

INTER-AMERICAN TROPICAL TUNA COMMISSION

COMISION INTERAMERICANA DEL ATUN TROPICAL

Bulletin — Boletín

Vol. VI, No. 9

(Completing the Volume)

(Completando el Volumen)

**OBSERVATIONS ON THE SPAWNING OF FOUR SPECIES OF
TUNA (*NEOTHUNNUS MACROPTERUS*, *KATSUWONUS
PELAMIS*, *AUXIS THAZARD* AND *EUTHYNNUS LINEATUS*) IN
THE EASTERN PACIFIC OCEAN, BASED ON THE
DISTRIBUTION OF THEIR LARVAE AND JUVENILES**

**OBSERVACIONES SOBRE EL DESOVE DE CUATRO ESPECIES
DE ATUN (*NEOTHUNNUS MACROPTERUS*, *KATSUWONUS
PELAMIS*, *AUXIS THAZARD* Y *EUTHYNNUS LINEATUS*) EN EL
OCEANO PACIFICO ORIENTAL, BASADAS EN LA
DISTRIBUCION DE SUS LARVAS Y JUVENILES**

by — por

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1963

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**OBSERVATIONS ON THE SPAWNING OF FOUR SPECIES OF TUNA
(*NEOTHUNNUS MACROPTERUS*, *KATSUWONUS PELAMIS*, *AUXIS
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Witold L. Klawe

INTRODUCTION

Knowledge of spawning habits is useful in the elucidation of the life history, ecology and population structure of tropical tunas, and is essential to the sound management of these resources. Until recently, little was known concerning the spawning of tunas, or about the distribution of their larval and juvenile stages, in the Eastern Pacific Ocean. Nichols and Murphy (1944) reported the capture off Colombia of young scombroids ultimately identified as frigate mackerel, *Auxis thazard* (Schaefer and Marr, 1948a). Fowler (1944) reported the capture off Manzanillo, Mexico of two young tunas, one of which is definitely and the other most likely *Neothunnus macropterus* (Klawe, 1959). In 1947, young of *N. macropterus*, *K. pelamis*, *A. thazard* and *E. lineatus* were caught offshore from Central America (Schaefer and Marr, 1948a, 1948b, and Schaefer, 1948). Further collections of young *N. macropterus*, *A. thazard* and *E. lineatus* were made in the same general area in the spring of 1949 (Mead, 1951). In January and February 1955, Clemens (1956) carried out experiments in rearing young tunas, *E. lineatus* and *A. thazard*, in shipboard aquaria, using fish caught off Central America. Matsumoto (1958) reported captures of larval *N. macropterus* and *K. pelamis* in the area along the 120th meridian of west longitude. Klawe (1958 and 1961b) reported captures of larval *N. macropterus* and *Auxis* from the Revillagigedo Islands. Captures of young *Auxis* and *E. lineatus* in the Gulf of Panama in January 1922 during the Dana Expedition have recently been reported by Matsumoto (1959). Capture of juveniles of *K. pelamis*, *E. lineatus* and *Auxis* in the area off tropical Mexico and in the area of outlying islands during the SCOT Expedition has been reported by Klawe (1960a).

Schaefer and Orange (1956) reviewed the literature concerning spawning of tropical tunas in the Pacific Ocean and by means of gonad studies explained the spawning activities of yellowfin and skipjack in some areas of the Eastern Pacific Ocean. Orange (1961) has extended this gonad investigation to include all areas of the Eastern Pacific Ocean from which these species are taken in commercial quantities.

Tropical tunas apparently spawn over a widespread area; the spawning season on the whole is very extended, and individual fish do not spawn all ova at once.

Although the Commission's primary concern is the investigation of yellowfin and skipjack tuna, this study also includes species which are at present of no commercial importance, because many of the problems inherent to their early life history are common to the yellowfin and skipjack. In addition, such genera as *Euthynnus* and *Auxis*, although not taken in this part of the world by commercial fishermen, are elsewhere exploited by commercial fisheries and are utilized as human food.

Collections of young tunas were made in the waters of the Eastern Pacific Ocean by the scientists of the Commission and, on many occasions, in conjunction with the scientists of Scripps Institution of Oceanography. In addition, a collection of young scombroids obtained by the staff of the Biological Laboratory at La Jolla of the U. S. Bureau of Commercial Fisheries was placed at our disposal.

The study was conducted mainly in the general area of the tuna fishery of the Eastern Pacific Ocean, as described by Shimada (1958), and Alverson (1959, 1960). Some data, however, were collected as far west as 120°W longitude, the eastern boundary of studies made by Matsumoto (1958), and Strasburg (1960).

Definitions applicable throughout this paper are as follows:

- (1) Larva—fish lacking the full complement of fin rays, especially the spines in the first dorsal fin (see Matsumoto, 1959). This term applies usually to individuals up to about 11 mm. in total length, but in many instances it is applied to young tuna caught in plankton nets.
- (2) Juvenile—fish with full fin-ray counts, i.e. small fish of total length of 12 mm. or more. Here again, on occasions, generalizations have been made to include all the young tuna caught under the nightlight.
- (3) Total length—direct distance from the tip of the snout to the tip of the shortest median ray in the caudal fin.

This paper reports on the methods and results of a study which had the following objectives:

- 1) To investigate the spawning of tunas in the Eastern Pacific Ocean by the distribution of their young;
- 2) To investigate the ecology of these young tunas;
- 3) To investigate how the young tunas should be collected most efficiently to provide representative data.

ACKNOWLEDGMENTS

While many individuals and organizations contributed to the preparation of this report, particular credit must be given to the scientists of the Scripps Institution of Oceanography of the University of California, and to those of the U. S. Bureau of Commercial Fisheries, Biological Laboratory at La Jolla, especially to the Director of this laboratory, Dr. E. H. Ahlstrom. Through the excellent cooperation of masters and crews of tuna-fishing vessels it was possible to collect specimens from aboard their vessels and this assistance is also gratefully acknowledged.

I also wish to thank those members of the Commission's staff who helped in obtaining specimens and data used here.

MATERIALS

Sampling methods

The sources of material were: (1) Net tows using regular, closing or larval nets, or an enlarged Clarke-Bumpus sampler; (2) collections made with a dip net from a drifting vessel at night where a light is used to attract fish and other marine organisms; (3) stomach contents of various fishes and sea-snakes. The data on catches by these methods are listed in Tables 1 through 9. In these tables the names of species have been abbreviated as follows: N. M. for *Neothunnus macropterus*, K. P. for *Katsuwonus pelamis*, A. T. for *Auxis thazard* and E. L. for *Euthynnus lineatus*.

The tuna egg is pelagic, as is the larva which hatches from it. Both are found in catches of zooplankton made with plankton nets. Tuna eggs are difficult, or impossible, to identify to species, and even to distinguish from other pelagic fish eggs of similar size and characteristics, consequently no attempt has been made to identify and enumerate them.

Most of the larvae captured were taken with one-meter nets of silk grit gauze or of nylon grit gauze (40 GG Bodmer Classification or 452 Nitex Number), with finer silk grit gauze or nylon grit gauze in the rear section and detachable cod-end (56 GG Bodmer Classification or 295 Nitex Number). The regular, or open-type, net was most commonly used. The closing net tows were made with nets which can be opened or closed after having lowered to the desired depth (Leavitt, 1935, 1938). Calibrated flow meters were mounted in the mouth of each net to record the volume of water strained.

Three types of tows were made with the regular nets: (1) standard oblique hauls from an approximate depth of either 300 or 400 meters; (2) shallow hauls in places where the depth did not permit a standard oblique haul; and (3) surface horizontal hauls, where the net was towed just below the surface.

Procedures used in taking a standard oblique haul have been described in "Data collected by Scripps Institution vessels on Eastropic Expedition"

in S. I. O. Reference 56-28. Briefly, the net is lowered from the surface to a depth of either approximately 300 meters by paying out 450 meters of wire, or approximately 140 meters by paying out 200 meters of wire, and the net is retrieved while the vessel is underway at a speed of about two knots. The depth of the tow is estimated from the wire angle and the length of wire out. The wire angle, and consequently the depth of the tow, vary somewhat from haul to haul.

At localities where the depth did not permit making a standard oblique tow from 140 meters, a horizontal tow was made at the maximum depth to which the net could be lowered without losing it on the bottom. This type of tow was made on only a few occasions in the immediate vicinity of islands.

The closing hauls were made with a special net, which was lowered to the desired depth and then opened by means of a messenger. A horizontal tow was made at a desired depth, and a messenger was then sent down to close the net before its return to the surface. The average depth of tow was estimated from the length of wire out and the wire angle.

Clarke-Bumpus samplers of enlarged size (Paquette, Scott, and Sund, 1961) were used on some of the cruises to sample plankton at different depths. The nylon netting used in the Clarke-Bumpus sampler was larger than that used for the regular nets and for the closing nets, being made of 706 Nitex Number in the body and of 316 Nitex Number in the cod-end of the sampler.

A special series of monthly collections from surface tows off Cape Blanco, Costa Rica, was made with half-meter (mouth opening 0.5 m.) plankton nets constructed of 452 Nitex Number nylon grit gauze in the body and of 295 Nitex Number nylon grit gauze in the rear section and cod-end. A larval net also used here was identical in shape and size with the plankton net, but the netting used throughout was nylon bobbinet (a product of Marion Textiles, New York) with a mesh opening of approximately one millimeter diameter.

Zooplankton collected with the various nets was preserved in four per cent formalin (approximately 1.6 per cent aqueous solution of formaldehyde) buffered with commercial borax. The volume of water sampled by each haul was determined by a method described by the personnel of the South Pacific Fishery Investigations of the U. S. Fish and Wildlife Service (1953).

The zooplankton collections were sorted under a binocular microscope and all small fish were removed from the samples. The tuna larvae were sorted out from these small fish and identified to species.

Since plankton collections provide both qualitative and quantitative data, they served as the main basis of study. Listed below are the expedi-

tions during which there were collected plankton samples used in this study:

| Year | Month | Expedition | Reference |
|------|---------|-----------------------|-----------------------------|
| 1952 | V-VIII | SHELLBACK | Wooster (1952) |
| 1955 | X-XII | EASTROPIC | SIO Reference 56-28 (1956) |
| 1956 | XI-XII | SCOPE | Holmes <i>et al</i> (1958) |
| 1957 | V-VI | ISLAND CURRENT SURVEY | Bennett and Schaefer (1960) |
| 1957 | VII | TUNA SPAWNING SURVEY | Klawe (1958 and 1961b) |
| 1958 | IV-VI | SCOT (TO 58-1) | Holmes and Blackburn (1960) |
| 1958 | X-XII | TO 58-2 | |
| 1959 | I-II | TO 59-1 | |
| 1959 | VIII-IX | TO 59-2 | |
| 1959 | XI-XII | COSTA RICA DOME | |

The stations where plankton tows were made are shown, for each cruise, in Figure 1. The numerous plankton tows made during the TUNA SPAWNING SURVEY (July, 1957) in the vicinity of Revillagigedos are denoted by appropriate shading.

In addition, the California Cooperative Oceanic Fishery Investigations has collected plankton in areas off California, off Baja California, and in the Gulf of California, regularly since 1949 (see Figure 1). The tuna larvae from these collections have been examined for this study (Table 3). Plankton collections made by the Consejo de Investigaciones Hidrobiológicas, since 1958, in Peruvian waters (shaded area along the Peruvian coast in Figure 1) were also examined for tuna larvae.

In November 1958 personnel of the Commission's Costa Rica laboratory in Puntarenas commenced monthly collections of tuna larvae and juveniles at a distance of 5 to 20 miles off Cape Blanco to determine the time of spawning of various tunas in the area. Collecting was done during hours of darkness, usually for three consecutive nights per month. The following three methods were employed: (1) tows with standard conical plankton net with a mouth opening of 0.5 meter diameter; (2) tows with a larval net, identical in shape and size to the plankton net, but made of different type of netting with larger openings; and (3) dipnetting under a light suspended overboard from a drifting vessel. The two nets were towed at the surface, usually for an hour.

The fact that small tuna are attracted to light at night has been utilized to capture young tunas with a dip net. On calm nights, a light was suspended overboard from a drifting vessel, to attract, among other organisms, young tunas. In Figure 2 the frequency of occurrence of young *Auxis*, by one-millimeter size-intervals, captured during the Eastropic Expedition is shown, the catches in night-light collections and in plankton-net collections being shown separately. It is interesting to note that practically all the *Auxis* that were caught with plankton net are larvae less than

10 mm. long, while the specimens caught under the night-light are of larger size with only a few individuals smaller than 10 mm. Since we accepted Matsumoto's definition of larval tuna, i.e. fish lacking the full complement of fin-rays (especially in the dorsal fin) then practically all fish caught by night-light are beyond that stage.

The stomach contents of pelagic fishes and the yellow-bellied sea-snake (*Pelamis platurus*) were the source of a small number of the young tunas used in this study (Table 7). When the specimens thus obtained were digested to the point where they could not easily be identified to species, the bony structures were examined by staining and clearing the specimens. Details of the identification of such material are described by Yabe, *et al* (1958) and Klawe (1961a).

Sampling problems

To determine the vertical distribution of larval tunas, the catches made with Clarke-Bumpus samplers and closing nets were examined and analyzed. The results show that only tows made above or in the thermocline contained tuna larvae (Table 8). Further evidence is obtained from SCOT Expedition catches made with closing nets at various depths, and with standard nets (Table 9). These catches, as was the case with Clarke-Bumpus samplers, indicate absence of larvae below the thermocline. However, a single larva was caught with a closing net towed at a depth varying from 82 to 94 meters (Station 88, Table 9) at a locality where the thermocline was at 23 meters. It is thought that the catches of this type of net are more susceptible to contamination than are those of Clarke-Bumpus samplers, and that this larva may actually have been taken from water above the thermocline.

This association of larvae with the mixed layer is no surprise. The pelagic eggs of tunas most likely do not sink below the pycnocline, which is well defined by the thermocline in our area of study. The association of the eggs of another scombrid, the Atlantic mackerel, *Scomber scombrus*, with the mixed layer has been shown by Sette (1943), who also demonstrated that larvae of *S. scombrus* occur in the mixed layer down to the thermocline and probably do not descend below that zone. Matsumoto (1958) reports having taken small numbers of larval tunas with a non-closing net down to depths of nearly 300 meters (i.e. considerably below the thermocline) but he suspects the possibility of contamination of catches with larvae captured while the net was being lowered or raised through the surface layer.

Furthermore, because of its sharp thermal gradient, the thermocline may act not only as a barrier for the larvae but may also be a site where some larval mortality takes place. Strasburg (1959) gives evidence that lateral thermal discontinuity in the surface layer may be the cause of mass mortality he observed for larvae of *Auxis*. (If we project this reasoning

for larvae passing through the thermocline, then here again the rapid change of temperature may cause death of the larvae). This may be due to direct "thermal death" caused by intolerance to rapid change of temperature, or be indirect and caused by changes of muscular activity which debilitate the larvae and subject them to excessive predation. Any prolonged stay of larval tunas below the thermocline would most likely retard larval development, since it would extend the duration of their larval life and thus extend their exposure to the perils of larval mortality which are to be expected to be greater than those of juveniles or adults.

To date no data have been collected regarding the distribution of larvae within the mixed layer itself.

A marked diurnal variation in catches of larvae because of their vertical migration or their ability better to avoid the nets at a certain time of the day would, of course, introduce a considerable variability in an assessment of the abundance of larvae. Wade (1951), Matsumoto (1959) and Strasburg (1960) concluded, from examination of the shallow tows that the larvae of *Katsuwonus* and *Auxis* were more numerous in night hauls than those made during daylight hours. For *Neothunnus* no increase in the catch rate for the night hauls was observed. Their conclusions were based on an analysis of average catches for two-hour periods of the day.

In Figure 3 mean bihourly catches made during the following cruises: Eastropic, SCOPE, Island Current Survey, Tuna Spawning Survey, SCOT, TO 58-2, and TO 59-1, are shown by species for each category of tow, i.e. (1) surface, (2) "140 meter," and (3) "300 meter" oblique tows. These values, based on 227 surface, 122 140-meter and 415 300-meter tows, include both the productive and the non-productive hauls. Many of the zero-catch tows were taken in areas where larvae would not be expected. However, these occurred randomly, in respect to time, and should not bias the day-night comparison of larval abundance.

The catches of larvae per tow (Table 2) indicate a contagious distribution of the larvae. For *Auxis* from the surface tows, the number of larvae varies from 0 to nearly 2000 larvae per 1000 meters of water strained. The catches of larval *Neothunnus* exhibit fluctuation of a similar nature. The most frequent catches lie between 1 and 10 larvae per 1000 meters of water strained.

Interpretation of the quantitative aspects of larval distribution requires caution as it is obvious that one tow which contains a large number of larvae will greatly influence the mean value.

This great variability in the number of larvae caught in individual tows prompted the author to use a ranking test (Mann-Whitney U Test) to evaluate the difference between the night and day catches of *Neothunnus* and *Auxis* in the three categories of tows. Tows taken between 0600 and 1759 were classified as day catches and those taken between 1800 and 0559

as night catches. Catches of individual tows were used, and tows not containing larvae were included. As can be seen from the table below, significant differences between the night and day catches are evident for the number of *Auxis* larvae in surface tows and "300 meter" oblique tows. (Surprisingly no differences are evident for *Auxis* larvae from the "140 meter" oblique tows. Of course, it is to be expected that catches from both types of oblique tows should show the same tendency.) There is no evidence from the test that there are differences between night and day catches of *Neothunnus* larvae in any type of tow.

Statistical comparison of the abundance of larval *Neothunnus* and *Auxis* in night and day plankton tows:

| Type of tow | <i>Neothunnus</i> | <i>Auxis</i> |
|---------------------|-------------------|-------------------|
| Surface | p = .12 | p = less than .01 |
| "140 meter" oblique | p = .94 | p = .60 |
| "300 meter" oblique | p = .29 | p = .01 |

The larger catches of larval *Auxis* are made in night time surface tows. This may be caused by diurnal migration of larvae or by the ability of larvae to avoid the nets at certain times of the day. It is possible that there is also a nocturnal increase of catches of *Auxis* larvae in both types ("140 and 300 meter") of oblique tows. If this is true then the dodging by larvae is primarily responsible for the increase, as we can assume that the oblique tows, either "300 meter" or "140 meter" sample throughout the entire range of vertical distribution of the larvae.

Tows made at different times of the day and night with several Clarke-Bumpus samplers spaced at different depths within the mixed layer would shed light on the problem of diurnal migration. It would be advisable to run simultaneous oblique tows. It should be pointed out that because of the contagious distribution of the number of larvae per tow, a very large number of such tows would be necessary.

METHODS OF ANALYSIS

Information on the time and area of tuna spawning can be obtained either by observation of the occurrence of eggs or recently hatched young in a given area, or by examination of adults for signs of gonad maturation or recent spawning. The second method, which involves the examination of ovaries from tunas caught by commercial fishermen, leads to useful inferences as to the spawning of tunas; however, being less direct, it should be considered cautiously for the following reasons: (1) Adult tunas are swift swimmers, capable of covering large distances within short periods of time, so that the location of capture of recently spent fish or of fish with nearly mature gonads may be fairly remote from the place of actual spawning. (2) Running-ripe yellowfin and skipjack tuna are rarely taken by the commercial fishery, either with hook and line or with purse-seine nets.

However, despite these limitations, this approach has a number of merits. Of these, the most prominent is that fairly regular examination of fish caught from various parts of the Eastern Pacific Ocean is possible. This method of studying tuna spawning has been reported on by Schaefer and Orange (1956), and Orange (1961).

The alternate method of obtaining information on the sites and seasons of spawning, by collecting and identifying tunas in early stages of development from the Eastern Pacific is not free of difficulties. Some inherent drawbacks are: (1) the pelagic eggs of various tunas, as yet, are not identified to genera and species; (2) the early larval stages of *Neothunnus macropterus* cannot be identified with absolute certainty; (3) the cost of obtaining collections of larval and juvenile stages on a regular basis from the various areas in the Eastern Pacific Ocean is prohibitive, because of the necessity of using research vessels.

An assumption is made that presence of very young fish indicates recent spawning in an area at, or near, the place of capture (Klawe and Shimada, 1959; Klawe 1960b, and 1961a). This assumption appears reasonable because: (1) the time of hatching of tuna eggs is thought to be short, about two days at most (Sanzo 1932, 1933; Vodyanitsky, 1936, and personal communication regarding hatching of eggs of *Parathunnus sibi* from Dr. Hiroshi Nakamura); (2) the young tunas grow very rapidly (Clemens, 1956); (3) the velocities of the surface currents within the Eastern Tropical Pacific Ocean do not appear to be great (Cromwell, 1958; Cromwell and Bennett, 1959).

The number of larvae of different species of tuna have been estimated, per 1000 cubic meters of water strained by the net. As mentioned earlier, tuna larvae in the Eastern Pacific Ocean are taken in the layer above the thermocline. It is, therefore, to be expected that tows made to the depth of 300 meters or 140 meters strain a considerable amount of "sterile" water below the thermocline, i.e. water devoid of tuna larvae. To standardize the tows to a common basis, so that quantitative comparisons could be made, correction factors to make all tows equivalent to surface tows have been derived. During SCOT Expedition, at several stations, simultaneous tows were made at various times of the day and the night with two nets of identical construction. One net was towed just below the surface; the other was used to make an oblique tow from an approximate depth of either 300 meters or of 140 meters. These data for paired tows have been tabulated in Tables 10 and 11 showing: (1) the depth of each tow, (2) the depth of the thermocline at a given station, and (3) the catch of tuna larvae per 1000 cubic meters of water strained.

Correlation between the number of tuna larvae caught in simultaneous surface and oblique tows has been examined, and proven to be significant at the one per cent level of probability (see below).

**Correlation between number of larvae (x) caught in
surface tows and oblique tows during SCOT Expedition**

Data transformed by $x' = \log \frac{x + 1}{1000 \text{ m}^3 \text{ water strained}}$

| Surface versus: | No. of simultaneous tows | Calculated <i>r</i> value |
|-----------------|--------------------------|---------------------------|
| "140 meter" tow | 31 | .476 |
| "300 meter" tow | 49 | .415 |

Examination of average catches of tuna larvae for the two groups indicates that, for the 49 pairs of surface tows and "300 meter" oblique tows, the surface tows, on the average, caught 9.2 times as many larvae as the deep tows. When the comparison is made for the surface tows and the "140 meter" tows, the surface tows caught an average of only 3.2 times as many larvae as the "140 meter" tows.

To test the reasonableness of the above figures, the ratio of the total water strained to the water strained above the thermocline was calculated for the two types of tows. Ratios of 9.2 and 4.5 were obtained for 49 "300 meter" tows and 31 "140 meter" tows, respectively. These values are similar to the ratios of 9.2 and 3.2 which were obtained when the larval catches of the surface tows were compared with the catches of the "300" and "140" meter oblique tows, respectively. It should be pointed out that there are inherent in these calculations several kinds of sampling errors, arising from uncertainties in determining: (1) amount of water strained, because of errors introduced by the calibration of the flow meters, (2) the depth of the tow, and (3) the thermocline depth, which is objectively estimated from bathythermograph slides. (For a few stations, because of lack of bathythermographic profiles, this depth was read from average charts prepared by Cromwell, 1958). Further attention is drawn to the fact that any possible diurnal migration has been neglected in the transformation of data.

To make catches of larvae from the oblique tows approximately comparable with the catches from surface tows, the number of larvae per 1000 meters of water strained was multiplied by 9.0 for the "300 meter" tows, and by 4.5 for the "140 meter" tows. Obviously, such adjustments are approximations, but the resulting figures are believed to reflect the relative abundance of tuna larvae throughout the Eastern Pacific Ocean.

A more nearly precise adjustment could, perhaps, be obtained by multiplying the catch of each individual oblique tow by the ratio of the depth of the tow to the depth of the mixed layer at the particular place and time the tow was taken. This, however, in view of the contagious nature of the distributions of tuna larvae, and other sources of sampling variability, was not considered to be worthwhile for this study.

Figures 4 through 7 show the abundance of larvae, calculated in this manner by one-degree areas, from plankton tows made during the following expeditions: EASTROPIC, SCOPE, TUNA SPAWNING SURVEY,

SCOT, TO 58-2, and TO 59-1. Dots indicate zero catches. Only the two most abundant species have been considered: *Neothunnus macropterus* and *Auxis thazard*. In order roughly to examine seasonal variations, the figures were prepared for two six-month periods, the data being insufficient for a finer time-stratification.

DISTRIBUTION OF YOUNG TUNAS AND TIME OF SPAWNING IN THE EASTERN PACIFIC OCEAN

Plankton hauls provide useful quantitative as well as qualitative data. Nightlight collections or collections made from stomachs of marine vertebrates give little data of a quantitative nature. The conclusions presented here, therefore, are based, to a large extent, on the captures of larval tunas made with plankton nets. The plankton hauls were made in the area outlined by dashed lines in Figures 4 through 11. The locations at which young tuna were captured are shown in Figures 8 through 11. These latter figures are based on collections examined by the author, in addition to young tuna from the Eastern Pacific Ocean reported in the literature.

The spawning of tunas is of a more or less seasonal nature. Data obtained during a two-year period off Costa Rica, Table 5, clearly show that the spawning intensity of various tunas is not the same throughout the year. In the area off Baja California, which has been relatively well sampled since 1949 by the California Cooperative Oceanic Fishery Investigations, larvae of *Neothunnus macropterus*, *Euthynnus lineatus* and *Auxis thazard* were captured only at certain times of the year (Table 3).

Unfortunately we do not have comparable data, collected on a similarly continuous basis, from the other parts of the Eastern Pacific Ocean. Most of our catches are not well distributed in time or in space, however, trends, which most likely reflect the seasonal spawning, can be detected.

Despite the fact that the collections from which Figures 4 through 7 were prepared were sporadic, some seasonal differences in larval abundance are evident. For example, if we examine the catches off central and southern Mexico, where plankton collections were made in January, February, May, June, September, October, November, and December, we can see that the abundance of larvae of yellowfin tuna is greater for the period May-October (Figure 4) than for the period November-April (Figure 5). This reflects the fact that the peak of spawning takes place off central Mexico in the second and third quarters as inferred by Orange (1961).

From Figure 4 it is evident that, in the area off Revillagigedo Islands, catches of yellowfin larvae were made in the period May-October. This fact indeed supports the conclusion based on gonad studies. However, practically no plankton collections were made in the vicinity of these islands in the period November-April.

There is lack of evidence, in these charts, of seasonal spawning of yellowfin off Central America, whereas our monthly collections off Cape Blanco, and also the gonad studies, give evidence of seasonal variation in amount of spawning. This is most likely because of the inadequacy of the data in that area for these charts.

The catches of yellowfin larvae in offshore waters not adjacent to oceanic islands occurred in the region of the Counter-Current (5° - 12° N), and these catches were made in the period May-October. This suggests that spawning in this area may be more intense in spring or summer. Again, however, it should be pointed out that no collecting of comparable intensity was carried out in the same waters in the period November-April. More data are necessary for most of the regions of the Eastern Pacific Ocean to construct charts to give adequate information concerning seasonal variations of larval abundance.

Information as to the spawning of the various tuna species in the Eastern Tropical Pacific may be summarized as follows:

Yellowfin tuna, *Neothunnus macropterus*

Extent of spawning

Figure 8 shows the distribution of localities of capture. Different symbols are used for captures made by means of plankton nets, by means of dip nets under the night-light, and for specimens obtained from stomachs of fish and sea snakes.

Larvae were collected from as far north as 46 miles SW of Abreojos Point off Baja California ($26^{\circ}09'N$, $114^{\circ}08'W$). The most southern point of collection, within our area of investigation, was off Point Elena, just north of the Gulf of Guayaquil, Ecuador. Larvae were also collected offshore only north of $3^{\circ}N$.

It is of great interest that no larvae were found in the offshore locations south of $5^{\circ}N$ except the occurrence at about latitudes $3^{\circ}N$ along the 120° meridian. This suggests that, in our area of investigation, offshore spawning takes place in the Counter-Current, but that there is little or no spawning in the waters of the Peru Current or its extension as the South Equatorial Current.

Baja California. This area, which seems to represent the most northerly region of spawning of the yellowfin tuna, has been thoroughly sampled at various times of the year since 1949, by vessels of the California Cooperative Oceanic Fishery Investigations. Only on a few occasions have yellowfin larvae been collected in these waters. In November 1956 a juvenile was dipnetted by the author in the vicinity of Lusitania Bank ($23^{\circ}36'N$, $111^{\circ}42'W$). The other time when young were collected was in October 1958 when CCOFI scientists captured 16 larvae at 8 stations off

Baja California (Table 3). On the basis of these facts, it can be concluded that this area, which is the most intensively sampled in the Eastern Pacific Ocean, must be of only minor importance for spawning of *N. macropterus* and that, based on the occurrence of these larvae and juveniles, spawning takes place in early fall. This agrees on the whole with the conclusions of Schaefer and Orange (1956) and of Orange (1961) that this is not a major spawning area.

Gulf of California. In this area, plankton tows have been made by the California Cooperative Oceanic Fishery Investigations. Processing of this material, however, has not yet been completed by that organization, so we cannot say at this time whether larval yellowfin may be found there or not. A few night-light collections were made by the author in September of 1956 but no young tunas were captured. No adequate samples of adult yellowfin have been obtained for studies of gonads (Orange, 1961). Therefore, the question of whether *N. macropterus* spawns in the Gulf of California must be left unanswered for the present.

Central and south Mexican coast. This area appears to be a region of intensive spawning during certain times of the year. Plankton collected in January, February, May, June, September, November and December contained yellowfin larvae. Night-light collections made in June off Manzanillo produced juveniles, which, without doubt, can be classified as *N. macropterus* (Fowler, 1944 and Klawe, 1959). Plankton collections made during the fall and early winter contained only a relatively small number of larvae.

Central American coast. This was the first recognized area of spawning of *N. macropterus* (Schaefer and Marr, 1948b). In the past decade, a number of collections has further substantiated the fact that yellowfin spawn offshore, from the Gulf of Tehuantepec to Point Mariato (7°12'N, 80°53.5'W). Plankton tows made in late spring contained yellowfin larvae. Listed below are average numbers of larvae caught per hour of surface tow during different months off Cape Blanco, Costa Rica, where regular sampling was carried out during 1959-1960.

| Month | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---------------|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|
| No. of larvae | 9.2 | 2.3 | 4.2 | 2.1 | 0.1 | 0.7 | 0.1 | 0.0 | 1.2 | 0.0 | 0.8 | 0.8 |

From these observations it appears that some spawning occurs throughout the year, but is most intensive from January through April, and with partial cessation in mid-summer.

No larvae or juveniles have been collected in the Gulf of Panama. It is difficult to say whether this is because it is not a spawning area, or is attributable to inadequate sampling.

Area off northern South America. Juvenile yellowfin have been captured during April in the general area off Cape Pasado and Point Elena, Ecuador.

Further collections carried out in this area in November, during the Eastropic Expedition, did not yield any larvae or juveniles.

The Consejo de Investigaciones Hidrobiológicas has taken plankton samples in a coastal strip about 60 miles wide off the coast of Peru but no tuna larvae have been encountered. No yellowfin were taken during the STEP-I Expedition (September-December 1960) off Peru.

Some spawning apparently takes place in the region off Cape Pasado and Point Santa Elena in spring and fall, but not enough plankton samples were taken in this area fully to define the time of spawning. Examination of gonads from this area, however, indicates that spawning occurs from January to March or April (Orange, 1961). As stated above, no young yellowfin have been collected in the area off Peru, and correspondingly, Orange (1961) found from examination of ovaries that this is not a spawning area.

Revillagigedo Islands. Schaefer and Orange (1956) indicate that spawning takes place in this region from May through September. Small numbers of yellowfin larvae were collected in this area in July 1957 during the Tuna Spawning Survey (Klawe, 1958, 1961b). A few collections were made near Clarion Island during the Island Current Survey in May 1957, and SCOT Expedition in May 1958. One tow, made in May 1957, contained two larvae. Plankton collections made west of Clarion Island in October of 1956 during the Eastropic Expedition did not contain larvae. Development of gonads of yellowfin tuna from the area of Revillagigedo Islands (Orange, 1961) indicates that a peak of spawning may occur here in August. The fact that no plankton tows were made in August may explain why larvae were not collected in larger numbers.

Area around and between Clipperton and Cocos Islands. The number of plankton and night-light collections made in this area is relatively small. Larvae have been collected in the vicinity of Clipperton and Cocos in May and October, and juveniles have been collected in December from the area off Cocos Island. The study of gonads shows that spawning may take place near Clipperton from November to April with a peak in March, and around Cocos Island in the months of February to April (Orange, 1961). It is likely, therefore, that spawning takes place throughout a large portion of the year, or even throughout the entire year.

Area between the Equator and 10°N, east of 122°W. In this area, larvae of yellowfin were collected in May and October. No larvae were found south of 5°N, except the occurrence at about 3°N near 120°W. This suggests that the spawning in this area is limited to the waters of the Counter-Current. As stated previously, the samples are insufficient to form a more definite opinion on the time of spawning in this area. In the area to the west of that considered here, larvae of *N. macropterus* have been caught throughout the year (Matsumoto, 1958) and quite likely the same may apply to the area under discussion, or at least to its western portion.

for larvae passing through the thermocline, then here again the rapid change of temperature may cause death of the larvae). This may be due to direct "thermal death" caused by intolerance to rapid change of temperature, or be indirect and caused by changes of muscular activity which debilitate the larvae and subject them to excessive predation. Any prolonged stay of larval tunas below the thermocline would most likely retard larval development, since it would extend the duration of their larval life and thus extend their exposure to the perils of larval mortality which are to be expected to be greater than those of juveniles or adults.

To date no data have been collected regarding the distribution of larvae within the mixed layer itself.

A marked diurnal variation in catches of larvae because of their vertical migration or their ability better to avoid the nets at a certain time of the day would, of course, introduce a considerable variability in an assessment of the abundance of larvae. Wade (1951), Matsumoto (1959) and Strasburg (1960) concluded, from examination of the shallow tows that the larvae of *Katsuwonus* and *Auxis* were more numerous in night hauls than those made during daylight hours. For *Neothunnus* no increase in the catch rate for the night hauls was observed. Their conclusions were based on an analysis of average catches for two-hour periods of the day.

In Figure 3 mean bihourly catches made during the following cruises: Eastropic, SCOPE, Island Current Survey, Tuna Spawning Survey, SCOT, TO 58-2, and TO 59-1, are shown by species for each category of tow, i.e. (1) surface, (2) "140 meter," and (3) "300 meter" oblique tows. These values, based on 227 surface, 122 140-meter and 415 300-meter tows, include both the productive and the non-productive hauls. Many of the zero-catch tows were taken in areas where larvae would not be expected. However, these occurred randomly, in respect to time, and should not bias the day-night comparison of larval abundance.

The catches of larvae per tow (Table 2) indicate a contagious distribution of the larvae. For *Auxis* from the surface tows, the number of larvae varies from 0 to nearly 2000 larvae per 1000 meters of water strained. The catches of larval *Neothunnus* exhibit fluctuation of a similar nature. The most frequent catches lie between 1 and 10 larvae per 1000 meters of water strained.

Interpretation of the quantitative aspects of larval distribution requires caution as it is obvious that one tow which contains a large number of larvae will greatly influence the mean value.

This great variability in the number of larvae caught in individual tows prompted the author to use a ranking test (Mann-Whitney U Test) to evaluate the difference between the night and day catches of *Neothunnus* and *Auxis* in the three categories of tows. Tows taken between 0600 and 1759 were classified as day catches and those taken between 1800 and 0559

as night catches. Catches of individual tows were used, and tows not containing larvae were included. As can be seen from the table below, significant differences between the night and day catches are evident for the number of *Auxis* larvae in surface tows and "300 meter" oblique tows. (Surprisingly no differences are evident for *Auxis* larvae from the "140 meter" oblique tows. Of course, it is to be expected that catches from both types of oblique tows should show the same tendency.) There is no evidence from the test that there are differences between night and day catches of *Neothunnus* larvae in any type of tow.

Statistical comparison of the abundance of larval *Neothunnus* and *Auxis* in night and day plankton tows:

| Type of tow | <i>Neothunnus</i> | <i>Auxis</i> |
|---------------------|-------------------|-------------------|
| Surface | p = .12 | p = less than .01 |
| "140 meter" oblique | p = .94 | p = .60 |
| "300 meter" oblique | p = .29 | p = .01 |

The larger catches of larval *Auxis* are made in night time surface tows. This may be caused by diurnal migration of larvae or by the ability of larvae to avoid the nets at certain times of the day. It is possible that there is also a nocturnal increase of catches of *Auxis* larvae in both types ("140 and 300 meter") of oblique tows. If this is true then the dodging by larvae is primarily responsible for the increase, as we can assume that the oblique tows, either "300 meter" or "140 meter" sample throughout the entire range of vertical distribution of the larvae.

Tows made at different times of the day and night with several Clarke-Bumpus samplers spaced at different depths within the mixed layer would shed light on the problem of diurnal migration. It would be advisable to run simultaneous oblique tows. It should be pointed out that because of the contagious distribution of the number of larvae per tow, a very large number of such tows would be necessary.

METHODS OF ANALYSIS

Information on the time and area of tuna spawning can be obtained either by observation of the occurrence of eggs or recently hatched young in a given area, or by examination of adults for signs of gonad maturation or recent spawning. The second method, which involves the examination of ovaries from tunas caught by commercial fishermen, leads to useful inferences as to the spawning of tunas; however, being less direct, it should be considered cautiously for the following reasons: (1) Adult tunas are swift swimmers, capable of covering large distances within short periods of time, so that the location of capture of recently spent fish or of fish with nearly mature gonads may be fairly remote from the place of actual spawning. (2) Running-ripe yellowfin and skipjack tuna are rarely taken by the commercial fishery, either with hook and line or with purse-seine nets.

However, despite these limitations, this approach has a number of merits. Of these, the most prominent is that fairly regular examination of fish caught from various parts of the Eastern Pacific Ocean is possible. This method of studying tuna spawning has been reported on by Schaefer and Orange (1956), and Orange (1961).

The alternate method of obtaining information on the sites and seasons of spawning, by collecting and identifying tunas in early stages of development from the Eastern Pacific is not free of difficulties. Some inherent drawbacks are: (1) the pelagic eggs of various tunas, as yet, are not identified to genera and species; (2) the early larval stages of *Neothunnus macropterus* cannot be identified with absolute certainty; (3) the cost of obtaining collections of larval and juvenile stages on a regular basis from the various areas in the Eastern Pacific Ocean is prohibitive, because of the necessity of using research vessels.

An assumption is made that presence of very young fish indicates recent spawning in an area at, or near, the place of capture (Klawe and Shimada, 1959; Klawe 1960b, and 1961a). This assumption appears reasonable because: (1) the time of hatching of tuna eggs is thought to be short, about two days at most (Sanzo 1932, 1933; Vodyanitsky, 1936, and personal communication regarding hatching of eggs of *Parathunnus sibi* from Dr. Hiroshi Nakamura); (2) the young tunas grow very rapidly (Clemens, 1956); (3) the velocities of the surface currents within the Eastern Tropical Pacific Ocean do not appear to be great (Cromwell, 1958; Cromwell and Bennett, 1959).

The number of larvae of different species of tuna have been estimated, per 1000 cubic meters of water strained by the net. As mentioned earlier, tuna larvae in the Eastern Pacific Ocean are taken in the layer above the thermocline. It is, therefore, to be expected that tows made to the depth of 300 meters or 140 meters strain a considerable amount of "sterile" water below the thermocline, i.e. water devoid of tuna larvae. To standardize the tows to a common basis, so that quantitative comparisons could be made, correction factors to make all tows equivalent to surface tows have been derived. During SCOT Expedition, at several stations, simultaneous tows were made at various times of the day and the night with two nets of identical construction. One net was towed just below the surface; the other was used to make an oblique tow from an approximate depth of either 300 meters or of 140 meters. These data for paired tows have been tabulated in Tables 10 and 11 showing: (1) the depth of each tow, (2) the depth of the thermocline at a given station, and (3) the catch of tuna larvae per 1000 cubic meters of water strained.

Correlation between the number of tuna larvae caught in simultaneous surface and oblique tows has been examined, and proven to be significant at the one per cent level of probability (see below).

**Correlation between number of larvae (x) caught in
surface tows and oblique tows during SCOT Expedition**

Data transformed by $x' = \log \frac{x + 1}{1000 \text{ m}^3 \text{ water strained}}$

| Surface versus: | No. of simultaneous tows | Calculated <i>r</i> value |
|-----------------|--------------------------|---------------------------|
| "140 meter" tow | 31 | .476 |
| "300 meter" tow | 49 | .415 |

Examination of average catches of tuna larvae for the two groups indicates that, for the 49 pairs of surface tows and "300 meter" oblique tows, the surface tows, on the average, caught 9.2 times as many larvae as the deep tows. When the comparison is made for the surface tows and the "140 meter" tows, the surface tows caught an average of only 3.2 times as many larvae as the "140 meter" tows.

To test the reasonableness of the above figures, the ratio of the total water strained to the water strained above the thermocline was calculated for the two types of tows. Ratios of 9.2 and 4.5 were obtained for 49 "300 meter" tows and 31 "140 meter" tows, respectively. These values are similar to the ratios of 9.2 and 3.2 which were obtained when the larval catches of the surface tows were compared with the catches of the "300" and "140" meter oblique tows, respectively. It should be pointed out that there are inherent in these calculations several kinds of sampling errors, arising from uncertainties in determining: (1) amount of water strained, because of errors introduced by the calibration of the flow meters, (2) the depth of the tow, and (3) the thermocline depth, which is objectively estimated from bathythermograph slides. (For a few stations, because of lack of bathythermographic profiles, this depth was read from average charts prepared by Cromwell, 1958). Further attention is drawn to the fact that any possible diurnal migration has been neglected in the transformation of data.

To make catches of larvae from the oblique tows approximately comparable with the catches from surface tows, the number of larvae per 1000 meters of water strained was multiplied by 9.0 for the "300 meter" tows, and by 4.5 for the "140 meter" tows. Obviously, such adjustments are approximations, but the resulting figures are believed to reflect the relative abundance of tuna larvae throughout the Eastern Pacific Ocean.

A more nearly precise adjustment could, perhaps, be obtained by multiplying the catch of each individual oblique tow by the ratio of the depth of the tow to the depth of the mixed layer at the particular place and time the tow was taken. This, however, in view of the contagious nature of the distributions of tuna larvae, and other sources of sampling variability, was not considered to be worthwhile for this study.

Figures 4 through 7 show the abundance of larvae, calculated in this manner by one-degree areas, from plankton tows made during the following expeditions: EASTROPIC, SCOPE, TUNA SPAWNING SURVEY,

SCOT, TO 58-2, and TO 59-1. Dots indicate zero catches. Only the two most abundant species have been considered: *Neothunnus macropterus* and *Auxis thazard*. In order roughly to examine seasonal variations, the figures were prepared for two six-month periods, the data being insufficient for a finer time-stratification.

DISTRIBUTION OF YOUNG TUNAS AND TIME OF SPAWNING IN THE EASTERN PACIFIC OCEAN

Plankton hauls provide useful quantitative as well as qualitative data. Nightlight collections or collections made from stomachs of marine vertebrates give little data of a quantitative nature. The conclusions presented here, therefore, are based, to a large extent, on the captures of larval tunas made with plankton nets. The plankton hauls were made in the area outlined by dashed lines in Figures 4 through 11. The locations at which young tuna were captured are shown in Figures 8 through 11. These latter figures are based on collections examined by the author, in addition to young tuna from the Eastern Pacific Ocean reported in the literature.

The spawning of tunas is of a more or less seasonal nature. Data obtained during a two-year period off Costa Rica, Table 5, clearly show that the spawning intensity of various tunas is not the same throughout the year. In the area off Baja California, which has been relatively well sampled since 1949 by the California Cooperative Oceanic Fishery Investigations, larvae of *Neothunnus macropterus*, *Euthynnus lineatus* and *Auxis thazard* were captured only at certain times of the year (Table 3).

Unfortunately we do not have comparable data, collected on a similarly continuous basis, from the other parts of the Eastern Pacific Ocean. Most of our catches are not well distributed in time or in space, however, trends, which most likely reflect the seasonal spawning, can be detected.

Despite the fact that the collections from which Figures 4 through 7 were prepared were sporadic, some seasonal differences in larval abundance are evident. For example, if we examine the catches off central and southern Mexico, where plankton collections were made in January, February, May, June, September, October, November, and December, we can see that the abundance of larvae of yellowfin tuna is greater for the period May-October (Figure 4) than for the period November-April (Figure 5). This reflects the fact that the peak of spawning takes place off central Mexico in the second and third quarters as inferred by Orange (1961).

From Figure 4 it is evident that, in the area off Revillagigedo Islands, catches of yellowfin larvae were made in the period May-October. This fact indeed supports the conclusion based on gonad studies. However, practically no plankton collections were made in the vicinity of these islands in the period November-April.

There is lack of evidence, in these charts, of seasonal spawning of yellowfin off Central America, whereas our monthly collections off Cape Blanco, and also the gonad studies, give evidence of seasonal variation in amount of spawning. This is most likely because of the inadequacy of the data in that area for these charts.

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Information as to the spawning of the various tuna species in the Eastern Tropical Pacific may be summarized as follows:

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Extent of spawning

Figure 8 shows the distribution of localities of capture. Different symbols are used for captures made by means of plankton nets, by means of dip nets under the night-light, and for specimens obtained from stomachs of fish and sea snakes.

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Baja California (Table 3). On the basis of these facts, it can be concluded that this area, which is the most intensively sampled in the Eastern Pacific Ocean, must be of only minor importance for spawning of *N. macropterus* and that, based on the occurrence of these larvae and juveniles, spawning takes place in early fall. This agrees on the whole with the conclusions of Schaefer and Orange (1956) and of Orange (1961) that this is not a major spawning area.

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Skipjack tuna, *Katsuwonus pelamis*

Too few *Katsuwonus pelamis* have been taken in the Eastern Tropical Pacific (Figure 9) to warrant reporting of the data by geographical areas as for yellowfin tuna.

Two juvenile skipjack tuna, *Katsuwonus pelamis*, were collected off Central America by Schaefer and Marr (1948b) in January and March of 1947. In spite of numerous collections made since that time, only a few larvae and juveniles of this species have been obtained. These were collected in October and November of 1952 by a Pacific Oceanic Fishery Investigations vessel at three stations situated approximately along the 120th meridian of west longitude (Matsumoto, 1958). In April of 1958, the Commission's scientists caught seven juveniles under a night-light off Cape Pasado, Ecuador. In May of the same year, one larva was collected north of Clipperton Island and seven larvae and one juvenile were collected in waters between Clipperton and Cocos Islands at various stations. One larva was collected at the same season in the Gulf of Tehuantepec.

It was observed by Matsumoto (1958) that a few larvae were found in plankton catches made in the equatorial region between 130° and 120°W longitude. Schaefer and Orange (1956), after examining skipjack gonads, concluded that some spawning by this species occurs in the vicinity of the Revillagigedo Islands. Subsequently, Orange (1961) examined a much larger number of specimens from that area and concluded that spawning in the vicinity of the Revillagigedo Islands most likely takes place from April to January, with a peak from April through June. As previously stated, no larvae of this species have so far been collected in plankton in the area of the Revillagigedo Islands. Another spawning region suggested by Orange is the area off Cocos Island, but again no larvae have been collected in the immediate vicinity of the island. He postulates, however, that the spawning season in this area is from January to April, and no collecting for young tuna has yet been done in that area during those months.

From the scarcity of young within our area of investigation, it appears that skipjack tuna spawn to only a limited extent in the waters of the Eastern Pacific Ocean. Schaefer and Orange (1956) and Orange (1961) arrived at essentially the same conclusion, but they indicate that the Revillagigedo Islands and Cocos Island may be places where spawning of this species takes place on a larger scale at some seasons.

Frigate mackerel, *Auxis thazard*

The author is aware that two species, or forms, of *Auxis* are recognized by many workers: the short-corseleted form, *A. thazard*, and long-corseleted form, *A. thynnoides*. It is possible that in the future more evidence will be obtained to substantiate the presence of two distinct species in the Eastern Pacific Ocean. There are intermediate forms in the Eastern

Pacific Ocean (Harold Clemens, personal communication); therefore, provisionally, the name *A. thazard* will be used for frigate mackerel from this region.

It is evident from the collection of larvae and juveniles from the Eastern Pacific that the most northerly area in which this species spawns is in the vicinity of Cedros Island and the head of the Gulf of California (Figure 10). The waters off Baja California and California are regularly sampled by vessels of the California Cooperative Oceanic Fishery Investigations program and no larvae have been captured north of this point. The spawning off Baja California appears to be limited to the more coastal areas, but this is not true in the more southern areas, where some spawning also takes place in a purely oceanic habitat far away from continents or islands.

The most southerly locality where young *Auxis* have been collected is off Point Santa Elena, Ecuador.

Larvae and juveniles have been collected in the vicinity of all major oceanic islands within our area of investigation. They have been found in the general area delimited by a straight line drawn from Point Santa Elena to the intersection of 10°N parallel and 116°W meridian and from there to Cedros Island off Baja California (Figure 10).

Along the Central American coast and that portion of the Mexican coast south of the Gulf of California, larval *Auxis* have been collected very frequently. In this area, which has been subjected to intensive collecting, *A. thazard* are the most plentiful tuna larvae. It is difficult to say whether adults of this species are as abundant, since there is no way to estimate their population. Although of no commercial importance, this species contributes to the tuna fishery indirectly because it forms a significant part of the food of adult yellowfin tunas (Alverson, in press).

The time of spawning seems to be restricted only in the northern part of the region, where spawning occurs only in the warmest months. In other areas, frigate mackerel apparently spawn throughout the year. The phenomenon of seasonal spawning exhibited in the northern region of the Eastern Pacific Ocean very likely repeats itself in the most southern area, but no adequate data exist to substantiate this. Our Cape Blanco series shows that, while *Auxis* spawns off Costa Rica throughout the year, a peak in spawning occurs from December to April. Listed below are the average number of larvae caught during different months off Cape Blanco per hour of surface tow:

| Month | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---------------|-----|-----|------|------|-----|-----|-----|------|-----|-----|-----|-----|
| No. of larvae | 7.6 | 1.0 | 21.7 | 18.3 | 3.8 | 0.5 | 0.2 | 0.9 | 3.5 | 0.1 | 1.3 | 6.0 |

Black skipjack, *Euthynnus lineatus*

The genus *Euthynnus* has world wide distribution in tropical and sub-

taneous surface and oblique tows proved to be statistically significant. The relative number of tuna larvae taken in surface and oblique hauls approximates the ratio of the depth of the oblique tow to the depth of the layer above the thermocline. This further substantiates the conclusion that the larvae are limited to the layer above the thermocline.

4. There is no clear indication that larvae of *Neothunnus macropterus* are more abundant in plankton tows made at night than in those made during the daylight. Significant differences in day and night catches of *Auxis thazard* larvae were found for surface tows and "300 meter" oblique tows, but, surprisingly enough, not for "140 meter" oblique tows.

5. Young tunas from the Eastern Pacific Ocean appear to be good indicators of recent spawning by the adults in the area of capture of these young.

6. The results of this study are in general agreement with those of investigations of spawning of tunas through examination of gonads.

7. Although the spawning of tunas is seasonal, in the warmer waters some spawning occurs throughout the entire year.

8. The following summarizes present knowledge of spawning of the four species of tunas in the Eastern Pacific Ocean:

Neothunnus macropterus: Spawns over an extensive area of the Eastern Pacific from the western coast of southern Baja California to Ecuador, both along the coast and in offshore waters. At the extremes of the distribution of the larvae, spawning takes place at the time of the year when the water is warmest. Off Central America the peak of spawning occurs in January through March.

Katsuwonus pelamis: Very limited spawning in coastal and oceanic waters of the area of our study. Young forms collected only on a few occasions, off Central America and as far north as the Gulf of Tehuantepec. Young collected also off Ecuador.

Auxis thazard: This species is the most numerous in the collections of larvae and juveniles from the area of our study. This species spawns near shore as well as offshore in the oceanic waters. Young have been collected as far north as Cedros Island, Baja California and the Gulf of California, and as far south as Ecuador. Off Central America, the peak of spawning occurs in winter and early spring.

Euthynnus lineatus: This species is more closely related to land masses than the other tunas dealt with here. The distribution of the young fairly well duplicates the coastal distribution of the adults. The adults occur both along the coast and in the vicinity of the major islands in the Eastern Tropical Pacific Ocean, and it is expected that spawning of this species takes place in the vicinity of these islands. Off Central America the peak of spawning is in early spring.

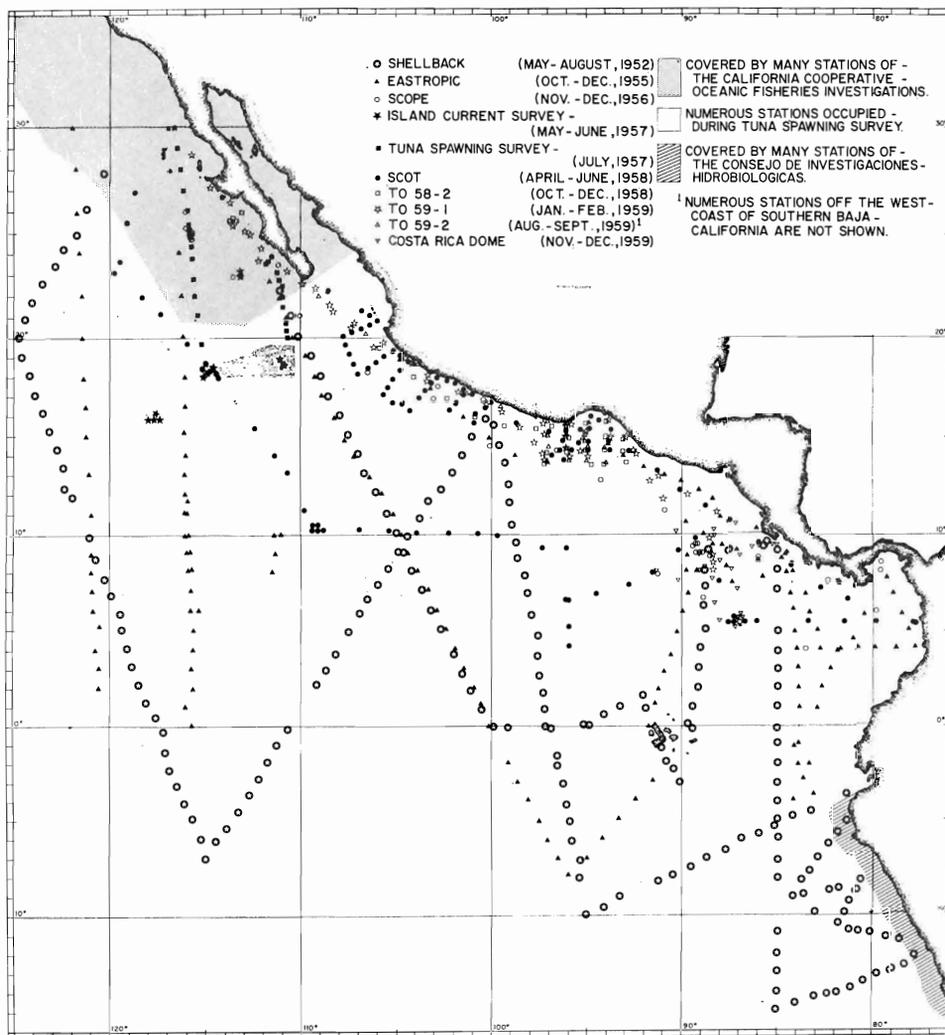


Figure 1. Locations of plankton tows which were examined for larval tunas.

Figura 1. Lugares en los que se hicieron arrastres con redes para plancton en busca de larvas de atunes.

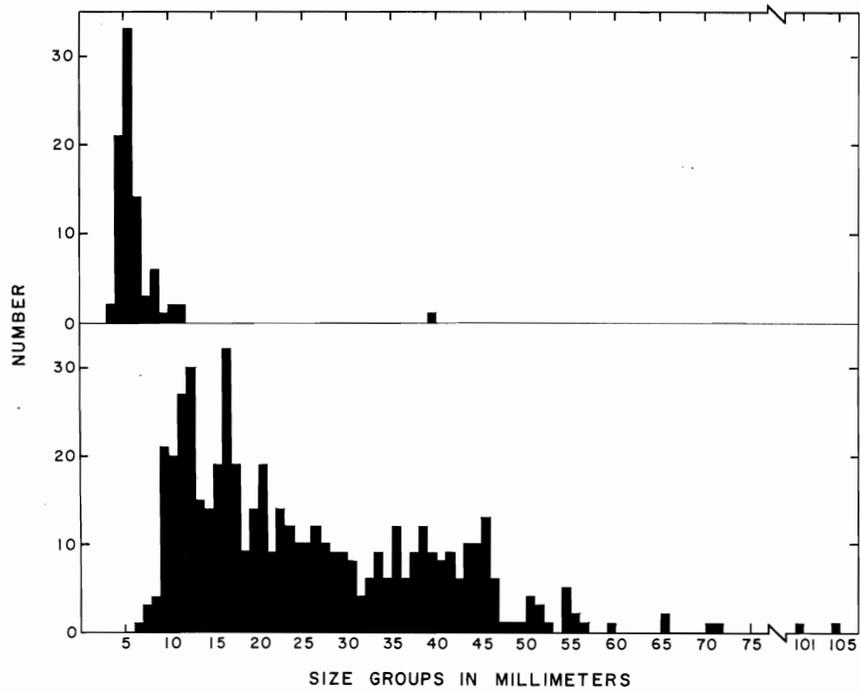


Figure 2. Size distribution of young *Auxis* caught during the Eastropic Expedition. Plankton-net collections (upper panel); night-light collections (lower panel).

Figura 2. Distribución de tamaños de *Auxis* jóvenes capturados durante la Expedición Eastropic. Las recolecciones con redes para plancton se muestran en el recuadro superior, y las hechas con luz artificial durante la noche en el recuadro inferior.

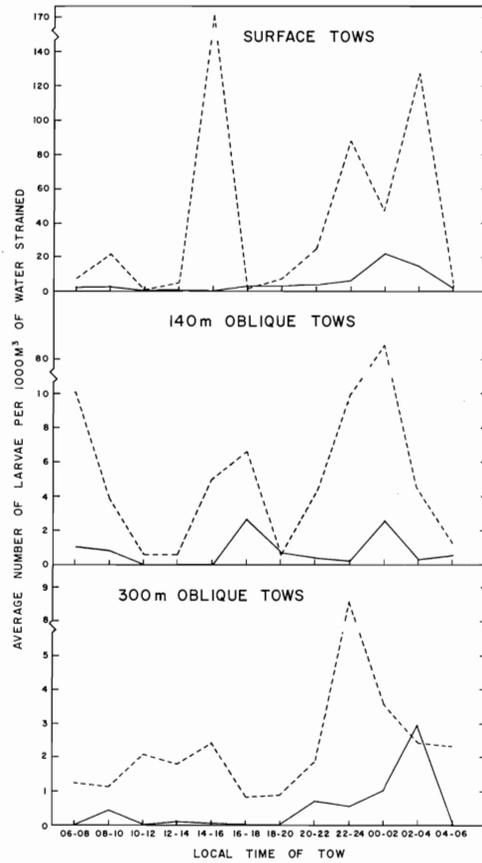


Figure 3. Bihourly catches of larval *Neothunnus macropterus* (solid line) and *Auxis thazard* (dashed line) in surface and oblique plankton tows of different depths.

Figura 3. Capturas (por periodos de dos horas) de larvas de *Neothunnus macropterus* (líneas continuas) y de *Auxis thazard* (líneas a guiones)—en los arrastres de superficie y oblicuos a diferentes profundidades con redes para plancton.

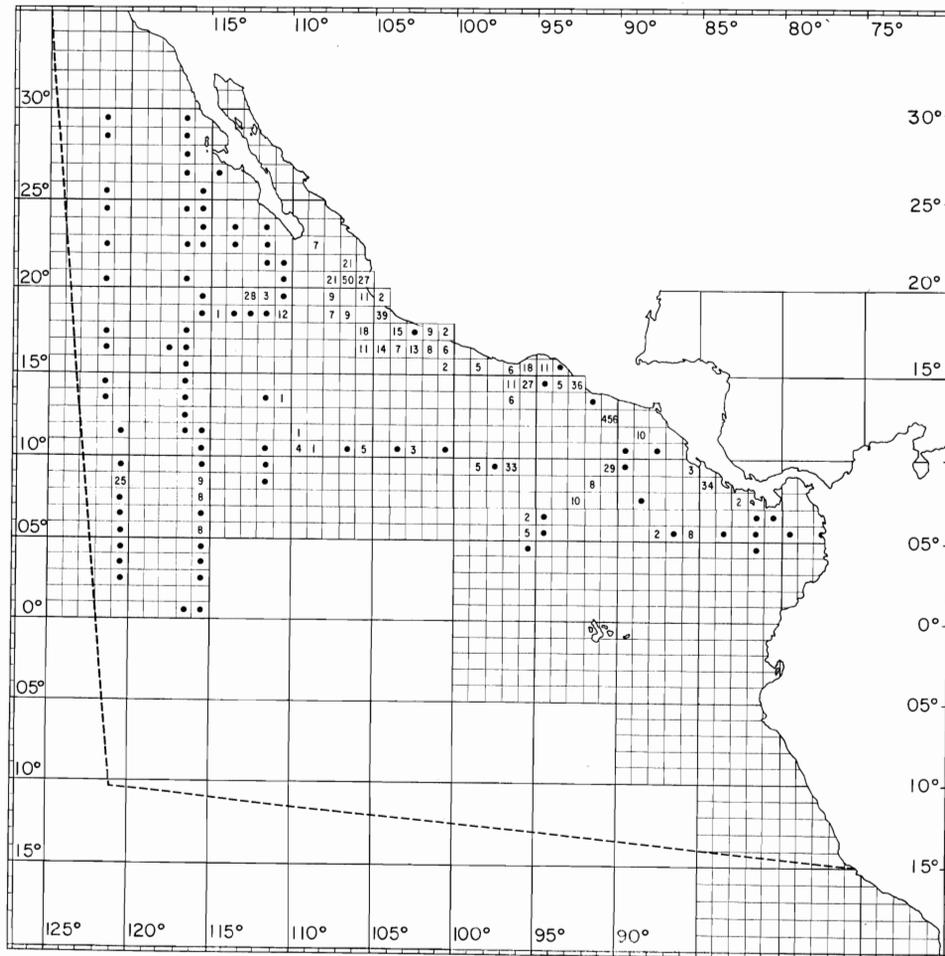


Figure 4. Abundance of larvae of *Neotbunnus macropterus* by one-degree areas, for the months of May to October, based on plankton collections.

Figura 4. Abundancia de las larvas de *Neotbunnus macropterus* por áreas de un grado, en los meses de mayo a octubre, con base en las recolecciones de plancton.

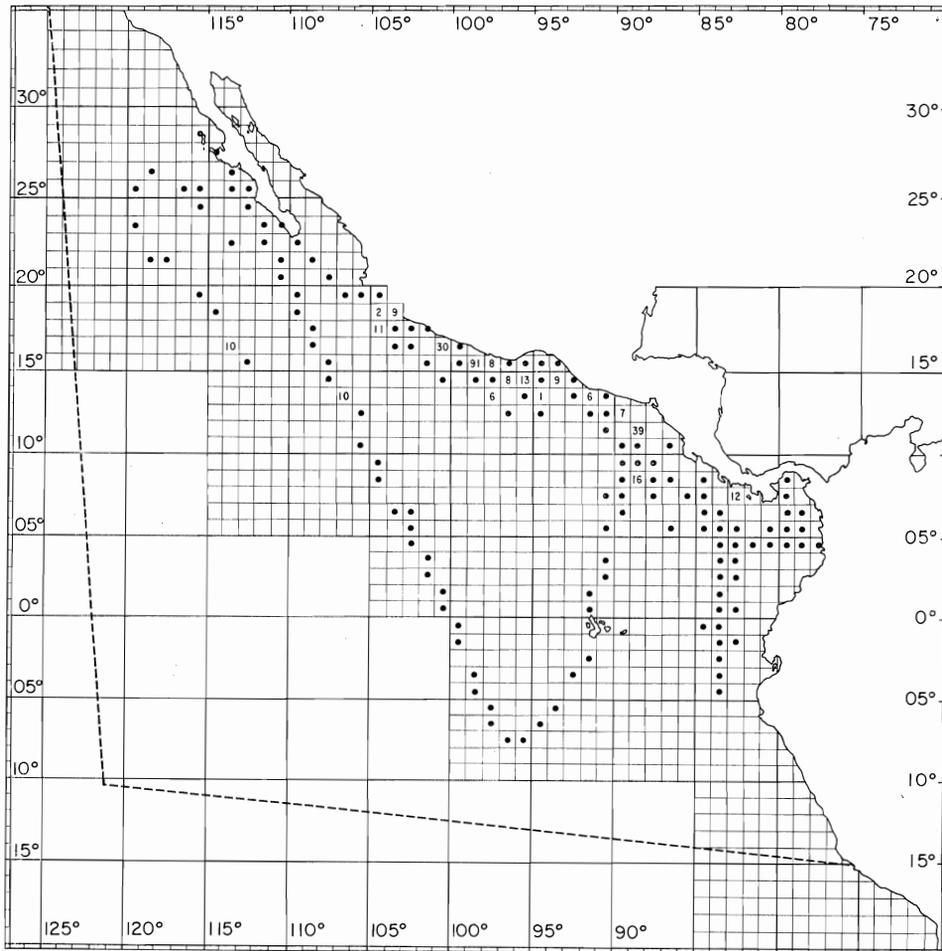


Figure 5. Abundance of larvae of *Neothunnus macropterus* by one-degree areas, for the months November to April, based on plankton collections.

Figura 5. Abundancia de las larvas de *Neothunnus macropterus* por áreas de un grado, en los meses de noviembre a abril, con base en las recolecciones de plancton.

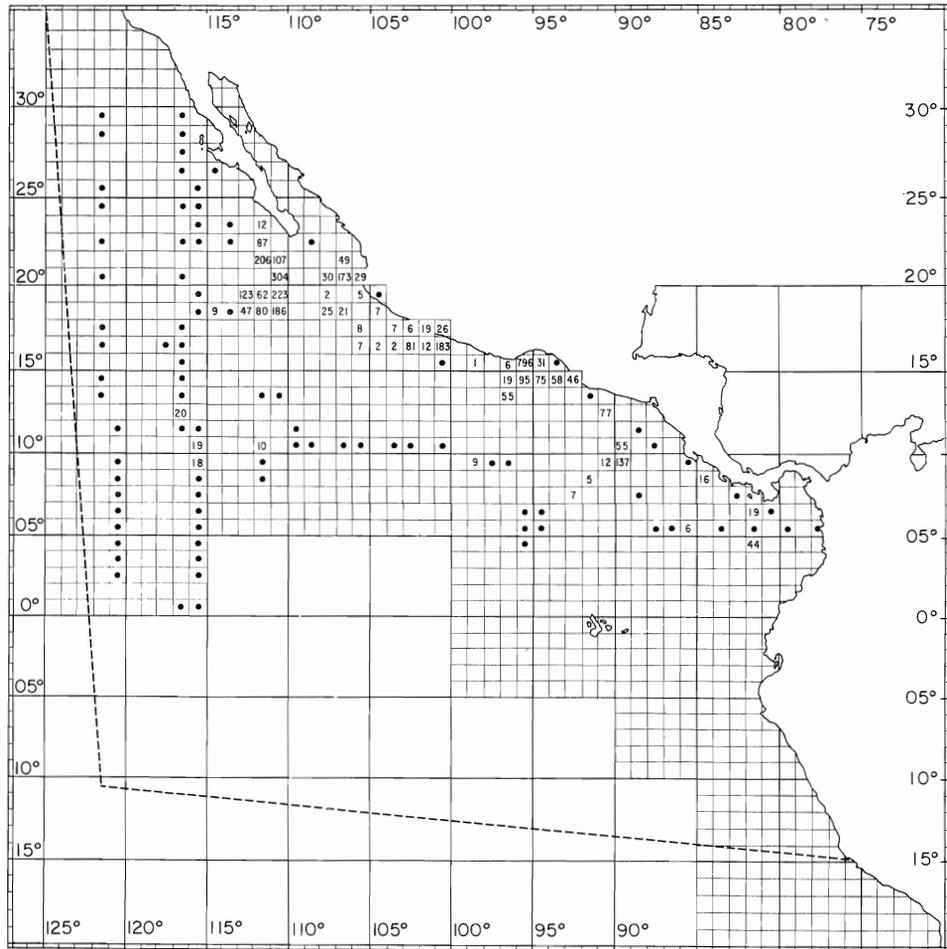


Figure 6. Abundance of larvae of *Auxis thazard* by one-degree areas, for the months May to October, based on plankton collections.

Figura 6. Abundancia de las larvas de *Auxis thazard* por áreas de un grado, en los meses de mayo a octubre, con base en las recolecciones de plancton.

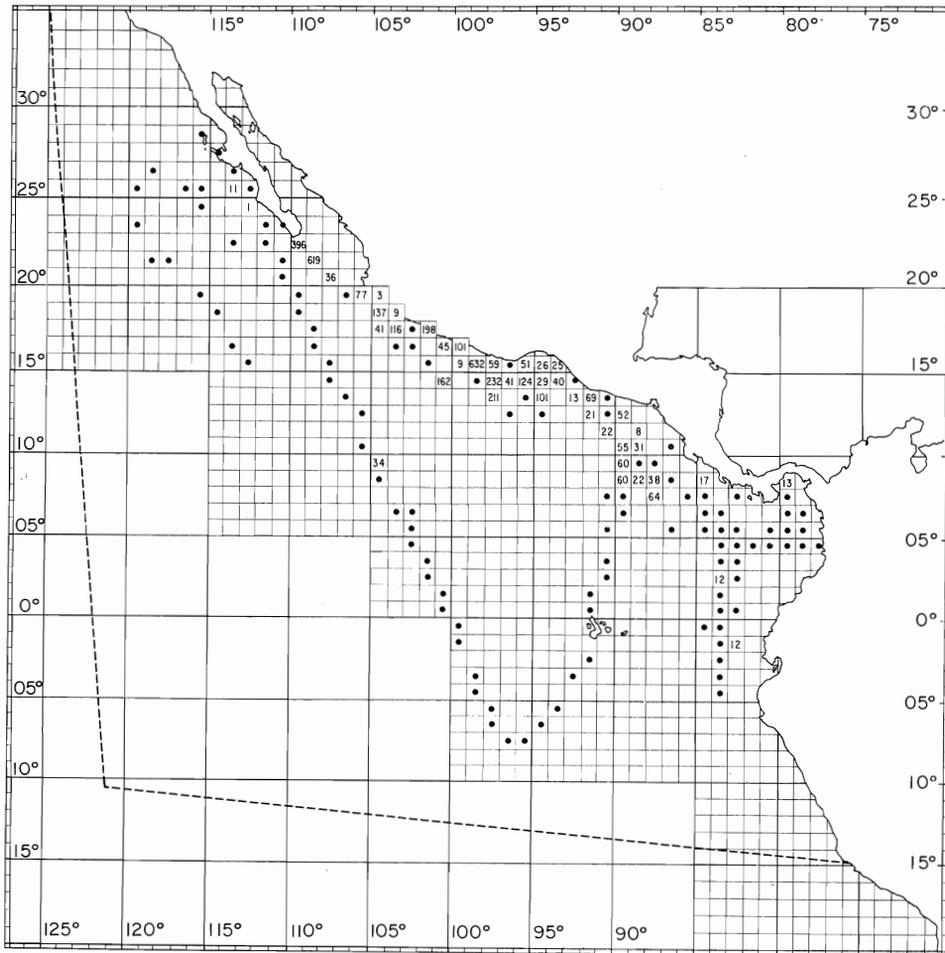


Figure 7. Abundance of larvae of *Auxis thazard* by one-degree areas, for the months November to April, based on plankton collections.

Figura 7. Abundancia de las larvas de *Auxis thazard* por áreas de un grado, en los meses de noviembre a abril, con base en las recolecciones de plancton.

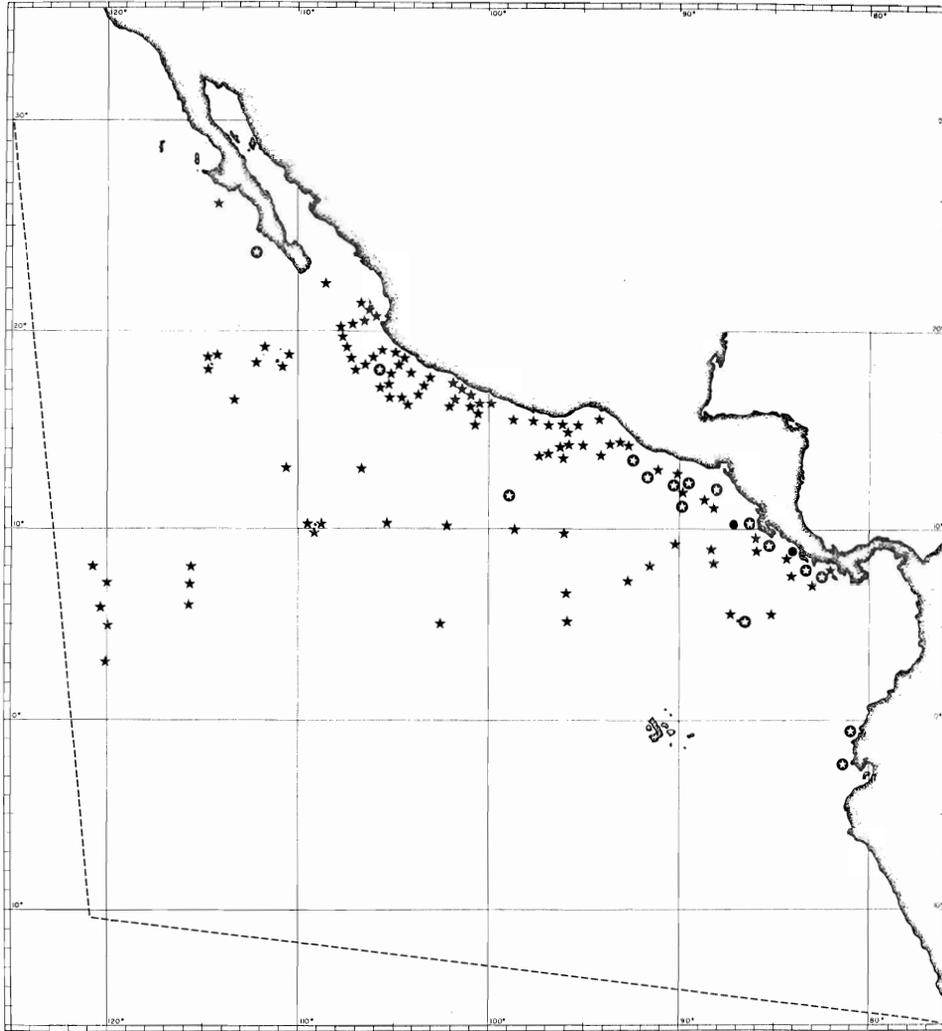


Figure 8. Locations of capture of larvae and juveniles of *Neobunnus macropterus*. Localities of capture are denoted by appropriate symbols (solid star, larvae from plankton tows; circle with a star, juveniles from night-light collections; and solid circle, juveniles from stomachs of vertebrates).

Figura 8. Lugares de captura de larvas y juveniles de *Neobunnus macropterus*. Los lugares de captura están señalados por distintos símbolos: las estrellas negras indican la obtención de larvas en los arrastres con redes para plancton; los círculos con una estrella, la captura de juveniles con luz artificial durante la noche; y los círculos negros, los juveniles encontrados en los estómagos de vertebrados.

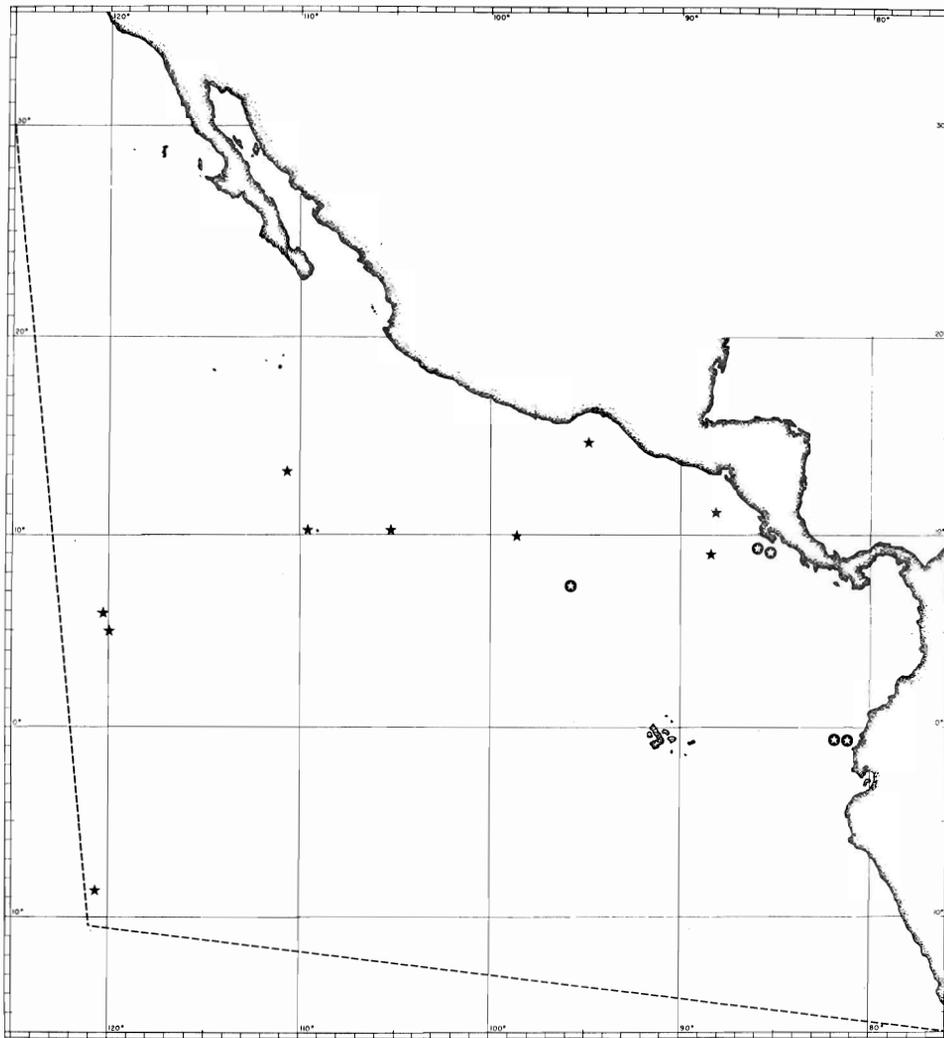


Figure 9. Locations of capture of larvae and juveniles of *Katsuwonus pelamis*. Localities of capture are denoted by appropriate symbols, as in Figure 8.

Figura 9. Lugares de captura de larvas y juveniles de *Katsuwonus pelamis*. Los lugares de captura están señalados por distintos símbolos como en la Figura 8.

★ NET TOWS
 ● NIGHT-LIGHTING

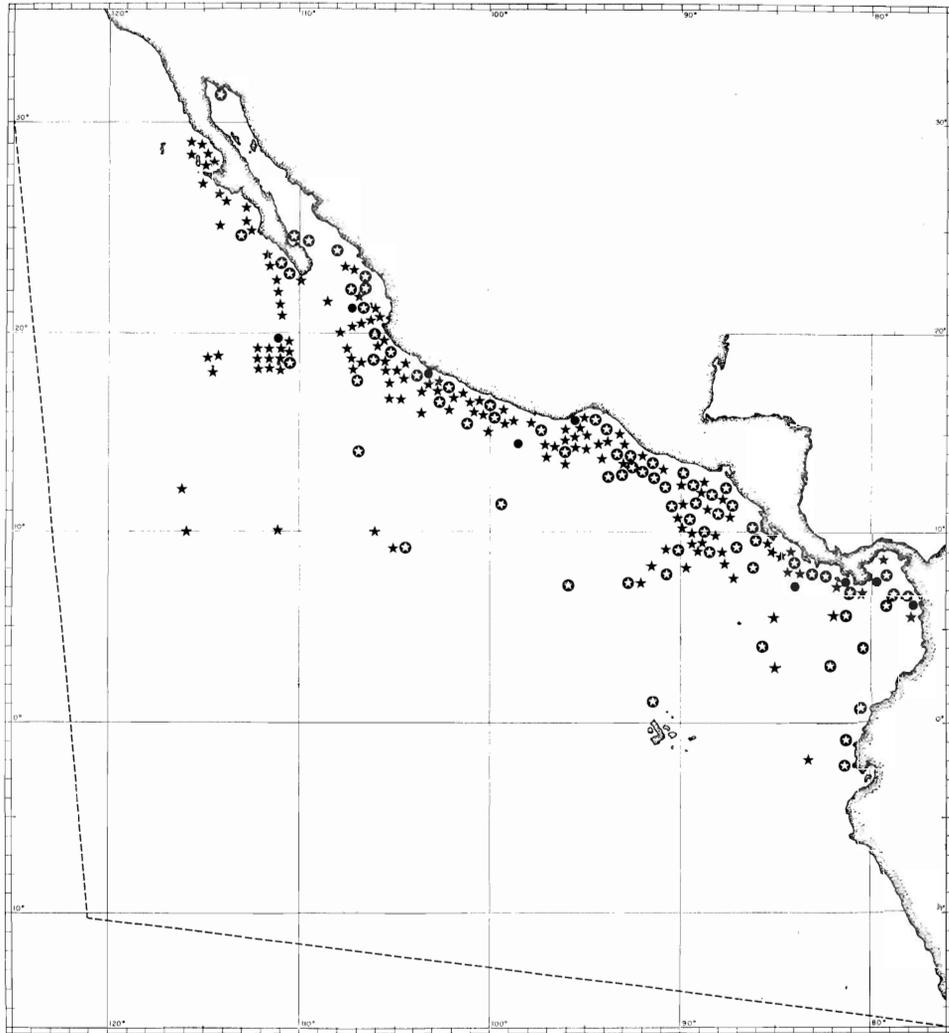


Figure 10. Locations of capture of larvae and juveniles of *Auxis thazard*. Localities of capture are denoted by appropriate symbols, as in Figure 8.

Figura 10. Lugares de captura de larvas y juveniles de *Auxis thazard*. Los lugares de captura están señalados por distintos símbolos como en la Figura 8.

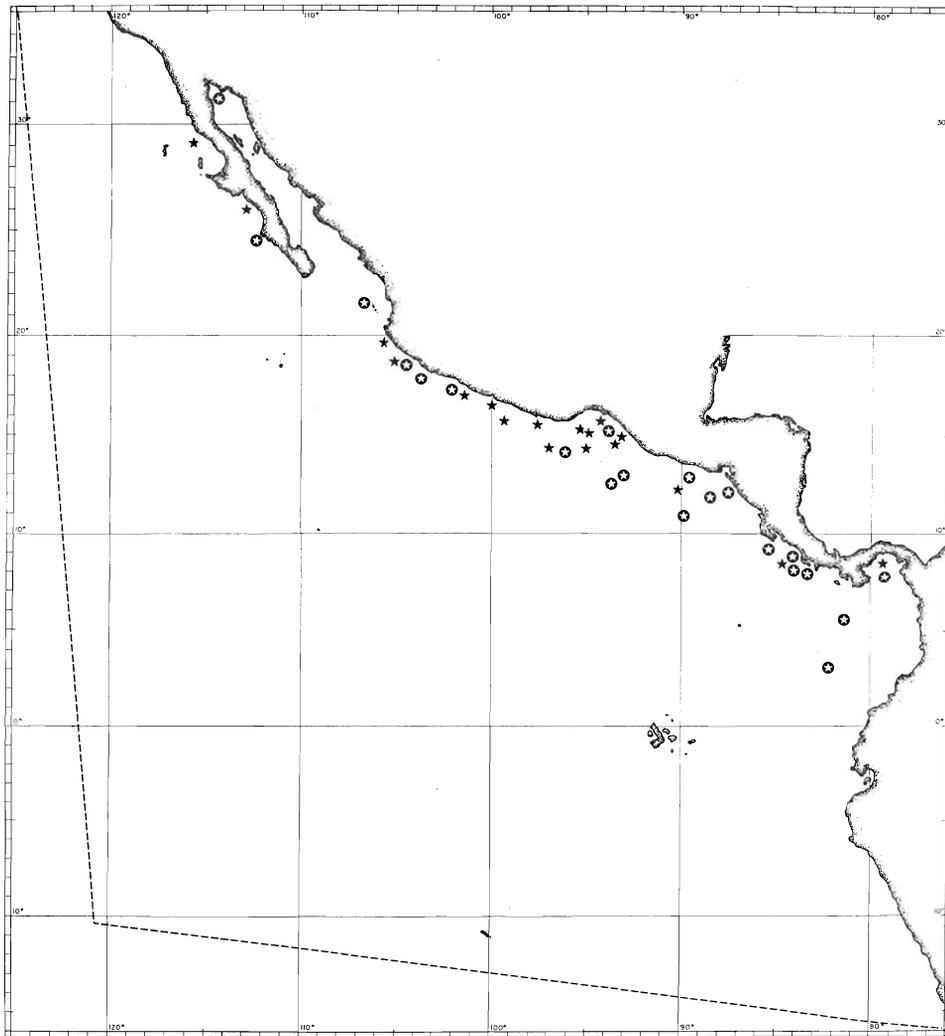


Figure 11. Locations of capture of larvae and juveniles of *Euthynnus lineatus*. Localities of capture are denoted by appropriate symbols, as in Figure 8.

Figura 11. Lugares de captura de larvas y juveniles de *Euthynnus lineatus*. Los lugares de captura están señalados por distintos símbolos como en la Figura 8.

TABLE 1. Larval tunas collected in plankton tows during SHELLBACK Expedition (May-August, 1952).

TABLA 1. Atunes en estado larval recolectados en los arrastres de plancton durante la Expedición SHELLBACK (mayo-agosto, 1952).

| Station No. | Lat. N | Position Long. W | Date | No. of larvae N.M. A.T. | |
|-----------------|---------|---------------------|---------|----------------------------|---|
| Estación No. | Lat. N | Posición Long. W | Fecha | No. de larvas N.M. A.T. | |
| 1952 | | | | | |
| 160 | 3°00' | 85°00' | July 29 | | 1 |
| 166 | 9°02.5' | 85°02' | Aug. 1 | 6 | 6 |
| 168 | 9°28.5' | 86°35.5' | Aug. 4 | | 2 |
| 200 | 5°03.5' | 102°32.5' | Aug. 16 | 1 | |

TABLE 2. Larval tunas collected in plankton tows during various expeditions.

TABLA 2. Atunes en estado larval recolectados en los arrastres de plancton durante diferentes expediciones.

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|----------------------------------|----------|---------|--------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| EASTROPIC EXPEDITION 1955 | | | | | | | | | | | | | |
| F-1 | 29°50 N | 116°55 | Oct. 2 | 1121 | 1056 | 293 | 19.3 | | | | | | |
| 2 | 27°54 | 116°47 | 3 | 0036 | 0108 | 330 | 19.1 | | | | | | |
| 4 | 24°02 | 116°31 | 4 | 0921 | 1053 | 305 | 23.2 | | | | | | |
| 5 | 22°00 | 116°23 | 5 | 0021 | 900 | 333 | 23.8 | | | | | | |
| 6 | 20°09 | 116°16 | 5 | 1236 | 952 | 330 | 24.5 | | | | | | |
| 7 | 17°56 | 116°12 | 6 | 0231 | 1000 | 317 | 25.5 | | | | | | |
| 8 | 16°31 | 116°13 | 6 | 1351 | 901 | 380 | 26.9 | | | | | | |
| 9 | 15°03 | 116°14 | 7 | 0026 | 978 | 312 | 27.2 | | | | | | |
| 10 | 14°01 | 116°13 | 7 | 0851 | 1026 | 291 | 27.1 | | | | | | |
| 11 | 13°00 | 116°11 | 7 | 1806 | 972 | 303 | 27.6 | | | | | | |
| 12 | 12°05 | 116°09 | 8 | 0151 | 902 | 308 | 27.4 | | | 2 | | 2 | |
| 13 | 11°02 | 116°05 | 8 | 1221 | 889 | 330 | 27.6 | | | | | | |
| 14 | 10°01 | 115°55 | 8 | 1921 | 926 | 310 | 27.4 | | | 2 | | 2 | |
| 15 | 9°06 | 115°44 | 9 | 0501 | 1029 | 308 | 26.7 | | | | | | |
| 16 | 8°11 | 115°37 | 9 | 1351 | 967 | 331 | 26.7 | 1 | | | | 1 | |
| 17 | 7°02 | 115°40 | 9 | 2226 | 1099 | 301 | 26.4 | 1 | | | | 1 | |
| 18 | 5°58 | 115°43 | 10 | 0821 | 1194 | 331 | 25.9 | 1 | | | | 1 | |
| 19 | 5°00 | 115°36 | 10 | 1841 | 960 | 325 | 23.9 | | | | | | |
| 20 | 4°04 | 115°35 | 11 | 0851 | 1392 | 194 | 23.5 | | | | | | |
| 21 | 3°05 | 115°44 | 11 | 1236 | 825 | 321 | 23.6 | | | | | | |
| 22 | 2°00 | 115°41 | 11 | 2151 | 904 | 299 | 24.0 | | | | | | |
| 23 | 0°58 | 116°03 | 12 | 0706 | 1488 | 168 | 23.0 | | | | | | |
| 24 | 0°04 | 115°39 | 12 | 2221 | 752 | 300 | 21.0 | | | | | | |
| 25 | 6°00 | 115°24 | 17 | 1521 | 990 | 322 | 25.8 | | | | | | |
| 27 | 8°02 | 115°40 | 18 | 0751 | 942 | 297 | 26.2 | | | | | | |
| 28 | 9°03 | 115°48 | 18 | 1722 | 1031 | 314 | 26.7 | | | | | | |
| 29 | 9°58 | 115°58 | 19 | 0051 | 978 | 325 | 27.0 | | | | | | |
| 30 | 10°58 | 115°58 | 19 | 0822 | 1032 | 308 | 27.3 | | | 2 | | 2 | |
| 31 | 11°41 | 115°59 | 19 | 1451 | 927 | 325 | 27.5 | | | | | | |
| 33 | 10°39 | 89°51 | Nov. 3 | 0951 | 986 | 293 | 26.0 | | | 6 | | 1 | |
| 34 | 10°03 | 88°52 | 3 | 2106 | 1026 | 309 | 26.5 | | | | | 7 | |
| 35 | 9°27 | 87°53 | 4 | 1021 | 948 | 323 | 26.5 | | | | | | |
| 36 | 8°24 | 87°35 | 4 | 2321 | 946 | 319 | 26.2 | | | 4 | | 5 | |
| 37 | 7°33 | 87°21 | 5 | 0850 | 980 | 307 | 25.8 | | | 7 | | 8 | |
| 38 | 7°47 | 85°45 | 5 | 2221 | 967 | 318 | 25.7 | | | | 1 | | |
| 40 | 8°39 | 84°46 | 6 | 2051 | 1067 | 286 | 25.9 | | | 2 | | 2 | |
| 42 | 8°54 | 84°42 | 11 | 0851 | 957 | 296 | 26.2 | | | | | | |
| 43 | 7°53 | 84°32 | 11 | 1651 | 1120 | 254 | 26.1 | | | | | | |
| 44 | 6°54 | 84°21 | 12 | 0121 | 951 | 314 | 25.7 | | | | | | |
| 45 | 6°04 | 84°09 | 12 | 0921 | 919 | 314 | 25.9 | | | | | | |
| 46 | 5°02 | 84°03 | 12 | 1821 | 1007 | 298 | 25.8 | | | | | | |
| 47 | 4°02 | 83°56 | 13 | 0306 | 977 | 336 | 25.5 | | | | | | |
| 48 | 3°02 | 83°51 | 13 | 1050 | 944 | 306 | 25.4 | | | | | | |
| 49 | 1°59 | 83°50 | 13 | 1851 | 1085 | 267 | 25.0 | | | | | | |
| 50 | 0°58 | 83°49 | 14 | 0221 | 972 | 318 | 24.3 | | | | | | |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|----------|----------|---------|--------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 51 | 0°00 | 83°47 | 14 | 2011 | 989 | 280 | 22.3 | | | | | | |
| 52 | 0°58 S | 83°50 | 16 | 0251 | 753 | 312 | 18.0 | | | | | | |
| 53 | 2°02 | 83°52 | 16 | 1151 | 578 | 348 | 17.8 | | | | | | |
| 54 | 2°54 | 83°35 | 16 | 2051 | 811 | 314 | 18.3 | | | | | | |
| 55 | 3°42 | 83°06 | 17 | 0521 | 612 | 314 | 18.0 | | | | | | |
| 56 | 1°59 | 83°20 | 20 | 2051 | 772 | 293 | 20.4 | | | 1 | | | 1 |
| 57 | 4°03 | 84°11 | 22 | 1721 | 868 | 289 | 19.0 | | | | | | |
| 58 | 0°00 | 91°41 | 27 | 2206 | 960 | 296 | 19.4 | | | | | | |
| 59 | 1°06 N | 91°31 | 28 | 0651 | 1012 | 318 | 22.6 | | | | | | |
| 60 | 1°58 | 91°17 | 28 | 1436 | 1230 | 225 | 24.1 | | | | | | |
| 61 | 2°51 | 90°52 | 28 | 2321 | 953 | 293 | 25.0 | | | | | | |
| 62 | 3°49 | 90°37 | 29 | 0736 | 1018 | 274 | 25.7 | | | | | | |
| 63 | 5°00 | 90°20 | 29 | 1621 | 1235 | 300 | 26.1 | | | | | | |
| 64 | 6°05 | 89°57 | 30 | 0251 | 1018 | 306 | 26.4 | | | | | | |
| 65 | 7°02 | 89°39 | 30 | 1051 | 1221 | 292 | 26.6 | | | | | | |
| 66 | 8°03 | 89°43 | 30 | 2206 | 970 | 306 | 26.2 | | | 1 | | | 1 |
| 67 | 8°54 | 89°36 | Dec. 1 | 0851 | 957 | 298 | 25.0 | | | | | | |
| 68 | 10°02 | 89°07 | 1 | 1951 | 972 | 298 | 25.2 | | | | | | |
| 69 | 11°02 | 88°46 | 2 | 0621 | 1068 | 263 | 27.0 | | | | | | |
| 70 | 11°48 | 88°25 | 2 | 1836 | 885 | 302 | 28.1 | | | 1 | | | 1 |
| 76 | 12°24 | 89°06 | 6 | 2221 | 986 | 302 | 27.4 | | | 5 | | 2 | 7 |
| 77 | 12°44 | 90°01 | 7 | 0521 | 1016 | 297 | 27.4 | | | | | | |
| 78 | 13°05 | 90°54 | 7 | 1306 | 946 | 309 | 28.0 | | | | | | |
| 79 | 13°31 | 92°02 | 7 | 2051 | 896 | 363 | 27.4 | | | | | | |
| 80 | 14°05 | 93°05 | 8 | 0521 | 961 | 305 | 28.0 | | | 8 | | 1 | 9 |
| 81 | 14°39 | 93°55 | 8 | 1251 | 979 | 301 | 28.5 | | | | | | |
| 82 | 15°48 | 95°03 | 8 | 2255 | 583 | 152 | 28.2 | | | | | | |
| 85 | 13°42 | 97°01 | 9 | 1920 | 1016 | 153 | 27.4 | | | 2 | | | 2 |
| 87 | 14°02 | 98°42 | 10 | 1751 | 991 | 292 | 28.2 | | | | | | |
| 88 | 14°58 | 100°14 | 11 | 0051 | 946 | 307 | 27.6 | | | 17 | | 5 | 22 |
| 89 | 15°58 | 101°32 | 11 | 1121 | 993 | 298 | 27.3 | | | | | | |
| 90 | 17°27 | 103°19 | 12 | 0321 | 992 | 318 | 25.8 | | | 24 | | | 24 |
| 91 | 19°00 | 104°57 | 12 | 1921 | 990 | 293 | 23.5 | | | | | | |
| H-1 | 29°56 | 121°59 | Oct. 2 | 2111 | 905 | 322 | — | | | | | | |
| 2 | 28°03 | 121°49 | 3 | 0911 | 903 | 311 | 18.5 | | | | | | |
| 3 | 28°58 | 121°48 | 4 | 0051 | 872 | 288 | 19.0 | | | | | | |
| 4 | 24°00 | 121°41 | 4 | 1611 | 870 | 320 | 21.3 | | | | | | |
| 5 | 22°00 | 121°35 | 5 | 0621 | 671 | 320 | 21.3 | | | | | | |
| 6 | 20°00 | 121°31 | 5 | 2121 | 907 | 324 | 24.0 | | | | | | |
| 7 | 17°57 | 121°26 | 6 | 1141 | 901 | 323 | 24.4 | | | | | | |
| 8 | 16°31 | 121°21 | 6 | 2341 | 738 | 330 | 25.8 | | | | | | |
| 9 | 14°58 | 121°15 | 7 | 1121 | 1061 | 312 | 26.0 | | | | | | |
| 11 | 13°02 | 121°03 | 8 | 0243 | 870 | 304 | 26.6 | | | | | | |
| 13 | 11°00 | 120°56 | 8 | 2141 | 835 | 305 | 27.6 | | | | | | |
| 15 | 9°00 | 120°48 | 9 | 1321 | 861 | 313 | 27.4 | | | | | | |
| 16 | 8°00 | 120°47 | 9 | 2221 | 720 | 309 | 27.0 | | | 2 | | | 2 |
| 17 | 7°00 | 120°46 | 10 | 0841 | 1020 | 322 | 26.4 | | | | | | |
| 18 | 6°01 | 120°46 | 10 | 1701 | 814 | 331 | 26.1 | | | | | | |
| 19 | 5°21 | 120°31 | 11 | 0211 | 833 | 307 | 25.0 | | | | | | |
| 20 | 4°01 | 120°40 | 11 | 1331 | 975 | 302 | 25.3 | | | | | | |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | | | | |
|----------|----------|---------|-------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|--|--|---|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | Total | | | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | | | | |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | Total | | | |
| 21 | | 120°32 | | 12 | 0011 | 891 | 329 | | | | | | | | | |
| 22 | | 120°32 | | 12 | 0901 | 539 | 223 | | | | | | | | | |
| 23 | | 111°28 | | 23 | 1221 | 1061 | 277 | | | | | | | | | |
| 24 | | 111°25 | | 23 | 2121 | 907 | 295 | | | | | | | | | |
| 25 | | 111°33 | | 24 | 0911 | 809 | 306 | | | | | | | | | |
| 27 | | 111°08 | | 25 | 2231 | 866 | 292 | | | | | | | | | |
| 29 | | 89°15 | Nov. | 3 | 1501 | 880 | 280 | | | 1 | | | | | | 1 |
| 30 | | 88°25 | | 4 | 0521 | 718 | 290 | | | | | | | | | |
| 31 | | 88°02 | | 4 | 1911 | 1027 | 292 | | | 1 | | | | | | 1 |
| 32 | | 86°33 | | 5 | 1101 | 1060 | 266 | | | | | | | | | |
| 33 | | 87°06 | | 5 | 2221 | 885 | 295 | | | | | | | | | |
| 34 | | 86°00 | | 6 | 1651 | 1192 | 281 | | | | | | | | | |
| 35 | | 84°32 | | 10 | 1521 | 991 | 306 | | | | | | | | | |
| 36 | | 84°10 | | 10 | 2351 | 1047 | 279 | | | | | | | | | |
| 37 | | 83°38 | | 11 | 1011 | 1070 | 260 | | | | | | | | | |
| 38 | | 83°26 | | 11 | 1801 | 1045 | 281 | | | | | | | | | |
| 39 | | 82°52 | | 12 | 0250 | 1031 | 320 | | | | | | | | | |
| 40 | | 82°48 | | 12 | 1131 | 926 | 320 | | | | | | | | | |
| 41 | | 81°45 | | 12 | 2051 | 1081 | 295 | | | | | | | | | |
| 42 | | 80°46 | | 13 | 0531 | 1038 | 286 | | | | | | | | | |
| 43 | | 79°46 | | 13 | 1411 | 1155 | 269 | | | | | | | | | |
| 44 | | 78°47 | | 13 | 2151 | 809 | 329 | | | | | | | | | |
| 45 | | 77°45 | | 14 | 1000 | 1279 | 228 | | | | | | | | | |
| 46 | | 78°09 | | 14 | 1811 | 1144 | 302 | | | | | | | | | |
| 47 | | 78°31 | | 15 | 0641 | 937 | 275 | | | | | | | | | |
| 48 | | 78°54 | | 15 | 1711 | 1117 | 271 | | | | | | | | | |
| 49 | | 79°20 | | 16 | 0126 | 888 | 130 | | | | | | | | | |
| 52 | | 80°31 | | 19 | 1436 | 1068 | 258 | | | | | | | | | |
| 53 | | 81°02 | | 20 | 0201 | 801 | 293 | | | | | | | | | |
| 54 | | 81°48 | | 20 | 1222 | 946 | 296 | | | | | | | | | |
| 55 | | 82°15 | | 21 | 0022 | 1003 | 243 | | | | | | | | | |
| 56 | | 82°45 | | 21 | 0931 | 985 | 254 | | | | | | | | | |
| 57 | | 82°57 | | 21 | 1741 | 1155 | 236 | | | | | | | | | |
| 59 | | 84°05 | | 22 | 0052 | 913 | 276 | | | | | | | | | |
| 61 | | 91°32 | | 29 | 1021 | 901 | 240 | | | | | | | | | |
| 62 | | 92°27 | | 29 | 1931 | 698 | 324 | | | | | | | | | |
| 63 | | 93°19 | | 30 | 0521 | 726 | 281 | | | | | | | | | |
| 64 | | 94°13 | | 30 | 1521 | 728 | 307 | | | | | | | | | |
| 65 | | 95°08 | Dec. | 1 | 0131 | 789 | 298 | | | | | | | | | |
| 66 | | 96°00 | | 1 | 1121 | 637 | 313 | | | | | | | | | |
| 67 | | 96°33 | | 2 | 0311 | 710 | 305 | | | | | | | | | |
| 68 | | 97°10 | | 2 | 1231 | 822 | 366 | | | | | | | | | |
| 69 | | 97°30 | | 2 | 2001 | 876 | 286 | | | | | | | | | |
| 70 | | 98°03 | | 3 | 0421 | 788 | 281 | | | | | | | | | |
| 71 | | 98°37 | | 3 | 1232 | 991 | 256 | | | | | | | | | |
| 72 | | 99°05 | | 3 | 2101 | 808 | 298 | | | | | | | | | |
| 73 | | 99°28 | | 4 | 0651 | 788 | 307 | | | | | | | | | |
| 74 | | 100°03 | | 4 | 1621 | 811 | 306 | | | | | | | | | |
| 75 | | 100°34 | | 7 | 0011 | 797 | 312 | | | | | | | | | |
| 76 | | 101°00 | | 7 | 0812 | 958 | 307 | | | | | | | | | |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|-------------------------|----------|----------|-------------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 77 | 3°03 | 101°35 | 7 | 1851 | 739 | 325 | 25.2 | | | | | | |
| 78 | 4°08 | 102°02 | 8 | 0411 | 847 | 283 | 25.6 | | | | | | |
| 79 | 5°05 | 102°26 | 8 | 1142 | 839 | 318 | 25.7 | | | | | | |
| 80 | 6°00 | 102°58 | 8 | 2001 | 799 | 291 | 25.9 | | | | | | |
| 81 | 6°59 | 103°25 | 9 | 0441 | 908 | 272 | 26.6 | | | | | | |
| 82 | 8°00 | 104°00 | 9 | 1421 | 812 | 293 | 27.4 | | | | | | |
| 83 | 9°03 | 104°34 | 10 | 0001 | 790 | 230 | 27.1 | | | 3 | | | 3 |
| 84 | 10°00 | 105°05 | 10 | 0711 | 763 | 277 | 27.2 | | | | | | |
| 85 | 10°59 | 105°35 | 10 | 1514 | 835 | 252 | 27.4 | | | | | | |
| 86 | 12°01 | 105°59 | 10 | 2311 | 818 | 310 | 27.2 | | | | | | |
| 87 | 13°00 | 106°38 | 11 | 0831 | 920 | 289 | 27.4 | 1 | | | | | 1 |
| 88 | 14°04 | 107°13 | 11 | 1651 | 875 | 272 | 27.2 | | | | | | |
| 89 | 14°58 | 107°37 | 12 | 0052 | 788 | 299 | 26.6 | | | | | | |
| 90 | 16°00 | 108°09 | 12 | 0921 | 929 | 241 | 26.2 | | | | | | |
| 91 | 17°00 | 108°38 | 12 | 1721 | 903 | 308 | 25.4 | | | | | | |
| 92 | 18°02 | 109°12 | 13 | 0102 | 875 | 243 | 25.7 | | | | | | |
| 93 | 19°01 | 109°40 | 13 | 1851 | 868 | 261 | 24.6 | | | | | | |
| 94 | 20°00 | 110°15 | 13 | 1641 | 787 | 285 | 24.4 | | | | | | |
| 95 | 21°00 | 110°38 | 14 | 0121 | 819 | 270 | 23.3 | | | | | | |
| 96 | 22°00 | 111°09 | 14 | 0831 | 729 | 296 | 21.5 | | | | | | |
| 97 | 22°56 | 111°43 | 14 | 1631 | 814 | 277 | 22.2 | | | | | | |
| SCOPE EXPEDITION | | | 1956 | | | | | | | | | | |
| O-9 | 25°44 N | 116°01.5 | Nov. 9 | 0721 | 802 | 313 | 20.4 | | | | | | |
| O-13 | 25°21 | 115°56 | 9 | 1030 | 850 | 313 | 20.7 | | | | | | |
| O-17 | 24°59 | 115°45 | 9 | 1336 | 847 | 307 | | | | | | | |
| O-19 | 24°54 | 115°42 | 9 | 1611 | 903 | 294 | 21.2 | | | | | | |
| O-21 | 24°42 | 115°42 | 9 | 1830 | 808 | 302 | 21.3 | | | | | | |
| S-1 | 22°57 | 113°35 | 10 | 1336 | 829 | 290 | 24.2 | | | | | | |
| S-2 | 21°07 | 110°03 | 11 | 1321 | 793 | 317 | 28.1 | | | | | | |
| S-3 | 19°17 | 106°32 | 12 | 1421 | 770 | 317 | 28.6 | | | | | | |
| S-4 | 17°27 | 102°53 | 13 | 1339 | 775 | 317 | 29.4 | | | | | | |
| S-5 | 16°15.5 | 100°28 | 14 | 0950 | 848 | 301 | 29.2 | | | 1 | | | 1 |
| S-6 | 14°17 | 96°34 | 15 | 1506 | 825 | 275 | 27.7 | | | 1 | | | 1 |
| S-7 | 12°41 | 94°15 | 16 | 1406 | 797 | 311 | 27.9 | | | | | | |
| S-8 | 11°13 | 90°55 | 17 | 1406 | 810 | 323 | 27.6 | | | 2 | | | 2 |
| S-9 | 8°56 | 88°30 | 18 | 2035 | 822 | 320 | | | | 2 | | | 2 |
| S-9-1 | 8°56 | 88°29.5 | 19 | 1004 | 899 | 268 | | | | | | | |
| S-9-2 | 8°55 | 88°56 | 19 | 1430 | 469 | 0 | | | | | | | |
| S-9-3 | 8°56 | 89°01 | 19 | 2050 | 819 | 284 | | | | 10 | | | 10 |
| S-9-3 | 8°56 | 89°01 | 19 | 1910 | 411 | 0 | | | | | | | |
| S-9-4 | 9°08 | 89°16 | 20 | 0805 | 842 | 285 | | | | | | | |
| S-9-4 | 9°08 | 89°16 | 20 | 0920 | 391 | 0 | | | | 37 | | | 37 |
| S-9-5 | 9°27 | 89°18 | 20 | 1906 | 875 | 287 | | | | | | | |
| S-9-5 | 9°27 | 89°18 | 20 | 2039 | 397 | 0 | | | | | | | |
| S-9-6 | 9°33 | 89°13 | 21 | 0736 | 754 | 308 | | | | 5 | | | 5 |
| S-9-6 | 9°33 | 89°13 | 21 | 0945 | 333 | 0 | | | | 55 | | | 55 |
| S-9-7 | 9°29.5 | 89°14 | 21 | 1901 | 850 | 0 | | | | 12 | | | 12 |
| S-9-7 | 9°29.5 | 89°14 | 21 | 2000 | 301 | 0 | | | | 52 | | | 52 |
| S-10 | 8°42 | 86°01 | 24 | 1336 | 804 | 276 | 26.9 | | | | | | |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|-----------------------------------|----------|----------|--------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Lat. | Long. W | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | | | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| S-11 | 7°37' | 82°25.5' | 25 | 1401 | 754 | 262 | | | | | | | |
| S-12 | 8°31.3 | 79°32' | 30 | 1845 | 304 | 0 | 26.7 | 1 | | | | | 1 |
| S-13 | 8°06' | 79°35' | 30 | 2345 | 304 | 0 | | | | 4 | 2 | 9 | 15 |
| S-14 | 7°38.5 | 79°38' | Dec. 1 | 0230 | 304 | 0 | | | | | | | |
| S-16 | 5°59' | 79°49' | 1 | 1406 | 745 | 319 | 26.7 | | | | | | |
| S-17 | 4°09' | 83°34' | 2 | 1336 | 756 | 307 | 27.0 | | | | | | |
| S-18 | 5°28.5 | 86°57' | 3 | 1515 | 728 | 292 | 26.4 | | | | | | |
| S-19 | 6°46' | 89°52' | 4 | 1611 | 772 | 305 | 27.1 | | | | | | |
| S-20 | 7°52' | 91°19' | 5 | 1421 | 758 | 301 | 25.6 | | | | | | |
| S-21 | 12°17' | 96°50' | 7 | 1635 | 762 | 306 | 25.4 | | | | | | |
| S-22 | 14°37' | 100°09' | 8 | 1406 | 703 | 319 | 29.5 | | | | | | |
| S-23 | 16°52' | 103°06' | 9 | 1350 | 785 | 311 | 29.0 | | | | | | |
| S-24 | 19°30' | 105°52' | 10 | 1351 | 758 | 313 | 26.9 | | | | | 1 | 1 |
| S-25 | 23°31' | 111°22' | 12 | 0808 | 802 | 306 | 23.8 | | | 1 | | | 1 |
| ISLAND CURRENT SURVEY 1957 | | | | | | | | | | | | | |
| 1 | 18°14' | 114°44' | May 12 | 1421 | 865 | 289 | 24.3 | | | | | | |
| 2 | 19°24' | 115°43' | 13 | 0251 | 831 | 298 | 23.1 | | | | | | |
| 4 | 19°32' | 114°56' | 13 | 1451 | 819 | 316 | 24.0 | | | | | | |
| 6 | 19°24' | 113°37' | 14 | 0436 | 1119 | 291 | 23.8 | | | | | | |
| 7 | 18°26' | 113°37' | 14 | 1451 | 799 | 327 | 24.1 | | | | | | |
| 9 | 18°15' | 114°38' | 15 | 0421 | 875 | 300 | 24.2 | | | | | | |
| 11 | 18°22' | 115°44' | 15 | 1521 | 889 | 290 | 23.9 | | | | | | |
| 12 | 17°22' | 115°43' | 16 | 0236 | 878 | 299 | 24.0 | | | | | | |
| 14 | 17°19' | 114°41' | 16 | 1406 | 850 | 306 | 24.6 | | | | | | |
| 16 | 17°24' | 113°30' | 17 | 0421 | 868 | 290 | 24.2 | | | | | | |
| 16B | — | — | 18 | 1956 | 464 | 131 | — | | | | | | |
| 21 | 18°21' | 114°39' | 20 | 1621 | 900 | 300 | 24.9 | | | | | | |
| 28 | 18°21' | 114°40' | 22 | 1321 | 921 | 299 | 24.8 | | | | | | |
| 34 | 18°21' | 114°46' | 24 | 0853 | 422 | 49 | 24.5 | | | | | | |
| 42 | 18°29' | 114°42' | 26 | 1521 | 858 | 299 | 23.7 | | | | | | |
| 47 | 18°20' | 114°48' | 28 | 1206 | 916 | 289 | 23.3 | | | | | | |
| 51 | 16°50' | 117°30' | June 1 | 2136 | 923 | 290 | 24.8 | | | | | | |
| 53 | 16°51' | 117°30' | 2 | 1026 | 916 | 289 | 24.8 | | | | | | |
| 57 | 16°53' | 117°30' | 2 | 1856 | 423 | 118 | 25.0 | | | | | | |
| 59 | 16°55' | 117°30' | 3 | 1421 | 856 | 309 | 24.9 | | | | | | |
| 60 | 16°52' | 117°28' | 4 | 0956 | 386 | 140 | 24.3 | | | | | | |
| 64 | 16°52' | 117°32' | 4 | 1956 | 445 | 118 | 24.6 | | | | | | |
| 65 | 16°52' | 117°30' | 5 | 0922 | 450 | 49 | 24.5 | | | | | | |
| 70 | 18°40' | 110°56' | 8 | 0956 | 420 | 138 | 24.1 | | | | | | |
| 73 | 18°49' | 111°06' | 8 | 1426 | 785 | 142 | 24.5 | | | | | | |
| 76 | 18°50' | 110°54' | 8 | 1811 | 416 | 137 | 24.2 | | | | | | |
| 79 | 22°58' | 113°10' | 10 | 0527 | 275 | 65 | | | | | | | |
| 80 | 22°52' | 113°11' | 10 | 0646 | 277 | 70 | | | | | | | |
| 82 | 23°04' | 113°13' | 10 | 1056 | 260 | 71 | | | | | | | |
| TUNA SPAWNING SURVEY 1957 | | | | | | | | | | | | | |
| 1 | 29°58' N | 116°42' | July 2 | 0520 | 773 | 319 | 18.1 | | | | | | |
| 2 | 29°00' | 116°30' | 2 | 1235 | 727 | 319 | 19.1 | | | | | | |
| 3 | 28°00' | 116°20' | 2 | 2155 | 818 | 310 | 19.2 | | | | | | |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|----------|----------|---------|-------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 4 | 26°56 | 116°08 | 3 | 0521 | 745 | 316 | 20.0 | | | | | | |
| 5 | 26°06 | 115°58 | 3 | 1210 | 740 | 316 | 21.1 | | | | | | |
| 6 | 25°29 | 115°52 | 3 | 1648 | 355 | 141 | 21.5 | | | | | | |
| 6 | 25°29 | 115°52 | 3 | 1720 | 608 | 0 | 21.5 | | | | | | |
| 7 | 25°12 | 115°48 | 3 | 1935 | 914 | 324 | 21.1 | | | | | | |
| 7 | 25°12 | 115°48 | 3 | 2010 | 344 | 148 | 21.1 | | | | | | |
| 7 | 25°12 | 115°48 | 3 | 2035 | 416 | 0 | 21.1 | | | | | | |
| 8 | 25°00 | 115°48 | 4 | 0745 | 285 | 71 | 21.4 | | | | | | |
| 8 | 25°00 | 115°48 | 4 | 0755 | 865 | 0 | 21.4 | | | | | | |
| 9 | 24°54 | 115°44 | 4 | 0942 | 427 | 67 | 21.6 | | | | | | |
| 9 | 24°54 | 115°44 | 4 | 0918 | 446 | 0 | 21.6 | | | | | | |
| 10 | 24°40 | 115°43 | 4 | 1150 | 702 | 320 | 22.0 | | | | | | |
| 10 | 24°40 | 115°43 | 4 | 1225 | 317 | 142 | 22.0 | | | | | | |
| 10 | 24°40 | 115°43 | 4 | 1243 | 440 | 0 | 22.0 | | | | | | |
| 11 | 24°27 | 115°40 | 4 | 1444 | 334 | 141 | 22.8 | | | | | | |
| 11 | 24°27 | 115°40 | 4 | 1501 | 442 | 0 | 22.8 | | | | | | |
| 12 | 23°48 | 115°37 | 4 | 1923 | 921 | 313 | 23.0 | | | | | | |
| 13 | 22°48 | 115°35 | 5 | -243 | 926 | 314 | 22.9 | | | | | | |
| 14 | 22°02 | 115°32 | 5 | 1004 | 936 | 316 | 23.6 | | | | | | |
| 15 | 21°04 | 115°24 | 5 | 1912 | 910 | 312 | 25.3 | | | | | | |
| 16 | 19°40 | 115°15 | 6 | 0530 | 938 | 316 | 25.6 | | | | | | |
| 17 | 18°38 | 115°06 | 6 | 1315 | 738 | 315 | 26.5 | | | | | | |
| 17 | 18°38 | 115°06 | 6 | 1350 | 345 | 142 | 26.5 | | | | | | |
| 17 | 18°38 | 115°06 | 6 | 1405 | 426 | 0 | 26.5 | | | | | | |
| 18 | 18°19 | 115°03 | 6 | 1730 | 339 | 141 | 26.4 | | | | | | |
| 18 | 18°19 | 115°03 | 6 | 1752 | 518 | 0 | 26.4 | | | | | | |
| 19 | 18°00 | 115°00 | 6 | 2105 | 827 | 317 | 25.9 | | | | | 2 | 2 |
| 19 | 18°00 | 115°00 | 6 | 2138 | 211 | 142 | 25.9 | | | | | | |
| 19 | 18°00 | 115°00 | 6 | 2200 | 522 | 0 | 25.9 | | | | | | |
| 20 | 18°03 | 114°39 | 7 | 0120 | 563 | 139 | 25.2 | | | | | | |
| 20 | 18°03 | 114°39 | 7 | 0136 | 681 | 0 | 25.2 | 1 | | 1 | | | 2 |
| 21 | 18°15 | 114°42 | 7 | 0434 | 706 | 142 | 26.0 | | | | | | |
| 21 | 18°15 | 114°42 | 7 | 0515 | 343 | 0 | 26.0 | | | | | | |
| 21 | 18°15 | 114°42 | 7 | 0532 | 448 | 313 | 26.0 | | | | | | |
| 22 | 18°40 | 114°43 | 8 | 0045 | 337 | 142 | 26.3 | | | | | | |
| 22 | 18°40 | 114°43 | 8 | 0105 | 676 | 0 | 26.3 | | | | | | |
| 23 | 18°42 | 114°22 | 8 | 0321 | 911 | 313 | 26.2 | 1 | | 1 | | 3 | 2 |
| 23 | 18°42 | 114°22 | 8 | 0356 | 331 | 142 | 26.2 | | | 1 | | | 1 |
| 23 | 18°42 | 114°22 | 8 | 0414 | 753 | 0 | 26.2 | 1 | | | | | 1 |
| 24 | 18°22 | 114°22 | 8 | 0658 | 558 | 144 | 26.4 | | | | | | |
| 24 | 18°22 | 114°22 | 8 | 0717 | 584 | 0 | 26.4 | | | | | | |
| 25 | 18°03 | 114°22 | 8 | 0940 | 690 | 320 | 26.3 | | | | | | |
| 25 | 18°03 | 114°22 | 8 | 1025 | 336 | 142 | 26.3 | | | | | | |
| 25 | 18°03 | 114°22 | 8 | 1041 | 477 | 0 | 26.3 | | | | | | |
| 25 | 18°03 | 113°54 | 8 | 1419 | 323 | 140 | 27.9 | | | | | | |
| 26 | 18°08 | 113°54 | 8 | 1435 | 500 | 0 | 27.9 | | | | | | |
| 26 | 18°08 | 113°26 | 8 | 1819 | 754 | 300 | 26.4 | | | | | | |
| 27 | 18°13 | 113°26 | 8 | 1856 | 325 | 139 | 26.4 | | | | | | |
| 27 | 18°13 | 113°26 | 8 | 1913 | 524 | 0 | 26.4 | | | | | | |
| 28 | 18°19 | 112°57 | 8 | 2241 | 301 | 138 | 26.4 | | | | | | |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|----------|----------|---------|-------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 28 | 18°19 | 112°57 | 8 | 2258 | 306 | 0 | 26.4 | | | | | | |
| 29 | 18°26 | 112°28 | 9 | 0230 | 567 | 310 | 26.0 | | | | | | |
| 29 | 18°26 | 112°28 | 9 | 0305 | 304 | 138 | 26.0 | | | | | | |
| 29 | 18°26 | 112°28 | 9 | 0322 | 414 | 0 | 26.0 | | | | | | |
| 30 | 18°42 | 112°28 | 9 | 0527 | 527 | 142 | 25.7 | | | | | | |
| 30 | 18°42 | 112°28 | 9 | 0544 | 490 | 0 | 25.7 | | | | | | |
| 31 | 19°01 | 112°28 | 9 | 0819 | 672 | 309 | 25.8 | | | | | | |
| 31 | 19°01 | 112°28 | 9 | 0858 | 324 | 138 | 25.8 | | | | | | |
| 31 | 19°01 | 112°28 | 9 | 0953 | 407 | 0 | 25.8 | | | | | | |
| 32 | 19°20 | 112°28 | 9 | 1230 | 290 | 132 | 25.7 | | | | | | |
| 32 | 19°20 | 112°28 | 9 | 1301 | 428 | 0 | 25.7 | | | | | | |
| 33 | 19°20 | 112°07 | 9 | 1520 | 636 | 315 | 26.9 | 2 | | 18 | | | 20 |
| 33 | 19°20 | 112°07 | 9 | 1554 | 289 | 139 | 26.9 | | | 7 | | | 7 |
| 34 | 19°04 | 112°07 | 9 | 1611 | 656 | 0 | 26.9 | | | 4 | | | 4 |
| 34 | 19°04 | 112°07 | 9 | 1756 | 244 | 140 | 26.9 | | | | | | |
| 35 | 18°46 | 112°07 | 9-10 | 1815 | 373 | 0 | 26.9 | | | | | | |
| 35 | 18°46 | 112°07 | 10 | 2238 | 390 | 310 | 26.0 | | | 4 | | | 4 |
| 35 | 18°46 | 112°07 | 10 | 0014 | 237 | 139 | 26.0 | | | | | | |
| 36 | 18°26 | 112°06 | 10 | 0032 | 334 | 0 | 26.0 | | | | | | |
| 36 | 18°26 | 112°06 | 10 | 0311 | 257 | 138 | 26.0 | | | | | | |
| 36 | 18°26 | 112°06 | 10 | 0328 | 424 | 0 | 26.0 | | | | | | |
| 37 | 18°26 | 111°46 | 10 | 0603 | 542 | 317 | 26.5 | | | 1 | | | 1 |
| 37 | 18°26 | 111°46 | 10 | 0637 | 296 | 137 | 26.5 | | | | | | |
| 37 | 18°26 | 111°46 | 10 | 0653 | 418 | 0 | 26.5 | | | 3 | | | 3 |
| 38 | 18°46 | 111°45 | 10 | 0928 | 243 | 141 | 26.8 | | | 7 | | | 7 |
| 38 | 18°46 | 111°45 | 10 | 0944 | 380 | 0 | 26.8 | | | 4 | | | 4 |
| 39 | 19°05 | 111°45 | 10 | 1224 | 399 | 312 | 27.6 | | | | | | |
| 39 | 19°05 | 111°45 | 10 | 1300 | 219 | 140 | 27.6 | | | | | | |
| 39 | 19°05 | 111°45 | 10 | 1321 | 388 | 0 | 27.6 | | | | | | |
| 40 | 19°25 | 111°45 | 10 | 1609 | 234 | 139 | 27.4 | 1 | | 22 | | | 23 |
| 40 | 19°25 | 111°45 | 10 | 1626 | 343 | 0 | 27.4 | | | 1 | | | 1 |
| 41 | 19°25 | 111°24 | 10 | 1906 | 386 | 309 | 26.8 | | | | | | |
| 41 | 19°25 | 111°24 | 10 | 1940 | 189 | 141 | 26.8 | | | | | | |
| 41 | 19°25 | 111°24 | 10 | 1957 | 273 | 0 | 26.8 | | | | | | |
| 42 | 19°05 | 111°23 | 10 | 2251 | 424 | 142 | 26.8 | | | 1 | | | 1 |
| 42 | 19°05 | 111°23 | 10 | 2309 | 619 | 0 | 26.8 | | | 16 | | | 16 |
| 43 | 18°45 | 111°23 | 11 | 0144 | 826 | 318 | 26.4 | | | | | | |
| 43 | 18°45 | 111°23 | 11 | 0221 | 394 | 134 | 26.4 | | | 2 | | | 2 |
| 43 | 18°45 | 111°23 | 11 | 0239 | 550 | 0 | 26.4 | | | | | | |
| 44 | 18°26 | 111°21 | 11 | 0509 | 390 | 137 | 26.2 | | | 4 | | | 4 |
| 44 | 18°26 | 111°21 | 11 | 0527 | 682 | 0 | 26.2 | | | 3 | | | 3 |
| 45 | 18°06 | 111°24 | 11 | 0800 | 741 | 319 | 26.7 | | | 8 | | | 8 |
| 45 | 18°06 | 111°24 | 11 | 0835 | 388 | 137 | 26.7 | | | 1 | | | 1 |
| 45 | 18°06 | 111°24 | 11 | 0855 | 584 | 0 | 26.7 | | | 7 | | | 7 |
| 45 | 18°06 | 111°24 | 11 | 0855 | 584 | 0 | 26.7 | | | 5 | | | 5 |
| 46 | 18°06 | 111°03 | 11 | 1131 | 388 | 140 | 28.2 | | | 1 | | | 1 |
| 46 | 18°06 | 111°03 | 11 | 1207 | 509 | 0 | 28.2 | | | 5 | | | 5 |
| 47 | 18°26 | 111°03 | 11 | 1423 | 737 | 316 | 28.8 | | | | | 1 | 1 |
| 47 | 18°26 | 111°03 | 11 | 1458 | 380 | 139 | 28.8 | | | 14 | | | 14 |
| 47 | 18°26 | 111°03 | 11 | 1516 | 539 | 0 | 28.8 | | | 10 | | | 10 |
| 47 | 18°26 | 111°03 | 11 | 1516 | 539 | 0 | 28.8 | | | 350 | | | 350 |
| 48 | 18°47 | 111°07 | 12 | 2244 | 383 | 141 | 26.5 | | | 10 | | | 10 |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|------------------------|----------|---------|-------------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 48 | 18°47' | 111°07' | 12 | 2302 | 506 | 0 | 26.5 | | | 60 | | | 60 |
| 49 | 19°06' | 111°03' | 13 | 0145 | 803 | 317 | 27.2 | | | 12 | | | 12 |
| 49 | 19°06' | 111°03' | 13 | 0220 | 385 | 140 | 27.2 | | | 4 | | | 4 |
| 49 | 19°06' | 111°03' | 13 | 0235 | 510 | 0 | 27.2 | | | | | | |
| 50 | 19°30' | 111°05' | 13 | 0509 | 408 | 136 | 26.7 | | | | | | |
| 50 | 19°30' | 111°05' | 13 | 0526 | 607 | 0 | 26.7 | | | | | | |
| 51 | 19°30' | 110°46' | 13 | 0746 | 815 | 320 | 26.6 | | | | | | |
| 51 | 19°30' | 110°46' | 13 | 0826 | 387 | 141 | 26.6 | | | 1 | | | 1 |
| 51 | 19°30' | 110°46' | 13 | 0840 | 601 | 0 | 26.6 | | | 42 | | | 42 |
| 52 | 19°05' | 110°46' | 13 | 1239 | 382 | 141 | 29.4 | | | | | | |
| 52 | 19°05' | 110°46' | 13 | 1256 | 585 | 0 | 29.4 | | | 32 | | | 32 |
| 53 | 18°45' | 110°46' | 13 | 1450 | 321 | 303 | 29.7 | | | 2 | | | 2 |
| 53 | 18°45' | 110°46' | 13 | 1526 | 386 | 140 | 29.7 | | | 1 | | | 1 |
| 53 | 18°45' | 110°46' | 13 | 1540 | 580 | 0 | 29.7 | | | 500 | | | 500 |
| 54 | 18°26' | 110°45' | 13 | 1805 | 860 | 137 | 29.0 | | | | | | |
| 54 | 18°26' | 110°45' | 13 | 1823 | 651 | 0 | 29.0 | | | | | | |
| 55 | 18°06' | 110°46' | 13 | 2101 | 786 | 316 | 28.2 | 2 | | 12 | | | 14 |
| 55 | 18°06' | 110°46' | 13 | 2138 | 377 | 141 | 28.2 | | | | | | |
| 55 | 18°06' | 110°46' | 13 | 2156 | 534 | 0 | 28.2 | | | 19 | | | 19 |
| 56 | 18°06' | 110°30' | 14 | 0008 | 403 | 136 | 28.4 | | | 12 | | | 12 |
| 56 | 18°06' | 110°30' | 14 | 0025 | 567 | 0 | 28.4 | | | 10 | | | 10 |
| 57 | 18°26' | 110°30' | 14 | 0254 | 839 | 312 | 27.9 | | | 8 | | | 8 |
| 57 | 18°26' | 110°30' | 14 | 0329 | 385 | 141 | 27.9 | | | 14 | | | 14 |
| 57 | 18°26' | 110°30' | 14 | 0346 | 596 | 0 | 27.9 | | | 1100 | | | 1100 |
| 58 | 18°45' | 110°27' | 14 | 0621 | 411 | 140 | 27.8 | | | 20 | | | 20 |
| 58 | 18°45' | 110°27' | 14 | 0640 | 612 | 0 | 27.8 | 1 | | 8 | | | 9 |
| 59 | 19°02' | 110°24' | 14 | 0917 | 763 | 318 | 28.5 | | | 2 | | | 2 |
| 59 | 19°02' | 110°24' | 14 | 0954 | 374 | 141 | 28.5 | | | | | | |
| 59 | 19°02' | 110°24' | 14 | 1013 | 544 | 0 | 28.5 | | | 22 | | | 22 |
| 60 | 19°25' | 110°32' | 14 | 1317 | 397 | 141 | 28.5 | | | | | | |
| 60 | 19°25' | 110°32' | 14 | 1334 | 531 | 0 | 28.5 | | | 4 | | | 4 |
| 61 | 20°00' | 110°35' | 14 | 1716 | 820 | 312 | 27.6 | | | | | | |
| 62 | 20°29' | 110°39' | 14 | 2104 | 796 | 317 | 26.6 | | | | | | |
| 63 | 20°58' | 110°44' | 15 | 0056 | 710 | 313 | 26.5 | | | 24 | | | 24 |
| 64 | 21°27' | 110°57' | 15 | 0542 | 838 | 318 | 26.0 | | | 10 | | | 10 |
| 65 | 21°56' | 111°00' | 15 | 1000 | 831 | 316 | 27.4 | | | 19 | | | 19 |
| 66 | 22°26' | 111°00' | 15 | 1416 | 824 | 313 | 27.7 | | | 8 | | | 8 |
| 67 | 22°43' | 111°06' | 15 | 1835 | 819 | 318 | 25.4 | | | | | | |
| 68 | 23°09' | 111°15' | 15 | 2325 | 364 | 142 | 25.4 | | | | | | |
| 68 | 23°09' | 111°15' | 15 | 2345 | 515 | 0 | 25.4 | | | 8 | | | 8 |
| 69 | 23°39' | 111°38' | 16 | 2006 | 773 | 317 | 25.2 | | | | | | |
| 70 | 23°36' | 111°42' | 16 | 2155 | 500 | 0 | | | | 4 | | 1 | 5 |
| SCOT EXPEDITION | | | 1958 | | | | | | | | | | |
| 1 | 26°53' N | 118°47' | Apr. 25 | 0020 | 1229 | 315 | 18.2 | | | | | | |
| 2 | 25°26' | 119°10' | 25 | 1325 | 1041 | 322 | 19.1 | | | | | | |
| 2 | 25°26' | 119°10' | 25 | 1356 | 571 | 0 | 19.1 | | | | | | |
| 3 | 23°37' | 119°30' | 26 | 0134 | 900 | 322 | 19.8 | | | | | | |
| 3 | 23°37' | 119°30' | 26 | 0200 | 855 | 0 | 19.8 | | | | | | |
| 4 | 23°10' | 119°42' | 26 | 0813 | 905 | 343 | 21.6 | | | | | | |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|----------|----------|---------|-------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 4 | 23°10 | 119°42 | 26 | 0848 | 428 | 0 | 21.6 | | | | | | |
| 4 | 23°10 | 119°42 | 26 | 0918 | 308 | 308 | 21.6 | | | | | | |
| 5 | 21°59 | 118°21 | 27 | 0128 | 317 | 317 | 20.7 | | | | | | |
| 5 | 21°59 | 118°21 | 27 | 0152 | 622 | 0 | 20.7 | | | | | | |
| 6 | 21°13 | 117°23 | 27 | 1224 | 966 | 315 | 21.2 | | | | | | |
| 6 | 21°13 | 117°23 | 27 | 1245 | 345 | 0 | 21.2 | | | | | | |
| 7 | 19°37 | 115°53 | 28 | 0132 | 990 | 317 | 23.1 | | | | | | |
| 7 | 19°37 | 115°53 | 28 | 0155 | 619 | 0 | 23.1 | | | | | | |
| 8 | 18°41 | 114°53 | 28 | 1215 | 946 | 317 | 24.2 | | | | | | |
| 8 | 18°41 | 114°53 | 28 | 1218 | 994 | 0 | 24.2 | | | | | | |
| 9 | 18°23 | 114°47 | 28 | 1619 | 974 | 0 | | | | | | | |
| 9 | 18°23 | 114°47 | 28 | 1625 | 1148 | 0 | | | | | | | |
| 10 | 18°04 | 114°28 | 28 | 2313 | 961 | 305 | | | | | | | |
| 10 | 18°04 | 114°28 | 28 | 2319 | 760 | 0 | | | | | | | |
| 11 | 18°21 | 114°40 | 29 | 0230 | 1030 | 0 | | | | | | | |
| 11 | 18°21 | 114°40 | 29 | 0235 | 1161 | 0 | | | | | | | |
| 12 | 18°32 | 114°50 | 29 | 0600 | 912 | 295 | | | | | | | |
| 12 | 18°32 | 114°50 | 29 | 0606 | 786 | 0 | | | | | | | |
| 13 | 18°09 | 114°32 | 29 | 1158 | 944 | 302 | 24.2 | | | | | | |
| 13 | 18°09 | 114°32 | 29 | 1205 | 1141 | 0 | 24.2 | | | | | | |
| 14 | 16°33 | 113°20 | 30 | 0127 | 904 | 319 | 25.5 | 1 | | | | 1 | |
| 14 | 16°33 | 113°20 | 30 | 0150 | 457 | 0 | 25.5 | | | | | | |
| 15 | 15°28 | 112°23 | 30 | 1216 | 977 | 288 | 27.1 | | | | | | |
| 15 | 15°28 | 112°23 | 30 | 1237 | 361 | 0 | 27.1 | | | | | | |
| 16 | 13°58 | 111°26 | May 1 | 0248 | 990 | 288 | 26.7 | | | | | | |
| 16 | 13°58 | 111°26 | May 1 | 0254 | 989 | 0 | 26.7 | | | | | | |
| 17 | 13°03 | 110°44 | 1 | 1152 | 1001 | 306 | 28.8 | | | | | | |
| 17 | 13°03 | 110°44 | 1 | 1200 | 1019 | 0 | 28.8 | 1 | 1 | | | 7 | 9 |
| 18 | 11°14 | 109°48 | 2 | 0132 | 906 | 306 | 28.7 | | | | | | |
| 18 | 11°14 | 109°48 | 2 | 0140 | 837 | 0 | 28.7 | 1 | | | | | 1 |
| 19 | | Missing | | | | | | | | | | | |
| 20 | 10°18 | 109°27 | 2 | 1709 | 910 | 297 | | | | | | | |
| 20 | 10°18 | 109°27 | 2 | 1714 | 786 | 0 | | 1 | | | | | 1 |
| 21 | 10°17 | 109°14 | 2 | 1956 | 936 | 0 | 29.6 | 1 | | | | | 1 |
| 21 | 10°17 | 109°14 | 2 | 2003 | 827 | 0 | 29.6 | | | | | | |
| 22 | 10°19 | 109°32 | 2 | 0031 | 935 | 278 | 29.0 | | | | | | |
| 22 | 10°19 | 109°32 | 2 | 0050 | 1008 | 0 | 29.0 | 13 | 1 | | | 1 | 15 |
| 24 | 10°18 | 108°57 | 3 | 1445 | 1022 | 235 | | | | | | | |
| 24 | 10°18 | 108°57 | 3 | 1454 | 869 | 0 | | 1 | | | | 1 | 2 |
| 25 | 10°16 | 109°13 | 3 | 1731 | 848 | 311 | 29.7 | | | | | | |
| 25 | 10°16 | 109°13 | 3 | 1743 | 966 | 0 | 29.7 | | | | | | |
| 26 | 10°17 | 109°15 | 3 | 1837 | 963 | 0 | | | | | | | |
| 26 | 10°17 | 109°15 | 3 | 1842 | 902 | 0 | | | | | | | |
| 27 | 10°19 | 109°09 | 3 | 2152 | 920 | 212 | | | | | | | |
| 27 | 10°19 | 109°09 | 3 | 2159 | 723 | 0 | | | | | | | |
| 28 | 10°22 | 106°56 | 4 | 1206 | 860 | 320 | 29.5 | | | | | | |
| 28 | 10°22 | 106°56 | 4 | 1210 | 782 | 0 | 29.5 | | | | | | |
| 29 | 10°18 | 105°18 | 5 | 0139 | 990 | 290 | 29.6 | | | | | | |
| 29 | 10°18 | 105°18 | 5 | 0138 | 1001 | 0 | 29.6 | 6 | 10 | 6 | | | 22 |
| 30 | 10°14 | 103°54 | 5 | 1203 | 871 | 308 | 29.8 | | | | | | |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|----------|----------|---------|-------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 30 | 10°14 | 103°54 | 5 | 1207 | 1074 | 0 | 29.8 | | | | | | |
| 31 | 10°11 | 102°12 | 6 | 0120 | 858 | 274 | 29.7 | | | | | | |
| 31 | 10°11 | 102°12 | 6 | 0125 | 692 | 0 | 29.7 | 2 | | | | | 2 |
| 32 | 10°08 | 100°41 | 6 | 1136 | 943 | 295 | 29.6 | | | | | | |
| 32 | 10°08 | 100°41 | 6 | 1144 | 831 | 0 | 29.6 | | | | | | |
| 33 | 9°54 | 98°40 | 6 | 0116 | 998 | 298 | 30.0 | | | | | | |
| 33 | 9°54 | 98°40 | 6 | 0125 | 807 | 0 | 30.0 | | | | | | |
| 34 | 9°44 | 97°18 | 7 | 1152 | 914 | 302 | 30.0 | | | | | | |
| 35 | 9°45 | 96°04 | 7 | 0343 | 1043 | 256 | | 2 | | | | | 2 |
| 35 | 9°45 | 96°04 | 7 | 0350 | 726 | 0 | | 35 | | | | | 35 |
| 36 | 6°30 | 95°55 | 9 | 0118 | 899 | 310 | 30.0 | | | | | | |
| 36 | 6°30 | 95°55 | 9 | 0132 | 973 | 0 | 30.0 | | | | | | |
| 37 | 5°10 | 95°54 | 9 | 1206 | 968 | 208 | 29.4 | | | | | | |
| 37 | 5°10 | 95°54 | 9 | 1214 | 671 | 0 | 29.4 | 3 | | | | | 3 |
| 38 | 4°15 | 95°52 | 9 | 1913 | 1051 | 266 | 29.1 | | | | | | |
| 38 | 4°15 | 95°52 | 9 | 1920 | 1016 | 0 | 29.1 | | | | | | |
| 42 | 6°36 | 95°57 | 10 | 1156 | 921 | 309 | 29.7 | | | | | | |
| 42 | 6°36 | 95°57 | 10 | 1155 | 622 | 0 | 29.7 | 1 | | | | | 1 |
| 45 | 6°52 | 94°29 | 11 | 1216 | 930 | 312 | 29.8 | | | | | | |
| 45 | 6°52 | 94°29 | 11 | 1223 | 657 | 0 | 29.8 | | | | | | |
| 46 | 7°22 | 92°47 | 12 | 0139 | 978 | 284 | 29.9 | 2 | | 1 | | | 3 |
| 46 | 7°22 | 92°47 | 12 | 0152 | 993 | 0 | 29.9 | 2 | | 4 | | | 8 |
| 47 | 8°02 | 91°32 | 12 | 1226 | 979 | 299 | 29.9 | 1 | | 1 | | | 2 |
| 47 | 8°02 | 91°32 | 12 | 1232 | 739 | 0 | 29.9 | 5 | | 2 | | | 6 |
| 48 | 9°08 | 90°12 | 13 | 0127 | 977 | 279 | 29.4 | | | 1 | | | 2 |
| 48 | 9°08 | 90°12 | 13 | 0139 | 559 | 0 | 29.4 | 16 | | 3 | | | 19 |
| 49 A | 9°49 | 89°15 | 13 | 1432 | 868 | 346 | 28.5 | | | 11 | | | 11 |
| 49 | 9°49 | 89°15 | 13 | 1440 | 600 | 0 | 28.5 | | | 160 | | | 160 |
| 49 B | 9°49 | 89°15 | 13 | 1950 | 966 | 302 | 28.5 | | | | | | |
| 49 | 9°49 | 89°15 | 13 | 2001 | 600 | 0 | 28.5 | | | 19 | | | 19 |
| 50 | 7°42 | 88°08 | 14 | 1211 | 946 | 301 | 29.7 | | | | | | |
| 50 | 7°42 | 88°08 | 14 | 1219 | 537 | 0 | 29.7 | | | | | | |
| 51 | 5°32 | 87°22 | 15 | 0136 | 956 | 306 | 29.0 | | | | | | |
| 51 | 5°32 | 87°22 | 15 | 0144 | 468 | 0 | 29.0 | | | | | | |
| 52 | 5°32 | 87°05 | 15 | 0538 | 966 | 280 | 29.1 | | | | | 1 | 1 |
| 52 | 5°32 | 87°05 | 15 | 0546 | 566 | 0 | 29.1 | | | | | | |
| 53 | 5°32 | 87°05 | 15 | 0925 | 1093 | 45-63 | | | | | | | |
| 53 | 5°32 | 87°05 | 15 | 0935 | 573 | 0 | | 1 | | | | | 1 |
| 54 | 5°33 | 87°23 | 15 | 1944 | 992 | 280 | 29.0 | | | | | | |
| 54 | 5°33 | 87°23 | 15 | 1950 | 577 | 0 | 29.0 | 1 | | | | | 1 |
| 55 | 5°34 | 87°06 | 15 | 0042 | 1078 | 36-60 | | | | | | 2 | 2 |
| 55 | 5°34 | 87°06 | 15 | 0050 | 563 | 0 | | | | | | | |
| 56 A | 5°30 | 86°25 | 16 | 0359 | 970 | 276 | 29.0 | | | | | 1 | 1 |
| 56 | 5°30 | 86°25 | 16 | 0405 | 578 | 0 | 29.0 | | | | | | |
| 56 B | 5°32 | 86°05 | 16 | 1351 | 883 | 281 | 29.0 | | | | | | |
| 56 | 5°32 | 86°05 | 16 | 1405 | 573 | 0 | 29.0 | | | | | | |
| 57 | 5°32 | 85°05 | 17 | 0130 | 887 | 293 | | 1 | | 1 | | | 2 |
| 57 | 5°32 | 85°05 | 17 | 0139 | 520 | 0 | | 3 | | 1 | | | 4 |
| 58 | 5°34 | 83°26 | 17 | 1214 | 1050 | 248 | 27.8 | | | | | | |
| 58 | 5°34 | 83°26 | 17 | 1220 | 723 | 0 | 27.8 | | | | | 3 | 3 |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total | |
|----------|----------|---------|-------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|-----|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total | |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | | |
| 59 | 5°34 | 81°29 | 18 | 0122 | 1049 | 253 | 28.9 | | | | | | | |
| 59 | 5°34 | 81°29 | 18 | 0134 | 688 | 0 | 28.9 | | | | | | | |
| 60 | 5°31 | 79°55 | 18 | 1210 | 970 | 297 | 27.0 | | | 8 | | | | 8 |
| 60 | 5°31 | 79°55 | 18 | 1220 | 562 | 0 | 27.0 | | | 13 | | | | 13 |
| 61 | 5°30 | 77°57 | 19 | 0228 | 1039 | 259 | 27.4 | | | | | | | |
| 61 | 5°30 | 77°57 | 19 | 0228 | 669 | 0 | 27.4 | | | | | | | |
| 62 | 5°28 | 77°46 | 19 | 1016 | 981 | 301 | 27.4 | | | | | | | |
| 62 | 5°28 | 77°46 | 19 | 1026 | 544 | 0 | 27.4 | | | | | | | |
| 69 | 6°42 | 81°14 | 24 | 0141 | 999 | 293 | 28.4 | | | 2 | | | | 2 |
| 69 | 6°42 | 81°14 | 24 | 0146 | 686 | 0 | 28.4 | | | | | | | |
| 70 | 7°15 | 82°41 | 24 | 1206 | 1004 | 261 | 29.1 | | | 14 | | | | 14 |
| 70 | 7°15 | 82°41 | 24 | 1210 | 917 | 0 | 29.1 | | | | | | | |
| 71 | 8°28 | 84°21 | 25 | 0032 | 933 | 304 | 29.5 | | | | | 1 | | 5 |
| 71 | 8°28 | 84°21 | 25 | 0041 | 1023 | 0 | 29.5 | 4 | | | | | | |
| 72 | 9°30 | 85°52 | 26 | 1154 | 917 | 309 | 29.3 | 30 | | 16 | 1 | | | 47 |
| 72 | 9°30 | 85°52 | 26 | 1203 | 783 | 0 | 29.3 | | | | | | 1 | 3 |
| 73 | 10°36 | 87°29 | 26 | 0120 | 930 | 288 | 28.9 | | | | | | | |
| 73 | 10°36 | 87°29 | 26 | 0126 | 459 | 0 | 28.9 | 2 | | | | | | |
| 74 | 11°27 | 88°45 | 26 | 1307 | 1226 | 203 | 29.7 | 1 | | | | | | 1 |
| 74 | 11°27 | 88°45 | 26 | 1213 | 908 | 0 | 29.7 | 11 | | | | | | 11 |
| 75 | 12°22 | 90°06 | 27 | 0128 | 206 | 273 | 29.9 | 32 | | 9 | | 1 | | 42 |
| 75 | 12°22 | 90°06 | 27 | 0135 | 566 | 0 | 29.9 | | | | | | | |
| 76 | 13°16 | 91°24 | 27 | 1140 | 809 | 295 | 31.1 | 340 | | 40 | | | | 380 |
| 76 | 13°16 | 91°24 | 27 | 1158 | 858 | 0 | 31.1 | | | | | | | |
| 77 | 14°12 | 92°47 | 28 | 0023 | 811 | 293 | 31.0 | | | | | | | |
| 77 | 14°12 | 92°47 | 28 | 0030 | 550 | 0 | 31.0 | | | | | | | |
| 78 | 14°14 | 93°48 | 28 | 0849 | 860 | 280 | 30.7 | | | 25 | | | | 45 |
| 78 | 14°14 | 93°48 | 28 | 0856 | 851 | 0 | 30.7 | | | | | | | |
| 79 | 14°38 | 93°52 | 28 | 1204 | 788 | 322 | 30.3 | 4 | | 10 | | | | 4 |
| 79 | 14°38 | 93°52 | 28 | 1215 | 851 | 0 | 30.3 | | | 2 | | | | 2 |
| 80 | 15°14 | 93°46 | 28 | 1827 | 464 | 152 | 30.0 | | | | | | | |
| 80 | 15°14 | 93°46 | 28 | 1805 | 487 | 0 | 30.0 | | | | | | | |
| 81 | 15°37 | 94°21 | 28 | 0026 | 828 | 288 | 29.4 | | | 4 | | | | 4 |
| 81 | 15°37 | 94°21 | 28 | 0033 | 814 | 0 | 29.4 | 9 | | 15 | | | | 24 |
| 82 | 15°48 | 94°53 | 29 | 0840 | 674 | 92 | 28.5 | | | | | | | |
| 83 | 15°20 | 94°55 | 29 | 1229 | 859 | 266 | 27.9 | | | | | | | |
| 83 | 15°20 | 94°55 | 29 | 1235 | 711 | 0 | 27.9 | | | | | | | |
| 84 | 14°41 | 94°56 | 29 | 1756 | 1050 | 238 | 27.9 | | | 5 | | | | 5 |
| 84 | 14°41 | 94°56 | 29 | 1803 | 561 | 0 | 27.9 | | 1 | 60 | | 4 | | 65 |
| 85 | 14°12 | 95°00 | 29 | 2312 | 936 | 302 | 29.5 | | | 12 | | | | 12 |
| 85 | 14°12 | 95°00 | 29 | 2318 | 734 | 0 | 29.5 | 35 | | 15 | | | | 50 |
| 86 | 14°14 | 95°51 | 30 | 0903 | 855 | 297 | 29.0 | | | | | | | |
| 86 | 14°14 | 95°51 | 30 | 0910 | 505 | 0 | 29.0 | 3 | | | | | | 3 |
| 87 | 13°46 | 96°08 | 30 | 1612 | 937 | 261 | 31.0 | 1 | | 8 | | | | 9 |
| 87 | 13°46 | 96°08 | 30 | 1620 | 587 | 0 | 31.0 | 1 | | 3 | | | | 4 |
| 88 | 15°11 | 96°55 | 31 | 0933 | 887 | 269 | 29.8 | | | 1 | | | | 1 |
| 88 | 15°11 | 96°55 | 31 | 0939 | 756 | 0 | 29.8 | | | | | | | |
| 89 | 15°12 | 96°04 | 31 | 1706 | 960 | 295 | 30.7 | 1 | | | | | | 1 |
| 89 | 15°12 | 96°04 | 31 | 1712 | 360 | 0 | 30.7 | 1 | | 1 | | 3 | | 2 |
| 90 | 15°15 | 95°23 | 31 | 2210 | 858 | 272 | 30.4 | | | 81 | | | | 84 |

SPAWNING OF TUNAS

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Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|----------|----------|---------|-------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 90 | 15°15' | 95°23' | 31 | 2218 | 817 | 0 | 30.4 | 15 | | 607 | 11 | | 633 |
| 91 | 14°41' | 95°20' | 1 | 0240 | 856 | 282 | 30.2 | | | 17 | | | 17 |
| 91 | 14°41' | 95°20' | 1 | 0249 | 539 | 0 | 30.2 | | | 35 | | 2 | 37 |
| 92 | 14°40' | 96°08' | 1 | 0955 | 962 | 260 | 30.1 | 3 | | 1 | | | 4 |
| 92 | 14°40' | 96°08' | 1 | 1010 | 1671 | 0 | 30.1 | 2 | | 1 | | | 3 |
| 93 | 14°18' | 96°22' | 1 | 1243 | 976 | 248 | 30.6 | | | 5 | | | 5 |
| 93 | 14°18' | 96°22' | 1 | 1249 | 707 | 0 | 30.6 | 3 | | | | | 3 |
| 93 | 14°18' | 96°22' | 1 | 1810 | 837 | 284 | 30.1 | | | 12 | | | 12 |
| 94 | 13°57' | 96°49' | 1 | 1816 | 768 | 0 | 30.1 | 5 | | 6 | | | 11 |
| 94 | 13°57' | 96°49' | 2 | 1200 | 979 | 301 | 30.0 | | | | | | |
| 95 | 15°36' | 98°43' | 2 | 1210 | 867 | 0 | 30.0 | 4 | | 1 | | | 5 |
| 95 | 15°36' | 98°43' | 2 | 2324 | 427 | 145 | 28.8 | | | 23 | | 13 | 36 |
| 96 | 16°39' | 100°05' | 2 | 2325 | 583 | 0 | 28.8 | 1 | | 159 | 1 | 3 | 164 |
| 96 | 16°39' | 100°05' | 2 | 0253 | 380 | 137 | 30.1 | 1 | | 1 | | | 2 |
| 99 | 16°25' | 100°25' | 6 | 0253 | 398 | 0 | 30.1 | 3 | | 9 | | | 12 |
| 99 | 16°25' | 100°25' | 6 | 0251 | 829 | 270 | 30.1 | | | | | | |
| 100 | 16°04' | 100°44' | 6 | 0811 | 969 | 0 | 30.1 | 1 | | | | | 1 |
| 100 | 16°04' | 100°44' | 6 | 0816 | 969 | 0 | 30.1 | | | | | | |
| 101 | 15°35' | 100°49' | 6 | 1552 | 356 | 156 | 30.3 | | | | | | |
| 101 | 15°35' | 100°49' | 6 | 1613 | 472 | 0 | 30.3 | 1 | | | | | 1 |
| 102 | 17°24' | 101°25' | 7 | 0444 | 397 | 127 | 29.6 | | | | | | |
| 102 | 17°24' | 101°25' | 7 | 0444 | 537 | 0 | 29.6 | 1 | | | 4 | 6 | 11 |
| 103 | 17°07' | 100°59' | 7 | 0850 | 455 | 104 | 29.9 | | | | | | 4 |
| 103 | 17°07' | 100°59' | 7 | 0854 | 552 | 0 | 29.9 | 1 | | | 7 | | 8 |
| 103 | 17°07' | 100°59' | 7 | 0854 | 552 | 0 | 29.7 | | | | 3 | | 3 |
| 104 | 17°03' | 101°26' | 7 | 1235 | 888 | 243 | 29.7 | 4 | | | 26 | | 30 |
| 104 | 17°03' | 101°26' | 7 | 1239 | 720 | 0 | 29.7 | 1 | | | 2 | | 3 |
| 105 | 16°36' | 101°50' | 7 | 1846 | 401 | 130 | 30.0 | 1 | | | | | 3 |
| 105 | 16°36' | 101°50' | 7 | 1847 | 629 | 0 | 30.0 | 3 | | | 1 | | 4 |
| 106 | 16°19' | 102°12' | 7 | 2155 | 347 | 132 | 29.7 | 1 | | | 7 | | 8 |
| 106 | 16°19' | 102°12' | 7 | 2158 | 417 | 0 | 29.7 | | | | 30 | | 30 |
| 107 | 17°40' | 101°45' | 8 | 0449 | 388 | 113 | 29.4 | | | | | | |
| 107 | 17°40' | 101°45' | 8 | 0453 | 398 | 0 | 29.4 | 8 | | | 1 | | 9 |
| 108 | 17°50' | 102°22' | 8 | 0731 | 415 | 115 | 28.4 | | | | | | |
| 108 | 17°50' | 102°22' | 8 | 0750 | 236 | 0 | 28.4 | | | | 1 | | 1 |
| 109 | 17°56' | 102°48' | 8 | 1207 | 878 | 243 | 28.5 | | | | | | |
| 109 | 17°56' | 102°48' | 8 | 1212 | 1122 | 0 | 28.5 | | | | 2 | | 2 |
| 110 | 17°36' | 103°08' | 8 | 1624 | 360 | 141 | 29.5 | | | | | | |
| 110 | 17°36' | 103°08' | 8 | 1626 | 337 | 0 | 29.5 | 1 | | | 3 | | 4 |
| 111 | 17°15' | 103°25' | 8 | 1947 | 480 | 118 | 29.3 | 3 | | | 1 | | 4 |
| 111 | 17°15' | 103°25' | 8 | 1950 | 666 | 0 | 29.3 | 9 | | | 1 | | 10 |
| 112 | 16°54' | 103°41' | 8 | 2330 | 471 | 108 | 28.8 | 1 | | | | | 1 |
| 112 | 16°54' | 103°41' | 8 | 2336 | 818 | 0 | 28.8 | 3 | | | 2 | | 5 |
| 117 | 16°18' | 104°14' | 11 | 1752 | 436 | 117 | 28.4 | | | | | | |
| 117 | 16°18' | 104°14' | 11 | 1756 | 391 | 0 | 28.4 | 3 | | | | | 3 |
| 118 | 16°37' | 104°37' | 11 | 2218 | 435 | 130 | 28.0 | | | | | | |
| 118 | 16°37' | 104°37' | 11 | 2220 | 398 | 0 | 28.0 | 8 | | | 1 | | 9 |
| 119 | 16°40' | 105°07' | 12 | 0138 | 575 | 167 | 27.4 | | | | | | |
| 119 | 16°40' | 105°07' | 12 | 0140 | 440 | 0 | 27.4 | 5 | | | 3 | | 8 |
| 120 | 17°03' | 105°36' | 12 | 0454 | 390 | 134 | 27.4 | 1 | | | | | 1 |
| 120 | 17°03' | 105°36' | 12 | 0456 | 389 | 0 | 27.4 | | | | | | |
| 121 | 17°27' | 105°22' | 12 | 0827 | 513 | 97 | 27.3 | 4 | | | | 1 | 5 |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|----------------|----------|---------|---------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 121 | 17°27 | 105°32 | 12 | 0830 | 668 | 0 | 27.3 | 15 | | 3 | | | 18 |
| 122 | 17°51 | 105°09 | 12 | 1249 | 862 | 275 | 28.3 | | | 1 | | | 1 |
| 122 | 17°51 | 105°09 | 12 | 1254 | 936 | 0 | 28.3 | 3 | | | | | 3 |
| 123 | 18°18 | 104°45 | 12 | 1841 | 404 | 136 | 28.6 | | | | | | |
| 123 | 18°18 | 104°45 | 12 | 1847 | 464 | 0 | 28.6 | 18 | | | | | 19 |
| 124 | 18°44 | 104°21 | 13 | 2300 | 431 | 119 | 28.1 | | | | | | |
| 124 | 18°44 | 104°21 | 13 | 2221 | 460 | 0 | 28.1 | | | 5 | 1 | | 6 |
| 125 | 19°03 | 104°45 | 13 | 0232 | 332 | 144 | 29.0 | | | | | | |
| 125 | 19°03 | 104°45 | 13 | 0234 | 423 | 0 | 29.0 | 1 | | | | | 1 |
| 126 | 19°20 | 105°10 | 13 | 0650 | 375 | 133 | 29.0 | | | | | | |
| 126 | 19°20 | 105°10 | 13 | 0700 | 462 | 0 | 29.0 | | | 4 | | | 4 |
| 127 | 19°01 | 105°35 | 13 | 1214 | 957 | 310 | 28.5 | 2 | | | | | 2 |
| 127 | 19°01 | 105°35 | 13 | 1211 | 676 | 0 | 28.5 | 2 | | 1 | | | 3 |
| 128 | 18°41 | 106°00 | 13 | 1644 | 388 | 124 | 28.5 | 1 | | | | | 1 |
| 128 | 18°41 | 106°00 | 13 | 1645 | 457 | 0 | 28.5 | 4 | | | | | 4 |
| 129 | 18°28 | 106°28 | 13 | 2043 | 362 | 141 | 27.8 | 1 | | | | | 1 |
| 129 | 18°28 | 106°28 | 13 | 2024 | 721 | 0 | 27.8 | 3 | | 12 | | | 15 |
| 130 | 18°11 | 106°55 | 14 | 0012 | 345 | 131 | 27.1 | | | | | | |
| 130 | 18°11 | 106°55 | 14 | 0014 | 321 | 0 | 27.1 | 2 | | 3 | | | 5 |
| 131 | 18°38 | 107°13 | 14 | 0456 | 361 | 147 | 26.0 | 1 | | 2 | | | 3 |
| 131 | 18°38 | 107°13 | 14 | 0458 | 523 | 0 | 26.0 | 1 | | | | | 1 |
| 132 | 19°07 | 107°26 | 14 | 0822 | 440 | 118 | 26.8 | 1 | | | | | 1 |
| 132 | 19°07 | 107°26 | 14 | 0825 | 419 | 0 | 26.8 | 5 | | | | | 6 |
| 133 | 19°37 | 107°37 | 14 | 1213 | 724 | 297 | 27.9 | | | | | | |
| 133 | 19°37 | 107°37 | 14 | 1220 | 943 | 0 | 27.9 | 1 | | | | | 1 |
| 134 | 20°02 | 107°41 | 14 | 1755 | 378 | 146 | 27.9 | | | | | | |
| 134 | 20°02 | 107°41 | 14 | 1758 | 444 | 0 | 27.9 | 2 | | 2 | | | 4 |
| 135 | 20°15 | 107°14 | 14 | 2040 | 440 | 126 | 27.7 | 1 | | 3 | | | 4 |
| 135 | 20°15 | 107°14 | 14 | 2042 | 487 | 0 | 27.7 | 23 | | 26 | | | 49 |
| 136 | 20°26 | 106°47 | 15 | 0112 | 356 | 126 | 28.9 | 9 | | 29 | | | 38 |
| 136 | 20°26 | 106°47 | 15 | 0113 | 493 | 0 | 28.9 | 16 | | 73 | | | 89 |
| 137 | 20°37 | 106°20 | 15 | 0455 | 335 | 142 | 28.1 | | | | | | |
| 137 | 20°37 | 106°20 | 15 | 0458 | 469 | 0 | 28.1 | 2 | | 2 | | | 4 |
| 138 | 20°50 | 105°59 | 15 | 0755 | 552 | 117 | 28.4 | 4 | | 7 | | | 11 |
| 138 | 20°50 | 105°59 | 15 | 0757 | 440 | 0 | 28.4 | 9 | | 10 | | | 19 |
| 139 | 21°05 | 106°16 | 15 | 1213 | 736 | 301 | 28.8 | 4 | | 5 | | | 9 |
| 139 | 21°05 | 106°16 | 15 | 1219 | 1032 | 0 | 28.8 | 4 | | 12 | | | 16 |
| 140 | 21°22 | 106°36 | 15 | 1635 | 356 | 134 | 29.3 | 1 | | 6 | | | 7 |
| 140 | 21°22 | 106°36 | 15 | 1637 | 471 | 0 | 29.3 | 9 | | | | | 9 |
| 143 | 22°18 | 108°32 | 16 | 1159 | 938 | 292 | 27.7 | 1 | | | | | 1 |
| 143 | 22°18 | 108°32 | 16 | 1209 | 735 | 0 | 27.7 | 3 | | | | 1 | 4 |
| 145 | 23°52 | 111°30 | 17 | 1146 | 370 | 118 | 22.4 | | | | | | |
| 145 | 23°52 | 111°30 | 17 | 1148 | 478 | 0 | 22.4 | | | | | | |
| 147 | 26°38 | 114°10 | 18 | 1155 | 927 | 294 | 16.1 | | | | | | |
| 147 | 26°38 | 114°10 | 18 | 1201 | 650 | 0 | 16.1 | | | | | | |
| TO-58-2 — 1958 | | | | | | | | | | | | | |
| 2 | 13°37 N | 92°56.8 | Nov. 22 | 0800 | 714 | 334 | 29.0 | | | 1 | | | 1 |
| 3 | 14°22 | 93°07 | 22 | 1750 | 1002 | 288 | 29.7 | 1 | | 8 | | | 9 |
| 4 | 14°56.5 | 93°06.5 | 23 | 0045 | 999 | 0 | 30.2 | | | 18 | 11 | | 29 |

SPAWNING OF TUNAS

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Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|-----------------------|----------|----------|---------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 5 | 15°39 | 93°59.5 | 23 | 0825 | 455 | 26 | 28.3 | | | 7 | 1 | | 8 |
| 6 | 14°59.5 | 94°01.5 | 23 | 1413 | 963 | 101 | 28.0 | | | | | | 13 |
| 7 | 14°21.5 | 94°02 | 23 | 1948 | 1412 | 200 | 28.0 | | | 9 | | | 9 |
| 8 | 13°41.5 | 94°04 | 24 | 0153 | 930 | 276 | 28.3 | | | 13 | | | 13 |
| 8 | 13°41.5 | 94°04 | 24 | 0341 | 1077 | 0 | 28.3 | 1 | | 496 | | | 497 |
| 9 | 13°39 | 94°52 | 24 | 1035 | 1093 | 271 | 27.6 | | | 2 | | | 2 |
| 10 | 14°18 | 95°02.8 | 24 | 2335 | 370 | 238 | 27.3 | 1 | | 21 | | | 22 |
| 10 | 14°18 | 95°02.8 | 24 | 0015 | 810 | 0 | 27.3 | 2 | | 30 | 1 | | 33 |
| 11 | 15°02 | 95°07.5 | 25 | 1713 | 1150 | 239 | 25.3 | | | | 1 | | 1 |
| 14 | 15°36 | 94°55 | 28 | 0544 | 1414 | 261 | 26.0 | | | 4 | | | 4 |
| 15 | 14°55 | 95°59 | 28 | 1100 | 1493 | 248 | 26.6 | | | 9 | | | 9 |
| 15-1 | 14°55 | 95°59 | 29 | 0130 | 922 | 0 | 26.6 | | | 9 | | | 9 |
| 16 | 14°18 | 96°04 | 29 | 0420 | 1075 | 259 | 26.4 | 1 | | 13 | | | 14 |
| 18 | 13°45 | 97°09 | 29 | 1725 | 1649 | 182 | 29.1 | 2 | | 2 | | 1 | 5 |
| 19 | 14°21 | 97°01 | 29 | 2345 | 1325 | 247 | 28.2 | | | 15 | | | 18 |
| 19 | 14°21 | 97°01 | 30 | 0020 | 717 | 0 | 28.2 | | | 393 | 24 | | 417 |
| 21 | 15°40 | 96°53 | 30 | 1845 | 451 | 109 | 27.2 | | | | | | 17 |
| 22 | 15°31 | 97°44 | 30 | 2325 | 1163 | 266 | 28.8 | 1 | | 11 | 5 | | 17 |
| 22 | 15°31 | 97°44 | Dec. 1 | 0010 | 706 | 0 | 28.8 | | | 40 | 15 | | 55 |
| 23 | 15°36 | 99°23.5 | 1 | 1110 | 978 | 325 | 30.0 | | | 1 | 1 | | 2 |
| 24 | 16°01.5 | 100°54 | 1 | 2300 | 1186 | 288 | 29.4 | | | 1 | | | 2 |
| 24 | 16°01.5 | 100°54 | 1 | 2345 | 459 | 0 | 29.4 | 10 | | 8 | | | 18 |
| 25 | 16°58.5 | 102°28 | 2 | 1109 | 1086 | 267 | 29.1 | | | | | | 2 |
| 26 | 17°54 | 104°06 | 2 | 2300 | 1036 | 319 | 28.7 | | | 2 | | | 2 |
| 26 | 17°54 | 104°06 | 2 | 2350 | 810 | 0 | 28.7 | 9 | | 53 | | | 62 |
| 27 | 25°54.5 | 113°07.5 | 5 | 1845 | 527 | 93 | 22.7 | | | | | | 2 |
| 28 | 25°35 | 113°25 | 5 | 2130 | 599 | 119 | 23.4 | | | | | | 2 |
| 29 | 25°39 | 113°31.5 | 5 | 2245 | 586 | 124 | 22.5 | | | | | 1 | 1 |
| 30 | 25°34 | 113°45.5 | 6 | 0015 | 571 | 123 | 22.0 | | | 9 | | | 9 |
| TO-59-1 — 1959 | | | | | | | | | | | | | |
| 1 | 28°38 N | 115°37 | Jan. 16 | 2215 | 172 | 144 | 17.6 | | | | | | |
| 2 | 27°12 | 114°40 | Jan. 17 | 1242 | 421 | 131 | 19.5 | | | | | | |
| 3 | 26°30 | 113°36.5 | 17 | 2217 | 390 | 0 | 20.0 | | | | | | |
| 4 | 25°05 | 112°55 | 18 | 1307 | 501 | 126 | 22.0 | | | | | | |
| 5 | 24°18 | 112°01 | 18 | 1307 | 549 | 0 | 23.1 | | | | | | |
| 6 | 23°13 | 110°41 | 19 | 1228 | 1065 | 208 | 23.2 | | | | | | |
| 7 | 22°25 | 109°14 | 19 | 2244 | 617 | 0 | 24.4 | | | | | | |
| 8 | 21°17 | 108°16 | 20 | 1153 | 1083 | 287 | 24.4 | | | | | | |
| 9 | 20°31.5 | 107°17 | 20 | 2205 | 1069 | 288 | 25.1 | | | 4 | | | 4 |
| 9 | 20°31.5 | 107°17 | 20 | 2245 | 717 | 0 | 25.1 | | | 28 | | | 28 |
| 10 | 19°35.5 | 106°03 | 21 | 1205 | 921 | 287 | 25.4 | | | | | | |
| 11 | 19°04 | 104°41 | 21 | 2220 | 745 | 273 | 27.3 | | | | | | |
| 11 | 19°04 | 104°41 | 21 | 2257 | 1084 | 0 | 27.3 | | | 3 | | | 3 |
| 12 | 18°10 | 103°26 | 22 | 1209 | 1033 | 310 | 27.4 | | | 1 | | | 2 |
| 13 | 15°29.5 | 98°32.5 | 27 | 0025 | 1083 | 278 | 28.3 | 1 | | 71 | 4 | | 87 |
| 13 | 15°29.5 | 98°32.5 | 27 | 0100 | 687 | 0 | 28.3 | 56 | | 463 | 4 | | 523 |
| 14 | 14°40 | 97°44 | 27 | 1200 | 1051 | 297 | 26.9 | | | | | | |
| 15 | 13°39 | 97°05.5 | 28 | 0011 | 1047 | 278 | 26.2 | | | 8 | | | 8 |
| 15 | 13°39 | 97°05.5 | 28 | 0046 | 588 | 0 | 26.2 | | | 443 | 22 | | 465 |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|----------|----------|----------|--------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 16 | 14°08 | 97°14 | 28 | 0645 | 986 | 303 | 28.0 | | | 5 | | | 5 |
| 17 | 15°00 | 97°02 | 28 | 1506 | 1005 | 289 | 29.0 | | | 4 | | | 4 |
| 18 | 15°45 | 97°05.5 | 28 | 2145 | 1010 | 304 | 27.9 | | | | | | |
| 18 | 15°45 | 97°05.5 | 28 | 2220 | 585 | 0 | 27.9 | | | | | | |
| 19 | 15°33 | 96°02 | 29 | 0909 | 486 | 129 | 27.0 | | | | | | |
| 20 | 15°00 | 96°06.5 | 29 | 1434 | 1045 | 306 | 28.3 | | | | | | |
| 21 | 14°19.5 | 96°03 | 29 | 2036 | 998 | 300 | 26.0 | | | | | | |
| 21 | 14°19.5 | 96°03 | 29 | 2112 | 365 | 0 | 26.0 | | | | | | |
| 22 | 13°47 | 95°51 | 30 | 0450 | 752 | 308 | 26.5 | | | 1 | | | 1 |
| 23 | 13°49 | 94°57 | 30 | 1155 | 981 | 308 | 27.2 | | | | | | |
| 24 | 14°14 | 95°05.5 | 30 | 2213 | 1054 | 295 | 26.7 | | | 12 | | | 12 |
| 24 | 14°14 | 95°05.5 | 30 | 2250 | 582 | 0 | 26.7 | | | 19 | | | 19 |
| 24-17 | 14°19 | 95°00 | Feb. 4 | 2325 | 640 | 0 | 26.9 | | | | | | |
| 25 | 15°06 | 95°01 | 5 | 2105 | 875 | 300 | 28.3 | | | 5 | | | 5 |
| 25 | 15°06 | 95°01 | 5 | 2140 | 667 | 0 | 28.3 | | | | | | |
| 26 | 14°47 | 93°48.5 | 6 | 2313 | 469 | 141 | 27.5 | | | 2 | | | 2 |
| 26 | 14°47 | 93°48.5 | 6 | 2330 | 617 | 0 | 27.5 | | | 9 | | | 9 |
| 27 | 14°01 | 92°23 | 7 | 1149 | 449 | 131 | 28.3 | | | | | | |
| 28 | 12°41 | 91°35 | 7 | 2204 | 963 | 309 | 27.5 | | | 2 | | | 2 |
| 28 | 12°41 | 91°35 | 7 | 2245 | 617 | 0 | 27.5 | | | 15 | | | 15 |
| 29 | 11°40 | 90°53 | 7 | 1210 | 962 | 320 | 26.4 | | | | | | |
| 30 | 8°10 | 88°06.5 | 10 | 0803 | 656 | 308 | 28.1 | 1 | | | | | 1 |
| 31 | 8°36 | 88°16 | 10 | 1834 | 1075 | 289 | 28.4 | | | | | | |
| 32 | 8°58 | 88°22 | 10 | 2244 | 995 | 291 | 27.9 | 2 | | | | | 2 |
| 32 | 8°58 | 88°22 | 10 | 2320 | 547 | 0 | 27.9 | 9 | 6 | | | | 15 |
| 33 | 9°49 | 88°32 | 11 | 0833 | 294 | 300 | 27.1 | | | | | | |
| 34 | 11°07 | 88°07 | 12 | 2304 | 1037 | 303 | 25.3 | 4 | 1 | | | | 5 |
| 34 | 11°07 | 88°07 | 12 | 2338 | 415 | 0 | 25.3 | 26 | | 4 | | | 30 |
| 35 | 12°06 | 89°36 | 13 | 1235 | 1227 | 243 | 25.7 | 1 | | 8 | | | 9 |
| 36 | 13°01 | 91°03 | 13 | 2302 | 1087 | 301 | 26.7 | | | 8 | | | 8 |
| 36 | 13°01 | 91°03 | 13 | 2238 | 665 | 0 | 26.7 | 4 | | 48 | | 1 | 53 |
| 37 | 14°12 | 92°35 | 14 | 1427 | 481 | 128 | 28.5 | | | | | | |
| 38 | 15°00 | 93°00 | 14 | 2334 | 287 | 0 | 28.5 | | | 1 | | | 1 |
| 39 | 15°37 | 95°58 | 15 | 2206 | 712 | 0 | 28.5 | | | | | | |
| 40 | 15°51 | 93°58 | 16 | 1200 | 1023 | 313 | 27.8 | | | | | | |
| 41 | 16°23 | 99°28 | 16 | 2208 | 992 | 304 | 28.6 | | | | | | |
| 41 | 16°23 | 99°28 | 16 | 2242 | 683 | 0 | 28.6 | | | 69 | | | 69 |
| 42 | 16°42.5 | 100°12 | 17 | 0913 | 871 | 275 | 28.4 | 6 | | 14 | | 8 | 28 |
| 43 | 17°14.5 | 101°37 | 17 | 2208 | 980 | 304 | 28.4 | | | 6 | | | 6 |
| 43 | 17°14.5 | 101°37 | 17 | 2240 | 644 | 0 | 28.4 | | | | | | |
| 44 | 17°47 | 103°14 | 18 | 1150 | 948 | 301 | 27.2 | | | 220 | | | 220 |
| 45 | 18°34 | 104°19.5 | 18 | 2207 | 1087 | 317 | 26.5 | | | 10 | | | 10 |
| 45 | 18°34 | 104°19.5 | 18 | 2240 | 466 | 0 | 26.5 | 1 | | 13 | | | 13 |
| 46 | 19°46 | 105°44 | 19 | 1239 | 1005 | 303 | 24.3 | | | 92 | | | 93 |
| 46 | 19°46 | 105°44 | 19-20 | 2338 | 965 | 313 | 24.3 | | | | | | |
| 46 | 19°46 | 105°44 | 20 | 0015 | 519 | 0 | 24.3 | | | 10 | | | 10 |
| 47 | 20°41 | 107°10 | 20 | 1205 | 1000 | 297 | 24.6 | | | 67 | | 5 | 72 |
| 48 | 21°35.5 | 108°25 | 20 | 2208 | 1036 | 312 | 24.4 | | | | | | |
| 48 | 21°35.5 | 108°25 | 20 | 2241 | 607 | 0 | 24.4 | | | 61 | | | 61 |
| 48 | 21°35.5 | 108°25 | 20 | 2241 | 607 | 0 | 24.4 | | | 430 | | | 430 |
| 49 | 22°42 | 109°50 | 21 | 1205 | 977 | 303 | 22.7 | | | 43 | | | 43 |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|----------------|----------|----------|---------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 50 | 23°40 | 111°06.5 | 21 | 2204 | 456 | 145 | 20.2 | | | | | | |
| 50 | 23°40 | 111°06.5 | 21 | 2221 | 533 | 0 | 20.2 | | | | | | |
| 51 | 24°57.5 | 112°35.5 | 22 | 1213 | 882 | 0 | 19.4 | | | 1 | | | 1 |
| 52 | 25°32 | 113°30 | 23 | 0221 | 62 | 111 | | | | | | | |
| 53 | 25°32 | 113°30 | 23 | 0504 | 1152 | 141 | | | | | | | |
| 54 | 25°32 | 113°30 | 23 | 0802 | 444 | 125 | | | | | | | |
| TO-59-2 — 1959 | | | | | | | | | | | | | |
| 1 | 26°29 N | 113°29 | Aug. 15 | 2009 | | | 25.2 | | | | | | |
| 2 | 26°19.2 | 113°51.8 | 15 | 0050 | | | 22.0 | | | | | | |
| 3 | 26°10.8 | 114°10.5 | 16 | 0530 | | | 21.5 | | | | | | |
| 4 | 25°58.5 | 114°25.2 | 16 | 0834 | | | 25.2 | | | | | | |
| 5 | 25°44.3 | 114°42.5 | 16 | 1444 | | | 25.4 | | | | | | |
| 6 | 25°39 | 115°04.5 | 16 | 1745 | | | 25.0 | | | | | | |
| 7 | 25°35.2 | 115°27.7 | 16 | 2110 | | | 24.5 | | | | | | |
| 8 | 25°19 | 115°42.8 | 16 | 0120 | | | 25.4 | | | | | | |
| 9 | 25°08.7 | 116°03.8 | 17 | 0604 | | | 25.4 | | | | | | |
| 10 | 24°31 | 115°45 | 17 | 1054 | | | 25.5 | | | | | | |
| 12 | 24°55 | 115°02 | 17 | 1937 | | | 25.3 | | | | | | |
| 13 | 25°06.5 | 114°43.2 | 18 | 0022 | | | 25.1 | | | | | | |
| 14 | 25°21.2 | 114°26.5 | 18 | 0515 | | | 24.9 | | | | | | |
| 15 | 25°24.5 | 114°04.8 | 18 | 0745 | | | 23.9 | | | | | | |
| 16 | 25°35.2 | 113°43.8 | 18 | 1227 | | | 22.9 | | | | | | |
| 17 | 25°47 | 113°25.8 | 18 | 1904 | | | 23.1 | | | | | | |
| 18 | 25°56.2 | 113°07.2 | 18 | 2208 | | | 25.0 | | | | | | |
| 20 | 25°34.5 | 113°22.7 | 19 | 1630 | | | 23.0 | | | | | | |
| 21 | 25°00 | 113°23.8 | 19 | 2230 | | | 23.8 | | | | | | |
| 22 | 24°53.8 | 113°48 | 20 | 0412 | | | 23.2 | | | | | | |
| 23 | 24°39.8 | 114°02 | 20 | 0654 | | | 21.2 | | | | | | |
| 24 | 24°29.2 | 114°22 | 20 | 1421 | | | 24.2 | | | | | | |
| 25 | 24°19 | 114°48 | 21 | 1600 | | | 26.3 | | | | | | |
| 26 | 24°10.5 | 112°03 | 21 | 1828 | | | 27.3 | | | | | | |
| 27 | 24°45 | 112°04 | 21 | 2328 | | | 26.9 | | | | | | |
| 27 | 24°25 | 112°04 | 21-22 | 2350 | | | 26.9 | | | | | | |
| 28 | 25°32.6 | 112°22.5 | 22 | 0603 | | | 25.6 | | 1 | | | | 1 |
| 29 | 25°22 | 112°47.5 | 22 | 0848 | | | 27.0 | | | | | | |
| 30 | 25°13.8 | 113°03 | 22 | 1409 | | | 26.8 | | | | | | |
| 31 | 24°36.2 | 112°39 | 22 | 1915 | | | 27.1 | | | | | | |
| 32 | 24°25.5 | 113°02.2 | 22 | 0145 | | | 25.8 | | | | | | |
| 33 | 24°18 | 113°25 | 23 | 0432 | | | 25.9 | | | | | | |
| 34 | 24°08 | 113°32.5 | 23 | 0801 | | | 24.2 | | | | | | |
| 35 | 23°55 | 114°01.5 | 23 | 1555 | | | 26.0 | | | | | | |
| 36 | 23°44.7 | 114°22 | 23 | 1939 | | | 26.2 | | | | | | |
| 38 | 23°26 | 114°55.2 | 24 | 0305 | | | 26.1 | | | | | | |
| 39 | 22°49.8 | 114°32.5 | 24 | 1040 | | | 24.9 | | | | | | |
| 41 | 23°12.5 | 114°04 | 24 | 1854 | | | 25.4 | | | | | | |
| 42 | 23°20 | 113°39.5 | 24 | 2207 | | | 24.9 | | | | | | |
| 42 | 23°20 | 113°39.5 | 24 | 2229 | | | 24.9 | | 13 | | | | 13 |
| 43 | 23°26.5 | 113°19 | 25 | 0404 | | | 25.4 | | | | | | |
| 44 | 23°40 | 112°58.2 | 25 | 0644 | | | 25.6 | | | | | | |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|----------|-----------|------------|---------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 45 | 23° 51' | 112° 40.3' | 25 | 1121 | | | 26.4 | | | | | | |
| 46 | 24° 12.5' | 112° 25' | 25 | 1820 | | | 26.9 | | | | | | |
| 47 | 23° 47.5' | 110° 59.5' | 26 | 0358 | | | 27.3 | | | | | | |
| 48 | 23° 37.2' | 111° 19' | 26 | 0637 | | | 26.9 | | | | | | |
| 49 | 23° 36.2' | 111° 49' | 26 | 1330 | | | 26.3 | | | | | | |
| 50 | 23° 26' | 112° 00' | 26 | 1540 | | | 26.5 | | | | | | |
| 51 | 23° 20.5' | 112° 15.6' | 26 | 1806 | | | 26.0 | | | | | | |
| 52 | 23° 10' | 112° 39.7' | 26 | 2340 | | | 26.6 | | | | | | |
| 53 | 23° 01.8' | 113° 00' | 27 | 0400 | | | 25.3 | | | | | | |
| 54 | 22° 54.2' | 113° 18.7' | 27 | 0646 | | | 25.3 | | | | | | |
| 55 | 22° 40.2' | 113° 34.8' | 27 | 0957 | | | 26.3 | | | | | | |
| 56 | 22° 02' | 113° 14' | 27 | 1705 | | | 24.8 | | | | | | |
| 57 | 22° 14.2' | 112° 53.8' | 27 | 2044 | | | 25.0 | | | | | | |
| 58 | 22° 27.5' | 112° 32.2' | 28 | 0200 | | | 25.2 | | | | | | |
| 59 | 22° 40.8' | 112° 12' | 28 | 0437 | | | 26.9 | | | | | | |
| 60 | 22° 48' | 111° 59.5' | 28 | 0638 | | | 26.9 | | | | | | |
| 61 | 22° 54' | 111° 41.5' | 28 | 1205 | | | 27.1 | | | | | | |
| 62 | 23° 02.2' | 111° 20.8' | 28 | 1645 | | | 27.5 | | | | | | |
| 63 | 23° 12.2' | 111° 04.2' | 28 | 2020 | | | 27.3 | | | | | | |
| 64 | 23° 23.8' | 110° 39.1' | 29 | 0155 | | | 27.6 | | | | | | |
| 65 | 22° 39.7' | 110° 35.5' | 29 | 0802 | | | 28.7 | | | | | | |
| 67 | 22° 55.3' | 110° 12.3' | 29 | 1450 | | | 30.6 | | | | | | |
| 68 | 18° 39' | 103° 59.3' | Sept. 4 | 1337 | 2061 | 193 | 29.6 | | 9 | | | | 9 |
| 69 | 15° 39' | 97° 00' | 6 | 0300 | 3243 | 146 | 29.5 | | 8 | | | | 10 |
| 69 | 15° 39' | 97° 00' | 6 | 0400 | 966 | 0 | 29.5 | 2 | 1 | | 2 | | 4 |
| 70 | 15° 00' | 97° 00' | 7 | 1340 | 1903 | 157 | 29.9 | | 5 | | | | 5 |
| 71 | 14° 19' | 97° 02.2' | 7 | 2017 | 1422 | 246 | 30.2 | 21 | 4 | | | | 25 |
| 72 | 13° 39.5' | 97° 00' | 8 | 0250 | 1775 | 241 | 29.7 | 106 | | | | | 106 |
| 72 | 13° 39.5' | 97° 00' | 8 | 0330 | 999 | 0 | 29.7 | 228 | | 10 | | | 238 |
| 73 | 13° 42.3' | 95° 56' | 8 | 1600 | 2156 | 131 | 29.6 | 8 | 9 | | | | 17 |
| 74 | 14° 20' | 95° 59' | 8 | 2218 | 2235 | 269 | 29.9 | 5 | 9 | | 6 | | 20 |
| 74 | 14° 20' | 95° 59' | 8 | 2253 | 977 | 0 | 29.9 | 5 | 15 | | 6 | | 26 |
| 75 | 15° 01.5' | 96° 02.8' | 9 | 0704 | 2508 | 268 | 29.0 | | 1 | | | | 1 |
| 76 | 15° 35' | 96° 02.3' | 9 | 1530 | 2271 | 150 | 30.2 | | 3 | | | | 3 |
| 78 | 14° 54.8' | 95° 07.1' | 10 | 2020 | 2474 | 267 | 29.0 | 6 | 27 | | 36 | | 69 |
| 79 | 14° 40' | 95° 02.1' | 10 | 2248 | 1587 | 283 | 29.1 | 5 | 6 | | | | 11 |
| 80 | 14° 23.4' | 94° 57.7' | 11 | 0430 | 834 | 0 | 29.1 | 1 | 4 | | | | 5 |
| 81 | 13° 39.5' | 95° 00' | 11 | 1425 | 1828 | 200 | 29.2 | 6 | 12 | | | | 18 |
| 82 | 13° 40' | 94° 00' | 11 | 0115 | 2058 | 293 | 29.4 | | 12 | | | | 12 |
| 83 | 14° 21.5' | 94° 01' | 12 | 0756 | 1458 | 267 | 29.6 | | 11 | | | | 16 |
| 84 | 16° 28' | 99° 32.5' | 13 | 0130 | 1686 | 290 | 29.9 | | 4 | | 5 | | 6 |
| 84 | 16° 28' | 99° 32.5' | 13 | 0200 | 1302 | 0 | 29.9 | | 3 | | 2 | | 3 |
| 85 | 17° 09.5' | 101° 16.8' | 15 | 2320 | 1760 | 283 | 30.2 | 1 | 4 | | | | 5 |
| 85 | 17° 09.5' | 101° 16.8' | 15-16 | 0001 | 1140 | 0 | 30.2 | 1 | 6 | | | | 7 |
| 86 | 18° 39.8' | 104° 08.8' | 16 | 2003 | 2483 | 286 | 29.2 | 5 | 31 | | | | 36 |
| 87 | 20° 09' | 106° 32' | 17 | 2312 | 1524 | 256 | 28.6 | | 7 | | | | 7 |
| 87 | 20° 09' | 106° 32' | 17 | 2349 | 1067 | 0 | 28.6 | 2 | | 103 | | | 105 |
| 88 | 22° 00.5' | 109° 04.3' | 18 | 2105 | 1918 | 293 | 29.1 | | | | | | |
| 88 | 22° 00.5' | 109° 04.3' | 18 | 2146 | 1069 | 0 | 29.1 | | | | 1 | | 1 |
| 89 | 24° 16.7' | 111° 59.7' | 19 | 2138 | 1918 | 293 | 26.7 | | | | 2 | | 2 |

Table 2. Continued

| Sta. | Position | | Date | Time started (local) | Water strained m ³ | Depth of tow m | Surface Temp. in °C | Number of larvae in sample | | | | | Total |
|-------------------------------|----------|----------|---------|----------------------|----------------------------------|-------------------------|------------------------------|--------------------------------|-------|-------|-------|------------------|-------|
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | Uniden. | |
| Estación | Posición | | Fecha | Hora (local) | Agua filtrada por m ³ | Prof. del arrastre en m | Temp. de la superficie en °C | Número de larvas en la muestra | | | | | Total |
| | Lat. | Long. W | | | | | | N. M. | K. P. | A. T. | E. L. | No identificadas | |
| 89 | 24°16.7 | 111°59.7 | 19 | 2110 | 887 | 0 | 26.7 | | | | | | |
| 91 | 26°33.6 | 113°54.1 | 20 | 2104 | 1113 | 0 | 23.0 | | | | | | |
| COSTA RICA DOME CRUISE — 1959 | | | | | | | | | | | | | |
| 4 | 10°10 | 90°05 | Nov. 15 | 0123 | 577 | 0 | 25.8 | | | | | | |
| 7 | 9°00 | 89°03 | 15 | 1558 | 1026 | 276 | 26.6 | | 1 | | | | 1 |
| 12 | 7°13 | 87°11 | 16 | 1722 | 891 | 323 | 26.8 | | | | | | |
| 14 | 10°29 | 87°10 | 17 | 1913 | 730 | 324 | 27.1 | | | | | | |
| 18 | 8°35 | 88°00.5 | 18 | 1357 | 897 | 325 | 27.2 | | | | | | |
| 18 | 8°35 | 88°00.5 | 18 | 1440 | 269 | 0 | 27.2 | | | | | | |
| 22 | 7°39 | 90°12 | 19 | 1050 | 0 | 246 | 25.8 | | | | | | |
| 26 | 8°09 | 91°17 | 20 | 1518 | 390 | 0 | 27.8 | | 4 | | | | 4 |
| 26 | 8°09 | 91°17 | 20 | 1727 | 579 | 305 | 27.8 | | 3 | | | | 3 |
| 30 | 8°10 | 89°05 | 21 | 1755 | 302 | 0 | 27.6 | | | | | | |
| 30 | 8°10 | 89°05 | 21 | 1810 | 818 | 300 | 27.3 | | | | | | |
| 33 | 8°13 | 87°52.5 | 22 | 1405 | 1066 | 0 | 23.4 | | 13 | | | | 13 |
| 33 | 8°13 | 87°52.5 | 22 | 1440 | 649 | 272 | 23.4 | | | | | | |
| 36 | 8°51.5 | 87°01 | 23 | 1230 | 696 | 0 | 25.6 | | | | | | |
| 36 | 8°51.5 | 87°01 | 23 | 1242 | 620 | 281 | 25.6 | | | | | | |
| 37 | 9°21 | 86°20 | 23 | 1911 | 1431 | 0 | 27.2 | 1 | | | | | 1 |
| 37-1 | 9°24 | 86°01 | 23 | 2213 | 0 | 0 | 27.1 | | | | | | |
| 37-2 | 9°26 | 85°39 | 24 | 0105 | 1010 | 0 | 27.2 | | 6 | | | | 6 |
| 37-3 | 9°29 | 85°18 | 24 | 0354 | 1329 | 0 | 27.2 | | 1 | | | | 1 |
| 37-4 | 9°29 | 85°07 | 24 | 0515 | 754 | 0 | 27.6 | | 2 | | | | 2 |
| 40 | 10°00 | 88°20.5 | 27-28 | 2350 | 1360 | 0 | 26.5 | | | | | | |
| 40 | 10°00 | 88°20.5 | 28 | 0015 | 984 | 322 | 26.5 | | | | | | |
| 41 | 10°14 | 88°20 | 28 | 1155 | 1404 | 0 | 26.3 | | | | | | |
| 43 | 9°13 | 90°09 | 29 | 0900 | 1282 | 230 | 26.8 | | | | | | |
| 46 | 7°46 | 88°26 | 30 | 1940 | 1205 | 0 | 26.1 | | 3 | | | | 3 |
| 46 | 7°46 | 88°26 | 30 | 1958 | 1220 | 236 | 26.1 | | | | | | |
| 49 | 6°25 | 88°15 | Dec. 1 | 2050 | 1431 | 0 | 27.6 | | | | | | |
| 50-7 | 5°35 | 87°09 | 2 | 2041 | 3290 | 0 | 27.0 | 8 | 1 | | | | 9 |
| 50-7 | 5°35 | 87°09 | 2 | 2116 | 967 | 311 | 27.0 | 6 | | | | | 6 |
| 50-16 | 5°28.5 | 86°58.5 | 3 | 0208 | 2703 | 0 | 26.8 | 2 | | | | | 2 |
| 50-16 | 5°28.5 | 86°58.5 | 3 | 0250 | 840 | 307 | 26.8 | 2 | | | | | 2 |
| 50-16 | 5°28.5 | 86°58.5 | 3 | 0447 | 999 | 304 | 26.8 | | | | | | |
| 51 | 5°22 | 86°51.5 | 4 | 0323 | 2915 | 0 | 26.7 | 19 | | | | | 19 |
| 53 | 5°29.5 | 87°01 | 4 | 0628 | 226 | 109 | 26.6 | | | | | | |
| 56 | 5°35 | 87°06 | 4 | 1503 | 629 | 307 | 26.9 | | | | | | |
| 59 | 8°18.5 | 88°46.5 | 6 | 1430 | 856 | 311 | 25.5 | | | | | | |

TABLE 3. Larval tunas collected in plankton tows during cruises of the Biological Laboratory La Jolla, of the U. S. Bureau of Commercial Fisheries.**TABLA 3. Atunes en estado larval recolectados en los arrastres de plancton durante los cruceros del Biológico Laboratory La Jolla del U. S. Bureau of Commercial Fisheries.**

| Cruise | Station | Position | | Date | No. | N. M. | No. | A. T. | No. | E. L. |
|-------------|----------------------|----------|----------|----------|-----|----------|-----|----------|-----|--------|
| | | Lat. N | Long. W | | | Size | | Size | | Size |
| Crucero | Estación | Posición | | Fecha | No. | N. M. | No. | A. T. | No. | E. L. |
| | | Lat. N | Long. W | | | Tamaño | | Tamaño | | Tamaño |
| 1956 | | | | | | | | | | |
| B-5608 | 127.34 | 26°55.3 | 114°06 | Aug. 14 | | | 1 | 5.0 | | |
| | 130.35 | 26°19 | 113°48.5 | Aug. 14 | | | 10 | 5.5-12.9 | | |
| | 133.25 | 26°04.5 | 112°48 | Aug. 13 | | | | | 1 | 7.0 |
| | 137.30 | 25°20 | 112°45.5 | Aug. 12 | | | 1 | 4.2 | | |
| | 130.40 | 26°09 | 114°07.5 | Aug. 14 | | | 7 | 4.2-8.0 | | |
| B-5609 | 133.25 | 26°04.6 | 112°48 | Sept. 11 | | | 1 | 5.7 | | |
| | 130.30 | 26°29 | 113°29 | Sept. 12 | | | 1 | 13.2 | | |
| | 123.42 | 27°14 | 114°59.7 | Sept. 13 | | | 1 | 6.7 | | |
| 1957 | | | | | | | | | | |
| B-5708 | 113.35 | 29°12 | 115°39 | Aug. 17 | | | 6 | | 1 | |
| | 115.35 | 28°55 | 115°27.5 | Aug. 17 | | | 10 | | | |
| | 115.40 | 28°45 | 115°47 | Aug. 17 | | | 5 | | | |
| | 117.26 | 28°56 | 114°41 | Aug. 17 | | | 2 | | | |
| | 117.30 | 28°48 | 114°56.5 | Aug. 18 | | | 1 | | | |
| | 117.35 | 28°36 | 115°16 | Aug. 18 | | | 2 | | | |
| | 117.40 | 28°28 | 115°35.5 | Aug. 18 | | | 11 | | | |
| | 118 ^s .30 | 28°30 | 114°45.5 | Aug. 18 | | | 19 | | | |
| | 118 ^s .35 | 28°20.5 | 115°05 | Aug. 18 | | | 3 | | | |
| | 119.23 | 28°19 | 114°53 | Aug. 18 | | | 2 | | | |
| | 120.30 | 28°13 | 114°34 | Aug. 18 | | | 5 | | | |
| | 120.35 | 28°03 | 114°54 | Aug. 19 | | | 2 | | | |
| | 133.25 | 26°04.5 | 112°48 | Aug. 20 | | | 15 | | | |
| | 133.30 | 26°03 | 112°46 | Aug. 20 | | | 1 | | | |
| 1958 | | | | | | | | | | |
| B-5810 | 130.50 | 25°49 | 114°45 | Oct. 16 | 1 | 6.3 | | | | |
| | 130.40 | 26°09 | 114°07.5 | Oct. 17 | 1 | 5.6 | | | | |
| | 140.30 | 24°45.5 | 112°24 | Oct. 20 | 5 | 4.4-7.9 | | | | |
| | 140.35 | 24°35.5 | 112°42.5 | Oct. 20 | 2 | 4.5, 5.3 | | | | |
| | 140.50 | 24°05.5 | 113°39.5 | Oct. 20 | 2 | 5.6, 5.5 | | | | |
| | 143.26 | 24°19 | 111°48 | Oct. 21 | 3 | 4.2-6.0 | | | | |
| | 147.20 | 23°56 | 111°03.5 | Oct. 22 | 1 | 6.8 | | | | |
| | 150.35 | 22°51.5 | 111°38.5 | Oct. 23 | 1 | 4.4 | | | | |

TABLE 4. Young tunas attracted with a night light and caught with a dip net.

TABLA 4. Atunes jóvenes atraídos con una linterna y capturados con un carcal.

| Position | | Date | N. M. | | K. P. | | A. T. | | E. L. | | Collector or reference |
|----------|---------|-----------------|-------|---------------|-------|---------------|-------|---------------|-------|---------------|---|
| Lat. | Long. W | | No. | Size mm. | |
| Posición | | Fecha | N. M. | | K. P. | | A. T. | | E. L. | | Recolector o referencia |
| Lat. | Long. W | | No. | Tamaño en mm. | |
| 4°01 N | 80°26 | 1941 Mar. 24 | | | | | 5 | 22-31 | | | Nichols and Murphy (1944) Schaefer and Marr (1948a) Fowler (1944), Klawe (1959) |
| 18°00 | 105°47 | June 28 | 2 | | | | | | | | |
| 9°22.5 | 85°47.5 | 1947 Jan. 28 | 2 | 14-15 | 1 | 21 | | | | | Schaefer and Marr (1948a) |
| 8°20 | 84°10 | Mar. 18 | | | | | | | 8 | 48-86 | Schaefer and Marr (1948a) |
| 9°20 | 85°20 | Mar. 19 | | | | | | | 10 | 29-56 | Schaefer and Marr (1948a) |
| 9°10 | 85°20 | Mar. 20 | | | 1 | 44 | | | 1 | 61 | Schaefer and Marr (1948a & b) |
| 9°20 | 85°10 | Apr. 1 | 20 | 10-24 | | | | | | | Schaefer and Marr (1948a) |
| 8°07.5 | 83°08.5 | May 7 | 1 | 41 | | | | | | | Schaefer and Marr (1948a) |
| 11°23 | 90°29.5 | 1949 May 7 | | | | | 28 | 10.5-29 | | | Mead (1951) |
| 10°58 | 89°56 | May 10 | | | | | 2 | 10-28 | 2 | 7.5-10.5 | Mead (1951) |
| 11°46 | 87°28 | May 15 | | | | | 3 | 12-35 | | | Mead (1951) |
| 11°46 | 87°41 | May 16 | | | | | 2 | 27-30 | | | Mead (1951) |
| 12°16 | 89°31 | May 17 | 25 | 15-25 | | | 2 | 28-30 | | | Mead (1951) |
| 11°20 | 87°20 | May 19 | | | | | 36 | 14.5-31 | 23 | 14-18 | Mead (1951) |
| 11°26 | 89°22 | May 22 | | | | | 15 | 18-35 | | | Mead (1951) |
| 10°47 | 89°20 | May 24 | | | | | 57 | 14-48 | | | Mead (1951) |
| 12°50 | 89°40 | May 27 | | | | | 1 | 19 | 2 | 18-24 | Mead (1951) |
| 11°05 | 89°55 | May 28 | 12 | 10.5-16 | | | 76 | 10.5-49 | | | Mead (1951) |
| 11°05 | 89°55 | May 29 | | | | | 12 | 20-35 | | | Mead (1951) |
| 12°11 | 90°18 | May 30 | 5 | 19-27 | | | 27 | 24.5-41 | | | Mead (1951) |
| 24°35 | 112°05 | 1951 Oct. 26 | | | | | | | 1 | 9.7 | J. W. Sefton, Jr. |
| 12°34 | 89°50 | 1955 Jan. 20 | | | | | | | 8 | 25 average | H. B. Clemens (1956) |
| 8°43 | 84°11 | Jan. 24 | | | | | | | 34 | 17-38 | H. B. Clemens (1956) |
| 9°35 | 86°17 | Nov. 1 | | | | | 37 | 10.5-34 | | | Eastropic Expedition |
| 10°34 | 89°33 | Nov. 2 | | | | | 94 | 11.5-57 | | | Eastropic Expedition |
| 10°03 | 88°52 | Nov. 3 | | | | | 122 | 10-45 | | | Eastropic Expedition |
| 10°52 | 88°02 | Nov. 4 | | | | | 9 | 20-45 | | | Eastropic Expedition |
| 9°12 | 87°06 | Nov. 5 | | | | | 78 | 7-30 | | | Eastropic Expedition |
| 4°03 | 85°45 | Nov. 12 | | | | | 1 | 22 | | | Eastropic Expedition |
| 7°42 | 79°20 | Nov. 16 | | | | | 6 | 22-60 | 1 | 30 | Eastropic Expedition |
| 3°01 | 82°15 | Nov. 21 | | | | | 45 | 17-48 | 6 | 27-38 | Eastropic Expedition |
| 1°06 | 91°30 | Nov. 28 | | | | | 71 | 10-36 | | | Eastropic Expedition |
| 10°02 | 89°07 | Dec. 1 | | | | | 28 | 11-32 | | | Eastropic Expedition |
| 11°48 | 88°25 | Dec. 2 | | | | | 30 | 17-42 | 1 | 46 | Eastropic Expedition |
| 12°24 | 89°06 | Dec. 6 | | | | | 4 | 51-104 | | | Eastropic Expedition |
| 9°03 | 104°34 | Dec. 10 | | | | | 1 | 55 | | | Eastropic Expedition |
| 19°00 | 104°57 | Dec. 12 | | | | | 3 | 66-70 | | | Eastropic Expedition |
| 18°37 | 107°01 | 1956 Mar. 9 | | | | | 3 | 13-38 | | | G. W. Bane |
| 21°06 | 106°45 | Mar. 10 | | | | | 1 | 60 | | | C. J. Orange |

Table 4. Continued

| Position | | Date | N. M. | | K. P. | | A. T. | | E. L. | | Collector or reference |
|----------|----------|----------|-------|---------------|-------|---------------|-------|---------------|-------|---------------|----------------------------------|
| Lat. | Long. W | | No. | Size mm. | |
| Posición | | Fecha | N. M. | | K. P. | | A. T. | | E. L. | | Recolector o referencia |
| Lat. | Long. W | | No. | Tamaño en mm. | |
| 16°37 | 102°38 | Mar. 10 | | | | | 1 | 21 | | | G. W. Bane |
| 21°04 | 106°40 | Mar. 11 | | | | | 37 | 32-87 | | | C. J. Orange |
| 12°20 | 90°18 | Mar. 19 | | | | | 38 | 16-45 | | | G. W. Bane |
| 12°08 | 88°12 | Mar. 21 | | | | | 9 | 17-33 | | | G. W. Bane |
| 12°08 | 88°12 | Mar. 21 | | | | | 12 | 16-30 | | | G. W. Bane and M. Doutre |
| 12°18 | 91°15 | June 18 | | | | | 4 | 10-17 | | | R. C. Hennemuth |
| 15°05 | 93°54 | Sept. 27 | | | | | 4 | 15-17 | 3 | 15-27 | W. L. Klawe |
| 13°47 | 93°20 | Sept. 28 | | | | | 20 | 13-58 | | | W. L. Klawe |
| 13°31 | 92°49 | Sept. 29 | | | | | 3 | 22-30 | | | W. L. Klawe |
| 13°49 | 92°44 | Sept. 30 | | | | | 138 | 10-43 | | | W. L. Klawe |
| 13°08 | 92°58 | Oct. 1 | | | | | 22 | 12-52 | | | W. L. Klawe |
| 13°29 | 91°30 | Oct. 2 | | | | | 50 | 20-60 | | | W. L. Klawe |
| 12°51 | 93°05 | Oct. 3 | | | | | 16 | 30-54 | 1 | 51 | W. L. Klawe |
| 13°19 | 93°33 | Oct. 4 | | | | | 71 | 16-61 | | | W. L. Klawe |
| 12°38 | 91°14 | Oct. 4 | | | | | 147 | 11-48 | | | W. L. Klawe |
| 12°39 | 91°21 | Oct. 6 | | | | | 19 | 11-37 | | | W. L. Klawe |
| 23°48 | 112°02 | Nov. 4 | 1 | 29 | | | | | | | W. L. Klawe |
| 14°00 | 96°11 | Nov. 15 | | | | | 18 | 23-49 | 1 | 30 | M. B. Schaefer and B. M. Shimada |
| 8°55 | 88°31 | Nov. 20 | | | | | 5 | 15.5-40 | | | M. B. Schaefer and B. M. Shimada |
| 8°55 | 88°31 | Nov. 21 | | | | | 4 | 13-17 | | | M. B. Schaefer and B. M. Shimada |
| 8°55 | 88°31 | Nov. 22 | | | | | 1 | 25 | | | M. B. Schaefer and W. Brandhorst |
| 19°27.5 | 106°08.5 | Dec. 4 | | | | | 75 | 10-50 | | | R. C. Counts |
| 7°27 | 90°45 | Dec. 5 | | | | | 30 | 7.5-25 | | | M. B. Schaefer |
| 22°21 | 106°45 | Dec. 6 | | | | | 7 | 14-33 | | | Fish and Wildlife O-5612 |
| 16°41 | 100°00 | Dec. 8 | | | | | 2 | 7-9.5 | | | M. B. Schaefer |
| 24°28 | 110°28 | Dec. 15 | | | | | 1 | 25.5 | | | Fish and Wildlife H-5612 |
| | | 1957 | | | | | | | | | |
| 17°24 | 102°04 | Feb. 1 | | | | | 6 | 19-37 | 1 | 21 | J. A. Renner and R. Hark |
| 18°01 | 103°59 | Feb. 3 | | | | | 5 | 8-38 | | | J. A. Renner and R. Hark |
| 15°28.2 | 101°16.3 | Feb. 4 | | | | | 3 | 15-19 | | | J. A. Renner and R. Hark |
| 20°05 | 105°53 | Feb. 12 | | | | | 7 | 23-32 | | | J. A. Renner and R. Hark |
| 22°03 | 106°35 | Feb. 17 | | | | | 15 | 13-41 | | | J. A. Renner and R. Hark |
| 12°07 | 93°19.5 | Feb. 24 | | | | | 14 | 12-27 | | | P. N. Sund |
| 15°48 | 99°33.5 | Feb. 25 | | | | | 1 | 15 | | | C. J. Orange and P. N. Sund |
| 12°59 | 92°02 | Feb. 25 | | | | | 1 | 39 | | | C. J. Orange and P. N. Sund |
| 15°36 | 100°46 | Feb. 25 | | | | | 1 | 23.5 | | | J. A. Renner and R. Hark |
| 6°42 | 81°11 | Mar. 26 | | | | | 8 | 48-113 | | | G. W. Bane |
| 15°11 | 97°25 | Mar. 31 | | | | | 10 | 11-59 | | | W. L. Klawe |
| 12°31 | 91°35 | Apr. 3 | | | | | 22 | | | | W. L. Klawe |
| 12°34 | 91°38 | Apr. 4 | 1 | 12 | | | 13 | 9-39 | | | W. L. Klawe |
| 12°39 | 91°40 | Apr. 5 | 1 | 11 | | | 4 | 20-33 | | | W. L. Klawe |
| 12°47 | 91°42 | Apr. 6 | | | | | 8 | 19-35 | | | W. L. Klawe |
| 13°13 | 89°54 | Apr. 8 | | | | | 2 | 14 | | | W. L. Klawe |
| 12°51 | 89°46 | Apr. 9 | | | | | 2 | 19-25 | | | W. L. Klawe |
| 12°22 | 87°39 | Apr. 9 | | | | | 87 | 11-24 | | | C. J. Orange |
| 12°03 | 89°44.5 | Apr. 12 | | | | | 2 | 20-37 | | | W. L. Klawe |
| 12°57 | 89°55 | Apr. 17 | | | | | 3 | 36-42 | | | C. J. Orange and P. N. Sund |
| 13°03 | 89°52 | Apr. 18 | | | | | 2 | 39-55 | | | C. J. Orange and P. N. Sund |

Table 4. Continued

| Position | | Date | N. M. | | K. P. | | A. T. | | E. L. | | Collector or reference |
|-------------|----------|------------|-------|---------------|-------|---------------|-------|---------------|-------|---------------|--|
| Lat. | Long. W | | No. | Size mm. | |
| Posición | | Fecha | N. M. | | K. P. | | A. T. | | E. L. | | Recolector o referencia |
| Lat. | Long. W | | No. | Tamaño en mm. | |
| 6°36 | 78°14 | Apr. 23 | | | | | 2 | 22-27 | | | W. L. Klawe |
| 6°18 | 77°53 | Apr. 24 | | | | | 5 | 32-40 | | | W. L. Klawe |
| 6°47 | 78°56 | May 2 | | | | | 1 | 35 | | | W. L. Klawe |
| 18°42 | 110°57 | July 12 | | | | | 3 | 32-37 | | | W. L. Klawe |
| 23°27 | 111°10 | July 16 | | | | | 1 | 43 | | | R. C. Hennemuth and W. L. Klawe |
| 23°36 | 111°42 | July 16 | | | | | 1 | 22.5 | | | R. C. Hennemuth and W. L. Klawe |
| 31°11 | 114°15 | Aug. 19 | | | | | 1 | 36 | 2 | 29.5-353 | Fish and Wildlife Cruise S-5708 |
| 1958 | | | | | | | | | | | |
| 0°45 S | 80°41 | Apr. 17 | 1 | 16 | 1 | 13 | 2 | 11-14 | | | C. L. Peterson and R. W. Hetzler |
| 0°23 S | 80°50 | Apr. 18 | 8 | 11-18 | 6 | 11.5-17 | 117 | 9-35 | | | C. L. Peterson and R. W. Hetzler |
| 2°12 S | 81°11 | Apr. 22 | 1 | 11.5 | | | 3 | 14-16 | | | C. L. Peterson and R. W. Hetzler |
| 7°12.5 N | 95°52.5 | May 11 | | | 1 | 18 | 1 | 14 | | | W. L. Klawe |
| 7°22 | 92°47 | May 12 | | | | | 1 | 17 | | | W. L. Klawe |
| 9°08 | 90°12 | May 13 | | | | | 8 | — | | | W. L. Klawe |
| 5°34 | 81°29 | May 18 | | | | | 1 | 57 | 1 | 60 | W. L. Klawe |
| 7°24.5 | 78°49 | May 20 | | | | | 5 | 17-27 | | | W. L. Klawe |
| 10°20 | 86°20 | May 20 | 23 | 7-11 | | | 39 | 7-10.5 | | | C. L. Peterson and R. W. Hetzler |
| 6°42 | 81°14 | May 24 | | | | | 2 | 34-59 | | | W. L. Klawe |
| 8°28 | 89°21 | May 25 | | | | | 2 | 19-23 | | | W. L. Klawe |
| 15°37 | 94°21 | May 28 | | | | | 5 | 16-22 | | | W. L. Klawe |
| 16°44 | 100°00 | June 5 | | | | | 4 | 25-36 | | | W. L. Klawe |
| 16°35 | 100°10 | June 5-6 | | | | | 36 | 14-29 | | | W. L. Klawe |
| 17°30 | 101°33 | June 10 | | | | | 97 | 16-66 | | | W. L. Klawe |
| 18°44 | 104°21 | June 12 | | | | | 1 | 11 | 5 | 20-27 | W. L. Klawe |
| 19°03 | 104°45 | June 13 | | | | | 16 | 23-46 | | | W. L. Klawe |
| 18°38 | 107°12 | June 14 | | | | | 1 | — | | | W. L. Klawe |
| 17°49 | 103°38.5 | June 15 | | | | | 410 | 6.4-41 | 99 | 7.5-45 | W. L. Klawe |
| 21°36 | 106°44 | June 15-16 | | | | | 190 | 20-42 | 3 | 18-48 | W. L. Klawe |
| 23°00 | 110°15 | June 17 | | | | | 36 | 11-51 | | | W. L. Klawe |
| 1959 | | | | | | | | | | | |
| 23°55 | 108°00 | Mar. 19 | | | | | 9 | 26-39 | | | C. J. Orange |
| 8°02 | 83°15 | Apr. 1 | | | | | 44 | 9-23 | | | G. C. Broadhead and B. M. Chatwin |
| 8°12 | 83°15.5 | Apr. 3 | | | | | 51 | 7.5-29 | 6 | 12-18 | G. C. Broadhead and B. M. Chatwin |
| 8°12 | 83°17 | Apr. 5 | 1 | 12 | | | 74 | 7-31 | 1 | 7.5 | G. C. Broadhead and B. M. Chatwin |
| 9°57 | 85°51 | Apr. 8 | | | | | 1 | 57 | | | G. C. Broadhead and B. M. Chatwin |
| 8°15 | 83°23 | Apr. 9 | | | | | 42 | 14-46 | 6 | 13-28 | G. C. Broadhead and B. M. Chatwin |
| 7°30 | 82°30 | Apr. 12 | 1 | 37 | | | 34 | 12-95 | | | G. C. Broadhead and B. M. Chatwin |
| 7°10 | 79°00 | Apr. 13 | | | | | 59 | 15-45 | | | G. C. Broadhead and B. M. Chatwin |
| 7°30 | 79°02 | Apr. 16 | | | | | 1 | 48 | | | G. C. Broadhead and B. M. Chatwin |
| 24°03.5 | 109°57 | Apr. 27 | | | | | 1 | 15 | | | A. M. Vrooman |
| 8°11 | 88°47 | Nov. 22 | | | | | 2 | 17.5-19 | | | W. L. Klawe |
| 9°21 | 86°20 | Nov. 23 | | | | | 1 | 118 | | | W. L. Klawe |
| 5°30 | 86°57 | Dec. 3 | 7 | 11.5-16 | | | | | | | W. L. Klawe |
| 1960 | | | | | | | | | | | |
| 17°25 | 102°07 | Mar. 24 | | | | | 19 | 14-185 | | | G. C. Broadhead, R. T. Umlor, B. D. Fink, D. R. Dugan |
| 15°55 | 97°58 | Mar. 27 | | | | | 281 | 14-42 | | | G. C. Broadhead, R. T. Umlor, B. D. Fink, D. R. Dugan |

Table 4. Continued

| Position | | | N. M. | | K. P. | | A. T. | | E. L. | | Collector or reference |
|----------|---------|----------|-------|---------------|-------|---------------|-------|---------------|-------|---------------|--|
| Lat. | Long. W | Date | No. | Size mm. | |
| Posición | | | N. M. | | K. P. | | A. T. | | E. L. | | Recolector o referencia |
| Lat. | Long. W | Fecha | No. | Tamaño en mm. | |
| 15°50 | 95°56 | Mar. 28 | | | | | 15 | 15-26 | | | G. C. Broadhead, R. T. Umlor, B. D. Fink, D. R. Dugan |
| 11°59 | 88°59 | Aug. 2 | | | | | 1 | 15 | | | F. M. Parham and R. E. North |
| 12°08 | 88°18 | Aug. 8 | 2 | 16.5-17 | | | | | | | F. M. Parham and R. E. North |
| 24°44 | 112°33 | Aug. 31 | | | | | 1 | 30 | | | B. D. Fink |
| 13°33 | 92°43 | Sept. 12 | 16 | 9.5-155 | | | 55 | 8.5-25.5 | | | B. D. Fink |
| | | 1961 | | | | | | | | | |
| 12°35 | 93°40 | Feb. 22 | | | | | 13 | 6.5-41 | 3 | 7.5-9.5 | D. C. Vann |
| 23°10 | 107°24 | Mar. 22 | | | | | 11 | 28-81 | | | F. J. Hester and I. W. Martin |
| 19°06 | 105°19 | Apr. 14 | | | | | 2 | 86.5-88 | | | F. J. Hester and R. R. Whitney |
| 17°14 | 101°56 | Apr. 16 | | | | | 4 | 41.5-45 | | | F. J. Hester and R. R. Whitney |
| 6°24 | 79°03 | Apr. 24 | | | | | 3 | 32-44 | | | B. D. Fink |

TABLE 5. Larval tunas collected in plankton tows off Cape Blanco, Costa Rica.

TABLA 5. Atunes en estado larval recolectados en los arrastres de plancton frente a Cabo Blanco, Costa Rica.

| Location from Cape Blanco | Date | Time started | Duration minutes | Type of net* | Surface Temp. °C | N. M. | | A. T. | | E. L. | | |
|----------------------------------|-------|--------------|---------------------|--------------|------------------------------|-------|---------------|----------|---------------|----------|---------------|----------|
| | | | | | | No. | Size mm. | No. | Size mm. | No. | Size mm. | |
| Lugar con respecto a Cabo Blanco | Fecha | Hora | Duración en minutos | Tipo de red* | Temp. de la superficie en °C | No. | Tamaño en mm. | No. | Tamaño en mm. | No. | Tamaño en mm. | |
| | 1958 | | | | | | | | | | | |
| 20 mi | S | Nov. 13 | 0115 | 30 | P | 27.7 | | | 3 | 5.5-6.5 | 1 | 6.5 |
| 20 mi | S | Nov. 13 | 0200 | 30 | P | 27.7 | | | 2 | 5.0-6.0 | | |
| 20 mi | S | Nov. 13 | 0235 | 30 | P | 27.7 | | | 1 | 7.0 | 1 | 9.0 |
| 20 mi | S | Nov. 14 | 0055 | 30 | P | 27.8 | 1 | 5.6 | 3 | 6.0-7.5 | 1 | 6.0 |
| 20 mi | S | Nov. 14 | 0130 | 30 | P | 27.9 | | | | | | |
| 20 mi | S | Nov. 14 | 0210 | 30 | P | 27.7 | | | | | 2 | 5.0 |
| 20 mi | S | Nov. 14 | 0245 | 30 | P | 28.1 | | | | | | |
| 20 mi | S | Dec. 27 | 0045 | 30 | L | 28.2 | | | | | | |
| 20 mi | S | Dec. 27 | 0125 | 30 | P | 28.4 | | | | | | |
| 20 mi | S | Dec. 27 | 0200 | 30 | P | 28.7 | | | 6 | 4.4-6.6 | | |
| 20 mi | S | Dec. 27 | 0240 | 30 | P | 28.7 | 1 | 5.7 | 9 | 3.3-7.1 | | |
| 15 mi | S | Dec. 28 | 0057 | 30 | P | 28.6 | 1 | 6.6 | 4 | 4.4-11.6 | | |
| 15 mi | S | Dec. 28 | 0135 | 30 | P | 28.5 | 1 | 6.2 | 5 | 4.5-7.2 | | |
| 15 mi | S | Dec. 28 | 0210 | 30 | P | 28.8 | | | | | | |
| 15 mi | S | Dec. 28 | 0245 | 30 | P | 28.8 | | | | | | |
| | 1959 | | | | | | | | | | | |
| 20 mi | S | Jan. 8 | 0100 | 30 | L | 28.3 | | | 1 | 20 | | |
| 20 mi | S | Jan. 8 | 0134 | 30 | P | 28.4 | | | 3 | 4.4-5.1 | | |
| 20 mi | S | Jan. 8 | 0209 | 30 | L | 28.3 | | | 1 | 16 | | |
| 20 mi | S | Jan. 8 | 0245 | 30 | P | 28.4 | | | 2 | 6.1 | | |
| 20 mi | S | Jan. 9 | 0124 | 30 | P | 29.1 | | | 9 | 3.8-6.4 | | |
| 20 mi | S | Feb. 12 | 0108 | 30 | P | | | | 1 | 6.3 | | |
| 20 mi | S | Feb. 12 | 0142 | 30 | L | | 1 | 6.9 | 1 | 7.2 | | |
| 20 mi | S | Feb. 12 | 0216 | 30 | P | | | | 1 | 8.3 | | |
| 20 mi | S | Feb. 12 | 0250 | 30 | L | | 10 | 3.5-6.6 | 2 | 6.7-7.0 | 1 | 5.0 |
| 20 mi | S | Feb. 12 | 2245 | 30 | P | | 12 | 3.8-6.1 | | | | |
| 20 mi | S | Feb. 12 | 2320 | 30 | L | | 2 | 6.1-7.4 | 2 | 8.8-8.9 | | |
| 20 mi | S | Feb. 12, 13 | 2355 | 30 | P | | | | | | | |
| 20 mi | S | Feb. 13 | 0030 | 30 | L | | 1 | 6.2 | 4 | 5.8-6.5 | | |
| 20 mi | S | Mar. 12 | 0108 | 45 | P | 29.3 | 17 | 4.1-6.6 | 5 | 3.9-4.7 | | |
| 20 mi | S | Mar. 12 | 0204 | 45 | P | 29.3 | | | | | | |
| 20 mi | S | Mar. 12 | 0300 | 45 | P | 28.8 | | | 2 | 4.5-5.1 | 3 | 5.1-6.7 |
| 20 mi | S | Mar. 12 | 0355 | 45 | P | 28.2 | | | 1 | 6.7 | 1 | 6.7 |
| 5 mi | E | Mar. 13 | 0003 | 60 | P | 31.2 | 14 | 4.4-7.3 | 5 | 5.5-6.5 | 2 | 6.2-8.2 |
| 5 mi | E | Mar. 13 | 0110 | 60 | L | 29.4 | 10 | 4.9-8.5 | 5 | 5.4-8.0 | 6 | 5.2-9.2 |
| 5 mi | E | Mar. 13 | 0215 | 60 | P | | 1 | 6.8 | | | | |
| 5 mi | E | Mar. 13 | 0320 | 60 | L | | | | | | 1 | 5.3 |
| 20 mi | S | Apr. 9 | 0105 | 60 | P | 29.4 | 6 | 3.6-7.0 | 54 | 3.6-7.2 | 2 | 6.5-7.7 |
| 20 mi | S | Apr. 9 | 0208 | 60 | P | 29.2 | 2 | 6.1-10.6 | 26 | 4.4-8.6 | 7 | 5.0-8.2 |
| 20 mi | S | Apr. 9 | 0322 | 60 | P | 28.4 | | | 3 | 4.8-6.6 | 12 | 4.1-7.1 |
| 20 mi | S | Apr. 9 | 0322 | 60 | L | 28.9 | | | 2 | 5.6-6.1 | | |
| 5 mi | E | Apr. 9 | 0435 | 60 | P | 28.1 | 1 | 5.5 | 4 | 4.6-7.1 | 23 | 4.5-7.5 |
| 5 mi | E | Apr. 10 | 0045 | 60 | L | 28.5 | 2 | 4.1-7.2 | 59 | 5.8-8.3 | 25 | 4.4-7.5 |
| 5 mi | E | Apr. 10 | 0150 | 60 | P | 28.5 | 1 | 4.5 | 14 | 3.3-9.4 | 12 | 4.4-7.2 |
| 5 mi | E | Apr. 10 | 0300 | 60 | L | 28.9 | 2 | 5.5-5.8 | 42 | 3.2-13.0 | 88 | 4.4-14.2 |
| 5 mi | SE | Apr. 10 | 0410 | 60 | L | 28.7 | | | | | | |

Table 5. Continued

| Location from Cape Blanco | Date | Time started | Duration minutes | Type of net* | Surface Temp. °C | N. M. | | A. T. | | E. L. | | |
|----------------------------------|-------|--------------|---------------------|--------------|------------------------------|-------|---------------|---------|---------------|---------|---------------|-----|
| | | | | | | No. | Size mm. | No. | Size mm. | No. | Size mm. | |
| Lugar con respecto a Cabo Blanco | Fecha | Hora | Duración en minutos | Tipo de red* | Temp. de la superficie en °C | N. M. | | A. T. | | E. L. | | |
| | | | | | | No. | Tamaño en mm. | No. | Tamaño en mm. | No. | Tamaño en mm. | |
| 10 mi | SE | May 7 | 0100 | 60 | P | 29.2 | | 3 | 5.5-8.0 | 5 | 5.5-8.0 | |
| 10 mi | SE | May 7 | 0220 | 60 | P | 29.1 | | 9 | 5.5-7.5 | 1 | 8.5 | |
| 10 mi | SE | May 7 | 0325 | 60 | P | | | 5 | 4.5-6.5 | 2 | 6.0-13.0 | |
| 10 mi | SE | May 7 | 2255 | 60 | P | 28.8 | | 2 | 6.0-9.0 | | | |
| 10 mi | SE | May 8 | 0000 | 60 | P | 28.8 | | 2 | 6.0-17.0 | | | |
| 10 mi | SE | May 8 | 0105 | 60 | P | 29.2 | 1 | 8.5 | 10 | 3.5-8.0 | | |
| 10 mi | SE | May 8 | 0210 | 60 | P | 28.4 | | 3 | 7.0-14.0 | | | |
| 10 mi | SE | May 8 | 0310 | 60 | P | 28.4 | 1 | 6.0 | 3 | 6.0-7.0 | | |
| 10 mi | SE | June 4 | 2115 | 60 | P | 28.6 | 2 | 7.7-3.3 | | | | |
| 10 mi | SE | June 4 | 2220 | 60 | P | 28.8 | 4 | 5.3-6.6 | | | | |
| 10 mi | SE | June 4 | 2330 | 60 | P | 28.9 | 1 | 6.6 | | | | |
| 10 mi | SE | June 5 | 0045 | 60 | P | 29.1 | 2 | 5.0-8.8 | | | | |
| 10 mi | SE | June 6 | 0035 | 60 | P | 29.1 | | | | | | |
| 10 mi | SE | June 6 | 0140 | 60 | P | 28.7 | | | | | | |
| 10 mi | SE | June 6 | 0245 | 60 | P | 28.7 | | | | | | |
| 10 mi | SE | June 6 | 0350 | 60 | P | 28.3 | | | | | | |
| 10 mi | SE | July 8 | 2310 | 60 | P | 28.3 | | 1 | 7.0 | | | |
| 10 mi | SE | July 9 | 0015 | 60 | P | 28.4 | | | | | | |
| 10 mi | SE | July 9 | 0125 | 60 | P | 28.3 | 1 | 3.4 | | | | |
| 10 mi | SE | July 9 | 0240 | 60 | P | 28.3 | | | | | | |
| 10 mi | SE | July 10 | 0005 | 60 | P | 27.7 | | | | | | |
| 10 mi | SE | July 10 | 0110 | 60 | P | 28.1 | | | | | | |
| 10 mi | SE | July 10 | 0220 | 60 | P | 27.8 | | 1 | 6.6 | | | |
| 10 mi | SE | July 10 | 0330 | 60 | P | 27.9 | | | | | | |
| 10 mi | SE | July 10 | 0440 | 60 | P | 27.8 | | | | | | |
| 6 mi | SE | Aug. 6 | 0000 | 60 | P | 28.8 | | | | | | |
| 6 mi | SE | Aug. 6 | 0115 | 60 | P | 28.2 | | | | | | |
| 6 mi | SE | Aug. 6 | 0220 | 60 | P | 28.4 | | | | | | |
| 6 mi | SE | Aug. 6 | 0325 | 60 | P | 28.3 | | | | | | |
| 12 mi | SE | Aug. 6 | 0020 | 60 | P | 28.1 | | | | 3 | 4.6-8.8 | |
| 12 mi | SE | Aug. 7 | 0125 | 60 | P | 28.1 | | | | | | |
| 12 mi | SE | Aug. 7 | 0230 | 60 | P | 28.1 | | 2 | 4.2-6.2 | | | |
| 12 mi | SE | Aug. 7 | 0330 | 60 | P | 28.2 | | 1 | 5.7 | | | |
| 12 mi | SE | Aug. 7 | 0435 | 60 | P | 28.1 | | | | | | |
| 20 mi | SE | Sept. 13 | 0100 | 60 | P | 28.0 | 7 | 5.2-6.4 | | | | |
| 20 mi | SE | Sept. 13 | 0205 | 60 | P | 27.9 | 2 | 5.2-5.4 | | | | |
| 20 mi | SE | Sept. 13 | 0315 | 60 | P | | 1 | 5.5 | | | | |
| 10 mi | SE | Sept. 14 | 2400 | 60 | P | 28.2 | | | | 4 | 4.8-5.7 | |
| 10 mi | SE | Sept. 14 | 0105 | 60 | P | 27.9 | | 4 | 6.4-7.5 | 5 | 6.1-7.4 | |
| 10 mi | SE | Sept. 14 | 0210 | 60 | P | 28.2 | 3 | 5.1-5.3 | 3 | 6.3-7.5 | | |
| 10 mi | SE | Sept. 14 | 0315 | 60 | P | 28.3 | | | | | | |
| 20 mi | SE | Sept. 14 | 0210 | 60 | P | 27.3 | 1 | 7.7 | | 5 | 4.4-7.5 | |
| 20 mi | SE | Oct. 25 | 0110 | 60 | P | 27.3 | | | | | | |
| 20 mi | SE | Oct. 25 | 0215 | 60 | P | 27.1 | | | | | | |
| 20 mi | SE | Oct. 25 | 0320 | 60 | P | 27.1 | | | | | | |
| 20 mi | SE | Oct. 25 | 0425 | 60 | P | 26.7 | | | | | | |
| 20 mi | SE | Nov. 24 | 0010 | 60 | P | 27.6 | | | | | | |
| 20 mi | SE | Nov. 24 | 0120 | 60 | P | 27.5 | 4 | 5.7-7.3 | | | | |
| 20 mi | SE | Nov. 24 | 0230 | 60 | P | 27.5 | 1 | 6.2 | 3 | 5.8-4.6 | 1 | 4.4 |

SPAWNING OF TUNAS

Table 5. Continued

| Location from Cape Blanco | | Date | Time started | Duration minutes | Type of net* | Surface Temp. °C | N. M. | | A. T. | | E. L. | |
|----------------------------------|-----|-------------|--------------|---------------------|--------------|------------------------------|-------|---------------|-------|---------------|-------|---------------|
| Lugar con respecto a Cabo Blanco | | Fecha | Hora | Duración en minutos | Tipo de red* | Temp. de la superficie en °C | No. | Tamaño en mm. | No. | Tamaño en mm. | No. | Tamaño en mm. |
| 20 mi | S | Nov. 24 | 0340 | 60 | L | 27.7 | | | | | | |
| 15 mi | S | Nov. 25 | 0007 | 60 | P | 27.7 | | | | | | |
| 15 mi | S | Nov. 25 | 0117 | 60 | L | 27.7 | | | | | | |
| 15 mi | S | Nov. 25 | 0225 | 60 | P | 27.6 | 1 | 5.5 | | | | |
| 15 mi | S | Nov. 25 | 0330 | 60 | L | 27.4 | | | | | | |
| 15 mi | S | Nov. 25 | 0435 | 60 | P | 27.4 | | | | | | |
| 1960 | | | | | | | | | | | | |
| 10 mi | S | Jan. 22 | 0000 | 60 | P | 27.7 | 2 | 4.1-4.4 | 1 | 3.8 | | |
| 10 mi | S | Jan. 22 | 0115 | 60 | L | 27.7 | | | | | | |
| 10 mi | S | Jan. 22 | 0220 | 60 | P | 27.4 | | | 18 | 2.2-4.2 | | |
| 10 mi | S | Jan. 22 | 0320 | 60 | L | 27.8 | | | | | | |
| 10 mi | S | Jan. 22, 23 | 2343 | 60 | P | 27.3 | 1 | 5.2 | | | | |
| 10 mi | S | Jan. 23 | 0050 | 60 | L | 27.8 | | | 20 | 3.3-6.6 | 9 | 4.1-5.5 |
| 10 mi | S | Jan. 23 | 0200 | 60 | P | 27.8 | | | 14 | 2.0-5.7 | 2 | 4.6-4.8 |
| 10 mi | S | Jan. 23 | 0305 | 60 | L | 27.8 | 1 | 7.7 | 6 | 4.4-9.7 | | |
| 20 mi | SSW | Feb. 25 | 0025 | 60 | P | 29.0 | | | | | | |
| 20 mi | SSW | Feb. 25 | 0140 | 60 | L | 28.8 | | | | | | |
| 20 mi | SSW | Feb. 25 | 0250 | 60 | P | 29.1 | | | | | | |
| 20 mi | SSW | Feb. 25 | 0400 | 60 | L | 28.9 | | | 1 | 4.0 | | |
| 15 mi | SSE | Feb. 26 | 0020 | 60 | P | 28.9 | | | | | | |
| 15 mi | SSE | Feb. 26 | 0130 | 60 | L | 28.8 | 1 | 5.1 | | | | |
| 15 mi | SSE | Feb. 26 | 0240 | 60 | P | 28.7 | 1 | 7.1 | | | | |
| 15 mi | SSE | Feb. 26 | 0400 | 60 | L | 28.8 | | | | | | |
| 20 mi | S | Mar. 30 | 0015 | 60 | P | 28.7 | 1 | 4.3 | 13 | 3.3-5.2 | | |
| 20 mi | S | Mar. 30 | 0120 | 60 | L | 28.7 | 1 | 5.0 | 17 | 3.5-5.4 | | |
| 20 mi | S | Mar. 30 | 0225 | 60 | P | 28.7 | 5 | 3.4-4.6 | 144 | 3.2-6.1 | 6 | 3.3-6.3 |
| 20 mi | S | Mar. 30 | 0330 | 60 | L | 29.0 | | | 8 | 5.4-6.6 | 19 | 4.3-8.6 |
| 10 mi | S | Mar. 31 | 0010 | 60 | P | 28.7 | 1 | 4.8 | 27 | 3.8-6.8 | | |
| 10 mi | S | Mar. 31 | 0120 | 60 | L | 28.6 | 1 | 6.2 | | | | |
| 10 mi | S | Mar. 31 | 0225 | 60 | P | 28.5 | 2 | 3.3-6.2 | 73 | 2.5-9.8 | 6 | 3.7-6.7 |
| 10 mi | S | Mar. 31 | 0330 | 60 | L | 29.3 | | | 24 | 3.8-8.6 | 4 | 6.6-8.3 |
| 25 mi | S | Apr. 21 | 0030 | 60 | P | 28.8 | 3 | 3.8-5.2 | 5 | 3.4-6.7 | | |
| 25 mi | S | Apr. 21 | 0135 | 60 | L | 28.6 | 7 | 3.3-8.5 | 40 | 4.2-7.2 | | |
| 25 mi | S | Apr. 21 | 0250 | 60 | P | 28.7 | 2 | 3.5-5.6 | 19 | 4.8-6.3 | | |
| 30 mi | S | Apr. 22 | 0010 | 60 | P | 28.6 | 1 | 4.4 | 3 | 4.2-5.2 | | |
| 30 mi | S | Apr. 22 | 0115 | 60 | L | 28.6 | | | 15 | 4.5-6.7 | | |
| 30 mi | S | Apr. 22 | 0225 | 60 | P | 28.5 | 5 | 3.8-4.8 | 6 | 5.3-29.0 | | |
| 20 mi | S | May 24 | 0010 | 60 | P | 28.6 | | | 1 | 6.6 | | |
| 20 mi | S | May 24 | 0125 | 60 | L | 28.1 | | | 5 | 3.4-6.2 | | |
| 20 mi | S | May 24 | 0245 | 60 | P | 28.2 | | | 5 | 4.4-5.8 | | |
| 10 mi | S | May 25 | 0010 | 60 | L | 28.6 | | | 1 | 6.2 | 1 | 6.5 |
| 10 mi | S | May 25 | 0120 | 60 | P | 28.7 | | | | | | |
| 10 mi | S | May 25 | 0230 | 60 | L | 28.5 | | | 4 | 5.4-6.3 | | |
| 20 mi | S | June 21 | 0007 | 60 | P | 28.0 | 1 | 4.3 | | | | |
| 20 mi | S | June 21 | 0115 | 60 | L | 27.9 | | | | | | |
| 20 mi | S | June 21 | 0220 | 60 | P | 27.8 | | | | | | |
| 10 mi | S | June 22 | 0005 | 60 | P | 28.3 | | | 1 | 6.4 | | |
| 10 mi | S | June 22 | 0115 | 60 | L | 28.3 | | | | | | |

Table 5. Continued

| Location from Cape Blanco | | Date | Time started | Duration minutes | Type of net* | Surface Temp. °C | N. M. | | A. T. | | E. L. | |
|----------------------------------|---|----------|--------------|---------------------|--------------|------------------------------|-------|---------------|-------|---------------|-------|---------------|
| Lugar con respecto a Cabo Blanco | | Fecha | Hora | Duración en minutos | Tipo de red* | Temp. de la superficie en °C | No. | Size mm. | No. | Size mm. | No. | Size mm. |
| | | | | | | | No. | Tamaño en mm. | No. | Tamaño en mm. | No. | Tamaño en mm. |
| 10 mi | S | June 22 | 0225 | 60 | P | 28.2 | | | | | | |
| 10 mi | S | July 21 | 0333 | 60 | P | 28.4 | | | | | | |
| 10 mi | S | July 21 | 0118 | 60 | L | 28.3 | | | | | | |
| 10 mi | S | July 21 | 0235 | 60 | P | 28.3 | | | | | | |
| 10 mi | S | July 21 | 2200 | 60 | P | 28.5 | | | | | | |
| 10 mi | S | July 21 | 2305 | 55 | L | 28.3 | | | 3 | 3.0-7.0 | 1 | 7.0 |
| 10 mi | S | July 22 | 0015 | 60 | P | 28.3 | | | 1 | 23.0 | | |
| 20 mi | S | Aug. 18 | 0005 | 60 | P | 27.3 | | | 1 | 4.0 | | |
| 20 mi | S | Aug. 18 | 0110 | 60 | L | 27.2 | | | | | | |
| 20 mi | S | Aug. 18 | 0215 | 60 | P | 26.9 | | | | | 1 | 6.0 |
| 10 mi | S | Aug. 19 | 0020 | 60 | L | 27.8 | | | | | | |
| 10 mi | S | Aug. 19 | 0130 | 60 | P | 27.0 | | | 6 | 4.0-6.0 | | |
| 10 mi | S | Aug. 19 | 0240 | 60 | L | 26.7 | | | 3 | 5.0-6.0 | | |
| 30 mi | S | Sept. 21 | 2330 | 60 | P | 28.2 | | | 14 | 4.5-5.5 | | |
| 30 mi | S | Sept. 21 | 2440 | 60 | L | 28.2 | | | 23 | 4.5-6.5 | | |
| 30 mi | S | Sept. 21 | 0145 | 60 | P | 28.1 | | | | | | |
| 10 mi | S | Sept. 22 | 2340 | 60 | L | 28.8 | | | | | | |
| 10 mi | S | Sept. 22 | 2445 | 60 | P | 28.4 | | | | | | |
| 10 mi | S | Sept. 22 | 0200 | 60 | L | 28.6 | | | 1 | 6.0 | | |
| 30 mi | S | Oct. 20 | 0010 | 60 | P | 28.7 | | | | | | |
| 30 mi | S | Oct. 20 | 0120 | 60 | L | 28.4 | | | 1 | 5.5 | | |
| 30 mi | S | Oct. 20 | 0225 | 60 | P | 28.3 | | | | | | |
| 10 mi | S | Oct. 21 | 0004 | 60 | L | 28.4 | | | | | | |
| 10 mi | S | Oct. 21 | 0110 | 60 | P | 28.7 | | | | | 1 | 7.5 |
| 10 mi | S | Oct. 21 | 0217 | 60 | L | 28.6 | | | | | | |

* P = plankton
L = larval

TABLE 6. Young tunas attracted with a night light and caught with a dip net off Cape Blanco, Costa Rica.**TABLA 6. Atunes jóvenes atraídos con una linterna y capturados con un carcal frente a Cabo Blanco, Costa Rica.**

| Location from Cape Blanco | | Date | No. | N. M. Size mm. | No. | A. T. Size mm. | No. | E. L. Size mm. |
|----------------------------------|------|-------------|-----|---------------------|-----|---------------------|-----|---------------------|
| Lugar con respecto a Cabo Blanco | | Fecha | No. | N. M. Tamaño en mm. | No. | A. T. Tamaño en mm. | No. | E. L. Tamaño en mm. |
| 1958 | | | | | | | | |
| 20 mi | S | Nov. 12/13 | | | 2 | 20-21 | | |
| 20 mi | S/SW | Nov. 13/14 | | | 5 | 25-41 | | |
| 20 mi | S | Dec. 26/27 | 1 | 26.0 | | | | |
| 15 mi | S | Dec. 26/27 | 1 | 27.0 | | | | |
| 1959 | | | | | | | | |
| 20 mi | S | Jan. 7/8 | | | 82 | 24-52 | 8 | 21-39 |
| 20 mi | S | Jan. 8/9 | | | 77 | 12-50 | 43 | 14-25 |
| 20 mi | S | Feb. 11/12 | 2 | 23,24 | 59 | 14-39 | 8 | 25-50 |
| 5 mi | SE | Mar. 11/12 | | | 190 | 10-39 | | |
| 20 mi | S | Apr. 8/9 | 12 | 16-20 | 29 | 12-34 | 4 | 11-25 |
| 5 mi | SE | Apr. 9/10 | 2 | 12,14 | 31 | 12-25 | 77 | 13-29 |
| 10 mi | SE | May 6/7 | 3 | 12-16 | 162 | 13-52 | 11 | 16-25 |
| 10 mi | SE | May 7 | | | 11 | 14-24 | | |
| 10 mi | W | June 5/6 | 1 | 18 | 67 | 14-66 | 2 | 17 ca. |
| 6 mi | S | July 9 | | | 169 | 9-21 | | |
| 6 mi | SE | Aug. 5 | | | | | 3 | 15-17 |
| 10 mi | S | Sept. 13/14 | | | 10 | 11-30 | | |
| 20 mi | S | Nov. 24 | | | 4 | 19-44 | 4 | 11.5-53 |
| 1960 | | | | | | | | |
| 10 mi | S | Jan. 22 | 8 | 10-14 | | | | |
| 10 mi | S | Jan. 22 | | | 524 | 6.6-35 | | |
| 20 mi | S/SW | Feb. 24 | 54 | 11-26 | 41 | 10-44 | 1 | 18 |
| 15 mi | SS/E | Feb. 25 | 5 | 11.5-13 | 64 | 9-49 | | |
| 20 mi | S | Mar. 29 | 2 | 22,29 | 22 | 14-30 | | |
| 10 mi | S | Mar. 30 | 7 | 8-31 | 650 | 10-33 | 12 | 15-28 |
| 25 mi | SS | Apr. 20/21 | | | 686 | 11-40 | | |
| 30 mi | S | Apr. 21/21 | | | 238 | 9.8-52 | | |
| 20 mi | S | May 23 | | | 571 | 9-35 | 14 | 13-21 |
| 10 mi | SS | May 24 | | | 192 | 10-45 | 6 | 9.5-24 |
| 20 mi | S | June 20 | | | 4 | 19-22 | | |
| 10 mi | S | June 21 | | | 7 | 18-35 | | |
| 10 mi | SS | July 20 | | | 132 | 10-36 | 4 | 13-17 |
| 10 mi | S | July 21 | | | 346 | 9-33 | 62 | 10-24 |
| 20 mi | S | Aug. 17 | | | 68 | 12-25 | 1 | 19 |
| 10 mi | SS | Aug. 18 | | | 2 | 12-26 | 3 | 12-18 |
| 30 mi | S | Sept. 20 | | | | | | |
| 10 mi | S | Sept. 21 | 22 | 11.0-11.5 | 77 | 10.5-25.0 | 51 | 12.5-24 |
| 30 mi | S | Oct. 20 | 10 | 13-21 | 33 | 9.5-25.0 | | |
| 10 mi | S | Oct. 21 | 7 | 20.5-30 | 186 | 10.5-30.0 | | |

TABLE 7. Young tunas from stomachs of vertebrates.

TABLA 7. Atunes jóvenes encontrados en los estómagos de vertebrados.

| Position | | Date | From stomach of | Species | No. | Size mm. |
|----------|---------|-------------|-------------------------------|-----------------------|-----|------------------|
| Lat. N | Long. W | | | | | |
| Posición | | Fecha | En el estómago de | Especie | No. | Tamaño en mm. |
| Lat. N | Long. W | | | | | |
| 8°45 | 83°55 | June 1938 | <i>Pelamis platurus</i> | <i>N. macropterus</i> | 8 | approx. 50 |
| 21°06 | 106°45 | March 1956 | <i>Katsuwonus pelamis</i> | <i>A. thazard</i> | 7 | — |
| 7°30 | 80°00 | April 1958 | <i>Neothunnus macropterus</i> | <i>A. thazard</i> | 3 | — |
| 7°00 | 84°00 | May 11 1958 | <i>Neothunnus macropterus</i> | <i>A. thazard</i> | 4 | 91 |
| 7°10 | 81°50 | May 20 1958 | <i>Neothunnus macropterus</i> | <i>A. thazard</i> | 2 | 65, 75 |
| 15°55 | 95°50 | Feb. 3 1959 | <i>Euthynnus lineatus</i> | <i>A. thazard</i> | 16 | 75-125 |
| 14°30 | 98°30 | March 1959 | <i>Neothunnus macropterus</i> | <i>A. thazard</i> | 1 | 60 |
| 6°30 | 77°40 | April 1959 | <i>Neothunnus macropterus</i> | <i>A. thazard</i> | 1 | 78 |
| 10°25 | 85°55 | May 1959 | <i>Neothunnus macropterus</i> | <i>N. macropterus</i> | 2 | 35, 40 |
| 18°30 | 104°30 | May 1959 | <i>Neothunnus macropterus</i> | <i>A. thazard</i> | 32 | approx. 90 |
| 19°30 | 110°30 | May 1959 | <i>Neothunnus macropterus</i> | <i>A. thazard</i> | 2 | 90 |

TABLE 8. Occurrence of tuna larvae in hauls made at various depths with Clarke-Bumpus samplers during TO 59-1 Cruise.**TABLA 8. Ocurrencia de larvas de atunes en arrastres hechos a diferentes profundidades con un muestreador Clarke-Bumpus durante el crucero TO 59-1.**

| Station | Time (local) | Depth of tow in m | Depth of thermocline in m | Number of larvae | | |
|----------|-----------------|--------------------------------------|--|------------------|-------|-------|
| | | | | N. M. | A. T. | E. L. |
| Estación | Hora (local) | Profundidad del arrastre en m. | Profundidad de la termoclina en m. | Número de larvas | | |
| | | | | N. M. | A. T. | E. L. |
| 10 | 1305-1320 | 74-103 | 20 | | | |
| | 1327-1348 | 36-49 | | | | |
| | 1349-1403 | 13-20 | | | 1 | |
| 12 | 1316-1331 | 82-111 | 24 | | | |
| | 1340-1355 | 23-29 | | | 2 | |
| | 1400-1416 | 13-16 | | | 2 | |
| 13 | 0127-0141 | 85-111 | 22 | | | |
| | 0105-0205 | 27-36 | | | | |
| | 0210-0225 | 6-7 | | | 13 | |
| 14 | 1304-1319 | 44-57 | 15 | | | |
| | 1320-1335 | 35-43 | | | | |
| | 1345-1400 | 20-26 | | | | |
| | 1404-1419 | 12-17 | | | 1 | |
| 32 | 2347-0002 | 74-92 | 16 | | | |
| | 0014-0029 | 38-49 | | | | |
| | 0033-0047 | 11-13 | | 3 | | |
| 36 | 2300-2315 | 90-113 | 48 | | | |
| | 2332-2338 | 54-74 | | | | |
| | 2345-2400 | 26-29 | | | 2 | |
| 38 | 0009-0024 | 19-24 | not well defined | | 20 | 1 |
| | 0029-0044 | Just below surface | | | 1 | |
| 42 | 1003-1018 | 126-166 | 38 | | | |
| | 1027-1042 | 87-116 | | | | |
| | 1354-1409 | 60-80 | | | | |
| | 1049-1104 | 44-57 | | | | |
| | 1415-1430 | 25-39 | | | 9 | |
| | 1110-1125 | 17-24 | | | 7 | |
| 46 | 2110-2125 | 87-119 | 28 | | | |
| | 1356-1411 | 83-111 | | | | |
| | 2133-2148 | 63-86 | | | | |
| | 1418-1433 | 64-83 | | | | |
| | 2149-2204 | 43-54 | | | | |
| | 2215-2230 | 29-41 | | | | |
| | 1500-1515 | 33-40 | | | | |
| | 1520-1535 | 23-32 | | | | |
| | 2236-2251 | 22-29 | | | | |
| | 2255-2310 | 13-16 | | | 1 | |
| | 1539-1554 | 12-16 | | | | |
| | 1600-1615 | Just below surface | | | 12 | |
| | 2315-2330 | Just below surface | | | 2 | |

TABLE 9. Occurrence of tuna larvae in hauls made at various depths with closing nets and in surface hauls made with standard nets during SCOT Expedition.

TABLA 9. Ocurrencia de larvas de atunes en los arrastres hechos a diferentes profundidades con redes obturantes y en los arrastres de superficie hechos con redes estándar durante la Expedición SCOT.

| Station | Type of net | Time (local) | Depth of tow in m | Depth of thermocline in m | No. of larvae | |
|----------|-------------|--------------|--------------------------------|------------------------------------|---------------|-------|
| | | | | | N. M. | A. T. |
| Estación | Tipo de red | Hora (local) | Profundidad del arrastre en m. | Profundidad de la termoclina en m. | No. de larvas | |
| | | | | | N. M. | A. T. |
| 23 | closing | | 18-32 | 27 | 1 | |
| | closing | | 118-162 | | | |
| | closing | | 225-273 | | | |
| 49 | standard | 1440-1510 | Just below surface | 7 | 169 | |
| | standard | 2001-2031 | Just below surface | | | |
| | closing | 0959-1015 | 12-21 | | | |
| 62 | closing | 1351-1411 | 149-173 | 31 | 1 | |
| | standard | 1026-1056 | Just below surface | | | |
| | closing | 0951-0936 | 7-17 | | | |
| 74 | closing | 0918-0936 | 33-50 | 24 | 11 | |
| | closing | 1302-1318 | 69-98 | | | |
| | standard | 1213-1243 | Just below surface | | | |
| 86 | closing | 1437-1452 | 10-23 | 33 | 3 | |
| | standard | 0910-0940 | Just below surface | | | |
| | closing | 1430-1445 | 24-35 | | | |
| 88 | closing | 0950-1005 | 52-66 | 23 | 1 | |
| | closing | 1234-1250 | 98-159 | | | |
| | standard | 0939-1009 | Just below surface | | | |
| 100 | closing | 0907-0923 | 5-12 | 24 | 1 | |
| | closing | 0840-0855 | 24-38 | | | |
| | closing | 1016-1031 | 45-61 | | | |
| 100 | closing | 0706-0721 | 82-94 | 24 | 1 | |
| | standard | 0816-0846 | Just below surface | | | |
| | closing | 1232-1255 | 46-55 | | | |
| | closing | 0936-0952 | 55-95 | | | |
| | closing | 0905-0920 | 41-79 | | | |

2

TABLE 10. Catches of tuna larvae in simultaneous surface and "300 meter" oblique plankton tows. Actual depth of each oblique tow and depth of the surface layer at each station is given.

TABLA 10. Capturas de larvas de atunes en los arrastres de plancton simultáneos de superficie y oblicuos a "300 metros." Se indica la profundidad real de cada arrastre oblicuo y la profundidad de la capa superficial en cada estación.

| Station No. | Time started (local) | Depth of tow m | Depth of surface layer in m. | Number of larvae per 1000 m ³ of water strained |
|--------------|----------------------|--------------------------------|--|--|
| Estación No. | Hora (local) | Profundidad del arrastre en m. | Profundidad de la capa superficial en m. | Número de larvas por 1000 m ³ de agua filtrada |
| 14 | 0150 | 0 | | 0 |
| | 0127 | 319 | 36 | 1.1 |
| 17 | 1200 | 0 | 65 | 8.8 |
| | 1152 | 306 | | 0 |
| 18 | 0140 | 0 | 80 | 1.2 |
| | 0132 | 306 | | 0 |
| 20 | 1714 | 0 | 72 | 1.3 |
| | 1709 | 297 | | 0 |
| 22 | 0050 | 0 | 65 | 14.9 |
| | 0031 | 278 | | 0 |
| 24 | 1454 | 0 | | 2.3 |
| | 1445 | 235 | 50* | 0 |
| 29 | 0138 | 0 | 39 | 11.0 |
| | 0139 | 290 | | 0 |
| 31 | 0125 | 0 | 70 | 2.9 |
| | 0120 | 274 | | 0 |
| 33 | 0125 | 0 | 33 | 14.9 |
| | 0116 | 298 | | 0 |
| 35 | 0350 | 0 | 20 | 48.2 |
| | 0343 | 256 | | 1.9 |
| 37 | 1214 | 0 | 20 | 4.5 |
| | 1206 | 208 | | 0 |
| 42 | 1145 | 0 | 23 | 1.6 |
| | 1156 | 309 | | 0 |
| 46 | 0152 | 0 | 31 | 9.1 |
| | 0139 | 284 | | 3.1 |
| 47 | 1232 | 0 | 20 | 8.1 |
| | 1226 | 299 | | 2.1 |
| 51 | 0144 | 0 | 26 | 2.1 |
| | 0136 | 306 | | 0 |
| 54 | 1950 | 0 | 20 | 1.7 |
| | 1944 | 280 | | 0 |
| 57 | 0139 | 0 | 19 | 7.8 |
| | 0130 | 293 | | 2.3 |
| 58 | 1220 | 0 | 21 | 4.1 |
| | 1214 | 248 | | 0 |
| 59 | 0134 | 0 | 10 | 18.9 |
| | 0122 | 253 | | 7.6 |

Table 10. Continued

| Station No. | Time started (local) | Depth of tow m | Depth of surface layer in m. | Number of larvae per 1000 m ³ of water strained |
|--------------|----------------------|--------------------------------|--|--|
| Estación No. | Hora (local) | Profundidad del arrastre en m. | Profundidad de la capa superficial en m. | Número de larvas por 1000 m ³ de agua filtrada |
| 69 | 0146 | 0 | 14 | 20.4 |
| | 0141 | 293 | | 2.0 |
| 70 | 1210 | 0 | 23 | 2.2 |
| | 1206 | 261 | | 0 |
| 71 | 0041 | 0 | 11 | 45.9 |
| | 0032 | 304 | | 5.4 |
| 72 | 1203 | 0 | 21 | 3.8 |
| | 1154 | 309 | | 0 |
| 74 | 1213 | 0 | 24 | 12.1 |
| | 1307 | 203 | | 0.8 |
| 75 | 0135 | 0 | 24 | 671.4 |
| | 0128 | 273 | | 0 |
| 77 | 0030 | 0 | 10 | 81.8 |
| | 0023 | 293 | | 0 |
| 78 | 0856 | 0 | 27 | 4.7 |
| | 0848 | 280 | | 0 |
| 79 | 1215 | 0 | 17 | 2.4 |
| | 1204 | 322 | | 12.7 |
| 81 | 0033 | 0 | 12 | 29.5 |
| | 0026 | 288 | | 4.8 |
| 84 | 1803 | 0 | 31 | 115.9 |
| | 1756 | 238 | | 4.8 |
| 85 | 2318 | 0 | 15 | 68.1 |
| | 2312 | 302 | | 12.8 |
| 86 | 0910 | 0 | 33 | 5.9 |
| | 0903 | 297 | | 0 |
| 87 | 1620 | 0 | 36 | 6.8 |
| | 1612 | 261 | | 9.6 |
| 88 | 0939 | 0 | 23 | 0 |
| | 0033 | 269 | | 1.1 |
| 89 | 1712 | 0 | 20* | 5.6 |
| | 1706 | 295 | | 1.0 |
| 90 | 2218 | 0 | 45 | 774.8 |
| | 2210 | 272 | | 97.9 |
| 91 | 0249 | 0 | 20 | 68.6 |
| | 0240 | 282 | | 19.9 |
| 92 | 1010 | 0 | 57 | 1.8 |
| | 0955 | 260 | | 4.2 |
| 93 | 1249 | 0 | 13 | 4.2 |
| | 1243 | 248 | | 5.1 |
| 94 | 1816 | 0 | 46 | 14.3 |
| | 1810 | 284 | | 14.3 |
| 95 | 1210 | 0 | 33 | 5.8 |
| | 1200 | 301 | | 0 |

Table 10. Continued

| Station No. | Time started (local) | Depth of tow m | Depth of surface layer in m. | Number of larvae per 1000 m ³ of water strained |
|--------------|----------------------|--------------------------------|--|--|
| Estación No. | Hora (local) | Profundidad del arrastre en m. | Profundidad de la capa superficial en m. | Número de larvas por 1000 m ³ of agua filtrada |
| 100 | 0816 | 0 | 24 | 1.0 |
| | 0811 | 270 | | 0 |
| 104 | 1239 | 0 | 20 | 41.7 |
| | 1235 | 243 | | 3.4 |
| 109 | 1212 | 0 | 50 | 1.9 |
| | 1207 | 243 | | 1.1 |
| 122 | 1254 | 0 | 34 | 3.2 |
| | 1249 | 275 | | 1.2 |
| 127 | 1211 | 0 | 23 | 4.4 |
| | 1214 | 310 | | 2.1 |
| 133 | 1220 | 0 | 27 | 1.1 |
| | 1213 | 297 | | 0 |
| 139 | 1219 | 0 | 20 | 15.5 |
| | 1213 | 301 | | 12.2 |
| 143 | 1209 | 0 | 20 | 5.4 |
| | 1159 | 292 | | 1.1 |
| Means | | 0 | 30.5 | 44.6 |
| | | 279.3 | | 4.8 |

* Estimated using Cromwell's publication (1958)

TABLE 11. Catches of tuna larvae in simultaneous surface and "140 meter" oblique plankton tows. Actual depth of each oblique tow and depth of the surface layer at each station is given.

TABLA 11. Capturas de larvas de atunes en los arrastres de plancton simultáneos de superficie y oblicuos a "140 metros." Se indica la profundidad real de cada arrastre oblicuo y la profundidad de la capa de superficie en cada estación.

| Station No. | Time started (local) | Depth of tow m | Depth of surface layer in m. | Number of larvae per 1000 m ³ of water strained |
|--------------|----------------------|--------------------------------|--|--|
| Estación No. | Hora (local) | Profundidad del arrastre en m. | Profundidad de la capa superficial en m. | Número de larvas por 1000 m ³ de agua filtrada |
| 96 | 2325 | 0 | 9 | 281.3 |
| | 2324 | 145 | | 84.3 |
| 99 | 0251 | 0 | 29 | 30.2 |
| | 0253 | 137 | | 5.3 |
| 101 | 1613 | 0 | 19 | 2.2 |
| | 1552 | 156 | | 0 |
| 102 | 0444 | 0 | 13 | 20.5 |
| | 0444 | 127 | | 0 |
| 103 | 0854 | 0 | 21 | 14.5 |
| | 0850 | 104 | | 8.8 |
| 105 | 1847 | 0 | 17 | 6.4 |
| | 1846 | 130 | | 7.5 |
| 106 | 2158 | 0 | 21 | 71.9 |
| | 2155 | 132 | | 23.0 |
| 107 | 0549 | 0 | 10 | 22.6 |
| | 0453 | 113 | | 0 |
| 110 | 1426 | 0 | 31 | 11.9 |
| | 1624 | 141 | | 0 |
| 111 | 1950 | 0 | 28 | 15.0 |
| | 1947 | 118 | | 8.3 |
| 112 | 1136 | 0 | 28 | 6.1 |
| | 2230 | 108 | | 2.1 |
| 117 | 1756 | 0 | 45 | 7.7 |
| | 1752 | 117 | | 0 |
| 118 | 2220 | 0 | 35 | 22.6 |
| | 2218 | 130 | | 0 |
| 119 | 0140 | 0 | 56 | 18.2 |
| | 0138 | 167 | | 0 |
| 120 | 0456 | 0 | 39 | 0 |
| | 0454 | 134 | | 2.6 |
| 121 | 0830 | 0 | 50 | 27.0 |
| | 0827 | 97 | | 9.8 |
| 123 | 1847 | 0 | 48 | 41.0 |
| | 1841 | 136 | | 0 |
| 124 | 2221 | 0 | 20 | 13.0 |
| | 2300 | 119 | | 0 |
| 125 | 0234 | 0 | 20 | 2.4 |
| | 0232 | 144 | | 0 |

Table 11. Continued

| Station No. | Time started (local) | Depth of tow m | Depth of surface layer in m. | Number of larvae per 1000 m ³ of water strained |
|--------------|----------------------|--------------------------------|--|--|
| Estación No. | Hora (local) | Profundidad del arrastre en m. | Profundidad de la capa superficial en m. | Número de larvas por 1000 m ³ de agua filtrada |
| 126 | 0700 0650 | 0 144 | 22 | 8.7 0 |
| 128 | 1645 1644 | 0 124 | 35 | 8.8 2.6 |
| 129 | 2024 2043 | 0 141 | 36 | 20.8 11.1 |
| 130 | 0014 0012 | 0 131 | 42 | 15.6 0 |
| 131 | 0458 0456 | 0 147 | 59 | 1.9 8.3 |
| 132 | 0825 0822 | 0 118 | 33 | 14.3 2.3 |
| 134 | 1758 1755 | 0 146 | 25 | 9.0 0 |
| 135 | 2042 2040 | 0 126 | 22 | 100.6 9.1 |
| 136 | 0113 0112 | 0 126 | 20 | 180.5 106.8 |
| 137 | 0458 0455 | 0 142 | 21 | 8.5 0 |
| 138 | 0757 0755 | 0 117 | 17 | 43.2 19.9 |
| 140 | 1637 1635 | 0 134 | 20 | 19.1 19.7 |
| Means | | 0 130.3 | 28.7 | 33.7 10.7 |

OBSERVACIONES SOBRE EL DESOVE DE CUATRO ESPECIES DE ATUN (*NEOTHUNNUS MACROPTERUS*, *KATSUWONUS PELAMIS*, *AUXIS THAZARD* Y *EUTHYNNUS LINEATUS*) EN EL OCEANO PACIFICO ORIENTAL, BASADAS EN LA DISTRIBUCION DE SUS LARVAS Y JUVENILES

por

Witold L. Klawe

INTRODUCCION

El conocimiento sobre los hábitos del desove es útil para el esclarecimiento de la historia natural, ecología y estructura de las poblaciones de atunes tropicales, y es esencial para la acertada administración de estos recursos. Hasta hace poco tiempo no se sabía mucho sobre el desove de los atunes o acerca de la distribución de sus larvas y juveniles en el Océano Pacífico Oriental. Nichols y Murphy (1944) informaron sobre la captura frente a Colombia de escómbridos jóvenes últimamente identificados como melva, *Auxis thazard* (Schaefer y Marr, 1948a). Fowler (1944) también informó sobre la captura de dos atunes jóvenes frente a Manzanillo, México, uno de los cuales era definitivamente *Neothunnus macropterus* y el otro era lo más probable que también lo fuera (Klawe, 1959). En 1947 se capturaron especímenes juveniles de *N. macropterus*, *K. pelamis*, *A. thazard* y *E. lineatus* frente a la América Central (Schaefer y Marr, 1948a, 1948b, y Schaefer, 1948). Otras recolecciones de ejemplares jóvenes de *N. macropterus*, *A. thazard* y *E. lineatus* fueron hechas en la misma área general durante la primavera de 1949 (Mead, 1951). En enero y febrero de 1955, Clemens (1956) efectuó experimentos de crianza de atunes jóvenes, *E. lineatus* y *A. thazard*, en acuarios a bordo para lo que empleó peces capturados frente a la América Central. Matsumoto (1958) informó sobre capturas de larvas de *N. macropterus* y *K. pelamis* en el área a lo largo del meridiano 120 de longitud oeste. Klawe (1958 y 1961b) ha dado cuenta también de capturas de larvas de *N. macropterus* y *Auxis* en las Islas Revillagigedo. Matsumoto (1959) ha informado recientemente acerca de capturas de ejemplares jóvenes de *Auxis* y *E. lineatus* en el Golfo de Panamá en enero de 1922 durante la Expedición Dana. Klawe (1960a) informó así mismo que durante la Expedición SCOT se capturaron juveniles de *K. pelamis*, *E. lineatus* y *Auxis* en el área frente a la zona tropical de México y en la región de las islas alejadas del continente.

Schaefer y Orange (1956) revisaron la literatura sobre el desove de los atunes tropicales en el Océano Pacífico, y valiéndose de los estudios sobre las gónadas explicaron las actividades concernientes al desove de los atunes de aleta amarilla y barriletes en algunas áreas del Océano Pacífico

Oriental. Orange (1961) ha ampliado esta investigación sobre las gónadas incluyendo todas las áreas del Océano Pacífico Oriental en donde se pescan estas especies en cantidades comerciales.

Aparentemente los atunes tropicales desovan en un área muy extendida; en conjunto la época de desove es muy extensa y cada pez no expulsa todas sus ovas de una sola vez.

A pesar de que el principal objetivo de la Comisión es la investigación sobre los atunes aleta amarilla y barriletes, este estudio incluye también especies que actualmente no son de importancia comercial, porque muchos de los problemas inherentes a la primera etapa de su historia natural son comunes también a los atunes de aleta amarilla y a los barriletes. Además, aunque los géneros *Euthynnus* y *Auxis* no son pescados en esta parte del mundo por los pescadores comerciales, son explotados en otras partes en forma comercial y utilizados como alimento para el hombre.

Los científicos de la Comisión han recolectado atunes jóvenes en las aguas del Océano Pacífico Oriental y en muchas ocasiones lo han hecho juntamente con científicos de la Institución Scripps de Oceanografía. Además, se puso a nuestra disposición una colección de escómbridos jóvenes obtenida por el personal del Biological Laboratory del Bureau of Commercial Fisheries de los Estados Unidos en La Jolla.

El estudio fué efectuado principalmente en el área general de la pesquería de atún en el Océano Pacífico Oriental, según la describen Shimada (1958) y Alverson (1959, 1960). Sin embargo, algunos datos son de tan al oeste como los 120°W de longitud que es el límite oriental de los estudios hechos por Matsumoto (1958) y Strasburg (1960).

Las definiciones aplicables al presente estudio son las siguientes:

- (1) Larva—pez que carece de todo el complemento de los radios de las aletas, especialmente de las espinas en la primera aleta dorsal (ver Matsumoto, 1959). Este término se aplica generalmente a los especímenes de hasta aproximadamente 11 mm. de longitud total, pero en muchos casos se aplica también a los atunes jóvenes capturados en las redes para plancton.
- (2) Juvenil—pez en que pueden contarse todos los radios de las aletas, i.e., peces pequeños con una longitud total de 12 mm. o más. En algunas ocasiones se han hecho generalizaciones que incluyen todos los atunes jóvenes capturados con luz artificial durante la noche.
- (3) Longitud total—la distancia directa entre la punta del hocico y la punta del radio mediano más corto de la aleta caudal.

El presente trabajo se refiere a los métodos y resultados de un estudio que tenía los siguientes objetivos:

- 1) Investigar el desove de los atunes en el Océano Pacífico Oriental por medio de la distribución de sus juveniles;
- 2) Investigar la ecología de estos atunes jóvenes;
- 3) Investigar la forma más eficaz en que deben recolectarse los atunes jóvenes para la obtención de datos representativos.

RECONOCIMIENTO

Aunque muchas personas y organizaciones han contribuido a la preparación de este informe, merecen particular mención los científicos de la Institución Scripps de Oceanografía de la Universidad de California y los del Biological Laboratory en La Jolla, especialmente el Director de dicho laboratorio, Dr. E. H. Ahlstrom. Gracias a la excelente cooperación de los capitanes y miembros de las tripulaciones de los barcos pesqueros atuneros fué posible recolectar especímenes a bordo de sus embarcaciones y esta colaboración es también reconocida con profunda gratitud.

Así mismo deseo manifestar mi agradecimiento a los miembros del personal científico de la Comisión que ayudaron a obtener los especímenes y datos utilizados en este estudio.

MATERIAL

Métodos de muestreo

Las fuentes del material fueron: (1) Por medio de arrastres con redes regulares, obturantes, o redes para larvas y con el muestreador Clarke-Bumpus agrandado; (2) Recolecciones hechas con un carcal en una embarcación a la deriva durante la noche, en donde se usa una luz para atraer a los peces y otros organismos marinos; (3) El contenido estomacal de varios peces y serpientes de mar. Los datos sobre las capturas por estos métodos están contenidos en las Tablas 1 a 9. En estas tablas se han abreviado los nombres de las especies como sigue: N. M. por *Neothunnus macropterus*, K. P. por *Katsuwonus pelamis*. A. T. por *Auxis thazard* y E. L. por *Euthynnus lineatus*.

El huevo del atún es pelágico, como lo es la larva que proviene de él. Ambos se encuentran en las capturas de zooplancton efectuadas con redes para plancton. Es difícil, o imposible, identificar por especies los huevos de los atunes, y aún distinguirlos de los huevos de otros peces pelágicos de tamaño y características similares; consecuentemente, no se ha intentado identificarlos ni enumerarlos.

La mayoría de las larvas capturadas se logró con redes de un metro de diámetro hechas de gasa fina de seda o de nylon (40 GG de la clasificación de Bodmer, o número 452 de Nitex) con un cedazo aún más fino de seda o de nylon en la sección posterior y con el extremo separable (56

GG de la clasificación de Bodmer, o número 295 de Nitex). La red más comúnmente usada fué la regular o sea la de tipo abierto. Los arrastres con redes obturantes fueron hechos con redes que pueden ser abiertas o cerradas después de haber sido bajadas a la profundidad deseada (Leavitt, 1935, 1938). En la boca de cada red se colocaron medidores de la corriente calibrados para registrar el volumen del agua filtrada en cada operación.

Se hicieron tres tipos de arrastres con las redes regulares: (1) arrastres oblicuos estándar desde una profundidad aproximada de 300 ó 400 metros; (2) arrastres a poca profundidad en los lugares en que el fondo no permitía un arrastre oblicuo estándar; y (3) arrastres de superficie horizontales, en los que la red pasaba exactamente debajo de la superficie.

El procedimiento usado en los arrastres oblicuos de tipo estándar ha sido descrito en "Data collected by Scripps Institution vessels on Eastropic Expedition" en S. I. O. Reference 56-28. Puede resumirse brevemente así: se hace descender la red desde la superficie hasta una profundidad de aproximadamente 300 metros soltando 450 metros de cable, o aproximadamente 140 metros soltando 200 metros de cable, y se recupera la red a una velocidad de más o menos dos nudos mientras el barco está en camino. La profundidad del arrastre se estima por el ángulo del cable y por la parte del mismo que queda fuera del agua. El ángulo del cable y consecuentemente la profundidad del arrastre varían un poco de un arrastre a otro.

En los lugares en donde el fondo no permitía hacer un arrastre oblicuo de tipo estándar a los 140 metros, se hizo un arrastre horizontal a la profundidad máxima a que se pudo bajar la red sin riesgo de perderla en el fondo. Este tipo de arrastre se hizo sólo en pocas ocasiones en la inmediata vecindad de las islas.

Los arrastres con redes obturantes se efectuaron con una red especial que se hacía descender a la profundidad deseada y entonces se abría por medio de un mensajero. Se efectuaba un arrastre horizontal a una profundidad determinada y luego se hacía bajar un mensajero para cerrar la red antes de su retorno a la superficie. La profundidad promedio del arrastre fué estimada por la longitud del cable fuera del agua y por el ángulo del mismo.

En algunos de los cruceros se usaron los muestreadores Clarke-Bumpus agrandados (Paquette, Scott y Sund, 1961) para obtener muestras de plancton de diferentes profundidades. La malla de nylon empleada en el muestreador Clarke-Bumpus era más grande que la usada para las redes de tipo regular y para las redes obturantes; estaba hecha con el número 706 de Nitex en el cuerpo y con el número 316 de Nitex en el extremo del muestreador.

Se efectuó una serie especial de recolecciones mensuales por medio de arrastres superficiales frente a Cabo Blanco, Costa Rica, con redes para plancton de medio metro (abertura de la boca 0.5 m.) construídas con gasa fina de nylon número 452 de Nitex en el cuerpo y con gasa fina de nylon número 295 de Nitex en la sección posterior y en el extremo. También se usó una red para larvas que era idéntica en forma y tamaño a la red para plancton, pero la malla de toda la red era de nylon "bobbinet" (un producto de Marion Textiles, Nueva York) de aproximadamente un milímetro de diámetro.

El zooplancton recolectado con las diversas redes fué conservado en formol al cuatro por ciento (aproximadamente 1.6 de solución acuosa de formaldehído) al que se le agregó bórax comercial como "buffer". El volumen del agua muestreada en cada arrastre fué determinado por un método descrito por el personal de South Pacific Fishery Investigations del U. S. Fish and Wildlife Service (1953).

Las recolecciones de zooplancton fueron clasificadas por medio de un microscopio binocular y todos los peces pequeños fueron separados de las muestras. Las larvas de atún fueron clasificadas y separadas de los pequeños peces e identificadas por especies.

Como las recolecciones de plancton proporcionan datos tanto cualitativos como cuantitativos, sirvieron como base principal del estudio. A continuación detallamos las expediciones durante las cuales se recolectaron las muestras de plancton utilizadas en este estudio:

| Año | Mes | Expedición | Referencia |
|------|---------|-----------------------|-------------------------------|
| 1952 | V-VIII | SHELLBACK | Wooster (1952) |
| 1955 | X-XII | ÉASTROPIC | SIO Reference 56-28 (1956) |
| 1956 | XI-XII | SCOPE | Holmes <i>et al</i> (1958) |
| 1957 | V-VI | ISLAND CURRENT SURVEY | Bennett y Schaefer (1960) |
| 1957 | VII | TUNA SPAWNING SURVEY | Klawe (1958 y 1961b) |
| 1958 | IV-VI | SCOT (TO 58-1) | Holmes y Blackburn (1960) |
| 1958 | X-XII | TO 58-2 | Blackburn <i>et al</i> (1962) |
| 1959 | I-II | TO 59-1 | Blackburn <i>et al</i> (1962) |
| 1959 | VIII-IX | TO 59-2 | Blackburn <i>et al</i> (1962) |
| 1959 | XI-XII | COSTA RICA DOME | |

Las estaciones en donde se hicieron arrastres para la obtención de plancton se indican en la Figura 1 para cada crucero. Los numerosos arrastres que se hicieron durante la TUNA SPAWNING SURVEY (Julio, 1957) en las vecindades de las Islas Revillagigedo han sido marcados con sombreado apropiado.

Además, la California Cooperative Oceanic Fishery Investigations ha recolectado plancton regularmente desde 1949 (ver Figura 1) en las

áreas frente a California, a Baja California y en el Golfo de California. Las larvas de atún de estas recolecciones han sido examinadas para el presente estudio (Tabla 3). Las recolecciones de plancton hechas por el Consejo de Investigaciones Hidrobiológicas desde 1958 en aguas peruanas (zona sombreada a lo largo de la costa peruana en la Figura 1) fueron también examinadas buscando larvas de atunes.

En noviembre de 1958 el personal del laboratorio de la Comisión en Puntarenas, Costa Rica, comenzó a recolectar mensualmente larvas y juveniles de atunes a una distancia de 5 a 20 millas frente a Cabo Blanco para determinar la época de desove de los diversos atunes en el área. Las recolecciones se hicieron durante las horas de oscuridad, generalmente por tres noches consecutivas cada mes. Se emplearon los tres métodos siguientes: (1) arrastres con una red para plancton estándar en forma de cono con una abertura de 0.5 m. de diámetro en la boca; (2) arrastres con una red para larvas idéntica en su forma y tamaño a la red para plancton pero hecha con diferente tipo de malla con aberturas más grandes; y (3) pescas con carcal con una luz suspendida a bordo de una embarcación a la deriva. Las dos redes fueron rastreadas en la superficie, generalmente durante una hora.

El hecho de que a los atunes pequeños se les atrae con luz artificial durante la noche ha sido utilizado para capturar atunes jóvenes con carcales. En las noches serenas se suspendía una lámpara eléctrica sobre la borda de una embarcación a la deriva para atraer atunes jóvenes entre otros organismos. En la Figura 2 se muestra la frecuencia, por intervalos de un milímetro de tamaño, de la aparición de *Auxis* jóvenes capturados durante la expedición Eastropic; las recolecciones hechas con luz artificial durante la noche y las realizadas con redes para plancton se indican separadamente. Es interesante anotar que prácticamente todos los *Auxis* capturados con redes para plancton son larvas de menos de 10 mm. de longitud, mientras que los especímenes recolectados atrayéndolos con la luz son de mayor tamaño y sólo unos pocos ejemplares son de menos de 10 mm. Como hemos aceptado la definición de Matsumoto sobre las larvas de los atunes, i.e. que son peces que carecen del total complemento de los radios de las aletas (especialmente en la aleta dorsal), prácticamente todos los peces capturados durante la noche se encuentran en un estado de mayor avance que el correspondiente a dicha definición.

Un pequeño número de los atunes jóvenes usados en este estudio ha provenido del contenido estomacal de peces pelágicos y de serpientes de mar (*Pelamis platurus*) (Tabla 7). Cuando los especímenes así obtenidos estaban digeridos hasta el punto de que no podían ser fácilmente identificados por especies, se examinaron las estructuras óseas mediante el teñido y aclarado de los especímenes. Los detalles de la identificación de este material están contenidos en un estudio de Yabe *et al* (1958) y en otro de Klawe (1961a).

Problemas del muestreo

Para determinar la distribución vertical de las larvas de los atunes, se examinaron y analizaron las capturas hechas con los muestreadores Clarke-Bumpus y con las redes obturantes. Los resultados demuestran que solamente los arrastres hechos sobre la termoclina o en ella contenían larvas de atunes (Tabla 8). Se obtuvo mayor evidencia por medio de las capturas de la Expedición SCOT hechas a varias profundidades con redes obturantes y con redes estándar (Tabla 9). Estas capturas, así como las realizadas con los muestreadores Clarke-Bumpus, indican la ausencia de larvas debajo de la termoclina. Sin embargo, con una red obturante arrastrada a una profundidad que varió de 82 a 94 metros (Estación 88, Tabla 9) se capturó una sola larva en un lugar en que la termoclina se encontraba en los 23 metros. Se cree que las capturas con este tipo de red son más susceptibles de contaminación que las que se efectúan con los muestreadores Clarke-Bumpus, y que esta larva en realidad puede haber sido pescada en aguas sobre la termoclina.

No es sorprendente esta asociación de las larvas con la capa de agua de mezcla. Es muy probable que los huevos pelágicos de los atunes no se hundan debajo de la picnoclina, la cual está bien definida por la termoclina en nuestra área de estudio. La asociación de los huevos de otro escómbrido, como por ejemplo la caballa del Atlántico, *Scomber scombrus*, con la capa de mezcla ha sido demostrada por Sette (1943), quién también demostró que las larvas de *S. scombrus* se presentan en la capa de mezcla hasta la termoclina y que probablemente no descienden debajo de esa zona. Matsumoto (1958) informa haber capturado pequeños números de larvas de atunes con una red obturante a profundidades de cerca de 300 metros, (i.e. considerablemente debajo de la termoclina) pero sospecha la posibilidad de una contaminación de las capturas con larvas cogidas mientras la red era bajada o subida a través de la capa superficial.

Más aún, a causa de su pronunciada gradiente termal, la termoclina puede actuar no sólo como una barrera para las larvas sino que puede ser también un sitio en donde tiene lugar algo de la mortalidad de éstas. Strasburg (1959) presenta evidencia de que la no continuidad termal lateral en la capa superficial puede ser la causa de la mortalidad en masa que él observó en las larvas de *Auxis*. (Si aplicamos este razonamiento a las larvas que pasan a través de la termoclina, nuevamente tenemos que el cambio abrupto de temperatura puede ser la causa de la muerte de las larvas). Esto puede ocurrir por "muerte termal" directa a causa de no tolerar el cambio rápido de temperatura, o por muerte indirecta causada por los cambios en la actividad muscular lo que debilita a las larvas y las deja indefensas contra la excesiva predación. La permanencia prolongada de las larvas de atún debajo de la termoclina probablemente podría retardar el desarrollo larval, ya que se extendería la duración de este estado de su vida y, en consecuencia, se extendería su exposición a los peligros de la

mortalidad larval que se cree son mayores que los de los peces juveniles o adultos.

Hasta la fecha no se han recolectado datos relativos a la distribución de las larvas dentro de la capa de agua de mezcla en sí. Desde luego que una notable variación diurna en las capturas de las larvas debida a sus migraciones verticales o a su habilidad para evitar mejor las redes en ciertos momentos del día tiene que introducir una variabilidad considerable en la determinación de la abundancia de las larvas. Wade (1951), Matsu-moto (1959) y Strasburg (1960), después de examinar los resultados de las capturas con redes de arrastre hechas a poca profundidad llegaron a la conclusión de que las larvas de *Katsuwonus* y de *Auxis* eran más numerosas en los arrastres nocturnos que en los hechos a la luz del día. No observaron aumento alguno en la tasa de la captura de *Neothunnus* en los arrastres durante la noche. Sus conclusiones se basaron en el análisis del promedio de las capturas durante periodos de dos horas del día.

En la Figura 3 se muestran los valores medios de las capturas por periodos de dos horas efectuadas durante los cruceros Eastropic, SCOPE, Island Current Survey, Tuna Spawning Survey, SCOT, TO 58-2 y TO 59-1, por especies y clase de arrastre, i.e. (1) de superficie, (2) a "140 metros," y (3) arrastres oblicuos a "300 metros." Estos valores, basados en 227 arrastres de superficie, 122 arrastres a 140 metros y 415 a 300 metros, incluyen tanto los arrastres productivos como los no productivos. Muchos de los arrastres de captura cero fueron hechos en áreas en las que no se esperaba encontrar larvas. Sin embargo, éstos ocurrieron al azar con respecto al tiempo y no deben inclinar a un lado ni a otro la comparación de la abundancia de larvas entre las capturas hechas de noche y de día.

Las capturas de larvas por arrastre (Tabla 2) indican una distribución contagiosa de las larvas. El número de larvas de *Auxis* en las pescas de arrastres de superficie varía de 0 a cerca de 2000 larvas por cada 1000 metros de agua filtrada por la red. Las capturas de larvas de *Neothunnus* exhibieron una fluctuación de naturaleza similar. Las capturas más frecuentes oscilan entre 1 y 10 larvas por cada 1000 metros de agua filtrada.

Debe ponerse especial cuidado en la interpretación del aspecto cuantitativo de la distribución de las larvas porque es obvio que un arrastre que contiene un gran número de larvas influye mucho en el valor promedio.

Esta gran variabilidad en el número de larvas capturadas en cada arrastre movió al autor a usar una prueba de clasificación (la Prueba U de Mann-Whitney) para evaluar la diferencia entre las capturas nocturnas y diurnas de *Neothunnus* y *Auxis* en las tres categorías de arrastres. Los efectuados entre 0600 y 1759 fueron clasificados como capturas diurnas y los efectuados entre 1800 y 0559 como capturas nocturnas. Se usaron las capturas de cada uno de los arrastres y se incluyeron los que no contenían larvas. Como puede verse en la tabla que sigue a continuación,

las diferencias entre las pescas nocturnas y las diurnas son evidentes y significativas en cuanto al número de larvas de *Auxis* en los arrastres de superficie y en los oblicuos a "300 metros." (Sorpresivamente, estas diferencias no son evidentes en las capturas de larvas de *Auxis* en los arrastres oblicuos a "140 metros." Por supuesto, es de esperarse que las capturas de ambos tipos de arrastres oblicuos debieran mostrar la misma tendencia). Por medio de esta prueba no hay evidencia de que hayan diferencias entre las capturas nocturnas y diurnas de larvas de *Neothunnus* en ningún tipo de arrastre.

Comparación estadística de la abundancia de las larvas de *Neothunnus* y de *Auxis* en los arrastres nocturnos y diurnos con redes para plancton

| Tipo de arrastre | <i>Neothunnus</i> | <i>Auxis</i> |
|------------------------|-------------------|------------------|
| En la superficie | p = .12 | p = menos de .01 |
| Oblicuo a "140 metros" | p = .94 | p = .60 |
| Oblicuo a "300 metros" | p = .29 | p = .01 |

Las mejores capturas de larvas de *Auxis* han sido hechas en los arrastres de superficie durante la noche. Esto puede ser causado por la migración diurna de las larvas o por su habilidad para evitar las redes en ciertos momentos del día. Es posible que también haya un aumento en las capturas de larvas de *Auxis* en ambos tipos de arrastres oblicuos (a "140 y a 300 metros"). Si ésto es cierto, entonces la evasión de las larvas es especialmente responsable por el aumento, porque podemos suponer que los arrastres oblicuos tanto a "300 metros" como a "140 metros" muestrean en todo el radio de la distribución vertical de las larvas.

Si se hicieran arrastres a diferentes horas del día y de la noche con diversos muestreadores de Clarke-Bumpus espaciados a diferentes profundidades dentro de la capa de mezcla, aclararían el problema de los movimientos migratorios diurnos. Sería conveniente realizar arrastres oblicuos simultáneos. Debe anotarse que debido a la distribución contagiosa del número de larvas por arrastre, sería necesario efectuar un gran número de arrastres.

METODOS DE ANALISIS

La información sobre las épocas y áreas de desove de los atunes puede obtenerse mediante la observación de la aparición de huevos o de atunes recién nacidos en un área determinada, o bien por medio del examen de los adultos para ver los signos de maduración de las gónadas o de un reciente desove. El segundo método, que comprende el examen de los ovarios de los atunes capturados por los pescadores comerciales, conduce a deducciones útiles en cuanto al desove de los atunes; sin embargo, por ser menos directo debe considerársele cuidadosamente por las siguientes razones: (1) Los atunes adultos son nadadores veloces, capaces de cubrir largas distancias en cortos períodos de tiempo, de modo que el lugar de

la captura de peces que han desovado recientemente, o de peces con gónadas casi maduras, puede estar bastante lejos del lugar en que realmente se realizó el desove. (2) Los atunes de aleta amarilla y barriletes acercándose a la madurez rara vez son capturados por la pesquería comercial, ya sea con caña y anzuelo o con redes de cerco. Sin embargo, a pesar de estas limitaciones, el método tiene algunas ventajas; entre éstas la más importante es que es posible examinar con bastante regularidad los peces capturados en varias partes de Océano Pacífico Oriental. Este método para el estudio del desove de los atunes ha sido dado a conocer por Schaefer y Orange (1956) y por Orange (1961).

El método alternativo de obtener información sobre los lugares y estaciones de desove, que es por medio de la recolección e identificación de atunes del Pacífico Oriental en los primeros estados de su desarrollo, no está exento de dificultades. Algunos de los problemas inherentes son: (1) Hasta ahora no ha sido posible identificar por géneros y especies los huevos pelágicos de varios atunes; (2) Los primeros estados larvales de la especie *Neothunnus macropterus* no pueden ser identificados con absoluta seguridad; (3) El costo para la obtención de colecciones de estados larvales y juveniles de las diferentes áreas del Océano Pacífico Oriental en forma regular es prohibitivo, debido a la necesidad de emplear barcos de investigación.

Se ha llegado a asumir que la presencia de peces muy jóvenes indica reciente desove en el área o cerca del lugar de la captura (Klawe y Shimada, 1959; Klawe 1960b y 1961a); ésto parece razonable porque (1) se cree que el tiempo para la eclosión de los huevos de los atunes es corto, aproximadamente de dos días a lo más (Sanzo 1932, 1933; Vodyanitsky, 1936, y comunicación personal del Dr. Hiroshi Nakamura sobre la eclosión de los huevos de la especie *Parathunnus sibi*); (2) los atunes jóvenes crecen muy rápidamente (Clemens, 1956); y (3) la velocidad de las corrientes de superficie dentro del Océano Pacífico Oriental Tropical no parece ser grande (Cromwell, 1958; Cromwell y Bennett, 1959.)

El número de larvas de las diferentes especies de atunes ha sido estimado por cada 1000 metros cúbicos de agua filtrada por la red. Como se dijo anteriormente, las larvas de los atunes en el Océano Pacífico Oriental se obtienen en la capa de agua sobre la termoclina. En consecuencia, es de esperarse que los arrastres hechos a profundidades de 300 o de 140 metros filtren una considerable cantidad de agua "estéril" de debajo de la termoclina, i.e. agua desprovista de larvas de atún. Para estandarizar los arrastres a una base común de modo que pudieran hacerse comparaciones cuantitativas, se han derivado factores de corrección para hacer que todos los arrastres sean equivalentes a los arrastres de superficie. Durante la Expedición SCOT, en varias estaciones se hicieron arrastres simultáneos a diversas horas del día y de la noche con dos redes de construcción idéntica. Se arrastró una red exactamente debajo de la super-

ficie y la otra fué empleada para hacer arrastres oblicuos a profundidades de 300 metros o de 140 metros aproximadamente. Los datos correspondientes a estos arrastres dobles han sido tabulados en las Tablas 10 y 11 que muestran: (1) la profundidad de cada arrastre, (2) la profundidad de la termoclina en una estación dada, y (3) la captura de larvas de atunes por cada 1000 metros cúbicos de agua filtrada por la red.

Se ha examinado la correlación entre el número de larvas de atunes capturadas en los arrastres simultáneos de superficie y oblicuos y ha demostrado ser significativa al nivel del uno por ciento de probabilidad (véase a continuación).

Correlación entre el número de larvas (x) capturadas en los arrastres de superficie y en los oblicuos durante la Expedición SCOT.

Datos transformados por $x' = \log \frac{x + 1}{1000 \text{ m}^3 \text{ agua filtrada}}$

| Arrastres de superficie versus: | No. de arrastres simultáneos | Valor calculado de r |
|--|-------------------------------------|-----------------------------|
| Arrastres a "140 metros" | 31 | .476 |
| Arrastres a "300 metros" | 49 | .415 |

El examen de las capturas promedio de las larvas de atunes correspondientes a los dos grupos indica que, en lo que se refiere a los 49 arrastres dobles de superficie y oblicuos a "300 metros", los de superficie capturaron 9.2 veces más larvas en promedio que los arrastres de profundidad. Cuando se hace la comparación entre los arrastres de superficie y los oblicuos a "140 metros", los primeros capturaron en promedio sólo 3.2 veces más larvas que los segundos.

Para probar la racionalidad de las cifras anteriores, se calculó la proporción del total de agua filtrada con relación al total de agua filtrada sobre la termoclina con respecto a los dos tipos de arrastre. Se obtuvo la proporción de 9.2 y de 4.5 para los 49 arrastres a "300 metros" y para los 31 a "140 metros", respectivamente. Estos valores son similares a las proporciones de 9.2 y 3.2 que se obtuvieron cuando se compararon las capturas de las larvas de los arrastres de superficie con las de los arrastres oblicuos a "300" y a "140" metros, respectivamente. Debe hacerse notar que inherentes a estos cálculos hay diversas clases de errores de muestreo que se producen por inseguridad en la determinación de: (1) la cantidad de agua filtrada debido a los errores en la calibración de los medidores de la corriente, (2) la profundidad de arrastre, y (3) la profundidad de la termoclina, la cual es estimada en forma objetiva por medio de las placas del batitermógrafo. (En algunas estaciones, cuando se carecía de los perfiles batitermográficos, la profundidad de la termoclina se tomó del promedio de las cartas preparadas por Cromwell, 1958). Debe recalcar el hecho de que en la transformación de los datos se han omitido las posibles migraciones diurnas.

Para poder comparar aproximadamente las capturas de las larvas de los arrastres oblicuos con las de los arrastres de superficie, el número de larvas por 1000 metros de agua filtrada se multiplicó por 9.0 para los arrastres a "300 metros", y por 4.5 para los efectuados a "140 metros". Es obvio que tales ajustes son aproximaciones, pero se considera que las cifras resultantes reflejan la abundancia relativa de las larvas de atunes en el Océano Pacífico Oriental.

Quizás podría obtenerse un ajuste más preciso mediante la multiplicación de la captura de cada uno de los arrastres oblicuos por la proporción de la profundidad del arrastre con relación a la profundidad de la capa de mezcla en el lugar y en el tiempo preciso en que el arrastre se efectuó. Sin embargo, en vista de la naturaleza contagiosa de la distribución de las larvas de atunes y de otras causas de la variabilidad del muestreo, no se consideró que ésto era valioso para este estudio.

Las Figuras 4 a 7 muestran la abundancia de las larvas, calculada por áreas de un grado en la forma antes indicada, según los arrastres con redes para plancton realizados durante las siguientes expediciones: EASTROPIC, SCOPE, TUNA SPAWNING SURVEY, SCOT, TO 58-2 y TO 59-1. Los puntos indican las capturas cero. Solamente se consideraron las dos especies más abundantes: *Neothunnus macropterus* y *Auxis thazard*. Con el fin de examinar aproximadamente las variaciones estacionales, se prepararon las figuras para dos períodos de seis meses, ya que los datos eran insuficientes para una estratificación de tiempo más precisa.

DISTRIBUCION DE LOS ATUNES JOVENES Y EPOCAS DE DESOVE EN EL OCEANO PACIFICO ORIENTAL

Los arrastres de plancton proporcionan datos útiles tanto cuantitativos como cualitativos. Las recolecciones nocturnas con luz artificial o las hechas del contenido estomacal de vertebrados marinos dan muy pocos datos de naturaleza cuantitativa. Por lo tanto, las conclusiones que se presentan en este trabajo están basadas en gran parte en las capturas de larvas de atunes hechas con redes para plancton. Los arrastres con estas redes se efectuaron en el área indicada por las líneas a guiones en las Figuras 4 a 11. En las Figuras 8 a 11 se muestran los lugares en que se capturaron atunes jóvenes. Estas últimas figuras están basadas en colecciones examinadas por el autor y además en las referidas en la bibliografía sobre atunes jóvenes del Océano Pacífico Oriental.

El desove de los atunes es de una naturaleza más o menos estacional. Los datos obtenidos frente a Costa Rica durante un período de dos años, Tabla 5, demuestran claramente que la intensidad del desove de varios atunes no es la misma en todo el año. En el área frente a Baja California, que ha sido relativamente bien muestreada desde 1949 por la California

Cooperative Oceanic Fishery Investigations, se capturaron larvas de *Neothunnus macropterus*, *Euthynnus lineatus* y *Auxis thazard* solamente en ciertas épocas del año (Tabla 3).

Desafortunadamente no disponemos de datos que hayan sido recogidos en una forma similar y continua en otras partes del Océano Pacífico Oriental para hacer comparaciones. La mayoría de nuestras capturas no están bien distribuídas ni en el tiempo ni en el espacio; sin embargo, pueden apreciarse tendencias que más bien parecen reflejar un desove estacional.

No obstante el hecho de que las recolecciones que sirvieron de base para preparar las Figuras 4 a 7 fueron esporádicas, es evidente que existen algunas diferencias estacionales en la abundancia de larvas. Por ejemplo, si examinamos las capturas frente al centro y al sur de México, en donde se hicieron recolecciones de plancton en enero, febrero, mayo, junio, septiembre, octubre, noviembre y diciembre, podemos ver que la abundancia de las larvas de los atunes de aleta amarilla es mayor en el período mayo-octubre (Figura 4) que en el período noviembre-abril (Figura 5). Esto refleja el hecho de que el máximo del desove ocurre frente al centro de México en los trimestres segundo y tercero como lo infirió Orange (1961).

Según la Figura 4, es evidente que las capturas de larvas de atunes aleta amarilla en el área frente a las Islas Revillagigedo fueron hechas en el período de mayo a octubre. Este hecho ciertamente apoya la conclusión a que se llegó basándose en los estudios de las gónadas. Sin embargo, durante el período noviembre-abril prácticamente no se hicieron recolecciones en las vecindades de estas islas.

No hay evidencia en estas cartas de un desove estacional del atún de aleta amarilla frente a la América Central, mientras que nuestras recolecciones mensuales frente a Cabo Blanco y nuestros estudios sobre las gónadas sí dan evidencia de una variación estacional en el monto del desove. Lo más probable es que ésto sea debido a lo inadecuado de los datos obtenidos en aquella área, los que han servido de base para la confección de dichas cartas.

Las capturas de larvas de atunes de aleta amarilla en aguas mar afuera no adyacentes a las islas oceánicas se realizaron en la región de la Contracorriente (5°—12°N) en el período mayo-octubre. Esto sugiere que el desove en esta área puede ser más intenso en la primavera o en el verano. Sin embargo, debe remarcarse de nuevo que durante el período noviembre-abril no se efectuó en las mismas aguas una recolección de comparable intensidad. Se necesitan más datos de la mayoría de las regiones del Océano Pacífico Oriental para confeccionar cartas que proporcionen una información adecuada sobre las variaciones estacionales de la abundancia de larvas.

La información sobre el desove de las diversas especies de atunes en el Pacífico Oriental Tropical puede resumirse como sigue:

Atún de aleta amarilla, *Neothunnus macropterus*

Extensión del desove

La Figura 8 muestra la distribución de los lugares de captura. Se han empleado diferentes símbolos para las capturas hechas por medio de redes para plancton y de carcales con luz artificial durante la noche, y para los especímenes encontrados en los estómagos de pescados y de serpientes de mar.

Se recolectaron larvas hasta en lugares tan al norte como 46 millas al SW de Punta Abreojos frente a Baja California ($26^{\circ}09'N$, $114^{\circ}08'W$). El punto más al sur de la recolección dentro de nuestra área de investigación fué frente a Punta Elena, justo al norte del Golfo de Guayaquil, Ecuador. También se capturaron larvas mar afuera, pero sólo al norte de los $3^{\circ}N$.

Es de gran interés que no se encontraran larvas en las localidades mar afuera al sur de los $5^{\circ}N$, excepto por la ocurrencia en los alrededores de los $3^{\circ}N$ a lo largo del meridiano 120° . Esto sugiere que, en nuestra área de investigación, el desove mar afuera se opera en la Contracorriente pero que hay muy poco desove, si lo hay, en las aguas de la Corriente del Perú o en su extensión como la Corriente Sudecuatorial.

Baja California. Esta área, que parece representar la región más al norte del desove de los atunes de aleta amarilla, ha sido muestreada concienzudamente en varias épocas del año desde 1949 por barcos de la California Cooperative Oceanic Fishery Investigations. Sólo en unas pocas ocasiones se han capturado larvas de atunes de aleta amarilla en estas aguas. En noviembre de 1956, el autor capturó con un carcal un espécimen juvenil en la vecindad del Banco Lusitania ($23^{\circ}36'N$, $111^{\circ}42'W$). En otra ocasión, en octubre de 1958, se recolectaron especímenes juveniles cuando científicos de CCOFI capturaron 16 larvas en 8 estaciones frente a Baja California (Tabla 3). Sobre la base de estos hechos, se puede llegar a la conclusión de que esta área, que es la más intensivamente muestreada en el Océano Pacífico Oriental, es sólo de menor importancia para el desove de *N. macropterus* y que, a juzgar por la presencia de estas larvas y juveniles, el desove se opera en los comienzos del otoño. Esto concuerda en conjunto con las conclusiones de Schaefer y Orange (1956) y de Orange (1961) de que no es una importante área de desove.

Golfo de California. En esta área, la California Cooperative Oceanic Fishery Investigations ha efectuado arrastres con redes para plancton. Sin embargo, el proceso y la clasificación del material no han sido completados por esa organización, de modo que no podemos decir por el momento si se han encontrado o no larvas de atunes de aleta amarilla.

En septiembre de 1956, el autor hizo unas pocas recolecciones con luz artificial durante la noche pero no logró capturar atunes jóvenes. No se ha logrado obtener muestras adecuadas de atunes de aleta amarilla adultos para el examen de las gónadas (Orange, 1961). En consecuencia, no se puede aseverar por el momento si *N. macropterus* desova en el Golfo de California o no.

Costa central y del sur de México. Esta área parece ser una región de desove intenso durante ciertas épocas del año. El plancton recolectado en enero, febrero, mayo, junio, septiembre, noviembre y diciembre contenía larvas de atunes aleta amarilla. Las capturas con luz artificial en la noche efectuadas en junio frente a Manzanillo produjeron juveniles que, sin lugar a duda, pueden ser clasificados como *N. macropterus* (Fowler, 1944; Klawe, 1959). Las recolecciones de plancton hechas durante el otoño y a principios del invierno sólo contenían un número relativamente pequeño de larvas.

Costa centroamericana. Esta fué la primera área reconocida de desove de *N. macropterus* (Schaefer y Marr, 1948b). En la pasada década, las recolecciones hechas han confirmado que los atunes de aleta amarilla desovan mar afuera, desde el Golfo de Tehuantepec hasta Punta Mariato (7°12'N, 80°53.5'W). Los arrastres con redes para plancton efectuados a fines de la primavera contenían larvas de atunes de aleta amarilla. A continuación damos el número promedio de las larvas capturadas por períodos de una hora de arrastres de superficie durante diferentes meses frente a Cabo Blanco, Costa Rica, en donde durante el período 1959-1960 se efectuó un muestreo en forma regular.

| Mes | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---------------|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|
| No. de larvas | 9.2 | 2.3 | 4.2 | 2.1 | 0.1 | 0.7 | 0.1 | 0.0 | 1.2 | 0.0 | 0.8 | 0.8 |

De estas observaciones se desprende que aparentemente se opera algún desove durante todo el año, pero que es más intenso de enero a abril, con detención parcial a mediados del verano.

No se han recolectado larvas ni juveniles en el Golfo de Panamá. Es difícil decir si ésto se debe a que el Golfo no es un área de desove, o si se puede atribuir a un muestreo inadecuado.

Area frente a la parte norte de Sudamérica. Durante abril se han capturado juveniles de atunes de aleta amarilla en el área general frente a Cabo Pasado y Punta Santa Elena, Ecuador. Otras recolecciones efectuadas en esta área en noviembre durante la Expedición Eastrop no produjeron larvas ni juveniles.

El Consejo de Investigaciones Hidrobiológicas ha tomado muestras de plancton en una franja costera de aproximadamente 60 millas de ancho

frente a la costa del Perú, pero no se han encontrado larvas de atunes. No se pescaron atunes de aleta amarilla durante la Expedición STEP-I frente al Perú (septiembre-diciembre de 1960).

Aparentemente, en la primavera y en el otoño se opera algún desove en la región frente a Cabo Pasado y Punta Santa Elena, pero no se tomaron suficientes muestras de plancton en esta área para determinar ampliamente la época del desove. Sin embargo, el examen de las gónadas de los pescados de esta área indica que el desove ocurre de enero a marzo o abril (Orange, 1961). Como se dijo anteriormente, en el área frente al Perú no se han recolectado atunes de aleta amarilla jóvenes y, coincidiendo con esto, por medio del examen de los ovarios Orange (1961) encontró que ésta no es un área de desove.

Islas Revillagigedo. Schaefer y Orange (1956) indican que el desove ocurre en esta región de mayo a septiembre. Pequeños números de larvas de atunes de aleta amarilla fueron recolectadas en esta área en julio de 1957 durante la Tuna Spawning Survey (Klawe, 1958 y 1961b). Se hicieron unas cuantas recolecciones cerca de la Isla Clarion durante la Island Current Survey en mayo de 1957 y durante la Expedición SCOT en mayo de 1958. En un arrastre efectuado en mayo de 1957 se encontraron dos larvas. Las recolecciones de plancton hechas al oeste de la Isla Clarion en octubre de 1956 durante la Expedición Eastropic no contenían larvas. El desarrollo de las gónadas de los atunes de aleta amarilla del área de las Islas Revillagigedo (Orange, 1961) indica que el máximo del desove puede ocurrir allí durante agosto. El hecho de que en agosto no se hicieran arrastres con redes para plancton puede explicar por qué no se recogieron larvas en mayores cantidades.

Area alrededor de las Islas Clipperton y del Coco y entre ambas. El número de recolecciones hechas en esta área por medio de arrastres con redes para plancton y de pescas con luz artificial durante la noche es relativamente pequeño. En mayo y octubre se han recolectado larvas en las vecindades de las Islas Clipperton y del Coco y en el mes de diciembre se han recolectado especímenes juveniles en el área frente a la Isla del Coco. El estudio de las gónadas muestra que el desove puede tener lugar de noviembre a abril, con un máximo en marzo, cerca de la Isla Clipperton, y en los meses de febrero a abril alrededor de la Isla del Coco (Orange, 1961). En consecuencia, es probable que el desove se opere durante una gran parte del año y aún durante el año entero.

Area entre el ecuador y los 10°N, al este de los 122°W. En esta área se recolectaron larvas de atunes de aleta amarilla en mayo y en octubre. No se encontraron larvas al sur de los 5°N, excepto la ocurrencia alrededor de los 3°N cerca de los 120°W. Esto sugiere que el desove en esta área está limitado a las aguas de la Contracorriente. Como se dijo anteriormente, las muestras son insuficientes para formar una opinión más definida

sobre la época del desove en esta área. En el área al oeste de la considerada aquí, se han capturado larvas de *N. macropterus* durante todo el año. (Matsumoto, 1958) y es muy probable que pueda ocurrir lo mismo en el área de que tratamos, o por lo menos en su parte occidental.

Barrilete, *Katsuwonus pelamis*

Se han recolectado muy pocos ejemplares de *Katsuwonus pelamis* en el Pacífico Oriental Tropical (Figura 9) como para justificar un informe con datos por áreas geográficas como se ha hecho con el atún de aleta amarilla.

En enero y marzo de 1947, Schaefer y Marr (1948b) recolectaron dos atunes juveniles de barriletes, *Katsuwonus pelamis*, frente a la América Central. A pesar de las numerosas recolecciones hechas desde entonces, sólo se obtuvo unos pocos juveniles y larvas de esta especie; éstos fueron recolectados en octubre y noviembre de 1952, a bordo de un barco de la Pacific Oceanic Fishery Investigations, en tres estaciones situadas aproximadamente a lo largo del meridiano 120 de longitud oeste (Matsumoto, 1958). En abril de 1958, los científicos de la Comisión capturaron siete juveniles con luz artificial durante la noche, frente a Cabo Pasado, Ecuador. En mayo del mismo año, se recolectó una larva al norte de la Isla Clipperton, y también se recolectaron siete larvas y un ejemplar juvenil en aguas entre la Isla Clipperton y la Isla del Coco en varias estaciones. En la misma época se recogió otra larva en el Golfo de Tehuantepec.

Matsumoto (1958) observó que en las capturas de los arrastres con redes para plancton realizados en la región ecuatorial entre los 130° y 120°W de longitud se habían encontrado unas cuantas larvas. Schaefer y Orange (1956), después de examinar las gónadas de los barriletes, llegaron a la conclusión de que en la vecindad de las Islas Revillagigedo se opera algún desove de esta especie. Posteriormente, Orange (1961) examinó un número mucho más grande de especímenes de aquella área y llegó a la conclusión de que es muy probable que en las vecindades de las Islas Revillagigedo el desove se opere de abril a enero, con un máximo de abril a junio. Como se dijo anteriormente, hasta ahora no se han recolectado larvas de esta especie en el plancton del área de las Islas Revillagigedo. Otra posible región de desove que sugiere Orange es el área frente a la Isla del Coco, pero tampoco se han recolectado larvas en las inmediaciones de la isla. Sin embargo, Orange postula que la época del desove en esta área es de enero a abril, y todavía no se han recolectado atunes jóvenes en esta región durante esos meses.

A juzgar por la escasez de juveniles dentro de nuestra área de investigación, parece que los barriletes desovan solamente en una extensión limitada de las aguas del Océano Pacífico Oriental. Schaefer y Orange (1956) y Orange (1961) llegaron esencialmente a la misma conclusión, pero indican que las Islas Revillagigedo y la Isla del Coco pueden ser

lugares en donde el desove de esta especie se opera en una escala mayor en ciertas épocas.

Melva, *Auxis thazard*

El autor tiene conocimiento de que dos especies o formas de *Auxis* son reconocidas por muchos investigadores: la forma de corselete corto, *A. thazard*, y la forma de corselete largo, *A. thynnoides*. Es posible que en el futuro se obtenga mayor evidencia para determinar la presencia de dos especies distintas en el Océano Pacífico Oriental. En el Océano Pacífico Oriental existen formas intermedias (comunicación personal de Harold Clemens); en consecuencia, usaremos provisionalmente el nombre de *A. thazard* para la melva de esta región.

Por medio de la recolección de larvas y juveniles del Pacífico Oriental, es evidente que el área más al norte del desove de esta especie está en la vecindad de la Isla Cedros y en la cabeza del Golfo de California (Figura 10). Las aguas de frente a Baja California y de frente a California son muestreadas regularmente por embarcaciones de la California Cooperative Oceanic Fishery Investigations usadas para el desarrollo de su programa y no se han capturado larvas al norte de estas aguas. El desove frente a Baja California parece estar limitado a las áreas más cercanas a la costa, pero no ocurre así en las áreas más al sur en donde también ocurre algún desove en zonas puramente oceánicas lejos del continente o de las islas.

El lugar más al sur en que se han recogido juveniles de *Auxis* es frente a Punta Santa Elena, Ecuador.

En las vecindades de todas las islas oceánicas más importantes de nuestra área de investigación se han recolectado juveniles y larvas, los que han sido encontrados en el área general delimitada por una línea recta que va de la Punta Santa Elena a la intersección del paralelo de los 10°N y el meridiano 116°W y de allí a la Isla Cedros frente a Baja California (Figura 10).

A lo largo de la costa de Centroamérica y en la parte de la costa mejicana al sur del Golfo de California se han recolectado bastante a menudo larvas de *Auxis*. En esta área, que ha sido objeto de una recolección intensiva, *A. thazard* es la más abundante de las larvas de atunes. Es difícil decir si los adultos de esta especie son tan abundantes o no, porque no hay manera de estimar su población. A pesar de que esta especie no tiene importancia comercial, contribuye indirectamente a la pesquería del atún porque constituye una parte significativa del alimento de los atunes de aleta amarilla adultos (Alverson, trabajo en prensa).

Parece que la época del desove está restringida solamente a la parte norte de la región en donde se opera sólo en los meses más calurosos. En otras áreas, la melva aparentemente desova durante todo el año. Es muy probable que el fenómeno del desove estacional que ocurre en la región

norte del Océano Pacífico Oriental se repita en el área más al sur, pero no existen datos adecuados para confirmar ésto. Nuestra serie de datos de Cabo Blanco demuestra que *Auxis* desova frente a Costa Rica durante todo el año, pero el máximo ocurre de diciembre a abril. A continuación se da una lista del número promedio de larvas capturadas durante diferentes meses frente a Cabo Blanco por períodos de una hora de arrastres de superficie.

| Mes | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---------------|-----|-----|------|------|-----|-----|-----|------|-----|-----|-----|-----|
| No. de larvas | 7.6 | 1.0 | 21.7 | 18.3 | 3.8 | 0.5 | 0.2 | 0.9 | 3.5 | 0.1 | 1.3 | 6.0 |

Barrilete negro, *Euthynnus lineatus*

El género *Euthynnus* tiene una distribución mundial en las latitudes tropicales y subtropicales. La especie *E. lineatus* está limitada en su distribución al Océano Pacífico Oriental, mientras que a *E. yaito* se le encuentra en el Pacífico Central y Occidental. A diferencia de otros atunes del Océano Pacífico Oriental, *E. lineatus* está asociado con las masas terrestres (Calkins y Klawe, en prensa). Su distribución se extiende desde Baja California hasta el norte del Perú y ha sido recolectado en las Galápagos y en las Islas del Coco y Malpelo. Alverson (en prensa) en su trabajo sobre el alimento de *Neothunnus macropterus* encontró que ejemplares adultos de *E. lineatus* habían sido ingeridos por los peces recolectados en el área de las Islas Revillagigedo y Clipperton. La distribución de jóvenes (Figura 11) también refleja la asociación con las masas terrestres. Todos los ejemplares jóvenes fueron recolectados cerca de la costa, siendo la distancia más lejana de ella de sólo alrededor de 120 millas. El único individuo que se encontró más afuera fué capturado cerca de la Isla Malpelo. Los lugares más al norte en que se han recolectado ejemplares jóvenes de *Euthynnus* han sido la cabeza del Golfo de California y frente a Punta Antonio en Baja California, y el punto más al sur la antes mencionada Isla Malpelo.

El desove en las aguas del norte está limitado a los meses de verano. Más al sur, el barrilete negro desova durante todo el año, con un posible máximo a principios de la primavera. Anotamos a continuación el número promedio de larvas capturadas frente a Cabo Blanco, Costa Rica, por períodos de una hora de arrastres de superficie en diferentes meses:

| Mes | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---------------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|-----|
| No. de larvas | 1.5 | 0.1 | 3.2 | 14.9 | 0.6 | 0.0 | 0.1 | 0.2 | 1.4 | 0.0 | 0.2 | 0.7 |

¿Desova el barrilete negro alrededor de las islas oceánicas alejadas del continente? Hay sólo la evidencia de un juvenil capturado cerca de la Isla Malpelo, y el autor asume que el desove se opera cerca de otras islas en donde se encuentran barriletes negros en estado adulto.

La asociación del género *Euthynnus* con las masas terrestres durante su vida conduce probablemente a la especiación dentro de su género. A este respecto difiere muchísimo de los géneros *Neothunnus*, *Katsuwonus*, *Auxis* y de otros atunes que tienen una distribución verdaderamente transoceánica.

RESUMEN

1. Este estudio sobre las áreas y épocas del desove y de su intensidad está basado en las recolecciones de larvas y juveniles de atunes del Océano Pacífico Oriental. Las formas jóvenes de los atunes empleados en este trabajo han tenido su origen en: (1) arrastres con redes para plancton, (2) pescas con luz artificial durante la noche, y (3) los estómagos de vertebrados. Como las recolecciones de plancton proporcionan datos tanto cualitativos como cuantitativos, han servido de base principal para este estudio.

2. El examen de la distribución vertical de las larvas en los arrastres con redes obturantes indica que dichas larvas están limitadas a la capa sobre la termoclina, por lo menos en el Océano Pacífico Oriental.

3. La correlación entre el número de larvas capturadas en los arrastres simultáneos de superficie y oblicuos ha probado ser de significancia estadística. El número relativo de larvas de atunes capturadas en los arrastres de superficie y oblicuos se aproxima a la proporción de la profundidad del arrastre oblicuo con relación a la profundidad de la capa sobre la termoclina. Esto confirma aún más la conclusión de que las larvas están limitadas a la capa sobre la termoclina.

4. No hay una clara indicación de que las larvas de *Neothunnus macropterus* sean más abundantes en los arrastres con redes para plancton hechos durante la noche que en los efectuados a la luz del día. Se encontraron diferencias significantes en las pescas diurnas y nocturnas de las larvas de *Auxis thazard* de los arrastres de superficie y oblicuos a "300 metros", pero sorprende bastante que estas diferencias no se registraran con respecto a los arrastres oblicuos a "140 metros".

5. Los atunes jóvenes del Océano Pacífico Oriental parecen ser buenos indicadores del reciente desove de los adultos en el área de captura de estas formas jóvenes.

6. Los resultados de este estudio concuerdan en general con los de las investigaciones sobre el desove de los atunes mediante el examen de las gónadas.

7. Aunque el desove del atún es estacional, en las aguas más calientes se opera algún desove durante el año entero.

8. Lo siguiente resume el conocimiento que hasta ahora se tiene

Cooperative Oceanic Fishery Investigations, se capturaron larvas de *Neotbunnus macropterus*, *Euthynnus lineatus* y *Auxis thazard* solamente en ciertas épocas del año (Tabla 3).

Desafortunadamente no disponemos de datos que hayan sido recogidos en una forma similar y continua en otras partes del Océano Pacífico Oriental para hacer comparaciones. La mayoría de nuestras capturas no están bien distribuidas ni en el tiempo ni en el espacio; sin embargo, pueden apreciarse tendencias que más bien parecen reflejar un desove estacional.

No obstante el hecho de que las recolecciones que sirvieron de base para preparar las Figuras 4 a 7 fueron esporádicas, es evidente que existen algunas diferencias estacionales en la abundancia de larvas. Por ejemplo, si examinamos las capturas frente al centro y al sur de México, en donde se hicieron recolecciones de plancton en enero, febrero, mayo, junio, septiembre, octubre, noviembre y diciembre, podemos ver que la abundancia de las larvas de los atunes de aleta amarilla es mayor en el período mayo-octubre (Figura 4) que en el período noviembre-abril (Figura 5). Esto refleja el hecho de que el máximo del desove ocurre frente al centro de México en los trimestres segundo y tercero como lo infirió Orange (1961).

Según la Figura 4, es evidente que las capturas de larvas de atunes aleta amarilla en el área frente a las Islas Revillagigedo fueron hechas en el período de mayo a octubre. Este hecho ciertamente apoya la conclusión a que se llegó basándose en los estudios de las gónadas. Sin embargo, durante el período noviembre-abril prácticamente no se hicieron recolecciones en las vecindades de estas islas.

No hay evidencia en estas cartas de un desove estacional del atún de aleta amarilla frente a la América Central, mientras que nuestras recolecciones mensuales frente a Cabo Blanco y nuestros estudios sobre las gónadas sí dan evidencia de una variación estacional en el monto del desove. Lo más probable es que esto sea debido a lo inadecuado de los datos obtenidos en aquella área, los que han servido de base para la confección de dichas cartas.

Las capturas de larvas de atunes de aleta amarilla en aguas mar afuera no adyacentes a las islas oceánicas se realizaron en la región de la Contracorriente (5°—12°N) en el período mayo-octubre. Esto sugiere que el desove en esta área puede ser más intenso en la primavera o en el verano. Sin embargo, debe remarcar de nuevo que durante el período noviembre-abril no se efectuó en las mismas aguas una recolección de comparable intensidad. Se necesitan más datos de la mayoría de las regiones del Océano Pacífico Oriental para confeccionar cartas que proporcionen una información adecuada sobre las variaciones estacionales de la abundancia de larvas.

La información sobre el desove de las diversas especies de atunes en el Pacífico Oriental Tropical puede resumirse como sigue:

Atún de aleta amarilla, *Neothunnus macropterus*

Extensión del desove

La Figura 8 muestra la distribución de los lugares de captura. Se han empleado diferentes símbolos para las capturas hechas por medio de redes para plancton y de carcales con luz artificial durante la noche, y para los especímenes encontrados en los estómagos de pescados y de serpientes de mar.

Se recolectaron larvas hasta en lugares tan al norte como 46 millas al SW de Punta Abrejos frente a Baja California ($26^{\circ}09'N$, $114^{\circ}08'W$). El punto más al sur de la recolección dentro de nuestra área de investigación fué frente a Punta Elena, justo al norte del Golfo de Guayaquil, Ecuador. También se capturaron larvas mar afuera, pero sólo al norte de los $3^{\circ}N$.

Es de gran interés que no se encontraran larvas en las localidades mar afuera al sur de los $5^{\circ}N$, excepto por la ocurrencia en los alrededores de los $3^{\circ}N$ a lo largo del meridiano 120° . Esto sugiere que, en nuestra área de investigación, el desove mar afuera se opera en la Contracorriente pero que hay muy poco desove, si lo hay, en las aguas de la Corriente del Perú o en su extensión como la Corriente Sudecuatorial.

Baja California. Esta área, que parece representar la región más al norte del desove de los atunes de aleta amarilla, ha sido muestreada concienzudamente en varias épocas del año desde 1949 por barcos de la California Cooperative Oceanic Fishery Investigations. Sólo en unas pocas ocasiones se han capturado larvas de atunes de aleta amarilla en estas aguas. En noviembre de 1956, el autor capturó con un carcal un espécimen juvenil en la vecindad del Banco Lusitania ($23^{\circ}36'N$, $111^{\circ}42'W$). En otra ocasión, en octubre de 1958, se recolectaron especímenes juveniles cuando científicos de CCOFI capturaron 16 larvas en 8 estaciones frente a Baja California (Tabla 3). Sobre la base de estos hechos, se puede llegar a la conclusión de que esta área, que es la más intensivamente muestreada en el Océano Pacífico Oriental, es sólo de menor importancia para el desove de *N. macropterus* y que, a juzgar por la presencia de estas larvas y juveniles, el desove se opera en los comienzos del otoño. Esto concuerda en conjunto con las conclusiones de Schaefer y Orange (1956) y de Orange (1961) de que no es una importante área de desove.

Golfo de California. En esta área, la California Cooperative Oceanic Fishery Investigations ha efectuado arrastres con redes para plancton. Sin embargo, el proceso y la clasificación del material no han sido completados por esa organización, de modo que no podemos decir por el momento si se han encontrado o no larvas de atunes de aleta amarilla.

En septiembre de 1956, el autor hizo unas pocas recolecciones con luz artificial durante la noche pero no logró capturar atunes jóvenes. No se ha logrado obtener muestras adecuadas de atunes de aleta amarilla adultos para el examen de las gónadas (Orange, 1961). En consecuencia, no se puede aseverar por el momento si *N. macropterus* desova en el Golfo de California o no.

Costa central y del sur de México. Esta área parece ser una región de desove intenso durante ciertas épocas del año. El plancton recolectado en enero, febrero, mayo, junio, septiembre, noviembre y diciembre contenía larvas de atunes aleta amarilla. Las capturas con luz artificial en la noche efectuadas en junio frente a Manzanillo produjeron juveniles que, sin lugar a duda, pueden ser clasificados como *N. macropterus* (Fowler, 1944; Klawe, 1959). Las recolecciones de plancton hechas durante el otoño y a principios del invierno sólo contenían un número relativamente pequeño de larvas.

Costa centroamericana. Esta fué la primera área reconocida de desove de *N. macropterus* (Schaefer y Marr, 1948b). En la pasada década, las recolecciones hechas han confirmado que los atunes de aleta amarilla desovan mar afuera, desde el Golfo de Tehuantepec hasta Punta Mariato (7°12'N, 80°53.5'W). Los arrastres con redes para plancton efectuados a fines de la primavera contenían larvas de atunes de aleta amarilla. A continuación damos el número promedio de las larvas capturadas por períodos de una hora de arrastres de superficie durante diferentes meses frente a Cabo Blanco, Costa Rica, en donde durante el período 1959-1960 se efectuó un muestreo en forma regular.

| Mes | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---------------|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|
| No. de larvas | 9.2 | 2.3 | 4.2 | 2.1 | 0.1 | 0.7 | 0.1 | 0.0 | 1.2 | 0.0 | 0.8 | 0.8 |

De estas observaciones se desprende que aparentemente se opera algún desove durante todo el año, pero que es más intenso de enero a abril, con detención parcial a mediados del verano.

No se han recolectado larvas ni juveniles en el Golfo de Panamá. Es difícil decir si ésto se debe a que el Golfo no es un área de desove, o si se puede atribuir a un muestreo inadecuado.

Area frente a la parte norte de Sudamérica. Durante abril se han capturado juveniles de atunes de aleta amarilla en el área general frente a Cabo Pasado y Punta Santa Elena, Ecuador. Otras recolecciones efectuadas en esta área en noviembre durante la Expedición Eastropic no produjeron larvas ni juveniles.

El Consejo de Investigaciones Hidrobiológicas ha tomado muestras de plancton en una franja costera de aproximadamente 60 millas de ancho

frente a la costa del Perú, pero no se han encontrado larvas de atunes. No se pescaron atunes de aleta amarilla durante la Expedición STEP-I frente al Perú (septiembre-diciembre de 1960).

Aparentemente, en la primavera y en el otoño se opera algún desove en la región frente a Cabo Pasado y Punta Santa Elena, pero no se tomaron suficientes muestras de plancton en esta área para determinar ampliamente la época del desove. Sin embargo, el examen de las gónadas de los pescados de esta área indica que el desove ocurre de enero a marzo o abril (Orange, 1961). Como se dijo anteriormente, en el área frente al Perú no se han recolectado atunes de aleta amarilla jóvenes y, coincidiendo con esto, por medio del examen de los ovarios Orange (1961) encontró que ésta no es un área de desove.

Islas Revillagigedo. Schaefer y Orange (1956) indican que el desove ocurre en esta región de mayo a septiembre. Pequeños números de larvas de atunes de aleta amarilla fueron recolectadas en esta área en julio de 1957 durante la Tuna Spawning Survey (Klawe, 1958 y 1961b). Se hicieron unas cuantas recolecciones cerca de la Isla Clarion durante la Island Current Survey en mayo de 1957 y durante la Expedición SCOT en mayo de 1958. En un arrastre efectuado en mayo de 1957 se encontraron dos larvas. Las recolecciones de plancton hechas al oeste de la Isla Clarion en octubre de 1956 durante la Expedición Eastropic no contenían larvas. El desarrollo de las gónadas de los atunes de aleta amarilla del área de las Islas Revillagigedo (Orange, 1961) indica que el máximo del desove puede ocurrir allí durante agosto. El hecho de que en agosto no se hicieran arrastres con redes para plancton puede explicar por qué no se recogieron larvas en mayores cantidades.

Area alrededor de las Islas Clipperton y del Coco y entre ambas. El número de recolecciones hechas en esta área por medio de arrastres con redes para plancton y de pescas con luz artificial durante la noche es relativamente pequeño. En mayo y octubre se han recolectado larvas en las vecindades de las Islas Clipperton y del Coco y en el mes de diciembre se han recolectado especímenes juveniles en el área frente a la Isla del Coco. El estudio de las gónadas muestra que el desove puede tener lugar de noviembre a abril, con un máximo en marzo, cerca de la Isla Clipperton, y en los meses de febrero a abril alrededor de la Isla del Coco (Orange, 1961). En consecuencia, es probable que el desove se opere durante una gran parte del año y aún durante el año entero.

Area entre el ecuador y los 10°N, al este de los 122°W. En esta área se recolectaron larvas de atunes de aleta amarilla en mayo y en octubre. No se encontraron larvas al sur de los 5°N, excepto la ocurrencia alrededor de los 3°N cerca de los 120°W. Esto sugiere que el desove en esta área está limitado a las aguas de la Contracorriente. Como se dijo anteriormente, las muestras son insuficientes para formar una opinión más definida

sobre la época del desove en esta área. En el área al oeste de la considerada aquí, se han capturado larvas de *N. macropterus* durante todo el año. (Matsumoto, 1958) y es muy probable que pueda ocurrir lo mismo en el área de que tratamos, o por lo menos en su parte occidental.

Barrilete, *Katsuwonus pelamis*

Se han recolectado muy pocos ejemplares de *Katsuwonus pelamis* en el Pacífico Oriental Tropical (Figura 9) como para justificar un informe con datos por áreas geográficas como se ha hecho con el atún de aleta amarilla.

En enero y marzo de 1947, Schaefer y Marr (1948b) recolectaron dos atunes juveniles de barriletes, *Katsuwonus pelamis*, frente a la América Central. A pesar de las numerosas recolecciones hechas desde entonces, sólo se obtuvo unos pocos juveniles y larvas de esta especie; éstos fueron recolectados en octubre y noviembre de 1952, a bordo de un barco de la Pacific Oceanic Fishery Investigations, en tres estaciones situadas aproximadamente a lo largo del meridiano 120 de longitud oeste (Matsumoto, 1958). En abril de 1958, los científicos de la Comisión capturaron siete juveniles con luz artificial durante la noche, frente a Cabo Pasado, Ecuador. En mayo del mismo año, se recolectó una larva al norte de la Isla Clipperton, y también se recolectaron siete larvas y un ejemplar juvenil en aguas entre la Isla Clipperton y la Isla del Coco en varias estaciones. En la misma época se recogió otra larva en el Golfo de Tehuantepec.

Matsumoto (1958) observó que en las capturas de los arrastres con redes para plancton realizados en la región ecuatorial entre los 130° y 120°W de longitud se habían encontrado unas cuantas larvas. Schaefer y Orange (1956), después de examinar las gónadas de los barriletes, llegaron a la conclusión de que en la vecindad de las Islas Revillagigedo se opera algún desove de esta especie. Posteriormente, Orange (1961) examinó un número mucho más grande de especímenes de aquella área y llegó a la conclusión de que es muy probable que en las vecindades de las Islas Revillagigedo el desove se opere de abril a enero, con un máximo de abril a junio. Como se dijo anteriormente, hasta ahora no se han recolectado larvas de esta especie en el plancton del área de las Islas Revillagigedo. Otra posible región de desove que sugiere Orange es el área frente a la Isla del Coco, pero tampoco se han recolectado larvas en las inmediaciones de la isla. Sin embargo, Orange postula que la época del desove en esta área es de enero a abril, y todavía no se han recolectado atunes jóvenes en esta región durante esos meses.

A juzgar por la escasez de juveniles dentro de nuestra área de investigación, parece que los barriletes desovan solamente en una extensión limitada de las aguas del Océano Pacífico Oriental. Schaefer y Orange (1956) y Orange (1961) llegaron esencialmente a la misma conclusión, pero indican que las Islas Revillagigedo y la Isla del Coco pueden ser

lugares en donde el desove de esta especie se opera en una escala mayor en ciertas épocas.

Melva, *Auxis thazard*

El autor tiene conocimiento de que dos especies o formas de *Auxis* son reconocidas por muchos investigadores: la forma de corselete corto, *A. thazard*, y la forma de corselete largo, *A. thynnoides*. Es posible que en el futuro se obtenga mayor evidencia para determinar la presencia de dos especies distintas en el Océano Pacífico Oriental. En el Océano Pacífico Oriental existen formas intermedias (comunicación personal de Harold Clemens); en consecuencia, usaremos provisionalmente el nombre de *A. thazard* para la melva de esta región.

Por medio de la recolección de larvas y juveniles del Pacífico Oriental, es evidente que el área más al norte del desove de esta especie está en la vecindad de la Isla Cedros y en la cabeza del Golfo de California (Figura 10). Las aguas de frente a Baja California y de frente a California son muestreadas regularmente por embarcaciones de la California Cooperative Oceanic Fishery Investigations usadas para el desarrollo de su programa y no se han capturado larvas al norte de estas aguas. El desove frente a Baja California parece estar limitado a las áreas más cercanas a la costa, pero no ocurre así en las áreas más al sur en donde también ocurre algún desove en zonas puramente oceánicas lejos del continente o de las islas.

El lugar más al sur en que se han recogido juveniles de *Auxis* es frente a Punta Santa Elena, Ecuador.

En las vecindades de todas las islas oceánicas más importantes de nuestra área de investigación se han recolectado juveniles y larvas, los que han sido encontrados en el área general delimitada por una línea recta que va de la Punta Santa Elena a la intersección del paralelo de los 10°N y el meridiano 116°W y de allí a la Isla Cedros frente a Baja California (Figura 10).

A lo largo de la costa de Centroamérica y en la parte de la costa mejicana al sur del Golfo de California se han recolectado bastante a menudo larvas de *Auxis*. En esta área, que ha sido objeto de una recolección intensiva, *A. thazard* es la más abundante de las larvas de atunes. Es difícil decir si los adultos de esta especie son tan abundantes o no, porque no hay manera de estimar su población. A pesar de que esta especie no tiene importancia comercial, contribuye indirectamente a la pesquería del atún porque constituye una parte significativa del alimento de los atunes de aleta amarilla adultos (Alverson, trabajo en prensa).

Parece que la época del desove está restringida solamente a la parte norte de la región en donde se opera sólo en los meses más calurosos. En otras áreas, la melva aparentemente desova durante todo el año. Es muy probable que el fenómeno del desove estacional que ocurre en la región

norte del Océano Pacífico Oriental se repita en el área más al sur, pero no existen datos adecuados para confirmar ésto. Nuestra serie de datos de Cabo Blanco demuestra que *Auxis* desova frente a Costa Rica durante todo el año, pero el máximo ocurre de diciembre a abril. A continuación se da una lista del número promedio de larvas capturadas durante diferentes meses frente a Cabo Blanco por períodos de una hora de arrastres de superficie.

| Mes | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---------------|-----|-----|------|------|-----|-----|-----|------|-----|-----|-----|-----|
| No. de larvas | 7.6 | 1.0 | 21.7 | 18.3 | 3.8 | 0.5 | 0.2 | 0.9 | 3.5 | 0.1 | 1.3 | 6.0 |

Barrilete negro, *Euthynnus lineatus*

El género *Euthynnus* tiene una distribución mundial en las latitudes tropicales y subtropicales. La especie *E. lineatus* está limitada en su distribución al Océano Pacífico Oriental, mientras que a *E. yaito* se le encuentra en el Pacífico Central y Occidental. A diferencia de otros atunes del Océano Pacífico Oriental, *E. lineatus* está asociado con las masas terrestres (Calkins y Klawe, en prensa). Su distribución se extiende desde Baja California hasta el norte del Perú y ha sido recolectado en las Galápagos y en las Islas del Coco y Malpelo. Alverson (en prensa) en su trabajo sobre el alimento de *Neotibunnus macropterus* encontró que ejemplares adultos de *E. lineatus* habían sido ingeridos por los peces recolectados en el área de las Islas Revillagigedo y Clipperton. La distribución de jóvenes (Figura 11) también refleja la asociación con las masas terrestres. Todos los ejemplares jóvenes fueron recolectados cerca de la costa, siendo la distancia más lejana de ella de sólo alrededor de 120 millas. El único individuo que se encontró más afuera fué capturado cerca de la Isla Malpelo. Los lugares más al norte en que se han recolectado ejemplares jóvenes de *Euthynnus* han sido la cabeza del Golfo de California y frente a Punta Antonio en Baja California, y el punto más al sur la antes mencionada Isla Malpelo.

El desove en las aguas del norte está limitado a los meses de verano. Más al sur, el barrilete negro desova durante todo el año, con un posible máximo a principios de la primavera. Anotamos a continuación el número promedio de larvas capturadas frente a Cabo Blanco, Costa Rica, por períodos de una hora de arrastres de superficie en diferentes meses:

| Mes | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---------------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|-----|
| No. de larvas | 1.5 | 0.1 | 3.2 | 14.9 | 0.6 | 0.0 | 0.1 | 0.2 | 1.4 | 0.0 | 0.2 | 0.7 |

¿Desova el barrilete negro alrededor de las islas oceánicas alejadas del continente? Hay sólo la evidencia de un juvenil capturado cerca de la Isla Malpelo, y el autor asume que el desove se opera cerca de otras islas en donde se encuentran barriletes negros en estado adulto.

La asociación del género *Euthynnus* con las masas terrestres durante su vida conduce probablemente a la especiación dentro de su género. A este respecto difiere muchísimo de los géneros *Neothynnus*, *Katsuwonus*, *Auxis* y de otros atunes que tienen una distribución verdaderamente transoceánica.

RESUMEN

1. Este estudio sobre las áreas y épocas del desove y de su intensidad está basado en las recolecciones de larvas y juveniles de atunes del Océano Pacífico Oriental. Las formas jóvenes de los atunes empleados en este trabajo han tenido su origen en: (1) arrastres con redes para plancton, (2) pescas con luz artificial durante la noche, y (3) los estómagos de vertebrados. Como las recolecciones de plancton proporcionan datos tanto cualitativos como cuantitativos, han servido de base principal para este estudio.

2. El examen de la distribución vertical de las larvas en los arrastres con redes obturantes indica que dichas larvas están limitadas a la capa sobre la termoclina, por lo menos en el Océano Pacífico Oriental.

3. La correlación entre el número de larvas capturadas en los arrastres simultáneos de superficie y oblicuos ha probado ser de significancia estadística. El número relativo de larvas de atunes capturadas en los arrastres de superficie y oblicuos se aproxima a la proporción de la profundidad del arrastre oblicuo con relación a la profundidad de la capa sobre la termoclina. Esto confirma aún más la conclusión de que las larvas están limitadas a la capa sobre la termoclina.

4. No hay una clara indicación de que las larvas de *Neothynnus macropterus* sean más abundantes en los arrastres con redes para plancton hechos durante la noche que en los efectuados a la luz del día. Se encontraron diferencias significantes en las pescas diurnas y nocturnas de las larvas de *Auxis thazard* de los arrastres de superficie y oblicuos a "300 metros", pero sorprende bastante que estas diferencias no se registraran con respecto a los arrastres oblicuos a "140 metros".

5. Los atunes jóvenes del Océano Pacífico Oriental parecen ser buenos indicadores del reciente desove de los adultos en el área de captura de estas formas jóvenes.

6. Los resultados de este estudio concuerdan en general con los de las investigaciones sobre el desove de los atunes mediante el examen de las gónadas.

7. Aunque el desove del atún es estacional, en las aguas más calientes se opera algún desove durante el año entero.

8. Lo siguiente resume el conocimiento que hasta ahora se tiene

sobre el desove de las cuatro especies de atunes del Océano Pacífico Oriental:

Neothunnus macropterus: Desova en una extensa área del Pacífico Oriental desde la costa occidental del sur de Baja California hasta el Ecuador, tanto a lo largo de la costa como en aguas mar afuera. En los extremos de la distribución de las larvas, el desove se opera en la época del año en que el agua es más caliente. Frente a la América Central el máximo del desove ocurre en enero hasta marzo.

Katsuwonus pelamis: El desove es muy limitado en las aguas costeras y oceánicas del área de nuestro estudio. Solamente en unas pocas ocasiones se recolectaron formas jóvenes: frente a la América Central y hasta tan al norte como el Golfo de Tehuantepec. También se han recolectado especímenes jóvenes frente al Ecuador.

Auxis thazard: Esta especie es la más numerosa en las recolecciones de larvas y juveniles del área de nuestro estudio. Desova cerca de la costa lo mismo que mar afuera en las aguas oceánicas. Se han recolectado especímenes jóvenes en lugares tan al norte como la Isla Cedros, Baja California, y el Golfo de California, y tan al sur como en el Ecuador. Frente a Centroamérica, el máximo del desove ocurre en el invierno y a principios de la primavera.

Euthynnus lineatus: Esta especie está relacionada más estrechamente con las masas terrestres que los otros atunes que hemos tratado aquí. La distribución de los peces jóvenes es bastante similar a la distribución costera de los adultos; éstos se encuentran tanto a lo largo de la costa como en las vecindades de las principales islas del Océano Pacífico Oriental Tropical, y se cree que el desove de esta especie tiene lugar en las cercanías de dichas islas. Frente a la América Central, el máximo del desove ocurre a principios de la primavera.

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