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ACTIVITY OF INCUBATING FEMALE LONG-EARED OWLS AS MEASURED BY FLUCTUATIONS IN NEST TEMPERATURES

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ABSTRACT.—In 1993 and 1997, activities of incubating Long-eared Owls (*Asio otus*) were measured in the Ljubljansko barje area (Slovenia). Fluctuations in nest temperature were used to record movements of females in three nests. The owls were about two times less active during the day than during the night. Approximately 10% of the movements resulted from feeding activities and the remainder were due to different movements on the nest. There were two prominent peaks in activity at dawn and dusk with less pronounced bursts in activity every 2–4 hr. These latter bursts of activity may have coincided with increased activity of voles which were the main prey.

KEY WORDS: *Long-eared Owl*; Asio otus; *nesting activity.*

Medición de la actividad de incubación de *Asio otus* a través de variaciones de temperatura del nido

RESUMEN.—En 1993 y 1997, la actividad de incubación de *Asio otus* fue medida en el área de Ljubljansko barje (Slovenia). Las fluctuaciones de temperatura fueron utilizadas para registrar los movimientos de la hembra en tres nidos. Los buhos fueron dos veces menos activos durante el día que en la noche. Aproximadamente 10% de los movimientos fueron el resultado de actividades de alimentación y los restantes de otro tipo de movimientos en el nido. Hubo dos picos de actividad notables, al atardecer y al amanecer con sobresaltos menores cada 2–4 horas. Estos sobresaltos de actividad pueden coincidir con el aumento de actividad de los roedores que son su presa principal.

[Traducción de César Márquez]

The Long-eared Owl (*Asio otus*) is considered to be one of the most strictly nocturnal owls (Glutz and Bauer 1980), spending the day hidden in a dense vegetation (Mikkola 1983). Due to its cryptic way of life, little information has been published on its nesting behavior (von Wendland 1957, Armstrong 1958, Wijnandts 1984, Korpimäki 1987, Craig et al. 1988). Unfortunately, methods of data collection have emphasized movements such as flight and have been unable to distinguish more subtle activities not involving flight. Since owls do not fly during the day, little is known about their daytime activity on their nests.

My objective in this study was to estimate the timing and pattern of nocturnal and diurnal activity of incubating female Long-eared Owls using fluctuations in nest temperature to indicate diurnal changes in nesting behavior.

METHODS

I used the nest temperature fluctuation recording method (NTFR) to monitor behavioral changes on the nest. The method is based on continual recording of nest temperature. Any change in position by an incubating bird, such as repositioning on the eggs, moving around the nest, or absence from the nest, is recorded as a rapid drop in nest temperature. The duration of movements can be obtained using the time intervals between the beginning of a nest temperature drop and the beginning of a rise in nest temperature (Fig. 1, Part A). Likewise, temperature drops during movements can be measured using the difference between temperature before movements and the lowest temperature reached during movements (Fig. 1, Part B). NTFR also enables collection of data on the duration of incubation between two movements (periods of uninterrupted incubation, Fig. 1, Part C) and the timing of the movements.

I studied the activity of long-ears during the incubation period at three nests located in the Ljubljansko barje area (south of Ljubljana, Slovenia) in 1993 and 1997. All three nests (N1, N2, and N3) were in artificial nesting platforms, consisting of wooden, open-topped boxes filled with straw. Platforms were located in spruce (*Picea* sp.) trees near forest edges. Recording in N1 began on 22 April 1993 after the clutch was complete ($N = 7$ eggs) and lasted for 9 d until the first young hatched. Recording in N2 began on 3 May 1993, after the clutch was completed ($N = 4$ eggs), and lasted for 15 d until the first young hatched. Recording in N3 began on 30 April 1997, after the clutch was completed ($N = 4$ eggs) and lasted for 18 d until the first young hatched. Data from the first day of recording (habituation period) were not used for analysis. Recording was interrupted each day at 1100 H for 3 hr in N1 and for 2 hr in N2, to save data

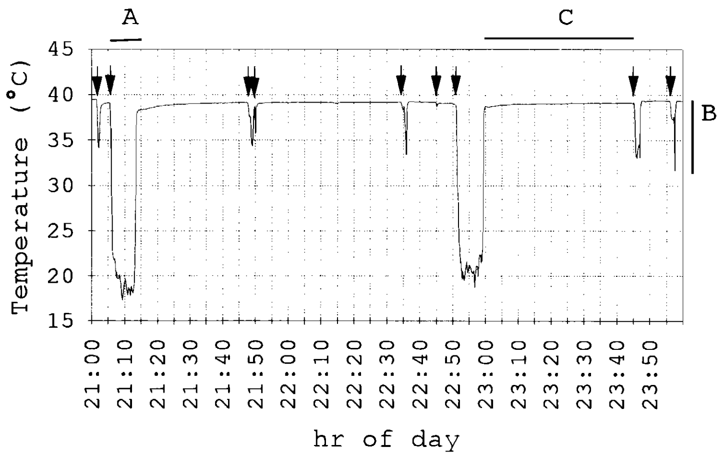

Figure 1. Long-eared Owl movements during incubation as recorded using the nest temperature fluctuation method (NTFR). Arrows indicate the beginning of movements. A represents the duration of a movement, B represents the temperature drop during a movement, and C represents the period of uninterrupted incubation.

on the computer disk. The incubating owl was not disturbed during this process. In N3, data were collected once per day without interrupting the collection process. While recording, sunrise and sunset were at about 0445 and 1915 H, respectively.

Nest temperatures were measured using a thermistor-type temperature probe (diameter = 2 mm, response time = 0.8 sec, Delta-T Co.) attached to a 30 m cable. A data logger (Delta-T Co.) was used for recording the data every 10 sec. The timing and duration of movements obtained with the NTFR method are comparable between nests. Nevertheless, the size of temperature drops in nests differed individually because of the number of eggs in nests, thickness of nesting material, influences of atmospheric conditions and microlocation of temperature probes. In N1, for example, the owl was considered to move if the temperature decreased by at least 0.1°C or more, or when there was a sudden drop of at least 0.3°C. In N2 and N3, temperature drops considered for movement were 0.2 and 0.5°C, respectively.

RESULTS AND DISCUSSION

Male Long-eared Owls either do not incubate and brood young or do so only occasionally and

Table 1. Movements of incubating Long-eared Owls at three nests in Slovenia.

	NEST 1	NEST 2	NEST 3	TOTAL
# days observed	8	14	17	39
# movements	413	690	1081	2184
# movments/24 hr				
$\bar{x}$	52	49	64	56
maximum	73	76	80	80
minimum	42	29	42	29
SD	10.2	11.5	10.4	12.5
$\bar{x}$ movements/hr (day)	1.5	1.6	2.1	1.7
$\bar{x}$ movements/hr (night)	3.5	3.3	3.4	3.4
# movements lasting ≥3 min/24 hr	3.5	6.3	4.1	4.8
# movements lasting ≥5 min/24 hr	2.0	3.4	1.7	2.4
duration of longest movement[a]	10:20	12:20	11:30	
duration of longest incubation[b]	04:50	05:22	03:13	
max. temp. drop during movement[c]	13.6	27.2	19.3	

[a] Duration in minutes and seconds.
[b] Duration in hours and minutes.
[c] Temperature in °C.

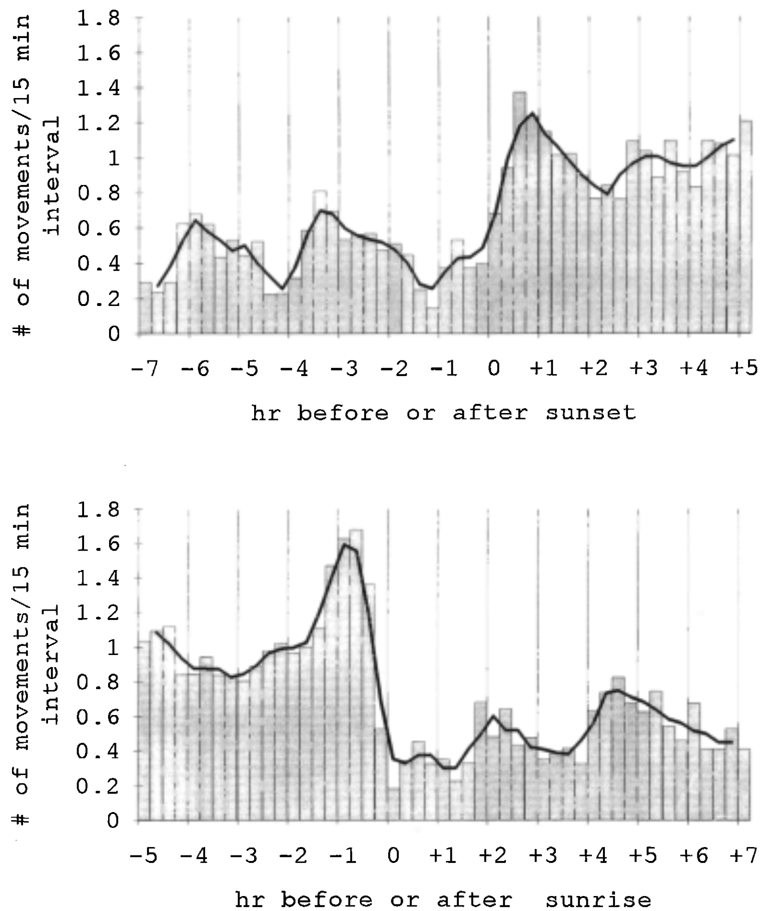

Figure 2. Activity pattern of Long-eared Owls during incubation. Data are averaged from three nests. Bars represent movement frequencies in 15 min intervals and lines represent three point moving averages. Data are shifted such that sunrise and sunset activity (denoted by 0) match between individual nests.

for very short periods (Glue 1977, Glutz and Bauer 1980, Wijnandts 1984, Marks et al. 1994, Scott 1997). Therefore, I assumed that movements detected with the NTFR method represented the activities of only female owls. Altogether, I recorded a total of 2184 movements at the three nests over 39 days (Table 1). The duration of movements ($\chi^2 = 140$, df $= 22$, $P < 0.001$) and the number of movements per day ($F = 7.6$, $P \leq 0.01$) were different among the nests.

Movements per hour were approximately twice as frequent during the night than during the day with movements lasting ≥3 min being nearly 6 times more frequent during the night. On average, females made only 2–3 movements in a 24-hr period that lasted longer than 5 min. Almost all occurred during the night with the longest lasting for 12.33 min. Female owls spent on average 170 sec/hr (67 min per day) not incubating eggs. This was about twice as long as reported by Wijnandts (1984) and was probably due to differences in data collection and inclusion of numerous movements on the nest that I was able to detect using NTFR. The longest uninterrupted incubation period lasted for 5.37 hr and the greatest temperature drop during a movement was 27.2°C (Table 1).

NTFR methods cannot identify the type of behavior that results in temperature changes in nests unless they are coupled with direct observations. Because von Wendland (1957) and Armstrong (1958) observed incubating female Long-eared Owls leaving their nests for 5–10 min during the evening to hunt and Wijnandts (1984) found that female Long-eared Owl movements during incubation consisted of an average of 2.8 flights from nests per night, with each flight lasting on average for 11.5 min, I concluded that 2–3 absences of female owls from nests in my study ≥5 min in duration (about 5% of all movements) were associated with female hunting behavior.

Another 5% of female movements apparently involved food deliveries by males to nests. Female owls move an average of 1.8–2.8 times per night (Wijnandts 1984, Marks et al. 1994) when males deliver prey items.

DeLong (1982: in Marks et al. 1994) reported that female owls turn eggs 5–12 times per night. This explains another 10–20% of the movements I recorded using NTFR. The remaining 70–80% of the movements were probably simply due to repositioning movements of females on their nests.

Daily activity patterns were similar at all three nests ($\chi^2 = 21$, df = 190, $P > 0.05$). There were two prominent peaks in activity approximately 1 hr before sunrise (at about 0400 H, Fig. 1) and 1 hr after sunset (at about 2000 H). Similar peaks in activity have also been reported for Long-eared owls by Wijnandts (1984) and Korpimäki (1987). In N1 and N2, less pronounced peaks appeared about 5 hrs after sunset (at midnight), while in N3 two peaks were observed 3 hr after sunset (2200–2300 H) and 3.5 hr before sunrise (0100–0200 H).

During the day, I observed less pronounced bursts in activity every 3–4 hr. These bursts of activity occurred in all three nests at about 2–3 and 5–6 hr before sunset and 2–3 and 4–5 hr after sunrise. A similar activity pattern with peaks at 2.5, 5, and 7.5 hr after sunrise has been shown in diurnal raptors in the Netherlands (Raptor Group 1982). These periods of peak activity coincide with the 2–4 hr activity periods of voles which are the main prey of Long-eared Owls (Davis 1933, Lehman and Sommersberg 1980, Raptor Group 1982, and Tamarin 1985). Voles are also the main prey of Long-eared Owls in Slovenia (Tome 1991, 1994). Therefore, vole activity may influence the activity of the owls since hunting is more successful when prey are active (Halle 1993).

There are several advantages to using the NTFR method of studying avian behavior as opposed to direct or indirect observations using video systems, radiotelemetry, automatic recording of nest visits using light traps, and systems for weighing nests. Advantages include the fact that NTFR is inexpensive, it uses low energy consumption, it is easy and quick with installation within 15 min and minimal disturbance during the operation. In addition, NTFR results include all the movements of females on nests and not just movements occurring when they leave or return. NTFR is also useful at night as well as during the day. Limitations of NTFR include the inability to determine the types of movements that cause temperature changes in nests and if and when mates swap incubation duties during the incubation period.

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