

Supplementary Materials Table of Contents

A. Supplementary Figures

- Figure S1. Comparison of *Anatalavis rex* and *Nettapterornis oxfordi*.
Figure S2. Details of the laterosphenoid and squamosal, postorbital and zygomatic processes.
Figure S3. Skulls of *Anhima cornuta*.
Figure S4. Quadrates of *Danielsavis nazensis* nov. gen. and other London Clay specimens.
Figure S5. Comparison of skulls, mandibles, sterna, furculae, and pelves of select Anseriformes and outgroups.
Figure S6. Comparison of pectoral elements of select Anseriformes and outgroups.
Figure S7. Comparison of pelvic elements of select Anseriformes and outgroups.
Figure S8. Phylogenetic trees of dataset 1.
Figure S9. Phylogenetic trees of datasets 2 and 3.
Figure S10. Phylogenetic trees of datasets 4 and 5.
Figure S11. Phylogenetic trees of dataset 6.
Figure S12. Fully-unconstrained and phylogenetically-unconstrained total-evidence (tip-dated) Bayesian phylogenies of dataset 7.

B. Supplemental Tables

- Table S1. Measurements of vertebrae and pedal phalanges of *Anachronornis anhimops* nov. gen. et sp.
Table S2. Relative lengths of select bones among taxa.
Table S3. Measurements of vertebrae and pedal phalanges of *Danielsavis nazensis* nov. gen et sp.
Table S4. Measurements of vertebrae and phalanges of NMS.Z.2021.40.2.
Table S5. Measurements of vertebrae and phalanges of NMS.Z.2021.40.3.
Table S6. Kishino Hasegawa test scores, Dataset 7, to accompany Figure 9A.
Table S7. Kishino Hasegawa test scores, Dataset 7, to accompany Figure 9B.

C. Characters and Scores of Dataset 1

D. Apomorphies Summarized by Dataset

A. Supplementary Figures

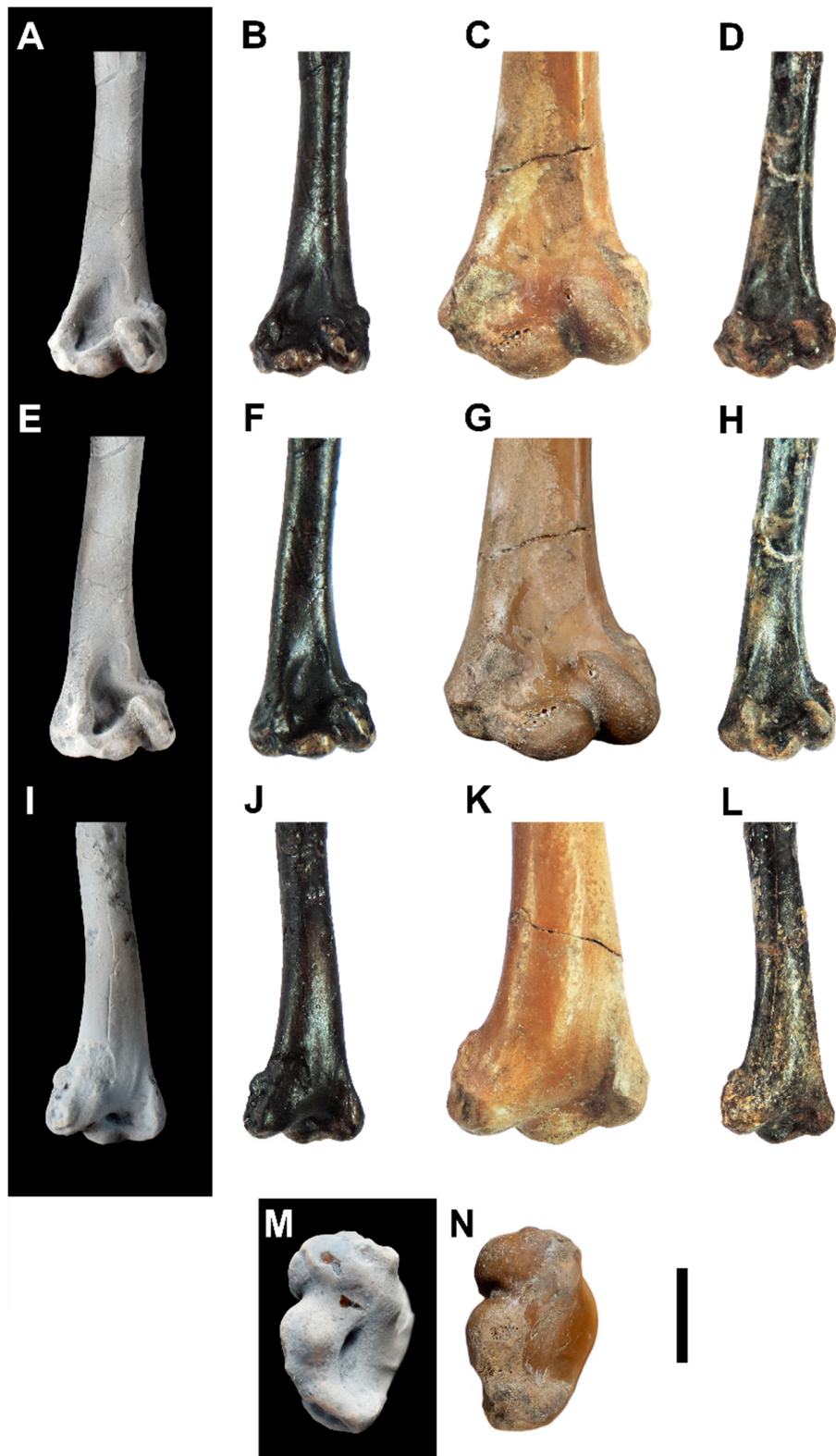
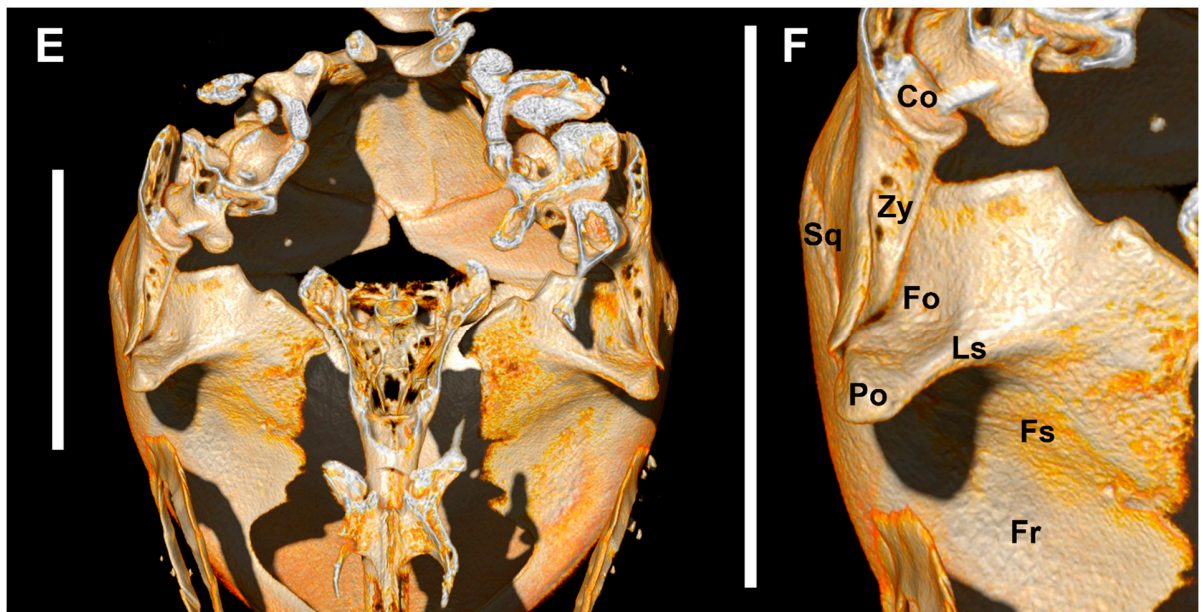
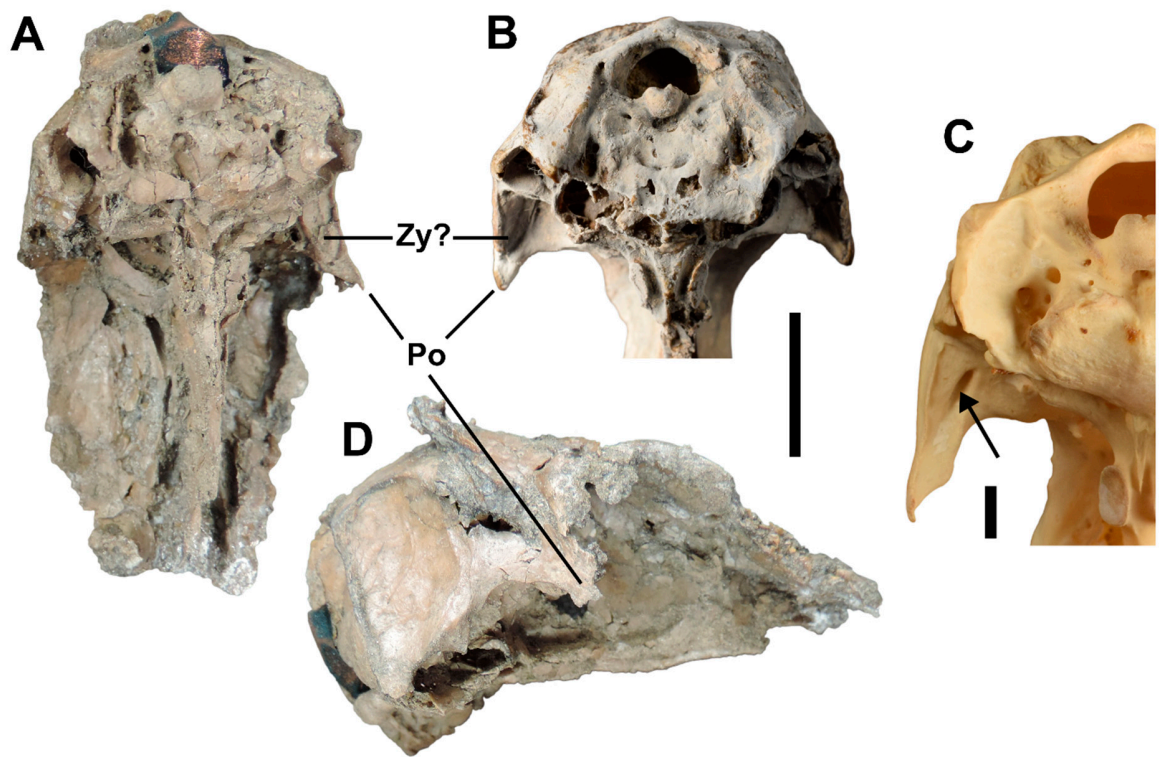


Figure S1. Distal left humeri of *Anatalavis rex* (cast of paratype YPM 948; **A,B,E,F,I,J,M**), *Nettapterornis oxfordi* (holotype BMNH A5922; **C,G,K,N**), and *Anachronornis anhimops* nov. gen. et sp. (holotype USNM 496700; **D,H,L**). Cranial view (**A-D**), rotated slightly cranioventrally (**E-H**), caudal view (**I-L**), and distal view (**M,N**). **B-D**, **F-H**, and **J-L** photographed side by side with care taken to ensure each was rotated to match the others as closely as possible. **A**, **E**, **I**, and **M** coated with ammonium chloride and photographed separately. **M** is enlarged to match **N** to facilitate comparison. The ventral condyle is larger and longer distally in *Nettapterornis* than in *Anatalavis*. Unlike *Nettapterornis*, the ventral epicondyle of *Anatalavis* is longer distally, weak cranially, and more pronounced caudally (flexor process). Its olecranon fossa is deeper, as is the scapulotricipital sulcus. Scale bar 1 cm. Image G courtesy of Susannah Maidment.

Figure S2 (below). Crania of *Nettapterornis oxfordi* (holotype BMNH A5922) in ventral (**A**) and right lateral (**D**) views, ventral view of *Anachronornis anhimops* nov. gen. et sp. (holotype USNM 496700; **B**), ventral view of young *Cygnus olor* (NMSU, uncatalogued; **C**), ventral view of μ CT image of immature *Anas platyrhynchos* (OUVC 10613; **E**) and enlarged inset (**F**). In each, the presumptive zygomatic process of the squamosal bone appears to be applied to the ventral surface of the temporal fossa nearly to the postorbital process. This feature appears to be distinct from the ossified aponeurosis of the AME externus muscle that forms the lateral margin of the postorbital process as seen in **D**. Abbreviations: squamosal cotyle for the quadrate (**Co**), fossa of ophthalmic rete (**Fo**), frontal (**Fr**), suture of frontal-laterosphenoid (**Fs**), crest of laterosphenoid (**Ls**), postorbital process (**Po**), squamosal (**Sq**), and zygomatic process (**Zy**). Arrow, presumptive suture of zygomatic process and laterosphenoid and an associated longitudinal fissure and series of foramina in *Cygnus*, not visible in the image. All scales = 1 cm. μ CT image courtesy of Lawrence D. Witmer.



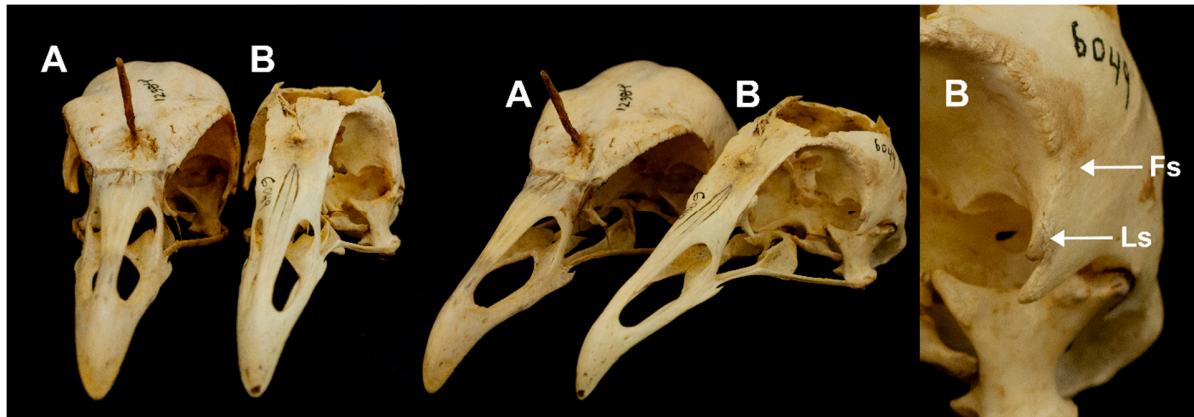


Figure S3. Skulls of *Anhima cornuta*, YPM ORN 109922 (A) and YPM ORN 103843 (B), illustrating ostensibly ontogenetic variation in supraorbital width and development of the postorbital process and associated features. Abbreviations as in Figure S2. Images courtesy of Juri A. Miyamae and Kristof Zyskowski.

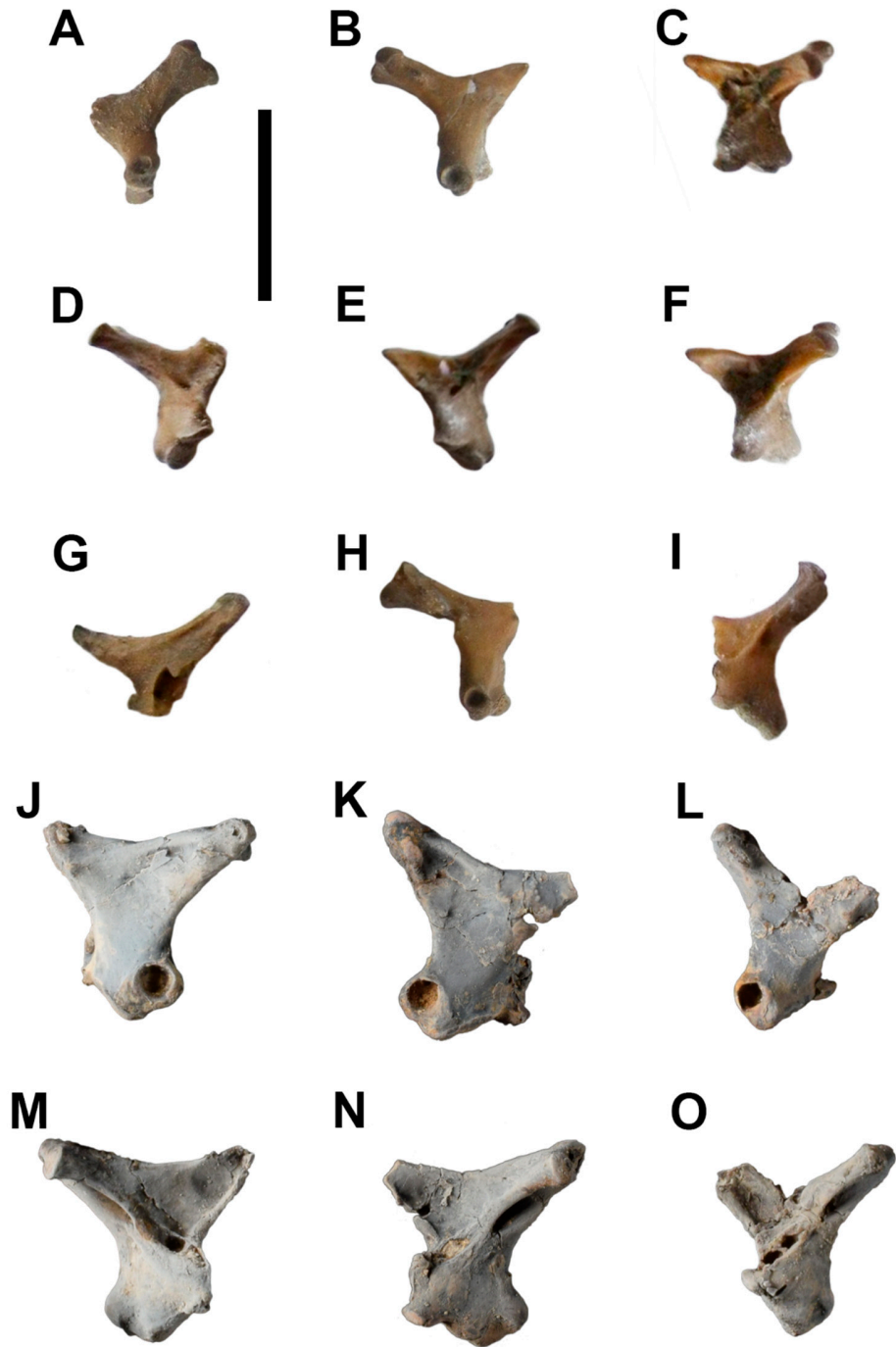


Figure S4. Quadrates of the holotype of *Danielsavis nazensis* nov. gen. et sp. (NMS.Z.2021.40.1) (A-F), screamer-like anseriform NMS.Z.2021.40.2 (G-I), the holotype of *Anachronornis anhimops* nov. gen et sp. (USNM 496701; J, K, M, N), and screamer-like anseriform USNM 496701 (L, O). Left lateral view (A, G, J), right lateral (B, H, K, L), left medial (D, M), and right medial (C, E, F, I, N, O). J-O coated with ammonium chloride. Scale bar 1 cm.

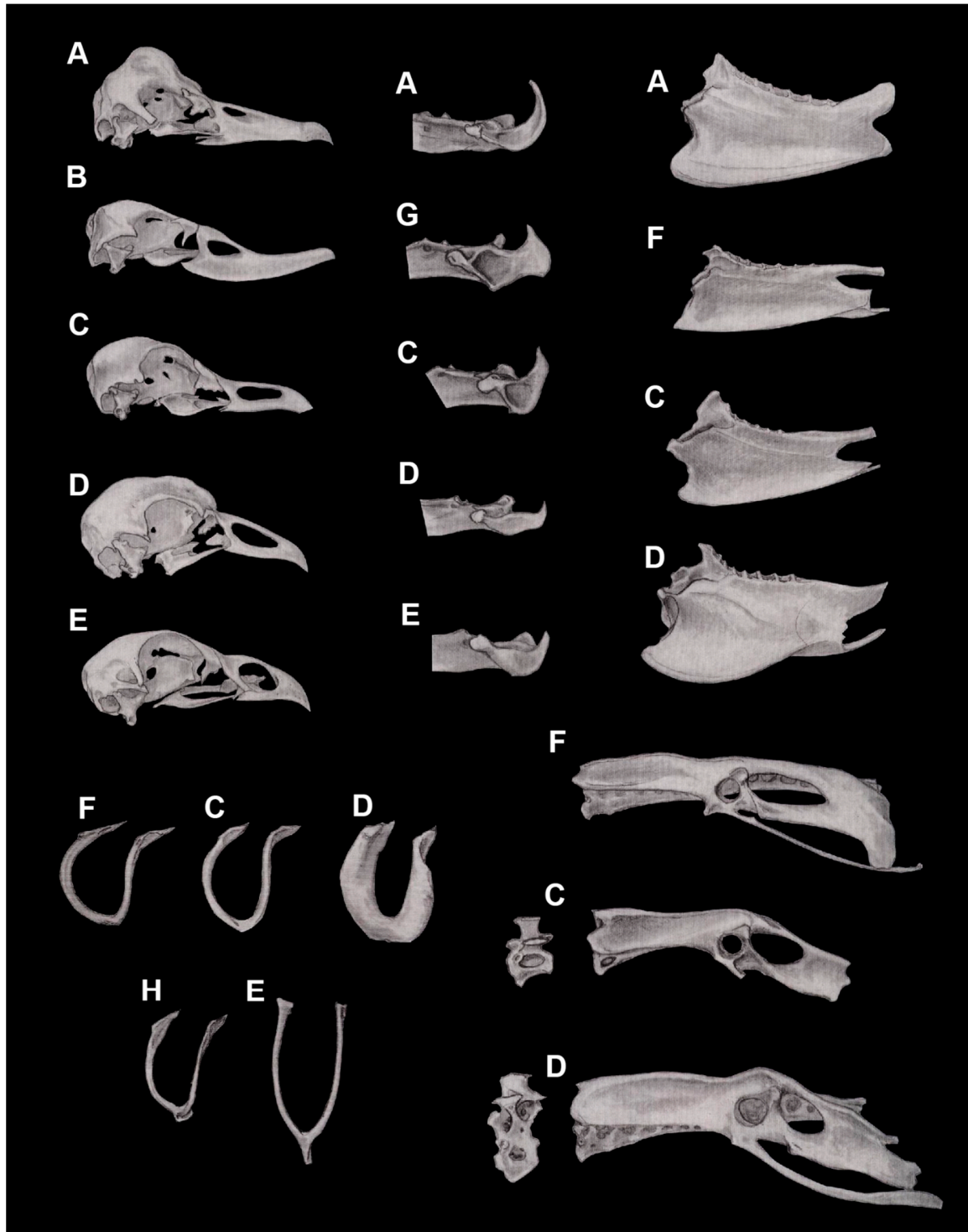


Figure S5. Comparison of *Anseranas* (A), *Presbyornis* (B), *Anachronornis* nov. gen. (C), *Chauna* (D), *Crax* (E), *Dendrocygna* (F), *Bucephala* (G), and *Burhinus* (H); right lateral aspect of skulls (**upper left column**), right medial aspect of mandibles (**upper middle column**), left ventrolateral aspect of sterna (**upper right column**), craniolateral aspect of furculae (**lower left rows**), and left lateral aspect of pelves and thoracic vertebrae (**lower right column**). Drawings not to scale.

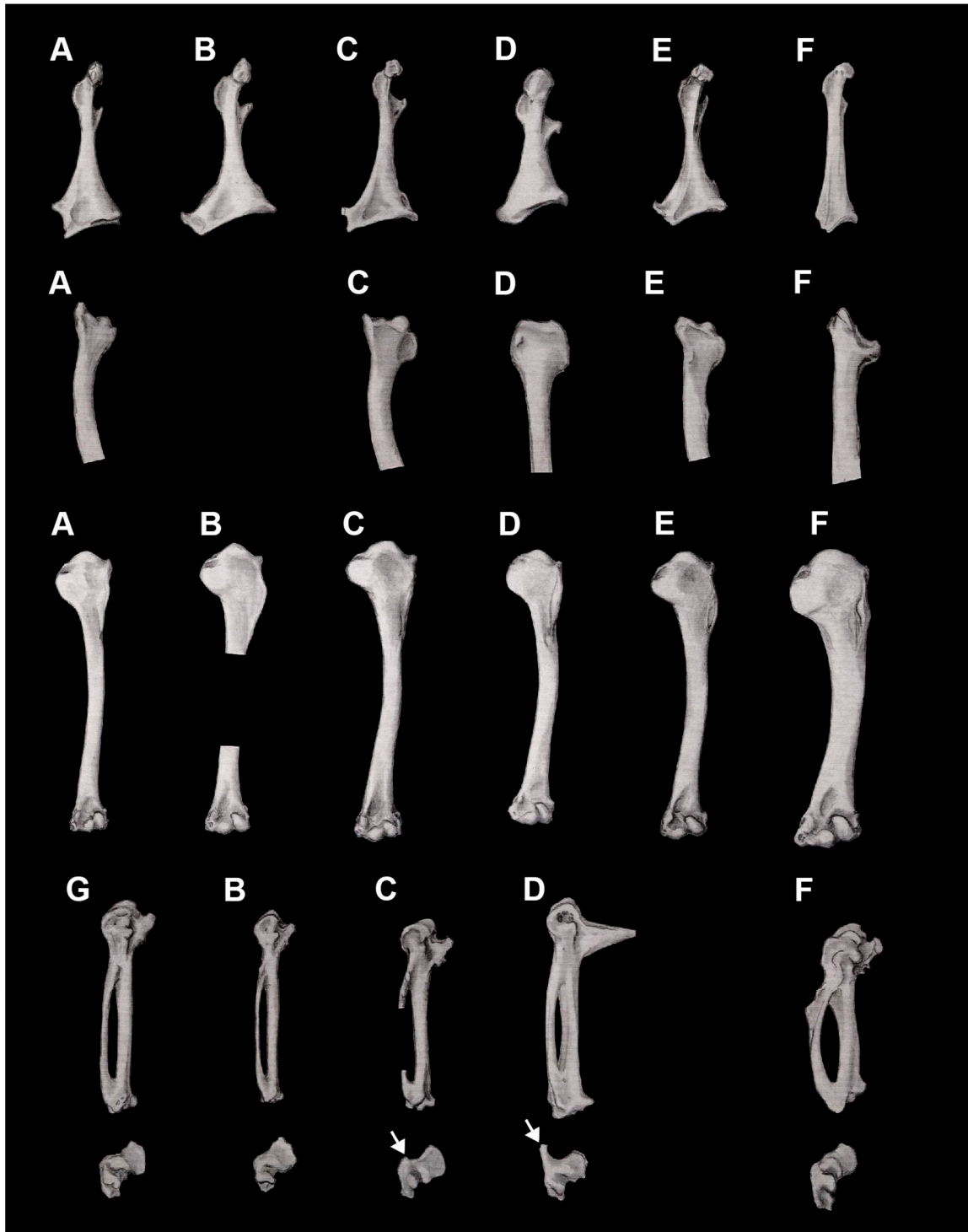


Figure S6. Comparison of pectoral elements of *Dendrocygna* (A), *Presbyornis* (B), *Anachronornis* nov. gen. (C), *Chauna* (D), *Burhinus* (E), *Crax* (F), and *Anseranas* (G); ventral aspect of right coracoids (**top row**); medial aspect of cranial extremity of left scapulae (**second row**), cranial aspect of left humeri (**third row**), medial and distal aspects of left carpometacarpi (**upper and lower bottom rows, resp.**). Arrows: cranioventral tuberosity, possibly exaggerated in *Anachronornis* nov. gen. due to crushing of major metacarpal. Drawings not to scale.

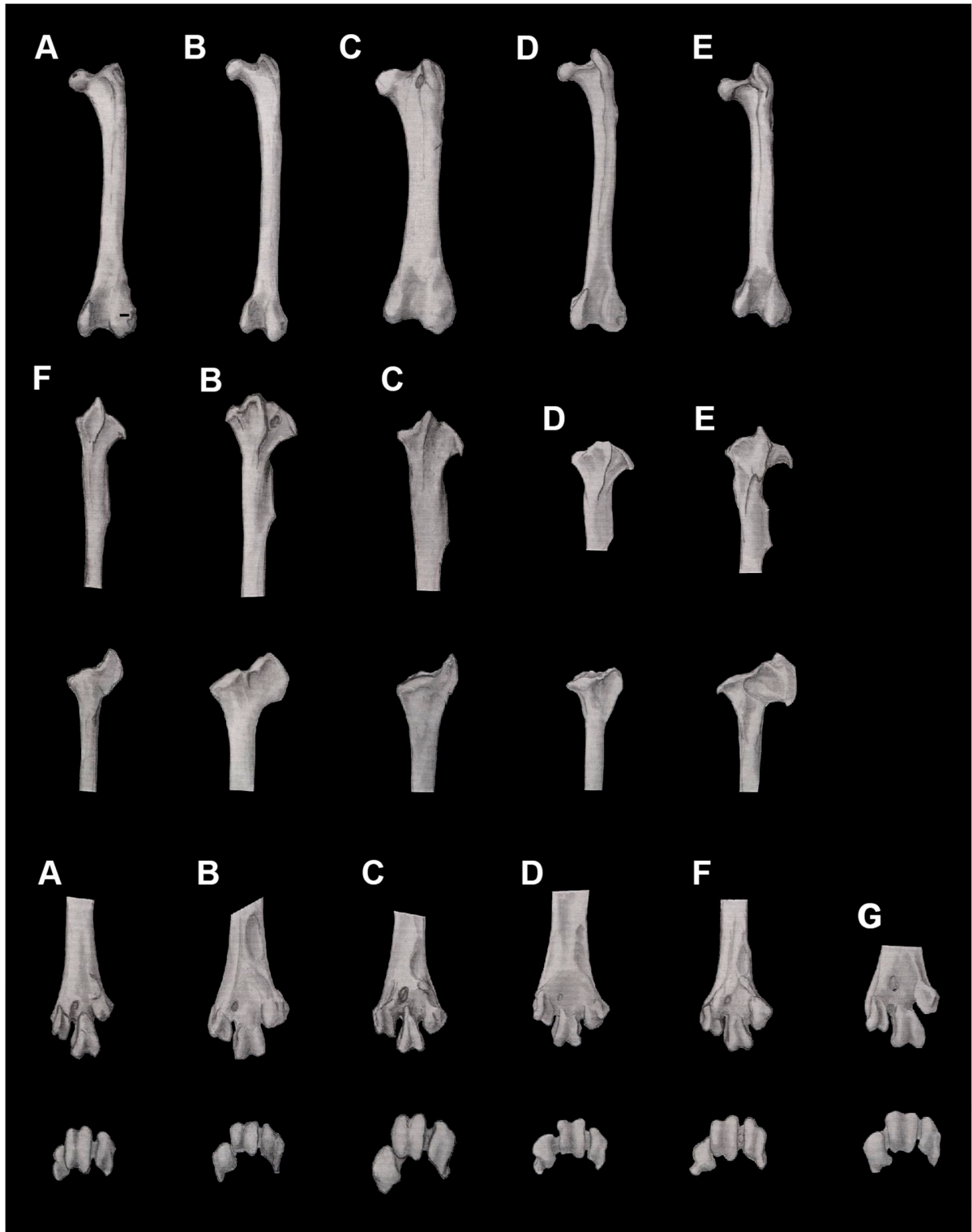


Figure S7. Comparison of pelvic elements of *Dendrocygna* (A), *Anachronornis* nov. gen. (B), *Chauna* (C), *Crax* (D), *Burhinus* (E), *Anseranas* (F), and *Presbyornis* (G); dorsal aspects of left femora (**top row**), cranial and medial aspects of left tibiotarsi (**upper and lower middle rows, resp.**), caudal and distal aspects of left tarsometatarsi (**upper and lower bottom rows, resp.**). Drawings not to scale.

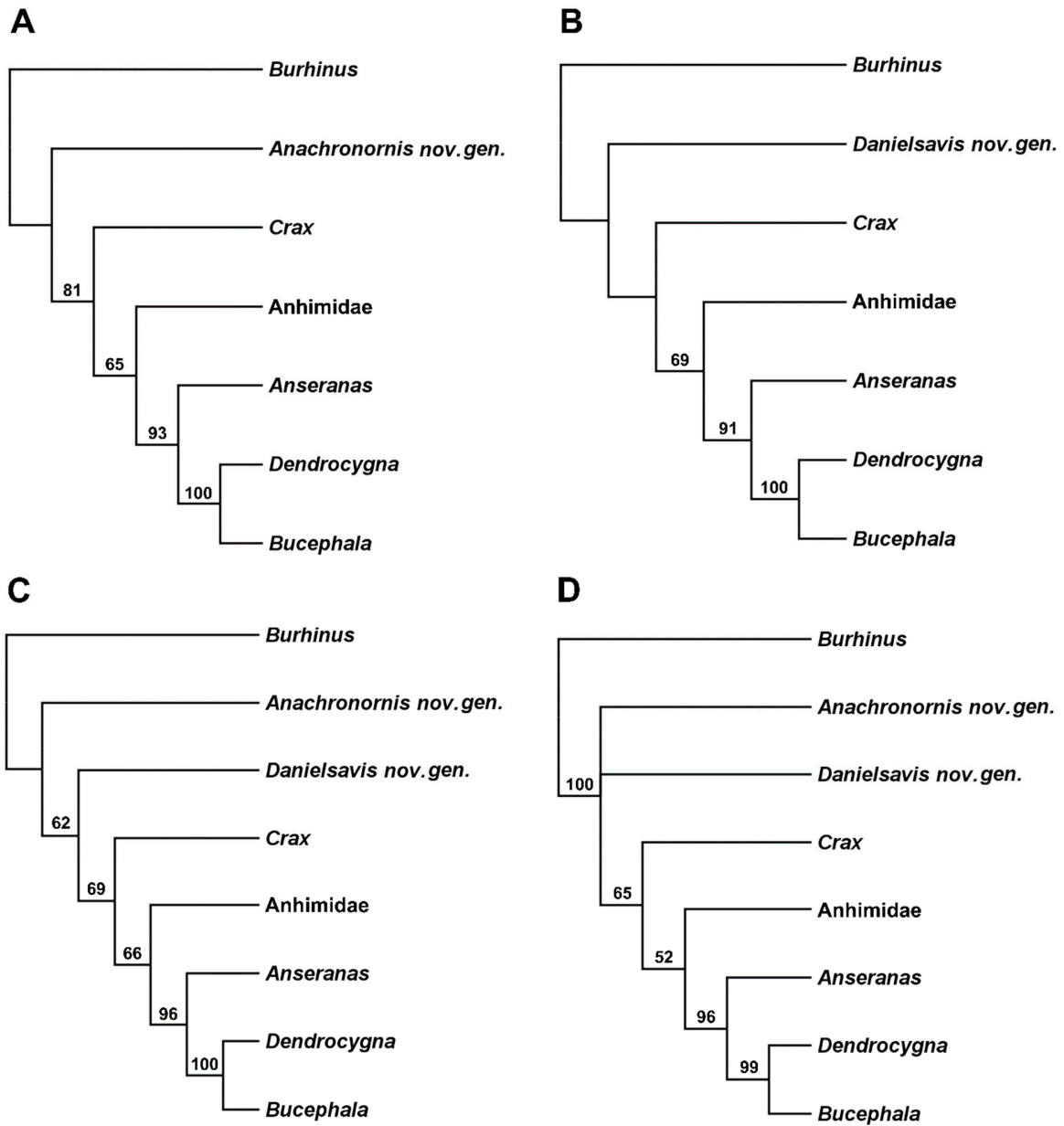


Figure S8. Phylogenetic trees of dataset 1. Maximum parsimony tree with bootstrap scores, with *Danielsavis* nov. gen. omitted (**A**), with *Anachronornis* nov. gen. omitted (**B**), and with both included (**C**). Unconstrained Bayesian analysis with PP scores (**D**).

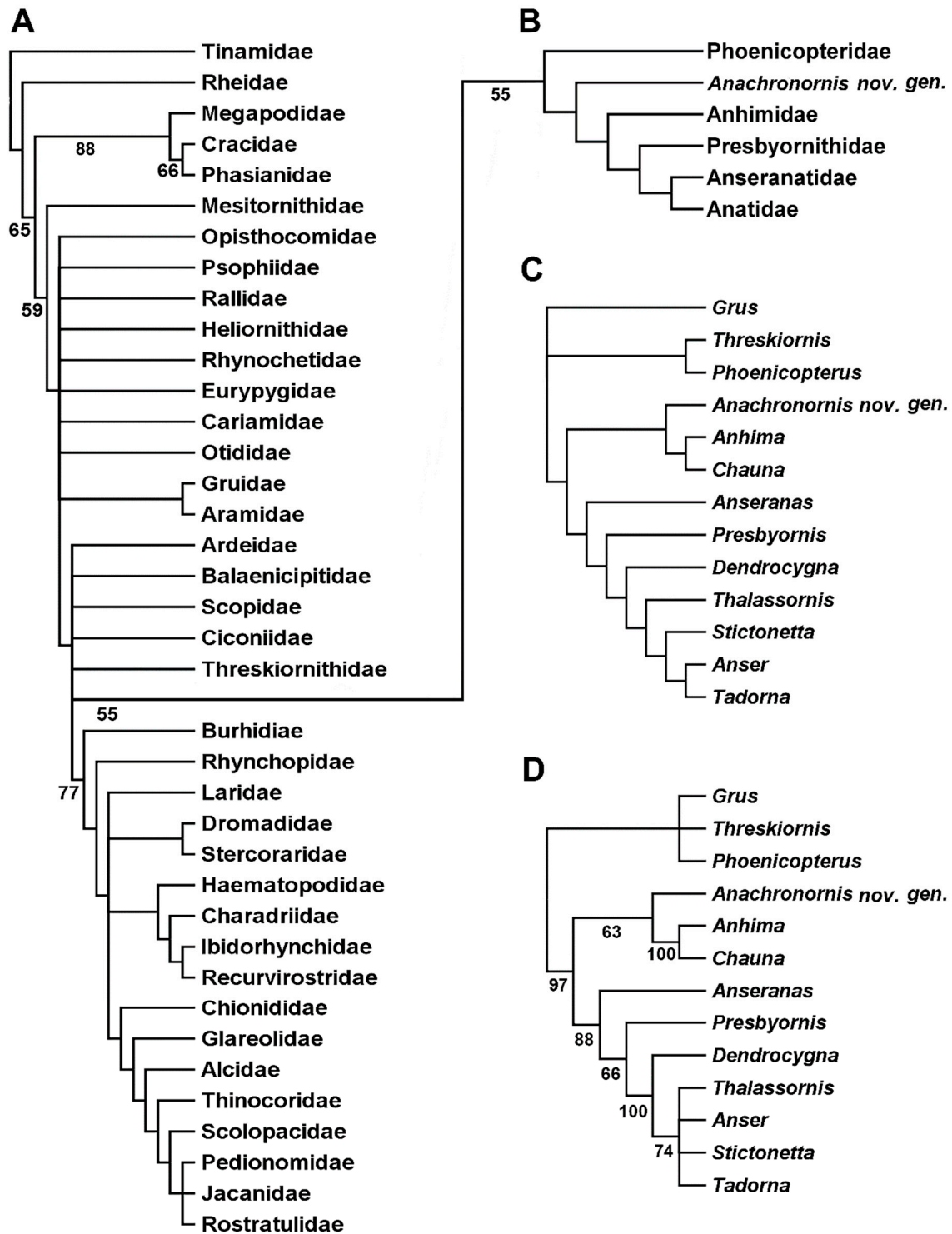


Figure S9. Parsimony phylogenetic trees of datasets 2 and 3, modified from Ericson 1997 [10]. Strict consensus of 216 equally most parsimonious trees from dataset 2 with bootstrap scores added (A) and (B), single maximum parsimony tree of dataset 3 (C), and bootstrap tree of dataset 3 (D).

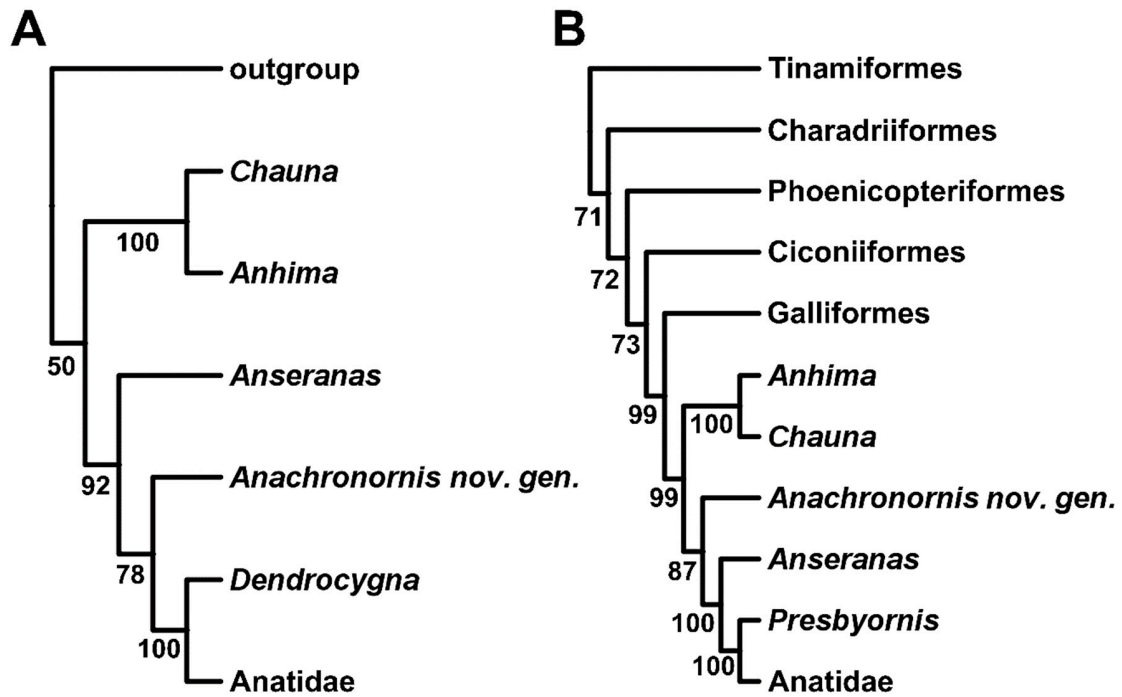


Figure S10. Parsimony phylogenetic trees of datasets 4 and 5. Single maximum parsimony tree of dataset 4, modified from Livezey 1986 [93] with BS scores added (**A**). Single maximum parsimony tree of dataset 5, modified from Livezey 1997 [1,94] with BS scores added (**B**).

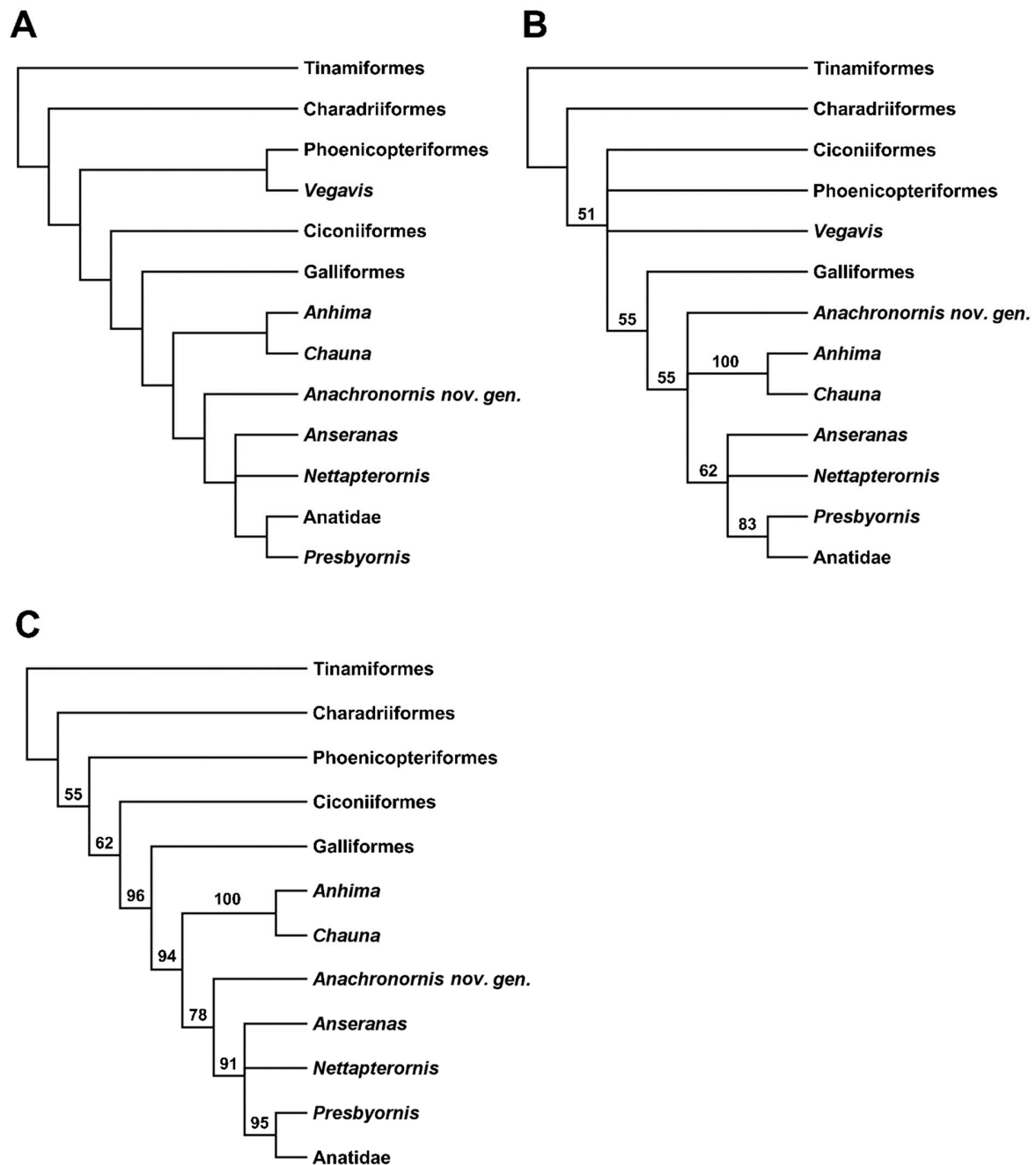


Figure S11. Parsimony phylogenetic trees of dataset 6 with *Nettapterornis* added to the dataset of Livezey [1, 93] as modified [12, 14]. Maximum parsimony tree (A), Bootstrap tree (B), Bootstrap tree with *Vegavis* omitted, same topology as Maximum Parsimony tree with *Vegavis* omitted (C).

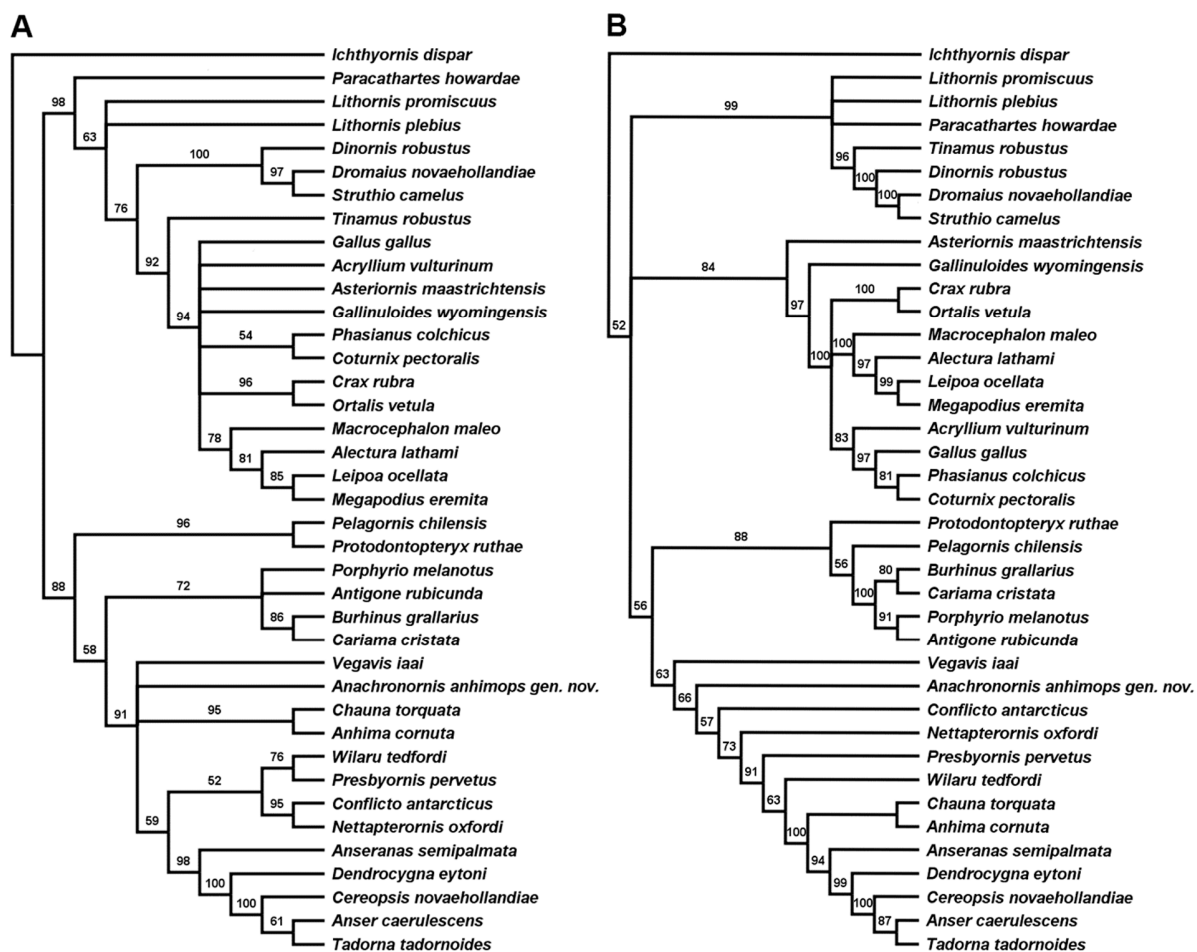


Figure S12. Phylogenetically-unconstrained maximum parsimony (MP) (A) and phylogenetically-unconstrained total-evidence (tip-dated) Bayesian (B) trees of dataset 7 [20, 95] with branches annotated with PP support values reported as percentages.

B. Supplementary Tables

Table S1. Measurements of vertebrae and pedal phalanges of *Anachronornis anhimops* nov. gen. et sp.

position	vertebrae				pedal phalanges						
	length	CL	CW	PW	PL	PW	PH	MW	MH	DW	DH
C1	4.1	2.5	-	6.5	19.4	3.9	3.8	2.3	2	2.6	2.6
C2	9.8	8.3	-	-	17.4	3	3.3	1.8	1.8	2.4	-
C3	10.6	7.8	~9	~10	11.4	2.9	2.9	1.8	1.5	2.4	1.9
C4	10.9	8.2	9.1	~10	11.7	-	-	1.7	1.7	2.3	1.9
C5	13.3	9.9	8.9	8.1							
C6	15.9	10.9	9.8	6.8							
C7	15.2	11.3	10.5	>7.8							
C8	>14	~12	~11	-							
C9	12	9.1	~10.6	~9							
C10	12.2	6.8	12	~8.8							
T1	11.1	5.7	12.8	6.7							
T2	10.3	7.1	~14	6.2							
T3	11	~9	-	-							
T4	11	9	-	-							
T5	10.1	8.9	-	-							
T6	-	8.3	-	-							
T7	10.2	8	-	4.3							
T8	9.5	7.1	-	4.5							
Cd	-	3.7	-	-							
Cd	-	3.4	-	-							
Cd	-	3.6	-	-							
Cd	-	3.6	-	-							

Table S1. Measurements of vertebrae and phalanges of *Anachronornis anhimops* nov. gen. et sp. Vertebrae are numbered sequentially without allowance made for potentially missing vertebrae. Positions of caudal vertebrae unknown. Digits and positions of phalanges are unknown, but none are proximal or ungual. Abbreviations: Centrum length (CL), cranial width (CW), bilateral width of caudal zygapophyses (PW), length (PL), proximal mediolateral width (PW), proximal dorsoplantar height (PH), midshaft mediolateral width (MW), midshaft dorsoplantar height (MH), distal mediolateral width (DW), and distal dorsoplantar height (DH). > indicates that the vertebra is sufficiently incomplete that measurement is an underestimate. ~ indicates that the measurement is an estimate because the vertebra may be diagenetically altered.

Table S2. Length of bones relative to humerus (%).

	CO	UL	CM	FE	TM
USNM 496700	44	100	52	80	-
FMNH PA725	-	94	-	60	-
NMS.Z.2021.40.1	68	118	65	-	64

Table S2. Length of bones relative to humerus. All normalized to length of humerus. Abbreviations: coracoid (CO), ulna (UL), carpometacarpus (CM), femur (FE), and tarsometatarsus (TM).

Table S3. Measurements of vertebrae and pedal phalanges of *Danielsavis nazensis* nov. gen et sp.

vertebrae			pedal phalanges				
position	CL	CW	position	PL	PW	DW	MH
atlas	-	5.6	digit I, phalanx 1	8.2	2.5	2.0	1.2
C2	8.0	8.0	digit 2, phalanx 1	11.3	3.0	2.5	1.5
C3	7.0	8.1	digit 2, phalanx 2	8.7	2.4	2.0	1.5
C4	6.7	6.6	digit 3, phalanx 1	12.3	3.7	3.0	2.0
C5	6.5	6.0	digit 3, phalanx 2	8.6	3.1	>2	1.8
C6	7.4	6.0	digit 3, phalanx 3	8.4	2.6	-	1.5
C7	-	-	digit 4, phalanx 1	8.1	3.0	2.6	1.5
C8	7.5	7.4	digit 4, phalanx 2	6.0	2.5	2.4	1.4
C9	6.1	-	digit 4, phalanx 3	4.5	2.3	3.0	1.5
C10	6.0	7.2	digit 4, phalanx 4	5.9	2.0	1.5	1.3
Cd2	3.0	6.0	ungual phalanx	7.1			
Cd3	3.1	2.8	ungual phalanx	6.1			
Cd4	3.0	2.8	ungual phalanx	5.8			
pygostyle	9.5	-	ungual phalanx	4.9			

Table S3. Measurements of vertebrae and phalanges of *Danielsavis nazensis* nov. gen., nov. sp. (NMS.Z.2021.40.1). Abbreviations: Centrum length (CL), cranial width (CW), phalanx length (PL), proximal mediolateral width (PW), distal mediolateral width (DW), and midshaft dorsoplantar height (MH). Vertebrae are numbered sequentially without allowance made for potentially missing vertebrae. Positions of ungual digits are unknown, but listed in order of presumed digit number based on length.

Table S4. Measurements of vertebrae and phalanges of NMS.Z.2021.40.2.

vertebrae			pedal phalanges				
position	CL	CW	position	PL	PW	DW	MH
C3	5.7	6.5	digit 1, phalanx 1	9.0	2.3	-	1.5
C4	6.2	6.3	digit 2, phalanx 2	9.0	2.8	2.2	1.4
C5	-	-	digit 3, phalanx 2	9.3	3.4	2.6	1.7
C6	7.0	8.0	digit 3, phalanx 3	9.0	2.5	2.1	1.3
C7	7.5	-	digit 4, phalanx 3	4.7	2.7	2.2	1.2
C8	7.5	~6.7	digit 4, phalanx 4	6.1	2.1	2.0	1.2
			ungual phalanx	7.0	2.7	-	-

Table S4. Measurements of vertebrae and phalanges of NMS.Z.2021.40.2. Abbreviations: Centrum length (**CL**), cranial width (**CW**), phalanx length (**PL**), proximal mediolateral width (**PW**), distal mediolateral width (**DW**), and midshaft dorsoplantar height (**MH**). Vertebrae are numbered sequentially without allowance made for potentially missing vertebrae. Position of ungual phalanx is unknown.

Table S5. Measurements of vertebrae and phalanges of NMS.Z.2021.40.3.

vertebrae			pedal phalanges				
position	CL	CW	position	PL	PW	DW	MH
C4	7.5	6.8	digit I, phalanx 1	9	2.2	2.0	1.2
C7/8	7.7	8	digit 2, phalanx 1	11.8	3	2.4	1.5
T	6.7	-	digit 2, phalanx 2	8.8	2.3	2.0	2.0
T	5.8	-	digit 3, phalanx 1	12	3.3	3.0	2.0
Cd	3	7.1	digit 3, phalanx 2	8.8	3	2.3	1.7
Cd	3	-	digit 3, phalanx 3	8.2	2.5	2.0	1.5
			digit 4, phalanx 1	8.0	3.0	2.6	1.5
			digit 4, phalanx 3	4.3	2.3	2.0	1.2
			digit 4, phalanx 4	5.7	2	2.0	1.3
			ungual phalanx	7.0			
			ungual phalanx	5.2			
			ungual phalanx	5.5			
			ungual phalanx	6.1			
			ungual phalanx	5.1			

Table S5. Measurements of vertebrae and phalanges of NMS.Z.2021.40.3. Abbreviations: Centrum length (**CL**), cranial width (**CW**), phalanx length (**PL**), proximal mediolateral width (**PW**), distal mediolateral width (**DW**), and midshaft dorsoplantar height (**MH**). Vertebrae are numbered sequentially and positions estimated. Positions of ungual phalanges are unknown, but listed in order of presumed digit number based on length.

Table S6 (below). Results of Kishino-Hasegawa (KH) tests of alternative placements of *Anachronornis* nov. gen. on phylogenetically-constrained Maximum Parsimony tree of dataset 7. Branch numbers 1-37 correspond to Figure 9A whereas 38-40 represent additional topologies. "***" indicates a significant difference from (i.e., worse than) "best" at $P < 0.05$; NS - not significant, two tailed parsimony KH P values shown but doubled for one-tailed test; diff - difference from "best" (length or log likelihood [-ln L]) determined by KH test, not phylogenetic analysis. All tests are normal approximations, parsimony KH characters ordered, and likelihood KH with equal rates. See Figure 9 and Appendix G9 for all trees and results.

Table S6. Kishino-Hasegawa test, Dataset 7, Maximum Parsimony Backbone Tree, Fig. 9A

branch	Parsimony KH				Likelihood KH			
	length	diff length	t	P	-ln L	diff -ln L	t	P
1	1627	26	3.4771	0.0006*	5560.16003	18.88048	2.404	0.0084*
2	1632	31	4.4779	<0.0001*	5560.16008	18.88052	2.404	0.0084*
3	1645	44	5.5131	<0.0001*	5582.23413	40.95458	4.934	<0.0001*
4	1648	47	5.7948	<0.0001*	5582.23412	40.95457	4.933	<0.0001*
5	1654	53	6.4381	<0.0001*	5590.32442	49.04486	5.576	<0.0001*
6	1630	29	4.2608	<0.0001*	5558.28229	17.00273	2.217	0.0137*
7	1628	27	3.9509	0.0001*	5558.27465	16.99509	2.215	0.0138*
8	1626	25	4.3515	<0.0001*	5558.09518	16.81562	2.193	0.0145*
9	1626	25	4.6429	<0.0001*	5558.09528	16.81573	2.193	0.0145*
10	1626	25	3.9027	0.0001*	5567.93627	26.65672	3.147	0.0009*
11	1627	26	3.4771	0.0006*	5571.22659	29.94704	3.500	0.0003*
12	1634	33	4.5981	<0.0001*	5571.22682	29.94727	3.500	0.0003*
13	1629	28	4.7008	<0.0001*	5567.93634	26.65679	3.147	0.0009*
14	1619	18	3.7544	0.0002*	5550.07755	8.79800	1.078	0.1410
15	1615	14	2.7765	0.0058*	5549.90866	8.62911	1.073	0.1420
16	1629	28	4.4555	<0.0001*	5571.19461	29.91506	13.282	<0.0001*
17	1629	28	4.4555	<0.0001*	5541.27955	(best)	NA	NA
18	1628	27	4.2331	<0.0001*	5571.19033	29.91077	13.081	<0.0001*
19	1655	54	6.3452	<0.0001*	5584.69923	43.41967	5.359	<0.0001*
20	1658	57	6.7984	<0.0001*	5584.69927	43.41971	5.359	<0.0001*
21	1662	61	6.9638	<0.0001*	5585.35967	44.08012	5.403	<0.0001*
22	1664	63	7.2317	<0.0001*	5585.35893	44.07938	5.400	<0.0001*
23	1607	6	1.9058	0.0577	5545.38974	4.11019	0.486	0.3136
24	1601	(best)	NA	NA	5544.64202	3.36247	0.391	0.3482
25	1606	5	1.5108	0.1319	5543.3893	2.10975	0.235	0.4073
26	1612	11	2.3103	0.0216*	5543.911	2.63144	0.278	0.3906
27	1609	8	1.5728	0.1168	5544.01677	2.73721	0.29	0.3861
28	1613	12	2.0693	0.0394*	5544.8883	3.60875	0.374	0.3543
29	1615	14	2.2283	0.0266 NS	5547.38804	6.10849	0.632	0.2638
30	1611	10	1.5466	0.1230	5547.01147	5.73192	0.582	0.2807
31	1613	12	1.8161	0.0704	5547.43199	6.15244	0.622	0.2671
32	1612	11	1.6088	0.1087	5547.02397	5.74442	0.578	0.2820
33	1617	16	2.2787	0.0234*	5551.45499	10.17544	1.001	0.1587
34	1615	14	2.0313	0.0431 NS	5551.36281	10.08326	0.992	0.1610
35	1614	13	2.1502	0.0324 NS	5544.7886	3.50905	0.362	0.3589
36	1624	23	3.2083	0.0015*	5554.01298	12.73343	1.197	0.1162
37	1622	21	2.7644	0.0061*	5554.01289	12.73334	1.197	0.1162
38	1628	27	3.3042	0.0011*	5563.89940	22.74435	1.953	0.0214*
39	1631	30	3.7742	0.0002*	5564.30423	23.14918	2.035	0.0009*

Table S7. Kishino Hasegawa test, Dataset 7, Phylogenetically-Constrained Total-Evidence Backbone Tree, Fig. 9B

Parsimony KH					Likelihood KH			
branch	length	diff	t	P	-ln L	diff	t	P
1	1625	16	2.2787	0.0234*	5527.64874	50.46782	9.238	<0.0001*
2	1632	23	3.1475	0.0018*	5527.64850	50.46758	9.237	<0.0001*
3	1649	40	4.7521	<0.0001*	5547.76417	70.58325	9.502	<0.0001*
4	1650	41	4.7795	<0.0001*	5547.76400	70.58308	9.502	<0.0001*
5	1656	47	5.3978	<0.0001*	5555.21919	78.03827	9.530	<0.0001*
6	1630	21	3.0414	0.0026*	5527.39562	50.21470	9.156	<0.0001*
7	1627	18	2.6815	0.0077*	5527.39564	50.21472	9.154	<0.0001*
8	1627	18	2.4704	0.0141*	5527.62446	50.44354	8.827	<0.0001*
9	1625	16	2.2337	0.0263*	5527.62639	50.44547	8.841	<0.0001*
10	1626	17	2.3089	0.0216*	5535.02324	57.84232	8.427	<0.0001*
11	1629	20	2.4831	0.0136*	5537.36402	60.18310	8.341	<0.0001*
12	1634	25	3.1983	0.0015*	5537.36407	60.18315	8.341	<0.0001*
13	1630	21	2.8658	0.0045*	5535.02310	57.84218	8.427	<0.0001*
14	1626	17	2.5577	0.0110*	5522.97158	45.79066	9.047	<0.0001*
15	1618	9	1.3745	0.1703	5522.23824	45.05732	8.160	<0.0001*
16	1620	11	1.5753	0.1162	5527.20912	50.0282	7.458	<0.0001*
17	1622	13	1.9046	0.0578	5527.20923	50.02831	7.458	<0.0001*
18	1630	21	2.8658	0.0045*	5537.68763	60.50671	7.357	<0.0001*
19	1627	18	2.382	0.0178*	5537.68754	60.50662	7.358	<0.0001*
20	1656	47	5.1954	<0.0001*	5549.44585	72.26493	7.680	<0.0001*
21	1658	49	5.4381	<0.0001*	5549.44554	72.26462	7.680	<0.0001*
22	1662	53	5.7208	<0.0001*	5550.26182	73.08090	7.738	<0.0001*
23	1664	55	5.893	<0.0001*	5550.25837	73.07745	7.728	<0.0001*
24	1617	8	1.374	0.1705	5519.10753	41.92661	11.10	<0.0001*
25	1613	4	0.666	0.5059	5519.09959	41.91867	10.952	<0.0001*
26	1612	3	0.5767	0.5646	5516.84966	39.66874	18.288	<0.0001*
27	1615	6	1.2258	0.2213	5517.06103	39.88011	19.489	<0.0001*
28	1617	8	1.7111	0.0881	5477.18092	(best)	NA	NA
29	1614	5	1.2925	0.1972	5516.17852	38.99760	14.335	<0.0001*
30	1614	5	1.2925	0.1972	5516.71555	39.53463	10.967	<0.0001*
31	1609	(best)	NA	NA	5513.39828	36.21736	7.021	<0.0001*
32	1613	4	0.9426	0.3466	5515.40467	38.22375	5.464	<0.0001*
33	1616	7	1.9506	0.052	5516.44174	39.26082	6.092	<0.0001*
34	1625	16	3.0662	0.0024*	5522.60029	45.41937	5.781	<0.0001*
35	1623	14	2.5803	0.0104*	5522.60003	45.41911	5.781	<0.0001*
36	1631	22	3.1579	0.0018*	5531.98828	54.80736	5.250	<0.0001*
37	1632	23	3.4927	0.0006*	5532.74432	55.56340	5.601	<0.0001*

Table S7. Results of Kishino-Hasegawa (KH) tests of alternative placements of *Anachronornis* nov. gen. on phylogenetically-constrained total-evidence (tip-dated) tree of dataset 7. Branch numbers 1-37 correspond to Figure 9B whereas 38-50 represent additional topologies. “*” indicates a significant difference from (i.e., worse than) “best” at $P < 0.05$; NS - not significant, two tailed parsimony KH P values shown but doubled for one-tailed test; diff - difference from “best” (length or log likelihood [-ln

L)) determined by KH test, not phylogenetic analysis. All tests are normal approximations, parsimony KH characters ordered, and likelihood KH with equal rates. See Appendix G14 for all trees and results.

C. Characters and Scores of Description and Dataset 1 of *Anachronornis anhimops* nov. gen. et sp.

Character states described and identified by parenthetic number in the Description of *Anachronornis anhimops* nov. gen. et sp. Characters are not polarized. Order of taxa in matrix: *Anachronornis* nov. gen., *Chauna*, *Anseranas*, *Dendrocygna*, *Bucephala*, *Crax*, *Burhinus*, *Danielsavis* nov. gen. U, unordered characters with more than two states; O, ordered characters.

Skull:

- 1) osseous nasal aperture and palatine fenestra: a) large, open, b) small, closed.
1 a b b a a b a
- 2) premaxilla, maxillary rostrum: a) short, vaulted ventrally, b) short, flat, c) long, vaulted. U
2 a b c c c a b a
- 3) premaxilla, neurovascular foramina: a) small, b) large.
3 a a a b b b a a
- 4) palatine, pars lateralis: a) broad, tapered caudally, b) broad, truncate caudally, c) narrow, truncate caudally, d) narrow, tapered caudally. U
4 a b c c c d b ?
- 5) palatine, foramen on dorsolateral surface rostral to choana: a) large, b) small, c) absent.
O
5 a b c c a/b c b ?
- 6) palatine, pterygoid articulation: a) complex, U-shaped, pedicellate, right and left palatines unfused, b) simple, blunt-ended, right and left palatines fused, c) "ball and socket" type [Livezey, 1997] (character 45) complex, two articular surfaces that interlock with the pterygoid, right and left palatines fused, d) simple, at end of long tapered pterygoid foot, right and left unfused, e) simple, pedicellate right and left unfused. U
6 a b c c c d e ?
- 7) calvaria, a) postorbital process short, b) postorbital process long, pronounced rostrally.
7 a a b b b a a ?
- 8) calvaria, temporal or pseudotemporal fossa (i.e., origins of depressor mandibulae and AME coronoidea or complex of muscles): a) evident in lateral view, b) not evident in lateral view, origin of depressor mandibulae not evident, origin of AME directed ventrally and completely or nearly completely enclosed laterally.
8 b b a a a a a ?
- 9) calvaria, lateral protuberances of nuchal crest: a) absent, b) present.
9 b a b b b a a ?
- 10) calvaria, occipital fontanelles: a) present, b) absent.
10 b b a a a b b ?
- 11) calvaria, impressions of nasal glands on supraorbital region of frontal bones: a) absent, b) present. *Danielsavis nazensis* nov. gen., nov. sp. scored on NMS.Z.2021.40.2.
11 a a a a b a b a
- 12) interorbital septum: a) incomplete, with a large interorbital foramen, b) nearly complete, with a small foramen, c) complete, no foramen. U
12 b c b b c c a ?
- 13) lacrimal: a) small, unfused, or with suture to frontal clearly visible without interruption at all points of contact, b) large, fused such that suture to frontal is obliterated. *Danielsavis nazensis* nov. gen., nov. sp. scored on NMS.Z.2021.40.2.
13 a a a b b a a b
- 14) lacrimal, cranioventral margin: a) horizontal or nearly so, b) oblique to vertical.
14 a b a a a b b ?

15) lacrimal, orbital process: a) discontinuous with supraorbital margin of frontal: b) continuous with supraorbital ridge (*Dendrocygna marginalis*). *Danielsavis nazensis* nov. gen., nov. sp. scored on NMS.Z.2021.40.2.

15 a b a b a b a b

16) ectethmoid: a) appears only as a low ridge on the mesethmoid, b) a lamina of bone that projects laterally towards the lacrimal.

16 a b a a a b ?

17) frontal, infraorbital fossa: a) large, well defined, b) poorly defined or absent.

17 a a a a b b ?

18) basisphenoid, basiptyergoid process: a) elevated, forming a lip around its entire circumference, b) low, nearly continuous with parasphenoid rostrum rostrally, c) absent. O = (a,b)c

18 a a a a b c ?

Quadrate:

19) mandibular process, condyles: a) medial condyle small, lateral condyle narrow and elongated in direction of medial condyle, caudal condyle absent, b) medial and lateral condyles large and rounded, caudal condyle absent, c) three condyles present, lateral condyle teardrop-shaped as its articular surface tapers to caudal condyle. O = (a,b)c

19 a a a a b c a

20) mandibular process, quadratojugal articulation: a) quadratojugal cotyle deep, set in quadratojugal process that is positioned caudodorsally to the lateral mandibular condyle, b) quadratojugal cotyle deep, communicating to ventral surface of quadrate via a notch that separates the quadratojugal process from the lateral mandibular condyle, c) quadratojugal cotyle set in lateral mandibular condyle. U

20 a a/b a a b c a

21) otic process, capitula: a) closely spaced, b) intermediately spaced, c) widely separated. U

21 b a a a a c b

22) otic process: a) caudal margin with groove that may or may not end ventrally in one or more (pneumatic?) foramina, b) caudal margin ungrooved, foramen on medial surface of otic process, c) caudal margin ungrooved, large foramen relatively dorsad on caudal margin between otic capitula, d) neither a foramen nor a groove present. U

22 a b/d a a b d c a

23) otic and orbital processes, tuberosities on lateral surfaces of the distal extremities of processes: a) neither present, b) tuberosity only on orbital process, c) both tuberosities present. U

23 c c b b/c c c a c

24) body, medial surface, basiorbital pneumatic foramen: a) present, b) absent.

24 a b b b b b a

25) orbital process, medial surface: a) deeply concave, b) shallowly concave, c) not concave. O

25 a b a a c a a

Mandible:

26) retroarticular process: a) bilaterally flattened, b) cylindrical or nearly so in cross section.

26 a a a a b ? b

27) retroarticular process: a) terminates distally as a dorsally projecting spur, b) appears as a low crest.

27 a a a a b a

28) tubercle of the adductor mandibulae externus, pars articularis, caput externa of Livezey and Zusi (2006): a) large, positioned on lateral surface of ramus, b) absent or positioned on dorsal margin of ramus. Note: this tubercle is present dorsolaterally in *Danielsavis nazensis* nov. gen.,

nov. sp. but it is not present laterally in NMS.Z.2021.40.2 but rather it is positioned closer to the dorsal margin of the coronoid region.

28 a b a a b b a

29) insertion of depressor mandibulae: a) not concave, b) shallowly concave, c) deeply concave to form a conical recess. U

29 b a b c c a b a

30) medial process, dorsal view: a) points slightly rostrally, b) points medially, c) points slightly caudally. O = a(b,c)

30 a b/c c c c b c a

31) medial process, pneumatic foramen: a) large, b) small, c) absent.

31 a b/c b c c b a a

32) ramus, dorsal margin, lateral view: a) straight, coronoid region (not the process) rises abruptly from tomial crest, b) decurved, coronoid region smoothly continuous with tomial crest.

32 a b a a a b b b

Vertebrae:

33) all thoracic vertebrae, body, lateral surface, large pneumatic cavity or foramen: a) absent, b) present.

33 b b a a a a b

34) notarium: a) absent, b) present.

34 a a b a a b a a

Sternum:

35) ratio of width to length at costal margin: a) 1:1.5, b) 1:1.75, c) 1:2, d) 1:3. U

35 a a c c b d a ?

36) caudal margin: a) single notched, b) double notched. Character state of *Danielsavis nazensis* nov. gen., nov. sp. is inferred from incomplete caudal margin.

36 a a a a b b a

37) median and lateral trabeculae: a) median trabecula longer than lateral trabecula, b) lateral trabecula longer than median trabecula.

37 b b b b a a a ?

38) rostrum, external spine: a) absent or inconspicuously small, b) medium to large, conspicuously present, blunt, c) extremely large. *Danielsavis nazensis* nov. gen., nov. sp. scored on NMS.Z.2021.40.2 and NMS.Z.2021.40.3. U

38 b a a a c b b

39) craniolateral process, lateral view: a) low, b) tall, narrow, or deeply notched cranially.

Danielsavis nazensis nov. gen., nov. sp. scored on NMS.Z.2021.40.2 and NMS.Z.2021.40.3.

39 a a a b b b b b

40) cranial margin, coracoid pila in lateral view: a) not raised cranial or dorsal to internal labrum of coracoidal sulcus, b) raised cranial or dorsal to internal labrum of coracoidal sulcus.

40 a b a a a b a a

41) lateral margin, proportion occupied by costal surface (measured cranially from most cranial part of craniolateral process): a) less than one half, b) more than one half.

41 a a b b b a a a

42) postcarinal plane: a) absent, b) present (*Anseranas marginalis*).

42 a b b a b a a b

43) carinal sulcus: a) absent, b) present.

43 a a/b a a a b a a

44) dorsolateral intermuscular line: a) continues to or near the caudal margin of the sternal plate, b) ends caudally at carina.

44 a b a a a a a ?

Coracoid:

45) insertion of the sternocoracoideus muscle: a) smoothly concave, with or without muscular lines, b) pneumatic foramen (or foramina) present. *Danielsavis nazensis* nov. gen., nov. sp. bears a hole on the right but not the left coracoid, but it is not clear whether this is a small pneumatic foramen or damage.

45 a b b a a b a a/b

46) acrocoroid process: a) wide, curving medially well over triosseal groove, crest for the attachment of triosseal ligament pointing sternad and discontinuously raised from the triosseal groove, b) wide, curving medially well over triosseal groove, no crest, c) narrow, crest for triosseal ligament present but low, d) narrow, no crest. O = (a,b)(c,d)

46 a d c c c b a b

47) scapular cotyle: a) large, deep, b) shallow.

47 a a a a b a a

48) procoracoid process: a) large, b) intermediate, c) small. U

48 a a a b b c a a

49) foramen of supracoracoid nerve: a) present, b) absent.

49 a a a b b b a a

50) sternal extremity: a) thin (dorsoventral), curved, wide (mediolateral), sternal articulation extends laterally almost entire width of sternal extremity, b) thick, all else as in state "a" (i.e., wide, sternal articulation extends laterally almost entire width), c) thick, external facies of sternal articulation forms pronounced crest on ventral surface, all else as in state "b", d) thick, narrow, sternal articulation restricted to medial half of sternal extremity. U

50 a b c c c d a b

51) sternal extremity, medial angle: a) acute (< 45 degrees), pointed, b) relatively more obtuse than state "a" (> 45 degrees, < 90 degrees), c) truncate, square. Note: multistate scoring of *Anachronornis* nov. gen. reflects bilateral asymmetry of right and left coracoids in USNM 496700. U

51 a/b a b b a c a b

52) sternal extremity, lateral angle: a) acute, positioned near sternal articulation, b) obtuse, positioned away from sternal articulation, c) obtuse, positioned near sternal articulation. U

52 a a b b b c a a

53) sternal extremity, crest or flange for attachment of the sternoclavicular membrane beginning at medial angle and continuing omally on medial margin of body: a) large, concave ventrally, b) absent or apparent only as a minor scar.

53 a b b a/b b b a a

54) sternal extremity, ventral surface: a) intermuscular line positioned far laterally with a deep fossa medial to it, b) intermuscular line positioned far laterally, with little or no fossa, c) intermuscular line positioned medially, bisecting ventral surface of coracoid, shallow medial fossa present. U

54 a b b a b c a b

Furcula:

55) overall configuration: a) wide, bowed, curved throughout, b) narrow.

55 a a b a a b a a

56) omal extremity, acrocoracoid articulation: a) short, pointed, an angle marks the acrocoracoid articulation but there is no tubercle, b) long, pointed, with a prominent tubercle marking the acrocoracoid articulation, c) block shaped. U

56 a a b b b c a b

Scapula:

57) neck and body: a) narrow, neck curved b) broad caudally, curved caudally only.

57 a a a a b a a

58) cranial extremity, acromion: a) short, b), intermediate, c) long. U

58 a a b b c c b c

59) humeral articulation (glenoid facet): a) pronounced laterally, short craniocaudally, b) less pronounced laterally, elongated craniocaudally, c) very pronounced laterally, short craniocaudally, elongated dorsoventrally. U

59 a a b b b c a

Humerus:

60) body: a) long, gently curved, b) robust, gently curved, c) very robust, strongly curved. U

60 a a a a b c a b

61) proximal extremity, bicipital crest: a) short, does not extend as far distally as the angle marking the midpoint of the deltopectoral crest, protrudes at high angle from body, b) expanded distally.

61 a a b b b b a

62) proximal extremity, dorsal tubercle: a) pronounced proximally and dorsally, b) less pronounced, not pronounced caudally, c) low. U

62 a b b b c c a a

63) proximal extremity, deltopectoral crest: a) long (proximodistal), thin (dorsoventral), upturned, expanded cranially, especially at distal end, b) long, thin, upturned, intermediately expanded, not especially at distal end, c) short, thick, dorsal surface not excavated, downturned, not expanded. *Danielsavis nazensis* nov. gen., nov. sp. is scored multistate to indicate uncertainty because distal part of cranial margin is damaged. U

63 a a b b c c a a/b

64) proximal extremity, tubercle at distal extremity of deltopectoral crest: a) absent, b) present.

64 a b a a a a a

65) proximal extremity, coracobrachial impression: a) broad, concave, poorly circumscribed, b) small, concave, well circumscribed, c) shallow, d) not excavated. U

65 a d b b b c a c

66) proximal extremity, pneumotricipital fossa: a) cavernous, no pneumatic foramen, b) deeply excavated, pneumatic foramen present, c) slightly excavated, pneumatic foramen present, d) not excavated, pneumatic foramen present. U

66 a c c b a d a a

67) proximal extremity, caput, relationship to caudal surface of "anatomical neck" (i.e., shaft immediately distal to caput): a) caput forms a lip overhanging recessed neck, b) no excavation, caput extends smoothly onto surface of neck.

67 a b b a a b a a

68) distal extremity, ventral condyle, cranial view: a) distally longest extension of humerus, b) intermediate in length, restricted to dorsal region, c) shorter than ventral epicondyle, restricted to dorsal region. U

68 a a a b b c a a

69) distal extremity, caudal view: a) olecranon fossa broad, humerotricipital groove deep, scapulotricipital groove deep, b) olecranon fossa broad, humerotricipital groove deep, scapulotricipital groove indistinct, c) olecranon fossa narrow, humerotricipital groove deep, scapulotricipital groove deep, d) olecranon fossa narrow, humerotricipital groove deep, scapulotricipital groove shallow. U

69 b b d c c d a b

70) distal view: a) condyles small craniocaudally, flexor process short, b) condyles large craniocaudally, flexor process slightly flared, deflected caudally, c) condyles large, flexor process flared. O

70 a a b c c a c a

Ulna:

71) body: a) curved proximal end only, not flattened, b) curved proximal only, slightly flattened distally, c) curved and flattened throughout. U

71 a a a b c a a

72) carpal tubercle: a) short, not pointed (in the Anhimidae, only *Chauna* exhibits this condition), b) long, pointed, c) long, rounded. U

72 a a b b c c b

Radius:

73) body: a) straight, b) bowed.

73 a b b b a b b a

74) distal extremity, cranial view: a) nearly symmetrical, widens abruptly from narrow body, b) asymmetrical, ventral margin pronounced distally, extremity attenuates gradually to shaft, c) asymmetrical, ventral margin straight with ridge extending onto body, dorsal margin pronounced, d) asymmetrical, ventral aponeurotic tubercle (i.e., dorsal margin) especially pronounced. U

74 a b b b c c d a

Carpometacarpus:

75) minor metacarpal: a) straight, b) bowed.

75 a a a a b a a

76) intermetacarpal space, intermetacarpal process: a) space intermediate, no process, b) space narrow, no process, c) space wide, process present. U

76 a a a b b c b a

77) distal metacarpal synostosis: a) short, b) long.

77 a b b b b ? b a

78) extensor process: a) in the longitudinal axis of carpometacarpus, the process lies at a level equal to the distal margin of the ulnocarpal articulation, b) positioned more proximally.

78 a a b b b b b b

79) spur of extensor process: a) absent, b) present.

79 a b a a a a a a

80) proximal extremity, supratrochlear and infratrochlear fossae and synostosis of alular and major metacarpals: a) deeply excavated dorsally or ventrally or both, b) not excavated. *Burhinus* and *Danielsavis nazensis* nov. gen., nov. sp. (scored NMS.Z.2021.40.3) are scored multistate due to their intermediacy.

80 a b a b a b a/b a/b

81) proximal view: a) dorsal margin of carpal trochlea large and offset cranially from ventral margin, b) ventral margin of carpal trochlea large and offset cranially from dorsal margin, c) dorsal margin large, equal to ventral margin cranially, d) dorsal margin very small, equal to ventral margin cranially. *Danielsavis nazensis* nov. gen., nov. sp. scored on NMS.Z.2021.40.3. U

81 a b c a a a d c

82) distal extremity, dorsal view: a) articular facet of major digit equal to or longer distally than articular facet of minor digit, b) articular facet of minor digit longer distally than that of major digit.

82 a b b a a b a a

83) distal extremity, cranioventral tuberosity (character 40 of Livezey, 1986 modified), distal view: a) not elevated cranially, lower than dorsal tubercle of major metacarpal, b) cranioventral tuberosity elevated cranially, but lower than dorsal tubercle (this character in the *Anachronornis anhimops* nov. gen., nov. sp. may be an artifact of crushing of the distal extremity of the carpometacarpus between the ventral and dorsal tubercles), c) ventral tubercle raised as a spur, extending further cranially than dorsal tubercle. U

83 b c a a a a a a

Pelvis:

84) pelvis in entirety, dorsal view: a) short, broad, b) elongate.

84 a b b b a a ?

85) iliosynsacral canal: a) large, opens at level of middle or cranial half of preacetabular ala of ilium, b) small, opens at level of caudal half of preacetabular ala of ilium, c) does not communicate to dorsal surface of pelvis. U

85 a c c b b a a ?

86) preacetabular ala of ilium, dorsal view: a) dorsal margin straight along caudal half, widely divergent caudally from midsagittal plane, b) dorsal margin curved along caudal half, widely divergent caudally, c) dorsal margin curved along caudal half, paired ilia bilaterally narrow caudally. U

86 a c c c c a b ?

87) pectineal process (preacetabular tubercle), lateral view: a) short, b) long.

87 a a a b b b a ?

88) pectineal process, ventral view (preacetabular tubercle): a) ventral surface deeply excavated, b) intermediate, c) ventral surface convex. O

88 a c c b b c a ?

89) dorsolateral crest of ilium, level of acetabulum, lateral view: a) distinctly raised, forms an angle dorsal to the acetabulum, and is more dorsal than the synsacrum, b) forms a slight angle above acetabulum, more dorsal than synsacrum, c) does not form an angle above the acetabulum and is not dorsal to synsacrum, d) iliac crest forms a slight crest above acetabulum but is not dorsal to synsacrum. U

89 a a b c c c d ?

90) obturator foramen, lateral view, length relative to acetabulum: a) long, b) short.

90 a a b b b b b ?

91) body of ischium, dorsal to obturator foramen, lateral view: a) deeply excavated, b) intermediate, c) convex. U

91 a c b b c b a ?

92) ischium, distal extremity, lateral view: a) short (estimated in *Anachronornis* nov. gen.), b) long.

92 a b b b b a a ?

93) dorsolateral crest of postacetabular ala of ilium, relationship to lateral surface of ala of ischium: a) crest present, ala ischii concave laterally, b) no crest, ala ischii flat or convex laterally.

93 a a a b b a a ?

94) ilioischadic foramen: a) large, b) intermediate, c) small. U

94 b b b a a b c ?

95) pudendal part of renal fossa, caudal recess: a) absent, b) present.

95 b b b a a b a ?

96) pudendal part of renal fossa, cranial recess: a) absent, b) present.

96 b b b a a b a ?

97) synsacrum, lateral processes of preacetabular vertebrae, number thereof: a) 4, b) 5, c) 6, d) 8. U

97 b d c c c a c ?

98) synsacrum, lateral processes of preacetabular vertebrae, position of articulation on preacetabular ala of ilium: a) very medially, especially the more cranial processes, b) laterally.

98 a b b b b a a ?

99) cranial renal fossa: a) large and wide cranial to acetabulum, b) small or absent cranial to acetabulum, closed ventrally by short lateral processes of preacetabular vertebrae articulating caudally near acetabulum.

99 a b b b b a a

100) synsacrum, costal processes of the acetabular vertebrae: a) discontinuous from processes of postacetabular vertebrae, long, tenuous, terminate laterally on the intermediate iliac crest that forms the cranioventral margin of the cranial recess of the pudendal part of the renal fossa, b) continuous with, although longer than, processes of postacetabular vertebrae, terminate laterally on the caudodorsal margin of the acetabulum, c) continuous with and indistinguishable from processes of postacetabular vertebrae, short, terminate on the medial margin of the postacetabular ala of the ilium. *Danielsavis nazensis* nov. gen., nov. sp. scored on NMS.Z.2021.40.3 in which costal processes of the acetabular vertebrae are markedly discontinuous from processes of postacetabular vertebrae but their articulation with the ilium is unknown. U

100 a a b c c a a a

101) synsacrum, costal processes of acetabular and postacetabular vertebrae, number thereof : a) 6, b) 7.

101 a a b b b b a ?

Femur:

102) pneumatic foramen: a) absent, b) present. ?

102 a b a a a a a ?

103) femur in entirety: a) long, slender, b) short, stout.

103 a b b b b a b ?

104) trochanteric crest, lateral view: a) truncate, b) elongated cranioproximally.

104 a b a a a b b ?

105) trochanteric fossa: a) deep, b) intermediate, c) absent. U

105 a b b c c a a ?

106) neck: a) long, constricted, b) short, c) short, very robust. U

106 a b b b c a b ?

107) distal extremity, cranial view: a) lateral condyle much longer distally than medial condyle b) condyles equal or subequal. *Danielsavis nazensis* nov. gen., nov. sp. scored on NMS.Z.2021.40.3.

107 a a b a a b a b

108) distal extremity, distal view: a) tall, narrow, medial condyle narrow, gap between medial condyle and tibiofibular crest wide, b) tall, narrow, medial condyle wide, gap between medial condyle and tibiofibular crest narrow, c) intermediate height and width, medial condyle narrow, gap between medial condyle and tibiofibular crest wide, d) short, wide, medial condyle wide, gap between medial condyle and tibiofibular crest narrow. U

108 a d b d c a d ?

109) medial crest of patellar groove, medial view: a) tall, rises abruptly from shaft, b) low.

109 a b a b b a b ?

110) tibiofibular crest, distal view: a) long, b) short.

110 a a a a a b a ?

111) fibular trochlea and tibiofibular crest, lateral view: a) cavity present in proximal portion, limiting the articular surface proximally, b) cavity absent.

111 a b b b b b a a

Tibiotarsus:

112) cranial cnemial crest, medial view: a) large, projects cranially more than proximally, b) small, projects more cranially than proximally, c) small, projects more proximally than cranially, d) large, projects as much or more proximally as cranially. U

112 a c d d d b a b

113) cranial cnemial crest, proximal view: a) positioned medially, b) positioned laterally.

113 a a a a a b b

114) proximal extremity: a) patellar crest low, retropatellar fossa shallow, b) patellar crest raised, retropatellar fossa deep.

114 b a a a a b a

115) lateral cnemial crest, cranial view: a) proximal margin curves distally to longitudinal orientation, lateral angle approximately 90°, b) proximal margin less curved, lateral angle obtuse or slightly acute, points laterad, c) oriented laterally, lateral angle a very acute, sharp hook pointing distally. U

115 a a b b b b c ?

116) lateral cnemial crest, caudolateral view: a) deeply concave, b) shallowly concave, c) convex. U

116 a c c c c b b ?

117) lateral cnemial crest, cranial view, deep pit: a) absent, b) present.

117 b a a a a a a

118) flexor fossa: a) deeply excavated, b) intermediate, c) shallow. U

118 a c c c b c a ?

119) tibial incisure: a) shallow, b) very deep.

119 a a a a a b a

120) fibular crest: a) short, b) long, c) very long. U

120 a b b b c b a ?

121) proximal extremity, lateral view, spur projecting distally towards fibular crest from lateral femoral articulation: a) small or absent, b) large. U

121 b a a a a b ?

Tarsometatarsus:

122) fossa of metatarsal I: a) large, deep, positioned medially, b) absent. U

122 a a a b b a b a

123) elevation of trochleae, plantar view: a) trochleae II and IV elevated proximally approximately equally, b) trochlea II elevated twice as much as trochlea IV, c) trochlea II elevated three times as much as trochlea IV. U

123 b a a b c a a a

124) trochlea II, distal view: a) broad, bulbous, grooved only slightly on most distal part or not at all, deflected plantad, b) narrow, grooved or not, compressed into shaft, c) very broad, square, grooved throughout, not deflected plantad. U

124 a a a b b a c a

125) trochlea II, collateral process, medial view: a) process knoblike, b) process bladeliike.

125 a a a b b a b a

126) trochlea II, collateral process, distal view: a) points plantad, b) points mediad.

126 a a b a a b a a

127) trochlea III, plantar view: a) articular surface broad and truncate proximally, b) long and tapered proximally.

127 a b a b b a a a

128) trochlea III, ratio of height to width, distal view: a) very wide (1.2), b) wide (1.4 - 1.6), c) narrow (1.8). U

128 b b b c c b a ?

129) trochlea III, distal view: a) lateral margin larger than medial margin, b) medial and lateral margins equal in size.

129 a a a a a b ?

130) lateral intertrochlear notch: a) narrow (*Anhima*), b) intermediate, c) wide (*Chauna*). U

130 a a/c c c b b c c

131) trochlea IV, distal view: a) dorsomedial margin level equal or more dorsal than dorsolateral margin of trochlea III, b) dorsomedial margin more plantad than dorsolateral margin of trochlea III.

131 a a a a b b b

132) distal neurovascular canal: a) large, b) small

132 a a a a b b a

133) distal interosseous canal, a) present, b) absent.

133 a a a b a a a

D. Summary of Putative Apomorphies of Select Taxa for Datasets 1-4 and 6

Dataset 1

1.1 *Anachronornis* nov. gen. included, *Danielsavis* nov.gen. omitted

1.1.1 Putative synapomorphies uniting *Anachronornis* nov. gen. as sister to Anseriformes to the exclusion of *Burhinus* and *Crax*

Unambiguous (7): 17, 36, 37, 39, 72, 131, 132

Ambiguous (10): 8, 9, 14, 28, 32, 33, 78, 90, 104, 116

1.1.2 Putative synapomorphies uniting *Anachronornis* nov. gen. as sister to Anhimidae

Unambiguous (8): 8, 33, 58, 69, 78, 89, 90, 115

Ambiguous (7): 5, 61, 83, 91, 97, 101, 130

1.1.3 Putative synapomorphies uniting *Anachronornis* nov. gen. as sister to Anseres

Unambiguous (8): 9, 12, 14, 22, 28, 32, 80, 104

Ambiguous (9): 4, 15, 29, 40, 45, 51, 67, 82, 123

1.2 *Danielsavis* nov. gen. included, *Anachronornis* nov. gen. omitted

1.2.1 Putative snapomorphies uniting *Danielsavis* nov. gen. as sister to Anseriformes to the exclusion of *Burhinus* and *Crax*

1.2.2 Unambiguous (5): 19, 36, 42, 72, 132

Ambiguous (14): 17, 18, 28, 33, 37, 81, 84, 85, 86, 92, 98, 99, 105, 116

1.2.3 Putative synapomorphies uniting *Danielsavis* nov. gen. as sister to Anhimidae

Unambiguous (2): 33, 69

Ambiguous (12): 5, 8, 16, 44, 61, 89, 90, 91, 97, 101, 102, 115

1.2.4 Putative synapomorphies uniting *Danielsavis* nov. gen. as sister to Anseres

Unambiguous (5): 22, 28, 51, 56, 59

Ambiguous (19): 4, 6, 7, 9, 10, 12, 13, 14, 25, 35, 40, 45, 63, 67, 72, 80, 81, 82, 104

1.3 *Anachronornis* nov. gen. and *Danielsavis* nov.gen. both included:

1.3.1 Putative synapomorphies uniting monophyletic *Anachronornis* nov. gen. and *Danielsavis* nov.gen. as sister to Anseriformes to the exclusion of *Burhinus* and *Crax*

Unambiguous (7): 17, 18, 19, 36, 37, 72, 132

Ambiguous (11): 8, 9, 14, 28, 33, 39, 42, 90, 104, 116, 131

1.3.2 Putative synapomorphies uniting *Anachronornis* nov. gen. and *Danielsavis* nov. gen. as monophyletic while sister to Anseriformes to the exclusion of *Burhinus* and *Crax*

Unambiguous (5): 21, 24, 30, 73, 77

Ambiguous (14): 4, 5, 31, 45, 53, 67, 82, 88, 91, 97, 111, 118, 120, 121

1.3.3 Putative synapomorphies uniting monophyletic *Anachronornis* nov. gen. and *Danielsavis* nov.gen. as sister to Anhimidae

Unambiguous (7): 8, 33, 58, 69, 89, 90, 115

Ambiguous (6): 5, 61, 78, 91, 97, 101

1.3.4 Putative synapomorphies uniting *Anachronornis* nov. gen. and *Danielsavis* nov. gen. as monophyletic while sister to *Anhimidae*

Unambiguous (9): 21, 24, 30, 31, 53, 73, 74, 77, 111

Ambiguous (23): 4, 5, 38, 45, 46, 62, 67, 82, 84, 85, 86, 88, 92, 98, 99, 103, 105, 106, 108, 116, 118, 120, 121

1.3.5 Putative synapomorphies uniting monophyletic *Anachronornis* nov. gen. and *Danielsavis* nov. gen. as sister to *Anseres*

Unambiguous (8): 9, 12, 14, 22, 28, 51, 80, 104

Ambiguous (13): 4, 15, 25, 29, 32, 40, 45, 56, 59, 67, 72, 82, 88

1.3.6 Putative synapomorphies uniting *Anachronornis* nov. gen. and *Danielsavis* nov. gen. as monophyletic while sister to *Anseres*

Unambiguous (9): 21, 24, 30, 31, 53, 73, 74, 77, 111

Ambiguous (21): 5, 38, 46, 62, 84, 85, 86, 88, 91, 92, 97, 98, 99, 103, 105, 106, 108, 116, 118, 120, 121

Dataset 2

2.1 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to pan-Anseriformes

2.1.1 while *Presbyornis* is sister to *Anseres*

Unambiguous (6): 3, 17, 23, 37, 44, 62

Ambiguous (3): 8, 64, 69

2.1.2 while *Presbyornis* is sister to *Anseriformes*

Unambiguous (5): 3, 23, 37, 44, 62

Ambiguous (7): 11, 17, 22, 25, 34, 64, 69

2.2 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Anhimidae*

2.2.1 while *Presbyornis* is sister to *Anseres*

Unambiguous (0): none

Ambiguous (1): 7

2.2.2 while *Presbyornis* is sister to *Anseriformes*

Unambiguous (1): 7

Ambiguous (6): 1, 11, 15, 20, 27, 38

2.3 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Anseres*

2.3.1 while *Presbyornis* is sister to *Anseres*

Unambiguous (1): 66

Ambiguous (5): 11, 22, 25, 34, 48

2.3.2 while *Presbyornis* is sister to *Anseriformes*

Unambiguous (0): none

Ambiguous (1): 26

Dataset 3

3.1 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to pan-Anseriformes while *Presbyornis* sister is to Anseres

Unambiguous (0): none

Ambiguous (11): 4, 8, 11, 12, 13, 16, 19, 27, 39, 43, 45

3.2 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to Anhimidae while *Presbyornis* is sister to Anseres

Unambiguous (4): 1, 39, 40, 42

Ambiguous (0): none

3.3 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to Anseres, excluding *Presbyornis*

Unambiguous (0): none

Ambiguous (0): none

3.4 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to pan-Anseres, including *Presbyornis*

Unambiguous (4): 5, 10, 17, 21

Ambiguous (6): 1, 18, 32, 39, 40, 42

3.5 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to pan-Anseres while *Presbyornis* is sister to Anatidae

Unambiguous (3): 16, 27, 43

Ambiguous (2): 7, 9

3.6 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Presbyornis* while both are sister to Anseres

Unambiguous (0): none

Ambiguous (2): 26, 51

Dataset 4

4.1 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to pan-Anseriformes

Unambiguous (0): none

Ambiguous (7): 2, 11, 12, 13, 17, 40, 50

4.2 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to Anhimidae

Unambiguous (0): none

Ambiguous (3): 3, 5, 20

4.3 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to Anseres

Unambiguous (1): 40

Ambiguous (7): 4, 16, 23, 30, 44, 55, 57

Dataset 6

6.1 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to pan-Anseriformes, including *Nettapterornis* and *Vegavis*

Unambiguous (12): 9, 17, 18, 27, 45, 52, 53, 55, 56, 85, 94, 95

Ambiguous (8): 5, 8, 34, 47, 59, 67, 86, 87

6.2 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to crown-Anseriformes

Unambiguous (1): 70

Ambiguous (8): 2, 5, 15, 49, 63, 68, 84, 90

6.3 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to Anhimidae

Unambiguous (8): 2, 5, 8, 15, 45, 49, 63, 84

Ambiguous (12): 4, 16, 22, 23, 30, 31, 33, 34, 37, 38, 40, 59

6.4 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to crown Anseres

Unambiguous (0): none

Ambiguous (2): 14, 69

Dataset 7

7.1 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to Palaeognathae

Unambiguous (5): 89, 131, 148, 197, 291

Ambiguous (22): 44, 45, 51, 57, 70, 110, 118, 120, 133, 156, 200, 212, 219, 230, 233, 236, 243, 252, 255, 259, 263, 296

7.2 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to Neognathae

Unambiguous (7): 34, 56, 180, 182, 183, 218, 221

Ambiguous (27): 5, 8, 17, 22, 28, 29, 39, 40, 50, 64, 75, 112, 120, 125, 129, 151, 165, 171, 179, 189, 223, 242, 254, 268, 288, 292, 294

7.3 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to Pelagornithidae

Unambiguous (7): 112, 120, 125, 153, 165, 223, 268

Ambiguous (22): 16, 19, 33, 54, 79, 81, 91, 110, 111, 119, 128, 168, 174, 182, 204, 209, 251, 253, 256, 260, 266, 290

7.4 Putative apomorphies uniting *Anachronornis* as sister to Neoaves

Unambiguous (2): 129, 140

Ambiguous (14): 17, 18, 42, 57, 71, 98, 103, 127, 139, 158, 218, 237, 248, 269

7.5 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Burhinus*

Unambiguous (9): 19, 106, 110, 112, 115, 139, 148, 153, 219

Ambiguous (18): 1, 57, 79, 107, 111, 156, 163, 175, 180, 181, 206, 231, 235, 241, 246, 247, 261, 262

7.6 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to Galloanseres

Unambiguous (1): 47

Ambiguous (13): 24, 29, 114, 129, 140, 153, 165, 176, 202, 209, 218, 223, 293

7.7 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to pan-Galliformes including *Asteriornis*

Unambiguous (4): 89, 120, 168, 200

Ambiguous (34): 40, 43, 44, 54, 70, 79, 91, 93, 98, 101, 103, 112, 118, 125, 128, 142, 146, 163, 177, 182, 188, 245, 246, 249, 254, 257, 258, 260, 261, 263, 266, 268, 272, 286

7.8 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Asteriornis*

Unambiguous (2): 46, 268

Ambiguous (31): 16, 18, 45, 71, 81, 87, 93, 94, 98, 99, 100, 106, 110, 111, 112, 115, 119, 126, 139, 156, 158, 161, 165, 174, 207, 217, 218, 222, 225, 226, 273

7.9 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Gallinuloides*

Unambiguous (2): 157, 182

Ambiguous (21): 16, 48, 51, 52, 56, 64, 65, 71, 98, 106, 119, 158, 174, 204, 207, 209, 217, 219, 262, 294, 295

7.10 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to crown-Galliformes

Unambiguous (3): 104, 153, 163

Ambiguous (10): 17, 18, 114, 139, 156, 171, 212, 249, 267, 293

7.11 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to pan-Anseriformes including *Vegavis*

Unambiguous (13): 19, 33, 48, 51, 53, 58, 110, 115, 131, 148, 204, 222, 290

Ambiguous (23): 6, 18, 37, 38, 64, 71, 97, 107, 111, 130, 136, 156, 158, 161, 181, 207, 217, 226, 235, 252, 259, 285, 296

7.12 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Vegavis*

Unambiguous (7): 120, 129, 140, 156, 158, 176, 226

Ambiguous (20): 16, 46, 47, 63, 79, 112, 117, 119, 127, 130, 171, 177, 185, 202, 209, 224, 255, 268, 272, 289

7.13 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to pan-Anseriformes excluding *Vegavis*

Unambiguous (3): 104, 157, 217

Ambiguous (9): 64, 65, 74, 165, 174, 241, 243, 244, 248

7.14 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to Anhimidae

Unambiguous (4): 18, 29, 81, 223

Ambiguous (8): 12, 16, 113, 161, 163, 189, 252, 257

7.15 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to pan-Anseres

Unambiguous (4): 65, 165, 174, 207

Ambiguous (18): 6, 43, 45, 46, 63, 69, 79, 98, 101, 112, 139, 153, 182, 188, 240, 258, 261, 285

7.16 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to stem-Anseres

Unambiguous (4): 71, 101, 129, 176

Ambiguous (15): 25, 36, 54, 70, 80, 90, 103, 119, 128, 168, 175, 209, 231, 268, 273

7.17 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Nettapterornis*

Unambiguous (1): 103

Ambiguous (15): 32, 47, 76, 97, 154, 168, 177, 187, 200, 202, 218, 219, 226, 272, 276

7.18 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Conflicto* & *Presbyornithidae*

Unambiguous (6): 89, 112, 119, 139, 140, 175

Ambiguous (6): 3, 10, 98, 108, 120, 156

7.19 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Conflicto*

Unambiguous (2): 3, 120

Ambiguous (16): 7, 29, 62, 93, 106, 118, 130, 143, 154, 177, 185, 215, 226, 241, 272, 276

7.20 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Presbyornithidae*

Unambiguous (3): 98, 156, 158

Ambiguous (9): 32, 76, 114, 145, 187, 189, 190, 218, 287

7.21 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Presbyornis*

Unambiguous (3): 218, 268, 273

Ambiguous (7): 128, 188, 204, 205, 235, 236, 269

7.22 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Wilaru*

Unambiguous (4): 145, 153, 187, 209

Ambiguous (24): 1, 7, 11, 16, 18, 29, 30, 34, 46, 47, 58, 63, 64, 161, 163, 166, 171, 177, 226, 257, 259, 261, 263, 294

7.23 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to crown-*Anseres*

Unambiguous (3): 46, 63, 182

Ambiguous (13): 24, 44, 76, 106, 118, 171, 196, 237, 253, 256, 260, 272, 276

7.24 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Anseranas*

Unambiguous (5): 76, 112, 158, 272, 276

Ambiguous (12): 12, 57, 74, 97, 108, 127, 188, 190, 236, 257, 266, 285

7.25 Putative apomorphies uniting *Anachronornis* nov. gen. as sister to *Anatoidea* (*Dendrocygna* and *Anatidae*)

Unambiguous (7): 79, 89, 118, 139, 140, 153, 223

Ambiguous (21): 1, 70, 82, 86, 93, 98, 103, 106, 114, 116, 120, 161, 177, 187, 209, 218, 240, 258, 261, 269, 273