

ASPECTS OF HOUSE FINCH BREEDING BIOLOGY IN HAWAII

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Bent (1968) summarized information available on the breeding biology of the House Finch (*Carpodacus mexicanus*). Although this species has been studied quite extensively in its North American home range, little attention has been paid to it in Hawaii. Grinnell (1911) reported on different color patterns of the House Finch in Hawaii, and Richardson and Bowles (1964) mentioned that on 23 June 1960 they found a nestling that had fallen from its nest on Kauai. On Mauna Kea, Berger (1972) found House Finch nests with eggs as early as 6 April (1968) and as late as 17 July (1967). Eleven nests were built on horizontal branches of mamane (*Sophora chrysophylla*) and two in naio (*Myoporum sandwicense*) trees. Complete clutches of three eggs were found in two nests, four eggs in five nests, and five eggs in one nest. The only other reference I have found to the breeding aspects of the House Finch in Hawaii is that of Hirai (1974) who studied an urban House Finch population in Honolulu from 1972 through 1974.

According to Caum (1933), the House Finch was introduced to Hawaii prior to 1870, probably having escaped from captivity. It is now established on all of the main Hawaiian islands. Berger (1972) wrote that "The Linnet is common in cities and towns, in both wet and dry rural areas, and in the high ranch and forest lands on Maui and Hawaii. It is uncommon in the depths of the near-virgin rain forests, but it is abundant in the mamane-naio forests on Mauna Kea, as well as in partly cutover mixed ohia-koa forests."

The House Finch population in Hawaii has been isolated but, aside from the work of Grinnell (1911), no one has looked at possible genetic shifts in this insular population. I undertook to determine if, in the past 100 years, any changes have occurred in the breeding habits of the House Finch in Hawaii.

STUDY AREA AND METHODS

I conducted field work on the island of Hawaii during the years 1970, 1971, and 1972; additional observations were made in the summers of 1969 and 1973. All of the major forested regions on Hawaii—the Kohala Mountain area, Mauna Kea, Mauna Loa, and Hualalai (fig. 1)—were visited. Most of my observations were made in area 2 on the northwestern slope of Mauna Kea. This region, hereafter referred to as

Puu Laau, is the last remaining major mamane-naio forest in Hawaii.

The stippled areas of figure 1 represent a broad spectrum of the forest types on the island of Hawaii; included are native, introduced, and mixed stands of vegetation. Areas 2, 3, and 5 are dry forest regions with annual rainfall of 76 cm or less; Puu Laau (2) has mean annual rainfall of 50 cm, Puu Waawaa (3) 64 cm, and Puu Lehua (5) has 76 cm. The Kohala Mountain complex (1) has a mean annual rainfall of 229 cm, Puu Oo (4) has 483 cm, and the Kulani-Mauna Loa complex (6) has 317 cm.

Birds were mist-netted, color-banded, and released from 1971 through 1973. Nest and tree heights were taken with a clinometer when it was impractical to use a tape measure. Nests and eggs were measured with calipers and weighed on a sensitive spring balance.

COURTSHIP

During early spring, the large flocks of House Finches on Hawaii disband, although not totally, and pairing ensues. I have often noted males courting females at this time of the year, an activity that continues until mid-summer. At 18:00 on 28 May 1973 at Puu Laau, a pair of birds flew into the uppermost dead branches of a mamane tree. The birds landed approximately 1 m apart with the female higher up on an ascending horizontal branch. The female turned and faced away from the male; he then started walking up the limb with his tail erect and fully spread, wings lowered at his side, and breast outward, thus making the head and neck assume a "ram-rod" position. As he walked he intermittently bowed and gave short, high-pitched chirps. Spaced between chirps were low trills. When he approached to within 20 cm of the female, she turned and chased him down the branch. This sequence was repeated twice until, on the third approach, the female did not chase but remained facing away from the male. After an interval of less than 1 min both birds flew into a grove of pines, presumably to roost for the night.

Courtship feeding of the female by the male occurs frequently during incubation, but I have observed it only twice prior to egg laying. On Kohala Mountain, during the third day of nest construction, I observed an unbanded male feed a banded female. The second instance happened on Mauna Kea (area 4), when a male fed a female prior to (or on the first day of) nest construction.

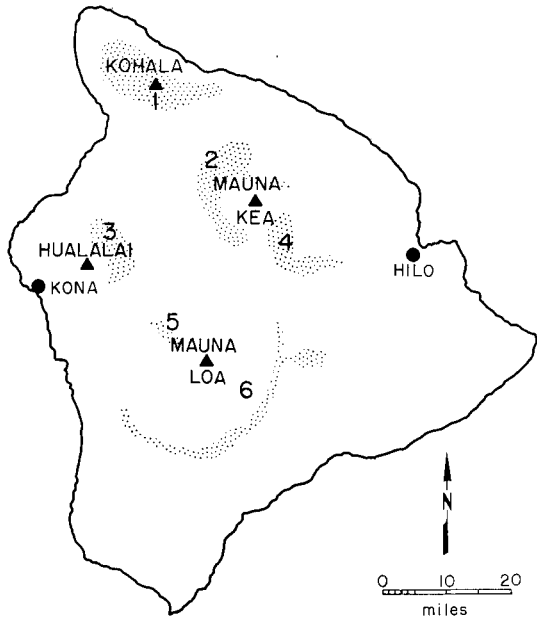


FIGURE 1. The island of Hawaii with stippled sites representing study areas.

NESTS

The House Finch uses almost any available species of tree for a nesting site. In the forests on Hawaii a fork or an upright limb, in the more open interior part of the tree, is the preferred nesting location. The nests I found were situated in the branches of trees with two exceptions; one on Hualalai, which was in a hole of an ohia (*Metrosideros polymorpha*) trunk and one nest that was wedged in the bark of a dead mamane tree at Puu Laau (van Riper 1974).

Mamane and naio make up over 95% of the trees in the Puu Laau area (van Riper 1975), and nest tree selection by the House Finch is influenced accordingly. Mamane, found in a 2:1 ratio over naio, is the preferred nesting tree (table 1). Mamane offers birds a denser canopy than naio. Four nests were

TABLE 1. Heights (in meters) of nests, nest trees, and randomly selected mamane and naio trees at Puu Laau, Hawaii.

	N	Mean \pm SD	Range
Mamane			
Random trees	91	6.5 \pm 2.6	2.7–11.9
Nest trees	36	6.0 \pm 1.9	3.4–10.7
Nests	43	4.7 \pm 1.6	2.3– 9.1
Naio			
Random trees	56	5.9 \pm 2.2	2.8–11.6
Nest trees	12	7.0 \pm 2.0	3.7–10.1
Nests	12	5.0 \pm 2.2	1.5– 9.0

TABLE 2. Location of nests in trees at Puu Laau, Hawaii.

Tree species	Number in		
	Terminal forks	Lateral forks	Branches
Mamane	10	17	15
Naio	2	6	4
Akoko	0	4	0

found in akoko (*Euphorbia olowaluana*) and one in an aalii (*Dodonaea viscosa*) shrub. I have found six nests in introduced pine trees at Puu Laau.

On Hualalai, House Finches use mamane, pukeawe (*Styphelia tameiameia*) shrubs, ohia, and kolea (*Myrsine lanaiensis*) trees. On Mauna Loa (area 5), along with the above mentioned, the sandalwood tree (*Santalum ellipticum*) is a frequent nesting location; in area 6 the koa (*Acacia koa*) is also sometimes used.

In the Kohala Mountain region I found 24 nests in introduced pine trees—mainly Norfolk Island pine (*Araucaria excelsa*)—and ironwood (*Casuarina equisetifolia*) along the edge of the forest. The birds prefer these trees presumably because pasture land of the Parker Ranch surrounds the forest and contains a multitude of food types. L. Omura (pers. comm.) found 18 nests in this area during the 1973 breeding season and all but one were in pine trees. The House Finch is not common in the deep forest of Kohala Mountain, where I found only eight nests, none more than 450 m from the forest edge; all were built in ohia trees.

Nest sites fell into three categories. *Terminal forks* included branches forming the most distant group of stems from the trunk in the topmost 20% of the canopy surface area. This category comprised over 35% of the potential nesting locations. *Lateral forks* were defined as the end clusters of branches in the remaining canopy. *Branches* included any horizontal or vertical limb within the canopy cover. House Finches preferred the open interior portions of a tree for nesting, as over 75% of the nests found in mamane and over 80% of those found in naio were placed either inside the canopy or in lateral forks (table 2). Nest height is influenced by the height of the nest tree ($r = 0.47$, $P < .005$, fig. 2). The considerable variance in nest height shows use of many places within a tree.

The three most aberrant points in figure 2 were all unusual nesting situations for House Finches. Nest *b* was the immense nest discussed earlier that had been built between the sloughing bark and trunk of a dead mamane.

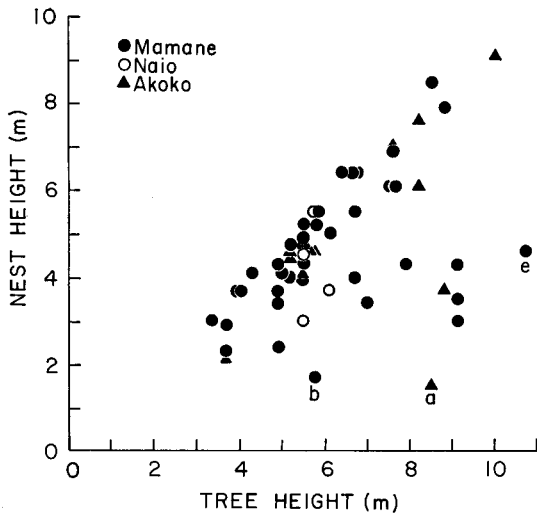


FIGURE 2. The relationship between nest height and tree height at Puu Laau, Hawaii.

Nests *a* and *c* were the only instances of House Finches nesting in the same tree with a bird of another species; nest *a* was situated below an Amakihi (*Loxops virens*) nest and *c* was across from and lower than an active Elepaio (*Chasiempis sandwichensis*) nest.

The nest is constructed almost entirely by the female. Only twice did I observe males bringing material to the nest, but in neither case was it incorporated into the nest proper. The male remained close by, however, and often aided in molding the nest in the early stages of construction. Nest construction lasted from 6 to 11 days before laying of the first egg.

Eight House Finch nests from the Puu Laau area were randomly chosen, and the materials used in their construction were identified (see Appendix). Grasses constituted the greatest part of the examined nests; species other than the four listed were probably employed in nest construction, but only those with inflorescences could be identified. Grass roots were interwoven into the nests and were the most commonly used material for lining the nest.

These roots were probably obtained from plants that had been pulled out by rooting feral pigs or grazing sheep.

House Finches have been reported to use the same nest for a second brood in a year. Only once in over 100 nests have I observed this in the forests on Hawaii. On 16 May 1971 I found a nest at 2135 m elevation at Puu Laau that contained two nestlings and two eggs; subsequently, all four young fledged. I returned to collect the nest on 11 June and found four new eggs in the nest.

The size and shape of House Finch nests built on tree branches on Hawaii are fairly uniform throughout the population (table 3). Nest *b* (of fig. 2), which was placed between the sloughing bark and trunk of a dead tree, was not included in these compilations. This nest had a significantly greater outer nest depth (21.3 cm) and nest weight (91.5 g) than the rest of the nests (it was in the normal range of variation for the other nest dimensions).

EGGS AND YOUNG

I have recorded 93 House Finch clutches on Hawaii. At Puu Laau the average clutch of 14 completed nests was 3.9 ± 0.7 eggs (mean \pm SD). In each, I observed and recorded the laying of each egg and, therefore, was almost certain that the clutch belonged to one bird. The eggs of the House Finch usually are laid at 24-hr intervals. However, in one nest the female skipped a day between egg number 3 and 4 in a four-egg clutch. The mean length of 16 eggs was 18.3 ± 0.13 mm and the width 13.2 ± 0.09 mm. The mean weight of the 16 eggs measured in the field was 1.5 ± 0.2 grams.

I recorded incubation periods from 12 to 14 days—12 ($n = 2$), 12.5 ($n = 6$), 13.0 ($n = 3$), 13.5 ($n = 2$), and 14.0 ($n = 1$). Only females incubated; after hatching they continued to brood for about a week with mean time spent on the nest decreasing daily. After 9 days, brooding was rarely observed. Nest-

TABLE 3. Measurements (cm) and weight (g) of House Finch nests built on tree branches on Mauna Kea, Hawaii.

	No. nests measured	Mean \pm SD	Range
Outer nest depth	21	7.1 ± 1.9	2.5–10.9
Total width	25	11.7 ± 1.9	8.1–17.0
Inside bowl diameter	21	5.6 ± 1.2	3.3– 7.6
Bowl depth	13	3.6 ± 0.7	2.5– 4.6
Rim thickness	24	2.5 ± 1.2	0.6– 4.6
Weight of nest	12	19.5 ± 3.3	13.7–25.2

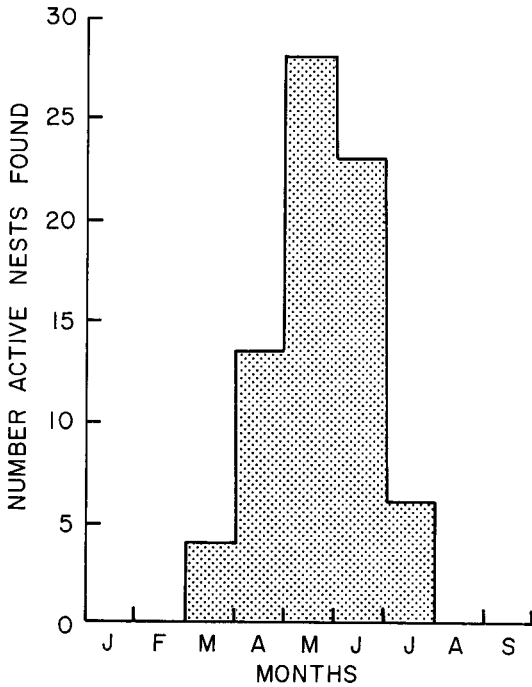


FIGURE 3. The number of active House Finch nests found on Mauna Kea from 1970 through 1973.

ling periods generally varied from 15 to 19 days (17.5 ± 1.3 days, $n = 9$), with two birds taking 20 days to leave one nest. In 6 of 13 nests, young of a clutch fledged at different times. I never saw young return after departure from the nest. When the young fledged they were fully feathered and able to fly from the nest. The young and parents remained in the vicinity of the nest for about a week before starting to move around in a family group.

BREEDING SEASON

The breeding season of the House Finch in Hawaii extends from early March until late July in the upper mountainous regions (fig. 3). The earliest nest with eggs I found was on 13 March (1971) and the latest on 14 July (1972). Most of the nesting occurred in April, May, and June. L. Omura found 18 nests in the Kohala Mountain area—3 in April, 9 in May, and 6 in June. In mid-July flocks became evident, and I have observed birds in large groups throughout the winter. The larger flocks of birds left the Puu Laau region during the winter months to lower elevations.

DISCUSSION

Most sources give the breeding season of the House Finch in North America as between March and early August. I found nests from early March through late July (fig. 3), thus

revealing little if any difference in the length of the breeding season in Hawaii. Baldwin (1953), Eddinger (1970), Berger (1972), and others have found that the native species of Hawaiian birds breed in late winter and early spring. As none of the extant native birds has the same dietary requirements as the House Finch, and because they nest at different times of the year, superficially there appears to be no competition between House Finches and other Hawaiian species.

For mainland birds, Bent (1968) gave clutch size as two to six with four or five eggs comprising the usual set. The measurements of 50 eggs averaged 18.8×13.6 mm. The mean clutch size of 3.9 eggs in my study and egg measurements of 18.3×13.2 mm are not at variance with these data. Bent suggested that the incubation period of from 12 to 14 days may be shortened in warmer climates. As high temperatures are not characteristic of the mountainous regions on Hawaii, my observed incubation periods of 12 to 14 days agree with his data. Evenden (1957) listed the nestling period of the House Finch as varying from 11 to 19 days. Except for the two birds that took 20 days to leave the nest, all nestling periods were within the extremes of those found in North America.

In Hawaii nest construction takes from 6 to 11 days with the female doing most of the work. This same time period was reported by Bent (1968) for birds in California, and he also mentioned that the female House Finch does the majority of the construction. The materials used vary with the locality, but there are some differences as well as similarities between nest materials used in Hawaii and western North America. Lichens have been reported in House Finch nests from California by Grinnell and Linsdale (1936), and at Puu Laau this was a favorite nesting material. In certain areas of New Mexico, sheep wool is used by the House Finch (Bailey 1928). Of the six passerine species that use sheep wool at Puu Laau, the House Finch probably uses it the least. Some species, such as the Elepaio, have nests made almost entirely of wool. It is surprising that the House Finch does not utilize this nesting material more as it is used in certain areas of North America.

One of the most striking similarities between Hawaiian and North American House Finches is the number of introduced plants from North America used in construction of the nest (Appendix). Of the 15 species that were identified, only four are native to Hawaii. Inasmuch as the Puu Laau area still has a reasonably high percentage of native plants, it seems pe-

culiar that the House Finch would use introduced plants for its nest. The birds are therefore not selecting nesting material on the basis of availability, but appear to be using plants that have been introduced from North America.

Bent (1968) listed nest height from 5 to 7 ft (ca. 1.5 to 2.1 m) but did not give tree height, while I found a mean nest height of 5 m. This suggests that the birds are nesting higher in Hawaii and that they may be building more nests in the external forks rather than in the interior of the tree. The nest measurements appear to bear this out. Bent gave the mean width of nests as 5 in (ca. 12.7 cm); my data show 11.7 cm. His total nest outer depth was 3 in (ca. 7.6 cm), whereas mine was 7.1 cm. This shows an increase in total height but a decrease in the total width, thus suggesting more nests being fit into forks rather than flattened as they are when placed on internal branches of the tree.

Willard (1923) reported on a marked tendency of the House Finch to return to the same nesting location in subsequent years. I marked over 100 nest sites in four years on Hawaii, yet I never saw a location being used in two consecutive years.

North American House Finches will use the nests of many other species after the original occupants leave. On Hawaii I have not found the House Finches using nests of other birds. One reason may be the rapid deterioration of nests due to climatic factors; 23 of 35 marked nests remained in the tree less than one month after the young fledged. Swift breakup of the nest may also inhibit use of the nest for a second brood. Two and three broods for the same nest have been reported by Aiken and Warren (1914), but on Hawaii I have observed this only once.

The abundance of the House Finch on Hawaii appears to have been enhanced by two factors. First, there being no seed-eating native birds, this niche was open for the House Finch. The second major factor appears to be the spread of ranching in Hawaii. Water troughs for cattle are now present over the entire island. House Finches depend heavily on these troughs. I have observed flocks of 100 and more House Finches at watering places in the drier areas. I am sure that without the supplies of water, the House Finch could not live in these dry regions.

SUMMARY

The House Finch was studied on the island of Hawaii from 1969 through 1973. The breed-

ing season here extends from early March through late July. Pair bond formation commences in early spring with characteristic male courting behavior. Both native and introduced trees are used as nesting sites and nest height is correlated with height of the tree. Favored areas of nest placement were found to be in the inside region of the tree; a shift in placement may be occurring to the outer branches in Hawaii. Nests are constructed by females, taking from 6 to 11 days. Measurements of nests are given, as is a list of the materials used. Clutch size was 3.9 ± 0.7 eggs and the mean weight of the eggs 1.5 ± 0.2 grams. Incubation period was 12 to 14 days (12.8 ± 0.6), and the nestling period varied from 15 to 19 days (17.5 ± 1.3). It appears that in the past 100 years the breeding biology of the House Finch in upper mountainous areas of Hawaii has changed little from that of the birds in western North America.

ACKNOWLEDGMENTS

I dedicate this paper to Unoyo Kojima, who for years has helped give direction to the Hawaii Audubon Society. Research was supported in part by the International Council for Bird Preservation, the McNerny Foundation, and the Hawaii Audubon Society. I would like to acknowledge the help of Darrel Herbst for identifying nest materials. Andrew Berger and John Stimson criticized the manuscript. I thank Irene and J. Quinn Casey who have given their support throughout the work.

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- APPENDIX. A checklist of the plants used in construction of House Finch nests on Puu Laau, Hawaii. The scientific and common Hawaiian name are given for each; frequency of use in eight randomly chosen nests along with the parts of the plants used is also included. Species native to Hawaii are denoted by an asterisk.
- Usnea* sp.* Lichen. Entire plant. Common in nests 4, 6, and 8.
- Bromus rigidus* Roth. Rippgut grass. Leaves, culms, and inflorescences. Common in nests 3 and 4.
- Dactylis glomerata* L. Orchard grass, cocksfoot. Leaves, culms, and inflorescences. Rare; only in nest 1.
- Holcus lanatus* L. Velvet grass, Yorkshire fog. Leaves, culms, and inflorescences. Abundant; in all except nest 1.
- Poa pratensis* L. Kentucky bluegrass. Leaves, culms, and inflorescences. Common in nest 4, 6, and 7.
- Conyza bonariensis* (L.) Cronq. Horseweed. Pieces of the inflorescence with one or more capitula. Occasionally achenes with included pappus were used in nest lining. Common; found in nests 1, 4, 5, and 6.
- Gnaphalium sandwicense* var. *kilaueanum** Deg. and Sherff. 'ena 'ena. Stems with included leaves and flowers. In one instance an entire plant, with short pieces of roots, was noted. Abundant; in nests 4, 5, 7, and 8.
- Sonchus oleraceus* L. Sow thistle, 'pua-lele. Incomplete capitula consisting of the peduncle, receptacle and involucre bracts. Rare; found only in nests 1 and 7.
- Lepidium virginicum* L. Wild pepper-grass. Flower stalks with included capsules. Rare; only in nests 4 and 5.
- Euphorbia olowaluana** Sherff. Akoko. Leaves only used. Found primarily in the lining. Rare; found only in nest 5.
- Sophora chrysophylla** (Salisb.) Seem. Mamane. Flowers, usually lacking petals; leaves in lining, but occasionally in bulk of nest. Common; in all nests except 5.
- Lythrum maritimum* HBK. Pukamole. Stems with included leaves and fruits. Rare; only in nest 8.
- Veronica plebeia* R. Br. Common speedwell. Stems with included fruits and leaves. Occasional; in nests 7 and 8.
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