

OBSERVATIONS ON DISTRIBUTION, DIET, AND BREEDING OF THE HAWAIIAN THRUSH

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Although hosting a variety of endemic birds, the Hawaiian Islands have only two native species of the Thrush family (Turdidae). The island of Hawaii supports only the larger species, the Omao (*Phaeornis obscurus obscurus*). Working in native forests throughout the past seven years, we have observed Omao many times, and because so little is known of the bird, we have compiled our data to elucidate present-day distribution, breeding habits, and diet of the species.

DISTRIBUTION

The Omao is presently believed to be extinct on Oahu and Lanai, much reduced on Molokai (Scott et al. 1977) and Kauai (Berger 1972), but still common on Hawaii. There has been, however, some reduction in its range on Hawaii (Fig. 1). We have failed to find the species in the Kohala Mountains or in the Kona area, although Perkins (1903) recorded it as quite abundant in Kohala; Wilson and Evans (1890-1899), Henshaw (1902), and Munro (1944) all cited the Omao as common in Kona. In a recent avian survey of the South Kona Forest Reserve, C. Morgan (pers. comm.) also failed to find any. Omao are still abundant in the windward (e.g., northeastern) forests on Hawaii, and have a continuous distribution from Kahuku Ranch, through Hawaii Volcanoes National Park, to the northern reaches of the Hilo Forest Reserve (Fig. 1).

The elevational distribution of the Omao is quite wide when compared to ranges of other extant native passerines, although its range has decreased. Henshaw (1902) found the bird present from 305 m in elevation to the upper forest limits. Today, lowest occurrence in the Kau Forest is 700 m, and in the Puna Forest Reserve approximately 550 m. In the Waiakea forests Omao are found as low as 800 m; throughout the Hilo Forest Reserve the lower elevational limit is approximately 1,000 m. In the latter region, an extensive area of forest die-back appears to limit the birds to the higher elevations. Upper elevational limits are still generally dictated by its habitat, the ohia (*Metrosideros collina*) and ohia-koa (*Acacia koa*) forests on both

Mauna Loa and Mauna Kea. We have, however, regularly seen Omao in alpine and sub-alpine scrub habitats on Mauna Loa. Omao populations in these habitat types above the Kau Forest Reserve were continuous with the forest population. However, there are widely scattered sightings of this species as high as 3,500 m on the eastern flank of Mauna Loa (J. Jacobi, pers. comm.). Because these high-altitude birds are so far removed from the nearest forest Omao, it is possible that they constitute distinct populations, although study with banded individuals is needed before this question can be resolved.

DIET

Little quantitative data exist on food preferences of the Omao. Henshaw (1902) found that less than five percent of the birds he collected contained insect parts, and that most of the stomachs held only berries. He did find an occasional stomach that had spiders or brown looper caterpillars (Geometridae), and also noted one that contained a minute land-shell. Omao were known to migrate to parts of the forest which had outbreaks of caterpillars (Perkins 1903). We have observed Omao gleaning for insects on branches and trunks of various tree species, but more frequently on koa and kawau (*Ilex anomala*). Larger trunks appeared to be preferred, and from perches birds often dashed into the air to hawk flying insects. Omao also forage on the ground.

These birds appear to eat mostly fruit, including that of kopiko (*Psychotria hawaiiensis*), kawau, ieie (*Freycinetia arborea*), mamaki (*Pipturus albidus*), olopuia (*Osmanthus sandwicensis*), olapa (*Cheirodendron trigynum*), and pilo (*Coprosma ernodeoides*, *C. menziesii*, *C. montana*, *C. pubens*, *C. rhynchocarpa*) in its diet (Henshaw 1902, Perkins 1903, Pratt 1971). Our observations indicate that Omao are opportunists, taking seasonal fruits with supplements of various insects (Table 1). In a kipuka (an island of forest in younger vegetation) off the Saddle Road on 9 March 1972, we saw an Omao displacing a smaller individual and then consuming ripe maile (*Alyxia olivaeformis*)

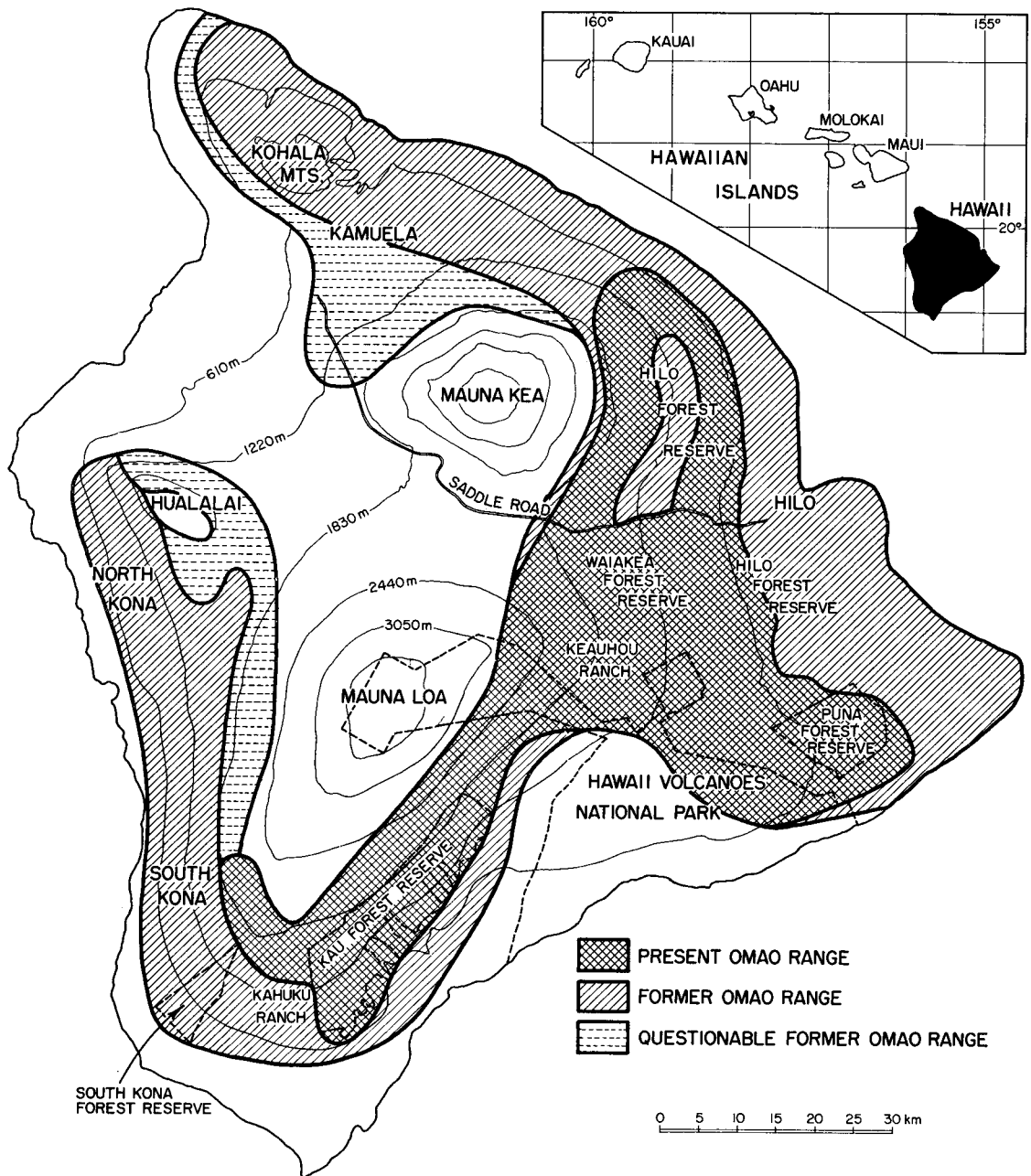


FIGURE 1. Map of Hawaii showing former, questionable former, and present day range of *Phaeornis obscurus*.

drupes at the perch site. In the Kau Forest on 20 May 1973 the birds were seen eating akala (*Rubus hawaiiensis*), the native Hawaiian raspberry, and ohelo (*Vaccinium berberifolium*, *V. reticulatum*) berries; on 20 May 1976 courtship feeding of pilo drupes was observed. On many occasions we have also watched birds eating olapa, pilo, kawau, pukiawe (*Styphelia tameiameia*), mamaki, and naio (*Myoporum sandwicense*) fruits.

The first author has successfully kept the OMAO in captivity on a diet of various fruits (e.g., grape, papaya, orange, apple, blackberry) supplemented with high protein cereals and insect larvae.

Table 1 suggests that preferred items are insects and drupes of the kawau. Contemporary ornithologists have found the bird utilizing different food sources than did earlier workers. This apparent shift in diet

TABLE 1. All food types known to be eaten by the Hawaiian Thrush.

Food type	Early observers						This study		
	Wilson and Evans (1890-1899)	Henshaw (1902)	Perkins (1903)	Munro (1944)	Pratt (1971)	Berger (1972)	Frequent (>20 observ.)	Occasional (10-20 observ.)	Infrequent (<10 observ.)
Land snails		x		x					
Insects		x	x	x	x		x		
Fruits									
Ieie (Pandanaeae)				x					
Mamaki (Urticaceae)		x							x
Olopuu (Oleaceae)			x						
Ohelo (Ericaceae)						x	x		
Pilo (Rubiaceae)					x			x	
Kopiko (Rubiaceae)	x	x	x						
Olapa (Araliaceae)			x			x	x		
Kawau (Aquifoliaceae)		x	x		x		x		
Maile (Apocynaceae)									x
Akala (Rosaceae)									x
Naio (Myoporaceae)							x		
Pukiawe (Epacridaceae)									x
Kolea (<i>Myrsine lanaiensis</i> : Myrsinaceae)									x
Painiu (<i>Astelia menziesiana</i> : Liliaceae)									x

probably is the result of the species being restricted to higher forests, resulting in feeding on fruit-bearing species of these forests (e.g., naio, ohelo, pilo). The principal food items reported by early workers (e.g., olopuu, ieie, mamaki) were more abundant in the lower wet forest habitat (Rock 1974), much of which has now been cleared for agricultural use.

BREEDING HABITS

SONG

Perkins (1903) felt that the song of the Hawaiian Thrush surpassed in beauty that of all other native birds, and somewhat resembled the song of the European Song Thrush (*Turdus philomelos*). Indeed, the Omao is a preeminent songster, and it frequently sings earlier and later than other passerine species on Hawaii, often before the sun has appeared and well after sunset (Table 2). We have recorded Omao singing in every month of the year. Its repertoire includes at least three songs and numerous call notes. The most commonly heard song is slurred upward and musical, often given in flight. Another version, much shorter, is given while perched. There also is a complex "whisper" song, usually given in the non-breeding season. Location calls are the most

commonly heard vocalizations and resemble a gurgled buzz. We have been able to discern three variations of this call, each used in a different behavioral situation. Wilson (1890-1899) also noted a distinctive alarm call which he described as a "remarkable hissing sound." Further study on Omao vocalizations will undoubtedly reveal more call notes.

NESTS

The first nest of the thrush on Hawaii was discovered in upland Kona by Perkins (1903). It was in a mamane (*Sophora chrysophylla*) tree but apparently was never completed. The next nest reported was from a kipuka off the Saddle Road near Mauna Kea (Berger 1969). This structure was located 1.1 m from the ground near the top of a tree fern (*Cibotium* sp.) trunk; it contained one piped egg. Berger (1972) reported another nest from the same area also situated on the side of a tree fern.

Within the past two years, five active Omao nests have been found on the Keauhou Ranch and in the Kau and Hilo Forest Reserves. Each was placed, not on the end of a branch or tree fern, but in a tree hollow or on a protected platform. We were not surprised to find the birds using well-concealed recesses in trees, as Skutch (1967) cited sim-

TABLE 2. Sequence of early morning avian vocalizations heard in native Hawaiian rain forests.

Time of day	Kau Forest Reserve			Hawaii Volcanoes National Park
	27 May 1976, 2,010 m elev., clear weather	22 June 1976, 1,560 m elev., overcast weather	25 June 1976, 1,000 m elev., clear weather	24 Nov. 1977, 1,525 m elev., clear weather
05:00				
05:05			Omao	
05:10	Omao		Apapane	
05:15	Apapane*	Omao		
05:20	Iiwi	Amakihi	Iiwi	
05:25	Amakihi	Akepa		
05:30				
05:35		Iiwi	Amakihi	
05:40	SUNRISE	Apapane	Japanese White-eye	
05:45		SUNRISE	SUNRISE	
05:50				
05:55				Omao
06:00				Apapane
06:05				
06:10				Japanese White-eye
06:15				Red-billed Leiothrix
06:20				Amakihi
06:25				
06:30				
06:35				SUNRISE

* Apapane (*Himatione sanguinea*), Akepa (*Loxops coccinea*), Amakihi (*Loxops virens*), Iiwi (*Vestiaria coccinea*), Japanese White-eye (*Zosterops japonica*), Red-billed Leiothrix (*Leiothrix lutea*).

ilar nesting locations for Central American thrushes. The subtropical *Myiadestes*, to which some authors (e.g., Ames 1975) believe the Omao is most closely related, nest in sheltered crevices in a variety of situations (Wagner 1955).

We found our first Omao nest on 25 May 1976 at 1,590 m elevation in the Kau Forest Reserve. The nest was 3 m from the ground on a pukiawe branch that fitted into an indentation of a much larger ohia (Fig. 2). It contained two nestlings, and by 7 June both young apparently had fledged. The nest was collected 9 August and had these measurements: height 109 mm, width from 188 to 257 mm, bowl width 68 mm, bowl depth 49 mm, rim thickness from 22 to 43 mm, and

weight 95 g. The body was composed primarily of olapa leaves, pieces of *Cibotium* sp. and *Sadleria cyatheoides* fronds, mosses, and a few dead ohia branches. The bowl was lined with fern rootlets.

On 19 and 20 May two nests were found on Keauhou Ranch. The first was 12 m up in a cavity formed by the trunk and loose bark of a dead ohia; only the main trunk, with a diameter-at-breast-height (dbh) of 38 cm, and one large branch remained. On 23 May, 3 and 8 June, adults were attentive, but when checked on 15 June the nest was empty. The second nest also was in a large ohia (tree height 18 m, dbh 59 cm) trunk cavity, 9 m from the ground. On 23, 24, and 27 May a bird was sitting, 1 June an adult was brood-



FIGURE 2. *Phaeornis obscurus* nest fitted into an ohia tree indentation, at 1,590 m elevation in the Kau Forest Reserve, Hawaii.

ing, and 8 June both adults fed the young. There was no activity on 15 June, and when checked 21 June the nest was empty (L. Hirai, pers. comm.). A third nest was found in the Kau Forest Reserve on 27 May 1977 at 1,725 m elevation. It was under construction 3.4 m up in a tree crevice which measured 25.4 cm high \times 7.6 cm wide \times 5.1 cm deep. The nest was being built principally of ferns and grasses at the junction of a large branch and the trunk. The nest-tree was an ohia 15.2 m high with a dbh of 50.8 cm. The last active nest was found in the Hilo Forest Reserve at 1,740 m on 18 June 1977. It was also in a cavity (63.5 cm high \times 38.1 cm wide \times 30.5 cm deep). Nest location was 4.6 m from the ground in a 9.1 m ohia (dbh 76.2 cm). This nest contained two eggs, and was composed of koa phyllodes and dry hoio (*Athyrium* sp.) rootlets outside, with grass and fern rootlets lining the cup.

EGGS

Berger (1972:106) described an Omao egg as having a "grayish white background heavily covered with small, irregularly shaped, reddish brown markings distributed over the entire surface of the egg." No measurements were given. The eggs found during the summer of 1977 had large lavender splotches on a lighter background; one egg was evenly covered with markings while another had markings concentrated at the larger end. Measurements of two eggs averaged 2 \times 3 cm.

YOUNG

The nest found 25 May 1976 contained two young in pin feathers. Both nestlings had their eyes open and when approached exhibited a fear response. Each had flesh colored



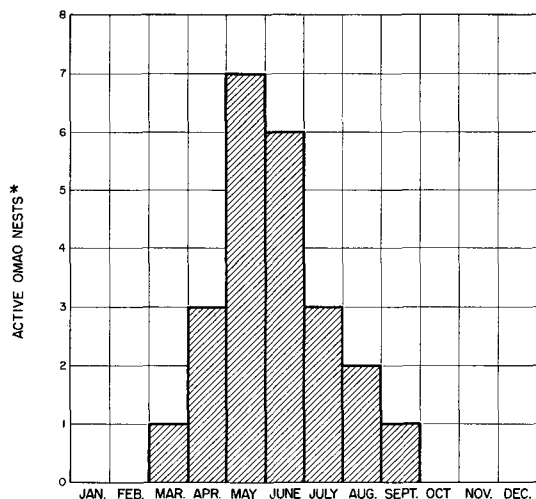
FIGURE 3. The first published photograph of a *Phaeornis obscurus* nestling, taken 25 May 1976 in the Kau Forest Reserve, Hawaii.

skin with black nestling down in the pterylae (Fig. 3). Brown feathers were just unsheathing from the primaries, secondaries, and dorsal tract. The anterior portion of the rictus was white and became light yellow toward the commissural point. The interior of the mouth was bright yellow.

During 30 min of observation an adult made one trip to this nest and fed the young four bright orange pilo drupes. The parent remained at the nest for several minutes and ate four fecal sacs before leaving. When young fledge they are brown with a white-speckled breast, but we have no information on how long they are cared for by the parents. Duration of bird activity at each nest we observed would indicate a nesting sequence (from initiation of nest building to fledging of the young) of approximately 30 days.

BREEDING SEASON

On the upper slopes of Mauna Loa (1,600 m) the 1978 Omao breeding season began sometime in late January or early February. During December 1977, Omao were more frequently seen in small flocks moving throughout the forest, and a male specimen found 10 December had regressed testes. A young male collected on 5 February 1978 had testes less than 1 mm, but on 7 February two mature males had quite swollen gonads. Male Omao mist-netted during February had cloacal protuberances ($n = 6$), and copulation was observed on 6 February. Furthermore, birds were seen carrying nesting material throughout late February and early March 1978. Therefore, nesting probably begins sometime in early February, reaches maximum during



* ONE NEST CAN OCCUPY MORE THAN ONE MONTH.

FIGURE 4. Active nests of *Phaeornis obscurus* on Hawaii, based on all known nesting records.

May or June, and declines in October (Fig. 4). Palmer (*in* Rothschild 1893-1900) thought the breeding season February to May. Although he shot a female on 17 September with an egg ready for expulsion, he considered it an anomaly. Munro (1944) found spotted young and birds taking leaves for nests, and he shot a number of Omaso with enlarged gonads (one female had an egg in the oviduct) in September-October 1891. Prior to 1978 all of our active nests occurred from May through July, as did Berger's (1972), but we saw recently fledged young on 8 October 1973 and 15 October 1978. From data presently available, the Omaso breeding season spans at least a nine-month period, and future studies of this species may show nesting to occur in the other three months of the year.

SUMMARY

Distribution, breeding habits, and diet of the Hawaiian Thrush were recorded over seven years on the island of Hawaii. The range has been much reduced, with the result that today the species occupies approximately 30% of its former range, no longer being found in the Kohala Mountains or in the Kona area.

Data on food preferences indicate the species subsists chiefly on fruits of native trees, when in season, and various insects. Comparison of present feeding habits with observations of earlier workers indicates that the diet has changed. This probably has been a consequence of the loss of suitable habitat at lower elevations.

One of the earliest and latest daily singers in Hawaii, the Omaso has a repertoire of at least three songs and a number of calls. The species exhibits courtship feeding. Five nests averaged 6.4 m from the ground; nesting materials include small twigs, leaves, grasses, mosses, and fern pieces. For the first time the species was found to nest either in cavities or on protected platforms. One or two eggs, each marked with large lavender splotches, compose the clutch. Nestlings have flesh-colored skin, black down, and a bright yellow gape pattern. Time from building of the nest to fledging of the young is about 30 days, and the overall breeding season of the species extends at least from February to October.

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LITERATURE CITED

- AMES, P. L. 1975. The application of syringeal morphology to the classification of the Old World Insect Eaters (Muscicapidae). *Bonn. Zool. Beitr.* 26:107-134.
- BERGER, A. J. 1969. Discovery of the nest of the Hawaiian Thrush. *Living Bird* 8:243-250.
- BERGER, A. J. 1972. *Hawaiian birdlife*. Univ. Press of Hawaii, Honolulu.
- HENSHAW, H. W. 1902. *Birds of the Hawaiian possessions with notes on their habits*. T. G. Thrum, Honolulu, Hawaii.
- MUNRO, G. C. 1944. *Birds of Hawaii*. Tongg Publ. Co., Honolulu, Hawaii.
- PERKINS, R. C. L. 1903. *Vertebrata (Aves)*, p. 368-465. *In* D. Sharp [ed.], *Fauna Hawaiiensis*, Vol. I. University Press, Cambridge.
- PRATT, T. K. 1971. *Environment and feeding behavior of the Hawaiian Thrush*. Unpubl. ms. (A copy has been deposited in the library at Hawaii Volcanoes National Park, Hawaii.)
- ROCK, J. F. 1974. *The indigenous trees of the Hawaiian Islands*. Charles E. Tuttle Co., Rutland, Vermont.
- ROTHSCHILD, W. 1893-1900. *The avifauna of Laysan and the neighbouring islands*. R. H. Porter, London.
- SCOTT, J. M., D. H. WOODSIDE, AND T. L. C. CASEY. 1977. Observations of birds in the Molokai Forest Reserve, July 1975. *Elepaio* 38:25-27.
- SKUTCH, A. F. 1967. *Life histories of Central*

- American highland birds. Publ. Nuttall Ornithol. Club No. 7.
- WAGNER, H. O. 1955. Zur Biologie des Bergclarinos (*Myiadestes obscurus* Lafr.). Bonn. Zool. Beitr. 6:200-206.
- WILSON, S. B., AND A. H. EVANS. 1890-1899. Aves Hawaiiensis: The birds of the Sandwich Islands. R. H. Porter, London.
- Avian Disease Laboratory, Cooperative National Park Resources Studies Unit, P.O. Box 54, Hawaii Volcanoes National Park, Hawaii 96718. Address of second author: Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service, P.O. Box 44, Hawaii Volcanoes National Park, Hawaii 96718. Accepted for publication 7 September 1978.*