MARINE TURTLES

HAWAIIAN AND OTHER

MARINE TURTLES AND NW HI

G.H. BALAZS FOLDER

2 of 2 - 1940s-1980s

LETTERS

"Focus On:" Sheds Light on Green Sea Turtles

Hearty congratulations are in order for publishing the "Focus On:" article on green sea turtles in the September/October '89 issue. Divers here in Hawaii often have the opportunity to see these graceful, gentle ocean creatures. However, often they are not aware that green turtles are fully protected under the U.S. Endangered Species Act. This includes protection from "harassment," such as approaching the animals so close they swim wildly away in fright, or grabbing onto their shells. Your article did a superb job of educating readers about the need for protecting these animals, while at the same time offering interesting facts about the animal.

This was indeed a refreshing breath of "compressed air" for us divers who all too often receive inadequate or no information about the protected status of sea turtles when reading your competitor's magazine (*Skin Diver!*).

George Balazs
Honolulu, HI

California Diver Takes Action Against Gill Nets

All California divers must get involved to get our deadbeat assemblymen moving on the gill net issue. I wrote a letter to both Assemblyman Trice Harvey of the 33rd district and Phil Wyman of the 34th district. Following is a letter I received from Harvey. I have yet to hear from Wyman, but I don't intend to stop with just a letter. Maybe I'll pay him a personal visit and bring him some dead fish. Think that will open his eyes?

Dennis Dilley
Bakersfield, CA

Dear Mr. Dilley:

Thank you very much for your letter supporting Assembly Bill 1 (Allen, Bates, Bradley and Ferguson). I appreciate hearing your views...

I find it horrifying that such atrocities are occurring to our ocean life as a result of gill nets and I assure you that I supported this measure when it came before me for a vote. The pictures that you enclosed with your letter were very sobering. I have been keeping aware of similar situations that are happening around the world as well as here in California and this is clearly a problem that needs to be rectified.

As you may know, this legislation has been brought up before in the 1988 legislative session and was under the title of Assembly Bill 2954. This was the only opportunity that I had to vote for it. Unfortunately, however, the measure failed due to strong opposition, mostly from the commercial fishing industry. AB 1 is basically the same bill reintroduced and is expected to face the same opposition...

Assemblyman Trice Harvey
33rd District, Sacramento, CA

Washington Game Law Listings a Bunch of "Ah-Baloney"

I think your person responsible for doing the game laws for Washington in the November/December '89 issue's "In Season" has nitrogen narcosis! At least we won't have to worry about out-of-state divers taking all of our game. It will take them some time to find a "kamchatka" abalone that is eight inches across. But on the other hand, they won't have that much time to search after the jail time they will serve for taking too many lingcod.

There are two sets of fish and game laws for the state of Washington, one for regular fishing and one for skin/scuba divers. Both are included in the game laws booklet, but they have to be fully read to see how they fit together in Washington's general game-taking scheme.

I realize that you probably have a space concern, and you've tried to summarize as best as possible, but what was printed in the November/December issue was not accurate, even in the shortened version. Good luck in finding an eight-inch abalone. I'll definitely let you know if I find one!

Finally, I ardently implore divers not to take wolf eels in Washington waters. Many have been tamed by divers for enjoyment. There are lots of other fish and things to eat. I would also urge that divers only take what they intend to eat, even if it is below the limit. Let's all help to conserve this wonderful natural resource!

Kay Hanvey
Chipmunk Enterprises
Olympia, WA

We stand corrected, and have revised Washington's game laws in our "In Season" section. Thanks for bringing this to our attention. — Ed.

Letters to the editor should be addressed to: PACIFIC DIVER Magazine, P.O. Box 6218, Huntington Beach, CA 92615. Letters may be edited for clarity and space.

of oceanic water with harbor water. Mundy made recommendations on the references necessary to identify fish larvae from Pago Pago Harbor, on the appropriate techniques for sample curation, and on the permanent museum collections where the samples could be stored once they are no longer of use to the DMWR. Recommendations also were made on modifications to the sampling design if future studies of this type are planned, and on the utility of the samples for the original purposes of the DMWR study.

The greatest value of this study is to document the seasonal occurrence of larvae, the species composition in the harbor, and the spawning seasons of fishes in the area. Future ichthyoplankton studies in Pago Pago Harbor would be justified to document changes in the biology of the harbor's fish community. (B. Mundy (808) 943-1212)

MARINE MAMMALS AND ENDANGERED SPECIES PROGRAM

Turtle Fecal Pellets Found on Hawaiian Beach Are Studied

Large numbers of buoyant fecal pellets began washing ashore in July 1989 at Kualoa Beach, Oahu, prompting a 40-day closure of the 1 km stretch of beach by the Hawaii Department of Health, according to George H. Balazs, a zoologist who heads the Honolulu Laboratory's Marine Turtle Research Program. In looking for the source of the pellets and their possible health hazards, State personnel initially suspected that the pellets were from pigs; human origin also was suggested. After a request by the State, however, Balazs identified the pellets as originating from the herbivorous Hawaiian green turtle, *Chelonia mydas*.

The green to brownish pellets (0.5-2 cm diameter; 5 cm long) consisted almost entirely of partially digested benthic algae, mainly *Codium* spp. and *Amansia glomerata*, which are commonly eaten by Hawaiian green turtles. Algae particles were clearly discernible with the naked eye after the pellets were broken open, and ova in the feces were determined to be non-mammalian and most likely from flukes that parasitize green turtles in Hawaii and elsewhere.

Over 300 pellets per day (range, 8-470 pellets per day; 40-day total, 5,500 pellets) were counted and collected for disposal by park maintenance personnel during the extreme periods. However, nearshore water samples analyzed by the Department of Health did not exceed the indicator bacterial limits set by the Environmental Protection Agency for ocean recreational waters (i.e., Colony Forming Units of fecal enterococci per 100 ml of seawater). Since the beach reopened on September 23, after the daily number of pellets declined and the health risks to humans were judged to be minimal, a few dozen pellets have continued to drift ashore each day.

The bacteriological aspects of the feces were measured in a preliminary follow-up study by Roger Fujioka and Carrie Fujioka, both of the University of Hawaii's Water Resources Research Center, in collaboration with Balazs. Fecal coliforms and fecal enterococci from turtle pellets freshly collected at Kualoa were low (Most Probable Number ((MPN) 3-43/g of feces) compared with mammalian and avian feces (MPN 10^6-10^8/g of feces). In addition, turtle pellets held at room temperature (21.5-25.5°C) had no multiplication of fecal coliforms or enterococci. Pellets placed in beakers of seawater for 15 days remained intact, were mostly buoyant, and had no bacterial growth. Breaking the feces into small pieces after 15 days also did not result in the isolation of fecal coliforms or enterococci from the water. Cultures performed for Salmonella by a private hospital and by the Hawaii Department of Agriculture were negative.

For the past 10 years, fecal pellets of green turtles have been known to wash ashore in small numbers on certain beaches in the Hawaiian Islands, and they have been used by scientists to identify food sources exploited by the turtles in certain nearshore foraging pastures. However, pellets had not been previously recorded at Kualoa Beach, even in small numbers, and green turtles are only occasionally sighted off this area. No unusual seasonal weather conditions or notable activity by turtles immediately off Kualoa occurred that might help to explain this acute event.

The most plausible area for the fecal pellets to have originated is Kaneohe Bay, which extends for some 13km immediately to the southeast of Kualoa Beach. A relatively large aggregation of mostly immature green turtles resides in the bay for foraging and resting purposes, but the number of resident turtles is not known to have suddenly increased in 1989. Turtles in this bay have experienced an increase in fibropapillomas, a debilitating and life-threatening tumor of unknown etiology. Furthermore, at least half of the turtles that were sighted during diving surveys or were hand-captured for tagging purposes in Kaneohe Bay now have tumors. Throughout the Hawaiian

Southwest FISHERIES CENTER

HONOLULU LA JOLLA MONTEREY TIBURON

REPORT OF ACTIVITIES January-February 1990

Islands in 1989, 49.6% of the 113 green turtles reported stranded had these tumors. (G. Balazs (808) 943-1240)

FISHERY MANAGEMENT RESEARCH PROGRAM

1989 Landings of NWHI Lobster Reported

The combined landings of spiny and slipper lobsters from the NWHI totaled 1.16 million lobsters in 1989, up 10% from 1988, according to data collected from the logbooks of NWHI fishermen. For the second year in a row, spiny lobster landings provided the bulk of the catch (81% by number). The 13 vessels active in 1989 took 33 trips, compared with 9 vessels taking 28 trips in 1988. Total trap-hauls equaled 1.07 million in 1989, compared with 845,000 trap-hauls in the previous year. As a result, the total catch per unit effort (CPUE) of legal-sized lobsters dropped from 1.25 in 1988 to 1.08 in 1989. The annual report for the fishery, including both biological assessment and revenue information, will be completed in April 1990. (S. Pooley (808) 943-1216)

Year-End Auction Activity Reported

During the last 2 weeks of December 1989, the number of longline fishing vessels off-loading at the Honolulu fish auction varied widely, from a low of 1 vessel to a high of 10 vessels, according to data collected by Kurt E. Kawamoto, fishery biologist. As a result, the volume of fish available on the auction floor fluctuated dramatically, occasionally causing substantial differences in prices among retail outlets. The NWHI bottomfish vessels made five trips during December, and only three of them targeted the New Year's market. Prices were not exceptionally high because good weather conditions in the main Hawaiian islands allowed local vessels of all sizes to consistently land fresh catches during the holiday period.

The highest priced tuna was a 151-lb bigeye tuna, which sold for $15.90/lb, while prices for onaga (red snapper, *Etelis coruscans*) peaked at $9.50/lb. Average daily prices generally did not exceed $8.00/lb (round weight) for tuna or $4.00/lb for bottomfish. (S. Pooley (808) 943-1216)

Commercial Fishing Vessel Inventory Prepared

A system for summarizing Honolulu-based, large-scale fishing vessel activities by 3-month periods (quarters) and by fisheries was recently completed by Ray F. Sumida, fishery biologist, and Stacey S. Yoshimoto, operations research analyst. The fisheries include NWHI bottomfish, precious coral, NWHI lobster (i.e., *Panulirus marginatus* and *Scyllarides squammosus*), *Heterocarpus* spp., skipjack tuna, and longline. Data for the system came from the shoreside monitoring activities of the Fishery Management Research Program in Hawaii. Data are summarized below for vessels that actively operated in a fishery in 1988 and 1989:

Fishery	Number of active vessels 1988	1989
NWHI bottomfish	13	6
Coral	1	1
NWHI lobster	9	12
Shrimp	1	3
Skipjack tuna	7	7
Longline	54	77

The summary charts are useful for spotting trends in a particular fishery or shifts in participation between fisheries. (S. Pooley (808) 943-1216)

Software System Developed for Modeling Production and Bioeconomics

A software system that allows for the calculation and prediction of biological and economic values from five surplus production models has been developed by Stacey S. Yoshimoto, operations research analyst. Written in dBASE 4, the system employs the Schaefer, Fox, Schnute, and Threshold models as well as a model developed by Yoshimoto; Raymond P. Clarke, a fishery development specialist with the NMFS Southwest Region Pacific Area Office; and Samuel G. Pooley, industry economist and leader of the Honolulu Laboratory's Fishery Management Research Program.

The system calculates intrinsic growth, catchability, and virgin biomass and employs the user's time series catch and effort data. The user can input cost and revenue parameters which are incorporated into a simple bioeconomic model (Gordon) that determines optimal yield, effort, and biomass values for maximum sustainable yield, maximum economic yield, and open access equilibrium, as well as predicted resource rent. The effects of discounting are demonstrated on optimal levels of resource rent, biomass, and yield. Any of the five models can be used to make predictions by using CPUE data from the previous time period and anticipated effort levels in the predicted time

3838 EAST LAS OLAS BOULEVARD
FORT LAUDERDALE, FLORIDA 33316 U.S.A.

Mr. Chuck Johnston, Editor
Hawaii Fishing News
P.O. Box 25413
Honolulu, Hawaii 96825

Dear Mr. Johnston:

We have just received your May, 1978 issue of **Hawaii Fishing News,** and we are most desirous of obtaining a copy of the photograph that appeared on your front cover. IGFA publishes many tagging articles and promotes tagging throughout the world. Surprisingly enough, we have great difficulty in obtaining good tagging photographs.

If you could not furnish us with this photograph, we would be most grateful if you could direct us to the person who does have this negative or a print.

I want to compliment you on your fine publication. It is one of the finest area fishing publications that we maintain in our International Library of Fishes. Certainly, the anglers in Hawaii should be very grateful for a publication that devotes this amount of space and a great number of photographs on recreational angling.

I do hope that you can help us with this photo.

Yours sincerely,
ELWOOD K. HARRY
President

UNIVERSITY OF HAWAII AT MANOA

HAWAII INSTITUTE OF MARINE BIOLOGY

P.O. BOX 1346
KANEOHE, HAWAII 96744

April 24, 1978

TO: Hawaii's Sport and Commercial Fishermen
FROM: George Balazs, Hawaiian Sea Turtle Research Program
SUBJECT: The Recovery of Turtles or Turtle Parts from the Stomachs of Large Fish

Virtually nothing is known about the life of sea turtles from the time they leave their natal beaches as one ounce hatchlings until they are first seen as juveniles (approx. 10 lbs or larger) in relatively shallow waters close to shore. This lack of information is due mostly to the fact that turtles under 10 lbs are seldom ever seen, thereby making them unavailable for scientific study. It has been reasonably assumed that smaller size turtles live for a period of time in the open ocean away from land where they feed at the surface on small animals (i.e. squids, crustaceans).

One method which I believe has considerable promise for gaining biological and ecological information on this little-known size category involves the indirect sampling of the turtles from the stomachs of pelagic fish such as tuna, mahimahi, marlin and others. These fishes (as well as sharks) could be expected to periodically eat small turtles. The recovery of whole small turtles or turtle parts from the stomachs of such predators is therefore entirely possible, provided that the person conducting the examination is alerted to the immense importance of such a finding.

If you should find a turtle or turtle part in the stomach of a fish, it would be greatly appreciated if you would contact me at your earliest opportunity (telephone 247-6631, collect if on an outer island). If I am not in my office when you call, please leave your name and number with our secretary and I will contact you as soon as I receive the message. After learning of your discovery by telephone, I would like to immediately pick up the recovered turtle material and transfer it to our laboratory for detailed study.

Thank you in advance for any assistance that you can provide to this research program. I would be pleased to talk with you at any time on matters relating to sea turtles.

Good fishing!

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Characteristics of Water Quality in Anchialine Ponds of the Kona, Hawaii, Coast.[1]

RICHARD E. BROCK, JAMES E. NORRIS,[2] DAVID A. ZIEMANN[3] AND MICHAEL T. LEE[4]

ABSTRACT: A study of the water quality characteristics of anchialine ponds of the Kona, Hawaii, coast suggests that groundwater is a major source of dissolved nutrients for these systems. These groundwater sources apparently show high spatial and temporal variability with respect to dissolved nutrients. Changes are apparent in the water quality characteristics of one anchialine pond system that has been subjected to considerable surrounding development. These changes are within the range of natural variability suggesting that this perturbation, at least over the short term (ca. 9 years), is not damaging since these nutrients frequently occur naturally in excess of concentrations which would control biological processes. Within an anchialine pond system that we have studied, spatial variability in water quality may be explained by a simple model of groundwater dilution with proximity to the sea.

ANCHIALINE PONDS are land-locked brackish water pools adjacent to the sea (Holthuis 1973). These pools have subterranean connections to the ocean and pond volumes respond to tidal fluctuations. Anchialine ponds are geographically restricted and are found in porous coralline or recent volcanic substrata. They are characterized by an unusual array of organisms, many of which are found only in the anchialine habitat. Anchialine ponds and their biota have only recently received attention in the literature (Holthuis 1973; Maciolek 1983; Kensley and Williams 1986). Most work has been concerned with descriptions of the biotope, taxonomy of the fauna, or hypotheses to explain observed faunal distribution; little quantitative information is available on the biota or any other component of the system. Reasons for this lack of information include the cryptic and hypogeal nature (*sensu* Maciolek 1983) of some anchialine species and the difficulty in sampling these systems.

In the Hawaiian Islands, anchialine ponds are found in the geologically young lava flows on Maui and Hawaii islands. More than 70% of the estimated 520 Hawaii Island anchialine ponds occur in a 53 km contiguous section of the Kona coast. The lands surrounding many of these Kona coast anchialine ponds have been proposed for or are undergoing resort and residential development. As a result, much of what is known regarding these anchialine systems is found not in the published literature, but rather in impact assessments written to fulfill environmental regulations.

One recently initiated development at the Waikoloa, Kona, area (between Waiulua and Anaehoomalu Bays) destroyed more than 130 anchialine ponds in late 1985; approximately 66 adjacent ponds with a combined water surface area of 1.4 ha were set aside in a 4.9 ha preserve (the Waikoloa Anchialine Pond Preservation Area—see Figure 1). Since the early 1970's, selected ponds in this Waiulua-Anaehoomalu complex (some of which are now in the preserve) were occasionally sampled for organism abundance or water quality characteristics. The literature on water quality characteristics of anchialine ponds is scant, and there are no comprehensive studies. Cox et al. (1969) reported nitrate, phosphate, and silicate levels from four Kona coast ponds; all other data are given in unpublished reports. With increasing human presence along the Kona coast, changes in anchialine pond water quality are likely. Such changes could have a profound effect on the biota. This study examines the water quality characteristics of an anchialine pond system undergoing surrounding development and tests the hypothesis that there has been no change in the water quality of this system since the commencement of development. We also propose a parsimonious hydrological model that explains the spatial variability observed in water quality characteristics of these ponds.

[1] Manuscript accepted March 1987.
[2] Hawaii Institute of Marine Biology, University of Hawaii, 1000 Pope Rd., Honolulu, HI 96822.
[3] Oceanic Institute, Makapuu Point, Waimanalo, HI 96795.
[4] U.S. Army Corps of Engineers, Pacific Ocean Division, Construction Operations Branch, Fort Shafter, HI 96858.

MATERIALS AND METHODS

Study Site

This study was carried out in the Waikoloa Anchialine Pond Preservation Area (WAPPA). The WAPPA is situated in the Waiulua Bay-Anaehoomalu section of the South Kohala District in Kona, Hawaii (Figure 1). The largest concentration of anchialine ponds on Hawaii Island was located in the Waiulua Bay area. In December 1985 more than 130 of these ponds were destroyed during the ongoing construction of a hotel complex. The WAPPA was established as a mitigative measure. Other development adjacent to and in the vicinity of the WAPPA has been undertaken over the last nine years; a golf course borders the preserve on the inland side and a road bisects it (completed in 1979, see Figure 1). About 550 m southeast of the management area is a second resort completed in 1981.

Three natural ponds were chosen for routine monthly sampling in the WAPPA. Sampling commenced in April 1986. The ponds were selected on the basis of their location in the system relative to nearby developments and the shoreline. The sampled ponds represent a range of situations from the inland/development margin of the preserve adjacent to the golf course to the natural shoreward/ocean border. Figure 1 presents a map of the WAPPA with existing borders and all extant ponds along with the three ponds (numbers 48, 155, and 188) that were routinely sampled; roadways and other nearby development are also indicated. Pond 48 was selected as representative of the inland location (approximately 308 m from the shoreline) that is close to development activities. Pond 155 is located in the center of the preserve (about 148 m from the ocean), and Pond 188 is situated close to the ocean (56 m away) and farthest away from direct construction activities.

Several other locations have been sampled monthly. One of these is a coastal well developed by the resort for irrigation purposes. The well is located about 1 km southeast and 850 m inland of the preserve, is well removed from coastal development, and serves as a source of natural (low salinity) groundwater for this study. As part of the permit requirements, the resort developer has dug the first of several man-made anchialine ponds (see Figure 1). These artificial ponds are designed to provide additional anchialine habitat. This first artificial water body is located just outside the WAPPA border about 50 m to the north of Pond 155. Water quality sampling of this pond commenced in July 1986 following its construction. In October 1986, water quality sampling of the irrigation water which is used on the golf course inland of the preserve was initiated. For comparative purposes, 24 anchialine ponds situated in the South Kohala–North Kona districts were sampled between November 1985 and September 1986. These ponds are representative of Kona coast anchialine systems and thus the water quality data serve as a control.

Data Collection and Laboratory Methods

In the field, replicate samples of several parameters were collected for laboratory analysis. Water samples that were analyzed for nutrients were filtered in the field through precombusted GFC (2.1 cm diameter) filters. All glassware and sample bottles were acid rinsed. With the exception of samples collected for salinity or chlorophyll analyses, all water quality parameters were sampled in triplicate. Although temperature and salinity stratification was occasionally observed in deeper (>70 cm) parts of some ponds, all

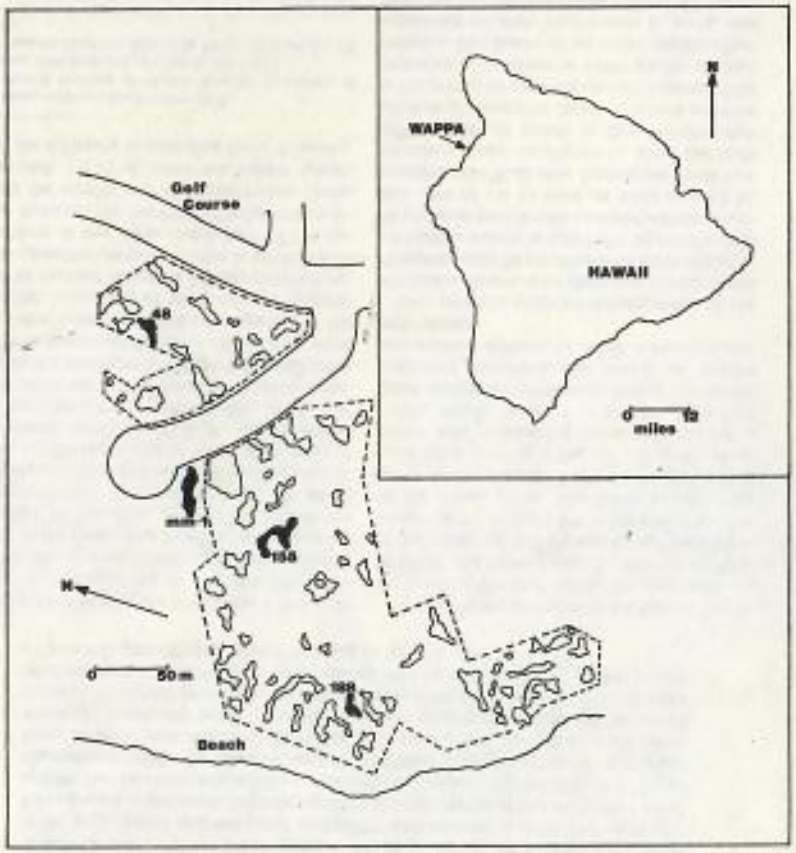

FIGURE 1. Map showing the location of four sampling sites (ponds 48, 155, 188, and mm-1) in the Waikoloa Anchialine Pond Preservation Area (WAPPA) The preservation boundary is shown as a dashed line. The location of the WAPPA on Hawaii Island is given in the inset.

samples were taken at a 15 to 20 cm depth in the water column to sample surface waters. Samples for salinity analyses were not filtered. Chlorophyll samples were collected and processed following the extraction and fluorescence procedures recommended by Jeffrey (1974), Jeffrey and Humphrey (1975), and Strickland and Parsons (1972). Salinity values were calculated from conductivity measurements obtained on a Plessey-Grundy model 6230N laboratory salinometer.

Micronutrient concentrations of samples were determined according to somewhat modified versions of the methods listed by Strickland and Parsons (1972). The analyses were performed on a Technicon Autoanalyzer II system. Using the autoanalyzer, PO_4^{-3} (as orthophosphate) was determined following methods as outlined by Murphy and Riley (1962), $NO_2^- + NO_3^-$ by the techniques of Armstrong, Williams, and Strickland (1966), NH_4^+ following the procedures of Solorzano (1969) and SiO_2 was determined after the methods of Strickland and Parsons (1972). More detailed information on the laboratory methods are given in Smith et al. (1981).

We commenced sampling the three natural ponds (nos. 48, 155 and 188) in April 1986. In May we began sampling the coastal well and in July, following its construction, the man-made pond was added to the list of regularly sampled localities. In October 1986 we initiated sampling of the water used to irrigate the golf course inland of the WAPPA. This irrigation water is drawn from the coastal well; the well water is used to dilute treated sewage effluent from the resort which is then utilized for irrigation purposes.

Data for the water quality parameters examined in this study were compared between natural ponds (pooling data for a given pond over all surveys) and between surveys (pooling data for all natural ponds in each survey). For the above comparisons and others made in this study, the Kruskal-Wallis analysis of variance was used (SAS Institute 1985).

RESULTS

The water quality data are summarized in Table 1. These data are presented sequentially with respect to station distance from the shoreline for each survey. Thus of the locations sampled, the most inland from the shoreline is the well, followed by Pond 48, the man-made Pond 155, and Pond 188 which is in closest proximity to the sea. The results of the Kruskal-Wallis one-way analysis that compares variables between the natural ponds (pooling data for a given natural pond over all surveys) and between surveys (pooling data for all natural ponds in each survey) are presented in Table 2. The results of these ANOVAs are discussed below.

Surface salinity measurements of the sampled locations in the WAPPA are given in Table 1. The tide state in all ponds was near mean low tide (0.0 m) during the first three sample periods and high (+0.05 to +0.8 m) during the last three. The tide during the October sample was unusually high. The sampled ponds in the preserve have maximum depths at mean tide of less than 1 m. The three natural ponds exhibited a between-pond gradient where surface salinity increased in a seaward direction. The deeper man-made pond exhibited a departure from this trend; in three of four samples, salinity was higher than in Pond 155.

Changes in surface salinity from one survey to the next are small; both Ponds 48 and 155 show a decrease in surface salinities at high tide while this is not apparent in either Pond 188 or the coastal well. The analysis of variance using pooled salinity data for each natural pond (48, 188, 155) over all surveys showed that significant differences exist between these ponds (Table 2). This horizontal salinity gradient is apparent in Table 1 and seems to be related to pond location relative to the sea. This gradient appears to be a relatively constant feature, for no statistically significant differences were found between surveys (Table 2).

The concentrations of nitrate plus nitrite (hereafter called nitrate) in the sampled ponds is given in Table 1. The data in Table 1 suggest some patterns: nitrate values were consistently lowest in the coastal well water, which presumably is representative of natural groundwater. The highest values were found in Pond 48, the most distant from the shoreline, and a trend of decreasing values is apparent in ponds located progressively closer to the shoreline. Similar to the salinity data this nitrate gradient is statistically significant between the natural ponds in the WAPPA but it is not between surveys (Table 2). The irrigation water sampled in October had a nitrate level of 46.21 μM.

The concentration of phosphate (PO_4^{-3}) in the various WAPPA ponds from April to October is given in Table 1. The distribution of phosphate shows a trend similar to nitrate in the WAPPA system: within any one sampling

TABLE 1

MEASUREMENTS OF WATER QUALITY PARAMETERS FROM THREE NATURAL PONDS, ONE MAN-MADE POND AND THE COASTAL WELL FROM THE WAPPA MADE OVER A SEVEN MONTH PERIOD FROM APRIL THROUGH OCTOBER, 1986. The tide state of each pond at the time samples were taken is presented simply as either low (L) or high (H)

LOCATION	SURVEY	TIDE	SALINITY (‰)	NO_3^- (μM)	PO_4^{-3} (μM)	NH_4^+ (μM)	SiO_2 (μM)	Chl *a* (mg/m3)
Coastal well	MAY	—	1.7	49.8	1.9	0.09	811	—
	JUL	—	1.7	47.6	2.0	0.05	814	—
	AUG	—	1.7	46.5	2.2	0.03	778	—
	SEP	—	1.7	47.4	2.4	0.04	791	—
	OCT	—	1.7	45.5	1.8	0.13	860	—
	X̄		1.7	47.4	2.1	0.18	811	—
	±S.D.		0.03	1.6	0.2	0.24	31	—
Pond 48	APR	L	6.3	74.7	5.1	0.90	745	0.07
	MAY	L	6.2	83.0	5.9	1.30	706	0.11
	JUL	L	6.4	79.4	6.5	1.20	705	0.09
	AUG	H	3.0	86.4	5.1	0.90	708	0.06
	SEP	H	4.1	98.1	5.7	0.91	738	0.08
	OCT	H	7.0	97.9	5.5	0.59	762	0.07
	X̄		5.7	86.6	5.3	1.00	732	0.08
	±S.D.		2.35	4.6	0.2	0.25	21	0.06
Man-made Pond	JUL	L	9.5	64.9	4.0	0.92	657	0.42
	AUG	H	7.3	66.3	3.8	0.47	681	0.67
	SEP	H	6.3	78.8	3.9	1.02	707	0.12
	OCT	H	7.8	78.6	4.2	1.29	691	0.04
	X̄		7.7	72.1	4.0	0.93	684	0.31
	±S.D.		1.3	7.0	0.2	0.31	21	0.29
Pond 155	APR	L	6.7	51.1	3.0	1.40	731	0.09
	MAY	L	6.5	78.3	3.6	1.03	701	0.11
	JUL	L	6.7	60.3	3.3	1.42	694	0.16
	AUG	H	5.2	60.6	3.6	1.11	708	0.09
	SEP	H	8.8	63.7	3.1	1.56	712	0.10
	OCT	H	4.1	68.6	3.2	0.71	751	0.07
	X̄		6.4	63.7	3.3	1.21	720	0.10
	±S.D.		1.4	8.6	0.3	0.30	21	0.03
Pond 188	APR	L	8.3	55.4	2.6	0.69	703	0.05
	MAY	L	10.5	50.4	2.4	0.85	638	0.08
	JUL	L	8.9	53.4	2.6	0.77	647	0.03
	AUG	H	9.6	45.0	2.7	0.57	628	0.09
	SEP	H	8.5	48.8	2.3	1.23	658	0.21
	OCT	H	15.2	44.4	2.4	0.72	598	0.06
	X̄		9.7	48.6	2.5	0.80	660	0.09
	±S.D.		2.3	4.6	0.2	0.22	40	0.06

TABLE 2

CHI-SQUARE VALUES FROM THE KRUSKAL-WALLIS ANOVA OF WATER QUALITY PARAMETERS. Analyses were performed with each response variable pooled across surveys (Pond analysis) and across ponds (Survey analysis). Significant differences at the $P < 0.01$ level are denoted with an asterisk

CLASS	SALINITY	NO_3	PO_4	NH_4	SiO_2	Chl *a*
Pond	14.80*	43.46*	47.16*	15.72*	12.85*	2.84
Survey	1.14	2.40	1.29	21.26*	7.53	5.54

period, phosphate concentration was lowest in the low salinity coastal well, highest in the most inland pond (48) and decreased in ponds located closer to the shoreline. These differences in phosphate levels between ponds are statistically significant (Table 2). This trend is apparently stable through time for there are no statistically significant differences between surveys (see Table 2). The phosphate concentration of the single irrigation water sample was 19.7 μM, over three times the concentration found at any other location.

Ammonium (NH_4^+) concentrations in the sampled ponds through the April–October period are also given in Table 1. The low salinity coastal well ammonium levels are an order of magnitude lower than the concentrations seen in the ponds. Although highest values were found in the central part of the preserve (Pond 155), the trend of decreasing ammonium concentrations with proximity to the shore persists. These differences are statistically significant between ponds as well as between surveys (Table 2) suggesting considerable fluctuation in concentration through time. The single irrigation water sample provided the highest ammonium concentration recorded in this study (9.4 μM), almost six times the concentration observed at any other location.

As with the other nutrients, silicate levels were highest inland and they decreased towards the sea (Table 1). The differences in the level of silicate between ponds are statistically significant but no significant differences exist between surveys (Table 2) suggesting that the seaward gradient in silicate is temporally stable. The silicate concentration from the single irrigation sample was 887 μM.

Chlorophyll *a* (Chl *a*) concentration in the sampled ponds did not exhibit any obvious trend; these data are given in Table 1. In the natural ponds (48, 155, and 188) mean Chl *a* concentrations are similar with no statistically significant differences apparent either between ponds or surveys. The highest Chl *a* values were found in the man-made pond.

Twenty-four anchialine ponds well removed from the Waikoloa pond preserve along the Kona coast were sampled for comparative purposes. Other than one pond with nearby hotel construction, these pools have been subjected to little or no surrounding development. The results of water quality sampling in these ponds are as follows ($\bar{X} \pm$ S.D.): salinity ranged from 1 to 14 ppt (6.3 ± 3.0 ppt), nitrate values were between 0.5 to 62.4 μM (38.1 ± 19.6 μM), phosphate concentrations were between 0.5 to 6.6 μM (2.0 ± 1.9 μM) and ammonium ranged from 0.3 to 14.8 μM with a mean of 3.1 ± 3.6 μM.

DISCUSSION

A characteristic feature of west Hawaii is its diffuse groundwater discharge at the shoreline (Cox et al. 1969). Estimates range from 2300 to 9400 $m^3\,day^{-1}\,km^{-1}$ of coastline in the vicinity of the WAPPA (Kanehiro 1977). This discharge is a result of the island's geologically young lavas. The high porosity of these lavas will not support water contained above sea level near the shoreline (Cox et al. 1969). Thus, anchialine ponds are restricted to depressions in the lava that extend down into the water table. Anchialine ponds are defined as having brackish water; this mixohalinity is the result of seaward-flowing groundwater moving through the porous substratum and mixing with warmer, more saline waters below. Typically the residence time of water in anchialine ponds is on the order of hours and is related to high substratum porosity (Kanehiro 1977). Because of the subterranean connection, anchialine ponds are tidally influenced; groundwater mixes with seawater and the water quality of the ponds reflect this interaction. Since groundwater and seawater show distinct differences in the water quality characteristics we measured, the pond characteristics are expected to display variability compatible with relative influence of a given water type prevailing at a given tidal condition. Thus tide state and the resulting variable degree of mixing contribute to the extant chemical conditions in anchialine ponds. These conditions may be further altered by other physical (e.g., solar radiation, basin permeability, and location, etc.) and biological processes (e.g., nutrient assimilation by plants).

Along the Kona coast, the greatest natural contribution of nutrients comes from groundwater rather than surface seawater (Bienfang, 1980). This author noted nearshore ocean water nutrient concentrations from a location 35 km south of the WAPPA as follows: nitrate 0.3 μM, phosphate 0.1 μM and ammonium 0.3 μM. Swain (1973) reported groundwater nitrate concentrations ($\bar{X} = 55.7$ μM, n = 2) and silicate concentrations ($\bar{X} = 1550$ μM, n = 2) from an upland well. Kay et al. (1977) noted Kona coast groundwater nitrate levels ranging from 27 to 108 μM ($\bar{X} = 57 \pm 15.3$ μM, n = 8) and phosphate concentrations from 1 to 3.9 μM ($\bar{X} = 2.1 \pm 0.3$ μM, n = 8). In the present study, groundwater nitrate, phosphate, and silicate, as represented by the coastal well samples, are all relatively high. Reported natural groundwater nutrient levels in other localities may be greater. Johannes (1980) reported groundwater nitrate levels between 115 and 380 μM from Perth, Australia, and Marsh (1977) noted nitrate concentrations in Agana, Guam groundwater of 178 μM.

The subterranean flow of the low-salinity, high-nutrient water towards the shoreline at Waikoloa is driven by the hydrostatic head developed inland; because of low rainfall and high substratum permeability this water table gradient is only about 19 cm km^{-1} (Kanehiro 1977). This suggests that the water chemistry of the WAPPA ponds is controlled by the net seaward flow of groundwater. The data for nitrate, phosphate, and silicate show a statistically significant gradient relative to pond location, decreasing with proximity to the shoreline. Salinity shows an opposing statistically significant gradient with respect to distance from the sea. These gradients appear to be relatively stable features (no statistically significant changes through time) and are probably caused by the dilution of groundwater with seawater on its movement towards the sea, as well as by modification due to biological activity (assimilation) in the ponds. Ammonium does not seem to follow the trend described for the other nutrients. The statistically significant spatial (between ponds) and temporal (between surveys) differences in ammonium concentrations are probably reflective of rapid turnover of this nutrient. Most of the plant biomass in these anchialine systems is comprised of benthic (attached) algae; phytoplankton which our Chl *a* samples measure comprises a small proportion of the total. Phytoplankton response to the nutrient gradient as measured by Chl *a* was low and not significant suggesting that pond water residence time is short relative to phytoplankton turnover.

The seaward flow of high nutrient groundwater and its dilution by nutrient-poor seawater provides a simple model that explains the observed trends in water chemistry of the Waikoloa anchialine ponds. Nutrient levels other than silicate in the natural groundwater (as represented by the coastal well) are, however, consistently lower than concentrations found in the inland ponds. Thus, if this model is correct, there must be additional nutrient input occurring between the coastal well and the inland border of the WAPPA (Pond 48). One possible source is the Waikoloa golf course situated about 30 m inland of the preserve. Water used to irrigate the grounds is enriched with treated sewage effluent. We obtained the following nutrient concentrations (in μM) from this irrigation water: nitrate 46.2, phosphate 19.7, ammonium 9.4, and silicate 887. Dry fertilizers (21–7–14, N : P : K ratio) are also applied to the golf course at an approximate rate of 276 kg ha^{-1} yr^{-1}. Nitrogen and phosphorus from these sources may be entering the WAPPA groundwater although Chang and Young (1977) found no leaching to groundwater beneath a golf course on Oahu receiving a similar nutrient subsidy. This (1977) study however was carried out on older, much less permeable substrate than is present at Waikoloa. Autochthonous input of nitrogen is also possible through nitrogen fixation by the kiawe tree (*Prosopis pallida*) which is present in the pond preserve. If significant autochthonous nutrient production was occurring throughout the preserve, one might expect a gradient of increasing nitrate levels towards the shoreline. This is not the case.

Comparative anchialine pond nutrient data are available from Cox et al. (1969). These authors noted nitrate, phosphate and silicate levels in four anchialine ponds adjacent to the

TABLE 3

Comparison of Mean Salinities (‰ ± SD) and Mean Nutrient Concentrations (μM ± SD) Taken in 1977 From Fifty Ponds Located in or Near the WAPPA (Bienfang 1977) and the Three Natural WAPPA Ponds Surveyed in This Study. Significant differences exist between the means of the two studies for nitrate and phosphate ($P < 0.01$, Kruskal-Wallis ANOVA)

Source	N	s (‰)	NO_3^-	PO_4^{-3}	NH_4^+
Bienfang (1977)	88	6.6 ± 1.8	17.81 ± 9.52	1.17 ± 0.33	0.94 ± 0.84
Present Study	18	7.4 ± 2.8	66.33 ± 17.70	3.70 ± 1.26	0.59 ± 0.30

WAPPA prior to any development. Mean concentrations (μM ± SD) are as follows: nitrate 54 ± 3.4, phosphate 1.5 ± 0.4, and silicate 609 ± 100. Other than phosphate which is low relative to the present study, these values are similar. More water quality data for the Waikoloa anchialine system prior to any development are available from Bienfang (1977). This author reported water quality data for 50 anchialine ponds overlapping with and in the vicinity of the WAPPA. The grand means for Bienfang's (1977) data as well as those from the present study are given in Table 3. A Kruskall-Wallis ANOVA of these data point to statistically significant positive differences in the concentrations of nitrate and phosphate between the two studies. These significant increases may be related to the use of enriched irrigation water (i.e., sewage effluent diluted with coastal well water) and fertilizers on the Waikoloa golf course constructed subsequent to Bienfang's (1977) survey.

In conclusion, this study documents statistically significant increases in nitrate and phosphate concentrations in the Waikoloa anchialine ponds since 1977. Although statistically greater, nutrient concentrations in the WAPPA presently fall into the range of values observed in the groundwater or other anchialine ponds along relatively undeveloped sections of the Kona coast. Periodic sampling of the biota in these ponds from 1972 (Maciolek and Brock 1974) to present has yielded no obvious changes, suggesting that the biota of anchialine pond systems are insensitive to the increased nutrient concentrations observed in this study. It appears that these nutrient species are in excess and thus are not limiting. Possible mechanisms to this apparent biotic insensitivity are the characteristic short water residence time of ponds and the usual presence of large numbers of endemic herbivorous crustaceans. Through their grazing these crustaceans appear to keep many macroalgal species from dominating the system. Any perturbation affecting these mechanisms could result in major shifts in the structure of anchialine pond communities.

ACKNOWLEDGMENTS

The authors wish to thank Drs. S. V. Smith, P. Bienfang, and J. H. Brock for their review of the manuscript. This work was supported in part by the Waikoloa Anchialine Pond Preservation Area Trust Fund. HIMB contribution no. 733.

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count includes all tagged pups, known deaths, and pups still nursing at the end of the field season. More than half of all births occur at French Frigate Shoals. Total births have increased over the past 2 years. Total known production was 161-184 pups in 1983-86, 204 pups in 1987, and 223 pups in 1988. The recent overall increase reflects increases in the numbers of pups born at French Frigate Shoals, Laysan Island, and Kure Atoll. The numbers of pups born at Lisianski Island and Pearl and Hermes Reef show no clear pattern and are less complete because of the low field effort at these two locations. (T. Johanos-Kam (808) 943-1221)

Green Turtle Habitats in Kaneohe Bay Documented for Long-Term Monitoring and Assessment

Two discrete habitat sites in Kaneohe Bay, Oahu, were recently identified as being intensively used by the green turtle, *Chelonia mydas*, according to George H. Balazs, Leader of the Marine Turtle Research Task. One site (ca. 0.25 km^2 3-7 m deep) is used as a benthic resting area for adult and immature turtles, and its bottom substrate is mainly outcroppings of *Porites* coral. The other site is a shallow (m deep), narrow, sandy bottom zone (100 m wide by 1 km long) where turtles forage on a luxuriant meadow of sea grass, *Halophila hawaiiana*.

During three daytime study visits to these sites, 15 turtles were hand-captured by researchers using scuba or snorkel gear. All turtles were measured and tagged, and the status of their health was assessed prior to release. No previously tagged turtles were encountered, although existing records show that adults originally tagged at the breeding site of French Frigate Shoals 750 km to the northwest have been resighted in Kaneohe Bay.

Two problems were identified during the course of this preliminary investigation. Fibropapillomas were found on 8 (57%) of the 15 turtles captured, constituting the highest rate seen thus far anywhere in Hawaii. The sizes of these epithelial growths ranged from 0.5 to 8 cm in diameter or length. Two of the turtles had multiple, extensive growths, which likely were interfering with normal behavior. Studies at other sites in Hawaii have shown that fibropapillomas on green turtles can grow rapidly and reach gross proportions in only 2-3 years. The second problem identified was the displacement of turtles from segments of the *Halophila* foraging pasture. This is due to tour operators and other vessels anchoring within the zone on a daily basis for recreational activities with large groups of people.

More information will be generated on both of these problems with the implementation of a long-term research and monitoring program. In the immediate future, cooperative work will take place with a veterinary pathologist from the University of Florida; the pathologist will visit Hawaii to biopsy fibropapillomas in search of the elusive etiological agent. (G. Balazs (808) 943-1221)

FISHERY MANAGEMENT RESEARCH PROGRAM

Preliminary Estimates of Hawaii's Fisheries Landings and Value in 1988

Preliminary estimates of Hawaii's commercial fishery were prepared by Samuel G. Pooley, Industry Economist, for inclusion in the NMFS publication, Fisheries of the United States, 1988. The estimates, using the publication's rather unusual reporting requirements, are as follows:

Species group	Pounds (1,000's)	$US (1,000's)
Marlin	2,757	2,853
Bottom fish	1,675	2,647
Tunas	12,705	23,754
Shellfish	1,531	5,508
Other fish	2,463	4,987
Total	21,131	39,749

These figures, which show a 30% increase over 1987, should be used only as early indications of Hawaii's fishery status in 1988. Revised figures will be included in the annual report modules prepared for the fishery management plans for the Western Pacific Regional Fishery Management Council (Council).

Preliminary Status Report on the Bottom Fish Fishery in the Northwestern Hawaiian Islands

A brief status report on Hawaii's bottom fish fishery was prepared for the Council's April meeting in American Samoa. The report, which is based on preliminary data from NMFS market sampling, shows that bottom fish landings in Hawaii have remained about the same for the past 3 years. However, landings from the Northwestern Hawaiian Islands (NWHI) have fallen by 34% since 1986, while landings from

Southwest FISHERIES CENTER

HONOLULU LA JOLLA MONTEREY TIBURON

REPORT OF ACTIVITIES March-April 1989

The Research Corp. of the Univ. Hawaii Annual Report 1980

Continuing Direct Projects

Programs reported in an earlier annual report that have continued their activity into this fiscal year are:

DR. JAMES E. ANDREWS
Hawaii Institute of Geophysics
MAC/DUMAND Project
State of Hawaii Marine Affairs Coordinator
MAC Task Order #168
$35,000

DR. GEORGE BALAZS
Hawaii Institute of Marine Biology
MAC/NWHI Fisheries Investigations: Survey/Assessment of Green Sea Turtle Resources
State of Hawaii/Marine Affairs Coordinator
MAC Task Order #173
$29,237

DR. THOMAS BURCH
Department of Health/Research & Statistics Branch
Vital Statistics Component of the Cooperative Health Statistics System
State of Hawaii/Department of Health
$57,658

DR. THOMAS BURCH
DR. ROBERT MYTINGER
Department of Health/Research & Statistics Branch/School of Public Health
Developing and Implementing the Manpower Component of the Cooperative Health Statistics System
State of Hawaii/Department of Health
$54,646

DR. THOMAS BURCH
DR. ROBERT MYTINGER
Department of Health/Research & Statistics Branch/School of Public Health
Developing and Implementing the Health Facilities Component of the Cooperative Health Statistics System
State of Hawaii/Department of Health
$36,912

DR. G. P. CARAYANNIS
International Tsunami Information Center
International Tsunami Information Center
National Weather Service
National Oceanic & Atmospheric Administration
$12,348

DR. KEITH E. CHAVE
Hawaii Institute of Geophysics
MAC/Hawaii Coastal Zone Data Bank
State of Hawaii/Marine Affairs Coordinator
MAC Task Order #157
$45,000

MR. WILLIAM R. COOPS
MR. LOU LOPEZ
DR. BILL H. CHEN
Research Corporation of the University of Hawaii
HGP-A Geothermal Wellhead Generator Feasibility Project
Department of Energy, State of Hawaii, Hawaii Electric Light Co., County of Hawaii
$6,352,000

MR. WILLIAM R. COOPS
Research Corporation of the University of Hawaii
HGP-A/DG Wellhead Generator
State of Hawaii/Department of Planning & Economic Development
$400,000
State of Hawaii contribution to the Wellhead Generator Project.

MR. WILLIAM R. COOPS
Research Corporation of the University of Hawaii
HGP-A/DG Wellhead Generator
County of Hawai
$100,000

MR. WILLIAM R. COOPS
Research Corporation of the University of Hawaii
Construction of Service Facilities for the Natural Energy Laboratory of Hawaii
State of Hawaii/Department of Planning & Economic Development
$1,080,000

DR. JOHN P. CRAVEN
MR. WILLIAM R. COOPS
Marine Programs
Office of the Marine Affairs Coordinator
MAC/Management of Makapuu Point Pier
State of Hawaii/Marine Affairs Coordinator
MAC Task Order #165
$5,000

DR. JOHN P. CRAVEN
Office of the Marine Affairs Coordinator

MR. BROOKS TAKENAKA
United Fishing Agency
MAC/Taape Fish Project Workshop
State of Hawaii/Marine Affairs Coordinator
MAC Task Order #208
$525

RCUH shall assist MAC in enhancing and increasing the public's knowledge of taape as a consumerable and palatable food.

DR. LEIGHTON TAYLOR
Waikiki Aquarium
Waikiki Aquarium Educational Pamphlets Project
Hawaiian Academy of Science
$2,000

Funds to be expended for the Waikiki educational pamphlets.

DR. LEIGHTON TAYLOR
Waikiki Aquarium
MAC/Feasibility Study on Relocating the Waikiki Aquarium
State of Hawaii/Marine Affairs Coordinator
MAC Task Order #205
$25,000

RCUH shall assist the MAC in carrying out the study of relocating the Waikiki Aquarium and to determine the nature, location and support for an appropriate State Aquarium.

DR. LEIGHTON TAYLOR
Waikiki Aquarium
MAC/Searound Facility
State of Hawaii/Marine Affairs Coordinator
MAC Task Order #177
$13,500

Complete installation of Searound Facility at Waikiki Aquarium and make facility a functioning entity.

DR. FRITZ THEYER
Hawaii Institute of Geophysics
Intergovernmental Personnel Act Assignment Agreement
National Science Foundation
$43,578

Funds to be used for the services of Dr. Fritz Theyer to the National Science Foundation. The purpose of this assignment is to strengthen the planning, development, and technical direction of deep sea drilling for scientific purposes. Particularly important are scientific coordination and evaluation of the Deep Sea Drilling Project and effective liaison with the Joint Oceanographic Institutions for Deep Earth Sampling and with the Earth Sciences community in general.

DR. JON VAN DYKE
School of Law
MAC/Investigation of the Legal Issues and Jurisdictional Disputes in the Pacific
State of Hawaii/Marine Affairs Coordinator
MAC Task Order #204
$5,000

RCUH shall assist in carrying out a study, an investigation and research on jurisdictional disputes in the Pacific area, their impact on international relations, the economic consequences, if any, and their effect in future sea conferences.

DR. NANCY WITHERS
Hawaii Institute of Marine Biology
MAC/Ciguatera/NWHI
State of Hawaii/Marine Affairs Coordinator
MAC Task Order #173
$4,373

Carry out investigations of the role of dinoflagellate *Gambierdiscus toxicus* in causing ciguatera, and to relate finding to conditions in Northwestern Hawaiian Islands.

MR. GEORGE YUEN
Department of Health
State Plan for Developmental Disabilities
State of Hawaii/Department of Health
$6,000

Completion of a State Plan for Developmental Disabilities.

MR. GEORGE YUEN
Department of Health
Women's Health & Family Planning Outreach Project
State of Hawaii/Department of Health
$5,735

RCUH shall provide support in developing two projects related to family planning education and outreach: (1) The Advocacy Training Project will train women's health advocates in Waikiki and Waianae and provide certain types of support to them in teaching and assisting women to prevent unwanted pregnancies and promote more healthful living; (2) The Fertility Awareness Training Project will develop training programs on the neighbor islands for family planning staff, public health nurses, teachers and others interested.

MR. GEORGE YUEN
Department of Health
Research Relative to Outcome Objectives
State of Hawaii/Department of Health
$56,265

RCUH shall provide to the Department of Health professional services to conduct research, design studies, compile and evaluate information, and prepare written reports of findings, conclusions, and recommendations to assist and advise the Department of Health concerning the achievement of outcome objectives for maternal and child health services.

The Cell Separator, a specially designed machine which is able to collect specific blood components, is operated at the Cancer Center by trained nurses.

Continuing Service Ordered Projects

Annual Report 1981

Programs reported in an earlier annual report that have continued their activity into the fiscal year are:

DR. JAMES BEARDEN
Cancer Center of Hawaii
RDNA-Binding Proteins and Control of RDNA in Tumors
National Cancer Institute
$147,886
(From 5/1/80 to 4/30/82)

DR. EDUARD BERG
Hawaii Institute of Geophysics
Crustal Deformation Observations
National Aeronautics & Space Administration
$90,000
(Total amount awarded $681,472)
(From 1/1/79 to 5/31/81)

DR. BARBARA BIRD
Agronomy & Soil Science
Bibliographic Information Research
USDA/UH
$3,000
(From 7/16/79 to 9/30/81)

DR. B. BEN BOHLOOL
Agronomy & Soil Science
Biological Nitrogen Fixation for Improved Food Production in the Tropics
U.S. Agency for International Developement
$7,370
(From 7/1/79 to 6/30/81)

DR. CHARLES BRETSCHNEIDER
DR. HANS J. KROCK
Department of Ocean Engineering
Research on Bio-Ecological Effects of Ocean Thermal Energy Conversion
Lawrence Berkeley Lab/Department of Energy
$670,529
(From 9/1/78 to 9/30/81)

MR. RICHARD M. BULLOCK
Department of Horticulture
Specialty Horticulture Crops
Stepan Chemical Company
$139,600
(From 7/1/77 to 6/30/81)

DR. JOHN CAPERON
Hawaii Institute of Geophysics
Continuous Culture Simulation of Water Column Dynamics
National Science Foundation
$50,000
(From 5/1/78 to 10/31/80)

DR. CLARA CHING
Cancer Center of Hawaii
Human Natural Killer Cell in Recurrent Virus Infection
National Institutes of Health
$94,439
(From 5/1/80 to 4/30/82)

DR. THOMAS CLARK
Hawaii Institute of Marine Biology
A Study of the Potential Enhancement and Aggregation of Fishery Resources Due to Floating Objects
NOAA/Sea Grant Year 13
$30,200
(From 6/1/80 to 5/31/81)

DR. THOMAS CLARKE
Hawaii Institute of Marine Biology
Ecology of Pelagic Fishes in the Central Pacific Ocean
National Science Foundation
$171,572
(From 7/1/77 to 10/31/80)

DR. JOHN CRAWEN
Marine Programs
Marine Programs Professional Correspondence Program
NOAA/Sea Grant
$17,840
(From 6/1/79 to 9/30/80)

DR. JOHN CRAWEN
Marine Programs
Law of the Sea Institute
NOAA/Sea Grant Year 13
$50,167
(From 6/1/80 to 8/31/81)

MR. TOM DINELL
Urban and Regional Planning Program
Hawaii Coastal Zone Management Program
Department of Planning & Economic Development
$247,000
(From 10/1/79 to 10/31/80)

DR. MAXWELL DOTY
Botany Department
Eucheuma Farming in Ponape
NOAA/Sea Grant Year 13
$25,776
(From 6/1/80 to 8/31/81)

1981

DR. MAXWELL DOTY
Botany Department
Implementation of Seaweed Farming in Hawaii
Department of Planning & Economic Development
$18,900
(From 12/1/79 to 11/30/80)

DR. FREDERICK DUENNEBIER
Hawaii Institute of Geophysics
IPOD Downhole Seismic Experiment
National Science Foundation
$210,000
(From 5/1/78 to 1/31/81)

DR. S.A. EL-SWAIFY
Agronomy & Soil Science
Small Farm Production
USDA/UH
$1,250
(From 7/16/79 to 6/30/81)

DR. DAVID EPP
Hawaii Institute of Geophysics
A Heat Flow Investigation of the Hawaiian Swell
Woods Hole Oceanographic Institution
$73,245
(From 3/1/80 to 8/31/82)

DR. SETSU FURUNO
Curriculum, Research & Development Group
Resource Access Project of the Pacific
Department of Health, Education & Welfare
$149,956
(From 30/79 to 9/29/80)

DR. JOSEPH GETTRUST
DR. CHARLES HELSLEY
Hawaii Institute of Geophysics
Participation in the Rose Experiment: Land Stations in Mexico
National Science Foundation
$110,000
(From 11/15/78 to 4/30/81)

DR. JOSEPH GETTRUST
Hawaii Institute of Geophysics
Analysis of Foreshocks and Aftershocks of the Petatlan Earthquake of March 14, 1979
National Science Foundation
$50,000
(From 5/15/80 to 10/31/81)

DR. FRED GREENWOOD
Pacific Biomedical Research Center
Pesticide Exposure of Kunia Residents
Environmental Protection Agency
$85,758
(From 1/1/80 to 12/31/80)

DR. RICHARD GRIGG
Hawaii Institute of Marine Biology
Reef and Shelf Benthic Ecology of the Hawaiian Archipelago
NOAA/Sea Grant Year 13
$43,562
(From 6/1/80 to 5/31/81)

DR. RICHARD GRIGG
(Team Leader)
Hawaii Institute of Marine Biology
Northwestern Hawaiian Islands Fishery Investigations
NOAA/Sea Grant Year 12
$212,781

Primary & Secondary Plankton Productivity & Potential Fishery Yields in the Hawaiian Archipelago
P.I. — Dr. Jed Hirota
$99,804

Reef & Shelf Benthic Ecology of the Hawaiian Archipelago
P.I. — Dr. Richard Grigg
$49,726

Survey & Assessment of the Green Sea Turtle Resource of the Northwestern Hawaiian Islands
P.I. — Dr. George Balaz
$26,785

Population Biology of Spiny Lobsters Throughout the Hawaiian Archipelago
P.I. — Drs. Craig MacDonald/John Stimson
$36,466

DR. THOMAS HALL
University of Hawaii
Community Based Cancer Control Program
Department of Health, Education & Welfare
$1,561,567
(Total amount awarded $4,155,467)
(From 8/1/77 to 7/30/82)

DR. JAKE HALLIDAY
Agronomy & Soil Science
Better Legume Inoculants for Acid Soils
USDA SEA/CR
$88,582
(From 1/21/80 to 1/31/83)

DR. JAKE HALLIDAY
College of Tropical Agriculture
NiTal Project
$303,082
(Total amount awarded $744,523)
(From 7/1/78 to 6/31/81)

DR. DANIEL K. HARTLINE
Pacific Biomedical Research Center
Quantitative Simulation of Simple Neuronal Nets
Public Health Service
$233,573
(From 8/1/79 to 7/31/81)

DR. DANIEL HARTLINE
Pacific Biomedical Research Center
Cellular Mechanisms in Neural Network Function
National Institutes of Health
$62,562
(From 4/1/80 to 3/31/82)

DR. PHILIP HELFRICH
Hawaii Institute of Marine Biology
Hawaii Institute of Geophysics
Mid-Pacific Marine Laboratory
Hydrogeochemistry Operation at Enewetak Atoll
Energy Research & Development Administration
$208,000
(Total amount awarded $1,411,943)
(From 7/1/76 to 9/30/81)

DR. PHILIP HELFRICH
DR. JOHN CAPERON
Hawaii Institute of Marine Biology
OTEC-Cold Water Aquaculture Experiments
NOAA/Sea Grant Year 13
$47,744
(From 6/1/80 to 5/31/81)

DR. CHARLES E. HELSLEY
Hawaii Institute of Geophysics
Geothermal Assessment and Reservoir Definition in Hawaii
U.S. Department of Energy
$171,559
(From 2/1/79 to 9/30/81)

DR. CHARLES E. HELSLEY
Hawaii Institute of Geophysics
Ship Operations and Snug Harbor Facility Support
State of Hawaii
$450,000
(From 12/23/80 to 6/30/81)

DR. CHARLES E. HELSLEY
Hawaii Institute of Geophysics
Acoustic, Geophysical, Chemical and Physical Oceanographic Environments in the Pacific Ocean
Office of Naval Research
$1,948,363
(Total amount awarded $8,812,818)
(From 7/1/74 to 2/28/82)

DR. CHARLES E. HELSLEY
Hawaii Institute of Geophysics
Oceanographic Instrumentation
National Science Foundation
$12,000
(From 2/1/80 to 7/31/81)

DR. CHARLES E. HELSLEY
DR. DONALD THOMAS
Hawaii Institute of Geophysics
Direct Heat Resources Assessment in Hawaii
Department of Energy
$350,000
(From 2/1/80 to 1/31/82)

DR. CHARLES E. HELSLEY
Hawaii Institute of Geophysics
Utilization of the R/V Moana Wave as a Surtass Test Platform
Military Sealift Command
Department of the Navy
$512,400
(From 4/1/80 to 9/30/80)

Vol. 3(1)

ATTENTION: BOX HOLDERS ON LANA'I AND MOLOKA'I

Post office boxholders on Lana'i and Moloka'i are requested to send in the CLIP & MAIL section of this newsletter if they wish to remain on the mailing list. All names received before June 30 will be kept on the mailing list. Everyone else will be dropped from the regular mailing list as of July 1. Individual requests will be included in the list after July 1. Regular readers on Lana'i and Moloka'i are strongly encouraged to spread the word on this new policy. NOTE: This policy does *not apply* to readers whose *name and address* appear on the mailing label; this policy does apply to readers with mailing labels which are addressed to "HAWAII RESIDENT".

It has been the policy of the Department of Planning and Economic Development to include box holders on Lana'i and Moloka'i on the Hawai'i CZNews mailing list. Due to the relatively small populations on these islands, the cost of printing and postage was not significant compared to the rest of the mailing list. The policy has been reconsidered in light of letters from Lana'i residents.

TURTLE INFORMATION NEEDED

George Balazs of the Hawaiian Sea Turtle Research Program is seeking biological and ecological information on young sea turtles (under 10 lbs.). Virtually nothing is known about sea turtles from the time they are born and until they are first seen as juveniles. It is believed that the smaller turtles live in the open ocean far away from land for a period of time. To gather more information, Balazs is looking for specimens of turtles found in the stomachs of pelagic fish such as tuna, mahimahi, marlin, shark and others. The information gathered in this project will be valuable in improving management of Hawaiian sea turtles.

Any fishermen finding such a fish with turtle contents in the stomach, should call Balazs at 247-6631 (neighbor islanders may call collect). He will arrange for immediate pick-up and delivery to a laboratory for study. For more information on this project, write to George Balazs, Hawai'i Institute of Marine Biology, P.O. Box 1346, Kane'ohe, Hawai'i 96744.

Dear Editor,

Is it legal to empty a swimming pool into a storm drain? In this particular case pool water flows about 200 yards in the storm drain and then directly onto the shoreline and into the ocean? Who should be notified?

Name withheld by request
Waimanalo, Hawai'i

(Ed: While the Dept. of Health Sanitation Division requires that pool "backwash" (the dirty water that gets flushed through a pool filter) must be discharged into a sewer (or cesspool, depending on the area), there are no regulations against draining pool water into storm drains. According to DOH engineers, such pool drainings occur infrequently, perhaps once a year. Regularly maintained pool water is not very dirty, they say, and any residual chemicals in the water are so dissipated and diluted that they should not create a pollution problem in receiving waters. On O'ahu, the City and County of Honolulu Building Dept. (requires that building plans be approved by the department's plumbing section. Where a continual drainage creates a nuisance or hazard, especially in a business or commercial district, persons should call the City and County Division of Public Works to report such cases.

Dear Editor,

I would like to acquire (buy) archaeological maps or copies of maps of Maui, specifically of Kahakuloa Valley where I own property.

Mahalo,

David P. McMullen
Lahaina, Maui

Ed. Write to the Dept. of Land and Natural Resources, Historic Sites Branch, P.O. Box 621, Honolulu, HI 96808, with your tax map key parcel number if you wish to determine whether any archaeological sites exist on your property. Also indicate what island it is located on. While the State Historic Preservation Office does have USGS maps that show archaeological sites, the office does not sell them, and prefers to deal with queries directly, because some sites are located on private property. Certain archaeological sites have already been surveyed and are included in the Hawai'i Register of Historic Places. The office said private land owners should already have been notified if such sites have been found on their property.

The Hawai'i CZM program 306 document lists several proposed activities aimed to identify and protect significant archaeological resources. One proposal would fund the development of a system of "sensitivity" maps to indicate areas of high archaeological potential (such as fishponds and heiaus). This is currently being done for the island of Kaua'i, under the Hawai'i CZM program.

HAWAI'I COASTAL ZONE NEWS
C/o Sea Grant/Marine Advisory Program
252-B Spalding Hall
University of Hawai'i
Honolulu, Hawai'i 96822

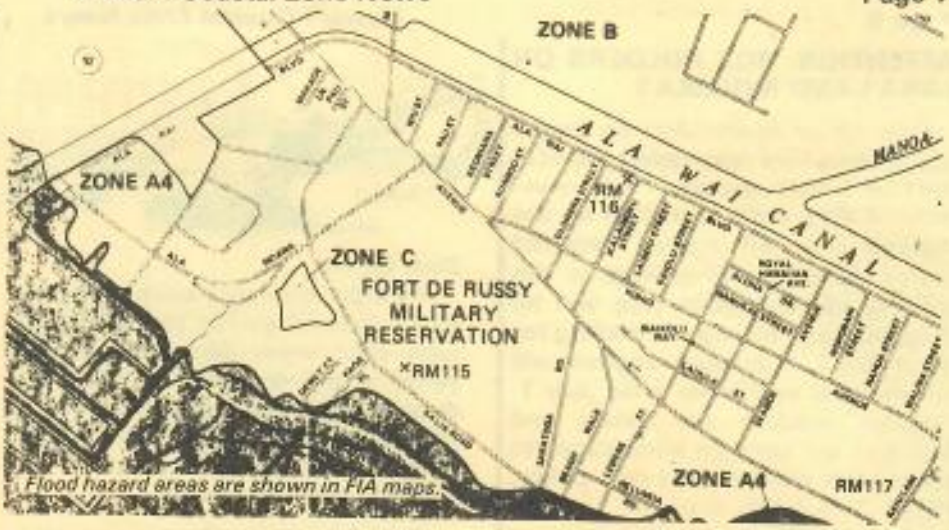
Reef flats, *continued from p. 4*

drifting sand also check the growth of stony corals close to shore, so they are not usually important components of reef flats, except at the seaward edges.

Both biologically constructive forces (lime-secreting organisms) and physically destructive forces (wave action and scour, breakdown by living things) are constantly acting on a reef with different degrees of success. In one spot, the balance of forces may be extending the reef sideways or upwards, in another — breaking it down, and elsewhere maintaining it more or less in uneasy equilibrium.

Storm waves and swells break and wrench pieces of rock from the seaward side of the reef. In places this action undermines the edge of the reef and is followed by collapse of large sections. The perforating, boring, tunneling and dissolving activities of algae, sponges, mollusks, worms, sea urchins and some fish also grind the solid reef into sediments of all sizes. This pulverized material fills in spaces in the reef rock, slides down the steep seaward wall of the reef, or is carried over the reef and is deposited on the shoreward side. In this way, the region between the reef and shore slowly fills with sand while it contributes to the destruction of the solid reef mass. On reef flats near streams, silt from the land may build up faster than it can be removed by wave action, and mud flats cover the reef flats, such as at Kane'ohe Bay.

○



FLOOD INSURANCE RATE MAPS AVAILABLE FOR PUBLIC REVIEW

The Federal Insurance Administration, HUD, has prepared for public review its preliminary National Flood Insurance Rate Maps for the City and County of Honolulu. Appeals on the maps should be made by July 15. These maps show the proposed flood base elevations (for 100-year flood and tsunami inundation) and are the basis for the flood plain management measures that the City Council will be required to adopt in order to qualify for participation in the National Flood Insurance Program (see *HCZNews*, February 1978 issue).

Persons who wish to appeal FIA proposed base flood elevations in the maps must submit technical data prepared by an engineer or similar professional. Maps and other information showing the detailed outlines of the flood-prone areas and the proposed base flood elevations are available for review at the following locations: O'ahu Civil Defense Agency, and the City and County of Honolulu Dept. of Land Utilization (both located in the Honolulu Municipal building), at the Dept. of Public Works, the City Clerk's office, City Hall, and at all Satellite City Halls.

Send comments to: Robert Moore, Assistant Administrator, O'ahu Civil Defense Agency, 650 S. King St., Honolulu, Hawai'i 96813. For further information call 523-4121.

The proposed elevations, together with flood plain management measures required by the Flood Disaster Protection Act of 1973 of the National Flood Insurance Act of 1968, will be used to calculate the appropriate flood insurance premium rates for new buildings and their contents, and for the second layer of insurance on existing buildings and their contents.

QUESTIONS and REMARKS

ADDRESSADDRESSADDRESSADDRESSADDRESSADDRESSADDRESSADDRE

PLEASE CHECK

CHANGE OF ADDRESS ☐

ADD TO MAILING LIST ☐

NAME

STREET

CITY STATE ZIP

CLIP &

CZNews welcomes all questions, suggestions and comments. Selected questions will be answered in a special column in future issues of CZNews.

If you have a change of address or know a friend who would like to receive CZNews fill out the name and address section and "clip & mail"

MAIL

that state. This rulemaking became effective 6 September 1979.

b) from *Federal Register*, Vol. 44, No. 181, 17 September 1979, page 54002: . . . the U.S. Fish and Wildlife Service recognizes that captive propagation is, in some cases, important for conserving species, and that the Endangered Species Act (as amended) authorizes the permitting of otherwise prohibited activities to enhance the propagation or survival of affected species. This rule grants general permission for persons to conduct otherwise prohibited activities with captive-bred wildlife under specified conditions, which are designed to protect wild populations of wildlife and to ensure that the activities will be conducted to enhance the propagation or survival of the species. This rulemaking (i.e., captive, self-sustaining populations) became effective on 17 September 1979.

PROPOSED Rulemaking:

a) from *Federal Register*, Vol. 44, No. 143, 24 July 1979, page 40442: the U.S. Fish and Wildlife Service now believes that the American crocodile (*Crocodylus actus*) populations outside of Florida population which was listed as Endangered on 25 Sept. 75, and the saltwater crocodile (*C. porosus*) populations exclusive of the Papua, New Guinea population to be endangered. Deadline for comments is 26 October 1979.

Send to: Director, (O.E.S.)
U.S. Fish and Wildlife Service
Department of Interior
Washington, D.C. 20240

b) from *Federal Register*, Vol. 44, No. 179, 13 September 1979, page 53422: the Fish and Wildlife Service re-proposes critical habitat for the Plymouth red-bellied turtle (*Chrysemys rubriventris bangsi*). Endangered status and critical habitat were originally proposed for this species on 19 May 1978, but the critical habitat portion of this proposal was withdrawn on 6 March 1979 because of procedural and substantive changes in the amended Endangered Species Act. Deadline for comments is 16 November 1979.

Send to: same as above

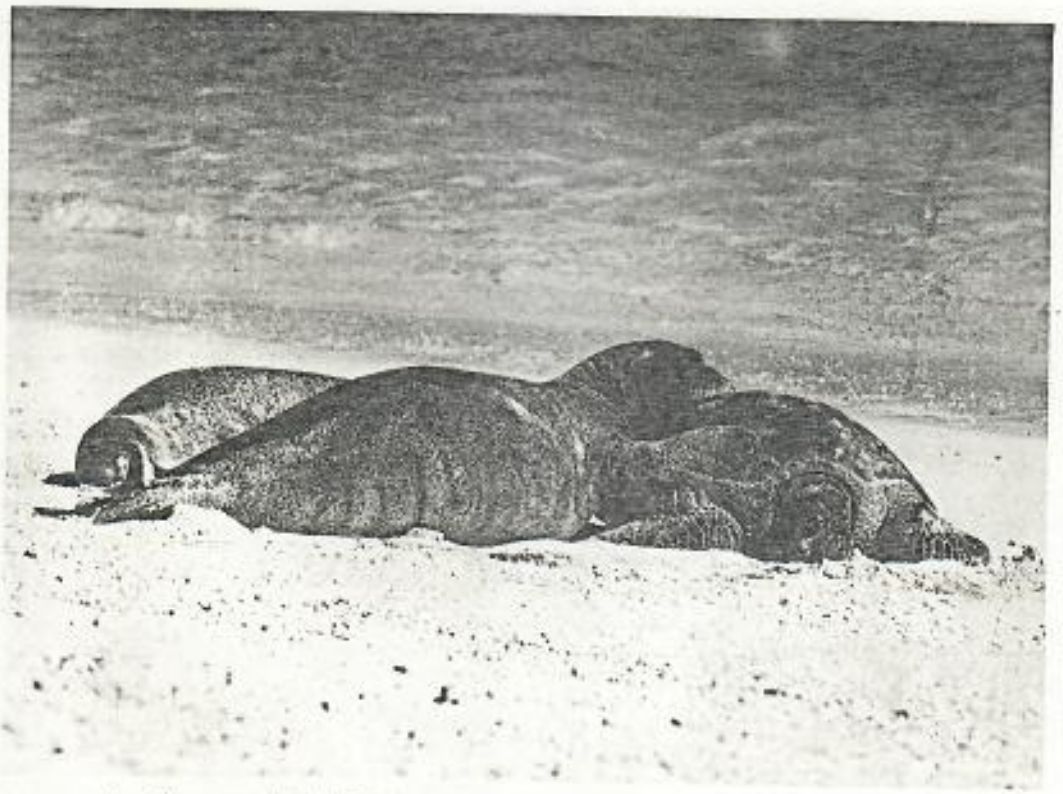
STATE-PROPOSED Rulemaking: Ohio House Bill 645—this bill will prohibit "any person owning or buying nonnative poisonous reptiles as pets, to prohibit any person from selling such reptiles except to a zoo, and to permit zoos to buy such reptiles for exhibition."

Comments to: Chairman Jerome Stana
State Agriculture, Conservation, and Environment Committee
Ohio Senate
State House
Columbus, Ohio 43215

NEW DUTCH HERP GROUP

The Nederlandse Studiegroep voor Anolissen, formed about two years ago, is a subdivision of the Nederlandse Vereniging voor Herpetologie en Terrarium-kunde. Their bulletin is devoted entirely to *Anolis* articles, and is published every two months. Major articles have English summaries. The group especially welcomes articles on *Anolis* reproduction, ethology and ecology. For more information, write:

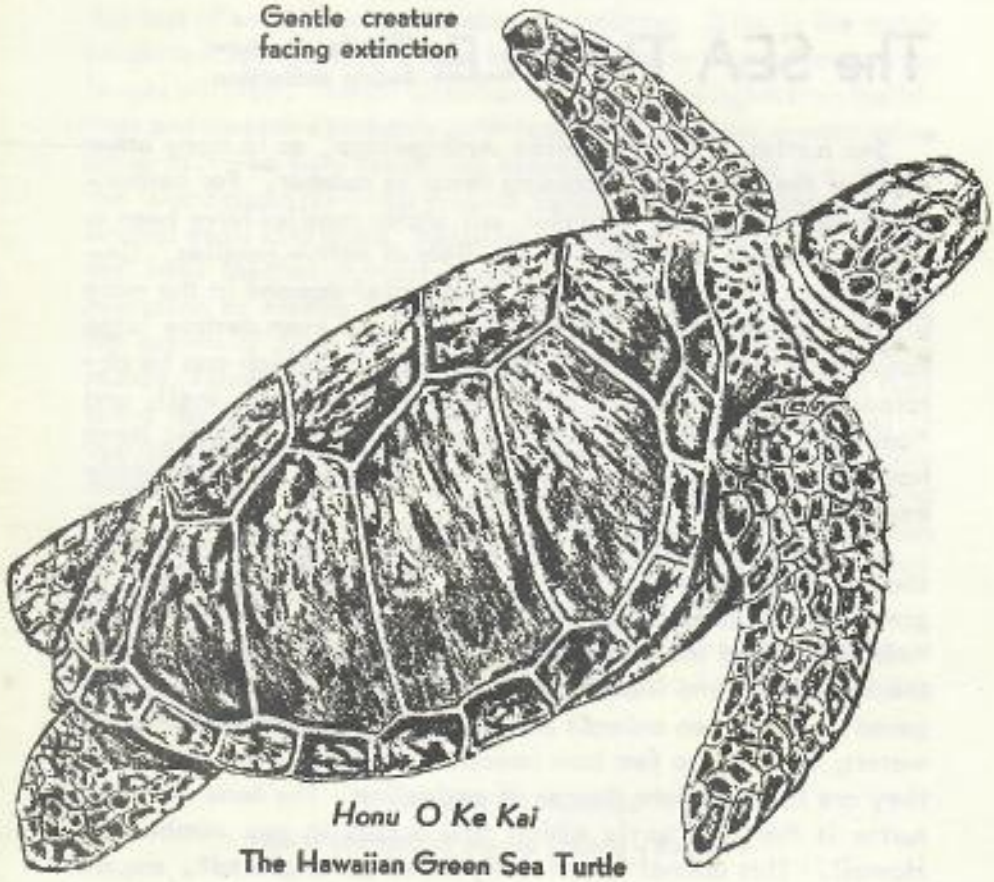
Frits R. vanLeeuwen, Secretary
N.S.A.
2e Boerhaavestraat 5^{hs}
1091 AK
Amsterdam, The Netherlands



Hawaiian green turtle (*Chelonia mydas*) and monk seals (*Monachus schauinslandi*) basking on a small islet at French Frigate Shoals (23°45'N, 166°10'W). Land basking by sea turtles has only been documented for *Chelonia*, with members of the Hawaiian population possibly being the only ones at the present time exhibiting this rare behavioral trait. Hawaiian green turtles and monk seals frequently share the same beaches and inshore waters, however it is relatively uncommon for direct physical contact to take place with one another. (Photograph by George H. Balazs, Hawaii Institute of Marine Biology, P. O. Box 1346, Kaneohe, Hawaii 96744).

The SEA TURTLE

Gentle creature
facing extinction



Honu O Ke Kai

The Hawaiian Green Sea Turtle

A Waikiki Aquarium Publication

The SEA TURTLE: Gentle creature facing extinction

Sea turtles in the Hawaiian Archipelago, as in many other areas of the world are becoming fewer in number. For centuries these unique and graceful salt water reptiles have been a valuable source of protein in the diets of native peoples. Unfortunately, an ever increasing commercial demand in the more affluent countries has acted to deplete and even destroy large colonies of these animals. Valuable products which can be obtained from sea turtles include steak, leather, oil, shell, and "calipee" for soup. The high prices paid for these exotic items have provided a strong incentive for fishermen to relentlessly exploit the world's remaining stocks.

Of the eight species of sea turtles which are known to exist today, three are found in Hawaii. Included are the ***honu*** or green turtle ***(Chelonia agassizi)***, the ***ea*** or hawksbill ***(Eretmochelys imbricata)***, and the leatherback ***(Dermochelys coriacea)***. Both the hawksbill and leatherback are officially listed as "endangered". These two animals are very seldom sighted in our island waters; in fact, so few now remain throughout the world that they are in immediate danger of extinction. The *honu* or green turtle is the only turtle which still occurs in any numbers in Hawaii. This animal is officially listed as "depleted", meaning that it is declining at a rate which gives cause for serious concern. Unfortunately some restaurants in Hawaii still serve green turtle steak. In addition, gift shops sell ornaments made from shell. Tourists, as well as residents who are unaware of the animal's plight, continue to purchase these items. If the present trends continue, the *honu* will surely be sold into extinction.

Besides overfishing, the green turtle is also in trouble due to the loss of sand beaches suitable for nesting. Sites in the major inhabited islands where egg laying formerly took place are no longer utilized. Human disturbances as well as lights from buildings and cars have probably interfered with delicate reproductive patterns. The only remaining breeding and nesting site left in the island chain is French Frigate Shoals, a reef area consisting of several small sand islets, 480 miles northwest of Honolulu. When the *honu* reaches maturity (approximately 200 lbs. or more), migration to French Frigate Shoals takes place, usually during the months of May and June. In August when the egg laying season is over the animals return to the major islands where they spend the greater part of their life feeding on limu (algae) in shallow coastal waters. Each female makes the journey only once every two to four years. It is unknown how the animals find their way across the many miles of open ocean. Recent studies by marine biologists at French Frigate Shoals have shown that relatively few nesting animals exist even at this site.

If the world's sea turtles are to survive, each of us must help by refusing to buy products derived from them and urging friends to do the same.

Prepared by G. H. Balazs
Hawaii Institute of Marine Biology - Kaneohe

for George Balazs
from Jack Beardsley

Insects and Other Terrestrial Arthropods from the Leeward Hawaiian Islands[1]

John W. Beardsley
University of Hawaii, Honolulu, Hawaii

Introduction

The Leeward Hawaiian Islands comprise a chain of small rocky islets, and coral atolls which extend west-northwest of Kauai. Nihoa, the nearest, is about 150 miles from Kauai, while Kure, the furthermost, is some 1,150 miles away (see map, p. 158). All Leeward Islands except Midway and Kure are now a part of the Hawaiian Islands National Wildlife Refuge administered by the U.S. Fish and Wildlife Service.

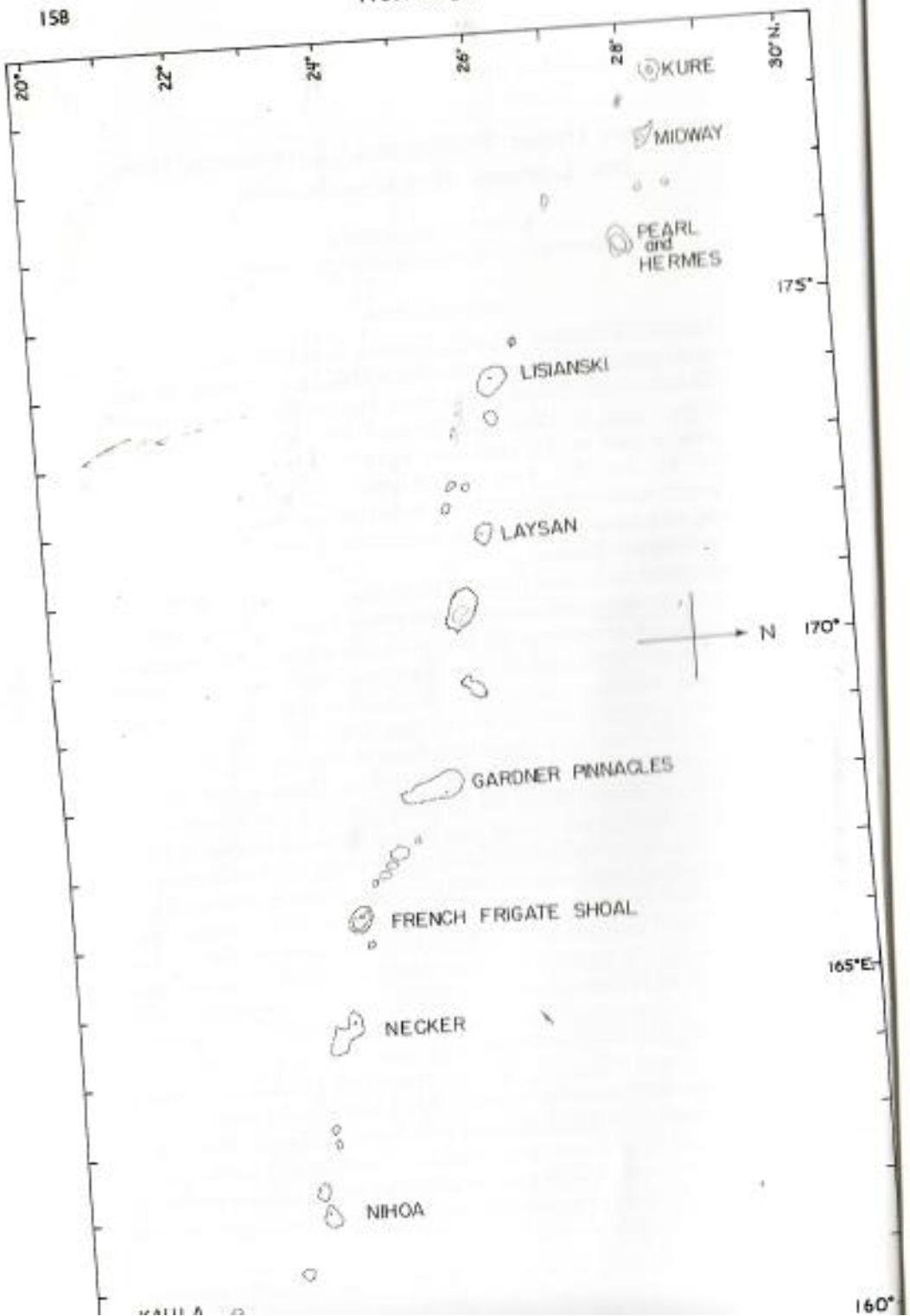
This paper summarizes results of recent entomological field work in these islands, and attempts to update the existing lists of insects and other terrestrial arthropods known.

The terrestrial arthropod fauna of these islands is a mixture of endemic or indigenous elements and recently, adventive forms. The numbers of endemic species are greatest on the two relatively undisturbed southeastern volcanic islands of Nihoa and Necker, and apparently have disappeared largely from the more northwesterly atolls where, in most cases, the original vegetation has changed drastically in the past 100 years or so. Extinction of native plants and endemic insects has been documented fairly well for Laysan (Christophersen & Caum, 1931, Butler & Usinger, 1963a). Unfortunately, less is known about the original biota of the other atolls.

Most recent immigrant insects now known from the Leeward Islands occur also on the larger inhabited islands of Hawaii; however, two species could become serious crop pests should they spread into agricultural areas of the state. The Egyptian cotton moth, *Spodoptera litura* (Fabricius), is established on Pearl and Hermes Atolls and may be present also on Kure Atoll and Midway. In addition to cotton, this insect is also a pest of many garden and truck crops throughout the tropical and subtropical areas of the Old World and on many south and western Pacific islands. A species of scarab beetle, *Anomala sulcatula* Burmeister, known as a pest of sugar cane in the Philippine and Mariana Islands, is present on Midway Island.

New immigrant arthropods are continuing to invade and spread within the Leeward Islands. Such immigrants may have profound effects upon the delicate ecosystems of these small islands. Therefore, it seems worthwhile to record the recently discovered additions to the known terrestrial faunas for the benefit of ornithologists, ecologists, and others concerned with the biota of these islands.

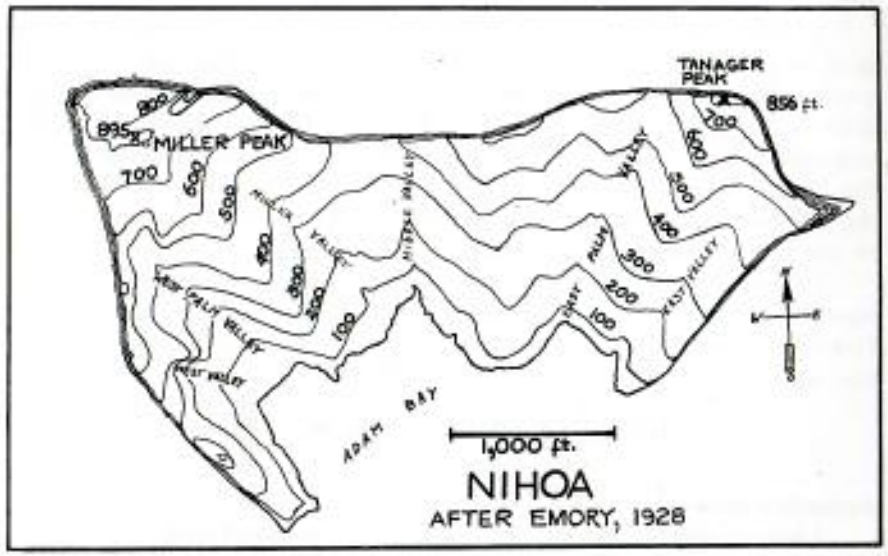
[1]Published with the approval of the Director of the Hawaii Agricultural Experiment Station as Technical Paper No. 784.



The principal work on terrestrial arthropods of the Leeward Islands (Bryan et al. 1926) deals with material collected by the 1923 Tanager Expedition and other earlier collectors. This paper contains a nearly complete listing of the species then known from each of the islands. Several recent papers list arthropods known to be from the following islands: Laysan (Butler 1961, Butler & Usinger 1963 a), Midway (Suehiro 1960), and Kure (Butler & Usinger 1963b). No attempt is made here to duplicate lists for these islands, although a few new records from my own recent collecting are given. A relatively complete list is provided for each remaining island I visited. I have indicated also the collection dates (year), pertinent host and other ecological data, abundance, etc.

One group of insects, the Mallophaga, is not included since they are being worked on by others. Published records of Mallophaga from the Leeward Islands are principally from Laysan Island (Thompson 1948; Zimmerman 1948, Vol. 2; Butler & Usinger 1963a), although the species concerned probably will be found wherever their avian hosts occur.

I am indebted to the following persons for assistance in identifying specimens: P. D. Ashlock, F. A. Bianchi, E. A. Chapin, Mrs. D. Fellows, D. E. Hardy, D. F. Hardwick, Louise M. Russell, C. W. Sabrosky, T. W. Suman, E. L. Todd, N. Wilson, W. W. Wirth, C. M. Yoshimoto, and E. C. Zimmerman. Other identifications are from Brayn (1926) or were made by this writer. Most Tanager Expedition material is at the Bernice P. Bishop Museum in Honolulu, and where misidentifications in Bryan's list are indicated, I have examined the specimens. Specimens collected by me in 1962 and 1964 will be placed in the Bishop Museum with duplicates in the collection of the Entomology Department,



University of Hawaii.

New island records in the species lists which follow are indicated by an asterisk.

Thanks are due the U.S. Fish and Wildlife Service (particularly to E. Kridler of the Honolulu office), the State of Hawaii Division of Fish and Game, personnel of the U. S. Navy and U. S. Coast Guard for making possible my field work in the Leeward Islands during 1962 and 1964 and to E. H. Bryan, Jr. of the B. P. Bishop Museum who kindly supplied maps and other information used to prepare the figures.

NIHOA ISLAND

Nihoa Island, the nearest and highest of the Leeward Islands, is a steep rocky remnant of a former extensive volcanic dome. The island's area is about 156 acres; the highest point about 895 feet (Emory, 1928). Although Nihoa was the site of a prehistoric Hawaiian settlement, it remains in a relatively undisturbed condition. The island is covered sparsely with a scrubby growth of native plants, predominantly *Chenopodium oahuense*, *Sida cordifolia*, *Solanum nelsoni*, *Sesbania tomentosa* and *Portulaca lutea*, with native bunch grass *Eragrostis variabilis* along some of the higher ridges, *Euphorbia celastroides* as a prostrate shrub above 800 feet on Miller Peak (the highest point on the island), and an endemic fan palm *Pritchardia remota* in scattered groves in two of the larger gulches. Other less prominent plants include *Amaranthus brownii*, *Panicum torridum*, *Rumex giganteus*, *Sicyos microcarpus*, and *Tribulus cistoides*. A few others are recorded which I did not see (Christophersen & Caum, 1931). All the plants are considered to be native, and, apparently, there are no recently established exotic weeds present.

I spent about 7 hours on Nihoa on 10, June 1962 and one night and most of two days in September, 1964. The vegetation was relatively green, indicating recent abundant rainfall in June, 1962, but was much drier in September, 1964. A total of 102 species of terrestrial arthropods was collected or observed during these two visits; 51 are new records. Of the 72 species listed by Bryan, 21 were not collected in 1962 or 1964. Of the 123 species listed below, at least 35 are restricted either to the island or are species endemic to the Hawaiian Archipelago.

In addition to the arthropods listed, a small gecko, *Lepidodactylus lugubris* Dumeril & Bibron (determined by Karl Frogner, University of Hawaii Department of Zoology) was taken in *Eragrostis* clumps in 1964, and appears to be a recently established immigrant.

CRUSTACEA (Det. by Mrs. D. Fellows)

Isopoda

Armadilliidae

**Armadillidium* or *Spherillo* sp., 1964, in *Eragrostis* clumps.

Porcellionidae

**Porcellio* (?) sp., immature specimen; 1964, in *Eragrostis* clumps.

ARACHNIDA

Pseudoscorpionida

*undetermined genus and species, 1964.

Araneida (Det. by T. W. Suman)

Argiopidae

*unidentified genus and species (mature ♀); 1964.

Clubionidae

**Chiracanthium diversum* L. Koch; 1964.

Oonopidae

**Gamasomorpha* sp. (1 ♀); 1964.

Salticidae

*unidentified genus and species; 1964.

Thomisidae

*unidentified genus and species (immature ♂); 1964.

INSECTA

Thysanura

Lepismatidae

Acrotelsella hawaiiensis (Silvestri); 1923. Listed by Bryan as an undetermined species (see Zimmerman 1948, 2 : 36).

Collembola

*undetermined genus and species; 1964.

Orthoptera

Blattidae

Cutilia soror (Brunner); 1923; 1964.
Periplaneta americana (L.); 1923.
Periplaneta australasiae (Fabricius); 1923; 1964.
Pycnoscelus surinamensis (L.); 1923; 1964.

Tettigoniidae

Banza nihoa Hebard; 1923; 1964, in *Eragrostis* clumps.

Dermaptera

Labiduridae

Euborellia annulipes (Lucas); 1923; 1964.

Psocoptera

undertermined genus and species; 1923: 1964.

Thysanoptera (Det. by F. A. Bianchi)

Thripidae

**Frankliniella sulphurea* (Schmutz); 1962; 1964, in flowers of *Sesbania*, *Tribulus* & *Solanum*.

Phlaeothripidae

**Haplothrips govedeyi* (Franklin); 1962; 1964, in flowers of above.

EMBIOPTERA

Oligotomidae

Oligotoma oceania Ross; 1923; 1962, in *Eragrostis* clumps, 1964 under *Chenopodium*; listed by Bryan as *O. insularis* McLachlan? (see Ross, 1951).

HEMIPTERA

Cydnidae

**Geotomus pygmaeus* (Dallas); 1964, at light.

Lygaeidae (Det. by P. D. Ashlock)

**Geocoris punctipes* (Say); 1964.

Nysius longicollis Blackburn; 1923.

Nysius nihoae Usinger; 1923; 1962; 1964, on *Chenopodium*.

Nysius suffusus Usinger; 1923; 1962; 1964, on *Chenopodium, Sida*.

The above *Nysius* species were listed by Bryan as "*Nysius* spp.".

Reclada moesta (White); 1923; 1964, in *Eragrostis* clumps.

Corizidae

**Liorhyssus hyalinus* (Stål); 1962, on *Chenopodium* and *Sida*.

Nabidae

Nabis capsiformis Germar; 1923; 1964.

Nabis sp. near *kahavalu* Kirkaldy; 1923; 1962, on *Chenopodium oahuense*. Listed as *Reduviolus kahavalu* by Bryan, but apparently distinct (see Zimmerman 1948, 3:152).

Anthocoridae

Orius persequens (White); 1923; 1962; 1964.

Miridae

**Hyalopeplus pelucidus* (Stål); 1962, on *Sida* and *Chenopodium*.

**Oronomiris hawaiiensis* Kirkaldy; 1962, on *Eragrostis*.

**Rhinachloa forticornis* Reuter; 1964, on *Chenopodium*.

"unidentified species"; 1923, specimens not located.

HOMOPTERA

Cicadellidae

**Circulifer tenellus* (Baker); 1962; 1964, on *Chenopodium oahuense*.

**Empoasca solana* De Long; 1962; 1964, on *Chenopodium*.

**Deltocephalus sonorus* Ball; 1962, on *Eragrostis*.

"*Nesosteles* spp."; 1923, specimens not located.

**Scaphytopius loricatus* (Van Duzee); 1962; 1964, on *Chenopodium* and *Sida*.

Delphacidae

**Sogatella kolophron* (Kirkaldy); 1962, on *Eragrostis*.

Aphididae

**Aphis craccivora* Koch; 1962; 1964, on *Solanum nelsoni* and *Tribulus*.

Pseudococcidae

**Rhizoecus hawaiiensis* (Hambleton); 1964, on roots of *Chenopodium*.

Phoenicococcidae

**Platycoccus tylocephalus* Stickney; 1962; 1964, on leaves of *Pritchardia remota*.

Diaspididae

**Odonaspsis ruthae* Kotinsky; 1962; 1964, on *Eragrostis* stems.

LEPIDOPTERA

Lycaenidae

**Lampides boeticus* (L).; 1962, one larva in *Sesbania* flower.

Noctuidae

Agrotis bryani (Swezey); 1923, 1964, adults at light.

Helicoverpa pallida Hardwick (Det. by D. F. Hardwick); 1923; 1962; 1964; larvae on *Chenopodium*, adults at light. Listed by Bryan as *Chloridea obsoleta* (Fabricius) (see Hardwick, 1965:89).

Pyralidae

Hymenia recurvalis (Fabricius); 1923; 1962; 1964, larvae and adults on *Chenopodium*.

**Lineodes ochrea* Walsingham (?); 1964, adults at light.

Tamsica sp. (Det. by E. C. Zimmerman); 1923; 1962; 1964, adults at light. Listed by Bryan as *Talis hyacinthina* Meyrick.

Pterophoridae

Megalorhipida defectalis (Walker); 1923. Listed by Bryan as *Trichoptilus oxydactylus* (Walker) (see Zimmerman 1958, 8:397).

Tortricidae

**Crocidosema plebiana* Zeller (?); 1962; 1964, larva in *Sida* flower, adults at light.

Hyponomeutidae

Hyposmocoma spp. (Det. by E. C. Zimmerman); 1964, three species taken at light. Bryan lists *H. arenella* Walsingham, *H. quinquemaculata* Walsingham and *H.* sp. from Nihoa, collected in 1923, but the specific identifications may not be correct.

Tineidae

**Monopis meliorella* (Walker); 1962, one adult.

Gracillaridae

Parectopa marginestrigata Walsingham; 1923; 1962; 1964, larvae and adults on *Sida*, larvae mining in leaves.

Cygnodidae (Det. by E. C. Zimmerman)

Petrochroa dimorpha Busck; 1923; 1964, adults at light.

Xylorictidae (Det. by E. C. Zimmerman)

**Thyrocopa* sp.; 1964, adults at light and reared from larva taken in litter under bushes.

COLEOPTERA

Staphylinidae

Atheta coriaria Kraatz; 1923.

Coccinellidae

Coelophora inaequalis (Fabricius); 1923, fragments (elytra) only.

**Scymnus debilis* Leconte; 1964, on *Eragrostis*.

Scymnus loewii Mulsant: 1923; 1962, feeding on *Platycoccus* on *Pritchardia;* 1964, on *Chenopodium* and *Euphorbia*. Listed by Bryan as *Pullus kinbergi* (Boheman).

"*Scymnus* sp., near *bipunctatus*"; 1923, specimens not located.

Nitidulidae

**Carpophilus dimidiatus* (Fabricius); 1964.

Cucujidae

Cryptomorpha desjardinsi Guenée; 1923.

Lathridiidae

**Lathridius* (?) sp.; 1962, ex *Eragrostis*, one.

Dermestidae

Dermestes ater De Geer; 1923; 1964, under dead birds. Listed by Bryan as *D. cadaverinus* Fabricius.

Dermestes frischii Kugelam; 1923; 1964, under dead birds. Misidentified in Bryan's list as *D. vulpinus* Fabricius.

Labrocerus sp.; 1923; 1964, on *Euphorbia celastroides*.

Tenebrionidae

Sciophagus pandanicola (Boisduval); 1923; 1964. Listed by Bryan as an undetermined species.

Histeridae

**Saprinus lugens* Erichson; 1964, under dead birds.

Anobiidae

**Xyletobius gossypii* Ford (?); 1964, at light.

Cioidae

Cis vagans Perkins; 1923; 1964, on *Euphorbia*.

Cleridae

Necrobia rufipes De Geer; 1923.

Cerambycidae

Plagithmysus nihoae Perkins; 1923, ex *Euphorbia* stems.

Chrysomelidae

Epitrix hirtipennis (Melsheimer); 1923; 1962; 1964, feeding on *Solanum nelsoni*. Misidentified in Bryan's list as *E. parvula* (Fabricius).

Anthribidae

Araecerus fasciculatus (De Geer); 1923; 1962; 1964, adults at light, on *Chenopodium* and on *Euphorbia*.

Curculionidae

Oodemus breviscapum Perkins; 1923; 1962; 1964, ex *Eragrostis*.

Oodemus erro Perkins; 1923; 1964.

Oodemus laysanensis Fullaway; 1923; 1962; 1964, reared from larvae in

Chenopodium stems.

Pentharthrum pritchardiae Perkins; 1923, on *Pritchardia*.

Rhyncogonus exsul Perkins; 1923; 1962, adults abundant on *Chenopodium*; 1964, a few adults in *Eragrostis* clumps.

Proterhinidae

Proterhinus abundans Perkins; 1923; 1964, on *Euphorbia*.

Proterhinus bryani Perkins; 1923, on *Euphorbia*.

DIPTERA

Chironomidae (Det. by D. E. Hardy)

**Chironomus esakii* Tokunaga, 1962.

**Telmatogeton pacificus* Tokunaga; 1964.

Dolichopodidae

Paraphrosylus acrosticalis (Parent); 1923. Listed by Bryan as *P.* sp. (see Hardy, 1964:249).

Syrphidae

**Ischiodon grandicornis* Macquart (?); 1962, seen flying but not captured.

Ephydridae

Neoscatella sexnotata (Cresson); 1923; 1962, 1964.

**Atissia antennalis* Aldrich (Det. by W. W. Wirth); 1962, one specimen.

Canaceidae

Canaceoides nudata (Cresson); 1923. Reported by Bryan in 1932.

Sphaeroceridae

**Leptocera hirtula* (Rondani) (?) 1962; 1964.

Asteiidae

Bryania bipunctata Aldrich; 1923; 1962; 1964. Listed by Bryan as an undetermined Asteinae.

*New genus and species (Det. by C. W. Sabrosky); 1962.

Drosophilidae (Det. by D. E. Hardy)

**Scaptomyza* (*Bunostoma*) sp.; possibly *hamata* Hardy; 1962 (one ♀)

**Scaptomyza* (*Parascaptomyza*) *pallida* Zetterstedt; 1962, one specimen.

Agromyzidae

Liriomyza sp.; 1923. Listed by Bryan as *Agromyza pusilla* Meigen.

**Pseudonapomyza spicata* (Malloch) (Det. by D. E. Hardy); 1962, one specimen.

Milichiidae

Milichiella orientalis Malloch; 1923. Listed by Bryan (1926) as an undetermined Milichiinae, and subsequently determined by Aldrich (Bryan, 1931).

**Leptometopa* n. sp. (Det. by C. W. Sabrosky); 1962; 1964, plentiful.

Chloropidae

Siphunculina signata (Wollaston); 1925; 1962; 1964, abundant.

Tachinidae

Achaetoneura archippivora (Williston); 1923.

Sarcophagidae

Goniphyto bryani Souza-Lopez; 1923; 1962; 1964. Listed by Bryan as an undetermined species.

Calliphoridae

Lucilia sericata Meigen (?); 1923; 1962; 1964.

Hippoboscidae

Olfersia spinifera Leach; 1923; 1962; 1964, adults at light.

HYMENOPTERA

Braconidae

**Apanteles marginiventris* Cresson; 1962, reared from *Hilicoverpa* larva; 1964.

**Chelonus blackburni* Cameron; 1962; 1964.

Doryctes pallidiceps (Perkins); 1923.

Ichneumonidae

Horogenes blackburni Cameron 1923; 1962; 1964.

Mymaridae (Det. by C. M. Yoshimoto)

**Lymaenon mexicanus* Perkins; 1964.

Eulophidae

Euderus metallicus Ashmead; 1923.

Hemiptarsenus semialbiclavus (Girault); 1923; 1964. Listed by Bryan as *Pseudopheliminus vagans* Timberlake, a synonym.

Eupelmidae

Eupelmus nihoaensis Timberlake; 1923.

Lepideupelmus bryani Timberlake; 1923.

Lepideupelmus robustus Timberlake; 1923; 1962; 1964.

Pteromalidae

**Spalangia drosophilae* Ashmead (Det. by C. M. Yoshimoto); 1962; 1964.

Diapriidae

*genus and species unidentified; 1964.

Bethylidae

Sclerodermus nihoaensis Timberlake; 1923.

Formicidae

Monomorium floricola (Jerdon); 1923; 1964.

Phrenolepis longicornis Fabricius; 1923; 1964.

Tapinoma melanocephalum (Fabricius); 1923; 1962; 1964.

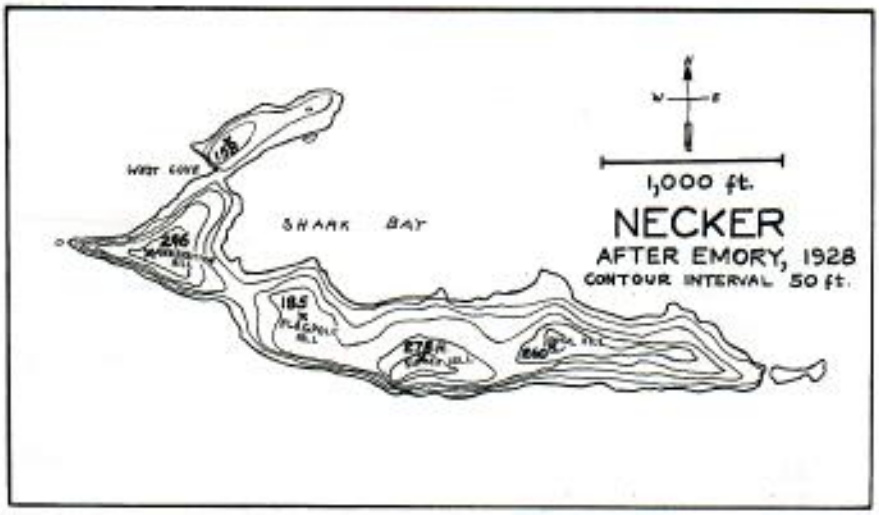
Tetramorium guineense (Fabricius); 1923; 1962; 1964.

Hylaeidae

Nesoprosopis perkinsiana Timberlake; 1923; 1964.

NECKER ISLAND

Necker Island, 300 miles northwest of Kauai, is both smaller and lower than Nihoa and consists of a long, roughly hook-shaped ridge with steep sides and a fairly broad, easily traversable summit at 150–200 ft elevation. The highest elevation is 278 feet, and the land area is about 41 acres



(Emory, 1928). The surface is rocky and is partly clothed with sparse, scrubby vegetation. During June, 1962, I spent approximately three hours on the island, and during September, 1964, one night and most of two days.

The flora of Necker includes only five species of vascular plants: *Chenopodium oahuense*, *Panicum torridum*, *Portulaca lutea*, *Sesbania tomentosa*, and *Sesuvium portulacastrum* (Christophrensen and Caum, 1931). Despite the simplicity of the flora, the terrestrial fauna includes a fair number of apparently endemic arthropods. Of the approximately 69 species here recorded, about 20 are known only from Necker, or from Necker and Nihoa. Twenty-eight of the species reported below are new records. Of the 41 species previously recorded, 10 were not re-collected in 1962 or 1964.

CRUSTACEA

Isopoda (Det. by Mrs. D. Fellows)

Porcellionidae

Porcellio* sp., Prob. *laevis Latrielle; 1964, on rocks, 30 feet above sea level.

ARACHNIDA

Araneida (Det. by T. W. Suman)

Lycosidae

**Lycosa* sp.; 1962; 1964.

Salticidae

*genus and species not identified; 1964.

Scytodidae

**Scytodes striatipes* (L. Koch); 1964.

Thomisidae

*genus and species not identified; 1962; 1964, common on *Chenopodium oahuense*.

ACARINA (Det. by N. Wilson)

Argasidae

**Ornithodoros* sp., *capensis* Neumann group; 1964.

CHILOPODA

Schendylidae

Nyctunguis bryanus Chamberlin; 1923.

Mecistocephalidae

Mecistocephalus spissus Wood; 1923.

INSECTA

ORTHOPTERA

Blattidae

Periplaneta americana (L.); 1923.

EMBIOPTERA

Oligotomidae

Oligotoma saundersii Westwood; 1923; 1964, ♂♂ at light. Listed by Bryan as *O. insularis* McLachlan?

DERMAPTERA

Labiduridae

Euborellia annulipes (Lucas); 1923; 1962; 1964.

PSOCOPTERA

unidentified genus and species; 1923; 1964.

THYSANOPTERA (Det. by F. A. Bianchi)

Phlaeothripidae

**Haplothrips gowdeyi* (Franklin); 1962; 1964.

Thripidae

**Frankliniella sulphurea* Schmutz; 1962; 1964.

HEMIPTERA

Lygaeidae (Det. by P. D. Ashlock)

Nysius chenopodii Usinger; 1923; 1962; 1964, on *Chenopodium*.

Nysius neckerensis Usinger; 1923; 1962; 1964, on *Chenopodium* and *Portulaca*. Apparently misidentified as *N. delectus* White in Bryan's list.

Miridae

**Rhinacloa forticornis* Reuter; 1964, on *Chenopodium*.

HOMOPTERA

Cicadellidae

**Circulifer tenellus* (Baker); 1962; 1964, plentiful on *Chenopodium*.

**Empoasca solana* De Long; 1962; 1964, plentiful on *Chenopodium*.
"*Nesosteles* spp."; 1923, specimens not located.

Pseudococcidae

**Ferrisia virgata* (Cockerell); 1964, on *Portulaca*.
**Pseudococcus* n. sp.; 1964, on *Chenopodium oahuense*.
**Rhizoecus hawaiiensis* (Hambleton); 1962; 1964, on roots of *Chenopodium* and *Portulaca*.

Diaspididae

**Hemiberlesia lataniae* (Signoret); 1962; 1964, on twigs and branches of *Chenopodium*.

LEPIDOPTERA

Lycaenidae

Lampides boeticus (L.); 1923; 1962; 1964, adults flying, larvae in *Sesbania* flowers.

Noctuidae

Helicoverpa pallida Hardwick (Det. by D. F. Hardwick); 1923; 1962; 1964, larvae on *Chenopodium*, adults at light. Misidentified in Bryan's list as *Chloridea obsoleta* (Fabricius).

Pyralidae

Hymenia recurvalis Fabricius; 1962; 1964; 1923, larvae and adults on *Chenopodium*.

Tortricidae

Crocidosema plebiana Zeller (?); 1923; 1964.

Hyponomeutidae

Hyposmocoma spp. (Det. by E. C. Zimmerman). Two species taken at light in 1964 appear to be identical to two of the 3 species from Nihoa. Bryan lists *H. mimica* Walsingham, *H. quinquemaculata* Walsingham, and *H.* sp. collected in 1923, but the specific determinations may not be correct.

Tineidae

Monopis meliorella (Walker); 1923.

Cygnodidae

Petrochroa dimorpha Busck (Det. by E. C. Zimmerman); 1923; 1964, at light.
Petrochroa neckerensis Swezey; 1923.

COLEOPTERA

Staphylinidae

*genus and species undetermined (minute); 1964, one.

Coccinellidae

Scymnus loewii Mulsant; 1923; 1962; 1964, on *Chenopodium*. Listed by Bryan as *Pullus kinbergi* (Boheman).

Nitidulidae

**Carpophilus dimidiatus* (Fabricius); 1964.

Dermestidae

Dermestes maculatus De Geer; 1923. Listed by Bryan as *D. vulpinus* Fabricius; specimen not located.

Dermestes ater De Geer; 1923; 1964. Listed by Bryan as *D. cadaverinus* Fabricius.

Labrocerus sp.; 1923.

Histeridae

**Acritus* sp.; 1962, ex ground litter.

Tenebrionidae

Sciophagus pandanicola (Boisduval); 1923; 1964. Listed by Bryan as an unidentified tenebrionid.

Elateridae

Itodactus novicornis Van Zwaluwenburg; 1923; 1964, under rocks under *Chenopodium*.

**Itodactus* sp.; 1964, under rocks under *Chenopodium*.

Anthribidae

Araecerus fasciculatus (De Geer); 1923; 1964.

Curculionidae

Rhyncogonus biformis Perkins; 1923; 1964, plentiful under *Chenopodium* bushes.

Oodemus laysanensis Fullaway; 1923; 1964, ex *Chenopodium* twigs.

Oodemus neckerensis Perkins; 1923; 1964.

DIPTERA

Chironomidae (Det. by D. E. Hardy)

**Telmatogeton pacificus* Tokunaga; 1964, adults at light.

Ceratopogonidae

*genus and species not yet identified; 1964.

Dolichopodidae

Paraphrosylus acrosticalis (Parent); 1923. Listed by Bryan as *P.* sp.

Phoridae

**Diplonevra peregrina* (Wiedemann); 1964.

Ephydridae

Neoscatella sexnotata (Cresson); 1923; 1962; 1964.

Atissia antennalis Aldrich; 1923. Not listed by Bryan (1926), but description based on specimens from Necker collected by Tanager Expedition (Aldrich, 1931).

Sphaeroceridae

**Leptocera hirtula* (Rondani) (?); 1964.

Asteiidae

*New genus and species (Det. by D. E. Hardy); 1964 (same as Nihoa species).

Chloropidae

Siphunculina signata Wollaston; 1923; 1962; 1964.

Milichiidae

Milichiella orientalis Malloch; 1923. Not listed by Bryan (1926), but a specimen from Necker was subsequently determined by Aldrich (Bryan, 1931).

**Leptometopa* n. sp. (Det. by C. W. Sabrosky); 1964.

Sarcophagidae

Goniophyto bryani Souza Lopez; 1923; 1962; 1964.

Hippoboscidae

Olfersia spinifera Leach; 1923; 1964, adults at light.

HYMENOPTERA

Encyrtidae

**Anagyrus* n. sp.; 1964, reared from *Pseudococcus* n. sp. on *Chenopodium*.

Eupelmidae

Lepideupelmus robustus Timberlake; 1923; 1964.

Signiphoridae

**Thysanus aspidioti* Ashmead; 1964, reared from *Hemiberlesia lataniae* on *Chenopodium*.

Pteromalidae (Det. by C. M. Yoshimoto)

**Spalangia drosophilae* Ashmead; 1964.

Formicidae

Cardiocondyla nuda minutior Forel; 1923; 1964.

Monomorium minutum Mayr; 1923; 1964.

Ponera kalakauae Forel; 1923.

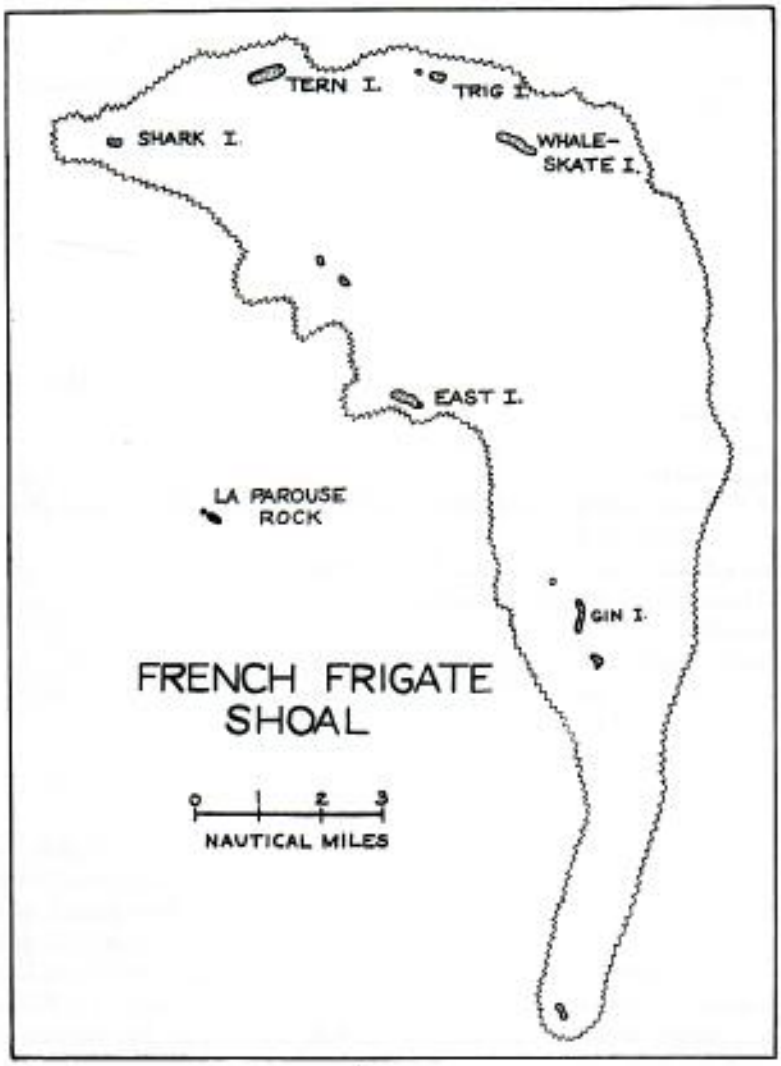
Tetramorium guineense (Fabricius); 1923; 1962; 1964.

FRENCH FRIGATE SHOAL

French Frigate Shoal, situated about 80 miles west of Necker, is a group of about a dozen small coraline islets with a total land area of some 50 acres enlosed within a large reef. The largest islet, Tern Island, is the site of a U.S. Coast Guard Station and is occupied now almost entirely by the airstrip, buildings, and other facilities associated with the station. Vegetation of a limited sort occurs on 6 or 7 of the islets. La Parouse Rock, a small remnant of the original volcanic dome, lies outside the fringing reef and, apparently, is void of higher plant life.

During the Tanager Expedition visit in 1923 only 6 species of vascular plants were found: *Boerhavia diffusa, Chenopodium oahuense, Ipomoea pes-caprae, Portulaca lutea* and *Tribulus cistoides*, (Christophersen & Caum, 1931). In addition to these, there are now several introduced weeds and a few ornamentals on Tern Island.

In June, 1962, I spent a few hours collecting on Tern Island, and in September, 1964, I made brief visits to Trig, Whale-Skate, and East Islets. Fifty-two species of terrestrial arthropods from the atoll are listed below, of which 25 are new records. Of the 27 species listed by Bryan (1926), 11 were not collected in 1962 or 1964.



Two species, *Agrotis kerri* Swezey and *Nysius frigatensis* Usinger are known only from French Frigate Shoal, and two or three others are forms known only from the Leeward group. The remainder are probably all relatively recent immigrants.

ARACHNIDA

ARANEIDA (Det. by T. W. Suman)

Argiopidae

**Neoscona* sp.; 1964, Whale-Skate I.

**Tetragnatha* sp.; 1964, Trig I.

Clubionidae

**Chiracanthium diversum* L. Koch; 1964, Whale-Skate I.

Salticidae

**Hasarius adansoni* (Audouin); 1964, Whale-Skate I.

INSECTA

ODONATA

Libellulidae

**Pantala flavescens* (Fabricius); 1962, Tern I., one adult flying.

ORTHOPTERA

Blattidae

Pycnoscelus surinamensis (L.); 1923; 1964, Trig I., Whale-Skate I., East I.

Periplaneta americana (L.); 1923.

Gryllidae

**Gryllodes sigillatus* (Walker); 1962, Tern I., under boards.

Gryllus oceanicus Le Guillon; 1923.

**Metioche vittaticollis* (Stål); 1964, Trig. I.

DERMAPTERA

Labiduridae

Anisolabis eteronoma Borelli; 1923; 1964, Trig I., Whale-Skate I. Listed by Bryan as *Anisolabis maritima* (Gene) (see Zimmerman 1948, 2:201).

Euborellia annulipes (Lucas); 1923; 1962, Tern I.

THYSANOPTERA (Det. by F. A. Bianchi)

Thripidae

**Frankliniella sulphurea* Schmutz; 1964, East I., on *Tribulus* flowers.

HEMIPTERA

Lygaeidae (Det. by P. D. Ashlock)

Nysius frigatensis Usinger 1923; 1962, Tern I.; 1964, Trig I., Whale-Skate I., East I., on *Chenopodium*, *Boerhavia* and *Portulaca*.

Nysius coenosulus Stål; 1923. Listed by Usinger (1942) and Zimmerman (1948, 3;104) as *N. nigriscutellatus* Usinger, a synonym.

The above were listed as *Nysius* spp. by Bryan (1926).

Nabidae

Nabis capsiformis Germar; 1923; 1962, Tern I.

HOMOPTERA

Cicadellidae

**Circulifer tenellus* (Baker); 1964, Trig I., Whale-Skate I., on *Chenopodium oahuense*.

Deltocephalus sonorus Ball; 1962, Tern I.; 1964, Trig I., on grass.

Aphididae

Aphis craccivora Koch; 1923; 1964, Whale-Skate I., East I., on *Chenopodium*, *Tribulus* and *Portulaca*. Listed by Bryan as *A. medicginis* Koch.

Pseudococcidae

**Ferrisia virgata* (Cockerell); 1964, Trig I., on *Portulaca* and *Boerhavia*.

Coccidae

**Saissetia oleae* (Bernard); 1962, Tern I., on *Coccoloba uvifera* twigs.

Diaspididae

**Hemiberlesia lataniae* (Signoret); 1964, Whale-Skate I., on twigs and branches of *Chenopodium oahuense*.

**Odonaspis ruthae* Kotinsky; 1962, Tern I., 1964 Trig I., on *Lepturus* stems.

LEPIDOPTERA

Noctuidae

Agrotis kerri Swezey; 1923.

**Chrysodeixis chalcites* (Esper); 1962, Tern I., one reared from larva on *Messerschmidia argentea* foliage.

Spodoptera exempta (Walker); 1923. Misidentified in Bryan's list as *S. mauritia* (Boisduval).

Pterophoridae

Megalorhipida defectalis (Walker); 1923; 1964, Trig I., Whale-Skate I., East I., on *Boerhavia*. Listed by Bryan as *Trichoptilus oxydactylus* (Walker).

Pyralidae

Hymenia recurvalis (Fabricius); 1923.

Tineidae

Erunetis kerri Swezey; 1923; 1964, Trig I.

Tineola uterella Walsingham; 1923.

Tortricidae

Crocidosema plebiana Zeller (?); 1923.

COLEOPTERA

Coccinellidae

Scymnus loweii Mulsant 1923; 1964, Trig I., Whale-Skate I. Listed by Bryan as *S. kinbergi* (Boheman).

Dermestidae

Dermestes ater De Geer; 1923; 1964, Trig I. Listed by Bryan as *D. cadaverinus* Fabricius.

Tenebrionidae

**Alphitobius laevigatus* Fabricius; 1964, Whale-Skate I., under boards.

Curculionidae

Dryotribus mimeticus Horn; 1923; 1964, Trig I., under driftwood.
Dryotribus wilderi Perkins; 1923.

DIPTERA

Syrphidae

**Ischiodon grandicornis* (Macquart); 1962, Tern I.; 1964, Trig I., Whale-Skate I., East I., adults flying, larvae preying on aphids.

Dolichopodidae

Paraphrosylus acrosticalis (Parent); 1923. Listed by Bryan as *P.* sp.

Ephydridae

**Hecamede persimilis* Hendel; 1962, Tern I.; 1964, Trig I., Whale-Skate I.

Agromyzidae

**Liriomyza* sp., *hawaiiensis* group; 1964, Tern I., reared from mines in *Tribulus* leaves, Trig I., Whale-Skate I.

Chloropidae

Siphunculina signata Wollaston; 1923; 1962, Tern I.; 1964, Trig I., Whale-Skate I., East I.

Sphaeroceridae

**Leptocera hirtula* (Rondani)?; 1962, Tern I.; 1964, Trig I.

Sarcophagidae

Goniophyto bryani Souza-Lopez; 1923; 1962, Tern I.; 1964, Trig I., Whale-Skate I., East I. Listed by Bryan as an undetermined species.

Hippoboscidae

Olfersia spinifera Leach; 1923.

HYMENOPTERA

Eulophidae

**Hemiptarsenus semialbiclavus* Girault; 1962, Tern I.; 1964, Tern I., reared from *Liriomyza* larvae in *Tribulus* leaves.

Formicidae

Cardiocondyla nuda Mayr; 1923;. 1964, Trig I.
**Phrenolepis longicornis* (Latreille); 1962, Tern I.
Ponera kalakauae Forel; 1923.
**Monomorium floricola* (Jerdon); 1962, Tern I.; 1964, Trig I.
Monomorium pharaonis (L.); 1923; 1964, Whale-Skate I.
**Tetramorium guineense* (Fabricius); 1962, Tern I.
**Tetramorium tonganum* Mayr; 1962, Tern I.

LISIANSKI ISLAND

Lisianski Island, about 360 miles WNW of French Frigate Shoal and 100 miles WNW of Laysan, is a single, roughly rectangular low coraline

islet approximately one-half square mile in area. The greatest elevation is about 40 feet.

Lisianski is now covered with low vegetation, although it was almost completely denuded by rabbits prior to the arrival of the Tanager Expedition in 1923. The vascular plants present include *Scaevola frutescens* (mostly along the beach margins), *Eragrostis variabilis*, *Portulaca lutea* (?), *Nama sandwicensis* and *Tribulus cistoides*. A few ironwood trees (*Casuarina sp.*) are present, also.

Approximately 7 hours were spent collecting insects on Lisianski on 18. IX. 64. Thirty-five species of terrestrial arthropods are known now from the island, 21 being new records. Bryan (1926) listed only 13 species, 7 of which were not re-collected in 1964. In addition, Hardwick (1964) recently has described an apparently endemic species of *Helicoverpa* from Lisianski, based on specimens apparently taken prior to 1923 by an unknown collector.

ARACHNIDA

Araneida (Det. by T. W. Suman)

Argiopidae

**Neoscona* sp.; 1964.

**Tetragnatha* sp.; 1964.

Clubionidae

**Chiracanthium diversum* L. Koch; 1964, plentiful.

INSECTA

Orthoptera

Blattidae

**Blatella germanica* (L.); 1964.

**Periplaneta americana* (L.); 1964.

Dermaptera

Labiduridae

Anisolabis eteronoma Borelli; 1923.

Thysanoptera (Det. by F. A. Bianchi)

Phlaeothripidae

**Karnyothrips melaleuca* (Bagnall); 1964, on *Eragrostis*.

Hemiptera

Lygaeidae (Det. by P. D. Ashlock)

Nysius fullawayi Usinger; 1923; 1964, on *Portulaca*. Listed by Bryan as *Nysius* spp.

Nabidae

Nabis capsiformis Germar; 1923.

HOMOPTERA

Aphididae

Aphis craccivora Koch; 1923; 1964, on *Tribulus*. Listed by Bryan as *A. medicaginis* Koch.

**Hysteroneura* sp.(Det. by Louise M. Russell); 1964, on *Eragrostis*.

Pseudococcidae

**Trionymus insularis* Ehrhorn; 1964, on *Eragrostis* stems, plentiful.

Coccidae

**Saissetia nigra* (Nietner); 1964, very heavy infestations on *Scaevola*, less abundant on *Eragrostis*.

Diaspididae

**Hemiberlesia lataniae* (Signoret); 1964, heavy infestation on twigs of *Scaevola*, also on *Portulaca*.

LEPIDOPTERA

Noctuidae

Helicoverpa minuta Hardwick; date unknown, presumably prior to 1923.

Pseudaletia unipuncta (Haworth); 1923.

Pterophoridae

**Megalorhipida defectalis* (Walker); 1964, plentiful on *Boerhavia*.

Tineidae (Det. by E. C. Zimmerman)

**Ereunetis kerri* Swezey; 1964, reared from larvae on *Eragrostis*.

Cygnodiidae (Det. by E. C. Zimmerman)

**Petrochroa dimorpha* Busck; 1964.

COLEOPTERA

Coccinellidae

**Scymnus loewii* Mulsant; 1964, preying on *Trionymus insularis*. Listed by Bryan as *S. kinbergi* (Boheman).

Dermestidae

Dermestes ater De Geer; 1923; 1964. Listed by Bryan as *D. cadaverinus* Fabricius.

DIPTERA

Dolichopodidae

Paraphrosylus acrosticalis (Parent); 1923; 1964, along rocky beach, preying on small flies. Listed by Bryan as *P.* sp.

Phoridae

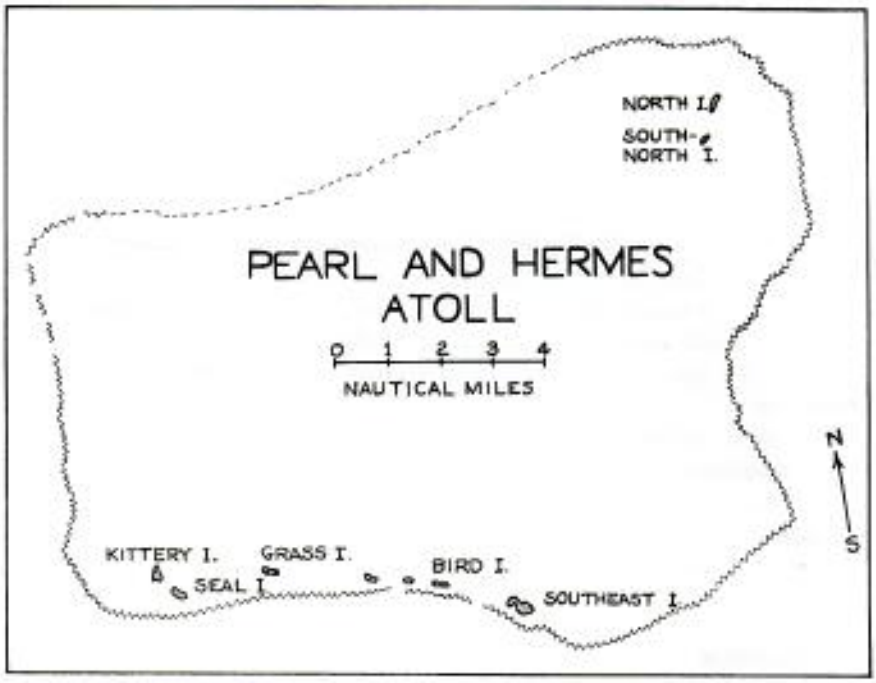
Diplonevia peregrina (Wiedemann); 1923; 1964. Misidentified in Bryan's list as *Apiochaeta scalaris* (Loew).

Ephydridae

**Hecamede persimilis* Hendel; 1964, along beach.

Canaceidae

Canaceoides nudata (Cresson); 1923; 1964, along beach.



ARACHNIDA

ARANEIDA (Det. by T. W. Suman)

Argiopidae

**Neoscona* sp.; 1964, North I., Southeast I.

**Tetragnatha* sp.; 1964, North I., Southeast I.

Salticidae

**Hasarius adansoni* (Audouin); 1964, Southeast I.

CHILOPODA

Geophilidae

Nonnaphilus alohanus Chamberlin; 1923.

INSECTA

ORTHOPTERA

Blattidae

**Periplaneta americana* (L.); 1964, Southeast I.

Pycnoscelus surinamensis (L.); 1923, 1964, Southeast I.

DERMAPTERA

Labiduridae

Anisolabis eteronoma Borelli; 1923; 1964, North I., Southeast I. Listed

by Bryan as *A. maritima* (Gene).

Euborellia annulipes (Lucas); 1923; 1964, North I., Southeast I.

PSOCOPTERA

*undetermined; 1964, Southeast I.

HEMIPTERA

Cydnidae

**Geotomus pygmaeus* (Dallas); 1964, Southeast I.

Lygaeidae (Det. by P. D. Ashlock)

Nysius fullawayi Usinger; 1923; 1964, North I., Southeast I., on *Boerhavia* and *Eragrostis*. Listed by Bryan as *Nysius* spp.

**Nysius palor* Ashlock; 1964, Southeast I., on *Portulaca*.

Nabidae

**Nabis capsiformis* Germar; 1964, North I.

Anthocoridae

**Orius persequens* White; 1964, North I., Southeast I.

Miridae

**Cyrtopeltis modesta* (Distant); 1964, North I., Southeast I., on *Boerhavia*.

HOMOPTERA

Delphacidae

Sogatella paludum (Kirkaldy); 1923; 1964, North I., on *Eragrostis*.

Aphididae

**Aphis craccivora* Koch; 1964, Southeast I., on *Tribulus*.

Pseudococcidae

**Antonina graminis* (Maskell); 1964, North I., Southeast I., on *Eragrostis* and *Lepturus* stems.

**Dysmicoccus brevipes* (Cockerell); 1964, Southeast I., on *Eragrostis* stems.

**Trionymus insularis* Ehrhorn; 1964, North I., on *Eragrostis* stems.

Diaspididae

**Odonaspis ruthae* Kotinsky; 1964, Southeast I., on *Eragrostis* stems.

NEUROPTERA

Chrysopidae

Chrysopa carnea Stephens; 1923. Listed by Bryan as *Chrysopa* sp.

LEPIDOPTERA

Noctuidae

**Heliothis zea* (Boddie); 1964, North I., adult flying, several small larvae on *Eragrostis*.

Spodoptera litura (Fabricius) (Det. by E. L. Todd); 1923; 1964, North I., Southeast I., several adults at light (Southeast) and one in flight (North). Bryan listed this species as "*Prodenia litura* (Fabr.)?" on

basis of a single abraded specimen taken in 1923, and determined by Swezey.

Spodoptera exempta (Walker); 1923. Misidentified in Bryan's list as *S. mauritia* (Boisduval).

Sphingidae

**Celerio lineata* (Fabricius); 1964, North I., Southeast I., several seen flying in daylight but not captured.

Pyralidae

**Hymenia recurvalis* (Fabricius); 1964, Southeast I., adults flying, larvae feeding on *Sesuvium*.

Tineidae

Ereunetis incerta Swezey; 1923; 1964, (North I.) on *Eragrostis*.

Cygnodiidae (Det. by E. C. Zimmerman)

**Petrochroa dimorpha* Busck; 1964 (Southeast I.), adults at light.

Plutellidae

Plutella maculipennis Curtis; 1923, 1964 (North I.)

COLEOPTERA

Coccinellidae

Scymnus loewii Mulsant; 1923; 1964, North I., Southeast I., adults and larvae feeding on mealybugs on *Eragrostis*. Listed by Bryan as *S. kinbergi*.

Dermestidae

Dermestes ater De Geer; 1923. Listed by Bryan as *D. cadaverinus* Fabricius.

**Dermestes maculatus* De Geer; 1964, Southeast I., under dead birds.

Tenebrionidae

Alphitobius laevigatus Fabricius; 1923; 1964, Southeast I.

Cleridae

**Necrobia rufipes* De Geer; 1964, Southeast I., under dead birds.

Anthribidae

**Araecerus fasciculatus* (De Geer); 1964, Southeast I., on *Eragrostis*.

DIPTERA

Phoridae

Diplonerva peregrina Wiedemann; 1923. Misidentified in Bryan's list as *Megaselia scalaris* (Loew).

Syrphidae

**Ischiodon grandicornis* (Macquart); 1964, North I.

Ephydridae

**Hecamede persimilis* Hendel; 1964, North I., Southeast I.

Agromyzidae

**Liriomyza* sp.; 1964, North I., adults flying, larvae mining leaves of *Lepidium*.

**Deltocephalus sonorus* Ball; 1964, on grass.

**Empoasca solana* Delong; 1964, on *Solanum nigrum*.

Pseudococcidae

**Antonina graminis* (Maskell); 1964, on *Eragrostis* stem.

Diaspididae

**Hemiberlesia lataniae* (Signoret); 1964, on *Lepidium*.

**Odonaspis ruthae* Kotinsky; 1964, *Eragrostis* stems.

LEPIDOPTERA

Noctuidae

**Spodoptera mauritia* (Boisduval); 1964, adults on mess-hall screen.

Gelichiidae

**Stoberhinus testaceus* Butler; 1964.

COLEOPTERA

Coccinellidae

**Scymnus notescens* (Blackburn); 1964.

DIPTERA

Ceratopogonidae

*undetermined genus and species; 1964.

Agromyzidae

**Pseudonapomyza spicata* (Malloch); 1964.

Chloropidae

**Siphunculina signata* (Wollaston); 1964.

Sphaeroceridae

**Leptocera hirtula* (Rondani)?; 1964.

HYMENOPTERA

Mymaridae

Polynema reduvioli Perkins; 1923; 1964.

Eulophidae

**Euderus metalicus* Ashmead (?); 1964.

Encyrtidae

**Anagyrus swezeyi* Timberlake; 1964.

**Bleptyrus insularis* (Cameron); 1964. This species is a parasite of *Ferrisia virgata*. The latter was stated to be heavily infesting *Boerhavia*, and apparently was abundant on other hosts as well, in 1961. In 1964 this mealy bug was scarce.

LAYSAN ISLAND

New records in my June, 1962 collections from Laysan have been cited by Butler and Usinger (1963a). Half a day was spent collecting on Laysan in September, 1964. An apparently recently established immigrant spider was found, but no new insects.

Also taken in 1964 and not previously reported from Laysan was a small lizard of the family Scincidae, *Cryptoblepharus boutoni poecilopleurus* (Wiegmann) (Det. by W. O. Wirtz II), several of which were seen.

ARANEIDA

Clubionidae (Det. by T. W. Suman)

**Chiracanthium diversum* L. Koch; 1964, plentiful.

The following insects collected in 1964 seem worthy of note.

COLEOPTERA

Coccinellidae

Scymnus loewi Mulsant (Det. by E. A. Chapin); 1912; 1964, feeding on *Trionymus insularis* on *Eragrostis*.
This is probably the species collected by Butler in 1959 on *Eragrostis*, the specimens of which were lost. (Butler & Usinger 1963a: 15) Listed by Bryan as *S. kinbergi* (Boheman).

Cleridae

Necrobia rufipes De Geer; 1912; 1964.

Curculionidae

Dryotribus mimeticus Horn; 1912, 1964, numerous specimens on underside of driftwood on beach.

DIPTERA

Milichiidae

**Leptometopa* n. sp. (Det. by C. W. Sabrosky); 1962; 1964. Same species from Nihoa, Necker, Lisianski and Pearl and Hermes Atoll, not previously recorded.

HYMENOPTERA

Pteromalidae (Det. by C. M. Yoshimoto)

Spalangia drosophilae Ashmead; 1962; 1964. Recorded as *Spalangia* sp. by Butler & Usinger (1963a).

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* Mackerel landed by the New England fleet, in sea-packed barrels, at all ports, was as follows:

Time.	1885.	1886.
Up to August 1	116,836	10,112
Week ending August 7	40,150	1,810
Week ending August 14	38,363	10,381
Week ending August 21	18,384	1,118
Week ending August 28	10,056	2,041
Three days ending August 31	10,153	2,812
Total to September 1	223,152	27,303

Whaling fleet of Provincetown, Mass., August 13, 1886.

Name.	Net tonnage.	No. of boats.	No. of men.	Location of whaling grounds.
Schooner William A. Crozier *	111.69	3	16	Atlantic Ocean.
Brig David A. Snaill †	113.83	3	16	Do.
Schooner Quickstep †	89.25	3	16	Do.
Schooner Ellen Rizpah †	93.43	3	16	Do.
Schooner Mary G. Curren †	97.03	3	16	Do.
Schooner Rising Sun †	95.09	3	16	Do.
Schooner Agate †	76.05	3	16	Do.
Schooner Antarctic †	85.57	3	16	Do.
Schooner Ruth †	78.81	3	16	Do.
Schooner Bloomer †	79.13	3	16	Do.
Schooner Alcyone †	87.61	3	16	Do.
Schooner Gago H. Phillips †	101.58	3	16	Do.
Steamer Angelia B. Nickerson	20.97	.....	6	Off New England coast.
Total	1,070.03	34	198	

* Arrived on August 9. † Now on voyage. ‡ Arrived June 14; now on second voyage.

GLOUCESTER, MASS., *August* 31, 1886.

78.—HAWAIIAN FISHING IMPLEMENTS AND METHODS OF FISHING.

By Mrs. EMMA METCALF BECKLEY,

Curator of the Hawaiian National Museum.

[Abstract.]

The Hawaiians have five methods of fishing: by spearing, hand-catching, baskets, hook-and-line, and with nets.

The spearing of fish is of two kinds, below and above water. That below water is the most important, and is generally employed for the different kind of rock fish. The spear used by the diver is a slender stick of from 6 to 7 feet in length, made of very hard wood, and sharply pointed at one end, but more tapering at the other. Since the possession of iron, spears are always tipped with it, but perfectly smooth, without hook or barb. Diving to a well-known station by a large coral rock or against the steep face of the reefs, the diver places himself in a half crouching position on his left foot, with his right foot free and extended behind, his left hand holding on to the rock to steady himself,

with snow-storms, prevailed. The French fleet were having a light catch of codfish. Reports from Norway are favorable, the catch of cod being one of the largest on record.

All halibut brought from Iceland are salted as soon as caught, and on arrival at the home port are smoked before going into the market. Vessels fishing for halibut on the banks nearer home put their catch on ice as soon as caught, and land it fresh. It is then packed with ice in boxes and quickly distributed through the leading fish-markets of the country.

Bait has been abundant all the month, weirs at Cape Cod nearly all the time having abundance of squid or small mackerel, often both. Weirs off the Maine coast have had a good catch of herring, more than was wanted by the fishermen.

Number and location of the New England fishing fleet during the last week of August.

Location.	Object.	No. of vessels.
Grand Banks, lat. 44° to 46°, long. 52° to 54°	Codfish	80
Grand Banks, lat. 44° to 45°, long. 49° to 51°	Halibut	25
Banquereau, lat. 44° to 45°, long. 58° to 60°	do	15
Between George's and Brown's Banks	do	15
George's and Brown's Banks, lat. 41° to 43°, long. 67° to 68°	Codfish	225
In Gulf of Saint Lawrence	Mackerel	175
Off the New England coast	do	75
Off the New England coast	Ground fish	200
On the way home from Iceland	Halibut	6
Off the New England coast	Whales	3
In Gulf of Saint Lawrence	Mackerel	1
Total		910

Receipts of fish at Gloucester, Mass., in August, 1886.

From—	Vessels.	Codfish.	Halibut.	Hake.	Haddock.	Cusk.	Pollock.	Sword-fish.	Mackerel.	Menhaden oil.
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Bbls.*	*Bbls.*
George's Bank	142	2,905,000	273,713	5,000	.....	5,000	.....	2,500	.....	.....
Brown's Bank	19	702,000	1,450	.....	.....	.....	2,000	.....	.....	.....
Banquereau	7	80,000	112,000	.....	.....	.....	.....	.....	.....	.....
Bay of Fundy	9	103,000	150	35,000	.....	.....	.....	12,573	.....	.....
Grand Banks	94	3,010,000	428,200	.....	.....	.....	.....	.....	.....	.....
New England shore	9	83,000	.....	30,000	7,000	.....	2,000	200	.....	.....
Flemish Cap	2	570,000	15,000	.....	.....	.....	.....	.....	.....	.....
La Have Bank	9	280,000	57,000	.....	.....	7,000	.....	.....	.....	.....
Nova Scotia, Cape shore	4	165,000	.....	15,000	.....	.....	.....	.....	.....	.....
Ireland	1	.....	99,000	.....	.....	.....	.....	.....	.....	.....
Off Newfoundland	1	.....	13,000	.....	.....	.....	.....	.....	.....	.....
Western Bank	6	330,000	46,800	15,000	.....	.....	.....	.....	.....	.....
Off Seal Island	7	223,000	2,500	.....	.....	.....	4,000	.....	.....	.....
Gulf of Saint Lawrence	27	.....	.....	.....	.....	.....	.....	.....	11,525	.....
Off New England shore	4	.....	.....	.....	.....	.....	.....	.....	122	.....
Tiverton, R. I	1	.....	.....	.....	.....	.....	.....	.....	.....	800
From small boats	...	12,000	.....	20,000	.....	.....	.....	.....	.....	.....
Total in August, 1886	282	8,482,000	1,051,813	141,000	7,000	12,000	8,000	15,108	11,647	800
Total in August 1885	414	7,122,000	1,112,050	60,000	42,000	30,000	.....	70,345	48,237	700

Additional receipts from Maine in August, 1886: 15,000 boxes of smoked herring, 600 quintals of dry hake, 83 barrels of cod oil.

and there he watches and waits for the fish. Fish in only two positions are noticed by him, those passing before and parallel to him, and those coming straight towards his face. When the fish is hit, the force of the blow generally carries the spear right through to the hand, thus bringing the fish up to the lower part or handle of the spear, where it remains while the fisherman strikes rapidly at other fish in succession should they come in a train, as they usually do.

Except in the case of "oopuhue" spearing, above-water spearing is very rarely used, and then generally in connection with deep-sea line-and-hook fishing. "Oopuhue" is the well-known poison fish of the Pacific, but is of a delicious flavor. It is generally speared in inclosed salt-water ponds from the stone embankments. The poison of this fish is contained in three little sacs, which must be extracted whole and uninjured. The fish is first skinned, as the rough skin is also poisonous in a slight degree. Should the teeth of the fish be yellow, then it is so highly charged with poison that no part of its flesh is safe even with the most careful preparation. "Oopuhue" caught in the open sea are always more poisonous than those from fish ponds.

Some fishermen dive to well-known habitats of certain fish and lobsters and, thrusting their arms under rocks or in holes, bring out the fish one by one and put them into a bag attached for the purpose to the loin cloth. Women frequently do the same in shallow waters, and catch fish by hand from under coral projections. It is also a favorite method employed by women in the capture of the larger varieties of shrimps and "oopus" in the fresh-water streams and "kalo" ponds. Goldfish are also caught in that way, and at the present time form no inconsiderable portion of the daily food of the poorer classes living near "kalo" patches or fresh-water ponds. Their power of reproduction is very great. The different kinds of edible sea-slugs are caught in the same way, although the larger kinds are sometimes dived for and speared under water.

There are two ways of octopus fishing. In shallow water the spear is used. Women generally attend to this. Their practiced eye can tell if an octopus is in a hole whose entrance is no larger than a silver dollar, and plunging their spears in they invariably draw one out. These mollusks have the peculiar property of drawing themselves out and compressing their bodies so as to pass through very narrow apertures many times smaller than the natural size or thickness of their bodies. Those caught in shallow waters vary from 1 to 4 feet in length, but the larger kinds live in deep water always and are known as blue-water octopus.

They are caught with cowries of the *Mauritiana* and sometimes of the tiger species. One or more of these shells is attached to a string with an oblong pebble on the face of the shell; a hole is pierced in one end of the back of one of the shells through which the line is passed, which, having been fastened, is allowed to project a few inches

below, and a hook whose point stands almost perpendicular to the shaft or shank is then fastened to the end of the line. Only the finest kind of *Mauritiana* or tiger cowries are employed for this purpose, as the octopus will not rise to a large-spotted or ugly one. The spots on the back must be very small and red, breaking through a reddish-brown ground; such a shell would have the strongest attractions for an octopus. Cowries with suitable spots, but objectionable otherwise, are slightly steamed over a fire of sugar-cane husks. This has the effect of giving them the desired hue.

The fisherman having arrived at his fishing-grounds first chews and spits on the water a mouthful of candle-nut meat which renders the water glassy and clear; he then drops the shell with hook and line into the water aad swings it over a place likely to be inhabited by an octopus. This being a voracious animal, when in its hole is always, according to Hawaiian fishermen, keeping a lookout for anything eatable that may come within reach of its eight arms. The moment a cowry is perceived, an arm is shot out and the shell clasped; if of the attractive kind, one arm after the other comes out, and finally the whole body is withdrawn from the hole and attaches itself to the cowry, which it closely hugs, curling itself all around it. It remains very quiet while being rapidly drawn up through the water, till, just as its head is exposed above water it raises it, when the fisherman pulls the string so as to bring its head against the edge of the canoe and it is killed by a blow from a club which is struck between the eyes. This must be done rapidly, before the animal has time to become alarmed and let go the cowry, when, should the arms be a fathom in length, it becomes a dangerous antagonist, as there would be risk of the fisherman being squeezed to death. Having eight arms, an octopus of such a size could very well manage two or three persons, as the cutting off of one or more of its arms does not affect the rest in the least.

Torch-light fishing is practiced on calm dark nights. The fish are either caught with small scoop-nets or are speared. Torch-light fishing is always done in shallow water where one can wade. The fisherman must be spry and light of step, passing through the water without a splash to disturb the fish, which remain quiet, as if dazzled by the light unless alarmed by the splashing or concussions in the water. The torches are made of split bamboos secured at regular intervals with leaves, or of twigs of the spurious sandal-wood bound together in the same manner.

The Hawaiians have four kinds of basket fishing. The first is with a basket looking something like the coal-scuttle bonnets of a hundred years ago, and is woven with the air roots of the *Freycinetia arborea*. This is used for mountain shrimping, and women always attend to it. They move in a crouching position through the water, moving small stones and thrusting sticks under the large ones to drive the shrimps to a suitable place which is always some place where the grass, ferns, or

branches of trees droop over on the water; the shrimps take refuge in or under these and the fisherwoman places her basket under the leaves and lifts them out of the water, when the shrimps drop into the basket; she then unties the small end and drops them into a small-mouthed gourd attached to a string, which she keeps floating after her for that purpose, and puts some fern leaves inside the gourd to keep the shrimps from creeping out, as they are lively little fellows living a long time out of water and scampering about on land like cockroaches.

The second is with a small basket made from the vines of the convolvulus, and it is renewed from day to day as wanted. A light framework of twigs is first tied together and then the vines, leaves and all, are wound in and out, round and round, till of the requisite size, 3 or 4 feet in circumference and about 1½ in depth. Shrimps pounded and inclosed in cocoa-nut fiber are occasionally placed at the bottom of the basket for bait, but usually the scent of the bruised and withering leaves seems to be sufficient. Women always attend to this kind of fishing. They wade out to suitable places, generally small sandy openings in coral ground or reef, and let the baskets down suitably weighted to keep them in position, the weights being attached in such a way as to be easily detached. Each woman then moves away from her basket to some distance from which she can watch the fish enter the basket. When all the fish that are in sight have entered, she takes the basket up and transfers the fish to a large small-mouthed gourd, and moves the basket to a fresh place.

Fishing in this way can be carried on only during a calm sunny day and at low tide. Since the introduction of the weeping-willow, baskets for this fishing are sometimes made of willow twigs. Such can be used over and over again. Men sometimes take such baskets and using sea-eggs for bait, with the top of the shell broken to expose the meat, place them in comparatively deep water, piling stones around them to keep them in place. They leave them thus for a day or two, and if the place is a good fishing-ground the basket will be full by the time they come for it.

The third kind of basket is shallow, of about the same size as the above but wider mouthed, used in deep water for catching a small, flat fish called "niui" that makes its appearance at intervals of from ten, fifteen, or twenty years. At the last appearance of the "niui," the imported marketing baskets were generally used by those who could not obtain the old-fashioned kind, as any old cast-away basket would do, with a little patching occupying perhaps five minutes, and two sticks bent over the mouth or opening from side to side and at right angles to each other for a handle to which to tie the draw-string. It should be twisted round and round above the jointure with a little of the sea convolvulus with the leaves on, so as to throw a little shade into the basket to keep the fish from being frightened while they are being drawn up to the surface of the water. In these baskets cooked pumpkins, half-roasted

sweet potatoes, or raw ripe papayas were placed for bait. The canoes thus provided would sail right into the midst of a school of these fish; the basket being lowered a few feet into the sea, and the fish being attracted by the scent of the bait, would rush into the baskets and feed greedily. As soon as the baskets were full of fish they would be drawn up and emptied into the canoe and then lowered again, with more bait if necessary, and this would go on till the canoe was loaded or the fishermen were tired. These fish are very good eating when they first arrive, as they are fat, with the liver very much enlarged; but after a month they become thinner, not perhaps procuring their proper food here, and then taste strong and rank.

The fourth kind of basket is the largest kind used in fishing by the Hawaiians. These are round, rather flat baskets, 4 to 5 feet in diameter by 2½ to 3 in depth, and about 1½ across the mouth. A small cylinder or cone of wicker is attached by the large end to the mouth and turned inward towards the bottom of the basket. This cone or cylinder is quite small at the free end, just large enough for the fish ("kala") to get in. Immediately below the end of this cone, on the bottom of this basket, is placed the bait, properly secured, which is a coarse, brownish-yellow alga, on which this fish feeds and from which it takes its name, ripe bread-fruit, cooked pumpkins, half-roasted sweet potatoes, and papayas. The fishermen generally feed the fish at a given place for a week or more before taking any, using for this purpose a large basket of the same kind, without the inverted cylinder and wider in the mouth, to allow the fish free ingress and egress. After a week or two of feeding they become very fat and fine flavored, as also very tame, and baskets full of fish can be drawn up in the taking basket without in the least disturbing those that are still greedily feeding in the feeding baskets. These baskets are occasionally used for other kinds of fish, substituting the bait known to attract that particular kind.

The Gilbert Islanders have of late years introduced fishing with a basket in a manner different from any formerly practiced by Hawaiians. This is an oblong basket, called by these people a "punger," larger at one end than another, with a flat and oval top, convex like a carriage top, and gradually sloping to the small end. A cone with the end cut off is inserted at the large end, the body of the cone being inside of and opening into the basket. A trap-door is fixed on the end of the cone in such a manner that it will open by a touch from the outside, but cannot be pushed open from the inside. The basket is taken to a good, sandy place, in 2 to 4 fathoms of water, where there is plenty of coral or stones handy. The fisherman then dives and places the basket in the exact position he wishes; he then takes pieces of coral rock and begins to build up and around the basket, inclosing it completely with stones so as to form an artificial dark retreat for the fish. The entrance to the cylinder or cone is left exposed, and the fish, seeing an inviting entrance to a dark place, go on an exploring expedition till they find

themselves inside. Once inside they cannot return. This basket is left from two days to a week in a position at the bottom of the sea, when the stones are displaced, the basket and its contents are hauled up to the canoe or boat, a door left at the smaller end of the basket is opened, the fish shaken out, and the basket is ready to be replaced in the sea.

There are only seven kinds of fish sought for in fishing with rod, hook, and line. The bait most liked is shrimp; earthworms are sometimes used and any obtainable fry of fish. The fisherman takes a handful of shrimps, baits his hooks, and then, bruising the remainder and wrapping it up in cocoa-nut fiber, ties it with a pebble on the line and close to the hooks; the bruised matter spreads through the water when the line is dropped and serves to attract fishes to the vicinity of the hooks.

For hook-and-line fishing practiced in deep water, bonitos and lobsters are the usual bait; for lack of these any kind of fish is used with varying results. For deep-sea fishing the hook and line are used without rods, and our fishermen sometimes use lines over 100 fathoms in length. Every rocky protuberance from the bottom of the sea for miles out, in the waters surrounding the islands, was well known to the ancient fishermen, and so were the different kinds of rock fish likely to be met with on each separate rock. The ordinary habitat of every known species of Hawaiian fishes was also well known to them. They often went fishing so far out from land as to be entirely out of sight of the low lands and mountain slopes, and took their bearing from the positions of the different mountain peaks, for the purpose of ascertaining the rock which was the habitat of the particular fish they were after.

The natives distinguish the sharks seen in Hawaiian waters into five species: The "mano-kihikihi" (hammer-headed shark) and the "lalakea" (white fin) are considered edible, as the natives insist that these never eat human beings; then comes the "mano-kanaka" (man shark), which only rarely bites people; then the "mano," a large white shark, the largest of all known to Hawaiians, but not a particularly ravenous one, which is seldom seen; the "niuhi" completes the list, a very large shark, and the fiercest of all, which, fortunately, very rarely makes its appearance in Hawaiian waters.

There are two general divisions of the kinds of nets in use here, the long nets and the bag or purse nets, with endless variations of those two main features. The finest of the long nets has a mesh one-half inch wide. It is generally 1½ fathoms in depth and from 40 to 60 fathoms in length. It is used to surround and catch the small mullets and "awas" in shallow waters for the purpose of stocking fish ponds. Small pebbles, frequently ringed or pierced, are used for sinkers and pieces of the *Hibiscus tiliaceus* and candle-nut tree for the floaters. Nets of 1 to 2 inch mesh are used for the larger mullets. A 2 to 2½ inch gill-net is sometimes stretched from a given point to another at high tide, and always across what they call fish-runs in shallow waters, which are

long, sandy openings in coral places. Two persons, or sometimes one, work this net, passing backward and forward to seaward of the net, taking out fish as fast as caught in the meshes. This way of fishing is only practiced at night. Sometimes a place where fish are seen or are likely to be is surrounded and the water inside the circle beaten, when the frightened fishes dart in every direction with great violence and are meshed.

A long net of 3 to 4 inch mesh is used for catching large fish, such as the "oio." It is of 80, 100, 140, or even 150 fathoms in length by 2 to 3 fathoms in depth. It is used in the deeper waters just inside, or in shallow waters just outside, the reef or breakers. For this fishing the fishermen go in canoes; one man is always standing upright on the cross-bars of the canoe, keeping a sharp lookout for a school of "oio." When he sees one, the canoes follow it at a distance from place to place, or wait patiently, if the fish remain in an unfavorable place, till they move into the accustomed fishing-grounds. Two or three canoes are almost always engaged together in this kind of fishing. When the fish are in a suitable place one canoe approaches very cautiously and stations itself where the net is to be dropped, while another one, carrying a net of the same kind, makes a wide circuit till immediately opposite, with the fish between, when the ends of the nets are dropped simultaneously from the two canoes, and both paddle in a semicircle while paying out the net and striving to meet the dropped ends of the opposite net as soon as possible, so as completely to inclose the school before the fish become alarmed. The first canoe having met the end of the opposite net, if on sandy bottom, keeps on one side of the net already down, drawing its own net after it, thus gradually reducing the circle, as well as making two or three rings of netting around the fish, so that if they make a rush to any given point and by their weight bear down the floaters, those escaping from the first circle will still be inclosed by the outer ones, and eventually be caught by becoming entangled and meshed. When the nets have been drawn to suit the head fisherman they all jump overboard with their canoe poles and by beating the water frighten the fish, which dash here and there with great violence, entangling themselves in the nets, and are easily captured.

In catching other kinds of fish these or smaller nets are used either in daylight or at night, though the best results are almost always obtained at night. The nets are dropped in a semicircle and some of the fishermen, making a wide sweep to the opposite side, spread out fan-shape and move rapidly towards the net, beating the water as they go with their arms, and thus driving the fish from quite a distance into the comparatively small area partly inclosed by the nets, while the two men holding the stick supporting the end of the net and standing perpendicularly in the water run towards each other on the approach of the beaters. Should the water be dirty and the net rather long, the ends are then gathered together until the circle is all reduced and the fish

all taken. If at night, numbers of rock fish are also taken with those that spread in schools.

The finest of all kinds of nets ("nae") has only one-fourth inch mesh. The "pua" net is for young mullet fry for stocking ponds or for eating. This net is generally a piece, a fathom square, attached on two sides to sticks about 3 feet in length and falled in, the bottom rope being shorter than the upper one and forming an irregular square opening to a shallow bag, which is supplemented by a long narrow bag about 3 or 4 inches wide and 2 feet deep. The sea convolvulus, generally found growing on the beach, is twisted, leaves, branchlets, and all, into two thick, bushy ropes some 15 or 20 feet in length, and these are attached on each side of the net to the side sticks; these lines are then drawn forward in a semicircle sweeping the shoals of fry before them till enough are partly inclosed, when the two free ends are brought rapidly together in a circle, which is gradually reduced, the same as in long-net fishing, till the fry are all driven into the bag.

The same size of mesh (¼ inch), but made into a much larger bag, is used in fishing for "ohua," a small kind of fish very highly prized by the natives, which lives in and feeds upon the coarse alga that grows on coral in shallow water. Long ropes, 100, 200, or even 300 fathoms in length, having dry "ki" leaves braided on them by the stems, the blade ends of the leaves hanging loose, are started from a given place in opposite directions to sweep around and finally inclose a circle, which is afterwards reduced in the same manner as in long fishing. Great numbers of men, women, and children assist at this kind of fishing to hold the ropes down to the bottom, and by the splashing and disturbance of the alga drive the fish away from the ropes and into the net. Persons are generally stationed every yard or so on the ropes for this purpose and also to disentangle the ropes if caught on a rock or other obstruction. When the circle is narrowed to from 10 to 15 feet in diameter one end of the ropes is untied and the ends attached to the ends of the side sticks of the bag-net, forming a guard on each side, and the circle further reduced till the fish are all driven into the net.

The diver's net is a small bag of 2-inch mesh, about 2½ feet across the opening or mouth of the bag and the same in depth. Two sticks are attached on each side of the opening, leaving a space of half a foot in width between them. This net is managed by one person, who dives to the small caves and holes at the bottom of the sea, which are always well known to the local fishermen, and placing his net across the opening or hole, mouth inwards, he then inserts a slender rod, with a tuft of grass at the end, into the hole, and gently drives the fish which may be in there into the open mouth of his net, which he closes by joining the two sticks together. Then placing his driving stick over the closed mouth as a further preventive, he rises to the surface, and emptying his bag into the canoe, goes to another cave or fish-hole, where he repeats the operation till tired or satisfied with the quantity caught.

Another net is for catching "uhu," a very highly prized kind of rock fish of two species, the red and the green. The red varieties are the more choice ones for eating raw. The green are not so fine flavored, but attain a larger size. The net for these fishes is a square of 2 or 3 inch mesh, which has been slightly gathered on the ropes and attached at the four corners to slender strong sticks tied together at the middle in such a way that they will cross each other at the middle and can be closed together when wanted. When crossed they spread the net open in the form of a shallow bag, a string is tied to the crossing of the two sticks, and the net is then ready for operations. A decoy fish, which may have been previously caught with the hook and line, is then dropped, with a string attached, in a place where fish of that kind are noticed or known to frequent, and gently moved back and forth; this is called "teasing the fish." Every fish of that kind which can see the decoy fish is immediately attracted to see the strange actions of this one, and when all have been attracted that are likely to be in the vicinity the net is gently dropped at a little distance from the decoy, which is then gently drawn into the net. All the fish rush after it into the net, which is then quickly pulled up, the sticks bending over, which elongates the bag, also reducing the opening or mouth. By a peculiar twitch and pull on the string the sticks can be made to swing around and lie parallel, thus effectually closing the bag. No diving is required for this net beyond that which is sometimes necessary to get the decoy. It is also used for several other kinds of rock fish of like habits, always first getting a decoy of the kind wanted. Fishermen almost always carry for this kind of fishing candle-nut or cocoa-nut meat, which they chew and spit over from time to time to smooth the sea so that they can observe the bottom.

The "opule" is taken in a similar manner in a bag-net, a fathom in length, having a small oval mouth 2 or 3 feet wide.

A large 1-inch mesh-net, 8 fathoms in depth, is used in deep waters for catching the Hawaiian mackerel, a small narrow fish caught only at certain seasons. Cooked pumpkins are placed at the bottom of the net for bait, and lowered some fathoms beneath the surface, and the scent of the pumpkin diffusing through the water attracts the fish and they enter the bag to feed on it. When a sufficient quantity of them have entered it is rapidly drawn up and emptied of fish. More pumpkin is put in, and the fishermen sail to a fresh place to drop the bag.

Two other nets are used for two kinds of very small fish that come at certain seasons in immense schools and are much used for bait. Pickled and dried they are very good eating. The net is a fine-mesh bag exactly like a "pua" net, but much larger. It is to be used with ropes with "ki" leaves attached, only this sort of fishing net requires no diving, as it is used in deep waters.

In another kind of decoy fishing the decoy used is a billet of hard wood something like a club, rounded at the ends and one end smaller

than the other, with a little ringed knob on the smaller end to tie a string to. This club, when prepared with the proper attention to the usual lucky or unlucky superstitions common to Hawaiian fishermen, is then slightly charred over a regulation fire. "Kukui"-nut meat and cocoa-nut in equal quantities are first baked, pounded, and tied up in a wrapping of cocoa-nut fiber (the sheath around the stem of a cocoa-nut leaf), and the fishermen then start on a canoe for the fishing-grounds. This should be in water not deeper than 4 or 5 fathoms. Arrived there the decoy is then greased with the oily juice of the pounded nuts and dropped overboard and allowed to hang suspended a few feet from the bottom. The scent of the baked nut meat diffusing through the water seems to have a powerful attraction for some kinds of fish, which surround the stick, seeming to smell or nibble at it. After awhile the bag-net is dropped over with its mouth open towards the stick, when the latter is moved gently into it, the fish still surrounding and following it into the net. Two persons then dive and, approaching the net gently, quickly close its mouth and give the signal to those in the canoe to haul it up.

The "hano" is a large bag net of very fine mesh, with a flaring mouth, used to capture flying-fish. There are two varieties of flying-fish here, entirely distinct from each other. The same net and method of capture is also employed for the "iheihe," a long thin fish, usually 1½ feet in length, with a very sharp-pointed snout, that generally arrives here at about the same time as the large flying-fish. The "hano" is also occasionally employed for the "akule," another fish that arrives in schools.

For catching the large flying-fish the "hano" is piled on a double canoe or large single one, and a start is made early in the morning with an attending fleet of from twenty to forty canoes. Women very often go in this kind of fishing to help paddle the canoes, as no particular skill is called for on the part of the general hands, the success of the fishing depending altogether on the good judgment and sight of the lookout. This person is generally on a light canoe manned by only two or three hands, and he is standing up always on the cross-ties of the canoe looking for the fish. Whenever he discerns a strong ripple he points it out to the rest of the canoes, who then surround the spot indicated while he confers with the head fishermen about the best place to drop the net, which depends upon which way the current sets. When the net is all ready the canoes paddle very quickly in towards it, splashing the water and driving the fish before them into the open net.

It seems that these fish will not dive to any depth, and are always found swimming very near the surface, so that, when completely surrounded by canoes, they can be driven wherever wanted. The fleet very often goes several miles out to sea; and this fishing is called "blue-sea fishing."

The "kolo" is the largest of all the nets, and can be used only in a very few places, like the harbor of Honolulu, Paulou, &c. It is an im-

mense bag from 16 to 24 fathoms in depth, small-meshed and narrow at the extreme end, but widening out into an immense flaring mouth, with long nets 16 to 20 fathoms deep attached on each side and called its ears. This is swept from one side to the other of the harbor, scooping up every kind of fish. A great many sharks 6 feet in length are sometimes caught in it, but the net is generally used when the mullet is in roe and is designed for the capture of large quantities of that fish. It requires a great many hands to manage it.

A large bag-net, somewhat smaller than the "kolo," but of the same general shape, is sometimes used. Two ropes of 300 or 400 fathoms in length, with "ki" leaves attached, and generally the rope of two or more "ohua" nets joined, are piled on to a large double canoe, which is taken out 2 or 3 miles from shore, attended by a fleet of from sixty to one hundred canoes. The head fisherman always goes on the canoe containing the net and ropes. Arrived at the proper distance, which must be just opposite the final drawing place, the end of one rope is joined to that of the other, and two canoes, manned by eight or ten strong men, take the other end of the rope, one each, and start in opposite directions and exactly parallel with the shore, while the double canoe remains stationary till all the rope is paid out. In the mean time the rest of the canoes have divided into two companies and follow the two leading canoes, stationing themselves at certain distances on the rope and helping to pull it. When the rope is all paid out, the two leading canoes then curve in to form a semicircle, at the same time always moving towards the shore. When a perfect semicircle has been made by the rope the double canoes and all the others move gradually forwards with it, while the leading canoes are pulling with all their might straight in to the shore. When either end is landed the men immediately leap out and taking hold of the line pull on it, at the same time going towards each other, which has the effect of narrowing the semicircle, while most of the canoes keep backing on to the double canoe, which always keeps the center. Arrived at a suitable place, which is always a clean sandy one a few rods from shore, the ropes are untied and attached to each end of the net; men, women, and children now gather on the rope, especially where it joins the net, and make a great disturbance with their feet, which drives all the fish into the net. Rope and net are finally drawn ashore.

We have two kinds of fish ponds or inclosures: Fresh-water ones, from half an acre to 2 or 3 acres in extent; and salt-water ponds, generally very large and inclosing an area of many acres. The salt-water ponds are of two kinds—those entirely closed, and in which fish are fed and fattened; and those surrounded by a low wall that is submerged at high tide and has openings, which are walled on each side like lanes leading in or out of the pond.

The lanes, or fish-runs, are from 15 to 20 feet in length and radiate from the wall inside and out. They are of about 2 feet in width at the

opening in the wall and widen out gradually till they are from 8 to 10 feet wide at the ends. At night when the tide is coming in, a man, or more frequently a woman, takes a small scoop-net just wide enough to fill the entrance of the opening and of 3 or 4 feet in depth, wades out to the entrance of one of these runs, and sitting on a raised stone platform on its side, made for that purpose, holds the net in the water at the entrance of an opening towards the sea and sits very quiet until a jerk in the net is felt, when it is immediately pulled up before the fish have time to return, and the fish are dropped into a gourd or basket, when the net is immediately returned to the water and waiting and watching are resumed. Two persons generally go to this kind of fishing and sit on opposite sides of the entrance, so that as one net is raised another one is still there, as under certain conditions of the water and weather two persons will be kept busy scooping up fish as fast as the nets can be lowered. No fish must be allowed to get free as that would put a stop to the fishing at that entrance during that turn of the tide.

These entrances are favorite stations for the ground-sharks of the neighborhood to prey on the fish as they go in or out, and so when the tide is about medium height the fishing people return to shore, as their platforms would be entirely submerged at high tide. At the turn of the tide, and when the platforms are exposed, other parties take their turn at the lanes, using those with entrances opening inwards. These fish ponds are sometimes owned by the proprietors of two adjoining lands, the people of one owning the right to fish during the rise of the tide and the other during the ebb. Long nets are also used in these ponds, but only during the condition of the tide belonging to each.

The large salt or brackish water ponds, entirely inclosed, have one, two, or four gates. These are of straight sticks tied on to two or three cross-beams, the sticks in the upright standing as closely as possible, so that no fish half an inch in thickness can pass them, while the water and young fry can pass freely in and out. Scoop-nets the width of the gates are used at these places at the flow of the tide to scoop up such fish as may be desired by the owner or pond-keeper for family use. When any large quantity is wanted the long net is used, the same as in shallow-sea fishing.

Fresh-water ponds are very seldom over half an acre in extent, and are for "oopu" and "opae" preserves, and sometimes for "awa," a kind of tropical salmon that breeds in brackish water and will live and grow fat in perfectly fresh water. The young fry of this fish are procured in shallow waters on the beach where a stream or spring of fresh water mingles with the sea, and are carried sometimes many miles inland in large gourds with water.

The catfish has been introduced within four years, and is doing well. Carp have also been introduced very recently, but it is yet too early to pronounce on the success of the experiment.

HONOLULU, *June* 25, 1883.

Vol. VI, No. 17. Washington, D. C. Nov. 8, 1886.

79.—AMERICAN CATFISH IN THE TROCADÉRO AQUARIUM OF PARIS.*

By Dr. JOUSSET DE BELLESME.

These fish,† which measured 12 centimeters [about 4¾ inches] in length. were in the beginning, owing to their small size, placed in one of the tanks for young fish in the aquarium, and remained there till November, 1885, when they were put in the large basin No. 6.

They were at first fed with raw meat; but as they did not seem to take very well to this kind of food, they were fed on raw fish chopped fine, which they appeared to like. As soon as they were transferred to the large basin they were fed on live fish.

The only water at the disposal of the aquarium is that which comes from the Vanne, whose temperature is 15° C. [59° Fahr.] in August and 9° C. [48.2° Fahr.] in December. It is hardly probable that this temperature is sufficiently high for the reproduction of the catfish. At any rate, those which we have in our aquarium, no matter to what variety they belong, have never spawned.

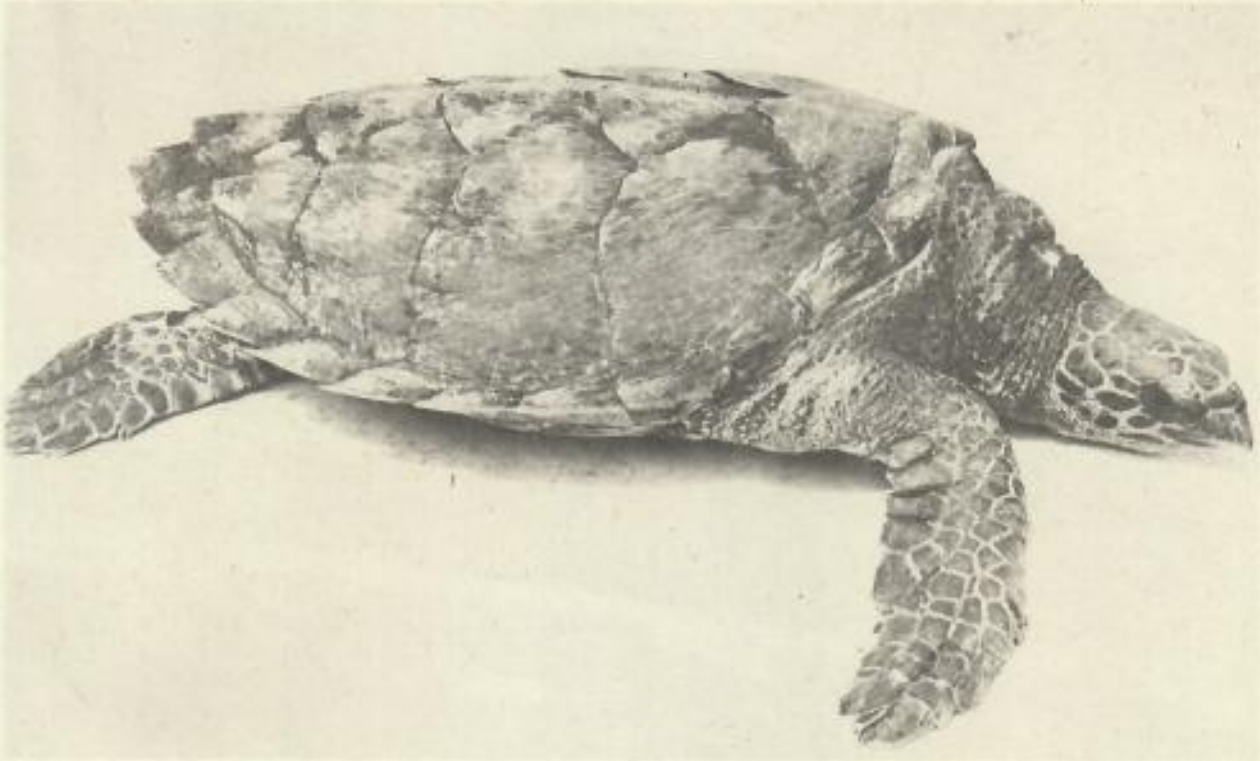
When the American catfish were transferred to basin No. 6 they were all alive and well, although they had not grown perceptibly. Since that time none of them have died, as far as we have been able to observe, for these fish have a habit of keeping in their holes and never coming out during the day, so that they are hardly ever seen. In basin No. 1 we had some of considerable size, and in order to assure ourselves of their existence it became necessary to empty the basin and carefully search for them at the bottom in the cracks between the rocks. Even then we did not always succeed in finding them. I have therefore reason to believe that the seven catfish which the Acclimatization Society has given us are still in existence, and the first time the basin is emptied I will search for them again in order to make sure of it.

I should state that the Trocadéro aquarium is by no means adapted to researches of this kind. The impossibility of varying the temperature of the large mass of water which feeds it prevents us from successfully reproducing any other fish but salmonoids. Moreover, our basins are too large for small fish, which easily escape observation.

PARIS, FRANCE, *May* 28, 1886.

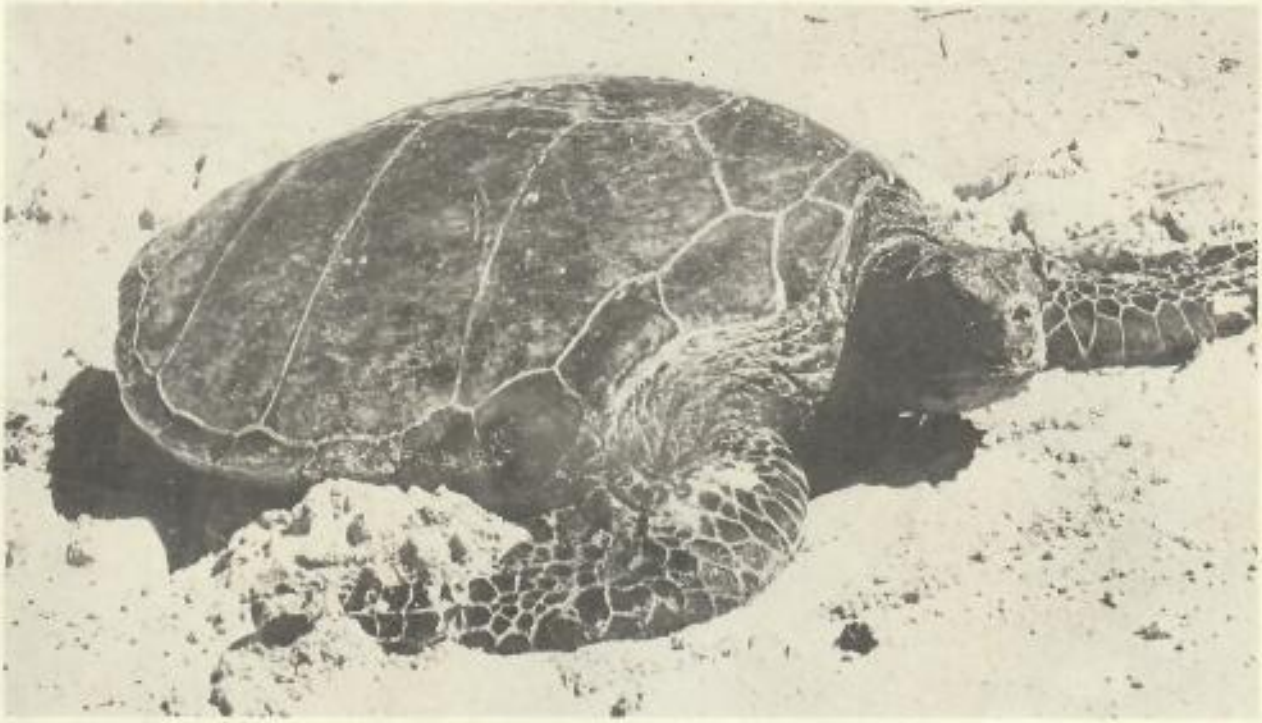
* "*Catfish dans l'aquarium du Trocadéro, Paris.*" From the *Bulletin mensuel de la Société Nationale d'acclimatation de France*, Paris, August, 1886. Translated from the French by HERMAN JACOBSON.

† For note on their receipt see Fish Commission Bulletin for 1886, p. 138; also Fish Commission Bulletin for 1885, p. 433.



HAWAII INSTITUTE OF MARINE BIOLOGY PHOTO By George H. Balazs

Common Name: Hawksbill Turtle
Scientific Name: Eretmochelys imbricata
Hawaiian Name: 'EA
Distribution: Native (indigenous) to the Hawaiian Islands and also found throughout other tropical and subtropical ocean areas. In Hawaii, usually found around the large, inhabited islands. The present population appears to be very small.
Description: This species grows to 30 inches or more in shell length. Adults weigh 100 pounds or more. Juveniles are colored various shades of brown, amber and gold. The body of the adult is dark brown or blackish above and is richly clouded with yellow. The scutes or "scales" of the head and flippers are brown or black and have a pale yellow border. The 13 large, brown, scutes of the carapace or dorsal "shell" are smooth and translucent; beautifully clouded with spots of black and yellow. The plastron or ventral "shell" is entirely yellow. This is the only sea turtle with overlapping scutes on the carapace. This is most noticeable in young turtles. As the turtles grow older, the scutes tend to assume an arrangement similar to the green sea turtle. Adult males have a longer, thicker tail than the females. The Hawksbill turtle was so named because its head is narrow and the upper jaw curves downward similar to the bill of a hawk.
Reproduction: Nests by burying eggs in sandy beaches above the high water mark. Single nestings have occurred in recent years on the islands of Molokai and Hawaii.
Remarks: Food consists of small crabs, molluscs and other invertebrate animals. In many areas of the world, this species continues to be exploited for the thick, translucent "tortoise shell" scutes. Scutes are commercially valuable, but of less importance than formerly due to the development of synthetic materials for ornamental use. The flesh of this species is not palatable, although the eggs are sought for food.
THE HAWKSBILL TURTLE IS OFFICIALLY CLASSED AS AN ENDANGERED SPECIES.



U. S. FISH AND WILDLIFE SERVICE PHOTO By Eugene Kridler

Common Name: Green Sea Turtle
Scientific Name: Chelonia sp.
Hawaiian Name: HONU
Distribution: Native (indigenous) to the Hawaiian Islands, as well as other tropical and subtropical ocean areas. Movements are not well understood. They appear to be migratory and have been recovered more than 1,500 miles from where they were tagged. Important feeding areas exist around the larger, inhabited Hawaiian Islands. This species formerly nested on the larger Hawaiian islands, however, the smaller northwestern islands of the Hawaiian Islands National Wildlife Refuge and Naval Station, Midway, probably support the last significant nesting green sea turtle population in the U. S.
Description: Green Sea Turtles grow to 42 inches or more in shell length. At maturity they weigh about 250 pounds. The largest recorded weight is 850 pounds. Each flipper has only one claw. The edges of the shell are fairly smooth. The tail of the males extends to the end of the hind flippers, while the tail of the females rarely extends to the end of the upper shell. Adult females have a steep sided upper shell. Juveniles vary in both color and shell contour. The common name refers to the color of the internal body fat.
Reproduction: Individual adult turtles return to sand beaches to lay eggs once every two to four years. Females lay eggs three to seven times at 13-day intervals from July to November. Each clutch contains about 100 white, leathery eggs, about the size of golf balls. The peak of hatching is in September and October. Hatchlings weigh one ounce and have black upper surfaces with white borders around each flipper. Hatchlings go to sea by sight.
Remarks: The primary food is marine plants. Growth is thought to be very slow. No methods are known for determining age. Destruction of nesting habitat, as well as over-harvesting have apparently caused the population decline. The total breeding population in the Hawaiian Islands is thought to be less than 1,200. IN THE STATE OF HAWAII THIS SPECIES IS PROTECTED BY STATE REGULATIONS AND CAN ONLY BE TAKEN WITH A STATE PERMIT. AT NAVAL STATION, MIDWAY ISLANDS, THE TAKING OF THIS SPECIES IS REGULATED BY CO NAVSTA MIDWAY INSTRUCTION.

considered to be established in Hawaii. **J.W. Beardsley.**

Schistocerca nitens nitens Thunburg: Mr. George Balazs, Univ. of Hawaii, Institute of Marine Biology, submitted an adult female specimen of the vagrant grasshopper, *Schistocerca nitens nitens* Thunburg, which he collected on Necker Island in the Leeward Hawaiian Island group on August 14, 1977. The specimen was determined by Dr. Beardsley. Mr. Balazs reported seeing numerous adults of this immigrant grasshopper on Necker and also on Nihoa Island. Necker is a confirmed new island record for *S. nitens*, but specimens from Nihoa are needed for confirmation. The possibility exists that large populations of this grasshopper could develop on these isolated leeward islands and cause serious damage to their vegetation. **J.W. Beardsley.**

Meteorus sp.: Dr. Beardsley exhibited two specimens of a braconid wasp which he has determined as a *Meteorus* sp. not previously known from Hawaii. Both specimens were collected in a light trap at Kailua, Oahu. The first was taken on July 22, 1977 and the second on October 8. The most common *Meteorus* species in Hawaii is *M. laphygmae* Viereck. *M. humilis* (Cresson) and *M.* sp. near *icterius* Nees are known to occur in Hawaii only on Maui. The species reported here is none of these, and apparently represents a recently established immigrant. **J.W. Beardsley.**

Leucania striata Leech: At the September meeting I reported on a newly discovered immigrant noctuid moth which had been determined by Dr. E.L. Todd, USDA Insect Identification Laboratory, as *Leucania* sp. probably *insecuta* Walker. At Dr. Todd's suggestion I sent a pair of specimens of this moth to Dr. Klaus Sattler at the British Museum, for comparison with the types of *L. insecuta* and related forms. Dr. Sattler has written to me concerning these specimens in a letter dated October 4, 1977 as follows:

"Mr. A.H. Hayes and I have examined your specimens, and believe they are *Leucania striata* Leech. Hampson synonymized *striata* with *insecuta* Walker. However, they appear to be distinct species.

Ogata's figures (Icones....) represent *striata* as Todd suspected. The genitalia figure is rather crude, but it agrees well enough with the type of *striata*. The clasper plate of your specimen differs slightly from that of the type. Without a proper taxonomic study it is difficult to say what the significance of this difference is. I suspect it merely means that the type and your specimens orginated from different geographic areas.

According to our information, *striata* is known only from Japan."

The "Icones" reference mentioned above is according to Todd, Ogata in Esaki et al. 1958, Icones Heterocerorum Japonicorum in Coloribus Naturalibus, p. 90, Fig E, Pl. 91, fig. 1986.

Since *L. striata* was synonymized with *L. insecuta* by Hampson (1905, Cat. Lepidoptera Phalaenae in British Museum, 5:534), and apparently has not been resurrected from synonymy before now, its use here constitutes a renewed status for this name which should be credited to Hayes and Sattler. Reference citations for the original description of *L. striata* is: Leech, 1900, Trans. Entomol. Soc. London for 1900, p. 127 **J.W. Beardsley.**

BAILEY, A.M. (1942) Audubon, 44: 150-161.

THE PORTULACA FLATS OF LAYSAN

By Alfred M. Bailey

THE surprise attack on Hawaii by a myriad of Japanese planes brings memories of my visit years ago to the chain of islands extending northwest of Honolulu for 1200 miles — and disturbing thoughts of the possibility of the Yellow Aryans using some of these reefs and coral atolls as air bases against our mid-ocean possessions. One in particular, Laysan, is a little coral island south of Midway, only 800 miles from Honolulu, and its proximity to the Hawaiians would make it a menace to us if members of an unfriendly power were stationed there. What the requirements are for an air base which would be dangerous to our Pacific islands is beyond my experience, but memories slip back to the extensive portulaca-grown flats on Laysan, so level and hard that they appeared in places like cemented runways.

It may be safely assumed that the Japanese have not overlooked the possibility of using this remote atoll as a jumping off place for raids. We have learned that the Japanese do unexpected things, and I only hope our military authorities have checked this island as a possible base for enemy planes.

The Japanese know Laysan and the islands of the Leeward group well, for the bombing of Pearl Harbor was not the first time they had encroached on our Hawaiian shores. In 1909 several groups of Japs were landed on these coral and volcanic reefs. Their mission was also one of destruction, but in this case they confined themselves with setting up camps and systematically destroying the long-winged sea birds which united in uncounted thousands. They came fully equipped to prepare the feathers for the millinery trade, and they set about their nefarious business with characteristic thoroughness.

It was in this same year that President Theodore Roosevelt issued an executive order reserving the islands of the Leeward group as breeding grounds for bird life, it was thought that such sanctuaries would insure for all time safe places of refuge for the millions of seabird and the few species of land birds which lived there. Hardly was the ink dry on Roosevelt's order when the hands of Japanese seared their slaughter of the inhabitants of the newly created bird haven. Midway Island was the first to be plundered, and when the poachers departed, only a few living birds remained of the once populous colonies.

Systematic Destruction

But it was on Laysan Island, 600 miles nearer Honolulu, that the Japanese carried on the greatest destruction. This little atoll, two miles long and one wide, was once clothed with a semitropical mass of wind-blown grasses and vines. It was a paradise for sea-bird life—the long-winged Albatrosses, Man-o'-war birds and Boobies. Because of millions of sea birds nesting there annually, great deposits of guano accumulated and layers of phosphate rock were built during the ages. An attempt was made forty or more years ago to export this rock for fertilizer, but owing to the excessive humidity, however, the chemical content was not on a par with deposits laid down in arid regions, and the enterprise was abandoned.

Laysan had become known to the ornithological world because of the thousands of sea birds which nested there, the birds were so numerous that the various species seemed to take turns using the island at different times of the year in order that there might have room to build their nests. The great Albatrosses arrived in November, the Man-o'-wars in January and Februarys, and the hordes of Terns came from the vast stretches of the ocean in March, so there was a continuous nesting period from November until midsummer. In addition to this vast assemblage of seafowl, Laysan was unique in having on its limited surface five species of birds found in no other place. There were the beautiful little curved-billed Laysan Honey-eater with reddish plumage, the inconspicuous little brown Laysan Miller-bird, the Laysan Finch, the flightless Laysan Rail, and the Laysan Teal. And so the island was known to naturalists throughout the world not only because of the wonderful concentrations of nesting sea birds, but for the endigenous races of birds developed through isolation.

It was on this little island that twenty-three poachers landed in May 1909, and for seven months systematically clubbed, shot, and skinned the birds. Albatrosses, great-winged fellows with snowy white breasts, seemed to have suffered particularly, but all species on the island were killed; the wings of more than 300,000 Albatrosses, Terns, Tropic-birds, Shearwaters, and Petrels were cut off, cured, and packed in burlap containers for shipment to Japan. Fortunately, the work was interrupted by the officers of the revenue cutter *Thetis* before the extermination of the colonies was completed. The Japs were hauled off to Honolulu along with their plunder, and a couple of years later it was the task of our party to take seven wagon loads of confiscated wings and feathers to the Waikiki dumping grounds to be burned.

The first group of naturalists to visit Laysan after the raid by the Japanese poachers was from the University of Iowa. Professor H. R. Dill reported:

> An old camera back of one of the huts might tell a story of cruelty that surpasses anything else done by these heartless, unsanitary pirates, not excepting the practice of cutting the wings from living birds and leaving them to die of hemorrhage. In this dry climate the living birds were kept by hundreds to starve slowly to death. In this way the fatty tissue lying next to the skin was used up, and the skin was left quite free from grease, so that it required little or no cleaning during preparation.

Many other revolting sights, such as the remains of young birds that had been left to starve and birds with broken legs and deformed beaks, were to be seen. Killing clubs, nets, and other implements used by these marauders were lying all about. Hundreds of boxes to be used in shipping the bird skins were packed in an old building. It was very evident they in-

tended to carry on their slaughter as long as the birds lasted.

Not only did they kill and skin the larger species but they caught and caged the finch, honey eater, and mallet bird. Cages and material for making them were found.

Civilization Progresses

The above is an excellent example of the ravages committed by man in his depredations of wildlife. The Japs had deliberately set out to kill as many as they could, and yet destructive as their efforts were, the results amounted to nothing in comparison with the havoc wrought by one careless individual who thought he was doing a good deed. Laysan presents a classic example of "Hell being paved with good intentions." The Japs had ravaged the bird colonies, given protection, however, mother nature could have repaired all the damage. But there was no safety to be had from a thoughtless individual. One of the men working on the phosphate deposits put a few pairs of rabbits on Laysan in order that they might increase and be a source of food for shipwrecked mariners. That was a kindly act, but the rabbits soon became too numerous and overran the island; they destroyed the vegetation so there was no longer a binding of vines and grasses to hold the loose sand. Dunes began to form, and with every wind, hundreds of burrow nesting sea birds were buried alive.

These oceanic creatures could have gone elsewhere, of course, but their inherited tendency to return to their old homes was strong; they kept coming back to familiar haunts in spite of changed conditions and consequently, as the island gradually became a desert, the birds perished in unbelievable numbers. The extinction of many of the creatures of the ancient past was no doubt due to this inability to overcome environmental changes. When the winds started blowing on Laysan, young Albatrosses would cuddle with the swift-moving sea of sand, become exhausted, and soon were covered over. The Petrels and Shearwaters nesting underground were the most terribly punished, their nesting burrows were choked with drift material, and although the birds often were able to dig part-way out, they perished with heads exposed.

Remote and Wind Blown Midway

Three years after these islands were raided by the Japs, four of us from the United States Biological Survey boarded the Revenue Cutter *Thetis* in Honolulu and, with Governess Lucas and Attorney General Lindsay of the islands, headed northwest along the chain of atolls. French Frigate Shoals, and Pearl and Hermes Reefs — named for two vessels shipwrecked on the treacherous shoals in one week — were visited enroute to Midway, the remote island of the group. A quarter of a century ago Midway Island—so well publicized in recent months by the exploits of our fighting men—was merely a bit of glistening coral sand and tangled chenopodium bushes surrounded by submerged reefs and shallow waters of undescribable beauty. The island served as a cable station for relaying messages from Honolulu to Japan, and the handful of cable folk, Englishmen, Scotsmen, and Irish, were taking pride in their efforts to reclaim the desert of wind blown sand. Their little settlement was deluged from blasts of ground coral which drifted with every violent wind, so the men had laboriously planted wire grasses secured off the coast of California, and gradually were able to push the desert back from their doorsteps. Gardens painstakingly planted and cared for gave them fresh vege-

Photo by Alfred M. Bailey

BLACK-FOOTED ALBATROSS — During most of the year they roam the Pacific's rolling waves, returning to the exposed sandy beaches of Laysan only for the brief months of courtship and nesting.

tables and fruit, a luxury to these island-bound people who had no connection with the outside world save their cable, and the little supply ship which made its way to and from Honolulu once each six months.

They had found, these cable folk, peace and contentment on their island paradise as long as the population consisted of males with a maximum number of one of the other sex; two women cooped up on an island a few miles square had not enough room for their sparring, so the cable-folk said, and it had become the unwritten law that women should be taboo. So ended the first war on these remote islands—banishment for the gentle folk. It was believed that the Irish operator who explained the scarcity of wives was exaggerating. We had dropped the anchor of the *Thetis* a few hours before, and he had had ample opportunity to celebrate our arrival from the generous store of ancient vintages saved for the purpose. We suggested that inasmuch as he was a confirmed bachelor he had grown disgruntled with age, but he insisted that any Paradise of the Pacific with more than one woman was destined to be a hell on earth.

Rabbits Everywhere

But it was Laysan that we were interested in, for our party, headed by Commodore G. R. Salisbury, was put ashore, outfitted for a three months' stay, in order that we might decrease the rabbits and give the vegetation a chance to reestablish itself. The *Thetis* arrived off the island early one December morning, when gray clouds scudded before strong winds and the giant waves of the mid-Pacific caused the ship to roll violently as we lay to, launching a life boat. Fortunately, there was a partial lee at the narrow entrance through the coral reef, and we landed all our supplies without mishap.

The commercial company that had attempted to remove the phosphate rock from Laysan had erected several buildings, and we made our headquarters in a rambling bungalow flanked by two coconut palms and a hau tree, with the whole Pacific Ocean for our frontyard. Great waves thundered over the coral reefs, breaking on the beach with flying sprays that kept us deluged with moisture whenever winds were blowing out to sea. Laysan was isolated. For three months we waited on our bird-island sanctuary, and in that time no boats approached our shores—in fact, not even distant smoke from a vessel marred the horizon.

There were rabbits everywhere. Each chenopodium bush would shelter half a dozen, and even the foundations of the buildings were undermined. Each clump of grass concealed a warren, and out on the open flats could be seen dozens of bunnies feeding on grasses pushing their way through cracks in the phosphate rock.

We could not hope to exterminate the beasts, for the ground was honeycombed with the burrows of Petrels and Shearwaters, sea birds which swarmed on Laysan in unbelievable numbers. The rabbits made themselves at home in these tunnels, so all we hoped was to lessen their number; in this we were successful, but the ultimate result was not changed. The vegetation was destroyed in the years following our expedition, the island slopes became a desert, and the Honey-eater and Miller-bird were not able to survive their change in environment. We had, however, transplanted Finches and Rails to other islands, particularly Midway, where they successfully established themselves, so only two of the five unique

HAWAIIAN TERNS AND SURF ALONG LAYSAN'S SEAWALL

Photos by Alfred M. Bailey

The wings of more than 500,000 of Laysan's birds were cut off, cured, and packed in burlap containers for shipment to Japan

forms vanished from the earth. If the Laysan Teal still exists, it is the rarest duck in the world, for there were only a dozen dwelling along the marshy borders of a brackish pool. They were so tame that I could decoy them within a few feet by merely lying prone and kicking my feet in the air. It had been the unwritten law of all naturalists who visited Laysan that the Teal should be undisturbed, that none should be collected for museums—and yet we all realized that the chances for this rare duck to stage an uphill battle was exceedingly remote. If the Japanese should use Laysan for a landing base, it is doubtful if the opportunity for a duck dinner would be waived—and one dinner for a few men would result in extermination.

The little Fairy Terns, white love birds with the gentleness of Doves, suffered in this Japanese invasion for they were easily captured, and practically the entire nesting colony was killed and the skins removed whole in order that they might be used to decorate hats. Fortunately, a few escaped and were once more building up their colonies. The love birds laid only one egg, usually on an exposed rock with no nest whatever, but occasionally an egg was found balanced precariously on a bare branch where the adult had to cover it with caution. Whenever we came near a nesting place, the old ones hovered overhead within arm's length, their dark eyes seeming all out of proportion in size. We watched one little brown chick emerge from the egg, and made daily visits to the nesting site during the next two months until the young one was able to fly.

LAYSAN TEAL

If the Japanese should use Laysan for a landing base, one Laysan Teal dinner for them would exterminate this rare duck.

LAYSAN ALBATROSSES

When heavy rains inundate their breeding grounds, these chief citizens of Laysan must raise the edges of their nests.

Life on Laysan

Ours was a pleasant Crusoe existence—just the four of us. Being the youngest member of the party, I was elected cook by a vote of three to one, and I will wager that I am the only field cook in existence that ever had a Commodore of the United States Navy split the kindling wood for him each morning, and had a Stanford man do the dishes. I had my work down to a system where meals took one hour or less, but it took our biologist most of the day to clean up Turtles on the beach, crayfish on the reefs, and the fishes of the sea took the curse off the boiled potatoes that were served daily for three months. Our poultry farm was a bit of exposed beach where the Gray-backed Terns laid their eggs by the thousands. Any eggs found there were bound to be fresh, for the beach was completely washed by waves every few days. The yolks were red, and four or five dozen whipped eggs made a pink omelet fearful to behold.

The crystal waters around our island were filled with marine life, the tide pools along the great sea wall were alive with queer goby fishes which leaped from one pothole to another to escape enemies, and spined sea urchins lined the exposed rocks where they received the full force of breaking waves. Fishes of brilliant colors grabbed any sort of lure we dangled for them, and great long-antennaed crayfish scuttled under submerged boulders when we tried to catch them.

Octopus and Turtles for Dessert

One of the early thrills of our sojourn was an exploration trip far out on the shore reef. Gentle winds were rolling white-crested combers over the jagged coral, hurling its water high, and as the waves passed we could see hundreds of sharks cruising in the deep holes as they occasionally came to the surface to slide over shallow ledges. I was standing on an exposed bit of coral when a wave came racing shoreward. I braced myself to take the blow, and as the wall of water struck, an octopus, a little fellow seven or eight feet across, came with the wave and landed amidships. Probably he thought my bare legs were a convenient resting place, but I had other ideas. It was my first experience with such an animal, so I let out a startled yell to my companions and hit the octopus in his center section, causing him to unwind his clinging tentacles and start away to safety in the depths. Certainly he had his evil intentions, but I lost a few years' growth in a short time.

Giant turtles crawled ashore to bask in the sun on all the sandy slopes. Bill of Stanford had a mathematical turn of mind. He figured that he could ride on a turtle's back in the water. By putting his weight on the back portion of the shell and pulling gently upward on the front, he could keep the animal at such an angle that it and the rider would stay on the surface. When we cast slight doubt upon his theories, he proved his calculations correct to a certain point. We found a large turtle asleep at the water's edge late one evening; our companion awakened the beast by climbing upon its back, and the startled old fellow made the sand fly as he paddled into the ocean. The rider remembered to balance as he figured; the turtle splashed over the surface a few yards into deep water and then quit paddling, and turtle and rider went below the waves.

The Ocean-Wandering Albatrosses

The chief citizens of Laysan were the Black-footed and Laysan Albatrosses. The former were dark-plumaged fellows which nested along the exposed beaches where the waves pounded over coral ledges with utter roar; the birds would face into the wind on stormy days, but when the weather was mild they sat fluffed out, each one having about as much territory as it could defend with its beak.

But the white-breasted Laysan Albatrosses were the most numerous. They inhabited the gentle slopes of the interior of the island, and the flats along the great salt lagoon. These Albatrosses were the chief sufferers when the Japs bombarded Laysan, and they will again be destroyed by thousands if the island is used as a landing place for airplanes. The flat areas of value as plane runways are the nesting grounds of the majority of the big white birds, and as such heavy-bodied creatures would be a hazard to planes taking off or landing, they would need to be exterminated.

These portulaca flats were not without their disadvantages as nesting places, for when torrential rains fell they often became inundated. The Albatrosses were persistent under adverse conditions, and it was a common sight to see old birds sitting upon their eggs when the water was almost deep enough to float them away. They would pull soil and vegetation about them, building the nest higher and higher, but even then thousands of eggs were destroyed. The Bristle-thighed Curlews—those birds which nest in northern Alaska and Siberia, and migrate to the Hawaiians for the winter—waited for an abandoned egg.

Photo by Alfred M. Bailey

FAIRY TERN

They were practically wiped out by the Japanese. Fortunately, a few birds escaped to build up a new nesting colony.

The Albatrosses started nesting late in December, and we found less than a hundred nests upon our arrival; it was not long, however, before thousands of others were under way. The paired birds were affectionate, and when one wanted to take a turn upon the nest, it would approach the nest and they would rub cheeks together, caressing, and talking in quiet tones. The one upon the nest was usually reluctant to leave, so the newcomer had to shove it gently away. Then, when this Albatross had possession of the precious egg, it was tucked under her carefully and the old one talked to it like a mother to a new-born babe.

The bird not on duty was usually ranging the ocean for the squid which makes the principal article of diet, but often there were groups of Albatrosses standing about more or less idly. They whiled the hours away by dancing—a strange performance which probably originated as a courtship affair but which has now deteriorated into an affair that is carried on for pleasure only. One old fellow, bored with it all, would snap his beak at a neighbor, wave his head, bow, and if the other felt inclined—the dance was on. They strutted and bowed, circling all the time, one invariably reaching around as though

Photo by Fred M. Bailey

MAN-O'-WAR BIRD AND CHRISTMAS ISLAND SHEARWATER

Birds on Laysan were so numerous that they seemed to take turns using the island at different seasons to have room to build their nests

taking something from under his wing and handed it to the other, who accepted it, bowed, and then threw his arched neck upward with beak in the air and gave a strange cry. When two were well started, another was sure to pad-pad into the arena and break into the dance. The performance then picked up speed and when others became involved, the Albatrosses became so excited that there was no order and one or two would leave and waddle off in disgust. At the height of their dance the birds were so interested in their own affairs that I could approach within a few feet, but when they were finally conscious of an intruder, they looked for all the world like youngsters caught in mischief.

Strange Cries in the Night

On moonlight nights we could hear them from all parts of the nesting area; the night life of such an island was no active one, for the nocturnal birds were probably more numerous than those that worked by day. The air was filled with storms of Petrels and Shearwaters, their strange cries from all directions indicating the countless thousands on the wing. It was necessary to cover our windows at night so islanded birds would not crash into them, and if we left a door open, Petrels were sure to flutter into the room. When traveling across the island with a lantern, we had to shield our faces to keep birds from flying into us.

The young Albatrosses were half grown in late March when the hordes of Sooty Terns invaded Laysan. The scouting birds had been circling the island for weeks, their *wide-a-wake, wide-a-wake* calls coming from such a distance that the birds were invisible. They were the latest to arrive in numbers and lived in colonies of thousands. The eggs being so close together that one had to walk with care to keep from crushing them. The downy Terns grew rapidly and passed on the wing the hurried young of earlier breeding species, and then the nesting season over, all ranged the far reaches of the Pacific.

The homes of all these Laysan nesting sea birds are on the rolling waves for eight to nine months of the year, they roam for thousands of miles and then the majority return to their ancestral dwelling place for the brief months of courtship and nesting along the historic portulaca flats adjacent to the salt lagoon.

Green Trees and Protection

These zones have dwelt wide Laysan in days gone by. It was ravaged by poachers and rabbits—as a bird sanctuary it seemed utterly destroyed—but recent reports indicate that the island will once more become a bird paradise. The vegetation is regaining its foothold, twining vines are again creeping over the moist sands, and bunch grass is tying the soil in place. Green trees and protection from rabbits, Japs, and other vermin, the bird colonies will reestablish themselves. Nothing will bring back the exterminated indigenous species, but their loss to the ornithological world will serve as one more reminder that the balance of nature is a delicate thing and that premeditated and thoughtless acts are equally dangerous.

This little island with its natural airfield—one of the few areas belonging to the United States to be sacked by Japanese—is in need of protection, and it is to be hoped that the myriad of feathered creatures will find sanctuary on their historic nesting ground along the portulaca flats, unmolested by an invasion of mechanical birds of unfriendly powers.

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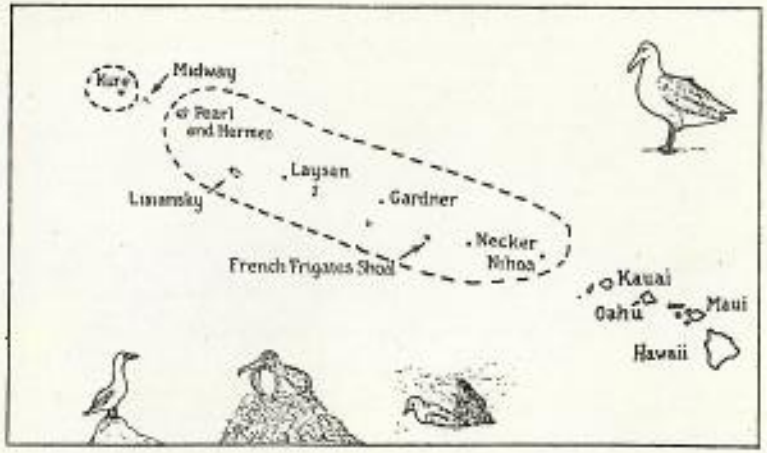
46. THE HAWAIIAN ISLANDS BIRD RESERVATION

To the northwest of Kauai and Niihau stretches for over 1,300 miles a line of small, rocky peaks, coral islets and shoals. These are the summits of the same long range of volcanic mountains of which the eight main islands of the Hawaiian group are a part. They are indeed mountains, for they rise over 18,000 feet above the floor of the Pacific Ocean just to reach the surface of the water. (See p. 1.)



The islands enclosed by the dash line are included in the Hawaiian Islands Bird Reservation. Around the margin are sketches of some of their inhabitants. Upper right, the Laysan Island Albatross. Below, left to right, a booby on a rock; a frigate bird on her nest of sticks; and a shearwater at the mouth of the burrow she makes in the sand. (Lisiansky should be spelled Lisianski.)

Four of the islets have rocky summits: Nihoa, 900 feet high; Necker, 275 feet high; Gardner, 170 feet, and La Perouse Rock (in French Frigates Shoal), 120 feet above sea level. Five are low coral islets, surrounded by shoals or reefs; Laysan, Lisianski, Pearl and Hermes, Midway and Kure (or Ocean) islands. The rest are just reefs on which the seas break.

These little specks of land have long been the refuge and breeding place for great numbers of sea birds. They have also served as stopping-places along the route of migration of the many birds which each fall fly down from Alaska and Siberia to winter in the warmer islands of the mid-Pacific, and each spring fly back to breed in their cold, northern homes.

Many Sea Birds

The sea birds which make these islands their headquarters, while they gather food from the near-by shoals and reefs, include the following: the Laysan Island albatross; the black-footed albatross or dark-brown gooney, which follows ships to pick up refuse from the galley; the thieving frigate bird, which robs the other industrious fishers of their hard-earned food, being himself incapable of alighting on the water; the ugly-faced and stupid-looking boobies; the graceful red-tailed tropic bird, and several species of terns, shearwaters and petrels.

With so many birds gathered together in small areas, hunters in search of plumes for trimming hats and for other purposes were naturally attracted to these islands. After several slaughterings of birds, some of the local citizens appealed to Washington. In 1909, through the interest of President Roosevelt, the islands from Kure to Nihoa, with the exception of Midway, were set aside as the Hawaiian Islands Bird Reservation, and placed under the control of the Biological Survey of the United States Department of Agriculture.

Poachers Arrested

Early in 1910 word somehow reached Honolulu that there were people killing birds on these islands. The United States revenue cutter "Thetis" was dispatched. On February 2 it returned with twenty-three Japanese, who were promptly turned over to the United States marshal and charged with poaching. Fifteen of these men had been arrested on Laysan, and eight on Lisianski. The conditions

which the ship's officers had found on these islands were most deplorable. They estimated that on Laysan Island alone some 259,000 birds had been ruthlessly slaughtered. The poachers had gone systematically through the huge bird colony, stunned the nesting birds with clubs, cut off the wings, and left the helpless birds to die. The quantities of wings had been cured and baled, preparatory to shipping them to the Laysan Feather Company of Tokyo, and thence to trim women's hats in Europe.

After this a close watch was kept over these islands to prevent further depredations. The government at Washington appointed Gerrit P. Wilder, an enthusiastic naturalist of Honolulu, the honorary warden of the bird reservation. It was made an offence not only to kill the birds, but even to annoy them, take their eggs, or disturb their nests. One might have thought that with such protection the birds would now be safe for all time. But such was not the case.

Rabbits Denuded Laysan

A quantity of guano, a substance much used for fertilizer, composed of the excrement of the myriads of sea birds combined with the coral sand, had been found on Laysan, and for several years this had been gathered and shipped. The manager of Laysan for the guano company had been afraid they might run out of food, if supplies failed to arrive, so he introduced a number of rabbits and turned them loose on the island, as a reserve food supply. Unfortunately, when he left the island he had left the rabbits behind. As the years passed these increased and multiplied, as rabbits will, and by 1920 in their search for green food they had eaten practically everything green on Laysan, except a small tobacco patch.

This denuding of the island had a disastrous effect upon the birds. In addition to the sea birds there were also several remarkable land birds on Laysan: a tiny flightless rail, a species of duck or "teal," a warbler, which, because it lived on moths, was called the "miller bird," and the Laysan finch and the Laysan honey eater, two relatives of

the native Hawaiian honey eaters. A most remarkable fact about these birds was that five species, found nowhere else in the world, could have developed and remained so long on two square miles of barren land. With their plant protection gone, and nothing to hold the wind-blown sand, these birds were threatened with extinction, and the island was fast becoming untenable even for nesting sea birds.

Rabbits Killed Off

In 1923 the Biological Survey sent an expedition to these little islands to investigate the situation and to see if it could be remedied. The U. S. navy loaned the use of the staunch little mine-sweeper "Tanager," and several local scientists, under the auspices of the Bishop Museum, went along to study the fauna and flora. One accomplishment of this expedition was to kill off all the rabbits on Laysan. They also found rabbits on Lisiansky, and exterminated them, too.

Now these islands are "coming back." The grass and herbs are springing up again. Sea birds are once more making the islands their breeding place and rendezvous. But the cure came almost too late to save the native birds. Nearly all of them are now extinct on Laysan. Fortunately specimens of the little flightless rail and finch were taken to Midway, where they are flourishing, but most of the others are no more.

46. HAWAIIAN ISLANDS BIRD RESERVATION

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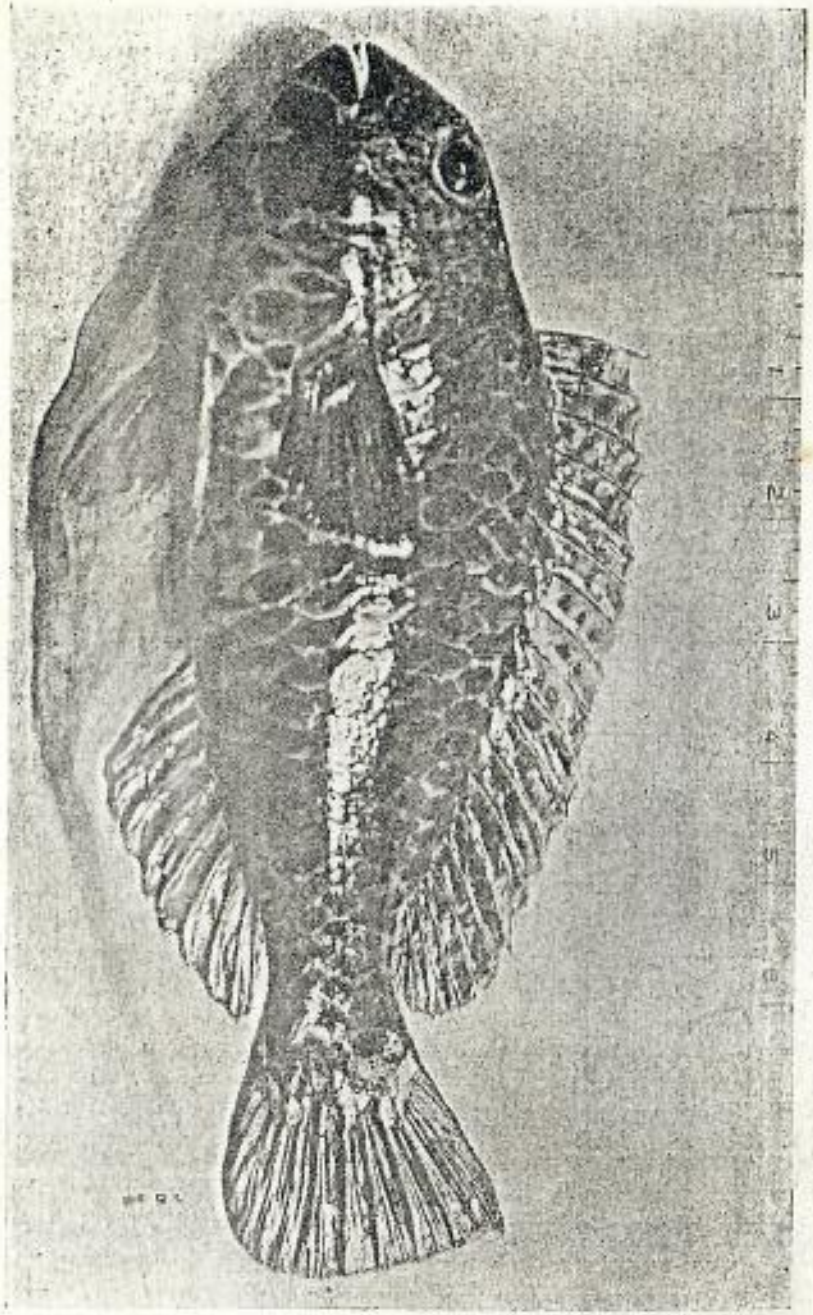


FIG. 8.—Scarides zonarcha Jenkins (doubtful).

brown, varied with drab; a patch of orange-brown scales behind the tip of the pectoral; teeth white; iris yellow; upper and lower lip dark red; an irregular dark red patch on the side of the head, which is followed behind and below by a number of scale marks of the same color; dorsal and anal about equal in height; dorsal light brown, passing into blackish-brown posteriorly, everywhere mottled with drab and brown of different shades; a blackish spot on the first and second membrane; pectoral uniform brown: ventrals drab-brown, the outer rays bluish-drab; anal drab-brown, brownish at the margin; caudal uniform umber-brown.

The type (B. P. B. Museum No. 3366) here described was secured in the Honolulu market February 12, 1903, and is 9.5 inches in length. (Fig. 8.)

Report of a Visit to Midway Island.

WM. ALANSON BRYAN.

Introduction.

DURING the months of July and August, 1902, the writer made a voyage in the schooner Julia E. Whalen to the small and isolated Marcus Island, in the interest of the Bishop Museum, to investigate its fauna and flora.[1] On the return voyage we called at Midway, and I was thus afforded an opportunity to see this small and then seldom visited island. Since our call was the last one to be made prior to the taking over of the island as a cable station, it seems that a brief account of the observations made during the day and a half on shore will not be out of place, especially since the island had been visited but once before by an ornithologist. It is hoped that the notes here given may in the future prove of value in noting the change in the plant and bird life which will doubtless be effected through the influence of the colony that has since been permanently established there.

As a matter of convenience the Hawaiian group has been divided into the windward or inhabited islands and the leeward or uninhabited chain. It is to this latter division that Midway belongs. Beginning at Niihau, the most western of the heretofore

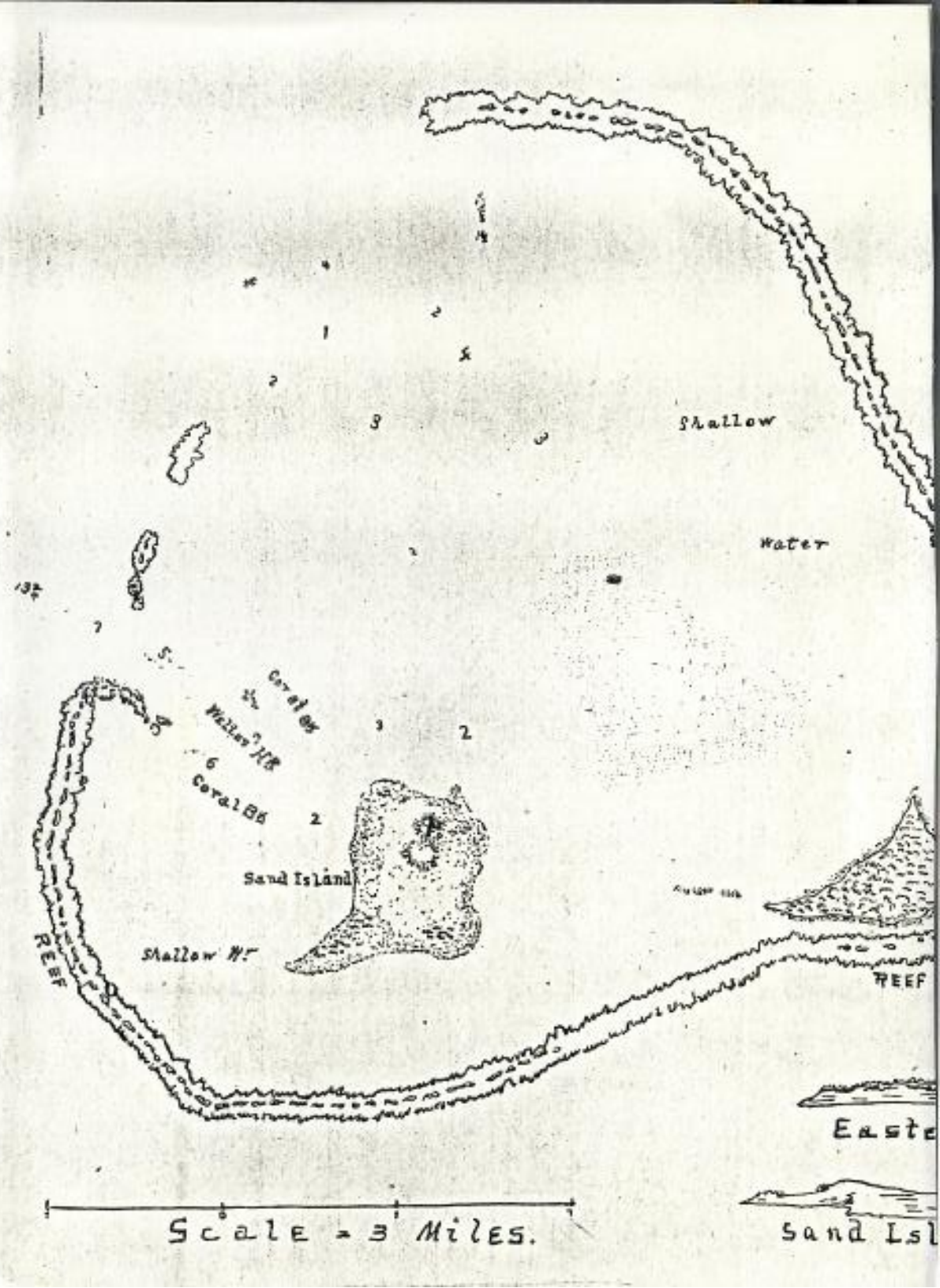
[1] Bryan. Monograph of Marcus Island. Occ. Pa. B. P. B. Mus., vol. ii, no. 1, pp. 77-140 (1903).

inhabited islands, and omitting a few barren rocks near it, the hain is composed, in the order mentioned, of Nihoa, Necker, French Frigates Shoal, Gardner, Laysan, Lisianski, Midway and Ocean Islands, together with various sunken rocks and reefs. Midway lies something over 1000 miles west by north from Honolulu (28° 12′ 22″ N., 177° 22′ 20″ W.), and is, as its name implies, near the geographical centre of the North Pacific.

For the ornithologist, interest centres about the pelagic birds which make these low coral islands their home, no less than about the migratory species which have established themselves as regular visitors. But such stragglers as may from time to time come ashore as ocean waifs on such out of the way places should always be recorded as a fact having an important bearing on the range and distribution of the species in question.

Narrative.

The return voyage from Marcus (24° 14′ N., 154° E.) was begun August 7. August 19 we crossed the 180° meridian and decided to stand down for Midway, since we were then less than 400 miles to the northwest of it. At 10 A. M. August 21, we sighted Sand, the larger of the two islets of the Midway group. When approaching the island from the north, as we did, or indeed from any direction, Sand is always the first island sighted. It is visible at a distance of not more than fifteen miles as a shimmering white strip along the horizon. On a nearer approach breakers can be seen on the reef surrounding it. By passing out well around the western end of the breakers our little vessel came safely to anchor in blue water off the wide, shallow opening in the northwest part of the reef. A boat was lowered and we began a row of more than four miles to shore. Landing on Sand Island we pulled our boat up on the beach in a little cove fronting on Wells Harbor, and went at once to the sailors' cabin close by. This cabin was built years ago from beach wood and wreckage, and has been rebuilt several times since to form shelter for shipwrecked crews that have gone ashore there. We found no signs of recent occupants, other than the cast-off garments of the colony of Japanese bird-poachers, to whose work of destruction I shall later refer. From the cabin we went to the high sand pile marked on the accompanying plan by a flag, in order to gather from that point of vantage the relation existing between the two islets and the surrounding reef.



Stretching from a point west by north from the spot where we stood, and extending from there about the southeast and north of us, could be seen the line of encircling breakers. Coral rocks awash were visible on the reef almost the whole way around. Thus, on the sides mentioned is formed an irregular coral barrier which is about six miles in its greatest diameter. To the northwest of our point of observation the reef is broken up or wanting. The entrance to the lagoon and into Wells Harbor is at the extreme south side of the open portion of the reef, and is about three-quarters of a mile in width. The remaining northern portion is very shallow, with narrow tortuous channels through the masses of submerged coral rock.

Well to the south and east of this lagoon enclosure are located the two bits of land which are designated as Sand and Eastern Island respectively. The one which served as a point of general observation is little more than a barren, blinding heap of sand, of irregular and constantly varying form, forty-three feet high; one mile and a quarter long by three-quarters broad more or less. Here and there the sand has been heaped up in piles a few feet high by the wind. On the top of most of these dunes a few hardy shrubs and grasses manage to subsist, and form the only relief for the eye in what is little else than a waste of shifting sand. Not far from the sailors' cabin referred to were a few graves, marked by three rude wooden crosses, which added the last touch to a picture of desolation such as I had never before witnessed.

To the east a mile or more, but connected with Sand Island by a narrow submerged sand spit lies Eastern Island. Its roughly formed triangular outline can be seen from so slight an elevation as that on which we stand, for it is nowhere more than twenty-five feet above sea level. Compared with the island just described it presents an interesting contrast, for it is clothed in green down to the beach, and differing thus in its flora, it differs still more in the number of birds which inhabit it. What freak of old ocean has placed these two specks of land side by side, under apparently the same conditions, and has covered the one with low shrubs, creeping plants and grasses, and has left the other an uninviting heap of sand? Eastern Island is smaller than its neighbor, being approximately one mile and one-quarter in length by half a mile wide in the broadest part. The centre is a trifle lower than the

edges, which gives it the general form of a broad, flat platter. Although composed of coral and coral sand it differs from Sand Island in having the interior portion mixed to some extent with vegetable mould and guano. Almost the whole surface of the island is honeycombed with the burrows of the Wedge-tailed Shearwater. Near the middle, on the northwest shore, were three crude shanties, two made of wood and one of grass. These had been standing a considerable time, and had doubtless been built by the Japanese poachers during some of their early visits.

Midway was discovered by Captain Brooks, of the Gambia, in 1859, who took possession of it for the United States. At one time the Pacific Mail Steamship Company intended using it as a depot for its transpacific steamers in preference to Honolulu, which was then under foreign influence. With this plan in view it was surveyed in 1867, but it was never utilized for the purpose intended. It was again carefully surveyed by the officers and men of the U. S. Iroquois in 1900, and an elaborate map, showing several thousand soundings, has been published. The second survey was made preparatory to the establishment of a cable and naval station there, which now gives the island an importance far out of proportion to its area.

The island has been repeatedly visited by small tramp vessels, and has more than once been the haven for shipwrecked sailors. However, it was not until Mr. Henry Palmer visited it in July, 1891, that the nature of its bird life was definitely made known, although all those who visited it made frequent reference to the swarms of sea birds that inhabited it.

Limited as our stay was to but a few hours, the following can be regarded as little more than a running list of the plants and birds which we were able to secure in a short time. Doubtless both the number of plants and birds could be increased without difficulty, while a protracted stay on the island would no doubt bring to light many interesting records of rare visitors, as well as record forms of bird life which would be common enough at other seasons of the year.

On the two islets I collected, in all, eleven species of plants, securing six on Sand and ten on Eastern. With the exception of a single species, *Eragrostis cynosuroides* (Retz), all the plants secured on Sand Island were found growing on Eastern. The

more important plants determined for Midway are: *Cenchrus calyculatus* Cav., *Boerhaavia tetrandra* Forst., a variety near *Lepidium oahuensis* Chan. I. Schl., *Capparis sandwichiana* DC., *Ipomæa insularis* Stend., *Scævola kœnigii* Vahl., *Tribulus cistoides* Linn., and *Eragrostis cynosuroides* (Retz). In addition to the above are three widely distributed beach plants, two of which are grasses that are as yet undetermined.

List of Birds.

LARIDÆ.

Sterna fuliginosa Gmel.—**Sooty Tern.**

Under the low *Scævola* bushes on the eastern end of Sand Island was an extensive colony of Sooty Terns that were rearing their young. They were in about the same stage of development as I had found them on Marcus Island. On Eastern the colony was much larger than on Sand Island. This was doubtless due to the more abundant growth of shrubs and grass, which was thick enough to furnish some protection from the sun. Although I made diligent search, only one egg, an infertile one, was found. From what I have seen on the outlying islands I conclude that all the colonies of Sooty Terns in the North Pacific nest at or near the same time. A good series of skins was secured.

Mr. Palmer spent a week on the island (July 11 to 19) without seeing the Gray-backed Tern, *Sterna lunata* (Peale). It is a peculiar freak in distribution that this species should be met with on all the low islands except Midway, but during my sojourn I did not see a single example, although here, as at Marcus, I was especially on the lookout for it.

Anous stolidus (Linn.).—**Noddy.**

There were but few examples of this species on either island. The few nests found were built on the ground, usually under the shrubs which grew on top of the sand mounds. The young were still in the down.

Micranous hawaiiensis Roths.—**Hawaiian Tern.**

Only a little colony of a dozen or twenty individuals were seen on Sand Island. These were huddled together sitting on the low bushes on a sand mound. I have observed that birds of this species seldom leave the place where they have been reared, so that when

disturbed they rise and circle gracefully about for a time, but always return to the same spot. When they alight they all sit facing the wind.

On Eastern Island I found a number of colonies of different sizes distributed here and there over the island. All of the twenty birds shot had the feet black in life. A nest located in the bushes toward the centre of Eastern Island may be taken as typical of all seen; it is a rather bulky structure composed for the most part of sea moss, to which were added twigs, leaves, bits of sponge, etc. All of the material is cemented together with the droppings of the bird. The nests were always placed in colonies of a dozen or more, and the fully fledged young were usually sitting on the bushes. But a single egg, which proved to be infertile, was found close by, and as the nests contained no young it would seem that this species nests earlier than the other Terns on the island.

The Hawaiian Tern seldom goes far out to sea. It is always to be seen in small flocks sailing about over the reefs in search of surface-swimming fish, which constitute its chief food.

Gygis alba kittlitzi Hartert.—**White Tern.**

This fearless and inquisitive bird was by no means abundant on Sand Island. The few found were sitting with their young in the bushes on the sand piles. Specimens secured were taken without difficulty by the hands. On Eastern Island the birds were more abundant. No eggs were collected, but one newly hatched young was secured. Young which were assuming the first plumage were quite common.

DIOMEDEIDÆ.

Diomedea immutabilis Roths.—**Gooney.**

There were the carcasses of a very few birds on Sand Island which had evidently been killed several months before our visit. On Eastern Island skeletons of this species were more common, but they were by no means as plentiful as those of the following species. I should say that the Gooney was less than a third as abundant as the Black-footed Albatross, judging by the number of dead bodies of each to be seen. None of our party saw a living bird of either species.

Diomedea nigripes Aud.—**Black-footed Albatross.**

Everywhere on Eastern Island great heaps, waist high, of dead albatrosses were found. Thousands upon thousands of both species had been killed with clubs, the wing and breast feathers stripped off to be sold as hat trimmings, or for other purposes, and the carcasses thrown in heaps to rot. After my acquaintance with the colony of bird pirates on Marcus Island it was but too apparent that a similar gang had been in full operation at Midway not many months prior to our visit, and that they had worked sad havoc among the birds there, in spite of the severe warning which had been given by Captain Niblack, of the Iroquois, to a party similarly engaged the season before. The work of exterminating the Midway colony was surely well under way, and I was convinced that unless something definite was done, and that at once, to prevent such wanton destruction, before long this colony of albatrosses, as doubtless all those on the low outlying islands, would be wiped out precisely as the one on Marcus Island had been.

On my return to Honolulu I took the matter up with the proper officials in Washington, among others addressing a letter to the Chief Executive, with the result that the subject was brought to the attention of the various cabinet officers concerned. With the cooperation of Dr. Henry Palmer, of the U. S. Biological Survey, together with the energetic services of Mr. Wm. Dutcher, President of the Audubon Societies, to whom the whole matter of bird protection for the Pacific had been presented in person by the writer, most satisfactory results have been obtained. A naval vessel will in the future make at least two patrol trips each year to the outlying islands of the Hawaiian group to break up or prevent further depredations. The officers and men stationed on Midway have strict orders to protect the bird colonies there. The fishing rights to certain of the outlying islands will only be let by the Territory, with special clauses protecting the bird colonies thereon; while the Japanese Government will in future refuse to allow predatory hunting and fishing vessels to leave Japanese ports.

PROCELLARIIDÆ.

Priofinus cuneatus (Salvin).—**Wedge-tailed Shearwater.**

This species was only occasionally met with under the bushes on the mounds on Sand Island, while on Eastern the whole interior

of the island was honeycombed by their burrows. They were so numerous indeed that crossing the island in any direction was a difficult task by reason of one dropping, unexpectedly, hip deep in them, only to climb out of the sand to repeat the experience again and again. They were abundant birds, everywhere dodging beside their holes, or stowed away in them. Several downy young but no eggs were secured.

The absence of the Christmas Island Shearwater, *Puffinus nativitatis* Streets, was another mystery in distribution. Having found it fairly common on Marcus Island, sitting beside its half grown young under the trees, and knowing that it had been met with at French Frigates Shoal and Laysan I fully expected to find it at Midway, especially on Eastern Island where the conditions are fully as favorable for its nidification as they are on Laysan. I am at a loss to account for such a freak in distribution, except it may be that the bird has a great attachment for the locality where the young is reared, and even though it knows of and possibly visits other islands equally suited to its habits, always returns to its own island to in turn rear its young. If such is the case it would indicate the difficulty of establishing new colonies or restocking old ones by artificial means.

PHAETHONTIDÆ.

Phaethon rubricauda Bodd.—**Red-tailed Tropic Bird.**

A few birds of this species were met with on both islets. All had young in the down, for which they would fight most savagely when molested.

SULIDÆ.

Sula piscator (Linn.).—**Red-footed Booby.**

A single individual, which had evidently been left behind when its neighbors took their leave of the island, was seen asleep on the bushes on Sand Island. I captured it in my hands. It was the only example seen by any of us.

Sula cyanops (Sund.).—**Blue-faced Booby.**

A number of this species was seen and a specimen was collected.

FREGATIDÆ.

Fregata aquila Linn.—**Man-o'-war Bird.**

There was quite a large colony of Man-o'-war Birds nesting on the top of the bushes on Eastern. Twenty-eight nests were counted all within a space a few rods square. The clatter of the bills of the downy young birds as one entered the colony was most interesting and curious.

SCOLOPACIDÆ.

Numenius tahitiensis (Gmel.).—**Bristle-thighed Curlew.**

The Curlew was quite common on the shore of Eastern Island, where I had little difficulty in securing a series of twelve specimens.

Arenaria interpres (Linn.).—**Turnstone.**

The Turnstone was met with on both islands at Midway.

RALLIDÆ.

Porzanula palmeri Prowh.—**Laysan Island Rail.**

A number of years ago Captain Walker, of Honolulu, carried a cage of the Laysan Rails down to Midway and liberated them on Eastern Island. They have multiplied until, at the time of our visit, they were almost as abundant there as they are on Laysan. A single immature specimen was taken, which, when compared with a large series in the Museum from Laysan, exhibits differences in coloration which would lead one unfamiliar with the circumstances of its introduction to separate it by a specific name.

August 26, 1905.

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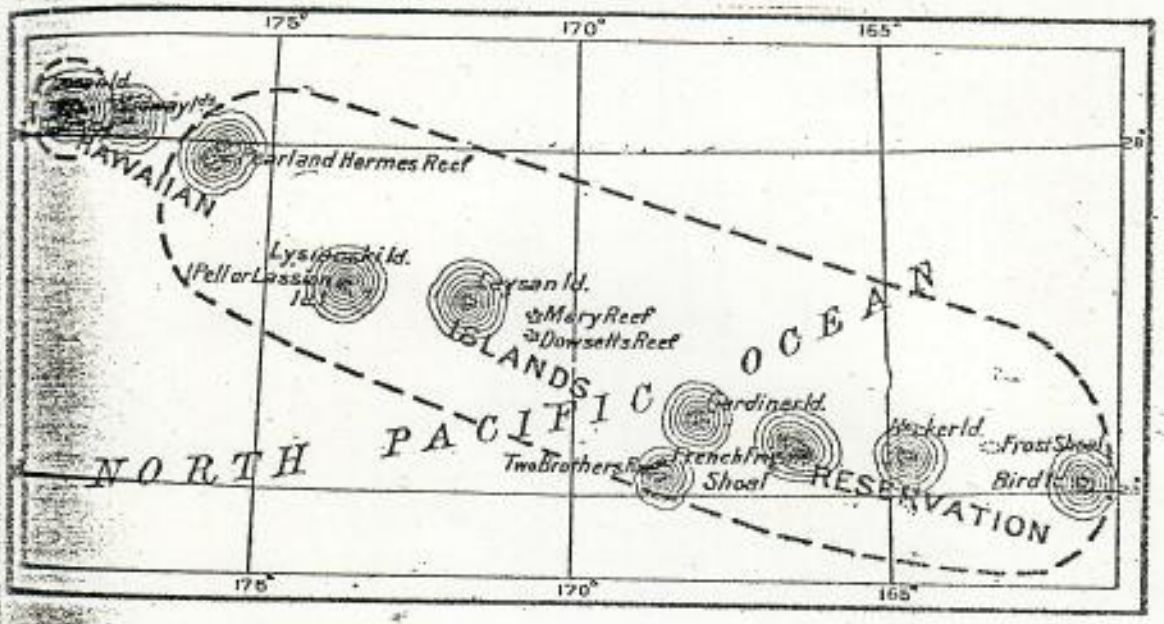


Laysan Island

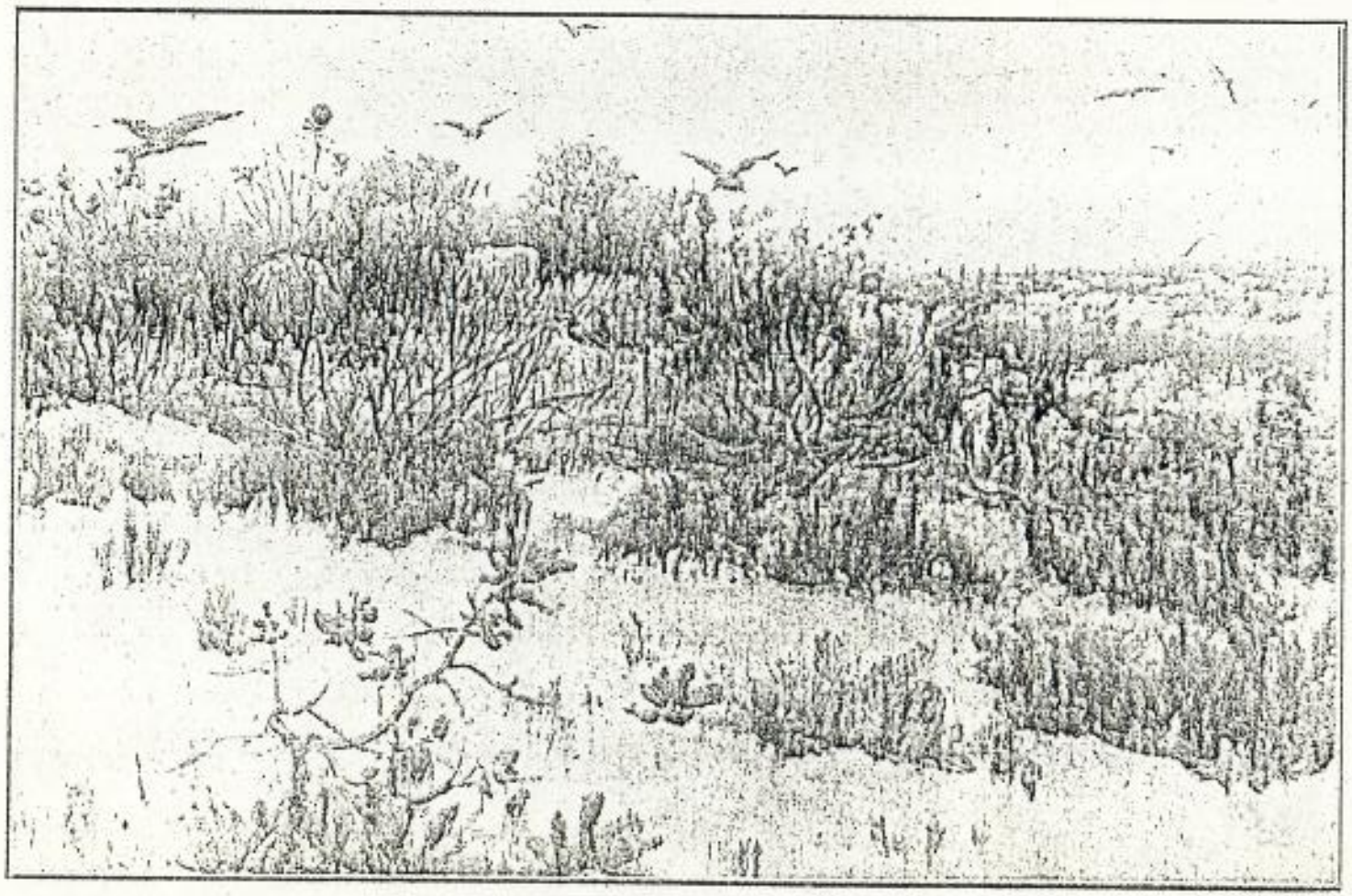
A Visit to Hawaii's Bird Reservation

BY

WILLIAM ALANSON BRYAN

In the leeward chain of islands of the Hawaiian group the Pacific possesses not only one of the great natural wonders of the western world, but a cruising, camping, fishing and outing park reservation that is in every sense unique.

Few, even the best informed people in the Hawaiian Islands or out of them for that matter, appreciate this important possession at its real worth. This, however, is not so difficult to understand as it might at first seem, since hardly one in a thousand of the limited number who have desired to make the journey among them has ever been permitted to visit these floating bits of coral sand that apparently bob aimlessly about, adrift on the bosom of the great wide ocean. Few, indeed, have a first-hand knowledge of what these possessions really are and know of the fascination they and their inhabitants possess as objects of natural



Painting by C. A. Corwin A Study—Hawaiian Tern Rookery.

interest. Then, too, the idea of utilizing these distant islands in any way that would suggest a natural park is so novel and out of the ordinary that it has not yet taken root in the mind of the man in the street.

To speak of a park to the average person is to call to his mind visions of shaded paths that ramble through wide well-wooded fields; stretches of closely cropped lawns; faultlessly ballasted driveways that wander in carefully calculated curves through miles of hand-made scenery or beside tried for streams and frankly artificial lakes.

To his vision of the proverbial city park our reader without conscious effort adds the usual accessories to which landscape architects have so long resorted in a desire to give a touch of nature and life to an otherwise lifeless, monotonous, stage-like scene. In the vision of the made to order park will come almost unbidden the occasional strutting peacock, the flock of tame white ducks floating on the lake, the proverbial gold fish in the fountain, and lastly the deer and the high deer close that in many a historic instance has proved to be the only excuse for the existence of the park at all.

With such a conception in the mind it is somewhat novel to look upon fifteen hundred miles of tropical blue ocean with here and there a tiny speck of land scattered over it as forming a suitable motif for a reservation of any sort, let alone a park preserve, and it is for that reason that a few words of simple explanation may not be out of place.

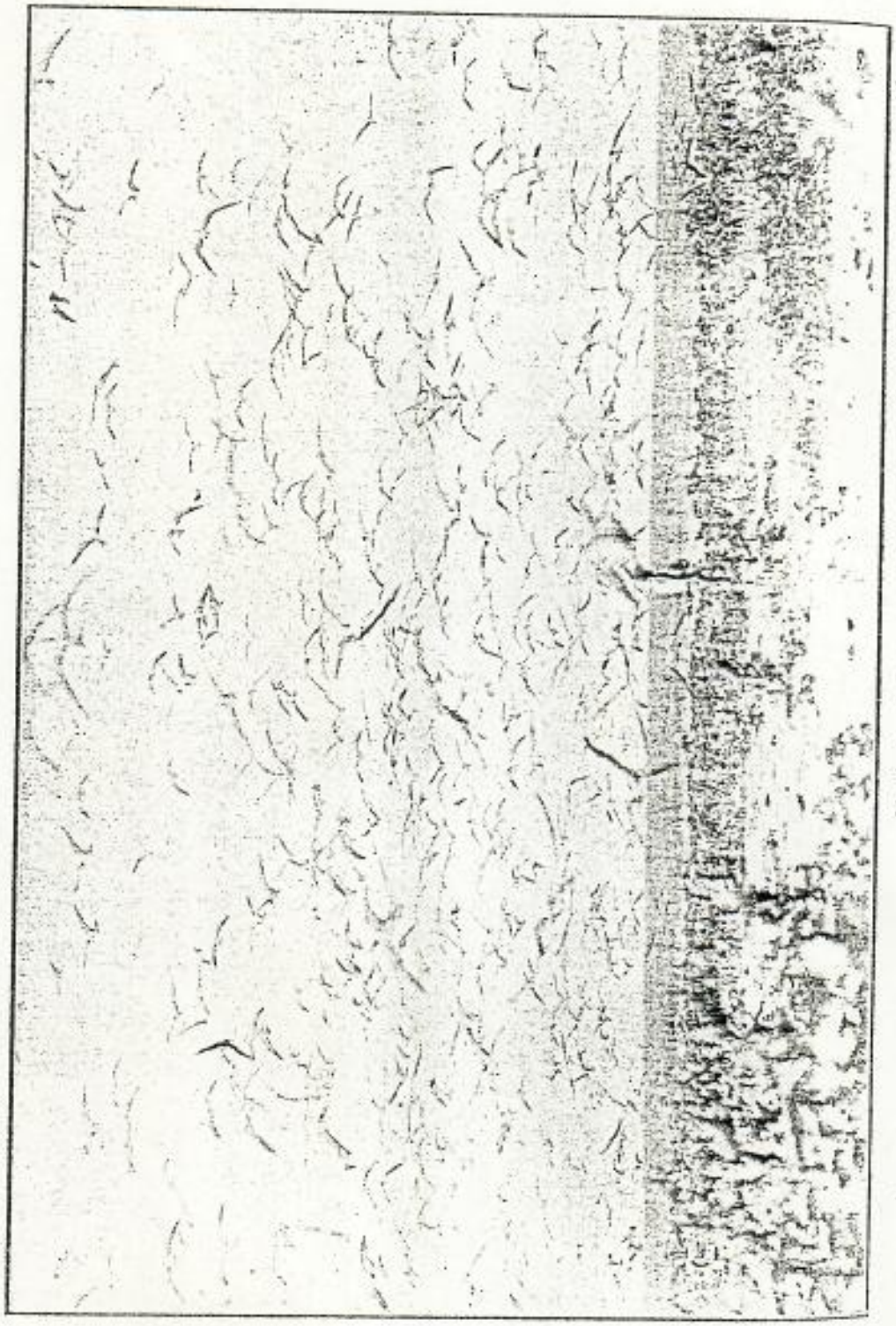
We are so accustomed to look upon Hawaii as meaning only the high and inhabited islands of the group that the average school boy even in Honolulu would hardly be able to give the names of the dozen or more islands, reefs and shoals that stretch away beyond Kauai and Niihau in the direction of Japan for a distance equal to half that across the continent of America. Ten to one he could not even suggest them as a part of the scattered territory over which Governor Frear of Hawaii is called upon to preside. Nevertheless, these low, scattered, ordinarily uninhabited and to many minds worthless coral islands form a part of the Hawaiian group; and, what is more to the purpose, Bird Island, Necker, French Frigate Shoal, Gardner, Laysan, Lysianski and Ocean Island and all of the reefs and shoals about them have been set aside by the executive order of a former President, himself a mighty hunter, to form the Hawaiian Islands Bird Reservation. The care and general supervision of the preserve has been placed in the hands of the Biological Survey of Washington, and it is that branch of the Federal Government that the natural inhabitants of the chain must look to for protection.

Taken collectively these islands constitute the world's only great ocean parkway and moreover they form a perfect paradise for the sea fowl and aquatic life for which tropical islands everywhere are justly famed.

Though all put together the exposed dry land and reefs of the reservation would hardly have an area of ten miles square it literally teems with fish and bird life. The sea bird population alone probably cannot be equaled in any other part of the world. Tens of millions of feathered fowl make their home on these lonely specks of land, repairing thither each year in countless flocks to establish rookeries and to rear their young. The reefs and waters about the islands fairly swarm with fish and other forms of sea life, so that they in reality form a densely populated natural zoological garden.

To the naturalist, the out-of-door enthusiast, the nature study photographer, or the man who simply loves out of the way places and the unusual and novel these islands leave little to be desired. A chance to run down along this chain is the opportunity of a lifetime and bound to result in a really worth while experience,—one that will live fresh in the memory long after the details of other trips and experiences have been mingled with the commonplace of life.

Unfortunately, at present, visiting the islands in the reservation is not the simple matter that it should be, nor that it is hoped it may be made in time. In former years the operations of a guano



Myriads of Sooty Terns.

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guano or bird lime
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make the journey to
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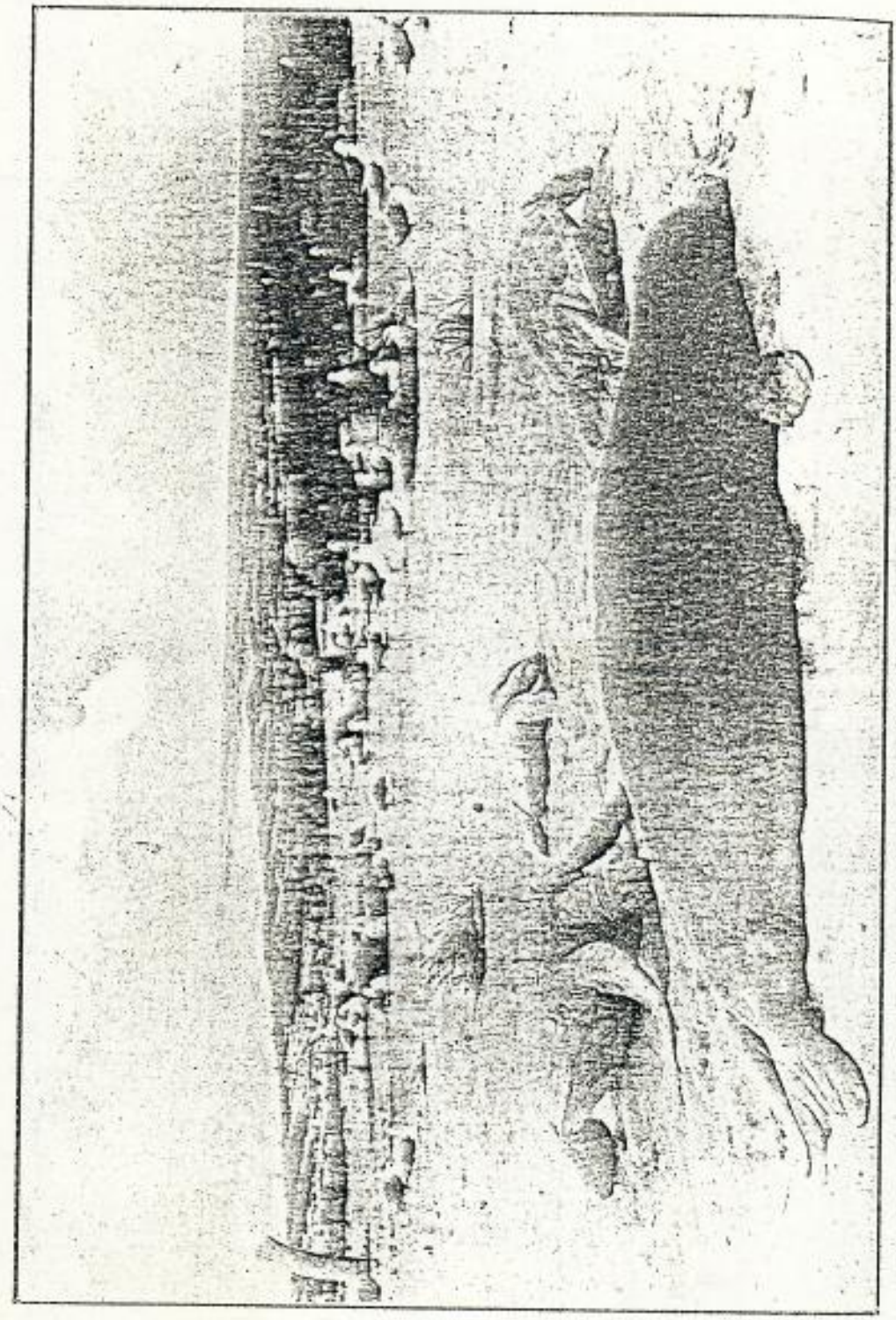
company, then engaged in exploiting the guano or bird lime deposits on the islands, made it possible, by invitation, to make the journey to Laysan Island from Honolulu during the summer months in one of the company's sailing vessels. Of late years, however, the company has ceased to carry on this one-time profitable business, with the result that the trip is next to an impossible one, except it be made in a vessel chartered especially for the outing. While this has never been seriously attempted as a vacation trip, it would make an ideal summer cruise for a yachting party. The islands average about a hundred miles apart and in most instances are easily and safely approached in daylight by small vessels. While the anchorage is usually in the open ocean on the lee shore, the uniform northeast trade winds render such a shelter a safe one and landing in a launch or whale boat through openings in the reef can be made with but little difficulty.

Since few have ever had an opportunity to visit even one of these interesting island worlds, the writer, who has made three cruises down the chain under widely different circumstances and the most favorable conditions, feels himself fortunate and favored far beyond the average. As his experience has been that of a field naturalist, his observations as such (which are to appear in print in another connection) may be of interest to some. But as two of these trips were made to Laysan Island with an interval of eight years between them, and as the outing as such in both cases proved to be in a hundred ways the most enjoyable social experience of a rather varied life spent in the open, it may be worth while to set down here a few of the many things of general interest about Laysan, since it is the most accessible and most widely known island of the entire chain. In doing so it is with a view to bringing before the casual reader some of the novel and interesting features of this bird wonderland, in the hope that it will stimulate in him a real interest in this justly famous reservation and create the desire to visit the islands. It is confidently hoped by so doing to add him to the rapidly increasing number, both at home and abroad, who would see this island chain conserved, developed and appreciated as a natural reservation that, under certain necessary restrictions, may be visited by such persons as have an interest in the preservation of our native flora as well as fauna and who feel a keen interest in the habits of birds and animals and have an intelligent desire to see and study them in their natural surroundings.

While the islands of the chain are all different each from the other and all intensely interesting, Laysan is in a certain sense typical of most of them. It is a raised coral atoll approximately two miles across that in general form has been compared to a broad shallow platter composed entirely of sand or raised coral reef not more than forty feet above the sea at the highest point on the sand rim, which completely surrounds the salt water lagoon that occupies the central part of the island. This lagoon is of especial interest, since its water contains more salt than does that of the open sea. This interesting fact tells much of the geological history of the island and points unmistakably to the origin of the land. It shows it to be a circular coral atoll that at the time of its elevation above the sea carried the water of the lagoon up to its present level. Since that time—and it must have been very long ago—the waters have evaporated to some extent and left that which remains more concentrated and salty than it was when the island was first made. About the edge of the lagoon the boggy earth is covered with crystals of salt mixed with chips of guano. This shell-like substance sparkles in the sun and suggests a band of silver at the water's edge. About this barren ring is a narrow band covered with low creeping vines. Back of this again is a growth of juncas which is backed up in turn by a ring of low bushes. The prevailing plant of the island, however, is a kind of coarse bunch grass that grows three or four feet high. More than a score of plants have found a footing there during the long period that has elapsed since the dry land first rose, so that at



Seal and Turtle Also Occur on Laysan.

Williams Photo.

Seal and Turtle Also Occur on Laysan.

the time of its discovery, and, indeed, on the occasion of my first visit, for a sand island it was well supplied with a low growth of hardy vines, grass and shrubs. Unfortunately the introduction of rabbits on the island has worked a sad change since then. When visiting the island at the instance of the Biological Survey, in company with the party of gentlemen from the State University of Iowa who made the journey to Laysan on the United States revenue cutter "Thetis" last April to gather material and specimens for a great group to be assembled at that university, I was astonished at the depredation wrought by the thousands of rabbits that swarmed over the island. Many of the plants that were abundant at the time of my former visit had completely disappeared before the incessant demand for food that this invading army of rodents brought about. Other species were marked and girdled ready for extermination, while only those that for one reason or another were but little desired as food by the rabbits had been able to hold their own in the struggle for existence.

If active steps are not taken by the government to check or exterminate the rabbits on Laysan, it is only a matter of a very short time indeed when they will reduce this green island to a barren heap of white sand.

Of the many things which interest the visitor at Laysan the great number of birds and their absolute fearlessness are perhaps most striking. Dr. Fisher, who visited the island in 1902 in the famous expedition of the "Albatross," writing of his impression of the enormous number of birds, has very truly said: "The effect of this at first was nearly overpowering. Where we made our way through the populous colony of sooty terns we had to exercise much care to avoid crushing their eggs and treading on the birds which struggled panic-stricken before us with the old ruse of a broken wing, and then, taking flight, swarmed over our heads. If we would converse, it was necessary to shout.

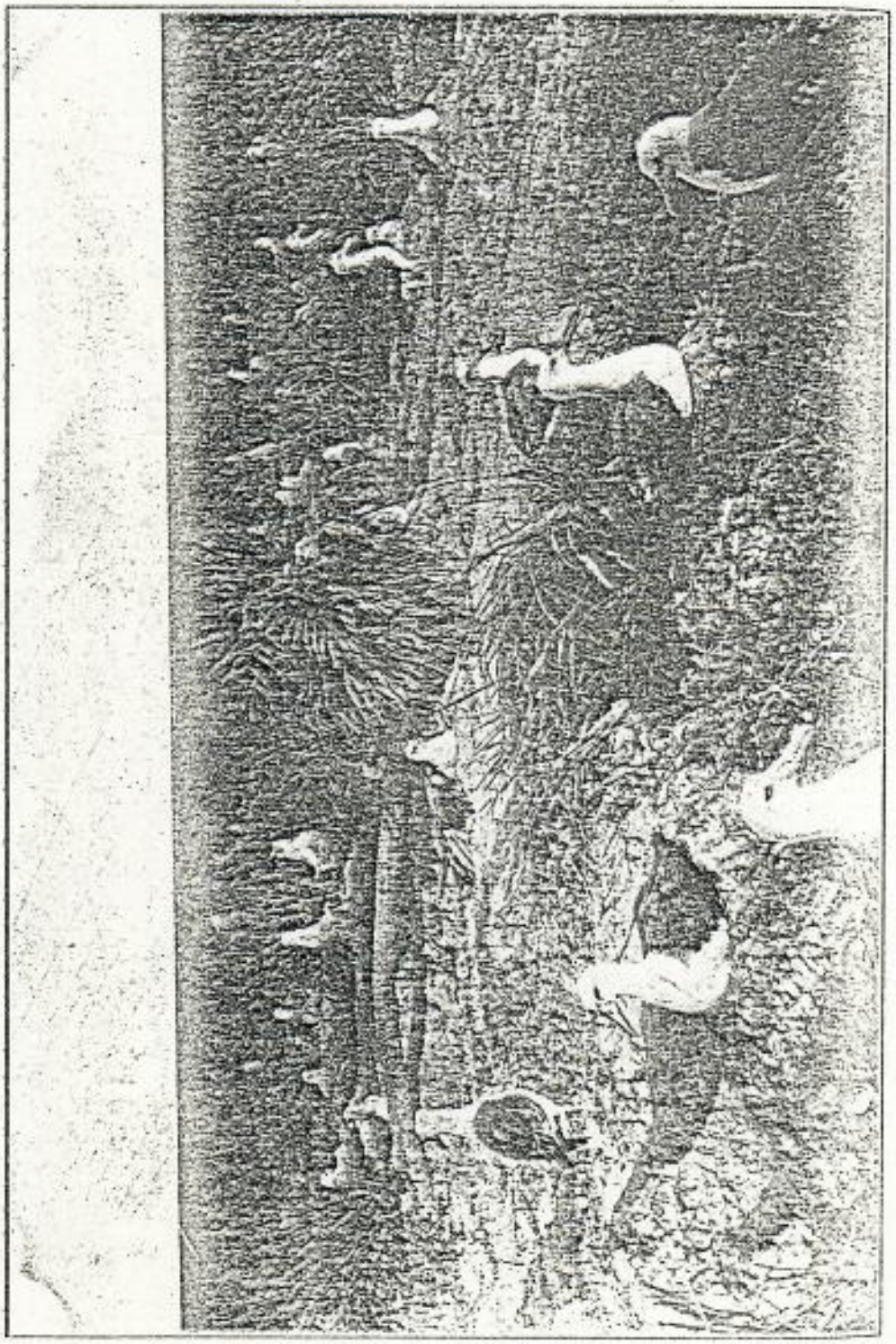
"Turning toward the center of the island, we were obliged to cross a wide area covered with tall grass and completely honey-combed with the burrows of petrels. Through the roofs of these tunnels the pedestrian is continuously breaking, sinking in the soft soil up to the knee. From out of the shadows of the tussocks young albatross, uncouth and awkward, snapped their beaks at us, and occasionally losing their balance from over-haste fell forward on their chins. This proceeding usually made them actually sick.

"Few of the adult birds, however, seemed frightened, and with the exercise of a little care we were able to approach most species as close as we wished. It was certainly gratifying to walk up to an albatross or a booby and watch it feed its young and to record this domestic duty with the camera."

More than two dozen species of sea, land, and shore birds frequent this island in great numbers during the year. They do not all breed at the same time; in fact, some of them, as the plover, the curlew, and the turnstone, do not breed on the island at all. Nevertheless, the island (especially at the time of my first visit) was literally covered from center to sea with breeding birds, mating birds, and young half-grown fledglings of a dozen or more species.

With such an astonishing population, numbering perhaps twice the inhabitants of Greater New York, it was to be expected that a study of the situation would reveal a method in their distribution. Generally speaking, the various species were grouped in more or less well-defined colonies. As a rule, these colonies had settled on certain localities that seemed to suit their fancy or convenience.

This distribution of this great population was not alone with reference to the surface of the island. There was a well-defined vertical distribution as well. With the thousands of birds seeking nesting sites, the necessary space for an adult bird to comfortably set upon was at a decided premium. Ap-



The Last Specimen of a Now Extinct Palm.

The Last Specimen of a Now Extinct Palm.

parently with an eye to the metropolitan conditions existing, certain species burrowed deep in the sand, often going six feet or more beneath the surface; others only a couple of feet down; others—and that the great majority—preferred the ground floor. A number nested in the grass tussocks, and still others higher up in the branches of the low shrubs. Again, still other species, as the frigate bird and certain boobies, nested only in the top story—the tops of the low bushes and shrubs.

But, in spite of the excellent use of the space at their disposal, all the birds which use Laysan as a breeding ground would not be able to find satisfactory space for their nesting operations if they all came at the same time. As a consequence, they have hit on a very excellent plan. They all take turns. Some birds leave with their young as soon as they are able to fly, and other species take their place. Thus there is a constant coming and going at Laysan, so that the visitor arriving there at different seasons of the year would find different species predominating in the bird population, while other species that at another season would be equally as abundant might not be found there at all. But visit this island or any one of the chain when you will, enough interesting material for a volume on birds can be gathered in an hour or two on shore.

Of the many curious birds of the island, perhaps the albatross, of which there are two species, is of the most general interest. This is due in part to their splendid size and part to their unusual domestic habits.

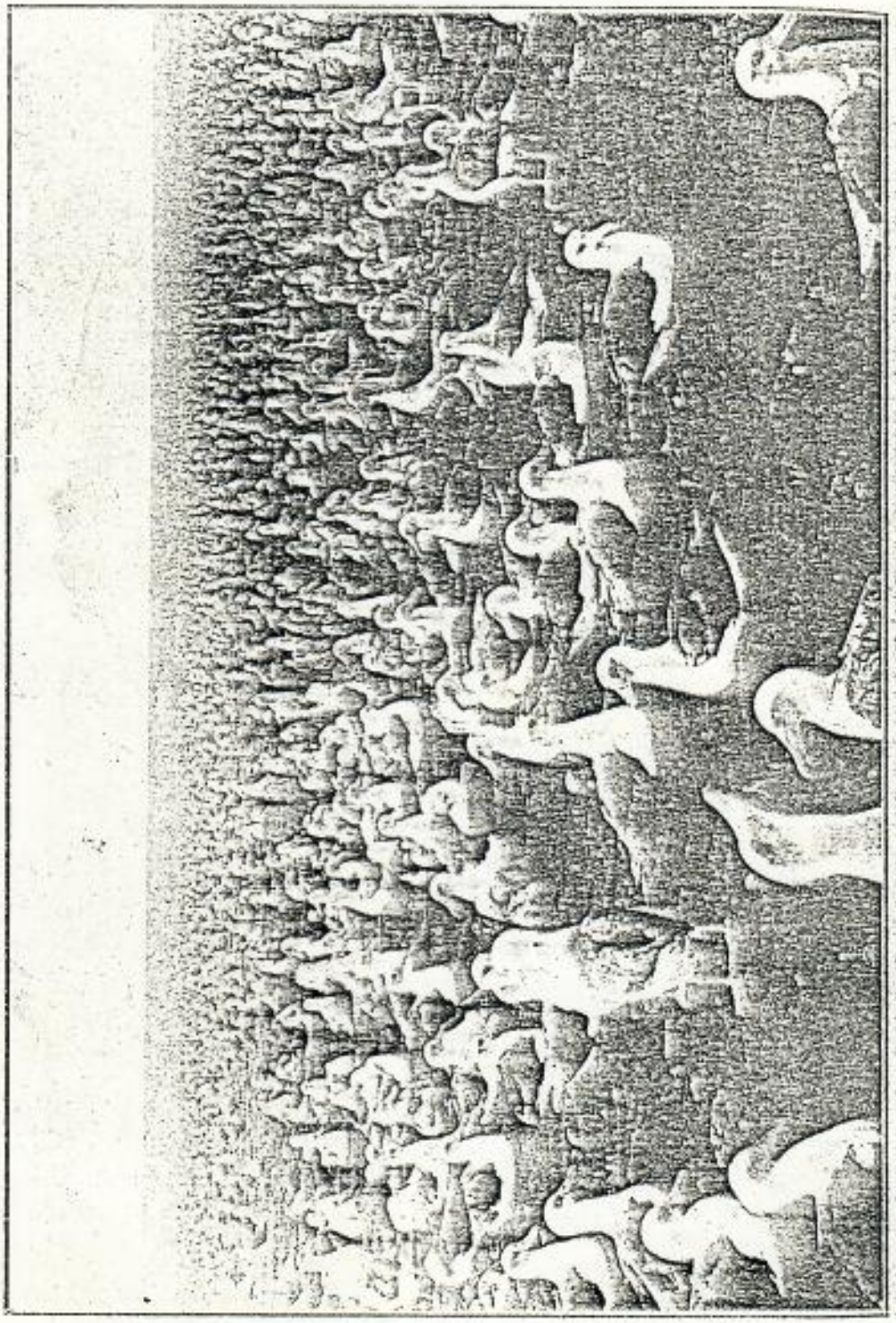
To mention Laysan without alluding particularly to its colony of albatross would be to suggest Hamlet with Hamlet left out, since they have so long been the principal actors and are responsible for the popular fame of Laysan, overshadowing the rest of the all-star company in which nature has made them appear in much the same degree.

The Laysan albatross or white-breasted gony is distributed all over the island, with the possible exception of the sea beach, which is especially popular with their brown-breasted, black-footed cousins. In certain places, as at the ends of the lagoon, they are, or rather were, more congested than in other localities. The dense colony shown in the illustration (taken when the guano company was operating its lease) was at the east end of the lagoon. To the progenitors of these birds is due the exceedingly valuable deposit of bird lime or guano, the accumulation of ages, which has been removed in years past and utilized as phosphate rock in chemical fertilizers.

At the time of our visit in April the young were about half-grown. Each pair of birds rear but a single young during the year. The nestlings are exceedingly comical creatures as they sit up on their heels and snap their bills at the passerby. At other times they sit passively and gaze stupidly about them. After the first demonstration is over they seldom object to having their heads stroked — often dozing off to sleep again without effort.

The old birds do not mind the presence of man—often walking up to the visitor, evidently intending to welcome him among them. Once in a while an individual will take hold of the visitor's finger or gently pull at his shoestrings or leggins, but once ordinary curiosity is satisfied and the freedom of the place extended to the visitor, they take up their former occupations or go on with their amusements in utter disregard of everything and everybody. Friendly as they are, they will not allow themselves to be handled, avoiding any attempt to touch their persons — evidently resenting such approaches as undignified.

As a colony they always seem to be on the best of terms with one another, and as they stand beside their young, which are covered with a brownish



The Laysan Island Albatross Colony.

Williams Photo.

The Laysan Island Albatross Colony.
Williams' Photo.

down, they present an attractive and splendid appearance, since they are as large as a goose, handsomely formed, and with every feather perfectly immaculate.

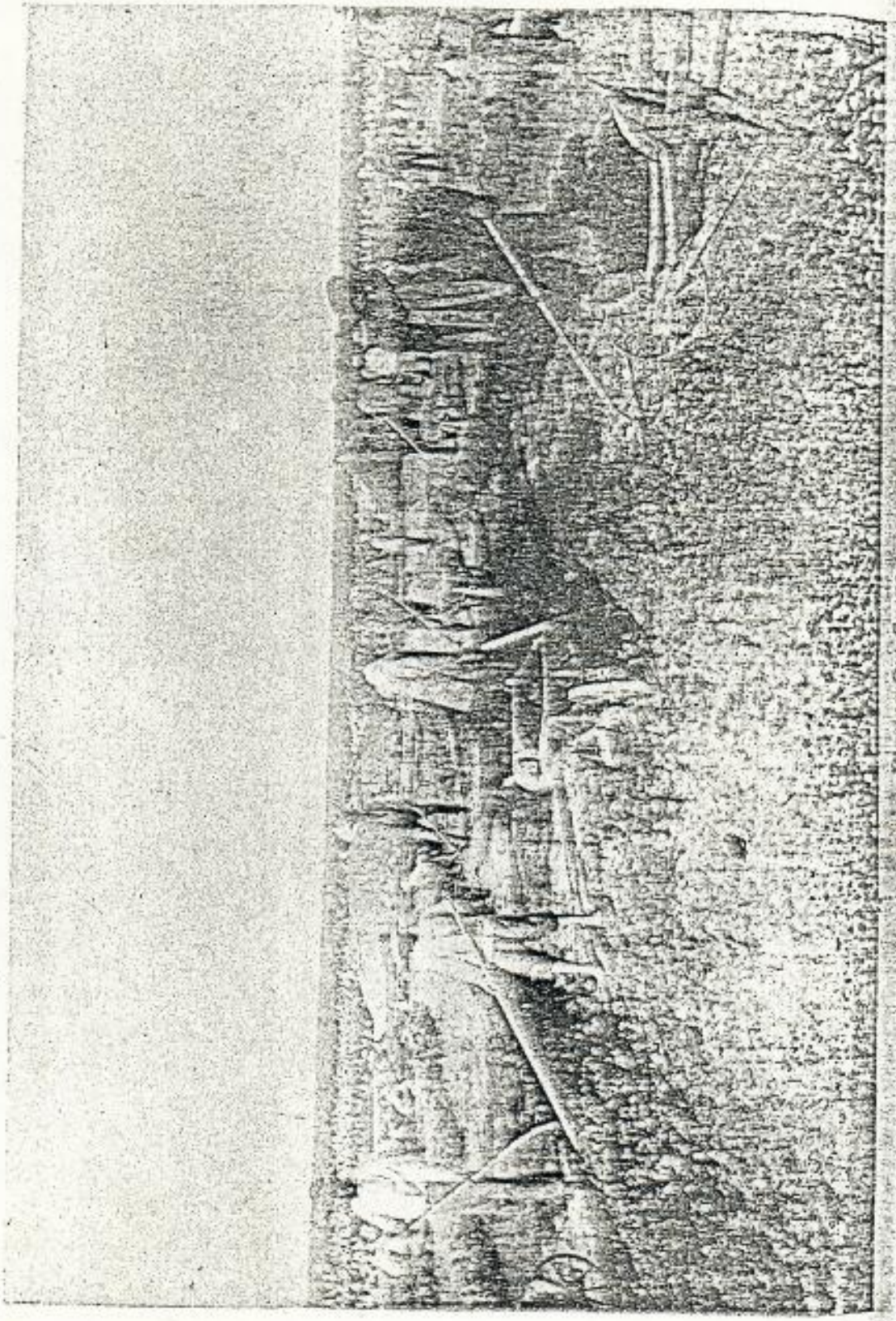
Mated birds seem to have a great fondness for each other and for their offspring. With this they combine a restless desire to keep themselves constantly employed at something. When they are not away at sea in search of fish and squid for their young, they usually employ the time on shore very pleasantly (if not especially profitably) by engaging in a curious form of amusement and diversion in the nature of a dance, which has become a real habit with them. They dearly love to dance, and often spend hours at a time, both by day and night, literally absorbed body and mind in this ludicrous performance.

My friend, Dr. Fisher, after discussing the origin of this curious habit, has so aptly described their "cake walk dance" or game, as one may prefer to call it, that it is a pleasure to quote from him as follows:

"At first two birds approach one another, bowing profoundly and stepping heavily. They swagger about each other, nodding and courtesying solemnly, then suddenly begin to fence a little, crossing bills and whetting them together, sometimes with a whistling sound; meanwhile pecking and dropping stiff little bows. All at once one lifts its closed wing and nibbles at the feathers beneath, or rarely, if in a hurry, quickly turns its head. The partner during this short performance assumes a statuesque pose, and either looks mechanically from side to side or snaps its bill loudly a few times. Then the first bird bows once, and pointing its head and beak straight upward, rises on its toes, puffs out its breast, and utters a prolonged nasal Ah-h-h-h-h, with a rapidly rising inflection, and with a distinctly 'anserine' and 'bovine' quality quite difficult to describe. While this song is being uttered the companion loudly and rapidly snaps its bill. Often both birds raise their heads in the air, and either one or both favor the appreciative audience with that ridiculous and indescribable bovine groan. When they have finished they begin bowing to each other again rapidly and alternately, and presently repeat the performance, the birds reversing their rôle in the game or not. In the most successful dances the movements are executed in perfect unison, and this fact much enhances the extraordinary effect."

Occasionally three or more will engage in in this dance, though often the production becomes too confused to carry it through to the end. An interesting variation is that exhibited when one or the other of the dancers will gather up a loose stone, stick, or straw and gravely offer it to the other, or attempt to place it nest-fashion about its feet. Many times I have bowed to these exceedingly polite birds only to have my bows returned, after which the gony would gaze at me with a curious, puzzled expression—evidently wondering at my awkward imitation of their exceedingly graceful salutation.

As has been said, the island was covered with these contented dancers eight years ago. Today more than half this splendid albatross colony has been wiped out of existence in the name of fashion and for the lust of gain. During the interval between the writer's first and second visit a company of Japanese were landed on the island to kill and cure birds for millinery purposes. That they were rudely interrupted in their spoilation by the U. S. Revenue Cutter "Thetis" is a truth well known, but the result of their poaching is everywhere too apparent. Everywhere over the island today are heaps of the bodies of the slain—silent proof that thousands of birds were killed and stripped of their wings and breast feathers and their bodies rudely thrown aside. This wholesale slaughter has had an appalling effect on the colony. The birds remaining were left in a sorry



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and indeed sadly decimated condition. Moreover, there is no assurance that the islands, even with the continued vigilance of a revenue cutter, will not again be visited by bird pirates who, during the interval between visits, will complete the work of destruction already so well under way.

While the main activities of the Japanese were directed against the two species of albatross, they were by no means averse to killing anything in the bird line that came their way. As a consequence, large numbers of birds of a dozen or more species were slaughtered by the wholesale.

Owing to the indiscriminate methods of killing adopted, usually only one or the other of the mated pairs was sacrificed. The mourning birds are slow in finding another mate. As but a single egg is laid by the majority of these ocean roaming birds, it will take ten years perhaps for this wonderful colony to regain its old numerical strength — provided, of course, that it is not again raided.

Fortunately, even after the wholesale slaughter of the birds and the result it has had on their nesting and mating habits, the birds remain as fearless as ever. It is devoutly to be hoped that traffic in birds' wings and feathers has been broken up in the Hawaiian Bird Reservation forever. Unfortunately there is no assurance that it will not be renewed without notice, and it is for this reason plain that the government must continue the visits of the "Thetis" or a similar vessel in authority that can call at all of the islands in the chain. But that alone will not suffice. A warden should be appointed who would have general supervision of these islands and their feathered inhabitants. Then with a resident warden, provided with a power sampan, frequent and unexpected visits could be made to the various islands.

With the island reservation thus controlled and policed, the first important step would have been taken looking toward the day, which the writer feels is not far distant, when this nation, and especially this Territory, will look upon this leeward chain of islands in the true light, as forming a great natural park as interesting and wonderful in its way and as instructive to visit as are any of the other great and famous national parks of which America is now justly proud.

Enough has been said to show that under proper safeguards the visiting of these reefs and islands by camping and fishing parties need result in no harm to the breeding colonies of birds. As years go by and birds become more rare elsewhere, the great reservation in the mid-Pacific will become what it should be today—an object of world interest and concern. The birds of these islands are to Hawaii and the nation a valuable possession, while as an attraction to visitors as well as to those who reside in these sunny islands they represent an asset that as yet is scarcely appreciated.

It is to be hoped that the representations now being made to the Territory and to the Federal Government may result in something being done to safeguard the birds of these lonely islands against the further despoliation and possible extermination by hunters, by rabbits, or in any other preventable way.

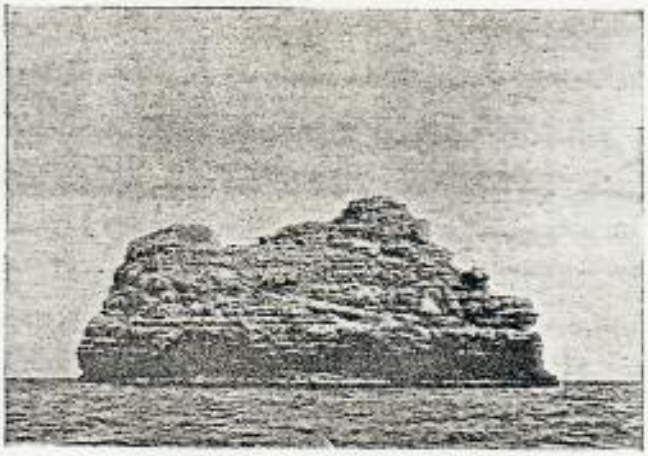
If the care of this truly remarkable reservation is taken up at once and in a vigorous manner, this interesting bird colony may be brought back into its original condition. On the other hand, if a policy of indifference and delay is indulged in, there is now no assurance that the birds of these islands may not be as completely wiped out as were the albatross on Marcus Island, where in the brief space of six years the writer found that a colony almost as large as that on Laysan was reduced to less than a score of birds through the unchecked activities of bird hunters.

French Frigate Shoal---Part of Hawaii

By Edwin H. Bryan, Jr.

French Frigate Shoal consists of a crescent-shaped reef on a circular platform about eighteen miles in diameter, located four hundred and eighty miles northwest of Honolulu. The reef forms a barrier against winds and currents around the north and east sides of the platform, which is covered to the south and west by water which averages one hundred feet in depth. Near the center of the platform stands a small rocky pinnacle, La Perouse Rock.

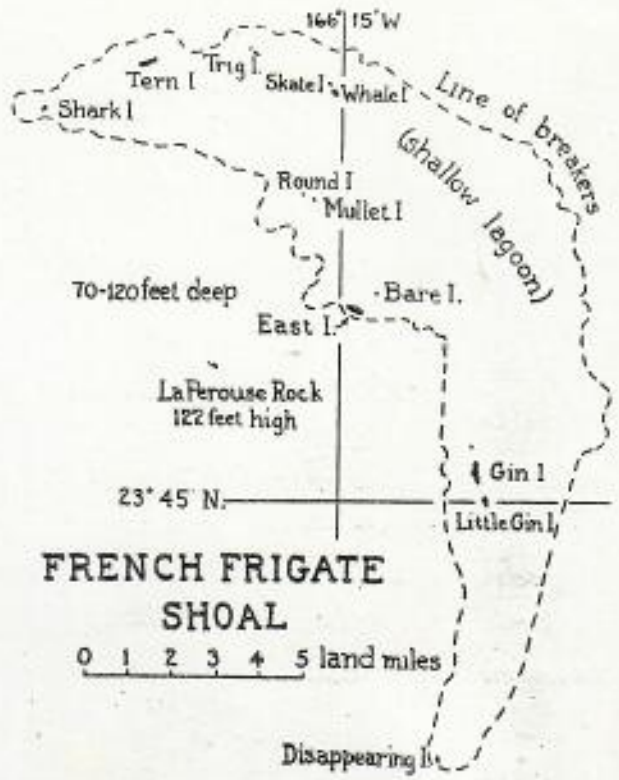
Professor Harold S. Palmer, in describing the geology of this shoal, characterizes it as a "stage in the normal cycle of a volcanic island in a warm region." Once upon a time, we may imagine, there rose on this spot a high volcanic dome, perhaps fifteen miles or more in diameter. Rain and waves eroded its slopes and coast until all that now remains above the sea, of the original island, is La Perouse Rock, five hundred feet long, eighty feet thick, and one hundred twenty-two feet high, and its little companion, three hundred and fifty feet to the northwest, which is one hundred feet long and forty feet wide, and ten feet high.



La Perouse Rock—E. H. Bryan, Jr. Photo

Corals grew upon the platform which the waves had carved, until they formed a sweeping curve of reef seventeen miles from tip to tip and five miles wide at its middle. On this reef the sand and coral debris is continually being piled into little islets; elsewhere there is a shallow lagoon. We know that these islets are being built up and washed away, for in 1859, when a survey was made by Captain N. C. Brooks of the Hawaiian Bark *Gambia*, there were five rather large coral islets, while in 1923, when the *Tanager* Expedition surveyed the shoal, we found sixteen small ones instead. The accompanying sketch map shows the arrangement of the islets in 1923, with the names we gave them. These isles have probably shifted around some by now.

In the lee of this crescent-shaped reef the water is calm and smooth when the trade wind blows, as it does most of the time. This has been found a safe landing place by several flights of sea planes which have flown there from Oahu during the past few years. The reef also breaks the force of the waves against the rocky remnant of the once lofty dome, and is helping to preserve it. In certain lights and from certain directions La Perouse Rock resembles a

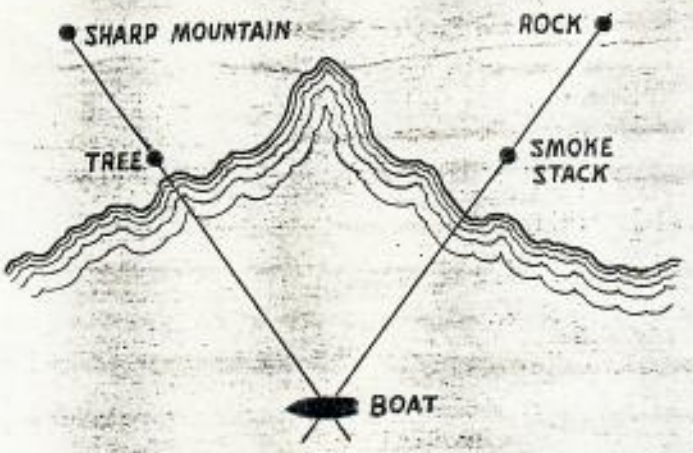


ship under full sail, but this resemblance to a frigate is not what gave the shoal its name. The name should really be called French Frigates Shoal, as we shall see from the account of its discovery.

The gallant French navigator, Jean Francois de Galaup comte de la Perouse, with his two little vessels, *Broussole* and *Astrolabe*, was westward-bound from California, on a voyage of discovery. The presence of large numbers of birds —boobies, man-o'-war birds, and terns—had put them on the alert for a sight of land, and on November 5 they discovered Necker Island. After making a survey of the shoals to the west of this lonely rock, the two vessels proceeded westward. "Since our departure from Monterey," runs the entertaining narrative, "we had never experienced a finer night, or a more pleasant sea; but this tranquillity of the water was

Continued to Page Thirty

Terns on French Frigate Shoal—E. H. Bryan, Jr. Photo

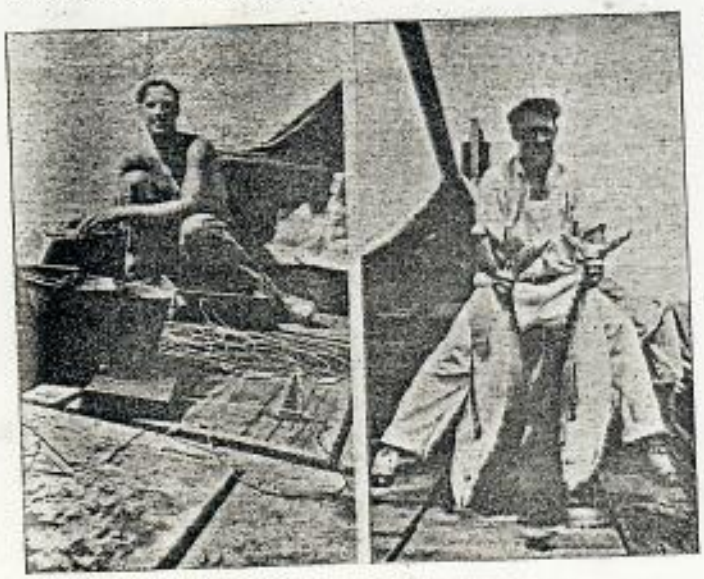


many of the sport fishermen care for it. Then again the lines must be very carefully made up, and few possess them or even know how to make them.

A small group of us are prepared for this type of fishing. This fish are caught almost anywhere about a mile and a half from shore in thirty fathoms. The fish will not bite at all on moonlight nights, although a strong light is always hung over the side of the boat while fishing. Akule are easily caught if the proper transparent lines are used and the nights are very dark. At times sharks will take the fish when the lines are being pulled in. In this case it is best to change your location.

Commercial fishermen of Kauai practically make their living on akule. Consequently it is the most common fish on the market.

Much skill is necessary for all types of fishing mentioned, as most fish will only bite when the proper hooks, baits, lines, location and time are considered. Many hours of work are necessary in preparing lines, etc.



Cedric Baldwin (left) and George Kruse (right)

Dried Bananas and Banana Flour

Bananas were dried by Mr. Peccinnini, an Italian, in Nuuanu Valley, Oahu; dried by the action of fire and safely packed for exportation—this in the year 1876.

"The nutritive value of flour made from dried bananas has attracted popular attention during the last couple of

French Frigate Shoal—Part of Hawaii

Continued from Page Fifteen

among the circumstances which had nearly proved fatal to us. Toward half past one in the morning we saw breakers at the distance of two cables length a-head of my ship. From the smoothness of the sea they made scarcely any noise, and some foam only, at distant intervals, was perceptible. The *Astrolabe* was a little farther off, but she saw them at the same instant with myself. Both vessels immediately hauled on the larboard, and stood with their head south-southeast; and as they made way during their maneuver, our nearest distance from the breakers could not, I conceive, be more than a cable's length."

La Perouse goes on to describe how the next day a careful survey was made of the shoal, which the discoverer named *"Basse des Fregates Francaises,* shoal of the French Frigates, because it had nearly proved the final termination of our voyage."

Until recently the history of French Frigate Shoal (the name is that officially adopted by the U. S. Geographic Board, October 1, 1924) has been a quiet one. Occasional vessels stopped, but most of them gave the dangerous spot a wide berth. The Provisional Government of Hawaii leased the area for twenty-five years from February 15, 1894, but little use was made of the place. On July 13, 1895 it was formally annexed for the Republic of Hawaii by Captain J. A. King. It was among the islands acquired by the United States, July 7, 1898, when Hawaii became a Territory. In 1909 it was made a part of the Hawaiian Islands Bird Reservation. Officially it is part of the City and County of Honolulu, but it is administered jointly with the U. S. Department of Agriculture.

In 1923 the sixteen sand islets had a total area of about forty-six acres, of which seventeen acres were covered with a sparse growth of grass and other low vegetation, herbs and vines, a total of six species. Their highest elevation was ten to twelve feet; most of the islets were lower. The population consisted of thousands of sea birds, most of them terns. With a calm sea it was quite possible to land on the southwest side of La Perouse Rock, but the precipitous slopes were so crumbly and slippery with bird guano that no one cared to climb to the top. Rock samples showed this remnant core to consist of olivine basalt, very similar to that which makes up much of the rest of the great chain of volcanic mountains the summits of which form the islands of the Hawaiian group.

Round Oahu by Bus and Rail

Continued from Page Twenty-Two

Here at Kalauao was fought a decisive battle of Hawaii in 1794. Boats flying the American Flag filled with American seamen aided the victor. King Kalanikupule won from his uncle Kaeo only to lose Oahu to Kamehameha the following year at the Battle of Nuuanu Pali.

Taro, from which poi and flour are made, abounds. We have passed nearby Ford Island—Mokuumeume—airhome of Army and Navy Aviation. Papaya. Waiau Rice Mill. Fish ponds. Bananas. Pearl City Station and the adjacent water-landing-place of the Pan-American Airways planes. Vegeta-

BAKER and HOWLAND Islands, separated by 37.5 miles, have many features of climate, soil, vegetation, and animal life in common. Both islands are of coral formation, about 18 or 20 feet high. They formerly yielded great quantities of guano, largely removed between 1850 and 1900. They are said to be under British protection, and were leased to the Pacific Islands Co., but the United States had a claim. [redacted] Both islands were visited by the U.S.S.Whippoorwill, with a scientific party, in 1924.

HOWLAND ISLAND (0° 49' N., 176° 43' W.) is about 2 miles long, N. and S. by 1000 yards wide. It is said to have been first reported by Captain George E. Netcher, of New Bedford, in 1842. Numerous vessels visited it during the height of the guano trade, ten whalers having called between June 21 and July 16,1857. Foot paths of smooth stones, still to be seen across broken coral on the S.E. side were noted as early as 1862, together with other evidence of native work. Emory (B.P.Bishop Museum Bul.123,1934) considers the kou trees and the native rats to be of Polynesian introduction. Tide: high water, full and change at about 7^h 11^m, spring rise 8 feet.

BAKER ISLAND (0° 13' N., 176° 33' W.) is about 1 mile E.& W. and 1500 yards wide, surrounded by coral reefs which dry in places at low tide. There is considerable evidence of the guano digging period: 4 brick cisterns, a roofless stone and mortar house and sites of several other houses, a large iron buoy, two tram line routes, and about 18 graves, one with the date 1899. Landing is difficult, both the Whippoorwill and the Itasca having had boats capsize. Winds from May to Oct. blow steadily from E to SE.; from Nov. to April, generally from E. to N.E., frequently interrupted by westerly winds and bad weather.

Climate:- The rainfall is scanty, as indicated by the vegetation. J.D. Hague (American Jour nal of Science,vol.34,pp.224-242,1862) stated that the sky is clear and cloudless; the temperature even, ranging from 76° F. at sunrise to88° at hottest part of day in the shade. Rain falls in light showers, not infrequently, but heavy showers are rare. During 4 winter months,1859-60, rain fell 23 times, total 1.84 inches. Rain squalls approaching the island, just before reaching it, may separate into two parts, which pass to N. and S., the cloud having been cleft by column of heated air rising above coral sand.

Present soils largely sandy, forming a shallow layer on top of solid coral conglomerate. Details concerning soils are given by Christopherson (B.P.Bishop Museum Bul.44,pp.63-66, 1927. Guano mostly removed.

Vegetation: Nearly continuous cover of low herbs and grasses, which can stand the dry conditions. One bunch grass (on Howland) two kinds on Baker, cover beach crests and portions of interior flat. Most of flat covered by Boerhaavia and two kinds of Portulaca. Howland has in all 6 kinds of plants; Baker about 15. Some on Baker are found only about the building sites at the west end, and may have arrived through man's agencies. Howland has two small groves of kou trees (Cordia subcordata). Although these look on the verge of extinction, they are today almost exactly as described in 1924, and scarcely different from their appearance in 1860. It is thought that their tops are killed back by the numbers of nesting blue-faced booby birds.

Birds: There is considerable difference between the bird life on these two islands, birds being much less numerous, both kinds and individuals on Baker. Frigates and three kinds of boobies are common to both. Four kinds of terns (noddy, sooty, white, and a slender, light gray) found on Howland, were not noted on Baker. No shearwaters, petrels, or tropic birds were noted on either. Of migratory birds: curlew (numerous and fat on Baker), turnstones, and what may have been wandering tatlers, were seen on both.

Red-legged hermit crabs were abundant on both; two kinds of lizards on Howland, one on Baker; rats very abundant on Howland, holes but no specimens on Baker.Fish and other marine life not so abundant as on Jarvis, although marine shells in some variety were seen. Sharks, porpoises, tuna, and other fish seemed to be common in surrounding waters.

No fresh water was seen, but it is suspected that brackish water might be had by digging.

Midway Island, U. S. A.

By E. H. Bryan, Jr.

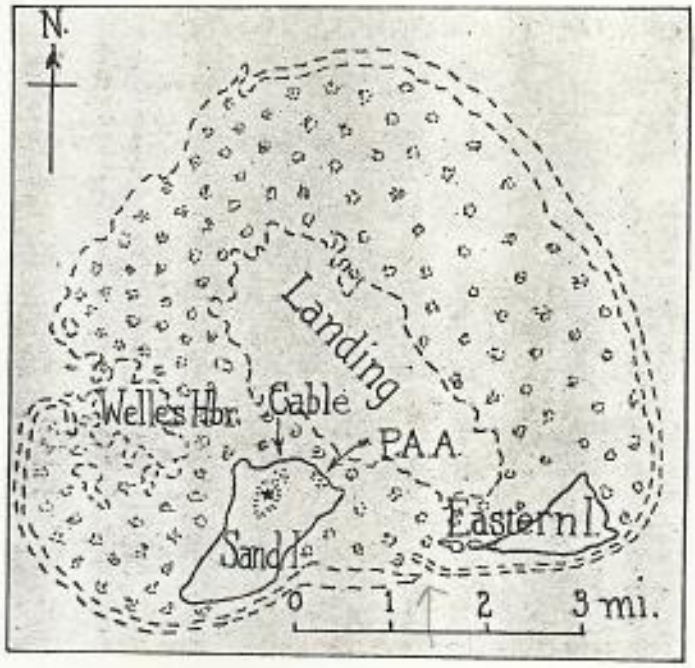
MIDWAY atoll crowns the summit of the next to the last peak from the northwest end of Hawaii's submerged mountain range. It is 1,150 miles northwest of Honolulu, 90 miles beyond Pearl and Hermes Reef, and 50 miles east of Kure, the final island of the chain. It consists of a nearly circular rim of coral reef, about 5 miles in diameter, enclosing a lagoon, the central portion of which ranges in depth from 25 to 50 feet, surrounded by a considerable expanse of shallower water. Much of the reef, especially on the northeast, forms a continuous flat-topped wall, standing some 5 feet out of the water and 6 to 15 feet wide. Some of it consists of irregular rocks, just about reaching the surface, and the west side, to the north of Seward Road, which gives entrance to Welles Harbor, is open, with only a few patches of reef.

Close to the southern rim of the atoll lie two low islands. Sand Island, the larger, measures a mile and a half long by a mile wide, and has a hill which reaches a maximum elevation of 43 feet, topped by a light. Formerly composed of nearly bare sand, now grass, shrubs, and trees have been planted on it by man until it is well wooded. Eastern Island is triangular in shape, about a mile and a quarter long by three-quarters of a mile wide. Of more compact soil, it has supported a growth of low scrub, including native species, since long before its discovery, and consequently has been called Green Island. Between these two islands there is a small passage, with a break in the south reef, such that a row boat can get through into the lagoon.

On Sand Island, near the north end, are now located a relay station of the Commercial Pacific Cable Company, established in 1902, and installations of the Pan American Airways. The lagoon provides a spacious landing place for the Trans-Pacific clippers at the end of their first jump from Honolulu toward Wake, Guam, Manila, and China. Midway is the only island in the "little end of Hawaii" which at present has permanent residents. On January 20, 1903, Midway was placed under the jurisdiction of the U. S. Navy Department, not being an official part of the Territory of Hawaii.

Midway was discovered July 8, 1859, by Captain N. C. Brooks of the Hawaiian bark *Gambia,* and by him called Middlebrook Islands. An account of this discovery, reprinted from the Polynesian of August 13, 1859, appears in the Paradise of the Pacific for October, 1936, on page 23. Captain Brooks took possession of the two islands in the name of the United States, a peculiar proceeding in view of the flag of his vessel, owned by B. F. Snow of Honolulu. Had he given the editors of the Polynesian a less glowing account of the new discovery, we would be inclined to believe the story that Captain Brooks kept the discovery secret so that he might sell the information to the North Pacific Mail and Steamship Company, who were on the lookout for a mid-Pacific coal depot for their vessels on the oriental run.

However that may be, the Pacific Mail Steamship Company learned about the atoll, and eight years later succeeded in having the American government send the U. S. S. *Lackawanna* to make a careful survey. With considerable ceremony, on Wednesday, August 28, 1867, in compliance with the orders of the Secretary of the Navy, formal possession was taken of what was termed Brooks' Island. Wrote Captain William Reynolds, commander of the *Lackawanna*: "It is exceedingly gratifying to me to have been thus concerned in taking possession of the first island ever added to the dominion of the United States beyond our shores, and I sincerely hope that this will by no means be the last of our insular annexations. I ventured to name the only harbor at this island after the present Honorable Secretary of the Navy (Welles), and to call its roadstead after the present Honorable Secretary of State (Seward)."



Midway Islands—Drawn by E. H. Bryan, Jr.

In 1870 the United States Congress appropriated $50,000 to be spent in blasting a 600-foot wide ship channel through the reef into the lagoon, doubtless at the insistence of the Pacific Mail Steamship Co., and based on observations made by the *Lackawanna.* The U. S. S. *Saginaw* was detailed to carry divers and equipment to Midway, arriving there on March 24, 1870. Dredging proceeded during the summer of 1870, but the weather was so bad that at the end of seven months little had been accomplished, the funds nearly exhausted, and the project was given up. The story of how the *Saginaw* was wrecked on Kure Island on its way back to Honolulu, has no place here, as we discussed it in our article on Kure Island. A full account of it has been given by George H. Read, in his "Last cruise of the *Saginaw.*"

On November 16, 1886, the little fishing schooner *General Seigel,* at anchor in Welles Harbor, was hit by a sudden gale and went to pieces on the reef. The gruesome adventures of its seven castaways, and how one of their number, Adolph Jorgensen, was left behind by his companions, is a well-known story, made famous by John Cameron's Odyssey. So also is the story of the manner in which, when he was about to be rescued by the 467-ton schooner *Wandering*

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Pali Road, Oahu—Hawaii Tourist Bureau Photo

MIDWAY ISLAND, U. S. A.

Continued from Page Seven

Minstrel, that vessel also was wrecked in almost the same spot. Five of the crew made off in one of the boats and were never heard of again. John Cameron, Jorgensen, and a Chinese boy, in another of the boats, succeeded in making the trip from there to Jaluit in the Marshall Islands. Captain F. D. Walker, his wife, three sons, and the remainder of the crew, who didn't die, lived for 14 months on the island until rescued by the fishing schooner *Norma*, March 16, 1889, and returned to Honolulu, April 7, 1889. If one believes John Cameron's Odyssey, Captain Walker appeared to have intentionally wrecked the *Wandering Minstrel* on Midway, and Jorgenson was not such a bad fellow, just little *pupule*. If, on the other hand, we accept the statements of Captain and Mrs. Walker (one account appears in the Paradise of the Pacific for November, 1936, pages 27-29), Jorgensen was a killer, and Cameron was little better.

Several naturalists visited Midway around the turn of the century: Henry Palmer, bird collector for Hon. Walter Rothschild, in July, 1891, and William Alanson Bryan, in August, 1902. The latter gives the last account of observations made on the island prior to the Cable Company installations, made later the same year and during 1903. (Occasional Papers of B. P. Bishop Museum, vol. II, no. 4, pp. 291-299, 1906) The schooner *Julia E. Whalen* was wrecked on Midway, October 22, 1903, while bringing supplies to the newly established cable station. The British bark *Carrollton*, with a load of coal from Newcastle for Honolulu, was lost on Midway, December 28, 1906. The crew was rescued by the cable ship *Restorer*. The Pacific Mail S. S. *Mongolia* went aground on the western side September 16, 1906, but succeeded in getting off again even before the arrival of the *Buford*, *Iroquois*, and *Restorer*, which went to her aid from Honolulu.

One might ask why so many wrecks have occurred on Midway. The answer is that the atoll is very low and hard to see, and also that it is subject, especially in the winter, to sudden and severe storms. Midway, although only about 400 miles further north than Honolulu, is no longer in the tropics, and has a much more temperate climate, which in winter becomes quite cold. This, together with the heavy winds, which drive the loose sand into every nook and corner, rule out this island as a winter resort. But in summer the climate is delightful. The position of Midway is 28 degrees 12 minutes 52 seconds north, 177 degrees 22 minutes 46 seconds west of Greenwich.

Perhaps the outstanding fact about the natural history of Midway is the

great change which Sand Island has undergone through the efforts of man. When the cable station was established, there were no trees and shrubs, and scarcely any herbs to keep the shifting sand in place. Daniel Morrison went to Midway as superintendent of the cable station in 1906, remaining until 1921. He imported a coarse grass (*Ammophila arenaria*) from the windswept beaches near San Francisco, and with it succeeded in holding the sand in place. He set out ironwood trees (*Casuarina equisetifolia*) as windbreaks, and numerous other kinds of ornamental and useful trees, shrubs, and herbs. Ship loads of soil were brought from Honolulu and used to encourage gardens and other plant growth. Mr. Morrison also imported canary birds and Laysan finches in 1906, and fostered the flightless rails which had also been introduced from Laysan. The island has been turned into quite a beauty spot, with livestock, poultry, lawns, and airy, spacious quarters, and now a good hotel, to attract the visitor, who might also be interested in splendid fishing.

The *Tanager* expedition, which explored the northwest Hawaiian islands in 1923, obtained a few specimens from Midway, to which have been added notes and specimens by Dr. D. R. Chisholm and others. The writer has a lengthy record of the plants, birds, insects, and fishes of the island and its adjacent waters, some of which have been published in Bishop Museum Bulletins 26, 27, 31, and 81, and other publications.

Now we read of a sudden awakening of interest in Midway on the part of the U. S. Navy and Army, and plans on foot to improve the harbor facilities of the atoll. This is not the first time such improvements have been contemplated. It is to be hoped that this will be more successful than earlier efforts. Edwin North McClellan, present editor of the Paradise of the Pacific, writing in the Honolulu Advertiser of September 16, 1927, reminds us that in March, 1904, Marines were ordered to Midway to "protect property and guard the cable employees from marauders who might visit the islands to kill the sea birds." A detachment arrived on Midway May 2, 1904, and set up two six-pounders; but they were withdrawn in the spring of 1908.

Of considerable value to the interests of Hawaii at present, with rapid and direct means of transportation from the Orient, is the "insect filter" which was established when F. C. Hadden, entomologist, was stationed on Midway, on November 24, 1936. His duty is to inspect and fumigate the clipper planes going in both directions. Already he has headed off insect pests which might have done considerable damage to the agriculture of Hawaii, (See Paradise of the Pacific for Jan. 1937, pp. 16, 30).

Weather observations were started on Midway in May, 1917. Now, with trans-Pacific flying, much more detailed weather data is being collected and sent to Honolulu. As many of the storms approach Hawaii from that direction, these observations are of great value in helping local weather forcasters.

Thus, with clipper landing facilities, cable relay station, insect filter, weather station, and potential advantages as a summer resort, Midway is a very useful and desirable little neighbor, and a valuable asset to the U.S.A., even though it isn't an official part of the Territory of Hawaii, and of the City and County of Honolulu, as it has frequently been considered.

DIGNIFYING LABOR

Some of our labor problems might be solved if public opinion classified all men and women, who earn their living by the sweat of their brows, as honorable, dignified and vital as the "white collar" laborers and others who do not perform manual labor. The millions of workers—who form the broad base of industrial civilization—are demanding this classification.

Royal Hawaiian Hotel, Waikiki, Honolulu

Lisianski, An Island of Hawaii

mentions turtles

By E. H. Bryan Jr.
Curator of Collections, Bernice P. Bishop Museum

Lisianski Island lies about 905 miles northwest of Honolulu and 115 miles west of Laysan, its nearest neighbor. It is a low, flat, sand and coral island, about a mile and a quarter long, north and south, and three-quarters of a mile wide. A V-shaped ridge of sand on the north reaches a height of 30 to 40 feet. On the south is a narrow crescent of sand dune, 20 feet high. Between is a depression, lower even than the 10 foot rim of the island, which is thought to have once been a lagoon or shallow lake. The island is situated on the northern edge of a large reef platform which extends several miles to the south.

Lisianski, not Lisiansky, is the name officially adopted by the U. S. Geographic Board, October 1, 1924. Other names by which it has been called are: Lassion, Pell, and Sapion; and Laskar, Lasan Rys, and Neavas are probably the same.

The island was discovered at 10:00 p. m. on October 15, 1805, when the Russian exploring ship *Neva*, commanded by Captain Urey Lisiansky, grounded on one of its reefs on the east side. Only by throwing overboard guns and other heavy objects was the vessel refloated. Hardly were they again in deep water until a sudden squall once more drove them onto an even more dangerous reef. By discarding cables, anchors, and the rest of their heavy objects, the *Neva* was again floated before the evening of the 17th. The next day, fortunately, was calm and all the heavy articles were recovered safely.

Going ashore on the 18th, Captain Lisiansky found numerous birds, large seals, turtles, and quantities of fish. The sandy surface, he noted, was full of holes (shearwater burrows) which were concealed by creeping plants. No fresh water was found. A quantity of shells, coral, sponges, and other specimens was collected, and huge redwood logs were seen on the beach. In his journal Captain Lisiansky says that "this island promises nothing to the adventurous voyager but certain danger." He concludes his account of it by saying: "To the southeast point of the bank where the vessel grounded, I gave the name of Neva; while the island itself, in compliance with the unanimous wishes of my ship's company, received the appellation of Lisiansky."

A dangerous shoal, 7½miles S.E. by ½ S. from the east side of the island was reported by Captain Stanikowitch in 1827.

Captain John Paty, in the course of an exploring expedition to islands N.W. of Oahu, on the Hawaiian schooner *Manuokawai*, visited the island on May 11, 1857. He reported the surface covered with coarse grass; and also the finding of fresh water by digging five feet at the center of the former lagoon basin. Birds, fish, seal, and turtle, he said, were abundant, but not so plentiful as at Laysan. He gave directions for approaching the island from a point west of the south end, steering into a lagoon-like area within the reef through a narrow break marked by two large patches of breakers, north and south of each other and ¼ miles apart. Within the reef and in the lee of the island, good anchorage was to be found in 4 to 8 fathoms of water, ½ to 1½ miles

out necessary. On the island he found some wreckage on which the name "Holder Borden" was carved. This vessel was wrecked in November, 1844, on what was called Pell's Island. No island has been found in the position given by Captain Pell of the whaling ship *Deleware*, so it has been concluded that Pell and Lisianski were the same.

In 1859 Lisianski was visited by Captain N. C. Brooks, in the Hawaiian bark *Gambia*. He furnishes navigators with considerable information about the surrounding reefs. A bank extends several miles to the south, shoaling from 19 fathoms to 8 fathoms near the reef. The island should not be approached from the south, Brooks states. On the east and north sides, the reef is about a mile from the island. On the west it extends in a curve to 2½ miles, with a lagoon within. The *Conahassett*, as well as the *Holder Borden*, was lost on this reef, according to Brooks. He recommends the best approach from the north and west, and gives detailed directions. A 2 foot tide was reported, as well as a strong current, the direction depending upon the wind. The low, southern part of the island, he said, was overgrown with shrubs (which probably means *Scaevola*). He reported finding a notice, dated April 27, 1859, left by the *San Diego*, taking possession of the island for parties in San Francisco.

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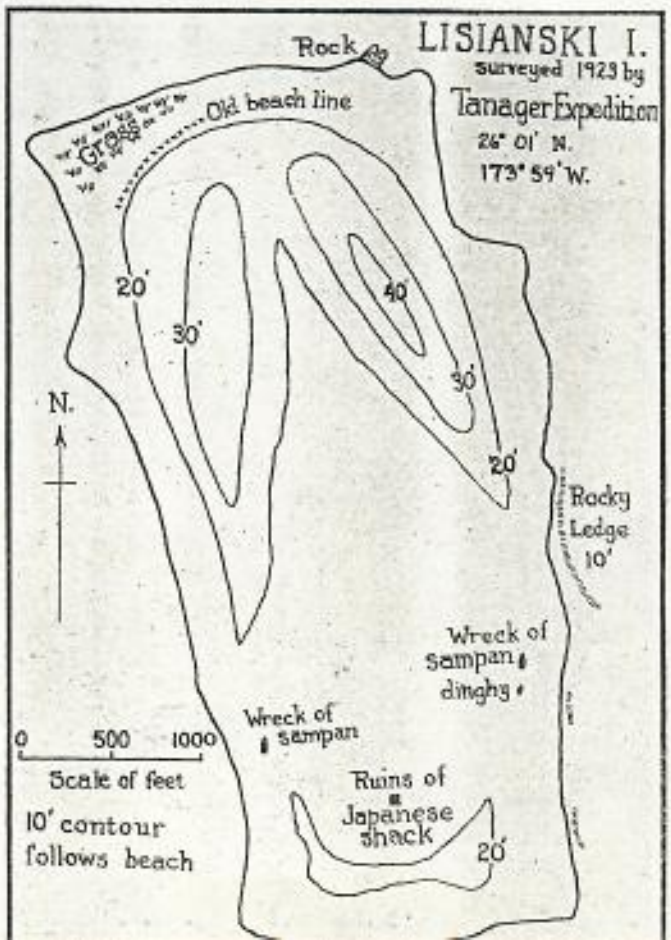


Lisianski, An Island of Hawaii

Continued from Page 31

On June 29, 1891, Captain F. D. Walker visited Lisianski in the schooner *Kaalokai*. He reports in his entertaining "Log" (published in 1909) that much of the island was covered with low scrub brush, behind a beautiful sand beach about 100 feet wide. Seals were sleeping on the beach, large mullet swam in shoals everywhere, and bird life was plentiful. "The island is a little paradise, or could be made one, at a moderate cost," he writes. He estimated that a thousand tons of good guano remained in the dry lagoon. Contrast the accounts given above with conditions a quarter of a century later.

The island was leased by the Hawaiian kingdom to the North Pacific Phosphate and Fertilizer Co. for 20 years from March 29, 1890. Carl Elschner, who visited the island in 1915, reported that some guano had been shipped from the island, but only the best, much partly phosphatized sand and soil remaining in the depressed area.

At some time prior to Elschner's visit rabbits had been introduced, probably from Laysan, whence they had been brought by Max Schlemmer. Left to themselves and without enemies, the rabbits had thrived for a time, multiplying in geometric proportion, as rabbits can. Soon the food supply began to be inadequate for the huge population. Lorrin A. Thurston, in the Honolulu Advertiser for June 1, 1923, presents a vivid picture of what must have taken place. There was a frantic search for food; then the rabbits became cannibals, the old devouring the young. He depicts the grewsome scene of a last newborn, skinny rabbit being devoured by the last starving mother rabbit.

Elschner saw the island at about its worst. Dreary and desolate, he called it, with its single tobacco patch, the remnant of that set out by Max Schlemmer, and two poorly looking specimens of Ipomoea, the only vegetation. With no plants to hold the sand, the birds were threatened with extinction. No fresh water was obtainable, shallow wells yielding only brackish water.

It may have been this, or a similar account, which finally prompted the U. S. Biological Survey, custodian of the bird reservation, to "do something about it." They cooperated with Bernice P. Bishop Museum and other local scientific institutions, in sending an expedition to the

N.W. Hawaiian islands, on the U. S. S. *Tanager,* in the spring of 1923. Many rabbits were killed off on Laysan, but when the party reached Lisianski they found the rabbits all dead and the vegetation beginning to come back. There was a patch of bunch grass *(Eragrostis)* at the northwest corner, and a few scattered plants of pickle weed *(Sesuvium)*, purslane *(Portulaca)*, and a local variety of a low, branching, native Hawaiian annual *(Nama.)* The late Gerrit P. Wilder, honorary warden of the bird reservation, planted seeds of *Barringtonia* trees at that time, but it is not known if they survived.

The remaining important event in Lisianski's recent history has to do with the slaughter of birds. The trouble began (or rather, first became extensively noticed) early in 1904, when a party of over 75 Japanese landed on the island. The presence of the party was reported by Captain Niblack of the U. S. S. *Iroquois* in April, 1904, and the U. S. Revenue Cutter *Thetis,* Captain O. C. Hamlet, was dispatched on May 8, to bring them off. It reached Lisianski June 16, and found the party well housed in four thatched-roof shacks, but with only a little rice and dried tern meat left, and consequently not at all unwilling to leave. Several hundred packages of dried bird's wings could not be removed at the time and were left on the island.

The leader of the bird poachers told Acting Governor Atkinson that the party had been stranded on the island when their schooner, *Aju,* sank. He said they had put up a signal of distress which had been seen by the *Taiyo Maru,* which had spared them some provisions and removed one of their party. With such a story, and as no law could be found which protected the birds, there was no prosecution. Both the Territory and the Federal Government thought that they ought to claim the bird feathers, which were valued at $20,000; but before Captain Weisbarth, who had been sent to get them, could reach the island, they all had been removed, probably by the schooner *Wiji Maru,* which had been active in bird killing, and had been warned away from Midway in June. This vessel was later wrecked on Pearl and Hermes Reef, part of its crew being found on Lisianski in September, 1904, together with part of the crew of the *Tanzi Maru.*

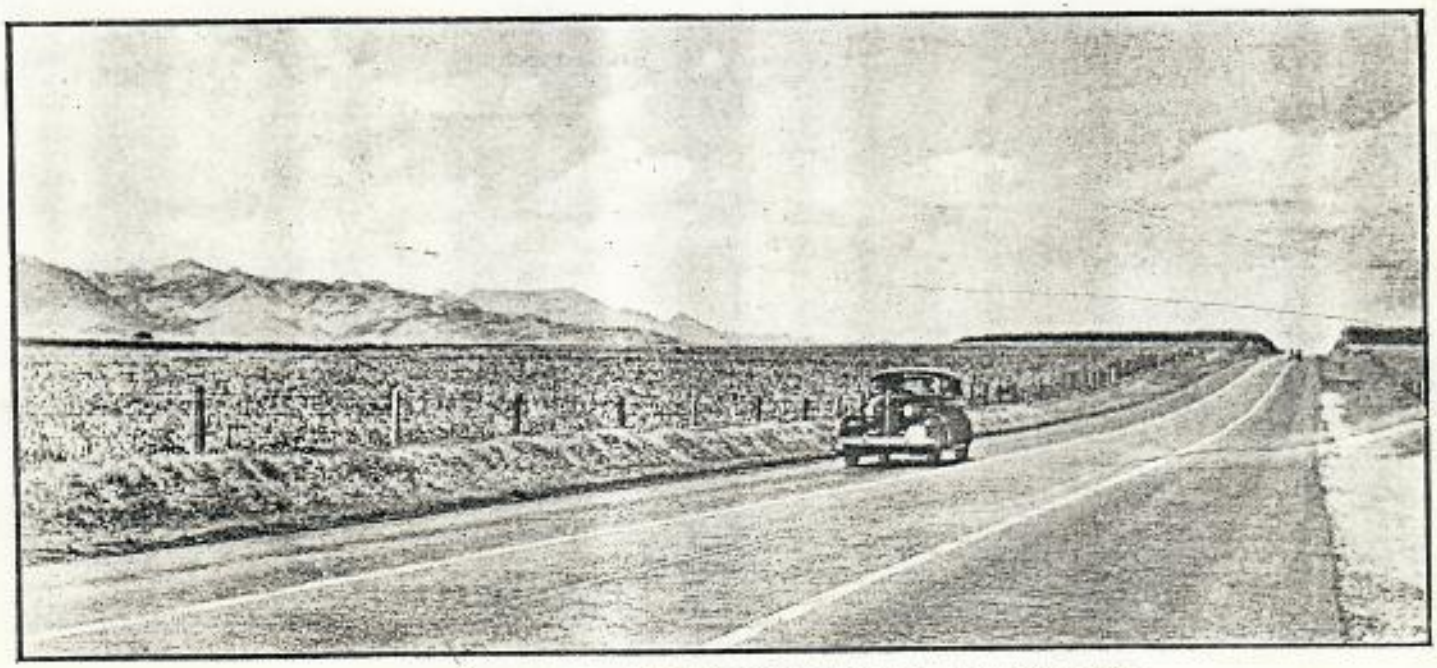
Such slaughter of bird life, however, stirred up interest in bird protection. An appeal was made to Washington, and in 1909 President Theodore Roosevelt initiated a joint resolution in Congress, which set aside the Hawaiian Islands Bird Reservation. So when the Cutter *Thetis* visited these islands again in January, 1910, and found 15 Japanese bird killers on Laysan and 8 on Lisianski, they were promptly arrested, brought to Honolulu on February 2, and turned over to the United States Marshall, charged with poaching. Today, with poaching at an end, the rabbits exterminated, and the vegetation again spreading over its low sandy surface, Lisianski is again becoming a populous bird sanctuary.

Bull in a Sugar-Cane Field

"They had very recently brought to this island [Maui] one of the bulls that Capt. Vancouver landed at Owhyhee [Hawaii]," wrote Captain Amasa Delano of his visit to that Island in 1806. "He made a very great destruction amongst their sugar canes and gardens, breaking into them and their cane patches, and tearing them to pieces with his horns and digging them up with his feet. He would run after and frighten the natives, and appeared to have a disposition to do all the mischief he could, so much so that he was a pretty unwelcome guest among them. There was a white man at this village, who told me that they had not killed any of the black cattle that Capt. Vancouver brought there; and that they had multiplied very much. This agreed with what I heard when there in 1801. I understood that the bull which they now had at Mowee, was the first of the cattle that had been transported from Owhyhee to any other place. I have within this year or two been told by several captains who have lately been to these Islands, that they have increased so much, that they frequently kill them for beef."

Marihuana Grows in Hawaii?

Narcotic agents are said to have discovered two large marhuana bushes growing in Pauoa Valley, near Honolulu.



ROAD TO SCHOFIELD BARRACKS—SUGAR AND MOUNT KAALA—Hawaii Tourist Bureau Photo

Laysan, an Island of Hawaii

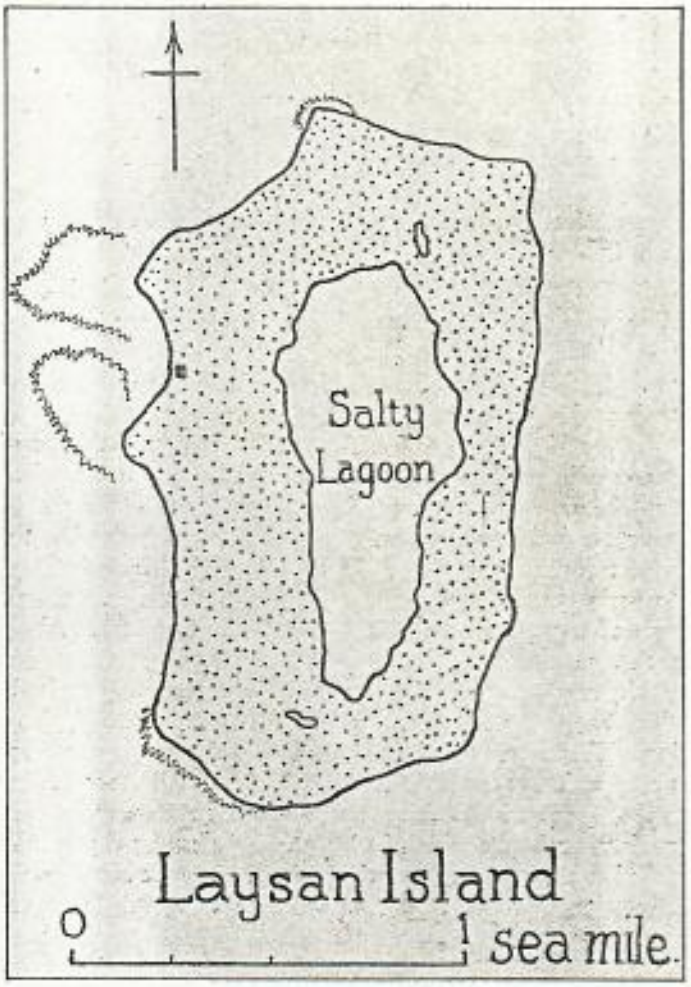
By E. H. Bryan, Jr.

IN SOME ways Laysan Island is the most fascinating and in some ways the most unfortunate of all the tiny dots of land in the "little end of Hawaii." In former days it supported the largest bird rookery of the entire chain. Although at no time during its recorded history did it reach an elevation of more than 50 feet above sea level, still on it once grew groves of sandalwood trees, dense thickets of bushes, and native fan palms, beneath whose shade there evolved five species of land birds, endemic to the island, and known nowhere else. And all this on an area of but two or three square miles.

As a result of all this bird life, great beds of valuable guano were deposited. These were formed when the droppings of myriad of birds, during countless years, reacted with the coral sand. Man found that guano was a fine fertilizer for his crops, so in the course of time man found his way to Laysan, and as usual upset the nicely adjusted balance which Nature had established there. Poachers also were attracted by the great numbers of birds, and ruthlessly slaughtered hundreds of thousands for their feathers. And for good measure, rabbits and guinea pigs were introduced which so completely ate off the remains of the vegetation that the very existence of the birds was threatened, and several kinds became extinct.

Laysan is located 790 miles to the northwest of Honolulu, in latitude 25° 42′ 14″ North, and longitude 171° 44′ 06″ West of Greenwich. Its nearest neighbors are Lisianski, 115 miles to the west; Gardner Pinnacles, 202 miles to the southeast; and Pearl and Hermes Reef, 260 miles to the northwest. The island is shaped like a great poi pounding board or oval serving dish, about a mile wide by two miles long, north and south. Some estimates give it 1.5 miles wide by 3 miles long, but this latter may either include the fringing reef, or be in land miles; the former is in nautical miles, and is scaled from the map. The surface is composed of loosely packed coral sand, with beds of coral reef and phosphate rock on the south and west sides. The beaches rise rather abruptly to a height of 15 to 18 feet, then flatten out, and slope gradually downward to a central depression, part of which is occupied by a salty lake, without connection with the sea. The surface of the lake is somewhat above sea level, and its depth was formerly up to 15 feet, although the amount of sand which drifted into it, while the island was denuded of vegetation, has made it much shallower.

Laysan Island's Albatross—E. L. Caum Photo, Courtesy Bishop Museum



William Alanson Bryan has suggested that Laysan was formerly a small atoll, the whole of which was elevated with reference to ocean level. It is surrounded by coral reefs, which on the western side are indented to form a snug landing place for small boats, with a safe anchorage off shore, so long as the trade winds blow and this is the lee side.

The island is reported to have been an American discovery, but the details are not available. Not knowing of the earlier visit, Captain Stanikowitch, who sighted the island on March 12, 1828, named it Moller Island after his ship. On May 1, 1857, Captain John Paty annexed the island to the Hawaiian Kingdom in the course of his famous 50 day voyage of discovery aboard the Hawaiian schooner *Manuokawai*. Said Captain Paty in his report:

"This is a low sand island, 25 to 30 feet high, 3 miles long and 1½ broad. The surface is covered with beach grass, and half a dozen small palm trees were seen. It has a lagoon in the center (salt) 1 mile long and half a mile wide, and not a hundred yards from the lagoon abundance of tolerable good fresh water can be had by digging two feet. Near the lagoon was found a deposit of guano.

"The island is literally covered with birds; there is, at a low estimate, 800,000. Seal and turtle were numerous on the beach, and might easily be taken. They were evidently

Continued on Page Twenty-Eight

Laysan, an Island of Hawaii

Continued from Page Twenty-One

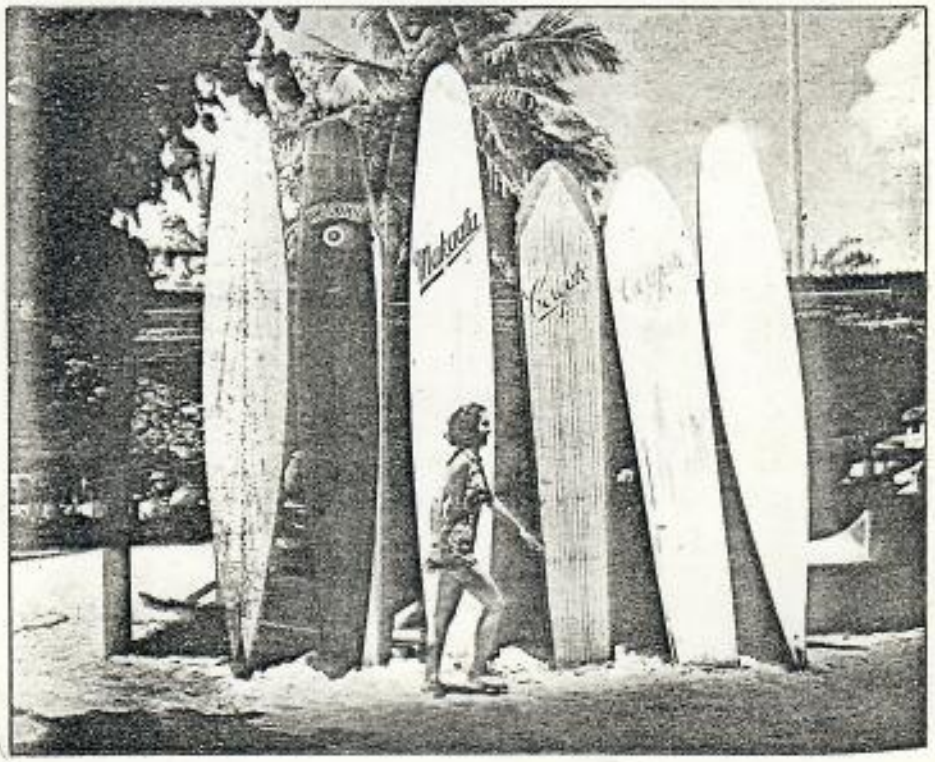
unaccustomed to the sight of man, as they would hardly move at our approach, and the birds were so tame and plentiful that it was difficult to walk about the island without stepping on them . . . Fish, too, are plentiful."

In 1859 Lieutenant J. M. Brooke visited Laysan in the *Fenimore Cooper*, and drew a map of the island, on which two palm trees are marked on the east shore of the lagoon. The map is now preserved in the Territorial Survey Office, in Honolulu. Later the same year Captain N. C. Brooks visited Laysan in the bark *Gambia*. He gives brief notes concerning the island, stating that it "is covered with a luxuriant growth of shrubs," and that "there are five palm trees on the island, and I collected 25 varieties of plants, some of them splendid flowering shrubs . . . "

George C. Munro, of Honolulu, spent 10 days on Laysan in June, 1891, while assisting Henry Palmer in collecting Hawaiian birds for the Hon. Walter Rothschild of Tring, England. He has penned an interesting account of "Myriad-nested Laysan" in *Asia* for October, 1930.

On March 29, 1890 Laysan was leased by the Hawaiian Kingdom for a period of 20 years to the North Pacific Phosphate and Fertilizer Company. The period of active guano digging lasted from 1892 to 1904. During this time numerous vessels visited Laysan. The Hawaiian schooner *Liholiho* made regular trips during 1892-93; the American bark *Irmgard*, in 1893; the American bark *Planter*, in 1894 and again in 1898; the American schooner *Robert Lewers*, in 1894; the Hawaiian schooner *Ka Moi*, in 1895; the American bark *C. D. Bryant*, in 1895 and 1897; the German bark *H. Hackfeld* in 1896; the Hawaiian schooner *Norma*, in 1896 and 1899; the Hawaiian steamer *Waialeale*, in 1898; the American brak *McNear*, in 1899, and others, made the hazardous run up through poorly charted reefs, to carry away loads of guano, or to take provisions to the little colony of guano diggers. Not all survived the trips; the wooden bark *Ceylon* was wrecked on Laysan in July, 1902. About May 1, 1904, the schooner *Robert Lewers* made a last trip to Laysan for the final cargo of guano for Hackfeld and Company, which firm gave up the lease shortly after this. The manager of the guano digging, Max Schlemmer, continued to live on the island until November, 1915.

About 1903 Captain Schlemmer introduced rabbits to Laysan, partly, it is said, to augment his food supply of fish, and partly, according to Professor Homer Dill, to start a rabbit canning bus-



SURFBOARDS REVIEW HAWAII BEAUTY AT WAIKIKI—Hawaii Tourist Bureau Photo

Oldest Frame House and Printshop West of the Rockies, Honolulu

iness. The first rabbits were brought in about 1903, the stock including Belgian hares and large white domestic English rabbits. The result of this cross produced a breed which would have delighted the heart of a geneticist. At all events, they bred prolifically, for within six years the island was overrun with them. They ate off much of the green vegetation. They lived anywhere and everywhere, under the bushes, in the holes with the shearwaters and petrels, and in burrows of their own. Domestic Guinea pigs were also introduced by Captain Schlemmer, but, although they bred well, they were as nothing compared with the rabbits. The destruction they caused has already been pictured for Lisianski Island. Conditions were even worse on Laysan. Literally every green leaf on the island was devoured, except the tobacco patch. Without vegetation to hold the sand and to afford shelter for the birds, the island quickly became an almost uninhabited desert, and the great populations of birds were threatened with extinction.

On top of this came the feather collectors, parties of Japanese, who slaughtered great numbers of Laysan albatross and other birds for their feathers, with which to trim hats. Local lovers of bird life complained to Washington, and on February 3, 1909, President Theodore Roosevelt, by executive order, set aside all of the islands from Kure to Nihoa, with the exception of Midway, as the Hawaiian Islands Bird Reservation, a sanctuary within which it was unlawful to kill or molest the birds. Thus, when a party of Japanese feather hunters landed on Laysan and Lisianski in the spring of 1909, they were promptly arrested by the revenue cutter *Thetis* and taken to Honolulu for trial.

In 1911 a scientific party from the Iowa State University visited Laysan to study the bird life and gather material for a splendid habitat group of sea birds. The party consisted of Professor Homer R. Dill, H. C. Young, C. J. Albrecht, photographer, and C. A. Corwin, artist, who spent 42 days on the island, and William Alanson Bryan, who joined the party for six days, while the *Thetis*, which took the party to the island on April 24, and called for it again June 5, was at that island. Professor Bryan, who had been on Laysan in 1902, had at that time estimated the bird population to be close to ten million. Now he estimated that it was not more than a tenth that much.

The Iowa party made an actual bird census, and found the number to be 1, 016,224 birds, as follows: sooty terns, 333,900, gray backed terns, 50,000, noddy terns, 5,500, Hawaiian terns, 3,000, white terns, 75, Laysan albatross, 180,000, black footed albatross 85,000, Bonin Island Petrels, 1,000, Sooty petrels, 3, red-tailed tropic birds, 300, blue-faced boobys, 65, red-footed boobys, 125, Christmas Island shearwaters, 75,000, wedge-tailed shearwaters, 100,000, frigate or man-o'-war birds, 12,500, Laysan

Hula and Cactus

teal, 6, Laysan flightless rails, 2,000, wandering tatlers, a very few, bristle-thighed curlew, 250, Pacific golden plover, 2,000, turnstones, 2,500, Laysan honey eaters, 300, Laysan finches, 2,700, and a few miller birds.

Various other scientific expeditions have visited Laysan. The first of these was that of Dr. H. H. Schauinsland, June to December, 1896. He collected a great many valuable specimens, which were worked up mainly by German scientists, and wrote an entertaining little book, "Drei Monate auf einer Korallen-insel", Bremen, 1899. The U. S. Fish Commission's *Albatross* visited Laysan in 1902, and a very valuable complete record of the bird life is presented by Dr. Walter K. Fisher, in the Fish Commission Bulletin for 1903. Carl Elschner presents observations, especially an analysis of the salinity of the lagoon, 9.1% chlorides of sodium and potassium, in 1915.

The *Tanager* expedition parties spent more than a month on Laysan during the spring of 1923. One of the objects of this scientific expedition, which was sponsored jointly by the U. S. Biological Survey, the Navy Department, and B. P. Bishop Museum, was to kill off the remaining rabbits. They found that the island had been transformed into a desert of sand, as shown in the photograph, which was taken at that time by E. L. Caum. Only four species of plants remained of the 26 species which had been previously reported. A report on the vegetation, summarizing what is known from the earliest notes made by C. Isenbeck, physician on the *Moller* in 1828, down to the observations of the *Tanager* botanists, has been published as Bulletin 81 of B. P. Bishop Museum.

Fish have been reported as extremely abundant about Laysan. Crawfish, and other forms of marine life also abound along the reef. Large turtles were formerly common along the beach, and still visit the island to lay eggs and sun themselves. This was the type locality for the famous Hawaiian seal, *Monachus schauinslandi*, now rare. Max Schlemmer reported killing 7 during 15 years residence on the island. In the line of insects, the species which attack dead birds are especially abundant. These include blow flies, ants, and dermestid beetles, which must have been exceedingly abundant at the time that hundreds of thousands of bird carcasses were thrown out to rot on the sands. They were reported as very troublesome in 1911.

Now that the enemies of the island are no more; that new plants have been set out to take the places of those which became extinct; the island is beginning to "come back." Templeton Crocker's yacht *Zaca*, returning in December of 1936, with a scientific party, reported that conditions, while not yet back to pre-poacher and pre-rabbit optimum, were greatly improved. So we have hopes that, after many misadventures, Laysan may once more become the "Paradise Isle of the Hawaiian Islands Bird Reservation."

FROM AN OLD DIARY

Continued from Page Twenty-Five

vessel having arrived since May 17, all were anxious to go off. I went with the pilot. It proved to be the English ship *Tinemouth*, Capt. Cole, 75 days from Canton. The *Louis Augusta*, Martin Capt., also arrived, a Dutch brig, the first colors of that nation ever hoisted here.

July 4.—A beautiful day. At 3:00 p. m., the King, Boki and Kaahumanu, the English Consul, residents and strangers sat down to an elegant dinner at Consul Jones'. A number of toasts and songs enlivened the company till evening.

July 7.—Trade most shocking dull with us, not averaging ten dollars per day.

July 19.—Mr. Charlton rode in a

Japanese Fishing God, near Blow Hole, Oahu

Gardner Pinnacles—A Barren Isle of Hawaii

By E. H. Bryan, Jr.

Curator of Collections, Bernice P. Bishop Museum

Certainly the most barren and probably the hardest to land on of all the Hawaiian islands are the Gardner Pinnacles, located 588 miles northwest by north of Honolulu, and 108 miles northwest of French Frigate Shoal, the nearest island neighbor. The position is N. 25°01′, 167°59′ W.

These isolated, barren rocks were discovered June 2, 1820, by the American whaler *Maro* of Nantucket, in command of Captain Joseph Allen. Incidently this vessel has the distinction of being the first of the many whalers to enter Honolulu harbor. Apparently Captain Allen did not make a landing on Gardner Pinnacles, for he greatly overestimates the size of the island, reporting it as being a mile in circumference and 900 feet high, with two large rocks at its southwest point.

In 1857 Captain John Paty visited Gardner in the Hawaiian exploring vessel *Manuokawai*. He reports that the island lies 607 miles west-northwest from Honolulu, and that it "is merely two almost inaccessible rocks, 200 feet high, extending north and south about one-sixth of a mile. A bank extends off to the southwest some 15 or 20 miles. The bottom seemed to be detached rocks, with sandy spaces between; I had 17 fathoms of water 10 miles south of the island. I think fish are plentiful on the bank."

A number of other vessels sighted the pinnacles during the middle part of the 19th century, reporting the island by various names, such as Man-of-War Rock, Pollard Rock, and Polland Island. There are also various spellings of Gardner, but the U. S. Board of Geographic Names has decided that Gardner Pinnacles is official. Positions were given for the island by Captain Stanikowitch and by Lieutenant Brooke, U. S. Navy. The latter describes the island as an inaccessible rock 170 feet high, with a base about 600 feet long, and a smaller rock close to its southwest extremity, from which a reef makes out one-half mile. He notes the bank as having 17 to 20 fathoms of water and extending out from the island on all sides, to the westward about 5 miles and southwest more than 8 miles.

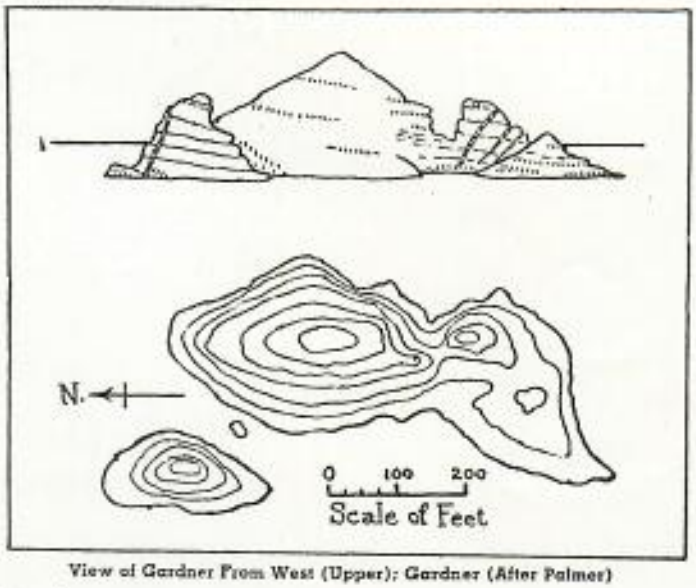
Captain F. D. Walker visited Gardner in the *Kaalokai*, June 9, 1891. In his entertaining "Log" (published in 1909) he writes as follows:

"At noon we sighted Gardiner Island, and at 2:30 were up to it.

"Gardiner Island is simply a rock one hundred and seventy feet high, or thereabouts, densely covered with birds. Hundreds of frigate birds were sailing majestically around it, watching with keen interest the results of the tropic birds' labors . . . ." He goes on to describe at length the manner in which these "highway robbers" of the bird islands harass the smaller birds as they return from fishing, and make them drop their hard-earned food, which they immediately swoop down and catch in mid-air.

"We fired a gun and the reverberation was like distant thunder. The whole colony of birds arose, and the air was clouded with them.

"There is no anchorage. The swell of the ocean breaks heavily even when the sea is calm. On the island's precipitous sides, the backwash or reflux rushes out a long way, making an experiment to land a very dangerous undertaking. To the westward there are a few detached rocks about seventy feet high. I could find no outlying dangers in our cruise around it, and as we could find nothing interesting or instructive to be gained, we took our departure at dusk and shaped our course for Maro Reef."



View of Gardner From West (Upper); Gardner (After Palmer)

Professor Harold S. Palmer, of the University of Hawaii, in Bernice P. Bishop Museum Bulletin 35, 1927, describes the topography and geology of the island. He was not a member of the *Tanager* Expedition party which landed in

Continued to Page Thirty-Six

Smaller Gardner Islet—Maj. Chapman Grant Photo ("Tanager" Ex) Courtesy Bishop Museum

Gardner Pinnacles

Continued from Page Eleven

May, 1923, but bases his descriptions upon field notes, sketches, and collections made by Dr. Stanley C. Ball, of the Bishop Museum staff. He says:

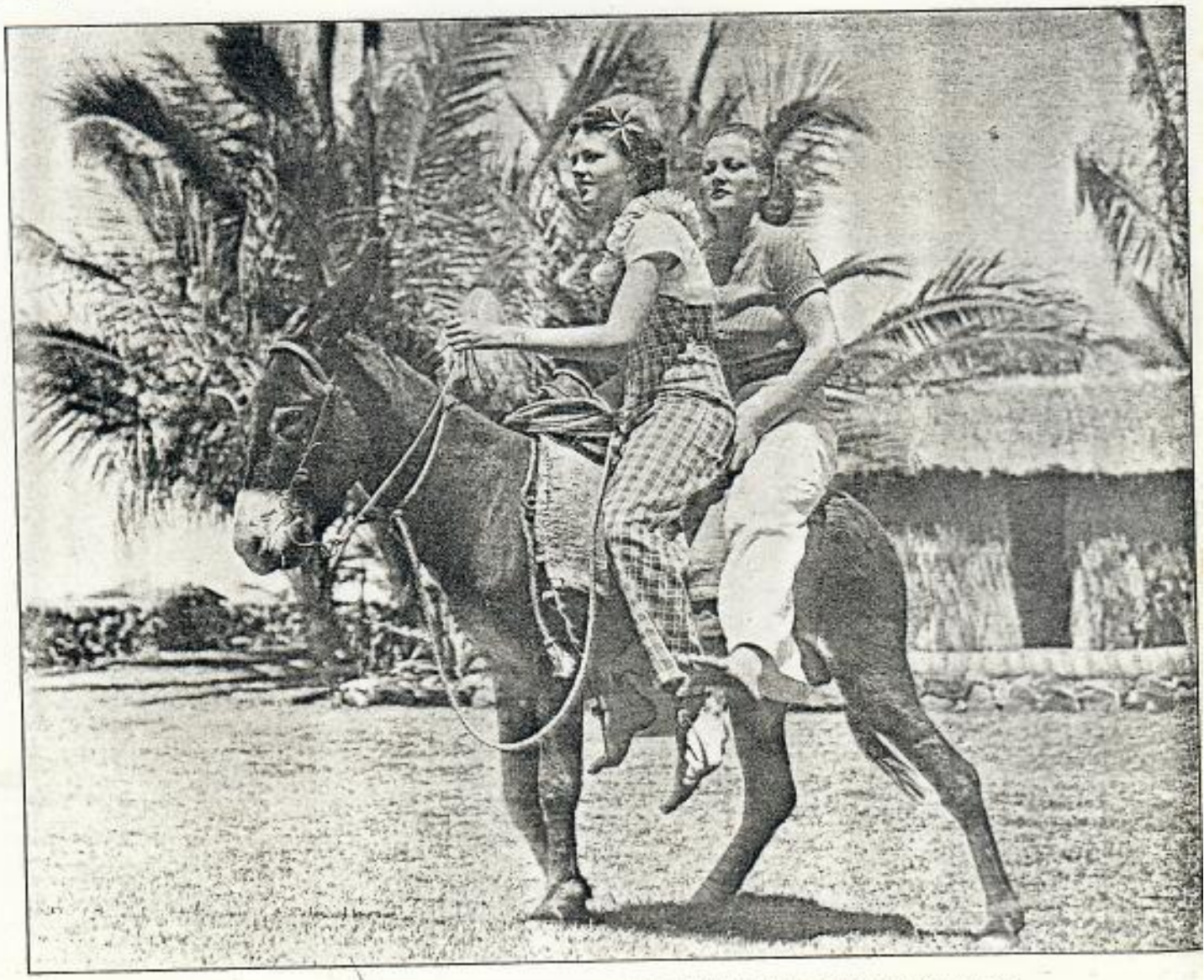
"Gardner consists of two islands which from the west or east appear as a single island, flanked by smaller northern and southern peaks. The smaller, northern peak belongs to the lesser island, which lies some 50 yards west of the north end of the larger island. A small, jagged rock rises a few feet above sea level in the channel between the two islands. Landings were made on both islands. Though it was necessary to swim to the smaller island, it was possible to land directly from the surf boat onto the larger island, one or two men jumping ashore each time the waves brought the boat in and before it was fended off . . ."

He goes on to describe the geologic formation of the island in some detail. All of the rocks observed on Gardner were fine-grained, dark basalt, except some weathered material thought to be tuff. All this was of volcanic origin. In cracks were found vein-like fillings of light-colored phosphate material; and there were crusts of lime. Bird droppings were everywhere.

Dr. Palmer suggests that Gardner Pinnacles are the remains of an island which was formerly larger, intermediate in size between Kahoolawe and Lanai, with an area of about 80 square miles. This island has been carved away by wind, rain, and waves until only the hard core of its volcanic dome remains. The island is at present surrounded by submarine banks which extend off from it about 5 miles on the east, north, and west, and 10 to 12 miles on the south. This great oval has an area of about 125 square miles. The accompanying sketches are based upon those published by Dr. Palmer from Dr. Ball's field observations on the island.

The botanists of the *Tanager* Expedition were able to take the day off. The steep slopes of Gardner Pinnacles are bare of vegetation, except for small pockets of purslane *(Portulaca)*, and algae on the lower, moist surfaces. The late Gerrit P. Wilder collected a small sample of *Portulaca*, but the specimens refused to dry, which is usual with this fleshy herb, and it is not positively known which of two species of purslane it is.

The insect collectors of the party



Duo of Hawaiian Pulchritude Aboard "Kona Nightingale" Going "To See"—Pan-Pacific Press Bureau Photo

Necker—Mystery Island of Hawaii

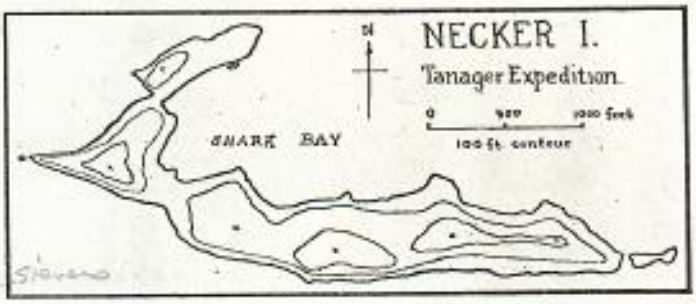
By E. H. Bryan, Jr.
Curator of Collections, Bernice P. Bishop Museum

Necker Island is a precipitous, narrow ridge of volcanic rock, about 1,300 yards long, east and west, by a tenth as wide. It has an area of 41 acres. From the western end a narrow spur extends about 200 yards northward, like the bone point on an Hawaiian trolling hook. The main crest undulates in a series of five hills: the western most of these, called Annexation Hill, is 246 feet high; the next, Flagpole Hill, 185 feet; the middle one, Summit Hill, 278 feet; the next, Bowl Hill, 260 feet; and east of that a narrow ridge, slightly over 200 feet high. To the east of the north spur, the highest point of which is 156 feet above the sea, is Shark Bay, a shallow, rocky cove, too rough to provide a landing place for the greater part of the year, when the trade winds blow. West of the spur, however, is a small cove, where landing can be made on rocky shelves in moderately calm weather.

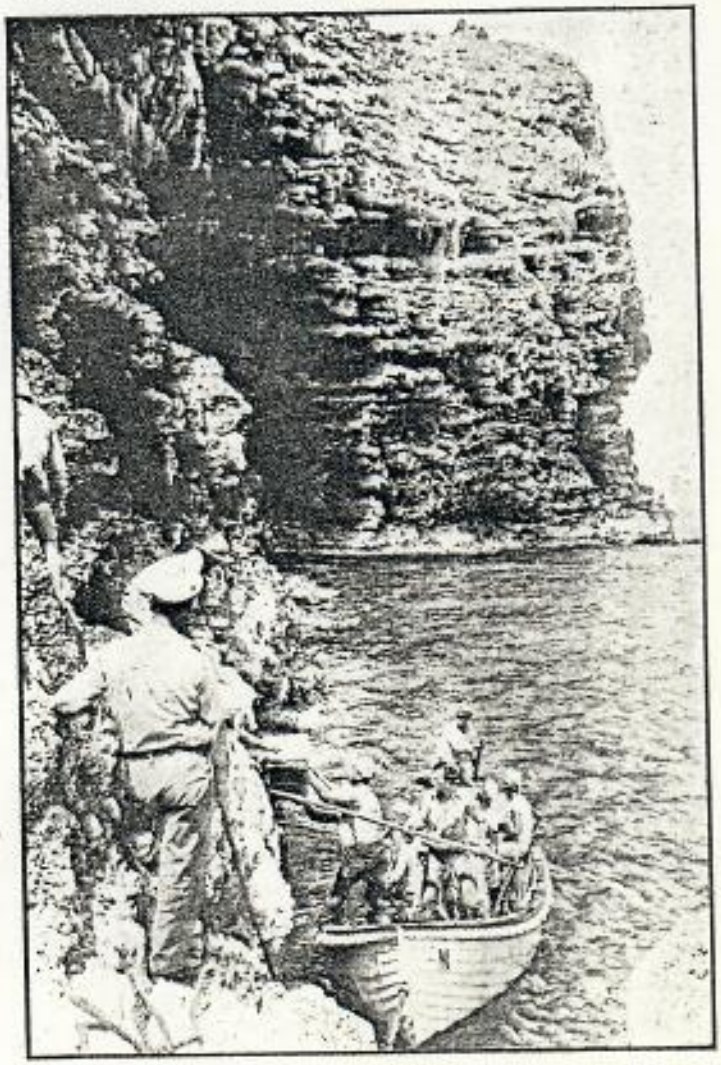
This rocky islet, particularly its nearly vertical sides, appears from a distance to be bare of vegetation. Closer examination discloses that its gently rounded crest and narrow terraces on its flanks are sparsely carpeted with five species of low, nearly prostrate plants: a species of goosefoot shrub *(Chenopodium sandwicheum)*, which is common throughout the main islands of the group, known to the Hawaiians as aweoweo, is commonest on the terraced slopes; a bunch grass *(Panicum torridum)*, called on the main islands kakonakona, is found on the northern slope, but very dry much of the time; purslane *(Portulaca lutea)*, the common ihi weed, is common on the flat tops; pickle weed *(Sesuvium portulacastrum)* grows on the lower northeastern slope of Annexation Hill, where it can be reached by the spray from waves dashing into Shark Bay; and a few plants of the much-branching ohai shrub *(Sesbania tomentosa)* sprawl, vine-like, along the windswept crest. None of the plants reaches a heighth of more than two feet above the thin, rocky soil. There is no sign of half a dozen other species of plants which were carefully set out by C. S. Judd, Territorial Forester, in June, 1923; apparently they could not stand the unfavorable conditions.

Dr. Harold S Palmer in 1923 estimated that the rainfall might be 20 to 25 inches a year. Two small seeps of water, strongly tainted with guano, might together furnish ten gallons of water a day. The only inhabitants larger than cockroaches and a native species of Rhyncogonus weevil, related to another on Nihoa and a number on the main islands of the Hawaiian group, are the birds. There are hordes of them, all sea birds. At certain times of the year their eggs cover every bit of level ground so thickly that it is difficult to walk without stepping on them. The birds rise in clouds at ones approach. Some species cry all day, and others moan and howl all night. The five days we spent on the island in June, 1923, seemed long enough to devote to such an inhospitable place.

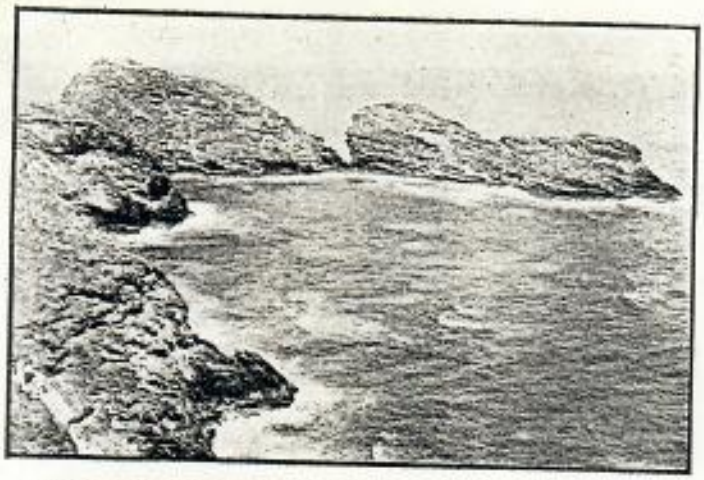
And yet to the student of native culture Necker Island is perhaps the most interesting spot in the Hawaiian Islands. By its very isolation and lack of hospitality it has preserved evidence of the culture of what is believed by Kenneth P. Emory, ethnologist at B. P. Bishop Museum, to have been



archaic Hawaiians. On the main islands of the group this ancient culture has been overlain by the changes brought about by the incoming Ari'i and their priests who arrived from the Society Islands by canoe during the twelfth and thirteenth centuries. Only fragments of the ditches, fishponds and other stone structures, ascribed to the Menehunes, represent this early culture on the larger islands. But on Necker were some 34 temple platforms, which seem to find their nearest counterparts in the marae of southeastern Polynesia. There, also, were found the famous stone images, beautifully carved stone bowls, adzes, sinkers, a grindstone,



Landing at Necker Island, 1923—H. S. Palmer Photo, Courtesy Bish. Mus.



Shark Bay, Necker Island—E. L. Coum Photo, Courtesy Bishop Museum

and human bones, all mute evidence of at least semi-permanent residence by a Polynesian people. Those who are interested in this subject will find Emory's "Archaeology of Nihoa and Necker Islands" (Bishop Museum Bulletin 53, 1928) a well written, convincing and entertaining account.

Necker Island was unknown to the Hawaiians at the time of its discovery on November 4, 1786, by La Perouse. This famous French navigator sailed within a third of a league of the island on his passage westward, noting the perpendicular cliffs, white with the droppings of birds, the absence of trees, and the violence of the sea which made it impossible to land. He called it *Ile Necker,* in honor of Monsieur Jacques Necker, French Minister of Finance under Louis XVI.

John Turnbull who visited the Hawaiian Islands, December, 17, 1802 to January 21, 1803, in the British ship *Margaret,* mentions in his account of the voyage that he learned that two Hawaiians, who had been engaged to dive for pearls on a reef in the leeward Hawaiian Islands, had landed on Necker, and had their curiosity aroused by a "range of stones, placed with some regularity in the manner of a wall, and about three feet high." They were apparently the first persons to set foot on Necker Island in modern times.

Lieutenant J. M. Brooke visited Necker during January, 1859, determining its position. During the summer of 1859, Captain N. C. Brooks, of the Hawaiian bark *Gambia,* on a sealing and exploring voyage, passed the island, but makes no mention of landing, although he states that "there is a ravine makes down from the southeast end of the rock, where at some seasons there is water. A boat may land in good water at the foot of this gulch."

Annexation Hill, Necker Island—E. L. Coum Photo, Courtesy Bish. Mus.

In 1894, Captain J. A. King was commissioned by Sanford B. Dole and authorized to annex Necker Island in the name of the Provisional Government of Hawaii. On board the Hawaiian steamer *Iwalani,* Captain William K. Freeman, arrived off Shark Bay on Sunday morning, May 27, 1894, at 11 a. m., and landed immediately. The landing party consisted of Captain King, Captain Freeman, Benjamin H. Norton, and nine sailors. A flagpole was erected on Annexation Hill, the Hawaiian flag hoisted, and Captain King read the annexation proclamation. In the course of their exploration of the island the party found some stone images and noted the stone platforms with their rows of upright stones. Fragments of six images were collected during the four hours spent on the island. Copies of seven photographs, taken at the time by B. H. Norton, engineer of the *Iwalani,* are now preserved in Bishop Museum.

On September 24, 1894, H.B.M.S. *Champion,* Captain Rooke, landed a party on Necker Island, which collected four more images, two of which are now in the British Museum. On July 12, 1895, Captain King headed another expedition to Necker, on the Revenue Cutter *Lehua,* to map the island and see if additional images could be found. Dr. William T. Brigham, first director of Bishop Museum, went to make scientific observations, but discovered no additional images. The survey was made by F. S. Dodge, of the Government Survey. Professor W. D. Alexander was also a member of the party.

Several other landings were made during the following quarter century, including two by George N. Wilcox, two by officers of the U. S. Revenue Cutter *Thetis* (1910 and 1913), H. L. Tucker and excursion party in 1917, and the late Gerrit P. Wilder, Warden of the Hawaiian Islands Bird Reservation, on the lighthouse tender *Kukui,* October 6, 1919. Mr. Wilder found the leg of an image.

The *Tanager* Expedition put two parties ashore between June 12 and 29, 1923. At this time a plane-table map was made by Charles S. Judd and Dr. H. S. Palmer, and a careful study was made of the plant and animal life by other members of the party. The *Tanager* returned July 14, 1924 with a party which made an archaeological survey of three days.

Officially Necker Island is part of the City and County of Honolulu, being one of the islands acquired by the United States, July 7, 1898. On June 2, 1904 it was leased for fishing purposes for 21 years. February 3, 1909, it became a part of the Hawaiian Islands Bird Reservation, and as such it is administered jointly by the U. S. Department of Agriculture, Bureau of the Biological Survey and the Territory of Hawaii.

Pineapples in 1843

Commodore Thomas ap Catesby Jones, of the United States frigate *United States,* at Waiakea near Hilo on the Island of Hawaii, in July of 1843, wrote that "the level land of the whole district for about five miles is one continued Garden, laid out in patches of fifteen rods square and ditched, planted with bananas, pineapples, tarra, melons, and tappah trees, beside sugar cane, which flourishes luxuriously in every direction."

Kaula—An Island of Hawaii

By E. H. Bryan, Jr.

"Wanalia was the man
And Hanala'a was the woman;
Of them was born Niihau, a land, an island.
There were three children of them
Born in the same day,
Niihau, Kaula, ending with Nihoa.
The mother then conceived no more,
No other island appeared thereafter."
(Mele composed by Kahakuikamoana;
as recorded by Fornander, IV:1, page 10.)

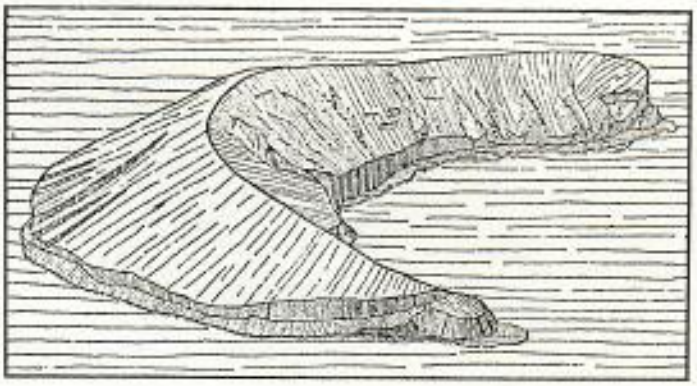
KAULA is a small, isolated islet, lying about 20 sea miles or 23 land miles to the west-southwest of the southern end of Niihau, and 150 sea miles west and a little north of Honolulu. Its position is about 21° 39′ North, and 160° 31′ 30″ West. Estimates of its height have been getting progressively smaller, until they are now between 500 and 600 feet, with the U. S. Coast and Geodetic Map of 1934 giving it 550 feet. Estimates of its area likewise vary, from 108 to 136 acres. Submarine soundings show that the islet lies near to the southeast edge of a submarine platform having an area of at least 30 square miles, with depths of from 6 to 50 fathoms.

Kaula is crescent-shaped, two-thirds of its ridge having a fairly level crest, but the south end sloping down gradually. The concave side of the crescent is toward the east, from which side, at a distance the island looks likes a sleeping seal with its head to the north. The lower slopes have been cut back into a sea cliff which makes the slopes almost impossible to climb, even after one has succeeded in landing on the wave-cut terrace, which cannot be done unless the sea is moderately calm. The Lighthouse Service has had to blast and build a way to the summit of the convex (west) side, and sometimes it is necessary to land by means of a hoist.

Kaula has been known for a long time to the Hawaiians, its name appearing frequently in the old meles, especially those of Kauai. Reference to the island may signify a place far away, on the very edge of the group of islands, as in the legend of Paka'a. When Kaewenuiaumi said to Pakaa's spirit "I am coming to search for you," the spirit of Paka'a answered, "I am living on Kaula," or in other words, the back of beyond. The islet also must have been visited at times for sea birds, for there are references such as the following, from the legend of Kawelo. That famous warrior chanted to his wife, Kanewahinukiaoha:

"When Hanalei thou shalt possess,
And the mats of Niihau thou shalt wear,
And the birds of Kaula thou shalt eat . . . "

There is another version of how Kaula came to be "born," besides the one at the beginning of this article. It runs as follows: After giving birth to Hawaii and Maui, Papa (the earth-mother) left her husband Wakea (the sky-father) and went back to Tahiti. After a short time wifeless, Wakea took to himself Kaulawahine, who as a result gave birth to Lanai. Tiring of her, he sought the company of Hina, who a little later gave birth to Molokai. Meanwhile Lauula, the plover, told Papa of her husband's faithlessness. Returning quickly to Hawaii, and learning what he had been doing, Papa deserted Wakea in a fury, and took Lua



Sketch of Kaula Rock—By H. S. Palmer, Courtesy Bishop Museum

for a husband. They had a child, Oahu, known as Oahu-a-lua. Finally Papa went back to Wakea, and by him gave birth to Kamawaelualanimoku (the "child of heavenly qualities"—Kauai), Niihau, Kaula, and Lehua. The mele (Fornander, IV:1, pp. 14, 18; VI: p. 360.) runs:

"Papa then went back to live with Wakea,
Papa was restless with child sickness,
Papa conceived the island of Kauai
And gave birth to Kamawaelualanimoku.
Niihau was only the after-birth,
Lehua separated them,
And Kaula was the closing one."

The lighthouse men when they finally succeeded in reaching the summit, in July, 1925, found on the northern part of the crest the remains of two stone structures which might have been heiaus (temples). On the concave (east) side, just below the summit, they also found a shelter cave, across the mouth of which was a low wall, suggesting that it, too, had been used by visiting Hawaiians.

The establishment of a light on the inaccessible summit of Kaula forms one of the most interesting and important events in the history of that seldom visited islet. The need for a light there had been felt for several years, because the island lies close to the direct route of vessels bound for the Orient. In 1921 Superintendent A. E. Arledge visited the

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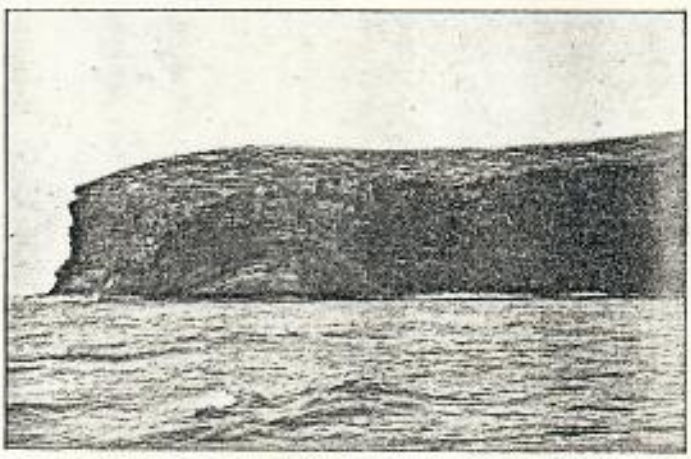


Great Sea Cave, Kaula Island—E. H. Bryan, Jr. Courtesy Bishop Museum

of Kali's crop this year to be sold with 40 or 50,000 coffee trees and they look very green. So also is Captain Rose's coffee. Why do not the Hawaiians plant coffee? The Elele urges them in this direction, but they do not obey, and only sit around.

L (for Limaikaika—Armstrong.)

"A SILENT CALL TO ARMS"

Continued from Page Twenty-six

service of their fellow citizens. Most of these calls come for the rescue of persons during flood disasters, while the call for riot duty and suppression of civil disorders and maintenance of law and order follow closely the number of calls for rescues from floods and storms. When the Guardsmen respond to an emergency call they do not face the situation in a haphazard manner. This has not always been the case, however, for there were times when considerable efficiency was lacking in the training of the Militia. Those days, we believe, have passed and now all National Guard units have a well-trained, efficiently-organized staff which has prepared plans and is constantly improving them for each type of call that may be made upon the Guardsmen to serve their fellow mankind or their country.

Mr. Average Citizen can take great pride and satisfaction in knowing that the Guardsmen are at all times ready for emergencies and desirous of supporting constitutional law and order. The ideals of this "democracy within a Republic" have their highest type of staunch supporters in the National Guardsmen of this community. The people of the Territory of Hawaii should feel proud of their all too small military force.

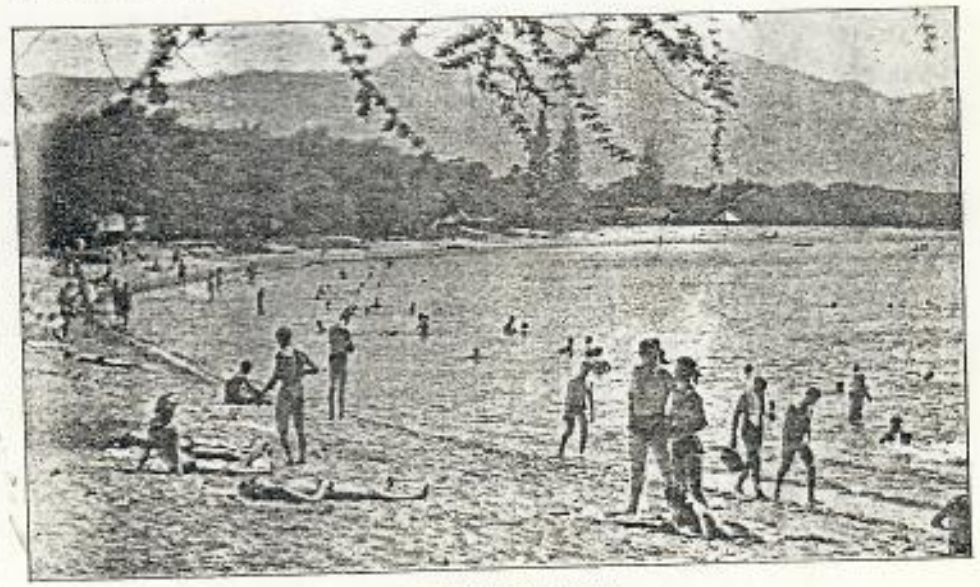
KAULA—AN ISLAND OF HAWAII

Continued from Page Twenty-seven

island on the lighthouse tender *Kukui*, but was unable to find a landing place, although the sea was moderately calm. He gave copies of the pictures which he took at that time to the German geologist, Immanuel Friedlaender, who published a paper on the geology and topography of the island in a German scientific journal. Friedlaender interpreted the photographs as showing that Kaula consists of ash or tuff ejected at two different times, and that it forms about a quarter of the circular rim of a crater, the rest of which has disappeared.

On July 1, 1923, the U. S. S. *Tanager*, returning from a scientific cruise to the northwest Hawaiian islands, circled the island, and a ship's boat rowed along the lee side and into the sea cave at the northeast end. At that time the writer reached his nearest approach to the island by touching the wall of the cave with a boat hook. No official landing was made, although two or three of the more daring members of the party succeeded in getting ashore on a rocky ledge, from which they could only work their way a few yards up the cliff face. A few photographs and longe-range observations were made from the ship.

Superintendent Ralph R. Tinkham also visited the island in 1923, without being able to make a landing. George Gay, manager of the Niihau ranch, is credited as being the first white man to have landed on the island, having swam ashore several years previous. He was unable to get off again through the breakers, and had to remain on the islet over night, until rescued by an Hawaiian crew in an outrigger canoe next day.



HALEIWA BEACH, OAHU

In order to learn more of the island an airplane photograph of it was urgently desired. In November, 1923, Brigadier General William Mitchell was in Hawaii inspecting army air corps. He volunteered to get pictures of Kaula. That was before the days of inter-island flights, so the plane was loaded onto the lighthouse tender *Kukui* and transported to Koloa, where it had to be taken apart in order to get it ashore in small boats. Meanwhile Commander John Rodgers, in command of the local navy air service, learned about General Mitchell's plans. That same spirit of rivalry which marks the Army-Navy game made its appearance. Why should the Navy let the Army run off with the honor of being the first to fly a plane over and photograph Kaula? So two navy flying boats were loaded on the *Pelican* and another minesweeper, and they set off for Kauai. There one of the planes was safely launched; and while the army plane was being made ready at a small field near Eric Knudsen's beach house, on the morning of November 8, Lieutenant E. Chourre piloted the navy plane over Kaula so photographer B. L. Houser was able to take the first picture of the islet from the air. Later a number of photographs were made by the 11th Photo Section, U. S. Army, from which Mr. Tinkham was able to construct maps and plans for the development of the light project.

In 1925 a party under the direction of Fred. A. Edgecomb, present Lighthouse Superintendent, succeeded in making a landing on July 10, and worked until the 21st building a trail and ladder to the summit. On August 21, 1931, Lighthouse Engineer Neil W. Wetherby, in making a reconnaissance of the islet, was washed off the cliff from a spot 30 feet above sea level. An old Hawaiian in the party maintained that this had happened because he had not first rowed into the sea cave to pay his respects to the shark god which dwelt there and ruled the islet. In spite of this omission he wasn't seriously hurt, and returned on August 2, 1932, with a carpenter, mechanic, and six laborers, to complete the installation of the derrick, shelter houses, and light. The light was finally put in commission August 18, 1932.

At this time, August 16 to 19, Dr. Harold S. Palmer, professor of geology at the University of Hawaii, and E. L. Caum, botanist with the Experiment Station, H. S. P. A., were able to make a study of the geology, plants, and bird life of the island. In a publication (B. P. Bishop Museum Bulletin 35) issued in 1927, Dr. Palmer described the geological formation of the island. He outlines the geologic history of Kaula as follows: First the eruption of volcanic rocks built up the platform upon which the islet stands to about sea level. Then it was eroded away. Then corals grew upon the summit of this planed-off mountain peak. After that there was a second period of volcanic activity and the tuff cone was formed, with its highest side toward the west. This tuff crater-rim was next eroded by wind, waves, and running water, the waves cutting a submarine terrace almost around the island. The level of the sea then dropped about fifteen feet with reference to the wave-cut terrace. And finally the present cycle of erosion took place. It is the wave-cut sea cliff, which turns the stream cut gulches into hanging valleys, that makes the faces of Kaula so difficult to climb.

Mr. Caum, in Bishop Museum Occasional Papers, Vol. XI, No. 21, 1936, discusses the vegetation and the bird life. Fifteen species of plants were found growing on Kaula. This August visit having followed a very dry summer, great areas of the slope appeared entirely barren, which following a rainy period might have supported grass and sedge. A grass, *Panicum lanaiense;* cactus, *Opuntia megacantha;* aweoweo, *Chenopodium sandwicheum; Amaranthus viridus; Portulaca caumii,* a new species of purslane and the commoner *Portulaca lutea* and *Portulaca oleracea;* the puncture vine, *Tribulus cistoides;* and *Euphorbia celastoides* were the most abundant species.

The noddy tern, *Anous stolidus,* was the most numerous species of bird. Other birds were white tern, the Necker Island tern, the sooty tern, the gray-back tern, Bulwer's petrel, wedge-tailed shearwater, red-tailed tropic bird, the blue-faced, red-footed, and common boobys, frigate birds, and the golden plover.

Mr. Caum also collected specimens of 15 species of insects: 2 kinds of ants, 2 wasps, 4 species of flies, 2 species of lady beetles, a moth, a leafhopper, a thrip, the familiar embiid, and some pseudoscorpions.

The lighthouse personnel have also captured specimens of a rat and a mouse, and report dry wood termites in lumber on the island.

The light atop Kaula is the second highest under the jurisdiction of the United States Lighthouse Service, being 562 feet above sea level. It is exceeded in height only by the Lehua light, 707 feet, off the northern end of Niihau. Lights at such elevations are only possible in regions, such as Hawaii, where there are no fogs. The Kaula light consists of a double 375 mm. acetylene beacon lantern, a type developed in Hawaii by M. Peter, Lighthouse Service mechanic. Each of the two lanterns has a 480 candle power light, visible at least 12 miles. The height is such that, under exceptional conditions of clearness, it might be seen at a distance of 27 miles from sea level. The upper light is automatically turned on when the sun stops shining on it. Should it burn out, the lower light would automatically turn on. The lights are supplied with gas from storage tanks lower down on the west side, where a hoist can lift the heavy tanks from the shore. Two independent pipes, each 1500 feet long, supply the lights. Two tanks each hold enough gas to keep the light burning for 15 months. The light could keep burning for two and a half years without refueling, if necessary.

One of our escorts: a friendly fairy tern

Above anchored cutter, masked booby stands on cornerstone of ancient Polynesian temple

Ensign Bob Cosby has hands full with shark hooked from cutter's longboat

Adventure off Hawaii

VOYAGE OF THE BUTTONWOOD

By ERWIN A. BAUER

Our cruise to a little-known refuge teeming with wildlife brings us a bonus—wild fishing

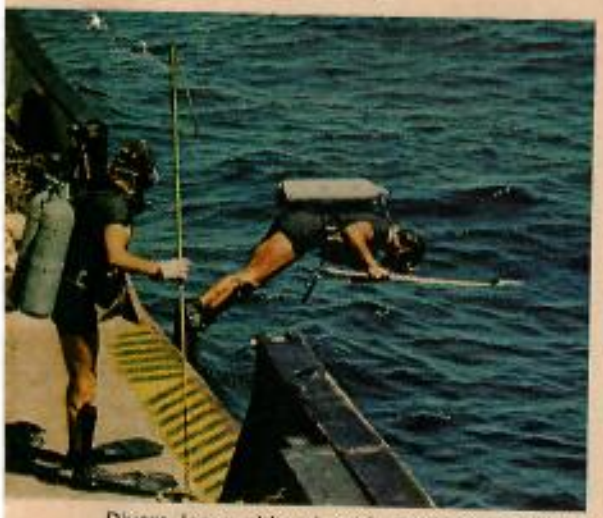
FOR MORE THAN A MILE the U.S. Coast Guard cutter Buttonwood cruised at half speed on a cautious approach to Lisianski Island. As I watched from the bridge beside Capt. Dave Smith and Gene Kridler, I could see white foam breaking over an irregular barrier reef. Beyond it and barely visible was a thin sand beach—Lisianski—topped with low green vegetation. Clouds of seabirds circled above the small Pacific island.

"There's our landing spot," Gene said, pointing to a lagoon beyond the reef, "if we can find a way through the coral."

A moment later, in water 12 fathoms deep, the Buttonwood's engines were briefly reversed and the anchor was dropped, and that seemed to be the signal for plenty of activity. Orders crackled over the public-address system. One crew of seamen made ready to lower a longboat in preparation for landing. On the buoy deck up forward, other Coast Guardsmen were inflating a rubber raft.

But the excitement that most interested me took place at the

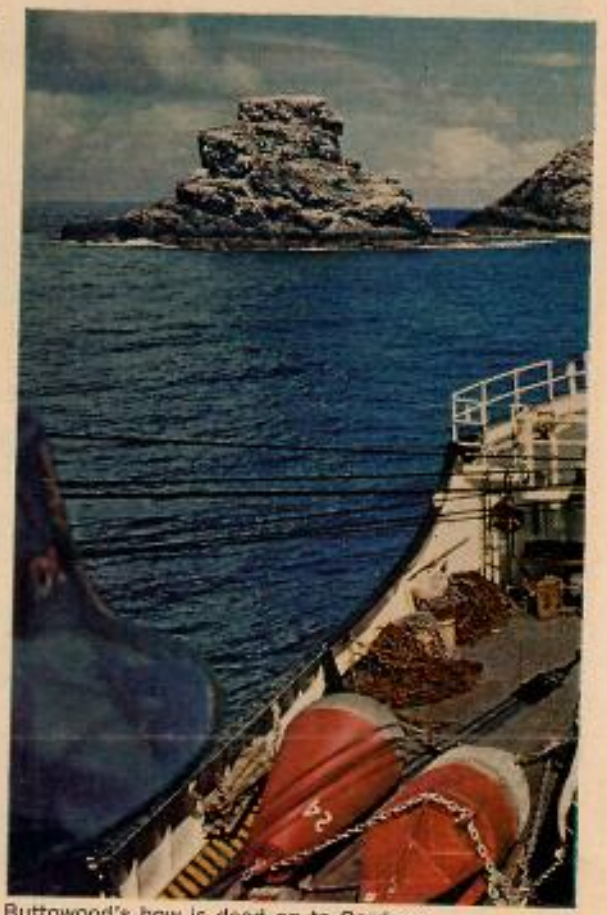
Crewmen measure, weigh uluas, which abound in Hawaiian Islands National Wildlife Refuge



Divers leave ship at reef, Gardner Pinnacles

Trolling from longboat invariably produced hard-fighting ulua up to 50 pounds

Above, a scene at beautiful but forbidding Necker Island, treacherous to land on. Bird at right, Laysan teal, may be the rarest duck on earth; it exists only on Laysan Island. Below, a young great frigate bird on nest a few yards from our tents on Laysan

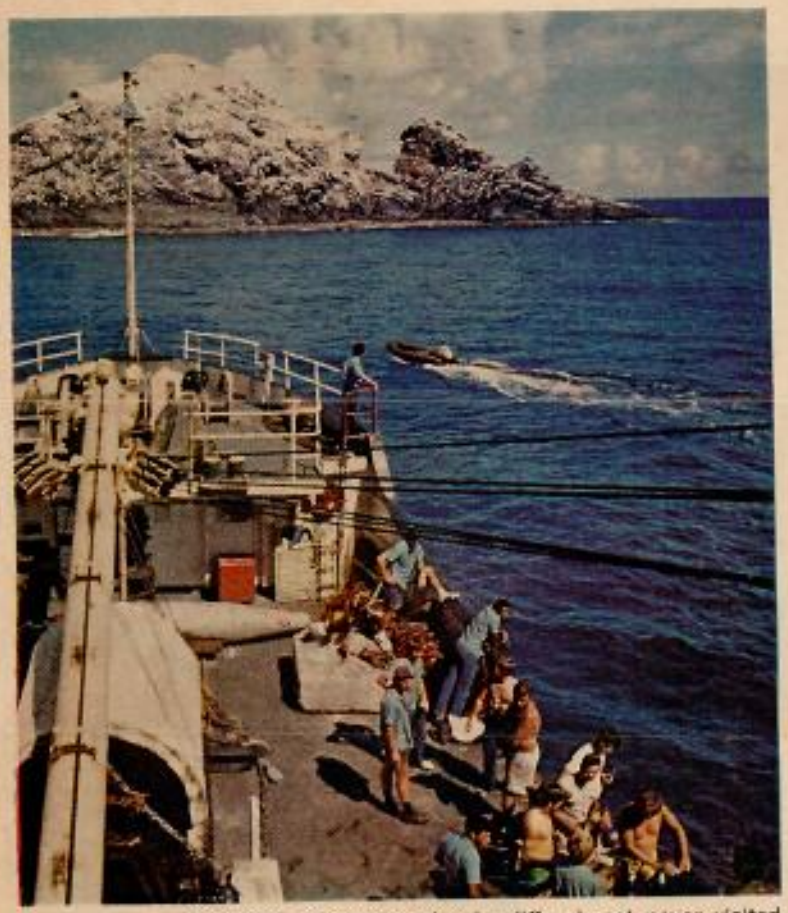


Buttowood's bow is dead on to Gardner . . .

Aerial view of barrier reef around Kure Island, another of outer Hawaiians

This 80-pound whitetip fought tough but was minnow next to other sharks we saw

John Sincock, left, Gene Kridler tag monk seal



. . . Pinnacles, upjutting volcanic cliffs almost never visited

Crewman Charlie Schlinke with trip's top ulua, a 73-pounder

VOYAGE OF THE BUTTONWOOD

continued

boat's fantail. There, almost every crew member who was not on watch duty or a work detail had broken out fishing tackle, and an astounding variety of baits and lures was being tossed overboard.

Somebody soon had a strike, and so did the man casting next to him. Then it was pure bedlam. With line evaporating from their reels, both men needed elbow-room, but many other lines were in the water, and the result was a snarl unlike any I had ever seen before. There was shouting and swearing, and, to confuse matters further, a third fish was hooked in the melee. The tumultuous scene looked like something out of an old-time slapstick movie.

"Get the gaff," somebody shouted.

"I think my fish is tangled in the prop," someone else moaned.

From a porthole just below the fishermen and all the action, a seaman appeared and reached far out with a gaff hook mounted on a 10-foot pole. He missed on his first two or three passes with the gaff, but finally he connected and heaved, and the fish—an ulua (pronounced "oo-LOO-a") of about 40 pounds—was hand-over-handed aboard. There it began to fight all over again, bouncing across the deck and scattering fishermen. Somebody caught it by the tail and conked it with a belaying pin, and in almost the same instant another angler was shouting "Strike!"

At that point I decided to set up my own tackle, but it was too late. Both the longboat and the rubber raft were in the water, and the ship's public-address system was calling for the landing party. That included me. I swapped the tackle for cameras in a waterproof rucksack and headed for the Jacob's ladder hanging from the buoy deck. My first taste of central-Pacific fishing would have to wait.

Through the years some of my greatest outdoor adventures have been those that were largely unplanned or at least unexpected, and this one may head the list. It wasn't supposed to be a fishing trip at all. I was a member of a government-sponsored scientific expedition to inspect one of America's *(continued on page 118)*

VOYAGE OF BUTTONWOOD

(continued from page 59)

least-known (but perhaps our most magnificent and valuable) wildlife sanctuaries—the Hawaiian Islands National Wildlife Refuge, which protects one of the most remarkable wildlife spectacles left on earth.

The refuge is really a necklace of lonely, tiny, uninhabited islands extending for 1,500 miles, from the Hawaii that is familiar to tourists to Midway Islands, the site of a midocean naval base and an important sea battle during World War II.

The leader of this annual expedition to the "wildlife islands"—also called "bird islands"—was Gene Kridler, a veteran biologist and manager of the refuge. Also in the party were John Sincock, a government biologist who was mostly concerned with Hawaii's endangered birds; Ken Norris, an authority on ocean mammals; Eric Schlemmer, probably the only living person who was born on any of the refuge islands (he was born on Laysan Island in 1904); and I.

My own mission was to photograph the wildlife, some of it very rare and occurring nowhere else, for a book on great wildlife islands of the world. I did carry along a fishing outfit—just because I always do, whatever my destination or assignment. But I had no thoughts of fishing, because Gene had written that it was not permitted in refuge waters or inside the 10-fathom (deep) line close to shore.

Because of the isolated nature of the islands, which are far from busy travel and shipping routes, access is possible only by small boat when the seas are calm enough to permit it. At times, landing is either impossible or highly hazardous, and on a number of earlier occasions Gene and John had nearly lost their lives trying to get ashore. Two of the islands, Necker and Gardner Pinnacles (which are really volcanic cliffs poking above the ocean's surface), are very treacherous. The Pinnacles, in fact, has known very few visitors in all history.

We were therefore totally dependent on the U.S. Coast Guard and the crew of the Buttonwood, a buoy tender stationed in Honolulu, to take us within small-craft-beachhead distance of each island.

Last September the other expedition members and I boarded the Buttonwood at Midway after a military flight from Honolulu, and we were immediately identified by the crew as the "bird people." One seaman got me aside and asked whether I had any spare line or large hooks in my luggage. I did, and shared what I had with him, but later I had second thoughts about the generosity.

The plan was to cruise from Midway back to Honolulu in stages, stopping at as many refuge islands as possible on the way. Gene and John had to census the rare birds and to count and tag as many monk seals and green sea turtles as possible. These outer, leeward Hawaiian Islands are the only home of this seal species and in fact are the only place where any seals still survive in tropical waters. The islands also are the major remaining breeding area of the green sea turtle under U.S. jurisdiction and possibly the only such area anywhere in the world.

Our first landing, on Lisianski, was rather easy. This sand island of only 382 acres is nowhere more than 40 feet above sea level. We made a complete circuit of the beautiful soft-sand beach, counting 248 seals and tagging many turtles on the flippers. The tagging is grueling work, but tag returns can tell the biologists much about the animal's growth, travels, and survival. We were constantly followed by clouds of fairy, sooty, and noddy terns, which nest by the millions here. The whole Lisianski scene is one of absolute wildness and escape.

Back on the Buttonwood that evening, my first priority was to rig up my four-piece plugcasting outfit, which fits into a duffelbag. But before I could fix a metal jig onto a short metal leader, an ulua of about 48 pounds was hauled aboard still full of fight, and suddenly my gear looked inadequate.

The ulua is a mid-Pacific species of the jack family (Caranx) and is similar to the Atlantic amberjack in size and shape. Like all its cousins, it is a very strong battler on any kind of gear.

Since the first hour or so of superfast action in the morning, the ulua fishing had become sporadic, mostly because many sharks had been attracted to the vicinity. On about my 10th cast I had a soft strike. But after I set the hook, line vanished from my casting reel so fast that I thought all of it would go. Somehow I stopped the run. Suddenly I was soaked with sweat.

For a while I thought I had a chance with the fish. Fifteen minutes passed, and I regained some line.

Chief Boatswain's Mate Charles Schlinke of Nixon, Texas, who was among the most serious of the anglers aboard, stood next to me against the rail. Earlier in the day he had boated a pair of large uluas.

"Just keep a steady pressure," he counseled, "and keep the line away from the hull."

I couldn't follow that last suggestion. Suddenly a big shark appeared at the surface, and the ulua made a strong surge down and under the ship. I could feel my line rubbing metal. Then it snapped. I'll never know if the ulua alone broke my line or if the shark had him when it happened. Anyhow, that was the last of the day's fishing action. Soon we were under way toward our next destination, Laysan Island.

After we'd anchored off Laysan the next morning, lines were again put over the fantail. Besides the uluas, which averaged much smaller here than at Lisianski, wrasses and other colorful fish came flopping aboard, most of them going unidentified.

Somebody hooked a small whitetip shark, and it was saved for bait. Later in the day it was used whole to tempt a large tiger shark that was seen cruising nearby. The tiger struck and was

sidered among the gamest of sharks, but this one came clear out of the water in a wild leap as soon as it tasted the hook. Then it fought savagely near the surface before two crew members gaffed and swung it aboard, being very careful to stay clear of the toothy jaws. It weighed 80 pounds—barely a minnow compared to what we saw next morning at French Frigate Shoals.

French Frigate is an atoll composed of several islands surrounded by an elaborate reef system. One island, Tern, is the site of a U.S.C.G. Loran (Long Range Aid to Navigation) Station that houses 18 men. It is the only inhabited place in the Hawaiian Refuge.

Just before our arrival, one of the Loran men, L. J. Bergeron of Baton Rouge, had landed a 12½-foot tiger shark. No scales were available, but the shark probably weighed half a ton, and it was only one foot 4½ inches shorter than the world record for that species.

Necker Island was the next stop on our eastward trip, and except for Gardner it is the most treacherous on which to land. Luckily the seas were fairly cooperative again, and a drenching was the worst that happened. Necker not only has a staggering amount of wildlife but is also the site of several temples built and abandoned by Polynesians many centuries ago. The builders must have reached this remote spot by outrigger canoe alone, and that remains a miraculous feat of navigation and survival.

"I wonder," one seaman mused out loud, "if they also discovered the fishing here."

There seemed to be more and bigger uluas around Necker than anywhere else we dropped anchor. We tied into them while casting or jigging from the boat and also by trolling from the Buttonwood's longboat when it was not needed for landing operations. It was the sort of bonanza that a fisherman encounters far too seldom, no matter how far he travels.

Radioman Bob Stockton of San Antonio, Texas, kicked off the action with a 64-pounder. Then several men were hooked up at the same time.

I missed a couple of strikes before connecting solidly with an ulua. I spent the next 20 minutes trying to wear out the strong fish before my light line failed.

The trip-record ulua was boated shortly thereafter. That 73-pounder, hooked by Charlie Schlinke while trolling from the longboat, remains the all-time record (as far as I now know) for the Buttonwood. But it was only two pounds heavier than the 71-pounder Bob Cosby hooked soon thereafter.

Again the sharks arrived, and again the uluas seemed to go elsewhere, but the action merely increased. One big tiger of 10 feet or so attacked a whole three-foot whitetip that was offered as bait and to which a large plastic float had been attached to absorb the shock of a hard strike on a taut line. The float was last seen disappearing toward Tokyo.

The great fishing around Necker proved also to be a sort of disaster, but not because of a fish shortage. Fewer fishermen were up to bat, mainly because much tackle had been smashed, many lures lost, and lines used up. I myself had to quit fishing because all I had left was a rod (fortunately intact) and a plugcasting reel with a sorely tested drag. Metal leaders and lures were completely gone when we upped anchor and cruised away from Necker.

One more island stop remained—Nihoa, another old volcanic peak and the home of countless seabirds. En route there many crewmen used off-duty time to try to repair tackle. I saw one man fixing a broken rod by using a section of aluminum tubing as a sleeve. A thorough search was made of every remote corner of the Buttonwood in trying to locate line, lures, and anything else that could be used. Not much was uncovered. But Bob Cosby and Charlie Schlinke worked all night to fashion large shark hooks out of scrap pieces of brass rod.

I have encountered crazy fishermen in the past, but few matched these Coast Guardsmen.

This story would have a happier ending if I could report bonanza fishing around Nihoa, but it didn't work out that way, probably because the tackle was too depleted. Only three uluas larger than 50 pounds came aboard; most of the action was supplied by sharks. One of the home-made hooks accounted for a 75-pound whitetip, which was lost to a bigger fish.

Then the anchor was raised for the final time, and on an extremely calm, beautiful sea we headed toward Honolulu and the end of our expedition to the wildlife islands.

"What do you think of our cutter and crew?" Capt. Dave Smith asked me on the way home.

"Great," I answered, "just great." Then I had an afterthought.

"If your Coast Guard recruiters would mention this Hawaiian Islands duty and especially the fishing," I added, "you'd have more volunteers than the service could handle."

"I think you're right," the young skipper said. "I'm getting excited about it myself." THE END

BAKING ON THE TRAIL

(continued from page 82)

and one of cooking oil, a teaspoon of salt, and just enough water to form a sticky dough. The dough should just be able to settle level in the pot, but if it's a little thinner, it won't matter.

The dough is spooned into a well-greased 1½-quart pot and placed on a thick bed of coals. More embers are heaped up around the sides. We cover the pot with our extra aluminum plate, which we fill with coals so that the bread will bake on top. Cooking takes from 15 to 30 minutes, depending on the heat. After the first 10 minutes, it is a good idea to check the bread frequently to prevent burning. When a straw comes out clean or the bread is firm and springy on top, it's done. The pack weight for the ingredients is slightly over eight ounces.

Often we bake a pot of bannock in the breakfast coals while we are cleaning up camp and packing. When we're ready to leave, we take the bread out of the pot to cool, then replace it and slip pot and all into our pack. At noon, we eat the bread with peanut butter and honey or brew up a cheese sauce from a packet of powdered cheddar mix and pour it over the crumbled bread for a wilderness Welsh rabbit (rarebit).

But if you really want to impress your camping partners, try a fruit pie or a yeast-raised pastry. There is something downright luxurious about a wilderness meal that ends with a slab of home-style pie or fresh-baked cinnamon rolls.

For such baking you need a reflector oven, but there is no need for a heavy commercial type. You can rig a reflector out of heavy-duty foil and wire, or you can make a sturdier model with a pair of throw-away aluminum cookie pans.

We use two of the 9 x 12-inch pans, hinging them together on the long side with two twists of wire. The hinge is set along the rear edge of our 4 x 13-inch backpacker's grill, which is supported by rocks. The top pan is angled over the grill and propped up by two wires attached to the front of the grill; the bottom pan is slanted under the grill. The open sides are closed with aluminum foil to increase heating efficiency. (See photos, page 83). The pans, wire, and foil, plus two throw-away baking dishes, weigh about four ounces.

To make a pie, you need two cups of prepared pie-crust mix and a two-serving packet of freeze-dried fruit. The total weight of these ingredients is under 12 ounces.

In the field, the flour is mixed with one-fourth cup of cold water to form a dry dough. Save out a tablespoon or so of the flour. Then, on smooth ground, spread out the foil that will later be used on the oven and sprinkle it with the extra flour. Put half the dough on the foil and roll it out with a plastic or aluminum bottle. When the dough is reasonably thin, flop it over into a well-greased eight-inch aluminum pie plate. With your fingers, thin it out and form it up to cover the rim.

If you don't have a bottle to roll the dough with, just make a thin pancake of the dough and place it in the plate. Then, starting in the center, press the dough, flattening it toward the edge. Keep at it until you have a thin crust covering the entire pan.

Meantime you can be boiling the package of freeze-dried fruit in the amount of water specified by the directions. When the fruit is thoroughly tender, remove it from the fire and add not more than one tablespoon of the remaining flour for thickening. The filling should be soupy, since the slow baking in low heat will tend to dry it out. Sweeten it to taste and add a little cinnamon if you like. Then pour it into the bottom crust.

Form the rest of the dough for the

hooked, but it easily snapped a line testing 100 pounds.

I had no chance to fish on our arrival at Laysan, because of the more-complicated landing preparations. On this two-square-mile island the wildlife group would camp for a week, at the end of which the Buttonwood would return to retrieve us. Everything for our stay, including enough water for any emergency, had to be carried ashore since we would have no communications of any kind with the rest of the world we had left behind.

No previous week of my life compared with that one on Laysan, and I'd never before lived so close to such an astronomical amount of wildlife. An estimated 11-million birds use the little island as a nesting site each year. At places the birds actually live in tiers: shearwaters and Christmas and Bonin Island petrels nest in burrows underground; noddies, sooty terns, and red-tail tropic birds lay eggs on the bare surface; great frigate birds with seven-foot wingspans and boobies roost in the low brittle bushes.

We pitched two tents on the only sand dune that was as much as 50 feet above sea level. Boobies roosted on our ridgepoles, and shearwaters burrowed underneath our cots after dark. The din of shearwaters and petrels each night was a constant moan.

On Laysan I saw and photographed the world's rarest duck, the Laysan teal, which lives only here. It is small and chocolate-colored, and it is believed that at one time only seven survived on earth. But after our census Gene and John estimated today's total population at about 150. At night we circled a small lagoon in the center of the island that is three times as salty as the ocean. The teal, which feed on brine flies, concentrated there, and we captured several teal in butterfly nets for tagging.

Also on Laysan I saw and filmed the very tame Laysan finch, another species of animal that is found nowhere else on earth.

The week at Laysan passed too quickly, probably because we were always busy. We found an abandoned, rusting Japanese longline fishing boat that had wrecked against the barrier coral, but we did not try to board it.

I snorkeled every day and was amazed at the abundance and variety of fish, even on the reefs closest to shore. Some that I could identify were butterflyfish, bandit fish, scads, wrasses, damselfish, school uluas, goatfish, and tangs. One or two monk seals and a turtle were curious enough to swim nearby. Late one afternoon I headed promptly for the beach when a shark appeared on the opposite side of a coral ridge. The fishing would have been great around Laysan, but these waters are within the restricted 10-fathom limit.

Our next destination was Gardner Pinnacles, a few acres of rock spires with a maximum height of 280 feet. Lisianski and Laysan, by contrast, are atolls surrounded by reefs and are comparatively easy of access. En route to Gardner all hands doubted whether we would be able to get ashore, but fortunately the sea grew very calm as we approached. Still it was not easy to scramble, at the precise crest of a swell, from a rubber raft onto a sharp, slippery cliff. Boatswain's Mate Tom Smotherman of Murfreesboro, Tennessee, did an expert job of holding the raft against the cliff.

Later in the day, back on the Buttonwood, Tom tied into a couple of uluas that he would never forget. The first simply broke off before he could get it turned around. The second gave him a long, tense workout before it was gaffed. Cargo scales on deck weighed the ulua in at 58 pounds, the top fish of the trip till then.

But less than an hour later the trip record was broken by Len Bobrowski of Philadelphia, a warrant officer, with a 59½-pounder. Then Charlie Schlinke topped them all with a 63-pounder. All those fish are worth bragging about.

As we had noticed before when the ulua fishing was fast, many sharks

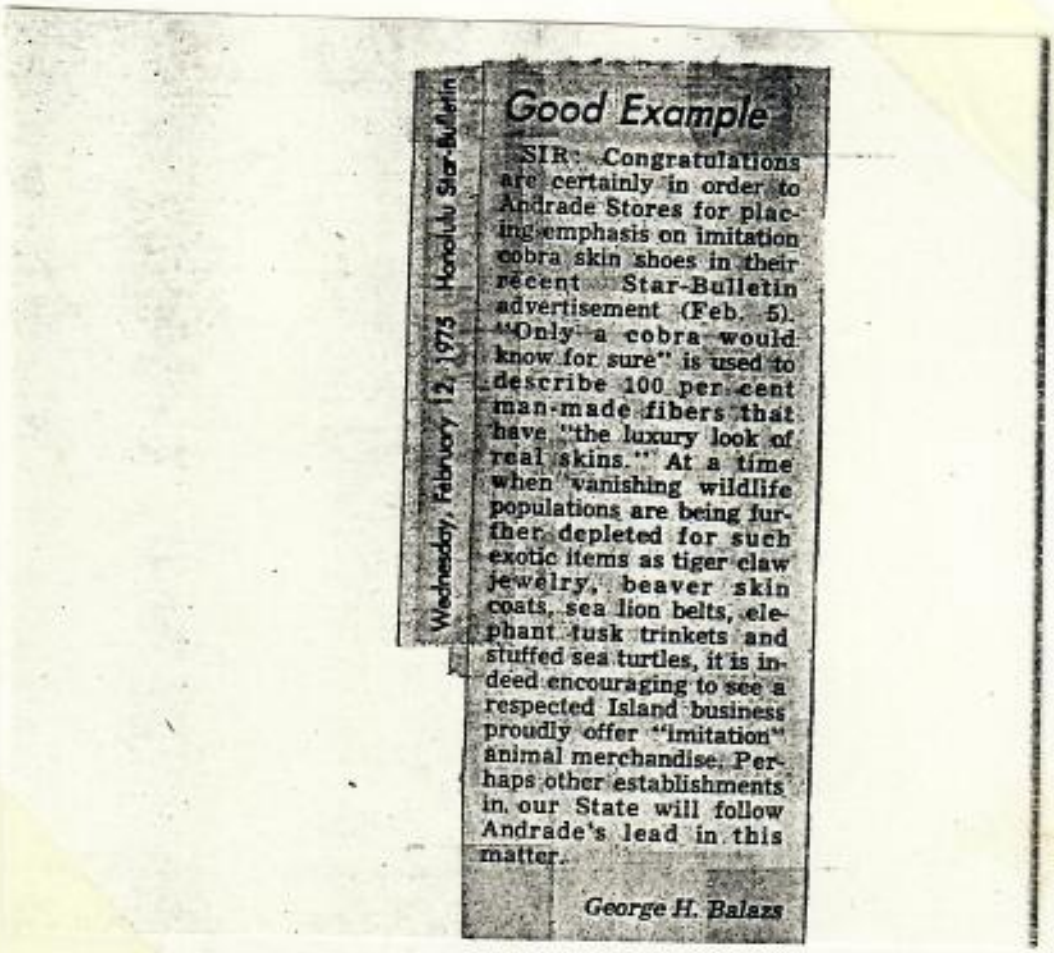
Ensign L. J. Bergeron landed this 12½-foot tiger shark from Tern Island beach

eventually appeared and ulua action fell off. The sharks, easy to spot in the clear water from the Buttonwood's decks, always drew plenty of spectators, and the fishermen tried for them with baits ranging from kitchen scraps to ulua tails and entrails.

The sharks were even more willing to strike than the uluas—so willing that they busted up far too much tackle.

After we'd come back on board after the Gardner landing, I had a ringside seat on the fantail as a pair of large whitetip sharks cruised past. Ensign Bob Cosby of Jacksonville, Florida, using a medium boat rod with 80-pound-test line on his reel, tossed a large chunk of meat into the sharks' path. Immediately the nearest one rolled and tore away a chunk of the meat but was not hooked. The second shark, though, nearly tore the rod out of Cosby's hands.

The whitetip is not generally con-



Wednesday, February 12, 1975 Honolulu Star-Bulletin

Good Example

SIR: Congratulations are certainly in order to Andrade Stores for placing emphasis on imitation cobra skin shoes in their recent Star-Bulletin advertisement (Feb. 5). "Only a cobra would know for sure" is used to describe 100 per cent man-made fibers that have "the luxury look of real skins." At a time when vanishing wildlife populations are being further depleted for such exotic items as tiger claw jewelry, beaver skin coats, sea lion belts, elephant tusk trinkets and stuffed sea turtles, it is indeed encouraging to see a respected Island business proudly offer "imitation" animal merchandise. Perhaps other establishments in our State will follow Andrade's lead in this matter.

George H. Balazs

Species receiving ongoing attention at HIMB are as follows:

Artemia salina (brine shrimp). Virtually all work in Stages I and II has been completed under a separate Sea Grant project, and the methods are being evaluated for commercial exploitation. Refinement of techniques for the intensive, continuous cultivation of *Artemia* is being conducted to provide food for other cultured organisms.

Caranx mate (omaka). Considerable experience has been acquired with this species, and its local abundance as well as its desirability as a food and sport fish give it an important place in finfish research. Because of their availability, omaka eggs and larvae are serving as a model system for the development of rearing techniques which should be applicable to most marine fishes with small pelagic eggs.

Mullidae (goatfishes). Goatfishes are valuable food fishes, good baitfish, and a potential sport fish; analyses from Stage I indicate that they will be amenable to cultivation.

Penaeus sp. (shrimp). Under funding from the U.S. Office of Economic Opportunity, a shrimp project at HIMB has nearly reached Stage III, the pilot production phase. With support from Sea Grant, feeding regimes and culture facilities will be improved.

Polydactylus sexfilis (moi). Data on growth rates and the natural spawning cycle are available for this valuable food and sport fish; funding levels permitting further work with this species would require that its adaptability to captive conditions needs to be tested more thoroughly, and the requirements of its early stages be further investigated.

Cellana sp. (opihi). Knowledge of these locally desirable and expensive mollusks is limited, but ecological information gathered during year 05′ should permit assessing their potential for aquaculture, and therefore a decision whether or not the species can ever lend itself to cultivation on an economically rational basis.

The species added to the program include:

Chelonia mydas (green sea turtle). There is a great demand for products from sea turtles (meat, shell, eggs, leather, oil), while natural stocks are being depleted by unrestrained fishing. These factors, plus the example of a successful turtle farming operation in the Caribbean, encourage investigating turtle culture. Early results with artificial rations show high growth rates among captive turtles.

Macrobrachium rosenbergii (Malaysian prawn). Thanks to the pioneering work of T. Fujimura of the Hawaii Division of Fish and Game, the commercial cultivation of *M. rosenbergii* is a reality in Hawaii. Contribution to this enterprise will be made in the refinement of feeding methods for its marine larvae and its euryhaline postlarvae and adults.

Ecology

Repeatable techniques have been developed for rearing the carangid fish, *Caranx mate* (omaka), through the larval stage, and an extensive series of experiments has established the types and concentrations of antibiotics which maximize embryonic and larval survival. The efficiency and rate of yolk utilization has been determined for omaka larvae, and by calorimetry and respirometry an energy budget has been constructed for these larvae, yielding insight into the energy requirements of first-feeding larvae during the "critical period". In order to determine optimal physical conditions for culture and the permissible range of fluctuations, temperature and salinity optima and zones of tolerance have been established for omaka eggs and early larvae. The effects of these factors on rates of development have been determined. Growth rates have been measured for juvenile and adult omaka and imported Japanese yellowtail maintained in net enclosures. Further information on the life history of *Penaeus marginatus* has been gathered.

Reproductive biology

The spawning seasons of two fish species with aquaculture potential, *Polydactylus sexfilis* (moi) and *Caranx mate* (omaka), have been determined from field samples. Work on local penaeid shrimp, *Penaeus marginatus*, is presently hampered because larvae can be obtained only from oviperous females collected at sea. Investigations of the physiological processes and metabolic requirements for ovarian maturation in *P. marginatus* is underway. *Octopus cyanea* has been spawned in captivity throughout the year by surgically eliminating a structure which inhibits gonadal maturation; however, for reasons listed above, this work will be phased out.

Nutrition

Methods of preparing artificial rations for marine species have been developed, and suitable binders to maintain the integrity of food in water have been found. Diets of various composition (different levels of protein and energy, different raw ingredients) have been evaluated as to their ability to produce good growth response in *Penaeus marginatus, Macrobrachium rosenbergii,* and *Chelonia mydas*. Methods of respirometry have been developed and applied to *P. marginatus* to establish energy requirements. Several types of cultured food have been used to rear larvae of *Scylla serrata* (mangrove crab).

Histological examination of the digestive systems of *P. marginatus* and *M. rosenbergii* have revealed fundamental structural differences. Radioisotope experiments have investigated the transport of glycine in the midgut of *P. marginatus*. A taste attractant has been found which stimulates goatfish to feed on artificial food, and behavioral studies of the responses of goatfish to various odors and/or tastes have been initiated.

Diseases

Various antibiotics have been screened and optimal control procedures developed for bacteria to enhance the embryonic and larval survival of cultured fish species. A cell line (OMKL) from omaka larvae has been established and characterized; this represents the first time a cell culture has been obtained from a larval form and only the second time a marine fish cell line has been established.

University of Hawaii

SEA GRANT INSTITUTIONAL PROGRAM

YEAR 06 Vol. 2

TITLE

Tropical Animal Aquaculture (R/A – 01)

PRINCIPAL INVESTIGATORS

John E. Bardach
Philip Helfrich

ASSOCIATE INVESTIGATORS

Gregory Ahearn
Wayne Baldwin
M. E. Bitterman
Coy C. Brooks
Richard Fay
E. Alison Kay
Philip C. Loh
Robert C. May
John M. Miller
Ernest Ross
Paul J. Scheuer

DURATION

Continuing

MOTIVATION

The pressure on marine animal populations continues to increase, in part because of their "common property" nature and in part because of competing uses of the sea by man. Especially in the coastal zone, pollution as well as animal habitat deterioration can be seen to infringe on and hinder the development of marine animal populations. To offset declining yields and increasing pressure, man must attempt to repair the damages he inflicts on the marine environment and to increase the numbers of animals he can harvest. This he does by intensifying sound management measures, spawning and rearing those species amenable to treatment as aquatic stock under strict control, always with sound economic principles in mind.

It is particularly appropriate that the University of Hawaii should play a major role in tropical aquaculture development, as Hawaii strongly depends on the sea. The University thus places special emphasis on and has a commitment to the development of marine sciences.

Experience to date in the various phases of the University of Hawaii's pursuits in aquaculture suggests team approaches. The main site of the work, at present, is the Hawaii Institute of Marine Biology on Coconut Island, but participants come from fields such as animal diseases, animal nutrition, chemistry, behavioral psychology, microbiology, agricultural engineering, and ocean engineering. All team members work with a core of marine biologists. At present, 3,000 square feet of air-conditioned laboratory space is devoted exclusively to aquaculture. In addition, numerous tanks, ponds, enclosed lagoons, and aquaria at Coconut Island are made available to the program. Support from within the University includes the use of shops, darkrooms, walk-in refrigerators, atomic absorption spectrophotometers, auto analyzers, electron microscopes, libraries, data-processing equipment, etc.

that state. This rulemaking became effective 6 September 1979.

b) from *Federal Register*, Vol. 44, No. 181, 17 September 1979, page 54002: . . . the U.S. Fish and Wildlife Service recognizes that captive propagation is, in some cases, important for conserving species, and that the Endangered Species Act (as amended) authorizes the permitting of otherwise prohibited activities to enhance the propagation or survival of affected species. This rule grants general permission for persons to conduct otherwise prohibited activities with captive-bred wildlife under specified conditions, which are designed to protect wild populations of wildlife and to ensure that the activities will be conducted to enhance the propagation or survival of the species. This rulemaking (i.e., captive, self-sustaining populations) became effective on 17 September 1979.

PROPOSED Rulemaking:

a) from *Federal Register*, Vol. 44, No. 143, 24 July 1979, page 40442: the U.S. Fish and Wildlife Service now believes that the American crocodile (*Crocodylus actus*) populations outside of Florida population which was listed as Endangered on 25 Sept. 75, and the saltwater crocodile (*C. porosus*) populations exclusive of the Papua, New Guinea population to be endangered. Deadline for comments is 26 October 1979.

Send to: Director, (O.E.S.)
U.S. Fish and Wildlife Service
Department of Interior
Washington, D.C. 20240

b) from *Federal Register*, Vol. 44, No. 179, 13 September 1979, page 53422: the Fish and Wildlife Service re-proposes critical habitat for the Plymouth red-bellied turtle (*Chrysemys rubriventris bangsi*). Endangered status and critical habitat were originally proposed for this species on 19 May 1978, but the critical habitat portion of this proposal was withdrawn on 6 March 1979 because of procedural and substantive changes in the amended Endangered Species Act. Deadline for comments is 16 November 1979.

Send to: same as above

STATE-PROPOSED Rulemaking: Ohio House Bill 645—this bill will prohibit "any person owning or buying nonnative poisonous reptiles as pets, to prohibit any person from selling such reptiles except to a zoo, and to permit zoos to buy such reptiles for exhibition."

Comments to: Chairman Jerome Stana
State Agriculture, Conservation, and Environment Committee
Ohio Senate
State House
Columbus, Ohio 43215

NEW DUTCH HERP GROUP

The Nederlandse Studiegroep voor Anolissen, formed about two years ago, is a subdivision of the Nederlandse Vereniging voor Herpetologie en Terrarium-kunde. Their bulletin is devoted entirely to *Anolis* articles, and is published every two months. Major articles have English summaries. The group especially welcomes articles on *Anolis* reproduction, ethology and ecology. For more information, write:

Frits R. vanLeeuwen, Secretary
N.S.A.
2e Boerhaavestraat 5^{hs}
1091 AK
Amsterdam, The Netherlands

Hawaiian green turtle (*Chelonia mydas*) and monk seals (*Monachus schauinslandi*) basking on a small islet at French Frigate Shoals (23°45'N, 166°10'W). Land basking by sea turtles has only been documented for *Chelonia*, with members of the Hawaiian population possibly being the only ones at the present time exhibiting this rare behavioral trait. Hawaiian green turtles and monk seals frequently share the same beaches and inshore waters, however it is relatively uncommon for direct physical contact to take place with one another. (Photograph by George H. Balazs, Hawaii Institute of Marine Biology, P. O. Box 1346, Kaneohe, Hawaii 96744).

Nat. Hist. N.Y. 18: 396-399
1918

The Monk Seal of the Southern Pacific[1]

DISCOVERY OF ITS BREEDING GROUNDS AMID THE TREACHEROUS SHOALS OF PEARL AND HERMES REEFS, THE HAWAIIAN ISLANDS

By ALFRED M. BAILEY

(Louisiana State Museum)

DURING the winter of 1912–13, I had the pleasure of being one of a party from the Biological Survey, United States Department of Agriculture, to visit the leeward group of the Hawaiian Islands. We made as complete a survey as possible of the different rocks, sandspits, and shoals which extend northwest from Honolulu, a distance of about fifteen hundred miles. Our party, under the leadership of Commodore G. R. Salisbury of the United States Navy, was taken among the islands on the revenue cutter "Thetis." Mr. G. R. Freer, the Governor of the Hawaiians, and Judge Lindsay, the Attorney General, accompanied us on the trip.

On the outgoing voyage, we stood off the volcanic bluffs of Necker and Bird Islands, but the huge swells that frothed against the steep walls prevented our making a landing. Mr. G. Willett, the ornithologist, succeeded in gaining shore by swimming, a somewhat hazardous feat, considering the nature of those waters.

We made a careful study of French Frigate Shoals, so named from the schooner-like appearance of the rock that stands sentinel over the crescent-shaped string of small sandspits gleaming a few feet above high-tide mark. All these little islands and shoals are famed for their stories of shipwrecked sailors. We landed on a small grass-crowned spit by wading among the beautiful head corals left partly exposed by the outgoing tide. On the highest point of land, surrounded by a colony of albatrosses, screaming boobies, and graceful terns, was a little excavation; four pegs with tattered canvas flapping listlessly marked the remains of a shelter, and the numerous bleaching turtle bones told plainly the main source of food. A half-rotted turtle shell turned bottom to the sky seemed still to ask for rain, and a broken oar blade lay half buried in the coral sand. The most unimaginative could read those few lines.

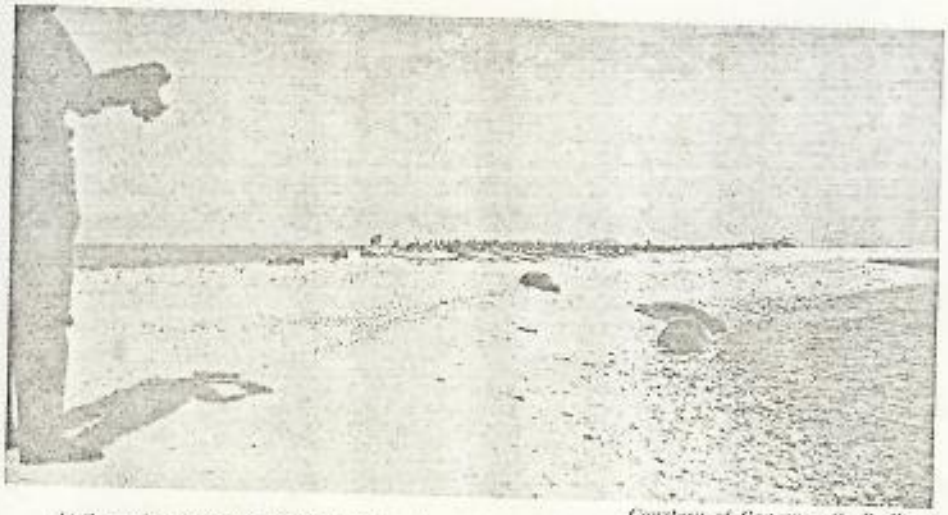
The "Thetis" landed our party on Laysan Island and went back to Honolulu, returning for us three months later. We had an enjoyable time during those three months, for Laysan is justly famed for her wealth of bird life, in spite of inroads made by feather hunters. The wonderful colony of albatrosses, the thousands of trim-rigged man o' war birds, terns, tropic birds, and waders make Laysan a real bird paradise. Unfortunately, rabbits have been introduced there, and the destruction of the grasses has allowed the sand to drift, so that thousands of young birds are smothered by the shifting dunes. We killed more than five thousand rabbits and, unless something more is done to exterminate them, I fear for the results. A strict watch was kept at all times for rare or new forms, and most of all, we wanted to take the Laysan seal. We patrolled the beach every day, and our efforts were finally rewarded by the taking of a large male specimen. We made careful notes and preserved the skin and skeleton for mounting.

We looked forward to our visit on Lisiansky with high hopes for, after taking one specimen on Laysan, and having reason to believe that Palmer had killed two on Lisiansky, we considered our chances were good of finding stragglers there. The "Thetis" took us directly to the island, which is only

[1] A species of seal was reported as inhabiting the warm waters of the Pacific near the Hawaiian leeward group, and although nine specimens had been collected on Laysan Island in fourteen years' time, none of the skins or skeletons had been saved for scientific purposes. This warm-water seal was described by Dr. Matschie as *Monachus schauinslandi* (*Sitz. Ber. Ges. Naturf. Freunde*, Berlin, p. 254, 1905). I believe that a Mr. Palmer collecting in that region for Rothschild, obtained two specimens on Lisianesky, but these were reported as lost overboard. As I have had experience in trying to cure a large seal without adequate instruments, in a tropical climate, I can readily understand the reason these skins were lost.—THE AUTHOR.

Courtesy of Commodore G. R. Salisbury

The Biological Survey of the United States Department of Agriculture sent an expedition on the revenue cutter "Thetis" to the leeward group of the Hawaiian Islands in 1912–13. One point of special interest lay in observation of the "Laysan seal," the real habitat and breeding grounds of which have always been a mystery since the finding of the first specimen on Laysan Island in 1905. Although strict watch was kept at all times for the rare Hawaiian seal, the expedition of 1912–13 saw only one specimen in the waters or on the beaches of Laysan during a three months' stay. This was a fine male, of which both skin and skeleton were saved for the United States National Museum. On Lisianesky Island, northwest of Laysan, two specimens were seen; but it was on Pearl and Hermes reefs, still farther north and never before visited by scientists, that the main rookery was found. The seals were so tame that they allowed approach to within a few feet. When approached too closely, however, they took to the water, although the old females showed a disposition to fight in protection of the young



Courtesy of Governor G. R. Freer

At the main breeding colony of these seals, on the treacherous Pearl and Hermes reefs—so named from ships wrecked there—we saw about sixty specimens altogether, including twenty females with pups, but the expedition was able to give only one day to investigation. There is urgent need for further study of the species, as the small number of seals in the rookery seems to indicate that they are rapidly becoming extinct

ninety miles to the northwest of Laysan, and we were not disappointed, for we found two specimens on the beach. We killed the female, but the other, presumably a male, escaped. The kill was a fine specimen, but was so heavy and cumbersome that we found it very difficult to drag it from the shallow water on to the shelving beach.

We then visited Midway, so well described in Stevenson's *The Wrecker*. The cablemen on Midway told us that seals occasionally wandered ashore, but that the visits were irregularly timed, and there was likely to be a straggler in summer as well as in winter. We made a survey of the islands, and enjoyed the hospitality of Captain Morrison, the head of the colony of cablemen. The captain took us around the reefs in his power launch, and pointed out the bones of the famed ship, "The Wandering Minstrel." "Wandering Minstrel,"—what an appropriate name for a boat cruising in those dreamy, beautiful waters! And the captain showed us the graves of two sailors who had not been able to stand the fourteen months of starvation and thirst that the survivors were forced to endure. We obtained additional data on the nesting birds, but no information relative to the seals.

We considered that our chances of success rested finally on Pearl and Hermes reefs, for these never had been visited by a scientific party so far as we knew. And there we found the main breeding colony. The place consists of numerous sandspits and shoals, surrounded by extensive barrier reefs, over which combers and white-topped breakers tumble with a continuous roar. These treacherous reefs are exceedingly dangerous to navigation, and received their names from the two ships, the "Pearl" and the "Hermes," which were wrecked within a week of each other. Because of storms, it was thought inadvisable to stay in that vicinity longer than necessary, so we decided to spend the one day only.

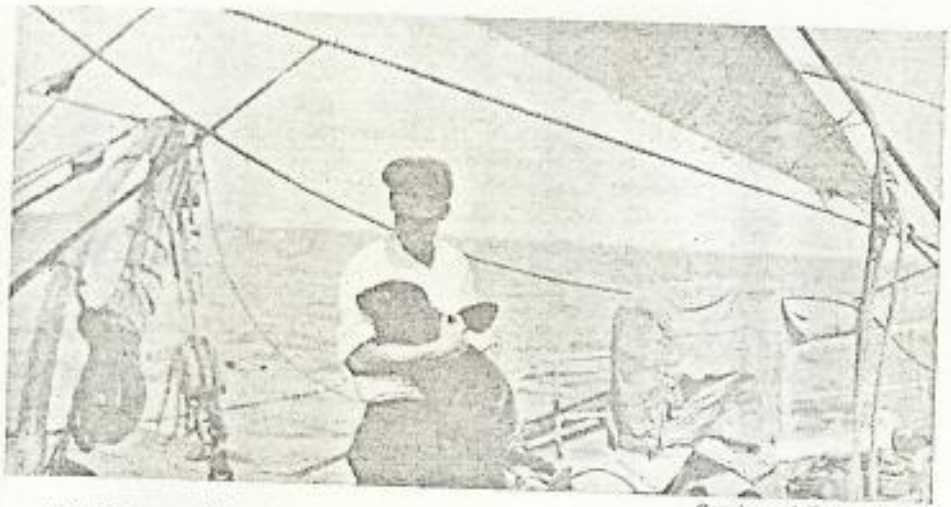
Mr. Willett visited the largest of the spits while I took another cutter and started for one charted about five miles off. Unfortunately, the spit seemed to have disappeared, for we could not find it, although we tacked back and forth through the reefs for several hours. The crystal-like water mirrored the bottom, and the beautiful many-colored coral fishes so characteristic of Hawaiian waters darted to and fro among the head coral, and the small reef sharks slid stealthily from one deep lead to another. A school of porpoises played off our bow and came in so close as almost to splash in the boat as they cut water, and huge loggerhead turtles slept lazily on the sandy keys. Sooty-backed terns winged close to the surface, their white breasts green with reflected light, and their shrill call, "wide-a-wake," seemed entirely out of place in those sleepy tropical seas.

Photograph by A. M. Bailey

We found two seals asleep on the beach at Lisiansky, and shot one of them, a large female. This warm-water seal is a huge, cumbersome creature, and difficult to handle in a tropical country, without adequate instruments

Photograph by A. M. Bailey

We saw numerous seals flopped out on the beach at Pearl and Hermes reefs, but the number of pups made a pitiful showing when we consider that this is the main breeding colony



Courtesy of George Willett

We took a pup alive back to the ship, a glossy black little fellow, which ceased its childlike cries only when held in our arms

We saw seals playing in the water or flopping out on the shining bars, but did not molest them. They were so tame that we approached within a few feet, and one half-grown pup lying out on a bar, flat on his back, rolled over and beat a hasty retreat only when I tickled him with the toe of my boot. The old females, however, were a little touchy when we approached too near the pups, and one of the sailors had a close call when an irate old lady slid down a bank—under which the sailor had been boredly awaiting our departure and where only a sailor's agility saved him from a drubbing.

The main rookery was located on the large island visited by Mr. Willett. It was topped with a scanty growth of tough wire grasses, just enough to keep the sand from drifting before the steady trade winds. Here we found about twenty females with pups, glossy black little fellows, a few half-grown ones and a very small number of bulls, probably fewer than sixty individuals in the rookery. It would be folly, of course, even to estimate the number of individuals at sea, but they must be few when we consider the pitifully small showing of young in the main breeding colony.

We took a pup back to the ship, and kept it alive for some time, but its distress was so great and its almost childlike cries so distracted the officers that we finally were obliged to kill it. The only time the little fellow would stop crying was when we held him in our arms.

We considered ourselves fortunate to have discovered the breeding colony of these seals whose real habitat has been a sort of mystery so long, and we contented ourselves with taking the three specimens I have mentioned. We felt that even with the favorable conditions which they have for their mode of life, the colony seems far from successful, and that an intimate study of their home life during the breeding season is very desirable.

The Laysan Seal

Nat. Hist. N.Y. 1918
18:399-400

By J. A. ALLEN

THE observations on the monk seal of the Laysan Islands here recorded by Mr. Bailey furnish highly interesting information respecting a hitherto little-known mammal, the existence of which, as he states, was first made known in 1905, when a skin and skull, parts of two other skulls, and a headskin were brought to the natural history museum in Bremen by its director, Dr. Schauinsland. These were described by Dr. Matschie of the Berlin Museum, by whom the species was named *Mo-*

nachus schauinslandi, after its discoverer. He found that it differed little from the two other known species of the genus, inhabiting respectively the Mediterranean and Caribbean seas. No other specimens appear to have reached any other museum until the return of the "Thetis" from the Laysan Islands in 1913, when the three specimens obtained by Mr. Bailey were received at the United States National Museum in Washington.

The genus *Monachus* is of especial interest on account of the isolation of its three modern representatives, all of which seem doomed to early extinction. The monk seal of what we may call the Mediterranean area appears not to have been very numerous within historic times. It is known to have occurred formerly in small numbers on both the European and the African coasts of this inland sea, and it also has been taken at the Madeira and Canary islands. The early naturalists appear to have had only scanty knowledge of it, and few modern museums can count it among their treasures. It was first formally introduced into technical natural history as *Phoca monachus* by Hermann in 1779, and separated generically from *Phoca* by Fleming in 1822 as the sole representative of his genus *Monachus*.

The only known West Indian seal forms the second species (in respect to its introduction into scientific literature) referable to this genus, it having been described by J. E. Gray, of the British Museum, in 1850, from an imperfect skin "from Jamaica," as *Phoca tropicalis*, and referred by him sixteen years later to the genus *Monachus*. This species, however, remained virtually unknown scientifically for the next twenty years, but nevertheless it has a most interesting and unique history, inasmuch as it was met with by Columbus near the end of August, 1494, as he approached the southern coast of Hispaniola, where his sailors killed eight of them for food.[1] Although this seal was abundant in the sixteenth and seventeenth centuries in the Caribbean Sea and southern part of the Gulf of Mexico, from the Bahama Islands westward to the islets off the coast of Yucatan, it was nearly destroyed for its oil in the eighteenth century and has since been on the verge of extermination throughout its former range.[2] It is still reported as occasionally seen or captured near Cuba and among the keys and islets southeast of the Bahamas.

The third species of *Monachus* was first made known, as stated above, from the Laysan Islands, and an account of its distribution and habits, so far as known, is given by Mr. Bailey in the present number of the JOURNAL.

These three forms of monk seal present a striking similarity in size, coloration, and structure, and thus show the strong persistence of characters inherited from a remote ancestor. As their present distribution is restricted to warm temperate and subtropical latitudes, interest is added to the question of how the Laysan seal reached the Pacific Ocean.

All the nearest relatives of *Monachus* are northern, inhabiting at present only north temperate and arctic littorals; it seems, therefore, unquestionable that its place of origin is northern, and probably not far from the present Mediterranean region. The Caribbean species beyond doubt was derived from North Atlantic stock. In what way it reached the West Indian region is open to speculation, where its presence has been assumed as evidence of a former land bridge between the Antilles and the Mediterranean region, before, however, it was known that still another species existed in the Pacific Ocean. It was suggested by its describer that the Laysan seal had reached its present home by way of a "northwest passage," or arctic route, which appears wholly improbable. It seems more reasonable to assume its derivation from the Caribbean area, it finding a way westward into the Pacific during a temporary submergence of the Isthmian region of Central America, probably in pre-Glacial times.

[1] See *Bulletin* Amer. Mus. Nat. Hist. II, p. 23, April, 1887.

[2] The known general history of this seal will be found summarized, together with a detailed account of its structure and relationships, based on the fine series of specimens exhibited in the mammal hall of the American Museum, collected at The Triangles, a group of rocky islets off the coast of Yucatan, in an article by the present writer, entitled: "The West Indian Seal (*Monachus tropicalis* Gray)." *Bulletin* Amer. Mus. Nat. Hist., Vol. II, pp. 1–34, pls. i–iv, April 25, 1887. (Adult and young, skull and principal parts of skeleton figured.)

Hawaiian Islands National Wildlife Refuge

By ERWIN A. BAUER

(All photographs by the author)

STRETCHING FOR 1,000 MILES westward beyond the main Hawaiian Islands known by tourists is a necklace of lonely, widely separated islands which few Americans know or have even heard about. Still these tiny bits of real estate are among the most precious of our public treasures. They are probably the most heavily utilized by wildlife of any islands on earth.

Variously known as the Leeward, Northwest or simply the "Bird" islands, the entire 2,000 acres of land is included in America's most remarkable wildlife sanctuary—the Hawaiian Islands National Wildlife Refuge. Also within the refuge boundaries are 200,000 acres of shallow lagoons and some of the least-disturbed, least-exploited ocean reefs on earth. The only human occupancy inside the refuge, which is administered by the U.S. Fish & Wildlife Service, is a U.S. Coast Guard loran station on Tern Island at the French Frigate Shoals. The rest belongs to an estimated 100 million birds and includes some of the most spectacular nesting colonies in the world.

In all history, relatively few humans have set foot on the "Bird Islands," which are virtually waterless and remote from normal shipping lanes. Some are atolls; others are the remains of volcanic cones. Usually once and occasionally twice each year, Gene Kridler, refuge manager, makes an inspection tour and a wildlife census of the islands. In September, 1971, John Sincock, a biologist who specializes in endangered species, Kenneth Norris, a marine mammalogist, and I joined Kridler on his inspection tour aboard the U.S.C.G. cutter *Buttonwood*. We boarded the vessel at the Midway Islands, a naval base now as well known for the huge nesting colony of gooney birds—Laysan and black-footed albatrosses—as for the World War II naval encounter nearby.

Lisianski at Dawn

The first destination in the sluggish (11 knots) voyage back eastward along the chain of islands was Lisianski, a day's cruise away and 6° east of the International Date Line. With the *Buttonwood* anchored offshore in 10 fathoms, a 25-foot surfboat loaded with scientific equipment was lowered just after daybreak, and the 5-mile run

IN THE BRUTAL HEAT *at Lisianski Island, Hawaiian Islands National Wildlife Refuge, a biologist uses a scissor-shaped gripper (left) to retain a Hawaiian monk seal so that a tag can be affixed to its flipper. This endangered species has better prospects for survival since creation of the refuge.*

through a maze of reefs toward the beach was begun. But long before the craft touched sand, clouds of noddy and sooty terns flew out to meet us. Boobies and great frigates flew escort above them. Hundreds of ruddy turnstones awaited and watched at the water's edge, and dozens of gray Hawaiian monk seals baked on the beaches.

Kridler's plan was to hike the 3½ miles completely around the 382-acre Lisianski, counting the seals and green sea turtles, and then live-capturing and tagging as many of both as could be caught. Capture gear, which included a huge scissor-shaped gripper to hold seals immobile, had to be lugged over the soft powdery sand and, in the brutal heat of autumn at latitude 26° north, the hike around Lisianski seemed more like 31 miles than 3½.

Altogether 119 seals were counted, and tags were affixed to the flippers of most of the pups and yearlings. Despite their lethargic appearance, the larger animals were too difficult and dangerous to handle; tagging had to be confined to the smaller ones. Although considered endangered, the Hawaiian

OF ALL THE "BIRD" ISLANDS, *Laysan is the easiest to land on because it is surrounded by protective barrier reefs.*

ANOTHER CHORE *of biologists taking the wildlife census on Lisianski Island is that of live capturing and tagging green sea turtles. This includes the difficult task of weighing the turtles (below left)*

monk seal, *Monachus schauinslandi*, now has much better prospects for survival than the other seals of tropical waters. The Mediterranean monk seal, *Monachus monachus*, is nearly gone and the Caribbean monk seal, *Monachus tropicalis*, is almost certainly extinct. Kridler and crew also tagged four turtles, one a 4-pounder, which was a surprise because few this small are ever found onshore. Most evidence suggests that the turtles do not come ashore until ready to breed or lay eggs. The largest turtle tagged weighed 250 pounds.

An Island of Birds

The next stop was Laysan Island, which is the easiest on which to land because of the intricate, protective barrier reefs all around it. A few hours after dropping anchor, the group was onshore with enough equipment to camp and be self-sufficient for a week. A comfortable, two-tent camp was set up on the island's highest point—the crest of a dune about 40 feet above sea level. The *Buttonwood* was scheduled to conduct routine exercises elsewhere and, as it vanished over the horizon, we began to count birds.

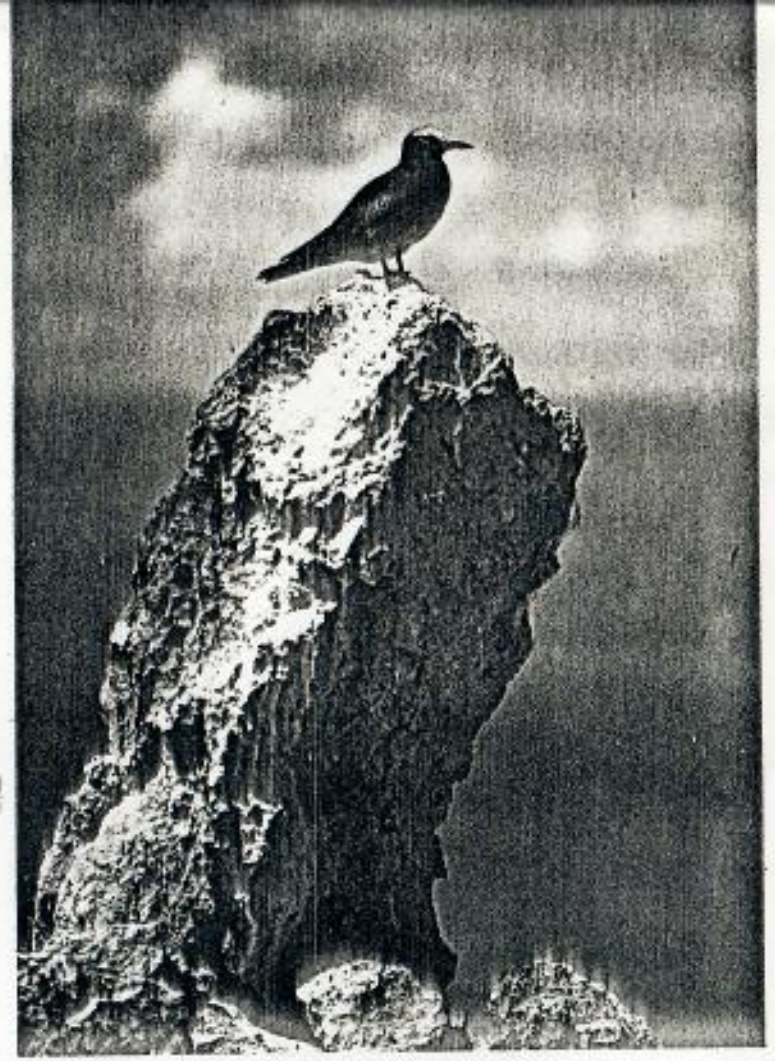
Laysan Island is saturated with birds. Each year, an estimated 9 to 10 million birds of at least 23 different species use the 1,100 acres to nest and rest. That amounts to 8,200 per acre and, although all are not on Laysan at the same time, it does mean that at times birds are nesting side by side and in three "layers." Shearwaters and petrels were found nesting underground, terns and tropic birds at ground level just above, and boobies, noddies, and frigates in the low shrubs just overhead.

The rarest species of waterfowl on earth, the Laysan teal, *Anas laysanensis*, lives only here. About 150 survive by skimming the brine flies from a landlocked lagoon, which is three times as salty as the surrounding ocean and is located in the center of the island. This nondescript chocolate-brown bird weighs 1½ pounds or so.

Catching the teals was done at night, mostly by walking the perimeter of the lagoon with a butterfly net. The tagging is a very critical matter because once the total population had been reduced to seven individuals. The number of recaptures and of young birds tagged each year gives Kridler an idea of how the rare ducks are prospering. Also, with the teals was a single pintail hen which could only have been blown to this sanctuary, perhaps from Alaska, by a severe storm.

Around the lagoon were great numbers of wandering tattlers, turnstones and whimbrels, all being restless migrants. Brown boobies, *Sula leucogaster*, perched on the tent ridge poles and great frigates, *Fregata minor*, fed on noisy reptilian young a few feet away. Both species had no fear of us or our activities. Rare Laysan finches, *Psittirostra cantans*, also found nowhere else, shared the meals spread on an outdoor table.

At the time, the most abundant species on Laysan was the wedge-tailed shearwater, *Puffinus pacificus*, a bird that nests in burrows it excavates in soft coral sand. Large areas of the island are honeycombed with burrows that are spaced about 3 or 4 feet apart. Although a wedge-tailed shearwater did not succeed in digging a burrow under a tent one night, it remained to watch the silhouettes of the curious figures inside making notes by yellow lantern light. All night, every night, the strange mournful chorus of Bonin Island petrels, *Pterodroma phaeopygia*, and Christmas Island shearwaters, *Puffinus nativitatus*, could be heard. The sounds were both magnified and muted by the wind, from a roar to a low moan. Both of these species were difficult to see because they were at sea all day and returned to land only at dusk. By daybreak, all were gone once more.



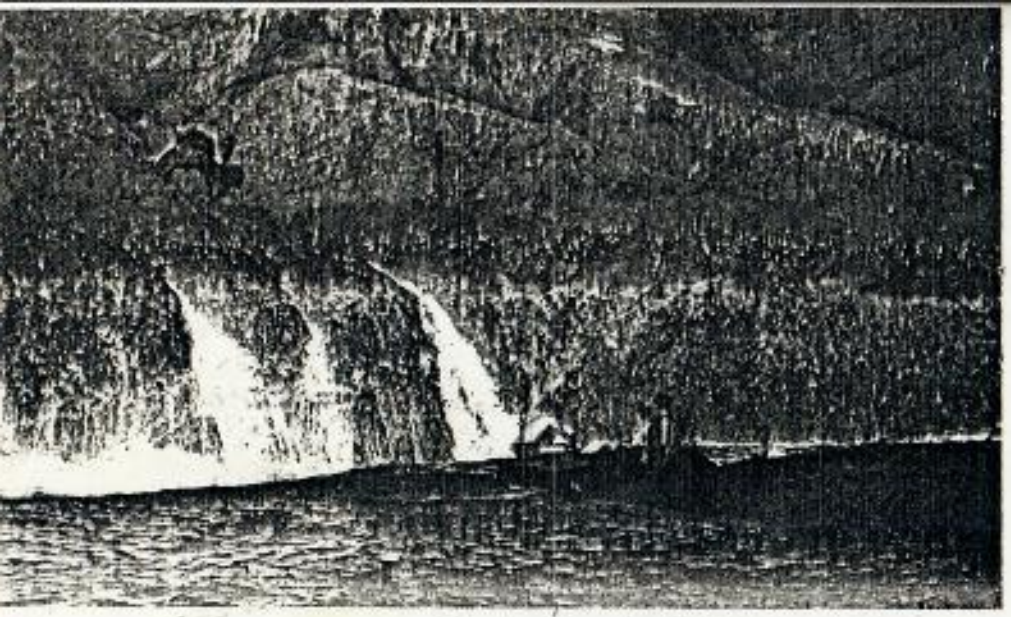
A NODDY ON A TEMPLE. *Nearly 300 feet above the sea, a crumbling stone Polynesian temple tops the island of Necker. The temple is believed to have been abandoned about 800 years ago and its remains now are used by boobies and frigates as a roost.*

BIRDS SATURATING THE SKIES *above Laysan Island include the brown booby. These birds fearlessly perched on the poles of the visitors' tents.*

IMPATIENT WITH HUNGER, *the baby red-tail tropic bird (bottom) awaits the return of the adult (below) to Nihoa Island, the home of tens of thousands of birds.*

Snorkeling the reefs of Laysan was as remarkable as the birdwatching. Here schools of neon-blue ulua, the abundant jacks of the central Pacific, plus lionfish, angelfish, Moorish idols, parrotfish, tangs, and several species of butterflyfish swam close to shore. But so did large whitetip sharks and, for me at least, that fact tipped the balance back in favor of birding on dry land.

At the turn of the century, there were grave problems in this paradise. Guano diggers, plume hunters, and the tragic introduction of European hares destroyed most of the vegetation and completely eliminated three native species—the flightless rail, *Porzanula palmeri*, the Laysan honeycreeper, *Himatione sanguinea freethi*, and a millerbird, *Acrocephalus familiaris*—and nearly doomed all the rest. When he learned about the destruction, just barely in time, President Theodore Roosevelt created the refuge by executive order. All pillage was stopped, the hares were eliminated, and Laysan gradually "recovered." In 1969, however, refuge manager Kridler had anxious moments when he learned that a Japanese longline fishing boat had crashed into the island and by a series of violent storms was swept up onto the beach. His fear was that this derelict would introduce brown rats onto the island, because these rodents have



EW HUMANS HAVE EVER BEEN ASHORE *at Gardner Pinnacles. The landing technique ed by refuge manager Kridler is to leap from a rubber raft, on the crest of a swell, nto the slippery, wet, sheer cliff. To return, he must jump from the cliff to the boat cking in the breakers and swells below.*

iped out the birds on more than one her island around the world. But, ckily, this craft was clean. There is ll, however, the worry about intro- cing strange exotic plants onto the ands, and these Kridler eradicates henever he finds them.

A Perilous Landing

Two days' sailing east of Laysan, e came upon Gardner Pinnacles, the mnant of an extinct volcano cover- g only 40 acres. Its white, guano- osted black peak juts about 180 feet ove the sea, and it is the least im- ortant island in the chain for wildlife. rhaps this is a lucky thing because e rock is constantly lashed by wild eakers and such heavy swells that nding is never really wise. Very, very few humans have ever been ashore on Gardner.

Because the ocean was extremely calm during most of the trip—and even though he nearly lost his life in a previous attempted landing—Kridler decided to try to go ashore. The technique was to run the nose of a rubber raft (rather than the rigid surfboat) up against an almost sheer cliff and hold it there. Then, on the crest of a swell, Kridler leaped to a thin foothold and scrambled free up the wet rocky face. On the return, he had to make a jump for the boat far below.

The next landing was on French Frigate Shoals. Beside the incredible amount of debris left to rust by previous military occupation of the shoals, we found where 48 green sea turtles had recently made nests in the warm sand. According to Kridler's calculations, as many as 1,000 females nest here every year. Many of these nests were very close together, with often as little as 5 feet between them. Kridler believes that French Frigate beaches are the major nesting site of green sea turtles left in North America. Turtles tagged at French Frigate have been captured by commercial fishermen at Hilo, Hawaii, over 600 miles away.

To weigh the several turtles caught onshore, we flipped them on their backs. Then one by one, two men suspended a turtle between them while the third read the scales. After tagging a flipper, each turtle was released upright to flop back into the warm ocean. Tagging reveals much about the turtles' migration habits, life history, and abundance.

Birds in a Temple

Except for Gardner Pinnacles, Necker is the most hazardous island in the refuge chain on which to land. The highest point of its 80 acres is about 280 feet above the sea, and it is reached by following a thin fissure upward in the face of a cliff. On the top is a crumbling stone parapet, now a convenient roost for boobies and frigates, but actually the remains of a Polynesian temple. Nothing is known today about the temple builders, exactly when they came or from where, but the most authoritative estimate is that the structure was abandoned (or the island last inhabited) between 700 and 800 years ago.

On the high ridges of Necker, Bulwer's petrels, *Bulweria bulwerii*, gray-back terns, *Sterna lunata*, and blue-gray noddies, *Procelsterna cerulea*, were observed for the first time during the expedition. The last two, which were nesting on open ledges of rock or on bare gravel, are extremely beautiful but very uncommon species. Nor were they nearly as confiding as a few fairy terns, *Gygis alba*, that had both eggs and young nearby, but which perched on my shoulders when I stood still long enough.

Each Species in Its Niche

The easternmost island of the Hawaiian National Refuge is Nihoa. Covering 156 acres, it is larger than either Gardner Pinnacles or Necker Island. But like them it is a brooding, dark volcanic cone which pokes one precipitous peak into the sky. On the initial approach, it seemed that any landing at all would be impossible because the sheer smooth cliffs fall away directly to the Pacific and, in many places, are undercut or eroded into caves. But after completely encircling the island, it was decided to make the landing at a series of volcanic rock shelves since the ocean was relatively calm.

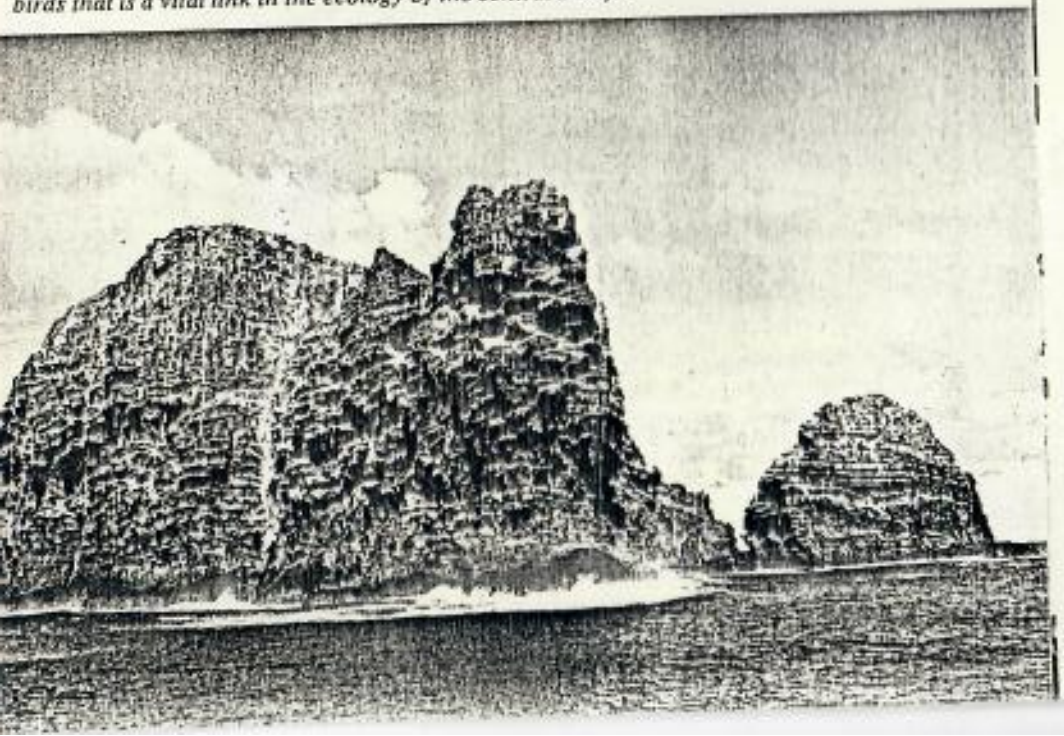
In no way is Nihoa (which is an old Hawaiian word for bird) a wildlife spectacle such as Lisianski or Laysan, perhaps only because it came after instead of before them on our trip. Still, it is the home of tens of thousands of sooty terns, *Sterna fuscata*, noddy terns, *Anous stolidus*, redtail tropic birds, *Phaëthon rubricauda*, boobies, frigates, and petrels, each inhabiting, as elsewhere, a different niche in the environment. Nests of the terns and tropic birds were on the ground, usually under brush, but seldom were they intermingled.

In addition, there are two endemic birds here that do not exist anywhere else—the Nihoa finch and the Nihoa millerbird. The first is abundant, in evidence everywhere, and very tame. There appeared to be no difference between it and the Laysan finch, but the millerbird, a species that was not even discovered until 1923, is entirely different. By nature the Nihoa millerbirds are very shy, compared to all other birds of the island, but two were spotted skulking close to the ground in dense and brittle vegetation.

A rare palm, the loulu, *Pritchardia remota*, is found only on Nihoa. About 800 trees survive there, midway between sea level and the island's crest, in two separate stands. Remains of terracing for agriculture on Nihoa are clear evidence that Polynesians at least tried to make a living there long ago, but with virtually no fresh water, it could not have supported many humans for very long. Stone images and figures collected on the island are now on view in the Honolulu Museum.

From Nihoa we continued eastward, back to the Hawaiian islands of tourists, where the most important birds are builders' "walking cranes" which can be seen perched high atop the countless high-rise hotels and condominiums under construction everywhere. Thanks to the old pioneer conservationist, Teddy Roosevelt, part of the Hawaiian Islands has been saved for the real birds, which must play an immense role in the ecology of the central Pacific Ocean.

ALTHOUGH INHOSPITABLE FOR MAN, *the tiny bits of real estate known as the Hawaiian Islands National Wildlife Refuge are the life support of an immense population of birds that is a vital link in the ecology of the central Pacific.*



A Magnificent Revolution

By CESARE EMILIANI
Rosenstiel School of Marine and Atmospheric Science
University of Miami

ALMOST UNNOTICED by the public at large, a fantastic revolution has been in progress in earth science—a revolution that has been inspired and fueled by research work not on land but at sea.

Before World War II, many fundamental questions went unanswered: How old is the earth? How was it formed? Are the continents and oceans permanent features? Where does the energy to create mountain ranges come from? How did the countless beds of sedimentary rocks, each graded from coarse sand to fine silt and clay, come about? Why does the earth have a magnetic field? What rocks make up the interior of the earth? How did the ice ages come about? Since World War II, many answers have been provided, some more satisfactory than others, of course, but answers nevertheless. And the pace has been breathtaking. Not only the learned monthlies and quarterlies became filled with innovative contributions in earth science, but even such weeklies as *Science* and *Nature*.

What really provided the impetus for the renovation of geological thought was the Manhattan Project. A simple experiment conducted by Enrico Fermi in Rome in the early thirties led scientists, a few years later, to realize the enormous potential of atomic energy. Because a war was in progress, a successful crash program was launched to develop *the bomb*. The task was incredibly difficult, and the scientific, technical, and organizational problems were colossal. Everything had to be invented while doing it. The success of the Manhattan Project remains to this day an unparalleled feat of human ingenuity under stress.

The Legacy of the Bomb

In the course of this project, great scientific and technical advances were made in the basic fields of physics and chemistry. These advances were applied, after the end of World War II, to the interdisciplinary field of earth science with extraordinary results. The age of the solar system and, therefore, also of the earth, was set at 4.5 billion years; ingenious theories, based on solid physicochemical principles, were proposed that accounted for the formation of the earth (and the other planets) from a "cold" nebula of dust and gases surrounding a young sun. Enough radioactive material was found to be contained in the interior