

Adjustments In Parental Care By The European Starling (*Sturnus Vulgaris*): The Effect Of Female Condition

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Abstract

Every organism has a limited amount of energy that can be expended towards growth, personal maintenance, and reproduction. Once an organism has reached sexual maturity, life history theory predicts a trade-off to exist between self-maintenance and investment in offspring. This study examined the extent to which male and female parental care was affected by a decrease in female body condition in a population of European Starlings (*Sturnus vulgaris*). By clipping wing and tail feathers on a female to reduce her foraging ability, female parental care was predicted to decrease, and male parental care to increase in compensation. Nests were observed during the 2002 breeding season. It was found that young raised at experimental nests fledged at significantly lower masses than those raised at control nests. This suggests that females compensated for their handicapped condition by decreasing reproductive energy expenditure, possibly by changing foraging strategy from prey of higher quality to prey of higher availability, combined with a slight decrease in feeding visits by both parents. Visitation rates by both parents at experimental nests tended to be slightly lower than those at control nests, though this difference was not statistically significant. Also, clipped females did not lose more body mass than control females during the reproductive season, indicating that females were not willing to pay the price for the increase in cost of reproduction.

Keywords: Body Condition, Energy Expenditure, Life History Theory, Parental Care, *Sturnus vulgaris*.

1. Introduction

Natural selection favors traits that increase an individual's fitness. However, energy is limited, so a balance between self and offspring is necessary to ensure maximum reproductive success [1]. Life history theory predicts a trade-off to exist between self-maintenance and investment in offspring. A parent may allocate most of its time and resources to self-maintenance and avoidance of predators. This strategy could extend the reproductive life of the parent, but the little energy remaining for investment in offspring would allow only minimal parental care. Conversely, a parent may invest heavily in offspring, but the potential risks of reproduction could decrease its own survival [2].

Many avian studies have investigated the trade-offs made by parents when faced with increased demands on their energy during reproduction. Females of several different passerine species have been found to reduce their clutch size when several of their flight feathers have been experimentally removed previous to laying. They also decreased their nestling feeding rates. However, treatment females lost more mass during the breeding season than control females, indicating that they bore the brunt of their handicap rather than passing the costs on to their offspring [3, 4, 5]. Wright and Cuthill [6] performed a handicapping experiment in which they added weights to the tails of European Starlings after laying. This resulted in a decrease in the weighted birds' parental care. The unweighted partner did not compensate for its partner, so the offspring suffered the costs of the manipulation. By reducing a parent's ability to care for itself and its young, these experiments are useful in determining how the parent allocates its energy expenditure between competing demands. With this information, one can begin to understand the selective pressures responsible for the evolution of parental care.

We examined the extent to which male and female parental care was affected by a decrease in female body condition in a population of European Starlings (*Sturnus vulgaris*). Female condition was reduced by decreasing her foraging ability, which we achieved by clipping wing and tail feathers. Starlings have relatively high lifetime reproductive success, due to high annual survival, flexibility of mating systems, and the production of two broods per female during each reproductive season [7]. Therefore, we predicted a reduction in condition would result in a corresponding decrease in investment in offspring. Furthermore, we predicted a decrease in female parental care would result in an increase in care by her male partner.

2. Methods

2.1. study site and species

The European Starling (*Sturnus vulgaris*) is an ideal species for examining trade-offs because of its success and abundance. Human disturbance has greatly increased starling habitat, as starlings often nest in man-made structures and exploit food resources found in urban and agricultural areas. Their low sensitivity to disturbance allows for experimentation without the risk of parents abandoning their young [8]. Starlings are secondary cavity nesters and are readily attracted to nest boxes. In addition, they are highly social, so pairs will utilize nests that are in close proximity to each other [8].

In northern Utah, starlings typically complete two broods during the breeding season, which begins in the spring and continues through early summer. The modal clutch size is 5 eggs, and full time incubation begins the day the last egg is laid [9]. Incubation lasts between 11 and 12 days, with the female responsible for about 70% of the incubation during the day, and all of it at night [8]. Nestlings are fed by one or both parents in the nest for 21-22 days, beginning at hatching (brood day 0), and continuing for an additional week after nest leaving.

This experiment was conducted at the Abbey of Our Lady of the Holy Trinity Monastery in Huntsville, Utah, during the 2002 breeding season. The nest box colony consisted of 98 wooden boxes (22 cm x 23 cm x 41 cm), each with a detachable lid for easy access to the nest, and a metal, sliding trap door to facilitate capture of adults. Boxes were attached to old barns and out-buildings, as well as fences surrounding alfalfa fields. Starlings forage for food in the highest soil layer and dense vegetation directly above it [10]. The many fields surrounding the study site provided excellent foraging opportunities for this starling population, which consisted of about 70 breeding pairs.

2.2. general procedures

Throughout the breeding season, we attempted to capture males and females for measurements and banding. We captured adults by tying fish line to the metal trap door on the nest box, so that, when a starling entered the box, the line could be pulled, trapping the bird inside. We measured each adult's culmen length (from nares to tip), tarsus length, wing chord, tail length, and body mass. To aid in quick identification from a distance, each adult was banded with a unique combination of colored leg bands (maximum of 2 bands per leg). Each combination included one silver U.S. Fish and Wildlife band, engraved with a unique identification number.

All nest boxes were checked twice weekly for nest building activity and for determination of clutch initiation. Clutch size was assigned when two successive nest visits yielded the same number of eggs in a nest. Nests were checked daily for hatching beginning about ten days after completion of laying, and the day that the first egg in a nest hatched was designated as brood day 0. Number of young, (or brood size), was recorded and the nestlings were weighed on brood days 0, 4, 8, and 12. On day 12, additional measurements were taken, such as wing chord and tarsus length. Also on this day, nestlings were banded with one silver U.S. Fish and Wildlife identification band. Beginning with day 14, nests were checked daily until all nestlings had left the nest.

Parents were identified and assigned to particular nests based on observations of incubation or nestling feeding. Males that did not exhibit parental care were designated to broods if observed in nest building activities, mating displays on a particular nest box, or nest defense.

2.3. experimental procedures

Nests were randomly allocated to either the experimental or control treatments when nestlings hatched. Females were captured near the time of hatching (brood day 0-2) for initial weighing and handicapping. Females allocated to the experimental treatment had primaries 3, 6, and 9, secondaries 3 and 6, and retrices 3 and 6 clipped near the base. This handicap was only temporary, as clipped feathers were replaced in the pre-basic molt. All females were

recaptured around brood day 14 for a second weighing to assess relative female body condition. We made three separate observations per nest, occurring around brood days 3, 9, and 18, to measure numbers of total visits and feeding visits by males and females. Each observation lasted from 60 to 120 minutes, and was done by either personal observation or recorded with a video camera.

We performed parametric analyses, except when assumptions of statistical tests could not be met. We analyzed mean brood mass and female mass loss during the nestling period to determine if foraging adjustments were made. We also tested for differences between control and experimental broods in number of fledged young, brood survival, and length of the nestling period. To assess any behavioral adjustments made to parental care, we examined the effect of treatment on total nest visitations made per young by males and females.

3. Results

Mean brood mass was significantly lighter at experimental nests than controls by the second week of the nestling period (Figure 1). A trend was observed in brood mass difference between treatments, beginning with no difference on day 4 ($F_{1,28} = 0.001$, $P = 0.972$), slight difference on day 8 ($F_{1,24} = 1.060$, $P = 0.313$), and finally, a significant difference on day 12 ($F_{1,21} = 6.763$, $P = 0.017$). Handicapped females lost on average about one gram more in body mass than control females during the nestling period, but this difference was not significant (Table 1). No significant difference was found between treatment groups in number of fledged young, brood survival, or length of the nestling period (Table 1).

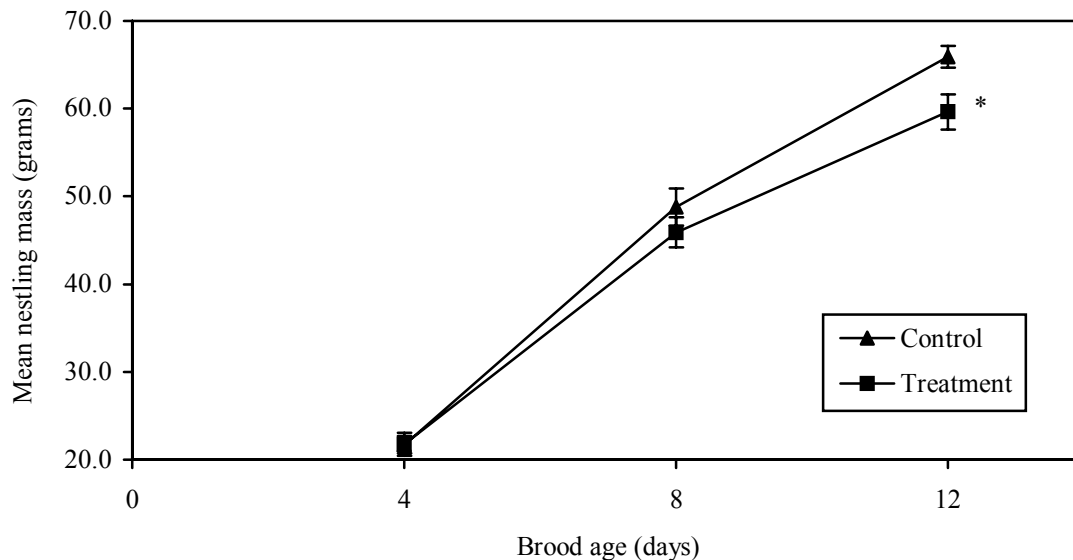


Figure 1 Mean (\pm SE) nestling mass at treatment nests and control nests during the nestling period (* $P < 0.05$).

Table 1 effects of treatment on several different variables during the nestling period.

VARIABLE	TREATMENT			CONTROL			F	P	df _{model, error}
	Mean	Std. Error	n	Mean	Std. Error	n			
Female mass loss (g)	5.167	0.427	9	6.011	1.229	9	38.000 ^d	0.825	1,16
Number of fledged young ^a	3.500	0.401	10	3.800	0.359	10	0.310	0.584	1,18
Brood survival ^b	0.972	0.019	12	0.923	0.033	11	49.000 ^d	0.175	1,21
Length of the nestling period (days) ^c	21.444	0.444	9	21.000	0.394	10	0.564	0.463	1,17
Female nest visits per hour									
Brood day 3	1.082	0.177	12	2.014	0.660	12	2.214	0.151	1,22
Brood day 9	2.123	0.439	12	2.599	0.381	11	0.659	0.426	1,21
Brood day 18	2.372	0.712	8	2.274	0.379	11	0.017	0.897	1,17

^aSuccessful nests only

^bNumber of young on day 12 / day 4; means were arcsin transformed for analysis

^cHatch day to fledge day

^dMann-Whitney U value

Analysis of variance for nest visitation rate per young per hour revealed no significant difference between treatment groups, but the mean visitation rate at experimental nests was slightly less than at control nests (Table 1). Only about half of the nests observed during the nestling period received any male parental care. Consequently, analysis of male visitation rate per young per hour was performed solely on those nests where males were observed caring for the young at least once. Males that participated in parental duties did so significantly less at experimental nests compared to control nests on brood day 9 (Figure 2; Mann-Whitney U-test; $U = 24.000$, $P = 0.028$).

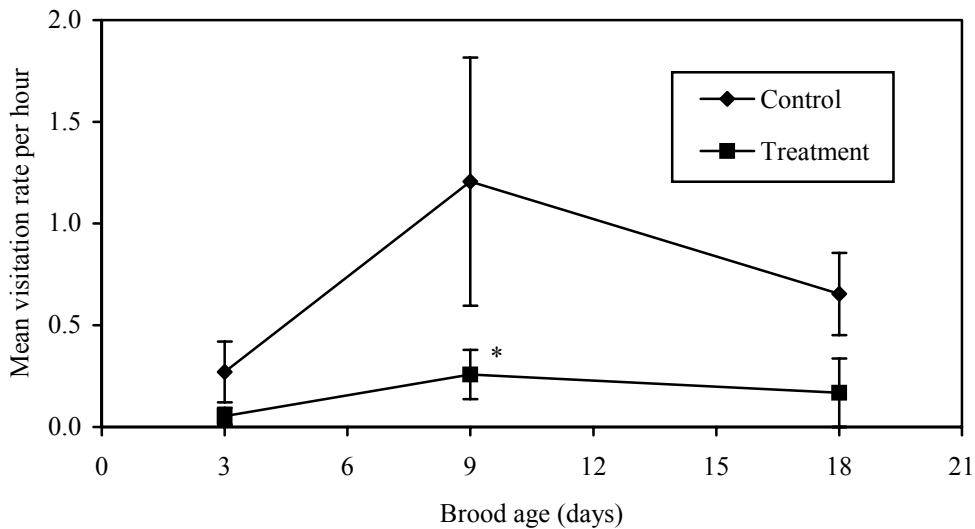


Figure 2 Mean (\pm SE) nest visitation rate per hour of males at treatment nests and control nests during the nestling period (* $P < 0.05$).

4. Discussion

Young raised by handicapped females fledged at a significantly lower mass than those raised in control nests. This suggests that handicapped females passed the consequences of their decreased condition onto their young, rather than suffering the consequences themselves. The decrease in brood mass may be due to a change in foraging strategy by the parents as a result of the female's manipulation. It is unknown whether this brood mass difference is due to a decrease in prey load per feeding trip, a change in prey type, or some combination of both. Wright et al. [11] found that starlings often make trade-offs from "quality", or more nutritious, prey, to "quantity", or more abundant, prey, when presented with the difficulty of feeding an artificially enlarged brood. This could explain our brood mass difference, if the parents were choosing less nutritious, more abundant prey to make up for the female's increased energy costs. A switch from quality food to quantity food would be consistent with our results of no difference in brood survival and number of fledged young. The effect of the trade-off would take some time to manifest itself, first in the form of decreased brood mass as the nestling period came to a close, and eventually resulting in decreased survival for the young. Investigation into the condition and survival of fledglings after nest leaving would be necessary, if this was the case.

Only half of the nests received any feeding visits by males, and we found that males who were caring for their young were doing so at lower rates at experimental nests versus control. A female handicapping experiment done on three tit species (*Parus* spp.) found that males were not willing to invest more in parental care after the handicapping of their mate, possibly due to a lack of paternity confidence, or because the mate was now considered "low quality" [4]. Wright and Cuthill [6] observed a slight increase in parental care by males after adding weights to the tails of their mates, though this did not completely compensate for the reduction in care by the females. It is possible that, in a population in which males were primarily monogamous and provided almost half of the total parental care (as was the case in the Wright and Cuthill experiment), handicapped females were able to decrease visitation rate with some assurance that their partners would compensate by increasing their parental care. In our population, females may have been unwilling to decrease parental care because of the unpredictability of male participation in parental duties. The European Starling is facultatively polygynous, with little to no parental care invested by males in broods of secondary females, and decreased male help for the broods of primary females, when compared to the investment made by monogamous males [12]. Polygyny has been observed in this population, which could be an important factor in the variation of male parental care observed in this experiment.

Because clipped females did not lose more body mass than control females, the results suggest that females were not willing to pay the price for the increase in cost of reproduction. Also, contrary to expectation, we found no difference in nest visitation rate between treatment and control females. It is possible that females do not work at their maximum capacity, to allow for environmental unpredictability. Therefore, any change would not threaten her survival and future reproduction [13]. Handicapped females could have adjusted their energy expenditure to come nearer to their maximum capacity, but as it was only a short-term adjustment, personal survival and current reproduction were not severely affected.

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