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From Nest Building to Fledging of Young in Great Grey Shrikes (*Lanius excubitor*) at Sede Boqer, Israel

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Introduction

The Great Grey Shrike (*Lanius excubitor*) is the most widely distributed of all true shrikes. Its breeding range is circumpolar, consisting of Alaska, Canada, most of Europe, North Africa, and Asia. In Israel it is a permanent resident in the Arava Rift Valley, in the Golan Heights, Samaria and in the Negev desert (PAZ 1987). Reproductive studies are limited to Europe (e. g. HUHTALA et al. 1977, BASSIN 1982, SOLIS & REBELLO 1985). No such studies have been done in the Middle East or North Africa (PAZ 1987), and between 1987 and 1989, I studied 21 pairs, and here I present data pertaining to their reproductive biology. In addition, the fact that populations are declining across Europe adds to the significance of understanding factors that influence the reproductive capabilities of this species.

Study area and methods

Great Grey Shrikes were studied on Sede Zin, a loess-covered plateau, near Sede Boqer (30° 52' N, 34° 47' E; 475 m asl) in the Negev Desert highlands, Israel. The region is arid with mild winters and warm summers (UNESCO 1977). Rainfall occurs in winter and averages 90 mm annually. Dew occurs on about 190 nights, amounting to 18 mm annually (ZANGVIL & DRUIAN 1980). The Sede Zin Plateau supports a sparse dwarf-shrub community dominated by *Hammada scoparia*, *Zygophyllum dumosum*, *Raemuria hirtella*, *Anabasis syriacus* and *Artemisia herba-alba*. The major woody species are *Tamarix nilotica*, *Atriplex halimus*, *Retama raetam* and *Thymelaea hirsuta*. The regional flora includes a large variety of herbs and geophytes (DANIN et al. 1975).

This study was conducted during the 1987, 1988 and 1989 breeding seasons (mid-January to mid-June). Birds were trapped using a Bal-Chatri trap (CLARK 1967), and all individuals included in the study and their offspring were banded with an aluminium band on one leg and a colored plastic band on the other, for individual recognition. During the three years, 73 adults and 253 young were banded. We used the shrikes' aggressive responses to playback and taxidermic mounts to map the borders of all territories studied. Nests were located, their dimensions were measured using a dial caliper (Bel-Art) with a precision of ±1 mm, and eggs were weighed daily, from the time they were laid until they hatched, using an electronic scale (K-Tron 1300) with a precision of ±0.02 g. I also measured the length and breadth of the eggs. Phenology and nesting behavior of nine breeding pairs were observed during the 1987 breeding season, 15 during 1988 and seven during 1989.

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Results and discussion

In all three years, Great Grey Shrikes were the earliest nesting passerines in the area. Territories defended by males against conspecifics and other avian species (especially wheatears, *Oenanthe*) averaged 62.5 ±7.8 SD ha, ranging from 53.6 to 76.9 ha. No seasonal differences were observed. Seven multi-brooded (≧3 broods) pairs were observed (six with three broods and one with four broods in a single season). Fourteen pairs were double-brooded and eight pairs were single-brooded. During 1989, skewed sex ratio of almost 2 : 1 (males : females) was discovered. Only seven females arrived for the breeding season; hence, 6 males did not breed. This fact emphasizes that the nesting ecology of the Great Grey Shrike is greatly affected by local environmental and other, yet unknown, factors.

Nest construction

During the three breeding seasons average time for completion of the nest was 9.0 ±3.2 SD days (n = 27 pairs). The nests are bulky structures made of sticks and twigs and incorporate surrounding branches of the nesting tree/bush with the outermost twigs. This anchors the nest and may prevent damage during rain, wind or sand storms. Average depth of inner cup was 5.2 ±0.8 cm (n = 31), average diameter of inner cup was 15.4 ±1.6 cm (n = 31), average external diameter was 18.6 ±3.3 cm (n = 28).

The Great Grey Shrikes nested in a variety of trees and bushes, building mainly in *Atriplex halimus* (74 %), but also in *Asperagus stipularis* growing on *Tamarix nilotica* (11 %), *Ochradenus baccatus* (6 %), and *Colutea istria* (4 %). Two nests (4 %) were built in a roll of barbed wire. All nest were situated in open areas and the nesting bush or tree itself was often used as a lookout point for potential predators or prey.

The average height of nests above ground was 95.2 ±27.9 SD cm (n = 33). No significant difference was found between the heights of the first and subsequent nests of the season (Mann Whitney U-Test; $U_{17,33}$ = 103 p >0.05), and nesting success was not affected by nest height ($U_{13,25}$ = 95, p >0.05). Loss of nests and death of young were associated with inclement weather early in the season, but parents that succeeded in breeding early also succeeded in fledging more young (Table 1).

Tab. 1. Length of incubation, average egg mass loss and hatching success for the 1987 breeding season of the Great Grey Shrike at Sede Boqer, Israel. Columns denoted by numbers represent: 1 — clutch size, 2 — number of eggs hatched, 3 — number of eggs infertile, 4 — number of eggs or young lost due to inclement weather, 5 — number of eggs or young lost to predation, 6 — % of young fledged.

Month	Eggs 1	2	3	4	5	6	Avg. Egg Mass Loss, %
February	31	17	2	12	—	54.8	11.1 ±1.8
March—April	27	20	4	3	—	74.1	13.0 ±2.4
May—June	23	13	1	—	9	56.5	14.3 ±2.6
Annual:	71	50	9	10	18	70.5	12.8 ±1.6

Clutch size, incubation and hatching success

Clutch size ranged from 5—7 eggs. The average clutch size for the three seasons was 5.8 ±0.6 eggs, and did not differ between the years ($U_{18,56}$ = 197, p >0.05; Table 1). Sixteen (29 %) of 56 clutches had 5 eggs, 39 clutches (69 %) 6 eggs, and only 1 (2 %) clutch comprised 7 eggs.

The most active month for breeding was April, and this concurs with SOLIS & REBELLO (1985), and BASSIN (1982). Great Grey Shrikes conform with VAN TYNE & BERGER (1976) and exhibit a latitudinal cline in clutch size. The average clutch size in northern Russia, 65° N, is 6.35 eggs (SUCHININ 1959, GAVRILOV et al. 1968); in Finland, 60° N, 6.2 eggs (HUHTALA et al. 1977); in Turkmenia, 40° N, 6.0; and in North Africa, 30° N, 5.0 eggs (ETHÉCOPAR & HUE 1967, PANOW 1983). At Sede Boqer (30° 52' N), in Israel, clutch size averaged 5.8 ±0.6. Size of the first clutch did not differ differ from those of renestings or subsequent attempts ($U_{22,28}$ = 345, p >0.05).

Shrikes are penultimate, or even ante-penultimate, incubators (KRIDELBAUGH 1983) and female Great Grey Shrikes start to incubate after the third egg (YOSEF & PINSHOW 1988b). Males do not incubate eggs or brood young, but do feed incubating and brooding females at the nest. Ante-penultimate incubation leads to asynchronous hatching with siblings often hatching 48 or more hours apart. In one instance, the first and the last siblings hatched more than 96 h apart. This difference in age leads to brood reduction during adverse weather conditions when food is in short supply, as described by HORSFALL (1984). Only in 1987 was active brood reduction observed. In mid-March, following strong winds and rain storms, the youngest chicks in three broods disappeared. In all three cases the two eldest siblings fledged from each nest. It is unknown as to what the parents did to the missing young. KRIDELBAUGH (1983) observed adults removing dead nestlings "as if they were foreign material or they may eat them or feed them to surviving young".

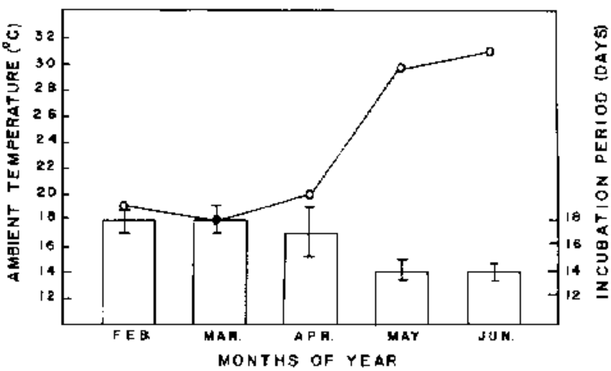

Fig. 1. Length of incubation as a function of month of year in Great Grey Shrikes; columns represent average incubation period (± SD); circles denote average ambient temperature.

Tab. 2. Reproductive success of Great Grey shrikes at Sede Boqer, Israel, in 1987, 1988 and 1989.

	x ± SD	1987	1988	1989
Clutch size	5.8 ±0.6	6.0 ±1.4	5.6 ±0.5	5.8 ±0.4
No. hatching (per nest)	4.7 ±2.1	3.9 ±1.5	4.8 ±3.5	5.5 ±0.8
Hatching success	85.2 %	75.2	85.7 %	94.8 %
No. fledging (per nest)	3.6 ±1.4	1.9 ±0.8	4.2 ±3.0	4.8 ±0.5
Fledging success	74.5 %	48.7 %	87.5 %	87.3 %
Nest success	63.2 %	31.7 %	75.0 %	82.8 %
Nest frequency	2.0 ±0.8	2.0 ±1.1	2.1 ±0.7	1.7 ±0.5

Incubation period was defined as being the period that began when incubation was initiated, and lasted till the last of the clutch hatched. Incubation averaged 16.8 ±1.6 SD days (range 14—18 days), and an average of 4.7 ±0.8 SD eggs hatched per nest (Table 2). 50 eggs failed to hatch due to infertility (24 %), inclement weather (28 %) and predation (48 %).

In 1987, month of nesting and ambient temperature (Ta) influenced length of incubation ($F_{1,3}$ = 78.967, p <0.01, One-Way ANOVA; Fig. 1). Earlier nestings had longer incubation periods (r^2 = 0.963, df = 11, p <0.003; Fig. 1), greater hatching success (Table 2), and less egg mass loss than later ones (Table 3; Fig. 2). Egg mass was influenced by day of incubation of the clutch ($F_{1,328}$ = 140.8, p <0.001, One-Way ANOVA). The mean mass of 84 eggs weighed within an hour of being laid was 5.1 ±0.7 SD g.

Hatching success was greatest in clutches laid early in the season, during February, and lowest during the hot months of May and June, also months of heightened predator activity (Fig. 2). Analyses by log-linear model showed a positive correlation between egg mass loss during period of incubation and Ta (G = 20.37, p <0.001), and between egg mass loss and hatching success (G = 27.72, p <0.001), but no correlation was found to exist between hatching success and T_a (Table 4).

Nestling and fledging period

Mean fledging period was 17.2 ±2.2 days (range 16—19 days, n = 29 nests). Young disturbed at their nests were transferred to neighbouring sites by the female (for further details see Yosef & Pinshow 1988a). This extraordinary behaviour of transferring

Tab. 3. Variation in length of incubation period, and average clutch mass loss as a function of month of the year in the Great Grey Shrike, Sede Boqer, Israel. All data were collected in 1987. Sample size is in parenthesis. Data are presented as mean (± SD).

Months of year	Incubation period (days)	Average clutch mass loss (%)
February—March	18 (6)	11.1 ±1.8 (4)
April	17 (4)	13.0 ±2.5 (5)
May—June	14 (3)	15.3 ±2.1 (4)

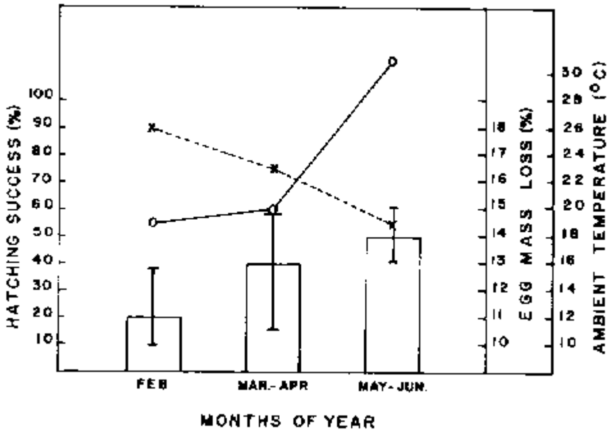

Fig. 2. Affects of ambient temperature on egg mass loss and hatching success in the Great Grey Shrike at Sede Boqer, Israel. Columns represent egg mass loss (± SD), "X" denote hatching success, and "O" denote ambient temperature.

young when nest sites have been disturbed has been reported in various locations within Israel. Guides at the Katzrin Field Study Center in the Golan Heights and rangers of the Nature Reserves Authority in the Arava (Rift Valley) Region have observed similar behaviour (E. Khoter, M. Ben-David, pers. comm.).

Fledging success was lower in 1987 than in 1988 or 1989 (Table 2). In 1987, frequent storms, rains and cold temperatures occurred just before hatching, and resulted in loss of entire clutches at two nests and brood reduction at three others. In 1988 and 1989, no clutches were lost to inclement weather.

After leaving the nest, the young remained in the nesting shrub for three or four days. They left the nest in the order of hatching; i. e., young that hatched first left first (n = 13 clutches). They left the nesting bush when capable of flying short distances (5—15 m), but remained dependent on their parents for food over the next three to four weeks. During this period, young learned to hunt, to impale prey with increasing accurary, and to fly greater distances. At the end of this period, they hunted on their own and gradually disappeared from the study area.

Tab. 4. Interactions of ambient temperature (Ta), egg mass loss (EMS) and hatching success (HS) in the Great Grey Shrike. The rows are the G-tests (with William's correction) resulting from the three-way log-linear model. All G values have one degree of freedom.

Interaction	G value
HS x EMS x Ta	0.00
EMS x Ta	20.37*
HS x Ta	0.21
HS x EMS	27.72*

* $p < 0.05$

Nesting success and renesting

The overall nesting success for three years was 63 % (n = 21 pairs, Table 2). Predation accounted for 48 % (24 of 50 eggs and young) of the nests lost. Adverse weather caused the death of 28 %, and 24 % were infertile eggs. Nesting success of Great Grey Shrikes exhibited great variability from year to year (31.7 % — 82.8 %; Table 2). Porter et al. (1975) reported similar variability in Loggerhead Shrikes (47.8 — 82.4 %).

In 1987, infertility, predation and adverse weather were the major cause of nesting failure. Infertility (established by candling) accounted for 9 eggs, 9 others were preyed upon and two nests with clutches of 5 eggs each were destroyed by rain storms (Table 1).

Extremely cold weather was recorded during 1988 and four unhatched embryos may have died of hypothermia. However, predation was found to be the major cause of nesting failure. Remains of fledglings (identified by leg bands) were found at the burrow of Little Owls, *Athene noctua*, one nine-day-old nestling was eaten by a snake, *Spalerosophus diadema*, and at another nest signs of snake predation were uncovered after one young disappeared. Adults gave warning calls when Lanner Falcons, *Falco biarmicus*, Eurasian Kestrels, *F. tinnunculus*, Eagle Owls, *Bubo bubo*, Little Owls, *Athene noctua*, and a migrant Arctic Skua, *Stercorarius parasiticus*, were observed in the vicinity. During 1989, signs of snake predation were found when four eggs disappeared. But, as previously mentioned, in only one instance each were snake and avian predation actually observed.

Summary

During 1987, 1988, and 1989 the reproductive biology of 21 pairs of Great Grey Shrikes, *Lanius excubitor*, was observed in Israel. Eggs were laid at 24 h intervals, 69 % of the clutches comprised 6 eggs, and average clutch size was 5.8 eggs. Incubation period averaged 16.8 days, and month of nesting and ambient temperature influenced length of incubation. Earlier nestings had longer incubation periods, greather hatching success, and less egg mass loss than later ones. An average of 4.7 eggs per nest hatched, and overall nesting success was 63 %. Infertility, predation and adverse weather were the major cause of nesting failure.

Zusammenfassung

1987 — 1989 wurde die Brutbiologie von 21 Paaren Raubwürger einer Population in Israel untersucht. Eiablage fand im 24 h-Intervall statt; 69 % der Gelege enthielten 6 Eier, die durchschnittliche Gelegegröße betrug 5,8 Eier. Die Brutdauer betrug im Mittel 16,8 Tage; Datum des Brutbeginns und Umgebungstemperatur beeinflußten die Brutdauer: Frühe Gelege wurden länger bebrütet, hatten größeren Schlupferfolg und geringeren Eimassenverlust als spätere. Im Mittel schlüpften aus 4,7 Eiern pro Nest Junge; der Bruterfolg insgesamt betrug 63 %. Unbefruchtete Eier, Nestraub und widrige Witterung waren die Hauptursachen von Verlusten.

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