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Supplementary material

Appendix 1. Summary of studies assessing the frequency of hatching failure in relation to one or more variables (see also Krist 2010 for a review of studies showing effects of egg size upon hatching failure)

Species	Scientific name	Variables associated with hatching failure	Variables not associated with hatching failure	Reference
Acorn Woodpecker	*Melanerpes formicivorus*	Increases with increasing complexity of social structure [a]		Koenig 1982
American Kestrel	*Falco sparverius*	Negatively related to female size	Male size [b]	Bortolotti & Wiebe 1993
Ash-throated Flycatcher	*Myiarchus cinerascens*		Year, elevation, hatch date, proximity to environmental contaminants	Fair & Myers 2002
Barn Swallow	*Hirundo rustica*	Negatively related to egg mass	Lay order, ambient temperature during incubation	Saino et al. 2004
Black Kite	*Milvus migrans*	First-laid eggs most likely to fail but only in synchronously incubated clutches. Failure more common if mean temperature was higher during incubation		Viñuela 1997, 2000

Black-legged Kittiwake	*Rissa tridactyla*	Positively correlated with parental relatedness		Mulard et al. 2009
Blue Tit	*Cyanistes caeruleus*	Increasingly frequent during a 30 year study		Deeming & du Feu 2011
Blue Tit	*Cyanistes caeruleus*		Presence of extra-pair young	Krokene et al. 1998
Cedar Waxwing	*Bombycilla cedrorum*	More common in nests in orchards, possibly due to exposure to pesticides		Rothstein 1973
Cliff Swallow	*Petrochelidon pyrrhonota*	Decreases as colony size increases	Lay date, nest ectoparasites, mean adult mass, incubation duration	Brown & Brown 2001
Coal Tit	*Periparus ater*	Increasingly frequent during a 30 year study		Deeming & du Feu 2011
Dickcissel	*Spiza americana*	Increased with lay date		Harmeson 1974
Eastern Bluebird	*Sialia sialis*	Increased with lay date, decreases with latitude, most common in small and large clutches		Cooper et al. 2006

Eastern Bluebird	*Sialia sialis*	Increases with season/nest attempt		Musselman 1935
Eastern Bluebird	*Sialia sialis*	Increases with season/nest attempt	X-ray irradiation of eggs	Norris 1958
Eastern Bluebird	*Sialia sialis*	Increases with season/nest attempt		Peakall 1970
Eastern Bluebird	*Sialia sialis*	Increases with season/nest attempt		White & Woolfenden 1973
Eastern Phoebe	*Sayornis phoebe*	More common among eggs capped by shells of brown-headed cowbirds *Molothrus ater*		Hauber 2003
European Blackbird	*Turdus merula*	More common among yearling females	Clutch size	Snow 1958
Great Reed Warbler	*Acrocephalus arundinaceus*	Positively related to parental relatedness, non-significant variation between years		Hansson 2004
Great Tit	*Parus major*		Year	Deeming & du Feu 2011
Great Tit	*Parus major*	Reduced by calcium supplementation [c]		Graveland & Drent 1997

Great Tit	*Parus major*	Females treated with antimalarial drug had higher hatching success		Knowles et al. 2010
Great Tit	*Parus major*		Presence of extra-pair young	Krokene et al. 1998
Great Tit	*Parus major*	More common in nests infested with fleas	Hatch date	Oppliger et al. 1994
Greater Prairie Chicken	*Tympanuchus cupido pinnatus*	Increased over 35 years, likely due to inbreeding associated with decreasing population size. Positively correlated with rainfall during incubation period		Westemeier et al. 1998
House Sparrow	*Passer domesticus*	Infertile eggs more common early in the lay sequence		Cordero et al. 1999
House Sparrow	*Passer domesticus*	Negatively related to egg size in 1 of 4 combinations of year and study site. More common among first-laid eggs		Murphy 1978a
House Sparrow	*Passer domesticus*	Negatively related to clutch size		Murphy 1978b
House Sparrow	*Passer domesticus*		Presence of extra-pair young, lay date	Whitekiller et al. 2000
Laughing	*Dacelo*	No difference in social groups of 2-6, but	Year, hatch date, pair	Legge 2000

Kookaburra	*novaeguineae*	sharp increase in groups of 7 [a]	duration, age of dominant female	
Lesser Kestrel	*Falco naumanni*	Declined during the 16 year study [e]. Negatively related to paternal age. Highest in medium-sized colonies	Parental relatedness, female heterozygosity, female age, parental size, clutch size, lay date	Ortego et al. 2010
Lesser Kestrel	*Falco naumanni*	Highest in small and large clutches. Negatively related to egg size. Positively correlated with mean daily temp during incubation but only for females in poor body condition	Colony size, year, parental age, parental size	Serrano et al. 2005
Lincoln's Sparrow	*Melospiza lincolnii*	First and last-laid eggs most likely to fail	Clutch size, egg size, lay date	Sockman 2008
Nazca Booby	*Sula granti*	Negative effect of egg size in only 1 of 11 years	Clutch size, egg size in 10 of 11 years	Clifford & Anderson 2002
New Zealand Stitchbird	*Notiomystis cincta*	Less common in females with higher inter-annual survival, but more common among very old females (>4 years)	Date, ambient temperature during incubation, supplementary food	Low & Part 2009

Pied Flycatcher	*Ficedula hypoleuca*		Breeding density	Alatalo & Lundberg 1984
Pied Flycatcher	*Ficedula hypoleuca*	Negatively related to egg size, positively related to clutch size. Most common in first- and last-laid eggs. Lowest in 1 unusually wet and cold year of a 4 yr study	Female or male condition, female size, female or male mass, lay date, male age, female age	Potti 1999, 2008
Pied Flycatcher	*Ficedula hypoleuca*		Year, clutch size	Virolainen 1984
Prothonotary Warbler	*Protonotaria citrea*	Infertile eggs more common in first clutches than second, especially among young females		Blem et al. 1999
Rainbow Bee-eater	*Merops ornatus*	Highest in 1 unusually wet year of a 3 year study		Boland 2004
Red Bishop	*Euplectes orix*	More frequent on territories of high quality males, especially when breeding synchrony was high. More common in broods without extra-pair young		Friedl & Klump 2005

Snow Geese	*Chen caeruleus*		Female age	Finney & Cooke 1978
Snow Petrel	*Pagodroma nivea*	Negatively related to lay date and female condition	Male condition [b]	Barbraud & Chastel 1999
Song Sparrow	*Melospiza melodia*	Most frequent among inbred females, especially when incubation coincided with wet weather		Marr et al. 2006
South Island Robin	*Petroica a. australis*		Year, egg size, incubation attentiveness, supplemental food	Mackintosh & Briskie 2005
Tree Pipit	*Anthus trivialis*	Lower in nests with relatively shaded orientation		Burton 2006
Tree Swallow	*Tachycineta bicolor*		Parental relatedness	Barber et al. 2005
Tree Swallow	*Tachycineta bicolor*	Reduced by calcium supplements provided to adults [d]. Negatively correlated with size of young females	No effect of body size in older females (> ASY)	Bidwell & Dawson 2005
Tree Swallow	*Tachycineta bicolor*	Lower in nests with extra-pair young	Female age, lay order,	Kempenaers et al. 1999

Wandering Albatross	*Diomedea exulans*	Negatively related to egg size		Croxall et al. 1992
Western Bluebird	*Sialia mexicana*		Year, elevation, hatch date, proximity to environmental contaminants	Fair & Myers 2002
Western Gull	*Larus occidentalis*	Highest in smallest and largest clutches		Hunt & Hunt 1973

a = cooperative breeder

b = both sexes incubate

c = environment calcium deficient

d = environment not calcium-deficient

e = population gradually recovering from a serious decline

Appendix 2. Summary of studies assessing the proportion of unhatched eggs which contain no visible embryo. Data restricted to eggs collected from clutches in which at least one other egg hatched.

Species	Scientific name	Eggs examined	Undeveloped eggs	Proportion undeveloped	Note	Reference
American Robin	*Turdus migratorius*	8	6	75.0	Pooled from 2 US populations	Rothstein 1973
Barn Swallow	*Hirundo rustica*	2	2	100.0		Rothstein 1973
Black-billed Cuckoo	*Coccyzus erythropthalmus*	1	1	100.0		Rothstein 1973
Blue Tit	*Parus caeruleus*	68	10	14.7	Male bias among dead embryos	Cichon et al. 2005
Cedar waxwing	*Bombycilla cedrorum*	41	37	90.2		Rothstein 1973
Chipping Sparrow	*Spizella passerina*	6	6	100.0		Rothstein 1973
Collared	*Ficedula*	116	16	13.8	Male bias among	Cichon et al. 2005

Flycatcher	*albicollis*				dead embryos	
Eastern Kingbird	*Tyrannus tyrannus*	5	3	60.0		Rothstein 1973
Eastern Phoebe	*Sayornis phoebe*	9	2	22.2	Pooled from 2 US populations	Rothstein 1973
Great Tit	*Parus major*	86	19	22.1	Male bias among dead embryos	Cichon et al. 2005
Green-rumped parrotlet	*Forpus passerinus*	42	40	88.0	Eggs characterized as 'little or no development'	Stoleson and Beissinger 1992
Hoopoe	*Upupa epops*	26	16	61.5	Status could not be assessed for four eggs	Martin-Vivaldi et al. 1999
House Sparrow	*Passer domesticus*	346	214	61.8	24 of the embryos found in the other 132 eggs died during	Seel 1968

					hatching	
House Sparrow	*Passer domesticus*	13	11	84.6		Cordero et al. 1999
Least Flycatcher	*Empidonax minimus*	1	1	100.0		Rothstein 1973
New Zealand stitchbird	*Notiomystis cincta*	148	30	27.0	Egg numbers calculated from rate of infertility	Low et al. 2007, Low and Part 2009
Piping plover	*Charadrius melodus*	20	2	10.0	Each data point refers to a nest, not an egg. 24 eggs examined.	Doherty and Heath 2011
Prothonotary warbler	*Protonotaria citrea*	26	11	42.3		Petit 1989
South Island robin	*Petroica a. australis*	18	2	11.1		Mackintosh and Briskie 2005

Tree Swallows	*Tachycineta bicolor*	43	19	44.2	8 undeveloped eggs were examined microscopically and found to be fertile	Kempenaers et al. 1999
Western Gull	*Larus occidentalis*	11	8	72.7		Hunt and Hunt 1973

Appendix 3. Characterization of 32 microsatellite loci used to genotype Kentucky House Sparrows (*k* = number of alleles, H_{obs} = observed heterozygosity, H_{exp} = expected heterozygosity, *F*(null) = Estimated frequency of null alleles).

Locus	*k*	H_{obs}	H_{exp}	*F*(Null)	Product sizes (bp)	Reference
Pdo1	11	0.875	0.865	-0.0095	157-201	Neumann & Wetton 1996
Pdo3	13	0.850	0.879	+0.0103	118-168	Neumann & Wetton 1996
Pdo5	15	0.900	0.847	-0.0396	204-264	Griffith *et al.* 1999
Pdo6	32	0.975	0.964	-0.0118	312-456	Griffith *et al.* 1999
Pdo7	30	0.400	0.958	+0.4073**	174-288	Griffith *et al.* 2007
Pdo9	13	0.925	0.841	-0.0550	377-426	Griffith *et al.* 2007
Pdo10	14	0.850	0.885	+0.0170	108-144	Griffith *et al.* 2007
Pdo14	14	0.800	0.759	-0.0397	185-217	Dawson *et al.* 2012
Pdo16A	12	0.800	0.858	+0.0304	269-297	Dawson *et al.* 2012

Pdo17	14	0.750	0.835	+0.0436	194-246	Dawson *et al.* 2012
Pdo18	16	0.750	0.889	+0.0831*	249-299	Dawson *et al.* 2012
Pdo22	9	0.650	0.727	+0.0480	101-133	Dawson *et al.* 2012
Pdo25	18	0.775	0.836	+0.0374	81-135	Dawson *et al.* 2012
Pdo27	9	0.850	0.801	-0.0350	230-246	Dawson *et al.* 2012
Pdo28	18	0.750	0.684	-0.0676	194-286	Dawson *et al.* 2012
Pdo33	15	0.850	0.919	+0.0326	220-266	Dawson *et al.* 2012
Pdo34	13	0.725	0.836	+0.0797*	166-194	Dawson *et al.* 2012
Pdo36	14	0.825	0.875	+0.0216	186-228	Dawson *et al.* 2012
Pdo40	16	0.825	0.899	+0.0369	291-321	Dawson *et al.* 2012
Pdo41	16	0.600	0.816	+0.1569**	178-226	Dawson *et al.* 2012
Pdo47	13	0.900	0.842	-0.0448	170-198	Dawson *et al.* 2012
PdoA08	7	0.650	0.749	+0.0691*	190-214	Garnier et al. 2009

PdoD09	9	0.675	0.647	-0.0224	142-160	Garnier et al. 2009
PdoF09	6	0.600	0.655	+0.0275	125-135	Garnier et al. 2009
Ase18	13	0.925	0.840	-0.0592	193-249	Richardson *et al.* 2000
CtC105	13	0.825	0.907	+0.0438	273-305	Tarvin 2006
Emb19	4	0.300	0.473	+0.2520**	123-155	Mayer *et al.* 2008
Emb112	9	0.750	0.693	-0.0546	136-156	Mayer *et al.* 2008
Escu4	11	0.700	0.817	+0.0703*	129-157	Hanotte et al. 1994
Fhu2	9	0.725	0.797	+0.0357	128-148	Ellegren 1992
Pamo12	10	0.725	0.825	+0.0540*	218-240	Izumi et al. 2009
Wbsw11	31	0.925	0.957	+0.0113	177-293	McRae & Amos 1999

* = modest frequency of null alleles

** = high frequency of null alleles

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