Great tits growing old

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Supplementary material

(a) *Maternal age and offspring natal dispersal*

Local survival only reflects fitness if emigration of chicks is independent of state (as shown for Wytham by Verhulst et al. 1997), and in our case independent of maternal age. We did not have data to relate emigration to maternal age directly, but we could test for a maternal age effect on natal dispersal distance, which has for example been found in common lizards *Lacerta vivipara* (Ronce et al. 1998). Natal dispersal distance for 3821 nestlings from 2191 mothers of known age was defined as the distance between an individual's nest box of birth and first breeding, and square-root transformed to assure normality (as in Szulkin & Sheldon 2008). It was then used in a hierarchical linear mixed model which included sex, fledging mass, laying date, distance of the natal nest box from the forest edge, maternal age, maternal ALR and all two-way interactions as fixed effects, and mother identity as a random effect. Maternal age dropped from the model (estimate ± SE: 0.21 ± 0.22, $\chi^2_1 = 0.93$, $P = 0.34$), and although natal dispersal and emigration may be different processes, this increased our confidence that local recruitment is a good measure of fitness with respect to maternal age. Maternal ALR did show a weak, but significant, negative effect (table S1), which suggests that the offspring of mothers with long reproductive lifespan disperse less far within the study site.

(b) *The effect of extreme reproductive lifespan*

In the within-individual senescence analysis described in the main paper, all breeding attempts by females of all age classes were included. As fitting quadratic effects, such as that of age^2, cause one end of the curve to be constrained by the other, we repeated the

analyses excluding 21 breeding attempts at ages 7, 8 and 9 to ensure our results were not driven by 18 females of exceptionally long reproductive lifespan. This did not alter the qualitative conclusions of the model (table S2).

Tables

Table S1. Result from a model testing the effects of maternal age and reproductive lifespan on square-rooted natal dispersal distance (m) of offspring (3821 chicks from 2191 mothers). (Shown are parameter estimates with standard errors and significance (* for $P < 0.05$, ** for $P < 0.01$, *** for $P < 0.001$). N/S implies a term was removed from the model because $P > 0.05$.)

parameter	est	SE	χ^2 (df=1)
sex	-3.78	0.35	118.28***
fledging mass	-0.03	0.01	10.82**
distance from edge	-0.02	0.01	6.92**
maternal age	N/S	.	.
maternal ALR	-0.32	0.12	6.63*
laying date	N/S	.	.
sex*fledging mass	N/S	.	.
sex*distance from edge	N/S	.	.
sex*maternal age	N/S	.	.
sex*maternal ALR	N/S	.	.
sex*laying date	N/S	.	.
mass*distance from edge	0.00	0.00	5.34*
mass*maternal age	N/S	.	.
mass*maternal ALR	N/S	.	.
mass*laying date	N/S	.	.
distance from edge*maternal age	N/S	.	.
distance from edge*maternal ALR	N/S	.	.
distance from edge*laying date	N/S	.	.
maternal age*maternal ALR	N/S	.	.
maternal age*laying date	N/S	.	.
maternal ALR*laying date	N/S	.	.
mother identity (r)	13.58	2.44	.
chick identity (r)	95.19	2.99	.

Table S2. Results from models testing the effects of age, selective disappearance and several fixed effects on recruitment at the individual-level as in the main paper (7341 breeding attempts by 4935 females, left), and when excluding the breeding records for females aged 7, 8 and 9 (7320 breeding attempts by 4935 females, right). (Shown are parameter estimates with standard errors and significance (* for $P < 0.05$, ** for $P < 0.01$, *** for $P < 0.001$).)

	individual-level model, age 1-9			**individual-level model, age 1-6**		
parameter	**est**	**SE**	**χ^2 (df=1)**	**est**	**SE**	**χ^2 (df=1)**
age	0.17	0.05	11.14***	0.15	0.05	8.06**
age²	-0.03	0.01	12.17***	-0.03	0.01	7.67**
ALR	0.04	0.02	9.26**	0.04	0.01	9.57**
status	0.11	0.03	12.80***	0.11	0.03	12.80***
density	-0.16	0.06	6.41*	-0.17	0.06	7.76**
year quality	0.31	0.06	27.59***	0.26	0.04	37.59***
female (r)	0.10	0.05	.	0.10	0.05	.
year (r)	0.15	0.04	.	0.15	0.04	.
area (r)	0.02	0.01	.	0.02	0.01	.

References

Ronce, O., Clobert, J. & Massot, M. 1998. Natal dispersal and senescence. *Proc. Natl. Acad. Sci. USA* **95**, 600-605.

Szulkin, M. & Sheldon, B. C. 2008. Dispersal as a means of inbreeding avoidance in a wild bird population. *Proc. R. Soc. B* **275**, 703-711.

Verhulst, S., Perrins, C. M. & Riddington, R. 1997. Natal dispersal of great tits in a patchy environment. *Ecology* **78**, 864-872.