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BIOLOGICAL STUDIES ON THE ANCHOVY, *THRYSSA GAUTAMIENSIS* BABU RAO (PISCES: ENGRAULIDAE)

by

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ABSTRACT

Biology of the anchovy, *Thryssa gautamiensis* BABU RAO, which forms a fishery in the Godavari estuary (East Coast of India) was studied for the three seasons, i.e. 1959-60, 1960-61 and 1961-62. The population pattern was studied during the three seasons by means of montly percentage length frequency curves and fitting normal curves. Length weight studies were made for the three seasons, the best fit equations to express the relationship have been calculated and differences of relationships within seasons have been tested. Relative condition ('Kn') variation studies have been made for the different length groups of the fish for the two sexes. The variations of fecundity in relation to length and weight of fish respectively were studied and the equation to express their relationships have been established. The spawning season and the sizes, of ova at different stages of maturity have been determined by means of ova diameter measurement studies. The food preferences of this species have been ascertained by studying the gut contents and their item wise percentage frequencies in different months.

INTRODUCTION

Thryssa gautamiensis BABU RAO was first described from Godavari estuary (east coast of India) and found to form an important constituent of the fishery of that estuary (BABU RAO 1971). Observations made on the biology of this species from Godavari estuary during the period 1959—'62 are presented briefly in this paper. The estuary is flooded with rain water from the upper reaches from July to September and there will not be any fishing during that period in the estuary; consequently data could not be obtained in that season.

MATERIAL AND METHODS

Samples of *Thryssa gautamiensis* were obtained from the fishermen catches (boat seine, gillnet and small shore seines) at the fishing centers situated on the Gautami branch of the Godavari estuary (Fig. 1). Regular weekly samples were taken at Neelapalli and monthly samples were taken at Bhairavapalem, Balusutippa, Masakapalli and Kotipalli. The analysis of

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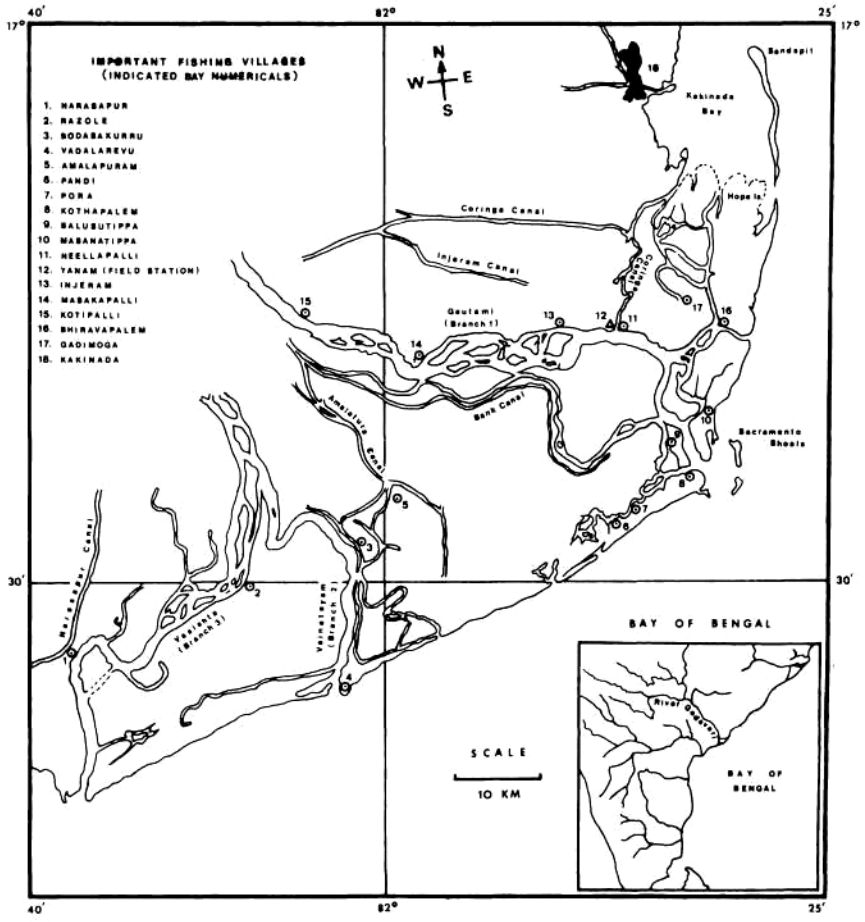

Figure 1. The Godavari estuary.

samples and the methods of study of the different biological aspects were, in general, the same as were followed in the case of *Anodontostoma chacunda* (BABU RAO 1965).

BIOLOGY

Length frequency studies

Length frequency data obtained from the samples were pooled monthwise for the years 1959-'6O, 1960—'61 and 1961—'62 (Table 1). It can be seen that no regular growth pattern is discernable in any of the three years, indicating that spawning period was extended. When normal curves

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TABLE I. Centimeter length groups in different months of the three seasons 1959-'6O, 1960-'61 and 1961-'62.

(A) 1959-1960 Season

Length in CM.	Number of Specimens							
	Nov. 1959	Dec 1960	Jan. 1960	Feb. 1960	March 1960	April 1960	May 1960	June 1960
6				1				5
7				1				14
8				3				20
9				_				6
10		1		_				11
11		-		1		1		6
12				1		1		11
13		1		-	5	6	2	23
14		-		-	2	17	10	11
15	4	2	1	3	_	12	17	8
16	6	6	4	4	_	3	11	3
17	7	1	1	11	-			2
18	5	1	1	2	_			
19	10	_	2	2				
20	8	3	3	2	1			
21	6	5	1	3	2			
22	9	2	1					
23	4	1	7					
24	4		4					
25	1							

(B) 1960 – 1961 Season

Length in CM.	Number of Specimens								
	Oct. 1960	Nov. 1960	Dec. 1960	Jan. 1961	Feb. 1961	March 1961	April 1961	May 1961	June 1961
10								1	1
11	3							2	2
12	12		1			6	3	18	3
13	9	1	-			10	8	22	5
14	4	1	2	4	2	10	21	24	6
15	5	2	10	2	3	10	23	15	6
16	2	18	12	7	3	5	17	4	2
17	-	20	19	4	1	11	15	6	2
18	_	25	11	-	-	7	11	2	-
19	2	14	14	3	2	4	2		-
20	2	8	4	-	3	4	3		1
21	_	3	4	1	6	7	1		1
22	_	1	-		2	4	1		1
23	1	4	1		1	_	1		
24		-				1			
25		1							

Table I continued ***(C)*** **1961-1962 Season**

Length	Number of Specimens								
in CM.	Nov. 1961	Dec. 1961	Jan. 1962	Feb. 1962	March 1962	April 1962	May 1962	June 1962	July 1962
9	1								
10	8								
11	8					1	1		1
12	12					-	-	5	4
13	10					3	2	22	2
14	2				1	6	6	18	8
15	3				8	5	14	12	7
16	5		3		24	8	12	7	4
17	10	2	2	1	23	9	10	7	1
18	14	-	8	4	10	-	6	6	-
19	28	7	27	9	2	2	-		1
20	21	10	10	10	9	3	2		-
21	11	17	7	5	9	4			1
22	9	35	-	3	-	-			2
23	13	36	1	1	4	-			5
24	3	13				1			3
25	3	5							
26		1							

were fitted to the percentage frequency curves of the 1961 '62 samples (HARDING 1949; CASSIE1954), it was found that the frequency curve of each month can be split up into several normal curves indicating the existence of many populations, which were the offspring of broods of different periods (Fig. 2), substantiating the contention that spawning was somewhat prolonged in this species. In general, it is evident from the percentage frequency curves of the three years that majority of adults occur during November February period and majority of juveniles occur in March — July period. Since floods set in the estuary from July onwards and extend up to September October period, this species, along with many other estuarine species, does not form fishery in the estuary during this period. Perhaps many of the estuarine fishes restrict themselves to the river mouth region during the floods, in view of the fact that the estuary is full of fresh water with little salinity (BABU RAO 1964, 1965).

Length weight relationship

Length and weight data were obtained for over 800 specimens during the period 1959 to 1962, covering three seasons. Averages of lengths and weights were obtained for each centimeter length groups (Table IV). Three

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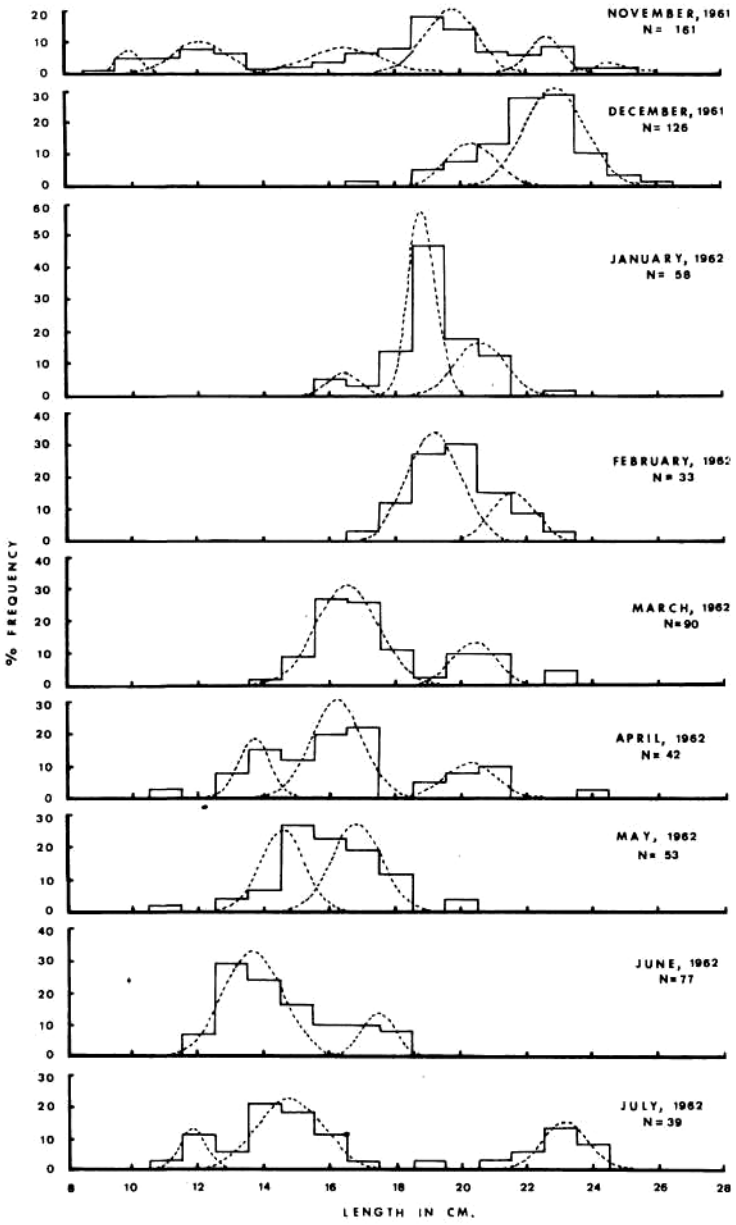

Figure 2. Normal curves fitted to-monthly percentage length frequencies for 1961-'62 season.

Sl No.	1959-'60 season				1960-'61 season				1961-'62 season			
	No of Specimens Studied	**Average of Total length**	**Average observed weight**	**Calculated weight**	**No. of Specimens Studied**	**Average Total length**	**Average observed weight**	**Calculated weight**	**No. of Specimens Studied**	**Average Total length**	**Average observed weight**	**Calculated weight**
1	12	8.46	2.71	2.14	6	11.65	9.58	8.39	2	13.70	14.50	14.22
2	5	9.37	4.30	4.10	29	12.57	11.97	11.23	3	14.53	18.33	17.85
3	9	10.46	6.50	6.03	29	13.46	14.41	14.40	16	15.36	22.25	21.90
4	6	11.38	9.17	8.41	36	14.47	18.14	18.56	30	16.51	27.10	28.31
5	8	12.58	12.89	12.15	35	15.45	22.97	23.17	20	17.45	35.75	34.22
6	11	13.56	15.41	15.77	35	16.52	29.43	28.94	20	18.48	41.40	41.52
7	20	14.54	19.33	19.98	35	17.37	33.37	34.06	30	19.53	48.57	49.83
8	23	15.53	23.76	24.82	35	18.48	41.03	41.60	30	20.43	57.13	57.67
9	24	16.47	30.48	30.02	30	19.41	48.46	48.63	30	21.30	66.30	66.00
10	20	17.35	34.60	35.46	20	20.30	53.70	56.03	30	22.46	78.20	78.14
11	10	18.31	41.40	42.11	20	21.41	66.50	66.20	30	23.38	88.43	88.78
12	13	19.54	51.00	51.65	8	22.48	77.13	76.90	10	24.34	99.00	100.65
13	13	20.38	57.30	58.65	8	23.38	88.13	87.04	5	25.12	113.40	111.15
14	14	21.43	68.64	68.89								
15	12	22.42	82.17	79.14								
16	11	23.36	90.36	89.85								
17	8	24.19	99.25	100.10								

equations were applied to the pooled length weight data to express the length weight relationship (Fig. 3). The equation $W = a + b.L^3$ was found to have the least sum of squared differences between observed and calculated weights (Table II) and hence taken as the equation expressing the lenght-weight relationship in the species. The equations for the individual seasons were calculated (Table III). When the length weight data of the three seasons were subjected to analysis of covariance it was found that the three seasons were not homogenous in expressing the relationship (Table V). The three seasons were taken pairwise and the significance test was applied to see which seasons differ significantly (Table VI). It was found that I960—'61 seasons significantly differs from the rest of the two seasons in having a low regression coefficient. 1959—'60 and 1961—'62 seasons did not differ from one another significantly (Fig. 4). The low regression coefficient in 1960—'61 season indicates a lower rate of increase of weight with length in this season when compared to the other seasons. This might be due to the generally poor occurrence of plankton (which forms the food of this species) during this season than the other two seasons (BABU RAO 1964).

Relative condition ('Kn')

Relative condition values of the specimens for the three seasons were obtained by dividing the observed weight by the calculated weight, which in turn is obtained by applying the respective length-weight equation of each season (LE CREN 1951; PILLAY 1958; BABU RAO 1965).

Monthly geometric mean 'Kn' values were calculated (Table VII) and plotted for the three seasons (Fig. 5). It was found that 'Kn' fluctuates throughout the season; however relatively higher 'Kn' values were obtained during September to January from whence it was found to decrease through February, March and April. From the month of May onwards an increase in the 'Kn' can be noticeable. This indicates that though spawning is prolonged, from September to January, maturing or fully mature specimens occur, intense spawning being taking place from February to April.

Geometric mean 'Kn' values were also obtained for the females at various lengths for the three seasons (Table VIII) and plotted (Fig. 5). It was found that from about 16 cm onwards the 'Kn' values fluctuate till the end. As was shown later, since maturing ovaries have a significant influence on the relative condition of females, it is clear that presence of mature and spent females right from 16 cm onwards, resulted in the fluctuation of 'kn' values from 16 cm onwards. It appears that this species breeds more than once in its life time and that breeding starts from 16 cm onwards. The high 'Kn' values indicating the presence of more number of mature females in the res-

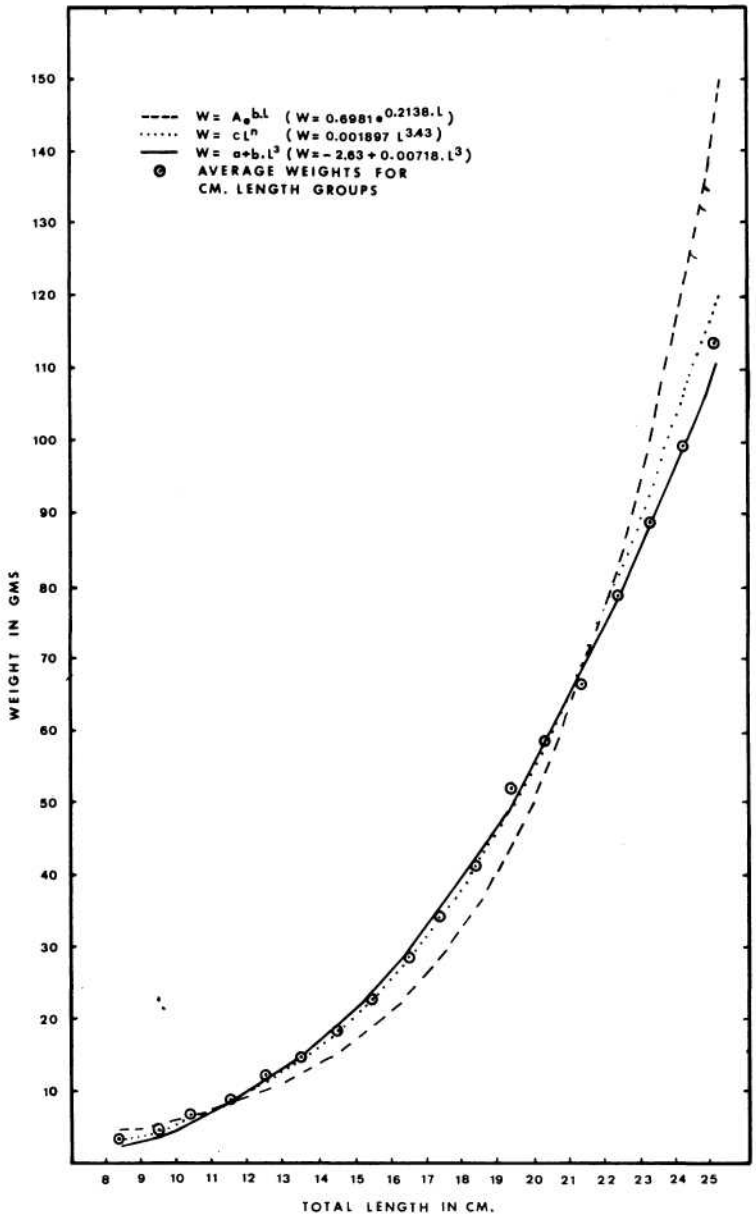

Figure 3. Length-Weight relationship for the pooled data of the three seasons.

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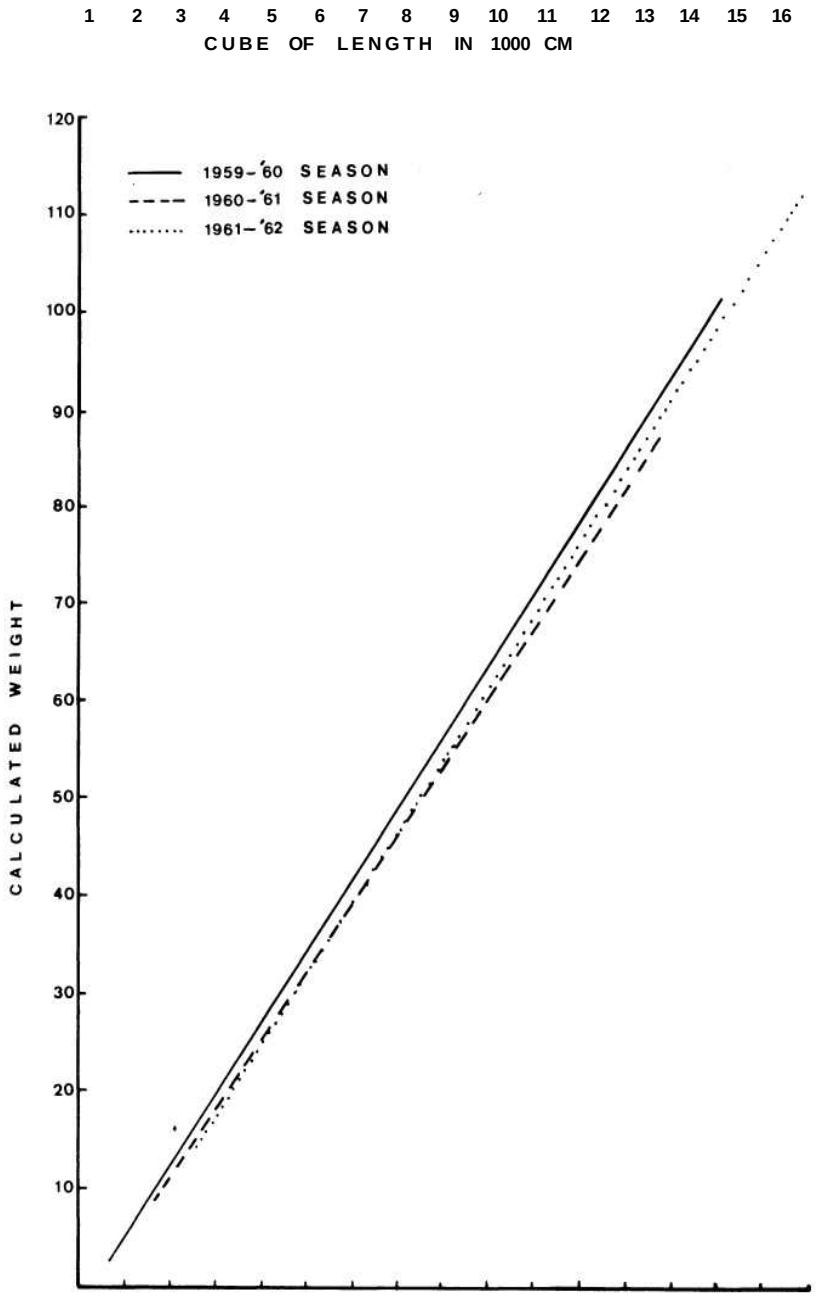

Figure 4. Cube of Length-weight relationship for the three seasons.

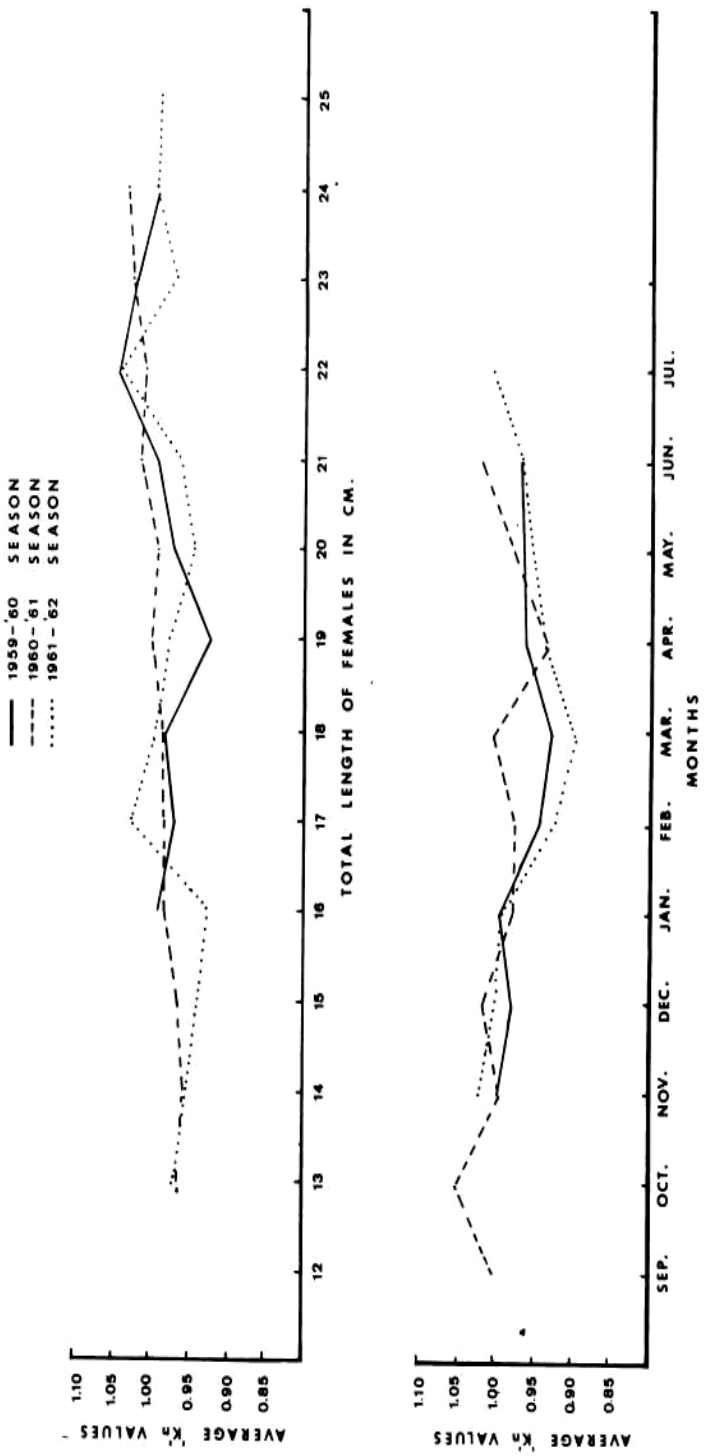

Figure 5. Relative condition ('Kn') variations in different length of females (Upper graph) and in various months (lower graph) in the three seasons.

TABLE II. Sum of squared differences between observed and calculated weights for the length—weight equations.

Equation	$\Sigma (W_o - W_c)^2$
$W = cL^n$ ($W = a.L^b$)	161.8573
$W = Ae^{b.L}$	2,492.2165
$W = a + b.L^3$	16.9751

TABLE III. Equations expressing length and weight of the pooled data and of different seasons

Season	n	Length range in cm.	Equation
Pooled data	808	8 – 25	$W = -2.63 + 0.00718. L^3$
1959 – 60	219	8 – 24	$W = -2.23 + 0.007223. L^3$
1960 – 61	326	11 – 23	$W = -2.57 + 0.006998. L^3$
1961 – 62	264	13 – 25	$W = -4.55 + 0.0073. L^3$

pective length range and the low 'Kn' value indicating the presence of more number of spent females in the respective length range.

Mean relative condition were also calculated for the various maturity stages of the females for the three seasons (Table IX). It can be seen that in all the three seasons relative condition steadily increases from Stage II to Stage VI of maturity through the intermediate stages and suddenly falls in the spent individuals (Fig. 6). Highest relative condition is encountered in

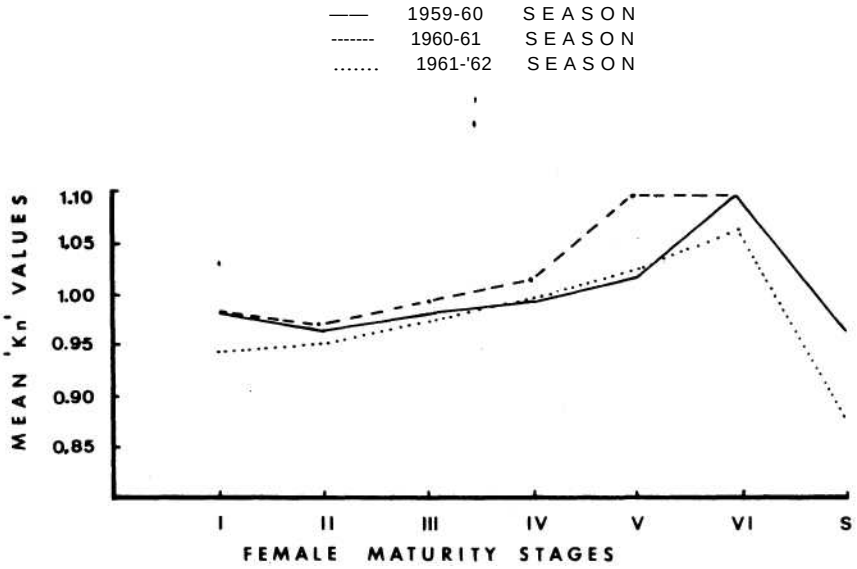

Figure 6. Relative condition ('Kn') variations in different female maturity stages in the three seasons.

TABLE V. Analysis of Covariance of length-weight data of different seasons to test the homogeniety of the relationship.

Seasons	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	D.F	$\sum (X - X)^2$	$\sum (x-x)(y-y)$	$\sum (Y - Y)^2$	**b**	$\sum (x-x)(y-y)$	$\sum 2Y'^2$	**D.F.**
1959-60	16	304,685,100	2,201,321	15,903	0.007223	15,900	3	15
1960-'61	12	161,830,810	1,132,207	7,939	0.006998	7,923	16	11
1961 -'62	12	235,319,500	1,718,063	12,563	0.007300	12,541	12	11
Totals	**40**	**701,835,410**	**5,051,591**	**36,405**	**0.007199**	**36,366**	**39**	**39**

(1) D.F. for unadjusted sums of squares (2) S.S. of V variate (3) Sums of products (4) S.S. of 'y' variate (5) regression Coefficients (7) adjusted sums of squares (8) D.F. for adjusted sums of squares.

	D.F	**Adjusted S.S.**	**Variance**	**F**	**P**	**Significance**
Totals	**39**	**39**				
Seasons	**37**	**31**	**0.8378 (Vi)**	**4.775**	**<0.05**	**Significant**
Difference	**8**	**2**	**4.0000 (V_2)**			

The notation is as given by GOULDEN (1939)

TABLE VI. Test of significance of the difference between regression coefficients between the different seasons, in the length weight relationship.

	Between 1959-'60 and 1960-'61 seasons	Between 1960-'61 and 1961-'62 seasons	Between 1961-'62 and 1959-'6O seasons
Standard error of difference of the regression coefficients	0.00009636	0.0001041	0.00009679
Difference in the regression Coefficients	0.000225	0.000302	0.000077
t	2.335	2.901	0.7956
degrees of freedom	26	22	26
Probability	<0.05	<0.01	>0.10
Significance	Significant	Significant	Not significant

TABLE VII. Mean 'Kn' values (Relative condition) at different months during the three seasons

	1959-'6O season		1960-61 season		1961-'6 2 season	
	n	Mean 'Kn'	n	Mean 'Kn'	n	Mean 'Kn'
September			9	1.0040		
October			35	1.0510		
November	62	0.9988	71	0.9970	108	1.0230
December	21	0.9797	64	1.0170	109	1.0020
January	25	0.9982	20	0.9768	64	0.9926
February	30	0.9445	19	0.9783	31	0.9251
March	11	0.9272	73	1.0040	95	0.8984
April	34	0.9610	88	0.9309	35	0.9358
May	35	0.9668	57	0.9757	54	0.9548
June	42	0.9661	44	1.0200	60	0.9651
July					37	1.0060

TABLE VIII. Mean 'Kn' values (Relative condition) of different length groups of females during the three seasons.

Length range of females in cm.	1959~'6O season		1960- -'61 season		1961- -'62 season	
	n	Mean 'Kn'	n	Mean 'Kn'	n	Mean 'Kn'
12.00- 12.99			4	1.0820		
13.00- 13.99			10	0.9665	3	0.9785
14.00- 14.99			14	0.9598	6	0.9579
15.00- 15.99			23	0.9658	10	0.9421
16.00 - 16.99	4	0.9919	18	0.9819	9	0.9260
17.00- 17.99	3	0.9712	26	0.9847	15	1.0260
18.00- 18.99	8	0.9809	29	0.9858	20	0.9949
19.00 - 19.99	4	0.9262	27	1.0000	57	0.9768
20.00 - 20.99	9	0.9714	17	0.9924	43	0.9488
21.00-21.99	12	0.9911	24	1.0160	41	0.9654
22.00 - 22.99	10	1.0410	11	1.0100	44	1.0040
23.00 - 23.99	11	1.0020	10	1.0240	46	0.9929
24.00 - 24.99	8	0.9913	4	1.0330	17	0.9924
25.00 - 25.99					7	0.9924

TABLE IX. Mean ′Kn′ values (Relative condition) at different female maturity stages during the three-seasons.

Female maturity stages	1959-'60 season		1960-'61 season		1961-'62 season	
	n	Mean 'Kn'	n	Mean 'Kn'	n	Mean 'Kn'
Stage I	8	0.9811	101	0.9826	120	0.9486
Stage II	15	0.9649	75	0.9725	40	0.9504
Stage III	12	0.9828	40	0.9988	42	0.9736
Stage IV	18	0.9922	21	1.0150	50	0.9993
Stage V	9	1.0170	12	1.0970	87	1.0270
Stage VI	6	1.0960	3	1.0970	13	1.0650
Spent	4	0.9656			3	0.8843

Stages V and VI of maturity. It is evident from this that in this species maturity of ovaries plays an important role in the relative condition of the females.

Fecundity

Female specimens in the Stages V and VI of maturity were selected for fecundity studies in the three seasons. Fecundity was estimated by volumetric method (BABU RAO 1965). Total length of fish and total weight of the fish on one hand and fecundity on the other were plotted and the relationship was expressed by a closely fitting curve and a corresponding equation for the three seasons (Table X - XIII, Figs. 7 — 1 2) . The cube equation $F = a + b.L^3$ was found to be suitable for expressing the total length and fecundity relationship and the linear regression equation $F = a + b.W$ was found to be suitable for expressing the weight of the fish and fecundity relationship (Table XIV). It can also be seen from Figure 11 that the females become mature from 16 cm onwards and capable of breeding till they attain a length of about 25 cm. This confirms the conclusions drawn in the relative condition variations study *(op. cit.)* that in females breeding is rather prolonged starting from 16 cm onwards.

Ova diameter measurement studies

Ovarian eggs of the different maturity stages occurring in the various length groups of the species in the 1961- '62 season, were measured and their percentage frequencies were plotted (Fig. 13). It is interesting to note that fully mature specimens (Stage VI) were encountered in various length groups starting from 17 cm group onwards, indicating that the species mature more than once in their life time and growth has no effect on the maturity and spawning of the individuals. This accounts for the ocurrence of various maturity stages from 16—17 cm onwards and since maturity has definite effect on the relative condition in the females (Fig. 6), it also explains the fluctuations in the relative condition from 16 cm onwards, in the females (Fig. 5). This also confirms the earlier observations that spawning is a prolonged process in view of the occurrence of mature ovaries during the different stages of growth.

From Fig. 13 it can also be established the size of ova at different stages of maturity: 0.40 - 0.50 mm in Stage III, 0.60 -0.70 mm in Stage IV, 0.70 — 0.80 mm in Stage V and 1.00 - 1.40 mm in Stage VI. The ova become nearly double the size when they enter into Stages VI from Stage V of maturity, due to the absorption of water; the eggs in Stage V are opaque, solid and light yellowish in colour, while in Stage VI they become

translucent and delicate (due to water content) and resemble the planktonic eggs in all features except in size.

Food

The food preference of this species was ascertained by a study of the percentage frequency of the guts containing various food organisms in different months for the 1960—'61 season (occurrence method). The

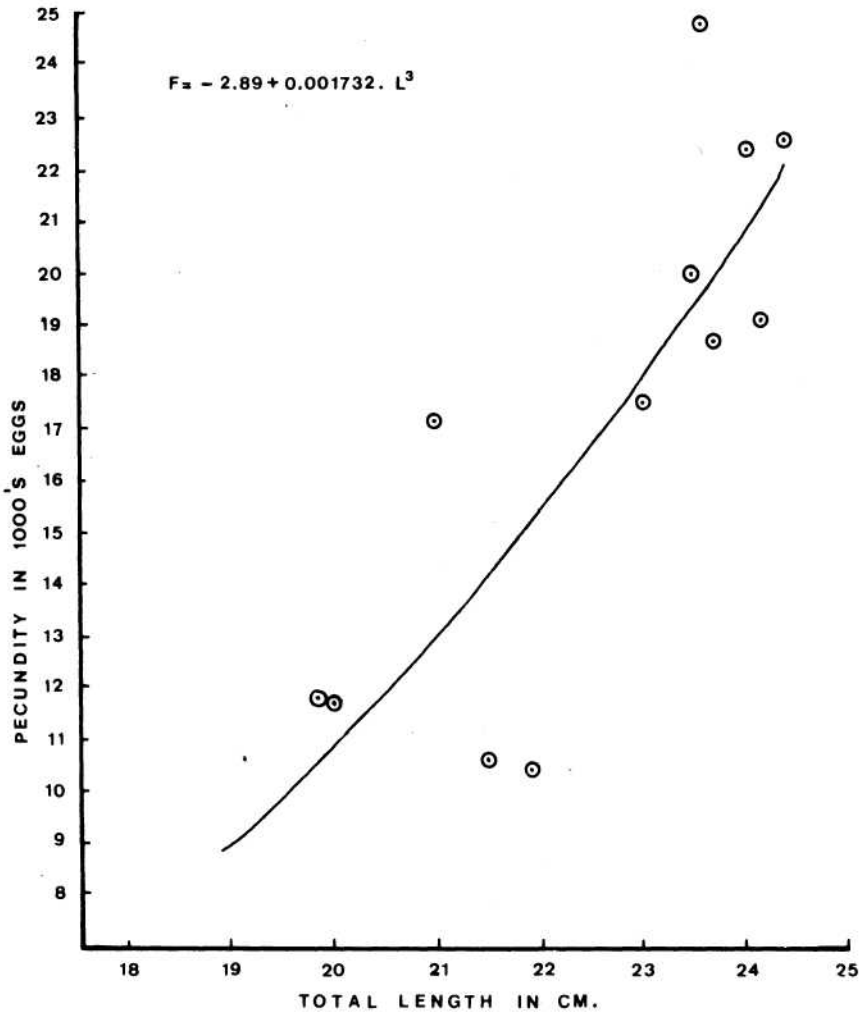

Figure 7. Total length - fecundity relationship for 1959-'60 season.

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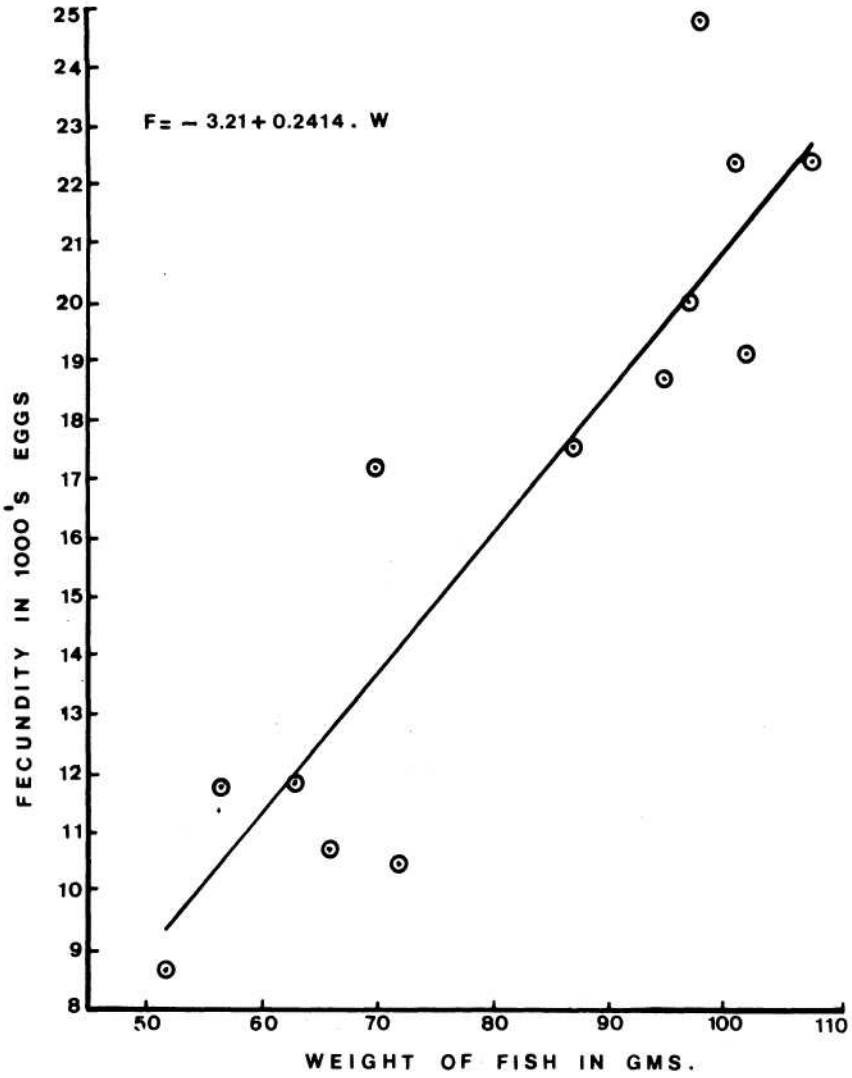
Figure 8. Weight of fish - fecundity relationship for 1959-'60 season.



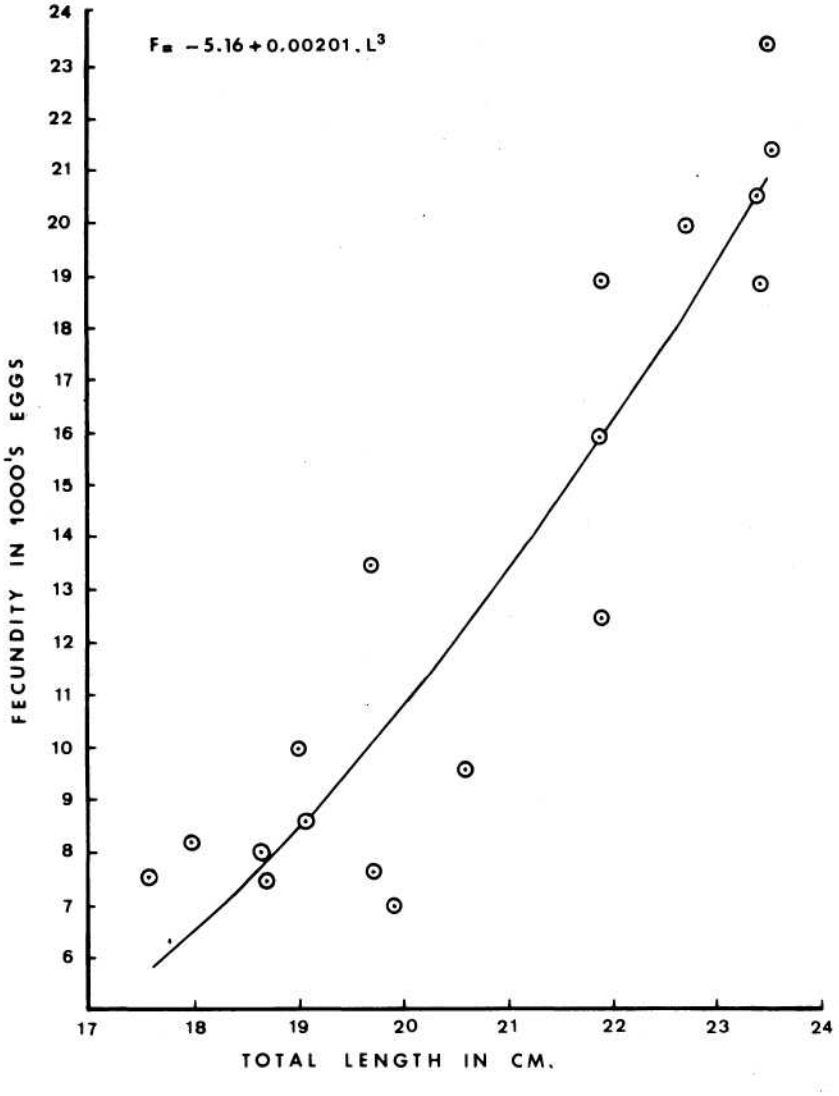


Figure 9. Total length - fecundity relationship for 1960-'61 season.

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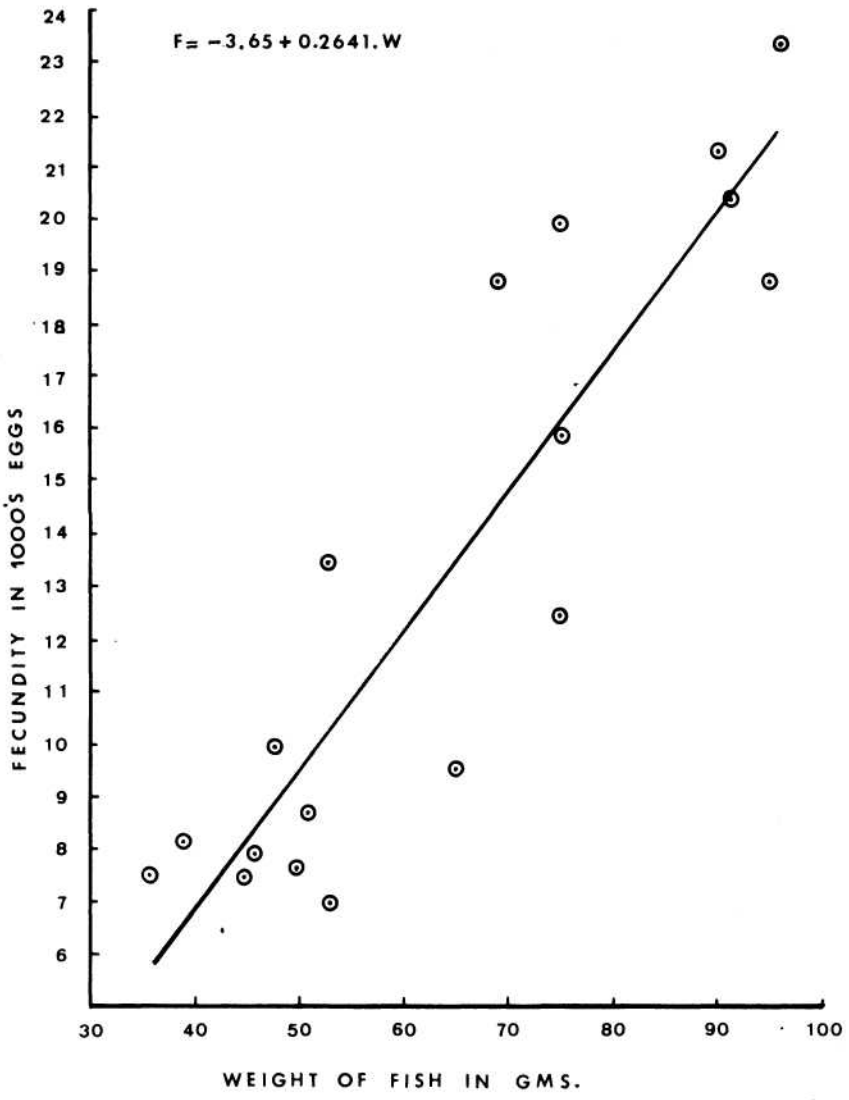

Figure 10. Weight of fish - fecundity relationship for 1960 - '61 season.

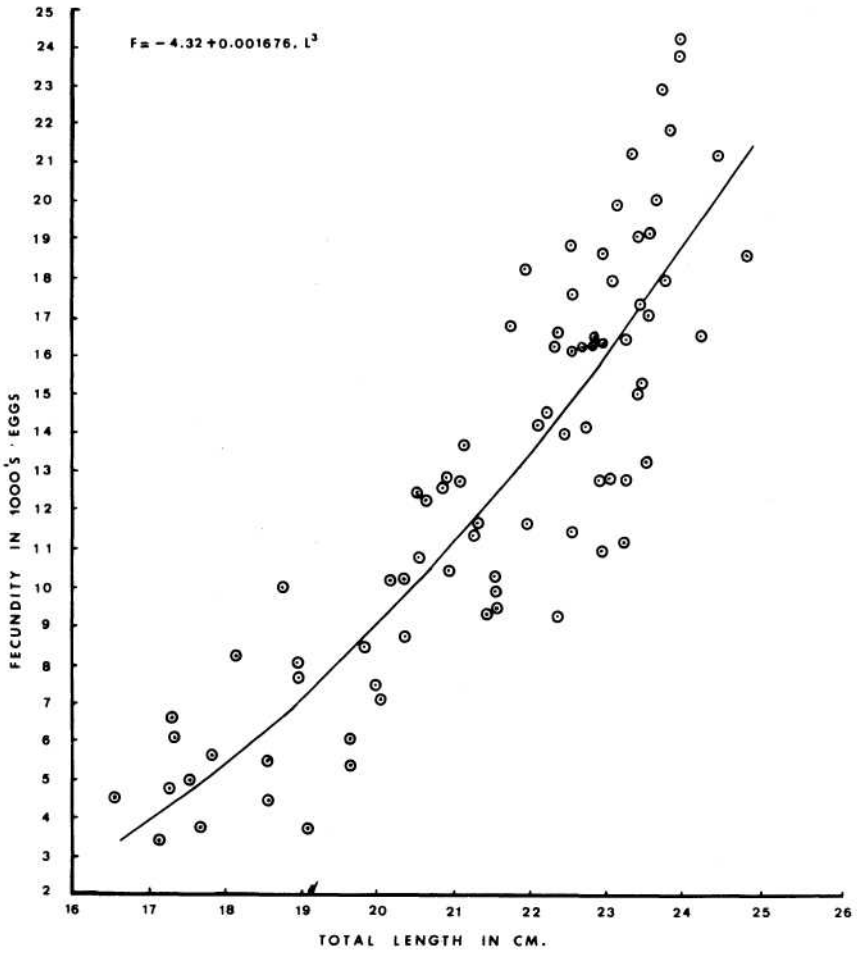

Figure 11. Total length - fecundity relationship for 1961-'62 season.

organisms (in order of maximum occurrence) that constitute the food of this species were prawns, crustacean larvae, fish, young molluscs, copepods, polychaets, isopods and amphipods. Nematode and trematode parasites were also found in the guts. Many guts contained digested material and a few empty guts were also encountered (Table XV). Prawns mainly belonged to the genera *Acetes, Metapeneus* and *Leander.* Crustacean larvae were mainly Megalopa and Lucifer and a few Zoea. Fishes belonged to the genera *Stolephorus, Leiognathus, Sciaena* and *Gerres.*

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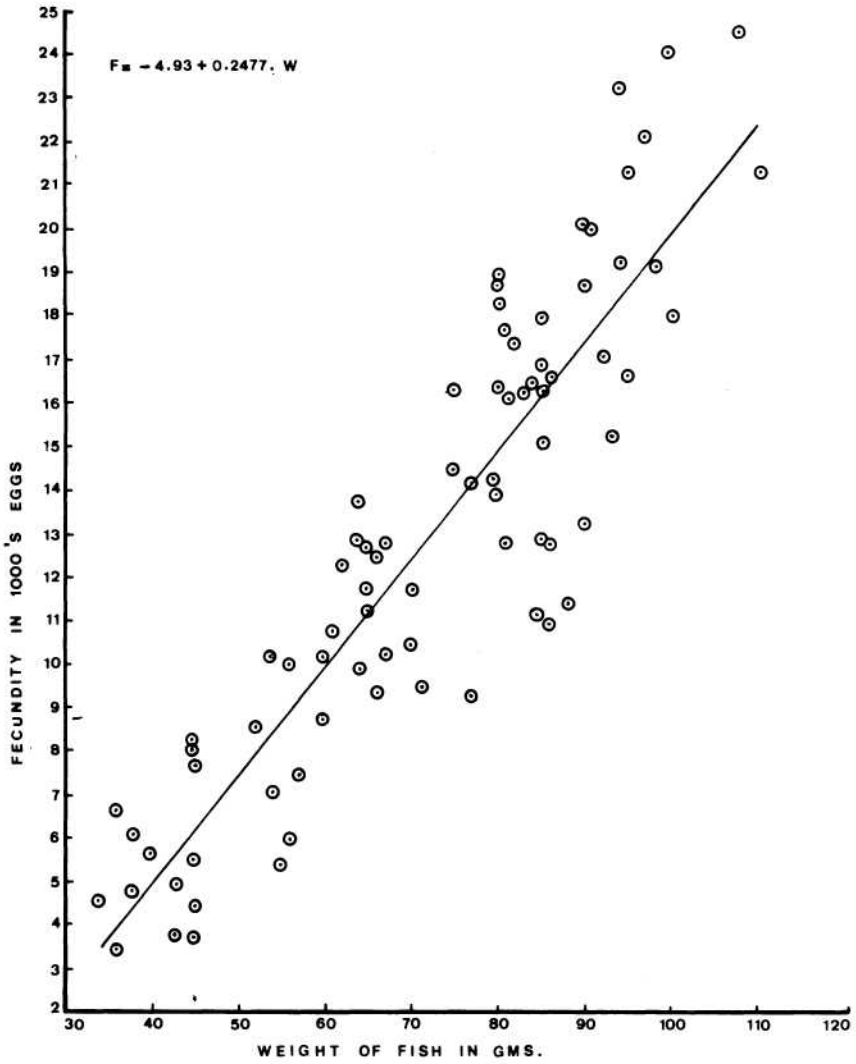

Figure 12. Weight of fish - fecundity relationship in 1961 - '62 season.

In its feeding habits this species seems to be predatory on pelagic organisms since its food mainly constitutes of Crustacean larvae. In view of the relatively few gill rakers, situated at considerable distance from one another, the gills are not suitable to filter the phytoplankton and hence phytoplankton did not form the food item in its guts.

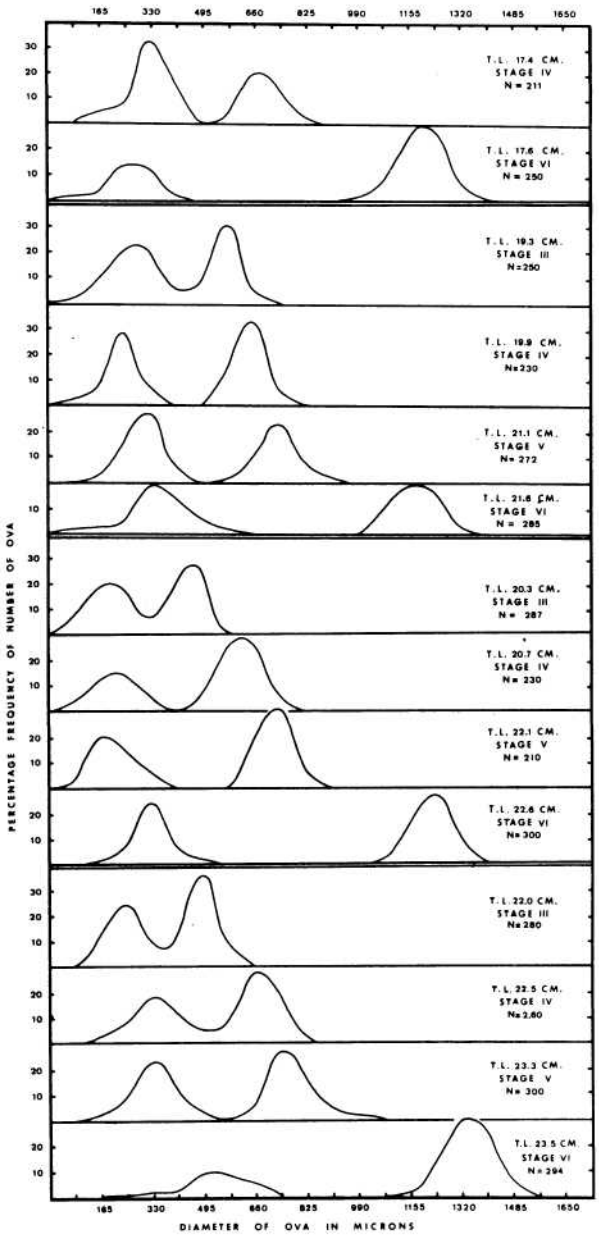

Figure 13. Percentage frequency **curves** of **the** ove diameters of the **various** female maturity stages in fishes **of different** lengths **in the** 1961-'62 **season.**

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TABLE X. Observed and calculated fecundity in fishes of different lengths and weights for the 1959-'60 season

S. .No.	Total length	Fecundity		S No	Weight of fish	Fecundity	
	in cm.	Observed	Calculated		in gms.	Observed	Calculated
1.	18.90	8,670	8,800	1.	52	8,670	9,340
2.	19.90	11,810	10,770	2.	57	11,710	10.550
3.	20.00	11,710	10,970	3.	63	11,810	12,000
4.	21.00	17,200	13,140	4.	66	10,660	12,720
5.	21.50	10,660	14,320	5.	70	17,200	13,690
6.	21.90	10,430	15,300	6.	72	10,430	14,170
7.	23.00	17,590	18,150	7.	87	17,590	17,790
8.	23.50	20,040	19,600	8.	95	18,730	19,720
9.	23.60	24,830	19,870	9.	97	20,040	20,210
10.	23.70	18,730	20,140	10.	98	24,830	20,440
11.	24.00	22,400	21,040	11.	101	22,400	21,170
12.	24,15	19,140	21,490	12.	102	19,140	21,410
13.	24.35	22,560	22,120	13.	107	22,560	22,620

TABLE XL Observed and calculated fecundity **in fishes** of different lengths and weights for the 1960-'61 season.

S. .No.	Total length	Fecundity		S No	Weight of fish	Fecundity	
	in cm.	Observed	Calculated		in gms.	Observed	Calculated
1.	17.60	7,500	5,800	1.	36	7,500	5,860
2.	18.00	8,100	6,560	2.	39	8,100	6,650
3.	18.70	7,480	7,980	3.	45	7,480	8,240
4.	18.70	7,920	7,980	4.	46	7,920	8,500
5.	19.00	9,960	8,630	5.	48	9,960	9,030
6.	19.10	8,630	8,850	6.	50	7,610	9,550
7.	19.70	7,610	10,210	7.	51	8,630	9,820
8.	19.70	13,430	10,210	8.	53	6,990	10,350
9.	19.90	6,990	10,680	9.	53	13,430	10,350
10.	20.60	9,520	12,420	10.	65	9,520	13,520
11.	21.90	12.480	15,950	11.	69	18,880	14,580
12.	21.90	15,930	15,950	12.	75	12,480	16,160
13.	21.90	18,880	15,950	13.	75	15,930	16,160
14.	22.70	19,950	18,350	14.	75	19,950	16,160
15.	23.40	18,860	20,580	15.	90	21,360	20,120
16.	23.40	20,480	20,580	16.	91	20,480	20,380
17.	23.50	21,360	20,940	17.	95	18,860	21,440
18.	23.50	23,370	20,940	18.	96	23,370	21,710

TABLE XII. Observed and calculated fecundity in fishes of different lengths for the 1961-'62 season.

Sl..No.	Total lenght	Fecundity		S.No.	Total length	Fecundity	
	in cm.	Observed	Calculated		in cm.	Observed	Calculated
1.	16.60	4,510	3,350	42.	22.30	14,450	14,260
2.	17.20	3,400	4,210	43.	22.40	9.230	14.500
3.	17.30	4,710	4,350	44.	22.40	16,280	14,500
4.	17.40	6,030	4,500	45.	22.40	16,530	14,500
5.	17.40	6,600	4,500	46.	22.50	13,950	14,770
6.	17.60	4,920	4.820	47.	22.60	11,400	15,020
7.	17.70	3,760	4,970	48.	22.60	16.100	15,020
8.	17.90	5,600	5,290	49.	22.60	17,640	15,020
9.	18.20	8,210	5,780	50.	22.60	18,900	15.020
10.	18.60	4,460	6,460	51.	22.70	16,200	15,280
11.	18.60	5,500	6,460	52.	22.80	14,180	15,540
12.	18.80	10,000	6,820	53.	22.80	16,280	15,540
13.	19.00	7,050	7,170	54.	22.80	16,330	15,540
14.	19.00	8,030	**7,170**	55.	22.90	16,290	15,800
15.	19.10	3,720	7,360	56.	23.00	10,930	16,070
16.	19.70	5,360	8,490	57.	23.00	12,750	16,070
17.	19.70	6,000	8,490	58.	23.00	18,700	16,070
18.	19.90	8,520	8,890	59.	23.10	12,780	16,330
19.	20.00	7,430	9,090	60.	23.10	17,980	16,330
20.	20.10	7,040	9,290	61.	23.20	19,950	16,600
21.	20.30	10,130	9,700	62.	23.30	11,180	16,880
22.	20.40	8,750	9,900	63.	23.30	12,860	16,880
23.	20.40	10,140	**9,900**	64.	23.30	16,470	16,880
24.	20.60	10,730	10,330	65.	23.40	21,270	17,190
25.	20.60	12,410	10,330	66.	23.50	15,080	17,430
26.	20.70	12,290	10,550	67.	23.50	15,210	17,430
27.	20.90	12,690	10,980	68.	23.50	17,390	17,430
28.	21.00	10,450	11,200	69.	23.50	19,130	17,430
29.	21.00	12,780	11,200	70.	23.60	13,260	17,710
30.	21.10	12,730	11,420	71.	23.60	17,080	17,710
31.	21.20	13,700	11,640	72.	23.60	19.200	17,710
32.	21.30	11,200	11,870	73.	23.70	20,020	17,980
33.	21.30	11,700	11,870	74.	23.80	18,000	18,270
34.	21.50	9,300	12,330	75.	23.80	23.200	18,270
35.	21.60	9,440	12,580	76.	23.90	22,100	18,560
36.	21.60	9,900	12,580	77.	24.00	24,030	18,840
37.	21.60	10,230	12,580	78.	24.00	24,530	18,840
38.	21.80	16,800	13,050	79.	24.30	16,570	19,720
39.	22.00	11,680	13,520	80.	**24.50**	21,230	20,330
40.	22.20	18,290	13,520	81.	24.00	18,700	21,550
41.	22.20	14,150	14,020				

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TABLE XIII. Observed and calculated fecundity in fishes of different weights for the 1961-'62 season.

S.No.	Weight of fish in gms.	Fecundity Observed	Fecundity Calculated	S.NO.	Weight of fish in gms.	Fecundity Observed	Fecundity Calculated
1.	34	4,510	3,490	42.	77	14,150	14,130
2.	36	3,400	3,990	43.	80	13,950	14,880
3.	36	6,600	3,990	44.	80	14,180	14,880
4.	38	4,710	4,480	45.	80	16,330	14,880
5.	38	6,030	4,480	46.	80	18,290	14,880
6.	40	5,600	4,980	47.	80	18,700	14,880
7.	43	3,760	5,720	48.	80	18,900	14,880
8.	43	4,920	5,720	49.	81.	12,750	15,120
9.	45	3.720	6.210	50.	81	16.100	15.120
10.	45	4,460	6,210	51.	81	17,640	15,120
11.	45	5,500	6,210	52.	82	17,390	15,380
12.	45	7,650	6,210	53.	83	16,280	15,620
13.	45	8,030	6,210	54.	84	16,470	15,870
14.	45	8,210	6,210	55.	85	11,180	16,120
15.	52	8,520	7,940	56.	85	12,860	16,120
16.	54	7,040	8,450	57.	85	15.080	16,120
17.	54	10,140	8,450	58.	85	16.200	16,120
18.	55	5,360	8,690	59.	85	16,290	16,120
19.	56	6,000	8,940	60.	85	16,800	16,120
20.	56	10,000	8,940	61.	85	17,980	16,120
21.	57	7,430	9,180	62.	86	10,930	16,360
22.	60	8,750	9,930	63.	86	12,780	16,360
23.	60	10,130	9,930	64.	86	16,530	16,360
24.	61	10,170	10,170	65.	88	11,400	16,860
25.	62	12,290	10,430	66.	90	13,260	17,350
26.	64	9,900	10,920	67.	90	18,700	17,350
27.	64	12,780	10,920	68.	90	20,020	17,350
28.	64	13,700	10,920	69.	91	19,950	17,600
29.	65	11,200	11,170	70.	92	17,080	17,850
30.	65	11/700	11,170	71.	93	15,210	18,100
31.	65	12,690	11,170	72.	94	19,200	18,350
32.	66	9,300	11,410	73.	94	23.200	18,350
33.	66	i2,410	11,410	74.	95	16,570	18,350
34.	67	10,230	11,660	75.	97	21,270	18,600
35.	67	12,730	11,660	76.	98	22,100	19,090
36.	70	10,450	12,410	77.	98	19,130	19,340
37.	70	11,680	12,410	78.	100	18,000	19,340
38.	71	9,440	12,650	79.	100	24,030	19,840
39.	75	14,450	13,650	80.	108	24,530	21,810
40.	75	16,280	13,650	81.	110	21,230	22,310
41.	77	9,230	14,130				

TABLE XIV. Equation expressing the relationship between total length and weight of the fish on one hand and fecundity on the other, in the three seasons.

Season	n	Equation	n	Equation
1959 -'60	13	F = -2.89 + 0.001732. L^3	13	F = -3.21+0.2414. W
1960 -'61	18	F = -5.16 +0.00201. L^3 =	18	F = -3.65 +0.2641. W
1961 -'62	81	F -4.32 + 0.001676. L^3	81	F = _4.93 + 0.2477. W

SUMMARY

Biology of the anchovy *Thryssa & autamiensis* in the Godavari estuary for the three seasons 1959-'6O, 1960—'61 and 1961—'62, was studied. Percentage length frequency curves for the various months of the three seasons have shown that majority of adults occur during November - February period and majority of juveniles occur in March — July period. When normal curves were fitted to the 1961-'62 data, it was found that in each month there were several normal curves indicating the existence of many populations, which were the offspring of broods of different periods.

Length-weight studies for the three seasons have shown that the best fit equation to express the two factors was $W = a + b.L^3$. Application of analysis of covariance to the length-weight data of the three seasons has revealed that 1960—'61 season significantly differed from the rest of the two seasons in having a low regression coefficient.

Relative condition ('Kn') variation studies have shown that 'Kn' values were higher during September to January from whence it decreased through February to April; from May onwards and increase of 'Kn' was recorded. Among female individuals 'Kn' was found to fluctuate from 16 cm onwards to the end. Since it was shown that maturing ovaries have a significant influence on the 'Kn' values of the females, this fluctuation from 16 cm onwards might be due to the maturity and spawning, in the females, which start after 16 cm onwards.

Variations of fecundity with total length and weight of the fish were studied for the three seasons; the equations $F = a + b.L^3$ and $F = a + b.W$ were found to express the relationship between fecundity on one hand and total length and weight of the fish respectively on the other. Mature specimens were encountered after 16.0 cm onwards.

Ova diameter measurement studies for the 1961-'62 season have shown that fully mature specimens were found to occur from 17 cm to 24 cm indicating prolonged spawning in the species. The size of ova at Stage

TABLE XV. Monthly percentage frequencies of the guts containing the listed food components for the 1960—'61 season.

Name of the food item	Sept. 1960 n = 10	Oct. 1960 n = 31	Nov. 1960 n = 85	Dec. 1960 n = 46	Jan. 1961 n = 23	Feb. 1961 n = 23	March 1961 n = 20	April 1961 n = 12	May 1961 n - 30	June 1961 n= 16	Average percentage for the season
Prawns	20.0	26.0	48.2	47.8	40.0	34.8	30.0	33.3	56.7	68.8	30.9
Megalopa	80.00	—	23.5	32.6	55.0	8.7	5.0	—	—	—	15.6
Lucifer	—	3.2	2.4	2.2	—	—	—	—	10.0	6.3	1.8
Other Crustacean larvae	—	_	—	—	—		10.0	_	_		0.8
Fish	10.0	26.0	22.4	17.4	20.0	13.0	10.00	25.0	23.3	25.0	14.6
Young Gastropods	—	—	-	—	-	4.3	—	16.7	6.7	—	2.1
Young Bivalves	—	-	-	—	-	—	-	8.3	26.7	6.3	3.2
Copepods	—	13.0	-	2.2	—	4.3	-	—	6.7	_	2.0
Polychaetes	—	3.2	—	-	—	-	—	—	—	6.3	0.7
lsopods	—	—	7.1	2.2	—	—	—	—	-	—	2.6
Amphipods	-	6.5	-	—	—	—	—	—	—	—	1.8
Digested material	—	16.1	15.3	4.3	10.0	34.8	55.0	8.3	13.3	18.8	13.4
Parasites											
Nematodes	—	6.5	1.5	—	—	_	_	16.7	3.3	6.3	2.6
Trematodes	10.0	9.7	4.7	4.3	_	13.0	5.0		6.7		4.1
Empty Guts	—	22.6	2.4	2.2	10.0	13.0	5.0	33.3	3.3		7.0

III of maturity was 0.40 - 0.50 mm, at Stage IV 0.60 - 0.70 mm, at Stage V 0.70 0.80 mm and at Stage VI 1.00 - 1.40 mm.

A study of the percentage frequency of the guts containing various food organisms in different months for 1960-'61 season has shown that the species prefers the following food organisms in the order mentioned: prawns, crustacean larvae, fish, young molluscs, copepods, polychaets, isopods and amphipods.

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