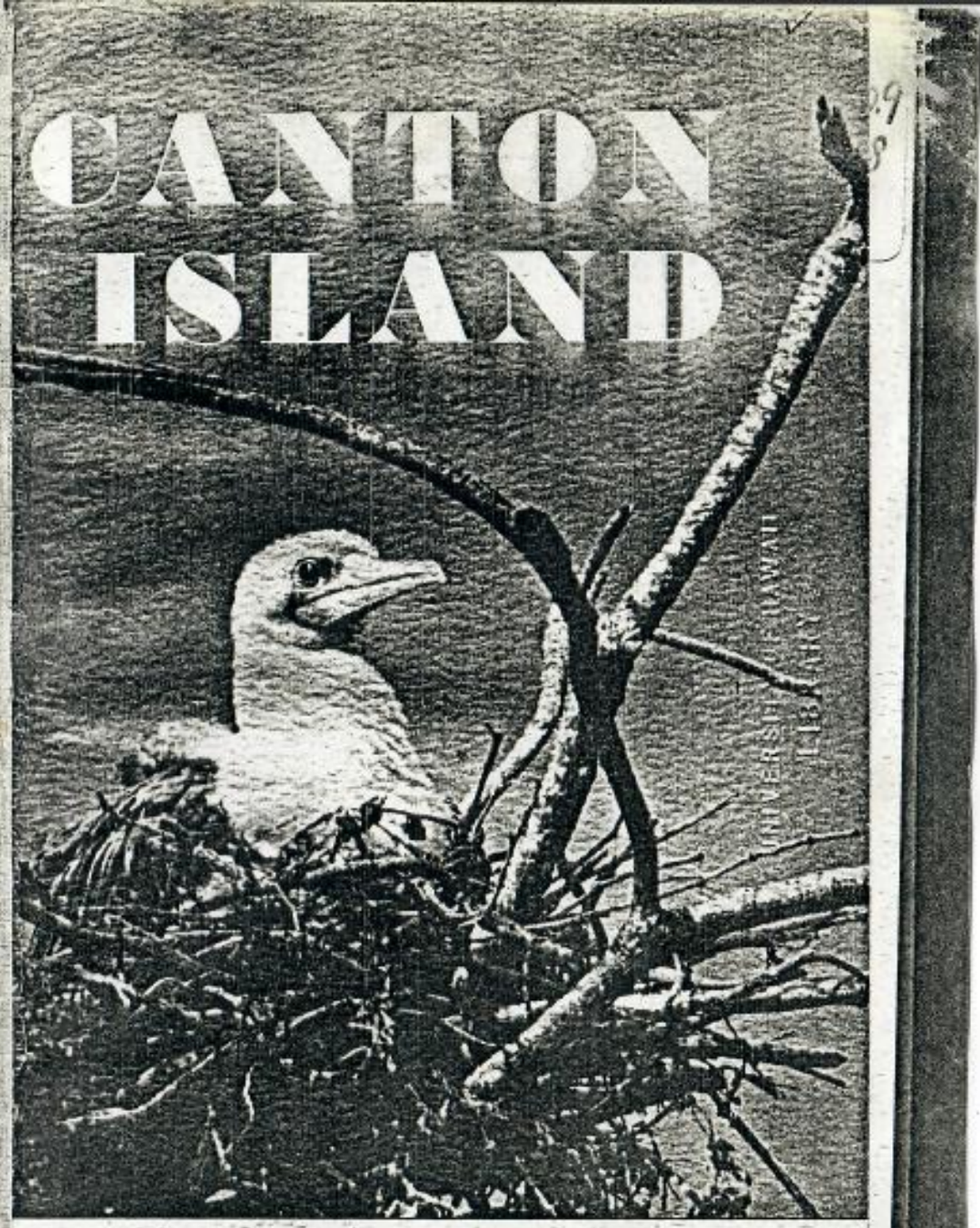
CANTON ISLAND



Cushman Murphy - Robert J. Niedrach - Alfred M. Bailey

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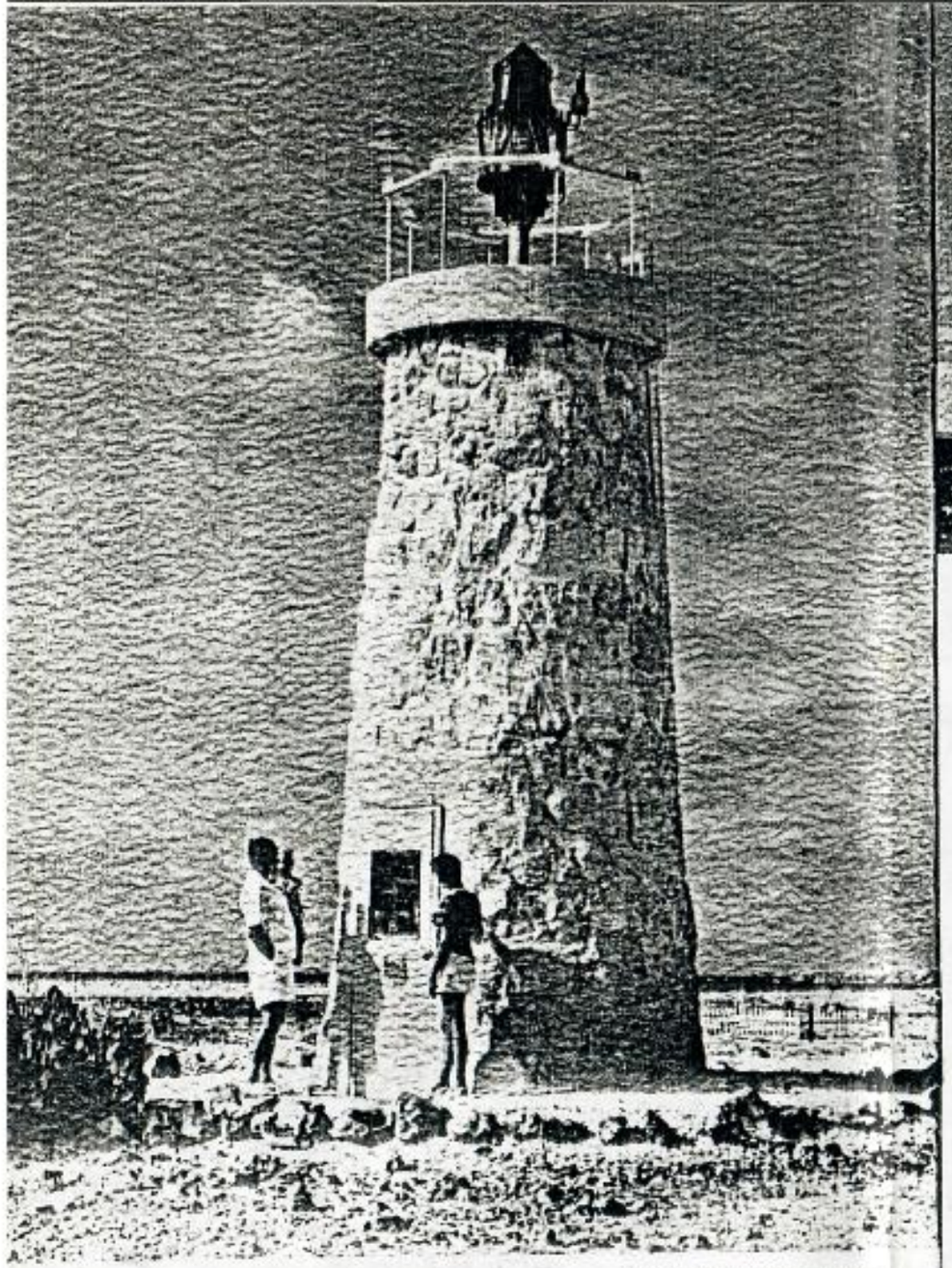


Photograph by Alfred M. Bailey and Robert J. Niedrach

MUSICK MEMORIAL LIGHT

Canton Island lighthouse named in honor of Captain E. C. Musick, who lost his life with members of the crew of the **Samoan Clipper** near Tutuila on January 11, 1938, on a pioneer flight for Pan American World Airways

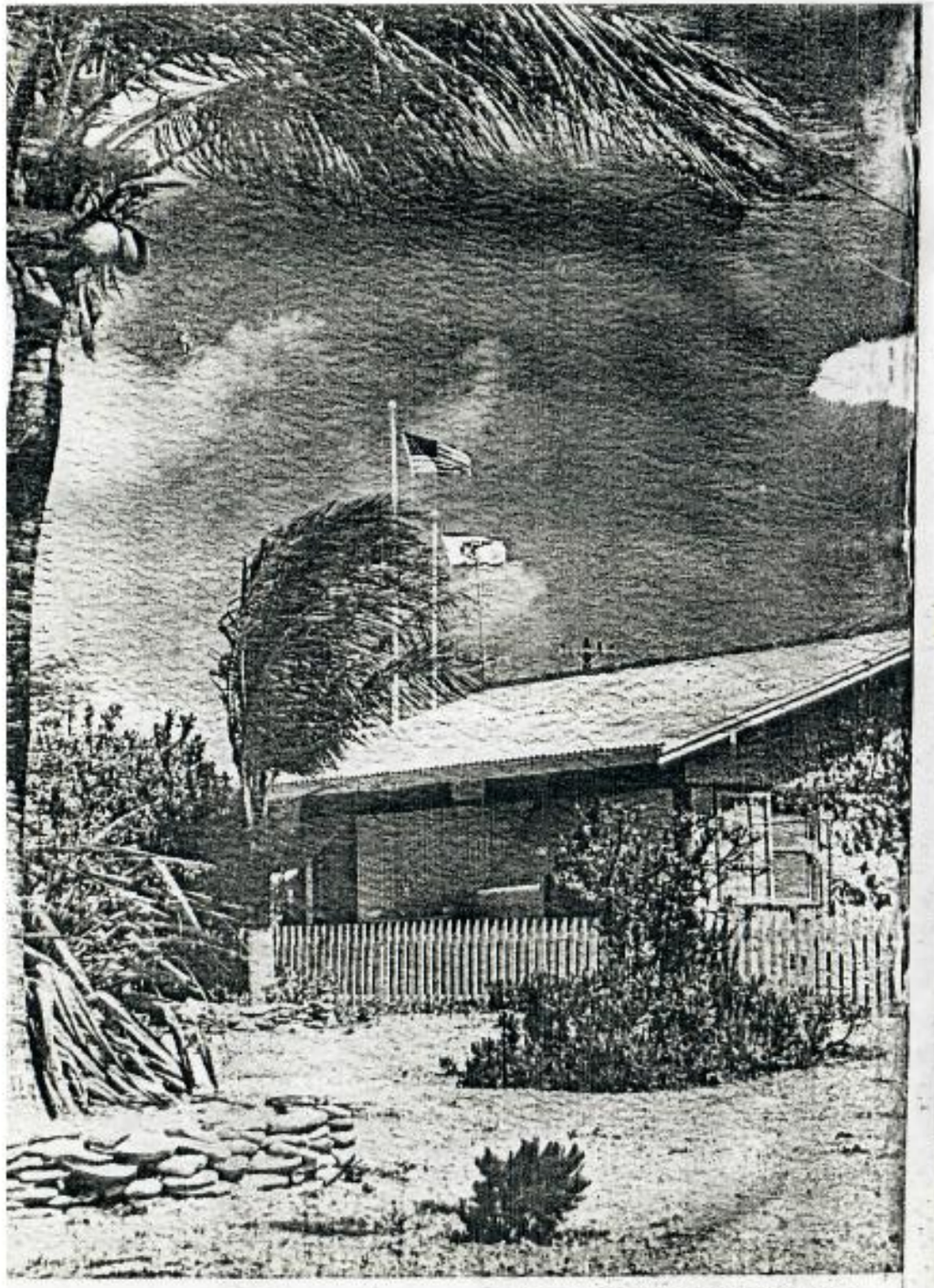
Photograph courtesy of William Mullahey

Canton Island

By Robert Cushman Murphy, Alfred M. Bailey and Robert J. Niedrach

The Phoenix Islands are a low-lying group of eight coral islands, located a few degrees south of the equator and from five to ten degrees east of the 180th Meridian, where the date changes from Sunday to Monday as you go west. Gardner, Hull, Sydney, and Canton are typical atolls, with narrow ribbons of sand encircling blue lagoons from which narrow entrances reach the sea, except on Sydney, which is a "doughnut" of land. In Enderbury, Phoenix, Birnie, and McKean, the lagoon has been reduced to a small pond or puddle in a basin of sand.

Canton is the largest, tapering from a width of four and a half miles on the west side to the southeast point, about ten miles distant. Its shape has been described as that of a pork chop; but all the meat is gone, leaving a narrow rim around the spacious lagoon. It lies 190 miles south of the equator. It is placed strategically from the standpoint of airplane travel, for it is 1630 nautical or 1875 statute miles from Honolulu—about an eight hour flight southward, and serves as a regular stepping stone for planes making the long air journey to Fiji and Australia. Consequently, it is one of the most important bases in the Central Pacific area.



Photograph by Patricia Bailey Witherspoon

TROPICAL CANTON ISLAND

Canton Island

By ROBERT CUSHMAN MURPHY, ALFRED M. BAILEY
and
ROBERT J. NIEDRACH

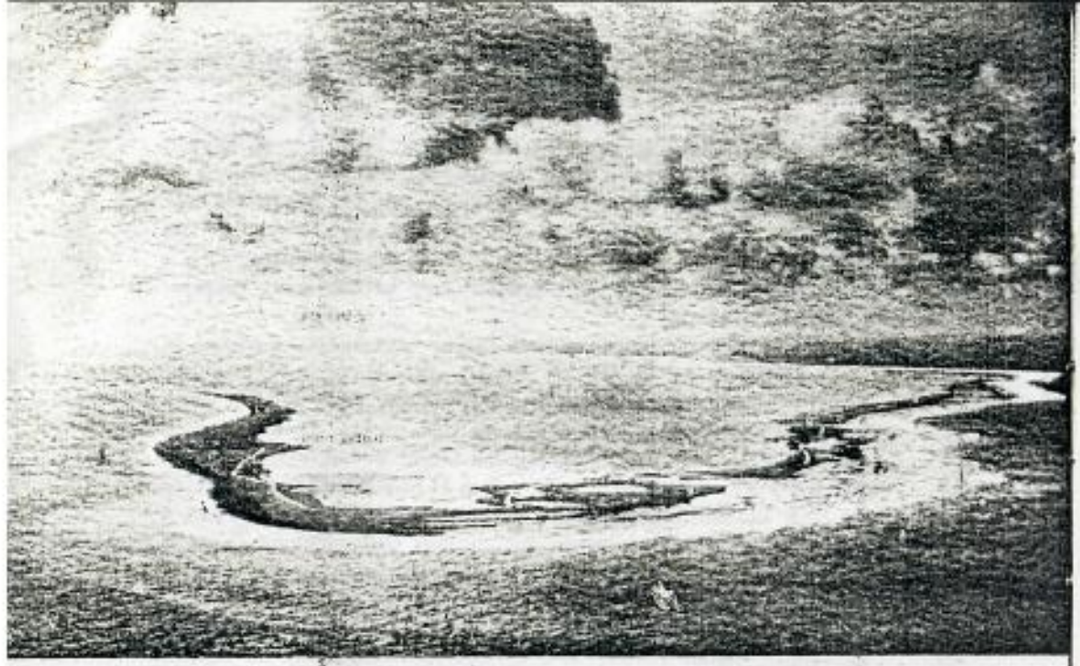
FOREWORD

This number of MUSEUM PICTORIAL is the second dealing with an expedition of the Denver Museum of Natural History. The first, *Stepping Stones Across the Pacific* (M.P.No.3), was an account of field work in the spring of 1949 on the islands of Oahu, Midway and Wake. Future numbers of MUSEUM PICTORIAL will deal with field activities in Fiji, Australia and New Zealand in 1949, 1952 and 1954.

The Denver Museum has had three expeditions to Australia and the South Pacific area, from August to December of 1949, for the same period in 1952, and from April to July, 1954. On the first trip I was accompanied by Henry C. Wichers of our Museum staff, and we stopped en route on Canton Island in the Phoenix Group, the Fiji Islands and New Caledonia. On our second journey, R. J. Niedrach and I carried on additional field work on Canton and the Fijis, and on the third I was accompanied to Canton, Fiji, Australia and New Zealand by my wife and our daughter, Patricia Bailey Witherspoon. On each occasion we were the guests of Pan American World Airways at their hotel on Canton Island, at the invitation of Vice Presidents H. E. Gray and Colonel C. M. Young and, thanks to Station Managers M. O. Trewhitt (1949), W. O. Buchanan (1952) and Richard E. Slater (1954), and to William Evans, U. S. Resident Administrator and Chief of the Civil Aeronautics Authority on the island, we were given every cooperation for collecting and photographic work.

Dr. Robert Cushman Murphy, Lamont Curator of Birds at the American Museum, visited Canton Island with Mrs. Murphy, April 12-14, 1949, and he has kindly agreed to join in the preparation of this report. The authors are indebted to E. H. Bryan, Jr., Curator of Collections of the Bernice P. Bishop Museum, for the compilation of the extensive historical notes, and the bibliography.

ALFRED M. BAILEY
DENVER MUSEUM OF NATURAL HISTORY
Denver, Colorado, December 15, 1954



Photographs U. S. Army Signal Corps

AERIAL PHOTOGRAPHS OF CANTON ISLAND
Above: View of the southeastern end where the bird colonies are located
Below: View of British settlement and Pan American area, with wrecked **President** Taylor upon a coral ledge

Historical Notes

(Compiled by E. H. Bryan, Jr.)

Canton was discovered independently by several ships, most of them American whalers. Just which one reached it first is not known, for each gave it a different name. It did not appear on maps published in 1791, but was mentioned by the Secretary of the the U. S. Navy in a list of Pacific islands published in 1828. It was a frequent haven for whale ships, which visited the region in some numbers during the period from 1820 to 1850. Despite its lack of water and trees, it presented a fair anchorage, and a place where weary seamen could get ashore and stretch their legs. What was more important, they could procure green herbs, if troubled with scurvy, and could augment their diet of "salthorse" and biscuits with some shore fishes, birds, and their eggs. The names Mary, Swallow, and Mary Balcourt bear witness to some of these early "discoveries."

Many hundreds of years before the coming of white men, Canton was probably visited by parties of venturesome Polynesians. Although no ancient archaeological sites have been found on Canton itself, stone platforms, which have been identified as ancient shrines, have been found on Sydney and Hull, 100 miles to the south. The absence of coconut palms and thickets of trees indicates that Canton was little more than a stopping place for these intrepid voyagers.

The name "Canton" came late, but stuck because of the dramatic circumstances connected with it. On March 4, 1854, the New Bedford whaleship *Canton*, Captain Andrew J. Wing, piled up on the atoll's reef. The crew got ashore without loss of life and was able to salvage a few supplies, food and water. The thirty-two men stayed on the island until March 30, and then set out in four whaleboats, Captain Wing heading for the Gilbert Islands, which he thought were about 800 miles to the westward. Winds and currents took him past these islands, and after forty-five days of terrible privations they reached the island of Tinian, in the Marianas. But their troubles were not yet over. The Spanish governor of the island would not believe their story of shipwreck, and ordered them to move on. He did allow them water and few coconuts, and thus slightly refreshed, they took to their four boats again. This time Captain Wing knew where he was, and headed for Guam, which they reached on May 19. Theirs was the record voyage of some 3,200 miles in forty-nine days of travel in open boats. Later the captain and crew obtained passage to Hong Kong, where they arrived August 22, 1854.

In 1872, Commander R. W. Meade, of the U.S.S. *Narragansett*, surveyed Canton Island during one of his cruises through the central Pacific in search of the notorious pirate and blackbirder, "Bully" Hayes. At that time he named the atoll Canton Island to commemorate this epic adventure of the equatorial Pacific.

The British maintain that H.M.S. *Curaco*, under command of Captain Gibson, visited Canton Island during the 1850's.

In 1856, Canton was named as one of the Pacific islands claimed by citizens of the United States under the "Guano Act." This act, passed by the United States Congress on August 18, 1856, permitted Americans to claim unoccupied islands in the name of the United States, for the purpose of removing the guano. Claims were made to about forty-eight islands under this Act. However, Canton does not seem to have been occupied by American guano diggers.

A little guano was dug by John T. Arundel Company, of London, during 1885 and 1886. They built a small stone pier into the lagoon from which a tram line was run to the site of digging operations near the middle of the north rim. They loaded the guano onto flat-bottomed boats and, avoiding the maze of reefs which choked the western half of the lagoon, traversed a narrow passage close to the south shore around to the lagoon entrance on the west side. Here sailing ships maintained a precarious anchorage while the lumpy and powdery material was put aboard. One of the vessels, the *Howard de Troop*, was wrecked near this entrance. Its name plate is now preserved in Bernice P. Bishop Museum.

The island was visited in June 1889 by H. M. S. *Egeria*, Commander Oldham, R.N., which was on a cruise to map and annex islands in the central Pacific for Great Britain. On board was a young naturalist, J. J. Lister, who made the pioneer observations on the bird life of the atoll.

In 1899, the British leased the island to the Pacific Islands Company but they did not develop it.

In 1916 it was leased to Captain Allen of the Samoan Shipping and Trading Company. He planted a few coconut palms near the entrance, but made no other use of the island. Ten of these coconut palms were still living, height about ten feet, when the writer visited Canton the first time as a member of the Whitney South Sea Expedition of the American Museum of Natural History, March 10 to 17, 1924. The ornithological accomplishments of this expedition are mentioned elsewhere.

In 1928, when Captain Kingsford-Smith and his three companions were flying the airplane *Southern Cross* on the pioneer flight from Hawaii to Fiji and on to Australia, the party, upon reaching

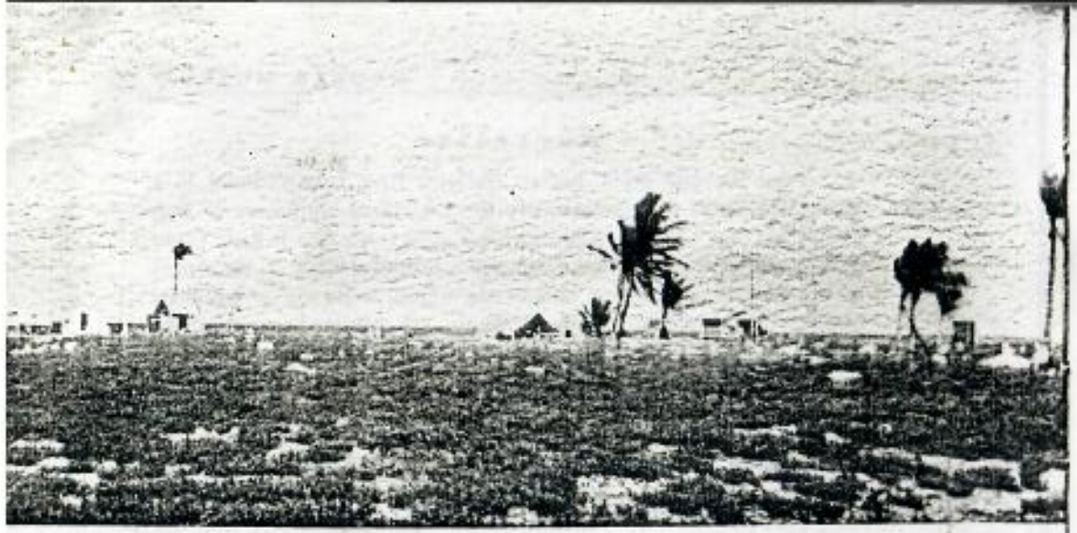
Honolulu, sent out a request for information regarding any possible emergency landing places between Hawaii and Fiji. The writer was able to furnish him with maps, photographs and exact data as to where he could land on the northern rim of Canton. He passed over the atoll in the dark, and fortunately did not have to try out this emergency landing place. In daylight, in ordinary weather, such a landing would have been quite feasible, even without prior preparation of the north rim.

Occupation of various central Pacific islands by Americans in 1935 prompted the British to reassert their sovereignty over the Phoenix Islands. On August 6, 1936, a party from H.M.S. *Leith* landed at Canton and posted a large sign on one of the coconut palms near the entrance, claiming the island in the name of King Edward VIII. On June 3, 1937, when H.M.S. *Wellington* brought the New Zealand astronomers to observe a total eclipse of the sun, a second sign was nailed up on the coconut palm, making claim in the name of King George VI (Edward, in the meantime, having abdicated.) In order to supply a more definite status, on April 8, 1937, the Phoenix Islands were placed, for safekeeping, in the Gilbert and Ellice Islands Colony, and its administrator added his sign to the collection at Canton, in October 1937. The main reason for this administrative arrangement was to provide for the colonizing of three southern Phoenix islands, Sydney, Hull, and Gardner, by surplus persons from the overcrowded Gilbert Islands. These islands were renamed respectively, Manra, Orona, and Nikomaroro.

Canton Island broke into the news in 1937, when parties of American and New Zealand astronomers independently chose it as the spot from which to observe the total eclipse of the sun, which occurred on July 8.

This eclipse was most remarkable for, "because of the time of year, relative distance of the sun and moon from the earth, and nearness of the eclipse path to the equator, the duration of darkness at the middle of the path of the eclipse was the longest in any eclipse in 1238 years." Unfortunately, there was no land within twelve hundred miles of the point where this maximum totality would occur; where the sun's rays would be blotted out for a total of seven minutes and four seconds, the longest since 699 A.D., the year after Carthage was destroyed. Consequently, although it lay far to the westward, along the path of totality, Canton Island was chosen as the site.

The American Expedition was sponsored jointly by the U.S. Navy and the National Geographic Society. Dr. S. A. Mitchell was the scientific leader, and the Navy detachment was under command of Captain J. F. Hellweg, of the U.S. Naval Observatory. The



Photograph by E. H. Bryan, Jr.

BRITISH (left) AND AMERICAN CAMPS ON CANTON ISLAND IN 1938

party travelled to Canton on the U.S. Navy seaplane tender *Avocet*, which was anchored off the lagoon entrance, near the spot where the S.S. *President Taylor* later was wrecked, during World War II. A tent city was set up along the shores of the colorful lagoon, and the waterfront took on the aspect of a boom town. Enough radio and other publicity was produced to put even this "barren desert" island on the map.

Two weeks after the American scientists landed, H.M.S. *Wellington* arrived offshore with the New Zealand eclipse party. At first there was a little misunderstanding over the matter of anchorage, but soon the two parties were fraternizing and aiding each other.

More than the eclipse was observed. Both British and Americans noted, as had the writer, that here was a spacious lagoon into which seaplanes could settle, as well as a flat rim which could be used by land planes. Both parties laid claim to the atoll, and each erected a monument which displayed the flag of its nation. The American monument was unveiled on Memorial Day before the personnel of both groups.

On August 31, 1937, two British agents, G. V. Langdale, formerly mate of the Fiji government yacht *Pioneer*, and F. H. Rostier, radio operator, were landed at Canton from H.M.S. *Leith*, with a Gilbertese servant and equipment and abundant supplies. They built a substantial building for radio and administration, and comfortable living quarters. They received supplies at intervals of about six months from British warships. They also set up radio telephone connections with the S.S. *Aorangi* and *Niagara*, which passed within a mile or so on their monthly trips between Australia and Canada.

Any needed supplies could be put into water-tight containers and dropped over the side, to be picked up by men from shore. A tower, twenty-four feet high, with a gasoline lamp on top, was erected so that the island could be seen at night from a distance of up to fourteen miles. Mr. Rostier was replaced by Tom Manning in January, 1938.

Despite all these British safeguards, an American party consisting of four "colonists", a surveyor and two radiomen, landed from the U. S. Coast Guard Cutter *Roger B. Taney*, at 9 A. M., March 7, 1938. They set up camp alongside the British. This had followed an administrative order, signed March 3, 1938, by President Franklin D. Roosevelt, placing Canton and Enderbury under jurisdiction of the United States Department of the Interior.

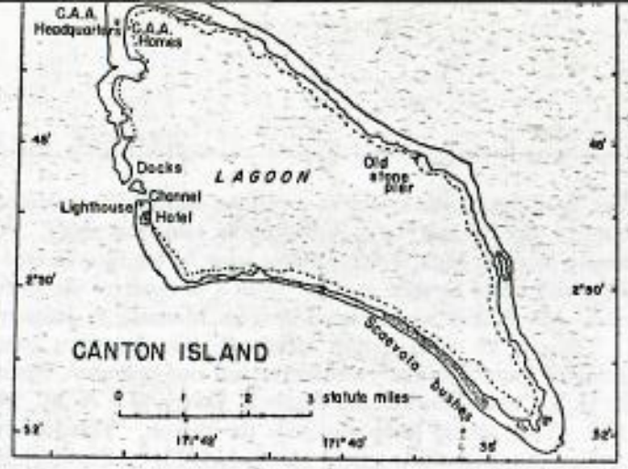
It was a friendly invasion. Each party shared the other's hospitality. Both knew that the settlement lay in Washington and London. This settlement finally was reached in April, 1939. Canton and Enderbury Islands were placed under joint British and American control for fifty years and "thereafter until such time as it may be modified or terminated by mutual consent." Air companies of both nations were to be given equal rights to such facilities as the islands afforded.

U.S. Coast Guard cutters visited Canton with supplies at intervals of about three months. The writer visited Canton again on one of these cruises, July 25 to 27, 1938. At that time the nearly completed lighthouse was given formal dedication. It was appropriately named Musick Light, in honor of Captain E. C. Musick, who lost his life, along with other members of his crew, when the *Samoan Clipper* crashed on January 11, 1938, near Tutuila, on a pioneer experimental flight for Pan American Airways.

During 1938 and 1939, Pan American Airways laid out and developed an extensive airport at Canton, cleared and deepened the lagoon, and initiated flights to New Zealand, using Canton as one of the ports of call.

In order to guard Hawaii against possible invasion by insect pests from south sea islands, an "insect filter" was established at Canton, similar to that in operation on Midway Islands. Here an entomologist inspected and fumigated every northbound plane as it rode at anchor in the lagoon overnight. He also studied the insects of Canton, to make sure that nothing potentially injurious to crops, animals or man in Hawaii or the mainland United States could get by alive. One of the entomologists who carried on this work was R. H. Van Zwaluwenburg, who published concerning the atoll and its insects.

With the approaching threat of war, means were sought for



By E. H. Bryan Jr.

CHART OF CANTON ISLAND

ferrying land planes across the Pacific to Australia. The writer recommended to his commanding general that the northern rim of Canton be used as a landing strip; a field was built which soon became the hub of central Pacific air movement. All plane traffic touched there and, consequently, many men were engaged in seeing that the little coral atoll did not fall into Japanese hands. In addition to the long runway for through traffic, an excellent landing strip was built for fighter planes, kept in scooped-out revetments and camouflaged with scaevola. It is stated that thirty-thousand American troops were brought to Canton, and many were stationed there for months. The entrance channel was dredged together with an auxiliary channel to a dock area to the north. A roadway was built around the atoll, crossing low places on causeways, and barracks, storehouses, a hospital, fortifications, and camp sites were erected over much of the surface. Nesting sites of the seafowl fared badly, although it is to the credit of the Armed Forces that, as soon as the crisis was ended, an effort was made to prevent further interference with wildlife.

Condominium on Canton has resulted in teamwork between the United States and Great Britain. The might of Pan American Airways developed the atoll into an extensive base even before the threat of war. The American Armed Forces developed it further, protected it, and delivered ample supplies. Labor has been furnished by Britain from her adjacent colonies. These peoples, in turn did much to give "local color" to Americans stationed on the atoll. Soldiers, sailors and airmen, as well as airfield personnel enjoyed the picturesque islanders, their dances and their fishing ability.

Narrative

Since the war years, human residents have been reduced to a permanent corps of approximately three hundred employees of Pan American, the Civil Aeronautics Authority and the British Community. Pan American has developed a beautiful oasis on the desert of coral sand, on the west side of the island, with sturdy buildings constructed to withstand strong winds. A commodious, typically tropical hotel was erected to serve passengers making overnight stops —the only one maintained by Pan American on the Australian run. Through the courtesy of Vice Presidents H. E. Gray and Colonel Clarence M. Young, the three Denver Museum field parties, as well as Dr. and Mrs. Murphy, were made guests of Pan American and given every facility for field work. The hotel is situated near the camping place used by members of the eclipse expedition, and the entire area has been planted with tropical growth.

This site has proved inconvenient, however, for it has been necessary to use a launch to cross the lagoon to the airfield. Consequently, Pan American headquarters is being moved to the north side of the island. Family quarters for employees, a passenger lounge, an emergency lay-over quarters for passengers, and homes for native workers have been erected.

The lagoon is a stretch of unbelievably blue water three and one-half miles wide and nine long, circled by a narrow strip of coral rock and sand ranging from a half mile to only one hundred yards wide. The island has a maximum height of around twenty-five feet and a bumpy road some twenty-nine miles long circles the lagoon. The beaches slope gently to the interior, quite in contrast to the broken coral in places on the outside where full force of the wind can hurl waves upon the shores.

The lagoon entrance is to the north of the British headquarters, with an exceedingly swift current with the change of tide. Fish move in great numbers, going in with the rising, and massing out as the waters recede. Nearby on the point is the Musick Memorial light, white against the blue of the tropical sky. Off to the left at the mouth of the channel into the lagoon is the wreck of the *President Taylor*, famous ship of the Dollar Line that crashed on the reef just at the entrance during the war. The officers thought they were being chased by a submarine; they were a little off their bearings, and ship was piled high upon the ledges. It lodged securely, but there was no loss of life.

A short time later some of the island boys went aboard the ship and built a fire; the ship was soon ablaze, and during the following

years was only a rusted hulk upon the coral shore as a reminder of the fine vessel that used to ply these waters of the Pacific. It served as an ideal fishing spot where the people of the island were accustomed to make excursions and fish in the deep water off the stern, and they were sorry when the salvage company started work in 1954 to destroy their landmark—cutting the great vessel into pieces to secure the valuable steel and copper.

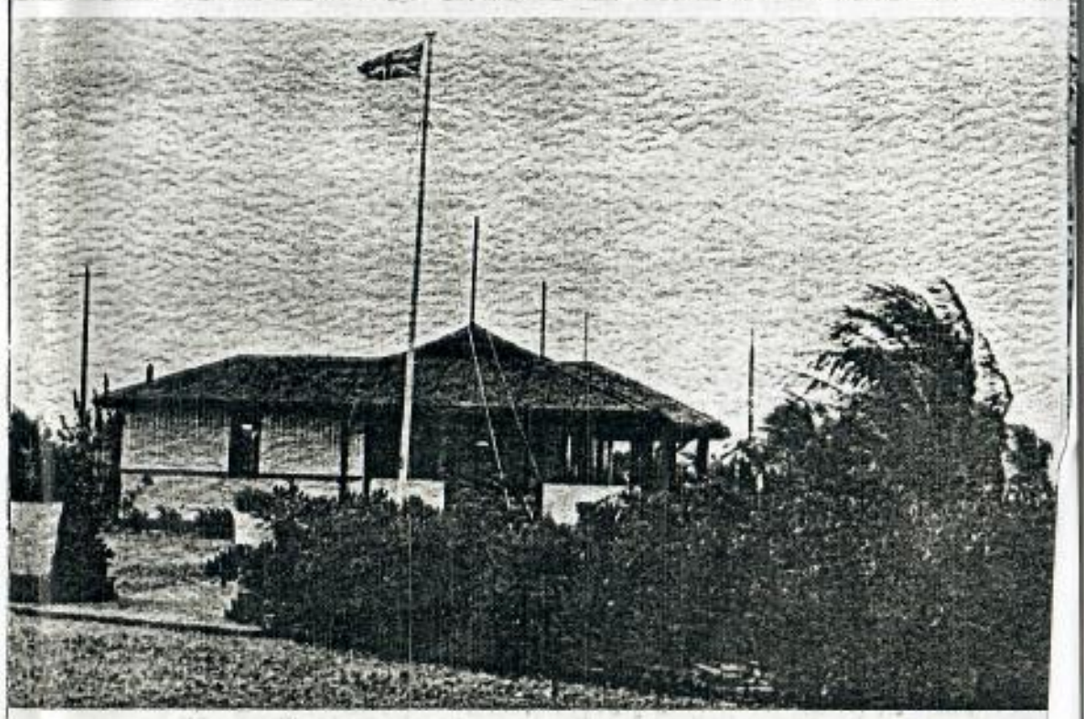
Romance writers have described the coral atolls of the Pacific as languorous palm-decked coral piles inhabited by sloe-eyed beauties —where life was easy and white men slowly disintegrated because of the monotony of their existence. Canton is just one of hundreds of such atolls, but few people living there have a chance to get bored —they are too busy—and families of the men stationed there seem to enjoy themselves. They do not have cars for the simple reason that there is no place to go, but their homes are of ample size and the easterly trades keep temperatures at a reasonable level. They have all the comforts that electricity can supply—radios, washing machines and refrigerators. Their children are browned by the tropical sun and the majority have blistered noses. Many of the youngsters do not know any other life.

There is scant vegetation on Canton, the most conspicuous plants being coconut palms and ornamental shrubs around the hotel and homes of the staff of the Civil Aeronautics Authority. Most of the growth clings close to the ground due, no doubt, to the ever blowing wind, although there are a few high bushes which serve as nesting places for seafowl.

Bryan (1940) compiled a list of plants on Canton, observed in 1924 and 1938, naming seventeen species as being native, that is vegetation occurring before the coming of Europeans. They are as follows:

Digitaria pacifica
Eragrostis whitneyi
Lepturus repens
Cocos nucifera
Boerhaavia diffusa
Sesuvium portulacastrum
Portulaca lutea
Cassytha filiformis
Tribulus cistoides
Suriana maritima
Triumfetta procumbens
Sida fallax
Ipomoea pes-caprae
Ipomoea grandiflora (I.tuba)
Cordia subcordata
Tournefortia argentea (Messerschmidia argentea)
Morinda citrifolia
Scaevola frutescens

Luomala (1951) records an additional forty species, the majority probably introduced, some of which no longer occur. There is a comparatively low annual rainfall on Canton, and consequently the coral expanse seems devoid of vegetation, and introduced plants



Photographs by Alfred M. Bailey and Robert J. Niedrach

Above: PAN AMERICAN HOTEL ON CANTON ISLAND
Below: HEADQUARTERS OF THE BRITISH SETTLEMENT

grow only with constant attention. *Scaevola*, *Cordia* and *Messerschmidea* are at their best on the southeastern tip where, naturally, the bush and tree-nesting sea birds are congregated.

The Murphys listed nine of the more conspicuous species of plants, all native as follows:

Cordia subcordata. Polynesian name, "kou." A small tree or tall shrub with smooth, oval, pale green, heavily veined leaves, orange trumpet-like flower, and nut-like fruit.

Messerschmidea argentea. Tree-heliotrope. A tree having elongate, whitish, hairy leaves and white flowers.

Scaevola frutescens. Hawaiian name, "naupaka." The most abundant shrub on the atoll. Leaves elliptic, nearly sessile; flower and fruit white.

Sida fallax. The commonest low, woody shrub. It bears small orange-yellow, mallow-like blossoms.

Sesuvium portulacastrum. A trailing, succulent herb, with glabrous, finger-like leaves and pink flowers.

Boerhaavia diffusa. A trailing vine with opposite, trifid leaves and tiny pink flowers. It creeps extensively over sandy patches.

Triumfetta procumbens. A beach-creeper with lobed leaves.

Portulaca lutea. A purslane with enlarged stem, fleshy leaves, and yellow flowers.

Lepturus repens. Bunch grass.

Many of these are widely distributed Indo-Pacific strand plants. *Sesuvium portulacastrum* is pan-tropical. The small shrub, *Sida fallax*, and the fleshy perennial, *Portulaca lutea*, are of central Pacific distribution. In addition to recently imported coconut palms, a number of alien shrubs, herbs, grasses, and weeds have now become naturalized in and near the settlements.

The remainder of the present life, other than birds, is soon listed. House mice have become established. Small flies are common in the shrubby growths inhabited by seafowl, and hippoboscid flies were observed in the plumage of the boobies. The only other insects were small grasshoppers and several species of butterflies, all abundant. The caterpillars of one or more of these were seen on the tree-heliotrope leaves, and they were destroying the leaves of the ornamental crown flowers near the hotel in 1954. It should be noted that Van Zwaluwenburg (1943) listed eighty-one species of insects and fifteen related land arthropods from Canton.

The Murphys found crabs and lizards to be the most conspicuous ground creatures in April, 1949. Their notes read, "The lizard, a two-inch skink (*Ablepharus boutoni peocilopleurus*)—which is somewhat shorter than its scientific name—is extremely numerous. We have never seen another piece of land, indeed, harboring so many reptiles. In parts of the island one of them would shoot out of hiding and dart in again about as often as a man took a step. At

times, it seemed to us, there must have been at least one lizard to each square yard of surface. This would suggest far more populous insect life than came to our attention. The lizards are most conspicuous before and after the heat of midday.

"When one of us put a foot on a bit of waterworn coral under which a skink had taken refuge, the reptile cast off its tail, which squirmed and wriggled in lively fashion for more than a minute, while the erstwhile owner got away. If the tail could lure us, who knew about the phenomenon of autotomy, into watching it instead of the more important half of the animal, we suppose that it might even more readily fool a golden plover, a migrant shore bird whose principal diet at Canton is this lizard." It is interesting to note that a few months later, in August, 1949, Bailey and Wichers saw very few; they were not numerous in August, 1952, and few were seen by Bailey and party in July, 1954.

Almost everyone who has reported on the island has made some mention of the enormous number of crabs. Gardner (1938) has written, "About our camp, the most ubiquitous, entertaining, and persistent animal was the hermit crab. This queer creature furnished the comic relief. He is shaped like our fresh water crawfish, about five or six inches long, but, unlike the crawfish, he lives in an appropriated shell which he constantly drags along with him. The hermit crab may be said to be the original trailer inhabitant, and he formed the habit long before we had automobiles.

"Each tiny hermit crab, shortly after being hatched, instinctively searches for a particular kind of spiral shell shaped like our snail shells and backs into it. It does this to protect its hind body, which, unlike its armored fore body and exposed appendages, is soft and vulnerable.

"The tail is curled into the spiral so that it becomes a part of the crab and is dragged along with it, trailer fashion, wherever it goes. As the crab grows, the shell is traded for a new and larger one. The full grown crabs have shells about as large as the closed fist.

"I saw a few large piles of these shells, unoccupied, and imagined that they might be trade-in places where the crabs assemble each season to barter their old shells for new ones."

The authors of this report observed crabs commonly. The animals swarmed around to tug at bodies of any museum specimens and, in 1952, they seemed particularly numerous in the colonies of grey-headed terns. These slim winged birds nest in flocks of thousands upon the ground but comparatively few are successful in rearing their young, for the hermit crabs are so numerous that they

Photograph by Robert Cushman Murphy

HERMIT CRAB TRACKS IN CANTON ISLAND SANDS

destroy whole populations of the newly hatched babies. The voracious crabs roam the island safely tucked away in their shells which they change as often as their growth demands. Many people on Canton are ardent collectors of sea shells and they often find desirable specimens serving as living quarters for land crabs. A lighted match held under the home of the crab will usually cause the animal to abandon its shelter immediately.

Even more plentiful on Canton Island than the crabs, possibly, were Polynesian rats (*Mus exulans*) up to the time of the second World War. It is thought that the great hordes of these rodents might have been responsible for the avifauna of Canton being somewhat poorer in species than that of other Phoenix Islands. It is significant that neighboring Enderbury Island, famous for the wealth of its bird life, has lacked the Polynesian rat since the days of the earliest investigations. Hague (1862), the first scientific visitor, presented an undeniable description of this mammal, "hardly larger than a large mouse," and stated that it subsisted on eggs and also upon sucking the blood of small birds, such a terns. Three-quarters of a century later, Gardner (1938) found the rats amazingly numerous, and confirmed their identification as the widespread Pacific insular species.

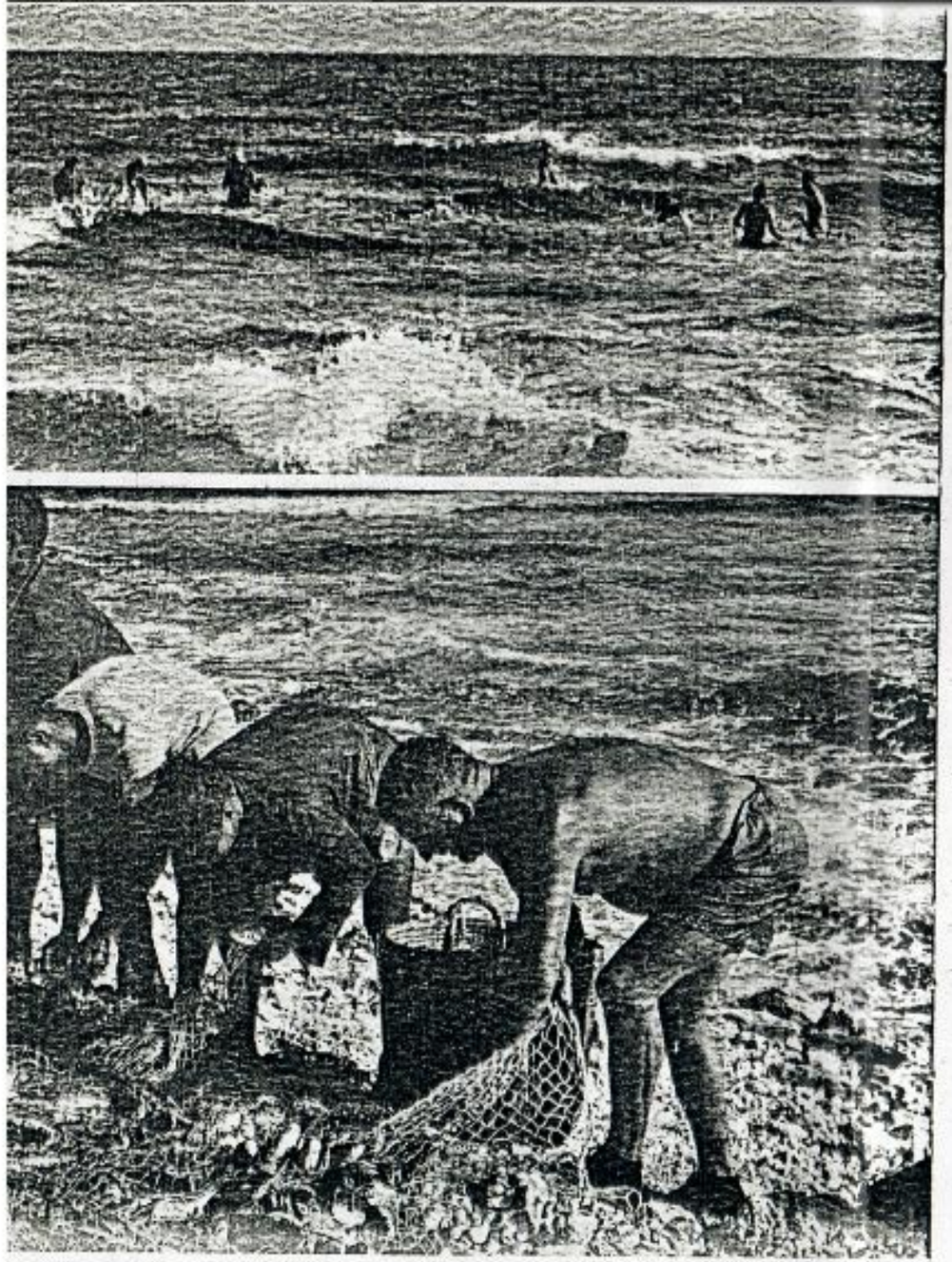
Fishing

The people living on Canton lead an outdoor existence. While their island home is nearly on the equator, the trade winds usually keep the temperatures within reasonable limits, and many of the employees of Pan American and the Civil Aeronautics Authority spend all their leisure hours fishing from the shores or trolling in the ocean or blue lagoon. The latter is a place of tropical beauty, and one of the delights is to observe the marine life through a glass bottom box, or to swim lazily along with a face mask, watching the myriad of brightly colored fishes, and the marvelous coral formation of the marine gardens—coral ranging from the great solid heads to the large delicate cup varieties. One of the favorite fishing spots, as previously mentioned, was from the deck of the wrecked *President Taylor*, and one evening Bailey, Wichers and Trewhitt joined some of the Gilbert Island boys. Every time a chunk of bait was cast overboard, the offering was enthusistically received. Fishes of colors rivaling the rainbow, ranging from red snappers a foot long to sharks seven feet in length, were dragged up the rusted sides of the once luxury liner until Trewhitt, somewhat plaintively, remarked, "You know, I get kinda tired of fish!"

The children and many of the women on Canton have excellent success fishing from the ferry dock, and occasionally the youngsters get hold of fish which they are unable to land. We watched a small boy bring a large rock cod along the pier and gaff him, a fish so heavy that he could not hold the struggling animal in the air to be photographed.

The P.A.A. employees rigged up seats and harness to attach to one of their launches for trolling, and the Baileys accompanied Dick Slater and others on an early morning excursion along the coast. The fishermen sat in seats with rods held in sockets in the harness, and when the wahoo struck, they usually came out of the water in their first frantic efforts to escape. Several were taken, ranging from twenty to thirty pounds each.

Canton has excellent sport fishing the year around, and commercial seining is becoming important. There was a Portuguese fisherman named Joe Medeiros on Canton in 1952 who was catching and supplying fresh fish to the Honolulu market nearly two thousand miles away. Bailey and Niedrach accompanied Buchanan across the lagoon to a winding road which led to a large warehouse back among some coral rubble, a warehouse that Joe had appropriated after the army had moved out. Joe was humped over a net, his back bronzed



Photograph by Alfred M. Bailey and Robert J. Niedrach

COMMERCIAL SEINING ON CANTON ISLAND
Two hundred pounds of mullet were caught on this pull of the seine

from tropical sun, making repairs where it had been torn on ragged coral.

"When are you dragging a net?" Buck asked, and Joe squinted out the window at the sun blurring through a mantle of clouds, did a little mental calculating which involved suntime and the stage of the tide, and came up with the solution. "In an hour and a half the tide will start out of the lagoon. First come the little fish. Soon after we catch a net full of mullet just in the breakers right close to the shore."

The three joined Joe at the suggested time, and transferred the photographic equipment in an old weapons carrier. Eight Gilbert and Ellice Island boys piled aboard with the seine and some baskets, and the car was headed over coral to the mouth of the channel into the lagoon. On the opposite side was the rusted hulk of the wrecked *President Taylor*.

The group stood on shore looking into the deep water, and watched thousands of mullet—just a black mass moving with the tide. The schools of fish were leaving with the swift current of the ebbing tide and, after they passed through the narrow passageway, they turned off to the right into the line of surf that was washing the shore edges. The natives took the seine down to the beach a hundred yards or more from the lagoon entrance and, keeping together, worked out into the ocean until white-crested waves pitched them from their feet. Then they made a line, extending the seine to its full length—some hundred feet and started shoreward, the end men going more rapidly than the others. When they were fifty yards out a couple of natives from the beach dashed in, splashing water, and yelling. The boys at the ends of the seine headed together, making a circle of the net floats. As soon as the trap was closed the frightened mullet began leaping over the seine, but the majority tried to swim through the mesh and were caught by their gill-covers. The net was carried ashore and over two hundred pounds of mullet from the one haul were tossed into buckets. All the fish weighed about one pound each.

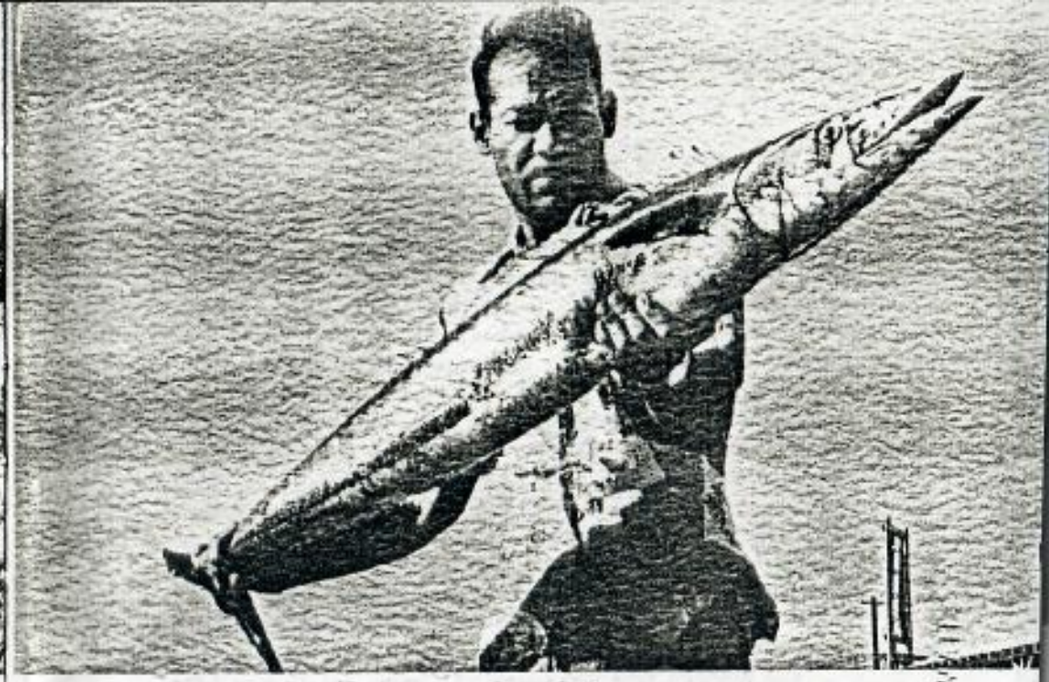
Later, when the tide was unfavorable, the boys seined in the lagoon where good catches of tropical fishes were made—*awa* running from five to thirty pounds; *oio* from twelve to sixteen; and the prized *ulua* which ran up to seventy pounds. Some of the reef fishes, especially the parrots, were brilliantly colored.

It is only because of the dependable plane transportation from Canton to Hawaii that commercial fishing is possible. The fish are dressed, chilled to near freezing, and sent by Pan American the nearly two thousand miles to Honolulu where there is a steady de-

Photographs by Alfred M. Bailey and Robert J. Niedrach

GILBERT AND ELLICE ISLAND FISHERMEN ON CANTON

Above: Some of the colorful catch from the glistening waters of the lagoon



Photograph by Muriel E. Bailey

WAHOO FROM CANTON WATERS

The streamlined wahoo are common fish off Canton shores. This thirty-pounder caught by Bailey

mand. The idea of sending fish from Canton to Honolulu seems to have originated with Jim Francis, a fisheries researcher of Honolulu. He formed the Marine Products Company which was later sold to Medeiros, Izami and Chee. The air freight rate in 1952 amounted to about fifteen cents a pound, so that the total cost was between twenty-five and thirty cents a pound for fish laid down at the market, and they sold in Honolulu for sixty to seventy-five cents. Two or three thousand pounds were shipped at a time, and Joe had supplied Honolulu with sixty-one thousand pounds during the preceding five months.

So excellent is the plane service that mullet caught the afternoon of Bailey and Neidrach's visit were put aboard the midnight plane and were in Honolulu the next morning. The U.S. Public Health inspectors closely check the shipments and then clear them for auction to Hawaiian dealers. So fish caught in the reefs of Canton are often served in Honolulu within twenty-four hours. The fishermen make a good living, Pan American has obtained considerable revenue through handling the cargo—and Canton Island has developed a thriving industry.

Below: Mullet caught by gill-covers off the mouth of the Channel

Birds of Canton Island

The richness of marine life adjacent to Canton Island is due in part to the submerged slopes of the Phoenix group. The area is one of fairly continuous current movement, and a physical effect of shallowing is to concentrate swimming and drifting organisms toward the upper strata of the ocean. Therefore, Canton, like the neighboring islands, offers a favored breeding station for birds that are directly or ultimately dependent upon the ocean for their food supply. This means virtually the entire avifauna, because there are no resident land birds.

The atoll is a resting place for shore birds of several species, which migrate between Alaskan and Siberian nesting grounds and south Pacific wintering areas. The latter extend, for some of them, as far as Australia and New Zealand. Such travelers from the Far North, like the resident species of Canton Island, live in a perpetual summer season for they spend only two or three months in the northern hemisphere, and in our autumn some of them travel five thousand miles or more southward across the equator and thus bask in the summer of the southern hemisphere.

The breeding bird populations of Canton are of most interest to visitors for these are made up of the tame or fearless species that can be inspected and photographed at close range. They all belong to four orders of birds, namely the Procellariiformes, or petrels; the Pelecaniformes, or frigate-birds, boobies, and tropic-birds; the Charadriiformes, which at Canton comprise only terns; and Anseriformes, or ducks.

Our knowledge of the life histories of most of these birds is still relatively slight, and there is need for prolonged, detailed, and, insofar as possible statistical information by observers who have an opportunity to keep them under observation throughout the entire cycle of the year. Some of the native species for example, have definite and precise nesting seasons. Such birds come from the sea in a period marked by relatively narrow date limits, court, lay their eggs, rear their young, and then depart. Other species, on the contrary, seem not only to be present but also to be engaged in the various stages of reproduction during most of the year. There may be periods in which a larger proportion of the population is nesting than at at any other calendar date, yet there still seems to be no season at which at least a few cannot be found at every stage of the reproductive process. Still other birds, such as one or more of the terns, are alleged to have two breeding seasons each year, a phenomenon which is not impossible, and perhaps not even unlikely, in view of what has

been learned in other parts of the world about the peculiar breeding behavior of the sooty tern. The point is that we know little on a well verified basis, and the need for earnest and regular recording is obvious, especially through bird banding by a resident naturalist.

Much also remains to be learned about the ecological relations among diverse species of seafowl that nest concentratedly in such small areas as the shrub patches and intervening open coral stretches on Canton. One of these birds is more or less predacious, or parasitic, on others. At the same time we see interesting examples of habits that tend toward the avoidance of conflict and competition. There are, for instance, three species of boobies which nest close together and which feed in the same waters, and yet each, in greater or less degree, occupies such a distinctive ecological niche that it can get along without mutual interference with the others. The masked booby (*Sula dactylatra personata*) and the brown booby (*Sula leucogaster*) nest on the ground; the red-footed booby (*Sula sula*), smallest species, nests only in shrubs or trees. It is, in fact, the only tree-nesting booby in the world. Thus the red-footed species is automatically eliminated from competition with the other two for nesting sites. In feeding habits all three of the boobies are still more individual and independent. The masked booby at Canton, as elsewhere throughout the tropical oceans, is primarily a catcher of flying fish, which it seizes at the surface of the water or even in the air. The brown booby eats a variety of herring-like fish, or fishes that are analogous in habits to the herring, and it obtains them by plunging from the air very much in the manner of a gannet. The red-footed booby, on the other hand, feeds mainly upon squid and little, if at all, upon fishes of any kind. Furthermore, it captures its cephalopod prey largely in the twilight of early morning and evening, when squids and other creatures of the intermediate depths are prone to ascend toward the surface of the sea. The red-tailed tropic-bird, another common nester at Canton, is likewise a squid eater, but its feeding range is, for the most part, much farther from shore than that of the red-footed booby.

Such, in brief, are a few of a doubtless infinite number of adaptive tendencies by which nature permits related organisms to live together without undue competition for subsistence.

Ornithological Investigations

Canton Island has been visited by ornithologists or other naturalists only infrequently and briefly. It was formerly completely off trade routes, whereas today it is readily accessible by air and

"During our three days ashore, the resident personnel put every comfort and facility at our disposal, including jeeps for excursions of twenty-five or more miles. We made collections covering nine species of plants and took many photographs of the island and its interesting concentrations of sea birds."

Other notes are incorporated in this report.

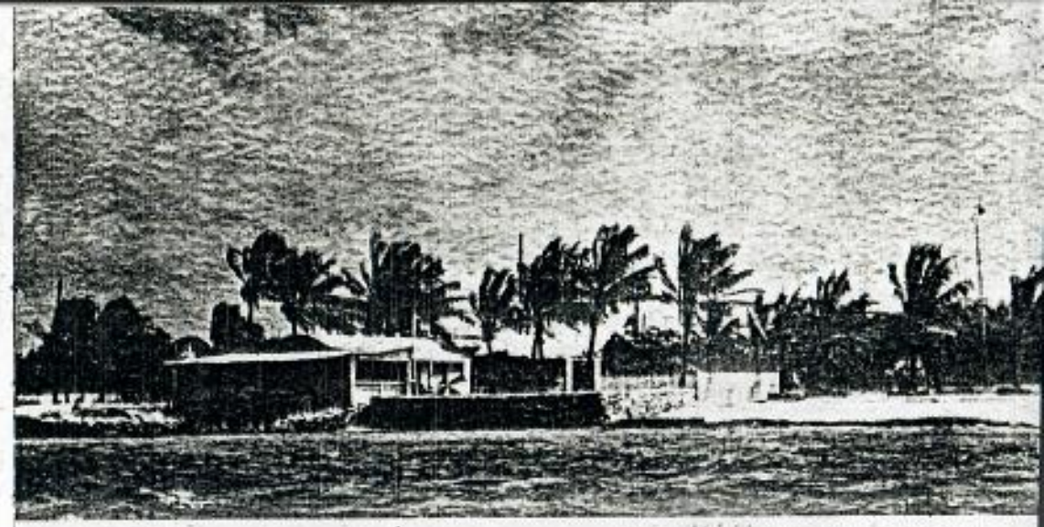
Bailey and Wichers, 1949. A. M. Bailey and Henry C. Wichers spent three days at Canton, August 28-30, 1949, as related in the Foreword. Arrangements had been made for their stay through the courtesy of Vice President H. E. Gray of Pan American, and they received the utmost co-operation from Station Manager M. O. Trewhitt. The primary purpose of the visit was to secure still and motion films for the Museum library, but a few red-footed boobies and man-o'-wars were collected.

Porter, 1950. H. P. Porter spent one day, April 1, on Canton, and recorded his observations in the Hawaiian ornithological journal Elepaio.

Bailey and Niedrach, 1952. A. M. Bailey made his second visit to Canton, in company with R. J. Niedrach, on August 15-18, 1952 to secure additional photographs, and data on the red-footed boobies. The work was carried on with the cooperation of Station Manager W. O. Buchanan, and William Evans, U. S. Resident Administrator, and Chief of the Civil Aeronautics Authority on Canton. Fortunately, Mr. Evans was interested in birds, and was able to make many suggestions to help with field work. R. J. Niedrach, assisted by Earl Sawyer of the Civil Aeronautics Authority, made numerous observations on bird colonies. A paragraph from Bailey's notes read:

"The island, that is the land mass, is just a thread of sand encircling the blue-green water of the lagoon, and it is a twenty-nine mile journey around over corrugated coral sands which cut tires to ribbons. Therefore, most traffic between P.A.A. villages on the west lagoon and C.A.A. on the north is by launch. We made the boat journey right after breakfast to pick up an old weapons carrier that Bill Evans, in charge of Civil Aeronautics Administration activities, had made available to us. We brought the old car back to the hotel so we could conveniently work the bird colonies only six miles away on the southeastern tip of the island."

Bailey, 1954. A. M. Bailey returned to Canton, his third visit in five years, June 22-25, 1954. He was accompanied by Mrs. Bailey and their daughter Patricia Witherspoon who was making observations for the National Audubon Society. Two trips were made to the bird colonies with William Evans and photographic studies were secured of the nesting sea birds. Five species were recorded nesting



Photograph by Patricia Bailey Witherspoon

PALMS UNDER TROPICAL SKIES

Pan American has created an oasis on a barren coral atoll

which were not observed by Bailey on other trips, the wedge-tailed shearwater, Phoenix Island petrel, brown booby, black noddy, and the fairy tern, and the data on the various species noted on the three journeys—1949, 1952 and 1954—are incorporated in this report under appropriate headings.

In addition to the publications or journals resulting from the visits listed above, we have had the benefit of information from several other sources, partly by word of mouth. Particularly valuable is a letter dated June 6, 1953, from William Evans, Chief of the Civil Aeronautics Authority at Canton Island, and subsequent notes.

In organizing data for the systematic list of birds, it has seemed advisable to consider the foregoing visits chronologically by *months* rather than by years. Observations noted in that order may supply at least a partial framework for the annual cycle in the life history of the birds. The order selected is therefore as follows:

Whitney South Sea Expedition	March 10-17
Porter	April 1
Murphy	April 12-14
American Eclipse Expedition	May 13-June
New Zealand Eclipse Expedition	May 27-June 8
Bailey and Witherspoon	June 22-25
Lister	June and July
Donaghho	July 25-27
Bailey and Niedrach	August 15-18
Bailey and Wichers	August 28-30

is a regular fueling stop—though usually in the middle of the night or early morning hours on many trans-Pacific flights. A record of the principal investigations is as follows:

J. D. Hague, 1862. Hague's reports on the chemistry of guano are supplemented by notes on the sea birds of the Phoenix group as a whole, rather than of Canton specifically. The guano exploiters of that date regarded the atoll as a relatively unimportant site. The birds mentioned by Hague include only those since reported on more fully by others. By "*Sterna hirundo*" this author presumably meant *Sterna lunata*.

Hague states that calms are rare at Canton, that the southeast trade winds blow throughout the northern hemisphere summer, and the northeast trade winds in the opposite season, when the swell and surf are also heaviest. Light showers are not infrequent, particularly at night during the northern summer months, but the total precipitation is very small. The sky is prevailingly cloudless, and shade temperatures range regularly up to 88° F.

J. J. Lister, 1889. Lister, accompanying a surveying voyage in H.M.S. *Egeria*, wrote the pioneer ornithological report on Canton Island. He listed about eighteen species of birds, plus eight others from adjacent islands. He also confirmed Hague's climatic summary by calling attention to the fact that in this part of the equatorial Pacific a relatively rainless belt extends both northward and southward from the equator.

Whitney South Sea Expedition, 1924. In this year the schooner *France*, owned by the American Museum of Natural History and on that voyage under charge of J. G. Correia, made the most important bird collections yet obtained at Canton. E. H. Bryan, Jr., was on this expedition, and recorded his observations made then, and in 1938, in several articles. The schooner arrived from Samoa on March 10 and remained at the atoll until March 17. Correia's journal has not been published, but several species of the petrels he collected have been studied and reported upon by Murphy, as cited below.

At the date of this visit, the coral reef was "strewn with wrecks." There were only ten coconut palms, of which but one was bearing fruit, and the disintegrating tracks and a single car of the old guano workings were still to be seen. Correia, who had wide experience all over the South Pacific, found the sun glare at Canton the worst he had ever endured.

Eclipse Expedition of 1937. A total eclipse of the sun on June 8, 1937, led to expeditions of national scope to Canton Island from the United States and from New Zealand. G. A. Buddle, a competent ornithologist of the New Zealand party, in H.M.S. *Wellington*, published his notes in 1938 and listed twenty species of birds, of which one (*Fregata magnificens*) represents a misidentification.

According to an oral report from Major Buddle, the New Zealand visitors planted many coconuts at Canton.

The simultaneous National Geographic Society-United States Navy party, voyaging in the U. S. seaplane tender *Avocet*, undertook no explicit ornithological study, but three of the popular accounts contain pertinent observations and reproductions of photographs (Mitchell, 1937; Hellweg, 1937; Gardner, 1938). Gardner observed that the constant trade wind kept Canton wholly free of annoyance from flies and mosquitoes. Only a few of the coconut plantings of earlier days had been able to survive the deficient rainfall of the island.

Donaghho and Munro, 1938. The next investigators were George C. Munro and W. R. Donaghho, who voyaged from Honolulu in the U.S. Coast Guard cutter *Roger B. Taney*, with the object of banding sea birds for the United States Biological Survey. They were accompanied by E. H. Bryan, Jr., and were at Canton from July 25-27, 1938. Donaghho (1952-53) later published an account of the birds observed at numerous islands during a voyage of considerable length.

At the date of this visit, the British and American colonies were in residence, with both flags flying. Birds were much scarcer than at either Howland or Enderbury Islands. Donaghho's other observations are incorporated below.

The Murphys, 1949. Returning from New Zealand, Dr. and Mrs. R. C. Murphy stayed at Canton Island as guests of the Pan American World Airways from April 12-14, 1949.

"When we approached from the west, after passing over Hull Island, early in the morning of April 12, the captain called us into the nose of the plane for our first daylight glimpse. (Twice before we had landed at midnight). From an altitude of 14,000 feet we saw Canton twenty miles ahead, appearing almost infinitely small in the blue ocean. This impression of minuteness held even while we were circling to a landing. But, once on the ground, the whole perspective altered. An extensive oceanic desert replaced the slender triangular figure that we had viewed from aloft. Now we could barely see across the colorful yet hazy lagoon to fragments of the rim, floating in blue mirage, that represented the farther shore. The width of three miles and the length of nine looked greater, and the encircling road of about twenty-nine miles was hard to comprehend because of our recent all-embracing view from high in air.

1. WEDGE-TAILED SHEARWATER *Puffinus pacificus chlororhynchus*

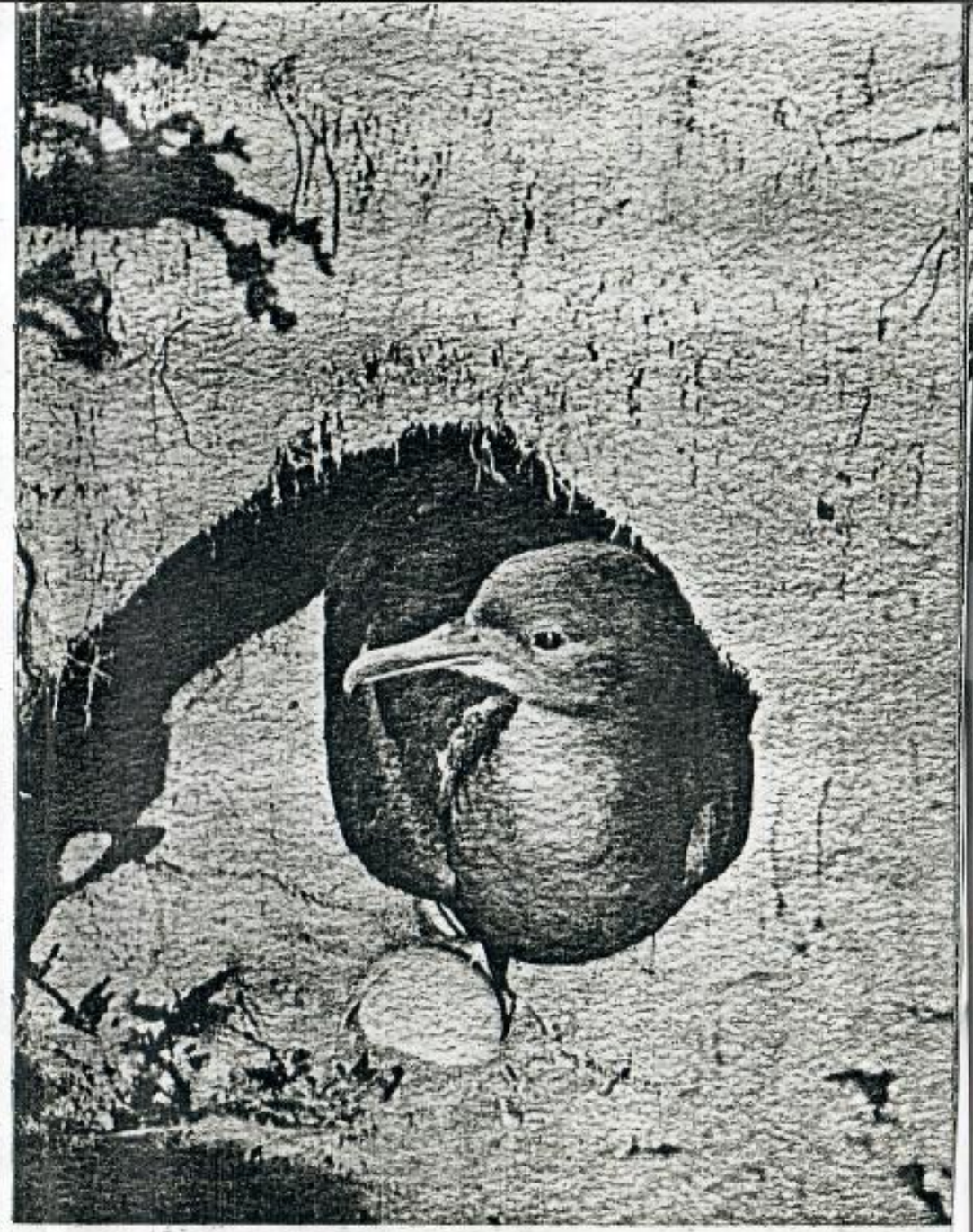
The Whitney South Sea Expedition collected fifteen specimens of this petrel at Canton and other Phoenix Islands. These have been reported upon by Murphy (1951). The reproductive period seems to be much less seasonal than that of populations of the same species at stations farther from the equator in both the northern and the southern hemisphere. It undoubtedly occupies fully two-thirds of the year, and perhaps occurs chiefly during months in which Canton has rarely been visited by naturalists. Buddle, in May or June, observed only one pair, in a partly finished burrow.

Bailey, Witherspoon and Evans visited the sandy area on the eastern side of the southern tip on June 23 and 24, 1954, and saw numerous burrows, and excavated a dozen, possibly. They found only two occupied by wedge-tails, both in the dusky phase, the nesting tunnels being six or more feet in depth. Each bird was on a single white egg partly incubated. They were querulous fellows, and fought with shrill shrieks and struck with open beaks and sharp claws. One was seen in flight at 4:30 in the afternoon, but they are usually nocturnal birds, remaining in their burrows or at sea until dusk.

There are a few conspicuous sand dunes, and an extensive area of windblown sand on the eastern shore, about six miles from the P.A.A. hotel. The terrain was covered with low bushes (*Sida fallax*), some of them with conspicuous yellow flowers, on June 23, and wherever conditions were favorable the entire landscape was riddled with burrows. It was impossible to tell occupied burrows from others for land crabs and the Polynesian rats were numerous and kept entrances well scuffed. It is probable, however, that there was a fairly large breeding colony, if the number of apparently active burrows was any indication. By far the most of Canton is covered with coral rock, and is unsuitable for birds which need to excavate their nesting sites.

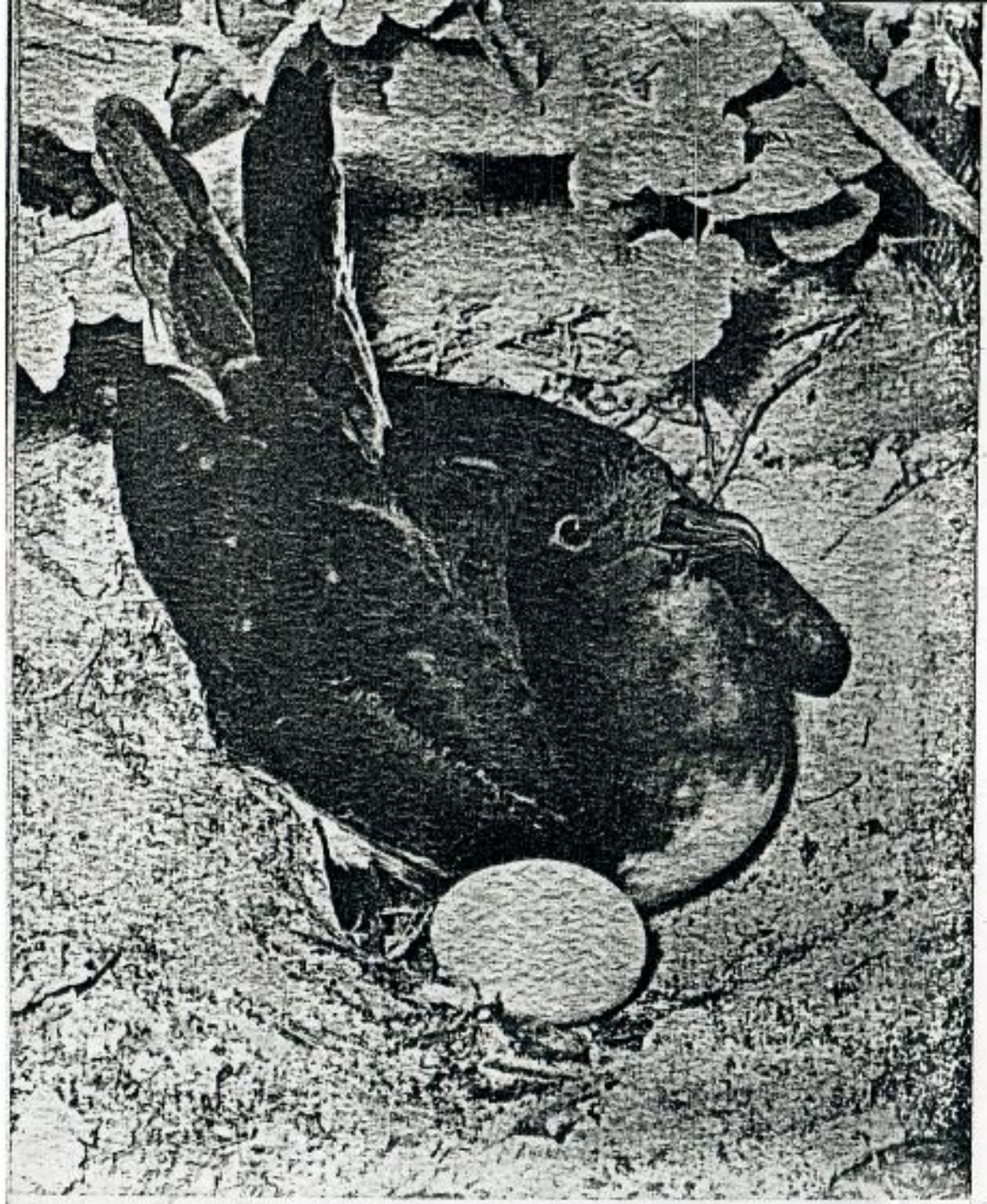
This shearwater is one of the "moaning birds," all of which are ground-nesting petrels. They acquired considerable fame during the late war because of their nightly choruses close to encampments of American troops. As one soldier put it, "They worship noise."

Most of the southern hemisphere colonies of the wedge-tailed shearwater are made up of birds of uniformly dark plumage. In the northern Pacific, on the other hand, some colonies have only white-breasted birds, whereas in others both plumage phases are represented. Among the Whitney Expedition specimens from Canton is a single white-breasted bird, the only one observed in the month of March among a nesting population numbering thousands.



Photograph by Alfred M. Bailey and Patricia Bailey Witherspoon

WEDGE-TAILED SHEARWATER
The nesting burrows on Canton Island were often five or more feet in depth



Photograph by Alfred M. Bailey and Patricia Bailey Witherspoon

PHOENIX ISLAND PETREL

These gentle white-breasted petrels usually nest under clumps of vegetation, but occasionally they go into shallow burrows

2. Dusky Shearwater *Puffinus lherminieri dichrous*

This species is a remarkably short-billed race of the topotypical Audubon's shearwater inhabiting the West Indies. The subspecies *dichrous* is found from the neighborhood of the Phoenix Islands westward through the tropical Pacific to the Pelew and Caroline groups.

The Whitney Expedition collected a series of the birds at Canton Island on March 11. These have been reported upon by Murphy (1927). They are all adults taken on the breeding grounds, with sex organs in various stages of enlargement. Moulting of the quills was in progress, but mating had no more than barely begun.

The species appears to be relatively fixed and regular as to nesting season. Buddle, in May and June, saw the birds only at night. Soon after dusk they commenced to come ashore and were found in pairs, of which there were about fifty in the colony under observation. The birds were employed in cleaning out the burrows and mating was in progress, but egg-laying had not started.

3. Christmas Island Shearwater *Puffinus nativitatis*

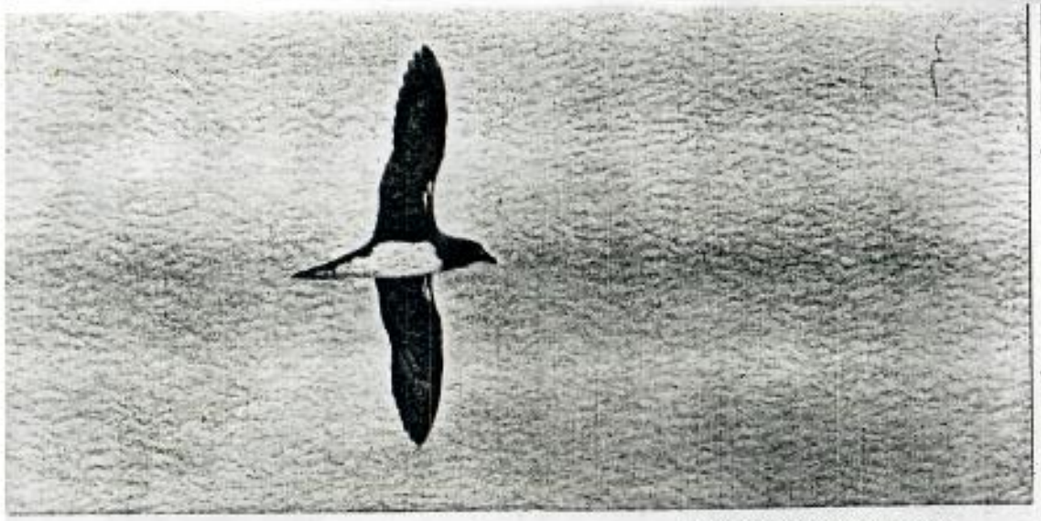
The Whitney South Sea Expedition collected one specimen at Canton on March 15, and many more from other islands of the Phoenix group during the same season.

Two pairs were observed by Buddle in May or June. One was preparing to nest in a crevice of the coral rock at the edge of a colony of the smaller dusky shearwaters. The two birds were found within their hiding place during the day. The other pair had its home under a large pile of coconuts at the base of one of the palms. Here they could be heard crooning at dawn and again at dusk. No eggs had appeared. Lister took one egg in June or July, and on July 25 Donaghho saw a bird which flew in from sea in the morning and wheeled about over the rocks.

4. Phoenix Petrel *Pterodroma alba*

A series of this surface-nesting species was obtained by the Whitney South Sea Expedition in March and has been reported upon by Murphy (1928), and by Murphy and Pennoyer (1952). The breeding season appears to be prolonged because young in all stages of growth were encountered at Christmas Island of the Line group in February, whereas eggs were taken at the Tonga group in July.

It is possible that at many single islands, such as Canton, the stages in the life history of the species are more seasonally fixed. The Murphys saw a single bird over the island in April, and Lister collected one egg in June or July.



Photograph by Alfred M. Bailey and Patricia Bailey Witherspoon

PHOENIX ISLAND PETRELS START FLYING IN MID-AFTERNOON

Several pairs of these white-breasted petrels were observed by Buddle from four o'clock onward, "wheeling and arching over the area occupied by the Dusky Shearwaters." They remained in the vicinity until late at night, and were not seen upon the ground. Specimens were collected by shooting. Donaghho saw two over a flat on July 25, and "every now and then one—probably the male—flew after another, following close on its tail. The pursuer often uttered a strange, shrill warble that ended with a low bubbling gurgling sound." In the late evening of July 27 Donaghho was returning from the southern end of the island, and he recorded: "As I neared the settlement, the orange hues of the sunset were becoming pale. I could see the forms of many Phoenix petrels as they wheeled and turned, like so many spirits of a departed world."

Bailey, Witherspoon and Evans saw numerous petrels on the southern tip on June 23. Their actions were as described by Buddle, the birds swinging low near the sandy terrain, sweeping by within a few feet of the observers. "One was found on its nest in a shallow depression under a *Sida fallax*, and when the branches were parted for photographic purposes, the gentle bird remained undisturbed, simply turning its back to the rays of light. Even when we half lifted the incubating bird to show the single white egg, there was little protest—just a half hearted jab with half closed beak, which was followed by the tucking of the egg back into the proper position. Another was found on its egg in a shallow burrow, about two feet deep." Unfortunately, Bailey was unable to visit the colony at dusk and after, but the several dozen birds flying in the late afternoon indicated that there must have been a sizable nesting community.

5. WHITE-TAILED TROPIC-BIRD *Phaethon lepturus*

Canton supposedly offers no breeding sites for this small cliff-dwelling tropic-bird, but on April 13 one followed a jeep in which the Murphys were riding, hovering only about thirty feet overhead for some time. Its curiosity was obviously aroused by the moving car.

Bailey and Niedrach saw two over the bird colony "flying fairly low over scaevola," August 17, 1952, and Bailey noted one over the P.A.A. hotel, strikingly white, its long white tail feathers against the blue of the equatorial sky on June 22, 1954. There is a possibility that the species may nest in some of the coconut trees adjacent to the P.A.A. village, and it would be well for future observers to search for them. Bailey photographed a young of this species in its nest in a crotch of an ironwood on Midway, on November 22, 1949.

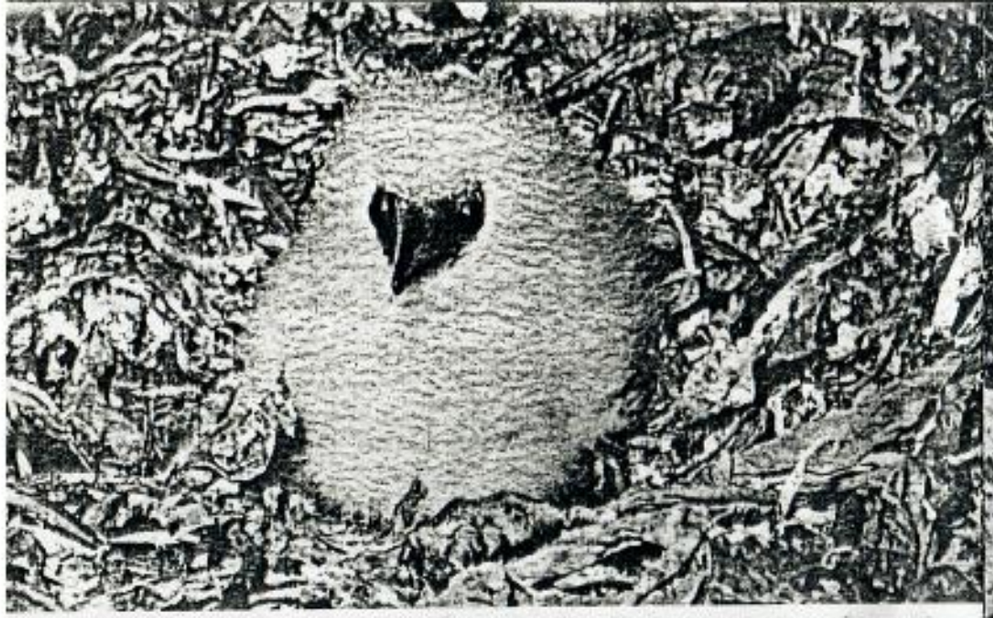
6. RED-TAILED TROPIC-BIRD *Phaethon rubricauda melanorhynchos*

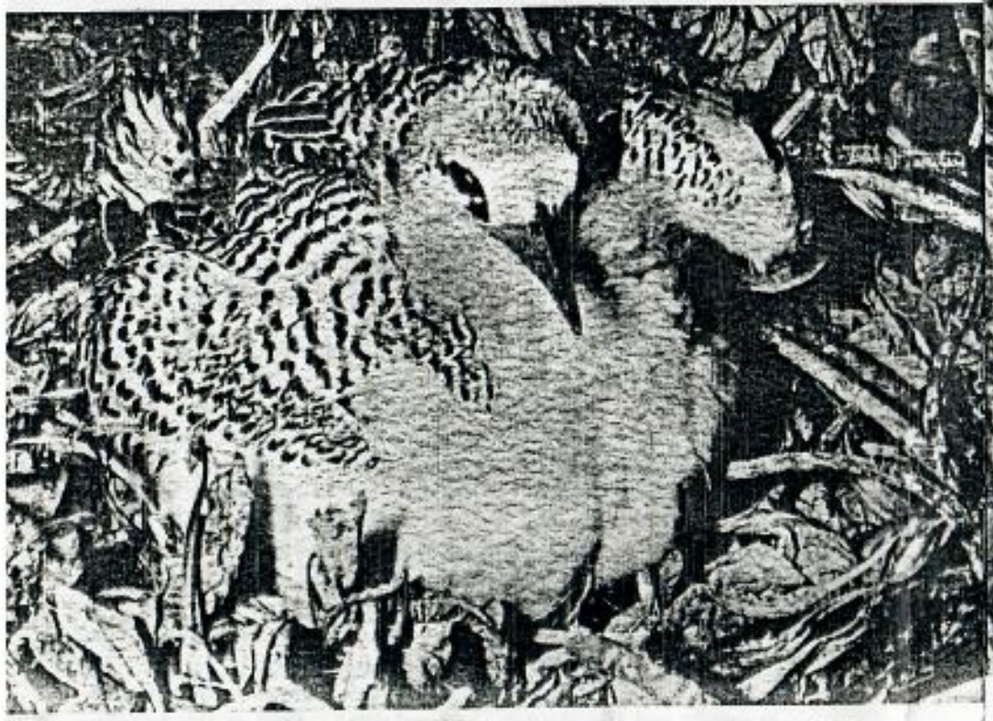
The large tropic-birds with their red beaks and satiny plumage, with a rose tinge, are the most striking of all Canton Island birds. Bailey, Niedrach and Wichers observed them more or less generally over the island, individual pairs cruising along, or rising from the rocky terrain. Their chief habitat, however, was on the southeastern tip of the island, where there may have been fifty pairs. Often there would be groups of half a dozen or more in the air, and at midday they seemed to put on displays, poising stationary on moving wings, and then drifting backward, while calling raucously. Nesting birds were found by watching performers drift down to cover—perhaps males displaying for their mates.

The Whitney South Sea Expedition collected six examples at Canton on March 12, and more from neighboring islands of the Phoenix group. They appear to be subspecifically different from the red-tailed tropic-birds occupying the Leeward Islands of Hawaii and probably pertain to the race *melanorhynchos*.

Evidently these birds have an extended breeding season. Dr. and Mrs. Murphy found one sitting as if in anticipation of egg-laying under a scaevola bush on April 12. Buddle found a colony of forty pairs under large blocks of coral on the west side of the atoll, near the present village, and smaller colonies elsewhere. Laying had evidently started early in May for he saw well incubated eggs and small young. Lister, likewise, found eggs in June.

Denver Musem parties located parent birds with downy young in middle and late August 1949 and 1952. Even at this late date, some pairs were apparently only beginning to nest because it was not unusual to find two birds together, without egg or young, beneath





Photographs by Patricia Bailey Witherspoon

RED-TAILED TROPIC-BIRD

Above: Downy young of the red-tailed-tropic-bird
Below: Large young of the tropic-bird

Photograph by Alfred M. Bailey
and Patricia Bailey Witherspoon

RED-TAILED TROPIC-BIRD

Often both birds will be at the nest site They have a beautifully marked reddish-brown egg. Note the long tail spike

the shrubbery. The adults were tame, usually remaining quiet under observation, but they protested stridently if they were interfered with. When occasion warrants they can use their sharp, saw-edged beaks efficiently.

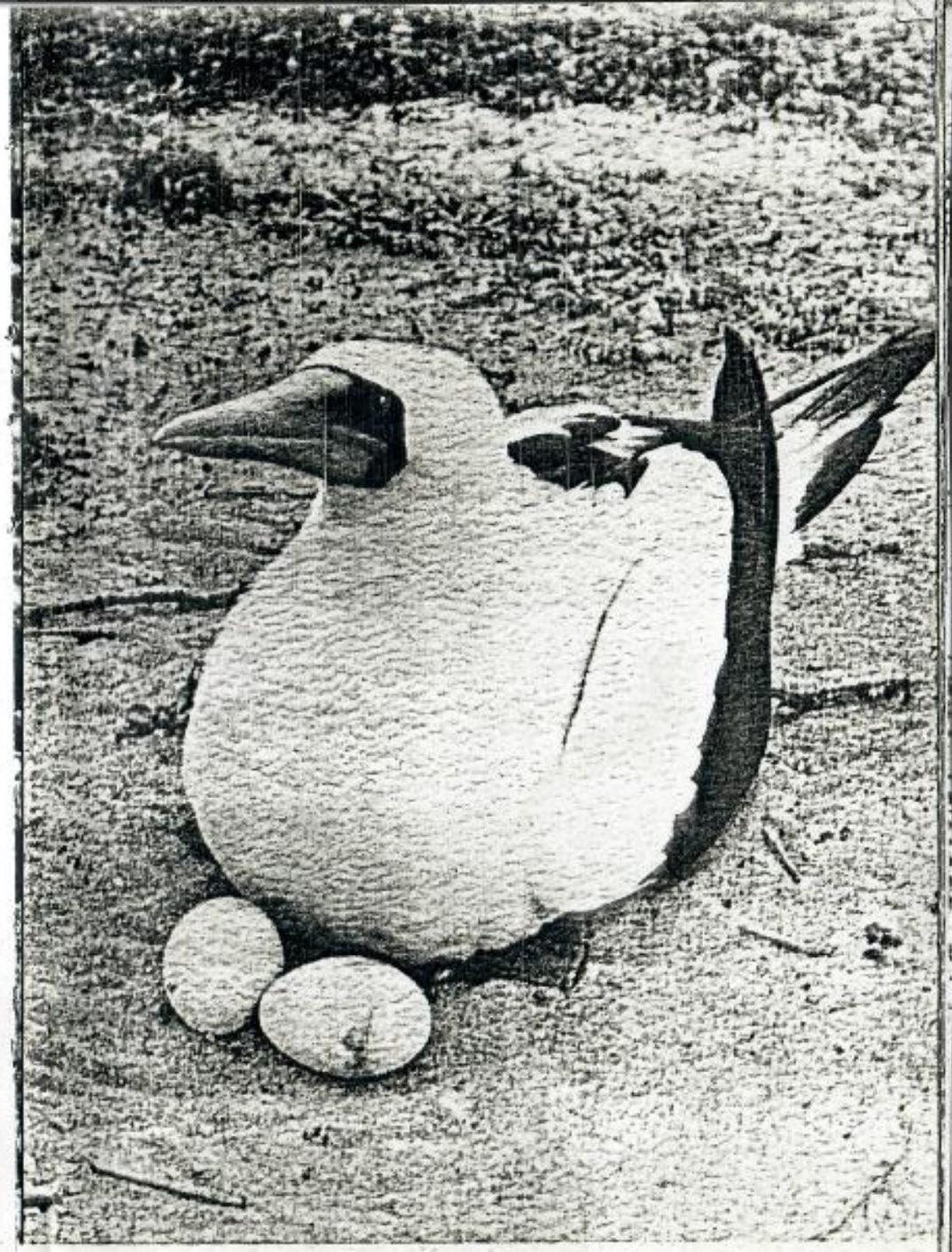
Owing to the fondness of the birds for heavy shade at their surface nesting sites, Bailey and his associates set high-speed flash units to make photographs in August, 1952 and on June 23-24, 1954. On the last trip numerous tropic-birds were seen during the middle of the day going through their characteristic courtship flights, in which performing birds hovered in the air and then drifted backward, giving forth with raucous calls as the wings rapidly beat the air. "A pair cruised together after such a display, the two keeping an even distance apart as they sailed along. On this occasion there was a brilliant glare of light off the coral rock, the sky was of a light blue, and the lagoon an indescribable pale green, and the birds came close enough that we could see the pink plumage and their conspicuous red tail spikes."

Two nests were found June 23 by just watching these birds perform and then drop to the ground to join their mates. Both were under coral ledges in perpetual shadow so the strobe light was used to secure photos. Two other nests were located the same day under a scaevola bush, one with a large satiny young with black markings, and the other contained a small downy chick attended by its parent. Both were in the heart of the dense stand of scaevola and it was necessary to break some of the intertwining branches in order to obtain photographs. Both the large young and the adult protested vociferously, and struck with their sharp beaks.

The following day Patricia Witherspoon returned to take photographs and found both young moved back into an adjacent tangle. It was interesting to note that the adult was not with the small young, and that at least twenty-five large hermit crabs were assembling within a few yards of the nest. The crabs were thrown as far as possible from the young one.

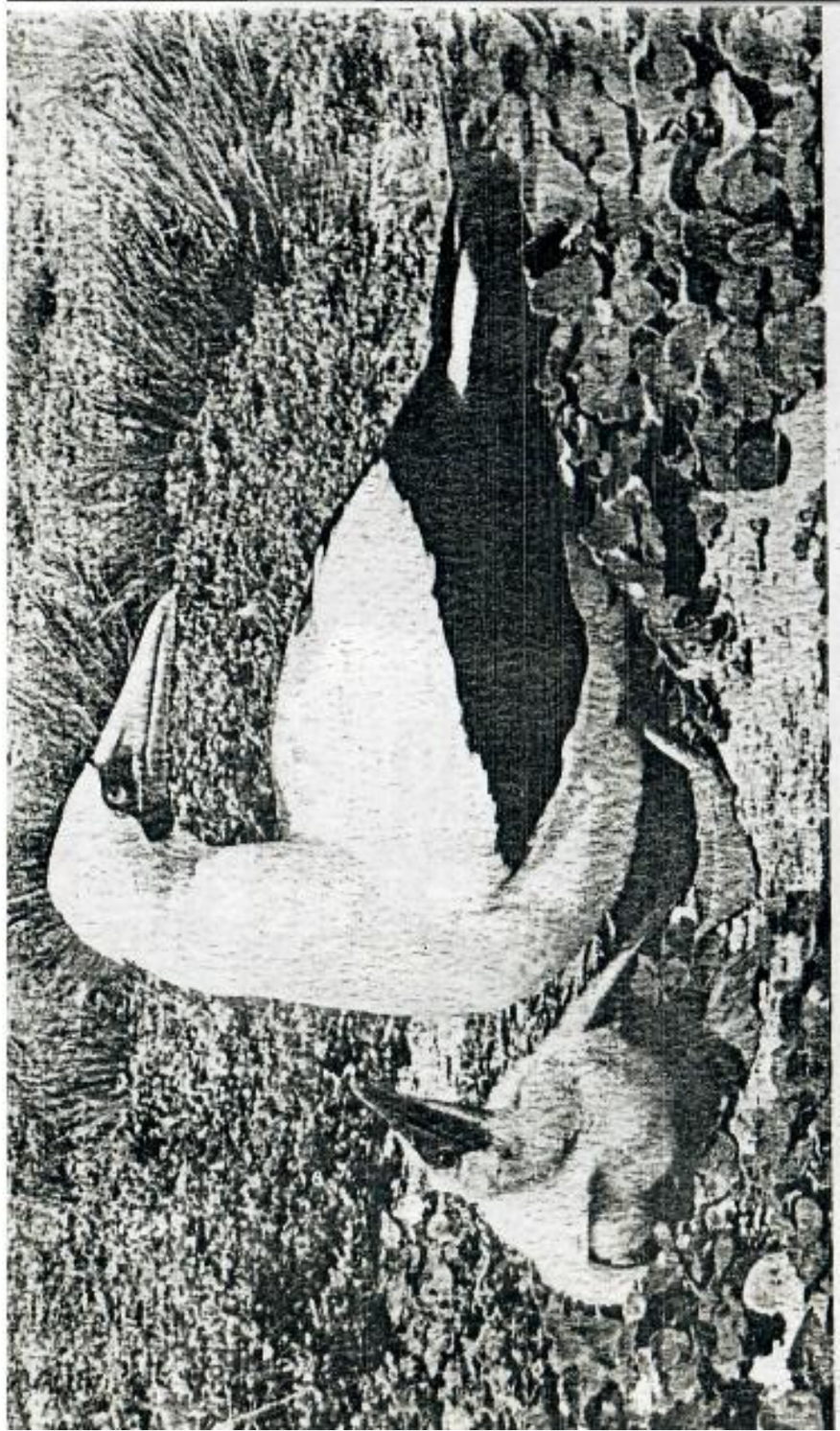
Evans reported that tropic-birds were not observed in late January, 1954 but that four or five were seen in nuptial flight on February 25.

According to Hague (1862) the red-tailed tropic-birds were used at the Phoenix Islands as "carrier pigeons." They were conveyed to sea, or carried even to relatively distant islands, after which a written message was tied to a leg. This was easily recovered after the birds had returned to their nests.



Three wide-range boobies are
MASKED BOOBY on Canton Island

Photograph by Alfred M. Bailey
and Patricia Bailey Witherspoon



Photograph by Alfred M. Bailey and Robert J. Niedrach

MASKED BOOBY

The boobies lay two eggs but rarely, if ever, raise more than one young

7. MASKED BOOBY *Sula dactylatra personata*

The masked or blue-faced booby has been found by most visitors to Canton; although its numbers seem to be considerably smaller than in former times. Buddle considered it the commonest of the boobies at the date of his visit, which is certainly not true today. He found them "scattered at intervals usually among the colonies of Frigate-birds." His observation that the breeding season is extended seems correct, for while he found courting birds and incubated eggs in May, Bailey and his companions saw pairs just starting to nest, others with eggs, and some with large young, on both of the Denver Museum trips, in mid-August, 1949, and in late August, 1952. A half dozen scattered pairs then nested along the flats on the eastern side of the island. On June 23-24, 1954 Bailey saw only five, a male incubating two eggs, and four others seen two at a time. The latter flushed while the observers were one hundred yards away, but the nesting booby posed readily for pictures on the 23rd—and was wild, and flushed the following day. Evans reported several in February, 1953, with three nests in April; he marked the sites, but no boobies attempted to lay anywhere in the near vicinity during the next fourteen months. These boobies lay two eggs, but rarely if ever succeed in rearing two young. When the babies first appear, they are naked, dark, scrawny little fellows, but they soon acquire a covering of white down. One of the adults usually attends the eggs or small young.

The Murphys found only about a dozen pairs in mid-April, all of which had begun to nest on open parts of the lagoon beach. Either one or two eggs were present at each site. Both birds of a pair were found together at several nests but only the incubating booby permitted close approach, the other making off.

To Bailey and his companions these large boobies seemed unaccountably wild. It is probable that they were harried during the war years, and it seems evident that there is only a remnant living on Canton at the present time, in comparison with their numbers in 1937.

The boobies are notoriously stupid, from man's point of view, not because they allow human beings to approach closely, but rather for permitting themselves to be everlastingly plundered by the man-o'-war birds. These long-winged pirates waylay boobies returning homeward heavily laden with fish; a man-o'-war will swoop down, grab the slow moving bird by the tail, upending it in mid-air. With startled squawks, the cumbersome booby disgorges his hard gained food supply, and the man-o'-wars almost always catch the fish before it strikes the water.

Photograph by Patricia Bailey Witherspoon

BROWN BOOBY

The young brown boobies leave their nest sites and wander over the coral rock in the near vicinity

Photograph by Alfred M. Bailey and Robert J. Niedrach

BROWN BOOBY

Adults are trim birds built for diving from the air to secure their finny prey. They nest upon the ground, and usually lay two eggs, but raise only one young

Photograph by Alfred M. Bailey and Robert J. Niedrach

RED-FOOTED BOOBY

The typical adult on Canton Island has a dark or mottled back, and is smaller than the booby of the northern hemisphere

nests, whereas in August 1952 there were few young, the majority of the nests still having eggs. In June, 1954, not many were nesting, the breeding area containing only a few nests with eggs or downy young.

The red-footed boobies of Canton Island are varied in color, a typical adult in full plumage having the characteristic red feet, white head, neck and underparts, and dark wings and back. Many have lighter wings, and backs mottled with white, and one in a hundred, possibly, will be immaculate white except for the black primaries. When Bailey first saw the boobies of Canton Island, he did not recognize them as *rubripes*, for he was acquainted with the form from north of the equator only, where all are in the white dress. Immature birds occur in brown plumage, and there is a brown phase of adults of this booby throughout much of its range, but none was seen nesting on Canton, and Bailey has never observed such birds on Midway, Laysan, and Oahu.

It does not seem logical that birds of such varied plumage with breeding areas ranging from the islands of the Indian Ocean to the tropical western and central Pacific Ocean should belong to one race. North of the equator—from Oahu northwest to Midway—the red-footed booby is a white bird; in the central Pacific bordering the equator, it is dark-winged with a dark back, and the light areas are more of a cream color than white as in the Midway birds, and we did not recognize an adult brown phase in any of these areas. The appearance of white birds similar in color to those of Hawaii, however, paired with the dark-winged boobies has made a confusing picture. The Denver Museum party collected a few birds and it is evident that there is a definite size difference, the birds of Canton averaging so much smaller that they could be separated racially on size alone, if the boobies of the other islands of the central Pacific region are similar to those of Canton.

It seems possible that, in the mid-Pacific Ocean, adjacent to the equator, there is a race of dark-winged and dark-backed or mottled-backed birds, while in the Hawaiian area there is a white race, much larger in average measurements. The intermediate plumage of many of the Canton Island birds could be the result of hybridism, the mating of the pure white birds with the dark. However, the one white specimen which was collected on Canton Island was a very small bird, a male (no. 26659) with an exposed culmen of 72 mm., and a wing of 350 mm., as compared with the smallest male from Midway with a culmen of 84 mm., and a wing of 369 mm. Immature birds seem to average about the same size as adults, but females tend to be larger than males. Unfortunately, all the speci-

Photograph by Alfred M. Bailey

RED-FOOTED BOOBY

The red-footed booby nests in bushes and trees. There is only one egg, and the white downy young looks much like that of the ground nesting species

8. Brown Booby *Sula leucogaster plotus*

One would judge from the published record that the brown booby has never been an abundant bird on Canton Island. Lister includes it, but possibly in error because he states that it nests in trees, which, of course, it never does. It is probable that he was referring to the dark phase of the red-footed booby. The brown booby was not found by the Whitney Expedition in March. Buddle observed it in small numbers in May and June, including several nests containing the normal clutch of two eggs and others with young. He described the nest as a fairly substantial structure of twigs and seaweed, placed on the ground.

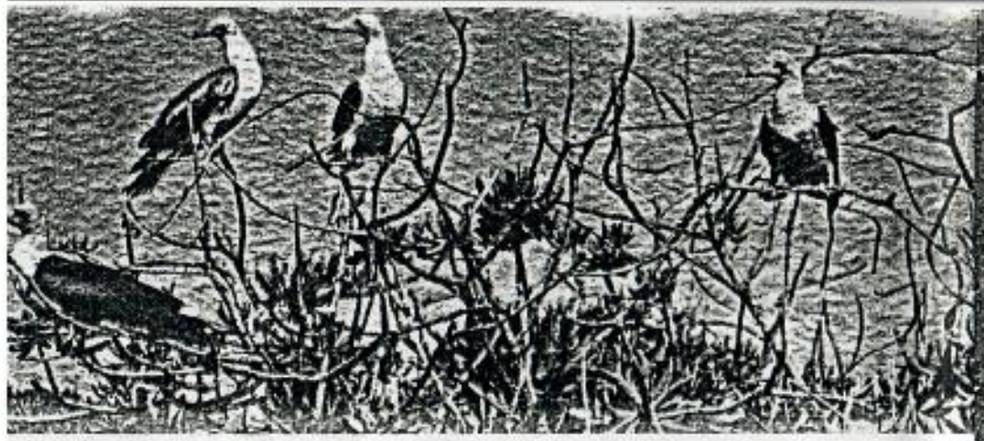
Bailey and his associates did not find the brown booby on the land in August, 1949 or 1952, but a dozen or more were noted regularly over the lagoon. Whenever groups of fish came near the surface, some sharp-eyed booby would soon locate them, and it was not long before there were ten or twelve boobies diving arrow-like at the blue waters. In these forays they were never joined by their blue-faced or red-footed relatives.

George Roseberry of the Civil Aeronautics Authority made an excellent kodachrome of a booby upon its nest on March 25, 1954. The bird was tame and was incubating a single egg. On June 23 the young one was a large blubbery fellow very much opposed to posing for its portrait, and it took the combined efforts of Bailey, Evans and Pat Witherspoon to corral the photographic victim. Both adults were present when the young one was first discovered, sitting on a coral boulder, but they would not allow an approach within one hundred yards.

Several were noted in pairs over the ocean off the mouth of the lagoon entrance early June 23, 1954, and the following day two over the lagoon near the P.A.A. headquarters.

9. Red-footed Booby *Sula sula* subspecies

These boobies nest commonly in the shrubbery at the southeastern tip of the island. They associate with the man-o'-war birds, and like many sea birds, are exceedingly tame. Their rather bulky nests are placed in bushes; each pair has but one egg, and the young, like other species of the family, are naked when first hatched, but are soon covered with a coat of white down. Apparently, their breeding season is a long one, but the peak of it does not necessarily run during the same months for two successive seasons. Buddle mentions young fully fledged in May while some adults were still nest building. In August, 1949, Bailey saw many downy young, pert fellows in white dress, sitting erect in their



Photograph by Alfred M. Bailey
and Robert J. Niedrach

RED-FOOTED BOOBY

It is a characteristic sight to see the boobies perching on the dead branches of the scaevolas

and Australian region; and two additional forms, one from Canton, and adjacent islands, and the other from the Hawaiian region westward.

The following is from Murphy's Canton Island notes:

"We found the red-footed booby extremely abundant. In mid-April, the birds were nesting and perching over large shrubby areas in several parts of the atoll. Many nests were mingled among those of man-o'-war birds. They were all fairly substantial platforms of twigs. Eggs and young at every stage of development were found, indicating a long or perhaps continual breeding season. One egg or chick was in every occupied nest. Newly hatched young and full grown brown fledglings, with little color in their beaks or feet, were seen in about equal proportions. Many of the downy chicks, clad in a pure white blanket over the purplish skin (which showed clearly on the inner side of the wings), rested while unattended by their parents with the head tucked down between the feet. When disturbed they would protest and threaten violently.

"Nine out of ten of the adults were of the grey phase, the white birds representing only a minute proportion of the population. Even these did not seem nearly as snowy as those intimately examined in a colony on the island of Oahu during the previous year. Throughout the heat of the day it was common for red-footed boobies of all ages and plumage phases to cover the crowns of the larger tree-heliotropes during what might be called their siesta."

Photograph by Alfred M. Bailey

PACIFIC MAN-O'-WAR BIRD

The long winged man-o'-wars are marvelous in flight as they circle with the air currents against cloud-flecked skies. A white-headed immature drifts along overhead

mens from Canton Island were taken from nests—and all but one in the Denver Museum were males. The specimens in the Museum collection measure as follows:

MEASUREMENTS OF SULA SULA subspecies
(Red-footed Booby)

					Culmen Exposed	Chord of wing
26013	Male	Canton Island	Aug. 30, 1949	brown back	78.0	363.0
26014	Male	Canton Island	Aug. 30, 1949	mixed back	78.6	371.0
26015	Female imm.	Canton Island	Aug. 30, 1949	brown back gray below	72.8	348.0
26659	Male	Canton Island	Aug. 17, 1952	back white	72.0	350.0
26660	Male	Canton Island	Aug. 17, 1952	back mixed	74.6	348.0
26661	Male	Canton Island	Aug. 17, 1952	back brown	73.3	344.0
25971	Female	Midway, Eastern	May 6, 1949	white back	86.8	388.0
25972	Male	Midway, Eastern	May 6, 1949	white back	86.0	387.0
25973	Male	Midway, Eastern	May 10, 1949	white back	84.0	369.0
25974	Female	Midway, Eastern	May 10, 1949	white back	81.3	382.0
25975	Female	Midway, Eastern	May 10, 1949	white back	83.1	374.0
26093	Female imm.	Midway, Sand Is.	Nov. 22, 1949	gray back gray head	88.8	374.0
26094	Female imm.	Midway, Sand Is.	Nov. 22, 1949	gray head down on head	79.8	371.0
18968	Male	Formosa	Apr. - 1926	back white	80.0	397.0
10452	Male	Laysan Island	May 10, 1911	back white		375.0
10453	Male	Laysan Island	May 10, 1911	back white	82.8	382.0

Munro recognized that the boobies south of the equator differed from those of the Leeward Islands northwest of the main Hawaiian group. He did not publish his observations, but in reply to a letter of inquiry he wrote on May 13, 1953, enclosing a copy of his report to the Bishop Museum under the heading of red-footed booby. In this report he suggested that "if this apparent subspecies has not been worked out, I would advise that the Museum get a full series of skins of all phases."

All in all, the boobies of this species present a difficult problem, and the above indefinite remarks are intended merely to call attention to an interesting study available to someone with the temerity to undertake the assembling of specimens from the entire range. When such a work is undertaken, it will not be surprising if the species breaks into at least five races: the typical form, from the West Indies and Atlantic region; *websteri*, from the Galapagos and the Revillagigedos group (and incidentally, one fine breeding colony on San Benedicto was destroyed when the island became an active volcano in June, 1952); *rubripes*, possibly from the Indian Ocean

Only a few birds in white plumage occur on Canton, but they, too are smaller than the nesting birds of the Hawn group

Photograph by Alfred M. Bailey and Robert J. Niedrach

RED-FOOTED BOOBY

It is evident that the bird population of Canton Island has been reduced since Buddle made his observations. Because of the activity of the war years—building of villages and landing fields—the majority of birds have been eliminated from nearby areas, and they tend to concentrate in colonies on the southern end. Certainly, this is true of the man-o'-wars, for Buddle mentions that their nests were found on every part of the island visited, whereas today they are concentrated on the eastern and southern shores. In June, 1954, Bailey and Evans found colonies extending northward along the east coast, covering more extensive areas than Evans had previously observed. The majority were building, or were incubating eggs, although there were many small young. The new colonies bordered the lagoon, and the bushes were only one or two feet high so the nesting platforms often nearly concealed the scraggly growth. The branches were small and made very insecure support for the rather fragile nests and the long-winged man-o'-wars.

The black males have red gular pouches which they inflate to the size of children's toy balloons, and the old fellows sit on empty nests with pouches filled with air, holding down claims against nest stealers until the females are ready to lay their eggs. Then the patient birds take their turns at incubation. There is one large white egg to a pair, usually deposited in a very flimsy nest. Actually building material is at a premium in large colonies and the birds are fortunate to be able to accumulate enough to make a substantial platform.

The man-o'-wars have long slender wings and forked tails, so they are extremely graceful in flight, often drifting along with no apparent movement of their outstretched wings—they just sail along, effortlessly riding the air currents. They are predacious in every sense and will steal and eat the young of other birds, and on occasion, of their own kind, and they plunder their neighbor's food. The boobies particularly suffer from the onslaughts of these skillful fliers.

Both sexes share the task of incubation, and as in many species of the order, the males are much smaller than the females.

In comparing the sizes of the three specimens from Canton with those from other areas, it was noted that the males average smaller and the single female we collected had a shorter beak, and much longer wing than the other females in the Denver Museum's collestion. The following measurements give a comparison of sizes of birds from Midway and Laysan, and San Benedicto—the island which became a volcano in 1952.

Photograph by Patricia Bailey Witherspoon

PACIFIC MAN-O'-WAR BIRD

The males often sit on the low scaevolas with red gular pouches inflated

Photograph by Alfred M. Bailey
and Robert J. Niedrach

PACIFIC MAN-O'-WAR BIRD

10. Pacific Man-o'-War Bird *Fregata minor palmerstoni*

These are the most conspicuous, if not the most abundant, birds on Canton. Like the red-footed boobies, the man-o'-war birds exhibited every stage of growth in April. The Murphys noted that courtship was in progress and the red balloons of the males made the large clumps of kou (*Cordia*) look like well decorated Christmas trees. But there were also eggs, newly hatched and half grown chicks, rusty-headed fledglings, and older white-headed young. Birds capable of flight seemed to be mixed up indiscriminately all over the nesting shrubs. The fledglings and other non-breeders sat cheek by jowl with adults and there was no evident resentment of the crowding. Nesting and perching red-footed boobies were tolerated, or perhaps welcomed, in the same way.

It seems surprising that birds of such predatory and thieving behavior should at the same time be so extremely gregarious. No nest was left unguarded for ten seconds but what a succession of robbers would swoop down and steal the timbers. Youthful and presumably non-breeding birds showed this propensity quite as much as adults. They would even fight for one another's loot in the air. Two were seen in a tug of war for a long piece of dry vine. They struggled in the air, with an intermingling of long black wings, until one bird was pulled upside down, whereupon it let go.

It seemed to be mostly females that sat on the building projects while their mates flew over and passed twigs from bill to bill. Discrimination was not too marked, however, for one male passed twigs to the male of a mated pair, the latter sitting side by side on their platform.

Man-o'-war birds are sometimes called voiceless, but nothing could be farther from the truth at the nesting ground. In April the air fairly rang with the mellow, tree-frog-like whistle of birds whirling about the shrubbery or welcoming their mates. It sounded like the ringing of silver bells. The music was somewhat ventriloquistic, so it was hard to tell from which bird it issued. It was difficult therefore to link up the note with a particular sex.

Many of the man-o'-wars circle over the ocean by day, but toward evening they return from sea to roost in great throngs. At this hour the high mounds of shrubbery become completely covered, and the latecomers occupy any little heap of brush or dead vegetation. Hundreds thus settle for the night on perches not more than eight or ten inches above the ground. One bird that had caught its wing in a crotch, was rescued and a fledgling was picked from the sand to which it had tumbled. Man-o'-war birds are virtually helpless when grounded.

MEASUREMENTS OF *FREGATA* M. subspecies

MALES (adults)

D.M.N.H. No.	Place of collection	Beak	Wing (chord)
26016	Canton Island	89.	530.
26018	Canton Island	92.	538.
25977	Eastern Island, Midway	101.	581.
10455	Laysan Island	104.	566.
21388	San Benedicto Is., Mexico	98.	563.
21389	San Benedicto Is., Mexico	99.	585.
21390	San Benedicto Is., Mexico	99.	566.

FEMALES (Adults)

26017	Canton Island	102.	604.
25978	Eastern Island, Midway	118.	589.
25979	Eastern Island, Midway	110.	589.
10456	Laysan Island	112.	597.
10458	Laysan Island	115.	596.
21387	San Benedicto Is., Mexico	105.	583.
21386	San Benedicto Is., Mexico	111.	.....

The young are naked when hatched, but are soon covered with white down. One or the other of the adults remains on the nest rim continuously for the first few weeks to protect the small young, and it is not until the white down disappears, and dark body plumage and brown head feathering make an appearance, that the old ones leave them alone.

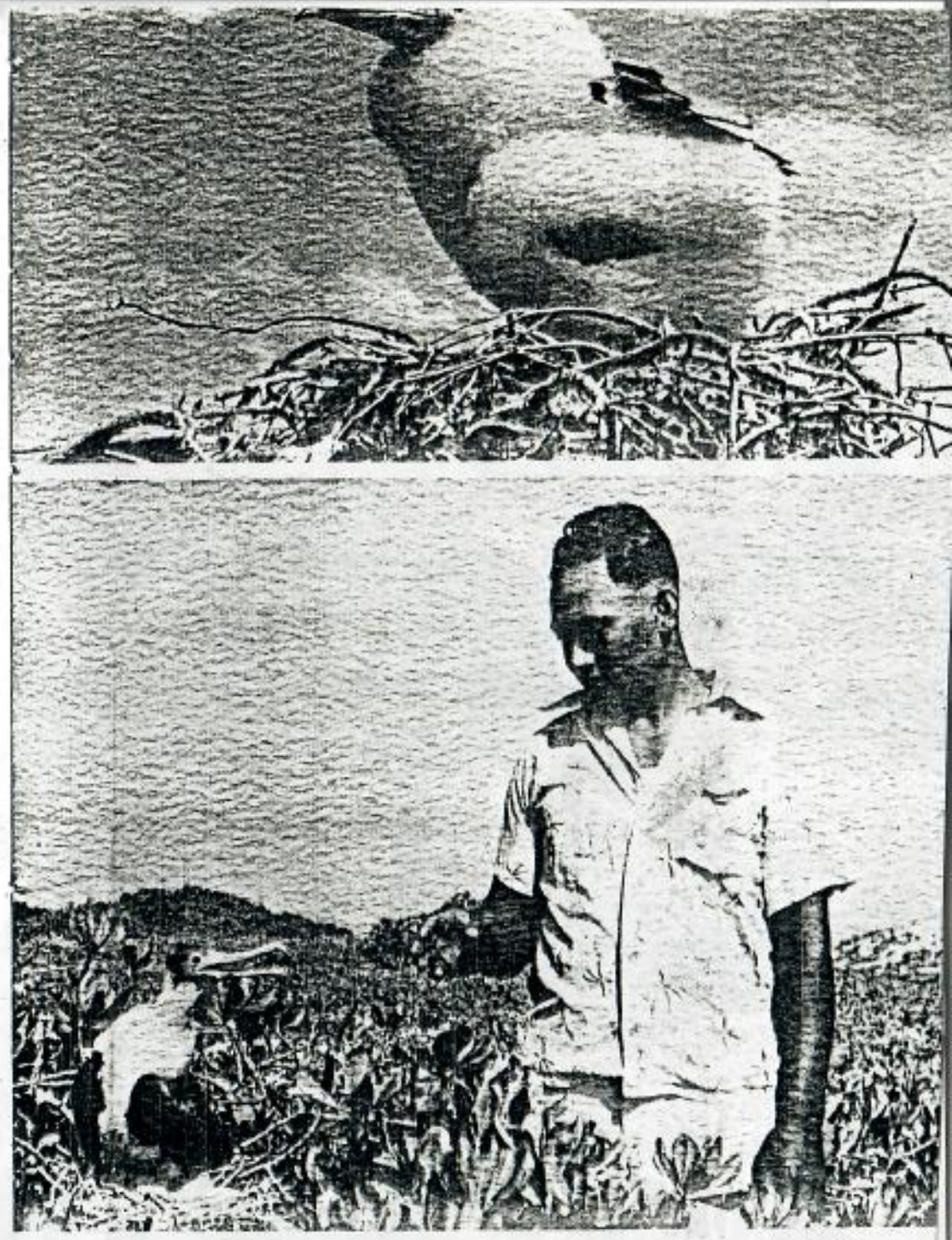
It is evident that the man-o'-wars have an extended nesting season, for the Murphys and Porter (1950) found eggs and very small young, and adult males going through courtship antics in April, while similar conditions were noted by Bailey and associates in August, 1949, 1952 and June, 1954.

Buddle states that the man-o'-war birds steal and eat the eggs of their own species, dropping the shells in air after swallowing the contents, and that sometimes they even pick up and finish off chicks of their own kind.

The Whitney Expedition collections include three skins from Canton.

11. LESSER MAN-O'-WAR BIRD *Fregata ariel*

Lister described this species, without knowing it, from nearby Phoenix Island. It was probably the man-o'-war bird inadvertently listed by Buddle, under the name "*Fregata magnificens*," as a visitor to Canton. *F. magnificens* is an exclusively American and Atlantic species, never recorded to the west of the Galapagos Islands. It is worth noting that in the course of twenty years, the Whitney South Sea Expedition collected man-o'-war birds at virtually every group of islands in the central and south Pacific Ocean without ever encountering *magnificens*.



Photographs by Patricia Bailey Witherspoon

PACIFIC MAN-O'-WAR BIRD

Above: Downy young with first scapular and wing feathers appearing
Below: Brown-headed young in first feather

Photographs by Alfred M. Bailey

PACIFIC MAN-O'-WAR BIRD

Photographs by Alfred M. Bailey

PACIFIC MAN-O'-WAR BIRD

Below: Downy young of the man-o'-war bird

Photograph by Alfred M. Bailey

TURNSTONE

The turnstones are regular, common visitors to Canton Island. They nest in the arctic regions

15. TURNSTONE *Arenaria interpres interpres*

Seven specimens were taken by the Whitney South Sea Expedition. The species was observed by Lister in June and July but not by Buddle in the same months of another year. Bailey and Niedrach found them fairly numerous in August in 1949 and 1952, and many, including bands of eight or more, were seen by Bailey and Witherspoon in late June, 1954. The birds are inconspicuous and easily overlooked, unless flushed, so their white markings are evident. A few were observed on each trip on an abandoned air strip, where they were possibly obtaining insects. None seemed in high plumage, but spring birds, observed by the Murphys in mid-April, included many in breeding dress.

16. BRISTLE-THIGHED CURLEW *Numenius tahitiensis*

Four examples of this species were collected by the Whitney South Sea Expedition at Canton in March.

These nesting birds of northern Alaska migrate southward and winter on the islands of the Pacific from Midway to New Caledonia. A few non-breeding birds must remain on Canton, for Lister saw them in groups of six and eight in June and July, when they might be expected to be at their nesting grounds. Buddle was at Canton about four weeks earlier in the year (May and June) and at that time the majority of the curlews were in pairs and were

probably on their way northward. The birds divided their time fairly evenly between the tidal waters and the sandy flats above tide level, where they appeared to find plenty of food." In August, 1949, Bailey noted two upon the sands some distance from the lagoon; several were seen in August, 1952, by Bailey and Niedrach, and Bailey saw three near the P.A.A. village June 23, and four on the opposite side of the lagoon near the grey-backed tern colony the following day.

A tradition at Canton is that the transient curlews occasionally raid the tern colonies for fresh laid eggs. While the slender curved bill might not seem well adapted to such a function, these birds have actually been seen and photographed while picking up and carrying away the eggs of albatrosses and other sea birds at Laysan Island.

17. WANDERING TATTLER *Heteroscelus incanus*

One example was taken at Canton in March by the Whitney Expedition. The species is also one of the eighteen reported by Lister in the months of June and July. The tattlers probably occur at Canton regularly in migration toward and from Alaskan nesting grounds. Bailey saw several in August, 1949, and on August 17 and 18, 1952, about eight single birds were observed by Bailey and Niedrach. They were numerous June 22-25, 1954, and Bailey and Witherspoon saw six to eight in a group on several occasions. The tattlers were seen both along the lagoon and among broken boulders on the outer or ocean side. Their plumages so well matched the latter preferred habitat that a bird was rarely sighted until it took flight, uttering its characteristic call.

The Murphys likewise saw tattlers on both inner and outer shores of Canton. Along the lagoon they mingled with turnstones and golden plovers, but they never followed the latter to the lizard-hunting spaces of the dry flats. One tattler showed great interest in a foot-long fish that had become stranded and was thrashing about on a coral ledge.

18. SHARP-TAILED SANDPIPER *Pisobia acuminata*

Four specimens were collected by the Whitney South Sea Expedition at Canton on March 14.

19. SANDERLING *Crocethia alba*

Two specimens were collected by the Whitney Expedition at Canton on March 12. Many species of shore birds nesting in the northern hemisphere migrate regularly through the South Pacific islands, so additional species may be recorded from Canton in days to come.

12. MALLARD *Anas platyrhynchos*

Mr. William Evans, in a letter dated June 6, 1953, reported the presence of mallards at Canton and their probable nesting. One of the men at the island related that he had seen a nest of eggs.

Mr. Evans has on several occasions seen flights of twenty or more ducks, presumably of this species, which usually remained at the island only a few days. In the autumn of 1952 a drake and duck arrived together. The birds were seen as a pair for some months, after which the drake alone was in evidence up to June, 1953, or later.

On October 27, 1947, when Dr. and Mrs. Murphy were sailing southwestward across the Pacific in the *Marine Phoenix*, a flock of twelve ducks, believed to be mallards, passed the vessel bound due south shortly before noon. The position was close to 8° 32′ N., 153° 01′ W. This is within five hundred miles of Christmas Island, of the Line group, and more than half way between San Francisco and Samoa. Later in the same day, a few additional ducks were observed on the course.

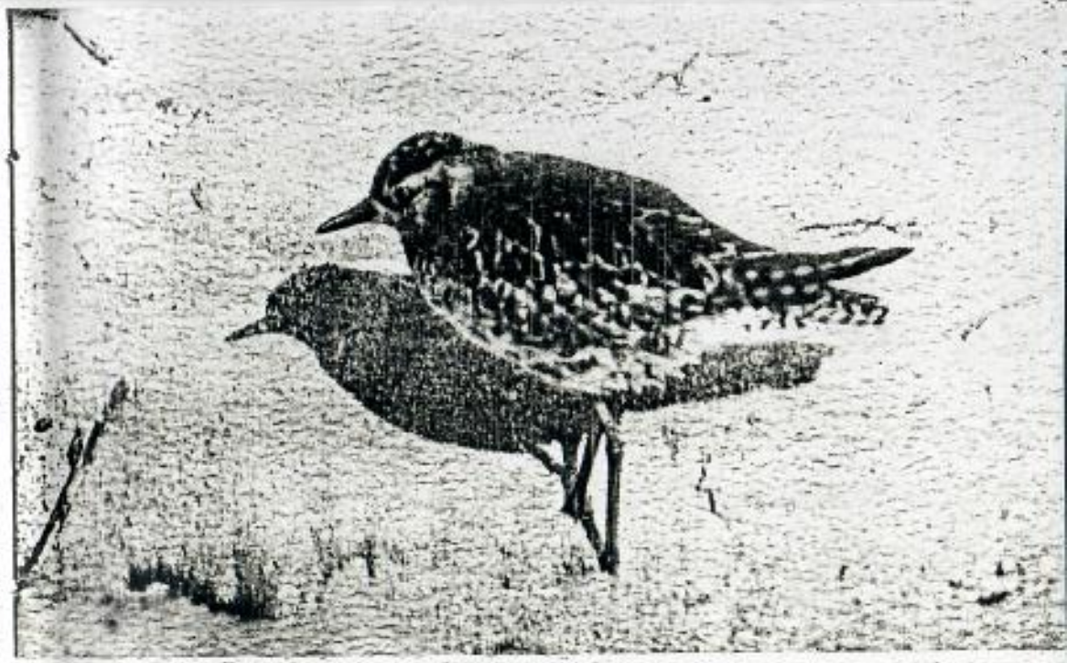
13. SHOVELLER DUCK *Spatula clypeata*

A pair of shoveller ducks was noted on a brackish pond adjacent to the C.A.A. village off and on during the summer of 1953. The birds were observed several times by William Evans, the male being in typical plumage with a dark green head. The female was brought to Mrs. Evans in a crippled condition in the early fall and it died shortly thereafter. Although Mr. Evans is well acquainted with shovellers, a wing was kept for identification. This is a wide ranging species which has been recorded in the Hawaiian Islands and Australia, so it is not surprising to have it occur on the atolls of the Phoenix group.

14. PACIFIC GOLDEN PLOVER *Pluvialis dominicus fulvus*

Four specimens were taken at Canton in March by the Whitney South Sea Expedition.

Lister reported groups of these birds in June and July, while Buddle found them in "fair numbers," many of the males in breeding plumage, and all in pairs. The majority were on the sandy flats in the man-o'-war and booby colonies. Bailey and Wichers saw possibly fifty birds in late August, 1949, none being in high plumage. They were very inconspicuous against the drab background, and would stand motionless unless pressed too closely. They seemed more common in mid-August, 1952, but possibly this is because more territory was covered. They were common June 22-25, 1954 when



Photograph by Alfred M. Bailey

PACIFIC GOLDEN PLOVER

These arctic nesting shore birds are regular migrants to equatorial islands of the Pacific Ocean. They occur commonly on Canton Island

Bailey next visited Canton, and several black-bellied birds, apparently in full breeding dress, were seen. On all three trips, the plovers were numerous along the dry flats adjacent to the lagoon, particularly on the east side of the island.

At the date of the Murphy's visit in mid-April, golden plovers were the commonest migrants on Canton. Many of them were in beautiful black-bellied breeding dress, but a number wore winter or immature brown plumage. Birds of the latter feathering were common in the plantings and around the paths and drives of the settlement. Many were also running about the landing strips, as well as coming right up to the doorsteps of the plane offices and other buildings.

The late Major Buddle was the first to report that the golden plovers fed at Canton upon the small native skinks. This was confirmed by the observations of Dr. and Mrs. Murphy. The birds spent much more time in the hot and dry places, scantily overgrown with low woody shrubs of the mallow (*Sida fallax*), than they did along the shores of the lagoon. They skirmished about rapidly and every now and then made darts to seize, mouth, and swallow a lizard. Residents related that specimens shot for food had sometimes proved to be crammed with lizards or the cast off tails of lizards.

21. GREY-BACKED TERN *Sterna lunata*

The grey-backed is a breeding bird from Midway and Laysan of the Hawaiian group southward throughout Oceania to the Fiji and Tuamotu groups, and the Moluccas.

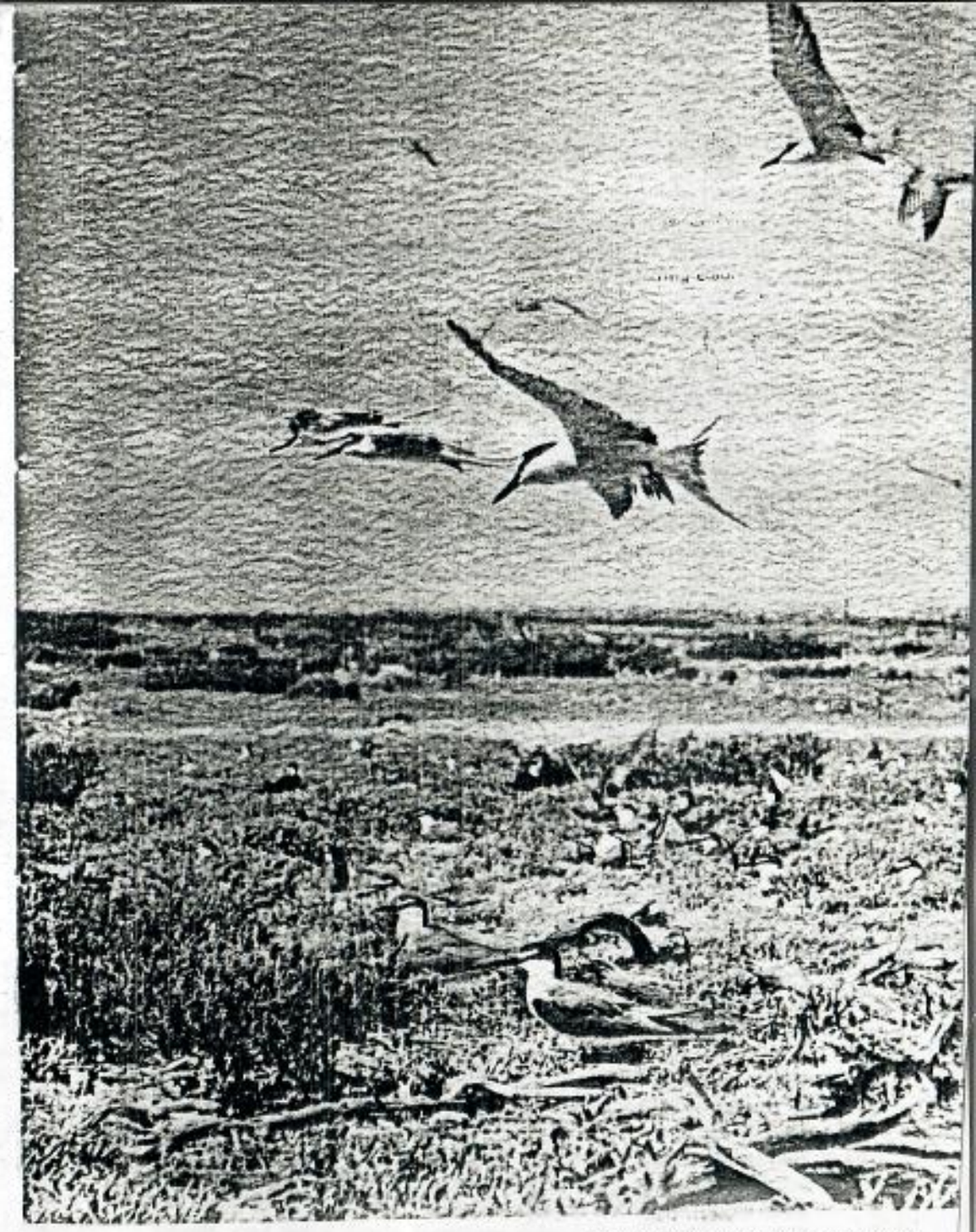
Hague (1862) apparently refers to this species when he states that an abundant tern, which he misnames, has two breeding seasons per year, and that although the numbers diminish between nesting periods the birds never entirely desert the Phoenix Islands.

Both Lister and Buddle recorded "vast numbers" of this species, the latter mentioning a colony of several thousand birds about a mile south of the settlement. The single egg of each pair was in a depression in the coral shingle. The eggs were laid at intervals of a few feet and were wonderfully camouflaged. "On May 28th breeding appeared to be at its height; no young were seen, and all eggs examined were fresh." It is probable that, owing to interference of man, this area has been abandoned.

At the date of the Murphy's visit, these terns, to the number of many thousands, were occupying a strip of the atoll devoid of large bushes. The ground was of weathered coral blocks and chips and the scanty vegetation was made up of low shrubs and vines, such as *Sida*, *Portulaca*, and *Boerhaavia*, with scattered clumps of bunch grass. At the approach of a car or pedestrian, the terns would rise with a great clamor, but they did not actually attack as the Arctic tern does.

In mid-April the whole colony gave the impression of having recently started its breeding cycle, and the men at the station reported that the birds had not been there a few weeks before. Single fresh eggs were scattered at intervals of three or four feet over many acres. In two of the unlined spots that served as nests a pair of eggs was seen; all others contained only one. When one sat quietly, the terns returned to nests as close as twenty-five feet away.

Bailey and Wichers saw a colony of several hundred birds with well grown young on the southern tip in late August, 1949. There were few in this same area in 1952, but there were possibly several thousand birds nesting on the eastern shore about three-fourths the way down from the airport. Many had eggs on the high beach where there was just an expanse of wind-blown sand, the nests often being mere depressions, but others having nicely constructed ones of carefully placed small rocks and stones. A nearby colony on the inner slope contained hundreds of downy to half grown young well hidden in grass. There was a constant shrieking of irate terns as they dived at interlopers, only to wheel by at the last moment.



Photograph by Patricia Bailey Witherspoon

GREY-BACKED TERN

The grey-backs occur on Canton Island in nesting colonies of thousands of individuals

20. Sooty Tern *Sterna fuscata oahuensis*

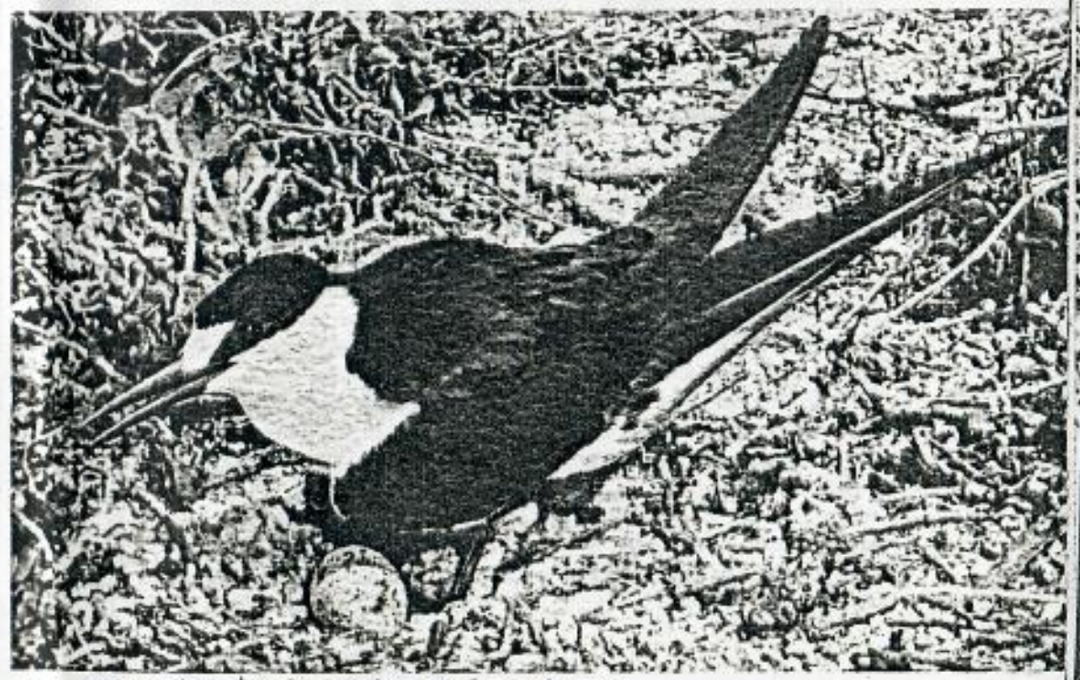
These wide-ranging colonial birds occur in unbelievable numbers on nesting islands from the tropics to as far north as Midway Island, and south to the coral sands of the Barrier Reef of Australia in the Pacific, and the rugged Ascension Island in the Atlantic. Six races have been recognized.

The sooty terns are apparently irregular in their appearance at Canton, or it may be that they were once abundant but have now practically abandoned the atoll. Lister reported thousands in June and July, 1889, but Donaghho at the same period of 1938 states that, although large colonies were occupying Enderbury Island, not a bird of the species was seen at Canton.

Gardner reports it as present in small numbers at the time of the Eclipse Expeditions, but Major Buddle in the same period saw none. Bailey found a few, perhaps not more than a dozen, near a small colony of grey-backed terns at the southern end of the atoll in August 1949; in August, 1952 several were noted in the same area, and on June 22-25, 1954 Bailey and Witherspoon saw possibly twelve pairs nesting among the thousands of grey-backed terns. The sooty terns had eggs at this time, and readily posed for the photographers. Even though their backs are much darker than their associates, *S. lunata*, they are not conspicuous upon their eggs or in flight. The few mingling with the thousands of flashing grey-wings could easily be overlooked. A specimen was collected to compare with skins taken in the Hawaiian Islands.

Not a single example was collected or reported by the Whitney Expedition in March. At the time of the Murphy's visit in April 1949, they heard about periodic visits of sooty terns from residents of the island who seemed, however, vague about dates and the size of the populations.

The species is in need of careful recording and study because of the curious variations in its nesting habits in other parts of the world. At the Dry Tortugas, off Florida, and on Midway and Laysan of the Hawaiian group, the sooty tern is an annual breeder in the northern hemisphere springtime; at Ascension Island, in the tropical Atlantic, its nine month nesting cycle has now been fully confirmed, a regime which constantly moves the nesting season forward by about three months each successive year (Chapin, 1954). At other localities, particularly in the Pacific Ocean, on a small island off Oahu, on Christmas and other equatorial islands it has been alleged that the sooty tern has two nesting seasons in each calendar year, but the fact has never been established.

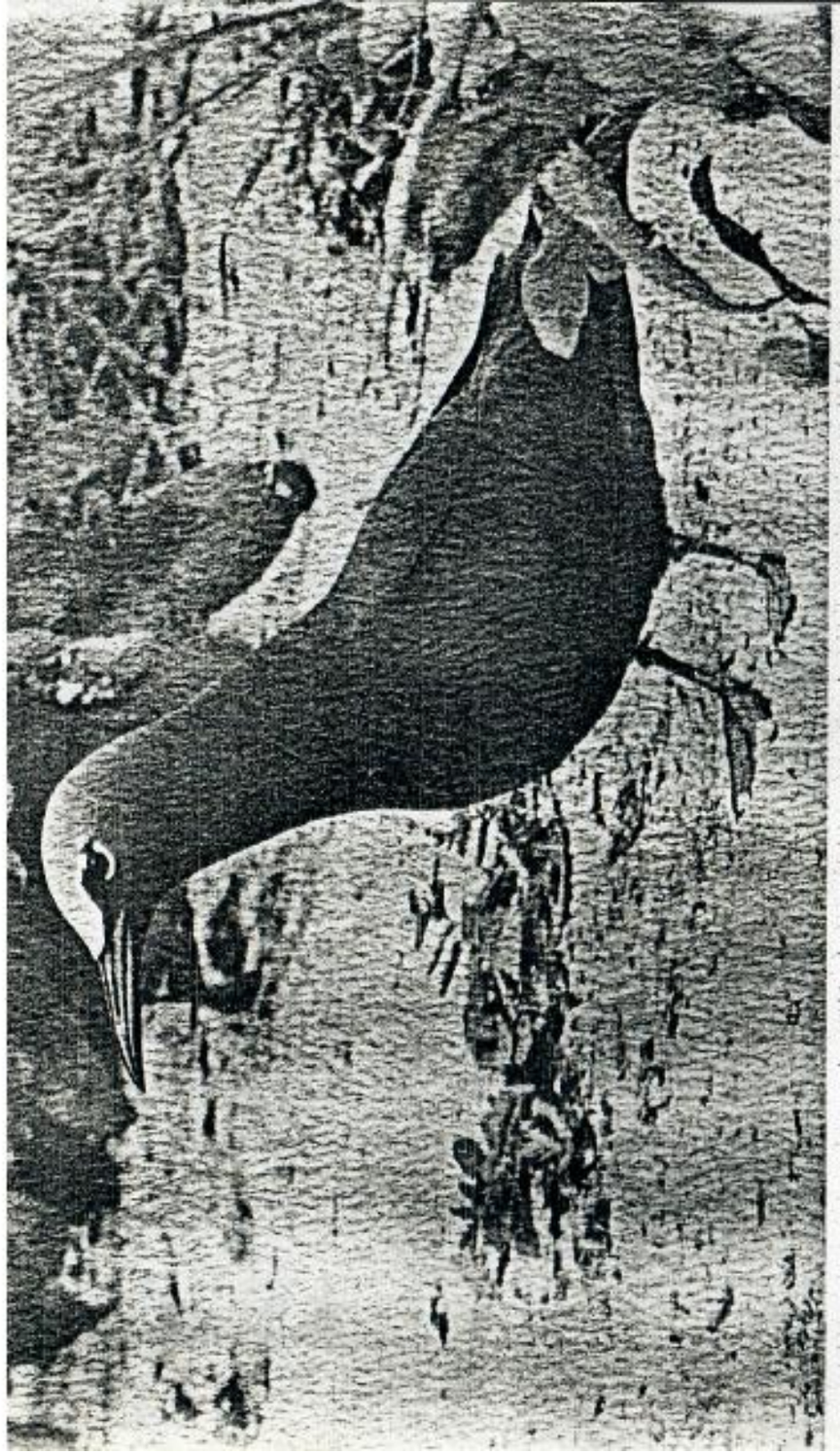


Below: Possibly twelve pairs of sooty terns were nesting among the thousands of grey-backs

Photographs by Alfred M. Bailey

IN A TERN COLONY

Above: Patricia Witherspoon watches a sooty tern in the grey-backed tern colony



Photograph by Alfred M. Bo

BROWN NODDY

These large noddies occur commonly on Canton, nesting on the coral rocks of dredge dumps, or in small communities adjacent to the grey-backed tern colonies

22. Brown-winged Tern — *Sterna anaethetus anaethetus*

Buddle reported several pairs, with no sign of nests, mingled in the large colony of *Sterna lunata*. No other observer at Canton refers to the species and it was not collected by the Whitney South Sea Expedition. The distributional status and relationships of these two rather closely related terns (*anaethetus* and *lunata*) require further study.

23. Black-naped Tern — *Sterna sumatrana sumatrana*

Six specimens were collected at Canton by the Whitney South Sea Expedition. The only other reports are those of Buddle and Lister, who saw the birds in flocks above the lagoon but failed to locate a nest.

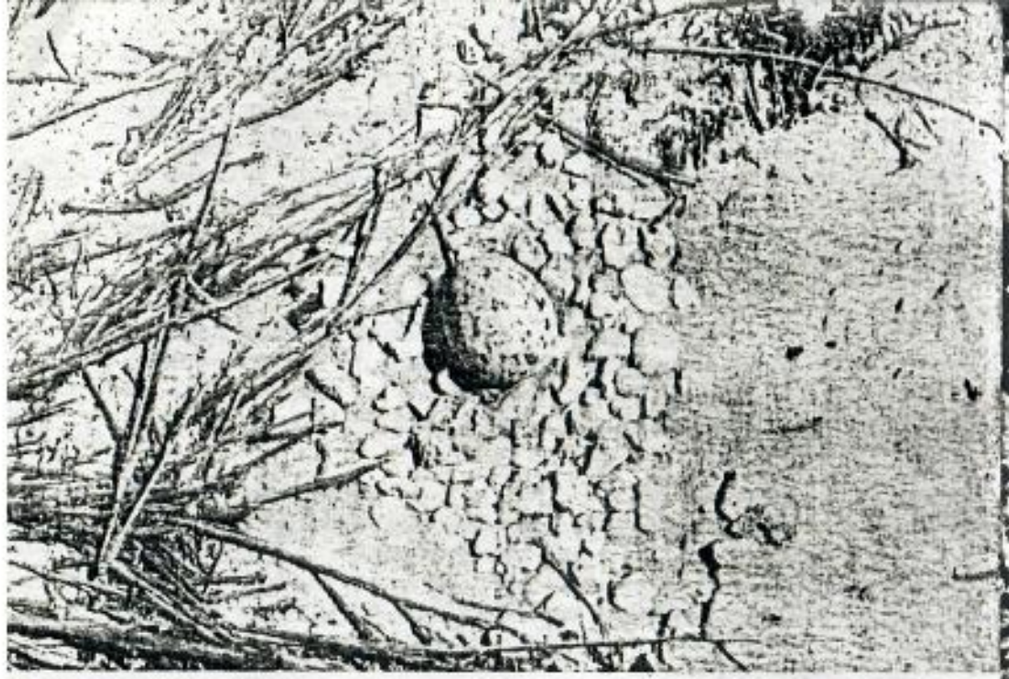
24. Crested Tern — *Thalasseus bergii cristatus*

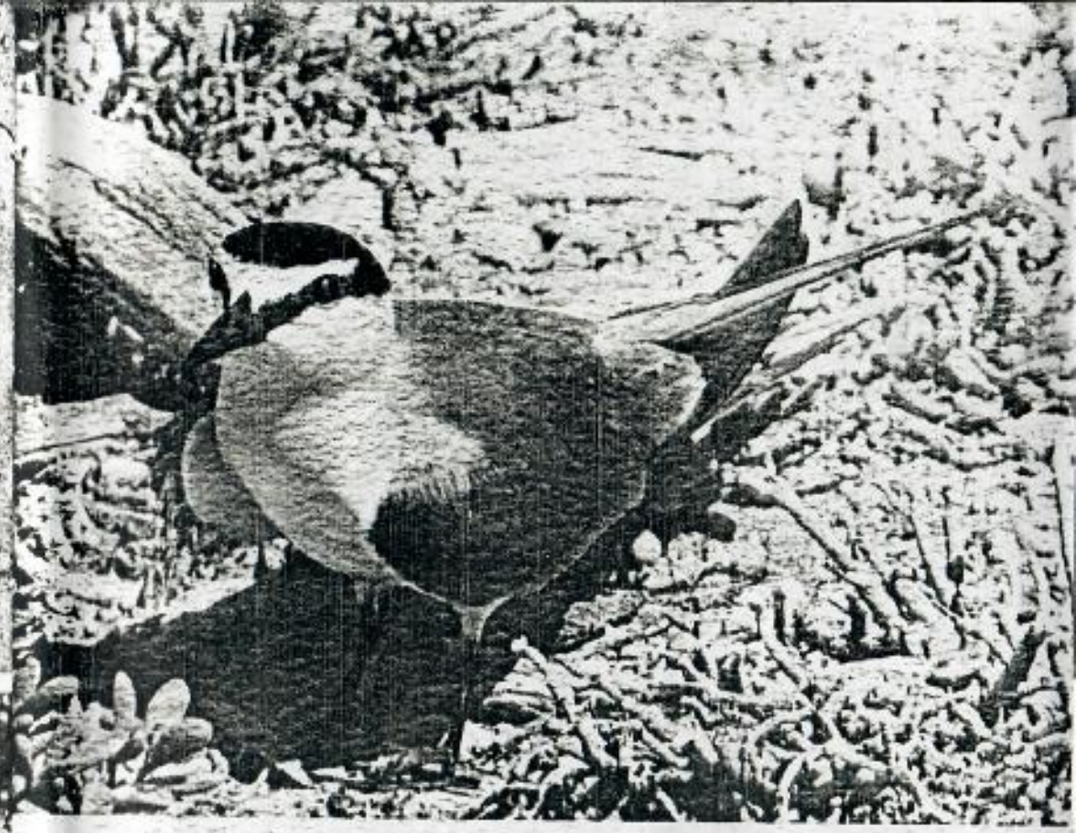
Five examples of this large species were collected by the Whitney Expedition at Canton between March 11 and 15. It is therefore possible that it may nest on the atoll. Other observers, however, report it only as occasionally seen flying above the lagoon or the outer reef. Bailey saw one, its yellow beak conspicuous, near the lagoon on August 29, 1949.

25. Brown Noddy — *Anous stolidus pileatus*

The noddy was found rather evenly distributed over the island in small numbers by Lister and Buddle. The latter mentions a colony of fifty birds nesting in a salt marsh north of the passage into the lagoon, and isolated nests found over much of the island. He considered that the birds had an extended nesting season in that during June he found eggs in all stages of incubation and young already losing their down. Lister observed half grown young in July. One of the favorite spots for the noddy at the present time is upon the great dredge dumps, where Bailey observed well grown young in August 1949 and 1952. Several hundred adults and young upon the wing were observed at the southeastern end of the island on the beach near the booby and man-o'-war colony. They rested on coral rocks and in the scaevolas, and were rather wild. They were not nesting on the dumps in 1954, but Bailey saw a few nesting on coral rock near the grey-backed tern colony on the eastern coast on June 22-25.

By the Murphys, in mid-April, brown noddies were seen along the channel and also about mounds of bull-dozed coral far from the settlement. They were rather shy, and gave no evidence of having selected nesting territories. On the 13th a large group—several hundred—rested on the ocean a short way outside the fringing reef.





Photograph by Patricia Bailey Witherspoon

GREY-BACKED TERN

These terns are so protectively colored that they blend with their surroundings, and flocks of thousands at rest are difficult to see

Bailey and Witherspoon observed two large colonies the latter part of June, 1954, one on a flat area of the island across the lagoon entrance from the British settlement, and the other in the same general locality where they were nesting in 1952. The majority of the terns had eggs, but a few young were appearing. The adults were very fearless, once they became accustomed to intruders, and soon settled upon their eggs, although the photographers were only a short distance away.

The grey-backs did not seem to resent the few sooty terns scattered through the colony, but they, like other terns, are pugnacious and seem to spend most of their time quarreling with their neighbors. Like other small ground-nesting birds, they suffer heavily from the predations of the thousands of hermit crabs which literally swarm over the nesting area. Young birds left unprotected by parents are greedily devoured by the strong-clawed crustaceans.

Below: The grey-backs nest in colonies of thousands. Photographs by Patricia Bailey Witherspoon

GREY-BACKED TERN

Above: The single egg is often deposited in a depression in the sand and lined with bits of rock, and coral

several twigs offer a precarious nesting place. On islands of more abundant tree growth the site is nearly always arboreal, and many eggs have been deposited, and have subsequently hatched, resting on nothing more secure than the swaying frond of a palm.

These terns frequently show marked curiosity, hovering over one's head, several together, uttering little querulous calls and watching intently with their large hazel eyes. Bailey secured color pictures in slow motion of three poised on outstretched wing.

28. BLUE-GREY NODDY *Procelsterna cerulea nebouxi*

The Whitney South Sea Expedition collected six examples at Canton in March. Several pairs were observed by Buddle in May and June, these being in various parts of the island. Although the terns appeared to be mated, Buddle was unable to locate a nest. Lister, however, found eggs in July.

No other visitor to Canton has reported the species.

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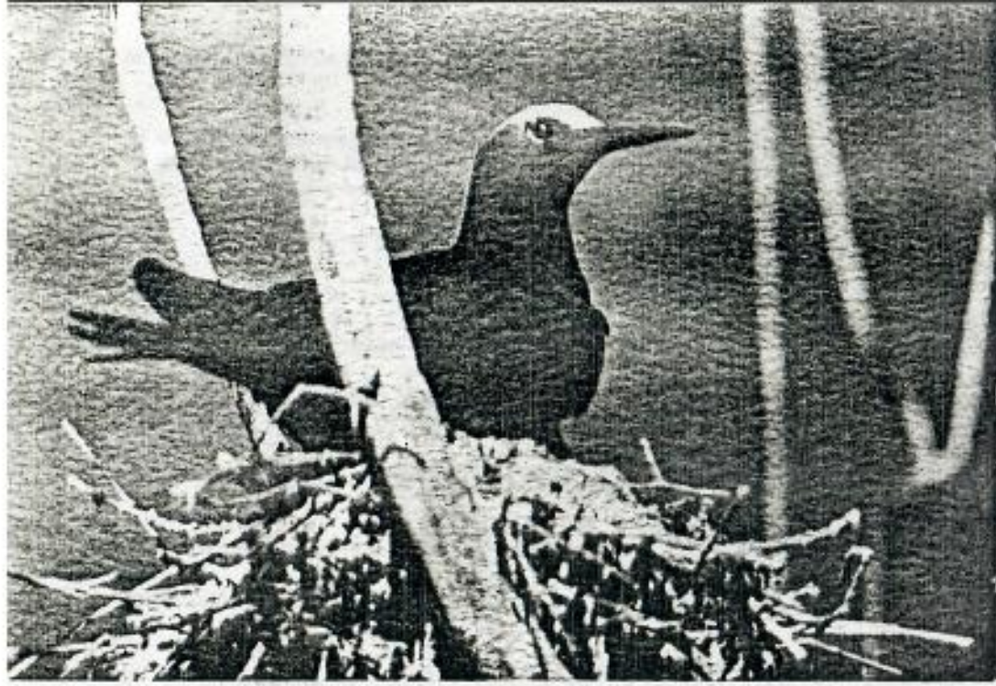


Photograph from a Kodachrome
by Alfred M. Bailey

BLACK NODDY

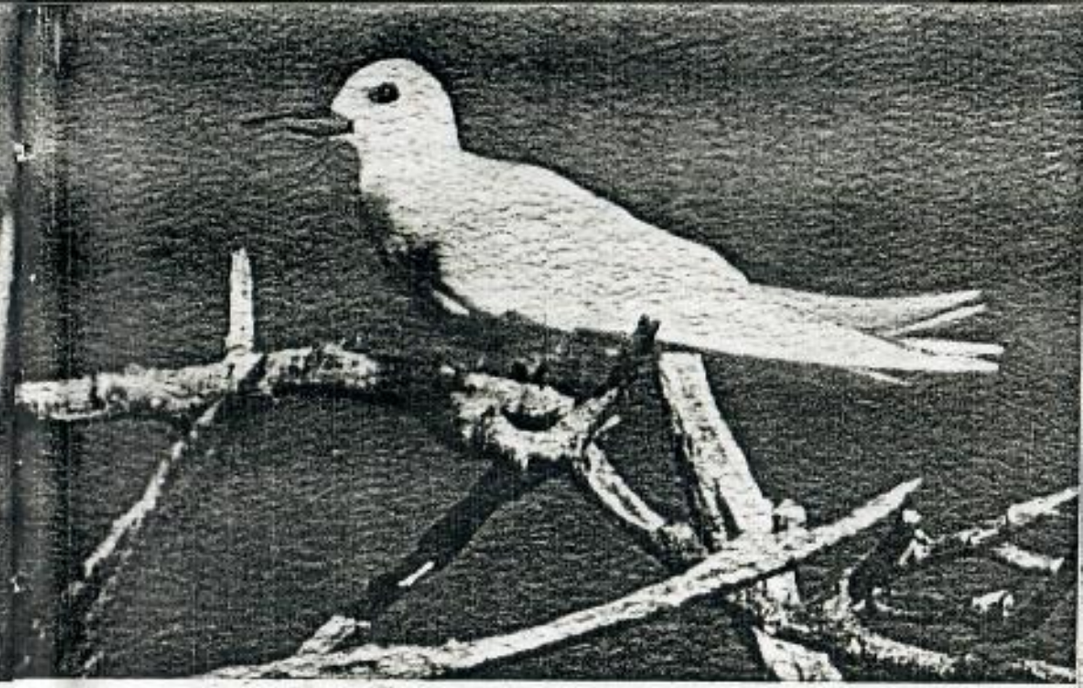
The small black noddies are tree nesting birds which breed regularly in the stands of dead Cordia on the southeastern end of Canton Island

The observation is noteworthy because the feathers of this species become quickly waterlogged. The birds do not dive, and they are believed to spend very little time on the surface of the water.

26. Black Noddy — *Anous minutus melanogenys*

The Murphys found many hundreds of them in the area of high shrubs, the same as that occupied by most of the red-footed boobies. They had not yet settled on nesting territory, for they were shy and highly mobile, flying off in black clouds and moving to similar areas out of eye range. They behaved like birds recently returned from a sea migration, but no local information about their seasonal regime was available.

Bailey and Niedrach saw possibly one hundred scattered through the scaevolas in the booby and man-o'-war colony at the southern end of the island on August 16 and 17, 1952. They seemed to favor a certain area but apparently they were not nesting. In 1954, however, Bailey and Witherspoon found a dozen pairs with their rather bulky nests ten feet from the ground in dead *Cordia*. Each nest contained a single egg, or a small downy black young.



Photograph from a Kodachrome
by Alfred M. Bailey

FAIRY TERN

These beautiful little sea birds occur on many of the islands of the Pacific Ocean

27. Fairy Tern — *Gygis alba candida*

Reported by practically all visitors to Canton, although the population is today relatively small when compared with that of other islands of the Phoenix group. The Whitney Expedition obtained examples at Hull, and elsewhere but none at Canton.

Porter saw many on April 1. Buddle found the species common and fairly well distributed in May and June, and observed both eggs and newly hatched young. The Murphys and Bailey and Niedrach found the adults in April and August, respectively, around the newly dredged coral dumps near the ship channel into the lagoon. Bailey and his associates concluded that they may have finished nesting before August. An egg was found by Patricia Witherspoon on June 23, 1954, however, on a horizontal branch of a *Cordia*, in the same patch of dead vegetation in which the black noddies were nesting. The bird was quite wild at first, but after a while returned and perched on branches above its egg, and color photographs of the white bird against the blue tropical sky were secured.

The fairy tern lays its single egg upon a log, a chunk of coral rock, on rough spots in the bark on horizontal tree limbs, or where

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Photograph by Alfred M. Bailey

SHEARWATER BURROW
And tracks on Canton Island sands

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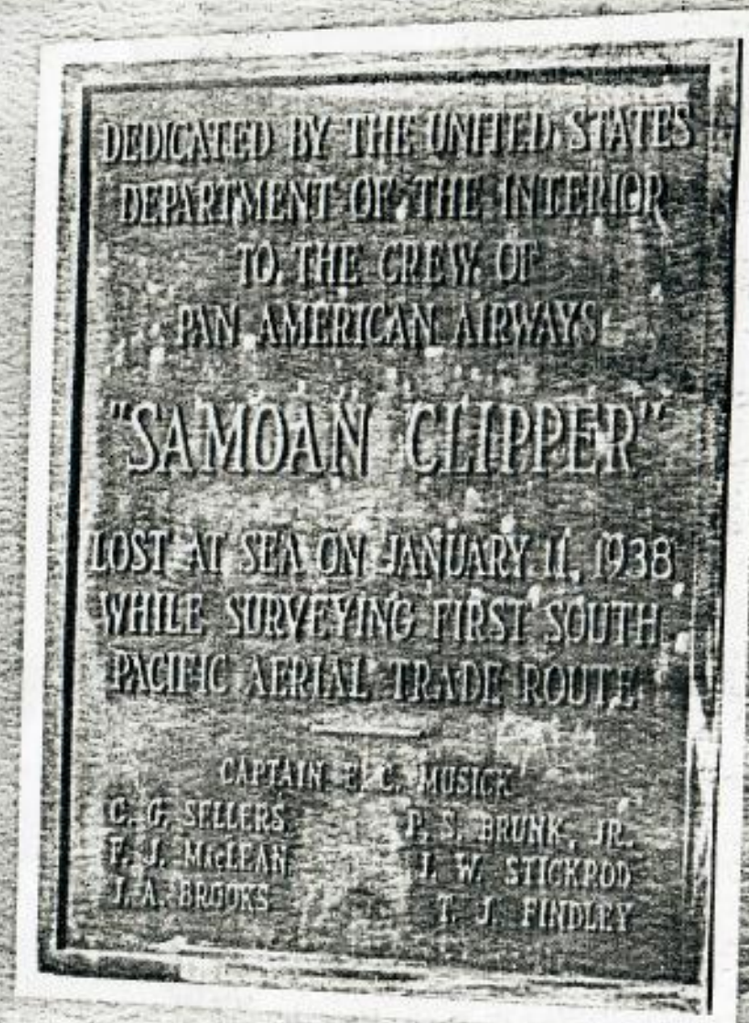

CANTON ISLAND
MEMORIAL PLAQUE

No.....

GILBERT AND ELLICE ISLANDS COLONY,
PHŒNIX ISLANDS DISTRICT.

No......

GILBERT AND ELLICE ISLANDS COLONY,
PHŒNIX ISLANDS DISTRICT.

TERO

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22n Aokati, 1966

AIA KA-7 NI KAKARABAKAU KAIN TE ADVISORY COUNCIL

E a tia ni karaoaki te ka-itua ni kakarabakau n te Advisory Council ke te Kauntira ni Kaetieti n te Auti ni Kabowi i Bairiki, Tarawa, man te Kanimabong ae 5 nakon te Kaabong ae 11 bongin Aokati. E moanaki te kakarabakau imwin kaukana n aia booreen bureitimanin te Korone ao imwin naba ana taeka ni butimaai te Unimane are Mr VJ Andersen, CMG, OBE, VRD, are boni ngaia naba te Beretitenti n te Kauntira anne, nakoia kain te Kauntira ake a bou. E kukurei ni butimaea te Kauoman n Unimane are Mr M.M. Townsend, MC, are tao e bon ataki iroumi ba ngaia ngkoa are e mamananga ni kaitira i aon abamakoro, imwin kitanan te Korone irouna 14 te ririki ao ngkai e a manga oki n riki ba te tia tei ibukin nakoana (ke te 'ex-officio member') n te Advisory Council. E kaota naba kukureina ni moani kaainakin te Kauntira anne irouia tan tei mai i tinaniku (unofficial members) ake Founuku Tipelu mai Nanumea, Itaia Tiaoti, MBE, mai Nikunau, Peter Kanere Koru mai Tabiteuea, Tebao Maitinara mai Abemama, ao ai Tekaai Tekaai mai Tarawa. E kaotia naba te Unimane ba a bae ni bibitaki n tai nako tan tei mai i aon abamakoro imwin kaainakin te Kauntira anne irouia tao uoua te ririki ba a aonga ni maiti kain te Korone ake a atai aroni babairen te Tautaeka.

E taku te Unimane ba iai te moa ni kakarabakau are e bo ni Beberuare ae nako ibukin baireani kamaitan kaniwangan ara Korone ni manen te tano are e kenaki i Banaba ma a aki bati bai iai ake a na iangoaki nakon ake a na iangoaki n te kakarabakau anne.

A maiti riki ana taeka te Unimane ibukin baike a na iangoaki ibukin te Korone nakon ririki aika imaira ma e kaotia ba te bai ae rangi ni bongana n te kakarabakau anne bon rinanoan baire ake a katauraoaki man te Tautaeka ibukin bitakin wakinan te Aro n Tautaeka are a nangi boni kona riki iai ara aomata ni kaain taiani botaki n tautaeka ma ni kaoti aia iango ibukin tautaekanan abaia, ao ai te waki teuana are e tabe ngkai ni wakinaki ibukin kawakan te Tautaeka n Aomata i aon abamakoro n te aro are a na boraoi ma bitaki ake a iangoaki.

Ni moani wakinan te kakarabakau anne e titiraki te tia tei mai Tangintebu are Pastor Amara Makaea are ngaia aia matantwi tan tei mai i tinaniku, ibukin reirein te Tautaeka ake taiani Primary Schools ba iai ake a tiba kateaki i aon abamakoro. Ao e kaekaki iroun Mr Urquhart are te Bonomwi ni Matantwi Ibukin Reirein te Korone ni kaotia ba akea moa reirei n aron akanne ake a kateaki n te ririki aei. Ma iai are e kaukaki n te kawa ae Tewai i Tabiteuea Maiaki are uoman tan reirei iai n Tebetemba n te ririki ae nako, ao iai are ti temanna te tia reirei iai n te kawa ae Taku i Tabiteuea Maiaki n Tianuare n te ririki aei. Irarikina, a tia ni manga kamaitaki riki tan reirei ibukin reirein abamakoro ake taian Islanc Council Schools i Onotoa, Nonouti ma Tabiteuea Meang.

E titiraki naba Amara Makaea ba aba ra n te Korone ake a tia ni karaoaki i aoia marae ni wanikiba ibukin te tango are a na karekeaki wanikiba ni mamananga imarenan Tarawa ma abamakoro n te Korone. E kaekaki iroun te Kauoman n Unimane are Mr Townsend are e taku ba akea moa ngkai te mane ibukin wakinan makuri akanne aingaia are bon akea moa ae e a tia. E titiraki naba Amara ba tera ana babaire te Tautaeka ibukin ukeraia tan akawa ake a matenako. Ao e kaekaki iroun naba Mr Townsend are e taku ba a kona n ukeraki tan akawa ake a bua ngkana iai te kantaninga ke a bon ataki raoi ba a na kuneaki. E a tia n noraki n tai aika a nako ikai ba e a matebuaka ukeraia tan akawa ake a matenako ngkana a tiba kaotaki taekaia imwin teuana te bong. E a tia naba n noraki ikai ao i Biti ba a maiti riki ana ibuobuoki ake e konai ni karaoi te kaibuke n ukeraia aomata ake a matenako nakon taiani wanikiba. E kaotia naba Mr Townsend ba bon taben te Tautaeka ni bairei manangan kaibuke ma wanikiba ibukin makuri n aron akanne ao bon akea te mane are e kabakaki ibukin kamanangakia ba boni makuri n ibuobuoki. E na boni wakina tabena anne te Tautaeka ngkana iai kabuanibai n aron akanne ake a manga riki.

Imwina a a manga taetae naba Amara ibukin taian Iango Ibukin Bitakin

te Aro n Tautaeka n ara Korone ae Kiribati ma Ereti ake a bon tia ni katauraoaki man te Tautaeka, ao e taku ba bon te maneka ni waerake teuana ae bongana ma n riai karaoana ba e aonga ni boraoi ara Korone ma aba nako ake i rarikina n te Betebeke. E taetae naba Amara Makaea ibukin taiani makuri n rikirake ake a tangoaki ma ni wakinaki ngkai ao e taku ba e riai ni butiaki Buritan ba e na kamaita riki ana mane n ibuobuoki nakoira. E kaota naba bonganan taian reirei n te Korone ao e taku ba teuana te bai ngkai are e tutuka rikirakeia ara aomata bon te bangabai ba e aki tau maitin te reirei. E a tia ni kuneaki aei irouia kain ara Korone ake a mananga ni maeka n tabo tabeua i tinaniku ba e kanganga irouia butiraoia ma kain tabo akanne ba kioina ngke a bangabai. E taetae naba ibukin Tarawa ao e taku ba e riai ni wakinaki raoi te kateitei i aona ngkai boni ngaia atun te Korone. E kaota naba ana tango ibukin te taowae irouia tani makuri n te BPC i Banaba ao e taku ngaia n ana tango ba e riki anne ba akea aia atatai aomata ake tani makuri n taiani baire ake a karaoaki ibukia ao irarikina, a bubuaka ma ni kairibuaka aia mataniwi ake a rineaki ke ni kateaki mai i buakoia. E butia te Tautaeka ba tera ngke e kona n rineia mataniwi ake a raraoi ma ni kairiri raoi ba e aonga n akea te taowae ao e na butiraoi kenakin te tano are boni ngaia oin reken ara mane i rarikin te takataka.

E kaekaki iroun Mr Freegard are e taku ba kanga bon akea ana bai te Tautaeka n rineia aia mataniwi tani makuri i Banaba ba bon aia bai tani makuri n rineia aia mataniwi ma e kona ni buokia te Tautaeka. Iai naba ana taeka Mr Freegard ni kaekan te titiraki teuana ibukin taiani makuri n ibuobuoki ake a wakinaki i aon abamakoro, ao e kaotia ba e tauraoi te Tautaeka n te Korone ni buoka te Tautaeka n Aomata n anganna te mane ibukin wakinan makuri akanne ke e kona naba ni bairea tangoan te mane man te Baba n Tango Mane are a na manga bon tabeutaia kain te aba are e anganaki, ni kabara.

E taetae naba Mr Freegard ibukin babairean te kariki irouia tanga n te aro are e na bon tau maitia ara aomata ma maitin te aba are e tau ibukia, ao e taku ba e a waki raoi ngkai te makuri anne i Tarawa, ao a na manga boni wakinaki i aon abamakoro ngkana e toamau te bao ni mamananga n rokoni kaibuken te Korone ake teniwa ake a kantaningaki rokoia n te ririki ae bou.

The Canton Scuttlebutt 15 FEB 1973 No. 473

NOTICE: George Balazs, Marine Biologist with the Hawaii Institute of Marine Biology will be here for one week to investigate and survey sea turtle populations found around the island. He is particularly interested in determining which areas are most frequented by nesting animals. He would like anyone with knowledge on nesting or beach track or hatchling sightings to please contact him or lease a message at Bldg 588. Although his research study will be confined to Canton, interest was expressed in nesting activity which may occur on any of the islands in the Phoenix Group. If you have information on sea turtles present on these outer islands he would greatly appreciate hearing fom you.

Balog

COPY

UNIVERSITY OF HAWAII

Hawaii Institute of Marine Biology

April 13, 1973

General J. D. Lowe
Department of the Air Force
Headquarters Space and Missile
Test Center (AFSC)
Vandenberg Air Force Base, Calif. 93437

Dear General Lowe:

Preliminary inquiries have been made to the Hawaii Institute of Marine Biology (HIMB) by Kentron Hawaii, Inc., as to our possible interest in participating in a USAF program aimed at protecting the environment of the Phoenix Islands. Being aware of your endorsement of such an environmental survey and being familiar with the Air Force obligation to protect such environment, I send the attached proposal for your consideration. As you probably know, Dr. F. R. Fosberg of the National Academy of Sciences and Dr. D. R. Stoddart of the Royal Society of London will conduct a terrestrial survey of the Phoenix Islands in the near future. We have discussed our interest in the marine aspects of this area with Dr. Fosberg. He was very enthusiastic and suggested that a first proposed visit should coincide with their visit in early June. I also wish to point out to you that the Hawaii Institute of Marine Biology is strategically located with respect to the Phoenix Islands and can provide ready access to the scientific expertise required for the project.

Drs. Fosberg and Stoddart will be primarily concerned with the terrestrial ecology of this area. Moreover, nearly all previously available information from this region deals with terrestrial aspects of the system. Therefore I recognize that our potential initial contribution is to be primarily centered on marine ecology.

Enclosed is a statement of our scientific concern. In this statement we point out the precarious balance of atoll ecosystems in general, and the ease with which man can disrupt - and has disrupted - this balance. Adequate knowledge can help prevent damage to this delicate environment and insure success of the USAF mission at this location. In addition, we point to the special scientific and aesthetic importance of the Phoenix Islands and of the biota to be found there.

Coconut Island · P.O. Box 1067 · Kaneohe, Hawaii 96744 / Cable Address: UNIHAW

Because of concern and interest in this matter, the following ad hoc advisory committee has been formed at HIMB to implement initial steps: Drs. A. H. Banner and S. V. Smith and Messrs. P. L. Jokiel, G. H. Balazs, E. B. Guinther and G. S. Key. The committee is largely oriented towards marine ecology but could be expanded to include personnel active in terrestrial ecology as well if such a need is indicated by the studies by Drs. Fosberg and Stoddart.

Also enclosed is a proposed two-phase environmental undertaking in the Phoenix Islands. The committee members have my approval to participate in this initial venture because of its considerable importance. Required USAF support for this effort is modest, but the results should be of considerable benefit as it would allow for the intelligent management of this region and help avoid operational delays and the large expense caused by poor environmental planning.

To this statement we attach documentation of our interest and concern in the Phoenix Islands as well as of the abilities and expertise of HIMB personnel to undertake such an effort. We believe that we at HIMB are uniquely suited both to gain from and to contribute to the proposed effort.

As Director of this laboratory, I therefore strongly endorse the project and the proposed involvement of our laboratory personnel in this venture. I therefore hope that you will give this statement your serious attention and that you will support our proposed efforts to increase the understanding of the Phoenix Island environment.

Sincerely,

John E. Bardach
Director

mk

Enclosures

cc: E. R. Ewen

TITLE

An Investigation of the Marine Turtle Populations in the Canton Island Area.

PRINCIPAL INVESTIGATOR

George H. Balazs

INSTITUTION

University of Hawaii, Hawaii Institute of Marine Biology

DURATION

One Year (1973-74)

MOTIVATION

Personal communications with the military commander (Col. Robert Hines) of the SAMTEC facility on Canton Island has revealed that marine turtles inhabit surrounding areas of that island in addition to those of Enderbury and Hull. Indication has been given that adult females actively nest in relatively large numbers on several sand beaches throughout the year. Hatchling turtles have been observed on occasion around installations, apparently attracted to lights.

All pertinent information obtained on marine turtles present in these areas strongly suggests a healthy, viable population of grazing, breeding and nesting animals. However, no published material presently exists either describing or defining this population. To date no studies have been carried out on these animals.

An investigation of this colony would have special significance at this time due to the fact that all marine turtles, on a world-wide basis, have experienced a drastic reduction in numbers over the past 100 years. This decline has mainly been due to the destruction of highly productive nesting sites and overfishing. Beaches in Bermuda, Cayman Island, and Mauritius, which were at one time sites for large numbers of nesting turtles, no longer function as such due to the encroachment of civilization. Concern by Pacific island nations for the decline in numbers of turtles inhabiting their waters has led to the enactment in recent years of extensive restrictions on the taking of these animals both in the water and on the beaches. In addition, several countries have initiated conservation and education programs dealing with these animals.

Because of the remoteness and lack of habitation in the Canton area, it is critical that this population of marine reptiles be examined, described and defined at the present time. In this way it will be best understood how to protect and perpetuate these animals.

OBJECTIVES OF PROJECT

1. To identify the various genera of marine turtles present in the Canton area and to determine in what proportions they exist.

2. To make estimates of the total numbers involved in the populations including the size distribution of individuals.

3. To locate and describe productive grazing areas.

4. To locate, identify and describe suitable nesting beaches.

5. To determine breeding and nesting seasons.

6. To initiate a tagging program which will help determine the geographical range of the members of the colony.

7. To make recommendations on how best to conserve the turtles in this area.

METHODS

An initial seven-day reconnaissance will be conducted during the month of January to familiarize the principal investigator with the locality. Aerial surveys will be made in an effort to locate suitable nesting beaches and look for markings indicative of nesting. Interviews will be made with residents in an effort to compile all existing local knowledge on sea turtles. Diving sessions will be carried out in select locations to evaluate and photograph turtles and underwater grazing pastures. One night of observations will be spent on both Enderbury and McKlean in addition to a remote area of Canton to determine if turtles are actively nesting during that time. At the completion of this visit, a preliminary report will be written.

Based on the finding of the reconnaissance, two seven-day visits are planned for the remainder of the project year. Scheduling of these site visits will be made based upon information and observations obtained from cooperating SAMTEC and Kentron personnel. Communications between the principal investigator and the base commander will be maintained at regular intervals. The sighting of significant numbers of nesting turtles will initiate site visits two and three respectively. During the course of these phases of the field research every effort will be made to tag, weigh and measure as many nesting animals as possible. The female's nesting behavior will be observed, recorded and compared to that described by researchers in other parts of the world.

At the end of the project year results from all studies will be compiled in the form of a formal report. Pertinent findings will be submitted for publication to the appropriate journals.

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Canton Island

	Temperature, °F low	high	Rainfall, inches
January	77.8	88.0	3.16
February	77.7	88.0	1.70
March	78.0	88.4	1.58
April	78.1	89.1	2.55
May	78.3	89.3	2.73
June	78.0	88.9	2.64
July	77.8	88.0	2.55
August	77.8	88.9	2.44
September	77.9	89.3	1.32
October	78.1	89.4	1.14
November	77.9	89.1	1.92
December	78.1	88.4	2.19

The green turtle (Chelonia sp.) nests on Canton Island at four select sand beaches along the north, east and south coastlines. Some nesting occurs during the entire year, however, the presence of larger numbers of animals in October and November suggests that seasonal reproduction also is in effect. Juveniles and adults are present in lagoon waters and immediately outside the major channel throughout the year. Within recent years turtles have also been reported on Bernie, Enderbury, Hull, Gardner and Sydney. Although there is no basis at this time for making an estimate of the total nesting population size utilizing Canton and the other islands in the Phoenix group, preliminary surveys conducted by the author indicate that a fairly large number of animals may be involved. Due to the absence of information in the literature on marine turtles in this area of the Pacific, intensive studies on both feeding and nesting populations are needed.

STATUS OF MARINE TURTLES IN THE PHOENIX ISLANDS

1. A Preliminary Survey of Canton Island

by George H. Balazs
Hawaii Institute of Marine Biology
P. O. Box 1346
Kaneohe, Hawaii 96744

INTRODUCTION

Background and Objectives

During the period February 13-20, 1973, a preliminary survey was made of the marine turtle population which exists in the Canton Island area. This low-lying coral atoll is the largest and northernmost of the eight islands which comprise the Phoenix group and is under the jurisdiction of the United States Air Force (USAF) Space and Missile Test Center (SAMTEC). Previous communications with personnel located on the island indicated that marine turtles commonly nest at several locations along the Canton Island coastline and that the lagoon and surrounding open ocean contain a substantial number of these salt water reptiles. In addition, it was reported that nesting pits and tracks are frequently seen on both Enderbury and Hull Islands.

The above communications motivated the author to review the literature in order to determine what, if any, scientific work had been conducted specifically on these marine turtles. No information could be found relating to species present, locations of nesting areas, breeding seasons, migration, population numbers, food utilized or any other important data concerning these animals. Little mention could be found that marine turtles did in fact even nest in the Phoenix Islands.

Information of this nature is critical to the continuing existence of any marine turtle colony. The endangered state of the world's marine turtles has been brought about by man's over-exploitation and encroachment on both the nesting beaches and the feeding grounds. For this reason it is imperative that all reproducing populations be identified and studied so that data can be obtained on how best to design and conduct a program of conservation.

Permission to enter Canton Island to conduct the preliminary study was granted by the USAF-SAMTEC as outlined in Appendix I. This report covers the work accomplished during the study and presents information based upon the investigator's observations and experiences while surveying and mapping nesting areas. Information is also contained which was compiled from interviews conducted with resident personnel having local knowledge about turtles. Based on the project's findings, recommendations are given which may assist the USAF-SAMTEC in its efforts to protect and perpetuate marine turtles in the Phoenix Islands.

SYNOPSIS OF ACTIVITY

The major portion of each day while on Canton was utilized surveying coastlines on foot in order to locate nesting areas. The investigator was fortunate in that partial transportation for this work was provided by FEC and Kentron personnel who made trips to outlying parts of the island. Once found, each area was recorded on a chart along with pertinent land marks and descriptions of adjacent vegetation and terrain. Further, the extent of nesting activity as well as the approximate age

of nesting pits and tracks were recorded. Substrate was sampled from each nesting location, and observations were made of possible egg and hatchling predators inhabiting the area. One night was spent at a coastal location observing the nesting behavior of two adult turtles that had come ashore. Evenings and other opportune times were used for informal interviews with interested persons who possessed local knowledge on marine turtles. A short article was placed in the local newsletter stating the investigator's interest and requesting anyone with marine turtle encounters to contact him. One diving and one sailing session were carried out in the island's lagoon to observe marine life and habitats. A part of one morning was spent reviewing papers relating to the ecology of the Phoenix Islands. These manuscripts are on file at the Base Commander's office and were made available to the investigator. The 20-minute motion picture entitled "A Legacy to Preserve" produced by the USAF was viewed one evening.

FINDINGS

Nesting Locations and Activity

The principal nesting areas on Canton Island occur at four distinct locations along the north, east and south coastlines. Figure 1 illustrates the boundaries of these areas which are labeled 1, 2, 3 and 4 respectively. The "x" notations in the figure indicate sites where signs of minor nesting activity were observed. A description of each principal area follows:

Area 1: This location is approximately 2.1 km long with a substrate consisting mostly of fine sand having a moderate to steep sloping beach

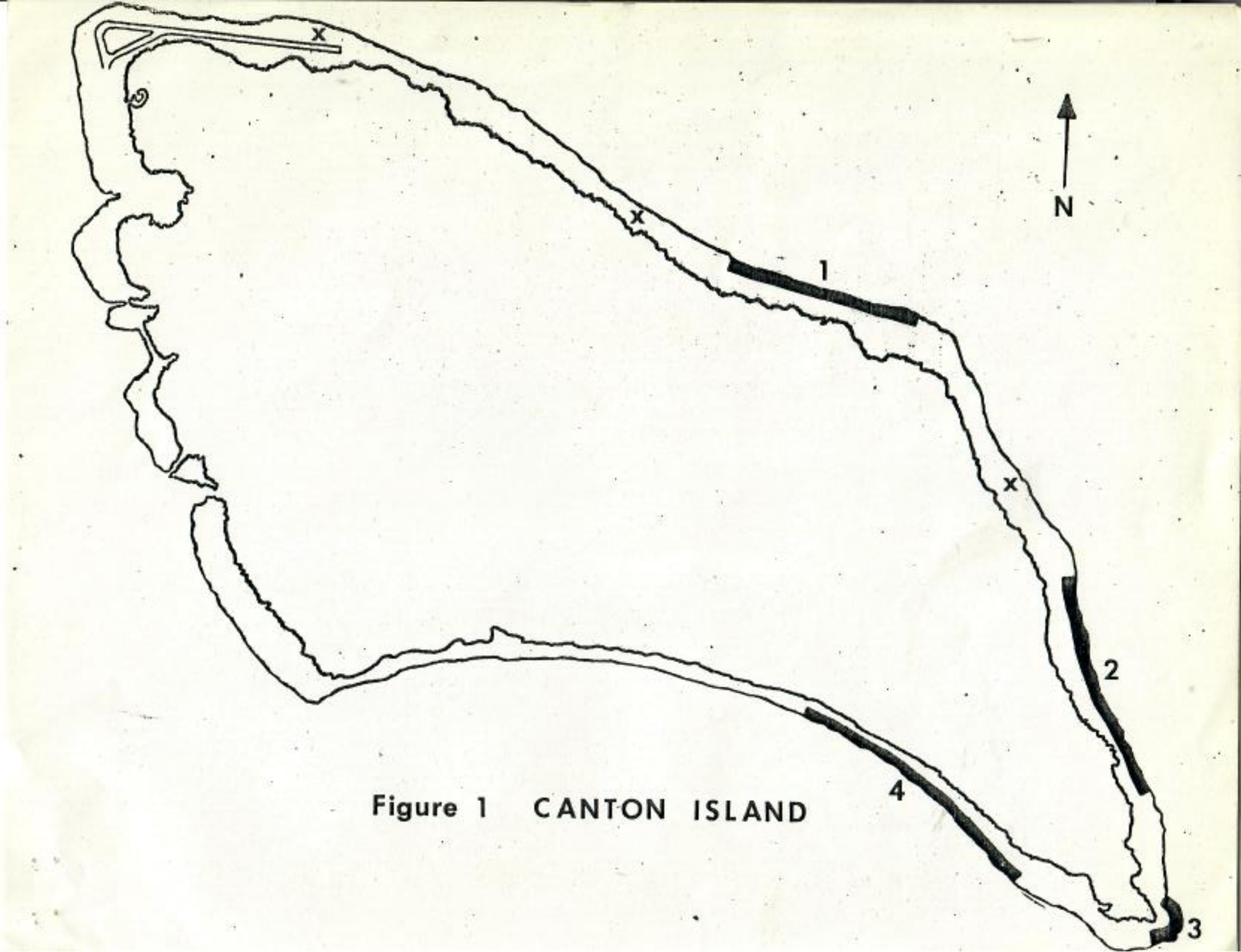

Figure 1 CANTON ISLAND

which leads up to a relatively flat, sparse vegetation zone. This sandy vegetation region is in some places narrow, dropping off abruptly toward the lagoon side to rough dense coral rubble. A wooden-framed structure is located to the western end of this area and is referred to by island personnel as the "beach house". The western end of an abandoned airstrip is almost directly inland from the beach house. The initial reconnaissance of this site revealed tracks representative of 16 nesting turtles. It was estimated that none of the tracks were older than 10 days. Area 1 was found to have the most recent evidence of nesting of any of those investigated. The investigator made frequent visits to this location, and at approximately 1800 hours on February 18, an adult turtle was observed inside the fringing reef. Upon return at 2300 hours two animals were found to be nesting in the vegetation zone, well above the high tide mark. Both turtles observed were identified to be the Green Turtle (Chelonia sp.). Upon completion of nesting, the animals were individually identified by placing a numbered tag on the trailing edge of the right-front flipper that bore the inscription "Notify University Hawaii - HIMB". On the 20th of February, two fresh sets of tracks were again observed in this same area.

Area 2: This nesting area extends for approximately 2.7 km. Two abandoned concrete transmitter bunkers are located directly inland from the center of this location. Along this area of the coastline the beach slopes gently up to a sparse vegetation zone. Fine sand is mixed with pieces of coral rubble, and in many places the beach is littered with timber. It was felt that this area hosted the largest number of nesting

turtles of any investigated. Although only one set of fresh tracks was observed in this area, more than 100 nesting pits were identified along the length of this coastline. Most of these appeared to be 2 or more months old.

Area 3: This area was the smallest of any located (0.4 km), covering the immediate beach area adjacent to the A-Site facility. A high concentration of old pits, probably the same age as those in area 2, were observed at this location. Above the high tide mark the land is flat and devoid of any vegetation. Large pieces of coral are found on the surface and driftwood is abundant. The underlying sand has a fine consistency but is mixed with larger coral pieces closer to the surface. Two visits were made to this area for nighttime observations. No fresh tracks were seen in this area.

Area 4: This location extends for approximately 3.1 km and consists of a gently sloping, fine sand and coral rubble beach with moderate to thick vegetation above the high tide mark. Small clam shells (Tridacna sp.) are abundant on the beach. Numerous pits were observed well into the vegetation zone and in many cases sites were found behind large shrubs placing them out of sight of the ocean. The reef flat along this coastline contains large masses of rough coral. Four fresh tracks were observed in Area 4.

Species Identification

In addition to observing the nesting adults, seven hatchlings held in the Base Commander's pond were examined. All were identified as being

the Green Turtle (Chelonia sp.). Most of the people interviewed felt that they had seen only one type of turtle during their encounters and photographic identification confirmed them to be the Green Turtle. Two reports were received describing turtles with distinct ridges on their carapace or upper shell. No ridges are found on Green Turtles. In view of these observations it may be reasonable to assume that one or more of the other four genera of marine turtles may be represented in this area.

Predation and Nesting Disturbance

The intertidal ghost crab, Ocypode sp., was found in large numbers at both Areas 1 and 2. Although present at Areas 3 and 4, the relative densities appeared to be somewhat less. This animal represents a serious threat to both hatchlings and eggs when they occur in proximity to nesting areas. Estimated losses from Ocypode predation range as high as 30% in some parts of the world. It is interesting to note the development of large colonies of these crabs on Canton at beach areas frequented by nesting turtles.

Several land crabs of the genus Cardisoma were seen but not in great enough numbers to represent a serious threat to turtles.

Numerous rodents estimated to be from 10-20 cm long were observed during night surveys. Since fresh and brackish water pools are located along the northeast coast, it is probably possible for numbers to rapidly increase during certain times of the year. These animals are a potential, if not an already existing predator to both turtle eggs and hatchlings.

Sea birds undoubtedly account for predation of hatchlings on Canton

as they do in other parts of the world. It was interesting to note a frigate bird (Fregata sp.) colony situated adjacent to Area 2. It is not known if this is a regularly used site for these birds.

A black tipped shark (Carcharhinus sp.), approximately 1 meter long was observed inside the fringing reef of Area 2. Such sharks and carangid reef fish account for large numbers of hatchling losses in areas where these predators are abundant.

The land hermit crab (Coenobita sp.) which utilizes the gastropod shell Turbo is abundant and widespread on the island but it is not felt that it is an active predator on either eggs or young turtles. Weak or injured hatchlings or uncovered eggs would probably be readily attacked by these crabs, but in the investigator's opinion no serious loss would be incurred under normal conditions because they are slow moving and do not burrow.

Disturbance of hatchlings and nesting adults occurs due to the following reasons: 1) lights near nesting beaches, either from structures, vehicle headlights, fishermen, or other nighttime activity; 2) the reported practice of driving vehicles on beaches or on the vegetation zone immediately above the high tide mark on the outer islands.

The investigator heard numerous reports describing both hatchling and adults becoming disoriented and traveling inland. This behavior seemed to be most common in Area 3. Personnel tend to believe that vibrations from generators at A-Site attract the animals. Based on the investigator's knowledge and experience, lights from the facility are responsible for the animals becoming confused. It has been sufficiently demonstrated

that marine turtles are able to find the ocean by photoreception.

It is the investigator's opinion that predation by humans has been held to a minimum due to: 1) strict regulations (OL-1 Regulation 126-1 and 127-1); 2) preliminary briefings on ecology before entering the island; and 3) frequent showing of the educational film on birds and turtles. However, it must be recognized that personnel from both Hawaii and Samoa may consider turtle meat and eggs to be a highly desirable food. One documented report was given concerning eggs being excavated shortly before the investigator's visit. In addition, an account was given about an individual being halted in the process of taking an adult which had come ashore to nest.

Other Islands in the Phoenix Group

The investigator made no personal marine turtle observations on any islands except Canton. The following limited information was obtained from personnel that had made visits to these atolls.

Enderbury Island - Heavy nesting reported at times along both the east and west coasts. Turtles are known to become disoriented and travel inland near the B-Site facility. This structure was described as having more lights than the A-Site facility.

Hull Island - Nesting reported along the west and south coasts. Continuous illumination of a SAMTEC facility was also described as existing on this atoll.

Sydney Island - Fresh tracks reported on the northwest shore during the investigator's visit.

Gardner Island - Fresh tracks reported on the south shore during the

investigator's visit.

Birnie Island - Tracks seen on several occasions.

Phoenix Island - No information available.

McKean Island - No information available.

CONCLUSIONS

Although there is no scientific basis at this time for making an estimate of the total size of the marine turtle nesting population on Canton, this preliminary study tends to indicate the involvement of a fairly large number of animals. It is the investigator's opinion, based on interviews and observations, that nesting takes place at some locations during the entire year. However, the similar age and abundance of pits in Areas 2 and 3 show that mass or seasonal nesting does occur at times, probably during October and November.

Since man's arrival, the ecology of Canton has been the most severely degradated of any of the Phoenix Islands. That the nesting of marine turtles on Canton has been able to continue in even moderate numbers attests to the former magnitude of this colony. The relatively unexploited state of some of the outer islands in the Phoenix group may well classify them as being among the most undisturbed and unaltered marine turtle nesting areas left in the entire Pacific basin. In fact, the size of the total nesting population in the Phoenix Islands could well constitute the largest found in any Central or South Pacific island group due to exploitation of the resource in the inhabited locations.

The investigator was duly impressed with the awareness of the need

to protect marine turtles displayed by the majority of the personnel. Interest was indicated in obtaining informative literature on marine turtle biology and arrangements were made to periodically send articles for distribution. In addition, the means were established for conducting periodic observations on turtle activity in Area 1. This will allow for the longer-term collection of some valuable nesting data.

RECOMMENDATIONS - Based on the study's findings, the following recommendations appear to be justified:

1. All lights at the A-Site facility should be eliminated except for the necessary red beacon at the top of the structure. A similar procedure should be followed at B-Site and any other facility having illumination on or near recognized marine turtle nesting areas.
2. The beach house located adjacent to nesting Area 1 should not be further developed as this would encourage frequent or heavy usage by personnel. The present infrequent utilization as a recreation center will probably not interfere with turtle nesting provided that the following conditions are met: 1) only a minimum amount of light be displayed during evening hours; and 2) food scraps and other wastes be removed so increases in rodent, crab or fly populations will not occur.
3. A system should be developed for monitoring the rodent population in the uninhabited areas of the island, particularly from the jet airstrip to the A-Site facility. If conditions are warranted it may be necessary to initiate an eradication program in the outlying areas.
4. The operation of motor vehicles on the beach or in the vegetation zone immediately above the high tide mark in nesting areas should be

eliminated. Such activity can cause extensive damage to both eggs and hatchlings located in nests under the sand.

5. Dehydrated hatchlings found wandering inland should be held in captivity only long enough for strength to be regained before releasing. During this period animals should be fed an abundant amount of shrimp or fish flesh. Release should be made only into the open ocean as this is the natural route of departure from land.

6. A preliminary survey of marine turtle nesting areas should be conducted on each island in the Phoenix group. Since no definitive base-line information relating to marine turtles is available on any of these islands, it is essential that an initial reconnaissance be carried out at the earliest possible time.

7. A means for monitoring the major nesting areas on each island at regular intervals should be established. This would include tagging and measuring of females in addition to nesting pit surveillance. Although it is believed that olfactory chemoreception may play an important part in marine turtle navigation, the exact method which enables migration over long distances is still unknown. What effect, if any, radar emissions can have on this navigating ability is completely unknown. In the course of monitoring nesting areas, some effort should be directed toward investigating this aspect of marine turtle biology.

Appendix I

Text of message received from Vandenberg Air Force Base dated 8 February, 1973 (No. 2841) relating to the investigator's entry to Canton Island:

UNCLAS SU/SUAS
SUBJ: USAEC MSG 020100Z FEB 73 QUOTED FOR BENEFIT OF OL-AE FILES. THIS MSG IN THREE PARTS.
PART I.
'W.B. HILLS SENDS. REQUEST ENTRY APPROVAL TO CANTON ISLAND FOR GEORGE BALAZS, SSN 564-54-0156, US CITIZEN, POB DETROIT, MICH, DOB 26 JAN 43, CONSIDERED GOOD SECURITY RISK AS OF 30 JAN 73, ASSOCIATED WITH HAWAII INSTITUTE OF MARINE BIOLOGY, UNIV. OF HAWAII. PURPOSE OF TRIP: TO CONFER WITH L/COL DEEM AND OTHER APPROPRIATE ADMINISTRATIVE PERSONNEL ON THE PRESERVATION OF TURTLE

PAGE 2 RUWJSLC0199 UNCLAS
BREEDING POPULATIONS ON CANTON ISLAND. DURATION OF STAY: 13 FEB 73 THRU 20 FEB 73. TRIP REQUESTED BY THE ISLAND COMMANDER.'
PART II.
FOR USAEC: REQUEST FOR ENTRY APPROVED WITH FOLLOWING STIPULATIONS/UNDERSTANDING:
1. SUBJECT STUDY IS AN INDEPENDENT STUDY WITHOUT AIR FORCE FUNDING.
2. MR BALAZS WILL REIMBURSE KENTRON HAWAII LTD AT THE ESTABLISHED DAILY RATE FOR HOUSING, MESSING, AND LAUNDRY.

3. THE STUDY IS CONFINED TO CANTON ISLAND.
4. ANY PHOTOGRAPHIC COVERAGE TO BE PROVIDED BY MR. BALAZS.
5. ANY STUDY REVIEWS DEVELOPED BE FORWARDED TO HQS SAMTEC/SUD FOR REVIEW AND APPROVAL WITH A COPY PROVIDED THE CANTON COMMANDER PRIOR TO PUBLICATION.
PART THREE.
FOR 619MASSQ/CCZ. REQUEST MR. BALAZS BE BOOKED VIA AEC FUNDED TRAVEL ORDERS ON THE 13 FEB FLIGHT

PAGE 3 RUWJSLC0199 UNCLAS
TO CANTON AND THE 20 FEB FLIGHT FROM CANTON TO HICKAM.
BT
#01999

NNNN≠

PLATE 1. BEACH HOUSE AND COASTLINE AT NESTING AREA 1.

PLATE 2. FRESH TURTLE TRACKS AT NESTING AREA 1.

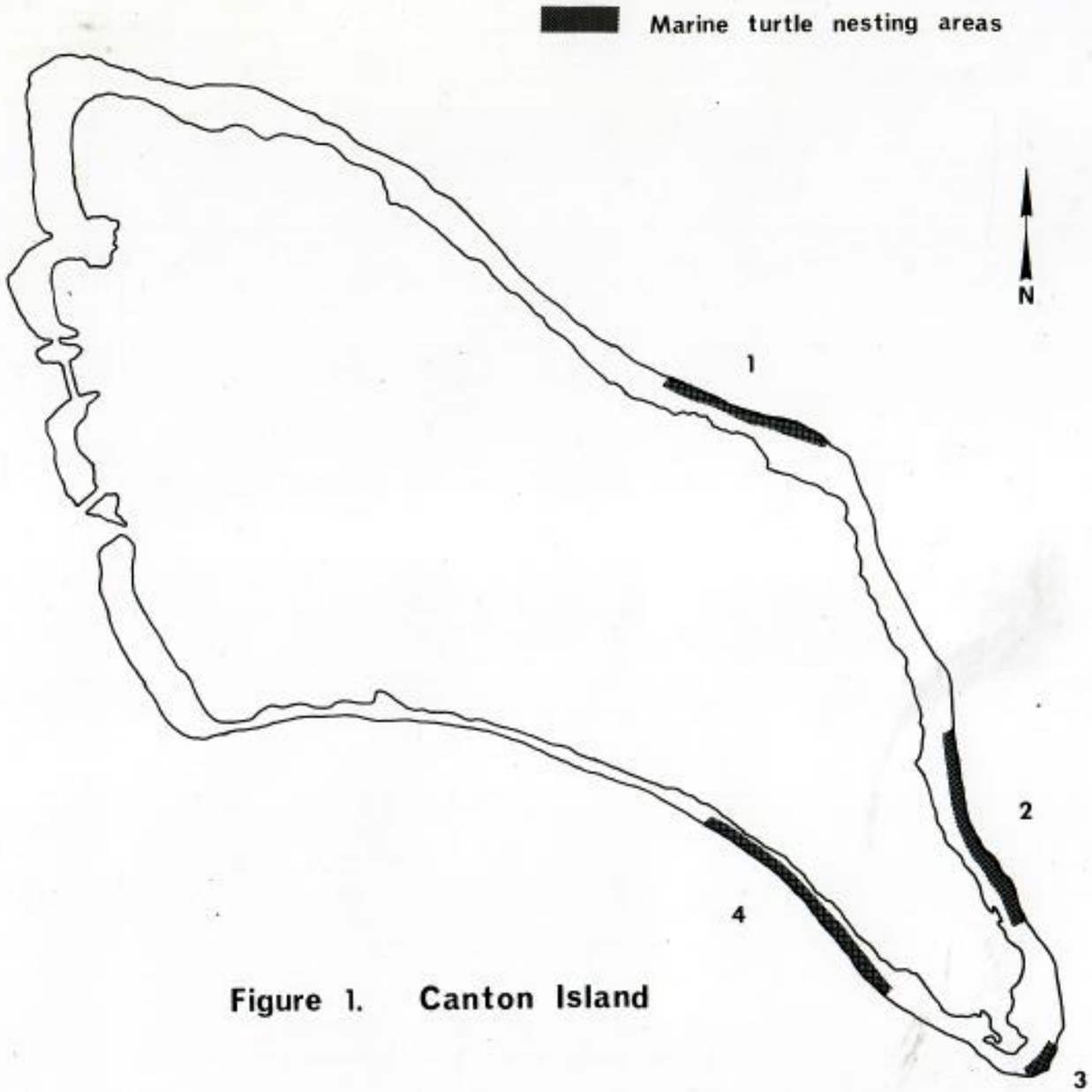

Figure 1. Canton Island