Supplementary materials for "Age-dependent and age-independent sexual selection on multiple male traits in the lekking black grouse (*Lyrurus tetrix*)" by Kervinen, Lebigre & Soulsbury

Supplementary Table 1. Spearman's rank correlation coefficients for morphological and behavioural traits of male black grouse quantified for a) all males, b) yearling males and c) older males (age ≥ 2 years). Significance: *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$.

a) All males

	Body mass	Lyre Length	Blue chroma	Eye comb size	Lek attendance	Fighting rate
Lyre Length	0.60***					
Blue chroma	0.09	0.17**				
Eye comb size	0.63***	0.64***	0.12*			
Lek attendance	0.48***	0.52***	0.08	0.47***		
Fighting rate	0.20**	0.22***	0.09	0.12	0.26***	
Distance from the lek centre	−0.32***	−0.23***	0.00	−0.26***	−0.62***	−0.51***

b) Yearling males

	Body mass	Lyre Length	Blue chroma	Eye comb size	Lek attendance	Fighting rate
Lyre Length	0.06					
Blue chroma	−0.05	0.01				
Eye comb size	0.21**	0.09	−0.07			
Lek attendance	−0.04	−0.03	0.08	−0.06		
Fighting rate	0.03	−0.02	0.10	−0.04	0.19	
Distance from the lek centre	0.01	−0.01	−0.02	−0.02	−0.47***	−0.48***

c) Adult males (i.e. ≥ 2 years old males)

	Body mass	Lyre Length	Blue chroma	Eye comb size	Lek attendance	Fighting rate
Lyre Length	0.08					
Blue chroma	−0.01	0.12				
Eye comb size	0.27***	0.08	0.05			
Lek attendance	0.22**	0.08	−0.12	0.11		
Fighting rate	0.06	0.09	0.05	−0.04	0.17**	
Distance from the lek centre	−0.25***	−0.13	0.07	−0.15*	−0.58***	−0.46***

NOTE: We used 'gls' models from the R package 'nlme' in our main analysis, as that enabled us to best account for the overdispersion in the data. However, as random slopes cannot be fitted in gls models, we reanalysed the data using lme models with random slope and random intercept (Supplementary Tables 2 and 3) and with the random intercept only (Supplementary Tables 4 and 5) for comparison to estimate the significance of the random effects in our models. As can be seen, there were no major differences in the results between gls (Tables 1 and 2 in the main document) and lme models: model ranks changed only slightly, the same models were averaged, and none of the model averaged estimates changed radically, but age had a significant positive quadratic effect on AMS in both lme models, which was only nearly significant in gls models (95% unconditional CI: [−0.48, 0.01], see Table 2 in the main document).

Supplementary Table 2. A suite of pre-selected biologically relevant alternative lme candidate models for comparison with Table 1 (in the main document). Asterisks denote interactions. Individual identity nested within study site (intercept) and its interaction with age (slope) were fitted as a random effects in all the models. Candidate models within 95% cumulative model weight (i.e. ranks 1 to 9) were averaged (see Supplementary Table 3). GLS model rank denotes the rank of the same gls model in our main analysis, which indicate minor differences in model selection.

Rank	Model	k	AIC_c	ΔAIC_c	w_i	Cum. w_i	LogLik	GLS model rank
1	Age+Age^2+AFL	13	1747.80	0.00	0.35	0.35	−860.44	1
2	Age+Age^2+AFL+Age*AFL	14	1748.87	1.08	0.20	0.55	−859.91	3
3	Age+AFL+LS+TE+Age*LS+Age*TE	16	1750.42	2.62	0.09	0.65	−858.52	2
4	Age+Age^2+AFL+LS+TE	15	1750.84	3.04	0.08	0.72	−859.81	6
5	Age+Age^2+AFL+LS+TE+Age*LS+Age*TE	17	1751.22	3.42	0.06	0.79	−857.83	4
6	Age+Age^2	12	1751.94	4.14	0.04	0.83	−863.58	9
7	Age+AFL+LS+TE+Age*AFL+Age*LS+Age*TE	17	1751.95	4.15	0.04	0.87	−858.20	5
8	Age+Age^2+AFL+LS+TE+Age*AFL	16	1751.96	4.17	0.04	0.92	−859.29	8
9	Age+Age^2+AFL+LS+TE+Age*AFL+Age*LS+Age*TE	18	1752.78	4.99	0.03	0.95	−857.52	7
10	Age+Age^2+TE	13	1754.07	6.27	0.02	0.96	−863.58	11
11	Age+Age^2+TE+Age*TE	14	1754.38	6.58	0.01	0.97	−862.66	10
12	Age+AFL	12	1755.66	7.87	0.01	0.98	−865.44	13
13	Age+Age^2+LS+TE	14	1756.13	8.33	0.01	0.99	−863.53	15
14	Age+AFL+Age*AFL	13	1756.38	8.58	0.00	0.99	−864.73	14
15	Age+LS+TE+Age*LS+Age*TE	15	1757.48	9.69	0.00	0.99	−863.14	12
16	Age+Age^2+LS+TE+Age*LS+Age*TE	16	1758.16	10.37	0.00	1.00	−862.39	16
17	Age+AFL+LS+TE	14	1758.68	10.88	0.00	1.00	−864.81	17
18	Age	11	1759.08	11.29	0.00	1.00	−868.21	19
19	Age+AFL+LS+TE+Age*AFL	15	1759.47	11.67	0.00	1.00	−864.13	18
20	Age+TE	12	1761.20	13.40	0.00	1.00	−868.21	20
21	Age+LS+TE	13	1763.31	15.52	0.00	1.00	−868.20	22
22	Age+TE+Age*TE	13	1763.33	15.53	0.00	1.00	−868.21	21
23	null	8	1789.21	41.41	0.00	1.00	−886.43	23

Supplementary Table 3. The relative importance and averaged coefficient estimates with unconditional standard errors and 95% unconditional confidential intervals of Age, Age^2, age of first lek attendance (AFL), lifespan (LS) and terminal event (TE; binary, indicates if it was the male's last year alive or not) and their relevant interactions on annual mating success in male black grouse in the model averaged lme models shown in Supplementary Table 2.

Parameter	Relative importance	Estimate	Unconditional SE	95% unconditional CI
Age	1.00	2.17	0.47	1.24, 3.10
AFL	0.96	−0.34	0.15	−0.63, −0.05
Age^2	0.87	−0.27	0.10	−0.46, −0.08
LS	0.34	0.16	0.21	−0.26, 0.59
TE	0.34	−0.37	0.38	−1.12, 0.37
Age:AFL	0.31	−0.17	0.17	−0.49, 0.16
Age:LS	0.22	−0.26	0.20	−0.65, 0.13
Age:TE	0.22	0.10	0.29	−0.46, 0.66

Supplementary Table 4. A suite of pre-selected biologically relevant lme candidate models for comparison with Table 1 in the main document. Asterisks denote interactions. Individual identity nested within study site was fitted as a random factor in all the models. Candidate models within 95% cumulative model weight were averaged (see Supplementary Table 5). GLS model rank denotes the rank of the same GLS model in our main analysis, which indicate minor differences in model selection.

Rank	Model	k	AIC_c	ΔAIC_c	w_i	Cum. w_i	LogLik	GLS model rank
1	Age+Age²+AFL	11	1743.19	0.00	0.29	0.29	−860.27	1
2	Age+AFL+LS+TE+Age*LS+Age*TE	14	1744.32	1.13	0.17	0.46	−857.63	2
3	Age+Age²+AFL+Age*AFL	12	1744.37	1.18	0.16	0.62	−859.79	3
4	Age+Age²+AFL+LS+TE+Age*LS+Age*TE	15	1745.51	2.31	0.09	0.71	−857.15	4
5	Age+AFL+LS+TE+Age*AFL+Age*LS+Age*TE	15	1746.07	2.88	0.07	0.78	−857.43	5
6	Age+Age²+AFL+LS+TE	13	1746.26	3.07	0.06	0.85	−859.67	6
7	Age+Age²+AFL+LS+TE+Age*AFL+Age*LS+Age*TE	16	1747.29	4.10	0.04	0.88	−856.96	7
8	Age+Age²	10	1747.53	4.34	0.03	0.92	−863.49	9
9	Age+Age²+AFL+LS+TE+Age*AFL	14	1747.56	4.37	0.03	0.95	−859.25	8
10	Age+Age²+TE+Age*TE	12	1748.92	5.73	0.02	0.97	−862.07	10
11	Age+Age²+TE	11	1749.63	6.44	0.01	0.98	−863.48	11
12	Age+LS+TE+Age*LS+Age*TE	13	1751.46	8.27	0.00	0.98	−862.27	12
13	Age+AFL	10	1751.54	8.35	0.00	0.99	−865.50	13
14	Age+Age²+LS+TE	12	1751.64	8.45	0.00	0.99	−863.43	15
15	Age+AFL+Age*AFL	11	1751.99	8.80	0.00	1.00	−864.67	14
16	Age+Age²+LS+TE+Age*LS+Age*TE	14	1752.61	9.42	0.00	1.00	−861.77	16
17	Age+AFL+LS+TE	12	1755.12	11.93	0.00	1.00	−865.17	17
18	Age	9	1755.53	12.34	0.00	1.00	−868.54	19
19	Age+AFL+LS+TE+Age*AFL	13	1755.69	12.50	0.00	1.00	−864.39	18
20	Age+TE	10	1757.50	14.31	0.00	1.00	−868.47	20
21	Age+TE+Age*TE	11	1759.29	16.10	0.00	1.00	−868.32	21
22	Age+LS+TE	11	1759.58	16.39	0.00	1.00	−868.46	22
23	null	8	1789.21	46.02	0.00	1.00	−886.43	23

Supplementary Table 5. The relative importance and averaged coefficient estimates with unconditional standard errors and 95% unconditional confidential intervals of Age, Age^2, age of first lek attendance (AFL), lifespan (LS) and terminal event (TE; binary, indicates if it was the male's last year alive or not) and their relevant interactions on annual mating success in male black grouse in the model averaged lme models shown in Supplementary Table 4.

Parameter	Relative importance	Estimate	Unconditional SE	95% unconditional CI
Age	1.00	2.10	0.46	1.21, 3.00
AFL	0.97	−0.36	0.15	−0.66, −0.06
Age^2	0.76	−0.25	0.11	−0.47, −0.03
LS	0.46	0.19	0.20	−0.21, 0.59
TE	0.46	−0.45	0.39	−1.22, 0.32
Age:LS	0.37	−0.25	0.18	−0.61, 0.10
Age:TE	0.37	0.13	0.28	−0.42, 0.68
Age:AFL	0.30	−0.12	0.14	−0.40, 0.16
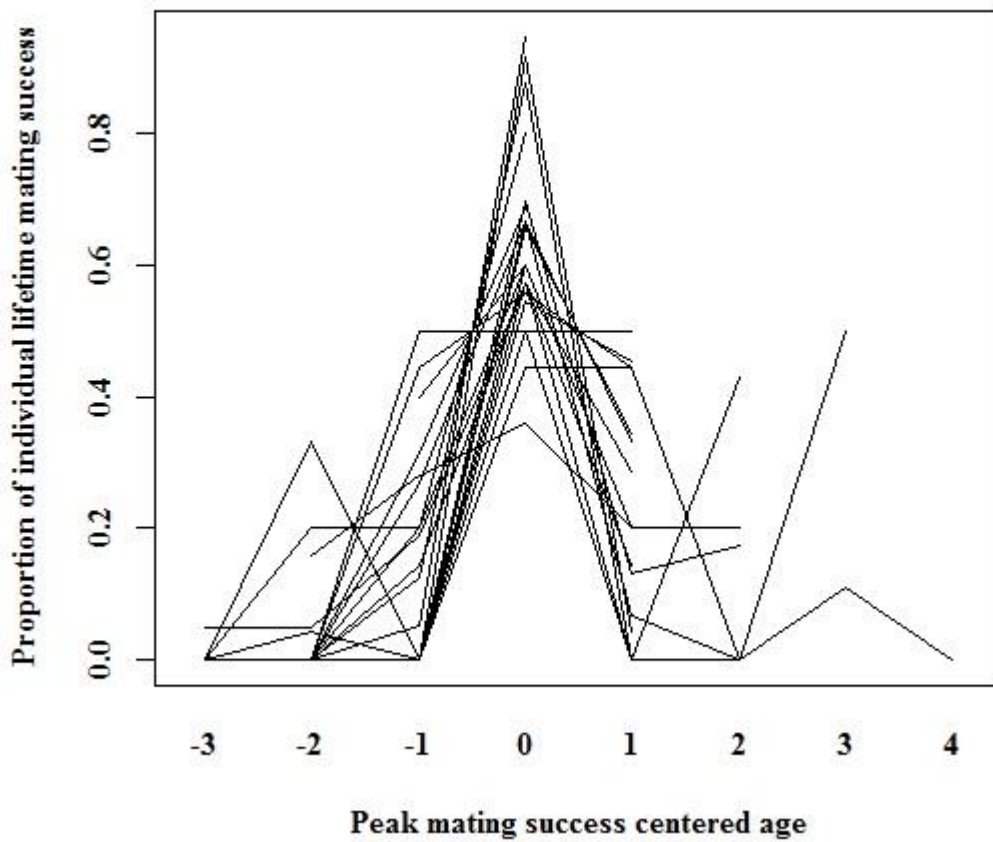
Supplementary Figure S1. Proportion of the AMS of individual LMS in males that had at least 1 copulation in 2 or more years (N = 25). Year of peak mating success (i.e. individual peak AMS) is denoted with 0 in the x axis. 80% of these males got >50% of their LMS in the year of their peak AMS.