

THE AVIFAUNA OF NIIHAU ISLAND, HAWAIIAN ARCHIPELAGO

By HARVEY I. FISHER

Niihau Island lies about 150 miles northwest of Honolulu and is about 25 miles west by south of the island of Kauai. It is approximately 17 miles long, and its greatest width is five miles. The highest elevation is 1281 feet, at Paniau, on the northeast coast.

The southern and northern ends and the western side of this volcanic island (fig. 1) are low, with sand and lava beds sloping gently to the sea. The east-central part of the island, from Halalii Lake on the south to Puu Alala on the north, is made up of rugged lava mountains rising toward the east where 1000-foot cliffs drop to the water's edge. In this mountainous portion is a rolling plateau (800 to 1100 feet) between Mount Kaeo and Pueo Point which extends north to Paniau; this plateau is formed of the heads of the numerous canyons that cut eastward through the cliffs to the sea and by the basins of the Kaumuhonu, Puniopo and Kahunaalii valleys extending westward.

In the lowlands are intermittent lakes. Halutu and Halalii lakes to the south were nearly dry when we visited the island. Apana Reservoir was broken and dry. The only surface water present was in Halutu Lake, in the small ponds north of Kiekie and southwest of Puuwai, and in the numerous sumps dug in tidal waters to supply brackish water for the livestock. Only cistern water is available for household use. At times, this supply must be augmented by using coconut milk and cactus pears (panini). The large acreages of cactus (*Opuntia*) established on the island by the Robinson family also are a major source of water for cattle. The above statements indicate that the island is extremely dry; it probably has an annual rainfall of less than 15 inches. Although the aridity is no doubt due to the fact that the mountains of Niihau are relatively low and that Niihau is in the lee of Kauai's 4500-foot mountains, the aridity is increased by the absence of any significant amounts of forest on Niihau itself.

There is no native forest of any sort left on the island; it apparently was destroyed by goats liberated by Captain Vancouver in 1794. Niihau was the first Hawaiian island to have goats released on it. Wilson and Evans (1890-1899:viii) noted the absence of the forest, but land mollusks of the genus *Carelia* were found. This indicated to them that there formerly were damp forests. Kiawe trees (*Prosopis chilensis*), started from seed by the Robinsons, are now the predominant vegetation of the lowlands, the mountain canyons and the steep slopes. Coconut palms (*Cocos nucifera*) are not found in abundance; a few acres here and there in the lowlands constitute the only plantings, although occasional trees are found elsewhere. Grasses of eleven kinds and indigo (*Indigofera suffruticosa*) form the main plant cover of the plateau. A nearly pure stand of pasture grasses, free from weeds because of the browsing of sheep, is to be found between Kiekie, Nonopapa and Halutu Lake. This was the only green spot on the island at the time of our visit and was the result of a recent rain in that area.

Although cactus is scattered over most of the island, it is most abundant and is the predominant plant in the region around the north side of Apana Reservoir. Unfortunately, the cactus is being killed out by a blight that reached the island within the last few years. In a few small areas of eroded soil east of Mount Kaeo a reforestation program has been initiated with varying degrees of success. One large area near Paniau has been taken over completely by koa haole (*Leucaena glauca*), an introduced shrub. It is so thick in this region that one cannot walk between the spindly trunks that rise 12 to 20 feet in height.

Land use on Niihau is limited to ranching operations, and it has been for the last three-fourths of a century. Because the feral goats were in competition with domestic stock, the owners, starting about 1890, made every effort to eliminate them. By 1912 the last goat had disappeared. Since that time cattle, horses and sheep have ranged over

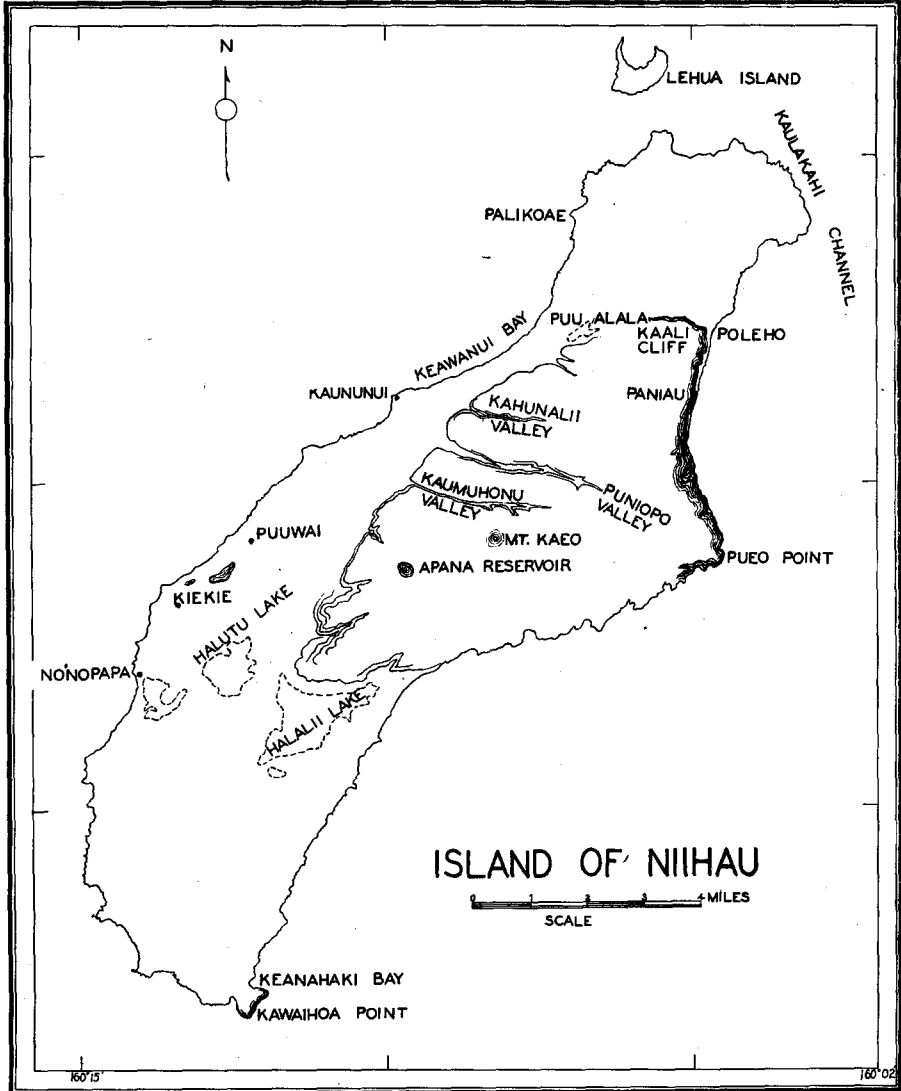


Fig. 1. Islands of Niihau and Lehua, Hawaiian Archipelago.

the entire island, subject to available water. Despite this extensive use the care of the owners has prevented overgrazing. There is much more vegetation now than there was 35 years ago. Bee-keeping has been an important phase of operations of the last half-century. The only areas under cultivation are small household gardens; there is not sufficient water for most crops.

Feral pigs exist in great numbers in all the lowland. Evidence of their rooting activities is everywhere. They are used as food by the Hawaiian population, but their numbers seem to be on the increase. Their success may in large part be the result of the bountiful supply of kiawe beans on which they feed. The cosmopolitan rat (*Rattus rattus*) is present in considerable numbers, but perhaps the most important mammalian predator of birds is the feral cat. Stories of the ferocity and abundance of these cats are almost legendary. Running them down with horses used to be a favorite sport. The mongoose (*Herpestes griseus*) is not present as it is on some other Hawaiian islands. No feral rabbits are to be found on Niihau; they are numerous on the nearby islet of Lehua. No dogs are allowed on the island. Although pigs, rats and cats are everywhere, ground-nesting birds such as the Ring-necked Pheasant, California Quail and Domestic Turkey are flourishing. The populations of pheasants and quail on Niihau seem to be higher per unit of area than in comparable areas on islands where the mongoose is present.

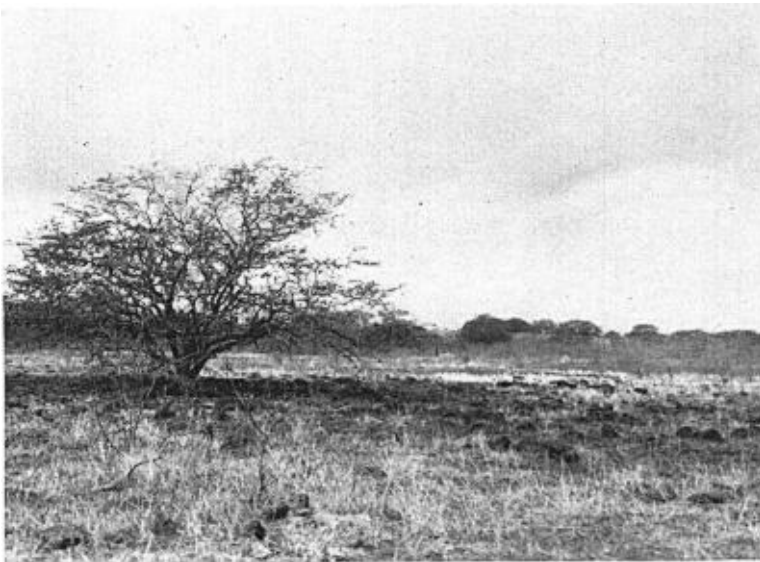


Fig. 2. Lowland vegetation two miles southeast of Nonopapa, Niihau.

In the late 1880's, employees of Lord Rothschild visited the island to collect specimens to be used in preparing his "Avifauna of Laysan and the Neighboring Islands." At about the same time Scott Wilson studied the birds of Niihau as part of his taxonomic and distributional work on Hawaiian birds. Since the turn of the century the only ornithologist to visit the island was Mr. George Munro, who spent a short time there in 1939.

During the summer of 1947 Mr. A. E. Robinson, one of the owners of Niihau, invited three members of the staff of the University of Hawaii to come to Niihau to make collections and to study the birds, insects and plants. Without the generosity and interest of Mr. Robinson the expedition would never have been possible. We remained on the island from August 12 through August 16 as guests in his ranch home. He provided horses and guides to enable us to visit all parts of the island in the short time available.

In the five days of work on the island, some 90 miles were covered on horseback. Forty-five specimens of birds were collected, and notes were made on populations, distribution and natural history. Because of the scarcity of certain introduced species such

as the Prairie Chicken, the "Hawaiian Chicken," *Gallus gallus*, and the Bush Partridge or quail (*Coturnix*) no specimens of them were taken. One day was spent on the small cone island of Lehua, which lies just off the north end of Niihau.

The avifauna of Niihau has particular interest to the ornithologist because all native birds have been eliminated and their places taken by successful exotic birds. Since the introduction by humans of exotic species has been under the control and supervision of one family, it is possible to note dates of introduction of many species. It is even feasible to judge the probable dates of entry of birds which have moved without human aid to



Fig. 3. North slope of Mount Kaeo from Kaumuhono Valley, Niihau.

Niihau from Kauai Island some 25 miles upwind. These latter dates are fairly accurate because the Robinson family has long been interested and informed on the birds of both Kauai and Niihau. The present report on the birds of Niihau will, it is hoped, be of importance to future ornithologists making critical studies of temporal distribution and of evolutionary changes in the exotic birds as these birds adapt themselves to the environments provided by the island.

As Niihau again becomes covered by some sort of vegetation, we can expect certain birds to establish themselves there. Aside from exotics the most probable avian pioneers in the area would be emigrants from Kauai which, as mentioned previously, lies up the trade winds from Niihau. Wilson and Evans (1890-1899:ix) noted that *Vestiaria coccinea*, the Iiwi, and *Himatione sanguinea*, the Apapane, were sometimes found on Niihau, apparently carried over by winds from Kauai, but that they soon perished. Both species are inhabitants of forest canopies. Neither is a strong-flying bird that might be expected to undertake this over-water trip of its own volition. We know that the White-eye (*Zosterops palpebrosus*), the Mynah (*Acridotheres tristis*) and others have established themselves on Niihau from Kauai stock. In the light of these events it is not unlikely that many other birds now on Kauai might arrive and survive on Niihau if the ecological conditions were proper for them. We might expect the Elepaio (*Chasiempis sandwichensis sclateri*) and the Kauai Thrush (*Phaeornis obscura myadestina*), which

are birds of the forest and brushland, to become established. Species such as the Amakihi (*Chlorodrepanis virens*) and the Creeper (*Paroreomyza bairdii*), birds of the under-stories of the forests, might not be expected to spread to Niihau as rapidly; however, they are present on all forested islands of the Hawaiian Chain. *Loxops caeruleirostris*, the Akepa, a relatively strong flyer and a bird of the high forest canopies, is another species that could arrive on Niihau.

Hence it would seem of significance to record the present avifauna. As each species is discussed an attempt will be made to indicate its relative abundance, date of introduction, distribution on the island, and the specific niche it now occupies.

Diomedea nigripes. Black-footed Albatross. This species was observed at sea about five miles east of Niihau. It is frequently seen offshore around the main group of Hawaiian Islands, but seldom does

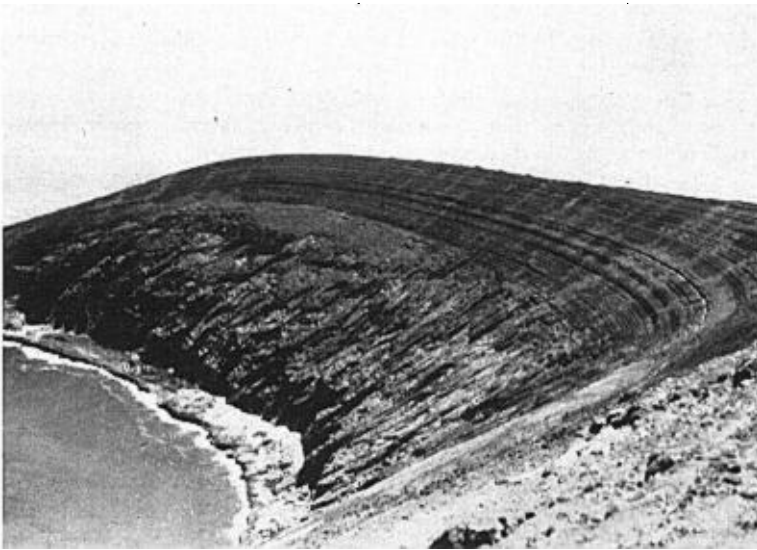


Fig. 4. West side of eastern arm of Lehua Island, showing lines of erosion used as nest sites.

it land on these islands. Munro (1946:28) has recorded one individual alive, although sick, on the Kailua Beach of Oahu. It is reported breeding on Kaula Island, 15 miles southwest of Niihau, and there are sight records (Caum, 1936) for it on Lehua.

Diomedea immutabilis. Laysan Albatross or Moli. Not observed on Niihau or Lehua during the period of observation, and no evidence of nesting could be found. Young of this species usually remain on the nesting grounds until late July or early August. If breeding had occurred this year, young probably would have been found. Munro (1944:18) stated that it sometimes nests on Niihau. Mr. Robinson has also noted occasional nesting there. Sporadic nesting of this sort may be expected in species extending their range as this albatross is apparently doing. Moir (1946:81) reported a pair performing part of the characteristic dance at Makahuena Point, Koloa, Kauai, in March, 1945, and in March, 1946. Although this probably was post-breeding behavior (egg-laying occurs in December and January usually) we may consider these birds as pioneers in a new or long-deserted breeding area. More recently, Fisher (1948:66) recorded the successful breeding of one pair on Moku Manu Islet off Oahu.

Diomedea albatrus. Short-tailed Albatross. Wilson and Evans (1890-1899:xxv) cited Rothschild as reporting this species just off Niihau.

Puffinus pacificus cuneatus. Wedge-tailed Shearwater or Uau Kani. At 11 a.m. on August 11 as we approached Niihau, between that island and Lehua, many of these birds circled over our sampan.

This species was observed on August 15 flying about the eastern cliffs of Niihau; no nests or burrows were observed. The following day thousands of these birds were found on Lehua. For the most part, single individuals were found with newly-hatched young; a few were still on eggs. In general, nesting sites were wind- and water-eroded pockets in the cinders and under more or less horizontal ledges of lava. Only a few burrows were found. In just a few small patches was there enough soil for burrows; apparently, as the cinder and lava disintegrate, the particles are blown or washed down the steep slopes into the sea, leaving only hard, bare structures.

Puffinus nativitatus. Christmas Island Shearwater. This shearwater was not observed on Niihau, but there was insufficient time to search likely places on the cliffs. Single adults were in two instances found under lava ledges on Lehua.

Puffinus newelli. Newell Shearwater or Ao. Three individuals having the characteristic white spots on the side of the neck and high on the flank were observed in the channel between Kauai and Niihau on August 16. Although this sight record of so rare a bird is perhaps of little value, there are no other common petrels or shearwaters in the area with which it could be confused. Local ornithologists on Kauai have from time to time reported unidentified birds resembling this species. Henshaw (1902:118) credited Mr. Francis Gay with securing specimens from Kauai.

Pterodroma leucoptera hypoleuca. Bonin Island Petrel. Only three individuals were observed, and these were seen about five miles off the northeast corner of Niihau. However, Wilson and Evans reported that Francis Gay sent in specimens from Niihau.

Bulweria bulwerii. Bulwer Petrel. Four were observed in the Kaulakahi Channel east of Niihau.

Oceanodroma castro cryptoleucura. Hawaiian Storm Petrel or Akeake. This species, which was first described from Kauai, was observed in the Kaulakahi Channel in 1893 by Palmer. Specimens were taken on Niihau by Francis Gay before 1900 (Henshaw, 1902:118; Rothschild, 1893-1900:53).

Phaethon rubricauda rothschildi. Red-tailed Tropic Bird or Ula. On the sheer cliffs of Kawaihoa Point at the south end of Niihau about 20 individuals were observed. Although nests were not actually seen, it was apparent from the activities of the adults that young were present on some of the ledges. Birds were also present along the cliffs between Poleho and Pueo Point. The population on Lehua was estimated at 400. A few of these were on eggs on August 16, but most nests contained nearly-fledged young. Nest sites were in wind-eroded pockets (fig. 4) and under ledges; they were not in "tight" colonies but were to be found wherever suitable conditions were present, from sea level to the top of Lehua (700 feet). Wilson and Evans stated that it was breeding on the cliffs of Niihau in 1890.

Phaethon lepturus dorotheae. White-tailed Tropic Bird or Koa. One individual was observed on the cliffs below Paniau, Niihau, and two flew over Lehua for some time. No evidence of nesting was found at either place.

Wilson and Evans made the statement that this species is common on all islands of the Hawaiian Group. Actually, it has been reported only from the five larger islands on the southeast end of the group and is restricted to certain small areas on them; individuals are, of course, frequently seen soaring in favorable locations away from these small areas.

Sula sula rubripes. Red-footed Booby, or "A" in Hawaiian. This species was abundant in the channel between Kauai and Niihau. Despite the fact that no birds were observed perching on Niihau it seems certain, judging from their activities about the steep cliffs on the eastern side of the island, that they do breed there. The colony of about 3000 individuals on Lehua was through with all nesting activities on August 16; no eggs were present and all young birds observed were capable of flying.

Sula leucogaster plotus. Brown Booby or "A". Munro (1944:35) stated that this species nests in cliffs on Niihau. Bryan and Greenway (1944:98) reported sight records off Niihau. I saw but one individual; it was flying east over Lehua toward Kauai.

Sula dactylatra personata. Blue-faced Booby or "A". None was found on Lehua or Niihau, but Caum (1936) found a few nesting on Kaula Island, a few miles west by south of Niihau, and reported their presence on Lehua. It is not unlikely that they may nest on the sandy areas at the north end of Niihau.

Fregata minor palmerstoni. Frigate-bird or Iwa. Although this species can be observed from time to time around most of the Hawaiian Islands, it is not abundant east of Oahu and its main breeding range probably lies west of Niihau. It is reported nesting on Kaula, but I found no nesting activity on

Niihau or Lehua. Six birds were seen at Kawaihoa Point on August 13, and three were present over Lehua on August 16.

Nycticorax nycticorax hoactli. Black-crowned Night Heron or Aukuu. This emigrant from America has spread widely over the eastern end of the Hawaiian Islands wherever suitable habitats are available. The absence of streams and permanent water on Niihau make the island almost uninhabitable for this species. Only one individual was found; it was near the small pond north of Kiekie. Formerly, there was a colony around Apana Reservoir which is now dry. Bryan and Greenway (1944:100) listed no records from Niihau, but refer to Rothschild, to Wilson and Evans, and to Henshaw, who all inferred that before 1900 it was on "all islands." Munro (1944:41) said it was uncommon on Niihau. It would seem quite likely that the increasing aridity of Niihau, occasioned by the loss of the native forest, has all but eliminated this species. It will be interesting to see if the population builds up again with increase in water resources as the vegetation is restored in part.

Anas wyvilliana wyvilliana. Hawaiian Duck or Koloa. As with the heron, the decrease in suitable habitat on Niihau has adversely affected this species. Only one sight record (Halalii Lake) was made during the present study. In 1902, Henshaw reported its presence in considerable numbers on "all islands," and Munro (1944:43) stated that originally it was common on all islands except Lanai and Kahoolawe. Palmer (Rothschild, 1893-1900:273) observed large flocks on lakes on Niihau, on some occasions "not less than 100." Today there is a good population on Kauai and scattered bands of a few individuals on some of the other eastern islands of the Hawaiian Group. Should environmental conditions on Niihau favor it, this duck would undoubtedly repopulate Niihau from Kauai.

Tympanuchus. Prairie Chicken. Mr. A. E. Robinson told us that the Prairie Chicken was brought to Niihau about 1934 and was released on the high, grassy plateaus in the east-central part of the island. On August 15 the writer saw two individuals near Paniau. Six more were observed in the same region by other members of the party. There seemed to be little doubt of the identification, but specific determination was impossible because, at the owner's previous request, no specimens were taken. Munro (1944:148) stated that *T. cupido* is supposed to have been liberated on Kauai.

Gallus gallus. Hawaiian Chicken. Chickens of a variety supposedly kept in a semi-wild state by the old Hawaiians have been secured from private individuals on Kauai. These were liberated within the last few years near a waterhole at the base of Kaali Cliff, west of Poleho. Approximately a dozen of these birds were found there, but none was observed elsewhere on the island. No specimens were taken.

Coturnix. Pectoral Quail; known on Niihau as Australian Bush Partridge. Mr. Robinson informed us that this bird spread all over the island after being released "within the last 15 years." However, I found them only in the grassy plateaus in the east-central part of the island; three at 600 feet elevation, one mile north of Kaeo, and three at 1000 feet just west and south of Paniau. No specimens were secured.

Lophortyx californica. California Quail or Manu Kapalulu. This species was first established on Niihau about 1900, but there have been several subsequent importations directly from California, one from Arizona, and several from previously established stock on Kauai. Specimens taken ranged from typical *L. c. brunnescens* to typical *L. c. californica*.

These quail are abundant in the kiawe-covered lowlands at the base of the mountains and in the canyons. They are concentrated especially about the water sumps, but coveys are widespread. Literally hundreds of these birds were to be found feeding, in groups on the ground, and perched in kiawe trees around the waterholes. In the flatter, more open coastal areas they are not as numerous, but on checking several locations it was found that even here one could see on the average more than 100 birds in a half-mile walk. In the grassy, plateau country there were few birds; one could ride for half an hour and see only 10 or 15 birds. Available water in this area is probably the limiting factor.

Phasianus colchicus. Ring-necked Pheasant or Kolahala. As far as could be determined from field observations, the population on Niihau is a mixture of two or more forms of this species. The lowlands have relatively few birds, except in the immediate vicinity of the waterholes. The open lava fields have almost none; the thickets of kiawe present the best cover in the lowlands. The birds were abundant in the tall-grass cover on the east, south and west slopes of Kaeo, and in the indigo vegetation one mile north of Kaeo. The grass and weeds of the plateau have by far the highest numbers,

quite in contrast to the distribution of the California Quail. Pheasants are perhaps only one-tenth as numerous as the quail, on an island-wide basis.

Although residents informed me that young pheasants could be found any time between late February and early December, all the young I saw were approximately half-grown.

Pavo cristatus. Peafowl or Pikake. This species was introduced on the Hawaiian Islands about 1860s and was released on Niihau in the 1890's. On Niihau, this species is almost entirely limited to the lowlands from Palikoe in the north to Keanahaki Bay in the south. The greatest concentration was at the base of the mountains opposite Keawanui Bay (150 found around one small waterhole), but from Kiekie south a pair could be found about every half-mile. None was observed in the mountains above Apana Reservoir or in any of the plateau country. Their range apparently extends only a short way up the various valleys that open to the west. One of the staple foods of the peafowl is the bean-like seed pod of the kiawe trees. The stomachs of the two specimens taken were filled with three-inch parts of pods containing the beans.

Meleagris gallopavo. Turkey or Pelehu. Thousands of these birds are distributed over the entire island. They are most abundant in the lowlands covered by kiawe trees, on the beans of which they feed, but the greatest concentration is from Kaumuhonu Valley north to Kaali Cliff. The southern end of the island has only scattered bands, as does the indigo and grass plateau.

Mr. Robinson said they had liberated White, Bronze and "Mexican Black" turkeys at various times. Counts on the stock predominating in three different areas showed a consistent ratio of eight Bronze Turkeys to three White Turkeys.

Fulica americana alai. Hawaiian Coot or Alae Awi. I saw no members of this species on Niihau, but Henshaw (1902:100) stated it was found on all islands, as did Munro (1944:54). Francis Gay collected it on Niihau. The fact that the natives of Niihau have a name for it probably indicates that it used to occur there, if it does not still occur there periodically. Munro (*op. cit.*) believed that it dispersed from Niihau when the temporary lakes or ponds dried up.

Pluvialis dominica fulva. Golden Plover or Kolea. This plover is to be found on all the Hawaiian Islands throughout the year; however, relatively few remain over the summer months. The birds were found on all the lowlands of Niihau and were especially numerous around the dry lakes. About 1000 were found in one flock in the Halutu Lake bed; most of these were in winter plumage. Although the species may not breed here, individuals in breeding plumage were not uncommon and were not usually in large flocks as might be expected of migratory individuals.

Numenius tahitiensis. Bristle-thighed Curlew or Kioea. Only two individuals (at Puu Alala and Kawaihoa Point) were found of this fall and winter visitant to the islands; like the Golden Plover, a few individuals remain over the summer. Although nesting in Hawaii of this and other shorebirds is usually considered improbable, there seems to be no reason why occasional pairs should not breed in suitable areas. Mr. John Rennie, formerly of Niihau, reported a curlew nesting there many years ago.

Heteroscelus incanus. Wandering Tattler or Ulili. Three individuals were observed on August 16 on Lehua.

Arenaria interpres interpres. Ruddy Turnstone or Akekeke. Of all the shorebirds on Niihau, this species was the most abundant and was found all over the island. A few flocks up to 20 in number were present on the sand beach at Kaununui; 250 in one flock were feeding on the short-grass flats at Puuwai; several thousand were feeding in the bed of Halutu Lake, and about 50 were found on the slopes of Kaeo, where the grass was sparse. Two were flushed from a bare spot on the grass plateau at the head of Puniopo Valley.

Crocethia alba. Sanderling or Hunakai. One was seen at Halutu Lake and one on Lehua.

Himantopus himantopus knudseni. Stilt or Aeo (Io). The stilt is one of the rare endemic birds. Munro (1944:60) believed the species was down to about 200 birds, but this now seems somewhat low in view of the flocks on Oahu, Niihau and Kauai. He also stated that the existing population appeared to migrate between Oahu and Niihau; this remains to be shown.

On Niihau, nine individuals were found at Halutu Lake, four on the pond north of Kiekie, and 49 on the water southwest of Puuwai. There is no question that the numbers have decreased greatly in the last 50 years due to increasing aridity and to increased predation by man, for Perkins (1903:453) found it common on nearly all the larger Hawaiian Islands, including Niihau.

Sterna anaethetus lunata. Gray-backed Tern or Pakalakala. Bryan and Greenway (1944:118)

included Niihau in the list of records for the Hawaiian Group; this was apparently based on Rothschild (1893-1900:285), for I have found no other positive records for Niihau. Caum (1936) found it on Kaula, and it is known from Kauai.

Sterna fuscata oahuensis. Sooty Tern or Ewaewa. This species was present in Kaulakahi Channel, and two birds were found on Lehua. Oddly enough, the species has never been recorded from Niihau, even as a visitor, despite the fact that it is present on Kaula and other islands to the west and on islands to the east of Niihau.

Anous stolidus pileatus. Noddy or Noio. Only one member of this species was found; this was taken at the northeast corner of Niihau. The species has never been reported from Niihau, but there are sight records from Kaula and Lehua.

Anous minutus melanogenys. Hawaiian Tern or Small Noio. About 200 were found on Lehua, standing on rock ledges at waterlevel or in caves. The "Noio Caves" of Lehua are at sea level, and the floor is covered with tidal water. One of these caves extended about 50 feet into the cliff. On ledges in the upper and back portions of these caves there were 23 nests, most of which contained nearly-fledged young.

A similar nesting situation is in a cave on the north side of Moku Manu Islet off Oahu. This type of nesting site is quite in contrast to that on Midway Island where the birds nest in the ironwood trees, *Casuarina*, and *Scaevola*, and to that on the Mokapu Cliffs of Oahu where the birds breed on narrow, open ledges.

Geopelia striata striata. Barred Dove or Ehako. The most abundant bird on the kiawe areas is this dove; it is the most numerous species on Niihau. A few were found feeding on Lehua; flights were observed between Niihau and Lehua. At present on Niihau it is relatively scarce in the mountain and plateau regions, due perhaps to absence of water, but small feeding groups are found even there. Around waterholes in the lowlands it was not unusual to find several thousand; estimates of 2600 and 3100 were made at two water sumps. Thus, it is evident that the bird has adapted itself to conditions on Niihau since its introduction and now utilizes the entire island, at least for its feeding. No nests or young were found.

Streptopelia chinensis. Chinese or Lace-neck Dove or Ekaho. Not nearly as abundant as the Barred Dove, this dove presents the same pattern of distribution—numerous in the lowlands and few in the mountains and plateaus. It was first found on Niihau about 1930, and apparently came to the island from Kauai.

Asio flammeus sandwichensis. Short-eared Owl or Pueo. Owls were seen only twice: one bird at Nonopapa, in the middle of a large area of introduced pasture grasses, and two birds perched in kiawe trees at Puu Alala. The Pueo was a common bird in Hawaii before 1900, but on islands other than Niihau much of its habitat has been taken over for agriculture. Why it is relatively scarce on Niihau is unknown.

Alauda arvensis. European Skylark or Manu Palaika. Francis Sinclair brought this species to Niihau before 1920 and later took some of this stock to Kauai for release there. Nowhere on Niihau is it abundant, but it was found everywhere except in those areas where kiawe or koa haole formed extensive, dense thickets. It occurred on all grassy areas in the sand dunes and on the plateaus, in short-weed patches in open stands of kiawe; some were even observed feeding on the steep, barren slopes of Lehua. Usually, the birds were seen as singles or doubles, rarely in groups of three or more. Specimens taken were typical of the species.

Acridotheres tristis. Mynah or Piakelo or Pihakelo. The Mynah apparently arrived on Niihau without human aid, some time after 1870. Mr. Robinson has frequently seen them flying in either direction in the middle of the channel between Kauai and Niihau. The Mynah is ubiquitous in the lowlands, but very few are to be found in the drier mountains and plateaus.

Sturnella neglecta. Western Meadowlark. This species was introduced to Niihau in 1934, according to Mr. Robinson. It apparently did not establish itself, for no birds have been seen in recent years. It is, however, well established on Kauai.

Zosterops palpebrosus. White-eye. The White-eye was first introduced to Hawaii (Oahu) in 1929. From Oahu it has spread unaided to the other large islands, including Kauai and Niihau. On the latter its numbers are still small, as a result perhaps of recent arrival or adverse environmental conditions. On Oahu this species frequents garden shrubbery and other moist thickets. On Niihau the

birds were to be found almost exclusively in the low, dense growth around the ranchhouse at Kiekie; a few were found in kiawe thickets near waterholes.

Munia punctulata. Ricebird or Manu Ailike. The Ricebird, since its introduction to the Hawaiian Islands (Oahu?) in 1865, has spread to all the islands. On Niihau it is a resident of the open kiawe growth where grass and weed patches are interspersed. I never found it in extensive thickets.

Richmondia cardinalis. Cardinal or Ulaula. Introduced to Kauai about 20 years ago, this species has become well established and has populated Niihau on its own. Nowhere on Niihau are the birds as abundant as, for example, in the moist gardens of Honolulu, but one may find singles or pairs in all parts of the island. They are most numerous around the water swamps in the lowlands.

Carpodacus mexicanus. House Finch or Ai-nikana. After Barred Doves, this species is the most abundant on Niihau. It was not introduced by man; it came apparently from Kauai where it was introduced many years ago. The House Finch is present everywhere on the island. Nests and eggs were found beneath shrubbery on the cliffs above Puu Alala. No red-crowned birds were seen or collected; all had yellow to orange crowns.

DISCUSSION

As may be observed in part from the foregoing accounts of species occurring on Niihau, the longitude (160°) of this island corresponds closely to a faunistic division between eastern and western islands of the Hawaiian Chain. Niihau and all islands to the east are relatively new geologically; those to the west are old. The eastern islands are high, sharp mountains which have not been worn down. Forests and soil are present. The middle third of the Hawaiian Chain consists, for the most part, of low, barren rocks with little soil, little plant growth of any kind, and very few trees. The rocks represent the tops of submerged mountains. Islands to the west of Gardner Pinnacles are extremely low, sand atolls with little native plant cover (other than *Scaevola*) at the present time.

Conditions on these islands were not always as described above; we know, for example, that Laysan Island had, within historical times, groves of sandalwood trees, *Santalum*, and dense thickets of brush. However, at the present time it is possible for the Hawaiian Islands to be subdivided into these three geographical regions which are more or less distinct in fauna and flora. The eastern division includes the larger eastern islands from Hawaii west to and including Niihau. The middle region extends from Kaula and Nihoa to Gardner Pinnacles. The western region includes the islands from Laysan to Kure.

To show this subdivision in the avifauna I have prepared figure 5. Not included are the migratory shorebirds and ducks, or any chance visitors.

It is apparent that there is considerable overlap between the west and middle parts, but there is a rather sharp line of separation in the avifauna in the region of Niihau. This is even more apparent than the figure would indicate, for the species that overlap most, *Puffinus pacificus cuneatus* and *Bulweria bulwerii*, breed in the eastern division only on three or four small islands off the coasts of Oahu and Hawaii. Further, the eastward extension of *Sula sula rubripes*, *Sterna*, and *Anous stolidus*, as shown in the figure, is based on breeding records on Moku Manu and Manana Islets off Oahu, and should not be considered typical of the larger eastern islands. The extension of *Diomedea immutabilis* into the eastern section is based on a single nesting on Moku Manu.

It should be noted that these small islands off Oahu, Molokai and Hawaii are ecologically similar to the middle section of the Hawaiian Chain. It has been reported that in 1890-1900 there were no seabirds nesting on these islets and that their populations there were wiped out by the Hawaiians who relished the meat of young petrels, shearwaters and terns. If this be true, the present breeding populations on these rocks are pioneers in reoccupation.

From the data in figure 5 one may also speculate on the species most likely to inhabit Niihau if there is a major change in ecological conditions (see p. 34). With increased water resources and subsequently greater plant growth, species from the

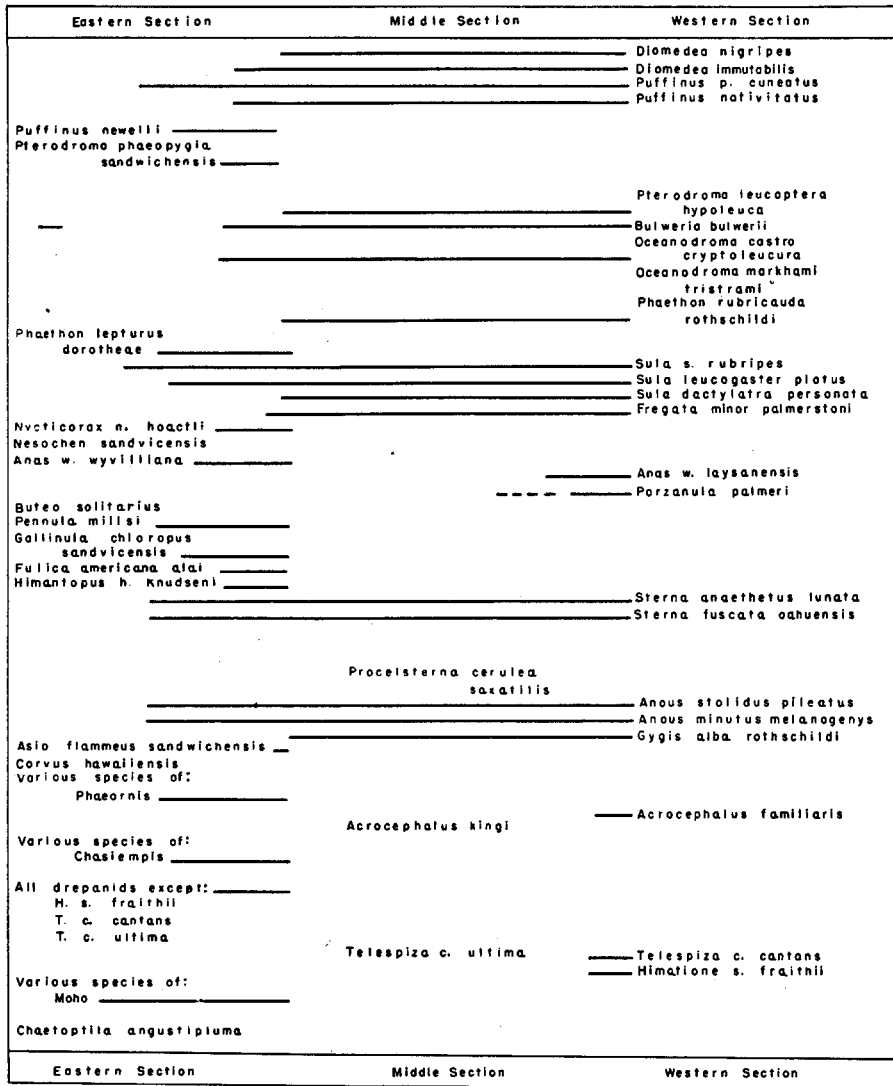


Fig. 5. East-west distribution of birds on the Hawaiian Islands.

eastern end might inhabit Niihau. With greatly increased aridity, less vegetation and possible human retreat from the island, western and middle section species may move in in greater numbers.

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