0).

Melanopareia bitorquata:
Unambiguous: 33(1 -> 0), 34(0 -> 1), 121(0 -> 1), 125(0 -> 1), 126(0 -> 1), 176(0 -> 1), 194(0 -> 1), 197(1 -> 0), 240(0 -> 1), 281(1 -> 0), 333(0 -> 1), 352(1 -> 0), 355(1 -> 0), 356(1 -> 0), 422(0 -> 1), 426(0 -> 1), 428(1 -> 0), 527(1 -> 0); DELTRAN: 214(0 -> 1), 219(0 -> 1), 337(0 -> 1), 515(0 -> 1), 539(0 -> 1); ACCTRAN: 150(1 -> 0), 184(1 -> 2).

(*Malurus* + *Menura* + *Climacterus* + *Corvus* + *Sylvia* + *Zosterops* + *Passer*):
Unambiguous: 63(1 -> 2), 66(0 -> 1), 114(1 -> 0), 115(0 -> 1), 220(0 -> 1), 261(0 -> 1), 303(0 -> 1), 307(2 -> 0), 334(0 -> 1), 335(0 -> 1), 338(1 -> 0), 369(0 -> 1), 488(1 -> 0), 507(1 -> 0); DELTRAN: 150(0 -> 1), 184(2 -> 1), 236(0 -> 1); ACCTRAN: 130(0 -> 1), 205(1 -> 0), 214(1 -> 0), 222(0 -> 1), 256(0 -> 1), 330(0 -> 1), 347(1 -> 0), 487(0 -> 1).

Tyranni
Unambiguous: 71(0 -> 3), 182(0 -> 1), 206(0 -> 1); DELTRAN: 67(0 -> 1), 184(2 -> 1), 214(0 -> 1), 255(0 -> 1); ACCTRAN: 61(0 -> 1), 195(0 -> 1), 215(0 -> 2), 236(2 -> 0), 317(0 -> 1), 342(0 -> 1), 379(1 -> 0), 395(1 -> 0), 515(1 -> 0).

(Passeri + *Melanopareia*):
Unambiguous: 280(0 -> 1), 286(1 -> 0), 536(1 -> 0); DELTRAN: 80(0 -> 3), 317(1 -> 0), 473(1 -> 0); ACCTRAN: 67(1 -> 0), 255(1 -> 0), 366(0 -> 1), 539(0 -> 1).

Acanthisitta chloris:
Unambiguous: 26(0 -> 1), 32(0 -> 1), 126(0 -> 1), 130(0 -> 1), 143(0 -> 1), 147(0 -> 1), 179(1 -> 0), 183(0 -> 2), 185(0 -> 1), 201(1 -> 0), 248(0 -> 1), 256(0 -> 1), 257(2 -> 0), 341(0 -> 1), 348(0 -> 1), 353(2 -> 1), 357(0 -> 1), 407(0 -> 1), 410(0 -> 1), 425(0 -> 1), 431(2 -> 1), 442(0 -> 1), 456(1 -> 0), 487(0 -> 1), 488(1 -> 0), 501(0 -> 1), 509(0 -> 1), 537(0 -> 1); DELTRAN: 33(1 -> 0), 67(0 -> 1), 150(0 -> 1), 236(0 -> 2), 255(0 -> 1), 317(1 -> 0), 366(1 -> 0), 379(0 -> 1), 403(0 -> 1), 467(0 -> 1), 515(0 -> 1), 548(0 -> 1); ACCTRAN: 337(1 -> 0).

Eupasseres
Unambiguous: 55(0 -> 1), 166(0 -> 1), 174(1 -> 0), 191(0 -> 1), 203(0 -> 1), 234(0 -> 1), 244(1 -> 2), 294(0 -> 2), 307(1 -> 2), 367(0 -> 1), 466(0 -> 3), 546(0 -> 1); DELTRAN: 467(0 -> 2); ACCTRAN: 33(0 -> 1), 80(0 -> 3), 184(2 -> 1), 214(0 -> 1), 219(0 -> 1), 403(1 -> 0), 467(1 -> 2), 473(1 -> 0), 548(1 -> 0).

Coliiformes

Unambiguous: 4(0 -> 1), 23(0 -> 1), 27(0 -> 1), 28(0 -> 1), 31(0 -> 1), 58(0 -> 1), 66(0 -> 1), 77(0 -> 1), 107(0 -> 1), 113(0 -> 1), 122(0 -> 1), 124(0 -> 1), 137(0 -> 1), 167(0 -> 1), 178(0 -> 1), 218(0 -> 1), 233(0 -> 1), 235(0 -> 1), 262(0 -> 1), 263(0 -> 1), 264(0 -> 1), 267(0 -> 1), 277(0 -> 1), 282(0 -> 1), 286(1 -> 0), 295(0 -> 1), 304(0 -> 1), 311(1 -> 0), 344(0 -> 1), 355(1 -> 0), 356(1 -> 0), 370(0 -> 1), 386(0 -> 1), 389(0 -> 1), 397(2 -> 0), 417(0 -> 1), 418(0 -> 1), 423(1 -> 0), 430(0 -> 1), 448(0 -> 1), 454(0 -> 1), 464(2 -> 1), 478(0 -> 1), 490(0 -> 1), 495(0 -> 2), 528(0 -> 2), 529(0 -> 1), 530(0 -> 2), 531(0 -> 1), 536(1 -> 0), 542(0 -> 2), 543(0 -> 1), 549(0 -> 1); DELTRAN: 33(1 -> 0), 133(0 -> 1), 259(0 -> 1), 337(0 -> 1), 403(0 -> 1), 449(0 -> 1), 548(0 -> 1); ACCTRAN: 144(0 -> 1), 157(0 -> 1), 163(0 -> 1), 287(1 -> 0), 358(1 -> 0), 379(1 -> 0), 427(1 -> 0), 467(1 -> 0), 485(0 -> 1), 486(0 -> 1), 539(0 -> 2).

Passeriformes
Unambiguous: 15(1 -> 0), 17(0 -> 1), 44(0 -> 1), 50(0 -> 1), 51(0 -> 1), 63(0 -> 1), 78(0 -> 1), 83(0 -> 1), 85(0 -> 1), 92(0 -> 1), 95(0 -> 2), 101(2 -> 0), 102(1 -> 4), 103(0 -> 1), 104(1 -> 0), 105(1 -> 0), 131(0 -> 1), 146(0 -> 1), 164(0 -> 1), 176(1 -> 0), 189(0 -> 1), 245(1 -> 0), 253(0 -> 1), 274(0 -> 1), 276(0 -> 1), 279(0 -> 1), 284(0 -> 1), 285(0 -> 1), 291(0 -> 1), 292(0 -> 1), 298(0 -> 1), 301(0 -> 1), 308(0 -> 1), 322(0 -> 1), 323(1 -> 0), 327(0 -> 2), 328(1 -> 0), 329(1 -> 2), 332(1 -> 2), 338(0 -> 1), 339(0 -> 1), 343(0 -> 1), 350(0 -> 1), 352(0 -> 1), 360(0 -> 1), 381(1 -> 0), 399(0 -> 2), 401(0 -> 1), 413(0 -> 1), 420(0 -> 1), 429(1 -> 2), 432(0 -> 1), 434(0 -> 1), 438(0 -> 1), 444(0 -> 1), 447(0 -> 1), 469(0 -> 1), 475(0 -> 1), 482(0 -> 1), 484(0 -> 1), 491(0 -> 1), 492(1 -> 0), 507(0 -> 1), 510(0 -> 1), 512(1 -> 2), 519(0 -> 1); DELTRAN: 96(0 -> 1), 97(0 -> 1), 98(0 -> 1), 144(1 -> 0), 199(1 -> 0), 228(1 -> 0), 259(0 -> 2), 287(0 -> 1), 334(1 -> 0), 351(1 -> 0), 358(0 -> 1), 427(0 -> 1), 485(1 -> 0), 486(1 -> 0); ACCTRAN: 67(0 -> 1), 150(0 -> 1), 200(2 -> 1), 255(0 -> 1), 259(1 -> 2), 317(1 -> 0), 366(1 -> 0), 449(1 -> 0), 515(0 -> 1), 525(1 -> 0), 534(1 -> 0).

Atelornis pittoides:
Unambiguous: 13(1 -> 0), 16(0 -> 1), 32(0 -> 1), 92(0 -> 1), 182(0 -> 1), 234(0 -> 1), 236(1 -> 2), 270(2 -> 0), 311(1 -> 0), 312(1 -> 0), 317(1 -> 0), 350(0 -> 1), 357(1 -> 0), 395(0 -> 1), 449(1 -> 0), 456(1 -> 0), 457(0 -> 1), 466(1 -> 2), 467(1 -> 2), 512(0 -> 2); DELTRAN: 220(0 -> 1), 244(0 -> 2), 429(1 -> 2), 441(0 -> 2), 525(1 -> 0); ACCTRAN: 73(1 -> 0), 95(1 -> 0), 115(1 -> 0), 161(1 -> 0), 200(1 -> 2), 244(1 -> 2), 429(0 -> 2).

Coracias benghalensis:
Unambiguous: 8(1 -> 0), 21(0 -> 1), 36(0 -> 1), 114(1 -> 0), 142(1 -> 0), 189(1 -> 0), 205(1 -> 0), 249(0 -> 1), 278(0 -> 1), 336(1 -> 0), 370(1 -> 0), 377(0 -> 1), 490(0 -> 1), 491(0 -> 1), 509(0 -> 1); DELTRAN: 73(0 -> 1), 95(0 -> 1), 115(0 -> 1), 116(0 -> 1), 161(0 -> 1), 200(2 -> 1), 244(0 -> 1), 271(1 -> 0), 427(0 -> 1), 429(1 -> 0), 438(0 -> 1); ACCTRAN: 220(1 -> 0), 441(2 -> 0).

Merops orientalis:
Unambiguous: 15(1 -> 0), 19(1 -> 0), 37(2 -> 0), 48(1 -> 0), 58(0 -> 1), 83(0 -> 1), 88(0 -> 1), 135(0 -> 1), 183(0 -> 1), 192(0 -> 1), 193(0 -> 1), 195(1 -> 0), 233(0 -> 1), 243(0 -> 1), 257(2 -> 1), 315(0 -> 1), 316(0 -> 1), 329(1 -> 2), 356(1 -> 0), 369(0 -> 1), 386(0 -> 1), 407(1 -> 0), 437(1 -> 0), 458(0 -> 1), 459(0 -> 1), 466(1 -> 0), 467(1 -> 0), 513(2 -> 1), 542(0 -> 1); DELTRAN: 73(0 -> 1), 95(0 -> 1), 115(0 -> 1), 161(0 -> 1), 200(2 -> 1), 220(0 -> 1), 441(0 -> 2), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0); ACCTRAN: 25(1 -> 0), 55(1 -> 0), 229(1 -> 0), 427(1 -> 0).

(*Atelornis* + *Coracias*):
Unambiguous: 23(0 -> 1), 28(0 -> 1), 39(0 -> 1), 52(0 -> 2), 53(0 -> 1), 62(0 -> 1), 68(0 -> 1), 71(3 -> 0), 104(1 -> 0), 117(1 -> 0), 121(0 -> 1), 136(1 -> 0), 147(0 -> 1), 148(0 -> 1), 163(0 -> 1), 214(0 -> 1), 259(0 -> 1), 366(1 -> 0), 401(1 -> 0), 435(1 -> 0), 479(0 -> 1), 481(0 -> 1), 488(0 -> 1), 536(1 -> 0), 549(0 -> 1); DELTRAN: 25(0 -> 1), 55(0 -> 1), 229(0 -> 1); ACCTRAN: 116(0 -> 1), 244(0 -> 1), 271(1 -> 0), 429(1 -> 0), 438(0 -> 1), 484(1 -> 0), 485(0 -> 1), 486(0 -> 1), 525(1 -> 0).

Todus mexicanus:
Unambiguous: 13(1 -> 0), 32(0 -> 1), 33(1 -> 0), 50(0 -> 1), 51(0 -> 1), 59(1 -> 0), 64(1 -> 0), 92(0 -> 1), 101(2 -> 0), 105(1 -> 0), 143(0 -> 1), 182(0 -> 1), 230(0 -> 1), 253(0 -> 1), 309(0 -> 1), 313(0 -> 1), 339(0 -> 1), 353(2 -> 1), 399(0 -> 1), 428(0 -> 1), 435(1 -> 2), 519(0 -> 1); DELTRAN: 25(0 -> 1), 55(0 -> 1), 142(1 -> 0), 229(0 -> 1), 240(0 -> 1), 397(2 -> 1), 456(1 -> 0), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0), 534(0 -> 1); ACCTRAN: 95(1 -> 0).

(*Merops* + *Atelornis* + *Coracias*):
Unambiguous: 35(0 -> 1), 102(1 -> 2), 109(0 -> 1), 150(0 -> 1), 215(0 -> 2), 217(0 -> 1), 252(2 -> 1), 341(0 -> 1), 358(1 -> 0), 363(0 -> 1), 365(0 -> 1), 440(1 -> 0), 512(1 -> 0), 524(1 -> 0); DELTRAN: 61(1 -> 0); ACCTRAN: 73(0 -> 1), 115(0 -> 1), 142(0 -> 1), 161(0 -> 1), 200(2 -> 1), 220(0 -> 1), 240(1 -> 0), 397(1 -> 2), 441(0 -> 2), 456(0 -> 1), 534(1 -> 0).

Alcedo atthis:
Unambiguous: 8(1 -> 0), 14(0 -> 1), 16(0 -> 1), 28(0 -> 1), 33(1 -> 0), 35(0 -> 1), 50(0 -> 1), 85(0 -> 1), 88(0 -> 1), 117(1 -> 2), 122(0 -> 1), 123(0 -> 1), 134(0 -> 1), 135(0 -> 1), 165(0 -> 1), 167(0 -> 1), 199(1 -> 0), 215(0 -> 1), 216(0 -> 1), 267(0 -> 1), 377(0 -> 1), 379(0 -> 1), 387(0 -> 1), 414(0 -> 1), 440(1 -> 0), 455(0 -> 2), 458(0 -> 1), 479(0 -> 1), 481(0 -> 1), 512(1 -> 0), 513(2 -> 0), 528(0 -> 1); DELTRAN: 39(0 -> 1), 126(0 -> 1), 240(0 -> 1); ACCTRAN: 55(1 -> 0), 95(1 -> 0), 112(0 -> 1), 149(1 -> 0), 189(1 -> 0).

Momotus momota:
Unambiguous: 23(0 -> 1), 32(0 -> 1), 34(0 -> 1), 52(0 -> 1), 72(0 -> 1), 82(0 -> 1), 87(0 -> 1), 92(0 -> 1), 128(0 -> 1), 143(0 -> 1), 148(0 -> 1), 163(0 -> 1), 166(0 -> 1), 185(0 -> 1), 186(0 -> 1), 197(1 -> 0), 214(0 -> 1), 242(1 -> 0), 249(0 -> 1), 270(2 -> 0), 289(0 -> 1), 302(1 -> 0), 303(0 -> 1), 311(1 -> 0), 339(0 -> 1), 347(1 -> 0), 413(0 -> 1), 429(1 -> 0), 449(1 -> 0), 453(1 -> 0), 487(0 -> 1), 507(0 -> 1); DELTRAN: 55(0 -> 1), 95(0 -> 1), 112(1 -> 0), 149(0 -> 1), 189(0 -> 1); ACCTRAN: 126(1 -> 0), 240(1 -> 0).

(*Todus* + Merops + Atelornis + Coracias):
Unambiguous: 80(0 -> 2), 125(0 -> 1), 352(0 -> 1), 357(0 -> 1), 370(0 -> 1), 546(0 -> 1); DELTRAN: 112(1 -> 0), 126(0 -> 1), 149(0 -> 1), 189(0 -> 1), 367(0 -> 1); ACCTRAN: 25(0 -> 1), 62(1 -> 0), 183(1 -> 0), 229(0 -> 1), 484(0 -> 1).

(*Momotus* + *Alcedo*):
Unambiguous: 104(1 -> 0), 121(0 -> 1), 205(1 -> 0), 218(0 -> 1), 228(1 -> 0), 257(2 -> 1), 491(0 -> 1); DELTRAN: 62(0 -> 1), 142(1 -> 0), 183(0 -> 1), 397(2 -> 1), 456(1 -> 0); ACCTRAN: 39(0 -> 1), 61(0 -> 1), 367(1 -> 0), 485(0 -> 1), 486(0 -> 1).

Indicator exilis pachyrhynchus:
Unambiguous: 22(0 -> 1), 64(1 -> 0), 98(0 -> 1), 130(0 -> 1), 142(1 -> 0), 151(0 -> 1), 229(0 -> 1), 230(0 -> 1), 350(0 -> 1), 387(0 -> 1), 409(1 -> 0), 413(0 -> 1); DELTRAN: 97(0 -> 1), 174(1 -> 0), 179(1 -> 0), 240(0 -> 1), 424(1 -> 0); ACCTRAN: 159(1 -> 0), 203(1 -> 0), 213(1 -> 0), 347(0 -> 1), 429(0 -> 1), 487(1 -> 0), 517(1 -> 0).

Picus viridis:
Unambiguous: 8(1 -> 0), 13(1 -> 0), 25(0 -> 1), 29(0 -> 1), 55(0 -> 1), 58(0 -> 1), 62(1 -> 0), 87(0 -> 1), 113(0 -> 1), 134(0 -> 1), 143(0 -> 1), 153(0 -> 1), 156(1 -> 0), 178(0 -> 1), 197(1 -> 0), 205(1 -> 0), 214(0 -> 1), 218(0 -> 1), 267(0 -> 1), 270(2 -> 0), 272(0 -> 1), 287(0 -> 1), 289(0 -> 1), 292(0 -> 1), 330(0 -> 1), 430(0 -> 1), 460(1 -> 0); DELTRAN: 159(0 -> 1), 203(0 -> 1), 213(0 -> 1), 347(1 -> 0), 429(1 -> 0), 487(0 -> 1), 517(0 -> 1), 549(0 -> 1); ACCTRAN: 97(1 -> 0), 240(1 -> 0).

Megalaima chrysopogon:

Unambiguous: 21(0 -> 1), 22(0 -> 1), 27(1 -> 0), 29(0 -> 1), 82(0 -> 1), 121(0 -> 1), 134(0 -> 1), 218(0 -> 1), 231(1 -> 0), 251(0 -> 1), 259(0 -> 1), 286(1 -> 0), 289(0 -> 1), 354(0 -> 1), 401(0 -> 1), 402(1 -> 0), 435(1 -> 2); DELTRAN: 97(0 -> 1), 221(0 -> 1), 240(0 -> 1), 549(0 -> 1); ACCTRAN: 72(1 -> 0), 191(1 -> 0), 313(1 -> 0).

Ramphastos ambiguus:
Unambiguous: 14(0 -> 1), 55(0 -> 1), 93(0 -> 1), 95(1 -> 0), 112(1 -> 0), 149(0 -> 1), 178(0 -> 1), 197(1 -> 0), 205(1 -> 0), 249(0 -> 1), 252(2 -> 0), 260(1 -> 0), 369(0 -> 1), 409(1 -> 0), 442(0 -> 1); DELTRAN: 15(1 -> 2), 71(0 -> 2), 72(0 -> 1), 159(0 -> 1), 191(0 -> 1), 313(0 -> 1); ACCTRAN: 221(1 -> 0), 240(1 -> 0), 549(1 -> 0).

(*Indicator* + *Picus*):
Unambiguous: 1(1 -> 0), 59(1 -> 0), 89(1 -> 0), 92(0 -> 1), 96(0 -> 1), 100(0 -> 1), 105(1 -> 0), 136(1 -> 0), 165(0 -> 1), 239(0 -> 1), 298(0 -> 1), 307(1 -> 2), 360(0 -> 1); DELTRAN: 72(0 -> 1), 83(0 -> 1), 191(0 -> 1), 221(0 -> 1), 313(0 -> 1); ACCTRAN: 333(1 -> 0).

(*Megalaima* + *Ramphastos*):
Unambiguous: 28(0 -> 2), 30(0 -> 1), 109(0 -> 1), 117(1 -> 0), 152(0 -> 1), 228(1 -> 0), 283(0 -> 1), 293(1 -> 0), 395(0 -> 1), 408(1 -> 0), 537(0 -> 1); DELTRAN: 104(1 -> 0), 203(0 -> 1), 213(0 -> 1), 333(0 -> 1), 347(1 -> 0), 429(1 -> 0), 487(0 -> 1), 517(0 -> 1); ACCTRAN: 15(1 -> 2), 83(1 -> 0), 174(0 -> 1), 179(0 -> 1), 424(0 -> 1).

S3.5 Character optimisation for Analysis 2

Cathartes burrovianus:
Unambiguous: 37(0 -> 1), 65(0 -> 1), 74(0 -> 1), 82(0 -> 1), 91(0 -> 1), 148(0 -> 1), 152(2 -> 1), 172(0 -> 1), 184(1 -> 2), 198(0 -> 1), 290(0 -> 1), 310(0 -> 1), 314(0 -> 1), 325(0 -> 1), 388(1 -> 0), 404(1 -> 0), 407(0 -> 1), 487(1 -> 0), 491(0 -> 1), 542(0 -> 1); DELTRAN: 1(1 -> 0), 186(0 -> 1); ACCTRAN: 112(0 -> 1).

Vultur gryphus:
Unambiguous: 62(0 -> 1), 117(1 -> 0), 130(0 -> 1), 137(0 -> 1), 147(0 -> 1), 150(0 -> 1), 392(0 -> 1), 522(0 -> 1), 529(1 -> 0); DELTRAN: 112(1 -> 0); ACCTRAN: 1(0 -> 1).

Horusornis vianeyliaudae:
Unambiguous: 222(0 -> 1), 248(0 -> 1), 252(1 -> 0), 266(0 -> 1), 270(1 -> 0), 272(0 -> 1), 329(0 -> 1), 334(1 -> 0), 335(0 -> 1), 361(1 -> 0), 436(0 -> 1), 492(0 -> 1), 500(0 -> 1), 518(1 -> 0), 542(2 -> 1); DELTRAN: 434(0 -> 1); ACCTRAN: 223(1 -> 0), 491(1 -> 0).

Pandion haliaetus carolinensis:
Unambiguous: 238(1 -> 0), 254(0 -> 1), 264(1 -> 0), 276(0 -> 1), 435(1 -> 2), 452(0 -> 2), 456(0 -> 1), 473(1 -> 0), 476(1 -> 2), 485(1 -> 2), 488(1 -> 0), 495(1 -> 2), 547(1 -> 0), 548(1 -> 0); DELTRAN: 32(1 -> 0), 35(2 -> 1), 36(1 -> 0), 38(1 -> 0), 61(0 -> 1), 62(0 -> 1), 71(0 -> 1), 73(0 -> 1), 74(0 -> 1), 89(0 -> 1), 101(0 -> 2), 109(0 -> 1), 112(0 -> 1), 115(1 -> 0), 155(0 -> 1), 162(1 -> 0), 174(0 -> 1), 198(0 -> 1), 209(2 -> 0), 223(0 -> 1), 392(0 -> 1), 397(0 -> 1), 398(0 -> 1), 404(1 -> 0), 408(1 -> 2), 464(1 -> 2), 465(1 -> 2), 491(0 -> 1), 513(2 -> 1); ACCTRAN.

Accipiter nisus:
Unambiguous: 182(0 -> 1), 190(0 -> 1), 248(0 -> 1), 289(0 -> 1), 306(1 -> 0), 313(0 -> 1), 336(0 -> 1), 527(1 -> 2), 538(0 -> 1); DELTRAN: 117(1 -> 2), 228(0 -> 1), 347(0 -> 1); ACCTRAN: 127(1 -> 0), 129(1 -> 0), 377(0 -> 1).

Buteo rufofuscus:

Unambiguous: 120(0 -> 1), 181(1 -> 0), 249(0 -> 1), 266(0 -> 1), 280(0 -> 1), 283(1 -> 2), 311(0 -> 1), 355(0 -> 1), 364(0 -> 1), 406(1 -> 0); DELTRAN: 127(0 -> 1), 129(0 -> 1), 377(1 -> 0); ACCTRAN: 117(2 -> 1), 228(1 -> 0), 347(1 -> 0).

Palaeoplancus sternbergi:
Unambiguous: 151(1 -> 0), 246(0 -> 1), 284(0 -> 1), 287(0 -> 1), 334(1 -> 0), 361(1 -> 0), 376(1 -> 0), 473(1 -> 0); DELTRAN: 347(0 -> 1), 377(1 -> 0); ACCTRAN.

(*Buteo* + *Accipiter*):
Unambiguous: 9(0 -> 1), 142(0 -> 1), 269(0 -> 1), 286(0 -> 1), 302(0 -> 1), 307(0 -> 1), 314(0 -> 1), 494(0 -> 1); DELTRAN: 23(0 -> 1), 71(0 -> 1), 149(0 -> 1), 150(0 -> 1), 172(1 -> 0), 203(1 -> 2), 206(0 -> 1), 257(1 -> 2), 321(0 -> 1), 388(0 -> 1), 441(0 -> 1), 442(0 -> 1), 512(0 -> 2), 521(1 -> 2), 530(2 -> 1); ACCTRAN.

Elanus caeruleus:
Unambiguous: 54(0 -> 1), 105(1 -> 0), 145(0 -> 1), 152(1 -> 0), 188(1 -> 0), 364(0 -> 1), 435(1 -> 2), 455(0 -> 1), 490(0 -> 1); DELTRAN: 32(1 -> 0), 117(1 -> 2), 127(0 -> 1), 129(0 -> 1), 228(0 -> 1), 404(1 -> 0), 491(0 -> 2); ACCTRAN: 71(1 -> 0), 491(1 -> 2).

(†*Palaeoplancus* + *Buteo* + *Accipiter*):
Unambiguous: 283(0 -> 1); DELTRAN: 491(0 -> 1); ACCTRAN: 23(0 -> 1), 32(0 -> 1), 149(0 -> 1), 150(0 -> 1), 172(1 -> 0), 203(1 -> 2), 206(0 -> 1), 257(1 -> 2), 321(0 -> 1), 347(0 -> 1), 377(1 -> 0), 388(0 -> 1), 404(0 -> 1), 441(0 -> 1), 442(0 -> 1), 512(0 -> 2), 521(1 -> 2), 530(2 -> 1).

(Pandionidae + †*Horusornis*):
Unambiguous: 218(0 -> 1), 370(1 -> 0), 477(0 -> 1), 481(0 -> 1), 486(1 -> 2); DELTRAN: 226(0 -> 1); ACCTRAN: 35(2 -> 1), 36(1 -> 0), 38(1 -> 0), 61(0 -> 1), 68(1 -> 0), 73(0 -> 1), 74(0 -> 1), 89(0 -> 1), 101(0 -> 2), 109(0 -> 1), 112(0 -> 1), 115(1 -> 0), 129(1 -> 0), 162(1 -> 0), 174(0 -> 1), 198(0 -> 1), 209(2 -> 0), 250(1 -> 0), 392(0 -> 1), 397(0 -> 1), 398(0 -> 1), 408(1 -> 2), 414(1 -> 0), 434(0 -> 1), 464(1 -> 2), 465(1 -> 2), 474(2 -> 1), 513(2 -> 1).

(*Elanus* + †*Palaeoplancus* + *Buteo* + *Accipiter*):
Unambiguous: 39(0 -> 1), 75(2 -> 1), 104(0 -> 1), 126(0 -> 1), 130(0 -> 1), 211(0 -> 1), 236(0 -> 1), 323(0 -> 1), 325(0 -> 1), 409(0 -> 1), 413(1 -> 2), 445(0 -> 1); DELTRAN: 68(0 -> 1), 223(0 -> 1), 250(0 -> 1), 393(1 -> 0), 414(0 -> 1), 474(1 -> 2); ACCTRAN: 62(1 -> 0), 117(1 -> 2), 127(0 -> 1), 155(1 -> 0), 226(1 -> 0), 228(0 -> 1).

Caracara cheriway:
Unambiguous: 73(0 -> 1), 108(1 -> 0), 155(1 -> 0), 161(0 -> 1), 247(0 -> 1), 259(1 -> 0), 277(0 -> 1), 311(0 -> 1), 329(1 -> 0), 356(1 -> 0), 391(1 -> 0), 404(1 -> 0), 406(1 -> 0), 491(0 -> 1); DELTRAN; ACCTRAN: 460(2 -> 1).

Daptrius ater:
Unambiguous: 45(0 -> 1), 441(1 -> 0), 470(1 -> 0), 483(1 -> 0); DELTRAN: 70(0 -> 2), 175(0 -> 1), 460(1 -> 2), 527(1 -> 0), 530(2 -> 1); ACCTRAN.

Falco sparverius:
Unambiguous: 3(0 -> 1), 52(1 -> 0), 104(0 -> 1), 160(0 -> 1), 225(0 -> 1), 509(0 -> 1); DELTRAN: 71(0 -> 2), 245(2 -> 1), 269(0 -> 1), 302(0 -> 1), 354(0 -> 1), 443(0 -> 1), 456(0 -> 1), 460(1 -> 2); ACCTRAN: 62(1 -> 0), 220(1 -> 0).

(*Daptrius* + *Caracara*):
Unambiguous: 9(0 -> 1), 32(1 -> 0), 117(1 -> 0), 156(0 -> 1), 186(1 -> 0), 198(0 -> 2), 258(0 -> 1), 305(0 -> 1); DELTRAN: 62(0 -> 1), 220(0 -> 1); ACCTRAN: 70(0 -> 2), 71(2 -> 0), 175(0 -> 1),

245(1 -> 2), 269(1 -> 0), 302(1 -> 0), 354(1 -> 0), 443(1 -> 0), 456(1 -> 0), 527(1 -> 0), 530(2 -> 1).

Micrastur ruficollis concentricus:
Unambiguous: 45(0 -> 1), 47(0 -> 1), 60(0 -> 1), 72(0 -> 1), 75(2 -> 1), 114(0 -> 1), 115(1 -> 0), 126(0 -> 1), 131(0 -> 1), 174(0 -> 1), 229(0 -> 1), 247(0 -> 1), 287(0 -> 1), 317(1 -> 0), 325(0 -> 1), 336(0 -> 1), 346(0 -> 1), 348(0 -> 1), 361(1 -> 0), 367(0 -> 1), 408(1 -> 0), 424(0 -> 1), 458(0 -> 1), 490(0 -> 1), 491(0 -> 2), 512(1 -> 2), 515(0 -> 1), 517(0 -> 1); DELTRAN: 62(0 -> 1), 134(0 -> 2), 220(0 -> 1), 245(2 -> 1), 269(0 -> 1), 302(0 -> 1), 354(0 -> 1), 443(0 -> 1), 456(0 -> 1), 474(1 -> 2); ACCTRAN: 134(1 -> 2).

(Falconinae + Polyborinae):
Unambiguous: 20(0 -> 1), 22(0 -> 1), 24(0 -> 1), 109(0 -> 1), 145(0 -> 1), 168(0 -> 1), 192(0 -> 1), 202(0 -> 1), 206(0 -> 1), 283(0 -> 2), 294(0 -> 2), 413(1 -> 2), 492(0 -> 1); DELTRAN: 134(0 -> 1); ACCTRAN: 460(1 -> 2), 474(2 -> 1).

(Pandionidae + †*Horusornis* + *Elanus* + †*Palaeoplancus* + *Buteo* + *Accipiter*):
Unambiguous: 5(1 -> 0), 25(0 -> 1), 58(1 -> 0), 102(1 -> 0), 177(0 -> 1), 244(0 -> 1), 258(0 -> 1), 306(0 -> 1), 460(1 -> 0), 526(0 -> 1); DELTRAN: 33(1 -> 0), 371(0 -> 1), 472(1 -> 0), 512(1 -> 0); ACCTRAN: 23(1 -> 0), 39(2 -> 0), 71(2 -> 1), 132(1 -> 0), 134(1 -> 0), 215(2 -> 1), 223(0 -> 1), 224(1 -> 0), 245(1 -> 2), 393(1 -> 0), 404(1 -> 0), 456(1 -> 0), 469(1 -> 0), 491(0 -> 1).

Falconiformes:
Unambiguous: 12(0 -> 1), 37(0 -> 1), 55(0 -> 1), 91(0 -> 1), 96(0 -> 1), 108(0 -> 1), 111(0 -> 1), 112(0 -> 2), 120(0 -> 1), 142(0 -> 1), 209(2 -> 1), 217(0 -> 1), 248(0 -> 1), 249(0 -> 1), 255(0 -> 1), 257(1 -> 2), 266(0 -> 1), 297(0 -> 1), 315(0 -> 1), 321(0 -> 1), 329(0 -> 1), 341(0 -> 1), 355(0 -> 1), 356(0 -> 1), 388(0 -> 1), 419(0 -> 1), 421(0 -> 1), 427(0 -> 1), 439(0 -> 1), 441(0 -> 1), 442(0 -> 1), 447(0 -> 1), 468(0 -> 1), 470(0 -> 1), 483(0 -> 1), 494(0 -> 1); DELTRAN: 23(0 -> 1), 39(0 -> 2), 68(0 -> 1), 129(0 -> 1), 132(0 -> 1), 155(0 -> 1), 215(1 -> 2), 224(0 -> 1), 226(0 -> 1), 250(0 -> 1), 414(0 -> 1), 469(0 -> 1); ACCTRAN: 32(0 -> 1), 33(0 -> 1), 220(0 -> 1), 269(0 -> 1), 302(0 -> 1), 354(0 -> 1), 371(1 -> 0), 443(0 -> 1), 472(0 -> 1), 512(0 -> 1).

Strix aluco:
Unambiguous: 49(0 -> 2), 95(2 -> 0), 142(0 -> 1), 198(0 -> 2), 200(1 -> 2), 214(0 -> 1), 218(0 -> 1), 243(0 -> 1), 249(0 -> 1), 250(0 -> 1), 303(0 -> 1), 311(0 -> 1), 313(0 -> 1), 373(0 -> 1), 380(0 -> 1), 413(1 -> 2), 424(0 -> 1), 429(0 -> 1), 448(0 -> 1), 449(0 -> 1); DELTRAN: 184(1 -> 2), 189(0 -> 1), 270(1 -> 0), 474(1 -> 2), 534(0 -> 1); ACCTRAN: 48(1 -> 0), 217(1 -> 0), 224(1 -> 0).

Tyto alba:
Unambiguous: 36(1 -> 0), 82(0 -> 1), 87(1 -> 0), 88(0 -> 1), 121(0 -> 1), 161(0 -> 1), 188(1 -> 0), 196(1 -> 0), 203(1 -> 0), 206(0 -> 1), 209(2 -> 1), 236(0 -> 1), 255(0 -> 1), 265(0 -> 1), 302(0 -> 1), 324(0 -> 1), 355(0 -> 1), 357(0 -> 1), 377(0 -> 1), 378(0 -> 1), 395(1 -> 0), 404(1 -> 0), 435(1 -> 2), 447(0 -> 1), 527(1 -> 2); DELTRAN: 48(0 -> 1), 217(0 -> 1), 224(0 -> 1), 270(1 -> 2), 434(0 -> 1); ACCTRAN: 184(2 -> 1), 270(0 -> 2), 474(2 -> 1), 534(1 -> 0).

†Ypresiglaux michaeldanielsi:
Unambiguous: 35(2 -> 1), 115(1 -> 0), 123(0 -> 1), 126(0 -> 1), 162(1 -> 0), 164(0 -> 1), 166(0 -> 1), 199(1 -> 0), 219(0 -> 1), 220(0 -> 1), 222(0 -> 1), 230(0 -> 1), 232(0 -> 1), 242(0 -> 1), 247(0 -> 1), 252(1 -> 2), 284(0 -> 1), 358(0 -> 1), 361(1 -> 0), 460(1 -> 0), 481(0 -> 1), 485(1 -> 2), 487(0 -> 1), 504(0 -> 1); DELTRAN: 169(0 -> 1), 184(1 -> 2), 217(0 -> 1), 224(0 -> 1), 245(2 -> 1), 474(1 -> 2), 490(0 -> 1); ACCTRAN: 215(2 -> 1), 433(1 -> 0), 434(1 -> 0).

Strigiformes:

Unambiguous: 37(0 -> 2), 112(0 -> 1), 119(0 -> 1), 147(0 -> 1), 160(0 -> 1), 165(0 -> 1), 201(0 -> 1), 244(0 -> 1), 264(0 -> 1), 331(0 -> 1), 341(0 -> 1), 452(0 -> 2), 453(0 -> 1), 455(0 -> 1), 468(0 -> 1), 492(0 -> 1), 496(0 -> 1), 521(1 -> 0); DELTRAN: 8(0 -> 1), 13(0 -> 1), 17(0 -> 1), 23(0 -> 1), 27(0 -> 1), 32(1 -> 0), 33(1 -> 0), 39(0 -> 2), 46(0 -> 1), 52(1 -> 2), 54(0 -> 1), 60(0 -> 1), 69(0 -> 1), 70(0 -> 2), 71(0 -> 2), 75(2 -> 0), 76(0 -> 1), 81(0 -> 1), 89(0 -> 1), 104(0 -> 1), 132(0 -> 1), 133(0 -> 1), 134(0 -> 1), 183(0 -> 2), 215(1 -> 2), 260(0 -> 1), 276(0 -> 1), 283(0 -> 1), 299(0 -> 1), 305(0 -> 1), 327(1 -> 0), 346(0 -> 1), 365(0 -> 1), 371(0 -> 1), 381(0 -> 1), 390(0 -> 1), 396(0 -> 1), 402(2 -> 1), 405(0 -> 1), 433(0 -> 1), 469(0 -> 1), 512(1 -> 0), 525(0 -> 1), 535(0 -> 1); ACCTRAN: 169(1 -> 0), 189(0 -> 1), 245(1 -> 2), 490(1 -> 0).

†Primoptynx poliotauros:
Unambiguous: 218(0 -> 1), 266(0 -> 1), 311(0 -> 1), 348(0 -> 1), 421(0 -> 1), 470(0 -> 1), 473(2 -> 0), 485(1 -> 0), 488(1 -> 0), 493(1 -> 0); DELTRAN: 169(0 -> 1), 214(0 -> 1), 433(0 -> 1), 434(0 -> 1), 474(1 -> 0), 490(0 -> 1), 534(0 -> 1); ACCTRAN: 224(1 -> 0), 226(1 -> 0), 471(1 -> 0), 474(2 -> 0).

(†*Ypresiglaux* + Strigiformes):
Unambiguous: 286(0 -> 1), 289(0 -> 1), 476(1 -> 2); DELTRAN: 226(0 -> 1), 228(0 -> 1), 229(0 -> 1), 456(0 -> 1), 471(0 -> 1), 472(1 -> 0), 477(0 -> 1), 486(1 -> 2), 495(1 -> 2); ACCTRAN: 214(1 -> 0), 217(0 -> 1), 270(1 -> 0), 276(0 -> 1), 299(0 -> 1), 365(0 -> 1), 535(0 -> 1).

(Falconiformes + †*Horusornis* + †*Palaeoplancus* + Accipitridae):
Unambiguous: 101(1 -> 0), 116(0 -> 1), 152(0 -> 1), 181(0 -> 1), 186(0 -> 1), 243(0 -> 1), 264(0 -> 1), 347(1 -> 0), 377(0 -> 1), 406(0 -> 1), 473(2 -> 1), 518(0 -> 1), 547(0 -> 1); DELTRAN: 48(0 -> 1), 105(0 -> 1), 180(0 -> 1), 214(0 -> 1), 259(0 -> 1), 471(0 -> 1); ACCTRAN: 62(0 -> 1), 68(0 -> 1), 129(0 -> 1), 133(1 -> 0), 155(0 -> 1), 184(2 -> 1), 228(1 -> 0), 250(0 -> 1), 283(1 -> 0), 402(1 -> 2), 414(0 -> 1), 534(1 -> 0).

(Strigiformes + †*Ypresiglaux* + *†Primoptynx*):
Unambiguous: 272(0 -> 1), 436(0 -> 1), 440(0 -> 1), 539(1 -> 2), 544(0 -> 1); DELTRAN; ACCTRAN: 8(0 -> 1), 13(0 -> 1), 17(0 -> 1), 27(0 -> 1), 46(0 -> 1), 52(1 -> 2), 54(0 -> 1), 60(0 -> 1), 69(0 -> 1), 70(0 -> 2), 75(2 -> 0), 76(0 -> 1), 81(0 -> 1), 89(0 -> 1), 104(0 -> 1), 105(1 -> 0), 169(0 -> 1), 180(1 -> 0), 183(0 -> 2), 229(0 -> 1), 259(1 -> 0), 260(0 -> 1), 305(0 -> 1), 327(1 -> 0), 346(0 -> 1), 381(0 -> 1), 390(0 -> 1), 396(0 -> 1), 405(0 -> 1), 433(0 -> 1), 434(0 -> 1), 477(0 -> 1), 486(1 -> 2), 490(0 -> 1), 495(1 -> 2), 525(0 -> 1).

Colius striatus kiwuensis:
Unambiguous: 80(0 -> 2), 101(2 -> 1), 109(0 -> 1), 132(0 -> 1), 151(0 -> 1), 334(1 -> 0); DELTRAN: 61(1 -> 0), 157(0 -> 1), 163(0 -> 1), 165(0 -> 1), 228(1 -> 0), 244(0 -> 1), 281(1 -> 0), 365(0 -> 1), 525(0 -> 1), 539(0 -> 2); ACCTRAN.

Urocolius macrourus pulcher:
Unambiguous: 34(0 -> 1), 191(0 -> 1), 199(1 -> 0), 247(0 -> 1); DELTRAN: 244(0 -> 2); ACCTRAN: 228(0 -> 1), 244(1 -> 2), 281(0 -> 1), 365(1 -> 0).

Masillacolius brevidactylus:
Unambiguous: 250(1 -> 0), 280(0 -> 1), 341(0 -> 1), 354(0 -> 1), 488(1 -> 0), 501(0 -> 2), 514(0 -> 1); DELTRAN: 15(1 -> 0), 228(1 -> 0), 281(1 -> 0), 521(0 -> 1); ACCTRAN: 4(1 -> 0), 259(1 -> 0), 453(1 -> 0), 490(1 -> 0).

Coliiformes:
Unambiguous: 1(1 -> 0), 113(0 -> 1), 134(0 -> 1), 218(0 -> 1), 233(0 -> 1), 251(0 -> 1), 336(0 -> 1), 452(0 -> 2), 454(0 -> 1), 472(0 -> 1), 543(0 -> 1); DELTRAN: 4(0 -> 1), 23(0 -> 1), 25(0 -> 1), 27(0 -> 1), 32(1 -> 0), 77(0 -> 1), 105(0 -> 1), 107(0 -> 1), 114(0 -> 1), 122(0 -> 1), 124(0 -> 1),

133(0 -> 1), 142(0 -> 1), 167(0 -> 1), 176(0 -> 1), 178(0 -> 1), 205(0 -> 1), 242(0 -> 1), 259(0 -> 1), 262(0 -> 1), 263(0 -> 1), 264(0 -> 1), 267(0 -> 1), 271(0 -> 1), 277(0 -> 1), 282(0 -> 1), 295(0 -> 1), 305(0 -> 1), 371(0 -> 1), 381(0 -> 1), 386(0 -> 1), 389(0 -> 1), 395(0 -> 1), 397(1 -> 0), 403(0 -> 1), 413(1 -> 0), 417(0 -> 1), 428(0 -> 1), 440(0 -> 1), 448(0 -> 1), 453(0 -> 1), 464(2 -> 1), 476(1 -> 0), 490(0 -> 1), 493(1 -> 0); ACCTRAN: 15(0 -> 1), 244(0 -> 1), 521(1 -> 0), 539(0 -> 2).

Eoglaucidium cf pallas:
Unambiguous: 55(0 -> 1), 201(1 -> 0), 225(1 -> 0), 254(0 -> 1), 257(2 -> 1), 266(1 -> 0), 307(1 -> 0), 347(1 -> 0), 465(2 -> 1), 474(0 -> 1), 491(0 -> 1), 503(0 -> 1), 515(0 -> 1); DELTRAN: 4(0 -> 1), 15(1 -> 0), 259(0 -> 1), 453(0 -> 1), 490(0 -> 1), 521(0 -> 1); ACCTRAN: 114(1 -> 0), 176(1 -> 0), 260(1 -> 0), 371(1 -> 0), 381(1 -> 0).

(†*Masillcolius* + Coliiformes)
Unambiguous: 137(0 -> 1), 269(0 -> 1), 278(0 -> 1), 331(0 -> 1), 487(1 -> 0); DELTRAN: 260(0 -> 1), 332(0 -> 1); ACCTRAN: 25(0 -> 1), 32(1 -> 0), 107(0 -> 1), 142(0 -> 1), 167(0 -> 1), 205(0 -> 1), 228(1 -> 0), 242(0 -> 1), 263(0 -> 1), 277(0 -> 1), 281(1 -> 0), 282(0 -> 1), 395(0 -> 1), 464(2 -> 1), 493(1 -> 0).

Apaloderma narina:
Unambiguous: 45(0 -> 1), 162(1 -> 0), 181(0 -> 1), 182(0 -> 1), 231(0 -> 1), 257(2 -> 1), 283(1 -> 2), 339(0 -> 1), 434(0 -> 1), 465(2 -> 1); DELTRAN: 215(1 -> 2), 429(1 -> 0); ACCTRAN: 183(1 -> 0), 286(1 -> 0), 303(1 -> 0), 512(0 -> 1).

Trogon melanurus eumorphus:
Unambiguous: 191(0 -> 1), 230(0 -> 1), 251(0 -> 1), 302(1 -> 0), 414(0 -> 1), 426(0 -> 1), 427(0 -> 1), 447(0 -> 1), 452(0 -> 1); DELTRAN: 61(1 -> 0), 183(0 -> 1), 286(0 -> 1), 303(0 -> 1), 512(1 -> 0), 538(0 -> 1); ACCTRAN: 215(2 -> 1), 429(0 -> 1).

Eotrogon stenorhynchus:
Unambiguous: 109(0 -> 1), 219(0 -> 1), 222(0 -> 1), 226(1 -> 0), 248(0 -> 1), 264(0 -> 1), 307(1 -> 0), 366(1 -> 0), 441(2 -> 1); DELTRAN: 215(1 -> 2), 303(0 -> 1), 379(0 -> 1), 429(1 -> 0), 456(1 -> 0), 512(1 -> 0); ACCTRAN: 114(1 -> 0), 260(1 -> 0).

Trogoniformes:
Unambiguous: 4(0 -> 1), 5(1 -> 0), 14(0 -> 1), 19(0 -> 1), 80(0 -> 1), 128(0 -> 1), 151(0 -> 1), 214(0 -> 1), 250(1 -> 0), 256(0 -> 1), 259(0 -> 1), 304(0 -> 1), 357(0 -> 1), 373(0 -> 1), 438(0 -> 1), 455(0 -> 2), 462(0 -> 1), 470(1 -> 2), 473(1 -> 0), 488(1 -> 0), 507(0 -> 1); DELTRAN: 1(1 -> 0), 8(0 -> 1), 28(1 -> 2), 33(1 -> 0), 47(1 -> 0), 48(2 -> 0), 49(1 -> 2), 55(0 -> 2), 56(0 -> 1), 70(0 -> 2), 71(0 -> 3), 72(0 -> 1), 75(2 -> 0), 76(0 -> 1), 77(0 -> 1), 82(0 -> 1), 88(0 -> 1), 95(0 -> 1), 101(2 -> 0), 102(1 -> 3), 114(0 -> 1), 117(1 -> 0), 131(0 -> 1), 134(0 -> 1), 146(0 -> 1), 148(0 -> 1), 173(0 -> 1), 185(0 -> 1), 186(0 -> 1), 260(0 -> 1), 298(0 -> 1), 324(0 -> 1), 365(0 -> 1), 367(0 -> 1), 387(0 -> 1), 389(0 -> 1), 399(0 -> 1), 408(1 -> 2), 409(1 -> 0), 467(0 -> 2), 536(0 -> 1); ACCTRAN: 379(1 -> 0), 456(0 -> 1).

Tockus nasutus:
Unambiguous: 4(0 -> 1), 15(1 -> 2), 27(0 -> 1), 47(1 -> 0), 49(1 -> 0), 52(0 -> 1), 55(0 -> 1), 56(0 -> 1), 62(1 -> 0), 73(0 -> 1), 83(0 -> 1), 109(0 -> 1), 146(0 -> 1), 149(0 -> 1), 158(0 -> 1), 194(0 -> 1), 195(1 -> 0), 197(1 -> 0), 249(0 -> 1), 257(2 -> 1), 306(0 -> 1), 307(1 -> 0), 308(0 -> 1), 347(1 -> 0), 397(1 -> 2), 458(0 -> 1), 484(0 -> 1), 543(0 -> 1); DELTRAN: 31(1 -> 0), 452(0 -> 1), 485(1 -> 0); ACCTRAN: 25(1 -> 0), 159(1 -> 0), 206(1 -> 0), 236(1 -> 0), 335(1 -> 0), 338(1 -> 0), 339(1 -> 0), 348(1 -> 0), 467(1 -> 0).

Upupa marginata:

Unambiguous: 20(0 -> 1), 21(0 -> 1), 22(0 -> 1), 32(1 -> 0), 80(0 -> 1), 82(0 -> 1), 85(0 -> 1), 117(1 -> 0), 122(0 -> 1), 123(0 -> 1), 124(0 -> 1), 130(0 -> 1), 147(0 -> 1), 172(1 -> 0), 182(0 -> 2), 215(1 -> 2), 259(0 -> 1), 266(1 -> 0), 270(2 -> 0), 288(0 -> 1), 289(0 -> 1), 296(0 -> 1), 301(0 -> 1), 337(0 -> 1), 358(0 -> 1), 375(0 -> 1), 378(0 -> 1), 386(0 -> 1), 414(0 -> 1), 426(0 -> 1), 441(2 -> 1), 453(0 -> 1), 466(0 -> 1), 490(0 -> 1), 491(0 -> 2); DELTRAN: 25(0 -> 1), 159(0 -> 1), 206(0 -> 1), 236(0 -> 1), 335(0 -> 1), 338(0 -> 1), 339(0 -> 1), 348(0 -> 1), 438(0 -> 1), 452(0 -> 2), 467(0 -> 1), 537(0 -> 1); ACCTRAN: 31(0 -> 1), 452(1 -> 2), 485(0 -> 1).

†Messelirrisor halcyrostris:
Unambiguous: 156(1 -> 0), 162(1 -> 0), 354(0 -> 1), 371(1 -> 0), 400(1 -> 0), 431(0 -> 1), 461(0 -> 1), 488(1 -> 0), 507(0 -> 1), 513(2 -> 1); DELTRAN: 25(0 -> 1), 159(0 -> 1), 179(1 -> 0), 331(0 -> 1), 332(0 -> 1), 335(0 -> 1), 338(0 -> 1), 339(0 -> 1), 348(0 -> 1), 456(1 -> 0); ACCTRAN: 136(1 -> 0), 336(1 -> 0), 493(0 -> 1), 536(1 -> 0).

Bucerotiformes:
Unambiguous: 34(0 -> 1), 163(0 -> 1), 184(2 -> 1), 192(0 -> 1), 216(0 -> 1), 269(0 -> 1), 350(0 -> 1), 373(0 -> 1), 374(0 -> 1), 377(0 -> 1), 460(1 -> 2); DELTRAN: 14(0 -> 1), 30(0 -> 1), 93(0 -> 1), 102(1 -> 2), 115(0 -> 1), 136(0 -> 1), 139(0 -> 1), 142(0 -> 1), 152(0 -> 2), 166(0 -> 1), 193(0 -> 1), 209(2 -> 0), 217(0 -> 1), 237(0 -> 1), 250(1 -> 0), 252(2 -> 1), 284(0 -> 1), 285(0 -> 1), 287(0 -> 1), 313(0 -> 1), 329(1 -> 2), 336(0 -> 1), 345(0 -> 1), 352(0 -> 1), 365(0 -> 1), 399(0 -> 1), 403(0 -> 1), 429(1 -> 0), 486(1 -> 0), 493(1 -> 0), 536(0 -> 1); ACCTRAN: 179(0 -> 1), 331(1 -> 0), 332(1 -> 0), 452(0 -> 1), 456(0 -> 1).

Atelornis pittoides:
Unambiguous: 13(1 -> 0), 16(0 -> 1), 92(0 -> 1), 182(0 -> 1), 234(0 -> 1), 236(1 -> 2), 270(2 -> 0), 311(1 -> 0), 312(1 -> 0), 317(1 -> 0), 350(0 -> 1), 357(1 -> 0), 395(0 -> 1), 449(1 -> 0), 456(1 -> 0), 457(0 -> 1), 466(1 -> 2), 467(1 -> 2), 512(0 -> 2); DELTRAN: 142(0 -> 1), 220(0 -> 1), 244(0 -> 2), 429(1 -> 2), 441(0 -> 2), 525(1 -> 0), 534(1 -> 0); ACCTRAN: 32(0 -> 1), 73(1 -> 0), 95(1 -> 0), 115(1 -> 0), 161(1 -> 0), 200(1 -> 2), 244(1 -> 2), 429(0 -> 2).

Coracias benghalensis:
Unambiguous: 8(1 -> 0), 21(0 -> 1), 36(0 -> 1), 114(1 -> 0), 189(1 -> 0), 205(1 -> 0), 249(0 -> 1), 278(0 -> 1), 336(1 -> 0), 370(1 -> 0), 377(0 -> 1), 490(0 -> 1), 491(0 -> 1), 509(0 -> 1); DELTRAN: 32(1 -> 0), 73(0 -> 1), 95(0 -> 1), 115(0 -> 1), 116(0 -> 1), 161(0 -> 1), 200(2 -> 1), 244(0 -> 1), 271(1 -> 0), 427(0 -> 1), 429(1 -> 0), 438(0 -> 1); ACCTRAN: 142(1 -> 0), 220(1 -> 0), 441(2 -> 0).

Merops orientalis:
Unambiguous: 15(1 -> 0), 19(1 -> 0), 37(2 -> 0), 48(1 -> 0), 58(0 -> 1), 83(0 -> 1), 88(0 -> 1), 135(0 -> 1), 192(0 -> 1), 193(0 -> 1), 195(1 -> 0), 229(1 -> 0), 233(0 -> 1), 243(0 -> 1), 257(2 -> 1), 315(0 -> 1), 316(0 -> 1), 329(1 -> 2), 356(1 -> 0), 369(0 -> 1), 386(0 -> 1), 407(1 -> 0), 437(1 -> 0), 458(0 -> 1), 459(0 -> 1), 466(1 -> 0), 467(1 -> 0), 513(2 -> 1), 542(0 -> 1); DELTRAN: 32(1 -> 0), 62(1 -> 0), 73(0 -> 1), 95(0 -> 1), 115(0 -> 1), 142(0 -> 1), 161(0 -> 1), 200(2 -> 1), 220(0 -> 1), 441(0 -> 2), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0); ACCTRAN: 25(1 -> 0), 55(1 -> 0), 183(0 -> 1), 427(1 -> 0).

(Brachypteraciidae + Coraciidae):
Unambiguous: 23(0 -> 1), 28(0 -> 1), 39(0 -> 1), 52(0 -> 2), 53(0 -> 1), 68(0 -> 1), 71(3 -> 0), 104(1 -> 0), 117(1 -> 0), 121(0 -> 1), 136(1 -> 0), 147(0 -> 1), 148(0 -> 1), 163(0 -> 1), 214(0 -> 1), 259(0 -> 1), 366(1 -> 0), 401(1 -> 0), 435(1 -> 0), 479(0 -> 1), 481(0 -> 1), 488(0 -> 1), 536(1 -> 0), 549(0 -> 1); DELTRAN: 25(0 -> 1), 55(0 -> 1), 183(1 -> 0); ACCTRAN: 62(0 -> 1), 116(0 -> 1), 244(0 -> 1), 271(1 -> 0), 429(1 -> 0), 438(0 -> 1), 484(1 -> 0), 485(0 -> 1), 486(0 -> 1), 525(1 -> 0).

Todus mexicanus:
Unambiguous: 13(1 -> 0), 33(1 -> 0), 50(0 -> 1), 51(0 -> 1), 59(1 -> 0), 64(1 -> 0), 92(0 -> 1), 101(2 -> 0), 105(1 -> 0), 143(0 -> 1), 182(0 -> 1), 230(0 -> 1), 253(0 -> 1), 309(0 -> 1), 313(0 -> 1), 339(0 -> 1), 353(2 -> 1), 399(0 -> 1), 428(0 -> 1), 435(1 -> 2), 519(0 -> 1); DELTRAN: 25(0 -> 1), 55(0 -> 1), 62(1 -> 0), 183(1 -> 0), 240(0 -> 1), 440(0 -> 1), 456(1 -> 0), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0); ACCTRAN: 32(0 -> 1), 95(1 -> 0).

(Meropidae + Brachypteraciidae + Coraciidae):
Unambiguous: 35(0 -> 1), 102(1 -> 2), 109(0 -> 1), 150(0 -> 1), 215(0 -> 2), 217(0 -> 1), 252(2 -> 1), 341(0 -> 1), 358(1 -> 0), 363(0 -> 1), 365(0 -> 1), 397(1 -> 2), 512(1 -> 0), 524(1 -> 0); DELTRAN: 61(1 -> 0); ACCTRAN: 73(0 -> 1), 115(0 -> 1), 142(0 -> 1), 161(0 -> 1), 200(2 -> 1), 220(0 -> 1), 240(1 -> 0), 440(1 -> 0), 441(0 -> 2), 456(0 -> 1), 534(1 -> 0).

Alcedo atthis:
Unambiguous: 8(1 -> 0), 14(0 -> 1), 16(0 -> 1), 28(0 -> 1), 33(1 -> 0), 35(0 -> 1), 50(0 -> 1), 85(0 -> 1), 88(0 -> 1), 117(1 -> 2), 122(0 -> 1), 123(0 -> 1), 134(0 -> 1), 135(0 -> 1), 165(0 -> 1), 167(0 -> 1), 199(1 -> 0), 215(0 -> 1), 216(0 -> 1), 267(0 -> 1), 377(0 -> 1), 379(0 -> 1), 387(0 -> 1), 414(0 -> 1), 455(0 -> 2), 458(0 -> 1), 479(0 -> 1), 481(0 -> 1), 512(1 -> 0), 513(2 -> 0), 528(0 -> 1); DELTRAN: 32(1 -> 0), 39(0 -> 1), 126(0 -> 1), 240(0 -> 1), 242(0 -> 1), 453(0 -> 1); ACCTRAN: 55(1 -> 0), 95(1 -> 0), 112(0 -> 1), 149(1 -> 0), 189(1 -> 0), 440(1 -> 0).

Momotus momota:
Unambiguous: 23(0 -> 1), 34(0 -> 1), 52(0 -> 1), 72(0 -> 1), 82(0 -> 1), 87(0 -> 1), 92(0 -> 1), 128(0 -> 1), 143(0 -> 1), 148(0 -> 1), 163(0 -> 1), 166(0 -> 1), 185(0 -> 1), 186(0 -> 1), 197(1 -> 0), 214(0 -> 1), 249(0 -> 1), 270(2 -> 0), 289(0 -> 1), 302(1 -> 0), 303(0 -> 1), 311(1 -> 0), 339(0 -> 1), 347(1 -> 0), 413(0 -> 1), 429(1 -> 0), 449(1 -> 0), 487(0 -> 1), 507(0 -> 1); DELTRAN: 55(0 -> 1), 95(0 -> 1), 112(1 -> 0), 149(0 -> 1), 189(0 -> 1), 440(0 -> 1); ACCTRAN: 32(0 -> 1), 126(1 -> 0), 240(1 -> 0), 242(1 -> 0), 453(1 -> 0).

(Todidae + Meropidae + Brachypteraciidae + Coraciidae):
Unambiguous: 80(0 -> 2), 125(0 -> 1), 352(0 -> 1), 357(0 -> 1), 370(0 -> 1), 546(0 -> 1); DELTRAN: 112(1 -> 0), 126(0 -> 1), 149(0 -> 1), 189(0 -> 1), 205(0 -> 1), 242(0 -> 1), 367(0 -> 1), 453(0 -> 1); ACCTRAN: 25(0 -> 1), 61(1 -> 0), 62(1 -> 0), 183(1 -> 0), 484(0 -> 1).

(Momotidae + Alcedinidae):
Unambiguous: 104(1 -> 0), 121(0 -> 1), 218(0 -> 1), 228(1 -> 0), 229(1 -> 0), 257(2 -> 1), 491(0 -> 1); DELTRAN: 456(1 -> 0); ACCTRAN: 39(0 -> 1), 205(1 -> 0), 367(1 -> 0), 485(0 -> 1), 486(0 -> 1).

Indicator exilis pachyrhynchus:
Unambiguous: 22(0 -> 1), 64(1 -> 0), 98(0 -> 1), 130(0 -> 1), 142(1 -> 0), 151(0 -> 1), 230(0 -> 1), 350(0 -> 1), 387(0 -> 1), 409(1 -> 0), 413(0 -> 1); DELTRAN: 97(0 -> 1), 174(1 -> 0), 179(1 -> 0), 205(0 -> 1), 240(0 -> 1), 424(1 -> 0); ACCTRAN: 159(1 -> 0), 203(1 -> 0), 213(1 -> 0), 229(0 -> 1), 347(0 -> 1), 429(0 -> 1), 487(1 -> 0), 517(1 -> 0).

Picus viridis:
Unambiguous: 8(1 -> 0), 13(1 -> 0), 25(0 -> 1), 29(0 -> 1), 55(0 -> 1), 58(0 -> 1), 62(1 -> 0), 87(0 -> 1), 113(0 -> 1), 134(0 -> 1), 143(0 -> 1), 153(0 -> 1), 156(1 -> 0), 178(0 -> 1), 197(1 -> 0), 214(0 -> 1), 218(0 -> 1), 267(0 -> 1), 270(2 -> 0), 272(0 -> 1), 287(0 -> 1), 289(0 -> 1), 292(0 -> 1), 330(0 -> 1), 430(0 -> 1), 460(1 -> 0); DELTRAN: 159(0 -> 1), 203(0 -> 1), 213(0 -> 1), 229(1 -> 0), 347(1 -> 0), 429(1 -> 0), 487(0 -> 1), 517(0 -> 1), 549(0 -> 1); ACCTRAN: 97(1 -> 0), 205(1 -> 0), 240(1 -> 0).

Megalaima chrysopogon:

Unambiguous: 21(0 -> 1), 22(0 -> 1), 27(1 -> 0), 29(0 -> 1), 82(0 -> 1), 121(0 -> 1), 134(0 -> 1), 218(0 -> 1), 231(1 -> 0), 251(0 -> 1), 259(0 -> 1), 286(1 -> 0), 289(0 -> 1), 354(0 -> 1), 401(0 -> 1), 402(1 -> 0), 435(1 -> 2); DELTRAN: 97(0 -> 1), 205(0 -> 1), 221(0 -> 1), 240(0 -> 1), 549(0 -> 1); ACCTRAN: 72(1 -> 0), 191(1 -> 0), 313(1 -> 0).

Ramphastos ambiguous:
Unambiguous: 14(0 -> 1), 55(0 -> 1), 93(0 -> 1), 95(1 -> 0), 112(1 -> 0), 149(0 -> 1), 178(0 -> 1), 197(1 -> 0), 249(0 -> 1), 252(2 -> 0), 260(1 -> 0), 369(0 -> 1), 409(1 -> 0), 442(0 -> 1); DELTRAN: 15(1 -> 2), 71(0 -> 2), 72(0 -> 1), 159(0 -> 1), 191(0 -> 1), 313(0 -> 1); ACCTRAN: 205(1 -> 0), 221(1 -> 0), 240(1 -> 0), 549(1 -> 0).

(Indicartoridae + Picidae):
Unambiguous: 1(1 -> 0), 59(1 -> 0), 89(1 -> 0), 92(0 -> 1), 96(0 -> 1), 100(0 -> 1), 105(1 -> 0), 136(1 -> 0), 165(0 -> 1), 239(0 -> 1), 298(0 -> 1), 307(1 -> 2), 333(1 -> 0), 360(0 -> 1); DELTRAN: 72(0 -> 1), 83(0 -> 1), 191(0 -> 1), 221(0 -> 1), 313(0 -> 1); ACCTRAN.

(Megalaimidae + Ramphastidae):
Unambiguous: 28(0 -> 2), 30(0 -> 1), 109(0 -> 1), 117(1 -> 0), 152(0 -> 1), 228(1 -> 0), 283(0 -> 1), 293(1 -> 0), 395(0 -> 1), 408(1 -> 0), 537(0 -> 1); DELTRAN: 104(1 -> 0), 203(0 -> 1), 213(0 -> 1), 229(1 -> 0), 347(1 -> 0), 429(1 -> 0), 487(0 -> 1), 517(0 -> 1); ACCTRAN: 15(1 -> 2), 83(1 -> 0), 174(0 -> 1), 179(0 -> 1), 424(0 -> 1).

Galbula dea:
Unambiguous: 23(0 -> 1), 35(0 -> 1), 58(0 -> 1), 61(1 -> 0), 80(0 -> 3), 93(0 -> 1), 121(0 -> 1), 135(0 -> 1), 147(0 -> 1), 157(0 -> 1), 161(0 -> 1), 163(0 -> 1), 200(2 -> 1), 215(0 -> 2), 222(0 -> 1), 230(0 -> 1), 243(0 -> 1), 254(0 -> 1), 303(0 -> 1), 307(1 -> 0), 309(0 -> 1), 337(0 -> 1), 350(0 -> 1), 354(0 -> 1), 386(0 -> 1), 437(1 -> 0), 443(0 -> 1), 479(0 -> 2), 480(0 -> 1), 503(0 -> 1), 539(0 -> 1), 546(0 -> 1); DELTRAN: 19(0 -> 1), 48(2 -> 1), 52(0 -> 2), 66(1 -> 0), 83(0 -> 1), 126(0 -> 1), 205(0 -> 1), 206(0 -> 1), 240(0 -> 1), 407(0 -> 1), 424(1 -> 0); ACCTRAN: 52(1 -> 2), 242(1 -> 0), 247(1 -> 0), 456(0 -> 1), 525(1 -> 0).

(Megalaimidae + Ramphastidae + Indicartoridae + Picidae):
Unambiguous: 34(0 -> 1), 120(0 -> 1), 122(0 -> 1), 245(1 -> 0), 255(0 -> 1), 269(0 -> 1), 301(0 -> 1), 305(0 -> 1), 329(1 -> 2), 335(0 -> 1), 359(0 -> 1), 399(0 -> 1), 428(0 -> 1), 431(0 -> 2), 441(0 -> 1), 452(0 -> 1), 466(0 -> 2), 467(1 -> 2), 498(0 -> 1), 509(0 -> 1), 534(1 -> 0); DELTRAN: 52(0 -> 1), 242(0 -> 1), 247(0 -> 1), 456(1 -> 0), 525(0 -> 1); ACCTRAN: 19(1 -> 0), 48(1 -> 2), 66(0 -> 1), 72(0 -> 1), 97(0 -> 1), 104(1 -> 0), 126(1 -> 0), 159(0 -> 1), 191(0 -> 1), 203(0 -> 1), 206(1 -> 0), 213(0 -> 1), 221(0 -> 1), 229(1 -> 0), 313(0 -> 1), 347(1 -> 0), 407(1 -> 0), 429(1 -> 0), 487(0 -> 1), 517(0 -> 1), 549(0 -> 1).

Coraciiformes:
Unambiguous: 37(0 -> 2), 38(0 -> 1), 47(1 -> 0), 49(1 -> 2), 176(1 -> 0), 256(0 -> 1), 326(0 -> 1), 327(0 -> 1), 401(0 -> 1), 423(1 -> 0), 460(1 -> 2), 461(0 -> 1), 466(0 -> 1), 488(1 -> 0); DELTRAN: 19(0 -> 1), 48(2 -> 1), 66(1 -> 0), 71(0 -> 3), 174(1 -> 0), 179(1 -> 0), 206(0 -> 1), 247(0 -> 1), 287(0 -> 1), 332(0 -> 1), 407(0 -> 1), 525(0 -> 1), 536(0 -> 1), 537(0 -> 1); ACCTRAN: 55(0 -> 1), 112(1 -> 0), 142(1 -> 0), 149(0 -> 1), 166(1 -> 0), 189(0 -> 1), 237(1 -> 0), 345(1 -> 0), 379(1 -> 0).

Piciformes:
Unambiguous: 27(0 -> 1), 207(0 -> 1), 231(0 -> 1), 253(0 -> 1), 316(0 -> 1), 328(1 -> 0), 372(0 -> 1), 373(0 -> 1), 374(0 -> 1), 397(1 -> 2), 489(0 -> 1), 495(0 -> 3), 523(0 -> 1); DELTRAN: 32(1 -> 0), 95(0 -> 1), 142(0 -> 1), 166(0 -> 1), 237(0 -> 1), 332(0 -> 2), 345(0 -> 1), 367(0 -> 1), 379(0 -> 1), 427(0 -> 1), 440(0 -> 1), 453(0 -> 2), 485(1 -> 0), 486(1 -> 2); ACCTRAN: 52(0 -> 1), 71(3 -

> 2), 83(0 -> 1), 287(1 -> 0), 332(1 -> 2), 424(1 -> 0), 453(1 -> 2), 486(0 -> 2), 536(1 -> 0), 537(1 -> 0).

(†Messelirrisor + Bucerotiformes):
Unambiguous: 135(0 -> 1), 137(0 -> 1), 408(1 -> 0), 473(1 -> 0), 514(0 -> 1); DELTRAN: 379(0 -> 1); ACCTRAN: 8(1 -> 0), 14(0 -> 1), 25(0 -> 1), 30(0 -> 1), 71(3 -> 0), 93(0 -> 1), 95(1 -> 0), 102(1 -> 2), 115(0 -> 1), 139(0 -> 1), 152(0 -> 2), 159(0 -> 1), 193(0 -> 1), 209(2 -> 0), 215(0 -> 1), 217(0 -> 1), 250(1 -> 0), 252(2 -> 1), 260(1 -> 0), 284(0 -> 1), 285(0 -> 1), 313(0 -> 1), 329(1 -> 2), 335(0 -> 1), 338(0 -> 1), 339(0 -> 1), 348(0 -> 1), 352(0 -> 1), 367(1 -> 0), 403(0 -> 1), 438(0 -> 1), 525(1 -> 0).

Picodynastornithes:
Unambiguous: 13(0 -> 1), 59(0 -> 1), 144(1 -> 0), 271(0 -> 1), 283(1 -> 0), 293(0 -> 1), 312(0 -> 1), 358(0 -> 1), 441(2 -> 0), 449(0 -> 1), 465(2 -> 1), 524(0 -> 1); DELTRAN: 8(0 -> 1), 31(1 -> 0), 136(0 -> 1), 215(1 -> 0), 236(0 -> 1), 260(0 -> 1), 331(0 -> 1), 336(0 -> 1), 467(0 -> 1), 493(1 -> 0); ACCTRAN: 19(0 -> 1), 32(1 -> 0), 48(2 -> 1), 66(1 -> 0), 126(0 -> 1), 174(1 -> 0), 205(0 -> 1), 240(0 -> 1), 242(0 -> 1), 247(0 -> 1), 365(1 -> 0), 399(1 -> 0), 407(0 -> 1), 427(0 -> 1), 429(0 -> 1), 440(0 -> 1), 453(0 -> 1).

(†*Eotrogon* + Trogoniformes):
Unambiguous: 81(0 -> 1), 189(0 -> 1), 220(0 -> 1), 232(0 -> 1), 244(0 -> 2), 252(2 -> 0), 254(0 -> 1), 377(0 -> 1), 468(0 -> 1), 494(0 -> 2), 513(2 -> 1); DELTRAN: 337(0 -> 1), 485(1 -> 3); ACCTRAN: 1(1 -> 0), 28(0 -> 2), 47(1 -> 0), 48(2 -> 0), 49(1 -> 2), 55(0 -> 2), 56(0 -> 1), 70(0 -> 2), 72(0 -> 1), 75(2 -> 0), 76(0 -> 1), 82(0 -> 1), 88(0 -> 1), 101(2 -> 0), 102(1 -> 3), 105(1 -> 0), 117(1 -> 0), 131(0 -> 1), 134(0 -> 1), 146(0 -> 1), 148(0 -> 1), 173(0 -> 1), 185(0 -> 1), 186(0 -> 1), 215(0 -> 2), 298(0 -> 1), 303(0 -> 1), 324(0 -> 1), 332(1 -> 0), 387(0 -> 1), 408(1 -> 2), 409(1 -> 0), 413(0 -> 1), 467(1 -> 2), 476(0 -> 1), 485(0 -> 3), 512(1 -> 0), 538(0 -> 1).

Picocoraciae:
Unambiguous: 64(0 -> 1), 311(0 -> 1), 320(0 -> 1), 321(0 -> 1), 356(0 -> 1), 370(1 -> 0), 487(1 -> 0); DELTRAN: 28(1 -> 0), 105(0 -> 1), 114(0 -> 1), 183(0 -> 1), 286(0 -> 1), 351(0 -> 1), 413(1 -> 0), 476(1 -> 0); ACCTRAN: 31(1 -> 0), 33(0 -> 1), 61(0 -> 1), 77(1 -> 0), 136(0 -> 1), 142(0 -> 1), 166(0 -> 1), 179(1 -> 0), 206(0 -> 1), 236(0 -> 1), 237(0 -> 1), 287(0 -> 1), 331(0 -> 1), 336(0 -> 1), 337(1 -> 0), 345(0 -> 1), 389(1 -> 0), 486(1 -> 0), 493(1 -> 0).

(†*Eoglaucidium* + †*Masillacolius* + Coliiformes):
Unambiguous: 235(0 -> 1), 272(0 -> 1), 304(0 -> 1), 344(0 -> 1), 418(0 -> 1), 430(0 -> 1), 431(0 -> 2), 449(0 -> 1), 528(0 -> 2), 531(0 -> 1), 542(0 -> 2), 549(0 -> 1); DELTRAN: 33(1 -> 0), 215(1 -> 0), 337(0 -> 1), 495(1 -> 2), 530(1 -> 2); ACCTRAN: 4(0 -> 1), 8(1 -> 0), 15(1 -> 0), 23(0 -> 1), 27(0 -> 1), 28(0 -> 1), 58(0 -> 1), 122(0 -> 1), 124(0 -> 1), 157(0 -> 1), 163(0 -> 1), 178(0 -> 1), 259(0 -> 1), 262(0 -> 1), 264(0 -> 1), 267(0 -> 1), 271(0 -> 1), 295(0 -> 1), 305(0 -> 1), 386(0 -> 1), 397(1 -> 0), 403(0 -> 1), 417(0 -> 1), 423(1 -> 0), 428(0 -> 1), 440(0 -> 1), 448(0 -> 1), 453(0 -> 1), 467(1 -> 0), 478(0 -> 1), 490(0 -> 1), 521(0 -> 1), 530(0 -> 2), 537(1 -> 0).

Eucavitaves:
Unambiguous: 62(0 -> 1), 87(1 -> 0), 89(0 -> 1), 195(0 -> 1), 229(0 -> 1), 355(0 -> 1), 460(0 -> 1), 472(0 -> 1), 527(1 -> 0), 529(1 -> 0), 548(1 -> 0); DELTRAN: 58(1 -> 0), 176(0 -> 1), 371(0 -> 1), 381(0 -> 1), 423(0 -> 1), 478(1 -> 0), 495(1 -> 0), 530(1 -> 0); ACCTRAN: 71(0 -> 3), 95(0 -> 1), 165(1 -> 0), 183(0 -> 1), 286(0 -> 1), 367(0 -> 1), 379(0 -> 1), 399(0 -> 1), 429(1 -> 0), 456(1 -> 0), 485(1 -> 0), 495(2 -> 0), 536(0 -> 1).

Barnardius zonarius:

Unambiguous: 204(1 -> 0), 206(2 -> 0), 216(0 -> 1), 230(0 -> 1), 256(1 -> 0), 303(0 -> 1), 435(2 -> 1), 465(2 -> 1), 467(1 -> 2), 512(0 -> 1), 529(1 -> 0), 545(1 -> 0); DELTRAN: 537(0 -> 1); ACCTRAN.

Probosciger aterrimus:
Unambiguous: 1(0 -> 1), 42(0 -> 1), 52(0 -> 2), 57(0 -> 1), 136(0 -> 1), 163(0 -> 1), 270(0 -> 1), 296(1 -> 0), 324(1 -> 0), 394(0 -> 1), 416(1 -> 0), 436(0 -> 1), 458(1 -> 0), 469(0 -> 1), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0); DELTRAN; ACCTRAN: 537(1 -> 0).

Psittrichas fulgidus:
Unambiguous: 85(1 -> 0), 312(0 -> 1), 358(0 -> 1), 429(1 -> 0), 467(1 -> 0); DELTRAN; ACCTRAN.

(*Proboscigar* + *Barnardius*):
Unambiguous: 39(2 -> 1), 215(1 -> 2), 217(0 -> 1), 413(1 -> 2), 428(0 -> 1); DELTRAN; ACCTRAN.

Deroptyus accipitrinus:
Unambiguous: 42(0 -> 1), 52(0 -> 2), 57(0 -> 1), 204(1 -> 0), 222(1 -> 0), 287(0 -> 1), 312(0 -> 1), 432(0 -> 1), 542(1 -> 2), 547(0 -> 1); DELTRAN: 537(0 -> 1); ACCTRAN.

Psittacus erithacus:
Unambiguous: 132(0 -> 1), 134(0 -> 1), 189(1 -> 0), 211(0 -> 1), 413(1 -> 0), 431(1 -> 0), 436(0 -> 1), 442(0 -> 1), 549(1 -> 0); DELTRAN; ACCTRAN.

(Psittaculidae + Psittacidae):
Unambiguous: 56(0 -> 1), 235(0 -> 1), 441(0 -> 2); DELTRAN: 440(0 -> 1); ACCTRAN.

(*Deroptyus* + *Psittacus*):
Unambiguous: 307(1 -> 0), 314(0 -> 1), 543(1 -> 0); DELTRAN: 518(0 -> 1); ACCTRAN: 440(1 -> 0).

Nestor notabilis:
Unambiguous: 55(2 -> 1), 62(0 -> 1), 85(1 -> 0), 132(0 -> 1), 134(0 -> 1), 163(0 -> 1), 407(0 -> 1), 416(1 -> 0), 428(0 -> 1), 441(0 -> 1), 467(1 -> 2), 469(0 -> 1); DELTRAN: 39(0 -> 1), 283(1 -> 0), 328(1 -> 0), 440(0 -> 1); ACCTRAN: 8(1 -> 0), 202(1 -> 0), 491(2 -> 0).

(Cacatuidae + Psittaculidae + Psittacidae):
Unambiguous: 3(0 -> 1), 4(1 -> 2), 14(0 -> 1), 15(1 -> 2), 141(0 -> 1), 175(0 -> 1), 182(0 -> 2), 228(0 -> 1), 249(0 -> 1), 277(0 -> 1), 294(0 -> 2), 296(0 -> 1), 371(0 -> 1), 458(0 -> 1), 512(1 -> 0); DELTRAN: 8(0 -> 1), 39(0 -> 2), 202(0 -> 1), 283(1 -> 2), 491(0 -> 2); ACCTRAN: 39(1 -> 2), 283(0 -> 2), 328(0 -> 1).

Strigops habroptilus:
Unambiguous: 42(0 -> 1), 52(0 -> 2), 56(0 -> 1), 63(0 -> 2), 75(2 -> 1), 212(0 -> 1); DELTRAN: 8(0 -> 1), 202(0 -> 1), 491(0 -> 2); ACCTRAN.

(*Nestor* + Cacatuidae + Psittaculidae + Psittacidae):
Unambiguous: 186(0 -> 1), 206(0 -> 2), 542(0 -> 1), 549(0 -> 1); DELTRAN: 154(0 -> 1), 156(0 -> 1), 162(1 -> 0), 165(0 -> 1), 214(0 -> 1), 220(0 -> 1), 222(0 -> 1), 239(0 -> 1), 254(0 -> 2), 257(0 -> 2), 258(0 -> 1), 259(0 -> 2), 264(0 -> 1), 265(0 -> 1), 270(2 -> 0), 278(0 -> 1), 354(0 -> 1), 384(1 -> 0), 388(0 -> 1), 401(0 -> 1), 402(1 -> 2), 410(0 -> 1), 427(0 -> 1), 431(0 -> 1), 438(0 -> 1), 479(0 -> 1), 523(0 -> 1); ACCTRAN: 39(0 -> 1).

†*Quercypsitta sudrei*:

Unambiguous: 226(1 -> 0), 329(1 -> 0), 449(0 -> 1), 465(2 -> 1), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0), 492(1 -> 0), 493(1 -> 0), 517(0 -> 1); DELTRAN: 455(0 -> 1), 471(0 -> 1), 479(0 -> 2); ACCTRAN: 470(2 -> 1).

(Strigopidae + Cacatuidae + Psittaculidae + Psittacidae):
Unambiguous: 452(0 -> 1), 454(0 -> 2), 462(0 -> 1), 490(0 -> 1), 501(0 -> 1), 508(0 -> 1), 511(0 -> 1); DELTRAN: 2(0 -> 1), 4(0 -> 1), 7(0 -> 1), 18(0 -> 1), 19(0 -> 1), 23(0 -> 1), 28(1 -> 3), 30(0 -> 1), 37(0 -> 1), 41(0 -> 1), 46(0 -> 1), 47(1 -> 0), 55(0 -> 2), 84(0 -> 1), 90(0 -> 1), 105(0 -> 1), 117(1 -> 2), 118(0 -> 1), 121(0 -> 1), 137(0 -> 1), 138(0 -> 1), 139(0 -> 1), 140(0 -> 1), 144(1 -> 0), 151(0 -> 1), 152(0 -> 2), 170(0 -> 2), 184(2 -> 1), 189(0 -> 1), 191(0 -> 1), 201(1 -> 0), 209(2 -> 0), 229(0 -> 1), 255(0 -> 1), 324(0 -> 1), 377(0 -> 2), 470(1 -> 2), 494(0 -> 1), 533(0 -> 1), 543(0 -> 1); ACCTRAN: 214(0 -> 1), 220(0 -> 1), 222(0 -> 1), 440(0 -> 1), 479(2 -> 1), 491(0 -> 2).

Piprites chloris tschudii:
Unambiguous: 322(1 -> 0), 408(1 -> 2), 436(0 -> 1), 452(2 -> 1); DELTRAN: 142(1 -> 0), 150(1 -> 0), 343(1 -> 0); ACCTRAN: 17(0 -> 1), 51(0 -> 1).

Tyrannus tyrannus:
Unambiguous: 38(0 -> 1), 48(2 -> 1), 235(0 -> 1), 255(1 -> 0), 280(0 -> 1), 367(1 -> 0), 397(1 -> 0), 413(1 -> 2), 441(0 -> 1), 536(1 -> 0); DELTRAN: 17(1 -> 0), 51(1 -> 0); ACCTRAN: 142(0 -> 1), 150(0 -> 1), 343(0 -> 1).

Rupicola peruvianus:
Unambiguous: 4(0 -> 1), 19(0 -> 1), 20(0 -> 1), 22(0 -> 1), 25(1 -> 0), 28(0 -> 1), 50(1 -> 0), 102(4 -> 1), 103(1 -> 0), 186(0 -> 1), 234(1 -> 0), 251(1 -> 0), 350(1 -> 0), 428(0 -> 1), 475(1 -> 0), 482(1 -> 0); DELTRAN: 17(1 -> 0), 51(1 -> 0), 142(1 -> 0), 150(1 -> 0), 249(0 -> 1), 343(1 -> 0); ACCTRAN: 407(1 -> 0).

(*Piprites* + *Tyrannus*):
Unambiguous: 126(0 -> 1), 146(1 -> 0), 270(2 -> 0), 356(1 -> 0), 426(0 -> 1), 515(0 -> 1); DELTRAN: 407(0 -> 1); ACCTRAN: 249(1 -> 0).

Neopelma chrysocephalum:
Unambiguous: 48(2 -> 1), 240(0 -> 1), 255(1 -> 0), 305(1 -> 0), 311(1 -> 0), 333(0 -> 1), 395(1 -> 0), 408(1 -> 2), 437(1 -> 0); DELTRAN: 249(0 -> 1), 407(0 -> 1); ACCTRAN: 247(0 -> 1).

(Cotingidae + Tyrannidae):
Unambiguous: 122(0 -> 1), 128(0 -> 1), 147(1 -> 0), 397(2 -> 1), 441(2 -> 0), 488(1 -> 0); DELTRAN: 236(2 -> 0), 247(1 -> 0), 512(2 -> 1); ACCTRAN: 17(1 -> 0), 51(1 -> 0), 142(1 -> 0), 150(1 -> 0), 343(1 -> 0).

Pitta sordida:
Unambiguous: 32(0 -> 1), 33(1 -> 0), 47(1 -> 0), 117(1 -> 0), 206(1 -> 0), 251(1 -> 0), 270(2 -> 0), 347(1 -> 0), 350(1 -> 0), 356(1 -> 0), 360(1 -> 0), 379(0 -> 1), 447(1 -> 0), 452(2 -> 0), 473(0 -> 1), 527(1 -> 0), 536(1 -> 0); DELTRAN: 80(3 -> 0), 247(1 -> 0); ACCTRAN: 205(0 -> 1), 444(0 -> 1).

(Pipridae + Cotingidae + Tyrannidae):
Unambiguous: 8(0 -> 1), 58(0 -> 1), 399(2 -> 1), 409(1 -> 0), 510(1 -> 0); DELTRAN: 205(1 -> 0), 220(0 -> 1), 303(0 -> 1), 308(1 -> 0), 444(1 -> 0); ACCTRAN: 80(0 -> 3), 249(0 -> 1), 407(0 -> 1), 512(2 -> 1).

Neodrepanis coruscans:

Unambiguous: 1(0 -> 1), 17(1 -> 0), 25(1 -> 0), 35(0 -> 1), 51(1 -> 0), 136(0 -> 1), 147(1 -> 0), 150(1 -> 0), 204(1 -> 0), 219(1 -> 0), 240(0 -> 1), 337(0 -> 1), 339(0 -> 1), 428(0 -> 1), 435(1 -> 0), 457(0 -> 1), 509(0 -> 1); DELTRAN: 80(3 -> 0), 205(1 -> 0), 395(1 -> 0), 444(1 -> 0); ACCTRAN: 220(1 -> 0), 303(1 -> 0), 308(0 -> 1), 377(1 -> 0).

(Pittidae + Pipridae + Cotingidae + Tyrannidae):
Unambiguous: 203(1 -> 0), 338(1 -> 0), 431(2 -> 0), 432(1 -> 0), 451(0 -> 1); DELTRAN: 377(0 -> 1); ACCTRAN: 247(1 -> 0), 395(0 -> 1).

Myrmornis torquate:
Unambiguous: 1(0 -> 1), 17(1 -> 0), 121(0 -> 1), 215(0 -> 1), 255(1 -> 0), 298(1 -> 0), 356(1 -> 0), 411(0 -> 1), 510(1 -> 0), 512(2 -> 1); DELTRAN: 317(0 -> 1), 515(1 -> 0); ACCTRAN: 67(1 -> 0), 182(1 -> 0), 286(1 -> 0).

Myrmothera campanisona minor:
Unambiguous: 117(1 -> 0), 347(1 -> 0), 426(0 -> 1), 431(2 -> 0), 452(2 -> 1); DELTRAN: 67(0 -> 1), 179(1 -> 0), 182(0 -> 1), 286(0 -> 1), 377(0 -> 1); ACCTRAN: 317(1 -> 0), 515(0 -> 1).

(Philepittidae + Pittidae + Pipridae + Cotingidae + Tyrannidae):
Unambiguous: 195(0 -> 1), 215(0 -> 2), 333(1 -> 0), 342(0 -> 1), 366(1 -> 0); DELTRAN: 67(0 -> 1), 71(0 -> 3), 174(1 -> 0), 182(0 -> 1), 286(0 -> 1), 317(0 -> 1), 515(1 -> 0); ACCTRAN: 80(3 -> 0), 205(1 -> 0), 444(1 -> 0).

(Thamnophilidae + Grallariidae):
Unambiguous: 8(0 -> 1), 251(1 -> 0), 348(0 -> 1), 409(1 -> 0), 437(1 -> 0), 473(0 -> 1); DELTRAN: 220(0 -> 1), 303(0 -> 1), 308(1 -> 0), 395(1 -> 0); ACCTRAN: 174(0 -> 1), 179(1 -> 0).

Melanopareia bitorquata:
Unambiguous: 34(0 -> 1), 121(0 -> 1), 125(0 -> 1), 147(1 -> 0), 150(1 -> 0), 176(0 -> 1), 194(0 -> 1), 197(1 -> 0), 240(0 -> 1), 255(1 -> 0), 281(1 -> 0), 337(0 -> 1), 352(1 -> 0), 355(1 -> 0), 356(1 -> 0), 422(0 -> 1), 426(0 -> 1), 527(1 -> 0), 539(0 -> 1); DELTRAN: 174(1 -> 0), 280(0 -> 1), 339(0 -> 1); ACCTRAN: 33(1 -> 0), 184(1 -> 2), 220(1 -> 0), 303(1 -> 0).

(Thamnophilidae + Grallariidae + Philepittidae + Pittidae + Pipridae + Cotingidae + Tyrannidae)
Unambiguous: 126(1 -> 0), 206(0 -> 1), 536(0 -> 1); DELTRAN: 33(0 -> 1), 184(2 -> 1), 379(1 -> 0); ACCTRAN: 67(0 -> 1), 182(0 -> 1), 280(1 -> 0), 286(0 -> 1), 308(1 -> 0), 317(0 -> 1), 339(1 -> 0), 395(1 -> 0), 515(1 -> 0).

Climacterus melanurus wellsi:
Unambiguous: 236(2 -> 1), 317(0 -> 1), 395(1 -> 0), 397(2 -> 1), 413(1 -> 0), 481(0 -> 1), 482(1 -> 0); DELTRAN: 219(0 -> 1), 228(0 -> 1), 330(0 -> 1), 347(1 -> 0); ACCTRAN: 85(0 -> 1), 255(0 -> 1), 280(1 -> 0), 440(0 -> 1).

Menura novaehollandiae:
Unambiguous: 25(1 -> 0), 30(0 -> 1), 35(0 -> 1), 37(0 -> 1), 38(0 -> 1), 39(0 -> 2), 44(1 -> 0), 47(1 -> 0), 48(2 -> 1), 66(1 -> 0), 129(0 -> 1), 196(0 -> 1), 197(1 -> 0), 199(0 -> 1), 204(1 -> 0), 206(0 -> 1), 211(0 -> 1), 214(0 -> 1), 242(1 -> 0), 244(2 -> 0), 245(0 -> 1), 251(1 -> 0), 253(1 -> 0), 270(2 -> 0), 272(1 -> 0), 308(1 -> 0), 312(0 -> 1), 329(2 -> 1), 337(0 -> 1), 356(1 -> 0), 358(1 -> 0), 370(0 -> 1), 392(1 -> 0), 401(1 -> 0), 409(1 -> 0), 411(0 -> 1), 431(2 -> 1), 444(1 -> 0), 447(1 -> 0), 547(0 -> 1), 548(0 -> 1); DELTRAN: 85(1 -> 0), 178(0 -> 1), 200(2 -> 1), 255(1 -> 0), 280(0 -> 1), 440(1 -> 0), 528(0 -> 1), 537(0 -> 1); ACCTRAN: 219(1 -> 0), 228(1 -> 0), 330(1 -> 0), 347(0 -> 1).

Passer domesticus:

Unambiguous: 9(0 -> 1), 55(0 -> 1), 56(0 -> 1), 72(0 -> 1), 85(0 -> 1), 117(1 -> 0), 146(1 -> 0), 179(1 -> 0), 251(1 -> 0), 317(0 -> 1), 549(0 -> 1); DELTRAN: 25(1 -> 0), 330(0 -> 1), 339(0 -> 1); ACCTRAN: 174(0 -> 1), 280(1 -> 0).

Zosterops lateralis:
Unambiguous: 130(1 -> 0), 548(0 -> 1); DELTRAN: 174(1 -> 0), 280(0 -> 1); ACCTRAN: 25(0 -> 1), 330(1 -> 0), 339(1 -> 0).

Sylvia borin:
Unambiguous: 181(0 -> 1), 426(0 -> 1); DELTRAN: 25(1 -> 0), 174(1 -> 0), 195(0 -> 1), 280(0 -> 1), 330(0 -> 1), 339(0 -> 1), 431(2 -> 0); ACCTRAN: 440(0 -> 1), 515(0 -> 1).

():
Unambiguous: 121(0 -> 1), 205(0 -> 1), 286(0 -> 1), 294(2 -> 0), 311(1 -> 0), 413(1 -> 0), 488(0 -> 1); DELTRAN: 440(1 -> 0), 515(1 -> 0); ACCTRAN: 195(1 -> 0), 431(0 -> 2).

Corvus brachyrhynchos:
Unambiguous: 33(1 -> 0), 51(1 -> 0), 55(0 -> 1), 56(0 -> 1), 117(1 -> 0), 130(1 -> 0), 182(0 -> 1), 229(0 -> 1), 236(2 -> 1), 251(1 -> 0), 256(1 -> 0), 269(1 -> 0), 270(2 -> 0), 317(0 -> 1), 355(1 -> 0), 356(1 -> 0), 358(1 -> 0), 366(1 -> 0), 409(1 -> 0), 411(0 -> 1), 452(2 -> 1), 510(1 -> 0), 512(2 -> 1); DELTRAN: 50(1 -> 0), 61(1 -> 0), 195(0 -> 1), 431(2 -> 0), 440(1 -> 0), 441(2 -> 0), 451(0 -> 1), 515(1 -> 0); ACCTRAN: 174(0 -> 1), 280(1 -> 0), 330(1 -> 0), 347(0 -> 1), 456(0 -> 1).

(Slyviidae + Zosteropidae + Passeridae):
Unambiguous: 204(1 -> 0), 222(1 -> 0), 297(1 -> 0), 492(0 -> 1); DELTRAN: 347(1 -> 0), 456(1 -> 0), 539(0 -> 1), 546(0 -> 1); ACCTRAN: 25(1 -> 0), 50(0 -> 1), 61(0 -> 1), 339(0 -> 1), 441(0 -> 2), 451(1 -> 0).

(Menuridae + Climacteridae):
Unambiguous: 52(0 -> 1), 97(1 -> 2), 234(1 -> 0), 321(0 -> 1), 415(0 -> 1), 426(0 -> 1), 435(1 -> 2), 442(0 -> 1), 443(0 -> 1), 487(1 -> 0), 542(0 -> 1), 549(0 -> 1); DELTRAN: 50(1 -> 0), 61(1 -> 0), 441(2 -> 1), 451(0 -> 1), 456(1 -> 0); ACCTRAN: 178(0 -> 1), 528(0 -> 1), 537(0 -> 1), 546(1 -> 0).

(Coravidae + Sylviidae + Zosteropidae + Passeridae):
Unambiguous: 17(1 -> 0), 147(1 -> 0), 343(1 -> 0), 367(1 -> 0), 509(0 -> 1); DELTRAN: 85(1 -> 0), 219(0 -> 1), 228(0 -> 1), 255(1 -> 0); ACCTRAN: 195(0 -> 1), 431(2 -> 0), 441(1 -> 0), 515(1 -> 0), 539(0 -> 1).

Malurus melanocephalus:
Unambiguous: 143(0 -> 1), 235(0 -> 1), 337(0 -> 1), 392(1 -> 0), 397(2 -> 1), 422(0 -> 1); DELTRAN: 55(0 -> 1), 280(0 -> 1), 330(0 -> 1), 339(0 -> 1), 347(1 -> 0), 441(2 -> 1); ACCTRAN: 219(1 -> 0).

(Menuridae + Climacteridae + Coravidae + Sylviidae + Zosteropidae + Passeridae)
Unambiguous: 126(1 -> 0), 205(1 -> 0), 333(1 -> 0); DELTRAN; ACCTRAN: 50(1 -> 0), 55(1 -> 0), 85(1 -> 0), 228(0 -> 1), 255(1 -> 0), 339(1 -> 0), 440(1 -> 0), 451(0 -> 1), 456(1 -> 0).

Suboscines:
Unambiguous: 130(1 -> 0), 214(0 -> 1), 256(1 -> 0), 307(0 -> 2), 487(1 -> 0); DELTRAN: 55(0 -> 1), 115(1 -> 0), 219(0 -> 1), 338(0 -> 1), 546(0 -> 1); ACCTRAN: 71(0 -> 3), 236(2 -> 0), 377(0 -> 1), 379(1 -> 0), 428(1 -> 0), 488(0 -> 1).

Oscines:

Unambiguous: 63(1 -> 2), 66(0 -> 1), 114(1 -> 0), 222(0 -> 1), 261(0 -> 1), 334(0 -> 1), 335(0 -> 1), 369(0 -> 1), 507(1 -> 0); DELTRAN: 33(0 -> 1), 184(2 -> 1), 220(0 -> 1), 303(0 -> 1), 428(0 -> 1), 488(1 -> 0); ACCTRAN: 61(1 -> 0), 115(0 -> 1), 330(0 -> 1), 338(1 -> 0), 347(1 -> 0), 441(2 -> 1).

Acanthisitta chloris:
Unambiguous: 26(0 -> 1), 32(0 -> 1), 67(0 -> 1), 143(0 -> 1), 183(0 -> 2), 185(0 -> 1), 203(1 -> 0), 248(0 -> 1), 286(0 -> 1), 307(0 -> 1), 333(1 -> 0), 341(0 -> 1), 348(0 -> 1), 353(2 -> 1), 357(0 -> 1), 403(0 -> 1), 407(0 -> 1), 425(0 -> 1), 442(0 -> 1), 501(0 -> 1), 509(0 -> 1), 536(0 -> 1), 537(0 -> 1), 548(0 -> 1); DELTRAN: 115(1 -> 0), 201(1 -> 0), 338(0 -> 1), 339(0 -> 1), 410(0 -> 1), 428(0 -> 1), 431(0 -> 1), 456(1 -> 0), 488(1 -> 0); ACCTRAN: 303(1 -> 0), 473(0 -> 1).

(Suboscines + Oscines):
Unambiguous: 80(0 -> 3), 166(0 -> 1), 179(0 -> 1), 191(0 -> 1), 234(0 -> 1), 244(1 -> 2), 257(0 -> 2), 294(0 -> 2), 366(0 -> 1), 367(0 -> 1), 466(0 -> 3), 467(1 -> 2); DELTRAN: 431(0 -> 2), 473(1 -> 0); ACCTRAN: 33(0 -> 1), 55(0 -> 1), 174(1 -> 0), 184(2 -> 1), 201(0 -> 1), 219(0 -> 1), 220(0 -> 1), 280(0 -> 1), 410(1 -> 0), 431(1 -> 2), 456(0 -> 1), 546(0 -> 1).

†*Eozygodactylus americanus*:
Unambiguous: 198(0 -> 1), 250(1 -> 0), 350(1 -> 0), 432(1 -> 0); DELTRAN: 249(0 -> 1), 395(1 -> 0); ACCTRAN.

†*Zygodactylus grandei*:
Unambiguous: 172(1 -> 0), 371(1 -> 0), 425(0 -> 1), 545(1 -> 0); DELTRAN: 190(1 -> 0), 232(0 -> 1), 351(0 -> 1), 435(1 -> 0), 502(0 -> 1), 505(0 -> 1), 506(0 -> 1), 515(1 -> 0); ACCTRAN.

Passeriformes
Unambiguous: 40(0 -> 1), 131(0 -> 1), 134(0 -> 1), 142(0 -> 1), 144(1 -> 0), 169(1 -> 0), 189(0 -> 1), 247(0 -> 1), 279(0 -> 1), 297(0 -> 1), 301(0 -> 1), 311(0 -> 1), 332(1 -> 2), 429(1 -> 2), 452(0 -> 2), 484(0 -> 1), 489(1 -> 0), 493(1 -> 0), 495(3 -> 0), 513(1 -> 2), 519(0 -> 1); DELTRAN: 25(0 -> 1), 50(0 -> 1), 51(0 -> 1), 63(0 -> 1), 78(0 -> 1), 83(0 -> 1), 92(0 -> 1), 95(0 -> 2), 96(0 -> 1), 97(0 -> 1), 98(0 -> 1), 102(1 -> 4), 103(0 -> 1), 150(0 -> 1), 156(0 -> 1), 164(0 -> 1), 165(0 -> 1), 199(1 -> 0), 259(0 -> 2), 271(0 -> 1), 276(0 -> 1), 285(0 -> 1), 287(0 -> 1), 291(0 -> 1), 292(0 -> 1), 298(0 -> 1), 305(0 -> 1), 308(0 -> 1), 322(0 -> 1), 327(1 -> 2), 328(1 -> 0), 329(1 -> 2), 343(0 -> 1), 397(1 -> 2), 401(0 -> 1), 411(1 -> 0), 420(0 -> 1), 423(0 -> 1), 427(0 -> 1), 438(0 -> 1), 441(0 -> 2), 444(0 -> 1), 476(1 -> 0), 482(0 -> 1), 485(1 -> 0), 486(1 -> 0), 491(0 -> 1), 492(1 -> 0), 510(0 -> 1); ACCTRAN: 232(1 -> 0), 338(0 -> 1), 339(0 -> 1), 431(0 -> 1), 435(0 -> 1), 488(1 -> 0), 502(1 -> 0), 527(0 -> 1).

†*Eozygodactylus* + †*Zygodactylus*:
Unambiguous: 273(0 -> 1), 354(0 -> 1), 381(0 -> 1); DELTRAN: 498(0 -> 1), 527(1 -> 0); ACCTRAN: 25(1 -> 0), 190(1 -> 0), 249(0 -> 1), 351(0 -> 1), 395(1 -> 0), 505(0 -> 1), 506(0 -> 1), 515(1 -> 0).

†*Primozygodactylus danielsi*:
Unambiguous: 44(1 -> 0), 250(1 -> 0); DELTRAN: 32(0 -> 1); ACCTRAN.

†*Primozygodactylus quintus*:
Unambiguous; DELTRAN: 129(0 -> 1), 201(1 -> 0), 302(1 -> 0), 303(0 -> 1), 344(0 -> 1), 347(1 -> 0), 369(0 -> 1), 435(1 -> 0), 448(0 -> 1), 455(0 -> 2), 456(1 -> 0), 458(0 -> 1), 473(1 -> 0), 474(0 -> 1), 477(0 -> 1), 478(0 -> 1), 517(0 -> 1), 527(1 -> 0); ACCTRAN: 32(1 -> 0).

†*Primozygodactylus longibrachium*:
Unambiguous: 142(0 -> 1); DELTRAN; ACCTRAN.

(†*Primozygodactylus quintus* + †*Primozygodactylus quintus)*:
Unambiguous: 151(0 -> 1); DELTRAN: 26(0 -> 1); ACCTRAN.

†*Primozygodactylus eunjooae*:
Unambiguous: 1(0 -> 1), 493(1 -> 0); DELTRAN: 32(0 -> 1), 232(0 -> 1); ACCTRAN.

(†*Primozygodactylus quintus* + †*Primozygodactylus quintus* + †*Primozygodactylus longibrachium)*:
Unambiguous; DELTRAN: 126(1 -> 0); ACCTRAN: 26(0 -> 1), 232(1 -> 0).

†*Primozygodactylus major:*
Unambiguous: 509(0 -> 1); DELTRAN: 232(0 -> 1); ACCTRAN.

(†*Primozygodactylus eunjooae* + †*Primozygodactylus quintus* + †*Primozygodactylus quintus* + †*Primozygodactylus longibrachium*):
Unambiguous: 228(0 -> 1); DELTRAN: 8(0 -> 1), 25(0 -> 1), 33(0 -> 1), 179(0 -> 1), 266(1 -> 0); ACCTRAN.

(†*Zygodactylus* + †*Eozygodactylus* + Passeriformes)
Unambiguous: 147(0 -> 1), 197(0 -> 1), 205(0 -> 1), 255(0 -> 1), 274(0 -> 1), 336(0 -> 1), 440(0 -> 1); DELTRAN: 244(0 -> 1), 253(0 -> 1), 317(1 -> 0), 376(1 -> 0); ACCTRAN: 8(1 -> 0), 115(1 -> 0), 156(0 -> 1), 276(0 -> 1), 292(0 -> 1), 298(0 -> 1), 305(0 -> 1), 308(0 -> 1), 329(1 -> 2), 343(0 -> 1), 347(0 -> 1), 411(1 -> 0), 420(0 -> 1), 427(0 -> 1), 441(0 -> 2), 444(0 -> 1), 476(1 -> 0), 477(1 -> 0), 482(0 -> 1), 485(1 -> 0), 486(1 -> 0), 491(0 -> 1), 492(1 -> 0), 498(0 -> 1), 510(0 -> 1).

(†*Primozygodactylus* +++):
Unambiguous: 229(0 -> 1), 429(1 -> 0), 523(0 -> 1); DELTRAN: 244(0 -> 2), 502(0 -> 1); ACCTRAN: 32(0 -> 1), 33(0 -> 1), 126(1 -> 0), 129(0 -> 1), 179(0 -> 1), 244(1 -> 2), 259(2 -> 0), 266(1 -> 0), 291(1 -> 0), 302(1 -> 0), 317(0 -> 1), 344(0 -> 1), 369(0 -> 1), 438(1 -> 0), 448(0 -> 1), 455(0 -> 2), 458(0 -> 1), 474(0 -> 1), 478(0 -> 1), 517(0 -> 1).

†*Eofringillirostrum boudreauxi*:
Unambiguous: 19(0 -> 1), 137(0 -> 1), 144(1 -> 0), 250(1 -> 0), 254(0 -> 1), 260(1 -> 0), 277(0 -> 1), 508(0 -> 1), 521(0 -> 1), 528(0 -> 1), 530(0 -> 2), 537(0 -> 1), 545(1 -> 0); DELTRAN: 8(0 -> 1), 48(2 -> 1), 117(1 -> 0), 317(1 -> 0), 470(1 -> 2), 473(1 -> 2), 477(0 -> 1), 535(0 -> 1); ACCTRAN: 15(0 -> 1), 244(1 -> 0), 473(0 -> 2), 527(0 -> 1).

(Primozygodactylidae + Passeriformes):
Unambiguous: 242(0 -> 1), 245(1 -> 0), 251(0 -> 1), 350(0 -> 1), 472(0 -> 1), 475(0 -> 1), 512(1 -> 2), 513(0 -> 1), 548(1 -> 0); DELTRAN: 15(1 -> 0), 112(0 -> 1), 114(0 -> 1), 334(1 -> 0), 352(0 -> 1), 356(0 -> 1), 358(0 -> 1), 453(0 -> 1), 469(0 -> 1), 507(0 -> 1); ACCTRAN: 25(0 -> 1), 48(1 -> 2), 117(0 -> 1), 435(1 -> 0), 470(2 -> 1), 502(0 -> 1), 535(1 -> 0).

†Parapsittacopes bergdahli:
Unambiguous: 215(1 -> 2), 217(0 -> 1), 252(0 -> 2), 254(0 -> 1), 292(0 -> 1); DELTRAN: 35(0 -> 1), 37(0 -> 1), 38(0 -> 1), 55(0 -> 1), 108(0 -> 1), 117(1 -> 2), 183(0 -> 1), 196(0 -> 1), 202(0 -> 1), 251(0 -> 1), 259(0 -> 2), 277(0 -> 1), 286(0 -> 1), 314(0 -> 1), 329(1 -> 0), 382(0 -> 1), 523(0 -> 1); ACCTRAN: 131(1 -> 0).

†Psittacomimus eos:

Unambiguous: 15(0 -> 1), 16(0 -> 1), 116(0 -> 1), 123(0 -> 1), 238(1 -> 0), 256(1 -> 0), 370(0 -> 1); DELTRAN: 131(0 -> 1), 232(0 -> 1), 337(0 -> 1), 396(1 -> 0), 447(1 -> 0), 476(1 -> 0), 484(0 -> 1), 485(1 -> 0), 486(1 -> 2), 501(0 -> 2); ACCTRAN: 329(0 -> 1).

†Psittacopes Lepidus:
Unambiguous: 8(0 -> 1), 17(1 -> 0), 151(0 -> 1), 229(0 -> 1), 278(0 -> 1), 377(0 -> 2), 548(1 -> 2); DELTRAN: 131(0 -> 1), 181(0 -> 1), 259(0 -> 1), 329(1 -> 0), 334(1 -> 0), 347(1 -> 0), 395(0 -> 1), 513(0 -> 1), 535(0 -> 1); ACCTRAN: 114(1 -> 0), 220(1 -> 0), 259(2 -> 1).

(†Parapsittacopes bergdahli + †Psittacomimus eos):
Unambiguous: 4(0 -> 1), 331(0 -> 1); DELTRAN: 114(0 -> 1), 162(1 -> 0), 220(0 -> 1), 234(0 -> 1), 270(2 -> 1), 291(0 -> 1), 303(0 -> 1); ACCTRAN: 183(0 -> 1), 251(0 -> 1), 277(0 -> 1), 334(0 -> 1), 337(0 -> 1), 347(0 -> 1), 382(0 -> 1), 395(1 -> 0), 396(1 -> 0), 523(0 -> 1), 535(1 -> 0).

†Pumiliornis tessellatus:
Unambiguous: 1(0 -> 1), 11(0 -> 1), 25(0 -> 1), 26(0 -> 1), 32(0 -> 1), 183(0 -> 2), 215(1 -> 2), 217(0 -> 1), 257(0 -> 2), 280(0 -> 1), 306(0 -> 1), 354(0 -> 1), 377(0 -> 1), 436(0 -> 1), 489(1 -> 0), 502(0 -> 1), 547(0 -> 1), 548(1 -> 0); DELTRAN: 28(1 -> 0), 47(1 -> 2), 48(2 -> 1), 220(0 -> 1), 379(0 -> 1), 535(0 -> 1); ACCTRAN: 232(1 -> 0), 259(2 -> 0), 272(1 -> 0), 303(1 -> 0).

(†Psittacopes Lepidus + †*Parapsittacopes bergdahli + †Psittacomimus eos):*
Unambiguous: 134(0 -> 1), 142(0 -> 1), 266(1 -> 0), 435(1 -> 0), 493(1 -> 0), 499(0 -> 1), 508(0 -> 1); DELTRAN: 191(0 -> 1), 272(0 -> 1), 479(0 -> 2); ACCTRAN: 28(0 -> 1), 35(0 -> 1), 55(0 -> 1), 131(0 -> 1), 234(0 -> 1), 379(1 -> 0), 476(1 -> 0), 484(0 -> 1), 485(1 -> 0), 486(1 -> 2), 501(0 -> 2), 513(0 -> 1).

(†*Eofringillirostrum boudreauxi* + Primozygodacylidae + Passeriformes):
Unambiguous: 40(1 -> 0), 44(0 -> 1), 215(1 -> 0), 331(0 -> 1), 332(0 -> 1), 355(0 -> 1), 399(0 -> 2), 515(0 -> 1); DELTRAN: 28(1 -> 0), 272(0 -> 1), 278(0 -> 1), 379(0 -> 1), 395(0 -> 1); ACCTRAN: 37(1 -> 0), 50(0 -> 1), 112(0 -> 1), 117(2 -> 0), 162(0 -> 1), 164(0 -> 1), 191(1 -> 0), 202(1 -> 0), 253(0 -> 1), 271(0 -> 1), 285(0 -> 1), 287(0 -> 1), 352(0 -> 1), 356(0 -> 1), 358(0 -> 1), 376(1 -> 0), 428(0 -> 1), 431(1 -> 0), 453(0 -> 1), 456(1 -> 0), 469(0 -> 1), 477(0 -> 1), 479(2 -> 0), 504(1 -> 0), 507(0 -> 1).

Psittacopedidae:
Unambiguous: 172(1 -> 0), 219(0 -> 1), 252(2 -> 0), 309(0 -> 1), 408(1 -> 2), 539(0 -> 1); DELTRAN: 15(1 -> 0), 244(0 -> 1), 431(0 -> 1), 470(1 -> 2), 504(0 -> 1), 527(1 -> 0); ACCTRAN: 8(1 -> 0), 38(0 -> 1), 47(1 -> 2), 108(0 -> 1), 165(1 -> 0), 181(0 -> 1), 196(0 -> 1), 201(0 -> 1), 220(0 -> 1), 270(2 -> 1), 278(1 -> 0), 286(0 -> 1), 314(0 -> 1), 329(1 -> 0), 401(1 -> 0), 447(1 -> 0), 473(0 -> 1).

(†*Qucerypsitta* + Psittaciformes):
Unambiguous: 218(0 -> 1), 435(1 -> 2), 481(0 -> 1), 499(0 -> 1); DELTRAN: 347(1 -> 0), 473(1 -> 0), 476(1 -> 0), 504(0 -> 1); ACCTRAN: 2(0 -> 1), 4(0 -> 1), 7(0 -> 1), 18(0 -> 1), 19(0 -> 1), 23(0 -> 1), 28(0 -> 3), 30(0 -> 1), 33(0 -> 1), 41(0 -> 1), 46(0 -> 1), 47(1 -> 0), 49(1 -> 0), 55(0 -> 2), 84(0 -> 1), 90(0 -> 1), 114(1 -> 0), 118(0 -> 1), 121(0 -> 1), 137(0 -> 1), 138(0 -> 1), 139(0 -> 1), 140(0 -> 1), 144(1 -> 0), 151(0 -> 1), 152(0 -> 2), 154(0 -> 1), 170(0 -> 2), 184(2 -> 1), 189(0 -> 1), 209(2 -> 0), 229(0 -> 1), 239(0 -> 1), 254(0 -> 2), 255(0 -> 1), 258(0 -> 1), 264(0 -> 1), 265(0 -> 1), 270(2 -> 0), 283(1 -> 0), 324(0 -> 1), 354(0 -> 1), 361(0 -> 1), 371(1 -> 0), 377(0 -> 2), 384(1 -> 0), 388(0 -> 1), 402(1 -> 2), 423(1 -> 0), 427(0 -> 1), 455(0 -> 1), 471(0 -> 1), 494(0 -> 1), 518(0 -> 1), 523(0 -> 1), 530(0 -> 1), 533(0 -> 1), 543(0 -> 1).

Psittacopedidae + *Eofringillirostrum* +Zygodactylidae + Passeriformes

Unambiguous: 17(0 -> 1), 101(2 -> 0), 130(0 -> 1), 146(0 -> 1), 169(0 -> 1), 179(1 -> 0), 236(0 -> 2), 269(0 -> 1), 297(1 -> 0), 307(1 -> 0), 360(0 -> 1), 370(1 -> 0), 432(0 -> 1), 529(1 -> 0), 534(1 -> 0); DELTRAN: 33(1 -> 0), 49(0 -> 1), 361(1 -> 0), 371(0 -> 1), 530(1 -> 0); ACCTRAN: 15(1 -> 0), 48(2 -> 1), 51(0 -> 1), 63(0 -> 1), 78(0 -> 1), 83(0 -> 1), 92(0 -> 1), 95(0 -> 2), 102(1 -> 4), 103(0 -> 1), 105(1 -> 0), 150(0 -> 1), 156(1 -> 0), 199(1 -> 0), 200(2 -> 1), 232(0 -> 1), 244(0 -> 1), 257(2 -> 0), 272(0 -> 1), 291(0 -> 1), 303(0 -> 1), 317(1 -> 0), 322(0 -> 1), 327(1 -> 2), 334(1 -> 0), 379(0 -> 1), 395(0 -> 1), 397(1 -> 2), 476(0 -> 1), 527(1 -> 0), 535(0 -> 1), 537(1 -> 0).

Coliiformes + Eucavitaves
Unambiguous: 66(0 -> 1), 104(0 -> 1), 112(0 -> 1), 115(1 -> 0), 197(0 -> 1), 203(1 -> 0), 323(0 -> 1), 327(1 -> 0), 366(0 -> 1), 376(1 -> 0), 411(1 -> 0), 441(0 -> 2), 447(1 -> 0), 513(0 -> 2); DELTRAN: 49(0 -> 1), 156(0 -> 1), 257(0 -> 2), 361(1 -> 0); ACCTRAN: 77(0 -> 1), 176(0 -> 1), 215(1 -> 0), 332(0 -> 1), 337(0 -> 1), 351(0 -> 1), 365(0 -> 1), 381(0 -> 1), 389(0 -> 1), 410(1 -> 0), 413(1 -> 0), 525(0 -> 1).

Psittacopasseres
Unambiguous: 1(1 -> 0), 31(1 -> 0), 32(1 -> 0), 85(0 -> 1), 126(0 -> 1), 228(1 -> 0), 256(0 -> 1), 284(0 -> 1), 434(0 -> 1), 489(0 -> 1); DELTRAN: 58(1 -> 0), 260(0 -> 1), 467(0 -> 1), 478(1 -> 0), 495(1 -> 3); ACCTRAN: 37(0 -> 1), 61(0 -> 1), 96(0 -> 1), 97(0 -> 1), 98(0 -> 1), 117(1 -> 2), 162(1 -> 0), 191(0 -> 1), 201(1 -> 0), 202(0 -> 1), 259(0 -> 2), 278(0 -> 1), 328(1 -> 0), 347(1 -> 0), 401(0 -> 1), 431(0 -> 1), 438(0 -> 1), 470(1 -> 2), 473(1 -> 0), 479(0 -> 2), 495(2 -> 3), 504(0 -> 1).

†Avolatavis europaeus:
Unambiguous; DELTRAN: 423(0 -> 1), 470(1 -> 2), 500(0 -> 1); ACCTRAN.

†Avolatavis tenens:
Unambiguous: 516(0 -> 1); DELTRAN: 177(0 -> 1), 400(1 -> 0), 410(0 -> 1), 537(0 -> 1); ACCTRAN.

†Eurofluvioviridavis robustipes:
Unambiguous: 179(1 -> 0), 180(0 -> 1), 383(1 -> 0), 454(0 -> 1), 476(1 -> 0), 530(1 -> 2), 542(0 -> 1); DELTRAN: 13(0 -> 1), 17(0 -> 1), 82(0 -> 1), 86(0 -> 1), 101(2 -> 0), 227(0 -> 1), 230(0 -> 1), 276(0 -> 1), 369(0 -> 1), 493(1 -> 0), 537(0 -> 2); ACCTRAN: 465(1 -> 2), 537(1 -> 2).

(†Avolatavis tenens + †Avolatavis europaeus):
Unambiguous: 514(0 -> 1); DELTRAN: 434(0 -> 1), 465(2 -> 1), 483(0 -> 1); ACCTRAN: 177(0 -> 1), 493(0 -> 1).

(†Eurofluvioviridavis robustipes + †Avolatavis tenens + †Avolatavis europaeus):
Unambiguous: 543(0 -> 1), 547(0 -> 1), 549(0 -> 1); DELTRAN: 495(1 -> 2), 521(0 -> 1); ACCTRAN: 225(1 -> 0), 227(0 -> 1), 230(0 -> 1), 361(0 -> 1), 369(0 -> 1), 434(0 -> 1), 470(1 -> 2), 483(0 -> 1), 500(0 -> 1).

(†Vastanavis eocaena + †Vastanavis cambayensis):
Unambiguous: 218(0 -> 1), 228(1 -> 0), 377(0 -> 1), 379(0 -> 1), 437(1 -> 0), 446(0 -> 1), 458(0 -> 1), 490(0 -> 1), 491(0 -> 2); DELTRAN: 217(0 -> 1), 225(0 -> 1), 248(0 -> 1), 254(0 -> 1), 267(0 -> 1), 268(0 -> 1), 270(2 -> 1), 329(1 -> 0), 361(1 -> 0), 465(2 -> 1), 493(1 -> 0); ACCTRAN: 495(2 -> 1).

(Coliiformes + Eucavitaves + Psittaciformes + Psittacopedidae + Zygodactylidae + Passeriformes):
Unambiguous: 174(0 -> 1), 226(0 -> 1), 353(0 -> 2), 409(0 -> 1), 496(1 -> 2), 528(1 -> 0); DELTRAN: 35(2 -> 0), 48(0 -> 2), 52(1 -> 0), 190(0 -> 1), 225(0 -> 1), 252(1 -> 2), 266(0 -> 1),

424(0 -> 1), 497(0 -> 1); ACCTRAN: 8(0 -> 1), 114(0 -> 1), 257(0 -> 2), 260(0 -> 1), 371(0 -> 1), 467(0 -> 1), 476(1 -> 0), 478(1 -> 0), 493(0 -> 1), 512(0 -> 1), 530(1 -> 0).

Vastanavidae:
Unambiguous: 334(1 -> 0), 449(0 -> 1), 455(0 -> 1), 503(0 -> 1), 511(0 -> 1); DELTRAN: 512(1 -> 0); ACCTRAN: 13(0 -> 1), 17(0 -> 1), 82(0 -> 1), 86(0 -> 1), 101(2 -> 0), 105(1 -> 0), 217(0 -> 1), 248(0 -> 1), 254(0 -> 1), 266(1 -> 0), 267(0 -> 1), 268(0 -> 1), 270(2 -> 1), 276(0 -> 1), 329(1 -> 0), 400(1 -> 0), 465(2 -> 1), 521(0 -> 1).

†*Plesiocathartes kelleri*:
Unambiguous: 355(0 -> 1), 356(0 -> 1), 542(0 -> 1); DELTRAN: 15(1 -> 0), 19(0 -> 1), 357(0 -> 1), 474(1 -> 2), 477(0 -> 1); ACCTRAN: 512(0 -> 1).

†*Plesiocathartes wyomingensis*:
Unambiguous: 20(0 -> 1), 278(0 -> 1); DELTRAN: 200(2 -> 0), 473(1 -> 2), 512(1 -> 0); ACCTRAN.

Leptosomus discolor:
Unambiguous: 21(0 -> 1), 27(0 -> 1), 181(0 -> 1), 198(0 -> 1), 217(0 -> 1), 336(0 -> 1), 341(0 -> 1), 371(0 -> 1), 378(0 -> 1), 381(0 -> 1), 395(0 -> 1), 453(0 -> 1), 513(1 -> 2), 525(0 -> 1), 529(1 -> 0), 550(0 -> 1); DELTRAN: 14(0 -> 1), 22(0 -> 1), 49(0 -> 2), 72(0 -> 1), 73(0 -> 1), 74(0 -> 1), 87(1 -> 0), 102(1 -> 2), 105(0 -> 1), 117(1 -> 0), 147(0 -> 1), 148(0 -> 1), 150(0 -> 1), 153(0 -> 1), 163(0 -> 1), 166(0 -> 1), 195(0 -> 1), 222(0 -> 1), 236(0 -> 1), 243(0 -> 1), 245(1 -> 2), 257(0 -> 1), 258(0 -> 1), 266(0 -> 1), 305(0 -> 1), 365(0 -> 1), 366(0 -> 1), 435(1 -> 2), 441(0 -> 1), 461(0 -> 1), 486(1 -> 2), 495(1 -> 2), 501(0 -> 1), 512(1 -> 0); ACCTRAN.

(†*Plesiocathartes kelleri* + †*Plesiocathartes wyomingensis)*:
Unambiguous: 259(0 -> 1), 463(0 -> 2); DELTRAN; ACCTRAN: 15(1 -> 0), 19(0 -> 1), 200(2 -> 0), 357(0 -> 1), 473(1 -> 2), 474(1 -> 2), 477(0 -> 1), 495(2 -> 1).

(Vastanavidae + Coliiformes + Eucavitaves + Psittaciformes + Psittacopedidae + Zygodactylidae + Passeriformes):
Unambiguous: 220(1 -> 0), 250(0 -> 1), 397(2 -> 1), 460(1 -> 0), 472(1 -> 0), 474(1 -> 0), 492(0 -> 1), 513(1 -> 0); DELTRAN: 393(1 -> 0), 534(0 -> 1); ACCTRAN: 28(1 -> 0), 48(0 -> 2), 58(1 -> 0), 156(0 -> 1), 165(0 -> 1), 180(1 -> 0), 190(0 -> 1), 224(1 -> 0), 225(0 -> 1), 252(1 -> 2), 361(1 -> 0), 407(1 -> 0), 410(0 -> 1), 424(0 -> 1), 537(0 -> 1).

(Leptosomiformes + †*Plesiocathartes kelleri* + †*Plesiocathartes wyomingensis*):
Unambiguous: 25(0 -> 1), 188(1 -> 0), 215(1 -> 2), 377(0 -> 1), 487(1 -> 0), 548(1 -> 0); DELTRAN: 35(2 -> 1), 52(1 -> 2), 180(0 -> 1), 224(0 -> 1), 407(0 -> 1), 493(1 -> 0); ACCTRAN: 14(0 -> 1), 22(0 -> 1), 33(0 -> 1), 35(0 -> 1), 49(1 -> 2), 52(0 -> 2), 72(0 -> 1), 73(0 -> 1), 74(0 -> 1), 87(1 -> 0), 102(1 -> 2), 117(1 -> 0), 147(0 -> 1), 148(0 -> 1), 150(0 -> 1), 153(0 -> 1), 163(0 -> 1), 166(0 -> 1), 195(0 -> 1), 222(0 -> 1), 236(0 -> 1), 243(0 -> 1), 245(1 -> 2), 257(0 -> 1), 258(0 -> 1), 305(0 -> 1), 365(0 -> 1), 366(0 -> 1), 423(1 -> 0), 435(1 -> 2), 441(0 -> 1), 461(0 -> 1), 486(1 -> 2), 501(0 -> 1), 534(1 -> 0).

†*Cyrilavis cf colburnorum*:
Unambiguous: 142(0 -> 1); DELTRAN: 110(0 -> 1), 112(0 -> 1), 148(0 -> 1), 149(0 -> 1), 190(0 -> 1), 255(0 -> 1), 360(1 -> 0); ACCTRAN: 229(1 -> 0), 230(1 -> 0).

†*Cyrilavis colburnorum*:
Unambiguous: 128(1 -> 0), 152(1 -> 0), 228(0 -> 1); DELTRAN: 40(1 -> 0), 197(0 -> 1), 229(0 -> 1), 230(0 -> 1), 355(0 -> 1), 379(0 -> 1), 384(0 -> 1), 397(2 -> 1), 401(0 -> 1), 421(0 -> 1), 425(0 -> 1), 534(0 -> 1), 537(0 -> 1), 540(1 -> 0); ACCTRAN: 110(1 -> 0), 112(1 -> 0).

†*Cyrilavis olsoni*:
Unambiguous: 182(0 -> 1); DELTRAN; ACCTRAN.

†*Serudaptus pohli:*
Unambiguous: 151(0 -> 1), 244(0 -> 1), 278(0 -> 1), 511(0 -> 1); DELTRAN: 1(0 -> 1), 15(1 -> 0), 49(0 -> 1), 52(1 -> 0), 252(1 -> 0), 396(1 -> 0), 521(0 -> 1), 526(0 -> 1), 543(0 -> 1); ACCTRAN.

(†*Cyrilavis colburnorum* + †*Cyrilavis cf colburnorum)*:
Unambiguous: 146(0 -> 1), 232(0 -> 1), 245(1 -> 2); DELTRAN: 260(0 -> 1), 453(0 -> 1); ACCTRAN: 49(1 -> 0).

(†*Cyrilavis olsoni* + †*Serudaptus pohli*):
Unambiguous: 250(0 -> 1); DELTRAN; ACCTRAN: 1(0 -> 1), 15(1 -> 0), 52(1 -> 0), 252(1 -> 0), 396(1 -> 0), 521(0 -> 1), 526(0 -> 1), 543(0 -> 1).

†Pulchrapollia eximia:
Unambiguous: 329(0 -> 1), 452(0 -> 1), 471(0 -> 1); DELTRAN: 33(1 -> 0), 55(0 -> 1), 110(0 -> 1), 111(0 -> 1), 112(0 -> 1), 115(1 -> 0), 123(0 -> 1), 203(1 -> 0), 248(0 -> 1), 252(1 -> 2), 277(0 -> 1), 511(0 -> 1); ACCTRAN: 379(1 -> 0).

†Pulchrapollia gracilis:
Unambiguous; DELTRAN: 379(0 -> 1); ACCTRAN.

†cf Pulchrapollia gracilis:
Unambiguous: 191(0 -> 1); DELTRAN: 182(0 -> 1); ACCTRAN.

†Pulchrapollia gracilis + †Pulchrapollia eximia
Unambiguous: 272(0 -> 1); DELTRAN: 302(0 -> 1), 303(0 -> 1), 307(0 -> 1), 358(0 -> 1), 365(0 -> 1), 370(0 -> 1), 376(0 -> 1); ACCTRAN: 248(0 -> 1), 277(0 -> 1).

†cf Pulchrapollia gracilis + †Pulchrapollia gracilis + †Pulchrapollia eximia
Unambiguous; DELTRAN: 228(0 -> 1), 229(0 -> 1), 230(0 -> 1), 423(0 -> 1), 424(0 -> 1); ACCTRAN: 511(0 -> 1).

(†*Cyrilavis olsoni* + †*Serudaptus pohli* + †*Cyrilavis colburnorum* + †*Cyrilavis cf colburnorum)*:
Unambiguous: 183(0 -> 1), 431(0 -> 1), 454(0 -> 1); DELTRAN: 512(1 -> 0), 513(1 -> 0); ACCTRAN: 33(0 -> 1), 197(0 -> 1), 255(0 -> 1), 307(1 -> 0), 355(0 -> 1), 360(1 -> 0), 397(2 -> 1), 421(0 -> 1), 425(0 -> 1), 453(0 -> 1), 499(1 -> 0).

cf. Pulchrapollia + †cf Pulchrapollia gracilis + †Pulchrapollia gracilis + †Pulchrapollia eximia
Unambiguous: 447(0 -> 1), 458(0 -> 1), 480(0 -> 1), 504(0 -> 1); DELTRAN: 459(0 -> 1), 499(0 -> 1); ACCTRAN: 55(0 -> 1), 182(0 -> 1), 190(1 -> 0), 228(0 -> 1), 252(1 -> 2), 260(1 -> 0), 302(0 -> 1), 303(0 -> 1), 358(0 -> 1), 365(0 -> 1), 370(0 -> 1), 534(1 -> 0).

Pseudasturides macrocephalus:
Unambiguous: 8(0 -> 1), 15(1 -> 0), 59(0 -> 2), 154(0 -> 1), 220(1 -> 0), 226(0 -> 1), 232(0 -> 1), 250(0 -> 1), 270(2 -> 0), 316(0 -> 1), 334(1 -> 0), 371(0 -> 1), 377(0 -> 1), 444(0 -> 1), 470(1 -> 2), 509(0 -> 1), 510(0 -> 1); DELTRAN: 13(0 -> 1), 86(0 -> 1), 190(0 -> 1), 260(0 -> 1), 307(0 -> 1), 440(0 -> 1), 499(0 -> 1); ACCTRAN: 229(1 -> 0).

(†*Cyrilavis olsoni* + †*Serudaptus pohli* + †*Cyrilavis colburnorum* + †*Cyrilavis cf colburnorum + cf. Pulchrapollia + †cf Pulchrapollia gracilis + †Pulchrapollia gracilis + †Pulchrapollia eximia):*

Unambiguous: 32(1 -> 0), 215(1 -> 2), 217(0 -> 1), 473(1 -> 0); DELTRAN: 407(0 -> 1), 492(0 -> 1); ACCTRAN: 13(1 -> 0), 230(0 -> 1), 376(0 -> 1), 379(0 -> 1), 384(0 -> 1), 440(1 -> 0), 459(0 -> 1), 512(1 -> 0), 513(1 -> 0), 537(0 -> 1), 540(1 -> 0).

Tynskya crassitarsus
Unambiguous: 416(1 -> 0); DELTRAN: 418(0 -> 1); ACCTRAN.

Tynskya waltonensis
Unambiguous; DELTRAN: 164(0 -> 1), 166(0 -> 1), 170(0 -> 1), 215(1 -> 2), 217(0 -> 1); ACCTRAN.

Tynskya brevitarsus
Unambiguous: 250(0 -> 1); DELTRAN: 266(0 -> 1), 268(0 -> 1), 271(0 -> 1); ACCTRAN.

Tynskya waltonensis + Tynskya crassitarsus
Unambiguous; DELTRAN: 112(0 -> 1), 116(0 -> 1), 129(0 -> 1), 130(0 -> 1); ACCTRAN.

Tynskya eocaena
Unambiguous; DELTRAN: 512(1 -> 0); ACCTRAN.

Tynskya brevitarsus + Tynskya waltonensis + Tynskya crassitarsus
Unambiguous; DELTRAN: 229(0 -> 1), 467(0 -> 1); ACCTRAN: 215(1 -> 2).

Messelastur gratulator
Unambiguous: 151(0 -> 1), 169(1 -> 0), 347(0 -> 1), 355(0 -> 1), 356(0 -> 1), 425(0 -> 1), 474(1 -> 2), 477(0 -> 1), 504(0 -> 1), 537(0 -> 1); DELTRAN: 5(1 -> 0), 9(0 -> 1), 13(0 -> 1), 19(0 -> 1), 58(1 -> 0), 277(0 -> 1), 300(0 -> 1), 315(0 -> 1), 411(1 -> 0), 427(0 -> 1), 519(0 -> 1), 534(0 -> 1), 544(0 -> 1); ACCTRAN: 112(1 -> 0), 260(1 -> 0), 489(1 -> 0), 492(1 -> 0), 499(1 -> 0).

Tynskya eocaena + Tynskya brevitarsus + Tynskya waltonensis + Tynskya crassitarsus
Unambiguous: 219(0 -> 1), 259(0 -> 2), 317(1 -> 0); DELTRAN: 260(0 -> 1), 440(0 -> 1), 455(0 -> 1), 489(0 -> 1), 492(0 -> 1), 499(0 -> 1); ACCTRAN: 217(0 -> 1), 512(1 -> 0).

Halcyornithidae
Unambiguous: 25(0 -> 1), 152(0 -> 1), 314(0 -> 1), 481(0 -> 1), 493(1 -> 0), 523(0 -> 1), 545(1 -> 0); DELTRAN: 4(2 -> 0), 224(0 -> 1), 305(0 -> 1), 489(0 -> 1); ACCTRAN: 17(1 -> 0), 110(0 -> 1), 111(0 -> 1), 123(0 -> 1), 148(0 -> 1), 149(0 -> 1), 190(0 -> 1), 203(1 -> 0), 424(0 -> 1), 491(1 -> 0), 525(1 -> 0), 542(1 -> 0).

Messelasturidae
Unambiguous: 140(0 -> 1), 460(1 -> 2), 463(0 -> 1), 464(2 -> 1), 521(0 -> 1), 543(0 -> 1); DELTRAN: 17(0 -> 1), 491(0 -> 1), 525(0 -> 1), 541(0 -> 1), 542(0 -> 1); ACCTRAN: 4(0 -> 2), 5(1 -> 0), 9(0 -> 1), 19(0 -> 1), 58(1 -> 0), 115(0 -> 1), 129(0 -> 1), 130(0 -> 1), 166(0 -> 1), 224(1 -> 0), 266(0 -> 1), 268(0 -> 1), 271(0 -> 1), 277(0 -> 1), 300(0 -> 1), 418(0 -> 1), 423(1 -> 0), 427(0 -> 1), 455(0 -> 1), 467(0 -> 1), 519(0 -> 1), 544(0 -> 1).

Waltonavis sp
Unambiguous: 81(0 -> 1), 156(0 -> 1), 188(1 -> 0), 219(0 -> 1), 232(0 -> 1), 244(0 -> 1), 245(1 -> 0), 272(0 -> 1), 303(0 -> 1), 341(0 -> 1), 357(0 -> 1), 379(0 -> 1), 458(0 -> 1), 459(0 -> 1), 474(1 -> 0), 487(1 -> 0); DELTRAN: 17(0 -> 1), 115(1 -> 0), 180(0 -> 1), 224(0 -> 1), 302(0 -> 1), 491(0 -> 1), 525(0 -> 1), 542(0 -> 1), 550(0 -> 1); ACCTRAN: 307(1 -> 0).

Messelasturidae + Halcyornithidae

Unambiguous: 120(0 -> 1), 162(1 -> 0), 228(1 -> 0), 254(0 -> 1), 329(1 -> 0), 361(1 -> 0), 449(0 -> 1), 465(2 -> 1), 472(1 -> 0), 479(0 -> 2), 495(1 -> 3), 508(0 -> 1), 549(0 -> 1); DELTRAN: 108(0 -> 1), 128(0 -> 1), 179(1 -> 0), 408(1 -> 0), 413(1 -> 2), 478(1 -> 0); ACCTRAN: 180(1 -> 0), 229(0 -> 1), 260(0 -> 1), 302(1 -> 0), 305(0 -> 1), 315(0 -> 1), 440(0 -> 1), 489(0 -> 1), 492(0 -> 1), 499(0 -> 1), 541(0 -> 1).

Leptosomiformes + Vastanavidae + Coliiformes + Eucavitaves + Psittaciformes + Psittacopedidae + Zygodactylidae + Passeriformes
Unambiguous: 1(0 -> 1), 36(1 -> 0), 47(0 -> 1), 144(0 -> 1), 196(1 -> 0), 297(0 -> 1), 384(0 -> 1), 404(1 -> 0), 447(0 -> 1); DELTRAN: 4(2 -> 0), 18(1 -> 0), 95(2 -> 0), 101(1 -> 2), 200(1 -> 2), 283(0 -> 1), 302(0 -> 1), 307(0 -> 1), 392(0 -> 1), 402(2 -> 1), 429(0 -> 1); ACCTRAN: 35(2 -> 0), 52(1 -> 0), 266(0 -> 1), 408(0 -> 1), 491(1 -> 0), 493(1 -> 0), 495(1 -> 2), 497(0 -> 1), 512(1 -> 0).

Waltonavis sp. + Messelasturidae + Halcyornithidae
Unambiguous: 169(0 -> 1), 347(1 -> 0), 360(0 -> 1), 370(1 -> 0), 376(1 -> 0), 468(0 -> 1); DELTRAN; ACCTRAN: 13(0 -> 1), 17(0 -> 1), 40(1 -> 0), 86(0 -> 1), 108(0 -> 1), 112(0 -> 1), 115(1 -> 0), 116(0 -> 1), 128(0 -> 1), 164(0 -> 1), 170(0 -> 1), 179(1 -> 0), 392(1 -> 0), 401(0 -> 1), 411(1 -> 0), 413(1 -> 2), 478(1 -> 0), 525(0 -> 1), 542(0 -> 1), 550(0 -> 1).

Masillaraptor cf parvunguis
Unambiguous; DELTRAN: 198(0 -> 2), 217(0 -> 1), 224(0 -> 1), 229(0 -> 1), 230(0 -> 1), 259(0 -> 1), 277(0 -> 1), 303(0 -> 1), 325(0 -> 1), 445(0 -> 1), 457(0 -> 1); ACCTRAN.

Masillaraptor parvunguis
Unambiguous: 495(1 -> 0); DELTRAN: 55(0 -> 1), 129(0 -> 1), 260(0 -> 1), 529(1 -> 2); ACCTRAN.

Danielsraptor phorusrhacoides
Unambiguous: 214(0 -> 1), 525(0 -> 1), 542(0 -> 1); DELTRAN: 5(1 -> 0), 39(0 -> 2), 111(0 -> 1), 139(0 -> 1), 142(0 -> 1), 189(0 -> 1), 248(0 -> 1), 391(0 -> 1), 392(0 -> 1), 408(1 -> 0); ACCTRAN: 224(1 -> 0).

Masillaraptor cf parvunguis + Masillaraptor parvunguis
Unambiguous: 177(0 -> 1); DELTRAN: 377(0 -> 1); ACCTRAN: 129(0 -> 1), 217(0 -> 1), 457(0 -> 1), 529(1 -> 2).

Waltonavis + Messelasturidae + Halcyornithidae + Leptosomiformes +++
Unambiguous: 201(0 -> 1), 270(1 -> 2), 396(0 -> 1), 416(0 -> 1), 463(2 -> 0), 464(0 -> 2), 465(0 -> 2), 470(0 -> 1), 473(2 -> 1), 496(0 -> 1); DELTRAN: 31(0 -> 1), 453(1 -> 0), 456(0 -> 1), 527(0 -> 1); ACCTRAN: 4(2 -> 0), 39(2 -> 0), 200(1 -> 2), 215(2 -> 1), 259(1 -> 0), 302(0 -> 1), 307(0 -> 1), 391(1 -> 0), 429(0 -> 1), 521(1 -> 0).

Masillaraptoridae
Unambiguous: 12(0 -> 1), 106(0 -> 1), 136(0 -> 1), 145(0 -> 1), 181(0 -> 1), 232(0 -> 1), 450(0 -> 1); DELTRAN: 180(0 -> 1), 215(1 -> 2), 423(0 -> 1), 491(0 -> 1), 521(0 -> 1); ACCTRAN: 5(1 -> 0), 55(0 -> 1), 111(0 -> 1), 139(0 -> 1), 142(0 -> 1), 189(0 -> 1), 198(0 -> 2), 229(0 -> 1), 230(0 -> 1), 248(0 -> 1), 260(0 -> 1), 277(0 -> 1), 303(0 -> 1), 325(0 -> 1), 377(0 -> 1), 445(0 -> 1), 453(0 -> 1), 456(1 -> 0), 527(1 -> 0).

Strigiformes + Falconiformes + Pandionidae + Horusornis + Accipitridae
Unambiguous: 19(0 -> 1), 38(0 -> 1), 151(0 -> 1), 173(0 -> 1), 397(2 -> 0), 463(2 -> 1), 464(0 -> 1), 465(0 -> 1), 487(1 -> 0), 529(1 -> 2), 542(0 -> 2), 543(0 -> 1); DELTRAN: 61(1 -> 0), 77(0 -> 1), 391(0 -> 1), 453(1 -> 0), 521(0 -> 1), 527(0 -> 1), 528(0 -> 2), 530(0 -> 2), 549(0 -> 1); ACCTRAN: 23(0 -> 1), 32(1 -> 0), 48(0 -> 1), 71(0 -> 2), 132(0 -> 1), 134(0 -> 1), 214(0 -> 1),

226(0 -> 1), 371(0 -> 1), 408(0 -> 1), 469(0 -> 1), 471(0 -> 1), 472(1 -> 0), 474(1 -> 2), 512(1 -> 0), 528(1 -> 2), 530(1 -> 2), 539(0 -> 1).

Masillaraptoridae + Waltonavis + Messelasturidae + Halcyornithidae + Leptosomiformes +++
Unambiguous: 220(0 -> 1), 257(1 -> 0), 329(0 -> 1), 395(1 -> 0), 426(1 -> 0), 437(0 -> 1), 513(2 -> 1); DELTRAN: 184(1 -> 2), 228(0 -> 1), 245(2 -> 1), 528(0 -> 1), 530(0 -> 1), 539(1 -> 0); ACCTRAN: 18(1 -> 0), 31(0 -> 1), 49(0 -> 1), 77(1 -> 0), 95(2 -> 0), 101(1 -> 2), 392(0 -> 1), 393(1 -> 0), 407(0 -> 1), 423(0 -> 1), 491(0 -> 1), 549(1 -> 0).

Cariama cristata
Unambiguous: 64(0 -> 1), 101(1 -> 2), 161(0 -> 1), 166(0 -> 1), 174(0 -> 1), 272(0 -> 1), 323(0 -> 1), 354(0 -> 1), 394(0 -> 1), 426(1 -> 0), 459(0 -> 1); DELTRAN: 134(0 -> 1), 206(0 -> 2); ACCTRAN: 77(1 -> 0), 206(1 -> 2).

Chunga burmeisteri
Unambiguous: 72(0 -> 1), 243(0 -> 1), 270(1 -> 0), 312(0 -> 1), 460(1 -> 0); DELTRAN: 77(0 -> 1), 134(0 -> 2), 206(0 -> 1); ACCTRAN: 134(1 -> 2).

Dynamopterus sp
Unambiguous: 329(0 -> 2), 355(0 -> 1), 437(0 -> 1), 473(2 -> 1), 474(1 -> 0); DELTRAN: 259(0 -> 1), 276(1 -> 0), 493(0 -> 1); ACCTRAN.

Cariamiformes
Unambiguous: 218(0 -> 1), 239(0 -> 1), 260(0 -> 1), 266(0 -> 1), 427(0 -> 1), 428(0 -> 1), 429(0 -> 2), 432(0 -> 1), 457(0 -> 1), 492(0 -> 1), 500(0 -> 1), 512(1 -> 2), 532(0 -> 1), 542(0 -> 1), 543(0 -> 1); DELTRAN: 11(0 -> 1), 28(1 -> 0), 31(0 -> 1), 32(1 -> 0), 40(1 -> 0), 43(0 -> 1), 49(0 -> 2), 55(0 -> 1), 73(0 -> 1), 91(0 -> 1), 99(0 -> 1), 111(0 -> 1), 112(0 -> 1), 114(0 -> 1), 115(1 -> 0), 117(1 -> 0), 129(0 -> 1), 132(0 -> 1), 142(0 -> 1), 152(0 -> 1), 182(0 -> 1), 183(0 -> 2), 198(0 -> 1), 220(0 -> 1), 250(0 -> 1), 281(1 -> 0), 296(0 -> 1), 297(0 -> 1), 311(0 -> 1), 319(0 -> 1), 321(0 -> 1), 327(1 -> 0), 348(0 -> 1), 362(0 -> 1), 385(0 -> 1), 398(0 -> 1), 408(1 -> 0), 412(0 -> 1), 425(0 -> 1), 435(1 -> 2), 520(0 -> 1), 540(0 -> 1), 549(0 -> 1); ACCTRAN: 259(1 -> 0), 276(0 -> 1), 493(1 -> 0).

Bathornis grallator
Unambiguous: 35(2 -> 0), 36(1 -> 0), 37(0 -> 1), 46(0 -> 1), 100(0 -> 1), 106(0 -> 1), 221(0 -> 1), 329(0 -> 1), 369(0 -> 1), 417(0 -> 1), 434(0 -> 1), 522(0 -> 1); DELTRAN: 28(1 -> 2), 30(1 -> 0), 39(0 -> 2), 117(1 -> 2); ACCTRAN: 28(0 -> 2), 540(1 -> 0), 549(1 -> 0).

Dynamopterus sp + Cariamiformes
Unambiguous: 227(0 -> 1), 300(0 -> 1), 302(0 -> 1), 340(0 -> 1); DELTRAN: 215(1 -> 2), 216(0 -> 1), 217(0 -> 1), 222(0 -> 1), 245(2 -> 0), 420(0 -> 1); ACCTRAN: 30(0 -> 1), 31(0 -> 1), 32(1 -> 0), 39(2 -> 0), 49(0 -> 2), 55(0 -> 1), 112(0 -> 1), 117(2 -> 0), 132(0 -> 1), 134(0 -> 1), 142(0 -> 1), 152(0 -> 1), 220(0 -> 1), 250(0 -> 1), 520(0 -> 1).

Strigiformes + Falconiformes + Pandionidae + Horusornis + Accipitridae + Masillaraptoridae + Waltonavis + Messelasturidae + Halcyornithidae + Leptosomiformes +++
Unambiguous: 102(0 -> 1), 194(1 -> 0), 196(0 -> 1), 209(0 -> 2), 317(0 -> 1), 370(0 -> 1), 388(1 -> 0), 413(0 -> 1), 495(0 -> 1); DELTRAN: 1(1 -> 0), 15(0 -> 1), 30(1 -> 0), 276(1 -> 0), 493(0 -> 1), 540(0 -> 1), 548(0 -> 1); ACCTRAN: 25(1 -> 0), 33(1 -> 0), 61(1 -> 0), 114(1 -> 0), 115(0 -> 1), 117(2 -> 1), 133(0 -> 1), 184(1 -> 2), 206(1 -> 0), 228(0 -> 1), 245(0 -> 1), 283(0 -> 1), 385(1 -> 0), 391(0 -> 1), 398(1 -> 0), 402(2 -> 1), 425(1 -> 0), 435(2 -> 1), 453(1 -> 0), 456(0 -> 1), 521(0 -> 1), 527(0 -> 1), 528(0 -> 1), 530(0 -> 1), 534(0 -> 1).

Bathornis grallator + Dynamopterus sp + Cariamiformes

Unambiguous: 4(2 -> 0), 79(0 -> 1), 89(0 -> 1), 225(0 -> 1), 328(1 -> 0), 334(1 -> 0), 335(0 -> 1), 337(0 -> 1), 344(0 -> 1), 361(1 -> 0), 376(1 -> 0), 379(0 -> 1), 529(1 -> 0); DELTRAN: 25(0 -> 1), 539(1 -> 0); ACCTRAN: 1(0 -> 1), 11(0 -> 1), 15(1 -> 0), 28(1 -> 0), 40(1 -> 0), 43(0 -> 1), 73(0 -> 1), 91(0 -> 1), 99(0 -> 1), 105(1 -> 0), 111(0 -> 1), 129(0 -> 1), 180(1 -> 0), 182(0 -> 1), 183(0 -> 2), 198(0 -> 1), 216(0 -> 1), 217(0 -> 1), 222(0 -> 1), 281(1 -> 0), 296(0 -> 1), 297(0 -> 1), 311(0 -> 1), 319(0 -> 1), 321(0 -> 1), 327(1 -> 0), 348(0 -> 1), 362(0 -> 1), 412(0 -> 1), 420(0 -> 1), 548(1 -> 0).

Sagittarius serpentarius
Unambiguous: 19(0 -> 1), 23(0 -> 1), 48(0 -> 1), 71(0 -> 1), 76(0 -> 1), 95(2 -> 1), 149(0 -> 1), 151(0 -> 1), 153(0 -> 1), 184(1 -> 0), 187(0 -> 1), 214(0 -> 1), 244(0 -> 2), 289(0 -> 1), 397(2 -> 0), 512(1 -> 2), 518(0 -> 1), 522(0 -> 1); DELTRAN: 1(1 -> 0), 15(0 -> 1), 25(0 -> 1), 46(0 -> 1), 77(0 -> 1), 105(0 -> 1), 114(0 -> 1), 115(1 -> 0), 117(1 -> 2), 159(0 -> 1), 177(0 -> 1), 206(0 -> 1), 210(0 -> 1), 218(0 -> 1), 259(0 -> 1), 385(0 -> 1), 398(0 -> 1), 425(0 -> 1), 435(1 -> 2), 548(0 -> 1), 549(0 -> 1); ACCTRAN: 39(2 -> 0).

Bathornis grallator + Dynamopterus sp + Cariamiformes + Strigiformes + Falconiformes + Pandionidae + Horusornis + Accipitridae + Masillaraptoridae +++
Unambiguous: 58(0 -> 1), 75(0 -> 2), 81(1 -> 0), 172(0 -> 1), 188(0 -> 1), 208(1 -> 0), 238(0 -> 1), 254(1 -> 0), 347(0 -> 1), 414(1 -> 0), 447(1 -> 0), 474(0 -> 1), 547(1 -> 0); DELTRAN: 252(0 -> 1); ACCTRAN: 30(1 -> 0), 46(1 -> 0), 159(1 -> 0), 177(1 -> 0), 210(1 -> 0), 215(1 -> 2), 218(1 -> 0), 224(0 -> 1), 245(2 -> 0), 276(1 -> 0), 408(1 -> 0), 493(0 -> 1), 539(1 -> 0), 540(0 -> 1).

Cathartidae
Unambiguous: 6(0 -> 1), 10(0 -> 1), 33(1 -> 0), 48(0 -> 2), 73(0 -> 2), 95(2 -> 0), 100(0 -> 1), 106(0 -> 1), 109(0 -> 1), 110(0 -> 1), 121(0 -> 1), 142(0 -> 1), 155(0 -> 1), 166(0 -> 1), 174(0 -> 1), 183(0 -> 2), 200(1 -> 2), 226(0 -> 1), 227(0 -> 1), 246(0 -> 1), 258(0 -> 1), 311(0 -> 1), 317(0 -> 1), 364(0 -> 1), 368(0 -> 1), 376(1 -> 0), 380(0 -> 1), 387(0 -> 1), 396(0 -> 1), 413(0 -> 2), 450(0 -> 1), 456(0 -> 1), 500(0 -> 1), 512(1 -> 0); DELTRAN: 39(0 -> 2), 46(0 -> 1), 159(0 -> 1), 177(0 -> 1), 180(0 -> 1), 210(0 -> 1), 218(0 -> 1); ACCTRAN: 186(0 -> 1).

Sagittariidae + Cariamiformes +++
Unambiguous: 5(0 -> 1), 35(0 -> 2), 36(0 -> 1), 152(2 -> 0), 305(1 -> 0), 306(1 -> 0), 377(1 -> 0), 393(0 -> 1), 395(0 -> 1), 545(0 -> 1); DELTRAN: 101(0 -> 1), 112(1 -> 0); ACCTRAN: 15(0 -> 1), 25(0 -> 1), 77(0 -> 1), 105(0 -> 1), 114(0 -> 1), 115(1 -> 0), 117(1 -> 2), 206(0 -> 1), 252(0 -> 1), 259(0 -> 1), 385(0 -> 1), 398(0 -> 1), 425(0 -> 1), 435(1 -> 2), 548(0 -> 1), 549(0 -> 1).

Chauna chavaria
Unambiguous: 4(0 -> 1), 8(0 -> 1), 73(0 -> 1), 76(0 -> 1), 86(0 -> 1), 89(0 -> 1), 99(0 -> 1), 137(0 -> 1), 144(0 -> 1), 183(0 -> 1), 198(0 -> 2), 203(1 -> 2), 206(0 -> 1), 209(0 -> 1), 227(0 -> 1), 246(0 -> 1), 255(0 -> 1), 281(1 -> 0), 290(0 -> 1), 310(0 -> 1), 314(0 -> 1), 347(0 -> 1), 354(0 -> 1), 360(0 -> 1), 368(0 -> 1), 409(0 -> 1), 410(0 -> 1), 413(0 -> 1), 428(0 -> 1), 429(0 -> 1), 432(0 -> 1), 485(1 -> 2), 493(0 -> 1); DELTRAN; ACCTRAN.

Telluraves
Unambiguous: 4(0 -> 2), 17(1 -> 0), 18(0 -> 1), 28(0 -> 1), 40(0 -> 1), 52(0 -> 1), 94(0 -> 1), 161(1 -> 0), 179(0 -> 1), 225(1 -> 0), 260(1 -> 0), 268(1 -> 0), 270(0 -> 1), 329(1 -> 0), 402(3 -> 2), 417(1 -> 0), 473(0 -> 2), 492(1 -> 0); DELTRAN; ACCTRAN: 1(1 -> 0), 39(0 -> 2), 46(0 -> 1), 101(0 -> 1), 112(1 -> 0), 159(0 -> 1), 177(0 -> 1), 180(0 -> 1), 210(0 -> 1), 218(0 -> 1).

Outgroup (Eudromia + Charadris + Eurypyga)
Unambiguous: 5(0 -> 1), 25(0 -> 1), 26(0 -> 1), 30(1 -> 0), 91(0 -> 1), 96(0 -> 1), 208(1 -> 0), 228(0 -> 1), 238(0 -> 1), 245(2 -> 0), 252(0 -> 1), 317(0 -> 1), 384(0 -> 1), 388(1 -> 0), 392(0 -> 1), 401(0 -> 1), 407(0 -> 1), 414(1 -> 0), 458(0 -> 1); DELTRAN; ACCTRAN: 11(0 -> 1), 32(1 -> 0),

48(0 -> 1), 114(0 -> 1), 162(1 -> 0), 168(0 -> 1), 194(1 -> 0), 200(1 -> 2), 219(0 -> 1), 220(0 -> 1), 302(0 -> 1), 325(0 -> 1), 371(0 -> 1), 411(1 -> 0), 457(0 -> 1), 465(0 -> 1), 522(0 -> 1), 529(1 -> 0), 537(0 -> 1), 539(1 -> 0).

Charadris vociferus
Unambiguous: 31(0 -> 1), 61(1 -> 0), 65(0 -> 1), 74(0 -> 1), 112(1 -> 0), 116(0 -> 1), 132(0 -> 1), 137(0 -> 1), 161(1 -> 0), 166(0 -> 1), 188(0 -> 1), 198(0 -> 1), 225(1 -> 0), 232(0 -> 1), 256(0 -> 1), 266(0 -> 1), 268(1 -> 0), 272(0 -> 1), 276(1 -> 0), 283(0 -> 2), 287(0 -> 1), 310(0 -> 1), 347(0 -> 1), 368(0 -> 1), 397(2 -> 1), 424(0 -> 1), 425(0 -> 1), 426(1 -> 0), 427(0 -> 1), 428(0 -> 1), 441(0 -> 1), 481(0 -> 1), 493(0 -> 1), 513(2 -> 1), 520(0 -> 1); DELTRAN: 11(0 -> 1), 32(1 -> 0), 48(0 -> 1), 75(0 -> 1), 114(0 -> 1), 219(0 -> 1), 220(0 -> 1), 324(0 -> 1), 325(0 -> 1), 411(1 -> 0), 413(0 -> 1), 457(0 -> 1), 464(0 -> 2), 465(0 -> 1), 529(1 -> 0), 537(0 -> 1), 539(1 -> 0); ACCTRAN: 162(0 -> 1), 168(1 -> 0), 194(0 -> 1), 302(1 -> 0), 464(1 -> 2).

Eurypyga helias
Unambiguous: 64(0 -> 1), 66(0 -> 1), 81(1 -> 0), 82(0 -> 1), 99(0 -> 1), 131(0 -> 1), 147(0 -> 1), 148(0 -> 1), 152(2 -> 1), 174(0 -> 1), 196(0 -> 1), 201(0 -> 1), 207(0 -> 1), 209(0 -> 1), 218(0 -> 1), 236(0 -> 1), 245(0 -> 1), 303(0 -> 1), 306(1 -> 0), 334(1 -> 0), 370(0 -> 1), 396(0 -> 1), 437(0 -> 1), 438(0 -> 1); DELTRAN: 75(0 -> 2), 162(1 -> 0), 168(0 -> 1), 194(1 -> 0), 302(0 -> 1), 413(0 -> 2), 464(0 -> 1); ACCTRAN: 11(1 -> 0), 32(0 -> 1), 48(1 -> 0), 75(1 -> 2), 114(1 -> 0), 219(1 -> 0), 220(1 -> 0), 411(0 -> 1), 413(1 -> 2), 457(1 -> 0), 465(1 -> 0).

Eudromia elegans
Unambiguous: 38(0 -> 1), 39(0 -> 2), 40(0 -> 1), 46(0 -> 1), 55(0 -> 1), 62(0 -> 1), 76(0 -> 1), 86(0 -> 1), 98(0 -> 1), 105(0 -> 1), 115(1 -> 0), 121(0 -> 1), 135(0 -> 1), 144(0 -> 1), 152(2 -> 0), 192(0 -> 1), 195(0 -> 1), 199(1 -> 0), 203(1 -> 0), 204(1 -> 0), 205(0 -> 1), 210(0 -> 1), 215(1 -> 0), 360(0 -> 1), 364(0 -> 1), 383(1 -> 0), 397(2 -> 0), 400(1 -> 0), 402(3 -> 4), 478(1 -> 0); DELTRAN: 11(0 -> 1), 32(1 -> 0), 48(0 -> 1), 114(0 -> 1), 162(1 -> 0), 168(0 -> 1), 194(1 -> 0), 219(0 -> 1), 220(0 -> 1), 302(0 -> 1), 371(0 -> 1), 411(1 -> 0), 457(0 -> 1), 465(0 -> 1); ACCTRAN.

Outgroup (Charadris + Eurypyga)
Unambiguous: 51(0 -> 1), 58(0 -> 1), 77(0 -> 1), 94(0 -> 1), 104(0 -> 1), 110(0 -> 1), 117(1 -> 0), 134(0 -> 1), 182(0 -> 1), 184(1 -> 2), 229(0 -> 1), 244(0 -> 1), 270(0 -> 2), 286(0 -> 1), 305(1 -> 0), 409(0 -> 1), 429(0 -> 2), 463(2 -> 0), 477(0 -> 1), 485(1 -> 2); DELTRAN: 200(1 -> 2), 522(0 -> 1); ACCTRAN: 75(0 -> 1), 324(0 -> 1), 413(0 -> 1), 464(0 -> 1).

S3.6 Character optimisation for Analysis 3 “Stiller” constraint

Charadris vociferus
Unambiguous: 11(0 -> 1), 31(0 -> 1), 32(1 -> 0), 48(0 -> 1), 61(1 -> 0), 65(0 -> 1), 74(0 -> 1), 75(2 -> 1), 81(0 -> 1), 112(1 -> 0), 114(0 -> 1), 116(0 -> 1), 132(0 -> 1), 137(0 -> 1), 166(0 -> 1), 174(1 -> 0), 188(0 -> 1), 194(0 -> 1), 198(0 -> 1), 219(0 -> 1), 220(0 -> 1), 225(1 -> 0), 232(0 -> 1), 256(0 -> 1), 266(0 -> 1), 272(0 -> 1), 283(0 -> 2), 287(0 -> 1), 302(1 -> 0), 306(0 -> 1), 310(0 -> 1), 368(0 -> 1), 397(2 -> 1), 411(1 -> 0), 424(0 -> 1), 425(0 -> 1), 427(0 -> 1), 428(0 -> 1), 441(0 -> 1), 457(0 -> 1), 465(0 -> 1), 481(0 -> 1), 513(2 -> 1), 520(0 -> 1); DELTRAN: 152(0 -> 2), 324(0 -> 1), 325(0 -> 1), 537(0 -> 1); ACCTRAN: 152(1 -> 2).

Eurypyga helias
Unambiguous: 64(0 -> 1), 66(0 -> 1), 82(0 -> 1), 99(0 -> 1), 131(0 -> 1), 147(0 -> 1), 148(0 -> 1), 161(0 -> 1), 162(1 -> 0), 168(0 -> 1), 196(0 -> 1), 201(0 -> 1), 207(0 -> 1), 209(0 -> 1), 218(0 -> 1), 236(0 -> 1), 245(0 -> 1), 268(0 -> 1), 276(0 -> 1), 303(0 -> 1), 334(1 -> 0), 347(1 -> 0), 370(0

-> 1), 396(0 -> 1), 413(1 -> 2), 426(0 -> 1), 437(0 -> 1), 438(0 -> 1), 464(2 -> 1), 493(1 -> 0); DELTRAN: 152(0 -> 1); ACCTRAN.

Cathartes burrovianus
Unambiguous: 37(0 -> 1), 65(0 -> 1), 74(0 -> 1), 82(0 -> 1), 91(0 -> 1), 112(0 -> 1), 148(0 -> 1), 198(0 -> 1), 290(0 -> 1), 310(0 -> 1), 314(0 -> 1), 407(0 -> 1), 487(1 -> 0), 542(0 -> 1); DELTRAN: 152(0 -> 1), 325(0 -> 1), 404(1 -> 0), 491(0 -> 1); ACCTRAN: 184(1 -> 2).

Vultur gryphus
Unambiguous: 1(0 -> 1), 62(0 -> 1), 117(1 -> 0), 130(0 -> 1), 137(0 -> 1), 147(0 -> 1), 150(0 -> 1), 172(1 -> 0), 388(0 -> 1), 392(0 -> 1), 522(0 -> 1), 529(1 -> 0); DELTRAN: 152(0 -> 2), 184(2 -> 1); ACCTRAN: 152(1 -> 2), 325(1 -> 0), 404(0 -> 1), 491(1 -> 0).

Accipiter nisus
Unambiguous: 182(0 -> 1), 190(0 -> 1), 248(0 -> 1), 289(0 -> 1), 306(1 -> 0), 313(0 -> 1), 336(0 -> 1), 527(1 -> 2), 538(0 -> 1); DELTRAN: 117(1 -> 2), 181(0 -> 1), 228(0 -> 1), 347(0 -> 1); ACCTRAN: 127(1 -> 0), 129(1 -> 0), 377(0 -> 1).

Buteo rufofuscus
Unambiguous: 120(0 -> 1), 249(0 -> 1), 266(0 -> 1), 280(0 -> 1), 283(1 -> 2), 311(0 -> 1), 355(0 -> 1), 364(0 -> 1), 406(1 -> 0); DELTRAN: 127(0 -> 1), 129(0 -> 1), 377(1 -> 0); ACCTRAN: 117(2 -> 1), 181(1 -> 0), 228(1 -> 0), 347(1 -> 0).

†Palaeoplancus sternbergi
Unambiguous: 151(1 -> 0), 246(0 -> 1), 284(0 -> 1), 287(0 -> 1), 334(1 -> 0), 361(1 -> 0), 376(1 -> 0), 473(1 -> 0); DELTRAN: 347(0 -> 1), 377(1 -> 0); ACCTRAN.

Buteo + Accipiter
Unambiguous: 9(0 -> 1), 142(0 -> 1), 269(0 -> 1), 286(0 -> 1), 302(0 -> 1), 307(0 -> 1), 314(0 -> 1), 494(0 -> 1); DELTRAN: 23(0 -> 1), 61(1 -> 0), 149(0 -> 1), 150(0 -> 1), 172(1 -> 0), 203(1 -> 2), 206(0 -> 1), 257(1 -> 2), 321(0 -> 1), 388(0 -> 1), 435(2 -> 1), 441(0 -> 1), 442(0 -> 1), 512(0 -> 2), 521(1 -> 2), 530(2 -> 1); ACCTRAN.

Elanus caeruleus
Unambiguous: 54(0 -> 1), 71(1 -> 0), 105(1 -> 0), 145(0 -> 1), 188(1 -> 0), 364(0 -> 1), 455(0 -> 1), 490(0 -> 1), 491(1 -> 2); DELTRAN: 32(1 -> 0), 117(1 -> 2), 127(0 -> 1), 129(0 -> 1), 228(0 -> 1), 404(1 -> 0); ACCTRAN: 152(1 -> 0).

†Palaeoplancus + Buteo + Accipiter
Unambiguous: 283(0 -> 1); DELTRAN: 152(0 -> 1); ACCTRAN: 23(0 -> 1), 32(0 -> 1), 149(0 -> 1), 150(0 -> 1), 172(1 -> 0), 203(1 -> 2), 206(0 -> 1), 257(1 -> 2), 321(0 -> 1), 347(0 -> 1), 377(1 -> 0), 388(0 -> 1), 404(0 -> 1), 435(2 -> 1), 441(0 -> 1), 442(0 -> 1), 512(0 -> 2), 521(1 -> 2), 530(2 -> 1).

Pandion haliaetus carolinensis
Unambiguous: 35(2 -> 1), 36(1 -> 0), 62(0 -> 1), 73(0 -> 1), 74(0 -> 1), 89(0 -> 1), 101(0 -> 2), 109(0 -> 1), 112(0 -> 1), 155(0 -> 1), 162(1 -> 0), 198(0 -> 1), 226(0 -> 1), 392(0 -> 1), 397(0 -> 1), 408(1 -> 2), 413(2 -> 1), 414(1 -> 0), 452(0 -> 2), 456(0 -> 1), 476(1 -> 2), 477(0 -> 1), 481(0 -> 1), 485(1 -> 2), 486(1 -> 2), 488(1 -> 0), 513(2 -> 1), 547(1 -> 0), 548(1 -> 0); DELTRAN: 32(1 -> 0), 115(1 -> 0), 152(0 -> 1), 181(0 -> 1), 398(0 -> 1), 404(1 -> 0), 464(0 -> 2), 465(0 -> 2), 473(2 -> 0), 474(0 -> 1), 495(0 -> 2); ACCTRAN: 75(1 -> 2), 117(2 -> 1), 325(1 -> 0), 464(1 -> 2), 465(1 -> 2), 495(1 -> 2).

Elanus + †Palaeoplancus + Buteo + Accipiter

Unambiguous: 38(0 -> 1), 39(0 -> 1), 68(0 -> 1), 104(0 -> 1), 126(0 -> 1), 130(0 -> 1), 174(1 -> 0), 209(0 -> 2), 211(0 -> 1), 218(1 -> 0), 236(0 -> 1), 238(0 -> 1), 250(0 -> 1), 254(1 -> 0), 264(0 -> 1), 276(1 -> 0), 323(0 -> 1), 370(0 -> 1), 409(0 -> 1), 445(0 -> 1); DELTRAN: 75(2 -> 1), 116(0 -> 1), 325(0 -> 1), 464(0 -> 1), 465(0 -> 1), 473(2 -> 1), 474(0 -> 2), 495(0 -> 1); ACCTRAN: 61(1 -> 0), 115(0 -> 1), 127(0 -> 1), 129(0 -> 1), 228(0 -> 1), 398(1 -> 0), 473(0 -> 1), 474(1 -> 2).

Sagittarius serpentarius
Unambiguous: 5(0 -> 1), 23(0 -> 1), 33(0 -> 1), 76(0 -> 1), 101(0 -> 1), 114(0 -> 1), 149(0 -> 1), 153(0 -> 1), 172(1 -> 0), 187(0 -> 1), 206(0 -> 1), 289(0 -> 1), 317(1 -> 0), 377(1 -> 0), 385(0 -> 1), 388(0 -> 1), 393(0 -> 1), 413(2 -> 0), 425(0 -> 1), 512(0 -> 2), 522(0 -> 1); DELTRAN: 30(0 -> 1), 46(0 -> 1), 75(2 -> 0), 81(0 -> 1), 95(2 -> 1), 115(1 -> 0), 117(1 -> 2), 159(0 -> 1), 184(2 -> 0), 188(1 -> 0), 194(0 -> 1), 208(0 -> 1), 210(0 -> 1), 244(0 -> 2), 398(0 -> 1), 493(1 -> 0), 540(1 -> 0); ACCTRAN: 152(1 -> 0), 184(1 -> 0), 244(1 -> 2), 258(1 -> 0), 306(1 -> 0), 404(0 -> 1), 491(1 -> 0).

Pandion + Elanus + †Palaeoplancus + Buteo + Accipiter
Unambiguous: 173(0 -> 1), 196(0 -> 1), 223(0 -> 1), 243(0 -> 1), 371(0 -> 1), 391(0 -> 1), 406(0 -> 1), 447(1 -> 0), 453(1 -> 0), 460(1 -> 0), 463(2 -> 1), 471(0 -> 1), 472(1 -> 0), 487(1 -> 0), 521(0 -> 1), 526(0 -> 1), 527(0 -> 1), 528(0 -> 2), 529(1 -> 2), 530(0 -> 2), 542(0 -> 2), 543(0 -> 1); DELTRAN: 184(2 -> 1), 244(0 -> 1), 258(0 -> 1), 306(0 -> 1), 491(0 -> 1); ACCTRAN: 30(1 -> 0), 32(1 -> 0), 46(1 -> 0), 75(0 -> 1), 81(1 -> 0), 95(1 -> 2), 159(1 -> 0), 188(0 -> 1), 194(1 -> 0), 208(1 -> 0), 210(1 -> 0), 464(0 -> 1), 465(0 -> 1), 473(2 -> 0), 474(0 -> 1), 493(0 -> 1), 495(0 -> 1), 540(0 -> 1).

Cathartidae
Unambiguous: 6(0 -> 1), 10(0 -> 1), 15(1 -> 0), 35(2 -> 0), 36(1 -> 0), 73(0 -> 2), 77(1 -> 0), 100(0 -> 1), 109(0 -> 1), 110(0 -> 1), 121(0 -> 1), 155(0 -> 1), 166(0 -> 1), 183(0 -> 2), 200(1 -> 2), 226(0 -> 1), 227(0 -> 1), 246(0 -> 1), 252(1 -> 0), 305(0 -> 1), 311(0 -> 1), 364(0 -> 1), 368(0 -> 1), 376(1 -> 0), 380(0 -> 1), 387(0 -> 1), 396(0 -> 1), 456(0 -> 1), 500(0 -> 1), 545(1 -> 0), 548(1 -> 0); DELTRAN: 25(1 -> 0), 30(0 -> 1), 39(0 -> 2), 46(0 -> 1), 48(0 -> 2), 75(2 -> 0), 81(0 -> 1), 95(2 -> 0), 106(0 -> 1), 142(0 -> 1), 159(0 -> 1), 188(1 -> 0), 194(0 -> 1), 208(0 -> 1), 210(0 -> 1), 258(0 -> 1), 306(0 -> 1), 450(0 -> 1), 493(1 -> 0), 540(1 -> 0), 549(1 -> 0); ACCTRAN: 19(1 -> 0), 48(1 -> 2), 181(1 -> 0), 259(1 -> 0), 397(0 -> 2).

Sagittarius + Pandion + Elanus + †Palaeoplancus + Buteo + Accipiter
Unambiguous: 71(0 -> 1), 105(0 -> 1), 151(0 -> 1), 214(0 -> 1), 395(0 -> 1), 435(1 -> 2); DELTRAN: 19(0 -> 1), 48(0 -> 1), 259(0 -> 1), 397(2 -> 0), 518(0 -> 1); ACCTRAN: 25(0 -> 1), 39(2 -> 0), 95(0 -> 1), 106(1 -> 0), 115(1 -> 0), 116(0 -> 1), 117(1 -> 2), 142(1 -> 0), 244(0 -> 1), 398(0 -> 1), 450(1 -> 0), 549(0 -> 1).

†Danielsraptor phorusrhacoides
Unambiguous: 177(1 -> 0), 214(0 -> 1); DELTRAN: 39(0 -> 2), 111(0 -> 1), 139(0 -> 1), 142(0 -> 1), 189(0 -> 1), 196(0 -> 1), 248(0 -> 1), 391(0 -> 1), 392(0 -> 1), 408(1 -> 0), 525(0 -> 1), 542(0 -> 1); ACCTRAN.

†Masillaraptor cf parvunguis
Unambiguous: 217(0 -> 1), 224(0 -> 1), 457(0 -> 1); DELTRAN: 198(0 -> 2), 229(0 -> 1), 230(0 -> 1), 257(1 -> 0), 259(0 -> 1), 277(0 -> 1), 303(0 -> 1), 325(0 -> 1), 445(0 -> 1); ACCTRAN.

†Masillaraptor parvunguis
Unambiguous: 129(0 -> 1), 529(1 -> 2); DELTRAN: 55(0 -> 1), 513(2 -> 1); ACCTRAN.

†Danielsraptor + †Masillaraptor

Unambiguous: 495(0 -> 1); DELTRAN: 215(1 -> 2), 220(0 -> 1), 423(0 -> 1), 447(1 -> 0), 450(0 -> 1), 491(0 -> 1); ACCTRAN: 525(0 -> 1), 542(0 -> 1).

Accipitriformes
Unambiguous: 186(0 -> 1), 218(0 -> 1), 228(1 -> 0), 238(1 -> 0), 245(1 -> 2), 254(0 -> 1), 260(1 -> 0), 276(0 -> 1), 347(1 -> 0), 370(1 -> 0), 414(0 -> 1), 426(0 -> 1), 437(1 -> 0), 528(1 -> 0), 530(1 -> 0), 539(0 -> 1), 547(0 -> 1); DELTRAN: 58(1 -> 0), 329(1 -> 0), 402(1 -> 2), 512(1 -> 0); ACCTRAN: 30(0 -> 1), 46(0 -> 1), 75(2 -> 0), 81(0 -> 1), 152(0 -> 1), 184(2 -> 1), 188(1 -> 0), 194(0 -> 1), 196(1 -> 0), 306(0 -> 1), 493(1 -> 0), 518(0 -> 1), 521(1 -> 0), 540(1 -> 0).

Masillaraptoridae
Unambiguous: 12(0 -> 1), 136(0 -> 1), 145(0 -> 1), 232(0 -> 1), 474(0 -> 1); DELTRAN: 106(0 -> 1), 181(0 -> 1), 521(0 -> 1), 549(1 -> 0); ACCTRAN: 55(0 -> 1), 111(0 -> 1), 139(0 -> 1), 189(0 -> 1), 198(0 -> 2), 215(1 -> 2), 220(0 -> 1), 229(0 -> 1), 230(0 -> 1), 248(0 -> 1), 257(1 -> 0), 277(0 -> 1), 303(0 -> 1), 329(0 -> 1), 391(0 -> 1), 392(0 -> 1), 408(1 -> 0), 423(0 -> 1), 445(0 -> 1), 447(1 -> 0), 512(0 -> 1), 513(2 -> 1).

Strix aluco
Unambiguous: 49(0 -> 2), 142(0 -> 1), 198(0 -> 2), 200(1 -> 2), 214(0 -> 1), 218(0 -> 1), 243(0 -> 1), 249(0 -> 1), 250(0 -> 1), 303(0 -> 1), 311(0 -> 1), 313(0 -> 1), 373(0 -> 1), 380(0 -> 1), 395(0 -> 1), 424(0 -> 1), 429(0 -> 1), 447(1 -> 0), 448(0 -> 1); DELTRAN: 95(2 -> 0), 189(0 -> 1), 196(0 -> 1), 209(0 -> 2), 270(1 -> 0), 449(0 -> 1); ACCTRAN: 82(1 -> 0), 217(1 -> 0), 224(1 -> 0), 404(0 -> 1).

Tyto alba
Unambiguous: 36(1 -> 0), 48(0 -> 1), 87(1 -> 0), 88(0 -> 1), 121(0 -> 1), 161(0 -> 1), 184(2 -> 1), 188(1 -> 0), 203(1 -> 0), 206(0 -> 1), 236(0 -> 1), 255(0 -> 1), 265(0 -> 1), 302(0 -> 1), 324(0 -> 1), 355(0 -> 1), 357(0 -> 1), 377(0 -> 1), 378(0 -> 1), 413(2 -> 1), 435(1 -> 2), 474(2 -> 1), 527(1 -> 2), 534(1 -> 0); DELTRAN: 82(0 -> 1), 209(0 -> 1), 217(0 -> 1), 224(0 -> 1), 270(1 -> 2), 404(1 -> 0), 434(0 -> 1); ACCTRAN: 95(0 -> 2), 196(1 -> 0), 209(2 -> 1), 270(0 -> 2), 449(1 -> 0).

†Ypresiglaux michaeldanielsi
Unambiguous: 35(2 -> 1), 112(1 -> 0), 115(1 -> 0), 123(0 -> 1), 126(0 -> 1), 166(0 -> 1), 199(1 -> 0), 219(0 -> 1), 220(0 -> 1), 222(0 -> 1), 230(0 -> 1), 232(0 -> 1), 242(0 -> 1), 247(0 -> 1), 252(1 -> 2), 284(0 -> 1), 358(0 -> 1), 361(1 -> 0), 481(0 -> 1), 485(1 -> 2), 492(1 -> 0), 504(0 -> 1); DELTRAN: 162(1 -> 0), 164(0 -> 1), 217(0 -> 1), 224(0 -> 1), 460(1 -> 0), 490(0 -> 1); ACCTRAN: 201(1 -> 0), 433(1 -> 0), 434(1 -> 0), 455(1 -> 0), 487(0 -> 1), 496(1 -> 0).

Strigiformes
Unambiguous: 37(0 -> 2), 119(0 -> 1), 147(0 -> 1), 160(0 -> 1), 165(0 -> 1), 169(1 -> 0), 215(1 -> 2), 244(0 -> 1), 245(1 -> 2), 264(0 -> 1), 331(0 -> 1), 341(0 -> 1), 452(0 -> 2), 453(0 -> 1), 468(0 -> 1), 521(1 -> 0); DELTRAN: 4(0 -> 2), 8(0 -> 1), 19(0 -> 1), 23(0 -> 1), 27(0 -> 1), 32(1 -> 0), 38(0 -> 1), 39(0 -> 2), 46(0 -> 1), 52(1 -> 2), 54(0 -> 1), 60(0 -> 1), 61(1 -> 0), 69(0 -> 1), 70(0 -> 2), 71(0 -> 2), 75(2 -> 0), 76(0 -> 1), 81(0 -> 1), 89(0 -> 1), 101(0 -> 1), 102(0 -> 1), 104(0 -> 1), 132(0 -> 1), 134(0 -> 1), 173(0 -> 1), 183(0 -> 2), 201(0 -> 1), 276(0 -> 1), 283(0 -> 1), 299(0 -> 1), 327(1 -> 0), 346(0 -> 1), 365(0 -> 1), 371(0 -> 1), 381(0 -> 1), 390(0 -> 1), 391(0 -> 1), 393(0 -> 1), 397(2 -> 0), 405(0 -> 1), 426(0 -> 1), 433(0 -> 1), 455(0 -> 1), 469(0 -> 1), 487(1 -> 0), 496(0 -> 1), 525(0 -> 1), 535(0 -> 1); ACCTRAN: 162(0 -> 1), 164(1 -> 0), 189(0 -> 1), 460(0 -> 1), 490(1 -> 0).

†Primoptynx poliotauros
Unambiguous: 214(0 -> 1), 218(0 -> 1), 266(0 -> 1), 311(0 -> 1), 348(0 -> 1), 421(0 -> 1), 485(1 -> 0), 488(1 -> 0), 493(1 -> 0); DELTRAN: 433(0 -> 1), 434(0 -> 1), 470(0 -> 1), 473(1 -> 0), 487(1 -> 0), 490(0 -> 1); ACCTRAN: 473(2 -> 0).

†Ypresiglaux + Strigiformes
Unambiguous: 226(0 -> 1), 286(0 -> 1), 289(0 -> 1), 471(0 -> 1), 474(0 -> 2), 476(1 -> 2); DELTRAN: 151(0 -> 1), 229(0 -> 1), 473(1 -> 2), 477(0 -> 1), 486(1 -> 2); ACCTRAN: 217(0 -> 1), 224(0 -> 1), 270(1 -> 0), 276(0 -> 1), 299(0 -> 1), 365(0 -> 1), 470(1 -> 0), 535(0 -> 1).

†Avolatavis europaeus
Unambiguous; DELTRAN: 423(0 -> 1), 470(0 -> 2), 500(0 -> 1); ACCTRAN.

† Avolatavis tenens
Unambiguous: 516(0 -> 1); DELTRAN: 177(0 -> 1), 397(2 -> 1), 400(1 -> 0), 404(1 -> 0), 410(0 -> 1), 537(0 -> 1); ACCTRAN.

† Pulchrapollia eximia
Unambiguous: 329(0 -> 1), 452(0 -> 1), 471(0 -> 1); DELTRAN: 55(0 -> 1), 110(0 -> 1), 111(0 -> 1), 115(1 -> 0), 123(0 -> 1), 203(1 -> 0), 248(0 -> 1), 252(1 -> 2), 260(1 -> 0), 277(0 -> 1), 511(0 -> 1); ACCTRAN: 379(1 -> 0).

† Pulchrapollia gracilis
Unambiguous; DELTRAN: 379(0 -> 1), 534(1 -> 0); ACCTRAN.

† cf Pulchrapollia gracilis
Unambiguous; DELTRAN: 182(0 -> 1), 191(0 -> 1); ACCTRAN.

† Pulchrapollia gracilis + † Pulchrapollia eximia
Unambiguous: 272(0 -> 1); DELTRAN: 302(0 -> 1), 303(0 -> 1), 358(0 -> 1), 360(0 -> 1), 365(0 -> 1); ACCTRAN: 248(0 -> 1), 277(0 -> 1), 511(0 -> 1).

† cf Pulchrapollia gracilis + † cf Pulchrapollia
Unambiguous; DELTRAN; ACCTRAN: 191(0 -> 1).

†Cyrilavis colburnorum
Unambiguous: 33(0 -> 1), 112(1 -> 0), 128(1 -> 0), 197(0 -> 1), 355(0 -> 1), 421(0 -> 1), 425(0 -> 1), 447(1 -> 0), 454(0 -> 1); DELTRAN: 13(1 -> 0), 40(1 -> 0), 152(1 -> 0), 245(1 -> 2), 379(0 -> 1), 384(0 -> 1), 397(2 -> 1), 401(0 -> 1), 453(0 -> 1), 537(0 -> 1), 540(1 -> 0); ACCTRAN: 110(1 -> 0).

† cf Pulchrapollia gracilis + † cf Pulchrapollia + † Pulchrapollia gracilis + † Pulchrapollia eximia
Unambiguous: 232(1 -> 0), 458(0 -> 1), 480(0 -> 1), 504(0 -> 1); DELTRAN: 201(0 -> 1), 423(0 -> 1), 424(0 -> 1), 459(0 -> 1); ACCTRAN: 55(0 -> 1), 245(2 -> 1), 252(1 -> 2), 260(1 -> 0), 302(0 -> 1), 303(0 -> 1), 358(0 -> 1), 397(1 -> 2), 453(1 -> 0), 534(1 -> 0).

†Cyrilavis cf colburnorum
Unambiguous: 142(0 -> 1), 183(0 -> 1), 255(0 -> 1), 431(0 -> 1), 499(1 -> 0); DELTRAN: 110(0 -> 1), 148(0 -> 1), 149(0 -> 1), 190(0 -> 1), 245(1 -> 2), 370(1 -> 0), 453(0 -> 1); ACCTRAN: 360(1 -> 0).

†Cyrilavis colburnorum + † cf Pulchrapollia gracilis + † cf Pulchrapollia + † Pulchrapollia gracilis + † Pulchrapollia eximia
Unambiguous: 228(0 -> 1), 229(0 -> 1), 230(0 -> 1); DELTRAN: 32(1 -> 0), 407(0 -> 1); ACCTRAN: 152(1 -> 0), 182(0 -> 1), 190(1 -> 0), 365(0 -> 1), 370(0 -> 1).

†Pseudasturides macrocephalus

Unambiguous: 8(0 -> 1), 59(0 -> 2), 154(0 -> 1), 226(0 -> 1), 270(2 -> 0), 316(0 -> 1), 371(0 -> 1), 377(0 -> 1), 444(0 -> 1), 470(1 -> 2), 509(0 -> 1), 510(0 -> 1), 512(0 -> 1), 513(0 -> 1); DELTRAN: 15(1 -> 0), 190(0 -> 1), 250(0 -> 1), 376(1 -> 0), 440(0 -> 1); ACCTRAN: 13(0 -> 1), 220(1 -> 0), 537(1 -> 0).

†Cyrilavis cf colburnorum + †Cyrilavis colburnorum + † cf Pulchrapollia gracilis + † cf Pulchrapollia + † Pulchrapollia gracilis + † Pulchrapollia eximia
Unambiguous: 146(0 -> 1), 215(1 -> 2), 217(0 -> 1), 334(0 -> 1), 473(1 -> 0); DELTRAN: 220(0 -> 1); ACCTRAN: 15(0 -> 1), 32(1 -> 0), 245(1 -> 2), 250(1 -> 0), 376(0 -> 1), 379(0 -> 1), 384(0 -> 1), 440(1 -> 0), 453(0 -> 1), 459(0 -> 1), 540(1 -> 0).

†Cyrilavis olsoni
Unambiguous: 182(0 -> 1); DELTRAN: 454(0 -> 1); ACCTRAN.

†Serudaptus pohli
Unambiguous: 151(0 -> 1), 244(0 -> 1), 278(0 -> 1), 511(0 -> 1); DELTRAN: 1(0 -> 1), 13(1 -> 0), 15(1 -> 0), 49(0 -> 1), 52(1 -> 0), 252(1 -> 0), 396(1 -> 0), 431(0 -> 1), 526(0 -> 1); ACCTRAN.

†Pseudasturides + †Cyrilavis cf colburnorum +++
Unambiguous: 232(0 -> 1), 307(0 -> 1), 521(1 -> 0), 543(1 -> 0); DELTRAN: 31(0 -> 1), 224(0 -> 1), 455(1 -> 0), 460(0 -> 1), 481(0 -> 1), 545(1 -> 0); ACCTRAN.

†Cyrilavis olsoni + †Serudaptus pohli
Unambiguous: 183(0 -> 1); DELTRAN: 250(0 -> 1); ACCTRAN: 1(0 -> 1), 49(0 -> 1), 52(1 -> 0), 252(1 -> 0), 396(1 -> 0), 431(0 -> 1), 454(0 -> 1), 526(0 -> 1).

†Tynskya crassitarsus
Unambiguous; DELTRAN: 196(0 -> 1), 416(1 -> 0), 418(0 -> 1); ACCTRAN.

†Tynskya waltonensis
Unambiguous: 215(1 -> 2); DELTRAN: 164(0 -> 1), 166(0 -> 1), 170(0 -> 1), 217(0 -> 1); ACCTRAN.

†Tynskya crassitarsus + †Tynskya eocaena
Unambiguous; DELTRAN; ACCTRAN: 416(1 -> 0).

†Tynskya brevitarsus
Unambiguous: 250(0 -> 1); DELTRAN: 266(0 -> 1), 268(0 -> 1), 271(0 -> 1); ACCTRAN.

†Tynskya waltonensis + †Tynskya crassitarsus + †Tynskya eocaena
Unambiguous; DELTRAN: 116(0 -> 1), 129(0 -> 1), 130(0 -> 1), 259(0 -> 2), 317(1 -> 0); ACCTRAN.

†Messelastur gratulator
Unambiguous: 112(1 -> 0), 151(0 -> 1), 169(1 -> 0), 260(1 -> 0), 347(0 -> 1), 355(0 -> 1), 356(0 -> 1), 425(0 -> 1), 474(1 -> 2), 477(0 -> 1), 489(1 -> 0), 492(1 -> 0), 499(1 -> 0), 504(0 -> 1), 512(0 -> 1); DELTRAN: 4(0 -> 2), 5(1 -> 0), 9(0 -> 1), 19(0 -> 1), 58(1 -> 0), 277(0 -> 1), 300(0 -> 1), 315(0 -> 1), 360(0 -> 1), 370(1 -> 0), 411(1 -> 0), 427(0 -> 1), 519(0 -> 1), 537(0 -> 1), 544(0 -> 1); ACCTRAN.

†Tynskya brevitarsus + †Tynskya waltonensis + †Tynskya crassitarsus + †Tynskya eocaena
Unambiguous: 219(0 -> 1); DELTRAN: 229(0 -> 1), 440(0 -> 1), 467(0 -> 1); ACCTRAN: 217(0 -> 1), 259(0 -> 2), 317(1 -> 0), 537(1 -> 0).

Halcyornithidae
Unambiguous: 17(1 -> 0), 25(0 -> 1), 152(0 -> 1), 314(0 -> 1), 523(0 -> 1); DELTRAN; ACCTRAN: 13(1 -> 0), 15(1 -> 0), 19(1 -> 0), 110(0 -> 1), 111(0 -> 1), 115(1 -> 0), 123(0 -> 1), 148(0 -> 1), 149(0 -> 1), 190(0 -> 1), 203(1 -> 0), 224(0 -> 1), 268(1 -> 0), 424(0 -> 1), 455(1 -> 0), 545(1 -> 0).

Messelasturidae
Unambiguous: 140(0 -> 1), 463(0 -> 1), 464(2 -> 1), 491(0 -> 1), 493(0 -> 1), 513(0 -> 1), 525(0 -> 1), 542(0 -> 1); DELTRAN: 220(0 -> 1), 376(1 -> 0), 460(0 -> 2), 541(0 -> 1); ACCTRAN: 4(0 -> 2), 5(1 -> 0), 9(0 -> 1), 58(1 -> 0), 129(0 -> 1), 130(0 -> 1), 166(0 -> 1), 229(0 -> 1), 250(1 -> 0), 266(0 -> 1), 271(0 -> 1), 277(0 -> 1), 300(0 -> 1), 418(0 -> 1), 423(1 -> 0), 427(0 -> 1), 460(1 -> 2), 467(0 -> 1), 481(1 -> 0), 519(0 -> 1), 544(0 -> 1).

†Quercypsitta sudrei
Unambiguous: 434(0 -> 1), 435(1 -> 2), 471(0 -> 1), 473(1 -> 0), 476(1 -> 0), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0), 492(1 -> 0), 496(1 -> 2), 504(0 -> 1), 517(0 -> 1); DELTRAN: 218(0 -> 1), 225(0 -> 1), 481(0 -> 1); ACCTRAN.

Messelasturidae + Halcyornithidae
Unambiguous: 474(0 -> 1), 497(1 -> 0), 508(0 -> 1); DELTRAN: 108(0 -> 1), 120(0 -> 1), 128(0 -> 1), 162(1 -> 0), 270(1 -> 2), 408(1 -> 0), 468(0 -> 1); ACCTRAN: 218(1 -> 0), 220(0 -> 1), 225(1 -> 0), 360(0 -> 1), 440(0 -> 1), 460(0 -> 1).

†Quercypsitta + Messelasturidae + Halcyornithidae
Unambiguous: 347(1 -> 0), 478(1 -> 0), 479(0 -> 2), 489(0 -> 1), 499(0 -> 1), 503(1 -> 0), 511(1 -> 0); DELTRAN: 495(2 -> 3); ACCTRAN: 270(1 -> 2), 370(1 -> 0), 376(1 -> 0), 468(0 -> 1), 481(0 -> 1), 495(1 -> 3).

†Vastanavis tenes + †Vastanavis cambayensis
Unambiguous: 217(0 -> 1), 248(0 -> 1), 260(1 -> 0), 267(0 -> 1), 297(0 -> 1), 377(0 -> 1), 379(0 -> 1), 437(1 -> 0), 446(0 -> 1), 458(0 -> 1), 490(0 -> 1), 491(0 -> 2), 543(1 -> 0), 549(1 -> 0); DELTRAN: 218(0 -> 1), 225(0 -> 1), 250(0 -> 1), 268(0 -> 1), 353(2 -> 0), 495(2 -> 1); ACCTRAN.

†Eurofluvioviridavis robustipes
Unambiguous: 1(0 -> 1), 180(0 -> 1), 227(0 -> 1), 230(0 -> 1), 276(0 -> 1), 369(0 -> 1), 383(1 -> 0), 454(0 -> 1), 465(1 -> 2), 476(1 -> 0), 530(1 -> 2), 542(0 -> 1); DELTRAN: 82(0 -> 1), 537(0 -> 2), 547(0 -> 1); ACCTRAN: 537(1 -> 2).

†Vastanavis tenes + †Vastanavis cambayensis + †Quercypsitta + Messelasturidae + Halcyornithidae
Unambiguous: 228(1 -> 0), 361(1 -> 0); DELTRAN: 254(0 -> 1), 257(1 -> 0), 470(0 -> 1); ACCTRAN: 218(0 -> 1), 225(0 -> 1), 495(2 -> 1), 547(1 -> 0).

†Avolatavis tenes + †Avolatavis europaeus
Unambiguous: 483(0 -> 1), 514(0 -> 1); DELTRAN: 434(0 -> 1), 547(0 -> 1); ACCTRAN: 400(1 -> 0), 470(1 -> 2), 500(0 -> 1).

Eurofluvioviridavis + †Vastanavis tenes + †Vastanavis cambayensis + †Quercypsitta + Messelasturidae + Halcyornithidae
Unambiguous: 179(1 -> 0), 493(1 -> 0); DELTRAN: 86(0 -> 1), 334(1 -> 0); ACCTRAN: 177(1 -> 0), 404(0 -> 1), 407(0 -> 1), 408(1 -> 0), 411(1 -> 0), 434(1 -> 0).

†Primoptynx + †Ypresiglaux + Strigiformes

Unambiguous: 272(0 -> 1), 436(0 -> 1), 440(0 -> 1), 463(0 -> 1), 464(2 -> 1), 528(1 -> 2), 529(1 -> 2), 530(1 -> 2), 539(0 -> 2), 542(0 -> 2), 544(0 -> 1); DELTRAN; ACCTRAN: 8(0 -> 1), 23(0 -> 1), 27(0 -> 1), 32(1 -> 0), 38(0 -> 1), 46(0 -> 1), 52(1 -> 2), 54(0 -> 1), 60(0 -> 1), 75(2 -> 0), 76(0 -> 1), 81(0 -> 1), 89(0 -> 1), 101(0 -> 1), 104(0 -> 1), 132(0 -> 1), 134(0 -> 1), 151(0 -> 1), 173(0 -> 1), 183(0 -> 2), 229(0 -> 1), 371(0 -> 1), 381(0 -> 1), 390(0 -> 1), 391(0 -> 1), 393(0 -> 1), 405(0 -> 1), 426(0 -> 1), 433(0 -> 1), 469(0 -> 1), 477(0 -> 1), 486(1 -> 2), 487(1 -> 0), 490(0 -> 1), 525(0 -> 1).

†Avolatavis tenes + †Avolatavis europaeus + †Eurofluvioviridavis + †Vastanavis tenes + †Vastanavis cambayensis + †Quercypsitta + Messelasturidae + Halcyornithidae
Unambiguous: 416(0 -> 1), 503(0 -> 1), 511(0 -> 1), 513(2 -> 0); DELTRAN: 449(0 -> 1), 455(0 -> 1), 460(1 -> 0), 496(0 -> 1); ACCTRAN: 4(2 -> 0), 31(0 -> 1), 39(2 -> 0), 40(1 -> 0), 86(0 -> 1), 108(0 -> 1), 116(0 -> 1), 120(0 -> 1), 128(0 -> 1), 170(0 -> 1), 250(0 -> 1), 254(0 -> 1), 257(1 -> 0), 268(0 -> 1), 315(0 -> 1), 334(1 -> 0), 397(0 -> 1), 401(0 -> 1), 410(0 -> 1), 423(0 -> 1), 473(2 -> 1), 537(0 -> 1), 541(0 -> 1), 547(0 -> 1).

Masillaraptoridae + Accipitriformes
Unambiguous: 5(1 -> 0), 112(1 -> 0), 180(0 -> 1), 377(0 -> 1), 463(0 -> 2), 464(2 -> 0), 492(1 -> 0); DELTRAN: 4(0 -> 2), 177(0 -> 1), 473(1 -> 2); ACCTRAN: 48(0 -> 1), 58(1 -> 0), 61(0 -> 1), 102(1 -> 0), 106(0 -> 1), 142(0 -> 1), 159(0 -> 1), 181(0 -> 1), 201(1 -> 0), 208(0 -> 1), 209(2 -> 0), 210(0 -> 1), 258(0 -> 1), 283(1 -> 0), 325(0 -> 1), 327(0 -> 1), 396(1 -> 0), 402(1 -> 2), 450(0 -> 1), 456(1 -> 0), 470(1 -> 0), 491(0 -> 1), 495(2 -> 0), 496(1 -> 0), 527(1 -> 0), 534(1 -> 0), 549(1 -> 0).

†Primoptynx + †Ypresiglaux + Strigiformes +++
Unambiguous: 13(0 -> 1), 17(0 -> 1), 169(0 -> 1), 174(1 -> 0), 305(0 -> 1), 453(1 -> 0), 465(0 -> 1), 472(1 -> 0), 543(0 -> 1); DELTRAN: 25(1 -> 0), 329(1 -> 0), 396(0 -> 1), 456(0 -> 1), 495(0 -> 2), 512(1 -> 0), 521(0 -> 1), 527(0 -> 1), 534(0 -> 1); ACCTRAN: 69(0 -> 1), 70(0 -> 2), 71(0 -> 2), 82(0 -> 1), 162(1 -> 0), 164(0 -> 1), 259(1 -> 0), 346(0 -> 1), 434(0 -> 1), 449(0 -> 1), 455(0 -> 1), 460(1 -> 0).

Colius striatus kiwuensis
Unambiguous: 80(0 -> 2), 101(2 -> 1), 109(0 -> 1), 132(0 -> 1), 151(0 -> 1), 334(1 -> 0), 365(0 -> 1); DELTRAN: 61(1 -> 0), 157(0 -> 1), 163(0 -> 1), 165(0 -> 1), 228(1 -> 0), 244(0 -> 1), 281(1 -> 0), 534(0 -> 1), 539(0 -> 2); ACCTRAN.

Urocolius macrourus pulcher
Unambiguous: 34(0 -> 1), 191(0 -> 1), 199(1 -> 0), 247(0 -> 1); DELTRAN: 244(0 -> 2); ACCTRAN: 228(0 -> 1), 244(1 -> 2), 281(0 -> 1).

†Masillacolius brevidactylus
Unambiguous: 280(0 -> 1), 341(0 -> 1), 354(0 -> 1), 453(1 -> 0), 488(1 -> 0), 501(0 -> 2), 514(0 -> 1); DELTRAN: 228(1 -> 0), 281(1 -> 0), 472(1 -> 0), 521(0 -> 1); ACCTRAN: 4(1 -> 0), 259(1 -> 0), 490(1 -> 0).

Coliiformes
Unambiguous: 1(1 -> 0), 15(0 -> 1), 113(0 -> 1), 134(0 -> 1), 218(0 -> 1), 233(0 -> 1), 250(0 -> 1), 251(0 -> 1), 336(0 -> 1), 452(0 -> 2), 454(0 -> 1), 543(0 -> 1); DELTRAN: 4(0 -> 1), 23(0 -> 1), 27(0 -> 1), 32(1 -> 0), 48(0 -> 2), 66(0 -> 1), 102(0 -> 1), 104(0 -> 1), 107(0 -> 1), 114(0 -> 1), 122(0 -> 1), 124(0 -> 1), 142(0 -> 1), 167(0 -> 1), 176(0 -> 1), 178(0 -> 1), 201(0 -> 1), 203(1 -> 0), 205(0 -> 1), 242(0 -> 1), 257(1 -> 2), 259(0 -> 1), 262(0 -> 1), 263(0 -> 1), 264(0 -> 1), 266(0 -> 1), 267(0 -> 1), 271(0 -> 1), 277(0 -> 1), 282(0 -> 1), 295(0 -> 1), 305(0 -> 1), 307(0 -> 1), 327(1 -> 0), 366(0 -> 1), 371(0 -> 1), 381(0 -> 1), 386(0 -> 1), 389(0 -> 1), 395(0 -> 1), 397(2 -> 0), 403(0 -> 1), 409(0 -> 1), 411(1 -> 0), 413(1 -> 0), 417(0 -> 1), 424(0 -> 1), 428(0 -> 1), 440(0

-> 1), 441(0 -> 2), 448(0 -> 1), 464(2 -> 1), 476(1 -> 0), 490(0 -> 1), 493(1 -> 0); ACCTRAN: 244(0 -> 1), 472(0 -> 1), 521(1 -> 0), 539(0 -> 2).

†Eoglaucidium cf pallas
Unambiguous: 25(1 -> 0), 55(0 -> 1), 254(0 -> 1), 347(1 -> 0), 465(2 -> 1), 474(0 -> 1), 491(0 -> 1), 503(0 -> 1), 515(0 -> 1); DELTRAN: 4(0 -> 1), 259(0 -> 1), 260(1 -> 0), 472(1 -> 0), 490(0 -> 1), 521(0 -> 1); ACCTRAN: 201(1 -> 0), 487(0 -> 1).

†Masillacolius brevidactylus + Coliiformes
Unambiguous: 137(0 -> 1), 225(0 -> 1), 269(0 -> 1), 278(0 -> 1), 331(0 -> 1); DELTRAN: 252(1 -> 2), 332(0 -> 1), 487(1 -> 0); ACCTRAN: 32(1 -> 0), 107(0 -> 1), 114(0 -> 1), 142(0 -> 1), 167(0 -> 1), 176(0 -> 1), 205(0 -> 1), 228(1 -> 0), 242(0 -> 1), 257(1 -> 2), 260(0 -> 1), 263(0 -> 1), 266(0 -> 1), 277(0 -> 1), 281(1 -> 0), 282(0 -> 1), 307(0 -> 1), 371(0 -> 1), 381(0 -> 1), 395(0 -> 1), 464(2 -> 1), 493(1 -> 0).

Apaloderma narina
Unambiguous: 45(0 -> 1), 162(1 -> 0), 181(0 -> 1), 182(0 -> 1), 231(0 -> 1), 283(1 -> 2), 339(0 -> 1), 434(0 -> 1), 465(2 -> 1); DELTRAN; ACCTRAN: 183(1 -> 0), 257(2 -> 1), 286(1 -> 0), 303(1 -> 0), 512(0 -> 1).

Trogon melanurus eumorphus
Unambiguous: 191(0 -> 1), 215(2 -> 1), 230(0 -> 1), 251(0 -> 1), 302(1 -> 0), 414(0 -> 1), 426(0 -> 1), 427(0 -> 1), 429(0 -> 1), 447(0 -> 1), 452(0 -> 1); DELTRAN: 61(1 -> 0), 183(0 -> 1), 257(1 -> 2), 286(0 -> 1), 303(0 -> 1), 512(1 -> 0), 538(0 -> 1); ACCTRAN.

Eotrogon stenorhynchus
Unambiguous: 109(0 -> 1), 219(0 -> 1), 222(0 -> 1), 248(0 -> 1), 250(0 -> 1), 264(0 -> 1), 307(1 -> 0), 366(1 -> 0), 456(1 -> 0); DELTRAN: 303(0 -> 1), 379(0 -> 1), 512(1 -> 0); ACCTRAN: 14(1 -> 0), 114(1 -> 0), 226(1 -> 0).

Trogoniformes
Unambiguous: 4(0 -> 1), 5(1 -> 0), 19(0 -> 1), 80(0 -> 1), 128(0 -> 1), 151(0 -> 1), 214(0 -> 1), 256(0 -> 1), 259(0 -> 1), 260(0 -> 1), 304(0 -> 1), 357(0 -> 1), 373(0 -> 1), 438(0 -> 1), 441(1 -> 2), 455(0 -> 2), 462(0 -> 1), 470(1 -> 2), 473(1 -> 0), 488(1 -> 0), 507(0 -> 1); DELTRAN: 1(1 -> 0), 8(0 -> 1), 14(0 -> 1), 28(1 -> 2), 33(1 -> 0), 47(1 -> 0), 55(0 -> 2), 56(0 -> 1), 66(0 -> 1), 70(0 -> 2), 71(0 -> 3), 72(0 -> 1), 75(2 -> 0), 76(0 -> 1), 82(0 -> 1), 88(0 -> 1), 95(0 -> 1), 101(2 -> 0), 102(2 -> 3), 105(1 -> 0), 114(0 -> 1), 117(1 -> 0), 131(0 -> 1), 134(0 -> 1), 146(0 -> 1), 148(0 -> 1), 173(0 -> 1), 185(0 -> 1), 186(0 -> 1), 226(0 -> 1), 298(0 -> 1), 324(0 -> 1), 367(0 -> 1), 387(0 -> 1), 389(0 -> 1), 397(2 -> 1), 399(0 -> 1), 408(1 -> 2), 467(0 -> 2), 536(0 -> 1); ACCTRAN: 379(1 -> 0).

Tockus nasutus
Unambiguous: 4(0 -> 1), 15(1 -> 2), 25(1 -> 0), 27(0 -> 1), 47(1 -> 0), 52(0 -> 1), 55(0 -> 1), 56(0 -> 1), 62(1 -> 0), 73(0 -> 1), 83(0 -> 1), 109(0 -> 1), 146(0 -> 1), 149(0 -> 1), 158(0 -> 1), 194(0 -> 1), 195(1 -> 0), 197(1 -> 0), 249(0 -> 1), 306(0 -> 1), 307(1 -> 0), 308(0 -> 1), 347(1 -> 0), 441(1 -> 2), 458(0 -> 1), 484(0 -> 1), 543(0 -> 1); DELTRAN: 31(1 -> 0), 49(2 -> 0), 215(2 -> 1), 452(0 -> 1), 453(1 -> 0), 485(1 -> 0); ACCTRAN: 49(1 -> 0), 159(1 -> 0), 206(1 -> 0), 236(1 -> 0), 257(2 -> 1), 335(1 -> 0), 338(1 -> 0), 339(1 -> 0), 348(1 -> 0), 467(1 -> 0).

Upupa marginata
Unambiguous: 20(0 -> 1), 21(0 -> 1), 22(0 -> 1), 32(1 -> 0), 80(0 -> 1), 82(0 -> 1), 85(0 -> 1), 117(1 -> 0), 122(0 -> 1), 123(0 -> 1), 124(0 -> 1), 130(0 -> 1), 147(0 -> 1), 172(1 -> 0), 182(0 -> 2), 259(0 -> 1), 266(1 -> 0), 270(2 -> 0), 288(0 -> 1), 289(0 -> 1), 296(0 -> 1), 301(0 -> 1), 337(0 -> 1), 358(0 -> 1), 375(0 -> 1), 378(0 -> 1), 386(0 -> 1), 397(2 -> 1), 414(0 -> 1), 426(0 -> 1),

466(0 -> 1), 490(0 -> 1), 491(0 -> 2); DELTRAN: 49(2 -> 1), 159(0 -> 1), 206(0 -> 1), 236(0 -> 1), 257(1 -> 2), 335(0 -> 1), 338(0 -> 1), 339(0 -> 1), 348(0 -> 1), 438(0 -> 1), 452(0 -> 2), 467(0 -> 1), 525(1 -> 0), 534(0 -> 1), 537(0 -> 1); ACCTRAN: 31(0 -> 1), 215(1 -> 2), 452(1 -> 2), 453(0 -> 1), 485(0 -> 1).

†Messelirrisor halcyrostris
Unambiguous: 156(1 -> 0), 162(1 -> 0), 354(0 -> 1), 371(1 -> 0), 400(1 -> 0), 431(0 -> 1), 456(1 -> 0), 461(0 -> 1), 488(1 -> 0), 493(0 -> 1), 507(0 -> 1), 513(2 -> 1); DELTRAN: 159(0 -> 1), 179(1 -> 0), 215(2 -> 1), 331(0 -> 1), 332(0 -> 1), 335(0 -> 1), 338(0 -> 1), 339(0 -> 1), 348(0 -> 1), 377(1 -> 0), 453(1 -> 0); ACCTRAN: 136(1 -> 0), 336(1 -> 0), 536(1 -> 0).

Bucerotiformes
Unambiguous: 34(0 -> 1), 163(0 -> 1), 184(2 -> 1), 192(0 -> 1), 216(0 -> 1), 269(0 -> 1), 350(0 -> 1), 373(0 -> 1), 374(0 -> 1), 460(1 -> 2); DELTRAN: 14(0 -> 1), 30(0 -> 1), 48(0 -> 2), 66(0 -> 1), 93(0 -> 1), 115(0 -> 1), 136(0 -> 1), 139(0 -> 1), 152(0 -> 2), 166(0 -> 1), 193(0 -> 1), 209(2 -> 0), 217(0 -> 1), 237(0 -> 1), 284(0 -> 1), 285(0 -> 1), 287(0 -> 1), 313(0 -> 1), 329(1 -> 2), 336(0 -> 1), 345(0 -> 1), 352(0 -> 1), 399(0 -> 1), 403(0 -> 1), 486(1 -> 0), 536(0 -> 1); ACCTRAN: 179(0 -> 1), 331(1 -> 0), 332(1 -> 0), 377(0 -> 1), 452(0 -> 1).

Atelornis pittoides
Unambiguous: 13(1 -> 0), 16(0 -> 1), 92(0 -> 1), 182(0 -> 1), 234(0 -> 1), 236(1 -> 2), 270(2 -> 0), 311(1 -> 0), 312(1 -> 0), 317(1 -> 0), 350(0 -> 1), 395(0 -> 1), 429(0 -> 2), 449(1 -> 0), 456(1 -> 0), 457(0 -> 1), 467(1 -> 2), 512(0 -> 2); DELTRAN: 244(0 -> 2), 466(0 -> 2), 525(1 -> 0), 546(0 -> 1); ACCTRAN: 32(0 -> 1), 73(1 -> 0), 95(1 -> 0), 115(1 -> 0), 161(1 -> 0), 200(1 -> 2), 244(1 -> 2), 357(1 -> 0), 466(1 -> 2).

Coracias benghalensis
Unambiguous: 8(1 -> 0), 21(0 -> 1), 36(0 -> 1), 114(1 -> 0), 142(1 -> 0), 189(1 -> 0), 205(1 -> 0), 220(1 -> 0), 249(0 -> 1), 278(0 -> 1), 336(1 -> 0), 370(1 -> 0), 377(0 -> 1), 441(2 -> 0), 490(0 -> 1), 491(0 -> 1), 509(0 -> 1); DELTRAN: 32(1 -> 0), 73(0 -> 1), 95(0 -> 1), 115(0 -> 1), 116(0 -> 1), 161(0 -> 1), 200(2 -> 1), 244(0 -> 1), 271(1 -> 0), 357(0 -> 1), 427(0 -> 1), 438(0 -> 1), 466(0 -> 1); ACCTRAN.

Merops orientalis
Unambiguous: 15(1 -> 0), 48(1 -> 0), 58(0 -> 1), 62(1 -> 0), 83(0 -> 1), 88(0 -> 1), 135(0 -> 1), 192(0 -> 1), 193(0 -> 1), 195(1 -> 0), 229(1 -> 0), 233(0 -> 1), 243(0 -> 1), 315(0 -> 1), 316(0 -> 1), 329(1 -> 2), 356(1 -> 0), 369(0 -> 1), 386(0 -> 1), 437(1 -> 0), 458(0 -> 1), 459(0 -> 1), 467(1 -> 0), 484(0 -> 1), 513(2 -> 1), 542(0 -> 1); DELTRAN: 25(1 -> 0), 32(1 -> 0), 71(0 -> 3), 73(0 -> 1), 95(0 -> 1), 115(0 -> 1), 161(0 -> 1), 200(2 -> 1), 357(0 -> 1), 401(0 -> 1), 429(0 -> 1), 485(1 -> 0), 486(1 -> 0), 488(1 -> 0), 536(0 -> 1); ACCTRAN: 19(1 -> 0), 37(2 -> 0), 55(1 -> 0), 257(2 -> 1), 407(1 -> 0), 427(1 -> 0), 466(1 -> 0).

Atelornis pittoides + Coracias benghalensis
Unambiguous: 23(0 -> 1), 28(0 -> 1), 39(0 -> 1), 52(0 -> 2), 53(0 -> 1), 68(0 -> 1), 104(1 -> 0), 117(1 -> 0), 121(0 -> 1), 136(1 -> 0), 147(0 -> 1), 148(0 -> 1), 163(0 -> 1), 183(1 -> 0), 214(0 -> 1), 259(0 -> 1), 366(1 -> 0), 435(1 -> 0), 479(0 -> 1), 481(0 -> 1), 549(0 -> 1); DELTRAN: 19(0 -> 1), 37(0 -> 2), 55(0 -> 1), 257(1 -> 2), 407(0 -> 1); ACCTRAN: 25(0 -> 1), 71(3 -> 0), 116(0 -> 1), 244(0 -> 1), 271(1 -> 0), 401(1 -> 0), 429(1 -> 0), 438(0 -> 1), 485(0 -> 1), 486(0 -> 1), 488(0 -> 1), 525(1 -> 0), 536(1 -> 0).

Alcedo atthis
Unambiguous: 8(1 -> 0), 14(0 -> 1), 16(0 -> 1), 28(0 -> 1), 32(1 -> 0), 35(0 -> 1), 85(0 -> 1), 88(0 -> 1), 112(0 -> 1), 117(1 -> 2), 122(0 -> 1), 123(0 -> 1), 134(0 -> 1), 135(0 -> 1), 149(1 -> 0), 165(0 -> 1), 167(0 -> 1), 189(1 -> 0), 199(1 -> 0), 215(0 -> 1), 216(0 -> 1), 267(0 -> 1), 377(0 ->

1), 379(0 -> 1), 387(0 -> 1), 414(0 -> 1), 455(0 -> 2), 458(0 -> 1), 479(0 -> 1), 481(0 -> 1), 512(1 -> 0), 513(2 -> 0), 528(0 -> 1); DELTRAN: 33(1 -> 0), 39(0 -> 1), 50(0 -> 1), 240(0 -> 1), 429(0 -> 1); ACCTRAN: 55(1 -> 0), 92(1 -> 0), 143(1 -> 0), 339(1 -> 0), 440(1 -> 0).

Momotus momota
Unambiguous: 23(0 -> 1), 34(0 -> 1), 52(0 -> 1), 72(0 -> 1), 82(0 -> 1), 87(0 -> 1), 95(0 -> 1), 126(1 -> 0), 128(0 -> 1), 148(0 -> 1), 163(0 -> 1), 166(0 -> 1), 185(0 -> 1), 186(0 -> 1), 197(1 -> 0), 214(0 -> 1), 242(1 -> 0), 249(0 -> 1), 270(2 -> 0), 289(0 -> 1), 302(1 -> 0), 303(0 -> 1), 311(1 -> 0), 347(1 -> 0), 413(0 -> 1), 449(1 -> 0), 453(1 -> 0), 487(0 -> 1), 507(0 -> 1); DELTRAN: 55(0 -> 1), 92(0 -> 1), 143(0 -> 1), 339(0 -> 1), 440(0 -> 1); ACCTRAN: 33(0 -> 1), 50(1 -> 0), 240(1 -> 0), 429(1 -> 0).

Todus mexicanus
Unambiguous: 13(1 -> 0), 51(0 -> 1), 59(1 -> 0), 62(1 -> 0), 64(1 -> 0), 101(2 -> 0), 105(1 -> 0), 182(0 -> 1), 183(1 -> 0), 230(0 -> 1), 253(0 -> 1), 309(0 -> 1), 313(0 -> 1), 399(0 -> 1), 428(0 -> 1), 435(1 -> 2), 484(0 -> 1), 519(0 -> 1); DELTRAN: 33(1 -> 0), 50(0 -> 1), 55(0 -> 1), 80(0 -> 2), 92(0 -> 1), 125(0 -> 1), 143(0 -> 1), 240(0 -> 1), 257(1 -> 2), 339(0 -> 1), 352(0 -> 1), 353(2 -> 1), 357(0 -> 1), 429(0 -> 1), 440(0 -> 1), 485(1 -> 0), 486(1 -> 0), 534(0 -> 1), 546(0 -> 1); ACCTRAN: 25(0 -> 1).

Momotus momota + Alcedo atthis
Unambiguous: 104(1 -> 0), 121(0 -> 1), 205(1 -> 0), 218(0 -> 1), 228(1 -> 0), 229(1 -> 0), 367(1 -> 0), 370(1 -> 0), 491(0 -> 1); DELTRAN: 25(1 -> 0); ACCTRAN: 39(0 -> 1), 80(2 -> 0), 125(1 -> 0), 257(2 -> 1), 352(1 -> 0), 357(1 -> 0), 485(0 -> 1), 486(0 -> 1), 546(1 -> 0).

Merops orientalis + Atelornis pittoides + Coracias benghalensis
Unambiguous: 35(0 -> 1), 61(1 -> 0), 109(0 -> 1), 150(0 -> 1), 217(0 -> 1), 341(0 -> 1), 363(0 -> 1), 512(1 -> 0); DELTRAN: 80(0 -> 2), 125(0 -> 1), 352(0 -> 1), 441(1 -> 2); ACCTRAN: 73(0 -> 1), 102(1 -> 2), 115(0 -> 1), 161(0 -> 1), 200(2 -> 1), 220(0 -> 1), 240(1 -> 0), 252(2 -> 1), 358(1 -> 0), 365(0 -> 1), 440(1 -> 0), 441(0 -> 2), 524(1 -> 0), 534(1 -> 0).

Todus mexicanus + Momotus momota + Alcedo atthis
Unambiguous: 142(1 -> 0), 215(2 -> 0), 397(2 -> 1), 456(1 -> 0); DELTRAN: 19(0 -> 1), 37(0 -> 2), 71(0 -> 3), 102(2 -> 1), 179(1 -> 0), 220(1 -> 0), 252(1 -> 2), 358(0 -> 1), 365(1 -> 0), 401(0 -> 1), 407(0 -> 1), 441(1 -> 0), 466(0 -> 1), 488(1 -> 0), 524(0 -> 1), 536(0 -> 1); ACCTRAN: 32(0 -> 1), 33(1 -> 0), 50(0 -> 1), 92(0 -> 1), 95(1 -> 0), 143(0 -> 1), 339(0 -> 1), 353(2 -> 1).

Indicator exilis pachyrhynchus
Unambiguous: 22(0 -> 1), 64(1 -> 0), 98(0 -> 1), 130(0 -> 1), 142(1 -> 0), 151(0 -> 1), 230(0 -> 1), 350(0 -> 1), 387(0 -> 1), 409(1 -> 0), 413(0 -> 1), 429(0 -> 1); DELTRAN: 97(0 -> 1), 174(1 -> 0), 179(1 -> 0), 240(0 -> 1), 424(1 -> 0); ACCTRAN: 159(1 -> 0), 203(1 -> 0), 213(1 -> 0), 229(0 -> 1), 347(0 -> 1), 487(1 -> 0), 517(1 -> 0).

Picus viridis
Unambiguous: 8(1 -> 0), 13(1 -> 0), 25(0 -> 1), 29(0 -> 1), 55(0 -> 1), 58(0 -> 1), 62(1 -> 0), 87(0 -> 1), 113(0 -> 1), 134(0 -> 1), 143(0 -> 1), 153(0 -> 1), 156(1 -> 0), 178(0 -> 1), 197(1 -> 0), 205(1 -> 0), 214(0 -> 1), 218(0 -> 1), 267(0 -> 1), 270(2 -> 0), 272(0 -> 1), 287(0 -> 1), 289(0 -> 1), 292(0 -> 1), 330(0 -> 1), 430(0 -> 1), 460(1 -> 0); DELTRAN: 159(0 -> 1), 203(0 -> 1), 213(0 -> 1), 229(1 -> 0), 347(1 -> 0), 487(0 -> 1), 517(0 -> 1), 549(0 -> 1); ACCTRAN: 97(1 -> 0), 240(1 -> 0).

Megalaima chrysopogon
Unambiguous: 21(0 -> 1), 22(0 -> 1), 27(1 -> 0), 29(0 -> 1), 82(0 -> 1), 121(0 -> 1), 134(0 -> 1), 218(0 -> 1), 231(1 -> 0), 251(0 -> 1), 259(0 -> 1), 286(1 -> 0), 289(0 -> 1), 354(0 -> 1), 401(0 ->

1), 402(1 -> 0), 435(1 -> 2); DELTRAN: 97(0 -> 1), 221(0 -> 1), 240(0 -> 1), 549(0 -> 1); ACCTRAN: 72(1 -> 0), 191(1 -> 0), 313(1 -> 0).

Ramphastos ambiguus
Unambiguous: 14(0 -> 1), 55(0 -> 1), 93(0 -> 1), 95(1 -> 0), 112(1 -> 0), 149(0 -> 1), 178(0 -> 1), 197(1 -> 0), 205(1 -> 0), 249(0 -> 1), 252(2 -> 0), 260(1 -> 0), 369(0 -> 1), 409(1 -> 0), 442(0 -> 1); DELTRAN: 15(1 -> 2), 71(0 -> 2), 72(0 -> 1), 159(0 -> 1), 191(0 -> 1), 313(0 -> 1); ACCTRAN: 221(1 -> 0), 240(1 -> 0), 549(1 -> 0).

Indicator exilis pachyrhynchus + Picus viridis
Unambiguous: 1(1 -> 0), 59(1 -> 0), 89(1 -> 0), 92(0 -> 1), 96(0 -> 1), 100(0 -> 1), 105(1 -> 0), 136(1 -> 0), 165(0 -> 1), 239(0 -> 1), 298(0 -> 1), 307(1 -> 2), 360(0 -> 1); DELTRAN: 72(0 -> 1), 83(0 -> 1), 191(0 -> 1), 221(0 -> 1), 313(0 -> 1); ACCTRAN: 333(1 -> 0).

Megalaima chrysopogon + Ramphastos ambiguus
Unambiguous: 28(0 -> 2), 30(0 -> 1), 109(0 -> 1), 117(1 -> 0), 152(0 -> 1), 228(1 -> 0), 283(0 -> 1), 293(1 -> 0), 395(0 -> 1), 408(1 -> 0), 537(0 -> 1); DELTRAN: 104(1 -> 0), 203(0 -> 1), 213(0 -> 1), 229(1 -> 0), 333(0 -> 1), 347(1 -> 0), 487(0 -> 1), 517(0 -> 1); ACCTRAN: 15(1 -> 2), 83(1 -> 0), 174(0 -> 1), 179(0 -> 1), 424(0 -> 1).

Galbula dea
Unambiguous: 23(0 -> 1), 35(0 -> 1), 58(0 -> 1), 61(1 -> 0), 80(0 -> 3), 93(0 -> 1), 121(0 -> 1), 135(0 -> 1), 147(0 -> 1), 157(0 -> 1), 161(0 -> 1), 163(0 -> 1), 200(2 -> 1), 222(0 -> 1), 230(0 -> 1), 243(0 -> 1), 254(0 -> 1), 303(0 -> 1), 307(1 -> 0), 309(0 -> 1), 337(0 -> 1), 350(0 -> 1), 354(0 -> 1), 386(0 -> 1), 437(1 -> 0), 443(0 -> 1), 479(0 -> 2), 480(0 -> 1), 503(0 -> 1), 525(1 -> 0), 539(0 -> 1); DELTRAN: 19(0 -> 1), 52(0 -> 2), 83(0 -> 1), 126(0 -> 1), 206(0 -> 1), 240(0 -> 1), 333(0 -> 1), 407(0 -> 1), 424(1 -> 0), 429(0 -> 1), 441(1 -> 0), 534(0 -> 1), 546(0 -> 1); ACCTRAN: 52(1 -> 2), 242(1 -> 0), 247(1 -> 0).

Megalaima chrysopogon + Ramphastos ambiguous + Indicator exilis pachyrhynchus + Picus viridis
Unambiguous: 34(0 -> 1), 48(1 -> 2), 66(0 -> 1), 120(0 -> 1), 122(0 -> 1), 215(2 -> 0), 245(1 -> 0), 255(0 -> 1), 269(0 -> 1), 301(0 -> 1), 305(0 -> 1), 329(1 -> 2), 335(0 -> 1), 359(0 -> 1), 399(0 -> 1), 428(0 -> 1), 431(0 -> 2), 452(0 -> 1), 456(1 -> 0), 466(0 -> 2), 467(1 -> 2), 498(0 -> 1), 509(0 -> 1); DELTRAN: 52(0 -> 1), 242(0 -> 1), 247(0 -> 1); ACCTRAN: 19(1 -> 0), 72(0 -> 1), 97(0 -> 1), 104(1 -> 0), 126(1 -> 0), 159(0 -> 1), 191(0 -> 1), 203(0 -> 1), 206(1 -> 0), 213(0 -> 1), 221(0 -> 1), 229(1 -> 0), 313(0 -> 1), 347(1 -> 0), 407(1 -> 0), 429(1 -> 0), 441(0 -> 1), 487(0 -> 1), 517(0 -> 1), 534(1 -> 0), 546(1 -> 0), 549(0 -> 1).

Coraciiformes
Unambiguous: 38(0 -> 1), 47(1 -> 0), 112(1 -> 0), 149(0 -> 1), 176(1 -> 0), 189(0 -> 1), 256(0 -> 1), 326(0 -> 1), 327(0 -> 1), 423(1 -> 0), 460(1 -> 2), 461(0 -> 1); DELTRAN: 126(0 -> 1), 174(1 -> 0), 206(0 -> 1), 242(0 -> 1), 247(0 -> 1), 287(0 -> 1), 332(0 -> 1), 537(0 -> 1); ACCTRAN: 37(0 -> 2), 49(1 -> 2), 55(0 -> 1), 80(0 -> 2), 125(0 -> 1), 166(1 -> 0), 237(1 -> 0), 345(1 -> 0), 357(0 -> 1), 370(0 -> 1), 379(1 -> 0), 401(0 -> 1), 466(0 -> 1), 488(1 -> 0).

Piciformes
Unambiguous: 27(0 -> 1), 207(0 -> 1), 231(0 -> 1), 253(0 -> 1), 316(0 -> 1), 328(1 -> 0), 372(0 -> 1), 373(0 -> 1), 374(0 -> 1), 453(1 -> 2), 489(0 -> 1), 495(0 -> 3), 523(0 -> 1); DELTRAN: 25(1 -> 0), 32(1 -> 0), 49(2 -> 1), 95(0 -> 1), 102(2 -> 1), 166(0 -> 1), 220(1 -> 0), 237(0 -> 1), 252(1 -> 2), 257(1 -> 2), 332(0 -> 2), 345(0 -> 1), 358(0 -> 1), 365(1 -> 0), 370(1 -> 0), 379(0 -> 1), 427(0 -> 1), 440(0 -> 1), 485(1 -> 0), 486(1 -> 2), 496(1 -> 2), 524(0 -> 1); ACCTRAN: 52(0 -> 1), 71(3 -> 2), 83(0 -> 1), 287(1 -> 0), 332(1 -> 2), 352(1 -> 0), 424(1 -> 0), 486(0 -> 2), 536(1 -> 0), 537(1 -> 0).

Bucerotiformes
Unambiguous: 135(0 -> 1), 137(0 -> 1), 408(1 -> 0), 473(1 -> 0), 514(0 -> 1); DELTRAN: 370(1 -> 0), 379(0 -> 1); ACCTRAN: 8(1 -> 0), 25(0 -> 1), 30(0 -> 1), 48(1 -> 2), 71(3 -> 0), 93(0 -> 1), 95(1 -> 0), 115(0 -> 1), 139(0 -> 1), 152(0 -> 2), 159(0 -> 1), 193(0 -> 1), 209(2 -> 0), 215(2 -> 1), 217(0 -> 1), 284(0 -> 1), 285(0 -> 1), 313(0 -> 1), 329(1 -> 2), 335(0 -> 1), 338(0 -> 1), 339(0 -> 1), 348(0 -> 1), 367(1 -> 0), 403(0 -> 1), 438(0 -> 1), 525(1 -> 0).

Picodynastornithes
Unambiguous: 13(0 -> 1), 59(0 -> 1), 144(1 -> 0), 205(0 -> 1), 250(0 -> 1), 260(0 -> 1), 271(0 -> 1), 283(1 -> 0), 293(0 -> 1), 312(0 -> 1), 449(0 -> 1), 465(2 -> 1); DELTRAN: 8(0 -> 1), 31(1 -> 0), 48(0 -> 1), 136(0 -> 1), 236(0 -> 1), 331(0 -> 1), 336(0 -> 1), 367(0 -> 1), 377(1 -> 0), 467(0 -> 1); ACCTRAN: 14(1 -> 0), 19(0 -> 1), 32(1 -> 0), 66(1 -> 0), 102(2 -> 1), 126(0 -> 1), 174(1 -> 0), 240(0 -> 1), 242(0 -> 1), 247(0 -> 1), 252(1 -> 2), 358(0 -> 1), 365(1 -> 0), 399(1 -> 0), 407(0 -> 1), 427(0 -> 1), 429(0 -> 1), 440(0 -> 1), 441(1 -> 0), 453(0 -> 1), 524(0 -> 1), 546(0 -> 1).

†Eotrogon + Trogoniformes
Unambiguous: 81(0 -> 1), 189(0 -> 1), 232(0 -> 1), 244(0 -> 2), 252(1 -> 0), 254(0 -> 1), 337(0 -> 1), 468(0 -> 1), 487(0 -> 1), 493(0 -> 1), 494(0 -> 2), 513(2 -> 1); DELTRAN: 25(1 -> 0), 453(1 -> 0), 485(1 -> 3); ACCTRAN: 1(1 -> 0), 28(0 -> 2), 33(1 -> 0), 47(1 -> 0), 55(0 -> 2), 56(0 -> 1), 70(0 -> 2), 75(2 -> 0), 76(0 -> 1), 77(0 -> 1), 82(0 -> 1), 88(0 -> 1), 101(2 -> 0), 102(2 -> 3), 105(1 -> 0), 131(0 -> 1), 134(0 -> 1), 146(0 -> 1), 166(1 -> 0), 173(0 -> 1), 185(0 -> 1), 186(0 -> 1), 236(1 -> 0), 298(0 -> 1), 303(0 -> 1), 324(0 -> 1), 336(1 -> 0), 387(0 -> 1), 389(0 -> 1), 397(2 -> 1), 408(1 -> 2), 467(1 -> 2), 485(0 -> 3), 538(0 -> 1).

Picocoraciae
Unambiguous: 64(0 -> 1), 142(0 -> 1), 311(0 -> 1), 320(0 -> 1), 321(0 -> 1), 356(0 -> 1), 409(0 -> 1), 413(1 -> 0), 476(1 -> 0); DELTRAN: 28(1 -> 0), 77(1 -> 0), 114(0 -> 1), 183(0 -> 1), 226(0 -> 1), 286(0 -> 1), 351(0 -> 1); ACCTRAN: 31(1 -> 0), 48(0 -> 1), 49(2 -> 1), 61(0 -> 1), 72(1 -> 0), 117(0 -> 1), 136(0 -> 1), 148(1 -> 0), 179(1 -> 0), 206(0 -> 1), 220(1 -> 0), 237(0 -> 1), 287(0 -> 1), 331(0 -> 1), 332(0 -> 1), 345(0 -> 1), 352(0 -> 1), 370(1 -> 0), 377(1 -> 0), 486(1 -> 0), 512(0 -> 1).

Leptosomus discolor
Unambiguous: 21(0 -> 1), 22(0 -> 1), 27(0 -> 1), 73(0 -> 1), 74(0 -> 1), 112(1 -> 0), 115(0 -> 1), 147(0 -> 1), 150(0 -> 1), 153(0 -> 1), 156(1 -> 0), 174(1 -> 0), 181(0 -> 1), 198(0 -> 1), 217(0 -> 1), 222(0 -> 1), 243(0 -> 1), 245(1 -> 2), 258(0 -> 1), 305(0 -> 1), 341(0 -> 1), 376(0 -> 1), 378(0 -> 1), 395(0 -> 1), 435(1 -> 2), 447(0 -> 1), 461(0 -> 1), 474(0 -> 1), 486(1 -> 2), 495(0 -> 2), 501(0 -> 1), 550(0 -> 1); DELTRAN: 14(0 -> 1), 35(0 -> 1), 52(0 -> 2), 72(0 -> 1), 77(1 -> 0), 117(1 -> 0), 148(0 -> 1), 163(0 -> 1), 166(0 -> 1), 236(0 -> 1), 336(0 -> 1), 407(0 -> 1), 429(0 -> 1), 492(1 -> 0), 512(1 -> 0); ACCTRAN: 66(1 -> 0), 104(1 -> 0), 190(1 -> 0), 327(0 -> 1), 411(0 -> 1), 424(1 -> 0), 453(0 -> 1), 534(1 -> 0).

Eucavitaves
Unambiguous: 58(1 -> 0), 62(0 -> 1), 89(0 -> 1), 176(0 -> 1), 180(1 -> 0), 188(0 -> 1), 197(0 -> 1), 203(1 -> 0), 225(0 -> 1), 229(0 -> 1), 323(0 -> 1), 355(0 -> 1), 361(1 -> 0), 423(0 -> 1), 478(1 -> 0), 527(1 -> 0), 528(1 -> 0), 530(1 -> 0); DELTRAN: 104(0 -> 1), 190(0 -> 1), 327(1 -> 0), 411(1 -> 0), 424(0 -> 1); ACCTRAN: 8(0 -> 1), 25(1 -> 0), 28(1 -> 0), 35(1 -> 0), 52(2 -> 0), 71(0 -> 3), 95(0 -> 1), 114(0 -> 1), 163(1 -> 0), 183(0 -> 1), 226(0 -> 1), 257(1 -> 2), 286(0 -> 1), 367(0 -> 1), 379(0 -> 1), 399(0 -> 1), 407(1 -> 0), 429(1 -> 0), 467(0 -> 1), 485(1 -> 0), 492(0 -> 1), 496(1 -> 2), 536(0 -> 1), 537(0 -> 1).

†Plesiocathartes kelleri

Unambiguous: 355(0 -> 1), 356(0 -> 1), 542(0 -> 1); DELTRAN: 19(0 -> 1), 35(0 -> 1), 52(0 -> 2), 357(0 -> 1), 474(0 -> 2), 477(0 -> 1), 495(0 -> 1); ACCTRAN: 512(0 -> 1).

†Plesiocathartes wyomingensis
Unambiguous: 20(0 -> 1), 278(0 -> 1); DELTRAN: 200(2 -> 0), 407(0 -> 1), 453(1 -> 0), 473(1 -> 2), 512(1 -> 0), 525(1 -> 0); ACCTRAN.

Cavitaves
Unambiguous: 15(0 -> 1), 371(0 -> 1), 381(0 -> 1), 529(1 -> 0); DELTRAN: 49(0 -> 2), 87(1 -> 0), 102(0 -> 2), 195(0 -> 1), 266(0 -> 1), 307(0 -> 1), 365(0 -> 1), 366(0 -> 1), 441(0 -> 1); ACCTRAN: 336(0 -> 1), 357(1 -> 0), 495(1 -> 0).

Plesiocathartidae
Unambiguous: 259(0 -> 1), 463(0 -> 2), 513(2 -> 1); DELTRAN; ACCTRAN: 19(0 -> 1), 200(2 -> 0), 473(1 -> 2), 474(0 -> 2), 477(0 -> 1), 525(1 -> 0).

†Waltonavis sp
Unambiguous: 17(0 -> 1), 81(0 -> 1), 169(0 -> 1), 196(0 -> 1), 219(0 -> 1), 232(0 -> 1), 244(0 -> 1), 245(1 -> 0), 257(1 -> 0), 303(0 -> 1), 341(0 -> 1), 347(1 -> 0), 360(0 -> 1), 370(1 -> 0), 379(0 -> 1), 458(0 -> 1), 459(0 -> 1), 468(0 -> 1), 491(0 -> 1), 542(0 -> 1), 550(0 -> 1); DELTRAN: 272(0 -> 1), 357(0 -> 1), 492(1 -> 0), 495(0 -> 1); ACCTRAN: 366(1 -> 0).

Plesiocathartidae + Cavitaves
Unambiguous: 215(1 -> 2), 377(0 -> 1), 493(1 -> 0), 548(1 -> 0); DELTRAN: 201(0 -> 1); ACCTRAN: 195(0 -> 1), 236(0 -> 1), 266(0 -> 1), 272(1 -> 0), 307(0 -> 1), 365(0 -> 1), 441(0 -> 1), 512(1 -> 0).

†Eoglaucidium + †Masillacolius + Coliiformes
Unambiguous: 197(0 -> 1), 215(1 -> 0), 226(0 -> 1), 235(0 -> 1), 304(0 -> 1), 323(0 -> 1), 337(0 -> 1), 344(0 -> 1), 361(1 -> 0), 418(0 -> 1), 430(0 -> 1), 431(0 -> 2), 449(0 -> 1), 460(1 -> 0), 528(1 -> 2), 530(1 -> 2), 531(0 -> 1), 542(0 -> 2); DELTRAN: 33(1 -> 0), 49(0 -> 1), 190(0 -> 1), 272(0 -> 1), 429(0 -> 1), 495(0 -> 2); ACCTRAN: 4(0 -> 1), 23(0 -> 1), 27(0 -> 1), 48(0 -> 2), 122(0 -> 1), 124(0 -> 1), 157(0 -> 1), 165(0 -> 1), 178(0 -> 1), 203(1 -> 0), 252(1 -> 2), 262(0 -> 1), 264(0 -> 1), 267(0 -> 1), 271(0 -> 1), 295(0 -> 1), 305(0 -> 1), 332(0 -> 1), 386(0 -> 1), 389(0 -> 1), 403(0 -> 1), 409(0 -> 1), 413(1 -> 0), 417(0 -> 1), 428(0 -> 1), 440(0 -> 1), 441(0 -> 2), 448(0 -> 1), 472(1 -> 0), 476(1 -> 0), 490(0 -> 1).

†Waltonavis sp. + Plesiocathartidae + Cavitaves +++
Unambiguous: 180(0 -> 1), 188(1 -> 0), 220(0 -> 1), 224(0 -> 1), 549(1 -> 0); DELTRAN: 260(1 -> 0), 487(1 -> 0), 496(0 -> 1); ACCTRAN: 14(0 -> 1), 33(0 -> 1), 35(0 -> 1), 49(1 -> 2), 52(0 -> 2), 72(0 -> 1), 77(1 -> 0), 87(1 -> 0), 102(1 -> 2), 117(1 -> 0), 148(0 -> 1), 166(0 -> 1), 259(1 -> 0), 357(0 -> 1), 397(0 -> 2), 407(0 -> 1), 453(1 -> 0), 492(1 -> 0), 495(2 -> 1), 521(1 -> 0).

Masillaraptoridae + Accipitriformes + †Primoptynx + †Ypresiglaux + Strigiformes + †Avolatavis +++
Unambiguous: 1(1 -> 0), 15(0 -> 1), 35(0 -> 2), 36(0 -> 1), 302(1 -> 0), 413(1 -> 2); DELTRAN: 18(0 -> 1), 33(1 -> 0), 52(0 -> 1); ACCTRAN: 4(0 -> 2), 19(0 -> 1), 25(1 -> 0), 39(0 -> 2), 177(0 -> 1), 196(0 -> 1), 297(1 -> 0), 329(1 -> 0), 353(2 -> 0), 473(1 -> 2), 512(1 -> 0).

Coraciimorphae
Unambiguous: 31(0 -> 1), 47(0 -> 1), 101(0 -> 2), 105(0 -> 1), 115(1 -> 0), 144(0 -> 1), 156(0 -> 1), 200(1 -> 2), 270(1 -> 2), 376(1 -> 0), 384(0 -> 1), 392(0 -> 1), 416(0 -> 1), 447(1 -> 0), 465(0 -> 2), 525(0 -> 1); DELTRAN: 95(2 -> 0), 209(0 -> 2), 283(0 -> 1), 297(0 -> 1), 396(0 -> 1), 404(1 -> 0), 456(0 -> 1), 470(0 -> 1), 527(0 -> 1); ACCTRAN: 18(1 -> 0), 49(0 -> 1), 52(1 -> 0), 66(0 ->

1), 104(0 -> 1), 163(0 -> 1), 190(0 -> 1), 260(1 -> 0), 272(0 -> 1), 366(0 -> 1), 411(1 -> 0), 424(0 -> 1), 429(0 -> 1), 487(1 -> 0).

Cariama cristata
Unambiguous: 64(0 -> 1), 77(1 -> 0), 161(0 -> 1), 166(0 -> 1), 272(0 -> 1), 323(0 -> 1), 354(0 -> 1), 394(0 -> 1), 459(0 -> 1); DELTRAN: 101(0 -> 2), 134(0 -> 1), 206(0 -> 2); ACCTRAN: 101(1 -> 2), 206(1 -> 2).

Chunga burmeisteri
Unambiguous: 72(0 -> 1), 174(1 -> 0), 243(0 -> 1), 270(1 -> 0), 312(0 -> 1), 426(0 -> 1), 460(1 -> 0); DELTRAN: 101(0 -> 1), 134(0 -> 2), 206(0 -> 1); ACCTRAN: 134(1 -> 2).

†Dynamopterus sp
Unambiguous: 260(1 -> 0), 355(0 -> 1), 492(1 -> 0); DELTRAN: 259(0 -> 1), 329(1 -> 2), 437(0 -> 1); ACCTRAN: 266(1 -> 0), 329(0 -> 2), 427(1 -> 0), 474(1 -> 0).

Cariamidae
Unambiguous: 218(0 -> 1), 239(0 -> 1), 276(0 -> 1), 428(0 -> 1), 429(0 -> 2), 432(0 -> 1), 457(0 -> 1), 473(1 -> 2), 493(1 -> 0), 500(0 -> 1), 512(1 -> 2), 532(0 -> 1), 542(0 -> 1), 543(0 -> 1); DELTRAN: 11(0 -> 1), 30(0 -> 1), 31(0 -> 1), 32(1 -> 0), 35(0 -> 2), 36(0 -> 1), 43(0 -> 1), 49(0 -> 2), 55(0 -> 1), 73(0 -> 1), 99(0 -> 1), 111(0 -> 1), 114(0 -> 1), 115(1 -> 0), 117(1 -> 0), 129(0 -> 1), 132(0 -> 1), 142(0 -> 1), 152(0 -> 1), 182(0 -> 1), 183(0 -> 2), 194(0 -> 1), 198(0 -> 1), 220(0 -> 1), 250(0 -> 1), 266(0 -> 1), 281(1 -> 0), 296(0 -> 1), 311(0 -> 1), 317(1 -> 0), 319(0 -> 1), 327(1 -> 0), 329(1 -> 0), 348(0 -> 1), 362(0 -> 1), 385(0 -> 1), 393(0 -> 1), 398(0 -> 1), 408(1 -> 0), 412(0 -> 1), 413(1 -> 0), 425(0 -> 1), 427(0 -> 1), 435(1 -> 2), 474(0 -> 1), 520(0 -> 1); ACCTRAN: 259(1 -> 0), 437(1 -> 0).

†Bathornis grallator
Unambiguous: 28(0 -> 2), 39(0 -> 2), 46(0 -> 1), 100(0 -> 1), 106(0 -> 1), 221(0 -> 1), 302(1 -> 0), 369(0 -> 1), 417(0 -> 1), 522(0 -> 1), 540(1 -> 0), 549(1 -> 0); DELTRAN: 37(0 -> 1), 112(1 -> 0), 117(1 -> 2), 434(0 -> 1), 474(0 -> 1); ACCTRAN: 220(1 -> 0), 250(1 -> 0).

†Dynamopterus sp + Cariamidae
Unambiguous: 227(0 -> 1), 300(0 -> 1), 340(0 -> 1); DELTRAN: 215(1 -> 2), 216(0 -> 1), 217(0 -> 1), 222(0 -> 1), 420(0 -> 1), 447(1 -> 0); ACCTRAN: 30(0 -> 1), 31(0 -> 1), 32(1 -> 0), 35(0 -> 2), 36(0 -> 1), 37(1 -> 0), 49(0 -> 2), 55(0 -> 1), 112(0 -> 1), 117(2 -> 0), 132(0 -> 1), 134(0 -> 1), 142(0 -> 1), 152(0 -> 1), 329(1 -> 0), 434(1 -> 0), 520(0 -> 1).

Caracara cheriway
Unambiguous: 73(0 -> 1), 108(1 -> 0), 155(1 -> 0), 161(0 -> 1), 247(0 -> 1), 259(1 -> 0), 277(0 -> 1), 311(0 -> 1), 329(1 -> 0), 356(1 -> 0), 391(1 -> 0), 404(1 -> 0), 406(1 -> 0), 491(0 -> 1); DELTRAN; ACCTRAN: 460(2 -> 1).

Daptrius ater
Unambiguous: 45(0 -> 1), 441(1 -> 0), 470(1 -> 0), 483(1 -> 0); DELTRAN: 70(0 -> 2), 175(0 -> 1), 460(1 -> 2), 527(1 -> 0), 530(2 -> 1); ACCTRAN.

Falco sparverius
Unambiguous: 3(0 -> 1), 71(0 -> 2), 104(0 -> 1), 160(0 -> 1), 225(0 -> 1), 509(0 -> 1); DELTRAN: 174(1 -> 0), 186(0 -> 1), 269(0 -> 1), 354(0 -> 1), 443(0 -> 1), 456(0 -> 1), 460(1 -> 2); ACCTRAN: 52(1 -> 0), 62(1 -> 0), 220(1 -> 0).

Polyborinae

Unambiguous: 9(0 -> 1), 32(1 -> 0), 117(1 -> 0), 156(0 -> 1), 198(0 -> 2), 245(1 -> 2), 258(0 -> 1), 302(1 -> 0), 305(0 -> 1); DELTRAN: 52(0 -> 1), 62(0 -> 1), 220(0 -> 1); ACCTRAN: 70(0 -> 2), 175(0 -> 1), 186(1 -> 0), 269(1 -> 0), 354(1 -> 0), 443(1 -> 0), 456(1 -> 0), 527(1 -> 0), 530(2 -> 1).

Micrastur ruficollis concentricus
Unambiguous: 45(0 -> 1), 47(0 -> 1), 60(0 -> 1), 72(0 -> 1), 75(2 -> 1), 115(1 -> 0), 131(0 -> 1), 229(0 -> 1), 247(0 -> 1), 287(0 -> 1), 325(0 -> 1), 336(0 -> 1), 346(0 -> 1), 348(0 -> 1), 367(0 -> 1), 408(1 -> 0), 458(0 -> 1), 474(1 -> 2), 490(0 -> 1), 491(0 -> 2), 492(1 -> 0), 512(1 -> 2), 515(0 -> 1), 517(0 -> 1); DELTRAN: 52(0 -> 1), 62(0 -> 1), 114(0 -> 1), 126(0 -> 1), 134(0 -> 2), 186(0 -> 1), 220(0 -> 1), 269(0 -> 1), 317(1 -> 0), 354(0 -> 1), 424(0 -> 1), 443(0 -> 1), 456(0 -> 1), 518(0 -> 1), 539(0 -> 1); ACCTRAN: 134(1 -> 2), 202(1 -> 0), 206(1 -> 0).

Falco + Polyborinae
Unambiguous: 20(0 -> 1), 22(0 -> 1), 24(0 -> 1), 109(0 -> 1), 145(0 -> 1), 168(0 -> 1), 192(0 -> 1), 283(0 -> 2), 294(0 -> 2), 361(0 -> 1), 413(1 -> 2); DELTRAN: 116(0 -> 1), 134(0 -> 1), 202(0 -> 1), 206(0 -> 1); ACCTRAN: 114(1 -> 0), 126(1 -> 0), 174(1 -> 0), 317(0 -> 1), 424(1 -> 0), 460(1 -> 2).

†Horusornis vianeyliaudae
Unambiguous: 218(0 -> 1), 252(1 -> 0), 270(1 -> 0), 272(0 -> 1), 335(0 -> 1), 436(0 -> 1), 477(0 -> 1), 481(0 -> 1), 486(1 -> 2), 500(0 -> 1); DELTRAN: 222(0 -> 1), 334(1 -> 0), 434(0 -> 1), 460(1 -> 0), 472(1 -> 0), 542(0 -> 1); ACCTRAN: 220(1 -> 0), 250(1 -> 0), 257(2 -> 1).

Micrastur + Falco + Polyborinae
Unambiguous: 215(1 -> 2), 217(0 -> 1), 224(0 -> 1), 249(0 -> 1), 355(0 -> 1), 356(0 -> 1), 370(0 -> 1), 441(0 -> 1), 470(0 -> 1), 483(0 -> 1), 494(0 -> 1); DELTRAN: 4(0 -> 2), 12(0 -> 1), 15(0 -> 1), 19(0 -> 1), 23(0 -> 1), 28(0 -> 1), 35(0 -> 2), 36(0 -> 1), 38(0 -> 1), 39(0 -> 2), 55(0 -> 1), 61(1 -> 0), 68(0 -> 1), 105(0 -> 1), 108(0 -> 1), 111(0 -> 1), 112(1 -> 2), 120(0 -> 1), 129(0 -> 1), 132(0 -> 1), 142(0 -> 1), 151(0 -> 1), 152(0 -> 1), 155(0 -> 1), 173(0 -> 1), 180(0 -> 1), 181(0 -> 1), 196(0 -> 1), 209(0 -> 1), 243(0 -> 1), 250(0 -> 1), 257(1 -> 2), 259(0 -> 1), 260(1 -> 0), 315(0 -> 1), 341(0 -> 1), 377(0 -> 1), 391(0 -> 1), 393(0 -> 1), 397(2 -> 0), 406(0 -> 1), 414(0 -> 1), 419(0 -> 1), 421(0 -> 1), 426(0 -> 1), 427(0 -> 1), 439(0 -> 1), 442(0 -> 1), 464(2 -> 1), 465(0 -> 1), 468(0 -> 1), 471(0 -> 1), 521(0 -> 1), 528(0 -> 2), 529(0 -> 2), 530(0 -> 2), 542(0 -> 2); ACCTRAN: 222(1 -> 0), 269(0 -> 1), 334(0 -> 1), 354(0 -> 1), 434(1 -> 0), 456(0 -> 1), 460(0 -> 1), 472(0 -> 1), 518(0 -> 1), 542(1 -> 2).

Nestor notabilis
Unambiguous: 55(2 -> 1), 62(0 -> 1), 85(1 -> 0), 132(0 -> 1), 134(0 -> 1), 467(1 -> 2); DELTRAN: 39(0 -> 1), 163(0 -> 1), 186(0 -> 1), 206(0 -> 2), 270(1 -> 0), 328(1 -> 0), 407(0 -> 1), 428(0 -> 1), 441(0 -> 1), 542(0 -> 1); ACCTRAN: 8(1 -> 0), 56(1 -> 0), 202(1 -> 0), 491(2 -> 0).

Strigops habroptilus
Unambiguous: 42(0 -> 1), 52(0 -> 2), 63(0 -> 2), 75(2 -> 1), 212(0 -> 1), 549(1 -> 0); DELTRAN: 8(0 -> 1), 56(0 -> 1), 202(0 -> 1), 491(0 -> 2); ACCTRAN: 39(1 -> 0), 186(1 -> 0), 206(2 -> 0), 542(1 -> 0).

Barnardius zonarius
Unambiguous: 39(2 -> 1), 204(1 -> 0), 206(2 -> 0), 215(1 -> 2), 216(0 -> 1), 217(0 -> 1), 230(0 -> 1), 256(1 -> 0), 303(0 -> 1), 428(0 -> 1), 435(2 -> 1), 465(2 -> 1), 467(1 -> 2), 512(0 -> 1), 529(1 -> 0), 545(1 -> 0); DELTRAN: 56(0 -> 1), 235(0 -> 1), 413(1 -> 2), 441(0 -> 2); ACCTRAN.

Psittacus erithacus

Unambiguous: 132(0 -> 1), 134(0 -> 1), 189(1 -> 0), 211(0 -> 1), 307(1 -> 0), 314(0 -> 1), 431(1 -> 0), 436(0 -> 1), 440(1 -> 0), 442(0 -> 1), 543(1 -> 0); DELTRAN: 413(1 -> 0), 549(1 -> 0); ACCTRAN: 56(1 -> 0), 235(1 -> 0), 413(2 -> 0), 441(2 -> 0).

Deroptyus accipitrinus
Unambiguous: 42(0 -> 1), 52(0 -> 2), 57(0 -> 1), 204(1 -> 0), 222(1 -> 0), 287(0 -> 1), 307(1 -> 0), 314(0 -> 1), 432(0 -> 1), 440(1 -> 0), 542(1 -> 2), 543(1 -> 0); DELTRAN: 547(0 -> 1); ACCTRAN: 56(1 -> 0), 235(1 -> 0), 441(2 -> 0).

Psittrichas fulgidus
Unambiguous: 85(1 -> 0), 358(0 -> 1), 429(1 -> 0), 467(1 -> 0); DELTRAN: 56(0 -> 1), 235(0 -> 1), 441(0 -> 2); ACCTRAN.

Psittaculidae
Unambiguous; DELTRAN: 175(0 -> 1); ACCTRAN: 549(1 -> 0).

Psittacidae
Unambiguous: 312(0 -> 1); DELTRAN; ACCTRAN: 413(2 -> 1), 547(0 -> 1).

Probosciger aterrimus
Unambiguous: 1(0 -> 1), 42(0 -> 1), 52(0 -> 2), 57(0 -> 1), 136(0 -> 1), 215(1 -> 2), 217(0 -> 1), 394(0 -> 1), 436(0 -> 1), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0); DELTRAN: 39(0 -> 1), 56(0 -> 1), 163(0 -> 1), 235(0 -> 1), 413(1 -> 2), 428(0 -> 1), 441(0 -> 2); ACCTRAN: 270(0 -> 1), 324(1 -> 0).

Psittacidae + Psittaculidae
Unambiguous: 296(0 -> 1), 416(0 -> 1), 458(0 -> 1), 469(1 -> 0), 537(0 -> 1); DELTRAN: 39(0 -> 2), 270(1 -> 0), 324(0 -> 1), 518(0 -> 1); ACCTRAN: 39(1 -> 2), 163(1 -> 0), 428(1 -> 0).

Strigopidae
Unambiguous; DELTRAN: 4(0 -> 1), 15(0 -> 1), 324(0 -> 1); ACCTRAN: 4(2 -> 1), 371(1 -> 0), 407(0 -> 1), 441(2 -> 1).

Probosciger + Psittacidae + Psittaculidae
Unambiguous: 3(0 -> 1), 14(0 -> 1), 141(0 -> 1), 182(0 -> 2), 228(0 -> 1), 249(0 -> 1), 277(0 -> 1), 283(0 -> 2), 294(0 -> 2), 512(1 -> 0); DELTRAN: 4(0 -> 2), 8(0 -> 1), 15(0 -> 2), 186(0 -> 1), 202(0 -> 1), 206(0 -> 2), 371(0 -> 1), 491(0 -> 2), 529(0 -> 1), 542(0 -> 1); ACCTRAN: 15(1 -> 2), 175(0 -> 1), 235(0 -> 1), 328(0 -> 1), 413(1 -> 2).

Neodrepanis coruscans
Unambiguous: 1(0 -> 1), 17(1 -> 0), 25(1 -> 0), 35(0 -> 1), 51(1 -> 0), 136(0 -> 1), 147(1 -> 0), 150(1 -> 0), 204(1 -> 0), 240(0 -> 1), 337(0 -> 1), 338(0 -> 1), 339(0 -> 1), 428(0 -> 1), 431(0 -> 2), 435(1 -> 0), 457(0 -> 1), 509(0 -> 1); DELTRAN: 206(0 -> 1), 215(0 -> 2), 308(0 -> 1), 317(0 -> 1), 379(1 -> 0), 395(1 -> 0), 473(1 -> 0), 536(0 -> 1); ACCTRAN: 219(1 -> 0), 377(1 -> 0), 444(1 -> 0), 451(1 -> 0).

Pitta sordida
Unambiguous: 32(0 -> 1), 33(1 -> 0), 47(1 -> 0), 117(1 -> 0), 203(1 -> 0), 205(0 -> 1), 247(1 -> 0), 251(1 -> 0), 270(2 -> 0), 347(1 -> 0), 350(1 -> 0), 356(1 -> 0), 360(1 -> 0), 432(1 -> 0), 447(1 -> 0), 452(2 -> 0), 527(1 -> 0); DELTRAN: 219(0 -> 1), 377(0 -> 1), 444(0 -> 1), 451(0 -> 1); ACCTRAN: 206(1 -> 0), 379(0 -> 1), 395(0 -> 1), 473(0 -> 1), 536(1 -> 0).

Melanopareia bitorquata

Unambiguous: 8(1 -> 0), 33(1 -> 0), 34(0 -> 1), 125(0 -> 1), 126(0 -> 1), 147(1 -> 0), 150(1 -> 0), 176(0 -> 1), 184(1 -> 2), 194(0 -> 1), 197(1 -> 0), 206(1 -> 0), 220(1 -> 0), 240(0 -> 1), 280(0 -> 1), 281(1 -> 0), 303(1 -> 0), 308(0 -> 1), 337(0 -> 1), 339(0 -> 1), 352(1 -> 0), 355(1 -> 0), 409(0 -> 1), 422(0 -> 1), 473(1 -> 0); DELTRAN: 426(0 -> 1), 527(1 -> 0), 539(0 -> 1); ACCTRAN: 251(0 -> 1), 348(1 -> 0), 395(0 -> 1), 437(0 -> 1).

Myrmornis torquata
Unambiguous: 1(0 -> 1), 17(1 -> 0), 215(0 -> 1), 298(1 -> 0), 317(0 -> 1), 411(0 -> 1), 510(1 -> 0), 512(2 -> 1), 515(1 -> 0); DELTRAN: 251(1 -> 0), 348(0 -> 1), 395(1 -> 0), 437(1 -> 0); ACCTRAN: 426(1 -> 0).

Myrmothera campanisona minor
Unambiguous: 117(1 -> 0), 174(0 -> 1), 179(1 -> 0), 347(1 -> 0), 452(2 -> 1); DELTRAN: 251(1 -> 0), 348(0 -> 1), 395(1 -> 0), 426(0 -> 1), 437(1 -> 0), 536(0 -> 1); ACCTRAN.

Melanopareia + Myrmornis
Unambiguous: 67(1 -> 0), 121(0 -> 1), 182(1 -> 0), 255(1 -> 0), 286(1 -> 0), 356(1 -> 0), 431(0 -> 2); DELTRAN; ACCTRAN: 536(1 -> 0).

Piprites chloris tschudii
Unambiguous: 322(1 -> 0), 408(1 -> 2), 436(0 -> 1), 452(2 -> 1); DELTRAN: 142(1 -> 0), 150(1 -> 0), 343(1 -> 0), 536(0 -> 1); ACCTRAN: 17(0 -> 1), 51(0 -> 1).

Tyrannus tyrannus
Unambiguous: 38(0 -> 1), 48(2 -> 1), 235(0 -> 1), 255(1 -> 0), 280(0 -> 1), 367(1 -> 0), 397(1 -> 0), 413(1 -> 2), 441(0 -> 1); DELTRAN: 17(1 -> 0), 51(1 -> 0); ACCTRAN: 142(0 -> 1), 150(0 -> 1), 343(0 -> 1), 536(1 -> 0).

Rupicola peruvianus
Unambiguous: 4(0 -> 1), 19(0 -> 1), 20(0 -> 1), 22(0 -> 1), 25(1 -> 0), 28(0 -> 1), 50(1 -> 0), 102(4 -> 1), 103(1 -> 0), 186(0 -> 1), 234(1 -> 0), 251(1 -> 0), 350(1 -> 0), 428(0 -> 1), 475(1 -> 0), 482(1 -> 0); DELTRAN: 17(1 -> 0), 51(1 -> 0), 142(1 -> 0), 150(1 -> 0), 249(0 -> 1), 343(1 -> 0), 515(1 -> 0); ACCTRAN: 407(1 -> 0).

Tyrannidae
Unambiguous: 126(0 -> 1), 146(1 -> 0), 270(2 -> 0), 356(1 -> 0), 426(0 -> 1); DELTRAN: 407(0 -> 1); ACCTRAN: 249(1 -> 0), 515(0 -> 1).

Neopelma chrysocephalum
Unambiguous: 48(2 -> 1), 240(0 -> 1), 255(1 -> 0), 305(1 -> 0), 311(1 -> 0), 408(1 -> 2); DELTRAN: 249(0 -> 1), 333(0 -> 1), 395(1 -> 0), 407(0 -> 1), 437(1 -> 0), 515(1 -> 0), 536(0 -> 1); ACCTRAN.

Rupicola + Tyrannidae
Unambiguous: 122(0 -> 1), 128(0 -> 1), 147(1 -> 0), 247(1 -> 0), 397(2 -> 1), 441(2 -> 0), 488(1 -> 0); DELTRAN: 236(2 -> 0), 451(0 -> 1), 512(2 -> 1); ACCTRAN: 17(1 -> 0), 51(1 -> 0), 142(1 -> 0), 150(1 -> 0), 333(1 -> 0), 343(1 -> 0), 395(0 -> 1), 437(0 -> 1).

Furnariidae
Unambiguous: 205(0 -> 1), 338(0 -> 1), 366(0 -> 1); DELTRAN: 333(0 -> 1), 444(0 -> 1); ACCTRAN: 195(1 -> 0), 215(2 -> 0), 251(1 -> 0), 317(1 -> 0), 342(1 -> 0), 348(0 -> 1), 426(0 -> 1), 451(1 -> 0), 473(0 -> 1), 515(0 -> 1), 527(1 -> 0), 539(0 -> 1).

Tyrannida

Unambiguous: 58(0 -> 1), 203(1 -> 0), 399(2 -> 1), 432(1 -> 0), 510(1 -> 0); DELTRAN: 195(0 -> 1), 215(0 -> 2), 317(0 -> 1), 342(0 -> 1), 473(1 -> 0); ACCTRAN: 249(0 -> 1), 407(0 -> 1), 444(1 -> 0), 512(2 -> 1).

Eurylaimides
Unambiguous; DELTRAN: 195(0 -> 1), 342(0 -> 1), 515(1 -> 0); ACCTRAN: 80(3 -> 0), 220(1 -> 0), 303(1 -> 0).

Tyrannides
Unambiguous: 8(0 -> 1), 409(1 -> 0); DELTRAN: 80(0 -> 3), 206(0 -> 1), 219(0 -> 1), 220(0 -> 1), 303(0 -> 1), 377(0 -> 1), 379(1 -> 0); ACCTRAN: 308(1 -> 0), 333(0 -> 1), 437(1 -> 0).

Passer domesticus
Unambiguous: 9(0 -> 1), 55(0 -> 1), 56(0 -> 1), 72(0 -> 1), 85(0 -> 1), 117(1 -> 0), 146(1 -> 0), 179(1 -> 0), 251(1 -> 0), 317(0 -> 1), 549(0 -> 1); DELTRAN: 25(1 -> 0), 61(0 -> 1), 339(0 -> 1); ACCTRAN: 174(0 -> 1), 280(1 -> 0).

Zosterops lateralis
Unambiguous: 130(1 -> 0), 330(1 -> 0), 548(0 -> 1); DELTRAN: 174(1 -> 0), 280(0 -> 1); ACCTRAN: 25(0 -> 1), 339(1 -> 0).

Sylvia borin
Unambiguous: 181(0 -> 1), 426(0 -> 1); DELTRAN: 25(1 -> 0), 174(1 -> 0), 195(0 -> 1), 280(0 -> 1), 339(0 -> 1), 431(2 -> 0); ACCTRAN: 440(0 -> 1), 515(0 -> 1).

Zosterops + Passer
Unambiguous: 121(0 -> 1), 205(0 -> 1), 286(0 -> 1), 294(2 -> 0), 311(1 -> 0), 413(1 -> 0), 488(0 -> 1); DELTRAN: 440(1 -> 0), 515(1 -> 0); ACCTRAN: 195(1 -> 0), 431(0 -> 2).

Corvus brachyrhynchos
Unambiguous: 33(1 -> 0), 51(1 -> 0), 56(0 -> 1), 117(1 -> 0), 130(1 -> 0), 182(0 -> 1), 229(0 -> 1), 251(1 -> 0), 256(1 -> 0), 269(1 -> 0), 270(2 -> 0), 317(0 -> 1), 330(1 -> 0), 347(0 -> 1), 355(1 -> 0), 356(1 -> 0), 358(1 -> 0), 366(1 -> 0), 409(1 -> 0), 411(0 -> 1), 451(0 -> 1), 452(2 -> 1), 510(1 -> 0), 512(2 -> 1); DELTRAN: 55(0 -> 1), 195(0 -> 1), 236(2 -> 1), 321(1 -> 0), 431(2 -> 0), 440(1 -> 0), 441(1 -> 0), 456(0 -> 1), 515(1 -> 0); ACCTRAN: 50(1 -> 0), 174(0 -> 1), 280(1 -> 0), 339(1 -> 0).

Sylvia + Zosterops + Passer
Unambiguous: 204(1 -> 0), 222(1 -> 0), 297(1 -> 0), 492(0 -> 1); DELTRAN: 50(0 -> 1), 441(1 -> 2), 539(0 -> 1), 546(0 -> 1); ACCTRAN: 25(1 -> 0), 55(1 -> 0), 61(0 -> 1), 236(1 -> 2), 441(0 -> 2), 456(1 -> 0).

Malurus melanocephalus
Unambiguous: 126(0 -> 1), 143(0 -> 1), 205(0 -> 1), 235(0 -> 1), 333(0 -> 1), 337(0 -> 1), 392(1 -> 0), 422(0 -> 1); DELTRAN: 50(0 -> 1), 55(0 -> 1), 280(0 -> 1), 339(0 -> 1), 397(2 -> 1), 456(0 -> 1); ACCTRAN: 219(1 -> 0), 228(1 -> 0).

Corvus + Sylvia + Zosterops + Passer
Unambiguous: 17(1 -> 0), 85(1 -> 0), 147(1 -> 0), 255(1 -> 0), 343(1 -> 0), 367(1 -> 0), 509(0 -> 1); DELTRAN: 219(0 -> 1), 228(0 -> 1); ACCTRAN: 195(0 -> 1), 397(1 -> 2), 431(2 -> 0), 440(1 -> 0), 441(1 -> 0), 515(1 -> 0).

Climacterus melanurus wellsi

Unambiguous: 317(0 -> 1), 395(1 -> 0), 413(1 -> 0), 481(0 -> 1), 482(1 -> 0); DELTRAN: 52(0 -> 1), 97(1 -> 2), 219(0 -> 1), 228(0 -> 1), 236(2 -> 1), 397(2 -> 1), 415(0 -> 1), 426(0 -> 1), 435(1 -> 2), 442(0 -> 1), 443(0 -> 1), 451(0 -> 1), 542(0 -> 1), 549(0 -> 1); ACCTRAN: 280(1 -> 0).

Malurus + Corvus + Sylvia + Zosterops + Passer
Unambiguous: 234(0 -> 1), 487(0 -> 1); DELTRAN; ACCTRAN: 50(0 -> 1), 52(1 -> 0), 55(0 -> 1), 97(2 -> 1), 321(1 -> 0), 339(0 -> 1), 415(1 -> 0), 426(1 -> 0), 435(2 -> 1), 442(1 -> 0), 443(1 -> 0), 451(1 -> 0), 456(0 -> 1), 542(1 -> 0), 549(1 -> 0).

Menura novaehollandiae
Unambiguous: 25(1 -> 0), 30(0 -> 1), 35(0 -> 1), 37(0 -> 1), 38(0 -> 1), 39(0 -> 2), 44(1 -> 0), 47(1 -> 0), 48(2 -> 1), 85(1 -> 0), 129(0 -> 1), 178(0 -> 1), 196(0 -> 1), 197(1 -> 0), 199(0 -> 1), 204(1 -> 0), 211(0 -> 1), 242(1 -> 0), 244(2 -> 0), 245(0 -> 1), 251(1 -> 0), 253(1 -> 0), 255(1 -> 0), 270(2 -> 0), 272(1 -> 0), 312(0 -> 1), 329(2 -> 1), 337(0 -> 1), 356(1 -> 0), 358(1 -> 0), 370(0 -> 1), 392(1 -> 0), 401(1 -> 0), 409(1 -> 0), 411(0 -> 1), 440(1 -> 0), 447(1 -> 0), 528(0 -> 1), 537(0 -> 1), 547(0 -> 1); DELTRAN: 52(0 -> 1), 97(1 -> 2), 206(0 -> 1), 214(0 -> 1), 280(0 -> 1), 415(0 -> 1), 426(0 -> 1), 435(1 -> 2), 442(0 -> 1), 443(0 -> 1), 451(0 -> 1), 542(0 -> 1), 549(0 -> 1); ACCTRAN: 219(1 -> 0), 308(1 -> 0), 444(1 -> 0), 546(1 -> 0), 548(0 -> 1).

Climacterus + Malurus + Corvus + Sylvia + Zosterops + Passer
Unambiguous: 66(0 -> 1), 330(0 -> 1), 347(1 -> 0), 431(1 -> 2); DELTRAN: 308(0 -> 1), 444(0 -> 1), 548(1 -> 0); ACCTRAN: 206(1 -> 0), 214(1 -> 0), 228(0 -> 1), 236(2 -> 1), 397(2 -> 1), 539(0 -> 1).

Tyranni
Unambiguous: 55(0 -> 1), 71(0 -> 3), 130(1 -> 0), 182(0 -> 1), 234(0 -> 1), 256(1 -> 0), 307(0 -> 2), 431(1 -> 0), 456(0 -> 1); DELTRAN: 50(0 -> 1), 67(0 -> 1), 115(1 -> 0), 174(1 -> 0), 214(0 -> 1), 286(0 -> 1), 546(0 -> 1), 548(1 -> 0); ACCTRAN: 195(0 -> 1), 215(0 -> 2), 236(2 -> 0), 317(0 -> 1), 342(0 -> 1), 377(0 -> 1), 379(1 -> 0), 395(1 -> 0), 428(1 -> 0), 442(1 -> 0), 488(0 -> 1), 515(1 -> 0).

Passeri
Unambiguous: 61(1 -> 0), 63(1 -> 2), 114(1 -> 0), 222(0 -> 1), 261(0 -> 1), 334(0 -> 1), 335(0 -> 1), 366(0 -> 1), 369(0 -> 1), 441(2 -> 1), 507(1 -> 0); DELTRAN: 80(0 -> 3), 220(0 -> 1), 303(0 -> 1), 428(0 -> 1), 473(1 -> 0), 488(1 -> 0); ACCTRAN: 50(1 -> 0), 52(0 -> 1), 67(1 -> 0), 97(1 -> 2), 115(0 -> 1), 280(0 -> 1), 286(1 -> 0), 415(0 -> 1), 426(0 -> 1), 435(1 -> 2), 443(0 -> 1), 536(1 -> 0), 542(0 -> 1), 549(0 -> 1).

Acanthisitta chloris
Unambiguous: 26(0 -> 1), 32(0 -> 1), 126(0 -> 1), 143(0 -> 1), 183(0 -> 2), 185(0 -> 1), 203(1 -> 0), 205(0 -> 1), 248(0 -> 1), 307(0 -> 1), 338(0 -> 1), 339(0 -> 1), 341(0 -> 1), 348(0 -> 1), 353(2 -> 1), 357(0 -> 1), 403(0 -> 1), 407(0 -> 1), 425(0 -> 1), 501(0 -> 1), 509(0 -> 1), 537(0 -> 1); DELTRAN: 50(0 -> 1), 67(0 -> 1), 115(1 -> 0), 286(0 -> 1), 308(0 -> 1), 410(0 -> 1), 428(0 -> 1), 442(0 -> 1), 444(0 -> 1), 488(1 -> 0), 536(0 -> 1); ACCTRAN: 206(1 -> 0), 303(1 -> 0), 473(0 -> 1), 548(0 -> 1).

Eupasseres
Unambiguous: 33(0 -> 1), 166(0 -> 1), 179(0 -> 1), 184(2 -> 1), 191(0 -> 1), 201(0 -> 1), 244(1 -> 2), 257(0 -> 2), 294(0 -> 2), 367(0 -> 1), 466(0 -> 3), 467(1 -> 2), 487(1 -> 0); DELTRAN; ACCTRAN: 80(0 -> 3), 174(1 -> 0), 214(0 -> 1), 219(0 -> 1), 220(0 -> 1), 410(1 -> 0), 451(0 -> 1), 546(0 -> 1).

†Eozygodactylus americanus

Unambiguous: 198(0 -> 1), 250(1 -> 0), 350(1 -> 0), 432(1 -> 0); DELTRAN: 147(0 -> 1), 249(0 -> 1), 395(1 -> 0); ACCTRAN.

†Zygodactylus grandei
Unambiguous: 172(1 -> 0), 371(1 -> 0), 425(0 -> 1), 545(1 -> 0); DELTRAN: 190(1 -> 0), 205(0 -> 1), 351(0 -> 1), 505(0 -> 1), 506(0 -> 1), 515(1 -> 0); ACCTRAN.

†Primozygodactylus danielsi
Unambiguous: 44(1 -> 0), 250(1 -> 0); DELTRAN: 32(0 -> 1); ACCTRAN.

†Primozygodactylus quintus
Unambiguous; DELTRAN: 129(0 -> 1), 232(1 -> 0), 302(1 -> 0), 303(0 -> 1), 317(0 -> 1), 344(0 -> 1), 369(0 -> 1), 440(1 -> 0), 448(0 -> 1), 455(0 -> 2), 458(0 -> 1), 473(1 -> 0), 474(0 -> 1), 477(0 -> 1), 478(0 -> 1), 517(0 -> 1); ACCTRAN: 32(1 -> 0).

†Primozygodactylus eunjooae
Unambiguous; DELTRAN: 1(0 -> 1), 32(0 -> 1), 493(1 -> 0); ACCTRAN.

†Primozygodactylus longibrachium
Unambiguous: 142(0 -> 1); DELTRAN; ACCTRAN.

†Primozygodactylus danielsi + †Primozygodactylus quintus
Unambiguous: 26(0 -> 1), 151(0 -> 1); DELTRAN; ACCTRAN: 232(1 -> 0).

†Primozygodactylus eunjooae + †Primozygodactylus longibrachium
Unambiguous; DELTRAN; ACCTRAN: 1(0 -> 1), 493(1 -> 0).

Primozygodactylus major †Primozygodactylus longibrachium
Unambiguous: 509(0 -> 1); DELTRAN; ACCTRAN.

†Primozygodactylus eunjooae + †Primozygodactylus longibrachium + †Primozygodactylus danielsi + †Primozygodactylus quintus
Unambiguous: 228(0 -> 1); DELTRAN: 8(0 -> 1), 25(0 -> 1), 33(0 -> 1), 179(0 -> 1), 255(1 -> 0), 266(1 -> 0); ACCTRAN.

†Zygodactylus + †Eozygodactylus
Unambiguous: 354(0 -> 1), 381(0 -> 1), 498(0 -> 1); DELTRAN: 197(0 -> 1), 273(0 -> 1), 274(0 -> 1), 336(0 -> 1); ACCTRAN: 25(1 -> 0), 190(1 -> 0), 205(0 -> 1), 249(0 -> 1), 351(0 -> 1), 395(1 -> 0), 505(0 -> 1), 506(0 -> 1), 515(1 -> 0).

Primozygodactylus major + †Primozygodactylus longibrachium + †Primozygodactylus danielsi + †Primozygodactylus quintus
Unambiguous: 229(0 -> 1), 244(1 -> 2), 429(1 -> 0), 523(0 -> 1); DELTRAN; ACCTRAN: 8(0 -> 1), 32(0 -> 1), 33(0 -> 1), 147(1 -> 0), 179(0 -> 1), 197(1 -> 0), 255(1 -> 0), 274(1 -> 0), 317(0 -> 1), 336(1 -> 0), 440(1 -> 0), 478(0 -> 1).

Passeriformes
Unambiguous: 131(0 -> 1), 134(0 -> 1), 142(0 -> 1), 156(0 -> 1), 169(1 -> 0), 189(0 -> 1), 247(0 -> 1), 276(0 -> 1), 279(0 -> 1), 292(0 -> 1), 297(0 -> 1), 298(0 -> 1), 301(0 -> 1), 305(0 -> 1), 311(0 -> 1), 329(1 -> 2), 332(1 -> 2), 343(0 -> 1), 347(0 -> 1), 411(1 -> 0), 420(0 -> 1), 427(0 -> 1), 429(1 -> 2), 452(0 -> 2), 476(1 -> 0), 482(0 -> 1), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0), 489(1 -> 0), 491(0 -> 1), 492(1 -> 0), 493(1 -> 0), 495(3 -> 0), 510(0 -> 1), 519(0 -> 1); DELTRAN: 18(1 -> 0), 25(0 -> 1), 51(0 -> 1), 63(0 -> 1), 78(0 -> 1), 83(0 -> 1), 92(0 -> 1), 97(0 -> 1), 98(0 -> 1), 102(1 -> 4), 103(0 -> 1), 147(0 -> 1), 150(0 -> 1), 164(0 -> 1), 165(0 -> 1), 197(0 -> 1), 199(1 ->

0), 209(0 -> 2), 259(0 -> 2), 270(1 -> 2), 271(0 -> 1), 274(0 -> 1), 283(0 -> 1), 285(0 -> 1), 287(0 -> 1), 291(0 -> 1), 322(0 -> 1), 327(1 -> 2), 328(1 -> 0), 336(0 -> 1), 388(1 -> 0), 401(0 -> 1), 402(2 -> 1), 423(0 -> 1), 438(0 -> 1), 441(0 -> 2), 513(0 -> 2); ACCTRAN: 40(0 -> 1), 115(1 -> 0), 308(0 -> 1), 442(0 -> 1), 444(0 -> 1), 477(1 -> 0), 488(1 -> 0), 513(1 -> 2), 536(0 -> 1).

Zygodactylidae
Unambiguous: 144(0 -> 1), 232(0 -> 1), 431(1 -> 0), 435(1 -> 0), 502(0 -> 1), 527(1 -> 0); DELTRAN: 40(1 -> 0), 513(0 -> 1), 548(1 -> 0); ACCTRAN: 129(0 -> 1), 259(2 -> 0), 266(1 -> 0), 273(0 -> 1), 286(1 -> 0), 291(1 -> 0), 302(1 -> 0), 344(0 -> 1), 369(0 -> 1), 438(1 -> 0), 441(2 -> 0), 448(0 -> 1), 455(0 -> 2), 458(0 -> 1), 474(0 -> 1), 517(0 -> 1).

†Eofringillirostrum boudreauxi
Unambiguous: 8(0 -> 1), 15(0 -> 1), 19(0 -> 1), 137(0 -> 1), 250(1 -> 0), 254(0 -> 1), 260(1 -> 0), 277(0 -> 1), 521(0 -> 1), 528(0 -> 1), 530(0 -> 2), 537(0 -> 1), 545(1 -> 0); DELTRAN: 40(1 -> 0), 117(1 -> 0), 473(1 -> 2), 477(0 -> 1), 508(0 -> 1), 535(0 -> 1); ACCTRAN: 244(1 -> 0), 473(0 -> 2).

Pararpasseres
Unambiguous: 48(1 -> 2), 242(0 -> 1), 245(1 -> 0), 251(0 -> 1), 350(0 -> 1), 470(2 -> 1), 472(0 -> 1), 475(0 -> 1), 512(1 -> 2); DELTRAN: 114(0 -> 1), 244(0 -> 1), 253(0 -> 1), 334(1 -> 0), 352(0 -> 1), 356(0 -> 1), 358(0 -> 1), 376(1 -> 0), 453(0 -> 1), 507(0 -> 1); ACCTRAN: 25(0 -> 1), 117(0 -> 1), 147(0 -> 1), 336(0 -> 1), 508(1 -> 0), 513(0 -> 1), 535(1 -> 0), 548(1 -> 0).

†Parapsittacopes bergdahli
Unambiguous: 215(1 -> 2), 217(0 -> 1), 252(0 -> 2), 254(0 -> 1), 292(0 -> 1); DELTRAN: 28(0 -> 1), 35(0 -> 1), 38(0 -> 1), 55(0 -> 1), 108(0 -> 1), 117(1 -> 2), 126(0 -> 1), 144(0 -> 1), 183(0 -> 1), 196(0 -> 1), 201(0 -> 1), 202(0 -> 1), 251(0 -> 1), 259(0 -> 2), 277(0 -> 1), 286(0 -> 1), 314(0 -> 1), 329(1 -> 0), 382(0 -> 1), 395(1 -> 0), 523(0 -> 1); ACCTRAN: 131(1 -> 0).

†Psittacomimus eos
Unambiguous: 15(0 -> 1), 16(0 -> 1), 116(0 -> 1), 123(0 -> 1), 238(1 -> 0), 256(1 -> 0), 370(0 -> 1); DELTRAN: 131(0 -> 1), 232(0 -> 1), 337(0 -> 1), 396(1 -> 0), 447(1 -> 0), 469(1 -> 0), 476(1 -> 0), 484(0 -> 1), 485(1 -> 0), 486(1 -> 2), 501(0 -> 2); ACCTRAN: 329(0 -> 1).

†Psittacopes Lepidus
Unambiguous: 8(0 -> 1), 17(1 -> 0), 151(0 -> 1), 229(0 -> 1), 278(0 -> 1), 377(0 -> 2), 548(1 -> 2); DELTRAN: 131(0 -> 1), 181(0 -> 1), 259(0 -> 1), 329(1 -> 0), 334(1 -> 0), 513(0 -> 1), 535(0 -> 1); ACCTRAN: 114(1 -> 0), 220(1 -> 0), 259(2 -> 1).

†Parapsittacopes + †Psittacomimus
Unambiguous: 4(0 -> 1), 331(0 -> 1), 347(0 -> 1); DELTRAN: 112(1 -> 0), 114(0 -> 1), 162(1 -> 0), 220(0 -> 1), 234(0 -> 1), 255(1 -> 0), 291(0 -> 1), 303(0 -> 1); ACCTRAN: 183(0 -> 1), 251(0 -> 1), 277(0 -> 1), 334(0 -> 1), 337(0 -> 1), 382(0 -> 1), 395(1 -> 0), 396(1 -> 0), 523(0 -> 1), 535(1 -> 0).

†Pumiliornis tessellatus
Unambiguous: 1(0 -> 1), 11(0 -> 1), 25(0 -> 1), 26(0 -> 1), 32(0 -> 1), 183(0 -> 2), 215(1 -> 2), 217(0 -> 1), 257(0 -> 2), 280(0 -> 1), 306(0 -> 1), 354(0 -> 1), 377(0 -> 1), 436(0 -> 1), 489(1 -> 0), 502(0 -> 1), 547(0 -> 1), 548(1 -> 0); DELTRAN: 47(0 -> 2), 220(0 -> 1), 379(0 -> 1), 535(0 -> 1); ACCTRAN: 259(2 -> 0), 272(1 -> 0), 303(1 -> 0), 508(1 -> 0).

†Psittacopes + †Parapsittacopes + †Psittacomimus
Unambiguous: 134(0 -> 1), 142(0 -> 1), 266(1 -> 0), 435(1 -> 0), 493(1 -> 0), 499(0 -> 1); DELTRAN: 191(0 -> 1), 272(0 -> 1), 479(0 -> 2), 508(0 -> 1); ACCTRAN: 28(0 -> 1), 35(0 -> 1),

55(0 -> 1), 131(0 -> 1), 232(0 -> 1), 234(0 -> 1), 379(1 -> 0), 476(1 -> 0), 484(0 -> 1), 485(1 -> 0), 486(1 -> 2), 501(0 -> 2), 513(0 -> 1).

Eofringillirostrum + Parapasseres
Unambiguous: 37(1 -> 0), 44(0 -> 1), 215(1 -> 0), 331(0 -> 1), 332(0 -> 1), 355(0 -> 1), 399(0 -> 2), 515(0 -> 1); DELTRAN: 47(0 -> 1), 272(0 -> 1), 278(0 -> 1), 317(1 -> 0), 379(0 -> 1); ACCTRAN: 40(1 -> 0), 50(0 -> 1), 112(0 -> 1), 117(2 -> 0), 126(1 -> 0), 162(0 -> 1), 164(0 -> 1), 191(1 -> 0), 197(0 -> 1), 202(1 -> 0), 220(1 -> 0), 253(0 -> 1), 270(1 -> 2), 271(0 -> 1), 274(0 -> 1), 285(0 -> 1), 287(0 -> 1), 352(0 -> 1), 356(0 -> 1), 358(0 -> 1), 376(1 -> 0), 453(0 -> 1), 477(0 -> 1), 504(1 -> 0), 507(0 -> 1).

Psittacopedidae
Unambiguous: 172(1 -> 0), 219(0 -> 1), 252(2 -> 0), 309(0 -> 1), 408(1 -> 2), 456(0 -> 1), 527(1 -> 0), 539(0 -> 1); DELTRAN: 244(0 -> 1), 504(0 -> 1); ACCTRAN: 38(0 -> 1), 47(1 -> 2), 108(0 -> 1), 144(0 -> 1), 165(1 -> 0), 181(0 -> 1), 196(0 -> 1), 201(0 -> 1), 255(1 -> 0), 278(1 -> 0), 314(0 -> 1), 329(1 -> 0), 401(1 -> 0), 428(1 -> 0), 447(1 -> 0), 469(1 -> 0), 473(0 -> 1), 479(0 -> 2).

Psittaciformes
Unambiguous: 2(0 -> 1), 7(0 -> 1), 28(0 -> 3), 30(0 -> 1), 41(0 -> 1), 46(0 -> 1), 48(1 -> 2), 55(0 -> 2), 84(0 -> 1), 90(0 -> 1), 95(2 -> 0), 101(0 -> 2), 118(0 -> 1), 121(0 -> 1), 137(0 -> 1), 138(0 -> 1), 139(0 -> 1), 140(0 -> 1), 152(0 -> 2), 154(0 -> 1), 156(0 -> 1), 170(0 -> 2), 189(0 -> 1), 200(1 -> 2), 218(0 -> 1), 229(0 -> 1), 239(0 -> 1), 254(0 -> 2), 258(0 -> 1), 265(0 -> 1), 307(0 -> 1), 321(1 -> 0), 354(0 -> 1), 361(0 -> 1), 370(0 -> 1), 377(0 -> 2), 395(1 -> 0), 397(2 -> 1), 435(1 -> 2), 452(0 -> 1), 454(0 -> 2), 462(0 -> 1), 476(1 -> 0), 479(0 -> 1), 481(0 -> 1), 490(0 -> 1), 494(0 -> 1), 499(0 -> 1), 501(0 -> 1), 511(0 -> 1), 523(0 -> 1), 530(0 -> 1), 533(0 -> 1), 534(0 -> 1); DELTRAN: 19(0 -> 1), 23(0 -> 1), 105(0 -> 1), 112(1 -> 0), 117(1 -> 2), 126(0 -> 1), 151(0 -> 1), 162(1 -> 0), 165(0 -> 1), 191(0 -> 1), 214(0 -> 1), 220(0 -> 1), 222(0 -> 1), 257(1 -> 2), 259(0 -> 2), 264(0 -> 1), 278(0 -> 1), 401(0 -> 1), 410(0 -> 1), 427(0 -> 1), 438(0 -> 1), 473(1 -> 0), 504(0 -> 1), 508(0 -> 1), 543(0 -> 1); ACCTRAN: 8(0 -> 1), 39(0 -> 1), 56(0 -> 1), 114(1 -> 0), 163(0 -> 1), 206(1 -> 2), 270(1 -> 0), 317(0 -> 1), 324(0 -> 1), 334(0 -> 1), 491(0 -> 2), 518(0 -> 1), 529(0 -> 1).

Psittacopedidae + Eofringillirostrum + Parapasseres
Unambiguous: 17(0 -> 1), 33(1 -> 0), 49(0 -> 1), 130(0 -> 1), 146(0 -> 1), 169(0 -> 1), 179(1 -> 0), 184(1 -> 2), 236(0 -> 2), 269(0 -> 1), 297(1 -> 0), 360(0 -> 1), 384(0 -> 1), 416(0 -> 1), 432(0 -> 1), 549(1 -> 0); DELTRAN: 257(1 -> 0), 371(0 -> 1); ACCTRAN: 4(2 -> 0), 15(1 -> 0), 18(1 -> 0), 19(1 -> 0), 23(1 -> 0), 47(0 -> 1), 51(0 -> 1), 63(0 -> 1), 67(0 -> 1), 78(0 -> 1), 83(0 -> 1), 92(0 -> 1), 102(1 -> 4), 103(0 -> 1), 105(1 -> 0), 150(0 -> 1), 151(1 -> 0), 186(1 -> 0), 199(1 -> 0), 209(0 -> 2), 214(1 -> 0), 222(1 -> 0), 244(0 -> 1), 257(2 -> 0), 264(1 -> 0), 272(0 -> 1), 283(0 -> 1), 286(0 -> 1), 291(0 -> 1), 303(0 -> 1), 322(0 -> 1), 327(1 -> 2), 379(0 -> 1), 388(1 -> 0), 402(2 -> 1), 423(0 -> 1), 427(1 -> 0), 535(0 -> 1), 542(1 -> 0), 543(1 -> 0).

Falconiformes
Unambiguous: 225(1 -> 0), 248(0 -> 1), 463(0 -> 1), 487(1 -> 0), 547(0 -> 1); DELTRAN: 214(0 -> 1), 264(0 -> 1), 474(0 -> 1), 495(0 -> 1), 543(0 -> 1); ACCTRAN: 12(0 -> 1), 28(0 -> 1), 35(0 -> 2), 36(0 -> 1), 38(0 -> 1), 39(0 -> 2), 55(0 -> 1), 61(1 -> 0), 62(0 -> 1), 68(0 -> 1), 108(0 -> 1), 112(0 -> 2), 116(0 -> 1), 117(2 -> 1), 120(0 -> 1), 132(0 -> 1), 134(0 -> 1), 142(0 -> 1), 152(0 -> 1), 155(0 -> 1), 173(0 -> 1), 180(0 -> 1), 181(0 -> 1), 196(0 -> 1), 209(0 -> 1), 243(0 -> 1), 260(1 -> 0), 315(0 -> 1), 328(0 -> 1), 341(0 -> 1), 377(0 -> 1), 391(0 -> 1), 397(2 -> 0), 406(0 -> 1), 414(0 -> 1), 419(0 -> 1), 421(0 -> 1), 426(0 -> 1), 437(1 -> 0), 439(0 -> 1), 442(0 -> 1), 443(0 -> 1), 464(2 -> 1), 468(0 -> 1), 471(0 -> 1), 521(0 -> 1), 528(0 -> 2), 529(0 -> 2), 530(0 -> 2), 539(0 -> 1).

Psittacopasseres
Unambiguous: 32(1 -> 0), 58(1 -> 0), 77(1 -> 0), 85(0 -> 1), 91(1 -> 0), 190(0 -> 1), 252(1 -> 2), 256(0 -> 1), 284(0 -> 1), 392(0 -> 1), 396(0 -> 1), 404(1 -> 0), 409(0 -> 1), 429(0 -> 1), 431(0 -> 1), 440(0 -> 1), 467(0 -> 1), 470(0 -> 2), 478(1 -> 0), 489(0 -> 1), 496(0 -> 2), 513(2 -> 0); DELTRAN: 250(0 -> 1), 424(0 -> 1), 434(0 -> 1), 437(0 -> 1), 460(1 -> 0), 465(0 -> 2), 472(1 -> 0), 495(0 -> 3); ACCTRAN: 52(1 -> 0), 97(0 -> 1), 98(0 -> 1), 111(1 -> 0), 129(1 -> 0), 162(1 -> 0), 165(0 -> 1), 191(0 -> 1), 259(1 -> 2), 278(0 -> 1), 371(0 -> 1), 393(1 -> 0), 401(0 -> 1), 410(0 -> 1), 428(0 -> 1), 438(0 -> 1), 441(0 -> 2), 465(1 -> 2), 473(1 -> 0), 474(1 -> 0), 495(1 -> 3), 504(0 -> 1), 508(0 -> 1).

Cariamiformes
Unambiguous: 79(0 -> 1), 89(0 -> 1), 335(0 -> 1), 337(0 -> 1), 344(0 -> 1), 376(1 -> 0), 379(0 -> 1), 463(0 -> 2), 464(2 -> 0), 548(1 -> 0); DELTRAN: 52(0 -> 1), 328(1 -> 0), 334(1 -> 0); ACCTRAN: 11(0 -> 1), 40(1 -> 0), 43(0 -> 1), 73(0 -> 1), 99(0 -> 1), 101(0 -> 1), 102(1 -> 0), 115(1 -> 0), 182(0 -> 1), 183(0 -> 2), 194(0 -> 1), 198(0 -> 1), 215(1 -> 2), 216(0 -> 1), 217(0 -> 1), 245(1 -> 0), 281(1 -> 0), 296(0 -> 1), 311(0 -> 1), 319(0 -> 1), 348(0 -> 1), 362(0 -> 1), 385(0 -> 1), 398(0 -> 1), 408(1 -> 0), 412(0 -> 1), 413(1 -> 0), 420(0 -> 1), 425(0 -> 1), 435(1 -> 2), 447(1 -> 0), 527(1 -> 0).

Eufalconimorphae
Unambiguous: 1(1 -> 0), 25(1 -> 0), 48(0 -> 1), 96(0 -> 1), 226(0 -> 1), 255(0 -> 1), 347(1 -> 0), 453(1 -> 0), 469(0 -> 1); DELTRAN: 37(0 -> 1), 40(0 -> 1), 102(0 -> 1), 245(0 -> 1), 266(0 -> 1), 527(0 -> 1); ACCTRAN: 4(0 -> 2), 15(0 -> 1), 19(0 -> 1), 23(0 -> 1), 105(0 -> 1), 126(0 -> 1), 151(0 -> 1), 186(0 -> 1), 202(0 -> 1), 214(0 -> 1), 257(1 -> 2), 264(0 -> 1), 327(0 -> 1), 424(0 -> 1), 460(1 -> 0), 465(0 -> 1), 472(1 -> 0), 495(0 -> 1), 542(0 -> 1), 543(0 -> 1).

Afroaves
Unambiguous: 28(0 -> 1), 91(1 -> 0), 133(0 -> 1), 184(1 -> 2), 225(1 -> 0), 370(0 -> 1), 528(0 -> 1), 529(0 -> 1), 530(0 -> 1); DELTRAN: 40(0 -> 1), 245(0 -> 1), 402(3 -> 1), 437(0 -> 1); ACCTRAN: 33(1 -> 0), 61(1 -> 0), 95(2 -> 0), 201(0 -> 1), 209(0 -> 2), 283(0 -> 1), 333(0 -> 1), 351(0 -> 1), 396(0 -> 1), 397(2 -> 0), 404(1 -> 0), 456(0 -> 1), 470(0 -> 1), 495(0 -> 2), 496(0 -> 1), 521(0 -> 1), 534(0 -> 1).

Australaves
Unambiguous: 228(1 -> 0), 321(0 -> 1), 361(1 -> 0), 388(0 -> 1), 395(0 -> 1); DELTRAN: 18(0 -> 1), 297(0 -> 1), 402(3 -> 2); ACCTRAN: 37(0 -> 1), 111(0 -> 1), 112(1 -> 0), 114(0 -> 1), 117(1 -> 2), 129(0 -> 1), 206(0 -> 1), 220(0 -> 1), 222(0 -> 1), 250(0 -> 1), 266(0 -> 1), 317(1 -> 0), 328(1 -> 0), 334(1 -> 0), 393(0 -> 1), 402(1 -> 2), 427(0 -> 1), 434(0 -> 1), 474(0 -> 1).

Outgroup Charadris + Eurypyga
Unambiguous: 26(0 -> 1), 51(0 -> 1), 96(0 -> 1), 104(0 -> 1), 110(0 -> 1), 117(1 -> 0), 134(0 -> 1), 182(0 -> 1), 184(1 -> 2), 200(1 -> 2), 229(0 -> 1), 244(0 -> 1), 270(0 -> 2), 286(0 -> 1), 377(0 -> 1), 384(0 -> 1), 392(0 -> 1), 401(0 -> 1), 407(0 -> 1), 409(0 -> 1), 429(0 -> 2), 458(0 -> 1), 477(0 -> 1), 485(1 -> 2), 522(0 -> 1); DELTRAN; ACCTRAN: 152(0 -> 1), 324(0 -> 1), 325(0 -> 1), 537(0 -> 1).

Telluraves
Unambiguous: 17(1 -> 0), 172(0 -> 1), 179(0 -> 1), 188(0 -> 1), 254(1 -> 0), 270(0 -> 1), 417(1 -> 0), 473(0 -> 1), 540(0 -> 1), 545(0 -> 1); DELTRAN; ACCTRAN: 18(0 -> 1), 40(0 -> 1), 52(0 -> 1), 102(0 -> 1), 245(0 -> 1), 259(0 -> 1), 297(0 -> 1), 327(1 -> 0), 402(3 -> 1), 437(0 -> 1), 527(0 -> 1).

Outgroup Eudromia + Chauna
Unambiguous: 58(1 -> 0), 75(2 -> 0), 76(0 -> 1), 77(1 -> 0), 81(0 -> 1), 86(0 -> 1), 94(1 -> 0), 144(0 -> 1), 161(0 -> 1), 268(0 -> 1), 276(0 -> 1), 305(0 -> 1), 306(0 -> 1), 360(0 -> 1), 426(0 -> 1), 463(0 -> 2), 464(2 -> 0); DELTRAN; ACCTRAN: 38(0 -> 1), 203(1 -> 0), 529(0 -> 1), 539(0 -> 1).

Chauna chavaria
Unambiguous: 4(0 -> 1), 5(1 -> 0), 8(0 -> 1), 25(1 -> 0), 30(0 -> 1), 73(0 -> 1), 89(0 -> 1), 91(1 -> 0), 99(0 -> 1), 137(0 -> 1), 152(0 -> 2), 183(0 -> 1), 194(0 -> 1), 198(0 -> 2), 206(0 -> 1), 208(0 -> 1), 209(0 -> 1), 227(0 -> 1), 228(1 -> 0), 238(1 -> 0), 245(0 -> 2), 246(0 -> 1), 252(1 -> 0), 255(0 -> 1), 281(1 -> 0), 290(0 -> 1), 302(1 -> 0), 310(0 -> 1), 314(0 -> 1), 317(1 -> 0), 354(0 -> 1), 368(0 -> 1), 388(0 -> 1), 409(0 -> 1), 410(0 -> 1), 414(0 -> 1), 428(0 -> 1), 429(0 -> 1), 432(0 -> 1), 485(1 -> 2); DELTRAN: 203(1 -> 2), 529(0 -> 1), 539(0 -> 1); ACCTRAN: 203(0 -> 2).

Eudromia elegans
Unambiguous: 11(0 -> 1), 26(0 -> 1), 32(1 -> 0), 39(0 -> 2), 40(0 -> 1), 46(0 -> 1), 48(0 -> 1), 55(0 -> 1), 62(0 -> 1), 96(0 -> 1), 98(0 -> 1), 105(0 -> 1), 114(0 -> 1), 115(1 -> 0), 121(0 -> 1), 135(0 -> 1), 162(1 -> 0), 168(0 -> 1), 192(0 -> 1), 195(0 -> 1), 199(1 -> 0), 204(1 -> 0), 205(0 -> 1), 210(0 -> 1), 215(1 -> 0), 219(0 -> 1), 220(0 -> 1), 347(1 -> 0), 364(0 -> 1), 371(0 -> 1), 383(1 -> 0), 384(0 -> 1), 392(0 -> 1), 397(2 -> 0), 400(1 -> 0), 401(0 -> 1), 402(3 -> 4), 407(0 -> 1), 411(1 -> 0), 413(1 -> 0), 457(0 -> 1), 458(0 -> 1), 465(0 -> 1), 478(1 -> 0), 493(1 -> 0); DELTRAN: 38(0 -> 1), 203(1 -> 0); ACCTRAN.

S3.7 Character optimisation for Analysis 3 “Prum” constraint

Charadris vociferus
Unambiguous: 11(0 -> 1), 31(0 -> 1), 32(1 -> 0), 48(0 -> 1), 61(1 -> 0), 65(0 -> 1), 74(0 -> 1), 114(0 -> 1), 116(0 -> 1), 132(0 -> 1), 137(0 -> 1), 166(0 -> 1), 174(1 -> 0), 188(0 -> 1), 194(0 -> 1), 198(0 -> 1), 219(0 -> 1), 220(0 -> 1), 232(0 -> 1), 256(0 -> 1), 266(0 -> 1), 272(0 -> 1), 276(1 -> 0), 283(0 -> 2), 287(0 -> 1), 310(0 -> 1), 347(0 -> 1), 368(0 -> 1), 397(2 -> 1), 411(1 -> 0), 424(0 -> 1), 425(0 -> 1), 426(1 -> 0), 427(0 -> 1), 428(0 -> 1), 441(0 -> 1), 457(0 -> 1), 465(0 -> 1), 481(0 -> 1), 493(0 -> 1), 513(2 -> 1), 520(0 -> 1); DELTRAN: 75(0 -> 1), 152(0 -> 2), 324(0 -> 1), 325(0 -> 1), 464(0 -> 2), 529(1 -> 0), 537(0 -> 1); ACCTRAN: 152(1 -> 2), 464(1 -> 2).

Eurypyga helias
Unambiguous: 64(0 -> 1), 66(0 -> 1), 81(1 -> 0), 82(0 -> 1), 99(0 -> 1), 112(0 -> 1), 131(0 -> 1), 147(0 -> 1), 148(0 -> 1), 161(0 -> 1), 162(1 -> 0), 168(0 -> 1), 196(0 -> 1), 201(0 -> 1), 207(0 -> 1), 209(0 -> 1), 218(0 -> 1), 225(0 -> 1), 236(0 -> 1), 245(0 -> 1), 268(0 -> 1), 302(0 -> 1), 303(0 -> 1), 306(1 -> 0), 334(1 -> 0), 370(0 -> 1), 396(0 -> 1), 413(1 -> 2), 437(0 -> 1), 438(0 -> 1); DELTRAN: 75(0 -> 2), 152(0 -> 1), 464(0 -> 1); ACCTRAN: 75(1 -> 2).

Cathartes burrovianus
Unambiguous: 37(0 -> 1), 65(0 -> 1), 74(0 -> 1), 82(0 -> 1), 91(0 -> 1), 112(0 -> 1), 148(0 -> 1), 184(1 -> 2), 198(0 -> 1), 290(0 -> 1), 310(0 -> 1), 314(0 -> 1), 325(0 -> 1), 404(1 -> 0), 407(0 -> 1), 487(1 -> 0), 491(0 -> 1), 542(0 -> 1); DELTRAN: 1(1 -> 0), 152(0 -> 1), 172(0 -> 1); ACCTRAN.

Vultur gryphus
Unambiguous: 62(0 -> 1), 117(1 -> 0), 130(0 -> 1), 137(0 -> 1), 147(0 -> 1), 150(0 -> 1), 388(0 -> 1), 392(0 -> 1), 522(0 -> 1), 529(1 -> 0); DELTRAN: 152(0 -> 2); ACCTRAN: 1(0 -> 1), 152(1 -> 2), 172(1 -> 0).

Accipiter nisus
Unambiguous: 182(0 -> 1), 190(0 -> 1), 248(0 -> 1), 289(0 -> 1), 306(1 -> 0), 313(0 -> 1), 336(0 -> 1), 527(1 -> 2), 538(0 -> 1); DELTRAN: 117(1 -> 2), 181(0 -> 1), 228(0 -> 1), 347(0 -> 1); ACCTRAN: 127(1 -> 0), 129(1 -> 0), 377(0 -> 1).

Buteo rufofuscus
Unambiguous: 120(0 -> 1), 249(0 -> 1), 266(0 -> 1), 280(0 -> 1), 283(1 -> 2), 311(0 -> 1), 355(0 -> 1), 364(0 -> 1), 406(1 -> 0); DELTRAN: 127(0 -> 1), 129(0 -> 1), 377(1 -> 0); ACCTRAN: 117(2 -> 1), 181(1 -> 0), 228(1 -> 0), 347(1 -> 0).

†Palaeoplancus sternbergi
Unambiguous: 151(1 -> 0), 246(0 -> 1), 284(0 -> 1), 287(0 -> 1), 334(1 -> 0), 361(1 -> 0), 376(1 -> 0); DELTRAN: 347(0 -> 1), 377(1 -> 0); ACCTRAN: 473(1 -> 0).

Buteo + Accipiter
Unambiguous: 9(0 -> 1), 142(0 -> 1), 269(0 -> 1), 286(0 -> 1), 302(0 -> 1), 307(0 -> 1), 314(0 -> 1), 494(0 -> 1); DELTRAN: 23(0 -> 1), 61(1 -> 0), 149(0 -> 1), 150(0 -> 1), 188(0 -> 1), 203(1 -> 2), 206(0 -> 1), 257(1 -> 2), 321(0 -> 1), 388(0 -> 1), 435(2 -> 1), 441(0 -> 1), 442(0 -> 1), 473(0 -> 1), 512(0 -> 2), 521(1 -> 2), 530(2 -> 1); ACCTRAN.

Elanus caeruleus
Unambiguous: 54(0 -> 1), 71(1 -> 0), 105(1 -> 0), 145(0 -> 1), 364(0 -> 1), 455(0 -> 1), 490(0 -> 1), 491(1 -> 2); DELTRAN: 32(1 -> 0), 117(1 -> 2), 127(0 -> 1), 129(0 -> 1), 172(0 -> 1), 228(0 -> 1), 404(1 -> 0), 473(0 -> 1); ACCTRAN: 152(1 -> 0), 188(1 -> 0).

†Palaeoplancus + Buteo + Accipiter
Unambiguous: 283(0 -> 1); DELTRAN: 152(0 -> 1); ACCTRAN: 23(0 -> 1), 32(0 -> 1), 149(0 -> 1), 150(0 -> 1), 172(1 -> 0), 203(1 -> 2), 206(0 -> 1), 257(1 -> 2), 321(0 -> 1), 347(0 -> 1), 377(1 -> 0), 388(0 -> 1), 404(0 -> 1), 435(2 -> 1), 441(0 -> 1), 442(0 -> 1), 512(0 -> 2), 521(1 -> 2), 530(2 -> 1).

Pandion haliaetus carolinensis
Unambiguous: 35(2 -> 1), 62(0 -> 1), 73(0 -> 1), 74(0 -> 1), 89(0 -> 1), 101(0 -> 2), 109(0 -> 1), 112(0 -> 1), 155(0 -> 1), 162(1 -> 0), 198(0 -> 1), 226(0 -> 1), 392(0 -> 1), 397(0 -> 1), 408(1 -> 2), 414(1 -> 0), 452(0 -> 2), 456(0 -> 1), 476(1 -> 2), 477(0 -> 1), 481(0 -> 1), 485(1 -> 2), 486(1 -> 2), 488(1 -> 0), 513(2 -> 1), 547(1 -> 0), 548(1 -> 0); DELTRAN: 32(1 -> 0), 75(0 -> 2), 152(0 -> 1), 172(0 -> 1), 181(0 -> 1), 188(0 -> 1), 398(0 -> 1), 404(1 -> 0), 464(0 -> 2), 465(0 -> 2), 474(0 -> 1), 495(0 -> 2); ACCTRAN: 36(1 -> 0), 75(1 -> 2), 117(2 -> 1), 413(2 -> 1), 464(1 -> 2), 465(1 -> 2), 495(1 -> 2).

Accipitridae
Unambiguous: 38(0 -> 1), 39(0 -> 1), 68(0 -> 1), 104(0 -> 1), 115(0 -> 1), 126(0 -> 1), 130(0 -> 1), 174(1 -> 0), 209(0 -> 2), 211(0 -> 1), 218(1 -> 0), 236(0 -> 1), 238(0 -> 1), 250(0 -> 1), 254(1 -> 0), 264(0 -> 1), 276(1 -> 0), 323(0 -> 1), 325(0 -> 1), 370(0 -> 1), 409(0 -> 1), 445(0 -> 1); DELTRAN: 36(0 -> 1), 75(0 -> 1), 116(0 -> 1), 413(1 -> 2), 464(0 -> 1), 465(0 -> 1), 474(0 -> 2), 495(0 -> 1); ACCTRAN: 61(1 -> 0), 127(0 -> 1), 129(0 -> 1), 228(0 -> 1), 398(1 -> 0), 473(0 -> 1), 474(1 -> 2).

Sagittarius serpentarius
Unambiguous: 23(0 -> 1), 76(0 -> 1), 95(2 -> 1), 101(0 -> 1), 114(0 -> 1), 149(0 -> 1), 153(0 -> 1), 184(1 -> 0), 187(0 -> 1), 206(0 -> 1), 289(0 -> 1), 306(1 -> 0), 317(1 -> 0), 377(1 -> 0), 385(0 -> 1), 388(0 -> 1), 393(0 -> 1), 425(0 -> 1), 512(0 -> 2), 522(0 -> 1); DELTRAN: 30(0 -> 1), 36(0 -> 1), 46(0 -> 1), 117(1 -> 2), 159(0 -> 1), 194(0 -> 1), 208(0 -> 1), 210(0 -> 1), 244(0 -> 2), 398(0

-> 1), 413(1 -> 0), 473(0 -> 2); ACCTRAN: 5(0 -> 1), 33(0 -> 1), 152(1 -> 0), 172(1 -> 0), 244(1 -> 2), 258(1 -> 0), 413(2 -> 0).

Pandionidae + Accipitridae
Unambiguous: 81(1 -> 0), 173(0 -> 1), 196(0 -> 1), 223(0 -> 1), 243(0 -> 1), 371(0 -> 1), 391(0 -> 1), 406(0 -> 1), 447(1 -> 0), 453(1 -> 0), 460(1 -> 0), 463(2 -> 1), 471(0 -> 1), 472(1 -> 0), 487(1 -> 0), 491(0 -> 1), 493(0 -> 1), 521(0 -> 1), 526(0 -> 1), 527(0 -> 1), 528(0 -> 2), 529(1 -> 2), 530(0 -> 2), 540(0 -> 1), 542(0 -> 2), 543(0 -> 1); DELTRAN: 5(1 -> 0), 33(1 -> 0), 244(0 -> 1), 258(0 -> 1); ACCTRAN: 30(1 -> 0), 32(1 -> 0), 46(1 -> 0), 75(0 -> 1), 159(1 -> 0), 188(0 -> 1), 194(1 -> 0), 208(1 -> 0), 210(1 -> 0), 404(1 -> 0), 464(0 -> 1), 465(0 -> 1), 473(2 -> 0), 474(0 -> 1), 495(0 -> 1).

Cathartidae
Unambiguous: 6(0 -> 1), 10(0 -> 1), 25(1 -> 0), 39(0 -> 2), 73(0 -> 2), 77(1 -> 0), 95(2 -> 0), 100(0 -> 1), 106(0 -> 1), 109(0 -> 1), 110(0 -> 1), 115(0 -> 1), 121(0 -> 1), 142(0 -> 1), 155(0 -> 1), 166(0 -> 1), 183(0 -> 2), 200(1 -> 2), 226(0 -> 1), 227(0 -> 1), 246(0 -> 1), 252(1 -> 0), 305(0 -> 1), 311(0 -> 1), 364(0 -> 1), 368(0 -> 1), 376(1 -> 0), 380(0 -> 1), 387(0 -> 1), 396(0 -> 1), 450(0 -> 1), 456(0 -> 1), 500(0 -> 1), 548(1 -> 0), 549(1 -> 0); DELTRAN: 5(1 -> 0), 30(0 -> 1), 33(1 -> 0), 46(0 -> 1), 48(0 -> 2), 159(0 -> 1), 194(0 -> 1), 208(0 -> 1), 210(0 -> 1), 258(0 -> 1), 413(1 -> 2), 473(0 -> 2); ACCTRAN: 48(1 -> 2), 545(1 -> 0).

Sagittariidae + Pandionidae + Accipitridae
Unambiguous: 15(0 -> 1), 19(0 -> 1), 35(0 -> 2), 71(0 -> 1), 105(0 -> 1), 151(0 -> 1), 214(0 -> 1), 259(0 -> 1), 395(0 -> 1), 397(2 -> 0), 435(1 -> 2); DELTRAN: 1(1 -> 0), 48(0 -> 1), 518(0 -> 1), 545(0 -> 1); ACCTRAN: 36(0 -> 1), 116(0 -> 1), 117(1 -> 2), 181(0 -> 1), 244(0 -> 1), 398(0 -> 1).

Strix aluco
Unambiguous: 49(0 -> 2), 142(0 -> 1), 198(0 -> 2), 214(0 -> 1), 218(0 -> 1), 243(0 -> 1), 249(0 -> 1), 250(0 -> 1), 303(0 -> 1), 311(0 -> 1), 313(0 -> 1), 373(0 -> 1), 380(0 -> 1), 395(0 -> 1), 424(0 -> 1), 429(0 -> 1), 447(1 -> 0), 448(0 -> 1); DELTRAN: 95(2 -> 0), 189(0 -> 1), 196(0 -> 1), 200(1 -> 2), 270(1 -> 0), 413(1 -> 2); ACCTRAN: 82(1 -> 0), 217(1 -> 0), 224(1 -> 0), 270(2 -> 0).

Tyto alba
Unambiguous: 36(1 -> 0), 48(0 -> 1), 87(1 -> 0), 88(0 -> 1), 121(0 -> 1), 161(0 -> 1), 184(2 -> 1), 188(1 -> 0), 203(1 -> 0), 206(0 -> 1), 209(2 -> 1), 236(0 -> 1), 255(0 -> 1), 265(0 -> 1), 302(0 -> 1), 324(0 -> 1), 355(0 -> 1), 357(0 -> 1), 377(0 -> 1), 378(0 -> 1), 404(1 -> 0), 435(1 -> 2), 449(1 -> 0), 474(2 -> 1), 527(1 -> 2), 534(1 -> 0); DELTRAN: 82(0 -> 1), 217(0 -> 1), 224(0 -> 1), 270(1 -> 2), 434(0 -> 1); ACCTRAN: 95(0 -> 2), 196(1 -> 0), 200(2 -> 1), 413(2 -> 1).

†Ypresiglaux michaeldanielsi
Unambiguous: 35(2 -> 1), 112(1 -> 0), 123(0 -> 1), 126(0 -> 1), 166(0 -> 1), 199(1 -> 0), 201(1 -> 0), 219(0 -> 1), 220(0 -> 1), 222(0 -> 1), 230(0 -> 1), 232(0 -> 1), 242(0 -> 1), 247(0 -> 1), 252(1 -> 2), 284(0 -> 1), 358(0 -> 1), 460(1 -> 0), 481(0 -> 1), 485(1 -> 2), 492(1 -> 0), 496(1 -> 0), 504(0 -> 1); DELTRAN: 162(1 -> 0), 164(0 -> 1), 217(0 -> 1), 224(0 -> 1), 490(0 -> 1); ACCTRAN: 433(1 -> 0), 434(1 -> 0), 455(1 -> 0), 487(0 -> 1).

Strigiformes
Unambiguous: 37(0 -> 2), 115(0 -> 1), 119(0 -> 1), 147(0 -> 1), 160(0 -> 1), 165(0 -> 1), 169(1 -> 0), 215(1 -> 2), 244(0 -> 1), 245(1 -> 2), 264(0 -> 1), 331(0 -> 1), 341(0 -> 1), 361(0 -> 1), 452(0 -> 2), 453(0 -> 1), 468(0 -> 1), 521(1 -> 0); DELTRAN: 4(0 -> 2), 8(0 -> 1), 19(0 -> 1), 23(0 -> 1), 27(0 -> 1), 32(1 -> 0), 33(1 -> 0), 38(0 -> 1), 39(0 -> 2), 46(0 -> 1), 52(1 -> 2), 54(0 -> 1), 60(0 -> 1), 69(0 -> 1), 70(0 -> 2), 71(0 -> 2), 75(2 -> 0), 76(0 -> 1), 81(0 -> 1), 89(0 -> 1), 101(0 -> 1), 104(0 -> 1), 132(0 -> 1), 134(0 -> 1), 173(0 -> 1), 183(0 -> 2), 276(0 -> 1), 299(0 -> 1), 346(0 -> 1), 365(0 -> 1), 371(0 -> 1), 381(0 -> 1), 390(0 -> 1), 391(0 -> 1), 393(0 -> 1), 397(2 -> 0), 405(0

-> 1), 426(0 -> 1), 433(0 -> 1), 455(0 -> 1), 469(0 -> 1), 487(1 -> 0), 525(0 -> 1), 535(0 -> 1); ACCTRAN: 162(0 -> 1), 164(1 -> 0), 189(0 -> 1), 490(1 -> 0).

†Primoptynx poliotauros
Unambiguous: 214(0 -> 1), 218(0 -> 1), 266(0 -> 1), 311(0 -> 1), 348(0 -> 1), 421(0 -> 1), 485(1 -> 0), 488(1 -> 0); DELTRAN: 433(0 -> 1), 434(0 -> 1), 473(1 -> 0), 487(1 -> 0), 490(0 -> 1); ACCTRAN: 217(1 -> 0), 270(2 -> 1).

†Ypresiglaux + Strigiformes
Unambiguous: 226(0 -> 1), 286(0 -> 1), 289(0 -> 1), 470(1 -> 0), 471(0 -> 1), 474(0 -> 2), 476(1 -> 2), 493(0 -> 1); DELTRAN: 151(0 -> 1), 228(0 -> 1), 473(1 -> 2), 477(0 -> 1), 486(1 -> 2); ACCTRAN: 224(0 -> 1), 276(0 -> 1), 299(0 -> 1), 365(0 -> 1), 473(0 -> 2), 535(0 -> 1).

†Cyrilavis cf. colburnorum
Unambiguous: 142(0 -> 1), 229(1 -> 0); DELTRAN: 110(0 -> 1), 148(0 -> 1), 149(0 -> 1), 190(0 -> 1), 255(0 -> 1), 347(1 -> 0), 370(1 -> 0); ACCTRAN: 230(1 -> 0).

†Cyrilavis colburnorum
Unambiguous: 112(1 -> 0), 128(1 -> 0), 152(1 -> 0), 228(0 -> 1); DELTRAN: 40(1 -> 0), 197(0 -> 1), 230(0 -> 1), 355(0 -> 1), 379(0 -> 1), 384(0 -> 1), 397(2 -> 1), 401(0 -> 1), 421(0 -> 1), 425(0 -> 1), 447(1 -> 0), 537(0 -> 1), 540(1 -> 0); ACCTRAN: 110(1 -> 0).

†Cyrilavis olsoni
Unambiguous: 182(0 -> 1); DELTRAN; ACCTRAN.

†Serudaptus pohli
Unambiguous: 151(0 -> 1), 244(0 -> 1), 278(0 -> 1), 511(0 -> 1); DELTRAN: 1(0 -> 1), 15(1 -> 0), 49(0 -> 1), 52(1 -> 0), 252(1 -> 0), 396(1 -> 0), 521(0 -> 1), 526(0 -> 1), 543(0 -> 1); ACCTRAN.

†Cyrilavis colburnorum + †Cyrilavis cf. colburnorum
Unambiguous: 146(0 -> 1), 232(0 -> 1), 245(1 -> 2); DELTRAN: 453(0 -> 1); ACCTRAN.

†Cyrilavis olsoni + †Serudaptus pohli
Unambiguous: 250(0 -> 1); DELTRAN; ACCTRAN: 1(0 -> 1), 15(1 -> 0), 49(0 -> 1), 52(1 -> 0), 252(1 -> 0), 396(1 -> 0), 521(0 -> 1), 526(0 -> 1), 543(0 -> 1).

†Pulchrapollia eximia
Unambiguous: 329(0 -> 1), 452(0 -> 1), 471(0 -> 1); DELTRAN: 33(1 -> 0), 55(0 -> 1), 110(0 -> 1), 111(0 -> 1), 123(0 -> 1), 203(1 -> 0), 248(0 -> 1), 252(1 -> 2), 260(1 -> 0), 277(0 -> 1), 511(0 -> 1); ACCTRAN: 379(1 -> 0).

†Pulchrapollia gracilis
Unambiguous; DELTRAN: 379(0 -> 1), 534(1 -> 0); ACCTRAN.

†Pulchrapollia gracilis + †Pulchrapollia eximia
Unambiguous: 272(0 -> 1); DELTRAN: 302(0 -> 1), 303(0 -> 1), 307(0 -> 1), 358(0 -> 1), 360(0 -> 1), 365(0 -> 1); ACCTRAN: 277(0 -> 1), 511(0 -> 1).

†cf Pulchrapollia gracilis
Unambiguous: 191(0 -> 1); DELTRAN: 182(0 -> 1); ACCTRAN.

†cf Pulchrapollia + †Pulchrapollia gracilis + †Pulchrapollia eximia
Unambiguous; DELTRAN; ACCTRAN: 248(0 -> 1).

†Cyrilavis colburnorum + †Cyrilavis cf. colburnorum + †Cyrilavis olsoni + †Serudaptus pohli
Unambiguous: 183(0 -> 1), 431(0 -> 1), 454(0 -> 1); DELTRAN: 13(1 -> 0), 513(1 -> 0); ACCTRAN: 33(0 -> 1), 197(0 -> 1), 255(0 -> 1), 307(1 -> 0), 355(0 -> 1), 360(1 -> 0), 421(0 -> 1), 425(0 -> 1), 447(1 -> 0), 453(0 -> 1), 499(1 -> 0).

†cf Pulchrapollia gracilis + †cf Pulchrapollia + †Pulchrapollia gracilis + †Pulchrapollia eximia
Unambiguous: 228(0 -> 1), 458(0 -> 1), 480(0 -> 1), 504(0 -> 1); DELTRAN: 230(0 -> 1), 423(0 -> 1), 424(0 -> 1), 440(1 -> 0), 459(0 -> 1), 499(0 -> 1); ACCTRAN: 55(0 -> 1), 182(0 -> 1), 190(1 -> 0), 252(1 -> 2), 260(1 -> 0), 302(0 -> 1), 303(0 -> 1), 358(0 -> 1), 365(0 -> 1), 370(0 -> 1), 397(1 -> 2), 534(1 -> 0).

†Pseudasturides macrocephalus
Unambiguous: 15(1 -> 0), 59(0 -> 2), 154(0 -> 1), 226(0 -> 1), 229(1 -> 0), 232(0 -> 1), 250(0 -> 1), 270(2 -> 0), 316(0 -> 1), 334(1 -> 0), 371(0 -> 1), 377(0 -> 1), 444(0 -> 1), 470(1 -> 2), 509(0 -> 1), 510(0 -> 1), 512(0 -> 1); DELTRAN: 8(0 -> 1), 86(0 -> 1), 190(0 -> 1), 307(0 -> 1), 376(1 -> 0), 499(0 -> 1); ACCTRAN: 217(1 -> 0), 220(1 -> 0).

†Cyrilavis colburnorum + †Cyrilavis cf. colburnorum + †Cyrilavis olsoni + †Serudaptus pohli + †cf Pulchrapollia gracilis + †cf Pulchrapollia + †Pulchrapollia gracilis + †Pulchrapollia eximia
Unambiguous: 32(1 -> 0), 215(1 -> 2), 473(1 -> 0); DELTRAN: 217(0 -> 1), 220(0 -> 1), 407(0 -> 1); ACCTRAN: 8(1 -> 0), 13(1 -> 0), 230(0 -> 1), 376(0 -> 1), 379(0 -> 1), 384(0 -> 1), 440(1 -> 0), 459(0 -> 1), 513(1 -> 0), 537(0 -> 1), 540(1 -> 0).

†Tynskya crassitarsus
Unambiguous: 416(1 -> 0); DELTRAN: 196(0 -> 1), 418(0 -> 1); ACCTRAN.

†Tynskya waltonensis
Unambiguous; DELTRAN: 164(0 -> 1), 166(0 -> 1), 170(0 -> 1), 215(1 -> 2), 217(0 -> 1); ACCTRAN.

†Tynskya brevitarsus
Unambiguous: 250(0 -> 1); DELTRAN: 266(0 -> 1), 268(0 -> 1), 271(0 -> 1); ACCTRAN.

†Tynskya waltonensis + †Tynskya crassitarsus
Unambiguous; DELTRAN: 115(0 -> 1), 116(0 -> 1), 129(0 -> 1), 130(0 -> 1); ACCTRAN.

†Tynskya brevitarsus + †Tynskya waltonensis + †Tynskya crassitarsus
Unambiguous; DELTRAN: 467(0 -> 1); ACCTRAN: 215(1 -> 2).

†Messelastur gratulator
Unambiguous: 112(1 -> 0), 151(0 -> 1), 169(1 -> 0), 260(1 -> 0), 355(0 -> 1), 356(0 -> 1), 425(0 -> 1), 474(1 -> 2), 477(0 -> 1), 492(1 -> 0), 504(0 -> 1), 512(0 -> 1), 537(0 -> 1); DELTRAN: 4(0 -> 2), 5(1 -> 0), 9(0 -> 1), 19(0 -> 1), 58(1 -> 0), 277(0 -> 1), 300(0 -> 1), 315(0 -> 1), 360(0 -> 1), 370(1 -> 0), 411(1 -> 0), 427(0 -> 1), 519(0 -> 1), 544(0 -> 1); ACCTRAN: 217(1 -> 0), 347(0 -> 1), 489(1 -> 0), 499(1 -> 0).

†Tynskya eocaena + †Tynskya brevitarsus + †Tynskya waltonensis + †Tynskya crassitarsus
node_134 --> node_133
Unambiguous: 219(0 -> 1), 259(0 -> 2), 317(1 -> 0); DELTRAN: 347(1 -> 0), 455(0 -> 1), 489(0 -> 1), 499(0 -> 1); ACCTRAN.

Halcyornithidae
Unambiguous: 17(1 -> 0), 25(0 -> 1), 152(0 -> 1), 224(0 -> 1), 314(0 -> 1), 481(0 -> 1), 521(1 -> 0), 523(0 -> 1), 545(1 -> 0); DELTRAN: 31(0 -> 1), 489(0 -> 1); ACCTRAN: 4(2 -> 0), 19(1 -> 0),

110(0 -> 1), 111(0 -> 1), 123(0 -> 1), 148(0 -> 1), 149(0 -> 1), 190(0 -> 1), 203(1 -> 0), 423(0 -> 1), 424(0 -> 1), 455(1 -> 0), 463(1 -> 0), 464(1 -> 2), 525(1 -> 0), 543(1 -> 0), 544(1 -> 0).

Messelastiridae
Unambiguous: 140(0 -> 1), 460(1 -> 2), 491(0 -> 1), 493(0 -> 1), 542(0 -> 1); DELTRAN: 220(0 -> 1), 376(1 -> 0), 463(0 -> 1), 464(2 -> 1), 525(0 -> 1), 541(0 -> 1), 543(0 -> 1); ACCTRAN: 5(1 -> 0), 9(0 -> 1), 58(1 -> 0), 115(0 -> 1), 129(0 -> 1), 130(0 -> 1), 166(0 -> 1), 266(0 -> 1), 268(0 -> 1), 271(0 -> 1), 277(0 -> 1), 300(0 -> 1), 418(0 -> 1), 427(0 -> 1), 467(0 -> 1), 519(0 -> 1).

†Primoptynz + †Ypresiglaux + Strigiformes
Unambiguous: 254(1 -> 0), 272(0 -> 1), 416(1 -> 0), 436(0 -> 1), 528(1 -> 2), 529(1 -> 2), 530(1 -> 2), 539(0 -> 2), 542(0 -> 2); DELTRAN: 463(0 -> 1), 464(2 -> 1), 543(0 -> 1), 544(0 -> 1); ACCTRAN: 23(0 -> 1), 27(0 -> 1), 31(1 -> 0), 32(1 -> 0), 38(0 -> 1), 39(0 -> 2), 46(0 -> 1), 54(0 -> 1), 60(0 -> 1), 75(2 -> 0), 76(0 -> 1), 81(0 -> 1), 86(1 -> 0), 132(0 -> 1), 134(0 -> 1), 151(0 -> 1), 173(0 -> 1), 183(0 -> 2), 257(0 -> 1), 371(0 -> 1), 381(0 -> 1), 390(0 -> 1), 391(0 -> 1), 397(1 -> 0), 405(0 -> 1), 426(0 -> 1), 433(0 -> 1), 434(0 -> 1), 469(0 -> 1), 473(1 -> 0), 477(0 -> 1), 486(1 -> 2), 487(1 -> 0), 490(0 -> 1).

Messelastiridae + Halcyornithidae
Unambiguous: 108(0 -> 1), 120(0 -> 1), 128(0 -> 1), 408(1 -> 0), 468(0 -> 1), 474(0 -> 1), 478(1 -> 0), 479(0 -> 2), 495(2 -> 3), 508(0 -> 1), 513(2 -> 1); DELTRAN: 162(1 -> 0), 179(1 -> 0), 257(1 -> 0), 270(1 -> 2), 413(1 -> 2), 497(1 -> 0); ACCTRAN: 40(1 -> 0), 52(2 -> 1), 116(0 -> 1), 170(0 -> 1), 220(0 -> 1), 228(1 -> 0), 307(0 -> 1), 315(0 -> 1), 347(1 -> 0), 360(0 -> 1), 370(1 -> 0), 376(1 -> 0), 401(0 -> 1), 407(0 -> 1), 411(1 -> 0), 489(0 -> 1), 499(0 -> 1), 541(0 -> 1).

†Avolatavis europaeus
Unambiguous; DELTRAN: 423(0 -> 1), 470(1 -> 2), 500(0 -> 1); ACCTRAN.

†Avolatavis tenens
Unambiguous: 516(0 -> 1); DELTRAN: 177(0 -> 1), 397(2 -> 1), 400(1 -> 0), 404(1 -> 0), 410(0 -> 1), 537(0 -> 1); ACCTRAN.

†Eurofluvioviridavis robustipes
Unambiguous: 180(0 -> 1), 383(1 -> 0), 454(0 -> 1), 465(1 -> 2), 476(1 -> 0), 530(1 -> 2), 542(0 -> 1); DELTRAN: 82(0 -> 1), 86(0 -> 1), 179(1 -> 0), 227(0 -> 1), 228(0 -> 1), 230(0 -> 1), 276(0 -> 1), 361(0 -> 1), 369(0 -> 1), 537(0 -> 2); ACCTRAN: 537(1 -> 2).

†Avolatavis tenens + †Avolatavis europaeus
Unambiguous: 493(0 -> 1), 514(0 -> 1); DELTRAN: 434(0 -> 1), 483(0 -> 1); ACCTRAN: 177(0 -> 1), 179(0 -> 1).

†Eurofluvioviridavis robustipes + †Avolatavis tenens + †Avolatavis europaeus
Unambiguous: 547(0 -> 1); DELTRAN: 513(2 -> 0), 543(0 -> 1); ACCTRAN: 227(0 -> 1), 230(0 -> 1), 361(0 -> 1), 369(0 -> 1), 434(0 -> 1), 470(1 -> 2), 483(0 -> 1), 500(0 -> 1).

†Vastanavis eocaena + †Vastanavis cambayensis
Unambiguous: 218(0 -> 1), 225(0 -> 1), 377(0 -> 1), 379(0 -> 1), 437(1 -> 0), 446(0 -> 1), 458(0 -> 1), 490(0 -> 1), 491(0 -> 2), 495(2 -> 1), 549(1 -> 0); DELTRAN: 217(0 -> 1), 248(0 -> 1), 250(0 -> 1), 257(1 -> 0), 260(1 -> 0), 267(0 -> 1), 268(0 -> 1), 353(2 -> 0); ACCTRAN: 228(1 -> 0), 543(1 -> 0).

†Primoptynz + †Ypresiglaux + Strigiformes + Messelastiridae + Halcyornithidae
Unambiguous: 1(1 -> 0), 229(0 -> 1), 297(1 -> 0), 440(0 -> 1); DELTRAN: 35(0 -> 2), 36(0 -> 1), 169(0 -> 1), 305(0 -> 1); ACCTRAN: 4(0 -> 2), 8(0 -> 1), 89(0 -> 1), 101(0 -> 1), 260(0 -> 1), 404(0 -> 1), 463(0 -> 1), 464(2 -> 1), 544(0 -> 1).

Vastanavidae
Unambiguous: 334(1 -> 0), 460(1 -> 0), 503(0 -> 1), 511(0 -> 1); DELTRAN: 455(0 -> 1); ACCTRAN: 104(1 -> 0), 248(0 -> 1), 250(0 -> 1), 267(0 -> 1), 268(0 -> 1), 270(2 -> 1), 276(0 -> 1), 393(1 -> 0), 400(1 -> 0), 410(0 -> 1), 423(0 -> 1), 513(2 -> 0), 525(1 -> 0), 537(0 -> 1).

Colius striatus kiwuensis
Unambiguous: 80(0 -> 2), 101(2 -> 1), 109(0 -> 1), 132(0 -> 1), 151(0 -> 1), 334(1 -> 0), 365(0 -> 1); DELTRAN: 157(0 -> 1), 163(0 -> 1), 165(0 -> 1), 244(0 -> 1), 281(1 -> 0), 539(0 -> 2); ACCTRAN.

Urocolius macrourus pulcher
Unambiguous: 34(0 -> 1), 191(0 -> 1), 199(1 -> 0), 228(0 -> 1), 247(0 -> 1); DELTRAN: 244(0 -> 2); ACCTRAN: 244(1 -> 2), 281(0 -> 1).

†Masillacolius brevidactylus
Unambiguous: 280(0 -> 1), 341(0 -> 1), 354(0 -> 1), 453(1 -> 0), 488(1 -> 0), 501(0 -> 2), 514(0 -> 1); DELTRAN: 281(1 -> 0), 472(1 -> 0), 521(0 -> 1); ACCTRAN: 4(1 -> 0), 259(1 -> 0), 490(1 -> 0).

Coliiformes
Unambiguous: 1(1 -> 0), 15(0 -> 1), 113(0 -> 1), 134(0 -> 1), 218(0 -> 1), 233(0 -> 1), 250(0 -> 1), 251(0 -> 1), 336(0 -> 1), 452(0 -> 2), 454(0 -> 1), 543(0 -> 1); DELTRAN: 4(0 -> 1), 23(0 -> 1), 27(0 -> 1), 32(1 -> 0), 47(0 -> 1), 48(0 -> 2), 66(0 -> 1), 104(0 -> 1), 107(0 -> 1), 114(0 -> 1), 122(0 -> 1), 124(0 -> 1), 142(0 -> 1), 167(0 -> 1), 176(0 -> 1), 178(0 -> 1), 203(1 -> 0), 205(0 -> 1), 242(0 -> 1), 257(1 -> 2), 259(0 -> 1), 262(0 -> 1), 263(0 -> 1), 264(0 -> 1), 266(0 -> 1), 267(0 -> 1), 271(0 -> 1), 277(0 -> 1), 282(0 -> 1), 295(0 -> 1), 305(0 -> 1), 307(0 -> 1), 366(0 -> 1), 371(0 -> 1), 381(0 -> 1), 386(0 -> 1), 389(0 -> 1), 395(0 -> 1), 397(2 -> 0), 403(0 -> 1), 409(0 -> 1), 411(1 -> 0), 413(1 -> 0), 417(0 -> 1), 424(0 -> 1), 428(0 -> 1), 440(0 -> 1), 441(0 -> 2), 448(0 -> 1), 464(2 -> 1), 476(1 -> 0), 490(0 -> 1); ACCTRAN: 244(0 -> 1), 472(0 -> 1), 521(1 -> 0), 539(0 -> 2).

†Eoglaucidium cf pallas
Unambiguous: 25(1 -> 0), 55(0 -> 1), 201(1 -> 0), 347(1 -> 0), 465(2 -> 1), 474(0 -> 1), 491(0 -> 1), 493(0 -> 1), 503(0 -> 1), 515(0 -> 1); DELTRAN: 4(0 -> 1), 228(0 -> 1), 259(0 -> 1), 260(1 -> 0), 472(1 -> 0), 490(0 -> 1), 521(0 -> 1); ACCTRAN: 254(0 -> 1), 487(0 -> 1).

†Masillacolius + Coliiformes
Unambiguous: 137(0 -> 1), 225(0 -> 1), 269(0 -> 1), 278(0 -> 1), 331(0 -> 1); DELTRAN: 252(1 -> 2), 254(1 -> 0), 332(0 -> 1), 487(1 -> 0); ACCTRAN: 32(1 -> 0), 107(0 -> 1), 114(0 -> 1), 142(0 -> 1), 167(0 -> 1), 176(0 -> 1), 205(0 -> 1), 228(1 -> 0), 242(0 -> 1), 257(1 -> 2), 260(0 -> 1), 263(0 -> 1), 266(0 -> 1), 277(0 -> 1), 281(1 -> 0), 282(0 -> 1), 307(0 -> 1), 371(0 -> 1), 381(0 -> 1), 395(0 -> 1), 464(2 -> 1).

Apaloderma narina
Unambiguous: 45(0 -> 1), 162(1 -> 0), 181(0 -> 1), 182(0 -> 1), 231(0 -> 1), 283(1 -> 2), 339(0 -> 1), 434(0 -> 1), 465(2 -> 1); DELTRAN; ACCTRAN: 183(1 -> 0), 257(2 -> 1), 286(1 -> 0), 303(1 -> 0), 512(0 -> 1).

Trogon melanurus eumorphus
Unambiguous: 191(0 -> 1), 215(2 -> 1), 230(0 -> 1), 251(0 -> 1), 302(1 -> 0), 414(0 -> 1), 426(0 -> 1), 427(0 -> 1), 429(0 -> 1), 447(0 -> 1), 452(0 -> 1); DELTRAN: 183(0 -> 1), 257(1 -> 2), 286(0 -> 1), 303(0 -> 1), 512(1 -> 0), 538(0 -> 1); ACCTRAN.

†Eotrogon stenorhynchus
Unambiguous: 109(0 -> 1), 219(0 -> 1), 222(0 -> 1), 248(0 -> 1), 250(0 -> 1), 264(0 -> 1), 307(1 -> 0), 366(1 -> 0), 456(1 -> 0); DELTRAN: 303(0 -> 1), 379(0 -> 1), 512(1 -> 0); ACCTRAN: 14(1 -> 0), 114(1 -> 0), 226(1 -> 0), 373(1 -> 0).

Trogoniformes
Unambiguous: 4(0 -> 1), 5(1 -> 0), 19(0 -> 1), 80(0 -> 1), 128(0 -> 1), 151(0 -> 1), 214(0 -> 1), 256(0 -> 1), 259(0 -> 1), 260(0 -> 1), 304(0 -> 1), 357(0 -> 1), 438(0 -> 1), 441(1 -> 2), 455(0 -> 2), 462(0 -> 1), 470(1 -> 2), 473(1 -> 0), 488(1 -> 0), 507(0 -> 1); DELTRAN: 1(1 -> 0), 8(0 -> 1), 14(0 -> 1), 28(1 -> 2), 33(1 -> 0), 55(0 -> 2), 56(0 -> 1), 66(0 -> 1), 70(0 -> 2), 71(0 -> 3), 72(0 -> 1), 75(2 -> 0), 76(0 -> 1), 82(0 -> 1), 88(0 -> 1), 95(0 -> 1), 101(2 -> 0), 102(1 -> 3), 105(1 -> 0), 114(0 -> 1), 117(1 -> 0), 131(0 -> 1), 134(0 -> 1), 146(0 -> 1), 148(0 -> 1), 173(0 -> 1), 185(0 -> 1), 186(0 -> 1), 226(0 -> 1), 298(0 -> 1), 324(0 -> 1), 367(0 -> 1), 373(0 -> 1), 387(0 -> 1), 389(0 -> 1), 397(2 -> 1), 399(0 -> 1), 408(1 -> 2), 467(0 -> 2); ACCTRAN: 379(1 -> 0).

Tockus nasutus
Unambiguous: 4(0 -> 1), 15(1 -> 2), 27(0 -> 1), 52(0 -> 1), 55(0 -> 1), 56(0 -> 1), 62(1 -> 0), 73(0 -> 1), 83(0 -> 1), 109(0 -> 1), 146(0 -> 1), 149(0 -> 1), 158(0 -> 1), 194(0 -> 1), 195(1 -> 0), 197(1 -> 0), 215(2 -> 1), 249(0 -> 1), 306(0 -> 1), 307(1 -> 0), 308(0 -> 1), 347(1 -> 0), 441(1 -> 2), 453(1 -> 0), 458(0 -> 1), 484(0 -> 1), 543(0 -> 1); DELTRAN: 31(1 -> 0), 49(2 -> 0), 452(0 -> 1), 485(1 -> 0); ACCTRAN: 32(0 -> 1), 49(1 -> 0), 206(1 -> 0), 236(1 -> 0), 257(2 -> 1), 358(1 -> 0), 467(1 -> 0).

Upupa marginata
Unambiguous: 20(0 -> 1), 21(0 -> 1), 22(0 -> 1), 25(0 -> 1), 47(0 -> 1), 80(0 -> 1), 82(0 -> 1), 85(0 -> 1), 117(1 -> 0), 122(0 -> 1), 123(0 -> 1), 124(0 -> 1), 130(0 -> 1), 147(0 -> 1), 159(0 -> 1), 172(1 -> 0), 182(0 -> 2), 259(0 -> 1), 266(1 -> 0), 270(2 -> 0), 288(0 -> 1), 289(0 -> 1), 296(0 -> 1), 301(0 -> 1), 335(0 -> 1), 337(0 -> 1), 338(0 -> 1), 339(0 -> 1), 348(0 -> 1), 375(0 -> 1), 378(0 -> 1), 386(0 -> 1), 397(2 -> 1), 414(0 -> 1), 426(0 -> 1), 466(0 -> 1), 490(0 -> 1), 491(0 -> 2); DELTRAN: 32(1 -> 0), 49(2 -> 1), 206(0 -> 1), 236(0 -> 1), 257(1 -> 2), 358(0 -> 1), 438(0 -> 1), 452(0 -> 2), 467(0 -> 1), 525(1 -> 0), 537(0 -> 1); ACCTRAN: 31(0 -> 1), 452(1 -> 2), 485(0 -> 1).

Atelornis pittoides
Unambiguous: 13(1 -> 0), 16(0 -> 1), 92(0 -> 1), 182(0 -> 1), 234(0 -> 1), 236(1 -> 2), 270(2 -> 0), 311(1 -> 0), 312(1 -> 0), 317(1 -> 0), 350(0 -> 1), 395(0 -> 1), 429(0 -> 2), 449(1 -> 0), 456(1 -> 0), 457(0 -> 1), 467(1 -> 2), 512(0 -> 2); DELTRAN: 244(0 -> 2), 466(0 -> 2), 525(1 -> 0), 534(1 -> 0), 546(0 -> 1); ACCTRAN: 32(0 -> 1), 73(1 -> 0), 95(1 -> 0), 115(1 -> 0), 161(1 -> 0), 200(1 -> 2), 244(1 -> 2), 357(1 -> 0), 466(1 -> 2).

Coracias benghalensis
Unambiguous: 8(1 -> 0), 21(0 -> 1), 36(0 -> 1), 114(1 -> 0), 142(1 -> 0), 189(1 -> 0), 205(1 -> 0), 220(1 -> 0), 249(0 -> 1), 278(0 -> 1), 336(1 -> 0), 370(1 -> 0), 377(0 -> 1), 441(2 -> 0), 490(0 -> 1), 491(0 -> 1), 509(0 -> 1); DELTRAN: 32(1 -> 0), 73(0 -> 1), 95(0 -> 1), 115(0 -> 1), 116(0 -> 1), 161(0 -> 1), 200(2 -> 1), 244(0 -> 1), 271(1 -> 0), 357(0 -> 1), 427(0 -> 1), 438(0 -> 1), 466(0 -> 1); ACCTRAN.

Merops orientalis
Unambiguous: 15(1 -> 0), 48(1 -> 0), 58(0 -> 1), 62(1 -> 0), 83(0 -> 1), 88(0 -> 1), 135(0 -> 1), 192(0 -> 1), 193(0 -> 1), 195(1 -> 0), 229(1 -> 0), 233(0 -> 1), 243(0 -> 1), 315(0 -> 1), 316(0 ->

1), 329(1 -> 2), 356(1 -> 0), 369(0 -> 1), 386(0 -> 1), 437(1 -> 0), 458(0 -> 1), 459(0 -> 1), 467(1 -> 0), 484(0 -> 1), 513(2 -> 1), 542(0 -> 1); DELTRAN: 32(1 -> 0), 71(0 -> 3), 73(0 -> 1), 95(0 -> 1), 115(0 -> 1), 161(0 -> 1), 200(2 -> 1), 357(0 -> 1), 401(0 -> 1), 429(0 -> 1), 485(1 -> 0), 486(1 -> 0), 488(1 -> 0); ACCTRAN: 19(1 -> 0), 37(2 -> 0), 55(1 -> 0), 257(2 -> 1), 407(1 -> 0), 427(1 -> 0), 466(1 -> 0).

Atelornis + Coracias
Unambiguous: 23(0 -> 1), 25(0 -> 1), 28(0 -> 1), 39(0 -> 1), 52(0 -> 2), 53(0 -> 1), 68(0 -> 1), 104(1 -> 0), 117(1 -> 0), 121(0 -> 1), 136(1 -> 0), 147(0 -> 1), 148(0 -> 1), 163(0 -> 1), 183(1 -> 0), 214(0 -> 1), 259(0 -> 1), 366(1 -> 0), 435(1 -> 0), 479(0 -> 1), 481(0 -> 1), 536(1 -> 0), 549(0 -> 1); DELTRAN: 19(0 -> 1), 37(0 -> 2), 55(0 -> 1), 257(1 -> 2), 407(0 -> 1); ACCTRAN: 71(3 -> 0), 116(0 -> 1), 244(0 -> 1), 271(1 -> 0), 401(1 -> 0), 429(1 -> 0), 438(0 -> 1), 485(0 -> 1), 486(0 -> 1), 488(0 -> 1), 525(1 -> 0).

Alcedo atthis
Unambiguous: 8(1 -> 0), 14(0 -> 1), 16(0 -> 1), 28(0 -> 1), 32(1 -> 0), 35(0 -> 1), 85(0 -> 1), 88(0 -> 1), 112(0 -> 1), 117(1 -> 2), 122(0 -> 1), 123(0 -> 1), 134(0 -> 1), 135(0 -> 1), 149(1 -> 0), 165(0 -> 1), 167(0 -> 1), 189(1 -> 0), 199(1 -> 0), 215(0 -> 1), 216(0 -> 1), 267(0 -> 1), 377(0 -> 1), 379(0 -> 1), 387(0 -> 1), 414(0 -> 1), 455(0 -> 2), 458(0 -> 1), 479(0 -> 1), 481(0 -> 1), 512(1 -> 0), 513(2 -> 0), 528(0 -> 1); DELTRAN: 33(1 -> 0), 39(0 -> 1), 50(0 -> 1), 240(0 -> 1), 429(0 -> 1); ACCTRAN: 55(1 -> 0), 92(1 -> 0), 143(1 -> 0), 339(1 -> 0), 440(1 -> 0).

Momotus momota
Unambiguous: 23(0 -> 1), 34(0 -> 1), 52(0 -> 1), 72(0 -> 1), 82(0 -> 1), 87(0 -> 1), 95(0 -> 1), 126(1 -> 0), 128(0 -> 1), 148(0 -> 1), 163(0 -> 1), 166(0 -> 1), 185(0 -> 1), 186(0 -> 1), 197(1 -> 0), 214(0 -> 1), 242(1 -> 0), 249(0 -> 1), 270(2 -> 0), 289(0 -> 1), 302(1 -> 0), 303(0 -> 1), 311(1 -> 0), 347(1 -> 0), 413(0 -> 1), 449(1 -> 0), 453(1 -> 0), 487(0 -> 1), 507(0 -> 1); DELTRAN: 55(0 -> 1), 92(0 -> 1), 143(0 -> 1), 339(0 -> 1), 440(0 -> 1); ACCTRAN: 33(0 -> 1), 50(1 -> 0), 240(1 -> 0), 429(1 -> 0).

Todus mexicanus
Unambiguous: 13(1 -> 0), 25(0 -> 1), 51(0 -> 1), 59(1 -> 0), 62(1 -> 0), 64(1 -> 0), 101(2 -> 0), 105(1 -> 0), 182(0 -> 1), 183(1 -> 0), 230(0 -> 1), 253(0 -> 1), 309(0 -> 1), 313(0 -> 1), 399(0 -> 1), 428(0 -> 1), 435(1 -> 2), 484(0 -> 1), 519(0 -> 1); DELTRAN: 33(1 -> 0), 50(0 -> 1), 55(0 -> 1), 80(0 -> 2), 92(0 -> 1), 125(0 -> 1), 143(0 -> 1), 240(0 -> 1), 257(1 -> 2), 339(0 -> 1), 352(0 -> 1), 353(2 -> 1), 357(0 -> 1), 429(0 -> 1), 440(0 -> 1), 485(1 -> 0), 486(1 -> 0), 546(0 -> 1); ACCTRAN.

Momotus + Alcedo
Unambiguous: 104(1 -> 0), 121(0 -> 1), 205(1 -> 0), 218(0 -> 1), 228(1 -> 0), 229(1 -> 0), 367(1 -> 0), 370(1 -> 0), 491(0 -> 1); DELTRAN: 61(0 -> 1); ACCTRAN: 39(0 -> 1), 80(2 -> 0), 125(1 -> 0), 257(2 -> 1), 352(1 -> 0), 357(1 -> 0), 485(0 -> 1), 486(0 -> 1), 546(1 -> 0).

Merops + Atelornis + Coracias
node_152 --> node_149
Unambiguous: 35(0 -> 1), 102(1 -> 2), 109(0 -> 1), 150(0 -> 1), 217(0 -> 1), 341(0 -> 1), 363(0 -> 1), 512(1 -> 0); DELTRAN: 80(0 -> 2), 125(0 -> 1), 352(0 -> 1), 441(1 -> 2); ACCTRAN: 61(1 -> 0), 73(0 -> 1), 115(0 -> 1), 161(0 -> 1), 200(2 -> 1), 220(0 -> 1), 240(1 -> 0), 252(2 -> 1), 358(1 -> 0), 365(0 -> 1), 440(1 -> 0), 441(0 -> 2), 524(1 -> 0), 534(1 -> 0).

Todus + Momotus + Alcedo
Unambiguous: 142(1 -> 0), 215(2 -> 0), 397(2 -> 1), 456(1 -> 0); DELTRAN: 19(0 -> 1), 37(0 -> 2), 71(0 -> 3), 179(1 -> 0), 220(1 -> 0), 252(1 -> 2), 358(0 -> 1), 365(1 -> 0), 401(0 -> 1), 407(0 -> 1), 441(1 -> 0), 466(0 -> 1), 488(1 -> 0), 524(0 -> 1); ACCTRAN: 32(0 -> 1), 33(1 -> 0), 50(0 -> 1), 92(0 -> 1), 95(1 -> 0), 143(0 -> 1), 339(0 -> 1), 353(2 -> 1).

Indicator exilis pachyrhynchus
Unambiguous: 22(0 -> 1), 64(1 -> 0), 98(0 -> 1), 130(0 -> 1), 142(1 -> 0), 151(0 -> 1), 230(0 -> 1), 350(0 -> 1), 387(0 -> 1), 409(1 -> 0), 413(0 -> 1), 429(0 -> 1); DELTRAN: 97(0 -> 1), 174(1 -> 0), 179(1 -> 0), 240(0 -> 1), 424(1 -> 0); ACCTRAN: 159(1 -> 0), 203(1 -> 0), 213(1 -> 0), 229(0 -> 1), 347(0 -> 1), 487(1 -> 0), 517(1 -> 0).

Picus viridis
Unambiguous: 8(1 -> 0), 13(1 -> 0), 25(0 -> 1), 29(0 -> 1), 55(0 -> 1), 58(0 -> 1), 62(1 -> 0), 87(0 -> 1), 113(0 -> 1), 134(0 -> 1), 143(0 -> 1), 153(0 -> 1), 156(1 -> 0), 178(0 -> 1), 197(1 -> 0), 205(1 -> 0), 214(0 -> 1), 218(0 -> 1), 267(0 -> 1), 270(2 -> 0), 272(0 -> 1), 287(0 -> 1), 289(0 -> 1), 292(0 -> 1), 330(0 -> 1), 430(0 -> 1), 460(1 -> 0); DELTRAN: 159(0 -> 1), 203(0 -> 1), 213(0 -> 1), 229(1 -> 0), 347(1 -> 0), 487(0 -> 1), 517(0 -> 1), 549(0 -> 1); ACCTRAN: 97(1 -> 0), 240(1 -> 0).

Megalaima chrysopogon
Unambiguous: 21(0 -> 1), 22(0 -> 1), 27(1 -> 0), 29(0 -> 1), 82(0 -> 1), 121(0 -> 1), 134(0 -> 1), 218(0 -> 1), 231(1 -> 0), 251(0 -> 1), 259(0 -> 1), 286(1 -> 0), 289(0 -> 1), 354(0 -> 1), 401(0 -> 1), 402(1 -> 0), 435(1 -> 2); DELTRAN: 97(0 -> 1), 221(0 -> 1), 240(0 -> 1), 549(0 -> 1); ACCTRAN: 72(1 -> 0), 191(1 -> 0), 313(1 -> 0).

Ramphastos ambiguus
Unambiguous: 14(0 -> 1), 55(0 -> 1), 93(0 -> 1), 95(1 -> 0), 112(1 -> 0), 149(0 -> 1), 178(0 -> 1), 197(1 -> 0), 205(1 -> 0), 249(0 -> 1), 252(2 -> 0), 260(1 -> 0), 369(0 -> 1), 409(1 -> 0), 442(0 -> 1); DELTRAN: 15(1 -> 2), 71(0 -> 2), 72(0 -> 1), 159(0 -> 1), 191(0 -> 1), 313(0 -> 1); ACCTRAN: 221(1 -> 0), 240(1 -> 0), 549(1 -> 0).

Indicator + Picus
Unambiguous: 1(1 -> 0), 59(1 -> 0), 89(1 -> 0), 92(0 -> 1), 96(0 -> 1), 100(0 -> 1), 105(1 -> 0), 136(1 -> 0), 165(0 -> 1), 239(0 -> 1), 298(0 -> 1), 307(1 -> 2), 360(0 -> 1); DELTRAN: 72(0 -> 1), 83(0 -> 1), 191(0 -> 1), 221(0 -> 1), 313(0 -> 1); ACCTRAN: 333(1 -> 0).

Megalaima + Ramphastos
Unambiguous: 28(0 -> 2), 30(0 -> 1), 109(0 -> 1), 117(1 -> 0), 152(0 -> 1), 228(1 -> 0), 283(0 -> 1), 293(1 -> 0), 395(0 -> 1), 408(1 -> 0), 537(0 -> 1); DELTRAN: 104(1 -> 0), 203(0 -> 1), 213(0 -> 1), 229(1 -> 0), 333(0 -> 1), 347(1 -> 0), 487(0 -> 1), 517(0 -> 1); ACCTRAN: 15(1 -> 2), 83(1 -> 0), 174(0 -> 1), 179(0 -> 1), 424(0 -> 1).

Galbula dea
Unambiguous: 23(0 -> 1), 35(0 -> 1), 58(0 -> 1), 80(0 -> 3), 93(0 -> 1), 121(0 -> 1), 135(0 -> 1), 147(0 -> 1), 157(0 -> 1), 161(0 -> 1), 163(0 -> 1), 200(2 -> 1), 222(0 -> 1), 230(0 -> 1), 243(0 -> 1), 254(0 -> 1), 303(0 -> 1), 307(1 -> 0), 309(0 -> 1), 337(0 -> 1), 350(0 -> 1), 354(0 -> 1), 386(0 -> 1), 437(1 -> 0), 443(0 -> 1), 479(0 -> 2), 480(0 -> 1), 503(0 -> 1), 525(1 -> 0), 539(0 -> 1); DELTRAN: 19(0 -> 1), 52(0 -> 2), 83(0 -> 1), 126(0 -> 1), 206(0 -> 1), 240(0 -> 1), 333(0 -> 1), 407(0 -> 1), 424(1 -> 0), 429(0 -> 1), 441(1 -> 0), 546(0 -> 1); ACCTRAN: 52(1 -> 2), 61(1 -> 0), 242(1 -> 0), 247(1 -> 0).

Indicator + Picus + Megalaima + Ramphastos
Unambiguous: 34(0 -> 1), 48(1 -> 2), 66(0 -> 1), 120(0 -> 1), 122(0 -> 1), 215(2 -> 0), 245(1 -> 0), 255(0 -> 1), 269(0 -> 1), 301(0 -> 1), 305(0 -> 1), 329(1 -> 2), 335(0 -> 1), 359(0 -> 1), 399(0 -> 1), 428(0 -> 1), 431(0 -> 2), 452(0 -> 1), 456(1 -> 0), 466(0 -> 2), 467(1 -> 2), 498(0 -> 1), 509(0 -> 1), 534(1 -> 0); DELTRAN: 52(0 -> 1), 61(0 -> 1), 242(0 -> 1), 247(0 -> 1); ACCTRAN: 19(1 -> 0), 72(0 -> 1), 97(0 -> 1), 104(1 -> 0), 126(1 -> 0), 159(0 -> 1), 191(0 -> 1), 203(0 -> 1),

206(1 -> 0), 213(0 -> 1), 221(0 -> 1), 229(1 -> 0), 313(0 -> 1), 347(1 -> 0), 407(1 -> 0), 429(1 -> 0), 441(0 -> 1), 487(0 -> 1), 517(0 -> 1), 546(1 -> 0), 549(0 -> 1).

Coraciiformes
Unambiguous: 38(0 -> 1), 112(1 -> 0), 149(0 -> 1), 176(1 -> 0), 189(0 -> 1), 256(0 -> 1), 326(0 -> 1), 327(0 -> 1), 423(1 -> 0), 461(0 -> 1); DELTRAN: 126(0 -> 1), 174(1 -> 0), 206(0 -> 1), 242(0 -> 1), 247(0 -> 1), 287(0 -> 1), 332(0 -> 1), 460(1 -> 2), 537(0 -> 1); ACCTRAN: 37(0 -> 2), 49(1 -> 2), 55(0 -> 1), 80(0 -> 2), 125(0 -> 1), 166(1 -> 0), 237(1 -> 0), 345(1 -> 0), 357(0 -> 1), 370(0 -> 1), 373(1 -> 0), 374(1 -> 0), 379(1 -> 0), 401(0 -> 1), 466(0 -> 1), 488(1 -> 0).

Piciformes
Unambiguous: 27(0 -> 1), 47(0 -> 1), 207(0 -> 1), 231(0 -> 1), 253(0 -> 1), 316(0 -> 1), 328(1 -> 0), 372(0 -> 1), 453(1 -> 2), 489(0 -> 1), 495(0 -> 3), 523(0 -> 1), 536(1 -> 0); DELTRAN: 32(1 -> 0), 49(2 -> 1), 95(0 -> 1), 166(0 -> 1), 220(1 -> 0), 237(0 -> 1), 252(1 -> 2), 257(1 -> 2), 332(0 -> 2), 345(0 -> 1), 358(0 -> 1), 365(1 -> 0), 370(1 -> 0), 373(0 -> 1), 374(0 -> 1), 379(0 -> 1), 427(0 -> 1), 440(0 -> 1), 485(1 -> 0), 486(1 -> 2), 496(1 -> 2), 524(0 -> 1); ACCTRAN: 52(0 -> 1), 71(3 -> 2), 83(0 -> 1), 287(1 -> 0), 332(1 -> 2), 352(1 -> 0), 424(1 -> 0), 460(2 -> 1), 486(0 -> 2), 537(1 -> 0).

Bucerotiformes
Unambiguous: 30(0 -> 1), 34(0 -> 1), 93(0 -> 1), 115(0 -> 1), 135(0 -> 1), 137(0 -> 1), 139(0 -> 1), 152(0 -> 2), 163(0 -> 1), 184(2 -> 1), 192(0 -> 1), 193(0 -> 1), 209(2 -> 0), 216(0 -> 1), 217(0 -> 1), 269(0 -> 1), 284(0 -> 1), 285(0 -> 1), 313(0 -> 1), 329(1 -> 2), 350(0 -> 1), 403(0 -> 1), 408(1 -> 0), 473(1 -> 0), 514(0 -> 1); DELTRAN: 14(0 -> 1), 48(0 -> 2), 61(0 -> 1), 66(0 -> 1), 102(1 -> 2), 166(0 -> 1), 237(0 -> 1), 287(0 -> 1), 345(0 -> 1), 352(0 -> 1), 370(1 -> 0), 373(0 -> 1), 374(0 -> 1), 379(0 -> 1), 399(0 -> 1), 460(1 -> 2), 486(1 -> 0); ACCTRAN: 8(1 -> 0), 48(1 -> 2), 71(3 -> 0), 95(1 -> 0), 367(1 -> 0), 438(0 -> 1), 452(0 -> 1), 525(1 -> 0).

Picodynastornithes
Unambiguous: 13(0 -> 1), 59(0 -> 1), 144(1 -> 0), 205(0 -> 1), 250(0 -> 1), 260(0 -> 1), 271(0 -> 1), 283(1 -> 0), 293(0 -> 1), 312(0 -> 1), 331(0 -> 1), 377(1 -> 0), 449(0 -> 1), 465(2 -> 1); DELTRAN: 8(0 -> 1), 31(1 -> 0), 48(0 -> 1), 236(0 -> 1), 367(0 -> 1), 467(0 -> 1); ACCTRAN: 14(1 -> 0), 19(0 -> 1), 66(1 -> 0), 102(2 -> 1), 126(0 -> 1), 174(1 -> 0), 179(1 -> 0), 240(0 -> 1), 242(0 -> 1), 247(0 -> 1), 252(1 -> 2), 332(0 -> 1), 365(1 -> 0), 399(1 -> 0), 407(0 -> 1), 427(0 -> 1), 429(0 -> 1), 440(0 -> 1), 441(1 -> 0), 524(0 -> 1), 546(0 -> 1).

†Eotrogon + Trogoniformes
Unambiguous: 81(0 -> 1), 189(0 -> 1), 232(0 -> 1), 244(0 -> 2), 252(1 -> 0), 254(0 -> 1), 337(0 -> 1), 453(1 -> 0), 468(0 -> 1), 487(0 -> 1), 493(0 -> 1), 513(2 -> 1); DELTRAN: 485(1 -> 3), 494(0 -> 2); ACCTRAN: 1(1 -> 0), 28(0 -> 2), 33(1 -> 0), 55(0 -> 2), 56(0 -> 1), 70(0 -> 2), 75(2 -> 0), 76(0 -> 1), 77(0 -> 1), 82(0 -> 1), 88(0 -> 1), 101(2 -> 0), 102(2 -> 3), 105(1 -> 0), 131(0 -> 1), 134(0 -> 1), 146(0 -> 1), 166(1 -> 0), 173(0 -> 1), 185(0 -> 1), 186(0 -> 1), 236(1 -> 0), 298(0 -> 1), 303(0 -> 1), 324(0 -> 1), 336(1 -> 0), 387(0 -> 1), 389(0 -> 1), 397(2 -> 1), 408(1 -> 2), 467(1 -> 2), 485(0 -> 3), 538(0 -> 1).

Picocoracie
Unambiguous: 64(0 -> 1), 136(0 -> 1), 142(0 -> 1), 311(0 -> 1), 320(0 -> 1), 321(0 -> 1), 356(0 -> 1), 409(0 -> 1), 413(1 -> 0), 476(1 -> 0); DELTRAN: 28(1 -> 0), 77(1 -> 0), 114(0 -> 1), 183(0 -> 1), 226(0 -> 1), 286(0 -> 1), 336(0 -> 1), 351(0 -> 1); ACCTRAN: 31(1 -> 0), 32(1 -> 0), 48(0 -> 1), 49(2 -> 1), 61(0 -> 1), 72(1 -> 0), 117(0 -> 1), 148(1 -> 0), 206(0 -> 1), 220(1 -> 0), 237(0 -> 1), 287(0 -> 1), 345(0 -> 1), 352(0 -> 1), 358(0 -> 1), 370(1 -> 0), 374(0 -> 1), 460(1 -> 2), 486(1 -> 0), 512(0 -> 1).

Leptosomus discolor
Unambiguous: 21(0 -> 1), 22(0 -> 1), 27(0 -> 1), 73(0 -> 1), 74(0 -> 1), 112(1 -> 0), 115(0 -> 1), 147(0 -> 1), 150(0 -> 1), 153(0 -> 1), 156(1 -> 0), 174(1 -> 0), 181(0 -> 1), 198(0 -> 1), 217(0 -> 1), 222(0 -> 1), 243(0 -> 1), 245(1 -> 2), 258(0 -> 1), 305(0 -> 1), 327(0 -> 1), 341(0 -> 1), 376(0 -> 1), 378(0 -> 1), 395(0 -> 1), 435(1 -> 2), 447(0 -> 1), 461(0 -> 1), 474(0 -> 1), 486(1 -> 2), 501(0 -> 1), 534(1 -> 0), 550(0 -> 1); DELTRAN: 14(0 -> 1), 35(0 -> 1), 47(0 -> 1), 72(0 -> 1), 77(1 -> 0), 102(1 -> 2), 117(1 -> 0), 148(0 -> 1), 163(0 -> 1), 166(0 -> 1), 236(0 -> 1), 336(0 -> 1), 407(0 -> 1), 429(0 -> 1), 492(1 -> 0), 512(1 -> 0); ACCTRAN: 66(1 -> 0), 104(1 -> 0), 190(1 -> 0), 411(0 -> 1), 424(1 -> 0), 495(0 -> 2).

Eucavitaves
Unambiguous: 25(1 -> 0), 52(2 -> 0), 58(1 -> 0), 62(0 -> 1), 89(0 -> 1), 176(0 -> 1), 180(1 -> 0), 188(0 -> 1), 197(0 -> 1), 203(1 -> 0), 225(0 -> 1), 229(0 -> 1), 323(0 -> 1), 355(0 -> 1), 361(1 -> 0), 423(0 -> 1), 478(1 -> 0), 527(1 -> 0), 528(1 -> 0), 530(1 -> 0), 536(0 -> 1); DELTRAN: 104(0 -> 1), 190(0 -> 1), 411(1 -> 0), 424(0 -> 1), 495(2 -> 0); ACCTRAN: 8(0 -> 1), 28(1 -> 0), 35(1 -> 0), 47(1 -> 0), 71(0 -> 3), 95(0 -> 1), 114(0 -> 1), 163(1 -> 0), 183(0 -> 1), 226(0 -> 1), 257(1 -> 2), 286(0 -> 1), 367(0 -> 1), 373(0 -> 1), 379(0 -> 1), 399(0 -> 1), 407(1 -> 0), 429(1 -> 0), 467(0 -> 1), 485(1 -> 0), 492(0 -> 1), 496(1 -> 2), 537(0 -> 1).

†Plesiocathartes kelleri
Unambiguous: 355(0 -> 1), 356(0 -> 1), 542(0 -> 1); DELTRAN: 19(0 -> 1), 35(0 -> 1), 357(0 -> 1), 474(0 -> 2), 477(0 -> 1), 495(2 -> 1); ACCTRAN: 512(0 -> 1).

†Plesiocathartes wyomingensis
Unambiguous: 20(0 -> 1), 278(0 -> 1); DELTRAN: 200(2 -> 0), 407(0 -> 1), 453(1 -> 0), 473(1 -> 2), 512(1 -> 0), 525(1 -> 0); ACCTRAN.

Cavitaves
Unambiguous: 15(0 -> 1), 371(0 -> 1), 381(0 -> 1), 529(1 -> 0); DELTRAN: 49(0 -> 2), 87(1 -> 0), 195(0 -> 1), 266(0 -> 1), 307(0 -> 1), 365(0 -> 1), 366(0 -> 1), 441(0 -> 1); ACCTRAN: 336(0 -> 1), 357(1 -> 0), 495(1 -> 0).

Plesiocathartidae
Unambiguous: 259(0 -> 1), 463(0 -> 2), 513(2 -> 1); DELTRAN; ACCTRAN: 19(0 -> 1), 200(2 -> 0), 453(1 -> 0), 473(1 -> 2), 474(0 -> 2), 477(0 -> 1), 525(1 -> 0).

†Waltonavis sp
Unambiguous: 17(0 -> 1), 81(0 -> 1), 169(0 -> 1), 196(0 -> 1), 219(0 -> 1), 232(0 -> 1), 244(0 -> 1), 245(1 -> 0), 257(1 -> 0), 303(0 -> 1), 341(0 -> 1), 347(1 -> 0), 360(0 -> 1), 370(1 -> 0), 379(0 -> 1), 458(0 -> 1), 459(0 -> 1), 468(0 -> 1), 491(0 -> 1), 493(0 -> 1), 542(0 -> 1), 550(0 -> 1); DELTRAN: 272(0 -> 1), 357(0 -> 1), 492(1 -> 0), 495(2 -> 1); ACCTRAN: 366(1 -> 0).

Plesiocathartidae + Cavitaves
Unambiguous: 215(1 -> 2), 377(0 -> 1), 548(1 -> 0); DELTRAN: 52(1 -> 2); ACCTRAN: 195(0 -> 1), 236(0 -> 1), 266(0 -> 1), 272(1 -> 0), 307(0 -> 1), 365(0 -> 1), 441(0 -> 1), 494(0 -> 2), 512(1 -> 0).

†Eoglaucidium + Masillacolius + Coliiformes
Unambiguous: 197(0 -> 1), 215(1 -> 0), 226(0 -> 1), 235(0 -> 1), 304(0 -> 1), 323(0 -> 1), 337(0 -> 1), 344(0 -> 1), 418(0 -> 1), 430(0 -> 1), 431(0 -> 2), 460(1 -> 0), 528(1 -> 2), 530(1 -> 2), 531(0 -> 1), 542(0 -> 2); DELTRAN: 33(1 -> 0), 49(0 -> 1), 52(1 -> 0), 190(0 -> 1), 272(0 -> 1), 429(0 -> 1), 449(0 -> 1); ACCTRAN: 4(0 -> 1), 23(0 -> 1), 27(0 -> 1), 48(0 -> 2), 52(2 -> 0), 122(0 -> 1), 124(0 -> 1), 157(0 -> 1), 165(0 -> 1), 178(0 -> 1), 203(1 -> 0), 252(1 -> 2), 259(0 -> 1), 262(0 -> 1), 264(0 -> 1), 267(0 -> 1), 271(0 -> 1), 295(0 -> 1), 332(0 -> 1), 386(0 -> 1), 389(0 ->

1), 397(2 -> 0), 403(0 -> 1), 409(0 -> 1), 413(1 -> 0), 417(0 -> 1), 428(0 -> 1), 440(0 -> 1), 441(0 -> 2), 448(0 -> 1), 476(1 -> 0), 490(0 -> 1).

†Waltonavis + Plesiocathartidae + Cavitaves
Unambiguous: 180(0 -> 1), 188(1 -> 0), 220(0 -> 1), 224(0 -> 1), 361(0 -> 1), 549(1 -> 0); DELTRAN: 228(0 -> 1), 254(1 -> 0), 260(1 -> 0), 487(1 -> 0); ACCTRAN: 14(0 -> 1), 33(0 -> 1), 35(0 -> 1), 49(1 -> 2), 72(0 -> 1), 77(1 -> 0), 87(1 -> 0), 102(1 -> 2), 117(1 -> 0), 148(0 -> 1), 166(0 -> 1), 305(1 -> 0), 357(0 -> 1), 407(0 -> 1), 449(1 -> 0), 472(0 -> 1), 492(1 -> 0), 495(2 -> 1), 521(1 -> 0).

Vastanavidae + †Primoptynz + †Ypresiglaux + Strigiformes + Messelastiridae + Halcyornithidae
Unambiguous: 13(0 -> 1), 15(0 -> 1), 17(0 -> 1), 25(1 -> 0), 174(1 -> 0), 329(1 -> 0), 453(1 -> 0), 512(1 -> 0); DELTRAN: 449(0 -> 1), 465(0 -> 1), 472(1 -> 0), 521(0 -> 1); ACCTRAN: 19(0 -> 1), 35(0 -> 2), 36(0 -> 1), 69(0 -> 1), 70(0 -> 2), 71(0 -> 2), 82(0 -> 1), 86(0 -> 1), 162(1 -> 0), 164(0 -> 1), 169(0 -> 1), 179(1 -> 0), 196(0 -> 1), 217(0 -> 1), 254(0 -> 1), 257(1 -> 0), 302(1 -> 0), 346(0 -> 1), 353(2 -> 0), 397(2 -> 1), 413(1 -> 2), 455(0 -> 1), 497(1 -> 0), 543(0 -> 1).

Coraciimorphae
Unambiguous: 18(1 -> 0), 101(0 -> 2), 105(0 -> 1), 144(0 -> 1), 156(0 -> 1), 376(1 -> 0), 384(0 -> 1), 392(0 -> 1), 447(1 -> 0); DELTRAN: 31(0 -> 1), 95(2 -> 0), 200(1 -> 2), 270(1 -> 2), 302(0 -> 1), 404(1 -> 0), 465(0 -> 2), 525(0 -> 1); ACCTRAN: 47(0 -> 1), 49(0 -> 1), 66(0 -> 1), 163(0 -> 1), 190(0 -> 1), 272(0 -> 1), 366(0 -> 1), 411(1 -> 0), 424(0 -> 1), 429(0 -> 1), 465(1 -> 2), 487(1 -> 0).

Cariama cristata
Unambiguous: 64(0 -> 1), 77(1 -> 0), 161(0 -> 1), 166(0 -> 1), 272(0 -> 1), 323(0 -> 1), 354(0 -> 1), 394(0 -> 1), 459(0 -> 1); DELTRAN: 101(0 -> 2), 134(0 -> 1), 206(0 -> 2); ACCTRAN: 101(1 -> 2), 206(1 -> 2).

Chunga burmeisteri
Unambiguous: 72(0 -> 1), 174(1 -> 0), 243(0 -> 1), 270(1 -> 0), 312(0 -> 1), 426(0 -> 1), 460(1 -> 0); DELTRAN: 101(0 -> 1), 134(0 -> 2), 206(0 -> 1); ACCTRAN: 134(1 -> 2).

†Dynamopterus sp
Unambiguous: 260(1 -> 0), 355(0 -> 1), 492(1 -> 0); DELTRAN: 259(0 -> 1), 329(1 -> 2), 493(0 -> 1); ACCTRAN: 266(1 -> 0), 329(0 -> 2), 474(1 -> 0).

Cariamiformes
Unambiguous: 218(0 -> 1), 239(0 -> 1), 276(0 -> 1), 427(0 -> 1), 428(0 -> 1), 429(0 -> 2), 432(0 -> 1), 437(1 -> 0), 457(0 -> 1), 473(1 -> 2), 500(0 -> 1), 512(1 -> 2), 532(0 -> 1), 542(0 -> 1), 543(0 -> 1); DELTRAN: 11(0 -> 1), 30(0 -> 1), 31(0 -> 1), 32(1 -> 0), 35(0 -> 2), 36(0 -> 1), 40(1 -> 0), 43(0 -> 1), 49(0 -> 2), 55(0 -> 1), 73(0 -> 1), 91(0 -> 1), 99(0 -> 1), 111(0 -> 1), 112(0 -> 1), 114(0 -> 1), 117(1 -> 0), 129(0 -> 1), 132(0 -> 1), 142(0 -> 1), 152(0 -> 1), 182(0 -> 1), 183(0 -> 2), 194(0 -> 1), 198(0 -> 1), 220(0 -> 1), 250(0 -> 1), 266(0 -> 1), 281(1 -> 0), 296(0 -> 1), 311(0 -> 1), 317(1 -> 0), 319(0 -> 1), 321(0 -> 1), 327(1 -> 0), 329(1 -> 0), 348(0 -> 1), 362(0 -> 1), 385(0 -> 1), 393(0 -> 1), 398(0 -> 1), 408(1 -> 0), 412(0 -> 1), 413(1 -> 0), 425(0 -> 1), 435(1 -> 2), 474(0 -> 1), 520(0 -> 1); ACCTRAN: 259(1 -> 0), 493(1 -> 0).

†Bathornis grallator
Unambiguous: 28(0 -> 2), 39(0 -> 2), 46(0 -> 1), 100(0 -> 1), 106(0 -> 1), 221(0 -> 1), 369(0 -> 1), 417(0 -> 1), 522(0 -> 1), 540(1 -> 0), 549(1 -> 0); DELTRAN: 37(0 -> 1), 117(1 -> 2), 434(0 -> 1), 474(0 -> 1); ACCTRAN: 220(1 -> 0), 302(1 -> 0).

†Dynamopterus sp + Cariamiformes
Unambiguous: 227(0 -> 1), 300(0 -> 1), 340(0 -> 1); DELTRAN: 216(0 -> 1), 217(0 -> 1), 222(0 -> 1), 302(0 -> 1), 420(0 -> 1), 447(1 -> 0); ACCTRAN: 30(0 -> 1), 31(0 -> 1), 32(1 -> 0), 35(0 -> 2), 36(0 -> 1), 37(1 -> 0), 49(0 -> 2), 55(0 -> 1), 112(0 -> 1), 117(2 -> 0), 132(0 -> 1), 134(0 -> 1), 142(0 -> 1), 152(0 -> 1), 250(0 -> 1), 329(1 -> 0), 434(1 -> 0), 520(0 -> 1).

Caracara cheriway
Unambiguous: 73(0 -> 1), 108(1 -> 0), 155(1 -> 0), 161(0 -> 1), 247(0 -> 1), 259(1 -> 0), 277(0 -> 1), 311(0 -> 1), 329(1 -> 0), 356(1 -> 0), 391(1 -> 0), 404(1 -> 0), 406(1 -> 0), 491(0 -> 1); DELTRAN; ACCTRAN: 460(2 -> 1).

Daptrius ater
Unambiguous: 45(0 -> 1), 441(1 -> 0), 470(1 -> 0), 483(1 -> 0); DELTRAN: 70(0 -> 2), 175(0 -> 1), 460(1 -> 2), 530(2 -> 1); ACCTRAN.

Falco sparverius
Unambiguous: 3(0 -> 1), 52(1 -> 0), 71(0 -> 2), 104(0 -> 1), 160(0 -> 1), 225(0 -> 1), 509(0 -> 1); DELTRAN: 174(1 -> 0), 186(0 -> 1), 269(0 -> 1), 302(0 -> 1), 354(0 -> 1), 443(0 -> 1), 456(0 -> 1), 460(1 -> 2), 527(0 -> 1); ACCTRAN: 62(1 -> 0), 220(1 -> 0).

Daptrius + Caracara
Unambiguous: 9(0 -> 1), 32(1 -> 0), 117(1 -> 0), 156(0 -> 1), 198(0 -> 2), 245(1 -> 2), 258(0 -> 1), 305(0 -> 1); DELTRAN: 62(0 -> 1), 220(0 -> 1); ACCTRAN: 70(0 -> 2), 175(0 -> 1), 186(1 -> 0), 269(1 -> 0), 302(1 -> 0), 354(1 -> 0), 443(1 -> 0), 456(1 -> 0), 527(1 -> 0), 530(2 -> 1).

Micrastur ruficollis concentricus
Unambiguous: 45(0 -> 1), 47(0 -> 1), 60(0 -> 1), 72(0 -> 1), 75(2 -> 1), 114(0 -> 1), 115(1 -> 0), 131(0 -> 1), 229(0 -> 1), 247(0 -> 1), 287(0 -> 1), 336(0 -> 1), 346(0 -> 1), 348(0 -> 1), 367(0 -> 1), 424(0 -> 1), 458(0 -> 1), 474(1 -> 2), 490(0 -> 1), 491(0 -> 2), 492(1 -> 0), 512(1 -> 2), 515(0 -> 1), 517(0 -> 1); DELTRAN: 62(0 -> 1), 126(0 -> 1), 134(0 -> 2), 186(0 -> 1), 220(0 -> 1), 269(0 -> 1), 302(0 -> 1), 317(1 -> 0), 325(0 -> 1), 354(0 -> 1), 408(1 -> 0), 443(0 -> 1), 456(0 -> 1), 518(0 -> 1), 527(0 -> 1), 539(0 -> 1); ACCTRAN: 134(1 -> 2), 145(1 -> 0), 202(1 -> 0), 206(1 -> 0).

Falco + Daptrius + Caracara
Unambiguous: 20(0 -> 1), 22(0 -> 1), 24(0 -> 1), 109(0 -> 1), 168(0 -> 1), 192(0 -> 1), 283(0 -> 2), 294(0 -> 2), 361(0 -> 1), 413(1 -> 2); DELTRAN: 116(0 -> 1), 134(0 -> 1), 145(0 -> 1), 202(0 -> 1), 206(0 -> 1); ACCTRAN: 126(1 -> 0), 174(1 -> 0), 317(0 -> 1), 325(1 -> 0), 408(0 -> 1), 460(1 -> 2).

†Horusornis vianeyliaudae
Unambiguous: 215(2 -> 1), 218(0 -> 1), 222(0 -> 1), 252(1 -> 0), 270(1 -> 0), 272(0 -> 1), 334(1 -> 0), 335(0 -> 1), 436(0 -> 1), 460(1 -> 0), 472(1 -> 0), 477(0 -> 1), 481(0 -> 1), 486(1 -> 2), 500(0 -> 1); DELTRAN: 434(0 -> 1), 542(0 -> 1); ACCTRAN: 220(1 -> 0), 370(1 -> 0).

Falconiformes
Unambiguous: 217(0 -> 1), 224(0 -> 1), 249(0 -> 1), 250(0 -> 1), 257(1 -> 2), 355(0 -> 1), 356(0 -> 1), 441(0 -> 1), 470(0 -> 1), 483(0 -> 1), 494(0 -> 1); DELTRAN: 19(0 -> 1), 23(0 -> 1), 28(0 -> 1), 37(0 -> 1), 38(0 -> 1), 61(1 -> 0), 68(0 -> 1), 91(0 -> 1), 105(0 -> 1), 108(0 -> 1), 112(0 -> 2), 120(0 -> 1), 129(0 -> 1), 132(0 -> 1), 151(0 -> 1), 152(0 -> 1), 155(0 -> 1), 173(0 -> 1), 209(0 -> 1), 243(0 -> 1), 255(0 -> 1), 260(1 -> 0), 315(0 -> 1), 321(0 -> 1), 341(0 -> 1), 370(0 -> 1), 393(0 -> 1), 395(0 -> 1), 397(2 -> 0), 406(0 -> 1), 414(0 -> 1), 419(0 -> 1), 421(0 -> 1), 426(0 -> 1), 427(0 -> 1), 437(1 -> 0), 439(0 -> 1), 442(0 -> 1), 464(0 -> 1), 465(0 -> 1), 468(0 -> 1), 469(0 ->

1), 471(0 -> 1), 528(0 -> 2), 529(1 -> 2), 530(0 -> 2), 542(0 -> 2); ACCTRAN: 269(0 -> 1), 354(0 -> 1), 434(1 -> 0), 456(0 -> 1), 518(0 -> 1), 542(1 -> 2).

†Masillaraptor cf parvunguis
Unambiguous; DELTRAN: 184(1 -> 2), 198(0 -> 2), 217(0 -> 1), 224(0 -> 1), 228(0 -> 1), 229(0 -> 1), 230(0 -> 1), 257(1 -> 0), 277(0 -> 1), 303(0 -> 1), 325(0 -> 1), 361(0 -> 1), 370(0 -> 1), 445(0 -> 1), 457(0 -> 1); ACCTRAN.

†Masillaraptor parvunguis
Unambiguous: 495(1 -> 0); DELTRAN: 129(0 -> 1), 513(2 -> 1), 529(1 -> 2); ACCTRAN.

†Danielsraptor phorusrhacoides
Unambiguous: 525(0 -> 1); DELTRAN: 5(1 -> 0), 139(0 -> 1), 189(0 -> 1), 214(0 -> 1), 392(0 -> 1), 408(1 -> 0), 542(0 -> 1); ACCTRAN: 129(1 -> 0), 529(2 -> 1).

†Masillaraptor cf parvunguis + †Masillaraptor parvunguis
Unambiguous: 177(0 -> 1); DELTRAN; ACCTRAN: 214(1 -> 0), 217(0 -> 1), 224(0 -> 1), 457(0 -> 1), 542(1 -> 0).

†Horusornis + Falconiformes
Unambiguous: 264(0 -> 1), 347(1 -> 0), 463(2 -> 1), 487(1 -> 0), 543(0 -> 1), 547(0 -> 1); DELTRAN: 214(0 -> 1), 226(0 -> 1), 266(0 -> 1), 453(1 -> 0); ACCTRAN: 38(0 -> 1), 112(0 -> 2), 116(0 -> 1), 120(0 -> 1), 132(0 -> 1), 134(0 -> 1), 151(0 -> 1), 152(0 -> 1), 186(0 -> 1), 243(0 -> 1), 255(0 -> 1), 257(0 -> 1), 260(1 -> 0), 341(0 -> 1), 392(1 -> 0), 406(0 -> 1), 414(0 -> 1), 419(0 -> 1), 426(0 -> 1), 427(0 -> 1), 437(1 -> 0), 439(0 -> 1), 464(0 -> 1), 465(0 -> 1), 468(0 -> 1), 471(0 -> 1), 527(0 -> 1), 528(1 -> 2), 530(1 -> 2), 539(0 -> 1).

Masillaraptoridae
node_175 --> node_174
Unambiguous: 106(0 -> 1), 136(0 -> 1), 232(0 -> 1), 423(0 -> 1), 447(1 -> 0), 450(0 -> 1), 473(1 -> 2), 491(0 -> 1), 492(1 -> 0), 549(1 -> 0); DELTRAN: 145(0 -> 1), 220(0 -> 1), 528(0 -> 1), 530(0 -> 1); ACCTRAN: 5(1 -> 0), 37(1 -> 0), 139(0 -> 1), 184(1 -> 2), 189(0 -> 1), 198(0 -> 2), 226(1 -> 0), 228(0 -> 1), 229(0 -> 1), 230(0 -> 1), 266(1 -> 0), 277(0 -> 1), 302(1 -> 0), 303(0 -> 1), 321(1 -> 0), 361(0 -> 1), 395(1 -> 0), 445(0 -> 1), 453(0 -> 1), 469(1 -> 0), 513(2 -> 1).

Nestor notabilis
Unambiguous: 55(2 -> 1), 62(0 -> 1), 85(1 -> 0), 132(0 -> 1), 134(0 -> 1), 467(1 -> 2); DELTRAN: 39(0 -> 1), 163(0 -> 1), 186(0 -> 1), 206(0 -> 2), 270(1 -> 0), 328(1 -> 0), 407(0 -> 1), 428(0 -> 1), 441(0 -> 1), 469(0 -> 1), 542(0 -> 1); ACCTRAN: 8(1 -> 0), 56(1 -> 0), 202(1 -> 0), 491(2 -> 0).

Strigops habroptilus
Unambiguous: 42(0 -> 1), 52(0 -> 2), 63(0 -> 2), 75(2 -> 1), 212(0 -> 1), 549(1 -> 0); DELTRAN: 8(0 -> 1), 56(0 -> 1), 202(0 -> 1), 491(0 -> 2); ACCTRAN: 39(1 -> 0), 186(1 -> 0), 206(2 -> 0), 542(1 -> 0).

Barnardius zonarius
Unambiguous: 39(2 -> 1), 204(1 -> 0), 206(2 -> 0), 215(1 -> 2), 216(0 -> 1), 217(0 -> 1), 230(0 -> 1), 256(1 -> 0), 303(0 -> 1), 413(1 -> 2), 428(0 -> 1), 435(2 -> 1), 465(2 -> 1), 512(0 -> 1); DELTRAN: 467(1 -> 2), 529(1 -> 0), 545(1 -> 0); ACCTRAN: 467(0 -> 2).

Psittrichas fulgidus
Unambiguous: 85(1 -> 0), 312(0 -> 1), 358(0 -> 1), 429(1 -> 0); DELTRAN: 467(1 -> 0); ACCTRAN.

Deroptyus accipitrinus
Unambiguous: 42(0 -> 1), 52(0 -> 2), 57(0 -> 1), 204(1 -> 0), 222(1 -> 0), 287(0 -> 1), 312(0 -> 1), 432(0 -> 1), 542(1 -> 2), 547(0 -> 1); DELTRAN; ACCTRAN.

Psittacus erithacus
Unambiguous: 132(0 -> 1), 134(0 -> 1), 189(1 -> 0), 211(0 -> 1), 413(1 -> 0), 431(1 -> 0), 436(0 -> 1), 442(0 -> 1), 549(1 -> 0); DELTRAN; ACCTRAN.

Bernardius + Psittrichas
Unambiguous; DELTRAN: 56(0 -> 1), 235(0 -> 1), 441(0 -> 2); ACCTRAN: 467(1 -> 0), 529(1 -> 0), 545(1 -> 0).

Psittacus + Deroptyus
Unambiguous: 307(1 -> 0), 314(0 -> 1), 440(1 -> 0), 543(1 -> 0); DELTRAN: 518(0 -> 1); ACCTRAN: 56(1 -> 0), 235(1 -> 0), 441(2 -> 0).

Probosciger aterrimus
Unambiguous: 1(0 -> 1), 42(0 -> 1), 52(0 -> 2), 57(0 -> 1), 136(0 -> 1), 215(1 -> 2), 217(0 -> 1), 394(0 -> 1), 413(1 -> 2), 436(0 -> 1), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0); DELTRAN: 39(0 -> 1), 56(0 -> 1), 163(0 -> 1), 235(0 -> 1), 428(0 -> 1), 441(0 -> 2), 469(0 -> 1); ACCTRAN: 270(0 -> 1), 324(1 -> 0).

Bernardius + Psittrichas + Psittacus + Deroptyus
Unambiguous: 296(0 -> 1), 416(0 -> 1), 458(0 -> 1), 537(0 -> 1); DELTRAN: 39(0 -> 2), 175(0 -> 1), 270(1 -> 0), 324(0 -> 1); ACCTRAN: 39(1 -> 2), 163(1 -> 0), 428(1 -> 0), 469(1 -> 0).

Strigopidae
Unambiguous; DELTRAN: 4(0 -> 1), 15(0 -> 1), 324(0 -> 1); ACCTRAN: 4(2 -> 1), 371(1 -> 0), 407(0 -> 1).

Probosciger + Bernardius + Psittrichas + Psittacus + Deroptyus
Unambiguous: 3(0 -> 1), 14(0 -> 1), 141(0 -> 1), 182(0 -> 2), 228(0 -> 1), 249(0 -> 1), 277(0 -> 1), 283(0 -> 2), 294(0 -> 2), 512(1 -> 0); DELTRAN: 4(0 -> 2), 8(0 -> 1), 15(0 -> 2), 186(0 -> 1), 202(0 -> 1), 206(0 -> 2), 371(0 -> 1), 491(0 -> 2), 542(0 -> 1); ACCTRAN: 15(1 -> 2), 175(0 -> 1), 235(0 -> 1), 328(0 -> 1), 441(1 -> 2).

†Quercypsitta sudrei
Unambiguous: 329(1 -> 0), 449(0 -> 1), 465(2 -> 1), 470(2 -> 1), 484(0 -> 1), 485(1 -> 0), 486(1 -> 0), 492(1 -> 0), 493(1 -> 0), 517(0 -> 1); DELTRAN: 455(0 -> 1), 456(0 -> 1), 471(0 -> 1), 479(0 -> 2); ACCTRAN: 220(1 -> 0), 226(1 -> 0).

Strigopidae + Probosciger + Bernardius + Psittrichas + Psittacus + Deroptyus
Unambiguous: 214(0 -> 1), 222(0 -> 1), 440(0 -> 1), 452(0 -> 1), 454(0 -> 2), 462(0 -> 1), 490(0 -> 1), 501(0 -> 1), 508(0 -> 1), 511(0 -> 1); DELTRAN: 2(0 -> 1), 7(0 -> 1), 19(0 -> 1), 23(0 -> 1), 28(0 -> 3), 30(0 -> 1), 37(0 -> 1), 41(0 -> 1), 46(0 -> 1), 48(1 -> 2), 55(0 -> 2), 84(0 -> 1), 90(0 -> 1), 95(2 -> 0), 101(0 -> 2), 105(0 -> 1), 117(1 -> 2), 118(0 -> 1), 121(0 -> 1), 126(0 -> 1), 137(0 -> 1), 138(0 -> 1), 139(0 -> 1), 140(0 -> 1), 151(0 -> 1), 152(0 -> 2), 154(0 -> 1), 156(0 -> 1), 162(1 -> 0), 165(0 -> 1), 170(0 -> 2), 189(0 -> 1), 191(0 -> 1), 200(1 -> 2), 220(0 -> 1), 226(0 -> 1), 229(0 -> 1), 239(0 -> 1), 254(0 -> 2), 255(0 -> 1), 257(1 -> 2), 258(0 -> 1), 259(0 -> 2), 264(0 -> 1), 265(0 -> 1), 266(0 -> 1), 278(0 -> 1), 307(0 -> 1), 354(0 -> 1), 361(0 -> 1), 370(0 -> 1), 377(0 -> 2), 397(2 -> 1), 401(0 -> 1), 410(0 -> 1), 427(0 -> 1), 431(0 -> 1), 438(0 -> 1), 479(0 -> 1), 494(0 -> 1), 523(0 -> 1), 527(0 -> 1), 530(0 -> 1), 533(0 -> 1), 534(0 -> 1), 543(0 -> 1); ACCTRAN: 441(0 -> 1), 479(2 -> 1), 491(0 -> 2).

Neodrepanis coruscans
Unambiguous: 1(0 -> 1), 17(1 -> 0), 25(1 -> 0), 35(0 -> 1), 51(1 -> 0), 136(0 -> 1), 147(1 -> 0), 150(1 -> 0), 204(1 -> 0), 240(0 -> 1), 337(0 -> 1), 338(0 -> 1), 339(0 -> 1), 428(0 -> 1), 431(0 -> 2), 435(1 -> 0), 457(0 -> 1), 509(0 -> 1); DELTRAN: 206(0 -> 1), 215(0 -> 2), 308(0 -> 1), 379(1 -> 0), 395(1 -> 0), 473(1 -> 0), 536(0 -> 1); ACCTRAN: 219(1 -> 0), 377(1 -> 0), 444(1 -> 0), 451(1 -> 0).

Pitta sordida
Unambiguous: 32(0 -> 1), 33(1 -> 0), 47(1 -> 0), 117(1 -> 0), 203(1 -> 0), 205(0 -> 1), 247(1 -> 0), 251(1 -> 0), 270(2 -> 0), 347(1 -> 0), 350(1 -> 0), 356(1 -> 0), 360(1 -> 0), 432(1 -> 0), 447(1 -> 0), 452(2 -> 0), 527(1 -> 0); DELTRAN: 219(0 -> 1), 377(0 -> 1), 444(0 -> 1), 451(0 -> 1); ACCTRAN: 206(1 -> 0), 379(0 -> 1), 395(0 -> 1), 473(0 -> 1), 536(1 -> 0).

Melanopareia bitorquata
Unambiguous: 8(1 -> 0), 33(1 -> 0), 34(0 -> 1), 125(0 -> 1), 126(0 -> 1), 147(1 -> 0), 150(1 -> 0), 176(0 -> 1), 184(1 -> 2), 194(0 -> 1), 197(1 -> 0), 206(1 -> 0), 220(1 -> 0), 240(0 -> 1), 280(0 -> 1), 281(1 -> 0), 303(1 -> 0), 308(0 -> 1), 337(0 -> 1), 339(0 -> 1), 352(1 -> 0), 355(1 -> 0), 409(0 -> 1), 422(0 -> 1), 473(1 -> 0); DELTRAN: 317(1 -> 0), 426(0 -> 1), 527(1 -> 0), 539(0 -> 1); ACCTRAN: 251(0 -> 1), 348(1 -> 0), 395(0 -> 1), 437(0 -> 1).

Myrmornis torquata
Unambiguous: 1(0 -> 1), 17(1 -> 0), 215(0 -> 1), 298(1 -> 0), 411(0 -> 1), 510(1 -> 0), 512(2 -> 1), 515(1 -> 0); DELTRAN: 251(1 -> 0), 348(0 -> 1), 395(1 -> 0), 437(1 -> 0); ACCTRAN: 317(0 -> 1), 426(1 -> 0).

Myrmothera campanisona minor
Unambiguous: 117(1 -> 0), 174(0 -> 1), 179(1 -> 0), 347(1 -> 0), 452(2 -> 1); DELTRAN: 251(1 -> 0), 317(1 -> 0), 348(0 -> 1), 395(1 -> 0), 426(0 -> 1), 437(1 -> 0), 536(0 -> 1); ACCTRAN.

Melanopareia + Myrmornis
Unambiguous: 67(1 -> 0), 121(0 -> 1), 182(1 -> 0), 255(1 -> 0), 286(1 -> 0), 356(1 -> 0), 431(0 -> 2); DELTRAN; ACCTRAN: 536(1 -> 0).

Piprites chloris tschudii
Unambiguous: 322(1 -> 0), 408(1 -> 2), 436(0 -> 1), 452(2 -> 1); DELTRAN: 142(1 -> 0), 150(1 -> 0), 343(1 -> 0), 536(0 -> 1); ACCTRAN: 17(0 -> 1), 51(0 -> 1).

Tyrannus tyrannus
Unambiguous: 38(0 -> 1), 48(2 -> 1), 235(0 -> 1), 255(1 -> 0), 280(0 -> 1), 367(1 -> 0), 397(1 -> 0), 413(1 -> 2), 441(0 -> 1); DELTRAN: 17(1 -> 0), 51(1 -> 0); ACCTRAN: 142(0 -> 1), 150(0 -> 1), 343(0 -> 1), 536(1 -> 0).

Rupicola peruvianus
Unambiguous: 4(0 -> 1), 19(0 -> 1), 20(0 -> 1), 22(0 -> 1), 25(1 -> 0), 28(0 -> 1), 50(1 -> 0), 102(4 -> 1), 103(1 -> 0), 186(0 -> 1), 234(1 -> 0), 251(1 -> 0), 350(1 -> 0), 428(0 -> 1), 475(1 -> 0), 482(1 -> 0); DELTRAN: 17(1 -> 0), 51(1 -> 0), 142(1 -> 0), 150(1 -> 0), 249(0 -> 1), 343(1 -> 0), 515(1 -> 0); ACCTRAN: 407(1 -> 0).

Tyrannidae
Unambiguous: 126(0 -> 1), 146(1 -> 0), 270(2 -> 0), 356(1 -> 0), 426(0 -> 1); DELTRAN: 407(0 -> 1); ACCTRAN: 249(1 -> 0), 515(0 -> 1).

Neopelma chrysocephalum
Unambiguous: 48(2 -> 1), 240(0 -> 1), 255(1 -> 0), 305(1 -> 0), 311(1 -> 0), 408(1 -> 2); DELTRAN: 249(0 -> 1), 333(0 -> 1), 395(1 -> 0), 407(0 -> 1), 437(1 -> 0), 515(1 -> 0), 536(0 -> 1); ACCTRAN.

Rupicola + Tyrannidae
Unambiguous: 122(0 -> 1), 128(0 -> 1), 147(1 -> 0), 247(1 -> 0), 397(2 -> 1), 441(2 -> 0), 488(1 -> 0); DELTRAN: 236(2 -> 0), 451(0 -> 1), 512(2 -> 1); ACCTRAN: 17(1 -> 0), 51(1 -> 0), 142(1 -> 0), 150(1 -> 0), 333(1 -> 0), 343(1 -> 0), 395(0 -> 1), 437(0 -> 1).

Furnariidae
Unambiguous: 205(0 -> 1), 338(0 -> 1), 366(0 -> 1); DELTRAN: 333(0 -> 1), 444(0 -> 1); ACCTRAN: 195(1 -> 0), 215(2 -> 0), 251(1 -> 0), 317(1 -> 0), 342(1 -> 0), 348(0 -> 1), 426(0 -> 1), 451(1 -> 0), 473(0 -> 1), 515(0 -> 1), 527(1 -> 0), 539(0 -> 1).

Tyrannida
Unambiguous: 58(0 -> 1), 203(1 -> 0), 399(2 -> 1), 432(1 -> 0), 510(1 -> 0); DELTRAN: 195(0 -> 1), 215(0 -> 2), 342(0 -> 1), 473(1 -> 0); ACCTRAN: 249(0 -> 1), 407(0 -> 1), 444(1 -> 0), 512(2 -> 1).

Eurylaimides
Unambiguous; DELTRAN: 195(0 -> 1), 342(0 -> 1), 515(1 -> 0); ACCTRAN: 80(3 -> 0), 220(1 -> 0), 303(1 -> 0).

Tyrannides
Unambiguous: 8(0 -> 1), 409(1 -> 0); DELTRAN: 80(0 -> 3), 206(0 -> 1), 219(0 -> 1), 220(0 -> 1), 303(0 -> 1), 377(0 -> 1), 379(1 -> 0); ACCTRAN: 308(1 -> 0), 333(0 -> 1), 437(1 -> 0).

Sylvia borin
Unambiguous: 181(0 -> 1), 195(0 -> 1), 426(0 -> 1), 431(2 -> 0), 440(0 -> 1), 515(0 -> 1); DELTRAN: 25(1 -> 0), 339(0 -> 1); ACCTRAN: 121(1 -> 0), 205(1 -> 0), 286(1 -> 0), 294(0 -> 2), 311(0 -> 1), 413(0 -> 1), 488(1 -> 0).

Zosterops lateralis
Unambiguous: 130(1 -> 0), 330(1 -> 0), 548(0 -> 1); DELTRAN: 121(0 -> 1), 205(0 -> 1), 286(0 -> 1), 294(2 -> 0), 311(1 -> 0), 413(1 -> 0), 488(0 -> 1); ACCTRAN: 25(0 -> 1), 339(1 -> 0).

Passer domesticus
Unambiguous: 9(0 -> 1), 72(0 -> 1), 146(1 -> 0), 179(1 -> 0); DELTRAN: 25(1 -> 0), 56(0 -> 1), 61(0 -> 1), 117(1 -> 0), 121(0 -> 1), 205(0 -> 1), 251(1 -> 0), 286(0 -> 1), 294(2 -> 0), 311(1 -> 0), 339(0 -> 1), 413(1 -> 0), 488(0 -> 1); ACCTRAN: 85(0 -> 1).

Sylvia + Zosterops
Unambiguous: 55(1 -> 0), 174(1 -> 0), 280(0 -> 1), 317(1 -> 0), 549(1 -> 0); DELTRAN: 85(1 -> 0); ACCTRAN: 56(1 -> 0), 117(0 -> 1), 251(0 -> 1).

Corvus brachyrhynchos
Unambiguous: 33(1 -> 0), 51(1 -> 0), 130(1 -> 0), 182(0 -> 1), 195(0 -> 1), 229(0 -> 1), 256(1 -> 0), 269(1 -> 0), 270(2 -> 0), 330(1 -> 0), 347(0 -> 1), 355(1 -> 0), 356(1 -> 0), 358(1 -> 0), 366(1 -> 0), 409(1 -> 0), 411(0 -> 1), 431(2 -> 0), 451(0 -> 1), 452(2 -> 1), 510(1 -> 0), 512(2 -> 1); DELTRAN: 56(0 -> 1), 85(1 -> 0), 117(1 -> 0), 236(2 -> 1), 251(1 -> 0), 441(1 -> 0), 456(0 -> 1); ACCTRAN: 50(1 -> 0), 205(1 -> 0), 339(1 -> 0).

Passer + Sylvia + Zosterops
Unambiguous: 204(1 -> 0), 222(1 -> 0), 297(1 -> 0), 492(0 -> 1); DELTRAN: 50(0 -> 1), 441(1 -> 2), 539(0 -> 1), 546(0 -> 1); ACCTRAN: 25(1 -> 0), 61(0 -> 1), 121(0 -> 1), 236(1 -> 2), 286(0 -> 1), 294(2 -> 0), 311(1 -> 0), 413(1 -> 0), 441(0 -> 2), 456(1 -> 0), 488(0 -> 1).

Malurus melanocephalus
Unambiguous: 126(0 -> 1), 143(0 -> 1), 235(0 -> 1), 280(0 -> 1), 317(1 -> 0), 333(0 -> 1), 337(0 -> 1), 392(1 -> 0), 422(0 -> 1); DELTRAN: 50(0 -> 1), 205(0 -> 1), 339(0 -> 1), 397(2 -> 1), 456(0 -> 1); ACCTRAN: 219(1 -> 0), 228(1 -> 0).

Corvus + Passer + Sylvia + Zosterops
Unambiguous: 17(1 -> 0), 147(1 -> 0), 255(1 -> 0), 343(1 -> 0), 367(1 -> 0), 440(1 -> 0), 509(0 -> 1), 515(1 -> 0); DELTRAN: 219(0 -> 1), 228(0 -> 1); ACCTRAN: 56(0 -> 1), 85(1 -> 0), 117(1 -> 0), 251(1 -> 0), 397(1 -> 2), 441(1 -> 0).

Climacterus melanurus wellsi
Unambiguous: 395(1 -> 0), 413(1 -> 0), 481(0 -> 1), 482(1 -> 0); DELTRAN: 52(0 -> 1), 97(1 -> 2), 219(0 -> 1), 228(0 -> 1), 236(2 -> 1), 321(0 -> 1), 397(2 -> 1), 415(0 -> 1), 426(0 -> 1), 435(1 -> 2), 442(0 -> 1), 443(0 -> 1), 451(0 -> 1), 542(0 -> 1); ACCTRAN.

Malurus + Corvus + Passer + Sylvia + Zosterops
Unambiguous: 55(0 -> 1), 234(0 -> 1), 487(0 -> 1); DELTRAN; ACCTRAN: 50(0 -> 1), 52(1 -> 0), 97(2 -> 1), 205(0 -> 1), 321(1 -> 0), 339(0 -> 1), 415(1 -> 0), 426(1 -> 0), 435(2 -> 1), 442(1 -> 0), 443(1 -> 0), 451(1 -> 0), 456(0 -> 1), 542(1 -> 0).

Menura novaehollandiae
Unambiguous: 25(1 -> 0), 30(0 -> 1), 35(0 -> 1), 37(0 -> 1), 38(0 -> 1), 39(0 -> 2), 44(1 -> 0), 47(1 -> 0), 48(2 -> 1), 85(1 -> 0), 129(0 -> 1), 178(0 -> 1), 196(0 -> 1), 197(1 -> 0), 199(0 -> 1), 204(1 -> 0), 211(0 -> 1), 242(1 -> 0), 244(2 -> 0), 245(0 -> 1), 251(1 -> 0), 253(1 -> 0), 255(1 -> 0), 270(2 -> 0), 272(1 -> 0), 280(0 -> 1), 312(0 -> 1), 317(1 -> 0), 329(2 -> 1), 337(0 -> 1), 356(1 -> 0), 358(1 -> 0), 370(0 -> 1), 392(1 -> 0), 401(1 -> 0), 409(1 -> 0), 411(0 -> 1), 440(1 -> 0), 447(1 -> 0), 528(0 -> 1), 537(0 -> 1), 547(0 -> 1), 548(0 -> 1); DELTRAN: 52(0 -> 1), 97(1 -> 2), 206(0 -> 1), 214(0 -> 1), 321(0 -> 1), 415(0 -> 1), 426(0 -> 1), 431(0 -> 1), 435(1 -> 2), 442(0 -> 1), 443(0 -> 1), 451(0 -> 1), 542(0 -> 1); ACCTRAN: 219(1 -> 0), 308(1 -> 0), 444(1 -> 0), 546(1 -> 0).

Climacterus + Malurus + Corvus + Passer + Sylvia + Zosterops
Unambiguous: 66(0 -> 1), 330(0 -> 1), 347(1 -> 0); DELTRAN: 308(0 -> 1), 431(0 -> 2), 444(0 -> 1); ACCTRAN: 206(1 -> 0), 214(1 -> 0), 228(0 -> 1), 236(2 -> 1), 397(2 -> 1), 431(1 -> 2), 539(0 -> 1).

Tyranni
Unambiguous: 55(0 -> 1), 71(0 -> 3), 130(1 -> 0), 174(1 -> 0), 182(0 -> 1), 234(0 -> 1), 256(1 -> 0), 307(0 -> 2), 456(0 -> 1); DELTRAN: 50(0 -> 1), 67(0 -> 1), 115(1 -> 0), 214(0 -> 1), 286(0 -> 1), 546(0 -> 1); ACCTRAN: 195(0 -> 1), 215(0 -> 2), 236(2 -> 0), 342(0 -> 1), 377(0 -> 1), 379(1 -> 0), 395(1 -> 0), 428(1 -> 0), 431(1 -> 0), 442(1 -> 0), 488(0 -> 1), 515(1 -> 0).

Passeri
Unambiguous: 61(1 -> 0), 63(1 -> 2), 114(1 -> 0), 222(0 -> 1), 261(0 -> 1), 334(0 -> 1), 335(0 -> 1), 366(0 -> 1), 369(0 -> 1), 441(2 -> 1), 507(1 -> 0), 549(0 -> 1); DELTRAN: 80(0 -> 3), 220(0 -> 1), 303(0 -> 1), 428(0 -> 1), 473(1 -> 0), 488(1 -> 0); ACCTRAN: 50(1 -> 0), 52(0 -> 1), 67(1 -> 0), 97(1 -> 2), 115(0 -> 1), 286(1 -> 0), 415(0 -> 1), 426(0 -> 1), 435(1 -> 2), 443(0 -> 1), 536(1 -> 0), 542(0 -> 1).

Acanthisitta chloris
Unambiguous: 26(0 -> 1), 32(0 -> 1), 126(0 -> 1), 143(0 -> 1), 183(0 -> 2), 185(0 -> 1), 203(1 -> 0), 248(0 -> 1), 307(0 -> 1), 338(0 -> 1), 339(0 -> 1), 341(0 -> 1), 348(0 -> 1), 353(2 -> 1), 357(0 -> 1), 403(0 -> 1), 407(0 -> 1), 425(0 -> 1), 501(0 -> 1), 509(0 -> 1), 537(0 -> 1), 548(0 -> 1); DELTRAN: 50(0 -> 1), 67(0 -> 1), 115(1 -> 0), 205(0 -> 1), 286(0 -> 1), 308(0 -> 1), 317(1 -> 0), 410(0 -> 1), 428(0 -> 1), 431(0 -> 1), 442(0 -> 1), 444(0 -> 1), 488(1 -> 0), 536(0 -> 1); ACCTRAN: 206(1 -> 0), 303(1 -> 0), 473(0 -> 1).

Passeri + Tyranni
Unambiguous: 33(0 -> 1), 166(0 -> 1), 179(0 -> 1), 184(2 -> 1), 191(0 -> 1), 201(0 -> 1), 244(1 -> 2), 257(0 -> 2), 294(0 -> 2), 367(0 -> 1), 466(0 -> 3), 467(1 -> 2), 487(1 -> 0); DELTRAN; ACCTRAN: 80(0 -> 3), 205(1 -> 0), 214(0 -> 1), 219(0 -> 1), 220(0 -> 1), 317(0 -> 1), 410(1 -> 0), 451(0 -> 1), 546(0 -> 1).

†Eozygodactylus americanus
Unambiguous: 198(0 -> 1), 250(1 -> 0), 350(1 -> 0), 432(1 -> 0); DELTRAN: 249(0 -> 1), 395(1 -> 0); ACCTRAN.

†Zygodactylus grandei
Unambiguous: 172(1 -> 0), 371(1 -> 0), 425(0 -> 1), 545(1 -> 0); DELTRAN: 190(1 -> 0), 205(0 -> 1), 232(0 -> 1), 351(0 -> 1), 435(1 -> 0), 502(0 -> 1), 505(0 -> 1), 506(0 -> 1), 515(1 -> 0); ACCTRAN.

Passeriformes
Unambiguous: 40(0 -> 1), 131(0 -> 1), 134(0 -> 1), 142(0 -> 1), 169(1 -> 0), 189(0 -> 1), 247(0 -> 1), 279(0 -> 1), 297(0 -> 1), 301(0 -> 1), 311(0 -> 1), 332(1 -> 2), 429(1 -> 2), 452(0 -> 2), 484(0 -> 1), 489(1 -> 0), 493(1 -> 0), 495(3 -> 0), 513(1 -> 2), 519(0 -> 1), 527(0 -> 1); DELTRAN: 18(1 -> 0), 25(0 -> 1), 51(0 -> 1), 63(0 -> 1), 78(0 -> 1), 83(0 -> 1), 92(0 -> 1), 97(0 -> 1), 98(0 -> 1), 102(1 -> 4), 103(0 -> 1), 150(0 -> 1), 156(0 -> 1), 164(0 -> 1), 165(0 -> 1), 199(1 -> 0), 209(0 -> 2), 259(0 -> 2), 266(0 -> 1), 270(1 -> 2), 271(0 -> 1), 276(0 -> 1), 283(0 -> 1), 285(0 -> 1), 287(0 -> 1), 291(0 -> 1), 292(0 -> 1), 298(0 -> 1), 305(0 -> 1), 322(0 -> 1), 327(1 -> 2), 328(1 -> 0), 329(1 -> 2), 343(0 -> 1), 388(1 -> 0), 401(0 -> 1), 402(2 -> 1), 411(1 -> 0), 420(0 -> 1), 423(0 -> 1), 427(0 -> 1), 438(0 -> 1), 441(0 -> 2), 476(1 -> 0), 482(0 -> 1), 485(1 -> 0), 486(1 -> 0), 491(0 -> 1), 492(1 -> 0), 510(0 -> 1); ACCTRAN: 144(1 -> 0), 232(1 -> 0), 431(0 -> 1), 435(0 -> 1), 488(1 -> 0), 502(1 -> 0).

†Zygodactylus + †Eozygodactylus
Unambiguous: 273(0 -> 1), 354(0 -> 1), 381(0 -> 1); DELTRAN: 144(0 -> 1), 317(1 -> 0), 498(0 -> 1); ACCTRAN: 25(1 -> 0), 190(1 -> 0), 249(0 -> 1), 351(0 -> 1), 395(1 -> 0), 505(0 -> 1), 506(0 -> 1), 515(1 -> 0).

†Primozygodactylus danielsi
Unambiguous: 44(1 -> 0), 250(1 -> 0); DELTRAN: 32(0 -> 1); ACCTRAN.

†Primozygodactylus quintus
Unambiguous; DELTRAN: 129(0 -> 1), 302(1 -> 0), 303(0 -> 1), 344(0 -> 1), 347(1 -> 0), 369(0 -> 1), 435(1 -> 0), 448(0 -> 1), 455(0 -> 2), 458(0 -> 1), 473(1 -> 0), 474(0 -> 1), 477(0 -> 1), 478(0 -> 1), 517(0 -> 1); ACCTRAN: 32(1 -> 0).

†Primozygodactylus eunjooae
Unambiguous: 1(0 -> 1), 493(1 -> 0); DELTRAN: 32(0 -> 1), 232(0 -> 1); ACCTRAN.

†Primozygodactylus quintus + †Primozygodactylus danielsi
Unambiguous: 26(0 -> 1), 151(0 -> 1); DELTRAN; ACCTRAN: 232(1 -> 0).

†Primozygodactylus longibrachium
Unambiguous: 142(0 -> 1); DELTRAN; ACCTRAN.

†Primozygodactylus eunjooae + †Primozygodactylus quintus + †Primozygodactylus danielsi
Unambiguous; DELTRAN: 33(0 -> 1); ACCTRAN.

†Primozygodactylus major
Unambiguous: 509(0 -> 1); DELTRAN: 232(0 -> 1); ACCTRAN.

†Primozygodactylus longibrachium + †Primozygodactylus eunjooae + †Primozygodactylus quintus + †Primozygodactylus danielsi
Unambiguous: 228(0 -> 1); DELTRAN: 8(0 -> 1), 25(0 -> 1), 144(0 -> 1), 179(0 -> 1); ACCTRAN.

†Zygodactylus + †Eozygodactylus + Passeriformes
node_205 --> node_200
Unambiguous: 147(0 -> 1), 197(0 -> 1), 255(0 -> 1), 274(0 -> 1), 336(0 -> 1), 440(0 -> 1); DELTRAN: 244(0 -> 1), 253(0 -> 1), 376(1 -> 0); ACCTRAN: 8(1 -> 0), 115(1 -> 0), 156(0 -> 1), 205(0 -> 1), 276(0 -> 1), 292(0 -> 1), 298(0 -> 1), 305(0 -> 1), 308(0 -> 1), 329(1 -> 2), 343(0 -> 1), 411(1 -> 0), 420(0 -> 1), 427(0 -> 1), 441(0 -> 2), 442(0 -> 1), 444(0 -> 1), 476(1 -> 0), 477(1 -> 0), 482(0 -> 1), 485(1 -> 0), 486(1 -> 0), 491(0 -> 1), 492(1 -> 0), 498(0 -> 1), 510(0 -> 1), 536(0 -> 1).

†Primozygodactylus major + †Primozygodactylus longibrachium + †Primozygodactylus eunjooae + †Primozygodactylus quintus + †Primozygodactylus danielsi
Unambiguous: 229(0 -> 1), 429(1 -> 0), 523(0 -> 1); DELTRAN: 244(0 -> 2), 502(0 -> 1); ACCTRAN: 32(0 -> 1), 33(0 -> 1), 129(0 -> 1), 179(0 -> 1), 244(1 -> 2), 259(2 -> 0), 266(1 -> 0), 286(1 -> 0), 291(1 -> 0), 302(1 -> 0), 317(0 -> 1), 344(0 -> 1), 347(1 -> 0), 369(0 -> 1), 438(1 -> 0), 448(0 -> 1), 455(0 -> 2), 458(0 -> 1), 474(0 -> 1), 478(0 -> 1), 517(0 -> 1).

†Eofringillirostrum boudreauxi
Unambiguous: 15(0 -> 1), 19(0 -> 1), 137(0 -> 1), 250(1 -> 0), 254(0 -> 1), 260(1 -> 0), 277(0 -> 1), 508(0 -> 1), 521(0 -> 1), 527(0 -> 1), 528(0 -> 1), 530(0 -> 2), 537(0 -> 1), 545(1 -> 0); DELTRAN: 8(0 -> 1), 117(1 -> 0), 317(1 -> 0), 473(1 -> 2), 477(0 -> 1), 535(0 -> 1); ACCTRAN: 144(1 -> 0), 244(1 -> 0), 473(0 -> 2).

Parapasseres
Unambiguous: 48(1 -> 2), 242(0 -> 1), 245(1 -> 0), 251(0 -> 1), 350(0 -> 1), 470(2 -> 1), 472(0 -> 1), 475(0 -> 1), 512(1 -> 2), 513(0 -> 1), 548(1 -> 0); DELTRAN: 112(0 -> 1), 334(1 -> 0), 352(0 -> 1), 356(0 -> 1), 358(0 -> 1), 469(0 -> 1), 507(0 -> 1); ACCTRAN: 25(0 -> 1), 117(0 -> 1), 435(1 -> 0), 502(0 -> 1), 535(1 -> 0).

†Psittacomimus eos
Unambiguous: 15(0 -> 1), 16(0 -> 1), 123(0 -> 1), 337(0 -> 1), 370(0 -> 1), 396(1 -> 0); DELTRAN: 4(0 -> 1), 116(0 -> 1), 232(0 -> 1), 238(1 -> 0), 256(1 -> 0), 331(0 -> 1), 447(1 -> 0), 476(1 -> 0), 484(0 -> 1), 485(1 -> 0), 486(1 -> 2), 501(0 -> 2); ACCTRAN: 329(0 -> 1), 334(0 -> 1).

†Psittacopes Lepidus
Unambiguous: 8(0 -> 1), 17(1 -> 0), 114(1 -> 0), 220(1 -> 0), 229(0 -> 1), 347(1 -> 0), 548(1 -> 2); DELTRAN: 151(0 -> 1), 181(0 -> 1), 259(0 -> 1), 278(0 -> 1), 329(1 -> 0), 334(1 -> 0), 377(0 -> 2), 395(0 -> 1), 513(0 -> 1), 535(0 -> 1); ACCTRAN: 4(1 -> 0), 331(1 -> 0).

†Parapsittacopes bergdahli
Unambiguous: 183(0 -> 1), 251(0 -> 1), 254(0 -> 1), 277(0 -> 1), 292(0 -> 1), 382(0 -> 1), 523(0 -> 1); DELTRAN: 4(0 -> 1), 28(0 -> 1), 35(0 -> 1), 37(0 -> 1), 38(0 -> 1), 55(0 -> 1), 108(0 -> 1), 117(1 -> 2), 126(0 -> 1), 144(0 -> 1), 196(0 -> 1), 201(0 -> 1), 202(0 -> 1), 217(0 -> 1), 259(0 -> 2), 286(0 -> 1), 314(0 -> 1), 329(1 -> 0), 331(0 -> 1); ACCTRAN: 252(0 -> 2), 395(1 -> 0), 535(1 -> 0).

†Psittacopes + †Psittacomimus
node_208 --> node_207
Unambiguous: 131(0 -> 1), 215(2 -> 1); DELTRAN: 252(2 -> 0), 479(0 -> 2), 493(1 -> 0); ACCTRAN: 116(0 -> 1), 151(0 -> 1), 217(1 -> 0), 238(1 -> 0), 256(1 -> 0), 259(2 -> 1), 278(0 -> 1), 377(0 -> 2).

†Pumiliornis tessellatus
Unambiguous: 1(0 -> 1), 11(0 -> 1), 25(0 -> 1), 26(0 -> 1), 32(0 -> 1), 183(0 -> 2), 257(0 -> 2), 280(0 -> 1), 306(0 -> 1), 354(0 -> 1), 377(0 -> 1), 436(0 -> 1), 489(1 -> 0), 502(0 -> 1), 547(0 -> 1), 548(1 -> 0); DELTRAN: 47(0 -> 2), 217(0 -> 1), 252(2 -> 0), 266(0 -> 1), 379(0 -> 1), 535(0 -> 1); ACCTRAN: 232(1 -> 0), 259(2 -> 0), 272(1 -> 0), 303(1 -> 0), 331(1 -> 0).

†Parapsittacopes + †Psittacopes + †Psittacomimus
Unambiguous: 134(0 -> 1), 142(0 -> 1), 234(0 -> 1), 435(1 -> 0), 499(0 -> 1), 508(0 -> 1); DELTRAN: 162(1 -> 0), 191(0 -> 1), 272(0 -> 1), 291(0 -> 1), 303(0 -> 1); ACCTRAN: 4(0 -> 1), 28(0 -> 1), 35(0 -> 1), 55(0 -> 1), 266(1 -> 0), 379(1 -> 0), 476(1 -> 0), 484(0 -> 1), 485(1 -> 0), 486(1 -> 2), 493(1 -> 0), 501(0 -> 2), 513(0 -> 1).

†Eofringillirostrum + Parapasseres
Unambiguous: 40(1 -> 0), 44(0 -> 1), 215(2 -> 0), 332(0 -> 1), 355(0 -> 1), 399(0 -> 2), 515(0 -> 1); DELTRAN: 47(0 -> 1), 272(0 -> 1), 278(0 -> 1), 331(0 -> 1), 379(0 -> 1), 395(0 -> 1); ACCTRAN: 37(1 -> 0), 50(0 -> 1), 112(0 -> 1), 117(2 -> 0), 126(1 -> 0), 162(0 -> 1), 164(0 -> 1), 191(1 -> 0), 202(1 -> 0), 220(1 -> 0), 253(0 -> 1), 270(1 -> 2), 271(0 -> 1), 285(0 -> 1), 287(0 -> 1), 352(0 -> 1), 356(0 -> 1), 358(0 -> 1), 376(1 -> 0), 431(1 -> 0), 453(0 -> 1), 456(1 -> 0), 477(0 -> 1), 479(2 -> 0), 504(1 -> 0), 507(0 -> 1).

Psittacopedidae
Unambiguous: 172(1 -> 0), 219(0 -> 1), 309(0 -> 1), 408(1 -> 2), 539(0 -> 1); DELTRAN: 220(0 -> 1), 244(0 -> 1), 431(0 -> 1), 453(1 -> 0), 456(0 -> 1), 504(0 -> 1); ACCTRAN: 8(1 -> 0), 38(0 -> 1), 47(1 -> 2), 108(0 -> 1), 165(1 -> 0), 181(0 -> 1), 196(0 -> 1), 201(0 -> 1), 217(0 -> 1), 252(2 -> 0), 278(1 -> 0), 314(0 -> 1), 329(1 -> 0), 401(1 -> 0), 428(1 -> 0), 447(1 -> 0), 469(1 -> 0), 473(0 -> 1).

Psittaformes
Unambiguous: 215(2 -> 1), 218(0 -> 1), 347(1 -> 0), 435(1 -> 2), 476(1 -> 0), 481(0 -> 1), 499(0 -> 1); DELTRAN: 453(1 -> 0), 473(1 -> 0), 504(0 -> 1); ACCTRAN: 2(0 -> 1), 7(0 -> 1), 28(0 -> 3), 30(0 -> 1), 39(0 -> 1), 41(0 -> 1), 46(0 -> 1), 48(1 -> 2), 55(0 -> 2), 56(0 -> 1), 84(0 -> 1), 90(0 -> 1), 95(2 -> 0), 101(0 -> 2), 118(0 -> 1), 121(0 -> 1), 137(0 -> 1), 138(0 -> 1), 139(0 -> 1), 140(0 -> 1), 151(0 -> 1), 152(0 -> 2), 154(0 -> 1), 156(0 -> 1), 163(0 -> 1), 170(0 -> 2), 186(0 -> 1), 189(0 -> 1), 200(1 -> 2), 206(1 -> 2), 229(0 -> 1), 239(0 -> 1), 254(0 -> 2), 255(0 -> 1), 257(0 -> 2), 258(0 -> 1), 264(0 -> 1), 265(0 -> 1), 270(1 -> 0), 307(0 -> 1), 317(0 -> 1), 321(1 -> 0), 324(0 -> 1), 354(0 -> 1), 361(0 -> 1), 377(0 -> 2), 395(1 -> 0), 397(2 -> 1), 427(0 -> 1), 455(0 -> 1), 471(0 -> 1), 494(0 -> 1), 518(0 -> 1), 523(0 -> 1), 527(0 -> 1), 529(0 -> 1), 533(0 -> 1), 534(0 -> 1), 543(0 -> 1).

Psittacopedidae + †Eofringillirostrum + Parapasseres
Unambiguous: 17(0 -> 1), 33(1 -> 0), 49(0 -> 1), 114(0 -> 1), 130(0 -> 1), 146(0 -> 1), 169(0 -> 1), 179(1 -> 0), 184(1 -> 2), 236(0 -> 2), 269(0 -> 1), 297(1 -> 0), 360(0 -> 1), 384(0 -> 1), 416(0 -> 1), 432(0 -> 1), 549(1 -> 0); DELTRAN: 226(0 -> 1), 257(1 -> 0), 371(0 -> 1), 529(1 -> 0); ACCTRAN: 4(2 -> 0), 15(1 -> 0), 18(1 -> 0), 19(1 -> 0), 23(1 -> 0), 47(0 -> 1), 51(0 -> 1), 63(0 -> 1), 67(0 -> 1), 78(0 -> 1), 83(0 -> 1), 92(0 -> 1), 102(1 -> 4), 103(0 -> 1), 105(1 -> 0), 144(0 -> 1), 150(0 -> 1), 199(1 -> 0), 209(0 -> 2), 232(0 -> 1), 244(0 -> 1), 272(0 -> 1), 283(0 -> 1), 286(0 -> 1), 291(0 -> 1), 303(0 -> 1), 322(0 -> 1), 327(1 -> 2), 331(0 -> 1), 334(1 -> 0), 370(1 -> 0), 379(0 -> 1), 388(1 -> 0), 402(2 -> 1), 423(0 -> 1), 530(1 -> 0), 535(0 -> 1), 542(1 -> 0).

Masillaraptoridae + †Horusornis + Falconiformes
Unambiguous: 12(0 -> 1), 35(0 -> 2), 36(0 -> 1), 39(0 -> 2), 55(0 -> 1), 142(0 -> 1), 180(0 -> 1), 181(0 -> 1), 196(0 -> 1), 248(0 -> 1), 377(0 -> 1), 391(0 -> 1), 521(0 -> 1); DELTRAN: 4(0 -> 2), 15(0 -> 1), 111(0 -> 1), 259(0 -> 1), 474(0 -> 1), 495(0 -> 1); ACCTRAN: 28(0 -> 1), 61(1 -> 0), 62(0 -> 1), 68(0 -> 1), 108(0 -> 1), 117(2 -> 1), 145(0 -> 1), 155(0 -> 1), 173(0 -> 1), 209(0 -> 1), 214(0 -> 1), 225(1 -> 0), 315(0 -> 1), 325(0 -> 1), 328(0 -> 1), 397(2 -> 0), 421(0 -> 1), 442(0 -> 1), 443(0 -> 1), 528(0 -> 1), 529(0 -> 2).

Psittacopasseres
Unambiguous: 32(1 -> 0), 52(1 -> 0), 58(1 -> 0), 77(1 -> 0), 85(0 -> 1), 190(0 -> 1), 250(0 -> 1), 252(1 -> 2), 256(0 -> 1), 284(0 -> 1), 396(0 -> 1), 404(1 -> 0), 409(0 -> 1), 424(0 -> 1), 429(0 -> 1), 460(1 -> 0), 463(2 -> 0), 464(0 -> 2), 465(0 -> 2), 467(0 -> 1), 470(0 -> 2), 472(1 -> 0), 478(1 -> 0), 489(0 -> 1), 496(0 -> 2), 513(2 -> 0); DELTRAN: 225(0 -> 1), 302(0 -> 1), 392(0 -> 1), 434(0 -> 1), 495(0 -> 3); ACCTRAN: 8(0 -> 1), 91(1 -> 0), 97(0 -> 1), 98(0 -> 1), 111(1 -> 0), 129(1 -> 0), 162(1 -> 0), 165(0 -> 1), 191(0 -> 1), 259(1 -> 2), 278(0 -> 1), 371(0 -> 1), 393(1 -> 0), 401(0 -> 1), 408(0 -> 1), 410(0 -> 1), 428(0 -> 1), 431(0 -> 1), 438(0 -> 1), 456(0 -> 1), 473(1 -> 0), 474(1 -> 0), 479(0 -> 2), 495(1 -> 3), 504(0 -> 1).

†Bathornis + †Dynamopterus + Cariamiformes
Unambiguous: 79(0 -> 1), 89(0 -> 1), 334(1 -> 0), 335(0 -> 1), 337(0 -> 1), 344(0 -> 1), 376(1 -> 0), 379(0 -> 1), 548(1 -> 0); DELTRAN: 225(0 -> 1), 328(1 -> 0), 395(0 -> 1), 529(1 -> 0); ACCTRAN: 11(0 -> 1), 40(1 -> 0), 43(0 -> 1), 73(0 -> 1), 99(0 -> 1), 101(0 -> 1), 102(1 -> 0), 114(0 -> 1), 182(0 -> 1), 183(0 -> 2), 194(0 -> 1), 198(0 -> 1), 216(0 -> 1), 217(0 -> 1), 222(0 -> 1), 245(1 -> 0), 281(1 -> 0), 296(0 -> 1), 311(0 -> 1), 319(0 -> 1), 348(0 -> 1), 362(0 -> 1), 370(1 -> 0), 385(0 -> 1), 398(0 -> 1), 412(0 -> 1), 413(1 -> 0), 420(0 -> 1), 425(0 -> 1), 435(1 -> 2), 447(1 -> 0), 530(1 -> 0).

Eufalconimorphae
Unambiguous: 1(1 -> 0), 25(1 -> 0), 48(0 -> 1), 96(0 -> 1), 115(0 -> 1); DELTRAN: 102(0 -> 1), 245(0 -> 1), 493(0 -> 1); ACCTRAN: 4(0 -> 2), 15(0 -> 1), 19(0 -> 1), 23(0 -> 1), 105(0 -> 1), 126(0 -> 1), 202(0 -> 1), 226(0 -> 1), 257(1 -> 0), 327(0 -> 1), 392(0 -> 1), 453(1 -> 0), 469(0 -> 1), 495(0 -> 1), 542(0 -> 1).

Eutelluraves
Unambiguous: 61(1 -> 0), 112(0 -> 1), 133(0 -> 1), 184(1 -> 2), 201(0 -> 1), 209(0 -> 2), 283(0 -> 1), 396(0 -> 1), 402(2 -> 1), 416(0 -> 1), 456(0 -> 1), 463(2 -> 0), 464(0 -> 2), 470(0 -> 1), 495(0 -> 2), 496(0 -> 1), 527(0 -> 1), 528(0 -> 1), 534(0 -> 1); DELTRAN: 28(0 -> 1), 102(0 -> 1), 245(0 -> 1), 327(1 -> 0), 370(0 -> 1), 530(0 -> 1); ACCTRAN: 31(0 -> 1), 52(1 -> 2), 95(2 -> 0), 104(0 -> 1), 200(1 -> 2), 228(0 -> 1), 270(1 -> 2), 305(0 -> 1), 333(0 -> 1), 351(0 -> 1), 404(1 -> 0), 449(0 -> 1), 465(0 -> 1), 472(1 -> 0), 521(0 -> 1), 525(0 -> 1).

Australaves
Unambiguous: 215(1 -> 2), 388(0 -> 1); DELTRAN: 254(1 -> 0); ACCTRAN: 28(1 -> 0), 33(0 -> 1), 37(0 -> 1), 91(0 -> 1), 111(0 -> 1), 117(1 -> 2), 129(0 -> 1), 206(0 -> 1), 220(0 -> 1), 225(0 -> 1),

259(0 -> 1), 260(0 -> 1), 266(0 -> 1), 317(1 -> 0), 321(0 -> 1), 328(1 -> 0), 395(0 -> 1), 408(1 -> 0), 434(0 -> 1), 474(0 -> 1), 493(0 -> 1), 529(1 -> 0).

Accipitriformes
Unambiguous: 4(0 -> 2), 177(0 -> 1), 180(0 -> 1), 186(0 -> 1), 218(0 -> 1), 238(1 -> 0), 329(1 -> 0), 414(0 -> 1), 492(1 -> 0), 512(1 -> 0), 539(0 -> 1), 547(0 -> 1); DELTRAN: 28(0 -> 1), 245(0 -> 2), 260(1 -> 0); ACCTRAN: 1(1 -> 0), 5(1 -> 0), 30(0 -> 1), 46(0 -> 1), 48(0 -> 1), 152(0 -> 1), 159(0 -> 1), 194(0 -> 1), 208(0 -> 1), 210(0 -> 1), 245(1 -> 2), 258(0 -> 1), 413(1 -> 2), 473(1 -> 2), 518(0 -> 1).

Eutelluraves + Australaves
Unambiguous: 58(0 -> 1), 75(0 -> 2), 81(1 -> 0), 188(0 -> 1), 276(1 -> 0), 297(0 -> 1), 306(1 -> 0), 347(0 -> 1), 361(1 -> 0), 377(1 -> 0), 426(1 -> 0), 437(0 -> 1), 540(0 -> 1); DELTRAN: 172(0 -> 1), 473(0 -> 1), 545(0 -> 1); ACCTRAN: 102(0 -> 1), 254(1 -> 0), 302(0 -> 1), 327(1 -> 0), 370(0 -> 1), 393(0 -> 1), 530(0 -> 1).

Outgroup Charadris + Eurypyga
Unambiguous: 26(0 -> 1), 51(0 -> 1), 58(0 -> 1), 91(0 -> 1), 96(0 -> 1), 104(0 -> 1), 110(0 -> 1), 115(0 -> 1), 117(1 -> 0), 134(0 -> 1), 182(0 -> 1), 184(1 -> 2), 200(1 -> 2), 228(0 -> 1), 229(0 -> 1), 244(0 -> 1), 270(0 -> 2), 286(0 -> 1), 384(0 -> 1), 392(0 -> 1), 401(0 -> 1), 407(0 -> 1), 409(0 -> 1), 429(0 -> 2), 458(0 -> 1), 463(2 -> 0), 477(0 -> 1), 485(1 -> 2), 522(0 -> 1); DELTRAN; ACCTRAN: 75(0 -> 1), 152(0 -> 1), 324(0 -> 1), 325(0 -> 1), 464(0 -> 1), 529(1 -> 0), 537(0 -> 1).

Telluraves
Unambiguous: 17(1 -> 0), 18(0 -> 1), 40(0 -> 1), 52(0 -> 1), 179(0 -> 1), 270(0 -> 1), 402(3 -> 2), 417(1 -> 0); DELTRAN; ACCTRAN: 28(0 -> 1), 33(1 -> 0), 172(0 -> 1), 245(0 -> 1), 260(1 -> 0), 473(0 -> 1), 545(0 -> 1).

Outgroup Eudromia + Chauna
Unambiguous: 76(0 -> 1), 77(1 -> 0), 86(0 -> 1), 94(1 -> 0), 112(0 -> 1), 144(0 -> 1), 161(0 -> 1), 225(0 -> 1), 268(0 -> 1), 305(0 -> 1), 360(0 -> 1); DELTRAN; ACCTRAN: 38(0 -> 1), 203(1 -> 0), 539(0 -> 1).

Outroup Chauna chavaria
Unambiguous: 4(0 -> 1), 5(1 -> 0), 8(0 -> 1), 25(1 -> 0), 30(0 -> 1), 73(0 -> 1), 89(0 -> 1), 99(0 -> 1), 115(0 -> 1), 137(0 -> 1), 152(0 -> 2), 183(0 -> 1), 194(0 -> 1), 198(0 -> 2), 206(0 -> 1), 208(0 -> 1), 209(0 -> 1), 227(0 -> 1), 238(1 -> 0), 245(0 -> 2), 246(0 -> 1), 252(1 -> 0), 255(0 -> 1), 281(1 -> 0), 290(0 -> 1), 310(0 -> 1), 314(0 -> 1), 317(1 -> 0), 347(0 -> 1), 354(0 -> 1), 368(0 -> 1), 388(0 -> 1), 409(0 -> 1), 410(0 -> 1), 414(0 -> 1), 428(0 -> 1), 429(0 -> 1), 432(0 -> 1), 485(1 -> 2), 493(0 -> 1); DELTRAN: 203(1 -> 2), 539(0 -> 1); ACCTRAN: 203(0 -> 2).

Outroup Eudromia elegans
Unambiguous: 11(0 -> 1), 26(0 -> 1), 32(1 -> 0), 39(0 -> 2), 40(0 -> 1), 46(0 -> 1), 48(0 -> 1), 55(0 -> 1), 62(0 -> 1), 91(0 -> 1), 96(0 -> 1), 98(0 -> 1), 105(0 -> 1), 114(0 -> 1), 121(0 -> 1), 135(0 -> 1), 162(1 -> 0), 168(0 -> 1), 192(0 -> 1), 195(0 -> 1), 199(1 -> 0), 204(1 -> 0), 205(0 -> 1), 210(0 -> 1), 215(1 -> 0), 219(0 -> 1), 220(0 -> 1), 228(0 -> 1), 302(0 -> 1), 364(0 -> 1), 371(0 -> 1), 383(1 -> 0), 384(0 -> 1), 392(0 -> 1), 397(2 -> 0), 400(1 -> 0), 401(0 -> 1), 402(3 -> 4), 407(0 -> 1), 411(1 -> 0), 413(1 -> 0), 457(0 -> 1), 458(0 -> 1), 465(0 -> 1), 478(1 -> 0); DELTRAN: 38(0 -> 1), 203(1 -> 0); ACCTRAN.

Appendix 4 List of characters not included in present study.

1. Upper beak dorsoventrally very deep and mediolaterally compressed: no (0), yes (1).

Mayr & Kitchener (2022, ch. 11).

Mayr & Kitchener (2022) did not illustrate or describe how the measurements are taken and unfortunately the photographed specimens in the published material do not allow for mediolateral measurements of the beak. In this work they scored, *Danielsraptor phorusrhacoides*, *Masillaraptor parvunguis* and other extinct Eocene Cariamiformes as having this feature present. Suggesting that basal Falconiformes and Cariamiformes had similar narrow but deep beak shapes similar to what is seen in Cenozoic Terror birds. This would need to be tested with more measurements from extant Telluraves.

2. Lacrimal, os superciliary: absent (0); present (1).

Migotto (2013, ch. 8)

In some subgroups of Accipitridae, the supraorbital process has a small bone structure that articulates with the caudal end, called the superciliary bone (Cracraft 1968, Jollie 1977). In the current study it is present in *Buteo rufofuscus* and *Accipiter nisus.* This character could be included in future studies but is not relevant for the character study.

3. Lacrimal, posterior margin of head in dorsal view: straight (0); concave, with supraorbital process (1).

Clarke et al. (2009, ch. 13), Bourdon et al. (2016, ch. 11).

A feature that may only be present in some Coraciidae and Alcedinidae, none observed in this study.

4. Quadrate, condylus lateralis, size of arcus jugal facet: moderate, roughly half of lateral facies (0); large, over two thirds of lateral facies (1).

Mather *et al.* (2022, ch. 68).

Tip of condylus lateralis forms a dorsal lip, which reaches beyond the cotyla quadratojugalis. The variation of the size of jugal facet only applies to derived Accipitridae not observed in this study.

5. Quadrate, cotyla quadratojugalis: deeply concave (0); shallow (1).

Mayr (2022, ch. 9).

A feature observed only in *Merops*, *Pici* and *Trogon*. Should add to future studies though this feature is not clear in the birds of this study.

6. Mandible, greatly widening in caudal direction, resulting in a subtriangular outline: no (0), yes (1).

Mayr & Kitchener (2023d, ch. 3).

A subtriangular outlined mandible is observed only in Tyto. Not relevant for this study, also not observed in *Tyto alba*.

7. Mandible, rostral portion: straight or slightly down-curved (0); strongly down-turned, with distinct angle of deflection (1).

Ksepka et al. (2019, ch. 18).

The above refence only scored for the mousebird *Urocolius macrourus pulcher*. This feature is also seen in the passerines *Menura novaehollandiae* and *Passer domesticus* as well as the extinct taxon *Eofringillirostrum boudreauxi*.

8. Mandible, area of pars symphysialis with rectangular cross section: absent (0), present (1).

Mayr & Kitchener (2023a, ch. 8), Mayr & Kitchener (2023b, ch. 8), Mayr & Kitchener (2023c, ch. 8), Mayr & Kitchener (2023d, ch. 3).

In the above references Bucerotiformes are scored as present. This description is unclear and so have removed this character.

9. Humerus, fossa musculi brachiallis: non distinct (0); defined (1); deep and sharply delimited (2).

Modified from Mayr et al. (2003, ch. 37), Mayr & Clarke (2003, ch. 79), Mayr & Clarke (2003, ch. 80), Mayr (2005a, ch. 40), Mayr (2005b, ch. 55), Mayr (2005b, ch. 56), Mayr (2006, ch. 48), Mayr et al. (2010, ch. 40), Mayr (2011, ch. 41), Bourdon et al. (2016, ch. 68).

An exceptionally deep and sharply delimited musculi brachialis is observed in *Indicator,* this was considered an autopomorphy of this taxon by Mayr et al. (2003). This feature was also proposed as a synapomorphy of the taxon Trogonidae and Steatornithidae (oil birds) by Mayr et al. (2003). Coliiformes and some Passeriformes are also scored as (2) even though fossa does not make a full ovate impression due to the position being more lateral (see ch. 271). An additional state is added to account for the variation of the depth seen throughout Telluraves where in some birds like Psittaciformes is barley visible. However, this fossa can be extremely ambiguous and so not included in this anaylsis.

10. Humerus, distal end ventrally inflected with ventrally projecting processus flexorius: no (0), yes (1).

Mayr & Kitchener (2022a, ch. 20).

This character is not clear.

11. Ulna, cotyla dorsalis lateral margin hooked in lateral view: absent (0); present (1).

Ksepka et al. (2011, ch. 47), Ksepka & Clarke (2012, ch. 50).

In the above references the cotyla dorsalis was originally described as “hooked shape” for all Falconiformes, Psittaciformes and Gracula (Passeriformes). This hook shape scored in the above analysis is not evident in basal Falconiformes and Psittaciformes of this analyse. A more curved cotyla dorsalis is more evident in Passeriformes but is not accounted for in this study as it can be ambiguous.

12. Carpometacarpus, distinct, narrow fossa supra-trochlearis fossa supratrochlearis running across dorsal portion of trochlea carpalis: no (0); yes (1).

Mayr & Kitchener (2023a) ch.49, Mayr & Kitchener (2023b) ch.48, Mayr & Kitchener (2023c) ch.48.

This was character was unclear and so have removed from this analysis.

13. Pelvis mediolaterally strongly compressed: no (0), yes (1).

Mayr & Kitchener (2022a, ch. 28).

Synapomorphy uniting Phorusrhacidae, which is not included in the present study.

14. Tarsometatarsus, medial position of cotyla medialis forming a proximally projecting lip: no (0), yes (1).

Mayr & Kitchener (2023a, ch. 48).

This feature is observed in Anhimidae, Strigiformes, *Primozygodactylus* and *Pumiliornis* (Mayr & Kitchener 2023a). This feature is not clear and could not score it for other birds of this study.

15. Tarsometatarsus, trochlea metatarsi II mediolaterally wider than trochlea metatarsi III: no (0), yes (1).

Mayr & Kitchener (2023d, ch. 19).

This character was not included because it becomes difficult to measure how expanded the mt II is with a large projection. Also, no indication on how this was measured. This feature is used as a possibly affinity of *Ypresiglaux michaeldanielsi* to Strigiformes (Mayr & Kitchener 2023d).

16. Tarsometatarsus, trochlea metatarsi IV with a laterally slanted distal margin, which forms an angle of about 45° relative to the longitudinal axis of the tarsometatarsus: no (0), yes (1).

Mayr & Kitchener (2023a, ch. 43), Mayr & Kitchener (2023b, ch. 82).

Observed in Coliiformes and stem Coliiformes. Should possibly include in future studies.