THE INSHORE SHARKS OF GUAM

METHODS OF SMALL-BOAT SHARK FISHING

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—Ed., June 2001

ABSTRACT

Fishing for sharks at depths up to 450 meters from small outboard boats was accomplished using solitary lines. Ten sharks were caught, most below 150 meters. *Carcharhinus falciformis*, *C. galapagensis*, and *Galeocerdo cuvieri* were recorded for the first time from Guam.

Hexanchus griseus and *C. menisorrah* were also taken but were not new to Guam. Morphometric, meristic, and ecological data for each shark are presented. The snout patterns formed by the ampullae of Lorenzini were examined for taxonomic purposes; however, the small sample size precluded evaluation of this character. A check-list of the sharks of Guam is presented as well as a key to the families and to the species of the family Carcharhinidae.

INTRODUCTION

The island of Guam is located at the southern end of the Marianas chain, at 13° north latitude and 144° east longitude. It is bordered by a shallow fringing reef, except for Cocos Lagoon at the southern end of the island (Fig. 1). Common inshore sharks, such as the blacktip (*Carcharhinus melanopterus*), gray (*C. menisorrah*), whitetip (*Triaenodon obesus*), and nurse (*Ginglymostoma ferrugineum*), have been collected on Guam but are rarely seen. These same species are relatively common elsewhere in the Marianas.

In August, 1971, one set each of solitary lines, 45 meters and 76 meters in length, were set off Amantes Point. Within a few minutes the deeper set produced a seven-foot silky shark (*C. falciformis*) (Fig. 8). Based on these results a pilot project was initiated to determine the types of sharks found in Guam waters and to delimit species distributional patterns. In addition, patterns formed by the ampullae of Lorenzini on the snouts of species found within the genus *Carcharhinus* were examined to determine the usefulness of this character as a taxonomic aid.

METHODS

The Guam sharkfishing program was. modeled after similar studies conducted in Hawaii by Tester (1969). There were several necessary modifications due to restrictions imposed by the small size of the boats (19- or 21-foot outboards) used in the program. All gear setting and hauling had to be done by hand and only solitary lines were used (Fig. 2). The fishing depth was estimated from available hydrographic charts.

Fishing Gear

The fishing gear consisted of six baskets (Fig. 3) of solitary lines, each line a different length and shown as follows:

1) 3/8" polypropylene-synthetic--76 meters

2) 1/4" cotton-synthetic----------90 meters

3) 1/4" cotton-synthetic----------152 meters

4) 5/16" kurolon----------182 meters

5) 1/4" cotton-synthetic----------217 meters

6) 1/4" cotton-synthetic----------304 meters

Baskets used to hold the coiled lines were common commercial plastic laundry baskets (Fig. 3). Each line was weighted with a five-pound weight made out of scrap rebar (1 1/2" diameter) with one-half a link of chain welded onto each end. A swivel (#11/0) was spliced onto the end of each main-line and to each leader. The leaders were one fathom (two meters) in

length and made up of 3/32" rust-resistant wire cable. Attached to the leader was a single marlin hook (Mustad) ranging in size from 9/0 to 14/0. Hooks were sharpened by file before each trip.

Each complete line was supported on the surface by one or more inflatable rubber buoys (capacity 2 cu. ft.) (Fig. 3 and 4). To prevent gear loss (the 304-meter line was lost when it became hooked on the bottom), a weak link was incorporated using 1/8" nylon line as a breakaway mechanism (Fig. 3).

Fishing Methods

Most of the fishing was done during daylight hours. Bait was obtained by spearfishing and frozen for future use. However, live fish was used when possible and in most cases a whole fish (slashed) was used. The bait was hooked directly under the backbone so it hung dorsal-ventrally. This was the preferred technique because the bait was firmly attached to the hook and allowed complete exposure of the point of the hook (Fig. 4). The lines were usually set at right angles to the shoreline in an effort to keep each line as close to the bottom as possible. Since currents usually ran parallel to the shore, it was likely that perpendicular sets would distribute bait smells over a greater area (Hobson, 1963). The 182-meter basket was usually set midwater as a pelagic line. Each basket was set with the boat moving slowly in a large circle, one man keeping light tension on the line as it peeled out of the basket. This avoided tangling of the leader around the weight or mainline. Six baskets could be set in 30 minutes. The lines were tended and rebaited when necessary. When a shark was caught, one or two persons with gloves pulled the line while one person coiled the line into the basket. When the shark was brought to the surface near the boat it was killed with a 12-gauge powerhead. The sharks were usually too large to bring aboard the boat and it was necessary to tow them to the beach to work on them.

Several overnight trips were made in the Orote area using deepwater, midwater, and surface sets. Bait consisted of live akule (*Trachurops crumenopthalmus*) caught using light monofilament line and small feathered hooks (Hawaiian style). These fish were held alive in a plastic trash container with holes cut in it for circulation and hung over board. They were attracted to the boat by means of a small electric light with shade hung over the side of the boat.

To fish below 300 meters, the 304-meter and 217-meter baskets were tied together and a heavy (25 lb) weight was hung one fathom below the hook by means of light cotton line (string). A chum-bag containing chopped fish guts and flesh was fastened to the top of the main-line weight. The heavy weight allowed a rapid descent of the line to the bottom (estimated to be around 456 meters). When on the bottom, the weight was broken loose by repeatedly pulling and releasing the line. This also released the chum-bag. The line was then buoyed on the surface and allowed to tail off the stern of the boat until dawn (Fig. 5).

A 285-pound test braided nylon handline with a 185-pound test wire leader and size 9/0 hook (without weight) was used for fishing with live akule in the surface and midwater zones.

While this line was fished, a frozen bait was left buoyed and floating near the surface from one of the baskets. Thus, the bottom, midwater, and surface zones were each represented by a bait.

Collection of Data

Sharks were identified from available description and keys (Bigelow and Schroeder, 1948 and Kato, Springer and Wagner, 1967). Close-up photographs of the snouts and teeth as well as general photographs were taken. Stomach contents were noted and all endo- and ectoparasites were collected and preserved. In some instances samples of teeth, jaws, fins, and eyes were preserved. Morphometric and meristic data were taken on all sharks.

RESULTS AND DISCUSSION

The records of sharks previously taken from Guam waters include *Ginglymostoma ferrugineum* (Orectolobidae), *Triaenodon obesus* (Triakidae), *Carcharhinus menisorrah* and *C. melanopterus* (Carcharhinidae), (Kami, Ikehara, and Deleon, 1968); *Alopias pelagicus* (Alopiidae), *Hexanchus griseus* (Hexanchidae), and *Sphyrna lewini* (Sphyrnidae), (Kami, 1972). These species are infrequently captured on Guam and very little taxonomic and ecological data has been collected. In this study, ten sharks were captured. They are: (1) *Hexanchus griseus* (Fig. 6A and B); (1) *Carcharhinus menisorrah* (Fig. 7) (1) *C. falciformis* (Fig. 8); (5) *C. galapagensis* (Fig. 9); and (2) *Galeocerdo cuvieri* (Fig. 10). Of these five species, *C. falciformis*, *C. galapagensis*, and *G. cuvieri*, are new records for Guam. A dicotmous key and descriptive checklist of sharks reported from Guam is provided in the appendix of this paper. Although Kami (1968) lists *Triaenodon obesus* as belonging to the family Triakidae, it characteristically falls into the family Carcharhinidae and is considered as a carcharhinid in the Key. All of the species in this study except *H. griseus* have been recorded as being dangerous to man (Gilbert, 1963, and Randall, 1963) .

A map of Guam and the areas fished are shown in Figure 1. Table 1 describes each fishing area according to month or months fished, number of line hours fished, species caught, and number of sharks caught per line hour. The most intensive fishing was done in the Orote point area with over 180 line hours. It appears that this area may have been "fished out" after the first few moths of fishing. No sharks were taken during the last 100 line hours. Similar declines in catch occurred in certain areas of Hawaii (Tester, 1969).

Table 2 summarizes the effectiveness of each basket or depth fished relative to number of hours fished, species caught, and number of sharks caught per line hour. Most of the sharks were caught at depths greater than 150 meters. Of the two caught on the 76-meter line, the silky (*C. falciformis*) was caught in midwater (greater than 300 meters) close to an actively feeding tuna school, and the gray (*C. menisorrah*) was captured near the bottom at approximately line depth off the mouth of an estuary at a time when a large school of akule (*Trachurops crumenopthalmus*) was moving into the channel. Both were caught during the preliminary fishing trials before beginning maximum fishing effort using all the baskets. No Galapagos

sharks (*C. galapagensis*) or tiger sharks (*G. cuvieri*) were taken from depths less than 150 meters except for one Galapagos caught on a handline near the surface at late night. Both of these sharks were commonly caught at night in the Hawaii program (Tester, 1969) at depths of 30 meters to about 60 meters and from about 150 meters to over 300 meters during daylight hours. This suggests a diurnal migration from deeper waters during the daytime to shallow inshore waters during darkness.

The average catch per unit of effort obtained in this study was 0.03. While this figure can be used as an index of relative abundance, it should be based on the consideration that: (1) Almost all of the fishing took place on the west (leeward) coast; (2) most of the standard basket fishing was done during daylight hours; (3) although it was preferable to set the baskets close to the bottom, depth was a matter of guesswork; and (4) most of the bait used had been previously frozen. In the Hawaii program (Tester, 1969), experimental fishing indicated that fresh fish was better bait than frozen or stale aku (*Katsuwonus pelamis*) and that 60 percent more sharks could have been caught if fresh fish had been used for bait in standard fishing. In this study, only 11 baits were lost during the program. At least 50 percent of the sharks that took a bait were caught. This statistic, however, may be underestimated because not all baits were necessarily lost to sharks. As noted in Table 2 several other fish were caught during the study. Three sharks were caught by foul hooking in the fins. The high hooking success was probably the result of presharpening the hooks before sets.

Table 3A and 3B present data gathered for each shark caught. Most of the sharks were over 200 centimeters in length, the largest 343 centimeters (*G. cuvieri*). The stomachs of all the sharks were empty or nearly empty except one tiger shark (*G. cuvieri*) caught off Facpi point contained a large green turtle weighing approximately 200 pounds. One of the Orote Galapagos sharks (*C. galapagensis*) was brought up with its entire abdomen missing (Fig. 13), apparently a victim of a large tiger shark which had surfaced and devoured four large pieces of shark liver previously thrown overboard. Tester (1969) reported tigers attacking hooked sharks in the Hawaii program.

The small number of specimens captured of the genus *Carcharhinus* precluded the possible use of the patterns formed by the ampullae of Lorenzini in the snout region for taxonomic purposes. Figures 11A and B shows the snout patterns of two of the three species of *Carcharhinus* captured during the study. There was also some intraspecific variation among *C. galapagensis* (Figs. 11B and 12). In order to properly explore this concept there should be a wide variety of species collected.

This study showed that inshore shark fishing from small boats could be done quite adequately with as few as two persons by using solitary lines. It appears that Guam does not have a large shark population both on the reef slopes and seaward below the thermocline. The three new records of sharks caught in this study bring Guam's shark record up to ten species representing six families. The Galapagos shark seems to be the most abundant shark inhabiting waters deeper than 70 meters. This shark has not previously been recorded west of the Hawaiian

Islands. Results of this nature point to the fact that much more work on sharks of the Marianas remains to be done. Similar studies should be undertaken throughout Micronesia. It may well be that taxonomic and ecological data would indicate a much broader distribution of certain sharks than previously thought. While Guam's beaches continue to attract tourists and the people of the islands throughout Micronesia continue to rely heavily on the adjacent waters to supply protein, almost nothing is known about the sharks inhabiting these waters except that sharks are present and shark attacks are not uncommon.

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Table 1. Fishing results of each area fished. The areas correspond to the locations shown in Figure 1. The numbers in parentheses indicate number of each species captured.

Area Fished	Month(s) Fished	Total Number of Line Hours Fished*	Species Caught (No.)		c/f No. Sharks Caught/Line Hour
Amantes Point	August,	4	*C. falciformis*	(1)	0.25
NCS	August	3	- - - - - -		0.0
Ritidian Point	August	2	- - - - - -		0.0
Tarague Beach	August	4	*C. galapagensis*	(1)	0.25
Catalina Point	August	3	- - - - - -		0.0
Double Reef	August	4	- - - - - -		0.0
	November	4	- - - - - -		0.0
Hospital Point	August	4	- - - - - -		0.0
	November	16	*C. galapagensis*	(1)	0.06
Ylig	September	4	*C. menisorrah*	(1)	0.25
Orote	September	3	- - - - - -		0.0
	October	99	*C. galapagensis*	(3)	0.05
			G. cuvieri	(1)	
			H. griseus	(1)	
	November	85	- - - - - -		0.0
Cocos (West)	October	25	- - - - - -		0.0
Facpi Point	November	2&	*G. cuvieri* (1)		0.04
Agat	November	12	- - - - - -		0.0
TOTALS		298		10	0.03

*Includes all fishing, i.e., incidental fishing as listed in Table 2.

Table 2. Fishing results of baskets or depth fished. Data from all areas is pooled.

Basket	Number of Hours Fished	Species Caught	c/f No. Sharks Caught/Line Hour	Other
76-meter	38	*C. falciformis* (1) *C. menisorrah* (1)	0.05	Barracuda (2) Eel (1)
90-meter	41	- - - - - - -	0.0	- - -
152-meter	45	*C. galapagensis* (1) *G. cuvieri* (1)	0.04	- - -
182- meter	39	*C. galapagensis* (1)	0.03	- - -
217-meter	43	*C. galapagensis* (1)	0.02	Grouper (1)
304-meter	18	*C. galapagensis* (1) *G. cuvieri* (1)	0.11	- - -
Handline	18	*C. galapagensis* (1)	0.06	- - -
Deep Set	20	*H. griseus* (1)	0.05	- - -_
Incidental Fishing	36	- - - - - -	0.0	- - -
TOTALS	298	10	0.03	4

Trolling, surface lines, and deep handlining.

Table 3A. Morphometric data for each shark caught. Measurements are in centimeters.

	sex	total length	snout to eye	snout to first dorsal	interdorsal	first dorsal fin	first dorsal fin	first dorsal fin height	second dorsal fin base distance	second dorsal fin	second dorsal fin	upper caudal lobe	lower caudal lobe	length of pectoral	body depth	snout length	internasal	mouth width	distance from tip of snout to nostrils
Carcharhinus galapagensis	f	115.0	7.6	39.2	26.6	12.5	5.2	13.4	4.7	5.0	4.1	30.5	15.0	22.6	20.3	9.8	8.1	11.8	5.2
C. galapagensis	f	253.0	20.0	79.0	58.0	24.0	9.0	27.0	9.0	10.0	6.0	61.0	35.0	53.0	41.0	18.0	16.5	25.0	7.0
C. galapagensis	m	239.0	14.5	73.0	58.5	22.0	7.5	23.0	8.0	8.0	5.0	64.0	33.0	45.0	--	14.5	15.0	20.5	4.5
C. galapagensis	f	264.0	16.0	83.0	64.0	23.0	10.5	29.0	9.0	10.5	7.5	71.0	34.0	50.0	30.0	17.5	15.5	25.5	6.5
C. galapagensis	m	234.0	15.0	73.0	61.0	21.0	9.5	23.5	7.0	9.0	6.5	61.0	32.0	44.0	27.0	15.0	14.5	22.0	6.0
C. falciformis	f	226.0	15.0	77.0	56.0	19.0	10.0	21.0	6.5	8.8	4.7	40.0	20.8	47.0	45.7	17.0	12.0	23.5	--
C. menisorrah	m	152.5	11.0	50.8	35.0	16.0	6.2	14.7	7.0	6.5	4.1	38.6	18.6	29.2	26.0	11.0	9.8	16.2	6.0
Galeocerdo cuvieri	m	343.0	27.5	109.0	89.0	36.0	18.0	26.5	27.5	14.0	8.5	63.0	38.0	49.0	60.0	15.0	18.0	39.0	5.0
G. cuvieri	m	332.0	19.0	97.0	80.0	39.0	19.0	28.0	16.0	16.0	9.5	86.0	41.0	47.0	50.0	13.0	16.0	34.0	5.5
Hexanchus griseus	m	313.0	20.0	177.0	NA	24.0	8.0	17.0	NA	NA	NA	95.0	24.0	38.0	48.0	16.0	16.0	46.0	12.5

Table 3B. Meristic and ecological data for each shark caught.

	# gill slits	species present	lateral keels present on peduncle	ridge present between dorsal fins	# dorsal fins	precaudal pits; dorsal, ventral or both	depth caught (meters)	caught night or day	bait used	stomach contents
Carcharhinus galapagensis	5	no	no	yes	2	d,v	3	n	live mackerel (*Trachurops crumenophthalmus*)	one small partly decomposed fish
C. galapagensis	5	no	no	yes	2	d,v	300	d	frozen tuna head (*Katsuwonus pelamis*)	empty
C. galapagensis	5	no	no	yes	2	d,v	150	d	frozen barracuda steak (*Sphyraena picuda*)	abdomen missing (Fig. 11)
C. galapagensis	5	no	no	yes	2	d,v	210	d	frozen barracuda steak (*S. picuda*)	fish bones
C. galapagensis	5	no	no	yes	2	d,v	180	d	frozen eel steak (*Gymnothorax* sp.)	empty
C. falciformis	5	no	no	yes	2	d,v	75	d	whole frozen fish (*Gaterin punctatissimus*)	empty
C. menisorrah	5	no	no	no	2	d,v	75	d	live surgeon fish (*Paracanthurus hepatus*)	empty
Galeocerdo cuvieri	5	yes	yes	yes	2	d,v	300	d	frozen barracuda steak (*S. picuda*)	crab skeletons and fish scales
G. cuvieri	5	yes	yes	yes	2	d,v	150	d	whole fresh rudder fish (*Kyphosus* sp.)	large partly decomposed green turtle
Hexanchus griseus	6	yes	no	NA	1	d	450	n	frozen barracuda steak (with chum-bag) (*S. picuda*)	empty

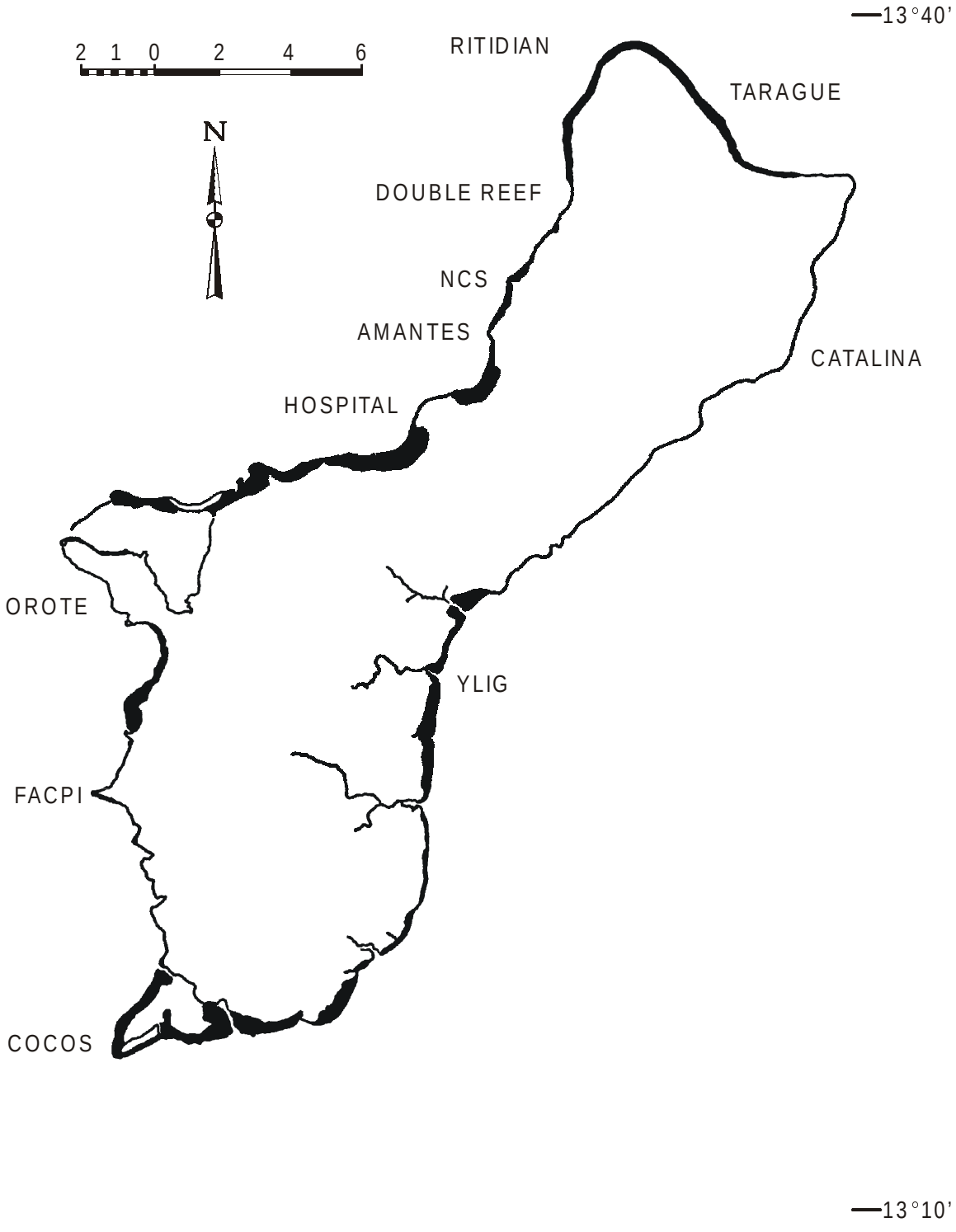

Figure 1. Localities of areas fished for sharks on Guam.

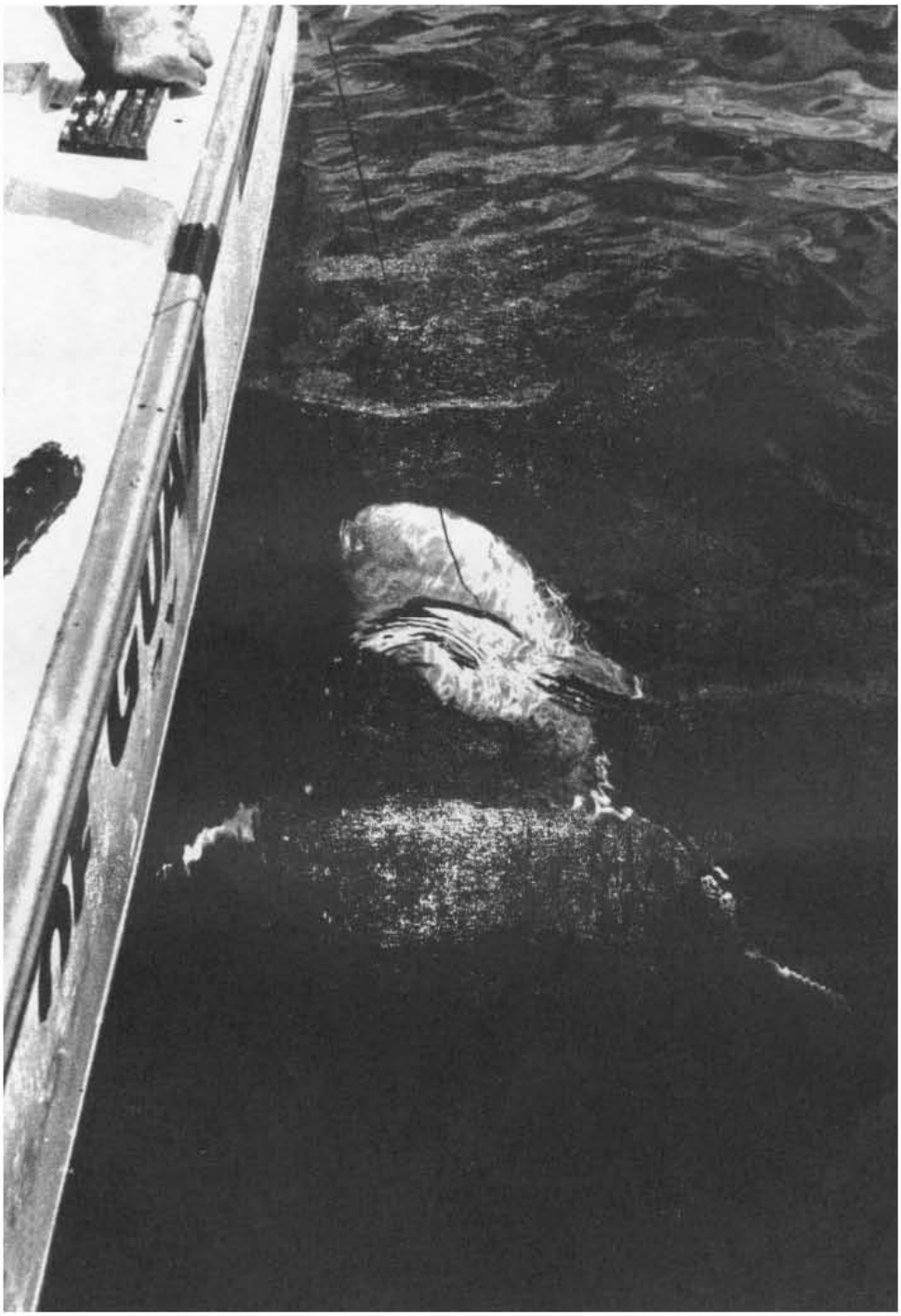

Figure 2. Tiger shark (*G. cuvieri*) caught on solitary line.

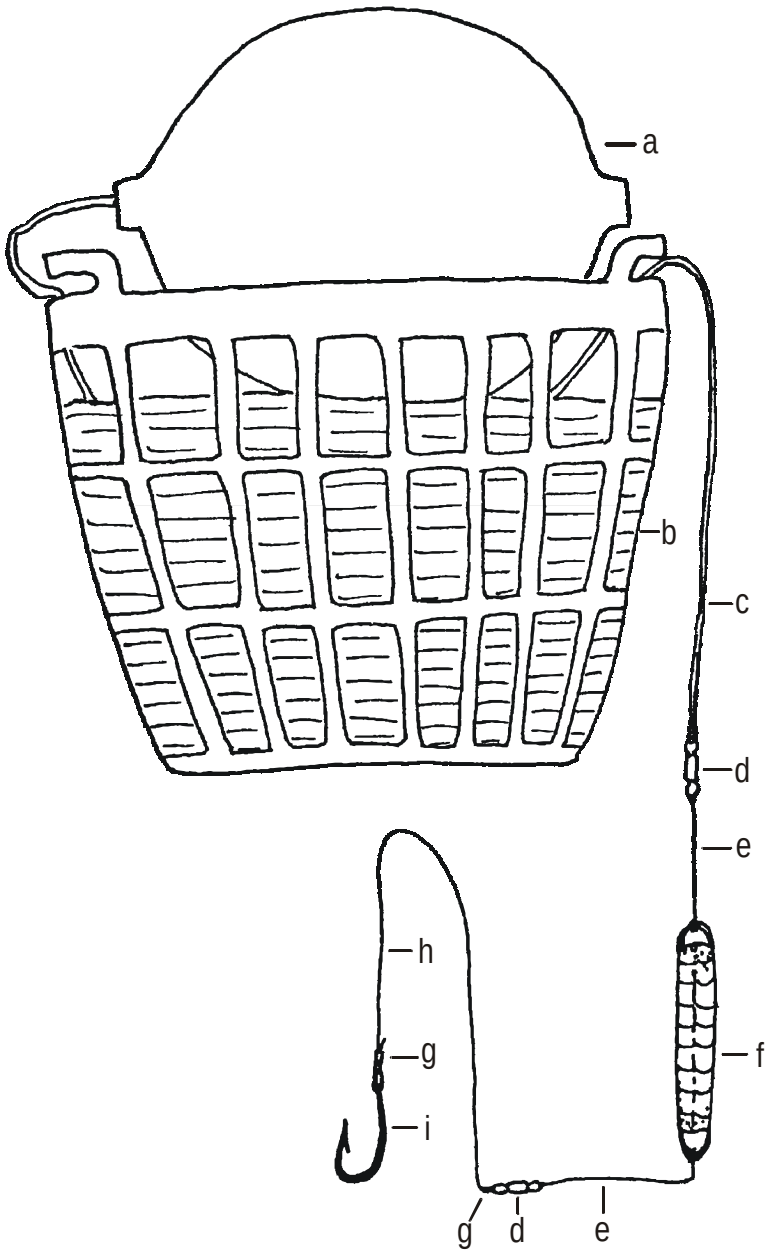

Figure 3. Coil of solitary line held in basket: a) buoy; b) basket; c) main-line; d) 11/0 swivel; e) 1/8" nylon breakaway line; f) 1 ½" rebar weight; g) micropress sleeve; h) 3/32" leader; i) marlin hook.

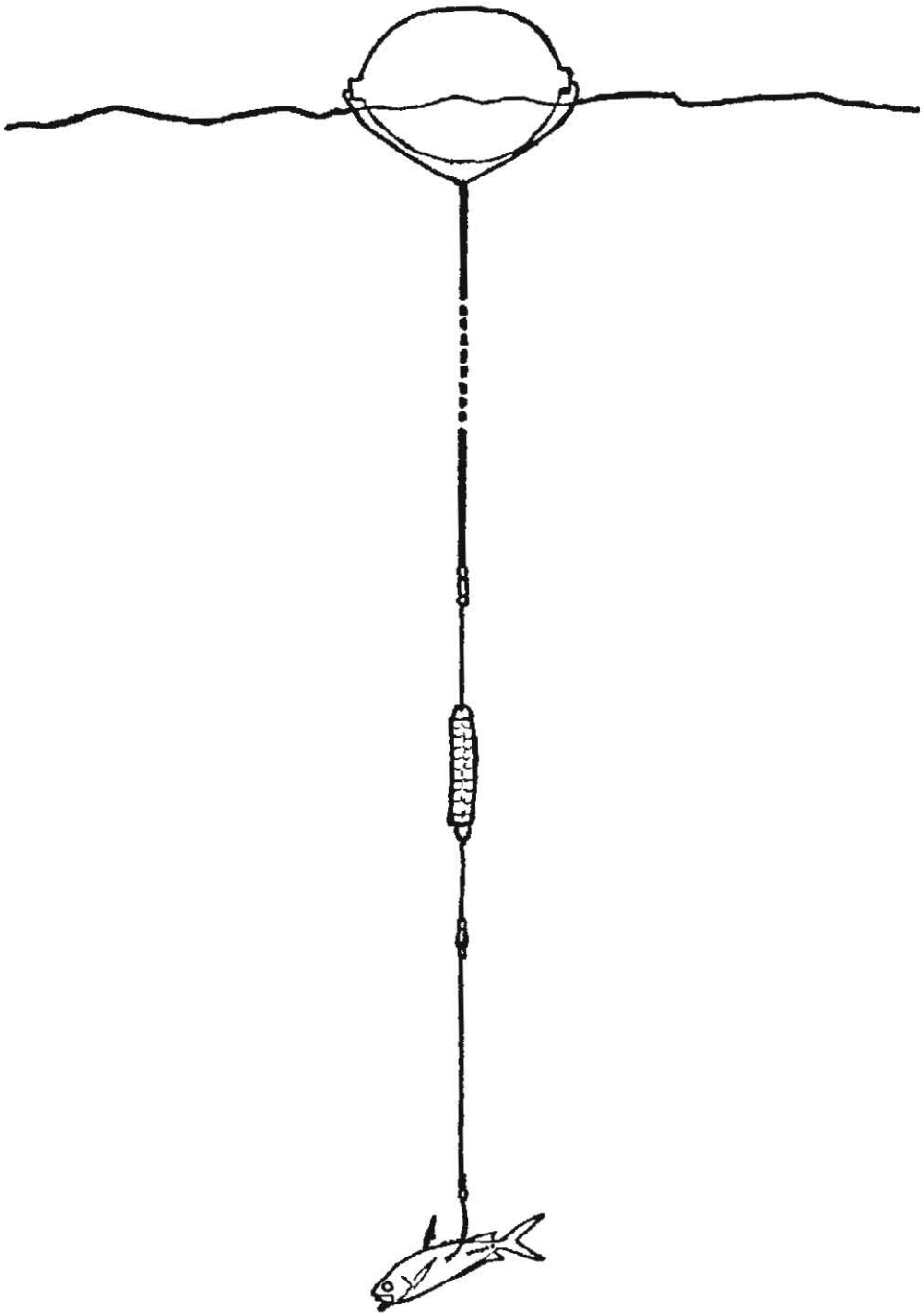

Figure 4. A set line supported on the surface by a buoy. Bait is hooked under the backbone to allow maximum exposure of the hook.

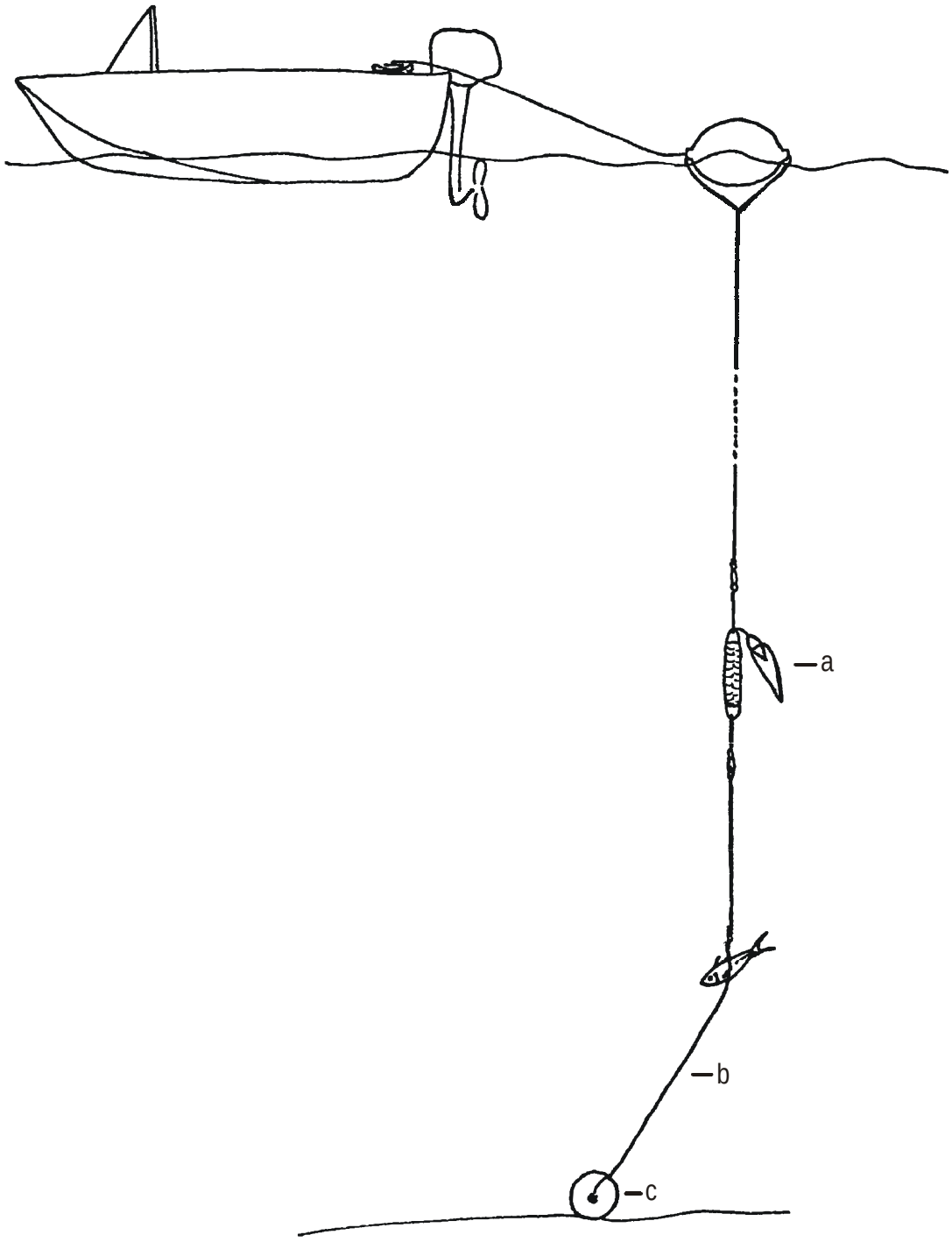

Figure 5. A deep-set, buoyed on the surface and tailing off the stern of the boat: a) chum-bag; b) light cotton break-away line; c) 25-lb weight.

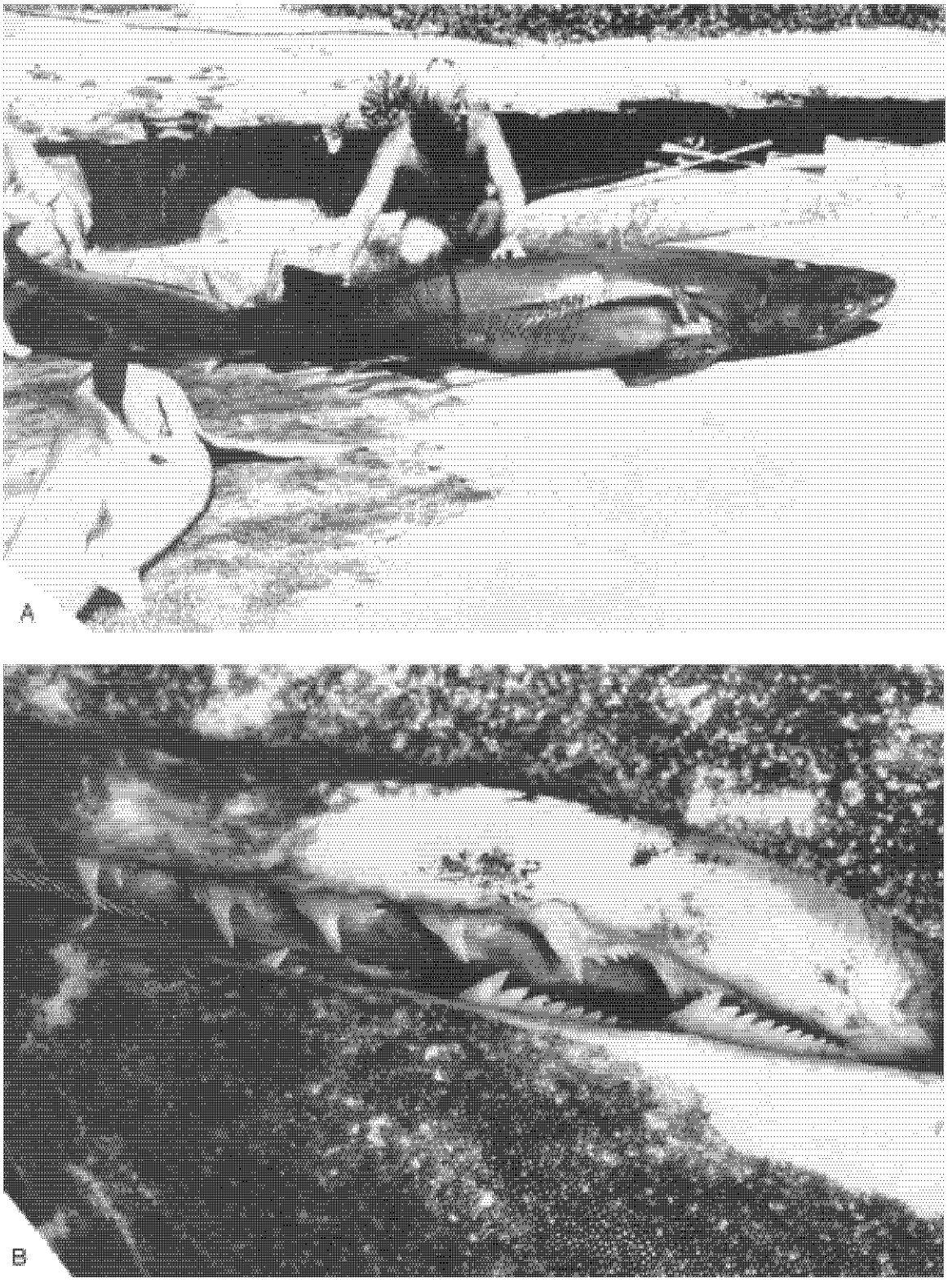

Figure 6. A) *Hexanchus griseus*. B) Teeth of *H. griseus*.

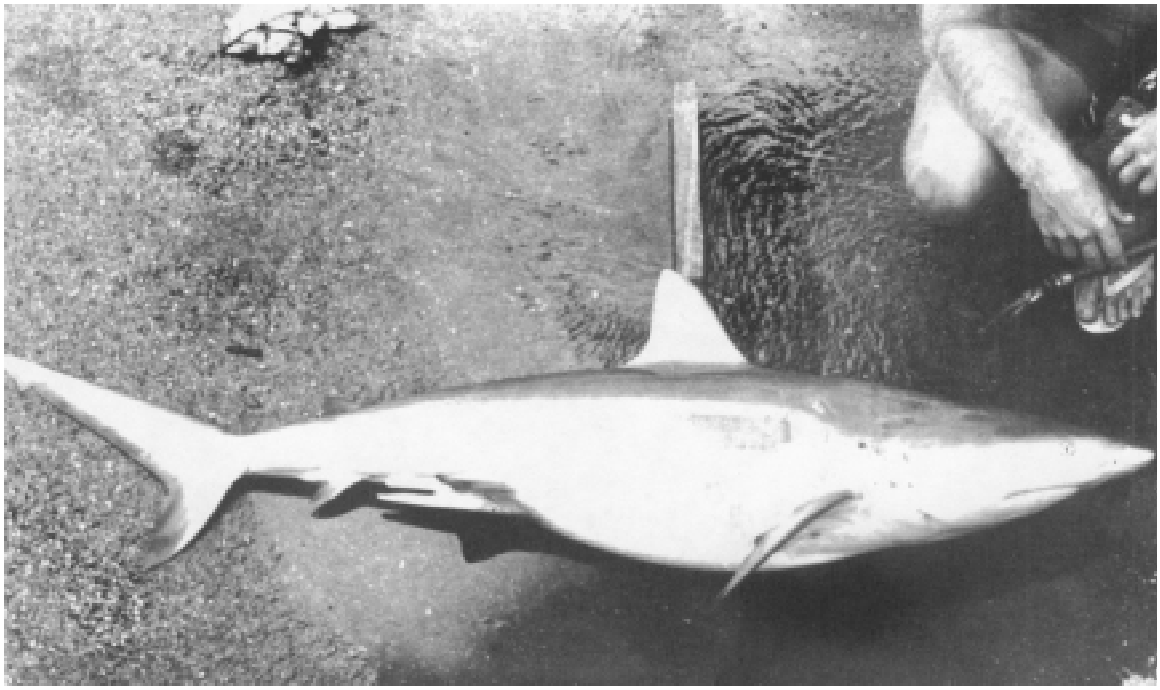

Figure 7. *Carcharhinus menisorrah*.

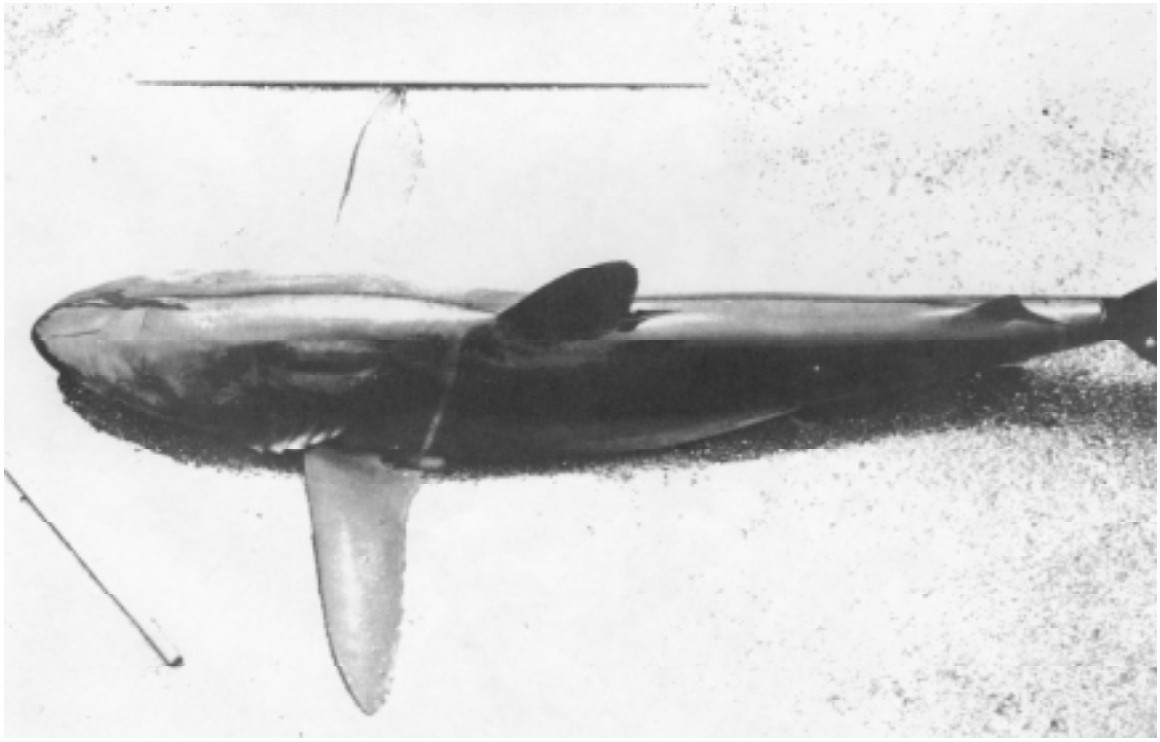

Figure 8. *Carcharhinus falcifornis.*

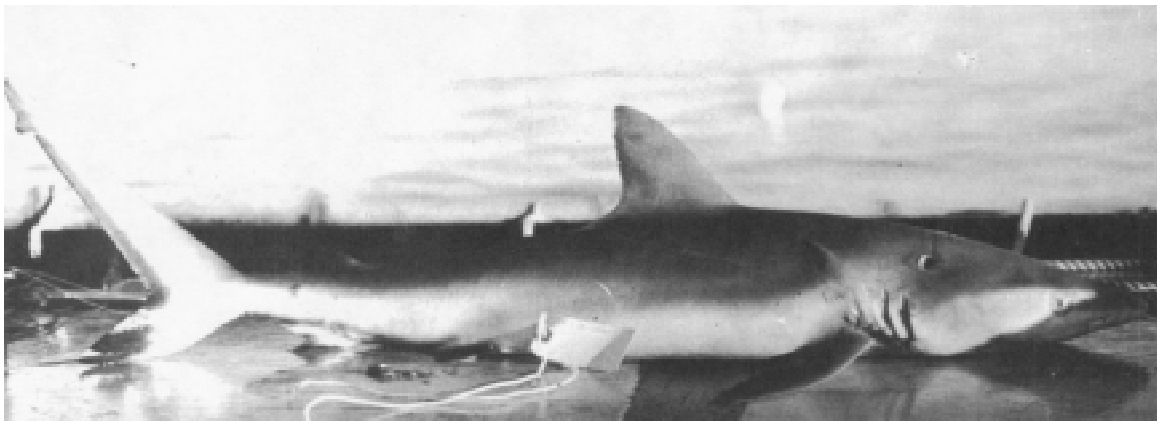

Figure 9. *Carcharhinus galapagensis*.

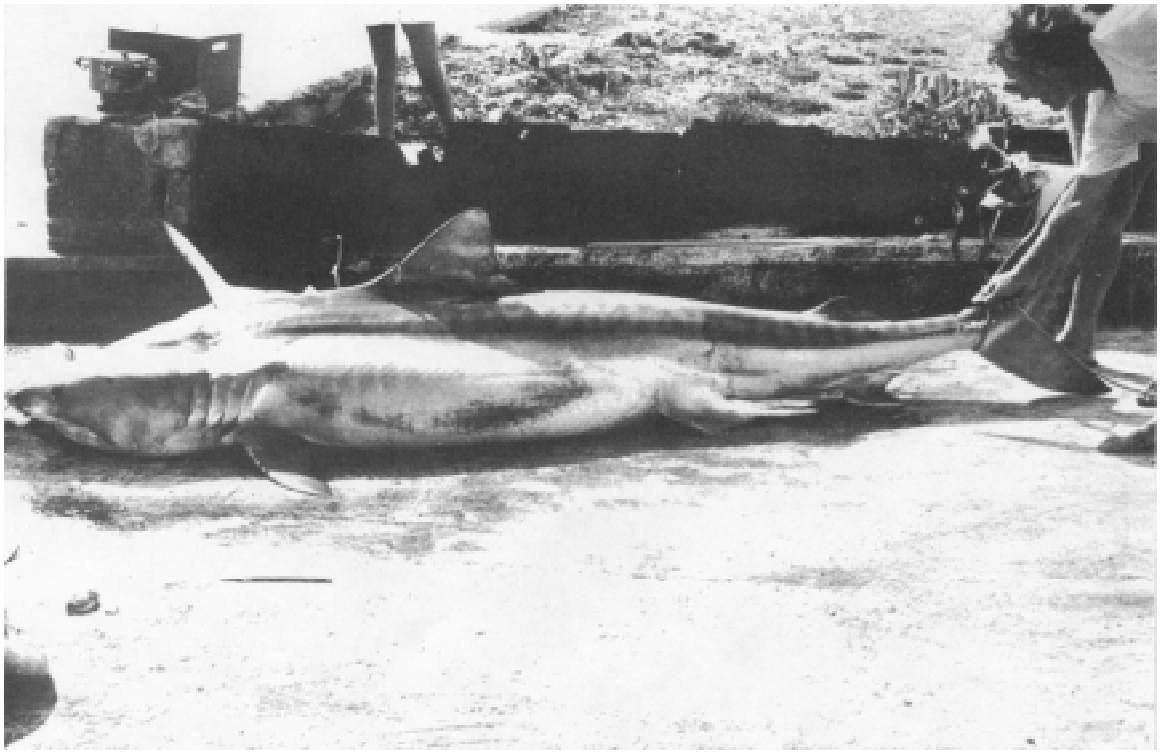

Figure 10. *Galeocerdo cuvieri*.

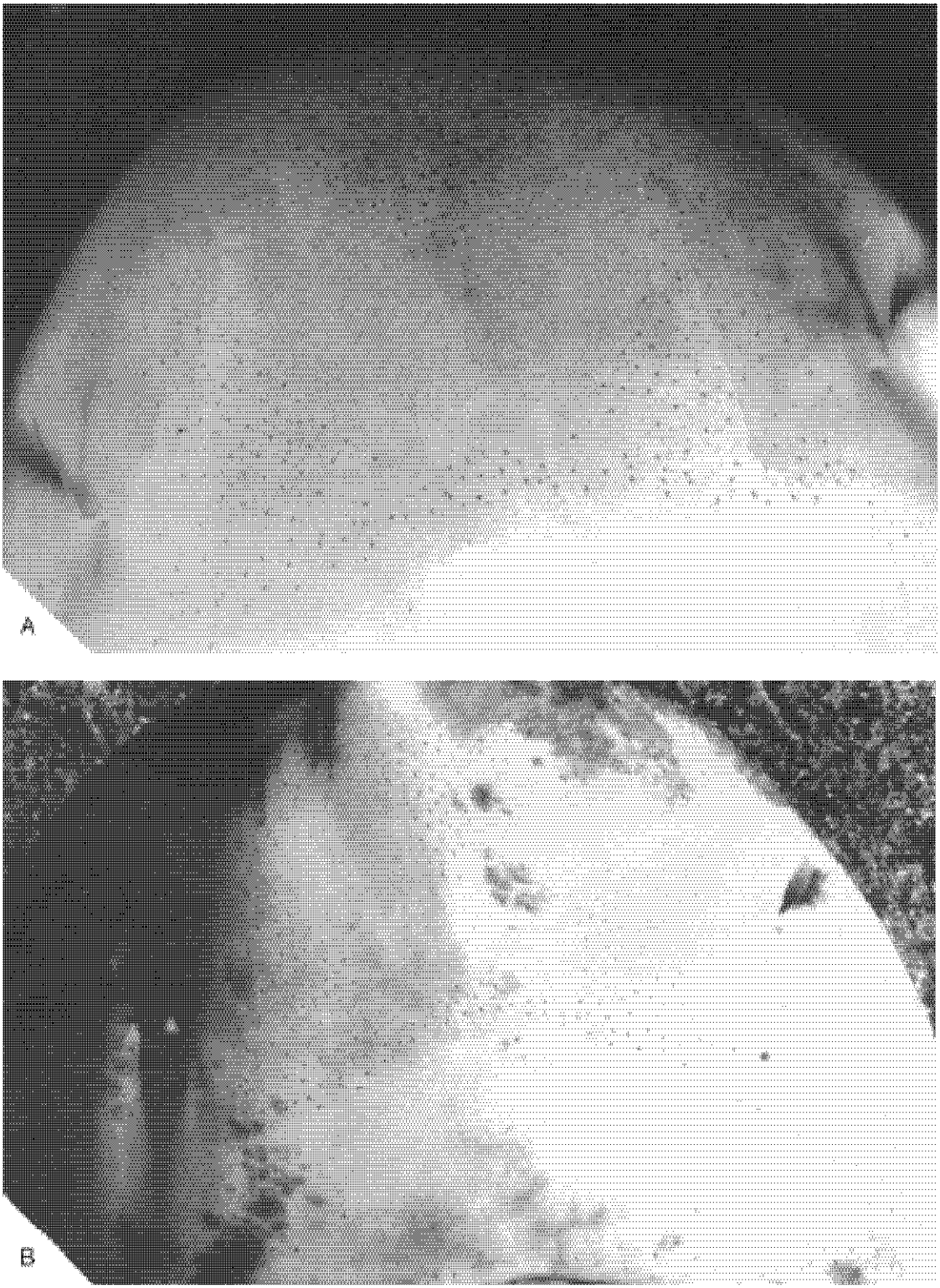

Figure 11. Patterns formed by the ampullae of Lorenzini on the snouts of two sharks: A) *C. menisorrah*; B) *C. galapagensis*.

Figure 12. Ampullae of Lorenzini snout pattern in a second specimen of *C. galapagensis*.

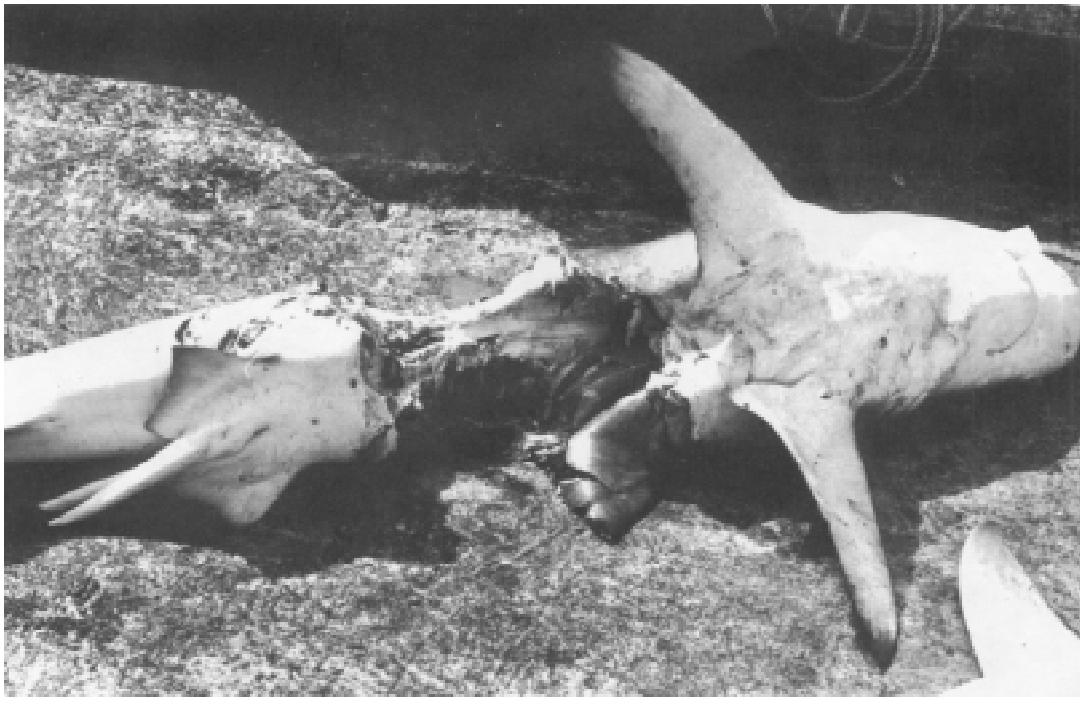

Figure 13. Galapagos shark (*C. galapagensis*) after attack by a tiger shark (*G. cuvieri*).

APPENDIX

(Adapted after Kato, Springer, and Wagner, 1967)

KEY TO FAMILIES OF GUAM SHARKS

1. Sharks with six or seven pairs of gill slits . . . . Hexanchidae

1. Sharks with five pairs of gill 2

   B. Origin of first dorsal fin directly over or behind origin of pelvic fins; fleshy barbel present on inner side of each nostril . . . . Orectolobidae

   2. Origin of first dorsal fin ahead of origin of pelvic fins; rear end of base of first dorsal fin never reaches to a point above the rear end of base of pelvic fins; fleshy barbel absent 3

3. Length of caudal fin about equal to length of body . . . . Alopiidae

3. Length of caudal fin much shorter than length of body, upper lobe of caudal fin more than twice as long as lower lobe, or laser lobe indistinct 4

   4. Head flattened and expanded laterally to form a spade-shaped or hammer-shaped structure . . . . Sphyrnidae

   4. Head not flattened or expanded . . . . Carcharhinidae (Includes *Triaenodon obesus*)

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CHECKLIST OF SHARKS FROM GUAM WITH KEY TO THE CARCHARHINIDAE

Family Hexanchidae – sixgill and sevengill sharks

Hexanchus griseus (Bonnaterre). These sharks have six pairs of gill slits and a single dorsal fin. The upper teeth are narrow and pointed and the lower teeth are broad and saw-like. The mouth is sub-terminal.

Family Orectolobidae – nurse sharks

Ginglymostoma ferrugineum (Lesson). This species differs from other sharks in this family by having angular fin corners.

Family Alopiidae – thresher sharks

Alopias pelagicus (Nakamura). The rear tip of the first dorsal fin terminates considerably anterior to the origin of the pelvic fins. The teeth have central cusps which are strongly oblique.

Family Sphyrnidae – hammerhead sharks

Sphyrna lewini (Cuvier, Griffith and Smith). The first dorsal is erect and not swept backward. There is a notch in the center of the leading edge of the hammer.

Family Carcharhinidae – requiem sharks

1. Spiracles present; sides of trunk in front of tail extended outward to form a low, hard keel; body with dark transverse blotches or stripes, especially prominent in small individuals, but often faded in larger individuals . . . . . *Galeocerdo cuvieri* (Lesueur) (tiger shark)

1. Spiracles absent; sides of trunk in front of tail without a keel; body without dark transverse blotches or stripes 2

    2. Teeth multicuspid, with smaller sharp cusps on one or both sides of the main cusps . . . . . *Triaenodon obesus* (Rüppell) (reef whitetip)

    2. Teeth unicuspid 3

3. Longitudinal ridge absent between the two dorsal fins, back smooth; the backs of preserved or dried specimens sometimes appear ridged 4

3. Longitudinal ridge present on the middle of the back between the two dorsal fins 5

4. Tips of most fins abruptly jet black . . . . . *Carcharhinus melanopterus* (Quoy and Gainard) (reef blacktip)

4. Tips of fins not black; rear margin and lower lobe of caudal fin conspicuously dark . . *Carcharhinus menisorrah* (Müller and Henle) (gray reef shark)

5. Length of free rear tip of second dorsal fin more than twice height of fin; anterior margin of first dorsal fin not high and straight; most upper teeth asymmetrical, with a pronounced notch on one side; dermal denticles small and low, giving the skin a smooth texture . . . . . *Carcharhinus falciformis* (Duller and Henle) (silky shark)

5. Length of free rear tip of second dorsal fin not greater than twice the height; anterior margin of first dorsal fin high and straight; most upper teeth broadly triangular, serrated; dermal denticles not small and low . . . . *Carcharhinus galapagensis* (Snodgrass and Heller) (Galapagos shark)