

THE BIRDS OF THE REVILLA GIGEDO ISLANDS, MEXICO

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The Revilla Gigedo Archipelago consists of a group of four volcanic, oceanic islands that lies southwest of Baja California, México. The archipelago is situated between 18° 20' and 19° 20' north latitude and between 110° 45' and 114° 50' west longitude. The islands are, in order of increasing size, Roca Partida, San Benedicto, Clarión, and Socorro. Although uninhabited, they are governed by the Mexican state of Colima. The island nearest to the mainland lies 210 miles southwest of the tip of Baja California.

Roca Partida is about 300 feet long and 25 feet wide; it has two small peaks 75 and 100 feet in height. No terrestrial vegetation is present and only sea birds roost or nest there.

San Benedicto is about four miles long and one and one-half miles wide. It had a limited flora and fauna, including one form of endemic land bird, but virtually all its biota was destroyed in 1952 by the eruption of a new volcano on the island.

Clarión is about six miles long and four miles wide. The vegetation consists of low scrub and prickly-pear cactus interspersed with large areas of grass. The highest point on the island, Mount Gallegos, is about 1000 feet above sea level.

Socorro is roughly nine miles on a side. Its highest point, Mount Evermann, rises to a height of 3700 feet. The vegetation of the west, south, and east sides of the island below 2000 feet consists predominately of a thick mass of the shrub *Croton masoni* and the cactus *Opuntia engelmanni*. The north side of the island and all the higher elevations have a vegetation of broad-leaved tropical plants including *Prunus capuli*, *Ficus conitifolia*, *Guettarda insularis*, and some bromeliads and orchids.

Hanna (1926) has given a general account of the islands, illustrated with maps and photographs, and Johnston (1931) has reviewed the botany of the archipelago. The major ornithological papers concerning the islands include those of Grayson (1871), Townsend (1890), Anthony (1898), and McLellan (1926); some additional references not cited elsewhere in the list to follow are Rothschild and Hartert (1899, 1902), Swarth (1933), and Taylor (1951).

There are no native mammals on any of the islands, but sheep were introduced on Socorro in 1869. Sheep are still present today, and the total population is estimated at about 2000 animals. The herpetofauna of the islands consists of two species of lizards—*Urosaurus auriculatus* on Socorro and *U. clarionensis* on Clarión—and one species of snake, the racer *Masticophis anthonyi* on Clarión. There are no amphibians or fresh-water fishes present, but land crabs (*Aegeocarcinus planatus*) are present on Socorro and San Benedicto.

Two temporary rain-filled ponds about 100 × 50 yards in size occur on Clarión, and one of similar size is found on Socorro. Occasionally there are streams and small pools on Socorro during rainy periods. There is a small seep in a canyon about 50 yards inland from Binner's Cove, Socorro, and there is a small spring at the water's edge at Grayson's Cove, Socorro, that is covered at high tide. No springs are known to exist on the other three islands.

The senior writer visited the Revilla Gigedo Archipelago for a month in March, 1953, and for two weeks in November, 1953, with expeditions of the Scripps Institution of Oceanography under the leadership of Mr. Adrian Richards. The first trip was aboard the research vessel *Paolina-T* and the second was aboard the *M/V Crest*.

The itinerary of the two trips was as follows:

Left San Diego, Calif.	March 3	Nov. 13
Roca Partida	March 7-8
San Benedicto	March 9-13	Nov. 17
Socorro	March 14-19	Nov. 18-21
San Benedicto	March 20
Clarión	March 23-26
San Benedicto	March 28
Arrived San Diego	April 3	Nov. 25

A total of three days was spent on Clarión, one on and about Roca Partida, three on San Benedicto, and six on Socorro. The remaining time was spent around each of the islands making bathymetric surveys.



Fig. 1. San Benedicto Island before the eruption of El Boquerón volcano. Herrera Crater is on the right and the "Ash Heap" on the left. El Boquerón now fills the valley between the "Ash Heap" and Herrera Crater. Photograph by G. D. Hanna in 1925.

San Benedicto Island has been of particular interest in recent years because of the eruption of a new volcano, El Boquerón (fig. 2), on August 1, 1952. The eruption began in a large valley between an old crater, Herrera, and the so-called Ash Heap at the southern part of the island. The volcano completely filled the valley, and by August 14 it had built up a cone 1000 feet high. It erupted again on November 1 and December 8, 1952. On December 8 it broke through at its east base and poured lava into the sea. By March 9, 1953, the volcano was dormant and probably dead, although there were still fumerols in the crater and about the fissure at its base. The lava was still warm to the touch and in places so hot as to prevent walking. By November, 1953, most signs of activity were gone save for occasional sulfur fumes.

Figure 1 shows the section of San Benedicto which had the heaviest vegetation before the volcano erupted. Figure 2 was taken about 15 minutes after the start of the eruption, and figure 3 shows approximately the same area as figure 1 some weeks after the eruption.

Pumice and pumice dust covered the entire island and offshore pinnacles to a depth of three to 10 feet. This killed all the vegetation and many of the nesting sea birds;

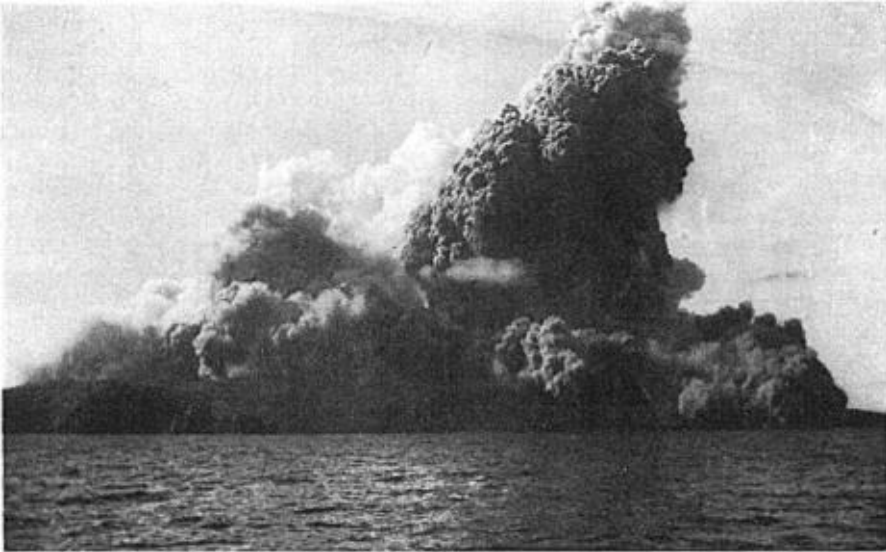


Fig. 2. San Benedicto Island approximately 15 minutes after the initial eruption of El Boquerón, 8:45 a.m., August 1, 1952. Photograph by Robert Petrie.



Fig. 3. San Benedicto Island today. Official United States Navy photograph, September 21, 1953.

buried skeletons, nests, and eggs were later uncovered (fig. 4). The endemic subspecies of Rock Wren, *Salpinctes obsoletus exsul*, was apparently exterminated.

In March, 1953, no wrens were found. Sea birds were numerous, but they roosted only on the sides of the north end of the island (fig. 5) and never on the fresh ash. Other than these birds, the only living things found were a few land crabs; no plants of any kind were present. In November, 1953, a great change was noted. On the north end of the island the pumice had begun to wash off the steep slopes and gulleys and young plants had sprouted. None of the older plants had survived, and all the new ones were apparently from seeds which had survived under the ash. In November, 1953, Dr. Herbert L. Mason (personal communication) found five of the ten species of plants known to have occurred on San Benedicto.

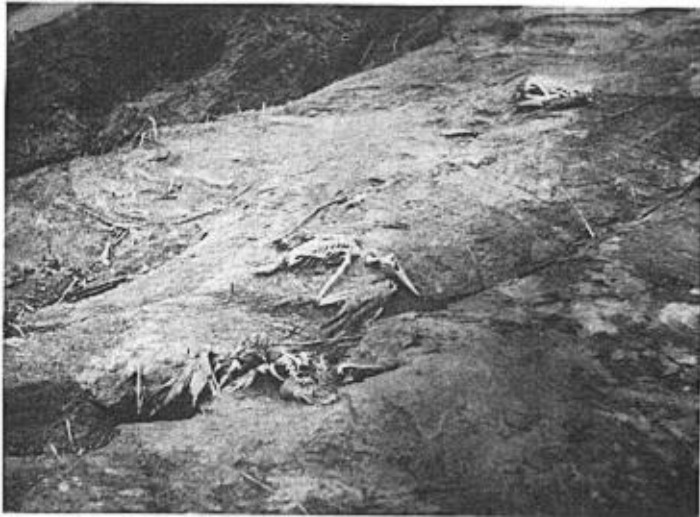


Fig. 4. Bird skeletons weathering out of ash of El Boquerón on November 17, 1953. Note unweathered ash at top of photograph and feathers on skeleton in foreground. Photograph by Herbert L. Mason.

In November, the birds were beginning to roost and nest on exposed soil in eroded areas, and boobies were found roosting on new pumice in nonwindy places. Crab holes and shearwater burrows were numerous at the north end of the island. The distribution of the birds on San Benedicto was mapped in March (fig. 5) and November. Hanna (1926) reported that the population of Lesser Frigate Birds, *Fregata minor palmerstoni*, on San Benedicto in 1925 was so high that many young were starving. The population of this species in November, 1953, was estimated at 150 to 200 birds. It will be interesting to note future changes in the numbers of nesting sea birds on San Benedicto.

In November, as in March, no Rock Wrens were seen on San Benedicto. It is conceivable that some of these birds may have flown to Socorro, 32 miles to the south, but none was seen there; there is little hope that any members of the San Benedicto population survive.

BIRDS OBSERVED IN MARCH AND NOVEMBER, 1953

The senior writer was primarily concerned with studying the reptiles of the archipelago, but he devoted as much time as possible to ornithology. Since little has been published on the habits and habitats of the resident birds of the islands, some data on these subjects are presented here. Only a few specimens were collected, and these are

now in the Dickey Collection, University of California, Los Angeles. G. Dallas Hanna collected a few specimens during the trip in November, 1953, and these are in the collection of the California Academy of Sciences, San Francisco; new records obtained were reported by Webster and Orr (1954) and are not repeated here. In the following accounts, new records for the archipelago are marked with an asterisk (*) and new records for an individual island are marked with a dagger (†).

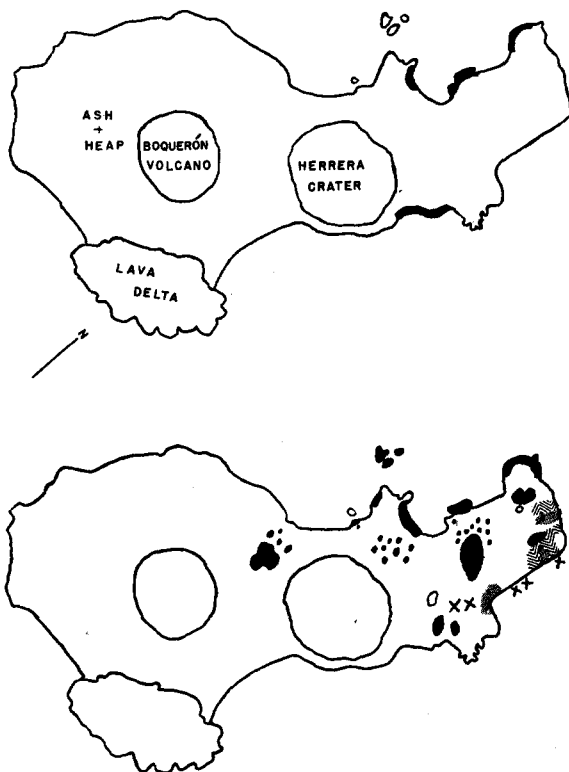


Fig. 5. Outline maps of San Benedicto Island showing locations mentioned in text and distribution of birds. Above, roosting sites of all species of birds (black areas) in March, 1953. Below, roosting sites of Blue-faced Boobies (black areas), Brown Boobies (small outlined areas on land), tropic birds (crosses), frigate birds (shaded area), and shearwaters (wavy lines) in November, 1953.

Puffinus pacificus chlororhynchus. Wedge-tailed Shearwater. This species was common about San Benedicto and Socorro, and the birds often came to the lighted ship at night. One was found dead on the beach at San Benedicto on March 11. At 5:20 p.m. on March 11, about 300 shearwaters were observed flying low over the water and feeding just south of the Ash Heap at San Benedicto. Also in the group were about 20 Blue-faced Boobies and an occasional frigate bird. By 5:30, the number of shearwaters had almost doubled. Many of them flew about the top of the Ash Heap (elevation 900 feet), their roosting site before the 1952 eruption, and then flew to the northwest side of the island. None was seen to go to the east side, where there were sulfur fumerols and fresh lava. During the following two days there were similar occurrences. The burrows of these shearwaters were evident

on the north end of San Benedicto on November 17, but no birds were seen. The Ash Heap apparently had not been used as a roosting site since the eruption in 1952.

About 10 Wedge-tailed Shearwaters were seen on March 19 around Oneal Rock, on the north side of Socorro, and about 130 were seen there on March 22. One carrying food in its beak was seen 54 miles northeast of Roca Partida on March 22; it was harassed by a frigate bird and dropped into the ocean.

Puffinus auricularis. Revilla Gigedo Shearwater. Thirty or 40 were observed at sea near the south end of Clarión on March 23, and five were seen off San Benedicto on November 17.

Phaethon aethereus mesonauta. Red-billed Tropic Bird. Two were seen flying about Roca Partida on March 8, and the species was common at San Benedicto during the March visit. On March 13, an unusual behavior pattern was observed at the south end of San Benedicto. At 2:50 p.m., 10 tropic birds were seen flying around the Ash Heap and over the water; they were calling loudly. By 2:52 their number had doubled, and more were coming in from all directions. By 2:58, 39 birds were present. They formed loosely-knit groups of from 5 to 10 birds each, and individuals often shifted from one group to another. These groups flew in wide circles, sometimes reaching an estimated height of 500 feet. At least one or two birds in each group were calling at any given time, so that vocalization was continuous.

From groups that were flying at an elevation of about 200 feet, two birds would leave the flock and glide together, one about 12 inches directly above the other, for a distance of 100 to 300 yards down to a level about 20 feet above the water. The gliding birds would then separate and rejoin the same or a different group of circling birds. The total number of such glides from all the groups was about five per minute. When gliding, the upper bird (a male?) kept its wings bent down and the lower bird (a female?) kept its wings arched up, so that the wing tips of the two birds were about three inches apart. No physical contact was noted. Occasionally a third bird would interfere with the gliding pair and cause them to separate. No organization within the circling groups could be detected, and no preliminary indication of which two birds would suddenly depart from the flock was noted. Occasionally, however, it seemed that the lower bird of the two would start out slightly before it was joined by the upper one. At 3:12 p.m. the flock began to disperse, but some pairs were still gliding down. By 3:20 only 16 birds were left, and by 3:50 all except three were gone. The total duration of this behavior pattern was about one hour.

Three tropic birds were seen at Socorro in mid-morning on March 17. Two began calling and gliding as described above, and the third attempted to interfere. On March 18, in mid-afternoon, two Tropic Birds were seen at sea on the north side of Socorro. They were flying one above the other, keeping one or two feet apart at all times. They flew in a zig-zag pattern, simultaneously changing direction about every 5 to 10 wing beats. At times the lower bird seemed to be a fraction of a second behind the upper in changing direction. No gliding was observed, and the zig-zag flight continued on out of sight.

No tropic birds were seen at Clarión. Some were seen at San Benedicto on November 17, including one bird on a nest with one egg. Tropic birds were less numerous in November than they were in March, and no gliding behavior was observed in November.

†*Pelecanus occidentalis californicus*. Brown Pelican. One was seen at San Benedicto on March 9.

Sula nebouxii. Blue-footed Booby. Several were seen on San Benedicto on November 17.

Sula dactylatra californica. Blue-faced Booby. About 20 were seen on or near Roca Partida on March 8. At San Benedicto, in March, they were often seen flying about the Ash Heap and then going to their roosting sites on the north end of the island. Twenty miles southeast of San Benedicto one flew past the boat at 11:00 p.m. on March 20. On November 17, many had begun to roost on eroded areas or new ash in nonwindy places on top of San Benedicto island. The largest of these groups consisted of about 500 birds. Many fledglings and immature birds were present here in November. Several adults were seen at the north end of Socorro on March 17 and November 20.

These boobies were common on Clarión, especially on the south and east sides of the island. Groups of 18 to 20 birds, paired and unpaired, were found sitting in low grass; the pairs were 20 to 30 feet apart, and each group was approximately 100 yards from the next one. The total population of Blue-faced Boobies on Clarión in March was estimated at 150 birds. At midday on March 25, a pair of these boobies was observed in copulation on the ground in the shade of a *Euphorbia* bush. Two pairs were sitting on eggs at this date.

Sula sula websteri. Red-footed Booby. Birds in brown plumage were noted about 50 miles east-northeast of Roca Partida on March 22, and at San Benedicto on November 9, 12, and 17. Birds in white plumage were seen only at Clarión, where they greatly outnumbered the brown ones.

In March, three major areas were found on Clarión where Red-footed Boobies were nesting. One group of about 30 birds was situated on the north side of the island, about one and one-half miles northeast of Mount Gallegos, and the other two groups were noted on the lower slope of the southeast side of the peak. The latter two were about one-half mile apart and consisted of about 50 and 70 birds, respectively. The total population was at least 150 individuals, possibly as many as 200.

The nests consisted of loose platforms of sticks placed about three feet above the ground in thick bushes. These were usually two to four feet apart, but some were as much as 20 feet away from others. About 20 per cent of the birds in the largest rookery were in brown plumage, and none of these had nests; they roosted in bare bushes. The other 80 per cent were in predominately white plumage, in which the amount of brown, black, and white varied considerably. About half of these birds were nesting, but not all of the nests yet contained the single bluish-white egg characteristic of this species. Empty nests were used for roosting. Some courtship and aggressiveness by males was noted, and occasionally a male would interfere with a courting pair on a neighboring nest.

Bill colors of brown-plumaged birds were highly variable. In some the bill was blue or brownish at the base and pink at the tip; in others it was all brownish or all blue.

Sula leucogaster brewsteri. White-bellied Booby. About 10 were seen at Roca Partida on March 8, and some of these were nesting. On San Benedicto, this species comprised about 5 per cent of the total booby population. Two nests, each with one egg, were found on San Benedicto on November 17, and individuals were seen there on March 9 and 28. White-bellied Boobies were also seen off the north side of Socorro on November 19 and 20.

Fregata minor palmerstoni. Lesser Frigate Bird. No more than 10 were seen about San Benedicto in March as most of their roosting places had been covered with pumice by the volcanic eruption of 1952, but large numbers were observed there on November 17. At that date there were two nesting colonies of about 36 and 80 birds each, and the total population was estimated at 150 to 200 birds.

In the 36-bird colony, the nests consisted of sticks and green plant matter from newly sprouted plants and were placed on the ground from two to six feet apart. Most of the nests contained one egg or one pin-feathered young. Birds with empty nests were carrying on courtship on the nest itself. One male was seen putting his head and neck around that of the female and then calling loudly and snapping his bill quickly; the female would then bite him on the neck or bill. In males, the bill was blue-black and the orbital ring black; in females, the bill was largely pink and the orbital ring red. Foot color was not recorded.

Frigate birds were seen on March 17 and 18 at the north end of Socorro, and on November 19 and 20 they were seen in the same area as well as elsewhere around the island. A group of four was seen during most of the latter day above a small cove at the north end of Socorro. Occasionally one would dive down and pick up a fish from the surface of the water; then the others would chase the one with the fish. Several were seen at Clarión in March; this island was not visited in November.

Leucophoyx thula. Snowy Egret. Four were seen at Clarión, on the beach at Sulphur Bay on March 23 and 24. They remained in the vicinity of the bay and were observed many times.

Nyctanassa violacea gravirostris. Yellow-crowned Night Heron. One was seen on March 16 on Socorro, standing on lava rocks just north of Binner's Cove.

Plegadis falcinellus mexicana. Glossy Ibis. Four were seen on March 23 and 24 with the four Snowy Egrets at Sulphur Bay on Clarión. Like the egrets, they stayed in the vicinity of the cove and were seen many times.

Buteo jamaicensis socorroensis. Red-tailed Hawk. This species was seen regularly at Socorro in both March and November, and the birds seemed to be more abundant at the higher elevations of the island. Possibly these hawks often feed on lizards, for the lizards of Socorro are much warier than the related species on Clarión, where no hawks are resident.

One Red-tailed Hawk seen soaring over San Benedicto (†) on November 17 was presumably of the Socorro race.

**Pandion haliaëtus carolinensis*. Osprey. One was seen at the east side of San Benedicto on November 17, and another, or possibly the same bird, was seen at Socorro on November 19.

**Falco peregrinus*. Peregrine Falcon. One was seen around Binner's Cove at Socorro on November 18.

Numerius phaeopus hudsonicus. Hudsonian Curlew. One was seen on the lava rocks north of Binner's Cove, Socorro, on March 15, and one was seen on top of the north end of San Benedicto (†) on November 17.

Actitis macularia. Spotted Sandpiper. Several were seen at Binner's Cove and at Henslow Point, Socorro, in March. One was collected by G. Dallas Hanna at the north end of Socorro on November 20. Several were seen at Sulphur Bay on Clarión in March.

**Ereunetes mauri*. Western Sandpiper. **Erolia minutilla*. Least Sandpiper. A flock of six birds of these two species was seen at Sulphur Bay, Clarión, on March 24. One of each species was collected, but the specimens were badly crushed in the ship's freezer and could not be preserved as skins or skeletons.

Himantopus mexicanus. Black-necked Stilt. Two were seen on the sandy beach at the east end of Sulphur Bay at Clarión on March 25.

Zenaidura macroura clarionensis. Mourning Dove. This species was not especially common on Clarión in March. It tends to prefer areas of rock covered by morning-glory (*Ipomea*). A few doves were seen on March 26 on Monument Peak, a barren lava and sedimentary pinnacle about 50 yards off the northwest tip of Clarión. Two males in good plumage taken on March 23 each had enlarged testes measuring 15 mm. in greatest diameter.

Zenaidura graysoni. Socorro Dove. This species was common around the lava rocks at low elevations on Socorro in March, but in November it was rare in such places and common above 1500 feet. At the higher elevations, the doves were usually found under fig trees (*Ficus*).

Columbigallina passerina socorroensis. Ground Dove. These doves were found primarily in areas of tall bunch grass or shrubs (*Croton masoni*) below 1000 feet on Socorro. Some were seen in a small cave in a cliff only 20 yards from the ocean, and in March one was seen on a rock at the ocean's edge apparently drinking sea water. The bird went through the motions of drinking, but there was no way of telling how much, if any, sea water was swallowed. Ground Doves were not common anywhere on the island, and they were quite wary although many other resident birds were very tame. In November they seemed more numerous than in March, especially about the north side of the island. On November 19, a juvenal Ground Dove barely able to fly was found near Binner's Cove, and a dead juvenile of about the same age was found nearby on the same day. One male with enlarged testes measuring 8×5 mm. was collected on March 16.

Aratinga holochroa brevipes. Green Parakeet. These noisy birds were common on Socorro in all forested areas, that is, in the higher parts of the island and in the forested canyons on the north side that extend down to the coast. They were very tame and were easily approached. On November 19, three males and two females were collected. None had enlarged gonads, and all were in fresh plumage with pin-feathers still present among the body feathers. One male had a single orange feather on the right side of the neck.

Speotyto cunicularia rostrata. Burrowing Owl. This species was common everywhere on Clarión. The owls were seen near the entrances to their burrows in the morning until about 10:00 a.m.; after that they withdrew and did not reappear until the late afternoon. Several Burrowing Owl pellets were examined, and all contained cricket remains and seeds of the prickly pear cactus that was in fruit in March. One pellet contained unidentified bird feathers. Cricket remains were found at the entrances of most of the burrows. These owls were quite tame, and with caution they could be approached to within two feet. Two males were collected on March 23. The testes of one were slightly enlarged and measured 8×5 mm.

†*Ceryle alcyon*. Belted Kingfisher. One was seen several times on March 18 flying over a small cove behind Henslow Point on the northwest side of Socorro.

†*Hirundo rustica erythrogaster*. Barn Swallow. About 20 were seen flying about or sitting on the pumice at the north end of San Benedicto on November 17. One of these, a male, was collected; it was slightly fat.

Corvus corax clarionensis. Raven. This species was noted only on the south and west sides of Clarión, and it was most numerous about Mount Gallegos. Many Ravens were molting their primaries in March. Although not especially wary, they flew if one approached closer than 10 or 20 feet. Flocks

of 52, 66, and 120 were seen in flight at various times, and a count of 320 Ravens in flight was made from the top of Mount Gallegos, from which the whole island could be seen. The total population in March was estimated at 400 to 450 birds. No Ravens were seen on San Benedicto in 1953.

Behavior which may have been courtship or aggressiveness was observed in March. Of a group of 15 birds on the ground, two would jump about two or three feet in the air while facing each other, hover momentarily, and sometimes claw at each other with their feet. This clawing was not very vigorous, and the performance did not seem to be strongly aggressive. After one "jump-up," one of the two birds would often chase the other out of the area where the group was gathered. Then both birds would jump up and down with wings half spread, but not necessarily facing each other as in the original encounter. Often one or both birds later returned to the group. Usually only one encounter took place at a time, and the other members of the group paid little or no attention to the participants. Raven droppings on Mount Gallegos contained seeds of cactus and those of a different but unidentified plant. No animal matter was recognized.

Thryomanes sissonii. Socorro Wren. This wren was fairly common in most habitats on Socorro, but it was most numerous in the non-forested portions below 2000 feet. It seemed to be unafraid of man. In March no territorial behavior or singing was noted, but in November the wrens sang often. A male in worn plumage was collected on March 16; the testes were not enlarged.

Troglodytes tanneri. Clarión Wren. This species was common on Clarión in March but was found principally among the vine-covered shrubs that occur over much of the island. In this respect, it differs from the Socorro Wren, found on Clarión, which is common in all habitats—in shrubs or grass, on rocks or bare ground. Clarión Wrens were often heard singing in March, and some territorial defense by threat was noted. The size of the territory seemed to vary with the density of the shrubs in which the bird was located. In the denser areas, the territories appeared to be 30 or 40 feet in diameter. Defense by threat consisted of screeching and wing-fluttering without any physical contact.

A female in worn plumage, collected on March 23, had follicles enlarged up to 1.5 mm. in diameter.

The large size of this wren as compared with mainland forms of *Troglodytes* seems to be correlated with larger egg size. Ed N. Harrison of Los Angeles has kindly allowed us to measure a set of three eggs of *T. tanneri*, taken on March 25, 1938, from his collection. The measurements (in mm.) are as follows: 19 x 24, 19.5 x 14, and 21 x 14 (av. 19.8 x 14). The average size of 40 sets of *T. aëdon parkmanii* as given by Bent (1948) is 16.3 x 12.6. The averages of the eggs of *tanneri* are thus 21.4 per cent longer and 11.1 per cent wider than those for *T. a. parkmanii*. In color, eggs of *tanneri* are similar to those of *parkmanii* but have sparser and more distinct (less blended) spotting which is more concentrated around the large end of the egg.

Chapman and Griscom (1924:284-285) called attention to the close resemblance between *Thryomanes sissonii* and some members of the genus *Troglodytes*, including *tanneri*. To this we might add that *T. tanneri* has certain characters (large size, relatively large bill, hallux much longer than outer toe) that resemble those of the genus *Thryothorus*; it lacks, however, the subterminal notch to the culmen characteristic of that genus. Field studies of the songs and behavior of both the Socorro and Clarión wrens are necessary to clarify their relationships.

Salpinctes obsoletus exsul. Rock Wren. As mentioned above, this endemic form could not be found anywhere on San Benedicto and is presumably extinct.

Mimodes graysoni. Socorro Thrasher. Thrashers were common at lower elevations on Socorro in March, and at that time they seemed to prefer open areas with a few shrubs. No singing or territorial behavior was noted. In November, thrashers appeared to be rare at lower elevations on the south side of Socorro but common in forested areas at higher elevations and in canyons on the north side of the island. Some aggressive behavior and much singing were noted at this season. A three-note whistled call was heard most often; it may be diagrammed as "— — —." A more extended and varied song was heard less often. It consisted of rambling warbled phrases of a variable nature, but frequently the same phrase was repeated several times in the manner of other members of the Mimidae. However, no mimicry of any kind was recognized. The birds were very tame and seemed reluctant to fly. They moved about by hopping, and none was seen to fly farther than 10 feet.

In March, several thrashers were seen on successive days around sheep carcasses, where they fed on blow flies congregated there. There was some aggressiveness during feeding, and only one bird at a time fed close to the carcass on each side. Flies were caught only when they alighted and not while in flight.

Two males were collected on March 14. One had testes measuring 3 x 1 mm. and was moderately fat; the other had testes measuring 4 x 2 mm. and was extremely fat. One female was collected in March; the follicles were not noticeably enlarged and the bird was not fat. The rectrices of all three birds were very worn, and the female had two half-grown new tail feathers. The remiges and body feathers were moderately worn.

Parula pitiayumi graysoni. Tropical Parula Warbler. These little warblers were fairly common at lower elevations on Socorro, but they seemed scarcer than the other endemic land birds although equally tame and easy to approach. They were most abundant in bushes and low trees four to five feet above ground, although they were often seen hopping across piles of lava. No singing or territorial behavior was noted in either March or November. One unsexed bird was collected on March 14; it was slightly fat.

**Dendroica castanea*. Bay-breasted Warbler. One of these warblers was found in a weakened condition on San Benedicto on November 18; it was captured alive and later prepared as a specimen for the Dickey Collection. The bird is an immature male with a few black feathers on the anterior part of the crown and a few bay feathers along the flanks.

Pipilo erythrophthalmus socorroensis. Red-eyed Towhee. Towhees were common on Socorro in the cactus and brush of the lower elevations but were rare among the trees. Like the Socorro Thrashers, they were tame and reluctant to fly; no flights of more than 10 feet were seen. No territorial behavior or song was noted in either March or November. In March, an adult was seen feeding a begging immature bird. Carl L. Hubbs has informed us (personal communication) that on Socorro on August 26, 1946, he heard towhees singing and discovered a nest of these birds in a shrub near the coast. The eggs were bluish gray with indistinct dark markings, as in other members of this species.

Two males were taken on March 14 in unworn plumage and were moderately fat; the testes were not enlarged. A female taken on March 16 in very worn plumage was not fat and did not have enlarged follicles. The iris was red.

DISCUSSION

The great potential mobility of birds and the strong element of chance involved in reaching remote islands usually makes it difficult to determine with any precision the area or population from which insular forms are derived. It is always of interest, however, to explore the possible origins of the avifauna of an oceanic archipelago.

Of the 25 species of birds known to breed on one or another of the Revilla Gigedo Islands, 10 are sea birds of the orders Procellariiformes, Pelecaniformes, and Charadriiformes. Only one form of sea bird, *Puffinus auricularis*, is endemic to the islands, and this species is a representative of a cosmopolitan genus. It may have been derived from the similar and wide-ranging *Puffinus puffinus*. All the other breeding sea birds are widely distributed species, and those of the Revilla Gigedo Islands have not differentiated from other populations.

It is surprising that no storm petrels (Hydrobatidae) breed in the archipelago; *Oceanodroma leucorhoa socorroensis* is misnamed, for it breeds on Guadalupe Island and only strays to the vicinity of Socorro.

The other 15 resident species are all land birds, including the Yellow-crowned Night Heron of Socorro. This relatively short-legged race is largely terrestrial in its habits, and it is found on the drier parts of the island as well as on the beaches. Of these 15 species, all but one are endemic forms of varying degrees of differentiation. The single exception, *Corvus corax clarionensis*, was described from Clarión as an endemic race, but the characters ascribed to it are found in other populations and the subspecies, if valid, is therefore not endemic to the Revilla Gigedo group. All the other land birds are well-marked forms, including the monotypic genus *Mimodes* and the distinct species *Zenaidura graysoni*. Whether or not the wrens *Thryomanes sissonii* and *Troglodytes tanneri* should be considered full species can be clarified only by careful study of their habits; in any case, they are morphologically distinct.

The ancestry of *Mimodes* is uncertain. Young specimens of *M. graysoni* are more

rufous, more heavily spotted on the under parts, and elsewhere more distinctly marked than are adults. In color pattern these immatures appear quite similar to certain species of *Toxostoma* such as *T. cinereum* of Baja California, but the resemblance may be no more than superficial. *Mimodes* has a subterminal notch on the culmen that is lacking in *Toxostoma* but present in several other mimid genera. Whatever its derivation, *Mimodes* is a well differentiated form whose progenitors cannot be identified or located with any confidence.

Aratinga holochroa brevipes and *Parula pitiayumi graysoni* are representatives of primarily neotropical species which, however, range both north and south of the Revilla Gigedo Islands. All the other land birds, including *Zenaidura graysoni*, are derived from primarily nearctic types that are found also both north and south of the latitude of the islands. Thus, although most of the land birds of the archipelago have a distinctly nearctic aspect, they may have been derived from populations on the mainland at low latitudes. It is also entirely possible that the resident parakeet and warbler populations came from mainland areas considerably north of the islands.

Johnston (1931) found that the great majority of the terrestrial plant species found in the Revilla Gigedo Archipelago show closest affinities with those of Baja California and northern México. The few species of reptiles found on the islands appear to be derived from closely related forms of the Sonora-Sinaloa area (Brattstrom, 1953, and manuscript). These data suggest that wind and currents are more likely to bring organisms to the archipelago from areas to the north of it than from the south, and the composition of the bird fauna does not conflict with this supposition.

It is interesting that no species of land bird is resident on more than one island, even though some species at least might be expected to find a satisfactory environment and little or no competition on an island other than their home. Possibly the original colonizers in each case were few in number, for then the chances of their reaching more than one of the widely-spaced islands would have been slight. The varying degrees of differentiation of the endemic forms suggest that the islands were reached at several different times rather than in one or even two waves. It is likely that the Mourning Dove first reached Socorro, evolving into *Zenaidura graysoni*, and that a much later contingent from the mainland colonized Clarión and differentiated into *Zenaidura macroura clarionensis*. The ancestors of the distinct *Mimodes graysoni* may have reached Socorro even earlier than those of the Socorro Dove, and those of the other passerines probably came later.

The geological age of the islands is not presently known, but the age sequence from oldest to youngest is believed to be Clarión, Roca Partida, Socorro, and San Benedicto (Adrian Richards, personal communication). It is possible that not all the islands were present or habitable at the time the first land birds arrived; if so, several colonizations must undoubtedly have occurred.

Although the places of origin of the endemic birds cannot be narrowed down to a small area, it is noteworthy that the avifauna of the archipelago is not merely a random sample of that of the nearest mainland. The scarcity or absence of fresh water on the islands is certainly an important factor in limiting the variety of resident land birds, and most of the insular forms are representatives of species with a wide range in many habitats. These birds are presumably able to survive and establish themselves in harsh environments. The Elf Owl, *Micrathene whitneyi graysoni*, might be considered an exception, but little is known of its habits and distribution outside of the United States, and it may be more widespread and successful than is now supposed. On the other hand, it is somewhat surprising that the House Finch, *Carpodacus mexicanus*, which has successfully colonized other islands off the Mexican coast, has never become established in the Revilla Gigedo group.

The future of the avifauna of the islands appears to be secure at present. There are no human inhabitants, and no mammals of any kind except the moderate and apparently stable population of sheep on Socorro. Few ships stop at any of the Revilla Gigedo Islands, and the birds are seldom molested. The remote location and generally barren aspect of the archipelago have so far protected its biota from all except volcanic destruction. While this fortunate condition still exists, it may be hoped that the Mexican government will guard against the introduction of mammals such as rabbits, cats, goats and others that have invariably brought disaster to the flora and fauna of insular regions.

CHECK-LIST OF THE BIRDS OF THE REVILLA GIGEDO ISLANDS

The following check-list has been compiled as a convenience for future visitors to the archipelago. Only those sea birds which breed or roost on the islands or which have been found immediately offshore are included. Sea birds breeding on one or another of the islands are presumed to occur in the vicinity of the others, and only the islands where actual nesting takes place are listed for such species. Species for which there is one record are listed as accidental; species recorded twice to several times are listed as casual. Many birds in these two categories probably occur much more regularly than the few records indicate. Sight records only are indicated by a double dagger (‡).

In several instances, the status of a species has been found to differ from that given by Friedmann, Griscom, and Moore (1950). We wish to thank H. Friedmann and L. Griscom for their kind assistance in determining the changes to be made.

Puffinus pacificus chlororhynchus. Wedge-tailed Shearwater. Breeds on San Benedicto.

Puffinus auricularis. Revilla Gigedo Shearwater. Breeds on Clarión, San Benedicto, and possibly Socorro.

Oceanodroma leucorhoa socorroensis. Leach Petrel. Casual to regular visitor to all islands.

Phaethon aethereus mesonauta. Red-billed Tropic Bird. Breeds on San Benedicto.

Pelecanus occidentalis californicus. Brown Pelican. Accidental on Socorro and San Benedicto (‡).

Sula nebouxi. Blue-footed Booby. Breeds on San Benedicto and possibly Roca Partida.

Sula dactylatra californica. Blue-faced Booby. Breeds on Clarión and San Benedicto.

Sula sula websteri. Red-footed Booby. Breeds on Clarión and San Benedicto.

Sula leucogaster brewsteri. Brown Booby. Breeds on San Benedicto and Roca Partida.

[*Phalacrocorax auritus albociliatus*. Double-crested Cormorant. We are unable to find an unquestionable record for this species although virtually all check-lists and reference works include the Revilla Gigedo Islands within its range. The original basis for inclusion seems to be the statements of Ridgway (1883, 1884) that this cormorant is found in the "Revillegiedo [sic] Islands" and (1887) Socorro Island specifically, but no definite sight records or specimens are mentioned. We feel that Ridgway must have been in error, for at the time of his writing no biologist had visited the islands since Grayson in 1867; the next observations and collections there were those of Townsend in 1889. Neither Grayson (1871) nor Lawrence (1871, reporting on Grayson's specimens) nor Townsend (1890) nor any subsequent visitor has recorded this or any other cormorant from Socorro or any other island of the Revilla Gigedo group. Thus, unless a specimen is found to substantiate Ridgway's citation, the Revilla Gigedo Islands should be excluded from the range of this species.]

Fregata minor palmerstoni. Lesser Frigate Bird. Breeds on San Benedicto and Clarión.

‡*Ardea herodias*. Great Blue Heron. Regular visitor to Clarión and Socorro.

‡*Leucophoyx thula*. Snowy Egret. Casual on Clarión.

Nyctanassa violacea gravirostris. Yellow-crowned Night Heron. Breeds on Socorro.

‡*Plegadis falcinellus mexicana*. Glossy Ibis. Casual on Clarión.

‡*Anas discolor*. Blue-winged Teal. Accidental on Clarión.

Buteo jamaicensis socorroensis. Red-tailed Hawk. Breeds on Socorro, casual on San Benedicto (‡).

A sight record for *B. j. calurus* on Socorro (Kaeding, 1905) is not considered reliable.

‡*Pandion haliaëtus carolinensis*. Osprey. Accidental on San Benedicto and Socorro.

‡*Falco peregrinus*. Peregrine Falcon. Accidental on Socorro.

[*Haematopus ostralegus frazari*. Oystercatcher. The inclusion of the Revilla Gigedo Islands within the range of this species in the *Distributional Check-list of the Birds of Mexico* is based on a mistaken reading of the paper by McLellan (1926) entitled "Expedition to the Revillagigedo Islands, Mexico, in 1925, VI. The Birds and Mammals." This paper includes records of the Oystercatcher from several other islands off the Pacific coast of México but not from the Revilla Gigedo group, and this archipelago should therefore be excluded from the range of the species.]

Pluvialis dominica fulva. Golden Plover. Accidental on Clarión. Several other records from Clarión are of undetermined subspecies.

‡*Charadrius hiaticula semipalmatus*. Semipalmated Plover. Accidental on Socorro.

Numenius phaeopus hudsonicus. Hudsonian Curlew. Casual on Clarión, Socorro (‡), and San Benedicto (‡).

Actitis macularia. Spotted Sandpiper. Regular visitor on Socorro and Clarión.

Catoptrophorus semipalmatus inornatus. Willet. Accidental on Socorro.

Heteroscelus incanus. Wandering Tattler. Regular visitor on Socorro, Clarión, and San Benedicto.

Arenaria interpres interpres. Ruddy Turnstone. Regular visitor on Clarión.

Crocethia alba. Sanderling. Accidental on Socorro.

Ereunetes mauri. Western Sandpiper. Accidental on Clarión.

Erolia minutilla. Least Sandpiper. Accidental on Clarión.

Himantopus mexicanus. Black-necked Stilt. Casual on Clarión.

[*Larus heermanni*. Heerman Gull. Mistakenly listed in the *Distributional Check-List of the Birds of Mexico* on the basis of records from Isabel Island off the coast of Nayarit. This island is not part of the Revilla Gigedo group and this species should therefore be dropped from the list of Revilla Gigedo birds (see Oystercatcher).]

‡*Larus occidentalis*. Western Gull. Casual on Clarión.

Sterna fuscata crissalis. Sooty Tern. Breeds on Roca Partida and Oneal Rock, Socorro.

Anous stolidus ridgwayi. Brown Noddy. Breeds on Roca Partida and Oneal Rock, Socorro.

Gygis alba. White Tern. Gifford (1913) stated that R. H. Beck took a single specimen of this tern, the only one seen, on Oneal Rock at Socorro on July 27, 1905. Almost all reference works since then have included the Revilla Gigedo Islands within the range of this species, and Friedmann, Griscom, and Moore (1950) reported a colony of White Terns on Oneal Rock. A search of the literature, however, fails to reveal a single record from the Revilla Gigedo Islands other than the original specimen mentioned by Gifford. No landings were made on Oneal Rock in 1953, but the boat passed within 100 yards of it many times in both March and November and no terns of any kind were seen. Mr. Gifford has kindly checked his field notes for the 1905 expedition and informs us that his statement that only one White Tern was found at Oneal Rock is correct. Thus, unless we have overlooked a subsequent record, the White Tern should be considered only an accidental visitor to the Revilla Gigedo Archipelago.

Zenaidura macroura clarionensis. Mourning Dove. Breeds on Clarión.

Zenaidura graysoni. Socorro Dove. Breeds on Socorro.

Columbigallina passerina socorroensis. Ground Dove. Breeds on Socorro.

Aratinga holochroa brevipes. Green Parakeet. Breeds on Socorro.

Micrathene whitneyi graysoni. Elf Owl. Breeds on Socorro.

Speotyto cunicularia rostrata. Burrowing Owl. Breeds on Clarión.

Asio flammeus flammeus. Short-eared Owl. Accidental on Clarión.

‡*Ceryle alcyon*. Belted Kingfisher. Accidental on Socorro and Clarión.

Hirundo rustica erythrogaster. Barn Swallow. Casual on Clarión; accidental on San Benedicto.

Corvus corax clarionensis. Raven. Breeds on Clarión; regular visitor on San Benedicto.

Thryomanes sissonii. Socorro Wren. Breeds on Socorro.

Troglodytes tanneri. Clarión Wren. Breeds on Clarión.

Salpinctes obsoletus exsul. Rock Wren. Formerly bred on San Benedicto; apparently exterminated in 1952.

‡*Mimus polyglottos*. Mockingbird. Accidental on Clarión.

Mimodes graysoni. Socorro Thrasher. Breeds on Socorro.

Anthus spinoletta pacificus. Water Pipit. Accidental on Socorro.

Parula pitiayumi graysoni. Tropical Parula Warbler. Breeds on Socorro.

- Dendroica castanea*. Bay-breasted Warbler. Accidental on San Benedicto.
 ‡*Molothrus ater*. Cowbird. Accidental on Clarión.
Pipilo erythrophthalmus socorroensis. Red-eyed Towhee. Breeds on Socorro.

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