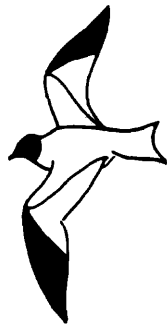


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THE NESTING BIOLOGY OF THE HOUSE FINCH IN HONOLULU, HAWAII

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The House Finch, *Carpodacus mexicanus frontalis* (Say), is a small seed-eating passerine found throughout western North America. It was introduced to Hawaii, probably from San Francisco as an escaped cage-bird, prior to 1870 (Grinnell 1911). Today it is found on all the main Hawaiian islands.

This was a field study of the nesting biology of the House Finch from January 1972 through July 1974, covering three nesting seasons. Some of the findings are discussed in relation to what is known about House Finch populations in North America.

METHODS AND STUDY SITE

Most of the study consisted of field observations, with almost daily checks of nests. Measurements were made using a caliper, ruler, or tape measure. Weights were obtained using Pesola scales. To facilitate future identification, eggs were marked with a black "Sharpie" pen; nestlings were marked in 1972 with red nail polish, but in 1973 and 1974 with a red Sharpie pen, which proved more satisfactory. Nestlings near fledging and adults were banded with U.S. Fish and Wildlife Service metal bands and one or two plastic bands in different color combinations. Unless otherwise indicated calculations are in the form mean \pm one standard deviation. The 0.05 value is considered the level of rejection.

The study site was confined to the University of Hawaii 0.4 km² main campus, located in Manoa Valley, a residential area in Honolulu.

HOUSE FINCH

The House Finch is one of about 15 bird species found on or near the campus. All are introduced except the migratory and nonnesting Golden Plover (*Pluvialis dominica*). From 25 to 50 pairs of House Finches nest on campus at any one time, the nesting season covering about six months from mid-February through August. The breeding season is followed from late July-August through October by a molting period.

THE NEST

In 1972 I found 91 nests, in 1973 103 nests, and in 1974 63 nests, under construction, with eggs or young. Nests do not usually persist from one year to the next or even through one nesting season; House Finches build new nests for each effort. Because House Finches do not defend very large territories, usually at the most only the small areas around the active nests, nests are often in close proximity to nests of other House Finches and bird species.

The 257 nests that I found were built in 26 different types of vegetation. Pandanus (*Pandanus*) and palms (*Palmae*) were the most common nesting trees, with 41.2% and 28.0% of the total number of nests, respectively. Monkeypod (*Samanea saman*) with 7.4% and Fiddlewood (*Citbarexylum spinosum*) with 6.6% were other frequently used trees. Nests usually were constructed on sites providing cover and shade, such as in clusters of pandanus leaves, on stems or axes of palm leaves, or in foliage located in the outer portions of trees.

The height of a nest was measured from the bottom of the nest to the ground below if the nest was lower than 4.6 m or estimated as closely as possible if higher. Heights were variable, ranging from 1.8 to 15.0 m, with an average in 1972 of 4.3 ± 1.5 m, in 1973 of 5.0 ± 2.4 m, and in 1974 of 4.6 ± 1.6 m.

Nest construction takes from 6 to 22 days, averaging 11.8 ± 4.7 days for 15 nests. Nest building is done almost exclusively by the female. Only material brought to the nest by the female is used, and the male aids the female in molding the nest only in the first half of the nest-building period. Thereafter only the female works on the nest, the male accompanying the female to and from the site, singing from a nearby perch. Preparation of the site, such as enlarging it by nibbling away adjacent leaves, takes the first one or two days of nest building. Then the foundation is laid down and the nest is molded into shape. At this stage larger-sized material is used, such as old Fiddlewood inflorescences, fibrous strips of Coconut (*Cocos nucifera*) and pandanus, fresh and dried grasses and leaves, string, paper strips, and feathers. The cup lining is finally added, consisting of fine and soft coconut fibers, hair, and frayed cigarette filters.

HOUSE FINCH

The finished cup-shaped nest varies from a rather loose to a very compact structure. Nest dimensions of 25 nests measured in 1973 were (in cm): outer width x length, $9.5 \pm 1.3 \times 12.0 \pm 3.3$; inner width x length, $5.5 \pm 0.6 \times 6.2 \pm 0.6$; outer cup depth, 7.3 ± 1.7 ; inner cup depth, 4.2 ± 0.8 ; and rim thickness from 1.0 ± 0.6 to 4.7 ± 2.8 .

EGGS AND CLUTCH SIZE

Copulation occurs at the invitation of the female and is seen, at the earliest, a few days before nest building is completed. I have never seen male courtship display lead immediately to a copulatory attempt.

Egg laying usually starts the day after nest building ends, although I observed a female adding material to a 1974 nest that contained at least three eggs. The first egg, and most probably the entire clutch, is laid in the early morning hours, before 08:00. Usually one egg per day is laid until the clutch is completed. Out of a total of 44 nests, only five had a day or more skipped in the laying of the clutch. In no case was more than one egg laid per day.

House Finch eggs are colored light blue, with black or brown-black specks or lines concentrated at the rounded ends. Egg measurements were taken only from nests that were found on or before the day the first eggs were laid and where the clutches were completed. Eggs were measured and weighed the day they were laid. Based on 197 eggs from 48 nests from the three study years, greatest width x length and weight averaged $13.5 \pm 0.6 \times 19.1 \pm 0.9$ mm and 1.89 ± 0.15 g, respectively. Eggs within a clutch do not show significant differences in weight whether they were laid first, second, third, fourth, or fifth in a clutch, in small or large clutches, or early or late in the nesting season (one-factor anovas, $P > 0.05$).

Bergtold (1913) gave measurements of House Finch eggs from Denver, Colorado, that averaged 13.7×19.6 mm, somewhat larger than my measurements. The larger eggs from Denver also were heavier in weight. Based on two clutches containing four and five eggs, an egg weighed 2.25 ± 0.08 g. There is a significant difference in the weights of the eggs from Denver and Honolulu (two-tailed t-test, $t = 7.030$, d.f. = 204, $P < 0.001$). Without other information, such as the availability of food for the House Finch populations on campus for the past three years and in Denver during the early 1900s, no adequate explanation is possible.

Clutch size on campus averaged about four eggs and does not differ significantly from those reported from Arizona and California (two-tailed t-tests, $P > 0.05$; Table 1). Only papers that have information amenable for statistical comparison are used in Table 1. Hensley's (1959) data were slightly modified in that I used $n = 11$, instead of his

HOUSE FINCH

Table 1. Clutch sizes for House Finches

	ARIZONA	CALI-FORNIA	CALI-FORNIA	HAWAII
RANGE	3-5	3-6	4-6	2-5
MEAN	4.0	4.3	4.4	4.2
STANDARD DEVIATION	0.4	0.9	0.6	0.6
NO. OF NESTS	11	18	25	127
SOURCE	Hensley (1959)	Grinnell and Linsdale (1936)	Evenden (1957)	This Study

n = 12, because one of the clutch sizes could not be determined from the paper. Also Grinnell and Linsdale (1936) caution that the four nests that they found with 3-egg clutches may have been incomplete.

THE INCUBATION PERIOD

The incubation period, the length of time between the laying of the last egg in the clutch until that egg hatches when all the eggs hatch, ranged from 11.5 to 13.5 days, averaging 12.8 ± 0.6 days for 29 nests. Clutch sizes of the nests used to calculate the incubation period ranged from two to five, but did not affect the length of the incubation period (one-factor anova, $F = 3.37$, $m/n = 3/25$, $P = 0.1-0.05$). The incubation period in Hawaii does not differ from the length of 13.3 ± 1.1 days (based on 11 nests) determined by Evenden (1957) at Sacramento, California (two-tailed t-test, $t = 1.887$, $d.f. = 38$, $P = 0.1-0.05$). Because of water evaporation, a House Finch egg loses $15.9 \pm 6.1\%$ of its original weight before hatching (based on 58 eggs from 22 nests).

An egg pips, at the earliest, less than 24 hours before the young hatches. Hatching may occur at any hour of the day or night, and the eggs of a clutch hatch out over a period of days and not all on one day. In rare instances one young may hatch each day until all the young have emerged. Usually two young hatch on the first day of hatching and one young per day thereafter until all the young have hatched. I have never found all the eggs of a clutch hatching on the same day. Eggs also hatch in the order that they are laid. In six cases where only one young hatched on the first day of hatching and where the entire clutch eventually hatched, the first egg laid was the one that hatched first. In nine other cases, where more than one young hatched on the first day, the remaining eggs in the clutches hatched in the order in which they were laid. The female gets rid of the egg pieces either by flying off with them or eating them at the nest.

HOUSE FINCH

Based on the hatching information and on temperature-probe readings at two 1973 nests, incubation, the application of heat to the eggs by the adult House Finch, possibly starts by the night the first egg of the clutch is laid and almost certainly by the second night, and not when the penultimate or last egg is laid, as in some other bird species.

THE NESTLING PERIOD

At hatching, a House Finch is helpless and blind, with some fluffy whitish down on the head and body. A chick fledges, or leaves the nest, 14 to 19 days after hatching, averaging in 1972 16.8 ± 1.1 days (based on 12 young from six nests) and in 1973 18.5 ± 1.0 days (based on 24 young from eight nests). By this time the young is rather fully feathered, with a short, stubby tail, only a few strands of down adhering to the head feathers, and distinctively swollen beak corners.

Nestlings are fed regurgitated seeds. Nestlings from 15 nests in 1972 and 28 nests in 1973 were weighed daily or almost daily. Figure 1 shows the mean weight \pm two standard deviations of a nestling from day 0 (the day the young hatches) until day 13. There is no significant difference between 1972 and 1973 in the weights for the respective days (two-tailed t-tests, $P > 0.05$). There is a steady increase in body weight of a chick from less than two g on the day of hatching to about 17 g, 13 days later. Although I could not obtain weights beyond day 13 without frightening the young prematurely from the nest, in two cases in 1973 a just-fledged young, 19 days old, and a chick, 18 days old and a day away from fledging, both weighed 19.0 g, suggesting that a House Finch nestling probably increases in weight to approximately that of an adult, 19.5 ± 1.6 g (based on weights, ranging from 16.9 to 23.8 g, of 43 adults trapped in 1973, with no difference in male and female body weights; two-tailed t-test, $t = 1.575$, d.f. = 41, $P = 0.4-0.3$).

At Denver, Colorado, Bergtold (1913) weighed eight young from two nests. At one nest four young hatched on the same day; at the other nest two nestlings hatched on the first day, one each on the second and the third days. Seven young took from 14 to 16 days to fledge; it is unclear if the eighth chick fledged. Figure 1 shows the average weight of a Denver nestling. The Colorado chicks weigh significantly more at hatching and through day 9 than the Hawaiian nestlings, but from day 10 to 13 there are no differences in the weights of the young from either localities (two-tailed t-tests). The fact that the nestlings from Denver and from Honolulu weighed the same by nestling day 13 would seem to indicate that the different growth curves were not affected by the food supply for the nestlings. The Denver young, however, hatched from eggs that were significantly heavier than those from which the Honolulu chicks hatched, and it may be that the rate of growth of a

HOUSE FINCH

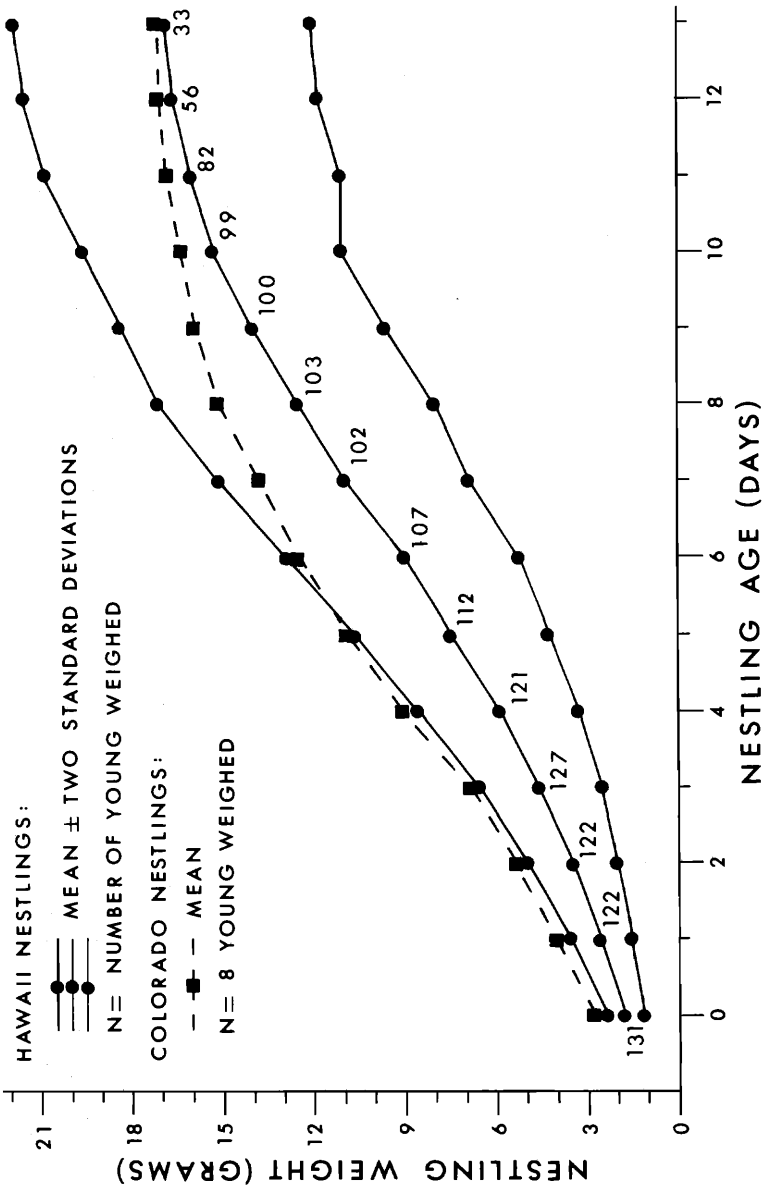


Figure 1. Weights of House Finch nestlings in Hawaii and Colorado.

HOUSE FINCH

nestling is affected by the weight of the egg. Schifferli (1973) had similar growth patterns when he compared weight developments of Great Tit (*Parus major*) nestlings hatched from heavy eggs with those young hatched from light eggs, concluding that egg weight can affect the rate of growth.

Because House Finch young hatch over a period of days and not all on the same day, there are differences in chick weights early (days 2 and 3) and later (days 9, 10, and 11) in the nestling period; older young, those that hatched on the first and second days of the hatching period, weigh more than their younger siblings, those that hatch on the third and fourth days (one-factor anovas, $P < 0.05$). Early in the nestling period, the eyes of the older young open before their still sightless and younger broodmates, giving the older chicks an advantage in being able to direct their gapes toward the feeding adult and possibly getting more of the food. Later in the nestling period, the older young are larger, more vigorous at feeding than their younger chickmates, and thus probably get more of the food. Although there seems to be some degree of sibling competition for food brought by the adults, in most cases House Finch nestlings that hatched later usually also survived to fledge.

THE FLEDGLING PERIOD

The young fly well when they leave the nest and seem to move out of the nesting area soon thereafter. A brood may fledge all in one day or over a number of days and seem to do so in the morning hours. Based on limited data, fledglings are fed by both adults for at least two weeks and probably are independent after three weeks. The adult pair then renests. Even with a six month nesting season in Hawaii, most likely only two broods can be raised successfully in one season by a pair because of the long nesting period (about two months, including 20 days before renesting) and the low nesting success that I found. In North America two broods in one season seem to be average for the House Finch (Evenden 1957, Gill and Lanyon 1965, Hensley 1954).

ADULT NESTING BEHAVIOR

Daily or almost daily observations of 60-minute duration in 1972 and 1973 at 9 nests during the egg-laying period, 23 nests during the incubation period, and 25 nests during the nestling period indicate that only the female House Finch incubates the eggs and broods the young. She is attentive at the nest during the daylight hours about 50% of the time on the day the first egg is laid and 90% of the time after the clutch is completed and until the eggs hatch. Nest attentiveness then declines

HOUSE FINCH

until 10 days after the young hatch, whereafter day brooding is infrequently observed. Night brooding ends about 12 to 14 days after the young hatch.

The male is seen at or near the nest about once an hour during the incubation period, returning to courtship-feed the female regurgitated seeds. Except in one case, males were not observed at the nests at sunset or night, and it may be that they roost together elsewhere during the nesting period, as reported by Evenden (1957).

House Finch nestlings are fed by both the male and the female; also during the first one-third of the nestling period the male feeds the female at the nest and she, in turn, feeds the nestlings. It is rare when no feedings occur during a 60-minute period and as many as four feeding trips may be made, averaging about two feedings per hour. The usual pattern in feeding the nestlings is for the adults to alternate in returning to the nest. Out of 30 feedings noted at 13 1973 nests where the young were more than seven days old, only four consecutive ones were by the same adult and only three feedings were within one minute of each other; times between feedings ranged from 1 to 38 minutes and averaged 16.7 ± 12.0 minutes.

NEST SANITATION

The House Finch belongs to the Carduelinae, a subfamily in which some of the species do not remove the fecal sacs of the young from the nest, a behavioral trait unusual for passerine birds. During the early part of the nestling period, both the male and the female remove the sacs, usually by eating them or, very rarely, by carrying them away. The first sacs appear on the rim from four to nine days after the first young hatch, averaging 6.1 ± 1.3 days (based on 29 nests inspected daily in 1972 and 1973). Especially when three or four young fledge, the nest rim may be covered with fecal matter, although the cup itself is often clean, partly because the older nestlings raise their cloacal regions over the rim when passing fecal sacs.

This fecal matter makes for an ideal "home" for many other animals, especially arthropods. Using the Tullgren-funnel method, the nest faunas from three 1972 nests were extracted and identified, revealing a combined total of 17 different types of animals. The most interesting animal found is a blood-sucking mite (*Mesostigmata: Dermanyssidae*). It was present at every nest I found, ranging from being scarcely noticeable to literally covering the nest and the nestlings. Because the chicks gained weight and fledged even at those nests where the mite populations were in the thousands, I do not believe that this mite is a direct cause of nestling mortality. The mites, though, may so weaken the

young that its chance of survival is greatly reduced after fledging. Bergtold (1913) collected a similar mite.

NESTING SUCCESS

Nesting success may be defined in a number of ways. In this paper nesting success is defined as the proportion of the number of young that fledge in relation to the number of eggs that are laid; hatching success as the proportion of the number of young that hatch in relation to the number of eggs that are laid; and nestling success as the proportion of the number of young that fledge in relation to the number of young that hatch. No nests were considered in computing nesting success where even one egg or young was lost, or believed lost, by my actions or by others. Also, only nests that were found before hatching began are included.

Table 2 lists nesting success for House Finch populations in Honolulu and North America, primarily urban and suburban environments. A number of the studies were done for more than one year, but for ease of computation a combined nesting success is given for each locale. Nesting success in Hawaii for the three seasons is 21.7% and compares similarly with the finding of West (1972) in New Mexico, but is significantly lower than in the other locations (2×2 X^2 tests). The higher nesting successes of Evenden's (1957) and Hensley's (1954) House Finch populations result from both higher hatching and nestling successes. The House Finch in Hawaii has a much lower nesting success than most other populations. In fact, nesting success for the Hawaiian House Finch is far lower than the 46% calculated by Nice (1957) for temperate altricial species. It is closer to the 30% found by Skutch (1966) for Central American species that build open or roofed nests. Although the nesting success of the Hawaiian House Finch is low, it is an abundant bird.

A total of 403 eggs or young were lost in the three study years. Nest losses were due to: strong winds knocking eggs and young from nests (34.7% of the total losses); predation, probably by a rat species, on eggs, young, and in six cases the nesting females (27.5%); failure of eggs to hatch because they were infertile, contained dead embryos, or were deserted (17.4%); and nestlings dying because they were inherently weak at hatching, starved to death, or became so entangled in the nest material, especially the hair used to line the cup, that they could not free themselves and were left behind when the rest of the brood fledged (20.3%). To an unknown extent, House Sparrows (*Passer domesticus*) interfere in House Finch nesting by stealing material from active nests, incorporating the material into their own, and probably even killing nestlings by pecking them to death and throwing them out of the nests.

HOUSE FINCH

Table 2. Nesting success of the House Finch.

LOCATION & SOURCE	YEARS	NESTS	EGGS LAID	EGGS HATCHED	NESTLINGS FLEDGED	HATCHING	% SUCCESS NESTLING	NESTING
New Mexico West (1972)	1	8	28	16	8	57.1	50.0	28.6
Colorado Bergtold (1913)	5	68	283		166			58.7
Arizona Hensley (1954)	2	10	41	33	33	80.5	100	80.5
California Evenden (1957)	5	37	117	80	57	68.4	71.2	48.7
Hawaii (This study)	3	135	515	278	112	54.0	40.3	21.7
1972	1	46	170	88	29	51.8	33.0	17.1
1973	1	46	181	111	55	61.3	49.5	30.4
1974	1	43	164	79	28	48.2	35.4	17.1

HOUSE FINCH

Similar House Sparrow interferences are reported from Colorado and California (Bergtold 1913, Evenden 1957).

SUMMARY

The nesting biology of the House Finch, *Carpodacus mexicanus frontalis* (Say), was studied for three nesting seasons on the University of Hawaii Manoa campus. From 25 to 50 pairs of House Finches nest in the study area from February through August, with nest construction taking approximately 12 days, the incubation period 13 days, the nestling period 17 or 18 days, and the fledgling period from two to three weeks. Clutch size averages four eggs, and a pair most likely successfully raises two broods per nesting season. Nesting success in Hawaii is low, 17% in 1972 and 1974 and 30% in 1973.

Findings indicate that the nesting biology of the House Finch in Hawaii does not differ greatly from populations in North America. Significant differences seem to exist, though, in egg weight, nesting success, and possibly in the nestling growth-pattern.

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Sketch by Erv Deis