

COLORATION FREQUENCIES OF MALE HOUSE FINCHES IN HAWAII

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In North America male House Finches (*Carpodacus mexicanus*) most often have parts of the head, breast, and rump colored red (Michener and Michener 1931). But in Hawaii, where the species was introduced prior to 1870 (Grinnell 1911), males show considerably more color variation, with yellow or orange frequently replacing the red. Largely on the basis of this difference in the males' coloration, Grinnell (1912a,b; later supported by Moore 1939) proposed the Hawaiian population as a separate species, "*Carpodacus mutans*," a proposal not generally accepted (e.g., AOU 1983).

Grinnell (1911) indicated that most male House Finches are colored yellow or orange on all the main Hawaiian Islands. Dunmire (1961), however, pointed out that males found at Haleakala, Maui, were mainly yellow or orange while the ones at Kilauea, Hawaii, were mostly red. During our work on the House Finch in Hawaii (Hirai 1975, van Riper 1974, 1976), we also noted marked differences in the proportions of red, orange, and yellow birds on different islands. We here present the first quantified information concerning the proportions of House Finch color phases in Hawaii.

Between 1973 and 1980 we documented the coloration of male House Finches on three main Hawaiian islands (Oahu, Lanai, and Hawaii). We made too few observations on Molokai, Maui, and Kauai to include those islands in our statistical analyses. On Lanai data on House Finch color were collected visually (see Hirai 1978), while on the other two islands data were collected both visually and by mist-netting birds. Since within each site the proportions of color categories derived from field observation and mist-netting did not differ significantly, data from the two methods were combined. On Oahu, birds were captured and observed within a 90-ha area centered on the University of Hawaii campus in the lower Manoa Valley, on Lanai within an 800-ha area north of Lanai City. Data for the larger island of Hawaii came from two widely separated locations: a 75-ha study area at Puu Laau on the southwestern slope of Mauna Kea (see van Riper 1987) and a 200-ha area on the Mauna Loa Strip Road in Hawaii Volcanoes National Park (see van Riper et al. 1986).

We assigned each male House Finch to one of three color categories: yellow, orange, or red. In an effort to eliminate the influence of wear and fading, all color data were collected between July and December, the postbreeding period in Hawaii (Hirai 1975, van Riper 1976). Efforts were also made to minimize the possibility of multiple observations of the same bird by counting birds along transects and at extended intervals between observation periods (e.g., see Hirai 1978). Banded birds were recorded only once; all recaptures and visual sightings of banded birds were eliminated from data analyses. All data were analyzed with chi-square tests; we accepted a difference as significant when the test indicated its probability was less than or equal to 0.05.

We found that frequencies of male House Finch coloration varied from Oahu to Lanai to Hawaii (Table 1). On the island of Hawaii, 49% of the males on Mauna Kea were red (the two Hawaii sites together averaged 43% red), while Lanai had about 25% and Oahu only 5% red males. The differences among the color-phase compositions of House Finch populations on each of the three islands ($\chi^2 = 120.7$) were

NOTES

Table 1 Coloration of Male House Finches in the Hawaiian Islands, 1973–1980

Color	Hawaii			
	Oahu	Lanai	Mauna Kea	Mauna Loa
Yellow	51 (54.8%)	66 (38.8%)	17 (6.3%)	4 (4.3%)
Orange	37 (39.8%)	61 (35.9%)	121 (45.2%)	63 (68.5%)
Red	5 (5.4%)	43 (25.3%)	130 (48.5%)	25 (27.2%)
Island totals	93	170		360

significant. There was even a significant difference between the two populations sampled on the island of Hawaii ($\chi^2 = 15.1$). Interestingly, one male observed on Mauna Kea in November 1974 had a red head and yellow rump while another bird mist-netted in October 1978 had a red head and orange rump.

From the literature, on Kauai and Maui (Dunmire 1961), and probably Niihau (Fisher 1951), it appears that most males are colored yellow or orange. On Maui we have observed mainly orange House Finches, while on Kauai we recorded 22% red, 45% orange, and 33% yellow males ($n = 9$). Although color frequencies differed significantly at each location that we examined, it appears that Hawaii is the only island with a substantial fraction of red House Finches.

Michener and Michener (1931) trapped 1226 male House Finches in California, noting 1001 as red (81.6% of the total) and 225 as yellow, orange, or orange-pink (18.4%). The difference between this ratio of red and non-red House Finches in California and that on Hawaii is significant ($\chi^2 = 209.7$).

The causes of these variations in color frequency in Hawaii are not yet completely known. Grinnell (1911) implied that the differences were genetically and physiologically based, brought about by the close inbreeding of the small original stock introduced to the Hawaiian islands. Dunmire (1961) felt that the differences were caused by diet rather than heredity. More recently, laboratory studies by Brush and Power (1976) strongly suggested that dietary factors, in concert with physiological ones, may account for differences in House Finch hues. They demonstrated that birds molt in red feathers if fed canthaxanthin. A simple test would be to capture yellow males in Hawaii, pluck a few feathers, and record how they grow back with and without dietary pigment supplements. The explanation that is finally accepted for these coloration differences will have to account for our observational differences in color frequencies of male House Finches among islands in the Hawaiian archipelago and between these islands and California.

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