SUPPLEMENTAL DATA

SEXUAL DIMORPHISM IN THE LATE MIOCENE MIHIRUNG
DROMORNIS STIRTONI (AVES: DROMORNITHIDAE) FROM THE
ALCOOTA LOCAL FAUNA OF CENTRAL AUSTRALIA

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TABLE S1. *Dromornis stirtoni* femora, tibiotarsi and tarsometatarsi: Physical measurements vs. Inferred measurements derived from landmark coordinate data. Assessment of the accuracy of inferred measurements derived from landmark coordinate data compared with the corresponding physical measurements recovered from preserved fossil structures. Normality of distribution was tested by the Shapiro-Wilks test, where P-values (P) > 0.05 indicate data are normally distributed; One-way ANOVAs include comparisons where P-values (P) > 0.05 indicate no significant difference was found between the assessed data. **Abbreviations:** CV, coefficient of variation; mm, millimeters; SD, standard deviation.

Physical measurements vs. Corresponding inferred measurements										
A. Femora	Maximum length		Proximal width		Distal width		Condylus lateralis-collum		Condylus medialis-collum	
Summary statistics	Measured	Inferred	Measured	Inferred	Measured	Inferred	Measured	Inferred	Measured	Inferred
n	15	15	33	33	18	18	18	18	17	17
Mean (SD) (mm)	400 (20.2)	416 (22.6)	165 (15.2)	169 (16.8)	198 (15.9)	200 (16.9)	365 (21.1)	374 (24.2)	329 (24.9)	340 (25.5)
Range (CV) (mm)	365-435 (5.1)	382-463 (5.4)	140-205 (9.2)	144-205 (9.9)	180-240 (8.1)	174-236 (8.5)	340-420 (5.8)	330-420 (6.5)	300-385 (7.6)	303-377 (7.5)
Distribution										
Shapiro-Wilk W (P)	0.97 (0.88)	0.97 (0.88)	0.97 (0.42)	0.96 (0.296)	0.91 (0.08)	0.97 (0.73)	0.92 (0.12)	0.98 (0.97)	0.93 (0.18)	0.91 (0.12)
One-way ANOVA				Degrees of freedom			F statistic		P (same) > 0.05	
Maximum length: Measured vs. Inferred				29			4.273		0.048	
Proximal width: Measured vs. Inferred				65			0.965		0.329	
Distal width: Measured vs. Inferred				35			0.105		0.748	
Condylus lateralis-collum: Measured vs. Inferred				35			1.591		0.216	
Condylus medialis-collum: Measured vs. Inferred				33			1.765		0.193	
B. Tibiotarsi	Maximum length		Articular length		Proximal width		Distal width			
Summary statistics	Measured	Inferred	Measured	Inferred	Measured	Inferred	Measured	Inferred	Measured	Inferred
n	10	10	14	14	9	9	13	13	13	13
Mean (SD) (mm)	798 (38.8)	880 (75.9)	733 (29.8)	821 (60.2)	224 (20.1)	243 (14.8)	153 (9.7)	156 (12.5)	153 (9.7)	156 (12.5)
Range (CV) (mm)	740-870 (4.9)	769-989 (8.6)	680-780 (4.1)	727-951 (7.3)	200-250 (8.9)	224-268 (6.1)	135-165 (6.3)	136-172 (7.9)	135-165 (6.3)	136-172 (7.9)
Distribution										
Shapiro-Wilk W (P)	0.97 (0.85)	0.93 (0.39)	0.96 (0.63)	0.97 (0.86)	0.88 (0.17)	0.96 (0.76)	0.91 (0.19)	0.92 (0.26)	0.91 (0.19)	0.92 (0.26)
One-way ANOVA				Degrees of freedom			F statistic		P (same) > 0.05	
Maximum length: Measured vs. Inferred				19			9.394		6.67E-03	
Articular length: Measured vs. Inferred				27			23.98		4.42E-05	
Proximal width: Measured vs. Inferred				17			5.474		0.033	
Distal width: Measured vs. Inferred				25			0.447		0.510	
C. Tarsometatarsi	Maximum length		Proximal width		Distal width		Trochlea metatarsi III width			
Summary statistics	Measured	Inferred	Measured	Inferred	Measured	Inferred	Measured	Inferred	Measured	Inferred
n	17	17	13	13	24	24	24	24	24	24
Mean (SD) (mm)	418 (30.9)	443 (36.2)	153 (13.4)	155 (15.1)	144 (12.1)	148 (11.9)	61 (5.5)	64 (5.9)	61 (5.5)	64 (5.9)
Range (CV) (mm)	360-480 (7.4)	374-506 (8.1)	125-175 (8.7)	128-180 (9.7)	125-170 (8.4)	130-174 (8.1)	54-72 (8.9)	54-75 (9.3)	54-72 (8.9)	54-75 (9.3)
Distribution										
Shapiro-Wilk W (P)	0.99 (0.99)	0.96 (0.7)	0.96 (0.78)	0.98 (0.99)	0.93 (0.12)	0.95 (0.28)	0.94 (0.16)	0.96 (0.38)	0.94 (0.16)	0.96 (0.38)
One-way ANOVA				Degrees of freedom			F statistic		P (same) > 0.05	
Maximum length: Measured vs. Inferred				33			4.902		0.034	
Proximal width: Measured vs. Inferred				47			0.922		0.342	
Distal width: Measured vs. Inferred				25			0.128		0.724	
Trochlea metatarsi III width: Measured vs. Inferred				47			2.792		0.102	

TABLE S2. Summary statistics of the complete inferred measurement data sets for *Dromornis stirtoni*; **A**, femora (n = 34), **B**, tibiotarsi (n = 19) and **C**, tarsometatarsi (n = 29) including linear measurements that were derived from coordinates for landmarks that were estimated. Normality of distribution was tested by the Shapiro-Wilks test, where P-values (P) > 0.05 indicate data are normally distributed. **Abbreviations:** **CV**, coefficient of variation; **mm**, millimeters; **SD**, standard deviation; **Troc**, trochlea.

Complete inferred measurement data sets.					
A. Femora	Maximum length	Proximal width	Distal width	Condylus lateralis-collum	Condylus medialis-collum
Summary statistics					
Mean (SD) (mm)	411.9 (31.5)	169.5 (16.7)	196.8 (16.1)	371.8 (28.4)	335.8 (24.5)
Range (CV) (mm)	352-476 (7.7)	144-205 (9.8)	170-236 (8.2)	315-426 (7.6)	294-378 (7.3)
Distribution					
Shapiro-Wilk W (P)	0.983 (0.856)	0.961 (0.263)	0.957 (0.197)	0.987 (0.942)	0.959 (0.236)
B. Tibiotarsi	Maximum length	Articular length	Proximal width	Distal width	
Summary statistics					
Mean (SD) (mm)	894.7 (67.2)	832.8 (58.9)	242.8 (22.4)	154.26 (13.0)	
Range (CV) (mm)	769-1007 (7.5)	727-951 (7.1)	201-293 (9.2)	132-172 (8.5)	
Distribution					
Shapiro-Wilk W (P)	0.978 (0.911)	0.979 (0.930)	0.971 (0.789)	0.934 (0.208)	
C. Tarsometatarsi	Maximum length	Proximal width	Distal width	Troc. metatarsi III width	
Summary statistics					
Mean (SD) (mm)	437.3 (38.3)	151.3 (14.6)	148.5 (11.9)	63.1 (5.9)	
Range (CV) (mm)	359-506 (8.8)	126-180 (9.6)	130-174 (8)	54-75 (9.4)	
Distribution					
Shapiro-Wilk W (P)	0.949 (0.175)	0.971 (0.591)	0.962 (0.362)	0.946 (0.148)	

TABLE S3. **A**, assessment of four body mass estimation algorithms from Anderson et al. (1985), Dickison (2007), Campbell and Marcus (1992) and Field et al. (2013) using femora least-shaft circumference measurements for *Dromornis stirtoni*. **B**, assessment of two body mass estimation algorithms from Dickison (2007), and Campbell and Marcus (1992) using tibiotarsi least-shaft circumference measurements for *D. stirtoni*. **C**, estimated body mass for *Aepyornis maximus* using the algorithms of Campbell and Marcus (1992) for femora and tibiotarsi. Shaft circumference metrics for *A. maximus* are sourced from Monnier (1913:140) who published only the range of the femora and tibiotarsi shaft circumferences that were measured. Normality of distribution was tested by the Shapiro-Wilks test, where P-values (P) > 0.05 indicate data are normally distributed; One-way ANOVAs include Tukey's pairwise comparisons where P-values (P) > 0.05 indicate the means of the assessed data are the same. Kruskal-Wallis test assessment of non-parametric data includes pairwise comparisons where P-values (P) > 0.05 indicate the means of the assessed data are the same. **Abbreviations:** **SD**, standard deviation; **CV**, coefficient of variation; **Ave. EBM**, average estimated body mass; **EBM**, estimated body mass; **No.**, number.

A. <i>D. stirtoni</i> estimated body mass: Femora least-shaft circumference measurements (n = 50)										
Summary Statistics	Anderson et al.		Dickison		Campbell and Marcus		Field et al.		Ave. EBM (excl. Anderson)	
Mean (Range) SD (kg)	305.5 (190.5-444.3)	60.2	477 (286-713.5)	101.4	501.5 (303.9-744.5)	104.5	491.1 (298.3-727.8)	101.9	489.9 (296.1-728.6)	102.6
Distribution										
Shapiro-Wilk W (P)	0.972 (0.289)		0.971 (0.263)		0.972 (0.269)		0.972 (0.272)		0.972 (0.268)	
One-way ANOVA No.1:	Tukey's pairwise comparisons; Q below diagonal, P (mean = same > 0.05) above diagonal									
	Anderson et al.		Dickison		Campbell and Marcus		Field et al.			
Anderson et al.			7.72E-06		7.72E-06		7.72E-06			
Dickison	12.93				0.56		0.876			
Campbell and Marcus	14.77		1.845				0.946			
Field et al.	13.99		1.062		0.783					
One-way ANOVA No.2:	Tukey's pairwise comparisons; Q below diagonal, P (mean = same > 0.05) above diagonal									
	Ave. EBM (excl. Anderson)		Dickison		Campbell and Marcus		Field et al.			
Ave. EBM (excl. Anders.)			0.924		0.942		0.999			
Dickison	0.886				0.631		0.902			
Campbell and Marcus	0.801		1.687				0.958			
Field et al.	0.085		0.971		0.716					
B. <i>D. stirtoni</i> estimated body mass: Tibiotarsi least-shaft circumference measurements (n = 46)										
Summary statistics	Campbell and Marcus		Dickison		Average EBM					
Mean (Range) SD (kg)	477 (348.9-632.1)	80.3	483 (340.2-659.4)	90.5	480.1 (344.6-645.8)	85.4				
Distribution										
Shapiro-Wilk W (P)	0.931 (0.009)		0.931 (0.009)		0.931 (0.009)					
Non-parametric Kruskal-Wallis test for equal medians:	P (mean = same > 0.05) above diagonal									
	Campbell and Marcus		Dickison		Average EBM					
Campbell and Marcus			0.687		0.687					
Dickison	1				0.687					
Average EBM	1		1							
C. <i>Aepyornis maximus</i> estimated body mass: Femora and tibiotarsi shaft circumference measurements										
Element	Femora		Tibiotarsi							
Median (Range) (kg)	527.9 (341.9-713.9)		360.6 (242.9-478.3)							

TABLE S4: Published measured body mass (g) of Australian anseriforms and palaeognaths from the sources listed below. Livezey and Humphrey's (1984:371) and Livezey's (1993:196, 1996a:79, 1996b:420, 1997:55) "dimorphism ratio" (DR) of males (♂) to females (♀) is presented for each taxon for comparison with the DR returned in this study for *Dromornis stirtoni* calculated using the results for sex assigned tibiotarsi, and display, breeding and nesting behavior characteristics (see Table S5). Phylogeny follows Dickinson and Remsen (2013) except where indicated (*).

Neognathae	Family	Sub-Family	Tribe	Genus/species	♂ (g) [n]	♀ (g) [n]	DR ♂/♀	Source
Anseriformes	Dromornithidae†			<i>Dromornis stirtoni</i> †	528400 [10]	451100 [9]	1.17:1	1
	Anseranatidae			<i>Anseranas semipalmata</i>	2766 [402]	2071 [359]	1.34:1	2
	Anatidae	Dendrocygninae		<i>Dendrocygna arcuata</i>	866 [287]	732 [293]	1.18:1	2
				<i>Dendrocygna eytoni</i>	788 [63]	792 [65]	0.99:1	2
		Oxyurinae		<i>Biziura lobata</i> *	2398 [243]	1551 [292]	1.55:1	2
				<i>Stictonetta naevosa</i> *	969 [63]	842 [31]	1.15:1	2
				<i>Malacorhynchus membranaceus</i> *	404 [77]	344 [81]	1.17:1	2
		Anserinae	Anserini	<i>Branta canadensis</i>	4078 [58]	3320 [45]	1.23:1	2
			Cereopsini	<i>Cereopsis novaehollandiae</i>	4400 [14]	4290 [1]	1.03:1	2
			Cygnini	<i>Cygnus atratus</i>	6270 [247]	5100 [219]	1.23:1	2
		Anatinae	Anatini	<i>Anas castanea</i>	683 [67]	593 [50]	1.15:1	2
				<i>Anas gracilis</i>	507 [210]	474 [138]	1.07:1	2
				<i>Anas platyrhynchos</i>	1735 [30]	1580 [19]	1.1:1	2
				<i>Anas rhynchotis</i>	667 [76]	665 [70]	1:1	2
				<i>Anas superciliosa</i>	1114 [131]	1025 [207]	1.09:1	2
			Aythiini	<i>Aythya australis</i>	902 [105]	838 [88]	1.08:1	2
			Tadornini	<i>Tadorna tadornoides</i>	1559 [67]	1291 [185]	1.21:1	2
				<i>Tadorna radjah</i>	934 [46]	839 [49]	1.11:1	2
		Anatinae—Genera incertae sedis		<i>Chenonetta jubata</i>	815 [45]	800 [26]	1.02:1	2
				<i>Nettapus pulchellus</i>	310 [47]	304 [26]	1.02:1	2
				<i>Nettapus coromandelianus</i>	403 [52]	380 [37]	1.06:1	2
Palaeognathae	Family	Sub-Family	Tribe	Genus/species	♂ (g) [n]	♀ (g) [n]	DR ♂/♀	Source
Struthioniformes	Struthionidae			<i>Struthio camelus</i>	115000 [?]	100000 [?]	1.15:1	4
Rheiformes	Rheidae			<i>Rhea americana albescens</i>	28706 [4]	22507 [6]	1.28:1	5
Apterygiformes	Apterygidae			<i>Apteryx australis</i>	2120 [15]	2540 [31]	0.83:1	3
				<i>Apteryx owenii</i>	1135 [51]	1351 [41]	0.84:1	2
				<i>Apteryx haasti</i>	1692 [7]	2418 [12]	0.7:1	3
Casuariiformes	Casuariidae	Casuariinae		<i>Casuarius casuarius</i>	31700 [2]	58500 [1]	0.54:1	2
		Dromaiinae		<i>Dromaius novaehollandiae</i>	31500 [11]	36900 [11]	0.85:1	4
Palaeognathae: New Zealand Moa			Fossil site locations	Genus/species	♂ (g) [n]	♀ (g) [n]	DR ♂/♀	Source
Dinornithiformes †	Dinornithidae		Nth Isle: Makirikiri	<i>Dinornis novaezealandiae</i> †	55800 [22]	109900 [49]	0.51:1	6
			Sth Isle: Canterbury	<i>Dinornis robustus</i> †	84000 [27]	166000 [72]	0.51:1	6

Abbreviations: †, Extinct Order/family/species; *, phylogenetic relationships proposed by Worthy and Lee (2008); ♂, male; ♀, female; g, grams; n, number of specimens measured; **DR** ♂/♀, dimorphism ratio—males/females; **Vols.**, Volumes. **Sources:** 1, this study; 2, Marchant and Higgins, Vols. 1A and 1B (1990); 3, Dunning (2008); 4, Davies (2002); 5, Navarro et al. (2005); 6, Worthy et al. (2005).

TABLE 5S: Published display, breeding and nesting behavior characteristics of Australian anseriforms and palaeognaths for association with Livezey and Humphrey's (1984:371) and Livezey's (1993:196, 1996a:79, 1996b:420, 1997:55) "dimorphism ratio" (DR) results (see Table S4). Phylogeny follows Dickinson and Remsen Jr. (2013) except where indicated (*).

Family	Sub Family	Species	Monogamy	Display	Incubation	Parental care	Nest defence	Nest Type	Nest Loc.
Anseranatidae		<i>A. semipalmata</i>	Lifelong	♂♀ (T)	♂♀	♂♀	♂♀ (♂+)	Platform veg.	P/O
Anatidae	Dendrocygninae	<i>D. arcuata</i>	Lifelong	♂♀	♂♀	♂♀ (♂+)	No data	In reeds/Ground	P
		<i>D. eytoni</i>	Lifelong	♂♀ (Cryptic)	♂♀	♂♀ (♂+)	No data	In grass/Ground	>D
	Oxyurinae	<i>Biziura lobata</i> *	No	♂♂♂ (Lek)	♀	♀	♀	Dense veg/Logs	P/O
		<i>Stictonetta naevosa</i> *	Seasonal +	♂+ ♀ (Cryptic)	♀	♀ (Aggr.)	♂♀ (♀+)	Dense veg/Ground	O
		<i>M. membranaceus</i> *	Prob. Lifelong	♂♀	♀	♂♀ (♂+)	♂♀ (♀+)	Hollow trees	P/O
	Anserinae	<i>Branta canadensis</i>	Sustained	♂♀ (T)	♀	♂♀	♂♀	Grassland/Ground	>D
		<i>C. novaehollandiae</i>	Lifelong	♂♀ (T)	♀	♂♀	♂♀	Grassland/Ground	>D
		<i>Cygnus atratus</i>	Sustained	♂♀ (T)	♀	♂♀	♂♀ (♂+)	Platform veg.	P/O
	Anatinae	<i>Anas castanea</i>	Lifelong	♂♀	♀	♂♀	♂	Hollow trees	P/O
		<i>Anas gracilis</i>	Lifelong	♂♀	♀	♂♀	♂	Hollow trees	P/O
		<i>Anas platyrhynchos</i>	Prob. Lifelong	♂♀	♀	♀	♂ (Short term)	Ground	P
		<i>Anas rhynchotis</i>	Probably	♂♂	♀	♀	Concealment	Concealed/Ground	IP
		<i>Anas superciliosa</i>	Probably	♂♀	♀	♀	♂	Hollow trees	D
		<i>Aythya australis</i>	Seasonal	♂♂♂ (No lek)	♀	♀	No data	Dense veg.	O
		<i>Tadorna tadornoides</i>	Prob. Lifelong	♀ (T)	♀	♂♀	♂♀ (♂+)	Hollow trees	P/O/>D
		<i>Tadorna radjah</i>	Prob. Lifelong	♂♀ (T)	♀	♂♀	♂♀	Hollow trees	P
	Anatinae Genera Incertae sedis	<i>Chenonetta jubata</i>	Sustained	♂♀	♀	♂♀	♂♀	Hollow trees	P/D
		<i>Nettapus pulchellus</i>	Sustained	♂♀	♀	♂♀	♂	Hollow trees	P/O
		<i>N. coromandelianus</i>	Seasonal +	No data	♀	♂♀	No data	Hollow trees	P/O
Struthionidae		<i>Struthio camelus</i>	None	♂+ ♀	♂♀	♂♀ (♂+)	♂+ ♀	Ground	>D
Rheidae		<i>Rhea americana</i>	None	♂♀	♂	♂	♂	Layer veg/Ground	>D
		<i>Rhea pennata</i>	None	♂	♂	♂	♂	Layer veg/Ground	>D
Apterygidae		<i>Apteryx australis</i>	Seasonal +	♂♀ (Cryptic)	♂	Weak	Concealment	Burrow/Hole	D
		<i>Apteryx owenii</i>	No data	♂♀ (Cryptic)	♂	Weak	Concealment	Burrow/Hole	D
		<i>Apteryx haasti</i>	Sustained	No data	♂♀	Weak	Concealment	Burrow/Hole	D
Casuariidae		<i>Casuarius casuarius</i>	None	♂	♂	♂ (Aggr.)	♂ (Aggr.)	Layer veg/Ground	>D
		<i>D. novaehollandiae</i>	None	♂♀	♂	♂ (Aggr.)	♂ (Aggr.)	Layer veg/Ground	>D

Abbreviations: ♂, male; ♀, female. **Monogamy:** **Lifelong**, predominately monogamous for life; **Prob. Lifelong**, probably lifelong monogamy; **Seasonal +**, generally seasonal, but some pairing maintained for multiple seasons; **Sustained**, generally lifelong monogamy, but some divorce/re-pairing observed. **Display:** **T**, triumph ceremony; ♂♂♂, multiple males display to unpaired female–female mate choice; ♂+ ♀, both sexes display, males more so. **Parental care/Nest defence:** ♂♀ (♂+), both sexes provide, males more so; ♂♀ (♀+), both sexes provide, females more so; ♂ (Aggr.), male aggressive; ♀ (Aggr.), female aggressive. **Nest type:** **Ground**, on ground level, often in a shallow depression; **Veg.**, vegetation. **Nest Loc:** nest location with respect to body of water; **D**, distal from water (within 1200 metres); **>D**, distant to water (generally further than 1200 metres); **O**, over water; **P**, proximal to water; **IP**, in proximity of water (within 200 metres). **DR M/F:** Dimorphism ratio–males/females. **Vols.**, volumes. *, phylogenetic relationships proposed by Worthy and Lee (2008). **Sources:** Marchant and Higgins, Vols. 1A and 1B (1990); Davies (2002); Kear, Vols. 1 and 2 (2005).

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