The Present Status of the Birds of Hawaii[1]

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THE GREAT EXPANSES of open ocean that separate the Hawaiian Islands from the major continental land masses of North America and Asia resulted in the evolution of a number of unique landbirds. Unfortunately, a higher percentage of species of birds have become extinct in Hawaii than in any other region of the world. Approximately 40 percent of the endemic Hawaiian birds are believed to be extinct, and 25 of the 60 birds in the 1968 list of "Rare and Endangered Birds of the United States" are Hawaiian ("Rare and Endangered Fish and Wildlife of the United States, 1968 edition," Bureau of Sport Fisheries and Wildlife, Washington, D. C.). Most of the native birds of Oahu have long been extinct, and few native landbirds are to be found on any of the main islands below 3,000 feet elevation.

Three general groups of birds are found in Hawaii today: endemic, indigenous, and introduced.

ENDEMIC HAWAIIAN BIRDS

Ten families of birds are recognized as having endemic genera, species, or subspecies in Hawaii (although taxonomic dispute still exists regarding the relationship of some Hawaiian forms to closely related North American forms); in addition, one entire family of birds (Drepanididae) is endemic to the Hawaiian chain of islands (Amadon, 1942; Mayr, 1943). An "endemic" form is one that occurs in one region only and is not found in any other part of the world. Ornithologists believe that the ancestors of these birds reached Hawaii from the areas indicated in Figure 1. The endemic Hawaiian birds, listed according to these 11 families, are discussed briefly.

1. Anatidae (ducks, geese, and swans)

The NENE or HAWAIIAN GOOSE (*Branta sandvicensis*) is endemic to the island of Hawaii, and in 1962 birds were first released in the Paliku Cabin area of Haleakala Crater on Maui. There is still debate as to whether or not the Nene originally inhabited Maui.

The Nene was on the verge of extinction in the 1940s, and the species is still included in the list of endangered species. In 1949 a Nene Restoration Program was begun by using a pair of captive birds obtained from Herbert Shipman of Hawaii. This has been a very successful program, and Nene have been raised in captivity both at the Severn Wildfowl Trust at Slimbridge, England, and at the State of Hawaii Fish and Game rearing station at Pohakuloa on the Saddle Road of Hawaii (Elder, 1958).

The program at Pohakuloa has been increasingly effective throughout the years, primarily through the dedicated efforts of Mr. Ah Fat Lee. Over 500 Nene have been raised at Pohakuloa during the period of 1949 through 1968. Most of these pen-reared birds have been released at several known habitats of wild Nene on the slopes of Mauna Loa; a smaller number have been released in Haleakala Crater.

The Nene is a highly specialized goose, adapted for living in a rugged habitat of lava flows far from any standing or running water (Miller, 1937). Among the more noticeable anatomical specializations for this terrestrial life is a reduction in the webbing between the toes. The birds spend much of the time on sparsely vegetated lava flows on Mauna Loa and Hualalai, at elevations between approximately 5,000 and 8,000 feet. Here the birds often build their nests on the lava although typically well concealed in clumps of vegetation. The nests are lined with the birds' own down feathers; the clutch consists of from 2 to 5 eggs.

The KOLOA or HAWAIIAN DUCK (*Anas wyvilliana*) originally was found on all of the main Hawaiian Islands except Lanai and Ka-

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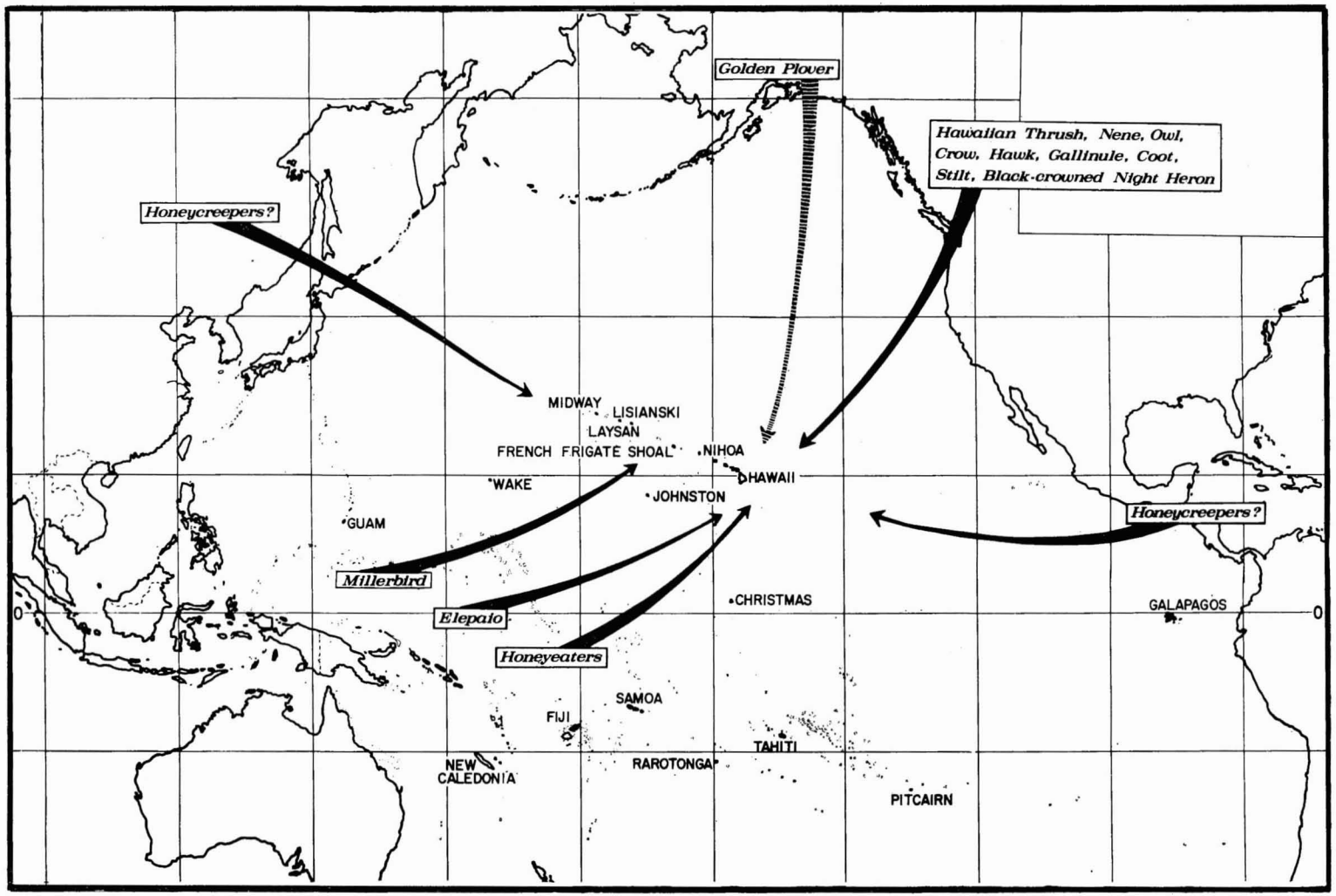

FIG. 1. Map of the Pacific Basin to show regions from which the ancestors of endemic Hawaiian birds are presumed to have originated. The broken arrow indicates the annual migratory flights of the Pacific Golden Plover between Alaska and the Hawaiian Islands.

hoolawe. A decline in numbers of Koloa on most of the islands was noted by several writers after the turn of the present century, and in recent years this duck has been found only on Kauai. A propagation program is now underway at Pohakuloa, Hawaii.

Man probably was the most serious predator on the Koloa, and the birds could be hunted legally during the early 1920s, when the bag limit was 25 ducks per day. Duck hunting was prohibited for a period of two years beginning in 1939, and hunting was further closed during World War II. Fortunately, duck hunting (both for the Koloa and the wintering migratory ducks) has been prohibited since that time. The decline in taro and rice acreages, however, has reduced suitable habitat for the birds.

Wild dogs are known to be serious predators on both ducklings and the adults in their flightless stage during the annual postnuptial molt. A number of other animals (e.g., largemouth bass, bullfrog) have been known to kill small ducklings on Kauai. The role of the mongoose in the great reduction or extinction of the Koloa throughout most of its former range is unknown, but it may be significant that Kauai, the last stronghold of the Koloa, is the only main island on which the mongoose has not been introduced. Wild cats, rats, and pigs also destroy nests.

The main breeding season on Kauai appears to be from December through May, although the species seems to breed throughout the year, inasmuch as nests or downy young have been found in all months except August (Swedberg, 1967). The well-concealed nests are built on the ground. Clutch size is reported to be from 2 to 10 eggs, with a mean of 8.3 eggs for wild birds. The Koloa is tolerant of varying climatic and ecological conditions. On Kauai the birds nest from sea level to 3,500 feet elevation, and in areas of annual rainfall varying from 35 to 125 inches.

The LAYSAN DUCK (*Anas laysanensis*) was in danger of extinction during the early part of this century (Rothschild, 1893–1900). Again man was the agent of destruction. The birds were hunted for sport and for food by the personnel of the guano mining company on Laysan, and, after these operations ceased, Japanese feather hunters also used large numbers of the ducks for food. Theodore Roosevelt established the Hawaiian Islands National Wildlife Refuge in 1909, but Alfred M. Bailey believed there were only seven ducks left by 1912. Alexander Wetmore (1925) counted 20 birds during the Tanager Expedition of 1923. Since that time, when the last of the rabbits were believed to have been killed, both the vegetation and the Laysan Duck have made a remarkable recovery. Because of the dense vegetation of the areas inhabited by the ducks, it is virtually impossible to make an accurate count of the birds, but the population is now thought to fluctuate between 100 and 600. The downward fluctuations in population that do occur are thought to result in part from severe winter storms, but there may be other, as yet unknown, reasons. The present habitat is thought to be adequate for about 600 ducks.

It is imperative for the future welfare of the Laysan Duck (as well as for the surviving honeycreeper and the tens of thousands of nesting seabirds) that predators (such as rats, cats, dogs) and pest insects and plants (which would alter the ecology of the island) be prevented from gaining access to Laysan Island.

Nests of the Laysan Duck are built on the ground and are well concealed among the vegetation. Little is known about the breeding biology in the wild, however. There are more than 150 birds in zoos and private aviaries; breeding pairs also are held at Pohakuloa, Hawaii.

2. Accipitridae (hawks, kites, and eagles):

The HAWAIIAN HAWK or IO (*Buteo solitarius*), for entirely unknown reasons, has always inhabited Hawaii only. The bird is now uncommon and has been placed on the list of rare and endangered species. The chief reason for the decline in numbers of this interesting bird is believed to be shooting by uninformed people who consider all hawks to be "chicken hawks." All available evidence, however, suggests that rodents form the main food of the Io. Although much rarer than the Hawaiian Owl, the hawk sometimes can be seen soaring high in the air on the slopes of both Mauna Loa and Mauna Kea.

Few nests of this species have been found and very little is known of its breeding habits. The birds build nests of twigs and sticks in trees, and one author has described a lining made of the stems and fronds of ferns. Two or three eggs are thought to form a clutch.

3. Rallidae (rails, gallinules, and coots):

The LAYSAN RAIL (*Porzanula palmeri*) had a historical life of 116 years. The species was discovered on Laysan Island in 1828, and it probably became extinct in 1944.

The devastation wrought by the rabbits released on Laysan Island in 1903 is well depicted by Alexander Wetmore (1925) after he visited Laysan in 1923 as a member of the Tanager Expedition: "On every hand extended a barren waste of sand. Two coconut palms, a stunted hau tree and an ironwood or two, planted by former inhabitants, were the only bits of green that greeted the eye. Other vegetation had vanished. The desolateness of the scene was so depressing that unconsciously we talked in undertones. From all appearances, Laysan might have been some desert, with the gleaming lake below merely a mirage."

It was estimated that there were about 2,000 rails on Laysan as late as 1915, but Wetmore and his party found only two birds, and the species is thought to have been extirpated there before 1936.

A pair of Laysan Rails was introduced to Midway Island in 1891. A large population had built up by the turn of the century and still existed in 1939. The extermination of the Laysan Rail on Midway, however, was very rapid after the onset of World War II when the U.S. Navy took over, and rats gained access to both Sand and Eastern islands. The last rails were seen on Eastern Island in June of 1944.

The Laysan Rail could easily have been saved from extinction if Government officials had heeded the pleas of ornithologists, but they were unable to obtain the necessary transportation to restock Laysan Island (or other islands) from the Midway population after the vegetation began to recover on Laysan. Although small and flightless, the Laysan Rail was a hardy bird, easily reared in captivity. Several birds survived the long sea voyage to England in the 1890s.

Like many rails on oceanic islands, the Laysan Rail had evolved into a flightless condition. The birds ate many kinds of insects, the flesh from the carcasses of other birds, and the eggs of the smaller seabirds, such as terns and petrels. Although the rails apparently sometimes broke open the eggs, they are said usually to have waited until Laysan Finches (*Psittirostra cantans*) broke through the shells with their more powerful bills and then chased the finches away to eat the egg contents.

The breeding season apparently extended from late March through July on Laysan, but downy young were seen on Midway in March. The nests were built on the ground or in grass tussocks and were constructed of dried stems and leaves of juncus and other plants. Unlike Mainland rails, which lay large clutches of eggs, the Laysan Rail laid 2 to 4 eggs in a clutch (Baldwin, 1947).

The HAWAIIAN RAIL (*Pennula sandwichensis*) was last collected on the island of Hawaii (near Olaa) about 1864, and was last seen about 1884 (Greenway, 1958, p. 235). Munro (1944, p. 51) believed that this rail "frequented most of the larger islands" and that "it certainly was on Molokai," although there is no good evidence for this belief. The nest, eggs, and newly hatched young were never described.

The causes of extinction of this small (about 5½ inches in total length), flightless rail are unknown, but it seems certain that rats, dogs, and cats played a large role in the extermination of this unique species. Hawaiian chiefs are said to have hunted the rail with bows and arrows.

The GALLINULE (*Gallinula chloropus sandvicensis*) is considered conspecific with the Common Gallinule of North America and Eurasia, although the Hawaiian birds are nonmigratory and have been inhabitants for an unknown length of time. Their distinctness is indicated by their subspecific name. These are birds of fresh-water ponds and marshes, and, because of the continuing disappearance of such habitats in Hawaii, the birds are considered endangered on all islands they still in-

habit. They formerly inhabited all of the main islands except Niihau and Lanai. Attempts to reestablish the birds on Hawaii and Maui appear to have been unsuccessful. Essential habitat is being destroyed to make way for housing developments, and mongooses, rats, dogs, and cats are serious predators on the birds. The prospects for survival of this species are considered by personnel of the Bureau of Sport Fisheries and Wildlife as "not good."

The gallinule builds its nest of reeds and other aquatic vegetation. Like its continental relatives, the bird is thought to lay large clutches of eggs (6 to 13). The newly hatched young have red bills and are covered with black down feathers; they are precocial and are able to run about and swim within a few hours after hatching.

The HAWAIIAN COOT (*Fulica americana alai*) also is considered conspecific with the North American members of this widely distributed species. Like the gallinule, however, the Hawaiian birds are nonmigratory and have been inhabitants of the Hawaiian Islands for a long period of time. They are given subspecific designation.

Coots occupy the same general type of freshwater ponds as gallinules, but they prefer more open water. The coot is found on all the main islands, and is especially common on Kauai and at Kanaha Pond on Maui. Munro (1944, p. 54) reported seeing "from 500 to 600 on a lagoon near Lihue, Kauai," in 1891, but nowhere are they so abundant now. One or more birds sometimes can be observed on the reservoir along the Old Pali Road in Nuuanu Valley, Oahu. Coots were on the game bird list until 1939. They are now classified as an endangered species, with an estimated total population of 1,500 birds.

Coots typically build relatively large floating nests of aquatic vegetation. Little is known of the clutch size of the Hawaiian Coot, but it presumably lays fewer than the 8 to 12 eggs of the Mainland birds. The newly hatched chicks are covered with black down except on the head, neck, and throat where the down is reddish-orange. The down is short or absent on the forehead and crown of the head, giving the bird a bald-headed appearance. Like gallinule chicks, the young are able to move about shortly after hatching, when the down has dried.

4. Recurvirostridae (avocets and stilts)

The BLACK-NECKED or HAWAIIAN STILT (*Himantopus himantopus knudseni*) is a large (16 inches), striking, black-and-white bird with very long reddish legs. This species is endemic to the islands of Niihau, Kauai, Oahu, Molokai, Maui, and Hawaii, but is now greatly reduced in numbers in most of its former range.

The stilt was considered a game bird until 1941, and still is sometimes shot illegally. The birds also are subject to predation by the mongoose and by feral dogs and cats. A major reason for the decline of this species, however, has been the continual draining of marshes and other wetland areas.

It is estimated that the total population of the stilt now numbers about 1,500 birds, which are found chiefly on Oahu and Maui. One of the major nesting and feeding habitats is at Kanaha Pond on Maui. This marsh area is in constant danger of being filled in because of pressures to enlarge the runways at the Kahului Airport. Another important breeding area is found among the ponds on the Kaneohe Marine Air Station on Oahu; efforts have been made with military personnel to have some of these ponds set aside as a sanctuary for the stilt.

The nest of the stilt is a simple "scrape" made on the ground by the birds themselves; small stones, bits of wood, and other debris often are added to the scrape. The normal clutch is 4 eggs. The newly hatched, precocial young are covered with a coat of variegated brownish down, which makes them very difficult to find after they leave the nest. The young are brooded for some time after hatching, but they run from the nest and hide in the surrounding vegetation when disturbed.

5. Stridgidae (owls)

The PUEO or SHORT-EARED OWL (*Asio flammeus sandwichensis*) differs from most species of continental owls in that it is diurnal in habits. It is found in open grassland (such as along the western part of the Saddle Road

of Hawaii), over lava flows, and in forested areas (both ohia and mamane-naio forests), and often it is seen near towns. This species appears to be tolerant of wide climatic extremes—from relatively dry areas (about 20 inches of annual rainfall) to the extremely wet Kokee area of Kauai. The Pueo is resident on all of the main islands of the chain, and it was prominent in Hawaiian mythology.

The Pueo builds its nest on the ground. The females are said to lay from 3 to 6 eggs in a clutch.

6. Corvidae (crows, jays, and magpies)

The HAWAIIAN CROW (*Corvus tropicus*) is endemic to the island of Hawaii only, being found in the Kona and Kau districts. The bird is now rare, and it is estimated that the total population may be no more than 30 birds. In former times, they were much more common and were found at elevations from 1,000 to 8,000 feet. Shooting is probably responsible for the decline of this sole representative of the crow family to have reached the Hawaiian Islands. The effect of the great alteration of the environment on the decline of the species is unknown.

Very little is known about the feeding habits or breeding biology of the Hawaiian Crow. The birds build nests of twigs and sticks, lined with finer plant materials. The eggs have been described as having a greenish background with brown markings around the larger end of the egg. In April 1964, Dr. P. Quentin Tomich (1967) found a nest containing five eggs in an ohia tree.

7. Turdidae (thrush family)

The SMALL KAUAI THRUSH (*Phaeornis palmeri*) is now known to inhabit only the ohia forests in the Alakai Swamp region of Kauai. The size of the remaining population is unknown, but, because of its restricted distribution, this species is thought to be rare and it is included in the list of rare and endangered species, as are most of the endemic Hawaiian birds. Both this thrush and the Hawaiian Thrush (*P. obscurus*) appear to tolerate very little change in environment. Hence the further spread of exotic plants into the depths of the Alakai Swamp must be prevented if the native birds are to be expected to survive; population levels of goats and pigs also must be controlled.

Nothing is known about the breeding habits of this thrush.

The HAWAIIAN THRUSH (*Phaeornis obscurus*) developed races on all of the main islands except Maui. The races found on Oahu and Lanai are presumed to be extinct; reports of survival of the Molokai race need to be confirmed (Richardson, 1949).

The Kauai race, or the Large Kauai Thrush (*P. o. myadestina*) appears to be even rarer than the Small Kauai Thrush, whereas the Large Kauai Thrush was said by early writers to be the most common forest bird on Kauai in 1891.

The Hawaii race (*P. o. obscurus*) still is fairly common in suitable habitat (Berger, 1969*a*). The birds inhabit the ohia forests in regions of high annual rainfall, in general above 3,000 feet elevation. The best areas are on the Saddle Road, Stainback Highway, and in the more undisturbed, wet forests of Hawaiian Volcanoes National Park, but this thrush also is found in ohia forests at higher elevations on the Kona coast.

A nest of this species and genus was first found near the Saddle Road on May 11, 1968, by Andrew J. Berger (1969). The nest, built on the trunk of a tree fern less than 5 feet above the ground, contained a single egg which was heavily covered by small, irregularly shaped, reddish-brown markings.

8. Sylviidae (Old World warbler family)

The LAYSAN MILLERBIRD (*Acrocephalus familiaris familiaris*) was one of three species of endemic birds to become extinct on Laysan prior to 1923 because of the destruction of the habitat by the rabbits. How the ancestors of this small bird (about 5½ inches in total length) managed to reach Laysan and Nihoa is, of course, unknown. Because of their Old World affinities, however, it is assumed that they came from Asia and "island-hopped" to reach Laysan and Nihoa islands.

The NIHOA MILLERBIRD (*Acrocephalus familiaris kingi*) has one of the most limited distributions of any bird species: Nihoa con-

tains 156 acres. Personnel of the Bureau of Sport Fisheries and Wildlife estimated a total population between 500 and 600 in 1967. The species is endangered because of its limited distribution, and it is imperative that rats, cats, and dogs be prevented from gaining access to Nihoa and the other islands in the Hawaiian Islands National Wildlife Refuge.

The birds are secretive in habits, usually staying in the dense cover afforded by *Chenopodium sandwicheum* (goosefoot) and *Sida fallax* (ilima). Several nests have been found in this vegetation, but little else is known about either the breeding biology or the feeding habits of the Nihoa Millerbird.

9. Muscicapidae (Old World flycatcher family)

The ELEPAIO (*Chasiempis sandwichensis*), important in Hawaiian folklore, has a puzzling distribution in that races have developed on Kauai, Oahu, and Hawaii, but there is no evidence that the species was ever found on the other main islands in the chain (Wilson and Evans, 1890–1899).

Although not as common as reported during the early 1900s, the Elepaio has been able to adapt to man-made changes in the environment as no other endemic landbird has been able to do. The Oahu race (*C. s. gayi*) is still fairly common in the mixed forests of the island, and a small population is resident in the lowland introduced forest near the head of Manoa Valley.

The Kauai race (*C. s. sclateri*) is common in the Kokee State Park area as well as in the Alakai Swamp. The Hawaii race (*C. s. sandwichensis*) is found both in the wet ohia forests and in the dry mamane-naio forest on Mauna Kea.

Frings (1968) found that the Oahu Elepaio defended a territory of 4.9 acres. The nest site is selected by the female, but both sexes take part in nest-building activities. The average height above ground of 32 nests was 25 feet. The small cup-shaped nests are very neat and compact, and contain large quantities of spider web, which aids in holding the plant materials together. The eggs have a white background covered with reddish-brown spots, which are concentrated at the larger end of the egg. The clutch size was 2 eggs in 15 nests and 3 eggs in one nest. The incubation period is 14 days, and the nestling period, 16 days. Frings found the breeding season in Manoa Valley to extend from mid-January to mid-June. The season differs on the other islands for as yet unanalyzed reasons.

10. Meliphagidae (honeyeater family)

This is a large Old World family, containing 160 species of birds. Two genera and five species were found in Hawaii, but all except one species are now thought to be extinct.

The four species of the genus *Moho* had patches of bright yellow feathers, prized by the early Hawaiians who used them for their feather capes and headdresses. The role that the Hawaiians played in causing the extinction of the several species of the Oo is unknown, but it may be significant that the sole known surviving species (on Kauai) has fewer yellow feathers than any of the other species. The evidence also suggests that the Oos, like most of the other endemic Hawaiian landbirds, are intolerant to any extensive changes in their environment. Also unknown is the role played by the three species of rats in the islands as predators on the eggs and young of tree-nesting birds; some species of rats are agile climbers and have been seen in tall trees and in tree ferns in the ohia forests.

The KAUAI OO (*Moho braccatus*), formerly thought to be extinct, was rediscovered by Dr. Frank Richardson in 1960 in the depths of the Alakai Swamp region (Richardson and Bowles, 1964). The bird is very rare and nothing is known of its breeding habits.

The OAHU OO (*Moho apicalis*) is thought to have become extinct within a short period after 1837 (Greenway, 1958, p. 423).

The MOLOKAI OO (*Moho bishopi*) was last reported in 1904 and is now presumed to be extinct.

The HAWAII OO (*Moho nobilis*) has not been reliably reported since 1934 and is listed as "probably extinct." It is certain that the birds no longer inhabit the forests where they were collected in the 1890s, but there are vast forest areas on Hawaii which have not been visited by ornithologists, and this species may

still exist in remote and relatively undisturbed areas.

The KIOEA (*Chaetoptila angustipluma*) was a large bird, about 13 inches in total length. Its color pattern was unlike that of any other Hawaiian bird: a black face mask, greenish-brown wings and tail, and a heavily streaked pattern of brown and white feathers on the head, upper back, and underparts. The type specimen was collected by the Pickering and Peale expedition in 1840 on the island of Hawaii, the only known range of the species. According to Munro (1944, p. 88) several additional specimens were collected by Mills about 1859. The species apparently has not been seen since that time.

11. Drepanididae (Hawaiian honeycreepers)

This endemic Hawaiian family exhibits among its numerous species the most striking example of adaptive radiation from an assumed single ancestral species of any bird family in the world. It demonstrates admirably, therefore, the results of evolutionary processes on oceanic islands. That this family of birds has not been studied more intensively in the past can be attributed, in part, to the fact that Charles Darwin visited the Galapagos Islands and not the Hawaiian Islands.

The members of this family reached all of the main Hawaiian Islands, and two species were found on certain of the Leeward Islands in historic times. The tragic remnant population of three individuals of the Laysan Honeycreeper (also incorrectly called the Laysan "Honeyeater"), a race of the Apapane, became extinct in 1923. The finch-billed Laysan Finch and Nihoa Finch still inhabit those respective islands.

It might be noted here that the name "finch" was given to these birds by taxonomists in the 1890s, because they thought that these large-billed birds (as well as some on the main islands) belonged to the finch family (Fringillidae). This interpretation was based almost exclusively on the superficial resemblance in bill shape and size. Later students of Hawaiian birds (particularly Perkins, 1901), concluded that a large number of the endemic Hawaiian birds had evolved from a single ancestral species; all of these were included in the family Drepanididae (formerly, also, Drepaniidae). No suitable evidence has been found since that time to refute this interpretation, although the possibility exists that we are not dealing, in fact, with a true monophyletic family. Nevertheless, I choose to follow the classification of the Hawaiian Honeycreepers proposed by Amadon (1950). There is a more recent system of classification (Greenway, 1968), but that author had no more information on anatomy or breeding biology than was available to Amadon.

Unfortunately, all of the highly specialized honeycreepers have become extinct on Oahu, Molokai, and Lanai, as have most of those on Hawaii. Kauai, the only island on which the mongoose was not introduced, is the only island which still has all of the endemic birds known to have occurred there. Most of these are confined to the Alakai Swamp region, and many are now rare. The east and northeast slopes of Haleakala also have proven a haven for the survival of unique Hawaiian birds.

One should note that the largest number of species of honeycreepers are now found in two relatively undisturbed wilderness areas: the Alakai Swamp of Kauai and the outer, windward slope of Haleakala. These are areas which have not been much disturbed by wild cattle, nor have they been desecrated by State foresters and ranchers.

Despite the remarkable bill adaptations found in the Hawaiian Honeycreepers, very little is known about this family of unique birds. The nests, eggs, and newly hatched young were never described for any of the extinct species (except for the Laysan Honeycreeper). A nest with eggs of the Palila was found for the first time by Andrew J. Berger in 1968 (Berger, 1969*b*); the first nests of the Akepa and the Creeper to be found were reported by C. Robert Eddinger in 1969. The incubation periods for this family also were first determined by Eddinger in 1969.

A. Subfamily Psittirostrinae

AMAKIHI (*Loxops virens*): This, the second most common living honeycreeper, is found on all of the main islands. The four subspecies are distributed as follows: *L. v. stejnegeri,* Kauai; *L. v. chloris,* Oahu; *L. v. wilsoni,* Maui,

Molokai, and Lanai; *L. v. virens,* Hawaii. The Amakihi is a characteristic bird of the wet ohia forests on the windward slopes of the islands, but it is also a common permanent resident of the dry mamane-naio forest on Mauna Kea. This broad climatic distribution suggests that the Amakihi may be the most adaptable of the surviving species of honeycreepers.

ANIANIAU (*Loxops parva*): This species is endemic to Kauai, and now is limited in distribution to the Kokee and Alakai Swamp regions of the island, where the bird is fairly common. The nest and eggs of this species were first described in 1969 (Berger, Eddinger, and Frings, 1969).

GREATER AMAKIHI (*Loxops sagittirostris*): This bird, which has been called also (inappropriately) the Green Solitaire, had a very short known history. The species was first collected near the Wailuku River on Hawaii in 1892. It was rediscovered by Perkins in 1895, but has not been observed since early in the present century. The early collecting sites probably were near the upper limits of the present sugar cane fields. However, there are extensive cloud forests along the Hamakua Coast of Hawaii where this species might still survive.

CREEPER (*Loxops maculata*): The six subspecies of this small bird with a relatively short bill are: *L. m. bairdi,* Kauai; *L. m. maculata,* Oahu; *L. m. flammea,* Molokai; *L. m. montana,* Lanai; *L. m. newtoni,* Maui; *L. m. mana,* Hawaii. The creeper is a relatively common bird in the Alakai Swamp region of Kauai and on the windward slope of Haleakala Crater, Maui. It is uncommon on Hawaii, rare on Oahu and Molokai, and presumed to be extinct on Lanai. An unusual feature of the Molokai race is that the males are reddish-brown, whereas the males of the other races have yellowish-green or brownish feathers, especially on the dorsal surface.

AKEPA (*Loxops coccinea*): This species differentiated into subspecies on Kauai (*L. c. caeruleirostris*), Oahu (*L. c. rufa*), Maui (*L. c. ochracea*), and Hawaii (*L. c. coccinea*). The Akepa is fairly common in the Alakai Swamp region of Kauai. It appears to be rare on Maui and Hawaii, and is presumed to be extinct on Oahu. The males of the Hawaii and Maui races have reddish-orange plumage, whereas the Kauai male has a yellow crown and underparts and olive-green back and wings.

KAUAI AKIALOA (*Hemignathus procerus*): This highly specialized honeycreeper with its long (over 2 inches) and strongly decurved bill was long feared to be extinct, but it was rediscovered in the Alakai Swamp region in 1960 by Richardson and Bowles (1964). The bird must be very rare, probably close to extinction, and has been found by very few observers.

AKIALOA (*Hemignathus obscurus*): Subspecies of a second closely related species of Akialoa formerly inhabited Oahu, Lanai, and Hawaii. Those on Oahu and Lanai are certainly extinct, and the Hawaii race is presumed to be extinct.

NUKUPUU (*Hemignathus lucidus*): The strongly decurved bill of the Nukupuu is unique among birds in that the lower mandible is only about half as long as the upper mandible. Subspecies formerly were distributed as follows: *H. l. hanepepe,* Kauai; *H. l. lucidus,* Oahu; *H. l. affinis,* Maui. The Oahu race is extinct; the Maui race was rediscovered in 1967; and the Kauai race is very rare, inhabiting the depths of the Alakai Swamp.

AKIAPOLAAU (*Hemignathus wilsoni*): The upper mandible of this closely related species also is long and strongly decurved but the lower mandible is straight, robust, and only about half as long as the upper mandible. The Akiapolaau has woodpecker-like habits in that it pounds its lower mandible into dead branches and tree trunks, searching for grubs and insects; the birds often forage on branches close to the ground. The Akiapolaau is endemic to the island of Hawaii. The bird is very rare, and, in recent years, has been sighted only in the mamane-naio forest on Mauna Kea, but formerly, at least, the species was found in Volcanoes National Park.

MAUI PARROTBILL (*Pseudonestor xanthophrys*): This remarkable stub-tailed bird with a large parrot-like bill is known to have oc-

curred only at higher elevations on the very wet, windward slopes of Haleakala, Maui. Virtually nothing is known about this rare bird. It was observed in the upper reaches of Kipahulu Valley in August 1967.

OU (*Psittirostra psittacea*): The Ou is a large-billed, yellow-headed bird with a greenish back. The species once inhabited Kauai, Oahu, Molokai, Lanai, Maui, and Hawaii. It is extinct on Oahu, Molokai, and Lanai; Maui is not even listed as part of the former range in most books, and the species has not been seen there for many years. The Ou apparently was last reported seen on Hawaii in 1955. The bird is rare on Kauai but can be found in the Alakai Swamp.

LAYSAN FINCH (*Psittirostra cantans cantans*): This species was first described by S. B. Wilson in 1890. It was undoubtedly because of its omnivorous feeding habits that the Laysan Finch managed to survive the destruction by rabbits of the vegetation on Laysan Island. During the extended breeding season of the seabirds, the Laysan Finch breaks the eggs of the several species of nesting terns, especially, and eats their contents. Wetmore found several dozen Laysan Finches on the island in 1923. The population has increased steadily since that time, and there were between 8,000 and 10,000 Laysan Finches on the island in 1967. Personnel of the U.S. Bureau of Sport Fisheries and Wildlife have since released birds on Southeast Island of Pearl and Hermes Reef; the population is now thought to number between 75 and 100 birds.

The Laysan Finch also was introduced on Midway Island in 1891 and again in about 1905. Bailey (1956, p. 124) wrote, however, that "the disappearance of the finches and the [Laysan] rails was very rapid when rats overran the islands during the war years, and few if any existed on Midway after 1944."

About two dozen Laysan Finches were presented to the Honolulu Zoo in 1966, and a similar number were sent to the University of Michigan.

NIHOA FINCH (*Psittirostra cantans ultima*): This honeycreeper was named "ultima" in 1917 by W. A. Bryan because he thought it would be the last endemic Hawaiian bird to be discovered. In 1923, however, Alexander Wetmore visited Nihoa and discovered the Nihoa Millerbird.

The Nihoa Finch is a successful species, with an estimated population in 1967 of between 4,800 and 5,000 birds on Nihoa's 156 acres. The survival of the species, however, depends upon maintenance of the native vegetation and prevention of the introduction on the island of rats and other mammalian predators.

PALILA (*Psittirostra bailleui*): The Palila is superficially similar to the Ou, being a large-billed and large-headed bird with a yellow head and throat but with a gray back. The bill of the Palila is dark in color, rather than light, and is differently shaped than the bill of the Ou. The Palila is found only on Hawaii. It had a wider distribution on that island in the past but is now known to occur only in the mamane-naio forests on the slopes of Mauna Kea, in general at elevations above 6,500 feet. The survival of the Palila, therefore, is entirely dependent on the recovery and continued maintenance of this forest. The present tree line is located at approximately 9,300 feet and is gradually receding because of overgrazing by the feral sheep on the State-owned game management areas on Mauna Kea. A superabundance of wild pigs also inhabits this relatively dry forest region.

GREATER KOA FINCH (*Psittirostra palmeri*): This and the next two species of Koa Finch provide ornithologists with a real puzzle. The three species were first discovered and described during the period between 1888 and 1892, all on the Kona slope of Mauna Loa. There are no reliable records of any one of these species having been seen since 1896.

LESSER KOA FINCH (*Psittirostra flaviceps*)

GROSBEAK FINCH (*Psittirostra kona*)

B. Subfamily Drepaniinae

APAPANE (*Himatione sanguinea*): This is the most common of the surviving species of honeycreepers, and it has undergone no important geographic variation. One race (*H. s.*

sanguinea) inhabits all of the six main Hawaiian islands. A second race (*H. s. freethii*) inhabited Laysan Island until becoming extinct in 1923.

The Apapane is the most conspicuous of the native birds in the wet ohia forests on all major islands, in general now above 3,000 feet elevation. It also is found along the Mauna Loa Strip Road in Volcanoes National Park, among both the scattered ohia trees and the groves of koa (Baldwin, 1953). The species rarely moves through the mamane-naio forest on Mauna Kea, and is not known to nest there. The places to observe this species most easily are at Kokee State Park on Kauai, Hosmer's Grove on Maui, and Volcanoes National Park on Hawaii.

CRESTED HONEYCREEPER (*Palmeria dolei*): This remarkably plumaged honeycreeper (totally unlike any other species) once inhabited both Molokai and Maui. The species is extinct on Molokai, and almost nothing is known about the birds on Maui. There they are found in the cloud forest on the northeast slope of Haleakala, presumably at elevations above 5,000 feet.

ULA-AI-HAWANE (*Ciridops anna*): According to Munro (1944, p. 99), the common name means "the red bird that feeds on the hawane" (the native Hawaiian palm, *Pritchardia* spp.). The color pattern of this species, too, was unlike that of any other honeycreeper. The species apparently was first collected about 1859 but it was not described until 1879. Palmer and Munro obtained one specimen from natives in the early 1890s, the last of this species ever reported.

IIWI (*Vestiaria coccinea*): This is the most striking in appearance of the common honeycreepers. The head and body feathers are a brilliant vermillion; there is a white patch in the otherwise black wings; and the long, decurved bill is salmon colored. This species once inhabited all of the main islands. It is extinct on Lanai and probably Molokai, and it is rare and presumably on the verge of extinction on Oahu. On Kauai, Maui, and Hawaii, however, it is still fairly common.

MAMO (*Drepanis pacifica*): The naturalists accompanying Captain Cook first collected this striking yellow and black bird with its very long, decurved, black bill, which was endemic only to the island of Hawaii in historic times. The head and body feathers were black but the rump, upper and lower tail coverts, thighs, bend of wing, and part of the under wing coverts were bright yellow. Munro (1944, p. 91) reported that the birds were still being collected for their yellow feathers in 1880, and that one man shot as many as 12 in one day with a shotgun. The species apparently was last seen in 1899.

BLACK MAMO (*Drepanis funerea*): This jet black bird with white on the wing feathers had an even larger, decurved bill than the Mamo. Endemic to Molokai, the species was discovered in 1893. The last specimens apparently were collected in 1907, and the species is thought to be extinct.

INDIGENOUS HAWAIIAN BIRDS

Indigenous birds are those native to Hawaii but whose normal range of distribution includes a much wider geographical area. Included among these indigenous Hawaiian birds are many seabirds, the Black-crowned Night Heron, and a number of migratory species that spend the nonbreeding season in the Hawaiian Islands. Most of these birds are illustrated in the books by Ord (1967) and Peterson (1961).

BLACK-CROWNED NIGHT HERON (*Nycticorax nycticorax hoactli*): This heron is considered indigenous rather than endemic (see gallinule and coot) because the Hawaiian birds have not been recognized as subspecifically distinct in plumage characters from the American continental birds. This subspecies has a very large breeding range, extending from Washington and Oregon south to northern Chile and south-central Argentina.

The Black-crowned Night Heron, found on all the main islands, inhabits marshes, ponds, and lagoons, where it feeds on aquatic insects, fish, frogs, and mice. The birds roost and nest in trees. The future of this species in Hawaii, like that of the gallinule and coot, is dependent on the preservation of suitable wetland habitat.

The Seabirds

These birds belong to several families of oceanic birds (as indicated below). They breed by the tens of thousands on the Leeward Islands, and certain species nest on the offshore islands of Kauai and Oahu (especially Moku Manu and Manana Island (Fisher, 1948*a*, 1966). The offshore islands are State wildlife refuges, and permission is required before visiting these islands.

A few species nest on the main islands. Red-footed Boobies (*Sula sula*) have established breeding colonies near the Kilauea Lighthouse on Kauai and on Ulupau Head, Oahu. Newell's Manx Shearwater (*Puffinus puffinus newelli*) is known to breed on almost inaccessible cliffs on Kauai. The Hawaiian Dark-rumped Petrel (*Pterodroma phaeopygia sandwichensis*) nests on the walls of Haleakala Crater, Maui, and, in smaller numbers, on Hawaii. Both species are thought to have nested formerly on all of the high islands, and both are listed as endangered species.

Families containing species that nest in the Hawaiian Islands and the species are these:

Diomedeidae (albatrosses or gooney birds)
- Black-footed Albatross (*Diomedea nigripes*)
- Laysan Albatross (*Diomedea immutabilis*)

Procellariidae (shearwaters, petrels, fulmars)
- Wedge-tailed Shearwater (*Puffinus pacificus*)
- Christmas Island Shearwater (*Puffinus nativitatus*)
- Newell's Manx Shearwater (*Puffinus puffinus newelli*)
- Dark-rumped Petrel (*Pterodroma phaeopygia sandwichensis*)
- Bonin Petrel (*Pterodroma hypoleuca*)
- Bulwer's Petrel (*Bulweria bulwerii*)

Hydrobatidae (storm petrels)
- Harcourt's Storm Petrel (*Oceanodroma castro*)
- Sooty Storm Petrel (*Oceanodroma markhami*)

Phaethontidae (tropicbirds)
- White-tailed Tropicbird (*Phaethon lepturus*)
- Red-tailed Tropicbird (*Phaethon rubricauda*)

Sulidae (boobies and gannets)
- Blue-faced or Masked Booby (*Sula dactylatra*)
- Brown Booby (*Sula leucogaster*)
- Red-footed Booby (*Sula sula*)

Fregatidae (frigatebirds)
- Great Frigatebird (*Fregata minor*)

Laridae (gulls, terns, and noddys)
- Sooty Tern (*Sterna fuscata*)
- Gray-backed Tern (*Sterna lunata*)
- Blue-gray Noddy (*Procelsterna cerulea*)
- Brown Noddy (*Anous stolidus*)
- White-capped or Hawaiian Noddy (*Anous minutus*)
- Fairy Tern (*Gygis alba*)

Migratory species

The most conspicuous of these is the Pacific Golden Plover (*Pluvialis dominica*), which spends the nonbreeding season in Hawaii, inhabiting grassy areas in the cities as well as in the mountains. Most of the birds molt into the full breeding plumage before leaving for Alaska, usually in April.

A number of species of ducks and shorebirds also are winter residents in the Hawaiian Islands (see Ord, 1967; Bryan, 1958; and Clapp and Woodward, 1968).

INTRODUCED OR EXOTIC BIRDS

Virtually all of the landbirds that one sees in Honolulu, as well as in lowland areas on all islands, are introduced species: for example, doves, mynahs, white-eyes, cardinals, mockingbirds, linnets (Fisher, 1948*b*; Eddinger, 1967*a*, 1967*b*; Walker, 1967; Warner, 1968). To see endemic birds, one must get into the mountains and the native forests; and few native birds remain on the island of Oahu.

In addition to the 76 species of game birds *known* to have been introduced in the main Hawaiian Islands as of 1967, at least 60 species of non-game birds have been released. These cover the gamut from the Chinese Fishing Cormorant (*Phalacrocorax carbo*) and the Guam Edible-nest Swiftlet (*Collocalia inexpectata*) to a wide variety of passerine birds. Fortunately, most of the introductions have been unsuccessful.

The exact number of birds which have been introduced is uncertain because an unknown number of cage birds have been released illegally by presumably well-meaning, but igno-

rant, citizens. A surprising number of weaver-finches (family Ploceidae, to which the House Sparrow, *Passer domesticus,* belongs) have been released intentionally by citizens on the slopes of Diamond Head in recent years, and a number of these seem to be established as breeding birds.

The success of an exotic bird introduced into a foreign environment is best exemplified, perhaps, by the Mejiro or Japanese White-eye (*Zosterops palpebrosus japonicus;* family Zosteropidae). According to Bryan (1958, p. 21), the White-eye was introduced to Oahu from Japan in 1929. This species has spread (apparently unaided by man) to all of the main islands; it is found both in the very dry and the very wet habitats, and from sea level to treeline on the mountains of Hawaii and Maui.

Another successful exotic is the Red-billed Leiothrix (*Leiothrix lutea;* family Timaliidae), which was released in 1918 and again in 1928–1929. This species prefers the wetter areas (both native and introduced vegetation), but is now widely distributed on the main islands. It is a common bird in the native forests, where it, as well as the White-eye, may be competing seriously with the endemic birds.

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