

NESTING BIOLOGY OF THE ROSY FINCH ON THE ALEUTIAN ISLANDS, ALASKA

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ABSTRACT.—The nesting biology of the Aleutian Rosy Finch (*Leucosticte griseonucha (arctoa) griseonucha*) was studied on the maritime tundra of Amchitka Island in the Aleutian Islands, Alaska. Fifty active nests were found, all in buildings or other man-made structures. Nests were re-used with new material added each year. Their densities were not limited by the availability of buildings or good nest sites. The maximum density was 13.9 nests/100 ha. Unlike their alpine relatives, these birds were double-brooded, with eggs in the nest from late April to early June and again in late June through at least mid-July. Mean hatch date for the first brood was 26 May. Mean clutch size was 4.5 eggs (range = 3–6). Incubation lasted 12–14 days, the nestling period 15–22 days (\bar{x} = 18 days). Egg survival during incubation was 73.9%, hatching success 93.9%, and nestling survival 79.1%, for an overall nest success of 54.9%. These high values are attributed to the near absence of predators on the island and to protected nest sites.

Rosy finches (*Leucosticte* spp.) breed in two disjunct habitats: above timberline in the alpine zone of the major mountain ranges of Asia and western North America, and at sea level on maritime tundra on the islands of the Bering Sea. The breeding biology of populations in alpine habitat has been studied by several workers (Twining 1938a, b, 1940; French 1959; Johnson 1965), but less information is available concerning maritime populations (Hanna 1922, Shreeve 1980). Rosy finches in both habitats share many common life history traits including cliff nesting, unbalanced sex ratios, and floating territories centered on the female. On the other hand, they differ morphologically, the maritime birds having nearly twice the body weight of any alpine member of the genus and a bill that is distinctly more slender than all but one of them (Johnson 1972, 1977). The slender bill and lowland tundra and beach habitat suggest a differing feeding ecology, while the longer season associated with the low elevation and maritime climate implies major adjustments in breeding schedule and perhaps productivity.

In this paper, I describe the nesting biology of the Aleutian Rosy Finch (*L. g. griseonucha*, nomenclature follows Johnson 1977 [The American Ornithologists' Union Committee on Classification and Nomenclature (1982) now places all North American species of *Leucosticte* in *arctoa*.—Ed.]), and especially its breeding chronology and output, and compare these data with those for alpine populations at the same latitude. Also, I will present data on nest densities and nesting success for the Aleutian birds, information previously unavailable for any member of the genus.

STUDY AREA AND METHODS

All data were collected from 14 May to 16 July 1968 on Amchitka Island (51°30'N) in the Rat Island group of the Aleutian Islands, about 2,200 km WSW of Anchorage, Alaska. Amchitka is about 65 km long and 2–7 km wide, and is oriented SE-to-NW. The southeastern two-thirds of the island is mostly below 100 m elevation and is covered by wet maritime tundra containing many ephemeral ponds and underlain by peat. By contrast, the northwestern third is relatively barren and mountainous (maximum elevation 354 m) with alpine meadows, fell-fields, scree, and talus. The physiography and vegetation were described by Shacklette et al. (1969).

During the breeding season, Amchitka is cool, windy, and blanketed by fog. Between May and July the sky is cloudy or overcast over 90% of the time and rain falls about 35% of the time (Armstrong 1977). Temperatures during May, June, and July average 3.9°, 5.6°, and 7.8°C, respectively, with a mean daily range of about 3.5°C. Wind speeds during the summer average about 26 km/h.

Kenyon (1961) and White et al. (1977) have described the avifauna. Land mammals are absent except for the Norway rat (*Rattus norvegicus*), which probably became established during World War II (Murie 1959). Rats apparently caused the decline and near extinction of the Winter Wren (*Troglodytes troglodytes*) and Song Sparrow (*Melospiza melodia*) on the island, but seem to have had little effect on the rosy finch.

The study was centered on the southeastern end of the island, where about 2,000 aban-

TABLE 1. Timing and duration of major events in the breeding cycle of rosy finches and Lapland Longspurs on Amchitka Island, Alaska, and rosy finches in the Rocky Mountains of Montana.

	Amchitka Island		Rocky Mountains
	Rosy finch	Lapland Longspur ^a	Rosy finch ^b
Egg-laying	28 April–26 May	30 May–30 June	16 June–6 July
Incubation	3 May–8 June	4 June–10 July	21 June–19 July
Nestlings	16 May–20 June	16 June–20 July	4 July–6 August
Fledging	3–20 June	7–20 July	22 July–6 August
Egg-laying to fledging	54 days	68 days	53 days

^a From Williamson and Emison (1971) and White et al. (1977).

^b R. E. Johnson (unpubl. data). Based on seven nests from Glacier National Park and three from the Mission Range, Montana; all between 47°20'N and 49°N latitude.

doned buildings provided potential nest sites. From 14 May to 16 July 1968 I examined the beaches, sea cliffs, and tundra on this part of the island, as well as the buildings. In addition, I made short trips to the central highlands and the small lowland section at the northwestern tip of the island.

I examined more than 500 buildings for nests, recording the type of building (quonset or frame), presence of active nests, clutch size, stage of nesting, height of the nest above the floor, nest location (shelf, rafter, other), and presence of old nests. Two areas of similar habitat, but where the density of buildings differed, were canvassed thoroughly for nests to determine breeding density.

Nesting success was determined by both Mayfield's exposure method and the standard method (Mayfield 1961). For comparison with existing data on Lapland Longspurs (*Calcarius lapponicus*), nesting success was also calculated as the percent of nests found before hatching that fledged at least one young. I estimated clutch size before mortality by using the mortality rates of eggs and of young and the percent hatching determined by Mayfield's procedure, and then worked backward to calculate loss. Lost individuals were then added to the number actually found in nests, and a mean adjusted for loss was calculated.

I generally visited each active nest every other day. I define "incubation period" as the time from laying of the last egg to the hatching of the last egg. Young were considered to have fledged when the last individual left the nest, regardless of whether it left the nest building immediately or remained inside for one or more days. Mean hatching date was determined by direct observation, or by counting, either backward from fledging or forward from completion of laying using an incubation period of 13 days and a nestling period of 18 days, as established in this study.

RESULTS AND DISCUSSION

TIMING OF NESTING

When I arrived on 14 May, birds had already begun to lay, and by 8 June all eggs had hatched. Based on 38 nests containing what appeared to be first broods, I calculated a mean hatch date of 26 May, with a range of hatching from 16 May to 8 June. Assuming a 13-day incubation period and four to five days for egg-laying, I estimated that laying for all nests occurred between 28 April and 26 May (Table 1). Females were incubating from 3 May to 8 June and young fledged from these nests between 3 and 20 June.

Although I did not attempt to locate new nests after 21 June, evidence indicated that this species had a second brood in late June or early July. First, I found one nest in which eggs were being laid on 1 and 2 July in a building where an earlier nest had successfully fledged young on 10 June; and another in which eggs were being incubated on 5 July (incubation continued through my last observation on 15 July). Second, copulations again became frequent, beginning about 28 June. Finally, adult females collected throughout the summer showed a resurgence of gonadal activity. From 22 May to 25 June only one of eight females collected had an ovary >10 mm long or ova >1 mm in diameter, and that bird was one of three obtained on the last day of this period. However, between 29 June and 13 July, four of six had ovaries >14 mm and ova >6 mm, and two had eggs in utero. The long delay after the first wave of laying (about 30 days), the synchrony within the first wave, and the apparent synchrony in the second, support the interpretation that these were second nestings, not replacements of failed nests.

Stejneger (1885) found that rosy finches on the Commander Islands were double-brooded and Kenyon (1961) suggested that those on

Amchitka occasionally have three broods, but neither provided specific records. Second nests are probably possible because the climate of the Bering Sea region is both predictable and uniform. Furthermore, the entire Aleutian chain, including Amchitka, is 5–10° south of Anchorage, Alaska, and hence the summer is not nearly as short as that on the Alaskan mainland or arctic tundra.

Lapland Longspurs, the most common breeding birds on the island, occurred in the same habitat as the finches, but were single-brooded (Williamson and Emison 1971). Rosy finches were able to breed twice by starting to breed a full month earlier than the longspurs and by completing the nesting cycle more rapidly (Table 1). The latter was possible even though the nestling period of the rosy finch was longer than that for the longspur (18 vs. 11 days), because the population of finches bred with greater synchrony (Table 1).

Rosy finches on the mainland in the alpine zone have not been reported to be double-brooded, but they do have the same tight synchrony as those on Amchitka (Table 1). Presumably, this synchrony first evolved in alpine areas as an adaptation to the short summer season, and has subsequently provided a pre-adaptation to multiple-brooding in locations such as Amchitka where the season is longer. The snow-free period in the lowland on Amchitka (1 May–31 October; Armstrong 1977) is about twice as long as it is in alpine areas of the mainland at the same latitude (15 June–31 August; R. E. Johnson, unpubl. data).

NEST LOCATION

I found 50 active nests associated with man-made structures, but none in the natural habitats (e.g., tundra, cliffs) where I spent most of my time. One nest was in a rock wall, another in an oil drum partially buried in the tundra, two were on the exterior of buildings, and the remainder inside buildings. Only one pair of birds usually occupied a building, although two pairs nested successfully at opposite ends of one extremely large sprawling structure. No other species of bird nested in buildings.

I surveyed 279 buildings on the eastern end of the island before the earliest known date of fledging. Twenty-nine had active nests and another 42 contained old used nests. Thus, at least 25% had served as nest sites at some time. Although 79% of these buildings were quonset huts, less than half of the active nests were in them (Table 2). In other words, finches showed a significant preference ($\chi^2 = 22.47$, $P < 0.001$, 1 df) for frame structures. Several factors probably account for this: most frame buildings

TABLE 2. Distribution and height of nests of rosy finches in 279 abandoned buildings on Amchitka Island, Alaska.

Type of building	Number of buildings	Number of active nests	Buildings with good nest sites ^a	Height of active nests ^b ($\bar{x} \pm SE$)
Quonset	220	13	99	1.94 \pm 0.13
Frame	59	16	41	2.47 \pm 0.25

^a Buildings with at least one potential nest site that was indistinguishable from other locations used successfully.

^b There is no significant difference ($P > 0.05$) between these nest heights; but see text.

were not paneled and their exposed rafters and wall supports offered a wide array of nest sites. In contrast, quonset huts had smooth, rounded interiors that provided few nest sites; 55% of them lacked shelves or irregularities where a nest might be placed. Also, potential nest sites were generally higher above the floor in frame buildings. Although the difference in mean heights of nests in the two types of buildings is not significant for this pre-fledging survey (Table 2), it is significant if the sample size is increased by including nests found later (frame = 2.94 m above floor, quonset = 1.73 m; $P < 0.001$, $n = 46$).

Nests were on rafters (15) and wooden shelves (26), behind broken panels (3), behind the top rung of a ladder nailed to a wall (1), and in a compartment in a tool cabinet (1). Metal shelves were avoided.

Nests appeared to be used for many years, becoming large as new material was added each year. Old nests were usually multilayered, with old eggs and dead young sometimes covered-over rather than removed. Other nests had expanded sideways, containing as many as three nest cups in a line within one mass of nest material. Some covered entire shelves, the largest being about 35 \times 100 cm in lateral dimensions and 15 cm deep.

I frequently visited cliff areas above beaches where the finches often fed, but found no nests there. Cliffs of this sort apparently harbored most nests before construction of buildings during World War II (Dall 1873), and were still commonly used in the 1950s (Krog 1953, Kenyon 1961). Some birds probably continue to nest on cliffs on other parts of the island, where I found birds but no buildings.

Cahn (1947) suggested that rosy finches nested in the tundra on Amaknak Island, but I found no evidence of this on Amchitka.

NEST DENSITIES

I thoroughly censused two areas before the earliest known date of fledging in order to deter-

TABLE 3. Comparison of nest and nest-site densities of rosy finches in two study areas on Amchitka Island, Alaska.

	Study area	
	A	B
Number of active nests	11	19
Size of area (ha)	79	382
Active nests/100 ha	13.9	5.0
Number of buildings/100 ha	162	24
Buildings with good nest sites ^a /100 ha	110	13
Percent of buildings with good nest sites ^a	67.9	54.2
Old nests ^b /100 ha	19.0	7.1

^a Sites indistinguishable from other locations used successfully.
^b Buildings with nests from previous years, but without active nests during the period of this study.

mine nest densities (Table 3). Area A, which had the higher density (13.9 nests/100 ha), also had more buildings, suggesting that the availability of acceptable nest sites might be limiting. This idea was reinforced by my observations that few birds were present in areas that lacked buildings. Two lines of evidence, however, indicate that something other than the number of nest sites controlled population size. First, if nest sites were limiting, one would expect nest densities to be proportional to building densities, which was not the case. Area A had more than 6.5 times the density of buildings of area B, but only 2.8 times the density of nests. Because buildings vary in suitability, one might argue that fewer buildings in area A were suitable. However, area A had 8.5 times as many buildings with good sites as area B (Table 3).

Second, many old nests were in buildings and sites not then in use in either area (Table 3). If nest sites were limiting, nearly all suitable sites should have been occupied. In these two areas combined, more than 58% of all buildings that had been used earlier were not in use during 1968. Moreover, 78% of those that I judged to be suitable were not used in that year. Taken together, these facts indicate that the availability of nest sites did not determine population levels, at least within areas A and B.

CLUTCH SIZE

Clutch size was estimated from 46 active nests believed to contain first broods, either eggs that were being incubated or young chicks. These included one nest with three, 26 with four, 18 with five, and one with six eggs or young, yielding a mean clutch size of 4.41 eggs. This value is probably low, because loss was possible at most nests before I first examined them. The nest that contained three young is

particularly suspect because I observed it only once, midway through the nestling period. Using Mayfield's (1961) procedure, I calculate that six individuals were probably lost from this group of nests. When these are included in the calculation of clutch size, the mean becomes 4.54 eggs.

Earlier records of clutch size on the Aleutian Islands are all from well east of Amchitka (11 nests on Adak [Shreeve 1980], one on Amaknak [Cahn 1947], one on Unalaska [Dall 1873]), and they yield a mean of 4.08 eggs. This value is significantly lower than the Amchitka mean ($P < 0.05$) and may be due to geographic variation along the Aleutian chain or between-year variation, but more likely is due to inclusion of incomplete clutches. For example, the series of nests from Adak all contained young and had an unusually high proportion of clutches of three chicks (3 of 11), especially for this latitude (Johnson 1965). These facts suggest that some mortality preceded observations. The Adak sample may also have contained second broods since three late nests (3–21 July) were included, which on average had fewer (3.33 vs. 4.25) young than the eight nests observed there in May and early June.

Clutch size on Amchitka was slightly, but not significantly ($P > 0.05$) higher than that for a sample of 10 nests of *L. t. tephrocotis* ($\bar{x} = 4.20$ eggs) from the alpine zone in the Rocky Mountains at a similar latitude (47–52° N). Thus, altitudinal differences seem not to influence clutch size.

INCUBATION PERIOD

The incubation period was 12–14 days for one egg in a nest that was abandoned by the female during hatching and 12–13 days in another where only three of four eggs hatched. These figures are similar to those published for other taxa of rosy finch on the mainland well to the south (*L. tephrocotis dawsoni*: 14–16 days [Wheelock 1920, Twining 1938a]; *L. atrata*: 12–14 days [French 1959]; *L. australis*: 13–14 days [Bailey and Niedrach 1965]). Hence, they do not support my earlier suggestion (Johnson 1965) that the rate of development diminishes with increasing clutch size to the north in this genus. It is also evident that maritime and alpine populations do not differ in their development.

NESTLING PERIOD

For 10 nests followed from completion of hatching to fledging, the nestling period ranged from 15 to 22 days and averaged 18 days. Nestlings that were 15 days of age or older became restless when approached and sometimes flew or jumped from the nest to the floor. They

often remained on the floor or were just outside the building for one or two days thereafter. This suggests that the mean nestling period for *undisturbed* nests is at least two days longer.

The few data available for other members of the genus appear in general agreement: 14 days for *L. g. littoralis* (Shaw 1936); 18–20 days for *L. atrata* (French 1959); 14–15 days for *L. australis* (Bailey and Niedrach 1965); and 14–21 days for *L. t. dawsoni* (Wheelock 1920, Dixon 1936, Twining 1938a). (All fledgings at the sixteenth day or earlier, except that for *littoralis*, occurred in response to the approach of an observer.) Thus, rosy finches at all elevations have nestling periods of similar duration.

NESTING SUCCESS

I determined nesting success from 35 nests containing first broods that were visited two or more times and did not appear disturbed by human activity. I found few nests during laying or early incubation; consequently nest-days of observation prior to hatching (86) were fewer than those during the nestling period (410), and my calculations of success are accordingly more reliable for the latter period. From these data I calculated the following probabilities: egg survival to hatching, 73.9%; hatching success, 97.9%; and nestling survival from hatching to fledging, 79.1%. The product of these values yielded a nesting success (i.e., the probability that eggs will survive from laying to fledging) of 57.2%. This value, calculated by the Mayfield (1961) procedure, is lower than that determined by the standard method (64.1%) and provides a better estimate when few nests are found before the start of incubation.

The only mortality that I saw during incubation occurred in two nests that were abandoned. No individual eggs disappeared from any nests and only one of 47 eggs that I watched closely failed to hatch. However, this sample may have underestimated hatching failure because eight nests containing chicks, as well as several nests from previous years, contained single unhatched eggs. When the eight eggs from active nests were incorporated into the calculations, which required inclusion of all 23 nests not observed before hatching, hatching success dropped to 93.9%. This figure exaggerates failure if any of the unhatched eggs were eggs remaining from a previous nesting or if individual nestlings were lost prior to my first nest observation, and exaggerates success if unhatched eggs were removed by the parents. These factors probably cancel one another. If this lower (93.9%) estimate of hatching success is used, nesting success becomes 54.9%.

Two nests with nestlings were abandoned. Also, one chick was lost from each of 11 otherwise successful nests, and two from another, in 1,662 nestling-days of observations. Four of these nestlings were found dead beneath their nests, one was on the nest shelf, two were in their nests, and the remainder simply disappeared. Those that were dead in nests probably starved, and many of the others may have also. Because rosy finches re-use old nests, nest parasites may also be a mortality factor (Ricklefs 1969).

Both nests that were abandoned during the nestling period were located on the outer side of buildings, and subject to wetting by wind-blown rain. These nests represent 50% of all nests found outside buildings, and their failure provides evidence of strong selection for their placement within buildings offering total protection from rain and wind.

I found no evidence of predation on nestlings or eggs. None of the nests showed signs of disturbance, and dead chicks were not visibly injured. The only ground predator on the island is the Norway rat, which is largely restricted to beach areas and riparian meadows (Williamson and Emison 1971). The presence of several old eggs and dead birds on the floors of the buildings suggests that rats did not frequent them during my study. Avian predators (e.g., Parasitic Jaegers, *Stercorarius parasiticus*) were uncommon, and probably had little direct effect on nests because these were indoors. Williamson and Emison (1971) also found that predation was low for nests of Lapland Longspurs on the island.

The nesting success of these rosy finches was high compared to values for most avian species and higher than that for the Lapland Longspur, the only other passerine on Amchitka for which data are available. Success for the longspur, calculated as percent of *nests fledging at least one young*, was 57% (Williamson and Emison 1971), compared to 73% for the finch. The high success of finches is probably because they have few predators and use protected nest sites. Lack (1954), Ricklefs (1969), and others have shown that hole-nesters and species that nest in buildings have higher success rates, and the values they cited are comparable to those in this study.

I know of no published figures for nesting success of rosy finches in alpine habitat, but I can make a tentative estimate from the fragmentary information presently available. Four of 24 nests of *L. t. dawsoni* found by Twining (1938a, 1940) were lost to predators, and the rest apparently fledged young, for a success rate (nests fledging at least one young) of 83%. All five nests of *L. t. tephrocotis* that I monitored (Johnson 1965) were successful (=100%). These

figures are probably biased upward because all of my nests and 11 of those reported by Twinning were found after hatching; thus, the observed losses were probably fewer than for nests watched for the entire nest period (see Mayfield 1961). These data nevertheless suggest that the nesting success of alpine populations of rosy finches is also high.

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