

NESTLING DIET, CHICK GROWTH AND BREEDING SUCCESS IN THE SOUTHERN GREY SHRIKE (*Lanius meridionalis*)

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ABSTRACT

Budden A. E., Wright J. 2000. *Nestling diet, chick growth and breeding success in the Southern Grey Shrike (Lanius meridionalis)*. Ring 22, 1: 165-172.

Data were collected on a population of Southern Grey Shrikes breeding in a 25 km² area of desert within the Syrian-African rift system, southern Israel. Parental provisioning behaviour to offspring was recorded with a video camera. The mass and body size of the chicks was recorded daily to assess chick growth. Prey delivered to the nest consisted primarily of invertebrates, as well as some vertebrate prey, and the size of the prey items increased with chick age. Age had no significant effect on parental visit rate although prey types delivered appeared to shift with increasing chick age. Curiously, there were no differences in the mean visit rate and size or type of prey delivered to nests that fledged young and those that failed. A logistic growth equation fitted to the data on chick weight yielded similar results to those recorded for Southern Grey Shrikes breeding in another desert region in Southern Israel.

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Key words: *Lanius meridionalis*, brood demand, parental care, prey selection

INTRODUCTION

Feeding nestling birds represents a considerable energetic cost to the parents (Bryant and Westerterp 1980, Drent and Daan 1980). The extent of this parental investment may be associated with factors including their own condition, the level of investment of their partner, food abundance and the demand of the brood (see Wright and Cuthill 1990). Parents can exert some control over brood demand by manipulating clutch size and/or brood size and the degree of asynchrony in hatching. However, the level of provisioning effort should also be adjusted according to the condition of offspring and brood demand will increase with the age of the chicks. Indeed, many studies have shown an increase in provisioning rate with increasing nestling age (Moreno 1987, Goodbred and Holmes 1996, Rytönen *et al.* 1996, Hogstad and Stenberg 1997).

The diet of the Southern Grey Shrike includes invertebrates, reptiles, small mammals and birds and such diversity allows shrikes to be highly opportunistic, selecting spatially or temporally abundant prey (Cade 1995). As with many of the family *Lanius*, Southern Grey Shrikes are capable of temporarily caching their prey, which can later be retrieved (Lefranc and Worfolk 1997). These complex foraging and hunting behaviours, uncommon in passerines, provide adult shrikes with a number of alternative strategies for meeting the demand of the brood. First, parents could increase the number of visits to the nest, which is common in other passerine species, but may afford shrikes a lower energetic cost due to the utilisation of food larders. Second, parents may increase the size of prey delivered to the nestlings, facilitated by the diversity of prey and butchering habits of the shrike. Finally, adults could select prey for their offspring on the basis of its nutritional quality (Wright *et al.* 1998).

This study aims to look at parental provisioning behaviour of the Southern Grey Shrike over a 14-day period of nestling development and determine the extent to which these three strategies are adopted.

METHODS

Data were collected during March-June 1998 on a population of Great Grey Shrikes (see Lefranc and Worfolk 1997, for notes on taxonomy) in the Shizaf Nature Reserve, Hazeva, southern Israel. Adult pairs were located throughout the season using observations of male courtship behaviour and vocalisations. Individuals were trapped with the use of a potter single-cell trap baited with mealworms (*Tenebrio* sp.) for the purpose of colour ringing. All nests were checked daily and during the mid-late stages of incubation a black cardboard box was placed near the nest to familiarise the adults with the camera equipment. The birds were left undisturbed on hatch day (day 0) and on day 1 a camera mount was set up ready for data collection on day 2. The birds nested predominantly in acacia trees (*Acacia* spp.) at a height of 1-2.5 m, usually in the centre of a dense part of the bush. Camera mounts were secured to a branch near the nest such that the angle of view was approximately 45° and the camera was no closer than 30 cm to the nest. This mount was left in position throughout the period of data collection and the camera was installed only when recording. Eight nests were used for video data collection, and all with a brood size greater than one.

Data were collected with the use of a Sony video Hi8 handycam CCD-TR100E set on short play, manual focus, and wide-angle lens. Observations were conducted between either 1-2.5 hours after sunrise or 3-4.5 hours after sunrise. These data were first collected 2 days after initial hatching (day 2) and every other day until day 14 inclusive. In some instances, data collection terminated earlier, either as a result of brood reduction to a single chick (one nest at day 6), predation (one nest at day 10) or premature fledging (one nest at day 12, three nests at day 14). Wing length and tarsus length were measured daily and body mass was recorded. Nestlings were

individually marked on their upper mandible with a coloured non-toxic waterproof pen.

From the video record of nest visits, data were extracted concerning the visit rate of the parents, the prey delivered and the prey size relative to the parents' bills.

RESULTS

Breeding success

Of 21 known pairs breeding in the study area, 68.2% fledged at least 1 young (mean = 1.4, $SD = 1.2$). The mean clutch size was 3.9 eggs ($SD = 0.57$) and the mean number of eggs per pair for the season was 4.2 eggs ($SD = 0.23$). Only 2 pairs went on to lay a second clutch (excluding re-cycle attempts), producing an average of 1.09 nestlings per season. Of 65 eggs, hatching success was 60.0% and fledging success was 30.8%.

Chick growth

Individual nestling mass measurements ($N = 267$) were collected between the ages of day 0 (hatch day) and day 15. These data were used in a logistic equation to determine a number of parameters of chick growth (Ricklefs 1968). Asymptotic body mass was calculated as 50.20 ± 1.11 g, constant parameters b and k were 11.56 ± 0.78 and 0.32 ± 0.14 , respectively ($R^2 = 0.997$). The point of inflection was calculated as 7.5 ± 0.2 days. The same equation was then used taking the mean measurement from each nest to control for non-independence of chicks. This yielded comparable results. The asymptotic body mass = 52.01 ± 1.47 g, the coefficient $b = 11.39 \pm 0.81$ and $k = 0.31 \pm 0.15$ ($R^2 = 0.997$). The point of inflection = 7.8 ± 0.3 days.

Visit rate

The number of visits per chick per hour was plotted against nestling age for each nest. A series of linear regressions were then performed and the slopes generated used in a one-sample t -test against zero. Visit rate did not significantly alter with age ($p = 0.062$; Table 1), although a positive trend can be seen in the coefficients generated by the individual regression analyses. A test for difference in visit rate delivered according to the success of the nest was conducted on data from day 2 and day 4. Nests were classified as either „failed” – failed to produce any young from that attempt, „premature fledge” – juveniles left the nest before day 14 and „fledged” – chicks remained in the nest until after the last day of data collection. The first category contains 2 nests, the second – 4 nests, and the third – another 2 nests. A Kruskal Wallis test revealed no significant difference in visit rates between the groups for either day 2 ($\chi^2 = 1.83$, $df = 2$, $p = 0.40$) or day 4 ($\chi^2 = 0.04$, $df = 2$, $p = 0.98$).

Table 1
Regressions of visit rate and prey size on age for each nest separately
and one-sample *t*-tests on the slopes generated

Nest symbol	Visit rate <i>b</i> -coefficient (slope)	Prey size <i>b</i> -coefficient (slope)
bms	0.138	0.089
bok	0.132	0.020
cnr	0.190	0.030
doj	0.053	0.052
shq	-0.105	0.019
wsz	0.400	0.057
ypb	0.183	0.009
zom	-0.027	0.254
One sample <i>t</i> -test on slope against zero (<i>p</i> -value)	0.062 (<i>t</i> = 2.224, <i>df</i> = 7)	0.052 (<i>t</i> = 2.337, <i>df</i> = 7)

Prey size

A linear regression of prey size against chick age was performed on all the data points within each nest. The slopes of these regression lines were then tested for a difference from zero with a one-sample *t*-test. This revealed the trend that as chicks got older, the prey they received tended to increase in size, although the result failed to reach significance ($p = 0.052$; Table 1). Again, we tested for differences in prey size between nests that fledged, those that fledged prematurely, and those that failed. These analyses were restricted to a single data point in the „failed” and „fledged” groups for days 2 and 4, respectively. This was due to no prey delivery to one of the nests on these occasions. Again, the Kruskal Wallis test revealed no significant difference between the groups for either day 2 ($\chi^2 = 2.41$, $df = 2$, $p = 0.30$) or day 4 ($\chi^2 = 4.82$, $df = 2$, $p = 0.09$).

Prey types

The prey types delivered from 315 parental feeding visits to the nest were recorded and are shown in Table 2. Table 2A details the prey types as recorded from the videos. These have then been grouped according to the primary method of locomotion (for invertebrates) in Table 2B (see Scott and Morrison 1995).

A chi-square analysis was performed against age on the four categories presented in Table 2B within each nest in order to examine any change in the prey types delivered over the nestling period (Table 3). These probability values were then combined in a technique to determine overall significance from independent tests (Sokal and Rohlf 1981). Although only one nest revealed a significant change with age, there was a significant effect overall when the combination of probabilities was performed ($p < 0.05$). There was no significant difference in prey types delivered to

nests that fledged, failed or fledged prematurely; chi-square analysis at age day 2 ($\chi^2 = 2.64$, $df = 6$, $p = 0.853$) and at age day 4 ($\chi^2 = 6.19$, $df = 6$, $p = 0.403$).

Table 2

Diet of nestlings of Southern Grey Shrike, Hazeva, Israel 1998.

A. prey as recorded from video, B. categories used in statistical analyses.

A.	n	%
small unid. invert.	48	19.8
<i>Dictyoptera</i>	22	9.1
<i>Orthoptera</i>	20	8.2
<i>Hymenoptera</i>	28	11.5
<i>Odonata</i>	12	4.9
unid. vert.	17	7.1
<i>Lepidoptera</i>	26	10.7
<i>Reptilia</i>	19	7.8
unid. flying invert.	9	3.7
<i>Lepidoptera larvae</i>	16	6.6
<i>Coleoptera</i>	19	7.8
<i>Mantodea</i>	2	0.8
<i>Aves</i>	3	1.2
<i>Miriapoda</i>	2	0.8
Total	243	100
B.	n	%
small unid. invert.	48	19.8
ground invert.	109	44.8
flying invert.	47	19.3
vetrebrates	39	16.1
Total	243	100

Table 3

Chi-square analyses of prey types delivered to nests across nestling age and calculation of overall significance from independent tests

Nest symbol	χ^2	df	p -value
bms	14.774	10	0.141
bok	21.005	15	0.137
cnr	43.930	18	0.001
doj	13.486	15	0.565
shq	10.989	12	0.530
wsz	4.278	3	0.233
ypb	16.093	15	0.376
zom	3.778	6	0.707
Combined test	29.684	16	0.020

To determine the composition of prey types delivered to the nest across age, regressions of the percentage of each prey against age were performed for each of the four prey categories within each nest separately. A one-sample *t*-test was then performed on the slopes generated (Table 4). The results show that within each prey category there was no significant change across age.

Table 4

Slopes (*b*-coefficient) from the regressions of the percentage of prey categories against age within each nest. The results of one-sample *t*-tests against zero are shown.

Nest symbol	Prey categories			
	Small unidentified	Ground invertebrates	Flying invertebrates	Vertebrates
bms	-6.19	5.24	0.95	1.00
bok	-7.05	1.98	2.86	2.21
cnr	-2.97	2.09	2.57	-1.69
doj	-0.42	2.74	-3.27	0.94
shq	2.00	-0.14	-0.57	-1.29
wsz	-3.34	-11.67	-10.00	25.00
ypb	2.07	-0.10	-3.07	0.89
zom	-4.17	0.60	-1.19	4.76
One sample <i>t</i> -test on slope against zero (<i>p</i> -value)	0.790 <i>t</i> = 2.052 <i>df</i> = 7	0.961 <i>t</i> = 0.510 <i>df</i> = 7	0.351 <i>t</i> = 1.000 <i>df</i> = 7	0.238 <i>t</i> = 1.290 <i>df</i> = 7

DISCUSSION

The breeding success of this population in 1998 is lower than that reported for shrikes breeding elsewhere in Israel (Inbar 1995). A mean clutch size of 3.9 eggs compares poorly with that of shrikes in the Negev (5.5 ± 0.7) and those breeding at Mount Hermon in northern Israel (4.6 ± 0.5). In addition, the occurrence of a second nesting attempt was infrequent in comparison with the Negev – 1.09 nestlings per season as opposed to an average of 1.66 reported by Yosef and Pinshow (1995). Hatching and fledging success were similarly low in the present study relative to earlier published data (Yosef and Pinshow 1995). However, despite the poor breeding success, the growth data for those chicks that hatched successfully is comparable with that of shrikes breeding elsewhere (Degen 1992). This suggests that 1998 was a poor season in Hazeva, resulting in small clutch sizes and a low hatch and fledge rate, as opposed to differences in the provisioning and chick rearing behaviours of birds in this region.

The visit-rate and prey-size data indicate that parents coped with the increase in the brood demand of growing chicks by providing larger prey as opposed to increasing their visit rate. This suggests that adult shrikes selected the size of prey when

foraging according to the age of the brood, or that they butchered prey into larger pieces before delivering to older nestlings. A possible explanation for such a strategy is that it may afford the adult birds reduced energetic costs of foraging as capturing fewer large prey over many small items may be more efficient due to the „sit-and-wait” nature of their hunting technique. Alternatively, offering older nestlings larger, less easily manipulated prey may encourage some degree of learning of prey handling skills in young (see Newton 1979). Indeed, in some instances whole and alive prey items were observed being delivered to older nestlings.

Although a difference was found in prey types delivered to the nest across ages, tests on the change of each prey category showed no consistent shift. The proportion of flying invertebrates and vertebrate matter in the diet remained relatively stable, yet the percentage of ground invertebrates in the diet tended to increase with age, with a possible compensatory decrease in the small, unidentified insect matter (Fig. 1). However, these trends may be confounded by prey size, since the prey types became easier to identify from the videotapes as prey size increased. Consequently, the proportion of unidentified insects decreased as more ground invertebrates were distinguished from the videos.

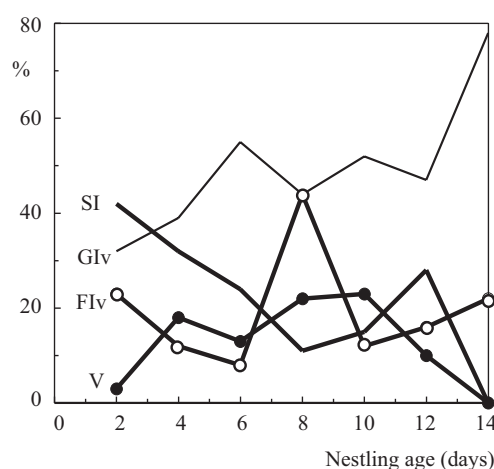


Fig. 1. Changes in the mean percentage of prey types in the diet of nestling of Southern Grey Shrikes with age. SI – small unidentified insects, GIV – ground invertebrates, FIV – flying invertebrates, V – vertebrates.

In conclusion, it would appear that despite the poor breeding success of this population in 1998, the growth rate of nestlings was comparable with that of shrikes breeding elsewhere. Increased brood demand arising from the development of the chicks appears to have been met by an increase in the size of prey delivered to the nest as opposed to an increased visit rate. There is also some evidence to suggest parents deliver different prey types at different stages of nestling development.

ACKNOWLEDGEMENTS

Thanks are extended to Dr. Reuven Yosef for discussions of shrike behaviour and access to his library, to the Hazeva Research and Development Centre, and to Avner Anava and family for support whilst in Israel. We are also grateful to Alex Maklakov for access to information on the Shizaf shrike population. This work was supported by NERC studentship GT4/97/288/TS.

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