AGE AND SIZE AT SEXUAL MATURITY OF WHITE GOBY (GLOSSOGOBIUS GIURUS), A COMMON SPECIES OF FISH OF LAGUNA DE BAY, WITH NOTES ON ITS FOOD HABITS [1]

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THREE PLATES AND SIX TEXT FIGURES

ABSTRACT

The pronounced depletion of the goby fishery of Laguna de Bay after 1950, probably resulting from the use of a non-selective fishing gear, the *seket*, initiated this study of the *biyang puti* (*Glossogobius giurus*).

The analysis of the length frequencies of 3,768 specimens, the examination of the ovaries of 1,019 female specimens and the measurement of the diameters of 3,233 ova formed the bases for the determination of the age and size at first sexual maturity of this species, collected from the Cardona and Taguig areas of Laguna de Bay, from August 1958 to August 1959.

The fish, on the average, matures at the end of its first year of life at size range 105–114.9 millimeters. The expanded or multiple spawning habit is characteristic of the species. However, maximum spawning activity takes place from June to August. Mature eggs measure from 0.55 to 0.83 mm. in diameter. Although the detailed study of the sexual maturity stages of the male *biyang puti* was not done, yet a close correlation with the maturity stages of corresponding female size groups was observed.

It was found from the 161 stomachs examined that although *biyang puti* is predominantly a vegetarian, yet it also utilizes zooplankton forms and other miscellaneous food items. Furthermore, it is at the same time a piscivore, feeding on its own kind. There is no significant variation in the kind of food items taken in by the different size groups. The presence of an unidentified fluke in the majority of the size ranges of fish examined suggests a case of parasitism which might be worthy of future study.

INTRODUCTION

The *biyang puti* or white goby, scientifically known as *Glossogobius giurus* (Hamilton Buchanan), is the largest and most important of Philippine gobies and is a valuable food fish in many fresh water units of the country. It used to be the most abundant and, therefore, most important fishery of Laguna de

[1] Excerpts from a thesis presented to the Faculty of the Graduate School of the University of Santo Tomas, in partial fulfillment or the requirements for the degree of Master of Science in Zoology, March, 1962.

of this number, 165 were motor-powered and 19 were non-powered. Widespread complaints were lodged by the fishing inhabitants around Laguna de Bay areas against the destructive effects through use of *seket*. Felix and San Antonio (1959) described the *seket* operation as a means of livelihood for a large segment of the inhabitants in the towns of Cardona, Tanay, Binañgonan, Angono, and Taguig in Rizal Province, and Sta. Rosa, Bay and Sta. Cruz in Laguna. Although the design varies somewhat in different fishing areas, the principle of operation is fundamentally the same, i.e., impounding the fishes after a *round-up*, brought about by the use of a scareline, livebox, scoop-net and boats. The number and size of boats used in the operation may be two or three, depending on the type of net used.

The *seket* is usually operated during daytime, depending on the place of the fishing ground and market. Catches are usually good during calm weather when the water is generally clear. Prevailing strong winds cause big waves which disturb easily the bottom, thus causing turbidity of the water. Clear water, however, increases the visibility of the mud clouds produced by the scareline, scaring the gobies towards the net and leading to more catch.

Each fisherman (normally seven persons form a team) is paid in *share* and *share alike fashion* after deducting all the operating expenses, such as fuel, rice, cigarettes, etc., from the gross sales of the catch. One share goes to the net, the livefish box and small banca; another share to each motor-banca, and, then share each to every fisherman. Previously each fisherman received a share ranging from ten to thirty pesos daily. This was much better than the present practice of daily shares which ranges from only five to twenty pesos as revealed by the fishermen themselves. (Felix and San Antonio, *op. cit.*)

REVIEW OF LITERATURE

Published reports on the study of the habits and life history of Philippine gobies are still few. This is particularly true of the studies on age and size at sexual maturity of Philippine fishes. Manacop and Capco (1955) described the goby dredge-trawl fishery of Laguna de Bay and noted that the mean standard length at sexual maturity of *biyang puti* is 125 millimeters. They also determined the mean size in a separate study undertaken during the same period of investigation of the goby dredge-trawl fishery. This is the only available reference that deals

with the size of *biyang puti*. Manacop (1953) reported on goby (*Anga*) *Sicyopterus extraneus*, stating that the size at first maturity in both sexes varied and that the adults fed primarily on various kinds of algae, particularly on the pennate diatoms.

Blanco (1956) reported on the general biology of the gobies that constituted the goby fry for *ipon* fisheries of the Laoag River and its adjacent marine shores. In this river, six species of gobies composed the bulk of the post-larval stages of the fishery during the September-December 1954 and January-February 1955 *ipon* seasons. These were *bukto, Chonophorus melanocephalus; bunog, Chonophorus ocellaris; virot, Eleotris melanosoma; balla* or *biya, Glossogobius giurus*; *campa, Rhyacichthys aspro;* and *paliling, Sicyoptrus lachrymosus.* Previously, Blanco (*op. cit.*) reported on the breeding habits and embryology of *Mirogobius lacustris* Herre.

Yosie Dotu (1957 C) described the life history of three species of Japanese gobies. He stated that *Odontamblyopus rubicundus* seemed to grow to 180 mm. in total length in a year and some individuals became mature in a year. *Luciogobius guttatus*, a smaller species, attained maturity after a year at 33 mm. T. L. in both sexes (Dotu, 1957 b); *Gobius lidwilli* grew to 17–20 mm. in T. L. for females and 16–19 mm. for males and became mature (Dotu, 1957 a). Dotu and Mito (1955) reported that *Sicydium japonicum* attained sexual maturity at 70 mm. in about 2 years.

OBJECTS OF THE STUDY

The objects of the present work are (*a*) to determine the average size of *Glossogobius giurus* at sexual maturity; (*b*) to determine the possible age of the fish at sexual maturity; and (*c*) to recommend regulatory measures aimed towards the conservation of this important fish species of Laguna de Bay, based on results obtained from (*a*) and (*b*).

Because of the fact that depletion of the fisheries of Laguna de Bay, especially that of the *biyang puti*, seems to be continuing in spite of the efforts of the government to rehabilitate the lake, it may be postulated that the *biyang puti* may be an exception to the rule that an increase in size and age will necessarily lead to an increase in sexual maturity, leading to more fish in the lake. Most probably, the majority of the fishes caught were immature and were not given a chance to breed or perhaps, many of those caught were already mature and were

Taguig, Rizal, the main landing area for this fish. Information about the fishery of Laguna de Bay was secured from fishermen from both towns. Fish samples, secured from known suppliers from Cardona and Taguig, were landed at Sta. Ana market, Manila. Laboratory examinations of the samples were carried on at the Entomology and Virus Laboratories of the Bureau of Plant Industry and the Biological Research Center Laboratory, National Institute of Science and Technology, Manila.

The data gathered for the determination of age and size at sexual maturity of *biyang puti* were limited for a period of one year. Originally, it was planned to get weekly samples of different sizes of fish in order to observe the length frequency distribution, maturity stages of the eggs, and the stomach contents, but because this investigation was done during the period when restrictions on fishing activities were initiated by the government in its efforts to rehabilitate the fisheries of Laguna de Bay, the original plan had to be modified. A sample of the species of fish under study was taken at least twice a month, inasmuch as a very limited supply only of *biyang puti* could be found in the local markets.

QUANTITY AND SIZE OF WHITE GOBY SOLD IN THE MANILA FISH MARKETS

Perusal of the Fisheries Statistics of the Philippines for 1959 showed that the annual production of commercial fishing vessels for goby has been nil since 1955, so that only the record for the year 1957 was represented, amounting to 30,870 kilograms for the entire country. The record must have been a poor representation of the fact for the amount is insignificant even for the landings of Laguna de Bay alone.

A monthly summary of *biyang puti* handled in the Manila markets for the years 1958 and 1959 was instituted and is shown in Figure 1. The fish recorded in this figure are those most probably caught from Laguna de Bay, inasmuch as a survey of the most important Manila markets showed that the gobies sold were those caught along the municipalities of Biñan, Sta. Rosa, Muntinlupa, Pasig, Taguig, Cardona and Binañgonan. For the year 1958, January, February, March, August, September, October, November and December seemed to be the months when the catch was highest; and for 1959, March to July seemed to be the months of highest catch.

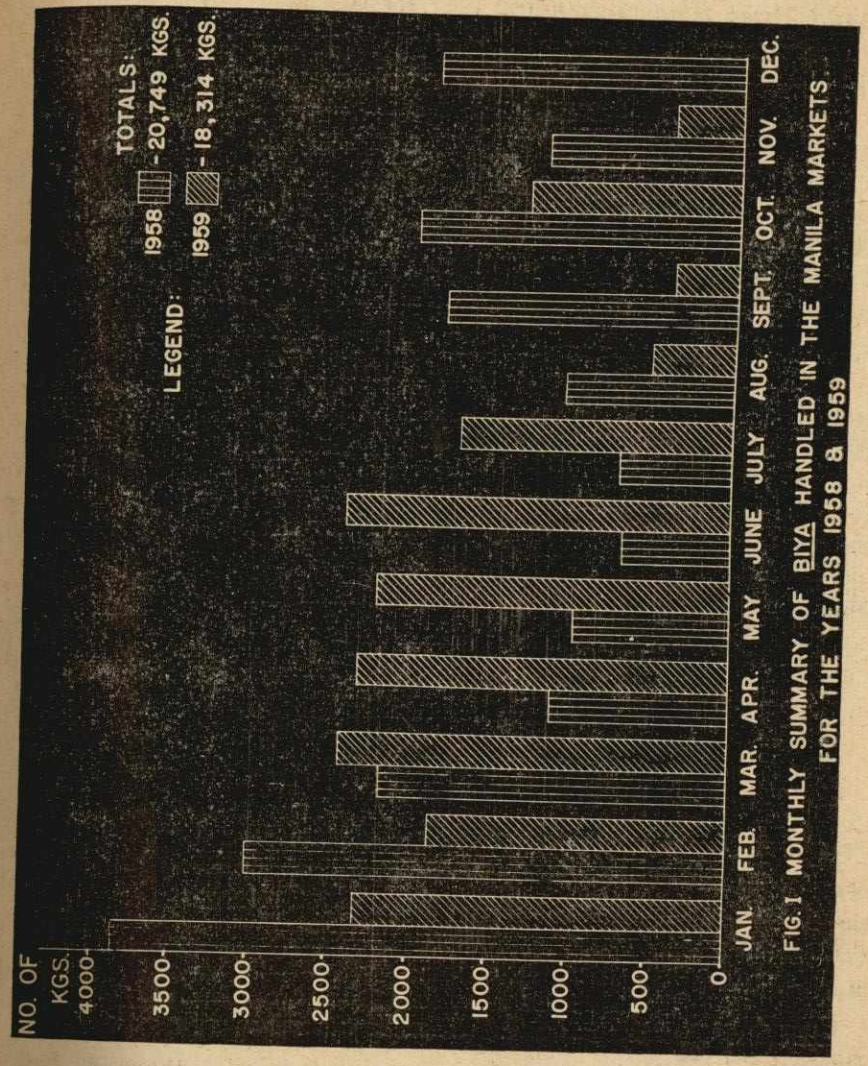

FIG. 1 MONTHLY SUMMARY OF BIYA HANDLED IN THE MANILA MARKETS FOR THE YEARS 1958 & 1959

The survey also showed that the *biyang puti* caught during the year 1958–1959 were very small, most of them about 40 to 130 millimeters in standard length (Plate 2, fig. 1). Specimens examined in this study ranged from 50 to 242 millimeters in standard length and were bought from a known fish dealer at the Sta. Ana Public Market, Manila (Plate 2, figs. 2 & 3).

In each sample, the standard lengths of all fish of both sexes were measured and recorded to the nearest millimeter.

For record purposes and later studies in correlation, the total length, width and depth of each fish at the region of the pectorals were also taken. However, in this study, the standard length is the measurement always referred to.

An analysis of length frequencies of 3,768 specimens of *biyang puti* was made. The so-called frequency method or Petersen method consists of a study of the progression modes in length frequency distributions in relation to time. Since the number of fish measured each month was not constant, the length frequency distributions were made comparable by converting the frequencies into percentages of total for each month. The examination of scales and other bony parts as practiced in temperate countries in determining age could not be used because in a tropical country like ours, such methods are not practical, inasmuch as the rings of growth in the bony parts could not be easily discerned with the absence of the four distinct seasons of the year, which are responsible for the appearance of the rings of growth.

DETERMINATION OF THE AGE

The length frequency method is also the method used to estimate the age of the fish studied. Inspection of the frequency polygons revealed that almost all of them showed the presence of at least two modes. These modes indicate the average lengths of the age groups to which the samples belong.

Together with the determination of the age was the determination of the size at first maturity of the species. To do this, the ovaries of 1,019 female specimens preserved in 5 percent formalin were examined and the condition of maturity ascertained. The presence of maturing and mature or ripe eggs was used as a criterion to determine the sexual maturity of the fish and, more or less, the spawning season. A scalpel was used to remove the pair of ovaries from each female. To determine the stage of maturity, a portion of the ovarian tissue was teased on a slide to separate the eggs; a drop or two of water were added to the material which was then covered with a cover glass and examined under a binocular stereoscopic microscope.

In addition, the diameters of 3,233 ova from female specimens caught from the towns of Taguig and Cardona were measured for determining the different stages of maturity. This was done with an eyepiece micrometer with a value of 15.8 micra (.0158 mm.) for each micrometer unit. The egg was measured at its longest diameter and recorded.

EXAMINATION OF THE STOMACH CONTENTS

To study the stomach contents of *biyang puti*, 161 specimens of both sexes were taken at random from the Cardona samples for a period of six months. The standard length of the specimens so examined ranges from 85 to 239 millimeters. Each specimen was dissected for its gut, and its contents examined with a microscope, two or three times. In the absence of a counting cell, the frequency of occurrence was used as a quantitative index. This method consists of recording the presence or absence of a given food item and is the easiest way of analyzing the stomach contents. Furthermore, the wide variety of foods and their small volumes made it most preferable to use the frequency-of-occurrence method.

The seasonal changes in the food of *biyang puti* could not be shown here for lack of sufficient data. It is unfortunate to mention the fact that due to some unavoidable reasons the examination of the gut contents the whole year round could not be made.

DISCUSSIONS

The Quantity of "Biyang Puti" Sold in the Manila Fish Markets

From the survey of the quantity of *biyang puti* landed and sold in the Manila fish markets, it can be seen that there was a decrease in the catch of *biyang puti* in Laguna de Bay (Fig. 1).

It is also shown that the quantity of *biyang puti* handled in the Manila markets is lower in 1959 than in 1958. This can be explained by the fact that a ban on the catching of this fish by means of *seket* and *pukot* from January 1 to December 31, 1959, was put in effect in Laguna de Bay, under Fisheries Administrative Order No. 3–6, dated October 13, 1958. It is interesting to note, however, that even with the existence of the ban then, the decrease in the quantity of fish handled in the city of Manila in 1959 was not significant. This may also be a reflection of the government's inability to enforce the prohibition governing the catching of this fish.

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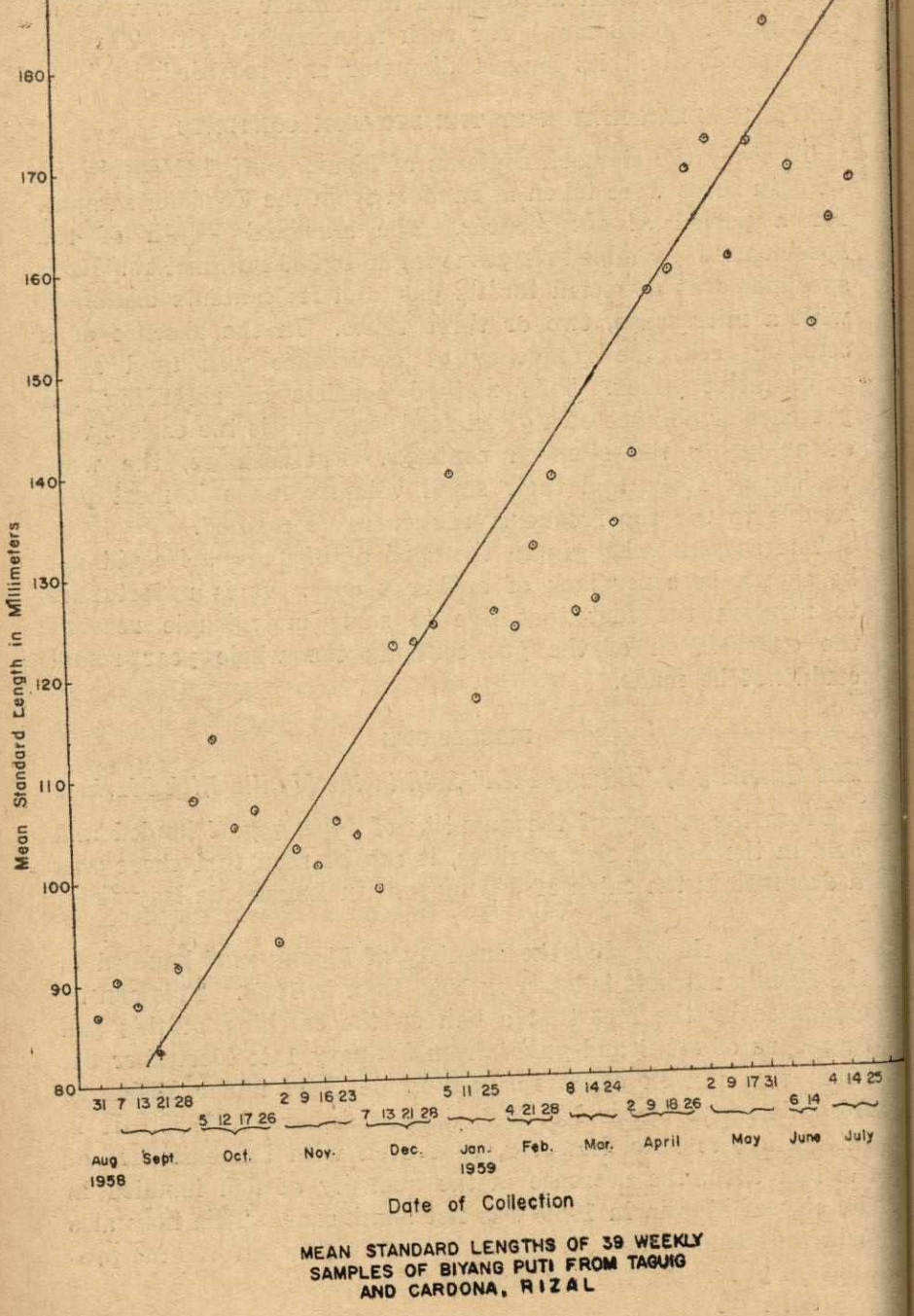


MEAN STANDARD LENGTHS OF 39 WEEKLY SAMPLES OF BIYANG PUTI FROM TAGUIG AND CARDONA, RIZAL

TABLE I

LENGTH-FREQUENCY DISTRIBUTION OF G. GIURUS COLLECTED FROM TAGUIG AND CARDONA, RIZAL FROM 1958-1959

SIZE RANGE (MM)	1958 AUG. T*	AUG. C**	SEPT. T	SEPT. C	OCT. T	OCT. C	NOV. T	NOV. C	DEC. T	DEC. C	1959 JAN. T	JAN. C	FEB. T	FEB. C	MAR. T	MAR. C	APR. T	APR. C	MAY T	MAY C	JUNE T	JUNE C	JULY T	JULY C
45-49.9																								
50-54.9			7	2																				
55-59.9		1	18	1																				
60-64.9		12	57	10	1																			
65-69.9		34	72	25	0																			
70-74.9		47	87	51	2		5	1																
75-79.9		45	76	27	4	1	10	8	2															
80-84.9		43	44	35	18	4	46	16	10			1												
85-89.9		34	37	17	27	8	66	24	25		1	1												
90-94.9		39	51	6	42	13	77	14	48	2	1	2	1		1									
95-99.9		37	38	4	34	15	68	11	43	5	10	4	4		5									
100-104.9		21	30	4	45	22	52	14	39	4	13	10	9		12		1							
105-109.9		9	31	0	43	24	31	13	30	3	13	3	12		16		5							
110-114.9		15	30	20	24	27	30	14	32	13	14	7	17		17		8							
115-119.9		4	20	12	37	38	33	8	26	4	15	4	14		11		7							
120-124.9		4	23	8	25	25	19	8	16	5	8	2	24		27		11							
125-129.9		0	9	7	13	9	20	7	19	5	16	8	16		18		11							1
130-134.9		2	14	6	13	7	6	2	16	3	15	2	23		14		17		1					2
135-139.9		3	2	4	1	2	7	3	14	4	11	2	21		18		11		5		3			5
140-144.9			1	3	3	0	2	0	6	6	8	0	19		15		17		2		0			5
145-149.9			1	1	1	0	1	1	3	4	5	2	10		7		13		8		0			10
150-154.9			1	0	0	1	1		3	0	7	3	5		10		11		15		2			11
155-159.9			0	3	0	2			2	0	5	2	2		6		12		12		4			10
160-164.9			1	1	1				0	1	3	0	3		4		9		11		3			5
165-169.9			2						1	1	2	1	1		2		6		11		4			4
170-174.9									0	1	2	0			0		6		14		4			7
175-179.9									2	0	2	0			2		5		7		6			1
180-184.9										0		1			2		4		4		4			1
185-189.9										0					0		3		3		6			0
190-194.9										0					0		2		3		1			3
195-199.9										0					1		3		5		2			0
200-204.9										1					1		3		2		2			1
205-209.9																	1		2		2			0
210-214.9																	0		2		1			2
215-219.9																	0		0					0
220-224.9																	1		1					1
225-229.9																			1					0
230-234.9																			1					1
235-239.9																			1					
240-244.9																			1					
245-249.9																								
250-254.9																								
TOTAL		350	652	247	834	198	476	144		337	62	151	55	161		189		167		112		44		71

* TAGUIG
** CARDONA

WEEKLY SAMPLE MEANS OF STANDARD LENGTHS INDICATING PRONOUNCED BREEDING SEASON

The weekly sample means of all samples were taken and graphically represented in Figure 2, as based on Table II. It may be noted therefrom that more small fish are caught during the months of August and September, the mean size of the fish increasing as the year progresses, indicating that although this species breeds throughout the year, yet there is more of

TABLE II.—*Mean standard lengths of weekly samples of biyang puti.*

Date	Mean standard length in Mm.	Date	Mean standard length in Mm.
1958		1959	
August 31	86.7	January 5	124.8
September 7	90.3	January 11	139.1
September 13	88.1	January 25	117.5
September 21	83.1	February 4	126.5
September 28	91.7	February 21	124.4
October 5	107.9	February 28	132.7
October 12	114.0	March 8	139.7
October 19	105.1	March 14	125.5
October 26	106.6	March 24	126.3
November 2	93.8	April 2	134.1
November 9	103.0	April 9	141.0
November 16	101.2	April 18	157.1
November 23	105.8	April 26	159.2
December 7	104.2	May 2	169.5
December 13	98.7	May 9	172.7
December 21	122.8	May 17	160.5
December 28	123.3	May 31	171.2
		June 6	183.6
		June 14	169.3
		July 4	153.1
		July 14	164.0
		July 25	168.0

the smaller fish caught during the onset of the rainy season. Although a ban was imposed in January 1959, yet the increasing mean standard length indicates a progressive increase in the size of fish in the lake, and it appears that the breeding season is more pronounced during the rainy season (June to August) as is logical and found to be true in other freshwater fishes.

SIZE AND AGE AT FIRST MATURITY

The length frequency distributions of all the specimens examined are shown in Table I and graphically represented in Figure 3. The length frequency distributions of total monthly samples are indicated in Figure 4. These curves were smoothed out by a moving average of three. The

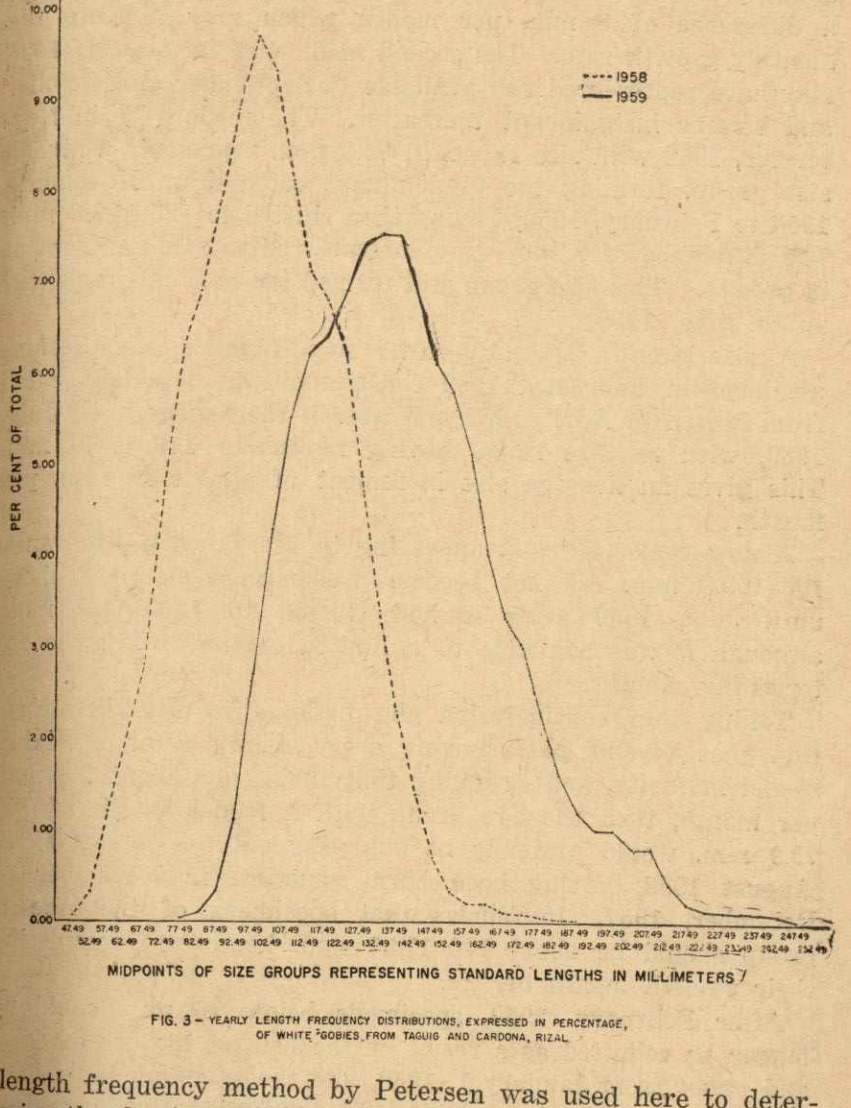


FIG. 3 – YEARLY LENGTH FREQUENCY DISTRIBUTIONS, EXPRESSED IN PERCENTAGE, OF WHITE GOBIES FROM TAGUIG AND CARDONA, RIZAL

length frequency method by Petersen was used here to determine the dominant size groups of the population under study. According to this method, the aggregate fish lengths fluctuate around certain modes, which represent dominant size groups.

Examination of the growth curves in Figure 4 shows the presence of at least two modes in almost all monthly samples collected. The first mode (A) appearing in August, 1958 and represented by size range 75–79.9 mm. was still abundant in

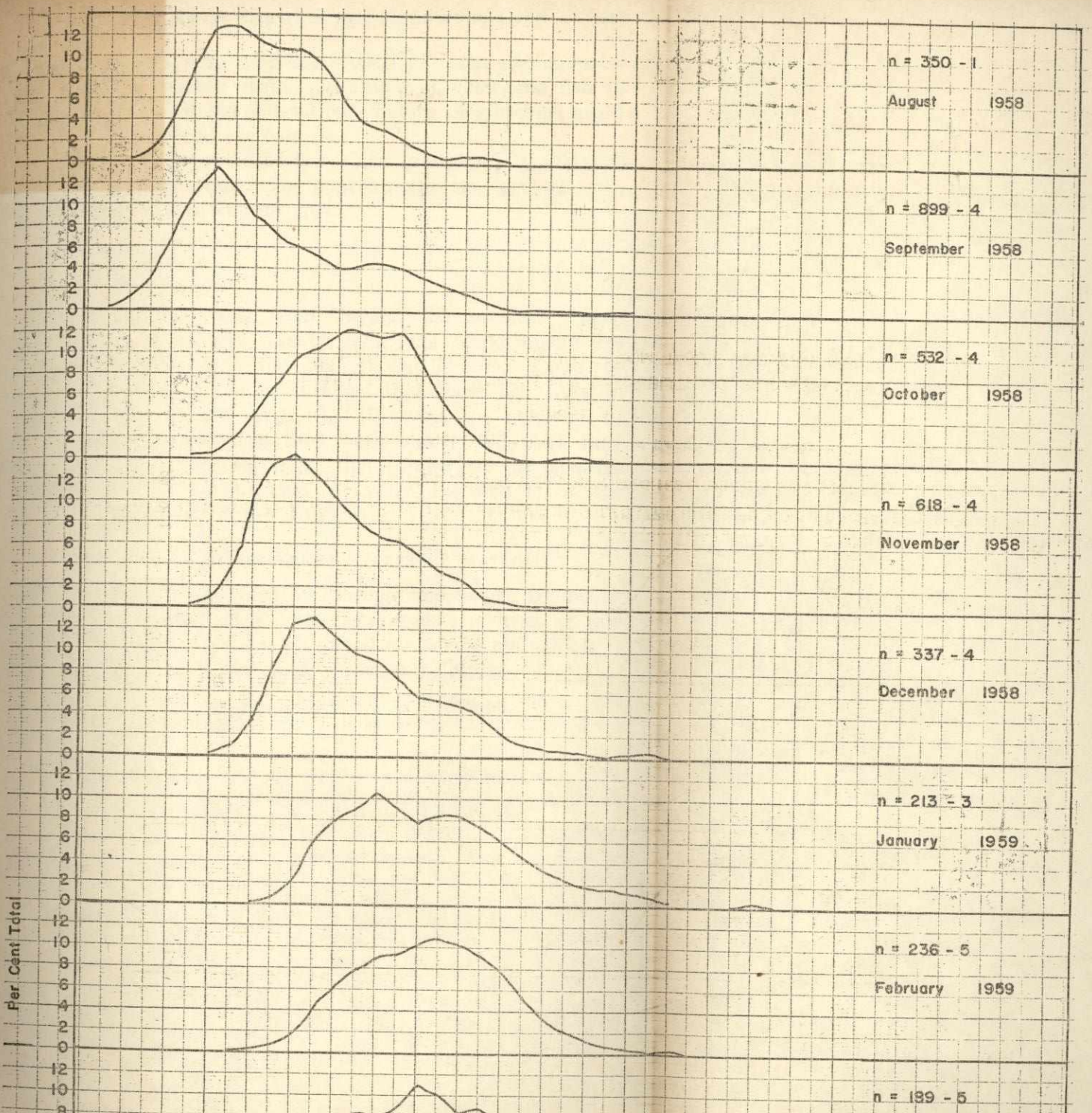
with the size range 125–129.9 mm. This gives
f 8 mm. per month which may indicate the
n rate. The second mode (B) in August, 1958
esented fish available in September and October
significant thereafter. The mode (C) in Sep-
vith size range 70–74.9 mm. represents a strong
rming the predominant catch from November,
ary, 1959, having then shifted to 125–129.9 mm.
of 9 mm. may indicate the monthly increment
his size group still formed the bulk of the fishery
959.

up (D) (105–109.9 mm.) which first became
February, 1959 constituted the dominant catch
o April, 1959 and was in the fishery until July,
s size range having moved to 170–174.9 mm.
average size increment of almost 11 mm. per

(E) just appearing in March with size range
n. did not become predominant in the fishery
959 after it had shifted to 150–154.9 mm.,
as available to a limited extent during the in-
nths.

o consideration the findings in this investiga-
ang puti spawns every month after attaining
ty, and assuming that they grow about 9.3 mm.
hen the age group with a modal length of 75–
uld probably be one year old fish (Age O) in
having been born sometime in November or
957. It follows that specimens of the Age 0
be about 110–114.9 mm. long upon completing
month of life.

uary, 1959, specimens below 75 mm. could no
lected as a result of the ban on the use of *sekc*
om January 1, 1959, and the sampling must have
with the catching of predominantly large-sized
se of larger-mesh gear. Nevertheless, the samples
ing this period helped to assess the real condition
ry. Since other fishing gears were used, the
consisted mainly of larger and therefore older
ranging from 75 to 249.9 mm. with a modal
0–134.9 mm. (Fig. 3). This goes to show tha



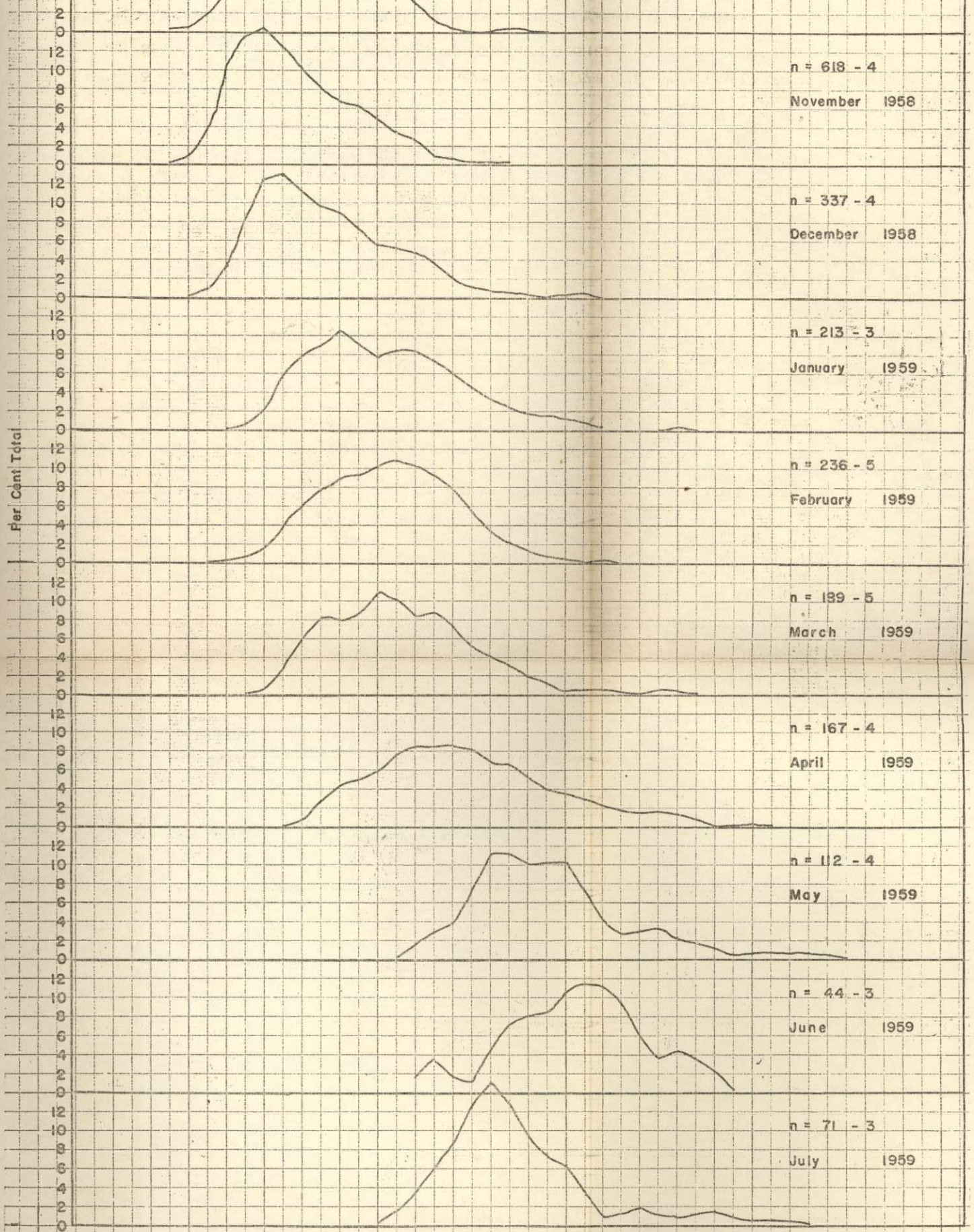


FIGURE 4

MONTHLY LENGTH FREQUENCY DISTRIBUTIONS, EXPRESSED IN PERCENTAGE, OF BIYANG PUTI FROM TAGUIG AND CARDONA, RIZAL

if selective gears were used for *biyang puti,* the fishing pressure would be readily eased and this will allow the fish to grow more and to breed at least once before they become available to such gear and are captured.

Assuming the presence of three age groups of *biyang puti* collected for this study, the approximate age groups with the following modal lengths are:

?–114.9 mm.	1st year (Age 0)
115–224.9 mm.	2nd year (Age I)
225– ? mm.	3rd year (Age II)

Among the specimens from Taguig, the smallest female fish found to be mature was 66 mm. long while among the specimens from Cardona, the smallest was 71 mm. From the above calculation, it can be inferred that these fish were in their first year of life (Age 0). However, the majority of the females matured when they were mostly 105–114.9 mm. long. Hence, at first maturity, this species on the average measures from 105–114.9 mm. or when the fish is at the end of its first year of life (Age 0).

SIZE OF EGGS AT DIFFERENT STAGES OF MATURITY

Most of the fish examined for the age and length frequency were discarded after they were measured, but most of the female specimens were later examined for sexual maturity and were preserved in 5 per cent formalin solution.

The Table for Maturity stages described in Buckmann (1929) was followed with suitable modifications. A brief description of the eggs for each stage follows:

Stage I: Juvenile—Eggs are very tiny and closely attached to each other by the connective tissue of the ovary, glassy transparent, more or less, rounded in shape.

Stage II: Quiet—The eggs occur singly and seen as transparent cells, each with a distinct nucleus. They are ovoid or elliptical in shape. Some are pear-shaped. Juvenile eggs are found together with the ova of this stage.

Stage III: Preparation—Eggs are single but are bigger in size, being twice or thrice longer than their width if elongated; others remain ovoid. They appear yellowish to grayish because they have become yolked.

Stage IV: Fusing or pressing together—Eggs become elongated or club-shaped. They appear dark and therefore opaque for they are totally yolked. They are crowded to each other.

Stage V: Stretching—Eggs are much bigger than in Stage IV and their shape tends to remain club-like; others become comma-like. The yolk in separate globules is opaque and fills the egg; some eggs are translucent.

Stage VI: Mature—The eggs are glassy transparent, with some regions remaining translucent as under V. Some are club-shaped, or comma-like and still others are elongated. The oil globules are not numerous for they appear to coalesce.

As found in other fishes, although the ova have been classified into definite stages, yet most of the ovaries examined cannot fall strictly under one stage category since eggs of different stages have been almost found together in one ovary. In most cases, two or more succeeding stages are always found together. It is this characteristic which also occurs in other species of fish that may explain the monthly spawning of this species throughout the year, a phenomenon known as expanded spawning habits. A rough classification of the ovaries examined was made by grouping them into four categories (immature, maturing, mature and spent), based on

TABLE III.—*Stages of the ovaries and corresponding egg diameters and the number of ovaries of female biyang puti collected from Taguig and Cardona, Rizal from September 1958 to August 1959*

Month and year	Condition of ovaries and diameters of eggs in mm.							Total examined	Percentage mature
	Immature		Maturing		Mature		Spent		
	I	II	III	IV	V	VI	VII		
	0.01 to 0.03	0.05 to 0.13	0.12 to 0.26	0.21 to 0.48	0.30 to 0.83	0.55 to 0.83			
1958									
September	11		22		1		-------	34	2.94
October	63		45		7		-------	115	6.08
November	103		59		20		3	185	10.80
December	105		44		24		2	175	13.71
1959									
January	56		23		27		-------	106	25.47
February	52		33		26		-------	111	23.42
March	58		26		16		1	101	15.84
April	41		8		32		1	82	39.04
May	21		14		13		1	49	26.56
June	4		2		8		-------	14	57.13
July	4		5		14		-------	23	60.83
August	8		5		11		-------	24	45.82
	-------		-------		199		8	1,019	32.15

TABLE IV.—*Monthly percentages of the different maturity stages of ovaries of biyang puti examined from September 1958 to August 1959.*

Month and year	Percentage				Total ovaries examined
	Immature	Maturing	Mature	Spent	
1958					
September	32.35	64.71	2.94	-------	34
October	54.78	39.13	6.08	-------	115
November	55.67	31.89	10.08	1.06	185
December	60.00	25.14	13.71	1.14	175
1959					
January	52.83	21.69	25.47	-------	106
February	46.85	29.72	23.42	-------	111
March	57.42	25.74	15.84	0.99	101
April	50.00	9.75	39.02	1.21	82
May	42.85	28.57	26.53	2.04	49
June	28.57	14.28	57.14	-------	14
July	17.39	21.73	60.86	-------	23
August	33.33	20.83	45.83	-------	24
GRAND TOTAL	-------	-------	-------	-------	1,019

the egg diameter of the most dominant stage present in the ovaries examined. The ovaries containing eggs of stages I and II are considered immature; the ovaries with eggs in stages III and IV, maturing; the ovaries with eggs in Stages V and VI, mature; and, the ovaries with loose walls and traces of ripe eggs, spent. (Tables III and IV and Plate 3).

To get the average size of the eggs of the different stages, the diameter of 3,233 eggs from female specimens was measured and averaged for a period of one year.

The size ranges of the different stages are:

Immature

Stage I—Frequencies with a range between 0.1 and 0.03 mm.

Stage II—Frequencies with a range between 0.05 and 0.13 mm.

Maturing

Stage III—Frequencies with a range between 0.12 and 0.26 mm.

Stage IV—Frequencies with a range between 0.21 and 0.48 mm.

Mature

Stage V—Frequencies with a range between 0.03 and 0.83 mm.

The eggs that are individually discernible to the naked eye are already mature and belong to stages V and VI, with a size ranging from 0.30 to 0.83 mm.

Although the study of the maturity stages of the male *biyang puti* was not conducted in great detail, gross examination of males corresponding size ranges done during sex determination of the fish showed that there is a close correlation with the maturity stages of corresponding female size groups.

FREQUENCY OF SPAWNING

From Table IV, it can be seen that during the months covered by the study, all collections of *biyang puti* indicate a high percentage of immature fish. However, maturing and mature fish are found during most months of the year, a strong evidence that spawning takes place continuously. A similar phenomenon was also found in the goby *Sicyopterus extraneous* by Manacop (*op. cit.*). Figure 5, a graphical representation of Table IV, shows very clearly the different conditions of the ovaries as they were seen during each month from September, 1958 to August 1959. It can be noted that the six-month period from September, 1958 to February, 1959 is characterized by ovaries with a small percentage of mature eggs, the immature and maturing eggs being more dominant. On the other hand, the period from June to August, 1959 is characterized by ovaries with a greater percentage of mature eggs and these months may be considered as the peak of spawning of the species during the year.

FOOD HABITS

Table V gives the percentage frequencies of occurrence of food in different size groups of 161 *biyang puti* taken from Cardona, Rizal, from January to June, 1959. The food items shown here are mainly prouped into three, namely: plants, animals, and unidentified miscellaneous items. Of these three, the plants are the most relished as evidenced by the wide variety of forms represented. Of the blue-green algae, *Microcystis* is most relished. It is absent in only one size group and in most cases the frequency of occurrence is 100%. Of the green algae, *Chlorella* and *Protoderma* are most commonly found in the collection of gut contents. *Chlorella* occurs in 25% to 100% of the stomachs examined and is represented in almost all size groups while *Protoderma* is used as food by practically all size groups in 18% to 100%. This is not as common as *Chlorella*. The diatoms were also found in the stomachs of this species. *Diatoma* is the most relished among fish of intermediate size groups. *Meridion* comes next; species of the other representative genera of Chrysophyta were used as food only by a limited few. The euglenophytes are represented by only three genera in few size ranges and also to a very limited extent. Two kinds of bacteria are relished—the *Bacillus* and the *Coccus* types, which when found in the

TABLE V.—*Percentage Frequencies of Occurrence of Food in Different Size*

Food item	Stand: 85–89.9	90–94.9	95–99.9	100–104.9	105–109.9	110–114.9	115–119.9	120–124.9	125–129.9	130–134.9	135–139.9	14 14
	1	4	5	7	8	10	11	9	7	9	12	9
Plants:												
Cyanophyta—												
Microcystis	100	75.0	60.0	85.7	100	80.0	63.6	66.6	100	100	100	100
Anabaena	100	------	------	------	37.5	50.0	45.4	------	------	------	------	------
Gloeocapsa	------	------	------	------	------	------	------	------	------	------	------	------
Aphanocapsa	------	------	------	------	------	------	------	------	------	------	------	------
Clathrocystis	------	------	------	------	------	------	------	------	17.3	------	------	------
Chlorophyta—												
Binuclearia	------	------	------	------	------	------	------	------	------	------	------	------
Chlorella	100	33.3	60.0	------	100	33.3	66.6	55.5	57.1	55.5	66.6	22
Chllorococcum	------	25.0	40.0	------	62.5	50.0	45.4	71.4	------	------	25.0	44
Chroococcus	------	------	------	------	------	------	45.4	------	------	33.3	------	22
Closterium	------	------	------	42.8	------	------	------	------	------	------	------	------
Coelastrum	------	------	------	------	------	------	------	22.2	------	------	16.6	22
Cosmarium	------	25.0	------	42.8	------	------	------	------	------	------	------	------
Gleocystis	100	75.0	------	57.1	75.0	50.0	------	44.4	42.8	22.2	25.0	------
Hormidium	------	------	------	------	------	------	18.2	------	------	------	------	------
Oocystis	------	------	40.0	42.8	------	------	------	11.1	28.6	------	------	------
Pandorina	------	------	------	------	------	------	36.2	------	28.6	------	------	------
Planktosphaeria	------	------	------	------	------	------	------	------	------	22.2	------	------
Protoderma	------	75.0	------	57.1	37.5	------	18.2	33.3	------	55.5	16.6	44.
Scenedesmus	------	------	40.0	------	------	------	------	------	------	------	------	------
Sphaerocystis	------	------	------	------	------	50.0	45.4	------	------	------	------	------
Stichococus	100	------	40.0	------	------	------	36.4	------	------	------	33.3	22.

Food item	Stand: 85–89.9	90–94.9	95–99.9	100–104.9	105–109.9	110–114.9	115–119.9	120–124.9	125–129.9	130–134.9	135–139.9	140 144
	1	4	5	7	8	10	11	9	7	9	12	9
Chrysophyta—												
Achnantes	------	------	------	------	------	50.0	------	------	------	22.2	------	------
Cyclotella	100	25.0	------	------	------	------	------	------	------	------	------	11.
Diatoma	------	75.0	------	------	------	------	------	44.4	42.8	55.5	58.3	88.
Fragilaria	------	------	40.0	------	------	------	------	------	------	------	------	------
Mastogloia	------	------	------	------	------	------	------	------	------	22.2	------	------
Meridion	------	75.0	40.0	14.5	37.5	------	45.4	------	28.6	55.5	33.3	44.
Nitzschia	------	------	------	------	------	------	------	------	------	------	------	------
Staurorois	------	------	------	------	------	------	------	33.3	------	------	------	------
Synedra	------	------	------	------	------	------	------	------	------	------	83.3	22.
Tabellaria	------	------	------	------	37.5	------	------	------	------	------	------	------
Euglenophyta—												
Chlamydomonas	------	------	------	------	------	------	------	33.3	------	------	------	------
Chlamydomonas (Resting stage)	------	------	------	------	------	------	------	------	------	------	------	------
Euglena	------	------	------	------	------	------	------	------	------	------	------	11.
Trachelomonas	100	25.0	------	------	------	------	------	------	------	------	------	------
Schizomycetes—												
Bacillus bacteria	100	25.0	80.0	85.7	62.5	70.0	------	66.6	57.1	77.7	66.6	55.
Coccus bacteria	------	------	------	------	42.8	50.0	45.4	33.3	57.1	55.5	50.0	44.
Higher plants fibers (unidentified)	------	------	------	------	------	------	------	------	28.6	------	------	------

Food item	Standa 85–89.9	90–94.9	95–99.9	100–104.9	105–109.9	11 0–114.9	115–119.9	120–124.9	125–129.9	130–134.9	135–139.9	140 144
	1	4	5	7	8	10	11	9	7	9	12	9
Animals:												
Protozoa—												
Coleps	------	------	------	------	------	------	36.4	------	------	------	16.6	------
Opalina	------	------	------	------	------	------	------	------	------	------	8.3	------
Peritrichida	------	------	------	------	------	------	------	22.2	28.6	------	------	------
Stentor	------	------	------	------	------	50.0	------	------	------	------	------	------
Unidentified ciliates	------	------	------	42.8	------	------	------	------	------	------	16.6	------
Rotifera	------	------	------	------	47.5	------	------	------	------	------	------	------
Crustacea *Cypris*	------	------	40.0	------	------	50.0	------	------	------	------	------	------
G. giurus Whole	------	------	------	------	------	------	------	44.4	14.3	------	41.7	------
Remains	------	25.0	------	57.1	75.0	50.0	100	44.4	57.1	55.5	------	44.
Sponge (spicules)	------	25.0	40.0	42.2	62.5	50.0	------	11.1	------	77.7	16.6	22.
Unidentified	------	------	------	------	------	------	------	------	------	------	------	------

TABLE V.—*Percentage Frequencies of Occurrence of Food in Different Size Groups of Biyang Puti Taken from Cardona, Rizal Farm January to June 1959*

Food item	Standard lengths and numbers of stomachs containing food																										
	85–89.9	90–94.9	95–99.9	100–104.9	105–109.9	110–114.9	115–119.9	120–124.9	125–129.9	130–134.9	135–139.9	140–144.9	145–149.9	150–154.9	155–159.9	160–164.9	165–169.9	170–174.9	175–179.9	180–184.9	185–189.9	190–194.9	195–199.9	200–204.9	205–209.9	220–224.9	225–229.9	230–234.9	235–239.9
	1	4	5	7	8	10	11	9	7	9	12	9	9	10	9	8	5	3	4	5	3	3	1	3	1	2	1	1	1
Plants:																													
Cyanophyta—																													
Microcystis	100	75.0	60.0	85.7	100	80.0	63.6	66.6	100	100	100	100	100	100	100	100	100	100	100	100	100	66.6	100	100	100	100	100	100	100
Anabaena	100				37.5	50.0	45.4						11.1							20.0									
Gloeocapsa														22.8															
Aphanocapsa																						33.3	100	33.3	100		100		
Clathrocystis									17.3																				
Chlorophyta—																													
Binuclearia												22.2	22.2																
Chlorella	100	33.3	60.0		100	33.3	66.6	55.5	57.1	55.5	66.6	44.4	33.3	80.0	66.6	37.5	80.0		25.0	80.0	100		100	33.3	100			100	100
Chllorococcum		25.0	40.0		62.5	50.0	45.4	71.4			25.0	22.2	22.2	20.0	22.2		20.0	66.6	100		100	33.3		33.3		50.0			
Chroococcus							45.4			33.3					33.3												100		
Closterium				42.8																									
Coelastrum								22.2			16.6	22.2	22.2	40.0	55.5		40.0		75.0										
Cosmarium		25.0		42.8																									
Gleocystis	100	75.0		57.1	75.0	50.0		44.4	42.8	22.2	25.0		33.3	80.0	77.7	37.5	20.0		50.0	20.0				33.3					
Hormidium							18.2																						
Oocystis			40.0	42.8				11.1	28.6										25.0										
Pandorina							36.2		28.6																				
Planktosphaeria										22.2																			
Protoderma		75.0		57.1	37.5		18.2	33.3		55.5	16.6	44.4	33.3	40.0	22.2	25.0	40.0		75.0	80.0	66.6	100	100	33.3	100	50.0	100	100	100
Scenedesmus			40.0																										
Sphaerocystis						50.0	45.4						22.2											33.3					100
Stichococus	100		40.0				36.4				33.3	22.2	22.2					33.3			66.6	66.6	100	33.3					

Food item	Standard lengths and numbers of stomachs containing food																										
	85–89.9	90–94.9	95–99.9	100–104.9	105–109.9	110–114.9	115–119.9	120–124.9	125–129.9	130–134.9	135–139.9	140–144.9	145–149.7	150–154.9	155–159.9	160–164.9	165–169.9	170–174.9	175–179.9	180–184.9	185–189.9	190–194.9	195–199.9	200–204.9	205–209.9	220–224.9	225–229.9	230–234.9	235–239.9
	1	4	5	7	8	10	11	9	7	9	12	9	9	10	9	8	5	3	4	5	3	3	1	3	2	1	1	1	1
Chrysophyta—																													
Achnantes						50.0				22.2				40.0															
Cyclotella	100	25.0										11.1																	
Diatoma		75.0						44.4	42.8	55.5	58.3	88.8	33.3	40.0	100	87.5	80.0	66.6	50.0	80.0		33.3	100	66.6		50.0	100		
Fragillaria			40.0																										
Mastogloia										22.2																			
Meridion		75.0	40.0	14.5	37.5		45.4		28.6	55.5	33.3	44.4	33.3	40.0	33.3					40.0	66.6	66.6	100						
Nitzschia														20.0															
Staurorcis								33.3																					
Synedra											83.3	22.2	22.2				20.0												
Tabellaria					37.5																								
Euglenophyta—																													
Chlamydomonas								33.3								12.5													
Chlamydomonas (Resting stage)																						33.3							
Euglena												11.1		20.0															
Trachelomonas	100	25.0																											
Schizomycetes—																													
Bacillus bacteria	100	25.0	80.0	85.7	62.5	70.0		66.6	57.1	77.7	66.6	55.5	44.4	70.0	77.7	37.5	60.0	66.6	25.0		66.6			33.3		50.0			100
Coccus bacteria					42.8	50.0	45.4	33.3	57.1	55.5	50.0	44.4	44.4	60.0	33.3	40.0	60.0		25.5		66.6			33.3		50.0			100
Higher plants fibers (unidentified)									28.6													100							

Food item	Standard lengths and numbers of stomachs containing food																										
	85–89.9	90–94.9	95–99.9	100–104.9	105–109.9	110–114.9	115–119.9	120–124.9	125–129.9	130–134.9	135–139.9	140–144.9	145–149.9	150–154.9	155–159.9	160–164.9	165–169.9	170–174.9	175–179.9	180–184.9	185–189.9	190–194.9	195–199.9	200–204.9	205–209.9	220–224.9	225–229.9	230–234.9	235–239.9
	1	4	5	7	8	10	11	9	7	9	12	9	9	10	9	8	5	3	4	5	3	3	1	3	1	2	1	1	1
Animals:																													
Protozoa—																													
Coleps							36.4				16.6																		
Opalina											8.3																		
Peritrichida								22.2	28.6				22.2			12.5													
Stentor						50.0							22.2																
Unidentified ciliates				42.8							16.6			20.0		25.0													
Rotifera					47.5																								
Crustacea *Cypris*			40.0			50.0																							
G. giurus Whole								44.4	14.3		41.7				44.4				50.0	40.0	33.3								
Remains		25.0		57.1	75.0	50.0	100	44.4	57.1	55.5		44.4		40.0	33.3	60.0	20.0	66.6	25.0	60.0		33.3	100	33.3		50.0	100		
Sponge (spicules)		25.0	40.0	42.2	62.5	50.0		11.1		77.7	16.6	22.2	22.2	60.0				66.6	25.0	80.0	33.3								
Unidentified																													

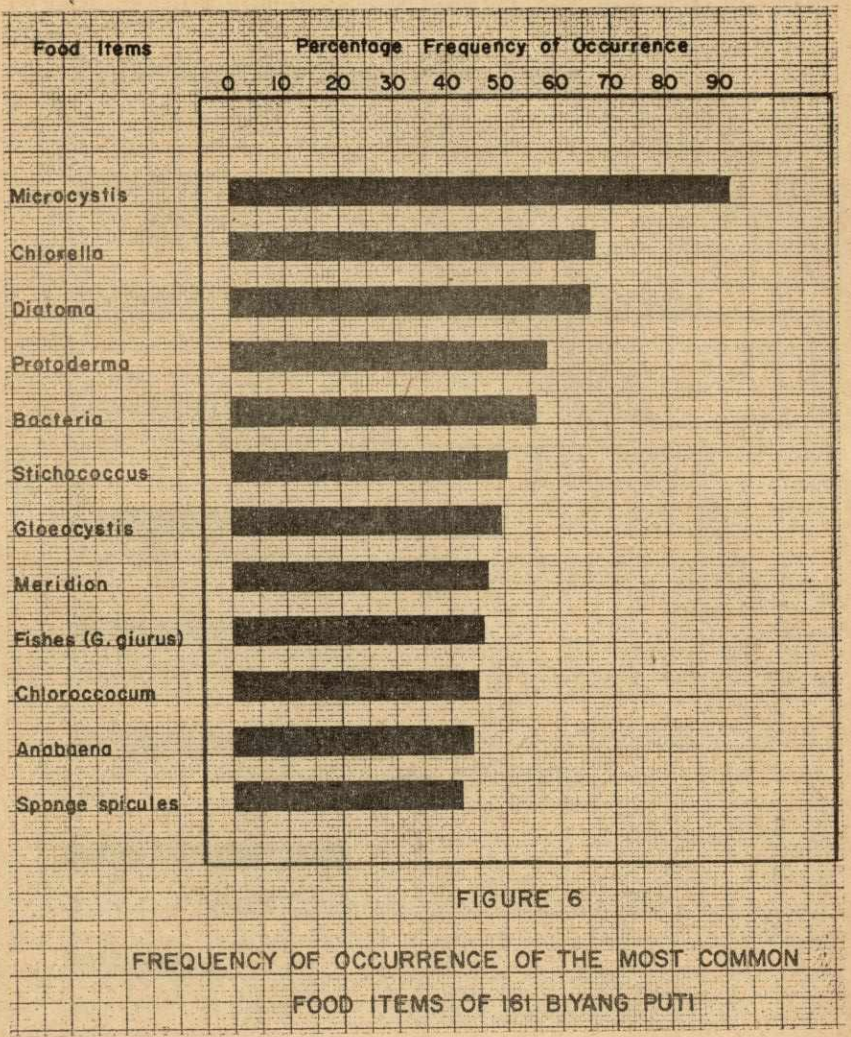


FIGURE 6

FREQUENCY OF OCCURRENCE OF THE MOST COMMON FOOD ITEMS OF 161 BIYANG PUTI

stomachs of the *biyang puti,* are never below 25% in percentage of occurence. Higher plants appear in the form of fibers which could not be identified due to the advanced state of decomposition.

The animal group includes representatives of Protozoa, Porifera, Rotifera, Crustacea, and fishes. The remains of fishes and the spicules of fresh water sponges are most commonly

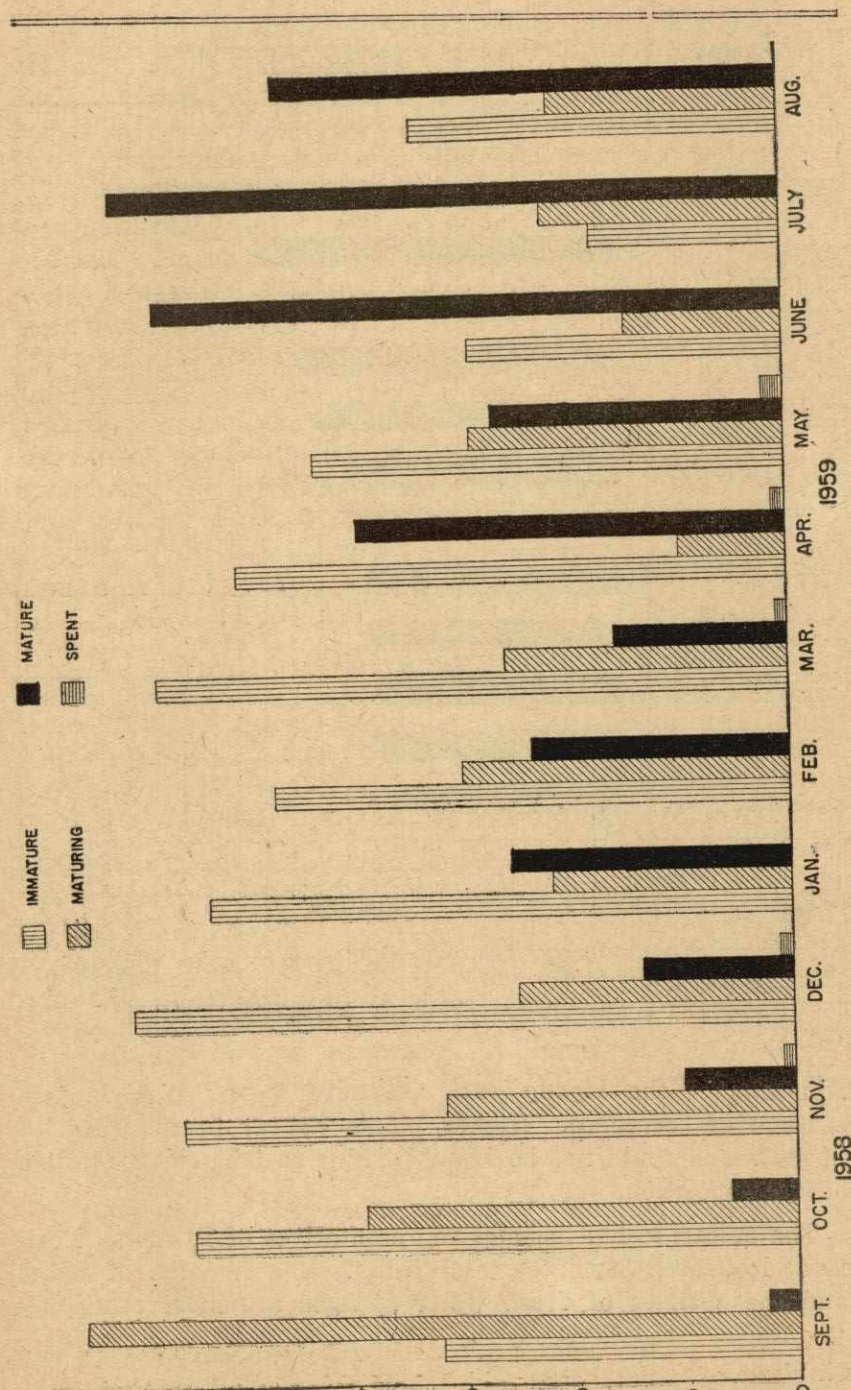


FIG. 5. Condition of ovaries of Biyang Puti from Taguig and Cardona, Rizal, from September, 1958 through August, 1959.

found. Remains of fishes occur in not less than 20% and sponge spicules, in not less than 10%.

A noteworthy interpretation that can be made here is the presence of either the whole body or remains of fishes. For the identification of the species, it is not difficult if the whole body is seen as in the seven size groups appearing in Table V. But in the case of those where only the remains in the form of scales and fins are found, it is difficult to identify the species. However, in this study, it can be assumed that the majority of those taken in belong to *G. giurus* since the whole bodies of fish found in the stomach were all of this particular species. Furthermore, several gobies that were measured for their standard lengths showed the presence of whole small gobies in their buccal cavities. Another evidence in favor of the assumption is the presence of ctenoid scales, which are exactly the type found in *biyang puti.* Thus, it can be assumed further that this species is cannibalistic because it preys upon its own kind.

The utilization of *Microcystis* as food by the *biyang puti* in Laguna Lake is of great importance from the point of view of public health, for the *biyang puti* help greatly in controlling foul odors that are formed by "blooms" of *Microystis* during summer.

The unidentified miscellaneous items which consist of detritus occurred only in one size group that range from 135–139.9 mm. indicating that the fish is not a detritus feeder.

It will be noted that the food preference of the *biyang puti* is for vegetation rather than for animals and other miscellaneous food items. This is clearly seen in Figure 6 which is a graphical representation of the most common food items taken in by *biyang puti.* It will also be noted that there is no significant variation in the kind of food items taken in by the different size groups.

In this fish, the occurrence of an unidentified fluke found in almost all size ranges of the fish examined is a case of parasitism. The occurrence in the stomach of any size group is never lower than 21%. It may be assumed that *biyang puti* is a host of the fluke since it is found, not only in the stomachs, but also in the walls of a few ovaries. This will be studied in the future.

SUMMARY AND CONCLUSIONS

The depletion of Laguna de Bay has been observed for a long time and since 1950, the commercial catches showed de-

finite and conclusive sign of depletion. But to be able to take the correct steps for its rehabilitation, a biological understanding of the different species inhabiting the lake is necessary. One of the fish species found in the lake is the *biyang puti, Glossogobius giurus,* an important source of protein to the people living along its shores for which the present study was devoted.

Fish collected from Cardona and Taguig, Rizal, amounting to 3,768 specimens of *biyang puti* were bought from the Sta. Ana Market so as to determine their age and size at sexual maturity. These were estimated with the use of the length-frequency method. To ascertain the sexual maturity of the species, gross microscopic examinations of 1,019 ovaries and measurement of the ovarian eggs were carried on. The food preference of 161 white gobies was also studied by examination of their stomach contents, using the frequency-of-occurrence of food items as a quantitative index.

The following important findings may be drawn from the results of this study:

1. On the average, *G. giurus* matures at size range 105–114.9 mm. or at the time when the fish is at the end of its first year of life (Age 0).

2. Eggs that are about to be spawned measure from 0.55 to 0.83 mm. in diameter.

3. Spawning takes place at monthly intervals as evidenced by the presence of usually three succeeding stages of eggs in sexually matured females.

4. *Microcystis* is the blue-green algae most utilized as food while *Protoderma* and *Chlorella* are the green algae most preferred. *Diatoma* and *Meridion* are the diatoms most frequently taken in.

5. While predominantly dependent on algae, *biyang puti* are also piscivorous and carnivorous, preying on their own kind.

6. An unidentified fluke has also been found associated with this species of fish, which is worth studying.

RECOMMENDATIONS

Based on the findings in this study, the following may be recommended for the conservation and/or rehabilitation of the *biyang puti, Glossogobius giurus* fishery of Laguna de Bay:

1. The catching of white gobies measuring less than 135

The use of *seket* and *kaladkad pambiya* must be banned completely, or at least, the mesh size opening (30 mm. mesh stretched), which is the size specified for experimental purposes for the impounding section of the net of a *seket,* must be enforced by law or Administrative Order to permit the easy passage or escape of the young and immature individuals, thereby providing enough spawning *biya* to spawn at least only once.

2. The peaks of the spawning season, the months of June, July and August, must be designated closed season periods and the provisions of Fisheries Administrative Order No. 35, dated June 4, 1953, entitled "Regulation of the *Kaladkad Pambiya* and the conservation of *Biyang Puti* in Laguna de Bay and its tributaries" must likewise be rigidly enforced.

3. The stocking of Laguna de Bay with the young of *biyang puti* should be made a regular project of the Bureau of Fisheries and other entities of the Government, charged with regulatory and law enforcement functions and responsibilities.

ACKNOWLEDGMENT

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forms; and, to all those who in one way or another made possible the successful completion of this study.

For all of them God's choicest blessings are implored.

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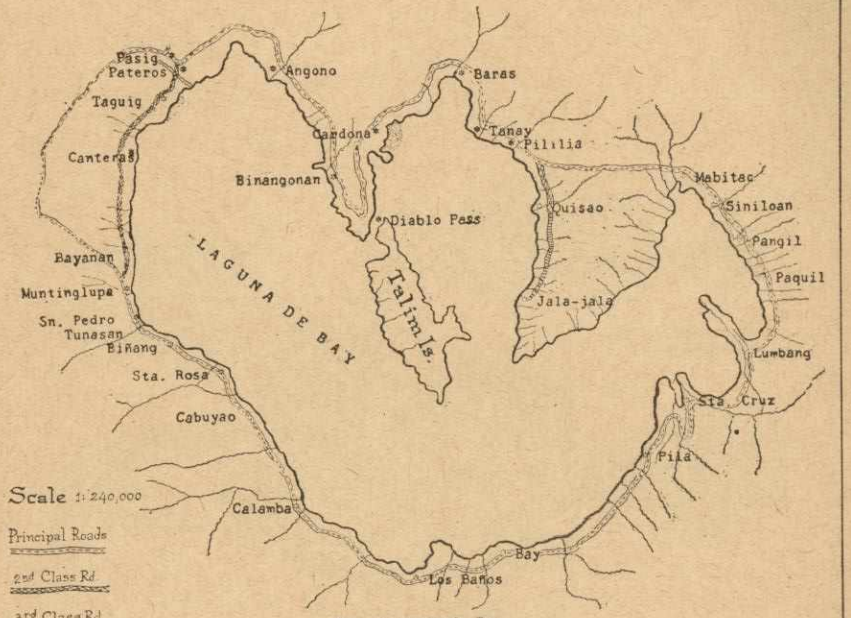
ILLUSTRATIONS

TEXT FIGURES

PLATES



Map of Laguna de Bay
Shaded parts indicate municipalities where white goby collections were made
PLATE 1

PLATE 1

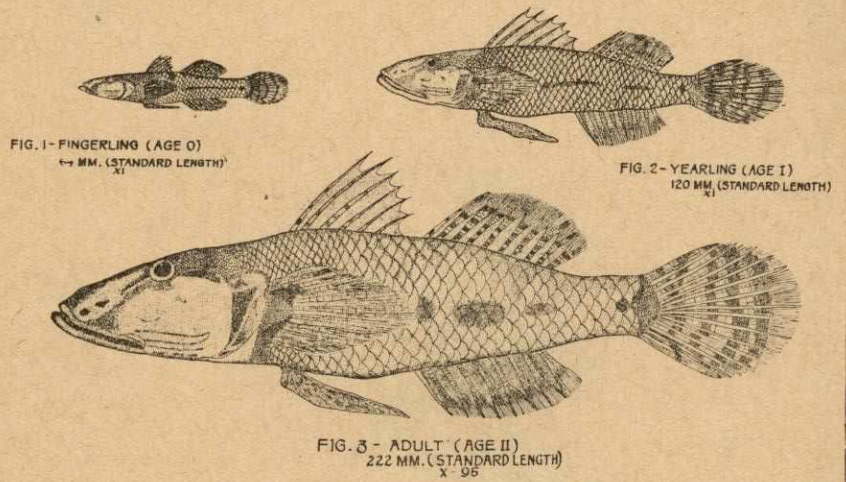


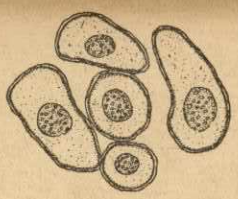
FIG. 1 - FINGERLING (AGE 0)
↔ MM. (STANDARD LENGTH)
X1

FIG. 2 - YEARLING (AGE I)
120 MM. (STANDARD LENGTH)
X1

FIG. 3 - ADULT (AGE II)
222 MM. (STANDARD LENGTH)
X .95

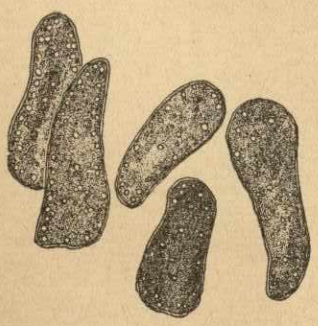
PLATE 2. *GLOSSOGOBIUS GIURUS* (BUCHANAN-HAMILTON)

STAGE 1: JUVENILÉ
X420

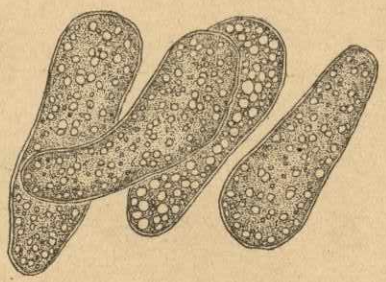


STAGE 2: QUIET
X128

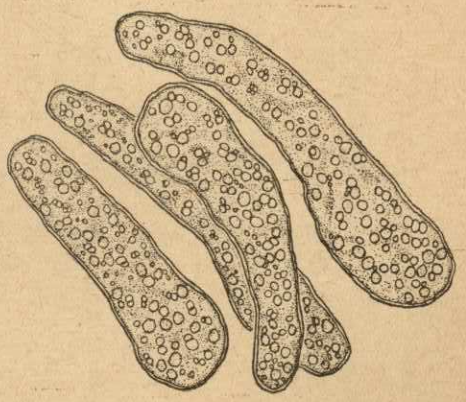
STAGE 3: PREPARATION
X97



STAGE 4: FUSING
X238



STAGE 5: STRETCHING
X 109



STAGE 6: MATURE
X 116

PLATE 3- STAGES OF MATURITY OF THE EGGS OF BIYANG PUTI