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MATERIALS AND METHODS

Experimental Protocol

Study plots were assigned at random one of the four following experimental treatments at the beginning of the study: (i) "increased" plots (I): 60% of nests received 1 to 3 additional nestlings; (ii) "decreased" plots (D): 30% of nests had all their nestlings removed, simulating nest predation; (iii) "control 1" plots (C1): 20% of nests had all their nestlings removed, and 40% received additional nestlings (i.e., movements of nestlings within the plot); and (iv) "control 2" plots (C2): no nestling was added in, or removed from, any nest. Within plot treatments, individuals may thus have received different individual treatments, and individuals may receive the same individual treatment in different plot treatments (brood increase in I and C1 plots, brood removal in D and C1 plots, and no manipulation in all plots).

Each plot was assigned the same treatment during the 3 years of manipulation (1997–1999), which mimicked the natural predictability of local reproductive success (S1). The experiment was performed in a total of 12 plots (three increased plots, three decreased plots, two control 1 plots and four control 2 plots) each year (except in 1997 where 9 plots were manipulated only), including a total of approximately 1100 nest boxes, housing approximately 340 breeding pairs, each year.

Immigration rates

Definition of immigration status. A breeding adult was considered as an immigrant to a plot when (i) it was unringed, or, if ringed, (ii) it had been caught breeding in another plot on its last capture as a breeder or was ringed as a chick in another plot (and not caught as a breeder previously).

Immigration rate was defined as the ratio of the number of immigrants on the number of nest boxes available to them. One immigration rate was computed for each age (yearlings vs. older) and sex class, thus giving a total of four values per plot per year.

Computation of the number of immigrants. Adult capture probability was linked to reproductive status and success, early failed breeders and polygynous males being less likely to be caught (S2). On average, 7.7% and 26.2% of breeding females and males, respectively, were missed each year in each plot. For each sex, the total number of immigrants in each age class (yearlings vs. older adults) was thus estimated as the proportion of immigrants of that class among caught individuals times the total number of breeders of the age class. The latter was in turn computed as the proportion of breeders of the age class among caught breeders times the total number of active nests. These estimations were unlikely to be biased because (i) neither the probability of breeding failure of unmanipulated nests, nor the probability of polygyny differed among treatments [breeding failure: \(N = 950, \chi^2(3) = 5.04, P = 0.17\); polygyny: \(N = 1135, \chi^2(3) = 1.24, P = 0.74\)], and (ii) breeder capture probability [obtained via capture-recapture methods; (S3, S4)] did not differ among treatments: the model with time-dependent \(t\) recapture rate \(P(t)\) was the lowest AIC model for both sexes (males: \(N = 805\) capture-recapture histories, AIC = 1162.85, df = 26, females: \(N = 1128\), AIC = 1384.86, df = 26; AIC values of the nearest model including treatment effect \(m\) on recapture rate: males: \(P(t \times m)\), AIC = 1165.38, df = 32; females: \(P(t + m)\), AIC = 1390.06, df = 29; in both cases, \(\Delta\)AIC > 2). Thus, the same percentage of breeders was missed in plots of each treatment, and they were missed for the same reasons.
Computation of the number of nest boxes available. Nest boxes occupied by residents and tits were considered unavailable to immigrants. Furthermore, yearlings, arriving late from migration \(S5\), have fewer boxes available than older individuals, because of the incumbent advantage of first arrived birds in contests for a box \(S5\). The number of nest boxes available to all immigrants of a given age and sex class was thus computed as the total number of boxes in the plot minus the number of boxes occupied by tits and old residents, in the case of the immigration of old birds, plus yearling residents and old immigrants in the case of yearling immigration.

Emigration Probability

Since an individual could be recorded as a breeder in more than two years, we selected the first dispersal event for each individual. For polygynous males [about 10 to 15\% of males \(S2\)], dispersal from/to the primary nest only was considered. Individuals not caught in one or more year(s) (i.e., that skipped breeding or were missed) were not more prone to disperse than individuals breeding two years in a row [adults: \(\chi^2(1) = 0.362, P = 0.55\); juveniles: \(\chi^2(1) = 0.101, P = 0.75\); all pairwise interactions not significant]. Thus all individuals were kept in the analyses. Results for juveniles will be shown elsewhere.

Statistical Analysis

We used multiple logistic regressions for emigration probability and analyses of covariance for immigration rate. We checked the fit of logistic regression models with likelihood-ratio and goodness-of-fit tests, and the normality and homosedasticity of residuals in ANCOVAs. Starting models contained the main effects plus all possible pairwise interactions.

SOM TEXT

Relation between mean number of fledglings and mean fledgling condition per plot. Our experiment artificially reversed the positive correlation between offspring quantity and quality (i.e., condition) that is observed in natural situations. Indeed, in plots with manipulated nests [i.e., increased (I) plots, control 1 (C1) plots and decreased (D) plots], mean fledgling number is negatively correlated to mean fledgling condition. This markedly differs from the relationship observed in plots with no manipulated nests both during our experiment [control 2 (C2) plots, 1997 to 1999] and during the course of the long-term study (1980 to 1996). In an analysis of variance of the mean number of fledglings per plot, the interaction term "mean-condition-at-fledging-per-plot" by "plot-experimental-status" (manipulated vs. unmanipulated) is significant: \(n = 128, F(1,124) = 7.00, P = 0.0092\) (note that unmanipulated plots did not differ between the two periods).

References


