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To: Head, Biology Branch
Office of Naval Research
Department of the Navy
Washington 25, D. C.

From: Bruce W. Halstead, M. D., Project Director
School of Tropical and Preventive Medicine
College of Medical Evangelists
Loma Linda, California.

Subj: REPORT ON AN INVESTIGATION OF POISONOUS AND VENOMOUS FISHES AT COCOS, GALAPAGOS AND LA PLATA ISLANDS DURING 4 DECEMBER 1952 to 28 JANUARY 1953.

INTRODUCTION

During 4 December 1952 to 28 January 1953 a field investigation was conducted on the poisonous and venomous fishes of Cocos, Galapagos and La Plata Islands. The trip was sponsored largely through the generosity of Mr. Woodrow G. Krieger, president of the Douglas Oil Company of California, and the Office of Naval Research During the forementioned period Mr. Krieger turned over his 96 foot yacht, the "Observer" to the School of Tropical and Preventive Medicine for use in the investigation. Mr. Krieger not only made his yacht available to the scientific party but also constructed a special laboratory and reefer facilities to accomodate our group.

The field party from the School of Tropical and Preventive Medicine included: Bruce W. Halstead, Norman C. Bunker, Jeanne M. Bunker, Leonard S. Kuninobu, and Donald G. Ollis. The Bunkers and Kuninobu departed with the boat from Newport, California, on 4 December 1952. Halstead and Ollis departed on 18 December 1952 via commercial plane to San Jose, Costa Rica, thence by train to Puntarenas, Costa Rica, where they joined the "Observer". All of the members of the expedition, with the exception of Ollis, returned via commercial and military air transportation to the United States by 28 January 1953.

The staff of this department are deeply grateful for all of Mr. Krieger's generosity and the cooperative efforts of the Office of Naval Research in providing

return transportation to the United States.

ITINERARY

3 Dec. 1952: DEPARTED LOMA LINDA, CALIFORNIA, 1800.

...By car to Balboa Bay Club. Boarded yacht "Observer".

4 Dec. 1952: DEPARTED BALBOA BAY CLUB, 1050.

...Enroute to San Benedicto Island.

6 Dec. 1952: PORT SAN BARTOLOME, MEXICO. 27° 401 36" N., 114° 53' 45" W.,

...HO Chart 1204. It was necessary to put into port for a few hours for minor repairs. This gave us an opportunity to use a night light for collecting specimens. Specimens were plentiful, but there was not a great variety of species. Fishes collected were mackerel and silversides. Some invertebrates were collected. Water temperature 16° C.

9 Dec. 1952: ARRIVED SAN BENEDICTO ISLAND 1630. 19° 20' N., 110° 48' W.,

...HO Chart 1685. This island is volcanic in origin and is of particular interest at this time because of its recent eruption and formation of a new crater. Mr. Adrian Richards, Scripps Institute of Oceanography, and Mr. Lou Walker, photographer, had requested transportation of Mr. Krieger to this island in order to make observations and measurements on the growth of the new crater.

Shore collecting at this island was impractical because of shear cliffs in places and the heavy surf surrounding the island. No tide pool areas were observed. Collections were limited to hook and line and night light fishing. Daytime line fishing yielded nothing. Night light fishing for two nights brought a fair number pompanos, flying fish and half beaks. One wanoo was taken on a troll line. Sharks were numerous and came

readily to the night light. Only one species was observed and and one of these was taken as a specimen. Water temperature 24.5° C.

11 Dec. 1952: DEPARTED SAN BENEDICTO ISLAND 1500.

...Enroute to Puntarenas, Costa Rica.

14 Dec. 1952: 15° 50' N., 98° 15' W.

...It was necessary to stop at approximately 2100 to change engine oil and we had the opportunity of using a night light. A few fish were caught and a great many invertebrates taken. Squid were numerous. Water temperature 25° C.

19 Dec. 1952: ARRIVED PUNTARENAS, COSTA RICA 1730.

...Three days were spent in this port. Halstead and Ollis joined the expedition at this point.

Daytime line fishing in this area yielded nothing, but night light fishing produced a few specimens of halfbeaks and catfish. Water temperature 26.5°C.

22 Dec. 1952: DEPARTED PUNTARENAS, COSTA RICA, 2030.

...Enroute to Cocos Island.

24 Dec. 1952: ARRIVED COCOS ISLAND 0530. 05 22' N., 87 04' W., HO Chart 1685.

...Cocos Island is about 13 miles in circumference, about four miles long to the northeast and southwest, and two miles wide. The highest elevation is approximately 1900 feet. The shore line is very irregular with many islets rocks and shoals. There are several bays. There is generally heavy surf all around the island. Chatham Bay, where the "Observer" anchored, is the best anchorage. The shore line of the bay consists mostly of steep cliffs except for two small beaches. Landings with small boats are easily made at these beaches.

The island is typically tropical with luxurious vegetation. Rainfall is heavy and there are many fresh water streams and falls. Wild goats were observed in several places and it is reported that there are wild pigs. Bird life is abundant and consists mostly of frigate birds and boobies. A few land birds were observed. There is no human population.

The best collecting area at Cocos Island proved to be at Chatham Bay. It was interesting to note that the fishes of this area represent a peculiar blend of Indo-Pacific, Panamanian and temperate South American forms. The fish faunas of Cocos, Galapagos and La Plata Islands are very similar. However, at La Plata Island less Indo-Pacific forms, such as Acanthurus, Chaetodon, Zanclus, etc., are to be seen. Puffers, Arothron meleagris and A. nigropunctatus, were found to be very common at Cocos. White-tipped sand sharks, Eulamia sp., were exceedingly abundant. Hammerhead, Sphyrna, and various other shark species were present in smaller numbers. Manta ray are also common. Cocos Island would be an exceptionally good area for conducting shark studies. The shark population is large and limited to a relatively small circumscribed area. The water around the island is clear, warm and shallow enough to facilitate underwater studies. Cocos Island ultimately proved to have the best all-round collecting conditions of any of the areas visited on this trip.

Fishes were collected by hook and line, spear, dynamite, dip net and rotenone. The beaches were not very satisfactory for seining because of coral and rocks. Dynamite proved to be the most effective method of collecting in open water.

The explosives used for collecting were half pound charges of a

sixty percent strength blasting gelatin supplied by the Hercules Powder Company. These charges were used in conjunction with a regular No. 6 blasting cap and waterproof fuse. The regular method of crimping the cap onto the fuse was not used. Instead, the two components were connected by inserting the fuse into the cap and sealing the joint with a short length of plastic electricians tape. This formed a strong and watertight joint which is necessary in under-water work. A lead pencil was used to punch a diagonal hole into the side of the charge where the cap was inserted. The extended fuse was taped to the charge as a safety precaution.

In previous experience it was found that lighting a fuse with a match under field conditions was extremely difficult. A method was suggested by Mr. John Fitch of California Fish and Game which we tried and found to be very satisfactory. A short piece of resistance wire was wound on a small porcelain fitting. The contacts on the fitting were in turn fastened to two 18-inch lengths of insulated wire for contact. Electricity was obtained from a Ray-O-Vac No. 641 dry cell battery for heating the element. When the fuse was to be started, contact was made and the fuse lit from the hot element. It was found that a short length of stainless steel fishing leader formed the best heating element.

Various strength charges of from one-sixth of a pound to two pounds were used. The most satisfactory size proved to be a one-half pound charge. Smaller charges were inadequate and produced few fish. Larger charges were too strong and severely damaged the fish internally. The explosives proved effective in most

any reasonable depth of water and were used successfully in water up to thirty or forty feet in depth. It was found that a maximum fuse length should be about four inches as the bubbles from a burning fuse seem to frighten the fish away.

Aqua-lungs were used for spearing and proved a valuable aid.

Fishes collected at Cocos Island are the following: rainbow runners, jacks, trigger, puffers, file, surgeon, squirrel, blennies, butterfly, snappers, mackerel, half beaks, stick, parrot, angel, demoiselle, groupers, moray eels, trumpet, gobies, wahoo, skipjack, yellowfin tuna, and shark. Water temperature 27°C.

28 Dec. 1952: DEPARTED COCOS ISLAND 2200.

...Enroute to Genovesa Island, Galapagos Islands.

30 Dec. 1952: ARRIVED GENOVESA ISLAND 1430. 00 19' 30" N., 89 57' W., HO Chart 1798.

...Genovesa Island (Tower Id.) is approximately two and one-half miles across. Anchorage was made in Darwin Bay. The island is volcanic in origin and is very dry and arid. Several types of cacti and brush grow on the island. There is a very heavy population of birds including several ocean and several land species. Marine iguanas, fur seals and sea lions were observed here.

Fish collecting was excellent in Darwin bay. Little collecting was done outside of the bay because of very rough water. Collecting was limited to hook and line, explosives, and poisoning tide pools. No spearing was done as the water was very murky in this area. Fishes collected are as follows: trigger, snappers, mackeral, squirrel, half beaks, stick, parrot, pomacanthids, pomacentrids, surgeon, blennies, mullet, pompano, and mackeral scad. Water Temperature 25°C.

31 Dec. 1952: DEPARTED GENOVESA ISLAND 1600.

...Enroute to San Cristobal Island.

1 Jan. 1953: ARRIVED WRECK BAY, SAN CRISTOBAL ISLAND, 0600. 00° 54' S., 89° 37' W., HO Chart 5926.

San Cristobal Island, the easternmost of the Galapagos Islands, is 24 miles long by 8 miles wide. The altitude at the southwestern end of the island raises to about 2500 feet. The island has plenty of water and is very fertile, especially in the higher regions. There are about 700 people on the island.

Collecting was not too good and was limited to hook and line and a little night light fishing. Fishes caught were groupers, snappers, corbina, and half beaks. Water temperature 21°C.

2 Jan. 1953: DEPARTED SAN CRISTOBAL ISLAND, 0200.

...Enroute to Academy Bay, Santa Cruz Island.

2 Jan. 1953: ARRIVED ACADEMY BAY, SANTA CRUZ ISLAND, 0600. 00° 45' S., 90° 18' W., HO Chart 5926.

Santa Cruz Island is approximately 22 miles long to the East and West and about 17 miles wide. The island is one large mountain about 2,300 feet high. According to the Island's inhabitants the population is about 200.

Academy Bay affords a good anchorage and there is quite a bit of reef area which appeared to be fair for collecting. Time was very limited at this point, however, so collecting was limited to a few blasts of dynamite. Fishes obtained were demoiselle, parrots, groupers, and triggers. Water temperature 22.5°C.

2 Jan. 1953: DEPARTED ACADEMY BAY 1100.

...Enroute to Seymour Bay, Santa Cruz Island.

2 Jan. 1953: ARRIVED SEYMOUR BAY 1600. 00 29' 30" S., 90 19' 30" W., HO Chart 1798.

This area was found to be considerably different ecologically from the places we had been previously. There are numerous river-like lagoons lined with mangrove trees. The fish population in this area was not large, but considerable blasting was done and some new specimens obtained. Night light fishing was also done. Fishes obtained were: grunts, rudder, triggers, needle, flying and half beaks.

3 Jan. 1953: DEPARTED SEYMOUR BAY, SANTA CRUZ ISLAND, 1000.

...En route to Sullivan Bay, San Salvadore Island.

3 Jan. 1953: ARRIVED SULLIVAN BAY, SAN SALVADORE ISLAND, 1700. 00 17' 10" S., 90 33' 45" W., HO Chart 1798.

San Salvadore Island is approximately 19 miles long east and west and about 11 miles wide. There are a number of small fresh lakes and streamlets in the higher altitudes (2,700) and is well covered with vegetation.

Sullivan Bay is on the eastern side of the island. Anchorage was made in Sullivan Bay just inside the lee of Bartholomew Island. Collecting was excellent in this area due to the variety of ecological conditions. Fishes were collected by hook and line, dynamite, rotenone, dip net and spear. Limited beach seine operations were attempted, but no fishes were taken by this method. Night light fishing was particularly good in this area and some fine specimens were captured. Fishes collected were: grunts, snappers, flying, half beaks, parrots, demoiselle fish, angel, wrasses, moray eels, blennies, and shark. Water temperature 24.5°C.

While in this area several attempts were made to harpoon and land a manta ray so samples could be taken and the jaws obtained

for our collection. Several rays were harpooned, but due to technical difficulties none were landed. Manta rays are very abundant in this area.

5 Jan. 1953: DEPARTED SULLIVAN BAY, SAN SALVADORE ISLAND.

...Enroute to Tagus Cove, Isabela Island.

6 Jan. 1953: ARRIVED TAGUS COVE, ISABELA ISLAND, 1200. 00 15' 30" S., 91 22' 20" W., HO Chart 1798.

Isabela Island (Albemarle) is the largest of the Galapagos Islands. It is somewhat the shape of a boot and is about 60 miles long. The southern side of the island is relatively green and quite thickly wooded, while the northern and western sides are arid. There are about 400 people on the island. Tagus cove, on the western side of the island, is an excellent anchorage.

Collecting was good in this area, but made rather difficult because of the very steep shores and deep water. Dynamite was the principal method of collection, however, some hook and line fishing was done. Night lite fishing was quite productive. Large numbers of Sphoeroides annulatus (?), a puffer, came to the night light and were quite easily captured with nets and spears. Puffers were more plentiful in Tagus Cove than in any area we have ever collected but they were all this single species. Fishes collected at Tagus Cove were: wrasses, groupers, mackeral, grunts, whitefish, puffers, mackeral scads, dolphin, and barracuda. Water temperature 20.5°C.

FERNANDINA ISLAND (Narborough):

...This island is immediately to the west of Isabela Island across a channel which is about 2 - 3 miles in width. The island is a large extinct volcano over 4000 feet high and is very barren.

The shore line of the eastern side of the island is well populated with large marine iguanas, penguins, flightless cormorants and other marine birds. Tide pools are numerous and collecting is very good. Line fishing along the shore is excellent for numbers, but there is not a great variety of fishes. Dynamite was used with good success and several tide pools were poisoned with rotenone. The only stingray captured during the whole trip was taken in this area.

Fishes collected were: grouper, stingray, wrasses, demoiselle, etc. Water temperature 21°C.

8 Jan. 1953: DEPARTED TAGUS COVE, ISABELA ISLAND, 1900.

...Enroute to Post Office Bay, Santa Maria Island.

9 Jan. 1953: ARRIVED POST OFFICE BAY, SANTA MARIA ISLAND, 0600. 01° 15' S., 90° 28' W., HO Chart 1801.

...Santa Maria Island is about 26 miles in circumference with an altitude of about 1700 feet. The northern side of the island is very dry, but the southern part is wet and supposedly good farm land. It is reported that wild cattle, pigs and goats are abundant.

Onslow Island is a small eroded island slightly east of Post Office Bay. A small amount of collecting was done here.

Fishes collected in this area were snappers, puffers, squirrel, rudder, mullet, blacksmith, demoiselle, grunts, rock and porcupine fish. Water temperature 23°C.

10 Jan. 1953: DEPARTED POST OFFICE BAY, SANTA MARIA ISLAND, 0130.

...Enroute to Espanola Island.

10 Jan. 1953: ARRIVED GARDENER BAY, ESPANOLA ISLAND, 0700. 01° 22' S., 89° 38' W., HO Chart 1798.

...No collecting was done in this area.

10 Jan. 1953: DEPARTED GARDENER BAY, ESPANOLA ISLAND, 1800.

...Enroute to La Plata Island, Ecuador.

12 Jan. 1953: 01 23' S., 82 07' W.

...The boat was stopped for about three quarters of an hour and collecting was excellent. Good collections of deep sea lantern fish and flying fish were made. Squid were numerous and some specimens were taken.

13 Jan. 1953: ARRIVED LA PLATA ISLAND, ECUADOR, 0600.

...La Plata is a small island about 3½ miles long, northwest and southeast, and about 1¼ miles wide at its northern end. Its highest altitude is just under 600 feet. The island is very arid. There is a permanent population of about 25 people, but at the time of our visit a group of transient native fishermen swelled the number to about 80.

Collecting in this area was not too good, although much time was spent in dynamiting and line fishing. It was interesting to note that the fish fauna of this island is quite similar to that of the Galapagos Islands. A few moray eels and red snappers were bought from the native fishermen.

Fishes collected here were: triggers, demoiselles, squirrel, herring, amberjack, moray eels, snappers, and a hammerhead shark.

14 Jan. 1953: DEPARTED LA PLATA ISLAND, 1300.

...Enroute to Quayaquil, Ecuador.

15 Jan. 1953: ARRIVED QUAYAQUIL, ECUADOR, 1600.

...A short time was spent at Guayaquil to pack gear and specimens and get everything ready for the return trip.

16 Jan. 1953: HALSTEAD DEPARTED.

...Via commercial plane to Panama and then by military plane to the United States.

18 Jan. 1953: BUNKERS AND KUNINOBU DEPARTED FOR THE UNITED STATES.

...Enroute to Quito, Ecuador, via commercial airline.

ARRIVED QUITO, 1100.

19 Jan. 1953: DEPARTED QUITO 1100.

...Enroute to Panama, via commercial airline.

ARRIVED TOCUMEN AIRPORT, PANAMA, 1630.

22 Jan. 1953: HALSTEAD ARRIVED IN LOMA LINDA, 1530.

24 Jan. 1953: DEPARTED ALBROOK AIR BASE, PANAMA, 0830, FLIGHT #D-16/24.

ARRIVED BROOKLEY FIELD, MOBILE, ALABAMA, 1630.

26 Jan. 1953: DEPARTED BROOKLEY FIELD, 1700, BASE OPERATIONS FLIGHT TO MC CLELLAN FIELD, SACRAMENTO, CALIFORNIA.

...Night stopover in Albuquerque, New Mexico.

27 Jan. 1953: BUNKERS AND KUNINOBU ARRIVED MC CLELLAN FIELD, 1500.

...Proceeded to Loma Linda via commercial air line and car.

COLLECTING TECHNIQUES

Blasting - The greatest percentage of specimens were collected by this method. It is fast, certain, and produces a good variety. Blasting has the decided disadvantage of being wasteful. More specimens are collected than can be used. However, in areas where nets and rotenone are of little value blasting is generally productive.

Spearing - Spearing proved to be very profitable at Cocos Island when used in conjunction with the Aqua-lungs. In the Galapagos Islands, however, the water was usually too murky for efficient spearing operations.

Poisoning- This techinque was reserved almost exclusively for tide pool collecting and was very practical for this type of work. No large scale poison operations were attempted on this trip.

Hook and line - This technique was employed at practically every stop made by the boat. Both bait fishing and trolling were done and many specimens caught.

When compared to blasting, this method, of course, does not result in nearly as many specimens for the time consumed. However, line fishing is useful for obtaining specimens which can not be procured by other methods.

CARE AND SHIPMENT OF SPECIMENS

Due to limited refrigerator space on the boat it was impossible for us to freeze our entire collection as is usually done. As soon as the fish were caught muscle and visceral samples were taken, tagged, placed in plastic bags and quick frozen. The specimen was then tagged, wrapped in gauze and preserved in 10% formalin. Two 55 gallon drums were filled with specimens, a large number of smaller fishes were preserved in gallon and quart jars.

The frozen material will be shipped in deep freezers, via the Grace Lines, to Los Angeles. It was planned that arrangements should be made for the preserved specimens to be taken to either San Diego or Los Angeles aboard a tuna clipper.

More fragile specimens were preserved separately in bottles. These will be shipped back with the other preserved specimens.

SUMMARY

1. An investigation on the poisonous and venomous fishes of Cocos, Galapagos and La Plata islands was conducted during 4 December to 28 January 1953. Members of the staff from the School of Tropical and Preventive Medicine consisted of Bruce W. Halstead, Norman C. Bunker, Leonard S. Kuninobu, Jeanne M. Bunker and Donald G. Ollis.
2. The Galapagos area was selected because of the unusual blending of temperate and tropical water currents and their respective fish faunas. Poisonous fishes are known to be present in the Indo-Pacific fauna and in the West Indian fauna. Hence we are anxious to determine if poisonous species occur in the intermediate Panamanian faunal belt, and if so - to what extent. There is some indication that fish poisoning may possibly be extending eastward but

there is not sufficient distributional data available at the present time to be certain. In this regard, the Galapagos survey should yield some extremely interesting and valuable information in the months to come.

3. Puffers were found to be present in large numbers at Chatham Bay, Cocos Island and at Tagus Cove, Isabela, Galapagos Islands. Moray eels and red snapper were quite numerous at La Plata Island. Since these groups are frequently toxic in the Western Pacific it will be interesting to see if toxic species are to be found among these groups in the Eastern Pacific.

4. Cocos Island has an exceedingly abundant shark population and would make an excellent area for conducting more extensive studies on the habits of sharks as they relate to man.

5. Representative collections of fishes were taken from as many different ecological areas as time and equipment would permit. Whenever possible duplicate collections were taken from each island visited.

6. Numerous black and white, kodachromes and moving pictures were taken by Mr. Donald G. Ollis. It is hoped that ultimately a motion picture can be prepared giving a documentary account of the over-all problem of ichthyosarcotoxism.

7. The final results of the Galapagos investigation will be reported upon the completion of the screening experiments.

Respectfully submitted,

Bruce W. Halstead

Bruce W. Halstead, M.D.

Norman C. Bunker

Norman C. Bunker.