Occurrence of Young Billfishes in the Central Pacific Ocean

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ABSTRACT

Plankton and other net-caught samples collected on past cruises of the National Marine Fisheries Service, Honolulu Laboratory vessels in Hawaiian and central Pacific equatorial waters were examined for billfish larvae and juveniles. Of the 342 billfish young found in 4,279 net tows, 209 were blue marlin, *Makaira nigricans*, 82 were shortbill spearfish, *Tetrapturus angustirostris*, 2 were sailfish, *Istiophorus platypterus*, 20 were swordfish, *Xiphias gladius*. Twenty-nine larvae were unidentified owing to excessive damage. A preponderance of the catches was obtained from hauls made at the surface during daylight.

In the equatorial central and North Pacific larvae of only three of the six billfish species nominally found in the Pacific were taken. The captures of these larvae (blue marlin, shortbill spearfish, and swordfish) fill the gaps in the known distribution of istiophorids and swordfish, and extend their distribution eastward to the Hawaiian Islands in the North Pacific. The two sailfish larvae were taken in New Hebrides waters in the western South Pacific.

The absence of striped marlin, *Tetrapturus audax*, larvae in Hawaiian waters was significant, since this species comprises nearly 82% of all istiophorids taken on the longline in the Hawaiian fishery. Their absence suggested that the striped marlin in Hawaiian waters probably migrate elsewhere to spawn. If this is true, then the spawning habits of this species differ significantly from those of blue marlin. A similar situation could hold for sailfish also.

In recent years fishery workers have given more attention to the early life history of billfishes, owing to the increasing importance of these fishes in the commercial and sport fishing catches. The billfishes in the Pacific Ocean are represented by two families: Istiophoridae and Xiphiidae. The Istiophoridae includes five species: *Istiophorus platypterus,* sailfish; *Tetrapturus angustirostris,* shortbill spearfish; *T. audax,* striped marlin; *Makaira nigricans,* blue marlin; and *M. indica,* black marlin. The Xiphiidae is represented by a single species, *Xiphias gladius,* swordfish. Larvae of all these species, mainly from the western Pacific, have been identified and reported by Japanese workers.

This study, based on larvae collected on past cruises of the National Marine Fisheries Service, Honolulu Laboratory (HL) vessels in Hawaiian and central Pacific equatorial waters, verifies the identifications reported by Yabe (1953), Yabe et al. (1959), Ueyanagi and Yabe (1959), and Ueyanagi (1959, 1962, 1964), and extends the distribution of larvae of certain billfishes eastward through the central Pacific.

IDENTIFICATION OF LARVAE

The three species of istiophorid larvae in our collection, blue marlin, sailfish, and shortbill spearfish, were easily identified on the basis of black pigmentation (Ueyanagi, 1963) on more than half the length of the lower jaw (sailfish) and on the branchiostegal membranes (shortbill spearfish). Larvae of blue marlin lacked this pigmentation. Since larvae of striped marlin also lack this pigmentation, the separation of blue from striped marlin is most difficult. Ueyanagi (1963) lists two main characters by which he separates the larvae of these two species: (1) the tip of snout either level or below center of eye (striped marlin), and (2) the "anterior edge of orbit projects forward" (blue marlin). The first character is highly subjective and lacks a clear definition of reference points. Even a slight distortion in the body can effect a change in the position of the eye relative to that of the tip of snout. The second

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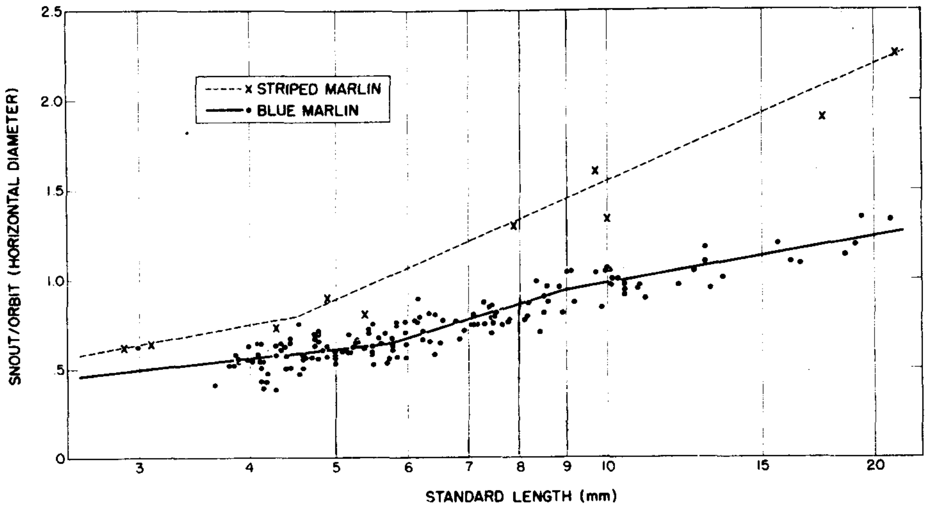

Figure 1.—Snout to orbit (horizontal diameter) ratios of blue and striped marlins. Growth stanzas fitted by Bartlett's best-fit line.

character needs clarification: it is the shape of the orbital crest as well as the extent of protrusion that sets the blue marlin larvae apart from those of striped marlin. In the blue marlin the anterior part of the orbital crest, beginning slightly ahead of the anterior naris, rises sharply and the anteriodorsal part is high and angular. In other istiophorid larvae the orbital crest slopes up and back more gradually (Ueyanagi, 1963, Plate 3).

A more useful character by which larvae of these two species can be separated is the snout to orbit ratio. Ueyanagi (1959) has used this character to show the difference between larvae of sailfish and blue marlin, except that his snout measurement included the distance from the tip of snout to center of eye with the orbit measured vertically. We have used snout length as measured from the tip to the anterior edge of the orbit and the orbit as measured horizontally. Regardless of which snout length or orbit measurement is used, the separation of the curves is similar.

Figure 1 shows the snout to orbit ratios of 138 blue marlin larvae from the central Pacific and 10 striped marlin from the western Pacific (seven measurements from Ueyanagi, 1964 and three measurements from specimens sent to us by Ueyanagi) plotted against standard length. Bartlett's (1949) best-fit lines were drawn through points representing growth stanzas for each species. Despite the small number of points shown for striped marlin, the separation of the species, at least in the larger size range, appears to be valid. Among the smaller stages (below 6 mm), however, the points approach each other close enough to make separation more difficult.

The scatter of points about the curve shown for blue marlin above 6 mm (Fig. 1) and the absence of snout to orbit ratios falling near the curve shown for striped marlin suggest that larvae from the central North Pacific without pigmentation on the posterior half of the lower jaw and branchiostegal membranes are all of blue marlin.

COLLECTION OF SAMPLES AND CATCHES

The samples of billfish larvae were obtained mainly from 1-m plankton net tows taken from vessels of the HL and other organizations from 1950 through 1970, and from 1- × 2-m neuston net tows in 1971. The plankton net was usually towed for 30 min, either horizontally at the surface or obliquely to depths ranging from 40 to 200 m. The neuston net, constructed entirely of 1-mm mesh netting, was used only on one cruise to the western Pacific. Owing to operational difficulties, this net was towed at the regular plankton net speed of 3.7-5.5 km/h for 30 min. Catches by the plankton and neuston nets included juveniles as large as 20 mm. A 12.2-m mouth diameter Cobb pelagic trawl, made of 19.0-mm stretch mesh netting lined with 6.4-mm netting at the cod end, was used on several cruises around Hawaii, in equatorial waters along long. 145°W, and in waters of the Trust Territory of the Pacific Islands from 1967 through 1971, and caught juveniles as large as 55 mm. The midwater trawl was usually towed at night for 3-6 h (Appendix Table 1). The area sampled with towed nets is extensive, covering nearly one-half of the Pacific Ocean (Fig. 2).

A total of 342 billfish larvae and juveniles was obtained from 4,279 net tows of all types. A summary of the catch by type of gear and tow (Table 1) shows that 4,170 tows (97%) were made with the 1-m plankton net, and that of this number 2,850 (68%) were oblique tows. Despite the large ratio of oblique to surface tows (2:1), the catch ratio was just the opposite. The surface tows caught five times as many larvae and juveniles as the oblique tows.

A closer look at the 1-m net tows by depth and time of day (Table 2) shows that most of the larvae were taken in the upper 1-m of water during daylight. The small numbers taken in the oblique tows suggest that these larvae are restricted to the surface, and the small catches in night tows suggest that these larvae migrate downward at night. Both observations are similar to the results obtained by Ueyanagi (1964) in the western Pacific, where he examined 32 day and 31 night plankton net samples from depths of 0, 20, and 40 m. He found that abundance of larvae decreased with depth during the day, and that the day catches at the surface were greater than those at night. His data point out one other aspect which does not appear in our data: that within the upper 40 m of

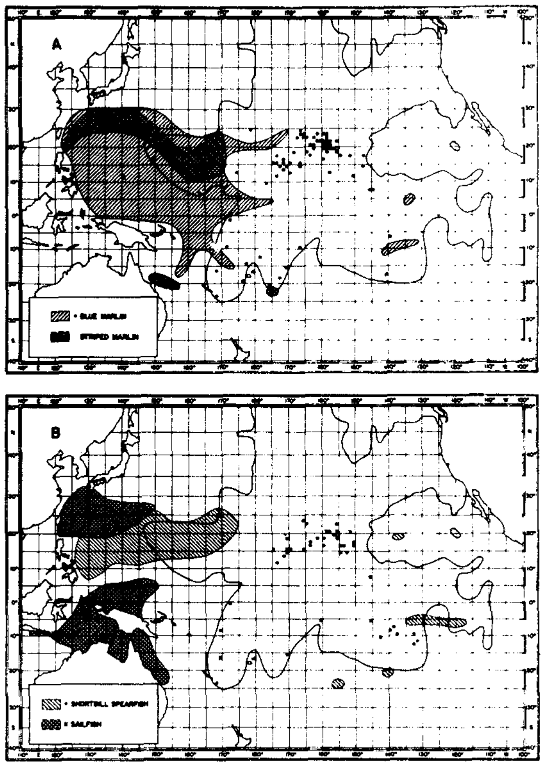

Figure 2.—Localities of captures of young Istiophoridae in the Pacific Ocean. Area sampled by the Honolulu Laboratory indicated by solid line and capture sites by black dots. Localities of captures by Howard and Ueyanagi (1965) shown as shaded areas.

Table 1.—Billfish larvae and juveniles collected by various gear from research vessels of the Southwest Fisheries Center, Honolulu Laboratory in the central Pacific Ocean, 1950-71.

			Larvae and juvenile catch						
Gear	Type of tow	Number tows	Blue marlin	Short-bill spear-fish	Sail-fish	Sword-fish	Damaged un-identi-fied	Total	Per-cent
1-m plankton net	30-min, surface	1,320	142	68	2	16	22	250	73.1
1-m plankton net	30-min, 40-200m oblique	2,850	25	14	0	4	7	50	14.6
Cobb pelagic trawl	6-h, 20-100m horizontal	92	18	0	0	0	0	18	5.3
1 × 2 m neuston net	30-min, surface	17	24	0	0	0	0	24	7.0
Totals		4,279	209	82	2	20	29	342	100.0
Percent			61.1	24.0	0.6	5.8	8.5	100.0	

Table 2.—Catch rates (catch per 100 tows) of billfish larvae in 1-m plankton net and 1- × 2-m neuston net.

Type of tow	No. of tows		Blue marlin		Shortbill spearfish		Sailfish		Swordfish		All species including unidentified larvae	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Surface	201	1,119	50.0	3.7	14.8	3.5	1.0	0.0	2.0	1.1	74.2	8.9
Oblique	1,280	1,570	0.7	1.0	0.4	0.5	0.0	0.0	0.2	0.1	1.5	2.1
Neuston	15	0	160.0	—	0.0	—	0.0	—	0.0	—	160.0	—

water, the catches at night at the three depths sampled were approximately equal.

The neuston net catches (Table 2) provide further information on the vertical distribution of these larvae. The net was normally towed with part of the net above the surface, so that on an average it only sampled the upper 0.5 m of water. The catch per tow was more than three times that of the 1-m net towed fully submerged at the surface. Since the neuston net strained roughly twice the volume of water as the 1-m net, the catch per unit volume of water strained was about 1.5 times that of the 1-m net. The higher catch rate of the neuston net thus suggests that billfish larvae could be concentrated not only in the upper 1-m of water but even closer to the surface.

DISTRIBUTION OF ISTIOPHORID LARVAE

Howard and Ueyanagi (1965) have plotted the occurrence of istiophorid larvae in the Pacific Ocean. Outlines drawn of their plots by species (Fig. 2) show that catches of most species were largely confined to the western Pacific. Our data of larval captures fill the gaps in the distribution given by Howard and Ueyanagi (1965), particularly around the Hawaiian Islands and in the central Pacific south of the equator. The northern limits of distribution of the four species of Istiophoridae in the western North Pacific are notably similar (Fig. 2, panels A and B). The southern limits of distribution for all species cannot be defined, since sampling for the larvae on all cruises east of long. 180° did not extend far enough southward. Judging on the basis of the close relationship between larval distribution and the 24°C surface isotherm (Ueyanagi, 1964; Jones and Kumaran, 1964) and on the configuration of the surface temperature isotherms across the South Pacific (U.S. Hydrographic Office, 1948), it seems that the southern limits of distribution of these larvae should not extend much beyond lat. 25°S.

Blue Marlin

Blue marlin larvae, which comprised 60.8% of all billfish larvae collected by us, occurred in both the North and South Pacific. In the North Pacific they were distributed heavily around the Hawaiian Islands and in waters to the west between lat. 7° and 24°N. This distribution seems to be contiguous with that shown by Howard and Ueyanagi (1965). In the South Pacific the larvae occurred in a band between lat. 0° and 24°S from the New Hebrides through the Tuamotu Archipelago. The western end of this band ties in with the southwestern outline of the distribution of Howard and Ueyanagi (1965). The intervening area (lat. 5°-10°N and long. 140°W-180°) appears to be devoid of blue marlin larvae, but this could be due to inadequate sampling; only a few surface day tows were made there. Sampling especially for billfish larvae would likely change this distributional picture and provide us with better information in the area east of long. 140°W and in equatorial waters westward to long. 180°.

Seasonal Distribution.—Seasonal changes in the distribution of blue marlin larvae were observed only in the Hawaiian Islands area, where enough seasonal sampling was done (Fig. 3). The blue marlin, as well as some other billfishes, spawn throughout the year in warm tropical and subtropical waters. At both the northern and southern fringes of distribution, however, spawning occurs only during the warm seasons (Howard and Ueyanagi, 1965). In the Hawaiian Islands area, the northern fringe of larval blue marlin distribution lies roughly parallel to the surface isotherms (Fig. 3) and moves northeastward and southwestward with the seasons. Thus, in the first quarter the larvae were found far south of the island, but in the second quarter they were abreast of the islands. In the third quarter the edge of larval distribution shifted northward a few degrees of latitude past the islands and moved back to just south of the islands in the fourth quarter. The northward shift of the distribution during the four seasons is about 10° to 11° of latitude.

Ueyanagi (1964) reports that larvae of istiophorid species occur generally in water that is warmer than 24°C. Jones and Kumaran (1964) also show that none of their larvae were taken in waters colder than 24.5°C. Our data (Appendix Table 1) show that although most of the blue marlin larvae were taken in water between 26° and 29°C, the lowest temperature associated with capture was 23.8°C.

Shortbill Spearfish

Larvae of shortbill spearfish comprised 24.3% of all billfish larvae collected by us. Their distributional pattern in the central Pacific is similar to that of blue marlin larvae (Fig. 2). North of the equator the captures were grouped around the Hawaiian Islands in an area bounded by lat. 10° and 23°N and long. 150° and 174°W. The area between long. 174°W and the eastern limit of Howard and Ueyanagi's (1965) data should also contain larvae of this species to show a continuous distribution from the western Pacific to the Hawaiian Islands. Because of inadequate sampling, only three surface day tows and eight oblique tows, no larvae were taken there.

South of the equator, larvae were taken in a band (lat. 0° to approximately 20°S) extending from the New Hebrides Islands through the Tuamotu Archipelago, similar to that for blue marlin. The gap in the distribution along the equator, between lat. 7°N and 5°S, may be interpreted in two ways: first, the gap could be due to insufficient samples of surface day tows; and second, the gap could represent a separation of the shortbill spearfish into northern and southern populations. The latter is supported

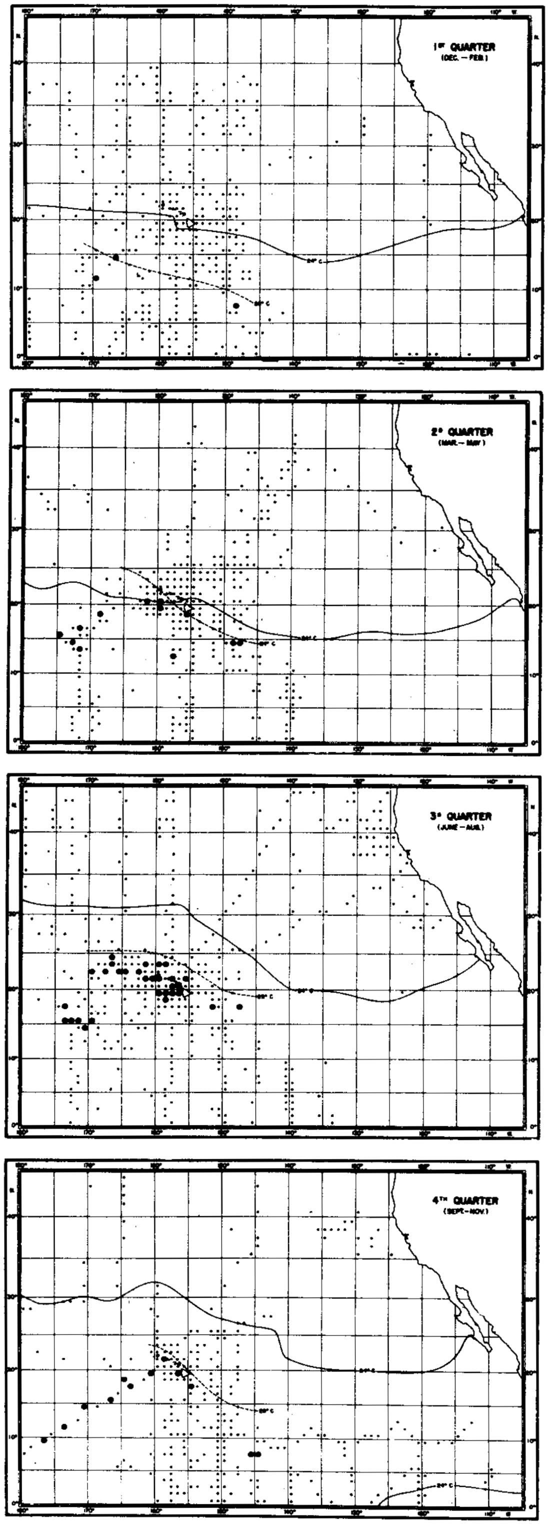

Figure 3.—Localities of captures of young blue marlin by quarters. Solid lines represent mean surface temperature for last month of quarter. Dashed lines represent surface temperature at time of sampling. Small open circles represent sampling with plankton nets in 1° square area; large solid dots represent capture sites.

by the discontinuous north-south distribution of larvae in the western Pacific, compared with the continuous distribution across the equator of blue marlin larvae.

Seasonal Distribution.—The seasonal occurrence of shortbill spearfish larvae in the Hawaiian Islands (Fig. 4) resembles that of blue marlin in certain respects, the northern edge of distribution being parallel to the chain of islands and the movement across the islands being from southwest to northeast. The differences, though small, are nevertheless evident. In the first quarter shortbill spearfish larvae were found approximately 500 km southwest of the islands, as compared to about 950 km for blue marlin larvae. The northern edge of the larval distribution shifted northeastward to about 320 km past the islands in the second quarter, retreated to the islands in the third quarter, and continued southwestward past the islands in the fourth quarter. This north-south movement of larval shortbill spearfish distribution seemed to precede that of larval blue marlin distribution by a full quarter.

One reason for these differences could be that the shortbill spearfish may be able to spawn in colder water than the blue marlin. The temperature data seem to suggest this. Shortbill spearfish larvae were found in waters with temperatures as low as 22.3°C, with most catches having been made in 25° to 26°C water. Both minimum and best catch temperatures for shortbill spearfish larvae were at least 1°C lower than for blue marlin larvae.

DISTRIBUTION OF XIPHIID LARVAE

Larvae of the Xiphiidae, the second of two families that make up the billfishes, were taken only occasionally. Only 20 specimens ranging in sizes from 5.8 to 23.0 mm were found in plankton samples taken from 1950 through 1971 (Table 1 and Appendix Table 2).

Larval and juvenile stages of swordfish from the Atlantic and Pacific Oceans have been described by a number of workers (Arata, 1954; Nakamura et al.,

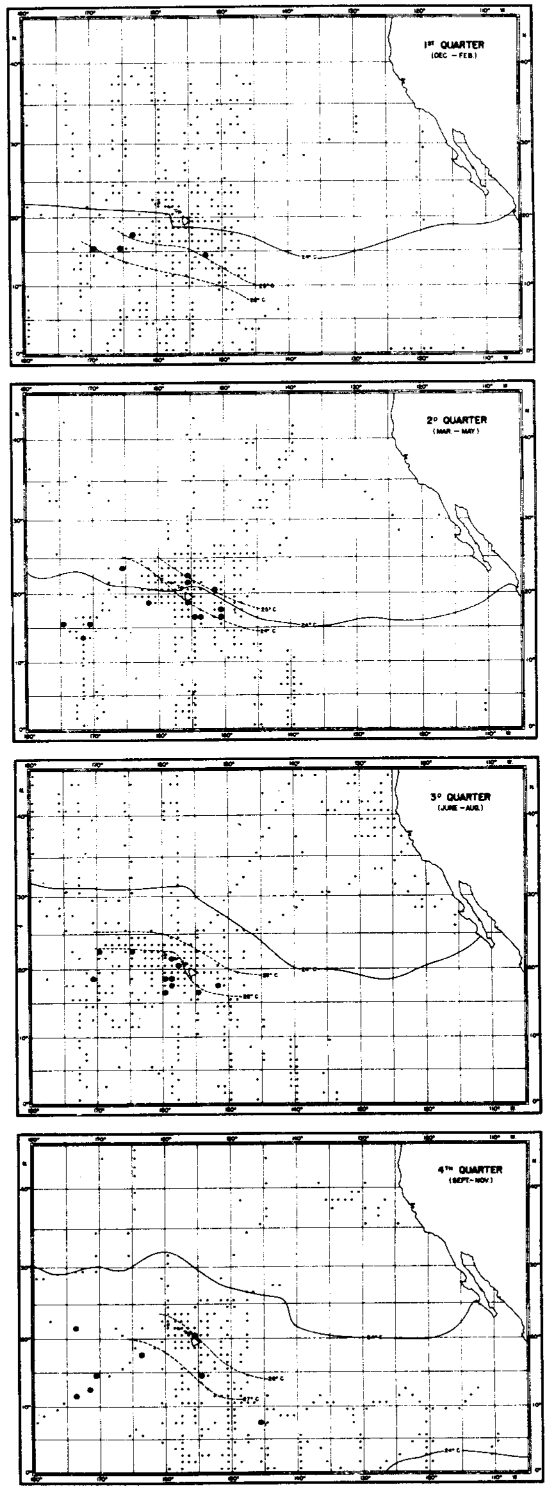

Figure 4.—Localities of captures of young shortbill spearfish by quarters. Solid lines represent mean surface temperature for last month of quarter. Dashed lines represent surface temperature at time of sampling. Small dots represent sampling with plankton nets in 1° square area; large dots represent capture sites.

1954; Yabe, 1951; and Yabe et al., 1959). The swordfish larvae are easily recognized by their long snouts and heavily pigmented elongate bodies. They have a prominent supraorbital crest similar to that of the marlins, but lack the enlarged posttemporal and preopercular spines. Larvae above 8.0 mm are even more distinctive; they have one or more rows of spinous scales on each side of the dorsal and anal fins, with those along the latter continuing forward to the level of the pectoral fin.

Although the important fishing areas for this species are mainly in temperate waters, the larvae and juveniles are found largely in tropical and subtropical waters throughout most of the Pacific. Figure 5 shows the locations of captures of swordfish larvae and juveniles below 80.0 mm recorded to date and those taken by HL ships. A similar plot of captures, exclusive of those taken by HL, was published by Jones and Kumaran (1964). (One capture site at lat. 23°N, long. 174°W is plotted erroneously. This should have been in the southern hemisphere.) Our samples extend the distribution of young swordfish to waters east of the Hawaiian Islands in the North Pacific, and partially fill in the gap between long. 132° and 172°W in the equatorial and South Pacific. The overall distribution, which extends roughly two-thirds the breadth of the Pacific, is similar to that of blue marlin larvae.

Although captures were spotty throughout the western and central Pacific, there were enough to show differences in spawning time in the various parts of the Pacific. The probable month of spawning (Fig. 5) was calculated for each individual, using the growth estimate of 0.6 mm per day derived by Arata (1954). According to these calculations spawning

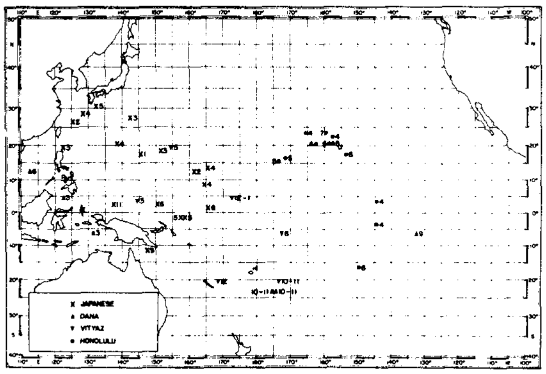

Figure 5.—Localities of captures of young swordfish <80 mm SL in the Pacific. (The numerals next to each capture site denote estimated month of spawning.)

Table 3.—Summary of young swordfish *(Xiphias gladius)* taken in plankton net tows in the Atlantic and Pacific Oceans.

Source[1]	No. of larvae <10 mm	No. of juveniles 10-80 mm	Total
Yabe (1951)	0	1	1
Arata (1954)	4	19	23
Yabe et al. (1959)	5	15	20
Sun Tsi-Gen (1960)	0	17	17
Honolulu Laboratory	14	6	20
Total	23	58	81
Percent	28.4	71.6	100

[1]Tåning (1955) examined 60 larvae of which 53 were <20 mm; no breakdown of larvae <10 mm available.

occurred in spring and summer (March through July) in the central North Pacific and in spring (September through December) in the western South Pacific south of lat. 10°S. In equatorial waters between lat. 10°N and 10°S, spawning occurred in all months of the year. Spawning also seemed to begin and end 1 or 2 mo earlier in the western Pacific in the Philippine-Formosa area, as compared with the Hawaiian Islands area. This is understandable when we consider: (1) that post-larval swordfish are usually taken in the Atlantic in waters having surface temperatures above 23.5°C (Taning, 1955), (2) that in the western Pacific this isotherm lies between Taiwan and the Philippine Islands as early as February, and (3) that in the central Pacific along the same latitude, the 23.5°C isotherm passes northward through the Hawaiian Islands in March or April, a difference of 1 to 2 mo.

A unique aspect about the captures of swordfish young is that of the small numbers taken in plankton nets, only 28.4% were larvae smaller than 10 mm (Table 3). Among other pelagic fishes, such as spearfishes, tunas, mackerels, etc., most of the larvae caught in plankton nets are below 10 mm. Perhaps the proportion of larvae caught is reduced inordinately by the disproportionate catches of juveniles. Among other fishes, particularly tunas and mackerels, juveniles above 10 mm are rarely caught, except in much larger gear such as midwater trawls. The large percentage of juveniles up to 80-mm long taken in plankton nets suggests that the swordfish young either do not react to the net quickly enough to avoid it or are exceptionally poor swimmers at this stage of development.

Also noteworthy is the apparent brevity of the spawning season in the northern and southern edges of distribution. Although spawning is indicated for most months of the year in the vicinity of the equator, it extended for only 4 mo, April to July, in the areas above lat. 20°N. By contrast, blue marlin and shortbill spearfish spawning extended over 5 and 6 mo, May through September and May through October, respectively, in Hawaiian waters.

The captures of swordfish larvae off Hawaii also provided new information on the lowest temperatures in which this species spawn. Two larvae (9.6 and 9.8 mm) were taken at long. 157°W in 23.3° and 23.6°C water, well below the lowest temperature previously recorded in the Pacific and comparable to the 23.5°C recorded from the southwestern Atlantic by Tåning (1955).

DISCUSSION

A comparison of the species composition of billfishes taken on the longline and the young taken in plankton nets in Hawaiian waters leads to interesting speculations concerning the spawning behavior of certain istiophorids. For example, the striped marlin is the predominant species taken commercially, in terms of both number and weight of fish caught. An average of 5,685 striped marlin, which make up 81.6% of all istiophorids caught on the longline, were taken annually from 1966 to 1970. Yet, no larva of this species has been recognized from our samples. Alternatively, blue marlin and shortbill spearfish comprise only 9.8% and 3.4%, respectively, of the istiophorids taken on the longline, but they make up the entire catch of young taken in these waters. Larvae of sailfish and black marlin also have not been recognized in our catches. These two species combined represent only 4.5% of the istiophorids taken on the longline.

The absence of striped marlin larvae in Hawaiian waters is probably due to absence of spawners. Length-frequency data (Royce, 1957; Howard and Ueyanagi, 1965) show that very young fish less than 150-cm modal length (11 kg[2]) first appear in the fishery in the fall and remain there continuously through two successive seasons, by which time they have attained a modal length of 220 cm (45 kg). No one has yet studied the size of striped marlin at initial spawning but it is suspected that fish in the last modal group may have reached sexual maturity, since fish of similar sizes were found with ripe gonads in the western Pacific between lat. 15° and 30°N (Howard and Ueyanagi, 1965). A more striking phenomenon about the striped marlin fishery in Hawaii is that fish in the last modal group disappear in July and do not reappear as a group in the fishery. To be sure striped marlin larger than this modal size have been taken there but only in small quantities comprising less than 1% of the total monthly catches.

On the basis of the discussion above and the occurrence of both larvae and adults with ripe gonads only in the area between lat. 15° and 30°N, west of long. 170°E (Howard and Ueyanagi, 1965) in the North Pacific, it is logical to assume that the striped marlin in Hawaiian waters leave the islands to spawn, most likely in the western North Pacific. If this is so, the spawning habit of this species differs significantly from that of blue marlin, which spawn almost continuously between lat. 30°N and 25°S in the western and central Pacific.

The absence of sailfish larvae in the central Pacific, except in the western South Pacific (New Hebrides Islands), suggests that this species also may spawn in selective areas.

[2]Conversion of weight (lb) to estimated length (cm) through courtesy of R.A. Skillman, Honolulu Laboratory.

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Appendix Table 1.--Record of catches of istiophorid larvae and juveniles by the Southwest Fisheries Center, Honolulu Laboratory from 1950 to 1971.

Gear	Type of tow	Depth of tow	Vessel[1]/ cruise/ station sample	Date	Time	Position		Duration of tow		Volume of water strained	Surface temperature	Surface salinity	Larval and juvenile catches[a]						Size range
						Latitude	Longitude						SF	BL	SB	BB	UN	Total	
								Hr.	Min.	m³	° C	°/°°							mm
1-m plankton net	Horizontal	0	S-4-24-1	5/14/50	0820	22°45' N	155°49' W	-	-	1255	22.9	-	-	-	1	-	-	1	5.0
Do.	do.	0	S-4-23-1	5/14/50	1852	22°40' N	157°10' W	-	-	2192	23.3	-	-	-	-	1	-	1	ca. 9.6
Do.	do.	0	S-4-4-1	5/17/50	1640	20°14' N	161°08' W	-	-	2125	24.2	-	-	1	-	-	-	1	4.5
Do.	do.	0	S-4-6-1	5/18/50	1048	19°25' N	159°50' W	-	-	2272	24.8	-	-	1	-	-	-	1	4.3
Do.	do.	0	S-4-7-1	5/18/50	1835	20°14' N	159°50' W	-	-	2967	24.9	-	-	1	-	-	-	1	5.0
Do.	do.	0	S-4-15-1	5/21/50	1610	20°13' N	158°30' W	-	-	2950	24.5	-	-	-	-	2	-	2	10.5, ca. 19.3
Do.	do.	0	S-4-20-1	5/23/50	0911	20°14' N	157°04' W	-	-	3346	23.6	-	-	-	-	1	-	1	6.6
Do.	do.	0	S-4-25-1	5/24/50	1333	21°54' N	155°48' W	-	-	2645	22.3	-	-	-	1	-	-	1	4.5
Do.	do.	0	S-4-28-1	5/25/50	1740	18°34' N	155°48' W	-	-	3169	23.8	-	-	1	-	-	-	1	4.6
Do.	do.	0	S-6-14-1	8/18/50	1720	20°50' N	158°32' W	-	-	2287	-	-	-	3	-	-	1	4	3.9-7.1
Do.	do.	0	S-6-16-1	8/19/50	0750	19°24' N	158°23' W	-	-	3380	26.6	-	-	4	-	-	-	4	4.3-5.3
Do.	do.	0	S-6-17-1	8/19/50	1522	18°30' N	158°29' W	-	-	2240	26.7	-	-	2	1	-	-	3	3.7-3.8
Do.	do.	0	S-6-18-1	8/20/50	0210	18°32' N	157°08' W	-	-	1609	26.2	-	-	-	-	-	1	1	3.4
Do.	do.	0	S-6-19-1	8/20/50	2311	19°31' N	157°10' W	-	-	2728	26.0	-	-	-	-	-	1	1	5.5
Do.	do.	0	S-6-20-1	8/21/50	0815	20°23; N	157°07' W	-	-	2112	26.2	-	-	1	2	-	-	3	3.1-5.2
Do.	do.	0	S-6-21-1	8/21/50	1412	20°56' N	157°10' W	-	-	2767	25.8	-	-	1	-	-	-	1	2.8
Do.	do.	0	S-6-25-1	8/22/50	1500	21°56' N	155°45' W	-	-	2816	25.7	-	-	4	-	-	-	4	4.0-6.0
Do.	do.	0	S-6-22-1	8/23/50	1754	21° 50' N	157°10' W	-	-	2586	25.7	-	-	1	-	-	-	1	6.0
Do.	do.	0	S-6-12-1	8/24/50	1250	22°43' N	158°26' W	-	-	2106	-	-	-	2	-	-	-	2	5.2, 6.3
Do.	do.	0	S-6-11-1	8/25/50	0500	23°27' N	159°46.' W	-	-	2374	-	-	-	2	-	-	-	2	5.1, 6.7
Do.	do.	0	S-6-1-1	8/25/50	1405	23°30' N	161°06' W	-	-	2047	26.0	-	-	2	-	-	-	2	5.1, 5.5
Do.	do.	0	S-6-3-1	8/26/50	1042	21°10' N	161°03' W	-	-	2150	26.7	-	-	2	-	-	-	2	4.5, 5.5
Do.	do.	0	S-6-4-1	8/26/50	1750	20°20' N	161°05' W	-	-	2251	26.7	-	-	-	-	-	4	4	4.6-5.6
Do.	do.	0	S-6-6-1	8/27/50	0950	19°26' N	159°50' W	-	-	2393	26.0	-	-	3	-	-	-	3	4.7-6.7
Do.	do.	0	S-6-9-1	8/28/50	1350	21°05' N	159°50' W	-	-	2456	26.0	-	-	3	-	-	-	3	5.4-10.2
1-m plankton net	horizontal	0	S-38-59-3	3/3/57	2035	17°48' S	135°06' W	-	-	1176		-	-	1	-	-	-	1	ca. 3.9
Do.	do.	0	S-38-62-3	3/17/57	2147	5°01' S	144°57' W	-	-	1778	28.7	35.37	-	-	1	-	-	1	3.3
Do.	do.	0	S-39-21-1	5/9/57	2010	23°03' N	165°23' W	-	-	-	25.1	35.21	-	-	6	5	-	11	SB 3.8-5.2, BB ca. 7.3-15.8
Do.	do.	0	S-39-28-1	5/15/57	2010	20°03' N	162°04' W	-	-	-	25.1	34.96	-	-	-	3	-	3	ca. 6.5-20.0
Do.	do.	0	G-30-14	8/23/56	0747	9°22' S	132°10' W	-	-	1670	25.2	35.41	-	-	1	-	-	1	6.5
Do.	do.	0	G-30-15-1	8/23/56	1954	9°48' S	132°07' W	-	-	1672	25.4	35.41	-	-	1	-	-	1	ca. 5.5
Do.	do.	0	G-30-17-4	8/24/56	2035	11°10' S	131°56' W	-	-	1776	25.0	35.71	-	-	1	-	-	1	4.2
Do.	do.	0	G-30-18	8/25/56	0750	12°12' S	132°05' W	-	-	1891	24.7	35.79	-	-	2	-	-	2	5.2, 6.0
Do.	do.	0	G-30-29-1	8/30/56	2000	9°22' S	137°01' W	-	-	1505	25.7	35.66	-	-	1	-	-	1	ca. 4.1
Do.	do.	0	G-30-31	9/1/56	0756	7°32' S	138°54' W	-	-	2021	25.6	35.64	-	-	7	-	-	7	ca. 5.2-7.2
Do.	do.	0	G-30-33	9/2/56	0750	8°50' S	139°08' W	-	-	1380	25.7	35.84	-	-	1	-	-	1	8.6
Do.	do.	0	G-45-29-2	7/29/59	1958	16°48' N	154°38' W	-	-	1284	25.9	-	-	-	1	-	-	1	ca. 4.3
Do.	do.	0	G-48-61	7/24/60	1955	16°04' N	160°08' E	-	-	-	28.9	-	-	1	-	-	-	1	5.1
Do.	do.	0	G-48-63	7/25/60	2000	18°16' N	160°11' E	-	-	-	28.9	-	-	2	-	-	1	3	4.0-4.5
Do.	do.	0	G-48-65	7/26/60	2000	19°56' N	160°09' E	-	-	-	28.8	-	-	2	-	-	-	2	4.3, 5.2
Do.	do.	0	G-53-17-1	7/8/61	1120	18°46' N	158°46' W	-	-	1675	26.0	34.68	-	-	1	-	-	1	7.6
Do.	do.	0	G-53-19-1	7/9/61	1107	16°01' N	159°55' W	-	-	2374	25.8	34.54	-	1	1	-	-	2	BL 6.0, SB 8.7
Do.	do.	0	G-53-27-1	7/12/61	1005	22°07' N	164°37' W	-	-	1803	26.2	35.05	-	-	1	-	-	1	10.1
Do.	do.	0	G-53-32-1	7/15/61	1000	22°58' N	169°21' W	-	-	2082	26.5	34.97	-	2	1	-	-	3	4.1-4.9
Do.	do.	0	G-53-34-1	7/16/61	1000	19°42' N	169°41' W	-	-	2097	26.9	34.84	-	-	-	-	1	1	8.0

Appendix Table 1.--Record of catches of istiophorid larvae and juveniles by the Southwest Fisheries Center, Honolulu Laboratory from 1950 to 1971.--Continued.

Gear	Type of tow	Depth of tow	Vessel[1]/ cruise/ station sample	Date	Time	Position: Latitude	Position: Longitude	Duration of tow: Hr.	Duration of tow: Min.	Volume of water strained	Surface temperature	Surface salinity	Larval and juvenile catches[2]: SF	BL	SB	BB	UN	Total	Size range
										m^3	° C	°/..							mm
1-m plankton net	horizontal	0	G-53-42-1	7/22/61	1009	22°29' N	167°05' W	-	-	1980	26.5	35.00	-	1	-	-	-	1	17.2
Do.	do.	0	G-53-46-1	7/24/61	1103	22°33' N	162°04' W	-	-	1865	26.4	34.83	-	2	-	-	-	2	5.5, 12.6
Do.	do.	0	G-53-48-2	7/25/61	0207	20°25' N	162°15' W	-	-	1691	26.9	34.84	-	1	-	-	-	1	4.4
Do.	do.	0	G-53-49-1	7/25/61	1104	19°02' N	162°07' W	-	-	2061	27.0	34.73	-	1	-	-	-	1	9.0
Do.	do.	0	G-53-52-2	7/27/61	0209	18°57' N	159°59' W	-	-	2213	26.3	34.67	-	-	1	-	1	2	4.0-4.4
Do.	do.	0	G-53-54-2	7/27/61	2105	21°50' N	159°54' W	-	-	1851	26.5	-	-	-	-	-	1	1	4.9
Do.	do.	0	G-54-4-1	10/ 1 /61	2007	14°14' N	154°32' W	-	-	1770	26.9	34.42	-	-	1	-	-	1	6.0
Do.	do.	0	G-55-5-1	1/17/62	1000	17°00' N	163°00' W	-	-	-	25.0	-	-	-	1	-	-	1	4.3
Do.	do.	0	G-55-7-1	1/18/62	0558	15°06' N	165°15' W	-	-	-	25.0	-	-	-	3	-	-	3	4.5-6.4
Do.	do.	0	G-55-8-1	1/18/62	1713	14°03' N	166°39' W	-	-	-	26.0	-	-	1	-	-	-	1	6.2
Do.	do.	0	G-55-11-1	1/19/62	1544	12°05' N	169°01' W	-	-	-	26.8	-	-	2	-	-	-	2	8.9, 9.9
Do.	do.	0	G-55-12-2	1/19/62	1903	11°47' N	169°19' W	-	-	-	27.1	-	-	-	-	-	1	1	3.8
Do.	do.	0	G-55-26-2	1/29/62	1356	9°40' S	171°38' E	-	-	-	29.2	-	-	5	-	-	1	6	3.5-10.2
Do.	do.	0	G-55-34-2	2/1/62	0758	15°36' S	169°52' E	-	-	-	28.7	-	-	-	-	-	1	1	3.8
Do.	do.	0	G-55-35-2	2/1/62	1355	16°16' S	169°28' E	-	-	-	28.5	-	2	-	-	-	-	2	4.6, 4.7
Do.	do.	0	G-55-36-2	2/1/62	2015	16°40' S	168°57' E	-	-	-	28.5	-	-	2	-	-	-	2	3.8
Do.	do.	0	G-55-53-1	2/15/62	0805	19°37' S	176°43' E	-	-	-	27.2	-	-	9	-	-	1	10	4.0-6.5
Do.	do.	0	G-55-62-1	2/23/62	0810	14°59' S	177°13' E	-	-	-	28.7	-	-	2	-	-	1	3	3.8-5.3
Do.	do.	0	G-55-85-1	3/1/62	2100	18°48' S	176°31' W	-	-	-	28.6	-	-	-	-	-	1	1	4.3
Do.	do.	0	G-55-86-2	3/2/62	0809	20°21' S	175°42' W	-	-	-	27.7	-	-	1	-	-	-	1	10.4
Do.	do.	0	G-55-102-1	3/13/62	1957	15°05' S	170°48' W	-	-	-	28.3	-	-	2	1	-	-	3	4.3-4.5
Do.	do.	0	G-55-111-2	3/22/62	0803	9°52' S	166°16' W	-	-	-	28.8	--	-	1	-	-	-	1	4.0
Do.	do.	0	G-58-49	7/15/62	1342	23°27' N	164°51' W	-	-	2080	26.5	34.94	-	1	-	-	-	1	8.4
Do.	do.	0	G-58-53	7/16/62	0100	24°17' N	166°15' W	-	-	2427	25.6	35.06	-	3	-	-	-	3	3.8-4.7
Do.	do.	0	G-58-60	7/17/62	0100	22°55' N	165°41' W	-	-	1644	26.5	34.93	-	1	-	-	-	1	3.9
Do.	do.	0	G-58-63	7/17/62	1300	22°10' N	164°12' W	-	-	1212	26.5	34.98	-	1	-	-	-	1	10.3
Do.	do.	0	G-69-1-1	10/8/63	0827	19°44' N	160°15' W	-	-	-	27.1	-	-	1	-	-	-	1	ca. 13.9
Do.	do.	0	G-69-3-1	10/9/63	0755	17°39' N	163°33' W	-	-	-	27.2	·	-	1	2	-	-	3	BL 9.4, SB 4.2, 18
Do.	do.	0	G-69-5-1	10/10/63	0754	15°24' N	166°55' W	-	-	-	27.3	-	-	7	-	-	-	7	4.3-6.0
Do.	do.	0	G-69-7-1	10/11/63	0757	14°32' N	170°22' W	-	-	-	27.8	-	-	2	1	-	-	3	7.6-11.5
Do.	do.	0	G-69-9-1	10/12/63	0757	11°30' N	173°35' W	-	-	-	28.2	-	-	11	2	-	-	13	5.9-13.3
Do.	do.	0	G-69-11-1	10/13/63	0758	9°11' N	176°48' W	-	-	-	28.2	-	-	2	-	-	-	2	3.8, 4.3
Do.	do.	0	G-69-27-1	10/22/63	0156	0°53' S	172°18' W	-	-	-	-	-	-	-	1	-	-	1	3.4
Do.	do.	0	G-69-28-1	10/22/63	0757	1°47' S	172°05' W	-	-	-	-	-	-	4	-	-	3	7	3.6-10.0
Do.	do.	0	G-69-36-1	10/24/63	2000	8°10' S	169°27' E	-	-	-	-	-	-	-	1	-		1	4.4
Do.	do.	0	G-69-75-1	11/22/63	1357	12°37' S	178°12' W	-	-	-	-	-	-	6	-	-	-	6	7.4-10.8
Do.	do.	0	E-3-42	3/8/64	1930	15°32' N	170°32' W	-	-	1920	-	-	-	2	-	-	-	2	6.0, ca. 6.4
Do.	do.	0	E-3-86	3/13/64	1939	16°50' N	172°03' W	-	-	3169	-	-	-	-	-	-	1	1	ca. 4.2
Do.	do.	0	E-5-16	5/9/64	1815	13°20' N	171°02' W	-	-	1657	-	-	-	4	2	-	-	6	4.9-8.6
Do.	do.	0	E-5-36	5/11/64	1815	14°24' N	172°38' W	-	-	1163	-	-	-	1	-	-	-	1	10.3
Do.	do.	0	E-5-53	5/13/64	1817	15°01' N	174°14' W	-	-	1516	-	-	-	-	1	-	-	1	9.2
Do.	do.	0	E-5-59	5/14/64	1815	16°52' N	171°19' W	-	-	1785	-	-	-	2	-	1	-	3	BL 3.9-ca. 6.0, BB
Do.	do.	0	E-6-17	6/8/64	1926	15°34' N	169°14' W	-	-	1063	-	-	-	3	-	-	-	3	ca. 7.0-7.8
Do.	do.	0	E-6-37	6/10/64	1923	14°17' N	170°13' W	-	-	1294	-	-	-	1	-	-	-	1	5.9
Do.	do.	0	E-6-61	6/12/64	1927	15°03' N	171°49' W	-	-	1271	-	-	-	5	-	-	1	6	3.6-7.7

Appendix Table 1.--Record of catches of istiophorid larvae and juveniles by the Southwest Fisheries Center, Honolulu Laboratory from 1950 to 1971.--Continued.

Gear	Type of tow	Depth of tow	Vessel[1]/ cruise station sample	Date	Time	Position		Duration of tow		Volume of water strained	Surface temperature	Surface salinity	Larval and juvenile catches[3]						Size range
						Latitude	Longitude						SF	BL	SB	BB	UN	Total	
								Hr.	Min.	m^3	° C	°/₀₀							mm
1-m plankton net	horizontal	0	E-6-80	6/14/64	1954	15°53' N	173°27' W	-	-	1455	-	-	-	5	-	1	-	6	BL 5.5-8.6, BB 23.0
Do.	do.	0	E-6-84	6/15/64	1922	18°27' N	170°53' W	-	-	-	-	-	-	-	1	-	-	1	4.9
Do.	do.	0	C-2-13	3/29/64	2003	14°37' N	147°58' W	-	-	678?	24.0	34.48	-	1	-	-	-	1	5.2
Do.	do.	0	C-3-13	4/27/64	2020	14°00' N	147°55' W	-	-	1839	24.8	34.52	-	1	-	-	-	1	6.5
Do.	do.	0	C-4-9	5/25/64	2003	20°28' N	151°04' W	-	-	1413	22.9	35.09	-	-	1	-	-	1	24.2
Do.	do.	0	C-4-10	5/26/64	2002	16°29' N	150°58' W	-	-	1588	24.2	34.53	-	-	1	-	-	1	3.8
Do.	do.	0	C-6-10	7/22/64	2000	17°18' N	151°01' W	-	-	2192	25.8	34.78	-	1	1	-	-	2	BL 6.0, SB 3.8
Do.	do.	0	C-6-14	7/26/64	2005	17°03' N	147°58' W	-	-	1515	26.0	34.46	-	1	-	-	-	1	5.8
Do.	do.	0	C-15-6	4/16/65	2000	16°10' N	154°00' W	-	-	2060	25.6	34.32	-	-	4	-	-	4	4.0-4.4
Do.	do.	0	C-15-10	4/20/65	2004	17°07' N	150°59' W	-	-	2573	24.8	34.42	-	-	2	-	-	2	4.6, ca. 4.8
Do.	do.	0	C-16-3	5/27/65	2007	12°58' N	157°04' W	-	-	1488	26.1	-	-	1	-	-	-	1	5.0
Do.	do.	0	C-46-23-3	10/21/69	0100	7°26' N	144°43' W	-	-	1333	28.4	33.84	-	1	-	-	-	1	5.2
Do.	do.	0	C-46-27-1	10/22/69	2100	7°29' N	145°05' W	-	-	1614	28.8	33.99	-	-	2	-	-	2	3.3, 3.8
Do.	do.	0	C-46-27-2	10/22/69	2300	7°29' N	145°05' W	-	-	1837	28.8	33.99	-	-	1	-	-	1	3.5
Do.	do.	0	C-46-29-2	10/23/69	2300	7°28' N	145°14' W	-	-	1535	28.9	33.85	-	-	1	-	-	1	ca. 2.8
Do.	do.	0	C-46-29-3	10/24/69	0100	7°28' N	145°14' W	-	-	1592	28.8	33.84	-	-	1	-	-	1	3.8
Do.	do.	0	C-46-31-1	10/24/69	2100	7°31' N	145°02' W	-	-	1734	28.9	33.84	-	-	1	-	-	1	3.8
Do.	do.	0	C-46-31-2	10/24/69	2300	7°31' N	145°02' W	-	-	1516	28.8	33.84	-	-	1	-	-	1	3.9
Do.	do.	0	C-46-31-3	10/25/69	0100	7°31' N	145°02' W	-	-	1536	28.8	33.91	-	2	1	-	-	3	4.3-4.5
Do.	do.	0	C-48-46-1	4/15/70	2300	3°22' N	144°56' W	-	-	1744	28.5	34.81	-	-	-	1	-	1	ca. 5.8
Do.	do.	0	C-48-79-1	4/23/70	2100	3°32' S	144°56' W	-	-	1268	28.8	34.92	-	-	-	1	-	1	6.6
Do.	oblique	0-40	S-21-30-1	8/14/53	0240	21°03' N	157°31' W	-	-	1954	26.1	35.16	-	1	-	-	-	1	4.5
Do.	do.	0-60	S-35-8-1	8/2/56	1455	21°12' N	158°22' W	-	-	1641	26.2	-	-	-	1	-	-	1	4.8
Do.	do.	0-60	S-38-64-2	3/5/57	2030	17°56' S	140°28' W	-	-	533	-	-	-	1	-	-	-	1	3.0
Do.	do.	0-60	S-47-14-1	10/19/58	0502	17°40' N	154°34' W	-	-	1253	26.3	34.72	-	1	-	-	-	1	5.5
Do.	do.	0-60	S-50-2	1/11/59	2008	14°42' N	152°21' W	-	-	1154	24.8	34.74	-	-	1	-	-	1	7.2
Do.	do.	0-60	S-50-33	2/3/59	2004	15°52' N	169°54' W	-	-	1394	24.8	34.83	-	-	2	-	-	2	5.9, 6.3
Do.	do.	0-60	G-41-169-1	8/19/58	2331	21°10' N	158°19' W	-	-	1749	26.7	34.91	-	-	1	-	-	1	5.2
Do.	do.	0-60	G-44-24-1	5/21/59	2003	18°03' N	161°03' W	-	-	1458	26.1	34.34	-	-	1	-	-	1	ca. 4.0
Do.	do.	0-60	G-44-32-1	5/30/59	2004	18°03' N	155°14' W	-	-	-	-	-	-	-	2	-	-	2	4.5, 5.1
Do.	do.	0-60	G-45-14-1	7/19/59	2032	20°40' N	163°42' W	-	-	1034	26.7	34.26	-	1	-	-	-	1	5.9
Do.	do.	0-60	G-45-15-1	7/20/59	2030	23°20' N	166°10' W	-	-	1055	26.4	34.70	-	1	-	-	-	1	9.4
Do.	do.	0-60	G-45-22-1	7/24/59	2024	23°07' N	159°00' W	-	-	811	26.7	34.37	-	1	-	1	1	3	Bl 4.0, UN 4.2, BB7.5
Do.	do.	0-60	G-45-29-1	7/29/59	1958	16°48' N	154°38' W	-	-	1284	25.9	-	-	-	-	1	-	1	?
Do.	do.	0-60	G-46-16-B	10/4/59	2034	22°48' N	153°42' W	-	-	1466	-	-	-	-	-	-	1	1	ca. 3.5
Do.	do.	0-60	G-46-21-A	10/10/59	2002	15°33' N	160°15' W	-	-	1421	26.9	34.53	-	-	-	-	1	1	ca. 5.0
Do.	do.	0-60	G-46-23-A	10/12/59	2004	18°08' N	164°57' W	-	-	1397	27.4	34.31	-	1	-	-	-	1	6.8
Do.	do.	0-60	G-52-79-1	4/20/61	0214	18°21' N	168°53' W	-	-	1498	25.4	34.72	-	1	-	-	-	1	4.3
Do.	do.	0-60	G-53-3-1	6/24/61	1130	19°04' N	155°59' W	-	-	1947	26.4	34.51	-	1	1	-	1	3	BL 4.8, SB 3.9, UN 4.3
Do.	do.	0-60	M-35-27-1	5/13/57	1716	22°20' N	157°46' W	-	-	1677	23.4	35.08	-	-	-	1	-	1	ca. 9.8
Do.	do.	0-140	S-43-88-1	2/20/58	2010	7°49' N	148°37' W	-	-	1506	27.8	-	-	1	-	-	-	1	3.9
Do.	do.	0-140	S-45-98-1	5/24/58	0314	6°34' S	139°41' W	-	-	1426	27.9	35.02	-	1	-	-	-	1	4.0
Do.	do.	0-140	S-45-158-1	6/21/58	2010	17°14' N	153°40' W	-	-	1951	25.1	-	-	-	-	1	-	1	6.9
Do.	do.	0-140	S-46- 1	7/22/58	2127	23°56' N	158°28' W	-	-	1623	25.4	-	-	2	-	-	1	3	4.4-6.9
Do.	do.	0-140	G-48-18	6/30/60	0600	17°06' N	173°51' W	-	-	-	27.2	-	-	2	-		-	2	6.0, 6.1

Appendix Table 1.--Record of catches of istiophorid larvae and juveniles by the Southwest Fisheries Center, Honolulu Laboratory from 1950 to 1971.--Continued.

Gear	Type of tow	Depth of tow	Vessel[1]/ cruise/ station sample	Date	Time	Position		Duration of tow		Volume of water strained	Surface temperature	Surface salinity	Larval and juvenile catches[2]						Size range
						Latitude	Longitude						SF	BL	SB	BB	UN	Total	
								Hr.	Min.	m³	° C	°/oo							mm
1-m plankton net	oblique	0-140	G-48-35	7/7/60	1801	12°53' N	174°28' E	-	-	-	27.8	-	-	1	-	-	-	1	4.6
Do.	do.	0-140	G-48-54	7/22/60	0600	11°34' N	159°54' E	-	-	-	28.7	-	-	-	-	-	1	1	4.9
Do.	do.	0-140	G-48-104	8/16/60	1800	24°15' N	178°54' E	-	-	-	29.0	-	-	1	-	-	-	1	4.5
Do.	do.	0-140	G-55-26-1	1/29/62	1358	9°40' S	171°38' E	-	-	-	29.2	-	-	1	-	-	-	1	4.9
Do.	do.	0-140	G-55-39-1	2/10/62	0808	23°29' S	168°04' E	-	-	-	25.8	-	-	1	1	-	-	2	BL 8.6, SB 12.8
Do.	do.	0-140	G-55-97-2	3/12/62	0804	18°14' S	172°07' W	-	-	-	27.8	-	-	1	-	-	-	1	5.1
Do.	do.	0-140	G-69-11-2	10/13/63	0759	9°11' N	171°48' W	-	-	-	-	-	-	1	-	-	-	1	3.4
Do.	do.	0-140	G-69-26-2	10/21/63	2002	0°02' S	172°31' E	-	-	-	-	-	-	1	-	-	-	1	4.3
Do.	do.	0-150	S-6-19-3	8/20/50	2311	19°31' N	157°10' W	-	-	4782	26.0	-	-	1	-	-	-	1	21.2
Do.	do.	0-200	S-5-7	7/4/50	1649	15°00' N	171°54' W	-	-	888	26.7	34.56	-	1	-	-	-	1	4.3
Do.	do.	0-200	S-17-21	9/11/52	1930	20°28' N	155°37' W	-	-	1679	25.5	35.05	-	-	1	-	-	1	6.4
Do.	do.	0-200	S-34-7	4/30/56	1540	16°31' N	153°58' W	-	-	2286	24.8	34.42	-	-	1	-	-	1	6.7
Do.	do.	0-200	S-34-136	6/28/56	1402	21°02' N	160°26' W	-	-	1927	25.2	34.92	-	1	-	-	-	1	6.3
Do.	do.	0-200	S-35-101	8/30/56	0803	10°47' S	143°01' W	-	-	1576	26.1	-	-	-	1	-	-	1	7.1
Do.	do.	0-200	S-35-137	9/11/56	0807	16°45' S	149°52' W	-	-	1537	25.9	-	-	-	-	1	1	2	?
Do.	do.	0-200	S-35-158	9/24/56	2110	5°52' S	160°03' W	-	-	1876	26.7	-	-	-	1	-	-	1	4.5
Do.	do.	0-200	S-35-168	9/29/56	2117	4°24' N	160°08' W	-	-	1687	26.9	34.81	-	-	-	1	-	1	?
Cobb trawl	horizontal	15-20	C-32-19	7/20/67	1944	20°59' N	158°30' W	6	0	-	28.0	-	-	1	-	-	-	1	9.2
Do.	do.	8-60	C-32-29	7/26/67	0343	21°00' N	158°32' W	4	12	-	26.0	-	-	2	-	-	-	2	16.6, 18.5
Do.	do.	14-20	C-32-66	9/15/67	0345	19°45' N	156°06' W	6	0	-	28.0	-	-	3	-	-	-	3	13.0-19.5
Do.	do.	87-119	C-32-67	9/15/67	1152	19°53' N	156°05' W	6	0	-	28.3	-	-	1	-	-	-	1	18.9
Do.	do.	13-18	C-32-70	9/16/67	1946	19°24' N	156°00' W	6	0	-	28.3	-	-	2	-	-	-	2	8.6, 10.6
Do.	do.	9-18	C-32-81	9/23/67	1941	21°22' N	158°14' W	6	0	-	27.5	-	-	1	-	-	-	1	9.8
Do.	do.	20	C-46-25	10/21/69	1948	7°26' N	144°42' W	-	-	-	28.6	-	-	2	-	-	-	2	ca. 12.0, 16.3
Do.	do.	50	C-53-54	4/24/71	1832	19°11' N	147°27' E	2	0	-	28.6	-	-	2	-	-	-	2	22.0, 24.1
Do.	do.	100	C-55-53	11/7/71	0030	21°03' N	147°54' E	2	55	-	28.7	-	-	4	-	-	-	4	20.0-55.0
Neuston net	do.	0	C-55-5	10/24/71	1229	21°52' N	173°05' W	-	30	-	27.8	-	-	-	1	-	-	1	9.2
Do.	do.	0	C-55-13	10/29/71	1230	22°30' N	168°22' E	-	30	-	-	-	-	3	-	-	-	3	5.5-6.1
Do.	do.	0	C-55-21	11/2/71	1230	22°52' N	149°06' E	-	30	-	-	-	-	1	-	-	-	1	10.0
Do.	do.	0	C-55-92	11/12/71	1230	16°17' N	149°16' E	-	30	-	-	-	-	1	-	-	-	1	4.5
Do.	do.	0	C-55-106	11/23/71	1230	6°50' N	163°36' E	-	30	-	-	-	-	2	-	-	-	2	6.7, 9.2
Do.	do.	0	C-55-132	12/1/71	1230	8°07' N	171°14' E	-	30	-	28.7	-	-	17	-	-	-	17	6.6-20.0

[1] S = Hugh M. Smith, G = Charles H. Gilbert, E = U.S.S. Energy, C = Townsend Cromwell, M = John R. Manning.

Appendix Table 2.--Record of catches of swordfish larvae and juveniles by Southwest Fisheries Center, Honolulu Laboratory from 1950 to 1971.

Gear	Type of tow	Depth of tow	Vessel cruise no.[1]	Station/ no. of samples	Date	Time (local)	Position Latitude	Position Longitude	Volume of meter	Surface temperature	Surface salinity	Size range (SL)
									m³	°C	‰	mm
1-m plankton net	Horizontal	0	S-4	15-1	5/21/50	1610	20°13' N	158°30' W	2950	24.5	--	10.5; 19.3
Do.	do.	0	S-4	20-1	5/23/50	0911	20°14' N	157°04' W	3346	23.6	--	6.6
Do.	do.	0	S-4	23-1	5/14/50	1852	22°40' N	157°10' W	2192	23.3	--	9.6
Do.	do.	0	S-39	21-1	5/9/57	2010	23°03' N	165°23' W	--	25.1	35.21	7.3; 8.8; 11.6; 13.4; 15.8
Do.	do.	0	S-39	28-1	5/15/57	2010	20°03' N	162°04' W	--	25.1	34.96	6.5; ca. 7.0; 19.6
Do.	do.	0	E-5	59-1	5/14/64	1815	16°52' N	171°19' W	1785	--	--	8.3
Do.	do.	0	E-6	80-1	6/14/64	1954	15°53' N	173°27' W	1455	--	--	23.0
Do.	do.	0	C-48	46-1	4/15/70	2300	3°22' N	144°56' W	1744	28.5	34.81	5.8
Do.	do.	0	C-48	79-1	4/23/70	2100	3°32' S	144°56' W	1268	28.8	--	6.6
Do.	Oblique	60	M-35	27-1	5/13/57	1716	22°20' N	157°46' W	1677	23.4	35.08	9.8
Do.	do.	60	G-45	22-1	7/24/59	2024	23°07' N	159°00' W	811	26.7	34.37	7.5
Do.	do.	140	S-45	158-1	6/21/58	2010	17°14' W	153°40' W	1951	25.1	--	6.9
Do.	do.	200	S-35	137-1	9/11/56	0807	16°45' S	149°52' W	1537	25.9	--	ca. 8.0 (head only)

[1]C = Townsend Cromwell, E = U.S.S. Energy, G = Charles H. Gilbert, M = John R. Manning, S = Hugh M. Smith.