Wilson Bull., 105(3), 1993, pp. 475–482

BREEDING BIOLOGY OF THE EURASIAN NUTHATCH IN NORTHEASTERN SIBERIA

VLADIMIR V. PRAVOSUDOV[1]

ABSTRACT.—The breeding biology of Eurasian Nuthatches (*Sitta europaea asiatica*) was studied in 1986–1990 in two habitats, riparian and upland forests, in the Magadan region, northeastern Siberia. Clutch sizes and breeding success averaged 6.49 eggs and 57.5%, respectively, and varied among years. Habitat influenced clutch size but not numbers of young fledged from successful nests. Within seasons, date of first egg was correlated negatively with clutch size, while in years in which breeding started later, nuthatches laid significantly larger clutches. Female age had a significant effect on the timing of the start of breeding, whereas neither female nor male age influenced clutch size or number of fledglings. Mass of young at the time of fledging was independent of brood size. The yearly mean brood size correlated positively and significantly with mean yearly nestling growth rate and mean body mass of nestlings at 18 days of age. *Received 22 Sept. 1992, accepted 12 Feb. 1993.*

The Eurasian Nuthatch (*Sitta europaea*) occupies a vast range from western Europe to eastern Siberia. Breeding biology of the nuthatch is not well known because of difficulties associated with access to natural cavities where this species nests. Although Eurasian Nuthatches have been studied in Europe (Löhrl 1958; Nilsson 1976, 1987; Schmidt et al. 1992), no one has examined the breeding biology of this common species in the eastern part of its range. In this paper, I describe several aspects of the breeding biology of (*Sitta europaea asiatica*) breeding in natural cavities in northeastern Siberia and discuss the influence of parental age and habitat on clutch size and breeding success.

STUDY AREA AND METHODS

All data were collected in the southern part of the Magadan region, northeastern Siberia (60°N, 150°E), in 1986–1990. Nuthatches were studied in two main habitat types, riparian forest (20–30 m tall) along rivers and upland forest (5–15 m tall). The riparian tracts were 0.1–4 km wide and were comprised mainly of larch (*Larix cajandery*), poplar (*Populus suoveolens*), and chosenia (*Chosenia arbutifolia*), with birch (*Betula* spp.), alder (*Alnus* spp.), and willow (*Salix* spp.) present to a lesser extent. The upland forest was located on gentle mountain slopes, where larch was the only tree and shrub pine (*Pinus pumila*) the most abundant shrub. The latter species formed dense thickets, especially at higher elevation.

All observations were made within a single 400-ha plot, which included both habitats. Nearly all nuthatches were individually marked with different combinations of colored leg bands. Breeding nuthatches were captured at the nests, and at other seasons in mistnets, surrounding feeders, and caged decoy birds. To gain access to nests placed in tree cavities, I fashioned a "door" in the wall opposite to the entrance. Thus, I was able to count eggs

---

[1] Institute of Biological Problems of the North, Academy of Sciences of the USSR, Far East Division, K. Marx pr. 24, Magadan, USSR. (Present address: Dept. of Zoology, The Ohio State Univ., 1735 Neil Ave., Columbus, Ohio 43210-1293.)

and nestlings, determine the length of incubation and nestling periods, and study nestling growth. Using Ricklefs' (1967) method, I found that the logistic equation was the most suitable for describing mass increase, and I used the growth constant K to describe nestling growth rate. There were different numbers of nests available for different analyses; altogether I found 46 nests, but only 37 were inspected regularly.

Multi-way analysis of variance (ANOVA) was used for the majority of the tests concerning the relationships among time of breeding, clutch size, number of fledglings, year, habitat, and parental age. The numbers of nests used for inspecting the effect of different factors were sometimes different (e.g., I knew the age of parents only in the second year of observations). Therefore, I first examined the effect of factors available for all nests, such as year, habitat, and date of first egg. Then, in subsequent tests, I omitted factors that had been found not to be statistically significant. For analysis, I divided brood size into two groups, large (6–8 young) and small (3–5).

RESULTS

Adult nuthatches lived in male-female pairs permanently in the same territories after they became breeders (Pravosudov, unpubl. data). Young nuthatches had two dispersal peaks; in summer, when they dispersed after becoming independent, and in spring, when those that had not found mates or territories during the winter moved again (Pravosudov, unpubl. data).

Nest holes.—Nuthatches most often (82.6%) occupied old holes of Great Spotted Woodpeckers (*Dendrocopos major*) and Three-toed Woodpeckers (*Picoides tridactylus*) and more rarely (15.2%) natural cavities in dead trees (mainly larch and poplar), mostly where branches had fallen off. Only once did a nuthatch pair breed in a nestbox (2.2%, N = 46). The mean height of nest holes above ground was 6.73 ± 3.09 m (range 1–14 m, N = 46). Nuthatches narrowed the entrance to cavities by plastering mud around the margins. Both plastering and nest building were performed solely by females, while males sometimes brought pieces of nest material to their mates. Females used larch and birch bark flakes to build a thick base to the nest (4–10 cm). Some females used dry leaves. Nuthatches often used the same hole in more than one year. The tendency to breed in the same nest hole was related to age, especially of males. Old males preferred to stay in old holes from year to year ($\chi^2 = 6.23$, df = 1, $P = 0.012$, N = 24), while old and young females and young males did not differ significantly in use of old or new holes, respectively ($\chi^2 = 2.57$, 0, 1.0; df = 1, 1, 1; $P = 0.11$, 1.0, 0.32, N = 24).

Timing of breeding.—The start of egg-laying varied among years from the beginning to the end of May (Table 1). A two-way analysis of variance showed that while year ($F_{4,28} = 21.7$, $P < 0.001$) had a significant effect on date of the first egg, neither habitat type nor the interaction term ($F_{1,28} = 1.4$, $P = 0.253$) were significant. Because habitat was not a significant factor, I lumped data from both habitats and tested the effects of year

TABLE 1

BREEDING CHARACTERISTICS OF EURASIAN NUTHATCHES IN THE MAGADAN REGION OF SIBERIA[a]

	1986	1987	1988	1989	1990	Total
No. of nests	6	9	8	8	6	37
Clutch size	7.50	6.11	5.37	7.12	6.67	6.49
	0.55	1.17	1.41	0.64	0.82	1.22
Brood size	7.40	6.00	4.83	5.86	6.33	5.97
	0.55	1.53	1.83	2.48	1.03	1.69
No. of fledglings from successful nests only	4.50	5.37	3.60	5.25	6.33	5.11
	1.91	1.30	0.55	1.26	1.03	1.48
No. of fledglings (all nests)	3.00	4.78	2.25	3.00	6.33	3.73
	2.75	2.17	1.91	2.94	1.03	2.62
Breeding success[b] (%)	40.0	78.2	41.9	42.1	94.9	57.5
Median date of first egg in May	22	18	10	22	20	20
	3.08	4.02	3.81	3.90	1.63	5.87
Nests lost to predators	—	—	1	1	—	2
Unsuccessful nests[c]	2	1	3	3	—	9

[a] For each cell of the table, the upper number is the mean and the lower is the standard deviation.

[b] No. of young fledged as percentage of eggs laid.

[c] Nests which had eggs, but in which nestlings were killed by predators or died from other causes.

and of using the same or a new hole on the date of first egg. Use of the same or a new hole for breeding did not affect the start of egg laying ($F_{1,18}$ = 0.9, $P = 0.36$) and this effect was not variable among years (i.e., interaction term not significant). Because habitat type and previous use of hole were not significant factors, I tested the role of parental age and year on the date when nuthatches laid the first egg. There was a significant negative relationship between first egg date and female age ($F_{1,13} = 5.5$, $P = 0.036$), but not between first egg date and male age ($F_{1,13} = 2.3$, $P = 0.15$). Again, interaction terms were not significant.

Nuthatches only laid one clutch per season, regardless of the fate of the first nest. Mean incubation period was 16.2 ± 0.7 days (range 15–17 days, N = 6) and nestlings spent an average of 20 days in the nest (range 18–22 days, N = 31). Parents continued to feed young for about two weeks after fledging.

Clutch size.—Clutch size ranged from 4 to 8 eggs, with a mode of 7 (Table 1, Fig. 1). Egg size was 19.6 ± 0.6 mm × 14.7 ± 0.3 mm. Eggs were incubated by the female only. It appeared that the female always covered the eggs with pieces of bark before leaving the nest. Analysis of covariance of clutch size over five years and two habitats, with date of the first egg as a covariate, showed significant variation among years ($F_{4,27}$ = 4.8, $P = 0.005$), habitat types ($F_{1,27} = 6.95$, $P = 0.014$), and first-egg dates ($F_{1,27} = 4.96$, $P = 0.034$). None of the interactions was significant

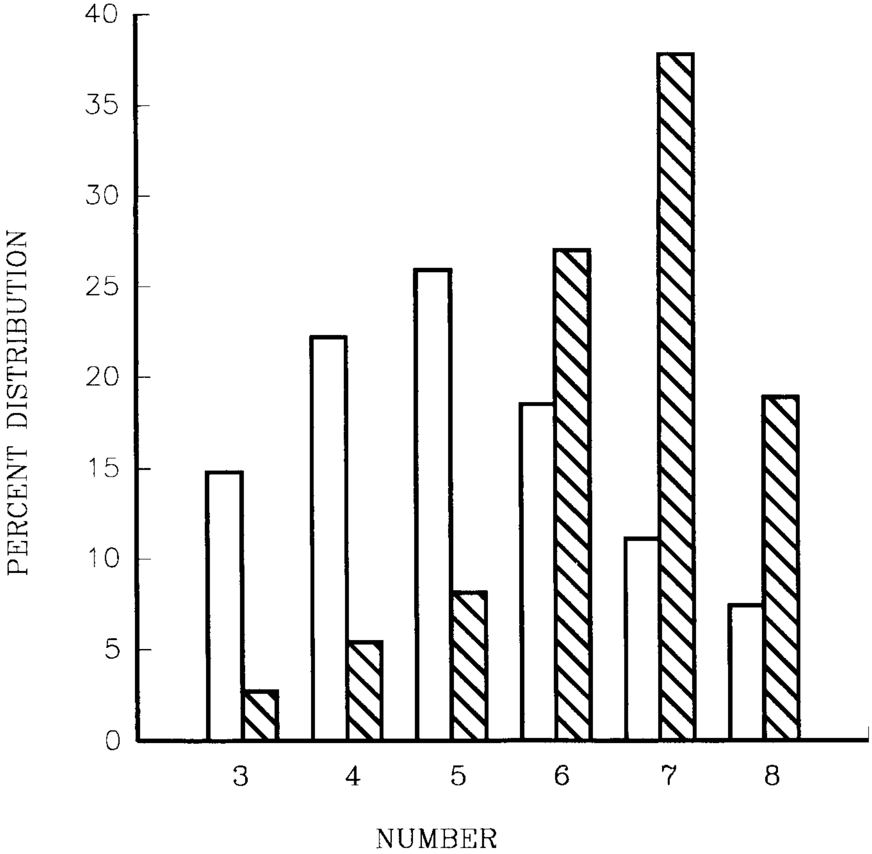

FIG. 1. Percent distribution of clutch sizes (open bars) and number of fledglings (crossed-hatched bars) during the five years of the study.

($P > 0.2$). This analysis indicated that in riparian forest, clutch sizes were significantly smaller (Table 2) and that birds starting to breed later laid fewer eggs (correlation from ANCOVA, $r = -0.13$, $P = 0.034$). However, a comparison of mean yearly clutch size with mean yearly date of first egg showed that in years when the egg-laying period began later, nuthatches had larger clutches (N = 5, Spearman rank correlation $r_s = 0.7$, $P = 0.01$). Because the sample size available for examining the influence of parental age on clutch size was considerably smaller, I performed a second ANOVA that included parental age as well as all other factors previously shown to be significant. This analysis showed no significant effect of either female age ($F_{1,11} = 0.1$, $P = 0.75$) or male age ($F_{1,11} = 0.6$, $P = 0.47$). All the other factors and interactions in this model were also not significant, a result that might have been due to the small sample size.

TABLE 2

BREEDING CHARACTERISTICS OF EURASIAN NUTHATCHES BREEDING IN TWO DIFFERENT HABITATS IN THE MAGADAN REGION OF SIBERIA (MEAN ± SD)

	Riparian forest	Upland forest
No. of nests	21	16
Clutch size	6.05 (0.24)	7.06 (0.28)
Brood size	5.60 (0.37)	6.47 (0.43)
No. of fledglings (successful nests only)	4.87 (0.38)	5.42 (0.43)
No. of fledglings (all nests)	3.48 (0.58)	4.06 (0.66)
Breeding success %[a]	59.8 (8.8)	57.2 (10.1)
Unsuccessful nests[b]	6 (28.6%)	2 (12.5%)
Height of nests, m	6.42 (2.87)	7.10 (3.38)
Mean date of first egg in May	18	19

[a] No. of young fledged as percentage of eggs laid.

[b] Nests which had eggs, but in which nestlings were killed by predators or died from other causes.

Nesting period and breeding success.—Hatching success in nuthatches was never lower than 80% (Table 1), and the number of fledglings varied from 3 to 8, most commonly 4 or 5. Analysis of covariance of the number of fledglings from all nests over different years in the two habitats, with date of first egg as a covariate, showed a significant variation among years ($F_{4,26} = 2.85$, $P = 0.04$) but no significant effect of habitat type ($F_{1,26} = 0.50$, $P = 0.48$) or date of the first egg ($F_{1,26} = 0.07$, $P = 0.79$). Interaction terms were not significant ($P > 0.2$). Because I had a smaller sample size available for examining the effect of parental age on the number of young fledged, besides using the ages of males and females in a subsequent analysis of variance, I used only year since it had previously been shown to be significantly important. This ANOVA showed no significant effect of female age ($F_{1,13} = 0.1$, $P = 0.76$), male age ($F_{1,13} = 0.7$, $P = 0.42$), or any interactions on the number of fledglings. Similar analyses applied only to successful nests indicated no significant influence of year, habitat type, first egg date, or parental age on the number of fledglings.

Although a three-way ANOVA showed no significant effect of year ($F_{3,18} = 1.8$, $P = 0.18$), habitat type ($F_{1,18} = 0.3$, $P = 0.59$), or brood size ($F_{1,18} = 0.06$, $P = 0.81$) on fledgling body mass, the mean yearly body mass of fledglings was significantly higher in years with larger number of fledglings (Spearman correlation, $N = 5$, $r_s = 1$, $P < 0.001$). Nestlings also grew significantly faster in years with larger mean numbers of fledglings; the correlation between mean yearly nestling growth rate (constant K of the logistic growth equation) and mean yearly number of fledglings was positive and significant ($N = 4$, $r_s = 1$, $P < 0.001$).

Nestling mortality was high enough to result in an average breeding success of only about 57.5% (percent of fledglings from number of eggs laid). However, mortality due to predation was rare, with only two cases detected, both probably by a weasel (*Mustela nivalis*) (Table 1). In every year, there were some nests in which the nestlings died of starvation (Table 1); for unknown reasons, the parents dramatically reduced feeding rates and the nestlings died several days later. In all such cases, the females disappeared before the next breeding season, presumably having died. In 1988, two of 15 pairs under observation did not breed at all. They began to plaster mud around the cavity entrance and to build the nest, but then ceased all breeding activity while continuing to hold their territory.

An analysis of variance of breeding success (percent of eggs that fledged) over different years and in two habitats showed significant variation among years ($F_{4,27} = 3.16$, $P = 0.03$, Table 1) but no relationship with habitat type ($F_{1,27} = 0.06$, $P = 0.81$, Table 2). The interaction term was also not significant.

DISCUSSION

Breeding behavior of the nuthatch.—Eurasian nuthatches in eastern Siberia show similar breeding ecology as populations in western Europe (Nilsson 1976, 1987). For example, in both locations nuthatches prefer to breed in natural holes, plaster mud around the nest entrance, build the nest of bark flakes or leaves, and attempt only a single clutch per year (Löhrl 1958; Nilsson 1976, 1987). The mean clutch size (6.49 eggs) of the Siberian birds I studied was similar to that reported from Sweden (6.8–7; Durango and Durango 1942, Nilsson 1976) and from West Germany (6.49; Schmidt et al. 1992). The mean number of fledglings from successful nests (5.12, 5.14) and overall breeding success (50%) observed in Sweden (Nilsson 1976, 1987) and in West Germany (Schmidt et al. 1992) were also very similar to those in Siberia.

The role of age in breeding.—I found no tendency for older nuthatches either to have larger clutches or to raise more fledglings than one-year old birds, but older females started laying earlier. These results agree with data obtained in Sweden (Enoksson 1990), Belgium (Matthysen 1989a, b) and Germany (Schmidt et al. 1992). Nilsson and Smith (1988) found that in Marsh Tits (*Parus palustris*) even small differences in hatching date greatly influenced juveniles' dominance status and probability of becoming established in a winter flock. The situation seems to be similar in the nuthatch. The first juveniles settling in a territory tend to remain there as a result of their higher social status in comparison with juveniles that appear later (Matthysen 1987; Enoksson, unpubl. data; Pravosudov, unpubl. data). Thus, early breeding is apparently very important, and older females have an advantage over younger ones.

Influence of habitat.—In my study, habitat type influenced clutch size. The most probable explanation might be related to food availability as shrub pines were common in the upland forest, but much less common in the riparian larch forest. Seeds of Shrub Pine were eaten and stored intensively by the nuthatches in autumn. Stored seeds can form an important component of the diet in winter and spring, and the number of stored seeds has been shown to influence breeding in some passerines (Swanberg 1981, Higuchi 1977). Possibly, nuthatch females living on the mountain slopes may have laid more eggs and have had a slightly higher overall breeding success because of a better food supply. In Germany, clutch size of Eurasian Nuthatches also varied by habitat type, although the number of fledglings did not differ (Schmidt et al. 1992).

Clutch size.—In the Eurasian Nuthatch, mass of nestlings on the 18th day of age did not vary with brood size. The absence of differences in nestling mass between large and small broods might be related to parental condition or territory quality (Högstedt 1980). If birds in different quality territories lay different numbers of eggs, and if nestlings from different brood sizes grow at similar rates, then clutch size may be mainly limited by the capacity of parents to feed the young. But such a capacity to feed young might be explained either by individual condition of the parents or by a possible link between feeding conditions in spring and summer. Perhaps increasing the clutch size beyond the optimum may lower the parents' future survival. Boyce and Perrins (1987) argued that in the Great Tit (*P. major*) clutch size in good years was lower, and in bad years higher than the optimum. In the Eurasian Nuthatch, I found a significant positive correlation between mean yearly clutch size and mean yearly growth rate of nestlings and also between mean yearly brood size and mean yearly body mass of young before fledging, i.e., in years with a larger mean clutch size nestlings grew faster. These results support the idea that feeding conditions during spring and summer might be correlated. Perhaps, females may somehow monitor the habitat and to some extent adjust clutch size to the prevailing conditions (Högstedt 1980).

ACKNOWLEDGMENTS

I am indebted to my wife, Elena V. Pravosudova, and E. Yu. Zimireva for help during field work. I thank all my colleagues in the Institute for many interesting discussions. I am very grateful to Bodil Enoksson, Jon Swenson, Hans Källander, Eric Matthysen, Thomas C. Grubb, Jr., and Daniel R. Petit who provided valuable comments on earlier drafts of this paper.

LITERATURE CITED

Boyce, M. S. and C. M. Perrins. 1987. Optimizing great tit clutch size in a fluctuating environment. Ecology 68:142–153.

DURANGO, A.-M. AND S. DURANGO. 1942. [Breeding of the nuthatch (*Sitta e. europaea* L.).]. Var Fagelvarld 1:33–44. (Swedish with English summary.)

ENOKSSON, B. 1988. Prospective resource defense and its consequences in the Nuthatch (*Sitta europaea* L.). Ph.D. diss., Univ. of Uppsala, Uppsala, Sweden.

———. 1990. Breeding in the European Nuthatch—the importance of female age. Acta XX Congressus Internationalis Ornitologici, (Supplement):412, Christchurch, New Zealand.

HIGUCHI, H. 1977. Stored nuts (*Castanopsis cupsidata*) as a food resource of nestling Varied Tit (*Parus varius*). Tori 26:9–12.

HÖGSTEDT, G. 1980. Evolution of clutch size in birds: adaptive variation in relation to territory quality. Science 210:1148–1150.

LACK, D. 1968. Ecological adaptations for breeding in birds. Methuen, London, England.

LÖHRL, H. 1958. Das Verhalten des Kleibers (*Sitta europaea caesia* Wolf). Z. Tierpsych. 15:191–252.

MATTHYSEN, E. 1987. Territory establishment of juvenile nuthatches (*Sitta europaea*) after fledging. Ardea 75:53–57.

———. 1989a. Territorial and nonterritorial settling in juvenile Eurasian Nuthatches (*Sitta europaea* L.) in summer. Auk 106:560–567.

———. 1989b. Fledging dates of Nuthatches (*Sitta europaea*) in relation to age, territory and individual variation. Bird Study 36:134–140.

NILSSON, S. G. 1976. Habitat, territory size, and reproductive success in the Nuthatch (*Sitta europaea*). Ornis Scand. 7:179–184.

———. 1987. Limitation and regulation of population density in the Nuthatch (*Sitta europaea* (*Aves*) breeding in natural cavities. J. Anim. Ecol. 56:921–937.

NILSSON, J.-A. AND H. G. SMITH. 1988. Effects of dispersal date on winter flock establishment and social dominance in Marsh Tit (*Parus palustris*). J. Anim. Ecol. 57:917–928.

RICKLEFS, R. E. 1967. A graphical method of fitting equations to growth curves. Ecology 48:978–983.

SCHMIDT K.-H., M. MARZ, AND E. MATTHYSEN. 1992. Breeding success and laying date of Nuthatches (*Sitta europaea*) in relation to habitat, weather and breeding density. Bird Study 39:23–30.

SWANBERG, P. 1981. [Clutch size in the Thick-billed Nutcracker (*Nucifraga c. caryocatactes*) in Scandinavia in relation to the supply of hazel nuts in the individual winter stores.] Var fagelvarld 40:399–408. (Swedish with English summary.)