UNITED STATES DEPARTMENT OF THE INTERIOR, Oscar L. Chapman, *Secretary*

FISH AND WILDLIFE SERVICE, Albert M. Day, *Director*

CONTRIBUTIONS TO THE BIOLOGY OF TUNAS FROM THE WESTERN EQUATORIAL PACIFIC

By Bell M. Shimada

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By Bell M. Shimada, *Fishery Research Biologist*

Research into the biology of Pacific tunas has advanced rapidly in recent years, yet much remains unknown about the life history and habits of tuna species inhabiting waters of the former Mandated Islands now known as the Pacific Trust Territories, in the western equatorial Pacific Ocean. In prewar years, some scientific studies were conducted by the Japanese, but these were limited in scope and directed primarily towards exploitation of the extensive tuna resources to be found near their island possessions.

With the opening of the Trust Territories on May 11, 1950, to Japanese mothership-type tuna-fishing operations, an opportunity was given the Pacific Oceanic Fishery Investigations of the United States Fish and Wildlife Service to gather important data on tunas of this region by sending a scientific and technical observer along with the first mothership expedition to leave Japan. I was subsequently detailed aboard the mothership *Tenyo Maru No. 2* and accompanied the expedition from June 12 to September 14, 1950. During this assignment my principal duties were to observe Japanese methods of fishing and processing tuna, and to collect morphometric data on various tuna species for use by the Pacific Oceanic Fishery Investigations in current studies on Pacific tuna populations. Some information was obtained also on other biological aspects of tunas. These incidental observations on the spawning of yellowfin and big-eyed tuna, on the occurrence of juvenile oceanic skipjack, and on the capture of adult bluefin tuna in the area covered by the expedition are summarized in this report.

These studies were made possible through the cooperation of the High Commissioner for the Trust Territories of the Pacific Islands and the Natural Resources Section, General Headquarters, Supreme Commander for the Allied Powers. The assistance rendered by various members of the Japanese Fishery Agency and the Taiyo Fishing Co., Ltd., aboard the mothership is also acknowledged.

COLLECTION OF DATA

The expedition, consisting of a mothership and 25 longline-fishing vessels, commenced its activities in the vicinity of 4°35′ north latitude and 143°32′ east longitude on June 17, 1950. As the season progressed, the center of fishing gradually shifted eastward at a rate of about 100 nautical miles a week, the changes in position of the vessels being dictated largely by the success of fishing in any one area. The deployment of fishing vessels in a north-and-south direction was bounded by 1° and 9° north latitude, but in general fishing was mostly between 1° and 5° north latitude, for it was here that the best catches were made. When operations were terminated on September 5, 1950, the mothership's position was 8° north latitude, 153°46′ east longitude, whence it returned to Japan. The easternmost limit reached by the catcher boats was 160° east longitude. In all, the expedition fished an area of approximately 305,000 square miles from which it took over 4,055 tons of tunas, spearfishes, sharks, and other fishes (table 1).

Table 1.—*Total catch, by species, of Japanese tuna mothership expedition, June–September 1950*

Species	Catch [1]
	Pounds
Yellowfin tuna (*Neothunnus macropterus*)	4,574,358
Big-eyed tuna (*Parathunnus sibi*)	699,014
Albacore (*Thunnus germo*)	65,378
Bluefin tuna (*Thunnus orientalis*)	3,430
Skipjack (*Katsuwonus pelamis*)	6,968
Black marlin (*Makaira mazara*)	1,760,389
White marlin (*Makaira marlina*)	48,182
Striped marlin (*Makaira mitsukurii*)	1,229
Sailfish [2] (*Istiophorus orientalis*)	28,160
Swordfish (*Xiphias gladius*)	13,656
Shark	895,022
Others [3]	23,048
Total	8,118,834

[1] Statistics provided by the Japanese Fishery Agency and converted to pounds using conversion factor of 8.27 lbs.=1 *kan*.
[2] Includes short-nosed marlin (*Tetrapturus brevirostris*).
[3] Includes barracuda (*Sphyraena argentea*), wahoo (*Acanthocybium solandri*), and dolphin (*Coryphaena hippurus*).

A few tunas were caught by pole and line at the surface, but gear employed chiefly was the longline. This type of gear was developed to a great

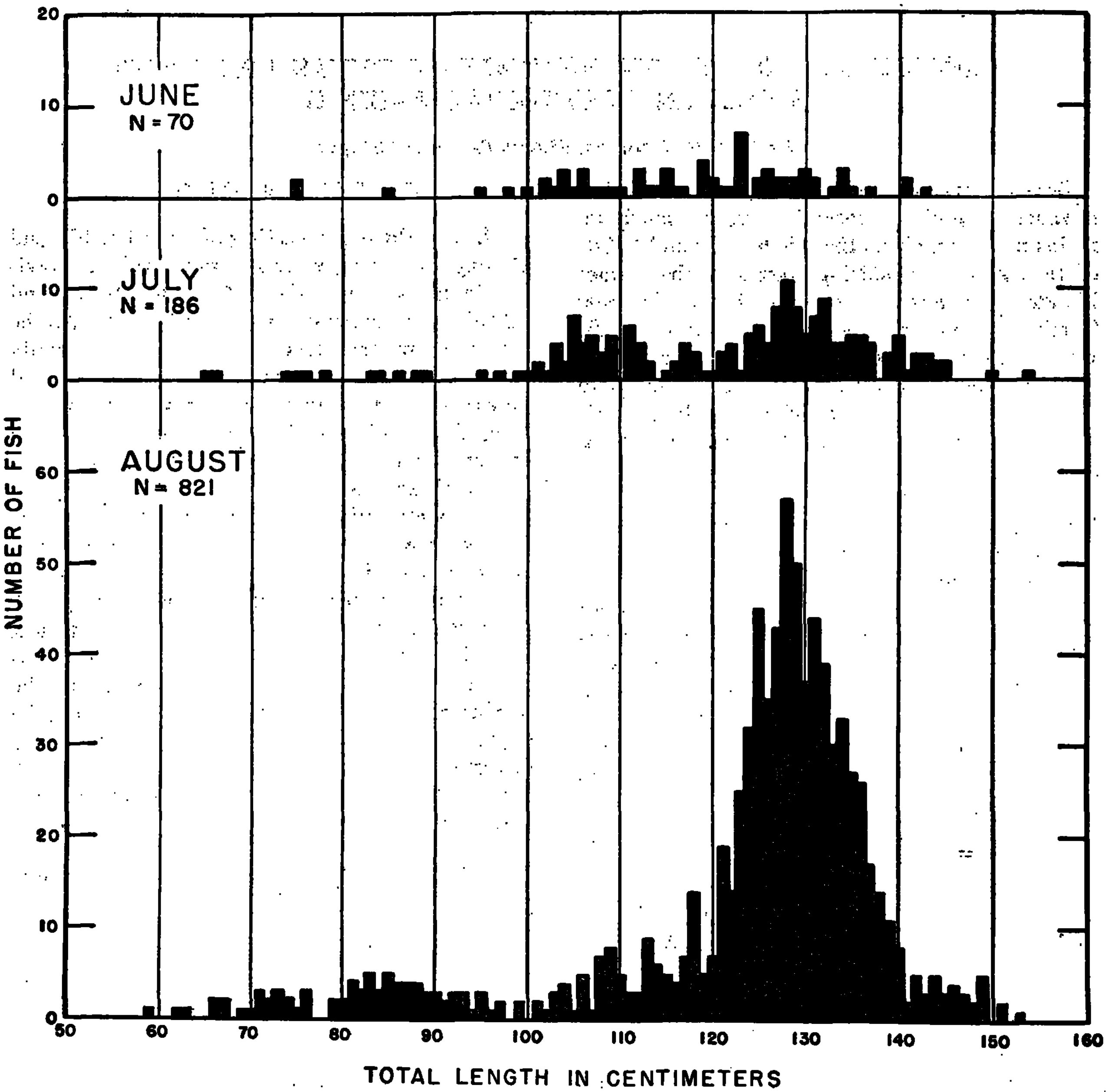

FIGURE 1.—Length frequencies of yellowfin tuna measured aboard the mothership *Tenyo Maru No. 2*, June–August 1950.

extent by the Japanese and is highly effective for fishing subsurface levels for tunas and other commercially valuable fishes otherwise unavailable to fishermen. Although variations in the construction of gear and minor differences in operating technique existed among the many fishing vessels of the expedition, the longlines were built and handled essentially in the same manner by all vessels. A good description of Japanese longline gear and fishing methods is given by Shapiro (1950).

The principal species of fish landed was the yellowfin tuna (*Neothunnus macropterus*) which comprised more than 50 percent of the total catch by weight and number. Yellowfin tuna, because of their export value, were delivered to the mothership as whole fish for freezing, whereas other species were usually gutted at sea. Those yellowfin not suitable for freezing in the round because of size or condition were butchered for filleting. Such fish were examined whenever possible for sexual maturity and food habits.

The big-eyed tuna (*Parathunnus sibi*) appeared less frequently in the catches than yellowfin tuna but ranked second in percentage composition of tuna landings by weight and number. Approximately 350 tons of this species were received by the mothership. Biological observations were made on big-eyed tuna similar to those for the yellowfin.

NOTES ON TUNA SPAWNING

Yellowfin (*Neothunnus macropterus*)

Previous studies on the gonads of yellowfin tuna have been largely confined to smaller fish, less than a meter in length, usually captured by surface-trolling gear (Schaefer and Marr 1948a, Wade 1950a). Schaefer and Marr's work (1948a) on the spawning of yellowfin tuna in Central American waters included large fish, but even so, representative samples from catches made by bait boats and purse seiners were composed predominately of fish measuring less than a meter. It is apparent, therefore, that fishing gear designed to fish at or near the surface catches smaller and younger fish than subsurface gear and for this reason does not supply material that gives information on the maturation of older fish.

The longline, on the other hand, captures larger fish. This is evident from figure 1 which shows the plotted length-frequency data for yellowfin tuna taken randomly from longline catches during the season. Length frequencies of fish of less than 80 cm. include not only those caught by longlines but also fish taken at the surface by pole-and-line gear.

Although the proportion of males was usually greater than that of females among yellowfin tuna examined, the sex ratio sometimes running as high as 80 males to 20 females in samples drawn from landed catches, no effort was made to analyze the condition of male gonads for it is extremely difficult, if not impossible, to make a reliable estimate of the state of maturity by gross examination. Milt was found in the central lumen of practically all testes examined, even in those which, from all appearances, would be classified either as spent or as ripening.

Female yellowfin tuna occurred more frequently among fish below 130 cm. in length than among the larger size groups, but in no case was it observed that the proportion of females exceeded that of males.

Ovaries of the fish examined were found to be immature, ripening, or in spent condition, by Marr's criteria (Schaefer and Marr, 1948a) of gonad classification. Since the yellowfin tuna probably spawns several batches of eggs over an extended period of time, as suggested by Schaefer and Marr (1948a), the ovaries possibly do not immediately become much reduced in size after spawning. A long-extended spawning season, with individuals spawning more than once, would result in an ovary ripening over a long period. For these reasons, it is difficult, as others have found, to distinguish between spawning and ripening ovaries. The tabulated results of gonad observations, table 2, probably include both of these categories under the classification of "ripening."

No ovaries that could be considered ripe or running ripe were found. The absence from catches of individuals ready to spawn has been noted wherever studies have been made on the spawning habits of yellowfin tuna. Schaefer and Marr (1948a) observed no running ripe females and hypothesized that, as spawning approaches, the fish either migrate beyond the range of the fishery or stop feeding. In the Philippine Islands, Wade (1950a) found ripe yellowfin in the course of his investigations but no spawning or spent individuals. Apparently this phenomenon is not limited to the yellowfin tuna, for it has been observed for big-eyed tuna (*Parathunnus sibi*), as noted later, and for oceanic skipjack (*Katsuwonus pelamis*) (Hatai et al. 1941).

During early August, yellowfin females with spent ovaries started to appear among catches made 150 to 200 miles east and northeast of Kapingamarangi Island (1°05′ N., 154°45′ E.). Some such ovaries, flabby in appearance and dark red in color, might also have been observed in late July if a check had been made then of incoming fish. Spent ovaries were observed up to the time fishing operations ceased in September.

From these superficial observations of gonads, it was conjectured that the yellowfin tuna to the east of Kapingamarangi Island had spawned in

Table 2.—*Sexual maturity of female yellowfin tuna caught in the western equatorial Pacific, June–August 1950*

Date examined	Approximate date of capture	Approximate locality of capture		Total length	Sexual maturity
		Latitude	Longitude		
				Millimeters	
June 25	June 22	3°20′ N.	141°53′ E.	1,269	Ripening.
Do	do	3°20′ N.	141°53′ E.	1,285	Do.
Do	do	3°20′ N.	141°53′ E.	1,269	Do.
Do	do	3°20′ N.	141°53′ E.	1,379	Do.
Do	do	3°20′ N.	141°53′ E.	1,416	Do.
Do	do	3°20′ N.	141°53′ E.	1,230	Do.
June 26	do	2°51′ N.	142°07′ E.	1,485	Do.
June 30	June 26	2°25′ N.	143°27′ E.	1,427	Do.
July 2	June 27	1°51′ N.	145°43′ E.	1,294	Do.
July 6	July 2	2°06′ N.	145°46′ E.	1,324	Do.
Do	do	2°06′ N.	145°46′ E.	857	Immature (or spent?)
Do	do	2°06′ N.	145°46′ E.	884	Do.
Do	do	2°05′ N.	142°10′ E.	1,142	Ripening.
Do	do	2°05′ N.	142°10′ E.	1,413	Do.
Do	do	2°05′ N.	142°10′ E.	1,189	Do.
Do	do	2°05′ N.	142°10′ E.	1,144	Do.
Do	do	2°05′ N.	142°10′ E.	1,064	Do.
Do	do	2°05′ N.	142°10′ E.	1,255	Do.
Do	do	2°05′ N.	142°10′ E.	1,032	Do.
Do	do	2°05′ N.	142°10′ E.	1,120	Do.
Do	do	2°05′ N.	142°10′ E.	1,232	Do.
Do	do	2°05′ N.	142°10′ E.	1,243	Do.
July 8	July 3	1°37′ N.	144°05′ E.	1,189	Do.
Do	do	1°37′ N.	144°05′ E.	1,446	Do.
Do	do	1°37′ N.	144°05′ E.	893	Do.
July 9	July 5	2°12′ N.	149°25′ E.	1,418	Do.
Do	do	2°12′ N.	149°25′ E.	1,353	Do.
Do	do	2°12′ N.	149°25′ E.	1,347	Do.
Do	do	2°12′ N.	149°25′ E.	1,257	Do.
Do	do	2°12′ N.	149°25′ E.	1,181	Do.
Do	do	2°12′ N.	149°25′ E.	638	Immature.
Do	do	2°12′ N.	149°25′ E.	673	Do.
Do	do	1°49′ N.	149°08′ E.	1,367	Ripening.
Do	do	1°49′ N.	149°08′ E.	1,222	Do.
Do	do	1°49′ N.	149°08′ E.	1,249	Do.
Do	do	1°49′ N.	149°08′ E.	1,364	Do.
Do	do	1°49′ N.	149°08′ E.	1,281	Do.
Do	do	1°49′ N.	149°08′ E.	1,303	Do.
Do	do	1°49′ N.	149°08′ E.	1,256	Do.
Do	do	1°49′ N.	149°08′ E.	1,344	Do.
July 13	July 9	4°25′ N.	150°58′ E.	1,420	Do.
Do	do	4°25′ N.	150°58′ E.	1,408	Do.
Aug. 3	July 29	1°18′ N.	155°30′ E.	1,428	Do.
Do	do	1°18′ N.	155°30′ E.	1,390	Do.
Do	do	1°18′ N.	155°30′ E.	1,154	Do.
Do	do	1°18′ N.	155°30′ E.	1,203	Do.
Do	do	1°18′ N.	155°30′ E.	1,350	Do.
Do	do	1°18′ N.	155°30′ E.	1,279	Do.
Do	do	1°18′ N.	155°30′ E.	1,233	Spent.
Do	do	1°18′ N.	155°30′ E.	857	Immature (or spent?).
Do	do	1°18′ N.	155°30′ E.	881	Do.
Do	do	1°18′ N.	155°30′ E.	1,212	Spent.
Do	do	1°18′ N.	155°30′ E.	1,471	Ripening.
Do	do	1°18′ N.	155°30′ E.	1,315	Do.
Do	do	1°18′ N.	155°30′ E.	1,312	Do.
Do	do	1°18′ N.	155°30′ E.	1,343	Do.
Aug. 4	July 31	1°10′ N.	157°29′ E.	1,395	Do.
Do	do	1°10′ N.	157°29′ E.	1,498	Do.
Do	do	1°10′ N.	157°29′ E.	1,213	Do.
Do	do	1°10′ N.	157°29′ E.	1,465	Spent.
Do	do	1°10′ N.	157°29′ E.	1,365	Do.
Do	do	1°10′ N.	157°29′ E.	1,307	Ripening.
Do	do	1°10′ N.	157°29′ E.	1,277	Do.
Aug. 20	Aug. 15	3°35′ N.	155°45′ E.	1,302	Do.
Do	do	3°35′ N.	155°45′ E.	1,275	Do.
Aug. 29	Aug. 26	2°22′ N.	156°34′ E.	1,092	Spent.
Do	do	2°22′ N.	156°34′ E.	1,250	Do.

Note.—Y. Yabuta of the Nankai Fisheries Experiment Station, Tokyo, Japan, assisted in making part of these observations.

July with active spawning commencing in June and extending into August. Further hypothesizing that a common yellowfin population had been fished during the season—and there appears to be no evidence to the contrary—it does not seem unreasonable to believe that spawning had occurred coincidentally throughout the area fished. The spawning season is most likely a long one and may not necessarily be limited to the summer months, but the peak of spawning probably is attained during that period.

Yellowfin tuna found elsewhere in the tropical western Pacific Ocean are generally believed to spawn most actively during the summer months. Preliminary studies by biologists of the Pacific Oceanic Fishery Investigations indicate that during 1950 this species spawned in the vicinity of the Hawaiian Islands from early June to September. In the eastern Pacific, however, the spawning season is considered to be during the late winter and early spring months (Schaefer and Marr 1948a). This variation in time of spawning may be connected to some extent with latitude, or it may be a race-connected characteristic. Differences in spawning times of different races of the same species in the same or similar places have been observed in other species of fish, such as the Pacific surf smelt (Schaefer 1936) and European herring (Lissner 1934).

Big-eyed tuna (*Parathunnus sibi*)

Since big-eyed tuna were usually eviscerated at sea, as previously mentioned, I was not able to examine many reproductive organs of this species. No check was made of the maturity of male fish, but some females that were brought in whole were opened and examined throughout the fishing season from late June to early September. These females possessed either ripening or ripe ovaries, with a few having what could be considered advanced-ripe ovaries. No running-ripe or fully spent ovaries were found. Ovaries classified as ripening may have been in a spawning state, because the big-eyed tuna, like the yellowfin, probably spawns over an extended period with successive batches of eggs being ripened and extruded.

Ovaries that appeared ripe were greatly enlarged, round in cross section, and light pink in color. Those approaching the running-ripe stage had translucent ova which were ready to emerge from the follicles. A sample of 1,000 eggs from such an ovary removed from a 1,102-mm. female showed a modal group of large eggs centering around 1.06 mm. in diameter (fig. 2). The largest eggs measured approximately 1.22 mm. The eggs probably increase a little more in size as water is absorbed after emission into the sea.

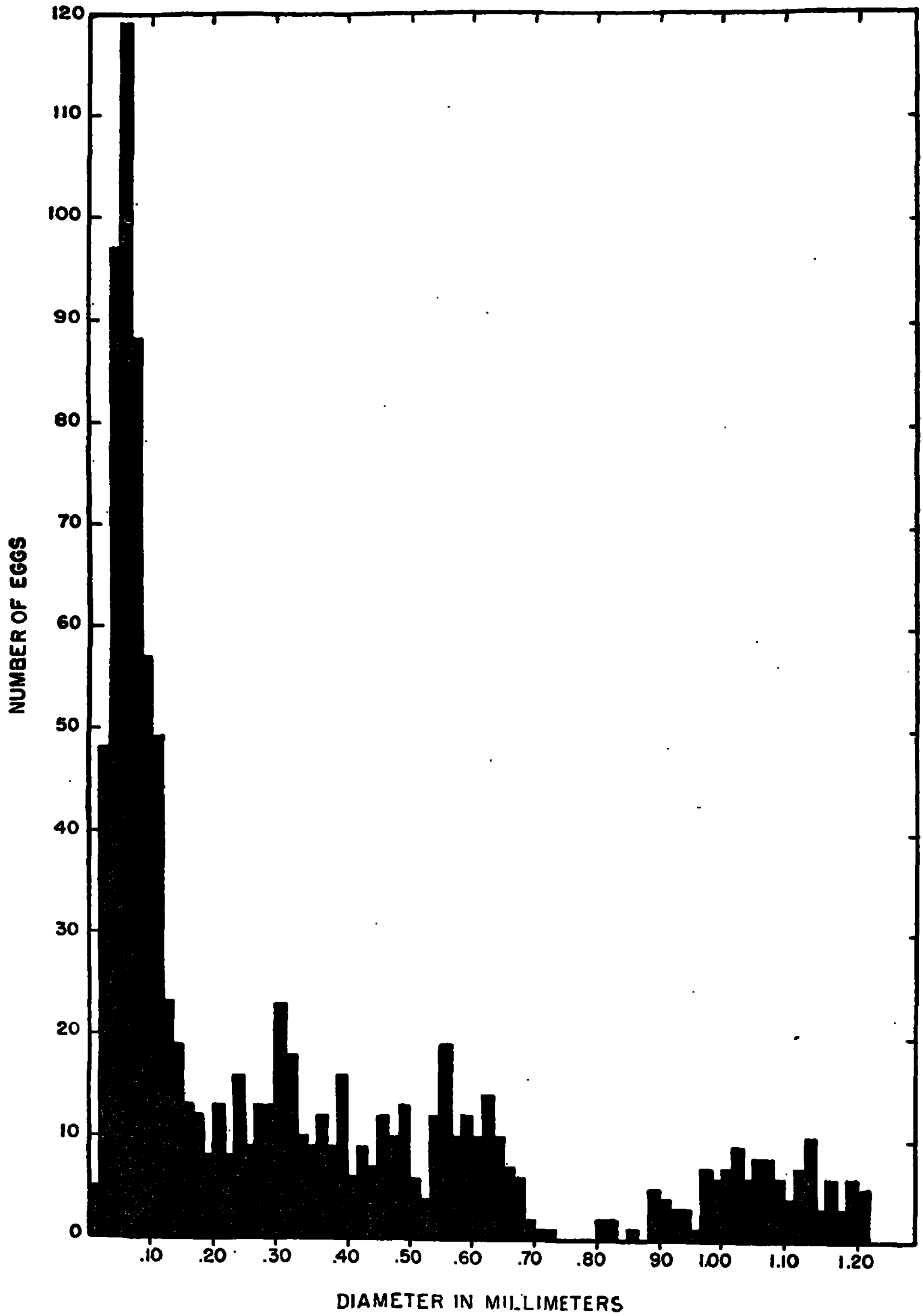

FIGURE 2.—Frequency histogram of ova diameters for a sample of 1,000 *Parathunnus sibi* eggs.

From these observations of gonads it may be inferred that the big-eyed tuna also spawns in the area south of the Caroline Islands. Partial verification of the existence of spawning grounds in these waters is furnished by Marukawa (Hatai et al. 1941), who reported at a gathering of Japanese scientists convened to discuss tuna and skipjack spawning that "Juveniles of big-eyed tuna measuring 4.2 to 4.3 inches were found inside yellowfin tuna taken by longlines in the Tokobei area (Tobi Island, 3° N., 131°31′ E.) last year, while I was in Palau, by a ship of the Fisheries Experiment Station." No mention is made, however, of the date of capture. Despite careful search, juveniles of big-eyed tuna were not found in the many stomachs of yellowfin tuna and other pelagic fishes examined aboard the mothership.

Little is known of the spawning season of the big-eyed tuna; observations, however, suggest that it spawns from June to September, and possibly later. The possibility is not excluded that spawning may be a year-round phenomenon.

RECORDS OF JUVENILE OCEANIC SKIPJACK (*KATSUWONUS PELAMIS*)

While examining stomachs of fish landed aboard the mothership, I recovered and preserved in formalin seven juvenile scombroids later identified as oceanic skipjack, *Katsuwonus pelamis*. One specimen, measuring 130 mm. from the snout to the end of the hypural plate, was found on July 21, 1950, in the stomach of a black marlin (*Makaira mazara*) caught a few days previously in the vicinity of 1°30′ N., 154°08′ E. Two additional juveniles of 132 mm. and 169 mm. were recovered on July 24, 1950, from a sailfish (*Istiophorus orientalis*) captured by longlines near 2°28′ N., 155°01′ E. The remaining four specimens, measuring 81 mm., 94 mm., 132 mm., and 148 mm., were found in stomachs of yellowfin tuna (*Neothunnus macropterus*), the smaller two on August 4, 1950, and the larger two on August 8, 1950. The earlier catches of yellowfin tuna were made at approximately 1°10′ N., 157°29′ E., and the later catches at 1°14′ N., 157°28′ E. Remains of fish up to 250 mm. in size and identified by skeletal characteristics as oceanic skipjack were found in tunas and other pelagic fish but were not retained because of their poor condition.

All of the listed juveniles except the 81-mm. fish were X-rayed in the laboratories of the Pacific Oceanic Fishery Investigations in Honolulu, Hawaii. On negatives taken of these juvenile scombroids the skeletal "trellis" of Kishinouye (1923) (="basketwork" of Godsil and Byers (1944)) was faintly visible in every case and placed these fish within Kishinouye's family Katsuwonidae. The Katsuwonidae include two genera: *Euthynnus*, which is composed of species having either 37 or 39 vertebrae (Kishinouye 1923, Schaefer and Marr 1948b), and *Katsuwonus*, which contains a single species characterized by 41 vertebrae (Kishinouye 1923). There is no knowledge of an overlap in vertebral counts between genera. The total count of 41 vertebrae, including the urostyle, therefore, specifically identified these juveniles as *Katsuwonus pelamis* Linnaeus.

For further verification, the 81-mm. juvenile was stained, using Hollister's method (1934). There are 41 vertebrae present with 20 precaudal and 21 caudal vertebrae. The lateral processes on the precaudal vertebrae are well developed and the inferior foramina form a "trellis" with the haemal arches. The haemal canal is large, and the first closed haemal arch is on the twelfth vertebra. The gill-raker count for the first gill arch on the left side, which is 15 for the upper arch and 38 for the lower, falls within the range of counts given for adults—15 to 20 and 36 to 38, respectively (Kishinouye 1923). Palatine teeth are present; vomerine teeth are absent. Vestigial palatine teeth were observed on the 94-mm. specimen and were absent on the next larger juvenile of 130 mm., so that palatine teeth disappear at a length somewhere between these two.

The presence of juvenile oceanic skipjack in stomachs of fish caught throughout the area fished by vessels of the expedition points to the existence of extensive spawning grounds in or adjacent to these waters. The only previous published record of juvenile skipjack from this general locality is that of Inanami (1942). Since this reference is not generally available, my translation of his paper is given here in full:

> When I went to Truk in June of this year, I was shown specimens of small skipjack at the Nankō Fisheries Company. Of the two, one specimen measuring over 6 *sun* (180 mm.) was unmistakably a skipjack juvenile; the other, measuring 1.5 *sun* (45 mm.) in length, may have

been a juvenile skipjack. The following data were gathered for these specimens:

(1) Dimensions: Length, 6.6 *sun* (198 mm.); weight 25 *momme* (94 grams).

Date of capture: 1700, April 23, 1939.

Place of capture: 4 nautical miles southwest of Sarashima Pass (Salat Pass, 7°14′ N., 152°01′ E.).

Method of capture: Pole fishing.

At the same time, a specimen which could have been placed in a rice bowl and assumed to have been about 3 *sun* (90 mm.) in length was caught but not retained owing to the carelessness of a crew member.

(2) Dimensions: Length, 1.5 *sun* (45 mm.); weight, 2 *momme* (8 grams).

Date of capture: May 3, 1940.

Place of capture: 14 nautical miles off Sarashima Pass.

Method of capture: Recovered from the stomach of a skipjack which apparently had been caught immediately after feeding, for there was no evidence of digestion.

It is said that small fish weighing 25 *momme* (94 grams) are extremely rare around Truk, but that fish of this size are often seen around Palau during certain seasons of some years.

Although oceanic skipjack are known to be abundant in the vicinity of the many islands and reefs of the western equatorial region, this species apparently is not landbound, for several schools were seen and fished far from land during the operations of the expedition. Spawning probably takes place in the open ocean, as well as near land, as inferred from the recovery of juveniles in fresh condition from fish caught in deep offshore waters. Judging from the sizes of young skipjack found, some spawning must occur during the spring months. Kishinouye (1924) estimates that young skipjack grow at a rate of more than 40 mm. a month. Calculations based on this growth rate suggest that juveniles recovered aboard the mothership in July were spawned in March and April, and those found later, in April, May, and June.

OCCURRENCE OF BLUEFIN TUNA (*THUNNUS ORIENTALIS*)

The bluefin tunas are generally regarded as temperate-zone forms and are seldom found in tropical waters. The capture of 10 large tunas identified as bluefin or black tuna, probably *Thunnus orientalis* (Temminck and Schlegel), by expedition vessels is therefore of interest (table 3). Furthermore, the frequency with which this species was caught this year indicates a possible change in factors governing its distribution or availability in the western equatorial region. Examination of available published logs covering the prewar activities of Japanese tuna-fishing vessels in the Palau, Mariana, and Caroline Islands failed to show bluefin tuna in their catches. With the exception of Abe's listing (1939) from the Palau Islands of a 240-mm. specimen identified as *Thunnus thynnus* (=*Thunnus orientalis*?), as far as is known, no other distribution records exist for bluefin tuna from this general area.

TABLE 3.—*Bluefin tuna captured in the western equatorial Pacific, June–September 1950*

Fish No.	Date of capture	Locality of capture	
		Latitude	Longitude
1	June 17	4°20′ N.	145°20′ E.
2	June 26	4°30′ N.	145°10′ E.
3	July 5	2°39′ N.	148°40′ E.
4	July 12	4°08′ N.	147°57′ E.
5	July 14	3°48′ N.	147°55′ E.
6	July 19	5°02′ N.	154°16′ E.
7	July 26	2°25′ N.	155°49′ E.
8	Aug. 10	4°00′ N.	157°30′ E.
9	Aug. 12	4°15′ N.	156°19′ E.
10	Sept. 4	2°25′ N.	155°49′ E.

The captured fish were all large and weighed from 150 to 500 pounds eviscerated and with gills removed. Since these fish were cleaned at sea immediately after capture and the viscera discarded, it was not possible to examine the internal organs and gill rakers. The pectoral fins of those individuals examined were comparatively short, and each fish was characterized by a dark over-all coloration, which varied from black dorsally to a dusky gray ventrally. Measurements of different body characters, using standard morphometric techniques described by Marr and Schaefer (1949), were taken of four fish. The data are presented in table 4.

There are three commonly recognized bluefin species inhabiting the Pacific Ocean: the southern bluefin tuna of Australia, *Thunnus maccoyi*; the Japanese bluefin or black tuna, *Thunnus orientalis*; and the so-called California bluefin tuna, *Thunnus thynnus*, which is found in the eastern Pacific and adjacent waters. The presently recognized northernmost limit of distribution of *T. maccoyi* is Sydney, Australia (Serventy 1941). The Japanese bluefin tuna, *T. orientalis*, which has yet to be proved distinct from *T. thynnus*, may occur as far south as the equator, for there are

TABLE 4.—*Measurements of four bluefin tuna from the western equatorial Pacific*

	Fish No. 1	Fish No. 3	Fish No. 5	Fish No. 7
Date of capture	June 17	July 5	July 14	July 26
Locality of capture:				
Latitude	4°20′ N.	2°39′ N.	3°48′ N.	2°25′ N.
Longitude	145°20′ E.	148°40′ E.	147°55′ E.	155°49′ E.
Approximate weight (less viscera and gills) lbs.			487	430
Total length mm.	2,255	2,139	2,239	2,205
Head length mm.	600	582	631	599
Snout to insertion first dorsal mm.	648	624	661	642
Snout to insertion second dorsal mm.	1,221	1,136	1,185	1,172
Snout to insertion anal mm.	1,354	1,253	1,373	1,310
Snout to insertion ventral mm.	696	649	748	674
Ventral insertion to vent [1] mm.	667	632	675	676
Greatest body depth mm.	578	550		
Length pectoral mm.	418	405	405	389
Length second dorsal mm.	441	344	423	377
Length anal mm.	391	331	428	365
Diameter of iris mm.	48	46	51	45

[1] Defined as the distance from a line connecting the insertions of the ventral fins to the anterior edge of the vent.

records of this species from the southern Philippine Islands as cited by Wade (1950b). However, Wade believed that the southern distribution of *T. orientalis* was limited to the northern Philippine Islands and that other records were of stray fish.

The bluefin tuna herein recorded have been assigned to *T. orientalis* on the basis of distribution alone. It may be shown in the future that *T. orientalis* is either a valid species or is synonymous with *T. thynnus*.

SUMMARY

Various biological investigations were conducted aboard a Japanese tuna mothership on tunas and other fishes landed by longline-fishing vessels which operated in waters south of the Caroline Islands during the summer of 1950. The results of these studies shed new light on the spawning and distribution of tuna species found in the western equatorial Pacific.

Gonads of yellowfin tuna and big-eyed tuna were examined for sexual maturity, and their condition suggests the existence of spawning grounds for these two species in or near the region fished. The yellowfin probably spawns most actively during the summer months. Observations of big-eyed tuna lead to the conclusion that this species spawns from June to September, and possibly during other seasons of the year.

Several juvenile oceanic skipjack were recovered from the stomachs of tunas and other pelagic fishes. This is definite proof that oceanic skipjack spawn extensively in or near the area covered by the expedition.

The occurrence of bluefin tuna in equatorial waters is recorded on the basis of several fish caught from June to September 1950.

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