

VOCALIZATIONS OF CASSIN'S FINCH IN NORTHERN UTAH

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Cassin's Finches (*Carpodacus cassinii*) breed in high mountain forests from British Columbia, Alberta, and Manitoba to northern Arizona (American Ornithologists' Union 1957). Their vocalizations have not been described except for brief observations of Ridgway (1877), Bailey (1928), and others. This paper describes songs of yearling and older male Cassin's Finches near a breeding colony, song variation in four neighboring but distinct summer populations, and a pair-specific call.

STUDY AREA AND METHODS

Figure 1 depicts the relative locations of the four study areas approximately 45 km NE of Logan, Utah. Beaver Mountain, site 143, and Sunrise (elevation 2,250 m) have a mixed forest of Lodgepole Pine (*Pinus contorta*), Quaking Aspen (*Populus tremuloides*), Douglas Fir (*Pseudotsuga menziesii*) and Subalpine Fir (*Abies lasiocarpa*) interspersed with open meadows. The forest near Tony Grove Lake (elevation 2,700 m) included more Engelmann Spruce (*Picea engelmannii*) and Subalpine Fir and was not accessible until mid-June each summer. I banded 71 finches in 1971, 451 in 1972, and 112 in 1973. I found no interchange of these birds among the study areas, indicating distinct populations. I marked 290 finches (241 males) with unique combinations of colored celluloid leg bands.

I recorded vocalizations of Cassin's Finches during a study of their social organization conducted in northern Utah from June 1971 to June 1974 (Samson 1974). I used a Nagra III B tape recorder and a 62 cm fiberglass parabolic reflector with a centrally mounted Altec 633 A microphone and, whenever possible, recorded color-marked finches. Vocalizations were analyzed by a Kay Electric Sound Spectrograph using the wide-band filter and FL-1 setting. A catalog of tracings produced from 714 audiospectrograms was used to distinguish song figure types, and each type was assigned a number. In this report a song formula is the numerical sequence representing the order of song figure types in a song. When a song formula was stereotyped, it was defined as a theme. A computer program developed matrices of preceding and following song figure types in songs of each finch to examine for song formulae or themes.

Songs of Cassin's Finches were recorded near a breeding colony at Beaver Mountain in the spring of 1972 (Table 1) and at the four study areas (Fig. 1) in May and June 1973. The role of song in territorial defense was examined by playback experiments from mid-April to late June 1972 at Beaver Mountain. Each week I played 8 to 10 songs of an unmarked older (than first-year) male recorded 28 March 1972 at Beaver Mountain to at least five different older males perched within or near a breeding colony and noted their response. In June 1973 at Beaver Mountain I tested the specificity of calls of four pairs by playback experiments. Each pair had an older male and at least one member was color-marked. I re-

corded calls of a mated pair when the male returned to a perch near the nest after foraging. After the female was fed and the male again left to forage, I played the calls to all four pairs. Movement by a pair member in response to a mate's call and not to calls of other pairs indicated that the call was pair-specific.

Older male Cassin's Finches have a reddish-pink plumage acquired at 14-16 months of age, and yearling males a streaked gray-brown plumage similar to all females. General features of Cassin's Finch summer ecology and of winter flocks are described elsewhere (Samson 1976a, 1977).

RESULTS

Flocks of 7 to 20 Cassin's Finches returned to Beaver Mountain, site 143, and Sunrise in late February 1972 and early May 1973. I collected 39 older males, 25 yearling males, and 3 females from these flocks. The singing birds always were males; whether yearling or older, males sang on arrival each spring but did not establish a territory nor use the same perch from day to day. A paired male ceased to sing when nest construction began in mid-May to mid-June but continued to defend his mate wherever her location. I did not observe song used in this defense nor did an older male respond by song or movement to any of the nine playback experiments I conducted.

SONG NEAR A COLONY

Yearling males. In late February and early March 1972 subsongs of yearling males were loud, lacked song figure types consistent in form, and varied in frequency, rhythm (Fig. 2), and length (Table 1). Songs of yearling males in late March developed into a series of recognizable song figure types that varied in shape, as did those of older males (Fig. 3). Of the 97 song figure types cataloged (Figs. 4 and 5), 11 were noted only in songs of yearling males. Nine of the 11 song figure types (nos. 41 to 44, 59, 68, 71, 72 and 76) appeared in March, 1 (no. 81) in April, and 1 (no. 93) in May.

A characteristic theme in songs of a yearling male was evident in April (Table 2). Only the introductory triplet, 53-53-4, was consistently shared although the order of the initial five or six figure types was similar among all yearling males. They often deleted or repeated one or two figure types in a series of songs but never inverted their order. A yearling male sang

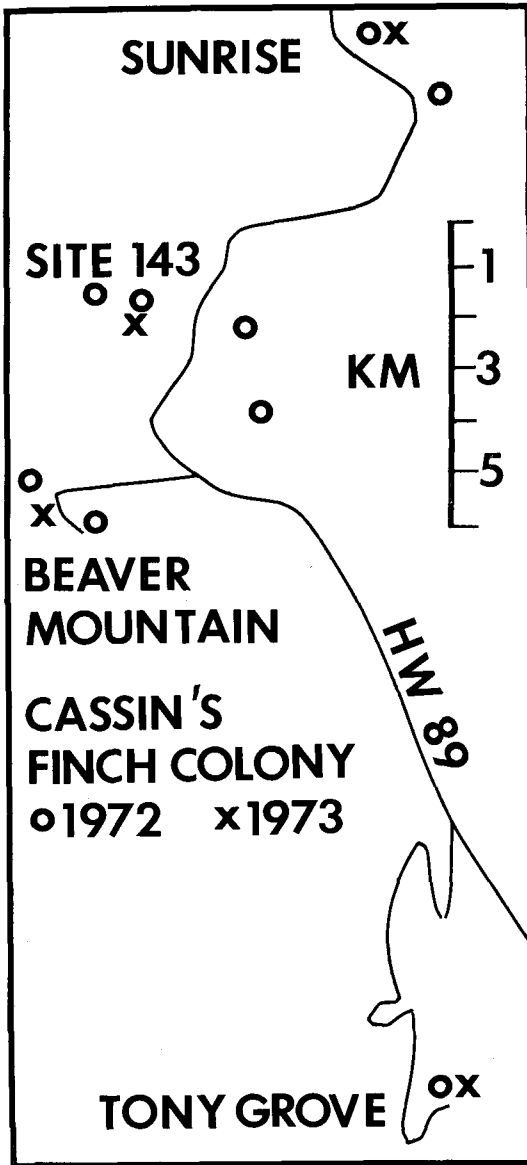


FIGURE 1. Relative locations of the four study areas in northern Utah.

2 to 13 ($\bar{x} = 6.1$) songs from a perch before moving. Songs from one perch were consistent in length. Yet on another perch or day, songs often were shorter or longer, accounting for the variability in length (Table 1). Songs ended in many figure types, and I could not detect any pattern in song termination. An individual yearling male sang 7 to 32 ($\bar{x} = 21$) figure types.

Although 172 yearling males were banded in 1972 and 28 in 1973, only three of 57 nests noted in 1972 and 1973 involved a pair with a yearling male. The non-breeding yearling males formed flocks and continued to sing to 9 June 1972 and 9 August 1973.

TABLE 1. Number and length of songs recorded and analyzed of yearling and older male Cassin's Finches at Beaver Mountain, Utah, in 1972.

	No. recorded ^a	No. analyzed	Length ^b (s)
<i>March</i>			
1 yr	32(5)	18(5)	15.4 ± 9.2 60.0
>1 yr	26(3)	12(3)	11.2 ± 6.7 59.9
<i>April</i>			
1 yr	27(8)	18(8)	11.9 ± 3.4 30.3
>1 yr	22(2)	9(2)	13.3 ± 5.9 44.3
<i>May</i>			
1 yr	72(19)	55(19)	19.2 ± 9.7 50.4
>1 yr	36(4)	31(4)	25.4 ± 13.1 51.7
<i>June</i>			
1 yr	37(7)	35(7)	10.4 ± 3.1 29.2
>1 yr	30(2)	10(2)	4.2 ± 1.5 35.1

^a Number of individuals in parentheses.

^b Mean ± one standard deviation with coefficient of variation below.

Older males. In early March 1972, an older male sang a theme regularly sharing the introductory triplet, 53-53-4, and often the following two or three figure types with other males (Table 2). They regularly merged songs, as on 15 May when a male sang continuously for 3 min 59 s repeating 15 similarly structured songs. Figure types were regularly omitted or repeated in a series of songs, but their order was uniform (Table 2). Song length was consistent in a series when given from a perch; but on different perches or days, song length often changed (Table 1). Individual older males sang 1 to 15 songs ($\bar{x} = 7.3$) from a perch before moving and included 13 to 53 ($\bar{x} = 27$) figure types. Songs ended in many figure types, and no pattern was evident in song termination. Each summer all older males were paired but they ceased singing by 1 June 1972 and 16 June 1973.

Song flights. These "moth" flights (terminology of Hinde 1955-56) of older and yearling males were direct, horizontal, and usually about 30 m long. I noted the date and location of 167 song flights observed in 1972 and 84 in 1973 at Beaver Mountain. In 1972 more flights were prior to nesting (older males 78:8, $P < 0.01$; yearling males 55:26, $P < 0.01$). They also tended to be adjacent to the colony rather than within it (older males 51:35; yearling males 42:39). The flights in

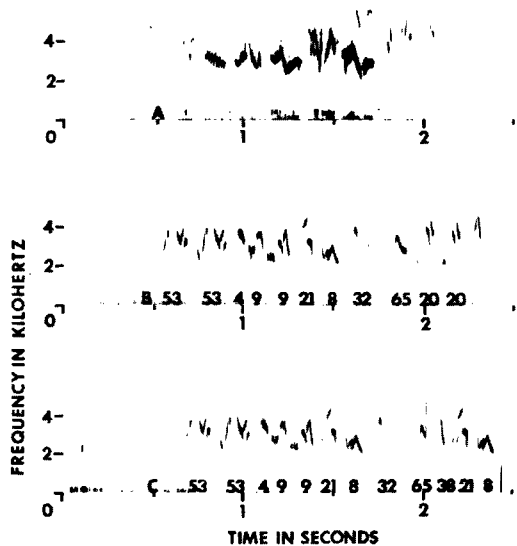


FIGURE 2. Audiospectrograms depicting song in Cassin's Finches at Beaver Mountain in 1972. A is a subsong of a yearling male recorded 8 March, B is a song of a yearling male recorded 28 April, and C is a song of an older male recorded 28 March.

1973 also were prior to colony establishment (older males 20:13; yearling males 31:20), but most were within the colony (older males 22:11; yearling males 28:23). Older males performed song flights from 21 March to 20 May 1972 and 8 May until 1 June 1973, and yearling males from 28 March to 9 June 1972 and 11 May to 11 August 1973.

The theme of an older or a yearling male during a song flight appeared similar to that in other songs. However, no introductory fig-

TABLE 2. Sequences of song figure types in songs of representative color-marked Cassin's Finch males at Beaver Mountain, Utah, in 1972.

Male	Song figure type sequence
GR ^a	53 53 4 9 5 8 12 21 26 92 92 13 13 16 46 96 22 35 36 35 36 53 53 4 9 5 8 12 21 26 92 13 13 16 46 96 22 35 36 35 35
BB ^a	53 53 4 9 5 6 7 8 22 61 75 75 13 13 16 39 53 53 4 65 5 6 7 8 22 61 75 13 13 16 39
BO ^b	53 53 4 9 6 7 75 45 11 39 75 45 14 12 22 26 29 8 8 8 53 53 4 5 6 7 75 45 11 39 75 45 14 12 22 26 29 8
BW ^b	53 53 4 9 6 7 9 8 8 17 14 39 39 71 16 91 92 56 61 82 82 89 89 76 27 25 82 83 53 53 4 5 9 6 8 8 17 39 39 71 16 91 56 61 82 82 89 89 76 27 25 25 82

^a Yearling male.
^b Older male.

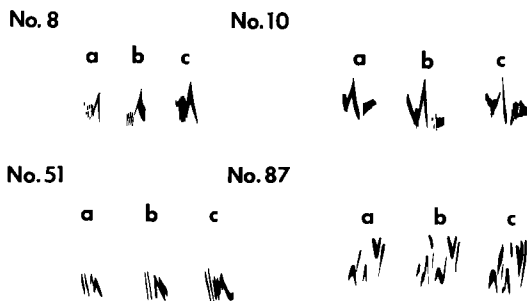


FIGURE 3. Variation in four representative song figure types. Figure No. 8: a. Older male June 1972; b. Yearling male June 1972; c. Older male June 1972 (all from Beaver Mountain). Figure No. 10: a. Older male May 1972 (Beaver Mountain); b. Yearling male June 1972 (Beaver Mountain); c. Older male June 1973 (Sunrise). Figure No. 51: a. Older male May 1972; b. Older male May 1972; c. Yearling male June 1972 (all from Beaver Mountain). Figure No. 87: a. Older male June 1973 (Sunrise); b. Older male June 1973 (site 143); c. Older male June 1973 (Tony Grove).

ure types were recorded because of the unpredictable onset of song.

Copulation. In May 1972 at Beaver Mountain, I recorded 11 songs during copulation of three pairs, all involving older males. Both sexes sang during copulation. The mean of 6.6 (SD = 0.3) figure types per second varied significantly ($P < 0.01$) from all other songs ($\bar{x} = 4.7$, SD = 0.6). The introductory triplet, 53-53-4, was shared by the males, songs were continuous prior to and during copulation, and

TABLE 3. Sequences of song figure types in songs of two representative Cassin's Finch males older than one year at the four study areas in northern Utah in 1973.

Site	Song figure type sequence
Beaver Mountain	53 53 4 9 9 21 8 32 65 38 31 88 53 53 4 9 63 19 19 11 45 75 11 11 39 19 19 11 45 11 39 11 63 19 19 11
Site 143	53 53 51 3 82 10 46 46 46 58 27 16 42 27 75 25 19 17 23 33 39 56 61 82 82 89 89 76 53 53 51 3 16 2 25 43 16 19 37 43 19 19 15 7 8 8 61 81 81 19 19 15
Sunrise	53 59 2 47 55 22 2 10 9 9 9 82 16 45 27 8 82 82 27 83 82 16 45 45 45 53 59 2 47 17 39 39 16 91 92 61 61 83 89 89 76 27 25 82 91 92 61 27 25
Tony Grove	35 53 71 97 45 45 60 11 19 19 77 13 8 8 14 39 29 16 27 8 10 10 35 53 71 97 43 43 89 11 19 19 83 16 42 27 10 80

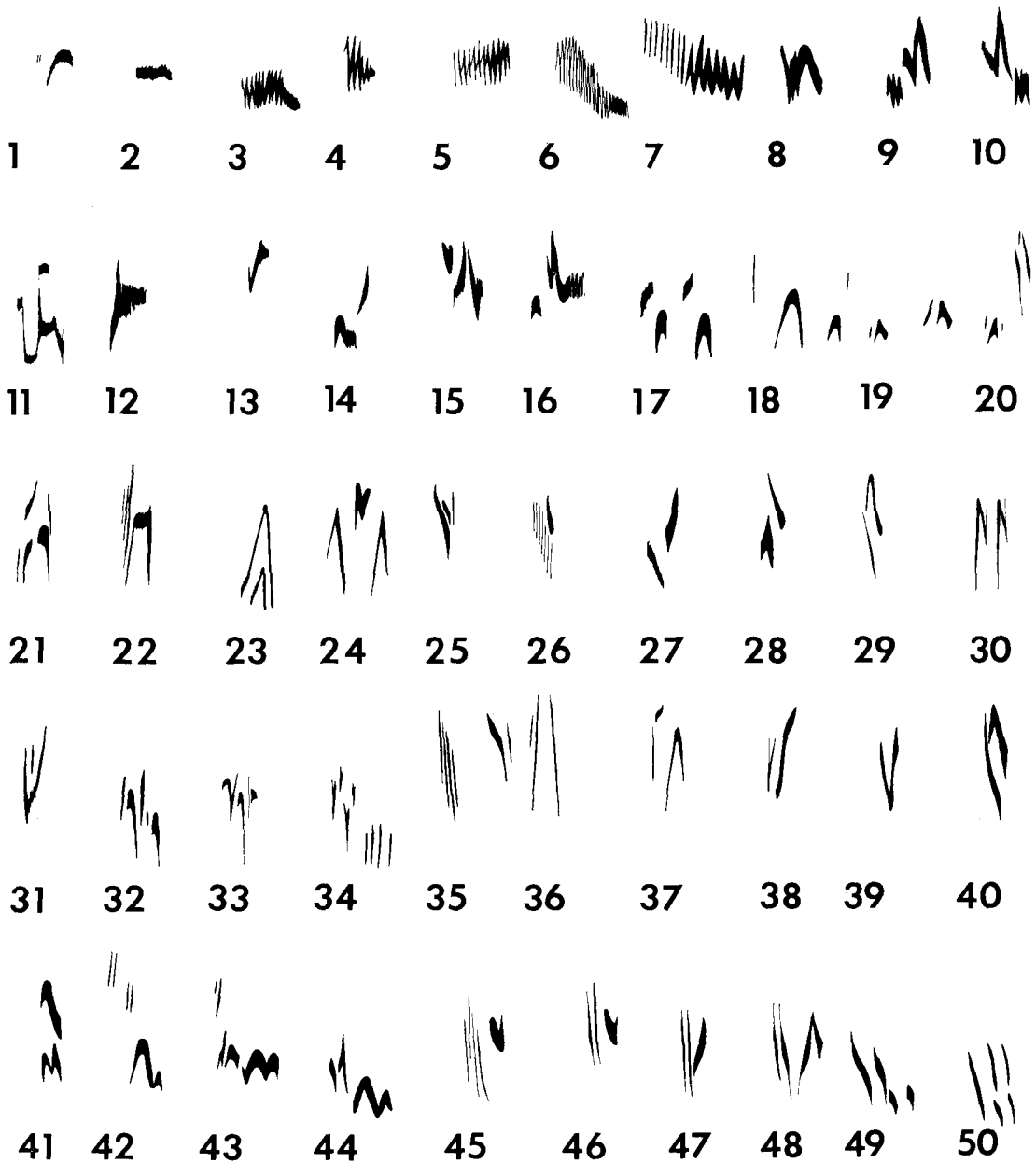


FIGURE 4. Catalog of song figure types of Cassin's Finch (figs. 1-50).

themes were similar to other songs of an individual male.

VARIATION AMONG POPULATIONS

In late May and early June 1973, I recorded and analyzed a total of 14 songs of one yearling and five older males at Sunrise, 19 songs of two yearling and five older males at site 143, 24 songs of four yearling and five older males at Beaver Mountain, and 11 songs of five older males at Tony Grove. Characteristics of songs of males (i.e., deletion or repetition of figure types, songs ending in many figure types, etc.) were similar to those in 1972.

However, at each site a male sang a characteristic theme sharing only the initial sequence of three or four figure types that appeared unique to a locale (Table 3).

The initial four figure types, 53-53-4-9 at Beaver Mountain were identical in 1972 and 1973 (Tables 2 and 3) even though only 6 of 451 birds banded in 1972 returned in 1973. Figure type 53 was second in order at Tony Grove (Fig. 6A) and began the initial sequence at site 143 (Fig. 6B) and Sunrise (Fig. 6C). Birds of the four sites did not share any other figure types in their initial triplet. No new figure types were recorded in 1973 al-

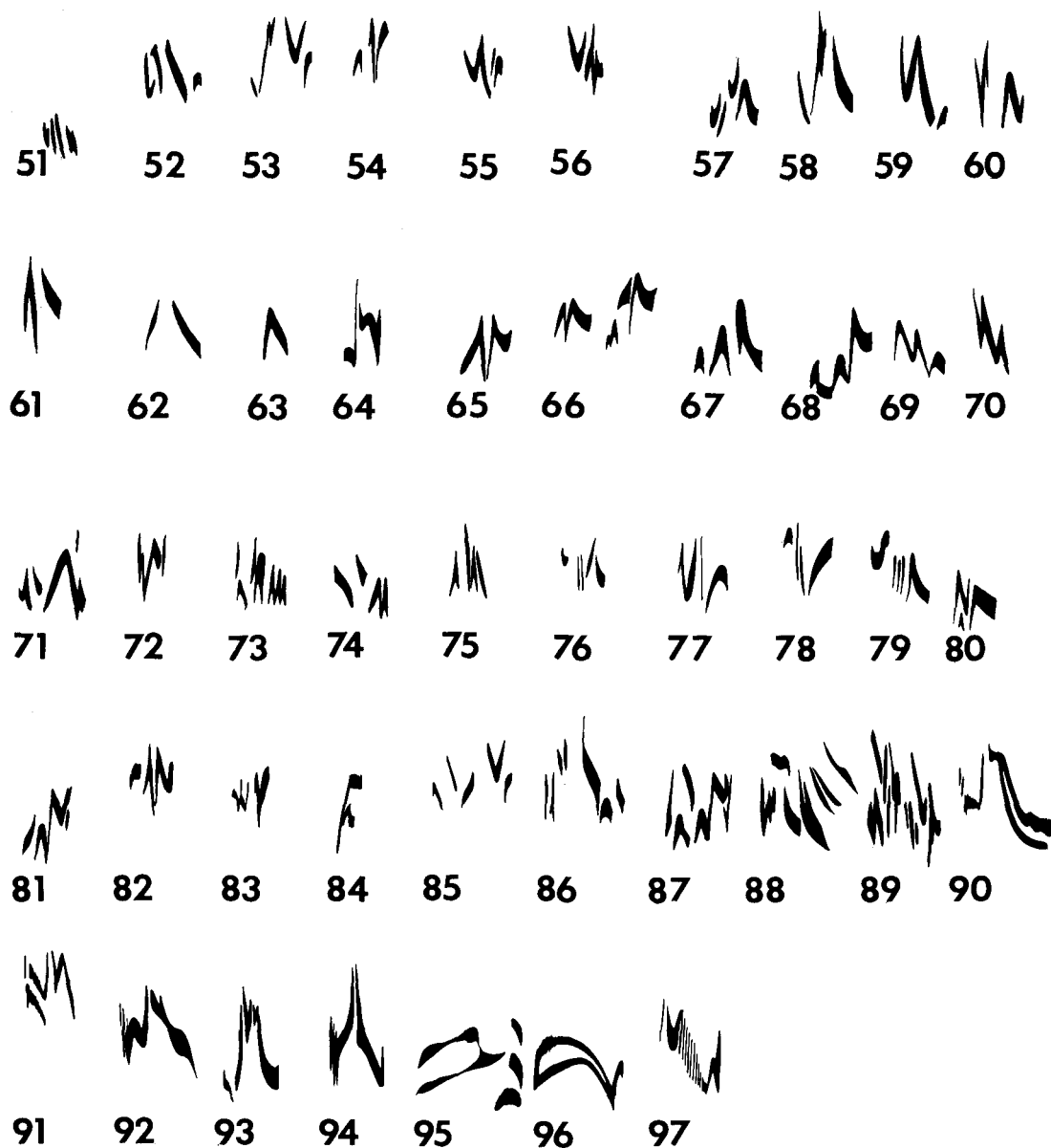


FIGURE 5. Catalog of song figure types of Cassin's Finch (figs. 51-97).

though the buzz (no. 7, Fig. 4; Fig. 6C) at Sunrise was distinctive to my ear.

CALLS

Feeding calls. Cassin's Finch males fed their mates on or near the nest during incubation and until nestlings were approximately four days old. During this period a paired male gave a loud distinct call as he returned after foraging to a perch near the tree with the nest. The female responded with a call or remained silent. She either left the nest, alighting on a nearby branch ready to receive food from her mate, or was fed at the nest. Feeding calls

recorded at four different nests at Beaver Mountain in 1973 are shown in Fig. 7.

Results of the four playback experiments were similar. After playback of the calls, the female immediately left the nest, alighting on a nearby branch where she had just been fed. The paired male, foraging at some distance from the nest, promptly returned to the same branch. In each experiment, nesting pairs responded only to their own calls ($P = 0.00145$ Fisher Exact Test). I interpret this to indicate that the calls were pair-specific.

Other calls. I recorded calls during four of six observed copulations in 1972 and during

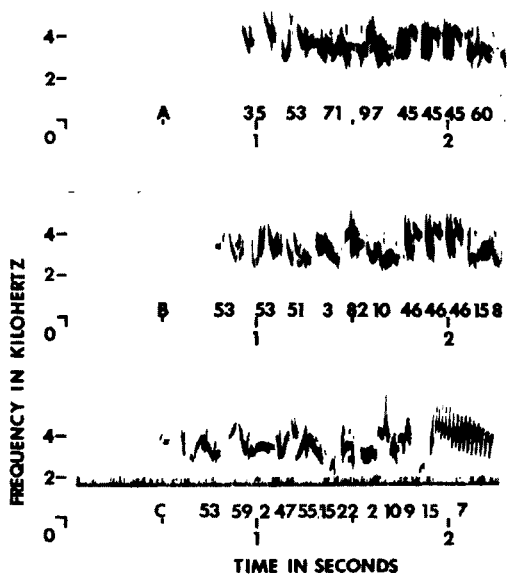


FIGURE 6. Audiospectrograms depicting representative songs at three study areas in June 1973. A is from Tony Grove, B from site 143, and C from Sunrise.

one of two observed in 1973. Members of a pair that did not sing gave nearly identical calls during copulation, but no two pairs had similar call notes. The call of an older male during a copulation is presented in Fig. 8A. A call recorded during courtship feeding of a pair with an older male is shown in Fig. 8B. Pairs could easily be located when this call was given. Calls during courtship feeding, copulation, and feeding were similar in form, in contrast to those of a perched male (Fig. 8C).

DISCUSSION

Cassin's Finches nest in colonies, carefully phasing breeding, molt, and fall departure from late May to early October (Samson 1976a, 1976b). Several aspects of their vocalizations may relate to their high altitude environment and nomadic lifestyle.

The long variable song of male Cassin's Finches prior to nesting may enhance hormone production. In another cardueline, Krood-sma (1976) found that captive female Belgian Canaries (*Serinus canaria*) responded to increased quality of song (i.e., larger repertoires of syllable types) by building nests faster and laying more eggs. Song in the Cassin's Finch, as in several other carduelines—the House Finch (*Carduelis mexicanus*; Thompson 1960), the Greenfinch (*C. chloris*; Thorpe 1958), and

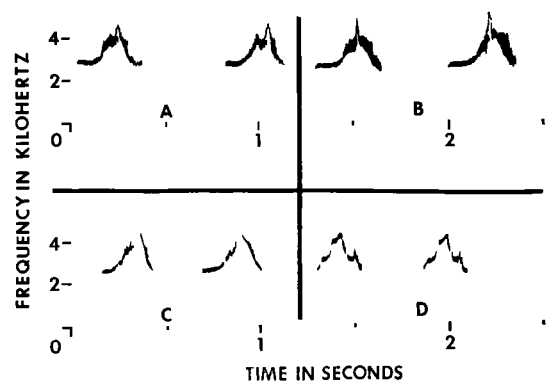


FIGURE 7. Audiospectrograms depicting pair-specific calls of four nesting pairs of Cassin's Finch at Beaver Mountain in June 1973.

the Linnet (*Acanthis cannabina*; Baptista 1972)—is non-territorial in function. Paired Cassin's Finch males reduced singing during nesting; the energy thus saved could be invested in other reproductive activities.

Yearling males continued to sing each summer, presumably to attract widowed females. The number of females limits breeding effort in these Cassin's Finch populations (Samson 1976a).

The system of introductory song figure types that identified a population could also aid breeding in the montane environment. If, as in the House Finch, flocks are intact from summer to summer (Mundinger 1975) a vocal system could be maintained within Cassin's Finch flocks even though they do not return to the same site to breed each year. Orejuela and Morton (1975) pointed out the importance of a dialect to another montane breeder, the Mountain White-crowned Sparrow (*Zonotrichia leucophrys oriantha*). In Cassin's Finch, a system similar to a dialect may aid in behaviorally isolating breeding populations to increase ecological flexibility (Marler 1970) in an environment subject to frequent and often dramatic changes.

A system of calls allowing recognition of mates in a nomadic species that breeds under temporal constraints also may be advantageous. A pair maintaining a bond from year to year may gain from experience and increase its reproductive success. If the pair bond is formed in winter, more time on the breeding area can be spent on other aspects of reproduction. Cassin's Finch females, like female American Goldfinches (*Carduelis tristis*; Mundinger 1970) and Twites (*Acanthis flavirostris*; Marler and Mundinger 1975) responded only to their mates' call and not to

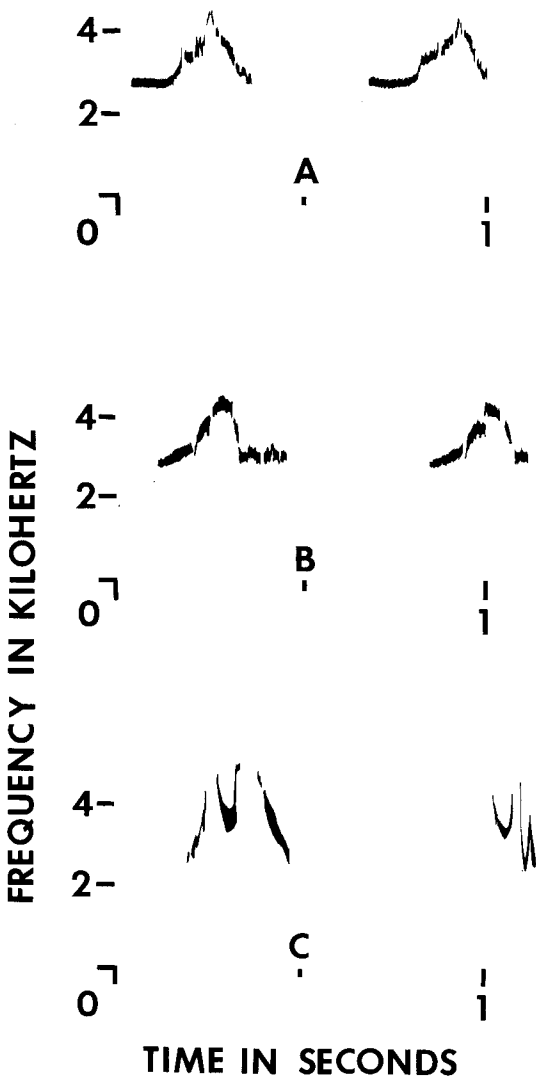


FIGURE 8. Audiospectrograms depicting calls of older male Cassin's Finches at Beaver Mountain in 1972. A is during copulation, B while courtship feeding, and C from a perch.

those of other males. This individual recognition would aid integration of reproductive behavior of nesting pairs of Cassin's Finch.

SUMMARY

Vocalizations of Cassin's Finch were studied in northern Utah in spring and summer of 1972 and 1973. Yearling males possess a repertory of 97 types of song figures, and older males 86. Each male sang a characteristic theme, sharing only the introductory three or four figure types with other males. These initial figure types may serve to identify breeding populations. Males often deleted or repeated one or two figure types but the order of figure types was consistent. Themes in songs

of an individual male from a perch, during copulation, and during song flights were similar. A call given when a male fed the female at the nest was pair-specific and provided for individual recognition. The vocalizations of Cassin's Finch seem well suited to a nomadic species breeding in a high altitude montane environment.

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