THE GALÁPAGOS AVIFAUNA

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The last review of the birds of the Galápagos archipelago was made by Swarth (1931) although Lévêque et al. (1966) summarized the migrants on and near the islands. Several authors (Brosset 1963; Curio and Kramer 1964; Harris 1968, 1969a,b,c,d, 1970a,b; Lévêque 1963, 1964; Nelson 1968; Snow and Snow 1969) have published distribution maps and/or counts of several species of resident birds but the status of the birds needs to be looked at as a whole to determine recent changes, due either to man or other factors or to gaps in our knowledge. This paper attempts to document the past and present status of all the birds known to have occurred within the islands or in the seas immediately surrounding them, and to suggest some possible reasons for the distributions of the land birds. Only a handful of wader species, *Heteroscelus incanus*, *Numenius phaeopus*, *Arenaria interpres*, *Charadrius semipalmatus*, and *Lobipes lobatus* can be considered to use the Galápagos as regular wintering grounds. Migrants are not discussed in detail (though all records known to me by 1 January 1973 are given) because of the review cited above. For general information on the islands and the flora, the reader is referred to the accounts of Thornton (1971) and Wiggins and Porter (1971), respectively.

NOMENCLATURE

For the names of the resident species, I have used Swarth (1931) as a basis but there have been many generic changes since this time. I have incorporated the modifications suggested by Lack (1945, 1947, 1969a) for the Geospizinae (Darwin's Finches) as well as a few other published opinions.

Inconsistencies are inevitable but no attempt is made to discuss the taxonomic status of species. Taxonomy is used here solely as a convenient "pigeon-holeing" system for naming birds. Changes involving the specific name have been made in the following species (with Swarth's nomenclature in parentheses): *Puffinus lherminieri* (*P. obscurus*), *Sula sula* (*S. piscator*), *Casmerodius albus* (*C. egretta*), *Haematopus ostralegus* (*H. palliatus*), *Himantopus himantopus* (*H. mexicanus*), *Tyto alba* (*T. punctatissima*), *Asio flammeus* (*A. galapagoensis*), *Pyrocephalus rubinus* (*P. nanus* and *P. dubius*). The nomenclature and sequence of the migrants follows that used by Lévêque et al. (1966). Overall, the order of species is very close to that of the 1957 edition of the A.O.U. Checklist of North American Birds.

The naming of the islands is as much a problem as naming the birds (see Bowman 1960). Most islands have several names, English and Spanish. I hope that this summary will be useful to field workers, therefore I have used the names now in common usage, but give below a list of alternatives. The official Spanish name is italicized. The relative location of each island is shown in figure 1.

Main Islands

Name in common use	Alternatives
Isabela	Albemarle
Fernandina	Narborough
James	*Santiago*, Salvador
Jervis	*Rábida*
Duncan	*Pinzón*
Santa Cruz	Indefatigable
San Cristóbal	Chatham
Barrington	*Santa Fé*
Hood	*Española*
Floreana	*Santa María*, Charles
Tower	*Genovesa*
Marchena	Bindloe
Pinta	Abingdon
Culpepper	*Darwin*
Wenman	*Wolf*

Minor Islands (where different)

Seymour	North Seymour
Baltra	South Seymour
Tortuga	Brattle
Crossman Islands	Los Hermanos

SPECIES LIST

A general statement is made of the status of each species, followed, where appropriate, by remarks on its status on each of the main islands. Except where explicitly mentioned, Seymour and Baltra are included with Santa Cruz, Gardner-near-Hood with Hood, and the

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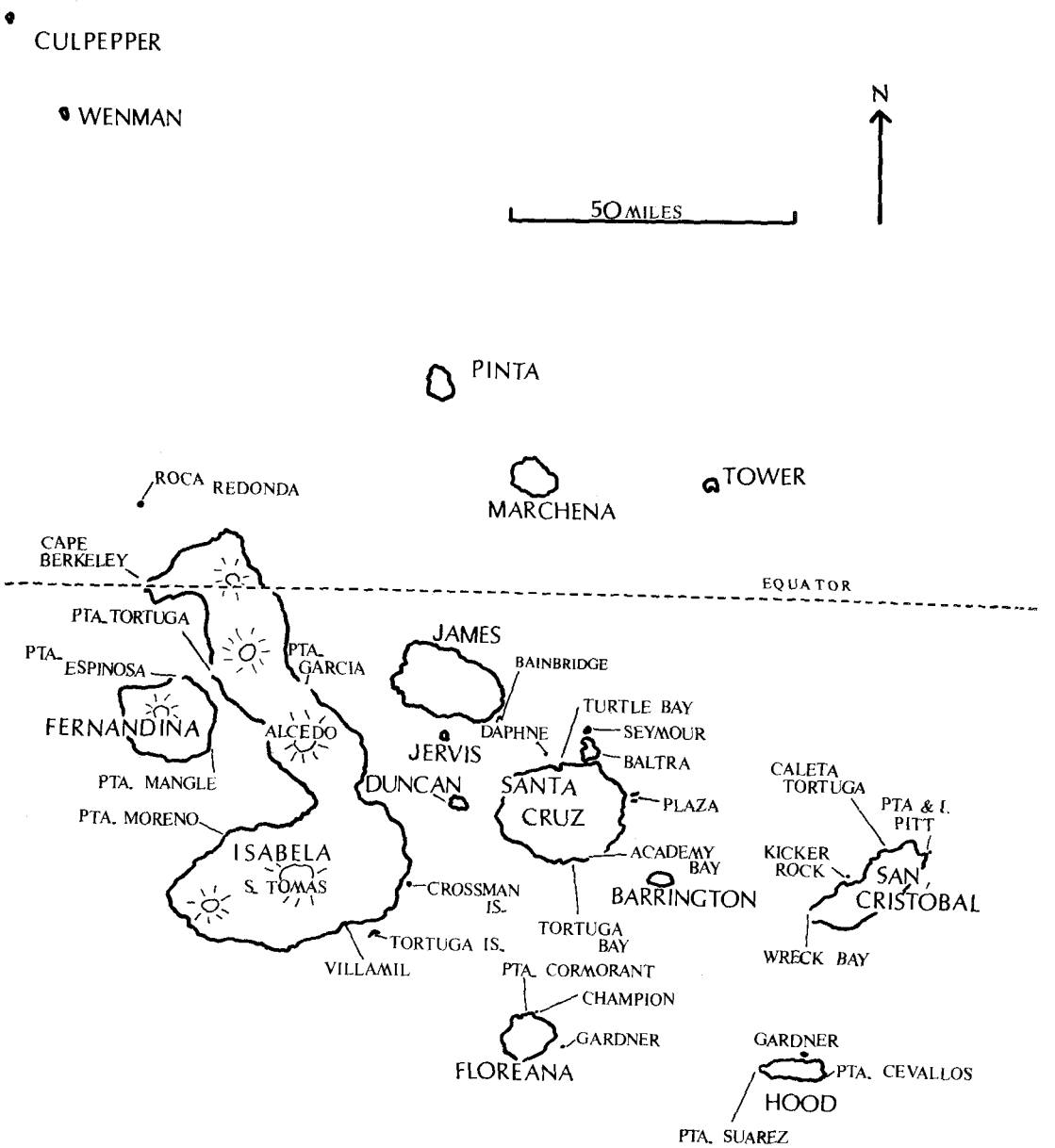

FIGURE 1. Map of Galápagos Archipelago showing places mentioned in the text.

various offshore islands of Floreana with Floreana, partly because we have relatively little information on the smaller islands and also because it seems that many of the birds (excluding mockingbirds) from the small islands travel regularly to and fro from the main islands. The other small islands are not mentioned in detail as observations are very sparse.

Current ornithology in the islands is based on the living birds, so that there are, in most cases, no specimens to support recent records. For the most important sight records, the initials of the observer(s) are given in parentheses after the record. Identification of any set of initials can be made by comparison with names in the acknowledgments; my own records are designated (MH). For the sake of brevity, the sources of older records considered by Swarth (1931) and Lévêque et al. (1966) are omitted. Where recent specimens are available, I have designated their location as follows: Charles Darwin Research Station (CDRS), California Academy of Sciences (CAS), and American Museum of Natural History (AMNH).

Spheniscus mendiculus. Galápagos Penguin. Endemic. Breeds in suitable areas around the coasts of Fernandina and western Isabela (from just north of Cape Berkeley to southwestern tip). Nonbreeding birds, especially immatures, are sometimes seen elsewhere on Isabela, James, Santa Cruz, and Floreana.

Birds have been recorded displaying on Santa Cruz and James but there is no evidence of breeding. Rare elsewhere but has been recorded on Jervis, Duncan, and Hood. Total population probably in region of 3–5000 birds (DB, MH).

Podilymbus podiceps. Pied-billed Grebe. Recorded three times in mangrove lagoons at Academy Bay (Santa Cruz): March 1960; 15–19 December 1961; 13 January–6 February 1966 (MC, MH).

Diomedea irrorata. Waved Albatross. Endemic. Breeds on the southern slopes and coasts and the extreme eastern tip of Hood. In 1970–71, the population was estimated at 12,000 pairs, far higher than previous, but incomplete counts (Brosset 1963; Lévêque 1964). Common at sea throughout the archipelago except January to March when birds migrate to waters off Ecuador and Peru. An albatross seen off Pinta, 17 July 1948, was probably *D. exulans* or *D. epomophora.*

Daption capense. Cape Pigeon. Recorded 23 October 1961 and 7 October 1965 (MC) but for July–November 1972 there is a total of 13 records, including corpses washed ashore on Santa Cruz and Isabela (DD, JG, TR, MH). Sea conditions during the latter part of 1972 were atypical (high sea water temperatures) and many unusual records occurred at this time.

Puffinus pacificus. Wedge-tailed Shearwater. Bird found eaten by *Asio flammeus* on Plaza, 19 September 1966 (MH; specimen CDRS). The species is not uncommon between Galápagos and Panamá.

Puffinus griseus. Sooty Shearwater. Dead bird washed ashore at Punta Tortuga (Isabela), 16 August 1971 (MH; specimen CDRS) and a live bird ashore at Villamil 14 January 1972 (JG). Six sightings May–June 1972 (BJ, RT, DD).

Puffinus carneipes. Pink-footed Shearwater. A live bird ashore at Villamil (Isabela), 15 January 1972 (JG) and sight records off Duncan (one bird) and off Punta Albemarle (three), 28 October and 22 November 1972, respectively (MH).

Puffinus lherminieri. Audubon's Shearwater. Resident. Nests on cliffs throughout the archipelago.

Procellaria parkinsoni. Parkinson's Petrel. Single birds shot off San Cristóbal, 14 October 1905; off Floreana, 4 May 1906; and well south of Isabela 18 June 1906, the only records for this area of the Pacific.

Pterodroma phaeopygia. Dark-rumped Petrel. Fairly common resident. Breeds in the humid and thickly vegetated highlands of Isabela (Santo Tomas, Alcedo), James, Santa Cruz, San Cristóbal, and Floreana. Numbers have been severely reduced by introduced predators and the clearing of the nesting areas for agriculture (Harris 1970b).

Pelagodroma marina. White-faced Storm Petrel. Three records within the islands: a bird aboard ship off San Cristóbal, 9 July 1967 (Harris and de Vries 1968); and sight records off Santa Cruz, June 1968 and off James, February 1969 (TR). In addition, specimens have been collected within 120 miles of the archipelago 18 June 1906 and September 1930 and a few other sight records were made further offshore.

Oceanodroma leucorhoa. Leach's Storm Petrel. Four records of birds aboard ships within the islands: two off Tower, 11 February 1970 (MH); single off Hood, 14 April 1970 (MH); and single off Floreana, 17 May 1971 (GM). A sight record was made near Wenman, 22 February 1971 (MH). Several specimens have been taken in this area of the Pacific, so may be commoner than these records suggest.

Oceanodroma castro. Band-rumped Storm Petrel. Fairly common resident. Breeds on various small islands and cliffs of some larger islands throughout the archipelago. Rarely recorded at sea.

Oceanodroma tethys. Wedge-rumped Storm Petrel. Resident Nests on Tower [ca. 200,000 pairs (Harris 1969a)], Isla Pitt, and almost certainly on Roca Redonda. Common at sea.

Oceanodroma markhami. Sooty Storm Petrel. Specimen collected off Fernandina, 12 July 1925.

Fregetta grallaria. White-bellied Storm Petrel. Specimen collected SE of Isabela, 11 June 1906 and a sight record, 17 July 1948, N of Pinta.

Pelecanus occidentalis. Brown Pelican. Resident. Breeds commonly on all the central islands and has also bred on Hood and Marchena. Uncommon visitor to Tower and Pinta; single record of two adults and an immature on Wenman, 23 February 1962 (RL). Unrecorded from Culpepper.

Sula sula. Red-footed Booby. Resident. Breeds on Tower [ca. 140,000 pairs (Nelson 1968)], Wenman, Culpepper, Gardner-near-Floreana, Punta and Isla Pitt (San Cristóbal). Sometimes seen ashore in trees where it does not breed, e.g., Seymour, Punta Cevallos (Hood), and Roca Redonda.

Sula dactylatra. Masked Booby. Resident. Common breeding species throughout the archipelago. Often roosts on islands and rocks where it does not breed.

Sula nebouxii. Blue-footed Booby. Very common resident. Breeds on most islands except those north of the equator (but has bred on Tower). Often roosts where it does not nest.

Nannopterum harrisi. Flightless Cormorant. Endemic. Breeds on sheltered rocks and beaches on Fernandina and Isabela (except south coast from Punta Garcia to Punta Moreno). Total population 1970–71 about 800 pairs (MH). Unrecorded outside the breeding range.

Fregata magnificens. Magnificent Frigatebird. Resident. Main breeding colonies on Seymour, Gardner-near-Floreana, near Punta Moreno (Isabela), Wreck Bay, and Kicker Rock (San Cristóbal). A few pairs breed on Daphne Minor and in colonies of *F. minor* on Wenman, Tower, Tortuga Island, and Punta Pitt (San Cristóbal).

Fregata minor. Great Frigatebird. Resident. Main breeding colonies on Hood, Gardner-near-Floreana, Tortuga Island; also on Crossmans, Isla and Punta Pitt (San Cristóbal), Tower, Culpepper, and Wenman. Both species of frigatebirds roost on rocks and in trees at places where they do not nest.

Ardea herodias. Great Blue Heron. Resident. Breeds only in coastal areas of the main islands. Rare on Hood and Tower; unrecorded on Culpepper, Wenman, Marchena, and Pinta.

Butorides striatus. Striated Heron, and *Butorides sundevalli.* Lava Heron. The situation regarding these two species is confused. *B. sundevalli* is endemic and common in the coastal areas of all the islands, and until recently there had been no suggestion that another *Butorides* sp. ever occurred in Galápagos. However, birds resembling *B. striatus* have been recorded on Isabela (nesting), Santa Cruz (nesting), Fernandina (see fig. 2), Duncan, Santa Cruz, San Cristóbal, and Pinta. Present knowledge is insufficient to ascertain whether there are two species of *Butorides* breeding in Galápagos which hybridize (as intermediates occur) or whether there is one, very variable species. If *B. striatus* does indeed breed, it is not a recent colonizer since skins assignable to the species were collected by the Academy Expedition 1905–6 (L. C. Binford, unpubl. data). Specimens of *B. striatus* are at CDRS, AMNH, CAS.

FIGURE 2. Striated Heron (*Butorides striatus*) at Punta Espinosa, Fernandina, July 1971.

For many years it was not realized that there were two species of *Butorides*, *B. striatus* and *B. virescens*, on Cocos Island and it is still not certain which breeds or whether both are resident (Slud 1967). The taxonomy of the group obviously needs some critical attention.

Bubulcus ibis. Cattle Egret. Regular migrant in small numbers. First identified in 1964 and now recorded from most islands, not only in the highlands with cattle but in sea lion colonies (e.g., Plaza, Hood). Extreme dates 2 August to 29 April.

Casmerodius albus. Common Egret. Resident. Occurs in small numbers in the coastal areas of the main islands; rarely recorded inland. Rather few nesting records but there is no evidence that the species is a migrant to the area. An all-dark heron, slightly smaller than this species, was seen at Turtle Bay (north Santa Cruz) sometime in 1967 (CA).

Leucophoyx thula. Snowy Egret. Migrant in small numbers. First recorded 28 December 1965 (MC), and since this date one or two have been seen irregularly in the southern part of Santa Cruz, Turtle Bay (Santa Cruz), southern Isabela, and at Punta Cormorant (Floreana) (MH). At least one bird has been seen in full breeding plumage, so it is conceivable that the species might one day nest. Extreme dates are July to 21 April.

Nycticorax nycticorax. Black-crowned Night Heron. A subadult seen at Turtle Bay (Santa Cruz), 1 April 1971 (HD).

Nyctanassa violacea. Yellow-crowned Night Heron. Resident. Breeds on all the main islands with the possible exceptions of Culpepper and Wenman.

Phoenicopterus ruber. Greater Flamingo. Resident. Seen regularly on a few salt lagoons on Isabela, James, Bainbridge Rocks, Jervis, Santa Cruz, and Floreana. Breeds or has bred on all these islands. Total population over 500 but less than 1000 birds.

Dendrocygna autumnalis. Black-bellied Tree Duck. Single at Villamil (Isabela), 2 July 1960.

Anas bahamensis. White-cheeked Pintail. Resident. Occurs on all the main islands where there are salt lagoons or permanent or temporary freshwater. Largest numbers seen in the crater lake of Fernandina.

Anas discors. Blue-winged Teal. Regular migrant in small numbers. Commonest October to March but has been recorded in most months. Normally frequents freshwater ponds.

Buteo galapagoensis. Galápagos Hawk. Endemic. Previously common on all the main islands except Tower, Culpepper, and Wenman. Now extinct on Floreana and San Cristóbal, very reduced in numbers on Santa Cruz. Visits but does not breed on Jervis. Total population about 130 pairs (TV).

Pandion haliaetus. Osprey. Migrant in very small numbers. Occasional birds spend the northern summer in the islands.

Falco peregrinus. Peregrine Falcon. Migrant in very small numbers. A total of 16 dated records, most between 21 November and 14 March but also recorded 16 May 1970 and 20 June 1967 (TV; MH).

Laterallus spilonotus. Galápagos Rail. Endemic. Common in the highlands of James and Santa Cruz, formerly very common on Pinta but now less so. Also breeds on Floreana, probably on Isabela, possibly on Fernandina. Recorded normally from the wetter inland areas but rarely in mangroves.

Neocrex erythrops. Paint-billed Crake. Resident. Nests on Santa Cruz and Floreana (specimens CDRS). Recorded since 1953 (Bowman 1960) but possibly overlooked for sometime, could occur on San Cristóbal and Isabela. Dead bird on Tower, Dec. 1972 (Kumerloeve, pers. comm.).

Porphyrula martinica. Purple Gallinule. A recently dead adult found off Santa Cruz, 13 February 1964 and a bird caught alive and photographed at Punta Suarez, February 1972 (DD). An immature aboard ship between Galápagos and Ecuador, 20 February 1968 (Castro and de Vries 1970) (specimen CDRS).

Gallinula chloropus. Common Gallinule. Resident. Confined to brackish lagoons and a few inland pools on San Cristóbal, Santa Cruz, southern Isabela, and Floreana. Heard calling at the crater lake on Fernandina, July 1957 (RB).

Haematopus ostralegus. Oystercatcher. Resident. Scattered pairs found on the coasts of main islands; total population very small, probably less than 100 pairs. Most numerous on Hood where there are 10–12 breeding pairs.

Charadrius semipalmatus. Semipalmated Plover. Common migrant. Small numbers always present but the species is most numerous August to April when flocks of over 50 birds have been seen.

Charadrius wilsonia. Wilson's Plover. Three birds seen at Punta Cormorant (Floreana), 10 May 1969 (RTP).

Charadrius vociferus. Killdeer. An adult photographed at Punta Tortuga (Isabela), 8 February 1971 (HRH; MH).

Pluvialis dominica. Golden Plover. Two birds seen at Tortuga Bay (Santa Cruz), 18 November 1962 (Hatch and Hailman 1967).

Squatarola squatarola. Black-bellied Plover. Regular migrant in small numbers, recorded in all months but most common during northern winter.

Aphriza virgata. Surfbird. A migrant in very small numbers. Recorded on James, 25–26 October 1961; Santa Cruz, 6 November 1961; Plaza, 21 October 1966 (MH); and at Villamil (Isabela), 20 March 1970 (MH), 7 September 1971, and April 1972 (JG).

Arenaria interpres. Ruddy Turnstone. Very common migrant to rocky shores, rare inland. Always present but most common August to March.

Arenaria melanocephala. Black Turnstone. Single bird seen with two *A. interpres* at a pond in the highlands of San Cristóbal, 29 September 1968 (MC).

Numenius phaeopus. Whimbrel. Migrant in large numbers. Although recorded all months, it is rather uncommon from end of April to mid-July. Up to 500 birds counted on a roost at Villamil (Isabela) (TV).

Actitis macularia. Spotted Sandpiper. Regular migrant in small numbers and not recorded every year. Extreme dates 23 August and 2 May.

Tringa solitaria. Solitary Sandpiper. Rare migrant. Recorded mainly from the highlands of Santa Cruz, 15 October 1961, 21 September 1964 to 7 April 1965 (MC), September 1965 to 19 April 1966 (MC), 30 October 1967 (MC). Only other records are inland on San Cristóbal, 12 October 1897 and December 1938 to February 1939, and on the north coast of Santa Cruz, 2 October 1968 (EU).

Heteroscelus incanus. Wandering Tattler. Common migrant. By far the most common shore bird in Galápagos, which must be one of the major wintering grounds for the species. Recorded throughout the year but only small numbers during the northern summer.

Catoptrophorus semipalmatus. Willet. Regular migrant in very small numbers, although up to 14 have been seen together. Recorded in all months but rare May to July. Most frequently seen on sand beaches at Villamil (Isabela) and Tortuga Bay (Santa Cruz).

Totanus melanoleucus. Greater Yellowlegs. Rare migrant recorded April 1923, 29 April 1932, February to March 1939, 2 April and 31 July 1960, 20–21 January 1962, 30 September to 7 October 1964 (MC), 16 February 1966 (MC), 4 January 1967 (TV), 6 to 11 April 1971 (JG), April 1972 (JG), November–December 1972 (JG, MH).

Totanus flavipes. Lesser Yellowlegs. Migrant in small numbers. Recorded in nine northern winters between 8 October and 9 May. Maximum numbers recorded 1938–39, when up to 13 frequented the lake of El Junco (San Cristóbal), 1965–66 (four records) (MC, TV, MH), and end of 1972 (ca. 10 records) (DD, MH).

Calidris canutus. Knot. Single bird at Punta Cormorant (Floreana), 10 May 1969 (RTP).

Erolia melanotos. Pectoral Sandpiper. Singles recorded in Santa Cruz highlands, October 1964 and 1 October 1967 (MC).

Erolia bairdii. Baird's Sandpiper. Birds collected on Barrington, 6 October 1897 and on Hood, 23 September 1957, and two found dead at James Bay, 28 October 1972 (MH; determined R. C. Laybourne).

Erolia fuscicollis. White-rumped Sandpiper. Single bird Cape Hammond (Fernandina), 1 November 1972 and two photographed Punta Cormorant (Floreana), 2 December 1972 (MH).

Erolia minutilla. Least Sandpiper. Migrant in small numbers in most years, the most common "peep." Extreme dates 8 September and 9 May, and largest flock 15 birds.

Micropalama himantopus. Stilt Sandpiper. Three records: near Villamil (Isabela), 27–28 April 1932, and 22 February 1966 (MC, TV), and Santa Cruz, 8 October 1962.

Limnodromus griseus. Short-billed Dowitcher. Dowitchers recorded near Villamil (Isabela), 14 March 1960, 4 January 1967 (TV), May 1971, January, April, November and December 1972 (JG); three birds (1 collected) on James, 26 October 1961 and two there, 21 February 1971 (MH); a single bird collected on Floreana, 24 November 1961; and five birds at Caleta Tortuga (San Cristóbal), 20 December 1965 (MC, MH). Apart from the collected specimens there is the possibility of confusion with the Long-billed Dowitcher (*L. scolopaceus*) which has been recorded on the Ecuadorian mainland.

Ereunetes pusillus. Semipalmated Sandpiper. Three collected on Floreana, 24 November 1961 and two seen there, 14 March 1971 (MH); sight records at James Bay, 28 October 1972 and at Academy Bay, 18 November 1972 (MH). Probably overlooked due to difficulties in field identifications.

Ereunetes mauri. Western Sandpiper. Few definite records: on James, 26 October 1961, 20 September 1968 (EU), 28 October 1972 (MH); Floreana, 24 November 1961 and 2 December 1972 (MH); and Barrington, 30 October 1970 (MH). This or *E. pusillus* seen also on ca. 15 other dates.

Limosa fedoa. Marbled Godwit. Several seen at Academy Bay (Santa Cruz), 9 November 1957; a single at Villamil (Isabela), 6 January to end of March (TV, MH), and start of August 1971 (JG).

Crocethia alba. Sanderling. Common migrant with flocks of over 100 birds on sand beaches. Some birds oversummer.

Himantopus himantopus. Common Stilt. Resident. Most common on salt lagoons but also occurs and nests on freshwater ponds and crater lakes.

Phalaropus fulicarius. Red Phalarope. A specimen taken off Fernandina, 25 August 1929; a single bird seen at Caleta Tortuga (San Cristóbal), 16 December 1965 (MC); five birds at Punta Cormorant (Floreana), 11 December 1965 (TV); and many records in large flocks of *L. lobatus* October–November 1972, a time when many other unusual sea birds were recorded (MH). Possibly overlooked in large flocks of *L. lobatus* but in most years must be rare.

Lobipes lobatus. Northern Phalarope. Common migrant. Numerous 1 August to 20 April, with flocks sometimes numbering several thousand birds during December and January. Normally on the open sea but small numbers on salt lagoons.

Steganopus tricolor. Wilson's Phalarope. Migrant. Small numbers occur between August and December but odd birds may be seen at any time. Usually on salt lagoons, rarely on tidal pools, and unrecorded on the open sea. Maximum flock 20 birds.

Stercorarius pomarinus. Pomarine Jaeger. An immature shot off Isabela, 15 December 1897 and three seen between Hood and Floreana, 8 December 1971 (RF). Unidentified jaegers seen 6 July 1961 and 22 November 1972 (MH).

Catharacta skua. Skua. Single bird seen off Cape Berkeley (Isabela), 12 March 1966 (MC) and a "probable" off Floreana, 17 January 1971 (CA).

Larus atricilla. Laughing Gull. An adult collected off Santa Cruz, 19 February 1962; a bird seen off Isabela, 12 March 1960; and several seen and photographed at several places in latter part of 1972 (DD, MH). "Probables" seen on several dates but specific separations from *L. pipixcan* are difficult as most birds are immature.

Larus fuliginosus. Lava Gull. Endemic. Widely but sparsely distributed throughout the archipelago; most numerous near human settlements. Total population less than 400 pairs (Snow and Snow 1969).

Larus pipixcan. Franklin's Gull. Migrant in very variable numbers, possibly increasing. Usually seen from October to May; largest count 35 at Wreck Bay (San Cristóbal), 7 December 1967 (TV). Most birds are immature.

Creagrus furcatus. Swallow-tailed Gull. Endemic [though a few pairs nest on Malpelo Island (Bond and de Schauensee 1938)]. Nests commonly throughout the archipelago except eastern and southern Fernan-

dina and western Isabela. Total population probably slightly higher than the 10,000 pairs estimated by Lévêque (1964) and Harris (1970a) due to the discovery of several new colonies, e.g., western Fernandina.

Sterna hirundo. Common Tern. Migrant in very small numbers. An immature collected on Hood, 26 November 1961 and two (out of a flock of 7) photographed at Villamil (Isabela), March 1970 (TR). About 20 other records could refer to this or *S. paradisaea*, especially common in latter part of 1972. Extreme dates August and March.

Sterna fuscata. Sooty Tern. Resident. Large numbers breed on Culpepper but birds are rarely seen elsewhere in the islands because the population feeds in the warmer waters north of the archipelago. Rarely heard at night calling at other sea-bird colonies. A bird killed by *Asio flammeus* on Tower in 1966 (MH).

Thalasseus maximus. Royal Tern. Migrant in very small numbers. Up to nine recorded at or near Villamil (Isabela) in 10 years between 1960 and 1972. Most records are between January and March but noted in all months.

Anous stolidus. Brown Noddy. Resident. Common nester on cliffs throughout the archipelago.

Gygis alba. Fairy Tern. Single sighting off Tower, 14 September 1906.

Zenaida galapagoensis. Galápagos Dove. Endemic. Widespread on all the main islands. Most common on Fernandina, James, Barrington, Hood, and Tower islands where there are few or no feral cats.

Coccyzus erythopthalmus. Black-billed Cuckoo. An immature found dead on Hood, 16 May 1970 (MH; determined L. C. Binford; specimen CDRS).

Coccyzus melacoryphus. Dark-billed Cuckoo. Resident. Common on Isabela, Fernandina, Santa Cruz, San Cristóbal, Floreana; uncommon on Duncan, rare on James (apparently unrecorded before 1966 and now only known from northwest coast and two areas inland), and a single record 10 July 1906 on Barrington.

Crotophaga sulcirostris. Groove-billed Ani. Single birds inland on Isabela, April 1962 (CA); Santa Cruz, 29 March 1966 (MC); and James, March 1967 (TR). Because of its association with cattle and its local reputation for removing ticks from cattle, it is possible that these birds were introduced by farmers. The seemingly weak flight might also support this view.

Tyto alba. Barn Owl. Resident. Common on Fernandina; uncommon on Isabela, Santa Cruz, James, and San Cristóbal; probably extinct on Floreana.

Asio flammeus. Short-eared Owl. Resident. Recorded from all the main islands except Wenman. Two records from Fernandina [specimen collected 9 January 1929 is in the Chicago Field Museum (per TV) and a sight record 3 July 1971 (DB)], and several recent sight records from Jervis. Commonly seen on the smaller islands with nesting sea-birds but not known to nest in such areas. Assumed to be resident on Culpepper where seen twice, 29 July 1897 and January 1964 (RB), on two of the very few landings on the island.

Chordeiles minor. Common Nighthawk. Two birds seen at Punta Suarez (Hood), 22–24 November 1963 and a single at Punta Cevallos (Hood), 12 December 1970 (MH). Although it is sometimes difficult to separate this species from *C. acutipennis*, the field characters of these birds were exactly right for *C. minor*. A bird heard calling at night inside the crater of Alcedo (Isabela), 23 April 1971 (CM) and an unidentified nighthawk seen at Academy Bay (Santa Cruz), 22 October 1972 (MH).

Megaceryle alcyon. Belted Kingfisher. Migrant in very small numbers. Recorded in seven northern winters between 1961 and 1971, extreme dates 20 October to 20 March. Most records are from Academy Bay (Santa Cruz) and are probably due to concentration of observers rather than of the birds. Also recorded on the north side of Santa Cruz, Daphne, Tower, Hood, Isabela, and Floreana.

Myiarchus magnirostris. Large-billed Flycatcher. Endemic. Widespread on the main islands except Tower (recorded 14 September 1906), Wenman (three on 24 September 1906). A bird caught at sea near Culpepper 25 July 1897.

Pyrocephalus rubinus. Vermilion Flycatcher. Resident. Breeds on most main islands except Barrington (five specimens, last seen 1929), Jervis (seven specimens, last 1906), Wenman (single 24 September 1906), and Hood [single sight record December 1970 (MH)]. Unrecorded on Culpepper and Tower.

Riparia riparia. Bank Swallow. Migrant. Recorded on 12 dates spread throughout the year. Specimen CDRS.

Hirundo rustica. Barn Swallow. Migrant. Occurs most years in small numbers during the northern winter. Some hirundines either oversummer or, more likely, survive that long before dying.

Petrochelidon pyrrhonota. Cliff Swallow. Single bird seen at sea some 60 miles north of Culpepper, 13 April 1932.

Progne subis. Purple Martin. Migrant in small numbers. First recorded October 1964 (MC) but possibly overlooked before this date. Since 1964, females or immatures have been recorded on various dates from Hood and Santa Cruz. Between June and December 1970 at least four were seen regularly at Punta Suarez (Hood) (MC). Skin of an immature at CDRS. The only record of males, two on Hood on 17 October 1972 (MH), may be due to confusion with the similarly all-dark *P. modesta*.

Progne modesta. Galápagos Martin. Endemic. Found in small numbers throughout the archipelago although unrecorded in the five most northern islands and Jervis. Very rare on Hood and not resident there.

Nesomimus trifasciatus. Charles Mockingbird. Endemic. Breeds on Champion and Gardner-near-Floreana with population of about 150 birds (Harris 1968). Now extinct on the main island of Floreana.

Nesomimus macdonaldi. Hood Mockingbird. Endemic. Common resident on Hood and Gardner-near-Hood.

Nesomimus melanotis. Chatham Mockingbird. Endemic. Common on San Cristóbal.

Nesomimus parvulus. Galápagos Mockingbird. Endemic. Common on all the main islands except those with the three species above and Duncan, which lacks a resident mockingbird. The two records of mockingbirds on Duncan, 14 August 1906 and 6 December 1968 (JB), are probably referable to this species.

Dendroica petechia. Yellow Warbler. Resident. Common on all the main and most of the smaller islands. Very widespread but apparently prefers greener areas than *Certhidea olivacea*, where both occur on dry islands.

Dolichonyx oryzivorus. Bobolink. Migrant. Most commonly seen between October and December but odd birds in other months. Numbers vary greatly from year to year.

Piranga rubra. Summer Tanager. A mummified adult male found on Hood, 30 August 1963. One or possibly two female-plumaged, unidentified tanagers seen in the farm lands of Santa Cruz, October and November 1964.

Geospiza magnirostris. Large Ground Finch. Endemic. Status difficult to elucidate for field identifications on strange islands are thought to be unreliable because of the difficulty, if not impossibility, of field separation from the largest beaked individuals of *G. fortis.* However, it has occurred on all the main islands except San Cristóbal, Culpepper, and Hood. Three specimens collected on Fernandina, January and April 1899, and two on Barrington, October 1897 and October 1905, could refer either to stragglers or to now extinct populations. The statements of Sammalisto (1967) that 1% of the finches breeding on Barrington can be assigned to *G. magnirostris* (similarly the 3% referred to *G. difficilis*) are considered to be due to misidentifications. The status of *G. magnirostris* on Floreana is obscure. The unusually large subspecies collected by Darwin with reasonable certainty on Floreana was thought now to be extinct, but a bird collected 20 September 1957 may be assignable to this form (Bowman 1961). Another *G. magnirostris* [considered by Swarth (1931) to be an abnormal *G. fortis*] collected there by the Academy Expedition is much smaller and probably refers to a straggler from another island. The species should probably be considered extinct, or nearly so, on Floreana.

Geospiza fortis. Medium Ground Finch. Endemic. Widespread on all the main islands except Culpepper, Tower, and Wenman (single collected 24 September 1906). In 1905–6, 15 nonbreeding birds were collected on Hood and they may be either stragglers or representatives of a now extinct population (see later). An early record from Tower is now known to be due to a mislabeled specimen (Trimble 1943; Parkes, unpubl. data).

Geospiza fuliginosa. Small Ground Finch. Endemic. Common on all main islands except Culpepper, Tower, and Wenman (though six individuals there 24 September 1906).

Geospiza difficilis. Sharp-beaked Ground Finch. Endemic. Occurs in the humid zones on James, Fernandina, Pinta and common on the arid islands of Tower, Wenman, and Culpepper. Previously in the humid zone on Santa Cruz but disappeared between 1932 and the visit of Lack in 1939 (Lack 1945). All subsequent records of this species on Santa Cruz almost certainly refer to misidentified *G. fuliginosa.* Darwin's specimens, which came from either Floreana or San Cristóbal (the former is considered more likely), belong to a distinct subspecies which is now extinct. Rothschild and Hartert (1899) reject a specimen collected by Markham on Floreana in February 1880 on the grounds that the species had never been recorded there, but since Markham visited no other island in the archipelago, there can be no chance of any mislabeling. Other old specimens from San Cristóbal (19 October 1897) and Isabela (4 January 1901) may also refer to extinct populations.

Geospiza scandens. Cactus Finch. Endemic. The drier areas of the main islands are the preferred habitat but the species is missing from Fernandina and islands with *G. conirostris.* Now extinct on Duncan.

Geospiza conirostris. Large Cactus Finch. Endemic. Commonly nests on Hood and Tower; also bred in 1966 on Wenman [a male seen feeding a fledged young (MH)] but otherwise only one other record of a specimen collected 8 January 1963 (Curio and Kramer 1965). The situation of the large-billed *Geospiza* sp. on Culpepper is confused. Rothschild and Hartert (1902) and Lack (1945, 1969a) refer specimens collected 1897–1906 to this species, whereas Swarth (1931) and Bowman (1961) would prefer them placed in *G. magnirostris.* A party which spent 2 days on the top of the island in April 1968 failed to see any large-billed geospizids (RB). Possibly the collected specimens may refer to stragglers or a very short-lived population now extinct, but the possibility still exists that the species still survives in vegetation at the base of the cliffs, where the earlier specimens were obtained. A single specimen from Pinta, 27 March 1963 (Curio and Kramer 1965). It is tempting to assume that the specimen labeled as having been collected on Gardner-near-Floreana on 31 October 1897 was an error of labeling, but Rothschild and Hartert (1899, 1902) were at pains to point out that this was not so, so the species must be considered a straggler to this island.

Platyspiza crassirostris. Vegetarian Finch. Endemic. Breeds on all the main islands except Barrington, Culpepper, Wenman, Tower, and Hood, most of which are too dry to support a purely vegetarian species. Four specimens collected on Duncan in 1897 and 1899 but not seen there since.

Camarhynchus parvulus. Small Tree Finch. Endemic. Resident on all the main islands except Culpepper, Tower, Hood, Marchena, and Wenman (two specimens collected 24 September 1906).

Camarhynchus pauper. Medium Tree Finch. Endemic. Found only in the highlands of Floreana, where common.

Camarhynchus psittacula. Large Tree Finch. Endemic. Has been recorded, and probably has bred, on all main islands except Hood, Tower, Wenman, and Culpepper. However, status uncertain on San Cristóbal (single collected 24 December 1900) and does not now breed on Barrington, though specimens collected 20 October 1906 (one), 6–7 October 1897 (three), and sight records May 1966 (TV) and 16 September 1968 (EU). Extinct on Duncan, last seen 1906.

Camarhynchus pallidus. Woodpecker Finch. Endemic. Breeds on Isabela, Fernandina (probably), Santa Cruz, James, San Cristóbal, and Duncan (rare). Also recorded on Jervis (specimens 1897 and 1905), Floreana (specimen 11 October 1905), and Barrington [two sight records including one with cactus spine, 15 September 1968 (EU) and a sight record on Pinta, 24 August 1968 (RP)].

Camarhynchus heliobates. Mangrove Finch. Endemic. Restricted to the dense mangrove areas on eastern Fernandina [seen 1971 at Punta Mangle (PK) but not for many years at Punta Espinosa (MH, TV, PK)] and the west coast of Isabela between just north of Punta Tortuga to just east of Punta Moreno. Specimens were collected early this century from southeast Isabela and a single in August 1971 at Cartago Bay Isabela (RB) but the status there needs confirmation. The total population must be very small due to the limited habitat.

Certhidea olivacea. Warbler Finch. Endemic. Breeds on all the main islands.

GEOSPIZA SPP. ON CROSSMAN AND DAPHNE ISLANDS

Ground finches collected on Daphne and Crossman islands are intermediate between *G. fortis* and *G. fuliginosa.* Forty-two specimens collected on Daphne have significantly larger beaks ($P < 0.05$) than 16 from the Crossmans (measurements in Lack 1945). Originally, Lack (1945) considered these populations to be the results of hybridization between *G. fortis* and *G. fuliginosa* but later (1947, 1969a) decided that they were more likely to be specialized derivatives of

G. fortis (Daphne) and *G. fuliginosa* (Crossmans). There have been no identifications of finches on the Crossmans since 1906. These extremely interesting populations need further investigation, if indeed they are still extant, as the many individuals I have seen on Daphne were mostly assignable to *G. fortis* and *G. fuliginosa*. The latter has been collected on Daphne (Lack 1945).

CHANGES IN THE AVIFAUNA

It is difficult even today, after more than 10 years' intensive field work by various ornithologists working at the Charles Darwin Research Station, to be certain of the distribution of breeding land birds. Large fluctuations in numbers of many species occur and the less common species may be so reduced that they are overlooked, only apparent when they suddenly appear in numbers. Therefore, any species considered to be extinct on any island could possibly still exist, though future records, if any, could in fact refer to individuals coming from other islands.

If there are difficulties in present-day records, what of the older ones? Virtually all the older records are substantiated by specimens but there still remains the chance of mislabeling. The oldest specimens are those collected by Darwin in 1835, but since he did not realize the significance of interisland differences until he had collected on San Cristóbal and Floreana, there are doubts as to the localities of some of his most important specimens.

Although some species have disappeared from some islands, as far as is known no indigenous species has become extinct. Some island extinctions have been brought about directly by man, notably *Buteo galapagoensis* on Floreana and San Cristóbal, and probably *Tyto alba* on Floreana. The disappearance of *Nesomimus trifasciatus* from the main island of Floreana is puzzling. Porter found it common there in 1813 (Beebe 1924) but there are no subsequent positive records, for the specimens collected by the *Beagle* expedition could possibly have come from Champion, which was visited by FitzRoy. It may be that cats on Floreana were responsible, but this seems unlikely because *Nesomimus* spp. on other islands have adjusted to introduced animals. Similarly perplexing is the absence of any *Nesomimus* on Duncan, only 6 miles from Santa Cruz where *N. parvulus* is abundant. On Duncan, introduced black rats (*Rattus rattus*) have prevented successful nesting of tortoises by eating the newly hatched young but, at least to my mind, it seems unlikely that these animals would have exterminated a land bird. Still the problem of mockingbird distribution in the archipelago remains unsolved.

In 1932 *Geospiza difficilis* was quite common in the highlands of Santa Cruz but it had apparently disappeared by 1939 (Lack 1945). On the other islands where this species also coexists with the rather similar *G. fuliginosa* (i.e., James, Fernandina, Pinta), *G. difficilis* is restricted to the highlands. Some of the highlands of Santa Cruz were cleared for agriculture about this time, but the amount of the habitat suitable for *G. difficilis* which was affected was small and its removal cannot be considered responsible for the loss of this bird. If man influenced it in some other way, there is no evidence how he did so; but *G. difficilis* is now absent on San Cristóbal (where recorded 1897), Floreana (1835, 1880), and Isabela (1901), all islands which would appear suitable, and which were the first to be settled by man. So it is quite possible that on those islands man was responsible, albeit indirectly, for the loss of the species.

GEOSPIZA FORTIS ON HOOD

In 1905–6, the Academy Expedition collected 15 specimens of *Geospiza fortis* on Hood, but despite intensive searches by several people the species has not been seen since. Lack (1969a) has considered the Hood *G. fortis* as stragglers from another island, but on ecological grounds it seems just as likely that they were representatives of a population which has become extinct due to a change of climate and/or the effects of introduced goats.

Hood is an arid, low-lying island on the outskirts of the archipelago. It is to be expected that it would have few species of land birds. However, Tower, smaller and even lower and having far fewer plant species, has three species of seed-eating *Geospiza* whereas Hood now has only two. The three species on Tower are the large-billed *G. magnirostris*, the small-billed subspecies of *G. conirostris*, and the small-billed *G. difficilis*. Hood has the very large-billed subspecies of *G. conirostris* and *G. fuliginosa*. *G. difficilis* and *G. fuliginosa* probably have closely similar ecological requirements, for only one of the two species is ever found on an arid island. Both can coexist on high islands; *G. difficilis* is found in humid areas and *G. fuliginosa*, in the arid zone. However, the factors which influence which species exists on any single arid island are unknown.

Measurements of *Geospiza* from Hood and Tower are given in table 1. Immediately apparent is the great difference between the two *G. conirostris* subspecies. Bowman (1961) has shown that the beaks of these birds are adapted to different foods, and so the seed

TABLE 1. Bill lengths and depths (mm) of *Geospiza* spp. discussed in the text (from Lack 1945).

Island and species	Sex	Bill length No.	Mean	SD	Bill depth No.	Mean	SD
Tower							
Geospiza magnirostris	♂	29	16.5	0.60	24	21.2	1.13
	♀	17	16.3	0.59	11	20.9	0.61
G. conirostris	♂	43	14.3	0.76	40	13.0	0.96
	♀	25	14.2	0.38	19	12.6	1.20
G. difficilis	♂	52	9.4	0.38	48	7.9	0.33
	♀	28	9.2	0.44	25	7.7	0.29
Hood							
G. conirostris	♂	87	15.4	0.94	80	16.0	1.10
	♀	52	14.8	0.86	51	15.1	0.91
G. fortis	♂	8	11.7	0.66	8	12.5	0.84
	♀	7	11.7	0.86	7	12.1	0.78
G. fuliginosa	♂	32	8.8	0.36	30	8.3	0.33
	♀	15	8.5	0.43	14	7.8	0.34

supply from 40 species of plants on Tower is being shared among three species of finches. It is tempting to assume that *G. conirostris* on Tower has evolved a smaller beak due to competition with the large-billed *G. magnirostris* (Lack 1947). The same might apply to *G. difficilis* on Tower, since it is smaller there than on any other island. It is, however, possible that the bill of *G. conirostris* on Tower is the normal size, and that on Hood the absence of competition with *G. magnirostris* has allowed *G. conirostris* to evolve a more massive beak and to exploit a food supply of larger, harder seeds without competition. Whether the observed differences are due to competition or lack of competition depends on what the original bill was like, a question which cannot be resolved since there is no island where the species exists alone.

The large gap between the mean beak sizes of *G. conirostris* and *G. fuliginosa* (table 1) on Hood suggests that there could once have been an intermediate species, which is supported by the number of plant species on Hood (96) compared with those on Tower (40). Considering also the 15 specimens of *G. fortis*, the most likely explanation is that *G. fortis* was once resident on Hood. Even if this conclusion is wrong, there must still be an explanation as to why so many *G. fortis* (and others must surely have escaped collection) were present on Hood and why the colonization of the island did not result.

Another unanswered question is why *G. fortis*, a generalized feeder, and not the more specialized *G. conirostris* became extinct on or could not colonize Hood. Possibly the presence of goats and a change of climate would have affected the number of annual plants which supply most of the seeds for *G. fortis*. *G. conirostris* can cope with the very hard seeds of trees such as *Prosopis* or *Acacia*, and also uses its bill to dig into gravelly ground for buried seeds. These might also be available to *G. fuliginosa* with its pointed bill, but not to *G. fortis* with its intermediate beak.

RECORDS OF THE ACADEMY EXPEDITION 1905–6

There are several other land birds besides those mentioned above which may have become extinct, but in their cases it is even more difficult to know whether the earlier records refer to breeding populations or to stragglers. My own conjectures are given in table 2, based on the number of specimens collected in relation to the collecting effort on each island, on the number of years during which specimens were collected, and on whether or not the islands appear to offer suitable habitat.

Most of the old records come from the year-long collecting trip of the California Academy of Sciences in 1905–6. When compared with 4 years of recent field work (1965–72), I find their records a great contrast to present-day findings. For instance, they spent just a few hours on Wenman and collected in only a very small area at the base of the cliffs. Yet they brought off the island a total of 13 individuals of five species (*Myiarchus magnirostris*, *Pyrocephalus rubinus*, *G. fortis*, *G. magnirostris*, *Camarhynchus parvulus*) which have not been seen there during six subsequent visits, including a 6-week stay by Curio and Kramer. The Academy group also took unique records on Hood (*G. fortis*), Tower (*M. magnirostris*), and Barrington (*Coccyzus melacoryphus*). Other expeditions between 1835 (the *Beagle*) and 1929 (the *Pinchot*) have collected 10 species on major islands where they have not been seen since. Thus, in the course of 90 years, 14 species were recorded on islands where they are not now found. Much more intensive field work in the last 40 years has added only five new island records: *G. conirostris* on Wenman and Pinta; *C. pallidus* on Pinta; *P. rubinus* on Hood; and *C. melacorpyphus* on James. Additionally, the earlier expeditions also collected various species on smaller islands where they are now lacking: *M. magnirostris* (breeding), *Dendroica petechia*, *G. magnirostris* and *N. parvulus* on Daphne minor; *C. parvulus* on Cowley and Champion; *C. psittacula*, *C. parvulus*, and *C. pallidus* on Seymour. On Floreana, *C. pauper* was collected on the coast whereas now, at least in most years, it is restricted to the highlands. It is difficult to escape the conclusion that something has changed.

TABLE 2. Distribution of Galápagos land-birds on the major islands.

	Isabela	Fernandina	James	Jervis	Duncan	Santa Cruz	Barrington	San Cristóbal	Hood	Floreana + islets	Tower	Marchena	Pinta	Culpepper	Wenman
Buteo galapagoensis	B	B	B	x	B	B	B	E	B	E		B	B		
Zenaida galapagoensis	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Coccyzus melacoryphus	B	b	B		B	B	x	B		B					
Tyto alba	B	b	B			B		B		(E)					
Asio flammeus	B	x	B	x	B	B	B	B	B	B	B	B	B	b	
Pyrocephalus rubinus	B	B	B	E	B	B	E	B	x	B		B	B		x
Myiarchus magnirostris	B	B	B	B	B	B	B	B	B	B	x	B	B	x	(E)
Progne modesta	B	B	B		B	B	B	B	x	B					
Nesomimus spp.	B	B	B	B	x	B	B	B	B	B	B	B	B	B	B
Dendroica petechia	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Geospiza magnirostris	B	(E)	B	B	B	B	(E)			x	B	B	B		B
G. fortis	B	B	B	B	B	B	B	B	E	B		B	B		x
G. fuliginosa	B	B	B	B	B	B	B	B	B	B		B	B		E
G. difficilis	(E)	B	B			E		(E)		(E)	B		B	B	B
G. scandens	B		B	B	E	B	B	B		B		B	B		
G. conirostris									B	x	B		x	?B	B
Platyspiza crassirostris	B	B	B	B	x	B		B		B		B	B		
Camarhynchus parvulus	B	B	B	B	B	B	B	B		B			B		(E)
C. pauper										B					
C. psittacula	B	B	B	B	E	B	(E)	x		B		B	B		
C. pallidus	B	b	B	x	B	B	x	B		x			x		
C. heliobates	B	B													
Certhidea olivacea	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B

B = almost certainly breeds now.
b = probably breeds now.
E = once resident, now extinct.
(E) = probably once resident, now not present (see text).
x = has been recorded, probably stragglers (see text).

Further evidence of major recent changes is supplied by the records of birds at sea. The Academy collected or saw four *G. fortis*, six *D. petechia*, and single *G. scandens* and *Progne modesta* quite a distance from land. In addition, a single *M. magnirostris* was taken in 1897 just north of Culpepper. The only land bird which I saw far from land was a single *Zenaida galapagoensis* midway between Isabela and Wenman. However, I did see migrants, including *Arenaria interpres*, *Crocethia alba*, *Numenius phaeopus*, *Charadrius semipalmatus* and *Bubulcus ibis*. Local people, capable observers who make their living traveling within the islands, and an ever-increasing number of amateur yachtsmen report a similar lack of sightings in the open sea, but doubtless some wandering still takes place. Several times I have seen flocks of *G. fuliginosa* set out to sea from Hood in the direction of Floreana, but there was generally evidence that they returned, although it is likely that the odd bird or flock might continue on to Floreana which is clearly visible.

There is little information on the weather earlier in this century, but reminiscences of the older settlers leave little doubt that the islands were much wetter in the 1920s than at present. Possibly the tops of Wenman and Jervis may have been as humid as the higher islands and could easily have supported *P. rubinus* (now missing from both), and *M. magnirostris* and *C. parvulus* (now missing from Wenman). Hood and Barrington would have much more greenery now if it were not for the extreme overgrazing by goats. Fewer goats and a little more rain would allow *P. rubinus*, *C. psittacula*, and *G. magnirostris* to breed on Barrington and *G. fortis*, on Hood. It is probable that a slight change in climate would explain most of the changes noted in the avifauna within the last 70 years. Further evidence is needed before one can speculate whether there has been an overall trend to drier years or a reduction in the frequency of wet years—the "El Niño" phenomenon.

If there were many interisland wanderings possibly with the establishment of species for

perhaps relatively short times following a series of wet seasons, it is difficult to see how the finches managed to speciate so widely. It is generally accepted that geographical isolation is a prerequisite for speciation, but there is little evidence for the time scale of any such evolution. Johnston and Selander (1964) have demonstrated that evolution to what would normally be considered the subspecies level has occurred within no more than 111 generations after the introduction of the House Sparrow (*Passer domesticus*) into North America. It could well be that the Geospizinae evolved initially at least as fast and that once evolution had progressed sufficiently to allow two closely related forms to coexist, further evolution, perhaps by character displacement, would be even more rapid.

RARE AND ENDANGERED SPECIES

The continuing increase in the human population both by the high birth rate and immigration, the associated spread of agriculture, the defoliation of the islands by goats, and the destruction of the native fauna by feral dogs, pigs, and cats create a depressing picture of the future of the Galápagos. However, as yet there are only a few bird species which can be considered endangered.

Although it is still relatively common, *Pterodroma phaeopygia* has declined markedly in the last 30–40 years since its nesting habitat makes good agricultural land, the killing of adults by dogs and pigs, and a very low nesting success due to rats (Harris 1970b). This species also nests in the Hawaiian archipelago but there too it is endangered. Unless land clearance can be stopped and some of the predators removed, the future of this species will be insecure.

The populations of several of the birds are small and there are no reasons to suggest that the rarest were ever more common, e.g., *Phoenicopterus ruber* (500–1000 birds), *Nannopterum harrisi* (800 pairs), *Spheniscus mendiculus* (few thousand individuals), *Larus fuliginosus* (less than 400 pairs), and *Haematopus ostralegus* (100 pairs). *Buteo galapagoensis*, although reduced in number by man, is quite secure on the uninhabited islands and might be able to recolonize lost areas if not molested.

ADDITIONS TO THE AVIFAUNA

The only addition to the breeding birds in recent years is *Neocrex erythrops*, which was discovered in 1953 (Bowman 1960), and now breeds on both Santa Cruz and Floreana. The Academy collectors may have overlooked this species although they collected intensively in habitats where the species is now common. The introduction of relatively large-scale land clearance has either allowed the species to colonize the island or to become more numerous and widespread.

Egretta thula was first recorded in 1965. It is becoming a regular visitor and has been seen in breeding plumage, so it may well breed in the future.

FACTORS INFLUENCING THE NUMBER OF LAND-BIRD SPECIES ON THE MAIN ISLANDS

Lack (1945, 1947), in his studies on variation in Darwin's Finches, concluded that the number of endemic subspecies of Geospizinae was inversely correlated with isolation, namely, the distance between the island and its nearest neighbor. Later, Bowman (1961) considered that the number of plant species on islands was more important than isolation in influencing both the amount of endemism on islands and the numbers of finch species found on any one island. Then Hamilton and Rubinoff (1963–67) treated the problem mathematically. They considered the roles of areas, number of plant species, and isolation (measured both by interisland distances and distance from the approximately central island of Santa Cruz) and found (1964) that in a linear analysis both isolation and the number of plant species were the best predictors of species numbers on islands—accounting for 48% and 31%, respectively, of the observed variation. But in a linear-nonlinear analysis, the log of elevation and the log of distance from the center of the archipelago were the most important factors (49%, 26%). Later (1967), they noted that numbers of insular species and endemics are respectively predicted by average and nearest-neighbor isolation, and not by area.—"only the Darwin Finches demonstrate emphatically the importance of isolation in regulating endemism and species abundance in the adaptive radiation of monophyletic bird groups within archipelagos." In other archipelagos, island area was a better predictor of species abundance. Lack's (1969a) recent survey showed that the range of each Geospizid, or rather the lack of each species on any particular island, could be explained either by the absence of suitable habitat or food or by the presence of a species with which it was likely to compete. Lack suggested that the findings of Hamilton and Rubinoff's (1967) evaluation that isolation was of the greatest importance might be due to incomplete and misleading plant lists for some of the less accessible islands. Further (1969b), in a survey of several island groups,

TABLE 3. Data used for multivariate analyses of numbers of bird species on islands and physical characteristics of the islands.

	No. of land bird species		No. of species			Altitude (ft)	Area (sq. miles)	Distance to next (miles) island	Distance to next high island (miles)
	Breeding now	Ever recorded	Ferns	Flowering plants	Total plants				
Isabela	20	21	59	244	303	5500	2249	2	2
Fernandina	18	20	7	90	97	4900	245	2	2
James	20	20	40	185	225	2974	203	3	11
Jervis	12	16	1	68	69	1203	2	3	3
Duncan	14	18	11	89	100	1502	7	6	6
Santa Cruz	19	20	71	306	377	2835	389	6	6
Barrington	12	17	2	60	62	850	7	9	9
San Cristóbal	16	19	31	221	252	2350	195	25	36
Hood	9	12	1	96	97	650	18	24	24
Floreana	16	22	23	227	250	2100	64	26	26
Tower	8	9	0	40	40	210	4	25	25
Marchena	14	14	4	45	49	1125	45	17	17
Pinta	16	18	16	85	101	2550	20	17	17
Culpepper	7	8	0	10	10[a]	550	1	19	96
Wenman	7	12	1	21	22	830	2	19	75

Altitudes of islands and interisland distances are taken from the U.S. Government Chart No. 1375 (1946 corrected 1953), island areas from Preston (1962), and plants from Wiggins and Porter (1971).

[a] Probably far too low (R. I. Bowman, pers. comm.).

he thought that ecological impoverishment of islands, including the number of plant species, was correlated with island area and isolation.

The recent publication of an up-to-date flora of Galápagos (Wiggins and Porter 1971) and the present re-evaluation of the status of the land birds (table 2) enable us to take a new look at the problem of species on various islands. All the land birds, except rails which need rather specialized conditions, but including the hawk, have been taken into account. It seems likely that all these species are interrelated as far as competition for food is concerned. Because of the difficulties of interpreting the older records when referring to stragglers or extinct populations, I have used only the number of species thought to breed on each island at present. The information used in the analysis is given in table 3. The numbers of plant species are taken from an up-dated copy of the Wiggins and Porter flora kept at the Charles Darwin Research Station. As far as possible, plants introduced by man are excluded.

A multivariate analysis with a library program and the ICL 1906A computer of the Computer Service, University of Oxford, was made using the numbers of breeding land birds as the dependent variable and other factors (columns 3–9) as the independent variables. In some cases the number of bird species correlated better with some transformation of an independent variable than with the linear measurement. Hence, the log of plants (ferns, flowering plants, and total plants), square root of the area, and square of the distances between islands were substituted for the linear values. The independent variables accounted for 94.9% of the insular variation in the number of land-bird species. By a step down procedure, the number of variables was reduced until only those having a significant influence were left. These were altitude ($P < 0.05$), log total plants ($P < 0.001$), and square of distance to the next island ($P < 0.1$, one-tailed test). These accounted for 90.5% of the variation. Leaving out the distance factor only lowered the variation to 87.7%. Plants on their own accounted for 72.9% and altitude alone, 71.3%; these two factors are highly correlated ($r = 0.61$, $P < 0.01$). It seemed unlikely that altitude per se would have much influence on the number of bird species over the small range of altitude considered here, except secondarily through plants. Nonetheless, removing the altitude component reduces the variation accounted for from 87.7% to 72.9% so that altitude does have some influence apart from that via the plants. Perhaps rainfall influences the birds through its effect on insects and soil arthropods. In this analysis, *Nesomimus trifasciatus* was taken as breeding on Floreana even though it is now restricted to Champion and Gardner. A separate analysis omitting this species indicated that one less species had little effect and only lowered slightly (to 87%) the combined influence of log plants and altitude.

Another analysis using all land-bird species

ever recorded on each island as the dependent variable again showed altitude and log plants to be the most important factors, accounting for 81.7% of the variation compared with 90.8% when all the independents were included. Log plants alone accounted for 75.2% and altitude alone, 56.7%. The square root of island area was also a significant factor ($P < 0.05$), but only accounted for 6.1%.

Obviously, the total number of plants is exerting the main influence on the number of bird species, whereas area, altitude alone, and isolation are much less important. The correlation being with the log of plants rather than simply plants may be due to the fact that the introduction of a few species to an impoverished island would significantly change the environment, whereas one or two introductions to an island with many plants would not be noticed. Also, given a humid zone, governed mainly by altitude but also by exposure to the prevailing winds, many more plant species would have to be introduced before an increase in land-bird species would be predicted. On Cerro Azul (Isabela), where the humid zone occurs at a much lower altitude than usual, a semiarid area, including cacti, occurs on the top of the volcano, suggesting that even if the islands were higher there would be no more diversification of the flora.

SUMMARY

Details are given of the past and present status of all birds recorded in the Galápagos Archipelago. Fifty-seven species are known to have bred, of these 28 are considered endemic. For the first time it is realized that either *Butorides striatus* breeds in Galápagos and hybridizes with the endemic *B. sundevalli* to give intermediates, or that there is a single, extremely variable species.

It seems likely that conditions have changed during the last 70 years and several island populations of land birds have become extinct. Although several birds have very small populations, the only species whose status gives rise for concern is *Pterodroma phaeopygia* which has suffered from land clearance and introduced mammals.

A multivariate analysis shows that the number of plant species is the main factor influencing the numbers of land-bird species breeding or occurring on any island. Isolation has little effect.

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