# The natural history of the Nubian Nightjar *Caprimulgus nubicus* in Israel

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The Nubian Nightjar is critically endangered in Israel, mainly due to habitat destruction. It is currently found only in the Kikar Sdom region south of the Dead Sea. The main ecological requirements for Nubian Nightjar territories are a patch of at least 50 ha of salt marsh, preferably near water sources, and adjacent open areas for foraging. Several new and previously undocumented aspects of the breeding cycle, courtship and food are presented.

## INTRODUCTION

The Nubian Nightjar *Caprimulgus nubicus* Lichtenstein 1823 (Plates 1&2), is the smallest nightjar in the Middle East, weighing only 45–55 g. The species is relatively widespread in the arid parts of eastern Africa, though regarded as uncommon. In the Middle East it is much scarcer, with localized populations along the Rift Valley, from Israel in the north to the Red Sea coast of the southern Arabian peninsula (Cleere 1999, Holyoak 2001). Over most of its range in Africa, the Nubian Nightjar is regarded as resident, but the northern populations of the Middle East are thought to be mostly summer visitors, which migrate south to east Africa for the non-breeding season (Shirihai 1996, Holyoak 2001, Kirwan 2004).

In Israel, until the mid-1980s, it was a localized but widespread breeder along the Rift Valley from the Beit She'an valley in the north to Eilat in the south, in suitable habitat. The local subspecies *tamaricis* is strongly associated with non-coastal salt marshes dominated by *Tamarix* and *Suedea* bushes and stands of *Phragmites*, with some open water sources—springs, oases *etc*. During the last two decades, this type of habitat in Israel has all but disappeared primarily due to the rapid development of agriculture, which consists mainly of greenhouse crops such as peppers and tomatoes. As a result, Nubian Nightjar numbers in Israel have dropped dramatically. Only 5 pairs were found in a 1999 national census covering all potential sites along the Rift Valley in Israel (Shirihai 2000). Four of these pairs were in Kikar Sdom region south of the Dead Sea, near the small settlement of Ne'ot Hakikar. This heavily land-mined area had been left untouched along the Israeli/Jordanian border, which prevented agricultural development and preserved natural habitats (Plate 3). Another pair was found at a water reservoir *c*20 km north. Currently, the Nubian Nightjar is regarded as critically endangered in Israel (Alon & Mayrose 2003).

**Plate 1** (left). Nubian Nightjar *Caprimulgus nubicus* adult (individual 1 in Table 1), Ne'ot Hakikar, Israel, August 2004. © *Yoav Perlman*

**Plate 2** (right). Nubian Nightjar *Caprimulgus nubicus* adult, Ne'ot Hakikar, Israel, March 2008. © *Yoav Perlman*

The main aims of my study on this little-known species were to determine the actual status of this species in the Kikar Sdom region and to describe its breeding biology, habitat use, food and other aspects of natural history there.


**Plate 3**. Breeding habitat of Nubian Nightjars in Israel, March 2005. © *Yoav Perlman*

## METHODS

The Kikar Sdom region (30° 57′N, 35° 23′E), south of the Dead Sea, includes the settlements of Ne'ot Hakikar and Ein Tamar and is at an elevation of *c*350 m below sea level. The climate at Kikar Sdom is hot and dry. The average annual rainfall is 40 mm, occurring only during winter, and varies considerably between years. Daytime air temperatures are high in summer, often exceeding 40°C; winter minimum night time air temperatures are relatively low, often below 10°C (Jaffe 1988).

During August 2004–July 2006 I spent approximately 300 nights in the field following and studying Nubian Nightjars. About 100 nights were dedicated to locating breeding pairs in suitable habitats. The birds were located either visually or vocally, using their distinctive calls and very vocal nature during the breeding season. On bright moonlit nights, it was possible to observe this species with binoculars or on darker nights, I used night vision goggles. I videoed the courtship behaviour of the nightjars using a Sony DRC-HC62 camcorder, manually attached to night vision goggles.

I trapped 7 adult Nubian Nightjars, during August 2004–July 2006, using mist nets (or a hoop net after spotlighting a bird sitting on a gravel road). Each nightjar was fitted with a 0.6 g or 1.5 g temperature-sensitive radio transmitter (Holohil Systems®, Ontario, Canada), and was ringed with a standard Israeli aluminium bird ring. An additional, juvenile, bird was trapped and ringed in June 2006 but was not fitted with a transmitter. Length of the closed wing (Stiles & Altshuler 2004) and tail measurements were taken to ± 0.5 mm and body mass measurements were taken to ± 0.5 g.

To track the nightjars in the field I used a model R1000 telemetry receiver (Communications Specialists Inc., Orange, CA). I used a Biotrack® Linflex 3™ flexible 3-element Yagi antenna for bearing determination, and an omni-directional Biotrack® model LM150 car mounted antenna.

Nightjar activity was recorded from one hour before dusk until half an hour after dawn. Location of each individual was noted continuously during the whole night, using standard triangulation techniques if two observers were present or by me moving fast from one point to another and obtaining quick fixes. To avoid disturbing the birds I kept a minimum of 30 m away and always observed them from within a car, keeping quiet and dark. When possible, I maintained visual contact in order to record the location of the birds to a resolution of a few metres and to note their behaviour.

Location, habitat type and activity were recorded for each nightjar. Activities noted were: resting (when the bird was stationary, inside cover); foraging; and territorial behaviour (calls heard and courtship displays seen). Foraging bouts were easily detected from changes in the intensity of the broadcast radio signal; signal strength rises rapidly as the nightjar sallies from the ground into the air (White & Garrott 1990). Permits for trapping and radio tagging were obtained from the Nature and Parks Authority.

Home ranges of the nightjars were calculated with ArcGIS® software using the Adaptive Kernel Home Range method, which describes the relative use of habitats by an organism in its home range. This method provides a graphical representation of how the animal occupies space with isopleths delineating areas in which the animal can be found with a given probability, reflecting the amount of time an animal spends in each area (Worton 1989, Seaman & Powell 1996). To calculate the home range of a nightjar, I used all data points recorded for it over the whole period it was tracked. It is worth noting that there was little dependence, if any, between consecutive locations taken during different foraging bouts, as the nightjars often behaved as central-place foragers, returning to their roost sites before changing foraging site. To estimate a robust home range, I calculated both 90% and 95% isopleths. The 90% isopleth gives a good estimate of home range, with low variance and less statistical bias than the commonly used 95% isopleth (Börger *et al* 2006).

I analyzed nightjar pellets by soaking them in 65% alcohol solution for a few minutes, examining the composition of the pellets by microscopy, and estimating the biomass of each taxon. This procedure is commonly used in bat faecal analysis (Whitaker 1988).

## RESULTS

### General

I tracked each radio-tagged nightjar for 5–15 nights, including only full nights of tracking (Table 1). Of the seven nightjars tracked, two were males, two were females, and three could not be sexed. Cleere (1999) and Holyoak (2001) mentioned slight morphological differences between sexes of this species but I was unable to distinguish between the sexes on this basis in the population I observed in Israel. I identified sex of four birds by their territorial behaviour in the field—males were very vocal, and exhibited courtship displays. Individuals 2 and 3, and 5 and 6 were pairs occupying overlapping territories, and were trapped in the same respective locations. The other individuals were trapped in three different locations within a circle of approximately 3 km radius.

### Status and habitat use

I found 21 pairs of Nubian Nightjar in the Kikar Sdom region and another two pairs at a water reservoir *c*20 km north of Kikar Sdom (at the same site where they were seen in 1999). All the pairs I found seemed to be involved in territorial activity during the breeding season.

The cores of the territories of all pairs were in patches of salt marsh larger than 50 ha. In these sites the nightjars roosted year-round. They were not found roosting in open areas.

**Table 1**. Monitoring periods and biometrics of seven adult Nubian Nightjars. Number of full nights relates to the number of nights I tracked an individual and obtained a complete data set. Number of partial nights relates to nights for which I obtained only partial data. These nights were excluded from analysis.

| Individual | Date | Sex | Length of closed wing (mm) | Body mass (g) | No. of full nights | No. of partial nights |
|---|---|---|---|---|---|---|
| 1 | August 2004 | Unknown | 158.5 | 61 | 5 | 2 |
| 2 | March 2005 | Female | 149 | 50 | 14 | 4 |
| 3 | March 2005 | Male | 156 | 51 | 7 | 3 |
| 4 | June 2006 | Unknown | 160 | 50 | 10 | 1 |
| 5 | March–April 2006 | Female | 153 | 50 | 15 | 0 |
| 6 | April–May 2006 | Male | 155 | 48 | 14 | 1 |
| 7 | June 2006 | Unknown | 154 | 50 | 8 | 0 |

Most pairs seen were near some sort of water source, usually a spring or irrigation canal. The nightjars apparently avoided the centres of large, homogeneous salt marsh patches, and preferred the edges of these patches. Foraging took place always in open areas, either along the edges of salt marsh patches, or over agricultural fields.

The specific choice of foraging site depended on habitat structure. In periods when the agricultural fields were covered by plastic greenhouses (polytunnels) or when the fields were totally dry after being ploughed, the nightjars foraged mainly near springs and irrigation canals or at the edges of salt marsh patches. In contrast, during May and June, after the plastic was taken off the fields and before the fields were ploughed, the nightjars foraged mainly over the productive agricultural fields.

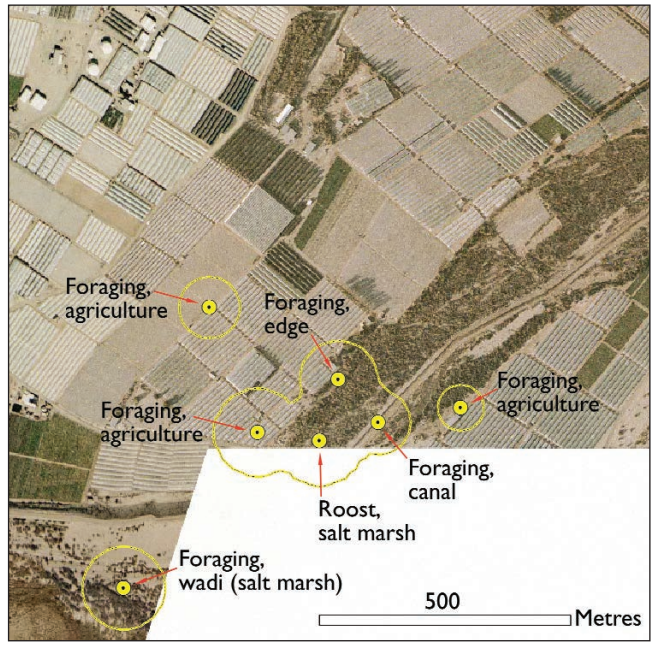


**Figure 1**. 95% isopleth home range of a female Nubian Nightjar *Caprimulgus nubicus* at Ne'ot Hakikar during March 2005 (8.4 ha). Each location is marked with a solid yellow circle; the home range is circled with yellow. For each location, usage (foraging or roost) and habitat are noted. © *Yoav Perlman*

I calculated the kernel home range of six nightjars (a representation of one home range is in Figure 1). I excluded the August 2004 bird from the analysis, as I only recorded five nights of data for it. The average home range size using the 90% and 95% isopleths was 7.4 ha (SD = 1.25, n = 6) and 8.43 ha (SD = 1.14, n = 6) respectively. The smallest salt marsh patch used by nightjars was 50 ha. The nightjars were usually quite sedentary, and moved rather short distances at night between foraging sites. The farthest foraging sites were 1300 m away from the roost site, but almost 80% of the foraging time was spent within a radius of 300 m from the roost site.

**Natural history**

Contrary to the published literature (Shirihai 1996, Holyoak 2001), the Nubian Nightjars in Israel appear to be resident and not summer breeding visitors. I regularly observed the nightjars in winter, though they were much less active then compared to other seasons, as they foraged for very short periods of the night and were silent. The low activity levels in winter are presumably attributable to the capacity to use energy-saving mechanisms, such as torpor (regulated hypothermia) (Reinertsen 1996), like many other Caprimulgiformes (*eg* McKechnie & Lovegrove 2002).

The nightjars responded strongly to the lunar cycle. On nights with a full moon, with high nocturnal light intensity levels, the nightjars foraged through most of the night. On dark nights with no moon, the nightjars foraged only during the twilight of dusk and dawn.

Plate 4. Impression of Nubian Nightjar *Caprimulgus nubicus* courtship flight, Ne'ot Hakikar, Israel, March 2006. © *Amir Balaban*

**Plate 5**. Nubian Nightjar *Caprimulgus nubicus* newly-fledged juvenile, Ne'ot Hakikar, Israel, May 2007. © *Yoav Perlman*

The breeding cycle of the Nubian Nightjars began in early March, when the birds became very vocal and apparently strictly maintained their territories. Courtship was noted in mid–late March (25–27 March 2005, 15–17 March 2006). It was always linked to periods of full moon. I documented and videoed the courtship behaviour of the Nubian Nightjar. The courtship took place in open areas, near the breeding sites. The courtship included two main activity types that lasted several minutes each. In the first, the male and female both sat on the ground, faced each other, spread their wings and tails showing the big white wing patches and tail corners, and called in great excitement. In the second activity the male flew about 1 m behind the female, both exhibiting a unique, buoyant and slow, flight, with the wings raised in a shallow V-shape, calling to each other in flight (Plate 4). After several sessions both birds disappeared into the vegetation, and possibly mated. Then they returned to the courtship arena and continued with the display. The longest courtship display I observed lasted about two hours, which included several possible mating events. During several sessions I observed the male perched on a tree or a greenhouse, about 2 m above the ground. These were the only instances in which I observed Nubian

Nightjars perched on an elevated object and not on the ground as they normally do.

I noted newly-fledged juveniles being fed by their parents in late April and early May 2007 (Plate 5). This is about 7 weeks after the predicted courtship period of early March (in 2007 I was not able to observe courtship). I observed three different families: two with two young and one with three young. Both parents were seen feeding the juveniles on the ground, just outside of the salt marsh patch where they had nested. On 25 June 2006 I trapped a fully grown, independent juvenile (Plate 6).

**Plate 6**. Nubian Nightjar *Caprimulgus nubicus* juvenile, Ne'ot Hakikar, Israel, June 2006. © *Arnon Tsairi*

I documented a difference in call between males and females. In the literature, both sexes are described as having a similar call, a double or triple 'koww-koww' or 'koww-koww-koww' (Holyoak 2001) or 'ow-wow' (Cleere 1999), which they seem to use for all interactions. However, by having fitted radio tags to birds, I could relate the different calls I heard from pair members to specific birds and by observing the behaviour of the birds determine their sexes. The call of the males was clearer and higher-pitched, while the females had a lower-pitched and hoarser call. Apart from the calls, I noted no morphological differences between sexes, contrary to published literature (Holyoak 2001). Both sexes showed similar wing and tail measurements, and a similar size and sharpness of the white wing patches.

**Food**

There are few references to the food of the Nubian Nightjar. Jackson (2000) mentioned stomach analyses of nine Nubian Nightjars, which contained mostly Lepidoptera (moths), but also Coleoptera (beetles), Orthoptera (grasshoppers), Dictyoptera (mantids) and Hemiptera (true bugs). Further details were not given. Cleere (1999) and Holyoak (2001) mentioned moths as being the main food and also noted grasshoppers, beetles and mantids.

In August 2004 and March 2005 respectively, I located the diurnal roost sites of two individuals that had shed their transmitters while the batteries still had power. In both cases I flushed the nightjars from their roost sites and found large numbers of faecal pellets, implying that both had roosted in exactly the same spot day after day for long periods.

I collected 30 pellets from the August 2004 roost site and three from the March 2005 site. The faecal pellets I examined contained mainly wing scales of noctuid moths, but also other hard parts that allowed identification of several taxa. Moths accounted for 88% of the total biomass on average. Other taxa that were identified were beetles, earwigs (Dermaptera), ants (Hymenoptera), bugs (Heteroptera) and flies (Diptera). The latter four taxa have not been described before as food of the Nubian Nightjar (Table 2).

## DISCUSSION

This study describes the general ecological characteristics of Nubian Nightjars and their territories in Israel. The nightjars breed and roost in salt marshes and forage in open areas, either over agricultural fields or near water canals and springs. Their foraging habits sure-

**Table 2**. Composition of 19 Nubian Nightjar faecal pellets. The percentage composition of each pellet is given for each insect group. UI = unidentified particles. Pellets 1–16 belonged to the August 2004 individual. Pellets 17–19 belonged to the March 2005 male. The large *Tamarix* flower was contained in a pellet.

| Pellet | Lepidoptera | Coleoptera | Dermaptera | Other | UI | Remarks |
|---|---|---|---|---|---|---|
| 1 | 80 | 0 | 10 | 10 | 0 | |
| 2 | 90 | 0 | 6 | 4 | 0 | |
| 3 | 70 | 20 | 0 | 0 | 10 | |
| 4 | 95 | 0 | 5 | 0 | 0 | |
| 5 | 80 | 20 | 0 | 0 | 0 | |
| 6 | 90 | 0 | 0 | 10 | 0 | |
| 7 | 80 | 0 | 10 | 0 | 10 | |
| 8 | 95 | 0 | 0 | 0 | 5 | Large *Tamarix* flower |
| 9 | 95 | 5 | 0 | 0 | 0 | |
| 10 | 95 | 5 | 0 | 0 | 0 | |
| 11 | 90 | 0 | 10 | 0 | 0 | |
| 12 | 90 | 5 | 5 | 0 | 0 | Many *Coleoptera* eggs |
| 13 | 100 | 0 | 0 | 0 | 0 | |
| 14 | 85 | 5 | 10 | 0 | 0 | |
| 15 | 99 | 0 | 0 | 1 | 0 | |
| 16 | 75 | 25 | 0 | 0 | 0 | |
| 17 | 75 | 20 | 0 | 5 | 0 | |
| 18 | 92 | 0 | 0 | 8 | 0 | |
| 19 | 100 | 0 | 0 | 0 | 0 | |
| Average | 88.21 | 5.53 | 2.95 | 2.00 | 1.32 | |

ly reflect a foraging technique of visually locating flying insects against the sky, and a need for open skies. Further, the nightjars require intermediate light intensities for foraging. They cannot locate their prey on totally dark nights, but avoid foraging before dusk or after dawn when light intensities are higher. They also avoid foraging near human light sources (*eg* street lights), unlike many other nightjar species that often exploit the higher insect densities near such light sources (Holyoak 2001, Frank 1988). The Nubian Nightjar in Israel requires a heterogeneous habitat, with dense salt marsh patches of at least 50 ha for breeding and roosting, and adjacent open areas for foraging, especially near water sources. Further, it is important that there are no artificial light sources near the nightjar territories.

My finding that the Israeli nightjar population is apparently resident, and not migrant as was previously thought, fits well with the conclusion reached by Kirwan (2004). He suggested that the different subspecies of Nubian Nightjar cannot be safely separated, and the differences between different individuals might represent responses to local climatic or geomorphologic conditions. Therefore, I suggest that specimens of *tamaricis* that were collected in east Africa might have been misidentified birds of local forms.

During my research I found 23 pairs of Nubian Nightjar in Israel. This is a large increase compared to the 5 pairs found in 1999. However, I suspect that this increase does not represent a true increase in population size but reflects, rather, the larger amount of time I spent searching compared to the previous work, and the fact that I could separate between neighbouring pairs using radio telemetry and identify them in the field.

My study population probably extends to the rich habitats on the Jordanian side of the border and perhaps represents a small part of a larger population. I heard several pairs calling from across the border on many occasions, and from observations and study of aerial photographs of the relevant area in Jordan, it seems that appropriate habitat is relatively extensive there. This should be surveyed for nightjars in the near future if possible.

The small population in Israel has a high risk of becoming extinct. The economic and social processes that led to the expansion of the agricultural lands along the Rift Valley in Israel have not slowed down, and the demand for more agricultural land is ever growing. The habitats where the nightjars breed and roost are not protected. However, as a result of my research, the Israeli Nature and Parks Authority has started work on creating a protected nature reserve that will preserve this important habitat type and its nightjars and protect the water sources of the Kikar Sdom region.

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