# A Report on the Poisonous Fishes Captured During the Woodrow G. Krieger Expedition to Cocos Island[1]

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THIS IS THE FOURTH of a series of epidemiological reports concerning the poisonous fishes of the tropical Pacific. The first report (Halstead and Bunker, 1954*a*) dealt with the Phoenix Islands, the second (Halstead and Bunker, 1954*b*) with Johnston Island, and the third (Halstead and Schall, 1955) with the Galápagos Islands. For a general résumé of the overall problem of poisonous fishes and ichthyosarcotoxism, the reader is referred to two earlier reports by the senior author (1951, 1953).

A more complete discussion of the manner in which fishes are believed to become poisonous has been published elsewhere (Halstead and Bunker, 1954*a*). There are probably a multiplicity of factors governing the degree of toxicity of a fish, viz., abundance of certain types of food, the availability of certain types of organic chemical constituents in that food, and the physiology of the fish.

Although numerous poisonous fish species are known to occur in the West Indies, Red Sea, and in various parts of the Pacific, a literature of more than 1500 publications on poisonous marine organisms is silent regarding the tropical Eastern Pacific. The basic objective of this expedition was to determine if poisonous fishes occurred in this region, with the hope that the knowledge gained thereby would contribute directly to a better understanding of the origin and distribution of toxic fishes in the tropical Pacific. As there are no inhabitants at Cocos, it was not possible to appraise the practical importance of the poisonous fishes found.

The expedition to Cocos Island was made possible through the generosity of Mr. Woodrow G. Krieger, president of the Douglas Oil Company of California, and the Office of Naval Research, Department of the Navy. In addition to making his 96-foot yacht, the "Observer," available to the scientific party, Mr. Krieger also installed special laboratory and refrigeration facilities on his yacht to accomodate our group. Grateful acknowledgement is made for the invaluable contributions to our research program of both Mr. Krieger and the Office of Naval Research. With the exception of the family Scaridae, all of the fishes listed in this report were identified by Dr. Boyd Walker of the Department of Zoology, University of California at Los Angeles. Dr. Leonard P. Schultz of the U. S. National Museum identified the scarids. Our sincere appreciation is expressed to these individuals for their valuable contributions to this report. The scientific party included Norman C. Bunker, Jeanne M. Bunker, Leonard S. Kuninobu, Donald G. Ollis, and the senior author. The "Observer" departed from Newport Bay, California, on December 3, 1952,

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and proceeded to Punta Arenas, Costa Rica, and thence to Cocos Island.

## GEOGRAPHY AND ECOLOGY OF COCOS ISLAND

Cocos Island is located at lat. 5°22'N., long. 87°04'W., (Hydrog. Off. 1951, Freeman 1951, Robson 1950, Chubb 1933) about 540 miles southwest of Panama. The island is 4 miles long by 2 miles wide. There are four peaks or hills, the highest of which rises to an altitude of 1,932 feet (Hydrog. Off., 1951; Chubb 1933, gives an altitude of 2,788 feet). From the main peak the ground slopes gradually to the summit of cliffs at a height of about 600 feet above sea level. The island is volcanic in origin and has a very irregular shore line obstructed by islets, rocks and shoal areas which may extend as much as one-half mile offshore. There are two principal bays or anchorages, Wafer and Chatham Bays, both of which are located on the northern side of the island. The water immediately surrounding the island is relatively shallow, ranging in depth from ¼ to 20 fathoms within 200 to 1,000 meters from the shore. The bottom at Chatham Bay, the area from which most of our Cocos Island specimens were taken, is of sand and large boulders. No coral reefs were observed. The surrounding water is clear, and the surface temperature at the time of our visit was 27° C. The extreme annual range is said to be about 5.5° C. A pounding surf about most of the island, except for some of the protected bays, makes boat landing a hazardous procedure.

The island has frequent torrential rains, luxuriant vegetation and an almost impenetrable jungle. Fresh-water streams and waterfalls are numerous. There is no human population at present. Wild goats were observed to be abundant. Hogs and rats are also reported to be present. Oceanic birds of various kinds are present in large numbers.

Collecting conditions at Chatham Bay were excellent for spear fishing, considerably better than any of the areas subsequently visited during the trip. White-tipped sharks, *Triaenodon obesus*, were found to be exceedingly abundant, but innocuous to skin divers. Various other species of shark were observed. Puffers, *Arothron setosus*, were present in large numbers. Fishes such as rainbow runners, jacks, triggerfish, filefish, surgeonfish, squirrelfish, blennies, butterflyfish, snappers, mackerels, half beaks, groupers, parrotfish, moray eels, trumpetfish, wahoo, skipjacks, yellowfin tunas, sailfish, were common.

## MATERIALS AND METHODS

### *Collection of Fishes*

The fish specimens were collected with the use of rotenone, spear, dynamite or dip net. Within a short time after collection the smaller specimens were sorted, labeled, placed in plastic bags according to the station from which they were taken, and frozen in a deep freeze unit. In the case of the larger specimens, samples were taken from the muscle, liver, intestines, and gonads in the field. An identification number was assigned to the tissue sample and a duplicate number given to the dissected fish which was then placed in a barrel of 10 per cent formalin for future taxonomic purposes. The frozen material remained in that condition until tested in the laboratory. A considerable amount of ecological data was accumulated at each station and may be obtained from the authors. The stations from which the specimens used in this study were taken are K 52—10 to 15, 17 to 19, 21 to 22 (see Fig. 1).

### *Methods Used in Screening Fishes*

Fishes were screened by preparing, whenever possible, aqueous extracts of muscle, liver, intestines, and gonads of each specimen. Four laboratory white mice were used for testing each extract. One ml. of the extract was used for each mouse. The mice were observed for a period of 36 hours and then classified as negative, weakly, moderately or strongly positive on the basis of symptoms developed. For details concerning the tech-

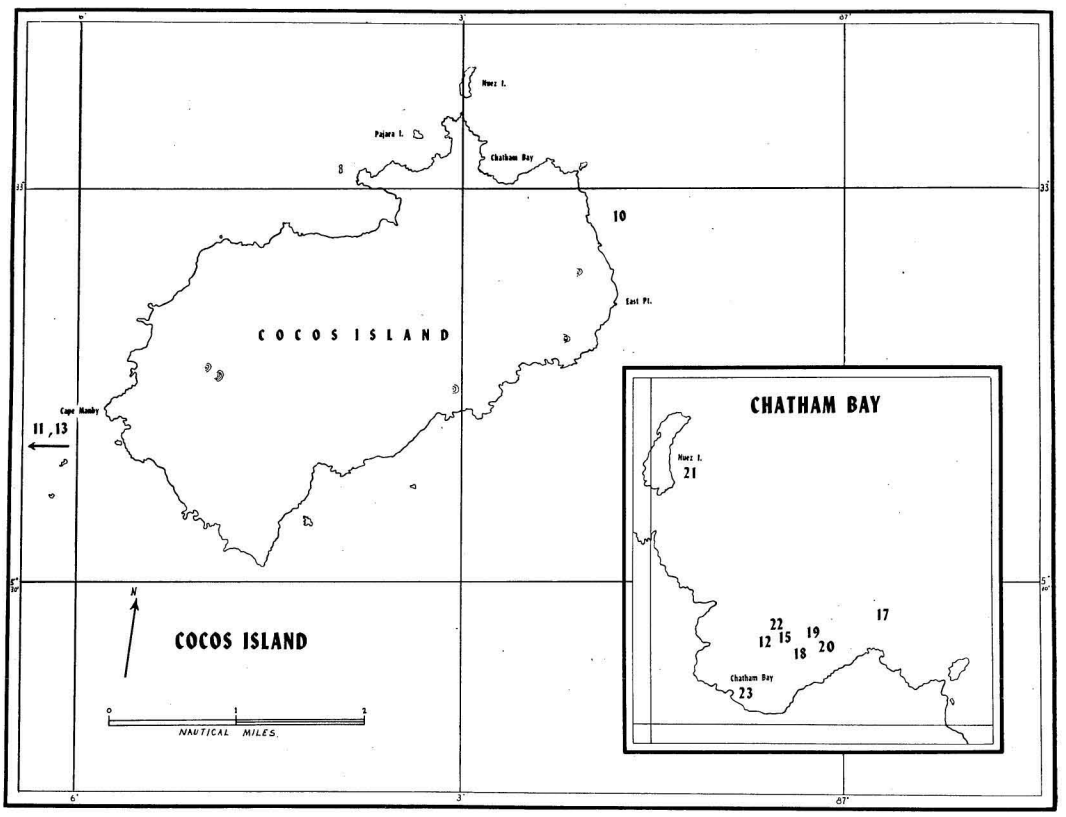


FIG. 1. Map of Cocos Island showing the locations (numbers 10–15, 17–19, 21, 22) at which specimens were collected.

niques used in testing for ichthyosarcotoxins see Halstead and Bunker (1954*a*).

*Terminology Used Concerning Degrees of Toxicity*

The classification used is an arbitrary one which gives some idea as to the degree of toxicity of a fish species within a particular geographical area. This method makes no attempt to differentiate between virulence and concentration. Moreover, the interpretation of *weakly positive* results in terms of human symptomatology is not clearly understood at this time. Hence, the reader is cautioned about arriving at hasty conclusions regarding the results of this study. The categories used are:

1. *Negative*—the test is negative if the mouse continues to remain asymptomatic during the maximum test period of 36 hours, or dies after that time.

2. *Weakly positive*—the test is weakly positive if the mouse shows definite symptoms such as lacrimation, diarrhea, ruffling of the hair, hypoactivity, ataxia, etc., but *recovers*.

3. *Moderately positive*—this term is used if the mouse develops hypoactivity, ruffling of the hair, lacrimation, diarrhea, paralysis, etc., and *dies within a period of 1 to 36 hours*.

4. *Strongly positive*—if the mouse develops hypoactivity, ataxia and paralysis which is usually followed by clonic or tonic convulsions of varying degrees, paradoxical respiration, respiratory paralysis, and *death occurs within a few seconds to one hour*.

TABLE 1

AN ANALYSIS OF COCOS ISLAND FISHES WITH REFERENCE TO THEIR TOXICITY
(Each specimen examined is listed separately)

| FISH TESTED | EXTRACT TESTED* | | | | | |
|---|---|---|---|---|---|---|
| | Muscle | Liver | Gonads | Intestine | Viscera | Intestinal Content |
| ACANTHURIDAE—Surgeonfish | | | | | | |
| *Acanthurus aliala* Lesson | – | | | | – | |
| *Acanthurus aliala* Lesson | – | | | W | | |
| *Acanthurus crestonis* (Jordan and Starks) | – | – | – | – | | |
| *Acanthurus crestonis* (Jordan and Starks) | M | | | | M | |
| *Ctenochaetus strigosus* (Bennett) | – | | | | M | |
| ALUTERIDAE—Filefish | | | | | | |
| *Alutera monoceros* Linnaeus | – | – | | – | | |
| *Alutera monoceros* Linnaeus | – | M | – | – | | |
| *Alutera monoceros* Linnaeus | – | – | | M | | |
| *Alutera monoceros* Linnaeus | – | – | | M | | |
| BALISTIDAE—Triggerfish | | | | | | |
| *Balistes verres* Gilbert and Starks | – | | | | – | |
| *Balistes verres* Gilbert and Starks | – | – | | | – | |
| *Balistes verres* Gilbert and Starks | – | | | | – | |
| *Balistes verres* Gilbert and Starks | W | | | | – | |
| *Balistes verres* Gilbert and Starks | – | – | | – | | |
| *Balistes verres* Gilbert and Starks | – | – | – | | | |
| *Balistes verres* Gilbert and Starks | – | – | | W | | |
| *Balistes verres* Gilbert and Starks | – | – | – | – | | |
| *Melichthys radula* (Solander) | – | – | | – | | |
| *Melichthys radula* (Solander) | – | – | – | – | | |
| *Melichthys radula* (Solander) | – | – | – | – | | |
| *Melichthys radula* (Solander) | – | W | – | M | | |
| *Melichthys radula* (Solander) | – | – | – | – | | |
| *Melichthys radula* (Solander) | – | – | – | – | | |
| *Melichthys radula* (Solander) | – | W | – | – | | |
| *Melichthys radula* (Solander) | – | | | | – | |
| CARANGIDAE—Pompano, Jacks | | | | | | |
| *Caranx caballus* Günther | M | | W | M | | |
| *Caranx melampygus* Cuvier and Valenciennes | – | – | – | | | |
| *Caranx melampygus* Cuvier and Valenciennes | – | – | – | W | | |
| *Caranx melampygus* Cuvier and Valenciennes | W | – | | – | | |
| *Elagatis bipinnulatus* (Quoy and Gaimard) | – | – | | – | | |
| *Elagatis bipinnulatus* (Quoy and Gaimard) | – | | | | – | |
| *Elagatis bipinnulatus* (Quoy and Gaimard) | – | – | – | – | | |
| CONGRIDAE—Conger eels | | | | | | |
| *Chiloconger* sp | – | | – | W | | |
| CYBIIDAE—Wahoo | | | | | | |
| *Acanthocybium solandri* (Cuvier and Valenciennes) | – | – | – | – | | |
| HAEMULIDAE—Grunts | | | | | | |
| *Anisotremus interruptus* (Gill) | M | W | – | – | | |
| *Anisotremus interruptus* (Gill) | – | | | | – | |
| HOLOCENTRIDAE— Squirrelfish | | | | | | |
| *Holocentrus suborbitalis* (Gill) | – | | | | – | |
| *Myripristis occidentalis* Gill | – | | | | – | |
| *Myripristis occidentalis* Gill | – | M | – | | | |
| *Myripristis occidentalis* Gill | – | | | | – | |
| *Myripristis occidentalis* Gill | – | | | | – | |
| *Myripristis occidentalis* Gill | – | | | | – | |
| *Myripristis occidentalis* Gill | – | | | | M | |
| *Myripristis occidentalis* Gill | – | | | | – | |

| FISH TESTED | EXTRACT TESTED* | | | | | |
|---|---|---|---|---|---|---|
| | Muscle | Liver | Gonads | Intestine | Viscera | Intestinal Content |
| ISTIOPHORIDAE—Sailfish | | | | | | |
| *Istiophorus greyi* Jordan and Hill | – | – | W | – | | |
| KATSUWONIDAE—Skipjacks | | | | | | |
| *Euthynnus lineatus* Kishinouye | – | – | W | – | | |
| KYPHOSIDAE—Rudderfish | | | | | | |
| *Kyphosus* sp. | – | | | | – | |
| LUTJANIDAE—Snappers | | | | | | |
| *Aphareus furcatus* (Lacépède) | – | | | | – | |
| *Aphareus furcatus* (Lacépède) | – | | | | – | |
| *Aphareus furcatus* (Lacépède) | – | | | | M | |
| *Aphareus furcatus* (Lacépède) | – | W | – | – | | |
| *Aphareus furcatus* (Lacépède) | – | – | – | M | | |
| *Aphareus furcatus* (Lacépède) | – | | – | – | | |
| *Lutjanus aratus* (Günther) | W | M | – | – | | |
| *Lutjanus jordani* (Gilbert) | – | | – | | – | |
| *Lutjanus jordani* (Gilbert) | – | – | – | | | |
| *Lutjanus jordani* (Gilbert) | – | – | – | | | |
| *Lutjanus jordani* (Gilbert) | – | | – | | | |
| *Lutjanus viridis* (Valenciennes) | M | | | | W | |
| *Lutjanus viridis* (Valenciennes) | – | | | | – | |
| *Lutjanus viridis* (Valenciennes) | – | | | | – | |
| *Lutjanus viridis* (Valenciennes) | – | | – | | – | |
| MULLIDAE—Surmullets | | | | | | |
| *Pseudupeneus xanthogrammus* Gilbert | – | – | | – | | |
| *Pseudupeneus xanthogrammus* Gilbert | – | | | | – | |
| *Pseudupeneus xanthogrammus* Gilbert | – | | – | – | | |
| POMACENTRIDAE—Damselfish | | | | | | |
| *Microspathodon bairdi* (Gill) | – | | | | | |
| PRIACANTHIDAE—Big Eyes | | | | | | |
| *Priacanthus cruentatus* (Lacépède) | – | | | | – | |
| *Priacanthus cruentatus* (Lacépède) | – | | | | – | |
| *Priacanthus cruentatus* (Lacépède) | – | | | | M | |
| SCARIDAE—Parrotfish | | | | | | |
| Scarid sp. nov. | – | M | | – | | |
| SERRANIDAE—Seabass | | | | | | |
| *Dermatolepis punctatus* Gill | – | – | – | – | | |
| *Dermatolepis punctatus* Gill | – | – | – | – | | |
| *Dermatolepis punctatus* Gill | – | | – | M | | |
| *Epinephelus labriformis* (Jenyns) | – | | – | – | | |
| *Epinephelus labriformis* (Jenyns) | – | | – | – | | |
| *Mycteroperca olfax* (Jenyns) | – | | | – | | |
| *Mycteroperca olfax* (Jenyns) | – | – | – | – | | |
| *Paranthias colonus* (Valenciennes) | – | | | | – | |
| *Paranthias colonus* (Valenciennes) | – | | | | – | |
| *Paranthias colonus* (Valenciennes) | – | | | | – | |
| SPARIDAE—Porgies, pargo | | | | | | |
| *Calamus taurinus* (Jenyns) | – | W | | | M | |
| TETRAODONTIDAE—Puffers, Globefish | | | | | | |
| *Arothron setosus* (Smith) | S | | | | S | |
| *Arothron setosus* (Smith) | S | M | | S | | |
| *Arothron setosus* (Smith) | S | | | | S | |

TABLE 1 (*Continued*)

| FISH TESTED | EXTRACT TESTED* | | | | | |
|---|---|---|---|---|---|---|
| | Muscle | Liver | Gonads | Intestine | Viscera | Intestinal Content |
| TETRAODONTIDAE—Puffers | | | | | | |
| *Arothron setosus* (Smith) | S | | | | S | |
| *Arothron setosus* (Smith) | S | | | | S | |
| *Arothron setosus* (Smith) | S | S | S | S | | |
| *Arothron setosus* (Smith) | S | | | | S | |
| *Arothron setosus* (Smith) | S | | | | S | |
| *Arothron setosus* (Smith) | S | S | S | S | | |
| *Arothron setosus* (Smith) | — | S | — | — | | M |
| *Arothron setosus* (Smith) | S | | | | S | |
| THUNNIDAE—Tunas | | | | | | |
| *Neothunnus macropterus* Temminck and Schlegel | — | — | — | — | | |
| *Neothunnus macropterus* Temminck and Schlegel | — | M | — | — | | |
| TRIAKIDAE—White-tipped sharks | | | | | | |
| *Triaenodon obesus* (Rüppell) | — | — | | — | | |
| *Triaenodon obesus* (Rüppell) | — | — | — | — | | |

* Explanation of symbols used:
—, results negative; W, weakly toxic; M, moderately toxic; S, strongly toxic.


## SUMMARY

Twenty-one families of Cocos Island fishes, representing 33 species and a total of 96 specimens were tested in this study. Of these, 22 species and 41 specimens, or about 67 per cent of the species and 43 per cent of the specimens, were found to be toxic. The musculature and viscera were tested on 95 cases. Seventeen specimens or 41 per cent of the toxic fishes had poisonous musculature, whereas 39 or about 95 per cent had toxic viscera. Both musculature and viscera were poisonous in 15, or 37 per cent, of the toxic specimens.

The fishes most likely to be used as food which were found to have toxic musculature included only five species:

*Caranx caballus*
*Caranx melampygus*
*Anisotremus interruptus*
*Lutjanus aratus*
*Lutjanus viridis*

It should be noted that two of the genera, *Caranx* and *Lutjanus*, are well established causative agents of ichthyosarcotoxism that have been incriminated in both the Caribbean Sea and throughout the tropical Pacific Ocean.

In general, the viscera are the portions of the fish which are most likely to be poisonous. A more complete analysis of the distribution of ichthyosarcotoxin in the body of the fishes examined is presented in Table 2. The fishes reported upon in this paper represent the major shore and some of the pelagic fish species likely to be used as food in the regions discussed. It was found that 76 per cent of the Cocos Island families contained toxic species.

The limited number of specimens collected for most of the species precludes the presentation of statistically valid results at this time. Much more study is necessary before definite conclusions can be reached regarding the edibility of species listed as "weakly positive" because of the difficulty of interpreting this reaction in terms of human symptomatology.


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TABLE 2
SUMMARY OF RESULTS OF TESTS FOR TOXICITY OF FISHES TAKEN AT COCOS ISLAND

| | SPECIES | SPECIMENS | MUSCLE | LIVER | GONADS | INTESTINES | VISCERA | INTESTINAL CONTENT |
|---|---|---|---|---|---|---|---|---|
| Total Tested | 33 | 96 | 96 | 46 | 42 | 48 | 41 | 1 |
| Total Found Toxic | 22 | 41 | 17 | 14 | 5 | 13 | 15 | 1 |
| Percentage Found Toxic | 67 | 43 | 18 | 30 | 12 | 27 | 37 | 100 |

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