

Supplementary material

Appendix

Table A1. List of species and variables.

Name	Penis length (cm)	Combined testes size (g)	Number of vaginal spirals	Promiscuity	Intensity of sexual conflict	Pairings per breeding season	Egg mass (g)	Clutch size	Male mass (g)	Female mass (g)	
White-faced Whistling Duck	<i>Dendrocygna viduata</i>	9.17	0.20		0	2	1	38.0	11	690	662
White-backed Duck	<i>Thalassornis leuconotus</i>	2.41			0	1	1	82.6	8	708	680
Cape Barren Goose	<i>Cereopsis novaehollandiae</i>	7.78			0	1	1	126.9	4	4300	3560
Red-breasted Goose	<i>Branta ruficollis</i>	1.25			0	1	1	78.2	5	1375	1094
Canada Goose	<i>Branta canadensis</i>	2.42	4.26	0	0	1	1	163.0	6	4460	4044
Bar-headed Goose	<i>Anser indicus</i>	11.78			0	1	1	142.2	5	2460	2230
Snow Goose	<i>Anser caerulescens</i>	12.50	17.90		0	3	1	127.0	4	2744	2630
Tundra Swan	<i>Cygnus columbianus</i>	2.33			0	1	1	280.0	4	7200	6200
Torrent Duck	<i>Merganetta armata</i>	1.58	0.43		0	1	1	62.0	3	482	330
Spur-winged Goose	<i>Plectropterus gambensis</i>	16.11	21.00			1	2	125.0	9	6100	4700
Orinoco Goose	<i>Neochen jubata</i>	2.67			0	1	1	64.5	9	1825	1250
Upland Goose	<i>Chloephaga picta</i>	7.00			0	1	1	128.0	6	3105	2690
South African Shelduck	<i>Tadorna cana</i>	6.00	0.25		0	1	1	97.1	10	1758	1417
Australian Shelduck	<i>Tadorna tadornoides</i>	8.56			0	1	1	90.0	10	1559	1290
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>	13.89	1.50		0	1	1	35.2	7	404	344
Muscovy Duck	<i>Cairina moschata</i>	13.30	30.00		1	2	3	78.7	9	2858	2022
Wood Duck	<i>Aix sponsa</i>	10.88	0.98		0	2	2	44.0	11	681	635
Mandarin Duck	<i>Aix galericulata</i>	6.60			0	1	2	38.7	9	628	512
Maned Duck	<i>Chenonetta jubata</i>	14.89	5.70		0	2	1	55.8	10	815	800
African Pygmy Goose	<i>Nettapus auritus</i>	7.50	0.01		0	1	2	22.9	9	285	260
Green Pygmy Goose	<i>Nettapus pulchellus</i>	3.90			0	1	2	25.0	10	310	304
Cinnamon Teal	<i>Spatula cyanoptera</i>	7.61	5.56		0	2	2	30.8	10	408	363
Northern Shoveler	<i>Spatula clypeata</i>	4.10	2.29	2.5	0	1	2	39.1	10	636	590
Eurasian Wigeon	<i>Mareca penelope</i>	3.75			0	1	2	46.4	9	819	724
Chiloe Wigeon	<i>Mareca sibilatrix</i>	12.44			0	2	1	57.2	7	939	828
American Wigeon	<i>Mareca americana</i>	5.30	0.99	2	0	2	2	44.1	9	792	719
African Black Duck	<i>Anas sparsa</i>	11.72			0	1	1	67.7	6	1027	909
Pacific Black Duck	<i>Anas superciliosa</i>	14.78	5.78		0	3		54.1	9	1059	981
Laysan Duck	<i>Anas laysanensis</i>	8.50			0	3		44.1	3	456	427
Mallard	<i>Anas platyrhynchos</i>	14.50	21.45	3.6	0	3	2	52.0	10	1170	1000
Mottled Duck	<i>Anas fulvigula</i>	13.06	2.40		0	2		51.0	10	1030	968
White-cheeked Pintail	<i>Anas bahamensis</i>	13.89			0	3	1	40.5	8	526	502
Yellow-billed Pintail	<i>Anas georgica</i>	17.22	21.34		0	3	1	37.0	4	632	535
Northern Pintail	<i>Anas acuta</i>	17.40	9.48	8	0	3	2	40.3	7	1035	986
Green-winged Teal	<i>Anas carolinensis</i>	13.90	0.75	8	0	3	2	25.2	9	322	309

Yellow-billed Teal	<i>Anas flavirostris</i>	15.28			0	3	1	34.3	7	420	395
Red-crested Pochard	<i>Netta rufina</i>	15.56			0	3	2	56.8	10	1130	1100
Redhead	<i>Aythya americana</i>	15.00			0	2	2	62.9	9	1071	990
Hardhead	<i>Aythya australis</i>	16.11	4.36		0	2	2	55.8	10	902	838
Lesser Scaup	<i>Aythya affinis</i>	6.70	4.70	3.5	0	3	2	48.2	10	850	790
Steller's Eider	<i>Polysticta stelleri</i>	10.39			0	1	2	55.1	8	848	834
King Eider	<i>Somateria spectabilis</i>	15.00	4.20		0	1	2	66.7	5	1668	1567
Common Eider	<i>Somateria mollissima</i>	5.90	5.80	0	0	1	2	111.0	4	2218	1915
Harlequin Duck	<i>Histrionicus histrionicus</i>	4.20	1.21	0	0	1	2	54.4	6	687	558
Scoter	<i>Melanitta nigra</i>	2.11	4.50		0	1	2	74.2	9	1100	800
Long-tailed Duck	<i>Clangula hyemalis</i>	15.20	9.75	7	0	2	2	44.1	8	932	814
Common Goldeneye	<i>Bucephala clangula</i>	2.80	1.10	0	0	1	2	64.1	9	1100	800
Barrow's Goldeneye	<i>Bucephala islandica</i>	3.00		1	0	1	2	67.7	8	1090	730
Common Merganser	<i>Mergus merganser</i>	8.00	5.25		0	1	2	79.2	9	1700	1232
Red-breasted Merganser	<i>Mergus serrator</i>	4.30	14.19	2	0	2	2	73.3	10	1135	908
Ruddy Duck	<i>Oxyura jamaicensis</i>	19.31	10.75	6	1	3	3	71.3	8	571	499
Blue-billed Duck	<i>Oxyura australis</i>	28.50			1	3	3	84.4	6	812	852
Musk Duck	<i>Biziura lobata</i>	20.62			1	2	3	127.9	3	2398	1551
N		53	31	14	52	53	51	53	53	53	53

Table A2A. Basic statistics of penis length (residuals from a log-log regression on male body mass) among waterfowl species related to three categories characterized by different frequencies of forced copulations, and the result of a Kruskal – Wallis Test.

Forced copulations	N	Mean	Median	Variance
none	27	-0.2121	-0.1353	0.1033
occasional	13	0.1178	0.1880	0.0443
frequent	13	0.2148	0.2404	0.0249
Test statistic $H = 19.5052$				
$F_{1.94, 40.3} = 16.8363, p < 0.00001$				

Table A2B. Results of regression analyses with penis length (residuals from a log-log regression on male body mass) or the number of vaginal spirals as the dependent (criterion) variables. Predictor variables were the intensity of sexual conflict (ordinal variable), occurrence of a promiscuous mating system, egg size (residuals from a log-log regression on female body mass), and combined testes mass (residuals from a log-log regression on male body mass). Bootstrap test based on B = 10,000 samples. See also Figs. 2 and 3.

Criterion	Predictors	Structure coefficient	Variance explained (R ²)	Bootstrapped 95% Confidence limits for R ²	P (d. f.)	Comment
Number of vaginal spirals			0.720	0.456 - 0.950	< 0.002 (2, 10)	Fig. 2
	Intensity of sexual conflict	0.9618			< 0.005	
	Log(egg size, residual)	-0.5009			0.195	
Log(penis length, residuals)			0.743	0.508 – 0.943	< 0.002 (2, 10)	
	Log(testes mass, residual)	0.8239			< 0.05	
	Number of vaginal spirals	0.8908			< 0.02	
Log(penis length, residuals)			0.493	0.296 - 0.683	<0.00001 (3, 49)	Fig. 3
	Promiscuity	0.5157			<0.005	
	Intensity of sexual conflict	0.8231			<0.001	
	Log(egg size, residual)	-0.4821			<0.005	

Table A2C. The analyses in Table A1B repeated with phylogenetically transformed data.

Criterion	Predictor(s)	Structure coefficient	Variance explained (R ²)	Bootstrapped 95% Confidence limits for R ²	P (d. f.)	Comment
Number of vaginal spirals			0.608	0.359 – 0.914	< 0.01 (2, 10)	
	Intensity of sexual conflict	0.9737			<0.01	
	Log(egg size, residual)	-0.5793			0.391	
Log(penis length, residuals)			0.660	0.425 – 0.918	< 0.005 (2, 10)	
	Log(testes size, residual)	0.8810			<0.05	
	Number of vaginal spirals	0.8474			< 0.05	
Log(penis length, residuals)			0.331	0.122 – 0.599	< 0.0002 (3, 49)	
	Promiscuity	0.3363			< 0.05	
	Intensity of sexual conflict	0.2909			0.511	
	Log(egg size, residual)	-0.8792			< 0.00005	

Table A3. Single correlations of penis length and number of vaginal spirals with other variables considered in analyses of 13 waterfowl species. Because we conducted multiple analyses on the same dependent variables, Bonferroni-corrected significances are additionally indicated with asterisks (below 5%, 1%, and 0.5% limit respectively) in this survey.

Criterion	Predictor	Raw data		Phylogenetically transformed data	
		r	P	r	P
Penis length (log-log residuals)	Promiscuity	0.408	0.167	0.340	0.256
	Clutch size	0.055	0.859	-0.106	0.859
	Intensity of sexual conflict	0.803	< 0.001 **	0.734	< 0.005 *
	Egg mass (log-log residuals)	-0.233	0.443	-0.349	0.243
	Testes mass (log-log residuals)	0.710	< 0.01 *	0.683	< 0.02
	Number of vaginal spirals	0.768	< 0.005 *	0.709	< 0.01 *
	Pairings/Year	0.537	< 0.1	0.253	0.404
Number of vaginal spirals	Promiscuity	0.225	0.460	0.235	0.440
	Clutch size	0.284	0.347	0.253	0.404
	Intensity of sexual conflict	0.816	< 0.001 ***	0.797	< 0.002 **
	Egg mass (log-log residuals)	-0.425	0.148	-0.466	0.108
	Testes mass (log-log residuals)	0.477	< 0.1	0.435	0.137
	Penis length (log-log residuals)	0.768	< 0.005 *	0.709	< 0.01 *
	Pairings/Year	0.234	0.442	0.064	0.837

Table A4. Univariate analysis of the phylogenetic dependence of characters with N = 53 used in this study. Pagel's λ indicates phylogenetic dependence, varying from 0 (no dependence) to 1 (trait evolved according to Brownian motion on the given phylogeny). However, values higher than 1 can arise as estimates if, trait values are more similar than that predicted by Brownian motion. Freckleton et al. 2002. Am. Nat. 160: 712-726.

Variable	λ	P	
Promiscuity	1.0105	< 0.00001	
Sexual size dimorphism	0.8895	< 0.00001	
Intensity of sexual conflict	0.8753	< 0.001	
Penis length (log-log residuals)	0.7680	<0.005	
Egg mass (log-log residuals)	0.7282	< 0.02	

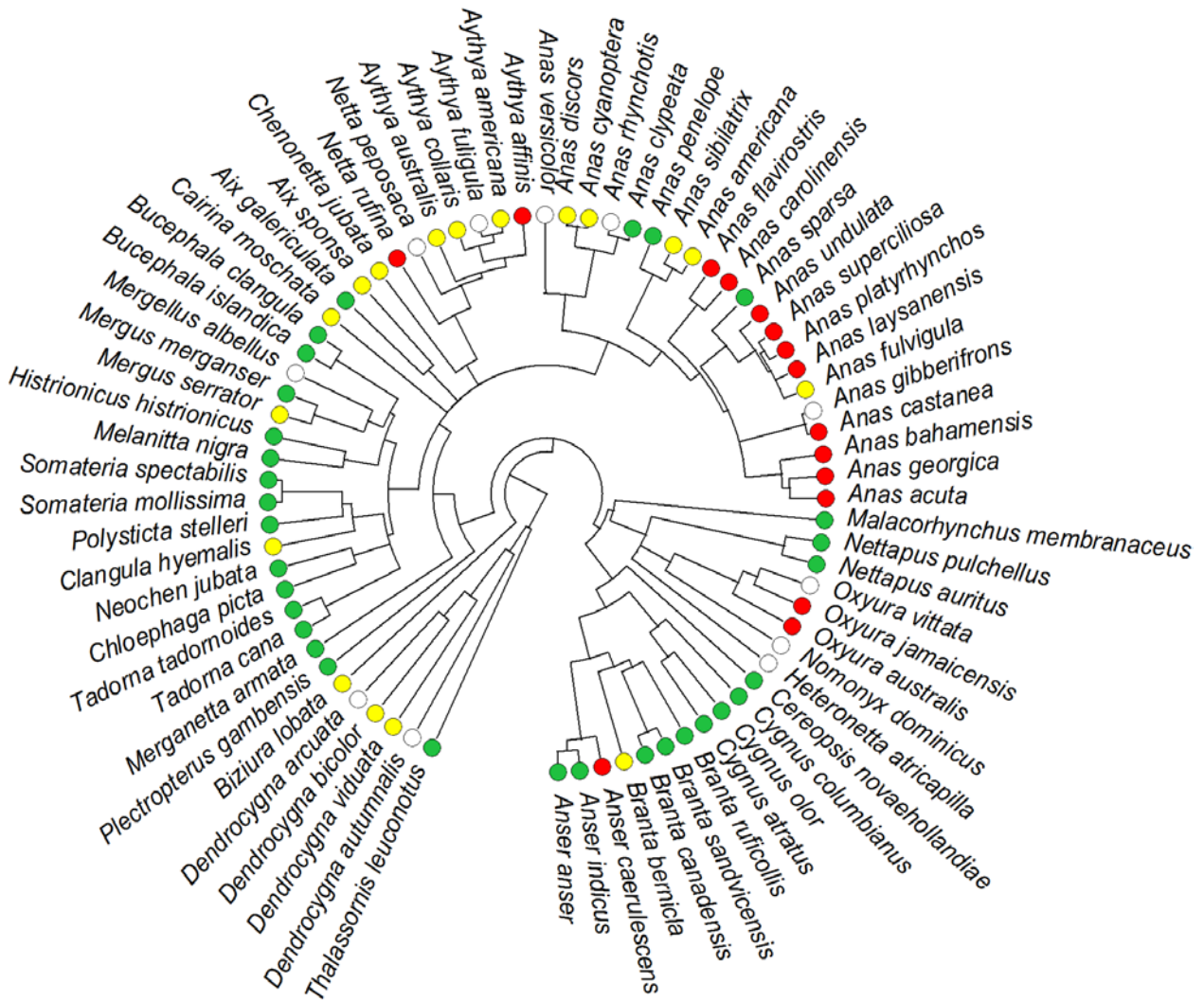


Figure A1. The phylogeny of the waterfowl species considered in the study, with the variable “intensity of sexual conflict” mapped on it. The branch lengths of the tree were smoothed with program r8s v1.8 (Sanderson 2003) for displaying purposes only. Empty circles denote missing data; green = no or very rare forced copulations, yellow = FC occurring occasionally, and red = frequent FC.

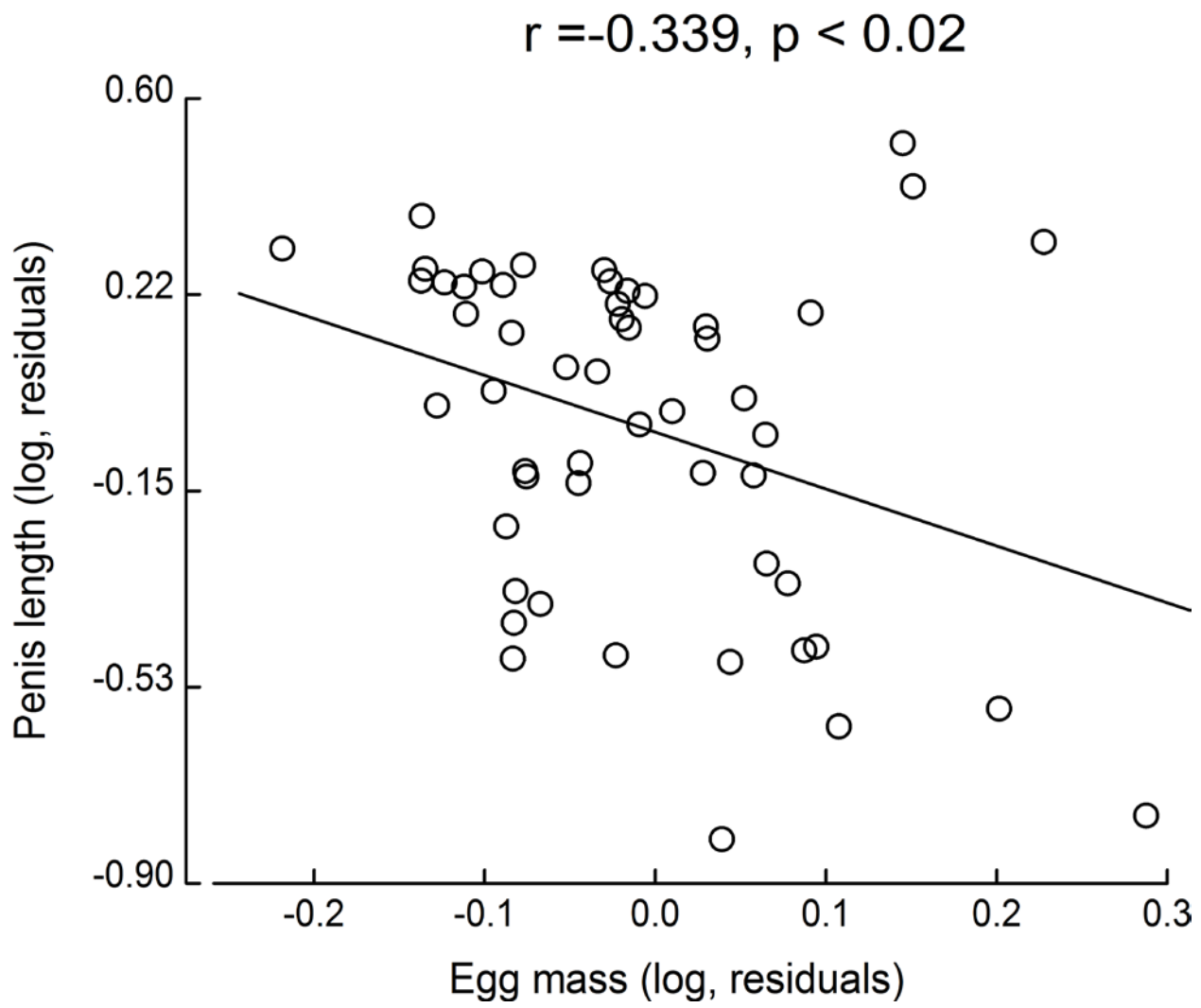


Figure A2. Plot of waterfowl egg mass (residuals of a log-log regression on female mass) versus penis length (residuals of a log-log regression on male mass).