SHARKS OF THE GENUS *Carcharhinus*

Associated with the Tuna Fishery in the Eastern Tropical Pacific Ocean

Circular 172

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES

ABSTRACT

The nature of the shark problem in the American purse seine fishery for tuna is discussed. Outlined are aspects of the problems that are under study by the Bureau of Commercial Fisheries Biological Laboratory, San Diego, California. A pictorial key, and photographic and verbal descriptions are presented of seven species of sharks of the genus *Carcharhinus* associated with tuna in the eastern tropical Pacific Ocean.

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SHARKS OF THE GENUS *Carcharhinus* ASSOCIATED WITH THE TUNA FISHERY IN THE EASTERN TROPICAL PACIFIC OCEAN

by

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by

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INTRODUCTION

The U.S. tuna fishery in the eastern tropical Pacific Ocean is principally a purse seine operation. Typical vessels have a capacity of 120 to 500 tons of tuna, and the fishery ranges from southern California to northern Chile and offshore several hundred miles. The waters between latitudes 25° N. and 5° S., which are rich in yellowfin and skipjack tunas, are also well supplied with sharks, some species of which appear to be associated with tuna. Although tuna is probably not a major food item for sharks under natural conditions, the purse seining operation makes it simple for sharks to obtain a free meal. When the net is pursed and the tuna are confined in a small bag of net, many become gilled or die of suffocation. It is easy for sharks to feed on these tuna, in the meantime ripping the net so that the entire catch is sometimes lost. Then the boat has to remain idle for several hours or even days while the crew mends the net. Hundreds of tons of fish and much fishing time are lost because of shark attacks. Most of the damage is done by sharks on the outside of the net; those within the net do some damage to the tuna and net, but they suffocate quickly and are troublesome mainly because they slow the net-stacking and brailing operations.

The study of the operations of the tuna fishery and the application of oceanographic and biological findings in improving fishing efficiency are the main functions of the Bureau of Commercial Fisheries Biological Laboratory, San Diego. Because of the widespread problem of sharks, a study of the sharks associated with the tuna purse seine fishery has been undertaken. The objectives of the study are (1) to determine whether shark damage to nets and catch can be reduced, (2) determine the population structure of the species involved, (3) increase our knowledge of the life histories of the pelagic sharks, and (4) compile a check list of the pelagic sharks found in the area of study.

Most of the sharks that are associated with the tuna fishery belong to the genus *Carcharhinus*. These sharks are quite similar in appearance, and it is difficult to differentiate the various species. The main purpose of this paper is to point out, by means of photographs and verbal descriptions, the major differences that characterize the various species. A general account of the shark study being done by the Bureau of Commercial Fisheries at San Diego is also presented.

Figure 1.--Repairing shark damage.

SOME ASPECTS OF THE SHARK STUDY

BIOLOGY OF THE SHARKS

A study of the life histories of sharks includes such aspects as reproduction, growth, food habits, mortality, distribution, and migration. In addition, taxonomy and population dynamics must be investigated. The information collected thus far is presented in the discussion of individual species. Much more data are needed to fill in the many gaps in our knowledge.

It has become clear during the course of our investigation that there is a great need for a thorough study of the classification of the sharks of the eastern Pacific. J. A. F. Garrick of the U.S. National Museum, Smithsonian Institution, is currently working on the taxonomy of carcharhinid sharks on a worldwide basis. The Bureau of Commercial Fisheries is cooperating with Garrick by collecting specimens for him.

A modest tagging program has been initiated to study the migration of sharks. To date, 180 sharks of several species have been tagged at three locations: Islas Revillagigedo, off Guatemala, and off southern Columbia. At the present time we are using strap tags attached to the dorsal fin, with or without a colored vinyl disc (fig. 2) but in the future we may also use dart tags (similar to the tuna tag) or disc tags attached to the dorsal fin.

We have asked the masters of purse seine vessels to record incidents of shark damage to their nets and of sightings of large aggregations of sharks in their logbooks. From these records, obtained through the cooperation of the Inter-American Tropical Tuna Commission, we hope to estimate more accurately the extent of damage to nets and catch and to obtain information on the distribution of sharks. The response has been good, and we have been able to derive some idea of shark distribution (fig. 3) from logbooks covering the first three quarters of 1962. Shark distribution derived from logbook accounts is inextricably tied in with distribution and abundance of tuna, and fishing effort. Blank areas in the figure do not necessarily indicate the absence of sharks, but may be due to absence of fishing effort in those areas. For the same reason, seasonal distribution cannot be determined except for those areas that are fished throughout the year.

SHARK BEHAVIOR

In recent years there has been an increased interest in shark behavior. Scientists in many parts of the world are currently studying the basic behavior patterns of sharks and are carrying on a search for an effective shark repellent. Although their results will be of help in our investigations, we need to experiment with our own species, because shark behavior differs from species to species.

In several preliminary experiments, we tested the effects of various shark repellents on sharks associated with the tuna fishery. These tests involved groups of 10-20 sharks of the following species: *Carcharhinus malpeloensis* (net-eater shark), *C. limbatus* (blacktip shark), *C. galapagensis* (galapagos shark), and *C. platyrhynchus* (silvertip shark). These are the sharks commonly found in the tuna fishing areas. In all tests, sharks were first attracted by chumming with bits of tuna flesh. After a number of individuals had assembled, a piece of bait "protected" by a repellent was offered to the sharks. The repellents used were: (1) liquid and cakes of the commercial "Shark Chaser" (a mixture of black dye and copper acetate), (2) fluorescein dye, (3) "bluestone" (copper sulfate), (4) "cherry bombs" (small explosives), (5) underwater sounds of various frequencies (100 to 60,000 c.p.s.), and (6) a flashing 1000-watt underwater lamp. None of these repellents were effective in preventing sharks from taking the bait. Bluestone, however, showed some indication of lessening the feeding activity of the sharks. It is well known that sharks are difficult to control when stimulated by food. Although our results thus far have been negative, more tests will have to be made before we can be certain of the effects of the various repellents.

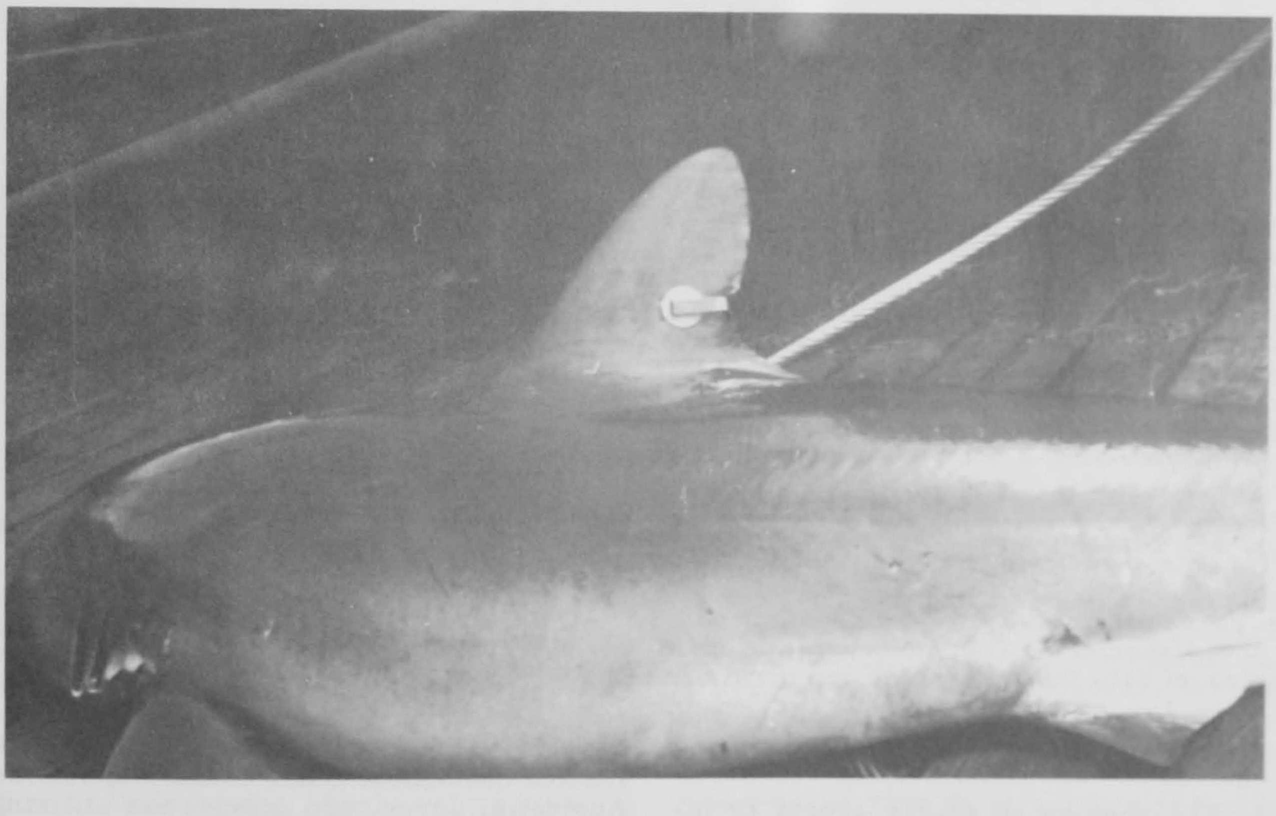

Figure 2.--Shark tagged with a Monel metal strap tag and a colored vinyl disc.

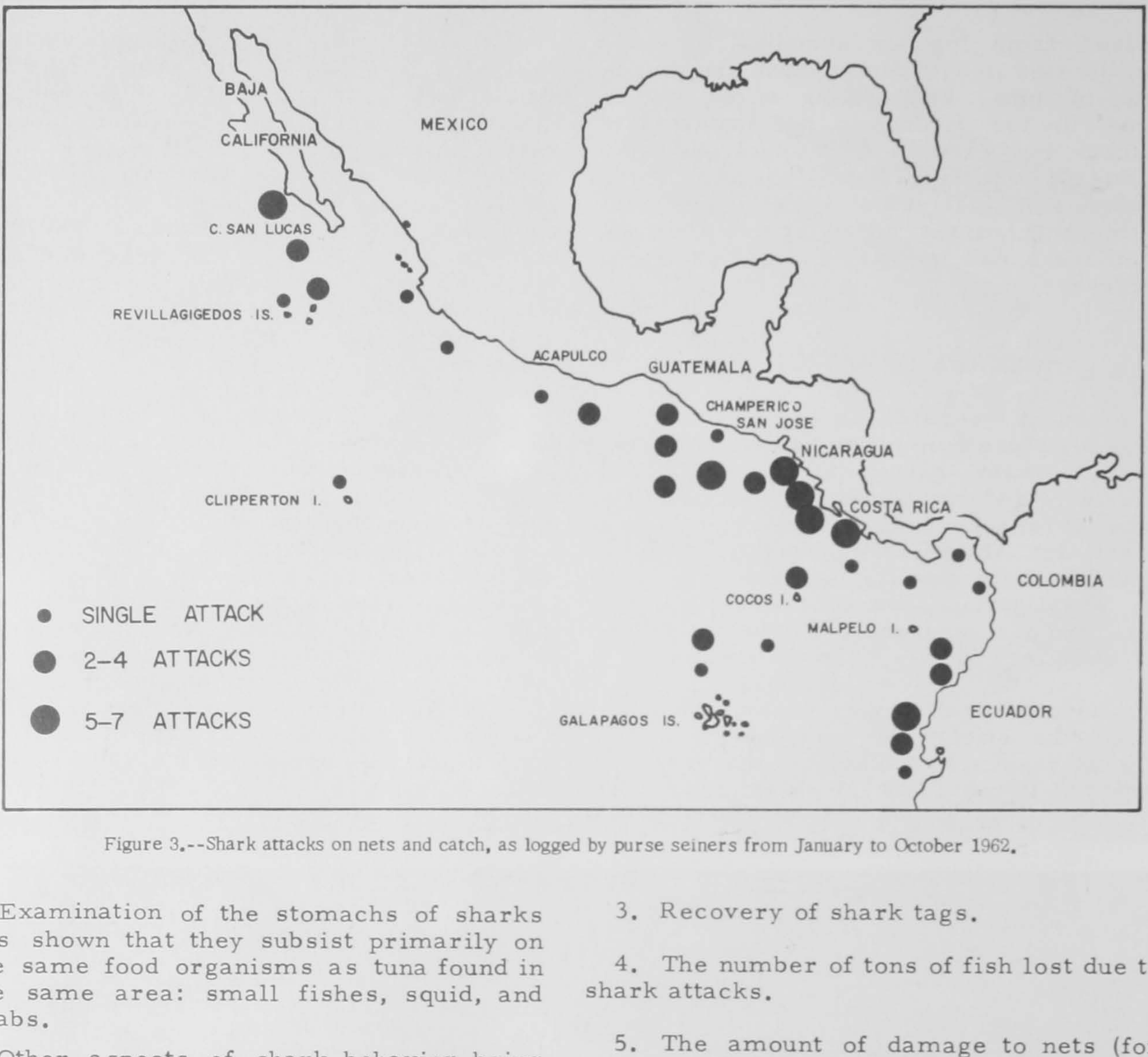

Figure 3.--Shark attacks on nets and catch, as logged by purse seiners from January to October 1962.

Examination of the stomachs of sharks has shown that they subsist primarily on the same food organisms as tuna found in the same area: small fishes, squid, and crabs.

Other aspects of shark behavior being studied are: (1) The nature of the shark-tuna association, (2) influence of other factors in their distribution, e.g., water temperature, species of tunas and food organisms present, other oceanographic and biological variables, and (3) patterns in their behavior.

AID OF FISHERMEN NEEDED

To obtain adequate data on the populations of sharks that are associated with the purse seine fishery, we need the aid of the fishermen. The following are examples of data that fishermen can provide:

1. The number (or tons) of sharks caught in individual sets.

2. The species of sharks caught or involved in attacks.

3. Recovery of shark tags.

4. The number of tons of fish lost due to shark attacks.

5. The amount of damage to nets (for example, how many man-hours are spent mending nets).

Such information, if kept by fishermen in their logbooks, will be of invaluable assistance in our investigation.

ECONOMIC IMPORTANCE OF SHARKS

The economic potential of sharks lies in the diversity of products that can be marketed: (1) flesh, for fresh fillet, dried meat, and meal, (2) teeth, for curios, (3) fins, for Chinese soups, (4) hide, for leather, and (5) liver, for vitamin A and oils.

These shark products are marketed at present in the United States, though in limited quantities. Other countries, such as Australia, Japan, and Mexico are utilizing sharks to a much greater extent. As the world's population increases rapidly, there will be continuing pressure for new sources of protein. Recent stress on the importance of fish protein concentrate or "fish flour", which uses species of fish that are now underutilized, supports this view. It is possible to reduce shark flesh to fish flour, or to use the flesh as fresh or salted fillets. Further, shark fins, livers, oils, and skins still have some commercial value. If the entire shark could be utilized, it might be economically feasible for U.S. fishermen to again fish for sharks.

Sharks are now important to the U.S. tuna fishermen only because they are detrimental to the fishery. The problem could possibly be lessened if a shark fishery were operating on tuna fishing grounds. Population control by fishing, or some other means such as selective poisoning, may be a practical way of reducing shark damage. A graphic example is the history of the "school shark" *(Galeorhinus australis)* in Australia. A steady decline in catch has been attributed to heavy fishing pressure, the effect of which was magnified by the shark's late sexual maturity, slow growth rate, low fecundity, and homogeneous population structure (Olsen, 1959). Similarly, the "soupfin shark" *(Galeorhinus zyopterus)* fishery in California, the "dogfish" *(Squalus suckleyi)* fishery in British Columbia, and the shark control program of the State of Hawaii's Division of Fish and Game all showed declines in catch that were probably due to fishing pressure (see Ripley, 1946, Barraclough, 1953, and Ikehara, 1961).

The immediate effects of a shark control program depend on the nature of the populations of sharks. If little or no migration occurs into a particular area, heavy fishing should lower the standing population quickly. The long-term effects are more difficult to forsee, but because of the low fecundity of sharks, a sustained fishing effort would probably keep the population at a low level.

A GUIDE TO SHARKS OF THE GENUS CARCHARHINUS ASSOCIATED WITH THE PURSE SEINE FISHERY IN THE EASTERN TROPICAL PACIFIC OCEAN

The correct identification of sharks is essential to our study. Further, it is necessary to have some means for fishermen and other observers to learn the names of the sharks if we are to benefit fully from their observations. The recognition of the different species is difficult for the casual observer. This is especailly true for sharks of the genus *Carcharhinus* which includes most of the sharks found in the tuna fishing areas.

The purpose of this guide is to provide a simple means of identifying sharks of the genus *Carcharhinus* that are associated with tuna in the eastern tropical Pacific Ocean. It is by no means a complete list of all sharks associated with the fishery, or of all sharks of the genus *Carcharhinus* found in the eastern Pacific. For example, the hammerhead and thresher sharks, which are not members of this genus, are fairly common in the fishery; however, these sharks are so easily recognized that it was considered unnecessary to include them. Undoubtedly, further investigation will require the addition of more sharks to our list.

The genus *Carcharhinus* is represented by at least 11 species in the eastern Pacific. Four of these have not yet been found in the tropical tuna fishing grounds and are not treated fully in this paper. The remaining seven which are described here have all been caught by purse seine fishermen. They are: *Carcharhinus altimus* (bignose), *C. azureus* (pigeye), *C. galapagensis* (galapagos), *C. lamiella* (bay), *C. limbatus* (blacktip), *C. malpeloensis* (net-eater), and *C. platyrhynchus*. (silvertip). The scientific names are those used by Rosenblatt and Baldwin (1958). These names are in a state of revision, and at least five *(C. azureus, C. lamiella, C. limbatus, C. malpeloensis*, and *C. platyrhynchus* are likely to be changed in the near future (Garrick, personal communication). The common names "bignose", "bay", and "blacktip" are those listed by the American Fisheries Society (1960). "Pigeye", "net-eater", and "silvertip" were coined because they are appropriate. The name "silvertip" is preferable to "whitetip" which is commonly used by fishermen when referring to *C. platyrhynchus* This is to avoid confusion with *C. longimanus*, an oceanic species whose common name is "whitetip shark".

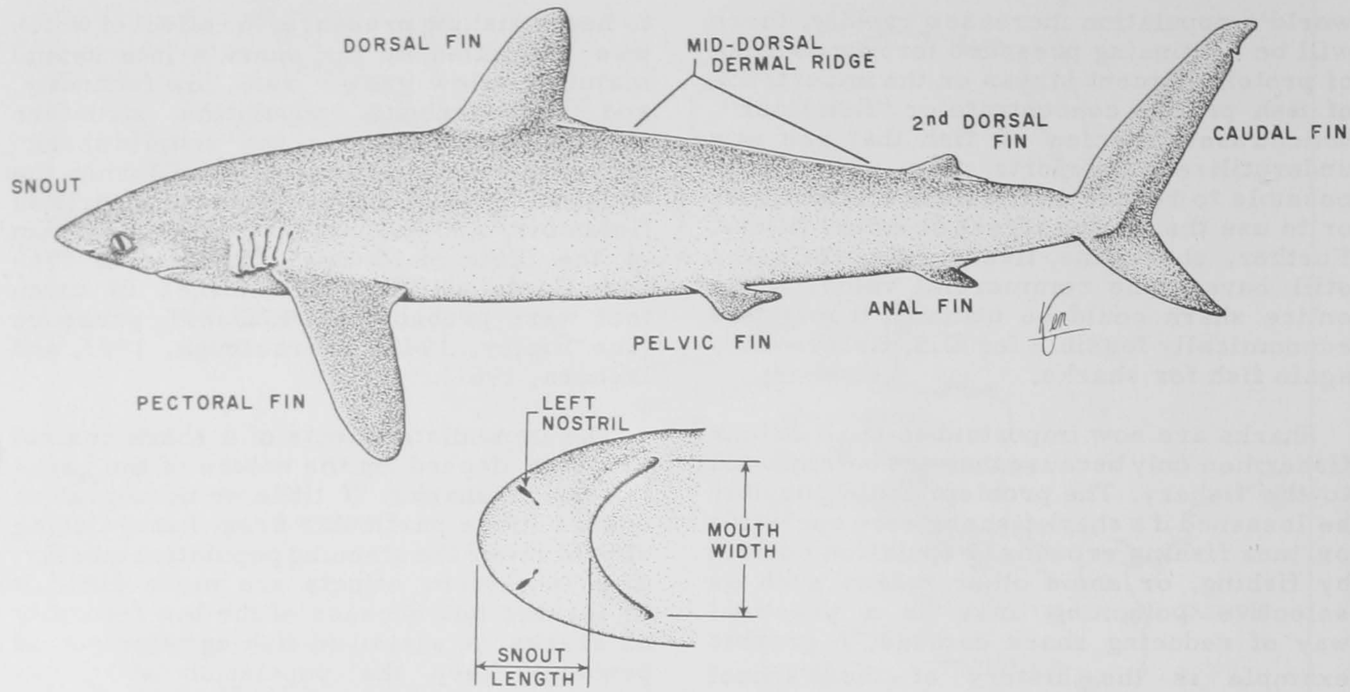

Figure 4.--Illustration of terms used in the description of sharks.

INTRODUCTION TO THE USE OF THE KEY

A standard procedure for determining the specific name of an animal is the use of a dichotomous key. This is simply an outline of distinctive characters presented as a series of opposing pairs. The user chooses one of two descriptions, the one that fits the animal, and through a step by step process of elimination obtains the name of the animal. Our key is designed to identify only the seven species of the genus *Carcharhinus* that are known to occur in the tuna fishery. Rosenblatt and Baldwin (1958) describe four other species, *C. remotus, C. porosus, C. velox,* and *C. longimanus,* that are found in the eastern Pacific. Of these, the first three will fit under *C. limbatus* in our key and are discussed under that species. *C. longimanus* is discussed under *C. platyrhynchus* because both sharks have white-tipped fins. It will be extremely helpful if fishermen bring back specimens or photographs of sharks (other than the hammerheads, threshers, and tiger sharks) which do not correspond to any of the descriptions given in the key. It is probable that such sharks are still unknown to science.

The characters used to describe and differentiate the seven sharks are diagrammed in figures 4 and 5. Most of the characters are self-explanatory. The "mid-dorsal dermal ridge", a raised or pinched line of skin extending nearly all the way between the first and second dorsal fins, is a very useful character in differentiating the species of the genus *Carcharhinus*. It may be extremely prominent, as in the bignose shark, where it is notably broad and high, or much less noticeable, as in the net-eater shark, where it is narrow and low. It can always be felt with the fingertips, however. About half of all the species of *Carcharhinus* have a dermal ridge, but five of the seven described here have this charasteristic.

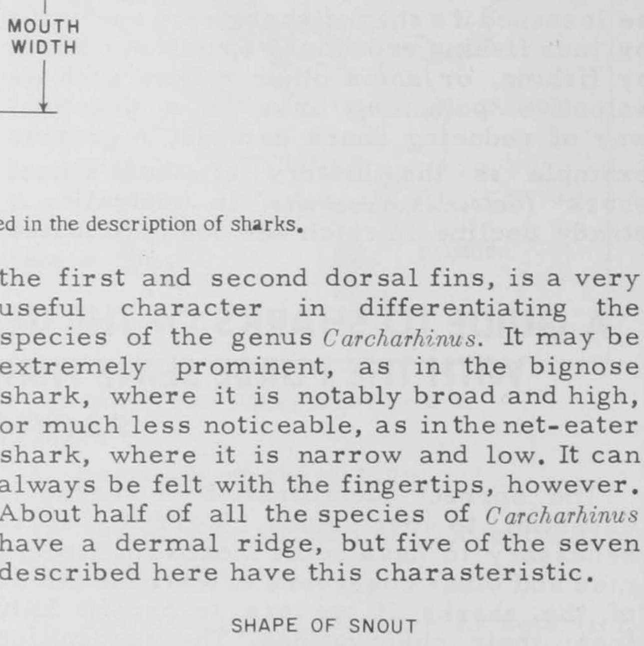

Figure 5.--Typical head and tooth shapes of sharks.

KEY TO SHARKS OF THE GENUS *Carcharhinus* ASSOCIATED WITH THE TUNA FISHERY IN THE EASTERN TROPICAL PACIFIC OCEAN

1. Back of shark smooth, no mid-dorsal dermal ridge between the 1st and 2nd dorsal fins . . . . see 2.

1a. Mid-dorsal dermal ridge present between the 1st and 2nd dorsal fins . . . . . . see 3.

2. Snout pointed as in figure 6; tips of fins plain or dusky in adults, black-tipped in juveniles. . . . . *C. limbatus* (blacktip shark).

2a. Snout extremely blunt as in figure 7; mouth width about 2.2 times the snout length; fin tips plain . . . . *C. azureus* (pigeye shark).

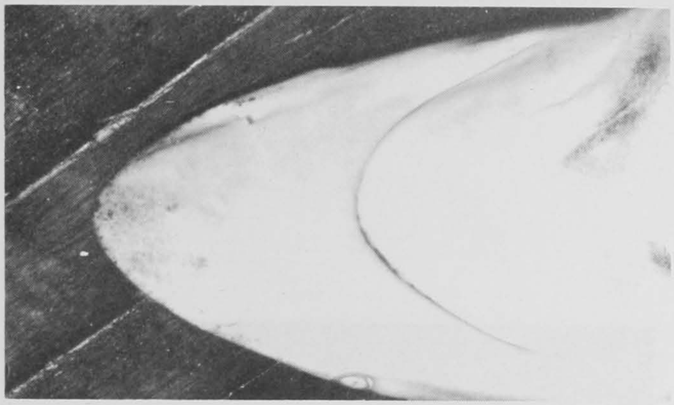

Figure 6.--Snout of blacktip shark.

Figure 7.--Snout of pigeye shark.

3. Tips of dorsal and pectoral fins white (fig. 8) . . . . . . *C. platyrhynchus* (silvertip shark).

3a. Tips of dorsal and pectoral fins not white . . . . see 4.

4. Snout broadly rounded as in figure 9; mouth width about 1.6 times greater than the snout length as in figure 10 . . . . see 5.

4a. Snout more narrowly rounded as in figure 11; mouth width only about 1.3 times greater than the snout length *(C. malpeloensis)* as in figure 12, or snout length greater than mouth width *(C. altimus)* . . . . see 6.

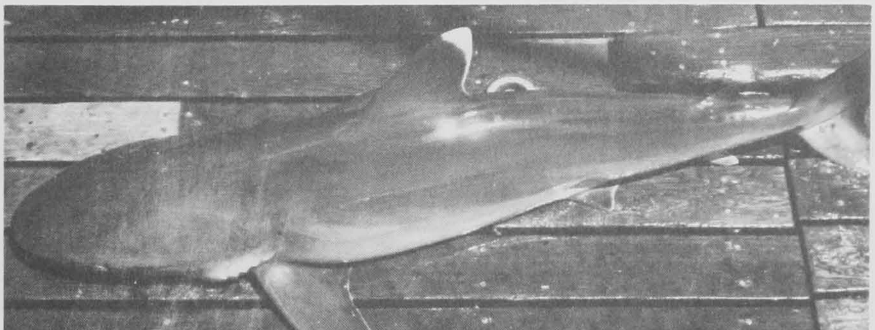

Figure 8.--Silvertip shark.

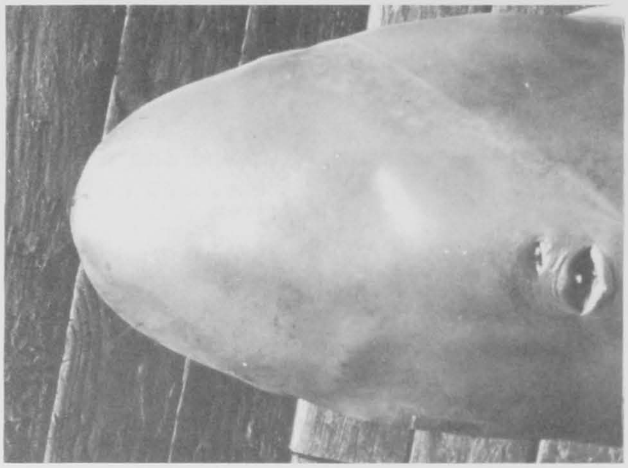

Figure 9.--Shark with a broadly rounded snout, dorsal view.

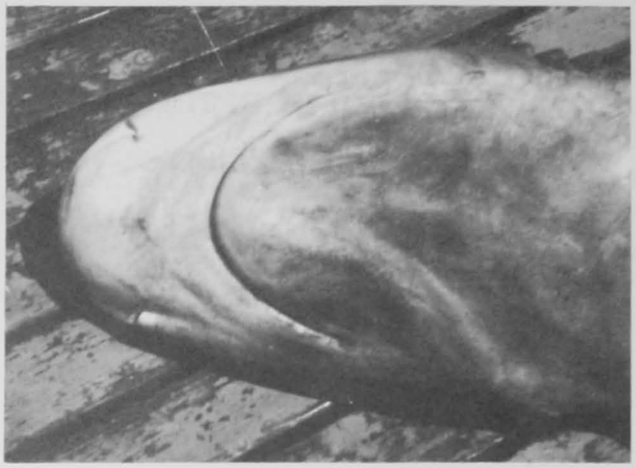

Figure 10.--Shark with a broadly rounded snout, ventral view.

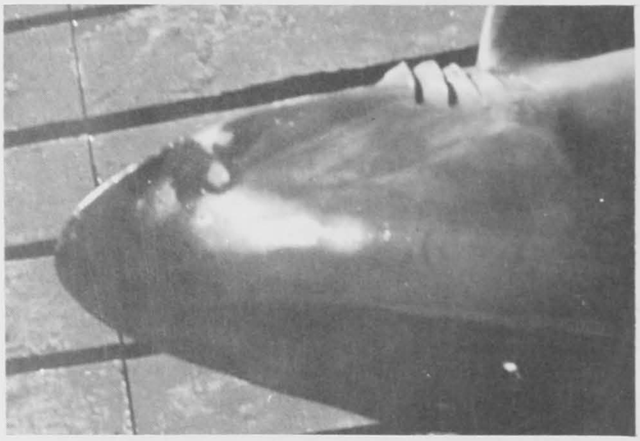

Figure 11.--Shark with a narrowly rounded snout, dorsal view.

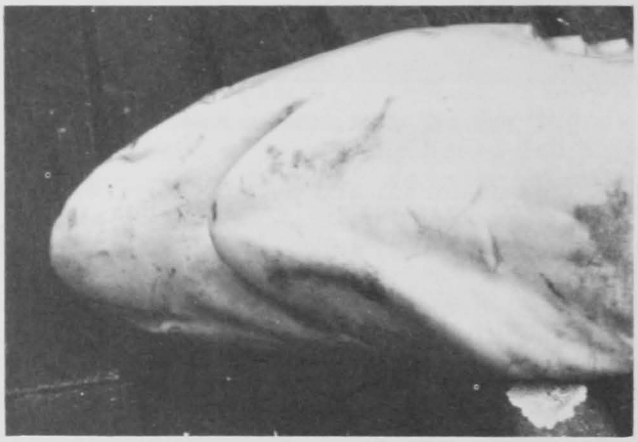

Figure 12.--Shark with a narrowly rounded snout, ventral view.

5. First dorsal fin somewhat narrow; front edge of the 1st dorsal fin only slightly curved, as in figure 13 . . . . *C. galapagensis* (galapagos shark).

5a. First dorsal fin broader; front edge of the 1st dorsal fin strongly curved, as in figure 14 . . . .*C. lamiella* (bay shark).

6. Front margin of each nostril almost straight, as in figure 15; posterior edge of 1st dorsal fin curved near the apex, as in figure 16; mouth width about 1.3 times greater than the snout length . . . . *C. malpeloensis* (net-eater shark).

6a. Front margin of each nostril with a prominent narrow lobe as in figure 17; posterior edge of the 1st dorsal fin almost straight near the apex, as in figure 18; snout length greater than mouth width . . . . *C. altimus* (bignose shark).

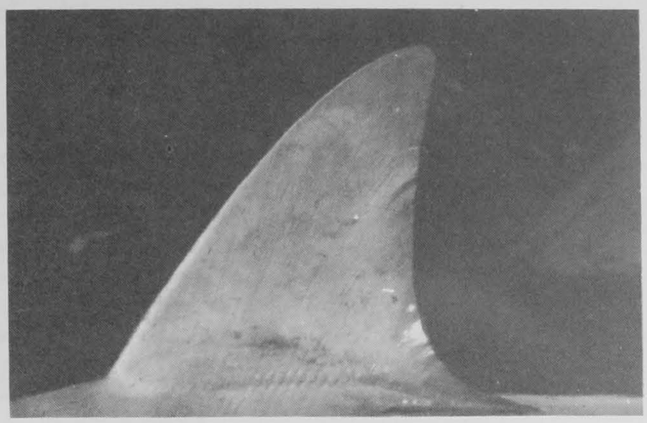

Figure 13.--Dorsal fin of galapagos shark.

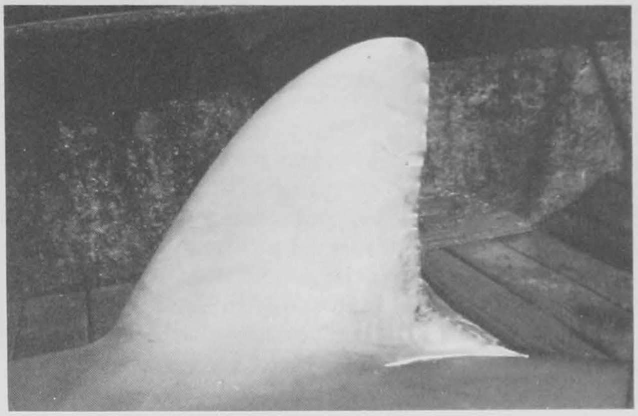

Figure 14.--Dorsal fin of bay shark.

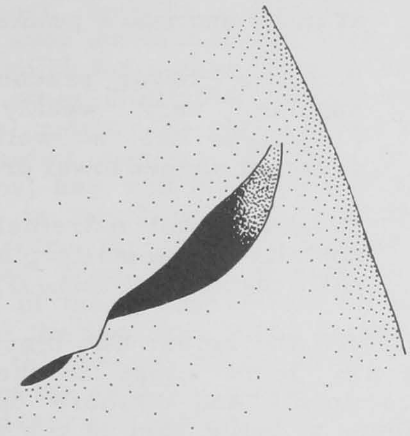

Figure 15.--Left nostril of net-eater shark.

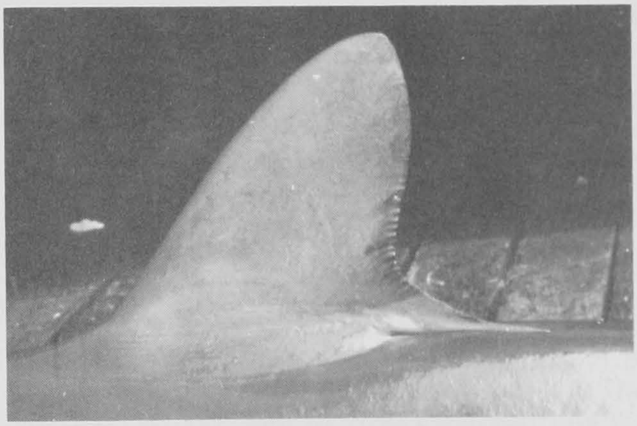

Figure 16.--Dorsal fin of net-eater shark.

Figure 17.--Left nostril of bignose shark, showing lobe.

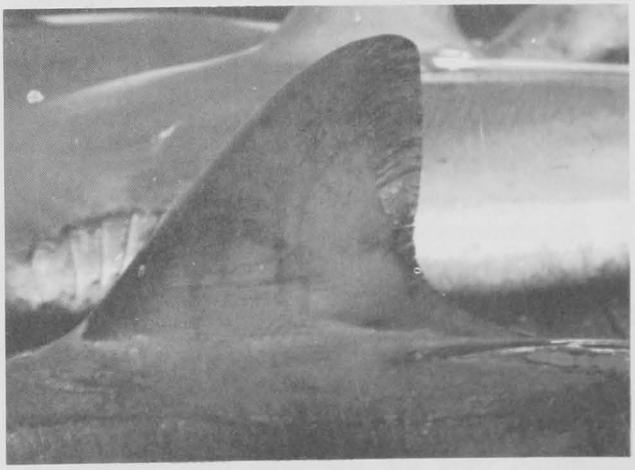

Figure 18.--Dorsal fin of bignose shark.

DESCRIPTIONS AND NOTES

Descriptions of the sharks given in the following pages are mainly derived from our own observations. They are applicable to adult or near-adult sharks only, except for *C. limbatus* whose juvenile coloration is discussed. We have not used descriptions given by other workers because of the confusion in nomenclature and because much of the literature is based on embryonic or juvenile sharks. As more data are obtained and the snarl in nomenclature is untangled, the accounts will undoubtedly be modified.

Blacktip shark, *Carcharhinus limbatus* (Müller and Henle)

1. Mid-dorsal dermal ridge absent.

2. Snout very pointed; mouth width slightly greater than the snout length.

3. Front teeth of upper jaw narrowly triangular; 29-31 teeth in outer row of upper jaw, 29-30 in lower (3 specimens).

4. Pectoral fins small and triangular, sharply pointed at tip.

5. First dorsal fin high, free rear tip short.

6. Body somewhat compact, noticeably arched anterior to the 1st dorsal fin; common sizes encountered about 5-6 feet.

7. Color of upper surface from a brownish-gray to a distinct bronze sheen; undersides white; a band of white along the midlevel of the side from the pelvic fin forward to below the 1st dorsal fin; juveniles with distinct black tips on all fins; in adults the black has usually faded from the anal fin tip, and is less prominent on the other fins except for the undersides of the pectoral and pelvic fin tips.

8. Distinctive characters: The blacktip and pigeye sharks are the only two sharks found in the tuna fishing grounds to date that do not have a dermal ridge between the dorsal fins. However, it should be noted that the blacktip may sometimes have a line between the fins that resembles a dermal ridge. Inspection by touch will reveal that the line is caused by a slight <u>indentation</u> rather than a ridge of skin. The blacktip, with its pointed snout and narrowly triangular teeth, is easily distinguished from the pigeye, which has a blunt snout and broadly triangular teeth. Three other sharks of the genus *Carcharhinus* found in the eastern Pacific, but not in the tuna fishing grounds, have the key characters of *C. limbatus:* lack of a mid-dorsal ridge and possession of a pointed snout. The following partial descriptions, from Rosenblatt and Baldwin (1958) will serve to distinguish these sharks from *C. limbatus:*

   C. porosus: origin of second dorsal about over the middle of the base of the anal fin (in *C. limbatus* both fins are about opposite each other); anterior margin of nostril expanded at inner end into a pointed lobe.

   C. remotus: lower precaudal pit triangular, very weakly developed (*C. limbatus* has a well-developed, crescent shaped lower precaudal pit).

   C. velox: snout extremely elongate; nostrils horizontally placed (diagonally placed in *C. limbatus*).

9. Habits and notes: The blacktip is generally found close to the shores of continents and offshore islands. They form a large part of the catch of the shark fisheries in Manzanillo and Mazatlan, Mexico. It is also abundant in the shrimp-fishing grounds off Costa Rica, where it harrasses the shrimpers by tearing holes in their trawls. Many blacktips are caught by purse seine fishermen on the shallow banks off Ecuador, where this species apparently replaces the net-eater in being the most abundant. Most of the blacktips taken by purse seiners are of adult size. The juveniles are probably found farther inshore.

Pigeye shark, *Carcharhinus azureus* (Gilbert and Starks)

1. Mid-dorsal dermal ridge absent.

2. Snout very blunt; mouth width about 2.2 times the snout length (7 specimens).

3. Front teeth of upper jaw large, broadly triangular; 25-28 teeth in outer row of upper jaw, 23-26 in lower jaw (7 specimens).

4. Pectoral fins long, wide near base, tapering to sharp point at tip.

5. First dorsal fin with a wide base; posterior edge sickle-shaped, anterior edge straight, free rear tip short.

6. Body very stocky; eight specimens captured were $6\frac{1}{2}$ - $9\frac{1}{2}$ feet in length, 235-430 pounds in weight.

7. Color of dorsal surface brownish-gray, sometimes with tiny blue spots; sides light gray; ventral surface yellowish-white; undersides of pectoral and pelvic fin tips white to dusky.

8. Distinctive characters: The extremely blunt snout, broadly triangular teeth, and tiny eyes set in a stocky head serve to distinguish the pigeye from the blacktip, the other shark that does not have a dermal ridge. The shape of the snout is somewhat similar to those of the galapagos, bay, and silvertip sharks. In addition to the lack of a mid-dorsal dermal ridge, the pigeye is further distinguished from these sharks by the position of the second dorsal fin in relation to the anal fin: in the pigeye, the base of the second dorsal starts ahead of that of the anal fin, while in all other sharks described herein, except *C. altimus*, the bases of both fins are positioned about opposite each other.

9. Habits and notes: The pigeye shark is comparatively rare in the tuna fishery. Its habitat is generally in the shallow waters of bays and estuaries, although it has been caught by purse seine fishermen off Corinto, Nicaragua. One specimen, caught by the purse seine vessel *West Point*, had five skipjack, half of a hammerhead shark, and a square yard of netting in its stomach. Our specimens were caught in and near Costa Rican bays. The pigeye is reputed to have attacked bathers at Mazatlan, Mexico.

Silvertip shark, *Carcharhinus platyrhynchus* (Gilbert)

1. Mid-dorsal dermal ridge present.

2. Snout broadly rounded; mouth width about 1.6 times the snout length (2 specimens).

3. Front teeth of upper jaw large, broadly triangular; 27-28 teeth in outer row of upper jaw, 25-27 in lower jaw (2 specimens).

4. Pectoral fins long and somewhat slender.

5. First dorsal fin high; both anterior edge and upper part of posterior edge usually straight; free rear tip moderately long.

6. Body somewhat stocky; common lengths encountered about 6 - $7\frac{1}{2}$ feet.

7. Color: Dorsal surface usually with a reddish-brown tinge, sometimes bronze; sides light reddish-brown fading into steel blue; undersides white; at least the first dorsal and pectoral fins, and usually all other fins also, with white tips; the second dorsal fin may be black-tipped.

8. Distinctive characters: The color of the fin tips immediately distinguishes the silvertip shark from all other described in this manual. Another shark which has this same characteristic is the "oceanic whitetip" shark, *C. longimanus*. Though common in the central Pacific, the oceanic whitetip appears to be rare in the eastern Pacific and has not yet been reported from the U.S. tuna purse seine fishing grounds. The two sharks can be readily distinguished because the silvertip has pointed pectoral and first dorsal fins, whereas the whitetip's are broadly rounded and extremely long.

9. Habits and notes: We have found large aggregations of silvertips close to the offshore islands of Islas Revillagigedo, Las Tres Marias, and Isla del Cocos. Purse seiners report that this species is one that attacks and damages seines and tuna.

Galapagos shark, *Carcharhinus galapagensis* (Snodgrass and Heller)

1. Mid-dorsal dermal ridge present.

2. Snout broadly rounded; mouth width about 1.6 times the snout length (5 specimens).

3. Front teeth of upper jaw large, broadly triangular; 29-32 teeth in front row of upper jaw, 27-31 in lower jaw (4 specimens).

4. Pectoral fins long, wide at base narrowing to sharp point at the tip.

5. First dorsal fin rather high, somewhat narrow; upper part of posterior edge straight, anterior edge nearly straight, but slightly curved at the tip; free rear tip moderately long.

6. Body somewhat stocky, but not as stocky as the pigeye shark; common lengths encountered about $7\frac{1}{2}$ - 9 feet; an 8-foot specimen weighed 175 pounds, a 9-foot specimen 285 pounds.

7. Color: Dorsal surface and sides plain brownish-gray, sometimes with greenish tinge; sides light gray with metallic green tinge; ventral surface yellowish white; undersides of pectoral fin tips dusky to dark.

8. Distinctive characters: The galapagos shark is very similar in appearance to the bay shark. The only overt difference appears to be in the shape of the first dorsal fin: the galapagos shark has a high and somewhat narrow first dorsal, with the anterior edge nearly straight, except near the tip which is curved; the first dorsal of the bay shark is somewhat lower, and is considerably curved on the anterior edge (see figures 13 and 14).

9. Habits and notes: The galapagos shark is commonly caught by purse seiners between Guatemala and Ecuador. It is probably the third most abundant shark associated with the fishery, and is known to attack tuna caught in the seine. This species is also found very close to the shores of offshore islands (Islas Revillagigedo, Isla del Cocos) and is occasionally caught by shark fishermen near Mazatlan.

Bay shark, *Carcharhinus lamiella* (Jordan and Gilbert)

1. Mid-dorsal dermal ridge present.

2. Snout broadly rounded; mouth width about 1.6 times the snout length (1 specimen).

3. Front teeth of upper jaw large, broadly triangular; 29-33 teeth in outer row of upper jaw, 27-32 in lower jaw (Garrick, personal communication).

4. Pectoral fins long, wide at base narrowing to sharp point at the tip.

5. First dorsal fin broad and high, anterior edge definitely curved, somewhat like a small arc of a circle.

6. Body somewhat stocky, but not as stocky as the pigeye shark.

7. Color: Dorsal surface brownish-gray to dark gray; undersides white.

8. Distinctive characters: The only overt difference between bay and galapagos sharks appears to be in the shape of the first dorsal fin (see item 8 under *C. galapagensis*).

9. Habits and notes: We have caught only a few individuals of this species, all over 7 feet, in the tuna fishing grounds. Bay sharks may be more common in shallow coastal waters. As its common name indicates, it has been found in bays.

Net-eater shark, *Carcharhinus malpeloensis* (Fowler)

1. Mid-dorsal dermal ridge present.

2. Snout narrowly rounded, neither sharply pointed nor very blunt; mouth width about 1.3 times the snout length (16 specimens).

3. Front teeth of upper jaw notched; 31-36 teeth in outer row of upper jaw, 32-36 in lower jaw (15 specimens).

4. Pectoral fins long and slender, not triangular.

5. First dorsal fin somewhat low and narrow; posterior edge curved near the tip, not abruptly vertical; free rear tip very long.

6. Body slender; of nearly 600 individuals caught, most were about 6 - $6\frac{1}{2}$ feet in length and 75-110 pounds in weight.

7. Color: Dorsal surface dark brown to dark gray, pectoral fins noticeably darker; sides metallic gray with greenish tinge; ventral surface white, except for dusky to dark tips on the pectoral and pelvic fins; color variant, rarely found, with light mottling over the entire dorsal surface.

8. Distinctive characters: The notched teeth, shape of the first dorsal and pectoral fins, and lobe-less nostrils distinguishes the net-eater shark from the bignose, which is another shark with a narrowly rounded snout.

9. Habits and notes: The net-eater is the most abundant shark associated with tunas and it is probably the most destructive to seines and catch. Of 570 sharks taken on the purse-seiner *Royal Pacific* between Guatemala and Ecuador in February-March 1962, about 500 were of this species. This species is also found close to offshore islands (Islas Revillagigedo, Las Tres Marias, Isla del Cocos).

Bignose shark, *Carcharhinus altimus* (Springer)

1. Mid-dorsal dermal ridge present, very prominent.

2. Snout narrowly rounded, elongated; width of mouth only 0.86 times the snout length (2 specimens).

3. Front teeth of upper jaw broadly triangular.

4. Pectoral fins large, broad at base narrowing to sharp point at tip.

5. First dorsal fin high; upper half of the posterior edge only slightly curved, abruptly vertical at the tip; free rear tip moderately long.

6. Body stocky, especially near the midsection.

7. Color: Dorsal surface a distinct bronze-gray, undersides dirty grayish-white.

8. Distinctive characters: The mid-dorsal ridge of this species is much better developed than in any other shark described in this manual. In addition, the bignose has a distinct bronze color, an elongated snout and a long lobe on the nostril. Also, the base of the second dorsal fin is slightly ahead of that of the anal.

9. Habits and notes: This shark had not been reported from the eastern tropical Pacific until 1962. In March of that year, five specimens were caught in a single set by the purse seiner *Royal Pacific* off Tumaco, Colombia. In August 1962, six females and one male of this species were caught on hook and line off Roca Partida, Islas Revillagigedo, from the purse seiner *West Point*. The bignose appears to be more active at night than during the day.

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J. A. F. Garrick of the U.S. National Museum, Smithsonian Institution, kindly identified our sharks, allowed us to use his drawings (figures 15 and 16) and critically reviewed the manuscript. Kenneth S. Raymond prepared figure 4.

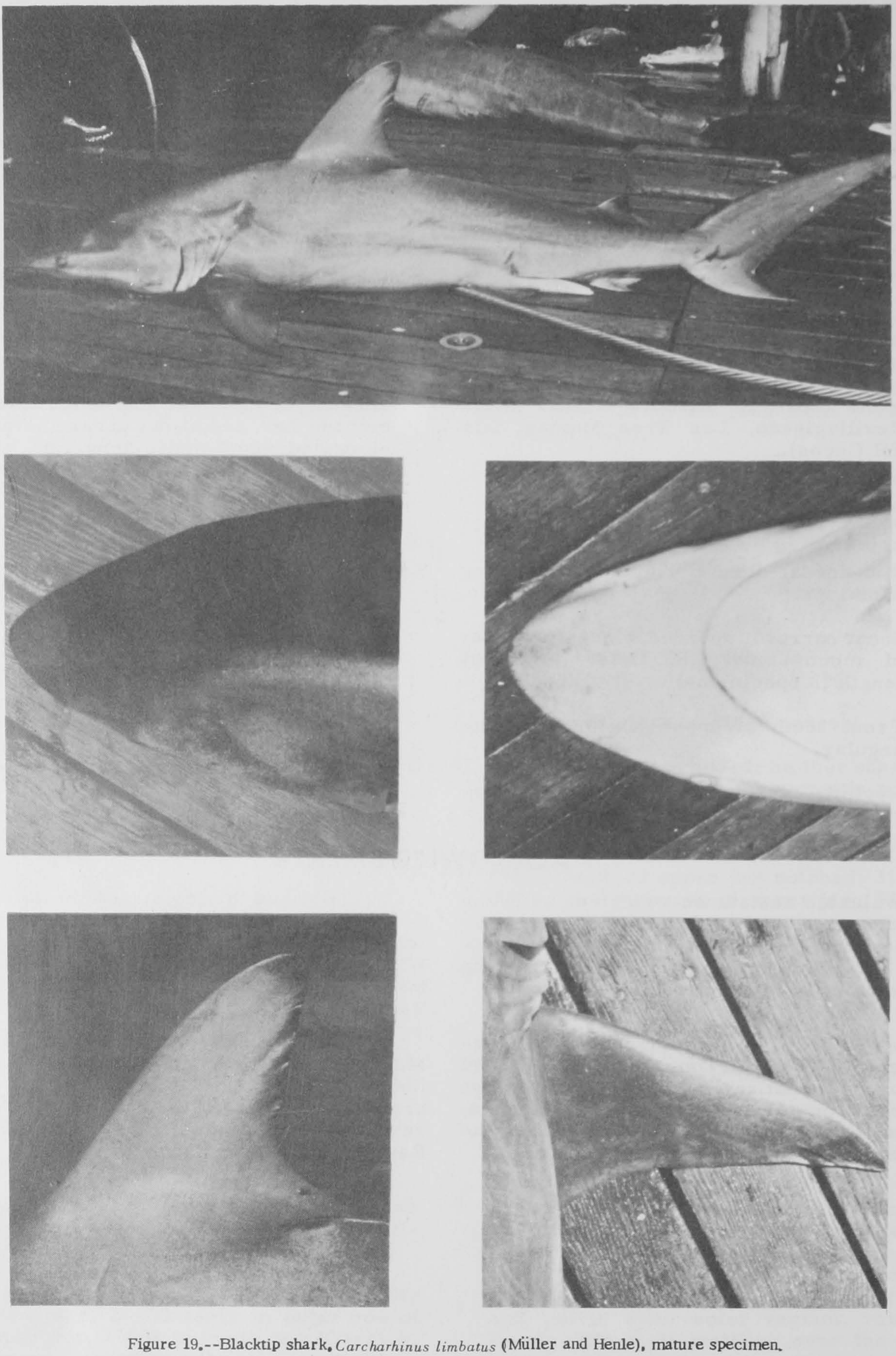

Figure 19.--Blacktip shark, *Carcharhinus limbatus* (Müller and Henle), mature specimen.

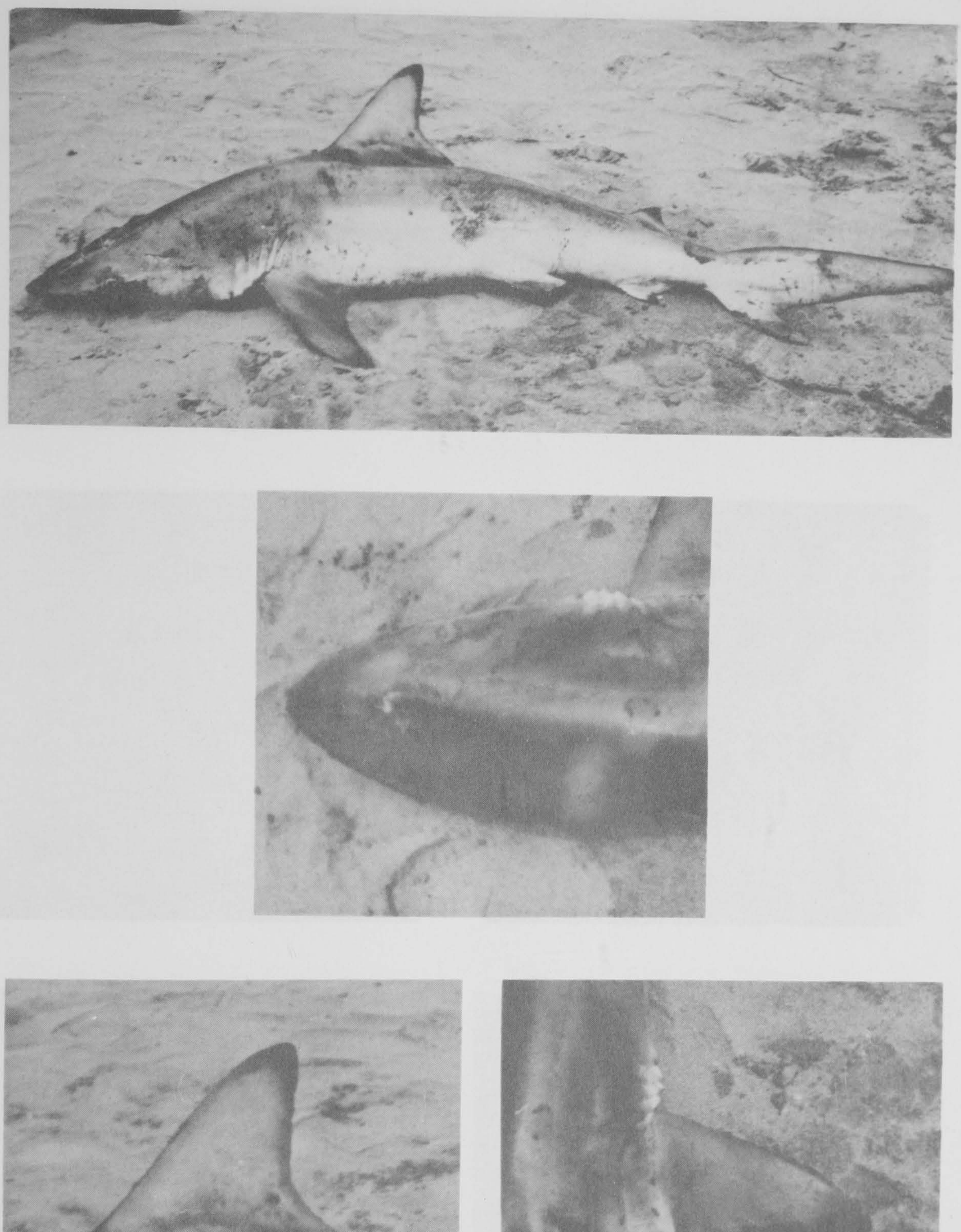

Figure 20.--Blacktip shark, *Carcharhinus limbatus* (Müller and Henle), immature specimen.

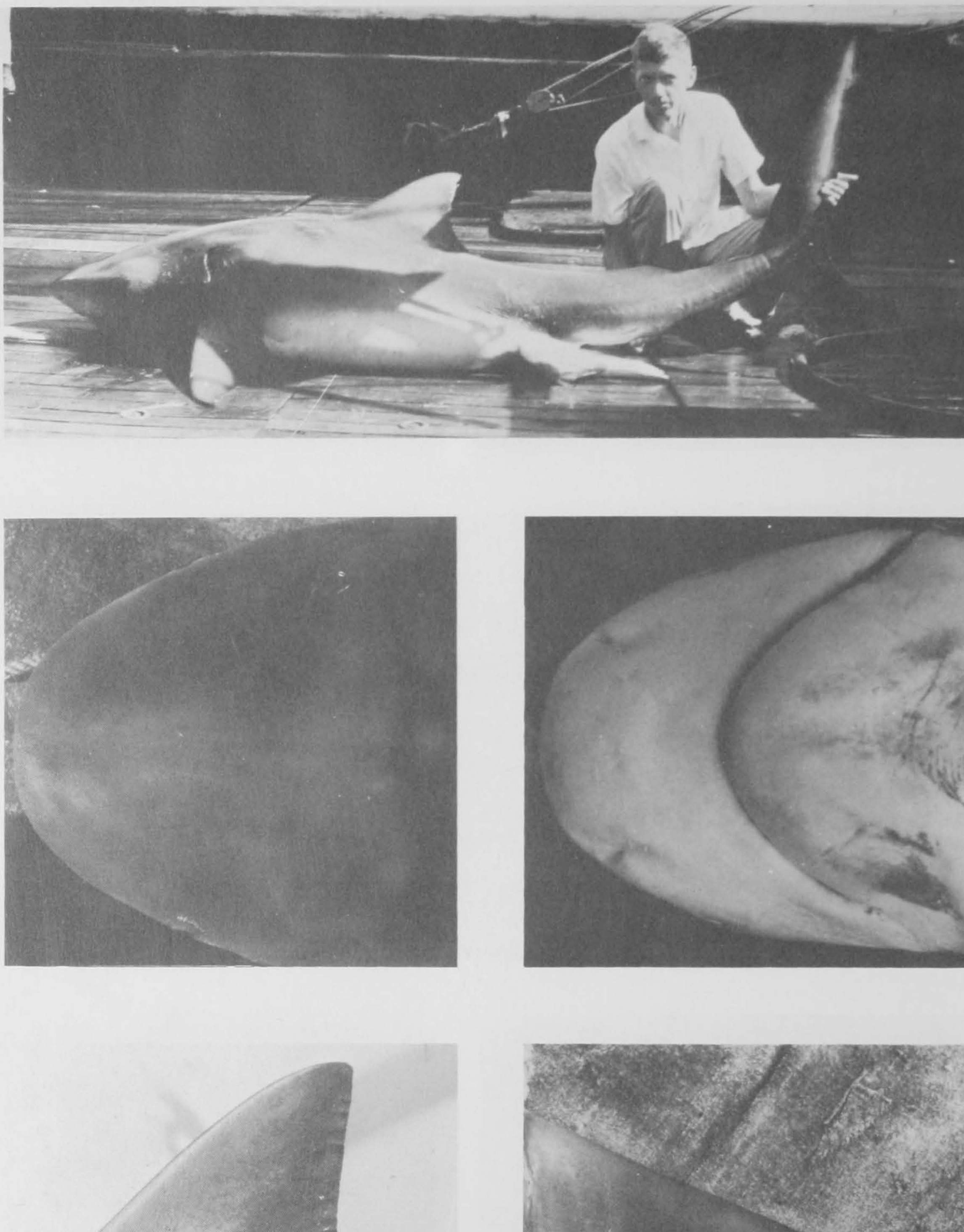

Figure 21.--Pigeye shark, *Carcharhinus azureus* (Gilbert and Starks).

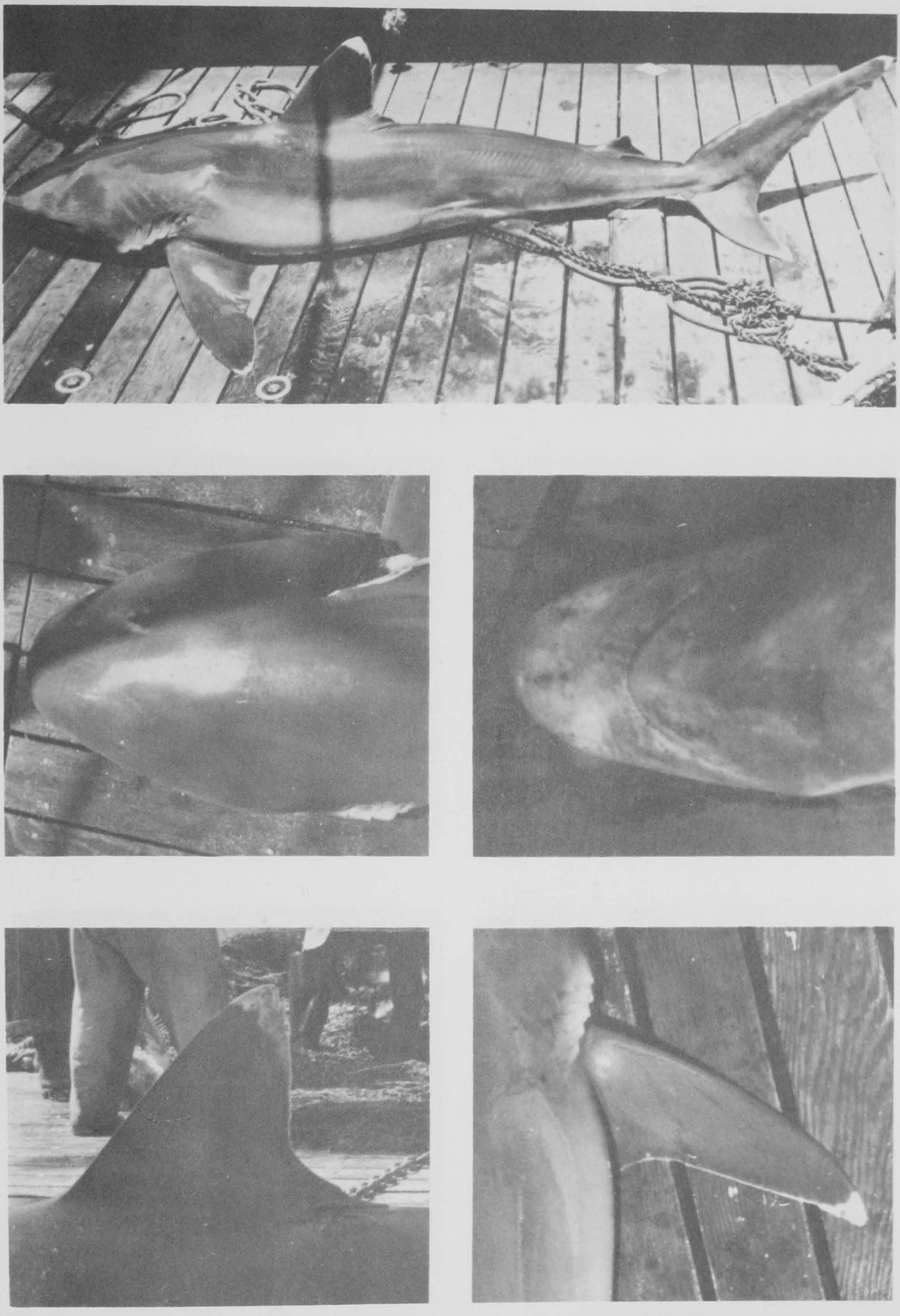

Figure 22.--Silvertip shark. *Carcharhinus platyrhynchus* (Gilbert).

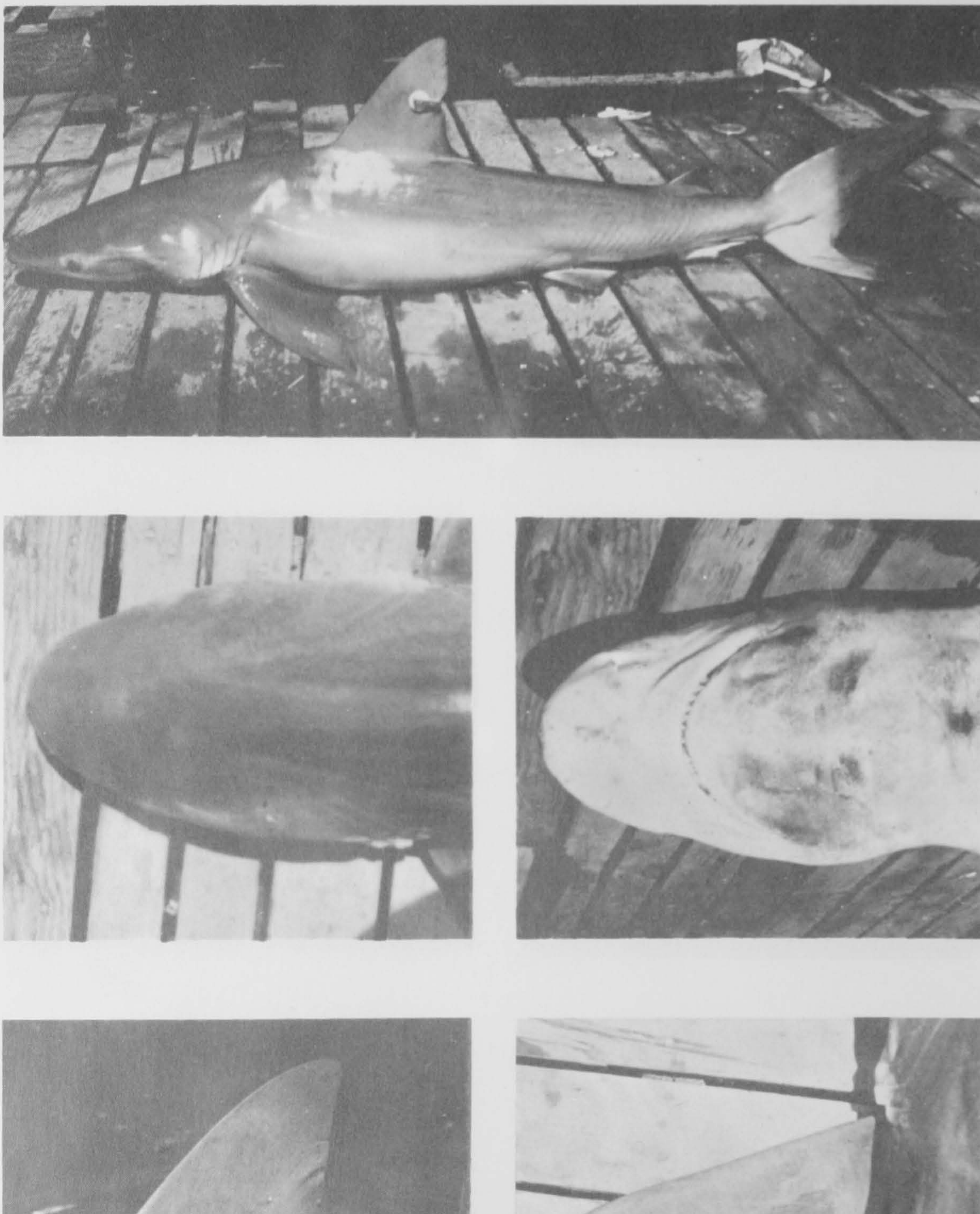

Figure 23.--Galapagos shark, *Carcharhinus galapagensis* (Snodgrass and Heller).

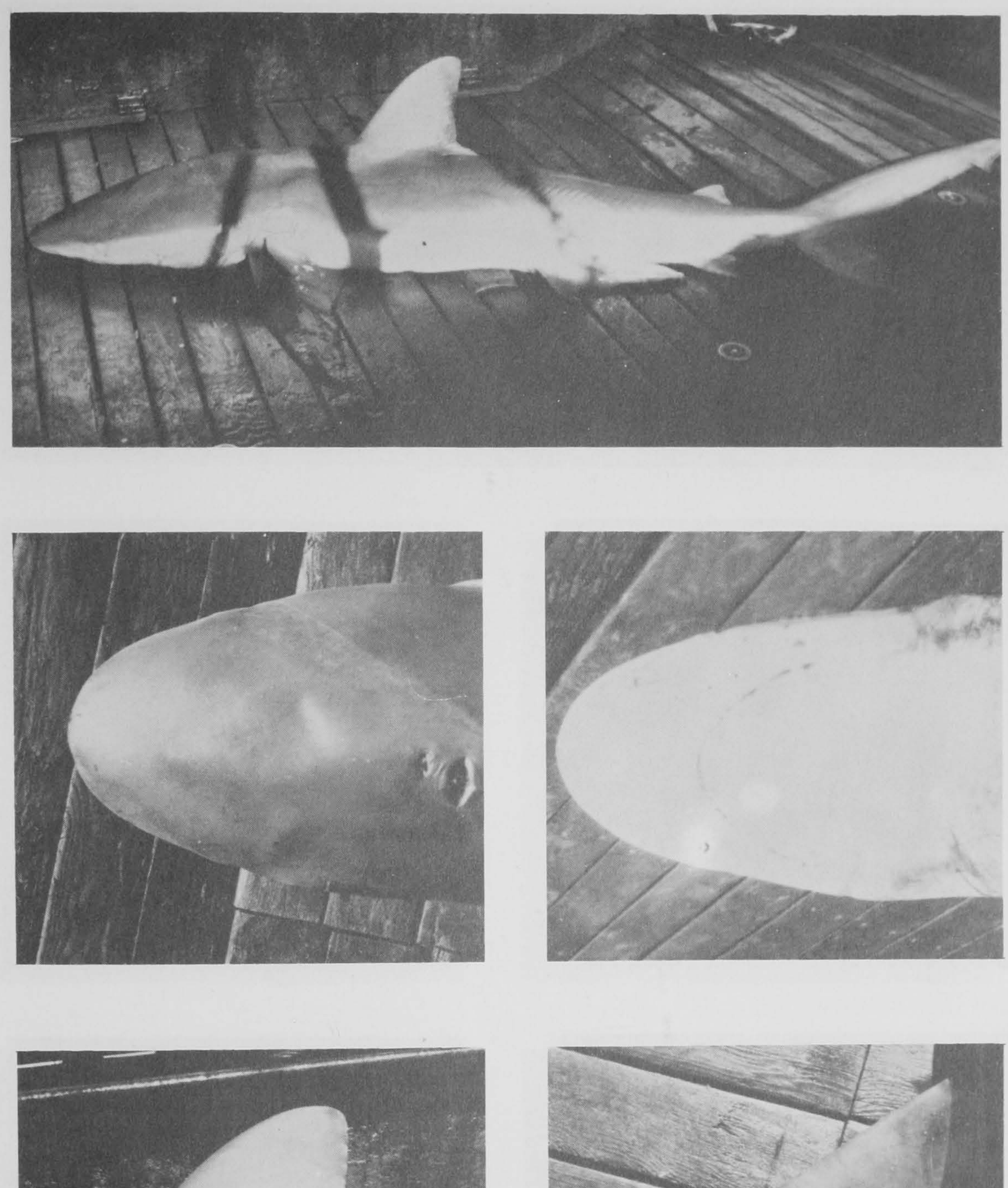

Figure 24.--Bay shark, *Carcharhinus lamiella* (Jordon and Gilbert).

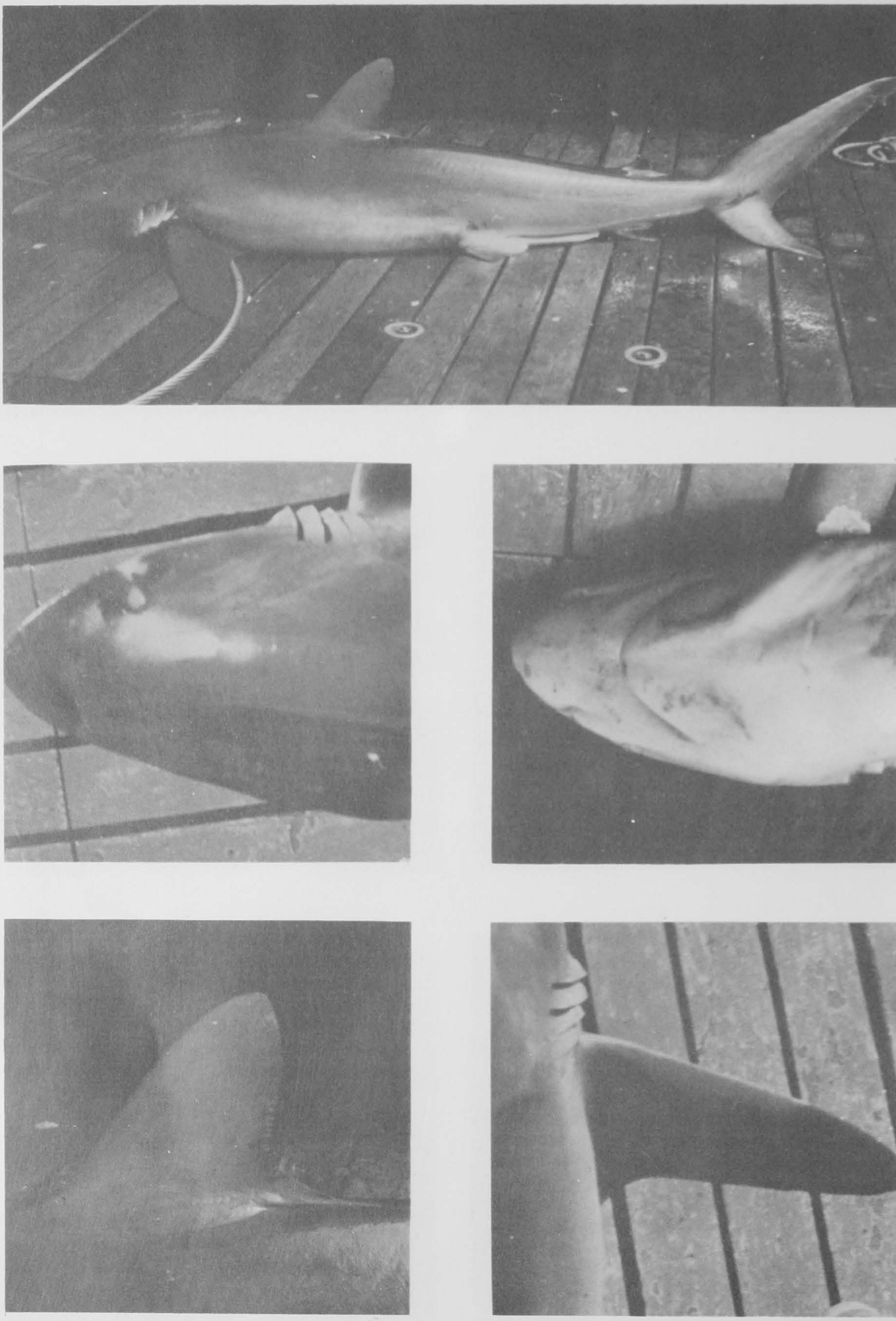

Figure 25.--Net-eater shark, *Carcharhinus malpeloensis* (Fowler).

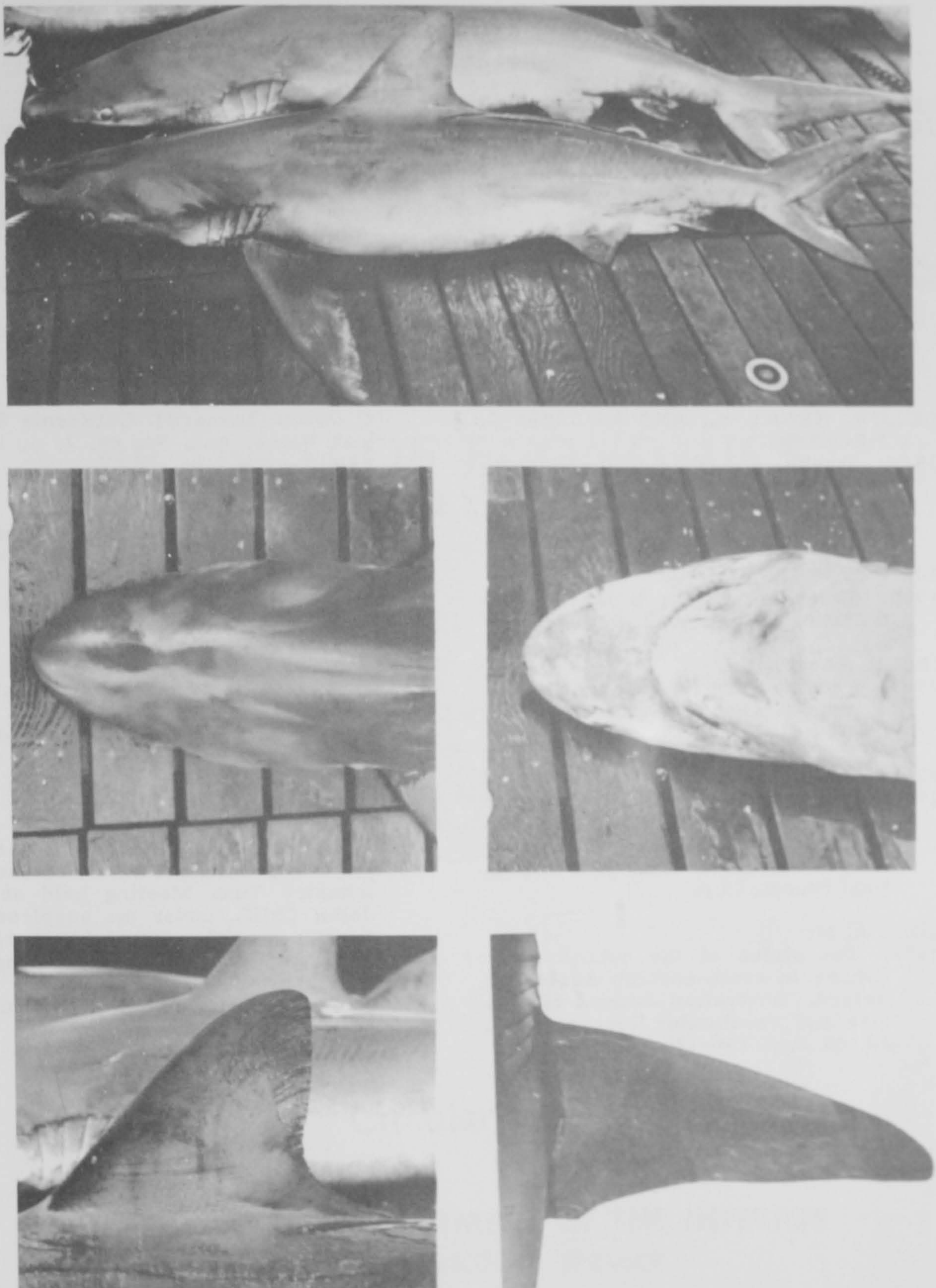

Figure 26.--Bignose shark, *Carcharhinus altimus* (Springer).

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