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**NOTES ON THE VASCULAR FLORA AND TERRESTRIAL VERTEBRATES OF
CAROLINE ATOLL SOUTHERN LINE ISLANDS**

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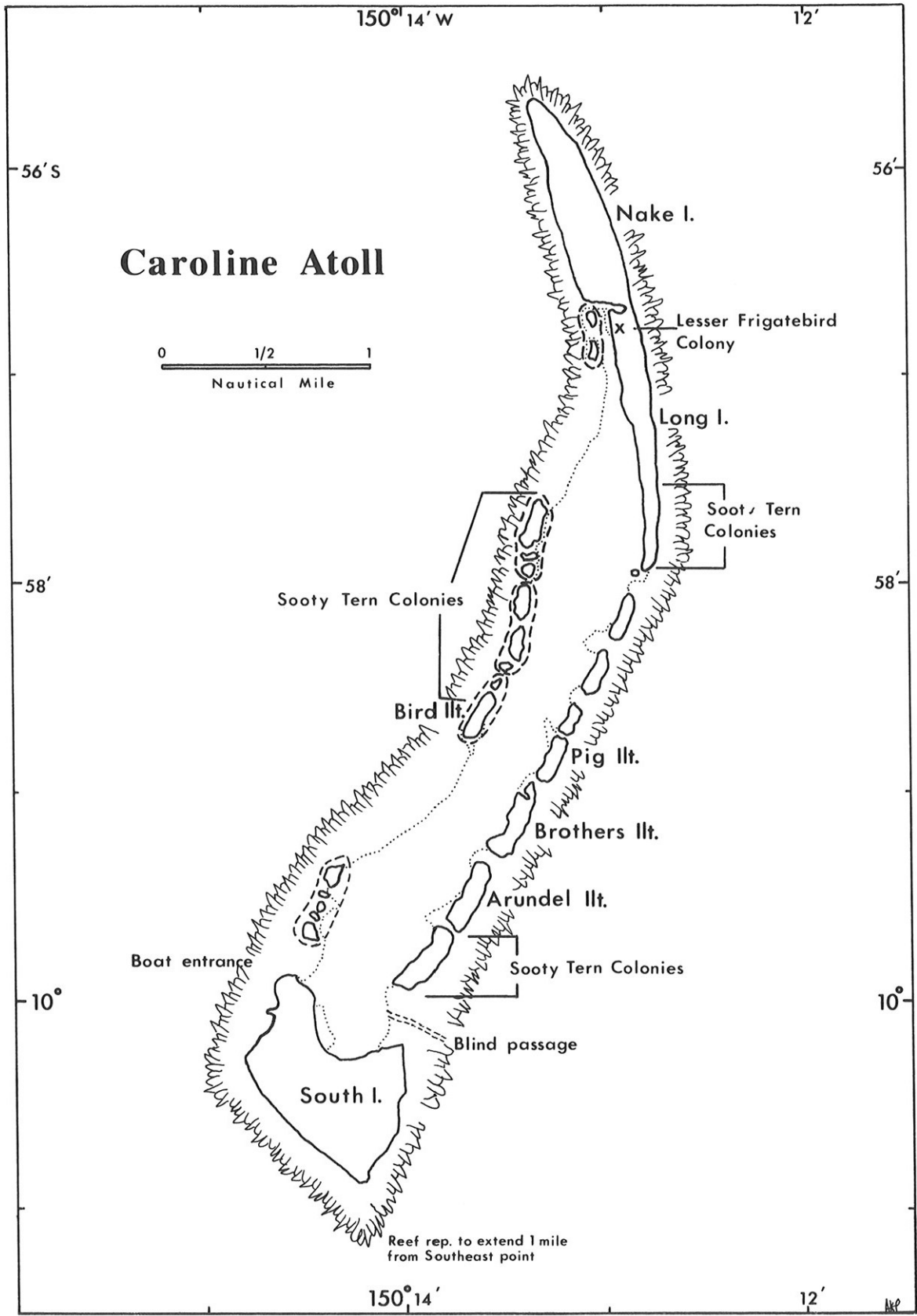


Figure 1. Map of Caroline Atoll. Modified from H. O. chart 928.

NOTES ON THE VASCULAR FLORA AND TERRESTRIAL VERTEBRATES OF CAROLINE ATOLL SOUTHERN LINE ISLANDS¹

by Roger B. Clapp² and Fred C. Sibley³

From 0900 on 17 June to 0615 on 19 June 1965 Caroline Atoll was visited by a field party from the Pacific Ocean Biological Survey Program (POBSP) of the Smithsonian Institution. The field party, led by Sibley, collected and made observations on vascular plants, fish, reptiles, mammals, and birds. All islands with the exception of the northern two-thirds of Nike were visited. Prior knowledge of the biota of Caroline Atoll is very scant, deriving almost entirely from the visits of F. D. Bennett in 1835, Devoy in 1875, and the U.S.S. Hartford in 1883. This paper summarizes earlier data and presents recent POBSP observations on the flora and terrestrial vertebrates, identifying many of them for the first time.

DESCRIPTION

Caroline is a low, densely vegetated, crescent-shaped coral atoll situated between 09°55' and 10°01' south latitude, and 150°14' and 150°13' west longitude. It is about 125 nautical miles east of Vostok Island and 125 miles northeast of Flint Island. The atoll is 5.75 miles long on the north-south axis, and attains a maximum breadth of 1.125 miles at the south end. Its area is ca. 942 acres and its circumference around the outer reef is about 13 miles (Holden and Qualtrough, 1884; Maude, 1953).

The central lagoon has much living coral, and coral heads break the surface. There are three large islands, Nike and Long to the north (conjoined on the east), and South to the south. Around the atoll rim and within the lagoon are small islets, many of which are unnamed (Figure 1). At low tide in 1965 there were 15 islets separated by water. Dry, unvegetated, flat areas of coral rock divide the islets, indicating that at one time over 25 separate islets may have existed.

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1. Paper No. 61, Pacific Ocean Biological Survey Program, Smithsonian Institution, Washington, D. C.
 2. Pacific Ocean Biological Survey Program, Smithsonian Institution.
 3. Point Reyes Bird Observatory, Bolinas, California.

BRIEF HISTORY OF MAN'S ACTIVITIES ON CAROLINE ATOLL

Caroline Atoll was discovered by Pedro Fernandez de Quiros on 21 February 1606 (Maude, 1959). The atoll was subsequently sighted or visited by parties from a number of passing ships. It was visited on 16 December 1795 by the British sloop Providence, commanded by W. R. Broughton, who named the island Caroline after the daughter of Sir P. Stephens, First Lord of the British Admiralty. In 1821 it was sighted by Captain Thornton of the English whaler Supply for whom it received the alternate name Thornton (Bryan, 1942). It was visited 10 to 13 October 1825 by Hiram Paulding on the U.S. schooner Dolphin, and in 1828 by a Captain Stavers. On 23 April 1835 F. D. Bennett (1840) visited the atoll from the whaler Tuscan. In 1875 Caroline was visited by C. D. Voy, a naturalist from California who collected molluscs (Pilsbry and Vannatta, 1905a, 1905b) and fish (Fowler, 1899, 1901). From 21 April through 9 May 1883 a party from the U.S.S. Hartford was there to observe a total eclipse of the sun (Holden, 1884). During the visit observations and collections were made of plants (Trelease, 1884) and lepidoptera (Butler and Strecker, 1884), and very sketchy observations of terrestrial vertebrates and invertebrates were made by Dixon (1884).

Archaeological remains found on Caroline indicate that the atoll was occupied, possibly by people from the Tuamotus (Emory, 1947), prior to European exploration of the Pacific, but the first recorded occupancy began in 1846 when Collie and Lucett, a British firm, established a small native agricultural experiment there (N.I.D., 1943).

Between 1865 and 1872 Messrs. Brown and Brothers planted coconuts on the atoll and in July 1868 there were 27 human occupants. In 1872 the island was leased to Houlder Brothers and Company of London, and later, in 1881, to their manager, J. T. Arundel. Approximately 10,000 tons of guano were exported between 1873 and 1895. Coconut palms were planted during this period and copra was harvested in small quantities (Bryan, 1942; N.I.D., 1943).

Caroline was subsequently leased to Messrs. S. R. Maxwell and Company Ltd., a New Zealand firm, and was worked continuously as a coconut plantation from 1916 until 1934 when the company failed. Exports during the latter part of this period amounted to about 14 tons per annum. For a short time thereafter Caroline was worked as a coconut plantation by the administrator for the company's affairs. By 1936 only a few Tahitian families were still occupying the atoll (N.I.D., 1943).

The atoll was evidently seldom occupied, if at all, after 1 June 1943 when the occupation leases were cancelled and possession of the atoll reverted to the British Western High Pacific Commission (Maude, 1953).

VEGETATION

In 1825, Paulding (1831) noted that Caroline had "some trees of a large size upon it and in most places a thick growth of underwood" and further remarked that "a boat load of pepper-grass and pursley, of which there was a great abundance" was obtained. He only mentions seeing one coconut tree which, in light of Bennett's observations (see below), suggests that South Island was not visited.

Nearly ten years later Bennett (1840) made more detailed observations of the vegetation. He recorded ten flowering plants and a fern, introduced three other species, and related that Cocos were found only in a grove on the northeast side of South Island--a grove that covered about one-fifth of the land area of that island. Bennett stated that the atoll was "covered with verdure" and that "the interior of the island [was] a surface of sand, mingled with coral debris as well as with decayed vegetable and animal matters, which give it increasing fertility". He also mentioned trees "attaining the height of twenty feet" which may indicate that Cordia or Pisonia groves or both covered a more extensive area in the last century. Bennett stated that "the woodlands are chiefly composed of two species of Tournefortia" which we can only interpret as a reference to Cordia as well as Tournefortia. We have not been able to determine the present disposition of Bennett's plant collection, if indeed it still exists.

The only reasonably thorough collection of plants was made by W.S. Dixon during the visit of the U.S.S. Hartford. Many of the plant species collected or observed by Dixon were probably introduced during the earlier occupation of the island. Dixon's collections and observations (27 or 28 flowering plants, a fern, an alga, and a fungus) were subsequently reported by Trelease (1884). All plants, with the exception of Fleurya ruderalis, were collected on South Island.

Below is a short summary of the vegetation of each large island and of the islet groups as observed by the POBSP in 1965.

South Island. Old Cocos groves cover most of South Island. Interspersed with these groves are thickets of Morinda that are often associated with Ipomoea tuba. In some open areas where Cocos have died or fallen the grass Lepturus repens forms a nearly closed stand with Ipomoea. A Suriana-Lepturus zone forms a fringing association around the island. Suriana forms a dense continuous border of shrubs on the north side bordering the lagoon (Figure 2). On the other sides the Suriana shrubs are taller (to 2 m), less compact, and more scattered. Patches of Lepturus are scattered here and there and often extend well outside and beyond the Suriana zone towards the high-tide line. Individual trees of Pisonia grandis and Cordia subcordata were likewise scattered over the island.

Nake Island. On Nake, which had been planted to Cocos like South Island, groves extend the entire length of the island. The greater robustness of these Cocos groves, the occurrence of Psilotum, and the more frequent occurrence of Tacca, suggest that Nake received more precipitation than other portions of the atoll.

Associations of Pandanus, Morinda and Tournefortia occur in open areas of the interior and along the edge of the Cocos stands. Along the northeast side an almost continuous stand of Tournefortia borders the area between the Cocos groves and the open sandy beach with its scattered clumps of Lepturus and the ubiquitous Boerhavia repens. Some older Tournefortia trees were nearly 3 meters high. Tacca was found in scattered groups in damp muck areas under the Cocos groves. The only Tribulus observed on the entire atoll was found in an open sandy area among Tournefortia shrubs on the south end of the island.

Long Island. Clumps of Morinda and Cordia occur on the north end. Pisonia, Cordia and Suriana were also observed. On both sides of the island Tournefortia forms a fringe with open areas supporting associations of Lepturus, Boerhavia, and Portulaca (Figure 3).

Windward Islets. Small Cordia groves are present on most of these small eastern islets. Brothers Islet has a few Cocos trees. Suriana, forming a dense stand with Tournefortia, was found (to 3 m in height) on the islet just south of Arundel Islet. Tournefortia is also an important component on the other windward islets.

Leeward Islets. The vegetation on these islets is much sparser than on those on the windward side of the atoll. Pandanus occurs on the three small islets south on Nake Island. Further south lies an islet with a few Cocos trees and Pisonia. The other islets on the south have Cordia and Tournefortia with Lepturus, Fleurya, and Heliotropium. The Fleurya occupies small sand-filled niches in the exposed coral rubble while the Heliotropium is found in sand on the lagoon side of the islets.

The general aspect of the vegetation indicated a lengthy dry spell prior to our visit.

VASCULAR FLORA OF CAROLINE ATOLL

Vascular plants were collected by C. R. Long (POBSP) on 17 and 18 June. Herbarium specimens will be deposited in the herbarium of the University of Hawaii and some duplicates in the herbaria of the United States National Museum and the Bernice P. Bishop Museum.

In the following list collection numbers are those of Long's. Species not previously known to occur on the atoll are marked with an asterisk.

Psilotaceae

*Psilotum nudum (L.) Beauv.

Found only on Nake I., common on wet base of Cocos, Long 3233.

Polypodiaceae

Polypodium scolopendria Burm. f.

Collected by Dixon and recorded by Bennett (as Polypodium phymatodes L.). Ground cover under Cocos forests on Nake I., Long 3244; under scattered Cocos north end of Long I., 3250; South I., 3287. Apparently thriving even under very dry conditions.

Pandanaeae

Pandanus tectorius Park.

An unidentified Pandanus was reported by Bennett and Trelease. Tree 2.5 m high at west edge of second islet south of Nake I., Long 3227. Also observed on Nake I.

Gramineae

Eleusine indica (L.) Gaertn.

Collected by Dixon. Not found by the POBSP.

Eragrostis tenella (Link) Beauv.

Collected by Dixon and reported by Trelease as E. plumosa Lk. Not found by the POBSP.

Lepturus repens (Forst. f.) R. Br.

Collected by Dixon. Tufts to 1.5 dm high in coral sand, on second islet south of Long I., Long 3211; islet northeast of South I., 3221; common growing in coral sand several meters above lagoon, Nake I., 3236; exposed site in sand on east windward side of Nake I., 3238; exposed site in sand, Long I., 3247; near lagoon shore of west side of fourth islet north of Bird I., 3259; numerous clumps under Suriana on South I., 3286.

Digitaria sp.

Collected by Dixon and recorded by Trelease as Panicum (Digitaria) marginata Lk.? C. R. Long who examined Dixon's specimen believes that it is a Digitaria which may be identical to Long 3235.

Bromeliaceae

Ananas comosa L.

Collected by Dixon who found it cultivated on Caroline. Not found by the POBSP.

Palmae

Cocos nucifera L.

Reported as "cocoa-nut trees" by Bennett and identified as above by Dixon. Dry groves of South I., Long 3285. Extensive stands cover Nake and South Is.; a scattered number on north portion of Long I.

Liliaceae

Crinum sp.

An unidentified lily collected by Dixon and reported by Trelease was probably in this genus.

Taccaceae

Tacca leontopetaloides (L.) O. Ktze.

Introduced by Bennett but not found by Dixon. Occasionally in moist muck of South I., Long 3213; in fruit on South I., 3219; common under Cocos forest of Nake I., 3234. Numerous patches found in muck on the south end of Nake I.

Moraceae

Ficus carica L.

Collected by Dixon. An introduction cultivated for its fruit. Not found by the POBSP.

Urticaceae

Fleurya ruderalis (Forst. f.) Gaud. ex Wedd.

Reported by Bennett and collected by Dixon. Common in shady areas of South I., Long 3215; scattered on an exposed site in coral rubble and sand, second islet south of Nake I. (west side), 3229; under shade of Cocos and Pisonia on north side of Long I., 3253. Many seedlings observed on Long I.

Chenopodiaceae

Boussingaultia gracilis Miers forma pseudo-basseloides Hauman

Collected by Dixon and reported by Trelease as B. baseloides. H. B. K. Trelease's comment that the specimen collected by Dixon was a "vine climbing over portico" suggests that it was introduced by residents of Caroline. Not found by the POBSP.

Nyctaginaceae

Boerhavia repens L.

Reported by Bennett as B. hirsuta and collected (as Boerhaavia, sp.?) by Dixon. Light purple flowers, second islet south of Long I.,

Long 3210; stems to 0.6 m long, large coriaceous leaves, red stems, islet northeast of South I., 3324; Nake I., 3239; stems to 0.5 m long, rooting at nodes, Nake I., 3225; north end of Long I., 3252; fourth islet north of Bird I., 3262; in shade, South I., 3289, 3291.

Pisonia grandis R. Br.

Collected by Dixon. Tree about 4 m high, north shore of South I., Long 3280. A small grove observed on the north end of Long I.

Portulacaceae

Portulaca lutea Sol.

Reported by Bennett. Trelease stated that Dixon recognized two varieties of Portulaca but neither was collected. Stems clumped, flowers yellow, islet northeast of South I., Long 3223; clumps 1.5 dm high, common in open coral and rubble, second islet south of Nake I., 3231; common on Nake I., 3237; common in gravel above lagoon shore on north end of Long I., 3255; fourth islet north of Bird I., 3257; common in exposed area on South I., 3292.

Cruciferae

Lepidium bidentatum Mont.

Collected by Dixon as L. piscidium Forst. Also reported by Bennett as a "Lepidium of luxuriant growth". Not found by the POBSP.

Leguminosae

Inocarpus fagiferus (Park.) Fosberg

Introduced by Bennett but not found subsequently.

Zygophyllaceae

*Tribulus cistoides L.

Stems to 0.8 m long in an open sandy area among Tournefortia shrubs on Long I., Long 3245. Not seen elsewhere on the atoll.

Surianaceae

Suriana maritima L.

Collected by Dixon. Shrub to 1.8 m high on east edge of islet northeast of South I., Long 3220.

Euphorbiaceae

Euphorbia pilulifera L.

Collected by Dixon. Not found by the POBSP.

Phyllanthus amarus Schum. and Thonn.

Collected by Dixon and recorded by Trelease as P. niruri L., Herb to 4 dm, common on the north side of South I., Long 3283.

Malvaceae

Sida fallax Walp.

Collected by Dixon who only found one specimen. Not found by the POBSP.

Guttiferae

Calophyllum inophyllum L.

Collected by Dixon but not found by the POBSP.

Caricaceae

Carica papaya L.

Collected by Dixon. An introduction not found by the POBSP.

Cucurbitaceae

Cucurbita pepo L.

"Recognized in cultivation" by Dixon but not found by the POBSP.

Convolvulaceae

*Ipomoea pes-caprae ssp. brasiliensis (L.) Van Ooststr.

Stems to 7 m long, in fruit, near copra shed, north shore, South I., Long 3281. Only one plant seen on the atoll.

Ipomoea batatas L.

Introduced by Bennett but not found subsequently.

*Ipomoea tuba (Schlecht.) G. Don

Trailing vine, white flowers, stems to 6 m long, common on South I., Long 3228; Nake I., 3242; trailing on Tournefortia at north end of Long I., 3251; stems to 25 m climbing over Morinda and Cocos on South I., 3293.

Boraginaceae

Cordia subcordata Lam.

Collected by Dixon. Tree to 4 m near lagoon, South I., Long 3213; tree to 3 m high in interior of islet in coral rubble about 15 meters above high tide line, west side of second islet south of Nake I., 3228; tree to 4.5 m high with orange flowers, common on interior of north end of Long I., 3246; fourth islet north of Bird I., 3261; tree to 4 m at edge of water along lagoon, north shore of South I., 3261.

Heliotropium anomalum H. and A.

Recorded (as Heliotropium curassavicum) by Bennett and collected by Dixon. In gravel of outer beach of islet northeast of South I., Long 3222; common in clumps to 1.2 dm high in exposed site in coral gravel on lagoon side of second islet south of Nake I. (west side), 3240; in gravel of lagoon shore, Long I., 3248; fourth islet north of Bird I., 3256; clumps to 2.8 dm high on coral gravel under Suriana on the southwest side of South I., 3288.

Tournefortia argentea L. f.

Probably seen by Bennett, and collected by Dixon. Small tree, with white flowers, 2.5 m high, edge of lagoon, South I., Long 3216; edge of islet northeast of South I., 3226; shrub 3 m high, above high-tide line, Nake I., 3241; Long I., 3249; common, fourth islet north of Bird I., 3258.

Scrophulariaceae

Russelia equisetiformis Schlecht.

Collected by Dixon as R. juncea Zucc. Trelease noted that it had been probably introduced. Not found by the POBSP.

Rubiaceae

Morinda citrifolia L.

Reported by Bennett and collected by Dixon. Small tree, 2 m high South I., Long 3214; young plant, 6 dm high, South I., 3217; shrub to 2.5 m, Nake I., 3232; common at edge of Pisonia forest north end of Long I., 3254; small tree to 3 m forming dense thickets, central area of South I., 3282.

TERRESTRIAL VERTEBRATES OTHER THAN BIRDS

"Small lizards" were reported in 1825 by Paulding (1831) but ten years later Bennett stated that he had seen no "lizards or other land amphibia." Dixon (1884) reported three species of lizards but did not identify them. Dixon also reported turtles (Chelonia mydas?) but noted they were not numerous.

Three species of lizards were found on the atoll by the POBSP and specimens were obtained of each: one Black Skink (Emoia nigra, USNM 158358), two Polynesian Geckos (Gehyra oceanica, USNM 158353-354), and three Mourning Geckos (Lepidodactylus lugubris, USNM 158355-357). No turtles were seen.

Domestic pigs were introduced by Captain Stavers in 1828 (Bryan, 1942) but none were present when Bennett visited the atoll seven years later. In 1848 several native families with "pigs, fowls, turkey, etc." were transported to Caroline by Edward Lucett (1851) and in 1868 the 27

persons living on the island were raising stock, pigs, and poultry (Bryan, 1942). No livestock were reported in 1883 by Dixon, nor were any found on the islands by the POBSP.

Rats were seen by both Bennett and Dixon. Bennett stated that the rats "were of a red-brown color," while Dixon noted that "the brown rat...is not numerous" and that "their nests were made in the cocoa-nut trees, just at the base of the fronds." The POBSP saw Polynesian Rats (Rattus exulans) on South Island and collected two (USNM 361450-451). USNM 361450 was a juvenile male weighing 19.3 grams and 361451 was a female weighing 53 grams. Measurements (in mm) of the total length, tail, hind foot, and ear for the two specimens were, respectively, 206, 106, 25, 15 and 270, 173, 30, 17. Rats were not common and were observed only on South.

OBSERVATIONS OF BIRDS

Few of the birds seen by Bennett and Dixon were identified to species but some were described in enough detail to allow an identification.

Bennett (1840) reported seven species: "a tree-nesting booby" (= Sula sula), "frigatebirds" (Fregata sp.), "a coot" (?), "curlews" (= Numenius tahitiensis), "a species of Totanus, similar to that we found at Raitea, with the exception that its legs are lemon-color, while in the Raitean species they were blue" (perhaps Heteroscelus incanum, while the bird seen at Raitea may have been Pluvialis dominica), "a great number of small pigeons, with white head and neck, and the rest of their plumage a rich brown color" (probably Anous tenuirostris but possibly A. stolidus), and "small white terns" (= Gygis alba).

Dixon (1884) reported 12 species but specific identification is reasonably certain for only four: "plover" (P. dominica), "curlew" (N. tahitiensis), a heron that occurred in "two varieties, brown and white" (= Demigretta sacra), and "an all-white tern" (= G. alba). He also reported "snipes" (Heteroscelus or Arenaria?), two species of "seagull" (?), "the noddy" (Anous sp. ?), the "Frigate bird" (Fregata sp.) a "Gannet" and a "Booby" (probably Sula sula and Sula sp.); he reported that a colleague had heard "the notes of a singing bird" (?). Arundel (1890) stated that "a pigeon" occurred on Caroline. This may have referred to Ducula but equally likely to Anous.

Thus, although a fairly wide variety of birds had been reported prior to the POBSP visit, specific identifications were reasonably certain for only five species: Red-footed Booby, Golden Plover, Bristle-thighed Curlew, Reef Heron, and White Tern.

In the following species accounts the numbers in parentheses following the species name are an estimate of the total number of flying birds, including breeding adults, nonbreeding adults, subadults and juveniles.

Following this figure is another which gives the estimated number of breeding birds.

These estimates are not very accurate since the brevity of the visit and the large number of islets visited precluded detailed census work. We present them because we feel that such estimates, although partly subjective, show relative abundance of the various species better than such words as "numerous", "common", or "scarce".

Annotated List

BLUE-FACED BOOBY (ca 10--at least 8 breeding birds) Sula dactylatra

POBSP personnel found two nests, one containing two eggs, the other a nestling, on the east side of Nike Island along the ocean beach. Navy personnel reported two other nests with eggs from the same area.

BROWN BOOBY (ca 15 \pm 10% -- at least 8 breeding birds) Sula leucogaster

Three nests, two with eggs and one with a nestling, were found on Nike Island. Five to eight adults were seen roosting on emergent portions of the coral reef along the southeast passage between South Island and the islet south of Arundel Islet.

RED-FOOTED BOOBY (5,000 \pm 25%--4,000 \pm 25% breeding birds) Sula sula

Red-footed Boobies were found nesting on almost all islands except South. Nests were found on a wide variety of plants (Cordia, Morinda, Pisonia, and Tournefortia) and contained eggs and young, with the latter ranging in size from recently hatched young to near-fledging juveniles. Several other nests were found that had been recently lined with fresh Pisonia leaves, suggesting that some females had not yet laid. In late April, 1835 (Bennett, 1840) Red-footed Boobies were building nests or hatching eggs (i.e., incubating). No young were seen and all eggs examined were heavily incubated.

Specimens: 3♂♂, 2♀♀, 18 June 1965: USNM 495106, ♂ left testis 10 x 4 mm, weight 726 g; USNM 495108, ♂ testes 14 mm, wt. 692 g; USNM 495109, ♂ testes 14 x 7 mm, wt. 635 g; USNM 495105, ♀, ovary 10 mm, granular, wt. 790 g; USNM 495107, ♀, ovary 20 x 10 mm, wt. 837 g; (USNM 495105 with a nestling, and 495106 and 495107 were collected from eggs).

GREAT FRIGATEBIRD (10,000 \pm 25%--8,000 \pm 25% breeding birds) Fregata minor

Great Frigatebirds were found nesting on almost all islands. Both eggs and young were present. Nests are found in the same habitat utilized by Red-footed Boobies.

Specimens: 2 ♀♀, both collected from eggs, 18 June 1965: USNM 495092 ovary 18 x 10 mm, 1g. ovum 4 x 4 mm, wt. 921 g; USNM 495093, 1g. ovum 3 mm, wt. 1200 g.

LESSER FRIGATEBIRD (1,000 \pm 10%, 400 \pm 10% breeding birds) Fregata ariel

Lesser Frigatebirds nested only near the north end of Long Island (Figure 1) where a small colony of ca 400 birds had constructed nests in low Morinda bushes and in small Cordia trees, both of which were much overgrown by Ipomoea tuba. Only eggs were found in the nests, but flying immatures, presumably birds from a previous breeding season, were noted. Other frigatebirds were seen displaying and building nests.

GOLDEN PLOVER (30 \pm 10%) Pluvialis dominica

Golden Plovers, like other shorebirds, were scarce but generally distributed throughout the coral reefs. They appeared, like other shorebirds, to be somewhat more abundant along the outer perimeter of the atoll.

Specimens: 18 June 1965: USNM 495722, σ , testes 3 x 2mm, wt. 113 g.

BRISTLE-THIGHED CURLEW (20 \pm 10%) Numenius tahitiensis

WANDERING TATTLER (70 \pm 10%) Heteroscelus incanum

Specimens: 3 $\sigma\sigma$, 18 June 1965: USNM 495726, testes 2 mm, wt. 102 g; USNM 495727, left testis 3 x 2 mm, wt. 101 g; USNM 495728, testes 3 x 2 mm, wt. 121 g.

RUDDY TURNSTONE (ca 5) Arenaria interpres

REEF HERON (40 \pm 25%) Demigretta sacra

Most Reef Herons were seen foraging singly around the reefs but appeared more common along the interior lagoon. No nests were found but the size of the gonads of one specimen (USNM 495303) suggests that the species may breed there.

Of ten different individuals tabulated on 18 June, half were white morph, half dark morph. No mottled individuals were seen.

Specimens: 2 $\sigma\sigma$, 1 ϕ , 17 June 1965; 1 σ , 18 June 1965: USNM 495301, σ , testes 5 x 3 mm, wt. 522 g; USNM 495302, σ , left testis 6 x 4 mm, wt. 540 g; USNM 495303, ϕ , lg. ovum 10 mm, wt. 541 g; USNM 498280, σ (skeleton).

SOOTY TERN (ca 500,000 \pm 25%--ca 400,000 \pm breeding birds) Sterna fuscata

Sooty Tern colonies were found on a number of the islets and several geographically discrete colonies were found on the same islet. In one instance colonies showed a discrete but small difference in their breeding cycles on the same island (Table 1). Most colonies contained incubated eggs to week-old chicks, indicating that peak eggs laying had occurred 2 to 5 weeks earlier (mid-late May).

Table 1. Sooty Tern Colonies on Caroline Atoll

Location of Colony	Approximate Number of Breeding Birds*	Breeding Status
Three groups of islets on west side of atoll just south of Nike I.	5,000	Eggs and small chicks
South half of Long I. (3 colonies)	100,000	Only downy young
	25,000	Eggs to week-old chicks
	20,000	Only eggs, most slightly incubated
Islet south of Arundel Islet (4 main colonies)	120,000	Eggs to week-old chicks (ca 20,000 eggs and 40,000 nestlings)
	10,000	Eggs to week-old chicks
	20,000	" "
	100,000	" "

*Most estimates determined by intensive banding or by estimating nesting density and colony area.

On most islands and on the islet south of Arundel, nests were located in the underbrush under stands of Tournefortia or other emergent vegetation or were in more open areas bordering such stands (Figure 5).

Considerable predation on eggs and nestlings by the coconut crab (Birgus latro) was noted in the colonies on the islet south of Arundel. Specimens: 1 ♂, 4 ♀♀, 17 June 1965: USNM 495481, ♂, rt. testis 7 x 5 mm, wt. 163 g; USNM 495479, ♀, ovary 11 x 5 mm, lg. ovum 2 x 2 mm, wt. 138 g; USNM 495480, ♀, ovary 10 mm, lg. ovum 1 mm, wt. 167 g; USNM 495482, ♀, ovary 10 x 7 mm, wt. 166 g; USNM 495483, ♀, ovary 10 x 7 mm, ova granular, wt. 159 g.

BROWN NODDY (1,000 ± 25%--800 ± 25% breeding birds) Anous stolidus

Nests contained both eggs and young.
Specimen: 17 June 1965: USNM 495562, ♂, testis 12 x 5 mm, wt. 150 g.

BLACK NODDY (7,000 \pm 25%, 5,000 \pm 25% breeding birds) Anous tenuirostris

Black Noddies were found nesting on most islands. The few nests examined contained eggs or young.

WHITE TERN (4,000 \pm 25% -- several thousand breeding birds) Gygis alba

White Terns were found breeding on most islands. About half of the breeding birds were with eggs, and half with young.

Specimen: 18 June 1965: USNM 495608, ♀, largest ovum 1.5 mm, wt. 100 g.

BLUE-GRAY NODDY (ca 5) Procelsterna cerulea

Several Blue-gray Noddies were seen flying over the central lagoon and one of these was collected. No birds were seen on the ground and no nests were found.

Specimen: 18 June 1965: USNM 495540, ♀, ovary 7 x 9 mm, lg. ovum 2 mm, wt. 54.1 g (in heavy body molt).

SUMMARY

Observations and collections of the flora and vertebrate fauna made by the Pacific Ocean Biological Survey Program in June 1965 are reported herein.

Twenty species of plants were collected including 18 flowering plants, a fern, and a psilotum. Of these the psilotum (Psilotum nudum) and three flowering plants (Tribulus cistoides, Ipomoea pes-caprae ssp. brasiliensis, Ipomoea tuba) had not been previously reported from the atoll. Five other species were collected for the first time (Pandanus tectorius, Cocos nucifera, Tacca leontopetaloides, Boerhavia repens, Portulaca lutea). Many other species previously recorded from Caroline were not found. Most of these were introduced species (e.g., Carica papaya, Curcubita pepo, Ficus carica) which probably did not survive the rigors of existence on the atoll.

Three species of lizards were collected and identified (Emoia nigra, Gehyra oceanica, and Lepidodactylus lugubris), none of which had been previously reported from the atoll but all of which are widespread in Polynesia. Polynesian Rats (Rattus exulans), which had not been previously identified to species, were also collected.

Fifteen species of birds were recorded. Four were migrant shorebirds (Golden Plover, Bristle-thighed Curlew, Wandering Tattler, Ruddy Turnstone) that occur commonly in the central Pacific. Reef Herons possibly breed on Caroline but may have wandered to the island from other breeding stations in the area. The remaining ten species are all seabirds that breed in the central Pacific. Of these, all were found breeding except the Blue-gray Noddy which is apparently only a visitor

to the atoll. Red-footed Boobies, Great and Lesser Frigatebirds, Sooty Terns, Brown and Black Noddies were all common to abundant, but Blue-faced and Brown Boobies were few in number.

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Figure 2. North side of South Island on lagoon. Note thick fringing stand of Suriana along high-water line. An occasional Pisonia or Cordia tree is found between the Suriana fringe and the Cocos forest.



Figure 3. East side of Long Island with Tournefortia fringe vegetation and scattered Suriana shrubs. Patches of Lepturus, Boerhavia, Portulaca association in foreground, Cocos to left.



Figure 4. North portion of Long Island as seen from the South Point of Nake Island. In the middle of Long Island are groves of Cordia and Pisonia with a dense fringing cover of Tournefortia



Figure 5. Sooty Tern colony among and under dense vegetation on Bird Islet.