ON THE BIOLOGY OF THE FLAT MOUTHED CATFISH *TACHYSURUS PLATYSTOMUS* (DAY) FROM MANDAPAM

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ABSTRACT

As determined from length-frequency studies, one-, two-, three- and four-year-old fish respectively attain 178, 256, 310 and 366 mm size. As indicated by the opercular bone, the corresponding sizes were at 173, 256, 349 and 387 mm and as by vertebrae, they were 177, 272, 340 and 388 mm. Von Bertalanffy growth curve, fitted to the estimates of lengths at ages derived from opercular bone, is given as:

$$L_t = 497.5 \left[1-e^{-0\ 35767(t-(-0.2305))} \right]$$

The length-weight relationship was significantly different for males and females. The low values of relative condition factor during December-February period was due to spawning. Yolked larvae were found to feed on planktonic organisms, even when they were in the mouth of the male parent. Even though the individuals of the species spawn only once and over a short period, the population as a whole may probably breed over November to February every year. Females and males first mature at 230 and 220 mm respectively. Fecundity varied from 32 to 40 ova in fish ranging from 230 to 390 mm in total length.

INTRODUCTION

The flat-mouthed catfish, *Tachysurus platystomus* (Day), a coastal species, is common along the Gulf of Mannar but stray in Palk Bay. Since a study on the biology of this species is useful because of its distribution and commercial importance, an attempt for it is made based on data collected during the period from November 1969 to December 1971 from the Gulf of Mannar and the Palk bay.

MATERIAL AND METHODS

Specimens of *Tachysurus platystomus* were collected at weekly intervals from the Gulf of Mannar and the Palk bay, landed at Mandapam by trawlers. Total length of each fish was measured to the nearest millimetre and weight to the nearest gram. The length data were grouped at 2 cm interval, and the pooled monthly length-frequency distribution was used for tracing modal progression.

Also, the length-frequency distribution of the samples collected during January 1971 to December 1971 was pooled and the polymodal distribution was split up by Probability technique (Cassie 1954).

Skeletal hard parts such as opercular bone and vertebra were examined for determination of age after they were boiled in water and cleaned in ether. Out of a total of 138 opercular bones collected and examined over a period of one year, only 105 were readable. The opercular length as well as the lengths to the various translucent zones were measured to the nearest mm from the fulcrum to the longest axis. The fifth vertebra was selected as its centrum is comparatively flat and easy to separate. The vertebral radii and ring radii were measured from the centre along a radial plane, to the longest axis of the vertebra under a low power binocular microscope, using an ocular micrometer. Out of 129 vertebrae collected and examined 118 were readable.

Seven maturity stages were recognized as in the case of *Osteogeneiosus militaris* (Pantulu 1963). Ova of less than one mm were measured with the aid of an ocular micrometer, each division having a magnification of 0.013 mm. Ova of more than one mm were measured by means of vernier calipers. Fecundity was estimated based on the total number of ripe ova present in fishes in advanced stages of maturity (V and VI).

Biology

Age determination by length frequency

In order to study the age, free-hand fits were made connecting the dominant modes as presented in Fig. 1. Here it may be seen that the mode at 50 mm of December 69 shifts to 170 mm in October 70. A mode seen at 50 mm in Nov. 70 has progressed to 90 mm in Feb. 71, which further shifts through 110 mm in Mar., 130 mm in May, 170 mm in Sept. to 190 mm in Nov. 71. Similarly, the 50 mm mode of Dec. 70 has progressed to 170 mm in Dec. 71. Thus it shows that the average growth during the first year is 171 mm at the rate of 14.9 mm per month. The age at recruitment, at a size of 50 mm as determined by extrapolation, was one month. Furthermore, from detailed observations it was found that the juveniles started a free demersal life when they attained a size of 45 to 55 mm, with a period of incubation of about one month. The 170 mm mode of Oct. 70 has progressed to 270 mm in Oct. 71 showing the size at 270 mm when it is two years old, with an average growth rate of 8.3 mm per month during the second year.

The mode of Sept. 70 at 270 mm has progressed to 350 mm in Aug. 71. Similarly, the mode at 270 mm of Dec. 70 has progressed to 330 mm in Dec. 71. Thus, the growth during the third year is at an average rate of 6.8 mm per month.

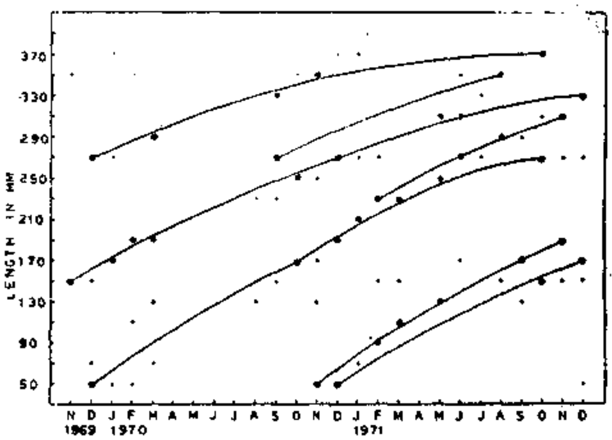

FIG. 1. Monthly modal progression in the length-frequency data of *T. platystomus*.

The different age groups in the polymodal frequency distribution are separated using Probability paper, based on data collected during Jan. to Dec. 71. The first modal length is at 103 mm, which represents the 0-year class. The second, third, fourth and fifth modes represent 178, 256, 310 and 363 mm in respective age classes I, II, III and IV (Fig. 2). These estimations closely agree with those obtained by Petersen's method of length frequency analysis.

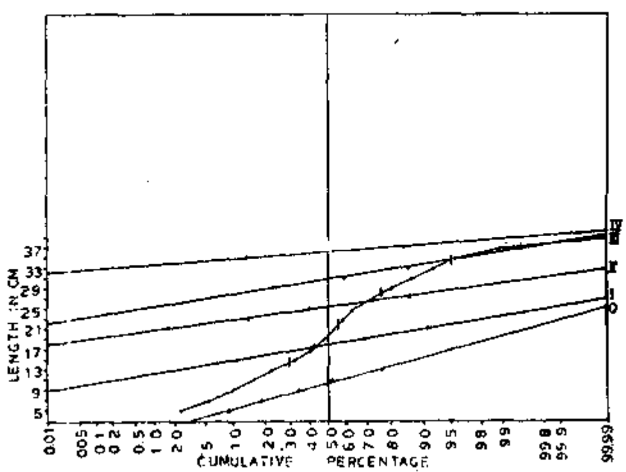

FIG. 2. Probability plot of the length-frequency distribution of *T. platystomus*.

Age determination from operculum

Translucent zones or checks that were patchy or which appeared only for short distances were considered as false and those zones that traversed the posterior, dorsal and ventral parts of the operculum as true zones. In all the opercular bones studied, a narrow translucent check was noticed near the fulcrum which, on back calculation, seems to have been formed when the fish attained a size of 45 to 55 mm in total length—the size at which the juveniles swim out of the parent's mouth to lead an independent life. This check has corresponded with the 'larval ring' noticed in *Neoplatycephalus macrodon*, which Fairbridge (1951) had described as an 'impression representing an adoption of a demersal life after the planktophagous phase as larvae.' Thus, the juvenile check formed in the operculum of *T. platystomus* might be due to the stress of sudden change of environment and food habits from the larval life in the mouth of the male parent to the free demersal life.

The margins of the opercular bones from fish caught during different months of the year were examined to ascertain the probable time of formation of translucent checks. A predominantly high proportion of the opercular bones exhibited translucent margins during the months December, January and February; whereas a high percentage of bones had opaque margins during March to November (Fig. 3). Therefore in *T. platystomus* one opaque and one translucent check together were taken to represent one year's growth.

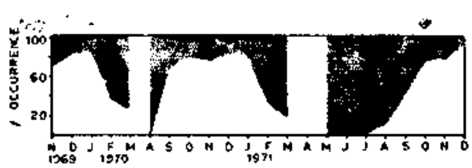

FIG. 3. Percentage of opercular bones with translucent margins (non-shaded portion) and opaque margins (shaded portion) during different months.

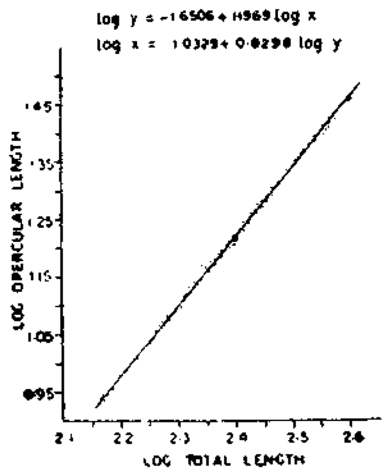

FIG. 4. The relationship between opercular length and total length of *T. platystomus*.

The first translucent check (excluding the juvenile check) is formed probably due to a retardation of linear growth brought about by the shift of energy utilization from somatic building to reprductive building. As the species spawns first when it is two years old and thereafter every year, the formation of the second and subsequent checks are perhaps a consequence of spawning. Cessation of feeding by males during the period of oral gestation, lasting about a month, may retard the linear growth in males; while in ripe females, as a consequence of excessive enlargement of ovary, the feeding intensity gets reduced leading to a like retardation. Thus, the cumulative effect of cessation of feeding and spawning stress may be the reason for the formation of translucent checks in the opercular bone. The occurrence of a high percentage of empty stomachs in the spawners corroborates this assumption.

The relationship of opercular bone length (Y) to fish length (X) was linear in the logarithmic form (Fig. 4), which coud be expressed by the formula

$$\log Y = -1.6506 + 1.1969 \log X$$

or conversly as

$$\log X = 1.0329 + 0.8298 \log Y$$

with correlation coefficient, $r = 0.9966$.

The direct proportion formula for back-calculation (van Oosten 1929) of length at different ages was not applicable in the present case since the data did not satisfy the requirement that fish length and age should be linearly related with an intercept at the origin. Hence, the linear regression of fish length on opercular bone length ($\log X = 1.0329 + 0.8298 \log Y$) was more appropriate for deriving a formula for the purpose of back-calculation (Smith 1955; Pantulu 1961, 1963). Based on this relationship the following formula was used to derive back-calculated lengths at different translucent checks:

$$\log L_n = \log L_t + b (\log r_n - \log R_t) \qquad \ldots\ldots\ldots\ldots\ldots (1)$$

where, L_n = length at age 'n', L_t = length at the time of capture, b = slope of regression line of fish length-opercular bone length relationship (0.8298), r_n = length of operculum at age 'n' and R_t = total length of operculum at the time of capture.

Substituting the values in the above equation, the back-calculated values of lengths at ages are derived and presented in Table 1.

Age determination from vertebra

The length of *T. platystomus* at the time of formation of successive translucent annuli was back-calculated by using the relationship between fish length and vertebral radius. This relationship (Fig. 5) was found to be linear in the logarithmic form which could be expressed as

$$\log X = 1.6521 + 0.4652 \log Y$$

or conversly as

$$\log Y = 3.3241 + 2.0557 \log X$$

with correlation coefficient, $r = 0.9780$.

TABLE 1. *Mean back-calculated lengths (mm) at the end of each year of life as determined by opercular bones.*

Size group in mm	No. of fish examined	Age in years I	II	III	IV
180-200	9	188			
200-220	14	181			
220-240	12	180			
240-260	14	178			
260-280	10	176	261		
280-300	7	172	271		
300-320	10	168	265		
320-340	12	162	271		
340-360	6	163	260	350	
360-380	8	170	268	357	380
380-400	3	169	258	342	393
Total	105				
Mean length		173	265	349	387
Growth increment		173	92	84	38

Invariably in all the vertebrae examined a narrow translucent 'juvenile ring' was noticed near the centre of the centrum, similar to the one noticed in the operculum. High percentage occurrence of vertebrae with translucent margins during December, January and February suggested their probable period of formation and annual nature same as noticed in the case of operculum. Back-calculation of lengths at time of formation of translucent rings was made by using the formula (1) by substituting the value of 'b' (0.4652) and are presented in Table 2.

Fitting von Bertalanffy growth equation

The von Bertalanffy growth equation:

$$L_t = L_\infty \left[1-e^{-K(t-t_0)} \right]$$

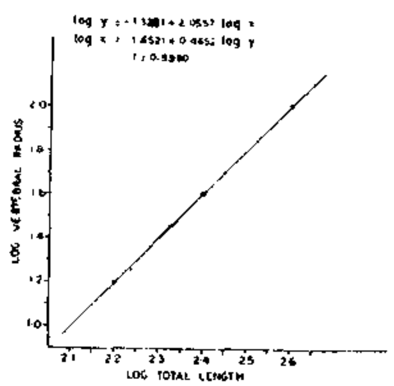

FIG. 5. Relationship between vertebral radius and fish length.

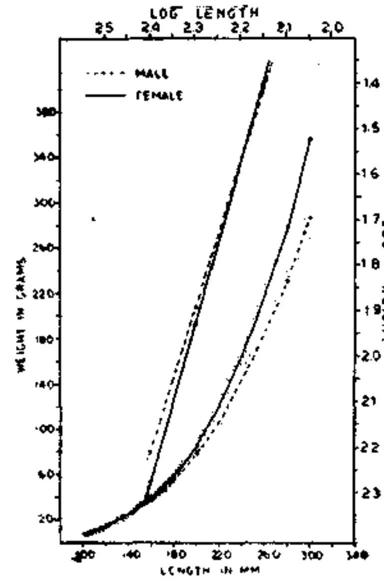

FIG. 6. Length-weight relationship of *T. platystomus*.

TABLE 2. *Mean back-calculated lengths (mm) at the end of each year of life as determined by vertebrae.*

Size group in mm	No. of fish examined	Age in years I	II	III	IV
180-200	9	183			
200-220	15	180			
220-240	17	190			
240-260	19	176			
260-280	11	167	265		
280-300	7	170	273		
300-200	10	163	261		
320-340	13	160	270		
340-360	6	159	262	357	
360-380	8	168	266	350	378
380-400	3	165	259	345	396
Total	118				
Mean length		171	265	351	387
Growth increment		171	94	86	36

was used for fitting the growth curve; the value of T_∞ was determined by using the method of Ford (1933) and Walford (1946). The value of t_0 was calculated graphically by using the method given by Ricker (1958). The estimated values of L_∞, K and t_0 were 497.5, 0.35767 and −0.2305 respectively. Thus, the von Bertalanffy growth equation of *T. platystomus* might be stated as:

$$L_t = 49.75 \left[1 - e^{-0.35767\,(t-(-0.2305))} \right]$$

This relationship adequately described the growth of *T. platystomus* in Mandapam waters, since the calculated lengths for each age group derived from this equation were nearly identical to the mean lengths obtained by back-calculation based on skeletal parts and also to mean lengths derived by length-frequency method (Table 3).

TABLE 3. *Comparison of estimates of lengths (mm) at different ages by various methods.*

Age in years	Length frequency Peterson's method	Length frequency probability paper	Opercular bones	Vertebrae	Von Bertalanffy growth equation
I	171	178	173	171	177
II	270	256	265	265	272
III	344	310	349	351	340
IV	—	363	387	387	388

Length-weight relationship

The length-weight values of *T. platystomus* when plotted gave the relationship which conformed to the general allometric formula. Plotting logs of weights on logs of total lengths revealed one linear regression value for males and another for females (Fig. 6). Test of significance by Analysis of covariance between the two regression values indicated that there was significant differences in the slope and elevation at 1% level between sexes (Table 4). Because of high significance in the F value at 1% level, different equations were justified for the two sexes. The equation for female was

$$\log W = -6.200263 + 3.532063 \log L$$

The Correlation coefficient for this regression (0.9913) showed a high degree of correlation between the two parameters. Regression equation for male was

$$\log W = -5.452548 + 3.193072 \log L$$

The correlation coefficient for this regression (0.9930) also showed a high degree of correlation between the two parameters.

The value of exponent 'b' for females and males was tested against the exponent in isometric growth by the formula of Snedecor (1956). The 't' values for both sexes were highly significant at the level of 1%, which indicated that the weight of the fish increased at a rate higher than the cube of length.

TABLE 4. *Comparison of regression lines—sex data of* T. platystomus.

	Source	d.f.	Sx^2	Sxy	Sy^2	b	Deviation from regression		
							d.f.	S.S.	M.S.
T	Within								
1	Male	155	1.3135	4.1941	13.5779	3.193072	154	0.1858	
2	Female	209	1.9003	6.7135	24.7135	3.532863	208	0.4211	
						Total	362	0.6069	0.001677
	pooled, W	364	3.2138	10.9076	37.7169	3.393988	363	0.6966	0.001919
		difference between slopes					1	0.0897	0.0897
	between, b	1	0.2219	0.9216	3.8273				
	W + b	365	3.4357	11.8292	41.5442		364	0.8160	
		Between adjusted means					1	0.1104	0.1194

Comparison of slopes: F = 0.0897|0.001677 = 53.48 (d.f. = 1,362) Significant at 1%
Comparison of elevations: F = 0.1194|0.001677 = 71.20 (d.f. = 1,362) Significant at 1%

d.f. = degrees of freedom, Sx^2 Sxy, Sy^2 = corrected sum of squares and products. s.s. = sum of squares, b = regression coefficient, M.S. = mean square.

Relative condition factor

The relative condition factor, K_n (Le Cren 1951) for immature fish has not shown much variation between months. Among mature fish, the K_n has shown generally low values from September-October reaching a dip during January-February (Fig. 7). This lowering of K_n during December-February period might be due to spawning as these troughs coincide with the peak breeding season. Also, the high percentage occurrence of translucent zone on the edge of the operculum and vertebra shows corroborative evidence in support of the above observation.

Food and feeding habits

Stomach contents of 684 fish collected from Gulf of Mannar and 120 fish from the Palk bay, ranging in sizes from 73 to 393 mm in total length, were

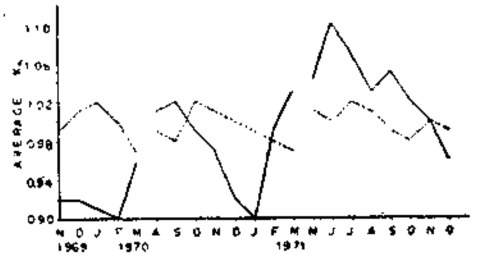

FIG. 7. Monthly fluctuations in condition factor (Kn) of immature (dotted line) and mature (solid line) *T. platyatomus.*

examined to understand the food habits. Differences were noticed in the qualitative and quantitative composition of the food of the larvae and immature and mature fish.

Sixteen yolked larvae, ranging from 35 to 45 mm in total length, collected from the mouth of gestating males, had planktonic organisms in their stomachs. The pércentage occurrance of different food items was as follows: nauplii 18.4%, zoea 6.8%, copepods 5%, alima 3.5% and digested matter 66.3%. Probably the planktonic organisms present in the respiratory incurrent of the parent might be ingested by the larvae as the same incurrent is also being utilized for their respiration. Fryer (1959) made similar observations on the feeding of the larvae of *Pseudotropheus tropheops* while they were in the oral cavity of the female even before all the traces of the yolk sac had disappeared.

A total of 254 immature fish from Gulf of Mannar and 39 fish from the Palk bay were examined to study the percentage occurrence of various food items in their stomach. The immature fish from the gulf mainly fed on polychaetes (12 to 50%) and *Philine* sp. (12 to 50%). Other important items found in the stomach were amphipods, juvenile prawns, crabs and ostracods, in the order of abundance. The food of fish from the Palk bay consisted of echiurids (12 to 40%), polychaetes (17 to 62%) and juvenile prawns (4 to 20%).

The major food items of the mature fish from the gulf were *Philine* sp. (14 to 40%), crabs (10 to 25%), *Squilla* sp. (10 to 20%), prawns (3 to 20%) and alpheids (4 to 23%). In the Bay the mature fish mainly fed on echiurids (20 to 35%), *Squilla* sp. (14 to 22%), prawns (5 to 24%) and crabs (7 to 13%). Empty stomachs were noticed in comparatively large numbers during November to February.

Thus, the food of the mature fish was more variable in composition and the components larger than that of immature fish. All the size groups of *T. platystomus* were found to feed on bottom epifauna and infauna as against *T. thalassinus,* of which the smaller size groups had been reported to feed on bottom fauna and the larger ones occasionally to feed from the column waters on larger food organisms (Menon 1979). As already said, the occurrence of empty stomachs in large numbers during the breeding period was perhaps due to the gestating male completely refraining from feeding and the gravid female feeding less intensely as reported in the case of *T. thalassinus* (Mojumder 1969).

Reproduction

The sex ratio during different months has not shown any significant difference by chi-square test. Generally the males were more numerous in the catch during the breeding season.

In a mature ovary of *T. platystomus* there were three different groups of ova, designated as 'a', 'b' and 'c'. Of these 'a' and 'b' are nonyolked groups, white in colour and frothy in nature, and seem nonfunctional and the group 'c' yolked and opaque, and functional (Menon, MS).

Development of ova: The percentage frequency of ova in different stages of maturity is shown in Fig. 8. In stage I the ova of the group 'c' were in size range 0.07 to 0.59 mm with the mode at 0.07 mm. In stage II, a batch of 'c' ova got separated from the general immature stock. The mode of the immature ova has progressed to 0.10 mm, while the most advanced group has a mode at 1.37 mm. In stage III, the immature of group 'c' has advanced further with a modal diameter of 0.59 mm and the most advanced group of ova has shown progress to a modal value of 1.63 mm. In stage IV, both the modes of group 'c' ova have progressed further, the first to a mode of 2.5 mm, and the most advanced group to 6.5 mm. The most advanced group of 'c' ova got separated from the preceding mode in stage V. The first group of ova has not shown any progress and remained at a modal diameter of 2.5 mm, while the most advanced group has shown a modal diameter of 8.5 mm. In the ovary of stage VI, while the preceding group remained the same, the most advanced group showed a modal diameter of 11.5 mm, with a maximum ova size of 12.5 mm. At stage VI, majority of the most mature group 'c' ova got loosened in the follicles and a few got separated from the follicles. Probably spawning takes place at this stage. In stage VII there was only one mode in the group 'c' ova at 2.5 mm and the ovary resembled stage III. The non-functional ova of groups 'a' an 'b' also progressed in size as maturity progressed and got spawned along with the ripe functional group 'c' ova.

Frequency of spawning: The ova-diameter-frequency polygon of a mature ovary of *T. platystomus* showed only one batch of ripe group 'c' ova, separate from the maturing batch. After spawning, the ovary resembled stage III with one batch of maturing ova. According to de Jong (1940) and Prabhu (1956), in these categories of fishes, the spawning takes place only once a year during a short distinct spawning period. The maturing group of ova, with a modal value

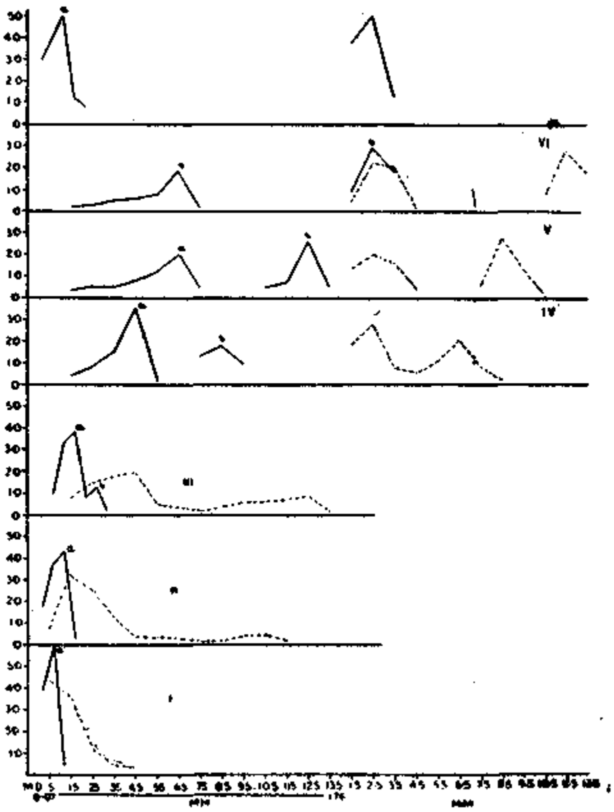

FIG. 8. Ova diameter frequency polygon of *T. platystomus* in different stages of maturity (solid line indicates non-functional groups 'a' and 'b' ova and dotted line functional group 'c' ova).

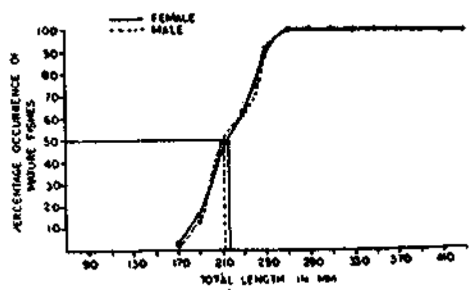

FIG. 9. Size at maturity.

of 2.5 mm, remaining in the spent ovary probably would contribute to the subsequent year's ripe ova, as there were no signs of their distintegration in the spent ovary. The presence of ripe and spent fish during November to February (Table 5) indicated that, though individuals spawned only once a year during

TABLE 5. *Percentage occurrence of males and females of* T. platystomus *in different stages of maturity in various months.*

	Sex	No. fish examined	Maturity stages I	II	III	IV	V	VI	VII
1969									
Nov.	M	30	23.3	10.0	23.3	—	16.7	20.0	6.7
	F	25	16.0	16.0	24.0	—	16.0	16.0	12.0
Dec.	M	20	10.0	15.0	40.0	—	—	15.0	20.0
	F	23	13.0	21.7	26.1	—	—	8.7	30.4
1970									
Jan.	M	20	45.0	20.0	—	—	—	15.0	20.0
	F	20	25.0	10.0	25.0	—	—	10.0	30.0
Feb.	M	33	46.5	21.2	24.2	—	—	—	6.1
	F	30	40.0	26.7	23.3	—	—	3.3	6.1
Mar.	M	8	50.0	50.0	—	—	—	—	—
	F	22	77.3	13.6	9.1	—	—	—	—
Aug.	M	14	21.4	7.1	42.9	21.4	7.1	—	—
	F	18	27.8	16.3	22.2	11.1	22.2	—	—
Sep.	M	10	—	30.0	20.0	—	50.0	—	—
	F	14	14.3	50.0	21.4	—	14.3	—	—
Oct.	M	20	—	30.0	40.0	—	30.0	—	—
	F	21	—	14.3	33.3	9.5	38.1	4.8	—
Nov.	M	23	—	21.7	13.0	26.1	26.1	13.0	—
	F	25	—	8.0	28.0	20.0	24.0	20.0	—
Dec.	M	25	8.0	12.0	32.0	—	16.o	24.0	8.0
	F	24	—	8.3	29.2	4.1	16.7	29.2	12.5
1971									
Jan.	M	18	38.9	11.1	5.6	—	—	22.2	22.2
	F	19	—	15.8	21.1	—	—	21.1	42.1
Feb.	M	31	38.7	22.6	32.3	—	—	3.2	3.2
	F	30	26.7	20.0	20.0	—	—	3.3	30.0
Mar.	M	19	57.9	21.1	21.1	—	—	—	—
	F	10	80.0	—	20.0	—	—	—	—
May	M	11	—	81.8	18.2	—	—	—	—
	F	10	40.0	—	60.0	—	—	—	—
Jun.	M	8	—	12.5	87.5	—	—	—	—
	F	7	—	28.6	71.4	—	—	—	—
Jul.	M	6	—	—	66.7	33.3	—	—	—
	F	8	—	12.5	75.0	12.5	—	—	—
Aug.	M	16	—	18.8	18.8	50.0	12.4	—	—
	F	22	—	31.8	22.7	27.3	18.2	—	—
Sep.	M	10	—	—	20.0	50.0	30.0	—	—
	F	20	—	10.0	35.0	20.0	30.0	5.0	—
Oct.	M	17	5.9	23.5	11.8	29.4	17.6	11.8	—
	F	19	15.8	10.5	21.1	—	36.8	15.8	—
Nov.	M	22	9.1	—	36.4	—	21.1	27.3	9.1
	F	22	13.6	9.1	13.6	—	13.6	31.8	18.2
Dec.	M	29	20.7	—	10.3	—	6.9	34.5	27.6
	F	25	12.0	4.0	24.0	—	—	28.0	32.0

Samples in Aug. 70 and May-Aug. 71 were from Palk Bay and rest from Gulf Mannar.

a short period, the population as a whole might breed over a longer period of time. However, December and January appeared to be the peak period of spawning since ripe and spent fishes were more common in these months.

Size at first maturity: As stage III comprises spent recovering stages also, individuals of this stage and above have been considered mature. Females and males up to 150 mm size group were all immature. Mature fishes of both sexes were first seen when they were 170 mm and above in sizes. The maturity curve for *T. platystomus* showed that 50% of the females first mature at a size of 230 mm and males at 220 mm (Fig. 9). Both females and males may spawn for the first time when they are two years old. The ratio of mean length at first maturity to the asymptotic length (l_m / L_∞) was found to be 0.43 for females and 0.42 for males.

Fecundity: Total count of all mature ova (group 'c'), destined to spawn in the ensuing spawning season was obtained by total enumeration. A sample of 18 ripe females ranging from 230 to 393 mm in total length was studied. The relation between fecundity and length of fish showed a linear relationship in the logarithmic form (Fig. 10 & 11), which could be expressed as;

$$\log F = -1.5598 + 1.2907 \log L$$

Where, F = fecundity and L = length of fish.

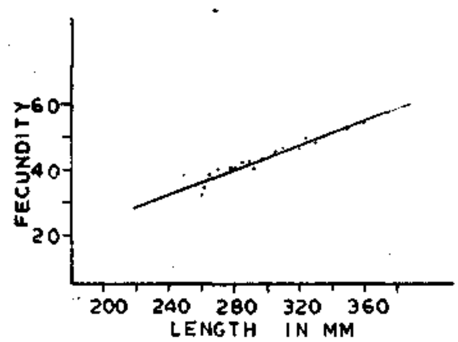

FIG. 10. Fecundity-fish length relationship of *T. platystomus*.

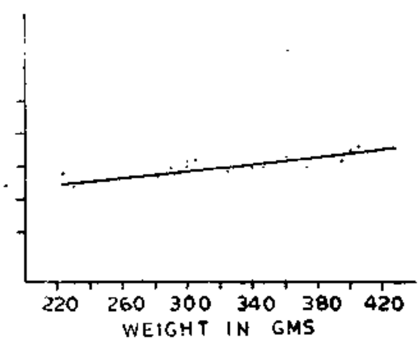

FIG. 11. Fecundity-fish weihgt relationship of *T. platystomus*.

The coefficient r was 0.9167. The length-weight relationship of the female showed the exponential value of 3.532863. This exponential value is higher than that observed in fecundity-length relationship, i.e., 1.2907, and hence it appears that the fecundity increases at a rate less than that of body weight in relation to total length. The regression of fecundity (F) on body weight (W) in the logarithmic form is,

$$\log F = 0.6504 + 0.3817 \log W$$

correlation coefficient r was calculated as 0.7619.

The exponential value of less than unity (0.3817) also confirms the above conclusion.

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