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Canton Island, South Pacific

by

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CANTON ISLAND, SOUTH PACIFIC

By

Otto Degener [1] and Edwin Gillaspy [2]

Mr. Garrison Costar, Engineer with the Civil Aeronautics Administration, in June 1950 commissioned Mr. Otto Degener, Collaborator in Hawaiian Botany of the New York Botanical Carden, to cover Canton Island with vegetation. Degener consulted with Col. Edwin H. Bryan, Jr., for firsthand information regarding the atoll. Bryan had visited Canton as early as 1924 for study and, when the "Southern Cross" was about to fly south in 1928, advised Sir Charles Kingsford-Smith to select this atoll as the best emergency landing place between Hawaii and Fiji. Degener flew from Honolulu to Canton for a week's stay in July 1950 - a distance of 1,630 nautical miles - with Mr. Costar and Mr. William H. Hatheway, a graduate assistant in botany at the University of Hawaii, whom he had selected as the man best qualified to assist him.

Degener returned to Canton for six weeks in April and May of 1951 to continue his biological studies and to prepare the present paper jointly with Mr. Edwin Gillaspy, then Island Manager, who is most familiar with the administrative and non-biological aspects of the island. The following pages contain a conglomeration of personal observations and a compilation of observations already in print by others or recently expressed to the two writers by various observant friends.

PURPOSE

Now that Canton Island is the site of an important airfield, there are two reasons for wishing to cover its bare wastes of coral rock and sand with plants. First, a cover of vegetation will stabilize the land. It will keep the sand from blowing about and away, and from penetrating costly wireless transmitters and other instruments to foul them. Second, it will be a boon to the 300-odd people stationed there. They will no longer be obliged to inhale clouds of dust nor be exposed to glare so intense as to cause in some cases symptoms of snow blindness. It will make living there much more pleasant and worthwhile.

1/ New York Botanical Garden

2/ Civil Aeronautics Administration

TOPOGRAPHY

Canton is the most northern of eight low coral islands known as the Phoenix Islands and lying between latitude 2° 30' and 4° 40' S., and longitude 170° 40' and 174° 40' W. It is a typical atoll with presumably a volcanic core. Its fringing reef rises so abruptly from the deep in most places that effective anchorage facilities are practically lacking for a vessel too large to enter the lagoon.

In 1943 one natural channel through the rim of the island was deepened by dredging, and a new one cut so that sea-going vessels not exceeding 420 feet in length can now tie up at a wharf 385 feet long in the lagoon. The current, however, through the channels between lagoon and open ocean can be very strong and treacherous, running at six to eight knots at flood and ebb tides. Ebb currents likewise produce a marked rip when mixing with the ocean currents up to a mile or more off the channel entrance. The hazard to which ships are exposed at Canton is apparent. In 1942, the SS "President Taylor", formerly the "President Polk", under contract from the President Lines to the United States Army as a troop ship, was caught in the channel current while trying to disembark troops as close to shore as possible because of enemy submarine danger. As a result she piled up on the reef at the entrance of the channel with her bow 270 yards from Musick Light. Salvage operations were abandoned when attempts to refloat her proved unsuccessful. The Army and Navy personnel, numbering up to 10,000 on Canton, soon stripped her of all usable gear, and to this day odd pieces of ship furniture and ventilators may be seen still in use on the island. A Japanese submarine once in late 1942 ineffectually shelled the useless hulk. The "President Taylor" became a favorite haunt for an afternoon of fishing or to while away a few hours from duty by island residents until it was gutted by fire in May 1948, rumored to have started from the explosion of an illicit whiskey still in her hold. She burned four days. The rusted and fire-blackened wreck then served as the most prominent landmark of the island, her funnel and masts being visible for eighteen miles at sea. In 1954, according to Mr. William J. Evans, the present U. S. Resident Administrator, the vessel is being cut up for scrap and hauled away.

Canton has been likened in shape to a pork chop. Its rim, now served with an auto road, is 150 to 1,800 feet wide. This encloses a lagoon of twenty-five square miles, which is about eight miles long and four miles wide at the west end. Until dredged out to a depth of about ten fathoms near the dock and the 1,600 by 1,800 foot ship turning basin, the lagoon was badly choked up with live coral near the entrances where the fresh ocean water enables the organisms to grow. The natural

depth of the lagoon is seldom more than two and a half fathoms, and extensive whitish mudflats, inhabited by colorful fiddler crabs, adjoin the shore. The lagoon, warmer than the surrounding ocean, is stocked with fish of many kinds, as well as with sting rays and sharks which last make swimmers keep a sharp lookout.

The island rim varies in height from twenty to ten feet or less. At certain areas along the outer or seaward coasts, where the waves hit the shore with great violence during storms, large flat polished boulders of broken reef, of breccia consisting of reef fragments, of hardpan consisting of consolidated sand, and tridacna clam shells are piled up to considerable heights. The inner shore slopes gently to the lagoon, ending in a white sandy beach or in low ledges of overhanging rock. The island has no supply of fresh water except the little that may be trapped during showers in upturned tridacna shells - natural Holy Water fonts. Such water, due to the humid atmosphere, evaporates but slowly during the day.

The average annual rainfall of about 19 inches is sparse for a tropical latitude and there is a scarcity of fresh water. To augment the supply that is caught in the form of rain from roofs of buildings and led into individual cisterns, both the Civil Aeronautics Administration (CAA) and the Pan American World Airways (PAA) have elaborate installations for the distillation of fresh water from the sea. This is a costly process making, of course, the watering of garden plants impracticable. An indication of the costliness of this process is shown by the fact that one good shower in April 1951 saved PAA about $3,000 in distillation costs.

The surface soil of Canton contains not a particle of autochthonous or native lava, notwithstanding the island's presumed igneous foundation. But here and there, particularly along the windward shores, are fragments of pumice. These are mostly tawny in color and less than six inches in diameter, though a few may be as large as a man's head. Several rounded pieces about a foot in diameter, for example, were discovered by Dr. S. G. Ross in April 1951. Such stones have been cast ashore after having floated here from some actively volcanic region perhaps thousands of miles distant. Another unexpected though extremely rare source of foreign soil is rocks embedded in the firm grasp of the roots of trees that have washed ashore. One large tree observed had transported six rocks, about a foot in diameter, to the island. Two of these rocks crumbled into fragments upon being hit with a club.

The surface of the land varies. The finest calcareous "clay" or silt occurs chiefly along the lagoon. Light, readily blown, pink sand consisting of Foraminifera shells of the genus Baculogypsina, and less abundantly of Spaerulata lessoni

and a species of Heterostegina, is common along the beach and far to the lee of it. It sifts in among coral fragments, shells and rubble. But where these are exposed to the full force of the wind, this pink sand hardly covers them, being blown away to find a wind-free resting place elsewhere. Canton, by the way, is the farthest north from which the almost microscopic organism, Baculogypsina, is yet known. The coral fragments are of all sizes up to about five inches in diameter. Elsewhere, especially along the beach, occur wave worn, solid platforms of consolidated reef fragments and sand half a mile and more long. The soil consists mostly of calcium carbonate derived from marine animals and plants comminuted in the main by wave action. In addition, there are extensive thin areas of porous hardened guano, the legacy left by myriads of sea birds of past ages. Such deposits were formerly exploited by man for fertilizer. The ruins of a stone wharf, perhaps built about 1870 and jutting out into the lagoon, and rusted iron rails overgrown with kou tree trunks remain today as a souvenir of this industry on the north central side of the island. Here and there are smaller but distinct areas of decayed vegetation forming an acid, moisture holding humus. Around large boulders, logs or other objects casting shade, is a very curious friable and rare soil consisting of the accumulated excrement of the terrestrial hermit crab (Coenobita perlatus) that may congregate by the hundreds in such situations during the heat of the day. Thus Canton soil varies from basic all the way to very acid, depending to what extent these types of soil are intermixed. Areas of acid soil, however, are very sparse indeed. In addition, these types of soil and their mixtures bear a trace to very high concentrations of salts derived from ocean spray, from flooding, and from capillary rise from the water table. These soils are rarely if ever leached out by an adequate supply of rainfall.

In many regions of the atoll the loose sand grains are cemented together to form at various depths a sidewalk-like hardpan. This cannot be penetrated by deep taproots, thus giving advantage to plants with shallow spreading roots or to quick-growing annuals that complete their entire life span after a few strong showers have drenched the upper inches of ground.

Canton, situated at latitude 2° 46' S., is sun baked. This, and the fact that many areas have been cleared of the little native vegetation they ever possessed by the bulldozers of the military during the war, makes the glare from the alabaster-white ground still more intense. The resulting heat, coupled with the warm water of the lagoon, causes a current of warm air to rise.* When large rain clouds approach such an island during the day, they sometimes split, drift around the island, and then coalesce again as they have passed; or if

* See Appendix A, p. 51.

these clouds are small, they tend to skirt the edge of the island, shedding most of their rain in the ocean. On the other hand at night, when the island heat no longer rises appreciably, the clouds no longer bypass the island and thus most of the rain falling on it consists of light night showers. Covering the island with more vegetation will slightly increase the fall of rain during the day which, in turn, will promote a slightly better growth of vegetation, a very desirable condition. If it were not for the warm water of the lagoon, almost landlocked, such an increase might be as much as six to ten inches annually. In time it may be found practicable to construct channels through various narrow parts of the rim into the lagoon to cool its waters, to reduce the salinity so as to increase plant and indirectly fish life, and to reduce the hazardous current that ships must now buck to tie up at the wharf.

Due to man's changes in the surface of Canton, it will be interesting to compare the future climate with that of the past. The following tables are reproduced from "Local Climatological Data", U. S. Weather Bureau, 1954.

Some weather statistics for early years, not shown below, have been consulted also. These, however, appear to be garbled in several instances. It is thought by some that for two years the figures for barometric pressure may have been added in error to rainfall, giving unusually high and spurious records of 80 and 100 inches. Be that as it may, the average rainfall based on carefully kept records is but 19 inches, with a recorded low of 8.71 inches in 1938 and a high of 35.97 in 1953. Most of the precipitation falls in showers during the period from March to August, with April and May often the wettest months. When the rainfall is scant during these two months, then the island vegetation becomes truly dry and sere.

Lightning and thunder are rare; hurricanes are unknown. Barometric pressure, following an almost regular semidiurnal tide-like movement, is worthless as an indication of weather changes. Average visibility is from 12 to 30 miles. Low clouds are few, and fog or mist is unknown. A haze, known to Hawaiians as ehukai and caused by salt particles cast into the atmosphere by waves breaking on the reef, may at times prove troublesome to land aircraft.

The air temperature is practically constant throughout the year, reaching about 88° F., in the afternoon and dropping to 78° F. at night. The following shows the temperature, taken over a period of eight years.

The prevailing winds blow from E.N.E. to E.S.E. West win are very rare. The breeze is usually a steady one of 12 to 14 miles per hour. This refreshing breeze makes this equatorial

atoll livable for man. It makes it more difficult for plants, however, to retain in their tissues the scant amount of water they have absorbed from the soil.

Because of local weather conditions, such as strength and direction of wind, it is difficult to predict the tide and current accurately for navigation. The mean high water interval is exactly 5 hours. The mean range is 3.3 feet, and the spring range is 4.0 feet. As there are but two breaks through the surrounding rim of land into the lagoon, the movement of water within the lagoon lags behind the ocean tides. When driving along the narrow southwest rim of the atoll with both expanses of water in full view at close range, the difference in water level between lagoon and ocean is at times so great as to look strangely unnatural. Because of the great shallow expanse of almost landlocked seawater exposed to the tropic sun, the lagoon water is far saltier than that of the open ocean.

The influence of the tide is noticeable throughout the entire rim of the island, no matter where test holes are bored to the water table. From tests made in early 1950 by Dr. L. H. MacDaniels, we find that the salt content varies tremendously on or in the rim. That of water from the open ocean has (as chloride) 20,300 mg. of chlorine per liter. Water from a drying pool at the extreme southeast end of the island was actually supersaturated and had a content of 90,000 mg. That of the Frigate Pool, where the birds with open beaks and lowered heads swoop down to dip up a drink of water in their lower bills measures but 4,200 mg. The new British well, three hundred feet northwest of the old one and three hundred feet from the lagoon, had only 2,000 mg., at a depth of three feet.

HISTORY

As prehistoric ruins prove, Sydney and Hull Islands, south of Canton, were evidently inhabited for some time by Pacific islanders before the coming of the white man. There is, however, no good evidence to show that such islanders ever lived on Canton for any length of time, though according to Carl E. Meinicke* quadrangular ruins of large coral blocks occur there which he considers as certainly ancient temples. Such people, with the aid of a large shell, could have dug down to potable, though salty, water. Whether they did so no one presently knows.

The whaler "Phoenix" discovered Winslow Reef, northwest of Canton, in 1851, and the name of this vessel became attached to the entire group of islands. As guano had become a commodity of great value, the American Guano Company, the United States

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*Meinicke, C. E. Die Inseln des Stillen Ozeans. 2 : 265 - 268. 1888.

LATITUDE 2° 46' S
LONGITUDE 171° 43' W
ELEVATION (ground) 9 feet

METEOROLOGICAL DATA FOR THE CURRENT YEAR

CANTON IS., SOUTH PACIFIC
TOPHAM FIELD
1954

Month	Temperature: Averages: Daily maximum	Daily minimum	Monthly	Extremes: Highest	Date	Lowest	Date	Degree days	Precipitation: Total	Greatest in 24 hrs.	Date	Snow, Sleet, Hail: Total	Greatest in 24 hrs.	Date	Relative humidity: 1:00 a. BST	7:00 a. BST	1:00 p. BST	7:00 p. BST	Wind: Average hourly speed	Prevailing direction	Fastest mile: Speed	Direction	Date	Percent of possible sunshine	Average sky cover sunrise to sunset	Number of days: Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet, Hail 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures: Maximum: 90° and above	32° and below	Minimum: 32° and below	Zero and below
JAN.	90.2	77.3	83.8	92	25#	74	19	0	0.43	0.22	23-24	0.0	0.0		82	80	65	77			32	ESE	27		5.9	5	15	11	7	0	0	0	21	0	0	0
FEB.	88.4	77.0	82.7	92	27#	73	10	0	0.20	0.18	9-10	0.0	0.0		80	82	66	76			23	ENE	17		6.1	6	11	11	4	0	0	0	10	0	0	0
MAR.	89.5	77.9	83.7	95	13	76	23	0	0.09	0.05	31	0.0	0.0		81	80	65	76			27	ENE	19		5.1	10	15	6	4	0	0	0	15	0	0	0
APR.	89.1	77.6	83.4	93	15	75	27#	0	1.09	0.50	27	0.0	0.0		84	84	66	79			22	ENE	11		5.7	7	14	9	5	0	0	0	12	0	0	0
MAY	90.3	76.7	84.5	93	19#	75	2	0	0.35	0.21	2	0.0	0.0		82	86	70	80			19	NE	11		5.4	7	17	7	4	0	0	0	22	0	0	0
JUN.	89.5	77.7	83.6	94	14	71	5	0	0.82	0.46	5	0.0	0.0		79	79	64	75			28	ESE	28		3.9	16	13	1	3	0	0	0	11	0	0	0
JUL.	88.3	77.8	83.1	92	11	74	26#	0	2.27	1.44	22-23	0.0	0.0		81	81	66	77			28	ESE	22		5.7	7	15	9	8	0	0	0	9	0	0	0
AUG.	88.7	77.1	82.9	94	6	73	21	0	1.98	0.63	3-4	0.0	0.0		80	80	64	76			22	ESE	13		4.7	11	15	5	11	0	0	0	8	0	0	0
SEP.	89.8	77.8	83.8	92	25#	76	28#	0	0.13	0.07	4	0.0	0.0		80	79	61	75			23	ESE	9		3.4	22	6	2	5	0	0	0	17	0	0	0
OCT.	90.4	78.1	84.3	97	29#	77	26#	0	0.24	0.15	31	0.0	0.0		75	74	58	71			21	E	27		4.9	13	12	6	3	0	0	0	20	0	0	0
NOV.	88.2	78.0	83.1	94	21	77	27#	0	0.03	0.03	21	0.0	0.0		77	75	62	73			23	ENE	4		5.1	8	15	7	1	0	0	0	9	0	0	0
DEC.	87.6	78.1	82.9	91	14#	75	3	0	0.16	0.15	3	0.0	0.0		76	75	61	73			23	ENE	27		5.4	5	20	6	2	0	0	0	8	0	0	0
Year	89.2	77.8	83.5	95	MAR. 13	71	JUN. 5	0	7.79	1.44	JUL. 22-23	0.0	0.0		80	80	64	76			32	ESE	JAN. 27		5.1	117	168	80	57	0	0	0	162	0	0	0

Ø Fastest observed one minute wind speed and its direction. This station is not equipped with automatic recording wind instruments

NORMALS, MEANS, AND EXTREMES

Month	Temperature: Normal: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Normal degree days	Precipitation: Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Sleet, Hail: Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	Relative humidity: 1:00 a. BST	7:00 a. BST	1:00 p. BST	7:00 p. BST	Wind: Mean hourly speed	Prevailing direction	Fastest mile: Speed	Direction	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days: Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Sleet, Hail .10 inch or more	Thunderstorms	Heavy fog	Temperatures: Max. 90° and above	Min. 32° and below	32° and below	0° and below
(a)	(b)	(b)	(b)	8		8			(b)	13		13		8		8	8		8		8	8	8	8							8	8	8	8	8	8	8	8	8	8	8	8
J	88.0	78.0	83.0	98	1947	74	1954#		1.08	4.94	1940	T	1950#	1.99	1951	0.0	0.0		0.0		80	79	65	75							5.8	4	18	9	6	0	0	0	16	0	0	0
F	88.0	78.0	83.0	96	1952#	73	1954#		0.54	2.10	1949	0.04	1945	1.69	1949	0.0	0.0		0.0		80	80	64	76							5.6	5	17	6	5	0	0	0	12	0	0	0
M	88.5	77.6	83.1	96	1949	71	1953		1.92	9.34	1940	0.07	1951	1.86	1953	0.0	0.0		0.0		83	83	66	79							5.7	6	17	8	9	0	*	0	14	0	0	0
A	89.3	78.0	83.7	97	1951#	70	1953		3.78	11.50	1940	0.90	1945	4.15	1953	0.0	0.0		0.0		85	85	68	81							5.8	7	19	7	14	0	1	0	18	0	0	0
M	90.0	78.3	84.2	98	1953	71	1953#		2.86	8.33	1953	0.35	1954	2.09	1953	0.0	0.0		0.0		83	83	67	79							5.9	7	15	9	12	0	2	0	21	0	0	0
J	90.0	78.5	84.3	96	1953#	71	1954		2.80	5.26	1945	0.65	1947	1.78	1948	0.0	0.0		0.0		81	80	66	77							5.7	6	16	8	11	0	1	0	19	0	0	0
J	90.0	78.4	84.2	96	1953#	71	1952		2.33	5.73	1945	0.60	1947	2.12	1950	0.0	0.0		0.0		80	79	64	77							5.8	5	19	7	11	0	1	0	20	0	0	0
A	90.0	78.3	84.2	97	1951	71	1953#		2.40	6.78	1943	0.18	1949	2.00	1950	0.0	0.0		0.0		80	80	64	76							5.4	6	17	8	11	0	*	0	18	0	0	0
S	90.3	78.4	87.4	97	1952#	72	1953		0.69	1.69	1947	0.05	1950	1.51	1948	0.0	0.0		0.0		78	77	60	74							4.6	11	15	4	6	0	0	0	11	0	0	0
O	90.2	78.0	84.1	97	1951	73	1947		0.39	1.41	1953	0.03	1942	0.70	1953	0.0	0.0		0.0		78	75	60	74							5.1	10	15	6	5	0	0	0	22	0	0	0
N	89.3	78.0	83.7	98	1947	74	1947		0.27	0.97	1953#	T	1945	0.53	1952	0.0	0.0		0.0		77	75	60	73							5.4	7	18	5	4	0	0	0	18	0	0	0
D	88.0	78.0	83.0	95	1953#	71	1948		0.95	4.81	1939	0.06	1947#	1.81	1951	0.0	0.0		0.0		77	76	64	75							6.2	5	16	10	4	0	0	0	12	0	0	0
Year	89.3	78.1	83.7	98	MAY 1953#	70	APR. 1953		20.01	11.50	APR. 1940	T	JAN. 1950#	4.15	APR. 1953	0.0	0.0		0.0		80	79	64	76							5.6	76	202	87	98	0	5	0	201	0	0	0

(a) Length of record, years. (b) Normal values are based on the period 1921-1950, and are means adjusted to represent observations taken at the present standard location. Partial years' data, 1940 and 1942 considered in extracting maximum and minimum monthly precipitation values.

Pages 7 and 8 reproduced from "Local climatological data with comparative data 1954 Canton Island, South Pacific" issued by U. S. Weather Bureau, 1955

AVERAGE TEMPERATURE

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	An'l.
1947	84.9	84.8	85.3	85.2	84.8	85.0	84.4	84.2	84.2	83.6	84.0	83.8	84.5
1948	83.4	83.2	83.6	83.8	85.3	85.8	85.2	84.6	84.8	84.7	84.3	83.8	84.4
1949	85.2	84.9	83.9	83.9	84.4	84.8	84.9	84.4	84.6	83.6	83.5	83.2	84.3
1950	81.4	82.4	81.9	82.6	83.1	82.3	82.3	82.3	82.4	84.1	83.1	82.5	82.5
1951	82.8	83.3	83.4	84.7	85.2	84.2	85.2	84.6	85.8	85.1	85.9	83.6	84.5
1952	84.7	84.8	84.6	84.6	85.1	85.0	84.5	84.2	84.6	84.6	84.6	83.7	84.6
1953	84.6	84.1	83.5	84.1	83.7	84.4	83.7	83.7	84.7	84.9	84.8	83.6	84.1
1954	83.8	82.7	83.7	83.4	84.5	83.6	83.1	82.9	83.8	84.3	83.1	82.9	83.5
RECORD MEAN													
TEMP	83.9	83.8	83.7	84.0	84.5	84.4	84.1	83.9	84.4	84.4	84.2	83.4	84.1
MAX	89.3	89.1	89.1	89.9	90.7	90.4	90.3	90.0	90.6	90.6	90.0	88.6	89.9
MIN	78.4	78.4	78.3	78.1	78.3	78.3	77.9	77.8	78.1	78.1	78.3	78.2	78.2

TOTAL PRECIPITATION

CANTON IS., SOUTH PACIFIC
TOPHAM FIELD
1954

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1937									.85	.41	.41	.03	-
1938	.23	.18	.82	1.93	.57	2.38	.85	.55	.66	.27	.21	.06	8.71
1939	.15	.05	.10	1.58	3.75	1.55	3.01	1.79	.25	1.23	.30	4.81	18.57
1940	4.94	.75	9.34	11.50	2.92	4.80	3.03	3.04	-	-	-	-	-
1941	-	-	-	-	-	-	-	-	-	-	-	-	-
1942	-	-	-	-	-	-	-	-	.15	.03	.37	.20	-
1943	.12	.17	.11	1.17	1.92	2.56	1.23	6.78	.30	.28	.60	.29	15.53
1944	2.96	.52	2.12	3.02	5.37	1.83	1.17	1.05	1.24	.08	.40	.74	20.50
1945	T	.04	1.21	.90	2.60	5.26	5.73	.54	.53	.61	T	.23	17.65
1946	-	-	-	-	-	-	-	-	-	-	-	-	-
1947	.17	.26	.08	1.59	.65	.65	.60	1.40	1.69	.89	.42	.06	8.46
1948	.86	1.24	5.99	10.32	4.44	3.19	1.20	3.18	1.64	.17	.06	.88	33.17
1949	T	2.10	1.16	2.16	3.45	1.00	.98	.18	.19	.09	.02	.17	11.50
1950	T	.29	.08	1.83	.44	2.36	5.50	4.04	.05	.16	.24	.10	15.09
1951	2.40	.32	.07	5.55	5.36	5.19	2.35	3.81	.77	.44	.22	3.88	30.36
1952	.19	.05	.97	2.67	5.21	2.10	3.23	3.48	.80	.79	.97	.27	20.73
1953	.77	.61	3.41	6.46	8.33	4.14	3.55	4.77	.65	1.41	.97	.90	35.97
1954	.43	.20	.09	1.09	.35	.82	2.27	1.98	.13	.24	.03	.16	7.79
RECORD MEAN	.64	.46	1.25	3.10	3.26	2.54	2.44	2.58	.68	.51	.34	.97	18.77

Records Sept. 1937 - April 1940 incl., Gilbert and Ellice Island Colony Administration (U.K.), 2° 49' S., 171° 43' W.; May-August 1940, US. Dept. of Interior, 2° 49' S., 171° 43' W.; Sept. 1942 - December 1945, U.S. Army Air Force at or within 2000 Ft of 2° 46' S., 171° 43' W. prior to August 1943 and at that location thereafter; Jan. 1947 - Present , U.S. Weather Bureau Office, 2° 46' S., 171° 43' W.

STATION LOCATION

Location	Occupied from	Occupied to	Airline distance and direction from previous location	South Latitude	West Longitude	Elevation above Sea level: Ground	Elevation above Sea level: Actual barometer elevation (H_a)	Elevation above Ground: Wind instruments	Elevation above Ground: Extreme thermometers	Elevation above Ground: Psychrometer	Elevation above Ground: Telepsychrometer	Elevation above Ground: Tipping bucket rain gage	Elevation above Ground: Weighing rain gage	Elevation above Ground: 8" rain gage	Elevation above Ground: Solar recorder	Remarks
BRITISH HEADQUARTERS RADIO	SEP 1937	PRESENT	-	2° 49'	171° 43'	-										Good exposure.
PRESENT HOTEL AREA, DEPT INTERIOR	SEP 1937	OCT 1940	-	2° 49'	171° 43'	-										Details not known.
HOTEL AREA IN BLDG, AT APPROACH TO FIRST SEA-PLANE DOCK (PAA)	SEP 1939	NOV 1941	-	2° 49'	171° 43'	-										
NAVY ADMINISTRATION BLDG (PAA EMPLOYEES IN NAVAL RESERVE)	NOV 1941	APR 1945	-	2° 49'	171° 43'	-										Move may have been a bit later than this.
TOPHAM FIELD, TERMINAL BLDG	MAY 1942	OCT 1946	-	2° 46'	171° 43'	9										AF station moved into terminal bldg. in July 1943. Prior location not known. Many details not known as part of this time Canton was a combat area.
" " "	OCT 1946	1/24/47	-	" "	" "	9	11									Between time AF abandoned station and the Weather Bureau took over with its own personnel, the WB contracted with PAA to man the station. On 12/28/46 the first WB employee arrived and on 1/24/47 the last PAA employee was relieved.
" " "	1/1/47	PRESENT	-	" "	" "	"	"	30	19	19			3	3	25	Good exposure.

This small land mass, being at most 20 feet above sea level, presents the minimum topographical influence.

REFERENCE NOTES

Unless otherwise indicated, dimensional units used in this bulletin are: temperature in degrees F.; precipitation and snowfall in inches; wind movement in miles per hour; and relative humidity in percent.

Record mean values at the end of the Average Temperature and Total Precipitation tables are long-term means based on the period of record beginning in 1947 and 1938 respectively. Values have not been corrected for changes in instrument location listed in the Station Location table. Partial years' data, 1940 and 1942, not used in computing precipitation means.

Sky cover is expressed in a range of 0 for no clouds or obstructions to 10 for complete sky cover. The number of clear days is based on average cloudiness 0-3 tenths; partly cloudy days on 4-7 tenths and cloudy days on 8-10 tenths. Degree days are based on a daily average of 65° F. Sleet and hail were included in snowfall totals, beginning with July 1948.

Data for earlier years may be obtained by contacting the Weather Bureau Office for which this publication was issued.

Heavy fog in the Means and Extremes Table also includes data referred to at various times in the past as "Dense" or "Thick". The upper visibility limit for heavy fog is 1/4 mile.

* Less than one half.
\- No record.
\# Also on earlier dates, months, or years.
T Trace, an amount too small to measure.

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NWRC, Asheville, N.C. --- 2/15/55 --- 350

Guano Company, and the Phoenix Guano Company were formed. Then in the Honolulu missionary publication "The Friend" of April 20, 1859, and elsewhere, the claim of ownership by these companies of about fifty guano islands was recognized by the United States Government. It stated that these islands which "have become the property of citizens of the United States. . . have been recognized by the Government as pertaining to its territories under the act of Congress approved August 18, 1856." One of these islands now newly under the American flag was Mary's Island. Its longitude and latitude were given, and these practically coincide with those of Canton. When Mary's Island was actually first discovered by the white man is not known, but it must have been previous to 1828 because that year it was listed in the Reynold's Report on page 12 as Mary Balcout's Island.

On March 4, 1854, the New Bedford whaleship "Canton", Capt. Andrew J. Wing, piled up on the reef of Mary Balcout's Island or, briefly, Mary's Island. After a short sojourn on the waterless island, the captain and crew took to their open boats and reached Guam after forty-nine days at sea. Commander R. W. Meade of the U.S.S. "Narragansett" surveyed Mary's Island in 1872, and at that time renamed the island "Canton" to commemorate the shipwreck eighteen years before. The name, though inappropriate, stuck. Unlike that of the city of southern China, however, the name Canton is now pronounced with the first syllable accented.

As the supply of guano became depleted in the Phoenix Islands, the American companies abandoned them. John T. Arundel and Company, a London concern, then stepped in and took over the islands between 1883 and 1890, the British flag being hoisted and a protectorate declared. In 1916 Canton and the neighboring islands were leased for eighty-seven years to Capt. Allen of the Samoan Shipping and Trading Company. He planted some coconut trees, with the purpose of starting a copra industry. The last tree, now an erect dead trunk thirty feet high, survived until 1950. Because this tree was visible to ships at sea, Canton was often known as the Lone Tree Island to sailors.

After Capt. Allen's death in 1925, the islands were again abandoned. But with aviation coming to the fore and the Phoenix Islands being possible airplane stepping stones between North America and Australia, the United States and Great Britain both became vitally interested in the Phoenix Group.

Though the British sloop "Leith" claimed Canton for the crown in 1936, when H.M.S. "Wellington" brought New Zealand scientists to this atoll on May 26, 1937 to study a solar eclipse, a U.S. Navy - National Geographic Society eclipse party aboard the Navy seaplane tender U.S.S. "Avocet" was already there. It had erected a concrete monument bearing embedded in it two American flags of porcelain enamel on stainless steel,

claiming ownership of the atoll for the United States. One flag faces the rising sun; the other, the setting sun. On one side of the cement block, at right angles to the flags, is the small brass seal of the National Geographic Society. On Memorial Day the monument was unveiled with appropriate ceremonies. The "Avocet" had selected the best anchorage in the channel and refused to move when the British demanded it. The British then fired a shot across the bow of the American vessel and, according to some reports, the Americans retaliated in like manner. Both captains, realizing that their behavior in this affair smacked of a Gilbert & Sullivan operetta, then wired their respective governments in London and Washington what to do next. Both received quite similar instructions to do nothing rash. Scientists of both nations then studied the eclipse of June 8, personally cordial though officially a bit cool. Then before departing to leave Canton to her sea birds and crabs, they left the flags of their respective nations flying, their flagpoles embedded firmly in stone foundations. In July the U.S. minesweeper "Swan" sailed to Canton in a vain search for the tragic Amelia Earhart Putnam and her navigator Fred Noonan. The following month Great Britain landed two radio operators and equipment there. The British Ambassador in Washington asked the U.S. State Department to remove the American markers claiming sovereignty. Instead of complying, President Franklin D. Roosevelt on March 3, 1938, put Canton, as well as neighboring Enderbury Island, under the jurisdiction of the Secretary of the Interior. Four days later four Americans of Hawaiian ancestry were disembarked from the U.S. Coast Guard cutter "Roger B. Taney" on Canton as colonists. On April 1 the Secretary of the Interior granted Pan American Airways a license to use Canton as a stop on the California-Hawaii-South Pacific flying route, all personnel to be American citizens.

Full title to Canton has not yet been settled. England claims ownership of the island because of her hoisting her flag on various members of the Phoenix Group, though not actually on Canton itself, between 1889-1892. The United States claims ownership because of discovery and advertised claims of ownership during whaling days, and particularly on the proclamation issued in the President's name on the general subject of islands, which reads as follows:

> "The first claim to title over undiscovered territory rests on the discoverer.
> 2. Under this point, many islands in the Pacific were first discovered by American flag ships.
> 3. The United States has always held that mere discovery does not give final title. If it is not followed by reasonable occupation it is insufficient.
> 4. In relation to the islands in question, of which there are many, the United States is assuming the right to occupy either because of (a) discovery,

(b) former occupation, or (c) failure of any other nation to occupy, or a combination of (a), (b), and (c)."

Differences regarding Canton were finally resolved between the two Powers on April 6, 1939, when U.S. Secretary of State Cordell Hull and British Ambassador Sir Ronald Lindsay signed a treaty whereby British aircraft are guaranteed equal use of American aviation facilities on Canton, the island to be an Anglo-American condominium for fifty years or until later modified or terminated. As a result, a distinct American and a distinct British community were built on the island in close proximity to one another on the southwest rim. The pioneer in this work was Pan American Airways, which commissioned the "North Haven" to leave San Francisco in May 1939 and to place a construction crew of forty-three and a great quantity of supplies on Canton. In seven months these men had built a modern hotel, a hospital and a radio station on Canton and had blasted dangerous coral heads out of the seaplane runway in the lagoon. The first plane flight occurred in August 1939. With outbreak of war, PAA service was temporarily suspended, and the Army and Navy made extensive improvements on the island. Thereafter the company resumed flights, operating under contract to the Naval Air Transport Service. In late 1942 Japanese submarines shelled the island thrice. On March 25, 1943, Japanese aircraft bombed the island, inflicting "slight damage."

The island was surveyed between March and July 1938 for the Department of the Interior and recently revised, chiefly vegetationally by Hatheway, see Fig. 1 of Atoll Research Bulletin 43.

As Canton provides the best facilities for landing both sea and land planes in the Equatorial Pacific, the United States first dredged out parts of the lagoon for a seaplane runway. But as seaplanes became obsolete, landing strips were built by U.S. Army engineers, one running east and west and the other north and south. Revetments, for the protection of fighter planes, also were built, and still remain. The east-west runway was extended and resurfaced by CAA in 1950. The north-south runway has since been abandoned as well as a fighter strip about three miles east of the main runway. The present runway is built to handle the largest commercial airliners now in use. It has a rotating beacon approximately forty feet above mean sea level with a split white light turning at 6 r.p.m. This has been reported as visible at distances of sixty miles by approaching planes, and thirty-six miles by surface vessels. It is lighted from dusk to dawn. The construction of this beacon makes Musick Light, a white cylindrical stone tower twenty-eight feet above the water on the south side of the lagoon entrance, less important. For some time it was lighted by request only. In 1954 it was maintained by the U. S. Coast Guard, and burned every night.

Musick Light was named in honor of Capt. Edwin C. Musick who inaugurated the first scheduled cargo and mail service between the United States and New Zealand on December 23, 1937. He and his crew perished off Samoa during the second flight in the following January. The plaque on the monument, erected in July 1938, reads as follows:

DEDICATED BY THE UNITED STATES
DEPARTMENT OF THE INTERIOR
TO THE CREW OF
PAN AMERICAN AIRWAYS
"SAMOAN CLIPPER"
LOST AT SEA ON JANUARY 11, 1938
WHILE SURVEYING FIRST SOUTH
PACIFIC AERIAL TRADE ROUTE

* * * * *

Captain E. C. Musick

C. G. Sellers	P. S. Brunk, Jr.
F. J. MacLean	J. W. Stickrod
J. A. Brooks	T. J. Findley

During the war pillboxes and other fortifications were erected, their cement remains still dotting the flat landscape. With the fall of Tarawa, Canton declined in military importance and in 1946 aviation facilities were transferred from the War Department to the Department of Commerce. In 1950, modern housing units for the CAA personnel were constructed near the runway on the northwest rim of the island. Plans are under way to consolidate all activities on the north side of the island. Pan American Airways, now renamed Pan American World Airways, and the British community are still on the south rim, as well as the quarters for American bachelor employees of CAA.

Canton Island gains its present importance from its strategic location. It is the fueling stop for three different commercial airlines, namely, Pan American World Airways, Qantas Empire Airways (QEA), and Canadian Pacific Airlines (CPA). These fly an aggregate of fifty passenger planes per month between Hawaii and Fiji. From these centers, as hubs, passengers can radiate by plane or boat to all parts of the earth. Canton Island has a wharf where vessels of 5,000 gross tons can tie up if necessary. It boasts two post offices in the very same building; one American, the other British. Postal service by air is available twice a week both north and south; by surface carrier at irregular intervals, averaging perhaps once in four to five months. Wireless service is available to the public. Being a center of air transport, installations are of the best. It has a modern weather bureau, employing seven men.

A hotel operated by PAA provides room and board at approximately $10.00 per day for transients. Moving the American population from the southside of the atoll to the northside has

gone apace. By 1954 CAA had ready for occupancy in the latter area 25 modern family quarters, had set up five quonsets, and had rehabilitated five former military quarters. PAA now has five family quarters; and Standard Oil, a two-family house there. A hospital, with a physician in constant attendance, is in the vicinity.

In 1951 there was no school for American children; but the few children of Gilbert and Ellice Islanders living in the British settlement were being taught by the fifteen year old daughter of the Chief of Police, a native of the Ellice Islands. By 1954, according to Evans, Canton "has a good school with a teacher furnished by the Department of the Interior, and a kindergarten-nursery school with a teacher hired by the residents. Twenty-six children attend the "grade" school, and twelve are in kindergarten. Three of the grade school pupils are Gilbertese - two girls and a boy. These Gilbertese children are bright. There is also a Gilbertese school in the British Compound."

Three oil companies do business on Canton. According to their announcements Asiatic Petroleum Corporation specializes in aviation gasoline and aircraft oils; Standard Oil Company of California, in Chevron aviation gasoline and R.P.M. aviation oil; and Standard-Vacuum Oil Company, in aviation gasoline 100/130 and Esso-aviation oil 120.

The only industry, not connected with air travel, is fishing. Three concerns are now licensed by the American and British governments to engage in this enterprise. Their catch is shipped by air to Honolulu. An impression of the relative importance of this business may be gained from the catch of one of the companies in July 1950. It removed a total weight of 17,984 pounds of fish from Canton, this amount breaking up into:

Mullet------	13,488	lbs.
Manini------	1,798	"
Aholehole---	1,079	"
Oio----------	899	"
Uu----------	719	"

The census of Canton Island, as of December 31, 1949 , is illuminating:

1. Population

Nationality	Men	Women	Children	Total
U. S. citizens	117	15	15	147
Gilbert and Ellice Islanders	106	15	13	134
New Zealanders	18	2	0	20
Fijians	12	0	0	12
Australians	8	0	0	8
Tongans	3	0	0	3
Part-Fijians	2	0	0	2
French	1	0	0	1
Total	267	32	28	327

2. Employer Organizations (employees only; dependents shown in totals above)

a. Fisher Associates
U. S.citizens----------32
Gilbert and Ellice Islanders------ 9
New Zealanders---------- 1

b. Pan American World Airways (estimated)
Gilbert and Ellice Islanders------66
New Zealanders----------15
Fijians----------12
Australians---------- 5
U. S. citizens---------- 4
Tongans----------3
Part-Fijians---------- 1
French---------- 1

c. Oil companies
U.S. citizens---------- 5
Gilbert and Ellice Islanders------ 5
Australians---------- 3

d. British Station
Gilbert and Ellice Islanders------16
New Zealanders---------- 1
Part-Fijians---------- 1

e. Private
Gilbertese---------- 1

(The 42 Fisher Associates personnel and the 5 U.S. citizens under Oil Companies are engaged in construction and do not represent "permanent" population, nor does the personnel of R.C.S. "Margaret", which vessel was in port on December 31, 1949.)

3. Federal Personnel
Civil Aeronautics Administration-----70
U.S. Weather Bureau---------- 7
U.S. Post Office Department---------- 1

The U.S. Government on Canton Island is administered like a ship at sea. The U.S..Administrator represents other government agencies in the following capacities: for example, for the CAA he is Island Manager; for Treasury he is Disbursing Agent/Cashier; for Justice he is Deputy Marshall; for Coast and Geodetic Survey he is Tide Observer.

(Of the 70 CAA employees shown, 25 are engaged in construction and do not represent "permanent" population.)

4. Traffic Data

Carrier	Weekly Flights	Passengers
Pan American World Airways	6	90
British Commonwealth Pacific Airlines	6	90
Canadian Pacific Airlines	1	15
U. S. Navy (Samoa)	1	15
Civil Aeronautics Administration	2/3	10
Weekly total	14 2/3	220
Annual total	762 2/3	11,440

(PAA has two weekly round trips from the U.S. mainland to Australia and one to New Zealand. BCPA has four round trips. CPA from Canada to Australia transits south one week and north the next. CAA aircraft fly from Oahu, Hawaiian Islands, to Canton Island and return approximately every three weeks. In 1954 Qantas Empire Airways replaced BCPA.)

5. Ships calling at Canton during the year

CAA----------9
Oil companies----------4
Gilbert and Ellice Islands Colony----3

The British Government on Canton is administered by the Colonial Office, and is in perfect harmony with the United States Administrator. British subjects are governed by British law; American citizens, by U.S. maritime law. Each nation respects the other's laws. It is forbidden under British law for Fijians and Gilbert and Ellice Islanders to drink intoxicating liquors; they have their harmless and refreshing kawa or yangona as a substitute. It is likewise forbidden for any British subject to supply any alcoholic drinks to such Pacific islanders, the punishment being imprisonment for three months or a fine of £50/0/ or both. For an American, for example, to aid a British subject in breaking this British liquor law might subject him to dismissa from his position on the island as an undesirable troublemaker. For any heinous crime, on the other hand, the suspect would be tried in Federal court in Honolulu, Hawaii.

In this condominium, American workmen receive wages as high as or higher than workmen performing similar tasks in Hawaii or the continental United States. British workmen under British rule receive wages according to British standards. For instance, according to a regulation posted by the District Officer, June 14, 1950, the following wages for the employment of domestic colored labor were established as the legal rate:

Duties	Frequency	Rate per month
Washing and/or ironing	Once per week	$4.00
" "	Twice per week	7.00
General housework	Up to 3 hrs. per day (6 days per week)	12.00

"(Employers are not expected to maintain employees as regards rations, should they desire to do this, the District Officer will immediately be advised of this intention and will determine a reduction in the salary or salaries concerned, to meet such a contingency.)"

LAND FLORA

From the biological standpoint it is more logical to begin a discussion of a flora with the most primitive plants, aquatic ones, and to end with the most complex. But as the purpose of the visit to Canton dealt primarily with land plants, we shall begin our discussion with these.

According to a manuscript of Bryan's, who visited the island in 1924: "The rim varies in height from ten to twenty feet, and is for the most part covered only with low, prostrate vegetation, consisting of herbs and vines of common wide-spread Pacific species of Portulaca, Boerhaavia, Sesuvium, patches of Lepturus (bunch grass), Triumfetta, two species of Ipomoea, and stunted Sida bushes. A stretch of about two miles along the south side is covered with scaevola bushes, from 8 to 12 feet high. There are a few scattered Pemphis* bushes, a few Morinda, Tournefortia [Messerschmidia], and dry, scrubby Cordia trees. Most of the trees are scattered along the middle portion of the north rim; there are two patches near the N.W. point. Near the main lagoon entrance (on "Observation Point") are half a dozen coconut palms, the remnant of a number which were planted; and two other coconut palms are standing on the N.W. point. In 1937 the New Zealand solar eclipse expedition planted about 3,000 sprouted coconuts, some on the S.W. side and some on the N.E.; in time some of these may grow."

Before dealing briefly with the plant communities, each kind of plant observed or collected up to May 1951 is listed, with pertinent notes, below. These are arranged taxonomically. Numbers after the names of Fosberg and Walker refer to actual specimens collected in January or March 1949 and to be deposited in the U.S. National Herbarium in Washington. These have not been studied by the writers, but are here recorded on the basis of personal information submitted by F. R. Fosberg. Numbers after the names of Degener and/or Hatheway refer to specimens collected by these workers in 1950 or 1951 and deposited at the New York Botanical Garden, at the Bishop Museum in Honolulu, in the U. S. National Herbarium, and usually elsewhere.

Pandanaceae

Pandanus tectorius, the screwpine or hala, is native to the tropics but not to Canton. It is cultivated on the grounds of the PAA hotel on the southwest side of the island. The larger of

*Evidently in error for Suriana.

the two specimens is about ten feet high, picturesque and moderately healthy. Degener shipped seeds from Honolulu to Canton in July 1950. These germinated and are now planted out in the CAA housing area. They should thrive with perhaps a little watering during the driest seasons until their roots penetrate the sandy soil to depths allowing them to draw upon the layer of lighter brackish water which floats upon the heavier sea and lagoon water underlying every part of Canton's rim of land, and rises and falls with the tide.

Gramineae

Cenchrus echinatus (Fosberg & Walker 30,202, 30,217; Degener & Hatheway 21,252), the common sandbur, is a grass native to tropical America and obviously of recent accidental introduction. It was first recorded as collected on Canton in late 1949 or early 1950 by Katharine Luomala in her "Plants of Canton Island, Phoenix Islands", in Occas. Pap. B. P. Bishop Mus. 20 : 172, 1951. This, however, is not the first collection of the species as Fosberg & Walker had collected it January 30 - 31, 1949. It is ubiquitous about the airport and the civilized areas and still rare or wanting where man, carrying the burs on his socks, has not gone. It is an annual, springing up quickly during rainy weather, maturing its troublesome burs and then dying until the next rains come to wake the seeds into life.

Chloris inflata (D. & H. 21,251), a finger grass, was growing naturalized in a small patch in July 1950 near the abandoned runway. Seeds scattered by Degener about the same time had grown and matured by May 1951 in a thick stand near the wharf and oil tanks on the north side of the island, and near the hotel on the south side.

Cynodon dactylon (D. & H. 21,286), the Bermuda grass, is sparingly naturalized and carefully planted by residents near the hotel, at the airport and in the CAA housing area. According to Van Zwaluwenburg in the Haw. Pl. Record for 1941, this grass came to the island in importations of soil from Oahu. Seeds were also imported by a resident of the CAA housing area for planting in 1950.

Digitaria sanguinalis (D. & H. 21,315), a slender creeping grass, was found sparingly naturalized about the airport in July 1950.

Digitaria pacifica (Fosberg 30,886; D. & H. 21,316 -21,318) is the native annual bunchgrass known as D. stenotaphrodes to some authorities. It has fingered flower heads. It is found scattered here and there, preferably in recently disturbed areas such as along the sandy side of the road. It is a lush green, grows quickly after rains and usually dies shortly before the next rainy season. It is variable on Canton, requiring extensive study and probably segregating into several varieties. It has

been collected since early days. This grass is badly eaten by a grasshopper (Ailopus tamulus), accidentally introduced from perhaps Samoa or Tonga.

Digitaria timorensis (Hatheway 518) is an Oriental grass of accidental introduction growing in a few waste places near the hotel. It was first collected in February 1951.

Eleusine indica (F. & W. 30,211; D. & H. 21,254), the goosegrass, is native to the Old World. It is naturalized and very common only near human habitations. It is evidently of recent introduction, being first collected by Fosberg and Walker in January 1949. It is very successful because it is a quick-growing annual that can complete its life span during the short wet season.

Eragrostis amabilis (D. & H. 21,297), a pretty and delicate grass, is naturalized mainly about the hotel, and will undoubtedly extend its range. It is of recent accidental introduction.

Eragrostis whitneyi (F. & W. 30,206; D. & H. 21,319 and 21,320), very closely related and perhaps not specifically distinct from E. paupera, is a native grass first collected by Bryan in 1938. It is a pretty, dwarf, tufted annual growing on hard, sandy plains as, for example, near the airport.

Eragrostis pectinacea (D. & H. 21,312) is a very rare grass growing near the wharf on the north side. It is of recent accidental introduction.

Lepturus pilgerianus (D. & H. 21,291) is a very rare, native bunchgrass thus far known only from Canton, where it grew in sand. It is peculiar in being the only annual in the genus.

Lepturus repens (F. & W. 30,212; D. & H. 21,311) is a native perennial bunchgrass with columnar flower stalks. It has been collected since early times. It is somewhat variable. It is darker, harsher, denser and more abundant than the native Digitaria, and is tolerant of drier, more firmly packed areas. Its leaves are eaten by the introduced grasshopper. The terrestrial hermitcrab, described later, may kill certain tussocks by pulling out with the roots clawfuls of culms, starting these depredations from the outside of the cluster and gradually working toward the center. Perhaps their tender bases taste akin to corn on the cob.

Panicum miliaceum (D. &. H. 21,314) was found growing very localized near the hotel in 1950. It is of accidental introduction, perhaps derived from spilled canary bird seed.

Setaria verticillata (D. & H. 21,253), the bristly foxtail, is a nasty weed native to Europe. It is found everywhere near

habitations and is obviously of recent accidental introduction. The clusters of seeds adhere to clothing of all kinds. This grass is a successful annual, disappearing during the dry season.

Cyperaceae

Cyperus rotundus (Degener 21,413), the nutgrass, is a troublesome sedge of lawns and gardens throughout the tropics. It was one of the plants recorded by Van Zwaluwenburg in the Haw. Pl. Record for 1941 as imported in "soil from Oahu." Degener observed a few good stands in 1951 growing near the hotel but nowhere else.

Fimbristylis diphylla (D. & H. 21,288 and 21,289), a perennial sedge, grows near the outdoor theater. Because of its proximity to human structures or habitations, it is suspected to be foreign to Canton. It was probably accidentally introduced as seed from some other South Sea island, perhaps in a clod of earth stuck to machinery or to the shoe of some member of the Armed Forces.

Fimbristylis pycnocephala (D. & H. 21,290), another perennial sedge, grows on a barren plain near the CAA housing area. It forms harsh tussocks with pincushion-like flower-heads radiating in all directions. Because of its occurrence only in an area disturbed by man, it likewise is suspected to be a foreigner. This is probably the species recorded by Luomala as occurring on Canton in 1949 - 1950 (ibid. 168) and identified as F. cymosa.

Palmaceae

Cocos nucifera, the coconut. Not a single coconut palm is native to Canton. All were obviously planted. As mentioned above, Capt. Allen planted some coconut trees in 1916. Two, probably relics of that planting, grew for many years on the northwest point and were conspicuous and useful landmarks for ships at sea. They had become about 10 feet tall by 1924. The last survivor died in 1950, at a height of about 25 feet. In 1937 the New Zealand eclipse expedition set out about three thousand, but few survived. According to H. W. Bigelow in 1939, there were "nine scattered palms," and according to E. J. Witt in April of the same year also "many very small ones" about 18 inches high. There are some nice trees of medium size about the hotel, unfortunately infested by the Florida red scale insect (Chrysomphalus ficus), evidently due to the introduction of unfumigated plants. Small coconut palms are no longer rare elsewhere on the atoll, but grow only successfully where given a little care.

Araceae

Anthurium and Philodendron of several species were being grown as house plants in 1951, as well as a number of other

plants, belonging to various botanical families, which will probably never survive to become an element in the local flora. Many of these are purchased in flowershops in Australia, Fiji or Hawaii, carried in ladies' handbags on the planes, and then kept alive on Canton for a limited length of time. To list such casual and ephemeral introductions kept on bookcases and dining-room tables is hardly worthwhile.

Amaryllidaceae

Crinum asiaticum, the grand crinum, is native to the Orient. This hardy herb was introduced recently from Hull Island for planting about the hotel and the Terminal Building. The plants readily propagate from the base and become crowded. They then need thinning and replanting for best results.

Musaceae

Musa nana and other kinds of bananas have been imported from various regions and planted out. They persist with some care. It is redorded that some were set out in 1937 and later, but in July 1950 none was observed. By April 1951 new corms had been imported and were growing nicely where properly watered.

Casuarinaceae

Casuarina equisetifolia (Fosberg 30, 876; D. & H. 21,303), the horsetail beefwood or ironwood, is native to Australia and elsewhere in the South Seas. It is not native to Canton. Several trees are growing near the hotel, and are quite healthy. More should be introduced, even though no other plants, excepting perhaps the tree heliotrope, will grow beneath their falling branches, which simulate pine needles.

Casuarina glauca (Degener 21,372), the coarse ironwood tree, is likewise native to Australia and is foreign to Canton. It grows near the hotel, where it was planted many years ago. It is peculiar in sprouting from the roots at considerable distances from the main trunk.

Polygonaceae

Coccolobis uvifera (Fosberg 30,878), the seagrape, is native to the Bahamas. It is a densely leaved shrub or small tree planted and thriving about the hotel. The fruit is edible and can be made into jam and jelly. The plant was recorded by Van Zwaluwenburg in 1943 (Proc. Haw. Ent. Soc. 11. 3 : 306) as "recently introduced." The trees flower and fruit abundantly after rains, the seeds often germinating in the rainy season where they fall under the trees. These seedlings die for the most part during the prolonged drought. The annual supply of seeds from these trees, properly planted out, could soon markedly improve the entire aspect of the atoll. The plants are often

infested with the long-tailed mealybug (Pseudococcus adonidum), for the control of which an insect enemy can be introduced.

Amaranthaceae

Amaranthus dubius (D. & H. 21,295), an amaranth possible to use as a potherb in time of famine, now grows sparingly as an introduced weed near human habitations as, for example, about the hotel. It is a welcome addition to the island, which the spiny one, not yet here, would not be. Should the latter come, it should be eradicated before it has the opportunity to spread and become another prickly pest. An amaranth, species not given, was mentioned first by Van Zwaluwenburg in the Haw. Pl. Record for 1941 as reaching Canton in importations of soil from Oahu. Then in 1943 in the Proc. Haw. Ent. Soc., he refers to it again as "the recent immigrant Amaranthus."

Nyctaginaceae

Boerhavia tetrandra (F. & W. 30,207; D. & H. 21,305, 21,313), is a native perennial herb. It is found throughout the island, thriving everywhere excepting in the lowest, saltiest area. It has a few exceedingly long, fleshy, juicy roots at the surface of the ground to take advantage of the gentlest showers whose rainfall fails to penetrate the soil deeply. Its leaves are fleshy and its long-stalked flower clusters are white, not pink, as reported by some writers. The entire group is a difficult one. Some authors consider our plant to be B. diffusa, perhaps correctly so. It is subject to a native fungus disease (Albugo sp.) that dwarfs its leaves.

Aizoaceae

Sesuvium portulacastrum var. griseum (F. & W. 30,203 - 30,205; D. & H. 21,373; Degener 21,451) is a prostrate herb forming extensive mats of thick stems and leaves, preferably in depressions near the lagoon beach where salts may accumulate on drying. The plant is somewhat evil smelling. Being fleshy and rather brittle, it dies in solid black lines soon after the wheels of a car have passed over it. Its pale pink flowers are hunted out by the hermitcrab which, as in the case of the native purslane, eats stamens and ovary. In this case these crabs also extract the ripening seeds from the somewhat fleshy capsules for food. Perhaps in doing so, some escape, thus aiding the plant's dissemination. The plant readily roots at the nodes. The species itself has been recorded in error from the atoll by previous writers.

Portulacaceae

Portulaca lutea (F. & W. 30,208; D. & H. 21,285), the native

yellow portulaca or purslane, is a beautiful succulent, pale green perennial, resembling the jade plant. It grows everywhere. Its thick branches rise slightly from the ground. Its flowers open tardily in the morning and do not wilt uhtil sunset or shade overtakes the plant. It can be eaten as a potherb in times of famine. The terrestrial hermitcrab feeds on the stamens and ovary, usually leaving the rest of the flowers attached to the plant.

Portulaca oleracea (Fosberg 30,881; D. & H. 21,283), the common purslane of Europe and America, is obviously of recent introduction. It may well have come from Hawaii to which Don Marin purposely introduced it in the early part of the nineteenth century. It is still of local distribution, growing mostly near human habitations. It is bound to spread and, from the appearance of a few plants, may be sparingly hybridizing with the native species. It differs from its native relative in being more prostrate, more slender, often somewhat red-stemmed, and in bearing smaller flowers opening usually in the morning and wilting at noon. It is used as a potherb, especially in France.

Cassythaceae

Cassytha filiformis (D. & H. 21,282), the love-vine, is native to Canton. It was first collected by Bryan in 1938. It is a rootless parasite consisting of pale green, intertwining string-like branches bearing tiny whitish flowers and marble-like fruits. Its sucking organs or haustoria rob other plants of sap. One love-vine may twine and gain nourishment from many different kinds of hosts. In one instance it was observed tnat one plant was growing on the native triumfetta alone, and thriving on this limited diet.

Leguminosae

Leucaena glauca (Fosberg 30,882; D. & H. 21,296), the haole koa of Hawaii, is a small tree with feathery leaves, pompons of small whiteoflowers and flat brown beans. It is native to tropical America. A few mature plants are in cultivation about the hotel, where they flower and sparingly reseed themselves. Van Zwaluwenburg stated in 1941 that the haole koa reached Canton in the importation of soil from Oahu. Thousands of seeds planted in April 1951 in many parts of the island appear to be tolerant of salt in tne soil, and tne seedlings are maintaining themselves in most cases where not exposed to extreme dryness.

Zygophyllaceae

Tribulus cistoides, the large-flowered caltrop or puncture vine, is typically a beach plant with flowers resembling a buttercup, and with nasty spiny fruits. These are a menace to barefoot bathers and may even puncture auto tires. This pretty weed was

recorded from Canton by Van Zwaluwenburg in the Haw. Pl. Record 45 : 17. 1941. It has not been observed by the writers who therefore consider the record erroneous.

Simaroubaceae

Suriana maritima (D. & H. 21,305), the baycedar, is native t coastal regions of both the Atlantic and the Pacific. It is a densely leafy shrub with small yellow flowers, and commonly grows gregariously. It is often used as a shelter by the ground-nesting tropic bird. This plant may have been mistaken for Pemphis by earlier writers.

Euphorbiaceae

Acalypha wilkesiana, the painted copperleaf, is a Fijian shrub now planted throughout the tropics as an ornamental hedge plant. A few specimens were observed cultivated in 1951 about the hotel. They were responding favorably to a little care and watering.

Chamaesyce hirta (Fosberg 30,873; D. & H. 21,298), the hairy-leaved spurge, is a low spreading herb with milky juice native to tropical America. It is a recent accidental introduction and grows well and often common in many areas influenced by man. It is a welcome addition to the ground cover of the island. More conservative botanists place this and the following two species in the genus Euphorbia.

Chamaesyce hypericifolia (F. & W. 30,216; D. & H. 21,300), the hypericum-leaved spurge, is related to the above. It is taller and is still rather rare, being known as yet only from the vicinities of the hotel and the airport.

Chamaesyce prostrata (D. & H. 21,299), the prostrate spurge, is another South American relative. It lies flat on the ground, has thread-like branches and tiny leaves. It is locally naturalized near the airfield, about the hotel and elsewhere but not away from the influence of man. This in itself proves its recent introduction. These three species may be the ones mentioned by Van Zwaluwenburg in 1941 as having come from Oahu in imported soil. The erect specimens collected by Luomala and recorded as E. prostrata were either parasitized by the fungus Nigredo proeminens or the specimens were misidentified.

"Euphorbia" (Fosberg 30, 214, 30,880), not seen by writers.

Euphorbia, see under Chamaesyce and Poinsettia.

Phyllanthus niruri, the niruri, a pantropic weed of American origin, was growing in 1951 in and about a box of soil imported from Fiji. It appeared to be spreading rapidly from seed to the surrounding area.

Poinsettia cyathophora (Fosberg 30,885; D. & H. year 1951) is sometimes called Euphorbia heterophylla var cyathophora. It is the fiddle-leaved poinsettia native to tropical America. Its upper leaves are basally blotched with bright red, adding color to the landscape. This erect herb is sparingly naturalized and protected in the spic and span British Settlement, where it grows on sun-scorched coral rubble that may act in part as a mulch to conserve ground moisture. It is of course a modest, wild relative of the garden poinsettia (P. pulcherrima), of which recently imported cuttings were being propagated in 1951 in cans by a resident of the CAA housing area.

Tiliaceae

Triumfetta procumbens (F. & W. 30,215; D. & H. 21,281), the trailing burbush, is native to Canton. It is a shrub with extremely long, trailing, woody branches and very long, spreading roots running just below the surface of the ground in all directions. It prefers arid dunes. The branches occasionally strike root five to six feet away from the mother plant, and from such centers additional trailing branches arise. The leaves are thick, roundish to slightly lobed, and bright green. The flowers are yellow and soon mature into spherical, spiny burs that lie in black masses where the mother plant may have eventually succumbed to an especially dry year. This plant could be mistaken for Tribulus.

Malvaceae

Hibiscus rosa-sinensis, the common hibiscus, is represented in gardens by less than a dozen plants.

Hibiscus tiliaceus, see under Pariti.

Pariti tiliaceum (Fosberg 30,888; D. & H. 21,284), the hau or vau of South Sea Islanders, is a relative of the hibiscus and by more conservative botanists placed in the same genus. It is a small tree with yellow flowers having a maroon center. These flowers fade reddish at night. In 1943 Van Zwaluwenburg reported insects "on the recently introduced 'hau'," thus giving us an approximate date as to the plant's coming to Canton. One slowly growing tree, suffering from drought, stands near the hotel laundry; a few others in neighboring gardens, and one at Musick Light. It produces flowers in spite of abuse. This tree, like many others introduced by Degener in 1950 for CAA, thrives when exposed to a little brackish water. A deep hole should have been dug for it through the coral rock and hardpan down to the water table. Into this hole a few posts or old boards should have been placed in an upright position before refilling with earth and planting the tree. The presence of the decaying boards would deter future formation of a troublesome hardpan and would facilitate root growth down toward water.

Sida carpinifolia, the hornbeam-leaved sida, is a native of tropical America but is now almost pantropic in distribution. It was represented in 1951 by a single wild plant growing near the hotel from a box of soil imported from Fiji.

Sida fallax (F. & W. 30,201; D. & H. 21,329), the ilima of the Hawaiian lei vendors, is a twiggy perennial shrub with finely velvety leaves and many small orange-yellow hibiscus-like flowers. It is native, and almost everywhere. For their dances, the South Sea islanders on Canton bedeck themselves with garlands made from this plant. The red-tailed tropic bird prefers to nest under its spreading canopy of branches and under the Suriana. Unlike the common ilima of Hawaii, whose flowers usually possess a dark eye, all flowers on Canton are uniformly colored. In studying thousands of plants, a few freaks or sports were observed. Should such plants become isolated on some island devoid of Sida otherwise and thus be prevented from cross-pollinating with more normal plants, they might develop into entirely new species or kinds. Such freak plants, therefore, are worthy of mention. One (D. & H. 21,330)possessed an unusually pale corolla; another (D. & H. 21,331), growing near the old guano diggings, bore filled flowers; and a third (D. & H. 21,332), growing near the CAA housing area, was densely twiggy and bore innumerable small leaves. These Sida, and the Scaevola as well, may be attacked by aphids. The ladybird beetle, Harmonia arcuata, however, tends to keep them under control.

Thespesia populnea (D. & H. 21,308), the milo of the Hawaiians, is a small tree with numerous leaves that can be eaten raw during times of famine. It bears an attractive hibiscus-like pale yellow flower with dark eye, and roundish corky seed pods that break open irregularly. Van Zwaluwenburg, at a meeting in May 1942 (published in the Proc. Haw. Ent. Soc. 11. 3 : 306.1943.), mentioned the occurrence of certain insects "On the introduced malvaceous tree 'milo'", thus proving that this species was on Canton previous to 1942, and even at that time was considered foreign to the native flora. In 1950 several trees were observed cultivated at the hotel and growing near the wharf on the north side of the island. This tree prefers access to brackish water.

Guttiferae

Calophyllum inophyllum, the true kamani of the Hawaiians, is native from India to the South Seas, exclusive of Canton. Where native, it grows to be a huge tree, bearing attractive white flowers and large round corky fruits from whose kernel a medicinal oil is expressed. The logs were used for canoes. A few trees were observed planted near the hotel. Their seemingly parallel-veined leaves were badly infested with the Florida red scale. Potted plants shipped to Canton by Degener in July 1950 and set out in the open were thriving in May 1951.

Tamaricaceae

Tamarix aphylla (Fosberg 30,877; D. & H. 21,306), the European tamarix, confusingly resembles the beefwood or ironwood. It bears, however, pink, heather-like flowers. Beautiful specimens have been planted on the hotel grounds. Cuttings from Oahu plants set out about some buildings in July 1950 were growing in April of the following year but were suffering from drought. They require a little watering and aid for their roots to penetrate the soil to greater depths.

Passifloraceae

Passiflora foetida, the foetid passionflower, native of tropical America, was observed in July 1950 growing carefully tended at the hotel and near the airport building. It is a recent introduction. Seeds planted in July 1950 by Degener did not germinate until after the unusual rains of April 1951.

Caricaceae

Carica papaya, the papaya, is native to tropical America and frequently grown locally from seeds derived from imported fruits. The seeds readily germinate and some of the resulting trees may grow to good size. Those observed are fruitless and invariably chlorotic, or yellowish. This is due either to the lack of some necessary mineral or more likely to the plant's inability to extract it from Canton, this soil perhaps holding it too firmly in some complex chemical bondage. Success might be gained by planting the seeds in a compost pit and adding a little solution recommended by local devotees of hydroponics. Reducing exposure to the intense sunlight might also be helpful in stimulating production of a crop.

Combretaceae

Terminalia catappa (Fosberg 30,875), the Indian almond, is native to the Old World. It is one of the few tropical trees that exhibits autumn coloration in its foliage. The kernel is edible and, rarely, the outer part of the fruit. It has been planted on the hotel grounds and would thrive excepting for insect injury. Seedlings, introduced in July 1950, were in a thriving condition the following May.

Terminalia samoensis (Fosberg 30,879), collected by Fosberg on March 6, 1949, was not collected by the writers. Nor did they notice T. melanocarpa or T. littoralis mentioned by Luomala.

Araliaceae

Polyscias guilfoylei, the panax of Hawaiian residents, was recorded in 1951 by Luomala as having been planted recently and

to have died later. It was noticed growing by Degener in the British Settlement in May 1951, but not thriving.

Apocynaceae

Ochrosia, species not determined, was observed in cultivation in 1950 on Canton by MacDaniels according to a personal communication.

Plumeria rubra (Degener, year 1951), the pink flowered frangipani, is native to tropical America. Several trees, cultivated in the hotel grounds living in July 1950 and covered with the crater scale, succumbed shortly after. Only one was surviving in May 1951. This scale insect is just another foreign pest that has been able to slip into the island for lack of proper regulations of inspection and fumigation. A few trees with small flowers from New Providence Island, Bahamas, where they are native and still growing wild, were set out in 1950 by Degener and are thriving.

Asclepiadaceae

Calotropis gigantea forma wilderi (D. & H. 21,294), the white crown flower, is a color form of the more common purple crown flower native to tropical Asia. It is commonly planted and grows well from cuttings. It, however, also suffers from chlorosis and its leaves may be eaten badly by caterpillars of the monarch butterfly, an insect occasionally flying here from over the ocean. The plant was recorded from the island for the year 1940 when Van Zwaluwenburg wrote about "the introduced Calotropis or 'crown flower'." Today a huge shrub grows near Musick Light, from which residents commonly gain cuttings.

Convolvulaceae

Calonyction species (D. & H. 21,309, 21,310), a moonflower, is obviously the second native morning glory recorded from Canton. It has been variously identified as Ipomoea grandiflora and I. tuba. It grows chiefly among arid guano deposits inland along the northeast rim. It is a climber bearing dark green, heart shaped leaves and large white flowers that bloom at night. By the time dry weather comes, it has matured its seeds and has died back to a massive rootstock. It is occasionally planted as an ornamental on trellises.

Ipomoea pes-caprae (Degener, year 1951), the beach morning glory, is practically pantropic, being limited in its extensive range, however, almost solely to sandy beaches. It was collected in 1924 by Bryan from "Canton Island, Obs. Point, lagoon side, small patch, el. ½ - 2 m." and in 1938 on "west end, near camp, on sandy beach, alt. 2 - 3 m." Van Zwaluwenburg recorded it from Canton in the Haw. Pl. Record 45 : 17. 1941. Degener found an old flowerless plant with massive rootstock near the hotel

rubbish dump in April 1951. The plant grew inland near the remains of an army camp. No other mature plants are known to him. And as the cotyledons of seeds he planted in April 1951 were injured as soon as they appeared above the ground by land hermitcrabs, he suspects that the one old plant may have been planted by a soldier and partly guarded by him from injury until it had become established. The previously recorded plants, likewise, may have been protected by man. Because of the abundance of this creeper along tropical shores, new wave-borne introductions to Canton probably arrive from time to time and may persist until they succumb to the ravages of the crabs during some period of food scarcity.

Boraginaceae

Cordia sebestena (Fosberg 30,874; Degener 21,374), the geigertree, is native to Florida and the Bahamas. It is a small tree with sandpapery leaves, brilliant scarlet flowers, and whitish fruit. From the size of the trees about the hotel grounds, this ornamental must have been planted ten or so years ago. It suffers a bit from dryness, but more from leaf-eating insects and from scales. It fruits freely and some of the seeds germinate where they fall. These should be planted in new localities as this tree is worthy of more extensive cultivation on the island.

Cordia subcordata (Fosberg 30,887; D. & H. 21,287), the kou of the Hawaiians, has corky seeds adapted for dispersal by ocean currents. The kou may have reached Canton without human aid. If it did, it is interesting to speculate how many seeds reached the atoll before one finally escaped destruction by hermitcrabs and grew to maturity. Two small healthy patches of kou forest, occurring on the southwest end of the island have long been shown on maps and used as landmarks at sea. One of these interesting groves is unfortunately being damaged by picnic parties, some of whose members are apt to wield an ax indiscriminately. Other clusters of kou trees grow mainly near the old guano wharf, practically at the edge of the lagoon. These are said to have been planted years ago. Seeds from such trees should be collected for cultivation elsewhere on the island. The branches of the kou grow mostly erect, making them impossible nesting sites for clumsy nest builders like boobies and frigate birds. These branches bear large, pale leaves and nectar-filled orange flowers followed by the corky fruits enclosing several seeds. The trees near the lagoon are sickly, their branches often dying back to near the base during dry seasons and thus lending to the tropical landscape a wintry appearance. Death of the branches is hastened by land hermitcrabs which climb them to shred and eat the crisp, juicy bark on one side, usually the upper, for a considerable length. Though many fruits are produced to litter the ground under the trees year after year, only those that are fortunate enough to get buried can sprout their seed. The seedlings bear two dark green, longitudinally pleated cotyledons,

As the kou casts welcome shade about itself, it is always the resting place for hundreds of hermitcrabs. Some of these may wander about in the grove any time of day, while the majority sleep until the heat of the sun has waned and it is time to sally forth for food. Thus, every hour of the day, these seedlings are at the mercy of an army of voracious crabs. Though many seedlings appear above ground after a period of rainy weather, the writer has yet failed to see a single one escape annihilation. Obviously, seedlings arising from seeds transported away from crab-infested groves have a better chahce for survival. In spite of the destruction of seedlings, the groves often increase in size. This is accomplished mainly by suckering. The kou grows rapidly, seeds planted in July 1950 being erect trees a foot or more high by the following April. Trees are often badly defoliated, particularly on the lee side, by the caterpillars of a moth (Achaea janata), which prefers to lay its eggs on the side of the tree protected from the wind. About the only natural enemy this caterpillar has on Canton is a true, evil-smelling bug. This predator inserts its needle-like beak into its victim, sucking its juices and killing it. It is called Oechalia consocialis.

Messerschmidia argentea (Fosberg 30,884), the tree heliotrope, is the most beautiful tree on the island. It is incorrectly known as Tournefortia and "skayviola." It is native and most commonly forms clumps or small groves, a typical one persisting at the newly established plant nursery near the airport. It bears small white flowers and silvery leaves which, when dried, may be used as a substitute for tobacco. The leaves are often eaten by caterpillars of an ornamental moth (Utetheisa pulchelloides), but seldom seriously. Near the hotel one of the trees has become badly infested with the minute hibiscus snow scale (Pinnaspis strachani). As long as the tree is allowed to stand in this condition, it remains a menace as this insect may spread from it to all the tree heliotropes on the island. It reproduces rarely from seed, clumps increasing their size from shoots arising from reclining branches.

Solanaceae

Lycopersicon esculentum var. (D. & H. 21,307), the wild tomato, grows near the airport near the ruins of army shacks. It was observed first in July 1950 and, almost dead, again in April 1951. It is a sprawling plant with unusual leaves. It matches perfectly tomato plants growing wild in the Galapagos Islands and may prove to be an undescribed variety.

Nicotiana glauca (D. & H. 21,305), the tree tobacco, is native to the New World. It is a slender tree with bluish stems and leaves, and yellow flowers. A single plant was found in July 1950 near the CAA housing area. It was without flower and fruit, and had been badly mauled by a bulldozer. Seeds brought from Honolulu in July 1950 and sown among coral rock had flowered by April of the following year. The plants had been blown flat by the prevailing wind and were chlorotic. It is a very desirable introduction of great promise.

Physalis angulata (Degener 21,411), the husk tomato, is sparingly introduced, a few plants growing naturalized in the British Settlement in May 1951.

Rubiaceae

Morinda citrifolia (Degener 21,412), the noni of the Hawaiians, is native to Pacific Islands and can be readily transported by water from one region to another because of a special air chamber located at one side of the seed. If it were native to Canton, one should expect to find seedlings, but none was observed. Bryan in 1924 reported the noni as occurring "Single or in clumps." Degener found a single large tree, loaded with flowers and fruit, near the old guano wharf. Scores of hermitcrabs were resting in its shade, and not a single seedling anywhere. The seeds are probably eaten upon germination.

Cucurbitaceae

Cucumis melo, the muskmelon, was found growing near some abandoned shacks in July 1950. The seeds probably came to the island in a breakfast fruit.

Goodeniaceae

Scaevola frutescens (Fosberg 30,872; D. & H. 21,301, 21,302), known as naupaka in its Hawaiian variety sericea by the Hawaiians, is found in many varieties and forms along many coastal regions of the Pacific. Through local confusion, its name obviously has been transferred to Messerschmidia as "skaviola." The plant native to Canton is a shrub eight or more feet high bearing large shiny smooth leaves, and white flowers and fruits. It grows gregariously. It is extremely important as, from time immemorial, its extensive groves were preferred as rookeries by boobies and frigate birds. The accumulation of their excrement, century by century, built up the guano deposits for which Canton first gained commercial recognition. Being gregarious, these birds avoid isolated naupaka bushes and instead nest in those growing in dense groves. Isolated bushes and groups of young bushes too small for nesting sites are usually a beautiful, crowded mass of healthy green leaves and white flowers and fruits. Bushes in the rookeries, in contrast, are sickly, dying or dead.

This unfavorable condition of the naupaka in the rookeries is not due so much to mechanical injury caused by the heavy birds clumsily alighting among the branches, as to the chemical action of the bird droppings. The details of these chains of chemical reactions, especially in a calcareous soil impregnated with sea salt, still remain to be worked out. Nevertheless, we are reasonably sure that two types of injury occur: first, the excrement of birds, rich in uric acid, is splattered wet over the leaves, in part absorbed by them, variously modified into other poisonous substances, and then translocated throughout the plant to its great detriment; second, much fresh excrement litters the ground. To this mass are added the whitewashed dying leaves as they fall or, in case of rare, cleansing showers, their

coating of filth. Simply explained, the naupaka in Canton rookeries are very like garden plants dying from an excess application of chicken manure. They just can't tolerate these various nitrogenous compounds in such concentrated form.

As a result of this interaction between nesting birds and plants, there appears to exist something of a cycle, not clear cut, to be sure. Under simplified, ideal conditions it might best be explained as consisting of flocks of birds gradually killing with their excrement a grove of naupaka bushes in one area. While this is transpiring, seedlings of naupaka are growing healthily elsewhere undisturbed by nesting birds. As the old poisoned bushes finally succumb and break to the ground, the birds, somewhat unwillingly at first, are forced to shift their rookeries to the stands of naupaka which by this time have grown sufficiently tall and sturdy for nesting sites. The cycle then repeats itself as these plants, in turn, gradually succumb to poisoning and crumble away, obliging the birds to shift to still another stand of young bushes, probably actually growing in a locale where their ancestors had been killed out several hundred or thousand years before. Test holes dug by Hatheway show deposits of guano where no shrubs now exist. We cannot imagine that the ancestors of our present guano-producing birds had radically different nesting habits from the present generation. The presence of guano almost certainly indicates the former presence of groves of vegetation.

Compositae

Emilia sonchifolia, the purple emilia, was not observed by the writers in 1950-51. But Van Zwaluwenburg in the Haw. Pl. Record for 1941 stated that "Importations of soil from Oahu have resulted in the recent establishment on Canton of several weeds such as Emilia sonchifolia. . ."

Pluchea odorata (F. & W. 30,210; D. & H. 21,295), the shrubby fleabane, is native from Florida to northern South America. It is naturalized here and there about the airfield and disturbed areas, and is evidently of recent accidental introduction. It is expected to extend its range.

* * *

Thus far, individual kinds of plants have been discussed. Now we shall deal briefly with associations* of plants.

Portulaca lutea and Boerhavia grow together, with the exclusion of every other kind of plant, in large areas of consolidated reef and rubble. When even slight showers fall, their shallow roots can absorb the rain, and this water is stored in their tissues for use during long periods of drought. In other places the rootless Cassytha likewise occurs, parasitic on the two plants. Where the soil is more sandy, Portulaca and Boerhavia may be associated with the perennial bunchgrass Lepturus. In general, Portulaca and Boerhavia are the two commonest native plants on Canton, growing almost everywhere,

* A more technical paper, with statistics, on plant communities is presented by Hatheway as Atoll Research Bulletin 43.

associated with practically every other plant excepting with Messerschmidia, Scaevola and kou. The reason is not that these three shrubs and trees are poisonous, like the Eucalyptus and Casuarina to other plants, but that they cast too much shade for these sun-loving herbs to tolerate.

Another close community, since historic times, grows only near the influence of man and consists of the annuals Cenchrus, Eleusine and Setaria; Cenchrus being the most abundant and, because of its prickly burs, the most annoying.

Suriana often grows alone in slab areas and less often in sandy areas swept by waves during violent storms. In 1951 many of the largest plants were dead, leaving fantastically gnarled branches and twigs reaching toward the sky. The frigate bird often roosts upon the sturdier branches but does not nest among them.

The native annual varieties of Digitaria often grow alone, preferably in recently disturbed sandy soil, as along the shoulders of roads. They require more moisture than Lepturus repens and can survive from year to year on Canton by having speeded up their life cycle. Being unable to survive periods of drought as growing plants, they survive them in the form of seed lying dormant on the ground.

A plant that occurs mostly amid rock slabs or on sand dunes nearest the ocean breakers is Triumfetta. This perennial creeping shrub has incredibly long, shallow roots able to absorb rain from gentle showers, and thick leaves with water storage tissues.

Scaevola grows gregariously mostly on the southeast, or windward, part of the atoll rim, perhaps because the rainfall there is slightly more than on the lee side of the island. A few isolated bushes occur across the lagoon on the opposite side, the corky fruits having been blown across the surface of the lagoon to that shore by the prevailing wind. Sporadic plants grow in a few other places as well.

The kou, probably due to the influence of man, is most abundant along the lagoon side near the old guano diggings. The plants grow alone or perhaps with a few Messerschmidia interspersed.

Sida, a sun-loving shrub, grows preferably in good sandy soil in association with any plants that do not subject it to shade.

The Sesuvium is most tolerant of salt and consequently grows alone; other kinds of plants cannot survive in low areas that are inundated by the lagoon. During dry weather and exceptionally low tides the ground where it grows glitters with salt crystals.

The native land flora of Canton Island, excluding the kou and the beach morning glory as plants of questionable nativity, comprises only fourteen kinds of flowering plants. Not a single fern, moss nor slime-mold is native. How many fungi and terrestrial true algae and blue-green algae occur is not yet known. There are quite a number to be found in unexpected places, as in the turbo shells carried about by the hermitcrabs on land. Due to commerce, the common molds found on foodstuffs have reached Canton. There are doubtless numbers of native fungi yet to be discovered, especially after spells of wet weather. Thus far a powdery mildew was collected by Degener on the native Sida; an Albugo on the leaves of Boerhavia; and a saprophytic, dirty yellow ascomycete, about 1 cm. wide, on introduced rubbish.

The paucity of native land plants on Canton is due to the scarcity of rain and its unfavorable distribution during the year, to the salty or nitrogen- and phosphates-impregnated character of the barren soil, to the low elevation enabling waves during storms and very rare tsunamis or tidal waves to scour the atoll bare of most life, and to the army of omnivorous hermitcrabs. Canton is not so isolated that seeds and other propagules of land plants cannot reach its shores. Almost all such castaways evidently find conditions too unfavorable for survival.

Even though Canton is unfavorable for the growth of plants, similarly arid, salty or chemically-poisoned regions throughout the world have been successfully invaded by various rugged plant pioneers. Some are peculiar to the Mojave and other alkali deserts in America; some to the calcareous soils of Florida, the Bahamas or Dalmatia; some to the Sahara; to Madagascar; to India; to Australia and the South Seas; or to the leeward sides of the Hawaiian Islands; etc. To cover Canton with a mantle of vegetation, however, is more than just selecting seeds of such pioneer species and sowing over the rim of the atoll. As a fundamental practice, seeds of potentially poisonous plants, such as those of the yellow oleander (Thevetia peruviana), or of thorny plants, such as the klu (Vachellia farnesiana) and algaroba (Prosopis chilensis), have been omitted. The following is a list of plants or seeds, with their native home, shipped by the writer to Canton chiefly in 1950. All were properly fumigated by the Board of Agriculture and Forestry, Honolulu, to guard against the danger of introducing insect pests. Some seeds of plants that should be able to grow on Canton could be supplied in only small quantities due to their extreme rarety. Others, of plants that probably will not grow there, were sent anyway because of their availability without extra cost or labor. After all, some of these may germinate and grow in particularly sheltered places. Only after these plants have actually become naturalized will it be worthwhile describing them in a supplement to the present paper.

Species sent to Canton in 1950, unless other date given, and place of origin:

MARSILEACEAE
Marsilea villosa - Hawaii

GRAMINEAE
Dactyloctenium aegyptium - Egypt
Digitaria henryi - Formosa
Echinochloa colonum - Pantropic
Ischaemum brachyatherum - Africa
Lagurus ovatus - Yugoslavia (1953)
Panicum cinereum - Hawaii
Panicum nubigeng - Hawaii
Panicum pellitum - Hawaii
Pennisetum sp.
Polypogon monspeliensis - Europe
Sporobolus virginicus - Southern United States
Tricholaena repens - Africa

CYPERACEAE
Cyperus javanicus - Hawaii
Cyperus trachysanthus - Hawaii
Fimbrystylis cymosa - Hawaii

PALMAE
Phoenix dactylifera - Africa
Pritchardia pacifica- Fiji
Pritchardia sps. - Hawaii

COMMELINACEAE
Commelina benghalensis - India
Rhoeo discolor - Bahamas

LILIACEAE
Sansevieria cylindrica - Africa
Sansevieria guineensis - Africa

AMARYLLIDACEAE
Furcraea gigantea - America

SANTALACEAE
Santalum ellipticum - Hawaii

POLYGONACEAE
Antigonon leptopus - Mexico
Coccolobis uvifera - Bahamas

CHENOPODIACEAE
Atriplex angulata - Australia
Atriplex halimoides
Atriplex semibaccata - Australia
Chenopodium oahuense - Hawaii
Kochia sp. - Australia

NYCTAGINACEAE
Mirabilis jalapa - Mexico

AIZOACEAE
Dorotheanthus criniflorus - Africa
Tetragonia expansa - New Zealand

PORTULACACEAE
Portulaca cyanosperma - Hawaii

PAPAVERACEAE
Argemone glauca - Hawaii

CAPPARIDACEAE
Capparis sandwichiana - Hawaii

CRUCIFERAE
Coronopus didymus - Europe
Lepidium o-waihiense - Hawaii

CRASSULACEAE
Kalanchoe tubiflora - Africa

LEGUMINOSAE
Acacia choriophylla - Bahamas
Desmanthus virgatus - Tropical America
Chamaecrista leschenaultiana - India
Dolichos lablab - Africa
Erythrina sandwicensis - Hawaii
Indigofera suffruticosa - West Indies
Medicago hispida - Asia
Medicago lupulina - Asia
Phaseolus lathyroides - Tropical America
Phaseolus trilobus - Asia
Sesbania tomentosa - Hawaii
Sophora tomentosa - South Seas
Tephrosia purpurea - Hawaii
Vigna marina - Hawaii

ZYGOPHYLLACEAE
Guaiacum officinale - Bahamas

MELIACEAE
Melia azedarach - India

SAPINDACEAE
Sapindus oahuensis - Hawaii

RHAMNACEAE
Colubrina asiatica - Hawaii

MALVACEAE
Abutilon mollissimum var. *sandwicense* - Hawaii
Gossypium brasiliense - South America
Gossypium tomentosum - Hawaii
Pariti tiliaceum - South Seas
Sida fallax - Hawaii
Thespesia populnea - Hawaii

STERCULIACEAE
Heritiera littoralis - South Seas
Waltheria americana - Hawaii

GUTTIFERAE
Calophyllum inophyllum - Hawaii

TAMARICACEAE
Tamarix aphylla - Asia

PASSIFLORACEAE
Passiflora foetida - Bahamas

CARICACEAE
Carica papaya - Tropical America

PUNICACEAE
Punica granatum - Mediterranean

LECYTHIDACEAE
Barringtonia asiatica - India

RHIZOPHORACEAE
Bruguiera sexangula - Malaya
Rhizophora mangle - Tropical America

COMBRETACEAE
Conocarpus erectus - Bahamas
Terminalia catappa - Malaya

PLUMBAGINACEAE
Plumbago zeylanica - Hawaii

OLEACEAE
Noronhia emarginata - Madagascar

GENTIANACEAE
Centaurium sebaeoides - Hawaii

APOCYNACEAE
Plumeria rubra - Tropical America

ASCLEPIADACEAE
Calotropis gigantea - Egypt

CONVOLVULACEAE
Ipomoea cairica - Egypt
Ipomoea cordofans - Africa
Ipomoea indica - Hawaii
Ipomoea japonica - Japan
Ipomoea pes-caprae - Hawaii
Ipomoea triloba - America
Jacquemontia sandwicensis - Hawaii
Operculina aegyptia - Egypt

BORAGINACEAE
Cordia subcordata - Hawaii
Heliotropium anchusaefolium - South America
Heliotropium curassavicum - Hawaii

VERBENACEAE
Stachytarpheta jamaicensis - Bahamas
Stachytarpheta urticaefolia - South America
Vitex trifolia var. simplicifolia - Hawaii

LABIATAE
Leonurus sibiricus - Asia
Marrubium vulgare - Asia
Ocimum gratissimum - India
Phlomis fruticosa - Yugoslavia (1953)
Plectranthus australis - Hawaii
Salvia coccinea - Mexico

SOLANACEAE
Capsicum frutescens - Tropical America
Lycium sandwicense - Hawaii
Lycopersicon esculentum var. galeni - South America
Nicandra physalodes - South America
Solanum nigrum - Hawaii

ACANTHACEAE
Asystasia gangetica - India

MYOPORACEAE
Myoporum sandwicense - Hawaii

RUBIACEAE
Canthium odoratum - Hawaii
Casasia clusiifolia - Bahamas
Morinda citrifolia var. Potteri - Fiji

CUCURBITACEAE
Citrullus vulgaris - Africa
Cucumis dipsaceus - Arabia
Momordica charantia var. abbreviata - Asia
Sicyos microcarpus - Hawaii

GOODENIACEAE
Scaevola frutescens var. sericea - Hawaii

COMPOSITAE
Bidens amplectens - Hawaii
Borrichia sp.
Eclipta alba - Asia
Gaillardia picta - Texas
Helianthus annuus - Kansas
Heterotheca grandiflora - California
Inula candida - Yugoslavia (1953)
Lipochaeta integrifolia - Hawaii
Lipochaeta remyi - Hawaii
Pluchea indica - India
Reichardia picroides - Southern Europe
Sonchus cornutus - Africa

After Degener with his efficient assistant returned to Hawaii from a week's stay on Canton in July 1950, he never expected to see the atoll again. From Honolulu, as per contract, he shipped the proper seeds, some in enormous quantities, and a few kinds of living plants, by CAA plane to their destination. Numerous residents of Canton, all busy with their professional duties, tried to sow the seeds during their spare time and even watered some choice plants with precious distilled water. But the task was so Herculean that the greater part of the shipments simply reposed in a warehouse, slowly deteriorating.

On the invitation of CAA for transportation and lodging, and PAA for meals, Degener volunteered his services for six weeks to bring the project to a successful close. Back on Canton in April 1951, he noticed numerous damselflies near the airport. Knowing these pretty, delicate insects to be aquatic in the larval stage, their presence proved the existence of fresh, or nearly, fresh water - SOMEWHERE!

The source was soon found - a rectangular body of water about 20 by 50 feet, and 3 to 4 feet deep. The site may have been excavated by some branch of the Armed Forces as an emergency source of water to fight conflagrations during the war. The sides were of wooden beams; the bottom, natural coral sand and rubble. The location, near a grove of "skayviolas" (Messerschmidia) not far from the airport, was ideal. It lay near the center of a wide part of the atoll's rim, just about right to take advantage of the so-called Ghyben-Herzberg lens.

Disturbing factors absent, this double-convex lens consists of a body of fresh ground water, originally derived from Canton rain, floating on top of the heavier sea water that has percolated under it from the ocean since prehistoric times (See Arnow, T., 1954, "The Hydrology of the Northern Marshall Islands"; Atoll Research Bull. 30, May.). Here, then, was a never failing source

of water that barely tasted salty, regularly rising and falling with the tide, though with a certain lag in time, and in height and depth. With the help of a gang of Gilbert and Ellice Islanders under the kinky-haired Melanesian Seitoa, a wooden platform was built so that the fluctuation in water level would alternately cover it a few inches and then leave it exposed to drying. With such labor, it took little time to gather from a neighboring kitchen midden thousands of discarded tins, stab holes in them, fill them with the best earth available, and then plant seeds of the more ornamental plants therein. Many of the species shipped to Canton, as study of the accompanying list shows, are more or less halophytic - salt-loving or at least salt-tolerant. Naturally they throve, irrigated by every tide with an abundant supply of near-sweet water. By the time Degener left the atoll in May 1951, this self-watering nursery was green with seedlings of many kinds, available for any one who wished to plant them about their barren, arid grounds. Many of these plants survived transplanting, particularly when occasionally watered with waste from the dishpan or bath.

The great majority of the seeds, particularly of grasses, were scattered, hit or miss, over the atoll in likely places. Others were planted in holes made in the sand and rubble with the human heel or with the spade. To ascertain what species on Canton can survive and maintain themselves from year to year in spite of drought, salt, intense sunlight, insects, sea birds, voracious hermitcrabs and competition with other plants, will be of considerable importance not only to tiny Canton but to similar islands throughout the world. The Canton project will help show workers elsewhere what activities to repeat or modify and what pitfalls to avoid.

AQUATIC FLORA

A discussion of the aquatic flora and fauna hardly concerns the present immediate problem of augmenting the flimsy mantle of vegetation on Canton's arid rim of land. Yet were it not for the aquatic flora and fauna, Canton Island would not even be in existence. It consists almost entirely of the accumulated remains of coral, mollusk, sea urchin and star fish, coralline alga, pink foraminifera shell, and the droppings of sea birds that have eaten free- swimming organisms of the open ocean as food. The terrestrial hermitcrabs that are such a hazard to the land plants are aquatic in their larval stage. So with the importance of the sea life in mind, the reader will perhaps excuse a continuation of this article about Canton. It will be brief, not purposely, but because of our present ignorance. This state of affairs should stimulate the resident having a flair for biology to spend some of his spare time collecting the yet unknown plants and animals of Canton to ship to eager specialists at the Bishop Museum and elsewhere for technical study. The

amateur collector and careful observer on Canton, collaborating with the museum expert surrounded by his musty books and pickled specimens thousands of miles distant, can solve so many fascinating and important puzzles. As such knowledge accumulates, a more complete article than the present one can be written for later readers. This one is but a beginning and barely scratches the surface.

Of blue-green algae, no one had collected any specimens previous to 1951, thus leaving practically an open field for a local resident in pursuit of an important hobby. The three specimens collected that year were actually found on land, but are being classified as aquatic because they developed mainly during an unusual period of rainy weather or were found in ditches occasionally subject to flooding by rain or tidal seepage. They are hardly land plants. Though microscopic, such plants, because of their enormous numbers, may help bind sand grains together and reduce drifting. This action may be mechanical, by means of the gelatinous plant surface, as well as chemical, by the liberation of carbon dioxide and the partial dissolving of the calcareous sand grains followed by cementation.

Microcoleus paludosus (Degener 21,341) forms a tough gelatinous coating over the surface of the sand on the atoll rim during periods of rainy weather. Of the blue-green algae on Canton it is the most useful sand binder.

Porphyrosiphon sp. (Degener 21,338) grows on or in the sand during periods of rainy weather but does not form a gelatinous coating. It is similarly useful, but to a lesser degree.

Scytonema hofmannii (Degener 21,347), like the previous two species, is dormant during dry weather. Soon after the coming of rain, it reproduces prodigiously, often washing into puddles in loosely flocculent masses to stain them a pale olive green.

A blue-green alga, not yet identified, is paradoxically beautifully pink. It imparts its color to extensive areas of drying salt flats near the narrow end of the atoll, occurring among crystals of sea salt.

Of the green, brown and red algae, commonly known as seaweeds, we likewise know very, very little so far as Canton is concerned. Some are important reef builders while others constitute the fundamental and first link in the complicated food chain terminating, we like to believe, in serving the highest type of organism, man, at the dinner table and elsewhere. It is an old story known to most of us but worth repeating.

These plants, bathed by sea water, actually a nutrient solution or nourishing soup to them, vary in size from the microscopic to about a foot in length, like the Turbinaria and the

Sargassum that are cast ashore so often. Employing sunlight as a source of energy - an activity not ordinarily possible to members of the Animal Kingdom - they manufacture sugar, starch and allied products for the purpose of growth and activity. Minute and often humble animals like worms, mollusks and crustaceans browse upon these algae for food. These animals in turn usually end up as food for larger and ever larger kinds until we realize that our economic fishes, sea birds, seals and even whales are, in a sense, simply reincarnations on a higher plane of the energy of algae originally trapped from the sun.

If conditions for the growth and abundance of algae are favorable, as along the Humboldt Current of South America, the surrounding water and air just teem with valuable fish and sea bird life. If conditions for algae are unfavorable, however, fish and bird life are scant, and our dining table may be missing a fish course and, as lack of guano fertilizer makes farming expensive, an extra vegetable or a salad. Thus the fluctuation in the growth and abundance of algal life in the ocean may affect man most intimately.

The first true alga collected on Canton may be Turbinaria ornata (F. & W. 30,213), gathered by Fosberg and Walker January 30 - 31, 1949. Subsequent collections, made mostly by Degener in abundance in 1951 and eventually to be deposited in the herbaria of the New York Botanical Garden, the Bishop Museum and elsewhere, were turned over to Dr. Maxwell Doty and kindly identified by him as follows:

CHLOROPHYTA

Ulvaceae

Enteromorpha sp. (Degener 23,660)
Ulva lactuca ? (Degener 23,661)

Cladophoraceae

Cladophora sp. (Degener 23,662)
Cladophoropsis membranacea (Degener 23,663)

Caulerpaceae

Caulerpa crassifolia (Degener 23,664)
Caulerpa peltata (Degener 23,665)
Caulerpa serrulata (Degener 23,666)

Valoniaceae

Dictyosphaeria cavernosa (Degener 23,667)
Valonia sp. (Degener 23,668)

PHAEOPHYTA

Fucaceae

Turbinaria ornata (Degener 23,669)

RHODOPHYTA

Gelidiaceae

Gelidium sp. (Degener 23,670)

Gigartinaceae

Ahnfeltia concinna (Degener 23,671)

Sphaerococcaceae

Gracilaria lichenoides ? (Degener 23,672)
Hypnea spinella (Degener 23,673)

Rhodomelaceae

Chondria sp. (Degener 23,674)
Herposiphonia tenella (Degener 23,675)

Ceramiaceae

Centroceras clavulatum (Degener 23,676)
Ceramium sp. (Degener 23,677)

Grateloupiaceae

Halymenia sp. (Degener 23,678)

Corallinaceae

Jania capillacea (Degener 23,679)
Lithothamnion sp. (Degener 23,680)

Among diatoms, a species of *Navicula* (Degener 21,337) was collected.

AQUATIC FAUNA

No worms seem to have been recorded from Canton thus far. Degener in 1951 observed some wide, colorful planarians, and under rocks on the ocean reef worms (*Eurythoe pacifica*) armed with stinging bristles; and earthworm-like worms in the fine sand of shallow areas of the lagoon. Lack of proper equipment, unfortunately, made their collecting impracticable at the time.

Apparently the first starfish ever collected was Linckia multifora (No. 271) by Bryan in 1925. Degener collected L. diplax (No. 1205) and a serpent star (No. 1206) twenty-six years later on the ocean reef. He of course observed sea urchins. Their spines can inflict dangerous wounds. Corals and sponges are everywhere, yet remain to be collected and studied. These can cause scratches and abrasions that at first sight appear trivial yet may cause stubborn ulcers. Application of a poultice wet with a solution of epsom salt to such wounds is a useful home remedy that may forestall the need of visiting a physician later. Mollusks are probably the best known of the marine animals native to the atoll. Though somewhat disappointing in form and coloration for what one would ordinarily expect on a tropic island, they are so easy to preserve that most people wandering along the shore gather them in a casual way. There have been some serious amateur collectors whose finds may have reached museums for determinations, but where is not presently known. Determination of the mollusks, collected chiefly by Degener, was begun by Dr. Louis Brand of Cincinnati and continued by Mr. A. Wray Harris of Honolulu. Due to the latter's untimely death on December 17, 1953, the complete list of Canton mollusks will appear as a supplement in the Hawaiian Shell News. The shipworms presently known from the atoll are:

Teredo samoaensis (R. S. Danner), 1941.
Teredo gregoryi (Van Zwaluwenburg), 1941.
Teredo bensoni (C. H. Edmondson), 1940 (?). This new species of shipworm was discovered in the "dredger Benson on its return to Honolulu after completing operations at Canton Island."

Nonmicroscopic crustaceans are abundant in species where coral or other kinds of rocky marine shelves and shores exist. There they find suitable shelter and food. The unusually salty lagoon of Canton with its barren sand and choking calcareous mud, particularly distant from the channel, is like a desertton land, able to support but little life. But the collector who can search the steep ocean bottom about Canton's rim from a depth of about 25 fathoms to the limit of high water will be rewarded with innumerable species never before recorded. Thus far the only crustaceans known to the writers from Canton, mostly from the ocean side, are the following: They were identified for the most part by Dr. C. H. Edmondson. Due to an oversight, original ecological data on the labels were discarded in transferring the specimens to permanent museum jars for preservation.

Limnoriidae

Limnoria multipunctata (U.S.N. Survey 5734), 1950. An isopod destructive to wood exposed to sea water, by excavating small burrows in it.

Palaemonidae

Anchistus miersi (Degener), 1951.

Stenopodidae

Gonodactylus sp. (Degener 5658), 1951.

Pontoniidae

Conchodytes meleagrinae (Degener 5685), 1951. A shrimp living in the mantle of the tridacna.

Coenobitidae

Coenobita perlatus (Degener 5661, 5662), 1951. The ubiquitous land hermitcrab; listed by Luomala in 1951 as C. olivieri.

Paguridae

Calcinus elegans (Degener 5665), 1951. A hermitcrab with orange markings.

Calcinus elegans var. (Degener 5669). The blue variety of the above; more abundant.

Calcinus herbstii (Degener 5666 - 5668), 1951. A hermitcrab, brown and white.

Clibinarius corallinus (Degener, 5670, 5671), 1951.

Porcellanidae

Pachycheles pisoides ? (Degener 5684), 1951. Not a typical crab though like one in appearance.

Inachidae (Majidae)

Micippa patypes (Degener 5667), 1951.

Portunidae

Thalamita picta (Degener 5682), 1951. A very active crab, running as well as swimming.

Xanthidae

Actaea sp. (Degener 5675), 1951.

Carpilodes bellus (Pan American World Airways 5449), 1949.

Chlorodopsis scabricula (Bryan 2386), 1924.

Chlorodposis areolata (Degener 5677), 1951. Common; legs hairy.

Eriphia scabricula (Degener 5678), 1951.

Eriphia laevimana (Degener 5672), 1951.

Leptodius sanguineus (Degener 5679), 1951.

Phymodius ungulatus (Degener 5683), 1951.

Polydectus cupulifer (Degener 5663), 1951. Crab carrying sea anemones.

Grapsidae

Geograpsus grayi (Degener 5681), 1951.

Metopograpsus messor (Degener 5680), 1951. Crab of mud and rocks, often going into brackish water.

Pachygrapsus minutus (Degener 5676), 1951. Crab of mud and rocks of lagoon shore and often crawling onto land.

Percnon planissimum (Degener 5664), 1951. Very active crab walking upside down on under side of flat rocks along reef.

Ocypodidae

Ocypode ceratophthalma (Degener 5659), 1951.

Lepadidae

Lepas anatifera (Van Zwaluwenburg 302), 1941. A goose barnacle.

Scalpellidae

Lithotrya pacifica (Degener 386), 1951. A stalked barnacle on reef exposed at low tide.

Fishes are plentiful and colorful. Casual observation of reef fishes of Canton by one familiar with those of Hawaii will reveal a high proportion of species common to both areas. Yet, usually a subtle difference is observable perhaps in color, shape or activity, differences lost upon death and preservation for later study in a museum. Too, food fishes that are wholesome in Hawaiian waters and elsewhere may be poisonous in Canton, especially if caught in the lagoon. Savory looking red snapper and rock cod are usually poisonous to eat. Such fish when eaten may cause paralysis, at times severe enough to endanger life unless the prompt aid of a physician is sought. This fact suggests that plant or microscopic animal life, the source of fish food, is fundamentally responsible. This problem presently is being investigated by Dr. S. Gregory Ross and a very few other pioneer workers. Sharks, sting rays and moray eels are common in the lagoon, making bathing exciting if not dangerous. Of course, all these creatures, when caught by birds, may add to form guano deposits of the future. Fishes of Canton are studied in Schultz' Fishes of the Phoenix and Samoan Islands collected in 1939 during the expedition of the U.S.S."Bushnell," Bull. U.S.N.M.180:1943.

Except for this the scientific study of the fishes of Canton is still in a preliminary stage. The first fishes collected for serious study appear to be Eviota viridis (E. H. Bryan, Jr.,4819) and Echeneis remora (Bryan 4895) in March 1924.

Land Fauna

The land fauna of Canton is meagre. The only wild mammal noticed was a single rat which ran with a strange jogging gait across the road at night before the car. It lost itself in a maze of trunks and twigs of a frigate bird rookery of scaevola bushes far from human habitations. It was the Polynesian rat whose ancestors may have reached the atoll in the double canoe of some adventurous Polynesian centuries ago, or perhaps on a larger vessel during the later guano digging days. It is not unlikely that the kou reached the island on the same canoe or vessel with the Polynesian rat. Besides man, of all possible ethnological strains imaginable, who is now furiously changing the sleepy atoll to his peculiar aims, the only other introduced mammals are dogs and cats. The dogs are of many breeds, have many friends and many masters, and are treated far more humanely than in the Hawaiian Islands where neglected, starving and mangy curs abound. None of these dogs is thus forced to run wild to forage for itself, a habit that might be disastrous to the rookeries. Some, strangely enough, enter the shallow water of the lagoon for their peculiar form of sport fishing: pouncing upon an occasional unwary mullet that may swim by. Cats, escaped from domestication, have run wild and obviously take their toll of nesting sea birds.

All Canton crustaceans have aquatic larvae. But a few crustaceans have become adapted for life on land toward maturity. Such, for instance, are the fiddler crabs. I observed hundreds of these brilliantly colored, gregarious animals about their burrows in the pale mud along the lagoon's edge. But the crabs that are really best adapted to terrestrial life, arouse interest and cause worry are the countless small pale hermitcrabs Coenobita perlatus. Every small dead spiral mollusk shell - there must be hundreds of thousands available about Canton - houses one of these lopsided, soft abdomened animals. They are particularly numerous feeding on the jetsam along the beach facing the lagoon, and also penetrate inland. Here they may be found seeking protection from the heat of the day under branches, fallen leaves and coral slabs, and in shaded crevices. As these crabs increase in size their housing shortage, for lack of an abundant supply of large mollusk shells, must be so acute as to cause a catastrophe eventually among them. Only those that can find the comparatively rare, catseye shell (Turbo), measuring up to about three inches in diameter, survive. Even so, these mature hermitcrabs, now red like boiled lobsters, are numerous enough to over-run the island. To be sure, they are useful scavengers, cleaning the rookeries of dead fledglings, the shores of dead fish and lobsters and the land, in general, of all dead animal matter. But as this supply

is certainly insufficient to keep these creatures well fed, they obviously must feed also on plants, those living miles from the rookeries being per force mainly vegetarian. They seem to browse among the vegetation, and even climb kou trunks and branches as high as four and a half feet in search of food. They eat the bark along the upper side, most kou trees showing long scars, the result of past injury. A common habit, especially of the less heavy individuals is to cleverly tear off and eat only the ovary and stamens of the flowers of Portulaca lutea and of the local Sesuvium. In the latter, I also observed them boring out of the ovary the ripening seeds for food. These are certainly not isolated acts, but ones perfected by practice and perhaps instinct. They probably decimate the flora, feeding particularly on tender seedlings of certain species, which ones have not yet been determined. I believe these hermitcrabs are largely responsible for the paucity of different kinds of plants on Canton, any seeds of new kinds of plants washing to its shores being subject to their inspection on germination and, if palatable, sacrificed to their appetite. The foreign plants now being introduced as seeds and seedlings to Canton likewise must not only surmount the drastic conditions of drought and salinity, but must surmount the hurdle of voracious hermitcrabs.

Though a nuisance in many ways, these land hermitcrabs are used as bait and as chumming material. They are interesting and, to Canton, economically important creatures. We know far too little about them. A complete life history would be a fascinating problem for some resident of Canton to work out during his spare time. In the month of April, for example, the females carry their numerous maroon eggs attached to their abdomens. When do they return to the ocean to allow these eggs to hatch their free-swimming larvae, that resemble so closely the shrimp-like ancestor of all hermitcrabs? Where do the hermitcrabs molt their hard unexpanding shells as they grow in size? Do they do so in burrows on land or in the ocean? How, with gills adapted for respiration in water, have they perfected respiration on land? How long do they live? Must they leave their borrowed mollusk shell kilt to defecate, or can they remove their body wastes otherwise? I have observed a loving pair beside a bunch of grass not too tenderly clawing at one another with legs and chelipeds, at the same time uttering their subdued chick, chick, chick, chick - chick, chick, chick, chick love song. How do they emit this sound without a voice or hear it without ears? Scores of similar questions remain to be answered, not all academic ones.

Native spiders are rare in kinds. The wolf spider, which weaves no web, is everywhere, running about in the open on the ground in search of insects. It is very beneficial to the atoll, probably the most efficient insect killer, the second being the migratory plover. The female carries its flat egg case wherever it goes. This spider not only sucks the juices of its victim but comminutes, like its common relative the house spider of

Hawaii, their bodies to almost dust-like particles. A spider found more often in abandoned shacks and bushes is Latrodectus geometricus. It is mostly immobile in its sprawling web, and parks its spherical egg cases in a corner of it. Though related to the infamous black widow, no cases of bites from this arachnid are known from Canton.

The number of native species of insects are few, as expected considering the difficulty for these small terrestrial creatures crossing extensive wastes of ocean to Canton and, when once there, finding suitable fare with such a limited flora. There is some injury to native plants by native insects, but in the main this is not serious. They have always been exposed to such depredations, and survived. What is, however, very serious is the habit of amateur plant lovers introducing plants of their choice by boat and plane from Fiji, Hawaii and elsewhere without fumigation against insect pests. As a result Canton Island is a safe, enemy free Paradise for some foreign insects such as mealy bugs that harass native and introduced grasses, scale insects that weaken coconut palms about the hotel grounds, crater scale on the single remaining Plumeria, etc. This unnecessary introduction of insect pests not only adds one more hurdle for plants to surmount for survival, it likewise makes Canton a very dangerous stepping stone for the passage of injurious pests to and from all regions touched by planes using the atoll for refueling or otherwise. An up-to-date list of insects of Canton, collected by Van Zwaluwenburg, Degener and others, will be found in Atoll Research Bulletin 42, by R. H. Van Zwaluwenburg.

Amphibians are entirely wanting. Of reptiles a gecko with its glue-tipped toes may climb slowly about the island shrubbery, driftwood and rocks at night for insects; and a graceful skink, differing in color from those in the Hawaiian Islands, may rush over the level sand and smooth rocks during the day for his fare. This last, if careless, may be snapped up for food by the migratory plover. A turtle may occasionally climb out of the sea to lay her eggs in the warm sand of the beach. No other reptiles occur.

Of birds Bryan recorded the following from the Phoenix Islands: "the frigate or man-o'-war; three species of boobies or gannets; the red-tailed tropic bird or bos'n bird; several species of terns, including the sooty, gray-backed, noddy, small noddy, white, and gray; three or more species of petrels and shearwaters. Several kinds of migratory birds are to be found in the winter, during their migrations; a few may be found at other times. These include the curlew, Pacific golden plover, wandering tatler, turnstone, and a few others." The boobies and frigate birds take up a stretch of about eight miles of Canton for their rookeries. There are no native land birds on Canton, but about the British community the Gilbertese residents own interesting looking chickens, which never stray far.

A few red-tailed tropic birds (Phaeton rubricauda) nest under thick tangles of sida bushes or in cavernous retreats under coral rock ledges. They make a frightening, metallic, machine like noise when disturbed. These birds affect vegetation but little.

Black, vulture-like frigate birds (Fregata minor palmerstoni), known in Hawaiian as iwa or "thief," are extremely common, nesting by the thousands in the scaevola bushes and very rarely on bunchgrass. After driving through such a rookery, our windshield and car body were found to be finely bespattered with minute droplets of whitish excrement, that had rained down from the birds flying overhead. Occasionally a parasitic Hippoboscid louse fly, looking like a large flattened black housefly, is knocked off a frightened bird and flies to the car, mistaking its dark body for that of its host.

The nests are coarse, excrement soiled and cemented affairs constructed of twigs and driftwood. During rare downpours, this filthy binding material may dissolve away, allowing the eggs to fall to the ground. Nesting material is evidently rare and highly prized, giving rise to cases of theft, a bird in flight occasionally filching a loose piece from a carelessly guarded nest. The iwa will even stoop to murder and cannibalism, flying off with an egg or newly hatched young to eat on the wing. There is usually one egg to a nest, entirely white and a bit larger than that of a chicken. Both sexes take turns setting on the egg, and later sitting on or over the growing chick. This is not only necessary to incubate the egg and later keep the chick warm in cool weather, but also as protection from too intense sunshine. At that time the males are resplendent with blood red, semitransparent throat pouches blown to balloon size, extending forward to the beak and downward to hide the breast. This color is supplied by innumerable blood-filled capillaries in the tissue of the pouch.

Not far from the rookeries of the iwa or frigate birds, which act like the harpies of Greek mythology in stealing food from the more industrious, are the rookeries of the stupid red-footed boobies or gannets (Sula sula rubripes). The name booby is from the Spanish word bobo, meaning "dunce" or "idiot." At times the rookeries of the aggressive marauder and boob-victim overlap at the edges. The nests of the booby contain a single white egg or a fluffy fledgling apiece.

According to T. Truman Wright,* the frigate birds "escort the stupid, spoon billed Ganets out to feed on schools of squid and small fish. When the Ganets get craws full and set sail for home to feed their young, the cruel curve beaked Frigates dive screaming after them, seize them by the tails and sling the food out of the smaller birds' mouths, which the Frigates scoop up on the wing. This goes on from dawn to dusk. The war cries of the Frigates and the plaintive screams of fleeing Ganets

*Wright, T. T., Canton Coral Capers, Trade Winds, Mimeographed publication by C.A.A., July 1951.

quiver down the trade winds like the wailings of lost souls."

It is commonly reported that frigate birds, lacking webbed feet, never land on the surface of the water because they cannot take off again. This is not true. I have seen a small flock of them playfully land, float and rise again from the placid surface of the lagoon.

The birds nesting in the scaevola are tame or, depending upon one's point of view, too innocent and stupid to fly from their nests when approached. The explanation for this habit is their nesting from time immemorial in areas where no predatory animals, two- or four-legged, have ever existed. Tame birds were not killed off but survived to reproduce their kind. Now, unfortunately, Pacific islanders employed as laborers, occasionally club the nesting birds at night, preparatory to a feast. Such vandalism and resulting pandemonium in the rookeries should be stopped by legislation in a condominium involving two great humane nations.

The ancestors of these and other kinds of sea birds have inhabited Canton Island during the nesting seasons ever since its existence, catching fish, squid and other sea life for food for themselves and their fledglings. Their droppings have accumulated and, because of the climate, have only in part leached away - certain constituents disappearing faster than others. The remaining decomposed and more or less fossilized excrement is known as guano, rich in phosphates, ammonium oxalate and urate. Because of its commercial value as fertilizer, Canton, as we have learned before, first received attention from man.

Canton, a Beautiful Oasis in a Desert of Ocean

When the native flora, as in the case of Canton, is incapable of covering the land to protect it from blowing away and from making it decently habitable for man, proper exotics should be introduced to meet this lack. In 1950, as mentioned above, CAA therefore engaged the writer to begin to improve Canton floristically. Though a good beginning has been made, present residents should not remain satisfied. The seeds of so many more desirable and beautiful plants suitable for Canton are waiting for them in the arid, saline regions of the tropics. They can import these to make their atoll an ever more beautiful oasis in a desert of ocean. They can show how bare islands through the tropics can be made decently livable for the ever-increasing hordes of mankind seeking a place in the sun - a fascinating challenge!

Appendix A

Excerpt from a letter to the author from Mr. Myron H. Kerner, Meteorologist In Charge, U. S. Weather Bureau, Canton Island, dated Nov. 25, 1954..

The statements regarding the local heating effect are in serious variance with the accepted theories. If vertical currents are created by local heating of the atoll of Canton, the effect would increase the amount of cloudiness and resulting rainfall, not divert it. As air is lifted, it is cooled adiabatically and if lifted far enough, will condense. Lifting may be caused when air is heated locally or when it climbs up the slope of terrain or up the slope of a more dense air mass or by converging air masses. Once started and with the initial force removed, it may or may not continue to rise, depending upon the vertical temperature distribution of the air mass. If the atoll afforded any of the lifting forces there should be a marked increase in cloudiness as a result but there appears to be no difference in cloudiness between that over the atoll and that over the ocean. In my 16 months of continous duty here, I have never observed any deviation in a cloud's course due to the island and there appears to be no reason to believe that the island has any effect on the rain.

Our precipitation is caused in three different ways. There are always some cumulus present; these are probably a result of local heating due to distant variation in the sea surface and converging air. Precipitation from these clouds is infrequent, light and spotty. The greatest amount occurs when the inter-tropical convergence zone (the narrow band where the trade winds converge on the doldrum belt giving large scale up lift to the air resulting in thunderstorm activity and copious rain showers) lying to the south of us moves over us for a few hours to a few days. Then Canton may get several inches in a day. The third source of precipitation results from small scale equatorial low pressure systems that move slowly from the Gilberts. The occurrence of precipitation from either of these latter two reasons is very irregular, which accounts for Canton's being a place of great extremes in seasonal precipitation.

However, there does appear to be a diurnal variation in precipitation, based on 26 months of record available since the installation of our recording rain gage. This period is still too short to come to any quantitative conclusions, but during this time over one half of the precipitation fell between the hours of midnight and 8:00 a.m. Of course, the diurnal variation in ocean temperature results in a slightly greater instability at night and we should expect more cloudiness then.