



Breeding Biology and Nestling Development of Golden-Crowned Sparrows in Alaska

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Breeding biology and nestling development of Golden-crowned Sparrows in Alaska.—Although substantial literature is available on the breeding biology of crowned sparrows (*Zonotrichia*), particularly the White-crowned Sparrow (*Z. leucophrys*) (cf. Morton 1976), little is known of the breeding and developmental biology of the Golden-crowned Sparrow (*Z. atricapilla*) (Kelly 1968, Verner and Willson 1969, Harrison 1978, Harrison 1979). Here I report on several aspects of the breeding biology of the latter species.

Study site and methods.—The study was conducted during June and July 1986 within an 8-km radius of Cold Bay, Alaska (55°12'N, 162°43'W), at about 20-m elevation near the tip of the Alaska Peninsula. This portion of the peninsula is maritime tundra, with patches of alders (*Alnus crispa*) and willow (*Salix* spp.) on slopes and along stream courses. For a more detailed description see Bailey (1974). The Golden-crowned Sparrow is a locally common to abundant breeder in southcoastal, southwestern, and western Alaska (Kessel and Gibson 1978), breeding as far west as suitable shrubby habitat exists (i.e., to Unimak Island in the Aleutian Islands about 50 km W of Cold Bay). Thus, my observations were near the western limit of the species' breeding range.

I observed 3 nests, which were visited daily when possible. I timed parental activities with a stopwatch. I did not capture or mark adults, but determined sex on the basis of differences in color of head markings (Mailliard 1932). Only the duller marked birds (presumed females) incubated and brooded, and only the birds with brighter yellow crowns and blacker head stripes (presumed males) sang. Nestlings were weighed daily (usually during a 2–3 h period around midday) to the nearest 0.1 g using a Pesola 30-g spring balance; body measurements were recorded to the nearest mm with a ruler. Nestlings were banded with U.S. Fish and Wildlife Service aluminum bands. Nestling growth rates were calculated as described by Ricklefs (1967). Significance level of statistical comparisons was set at $P \leq 0.05$.

Nest building and egg laying.—All 3 nests were cups of fine grass stems set in depressions in the ground and overhung by surrounding vegetation. Due to the nature of the overhanging vegetation, each nest had a definite entrance orientation. Nest 1 faced ENE and was in a patch of 0.8-m tall salmonberry (*Rubus spectabilis*). Nest 2 faced NW and was in a patch of 1-m tall willow. Nest 3 faced SSW and was under a small clump of 0.25-m tall lupine (*Lupinus* sp.) about 1 m from a patch of alder. Only nest 1 was discovered prior to egg laying. The nest was a well-formed cup on 4 June, with the final lining of ptarmigan feathers added on 6 June. The first egg was laid on 7 June, followed by 1 egg laid daily until the clutch of 5 eggs was completed. During this time the male sang frequently from several perches up to 75 m from the nest, but once the clutch was completed, his singing nearly ceased for the remainder of the nesting cycle. The clutch of nest 2 had 4 eggs. The clutch size of nest 3 could not be determined because I did not find it until the 5 nestlings were well feathered.

Incubation period.—The incubation period could be determined only for nest 1. Incubation began the day the last egg was laid (11 June), and 4 of 5 eggs hatched by the morning of 23 June. The last egg hatched by the following morning. Incubation lasted 12–12.5 days. Three of 4 eggs from nest 2 hatched by the morning of 25 June, and the last egg hatched by the morning of the following day.

During 5 h of observation, made over the 5 days prior to hatching from a hidden position 30 m from the nest, female 1 incubated 72% of the time (43 of 60 checks made at 5-min intervals). She flushed from the nest only when I approached to within 3 m.

Nestling period and nestling development.—At nest 1, 2 nestlings left the nest on 1 July, and the remaining 3 departed after I weighed them on 2 July. Only 2 nestlings remained in

TABLE 1
MEASUREMENTS OF GOLDEN-CROWNED SPARROW NESTLINGS NEAR COLD BAY, ALASKA

Age (days)	Weight (g)	Tarsus (mm)	Manus (mm)	Primaries (mm)*	Rectrices (mm)
0	3.0 ± 0.3 (7) ^b	5.0 ± 0.0 (7)	6.9 ± 0.4 (7)	—	—
1	5.1 ± 0.8 (9)	7.0 ± 0.7 (9)	8.2 ± 0.9 (9)	—	—
2	8.2 ± 1.0 (9)	9.7 ± 1.1 (9)	10.4 ± 0.8 (9)	—	—
3	11.4 ± 1.1 (9)	11.9 ± 1.1 (9)	12.6 ± 1.1 (9)	2.5 ± 0.9 (4)	—
4	15.6 ± 1.3 (9)	15.4 ± 1.5 (9)	15.8 ± 1.2 (9)	4.8 ± 1.8 (9)	—
5	19.7 ± 1.4 (9)	17.8 ± 0.9 (9)	18.0 ± 0.9 (9)	9.2 ± 2.3 (9)	1.7 ± 0.5 (3)
6	22.8 ± 1.1 (9)	19.7 ± 0.8 (9)	19.7 ± 0.9 (9)	14.6 ± 2.2 (9)	4.0 ± 1.9 (9)
7	24.0 ± 1.2 (9)	21.9 ± 0.3 (9)	21.0 ± 0.7 (9)	18.8 ± 6.9 (9)	7.8 ± 1.7 (9)
8	24.4 ± 1.4 (7)	22.0 ± 0.0 (7)	22.0 ± 0.0 (7)	29.4 ± 3.4 (7)	11.3 ± 0.5 (7)
9	23.1 ± 1.8 (5)	22.0 ± 0.0 (5)	22.0 ± 0.0 (5)	33.0 ± 3.2 (5)	13.2 ± 1.6 (5)

* Longest primary.

^b $\bar{x} \pm$ SD (N).

nest 2 on 4 July, and none was there the next day. The nestling period was about 9.5–10.5 days, although this is probably artificially short because I handled the young daily. Nestlings from nest 3, which was found on 10 July, left the nest on 12 and 13 July.

Nestlings reached 99% of fledging weight, 90% of fledging tarsus and manus length, and 44% of fledging primary (remiges) growth by day 6 (Table 1). The observed pattern of growth is best described by the logistic equation (see Ricklefs 1967). Assuming an asymptotic weight of 26.0 g (based on the last 2 nestlings in nest 3, which weighed 27.0 and 25.1 g on the day prior to their leaving the nest), the specific growth rate constant (K), which measures growth rate relative to the asymptote, was 0.632, with an inflection point at 4.4 days. The asymptote is about 82% of average adult weight (adults from British Columbia and Alaska in May to July had a mean weight of 31.8 g [N = 21]). The instantaneous growth rate at the inflection point ($Ka/4$) was 4.1 g/day.

On the hatch date, Golden-crowned Sparrows were 0.3–0.6 g heavier than White-crowned Sparrows (King and Hubbard 1981). A comparison of hatching weights of these two species from Alaska shows that the difference is significant ($t = 2.152$, $df = 70$, $P < 0.05$).

The following description of nestling development is a composite based on all individuals from all 3 nests. On hatching day (day 0), sparse gray down was about 15 mm long in the capital, spinal (on back only), humeral, femoral, and alar tracts. Eyes were closed and the nestlings gaped silently. Mouth lining was uniformly red, surrounded by a yellow rim on the beak. On day 2, all but the crural and ventral tracts darkened under the skin. When begging, nestlings did not vocalize, but some "peeped" faintly when handled. On day 3, eyes were beginning to open, the tips of primary pin feathers were beginning to penetrate the skin of some chicks, and the crural and anterior portions of their ventral tracts (to the breast region) were darkening under the skin. On day 4, gaping began to be accompanied by faint "peeps," eyes were almost fully open, and all tracts had pin feathers emerging. On day 5, nestlings oriented and gaped towards the nest entrance. No fear reaction was evident when they were handled. Feather tips were beginning to split in ventral, humeral, crural, and spinal tracts. By day 7, unhandled nestlings crouched silently and did not gape; one attempted to hop away. Pin feathers in all tracts were splitting. On day 8, several nestlings jumped from nests after crouching and being handled. On day 9, some nestlings gave a

harsh distress call and struggled when handled. All could stand and perch without difficulty but were still flightless and remained so until after leaving the nest.

Parental activities during nestling period.—Female 1 brooded her nestlings at least until 30 June (2 days prior to nest departure). In 5 h of observation during the nestling period, the proportion of time spent by the female brooding ranged from 67% (8 of 12 5-min checks) on 23 June to 17% (2 of 12 5-min checks) on 27 and 30 June. She was not seen brooding thereafter. Female 2 was flushed from her nest on 25 and 26 June, but not after that date (N = 8 checks to fledging). Males were never flushed from nests, nor were they seen to brood.

Both sexes fed nestlings and removed fecal sacs. During 3 h of observation at nest 1 (over the 3 days prior to fledging), the male delivered food 5 times but removed no fecal sacs. Female 1 made 39 deliveries and removed 4 fecal sacs. During 2.75 h of observation at nest 3 (over the 2 days prior to fledging), the male made 12 food deliveries and removed 4 fecal sacs; the female made 9 food deliveries and removed 1 fecal sac. Recognizable foods delivered to nestlings included lepidopteran larvae, an adult butterfly (*Pieris napi*), adult crane flies (Diptera: Tipulidae), and adult stoneflies (Plecoptera).

Postfledging dispersal.—Two of the young from nest 1 were captured on 5 July, 2 and 3 days after leaving the nest. The two fledglings were 75 m and 80 m from the nest, respectively. They were 50 m apart and capable of short flights, and tried to escape by hiding. Both adults fed both nestlings.

Discussion.—My data indicate a close similarity between the incubation periods of Golden-crowned and White-crowned sparrows (King and Hubbard 1981). The age of fledging of Golden-crowned Sparrows is more like that of southern White-crowned Sparrows than that of the more northern populations. The greatest difference in fledging age is with the Alaska White-crowned Sparrow populations (see King and Hubbard 1981), in which nestlings fledge 8.0–9.0 days after they hatch. In part, this difference in fledging age is probably a function of the larger body size of Golden-crowned Sparrow nestlings (19–20 g at fledging for White-crowned Sparrows vs at least 23–24 g for Golden-crowned Sparrows). Development of nestling Golden-crowned Sparrows is also similar to that of White-crowned Sparrows (Morton et al. 1972, King and Hubbard 1981), although the growth rate constant (K) of Golden-crowned Sparrows is larger.

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Caching by Red-breasted Nuthatches.—The Red-breasted Nuthatch (*Sitta canadensis*) breeds in boreal forests and erupts southward in winters when its normal food of conifer seeds is in short supply (Larson and Bock 1986). Roberts (1979) remarked that caching is undocumented in such eruptive individuals far from their coniferous forest breeding areas. During the winter of 1985-86, we studied "copying" of food-finding (Krebs 1973) by free-ranging birds of a bark-foraging guild in Ohio. Although Red-breasted Nuthatches are usually absent from the deciduous woodlands of our study area, we encountered the species during a replicate of an experiment (described elsewhere) when three individuals provided us with evidence that caching occurs in birds wintering outside the breeding range.

We made available to color-marked birds of mixed-species foraging flocks a supply of mealworms (*Tenebrio* sp.) hidden in a hollow sapling. The mealworms could be extracted only through a small inconspicuous hole. Dominance relationships within and across species were determined from records of chases and supplanting attacks (Hinde 1952).

Mealworms were taken by three Red-breasted Nuthatches between 09:48 on 31 January and 08:36 on 1 February (Fig. 1). For comparative purposes, we also show the record of mealworms taken by the dominant pair of Carolina Chickadees (*Parus carolinensis*) in the same flock. Carolina Chickadees did not cache mealworms during any of our observations. We confined our analysis of caching to the period between 11:36 and 16:00 on 31 January, when all three nuthatches and both chickadees were removing mealworms. At 11:36, air temperature in the shade was -3.0°C , wind velocity 1 m above the ground was 0.7 m sec^{-1} , direct solar radiation was 8 mW cm^{-2} , and snow depth was 8 cm.

Although we were able to observe the nuthatches caching mealworms in neighboring trees periodically throughout the day, we concentrated most of our attention on the food source