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ON THE BIOLOGY OF *SAURIDA TUMBIL* (BLOCH. 1801)* FAMILY SYNODONTIDAE IN PHILIPPINE WATERS

By

K. TIEWS
Institute für Küsten-und Binnenfischerei der
Bundesforschungsanstalt für Fischerei,
Hamburg, Germany
and
A. MINES and I.A. RONQUILLO
Philippine Fisheries Commission
Manila, Philippines

ABSTRACT

This paper presents information on the biology of *Saurida tumbil,* which includes distribution, age and rate of growth, maturity, food, sex ratios and spawning. The study showed that the decline in catch per unit of effort for 1956 to 1957 in the trawl fishery was the result of natural causes.

INTRODUCTION

In October 1956, the Bureau of Fisheries initiated an intensive biological study of the important food fishes under the guidance of the senior author (Tiews, 1959), then technical expert of the United Nations, assigned to the Bureau of Fisheries to assist in planning marine fisheries biological researches and train research workers, to help solve fisheries problems.

This paper presents the result of the first one and half years of the biological study of *Saurida tumbil,* the most important lizard fish of the family Synodontidae. The lizard fish (Filipino *Kalaso*) ranked fourth among the landings of the most important food fish

* This paper is dedicated in friendship to Prof. Dr. A.V. Brandt on the occasion of his 60th birthday.
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species of the Philippines (Tiews, 1959) with a catch of 4,580 metric tons in 1956.

The members of the family Synodontidae represent typical examples of demersal fish species. They are mainly caught in commercial quantities by otter trawls.

The lizard fishes comprise 25 to 30% of the total otter trawl catches. They are abundant throughout the whole Philippine waters, and are very popular to the average Filipino family in places of great population density, especially those who cannot afford the price of the more expensive fishes.

The members of the family Synodontidae are not only plentiful in the Philippine Archipelago, but also in neighboring countries, like Southern Japan, Hong Kong, Taiwan and Thailand, even in the waters of Australia. A knowledge of the biology of the group is of paramount importance to the region.

MATERIALS AND METHOD

The materials used in this research study were taken from the catches of commercial otter trawls twice a month in Manila Bay, and, for comparison every three months in San Miguel Bay, Camarines Sur, east coast of Luzon. Collections were made by biological assistants (field men), sent out to join commercial otter trawlers during their fishing operations. Every month, one group of field men joins a fishing vessel which fished in the shallow waters of Manila Bay (less than 20 fathoms deep) and another group joins a fishing vessel which fished in waters deeper than 20 fathoms. Once every three months, a group of field men joins trawlers fishing in San Miguel Bay, to assist in this study and other researches.

Specimens of *Saurida tumbil* were randomly collected from the catches, preserved in 4% formalin and brought to the laboratory for further study. The field men collected length composition data of the catch during each haul of the net. The field men also made a qualitative and quantitative analysis of the total catch.

From the laboratory samples, the total length, fork length, standard length, weight, sex and sexual maturity stage, stomach content, as well as infection by parasites were recorded. Meristic characters, such as vertebrae counts, counts of the various fin rays and measurements of different fins, were recorded for taxonomic studies. The total length of the fish was used in the study of the length composition of the catch.

A total of 55,878 pieces of *Saurida tumbil* were measured in Manila Bay and 1,265 samples in San Miguel Bay.

Saurida tumbil is the most abundant among the lizard fishes. It represents more than 90% of the total lizard fish landings in most months.

COMPARISON OF MANILA BAY AND SAN MIGUEL BAY

Two fertile fishing grounds were studied. Observations were made on the commercial catches of both Manila Bay and San Miguel Bay. In Manila Bay, during the period surveyed, the surface temperature ranged from 26.4°C to 31.2°C annually, bottom temperature ranged from 26.4°C to 30.0°G, and the salinity from 15.4°/oo to 34.5°/oo. On the other hand, in San Miguel Bay surface temperature ranged from 25.6°C to 31.6°C, bottom temperature from 26.5°C to 31.2°C and the salinity from 26.0°/oo to 34.6°/oo.

Topographically, the conditions existing in both bodies of water are relatively similar, although in area, Manila Bay is about 2.6 times as large as San Miguel Bay. The nutrient supply of Manila Bay comes mainly from the different rivers that discharge into it (Megia, *et al.* 1952). Two most important rivers that greatly contribute to the fertilization of Manila Bay are the Pasig River and the Pampanga River. Similarly, San Miguel Bay derives most of its fertility from river discharges. The big Bicol River and other rivers supply the bay with the nutrient salts from the land.

The entrance to Manila Bay is guarded by Corregidor Island, dividing it into two openings, providing an outlet and an inlet channel allowing the free circulation of sea water in the bay. A similar condition exists in San Miguel Bay, with the presence of Karingo Island in its mouth.

Both bays open into big bodies of water. Manila Bay is fed with oceanic water from the China Sea and San Miguel Bay from the Pacific Ocean.

Sandy-muddy to completely muddy substrata are found in both bays. However, San Miguel Bay is shallower than Manila Bay. (Tiews, Ordoñez and Ronquillo, MS 1968).

DISTRIBUTION

For this study, Manila Bay was divided into two areas: Area I up to 20 fathoms deep, and Area II deeper than 20 fathoms.

Saurida tumbil is caught in nearly equal quantities from both Area I and Area II. The largest and mature fish are, however, mostly caught in the deeper area (Area II), including the area outside the bay (Table I).

In San Miguel Bay, catches are differentiated between those made inside the bay and those made outside the bay, i.e. (Camarines Sound), the area surrounding the mouth of the bay. Analysis of the catches showed that *Saurida tumbil* dominated the lizard fish catches by more than 90% in both areas. Relatively, they are more abundant and are bigger outside the bays than inside.

LIFE HISTORY

a) *Reproduction*

1. *Sexual Maturity Stages Key*

The determination of the gonadal conditions of the lizard fishes was based on the Heincke-Maier's sexual maturity determination (Buckmann, 1929), which was found to be best fitted for these species after some modifications. Maturity stage determinations on fresh specimens were carried out only at the beginning of the study. Later on gonads were preserved in weak formalin solution and the maturity stages key accordingly adjusted.

During the first spawning, not all eggs ripen together and are extruded. Only 1/3 to 1/2 of the ovary length contains ripe or running eggs while the other portion carry maturing eggs. After spawning, the ovary is not completely empty, but eggs of Stages II and III are left in the hind portion of the loose ovary. Therefore, a ninth stage (Recovering Spents) was adopted.

The following key was used:

Stage I — Immature:

Testes: Very thin strip and glassy transparent, laid close to the vertebral column. In formalin, colorless to whitish, but transparency is preserved.

Ovaries: Very small and transparent, colorless to grayish. Eggs not visible to the naked eye. Under the microscope,

TABLE I. Average catch per hour of *Saurida Tumbil* in Manila Bay in kilograms.

Month	Area I	Area II
November 1956	2.1 kgs/hr.	0.5 kgs/hr.
January 1957	No data available	2.3
February "	3.0	4.5
March "	5.6	0.5
April "	4.7	3.3
May "	3.8	1.8
June "	3.7	3.4
July "	6.9	4.0
August "	3.7	0.5
September "	0.6	No data available
October "	3.8	2.4
November "	0.8	1.9
December "	1.0	No data available
January 1958	0.9	" "
February "	1.5	1.1
March "	No data available	0.9
April "	1.3	0.8
May "	2.1	1.7
June "	2.5	2.2
July "	0.8	1.1
August "	0.3	No data available
September "	0.4	7.3
October "	1.3	No data available
November "	0.5	0.4
Total average	2.3	2.1

the eggs appear to be glassy transparent crowded cells with no definite size and shape. In formalin, the ovary is transparent grayish.

Stage II — Maturing Virgins:

Testes: Translucent reddish-gray to dull gray, less than half the length of the body cavity; in preserved materials, dull grayish translucent.

Ovaries: Translucent, red-reddish gray with compact wall and the area near vertebral column is well filled. Under the binocular microscope, eggs can be distinguished as polygonally shaped transparent cells. Size of ovary is about half the length of the body cavity. In preserved materials, the ovary is dull grayish-red, with reduced translucency.

Stage III — Preparing Stage:

Testes: Opaque white, with blood capillaries evident. It occupies about half of the length of the body cavity. In formalin, it is opaque white.

Ovaries: Opaque, reddish-gray to reddish orange. Volume and size are bigger than Stage II, occupying a little more than half of the body cavity. Rich in blood capillaries. Eggs are visible to the naked eye as yellowish-orange opaque granules. Under the binocular microscope the start of the deposition of yolk can be noticed, no definite shape. With preserved materials, the ovary is opaque yellowish-orange to light yellow and eggs are light yellow opaque granules, whose yolk development can be seen under the microscope.

Stage IV — Developing Stage:

Testes: Opaque, white, no milt appears by pressure. Testis compact and occupying about 2/3 of the length of the body cavity; in preserved specimens, white in color and compact.

Ovaries: Totally opaque, reddish-orange and volume is well filled. Eggs are clearly recognizable with light orange to reddish color and opaque. They are crowded against one another and therefore polygonal. Under the binocular microscope all the eggs which are to be laid are

completely yolked. In this stage, the division of the content of the ovary is recognizable. About 1/2 to 2/3 of the ovary is filled with yolked eggs which are to be spawned and the remaining half is filled with yolkness or developing eggs.

In preserved specimens, the ovary is opaque and yellowish orange. Individual eggs are yellowish.

Stage V — Gravid Stage:

Testes: Opaque white and definite length of 2/3 of body length is attained. Very compact and with pressure, white milt runs out slowly. In fresh specimen, opaque white and compact.

Ovaries: Opaque orange red, very compact and definite length and thickness is reached. Eggs which are to be spawned are round and some are already translucent and mature. In preserved materials, portion of ovary with eggs to be spawned is light orange and translucent eggs are distinguishable.

Stage VI — Running Out (Spawning) Stage:

Testes: Soft and creamy white. Milt runs out with slight pressure. Length same as Stage V. In preserved specimen, soft and white. Milt runs out when pressed.

Ovaries: The region containing the running ripe eggs is translucent and orange-red, very compact and elastic, and with slight pressure, transparent ripe eggs run out. Length similar to Stage V. In preserved specimen eggs are transparent, yellowish-orange.

Stage VII — Half-spent:

Testes: Opaque white, with soft and loose wall. Volume decreased and when pressure is applied milt still runs out. In preserved specimens, there were the same characteristics as in fresh specimen, although the degree of softness and looseness is less.

Ovaries: Loose and soft wall and volume is decreased, slightly shorter than Stage VI. Most of the glassy transparent ripe eggs are already extruded. Dark red in color as a whole. In formalin, same characteristics are found although color is not well pronounced, color is light orange red.

Stage VIII — Fully Spent:

Testes: Reddish gray very loose wall and rich in blood capillaries, shorter, as in the preceding Stage VI or VII. Sometimes a little degree of translucency is observed. No milt runs out when pressed. In preserved materials, yellowish gray and loose walls.

Ovaries: With loose walls, sometimes with folds, very much shorter and bloody. Traces of shrunken eggs are found within.

Stage IX (VIII-II) —- Recovering Spents:

Testes: Much reduced in size, reddish gray with some degree of translucency, rich in blood capillaries. Though empty, walls are no longer loose. In preserved specimen, yellowish gray.

Ovaries: Small in size about Stage IV, and with normal wall filled with remains of reabsorbed eggs. Eggs for the next spawning period are already in Stage III; bloody and volume is full. In preserved materials, same characteristics are observed, dull gray with plenty of blood capillaries.

To demonstrate clearly the increase of egg sizes from Stages II to VI, measurements of the egg diameter on subsamples of eggs were undertaken (Fig. 1). The eggs were separated by Gilson's solution.

2. *Spawning Time (Gonadal Condition)*

A total of 7,314 specimens composed of 4,620 males and 2,694 females of all sizes were checked during their maturity stages from November 1956 up to May 1958 (see Figs. 2 and 3).

We found that the female *S. tumbil* in Manila Bay and adjacent waters attains maturity at a total length of 19-21 cm. and the males at a length of 17-19 cm.

Okada and Kyushin (1955) reported that the *S. tumbil* in the East China and Yellow Seas attained first maturity at a fork length of 34-35 cm. for the females and 28 cm. for the males. In these waters, the average fork length of the catch was 35-38 cm. for the females and 30-33 cm. for the males; the females attaining a maximum of 64 cm. fork length and the males of 48 cm. Comparing this with the S. *tumbil* stocks of Manila Bay the mean total length of the females was only 23-25 cm. reaching a maximum length of 33 cm. (Table II).

TABLE II. Mean length of the *S. tumbil* catches in Manila Bay calculated from the laboratory samples.

Area I

Month	Female		Male	
	n_1	x_1	n_2	$\bar{x}_2$
Nov.56 - Jan.57	98	15.8	220	17.7
Feb. - Mar.57	117	17.2	1006	17.4
June - July 57	416	18.3	310	17.3
Aug. - Sept.57	491	17.0	446	16.1
Oct. - Nov. 57	293	15.4	178	13.8
Dec.57 - Jan. 58	323	16.8	348	15.0
Feb. - Apr. 58	306	18.8	421	17.5
May - June 58	112	18.9	147	17.7
Total	2156	17.3	3076	16.6

Area II

Nov.56 - Jan. 57	128	13.9	491	13.8
Feb. - Apr. 57	118	23.3	321	21.3
May - June 57	203	20.6	218	19.4
July - Aug. 57	59	25.1	121	20.8
Oct. - Nov. 57	21	24.5	236	18.9
Feb. - Mar. 58	57	23.8	124	21.8
May - June 58	48	22.1	120	19.6
Total	634	21.9	1631	19.4

It was found that the *Saurida tumbil* population in Manila Bay and adjacent waters had a protracted breeding period and spawns two or even three times a year in a quite irregular manner. Throughout the year, mature individuals with ripe gonads are observed among the commercial catches (Fig. 4). There was no pronounced spawning season, during the period under observation, however, spawning activity was smallest during December 1957 to Janaury 1958. Spawning in spring 1958 was much reduced compared with spring 1957. A certain peak of spawning was observed in October 1957.

3. *The Spawning Grounds*

For a year and a half, observations pertaining to the location of the spawning ground of *S. tumbil* were intensively conducted. It was presumed that *S. tumbil* breeds in deeper waters of Manila Bay, near the opening of the bay or even outside the bay, as ripe fish were caught there. Liu and Tung (1959), noted that this species breeds in Taiwan strait which would correspond in depth to areas outside Manila Bay (40 m.).

It was also observed that young specimens of *S. tumbil* below 10 cm. were much more available in deeper portion of the bay and rarely found in the baby trawl catches of the shallow water below 5 fathoms (Tiews and Borja, 1965).

4. *Fecundity*

Twenty-five ovaries of *Saurida tumbil* were studied in detail to determine the number of eggs present in the ovaries. The ovaries sampled were of maturity Stages IV-VI (Table III). For separating the egg cells, Gilson solution was used.

Egg numbers greatly fluctuated. Fish from 22-36 cm. in length, had an average of about 28,000 eggs. It was not possible to find a clear relationship between the number of eggs and the length of fish. The sampling was too limited.

b) *Food and Feeding Habits*

1. *Manila Bay*

A total of 7,238 stomachs of *Saurida tumbil* from Manila Bay samples, composed of all sizes, were examined to study their food and the feeding habits of the lizard fishes (Table IV).

From the total number of specimens examined, 4,710 fishes had empty stomachs and 2,528 specimens were with full stomachs. In 33.7% of the fishes, unidentified fish was found in their stomachs. Of the stomachs, 11% were filled with digested food mass.

TABLE III. Egg counts of *Saurida Tumbil.*

Length of Fish	Length of Gonad	Maturity stage	Total Number of Eggs
25.2	8.7	IV	23,733
25.6	7.9	IV	8,175
26.0	7.8	IV	17,566
26.4	9.8	IV	32.040
30.1	6.8	IV	12,033
31.5	6.8	IV	33.416
	Aver.8.0		Aver.-21,160 eggs
22.1	7.1	V	9,800
23.4	7.6	V	23,797
24.5	7.6	V	21,720
25.3	8.2	V	8.360
26.2	8.4	V	21,400
26.8	8.1	V	24,320
27.0	8.5	V	19,233
27.2	8.9	V	28,020
27.4	9.4	V	35,665
29.5	9.4	V	90,192
29.6	11.0	V	13,033
31.7	10.3	V	12,600
33.7	8.1	V	43,083
36.0	11.9	V	38,300
	Aver.9.0		Aver.-27,823 eggs
24.0	8.7	VI	12,533
25.1	9.0	VI	23,160
27.1	10.9	VI	47,782
30.6	10.4	VI	34,533
30.7	10.7	VI	12,533
	Aver.9.9		Aver.-26,108 eggs

TABLE IV. Stomach content of *S. Tumbil* sampled from Manila Bay.

	Jan.-Feb. 1957		Mar.-April 1957		May-June 1957		July-Aug. 1957		Sept.-Oct. 1957	
No. of fishes researched	1,931		308		650		930		924	
w/empty stomach	1,407		229		490		694		584	
w/stomach content	524		79		160		236		340	
FOOD ITEMS:	No. food organ.	No. of guts	Food organ	No. of stom.	Food org.	No. of guts	Food org.	No. of guts	Food org.	No. of guts
S. heterolobus	-	-	-	-	-	-	-	-	-	-
S. buccaneeri	-	-	-	-	1	1	-	-	4	4
S. sp.	-	-	-	-	2	2	-	-	1	1
S. indicus	-	-	-	-	-	-	2	2	2	2
S. commersonii	-	-	-	-	1	1	-	-	-	-
Unid. Stoloph. sp.	85	85	14	14	33	29	58	55	29	29
Leiognathus splendens	-	-	2	2	-	-	1	1	2	1
L. insidiator	-	-	-	-	21	20	32	30	7	6
L. bindus	-	-	-	-	1	1	-	-	8	8
L. ruconius	-	-	-	-	-	-	5	5	1	1
L. daura	-	-	-	-	-	-	2	2	-	-
L. blochii	-	-	-	-	-	-	1	1	-	-
L. leuciscus	-	-	-	-	-	-	-	-	1	1
L. lineolatus	-	-	-	-	-	-	-	-	-	-
Unid. Leiognathus sp.	40	36	4	4	3	3	-	-	-	-
Gazza minuta	-	-	-	-	-	-	2	2	1	1
Gobius sp.	11	10	13	12	20	18	46	45	61	61
Caranx	3	3	3	3	6	6	-	-	-	-
Apogon	13	13	3	3	23	22	12	12	3	3
Platycephalus	6	6	5	5	3	3	5	5	5	4
Sardinella longiceps	2	2	2	2	1	1	2	2	4	3
Sardinella fimbriata	3	3	-	-	4	4	-	-	-	-
Pomadasis sp.	2	2	2	2	-	-	1	1	-	-
Nemipterus sp.	2	2	2	2	-	-	1	1	-	-
Decapterus sp.	2	2	3	3	2	1	2	2	-	-
Saurida tumbil	2	2	-	-	1	1	3	3	4	4
S. undosquamis	-	-	-	-	-	-	-	-	-	-
Upenoides	1	1	-	-	1	1	-	-	-	-
Trichiurus haumela	-	-	-	-	-	-	-	-	2	2
Flatfish sp.	3	2	-	-	-	-	-	-	1	1
Pipefish sp	1	1	-	-	-	-	-	-	-	-
Therapon	1	1	-	-	-	-	1	1	-	-
Rastrelliger	1	1	-	-	1	1	-	-	-	-
Gerres filamentosus	-	-	-	-	1	1	-	-	-	-
Unid. fish species	216	216	9	9	24	23	38	37	74	73
Loligo	26	26	2	2	4	4	14	14	15	14
Sepia	-	-	-	-	-	-	-	-	1	1
M. monoceros	-	-	-	-	1	1	2	2	-	-
P. monodon	-	-	-	-	-	-	-	-	-	-
Parapenaeopsis (Quakit)	-	-	-	-	2	2	1	1	1	1
Acetes (Alamang)	-	-	-	-	-	-	3	1	936	97
Unid. shrimps	11	11	-	-	2	2	5	5	1	1
Fishes with digested food organisms		99		16		12		6		21

TABLE IV (Cont'd)
Stomach content of *S. tumbil* sampled from Manila Bay.

No. of fishes researched	Nov. - Dec. 1957		Jan. - Feb. 1958		March - April 1958		May - June 1958	
w/empty stomach	731		803		530		431	
w/stomach content	358		410		298		240	
	373		393		232		291	
FOOD ITEMS:	Food items	No. of org., guts	Food items	No. of org., guts	Food items	No. of org., guts	Food items	No. of org., guts
S. heterolobus	-	-	6	6	3	3	2	2
S. buccaneeri	-	-	2	2	-	-	1	1
S. sp.	-	-	2	2	1	1	1	1
S. indicus	-	-	1	1	-	-	1	1
S. commersonii	-	-	1	1	-	-	-	-
Unid. Stolephorus sp.	47	35	41	37	4	47	27	24
Leiognathus splendens	-	-	-	-	1	1	-	-
L. insidiator	12	12	25	20	4	13	7	6
L. bindus	10	10	35	31	2	12	12	12
L. ruconius	-	-	1	1	-	-	-	-
L. daura	-	-	-	-	-	-	-	-
L. blochii	-	-	-	-	-	-	-	-
L. leuciscus	-	-	-	-	-	-	-	-
L. lineolatus	-	-	-	-	-	-	-	-
Unid. Leiognathus sp.	-	-	-	-	2	2	-	-
Gazza minuta	-	-	-	-	2	2	-	-
Gobius sp.	76	75	41	40	8	7	23	23
Caranx	8	8	5	5	1	1	-	-
Apogon	4	3	16	15	13	11	3	3
Platycephalus	-	-	2	2	5	5	2	1
Sardinella longiceps	1	1	3	3	3	3	-	-
Sardinella fimbriata	1	1	3	3	-	-	-	-
Fowdasia sp.	1	1	2	2	2	2	-	-
Mesopterus sp.	1	1	3	3	-	-	3	3
Drepterus sp.	4	2	-	-	-	-	1	1
Saurida tumbil	1	1	2	2	-	-	3	2
S. undosquamis	-	-	-	-	-	-	1	1
Pomacids	1	1	2	2	-	-	-	-
Priolepis hemeli	4	4	-	-	-	-	-	-
Flatfish sp.	-	-	-	-	1	1	1	1
Pipefish sp.	-	-	1	1	1	1	-	-
Therapon	-	-	-	-	-	-	-	-
Rastrelliger	-	-	-	-	-	-	-	-
Gerres filamentosus	-	-	-	-	-	-	1	1
Unid. fish species	161	159	177	170	95	90	77	76
Loligo	3	3	9	9	6	6	10	9
Sepia	-	-	-	-	-	-	-	-
M. monoceros	-	-	-	-	-	-	-	-
P. monodon	1	1	-	-	-	-	-	-
Parapenaeopsis (Quakit)	-	-	-	-	1	1	3	3
Acetes (Alamang)	-	-	-	-	-	-	-	-
Unid. shrimps	6	5	1	1	6	6	1	1
Fishes with digested food organisms	53		99		17		14	

TABLE IV (Cont'd)
Stomach content of *S. tumbil* sampled from Manila Bay.

No. of fishes researched	Grand Total 7,238			
w/empty stomach	4,710			
w/stomach content	2,528			
FOOD ITEMS:	Food items	No. of org., guts	A* %	B %	C
S. heterolobus	11	11	0.35	0.44	.0044
S. buccaneeri	8	8	0.25	0.32	.0032
S. sp.	7	7	0.22	0.28	.0028
S. indicus	5	5	0.16	0.20	.0020
S. commersonii	2	2	0.06	0.08	.0008
Unid. Stolephorus sp.	383	355	12.09	14.04	.1515
Leiognathus splendens	6	5	0.19	0.20	.0024
L. insidiator	118	107	3.70	4.23	.0467
L. bindus	78	74	2.45	2.93	.0308
L. ruconius	7	7	0.22	0.28	.0028
L. daura	2	2	0.06	0.08	.0008
L. blochii	1	1	0.03	0.04	.0004
L. leuciscus	1	1	0.03	0.04	.0004
L. lineolatus	2	2	0.06	0.08	.0008
Unid. Leiognathus sp.	49	45	1.54	1.78	.0194
Gazza minuta	3	3	0.09	0.12	.0012
Gobius sp.	299	291	9.38	11.51	.1189
Caranx	14	14	0.44	0.55	.0055
Apogon	69	76	2.60	3.01	.0328
Platycephalus	60	55	1.88	2.17	.0237
Sardinella longiceps	19	18	0.60	0.71	.0075
Sardinella fimbriata	11	11	0.35	0.44	.0044
Fowdasia sp.	9	9	0.28	0.36	.0036
Mesopterus sp.	11	11	0.35	0.44	.0044
Drepterus sp.	10	9	0.31	0.36	.0040
Saurida tumbil	15	13	0.47	0.51	.0059
S. undosquamis	3	2	0.09	0.08	.0012
Pomacids	5	5	0.16	0.20	.0020
Priolepis hemeli	6	5	0.19	0.24	.0024
Flatfish sp.	5	4	0.16	0.16	.0020
Pipefish sp.	3	3	0.09	0.12	.0012
Therapon	2	2	0.06	0.08	.0008
Rastrelliger	2	2	0.06	0.08	.0008
Gerres filamentosus	2	2	0.06	0.08	.0008
Unid. fish species	871	696	27.33	33.74	.3445
Loligo	89	87	2.79	3.44	.0352
Sepia	1	1	0.03	0.04	.0004
M. monoceros	3	3	0.09	0.12	.0012
P. monodon	1	1	0.03	0.04	.0004
Parapenaeopsis (Quakit)	8	8	0.25	0.32	.0032
Acetes (Alamang)	939	98	29.47	3.88	.3714
Unid. shrimps	33	32	1.04	1.26	.0131
Fishes with digested food organisms	227		10.96		
	3,187	2,528	100.00		

* A = Percentage Composition of Diet (Dominance) (Specified food item/Total of all food items x 100).
B = Frequency of Occurrence (No. of Feeders of a particular food item/Total No. of fish with stomach content x 100).
C = Average Feeding; (No. of Specified food item/Total No. of fish with stomach content).

Saurida tumbil mainly fed on anchovies (*Stolephorus*), 416 anchovies were recorded from 388 stomachs, followed by *Gobius* spp. of which 299 specimens were found from 291 stomachs. Of the *Stolephorus, S. heterolobus* and *S. buccaneeri* are most common. Next in abundance to the gobies were *Leiognathus* spp. of which *L. insidiator* and *L. bindus* were the favorite food items. *Apogon* sp., which is caught in fair abundance in Manila Bay throughout the year, was next in importance. Mollusks were represented by *Loligo* and *Sepia*. Acetes or "alamang," a decapod, was found to be abundant only from July to October. Other decapods that contributed to the diet composition of *S. tumbil* were the *Metapenaeus monoceros, Penaeus monodon* and *Parapaenaeus* sp.

The voraciousness and the ability of the lizard fish to catch its prey are very remarkable. Even elusive and fast swimming animals, such as *Loligo,* hardly escape the jaws of the lizard fish. The teeth in both jaws are of several rows, depressible and very sharp, more or less curved towards the interior of the mouth. The tongue is also covered with numerous sharp fine teeth and the mouth has a very wide gape. The elasticity of the stomach of the lizard fish is quite amazing. The size of the stomach can be doubled or tripled when filled. An empty stomach of 3 cm. long occupying about 1/3 of the length of the body cavity, can attain a length of up to 9 cm. when full, occupying practically the total body cavity, extending up to the posterior of the origin of the anal fin. The fishes eaten by the lizard fish had a mean length proportion of 0.36 to the length of the predator. On the average, 7.4% of the mean weight of the lizard fish with stomach contents is contributed by the volume of food present in the stomach.

Except for the seasonal appearance of the *Acetes,* no other apparent variation in the diet of the lizard fish was observed. Fish was the favorite food. Other favorite food items were crustaceans and mollusks. There was no clear indication of any periodical fluctuation in the feeding frequency, throughout the period of study.

2. *San Miguel Bay*

Of the total 1,265 specimens of *S. tumbil* collected from San Miguel Bay, 616 had empty stomachs. The most important diet of the lizard fish in this locality was also the anchovy, of which 431 specimens were found in 243 stomachs. *Stolephorus buccaneeri* was the common anchovy found. As in Manila Bay, gobies ranked next. Crustaceans were represented by *Metapenaeus monoceros, Penaeus*

monodon, Parapenaeosis, Acetes and *Palaemon* sp. *Acetes* was present in the diet only during the month of February 1958, in fair abundance. Of the mollusks, only *Loligo* was found in the samples from San Miguel Bay (Table V).

Of the lizard fish with stomach contents, 92.5% fed upon fishes, including young lizard fishes, 5.4% fed on crustaceans and only a meager percentage of 1.2% fed on mullusks. No periodic fluctuations in the amount or composition of the diet was observed in the area, except for the seasonal appearance of the *Acetes*.

3. *Comparison of the Stomach Contents of the Lizard Fishes in Manila Bay and in San Miguel Bay*

Because of the differences between the fish population in Manila Bay and in San Miguel Bay, there were also differences in the food items of the lizard fishes in these areas. There was a greater variety of food available in Manila Bay than in San Miguel Bay. The monthly average feeding computation, however, suggested that the lizard fishes in San Miguel Bay had more food at their disposal than those in Manila Bay. Of the total number of 1,265 fish sampled from San Miguel Bay, 51.30% had full stomachs, compared with 34.93% of the total 7,238 specimens studied in Manila Bay. In both areas, anchovy was the most common food item. There were also more anchovies found per stomach in San Miguel Bay than in Manila Bay. The only seasonal food item was *Acetes*. In Manila Bay, *Acetes* was abundant in the food composition of the lizard fish in July, September and October during the Southwest monsoon and in San Miguel Bay in February during the Northeast monsoon season.

POPULATION

a) *Availability*

The catch statistics data collected by the field men from the commercial fishing vessels are shown in Tables I and VI and in Fig. 5. The catch of *S. tumbil* per unit of effort showed a gradual decrease from the time the study was started in November 1956. From November 1956 to November 1957, an average of 2.8 kilogram per hour of dragging from both Area I and Area II were obtained. From December 1957 to November 1958, the average catch per hour of dragging in both areas went down to only 1.4 kg.

TABLE V. Stomach content of *Saurida tumbil* sampled from San Miguel Bay.

	July 1957		Sept. 1957		May 1958		Feby. 1958		Total				
Tot.No.of Spec. researched	190		214		595		266		1,265				
with empty stomach	135		111		227		143		616				
with stomach content	55		103		368		123		649				
	No.of food organism	No.of fish	No.food organ.	No.of fish	No.food organ	No.of fish	No.food organ.	No.of fish	Sum of f.organ.	Grand tot. of fishes	% A	% B	% C
Food Items:													
S. heterolobus	-	-	-	-	13	6	-	-	13	6	1.38	0.92	.0200
S. buccaneeri	-	-	29	17	3	2	2	2	34	22	3.62	3.39	.0524
Stolephorus sp.	-	-	2	2	6	5	1	1	9	8	0.96	1.23	.0139
Unidentif. Stoleph. sp.	33	22	48	26	263	128	31	25	375	211	39.87	32.49	.5775
L. splendens	-	-	2	2	-	-	2	2	4	4	0.43	0.62	.0062
L. insidiator	1	1	5	4	-	-	3	2	9	7	0.96	1.08	.0139
L. bindus	1	1	3	3	-	-	-	-	4	4	0.43	0.62	.0062
L. indicus	2	2	-	-	-	-	-	-	2	2	0.21	0.31	.0031
L. ruconius	-	-	-	-	-	-	1	1	1	1	0.11	0.15	.0015
Unident.Leiognathus sp.	-	-	-	-	-	-	3	3	3	3	0.32	0.46	.0046
Gazza minuta	-	-	-	-	-	-	1	1	1	1	0.11	0.15	.0015
Gobius sp	4	4	2	2	82	78	-	-	88	84	9.36	12.94	.1355
Carenx	2	2	-	-	-	-	1	1	3	3	0.32	0.46	.0046
Apogon	-	-	1	1	-	-	1	1	2	1	0.21	0.15	.0031
Platycephalus	-	-	-	-	14	9	-	-	14	9	1.49	1.39	.0216
Sardinella longiceps	3	3	2	1	1	1	-	-	6	5	0.64	0.77	.0092
Sardinella fimbriata	2	2	2	1	-	-	-	-	4	3	0.43	0.46	.0062
Pomadasids sp.	1	1	-	-	-	-	2	2	2	2	0.21	0.31	.0031
Decapterus sp.	1	1	-	-	-	-	1	1	1	1	0.11	0.15	.0015
Saurida tumbil	1	1	1	1	-	-	1	1	2	2	0.21	0.31	.0031
Upeneoides	1	1	1	1	-	-	1	1	2	2	0.21	0.31	.0031
Trichiurus haumela	1	1	1	1	-	-	1	1	2	2	0.21	0.31	.0031
Flatfish	-	-	-	-	-	-	1	1	1	1	0.11	0.15	.0015
Therapon	-	-	-	-	-	-	1	1	1	1	0.11	0.15	.0015
Cerres filamentosus	-	-	-	-	128	120	61	58	227	216	24.13	33.26	.3496
Unidentif. fish sp.	13	13	25	25	1	1	-	-	8	8	0.85	1.23	.0123
Loligo	2	2	1	1	-	-	1	1	4	3	0.43	0.46	.0062
M. monoceros	1	1	-	-	2	1	1	1	3	3	0.43	0.46	.0062
P. monodon	-	-	-	-	6	6	1	1	7	7	0.74	1.08	.0108
Parapenaeopsis (wakit)	-	-	-	-	4	4	-	-	4	4	0.43	0.62	.0062
Palaemon sp.	-	-	-	-	-	-	97	16	97	16	10.31	2.46	.1494
Acetes (alamang)	-	-	2	2	1	1	1	1	4	4	0.43	0.62	.0062
Unident. sp.! shrimps	-	-	4	4	1	1	1	1	6	6	0.64	0.92	.0092
Fishes w/digested food									940	649	100.00		

A = Percentage dominance of Diet; B = Frequency of Occurrence;
C = Average Feeding

TABLE VI. Average catches of *S. tumbil* from areas I & II of Manila Bay per 10 hours of trawling.

Month	A Ave.Catch per 10 hrs	B Ave.Length of fish	C Ave. Wt./ per fish	D Ave.No.of fish/10hrs.	E Ave.No. by sexes		F Ave.No.of mature fish		G Ave.No.of Spawners		H Ave.No.of immature fish	
					M	F	M	F	M	F	M	F
November 1956	12.9 kg	17.0 cm	36.8 gr	351	257	94	175	26	129	25	82	68
January 1957	23.2	17.0	36.8	631	465	156	184	54	61	34	291	95
February "	37.5	19.0	51.4	729	639	90	379	55	166	16	260	35
March "	30.1	15.0	24.5	1230	903	327	655	144	193	0	248	183
April "	39.9	20.0	58.7	680	530	150	470	116	165	77	60	34
May "	27.5	23.0	106.9	257	148	109	112	78	34	12	36	31
June "	35.5	17.0	36.8	965	423	542	305	153	11	45	118	389
July "	54.5	18.0	43.1	1265	601	664	376	255	144	24	225	409
August "	20.9	18.0	43.1	485	260	225	144	116	40	27	116	109
September "	5.9	16.0	31.0	189	87	102	11	12	3	6	76	90
October "	31.1	18.0	43.1	721	607	114	415	27	360	14	192	87
November "	13.6	17.0	36.8	368	159	209	41	29	17	8	118	180
December "	10.4	16.0	31.0	335	158	177	21	21	1	0	137	156
January 1958	9.2	18.0	43.1	213	97	116	6	22	0	0	91	94
February "	13.1	19.0	51.4	255	144	111	36	30	9	4	108	81
March "	9.0	20.0	58.7	152	110	42	105	42	25	9	5	0
April "	10.3	20.0	58.7	176	106	70	38	36	8	1	68	34
May "	18.5	22.0	83.0	223	170	53	94	20	41	6	76	33

TABLE VII. Sex ratio of *S. tumbil* by month in Manila Bay (Area I and Area II).

Date of Collection	Area I No. of samples	Male	Female	Ratio(male in % of total)	Area II No. of samples	Male	Female	Ratio (male in % of total)
November 1956	3	113	57	66.5	1	82	16	83.7
January 1957	1	98	27	78.4	4	408	139	74.6
February "	6	946	87	91.6	2	161	72	69.1
March "	1	69	25	73.4	0	0	0	0
June "	2	102	127	44.5	1	72	96	42.9
July "	3	205	188	52.2	1	70	116	37.6
August "	3	132	124	51.6	2	49	38	56.3
September "	4	313	369	45.9	0	0	0	0
October "	1	23	30	43.4	2	179	8	95.7
November "	3	159	271	37.0	1	56	13	81.2
December "	2	115	129	47.1	0	0	0	0
January 1958	3	233	194	54.6	0	0	0	0
February "	2	160	133	54.6	2	53	30	63.9
April "	4	261	173	60.1	0	0	0	0
May "	1	94	48	66.1	3	93	10	90.3
June "	2	23	66	25.8	1	26	38	40.6
Total	41	3046	2043	59.0	20	1249	576	67.2

From the length composition data it can be concluded that during the season, November 1956 to November 1957, young *S. tumbil* were constantly entering the fishery, especially, during the months of November 1956 to August 1957 (Fig. 6). However, from November 1957 up to November 1958 and onwards, very little recruitment of young *S. tumbil* was observed in the fishery. Thus, the decline of catch per unit of effort may be explained by lack of recruitment. Another reason is that relatively fewer fish spawned in the bay in the second period, which might suggest that the spawning fish went to other spawning grounds. Natural factors seem to be entirely responsible for the decline of the catch per unit of effort.

b) *Sex Ratio*

1. *In Manila Bay*

The sex-ratio of *S. tumbil* varied considerably, with an average of 59.0% in Area I in favor of the males. In Area II, there was greater preponderance of males, with an average of 67.2% (Table VII), but there were also times when females were more abundant, as in June, July, September, November 1957 to January 1958 and June 1958.

Liu and Tung (1959) found an excess of males in Taiwan Strait except during the spawning season, when females predominated.

The sex ratios of the immature and mature individuals vary in a rather parallel way although in the breeding group, males were even more dominant (Table VI). This shows that females leave the fishing grounds to spawn. Consequently the fishing grounds of Manila Bay are only to a certain extent, the spawning grounds.

2. *San Miguel Bay*

In San Miguel Bay, the inner grounds sex ratio was found to be 50.7% males and 49.3% females. However, outside the bay 67.2% of the fish were males.

c) *Length Composition and Growth and Age Estimates*

During the course of this study, efforts were made to determine the growth rate of *S. tumbil*. The first method tried was with the use of scales and otoliths. As no growth rings could be discerned from the otoliths and scales of the lizard fish, the Petersoen method was applied to estimate the growth.

Two series of length-frequency curves were made. One on board the fishing vessels with mixed sexes but separated as to fishing grounds, the other in the laboratory where sexes were separated regardless of fishing grounds.

Fig. 6 shows the length-frequency distribution of fishes measured on board the fishing vessels. Four size groups were traced from January 1957 with modes (AA) at 21 cm. mode (BB) at 15 cm. mode (CC) at 13 cm. and mode (DD) at 9 cm.

The size group *AA* was traced in the fishery until August the same year. A mode of 24 cm. small but clearly seen in July, showed a constant increment giving an average growth rate of about 5 mm. a month.

Size group *BB* could be traced for a much longer period, i.e. until November 1957 with a mode at 21 cm. At the end of 10 months the mode had moved by 60 mm. and showed an average growth increment of about 6 mm. a month. In January 1957 it was observed to be a fairly strong size-group in Area II. The following month this group was predominant only in Area I (August and October) and was then consistently available in that area. It was fished heavily in Area II in November, when it was abundant.

Brood *CC* of 13 cm. only a few weeks younger than *BB*, appeared first in the fishery on Nov. 1956 and became the mainstay of the fishery in both areas in July 1957 at a mode of 17.5 cm. This shows an increase of 4 cm. in 8 months, a growth rate of about 5 mm. a month. This particular brood played an important role in the fishery for several months until July 1958 when it was fished for the last time in Area I with a mode of 25 cm. showing a difference of 7 5 cm for 12 months, and indicating an increase of about 6 mm. per month

Brood *DD* is a size-group which was traced for a longer period than the rest. It was first sampled among the catches of Area II in January 1957 with a mode at 9 cm. By March, a good percentage of the catch from Area I was made up of this brood. During the following months the brood was not available from either areas. However, in September it was available again in Area I, then represented by fishes with a mode between 14 and 15cm. From September to December the catch was made up mostly by this strong size-group with a mode at 16 cm. (December). This brood stayed in the fishery until December 1958 in Area I (mode 23) and may be considered one of the very successful broods during the period under. review. By August and September 1958 the catch contained a high percentage of this brood (mode 20 cm.). For 12 months the mode

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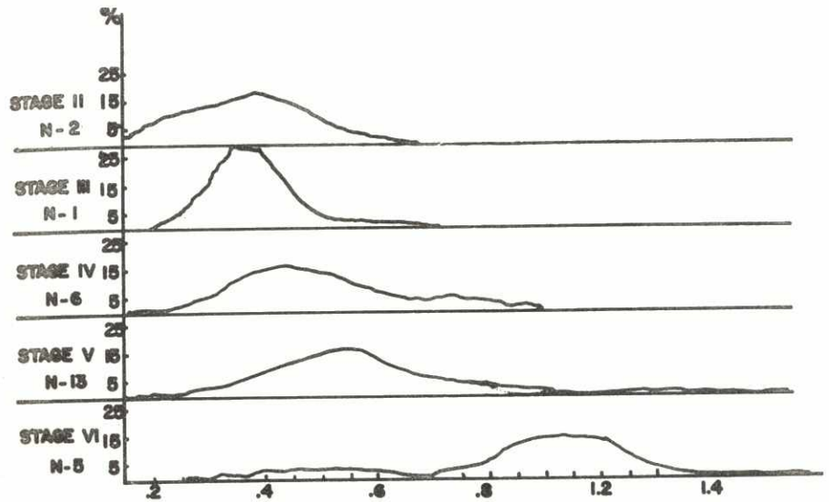

Fig. 1. Egg diameters of different maturity stages of *Saurida Tumbil.*

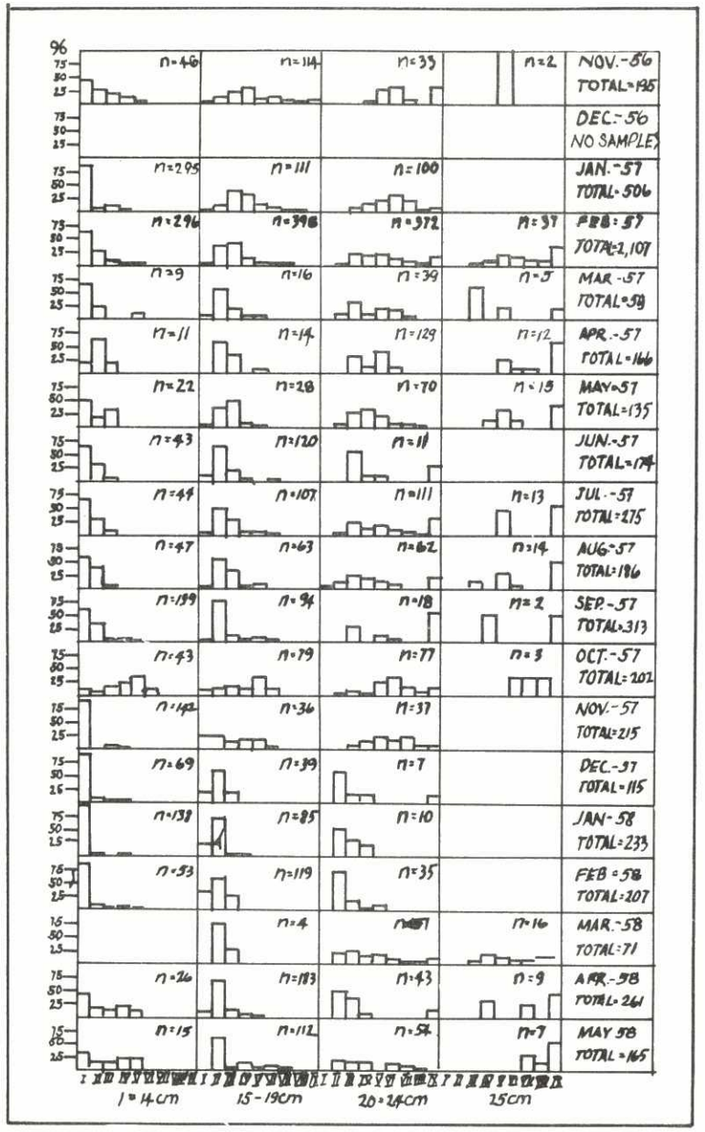

Fig. 2. Monthly sexual maturity condition of *Saurida Tumbil* in Manila Bay, Area I and II (male).

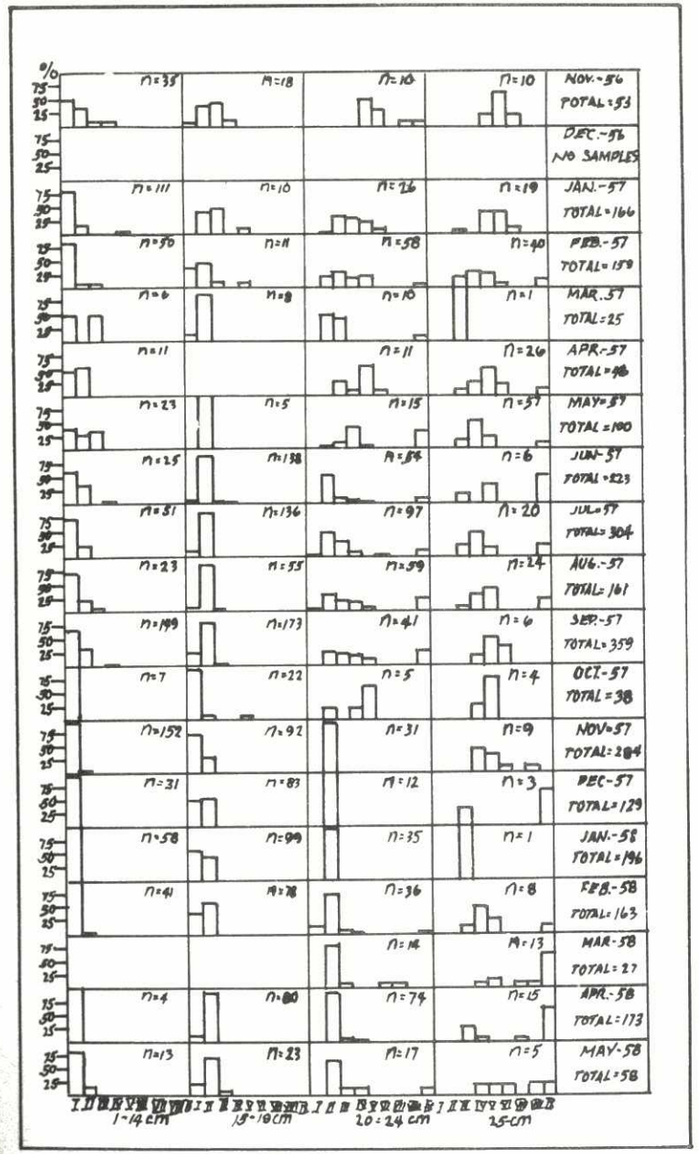

Fig. 3. Monthly sexual maturity condition of *Saurida Tumbil* in Manila Bay, Area I and II (female).

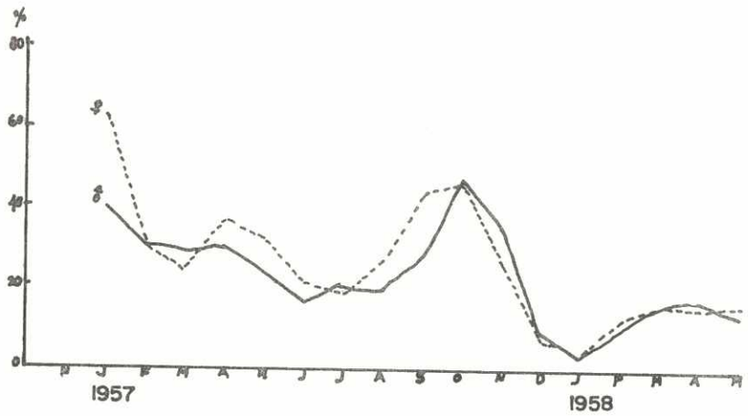

Fig. 4. Share of the male and female spawners of *Saurida Tumbil* on the total catch in Manila Bay.

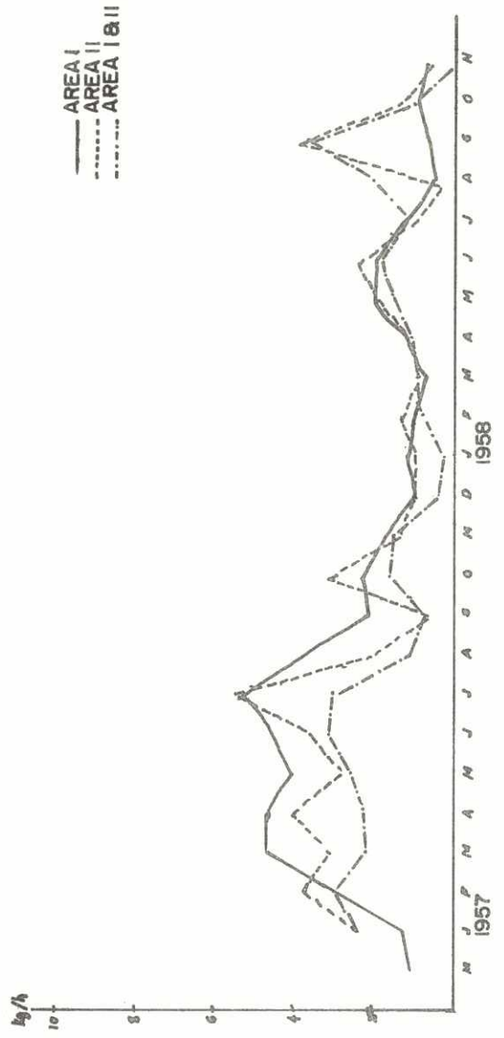

Fig. 5. Graphical representation of the catch per hr. in kilograms. of *Saurida Tumbil* in Manila Bay.

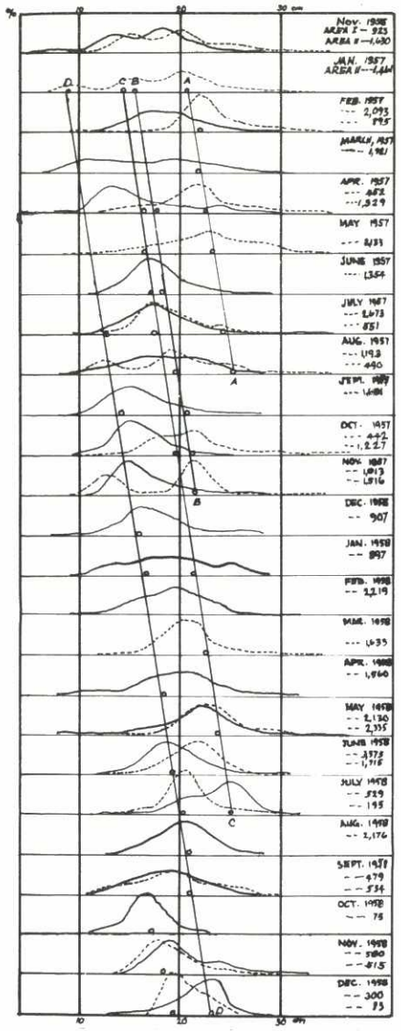

Fig. 6. Length frequency distribution of *Saurida Tumbil* measured aboard the commercial fishing boats in Manila Bay for Areas I and II.

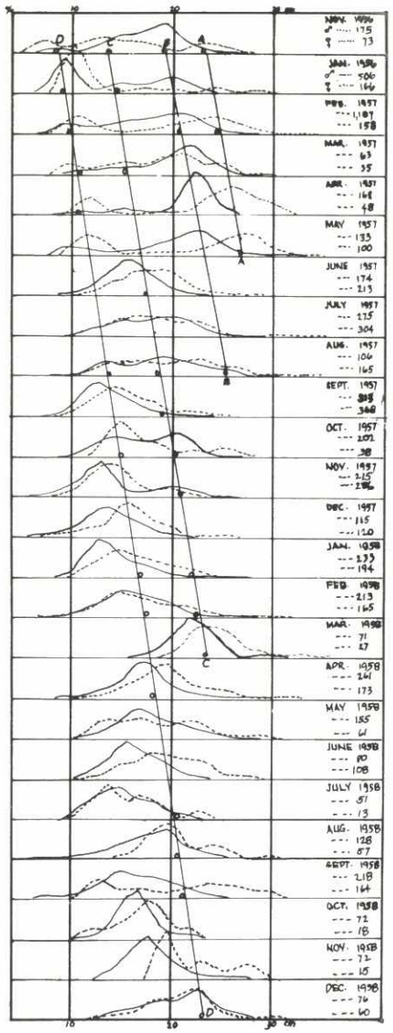

Fig. 7. Length composition of *Saurida Tumbil* by sexes studied in the laboratory, Manila Bay, Areas I and II continued.

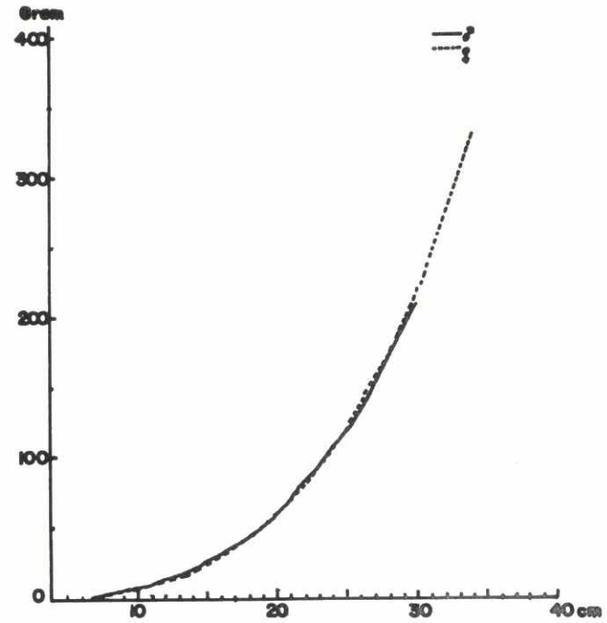

Fig. 8. Length-weight correlation of *Saurida Tumbil*.