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## THE BREEDING SEASON OF THE HAWAII 'AMAKIHI


ANDREW J. BERGER[1]

*University of Hawaii*


FIGURE 1.—Nestling Hawaii *'amakihis* (Nest No. 10) gaping for food. Note the rose-red mouth lining, which serves as a "target" area for the adults when feeding the young. Startech picture taken November 21, 1966. This is the first published photograph of the nestlings of any race of the *'amakihi*.

IT IS A TRAGIC FACT that the nests and eggs of most of the extinct members of the Hawaiian honeycreeper family (Drepanididae) were never described. This is especially tragic because the endemic Hawaiian honeycreepers provide zoologists with the example *par excellence* of adaptive radiation within a family of animals: or, to put it another way, the best example of the results of evolutionary processes on oceanic islands. The example is even more striking than that of the much better known Darwin's finches (the Geospizinae) of the Galapagos Islands. At the same time, the evidence suggests that as many as 40 percent of the species or subspecies of honeycreepers are extinct, and that the status of a large number of the living forms can only be described as precarious.

Field work on the native land birds of Hawaii is very difficult. The volcanic origin of the islands and wind and water erosion over countless thousands of years have produced deep valleys and precipitous cliffs, where climbing is hazardous or absolutely impossible. In the cloud forests, the best honeycreeper habitat, with an annual rainfall of somewhere between 100 and 600 inches, one must anticipate working in the rain or, at least, in a fog-saturated atmosphere. In addition, the relatively rapid revegetation of rough *aa* lava flows makes it imperative to watch every footstep. Tree ferns and ground vegetation often conceal gaping holes and crevices. One can look for birds only when standing still and not while strolling along. One simply does not stroll when searching for honeycreepers.

The first serious collection and study of Hawaiian birds did not occur until the last two decades of the 19th century. Those collectors and writers were justifiably concerned primarily with the discovery of new species. Few found nests and they did not comment on the breeding season of Hawaiian birds. Bryan (1905, p. 243) remarked that "from the meagre data that has thus far been gathered we conclude that April and May are the months in which [*Chlorodrepanis*] *virens* [*Loxops v. virens*] breeds." It may be noted here that many of the honeycreepers have only an Hawaiian and a Latin scientific name. Only a few also have English names, so that one simply has to become familiar either with the Hawaiian or the scientific names.

We still know very little about the breeding biology or the length of the nesting season of the living species. Baldwin's study (1953) of three species of honeycreepers in the vicinity of Hawaii National

Park on the island of Hawaii is the only reliable published paper on the breeding biology of these birds. He compared the annual cycle of the Hawaii *'amakihi* (*Loxops v. virens*), the *'apapane* (*Himatione s. sanguinea*), and the *'i'iwi* (*Vestiaria coccinea*) on the slopes of Hawaii's two active volcanoes, Mauna Loa and Kilauea. He stated that "observations for the purpose of elucidating the male gonadal cycle included mainly measurements of the fresh gonads *in situ* at the time the body cavity was opened in each specimen." Baldwin saw his first fledgling *'amakihis* in the middle of May, but he added that, based on all of the information at his disposal, he would "interpret this as meaning not that fledglings do not appear before May but rather that most nesting in this species is done in late spring and early summer."

Another complicating factor in the study of Hawaii's native land birds, therefore, is the lack of specific information on the breeding season. One has only a vague idea of when he should be looking for nests. Baldwin wrote (pers. comm., October 18, 1965): "Even with the numerous species, it was exceedingly hard to find good nests to study. One thing that contributed to the difficulty was the drawn-out and protracted period of nesting, so that not many nests were active at one time in any area. You would be out there looking for a nest in what you thought was the beginning of the nesting season, and a fledged young would fly by."

My own attentions were focused on late winter and early spring as the probable nesting season for the honeycreepers by my experiences in 1964, when on February 23 I found nests under construction by the *'i'iwi* and the *'anianiau* (*Loxops parva*), near the Alakai Swamp on the island of Kauai. I witnessed copulation by a pair of Kauai *'amakihi* that same day. I also found a nearly completed, but empty, nest of the Hawaii *'amakihi* on the Dillingham Ranch on Hawaii on May 9, 1964.

I visited the Kaohe Game Management Area on the southwestern slope of Mauna Kea for a short time on May 20, 1966, and saw a female *'amakihi* carrying nesting material at that time. I returned to the area on June 13, and found two active *'amakihi* nests. A female *'amakihi* was incubating two eggs in one nest. The other nest held one nestling in pin feathers and one unhatched egg. I spent July 10 and 11 in the area again, but found no active nests.

FIGURE 2.—Nest and two eggs of the Hawaii *'amakihi*. A Startech photograph of Nest No. 1. June 15, 1966. This is the first published colored photograph of the nest and eggs of any race of the *'amakihi*.

The Kaohe Game Management Area and the contiguous Mauna Kea Game Management Area contain about 10,000 acres of *mamane-naio* forest. The two areas extend from an elevation of about 6,000 to 10,000 feet. The present tree line, however, ends at about 9,300 feet, and the feral sheep and pigs are rapidly destroying the vegetation there, thus preventing regeneration and lowering the timber line. This area is, unfortunately, the only known breeding grounds for the *palila* (*Psittirostra bailleui*).

FIGURE 3.—The *mamane-naio* forest on the Kaohe Game Management Area on the slopes of Mauna Kea. Mauna Loa (13,680 feet) lies in the background. Photographed by the author, July 17, 1967.

The only way to discover an essentially unknown breeding season is to visit the study areas periodically throughout the year until the question is answered. I made my first "postbreeding" visit to the Mauna Kea study area on November 3, 1966, spending two days there. The male *'amakihis* appeared to be in full song. I was, nevertheless, somewhat surprised to find a female *'amakihi* adding lining material to a nest on November 3. I found two more nests that day: one under construction and another with one egg. I found two additional nests the following day. A female *'amakihi* was incubating three eggs in one of the nests. The other nest held three nestlings, which I estimated to be three or four days old. The latter nest, of course, indicates that some *'amakihis* on Mauna Kea begin to nest by mid-October.

During the following nine months, I visited the study area on the slopes of Mauna Kea 13 times, spending from one to three days observing the *'amakihis* on each trip. I found a total of 40 active nests during this period. I discovered that not only did the breeding season begin by mid-October in 1966, but also that the season is, indeed, a protracted one, having extended from October to at least

May, 1967. How much variation there may be from year to year remains to be determined by continuing studies on the area.

It was surprising to discover that, although the *'amakihi* was first described technically in 1782, there seemed to be no detailed statements in the literature about the nesting of this very common species. R. C. L. Perkins wrote (1903, p. 410) that he had seen the nest "in many kinds of trees, sometimes at no great height from the ground, and poorly concealed," but he did not mention any specific nests.

Some *'amakihi* nests, however, are very well concealed, and may be barely visible from only one position on the ground. The birds, also, often build their nests so near the tips of small and brittle branches that it is impossible to check the contents of the nests or to measure their height above the ground. I found the average measured height above ground of 28 *'amakihi* nests to be 13.4 feet, with a range from 7.4 to 19.2 feet. I estimated the height of several nests I could not reach to be at least 25 feet above the ground. Of 41 nests, 32 were built in *mamane* (*Sophora chrysophylla*), and 9 were in *naio* (*Myoporum sandwicense*). One nest which Dr. Charles Lamoureaux analyzed for me was composed primarily of *mamane* (including leaflets, petiole and rachis of leafstalks, and one seed pod), runners of a grass, and the whole plants of the lichen *Usnea*. There also were a few bits of thistledown (the pappus of *Cirsium lanceolatum*), as well as a few feathers.

Bryan (1905) described a single nest and its three eggs of the Hawaii *'amakihi,* which were collected by a friend in the Hamakua district of Hawaii on May 3, 1905. Bryan commented that the eggs "are much paler in color than those figured by Professor Newton," but that the eggs illustrated by Walter Rothschild in his *The Avifauna of Laysan* (1893-1900) "are very satisfactory figures." Bryan added that the nest shown by Rothschild "lacks character" and that the nest and eggs in the work by Wilson and Evans (1890-1899) "are both misleading."

Insofar as I have been able to determine, only one additional active *'amakihi* nest was mentioned in the literature during the period from 1905 to 1964. Baldwin (1953) referred to three banded *'amakihis* that left their nest on June 14, 1941. King and Bratley (1964) told of a nest with two eggs they found in the Kaohe Game Management Area on April 18, 1964.

None of the early workers apparently found enough nests to permit comment on the clutch size of the *'amakihi*. In my nests, the clutch was two eggs in seven nests, and three eggs in sixteen nests. I also found one nest with four eggs; this was on March 14, 1967, when I had the pleasure of introducing Drs. Konrad Lorenz and Ernst S. Reese to the honeycreepers on Mauna Kea.

When a United States mainlander thinks of Hawaii, he is likely to think of Waikiki Beach with its surfers, palm trees, and tropical climate, where the monthly variation in temperature may be less than 15 degrees. The picture is entirely different in the mountains of the other islands. Pohakuloa on the Saddle Road of Hawaii is approximately 10 miles, as the crow flies, from the study area on Mauna Kea. Pohakuloa is at an elevation of about 6,500 feet. Here the monthly variation in temperature (difference between maximum and minimum temperatures) varies from 41° to 56° F., and averages about 51°. During only two months (June and August) in 1966 did the nighttime temperature at Pohakuloa not drop below 32° F.

The maximum temperature at Pohakuloa during October, 1966, was 78° F.; the minimum temperature was 31° F. This was the month that at least one pair of *'amakihis* built their nest and incubated a clutch of three eggs; these hatched on or about October 31. Moreover, the other *'amakihis* which nested throughout the winter of 1966-1967 were exposed to even lower temperatures (27° F. in December, and 22° F. in January).

We are accustomed to thinking of the prairie horned larks (*Eremophila alpestris*), which nest in Michigan and other northern states in March and April when snow and below-freezing temperatures are to be expected, as hardy birds. In tolerance of low temperatures we must also view the *'amakihis* on Mauna Kea as hardy birds. Several intriguing problems for future study immediately come to mind. What factors trigger the initiation of the breeding cycle during October in the Mauna Kea *'amakihis* when the days are growing shorter? Are these the same factors that stimulate breeding of the *'amakihis* that nest in the *'ohi'a* (*Metrosideros*) forests on Mauna Loa? How rapidly does temperature regulation develop in nestling *'amakihis* that are hatched when below-freezing nighttime temperatures are commonplace?

Because of the high endemism of its plants and animals, Hawaii has been described as the "most unique" land area in the world. It

is recognized as an outstanding natural laboratory for the study of evolutionary processes. We may hope that enough of the native vegetation is preserved long enough for many scientists to search for answers to the innumerable intriguing and unanswered biological questions in the Hawaiian Islands.

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## NOTES

* Volume XXIV of the Occasional Papers is published in honor of Edwin H. Bryan, Jr., whose service to Bishop Museum began in 1919. He was for many years Curator of Collections, and at present is Manager of the Museum's Pacific Scientific Information Center. This was one of the papers read at a Symposium, held at the Museum on April 13, 1968, honoring Mr. Bryan on the occasion of his 70th birthday.

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