# Mass estimation of extinct taxa and phylogenetic data both influence analyses of character evolution in a large clade of birds (Telluraves) (Supplementary Material, DOI:10.1098/rspb.2019.0049)

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## S1 Competitive release for Telluraves species following the K-Pg boundary

In the analyses of unmodified phylogenetic data and mass estimates derived from all available data we recovered support for a BM$_{shift}$ model where the rate of evolution ($\sigma^2$) increased from 0.003 to 0.027. This increase in rate is potentially suggestive of competitive release as differentiation in body size linked to differences in resource use (Lack, 1946; Ashmole, 1968; Schoener, 1974; Wilson, 1975; Santa Rosalia reconsidered: size ratios and competition, 1981; Werner and Gilliam, 1984; Martin, 1985). During the Cretaceous ornithurines (all modern birds and their nearest relatives) likely faced significant competitive pressure from the now extinct enantiornithines (Dyke and Nudds, 2008), and perhaps even pterosaurs (Butler et al., 2009; Benson et al., 2014). Competition was likely strongest with enantiornithines because their skeletal elements, especially the forelimbs, had similar proportions and thus likely served similar functions (Dyke and Nudds, 2008). Additionally, enantiornithines were a well-established, diverse group before ornithurines are hypothesized to have originated, so they might have suppressed early ornithurine diversity. Extinction of competing groups at the K-Pg extinction event likely created many ecological opportunities for neornithines (modern birds, in which Telluraves forms a monophyletic group) to radiate, as has been frequently suggested (Jarvis et al., 2014; Prum et al., 2015). Although this ecological opportunity would have been sudden, our results suggest only gradual increase in variation through the Cenozoic. No burst of size variation early in the clade's history may be due to differentiation with respect to morphological shape, rather than size. Alternatively, this result may be explained by ecological constraint. Extant members of Telluraves are principally arboreal foragers, so their need to maneuver and perch in close environments places additional restrictions on body size on top of the physiological constraints experienced by all species. Although some large species can forage in trees (for example, the Great hornbill (*Buceros bicornis*) can weigh up to 4kg; Dunning, 2007), they are uncommon. Only two extinct species fall outside of the range of the extant species included here (*Messelirrisor halcyrostris* and M. parvus, Mayr 1998ax), which may suggest that extinct species experienced similar constraints, but this hypothesis would benefit from further investigation.

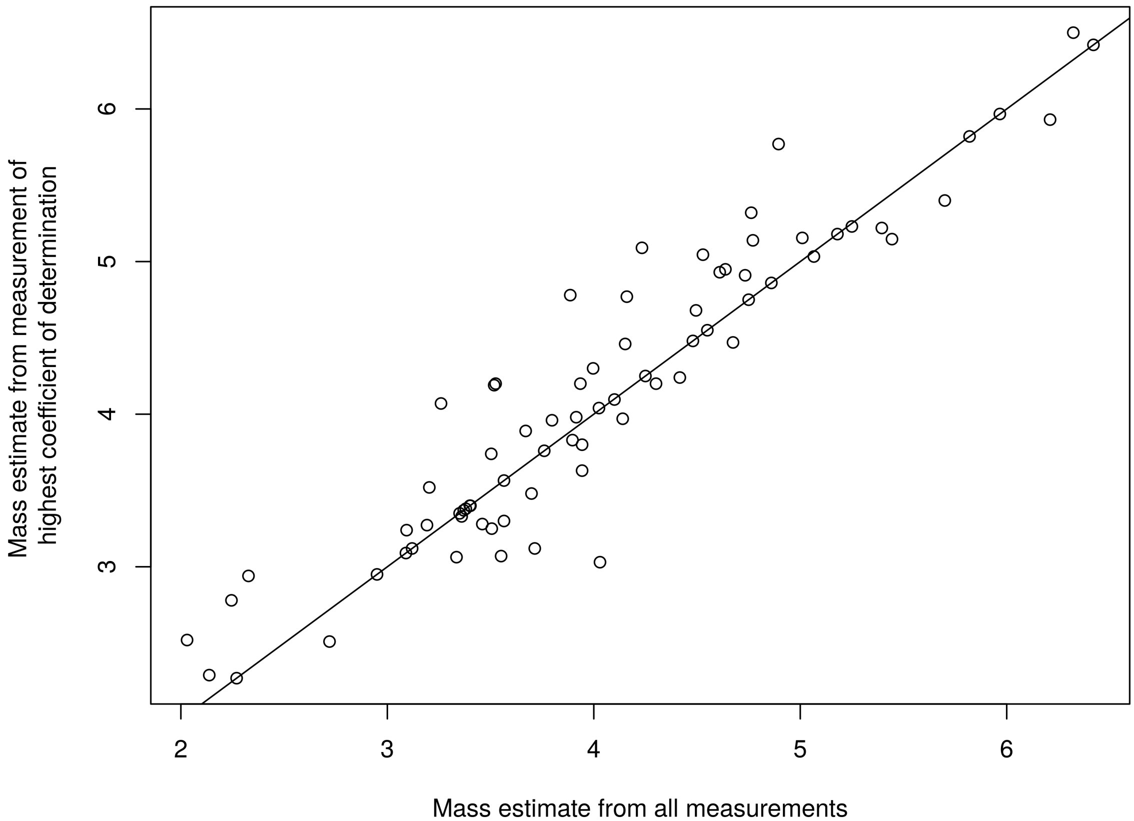


Figure S1: Comparison of mass estimates for 76 extinct species between using all available measurements and only using the measurement with the highest coefficient of determination. The solid lines denotes a 1 to 1 relationship.

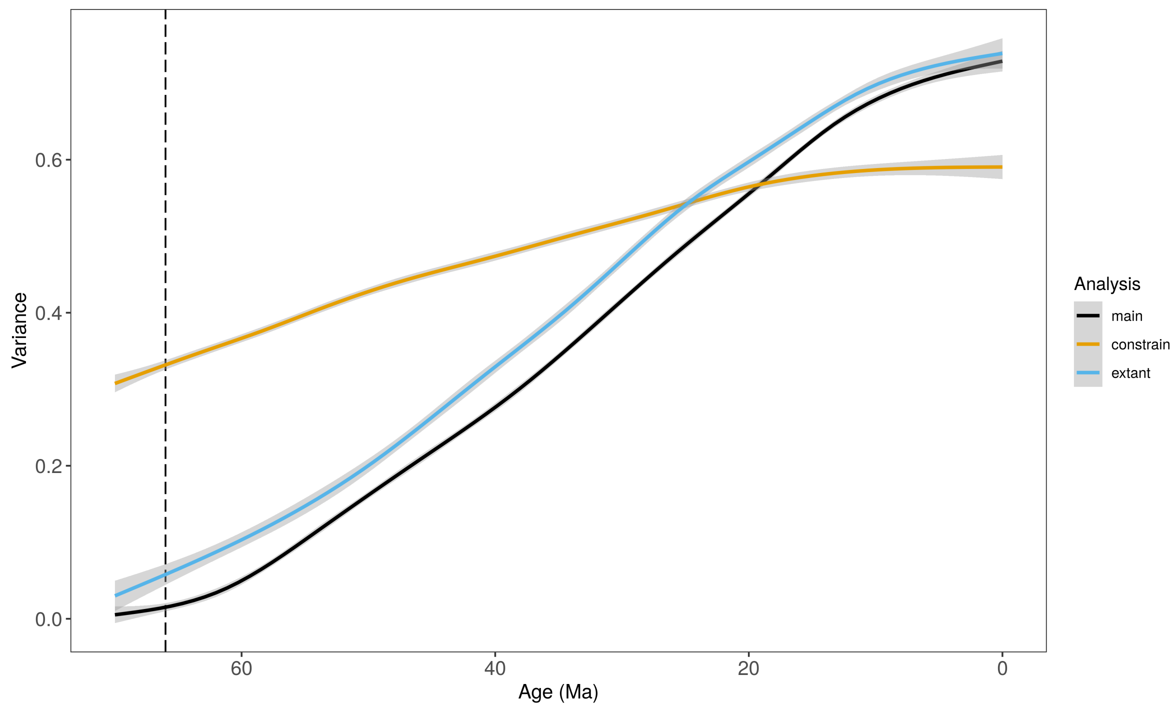


Figure S2: Maximum variance through time based on three models of evolution, when all available measurements were used to estimate the mass of extinct taxa. Main: the principal phylogenetic result from Crouch et al. (2019); constrain: phylogenetic trees with topological constraints to match current hypotheses regarding species relationships; and extant: analysis of only extant taxa. Prediction intervals in gray show variation in estimates due to topological variation in the sampled phylogenetic data.

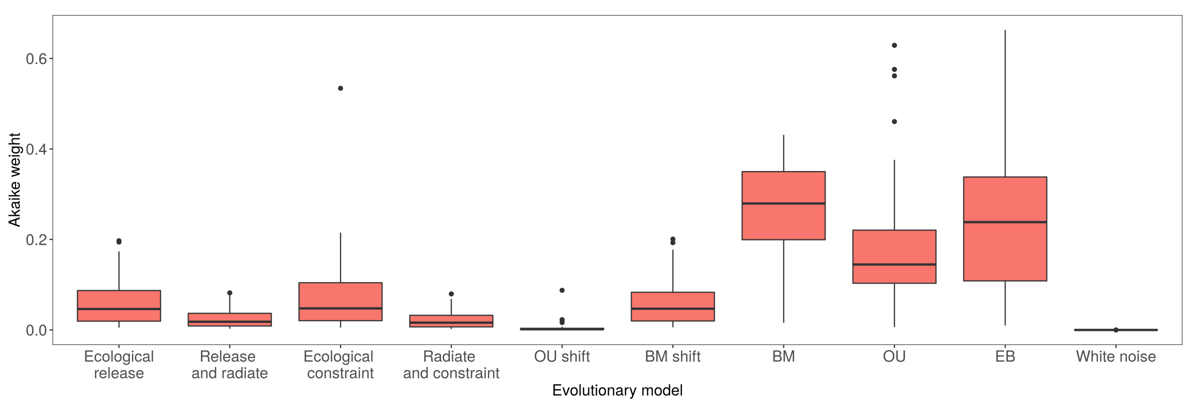


Figure S3: Distribution of Akaike weight scores for the ten models of evolution fit only to the analysis of extant taxa.

Table S1: Extinct taxa included in this study. References denoted by superscript numbers are provided in Table S2. The mean and standard errors for each species is provided in a separate .csv file.

| Species | Age (Ma) | Element | Measurement(mm) | ln(Estimated Body Size) |
|---|---|---|---|---|
| Nelepsittacus daphneleeae | 16 - 19 [1] | Tarsometatarsus Shaft Width [43] | 4.0 | 6.42 |
| Nelepsittacus donmertoni | 16 - 19 [1] | Humerus Shaft Width [43] | 3.3 | 4.96 |
| | | Humerus Shaft Width [43] | 3.3 | 4.96 |
| | | Humerus Shaft Width [43] | 3.6 | 5.18 |
| | | Humerus Shaft Width [43] | 3.4 | 5.03 |
| | | Tarsometatarsus Shaft Width [43] | 2.4 | 5.20 |
| Nelepsittacus minimus | 16 - 19 [1] | Tarsometatarsus Shaft Width [43] | 2.0 | 4.77 |
| | | Tarsometatarsus Length [43] | 17.8 | 3.55 |
| Australopicus nelsonmandelai | 3.6 - 5.3 [2] | Tarsometatarsus Shaft Width [2] | 2.2 | 5.00 |
| | | Tarsometatarsus Shaft Width [2] | 2.1 | 4.89 |
| | | Tarsometatarsus Shaft Width [2] | 2.1 | 4.89 |
| | | Tarsometatarsus Shaft Width [2] | 2.1 | 4.89 |
| | | Tarsometatarsus Shaft Width [2] | 2.0 | 4.77 |
| | | Tarsometatarsus Shaft Width [2] | 2.3 | 5.10 |
| | | Tarsometatarsus Shaft Width [2] | 2.3 | 5.10 |
| | | Tarsometatarsus Length [2] | 24.3 | 4.24 |
| | | Tarsometatarsus Length [2] | 24.1 | 4.23 |
| | | Tarsometatarsus Length [2] | 23.1 | 4.13 |
| | | Tarsometatarsus Length [2] | 22.8 | 4.10 |
| | | Tarsometatarsus Length [2] | 25.0 | 4.31 |
| Piculoides saulcetensis | 20.4 - 23 [4] | Tarsometatarsus Shaft Width [4] | 1.1 | 3.35 |
| Eocoracias brachyptera | 40.4 - 48.6[1] | Femur Length[31] | 32.1 | 5.04 |
| | | Tibiotarsus Length[31] | 41.3 | 4.26 |
| | | Tarsometatarsus Length[31] | 18.2 | 3.60 |
| | | Tarsometatarsus Length[31] | 18.2 | 3.60 |
| | | Tibiotarsus Length[31] | 36.4 | 3.92 |
| | | Tibiotarsus Length[31] | 36.2 | 3.91 |
| | | Tarsometatarsus Length[31] | 18.1 | 3.59 |
| | | Humerus Length[31] | 44.4 | 5.08 |
| | | Humerus Length[31] | 44.7 | 5.10 |
| Geranopterus alatus | 33.9 - 37.2 [1] | Humerus Length[31] | 47.7 | 5.23 |
| | | Coracoid Shaft Width[31] | 2.7 | 5.27 |
| Geranopterus milneedwardsi | 33.9 - 37.2 [1] | Humerus Width [31] | 3.6 | 5.18 |
| Pici indet | 23 - 28.4 [5] | Tarsometatarsus Shaft Width [5] | 1.0 | 3.12 |
| Primozygodactylus major | 40.4 - 48.6 [6] | Tarsometatarsus Length[6] | 28.0 | 4.56 |
| | | Tibiotarsus Length[6] | 39.0 | 4.11 |
| | | Tibiotarsus Length[6] | 39.8 | 4.16 |
| | | Tibiotarsus Length[6] | 42.8 | 4.36 |
| | | Tibiotarsus Length[6] | 44.0 | 4.43 |
| | | Femur Length[6] | 24.6 | 4.29 |
| | | Humerus Length[6] | 29.0 | 4.20 |
| Primozygodactylus eunjooae | 40.4 - 48.6 [6] | Femur Length[6] | 17.5 | 3.33 |
| | | Tibiotarsus Length[6] | 29.8 | 3.39 |
| Zygodactylus luberonensis | 28.4 - 33.9 [1] | Humerus Length [6] | 17.2 | 3.12 |
| | | Humerus Length [6] | 17.2 | 3.12 |
| | | Tibiotarsus Length [6] | 34.8 | 3.80 |
| | | Tibiotarsus Length [6] | 34.7 | 3.80 |
| | | Tarsometatarsus Length [6] | 24.6 | 4.27 |
| | | Tarsometatarsus Length [6] | 24.5 | 4.26 |
| Primozygodactylus danielsi | 48 - 51 [7] | Humerus Length[6] | 16.4 | 3.02 |
| | | Humerus Length[6] | 16.5 | 3.03 |
| | | Humerus Length[6] | 17.4 | 3.14 |
| | | Femur Length[6] | 16.5 | 3.17 |
| | | Femur Length[6] | 17.2 | 3.28 |
| | | Femur Length[6] | 16.0 | 3.08 |
| | | Tibiotarsus Length[6] | 27.4 | 3.16 |
| | | Tibiotarsus Length[6] | 27.3 | 3.15 |
| | | Tibiotarsus Length[6] | 29.4 | 3.35 |

| Species | Age (Ma) | Element | Measurement(mm) | ln(Estimated Body Size) |
|---|---|---|---|---|
| | | Tibiotarsus Length[6] | 27.5 | 3.17 |
| | | Tarsometatarsus Length[6] | 19.6 | 3.77 |
| | | Tarsometatarsus Length[6] | 19.7 | 3.78 |
| | | Tarsometatarsus Length[6] | 20.7 | 3.89 |
| | | Tarsometatarsus Length[6] | 19.0 | 3.70 |
| Primozygodactylus ballmanni | 48 - 51[7] | Humerus Length[6] | 21.0 | 3.53 |
| | | Humerus Length[6] | 20.5 | 3.48 |
| | | Humerus Length[6] | 20.0 | 3.43 |
| | | Femur Length[6] | 20.8 | 3.82 |
| | | Tibiotarsus Length[6] | 33.0 | 3.66 |
| | | Tarsometatarsus Length[6] | 24.6 | 4.27 |
| Eobucco brodkorbi | 39 - 50 [1] | Tarsometatarsus Length [29] | 26.95 | 4.48 |
| Neanis kistneri | 50.3 - 55.8 [29] | Humerus Shaft Width [29] | 1.8 | 3.4 |
| Eoglaucidium pallas | 48.5 - 55.8 [10] | Humerus Length [10] | 46.3 | 5.17 |
| | | Humerus Length [10] | 43.9 | 5.06 |
| | | Humerus Length [10] | 47.9 | 5.24 |
| | | Humerus Length [10] | 44.1 | 5.07 |
| | | Humerus Length [10] | 46.6 | 5.18 |
| | | Humerus Length [10] | 44.2 | 5.07 |
| | | Humerus Length [10] | 46.6 | 5.18 |
| | | Femur Length [10] | 35.9 | 5.36 |
| | | Femur Length [10] | 31.9 | 5.02 |
| | | Tibiotarsus Length [10] | 45.7 | 4.53 |
| | | Tibiotarsus Length [10] | 46.5 | 4.58 |
| | | Tibiotarsus Length [10] | 49.5 | 4.75 |
| | | Tibiotarsus Length [10] | 49.6 | 4.75 |
| | | Tarsometatarsus Length [10] | 22.2 | 4.04 |
| | | Tarsometatarsus Length [10] | 22.2 | 4.04 |
| | | Tarsometatarsus Length [10] | 22.3 | 4.05 |
| | | Tarsometatarsus Length [10] | 26.0 | 4.40 |
| | | Tarsometatarsus Length [10] | 25.8 | 4.38 |
| | | Tarsometatarsus Length [10] | 24.2 | 4.24 |
| Eoglaucidium spp | 48.5 - 55.8 [10] | Tibiotarsus Length[10] | 35.7 | 3.87 |
| | | Tarsometatarsus Length[10] | 22.2 | 4.04 |
| | | Tarsometatarsus Length[10] | 21.1 | 3.93 |
| | | Femur Length[10] | 25.0 | 4.34 |
| | | Femur Length[10] | 27.2 | 4.58 |
| Masillacolius brevidactylus | 46 - 52 [10] | Humerus Length [10] | 19.7 | 3.40 |
| | | Tibiotarsus Length [10] | 21.5 | 2.51 |
| | | Tarsometatarsus Length [10] | 20.4 | 3.85 |
| | | Tarsometatarsus Length [10] | 20.4 | 3.85 |
| Anneavis anneae | 50.3 - 55.4 [15] | Coracoid Length[15] | 23.2 | 4.51 |
| | | Coracoid Length[15] | 22.8 | 4.46 |
| | | Humerus Length[15] | 41.7 | 4.95 |
| | | Humerus Length[15] | 40.1 | 4.87 |
| | | Femur Length[15] | 27.7 | 4.63 |
| | | Femur Length[15] | 33.4 | 5.15 |
| | | Femur Diameter[15] | 2.8 | 5.20 |
| | | Femur Diameter[15] | 2.8 | 5.20 |
| | | Tarsometatarsus Length[15] | 23.7 | 4.19 |
| | | Tarsometatarsus Length[15] | 23.5 | 4.17 |
| Sandcoleus copiosus | 50.3 - 55.8 [15] | Coracoid Length [15] | 24.7 | 4.70 |
| | | Coracoid Length [15] | 24.4 | 4.67 |
| | | Humerus Length [15] | 46.3 | 5.17 |
| | | Humerus Length [15] | 45.6 | 5.14 |
| | | Femur Length [15] | 36.7 | 5.42 |
| | | Femur Length [15] | 36.5 | 5.40 |
| | | Tarsometatarsus Length[15] | 28.1 | 4.57 |
| Chascacocolius oscitans | 50 - 54 [15] | Humerus Length [15] | 26.5 | 4.01 |
| | | Coracoid Length [15] | 17.8 | 3.70 |
| | | Humerus Length [15] | 26.6 | 4.04 |
| | | Femur Length [15] | 25.1 | 4.35 |
| Rupelramphastoides knopfi | 28.4 - 33.9 [1] | Humerus Length [45] | 11.5 | 2.29 |
| | | Femur Length [45] | 10.8 | 1.97 |

| Species | Age (Ma) | Element | Measurement(mm) | ln(Estimated Body Size) |
|---|---|---|---|---|
| | | Tibiotarsus Length [45] | 19.0 | 2.18 |
| | | Tibiotarsus Length [45] | 18.5 | 2.11 |
| Serudaptus pohli | 40.4 - 48.6 [8] | Humerus Length [8] | 38.4 | 4.78 |
| | | Tibiotarsus Length [8] | 38.2 | 4.05 |
| | | Tibiotarsus Length [8] | 37.4 | 4.00 |
| | | Tarsometatarsus Length [8] | 15.7 | 3.27 |
| | | Tarsometatarsus Length [8] | 16.1 | 3.33 |
| Sandcoleidae indet | 45 - 52 [8] | Humerus Length [8] | 40.8 | 4.91 |
| | | Humerus Length [8] | 41.6 | 4.95 |
| | | Femur Length [8] | 32.6 | 5.09 |
| | | Tibiotarsus Length [8] | 42.4 | 4.33 |
| | | Tarsometatarsus Length [8] | 23.7 | 4.19 |
| | | Tarsometatarsus Length [8] | 23.7 | 4.19 |
| Avolatavis tenens | 51.57 - 51.75 [22] | Femur Length [22] | 24.7 | 4.30 |
| | | Tibiotarsus Length [22] | 40.8 | 4.23 |
| | | Tarsometatarsus Length [22] | 17.1 | 3.46 |
| Zygodactylidae UWGM21421 | 50.3 - 55.8 [16] | Tibiotarsus Length [16] | 21.5 | 2.51 |
| | | Tarsometatarsus Length [16] | 13.5 | 2.93 |
| Eozygodactylus americanus | 50.3 - 55.8 [17] | Coracoid Length [16] | 13.8 | 2.92 |
| | | Humerus Length [16] | 16.8 | 3.07 |
| | | Humerus Length [16] | 16.8 | 3.07 |
| | | Femur Length [16] | 19.7 | 3.67 |
| | | Tibiotarsus Length [16] | 30.6 | 3.46 |
| | | Tarsometatarsus Length [16] | 21.7 | 3.99 |
| | | Tarsometatarsus Length [16] | 21.8 | 4.00 |
| | | Tarsometatarsus Length [16] | 20.9 | 3.91 |
| | | Tarsometatarsus Length [16] | 20.5 | 3.87 |
| Zygodactylus grandis | 50.3 - 55.8[16] | Coracoid[16] | 13.7 | 2.90 |
| | | Humerus Length [16] | 18.3 | 3.25 |
| | | Femur Length [16] | 16.8 | 3.22 |
| | | Tibiotarsus Length [16] | 33.0 | 3.66 |
| | | Tibiotarsus Length [16] | 33.6 | 3.71 |
| | | Tarsometatarsus Length [16] | 21.4 | 3.95 |
| | | Tarsometatarsus Length [16] | 20.2 | 3.83 |
| Quercypsitta ivani | 33.9 - 37.2 [9] | Coracoid [9] | 19.8 | 4.03 |
| Quercypsitta sudrei | 33.9 - 37.2 [9] | Coracoid [9] | 21.6 | 4.29 |
| | | Tarsometatarsus Length [9] | 17.95 | 3.57 |
| | | Tarsometatarsus Diameter [9] | 1.35 | 3.83 |
| Messelirrisor parvus | 40.4 - 48.6 [1] | Coracoid [51] | 8.8 | 1.54 |
| | | Humerus Length [51] | 12.9 | 2.52 |
| Messelirrisor halcyrostris | 40.4 - 48.6 [1] | Coracoid [51] | 9.3 | 1.71 |
| | | Humerus Length [51] | 14.6 | 2.78 |
| Messelirrisor grandis | 40.4 - 48.6 [1] | Humerus Length [51] | 19.3 | 3.36 |
| | | Humerus Length [51] | 20.1 | 3.44 |
| Plesiocathartes kelleri | 51 - 54.5 [13] | Humerus Length [19] | 49.8 | 5.32 |
| | | Femur Length [19] | 29.0 | 4.76 |
| | | Tibiotarsus Length [19] | 46.2 | 4.56 |
| | | Tarsometatarsus Length [19] | 26.2 | 4.41 |
| Plesiocathartes europaeus | 33 - 45 [18] | Tarsometatarsus Length [19] | 30.0 | 4.71 |
| | | Tarsometatarsus Length [19] | 32.0 | 4.86 |
| | | Tarsometatarsus Length [19] | 34.2 | 5.01 |
| Plesiocathartes geiselensis | 33 - 45 [18] | Tibiotarsus Length [19] | 79.1 | 6.00 |
| | | Tarsometatarsus Length [19] | 40.8 | 5.40 |
| Plesiocathartes major | 33 - 45 [19] | Coracoid [19] | 33.7 | 5.65 |
| | | Coracoid [19] | 34.7 | 5.74 |
| | | Tibiotarsus Length[19] | 69.1 | 5.64 |
| | | Tibiotarsus Length[19] | 69.1 | 5.64 |
| | | Tarsometatarsus Length[19] | 36.4 | 5.15 |
| | | Tarsometatarsus Length[19] | 36.6 | 5.16 |
| | | Tarsometatarsus Length[19] | 36.2 | 5.13 |
| Plesiocathartes wyomingensis | 33 - 45 [19] | Humerus Length [19] | 62.0 | 5.77 |
| | | Tarsometatarsus Length[19] | 26.0 | 4.40 |
| | | Tarsometatarsus Length[19] | 27.0 | 4.48 |
| | | Tibiotarsus Length[19] | 53.0 | 4.93 |

| Species | Age (Ma) | Element | Measurement(mm) | ln(Estimated Body Size) |
|---|---|---|---|---|
| Oligocolius brevitarsus | 28.4 - 33.9 [1] | Femur Length [46] | 21.6 | 3.92 |
| | | Tibiotarsus Length [46] | 27.6 | 3.18 |
| | | Tarsometatarsus Length [46] | 15.8 | 3.28 |
| Vastanavis cambayensis | 48.6 - 55.8 [1] | Coracoid Width [49] | 3.3 | 5.73 |
| | | Coracoid Width [49] | 3.4 | 5.80 |
| | | Coracoid Width [49] | 3.6 | 5.93 |
| Vastanavis eocaena | 48.6 - 55.8 [1] | Coracoid Width [49] | 3.9 | 6.11 |
| | | Coracoid Width [49] | 3.6 | 5.93 |
| | | Coracoid Width [49] | 3.5 | 5.86 |
| Messelastur gratulator | 40.4 - 48.6 [1] | Humerus Length [47] | 36.6 | 4.68 |
| | | Tibiotarsus Length [47] | 42.0 | 4.31 |
| Psittacopes lepidus | 48 - 52 [11] | Humerus Length [11] | 18.3 | 3.25 |
| | | Humerus Length [11] | 18.2 | 3.24 |
| | | Humerus Length [11] | 18.8 | 3.30 |
| | | Humerus Length [11] | 18.8 | 3.30 |
| | | Tarsometatarsus Length [11] | 13.1 | 2.87 |
| Pulchrapollia gracilis | 48.6 - 55. 8 [12] | Femur Length [12] | 20.6 | 3.79 |
| | | Femur width [12] | 1.7 | 3.96 |
| | | Coracoid width [12] | 1.6 | 4.09 |
| | | Tarsometatarsus Length [12] | 16.3 | 3.35 |
| Eocolius walkeri | 54.4 - 56.4 [20] | Coracoid [20] | 18.4 | 3.80 |
| | | Humerus Length [20] | 22.0 | 3.63 |
| | | Tarsometatarsus Length [20] | 26.0 | 4.40 |
| Palaeospiza bella | 33.9 - 37.2 [1] | Humerus Length [48] | 23.2 | 3.74 |
| | | Tibiotarsus Length [48] | 28.1 | 3.23 |
| | | Tarsometatarsus Length [48] | 17.7 | 3.54 |
| Primocolius minor | 37.2 - 40.4 [1] | Tarsometatarsus Length [21] | 16.4 | 3.37 |
| Primocolius sigei | 37.2 - 40.4 [1] | Humerus Length [21] | 23.5 | 3.76 |
| Oligocolius psittacocephalon | 24.6 - 24.8 [21] | Humerus Length [21] | 25.0 | 3.89 |
| | | Tarsometatarsus Length [21] | 17.0 | 3.45 |
| Primotrogon wintersteini | 28.4 - 33.9 [1] | Tarsometatarsus Length [50] | 12.7 | 2.80 |
| | | Tibiotarsus Length [50] | 24.9 | 2.91 |
| | | Humerus Length [50] | 27.2 | 4.07 |
| Quasisyndactylus longibrachis | 45 - 55 [23] | Humerus Length [23] | 15.8 | 2.94 |
| | | Tibiotarsus Length [23] | 17.3 | 1.93 |
| | | Tarsometatarsus Length [23] | 9.8 | 2.22 |
| | | Tarsometatarsus Length [23] | 9.8 | 2.22 |
| Phirriculus pinicola | 17 - 22 [24] | Humerus Length [24] | 21.6 | 3.59 |
| | | Humerus Length [24] | 21.2 | 3.54 |
| Paleotodus itardiensis | 28.4 - 33.9 [27] | Femur Length [27] | 14.7 | 2.84 |
| | | Coracoid [27] | 15.1 | 3.20 |
| | | Humerus Length [27] | 18.2 | 3.24 |
| Paleotodus emryi | 33.3 - 33.9 [28] | Femur Length [28] | 16.6 | 3.18 |
| | | Humerus Length [28] | 20.9 | 3.52 |
| | | Tibiotarsus Length [28] | 24.9 | 2.91 |
| Selmes absurdipes | 42 - 48 [30] | Tarsometatarsus Length [30] | 20.2 | 3.83 |
| | | Tibiotarsus Length [30] | 28.8 | 3.30 |
| Species A | 35 - 50 [31] | Tarsometatarsus Length [31] | 30.5 | 4.75 |
| Upupa antaios | 0.0001 - 0.001 [33] | Humerus Length [33] | 33.1 | 4.47 |
| | | Humerus Width [33] | 3.1 | 4.80 |
| | | Humerus Width [33] | 3.1 | 4.80 |
| | | Humerus Width [33] | 3.2 | 4.88 |
| | | Femur Length [33] | 28.1 | 4.67 |
| | | Femur Width [33] | 2.5 | 4.92 |
| | | Tibiotarsus Length [33] | 40.1 | 4.18 |
| Paracoracias occidentalis | 45 - 55 [35] | Femur Length [35] | 29.3 | 4.78 |
| | | Femur Length [35] | 29.5 | 4.80 |
| | | Humerus Length [35] | 43.7 | 5.05 |
| | | Humerus Length [35] | 43.6 | 5.04 |
| | | Tibiotarsus Length [35] | 39.8 | 4.16 |
| | | Tibiotarsus Length [35] | 39.6 | 4.15 |
| | | Tarsometatarsus Length [35] | 19.2 | 3.72 |
| Mopsitta tanta | 48.6 - 55.8 [1] | Humerus Length [38] | 67.0 | 5.93 |
| | | Humerus Width [38] | 6.0 | 6.49 |

| Species | Age (Ma) | Element | Measurement(mm) | ln(Estimated Body Size) |
|---|---|---|---|---|
| Psuedasturidae indet | 48.6 - 55.8 [38] | Humerus Length [38] | 29 | 4.20 |
| | | Humerus Width [38] | 2.0 | 3.67 |
| Bavaripsitta ballmanni | 13.5 - 15 [39] | Tarsometatarsus Length [39] | 13.6 | 2.95 |
| Eclectus infectus | 0.01 - 1 [42] | Femur Length [42] | 51.3 | 6.36 |
| | | Femur Width [42] | 4.7 | 6.50 |
| | | Tarsometatarsus Width [42] | 3.9 | 6.36 |
| | | Humerus Width [42] | 5.1 | 6.07 |
| Primobucco perneri | 40.4 - 48.6 [1] | Humerus Length [52] | 28.6 | 4.17 |
| | | Humerus Length [52] | 28.9 | 4.19 |
| | | Humerus Length [52] | 25.2 | 3.91 |
| | | Humerus Length [52] | 26.5 | 4.01 |
| | | Humerus Length [52] | 25.8 | 3.96 |
| | | Humerus Length [52] | 29.3 | 4.22 |
| | | Humerus Length [52] | 29.3 | 4.21 |
| | | Tarsometatarsus Length [52] | 23.1 | 4.13 |
| Primobucco mcgrewi | 48.6 - 55.8 [1] | Tibiotarsus length [52] | 26.7 | 3.09 |
| Picavus litencicensis | 29.5 - 32[53] | Femur Length[53] | 12 | 2.27 |
| Pseudastur macrocephalus | 48 - 52[54] | Humerus Length [55] | 27.6 | 4.10 |
| | | Humerus Length [55] | 30.5 | 4.30 |
| | | Humerus Length [55] | 29.0 | 4.20 |
| | | Tibiotarsus Length [55] | 30.5 | 3.45 |
| | | Tibiotarsus Length [55] | 30.6 | 3.46 |
| | | Tibiotarsus Length [55] | 31.9 | 3.57 |
| | | Tibiotarsus Length [55] | 29.0 | 3.31 |
| | | Tarsometatarsus Length [55] | 15.5 | 3.24 |
| | | Tarsometatarsus Length [55] | 15.5 | 3.24 |
| | | Tarsometatarsus Length [55] | 14.2 | 3.05 |
| | | Tarsometatarsus Length [55] | 13.0 | 2.85 |
| Xenopsitta fejfari | 16 - 23[56] | Tarsometatarsus Length[56] | 16.5 | 3.38 |
| Capitonides protractus | 13.8 - 16 [41] | Humerus Length [41] | 26.0 | 3.97 |
| | | Tarsometatarsus Length [41] | 25.0 | 4.31 |
| Palaeopsittacus georgei | 48.6 - 55.8 [40] | Coracoid [40] | 23.5 | 4.55 |
| Brachypteracias langrandi | 0.001 - 0.002 [32] | Humerus Length [32] | 47.4 | 5.22 |
| | | Humerus Width [32] | 4.2 | 5.57 |
| Coliiformes indet | 45 - 52 [10] | Tarsometatarsus Length [10] | 20.4 | 3.85 |
| | | Humerus Length [10] | 25.8 | 3.98 |
| London Clay Species A | 48.6 - 55.8[11] | Coracoid[11] | 21.2 | 4.24 |
| | | Tibiotarsus Length [11] | 36 | 3.89 |
| | | Tarsometatarsus Length [11] | 19.1 | 5.12 |
| Clericolius acriala | 51.57 - 51.75 [21] | Tibiotarsus Length [21] | 34.8 | 3.80 |
| | | Tarsometatarsus Length [21] | 21.9 | 4.01 |
| | | Tarsometatarsus Length [21] | 22.0 | 4.02 |
| Motmot indet | 4.9 - 10.3 [26] | Humerus Shaft Width [26] | 2.5 | 4.25 |
| Cyrilavis olsoni | 48.6 - 55.8 [1] | Humerus Length [44] | 28.8 | 4.19 |
| | | Coracoid [44] | 16.0 | 3.37 |
| | | Tibiotarsus Length [44] | 28.5 | 3.27 |
| | | Tarsometatarsus Length [44] | 15.5 | 3.24 |

Table S2: Associated references for the data presented in Table S1

| Number | Reference |
|---|---|
| 1 | paleo-db.org |
| 2 | Manegold and Louchart (2012), horizon age checked on paleodb.org |
| 3 | Brodkorb (1970), horizon age checked on paleodb.org |
| 4 | De Pietri et al. (2011) |
| 5 | Mayr (2001b), horizon age checked on paleodb.org |
| 6 | Mayr and Zelenkov (2009), horizon age checked on paleodb.org |
| 7 | Mayr (1998c), horizon age checked on paleodb.org |
| 8 | Mayr (2000b), horizon age checked on paleodb.org |
| 9 | Mourer-Chauviré (1992), horizon age checked on paleodb.org |
| 10 | Mayr and Peters (1998), horizon age checked on paleodb.org |
| 11 | Mayr and Daniels (1998), horizon age checked on paleodb.org |
| 12 | Dyke and Cooper (2000), horizon age checked on paleodb.org |
| 13 | Mayr (2002), horizon age checked on paleodb.org |
| 14 | Boles (1997), horizon age checked on paleodb.org |
| 15 | Houde and Olson (1992), horizon age checked on paleodb.org |
| 16 | DeBee (2012), horizon age checked on paleodb.org |
| 17 | Weidig (2010), horizon age checked on paleodb.org |
| 18 | Weidig (2006), horizon age checked on paleodb.org |
| 19 | Weidig (2006) |
| 20 | Dyke and Waterhouse (2001) |
| 21 | Mayr (2013) |
| 22 | Ksepka and Clarke (2012) |
| 23 | Mayr (2004), horizon age checked on paleodb.org |
| 24 | Mlíkovský and Göhlich (2000), horizon age checked on paleodb.org |
| 25 | Mayr and Smith (2013) |
| 26 | Becker (1986), horizon age checked on paleodb.org |
| 27 | Mayr and Micklich (2010), horizon age checked on paleodb.org |
| 28 | Mayr and Knopf (2007) |
| 29 | Feduccia and Martin (1976), horizon age checked on paleodb.org |
| 30 | Mayr (2001a) |
| 31 | Mayr and Mourer-Chauviré (2000), horizon age checked on paleodb.org |
| 32 | Goodman (2010) |
| 33 | Olson (1975) |
| 34 | Mourer-Chauviré et al. (2013), horizon age checked on paleo-db |
| 35 | Clarke et al. (2009), horizon age checked on paleodb.org |
| 36 | Ksepka and Clarke (2010) |
| 37 | Mayr (2010), horizon age checked on paleodb.org |
| 38 | Waterhouse et al. (2008), same formation as *Mopsitta tanta* |
| 39 | Mayr and Göhlich (2004), horizon age checked on paleodb.org |
| 40 | Harrison (1982), horizon age checked on paleodb.org |
| 41 | Ballman (1983), horizon age checked on paleodb.org |
| 42 | Steadman (2006) |
| 43 | Worthy et al. (2011) |
| 44 | Ksepka et al. (2011) |
| 45 | Mayr (2005a) |
| 46 | Mayr (2000a) |
| 47 | Mayr (2005c) |
| 48 | Ksepka and Clarke (2009) |
| 49 | Mayr et al. (2010) |

| Number | Reference |
|---|---|
| 50 | Mayr (2005b) |
| 51 | Mayr (2000c) |
| 52 | Mayr et al. (2004) |
| 53 | Mayr and Gregorová (2012) |
| 54 | Morlo et al. (2004) |
| 55 | Mayr (1998b) |
| 56 | Mlíkovský (1998) |

Table S3: Extant species included in this study. *n* is the total number of taxa represented by the species in the phylogeny. Note that this is not necessarily the total number of described species, but the number for which body mass data were available.

| Order | Species in phylogeny | *n* | Additional taxa represented |
|---|---|---|---|
| Bucerotiformes | *Rhinopomastus cyanomelas* | 3 | Rhinopmastus |
| | *Upupa epops* | 2 | Upupa |
| | *Phoeniculus purpureus* | 5 | Phoeniculus |
| | *Tockus nasutus* | 14 | Tockus, Lophoceros |
| | *Rhyticeros undulatus* | 33 | Penelopides, Rhabdotorrhinus, Rhyticeros, Aceros, Antrhacoceros, Ocyeros, Annorhinus, Buceros, Rhinoplax, Bycanistes, Ceratogyma, Tropicranus, Horizocerus, Berenicornis |
| | *Bucorvus abyssinicus* | 2 | *Bucorvus leadbeateri* |
| Coliiformes | *Colius colius* | 2 | *Colius castanotus* |
| | *Colius leucocephalus* | 1 | – |
| | *Colius striatus* | 1 | – |
| | *Urocolius indicus* | 1 | – |
| | *Urocolius macrourus* | 1 | – |
| Trogoniformes | *Trogon melanurus* | 19 | Trogon, Priotelus |
| | *Pharomachrus antisianus* | 6 | Pharomachrus, Euptilotis |
| | *Harpactes ardens* | 11 | Harpactes, Apaloderma, Apalharpactes |
| Leptosomiformes | *Leptosomus discolor* | 1 | – |
| Coraciiformes | *Todus angustirostris* | 2 | *Todus multicolor* |
| | *Todus todus* | 2 | *Todus mexicanus* |
| | *Todus subulatus* | 1 | – |
| | *Coracias garrulus* | 8 | Coracias |
| | *Eurystomus orientalis* | 4 | Eurystomus |
| | *Atelornis corssleyi* | 1 | – |
| | *Atelornis pittoides* | 1 | – |
| | *Brachypteracias leptosomus* | 1 | – |
| | *Brachypteracias squamigera* | 1 | – |
| | *Alcedo atthis* | 2 | *Alcedo coerulescens* |
| | *Alcedo quadribrachys* | 2 | *Alcedo semitorquata* |
| | *Alcedo meninting* | 2 | *Alcedo hercules*, *Alcedo euryzona* |
| | *Alcedo leucogaster* | 6 | Corythornis, Ispidina |
| | *Ceyx pictus* | 6 | Ceyx |
| | *Megaceryle alcyon* | 4 | Megaceryle |
| | *Chloroceryle americana* | 5 | Chloroceryle, Ceryle |
| | *Todiramphus chloris* | 16 | Halcyoninae |
| | *Merops orientalis* | 25 | Meropidae |
| | *Hylomanes momotula* | 4 | Eumomota, Electron |
| | *Momotus mexicanus* | 6 | Momotus, Barypthengus, Aspatha |
| Piciformes | *Malacoptila semicincta* | 31 | Bucconidae |
| | *Galbula ruficauda* | 16 | Galbulidae |
| | *Indicator maculatus* | 17 | Indicatoridae |
| | *Lybius dubius* | 7 | Lybius |
| | *Pogoniulus bilineatus* | 9 | Pogoniulus |
| | *Trachyphonus darnaudii* | 13 | Trachyphonus, Cryptolybia, Buccanodon, Gymnobucco, Stactolaema |
| | *Megalaima virens* | 19 | Megalaimidae |

| Order | Species in phylogeny | *n* | Additional taxa represented |
|---|---|---|---|
| | *Picumnus cirratus* | 27 | Jynx, Sasia, Picumnus, Nesocites, Hemicircus |
| | *Blythipicus rubiginosus* | 2 | *Blythipicus pyrrhhotis* |
| | *Chrysocolaptes lucidus* | 3 | Reinwardtipicus, Chrysocolaptes |
| | *Campephilus haematogaster* | 7 | Campephilus |
| | *Campethera caroli* | 73 | Picini |
| | *Dendrocopos major* | 86 | Melanerpini |
| | *Ramphastos toco* | 7 | Ramphastos |
| | *Pteroglossus torquatus* | 13 | Pteroglossus |
| | *Andigena cucullata* | 5 | Andigena, *"Selenidera" spectabilis* |
| | *Selenidera maculirostris* | 5 | Selenidera |
| | *Aulacorhynchus derbianus* | 6 | Aulacorhynchus |
| | *Capito niger* | 13 | Capitonidae |
| | *Semnornis ramphastinus* | 2 | Semnornis |
| Psittaciformes | *Cacatua galerita* | 21 | Cacatuidae |
| | *Poicephalus gulielmi* | 8 | Poicephlus, Psittacus |
| | *Bolborhynchus lineola* | 10 | Amoropsittacini |
| | *Brotogeris chiriri* | 8 | Brotogeris |
| | *Triclaria malachitacea* | 10 | Pionopsitta, Triclaria, Hapalopsittaca, Pyrilia, Graydidascalus, Alipiopsitta |
| | *Pionus maximiliani* | 4 | Pionus |
| | *Barnardius zonarius* | 1 | – |
| | *Myiopsitta monachus* | 1 | – |
| | *Nestor notabilis* | 2 | Nestor |
| | *Strigops habroptilus* | 1 | – |
| | *Amazona amazonica* | 25 | Amazona |
| | *Phyrrhura picta* | 52 | Arini |
| | *Coracopsis vasa* | 4 | Psittrichasinae |
| | *Psittacula krameri* | 32 | Psittaculini |
| | *Psittacella brehmii* | 4 | Psittacella |
| | *Northiella haematogaster* | 1 | – |
| | *Pezoporus wallicus* | 1 | – |
| | *Psephotus haematonotus* | 1 | – |
| | *Neophema splendida* | 7 | Neopsephotus, Neophema |
| | *Purpureicephalus spurius* | 5 | Psephotellus |
| | *Platycercus eximius* | 6 | Platycercus |
| | *Lathamus discolor* | 2 | Pyrrhulopsis |
| | *Cyanoramphus novaezelandiae* | 5 | Eunymphicus, Cyanoramphus |
| | *Agapornis roseicollis* | 15 | Agapornthini |
| | *Trichoglossus haematodus* | 37 | Loriini |
| Passeriformes | *Ancanthisittca chloris* | 3 | Xenicus |
| | *Pitta versicolor* | 43 | Eurylaimides |
| | *Tyrannus tyrannus* | 288 | Tyrannidae |
| | *Thamnophilus ruficapillus* | 188 | Thamnophilidae |
| | *Conopophaga lineata* | 14 | Conopophagidae, Melanopareiidae |
| | *Grallaria ruficapillus* | 41 | Grallariidae |
| | *Formicarius colma* | 58 | Rhinocryptidae, Formicariidae |
| | *Sclerurus rufigularis* | 15 | Sclerurinae |
| | *Dendrocincla merula* | 15 | Glyphorynchus, Certhiasomus, Sittasomus, Deconychura, Dendrocincla |
| | *Xiphocolaptes major* | 18 | Nasica, Dendrexetastes, Dendrocolaptes, Hylexetastes, Xiphocolaptes |

| Order | Species in phylogeny | *n* | Additional taxa represented |
|---|---|---|---|
| | *Xiphorhynchus fuscus* | 24 | Xiphorhynchus, Dendroplex, Campylorhamphus |
| | *Lepidocolaptes angustirostris* | 9 | Lepidocolaptes, Drymornis, Drymotoxeres |
| | *Pygarrhichas albogularis* | 4 | Pygarrhichadini, Berlepschiini |
| | *Lochmias nematura* | 18 | Lochmias, Geocerthia, Upucerthia, Cinclodes, Phleocryptes, Limnornis |
| | *Furnarius rufus* | 6 | Furnarius |
| | *Pseudocolaptes boissonneautii* | 3 | Pseudocolaptes, Tarphonomus, Premnornis |
| | *Philydor pyrrhodes* | 20 | Anabazenops, Megaxenops, Cichlocolaptes, Heliobletus, Philydor, Anabacerthia, Syndactyla |
| | *Automolus infuscatus* | 16 | Ancistrops, Clibanornis, Thripadectes, Automolus |
| | *Margarornis rubiginosus* | 4 | Margarornini |
| | *Asthenes baeri* | 38 | Aphrastura, Leptasthenura, Phacellodomus, Hellmayrea, Coryphistera, Anumbius, Asthenes |
| | *Synallaxis frontalis* | 27 | Mazaria, Schoeniophylax, Certhiaxis, Synallaxis |
| | *Atrichornis clamosus* | 2 | *Atrichornis rufescens* |
| | *Menura novaehollandiae* | 2 | *Menura alberti* |
| | *Climacteris picumnus* | 6 | Climacteris |
| | *Cormobates leucophaeus* | 2 | *Cormobates placens* |
| | *Ailuroedus crassirostris* | 3 | Ailuroedus |
| | *Ptilonorhynchus violaceus* | 6 | Ptilonorhynchus, Chlamydera |
| | *Sericulus chrysocephalus* | 4 | Sericulus, Scenopoeetes, Amblyornis |
| | *Amytornis goyderi* | 10 | Amytornis |
| | *Malurus cyaneus* | 23 | Malurus, Chenorhamphus, Clytomyias, Sipodotus, Stipiturus |
| | *Dasyornis broadbenti* | 3 | Dasyornis |
| | *Pardalotus striatus* | 7 | Pardalotus |
| | *Sericornis frontalis* | 77 | Pachycare, Oreoscopus, Gerygone, Acanthornis, Aphelocephala, Acanthiza, Smicrornis, Pycnoptilus, Pyrrholaemus, Chthonicola, Hylacola, Calamanthus, Origma, Crateroscelis, Sericornis |
| | *Philemon citreogularis* | 62 | Phlidonyrini, Melithreptini, Philemonini, Myzomelini |
| | *Acanthorhynchus tenuirostris* | 2 | Acanthorhynchus |
| | *Certhionyx variegatus* | 27 | Prosthemaderini, Gliciphilini, Epthianurini |
| | *Anthocaera carunculata* | 53 | Meliphaginae |
| | *Orthonyx temminckii* | 3 | Orthonyx |
| | *Cracticus torquatus* | 6 | Cracticus |
| | *Peltops montanus* | 2 | Peltops |
| | *Strepera graculina* | 3 | Strepera |
| | *Artamus cinereus* | 11 | Artamus |
| | *Pyrrhocorax pyrrhocorax* | 49 | Pyrrhocoracinae, Cissinae, Perisoreinae, Cyanocoracinae |
| | *Garrulus glandarius* | 3 | Garrulus |
| | *Pica pica* | 9 | Pica, Zavattariornis, Ptilostomus, Podoces |
| | *Nucifraga caryocatactes* | 3 | Nucifraga |
| | *Corvus corax* | 38 | Corvus, Coloeus |
| | *Parus major* | 52 | Paridae |
| | *Sitta frontalis* | 19 | Sittidae |
| | *Certhia familiaris* | 7 | Certhiidae |
| | *Thryothorus ludovicianus* | 56 | Thryothorinae |

| Order | Species in phylogeny | *n* | Additional taxa represented |
|---|---|---|---|
| | *Troglodytes troglodytes* | 34 | Odontorchilus, Catherpes, Hylorchilus, Salpinectes, Microcerculus, Nannus, Ferminia, Cistothorus, Thryorchilus, Troglodytes |
| | *Sturnella neglecta* | 10 | Sturnella, Dolichonyx |
| | *Caicus melanicterus* | 16 | Cacicinae |
| | *Icterus spurius* | 33 | Icterus |
| | *Agelaius phoeniceus* | 11 | Agelaius, Nesopsar |
| | *Molothrus ater* | 49 | Agelaiinae |
| | *Rhodospiza obsoleta* | 178 | Fringillidae |
| | *Passer domesticus* | 54 | Passeridae |
| | *Mniotilta varia* | 110 | Parulidae |
| | *Calcarius lapponicus* | 1 | – |
| | *Calcarius pictus* | 1 | – |
| | *Plectrophenax hyperboreus* | 1 | – |
| | *Plectrophenax nivalis* | 1 | – |
| | *Xanthocephalus xanthocephalus* | 1 | – |
| | *Trichodroma muraria* | 1 | – |

Table S4: AIC and $AIC_w$ scores for model fitting analyses that include extinct taxa. Mean values are reported, with standard deviations in parentheses. 'Main' is where untransformed phylogenetic data were used in the analysis, 'constrain' is where phylogenetic data that had been reconstructed with topological constraints was used, and 'scale' is where phylogenetic data that had been scaled to have entirely Cenozoic divergence dates was used. For the scale analysis, only models describing a single mode of evolution were fit to the data. Dashes indicate where the fit of models was not estimated.

| | | Main analysis | | Constrain | | Scale | |
|---|---|---|---|---|---|---|---|
| **Morphological data** | **Model** | **$\Delta$AIC** | **$AIC_w$** | **$\Delta$AIC** | **$AIC_w$** | **$\Delta$AIC** | **$AIC_w$** |
| *All available* | Post-K-Pg release | 4.16 (4.61) | 0.13 (0.10) | 3.04 (3.09) | 0.13 (0.10) | – | – |
| | Post-K-Pg release and radiate | 6.07 (4.73) | 0.05 (0.05) | 3.83 (2.86) | 0.09 (0.09) | – | – |
| | Post-K-Pg constraint | 5.09 (4.69) | 0.10 (0.11) | 4.30 (2.92) | 0.08 (0.07) | – | – |
| | Radiate, post-K-Pg constraint | 3.21 (3.85) | 0.18 (0.17) | 5.25 (3.23) | 0.07 (0.15) | – | – |
| | $OU_{shift}$ | 7.89 (4.60) | 0.03 (0.05) | 5.44 (4.04) | 0.08 (0.12) | – | – |
| | $BM_{shift}$ | 3.84 (6.69) | 0.33 (0.35) | 2.38 (2.90) | 0.23 (0.25) | – | – |
| | BM | 28.46 (40.70) | 0.00 (0.00) | 8.61 (8.79) | 0.08 (0.14) | 52.41 (29.50) | 0.00 (0.00) |
| | OU | 10.61 (6.08) | 0.02 (0.05) | 6.86 (5.87) | 0.06 (0.07) | 12.54 (12.35) | 0.23 (0.37) |
| | Early burst | 26.42 (41.75) | 0.01 (0.02) | 10.66 (8.79) | 0.03 (0.05) | 5.24 (12.16) | 0.55 (0.39) |
| | BM with trend | 24.34 (33.6) | 0.02 (0.08) | 7.75 (7.28) | 0.06 (0.08) | 10.13 (14.00) | 0.15 (0.20) |
| | White noise | 62.21 (18.44) | 0.02 (0.12) | 101.59 (14.25) | 0.00 (0.00) | 34.04 (17.66) | 0.06 (0.21) |
| *No intraspecific error* | Post-K-Pg release | 28.70 (24.69) | 0.00 (0.01) | 13.73 (14.20) | 0.02 (0.03) | – | – |
| | Post-K-Pg release and radiate | 30.72 (24.70) | 0.00 (0.00) | 14.47 (13.45) | 0.01 (0.01) | – | – |
| | Post-K-Pg constraint | 9.49 (11.99) | 0.06 (0.11) | 15.22 (9.99) | 0.01 (0.01) | – | – |
| | Radiate, post-K-Pg constraint | 3.18 (3.60) | 0.30 (0.28) | 2.57 (2.70) | 0.40 (0.40) | – | – |
| | $OU_{shift}$ | 9.32 (3.58) | 0.01 (0.01) | 9.50 (8.39) | 0.04 (0.08) | – | – |
| | $BM_{shift}$ | 28.78 (24.64) | 0.00 (0.01) | 13.10 (13.06) | 0.02 (0.02) | – | – |
| | BM | 30.94 (45.78) | 0.00 (0.01) | 15.64 (18.18) | 0.08 (0.13) | 84.88 (49.60) | 0.00 (0.00) |
| | OU | 2.22 (4.22) | 0.45 (0.31) | 4.51 (8.40) | 0.32 (0.25) | 10.74 (13.18) | 0.32 (0.40) |
| | Early burst | 24.78 (47.30) | 0.06 (0.14) | 17.69 (18.19) | 0.03 (0.05) | 11.13 (22.50) | 0.53 (0.45) |
| | BM with trend | 22.59 (38.93) | 0.11 (0.23) | 12.63 (14.65) | 0.06 (0.07) | 22.75 (27.12) | 0.04 (0.10) |
| | White noise | 45.74 (17.75) | 0.00 (0.00) | 85.07 (16.03) | 0.00 (0.00) | 22.36 (16.84) | 0.12 (0.26) |
| *Measurement with greatest predictive power* | Post-K-Pg release | 16.49 (17.54) | 0.01 (0.03) | 2.64 (4.11) | 0.16 (0.10) | – | – |
| | Post-K-Pg release and radiate | 18.40 (17.63) | 0.01 (0.03) | 3.78 (4.02) | 0.10 (0.10) | – | – |
| | Post-K-Pg constraint | 7.07 (11.65) | 0.12 (0.15) | 5.25 (4.12) | 0.06 (0.12) | – | – |
| | Radiate, post-K-Pg constraint | 1.92 (3.10) | 0.41 (0.29) | 3.09 (2.35) | 0.17 (0.26) | – | – |
| | $OU_{shift}$ | 7.07 (3.93) | 0.04 (0.03) | 4.06 (3.52) | 0.12 (0.17) | – | – |
| | $BM_{shift}$ | 15.91 (17.78) | 0.02 (0.05) | 2.64 (3.95) | 0.16 (0.11) | – | – |
| | BM | 31.99 (45.42) | 0.00 (0.00) | 17.61 (16.02) | 0.03 (0.07) | 83.86 (48.01) | 0.00 (0.00) |
| | OU | 4.28 (4.75) | 0.23 (0.25) | 8.99 (8.13) | 0.05 (0.07) | 12.06 (13.34) | 0.26 (0.37) |
| | Early burst | 25.33 (47.04) | 0.05 (0.12) | 19.66 (16.02) | 0.01 (0.03) | 9.60 (20.64) | 0.55 (0.43) |
| | BM with trend | 22.81 (38.92) | 0.11 (0.23) | 15.67 (12.88) | 0.02 (0.03) | 19.71 (25.95) | 0.08 (0.17) |
| | White noise | 48.30 (17.43) | 0.00 (0.00) | 91.68 (16.00) | 0.00 (0.00) | 23.98 (17.01) | 0.12 (0.26) |

Table S5: AIC and $AIC_w$ scores for model fitting analyses of only extant taxa. Mean values are reported, with standard deviations in parentheses.

| **Model** | **$\Delta$AIC** | **$AIC_w$** |
|---|---|---|
| Post-K-Pg release and radiate | 4.27 (2.39) | 0.06 (0.05) |
| Post-K-Pg constraint | 5.98 (2.40) | 0.03 (0.02) |
| Radiate, post-K-Pg constraint | 4.06 (2.49) | 0.07 (0.08) |
| Radiate.constrained | 6.26 (2.43) | 0.02 (0.02) |
| $OU_{shift}$ | 10.51 (2.95) | 0.01 (0.01) |
| $BM_{shift}$ | 4.19 (2.39) | 0.06 (0.05) |
| BM | 1.03 (1.62) | 0.26 (0.12) |
| OU | 1.73 (1.39) | 0.19 (0.14) |
| Early burst | 1.40 (1.91) | 0.24 (0.16) |
| White noise | 93.49 (3.81) | 0.00 (0.00) |

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