DIVISION OF FISH AND GAME OF CALIFORNIA
BUREAU OF COMMERCIAL FISHERIES
FISH BULLETIN No. 37
The California Barracuda
(Sphyraena argentea)

By
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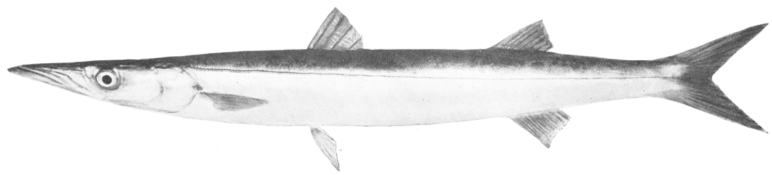

The California barracuda (*Sphyraena argentea*).

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1. LIFE HISTORY OF THE CALIFORNIA BARRACUDA

1.1. ACKNOWLEDGMENTS

The study of the life history of the barracuda, of which this paper is the report, was initiated by the International Fisheries Commission (United States and Mexico). Most of the preliminary survey of the fishery and the literature was carried on under the direction of this body. The material collected during this period was kindly turned over to the California Division of Fish and Game in 1927 when the United States-Mexican convention was abrogated.

Several people have contributed in various ways to the progress of this investigation. Mr. W. L. Scofield, Director of the California State Fisheries Laboratory, was frequently consulted for advice and suggestions. Commercial fishermen and dealers generously permitted measurements of fish on the boats and in the markets. Mr. Scotti Carmen of San Pedro and Mr. A. Wagner of Long Beach made possible the collection of young fish for the growth studies. Mrs. Hilda E. Walford aided in tabulating frequency records from the original data. Dr. F. W. Weymouth of Stanford University and Dr. W. F. Thompson of the International Fisheries Commission (United States and Canada) very kindly read the manuscript and offered criticisms and suggestions. To all these people and to the staff members of the California State Fisheries Laboratory, who were helpful in many ways, the author is very grateful.

September, 1931.

1.2. INTRODUCTION TO THE PROBLEM

1.2.1. Literature

Although there are at least fifteen kinds of barracuda distributed in all the warm seas of the world, the California barracuda (Sphyraena argentea) is the only one which may be considered of sufficient commercial importance to constitute a distinct "fishery." If one may judge by the available statistics, the barracuda of the west coast of Mexico and Central America, those of the Atlantic coast of North America, of the tropical Atlantic, of the coasts of southern Europe, of Africa, and of the seas of Asia, are to the countries which exploit them but little more than incidental additions to the usual landings of other species. It is not surprising, therefore, in the absence of economic necessity, that studies on the biology of any of these fishes have been neglected for those on more important species. Although from Aristotle down, a fairly voluminous literature exists on the nomenclature, the habitats, the voraciousness, and the food value of the various species, practically nothing has been written about the habits or the life histories. As for the California barracuda, a number of scattered notes on the distribution is all that has added to our knowledge of its biology since Girard first named the species in 1854.

1.2.2. Other Pacific Coast Species

Notwithstanding the fact that within the range of California fishing activities, there are two species of barracuda, Sphyraena argentea and Sphyraena ensis, only the former has yet reached the California markets. Sphyraena ensis is known to occur from the Gulf of California to Panama Bay, but possibly because of the availability of Sphyraena argentea farther north, possibly because of the smaller size or the inferior quality of Sphyraena ensis, it has not been taken by our fishermen. Although Sphyraena argentea is distributed from Cape San Lucas, Lower California, north to Puget Sound, it is important

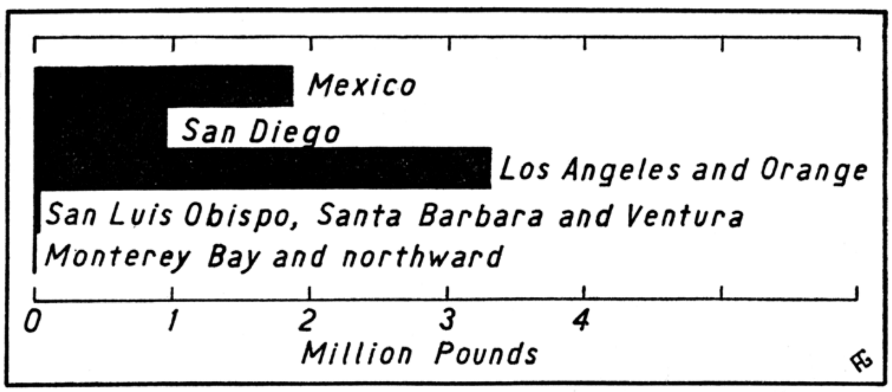

FIG. 1. Average annual catches (1925–1929) for the various fishing districts compared. The Mexican catch is delivered to San Diego and Los Angeles counties.

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commercially only south of Ventura County, California. The importance of the several barracuda fishing regions is illustrated in figure 1, a graph showing the average yearly catches by districts for the five-year period ending 1929.

1.2.3. Fishing Seasons

While the local season for barracuda lasts about six months of the year, a catch of almost two million pounds from Mexico stocks the markets during the other months. Although occasional fish are taken locally during the winter months, the first appearance of schools, marking the beginning of the local season, occurs about the middle of March. After increasing rapidly to its maximum in May, the catch drops off gradually, and in October, the fish seem to disappear. Beginning about the middle of October and continuing throughout the winter, boats go south of the international boundary line, often as far as Cape San Lucas, where they readily find schools of barracuda, which they fish as long as the California fishing grounds are not yielding. Figure 2 illustrates the seasons in California and in Mexico, with average monthly catches expressed as percentages of the average annual catches from each region for the five-year period ending 1929.

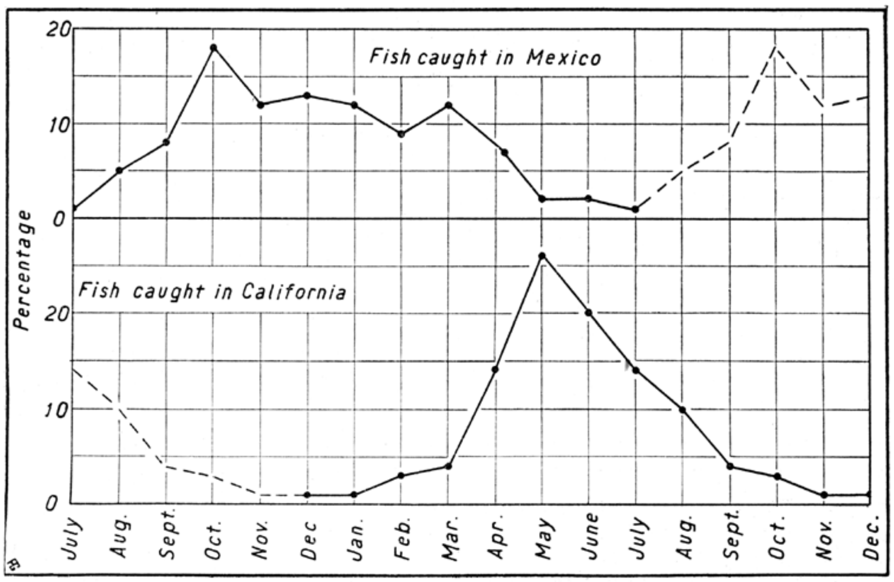

FIG. 2. Comparing the barracuda fishing season in Mexico with that in California.

FIG. 2. Comparing the barracuda fishing season in Mexico with that in California

It has been shown elsewhere (Skogsberg, 1925; Walford, 1929) that, in general, there is a definite seasonal progression from south to north in the appearance of the local fish. Figure 3 shows this progression graphically with average monthly catches by districts, expressed as percentages of the average annual catches for the five-year period ending 1929. While the majority of the fish delivered to Los Angeles early in the season, that is, March and April, are taken off Oceanside, a few catches are made off San Clemente, Santa Monica and San Pedro. In other words, the south-to-north progression is not a definite, clear-cut movement of the fishery, merely a trend. From the middle of May, the locality of the fishing moves northward to Newport, thence to the region between Long Beach and Santa Monica, where the greatest part of the fishing for Los Angeles County is carried on. Toward the end of the season, at the end of August and in September, the Los Angeles fishermen make most of their catches north of San Pedro, from between Santa Monica and Santa Barbara. Throughout the season, fish are taken from three-fourths to eight miles, usually about three miles, away from shore. They are caught from the surface to five fathoms, usually from one and one-half to two fathoms deep.

1.2.4. Fishing Methods

There are three general types of fishing gear used to catch barracuda commercially: (1) Circle nets, that is, purse seines and other closely related nets which operate on the same principle; (2) gill nets; and (3) jigs.

1.2.4.1. Purse Seines and Allied Nets

Allied to the purse seines are the round haul or lampara, and the ring nets, all of which operate as impounding nets. That is, they are used to surround and trap schools or portions of schools by pursing the bottom of the net, in the case of the purse seine, or by hauling the ends on board until the catch is concentrated in a bag of the net, in the case of the lampara, or by a combination of the two methods in the case of the ring net. These gears have been described fully by Higgins and Holmes (1921), Skogsberg (1925). Scofield (1929), Fry (1930), and Whitehead (1931). For barracuda, the nets are from 200 to 275 fathoms long by 20 to 30 fathoms deep, and in the main body have a mesh, which, when stretched, measures 2 to 2½ inches. The boats are from 40 to 65 feet long and carry a crew of 6 to 10—usually 9—men. In this type of fishing, it is possible to locate the schools by the ripples which they make in the surface of the water, and to identify the fish in the schools by the character of these ripples. Once a school is located, it is a matter of one or more hours to put out the net, surround the school, land the catch, and restore the net to the boat.

1.2.4.2. Gill Nets

The gill net is more in the nature of a trap which is set to entangle the fish as they go by. It is a plain, curtainlike net with stretched meshes of 3# to 3¾ inches, a size large enough to permit the heads of the fish to pass through and to catch them by their gill covers when they attempt to escape. The entire net is made up of 4 to 20 similar pieces, each about 17 to 20 fathoms long and about 6 to 10 fathoms deep. Since by this method of fishing it is useless to attempt to locate the schools first, the net is put out wherever the men judge they will make a catch, such judgment usually depending on the yield of previously fished areas. The net is floated by cork buoys at a regulable depth which depends on judgment and previous experience. Barrels are used as markers to facilitate locating the nets. The gill net boats are from 25 to 40 feet long and carry a crew of 1 to 3—usually 3—men. In operation, the boats leave for the fishing grounds late in the afternoon. The nets are put out in the evening and, not being anchored, drift with the current. Two or three times during the night or sometimes not until the next morning, the nets are hauled in and the fish removed.

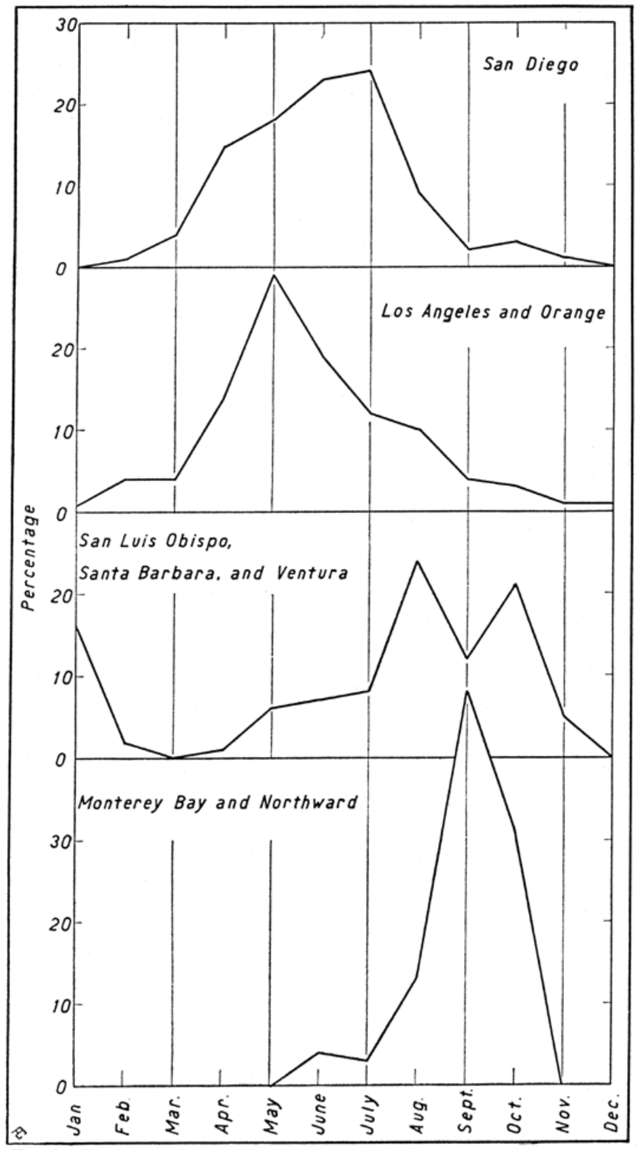

FIG. 3. Comparing the barracuda fishing seasons of the various regions in California.

FIG. 3. Comparing the barracuda fishing seasons of the various regions in California

1.2.4.3. Jigs

Jig fishing for barracuda consists in drawing a line with an artificial, barb-hooked, bone lure through the water astern of a boat moving approximately three miles an hour. In commercial fishing several lines are trolled at the same time by the following device: Poles, called outriggers, extend from each side of the boat, each with a line at its tip, and often with another near the midway point. Leaders attached to each line which can not be reached from the boat, enable the fishermen to pull individual lines in to where they can be reached without moving the outrigger. The fish are pulled in and removed from the hooks without stopping the boat. When the fishermen find a school, they troll back and forth, covering the area as thoroughly as possible as long as good catches continue to be made. Jig boats range from 17 to 40 feet long, and carry usually one man, though sometimes two or three, depending on the size of the boat. The lines are usually 15 to 20 fathoms long.

1.2.5. Commercial Sizes

Figure 4 presents graphically the sizes of fish as measured in centimeters from the tip of the lower jaw to the tip of the tail. The fish included in this graph comprised an extensive sample of the commercial catch made in 1928, in which from 100 to 300 unselected fish were measured in the various markets each working day throughout the barracuda fishing season. The boats which caught the fish, as well as their gear, were noted and the captains questioned as to the localities of the catches. The smallest length in the total sample was 53 centimeters (20.9 inches); the greatest, 108 centimeters (42.5 inches); and the most frequent, 76 centimeters (29.9 inches). Although there is no noticeable difference in the size of the fish taken at different localities near the mainland, there is evidence to substantiate the

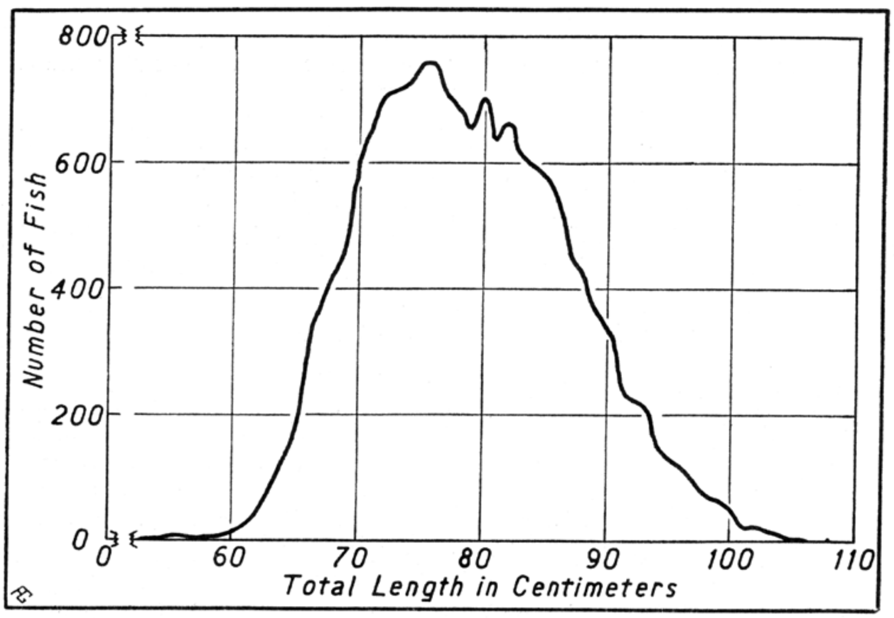

FIG. 4. The distribution of sizes of fish in the commercial catch as indicated by random sampling.

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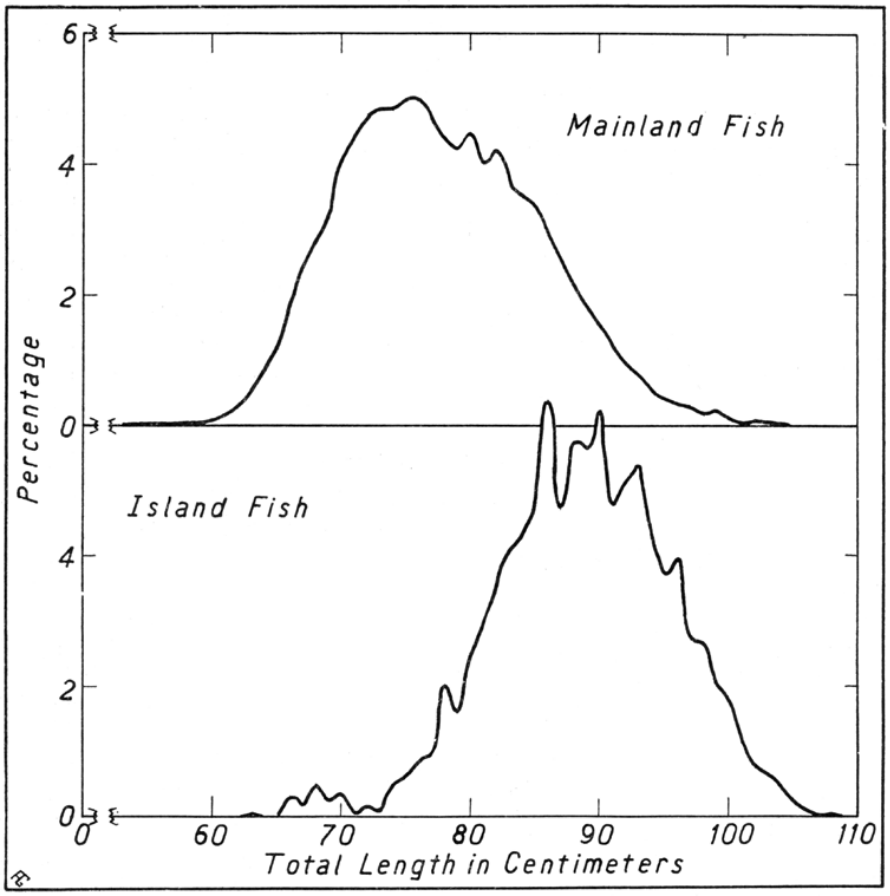

FIG 5. Comparing sizes of fish taken off the mainland with those of fish taken off the Channel Islands.

FIG. 5. Comparing sizes of fish taken off the mainland with those of off fish taken off the Channel Islands

claims made by fishermen that the catches made near the Channel Islands consist of a greater proportion of larger fish than do those taken closer inshore. Figure 5, which compares the number of fish at each length in samples taken from the two localities during the same time, shows a difference of 10 centimeters between the modes.

1.2.6. History of Regulatory Measures

In 1915 the first conservation law applicable to barracuda, making the capture of fish smaller than 18 inches (about ¾-pound) illegal, was passed by the California State Legislature. In 1917, the size limit was altered from 18 inches to 3 pounds, and has remained unchanged since. In 1925, the first law regulating the method of taking barracuda was passed, prohibiting the use of purse seines and round haul nets for this purpose. In 1927, this law was amended to permit these nets to operate from August 1 to May 15. In 1929, the law was still further changed to open barracuda fishing to purse seine and round haul nets only between August 1 and April 30.

1.2.7. The Problem

The growing importance of the fish which occur both in Mexican and in United States waters and which consequently must be conserved by international action, led, in 1926, to the conclusion of a treaty between the United States and Mexico, creating an *International Fisheries Commission*. The purpose of this body was "to facilitate the labors of the corresponding authorities in conserving and developing the marine life resources in the ocean waters off certain coasts of each nation." Part of the program of the Commission was the investigation of the life history of the barracuda, and, accordingly, a preliminary study was begun. When in 1927, this treaty was abrogated and the Commission dissolved, the California Division of Fish and Game continued the barracuda investigation, with the aim of answering the following questions:

1. When do the barracuda spawn?
2. How frequently do they spawn?
3. At what age does first spawning take place?
4. What is the rate of growth?
5. What is the age composition of the catch?
6. What does the three-pound size limit protect?

The following discussion presents what evidence has been collected in the study of these questions and of the problems connected with them.

The data presented in this paper have been gathered entirely from specimens in the San Pedro fish markets or from special hauls made off Los Angeles County. Since this region is the focus of the barracuda fishery, the partial treatment which we have given to the problem seems adequate for general purposes.

The measurements which have been used throughout the paper are all of the greatest length of the fish, that is, from the tip of the lower jaw to the longest ray of the caudal fin. The measurements were recorded in whole centimeters, and the millimeters disregarded. For example, lengths of 24.4, 24.6, 24.9 centimeters were all called 24. As a correction, 0.5 centimeter was added to all averages used in the calculations. The special methods which have been used in the several phases of this investigation are all described under the sections dealing with these phases.

1.3. DISCUSSION OF THE PROBLEM

1.3.1. Spawning Season

In order to determine approximately the spawning season of the barracuda, the sexual organs of several fish were examined each working day that round (uncleaned) fish were in the markets. In 1927, these observations were made on 16,500 fish landed between June and October, and in 1928 on 18,000 fish landed between March and October. Since this work was done in several markets each day, it is probable that the catches of many boats were thus sampled, and a fair representation of the commercial catch obtained.

1.3.1.1. Description of the Gonads

1.3.1.1. Females

Because the developmental stages were clearly marked and because they were all present at one time or another during the fishing season, they were distinguished by gross observation and classified as follows:

Stage *a*: Ovary full of immature eggs only, characterizing a resting stage between spawning seasons.

Stage *b*: Ovary full of maturing eggs, that is, developing toward maturity.

Stage *c*: Ovary full of mature eggs, which are ready to be extruded.

Stage *d*: Ovary spent; again full of immature eggs only, with few maturing and mature eggs.

In stage *a*, since no eggs are visible to the naked eye, the granulation characterizing the presence of maturing eggs is absent. The ovary is pinkish in color, rather gelatinous in texture, very slender in girth. As maturity approaches, many of the eggs grow to visible size, appearing as small, yellow granules, which increase in number, and fill the gonad so full that the pinkness characterizing the immature eggs is entirely obscured. The yellow color and opacity readily identifies these eggs as being in stage *b*. On reaching maturity, stage *c*, the eggs lose their yellowness, attain a translucent grayish color, become detached, fill the lumen of the ovary, and when the belly is pressed, flow forth freely from the external opening of the gonaduct. Toward the end of the spawning season, the diameter of the ovaries decreases; the organ becomes flaccid, its color pink, and finally its appearance is the same as that of the immature fish of stage *a*. Although this last stage is classed as stage *d*, there is, to gross observation, no sharp distinction between spent fish of the end of one season and immature fish of the beginning of the next. Ovaries of group *b* net a fair price in the markets as roe as long as the eggs are yellow. As maturity approaches, however, and some of the eggs attain transparency, the gonad becomes valueless commercially.

1.3.1.1. Males

Since the minuteness of even the mature spermatozoa renders the classification of their developmental stages exceedingly difficult, only three distinctions are made for the males: stage *A*, immature; stage *B*, mature; stage *C*, spent. The testes of the immature male (stage *A*) are firm in texture, slender, and pale brownish or greenish. As the sperm mature, the gonads become white, less firm in texture, and increase in size. These characteristics render stage *B* readily recognizable. When the belly of a mature male is pressed, the milt oozes through the opening of the gonaduct. At the end of the spawning season, the testes diminish in size, become brownish or greenish as in stage *A*. Firm specimens of mature testes have a slight commercial value, being claimed by a few epicures to be of finer flavor than the roe.

1.3.1.2. Duration of the Spawning Season

1.3.1.2. Beginning of the Spawning Season

Since fish were not available during the winter months, it can only be inferred by certain evidence that spawning does not occur during this period. In the first place, it was observed in the markets during 1927 that in October, just before the fish disappeared, practically all specimens of males and females were spent. Moreover, fishermen who delivered barracuda from Mexico reported the absence of roe and milt in the fish, which were already dressed when landed. Finally, many specimens observed in the beginning of the 1928 fishing season were of stages *a* and *A*. The earliest record of maturing fish obtained in 1928 was of March 22, when the *California II* landed a large load of locally caught, cleaned fish, most of which, according to the captain, had had roe or milt in them. On March 26, about a ton of cleaned barracuda was landed, including 15 round specimens, all of which were maturing (stages *b* or *B*). Beginning April 2 and continuing throughout the fishing season, local fish were delivered round, and actual observations were possible. Since the eggs yield so much more readily to field observation than the spermatozoa do, the maturity of the former was adopted as a criterion of the spawning season. The first mature (stage *c*) females were seen by us in the markets on May 2, when 44 per cent of the females had running spawn. At no time of the year, as indicated by the field observations, are all of the females spawning at once, the relative number of spawning females changing from day to day, sometimes quite radically. The daily observations for 1928 are shown graphically in figure 10, in which the ratio of spawning females (stage *c*) to all females is represented by the solid line. There is evident in this graph no apparent periodicity or regularity in the periods of greatest spawning.

1.3.1.2. End of the Spawning Season

At the beginning of the fishing season, only 25 per cent of the adult females and 39 per cent of the adult males were immature (stages *a* and *A*), the remainder of the females being maturing (stage *b*) and the remainder of the males being mature (stage *B*). After the first two weeks of May, no more immature fish were observed. Beginning the latter part of July, spent males and females made their first appearance in the catch, increasing in numbers as the fishing season declined, attaining almost 100 per cent at the end. The last spawning female was observed in the markets on September 30. Figure 6 shows the relation of immature females (stage *a*) and spent females (stage *d*) to all females observed in 1928, expressed in percentage. That the immature and spent stages (*A* and *C*) of the males occur at the same time as the corresponding stages in the females is evident from the following table:

TABLE 1

Occurrence of Immature and Spent Fish

(The figures are percentages of the total number of males and females, respectively)

Date	*Immature males (Stage A)*	*Spent males (Stage C)*	*Immature females (Stage a)*	*Spent females (stage d)*
April 1-15	39	0	25	0
April 16-30	4	0	5	0
May 1-15	0	0	0	0
May 16-31	0	0	0	0
June 1-15	0	0	0	0
June 16-30	0	0	0	0
July 1-15	0	0	0	0
July 16-31	0	0	0	0
Aug. 1-15	0	1	0	1
Aug. 16-31	0	19	0	2
Sept. 1-15	no data	no data	no data	no data
Sept. 16-30	0	93	0	95

TABLE 1

Occurrence of Immature and Spent Fish (The figures are percentages of the total number of males and females, respectively)

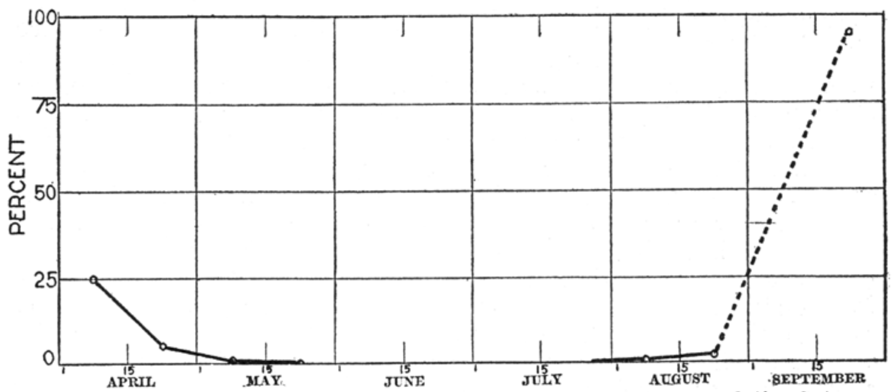

FIG. 6. The curve between April 1 and June 1 represents the relation between the immature females and all females, expressed in percentage. The curve between July 15 and September 30 shows the relation between spent females and all females, expressed in percentage.

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1.3.1.2. Limitations in the Spawning Season Data

Because of the absence in quantity of material before and after the spawning season, we can not be certain that our data give an accurate picture. It is possible that the fish are taken in large numbers only during a spawning migration. If this is true, the mature fish may tend to be selected by the fishermen, and, consequently, the percentage of immature fish may not be accurately represented. Furthermore, during the climax of this spawning migration, it is possible that the quantities landed do not adequately represent the number of fish spawning, because the fleet can not handle as high a proportion of the run then as when the fish are scarcer. If this is true, the spawning season might be more highly concentrated than the present data show.

1.3.1.3. Spawning and Fishing Seasons

The spawning season is summarized in figure 7, where the data have been grouped into half-monthly periods and the relation shown between the number of spawning females and the total number of females, expressed in percentage. The original data, shown by the small circles, were smoothed to demonstrate the general trend of the

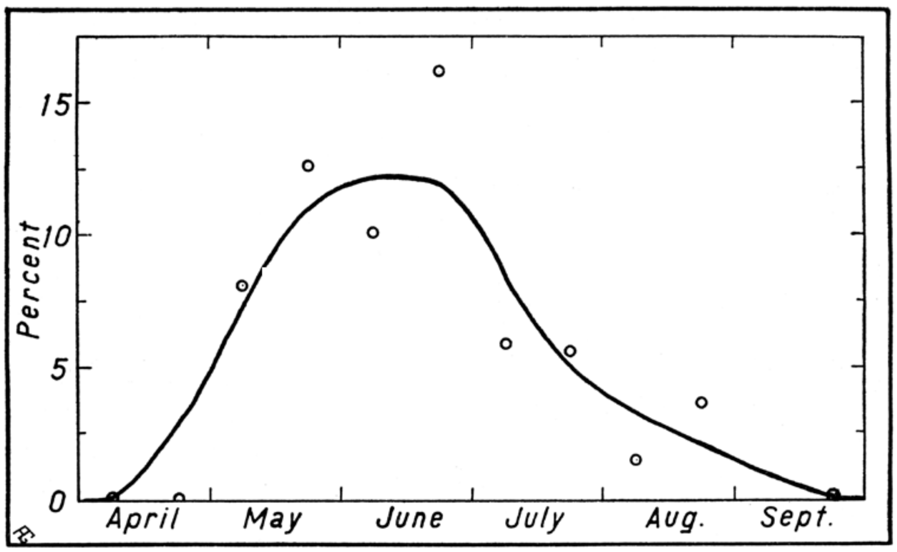

FIG. 7. Summary of the barracuda spawning season as indicated by the percentage relation between spawning females and all females. The daily observations are grouped into half-monthly periods. The original data, shown by the open circles, are smoothed to show the trend of the season.

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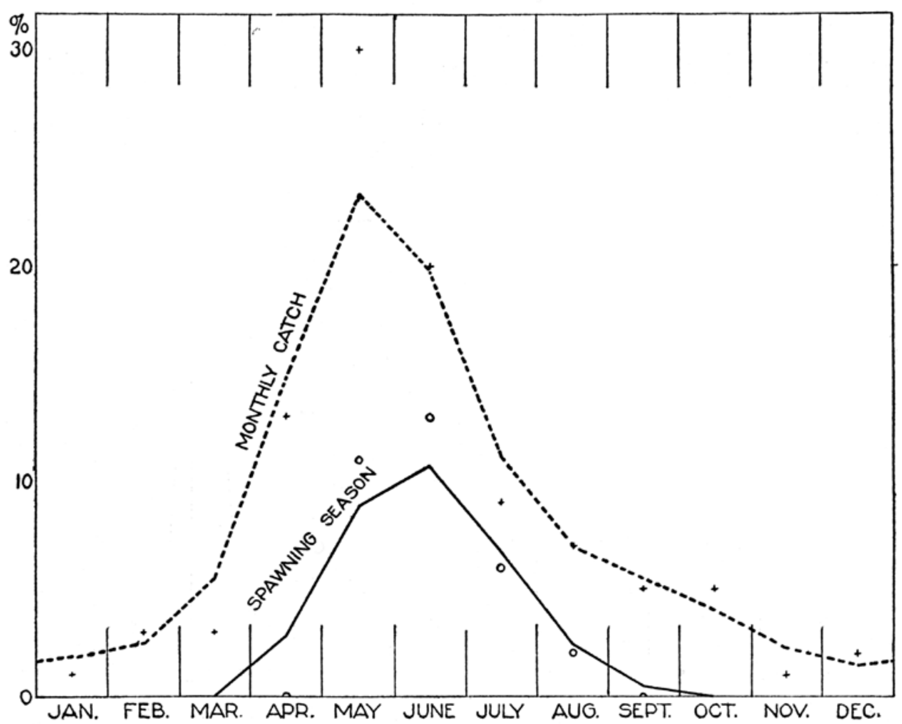

FIG. 8. Comparison between the monthly catch and the spawning season.

FIG. 8. Comparison between the monthly catch and the spawning season

season. The span of the 1928 season, as conservatively estimated in this graph, was from between April 1 and 15 to between September 15 and 30. The height of the season occurred between May 15 and July 15. In figure 8, the above data are grouped into *monthly* periods and compared to the fishing season, the original figures being smoothed to show the trends. A relationship between the spawning season and the fishing season is clearly suggested by the rises, heights and declines of both curves.

1.3.1.4. Sex Ratio and the Spawning Season

of passing interest, and possibly of some relation to the spawning season is the fact that the proportion of the number of males to the number of females fluctuates from day to day, often very sharply. During the course of the season, the sex ratio hovers around unity, with a distinct tendency for the males to preponderate. In 1928, of 18,005 fish examined during the entire summer, 55 per cent were males. In 1927, of 16,530 fish, 52 per cent were males. In 1922, of 1806 fish examined, 55 per cent were males (Skogsberg, 1925). of 9000 young barracuda of the first year class, 49.5 per cent were males, or practically a unity ratio. The cause of a preponderance of one sex during the spawning season, apparently connected with maturity, may possibly be due to spawning migrations, to different habits of the two sexes or possibly to selective fishing. An unequal sex ratio has been noticed in several other species of fish, sometimes with the males predominating, as in the true smelts (Kendall, 1926), though more frequently with the females predominating, as in the jack smelt (Clark, 1929), grunion (Clark, 1925), California sardines (unpublished records of the California State Fisheries Laboratory), or in the European plaice (Hefford, 1909). That there may be some relation between sex ratio and spawning season is suggested by a noticeable tendency for the proportion of males to vary as the proportion of spawning females. Figure 9 and Figure 10 compare the ratio of males and all fish (broken line)

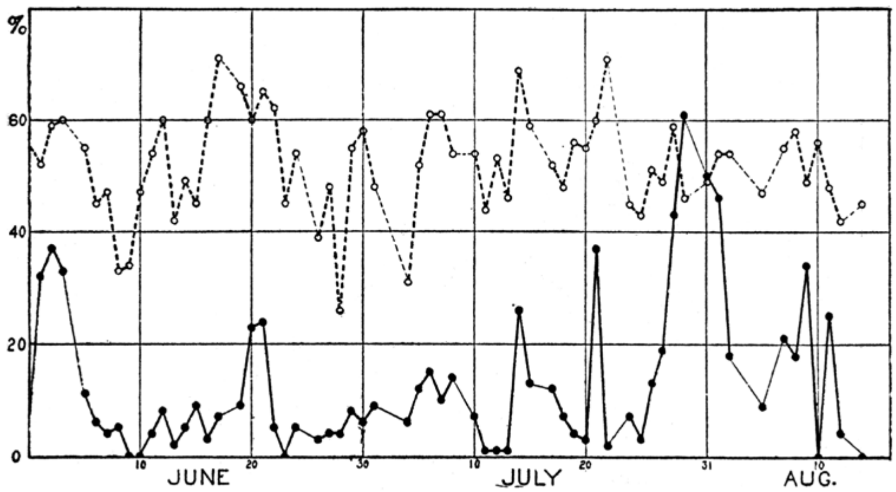

FIG. 9. Daily spawning season observations for 1927. The broken line represents the relation between the number of males and all fish, expressed in percentage. The solid line shows the relation between the number of spawning females and all females, expressed in percentage.

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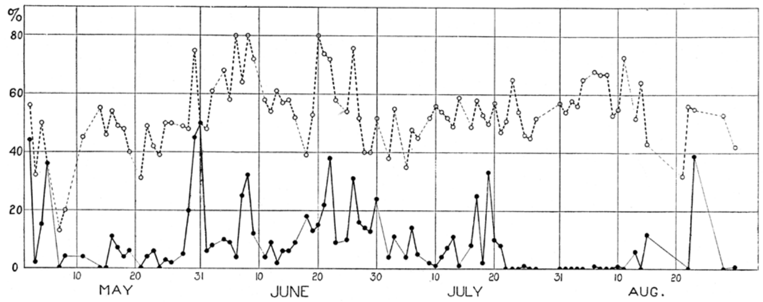

FIG. 10. Daily spawning season observations for 1928. The broken line represents the relation of the number of males to all fish. The solid line shows the relation of the number of spawning females to all females. Relations are expressed in percentage.

FIG. 10. Daily spawning season observations for 1928. The broken line represents the relation of the number of males to all fish. The solid line shows the relation of the number of spawning females to all females. Relations are expressed in percentage

with the ratio of spawning females and all females (solid line), expressed in percentage, for 1927 and 1928, respectively. In figure 11, these observations are so combined to show the ratio of the males to all fish by half-monthly periods. The tendency for a higher preponderance

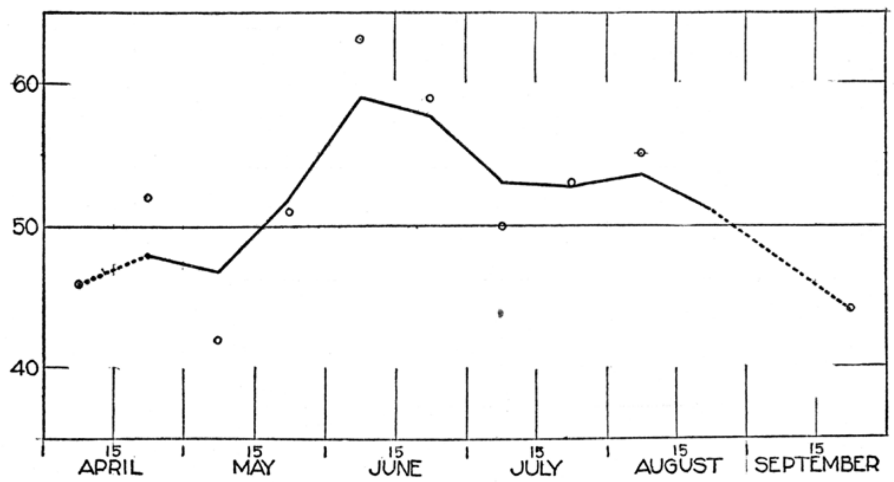

FIG. 11. Relation for 1928 of the number of males to the total number of fish, expressed in percentage. The observations are grouped in half-monthly periods and represented by the small circles. The data are smoothed to show the general trend which is represented by the heavy line.

FIG. 11. Relation for 1928 of the number of males to the total number of fish, expressed in percentage. The observations are grouped in half-monthly periods and represented by the small circles. The data are smoothed to show the general trend which is represented by the heavy line

of males to occur while the spawning season is at its height is clearly evident. Moreover, if the original data from the 1927 and 1928 seasons be combined, there is a positive coefficient of correlation between the ratio of spawning females to all females and the ratio of males to all fish of .304 ± .047. Since the coefficient is more than six times the probable error, we may consider it of some significance.

1.3.1.5. Frequency of Spawning

While an extensive microscopic study of the eggs was not made, some evidence justifies the belief that each barracuda spawns more than once each season. If there were only one spawning a season, it should seem reasonable to expect (1) the presence of spent fish in the catch throughout the season, and (2) the presence of only two groups of eggs in mature fish: immature (stage *a*) and mature (stage *c*).[1] As has already been explained, immature fish and spent fish appear only at the beginning and at the end of the season, respectively. That mature ovaries contain not only the transparent eggs of stage *c* but also the opaque, yellow eggs of stage *b* is clearly evident to casual inspection. Microscopic examination of several specimens not only has verified this observation, but has revealed apparently a third group of eggs. Figure 12, contributed by Dr. Frances N. Clark, pictures the distribution of 500 egg diameters in a sample of barracuda eggs which were teased directly from a mature ovary onto a glass

[1] Several writers have interpreted three groups of eggs in fish as indicative of more than one spawning a season, for example: Clark (1925 and 1929) for the grunion and jack smelt, and Kisselevitch (1923) for the Caspian herring.

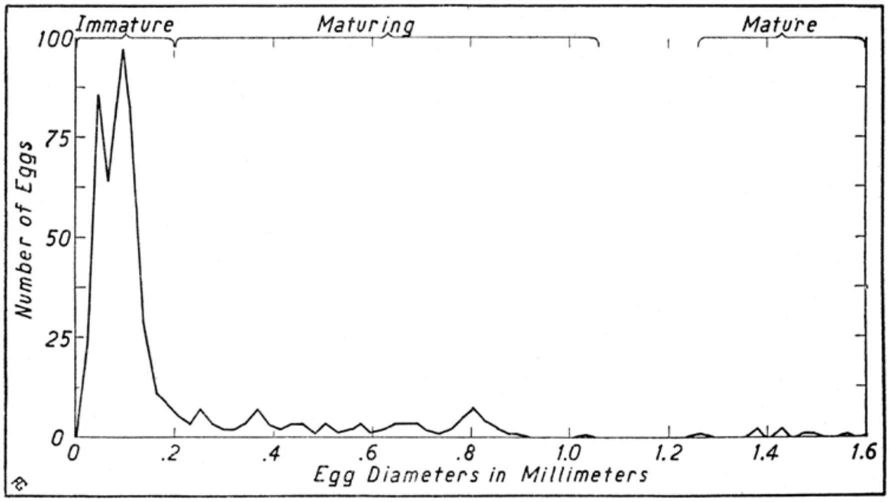

FIG. 12. Showing the size distribution of eggs from a spawning (stage *c*) female. By the method of sampling with which these data were collected, a fair approximation of the true proportion of the various stages is given.

FIG. 12. Showing the size distribution of eggs from a spawning (stage c) female. By the method of sampling with which these data were collected, a fair approximation of the true proportion of the various stages is given

slide which was marked with columns to prevent repetition of measurements. By this method of sampling, the various sizes of eggs appear in proportions approximating those in which they occur in the ovary. The numerous group at the extreme left of the graph, from 0 to 0.2 millimeter in diameter, comprises the microscopic eggs. From 0.2 to about 1.04 millimeters are represented the opaque yellow eggs, and from about 1.24 to 1.6 millimeters the mature eggs. Because the true number of mature eggs is small as compared to the number of eggs in the intermediate group, and very slight indeed in proportion to the great quantity in the microscopic group, few measurements of mature eggs are shown in the sample graphed in figure 12. In order to demonstrate these larger groups more effectively, a sample of 1000 eggs was taken by the following method: When the gonad from which this sample was taken was placed in the formaldehyde, the walls were

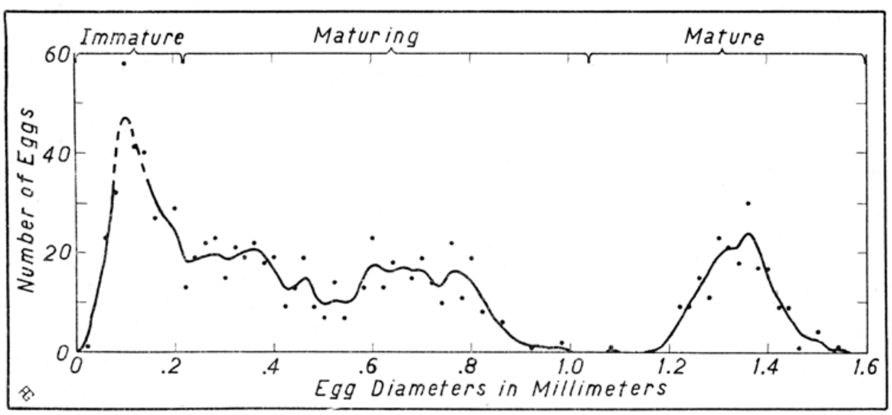

FIG. 13. Showing the size distribution of eggs from a spawning (stage *c*) female. In collecting the data for this figure, only a small proportion of the immature eggs was measured in order to accentuate the maturing and mature eggs. The original data, shown by the dots, are smoothed.

FIG. 13. Showing the size distribution of eggs from a spawning (stage c) female. In collecting the data for this figure, only a small proportion of the immature eggs was measured in order to accentuate the maturing and mature eggs. The original data, shown by the dots, are smoothed

ruptured and squeezed, so that the mature, many of the maturing, and some of the immature eggs were forced away from the ovary to the bottom of the jar. The sample was obtained with a pipette from various levels of the settled eggs, spread on a columned glass slide and measured. By this method of sampling, the relative numbers of mature and maturing eggs are considerably accentuated. In figure 13 where the diameter frequencies of these eggs are graphed, three chief stages of eggs are readily distinguishable: the immature group, shown in dotted lines to suggest the incompleteness of its numbers, from 0 to about 0.2 millimeter; the maturing group, which itself consists evidently of more than one group, from about 0.2 millimeter to about 1.0 millimeter; and the mature group from about 1.14 to 1.6 millimeters.

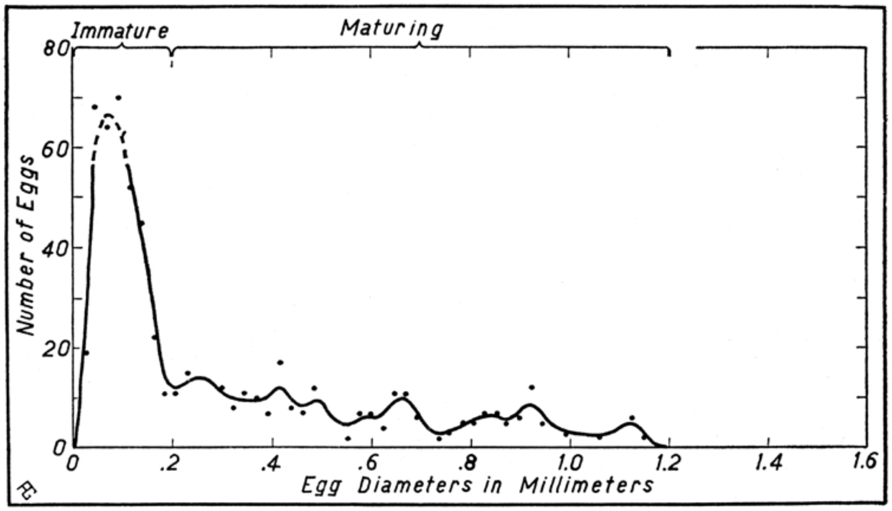

FIG. 14. Showing distribution of egg diameters in a maturing female. The original data, shown by the dots, are smoothed to show the trend.

FIG. 14. Showing distribution of egg diameters in a maturing female. The original data, shown by the dots, are smoothed to show the trend

Figure 14 shows frequencies of 650 diameter measurements from a maturing (stage *b*) specimen, the method of sampling being the same as that used for figure 12. Here there are only two chief groups distinguishable: the microscopic eggs, which appear in figures 12 and 13; and the opaque, yellow eggs, which in the other graphs form the intermediate group.

The eggs in all of these cases were measured under a compound microscope with an eyepiece micrometer which was kept in the same position. The slide on which the eggs lay was not permitted to rotate; consequently, the eggs were measured at any diameter that fell in line with the micrometer scale, thus eliminating selection of longest or shortest diameters.

Since throughout the season, the ovaries of spawning females contain opaque, yellow eggs as well as mature and immature ones, and since no spent females appear during the heights of the spawning season, it seems fair to conclude that a female spawns more than once during a season on the assumption that all eggs above 0.2 millimeter are shed in the same season.

1.3.1.6. Number of Mature Eggs Produced for One Spawning

The condition found to be true of so many fishes that the number of eggs produced by individuals of different sizes varies considerably, the larger fish producing more eggs, is true also of barracuda. Since this fact might possibly have some bearing on legislation, the number of mature eggs in eleven fish of different sizes was estimated.

To eliminate the possibility of loss of eggs by extrusion in the nets, on the boats or in the markets, ovaries which were just on the verge of spawning, that is, in which the mature eggs had not yet broken their follicles to reach the lumen, were selected. Since specimens were collected several months before the calculations were made, it was necessary to preserve them in formaldehyde. The method of calculating the number of mature eggs was as follows: The whole ovaries were removed from the formaldehyde, and after being drained of their excess moisture for several minutes, were weighed to the nearest gram. Following this procedure, a sample consisting of five small, approximately equally sized lots of eggs was taken from different parts of the ovaries of each fish, placed in a weighing bottle of known weight, and weighed to the nearest one-tenth milligram. The number of mature eggs (stage *c*) in each sample was then determined by counting; the number of eggs per gram calculated and multiplied by the weight of the entire preserved gonad. The number of mature eggs in the ovary, thus estimated, was recorded to the nearest thousand to emphasize the estimated nature of the figure. The following table, which presents the results of these egg counts, clearly shows that the number of mature eggs increases with the size of the fish.

TABLE 2

Number of Mature Eggs Produced for One Spawning

Total length (in cm.)	*Age (in years)*	*Weight of fish (in grams)*	*Weight of fresh ovary (in grams)*	*Calculated number of mature ova (to nearest thousand)**
50	2	414	28	51,000
53	2	506	30	42,000
56	3	590	50	71,000
63	4	900	110	163,000
70	4	1,131	104	172,000
72	4	1,339	229	247,000
79	5	1,572	134	170,000
86	7	1,998	173	294,000
91	7	2,867	480	340,000
93	7	3,106	261	309,000
94	6	3,226	340	484,000

* Calculations were made from preserved ovaries.

TABLE 2
Number of Mature Eggs Produced for One Spawning

1.3.1.7. Size of Barracuda and Number of Mature Eggs Produced

In order to determine approximately the degree of relationship which exists between the number of eggs and the size of fish, coefficients of correlation (Pearson) were calculated for the relation between number of eggs and age of fish, total length of fish, and weight of fish. The results of these calculations are shown in the following table:

TABLE 3

Correlation Between Size of Barracuda and Number of Mature Eggs

Correlation (r) between	*r.*	*P.*	*No. specimens*
Age and number of mature eggs	.530	.09	11
Total length of fish and number of mature eggs	.908	less than .01	11
Weight of fish and number of mature eggs	.959	less than .01	11

TABLE 3
Correlation Between Size of Barracuda and Number of Mature Eggs

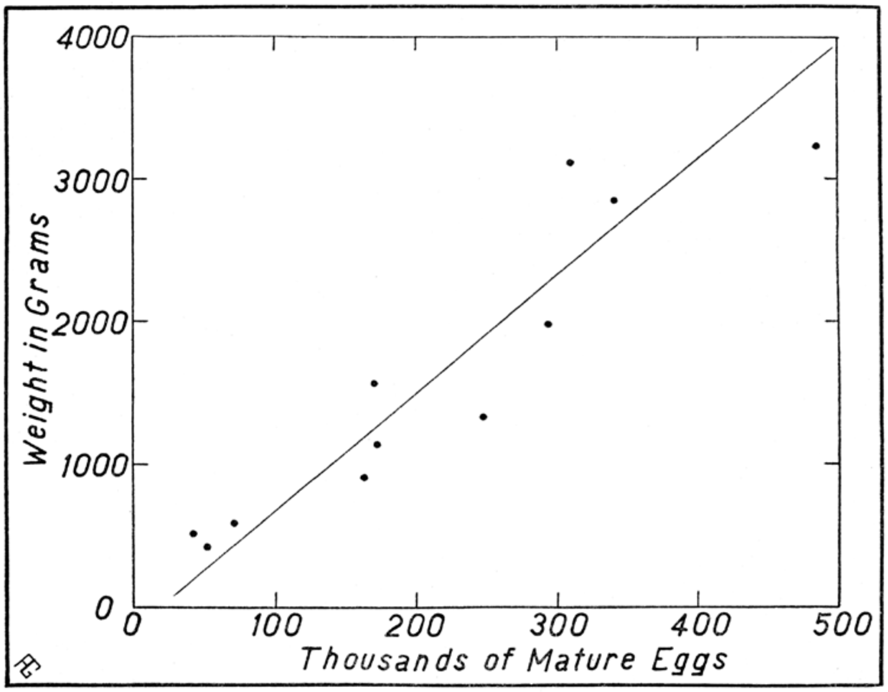

FIG. 15. Scatter diagram showing the relation between the number of mature eggs in a spawning female and the weight of the whole fish.

FIG. 15. Scatter diagram showing the relation between the number of mature eggs in a spawning female and the weight of the whole fish

From table 3, it is evident that the number of eggs produced is, of the three values considered, most closely correlated to weight and least to age. The relationship between weight and egg production is shown graphically in the scatter diagram, figure 15. Because the low number of specimens reduces the significance of *r, P* (Fisher, 1925, p. 157) was used as a measure of reliability. This figure, to be interpreted as the probability that chance alone would produce a similar degree of correlation, shows that only the second and third coefficients in table 3 signify. Notwithstanding the scantiness of the material, therefore, the magnitude of the higher coefficients is sufficient to emphasize the importance of the larger fish and to minimize the value of the first spawning seasons. In other words, the question of what size limit should be imposed is complicated. If 75 per cent of the females spawn in their second year and 100 per cent in their third, should protection during these two seasons of relatively slight spawning be considered sufficient to propagate the race? A study of the sizes and ages of fish in the commercial catch helps us to form an opinion in this matter.

1.3.2. Age Determination

Age determinations in the barracuda were made largely by a study of the scales. This method of deciphering the age of fishes has been used on so many species, by so many workers, and such excellent bibliographies on the subject have been published, for example, by Graham (1928) and Van Oosten (1929) that an introduction to the method seems superfluous. However, since it would be absurd to offer the successes or failures of scale readings for any one species as a test for the validity of scale readings for any other species, it will be necessary to present in detail the evidence to support this method for barracuda.

1.3.2.1. Description of Scales and Definition of Terms

The scales of Sphyraena argentea are of various shapes, generally circular or oval. Their surfaces are sculptured with many concentric ridges, referred to in this paper as circuli, which are interrupted and divided into short sections by numerous radial ridges called radii. Presumably the scales, in general, grow in proportion to the growth of the fish. Thus, irregularities in the annual growth of the fish are reflected by irregularities in the annual growth of the scales, which in turn are reflected by irregularities in the appearance of the circuli and radii. The suspension of growth of the winter, together with the new growth of the spring, causes a scar, called the annulus, to be formed around the margin of the scale. It is the intention of this paper to demonstrate that these scars are yearly in occurrence and hence can be used to determine the age of the barracuda.

Exhibit *A* of the evidence to support the validity of barracuda scale readings is the demonstration of growth cessation in at least the first year class. Exhibit *B* is the actual observation and recording of the time when the annulus is formed. Exhibit *C* is a comparison between a length frequency polygon of all fish studied and length frequency polygons of the separate year classes as deciphered from scales. These exhibits are presented in the following pages.

1.3.2.2. Growth of the Young

1.3.2.2. Source of Material

The young fish which were used in this investigation were especially caught for us by two commercial fishermen. Mr. Scotti Carmen, owner of a small round haul net used for catching kingfish, smelts, salt-water perch, and other small species, took about 99 per cent of the fish; Mr. A. Wagner, operator of a small-meshed dip net off Pine Avenue Pier in Long Beach, caught about 1 per cent. These men were given permits legalizing the catch of undersized fish, and in order to eliminate selection of sizes as much as possible, were paid for very small fish by the piece and for larger fish by the pound. Mr. Carmen confined all his fishing within two miles off the shore between Newport and Santa Monica, as shown in figure 16, a distance of about 40 miles, and made most of his catches off Long Beach. Since the two sets of data revealed no disparity in size of fish, they were combined throughout our work. Altogether, 26,752 small fish were measured from June 3, 1927, to July 31, 1928.

1.3.2.2. First Appearance of 1927 Year Class

For some unaccountable reason, only a few scattered collections of small fish were obtained from October, 1926, until April, 1927, but in April, 1927, a very large number was collected. A graph, showing the numbers of fish at each length in this sample, is plotted in figure 17A. Notwithstanding the low number of fish taken previously, an observation of the sizes of these fish gave confidence to the assumption that the April sample represents the smallest fish available to the fishermen

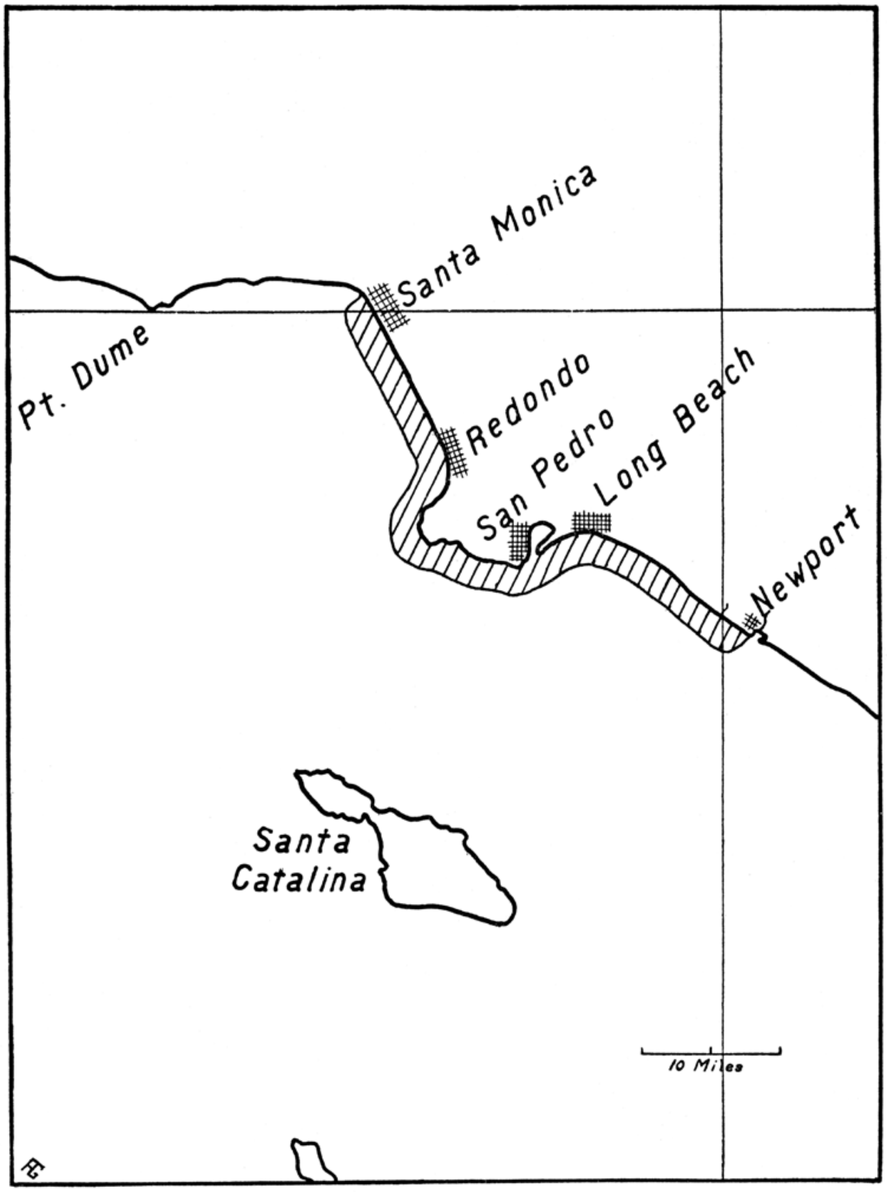

FIG. 16. The shaded area shows the regions where the small fish used in this study were obtained.

FIG. 16. The shaded area shows the regions where the small fish used in this study were obtained

at that time. From June 1 to July 27, no fish smaller than 22 centimeters was taken by our fishermen. (See fig. 18.) On July 27, however, Mr. Wagner caught a number of barracuda which were decidedly smaller than any which had been taken previously that year, the measurements of which formed a distinct group among all fish measured in July. In subsequent collections, this distinct group persisted, and for a year, by means of very generous samples, it was possible to follow its growth and to observe in the scales the time when the annulus was formed.

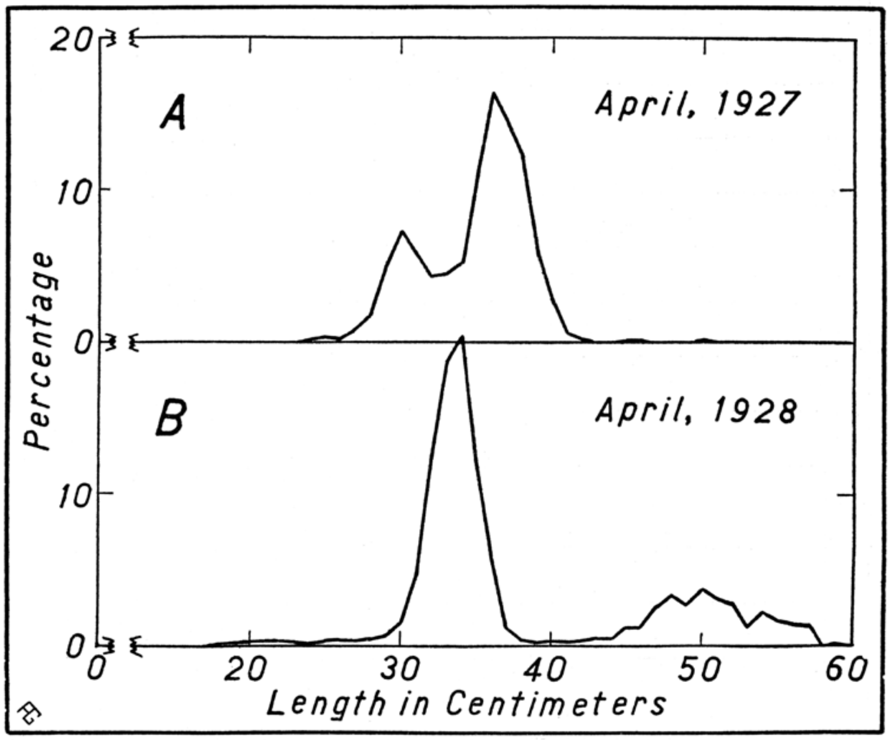

Fig. 17. Comparing the sizes of young fish taken in April, 1927, with those taken in April, 1928.

FIG. 17. Comparing the sizes of young fish taken in April, 1927, with those taken in April, 1928

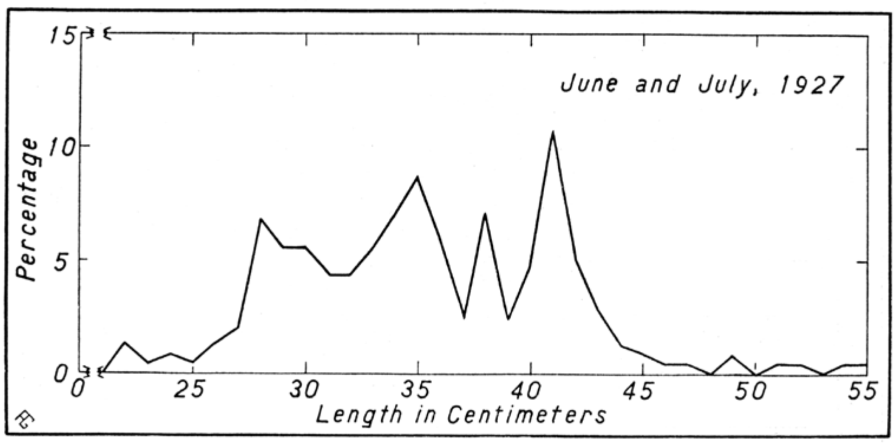

Fig. 18. Size distribution of young fish taken in June and July, 1927.

FIG. 18. Size distribution of young fish taken in June and July, 1927

1.3.2.2. Growth of the 1927 Year Class

Figure 19 shows the frequencies at each length, plotted in half-monthly periods from July 16, 1927, to July 31, 1928. The small size of fish in the group between 7 and 13 centimeters in July, 1927, the rapidity in growth of this group, the absence of an annulus on the scales, the fairly close correspondence between the April, 1928, sample and the April, 1927, sample (see fig. 17), and the appearance of a group of sizes in July, 1928, similar to what was collected

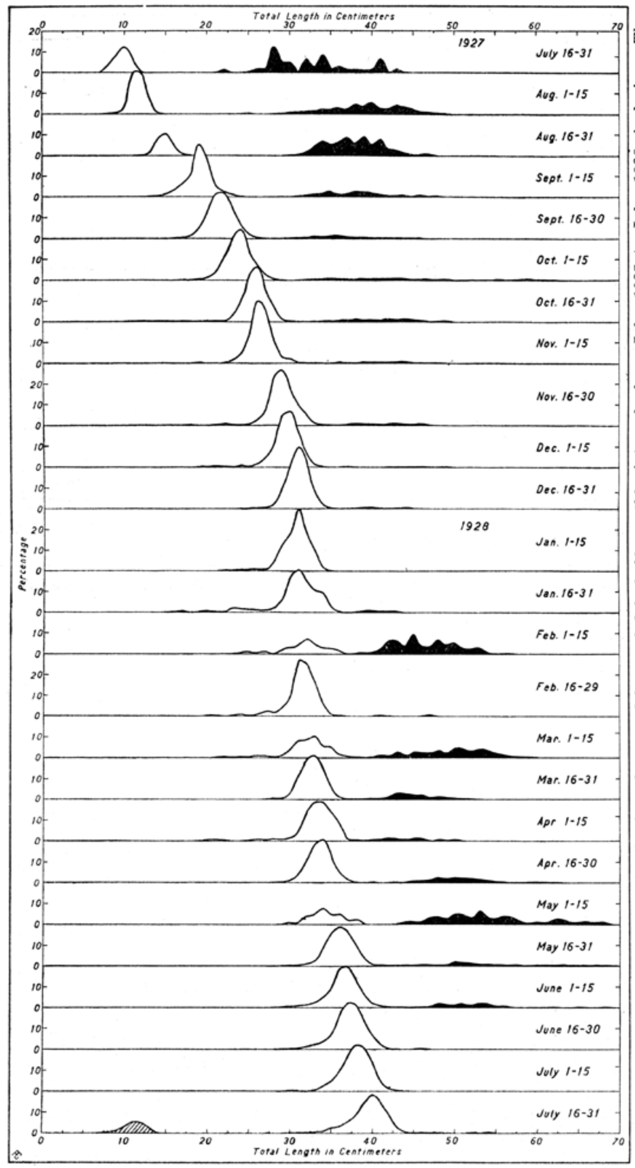

FIG. 19. Showing the size distribution of young fish sampled in half monthly intervals from July, 1927 to July, 1928, inclusive. The curves representing the 1926 year class are blackened; the curve representing the 1928 year class is cross-hatched.

FIG. 19. Showing the size distribution of young fish sampled in half monthly intervals from July, 1927 to July, 1928, inclusive. The curves representing the 1926 year class are blackened; the curve representing the 1928 year class is cross-hatched

in July, 1927, all justify accepting this distinct year class as representing the youngest in 1927. The rather noticeable skewness of the 1927 curves after December, caused by a few unusually small fish, is probably explicable by the fact that the first appearance of this year class occurs before the end of the spawning season. These smaller fish are probably the result of late spawning. The slight dispersion of all of these curves, difficult to understand in the light of the protracted spawning season, may possibly be explained by the fact that the fish were all taken from the same locality, a rather small area, whereas, the fish from which the spawning season was studied, were caught from a much greater area. The April, 1927 sample of the 1926 year class (see fig. 17A) exhibits a distinct bimodality, caused, presumably, by some peculiarity in the 1926 spawning season. The rather large number of fish involved in the sample—1441—and the fact that another smaller sample also taken in April, 1927, shows the same characteristics as figure 17A, obviate the possibility of accounting for this bimodalism as due to errors in sampling. Two arguments refute the supposition that this effect indicates the presence of two age groups: (1) the scale readings placed all these fish in the 1926 year class, and (2) similar bimodalism does not obtain in any of the frequency polygons of measurements taken of small fish during 1928.

1.3.2.2. Growth of the 1926 Year Class

Aside from the smooth continuity of the modes in the 1927 year class, the most striking feature of figure 19 is the retardation in growth between about December and March, and the resumption in growth after March. This phenomenon is shown more conspicuously in figure 20, in which the average lengths of the 1927 year class are plotted by half-monthly periods. This slackening of growth, already demonstrated for so many species of animals, is the usually accepted cause for the formation of

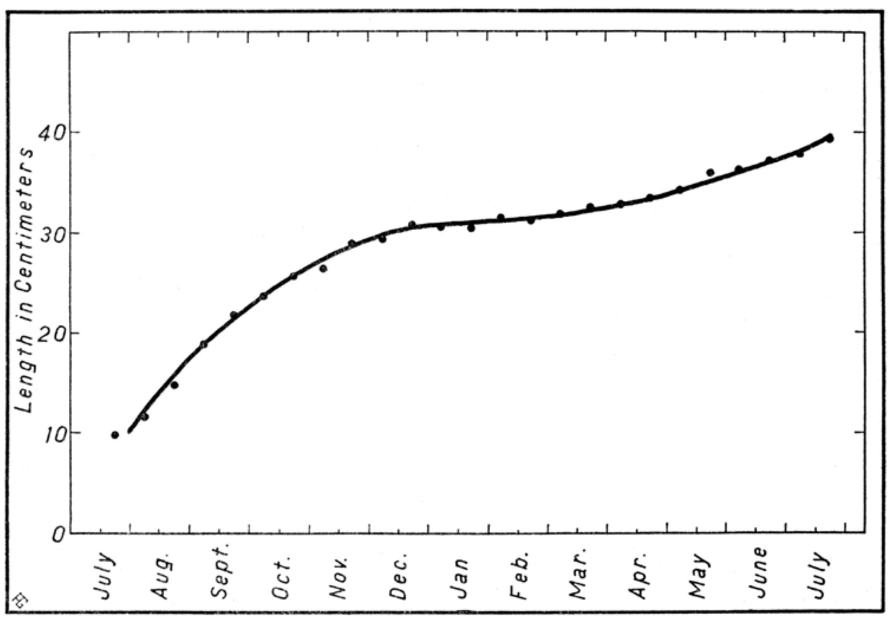

FIG. 20. Showing the first year's growth of the barracuda. The dots represent the average total lengths, the solid line the trend.

FIG. 20. Showing the first year's growth of the barracuda. The dots represent the average total lengths, the solid line the trend

an annulus in scales, and therefore is an important link in our chain of evidence. Unfortunately, since the fishing of Messrs. Carmen and Wagner failed to net sufficient specimens of the two and three year old fish to form a basis for detailed growth studies of these classes, we are unable to demonstrate cyclical changes in growth beyond the first year. The measurements of young fish larger than the 1927 year class were grouped into bimonthly periods and plotted in figure 21. Although, because of small numbers of specimens, these curves are

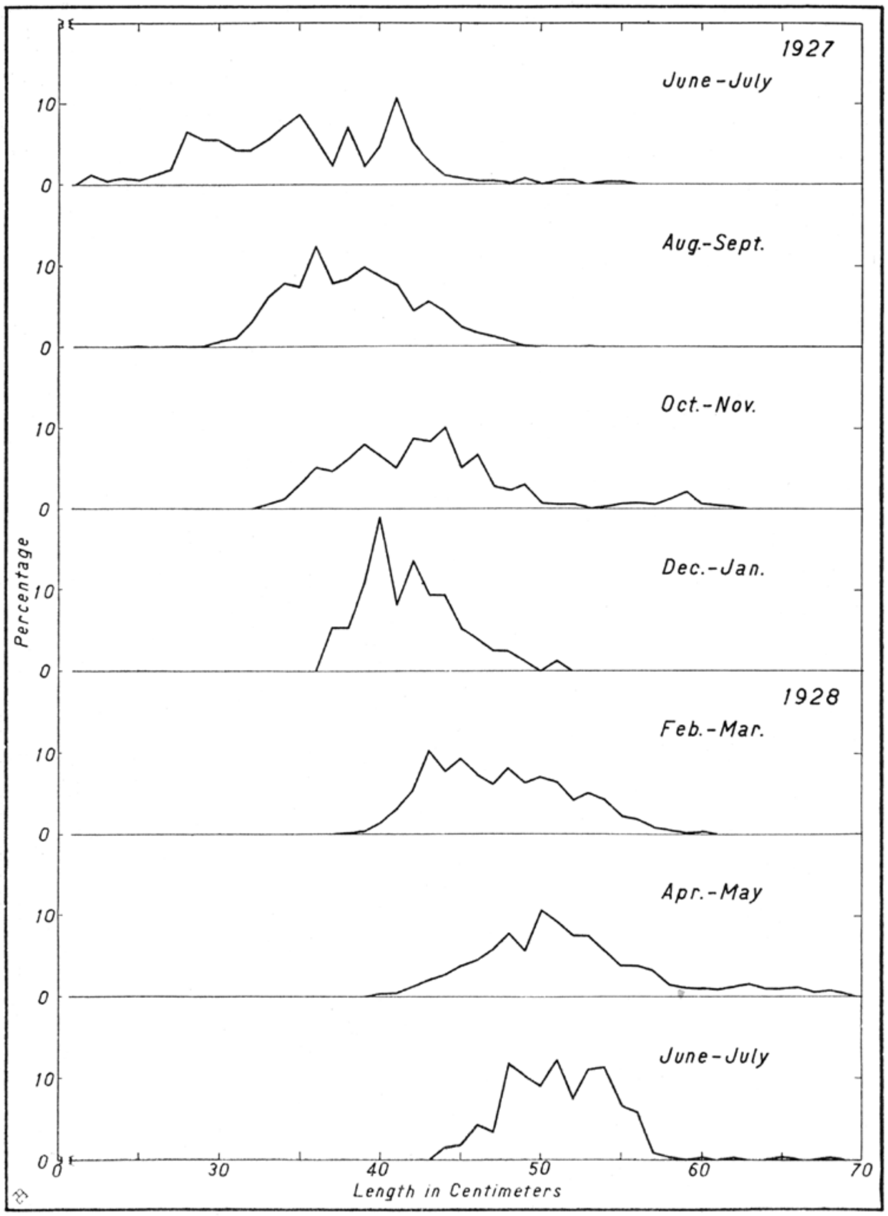

FIG. 21. Showing the size distribution of second year fish, in bimonthly periods from June, 1927, to July, 1928, inclusive.

FIG. 21. Showing the size distribution of second year fish, in bimonthly periods from June, 1927, to July, 1928, inclusive

exceedingly irregular, they are, according to the scale readings, with the exception of the October-November curve and the April-May curve, all of the 1926 year class. The two curves mentioned above contain a few specimens of the 1925 year class, indicated by the two low modes to the right of the dominant modes.

1.3.2.3. Time of Formation of the Annulus

1.3.2.3. Young Fish

Although the annulus is presumed to be caused by a resumption following a slowing down of growth, it does not become manifest until some time after growth has recommenced. In other words, if the annulus is due to slackened growth, the actual registration of the annulus on the scale occurs some time before our observations detect its presence. To determine the approximate time when the first annulus is formed, scales of 2,359 fish of the 1927 year class taken during the year ending July, 1928, were used. In addition to these, 152 scales of 1926 year class fish taken during July, 1927, were used. The results of these studies are shown in the solid line of figure 22, in which the data have been smoothed by eye to show the trend. It is to be observed that no annulus appeared before the week of May 6–12 in 1928; that annuli appeared on 50 per cent of the scales during the week of May 27–June 2, and on 100 per cent of the scales after the week of July 1–7. The total period covered during which the annuli became evident was nine weeks. As we have already seen (fig. 20), slackening in growth occurred during the winter, from about December 15 to about March 15, the period preceding annulus formation in the scales of the young fish.

1.3.2.3. Older Fish

Because of the limitations of the fishing season, scale studies of large fish are restricted to the fishing months—April to September. Since the 1928 scale collection of market fish does not extend beyond July 7, 265 scales from the 1927 collection taken August 12 and September 9 were used. In order to find approximately the time of formation of the annulus in these scales, we indicated, while recording each scale reading, whether there was an annulus close to the margin of the scale or whether there was a considerable space between the margin and the last annulus. Because the annuli which are formed after about the fifth year are very close to each other, all fish older than five years were excluded from this study. The results of these observations are shown graphically in the broken line in figure 22. Before the week of April 22–28, none of the scales registered an annulus near the margin; between June 24 and July

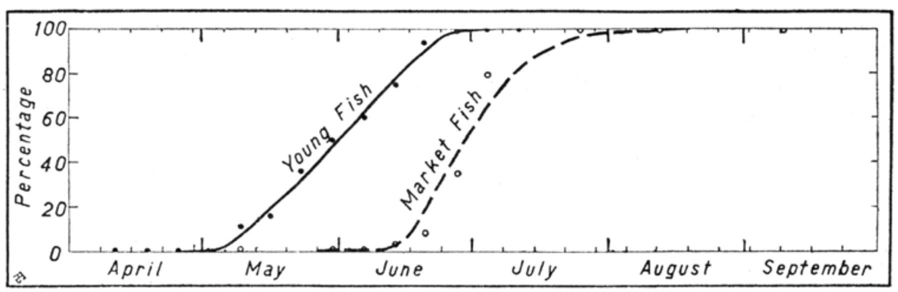

FIG. 22. Showing the time when the annulus becomes visible in the scales. The original observations, shown by solid dots for the young fish and by open circles for the market fish, are smoothed to show the trend.

FIG. 22. Showing the time when the annulus becomes visible in the scales. The original observations, shown by solid dots for the young fish and by open circles for the market fish, are smoothed to show the trend

7, the percentage increased from 35 to 79; on August 12, 1927, 100 per cent of the scales showed an annulus. Notwithstanding the incompleteness of the 1928 material, the trend of the curve moved rapidly toward 100 per cent. The difference between the time when the annulus is formed in small and large fish may be explained by the slower growth in the large fish, which presumably delays the exposure of the annulus. The formation of annuli on the scales of the fish sampled, during a definite period of the year—the spring—not at haphazard times throughout the year, and the fact that finally 100 per cent of the scales registered an annulus near the margin, constitute strong arguments in support of the premise that these marks are yearly in occurrence.

1.3.2.4. Scale Readings

1.3.2.4. Methods

During the period from April 1 to July 8, 1928, scales were collected from 5000 market fish and from 2208 young fish. After the length and sex of each fish had been recorded, several scales were removed from the region under the pectoral fin, or if necessary, from other parts of the body, and placed in an envelope. Although an extensive preliminary survey had evidenced that all legible scales on a given fish register the same number of annuli, it was found that scales from some parts of the body are more distinctly marked than those from others. The scales in the anterior part of the body are round, but those situated farther back are oval and more difficult to decipher. Not only are the scales under the pectoral fin of the round type, but, being free from dark pigment, they need less cleaning. Five or six scales from each envelope were mounted in water on a glass slide and examined under a compound microscope without reference to the size of the fish. Ages were recorded as the number of winters completed, the area between annuli being considered indicative of summer and autumn growth and winter quiescence. For the purpose of this study, March 31 was arbitrarily designated the last day of winter. Thus, a scale which registered no annulus but showed the growth of the previous summer and autumn, was recorded as belonging to the 0 year class prior to April 1, to the I year class on and after that date. A scale showing one annulus beyond which was an area of growth, was recorded as belonging to the I year class before and to the II year class on and after April 1. While the spaces between the first five annuli were sufficiently wide for reasonably consistent and accurate counting, those beyond six became too narrow, and the year marks too crowded, to justify any attempt at trustworthy age determination beyond six years.

After all the scales had been interpreted, the number of fish at each length within each separate age class was recorded and graphed. These graphs (length frequency polygons) were then all superimposed upon a length frequency polygon of all the fish combined. (See fig. 23) The 0, I and II year classes correspond completely with modes in the total fish curve. Because of considerable overlapping beyond the II year class, complete correspondence is not possible, and no attempt is made to prove the readings of the older classes by this method. Nevertheless, reflections in the modes of the IV and V year classes are suggested in the total curve. The skewness in the I year class is due to the method of sampling, in which a few of the smaller individuals were

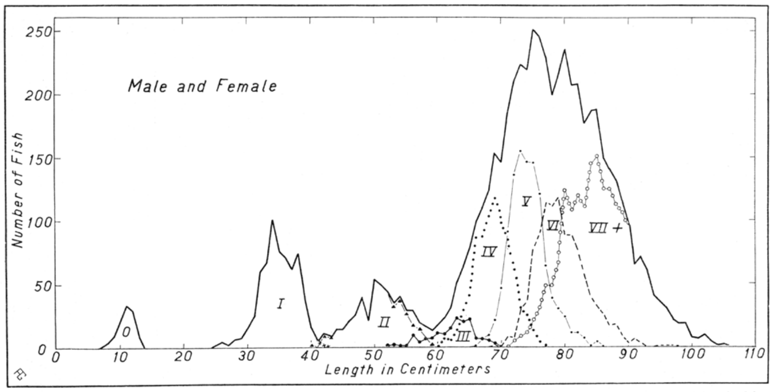

Fig. 23. Comparing the size distribution of all fish sampled (represented by the solid line) with that of each age class as determined by scales (represented by the broken lines, dots, etc.). Where the two lines coincide, only the solid line is used.

FIG. 23. Comparing the size distribution of all fish sampled (represented by the solid line) with that of each age class as determined by scales (represented by the broken lines, dots, etc.). Where the two lines coincide, only the solid line is used

deliberately chosen for scale studies. Since the second year fish were nearly all part of the special collections of young fish, the skewness in the II year class curve is doubtless due to a selection by the fishermen against the larger sizes. The suppression of year class III is due to two causes: First, the legal size limit falling at about 72 centimeters, beyond the upper limit of the three-year-olds, necessitated a repression by the commercial fishermen. Second, the III year class, falling in the upper part of the size range of *small* fish, was probably excluded by the special fishermen. While the curves of the next two year classes, the fours, which fall mostly below, and the fives, which fall mostly above the three-pound limit, are reasonably symmetrical, the curve of the sixes is noticeably skewed. This obliquity, due, no doubt, to inaccuracies in scale readings and to the difficulty of distinguishing ages older than six, further justifies not using readings beyond six. Separate graphs for males and females, shown in figure 24, indicate no particular peculiarities except an inexplicable mode in the older-than-six curve of the females.

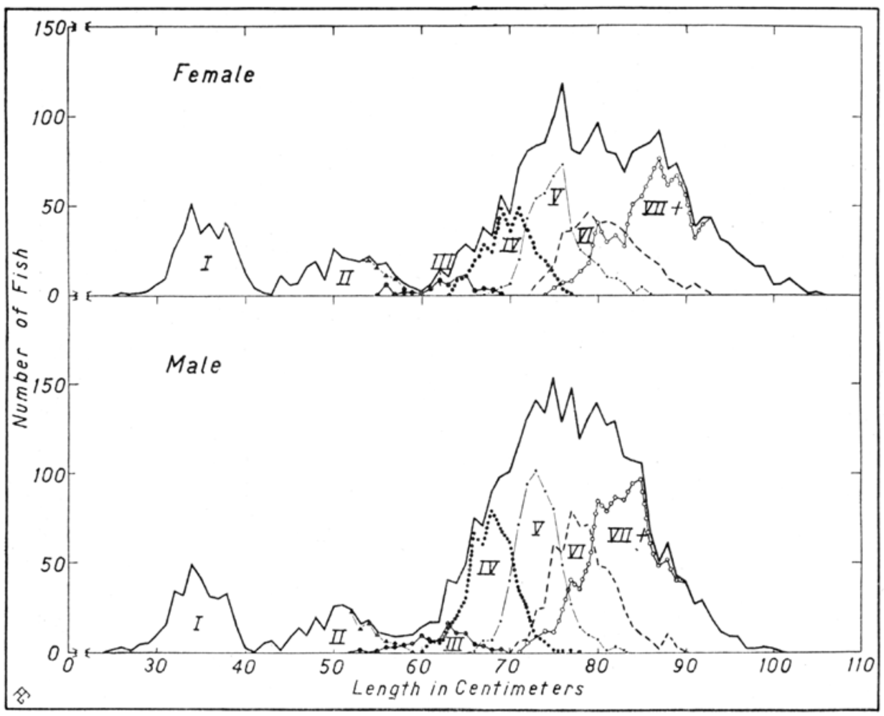

FIG. 24. Comparing for each sex the size distribution of all fish sampled (represented by the solid line) with that of each age class as determined by scales (represented by the broken lines, dots, etc.). Where the two lines coincide, only the solid line is used.

FIG. 24. Comparing for each sex the size distribution of all fish sampled (represented by the solid line) with that of each age class as determined by scales (represented by the broken lines, dots, etc.). Where the two lines coincide, only the solid line is used

1.3.2.5. Consistency in Scale Readings

In order to measure the percentage of scales which, by reason of their indefiniteness, admit of uncertainty in age determinations, and to evaluate the ability of one to read the scales consistently, two tests were made. First, three months after all the age studies had been completed, 200 unselected scales, representative of all sizes, were again aged, and under a different magnification than had been used before. When these second readings were compared with the first, it was found that 179, or 89.5 per cent, were the same. All of the one-, two- and three-year-old readings in both sets of data agreed. A few inconsistencies occurred between the four- and five-year-olds, a few more between the fives and sixes, and most between the sixes and older-than-sixes. In other words, the greatest error in the barracuda scale readings occurred in the older fish.

The second test was to submit a series of 32 scales to another person to interpret. Dr. Frances N. Clark, who kindly made this test, with no previous experience with barracuda scales, agreed with the author's readings in 21, or 66 per cent, of the cases. In a second reading by Dr. Clark, this percentage increased to 88. While these tests do not prove the validity of the age readings, they do assure that the annuli on barracuda scales can be counted with a fair degree of consistency.

1.3.2.6. Annual Growth

It is possible, by means of the scale readings, to trace approximately the growth of the barracuda for six years of its life, but because of the limitations in the availability of material imposed by the fishing season, growth studies sufficiently detailed to reveal cyclical changes beyond the first year were prevented. The solid line in figure 25 shows the average total lengths of each year class, for both sexes combined, for the period April 1 to July 7, 1928, and the dotted line plus and minus three times the standard deviation. Growth in the

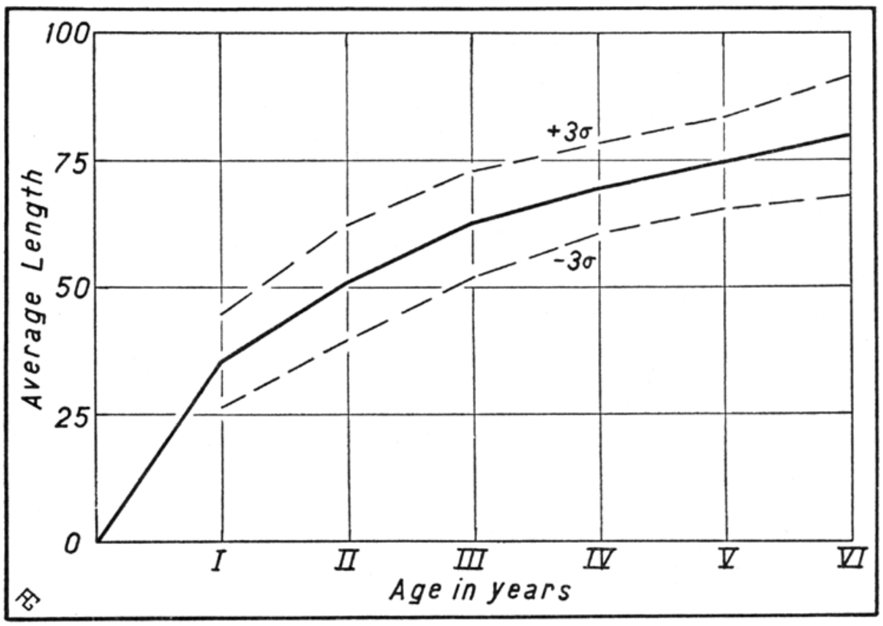

FIG. 25. Showing the growth of the barracuda for six years. The solid line connects the average lengths, the dotted lines plus and minus three times the standard deviation. Lengths are in centimeters.

FIG. 25. Showing the growth of the barracuda for six years. The solid line connects the average lengths, the dotted lines plus and minus three times the standard deviation. Lengths are in centimeters

barracuda, as has been shown for many other species of fishes, is rapid during the first year, and decreases gradually during succeeding years. In figure 26 normal probability curves for each sex have been constructed from the original data, which are shown by the open circles

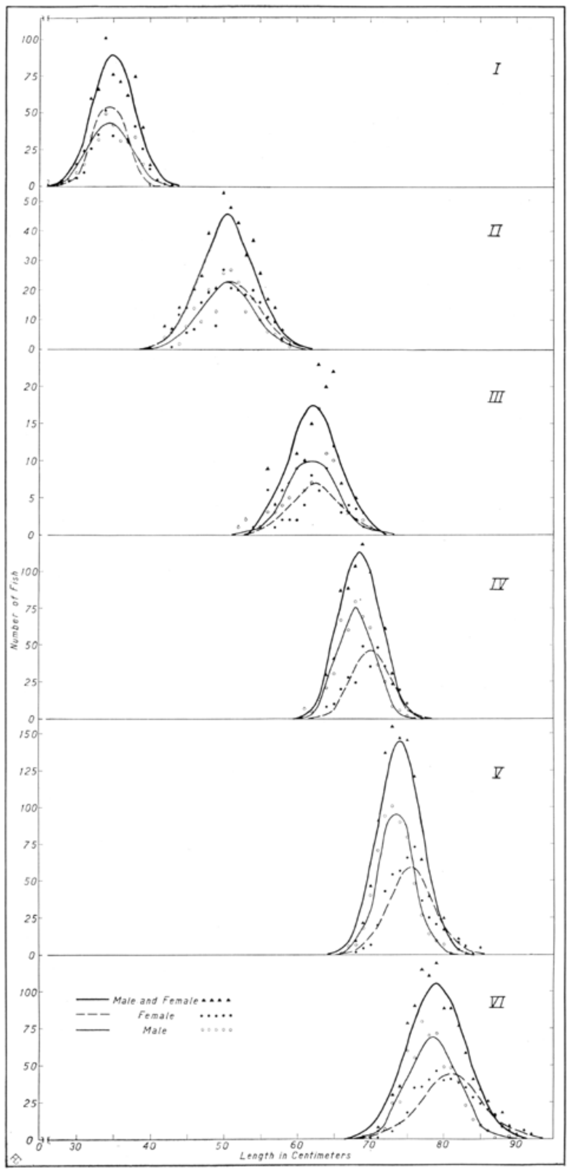

FIG. 26. Normal size distributions of total fish, of males and of females, at each age class as determined by scales. The original figures are indicated by the symbols shown in the lower left hand corner of the chart.

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FIG. 26. Normal size distributions of total fish, of males and of females, at each age class as determined by scales. The original figures are indicated by the symbols shown in the lower left hand corner of the chart

for the males and by closed circles for the females. No significant difference in size between the sexes is noticeable until the fourth year, when the females appear to be about 3 per cent larger. That this dimorphism becomes slightly greater in the oldest fish is indicated by a difference of 5 centimeters between the largest males and the largest females in the older-than-six curve.

1.3.2.6. Maximum Age

Although, as it has already been explained, age readings beyond six years were not included in this investigation, scales of a few older fish were fairly legible. No fish that was aged seemed to have attained more than eleven years. The largest fish that was collected, 105 centimeters long, registered only 11 rings. If these estimations are correct, the barracuda can not be considered to be a long-lived species, as compared with such fish as the northern halibut, which lives to be at least eighteen years old (Thompson, 1914), or as the European herring, which attains at least twenty years (Lea, 1930).

1.3.3. Age and Size at First Spawning

In determining the age and size at first spawning, both the fish which were sampled in the markets and the small fish that were especially caught for the barracuda investigation, were used. The gonads of all fish measured throughout the year were examined and their condition recorded. Since none of the smaller fish showed signs of maturity before or after the spawning season of the adult fish, yet since there was a possibility of their having a shorter spawning season, only fish taken during the heights of the adult spawning season, that is, from May 15 to July 25, were considered. For the females, the presence of ovaries of the group *b* class, that is, full of maturing eggs, was considered sufficient evidence that spawning would be accomplished during the same season. For the males, the whiteness and enlargement of the gonads characteristic of maturity was the criterion.

Figure 27 shows graphically for both sexes the percentage of mature fish among those of each length, plotted by centimeters. Both sets of data are smoothed by eye to show the trends. Figure 28 presents the number of mature fish at each age, as determined by scale readings. Comparison of this graph with the year class frequency

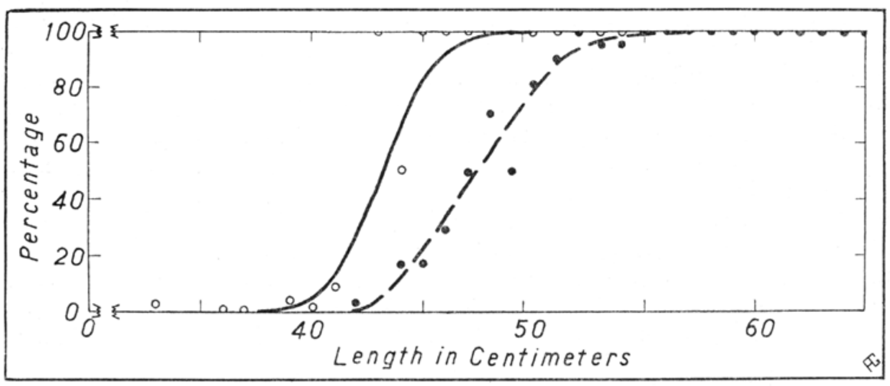

FIG. 27. Showing the size when first maturity occurs. The open circles represent the percentage of males, and the black dots the percentage of females, which mature at the indicated lengths. The solid line for the males, the broken line for the females show the trends.

FIG. 27. Showing the size when first maturity occurs. The open circles represent the percentage of males, and the black dots the percentage of females, which mature at the indicated lengths. The solid line for the males, the broken line for the females show the trends

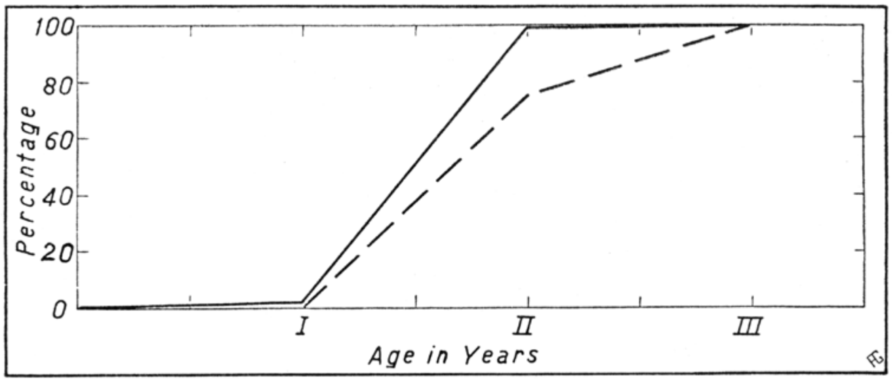

FIG. 28. Showing the age when first maturity occurs. The solid line represents the percentage of males, and the broken line the percentage of females which mature at the indicated ages.

FIG. 28. Showing the age when first maturity occurs. The solid line represents the percentage of males, and the broken line the percentage of females which mature at the indicated ages

curves of figure 23 shows that maturity, at least in the females, is evidently dependent on size rather than on age. For example, 29 per cent of the two-year-old females are mature at 46 centimeters, 50 per cent at 49 centimeters, 100 per cent at 55 centimeters. Spawning of the males at an earlier age and smaller size than of the females, as shown in both figures, is a condition which has been noted for many species of fish. Tables 4 and 5 detail the data which were available in this study.

1.3.4. Growth in Weight

In order to effect a more complete picture of the growth of the barracuda and to provide a suitable basis for judgment of the present three-pound size limit, a study of the relation between the length and the weight was made, on the basis of measurements and weights (in grams), of 575 individuals. Since all sizes were not available at the same time, it was necessary to use small fish collected from August 1, 1927, to July 1, 1928, but the market sizes were all taken during June, 1928.

1.3.4.1. Methods

The data thus obtained were treated by the usual methods employed in these studies, the formula $W = KL^{x}$ being used, in which *W* is the weight, *K* a constant, *L* the length, and *x* the power expressing the relation between increases in weight and length. The natural numbers were changed to logarithms, and the latter fitted with a straight line by the method of averages (Lipka, 1918, p. 126). Because the line of regression of weight on length may differ from that of length on weight, as is common in ordinary linear correlation, a single curye for predicting weight from length and length from weight might lead to difficulty. Theoretically, the two curves should be drawn separately, unless the two are close enough to render the difference negligible for ordinary purposes. However, for barracuda, the two regressions, plotted on a logarithmic scale in figure 29, are so close, that it is justifiable to use one curve in this paper.

Assuming that the form and specific gravity of a fish does not change, the weight may be expected to increase as the cube of the length, or, stated symbolically, $W = KL^3$. Although this relationship

TABLE 4

Age at First Spawning of Barracuda

Age in years	Total number females	Number mature females	Per cent mature females	Total number males	Number mature males	Per cent mature males
1	3,067	0	0	3,115	49	1.6
2	193	146	75.6	153	152	99.3
3	43	43	100.0	54	54	100.0

TABLE 4

Age at First Spawning of Barracuda

TABLE 5

Size at First Spawning of Barracuda, May 15 to July 25

Total length in centimeters	Females			Males		
	Total number	Number mature	Per cent mature	Total number	Number mature	Per cent mature
33	------	------	------	63	1	2
34	------	------	------	177	0	0
35	------	------	------	307	0	0
36	------	------	------	552	4	1
37	------	------	------	624	6	1
38	------	------	------	583	8	1
39	401	0	0	408	15	4
40	242	0	0	332	5	1
41	122	0	0	104	9	9
42	52	0	0	33	1	3
43	15	0	0	6	6	100
44	12	2	17	2	1	50
45	6	1	17	8	8	100
46	7	2	29	14	14	100
47	16	8	50	9	9	100
48	19	13	70	20	20	100
49	8	4	50	13	13	100
50	27	22	81	26	26	100
51	21	19	90	27	27	100
52	20	20	100	23	23	100
53	19	18	95	13	13	100
54	20	19	95	17	17	100
55	16	16	100	10	10	100
56	11	11	100	6	6	100
57	9	9	100	5	5	100
58	3	3	100	3	3	100
59	1	1	100	3	3	100
60	5	5	100	5	5	100
61	11	11	100	11	11	100
62	10	10	100	10	10	100
63	24	24	100	24	24	100
64	28	28	100	------	------	------
65	38	38	100	------	------	------
66	71	71	100	------	------	------
67	68	68	100	------	------	------
68	88	88	100	------	------	------
69	96	96	100	------	------	------
70	101	101	100	------	------	------

TABLE 5

Size at First Spawning of Barracuda, May 15 to July 25

has been found to obtain in many animals, for example in the edible crab (Weymouth, 1918, p. Q86), a higher or lower exponent than the cube has been found for many species, for instance, in the Pismo clam (Weymouth, 1923, p. 66) and in the California sardine (Clark, 1928, p. 10). In other words, at the various lengths, the ratio [*weight*/*length* 3] is in some animals not constant, but decreases with increase in length, or vice versa. In the barracuda, the value of *x* was found for the average weight at each length to be 2.983; for the average length at each weight 2.973—figures close enough to 3 to be demonstrative of but slight changes in configuration with increase of size. The value of

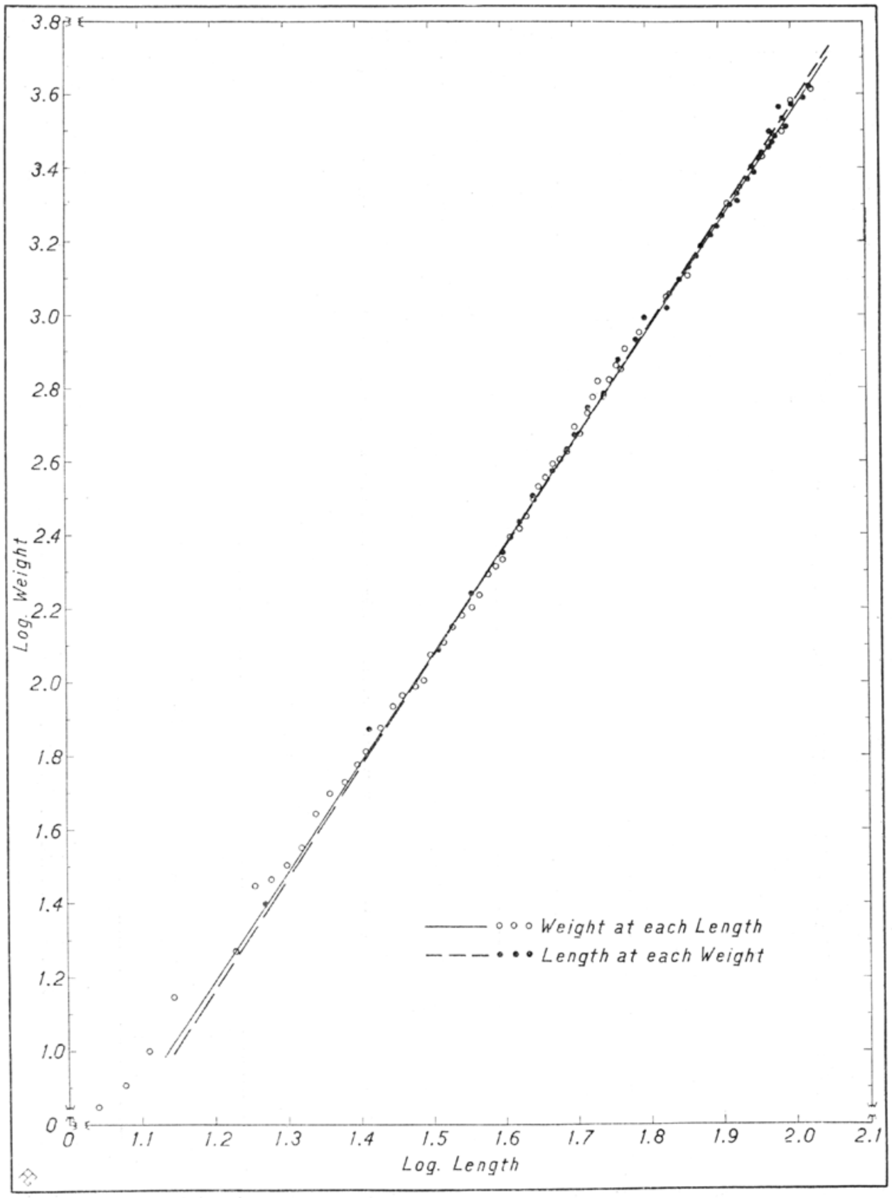

FIG. 29. Average weight at each length (solid line, open circles) compared with average length at each weight (broken line, black dots). The data are plotted on a logarithmic scale and fitted by the method of averages.

FIG. 29. Average weight at each length (solid line, open circles) compared with average length at each weight (broken line, black dots). The data are plotted on a logarithmic scale and fitted by the method of averages

K for the average weight at each length was .003962, thus making the formula for obtaining the weight in grams when the length is known, W = $.003962\ L^{2.983}$ Figure 30 presents the weights (vertical lines) plotted against the lengths (horizonal lines) fitted with a curve constructed from the above formula. It is to be observed that at certain places on the curve, notably between 50 and 60 centimeters, and between 70 and 90, the original data digress more or less from the fitted curve, thus revealing complications in the rule. Apparently the value of *x* changes during life, possibly at maturity (around 50 centimeters) and with advanced age, possibly seasonally. That the value of *K* changes seasonally has been demonstrated for other fishes, for example for the California sardine (Clark, 1928).

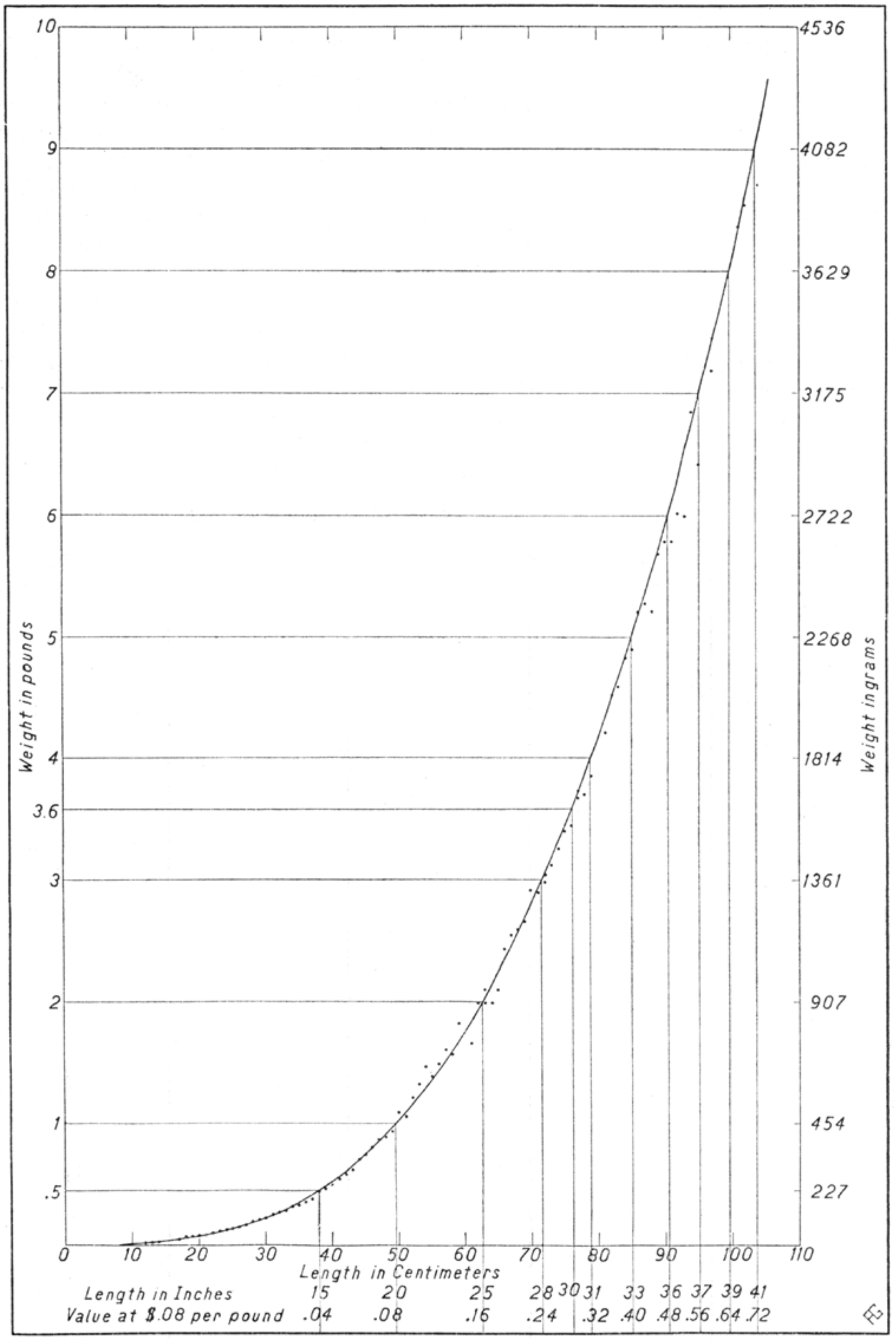

FIG. 30. Showing the calculated weight at each length and the value at eight cents per pound. The original observations, indicated by the black dots, are fitted by the method of averages.

FIG. 30. Showing the calculated weight at each length and the value at eight cents per pound. The original observations, indicated by the black dots, are fitted by the method of averages

1.3.4.2. Economic Bearing of Growth in Weight

Figure 30 also shows the weights in pounds and grams, the lengths in feet and centimeters, as well as the value of the fish in terms of 8 cents a pound, an arbitrary, roughly representative figure. The same data are presented in table 6. The salient revelations of figure 30 which are of interest economically are these: While growth in length proceeds rapidly at first, more slowly later, growth in weight, on the contrary, is relatively slow at first, rapid later. Since the value of the fish in terms of dollars and cents is directly dependent on weight, only indirectly dependent on length, the importance of the larger fish is of interest not only to conservationists, but of economic concern to the fish dealers. Table 7 gives the calculated weight for the average length of each year class, the value at 8 cents a pound, and the annual percentage increase in value per fish. Notwithstanding the fact that the subject is considerably complicated by the factor of mortality, it is obvious that up to a certain point, for maintaining a relatively high size limit, the fishermen are paid not only by the knowledge that they are helping to provide for the perpetuation of the supply, but by actual higher monetary returns for their efforts.

TABLE 6

A Table of Weights and Lengths of Barracuda Calculated from the Formula W= .003962 $L^{2.983}$

Total length in centimeters	Total length in inches	Calculated weight in grams	Calculated weight in pounds	Value at 8 cents per pound
11.0	4.3	5		
13.0	5.1	8		
14.0	5.5	10		
17.0	6.7	19		
19.0	7.5	26		
21.0	8.3	35		
23.0	9.1	46		
25.0	9.8	59		
27.0	10.6	74		
29.0	11.4	91		
31.0	12.2	111		
33.0	13.0	134		
35.0	13.8	160		
37.0	14.6	188		
39.4	15.5	227	.5	.04
41.0	16.1	256		
43.0	16.9	295		
45.0	17.7	338		
47.0	18.5	385		
49.7	19.6	454	1.0	.08
51.0	20.1	491		
53.0	20.9	551		
55.0	21.7	615		
56.9	22.4	680	1.5	.12
57.0	22.4	684		
59.0	23.2	758		
62.7	24.7	907	2.0	.16
67.5	26.6	1,134	2.5	.20
71.8	28.3	1,361	3.0	.24
75.6	29.8	1,588	3.5	.28
79.1	31.4	1,814	4.0	.32
82.2	32.4	2,041	4.5	.36
85.2	33.5	2,268	5.0	.40
88.0	34.6	2,495	5.5	.44
90.6	35.7	2,722	6.0	.48
93.0	36.6	2,948	6.5	.52
95.4	37.6	3,175	7.0	.56
97.6	38.4	3,402	7.5	.60
99.8	39.3	3,629	8.0	.64
101.8	40.1	3,856	8.5	.68
103.8	40.8	4,082	9.0	.72
105.7	41.6	4,309	9.5	.76

TABLE 6

A Table of Weights and Lengths of Barracuda Calculated from the Formula W = .003962 $L^{2.983}$

TABLE 7

Annual Increase in Value of Barracuda

Year class	Average total length in centimeters	Weight in pounds	Value in cents (at 8 cents per pound)	Annual percentage increase in value
1	35.39	.36	.03	
2	51.08	1.08	.09	200
3	62.82	2.02	.16	78
4	69.26	2.78	.22	38
5	74.71	3.37	.27	23
6	79.92	4.14	.33	22

TABLE 7

Annual Increase in Value of Barracuda

1.3.5. What Does the Three-Pound Limit Protect?

The foregoing discussion on the growth of the barracuda presents a reasonable basis for evaluating the protection afforded by the three-pound size limit. While the calculated length of the three-pound fish is 71.8 centimeters, or 28.3 inches, there is a variation in the actual measurements about this figure, some fish being larger, others smaller than 71.8 centimeters. Nevertheless, most measurements occur near the calculated value, others fall less near, but none occurs very far away. In other words, with each calculated weight as a median, the actual lengths can be arranged in normal probability curves. Figure 31 illustrates

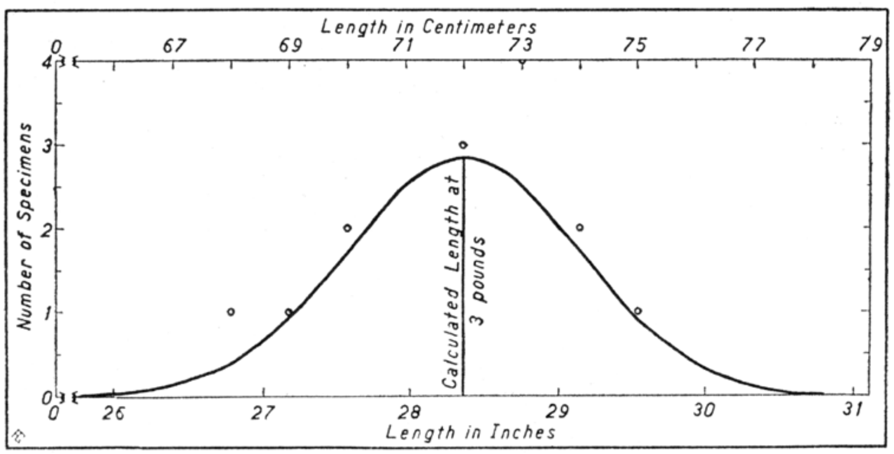

FIG. 31. Showing the normal distribution of lengths at three pounds.

FIG. 31. Showing the normal distribution of lengths at three pounds

this premise with a probability curve of the lengths which occur from 1304 to 1417 grams (2.875 and 3.124 pounds). The average deviation of the actual lengths from the calculated lengths of 66 to 78 centimeters was 2.057 ± .026 centimeters or .810 ± .0102 inches. In spite of these biological variations, since there are theoretically as many three-pound fish that are longer as there are that are shorter than 28.3 inches, it is justifiable to use this length, without regard to variations, in our study.

If the three-pound limit operated with exactitude, there should be in the markets a rather abrupt drop in the numbers of fish shorter than 28.3 inches. Such a precise operation of the law, however, would have to presuppose many conditions which do not exist. In the first place, as willing as fishermen may be to cooperate in the enforcement of this law, certain conditions prevent their knowing when they are not strictly observing it. Since no fishing boat carries scales, fishermen must trust to their judgment in separating the legal from the illegal sized fish.

When the fish reach the markets, they are packed by the fishermen into boxes, which are then hauled ashore and weighed. Soon after the fish are delivered into the markets, they are removed from the boxes, thrown on to the butchers' tables, cleaned and washed. Since during the heights of the season, many hundreds of fish must be cleaned daily, and since barracuda spoil rather readily while not on ice, and soften with much handling, speed is an essential qualification of the butchers. To weigh each fish individually would lessen the speed considerably, increase the handling, and the expense of handling, would make the law very unpopular, and probably lead to an economic loss. Consequently the marketmen as well as the fishermen must depend upon personal judgment in distinguishing illegal sized fish. As for the law enforcement machinery of the California Division of Fish and Game, additional complicating factors obtain. Is a man's catch to be seized, for example, because in a box of fish there happens to be two or three specimens that are 2.9 pounds? The prevalence of borderline cases such as this requires the continual judgment of the officers. Furthermore, to maintain a staff of officers to weigh and approve each fish individually would not only hasten the spoilage of the fish, but would be a clumsy, inept enforcement of the letter of the law. The officers make seizures and arrests in cases where there has been obvious intention of breaking the law, or where the number of borderline or small sizes is more than incidental.

In view of the foregoing facts, it is not surprising that some percentage of the commercial catch consists of undersized fish. During the entire 1928 season, measurements were taken of the fish which were observed for condition of maturity. These fish were measured on the tables during the cleaning, without regard to size. Since this work was carried on in all markets, the catches of many of the boats were sampled, and the total data should be a fair representation of the entire commercial

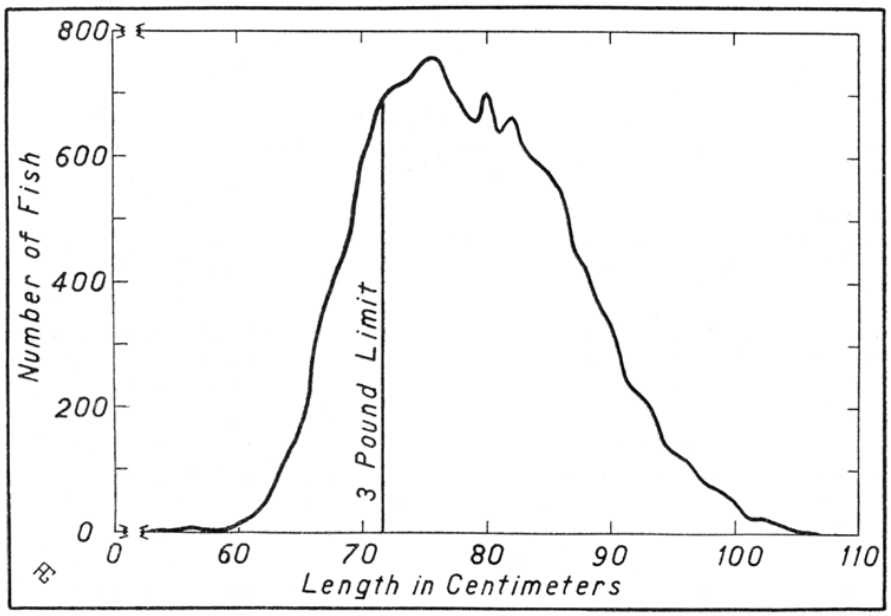

FIG. 32. Size distribution of fish taken in the markets, showing the proportion of illegal sized fish that occurs in the commercial catch.

FIG. 32. Size distribution of fish taken in the markets, showing the proportion of illegal sized fish that occurs in the commercial catch

catch. Figure 32 presents graphically the number of fish at each length, a total of 16,367 specimens. It can be calculated from these data, that 16 per cent of the fish sold in the markets in 1928 were undersized. While the figures presented are for one year only, the presence of a not inconsiderable proportion of small fish was observed in 1927 and again in 1930. Table 8, in which the numbers of fish sampled and the amounts and percentages of undersized fish are tabulated by gears and by location of catches, shows that apparently only the catches made off the mainland contain undersized fish; those made off the islands contain practically none.

TABLE 8

Undersized Fish by Gears and by Districts

Gear	*Mainland Fish* Number specimens	Number undersized	Per cent undersized	*Island Fish* Number specimens	Number undersized	Per cent undersized
Gill nets	10,351	1,420	13.72	--	--	--
Circle nets	1,922	511	26.59	1,249	23	1.84
Jigs	2,650	702	26.49	195	4	2.05
Totals	14,923	2,633	17.64	1,444	27	1.87

TABLE 8

Undersized Fish by Gears and by Districts

In spite of the relatively low numbers in the sample of fish taken by the circle nets and jigs, the close observance given to the fishery in 1928, and the rather extensive field work, lends assurance to the belief that these figures are a fair representation of the proportions of barracuda fishing carried on by the different types of gears, and that these samples are reasonably representative of the catches. The evidence at hand, then, not only gives some degree of support to the contention that circle net boats land a greater proportion of undersized fish than do the gill net boats, but also shows a like tendency on the part of the jig boats.

By comparing now figure 32 with figure 23, some idea of the real protective value of the three-pound limit may be gained. All of the one-year-old fish are protected, practically all of the two and most of the three. Theoretically most of the four and some of the five are protected, but in actual practice, none of the five, and if we may judge by the symmetrical, almost "bell-shaped" curve of the four-year-olds, the four-year fish are little, if at all, restricted from the commercial catch.

Since 75 per cent of the females spawn in the second year, and 100 per cent in the third, it is evident that 100 per cent of the fish are protected during at least one spawning season, less than 75 per cent during two, possibly a small percentage during three. However, the relation between the size of fish and number of mature eggs produced makes clear that the first spawning season, and perhaps even the second, should not be depended upon to maintain the species. Whether the three-pound limit has given adequate protection to the barracuda, it is not possible to say in the light of present knowledge. The decrease in total catch since 1925 may possibly be explained by the suppression of the purse seine rather than by a depletion of the population. An investigation and analysis of the statistics of the barracuda catch should give a more adequate basis for judgment. In any case, it is certain that if a size limit is to operate efficiently, it should be stated in terms of length rather than weight, so that the fishermen on the fishing grounds can have a more convenient and practicable method of distinguishing illegal sized fish than is afforded by scales. Furthermore, the above evidence argues that when it is decided what size limit is desired, a higher figure than this limit should be designated as legal in order to make allowance for the proportion of undersized fish which gets into the catch.

1.4. SUMMARY

1. Practically nothing has been written on the biology of any of the barracudas of the world.

2. The only species of barracuda which reaches California markets, Sphyraena argentea, occurs from Cape San Lucas north to Puget Sound, but is taken in important numbers only south of Ventura County.

3. Catches are made in California from March until October, mostly in May, and in Mexico for delivery into California, from October until March.

4. There is a tendency for catches to be made farther north as the season progresses.

5. The commercial catch comprises fish from about 53 to about 108 centimeters.

6. Evidence is presented to show that fish from the Channel Islands are larger than those taken near the mainland.

7. There are three types of fishing gear used to catch barracuda: gill nets, circle nets and jigs.

8. At present (January, 1931), three pounds is the minimum size legally permitted to be taken.

9. The material for this study was gathered from the San Pedro fish markets and in special hauls which were made between Newport and Santa Monica.

10. Evidence is presented to show that:

–a. Barracuda spawn between April and September, a period concurring rather closely with the fishing season.

–b. Only a small proportion of the females spawns at the same time, the relative number fluctuating throughout the season.

–c. There is a tendency for the relative number of males to fluctuate as the relative number of spawning females.

–d. Individual fish spawn more than once each season.

–e.The number of mature eggs produced varies, the large fish producing more eggs than do the smaller.

–f. During the first year, there is a slackening in growth between December and March.

–g. Annuli were observed to form on the scales of first year fish between the beginning of May and the end of June, and on the scales of older fish between the beginning of June and the beginning of August.

-h. Age may be interpreted from the scales with reasonable accuracy up to the seventh year.
–i. Growth proceeds at about the same rate for both sexes until the fourth year, when the females appear to be about 3 percent larger than the males.
–j. Barracuda attain an age of at least 11 years.
–k.Of the females, 75 percent spawn in the second year, 100 percent in the third; of the males, a small percentage spawn in the first year, 100 percent in the second.
–l. Spawning, at least in the females, and in the region studied, is more closely related to size than to age.
–m. The usual length-weight relationship was found to obtain, that is, W=KLx, value of x being in these data 2.983.
–n.As the present three-pound limit operates, only the first three year classes are protected from commercial fishing.

1.5. SUMMARY OF RECOMMENDATIONS

1. A statistical analysis should be made on the catch records of the California barracuda, in order to learn the present condition of the population.

2.The present size limit of three pounds should be changed to not less than thirty inches.

1.6. LITERATURE CITED

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1.7. PLATE I

1—Barracuda scale of a year class 0 specimen taken in August, 1927, showing no annulus. (Magnified about 85 diameters.)

2—Scale of a year class I specimen taken in April, 1928, showing no annulus. (Magnified about 60 diameters.)

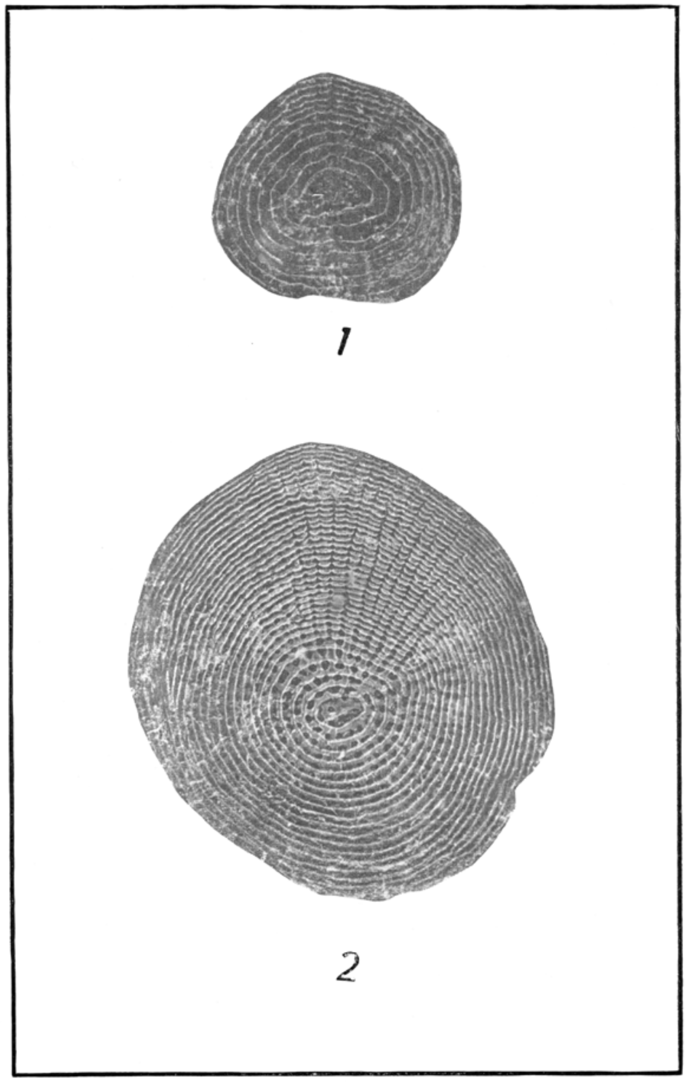

PLATE I

1.8. PLATE II

3—Scale from a year class I specimen, showing 1 annulus.

4—Scale from a year class II specimen, showing 2 annuli.

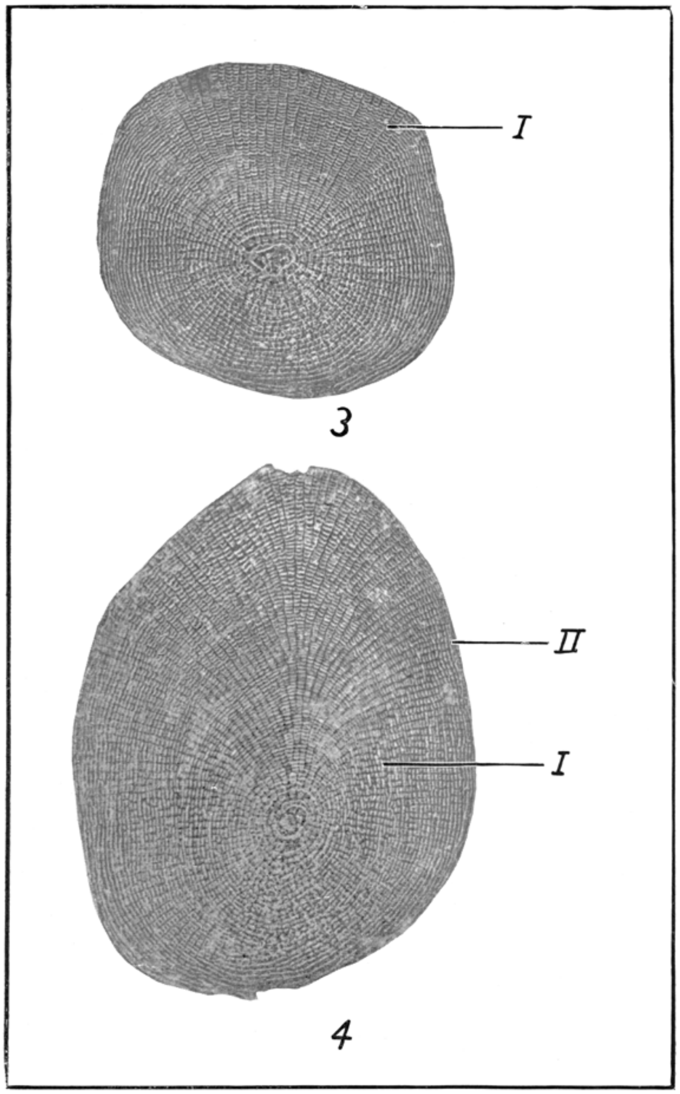

PLATE Ii

1.9. PLATE III

Scale of a year class III specimen, showing 3 annuli.

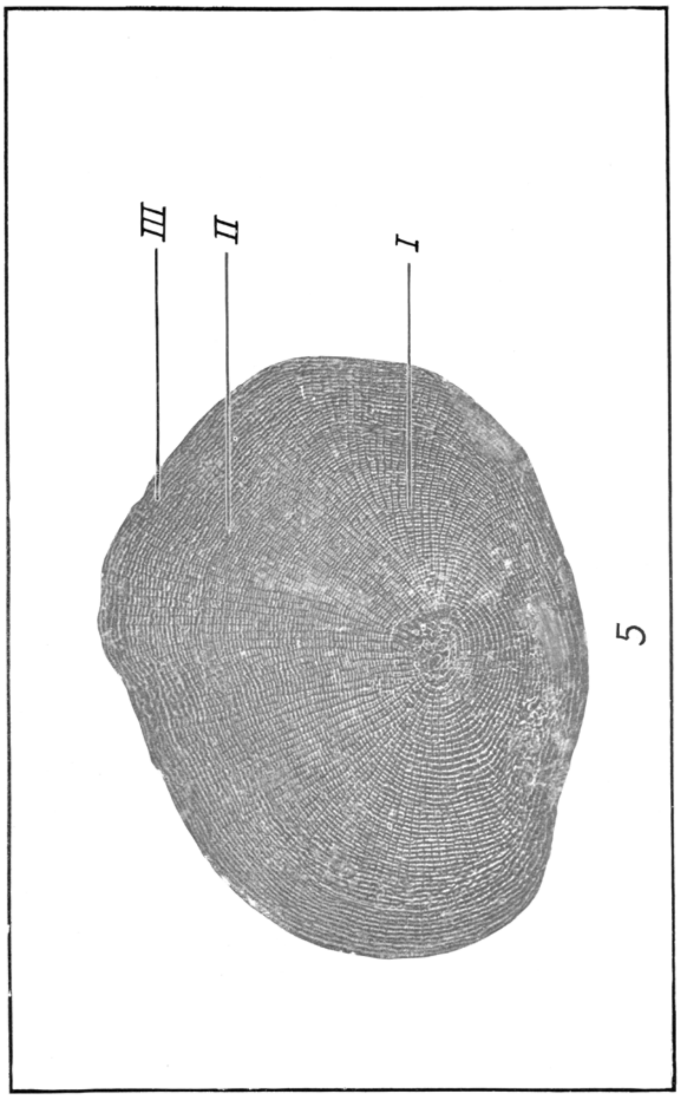

PLATE III

1.10. PLATE IV

Scale of a year class IV specimen, showing 4 annuli.

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PLATE IV

1.11. PLATE V

Scale of a year class V specimen, showing 5 annuli.

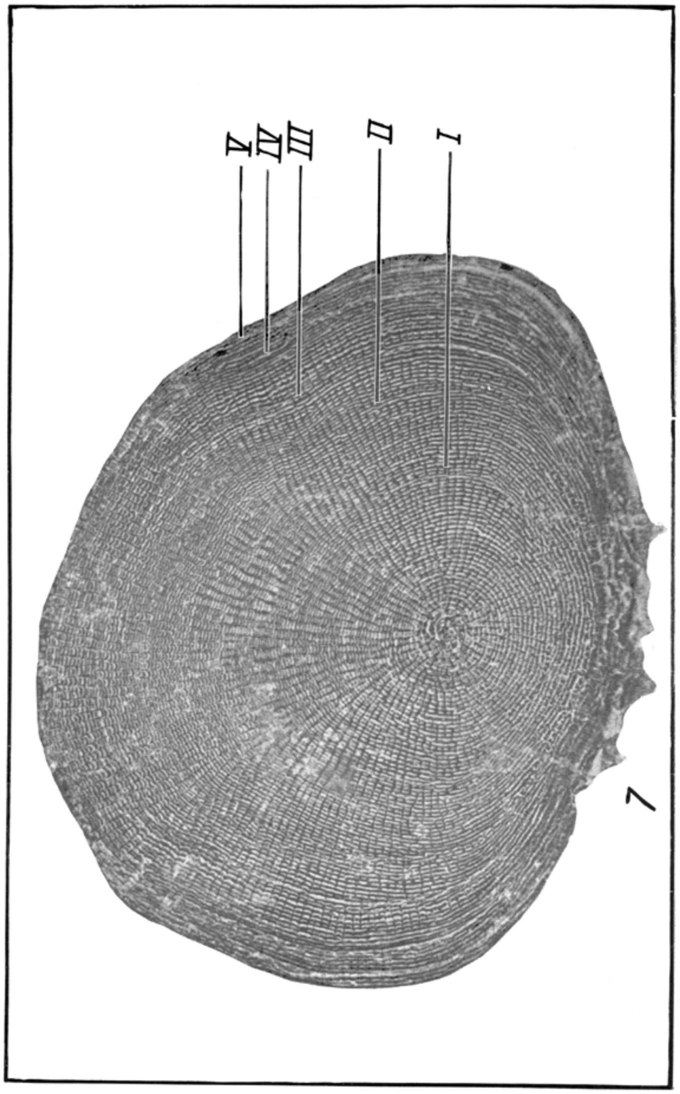
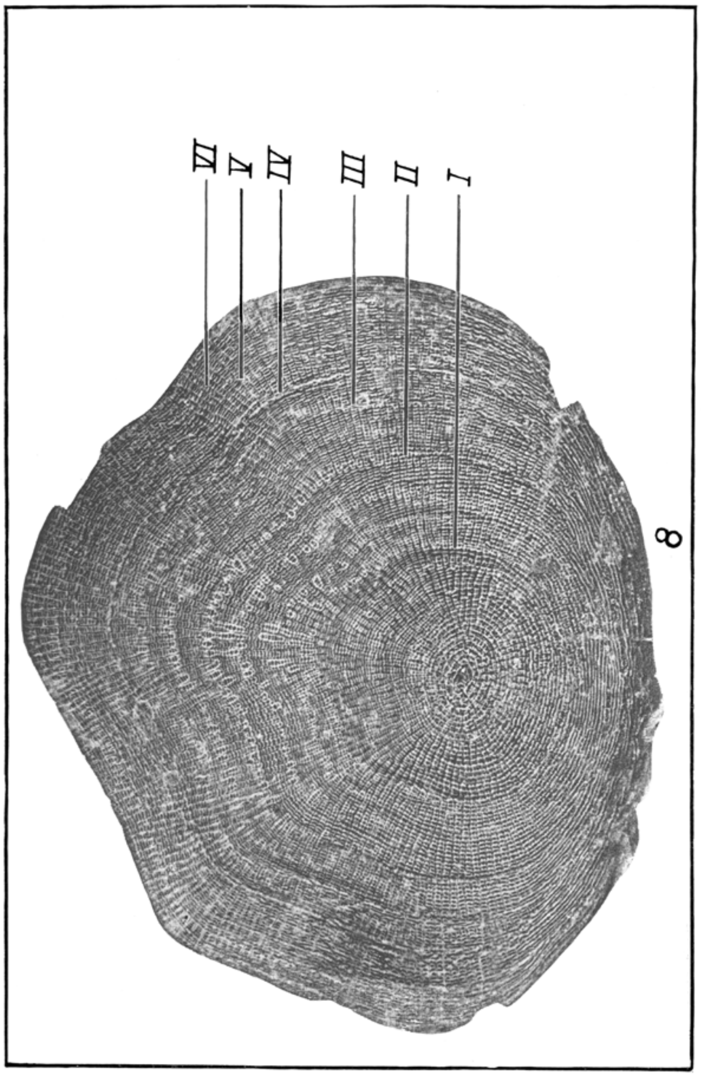


PLATE V

1.12. PLATE VI

Scale from a specimen older than 6 years, showing at least 6 annuli.



Insert 3—95288

PLATE VI

TABLE 9

Daily Spawning Observations, 1928

Date	Total number females	Females			Total number males	Males	
		Number immature (Stage *a*)	Number mature (Stage *c*)	Number spent (Stage *d*)		Number immature (Stage *A*)	Number spent (Stage *C*)
April 2	6	1			1	1	
April 10	19	15			29	24	
April 13	58	5			34		
April 16	45	13			37	4	
April 17	38	6			37	10	
April 23	102	1			104	2	
April 25	37	1			36		
April 26	15				16		
April 27	33				45		
April 28	134				167		
May 2	27		12		34		
May 3	45		1		21		
May 4	164		27		153		
May 5	84		30		45		
May 7	100				15		
May 8	159	1	4		41		
May 11	273		7		249		
May 14	103				127		
May 15	46				40		
May 16	100		11		117		
May 17	101		7		97		
May 18	100		4		92		
May 19	111		7		73		
May 21	25				11		
May 22	100	1	4		96		
May 23	106		6		77		
May 24	100				63		
May 25	81		3		80		
May 26	100		3		98		
May 28	100		5		96		
May 29	81		16		75		
May 30	100		45		305		
May 31	107		54		107		
June 1	100		6		94		
June 2	138		11		216		
June 4	61		6		131		
June 5	86		7		120		
June 6	27		1		119		
June 7	100		25		180		
June 8	44		14		172		
June 9	62		8		156		
June 11	86		4		113		
June 12	53		5		63		
June 13	52		1		81		
June 14	60		4		81		
June 15	101		6		139		
June 16	102		9		109		
June 18	100		18		63		
June 19	100		13		111		
June 20	52		8		230		
June 21	65		14		183		
June 22	65		24		168		
June 23	100		9		140		
June 25	100		10		119		
June 26	55		17		179		
June 27	100		16		109		
June 28	104		15		68		
June 29	101		13		67		
June 30	45		11		48		
July 2	50		2		31		
July 3	63		7		76		
July 5	108		4		60		
July 6	100		14		92		
July 7	100		5		83		
July 9	100		2		110		
July 10	100		1		126		
July 11	100		7		117		
July 12	100		7		107		
July 13	63		7		60		
July 14	77		1		112		
July 16	100		8		97		
July 17	100		25		137		
July 18	58		1		65		
July 19	21		7		21		
July 20	76		8		101		

TABLE 9
Daily Spawning Observations, 1928

TABLE 9—Continued

Daily Spawning Observations, 1928

Date	Total number females	Females			Total number males	Males	
		Number immature (Stage *a*)	Number mature (Stage *c*)	Number spent (Stage *d*)		Number immature (Stage *A*)	Number spent (Stage *C*)
July 21	52		4		45		
July 22	35				36		
July 23	51				94		
July 24	100		1		116		
July 25	102				88		
July 26	100				82		
July 27	65				70		
July 31	100				130		
Aug. 1	100				116		
Aug. 2	100				138		
Aug. 3	100				125		
Aug. 4	42				77		1
Aug. 6	100		1		208		
Aug. 7	100				200		
Aug. 8	100				201		
Aug. 9	33				37		
Aug. 10	82		1		99		
Aug. 11	20				59		
Aug. 13	99		6	5	110		11
Aug. 14	75				134		
Aug. 15	67		8		51		
Aug. 21	21			1	10		2
Aug. 22	100			6	129		32
Aug. 23	38		11	1	47		
Aug. 28	95				108		15
Aug. 30	100		1		72		21
Sept. 19	100			95	80		74

TABLE 9
Daily Spawning Observations, 1928

TABLE 10

Average Total Lengths of Year Class 1927 by Half-Monthly Periods, Showing the First Year's Growth

Period	Average Total length (cm.)	Standard deviation	Standard error (+ or —)	Number of specimens
July 16-31, 1927	10.2	.94	.222	18
Aug. 1-15, 1927	12.1	.86	.037	545
Aug. 16-31, 1927	15.3	.95	.072	174
Sept. 1-15, 1927	19.5	1.58	.069	522
Sept. 16-30, 1927	22.1	1.60	.039	1,726
Oct. 1-15, 1927	24.2	1.58	.046	1,195
Oct. 16-31, 1927	26.2	1.55	.041	1,435
Nov. 1-15, 1927	26.9	1.41	.054	691
Nov. 16-30, 1927	29.4	1.58	.049	1,033
Dec. 1-15, 1927	29.8	1.91	.068	767
Dec. 16-31, 1927	31.4	1.42	.034	1,699
Jan. 1-15, 1928	31.1	1.80	.112	258
Jan. 16-31, 1928	31.0	3.06	.191	257
Feb. 1-15 1928	32.0	2.71	.277	96
Feb. 16-29, 1928	31.7	2.07	.128	263
Mar. 1-15, 1928	32.3	2.95	.136	474
Mar. 16-31, 1928	33.1	1.55	.043	1,298
April 1-15, 1928	33.4	2.89	.119	587
April 16-30, 1928	34.0	1.52	.041	1,400
May 1-15, 1928	34.6	2.05	.175	137
May 16-31, 1928	36.5	1.85	.055	1,099
June 1-15, 1928	36.9	2.11	.065	1,057
June 16-30, 1928	37.6	2.02	.040	2,501
July 1-15, 1928	38.4	1.97	.056	1,250
July 16-31, 1928	39.9	3.41	.151	511

TABLE 10
Average Total Lengths of Year Class 1927 by Half-Monthly Periods, Showing the First Year's Growth

TABLE 11

Time of Annulus Formation—Year Class I

Date	Number examined	Number with annuli	Per cent with annuli
1928 (Year class 1927)			
July 24–30	18	0	0
July 31–Aug. 6	50	0	0
Aug. 7–13	42	0	0
Aug. 14–20	15	0	0
Aug. 21–27	20	0	0
Aug. 28–Sept. 3	24	0	0
Sept. 4–10	10	0	0
Sept. 11–17	50	0	0
Sept. 18–24	25	0	0
Sept. 25–Oct. 1	30	0	0
Oct. 2–8	20	0	0
Oct. 9–15	20	0	0
Oct. 16–22	25	0	0
Oct. 23–29	50	0	0
Oct. 30–Nov. 5	35	0	0
Nov. 6–12	8	0	0
Nov. 13–19	23	0	0
Nov. 20–26	40	0	0
Nov. 27–Dec. 3	46	0	0
Dec. 4–10	40	0	0
Dec. 11–17	45	0	0
Dec. 18–24	30	0	0
Dec. 25–31	39	0	0
Jan. 1–7	20	0	0
Jan. 8–14	35	0	0
Jan. 15–21	------	------	------
Jan. 22–28	20	0	0
Jan. 29–Feb. 4	32	0	0
Feb. 5–11	28	0	0
Feb. 12–18	42	0	0
Feb. 19–25	50	0	0
Feb. 26–Mar. 3	50	0	0
Mar. 4–10	50	0	0
Mar. 11–17	50	0	0
Mar. 18–24	75	0	0
Mar. 25–31	25	0	0
April 1–7	------	------	------
April 8–14	76	0	0
April 15–21	100	0	0
April 22–28	26	0	0
April 29–May 5	14	0	0
May 6–12	64	7	11
May 13–19	77	12	16
May 20–26	53	19	36
May 27–June 2	133	66	50
June 3–9	35	21	60
June 10–16	60	45	75
June 17–23	115	108	94
June 24–30	81	80	99
July 1–7	55	55	100
July 8–14	55	55	100
July 15–21	------	------	------
July 22–28	81	81	100
1927 (Year class 1926)			
July 1–7	152	152	100
Total	2,359		

TABLE 11
Time of Annulus Formation—Year Class I

TABLE 12

Time of Annulus Formation—Market Sizes

Date	Number examined	Number with annuli	Per cent with annuli
1928			
April 1– 7	5	0	0
April 8–14	69	0	0
April 15–21	81	0	0
April 22–28	182	2	1
April 29–May 5	21	0	0
May 6–12	264	2	1
May 13–19	180	0	0
May 20–26			
May 27–June 2	153	1	1
June 3– 9	241	2	1
June 10–16	217	6	3
June 17–23	256	20	8
June 24–30	293	104	35
July 1– 7	184	146	79
1927			
Aug. 12	175	175	100
Sept. 9	90	90	100

TABLE 12
Time of Annulus Formation—Market Sizes

TABLE 13

Average Length at Each Age Class

Age class	Males		Females		Total fish	
	Mean total length (cm.)	Standard error (+ or —)	Mean total length (cm.)	Standard error (+ or —)	Mean total length (cm.)	Standard error (+ or —)
0					11.49	.118
I	34.95	.161	34.43	.134	35.39	.113
II	50.85	.250	50.79	.262	51.08	.182
III	62.53	.369	62.72	.439	62.82	.284
IV	68.49	.117	69.96	.152	69.26	.100
V	73.85	.103	75.37	.144	74.71	.091
VI	78.85	.141	80.78	.199	79.92	.123

TABLE 13
Average Length at Each Age Class

TABLE 14

Total Lengths of Barracuda, the Ages of Which Were Determined from Scales, April 1—July 8, 1928

Total length (cm.)	Year classes															
	0	I		II		III		IV		V		VI		VII +	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
8	3														
9	8														
10	20														
11	33														
12	28														
13	8														
14															
15															
16															
17															
18															
19															
20															
21															
22															
23															
24															
25		2													
26		3	1												
27		1	1												
28		4	2												
29		4	3												
30		9	6												
31		15	9												
32		34	26												
33		32	35												
34		49	52												
35		42	34												
36		31	40												
37		30	32												
38		33	41												
39		15	25												
40		2	12		1										
41			4												
42			2	4	4										
43			1	6	1										
44				2	12										
45				8	6										
46				14	7										
47				9	16										
48				20	19										
49				13	8										
50				26	27										

TABLE 14

Total Lengths of Barracuda, the Ages of Which Were Determined from Scales, April 1—July 8, 1928

51				27	21										
52				23	20	1									
53				13	19	2									
54				17	20		1								
55				10	16	1									
56				6	11	3	6								
57				5	9	3	1								
58				3	4	4	2								
59				1	1	5	2								
60						9	2								
61						6	4	7							
62						7	8	5							
63						17	6	13							
64						11	9	21	8						
65						10	12	31	10						
66						4	3	67	20	1					
67						3	4	60	28	6			1		
68						2	3	79	24	7	2				
69						2	1	69	49	18	4	2			
70								62	36	40	7		1		
71								37	48	71	20	6	2		
72								25	36	94	43	7		5	
73								8	23	101	54	24	6	8	
74								6	19	90	57	25	11	12	
75								2	11	80	66	60	18	11	4
76								1	3	48	73	55	35	24	7
77								1	1	27	37	79	36	40	8
78										14	25	70	41	35	13
79										9	21	72	47	49	18
80										7	17	48	40	84	40
81										1	10	47	41	79	29
82										3	8	39	38	87	33
83										1	6	23	35	85	27
84											1	13	28	94	51
85											4	9	24	96	55
86												6	20	60	65
87												1	16	49	76
88											1	10	8	52	61
89												2	6	40	67
90													3	38	56
91													6	27	32
92													3	29	40
93														18	43
94														11	31
95													1	8	27
96													1	8	22
97													1	2	20
98														2	16
99														3	16
100														2	5
101															6
102															9
103															4
104															1
105															2

TABLE 14—Cont'd.

TABLE 15

Comparison of the Lengths of Barracuda from the Channel Islands and from the Mainland

Samples taken during 1928

Total length (cm.)	Frequency	
	Island fish	Mainland fish
53	----------	1
54	----------	3
55	----------	4
56	----------	8
57	----------	5
58	----------	6
59	----------	8
60	----------	15
61	----------	25
62	----------	47
63	1	81
64	----------	126
65	----------	176
66	5	278
67	3	366
68	8	417
69	4	471
70	6	596
71	1	654
72	3	704
73	2	716
74	8	716
75	10	745
76	13	744
77	15	689
78	33	649
79	26	627
80	40	663
81	47	592
82	57	607
83	66	544
84	69	524
85	77	501
86	103	439
87	76	373
88	93	330
89	91	275
90	100	236
91	77	177
92	83	139
93	87	121
94	69	82
95	60	68
96	64	54
97	44	49
98	47	27
99	33	35
100	29	22
101	20	1
102	12	12
103	11	7
104	8	4
105	4	----------
106	2	----------
107	----------	----------
108	1	----------
Totals	1,608	14,759

TABLE 15

Comparison of the Lengths of Barracuda from the Channel Islands and from the Mainland

TABLE 16

Frequency Table—Total Lengths of Fish Taken in Special Hauls in 1927-1928

Total length (cm.)	1927											1928													
	July	August		September		October		November		December		January		February		March		April		May		June		July	
	16-31	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-29	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8	2	1																							3
9	5	4																							8
10	7	36																							20
11	4	208																							33
12		216	2				1																		28
13		78	10	1	2																				8
14		2	54	2	1																				
15			70	11			3									1									
16			33	25	2		1						1			1									
17			5	45	4	1	3						2			1									
18				78	33	1	1		3										1						
19				173	105	8	1	1	1	3			1					2							
20				124	266	22	1		1	2			2		1	2		4							
21				39	416	55	2		1	4	1		1		1	2		5	1						
22	1			15	419	158	6	1	5	3	1	1				5		4	3						
23				9	294	284	50	13	1	3	2	1	6		1	2	2	1	3						
24					127	334	177	38	2	8	1	2	5	2	2	4			1				1		
25		1			46	193	372	108	7	3	1	2	5	3	1	4		3				1	1		
26	1				11	96	440	221	34	15	3	2	4	2	3	11	3	7				2	1		
27	1	1				33	247	187	82	42	12	2	3	3	6	9	4	5	1			2			1
28	7	1				9	110	83	257	96	45	13	6		5	5	9	9	2	1	2	2	3		
29	3	1				1	17	21	287	195	180	35	18	6	13	16	13	6	11	1	2	2	3	1	
30	3	7	2		1		3	16	187	208	385	47	48	11	29	39	60	13	26	5	6	10	5	4	
31		11	3	1	2			2	105	132	524	78	56	14	73	78	185	36	74	4	8	13	18	6	2
32	4	14	13	7	6				49	47	372	46	39	21	68	82	323	93	213	17	17	19	34	3	2
33	1	19	30	10	25	3		1	8	5	135	25	27	13	43	95	347	125	341	21	38	28	52	10	3
34	5	25	48	13	19	7	3		1	1	32	4	26	9	14	49	237	122	381	32	128	67	99	34	6
35	1	22	35	17	26	10	4				5		6	7	2	47	94	89	213	19	213	121	185	65	15
36	2	33	46	10	27	9	11	4					1	5	1	14	19	53	89	20	255	244	426	129	20
37	1	24	57	11	13	8	13	1		3	1					6	1	6	30	8	223	258	555	220	35

TABLE 16

Frequency Table—Total Lengths of Fish Taken in Special Hauls in 1927–1928

TABLE 16—Continued

Frequency Table—Total Lengths of Fish Taken in Special Hauls in 1927-1928

Total length (cm.)	1927											1928													
	July	August		September		October		November		December		January		February		March		April		May		June		July	
	16-31	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-29	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31
38	1	48	38	18	8	6	17	1	5		3		1	1		3	1	4	7	9	132	170	545	275	54
39	1	40	62	17	12	10	16	5	6		6		2	2			2	2	3		51	78	331	259	90
40	1	59	34	14	10	6	15	4	6		11		3	3		2	9	5	4		12	23	173	159	114
41	4	31	53	9	11	8	11	3	2	1	3		2	8	1	11	11	4	2		6	12	55	62	92
42		23	22	6	9	10	22	4	5	2	5	1	2	19		9	27	10	2	1	4	4	8	13	56
43	1	44	18	4	9	11	21	4	3	1	4		2	18		25	59	9	8	1	3	3	4	5	17
44		35	12	4	7	14	24	6	3		7			11		15	51	7	8	6	6	4	1	3	4
45		25	6	2	1	3	15	1	5	1	3			28		22	43	10	19	6	5	4		1	
46		11	4	7	3	7	14	1	9	2	1			11		21	41	8	24	4	10	8	3	1	2
47		12	5	1		8	3	1	1	1	1			11	2	26	22		35	15	9	9			
48		5		3	2	5	4	2			2			20		33	27	5	48	16	11	26		1	2
49		1			1	6	7	1		1				13	1	28	20	2	37	11	8	23	1	1	
50						4								16		44	9	6	53	22	28	22	1		
51						2	1				1			8		41	14	1	44	21	27	29		2	
52						2	1							7		31	4	1	38	14	23	18			1
53			1											8		37	4		32	28	15	27	1		
54						1								3		34	3	1	21	16	18	27			2
55						3								1		20			13	12	13	15	1		
56	1					4								1		15	1		8	18	12	14	1	1	
57						3								1		8		1	4	15	11	2			
58						6										5			1	6	8	1			
59						10										1			3	4	3				
60						3										2			2	5	3	1			
61	1					2														4	4				
62						1													1	9	2	1			
63																				10	8				
64																				6	4				
65																1				5	5	1			
66																1				6	5				
67																				3	4				
68																				5	3	1			
69																				1	3				
70																					3				
71																				2					
72																				1					

TABLE 16
Frequency Table—Total Lengths of Fish Taken in Special Hauls in 1927–1928

2. II
A BIBLIOGRAPHY OF BARRACUDAS

2.1. INTRODUCTION

Although this list is by no means a complete bibliography to the Sphyraenidae, it does contain most of the important articles published to date (September, 1931) that refer to this family or its members. The libraries consulted in making this compilation were those of the California State Fisheries Laboratory, the University of California, and of Stanford University. Each of the publications listed is in at least one of these libraries. All were examined by the author, and, since the importance of articles depends so much upon the needs of the individual no evaluation is made of any entry.

2.2. AUTHORS' LIST OF TITLES

2.2.1. A

Abbot, Charles C. 1868. Catalogue of vertebrate animals of New Jersey. *In* Geology of New Jersey. Newark, p. 812. "S. borealis generally to be met with in small streams of coast counties of the state."

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1858. Fishes. *In* Explorations and surveys for a railroad route from the Mississippi River to the Pacific Ocean. U. S. War Department, pt. 4, p. 1, 38–39, pl. 14. Description and figure of S. argentea.

Gmelin, Johann Frederick. 1788. Caroli a Linné . . . Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tom. 1, pars 3. Editio decimo tertia, aucta, reformata. Cura Joannis Frederico Gmelin. Lipsiae, p. 1389. Esox sphyraena: described.

Goode, George Brown. 1876. Catalogue of the fishes of the Bermudas. U. S. National Museum, Bulletin, vol. 5, p. 61. S. spet, S. picuda, both good food fishes; the latter common, breeding plentifully.

1879. The natural and economical history of the American menhaden. U. S. Commission of Fish and Fisheries, Report [for 1877], p. 69, 88. Lists S. borealis as "wandering or surface fish;" says the barracudas sometimes drive the menhaden from their usual feeding grounds.

1880. A preliminary catalogue of the fishes of St. John's River and the east coast of Florida, with descriptions of a new genus and three new species. U. S. National Museum, Proceedings, vol. 2, p. 116. S. picuda listed from south Florida.

1884. Natural history of useful aquatic animals. *In* The fisheries and fishery industries of the United States. Washington, sec. 1, p. 448, pl. 178. S. picuda, S. borealis figured; natural history of all North American species; believes specimens of S. borealis may be the young of S. spet of Europe.

1887. The fishermen of the United States. *In* The fisheries and fishery industries of the United States. Washington, sec. 4, p. 34. "The Spaniards of Santa Cruz have in use two boats. They live in the southern part of Santa Cruz City, and fish for rockfish, sea bass, and barracuda."

Goode, George Brown, and Bean, Tarleton H. 1879. Catalogue of a collection of fishes obtained in the Gulf of Mexico by Dr. J. W. Velie, with descriptions of seven new species. U. S. National Museum, Proceedings, vol. 2, p. 342. S. picuda listed.

1880. Catalogue of a collection of fishes sent from Pensacola, Florida, and vicinity, by Mr. Silas Stearns, with description of six new species. U. S. National Museum, Proceedings, vol. 2, p. 146–147. S. picuda, S. borealis, S. vulgaris, S. guaguancho: descriptions; the latter species with extensive measurements (specimens from different localities).

1883. A list of the species of fishes recorded as occurring in the Gulf of Mexico. U. S. National Museum, Proceedings [for 1882], vol. 5, p. 239. S. picuda, S. guaguancho: listed.

Goodrich, Edwin Stephen. 1909. Vertebrata craniata (cyclostomes and fishes). *In* Treatise on zoology, *by* E. R. Lankester. London, 1900–1909, vol. 9, p. 419. Brief description of skeletal anatomy of Sphyraena.

Govindan, V. 1916. Fishery statistics and information, west and east coasts, Madras Presidency. Madras Fisheries Bureau, Bulletin, no. 9, p. 44. Sphyraena sp.: common names, season, locality.

Green, C. F. 1927. Scientific names of fish caught by the S. S. "Tongkol." Straits Settlements and Federated Malay States Fisheries Department, Annual Report [for 1926], Appendix I, p. 16. S. jello, S. obtusata occur occasionally.

Gregory, William K. 1920. Studies in comparative myology and osteology. No. IV. A review of the evolution of the lachrymal bone of vertebrates. American Museum of Natural History, Bulletin, vol. 42, p. 112, fig. 6. Cranium of S. barracuta *(sic):* figured.

Grenholm, Ake. 1923. Studien über die Flossenmuskulatur der Teleostier. Uppsala, p. 85–87, fig. 71. Morphology of fin musculature in S. obtusata: figure showing muscles of the caudal fin.

Gruvel, A. 1925. L'Indo-Chine, ses richesses marines et fluviales. Paris, p. 80, 2 figs. S. forsteri, S. obtusata, S. acutipinnis: listed; the last two figured.

Gudger, E. W. 1918. Sphyraena barracuda; its morphology, habits and history. Carnegie Institution of Washington, Department of Marine Biology, Papers, vol. 12, p. 55–108, 25 figs. Review of literature.

Gudger, E. W., and Breder, C. M. 1928. The barracuda (Sphyraena) dangerous to man. American Medical Association, Journal, vol. 90, p. 1938–1943, 4 figs. Accounts of attacks on man by barracuda.

Guérin-Ganivet, J. 1912. La faune ichthyologique des côtes méridionales de la Bretagne. Laboratoire de Zoologie et de Physiologie Maritimes de Concarneau, Travaux scientifiques, vol. 4, no. 6, p. 80. S. spet in the waters of the lower Loire.

Guichenot, Alphonse. 1853. Poissons. *In* Histoire physique, politique et naturelle de l'isle de Cuba, *by* Ramon de la Sagra. Paris, vol. 5, p. 37–42. S. becuna, S. guachancho, S. barracuda: descriptions, synonymy, food value.

Gundlach, Juan. 1881. Apuntes para la fauna Puerto-Riqueña. R. Sociedad Española de Historia Natural, Annales, p. 334. S. picuda listed from Cuba, Santo Domingo, Puerto-Cabello, Brazil, Panama, San Martin.

Günther, Albert C. L. G. 1860. Catalogue of the acanthopterygian fishes in the collection of the British Museum. London, vol. 2, p. 334–341. Descriptions of S. vulgaris, S. novae hollandiae, S. picuda, S. jello, S. forsteri, S. japonica, S. argentea, S. commersonii, S. nigripinnis, S. dussumieri, S. obtusata, S. langsar, S. Brachygnathus, S. flavicauda, S. agam.

1877. Andrew Garrett's Fische der Südsee. Heft 6. Museum Godeffroy, Hamburg, Journal, heft 13, p. 211–212, taf. 119. S. forsteri, S. obtusata: described, figured.

1880.1. Report on the shore fishes procured during the voyage of the H. M. S. Challenger in the years 1873–1876. Report of the Scientific Results of the Voyage of the H. M. S. Challenger, 1873–1876. London, p. 3. S. vulgaris from St. Jago listed.

1880.2. An introduction to the study of fishes. Edinburgh, p. 499–500. Description of family, and discussion of its position in phylogenetic system.

2.2.8. H

Haley, A. 1875. Descriptions of new species of fish in the collection of the British Museum. Annals and Magazine of Natural History, ser. 4, vol. 15, p. 270. S. güntheri, n.s., described from Colon.

Hay, Oliver Perry. 1902. Bibliography and catalogue of the fossil vertebrata of North America. U. S. Geological Survey, Bulletin, no. 179, p. 399–400. Bibliography of fossil species.

Heilner, Van Campen. 1918. The game fishes of Florida. American Angler, vol. 3, p. 399–400, 1 fig. Sport fishing for barracuda.

Heller, Edmund, and Snodgrass, Robert Evans. 1903. New fishes. Washington Academy of Sciences, Proceedings, vol. 5, p. 190, pl. 2. S. idiastes, n.s.: described, figured.

Henderson, John Brooks. 1916. The cruise of the Tomas Barrera. P. 51. A sportsman's observations of the barracuda.

Henshall, James A. 1895. Notes on fishes collected in Florida in 1892. U. S. Fish Commission, Bulletin [for 1894], vol. 14, p. 213. S. guaguanche not common, and found in deeper water than is S. picuda; S. picuda abundant along the keys.

Hildebrand, Samuel F., and Schroeder, William C. 1928. Fishes of Chesapeake Bay. U. S. Bureau of Fisheries, Bulletin [for 1927], vol. 43, pt. 1, p. 197–198, fig. 112. S. guachancho and S. borealis described, the latter figured.

Hoffman, Horace Addison, and Jordan, David Starr. 1892. A catalogue of the fishes of Greece, with notes on the names now in use and those employed by classical authors. Academy of Natural Sciences of Philadelphia, Proceedings [for 1892], pt. 2, p. 253. Classical and modern Greek names of S. sphyraena, in Greek script.

Holder, Charles Frederick. 1903. The big game fishes of the United States. New York, p. 88–104, 1 fig. Sport fishing methods for Florida and California barracudas; personal experiences.

1908. Big game at sea. P. 282–286. Personal experiences of a sportsman with California barracuda.

1910. The Channel Islands of California. Chicago, p. 125. Sport fishing methods for California barracuda.

1915. Attempts to protect the sea fisheries of southern California. California Fish and Game, vol. 1, p. 9. Describes quantity of fish prevalent in California in 1886; decries depletion; offers Tuna Club as an influence for conservation.

Hornell, James. 1917. A statistical analysis of the fishing industry of Tuticorin (South India). Madras Fisheries Bulletin, vol. 11, p. 70, 85, 93. S. jello and S. obtusata among first 36 fish in importance; common names; statistics.

Houssay, Frederic. 1912. Forme, puissance et stabilité des poissons. Collection de Morphologie Dynamique, Paris, vol. 4, p. 258. Relation between total length and depth in S. spet.

Hubbs, Carl L. 1928. A check-list of the marine fishes of Oregon and Washington. Pan-Pacific Research Institution, Journal, vol. 3, no. 3, p. 12. S. argentea: listed.

Hutton, F. W. 1904. Index faunæ Novæ Zealandiæ. London, p. 46. S. obtusata: listed.

2.2.9. J

Japan. Ministry of Agriculture and Forestry. 1926. The statistical abstract of the Ministry of Agriculture and Forestry, 1925, p. 51. 612, 555 kwan of barracuda, valued at 864,469 yen, taken in 1925.

Jenkins, J. Travis. 1911. Report on the working of the steam trawler "Golden Crown" for the quarter ending December 31, 1908. *In* Collection of papers dealing with the fishery survey of the Bay of Bengal. Calcutta, p. 35. Sphyraena sp.: listed.

Jenkins, Oliver P. 1901. Descriptions of fifteen new species of fishes from the Hawaiian Islands. U. S. Fish Commission, Bulletin [for 1899], vol. 19, p. 387–388. Descriptions and figures of S. helleri, n.s., and of S. snodgrassi, n.s.

1904. Report on collections of fishes made in the Hawaiian Islands, with descriptions of new species. U. S. Fish Commission, Bulletin [for 1902], vol. 22, p. 438. S. snodgrassi the same as S. commersoni.

Jordan, David Starr. 1884.1. Notes on species of fishes improperly ascribed to the fauna of North America. Academy of Natural Sciences of Philadelphia, Proceedings [for 1884], p. 101. Denies that S. borealis is the same as S. sphyraena.

1884.2. The fishes of Florida Keys. U. S. Fish Commission, Bulletin [for 1884], vol. 4, p. 77. S. picuda taken in the winter in large numbers by trolling.

1885. List of fishes collected at Key West, Florida, with notes and descriptions. U. S. National Museum, Proceedings, vol. 7, p. 117. S. picuda: natural history.

1886.1. Notes on fishes collected at Beaufort, North Carolina, with a revised list of the species known from that locality. U. S. National Museum, Proceedings, vol. 9, p. 27. S. borealis: listed.

1886.2. A preliminary list of the fishes of the West Indies. U. S. National Museum, Proceedings, vol. 9, p. 572. S. picuda, S. guachancho, S. picudilla, S. sphyraena: listed.

1887. The fisheries of the Pacific coast. *In* The fisheries and fishery industries of the United States. Washington, sec. 2, pt. 16, p. 595, 597, 600, 605, 618. Total catch of barracuda in different regions of California.

1890.1. Catalogue of fishes collected at Port Castries, St. Lucia, by the steamer Albatross, November, 1888. U. S. National Museum, Proceedings, vol. 12, p. 648. S. guaguanche: listed.

1890.2. List of fishes obtained in the harbor of Bahia, Brazil, and in adjacent waters. U. S. National Museum, Proceedings, vol. 13, p. 317. S. picudilla: listed.

1895. The fishes of Sinaloa. California Academy of Sciences, Proceedings, ser. 2, vol. 5, pt. 1, p. 425. s. ensis "rather common in the harbor."

1904. Notes on fishes collected in the Tortugas Archipelago. U. S. Fish Commission, Bulletin [for 1902], vol. 22, p. 539. S. barracuda: listed.

1905. A guide to the study of fishes. New York, vol. 1, p. 206; vol. 2, p. 222–223, 1 fig. Osteology; morphology; habits; food value; S. barracuda: figured.

1923. A classification of fishes including families and genera as far as known. Stanford University Publications, University Series, Biological Sciences, vol. 3, no. 2, p. 178. Umbla, Sphyraena, Sphoerina, Agriosphyraena: listed.

1925. Fishes. New York, p. 437–438. Popular description; habits; food value; S. barracuda; figured.

1927. Shore fishes of Samoa. Pan-Pacific Research Institution, Journal, vol. 2, no. 4, p. 5. S. obtusata, S. forsteri: listed.

1929. Manual of the vertebrate animals of the northeastern United States inclusive of marine species. New York, 13. ed., p. 129. Lists northeastern Atlantic species.

Jordan, David Starr, and Evermann, Barton Warren. 1896.1. A check-list of the fishes and fish-like vertebrates of North and Middle America. U. S. Commission of Fish and Fisheries, Report [for 1895], p. 334–335. S. barracuda, S. ensis, S. guaguanche, S. picudilla, S. borealis, S. argentea, S. sphyraena: listed.

1896.2. The fishes of North and Middle America. U. S. National Museum, Bulletin, no. 47, pt. 1 [1896], p. 822–826; pt. 4 [1900], pl. 128, fig. 349. Key to, and description of: S. picuda, S. guachancho, S. picudilla, S. borealis, S. argentea, S. sphyraena.

1903. Notes on a collection of fishes from the island of Formosa. U. S. National Museum, Proceedings, vol. 25, p. 333. S. jello, S. japonica, S. forsteri: listed.

1905. The shore fishes of the Hawaiian Islands, with a general account of the fish fauna. U. S. Fish Commission, Bulletin [for 1903], vol. 23, p. 141–143. Descriptions and figures of S. snodgrassi and of S. helleri.

1908. The American food and game fishes. New York, p. 258–260, 1 pl. Key to, and descriptions of American species; photograph of S. barracuda.

1917. The genera of fishes from Linnaeus to Cuvier, 1758–1883, seventy-five years, with the accepted type of each. Pt. 1. Stanford University Publications, University Series, p. 43, 52, 58. Sphyraena, Umbla: listed.

1926. A check list of the fishes of Hawaii. Pan-Pacific Research Institution, Journal, vol. 1, no. 1, p. 8. S. helleri, S. snodgrassi: listed.

Jordan, David Starr; Evermann, Barton Warren; and Clark, Howard Walton. 1930. Check list of the fishes and fishlike vertebrates of North and Middle America north of the northern boundary of Venezuela and Colombia. U. S. Commissioner of Fisheries, Report [for 1928], pt. 2, p. 255. S. sphyraena, S. argentea, S. ensis, S. borealis, S. guachancho, S. picudilla, S. barracuda: listed.

Jordan, David Starr, and Gilbert, Charles H. 1878. Notes on the fishes of Beaufort Harbor, North Carolina. U. S. National Museum, Proceedings, vol. 1, p. 381. Identifies S. borealis with S. spet.

1882.1. List of fishes collected at Mazatlan, Mexico, by Charles H. Gilbert. U. S. Fish Commission, Bulletin [for 1882], vol. 2, p. 106. S. ensis: listed.

1882.2. Synopsis of the fishes of North America. U. S. National Museum, Bulletin, no. 16, p. 410–412. Descriptions of S. argentea, S. spet, S. guaguancho, S. picuda.

1883. Notes on a collection of fishes from Charleston, South Carolina, with descriptions of three new species. U. S. National Museum, Proceedings, vol. 5, p. 589. S. picuda rare off Charleston Harbor; description of species.

Jordan, David Starr, and Gunn, James Alexander. 1898. List of fishes collected at the Canary Islands by Mr. O. F. Cook, with descriptions of four new species. Academy of Natural Sciences of Philadelphia, Proceedings [for 1898], p. 340. S. sphyraena: listed.

Jordan, David Starr, and Hubbs, Carl Leavitt. 1925. Record of fishes obtained by David Starr Jordan in Japan. Carnegie Museum, Memoirs, vol. 10, no. 2, p. 206. S. japonica and S. pinguis: listed.

Jordan, David Starr, and Jordan, Eric Knight. 1922. A list of the fishes of Hawaii, with notes and descriptions of new species. Carnegie Museum, Memoirs, vol. 10, no. 1, p. 29–30. S. helleri generally common; S. snodgrassi, common in the markets, requires to be compared with other large barracudas of the south seas.

Jordan, David Starr, and Metz, Charles William. 1913. A catalog of the fishes known from the waters of Korea. Carnegie Museum, Memoirs, vol. 6, no. 2, p. 26. S. obtusata, "a fine food fish," from Fusan.

Jordan, David Starr, and Richardson, Robert Earl. 1908. Fishes from the islands of the Philippine Archipelago. U. S. Bureau of Fishes, Bulletin, vol. 27, p. 245. S. jello: listed; uncertain of identification of S. commersonii.

1912. A catalog of the fishes of Formosa. Carnegie Museum, Memoirs, vol. 4, no. 4, p. 176. S. jello, S. langsar, S. japonica, S. forsteri: listed.

Jordan, David Starr, and Rutter, Cloudsley. 1897. A collection of fishes made by Joseph Seed Roberts in Kingston, Jamaica. Academy of Natural Sciences of Philadelphia, Proceedings [for 1897], p. 98. S. barracuda, S. guachancho: listed.

Jordan, David Starr, and Seale, Alvin. 1905.1. List of fishes collected at Hong Kong by Captain William Finch, with description of five new species. Davenport Academy of Sciences, Proceedings [for 1905], p. 4–5. S. putnamiae, n.s., from Hong Kong, described.

1905.2. List of fishes collected by Dr. Bashford Dean on the Island of Negros, Philippines. U. S. National Museum, Proceedings, vol. 28, p. 774. S. jello: listed.

1906. The fishes of Samoa. U. S. Bureau of Fisheries, Bulletin, vol. 25, p. 218–219. S. obtusata, S. forsteri, S. helleri, S. snodgrassi, S. grandisquamis, S. megalolepis, S. kenie: listed.

1907. Fishes of the islands of Luzon and Panay. U. S. Bureau of Fisheries, Bulletin, vol. 26, p. 11. S. obtusata from Cavite; S. jello from Manila.

Jordan, David Starr, and Snyder, John Otterbein. 1901. A list of fishes collected in Japan by Keinosuke Otaki, and by the U. S. Steamer Albatross, with descriptions of fourteen new species. U. S. National Museum, Proceedings, vol. 23, p. 351. S. japonica from Tokyo.

1907. Notes on fishes of Hawaii, with descriptions of new species. U. S. Bureau of Fisheries, Bulletin, vol. 26, p. 208. S. helleri listed; S. snodgrassi probably not same as S. commersoni.

Jordan, David Starr, and Starks, Edwin Chapin. 1917. Notes on a collection of fishes from Ceylon with descriptions of new species. Carnegie Museum, Annals, vol. 11, no. 3–4, p. 439. S. langsar, S. jello: listed.

Jordan, David Starr; Tanaka, Shigeho; and Snyder, John Otterbein. 1913. A catalogue of the fishes of Japan. Imperial University of Tokyo, College of Science, Journal, vol. 33, art. 1, p. 110–111. S. jello listed from Red Sea, Cape of Good Hope, Bay of Bengal, Seas of Pinang, Java, Amboyna, and Japan (perhaps not Japanese); S. japonica listed from Sea of Japan; S. nigripinnis listed from Tokyo to Nagasaki; S. pinguis listed from Tokyo to Nagasaki, and from Chefoo.

Jordan, David Starr, and Thompson, Joseph C. 1905. The fish fauna of the Tortugas Archipelago. U. S. Bureau of Fisheries, Bulletin [for 1904], vol. 24, p. 236. S. barracuda: listed.

Jordan, David Starr, and Thompson, William Francis. 1914. Record of the fishes obtained in Japan in 1911. Carnegie Museum, Memoirs, vol. 6, no. 4, p. 239. S. pinguis: listed.

2.2.10. K

Kendall, William C., and Goldsborough, Edmund L. 1911. Reports on the scientific results of the expedition to the tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900. XIII, The Shore Fishes. Harvard College, Museum of Comparative Zoology, Memoirs, vol. 26, no. 7, pt. 13, p. 261–262. S. obtusata listed from Caroline Islands and Fiji Islands; S. forsteri listed from Fiji Islands.

Kincaid, Trevor. 1919. An annotated list of Puget Sound fishes. Washington Department of Fisheries, p. 18, fig. 32. S. argentea not common in Puget Sound; figure of Sphyraena (sp.?).

Klunzinger, Carl Benjamin. 1870. Synopsis der Fische des Rothen Meeres. I Theil. Percoiden-Mugiloiden. Zoologisch-Botanischen Gesellschaft in Wien, Verhandlungen, vol. 20, p. 819–823. Descriptions of S. obtusata, S. agam, S. qenie (n.s.), S. jello.

1884. Die Fische des Rothen Meeres. Eine kritische Revision mit Bestimmung-stabellen. Teil I. Acanthopteri veri Owen. Stuttgart, p. 127. Key to, and descriptions of: S. obtusata, S. chrysotaenia (n.s.), S. agam, S. Jello, S. kenie.

2.2.11. L

Labat, Jean B. 1724. Nouveau voyage aux Isles de l'Amérique. Vol. 1, p. 155–157. Description, habits, food value of eastern American barracuda (sp.?).

Lacépède, Bernard Germain Étienne. 1804. Histoire naturelle des poissons. Paris, vol. 12, p. 94–97, pl. 9, fig. 3. "S. spet, la Sphyrène Chinoise": relationship, description, food value.

1832. Oeuvres, comprenant l'histoire naturelle des quadrupèdes ovipares, des serpents, des poissons et des cétacés. Paris, vol. 12, p. 104–107. S. spet: description, natural history, synonymy.

Latham, Roy. 1919. Record of fishes at Orient, Long Island, in 1918. Copeia, no. 71, p. 56. S. borealis: listed.

Leidy, Joseph. 1856. Indications of twelve species of fossil fishes. Academy of Natural Sciences of Philadelphia, Proceedings, vol. 7, p. 397. S. major: listed.

1857. Notices of remains of extinct vertebrate animals of New Jersey, collected by Prof. Cook, of the State geological survey, under the direction of Dr. W. Kitchell. Academy of Natural Sciences of Philadelphia, Proceedings, vol. 8, p. 221. Crown of anterior tooth from S. speciosa described.

1860. Remarks on Saurocephalus and its allies. American Philosophical Society, Transactions, vol. 11, p. 91. Compares Saurocephalus with Sphyraena.

1877. Description of vertebrate remains, chiefly from the phosphate beds of South Carolina. Academy of Natural Sciences of Philadelphia, Journal, n.s., vol. 8, pt. 3, p. 254, pl. 34, figs. 37–41. Isolated teeth of S. major Leidy from the fossils of the Ashley phosphate beds are described and figured.

Levi-Morenos, David. 1912. Per organizzare la pesca nella Libia. R. Comitato Talassografico Italiano, Memoria 16, p. 34. Common Italian, Arabic and French names of S. vulgaris.

Linné, Carolus. 1766. Systema naturae per regna tria naturae secundum classes, ordines, genera, species. Editio duodecima, reformata. Holmiae, t. I, p. 515, sp. 1.

Linton, Edwin. 1901. Parasites of fishes of the Woods Hole region. U. S. Fish Commission, Bulletin, vol. 19, p. 444. Food of S. borealis; no entozoa found.

1905. Parasites of fishes of Beaufort, North Carolina. U. S. Bureau of Fisheries, Bulletin, vol. 24, p. 361. Food of S. borealis; no entozoan parasites.

1908.1. Helminth fauna of the Dry Tortugas. Carnegie Institution of Washington, Papers, vol. 1, p. 160, 162, 164. S. barracuda with nematode and trematode parasites.

1908.2 Notes on parasites of Bermuda fishes. U. S. National Museum, Proceedings, vol. 33, p. 116, 1 fig. Distomum from S. sphyraena.

1910. Helminth fauna of the Dry Tortugas. II. Trematodes. Carnegie Institution of Washington, Papers, vol. 4, p. 17, 19, 81. Gasterostomum sp. found parasitic on S. barracuda; food of S. barracuda consists of fish.

Lleó, José M. 1923. Costas de Cataluña. La pesca maritñma en España en 1920. Instituto Español de Oceanografía, Boletín de Pescas, no. 81–85. Common name of S. sphyroena (*sic*).

Lockington, W. N. 1879. Report upon the food fishes of San Francisco. California Commission of Fisheries, Report [for 1878–1879], p. 32. S. argentea obtained usually south of San Francisco Bay and at the Farallones, but occurs at least as far north as Tomales.

1880. Report upon the edible fishes of the Pacific coast, U. S. A. California Commission of Fisheries, Report [for 1880], p. 20, 48. S. argentea: season, range, food value.

Lord, Clive. 1927. A list of the fishes of Tasmania. Pan-Pacific Research Institution, Journal, vol. 2, no. 4, p. 14. S. novae-hollandiae: listed.

Lozano, Luis. 1919. Los peces de la fauna íberica en la colecció del museo en I de Enero de 1919. Museo Nacional de Ciencias Naturales, Trabajos, ser. zool., no. 39. S. sphyraena from Malaga.

Lütken, Christian Frederik. 1878. Ichthyolgrafiske Bidrag. Tillægsbemærkninger om sugefiske og svaerdfiske. Videnskabelige Meddelelser fra den Naturhistoriske Forening, 1877–1878, ser. 3, p. 242–243. Commensalism between other fishes and S. barracuda.

Lydekker, Richard. 1901. The new natural history. New York, vol. 5, p. 2767, fig. p. 2748. Description, habits, food value of Sphyraena; S. vulgaris figured.

2.2.12. M

McCulloch, Allan R. 1922. Check list of the fishes and fish-like animals of New South Wales. Sydney, p. 40–41, pl. xiv, fig. 149a-b. Key to species; S. obtusata not uncommon; S. novae-hollandiae uncommon in Sydney markets; S. waitii perhaps merely the young of the preceding.

Macgillivray, John. 1852. Narrative of the voyage of H. M. S. Rattlesnake. London, vol. 1, p. 69. Sport fishing for barracuda at Bass' Strait (Victoria).

Macleay, William. 1882. Descriptive catalogue of the fishes of Australia. Linnean Society of New South Wales, Proceedings, vol. 6, p. 32–35. S. novae-hollandiae, S. fosteri, S. commersonii, S. obtusata, S. langsar, genus Lanioperca, Lanioperca mordax: descriptions.

Madras Fisheries Bureau. 1915. A list of Tamil names of the fish of the Madras Presidency. *In* Papers from 1899 relating chiefly to the development of the Madras Fisheries Bureau, vol. 1, p. 234. S. jello: common name.

Madras Fisheries Department. 1930. Fish statistics for 1926–27. Madras Fisheries Bulletin, vol. 23, p. 126. Total landings of barracuda.

Malpas, A. H. 1926. The marine biological survey of the littoral waters of Ceylon. Bulletins of Ceylon Fisheries, vol. 2, p. 17. Sphyraena sp. listed among first-class edible fishes.

Maxwell, C. N. 1921. Malayan fishes. Singapore, p. 27, 91. S. novae-hollandiae, S. obtusata, S. jello, S. commersonii: listed.

Meek, Alexander. 1916. The migrations of fish. London, p. 207. Distribution, modern and geologic (short paragraph).

Meek, Seth E., and Hildebrand, Samuel F. 1923. The marine fishes of Panama. Field Museum of Natural History, Publ. no. 215, vol. 15, pt. 1, p. 282–288. S. barracuda, S. guachancho, S. borealis, S. picudilla: on the east coast; S. ensis: on the west coast.

Meek, Seth E., and Newland, Robert G. 1884. A review of the American species of the genus Sphyraena. Academy of Natural Sciences of Philadelphia, Proceedings [for 1884], p. 67–75. Reviews S. picuda, S. ensis, S. guaguanche, S. picudilla, S. borealis, S. sphyraena, S. argentea.

Metz, Charles W. 1912. The fishes of Laguna Beach, California. I. Laguna Marine Laboratory, Annual Report, vol. 1, p. 31. S. argentea chief market fish taken at Newport, California, during the summer.

Metzelaar, Jan. 1919. Over Tropisch Atlantische Visschen. [Text in English.] Amsterdam, p. 41. S. picuda, S. guachancho, S. picudilla: descriptions, habitats.

Moreau, Émile. 1881. Histoire naturelle des poissons de la France. Paris, p. 211–215, fig. 171. S. spet: description, habits, habitat.

Moreau de Jonnès, Alexandre. 1819. Recherches sur les poissons toxicofères de Indes occidentales. Société Philomathique, Paris, Bulletin, p. 136. S. becuna listed among poisonous fish.

Mori, Tamezo. 1928. A catalogue of the fishes of Korea. Pan-Pacific Research Institution, Journal, vol. 3, no. 3, p. 5. S. obtusata: listed.

Moseley, H. N. 1879. Notes by a naturalist on the "Challenger," being an account of various observations made during the voyage of H. M. S. "Challenger" round the world, in the years 1872–1876 . . . London, p. 74. S. barracuda taken off St. Paul's Rocks.

Mowbray, Louis L. 1916. Fish poisoning (ichthyotoxismus). New York Zoological Society, Bulletin, vol. 19, p. 1422–1423. Quoted in Copeia, 1917, no. 48, p. 81–84. Believes fish poisoning to be a form of ptomaine, caused by failure to ice fish.

1922.1. Certain citizens of the warm sea. National Geographic Magazine, vol. 41, no. 1, p. 36–53, 1 col. pl. Voraciousness; food value.

1922.2. The barracuda. New York Zoological Society, Bulletin, vol. 25, p. 143–144, 2 figs. Habits; voraciousness; sport fishing methods; two figures of S. barracuda.

Murphy, R. C. 1914. Notes on pelagic fishes. Copeia, no. 6, p. 2. Specimen of S. picuda taken at latitude 31° 50' No., longitude 50° 49' W., with two large trematodes in its intestines.

Murray, James A. H. 1888. A new English dictionary on historical principles. Oxford, vol. 1, p. 679. Definition of barracuda.

2.2.13. N

Nayudu, Ramaswami M. 1921. A statistical analysis of an inshore fishing experiment at Madras, 1919. Madras Fisheries Bulletin, vol. 12, p. 123. Sphyraena sp. one of "13 most important food-fishes of Madras caught by our canoes during 1919."

Nichols, John Treadwell. 1912. Notes on Cuban fishes. American Museum of Natural History, Bulletin, vol. 31, art. 18, p. 184. S. picuda considered one of the four most poisonous Cuban fishes, its sale being prohibited in Havana and Matanzas; S. guachancho is very abundant in the markets.

1921. A list of Turk Islands fishes, with a description of a new flatfish. American Museum of Natural History, Bulletin, vol. 44, art. 3, p. 22. S. barracuda (very common) and S. picudilla off the Turk Islands.

1924. Curious inhabitants of the Gulf Stream. *In* The book of fishes. National Geographic Society, p. 167–170, 1 fig. Toxic properties of S. barracuda; photograph of living barracuda in clear water off Florida.

Nichols, John Treadwell, and Breder, C. M. 1927. The marine fishes of New York and southern New England. Zoologica, vol. 9, no. 1, p. 72–73. S. barracuda, S. Borealis: distribution, size, food.

Nichols, John Treadwell, and Murphy, Robert Cushman. 1922. On a collection of marine fishes from Peru. American Museum of Natural History, Bulletin, vol. 46, art. 9, p. 506. S. idiastes at Lobos de Tierra Island.

Nicholson, Henry Alleyne, and Lydekker, Richard. 1889. A manual of palæontology for the use of students, with a general introduction on the principles of palæontology. Edinburgh and London, 3. ed., p. 1006. Sphyraena from middle Eocene of Monte Bolca; Cladocyclus, an extinct genus, from the upper Cretaceous of England and Brazil.

Nidever, H. B. 1926. Purse seining in southern California. California Fish and Game, vol. 12, p. 45. After the law was passed prohibiting the catch of barracuda with purse seines, many of these boats went to Mexico to fish.

1928. Bootleg barracuda. California Fish and Game, vol. 14, p. 84. Describes the problems confronting enforcement officers.

Ninni, E. 1923. Primo contributo allo studio dei pesci e della pesca nelle acque dell'impero ottomano. Missione Italiana per l'Esplorazione dei Mari di Levante, vol. 5, p. 34. S. spet not common in the markets of Constantinople.

2.2.14. O

Ogilby, J. Douglas. 1908. New or little known fishes in the Queensland Museum. Queensland Museum, Annals, no. 9, pt. 1, p. 29. S. waitii, n.s.: described.

1915. The commercial fishes and fisheries of Queensland. Brisbane, p. 8, 49. The young of S. obtusata, when frightened upend themselves among the dugong grass, their snouts directed downwards, their tails moving slowly to and fro in unison with the rhythmic motion given by the tide to the blades of grass; other habits recounted; common name.

Osburn, Raymond C., and Nichols, John Treadwell. 1916. Shore fishes collected by the "Albatross" expedition in Lower California with descriptions of new species. American Museum of Natural History, Bulletin, vol. 35, art. 16, p. 158. S. argentea at Agua Verde Bay.

Owen, Richard. 1839. On the structure of teeth, and the resemblance of ivory to bone, as illustrated by microscopical examination of the teeth of man, and of various existing and extinct animals. *In* Notices and abstracts of communications to the British Association for the Advancement of Science, Newcastle meeting, August, 1838, p. 142. Description of teeth in Dictyodus, a Sphyraenoid species.

1845. Odontography; or a treatise on the comparative anatomy of the teeth, etc. London, p. 6, 12, pl. 53. Structure of the teeth of Sphyraena.

2.2.15. P

Pardo, Luis. 1919. Nombres vulgares de la fauna Valenciana. Instituto General y Técnico de Valencia, Anales, 1918, no. 14, p. 16. S. spet: listed.

Parr, Albert Eide. 1930. Teleostean shore and shallow-water fishes from the Bahamas and Turks Island. Bingham Oceanographic Collection, Bulletin, vol. 3, art. 4, p. 45. S. barracuda from Rum Cay and from Crooked Island, Bahamas.

Pellegrin, Jacques. 1900. Les poissons vénéneux. P. 80–83, fig. 12. *Reviewed in* Revue Scientifique, sér. 4, vol. 14, p. 178–180. Description and discussion of food value of S. vulgaris, S. picuda, S. jello.

1914. Missions Gruvel sur la côte occidentale d'Afrique (1905–1912). Poissons. Institut Océanographique de Monaco, Annales, vol. 6, no. 4, p. 33–34. S. vulgaris from Baie du Lévrier, côtes du Sénégal and Mossamédès; S. dubia from Lagune de Grand-Bassam and from Baie de Libreville.

Pétillot, Loÿs. 1911. Une richesse du Cambodge; la pêche et les poissons. Paris, p. 161. S. jello from Cochin China.

Phillipps, W. J. 1927. A check-list of the fishes of New Zealand. Pan-Pacific Research Institution, Journal, vol. 2, no. 1, p. 12. S. obtusata: listed.

Pictet, F. J. 1854. Traité de paléontologie, ou histoire naturelle des animaux fossiles. Paris, p. 93. S. bolcensis, S. gracilis, S. maxima, S. amici: listed.

Pike, Nicholas. 1873. Sub-tropical rambles in the land of the Aphanapteryx (Island Mauritius). New York, p. 286, 294. Personal experiences with barracuda ("tazarre") in Mauritius.

Plinius Secundus, C. n. d. The history of the world, commonly called the natural history of C. Plinius Secundus. Philemon Holland, translator. London, 1634, p. 452.

Poey, Felipe. 1858. Memoiras sobre la historia natural de la Isla de Cuba. Vol. 2, p. 162–168. Descriptions of S. picudilla, S. picuda, S. guaguanche.

1863.1. Enumeration of the fish described and figured by Parra, scientifically named by Felipe Poey. Academy of Natural Sciences of Philadelphia, Proceedings [for 1863], p. 179. S. picuda: listed.

1863.2. Descriptions des poissons nouvelles ou peu connues. Academy of Natural Sciences of Philadelphia, Proceedings [for 1863], p. 187. S. picuda: listed.

1868. Synopsis piscium Cubensium. Havana, p. 359. S. picuda, S. picudilla, S. guaguanche: descriptions.

2.2.16. R

Reeve, Henry Fenwick. 1912. The Gambia, its history, etc. A description of the birds, beasts and fishes found therein. London, p. 273. "The barracouta (sp.?) penetrates the upper waters as far as McCarthy, 160 miles from the sea . . ."

Reeves, Cora D. 1927. A catalogue of the fishes of northeastern China and Korea. Pan-Pacific Research Institution, Journal, vol. 2, no. 3, p. 8. S. nigripinnis listed; S. obtusata listed from Ningpo; S. pinguis listed from Chefoo and Chinwangtao; S. putnamiae from Hong Kong.

Regan, C. Tate. 1915. A collection of fishes from Lagos. Annals and Magazine of Natural History, vol. 15, no. 85, p. 128. S. guachancho: listed from both coasts of Atlantic.

Richardson, John. 1836. The fish. *In* Fauna boreali-Americana; or the zoology of the northern parts of British America. London, p. 5, 32, 33. S. picuda: listed.

Risso, A. 1826. Histoire naturelle des principales productions de l'Europe méridionale et particulièrement de celles des environs de Nice et des Alpes Maritimes. Paris, vol. 3, p. 471. Sphyraena (genus): description, natural history.

Rochefort, Charles de 1666. The history of the Caribby Islands. John Davies, translator. London, bk. 1, p. 106. On the voraciousness of the barracuda.

Rondelet, Guillaume. 1558. La première (et seconde) partie de l'histoire entière des poissons. P. 185–186, 1 fig. Description and figure of Sphyraena; common names in different countries.

Roughley, T. C. 1916. Fishes of Australia and their technology. Technological Museum, Sydney, Technical Education Series no. 21, p. 45–46. Description, distribution, habits, food, fishing methods, food value, and supply of S. novae-hollandiae.

Roule, Louis. 1919. Poissons provenant des campagnes du yacht Princesse Alice (1891–1913) et du yacht Hirondelle II (1914). Résultats des Campagnes Scientifiques Accomplies sur son Yacht par Albert I, Prince Souverain de Monaco, no. 52, p. 41. S. sphyraena from Baie de St. Florent, Corsica.

Rüppell, Eduard. 1835. Neue Wirbelthiere zu der Fauna von Abyssinien gehörig . . . P. 99–100, pl. 25, fig. 2–3. S. agam (n.s.), S. flavicauda (n.s.): described, figured.

2.2.17. S

Salviano, Hippolyto. 1554. Aquatilium animalium historiae liber primus, cum eorundum formis, aere excusis. Romae, p. 70–71, pl. 8. European barracuda: names; habitat; natural history; food value.

Satsuma, Osumi and Hiuga. 1890. Preliminary report upon the fisheries of Japan. [Text in Japanese; title in English.] Japan. Department of Agriculture and Commerce, Fishery Bureau, vol. 1, pt. 3, 3 pls. S. japonica, S. nigripinnis, S. obtusata: figured.

Sauvage, H. E. 1865. Les poissons. *In* Merveilles de la nature. Paris, p. 324–326, fig. 342. S. vulgaris, S. barracuda: descriptions; distributions; habits; poisoning from eating the flesh of.

1891. Historie physique, naturelle et politique de Madagascar. Paris, p. 410–413, 522. S. obtusata, S. agam: descriptions.

Saville-Kent, William. 1893. The great barrier reef of Australia. P. 293. S. obtusata, S. dentatus, S. langsar, S. forsteri, S. commersoni, S. novaehollandiae: range.

Schlesinger, Günther. 1911. Schwimmen und Schwimmtypen flinker Meeresfische. Kosmos (Handweiser für Naturfreunde), vol. 8, p. 285, fig. 3. Swimming of the barracuda analyzed.

Schroeder, William C. 1924. Fisheries of Key West and the clam industry of southern Florida. U. S. Commissioner of Fisheries, Report [for 1923], App. 12, p. 6. S. barracuda not sold in large quantities in Florida, but much sought after by sportsmen.

Scofield, Norman B. 1924.1. The lampara net. California Fish and Game, vol. 10, p. 68, 69. The case against the lampara type of fishing gear, and the defense.

1924.2. The purse seine. California Fish and Game, vol. 10, p. 186. History of the purse seine.

Scofield, William L. 1925. The 1924 commercial catch of fish in California. California Fish and Game, vol. 11, p. 165. Yearly catches of barracuda from 1920 to 1924 compared.

Seabra, A. F. de 1911. Catalogue systématique des vertébrés du Portugal. Société Portugaise des Sciences Naturelles, Bulletin, vol. 6, p. 25. S. sphyraena: listed.

Seale, Alvin. 1903. Report of a mission to Guam. Part II. Fishes. Bernice P. Bishop Museum, Occasional Papers, vol. 1. S. obtusata: listed and described.

1906. Fishes of the south Pacific. Bernice P. Bishop Museum, Occasional Papers, vol. 4, no. 1, p. 18, 1 fig. S. obtusata from Fatè, New Hebrides; S. goodingi, n.s., from Nukuhiva, Marquesas Islands.

1909. New species of Philippine fishes. Philippine Journal of Science, vol. 4, no. 6, sec. A, p. 502–503. Description of S. aureoflammea Seale, n.s.

1910. Fishes of Borneo, with descriptions of four new species. Philippine Journal of Science, vol. 5, no. 4, sec. D, p. 268. S. toxeuma Fowler, a valuable food-fish of Borneo.

1914. Fishes of Hongkong. Philippine Journal of Science, vol. 9, p. 61. S. obtusata, S. jello: listed.

Seale, Alvin, and Bean, Barton A. 1908. On a collection of fishes from the Philippine Islands, made by Major Edgar A. Mearns, Surgeon, U. S. Army, with descriptions of seven new species. U. S. National Museum, Proceedings, vol. 33, p. 241. S. obtusata: listed.

Sella, Massimo. 1912. Alcuni appunti sulla pesca del pesce nella Libia. R. Comitato Talassografico Italiano, Memoria 18, p. 24. S. spet: common names, season for fishing.

Shaw, George. 1804. General zoology of systematic natural history. Pisces. London, vol. 5, pt. 1, p. 105. "Esox barracuda": description; habits.

Skogsberg, Tage. 1925. Preliminary investigation of the purse seine industry of southern California. California Fish and Game Commission, Fish Bulletin, no. 9, p. 34–53. [*Reviewed by* W. F. Thompson and Elmer Higgins in California Fish and Game, vol. 9, p. 87–98.] California barracuda: range; season; spawning; fishing methods; protective measures.

Smith, Hugh M. 1895. Notes on a reconnaissance of the fisheries of the Pacific coast of the United States in 1894. U. S. Fish Commission, Bulletin, vol. 14, p. 230, 284. S. argentea: food value; demand; catch. Describes unusual destruction of fish by an unknown cause in 1894.

1898. The fisheries found in the vicinity of Woods Hole. U. S. Fish Commission, Bulletin, vol. 17, p. 94. S. barracuda, S. guachancho: rare stragglers; S. borealis: common from October to December.

1899. Report on the inquiry respecting food-fishes and the fishing-grounds. U. S. Commission of Fish and Fisheries, Report [for 1898], p. CLX. S. argentea: season; time of appearance. Believes its movements toward the coast are chiefly from deep water offshore.

1907. The fishes of North Carolina. North Carolina Geological and Economic Survey, vol. 2, p. 183, fig. 73. S. borealis not uncommon in the harbor at Beaufort; figured in text.

Smith, Hugh M., and Pope, Thomas E. B. 1907. List of fishes collected in Japan in 1903, with descriptions of new genera and species. U. S. National Museum, Proceedings, vol. 31, p. 464. S. japonica from Yamagawa.

Smith, Hugh M., and Seale, Alvin. 1906. Notes on a collection of fishes from the Island of Mindanao, Philippine Archipelago, with descriptions of new genera and species. Biological Society of Washington, Proceedings, vol. 19, p. 76. S. obtusata: listed; common names.

Snodgrass, Robert Evans, and Heller, Edmund. 1905. Shore fishes of the Revillagigedo, Clipperton, Cocos and Galapagos Islands. Washington Academy of Sciences, Proceedings, vol. 6, p. 354. S. idiastes: listed.

Snyder, John Otterbein. 1904. A catalogue of the shore fishes collected by the steamer "Albatross" about the Hawaiian Islands in 1902. U. S. Fish Commission, Bulletin, vol. 22, p. 523. S. commersonii: listed from Honolulu.

1912.1. Japanese shore fishes collected by the United States Bureau of Fisheries steamer "Albatross" Expedition of 1906. U. S. National Museum, Proceedings, vol. 42, p. 409. Key to S. pinguis, S. japonicais (*sic*), S. nigripinnis; (S. nigripinnis not seen by author).

1912.2. The fishes of Okinawa, one of the Riu-Kiu Islands. U. S. National Museum, Proceedings, vol. 42, p. 495. S. obtusata and S. commersoni: listed.

Spencer, Evelene, and Cobb, John N. 1921. Fish cookery; six hundred recipes for the preparation of fish, shellfish and other aquatic animals, including fish soups, salads and entrées, with accompanying sauces, seasonings, dressings and forcemeats. Boston, p. 42–44. Six recipes for cooking barracuda.

Starks, Edwin Chapin. 1900.1. The osteological characters of the fishes of the sub-order Percesoces. U. S. National Museum, Proceedings, vol. 22, p. 3, 8, pl. 1, fig. 1; pl. 2, fig. 1; pl. 3, fig. 1. Osteology of Sphyraenoidae, and of S. argentea.

1990.2. The osteology and relationship of the Percoidean fish, Dinolestes lewini. U. S. National Museum, Proceedings, vol. 22, p. 114, 115, 116. Compares osteology of Dinolestes with that of Sphyraena.

1913. The fishes of the Stanford expedition to Brazil. Stanford University Publications, University Series, no. 12, p. 41. S. barracuda taken at Natal (Brazil).

Stead, David G. 1906. Fishes of Australia. Sydney, p. 82. S. novae-hollandiae most important species in Australia.

Steindachner, Franz. 1866. Zur Fischfauna von Port Jackson in Australien. K. Akademie der Wissenschaften, Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Klasse, vol. 53, p. 424–481. S. grandisquamis, n.s.: described from Port Jackson, Australia.

1895. Die Fische Liberia's. Leyden Museum, Notes, vol. 16, p. 32. S. dubia: described.

Stevenson, Charles H. 1899. The preservation of fishery products for food. U. S. Fish Commission, Bulletin, vol. 18, p. 414. Describes dry-salting of California barracuda.

Storer, David Humphreys. 1846. A synopsis of the fishes of North America. American Academy of Arts and Sciences, Memoirs, n.s., vol. 2, p. 256, 261, 299, 300. S. becuna, S. barracuda, S. guachancho, S. borealis: synonymy: brief descriptions.

Sumner, Francis B.; Osburn, Raymond C.; and Cole, Leon J. 1913. A biological survey of the waters of Woods Hole and vicinity. Section 3. A catalogue of the marine fauna. U. S. Bureau of Fisheries, Bulletin, vol. 31, pt. 2, p. 747–748. S. barracuda, a rare straggler; S. guachancho rare; young of S. borealis common, adults rare.

Swain, Joseph. 1882. An identification of the species of fishes described in Shaw's General zoology. Academy of Natural Sciences of Philadelphia, Proceedings [for 1882], p. 307. Identifies "Esox barracuda" as Sphyraena picuda.

Swainson, William. 1839. The natural history of fishes, amphibians and reptiles, or monocardian animals. *In* Cabinet cyclopedia, by Dionysus Lardner. London, 1838–1839, vol. 2, p. 175. Description of subfamily Sphaerina (*sic*).

2.2.18. T

Temminck, C. J., and Schlegel, Hermann. 1850. Pisces. *In* Fauna Japonica. Lugduni Batavorum, vol. 3, p. 33–34, pl. 13, fig. 1–2. S. japonica, S. nigripinnis, S. obtusata: described; the last two figured.

Tenison-Woods, J. E. 1882. Fish and fisheries of New South Wales. Sydney, p. 11, 20, 69, pl. 28. Lists S. novae-hollandiae, S. obtusata and Lanioperca mordax in Sphyraenidae; S. obtusata and Lanioperca mordax figured.

Thompson, Will F. 1922. The fisheries of California and their care. California Fish and Game, vol. 8, p. 166, fig. 72. Calls attention to the great increase in the barracuda catch.

Townsend, C. H. 1899. Report of the division of statistics and methods of the fisheries. [Quotes "Mr. Rutter."] U. S. Commission of Fish and Fisheries, Report [for 1898], p. CLXIII, CLXIV. Statistics and fishing methods.

Tybring, Oscar. 1886. Poisonous fish. U. S. Fish Commission, Bulletin, vol. 6, p. 150. Fish poisoning from eating S. becuna and S. barracuda.

2.2.19. U

Ulrey, Albert B., and Greeley, Paul O. 1924. Marine fishes (Teleostei) of southern California. Southern California Academy of Sciences, Bulletin, vol. 23, p. 58. Key to family; no description.

1928. A list of the marine fishes (Teleostei) of southern California with their distribution. Southern California Academy of Sciences, Bulletin, vol. 27, p. 41. Range of S. argentea.

United States Bureau of the Census. 1911. Fisheries of the United States, 1908. U. S. Bureau of the Census, Special Reports, p. 26, 30, 34, 287. Statistics of the barracuda fishery; quantity and value by geographic divisions, by gear, by states, and pickled.

United States Commission of Fish and Fisheries. 1873+. Reports. [Published annually.] Most numbers, especially sections later entitled "Fishery industries of the United States," contain statistics showing amount of fish captured, method of capture, price, *etc.*

2.2.20. W

Waite, Edgar R. 1921. Catalogue of the fishes of South Australia. South Australian Museum, Records, vol. 2, no. 1, p. 85, 2 figs. S. novae-hollandiae, an excellent table fish and a good game fish; S. obtusata listed.

1923. The fishes of South Australia. Adelaide, p. 109, 2 figs. S. novae-hollandiae and S. obtusata: descriptions and figures; of S. obtusata: "The young are striped and live among dugong grass; when danger threatens, they ... upend themselves, their snouts directed upwards, their tails moving in unison with the blades of grass to which the stripes on the fish bear remarkable resemblance."

Walbaum, Johanne Julio. n.d. Jacobi Theodori Kleinii ichthyologia enodata sive index rerum ad historiam piscium naturalem. Lipsiae. Sphyraena (genus) described.

1792. Petri Artedi renovati, pars 3. Petri Artedi sueci genera piscium in quibus systema, etc. P. 93–94. S. barracuda: described.

Walford, Lionel A. 1929.1. Barracuda. *In* The commercial fish catch of California for the years 1926 and 1927. California Division of Fish and Game, Fish Bulletin, no. 15, p. 38–41. California barracuda: range, season, fishery.

1929.2. The spawning season of the California barracuda (Sphyraena argentea). California Fish and Game, vol. 15, p. 111–118, figs. 33–38. Spawning season; sex ratio.

1931. Handbook of common commercial and game fishes of California. California Division of Fish and Game, Fish Bulletin, no. 28, p. 71, fig. 48. General brief information about the California barracuda; photograph of S. argentea.

Weber, Max. 1913. Die fische der Siboga-Expedition. *In* Monographie 57, Uitkomsten op Zoologisch, Botanisch, Oceanographisch en Geologisch Gebied versameld in Nederlandsch Oost-Indië 1899–1900 aan boord H. M. Siboga onder commando van Luitenant ter zee I kl. G. F. Tydeman. Leiden, p. 150–152. S. jello, S. commersonii, S. obtusata, S. langsar: listed from Dutch East Indies, distribution, description and proportional measurements of S. jello.

Weber, Max, and Beaufort, L. F. de. 1921. Contributions to the knowledge of Indo-Australian fishes. Rijks Museum van Natuurlikje Historie te Leiden, Zoologische Mededeelingen. Believes S. commersoni to be inseparable from S. picuda.

1922. The fishes of the Indo-Australian Archipelago. Leiden, vol. 4, p. 218–229. Indo-Australasian species of Sphyraena: described, geographic distribution, key; S. jello, S. altipinnis, S. forsteri, S. picuda, S. japonica, S. obtusata, S. langsar, S. brachygnathus: listed.

Webster's New International Dictionary of the English Language. 1929. Springfield, Massachusetts, p. 185, 2010. Dictionary definitions of barracuda and Sphyraena.

West Coast Fisheries. 1930. A sub-tropical fish—barracuda. West Coast Fisheries, July, p. 21. Food value; fishing methods; season; fishing localities.

Whitley, Gilbert P. 1927. A check-list of fishes recorded from Fijian waters. Pan-Pacific Research Institution, Journal, vol. 2, no. 1, p. 4. S. forsteri, S. obtusata, S. commersonii, S. novae-hollandiae: listed.

Wilcox, William A. 1895. The fisheries of the Pacific coast. U. S. Commissioner of Fish and Fisheries, Report [for 1893], p. 191–192. Total catch for 1889–1892; in 1891, a firm in Wilmington began extensive curing of fish . . . chiefly mackerel and barracuda.

Wilson, Charles Branch. 1905. North American parasitic copepods belonging to the family Caligidae. U. S. National Museum, Proceedings, vol. 28, p. 603. Caligus isonyx taken from the gills of S. barracuda in the West Indies.

1911. North American parasitic copepods. Descriptions of new genera and species. U. S. National Museum, Proceedings, vol. 39, p. 627. Midias lobodes from the outside surface of the head of a great barracuda (Sphyraena barracuda).

Woodward, Arthur Smith. 1901. Catalogue of the fossil fishes in the British Museum. London, p. 365–369. S. bolcensis, S. intermedia, S. suessi: listed, described.

2.2.21. Y

Yarrow, H. C. 1877. Notes on the natural history of Fort Macon, N. C., and vicinity. (No. 3.) Academy of Natural Sciences of Philadelphia, Proceedings, p. 212. S. borealis uncommon; a few taken occasionally near Cape Lookout.

2.2.22. Z

Zittel, Karl A. von. 1890. Handbuch der Palaeontologie. I. Abtheilung-Palaeozoologie. München und Leipzig, vol. 3, p. 312. Fossil species of Sphyraena listed: S. bolcensis, S. gracilis, S. maxima, S. tyrolensis.

1902. Text-book of palaeontology. New York, p. 108. Sphyraena occurs in the upper Cretaceous of England, Colorado, and New Mexico, and in the upper Eocene of Monte Bolca.

2.3. SUBJECT INDEX

NOTE.—Entries marked with an asterisk (*) are illustrated. The abbreviation *S.* refers to the generic name Sphyraena.

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Upper Cretaceous of England	–
Nicholson and Lydekker, 1889.	*
COCHIN CHINA	·
Pétillot, 1911.	–
COMMENSALISM	·
Lütken, 1878.	–
COMMON NAMES	·
Africa	–
Barnard, 1925.	*
Boulenger, 1901.	*
Ancient	–
Aldrovandi, 1613.*	*
Aristotle, *n. d.*	*
Cuvier and Valenciennes, 1829.	*
Gesner, 1558.	*
Gudger, 1918.	*
Hoffman and Jordan, 1892.	*
Plinius, *n. d.*	*
Arabia	–
Levi-Morenos, 1912.	*
Australia	–
Ogilby, 1915.	*
Roughley, 1916.	*
Waite, 1923.	*
Balearic Islands	–
Buen, F., 1922.1.	*
Europe	–
Salviano, 1554.	*
France	–
Levi-Morenos, 1912.	*
General	–
Artedi, 1738.	*
Bloch, 1797.	*
Greece	–
Hoffman and Jordan, 1892.	*
India	–
Govindan, 1916.	*
Hornell, 1917.	*
Madras Fisheries Bureau, 1915.	*
Italy	–
Faber, 1883.	*
Levi-Morenos, 1912.	*
Libya	–
Levi-Morenos, 1912.	*
Sella, 1912.	*
Mauritius (Indian Ocean)	–
Pike, 1873.	*
Mediterranean	–
Buen, O., 1912, 1926.	*
Philippine Islands	–
Smith and Seale, 1906.	*
Spain	–
Buen, F., 1922.1.	*
Lleó, 1923.	*
Sphyraena spet	–
Bonaparte, 1841.	*
Turkey	–
Dévedjian, 1926.	*
Various countries	–
Rondelet, 1558.	*

- **CONSERVATION**
  - **California**
    - Holder, 1915.
- **COOKING METHODS (Recipes)**
  - California State Fish Exchange, 1928.
  - Spencer and Cobb, 1921.
- **CORSICA**
  - Roule, 1919.
- **COSTA RICA**
  - Fowler, 1917.1, 1917.2.
- **CUBA**
  - Guichenot, 1853.
  - Nichols, 1912.
  - Poey, 1858, 1868.
- **CURING**
  - **S. argentea**
    - Stevenson, 1899.
    - Wilcox, 1895.

2.3.4. D

- **DICTIONARY DEFINITION OF BARRACUDA**
  - Murray, 1888.
  - Webster's New International Dictionary, 1929.
- **DICTYODUS**
  - **Teeth of—**
    - Owen, 1839.
- **DINOLESTES**
  - **Osteology of—compared with that of Sphyraena**
    - Starks, 1900.2.
- **DRY SALTING**
  - **S. argentea**
    - Stevenson, 1899.
- **DUTCH EAST INDIES**
  - Weber, 1913.

2.3.5. E

- **EARLY DEVELOPMENT**
  - **S. argentea**
    - Barnhart, 1927.
- **ESOX BARRACUDA**
  - **Description**
    - Shaw, 1804.
  - **Identified as S. picuda**
    - Swain, 1882.
- **ESOX SPHYRAENA**
  - **Description**
    - Bloch, 1797.*
    - Bonnaterre, 1788.
    - Cuvier, 1834.*
    - De Blainville, 1818.
    - Gmelin, 1788.
    - Linné, 1766.

2.3.6. F

- **FIJI ISLANDS**
  - Kendall and Goldsborough, 1911.
  - Whitley, 1927.
- **FISHING METHODS**
  - **California**
    - Collins, 1892.
    - Craig, 1927.
    - Eigenmann, 1892.
    - Fry, 1931.
    - Goode, 1887.
    - Nidever, 1926.
    - Scofield, N. B., 1924.1, 1924.2.
    - Walford, 1931.
  - **Florida**
    - Jordan, 1884.2.
  - **Italy**
    - D'Ancona, 1926.
  - **Maori**
    - Bullen, 1928.
  - **Sport Fishing**
    - **Australia**
      - Macgillivray, 1852.
    - **California**
      - Holder, 1903, 1908, 1910.
    - **Florida**
      - Heilner, 1918.
      - Holder, 1903.
      - Mowbray, 1922.1, 1922.2.
    - **United States**
      - Townsend, 1899.
    - **West Indies**
      - Forbin, 1924.
- **FLORIDA**
  - Catesby, 1743.
  - Evermann and Kendall, 1900.
  - Fowler, 1906.
  - Goode, 1880.
  - Goode and Bean, 1880.
  - Henshall, 1895.
  - Holder, 1903.
  - Jordan, 1884.2, 1885.

FOOD OF BARRACUDA ·
Linton, 1901, 1905, 1910. –
Nichols and Breder, 1927. –
FOOD VALUE ·
Barracuda (sp.?) –
Catesby, 1743. *
Clark and Davi, 1919. *
Dampier, 1729. *
Du Tertre, 1667. *
Labat, 1724. *
Malpas, 1926. *
Salviano, 1554. *
European barracuda –
Salviano, 1554. *
S. argentea –
Bauder, 1920. *
California State Fish Exchange, 1928. *
Lockington, 1880. *
Smith, 1895. *
Stevenson, 1899. *
West Coast Fisheries, 1930. *
S. barracuda –
Guichenot, 1853. *
Schroeder, 1924. *
S. becune –
Guichenot, 1853. *
S. guachancho –
Boulenger, 1901. *
Guichenot, 1853. *
S. jello –
Pellegrin, 1900. *
S. novae-hollandiae –
Roughley, 1916. *
Waite, 1921. *
S. obtusata –
Jordan and Metz, 1913. *
S. picuda –
Bean, 1890. *
Pellegrin, 1900. *
S. snodgrassi –
Bryan, 1915. *
S. spet –
Caraffa, 1929. *
Lacépède, 1804. *
S. toxeuma –
Seale, 1910. *
S. vulgaris –
Pellegrin, 1900. *
"Sudis" –
Plinius, *n. d.* *
FORMOSA ·
Jordan and Evermann, 1903. –
Jordan and Richardson, 1912. –
FOSSIL BARRACUDA ·
Agassiz, 1843,* 1845. –
Cope, 1867. –
Hay, 1902. –
Leidy, 1856, 1857. –
Nicholson and Lydekker, 1889. –
Pictet, 1854. –
Woodward, 1901. –
Zittell, 1890, 1902. –
FRANCE ·
Guérin-Ganivet, 1912. –
Moreau, 1881. –

2.3.7. G

GALAPAGOS ·
Snodgrass and Heller, 1905. –
GREECE ·
Facciolà, 1911. –
Hoffman and Jordan, 1892. –
GUAM ·
Seale, 1903. –
GUIANA ·
Fermin, 1769. –
GULF OF CALIFORNIA ·
Gilbert and Starks, 1904. –
GULF OF MEXICO ·
Goode and Bean, 1879, 1883. –

2.3.8. H

HAITI ·
Beebe, 1928. –
Beebe and Tee-Van, 1928. –
Fowler, 1915. –
HAWAII ·
Bryan, 1915. –
Fowler, 1901, 1922. –
Jenkins, O. P., 1901, 1904. –
Jordan and Evermann, 1905, 1926. –
Jordan and Jordan, 1922. –
Jordan and Snyder, 1907. –
Snyder, 1904. –

2.3.9. I

INDIA ·
Chaudhuri, 1917. –
Day, 1865, 1888, 1889. –
Hornell, 1917. –
Jenkins, J. T., 1911. –
INDO-AUSTRALIAN ARCHIPELAGO ·
Weber and Beaufort, 1921, 1922. –
INDO-CHINA ·
Chabanaud, 1926. –
Gruvel, 1925. –
ITALY ·
Bonaparte, 1841. –
D'Ancona, 1926. –

2.3.10. J

JAMAICA
Borodin, 1928. –
Jordan and Rutter, 1897. –
JAPAN
Bleeker, 1854.1, 1854.2. –
Japan. Ministry of Agriculture and Forestry, 1926. –
Jordan and Hubbs, 1925. –
Jordan and Snyder, 1901. –
Jordan, Tanaka and Snyder, 1913. –
Satsuma, Osumi and Hiuga, 1890. –
Smith and Pope, 1907. –
Snyder, 1912.1. –
Teminck and Schlegel, 1850. –

2.3.11. K

KAMABOKA
Preparation of –
Bauder, 1920. *
KIPPERING
Clark and Davi, 1919. –
Cobb, 1919. –
KOREA
Jordan and Metz, 1913. –
Mori, 1928. –

2.3.12. L

LANIOPERCA MORDAX
Australia –
Macleay, 1882. *
Tenison-Woods, 1882.* *
LAWS
California –
California Division of Fish and Game, 1916+. *
Craig, 1927. *
Nidever, 1926, 1928. *
LIFE HISTORY
S. argentea –
Walford, 1929.2. *
LOCOMOTION
Breder, 1926. –
Schlesinger, 1911. –
LONDON CLAY
Agassiz, 1845. –
LONG ISLAND
Baird, 1855. –
LOWER CALIFORNIA
California Fish and Game, 1923. –
Gill, 1863. –
Osburn and Nichols, 1916. –

2.3.13. M

MADAGASCAR
Sauvage, 1891. –
MADRAS
Madras Fisheries Bureau, 1915. –
Madras Fisheries Department, 1930. –
Nayudu, 1921. –
MALAY
Cantor, 1850. –
Duncker, 1904. –
Green, 1927. –
Maxwell, 1921. –
MARQUESAS ISLAND
Seale, 1906. –
MARYLAND
Hildebrand and Schroeder, 1928. –
MASSACHUSETTS
Smith, 1898. –
Sumner, Osburn and Cole, 1913. –
MAURITIUS (Indian Ocean)
Pike, 1873. –
MEDITERRANEAN
Buen, O., 1912, 1926. –
Caraffa, 1929. –
Fage, 1907, 1911. –
Garcia, 1921. –
Lozano, 1919. –
MEXICO
Campeche –
Dampier, 1729. *
Mazatlan –
Jordan and Gilbert, 1882.1. *

2.3.14. N

NATURAL HISTORY
Beebe, 1928. –
Breder, 1926. –
Bullen, 1904. –
Cuvier and Valenciennes, 1829. –
Eigenmann, 1892. –
Forbin, 1924.* –
Goode, 1879. –
Gudger, 1918. –
Henderson, 1916. –
Jordan, 1885, 1905, 1925. –
Lacépède, 1832. –
Nichols, 1924.* –
Ogilby, 1915. –
Reeve, 1912. –
Risso, 1826. –
Roughley, 1916. –
Salviano, 1554. –
Waite, 1923. –
NEW ENGLAND
Nichols and Breder, 1927. –

- **NEW HEBRIDES**
  - Seale, 1906.
- **NEW JERSEY**
  - Abbot, 1868.
  - Baird, 1855.
  - Fowler, 1905, 1920.1.
  - Leidy, 1857.
  - **Miocene of**
    - Cope, 1875.
- **NEW YORK**
  - Bean, 1903.
  - Breder, 1925.
  - De Kay, 1842.
  - Latham, 1919.
  - Nichols and Breder, 1927.
- **NEW ZEALAND**
  - **Fishing methods**
    - Bullen, 1928.
    - Hutton, 1904.
    - Phillipps, 1927.

2.3.15. O

- **OCEANIA** (*See also under* Individual islands.)
  - Fowler, 1925, 1928.
  - Fowler and Ball, 1925.
- **OREGON**
  - Hubbs, 1928.

2.3.16. P

- **PANAMA (Atlantic)**
  - Borodin, 1928.
  - Fowler, 1904.1, 1917.1, 1917.2.
  - Haly, 1875.
  - Meek and Hildebrand, 1923.
- **PANAMA (Pacific)**
  - Gilbert and Starks, 1904.
  - Meek and Hildebrand, 1923.
- **PARASITES ON BARRACUDA**
  - Linton, 1901, 1905, 1908.1, 1908.2, 1910.
  - Murphy, 1914.
  - Wilson, 1905, 1911.
- **PERU**
  - Evermann and Radcliffe, 1917.
  - Nichols and Murphy, 1922.
- **PHILIPPINE ISLANDS**
  - Evermann and Seale, 1907.
  - Fowler, 1918.
  - Fowler and Bean, 1923.
  - Jordan and Seale, 1905.2, 1907.
  - Seale, 1909.
  - Seale and Bean, 1908.
  - Smith and Seale, 1906.
- **POISON FROM EATING ATLANTIC BARRACUDA.** (*See also* Food value.)
  - Duméril, 1867.
  - Du Tertre, 1667.
  - Ferguson, 1821.
  - Fermin, 1769.
  - Gudger, 1918.
  - Moreau de Jonnès, 1819.
  - Mowbray, 1916, 1922.1.
  - Nichols, 1912, 1924.
  - Pellegrin, 1900.
  - Sauvage, 1865.
  - Tybring, 1886.
- **PORTO RICO**
  - Evermann and Marsh, 1902.
  - Fowler, 1904.1.
- **PORTUGAL**
  - Seabra, 1911.

2.3.17. R

- **RED SEA**
  - Klunzinger, 1870.
- **RELATIONSHIP**
  - Günther, 1880.2.
  - Lacépède, 1804.
- **RIU-KIU ISLANDS**
  - Snyder, 1912.2.

2.3.18. S

- **SAMOA**
  - Jordan, 1927.
  - Jordan and Seale, 1906.
- **SAUROCEPHALUS**
  - **Compared with Sphyraena**
    - Leidy, 1860.
- **SAURODONTIDAE**
  - **Compared with Sphyraenidae**
    - Cope, 1870.
- **SCALES, DESCRIPTIONS OF BARRACUDA—**
  - **S. borealis**
    - Cockerell, 1914.*
  - **S. picuda**
    - Cockerell, 1914.
- **SCHOOLING HABITS**
  - Aristotle, *n. d.*
- **SEX RATIO**
  - **S. argentea**
    - Walford, 1929.2.
- **SINALOA**
  - Jordan, 1895.

SPAIN	·
Borja, 1921.	–
Garcia, 1921.	–
Lozano, 1919.	–
Pardo, 1919.	–
SPAWNING	·
S. argentea	–
Skogsberg, 1925.	*
Walford, 1929.2.	*
SPHYRAENA (Genus Only)	·
Jordan, 1923.	*
Jordan and Evermann, 1917.	*
Leidy, 1860.	*
Lydekker, 1901.	*
Description	–
Aldrovandi, 1613.*	*
Cuvier, 1817.	*
Dumeril, 1856.	*
Risso, 1826.	*
Walbaum, *n.d.*	*
First described	–
Bloch and Schneider, 1801.	*
Fossil forms, distribution of—	–
Zittel, 1902.	*
Middle Eocene of Monte Bolca	–
Nicholson and Lydekker, 1889.	*
Osteology of—compared with that of Dinolestes	–
Starks, 1900.2.	*
Skeleton	–
Goodrich, 1909.	*
Starks, 1900.1,* 1900.2.	*
Teeth	–
Owen, 1845.	*
S. ACUTIPINNIS	·
Africa, south	–
Barnard, 1925.*	*
India	–
Day, 1888, 1889.	*
Indo-China	–
Gruvel, 1925.*	*
S. AFRICANA	·
First described, south Africa	–
Gilchrist and Thompson, 1909.	*
S. AGAM	·
Description	–
Günther, 1860.	*
First described, Abyssinia	–
Rüppell, 1835.*	*
Madagascar	–
Sauvage, 1891.	*
Red Sea	–
Klunzinger, 1870, 1884.	*
S. ALTIPINNIS	·
Indo-Australian Archipelago	–
Weber and Beaufort, 1922.	*
S. AMICI (Extinct Species)	·
Agassiz, 1843.*	–
Pictet, 1854.	–
S. ARGENTEA (*See also* California)	·
Description	–
Girard, 1858.*	*
Günther, 1860.	*
Jordan and Evermann, 1896.2.	*
Jordan and Gilbert, 1882.2.	*
Meek and Newland, 1884.	*
Distribution	–
Jordan, Evermann and Clark, 1930.	*
Skogsberg, 1925.	*
Ulrey and Greeley, 1928.	*
Walford, 1929.1, 1931.*	*
Egg and embryo	–
Barnhart, 1927.*	*
First described	–
Girard, 1854.	*
Fishing methods	–
Skogsberg, 1925.	*
Laguna Beach	–
Metz, 1912.	*
Lower California	–
Gill, 1863.	*
Osburn and Nichols, 1916.	*
Migrations	–
Smith, 1899.	*
Northern range	–
Lockington, 1879, 1880.	*
Oregon	–
Hubbs, 1928.	*
Osteology	–
Starks, 1900.1.*	*
Recipes for cooking	–
California State Fish Exchange, 1928.	*
San Francisco southward	–
Cooper, 1868.	*
Season	–
Lockington, 1880.	*
Skogsberg, 1925.	*
Smith, 1899.	*
Walford, 1929.1.	*
Spawning season	–
Skogsberg, 1925.	*
Walford, 1929.2.	*
Unusual destruction of—	–
Smith, 1895.	*
Washington	–
Hubbs, 1928.	*
Kincaid, 1919.	*

S. AUREOFLAMMEA	·
Philippine Islands	–
Fowler and Bean, 1923.	*
First described	–
Seale, 1909.	*
S. BARRACUDA	·
Bahamas	–
Nichols, 1921.	*
Parr, 1930.	*
Bermuda	–
Bean, 1906.	*
Brazil	–
Moseley, 1879.	*
Starks, 1913.	*
Commensalism with other species	–
Lütken, 1878.	*
Costa Rica	–
Fowler, 1917.1.	*
Cranium	–
Gregory, 1920.*	*
Description	–
Breder, 1929.*	*
Jordan and Evermann, 1896.2, 1908.*	*
Storer, 1846.	*
Walbaum, 1792.	*
Distribution	–
Breder, 1929.*	*
Jordan and Evermann, 1896.1.	*
Jordan, Evermann and Clark, 1930.	*
First described	–
Cuvier and Valenciennes, 1829.	*
Florida	–
Evermann and Kendall, 1900.	*
Fowler, 1906.	*
Schroeder, 1924.	*
Food of—	–
Linton, 1910.	*
Food value	–
Gudger, 1918.*	*
Guichenot, 1853.	*
Schroeder, 1924.	*
Tybring, 1886.	*
Fossil	–
Agassiz, 1843.*	*
General	–
Gudger, 1918.*	*
Jordan, 1905,* 1925.*	*
Mowbray, 1922.2.*	*
Sauvage, 1865.	*
Habits	–
Gudger, 1918.*	*
Haiti	–
Beebe and Tee-Van, 1925.	*
Fowler, 1915.	*
Jamaica	–
Jordan and Rutter, 1897.	*
Locomotion	–
Breder, 1926.	*
Morphology	–
Gudger, 1918.*	*
Jordan, 1905.*	*
New England	–
Nichols and Breder, 1927.	*
Smith, 1898.	*
Sumner, Osburn and Cole, 1913.	*
New Jersey	–
Fowler, 1905,* 1920.1.	*
New York	–
Nichols and Breder, 1927.	*
Oceania	–
Fowler, 1928.	*
Panama (East Coast)	–
Meek and Hildebrand, 1923.	*
Parasites on—	–
Linton, 1908.1, 1910.	*
Wilson, 1905, 1911.	*
Porto Rico	–
Evermann and Marsh, 1902.	*
Fowler, 1904.1.	*
Sumatra	–
Fowler and Bean, 1927.	*
Tortugas	–
Jordan, 1904.	*
Jordan and Thompson, 1905.	*
S. BECUNE [BECUNA]	·
Description	–
Cuvier and Valenciennes, 1829.	*
Guichenot, 1853.	*
Storer, 1846.	*
Poison from eating	–
Tybring, 1886.	*
West Indies	–
Moreau de Jonnès, 1819.	*
S. BOLCENSIS (Fossil Form)	·
Eocene of Monte Bolca	–
Eastman, 1911.	*
General	–
Agassiz, 1843.*	*
Pictet, 1854.	*
Woodward, 1901.	*
Zittel, 1890.	*
S. BOREALIS	·
Aquaria	–
Bean, 1897.	*
Atlantic coast (America)	–
Breder, 1929.*	*
Nichols and Breder, 1927.	*
Bermuda	–
Bean, 1906.	*
Cape Cod to Florida	–
Gill, 1873.	*
Carolina	–
Coles, 1910.	*
Jordan, 1886.1.	*
Smith, 1907.*	*
Yarrow, 1877.	*

Description	–
Jordan and Evermann, 1896.2.	*
Meek and Newland, 1884.	*
Storer, 1846.	*
Distribution	–
Jordan and Evermann, 1896.1.	*
Jordan, Evermann and Clark, 1930.	*
First described	–
De Kay, 1842.	*
Florida	–
Evermann and Kendall, 1900.	*
Goode and Bean, 1880.	*
Food	–
Linton, 1901, 1905.	*
Maryland	–
Hildebrand and Schroeder, 1928.*	*
Massachusetts	–
Smith, 1898.	*
Sumner, Osburn and Cole, 1913.	*
Natural history	–
Goode, 1879.	*
New Jersey	–
Abbott, 1868.	*
Bean, 1889.	*
Fowler, 1905.*, 1920.1.	*
New York	–
Bean, 1903.	*
Breder, 1925.	*
De Kay, 1842.	*
Latham, 1919.	*
Panama	–
Meek and Hildebrand, 1923.	*
Parasites on—	–
Linton, 1901, 1905.	*
Same as S. spet	–
Goode, 1884.*	*
Jordan and Gilbert, 1878.	*
Same as S. sphyraena	–
Collett, 1896.	*
Jordan, 1884.1.	*
Scales	–
Cockerell, 1914.*	*
West Indies	–
Fowler, 1904.1.	*
S. BRACHYGNATHOS [BRACHYGNATHUS]	·
Description	–
Günther, 1860.	*
Indian Archipelago	–
Bleeker, 1854.2.	*
Indo-Australian Archipelago	–
Weber and Beaufort, 1922.	*
S. CHRYSOTAENIA.	·
First described, Red Sea	–
Klunzinger, 1884.	*
S. COMMERSONII	·
Africa, south	–
Barnard, 1925.	*
Gilchrist and Thompson, 1909.	*
Australia	–
Macleay, 1882.	*
Saville-Kent, 1893.	*
Description	–
Günther, 1860.	*
Dutch East Indies	–
Weber, 1913.	*
Fiji	–
Whitley, 1927.	*
Fins (Anatomy)	–
Bridge, 1896.	*
First described	–
Cuvier and Valenciennes, 1829.	*
Hawaii	–
Fowler, 1922.	*
Jenkins, O. P., 1904.	*
Jordan and Snyder, 1907.	*
Snyder, 1904.	*
India	–
Day, 1888, 1889.	*
Indian Archipelago	–
Bleeker, 1854.2.	*
Malay	–
Maxwell, 1921.	*
Oceania	–
Fowler, 1901.	*
Philippine Islands	–
Jordan and Richardson, 1908.	*
Riu-Kiu Islands	–
Snyder, 1912.2.	*
Same as S. picuda	–
Weber and Beaufort, 1921.	*
S. DENTATUS	·
Saville-Kent, 1893.	–
S. DUBIA	·
Africa, west	–
Pellegrin, 1914.	*
Liberia	–
Steindachner, 1895.	*
S. DUSSUMIERI	·
Description	–
Günther, 1860.	*
S. ENSIS	–
Description	*
Jordan and Evermann, 1896.2.	+
Meek and Newland, 1884.	+
Distribution	*
Jordan and Evermann, 1896.1.	+
Jordan, Evermann and Clark, 1930.	+
Gulf of California	*
Gilbert and Starks, 1904.	+
Magdalena Bay	*
California Fish and Game, 1923.	+

Mexico (West Coast)	*
Jordan and Gilbert, 1882.1.	+
Panama (Pacific)	*
Fowler, 1904.1.	+
Gilbert and Starks, 1904.	+
Meek and Hildebrand, 1923.	+
S. FLAVICAUDA	–
Description	*
Günther, 1860.	+
First described, Abyssinia	*
Rüppell, 1835.*	+
S. FORSTERI	–
Australia	*
Macleay, 1882	+
Saville-Kent, 1893.	+
Description	*
Cuvier and Valenciennes, 1829.	+
Günther, 1860, 1877.*	+
Fiji	*
Kendall and Goldsborough, 1911.	+
Whitley, 1927.	+
Formosa	*
Jordan and Evermann, 1903.	+
Jordan and Richardson, 1912.	+
Indian Archipelago	*
Bleeker, 1854.2.	+
Indo-Australian Archipelago	*
Weber and Beaufort, 1922.	+
Indo-China	*
Chabanaud, 1926.	+
Gruvel, 1925.	+
Oceania	*
Fowler, 1928.	+
Samoa	*
Jordan, 1927.	+
Jordan and Seale, 1906.	+
S. GOODINGI	–
First described, Marquesas Island	*
Seale, 1906.	+
S. GRACILIS (Extinct Species)	–
Agassiz, 1843.*	*
Pictet, 1854.	*
Zittel, 1890.	*
S. GRANDISQUAMIS	–
First described, Port Jackson, Australia	*
Steindachner, 1866.	+
Samoa	*
Jordan and Seale, 1906.	+
S. GUACHANCHO [GUACHANCHE]	–
Africa	*
Boulenger, 1901.	+
Africa, west	*
Regan, 1915.	+
Atlantic coast (America)	*
Breder, 1929.*	+
Metzelaar, 1919.	+
Costa Rica	*
Fowler, 1917.1, 1917.2.	+
Cuba	*
Guichenot, 1853.	+
Nichols, 1912.	+
Description	*
Storer, 1846.	+
Distribution	*
Jordan, Evermann and Clark, 1930.	+
First described	*
Cuvier and Valenciennes, 1829.	+
Florida	*
Evermann and Kendall, 1900.	+
Goode and Bean, 1880.	+
Henshall, 1895.	+
Gulf of Mexico	*
Goode and Bean, 1883.	+
Haiti	*
Beebe and Tee-Van, 1928.	+
Jamaica	*
Jordan and Rutter, 1897.	+
Maryland	*
Hildebrand and Schroeder, 1928.	+
Massachusetts	*
Smith, 1898.	+
Sumner, Osburn and Cole, 1913.	+
New York	*
Bean, 1903.	+
Panama (Atlantic)	*
Borodin, 1928.	+
Fowler, 1917.1, 1917.2.	+
Meek and Hildebrand, 1923.	+
Porto Rico	*
Evermann and Marsh, 1902.	+
West Indies	*
Jordan, 1886.2.	+
Metzelaar, 1919.	+
S. GUAGUANCHE [GUAGUANCHO]	*
Cuba	+
Poey, 1858, 1868.	
Description	+
Jordan and Evermann, 1896.2.	
Jordan and Gilbert, 1882.2.	
Meek and Newland, 1884.	
Distribution	+
Jordan and Evermann, 1896.1.	
West Indies	+
Jordan, 1890.1.	
S. GÜNTHERI	*
First described, Colon	+
Haly, 1875	
S. HELLERI	*
First described, Hawaii	+
Jenkins, O. P., 1901.	

Hawaii	*
Fowler, 1922.	
Jordan and Evermann, 1905,* 1926.	
Jordan and Jordan, 1922.	
Jordan and Snyder, 1907.	
Samoa	+
Jordan and Seale, 1906.	
S. IDIASTES	*
First described	+
Heller and Snodgrass, 1903.	
Galapagos	+
Snodgrass and Heller, 1905.	
Peru	+
Evermann and Radcliffe, 1917.	
Nichols and Murphy, 1922.	
S. INTERMEDIA (Fossil Form)	*
Description	+
Woodward, 1901.	
S. JAPONICA	*
Description	+
Bloch and Schneider, 1801.	
Günther, 1860.	
First described	+
Cuvier and Valenciennes, 1829.	
Formosa	+
Jordan and Evermann, 1903.	
Jordan and Richardson, 1912.	
Indo-Australian Archipelago	+
Weber and Beaufort, 1922.	
Japan	+
Bleeker, 1854.1.*	
Jordan and Hubbs, 1925.	
Jordan and Snyder, 1901.	
Jordan, Tanaka and Snyder, 1913.	
Satsuma, Osumi and Hiuga, 1890.*	
Smith and Pope, 1907.	
Snyder, 1912.1.	
Temminck and Schlegel, 1850.	
Johnston Island (Oceania)	+
Fowler and Ball, 1925.	
Natal	+
Fowler, 1929.	
Oceania	+
Fowler, 1928.	
S. JELLO	*
Africa, south	+
Barnard, 1925.	
Gilchrist and Thompson, 1908.	
Ceylon	+
Jordan and Starks, 1917.	
Cochin China	+
Pétillot, 1911.	
Description	+
Günther, 1860.	
Pellegrin, 1900.	
Weber, 1913.	
Distribution	+
Jordan, Tanaka and Snyder, 1913.	
Dutch East Indies	+
Weber, 1913.	
First described	+
Cuvier and Valenciennes, 1829.	
Formosa	+
Jordan and Evermann, 1903.	
Jordan and Richardson, 1912.	
Hong Kong	+
Seale, 1914.	
India	+
Day, 1865, 1888, 1889.	
Hornell, 1917.	
Indian Archipelago	+
Bleeker, 1854.2.	
Indo-Australian Archipelago	+
Weber and Beaufort, 1922.	
Indo-China	+
Chabanaud, 1926.	
Liberia	+
Büttikofer, 1890.	
Madras	+
Madras Fisheries Bureau, 1915.	
Malay	+
Cantor, 1850.	
Duncker, 1904.	
Green, 1927.	
Maxwell, 1921.	
Oceania	+
Fowler, 1928.	
Philippine Islands	+
Evermann and Seale, 1907.	
Jordan and Richardson, 1908.	
Jordan and Seale, 1905.2, 1907.	
Red Sea	+
Klunzinger, 1870, 1884.	
S. KENIE. *See* **S. QENIE**	*
S. LANGSAR	*
Australia	+
Macleay, 1882.	
Saville-Kent, 1893.	
Ceylon	+
Jordan and Starks, 1917.	
Description	+
Günther, 1860.	
Dutch East Indies	+
Weber, 1913.	
Formosa	+
Jordan and Richardson, 1912.	
Indian Archipelago	+
Bleeker, 1854.2.	
Indo-Australian Archipelago	+
Weber and Beaufort, 1922.	
Oceania	+
Fowler, 1928.	
Philippine Islands	+
Evermann and Seale, 1907.	
Fowler, 1918.	

S. LUCASANA *
Lower California +
Gill, 1863.
S. MAJOR (Fossil Form) +
Leidy, 1856.
Phosphate beds of South Carolina +
Leidy, 1877.
S. MAXIMA (Fossil Form) +
Pictet, 1854.
Zittel, 1890.
S. MEGALOLEPIS +
Samoa
Jordan and Seale, 1906.
S. NATALENSIS +
First described
Bonde, 1924.*
S. NIGRIPINNIS +
China
Reeves, 1927.
Description
Günther, 1860.
Japan
Jordan, Tanaka and Snyder, 1913.
Satsuma, Osumi and Hiuga, 1890.*
Snyder, 1912.1.
Temminck and Schlegel, 1850.*
S. NOVAE-HOLLANDIAE +
Australia
Macleay, 1882.
McCulloch, 1922.*
Roughley, 1916.
Saville-Kent, 1893.
Stead, 1906.
Tenison-Woods, 1882.
Waite, 1921, 1923.*
Description
Günther, 1860.
Fiji
Whitley, 1927.
Malay
Maxwell, 1921.
Tasmania
Lord, 1927.
S. OBTUSATA +
Abrolhos Islands
Alexander, 1922.
Africa, south
Barnard, 1925.
Bonde, 1924.
Australia
Alexander, 1922.
Macleay, 1882.
McCulloch, 1922.*
Ogilby, 1915.
Saville-Kent, 1893.
Tenison-Woods, 1882.*
Waite, 1921, 1923.*
Caroline Islands
Kendall and Goldsborough, 1911.
China
Reeves, 1927.
Seale, 1914.
Description
Günther, 1860, 1877.*
Dutch East Indies
Weber, 1913.
Fiji Islands
Kendall and Goldsborough, 1911.
Whitley, 1927.
Fin Musculature
Grenholm, 1923.*
First described
Cuvier and Valenciennes, 1829
Guam
Seale, 1903.
Hong Kong
Seale, 1914.
India
Day, 1888,* 1889.*
Hornell, 1917.
Indian Archipelago
Bleeker, 1854.2.
Indo-Australian Archipelago
Weber and Beaufort, 1922.
Indo-China
Gruvel, 1925.*
Japan
Satsuma, Osumi and Hiuga, 1890.*
Temminck and Schlegel, 1850.*
Korea
Jordan and Metz, 1913.
Mori, 1928.
Madagascar
Sauvage, 1891.
Malay
Cantor, 1850.
Duncker, 1904.
Green, 1927.
Maxwell, 1921.
Natural history
Ogilby, 1915.
New Hebrides
Seale, 1906.
New Zealand
Hutton, 1904.
Phillipps, 1927.
Oceania
Fowler, 1928.
Philippine Islands
Evermann and Seale, 1907.
Jordan and Seale, 1907.
Seale and Bean, 1908.
Smith and Seale, 1906.

Red Sea +
Klunzinger, 1870, 1884.
Samoa
Jordan, 1927.
Jordan and Seale, 1906.
Riu-Kiu Islands
Snyder, 1912.2.
S. PICUDA +
Bermuda
Goode, 1876.
British America
Richardson, 1836.
Carolina
Jordan and Gilbert, 1883.
Cuba
Nichols, 1912.
Poey, 1858, 1868.
Description
Günther, 1860.
Jordan and Gilbert, 1882.2.
Meek and Newland, 1884.
Pellegrin, 1900.
Poey, 1863.2.
First described
Bloch and Schneider, 1801.*
Florida
Goode, 1880.
Henshall, 1895.
Jordan, 1884.2, 1885.
General
Cuvier and Valenciennes, 1829.
Goode, 1884.*
Gulf of Mexico
Goode and Bean, 1879, 1883.
Identification from Parra
Poey, 1863.1.
Indo-Australian Archipelago
Weber and Beaufort, 1922.
New Jersey
Bean, 1889.*
Oceania
Fowler, 1925.
Poison from eating
Pellegrin, 1900.
Scales of—
Cockerell, 1914.
Same as S. commersoni
Weber and Beaufort, 1921.
Tropical Atlantic
Metzelaar, 1919.
Murphy, 1914.
West Indies
Gundlach, 1881.
Jordan, 1886.2.
Metzelaar, 1919.
Yucatan
Bean, 1890.
S. PICUDILLA +
Bahamas
Nichols, 1921.
Bermuda
Bean, 1906.
Brazil
Jordan, 1890.2.
Cuba
Poey, 1858, 1868.
Description
Fowler, 1904.1.
Jordan and Evermann, 1896.2.
Meek and Newland, 1884.
Distribution
Jordan and Evermann, 1896.1.
Jordan, Evermann and Clark, 1930.
Haiti
Beebe and Tee-Van, 1928.
Jamaica
Borodin, 1928.
Panama
Meek and Hildebrand, 1923.
Porto Rico
Evermann and Marsh, 1902.
West Indies
Fowler, 1931.
Jordan, 1886.2.
Metzelaar, 1919.
S. PINGUIS +
China
Reeves, 1927.
Distribution
Jordan, Tanaka and Snyder, 1913.
Japan
Jordan and Hubbs, 1925.
Jordan and Thompson, 1914.
Snyder, 1912.1.
S. PLUMERII +
Bloch and Schneider, 1801.
S. PUTNAMIAE +
China
Reeves, 1927.
First described
Jordan and Seale, 1905.1.
S. QENIE [KENIE] +
First described, Red Sea
Klunzinger, 1870, 1884.
Oceania
Fowler, 1928.
Samoa
Jordan and Seale, 1906.
S. RAGHAVA +
First described, India
Chaudhuri. 1917.*

S. SNODGRASSI +
First described, Hawaii
Jenkins, O. P., 1901.
Hawaii
Bryan, 1915.
Jenkins, O. P., 1901, 1904.
Jordan and Evermann, 1905,* 1926.
Jordan and Jordan, 1922.
Jordan and Snyder, 1907.
Samoa
Jordan and Seale, 1906.
Tahiti
Fowler, 1904.1.
S. SPECIOSA (Fossil Form) +
Miocene
Cope, 1867.
New Jersey
Leidy, 1857.
S. SPET +
Bermuda
Goode, 1876.
Carolina
Jordan and Gilbert, 1878.
Corsica
Caraffa, 1929.*
Description
Jordan and Gilbert, 1882.2.
Lacépède, 1804, 1832.
Depth (in relation to length)
Houssay, 1912.
France
Guérin-Ganivet, 1912.
Moreau, 1881.
Italy
Bonaparte, 1841.*
D'Ancona, 1926.
Libya
Sella, 1912.
Mediterranean
Carus, 1893.
Fage, 1907.
Spain
Pardo, 1919.
Turkey
Ninni, 1923.
S. SPHYRAENA +
Africa, west
Fowler, 1920.2.
Atlantic coast (America)
Breder, 1929.
Jordan, 1884.1.
Bermuda
Barbour, 1905.
Bean, 1906.
Canary Islands
Jordan and Gunn, 1898.
Description
Jordan and Evermann, 1896.2.
Meek and Newland, 1884.
Distribution
Jordan and Evermann, 1896.1.
Jordan, Evermann and Clark, 1930.
Italy
Facciolà, 1911.
Mediterranean
Fage, 1911.
Garcia, 1921.
Parasites on
Linton, 1908.2.
Portugal
Seabra, 1911.
Spain
Buen, F., 1919, 1922.1.
Garcia, 1921.
Lleó, 1923.
Lozano, 1919.
Turkey
Dévedjian, 1926.*
West Indies
Jordan, 1886.2.
Young of—
Collett, 1896.
S. STRENUA +
First described, Australia
De Vis, 1884.
S. SUESSI +
Woodward, 1901.
S. TOME +
First described
Fowler, 1904.1.*
S. TOXEUMA +
Borneo
Seale, 1910.
First described, Sumatra
Fowler, 1904.2.*
S. TYROLENSIS (Fossil Form) +
Zittel, 1890.
S. VIRIDENSIS +
First described
Cuvier and Valenciennes, 1829.

2.3.19. T

2.3.20. U

2.3.21. V

2.3.22. W

WASHINGTON (State)	·
Hubbs, 1928.	–
Kincaid, 1919.	–
WEST INDIES (*See also under* **Individual islands**)	·
General	–
Du Tertre, 1667.	*
Ferguson, 1821.	*
Forbin, 1924.*	*
Fowler, 1904.1, 1931.	*
Gundlach, 1881.	*
Jordan, 1886.2, 1890.1.	*
Metzelaar, 1919.	*

2.3.23. Y

YUCATAN	·
Bean, 1890.	–

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Higgins, Elmer. A Study of Fluctuations in the Sardine Fishery at San Pedro.
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