

SEA TURTLES-CANTON ISLAND

GH BALAZS

ECLIPSE ADVENTURES ON A DESERT ISLE

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GEORGE H. BALCH

BY CAPT. J. F. HELLWEG, U. S. N.

Commanding U. S. Navy Detachment, Eclipse Expedition, 1937

THAT all-important day, May 6, of our sailing from the Hawaiian Islands for the National Geographic Society-United States Navy Eclipse Expedition, toward which our efforts had been bent for more than two months, dawned hot and still. A tropical rain the night before had made everything muggy and heavy; the clouds still hung threateningly over the tops of the mountains around Honolulu.

As we hurried through town in our little car, not much was said. Each was busy with his own thoughts, checking over for the hundredth time all details to insure that none of our eleven tons of scientific equipment, ranging from huge telescopic cameras to tiny stop watches, had been overlooked in the rush of the last two weeks.

Each knew he had done his best during those hectic days, from the moment we arrived in Honolulu and started moving the expedition's freight even before we had located our hotel rooms. Yet each of us was tormented by the same unspoken questions: Would everything work? Had we overlooked any detail?

The scientific party, led by Dr. S. A. Mitchell, had arrived on the *Mariposa* on May 3, and had been busy checking their equipment and procuring last-minute supplies, such as flashlight batteries and sun helmets. For months previously they had been working feverishly to prepare the delicate apparatus that would record the scientific data of the eclipse (page 361).

Suddenly we made out the *Avocet*, a Navy seaplane tender assigned to the expedition, lying snugly alongside her dock on the water front. Her undisturbed, peaceful air, her smart appearance, her very evident readiness to go, cheered us tremendously. Her gear and equipment were stowed and lashed as only seamen can do it; everything was trim and taut. We were ready.

As the time for our departure approached, the crowd was hurrying down converging streets toward the dock. The Governor of the Islands and his staff arrived, followed almost immediately by Admiral Murfin, from Pearl Harbor.

Ladies carried fragrant leis. The Royal Hawaiian Band was already in its place outboard of the gangway, cars began to

gather on the dock, and the National Broadcasting Company experts were busy rigging their portable equipment.

Abruptly conversation ceased, a clear strong voice was speaking. The broadcast was on. Music by the band, addresses by Governor Joseph B. Poindexter, Admiral Orin G. Murfin, and the members of the expedition followed.

Again the soft Hawaiian music, a few last earnest goodbyes, and then a sharp "All on board." "Stand by your lines."

The gangway was hauled on board, the crowd on the dock separated into small groups, and those without any duties lined the rail.

"Let go, aft."

"Slow astern, hard right."

"Let go, forward."

And with that, our eclipse adventure had begun.

OFF, ON COURSE 207

The *Avocet* slowly turned and headed for the open sea. The crowd on the dock grew smaller and smaller, their faces became blurred, the handkerchief-waving groups melted together, three long blasts on the *Avocet's* whistle, and Lieut. Williamson, our skipper, said quietly, "We're on course 207, sir, our course for Enderbury." * Seven days later, still on course 207, after a remarkable run, we sighted, in the early morning light, palm trees, creamy surf, and then the dazzling white sand of a low-lying tropical isle.

But meanwhile there were many interesting happenings on board ship.

The second night out, at dinner, Dr. Herman A. Gross, Navy surgeon, and I were spinning yarns about China.

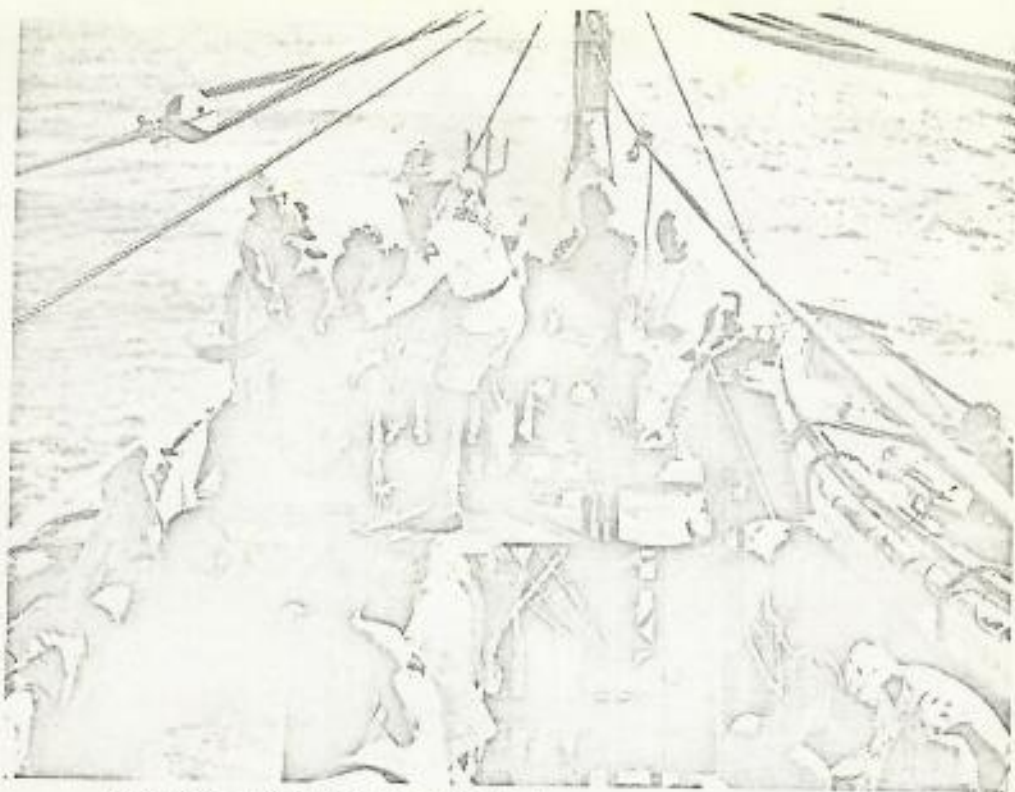
"Captain, do you remember that big mail buoy just outside of Chinwangtao?"

"Why, yes, doctor, but I never put any letters in it. I always felt that those Chinese pirates stole half of the letters."

Someone interrupted with "Captain, what does a mail buoy look like? What are they for?"

"Oh, down here, they are big yellow buoys with large, blue M's painted on their

* See page 380, and The Map of the Pacific Ocean, published as a supplement to THE NATIONAL GEOGRAPHIC MAGAZINE for December, 1936.



NEPTUNE'S AIDES DUCK A LANDLUBBER AS THEY CROSS THE EQUATOR

The "pollwog," about to be initiated according to old sea custom, is tossed into the canvas tank, where two husky "shellbacks" (men who have crossed the Line before) will see to it that he experiences salt water. Neptunus Rex, with long beard and trident, supervises the ceremony with his court, which includes the Royal Baby, seated at the right. Scientists and naval officers who had not passed the Equator before were initiated along with the humblest gobs. Even Jerry, the ship's dog, was given a ducking, and emerged a full-fledged but thoroughly disgusted shellback.

sides, just like the Matson Line's ship stacks. You put your letters in the buoy, and the next ship picks them up."

The doctor abruptly changed the subject. Nothing further was said about the mail buoy, but late into the night members of the expedition were busily writing letters and asking what kind of stamps had to be used on mail buoy letters.

I believe it was the next afternoon before someone became suspicious and letter writing ceased.

TROPICAL SQUALLS AND STARS

Everybody quickly fell into the routine of shipboard life. The *Avocet* proved an excellent ship, riding the long, following seas like a duck. All hands ate their heads off, and, much to the cook's disappointment, no one missed his mess. After several days, the cook complained, "I can't save a thing; they all eat like horses."

We passed through the usual number of tropical showers, some were real rain squalls; but, between squalls, the sun came out hotter than ever.

Every morning early, I had the boat-swain's mate hook up the fire hose and hit me with it at about five feet. I could never convince the others of the stimulating effect of that salt-water shower delivered with a fire hose and plenty of pressure.

Life on board was easygoing and peaceful; all hands tried to keep occupied. After dinner every night, the card players got under way; others went on the bridge to look at the ever beautiful panorama. Tropical stars from the dark deck of a ship at sea are one of nature's most inspiring sights.

On May 10, we had our first radio broadcast (pages 392, 393, 394).

At sunset on the eleventh, the ship was hailed by an unusual-looking individual who announced himself as Davy Jones, a



HIGH IN A PALM TREE SITS A RED-FOOTED BOOBY, NOISY ISLAND NATIVE

The screeching of these birds ruined many a scientist's sleep as they flew over the camp on moonlight nights. This booby is resting, not nesting, in one of the few coconut palms on Canton Island. The New Zealand eclipse party planted a thousand coconuts here (page 391).

minister from the court of Neptune. He delivered a "summons extraordinary, subpoena mandatorium" from the Royal Court of the Raging Main to each of the landlubbers on board, requiring their presence the following day before the court of Neptuneus Rex (page 378).

Separate charges were preferred against each one. Everyone on board was subpoenaed except about 17 old shellbacks who had crossed the Equator before. They were heartily greeted as old friends by Davy Jones.

May 12 was hot and clear. Neptune's party came on board early and held court. The court, festivities, initiations, and duckings progressed systematically until all the polliwogs, or landlubbers, had been duly initiated into the guild.

After Neptune and his court had been photographed by The Geographic's expert sharpshooter, they bade the Captain good-bye and left the ship. The rest of the day was spent by the recently initiated in re-

moving traces of the ceremony. Those whose love-locks had been snipped off regarded themselves in mirrors rather ruefully.

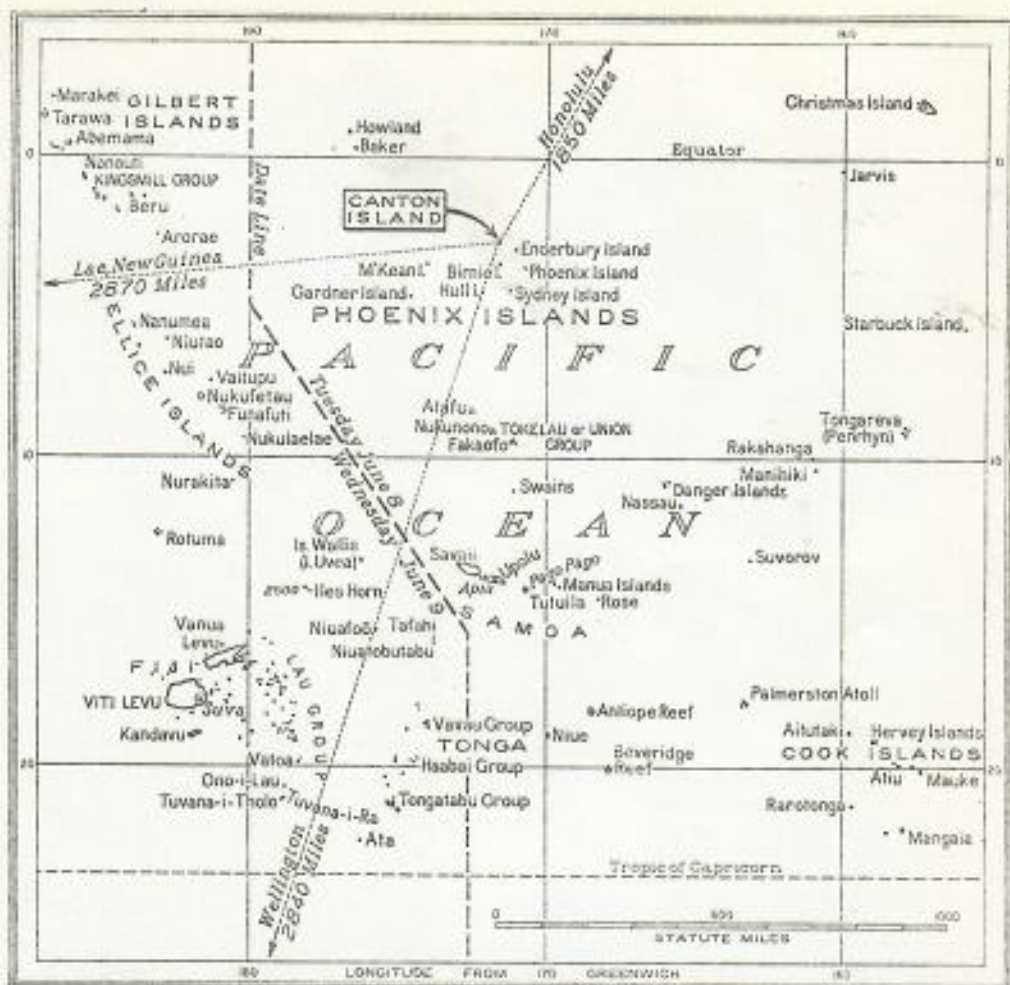
Our genial artist, "Michelangelo" (Charles Bittinger), prepared to engross the diplomas for all the new shellbacks.

That night the captain reported that he would have to slow down to make the island in daylight. Accordingly we slowed to eight knots until daylight when we speeded up to ten.

THE THRILL OF A CORAL ISLE

Soon we had Enderbury Island close aboard on our port bow (map, page 380).

That first view can never be forgotten by any of us—a very small, low isle with its few palm trees bent by the wind, its snow-white coral beach smothered in foamy breakers that rolled in continuously from nowhere and broke themselves with a loud roar on its shining shore. It was surrounded by crystal-clear water of the purest jade, in



Drawn by Newman Banister

REMOTE CANTON ISLAND HAD ITS BRIEF DAY IN THE DARKENED SUN

Less than 200 miles south of the Equator, Canton is one of the eight tiny islands of the Phoenix Group. To the northwest is Howland Island, which was the objective of Amelia Earhart's flight from Lae, New Guinea, on her way around the world. The Phoenix Islands and others near by were included in the U. S. Navy's search for Miss Earhart and her navigator, Frederick J. Noonan. The Phoenix land patches are all of coral formation, rising only 20 to 30 feet above sea level.

turn bordered by the most dazzling blue, extending right out to the ship's side.

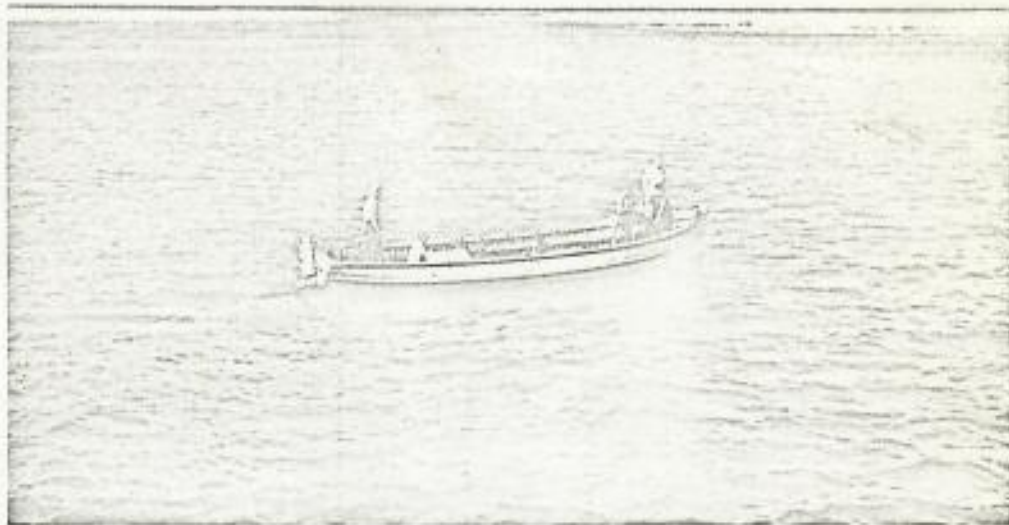
Above it, thousands and thousands of birds—black birds with blood-red balloons hanging from their necks, white birds, brown birds, all kinds of birds, all colors—wheeled around and around in their never-ending aerial parade.

The spell was broken by the racket of the winch lowering the motor sailing launch over the side. Quickly the boatswain shoved off, and stood in close to the outer line of breakers. To us, he seemed always about to be caught in the breakers. We

could see the men heaving the lead, seeking anchorage, and, with apparent disappointment, standing farther down the shore line to try it again.

The launch rapidly signaled, "No bottom at 35." We acknowledged, and the captain turned to me with, "It certainly does *not* look good to me."

On and on, for more than two hours, the motor launch skirted the reef. Once she signaled, "Twenty-five fathoms, hard, irregular bottom." Before she had moved a boat's length, she again signaled "No bottom at 35."



HEAVING THE LEAD NEAR THE ENTRANCE TO CANTON'S BLUE LAGOON

Sailors from the *Avocet* measure the depth of water in search of an anchorage. The ocean bottom dropped off so steeply around the island that only outside the entrance to the central lagoon, where currents had built a "delta," could the ship find a place shallow enough to drop her "mud hook." The entrance to the haven, showing in the background, is about 150 yards wide. Within, the water was quiet and supplies were easily landed on the inner shore. The Expedition camp (page 385) was set up to the right of the passage.

Such a bottom was plainly impossible, so I advised Lieut. Williamson to recall his boat and to proceed to Canton Island. If that proved worse we would have to consider further what could best be done.

Two and a half hours later we sighted a number of apparently disconnected humps on our starboard bow. They gradually grew together and we found ourselves skirting an island, very narrow, very white, and with the bluest blue water on the other side extending off to the horizon.

AN IDYLIC LAGOON

Canton, or Mary Island, is a large atoll. Its lagoon is a beautiful stretch of glass-smooth, deep-blue water. The surrounding rim is nowhere very wide and sometimes very narrow.

On the sea side, in never-ending march, the breakers pounded their way with an incessant roar, throwing skyward high plumes of pure white.

At the salient points jutting out into the sea, those imposing breakers extended far

offshore. I counted as many as six and seven at once, all racing madly after each other and crashing on the beach.

FINDING THE HUMPS

From his wealth of experience, the boatswain said, "We'll find a good anchorage, Captain, right off the mouth of that lagoon."

"Wherever you have a big lagoon repeatedly discharging through a narrow entrance, the tides sweep the coral sand in and out and always pile it up in two humps, on either side of the entrance. All you got to do is find the humps; we'll find 'em."

And the boatswain was right. We located an excellent anchorage just to the southward of the southern entrance to the lagoon.

The captain anchored in ten fathoms with 60 fathoms of chain. Everything looked fine. The tide was running strong ebb, and there were large slicks on the water, indicating swirling water below.

We immediately sent the motorboat ashore to examine conditions in the lagoon. In the meantime, we were all curiously

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ISLAND BIRDS GET "MIKE FRIGHT" DURING A BROADCAST

The announcer (right) and an assistant hold a feathered native up to the microphone, while two others await their turn to address an invisible audience thousands of miles away. Charlie, the Hawaiian boy, is in charge of a frigate bird (page 390). The hooded man at the left grasps the wings of a blue-faced booby.

looking over the side, examining the bottom which, although ten fathoms down, was clearly visible.

The fishermen immediately broke out their lines. In a very short time, fish of all colors and all sizes were being hauled in rapidly. They snapped at anything.

The "Padre" (Dr. McNally) hauled in a beauty only to see a shark snap off all but the head when it was practically alongside. The largest fish caught that night weighed almost 50 pounds. Chowder was assured!

Soon the motorboat returned with enthusiastic reports of conditions on shore. The boatswain, who apparently had something up his sleeve for every possible contingency, had even brought a float along. This was towed ashore the next morning and converted into an excellent dock. On it we were able to land even our heaviest apparatus.

Those who went ashore with the boatswain must have run along the beach like

school children picking up shells, for they all came back loaded with them—all kinds, from the most delicately colored rose tints to the beautiful marble whites, metallic blues, and queer-looking mixtures. The shapes were as varied as the coloring.

ADRIPT FOR A NIGHT

But before we were to see the shore again and step foot on it we were to take another cruise, but only for overnight.

Apparently we had anchored where the slope of the bottom was very steep. The anchor was evidently lying on a submarine hillside and the 60 fathoms of chain slid down the hill below the anchor.

Every time we tugged at the chain, the anchor slid a little farther down the hill. Finally away it went with a bang, and we were adrift with our anchor hanging down under us at the end of 60 fathoms of chain, and no bottom.

We were perfectly safe, as the steady

trade wind was blowing us rapidly off shore. We picked up our anchor and drifted all night, and that ended the thirteenth.

The next morning, bright and early, we steamed back to our island. This time we stood farther in toward the reef, and put the motor-sailer over to sound ahead of the ship and to examine the bottom through a water glass. The men selected a spot in seven fathoms which they buoyed after examining all around that locality.

The *Avocet* dropped her anchor alongside the anchorage buoy, and there we remained. Engines were secured, repairs and overhaul were started, and all preparations for the return trip to Honolulu were begun.

In the meantime, the ship's company was busy rigging out boats, casting off lashings on boxes and equipment, breaking out the afterhold and getting everything ready for a quick transfer to the beach. The first boat ashore took a full load of lumber and the float.

By the time the second boat was loaded and had reached the lagoon the boatswain had constructed his dock and the equipment could be passed over the side to the dock and skidded on rails clear of the beach.

By early afternoon we had landed seven boatloads of equipment and were ready to begin construction of the camp.

Flares such as you see along automobile roads under repair were carried ashore and placed along the beach on high points so that the ship could watch her anchorage during the night. It was astonishing how large those flares looked in the black darkness.

The ship was riding easily, with no strain on the chain at any time. The sea on the lee side of the big atoll was smooth, but down beyond the first point, we could see the surf running high and pounding itself to pieces on the headland.

SOUTH SEA FISH STORIES

It was so smooth near the ship that even the little dinghy, an 18-foot boat, was manned and out rowing around trying to catch fish. Everybody was fish-crazy. There were almost as many lines over the side during the rest periods as confetti over the side of a departing Matson liner at Honolulu.

Everybody chipped into a pool and a fishing contest was started, with daily and final prizes for the largest fish caught.

Before nightfall one man had landed a 37-pound ulua (cravellé jack), one of the best food fishes in these waters. They run from one to four feet long, and weigh from ten to fifty pounds.

By dinner time, everybody was tired and we were willing to return on board and turn in. But not the fishermen. Oh, no! They fished long into the night. My last conscious act was sitting up suddenly when I heard someone near by yell, "Hold him, hold him! What did you let him get away for?"

Saturday morning all hands were up bright and early. The supplies and gear continued to flow steadily, boatload after boatload, toward the beach.

We were lucky to have an experienced sergeant of the Marine Corps with us to take charge of the camp. The rapidity with which our tent village grew was astonishing. Before we fully realized it, all tents were up, all cots were rigged, mattresses, pillows, and mosquito nets (which were never used) were in place.

Meanwhile, others were rigging our big mess tent and our galley. The carpentering gang was busily sawing and hammering our one main structure together.

Our dock presented the appearance of a very busy river landing (page 385). All we needed were a couple of stores, a church, and a tavern to complete the picture. Groups of men, each knowing exactly what they had to do, were rapidly separating and distributing boxes received ashore.

"TOWN HALL" AND "RADIO CITY"

Supplies were rushed to the mess shack, building material to the site of our "town hall," radio equipment to the local "Radio City," and personal effects to the proper tents. All hands appeared to be working under full pressure—what the bluejackets would call "a four-boiler run."

By nightfall the entire framework of our town hall was erected, and some of the siding was already on.

That building was 37 feet long by 14 feet wide, with a head space of 10 feet. It contained two photographic darkrooms, eight by eight, side by side. The inboard one was lined with two thicknesses of a special insulating material to help maintain the proper temperature.

Outside we mounted an air-cooling unit. Dr. Theodore Dunham and Mr. Thompson had brought from Honolulu.

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BIRDS WERE SO THICK ON ENDERBURY THAT THESE HARDLY WOULD HAVE BEEN ROOM FOR THE EXPEDITION

Although it proved impossible to land the Expedition at Enderbury Island, a small exploring party returned there after camp was established on Canton Island. Captain J. F. Halloway (left) and a companion, with Jerry, the *Arceuth's* little dog mascot (right), are standing in front of one of the many piles of rock that cover the island. In the left background is one of several ruined stone houses believed to have been built by guano collectors who formerly lived here.

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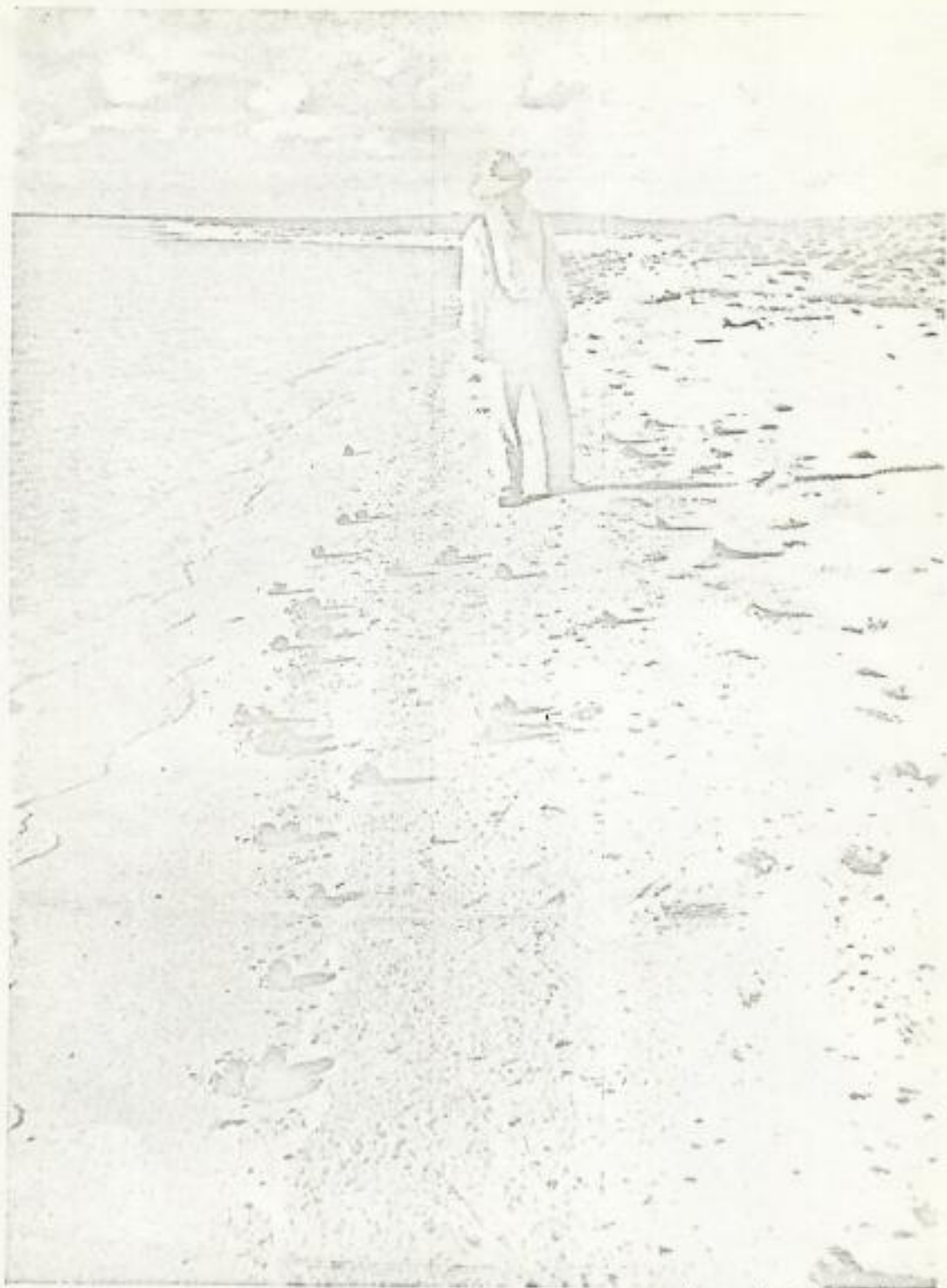
THE ECLIPSE CAMP BROUGHT BRIEF LIFE AND BUSTLE TO A WIND-SWEPT DESERT ISLAND

This general view of the camp is looking north. At the extreme left is the mess tent. In the left foreground are the tents of the New Zealand Eclipse Expedition, while beyond are the tents occupied by the National Geographic Society-U. S. Navy Expedition. The United States flag, and the National Geographic Society's flag just below it, are flying on the pole in the center. The large structure is the wooden photographic darkroom built by the Expedition. Its roof was painted white to reflect the sun's rays, reducing its interior temperature by several degrees. Next to it is the long row of instruments mounted to point eastward out over the lagoon in the center of Canton Island. Dr. Gardner's camera, known as "Big Bertha," is at the extreme right. The "street" between the instruments and tents was called "Broadway," that between the two rows of tents was "Fifth Avenue."



LIKE A BOOM TOWN, THE EXPEDITION'S TENT CITY SPREADS OVER THE SAND BEHIND A BUSTLING WATER FRONT

The first launch sent ashore from the *Avocet* built the little landing, using a float that had been brought from Honolulu and some timbers from a sailing vessel wrecked here years before. In the quiet lagoon all supplies, including the heavy scientific equipment, were safely unloaded from the boats. The pile of lumber on the beach was used to construct the darkroom.



Photograph by Irvine C. Gardner

CANTON'S HERMIT CRABS START OFF FOR THEIR DAILY THIEVING

Biggest nuisance, but also biggest clowns, were the ludicrous hermit crabs that swarmed on the island. Charles Bittinger, the expedition's artist, watches the creatures on their daily morning march from the water's edge to camp where they would drag away small objects, edible or not. Soap was their favorite plunder. One made off with a pair of Dr. Richtmyer's socks, and he never saw them again!

The building was planned to be on the exact azimuth Dr. Dunham needed for his spectroscopic work.

Next to Dr. Dunham's half-ton machine we mounted Dr. Gardner's generator. All the rest of the building was given over to the complicated rigging required by Dr. Dunham's special apparatus.

After the structure was completed, it was entirely covered with tar paper. Then the sides subjected to the morning sun and the roof were painted white by our radio announcer (George Hicks). Richard H. Stewart, National Geographic Society photographer, was one of the hardest working and most competent carpenters.

By the time this was all finished Dr. Gardner had planned and had built a cement mixer and measuring gadget which saved much time. Forms were made, and concrete was mixed and poured.

By nightfall the camp began to take on an appearance of permanency.

Just before dinner we all went down to the lagoon wharf and dived into the crystal depths. At first it felt queer to swim around with so many kinds of fish near by, all staring at us with their big popeyes.

Once in the water it was hard to get out. But somebody yelled "Shark!" and there was a wild scramble for the beach.

When everybody was in water not over ten inches deep we all looked for the shark, which was well offshore, cruising up and down near a coral patch, and occasionally showing his fin.

The boatswain gave me a pair of water goggles with which I could see perfectly under water.

SWIMMING AMID FISH AND CORAL

Swimming around with them on, face in the water, I could scan all the wonderfully beautiful sights below—the white coral sand, the outcroppings of coral, odd and grotesque in shape and infinite in variety. Some of the formations were as delicate as fine lace.

In and around them all were the hundreds of gaily colored fish. They were not disturbed by our nearness, but went about their business, paying us scant attention.

Occasionally curious ones swam toward us, looked us over with their funny eyes, and then swam away, apparently disappointed. But let a big fish appear, and, with lightning rapidity, the others vanished as if by magic.

Swimming with goggles spoiled me for regular swimming. I carried mine around my neck all the time. A hundred times I wished that I could let everyone in the world see the wonderful and beautiful things in the lagoon.

It gave me a very strange feeling, being way down there with gaudy parrot fish, a vivid green; a brilliant silverfish, with one half of the body a gorgeous gold; the little bluefish, looking just like the beautiful bluebirds you see in the spring; or the dignified ulua, metallic blue on the back and silver gray underneath; together with dozens and dozens of all kinds and colors of fish playing hide-and-seek around the big coral heads which looked like enormous cauliflower flowers.

And then we would see a long, dark shape slowly working its way toward us and we would scramble into shallow water.

A "BIG FELLER" APPROACHES

One evening, Hicks, a surf boy, and I, were playing around a big coral patch, watching the latest color scheme in gaudy fish. I had just veered toward shore when Hicks yelled. Turning quickly, I saw, not one black fin, but what looked like two large white ones.

Charlie, the surf boy, had just gone under with his spear. Suddenly the big blanket fish (sting ray), for that is what it was, darted forward, its dangerous tail sweeping by.

Hicks and I were practically out of the water. Charlie couldn't make it. I saw him throw himself backwards under water like a crab, and draw back his spear to plunge it in the big fellow if it turned on him. It was all over in a few seconds. But when Charlie came out he was laughing, chattering, and looking scared all at once.

He kept repeating "Big feller, big feller," with his eyes wide and frightened. Then he told us that he feared the huge rays more than anything else in the water.

Several of these large rays were hooked, but the combined strength of all hands near by never was equal to landing one; a harpoon was needed. One night the men hauled one up close to the beach in the entrance, but with a single jerk he straightened out a big hook especially made on board and was off seaward at full speed.

Sunday morning, our first Sunday on shore, with the early sun shining through the low-hanging clouds, and the gentle mur-



Dr. C. Gardner

on the island
on the water's
plunder. One



Photograph by Irvine C. Gardner

NOT A PILE OF SEA SHELLS, BUT HERMIT CRABS EATING COCONUT

The discarded shells of snail-like mollusks are worn as armor by these crabs, with little but the legs protruding. Like turtles, they curl up inside the shell when attacked. This group swarmed around a split-open coconut like dogs around a butcher's wagon.

mur of the water on the beach, Father McNally was holding divine worship. The men were kneeling on the white sand, facing the east with the sun illuminating their faces. I never saw a more beautiful service.

Day by day good weather continued. Our camp life ran smoothly.

Busy as the proverbial bees were the scientists, some of whom, even in the three weeks before the eclipse, barely had time to do all that was necessary to adjust their delicate instruments. Up with the sun, breakfast soon after daylight—we were keeping daylight-saving time—work until noon, lunch, then maybe a brief rest, but usually steady work all afternoon, then a brief swim before supper.

Even after dark the scientists often continued working, focusing their instruments on the full moon or the stars in preparation for the eclipse.

One group played bridge in the mess tent every night. Sometimes I went rat shooting. The fishermen would go down to the entrance to the lagoon, and try to catch a big one in the racing current.

We erected a flagpole near my tent and every morning the National colors, with

the National Geographic Society's flag beneath, were hoisted (page 385).

After the camp and the concrete foundations for the instruments were completed, we began the long and tedious task of mounting, testing, and adjusting the many pieces of scientific apparatus.

A scientist on a desert island is in much the same fix as Robinson Crusoe. If he has forgotten a screwdriver or some nuts and bolts he can't run down to the five-and-ten for them. He must do without, or rig up a substitute from materials at hand.

Dr. Richtmyer needed a heavier weight for his driving clock, so he made it out of old rusty iron from a ship that had been wrecked on the island.

**A SHIP OFFERS TO "RESCUE"
THE EXPEDITION**

It was decided to make a day's survey of Enderbury to get first-hand information about that island. Accordingly, certain members of the staff accompanied me on board the *Avocet* the night of May 23, as we were to make an early (2 a. m.) start.

About 10 p. m. we made out a steamer's lights to the westward.



A SCIENTIFIC "PIED PIPER" LURES RATS TO THEIR DOOM

Poisoned meal, not music, is the rodent exterminator used by Charles G. Thompson, President of the Foundation for Astrophysical Research. The rats, which probably came ashore from a wrecked ship, were such a nuisance that the photographer had to move his bed atop the darkroom so they would not keep him awake. The animals probably live on birds' eggs and young birds, but it is a mystery how they get water to drink.

Abruptly she turned and headed in toward the island. Soon she was close enough to signal and announced that she was the *S. S. Niagara*, of the Canadian Australasian Line, en route from Suva to Honolulu.

Seeing the flares on a desert island, she had stood in to learn if we needed anything. When she first saw the flares she could not see the ship's lights at anchor close inshore, and probably thought our range flares were signals for help.

A fine example of what sailors call "good sea manners!"

We thanked the captain and he turned and went back on his course.

The next morning at daylight we were close aboard on the lee side of Enderbury Island.

Lieut. Williamson and I went ashore in the surfboat. Fortunately the surf was not heavy, so we made it without difficulty. The next boat brought Dr. McNally, Mr. Stewart, Mr. Hicks, and Mr. Brown.

We divided into two parties, the captain, Hicks, and McNally taking the south-

ern half of the island; Stewart, Brown, and I taking the northern half.

The island was barren and extremely rough, its surface covered with loose, irregularly shaped bits of coral, looking as if an army of giants had amused themselves by piling them in long, high ridges (p. 384).

As we walked, the loose surface kept slipping and sliding. Progress was slow and difficult.

About the whole was an exaggerated odor of a chicken yard; overhead was a constant and curious bird parade. Some flew so close that they seemed to be trying to peer under our hat brims to see who the intruders were.

THE ADVENTURES OF JERRY

Jerry, the *Avocet's* mascot, remained with our party. The birds were even more curious about the little black dog than about us.

After hours of laborious travel, we started back by way of the beach. Even though that route was longer, we preferred it to crossing the ridges of loose coral again.

Byline C. Gardner

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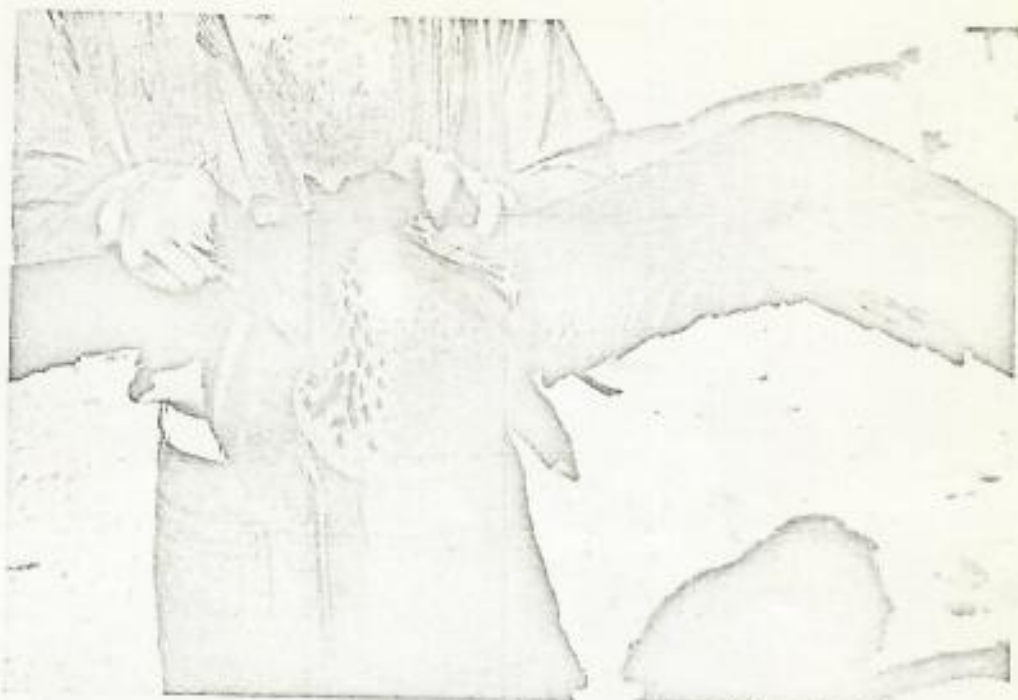
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Photograph by Irvine C. Gardner

THE MAN-O'-WAR BIRD'S THROAT SWELLS WITH AFFECTION

The male carries under his chin a pouch of brilliant turkey red which during the mating season he inflates with air to the size of a toy balloon. The feathers are dark brown. The man-o'-war bird, sometimes called the frigate bird, lives largely by snatching fish caught by other birds (367). Sometimes hundreds of the "man-o'-wars" could be seen riding almost motionless, with wings outspread, on the trade wind currents above Canton Island.

Upon reaching the surfboat, which was high and dry, the men reported that the tide had dropped away so suddenly they had been caught.

Waiting until the southern party returned, we began the tedious task of rolling the boat down to the water. Using a piece of driftwood about five inches in diameter, we gradually moved it out toward the breakers.

Handling a boat in breakers at low tide is always more dangerous than at high. When we were about halfway out, we wound the boat end for end so that we need not further jeopardize things by having to turn it about while we were rowing.

Little Jerry followed all our movements anxiously. Just when we reached shallow water, the tide changed abruptly and began rolling in very fast.

It took all hands to hang on to the gunwale and keep the boat from being capsized. Suddenly I looked back and there was poor Jerry halfway ashore, shaking

like a leaf, and with his whole soul in his pleading eyes. Turning back quickly I ran toward him. As I approached, the little fellow crouched down trembling.

I slung my binoculars over one shoulder and my bag over the other to free my hands. Then I hoisted him on my shoulder to hold him securely, leaving one arm free to balance myself in the surf.

Jerry hooked his little nails into my back to help hang on. As I worked my way out toward the boat, I patted him and tried to reassure him.

By the time I reached the boat, which was bucking like a horse with each breaker, I saw a mean-looking fin just outboard. So we hung on and waited.

Before the next big breaker came in, the fin had disappeared, and we tried it again. By this time we had four men in the boat and they had oars rigged out to start as soon as we could all jump in.

Just then a big breaker picked up the boat and rolled it toward me. Tossing Jerry into it, and scrambling forward,

I made it easily, as the gunwale was low on my side.

Seeing a pair of hands clutching the opposite gunwale, I helped haul the boatswain's mate over, and then, yelling to the men to give way hard, rigged out the long steering oar which the boatswain's mate grasped and used with all his strength.

Before the next breaker reached us we were out beyond the coral heads and soon were clear of the breakers.

The ship had stood in very close to shore and we were soon alongside and all hands climbed on board. One of the men forward passed Jerry on board. As soon as he hit the deck he raced up and down like mad for a couple of turns.

Ever since then, when he sees me he gives me a friendly lick, and when I have time to pet him he thanks me as plainly as a little dog can.

THE "WELLINGTON" BRINGS TELESCOPES AND COCONUTS

H. M. S. *Wellington* arrived May 26, and landed the New Zealand eclipse party (page 394). They found our dock and our two-wheel truck helpful for handling their instruments and equipment. The truck was particularly useful for transporting about a thousand coconuts they had brought for planting on a large area to the southward of our camp.

The two expeditions quickly became friendly. The officers of the *Wellington* entertained the members of both scientific parties and officers of the *Avocet* aboard their ship, and later the scientists of both expeditions entertained each other on shore. A field day ashore for the enlisted men of the two ships was a complete success.

Our resourceful doctor helped them improvise a stove from scrap material and constructed an odd but efficient smoke-stack from empty cans and roofing nails.

When we built our monument and mounted the two stainless-steel American flags, it was the doctor who mixed some fine finishing concrete and smoothed and shaped our monument into a really handsome structure (page 376).

On Decoration Day we unveiled the monument with appropriate ceremonies.

Now that the critical day drew near, the weather, which had been perfect, began to act uncertainly. One night the whole camp was nearly blown away. For several days and nights we had daily storms. An-

other night the *Wellington* dragged badly.

And then the weather seemed satisfied for a while and behaved itself. But we were all anxiously watching the eastern sky every morning at eclipse time, and we were not encouraged.

The day before eclipse found us worried. The pessimists said we might as well pack up and save time. The optimists thought everything would be all right. The rest of us hoped for the best.

On eclipse morning no one could sleep. I was up at 3 a. m., looking at the weather. At four o'clock it began to blow, and the whole eastern sky was overcast with heavy, dark nimbus clouds. We anxiously watched them and were delighted to see them swing to the southward.

At daylight, the cloud formation had changed completely, and there was a good percentage of clear sky.

And then the sunrise! It was particularly beautiful; were I an artist I would have tried to catch it to cherish forever.

The zero hour approached. The launch from the *Avocet* landed a large party on the dock. They went to their assigned stations. Everybody made his final tests and adjustments. Dunham and Thompson had worked throughout the night.

The doctor came to my tent and together we made arrangements for the visual work. A dozen times I looked at the watch, set to Greenwich time.

"ONE MINUTE TO GO!"

Previously I had carefully made three comparisons and recorded them in our eclipse record book. While waiting I caught myself mentally counting. And then the doctor said, very quietly, "Only about one minute to go."

That first contact, when the moon begins to cover the sun, is always a heart-breaker. I have seen Dr. Robertson, who has calculated at least a hundred eclipses, walking faster and faster until he was almost dog-trotting, just before the first contact, and then suddenly stop, jerk off his hat, and rub his hand slowly over his head as the observer marked it exactly on time.

So it was with us. We knew it was going to happen, it had to happen, and yet we both felt strained. To my question, "How much longer, Doctor?" there was no answer. After a pause a quiet, "She's coming on, Captain," and then, "Mark."



Irvine C. Gardner

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Photograph by Carl Markert.

"HELLO, DADDY! THIS IS KEITH"

The son of John E. Willis, of the U. S. Naval Observatory, broadcasts in Washington, D. C., to his father on distant Canton Island. At the table is Mrs. Richard H. Stewart, wife of the Expedition photographer. She and her two daughters went on the air, telling Stewart, 6,500 miles away, to swim in the lagoon if he must, but to look out for sharks.

As if his "Mark" had been communicated by some secret means to the moon, an infinitely small notch appeared on the edge of the sun high up on the right side.

I found my body relaxed; it suddenly dawned on me that I had been as tense and taut as a wire line.

Hurrying across to the boxing arena which we had filled with white sand, and around which we had stationed eight blue-jackets with stop watches to note and time the shadow bands, I gave them some last-minute instructions.

Dr. Mitchell quietly made the rounds, inquiring of each man whether all preparations were complete, then turned to his own apparatus with his three groups of assistants.

Slowly, steadily, the black shadow descended across the face of the sun.

Darkness came on, and it seemed that night should fall, yet I knew night couldn't be falling at that time of day. This queer darkness was confusing. It did not look like the growing darkness of approaching night, partly because the shadows did not grow longer as they do with the setting sun.

A hush spread over the whole place, no birds were in the air where, a short time before, there had been hundreds. All sound seemed to fade out. It grew darker. The tension was painful.

Yet with the suspense went a wonderful feeling of exaltation that suffused every man in camp. Long weeks of uncertainty were over. At last we were sure that no clouds could possibly interfere with our observations of the eclipse.

"Thirty seconds to go."

I wondered whether everybody else was cool and collected, or had buck fever as I had. I wished the doctor would stop scuffing his feet on the coral.

"Special signal, Richtmyer, 16 seconds to go."

Dr. Richtmyer sprang into instant action. Dr. Dunham was timing his movements exactly with Richtmyer's. An error might blow all the latter's lights and ruin his entire project. Our portable generator was standing up perfectly under this severe tax and we all prayed that there would be no mishaps.

"Ten seconds to go."



STANDING ROOM ONLY AT "RADIO CITY" TO HEAR MESSAGES FROM HOME

On the outside, listening in, are members of the Expedition who could not crowd into the tent. It was about 3 p. m. here on Canton Island, while in Washington, D. C. where the men's relatives were talking to them through the microphone, it was about nine o'clock at night.

Dunham and Thompson were burning with intensity as they performed each act with meticulous care.

"Stand by!"

The gorgeous Baily's beads* were appearing. The darkness was almost complete. Stars were beginning to twinkle.

"Doctor, did you press that key?"

"Mark."

A SPECTACLE OF SUBLIME BEAUTY

"One, Two, Three, Four," was sounding all over the site through National Broadcasting Company loud-speakers.

I was speechless at the sublime beauty of the whole spectacle. Those magnificent prominences, with a coloring impossible for humans to copy! The ethereal delicacy of the far-flung corona, its pearly illumination extending out into space millions and millions of miles!

The counting of the precious seconds measuring the period of totality was going steadily on—"121, 122"—and I knew the doctor would keep on counting till I gave him the signal that totality had ended.

* Baily's beads are formed by sunlight shining between the mountains on the advancing edge of the moon.

Suddenly the doctor kicked my leg. It startled me. What had I done? Had I forgotten something? I was in a panic. And then I saw him frantically pointing under the table.

Looking down, I saw his motion-picture camera. He had asked me to take some pictures just after the one hundred and twentieth second.

I stooped, caught the camera, jumped up, and pointed it toward the beautiful corona. I pressed the key down and heard the hum of the camera making an indelible record of the sublime spectacle.

"130, 131."

I guess that's enough for the doctor. Down went the camera, and again the intent watching. George Hicks' rich voice could be heard above the counting, describing in glowing and gifted words the wonderful beauty of this celestial extravaganza.

Suddenly I forgot my surroundings. The bare nakedness of our camp faded out, and I was in an enormous, high-vaulted cathedral, with everything mammoth and beautiful. Indescribably sweet music filled the air. I wanted to swallow, but couldn't.



"THE WEATHER IS PERFECT, AND WE'RE ALL AS HAPPY AS CLAMS!"

From the roof of the Expedition's photographic darkroom, the good news that clouds will not interfere with the eclipse is flashed to the world by George Hicks (right), National Broadcasting Company announcer with the Expedition. The assistant is ready with a flashlight so that Mr. Hicks can see his notes during the darkness of total eclipse. In the background, right, is the Expedition ship, U. S. S. *Albatross*, and at left H. M. S. *Wellington*, which brought the New Zealand party to Canton Island (page 391).

My eyes smarted.

"155, 156."

I could see Father McNally moving with the regularity of a machine, timing each movement to the continuous count. I could see mentally the feverish activity of each instrument. Hicks' melodious voice went on and on. I wondered how he could think of all the things he said. His talk had to be extemporaneous; he had never seen an eclipse before.

"207, 208, 209."

"End of totality!"

And then the overwhelming beauty of the Baily's beads, the magnificent ring setting, and the glory of the sun as it

burst forth, dissipating the weird darkness.

The birds immediately took the air, daytime noises began again, the bareness of our camp was thrust upon us with all its nakedness.

The eclipse of 1937 was over.

Then came the celebration! For half an hour nobody did anything but walk around and feel happy. The scientists acted like college boys whose team has just won a football game!

With a good job done, we suddenly realized that now we could go home. Packing began at a furious rate. Thirty hours later the *Albatross* weighed anchor, and we watched Canton Island disappear into the sunset.

INDEX FOR JANUARY-JUNE, 1937. VOLUME READY

Index for Volume LXXI (January-June, 1937) of the NATIONAL GEOGRAPHIC MAGAZINE will be mailed upon request to members who bind their copies as works of reference.

October 23, 1975

To: Martin Vitousek
From: Stephen V. Smith
Subject: Canton.

I'll write this down, so you will have it upon your return. I talked with Ed Ewen, USAF/SAMTEC (Vandenberg) on Monday, October 20. He is no longer involved with Canton, but he had considerable information and ideas. In places, some of the details become fuzzy, because information has become classified since our last conversation with them. Any cryptic notes on here are probably for my future use!

People:

Col. L. D. (Lonnie) Benson OX 53350 or OX 55780
Chief of Staff Air Force RDPQ
The Pentagon
Washington, D. C. 20030 (the guy who has best over-
all handle on things)

Major Mike Maddock
Vandenberg X 9261
SAMTEC/PMEA (request for entry to Canton)

Capt. John Peters
Vandenberg X 3016
SAMTEC/CEI (copy of our NUC TP)

Col. "Curt" Curtis 449-5604 or 449-5860
SAMTEC Liaison
Hickam (?) (local, anyway)

Major General ? Newby
Commander SAMTEC
Vandenberg 93437 X 6071

Memo to Martin Vitousek
October 23, 1975

Page 2

Ewen said it has been decided that USAF will stay in Canton for at least 5-6 more years, although in a greatly altered operation. Global will stay there to run it. It will be open for visitors, if they have an appropriate excuse. Ewen encouraged me to contact Maddock if there was any reason for possible site visit by U. H. personnel (either on our \$ or possibly funded by USAF). Apparently there has been about 1.3×10^6 buildup since I was there (1973).

If we (or whoever) should submit a proposal from U.H., probably should refer to earlier proposal. Ewen suggests an explanatory letter to Newby might be appropriate. Perhaps ideas of permanent base, portable lab, or some other concept is worth exploring. Might be possible to gain access to site even on our own funding (i.e., USAF permission to go but without funding from them). Clearly (although not said over phone) the problem of involvement by non-U.S. nationals still exists.

Curtis by now has supposedly been briefed of possible U. H. interest and can in turn fill us in on further details.

Although I can see definite advantages to possible permanent facility there, my own interest does not presently extend beyond another possible short-term (2 or so weeks) study. I'm willing to be convinced that my interests should be otherwise.

cc: G. Woollard
W. Coops
P. Jokiel

Balazs

Research Proposal Submitted to the U. S. Air Force
by
University of Hawaii, Hawaii Institute of Marine Biology
P. O. Box 1346, Kaneohe, Hawaii 96744

Title of Proposed Project:

"Marine Environmental Reconnaissance Studies,
Phoenix Islands"

Applicant:

Albert H. Banner
Professor
Department of Zoology and Hawaii Institute of Marine Biology

Co-Investigators:

S. V. Smith
P. L. Jokiel
G. H. Balazs
E. B. Guinther
G. S. Key

Proposed Starting Date: Immediately

Amount Requested: No direct dollar commitment in Phase I.

Proposed Duration: One Year for Phase I

Balazs

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FORWARD

Individuals who have not studied atoll environments generally lack an appreciation for their delicate, almost precarious, ecological balance and the degree to which even small disturbances by man can be disruptive. Films of petroleum and waste oils discharges from ships have had dire consequences on sea birds and aquatic organisms exposed at low tide. Concussions from blasting underwater obstructions have destroyed much marine life, and at Canton Islands these practices have been observed to be particularly destructive to sea turtles and fish. The pass at Canton was deepened during WWII to permit the entry of ships, and the resulting increased tidal exchange exposed and killed corals on the shallow reef flats. Rats have been accidentally introduced on many atolls and have decimated the sea bird populations by feeding on the eggs and young of these species.

Recently, the French CEA (their equivalent of the Atomic Energy Commission) has modified the reefs of the Tuamotuan Atoll of Hao to use as a staging base for the Mururoa test program. Within 18 months almost all of the valuable reef fish became dangerously toxic, and an epidemic of ciguatera poisoning spread through the native population.

American agencies have not been without their share of mishaps from disrupting the atoll environment. Many of these mistakes have been expensive in both time and comfort. Some have also been particularly disastrous to the atoll environment. Our government is only now realizing the cost of restoring the environment after the gross disruptions on Bikini and Eniwetok Atolls. Causeways which were built on Palmyra Atoll dammed off portions of the lagoon and destroyed the normal marine life there.

The 1964 dredgings at Johnston Island Created a fine silt which still clings to portions of the lagoon, killing corals and fishes. Kwajalein and Eniwetok Atolls have been extensively bulldozed, leaving the bases there with the blinding whiteness of exposed coral and little chance for rapid replacement of the normal plant cover. The top soil on these islets has been buried and the fresh water lens seriously disrupted.

A particularly costly undertaking has been the USAF-DNA PACE program at Eniwetok Atoll. A plan to simulate an atomic explosion with conventional explosives on one of the still-denuded islets has been stopped by a Federal court order, which may be converted into a permanent injunction. Nearly four million dollars were spent on this program without concern for the certainty that a massive explosion would have loosed into the environment amounts of radioactive materials which are now safely buried. This renewed radioactivity would have further delayed the scheduled return of the Eniwetokese to their ancestral home.

Inadequate awareness of the potential environmental hazards of such operations have not only lead to unnecessary environmental destruction, but have often resulted in the failure of numerous long and short term programs. Ignorance of atoll geomorphological processes has led to practices which cause erosion. Piers and moles have been destroyed by storms and currents; beaches have been eroded due to the improper placement of shoreline facilities; dredged passes have rapidly refilled; expensive installations have been damaged or destroyed when storm-driven waves swept across low-lying islets; and environmental disruptions have produced serious medical and public health problems for base personnel.

Such dangers are clear and present in the Phoenix Islands as a result of military operations there. Both Paul Jokiel and George Balazs have made observations and have recognized blasting, dredging, and oil spills among the complex and potentially disastrous environmental disruptions there (see the trip report by Captain Callahan, USAF/Environmental Health Lab). The USAF has done an admirable job of attempting to avoid environmental damage but we believe that inputs from scientists experienced in atoll ecology would strengthen the present efforts to protect that ecosystem.

ECOLOGICAL REGULATIONS AND RESTRAINTS

Increasing environmental awareness on the part of elected officials and the general citizenry has prompted the Federal government to set forth guidelines on environmental matters. It is useful to review the scope of these guidelines as they apply to those governmental agencies either directly or indirectly involved with the Phoenix Islands.

At the present time, the Department of the Air Force has administrative control of these islands. Section 2 of Executive Order 11514 defines the environmental responsibilities of Federal agencies and requires that the heads of such agencies shall:

"Monitor, evaluate, and control on a continuing basis their agencies' activities so as to protect and enhance the quality of the environment."

"Heads of agencies shall consult with appropriate Federal, State and local agencies in carrying out their activities as they affect the quality of the environment."

"Develop procedures to ensure the fullest practicable provision of timely public information and understanding of Federal plans and programs with environmental impact in order to obtain the views of interested parties."

"Engage in exchange of data and research results, and cooperate with agencies of other governments to foster the purposes of the Act."

"Insure that information regarding existing or potential environmental problems and control methods developed as part of research, development, demonstration, test, or evaluation activities is made available to Federal agencies, States, counties, municipalities, institutions, and other entities, as appropriate."

AFM 126-1 "Conservation and management of Natural Resources," 22 February 1972 applies to all land under Air Force jurisdiction. This document states that first priority be given to the protection and preservation of habitat utilized by rare and endangered species and special interest areas. Certainly, the sea turtles and some of the sea birds of the Phoenix group qualify as rare and endangered species. We discuss the Phoenix Islands as a scientific special interest area, (Appendix II). AFM 126-1 further points out that such irreplaceable resources must be both protected and managed to enhance their value.

We understand that the United States government has an agreement with Great Britain to protect the ecology of the Phoenix Islands. Mismanagement of this unique region could jeopardize U. S. - British relations in the Pacific, and possibly censure by international scientific and wildlife organizations.

THE PHOENIX ISLANDS

The recommendations of the JOC Phoenix Islands Ecological Committee (Captain David E. Lewis) state that:

"A periodic inspection of the islands should be established for monitoring the effectiveness of island operating procedures and their effect on the ecology. The inspection group should include personnel in the field of Pacific Island ecology."

During a visit to the Phoenix Islands in June of 1972, Captain Callahan (USAF/Environmental Health Lab) recommended that the Air Force establish a working relationship with the Hawaii Institute of Marine Biology (HIMB) to realize the value of the Phoenix Islands as a scientific resource and to develop the knowledge needed to evaluate the USAF impact on these islands.

The preceding discussion can be summarized in two main points; (1) the Air Force has been charged with the responsibility for environmental protection in areas under its control; (2) there is a strong implication that appropriate agencies such as HIMB be enlisted to assist in this mission.

Ultimately, the USAF/Environmental Health Lab will probably be responsible for any overall environmental program in the Phoenix Islands. However, the USAF/EHL would probably be the first to admit that they lack the personnel experienced in atoll ecology to carry out an extensive program. We also recognize that the regulations outlined above have placed a burden on the Armed Forces which clearly departs from their traditional role. Research institutions like HIMB do, by their very nature, possess the scientific resources and interests to assist the military in meeting these obligations. While HIMB has not been legally charged with assisting in these areas, we do recognize a moral obligation on our part to use our acquired expertise when necessary. Moreover, we do have a strong interest in understanding atoll ecosystems.

AREA OF POSSIBLE COOPERATION

As a preliminary step we have identified a number of researchers at HIMB who are working on coral reef and atoll ecology and who are willing to volunteer their time and efforts to carry out the initial steps with the USAF concerning the Phoenix Islands. We see our objectives as;

(1) establishing a working relationship between USAF and HIMB and to lay the groundwork for future joint activities; (2) to carry out the preliminary scientific reconnaissance needed to design a continuing program; and (3) to acquire scientific information from this unique region to aid us in our own research on atoll ecology. The six members of this ad hoc group are listed below.

Chairman:

Dr. Albert H. Banner

Members:

Dr. Stephen V. Smith
Paul L. Jokiel
George H. Balazs
Eric B. Guinther
Gerald S. Key

All of these individuals are experienced in atoll ecology, and three members of the group have visited the Phoenix Islands. Dr. Banner visited Canton several years ago, and Messers Jokiel and Balazs have been there within the last year. During June 1973 Mr. Jokiel, at the request of the Air Force, advised Captain Callahan (USAF/EHL) on matters concerning the ecology of Canton, while Mr. Balazs conducted a preliminary survey of sea turtles at Canton during February 1973. As we or the USAF see the need to do so, this group could be altered and/or expanded.

We visualize a two-phase effort by HIMB in the Phoenix Islands; details for which are given in Appendix I. Generally, Phase I would provide us with initial first-hand information on the general ecology of the area and Phase II would establish a continuing scientific program.

During the initial phase, we would be providing a considerable contribution through public agencies which presently support us; USAF support would be minimal, including only transportation, food and lodging. We can offer our support only because the Director of HIMB, Dr. John E. Bardach, recognizes the considerable importance of our proposed efforts. The HIMB contribution per man would amount to approximately two lab and report-writing days for each day in the field. Thus, the HIMB contribution includes approximately 300 man-days of professional services plus technical and clerical assistance in data analysis and report preparation as well as the use of substantial equipment and supplies. Such an initial study involving an obvious and substantial contribution of non-military public funds can be justified because of the lack of information about the area; future expenditures cannot be so justified.

Phase II efforts, after the USAF has evaluated our initial performance, would include possible expansion to an on-going program with modest Air Force support. We foresee mutual benefits to this proposed arrangement. Our information would be available for the USAF/EHL to use in environmental assessment and monitoring, and we would have realized our own research objectives. Moreover, HIMB scientists will be able to

combine their previous familiarity expertise in atoll ecology with first-hand knowledge in the Phoenix Islands so as to serve as well-versed advisors to the base commander and to SAMSO on matters involving the environment. These scientists will have the ability to recognize potential problems and suggest proper action, and the relative proximity of Hawaii to the Phoenix Islands will make this pool of talent readily available in case of an environmental emergency.

Additionally, we are now compiling available scientific data on the Phoenix Islands, and have started to develop a reference collection of the marine life to be found there. During the course of the study, a catalog of species identified will be compiled in the form presently being used by the Hawaiian Coastal Zone Data Bank. Collections of various organisms will be made for later identification by taxonomic specialists.

A bonus to the proposed plan would be the aid the program would give the morale of those confined on islands for long periods of time. George Balazs has already recruited five volunteers at Canton to assist in the turtle survey by observing nesting activities in their off-duty hours and by sending their data to HIMB. Needless to say, such effort will be of great benefit to the environment and will be of morale/educational value to the base personnel.

In off-duty hours, interested island personnel could readily collect scientific specimens or monitor various parameters in the absence of scientists. Such constructive activity can greatly reduce the frequent boredom of atoll life, especially among those needing intellectual stimulation. This activity will also make island residents more aware of the ecological value of the islands and will promote a general attitude of respect for the natural environment.

APPENDIX I: Planned Efforts in the Phoenix Islands

Phase I. Preliminary Marine Reconnaissance

First priority will be given to Canton since this is the site of major activity.

- Balazs: Turtle survey. Numbers and species present; mapping nesting sites; establish duration and intensity of breeding; initial tagging program. These efforts will be a continuation of initial observations.
- Guinther: Survey of intertidal fauna, survey of "estuarine" conditions along shoreline; descriptive work on high saline environments; water table.
- Jokiel: Lagoon sediments; temperature survey; salinity survey, turbidity, chlorophyll distribution (phytoplankton), preliminary coral distribution; nutrients. Initial observations have already been made.
- Smith: CO₂ biogeochemistry; productivity and residence time estimates for water within lagoon.
- Key: Lagoon water chemistry; preliminary analysis of reef fish communities.

It is well to consider how the HIMB work plan for Phase I relates to USAF needs. Water property studies will define the physical-chemical environment present in the lagoon as these properties relate to natural conditions and to artificial perturbations. Residence time estimates for lagoon water will spell out the flushing characteristics of natural and artificial materials in the water.

Biological surveys will help to identify rare and endangered species and to relate biological distribution to characteristics of the water and sediment. The turtle survey is particularly important to assessing the

distribution of an endangered animal known to live, breed and nest in the area. Because this effort is so important and has already begun, we present the initial report as Appendix III.

Studies of the ground water body and its interaction with the "estuarine" ponds and inlets will provide information pertinent to fresh well-water use on the atoll, sources of contamination of this well-water and long term fluctuations in the volume of fresh or brackish water within the island structure.

Numerous other examples could be given of how such baseline data will be used by the USAF, but the preceeding should illustrate the basic value of such knowledge.

We estimate that one year would be required to complete the preliminary objectives. During this period of time, the details of Phase II can be worked out. Initially HIMB would contribute scientists and equipment needed to undertake the proposed studies, and USAF provide logistic support. Logistic support for Phase I would be limited to two one-week trips by a party of four scientists (summer 1973 and winter 1973) as well as three one-week trips by a party of two (various times during year). USAF would supply transport, food and lodging for these people.

Air Fare - 14 round trips (Honolulu - Canton)
Excess baggage (scientific gear) - less than 300 lbs/scientist.
Per diem - 98 man-days

While the party is on the Phoenix Islands we would need the following:

Outboard motor boat on Canton.
Space for instruments (possibly we could use part of base hospital).
Surface transportation.
Transportation to outer islands.
Access to ecological and meteorological data on file at Canton Island.

HIMB personnel will sign waivers before leaving Hawaii. All investigators will follow all base regulations and only certified personnel will use SCUBA. In light of the professional caliber of the people involved, we anticipate no problems in regulating their activities, as demonstrated by actions of HIMB staff members that have previously visited this site. Reports of their activities and findings will be filed before leaving the base, and a complete scientific report will be submitted after the data has been analyzed at HIMB. An example of this type of work is included as Appendix III (George Balazs' report). Other evidence is in file in the form of a report by Captain Callahan and Paul Jokiel (June 1972).

Phase II. Expanded Efforts

Once the initial work is underway, and the USAF has been given time to evaluate our performance, we would jointly begin to formulate a mutually satisfactory agreement for continuation and/or expansion of the effort. This might involve setting up a small laboratory at Canton and a gradual build up to the level of the present Atomic Energy Commission - University of Hawaii facility at Eniwetok Atoll. The experience of the AEC and the University of Hawaii with the Eniwetok Marine Biological Laboratory (EMBL) has shown the great mutual value of such a laboratory. The EMBL was created in 1954 to carry on general marine studies, utilizing AEC facilities, transportation, messing and housing. Its cost, when compared to the other costs of the AEC program on Eniwetok, was trivial. However, its value to the AEC was great, for through the visits of many scientists a knowledge of the environment of the atoll was built up far better than had the AEC

attempted to move teams of scientists under contract into the field. Its value to science was even greater, for it permitted marine biologists of all specialties to visit the only marine laboratory in the world situated on a coral atoll.

It is suggested therefore, that if the reports of the reconnaissance team are favorable, the Air Force consider the creation of a similar laboratory on Canton Island. The initial facilities could be taken, as they were at Eniwetok, from existing structures, like trailers. Housing would be in the BOQs; messing would be in the military or civilian messes; transportation to and from Canton would be on the regularly scheduled flights, while land transportation on the island would be through the motor pool. For marine studies, one or two outboards could be assigned. As at Eniwetok, the scientists visiting for their own studies (as opposed to those making specific studies requested by the Air Force) would require no financial support beyond transportation and subsistence.

At this time it is difficult to arrive at a realistic budget, because the cost of supporting the field laboratory would depend on its size and the amount of its use. Possibly after a few years it might grow as large as that at Eniwetok which has a budget of \$55,000 a year. The cost of special environmental studies would depend entirely upon their scope.

We enclose as Appendix V a report on Kwajalein Atoll to demonstrate the potential value of HIMB cooperation at Canton Island. Appendix VI demonstrates the contribution to operations at Canton Island from a one-week visit by Paul Jokiel.

APPENDIX II: Statement of Phoenix Islands as a
Special Interest Area (Scientific)

The Phoenix Islands represent a "stepping stone" between Micronesia and the Line Islands. Although the latter groups have been studied to some extent, scientific knowledge of the marine environment of the Phoenix group is still virtually absent, and investigation of this area promises to yield useful data on the zoogeography of tropical Pacific life forms. As an example, one of the specimens of alpheid shrimp recovered by Paul Jokiel from Canton Island has been identified as a possible new species but is tentatively grouped with another new species known only from Western Australia (Synalpheus sp. nov.). George Balazs concluded on his last visit that the relatively unexploited state of some of the outer islands in the Phoenix group may well classify them as being among the most undisturbed and unaltered marine turtle nesting areas in the Pacific.

The lagoon at Canton is unique in that it exchanges water with the open ocean only at one location. This has resulted in an ideal, uncomplicated situation for the study of various biogeochemical interactions. One such interaction, of both practical and scientific interest, is that between the sea or lagoon and the ground water body within the island structure. Much of this interaction occurs in the ponds and inlets along the island shore where materials from the sea are deposited by biological and physical processes and materials from the land are returned to the sea through ground water seepage and tidal flushing. The unusual shape of Canton Atoll, alluded to above, enhances the possibilities of tracing materials participating in long term cyclical exchange between the land and the sea, providing data applicable throughout the tropical Pacific.

APPENDIX IV: Interaction With the Interested Government Agencies

Eventually we should consider the inclusion of certain other individuals and agencies which have an interest or jurisdiction in the Phoenix Island group, or at least keep them informed of our progress. Any such list should include the following:

Environmental Protection Agency:

Dave Clark
Surveillance and Analysis Div.
EPA Region 9
100 California Street
San Francisco, California 94111

Phil Wood
Water Quality Standards Section

Bill Helphingstine
Federal Facilities Section

C. Seeley
EPA Pacific Basin Director
1000 Bishop Street
Honolulu, Hawaii 96813

Capt. David E. Lewis
JOC Phoenix Island Ecological Committee
Department of the Air Force
6595th Space Test Group (AFSC)
Vadenberg Air Force Base
California 93437

Walter W. Melvin Jr., Col. USAF, MC
Commander
USAF Environmental Health Lab/CC
Kelley AFB, Texas 78241

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By N. L. H. KRAUSS

The ten islands of the Phoenix Group lie on both sides of the equator, east of the International Date Line and north of Samoa and the Tokelau Islands. Howland Island, the northernmost, lies 1,650 nautical miles southwest of Honolulu. The islands from north to south are Howland, Baker, Canton, Enderbury, Birnie, McKean, Phoenix, Sydney, Hull and Gardner Islands. The total area is 12.48 square miles and Canton Island is the largest (3.5 square miles).

Many of the islands were discovered by the crews of American whaling ships. The two first discovered ones seem to be Baker Island, said to have been discovered by Capt. Elisha Polger of Nantucket, Massachusetts, in the whaler "Equator" in 1818, and Canton Island, believed to have been found before 1820. Baker and Howland are American possessions; Canton and Enderbury are under joint American-British administration; and the other six are part of the British Gilbert and Ellice Islands Colony. An important airport on the North America to Australia and New Zealand route was operated on Canton Island until 1958.

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

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25th. July 1973

Dear George,
I have received your letter redirected to me in Australia from FIJI, where it was sent by you.

It is only a month since I returned from the Fijian group of islands to my home at Buderim Queensland Australia. In the interim period since I met you at Canton I spent some time in Pago Pago in association with the De Jong fishing Co. also in Apia - Western Samoa. Later I was in Tarawa where you will recall the fighting was severe during the last war.

My two young colleagues at Canton, Neville & Ian are still in Suva, their home base and when I left they were trying to lease or purchase a larger tug to effect some work offering around the group of islands.

I had a trip in a chartered catamaran sailing yacht as a crewman to assist a charter skipper with his clients who were americans and liked to dive all day. I always have had an interest in cooking and like to fiddle in the kitchen. So the charter skipper had a birthday coming up and we gave him a surprise birthday party and I made a huge fruit cake which took me two days to make and ice. The party and the cake were a huge success. Curiously enough I have left behind in the islands not so much my ability as a marine civil engineer but a big reputation as a cook. So I am welcome there again principally in the latter capacity.

The film you provided for me could not be developed in Fiji, and the subsequent films I purchased in the islands were similar. So - I refrained from posting them to Kodak in Melbourne Aust until I came home. I have one returned and prints as slides may be of interest to you. I will turn of the next batch and then have some duplicates for you.

My visit to Canton was most interesting. I can remember we were busy there when the astronauts were stationed there for the long period recently completed. I told my friends about you being a peeping Tom at Canton.

If by any chance you find time to visit Queensland we are about 65 miles north of Brisbane which is the capital city of this State. We will be pleased to see you and have room in a district we believe is the best in the world. I will forward the slides when received.

Sincerely, Bill Bain.

W. Bain.
Buderim Mountain. Q. Australia 4556



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My visit to Canton was most interesting. I can imagine they were busy there when the astronauts were stationed in the capsule for the long period recently completed. I have commented to my friends about you being a peeping Tom on Madame Turtle at Canton.

If by any chance you find time to visit Queensland Australia, we are about 65 miles north of Brisbane which is the Capital city of this State. We will be pleased to see you and have a spare room in a district we believe is the best climate in the world. I will forward the slides when received.

Sincerely, Bill Bain.

W. Bain.
Buderim Mountain. Q. Australia 4556

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE TEST CENTER (AFSC)
VANDENBERG AIR FORCE BASE, CALIFORNIA 93437



Office of the Commander

1 May 1973

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

Dear Mr. Balazs

I read your final report on the Status of Marine Turtles on the Phoenix Islands with great interest and pleasure, particularly the conclusion that the "..... nesting population in the Phoenix Islands could well constitute the largest found in any Central or South Pacific island group"

We at SAMTEC are well aware of the environmental responsibilities of our stewardship of the Phoenix Islands. We strive not to degrade the environment or to disturb the natural inhabitants of the area. More than that, we like to, where possible, improve the situation to perhaps make up for past mal-practices, those present disturbances that are inherent and necessary to our operations and of course the mal-practices by others elsewhere in the world.

I was pleased that you felt we had an awareness of the need to protect the marine turtles and were doing so. I suspect that the turtles on Canton are better protected and less disturbed than on any other inhabited island and we plan to keep it that way. I have asked Colonel Deem to review your recommendations and carry out as many of them as we can. We will reemphasize the rules regarding disturbing and harming turtles or their eggs. We would also not look unfavorably on future surveys provided they were consistent with our very limited resource and support capabilities.

I wonder, if there is not more that could be done on a limited, local self-help, voluntary basis to significantly improve the Canton turtle population - provided of course this is desirable. I would not presume to propose how this could be done, but I throw out the following as an example of the type of effort I mean. An expert such as yourself would certainly have to come up with the proper scheme to best achieve the desired results:

The survival rate of the baby turtles is very, very low - I've heard 2-3%.

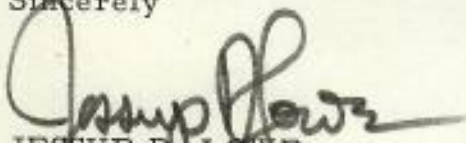
We have, as you mentioned, rescued and protected young turtles until they were large enough to have an improved survival probability - considerably higher, I would assume.

Could not some means be found to protect larger numbers of the baby turtles (perhaps eggs too) in holding ponds (incubators) where they would be allowed to pass the critical stage (whatever that is) before being released to the open sea?

Should such a technique be feasible, desirable and practical on a self-help basis, I would be willing to sponsor or suggest it as a service project to Colonel Deem for possible voluntary support by the conservation oriented people on the island.

If such an idea has any merit, I would be pleased to hear from you.

Sincerely


JESSUP D. LOWE
Major General, USAF
Commander

May 11, 1973

Major General Jessup D. Lowe
Commander, Headquarters Space and
Missile Test Center (AFSC)
Vandenberg Air Force Base, California 93437

Dear General Lowe:

Thank you for your letter of May 1 regarding marine turtles in the Phoenix Islands. I was pleased to learn of your own personal concern for these saltwater reptiles and of your awareness of the pressures they have been subjected to throughout the world in recent years.

The practice of holding weak and disoriented hatchlings until strength has been regained is a sound conservation procedure. Animals left to wander further inland would most certainly die from exposure. While the young turtles are in captivity, it is essential that they receive frequent feeding. Small pieces of sea food flesh (e.g., fish, shrimp, squid) is the most readily accepted diet. It is amazing how much and often they will eat starting from a few days after hatching. In two or three weeks they should be strong enough for release.

The concept of removing eggs to protected surroundings with subsequent hatching and release has attracted attention in past years as an experimental method of re-establishing depleted areas. Archie Carr, one of the world's foremost authorities on marine turtles, hatched and transplanted more than 100,000 one-day old green turtles in the Caribbean during the early 1960's. Most of the releases were at sites where turtles formerly nested in abundance. To date there are no indications of success and the project was halted several years ago. Rearing hatchlings past the early high mortality stage sounds like a reasonable method for increasing numbers, however, what effect this practice can have on feeding cycles, migratory abilities and most important, sexual maturation, is completely unknown. It is for this reason that the Marine Turtle Specialists Group of the International Union for the

Major General Jessup D. Lowe
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May 11, 1973

Conservation of Nature (IUCN) does not endorse such procedures unless absolutely necessary. That is, if predation on eggs and/or hatchlings is unnaturally high and cannot be controlled. Based on my experience and research to date, I tend to agree with this opinion. Disruption of the life cycle could possibly create greater mortality on a long term basis. The best method of conservation is to allow natural re-stocking - provide protection for nesting females, eggs and hatchlings from man. In addition, keep wild predators (rats, dogs, etc) to a minimum and eliminate external disturbances (lights, vehicles on beaches, etc). Your organization is doing this at present by enforcement of strict regulations.

I might further mention that two of the highest research priorities outlined by the IUCN for the effective conservation and management of marine turtles are:

1. The mapping of group nesting sites including the surveying and censusing of colonies; and
2. Population ecology studies to improve man's knowledge of structure, proliferation and relations between breeding and feeding groups. The more we can learn of the needs of turtles, the more we can do to perpetuate them.

My eight days on Canton allowed me to access the situation and determine what work needs to be accomplished and can be of real value. I feel that I was fortunate in being able to accomplish as much as I did in such a short time. I would like to thank you again for granting the permission for this study. I am sure that further and more extensive work on my part in the Phoenix Islands would prove beneficial to both our organizations, as well as to the turtles.

Again, thank you for your interest.

Sincerely,

George H. Balazs
Jr. Marine Biologist

mk

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE TEST CENTER (AFSC)
VANDENBERG AIR FORCE BASE, CALIFORNIA 93437



27 AUG 1973

Mr George H. Balazs
Jr Marine Biologist
University of Hawaii at Manoa
P O Box 1346
Kaneoche, Hawaii 96744

Dear Mr Balazs

I have reviewed your letter of 3 July requesting permission to enter the Phoenix Islands this fall to continue your studies of the Marine Turtles and further requesting Air Force support for your transportation and meals. Regretfully, we are unable to honor your request for support.

As I stated in my May letter, further surveys are welcomed provided they are consistent with our limited resources and support capabilities. There are no funds available to support this type of survey.

The United States Air Force Environmental Health Laboratory will conduct an Ecological Base Line Survey in the near future. The proposed plan includes Marine Biology disciplines from the Navy. If this portion of the study does materialize, we will be most happy to share with you any data pertaining to Marine Turtles.

I am advised that interested personnel at Canton are continuing a reporting system to keep you current on the Marine Turtle activities. I trust such data will be of benefit to you.

Sincerely

A handwritten signature in dark ink, appearing to read "Jessup D. Lowe", is written over the typed name and title.

JESSUP D. LOWE
Major General, USAF
Commander

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE TEST CENTER (AFSC)
VANDENBERG AIR FORCE BASE, CALIFORNIA 93437



REPLY TO
ATTN OF: SUXD

2 DEC 1974

SUBJECT: Request to Visit Canton Island, University of Hawaii

TO: University of Hawaii at Manoa
ATTN: Mr G. H. Balazs
P.O. Box 1346
Kaneohe, Hawaii 96744

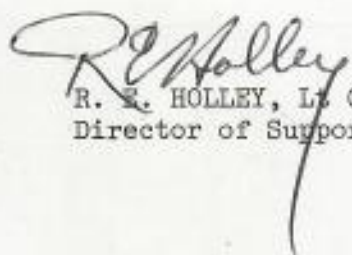
1. References:

a. Telecon on 15 November 1974 between Mr Balazs and SAMTEC, Mr Ewen.

b. May 1974 telecon between SAMTEC, Mr Ewen and Mr Balazs.

2. Reference b was stimulated by recommendations from the Naval Undersea Center during their review of the Giant Patriot Environmental Impact Study effort. At that time, there were several questions discussed concerning possible effects upon marine turtles during the reentry vehicle termination and recovery operations. However, the Giant Patriot program was cancelled immediately after discussions in reference 1b so the proposal to solicit your assistance was not pursued any further. If and when the program is approved for implementation, the requirement for further studies will be reconsidered.

3. In the interim, perhaps some of the interested islanders can assist you in your pursuit of observation data. Suggest you contact the Island Commander, Lt Col Philip Stack and describe your interest. He may be able to stimulate reporting directly to your post office box in Kaneohe.


R. S. HOLLEY, Lt Col, USAF
Director of Support

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE TEST CENTER (AFSC)
VANDENBERG AIR FORCE BASE, CALIFORNIA 93437



30 MAR 1973

University of Hawaii
Hawaii Institute of Marine Biology
Coconut Island
P.O. Box 1346
Kaneohe, Hawaii 96744

Attention: Mr. G. H. Balazs

Dear Mr. Balazs

This is in response to your 23 March 73 letter.

With respect to your 3 March 73 report of findings at Canton Island, it was very well written and received and will serve as a basis for further studies during the base line survey efforts scheduled for FY 74. We are indebted to you for the apparent all out effort required to get it to us in time for our survey planning meeting on 6 March. Your recommendations were accepted as reasonable although there was some question concerning the extent to which SAMTEC should go into the turtle study areas and yet stay within the confines of the Air Force mission in the Phoenix Islands, as it pertains to the overall ecology programs.

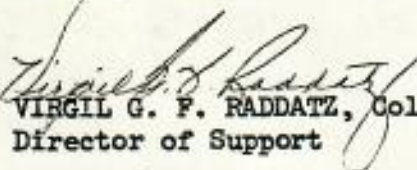
Based upon the interest expressed during our discussions in the 6 March meeting, your requests in the 2nd and 3rd paragraphs of your 23 March letter do not appear unreasonable. In fact, the use of tags and questionnaires by interested and concerned individuals could provide a mutual benefit to your program as well as provide a basis for further studies pertinent to the base line survey efforts.

With respect to your request concerning press releases and publication of your findings, we kindly request you be governed by the following general guidelines:

a. Interviews with the local newspaper that contain questions about what we do at Canton should simply indicate that it is a terminal area for Department of Defense research and development missile launches. Any requests for news media visits to Canton must be referred to SAMTEC/CEI. If photos are requested and provided, only those which do not reflect equipment at Canton in the background can be released. Generally, your remarks about Canton should be restricted to your study of the turtles; however, you certainly may say that Canton contractor personnel are assisting you in a follow-on continuing study effort.

b. Essentially the above guidelines also apply to your question about science writer inquiries, however, in so far as your own article is concerned, we would like to see a draft of it before you send it to any journal.

Please be assured that we are interested in your work not just as editors of your studies and stories, but primarily because they represent a positive scientific endeavor. The editorial precautions are imposed by the Department of Defense policies.


VIRGIL G. F. RADDATZ, Colonel, USAF
Director of Support

Cy to: Canton OL/AE, w/l atch
SAMTEC/CEI, w/l atch
SAMTEC/XPS, w/l atch
SAMTEC/EN, w/l atch
SAMSO/DE, w/l atch
SAMSO/DEC, w/l atch

TITLE

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

PRINCIPAL INVESTIGATOR

George H. Balazs

INSTITUTION

University of Hawaii, Hawaii Institute of Marine Biology

DURATION

One Year (1973-74)

MOTIVATION

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

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

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

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

OBJECTIVES OF PROJECT

1. To identify the various genera of marine turtles present in the Canton area and to determine in what proportions they exist.
2. To make estimates of the total numbers involved in the populations including the size distribution of individuals.
3. To locate and describe productive grazing areas.
4. To locate, identify and describe suitable nesting beaches.
5. To determine breeding and nesting seasons.
6. To initiate a tagging program which will help determine the geographical range of the members of the colony.
7. To make recommendations on how best to conserve the turtles in this area.

METHODS

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

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

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

BIBLIOGRAPHY

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The Ecology and Migration of Sea Turtles, 1. Results of field work in Florida.
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The Ecology and Migration of Sea Turtles, 2. Results of field work in Costa Rica.
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Hendrickson, J. R., 1958:

The Green Sea Turtle, Chelonia mydas in Malaya and Sarawak.
Proc. Zool. Soc. London. Vol 130:4 pp 455-535.

Hirth, H. F., 1971:

Synopsis of Biological Data on the Green Turtle (Chelonia mydas).
FAO Fisheries Synopsis No. 85 Rome.

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FAO 482 Rome.

Parsons, J. J., 1962:

The Green Turtle and Man.
University of Florida Press, Gainesville.

Canton Island

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

Bulay

D R A F T: April 10, 1973

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

Dear General Lowe:

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

Drs. Fosberg and Stoddart will be primarily concerned with the terrestrial ecology of this area. Moreover, nearly all previously available information from this region deals with terrestrial aspects of the system. Therefore we recognize that our potential contribution is to be primarily centered on marine ecology. However, if indicated by Drs. Fosberg and Stoddart, we can call upon those University of Hawaii personnel presently working on atoll terrestrial ecology to broaden our proposed research base.

General J. D. Lowe

Page Two

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

Because of our concern and interest, we have formed an ad hoc advisory committee at the Hawaii Institute of Marine Biology (HIMB) to implement initial steps. This committee is largely oriented towards marine ecology but could be expanded to include terrestrial ecology as well. We have also written a proposed two-phase environmental undertaking in the Phoenix Islands. Required USAF support for this effort is modest, but the results should be of considerable benefit as it would allow for the intelligent management of this region and help avoid operational delays and the large expense caused by poor environmental planning.

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

We therefore hope that you will give this statement your serious attention and that you will support our proposed efforts to increase the understanding of the Phoenix Island environment.

Sincerely,

A. H. Banner, Professor, Zoology
S. V. Smith, Asst. Marine Biologist
P. L. Jokiel, Research Associate
G. H. Balazs, Jr. Marine Biologist
E. B. Guimther, Grad. Assistant
G. S. Key, Research Assistant

Enclosures

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE TEST CENTER (AFSC)
VANDENBERG AIR FORCE BASE, CALIFORNIA 93437



73 JUN 15 PM 1:54

12 JUN 1973

CRA
OFFICE OF
RESEARCH
ADV Mr. Howard P. McKaughan
University of Hawaii
Office of Research Administration
Honolulu, Hawaii 96825

Dear Mr. McKaughan

Reference my letter of 7 May 1973. Further consideration of your proposal for support of a research grant has indicated that the proposed effort transcends the Space and Missile Test Center (SAMTEC) mission in the Phoenix Islands and that it would be more appropriate to forward your proposal to a DoD agency that has a mission directly related to the marine biology disciplines. As such, the proposal and related correspondence have been forwarded to the Air Force Office of Scientific Research in Arlington, Virginia, for review and evaluation. Future correspondence concerning your proposal should be directed to that office at 1400 Wilson Boulevard, Arlington, Virginia 22209.

We wish to express our appreciation for your interest in our programs and the efforts you have expended in the preparation and submission of this proposal.

Sincerely

Stanley R. Radom

STANLEY R. RADOM
Unsolicited Proposal Control Officer

UH dists:

Dr McKaughan

Dr Banner

CGAO

Dr Steve Smith, HIAIB

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE TEST CENTER (AFSC)
VANDENBERG AIR FORCE BASE, CALIFORNIA 93437



23 August 1973

University of Hawaii at Manoa
Hawaii Institute of Marine Biology
Attn: Mr. George Balazs
P. O. Box 1346
Coconut Island
Kaneoche, Hawaii 96744

Dear Mr. Balazs

Your manuscript "Marine Turtles in the Phoenix Islands" is hereby cleared for publication. When it is printed, please drop us a line telling us in what publications we can find it.

Sincerely

A handwritten signature in cursive script that reads "Edward A. Howell".

EDWARD A. HOWELL, Captain, USAF
Chief of Information



Federal Electric Corporation

23 July 1973

Hawaii Institute of Marine Biology
Attn: Mr. G. H. Balazs
P.O. Box 1346
Coconut Island
Kaneohe, Hi. 96744

SAMTEC O/L-1
APD
San Francisco, Ca. 96401
WTR PROJECT
0500-072-73/S7

Dear George,

Received your letter of 3 July 1973. It was nice to hear from you again. By the time you receive this, I will be in Mulege, Baja California Sur on vacation and working on my personal projects.

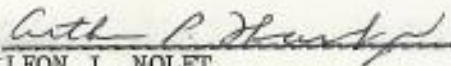
Please accept my apologies for the delay in answering but, I had to clear your request with Lt. Col. Deem. You may not be aware of it but, we retain very few film files on Canton. Most of the negatives, etc. are in the Vandenberg AFB repository. It is suggested that you write to HQ SAMTEC, ATTN: SU, Vandenberg AFB, Ca. 93437 making the same request you made of me. I'm sure, if they have the pictures, they will provide them for you. If not, they may task us to provide them.

For your information, we've recently had a visit from an ecology review team comprised of Dr. F. R. Fosberg of the Smithsonian Institute, Dr. D. R. Stoddart of the Royal Society and Mr. R. B. Clapp of the U. S. Wildlife Service. Mr. Clapp was interested in your endeavors here. I provided him with your address so he could contact you on his return trip through Hawaii or, possibly, drop you a line when he returned to Washington.

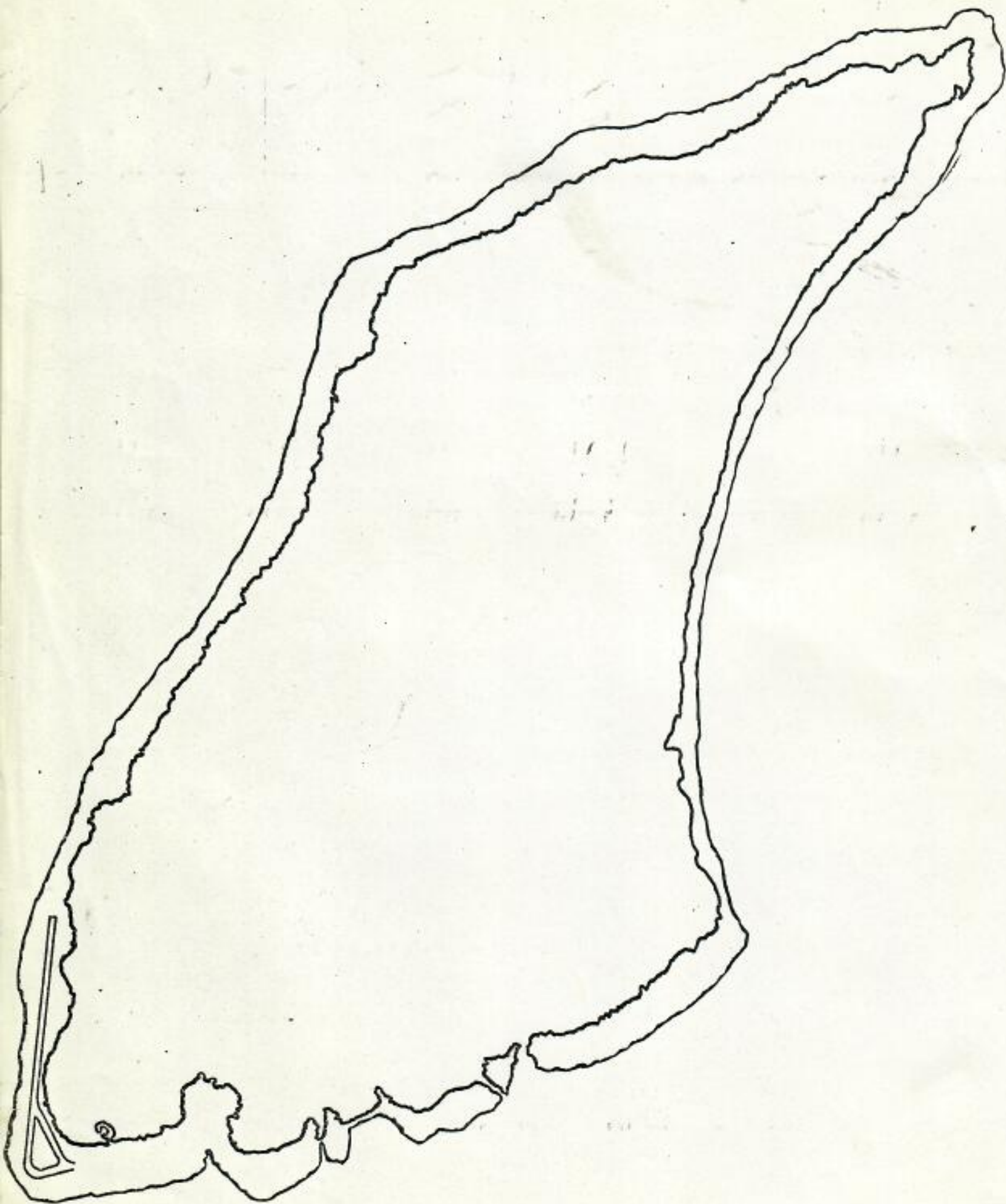
Looking forward to seeing you on your next trip to Canton and hoping the above will be of some assistance to you, I remain;

Sincerely,

FEDERAL ELECTRIC CORPORATION

For 
LEON J. NOLET
Manager, Canton Island Dept.

LJN:APF:RWB:rwb



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE TEST CENTER (AFSC)
VANDENBERG AIR FORCE BASE, CALIFORNIA 93437



30 MAR 1973

University of Hawaii
Hawaii Institute of Marine Biology
Coconut Island
P.O. Box 1346
Kaneohe, Hawaii 96744

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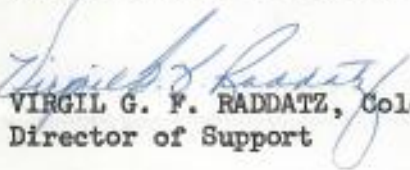
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VIRGIL G. F. RADDATZ, Colonel, USAF
Director of Support

Cy to: Canton OL/AE, w/1 atch
SAMTEC/CEI, w/1 atch
SAMTEC/XPS, w/1 atch
SAMTEC/EN, w/1 atch
SAMSO/DE, w/1 atch
SAMSO/DEC, w/1 atch

U.S. ATOMIC ENERGY COMMISSION/JTG 8.5
HOLMES & NARVER, INC./TU 8.5.1
P. O. BOX 9186
HONOLULU, HAWAII 96820

ORDER NO. 940

DATE 6 FEBRUARY 1973

ORIGINAL

TO: INDIVIDUAL(S) LISTED

SUBJECT: TRAVEL ORDERS

1. THE FOLLOWING LISTED PERSONNEL WILL PROCEED ON OR ABOUT 13 FEBRUARY 1973, FROM HONOLULU, HAWAII TO CANTON ISLAND, TO ACCOMPLISH TASK OF MUTUAL INTEREST TO THE DOD/AEC ON TEMPORARY DUTY FOR APPROXIMATELY ONE (1) WEEK AND UPON COMPLETION THEREOF, WILL RETURN TO HONOLULU, HAWAII.
2. INDIVIDUAL(S) LISTED BELOW HAVE CLEARANCE(S) AS INDICATED:

NAME	S.S. NO.	CLEARANCE	AEC NO.	DATE GRANTED
BALAZS, GEORGE	UNIV. HAWAII	564-54-0156	GSR	2-12-73

3. ACCOUNT CLASSIFICATION: TRAVEL IS PROPERLY CHARGEABLE TO CIC T116-31.
4. AUTHORIZATION: TRANSPORTATION VIA MAC AIRCRAFT IS AUTHORIZED UNDER THE PROVISIONS OF AFR 76-15 AND FOLLOWING REFERENCES: (a) LTR DTD 6/23/70, DEPT. OF THE AIR FORCE, HQ 6486TH ABW (PACAF), TO DIR., PASO/JTG 8.5, SUBJ: CUSTOMER IDENTIFICATION CODES IN SUPPORT OF JOHNSTON ATOLL AND OTHER LOCATIONS; (b) MSG, 6486 ABW (BCPTB), 040608Z JUN 70, SUBJ: REQUEST FOR CONTRACTOR CIC's; (c) LTR, HQ MAC (MABIFA), 6/9/70, SUBJ: REQUEST FOR CONTRACTOR CIC's; (d) LTR, HQ MAC (MABIF), 9/20/66, SUBJ: MAC TRANSPORTATION CHARGES (AEC LTR, HOA:NSR-1915, 8/12/66).
5. SPECIAL INSTRUCTIONS: MR. BALAZS IS AUTHORIZED 50 LBS. EXCESS BAGGAGE WEIGHT.

ORIGINAL

F. L. Van Rensselaer

AUTHORIZED SIGNATURE

DISTRIBUTION:

- 5 EACH - INDIVIDUAL(S) LISTED (AEC)
- 2 EACH - INDIVIDUAL(S) LISTED (H&N)
- 3 EACH - H&N PERSONNEL DEPT. (HONO)
- 3 EACH - H&N PERSONNEL DEPT. (J.A.)
- 1 COPY - H&N DIVISION CONTROLLER (HONO)

SRA 5260 jf

MAC TRANSPORTATION AUTHORIZATION

C- 2684327

1. GRADE/TITLE MR.	2. NAME (Last, First, Middle Initial) BALAZS, GEORGE and no other	3. APO HIK CIS 2CT FZ 02
-----------------------	--	-----------------------------

4. SSAN OR PASSPORT NO. 564 54 0156	5. DEPENDENT AND N A	6. AUTHORIZED 115	BAGGAGE WEIGHT SHIPPED
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7. FISCAL DATA (Enter complete accounting classification) SO 940 FEB73 US ATOMIC ENERGY COMMISSION HOLMES & NARVER, HNL, HI	8. ISSUED BY (Activity and Date) JAMES R. MURPHY CPT USAF TMO APO SF 9853 FEB73
---	---

9. CUSTOMER IDENTIFICATION CODE T115-31	10. REPORT TO (APOE) HICKAM AFB/MAC TERMINAL	a. ON (Date & Time) 13 FEB / 0800	b. FOR FLIGHT NO. COL7H	c. DESTINATION (APOD) CANTON ISLAND
--	---	--------------------------------------	----------------------------	--

11. SPECIAL INSTRUCTIONS
MANDATORY
 CONTACT MAC AT
 449-1952 4 to 2
 HOURS PRIOR TO REPORTING
 OR TIME TO CONFIRM FLIGHT
 449-6833 DEPARTURE

12. FINAL DESTINATION AND ULTIMATE DUTY STATION ADDRESS

13. EMERGENCY ADDRESS DATA
 HOLMES & NARVER, INC.
 531 Ohehia Street
 Honolulu, Hawaii 96819

DD FORM 1482
 1 DEC 69
 ACCOUNTABLE.
 PREVIOUS EDITIONS WILL BE USED.

6/20/78

George -

These bones were retrieved by myself & guy Enos at Canton.

They were found at the base of a 10-20 revittment (sp) at the W end of the airstrip. The turtle must have been one half of a mt. Clumber

I don't think it was hauled there & butchered because fragments of the shell were there. I assume a "turtle butcher" would have kept the shell

sea

Revittment
(sp) (w/ shell)

AIRSTRIIP

Revit

Sea

Beach

turtle

AIR
STRIP

(Crawled around?)

Aloha

Uighita

■ Marine turtle nesting areas

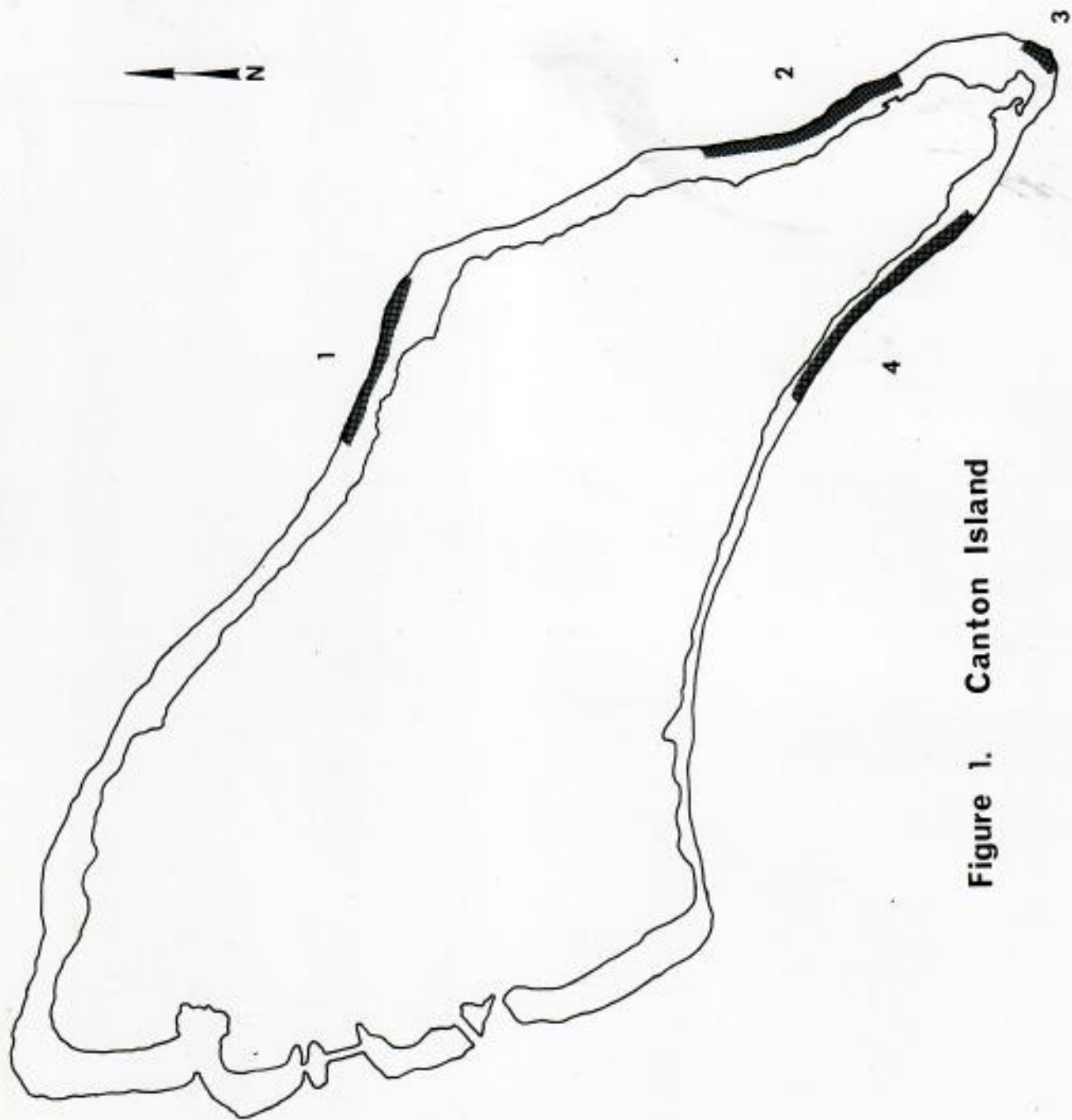


Figure 1. Canton Island

ATOLL RESEARCH BULLETIN

No. 65

Some Marine Algae from Canton Atoll

by

E. Yale Dawson

LIBRARY OF
GEORGE H. BALAZS

Issued by

THE PACIFIC SCIENCE BOARD

National Academy of Sciences--National Research Council

Washington, D. C.

May 15, 1959

Some Marine Algae from Canton Atoll^{1/}

by

E. Yale Dawson

The following annotated list has resulted from an examination of a collection of algae made during the first part of February, 1958, by Dr. and Mrs. Otto Degener on Canton Atoll in the Phoenix group. Only the green, brown, and red algae are treated here, inasmuch as a rather large series of Cyanophyta has been identified by Dr. Francis Drouet and is accounted in Bulletin No. 64.

With the exception of about a dozen species mentioned by Degener & Gillaspy (1955) on the basis of determinations by M. S. Doty, this is the first floristic list of which I am aware of the marine vegetation of Canton Atoll, or of any island in the Phoenix group. Accordingly, these records supplement and extend our knowledge of central Pacific atoll floras derived from such reports as have appeared in recent years for the Marshall, Gilbert, and Line Islands (cf. Taylor 1950, Dawson, Aleem & Halstead 1955, Dawson 1956, 1957, Moul 1957).

The specimens are cited according to Degener collection numbers. The first set of specimens, all of which are liquid preserved, has been deposited in the Herbarium of the University of California, Berkeley.

CHLOROPHYTA

Enteromorpha clathrata (Roth) J. Ag. 24841.

Enteromorpha sp. 24863. This appears to agree with what Chapman has called E. clathrata var. pumila (Aresch.) Chapm. from New Zealand.

Enteromorpha kylinii Bliding 24763; 24764; 24739; 24849?

Ulvela lens Crowan 24843a, growing on Caulerpa serrulata.

Cladophora fascicularis (Mert) Kütz. 24717. This material, about $\frac{1}{2}$ cm. tall, is in good agreement with Borgesen's illustrations of specimens both from Mauritius and the West Indies. The specimens are much smaller in height than many West Indian ones, but agree in cell size and form.

Cladophora flexuosa (Griffiths) Harv. 24852. The specimens show such close accord in size, habit, branching and cell form with this tropical Atlantic species as to be referable here with reasonable certainty. The similarity to Vicker's illustration of the species from Barbados is especially striking. The plant is reported from Australia, but apparently not from the central Pacific.

1. Contribution from the Beaudette Foundation for Biological Research, Solvang, California.

Dictyosphaeria cavernosa (Forrsk.) Börg. 24724; 24735; 24832;
24839; 24865.

Boodlea composita (Harv.) Brand 24716b; 24719. The latter specimen represents a lax form and bears much sterile Ceramium gracillimum v. byssoides.

Cladophoropsis gracillimum Dawson 24758. These are in good agreement in structure, but are slightly coarser than either the Mexican type or material from Arno Atoll, Marshall Islands, and much coarser than Eniwetok material. The colony is quite compact and the filaments densely arranged in a rather erect fashion. The exceedingly long cells and thick, stratified walls are distinctive. Number 24781 is still coarser, up to 140 μ in diameter in some places, although mostly about 125 μ . Some of the walls are up to 20 μ thick. This would seem to be a particularly robust form of this generally slender species.

Cladophoropsis sundanensis Reinbold 24715. This is very much like material from Palmyra Island, forming rounded, compact colonies as reported from there. The filaments are about the same size or tending to be slightly larger. 24826a, growing in a turf with Jania tenella, has filaments 70-100 μ in diameter. 24747 is a very young colony compacted with Lyngbya filaments. 24766 shows the characteristic sub-spherical clumps, but the cells are very long. 24820 has filaments 100-130 μ in diameter. 24846 is a darker colored form with somewhat shorter cells than other material from this area. It may be a distinct entity, but points of distinction are not clear.

Derbesia attenuata Dawson 24572a. Well developed, typical material, on Turbinaria.

Caulerpa racemosa var. peltata (Lamx.) Eubank 24713; 24716;
24756a; 24787; 24831; 24845; 24861; 24864.

Caulerpa racemosa var. turbinata (J. Ag.) Eubank 24784.

Caulerpa serrulata (Forrsk.) J. Ag. emend. Börg. 24751; 24756;
24782; 24843.

Caulerpa urvilleana Mont. var. 24840; 24842.

Bryopsis pennata Lamx. 24731; 24743 (On Turbinaria); 24822a;
24837; 24850. Unilateral branching is especially prominent and consistent in this last collection.

The following identifications and notes on Codium are provided by Dr. Paul C. Silva, University of Illinois.

Codium ovale Zanard. 24746; 24740. This latter collection is a mixture of two species growing in intimate association: Codium ovale and a member of the C. arabicum complex. The known range of C. ovale has now been extended beyond the type locality

(New Guinea) to include Kwajalein, Majuro and Canton islands. The adherent Codium is somewhat more cerebriform than is usual for C. arabicum, but anatomically it clearly reveals its relationship to the C. arabicum complex.

Codium geppii O. C. Schmidt 24714; 24570; 24788; 24821; 24851; 24825. These are very similar to the type collection. In the Indo-Pacific region a member of the C. arabicum complex and one of the C. geppii complex are always found as an integral part of the biocoenosis of coral reefs. In the Atlantic a similar, but less constant, relationship holds: an adherent form, referable to the C. intertextum complex, is invariably present on coral reefs, while a repent form, referable to the C. repens complex, is found only on certain islands.

Halimeda fragilis Taylor 24774.

Halimeda micronesica Yamada 24768. A good specimen 6-7 cm. tall.

Halimeda opuntia (L.) Lamx. 24771.

PHAEOPHYTA

Ectocarpus indicus Sonder 24836. Good material on Turbinaria with very long plurilocular sporangia often to 200 μ or more.

Sphacelaria furcigera Kütz. 24754 (on old Turbinaria); 24752b.

Sphacelaria sp. 24723a. This may be a tropical form of S. subfusca Setch. & Gard. The specimens have propagulae like S. furcigera, but many of them are trifurcate rather than bifurcate. Plurilocular sporangia, however, are dominant on this material.

Dictyota friabilis Setchell 24845a; 24828; 24859; 24862; 24868. This latter collection is almost without doubt like the type from Tahiti.

Dictyopteris repens (Okam) Börg. 24752 (small amount).

Pocockiella papenfussii Taylor 24824.

Pocockiella variegata (Lamx.) Papenf. 24765.

Turbinaria ornata (Turn.) J. Ag. 24783.

Turbinaria trialata (J. Ag.) Kütz. 24721.

RHODOPHYTA

Gelidium pusillum (Stackh.) Le Jolis 24736. Typical, small, cystocarpic material 3-4 mm. tall.

Pterocladia sp. 24742; 24755. These tetrasporic and cystocarpic materials are well developed, over 2 cm. tall, and pinnately branched much as in Pterocladia nana Okam. from southern Japan and Formosa. They may be referred provisionally to that species, but additional Pterocladia collections from the central Pacific, such as at Palmyra Island where one is reported from intestinal contents of fishes (Dawson, Aleem and Halstead, 1955) are needed to enable us to interpret more satisfactorily the occurrence of this genus.

Gelidiella rigidiuscula (Grunow) J. Feldmann 24737. This richly fertile material has the stichidia and branching much as in G. acerosa, but is smaller in size: 300 μ down to 120 μ in the ultimate branchlets. This is in agreement with the discussion and key in Feldmann (1931) of G. rigidiusculum from Ceylon, for which reproduction is not reported. The size and habit are much like G. hancockii from the Gulf of California, but that species has cylindrical tetrasporangial stichidia on short lateral branchlets rather than acute, bulbous, terminal ones as in the present material. This disposition seems justified awaiting the report of fertile material from Ceylon for comparison. 24838 (with some Herposiphonia secunda); 24759 (tetrasporangial); 24832a (some growing with Dictyosphaeria); 24789. The tetrasporangial stichidia in this collection are so abundant as to terminate almost every branch.

Gelidiopsis intricata (C. Ag.) Vickers 24728; 24857a.

Jania capillacea Harv. 24857.

Jania micrarthrodia Lamx. 24761a (cystocarpic); 24737a (with Gelidiella rigidiuscula); 24860.

Jania tenella Kütz. 24826 (in mixture); 24822 (a questionable form with very abundant conceptacles).

Hypnea esperi Bory? 24730; 24854. These specimens have the tetrasporangial sori in part at first unilateral on the branches, causing some distortion. Later they may fill in all around. They are similar in this character to specimens reported and illustrated by Setchell as H. nidifica J. Ag. from Tahiti.

Gracilaria sp. 24866. This may be the plant described as Corallopsis reptans Weber van Bosse, from the Kei Islands.

Lomentaria sp. 24864b.

Ceramium clarionensis Setch. & Gard. 24730b.

Ceramium equisetoides Dawson 24864a. These are in good agreement with Pacific Mexican specimens.

Ceramium gracillimum var. byssoides (Harv.) G. Mazoyer 24716a; 24784a (with Caulerpa racemosa v. turbinata); 24730a (a very lax form); 24804; 24843b.

Ceramium vagabunde Dawson 24843c. This material is somewhat more slender than Eniwetok specimens and has nodal bands more like those of the material reported from Isla San Benedicto, Mexico, yet the agreement is generally satisfactory. Growing with Caulerpa serrulata.

Ceramium sp. 24840a. Fertile, tetrasporangial material apparently near C. personatum Setch. & Gard. The agreement is good except that the descending appendages within the axial cells were not observed. The tetrasporangia are at first abaxial, then whorled and involucrate. Growing with Caulerpa urvilleana.

Griffithsia sp. 24864c, sterile.

Herposiphonia secunda (Ag.) Ambronn 24733 (richly developed); 24805; 24829 (richly developed); 24834.

Heterosiphonia wurdemannii var. laxa Borg. 24748 (mixed with Herposiphonia); 24741 (in mixture); 24854a (on old Turbinaria); 24853.

The following determinations and notes on Polysiphonia are provided by Dr. George J. Hollenberg of the University of Redlands, California

Polysiphonia ferulacea Suhr 24866a. This determination is probably correct if Tseng, Cribb and others have been correct in their identifications of Pacific specimens. It should be considered tentative, however, until male plants are found.

Polysiphonia flaccidissima Hollenberg 24867. This determination is probably reliable although the segments are shorter (1.0-1.5 diameters) and the trichoblasts are not well developed and with tapering tips.

Polysiphonia mollis Hook. & Harv. ?? 24823. This identification is doubtful because of (1) small size; (2) obvious sympodial branching; (3) very long, continuous tetrasporangial branches.

Laurencia nana Howe 24761. The cortical cells are of the non-palisade type, although an error occurs in expressing this in Dawson 1957, p. 124.

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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 Garden, 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 $2^{\circ} 30'$ and $4^{\circ} 40'$ S., and longitude $170^{\circ} 40'$ and $174^{\circ} 40'$ 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 up-turned 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

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

AVERAGE TEMPERATURE

TOTAL PRECIPITATION

CANTON IS., SOUTH PACIFIC
TOPGAL FIELD
1954

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1947	84.9	84.8	85.3	85.2	84.8	85.0	84.4	84.2	84.2	82.6	84.0	82.8	84.3
1948	82.4	83.2	83.6	83.6	83.3	85.8	82.2	84.6	84.8	84.7	84.3	83.8	84.4
1949	83.7	84.9	82.9	82.9	84.4	84.8	84.9	84.4	84.8	82.9	82.3	82.2	84.2
1950	81.4	82.4	81.9	82.6	83.1	82.2	82.3	82.4	84.1	83.1	83.6	83.3	
1951	83.8	83.2	83.4	84.7	85.2	84.2	83.2	84.8	85.8	85.2	85.9	83.0	84.5
1952	84.7	84.0	84.6	84.8	85.1	85.0	84.2	84.0	84.4	84.8	83.7	84.6	84.6
1953	84.6	84.1	83.5	84.1	82.7	84.4	83.7	83.7	84.7	84.9	84.8	83.6	84.1
1954	82.5	82.7	83.7	82.4	84.5	82.6	82.1	82.0	82.8	84.5	82.1	82.9	82.5
RECORD													
MEAN													
TEMP	83.9	82.2	83.7	84.0	84.3	84.4	84.1	82.9	84.4	84.2	83.4	84.1	84.1
MAX	85.2	85.1	86.1	84.9	86.7	86.4	86.0	86.0	86.6	86.9	86.0	84.5	86.3
MIN	78.4	78.4	79.3	78.1	78.2	78.2	77.9	77.0	78.1	78.1	78.0	78.2	78.2

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1937													
1938	.22	.18	.02	1.93	.87	2.38	.45	.55	.46	.27	.21	.04	8.71
1939	.13	.08	.10	1.58	2.75	1.55	1.01	1.79	.20	1.23	.30	4.81	18.37
1940	4.94	.75	9.04	11.90	2.92	4.80	3.02	3.94					
1941													
1942									.15	.00	.37	.20	
1943	.12	.17	.11	1.17	1.92	1.56	1.23	6.78	.30	.28	.80	.39	15.33
1944	2.98	.92	2.13	3.02	3.37	1.82	1.17	1.05	1.24	.08	.40	.74	20.80
1945		.84	1.21	.90	2.60	5.26	8.73	.94	.30	.61	.7	.23	17.43
1946													
1947	.57	.38	.68	1.53	.65	.63	.60	1.40	1.09	.89	.42	.06	8.48
1948	.86	1.24	5.29	10.32	4.68	3.19	3.20	3.18	1.64	.17	.06	.58	23.17
1949		2.10	1.58	2.18	2.62	1.03	.28	.10	.19	.09	.02	.17	11.58
1950		.19	.58	1.43	.64	2.38	3.50	4.04	.05	.12	.24	.10	13.09
1951	2.40	.22	.07	0.35	5.38	8.19	2.39	3.81	.77	.44	.22	3.08	20.28
1952	.10	.03	.07	2.47	5.21	3.19	3.23	3.48	.80	.79	.97	.27	20.73
1953	.77	.61	3.41	6.46	8.22	4.14	3.52	4.77	.55	1.41	.97	.90	32.97
1954	.43	.20	.09	1.09	.38	.82	2.27	1.98	.12	.24	.03	.15	7.79
RECORD													
MEAN	.64	.43	1.25	3.10	3.26	2.84	2.44	2.58	.48	.51	.34	.07	18.77

Records Sept. 1937 - April 1940 incl., Gilbert and Ellise Island Colony Administration (U.S.A.), 2° 49' S., 171° 43' W.; May-August 1940, U.S. 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	Altitude and direction from previous location	South Latitude	West Longitude	Elevation above								Remarks	
						Sea level		Ground							
						Ground	Actual barometric elevation (ft)	Wind instruments	Extreme thermometers	Psychrometer	Telepyrometer	Tipping bucket rain gauge	Weighting rain gauge		10" rain gauge
BRITISH HEADQUARTERS RADIO	SEP 1937	PRESENT		2° 49'	171° 43'	-									Good exposure.
PRESENT HOTEL AREA, DEPT INTERIUM	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'	-									None may have been a bit later than this.
NAVY ADMINISTRATION BLDG (PAA EMPLOYEES IN NAVAL RESERVE)	NOV 1941	APR 1943	-	2° 49'	171° 43'	-									If 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.
TOPGAL FIELD, TERMINAL BLDG	MAY 1943	OCT 1946	-	2° 46'	171° 43'	0									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. Good exposure.
"	OCT 1946	1/24/47	-	"	"	0	15								
"	1/1/47	PRESENT	-	"	"	-		20	19	19	3	3	23		

This small land mass, being at least 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 1936 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 60° F. Frost and hail were included in snowfall totals, beginning with July 1943.

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.
- 0 Also on earlier dates, months, or years.
- T Trace, an amount too small to measure.

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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:

1. "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
F. J. MacLean
J. A. Brooks

P. S. Brunk, Jr.
J. W. Stickrod
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. <u>Population</u>	Men	Women	Children	Total
<u>Nationality</u>				
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 dismissal 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*³ 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 hermit crab, 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 skin 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 recorded 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 hermit crab 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 until sunset or shade overtakes the plant. It can be eaten as a potherb in times of famine. The terrestrial hermit crab 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 that one plant was growing on the native triumphetta 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 white flowers 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 the soil, and the 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 to 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 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 moon-flower, 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. $\frac{1}{2}$ - 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 crimp, 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 chance 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 rarity. 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 nubigena - Hawaii

Panicum pellitum - Hawaii

Pennisetum sp.

Polypogon monspeliensis - Europe

Sporobolus virginicus - Southern United States

Tricholaena repens - Africa

CYPERACEAE

Cyperus javanicus - Hawaii

Cyperus trachysanthus - Hawaii

Fimbristylis 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 sandwichensis - 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
Nicanoria 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 amplexans - Hawaii

Borrchia sp.

Eclipta alba - Asia

Gaillardia picta - Texas

Helianthus annuus - Kansas

Heterotheca grandiflora - California

Inula candida - Yugoslavia (1953)

Lipochaeta integrifolia - Hawaii

Lipochaeta romyi - 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 "skayvioles" (Messer-schmidia) 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 thrive, 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)

TRACHEOPHYTES

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)

Ceramiales

Centroceras clavulatum (Degener 23,676)

Ceramium sp. (Degener 23,677)

Grateloupiaceae

Halymenia sp. (Degener 23,678)

Corallinales

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 samoensis (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 desert 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.

Pontonidae

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.

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

Eriphia scabricula (Degener 5678), 1951.

Eriphia laevimana (Degener 5672), 1951.

Leptodius sanguineus (Degener 5679), 1951.

Phymodius unguatus (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 racks, 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. 130:1943.

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 hermit crabs 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 hermit crabs, 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 ^{eggs seen} their numerous maroon eggs attached to their abdomens. ^{February} 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 un-expanding 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 tatter, 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 bobó, 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 resting 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 continuous 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.

Appendix A

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

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

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

However, there does appear to be a diurnal variation [redacted] in precipitation, based on 26 months of record available [redacted] since the installation of our recording rain gage. This [redacted] record is still too short to come to any quantitative conc- [redacted] lusion, but during this time over one half of the precipi- [redacted] tation fell between the hours of midnight and 3:00 a.m. Of [redacted] course the diurnal variation in ocean temperature results [redacted] in a [redacted] greater instability at night and we should [redacted] expect more cloudiness then.

FEBRUARY 1973 SCHEDULE TO KWAJALEIN, ENIWETOK, CANTON, AMERICAN SAMOA

PASSENGER FLIGHTS TO KWAJ, ENT.

		CAPITOL INTERNATIONAL AIRLINES CHARTER FLIGHT - ETD			ETA	CHECK-IN 2 HOURS PRIOR TO ETD	
HIK	KWAJ	FLT NO.	C-033H	FRI. FEB. 2	0800	1300	93 PAX/5 PLTS
KWAJ	HIK		C-034H	FRI. FEB. 2	1430	1915	
HIK	KWAJ	FLT NO.	C-033H	MON. FEB. 5	0800	1300	63 PAX/7 PLTS
KWAJ	HIK		C-034H	MON. FEB. 5	1430	1915	
HIK	KWAJ	FLT NO.	C-035H	WED. FEB. 7	0800	1300	- THEN TO ENT. 63 PAX/7 PLTS
KWAJ	HIK		C-036H	WED. FEB. 7	1745	2230	
HIK	KWAJ	FLT NO.	C-033H	FRI. FEB. 9	0800	1300	63 PAX/7 PLTS
KWAJ	HIK		C-034H	FRI. FEB. 9	1430	1915	
HIK	KWAJ	FLT NO.	C-033H	MON. FEB. 12	0800	1300	63 PAX/7PLTS
KWAJ	HIK		C-034H	MON. FEB. 12	1430	1915	
HIK	KWAJ	FLT NO.	C-035H	WED. FEB. 14	0800	1300	- THEN TO ENT. 81 PAX/6 PLTS
KWAJ	HIK		C-036H	WED. FEB. 14	1745	2230	
HIK	KWAJ	FLT NO.	C-033H	FRI. FEB. 16	0800	1300	81 PAX/6 PLTS
KWAJ	HIK		C-034H	FRI. FEB. 16	1430	1915	
HIK	KWAJ	FLT NO.	C-033H	MON. FEB. 19	0800	1300	63 PAX/7PLTS
KWAJ	HIK		C-034H	MON. FEB. 19	1430	1915	
HIK	KWAJ	FLT NO.	C-035H	WED. FEB. 21	0800	1300	- THEN TO ENT. 63 PAX/7PLTS
KWAJ	HIK		C-036H	WED. FEB. 21	1745	2230	
HIK	KWAJ	FLT NO.	C-033H	FRI. FEB. 23	0800	1300	63 PAX/7 PLTS
KWAJ	HIK		C-034H	FRI. FEB. 23	1430	1915	

HIK	KWAJ	FLT NO.	C-033H	MON. FEB. 26	0800	1300	63 PAX/7 PLTS
KWAJ	HIK		C-034H	MON. FEB. 26	1430	1915	
HIK	KWAJ	FLT NO.	C-035H	WED. FEB. 28	0800	1300	63 PAX/7 PLTS - THEN TO ENT.
KWAJ	HIK		C-036H	WED. FEB. 28	1745	2230	

CARGO FLIGHTS TO KWAJ, ENT, JON

MONDAYS HIK JON ENT KWAJ - ETD HIK 0930 ETA JON 1130 - FLT NO. 0833
 TUESDAYS KWAJ JON HIK - ETD JON 2055 ETA HIK 2255 - FLT NO. 0834

CONTINENTAL (AIR MICRONESIA) FLIGHTS - DEPART FROM INTERNATIONAL AIRPORT

HNL MIDWAY KWAJ FLT NO. 665 - SUNDAYS - ETD 0630 ETA 1052
 KWAJ HNL FLT NO. 664 - MONDAYS - ETD 1745 ETA 0013 (Tues.)

HNL MIDWAY KWAJ FLT NO. 667 - TUESDAYS- ETD 0630 ETA 1052
 KWAJ HNL FLT NO. 668 - WEDNESDAY-ETD 1745 ETA 0013 (Thurs.)

HNL MIDWAY KWAJ FLT NO. 669 - THURSDAYS-ETD 0600 ETA 1022
 KWAJ HNL FLT NO. 666 - FRIDAYS ETD 1745 ETA 0013 (Sat.)

TO CANTON ISLAND AND AMERICAN SAMOA

HNL CANTON PAGO PAGO FLT NO. CAPITOL C-017H TUESDAYS ETD 0800 ETA CIS 1045 ETA HNL 2155
 HNL CANTON PAGO PAGO FLT NO. MAC 0517 FRIDAYS, 2nd AND 16th ETD 1105.

CHANGES THIS MONTH: CARGO FLIGHT DEPARTURE TIME FROM HICKAM TO JON, ENT, KWAJ
 CARGO FLIGHT DEPARTURE TIME FROM HICKAM TO CANTON

245
~~2755~~
 3.45
 18:10

KENTRON HAWAII LTD



The Canton Scuttlebutt

VOL. 3

TUESDAY -- 13 February 1973

No. 471

CUBA -- President Nixon indicated today the United States and Cuba have reached an agreement on ways to handle hijacking. Nixon referred in impromptu remarks to what he claimed "The Hijacking Agreement with Cuba." He said Secretary of State Rogers could fill newsmen in at an appropriate time.

Nixon told the newsmen at the White House that Rogers and Treasury Secretary Shultz are going to Florida to discuss the dollar devaluation and trade legislation with AFL-CIO President George Meany.

Nixon said one subject he'd discussed with Rogers was the hijacking agreement.

WASHINGTON -- President Nixon plans to ask Congress for legislation to promote US sales abroad following devaluation of the dollar. As he began a White House meeting with Treasury Secretary Shultz, Nixon said the devaluation is at best only a temporary solution.

He said he's not talking about another round of lowering barriers, but also that some trade categories will have to go up, to give America what he called a "fair shake" abroad. Nixon said that in some cases imports to the United States can drive an American business right out of existence.

He added: "to get a policy of freer trade we must always have in the background protection."

The United States announced a ten per cent devaluation of the dollar last night. Congress will be asked to implement it by raising the official price of gold from \$38 to 42.22. Actually, that amounts to a little more than eleven per cent. But the ten per cent figure is drawn from the dollar's value on exchange markets in relations to so-called paper gold.

Many American business spokesmen have hailed the move, and the stock market surged ahead on wall street today. Then retreated somewhat. The first hour of trading saw a record total of nine million, 243 thousand shares change hands.

One New York economist called the devaluation the economic equivalent of President Nixon's Peking Trip.

A brokerage firm official says such US industries as Motors, Steels and Chemicals stand to gain from the devaluation, because they are big exporters. General Motors said its domestic prices will be more competitive with those of foreign cars. Because the devaluation tends to make imports more expensive, Japan's Toyota Motor Sales Company says it expects its US sales to drop 20 to 30 per cent.

WASHINGTON -- The Pentagon has good news for the families of 20 more American prisoners of war: North Vietnam says it plans to release them in a few days.

Pentagon spokesman Jerry Friedheim said the North Vietnamese informed the United States of their plans through what he called communication channels. Friedheim did not specify--but observers suggest it's a goodwill gesture in connection with Presidential aide Henry Kissinger's just-concluded visit to Hanoi.

The move follows the release of 135 other servicemen and eight civilians yesterday by North Vietnam and the Viet Cong. All but three are at Clark Air Base in the Philippines, undergoing checkups and other formalities prior to be returned to the United States. Of the three, two already are flying home because of illness in their families. And the third remained in Saigon by choice.

The man who stayed in Saigon is Richard Waldhaus, a civilian from Pittsburg, California. His mother, Mrs. George Waldhaus, said today she has no idea why he made the decision. She added that he has not phone her yet. When a newsman asked her whether he might be doing undercover work of the CIA or some other agency, she said: "I don't know." He was reported captured in 1971.

Burt Lancaster, British Edition

ULZANA'S RAID

Patty Duke, Rosemary Murphy

YOU'LL LIKE MY MOTHER

AT THE MOVIES

TUESDAY NIGHT

RENTON HAVAN NORTH

SCUTTLE BUT I

SCUTTLE BUTT

TUESDAY NIGHT
AT THE MOVIES

YOU'LL LIKE MY MOTHER
Patty Duke, Rosemary Murphy
ULZANA'S RAID
Burt Lancaster, Bruce Wilson

YOU'LL LIKE MY MOTHER -- (Suspense Drama) -- Patty Duke stars as a young widow about to have a baby under very trying circumstances. An unsympathetic mother-in-law, a snowstorm, and a psychopathic killer are her main problems.

ULZANA'S RAID -- (Western) -- American history, the Chiracahua Apache called Ulzana was a savage whose exploits are depicted in the film. He is remembered chiefly for a raid in which he brutally murdered white settlers.

WSDNESDAY -- LUNCH -- Vegetable Soup, Salad & Relish Bar w/Assorted Dressing
MENU Baked Stuff Peppers w/Mushroom gravy, Cold Cuts, Pinto Beans
w/Ham Hock, Sautee Chinese Cabbage, Mashed Potatoes, Fruit Jello,
Ice Orangeade, Coffee, Tea & Milk.

DINNER -- Soup du Jour, Salad Bar w/Assorted Dressing, Roast
Prime Rib of Beef, Au Jus Horseradish, Baked Potatoes, Buttered
Broccoli, Hard French Rolls, Strawberry Short Cake, Whipped Cream,
Ice Tea w/Lemon, Coffee, Tea & Milk.

WEDNESDAY TIDES -- HIGH 0441 HT 3.4 LOW 1015 HT 0.5
HIGH 1657 HT 4.0 LOW 2253 HT 0.3

NO T. V. TONIGHT

CLOSING WALL STREET -- Prices finished only moderately higher on the New York Stock Exchange. The market had surged ahead this morning on the news of the dollar devaluation, but profit taking ate into the gains. Trading was heavy, and the Dow Jones Industrials closed up five points.

DOW JONES CLOSING AVERAGES

30 Industrials 996.76 UP 5.19
20 Transportation 206.94 Down 0.19
15 Utilities 113.75 Down 0.29
65 Stocks 314.79 UP 0.78

NEWS BRIEFS -- (Sports) -- The verbal shoot-out between Marvin Miller and Bowie Kuhn continued today..

Kuhn, the Baseball Commissioner commented in New York on the statement by Miller, the Director of the Major League Players Association, yesterday.

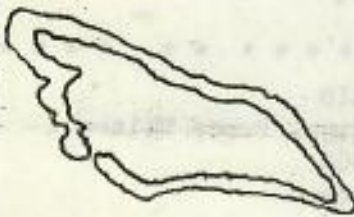
Kuhn seemed incensed by Miller's hint that the player representatives of each of the 24 teams may have to talk to the entire membership. That, Miller pointed out, could delay the opening of Spring Training, which is scheduled for March first. The owners already have delayed early workouts.

Kuhn said that Miller was trying to create confusion in the minds of the clubs, the players and the public. He said the bargaining could degenerate into name-calling. He added that, for the moment, he believes that's what Miller wanted.

The Iron-man southpaw of the Chicago White Sox, Wilbur Wood, signed a two-year contract today. As usual, no figures were given. But General Manager Stu Holcomb of the Sox said Wood's salary was comparable to the pay of other star pitchers in the majors.

Star catcher Johnny Bench of the Cincinnati Reds has signed his 1973 contract and it's in six figures. This is Bench's first year over the 100 thousand dollar mark. Exact figures are not available. Bench was the Most Valuable Player in the National League last year and has won that honor in two of the past three seasons. He underwent lung surgery earlier this winter but is believed to be almost fully recovered. Bench had a benign growth removed.

Gale Sayers has accepted the job of Assistant Athletic Director at the University of Kansas, his Alma Mater. Sayers retired from pro football after a series of knee injuries. He had been a star running back for the Chicago Bears. At Kansas, he will work in the areas of recruiting, public relations, counseling and coaching.



KENTRON HAWAII LTD



The Canton Butterbutt

VOL. 3

WEDNESDAY -- 14 February 1973

No. 472

LONDON -- The devalued dollar was hit by a wave of selling in foreign exchange today as government ministers sought to restore monetary stability. Heavy dollar selling was first reported in the Tokyo Market. The wave hit Zurich later and carried the dollar to new lows against the floating Swiss Franc.

The price of gold on the free market hit a record high on the London Bullion Market.

HANOI -- North Vietnam and the United States have agreed to set up a Joint Economic Commission. And the White House says it probably will be established in about one month.

A communique on the talks which Henry Kissinger concluded in Hanoi yesterday says they covered US aid to South Vietnamese reconstruction and post-war economic ties.

In addition, it says they reviewed recent implementation of the peace agreement and discussed what they called various imperative measures which should be taken to improve and expedite the implementation. There was no elaboration.

However, Presidential News Secretary Ronald Ziegler says the two sides have agreed on the need for a system to try to determine the fate of Americans missing in action.

Ziegler also said decisions should be made soon on designating entry points in the south through which replacement military supplies could be channeled.

The communique also noted that there would be periodic exchanges of views to insure that the peace agreement is carried out.

Ziegler was asked how much aid the United States might be prepared to give North Vietnam for reconstruction. He said such matters will be taken up by the Commission and will be subject to consultation with Congress. He said he could not answer a question as to whether Congress might be represented on the Commission.

Republican Congressman H. B. ...

as what he calls "the conduit for the handout." He said Congress probably will not have any say about setting it up, but will have a lot to say about what goes into it. Cross added: "I'm opposed to paying them anything."

WASHINGTON -- The United States has officially accused the Viet Cong of delaying the release of 27 American prisoners of war earlier this week. The protest was handed to the Viet Cong representative on the Joint Military Commission and filed with the International Control Commission.

Release of the 27 was held up for half a day when a snafu developed over South Vietnamese release of communist prisoners.

In all, 143 US prisoners have been released in North and South Vietnam. Two already have flown back to the United States, to visit their severely ill mothers. Twenty more are due at Travis Air Force Base in California later today. They stopped for refueling at Hickam Air Base in Hawaii a short while ago. All the others released this week -- except for one who elected to stay in Vietnam -- still are at Clark Air Base in the Philippines.

Twenty more Americans are due to be released by North Vietnam within the next few days.

The released American prisoner who chose to remain in Vietnam, civilian Richard Waldhaus of Pittsburg, California, left a military hospital in Saigon today. American sources say he went to look for a Vietnamese friend. He reportedly was accompanied by several escorts provided by the US Embassy. Embassy spokesmen could not be reached for comment on the case of Waldhaus, whose presence in Vietnam has been somewhat of a mystery.

WASHINGTON -- President Nixon is said to have ordered the Veterans Administration to rescind one of the proposed revisions in Disability Benefits. Critics say the revision in question would cost Vietnam-era soldiers millions of dollars in government aid.

A House Committee official says he has been told the administration will announce later today that the proposal has been killed.

ELVIS PRESLEY
ELVIS ON TOUR
Burt Lancaster, Bruce Wilson
ULZANA'S RAID

AT THE MOVIES
WEDNESDAY NIGHT

S C U T T L E B U T T

SCUTTLEBUTT

WEDNESDAY NIGHT
AT THE MOVIES

ULZANA'S RAID
Burt Lancaster, Bruce Wilson
ELVIS ON TOUR
Elvis Presley

ULZANA'S RAID -- (Western) -- In American history, the Chiracahua Apache called Ulzana was a savage whose exploits were depicted in the film. He is remembered chiefly for a raid in which he brutally murdered white settlers.

ELVIS ON TOUR -- (Musical Documentary) -- The film follows Elvis throughout his long and arduous city-by-city tour earlier this year. We see him performing and behind the scenes.

THURSDAY -- LUNCH -- Cream of Asparagus Soup, Salad & Relish Bar w/Assorted Dressing, Beef Stew, Cold Cuts, Southern Hash, Buttered Lima Beans, Mashed Potatoes, Ice Fruit Punch, Pudding, Coffee, Tea & Milk.

DINNER -- Soup du Jour, Salad Bar w/Assorted Dressing, Grilled Pork Chop, w/Apple Sauce/Gravy, Pork Long Rice w/Cabbage, Oven Brown Potatoes, Buttered Vegetable, Mixed Nut Cake, Iced Tea w/Lemon, Coffee, Tea & Milk.

THURSDAY TIDES -- HIGH 0527 HT 3.6 LOW 1100 HT 0.4
HIGH 1744 HT 4.0 LOW 2336 HT 0.2

NO T. V. TONIGHT

FOR SALE: 7x35 Selsi Binoculars with carrying case.
New Call Clay at 263 or 207 or at Bldg 561.

CLOSING WALL STREET -- The New York Stock Market closed with sharp losses in moderate trading. Brokers said investors were having second thoughts about the dollar devaluation and related American trade moves.

DOW JONES CLOSING AVERAGE

30 Industrials 979.91 Down 16.85
20 Transportations 204.16 Down 2.78
15 Utilities 113.46 Down 0.29
65 Stocks 310.46 Down 4.33

NEWS BRIEFS -- The revolving door at the office of the Baltimore Colts was whirling today and in walked a new head coach.

He is Howard Schnellenberger, formerly an assistant to Don Shula on the Miami Dolphins, who formerly was coach of the Colts. The man who hired the new Baltimore coach is General Manager Joe Thomas, who used to be the General Manager of the Dolphins.

Thomas who embarked on a house-cleaning program at Baltimore and has traded eight players in the past month. Schnellenberger replaces John Sandusky as coach of the Colts.

The new head coach and general manager of the New England Patriots, Chuck Fairbanks, named ten assistants today. One is former quarterback Bill Nelson of the Cleveland Browns. Another is the one-time head coach of Green Bay, Phil Bengston. Peter Hadhazy, a holdover, will be assistant to the general manager. Other assistants, all new, will be Hank Bullough, Red Miller, Bill Pace, Sam Rutigliano, Jim Valek, Larry Weaver and Charley Sumner.

The magazine "Sports Illustrated" reports that Kareem Abdul-Jabbar travels with a police bodyguard because of fear of assassination. Plainclothesmen have traveled with the seven-foot-two center of the Milwaukee Bucks since seven persons were murdered last month in Washington. They were members of the Hanafi Moslems. Jabbar also is a member of the Orthodox Moslem Sect.

POOR MAN'S BINGO TONIGHT AT 1900 HOURS. CARDS SOLD AT \$1.00 EACH.

JACKPOT IS \$325.00 at 55 NUMBERS. COME EARLY FOR THE DOOR PRIZE.

KENTRON HAWAII LTD



The Canton
Buttbutt

VOL. 3

THURSDAY - 15 February 1973

No. 473

SAIGON -- The US Command reports the United States is fast approaching the half-way mark in getting all of its military forces out of Vietnam by the March 28th deadline. The Command says American troop strength in Vietnam is already to its lowest level in nearly a decade. The troop level is now 15 thousand-744.

The Command says 14 hundred-55 American troops have been withdrawn in the past four days.

LAOS -- The Pentagon says American planes have stepped up their activity over Laos as the communists try to gain important positions in anticipations of a cease-fire. Spokesman Major-General Daniel James says American planes have been flying an average of about 380 sorties a day over Laos this week. A sortie is a single flight by a single plane.

He says the Laotian Government requested the strikes.

James also said there has been US air activity--at a very low level, as he put it--over Cambodia.

In Saigon, another incident of alleged South Vietnamese hard-line tactics with members of the International Commission of Control and Supervision is reported. The head of Indonesia's contingent on the ICCS-Lieutenant General Charsono--charges that the Saigon Government's military police blocked his party from attending a Viet Cong reception at Tan Son Nhut Airport. He says a technicality was involved.

The White House says Presidential Aide Henry Kissinger met with Chinese Premier Chou En-Lai for three and a half hours today. Kissinger flew to Peking from Hong Kong. In all, he is due to spend five days in the Chinese capital, and then fly to Tokyo and Washington.

In his Washington News Conference today, Secretary of State Rogers commented on Kissinger's trip. He said the US has expectations of improvement in relations with China. But he did not elaborate.

WASHINGTON -- President Nixon has scheduled a cabinet meeting tomorrow. News Secretary Ronald Ziegler says Vice-President Agnew will discuss his recent Southeast Asian trip and Treasury Secretary Shultz will talk about the devalued dollar and other trade and monetary developments.

The dollar opened lower on most foreign money markets today, but became a bit firmer on many of them later. Gold, meanwhile, soared to such record highs as \$75.93 an ounce in Hong Kong and more than \$73.87 in Zurich, Switzerland.

President Nixon had a luncheon date at the Pentagon with the Joint Chiefs of Staff and the heads of the Army, Navy and Air Force. Earlier, he told newsmen that problems of US relations with Europe will be under intense discussion during his current term.

HAVANA -- The United States has signed a five-year treaty with Cuba designed to curb the hijacking of planes and ships and to punish hijackers. Secretary of State Rogers signed in Washington in the presence of the Czechoslovak Minister, who represents Cuban Affairs in the United States. A Cuban official signed at the same time in Havana. Havana Radio announced this some two hours after the Washington signing.

The pact provides for the prosecution or extradition of any person who seizes a plane or vessel of one country and diverts it to the other.

NEW YORK -- A scientific team at the State University of New York in Stony Brook says it believes the orange soil found on the moon by the Apollo-17 astronauts is far older than they thought. Astronaut-Geologist Harrison Schmitt had suggested it might be only ten million years old. But the Stony Brook team says radiation tests indicate its age is more like three and three quarter billion years.

That would indicate that there has been no volcanic activity on the moon in any fairly recent geological age

SUCH GOOD FRIENDS
ELVIS PRESLEY
ELVIS ON TOUR

AT THE MOVIES
THURSDAY NIGHT

S C U T T L E B U I T

REVENUE DIVISION

SCUTTLE BUTT

THURSDAY NIGHT
AT THE MOVIES

ELVIS ON TOUR
Elvis Presley
SUCH GOOD FRIENDS
Dyan Cannon, James Coco

ELVIS ON TOUR -- (Musical Documentary) -- The film follows Elvis throughout his long and arduous city-by-city tour earlier this year. We see him performing and behind the scenes.

SUCH GOOD FRIENDS -- (Comedy Drama) -- While her husband's life hangs in the balance, a wife discovers things about his past she never knew.

FRIDAY -- LUNCH -- New England Oyster Chowder, Salad & Relish Bar w/Assorted Dressing, Deep Fried Shrimp w/Cocktail Sauce, Grilled Halibut Steak w/Tartar Sauce/Lemon, Parsley Potatoes, Mexican Style Corn, Raisin Bread Pudding, Ice Lemonade, Coffee, Tea & Milk.

DINNER -- Soup du Jour, Salad Bar w/Assorted Dressing, Roast Sweet Pork (Char Siu), Beef w/Vegetables, Snowflake Potatoes, Harvard Beets, Banana Cake, Ice Tea w/Lemon, Coffee, Tea & Milk.

FRIDAY TIDES -- HIGH 0612 HT 3.7 LOW 1149 HT 0.4

HIGH 1847 HT 4.0 LOW -- -----

NO T. V. TONIGHT

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

CLOSING WALL STREET - Prices drifted downward today on the New York Stock Exchange and closed lower. Trading was slow as volume slackened sharply from the frantic up-and-down period of yesterday and Tuesday. The Dow Jones Industrial Average opened mixed, turned upward for a brief time but then slipped lower, finally closing down more than six and three-quarter points.

DOW JONES CLOSING AVERAGES

30 Industrials 973.13 Down 6.78
20 Transportation 202.99 Down 1.17
15 Utilities 113.34 Down 0.12
65 Stocks 308.70 Down 1.76

NEWS BRIEFS -- In addition to the 40 freed POWs arriving at Travis Air Force Base today, civilian Richard Waldhaus of Pittsburg, California is due from Saigon on a commercial flight. Waldhaus, whose presence in Vietnam has been somewhat of a mystery, chose to stay in Saigon instead of going to Clark Air Base. And yesterday he reported journeyed into the countryside with escorts from the US Embassy -- to search in vain for a missing Vietnamese girl friend. He headed home today -- escorted by a US information agency official.

KENTRON HAWAII LTD



The Canton
Scuttlebutt

VOL. 3

FRIDAY -- 16 February 1973

No. 474

SAIGON -- An American helicopter on a cease-fire mission but without the distinctive markings of a truce craft was shot down today near An Loc, 60 miles north of Saigon. The US Command says it was on loan to a civilian group working for the Joint Military Commission and had delivered a jeep and office equipment at An Loc. It was hit by small arms and automatic fire and crashed and burned. Five Americans were injured.

The US delegation to the Joint Military Commission made a verbal protest to the communist delegates.

The South Vietnamese command accuses the communists of more than 150 violations of the cease-fire in the latest 24-hour period. It claims more than 200 North Vietnamese and Viet Cong were killed and says more than 30 South Vietnamese died in the fighting.

A high ranking pathet Lao official has discounted reports of an imminent cease-fire in Laos. The official -- said in Vientiane that his side has made compromises in peace talks and is waiting for Premier Souvanna Phouma's government to make some.

CLARK AIR BASE, PHILIPPINES -- The doctor in charge of medical treatment of returning prisoners of war said today most of the prisoners returned so far are in "real good" condition. Colonel John Ord, who commands the Clark Air Base Hospital in the Philippines, said the men appear to have been well cared for.

Ord said both the physical and mental condition of the men appear good. He said they apparently had been fed adequately, although they did not get some of the things taken for granted in an American diet.

TRAVIS, AIR FORCE BASE -- The red carpet at Travis Air Force Base in California is getting a workout with more planeloads of returning US prisoners of war using it. A crowd of about 500 greeted the first group of 20 arrivals today. A second flight was due soon at Travis, with a third flight of more prisoners to arrive later today.

Navy Lieutenant Commander Everett Alvarez, who was the first American flyer shot down in North Vietnam more than eight years ago, is aboard the second plane.

A poster reading "You're the greatest -- we love you," greeted the men as they left the first plane today.

The Pentagon says North Vietnam will release 20 more US prisoners of war in Hanoi Sunday. Sixteen are Air Force personnel and four are Navy men.

FORT BENNING, GEORGIA -- The Army Court of Military Review has upheld the conviction of Lieutenant William Calley in the mass killings at My Lai in South Vietnam. The court also approved his sentence of 20 years at hard labor. Calley, who is confined to quarters at Fort Benning, Georgia, could not be reached for comment. But his military lawyer, Captain J. Houston Gordon said "we were not surprised, we were certainly disappointed." Gordon also said they will appeal to the US Court of Military Appeals.

President Nixon has said he ultimately will review the Calley Case.

Calley originally was sentenced to life imprisonment on his conviction by Court Martial at Fort Benning, Georgia. He was found guilty of pre-meditated murder of not less than 22 Vietnamese. The commander of the Third Army reduced the sentence to 20 years.

The Army says the Court of Military Review rejected Calley's argument that he did not intend to commit murder and was only obeying orders. It also rejected such contentions as one that pre-trial publicity included the outcome of the proceedings. The Review Court also denied Calley's petition for a new trial.

Calley has filed a separate request for clemency and parole with Army Secretary Froehle. The Army says no decision has been reached yet in that aspect of the case.

SCUTTLE BUTT

FRIDAY NIGHT
AT THE MOVIES

SUCH GOOD FRIENDS
Dyan Cannon, James Coco
HEAVEN WITH A GUN
Barbara Hershey, Carolyn Jones

SUCH GOOD FRIENDS -- (Comedy Drama) -- While her husband's life hangs in the balance, a wife discovers things about his past she never knew.

HEAVEN WITH A GUN -- (Western) -- A reformed bad guy comes to a western town to set up a church and becomes embroiled in the feud over water rights between cattle and sheep ranchers.

SATURDAY -- LUNCH -- Chicken Mustard Cabbage Soup, Salad & Relish Bar w/Assorted Dressing, Hamburger Patties w/Bun, Chili Con Carne, Steamed Frankforters, Sautee Cabbage w/Pork, French Fried Potatoes, Assorted Cold Cuts, Fruit Jello, cookies, Ice Fruit Punch, Coffee, Tea & Milk.

DINNER -- Soup du Jour, Salad Bar w/Assorted Dressing, Assorted Dressing, Grilled New York Cut Steak, Garlic Bread, Pago Pago Taro, French Cut Potatoes, Buttered Mixed Vegetables, Fresh Peach Short Cake, Whipped Cream, Ice Tea w/Lemon, Coffee, Tea & Milk.

SATURDAY TIDES -- HIGH 0654 HT 3.7 LOW 0019 HT 0.3
HIGH 1910 HT 3.8 LOW 1232 HT 0.5

NO T. V. TONIGHT

NOTICE: George Balazs, Marine Biologist with the Hawaii Institute of Marine Biology will be here for one week to investigate and survey sea turtle populations found around the island. He is particularly interested in determining which areas are most frequented by nesting animals. He would like anyone with knowledge on nesting or beach track or hatching sightings to please contact him or leave a message at Bldg 503. Although his research study will be confined to Canton, interest was expressed in nesting activity which may occur on any of the islands in the Phoenix Group. If you have information on sea turtles present on these outer islands he would greatly appreciate hearing from you.

Monday, 19th being a holiday, request all time cards for week ending 18 February 1973 be turned in to finance on Saturday, 17 Feb 1973 no later than 1530 hours. Unprogrammed overtime for Saturday night and Sunday will be turned in before 0800 hours on Tuesday morning.

FOR SALE: Hi-Test Safety Shoes size 10 E
\$17.00 See Ken West Bldg 561

CLOSING WALL STREET -- The New York Stock Market has closed higher. The Dow Jones Industrial Average was up more than six points. Trading was moderate. The tape was one minute late on the bell. The stock markets will be closed Monday for Washington's Birthday.

DOW JONES CLOSING STOCK AVERAGES

30 Industrials 979.23 UP 6.10
20 Transportation 203.30 UP 0.31
15 Utilities 113.15 Down 0.19
65 Stocks 309.88 UP 1.18

A young lady was playing golf one day and just as she bent over to pick up her ball, another ball came zooming and popped her right in the fanny. She was hurt badly, so she went to the doctor. "Where did it hit you?" he asked. "Between the first and second holes," replied the lady. "In that case," said the doctor, "it doesn't leave me much room for the needle!"

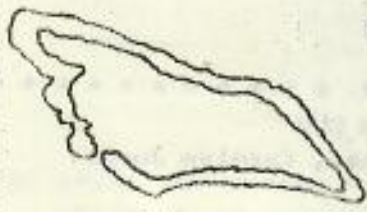


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The Canton Scuttlebutt

VOL. 3

SATURDAY -- 17 February 1973

No. 475

SWEDEN -- An American Resisters' Group in Canada, AM-Ex-Canada, is sponsoring organization of the meeting which begins Monday. Also setting up the two-day affair is safe return, a New York-based committee working for universal amnesty and up from exile, the American Resisters' Group in Sweden.

George Carrano on Blauvelt, New York, fled to Sweden in 1968 when he received a draft induction notice. He is one of the half dozen resisters representing up from exile at the conference.

"There are 500 American exiles in Sweden and 90 per cent of them will return home if they get the chance," Carrano said.

UHL said a Resisters' delegation from England was expected today.

Scheduled for arrival Sunday morning were some 15 representatives of U.S. Anti-War, church and civil liberties organizations who will participate in the conference.

Carrano said "We will be speaking for one million resisters who have been penalized in some way."

UHL added "this meeting will give the exiles a chance to work out a minimal solution.

He said that a group of active-duty American GI's stationed in West Germany were also arriving today for the meeting.

President Nixon has maintained a strong anti-amnesty position.

Taipei, Taiwan -- The Nationalist Chinese Defense Ministry tonight branded as "absurd and ridiculous" a Hong Kong Press report that Taiwan will sign a non-aggression pact with the Soviet Union.

The South China Morning Post, an English Language Newspaper published in Hong Kong, reported today a top official of Taiwan's Ministry of Defense, who traveled to Hong Kong incognito, told some 30 members of the legislative Yuan (The Senate) : "The Nationalists have threatened to lease one or more of their off-shore islands, such as the Pescadores, to the Soviet Union as a naval base for a non-aggression pact with Moscow in event of the abrogation of the US Security Pact in line with Taiwan's flexible diplomacy.

This flexible diplomacy of developing relations with anti-Peking Communist countries was adopted last year by the former Foreign Minister and now minister without portfolio, Chou Shu-Kai, with the consent of top Nationalist decision makers, the British-owned post reported the official as saying.

Tonight, a spokesman of the Defense Ministry said no ranking official from Taiwan has ever made such remarks to anyone in Hong Kong.

He said it was "common sense" that the Nationalist China will under no circumstances form any alliance with any communist country in its struggle against the Peking government.

TOKYO -- The United States and China have agreed on the pull out of American troops from Taiwan, a Japanese correspondent in Peking reported today.

The Asahi Shimbun, one of the three largest newspapers in Japan, said US Presidential Adviser Henry Kissinger and Chinese Premier Chou En-Lai have come to an agreement on the "withdrawal of a large number of US military personnel" from Taiwan.

Kissinger is in Peking following his visit to Hanoi for talks on Post-War Indochina reconstruction. He is schedule to arrive in Tokyo next Monday for a meeting with Prime Minister Kakuei Tanaka.

The Asahi Shimbun report on the US troop pullout from Taiwan is ambiguous and was not attributed to any Chinese government official. The United States has made no definite announcement on whether it will completely withdraw its forces from Taiwan now that the Vietnam War has ended.

The Asahi Shimbun also reported that Kissinger and Chinese officials have agreed on establishment of a permanent US trade office in China and an exchange of journalists.

Japanese newspapers, which have been able to keep their resident correspondents in Peking, said that the Chinese have reported extensively on Kissinger's visit.

SCUTTLE BUTT

SATURDAY NIGHT
AT THE MOVIES

HEAVEN WITH A GUN

Barbara Hershey, Carolyn Jones
P. J.

Wilfred Hyde White, Brock Peters

HEAVENS WITH A GUN -- (Western) -- A reformed bad guy comes to a western town to set up a church and becomes embroiled in the feud over water rights between cattle and sheep ranchers.

P. J. -- (Crime Drama) -- A private detective who gets the job of protecting the secretary mistress of a malevolent millionaire is kept busy heading off sinister attempts on her life and falls in love with her.

SUNDAY -- BRUNCH - 0600--1200 Hours -- Chilled Fruit Juices, Assorted Fresh Fruits;

MENU Hot & Cold Cereal w/milk, Cream of Beef, Portugese Sausage, Grilled Breakfast chops, Eggs Fried to Order, Hot Cake w/Syrup, German Fried Potatoes, Breakfast Sweet Roll, Potato Salad, Chef's Special, Fruit Jello, Cookies, Assorted Cold Cuts, Fruit Punch, Coffee, Tea & Milk.

DINNER -- Saimin Soup, Salad Bar, Assorted Dressing, Grilled Shish Kebab, Baked Pork & Beans, French Fried Potatoes, Buttered Cauliflowers, Chocolate Cake, Ice Tea w/Lemon, Coffee, Tea & Milk.

SUNDAY TIDES -- HIGH 0735 HT 3.6 LOW 0057 HT 0.4
HIGH 1952 HT 3.6 LOW 1316 HT 0.6

NO.T.V. TONIGHT

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

NEWS BRIEFS -- (Laos) -- The government has said it will turn over to the communist a list of 121 North Vietnamese prisoners it has in detention when a cease-fire agreement is reached. So far there has been no official mention of any pathet Lao prisoners by the government.

In military development, sources here disclosed that CIA-sponsored irregular troops have again occupied the entire depopulated town of Muang Phalane west of the Ho Chi Minh Trail complex in Central Laos and that fighting in the area was continuing. The town has changed hands three times in the past two months.

Continued fighting was also reported around Paksong on the Bolovens Plateau in far northern Laos, which may be occupied by CIA irregulars last week. The town was reported virtually destroyed by US air strikes.

In far northern Laos, sources said that efforts to recapture the irregular base of Nam Yu, located about 25 miles from the major Mekong River town of Ban Houie Sai, have been so far unsuccessful. Nam Yu, a base formerly used to launch CIA-organized guerrilla missions into southern China, fell to the communist two weeks ago.

(Cairo) -- Feb 17 UPI - Following were results in Friday's second day of play in the 28th Three-Cushion Billiards World Championships in Cairo:

Nobuyaki Kobayashi, Japan (number of cannons) 60, (number of turns) 58, (best turn) 8, (average) 1.034.

Labilh Yousri, Egypt, 30--58 -- 4 -- .672.

Raymond Ceulemans, Belgium 60 -- 41 -- 6 -- 1.463

Muftafa Diab, Egypt, 30 -- 41 -- 4 -- .751

Humberto Suguimizu, Peru, 60 -- 78 -- 5 -- .769

Mohammed Diab, Egypt, 38 -- 78 -- 7 -- .487

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