

**Supplementary material**

## **Appendix 1**

**Table A1:** List of species used in the study, with sample sizes, testes data sources, and method used to estimate peak testis size during the breeding season.

**Table A2:** Number of extant species per family in each size and shape asymmetry category.

**Table A3:** Summary of model results where there was no significant effect of the predictors of interest.

**References:** Literature sources for the testes size data and the phylogeny used in our analyses.

**NOTE:** The data file (comma-separated format) and phylogeny file (Nexus format) used in the analyses are available in Dryad.

**Table A1.** List of species used in the study, with sample sizes, testis data sources and peak size estimation methods. See ‘References’ for full details on sources.

Scientific Name	Order	Family	Source of Testis Data	Detailed Source	Peak Estimation	N
<i>Accipiter cirrocephalus</i>	Accipitriformes	Accipitridae	Museum Collections	AM	polynomial fit	6
<i>Accipiter cooperii</i>	Accipitriformes	Accipitridae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	16
<i>Accipiter fasciatus</i>	Accipitriformes	Accipitridae	Museum Collections	AM	polynomial fit	13
<i>Acridotheres tristis</i>	Passeriformes	Sturnidae	Literature	Dang & Guraya (1978)	indirect	—
<i>Acrocephalus melanopogon</i>	Passeriformes	Acrocephalidae	Laboratory Books	TR Birkhead (unpub.)	means	4
<i>Acrocephalus paludicola</i>	Passeriformes	Acrocephalidae	Laboratory Books	TR Birkhead (unpub.)	means	4
<i>Acrocephalus schoenobaenus</i>	Passeriformes	Acrocephalidae	Laboratory Books	TR Birkhead (unpub.)	means	16
<i>Acrocephalus scirpaceus</i>	Passeriformes	Acrocephalidae	Laboratory Books	TR Birkhead (unpub.)	means	4
<i>Aegithalos caudatus</i>	Passeriformes	Aegithalidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Aegolius acadicus</i>	Strigiformes	Strigidae	Museum Collections	Cornell, FMNH	polynomial fit	9
<i>Agelaius phoeniceus</i>	Passeriformes	Icteridae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Ailuroedus crassirostris</i>	Passeriformes	Ptilonorhynchidae	Museum Collections	AM	polynomial fit	5
<i>Alauda arvensis</i>	Passeriformes	Alaudidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Alectoris chukar</i>	Galliformes	Phasianidae	Literature	Delehanty & O'Hearn (2005)	indirect	24
<i>Alisterus scapularis</i>	Psittaciformes	Psittacidae	Museum Collections	AM	polynomial fit	5
<i>Amblyospiza albifrons</i>	Passeriformes	Ploceidae	Museum Collections	Cornell, FMNH	polynomial fit	5
<i>Ammodramus caudacutus</i>	Passeriformes	Emberizidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Ammodramus maritimus</i>	Passeriformes	Emberizidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Amytornis striatus</i>	Passeriformes	Maluridae	Laboratory Books	M Rowe & S Pruett-Jones (unpub.)	means	6
<i>Anas castanea</i>	Anseriformes	Anatidae	Museum Collections	AM	polynomial fit	5
<i>Anas clypeata</i>	Anseriformes	Anatidae	Literature	DuBowy (1985)	direct	—
<i>Anas discors</i>	Anseriformes	Anatidae	Literature	DuBowy (1985)	direct	—

Scientific Name	Order	Family	Source of Testis Data	Detailed Source	Peak Estimation	N
<i>Anas georgica</i>	Anseriformes	Anatidae	Literature	Weller (1975)	indirect	—
<i>Anas gibberifrons</i>	Anseriformes	Anatidae	Museum Collections	AM	polynomial fit	12
<i>Anas platyrhynchos</i>	Anseriformes	Anatidae	Museum Collections	CM, Cornell, FMNH, AM, ROM	polynomial fit	11
<i>Anas superciliosa</i>	Anseriformes	Anatidae	Museum Collections	AM	polynomial fit	20
<i>Anser caerulescens</i>	Anseriformes	Anatidae	Museum Collections	CMN, Cornell	polynomial fit	6
<i>Aratinga pertinax</i>	Psittaciformes	Psittacidae	Museum Collections	FMNH	polynomial fit	6
<i>Ardea herodias</i>	Pelecaniformes	Ardeidae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	44
<i>Asio otus</i>	Strigiformes	Strigidae	Museum Collections	Cornell, ROM, UTEP	polynomial fit	5
<i>Athene cunicularia</i>	Strigiformes	Strigidae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	9
<i>Basileuterus coronatus</i>	Passeriformes	Parulidae	Museum Collections	FMNH	polynomial fit	6
<i>Branta canadensis</i>	Anseriformes	Anatidae	Museum Collections	CM, Cornell, UTEP	polynomial fit	7
<i>Brotogeris versicolurus</i>	Psittaciformes	Psittacidae	Museum Collections	FMNH	polynomial fit	11
<i>Bubo virginianus</i>	Strigiformes	Strigidae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	31
<i>Bubulcus ibis</i>	Pelecaniformes	Ardeidae	Museum Collections	CM, Cornell, FMNH, AM	polynomial fit	55
<i>Bucephala albeola</i>	Anseriformes	Anatidae	Museum Collections	CM, Cornell	polynomial fit	5
<i>Buteo jamaicensis</i>	Accipitriformes	Accipitridae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	16
<i>Cacomantis flabelliformis</i>	Cuculiformes	Cuculidae	Museum Collections	Cornell, AM	polynomial fit	5
<i>Carduelis cannabina</i>	Passeriformes	Fringillidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Carduelis chloris</i>	Passeriformes	Fringillidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Catharus fuscescens</i>	Passeriformes	Turdidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	7
<i>Catharus ustulatus</i>	Passeriformes	Turdidae	Museum Collections	CM, Cornell, FMNH, SNOMNH	polynomial fit	14
<i>Centropus grillii</i>	Cuculiformes	Cuculidae	Literature	Frey & Goyman (2009)	means	8
<i>Chalcophaps indica</i>	Columbiformes	Columbidae	Museum Collections	AM	polynomial fit	8
<i>Charadrius vociferus</i>	Charadriiformes	Charadriidae	Museum Collections	CM, FMNH	polynomial fit	11
<i>Chloroceryle aenea</i>	Coraciiformes	Alcedinidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	5

Scientific Name	Order	Family	Source of Testis Data	Detailed Source	Peak Estimation	N
<i>Chloroceryle americana</i>	Coraciiformes	Alcedinidae	Museum Collections	FMNH, UTEP	polynomial fit	5
<i>Chrysococcyx lucidus</i>	Cuculiformes	Cuculidae	Museum Collections	AM	polynomial fit	5
<i>Cinnyris sovimanga</i>	Passeriformes	Nectariniidae	Museum Collections	FMNH	polynomial fit	9
<i>Cistothorus platensis</i>	Passeriformes	Troglodytidae	Museum Collections	FMNH	polynomial fit	7
<i>Cloropipo holochlora</i>	Passeriformes	Pipridae	Museum Collections	FMNH	polynomial fit	6
<i>Coccyzus americanus</i>	Cuculiformes	Cuculidae	Museum Collections	CM, Cornell, FMNH, SNOMNH, UTEP	polynomial fit	14
<i>Collocalia linchi</i>	Apodiformes	Apodidae	Museum Collections	AM	polynomial fit	5
<i>Columba fasciata</i>	Columbiformes	Columbidae	Literature	Alcocker (1981)	indirect	—
<i>Columba livia</i>	Columbiformes	Columbidae	Museum Collections	CM, Cornell, FMNH, AM, UTEP	polynomial fit	12
<i>Columba oenas</i>	Columbiformes	Columbidae	Literature	Yu (1998)	means	10
<i>Columba palumbus</i>	Columbiformes	Columbidae	Literature	Ljunggren (1969)	means	2
<i>Contopus virens</i>	Passeriformes	Tyrannidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	6
<i>Corvus corone</i>	Passeriformes	Corvidae	Laboratory Books	TR Birkhead (unpub.)	means	3
<i>Corvus frugilegus</i>	Passeriformes	Corvidae	Laboratory Books	TR Birkhead (unpub.)	means	7
<i>Corvus splendens</i>	Passeriformes	Corvidae	Literature	Dang & Guraya (1978)	indirect	—
<i>Coturnix coturnix</i>	Galliformes	Phasianidae	Literature	Rodriguez-Tejeiro (1992)	direct	—
<i>Coturnix japonica</i>	Galliformes	Phasianidae	Literature	Yu (1998)	means	10
<i>Crotophaga major</i>	Cuculiformes	Cuculidae	Literature	McNeil (1968)	indirect	2
<i>Cyanistes caeruleus</i>	Passeriformes	Paridae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Daption capense</i>	Procellariiformes	Procellariidae	Museum Collections	AM	polynomial fit	5
<i>Dendrocygna eytoni</i>	Anseriformes	Anatidae	Museum Collections	AM	polynomial fit	8
<i>Densdroica magnolia</i>	Passeriformes	Parulidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	13
<i>Densdroica palmarum</i>	Passeriformes	Parulidae	Museum Collections	Cornell, FMNH	polynomial fit	7
<i>Densdroica petechia</i>	Passeriformes	Parulidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	19
<i>Densdroica pinus</i>	Passeriformes	Parulidae	Museum Collections	Cornell, FMNH	polynomial fit	8

Scientific Name	Order	Family	Source of Testis Data	Detailed Source	Peak Estimation	N
<i>Densdroica striata</i>	Passeriformes	Parulidae	Museum Collections	FMNH	polynomial fit	6
<i>Dolichonyx oryzivorus</i>	Passeriformes	Icteridae	Laboratory Books	TR Birkhead (unpub.)	means	4
<i>Dryocopus pileatus</i>	Piciformes	Picidae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	8
<i>Egretta caerulea</i>	Pelecaniformes	Ardeidae	Museum Collections	Cornell, FMNH	polynomial fit	10
<i>Egretta novaehollandiae</i>	Pelecaniformes	Ardeidae	Museum Collections	AM	polynomial fit	15
<i>Egretta thula</i>	Pelecaniformes	Ardeidae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	7
<i>Elaenia flavogaster</i>	Passeriformes	Tyrannidae	Museum Collections	FMNH	polynomial fit	8
<i>Emberiza citrinella</i>	Passeriformes	Emberizidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Emberizoides herbicola</i>	Passeriformes	Thraupidae	Museum Collections	FMNH	polynomial fit	6
<i>Empidonax vireescens</i>	Passeriformes	Tyrannidae	Museum Collections	CM, FMNH	polynomial fit	6
<i>Erithacus rubecula</i>	Passeriformes	Muscicapidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Eudocimus albus</i>	Pelecaniformes	Threskiornithidae	Museum Collections	CM, FMNH	polynomial fit	7
<i>Eudynamys scolopacea</i>	Cuculiformes	Cuculidae	Museum Collections	Cornell, AM	polynomial fit	6
<i>Euplectes afer</i>	Passeriformes	Ploceidae	Laboratory Books	TR Birkhead (unpub.)	means	13
<i>Euplectes orix</i>	Passeriformes	Ploceidae	Laboratory Books	TR Birkhead (unpub.)	means	17
<i>Foudia madagascariensis</i>	Passeriformes	Ploceidae	Museum Collections	CM, FMNH	polynomial fit	9
<i>Fregata magnificens</i>	Pelecaniformes	Fregatidae	Museum Collections	Cornell, FMNH	polynomial fit	5
<i>Fregata minor</i>	Pelecaniformes	Fregatidae	Museum Collections	AM	polynomial fit	5
<i>Fringilla coelebs</i>	Passeriformes	Fringillidae	Laboratory Books	TR Birkhead (unpub.)	means	8
<i>Gallinago media</i>	Charadriiformes	Scolopacidae	Literature	Cartar (1985)	indirect	—
<i>Gallus gallus</i>	Galliformes	Phasianidae	Literature	Kimball et al. (1997)	direct	19
<i>Geothlypis aequinoctialis</i>	Passeriformes	Parulidae	Museum Collections	FMNH	polynomial fit	6
<i>Geothlypis trichas</i>	Passeriformes	Parulidae	Museum Collections	CM, Cornell, FMNH, ROM	polynomial fit	20
<i>Glaucis hirsutus</i>	Apodiformes	Trochilidae	Museum Collections	CM, FMNH	polynomial fit	8
<i>Herpsilochmus axillaris</i>	Passeriformes	Thamnophilidae	Museum Collections	FMNH	polynomial fit	7

Scientific Name	Order	Family	Source of Testis Data	Detailed Source	Peak Estimation	N
<i>Heterocercus flavivertex</i>	Passeriformes	Pipridae	Museum Collections	FMNH	polynomial fit	5
<i>Hirundo rustica</i>	Passeriformes	Hirundinidae	Laboratory Books	TR Birkhead (unpub.)	means	5
<i>Hylocichla mustelina</i>	Passeriformes	Turdidae	Museum Collections	CM, Cornell, DMNH, FMNH	polynomial fit	17
<i>Hypsipetes madagascariensis</i>	Passeriformes	Pycnonotidae	Museum Collections	FMNH	polynomial fit	14
<i>Icterus spurius</i>	Passeriformes	Icteridae	Laboratory Books	TR Birkhead (unpub.)	means	4
<i>Ictinia plumbea</i>	Accipitriformes	Accipitridae	Museum Collections	CM, FMNH	polynomial fit	6
<i>Ixobrychus exilis</i>	Pelecaniformes	Ardeidae	Museum Collections	Cornell, FMNH	polynomial fit	15
<i>Lagopus muta</i>	Galliformes	Phasianidae	Museum Collections	CM, CMN, FMNH	polynomial fit	18
<i>Larus argentatus</i>	Charadriiformes	Laridae	Museum Collections	CMN, Cornell, FMNH	polynomial fit	6
<i>Larus atricilla</i>	Charadriiformes	Laridae	Museum Collections	Cornell, FMNH	polynomial fit	13
<i>Larus californicus</i>	Charadriiformes	Laridae	Literature	Johnson (1956)	indirect	—
<i>Larus delawarensis</i>	Charadriiformes	Laridae	Museum Collections	CM, Cornell, FMNH, AM	polynomial fit	13
<i>Larus glaucescens</i>	Charadriiformes	Laridae	Museum Collections	CM, Cornell, FMNH	polynomial fit	7
<i>Larus glaucoides</i>	Charadriiformes	Laridae	Museum Collections	CMN	polynomial fit	5
<i>Lathrotriccus euleri</i>	Passeriformes	Tyrannidae	Museum Collections	Cornell, FMNH	polynomial fit	7
<i>Lepidothrix coronata</i>	Passeriformes	Pipridae	Museum Collections	CM, FMNH	polynomial fit	5
<i>Leptotila rufaxilla</i>	Columbiformes	Columbidae	Museum Collections	CM, FMNH	polynomial fit	6
<i>Liosceles thoracicus</i>	Passeriformes	Rhinocryptidae	Museum Collections	FMNH	polynomial fit	5
<i>Locustella luscinioides</i>	Passeriformes	Locustellidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Macropygia amboinensis</i>	Columbiformes	Columbidae	Museum Collections	AM	polynomial fit	10
<i>Malurus amabilis</i>	Passeriformes	Maluridae	Laboratory Books	M Rowe & S Pruett-Jones (unpub.)	means	4
<i>Malurus cyaneus</i>	Passeriformes	Maluridae	Laboratory Books	M Rowe & S Pruett-Jones (unpub.)	means	6
<i>Malurus elegans</i>	Passeriformes	Maluridae	Laboratory Books	M Rowe & S Pruett-Jones (unpub.)	means	6
<i>Malurus lamberti</i>	Passeriformes	Maluridae	Laboratory Books	M Rowe & S Pruett-Jones (unpub.)	means	5
<i>Malurus leucopterus</i>	Passeriformes	Maluridae	Laboratory Books	M Rowe & S Pruett-Jones (unpub.)	means	6

Scientific Name	Order	Family	Source of Testis Data	Detailed Source	Peak Estimation	N
<i>Malurus melanocephalus</i>	Passeriformes	Maluridae	Laboratory Books	M Rowe & S Pruett-Jones (unpub.)	means	20
<i>Malurus pulcherrimus</i>	Passeriformes	Maluridae	Laboratory Books	M Rowe & S Pruett-Jones (unpub.)	means	5
<i>Malurus splendens</i>	Passeriformes	Maluridae	Laboratory Books	M Rowe & S Pruett-Jones (unpub.)	means	6
<i>Megaceryle alcyon</i>	Coraciiformes	Alcedinidae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	19
<i>Melospiza melodia</i>	Passeriformes	Emberizidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Mergus cucullatus</i>	Anseriformes	Anatidae	Museum Collections	CM, Cornell	polynomial fit	6
<i>Microcerculus marginatus</i>	Passeriformes	Troglodytidae	Museum Collections	FMNH	polynomial fit	5
<i>Mionectes oleagineus</i>	Passeriformes	Tyrannidae	Museum Collections	Cornell, FMNH	polynomial fit	9
<i>Mionectes olivaceus</i>	Passeriformes	Tyrannidae	Museum Collections	Cornell, FMNH	polynomial fit	28
<i>Momotus momota</i>	Coraciiformes	Momotidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	5
<i>Monticola imerinus</i>	Passeriformes	Muscicapidae	Museum Collections	FMNH	polynomial fit	7
<i>Myiarchus crinitus</i>	Passeriformes	Tyrannidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	5
<i>Myiarchus ferox</i>	Passeriformes	Tyrannidae	Museum Collections	FMNH	polynomial fit	5
<i>Myiobius villosus</i>	Passeriformes	Tyrannidae	Museum Collections	FMNH	polynomial fit	5
<i>Myiopagis viridicata</i>	Passeriformes	Tyrannidae	Museum Collections	FMNH	polynomial fit	5
<i>Myiotriccus ornatus</i>	Passeriformes	Tyrannidae	Museum Collections	FMNH	polynomial fit	7
<i>Myrmotherula axillaris</i>	Passeriformes	Thamnophilidae	Museum Collections	Cornell, FMNH	polynomial fit	7
<i>Myrmotherula longipennis</i>	Passeriformes	Thamnophilidae	Museum Collections	CM, FMNH	polynomial fit	5
<i>Newtonia brunneicauda</i>	Passeriformes	Vangidae	Museum Collections	FMNH	polynomial fit	6
<i>Ninox novaeseelandiae</i>	Strigiformes	Strigidae	Museum Collections	AM	polynomial fit	5
<i>Ninox strenua</i>	Strigiformes	Strigidae	Museum Collections	AM	polynomial fit	5
<i>Nycticorax caledonicus</i>	Pelecaniformes	Ardeidae	Museum Collections	AM	polynomial fit	8
<i>Nycticorax nycticorax</i>	Pelecaniformes	Ardeidae	Museum Collections	CM, Cornell, FMNH, AM, UTEP	polynomial fit	10
<i>Oceanites oceanicus</i>	Procellariiformes	Hydrobatidae	Museum Collections	CM, AM	polynomial fit	5
<i>Oporornis philadelphia</i>	Passeriformes	Parulidae	Museum Collections	Cornell, FMNH	polynomial fit	6



<b>Scientific Name</b>	<b>Order</b>	<b>Family</b>	<b>Source of Testis Data</b>	<b>Detailed Source</b>	<b>Peak Estimation</b>	<b>N</b>
<i>Oryzoborus angolensis</i>	Passeriformes	Thraupidae	Museum Collections	CM, FMNH	polynomial fit	11
<i>Otus asio</i>	Strigiformes	Strigidae	Museum Collections	CM, Cornell, FMNH, AM, UTEP	polynomial fit	44
<i>Pachyptila turtur</i>	Procellariiformes	Procellariidae	Museum Collections	AM	polynomial fit	6
<i>Pandion haliaetus</i>	Accipitriformes	Pandionidae	Museum Collections	FMNH, AM, UTEP	polynomial fit	14
<i>Parula americana</i>	Passeriformes	Parulidae	Museum Collections	Cornell, FMNH	polynomial fit	6
<i>Parus major</i>	Passeriformes	Paridae	Laboratory Books	TR Birkhead (unpub.)	means	3
<i>Passer domesticus</i>	Passeriformes	Passeridae	Laboratory Books	TR Birkhead (unpub.)	means	19
<i>Passer melanurus</i>	Passeriformes	Passeridae	Laboratory Books	TR Birkhead (unpub.)	means	28
<i>Passer montanus</i>	Passeriformes	Passeridae	Literature	Yu (1998)	means	7
<i>Pelecanus occidentalis</i>	Pelecaniformes	Pelecanidae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	7
<i>Phaeomyias murina</i>	Passeriformes	Tyrannidae	Museum Collections	FMNH	polynomial fit	7
<i>Phaethon lepturus</i>	Phaethontiformes	Phaethontidae	Museum Collections	Cornell, AM	polynomial fit	13
<i>Phaethon rubricauda</i>	Phaethontiformes	Phaethontidae	Museum Collections	FMNH, AM	polynomial fit	11
<i>Phaethornis superciliosus</i>	Apodiformes	Trochilidae	Museum Collections	Cornell, FMNH	polynomial fit	5
<i>Phalacrocorax auritus</i>	Pelecaniformes	Phalacrocoracidae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	30
<i>Phalacrocorax varius</i>	Pelecaniformes	Phalacrocoracidae	Museum Collections	AM	polynomial fit	5
<i>Phalaropus fulicariia</i>	Charadriiformes	Scolopacidae	Museum Collections	CMN	polynomial fit	6
<i>Philepitta castanea</i>	Passeriformes	Philepittidae	Museum Collections	FMNH	polynomial fit	16
<i>Philomachus pugnax</i>	Charadriiformes	Scolopacidae	Laboratory Books	TR Birkhead (unpub.)	means	5
<i>Phlogophilus harterti</i>	Apodiformes	Trochilidae	Museum Collections	FMNH	polynomial fit	8
<i>Phoenicurus ochruros</i>	Passeriformes	Muscicapidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Phyllastrephus fischeri</i>	Passeriformes	Pycnonotidae	Museum Collections	Cornell, FMNH	polynomial fit	5
<i>Phylloscopus trochilus</i>	Passeriformes	Phylloscopidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Piaya cayana</i>	Cuculiformes	Cuculidae	Museum Collections	Cornell, FMNH	polynomial fit	5
<i>Pica pica</i>	Passeriformes	Corvidae	Laboratory Books	TR Birkhead (unpub.)	means	5

Scientific Name	Order	Family	Source of Testis Data	Detailed Source	Peak Estimation	N
<i>Picoides pubescens</i>	Piciformes	Picidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	5
<i>Pipra chloromeros</i>	Passeriformes	Pipridae	Museum Collections	FMNH	polynomial fit	9
<i>Pipra fasciicauda</i>	Passeriformes	Pipridae	Museum Collections	FMNH	polynomial fit	6
<i>Piranga olivacea</i>	Passeriformes	Cardinalidae	Museum Collections	CM, Cornell, FMNH, ROM, UTEP	polynomial fit	20
<i>Platycercus elegans</i>	Psittaciformes	Psittacidae	Museum Collections	FMNH, AM	polynomial fit	14
<i>Platycercus eximius</i>	Psittaciformes	Psittacidae	Museum Collections	Cornell, AM	polynomial fit	6
<i>Ploceus nelicourvi</i>	Passeriformes	Ploceidae	Museum Collections	FMNH	polynomial fit	7
<i>Ploceus velatus</i>	Passeriformes	Ploceidae	Laboratory Books	TR Birkhead (unpub.)	means	22
<i>Podargus strigoides</i>	Caprimulgiformes	Podargidae	Museum Collections	Cornell, AM	polynomial fit	8
<i>Podilymbus podiceps</i>	Podicipediformes	Podicipedidae	Museum Collections	Cornell, FMNH, UTEP	polynomial fit	15
<i>Poecile atricapillus</i>	Passeriformes	Paridae	Museum Collections	Cornell, FMNH	polynomial fit	7
<i>Poecile carolinensis</i>	Passeriformes	Paridae	Museum Collections	Cornell	polynomial fit	5
<i>Poliocephalus poliocephalus</i>	Podicipediformes	Podicipedidae	Museum Collections	AM	polynomial fit	5
<i>Prunella modularis</i>	Passeriformes	Prunellidae	Laboratory Books	TR Birkhead (unpub.)	means	12
<i>Psephotus haematonotus</i>	Psittaciformes	Psittacidae	Museum Collections	Cornell, AM	polynomial fit	5
<i>Pterodroma lessonii</i>	Procellariiformes	Procellariidae	Museum Collections	AM	polynomial fit	6
<i>Pteroglossus torquatus</i>	Piciformes	Ramphastidae	Museum Collections	Cornell, FMNH	polynomial fit	5
<i>Ptilinopus regina</i>	Columbiformes	Columbidae	Museum Collections	AM	polynomial fit	8
<i>Ptilinopus superbus</i>	Columbiformes	Columbidae	Museum Collections	AM	polynomial fit	7
<i>Puffinus gavia</i>	Procellariiformes	Procellariidae	Museum Collections	AM	polynomial fit	9
<i>Puffinus gravis</i>	Procellariiformes	Procellariidae	Museum Collections	Cornell	polynomial fit	7
<i>Puffinus lherminieri</i>	Procellariiformes	Procellariidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	7
<i>Puffinus pacificus</i>	Procellariiformes	Procellariidae	Museum Collections	Cornell, AM	polynomial fit	27
<i>Puffinus tenuirostris</i>	Procellariiformes	Procellariidae	Museum Collections	Cornell, FMNH, AM	polynomial fit	21
<i>Pycnonotus goiavier</i>	Passeriformes	Pycnonotidae	Museum Collections	FMNH	polynomial fit	8

Scientific Name	Order	Family	Source of Testis Data	Detailed Source	Peak Estimation	N
<i>Pyrrhula pyrrhula</i>	Passeriformes	Fringillidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Quelea quelea</i>	Passeriformes	Ploceidae	Laboratory Books	TR Birkhead (unpub.)	means	18
<i>Quiscalus major</i>	Passeriformes	Icteridae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Ramphocelus carbo</i>	Passeriformes	Thraupidae	Museum Collections	CM, FMNH	polynomial fit	19
<i>Rhegmatorhina melanosticta</i>	Passeriformes	Thamnophilidae	Museum Collections	FMNH	polynomial fit	5
<i>Rynchops niger</i>	Charadriiformes	Laridae	Museum Collections	Cornell, FMNH, UTEP	polynomial fit	7
<i>Scardafella inca</i>	Columbiformes	Columbidae	Museum Collections	FMNH, UTEP	polynomial fit	5
<i>Schistoclamys melanopis</i>	Passeriformes	Thraupidae	Museum Collections	FMNH	polynomial fit	5
<i>Scolopax minor</i>	Charadriiformes	Scolopacidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	12
<i>Seiurus aurocapilla</i>	Passeriformes	Parulidae	Museum Collections	CM, Cornell, DMNH, FMNH	polynomial fit	35
<i>Seiurus noveboracensis</i>	Passeriformes	Parulidae	Museum Collections	Cornell, FMNH	polynomial fit	8
<i>Sericulus chrysocephalus</i>	Passeriformes	Ptilonorhynchidae	Museum Collections	AM	polynomial fit	5
<i>Serinus canaria</i>	Passeriformes	Fringillidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Setophaga ruticilla</i>	Passeriformes	Parulidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	5
<i>Sialia sialis</i>	Passeriformes	Turdidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	7
<i>Sicalis columbiana</i>	Passeriformes	Thraupidae	Museum Collections	FMNH	polynomial fit	11
<i>Sitta canadensis</i>	Passeriformes	Sittidae	Museum Collections	Cornell, FMNH	polynomial fit	5
<i>Sitta carolinensis</i>	Passeriformes	Sittidae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	12
<i>Somateria spectabilis</i>	Anseriformes	Anatidae	Museum Collections	CMN, FMNH, UTEP	polynomial fit	7
<i>Sphecotheres viridis</i>	Passeriformes	Oriolidae	Museum Collections	Cornell, AM	polynomial fit	8
<i>Sphyrapicus varius</i>	Piciformes	Picidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	22
<i>Sporophila americana</i>	Passeriformes	Thraupidae	Museum Collections	Cornell, FMNH	polynomial fit	7
<i>Sporophila minuta</i>	Passeriformes	Thraupidae	Museum Collections	FMNH	polynomial fit	5
<i>Sporophila nigricollis</i>	Passeriformes	Thraupidae	Museum Collections	FMNH	polynomial fit	7
<i>Stercorarius longicaudus</i>	Charadriiformes	Stercorariidae	Museum Collections	CMN	polynomial fit	6

<b>Scientific Name</b>	<b>Order</b>	<b>Family</b>	<b>Source of Testis Data</b>	<b>Detailed Source</b>	<b>Peak Estimation</b>	<b>N</b>
<i>Stercorarius parasiticus</i>	Charadriiformes	Stercorariidae	Museum Collections	CMN	polynomial fit	5
<i>Sterna albifrons</i>	Charadriiformes	Laridae	Museum Collections	FMNH, AM	polynomial fit	6
<i>Sterna hirundo</i>	Charadriiformes	Laridae	Museum Collections	CM, Cornell, FMNH, AM	polynomial fit	9
<i>Sterna paradisaea</i>	Charadriiformes	Laridae	Museum Collections	CM, CMN	polynomial fit	6
<i>Stictonetta naevosa</i>	Anseriformes	Anatidae	Museum Collections	AM	polynomial fit	8
<i>Stipiturus malachurus</i>	Passeriformes	Maluridae	Laboratory Books	M Rowe & S Pruett-Jones (unpub.)	means	6
<i>Strix varia</i>	Strigiformes	Strigidae	Museum Collections	CM, Cornell, FMNH, UTEP	polynomial fit	12
<i>Sturnus vulgaris</i>	Passeriformes	Sturnidae	Laboratory Books	TR Birkhead (unpub.)	means	5
<i>Sula bassana</i>	Pelecaniformes	Sulidae	Museum Collections	Cornell	polynomial fit	5
<i>Sula dactylatra</i>	Pelecaniformes	Sulidae	Museum Collections	FMNH, AM, UTEP	polynomial fit	5
<i>Sula serrator</i>	Pelecaniformes	Sulidae	Museum Collections	Cornell, AM	polynomial fit	10
<i>Sula sula</i>	Pelecaniformes	Sulidae	Museum Collections	Cornell, FMNH, AM	polynomial fit	10
<i>Sylvia curruca</i>	Passeriformes	Sylviidae	Laboratory Books	TR Birkhead (unpub.)	means	4
<i>Tachybaptus novaehollandiae</i>	Podicipediformes	Podicipedidae	Museum Collections	AM	polynomial fit	12
<i>Tachycineta bicolor</i>	Passeriformes	Hirundinidae	Literature	Kempanaers et al. (2002)	means	36
<i>Taeniopygia guttata</i>	Passeriformes	Passeridae	Laboratory Books	TR Birkhead (unpub.)	means	23
<i>Thalassoica antarctica</i>	Procellariiformes	Procellariidae	Museum Collections	AM	polynomial fit	7
<i>Thamnophilus doliatus</i>	Passeriformes	Thamnophilidae	Museum Collections	Cornell, FMNH	polynomial fit	6
<i>Thamnophilus punctatus</i>	Passeriformes	Thamnophilidae	Museum Collections	Cornell, FMNH	polynomial fit	5
<i>Thraupis episcopus</i>	Passeriformes	Thraupidae	Museum Collections	FMNH	polynomial fit	11
<i>Thraupis palmarum</i>	Passeriformes	Thraupidae	Museum Collections	FMNH	polynomial fit	6
<i>Threnetes ruckeri</i>	Apodiformes	Trochilidae	Museum Collections	FMNH	polynomial fit	5
<i>Threskiornis spinicollis</i>	Pelecaniformes	Threskiornithidae	Museum Collections	AM	polynomial fit	6
<i>Thryothorus ludovicianus</i>	Passeriformes	Troglodytidae	Museum Collections	Cornell, FMNH, AM	polynomial fit	5
<i>Todiramphus sanctus</i>	Coraciiformes	Alcedinidae	Museum Collections	AM	polynomial fit	9

<b>Scientific Name</b>	<b>Order</b>	<b>Family</b>	<b>Source of Testis Data</b>	<b>Detailed Source</b>	<b>Peak Estimation</b>	<b>N</b>
<i>Trichoglossus haematodus</i>	Psittaciformes	Psittacidae	Museum Collections	FMNH, AM	polynomial fit	5
<i>Troglodytes aedon</i>	Passeriformes	Troglodytidae	Museum Collections	CM, Cornell, FMNH	polynomial fit	14
<i>Turdus fuscater</i>	Passeriformes	Turdidae	Museum Collections	FMNH	polynomial fit	6
<i>Turdus leucops</i>	Passeriformes	Turdidae	Museum Collections	FMNH	polynomial fit	5
<i>Turdus merula</i>	Passeriformes	Turdidae	Laboratory Books	TR Birkhead (unpub.)	means	9
<i>Turdus migratorius</i>	Passeriformes	Turdidae	Museum Collections	CM, Cornell, DMNH, FMNH, UTEP	polynomial fit	48
<i>Turdus philomelos</i>	Passeriformes	Turdidae	Laboratory Books	TR Birkhead (unpub.)	means	2
<i>Tyrannus savana</i>	Passeriformes	Tyrannidae	Museum Collections	FMNH	polynomial fit	6
<i>Tyto alba</i>	Strigiformes	Tytonidae	Museum Collections	CM, Cornell, FMNH, AM, UTEP	polynomial fit	18
<i>Tyto novaehollandiae</i>	Strigiformes	Tytonidae	Museum Collections	AM	polynomial fit	5
<i>Vireo griseus</i>	Passeriformes	Vireonidae	Museum Collections	Cornell, FMNH	polynomial fit	8
<i>Xanthomixis zosterops</i>	Passeriformes	Bernieridae	Museum Collections	FMNH	polynomial fit	8
<i>Zenaida asiatica</i>	Columbiformes	Columbidae	Museum Collections	Cornell, FMNH, UTEP	polynomial fit	9
<i>Zenaida macroura</i>	Columbiformes	Columbidae	Museum Collections	CM, Cornell, DMNH, FMNH, UTEP	polynomial fit	26
<i>Zosterops lateralis</i>	Passeriformes	Zosteropidae	Museum Collections	ANWC	polynomial fit	41
<i>Zosterops luteus</i>	Passeriformes	Zosteropidae	Museum Collections	ANWC	polynomial fit	6

**Table A2.** The number of extant bird species with different testis size- and shape-biases. Families listed here in the same order as Table 1. See Table 2 for orders that had only one family.

Family	Size Asymmetry			Shape Asymmetry		
	Left-bias	Right-bias	Symmetric	Left-bias	Right-bias	Symmetric
Trochilidae	1	0	3	2	0	2
Apodidae	1	0	0	—	—	—
Ardeidae	7	1	0	6	2	0
Threskornithidae	2	0	0	1	0	0
Pelecanidae	1	0	0	1	0	0
Fregatidae	2	0	0	0	2	0
Phalacrocoracidae	2	0	0	2	0	0
Sulidae	2	2	0	2	2	0
Procellariidae	5	4	0	2	7	0
Hydrobatidae		2	0	0	1	0
Scolopacidae	2	2	0	2	1	0
Laridae	10	0	0	6	3	0
Stercorariidae	2	0	0	1	1	0
Charadriidae	1	0	0	1	0	0
Strigidae	7	1	0	3	5	0
Tytonidae	1	1	0	2	0	0
Accipitridae	1	4	0	3	2	0
Pandionidae	1	0	0	0	1	0
Picidae	2	1	0	3	0	0
Rhamphastidae	0	1	0	1	0	0
Alcedinidae	3	1	0	1	3	0
Momotidae	1	0	0	1	0	0
Maluridae	4	6	0	7	3	0
Paridae	3	1	0	1	3	0
Acrocephalidae	2	2	0	4	0	0
Locustidae	0	1	0	0	1	0
Bernieridae	1	0	0	0	1	0
Hirundinidae	0	2	0	1	1	0
Pycnonotidae	3	0	0	2	1	0
Zosteropidae	2	0	0	2	0	0
Sylviidae	1	0	0	0	1	0
Phylloscopidae	1	0	0	0	1	0
Aegithalidae	1	0	0	1	0	0
Alaudidae	1	0	0	1	0	0
Ploceidae	5	2	0	5	2	0
Passeridae	1	2	1	2	1	0
Fringillidae	4	1	0	4	0	0

Family	Size Asymmetry			Shape Asymmetry		
	Left-bias	Right-bias	Symmetric	Left-bias	Right-bias	Symmetric
Icteridae	2	2	0	4	0	0
Parulidae	12	1	0	10	3	0
Emberizidae	3	1	0	0	5	0
Thraupidae	6	4	0	10	0	0
Cardinalidae	1	0	0	1	0	0
Prunellidae	1	0	0	0	1	0
Nectarinidae	1	0	0	1	0	0
Sturnidae	1	1	0	0	1	0
Muscicapidae	2	1	0	1	2	0
Turdidae	8	1	0	8	1	0
Troglodytidae	4	0	0	4	0	0
Sittidae	2	0	0	2	0	0
Corvidae	3	1	0	1	2	0
Vireonidae	1	0	0	1	0	0
Oriolidae	1	0	0	1	0	0
Vangidae	1	0	0	1	0	0
Ptilonorhynchidae	1	1	0	2	0	0
Thamnophilidae	6	0	0	4	2	0
Rhynocrynidae	1	0	0	1	0	0
Tyrannidae	11	2	0	8	5	0
Pipridae	5	0	0	5	0	0
Philepittidae	1	0	0	1	0	0

**Table A3.** Models of testis size and shape asymmetry, controlling for phylogeny using the *pgls* function in the R package *caper* (Orme et al. 2012). Lambda ( $\lambda$ ) estimates the phylogenetic signal using maximum likelihood (Freckleton et al. 2002). Effect sizes were calculated following Nakagawa & Cuthill (2007). For each model, estimates of the coefficients for each effect are listed, and significance levels tested with the t-statistic; significant effects are shown in bold text.

Association	N (species analyzed)	$\lambda$ (95%CL)	R <sup>2</sup>	Effect Size (95%CL)	Estimate±s.e.	t (p)
f. Shape Asymmetry ~ <b>Size Asymmetry</b>	245 (all but <i>Bucephala</i> sp.)	0.66 (0.35, 0.86)	0.02	r = -0.14 (-0.26, -0.07)	-0.05±0.03	2.12 (0.04)
g. Size Asymmetry	65 (right size-bias)	0.97 (0.64, 1.00)	0.03			
~ Body Mass				r = -0.02 (-0.27, 0.23)	-0.02±0.10	0.15 (0.88)
~ Combined Testes Mass				r = 0.15 (-0.1, 0.40)	0.07±0.06	1.19 (0.24)
h. Shape Asymmetry	79 (right shape-bias)	0.00 (0, 0.36)	0.04			
~ Body Mass				r = -0.19 (-0.41, -0.04)	-0.03±0.02	1.67 (0.10)
~ Combined Testes Mass				r = 0.17 (-0.06, 0.39)	0.03±0.02	1.48 (0.14)
i. Size Asymmetry	100 (left size-bias)	0 (0, 0.78)	0.18			
~ <b>Body Mass</b>				r = 0.33 (0.14, 0.53)	0.22±0.06	3.47 (0.0008)
~ <b>Combined Testes Mass</b>				r = -0.42 (-0.62, -0.22)	-0.30±0.07	4.51 (<0.0001)
~ Dichromatism				d = -0.24 (-0.65, 0.17)	-0.09±0.08	1.21 (0.23)
j. Size Asymmetry	33 (right size-bias)	0.87 (0.22, 1.00)	0.26			
~ <b>Body Mass</b>				r = -0.46 (-0.82, 0.10)	-0.35±0.12	2.77 (0.01)
~ Combined Testes Mass				r = 0.33 (-0.03, 0.69)	0.17±0.09	1.88 (0.07)
~ Dichromatism				d = 0.67 (-0.04, 1.38)	0.14±0.08	1.84 (0.08)
k. Size Asymmetry	136 (left size-bias)	0.29 (0.03, 0.68)	0.10			
~ <b>Body Mass</b>				r = 0.24 (0.07, 0.41)	0.20±0.07	2.85 (0.005)
~ <b>Combined Testes Mass</b>				r = -0.25 (-0.42, -0.08)	-0.18±0.06	2.90 (0.004)
~ Polyandry				d = -0.16 (-0.98, 0.66)	-0.15±0.16	0.92 (0.36)



Association	N (species analyzed)	$\lambda$ (95%CL)	$R^2$	Effect Size (95%CL)	Estimate $\pm$ s.e.	t (p)
l. Size Asymmetry	56 (right size-bias)	0.95 (0.48, 1.00)	0.03			
~ Body Mass				r = -0.01 (-0.28, 0.26)	-0.008 $\pm$ 0.12	0.06 (0.95)
~ Combined Testes Mass				r = 0.13 (-0.14, 0.40)	0.06 $\pm$ 0.06	0.93 (0.35)
~ Polyandry				d = -0.21 (-0.95, 0.55)	-0.12 $\pm$ 0.16	0.75(0.46)
m. Size Asymmetry	94 (left size-bias)	0.74 (0.19, 1.00)	0.13			
~ <b>Body Mass</b>				r = 0.21 (0.01, 0.41)	0.23 $\pm$ 0.12	2.02 (0.047)
~ <b>Combined Testes Mass</b>				r = -0.30 (-0.50, -0.09)	-0.26 $\pm$ 0.09	2.92 (0.004)
~ Breeding Zone				d = -0.24 (-0.75, 0.28)	-0.13 $\pm$ 0.12	1.13 (0.26)
~ Migration				d = 0.39 (-0.02, 0.80)	0.18 $\pm$ 0.10	1.85 (0.07)
n. Size Asymmetry	37 (right size-bias)	0.94 (0.44, 1.00)	0.31			
~ Body Mass				r = -0.28 (-0.62, 0.05)	-0.25 $\pm$ 0.15	1.67 (0.10)
~ <b>Combined Testes Mass</b>				r = 0.52 (0.18, 0.86)	0.34 $\pm$ 0.10	3.45 (0.002)
~ Breeding Zone				d = -0.62 (-1.51, 0.26)	-0.20 $\pm$ 0.11	1.80 (0.08)
~ Migration				d = 0.48 (-0.17, 1.13)	0.13 $\pm$ 0.10	1.39 (0.17)
o. Size Asymmetry	136 (left size-bias)	0.54 (0.16, 0.84)	0.09			
~ Body Mass				r = 0.21 (0.04, 0.38)	0.20 $\pm$ 0.08	2.52 (0.13)
~ <b>Combined Testes Mass</b>				r = -0.29 (-0.46, -0.12)	-0.24 $\pm$ 0.07	3.44 (0.0008)
~ Seeds or Grains in Diet				d = 0.16 (-0.18, 0.50)	0.07 $\pm$ 0.08	0.92 (0.36)
p. Shape Asymmetry	126 (left size-bias)	0.64 (0.15, 0.89)	0.02			
~ Body Mass				r = -0.13 (-0.31, 0.05)	-0.06 $\pm$ 0.04	1.44 (0.15)
~ Combined Testes Mass				r = 0.09 (-0.09, 0.26)	0.03 $\pm$ 0.03	0.97 (0.33)
~ Seeds or Grains in Diet				d = 0.03 (-0.33, 0.38)	0.005 $\pm$ 0.04	0.14 (0.89)

## References

### Table A1 Sources

- Alcocer, J. M. 1981. Notas sobre medidas, muda de las remigeras y gonadas en palomba serrana *Columba fasciata vioscae*. Centzontle 1: 137–146.
- Cartar, R.V. 1985. Testis size in sandpipers. Naturwiss 72: 157–158.
- Dang, H. R. and Guraya, S. S. 1978. Testis growth and regression in harmful birds in the Punjab in relation to some environmental factors. Aust J Zool, 26: 39–45.
- Delehanty, D. J. and O'Hearn, P. P. 2005. Behavioral and morphological asymmetries in chukar *Alectoris chukar* copulation. J Avian Biol 36: 276–279.
- DuBowy, P. J. 1985. Moults and plumages and testicular regression of post-breeding male Blue-winged teal (*Anas discors*) and Northern shovelers (*Anas clypeata*). J Zool 207: 459–466.
- Frey, R., and Goymann, W. 2009. A single functional testis and long deferent duct papillae: the peculiar male reproductive tract of the classically polyandrous, sex-role reversed Black Coucal (*Centropus grillii*). J Ornithol 150: 827–838.
- Johnson, D. W. 1956. The annual reproductive cycle of the California gull. I. Criteria of age and the testis cycle. Condor 58: 134–162.
- Kempnaers, B., Peer, K. and Vermeirssen, E. 2002. Testes size and asymmetry in the tree swallow *Tachycineta bicolor*: a test of the compensation hypothesis. Avian Sci 2:115–122.
- Kimball, R. T., J. D. Ligon, and Merola-Zwartjes, M. 1997. Testicular asymmetry and secondary sexual characters in red jungle fowl. Auk 114: 221–228.
- Ljunggren, L. 1969. Seasonal studies of wood pigeon populations. Viltrevy 6: 41–126.
- McNeil, R. 1968. Biometric analysis of testicular bilateral asymmetry of *Crotophaga major*. Ibis 110: 87–89.
- Rodriguez Teijeiro, J. D., Gallego, S. and Puigcerver, M. 1992. Biometric analysis of testicular bilateral asymmetry of the quail. Historia Animalium 1: 87–93.
- Weller, M. W. 1975. Ecology and behaviour of the South Georgia pintail *Anas g. georgica*. Ibis 117: 217–231.
- Yu, Z. 1998. Asymmetrical testicular weights in mammals, birds, reptiles and amphibia. Internl J Androl 21: 53–55.

AM: Australian Museum (Sydney)

ANWC: Australian National Wildlife Collection (Canberra)

CMN: Canadian Museum of Nature (Ottawa)

UTEP: Centennial Museum of Natural History (El Paso, TX)

Cornell: Cornell University Museum of Vertebrate Zoology (Ithaca, NY)

CM: Carnegie Museum of Natural History (Pittsburgh, PA)

FMNH: Field Museum of Natural History (Chicago)

SNOMNH: Sam Noble Oklahoma Museum of Natural History, University of Oklahoma (Oklahoma)

ROM: Royal Ontario Museum (Toronto)

### Table A3 Sources

- Freckleton, R. P., Harvey, I. F., and Pagel, M. 2002. Phylogenetic analysis and comparative data: a test and review of evidence. Am. Nat. 160: 712-726.

- Nakagawa, S., and Cuthill, I. 2007. Effect size, confidence interval and statistical significance: a practical guide for biologists. *Biol. Rev.* 82: 591-605.
- Orme, D., Freckleton, R., Thomas, G., Petzoldt, T., Fritz, S., Isaac, N. and Pearse, W. 2012. caper: Comparative Analyses of Phylogenetics and Evolution in R. R package version 0.5. <http://CRAN.R-project.org/package=caper>

### **Phylogeny Sources**

- Alstrom, P., Ericson, P. G., Olsson, U., and Sundberg, P. 2006. Phylogeny and classification of the avian superfamily Sylvioidea. *Mol Phylogenet Evol* 38: 381–397.
- Barker, F. K., Barrowclough, G. F., and Groth, J. G. 2002. A phylogenetic hypothesis for passerine birds: taxonomic and biogeographic implications of an analysis of nuclear DNA sequence data. *Proc R Soc Lond B* 269: 295–308.
- Barker, F. K., Cibois, A., Schikler, P., Feinstein, J., and Cracraft, J. 2004. Phylogeny and diversification of the largest avian radiation. *Proc Natl Acad Sci USA* 101: 11040–11045.
- Barrowclough, G. F., Groth, J. G., and Mertz, L. A. 2006. The RAG-1 exon in the avian order Caprimulgiformes: phylogeny, heterozygosity, and base composition. *Mol Phylogenet Evol* 41: 238–248.
- Bleiweiss, R. 2002. Patagial complex evolution in hummingbirds and swifts (Apodiformes): a molecular phylogenetic perspective. *Biol J Linn Soc* 77: 211–219.
- Burns, K. J. 1998. A phylogenetic perspective on the evolution of sexual dichromatism in tanagers (Thraupidae): The role of female versus male plumage. *Evolution* 52: 1219–1224.
- Carson, R. J., and Spicer, G. S. 2003. A phylogenetic analysis of the emberizid sparrows based on three mitochondrial genes. *Mol Phylogenet Evol* 29: 43–57.
- Christidis, L., and Schodde, R. 1997. Relationships within the Australo–Papuan fairy–wrens (Aves: Malurinae): an evaluation of the utility of allozyme data. *Aust J Zool* 45: 113–129.
- Cracraft, J., and Donoghue, M. J. 2004. *Assembling the Tree of Life*. Oxford: Oxford University Press.
- DeFilippis, V. R., and Moore, W. S. 2000. Resolution of phylogenetic relationships among recently evolved species as a function of amount of DNA sequence: an empirical study based on woodpeckers (Aves: Picidae). *Mol Phylogenet Evol* 16: 143–160.
- Dimcheff, D. E., Drovetski, S. V., and Mindell, D. P. 2002. Phylogeny of Tetraoninae and other galliform birds using mitochondrial 12S and ND2 genes. *Mol Phylogenet Evol* 24: 203–215.
- Donne–Gousse, C., Laudet, V., and Hanni, C. 2002. A molecular phylogeny of anseriformes based on mitochondrial DNA analysis. *Mol Phylogenet Evol* 23: 339–356.
- Ericson, P. G. P., Jansen, A. L., Johansson, U. S., and Ekman, J. 2005. Inter–generic relationships of the crows, jays, magpies and allied groups (Aves : Corvidae) based on nucleotide sequence data. *J Avian Biol* 36: 222–234.
- Fain, M. G., and Houde, P. 2007. Multilocus perspectives on the monophyly and phylogeny of the order Charadriiformes (Aves). *BMC Evol Biol* 7: 35.
- Gonzalez, J., Düttmann, H., and Wink, M. 2009. Phylogenetic relationships based on two mitochondrial genes and hybridization patterns in Anatidae. *Journal of Zoology* 279: 310–318.
- Griffiths, C. S. 1999. Phylogeny of the Falconidae inferred from molecular and morphological data. *Auk* 116: 116–130.

- Hackett, S., Kimball, R., Reddy, S., Bowie, R., Braun, E., Braun, M., Chojnowski, J., Cox, W., Han, K., Harshman, J., Huddleston, C., Marks, B., Miglia, K., Moore, W., Sheldon, F., Steadman, D., Witt, C., and Yuri, T. 2008. A phylogenomic study of birds reveals their evolutionary history. *Science* 320: 1763–1768.
- Helbig, A. J., Kocum, A., Seibold, I., and Braun, M. J. 2005. A multi-gene phylogeny of aquiline eagles (Aves: Accipitriformes) reveals extensive paraphyly at the genus level. *Mol Phylogenet Evol* 35: 147–164.
- Hughes, J. M. 2000. Monophyly and phylogeny of cuckoos (Aves, Cuculidae) inferred from osteological characters. *Zool J Linn Soc–Lond* 130: 263–307.
- Johansson, U. S., Fjelds , J., and Bowie, R. C. 2008. Phylogenetic relationships within Passerida (Aves: Passeriformes): a review and a new molecular phylogeny based on three nuclear intron markers. *Mol Phylogenet Evol* 48: 858–876.
- Johnson, K. P., De, K., S, Dinwoodey, K., Mateman, A. C., Ten, C., C, Lessells, C. M., and Clayton, D. H. 2001. A molecular phylogeny of the dove genera *Streptopella* and *Columba*. *Auk* 118: 874–887.
- Kennedy, M., and Page, R. D. M. 2002. Seabird supertrees: Combining partial estimates of procellariiform phylogeny. *Auk* 119: 88–108.
- Klicka, J., Voelker, G., and Spellman, G. M. 2005. A molecular phylogenetic analysis of the "true thrushes" (Aves: Turdinae). *Mol Phylogenet Evol* 34: 486–500.
- Lerner, H. R., and Mindell, D. P. 2005. Phylogeny of eagles, Old World vultures, and other Accipitridae based on nuclear and mitochondrial DNA. *Mol Phylogenet Evol* 37: 327–346.
- Lovette, I. J., and Bermingham, E. 1999. Explosive speciation in the New World *Dendroica* warblers. *Proc R Soc Lond B* 266: 1629–1636.
- Lovette, I. J., and Bermingham, E. 2002. What is a wood-warbler? Molecular characterization of a monophyletic parulidae. *Auk* 119: 695–714.
- Mann, N. I., Dingess, K. A., Barker, K. F., Graves, J. A., and Slater, P. J. B. 2009. A comparative study of song form and duetting in neotropical *Thryothorus* wrens. *Behaviour* 146: 1–43.
- McCracken, K. G., and Sheldon, F. H. 1998. Molecular and osteological heron phylogenies: Sources of incongruence. *Auk* 115: 127–141.
- Moyle, R. G. 2004. Phylogenetics of barbets (Aves: Piciformes) based on nuclear and mitochondrial DNA sequence data. *Mol Phylogenet Evol* 30: 187–200.
- Moyle, R. G., Chesser, R. T., Brumfield, R. T., Tello, J. G., Marchese, D. J., and Cracraft, J. 2009. Phylogeny and phylogenetic classification of the antbirds, ovenbirds, woodcreepers, and allies (Aves: Passeriformes: infraorder Furnariides). *Cladistics* 25: 386–405.
- Moyle, R. G. 2006. A molecular phylogeny of kingfishers (Alcedinidae) with insights into early biogeographic history. *Auk* 123: 487–499.
- Murray, B. W., McGillivray, W. B., Barlow, J. C., Beech, R. N., and Strobeck, C. 1994. The use of cytochrome b sequence variation in estimation of phylogeny in the Vireonidae. *Condor* 96: 1037–1054.
- Nguembock, B., Fjelds , J., Couloux, A., and Pasquet, E. 2009. Molecular phylogeny of Carduelinae (Aves, Passeriformes, Fringillidae) proves polyphyletic origin of the genera *Serinus* and *Carduelis* and suggests redefined generic limits. *Mol Phylogenet Evol* 51: 169–181.
- Outlaw, D. C., Voelker, G., Mila, B., and Girman, D. J. 2003. Evolution of long-distance migration in and historical biogeography of *Catharus* thrushes: A molecular phylogenetic approach. *Auk* 120: 299–310.
- Sheldon, F. H. 1987. Phylogeny of herons estimated from DNA–DNA hybridization data. *Auk* 104: 97–108.
- Sibley, C. G., and Ahlquist, J. E. 1990. *Phylogeny and Classification of Birds*. New Haven: Yale University Press.
- Svensson, E., and Hedenstrom, A. 1999. A phylogenetic analysis of the evolution of moult strategies in Western Palearctic warblers (Aves : Sylviidae). *Biol J Linn Soc* 67: 263–276.

- Swierszewski, E. V., and Raikow, R. J. 1981. Hind limb morphology, phylogeny, and classification of the Piciformes. *Auk* 98: 466–480.
- Tello, J. G., Moyle, R. G., Marchese, D. J., and Cracraft, J. 2009. Phylogeny and phylogenetic classification of the tyrant flycatchers, cotingas, manakins, and their allies (Aves: Tyrannides). *Cladistics* 25: 429–467.
- Thomas, G. H., Wills, M. A., and Szekely, T. 2004. A supertree approach to shorebird phylogeny. *BMC Evol Biol* 4: 28.
- Voelker, G., Rohwer, S., Bowie, R. C., and Outlaw, D. C. 2007. Molecular systematics of a speciose, cosmopolitan songbird genus: defining the limits of, and relationships among, the *Turdus* thrushes. *Mol Phylogenet Evol* 42: 422–434.
- Voelker, G., and Spellman, G. M. 2004. Nuclear and mitochondrial DNA evidence of polyphyly in the avian superfamily Muscicapoidea. *Mol Phylogenet Evol* 30: 386–394.
- Wink, M., and Heidrich, P. 2000. Molecular systematics of owls (Strigiformes) based on DNA sequences of the mitochondrial cytochrome b gene. In *Raptors at Risk* (ed. Chancellor, R. D., and Meyburg, B.-U.), pp. 819–828. Hancock House.
- Wright, T. F., Schirtzinger, E. E., Matsumoto, T., Eberhard, J. R., Graves, G. R., Sanchez, J. J., Capelli, S., Muller, H., Scharpegge, J., Chambers, G. K., and Fleischer, R. C. 2008. A multilocus molecular phylogeny of the parrots (Psittaciformes): support for a Gondwanan origin during the cretaceous. *Mol Biol Evol* 25: 2141–2156.