

## Notes on the life-history of the sword-fish, *Xiphias gladius* LINNAEUS

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### 1. Previous records and the material examined

The postlarval and the young stages of the sword-fish have been represented by the specimens shown in table 1.

**Table 1**      Records of the young specimens of the sword-fish

author	size	locality	season
Luetken	37 mm (total length)	Atlantic	Unknown
Goode	ca. 200 mm ( // )	Unknown	Unknown
S. Nakamura (1935)	660, 860 mm ( // )	Off shore of Chiba Pref.	Spring
Yabe      (1951)	11.7–27.4 mm ( // )	Adjacent waters of Okinawa Is.	May

We wish to report on the results of our studies on the life-history of the sword-fish the material of which has been obtained from the waters near Bonin Islands and Minami-torishima and in South Sea Islands. The dates, localities and the methods of collecting, and the number and size of the specimens are shown in table 2.

**Table 2**      The size, date, number and localities of the specimens

locality	latitude	date	length (mm)	a	b	c	remarks
Adjacent seas of Bonin		Early part of May 1949	21.0 23.5	2			Station not known
Adjacent seas of Minami- torishima	24°—26°	June 1949	100—310	67	42	111	Mainly from the stomach of Euma- kaira nigra
	//	Feb., 1950	250.0	1	1	56	From the stomach of Kajikia mitsu- kurii
	//	Apr., 1950	Ripe ovarian ova				2280 mm long*

Tropical seas of western Pacific (145°—157°E)	8°—10°	July, 1950	695.0*	1			Caught by long line
	〃	Aug., 1950	580.0	1			〃
	6°—8°	July, 1950	270.0	1	1	37	From the stomach of <i>E. nigra</i>
	〃	〃	1164.0*	1			Caught by lone line
	4°—6°	〃	510.0	1	1	37	From the stomach of <i>E. nigra</i>
	2°—4°	〃	230.0—440.0	5	5	86	〃
	0°—2°	〃	500..	1	1	13	〃
	〃	〃	454.0	1			Caught by long line
	〃	Aug., 1950	434.0	1			〃

- Notes: a. Number of specimens  
b. Number of stomachs in which the specimens were found  
c. Number of stomachs examined

\* Length represented by the distance between eye and fork; in others the distance between eye and caudal peduncles.

## 2. Morphometric measurements

The specimens collected from the stomach contents of the tunas or the spear-fishes are digested in various degrees. As the damage by the digestion is most heavy in the portion of the snout, the length of the body is represented by the distance between the eye and the base of the caudal fin. Table 3 shows the measurements and the proportion of the important parts of the bodies of the specimens in various sizes.

Table 3 The measurements and proportions of the bodies

	I	II	III	III	V
Body length	23.5	100.0	252.0	454.0	580.0
Upper jaw Caudal peduncle	44.5	160.5	385.0	780.0	1123.0
Snout length	19.0	54.0	120.0	314.0	516.0
Upper jaw length	21.0	62.5	141.0	357.0	584.0

Length of lower jaw		16.0	45.0	88.0	152.0	171.0
Postorbital space		3.0	9.5	28.0	84.0	121.0
Diameter of eye		2.3	5.0	12.0	19.0	27.0
Height of dorsal fin	1) at origin	2.2	10.0	33.0	154.0	218.0
	2) at anus	3.3	14.5	51.5	35.0	23.0
	3) at terminus	2.0	10.0	16.0	25.0	33.0
Height of anal fin	1) at origin	2.2	6.5	29.0	70.0	129.0
	2) at terminus	1.8	5.9	10.0	22.0	30.0
Length of pectoral fin		3.0	17.5	61.0	138.0	191.0
Length of caudal fin	1) at shortest	4.0		30.0	34.0	40.0
	2) at the longest	0.4	16.5	59.0	150.0	212.0
Height of body	1) at anus	3.0	13.5	31.0	110.0	155.0
	2) 1st D. insertion	2.0		24.0	80.0	111.0
	3) at caudal peduncle	1.2	4.0	9.5	27.0	27.0
Pectoral origin anus		9.5		100.0	206.0	218.0
Lower jaw length/Upper jaw length		76.2	72.0	62.4	42.6	29.4
Snout length/Body length		80.9	54.0	47.6	69.2	29.3
Body height/Postorbital length		12.8	13.5	14.3	24.2	26.0
Diameter of eye/Postorbital length		76.7	52.6	41.4	22.6	22.3
Dorsal insertion/Body height		73.3	74.3	91.7	140.0	140.6
Dorsal height at anus/Body height		110.0	107.4	143.1	31.8	14.8
Dorsal height at terminus/Body height		66.7	74.7	44.4	20.0	21.3
Pectoral length/Body length		12.2	17.5	24.2	30.4	32.9

Such proportions as the length of the lower jaw to the upper, and the diameter of the eye to the postorbital space are in inverse proportion, and the depth to the length of the body, and the length of the pectoral fin to the length of the body are proportional to the growth. However these proportions are proportional or inverse proportional to the growth, the tendencies of the change are regular, but such proportions as snout to the length of the body and height of the dorsal fin to the depth do not change regularly and there are the stages when the proportions become reversed. On some other items which are not shown in table 3, brief descriptions on each specimen are made and some morphological comparisons are made as follows.

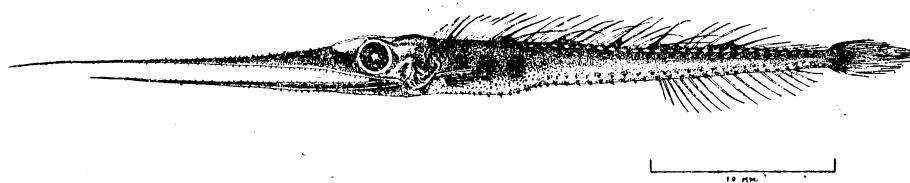


Fig. 1. Young of *Xiphias gladius*, 23.5 mm. long.

1). The specimens 23.5 mm. long (fig. 1)

Body much more elongated than that of the adult. 4 lateral rows of scales of bony plates exist, of which one each along the dorsal and ventral extremities of the side of the body, and two between these rows. Each scale has 2 - 4 long and sharp processes, which are especially remarkable in the posterior half of the body. There are spiny processes on the dorsal side of the orbit and on both sides of the posterior portion of the lower jaw. Two spines exist of the posterior margin of the preoperculum, 3 smaller ones in the front of the base of these two spines, and tricuspid spine on the post-temporal. There are also fine spines along the posterior half of the dorsal side of upper jaw and the ventral side of the lower.

Lower jaw much more elongated than in the adult, its length reaches about 76% of the upper. Teeth are in single row on both jaws. Anus situated about the midway between the base of the pectoral and that of the caudal. Dorsal fin single, not yet separated, its rays are remarkably high; those in the front being  $\frac{2}{3}$  of the depth of the body, median ones highest, nearly 1.5 of the depth of the body at the anus, from there their heights gradually decrease posteriorly. Anal fin single, its origin is at a little distance from the anus. The rays are low in the front, median ones high nearly equal to the depth. Pectoral fin well developed, its length nearly equal to the depth of the body. No ventral fin. Caudal fin not forked but pointed. In the specimen preserved first in formalin and removed in alcohol, snout, head and the dorsal

side of the body brown, side of the body dark brown and the ventral side white. The base of the dorsal fin blackish brown and its margin brown. Anal and the pectoral fin little colored, caudal rays somewhat brownish, the iris dark green. 6 transverse bands present on the dorsal fin and one on the anal as described by Luetken. A faint lateral band exists along the median rays of the caudal fin.\*

2). The specimen 100 mm. long

The longitudinal 4 rows of scales are very remarkable. Those in the posterior half are larger and the spines on them are also more remarkable than those in the front half of the body. Spines on the scales are 2 - 4 in number, the relative length of these spines somewhat decrease than in the specimen 1. The spiny processes on the dorsal margin of the orbit, posterior portion of the lower jaw and the posterior margin of the preoperculum have already disappeared. The degeneration of the teeth remarkable, in single row making minute serration on both jaws. The relative length of the lower jaw to that of the upper decreases, and the relative length of the snout to the length of the body is much shorter than that of the specimen 1. Caudal fin is rather rounded.

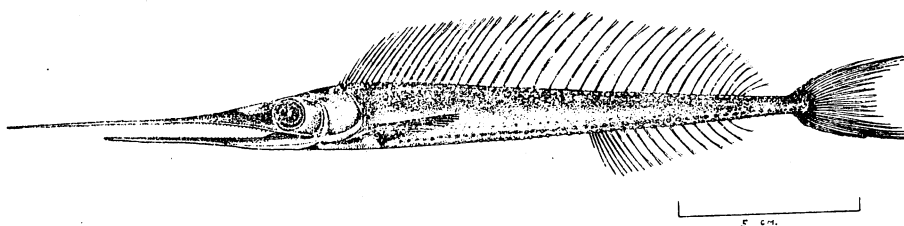


Fig. 2. Young of *Xiphias gladius*, 252 mm. long.

3). The specimen 252 mm. long (fig. 2)

Scales yet exist along the side of the body. Those of them situate in the posterior half of the body are large. In this stage of the growth, nearly half of the scales are smooth, because of the spines on them disappeared. Considering from the fact that the spines on the scales are easily falled off by the rubbing with the pincette, it seems that the spines do not degenerate but they are deciduous in some stage of the growth. The scales in the median two rows are smaller than those of the dorsal and ventral extreme rows. There are many minute scaly substances between these scales so as to

\* Smaller specimens of 11.7-27.4 mm. total length were reported by Yabe, from the adjacent seas of Ryukyu.

fill up the aperture of these scales. The proportion of the length of the snout to that of the body is smallest in this stage (see table 2). Dorsal and anal fin are yet single. The fin rays of the dorsal are highest in the median part, the margin of the fin somewhat concave in the anterior half and convex in the posterior. The height of the anal fin rays are highest in front and gradually decreases posteriorly. Caudal fin forked widely. Anus situates in front of the anal fin, aperting from its origin about  $\frac{3}{4}$  of the depth of the body. The keel on the caudal peduncle is not yet developed.

4). The specimen 454 mm. long.

Scales degenerated conspicuously, inbedded in the skin, but their existence are still traceable exteriorly. The relative length of the snout to that of the body is considerably larger than that of the specimen 3. The dorsal and the anal fin show the tendency to separate into two bases. Caudal fin forked deeply. The caudal peduncle depressed, keels already deveveloped as seen in the adult. The feature and the color of the body becomes approximately equal to those of the adult, but there are fine thread-like transverse black bands of about 10mm. are in a row, aperting 10-20 mm., along the center of the side of the body. The lateral lines are not observed in those specimens as shown in 1)-3), but though it is indistinct, it exists in this stage. The lateral line starts from below the origin of the first dorsal fin, making wavy curve of about 10mm. and disappears backward.

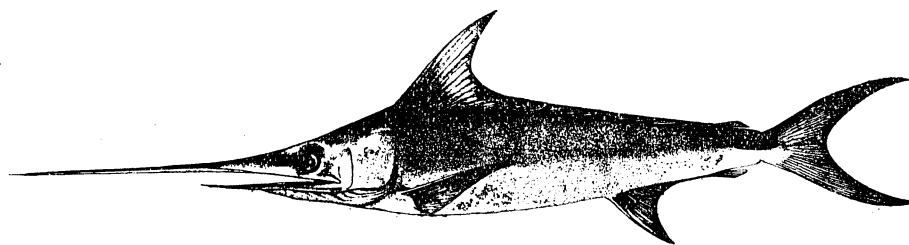


Fig. 3. Young of *Xiphias gladius*, 580 mm. long.

5). The specimen 580 mm. long (fig. 3)

The most remarkable differences between the present and the previous specimens are that the dorsal and the anal fins separated in two bases, and there is not even the trace of the scales. There is no remarkable distinction from the adult in the feature of the body, except the relative length of the snout to that of the body, which is somewhat larger in this stage. The scale has already degenerated completely and the lateral line perfectly disappeared.

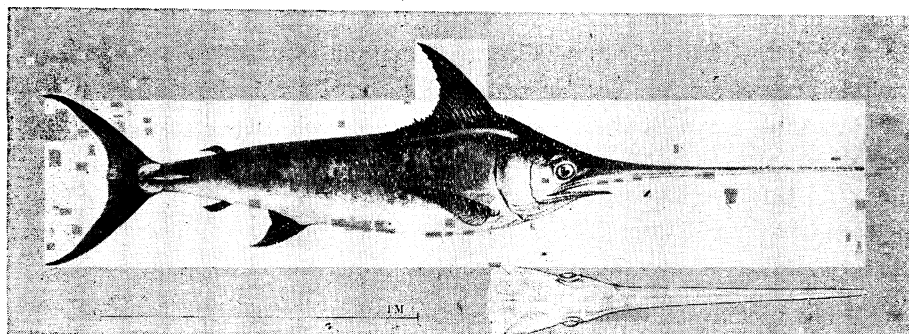


Fig. 4. Adult of *Xiphias gladius*, from Hirasaka and Nakamura, 1947.

### 3. The distribution of the young in the north-western Pacific area

As shown in tables 1 and 2, the running ripe ovarian ova are found in April in the adjacent seas of Minami-torishima (Long. 156° 51' E; Lat. 25° 17' N), and the larvae are collected by the horizontal towing of the larva-net in the adjacent waters of the Bonin and Ryukyu Islands. The season of the collection of the larvae is May in both cases. Such facts as mentioned above will prove that this fish spawns, at least between April to May, in the vast areas of the North Equatorial Current and in the Kuroshio Current. Hitherto the spawning season of this species is considered from August to September in the North-West Pacific Ocean.\* Therefore the present knowledge on the spawning habit of this fish must be added to that of the previous.

Although the sizes of the youngs which are found in the stomach are various, numerous specimens were collected in June in the area of North Equatorial Current (mainly in the adjacent seas of Minami-torishima). Our same investigations have been carried out also in February, April and December, nevertheless none of the young specimens were ever collected except the only one taken in February (see table 2). Regionally the distribution of the youngs is limited south of 26°N; none of them, smaller than 500 mm., has been reported north of 26°N.

The data from the area between 0°-10°N were collected between July and August, 1950. The distribution between the area from 10°-24°N is not clarified, because the investigation has never been tried in this area, but it is thought to be sure that the youngs in various sizes may distribute also in this area. There are some differences in the sizes between the specimens collected in the adjacent seas of Minami-torishima in June and those collected in the South Sea Islands Area in July and August. In comparison with the sizes of

\*Toshiji Kamohara 1940. Fauna Nipponica vol, xv, Fas. II. No. v. Scombroidei.

the former are from 100 mm. to 310 mm., the latter are from 230 mm. to 510 mm. Other immature specimens of the size from 454 mm. to 695 mm. were collected from the catch by the long line in the latter area. In addition to the difference of the year, there are no data that connect the both areas, and furthermore there is seasonal difference of about a month between the collection from both areas. Therefore it is not clear whether the difference of the sizes of both areas is based upon the difference of the growth during a month or due to the annual difference of the growth; but it is thought to be sure that the youngs are distributed widely in the area between Equator and 26°N, at least during June to August. Hence there is no means to determine the age or the growth-rate of this fish, it is not able to clarify that how long these youngs passed after the hatching, but the fact that the larvae of the length from 18mm. to 30-40mm. are found in the area of North Equatorial Current and in the adjacent seas of Ryukyu, the size of the youngs found out from the stomach contents between June and August, will present very interesting suggestion to the spawning habits of this species. It is thought that these facts, above mentioned, will confirm our hypothesis on the spawning habits, that the spawning of such pelagic fishes as tunas or spear-fishes will take place in the vast area and time. It is thought also to worth notice that the sword-fish spawns in the tropical seas, notwithstanding the fish has the habit of living rather in the cold waters and the fishing ground, where the catches are relatively massive, are almost limited to north of the subtropical convergence.

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