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Night rest and nest-visit frequency at five nests of Pied Flycatcher, *Ficedula hypoleuca* (Pall.), in Swedish Lapland

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ABSTRACT

Three recorders were used to study the night rest and the nest-visit frequency at five nests of Pied Flycatcher (*Ficedula hypoleuca* (Pall.)) at Ammarnäs, Swedish Lapland (66° N). The first had a thermistor in an artificial egg in the nest, the second a micro switch mounted just in front of the nest box entrance, and the third a photo-resistor mounted in the entrance wall. The daylight was continuous but nevertheless the birds showed a rest period with uninterrupted incubation and no passage through the nest box entrance. The length of the rest period varied from 3½ to 9 h. The two longest rests occurred during the egg-laying period and included the time when the egg was laid. The average length of the rest during incubation (one nest) was 6 h 20 min, during the nestling period (five nests) usually 4–5½ h. The first rest after hatching was sometimes as long as those during the incubation period. The rest period coincided with the darkest period of the day: 20.00–05.00 h. During the incubation period the rest was divided by midnight in almost equal parts, during the late nestling period the rest fell mainly after midnight. Significant displacements of the time for the start or the end of the rest were recorded. The nest-visit frequency at a nest with 3 nestlings did not increase as the nestling period proceeded in contrast to the frequencies at nest with 5 or 6 nestlings, where the highest frequencies were recorded on the 9–10 days of nestling period. Four nests showed a significant change in the day-time nest-visit frequency. There were no peaks in the morning and evening hours, but two nests with 5 and 6 nestlings respectively had a significant higher frequency after 12.00 h.

Introduction

In June–July the daylight at Ammarnäs, Swedish Lapland (65°58′ N, 16°13′ E) is continuous even though the sun is below the horizon for some hours. It has often been recognized that passerine birds during such circumstances have a circadian activity rhythm with a period of inactivity, a period of rest, during the night hours (Palmgren, 1935; Armstrong, 1954; Brown, 1963; Weeden, 1966, and others).

In 1965 the egg temperatures and the nest visits of breeding Pied Flycatcher, *Fidecula hypoleuca* (Pall.) were automatically recorded to obtain figures of the circadian activity rhythm, paticularly the length of the rest period and the nest-visit frequency. The study was carried out at five nest boxes in mixed birch-spruce wood some 500 m above sea level in the mountain area at Ammarnäs. Breeding data and

Table 1. Breeding data and extent of recordings at five nest boxes.

Nest box	Breeding data				Recording data		
	Egg no.	Young no.	Egg-laying	Beginning of hatching	Photo method	Temper. method	Switch method
14	6	3		27.6.	26.6–9.7.		
1	6	5		26.6.	24.6–6.7.		
4	7	6		25.6.	27.6–9.7.		
16	6	6		24.6.	26.6–9.7.		
44	6	6	11–16.6.	1.7.		14.6–6.7	12–15.6. 17–18.6. 25–28.6. 29.6–10.7

extent of recordings are shown in Table 1. The breeding biology of the Pied Flycarchers in the district was studied by Hanson *et al.* (1966) and the density of the breeding passerine bird populations was determined by Enemar *et al.* (1965).

Temperature recording

The temperature measurements was carried out by means of a thermistor (type B5, $R_{25°}$ about 2500 ohms; Hafo, Solna, Sweden) and a galvanometric point recorder (type ERMI; L. M. Ericsson, Stockholm). The thermistor was mounted in paraffin that was the same shape as an egg of a Pied Flycatcher. It was soldered on a conductor that was buried into the nest material anchoring the paraffin egg in a central position of the nest cup. The electrical resistance of the thermistor was recorded every third minut .

Fig. 1 shows the egg temperatures during 72 h. When the egg temperature was rising or fluctuating at a comparatively high value, the female was incubating. An incubating bird lies still on the eggs, and this behaviour is characterized as a fixed pattern (Baerends, 1959). Now and then it rises, turns the eggs, changes position on the nest, ruffles the belly feathers and sinks again on the eggs. These behaviours are also fixed patterns, but they are appetitive behaviours to the incubation. When all these behaviours are performed the female may be considered incubating in an extended sense, used in this study. A period with uninterrupted incubation has been called a sitting spell by Drent (1967). When the temperature fell, the female was off the nest. With automatic registration of the egg temperature it is possibble to determine the time that the female incubated and the time spent off the nest. Balwin and Kendeigh (1927) used thermocouples in the nest and continuously recorded the egg temperature estimating the time of »attentiveness» and »inattentiveness». Drent (1967) discussed the nomenclature of period of parental care.

The temperature recordings were employed at nest box 44. It started when the third egg was laid and included five days of the nestling period. The body temperature of nestling House Wren (*Troglodytes aëdon* Veillot) closely followed the ambient temperature during the first days after hatching, while homiothermy developed during the 4–9 days (Baldwin and Kendeigh, 1932). The female Pied Flycatcher normally ceases brooding the nestlings when they are 4–9 days (Creutz, 1955; Curio, 1959).

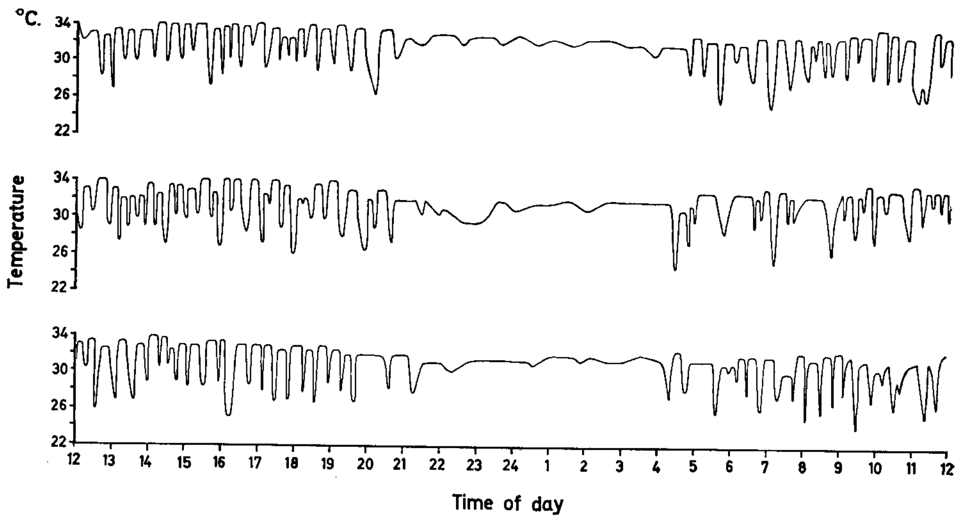

Fig. 1. Temperature recordings every third minute at box 44 during 72 h on 25–28 June 1965 (CET).

Nest-visit recording

The first type of recorder contained an electrical circuit with a micro switch just in front of the entrance into box 44. When a bird passed the entrance, it closed the micro switch and an alternating relay either completed or broke the current through an electromagnetic spiral acting on a recording pen. The event was recorded by a transverse line on the paper, that was fixed to a rotating, clock work cylinder (speed 39 mm/h). Similar methods to register bird activity have been used by several other authors, e.g. v. Haartman (1954) in a study of Pied Flycatchers.

The second type of recorder contained a photo-resistor and a lamp in the walls of the nest box entrance. A passage of a bird caused a sudden change in the electrical resistance, and the event was recorded by a pen drawing a transverse line on the paper (speed 165 mm/h) and by a counter. From time to time no registrations were obtained, as the mains voltage of the house was too low, and there was some trouble in focusing the light upon the photo-resistor.

No direct observations of the nest visits were made. They were determined solely by means of the records. At times three or more transversal lines were so close together that they partially or completely coincided. Then it was presumed that a single passage of one bird brought about several transversal lines. This happened particularly with the photo recording method. Similarly during the nestling period, it occasionally happened that there was a large number of records with very short intervals. Here it was presumed that both the male and the female were present at the nest entrance, but that only a proportion of the records were due to visits to the nestlings. This way of calculating the nest visits probably gave a result more in agreement with the actual events at the nest box than the mere sum of records on the paper.

Length of night rest

During much of the night the egg temperature was fairly constant at about 33°C (Fig. 1), and no switch record occurred. Thus the female was continuously incubating the eggs. She may have changed position on the eggs, but she did not leave the nest box. This time of uninterrupted incubation represents a rest period in activities outside the box, i.e. finding food. The rest period could be estimated by means of all three methods, the time and length being compiled to Figs. 2 and 3.

Egg-laying period. The rest during the night 12–13 June at the box 44 lasted for 7 h and 25 min as recorded by the switch method. During this time the third egg was laid. The following rest period lasted for 8 h 55 min, when the fourth egg was laid. During the nights 14–15 and 15–16 June both switch and temperature methods were in operation both giving the following results: 3 h 25 min and 5 h 10 min for the two nights respectively. These two rest periods were thus considerably shorter than the two proceeding. The first period off the nest in the latter two cases lasted for about 10 min after which continuous incubation was resumed for another 1 and 2 h respectively. This latter situation was unusual for the Pied Flycatcher's daytime behaviour and may be connected with the laying of the fifth and sixth eggs.

Incubation period. The rest periods at nest box 44 lasted for a minimum 4 h 15 min, a maximum 7 h 45 min, and an average 6 h 20 min as recorded by the temperature method. The switch method sometimes recorded a shorter rest. There are tvo explanations. First, the female may have been off the nest for such a short time that no record was made by the temperature method. Second, the male may have paid a visit to the nest.

Nestling period. According to the switch recording method at box 44, the first rest period after hatching lasted for $6\frac{1}{2}$ h, while the following rest periods were shorter, 4–$4\frac{1}{2}$ h. With the temperature recording method the first and second rest after hatching were recorded to be about $7\frac{1}{2}$ h and the three following $5\frac{1}{2}$–$6\frac{1}{2}$ h. From this it is evident that the first rest after hatching was as long as those during the later part of the incubation period and longer than those during the following nestling period. It was also evident that the switch method recorded a shorter night rest than the temperature method. The same kind of differences between the two methods occurred during the incubation period as discussed above. During the nestling period it was probably the activity of the male feeding the nestlings that caused most of the differences. The 7–9 rest periods after hatching were on average 3 h 20 min according to the switch method, and they were thus shorter than during the earlier part of the nestling period. The rest periods at boxes 1, 4, 14 and 16 lasted on average for $4\frac{1}{2}$–$5\frac{1}{2}$ h. As the nestling period proceeded there was a significant decrease in the length at box 1 (analysis of regression disregarding the first nestling day, $0.05 > P > 0.01$; cf. Fig. 3).

Time of night rest

During the *incubation period* at box 44 (Fig. 2) the rest mostly occurred between 21.00 and 04.00 (CET). The midnight divided the time into almost equal parts. As the incubation period proceeded the time for the end of the rest showed about one hour's displacement towards the latter part of the night.

During the early *nestling period* at box 4 and 14 (Fig. 3) the end of the rest occurred at about 02.00 h and during the late nestling period at about 03.00 h. At box 44 (Fig. 2) the time for the end of the rest was 03.00–04.00 h during the early nestling period

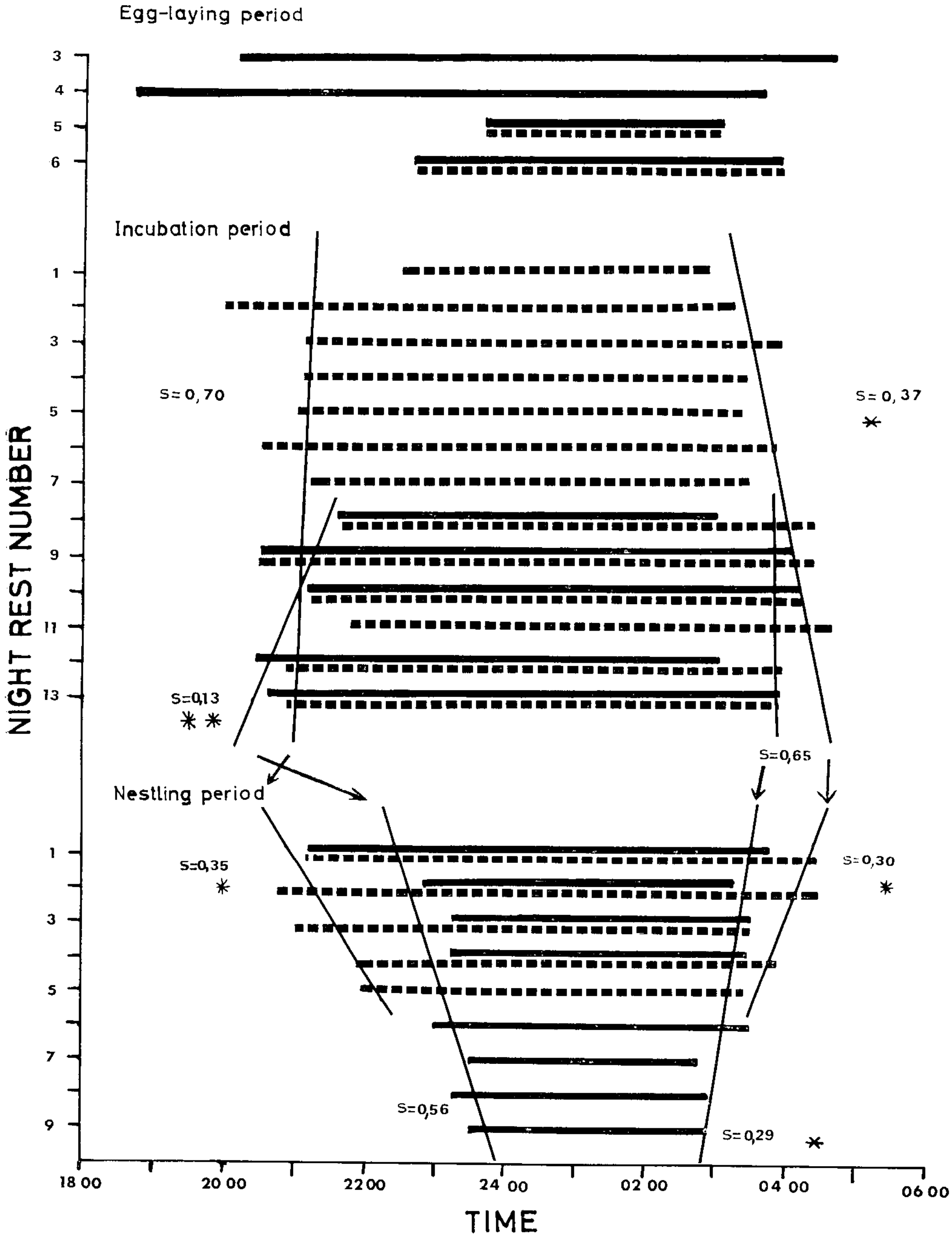

Fig. 2. Time and length of night rest at box 44 with 6 nestlings as recorded by the temperature method (solid black horizontal lines) and the switch method (black and white horizontal lines). The regression lines for time of start and end of rest are shown as vertical lines with standard deviation (s) and significance for displacement of time (1 to 2 asterisks) indicated. The first day of nestling period was not taken into account in the regression lines for the nestling period.

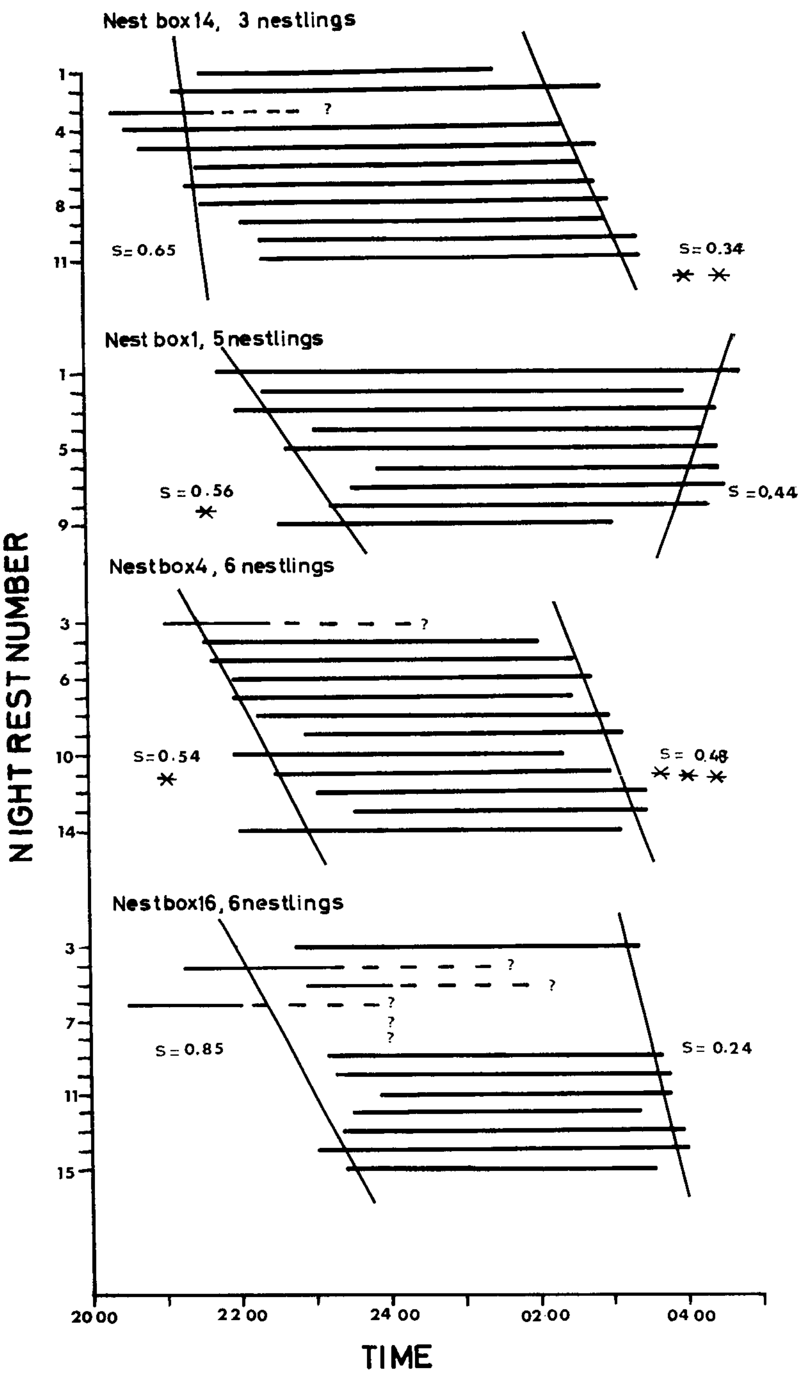

Fig. 3. Time and length of night rest at four boxes during the nestling period as recorded by the photo method (horizontal lines). The regression lines for start and end of rest are shown as vertical lines with standard deviation (*s*) and significance for displacement of time (1, 2, and 3 asterisks) indicated. The first day of nestling period was not taken into account in the calculation of regression lines.

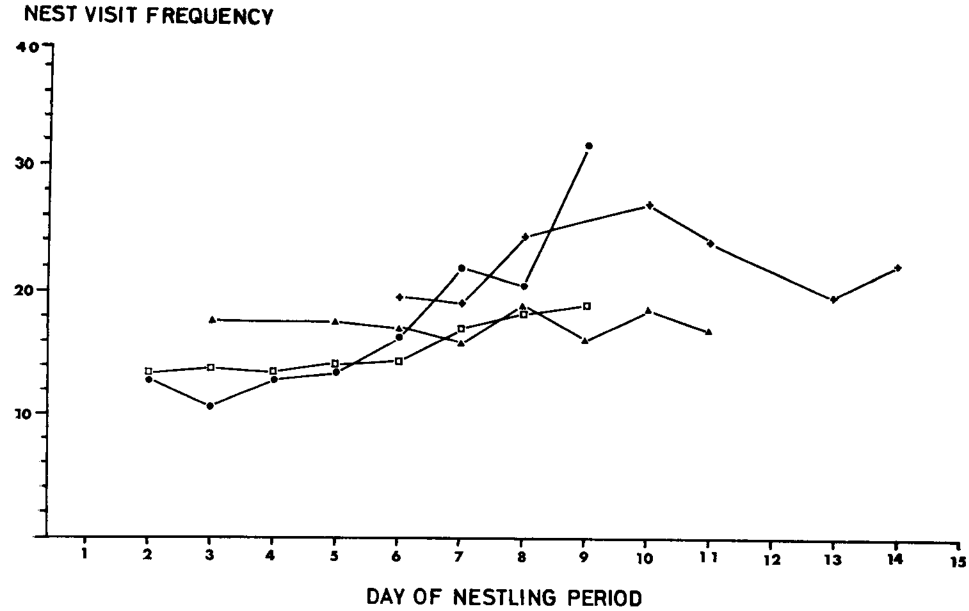

Fig. 4. Average daily nest-visit frequency during the nestling period as recorded by the photo method: ▲, Box 14, 3 nestlings; ●, box 1, 5 nestlings; +, box 4, 6 nestlings; and by the switch method: □, box 44, 6 nestlings.

and 02.00–03.00 h during the late nestling period. This displacement towards an earlier time may be connected with the shortening of the rest period. At all nests the rest during the late nestling period fell mainly after midnight.

Nest-visit frequency

The nest-visit frequencies during the nestling period were arranged in two ways: day of nestling period and hour of day. The values of each nest were compiled to a table. At box 16 there were so many interruptions in the recording that the values were disregarded in the following treatment. The first day of nestling period (box 1 and 14) was not taken into account, as the feeding of the nestlings was then irregular and the nest visit frequency a bad indication of the feeding activity. At box 1, 4, 14 and 44 the missing values amounted to 7–18 %. These values were estimated by the least square method in order to facilitate an analysis of variance. Degrees of freedom for error was diminished by the number of missing values. The analysis for most boxes comprised 8 days (cf. Table 1) and 15 hours. The average daily nest-visit frequencies are shown in Fig. 4 and the average hourly frequencies during the 7–10 days of nestling period in Fig. 5.

There was no significant increase in the *daily nest-visit frequency* at box 14 with 3 nestlings during the 5–11 days of nestling period ($P > 0.05$). At the remaining boxes with 5–6 nestlings the increase was significant ($P < 0.0005$), and the highest values were recorded when the nestlings were 9–10 days old (cf. v. Haartman, 1954, Diagram

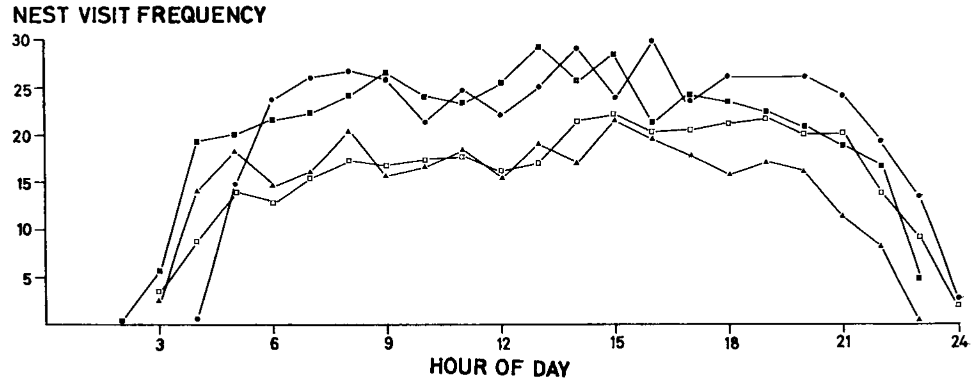

Fig. 5. Average hourly nest-visit frequency during the 7–10 days of nestling period as recorded by the photo method: ▲, Box 14, 3 nestlings; ●, box 1, 5 nestlings; +, box 4, 6 nestlings; and by the switch method: □, box 44, 6 nestlings.

5, Table 9). There was a significant change in the *hourly nest-visit frequency* during the day at the four nests (box 14: $0.01 > P > 0.005$; boxes 1, 4, and 44: $P < 0.001$).

The day-time variation in nest-visit frequency was further analyzed. A bimodal rhythm has often been observed in the locomotor activity of birds with one peak in the morning and another in the evening. Aschoff (1966) concluded, that this pattern is a persistent property of a circadian oscillating system. For each nest the mean values per hour were calculated. Using Student's *t*-test, no indication of any such activity pattern was found. The average nest-visit frequency before noon and those after that time was then compared, and the same test applied. Box 14 with 3 nestlings showed no significant difference between the two groups of frequencies ($0.2 > P > 0.1$). At box 4 with 6 nestlings the difference approached significance ($0.1 > P > 0.05$), while box 1 and 44 showed a significant difference ($P < 0.001$). The same type of daily activity pattern was on some days found by v. Haartman (1954, Diagrams 2–3).

The photo method was employed at boxes 1, 4, and 14. The average hourly nest-visit frequency during the 7–10 days of nestling period was calculated (Fig. 5). The values were compared by means of the simple sign test. There was no difference in average nest-visit frequency between boxes 1 and 4, with 5 and 6 nestlings respectively ($P > 0.5$). Box 14 with 3 nestlings had a significantly lower frequency than both box 1 and box 4 ($P < 0.001$). Similar differences in nest-visit frequency between clutches with differing number of nestlings have been recorded for the Pied Flycatcher by e.g. v. Haartman (1954) and Curio (1959).

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REFERENCES

ARMSTRONG, E. A., 1954. The behaviour of birds in continuous daylight. Ibis *96*, 1–30. London.

ASCHOFF, J., 1966. Cicadian activity pattern with two peaks. Ecology *47*, 657–662. Lancaster.

BAERENDS, G. P., 1959. The ethological analysis of incubation behaviour. Ibis *101*, 357–368. London.

BALDWIN, S. P., and KENDEIGH, S. C., 1927. Attentiveness and inattentiveness in the nesting behaviour of the house wren. Auk *44*, 206–216. Lancaster.

—— 1932. Physiology of the temperature of birds. Sci. Publ. Cleveland Mus. Nat. Hist., vol. 3. Cleveland.

BROWN, R. G. B., 1963. The behaviour of the Willow Warbler, *Phylloscopus trochilus*, in continous daylight. Ibis *105*, 63–75. London.

CREUTZ, G., 1955. Der Trauerschnäpper (*Muscicapa hypoleuca* (Pallas)). Eine Populationsstudie. Journ. Orn. *96*, 241–326. Berlin.

CURIO, E., 1959. Verhaltensstudien am Trauerschnäpper. Zeitschr. Tierpsych., Beiheft 3. Berlin.

DRENT, R. H., 1967. Functional aspects of incubation in the Herring Gull (*Larus argentatus* Pont.). Behaviour, Suppl. *XVII*. Leiden.

ENEMAR, A., HANSON, S. Å., and SJÖSTRAND, B., 1965. The composition of the bird fauna in two consecutive breeding seasons in the forests of the Ammarnäs area, Swedish Lapland. Acta Univ. Lund., Sectio II, No. 5, Lund.

HAARTMAN, L. v., 1954. Der Trauerfliegenschnäpper. III. Die Nahrungsbiologie. Acta Zool. Fenn. *83*. Helsingfors.

HANSSON, S. Å., LENNERSTEDT, I., MYHRBERG, H., and NYHOLM, E., 1966. Holkfågelstudier i Ammarnäsområdet. Fauna och Flora *61*, 225–254. Uppsala.

PALMGREN, P., 1935. Über den Tagesthytmus der Vögel im arktischen Sommer. Orn. Fenn. *12*, 107–121. Helsingfors.

WEEDEN, J. S., 1966. Diurnal rhythm of attentiveness of incubating female Tree Sparrow (*Spizella arborea*) at a northern latitude. Auk *83*, 368–388. Lancaster.

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Uppsala 1969. Almqvist & Wiksells Boktryckeri AB