MATURITY, SPAWNING AND FECUNDITY OF CATFISH *TACHYSURUS TENUISPINIS* (DAY)

S. S. DAN

Waltair Research Centre of CMFR Institute, Waltair.

ABSTRACT

Fecundity in *Tachysurus tenuispinis* of size range 28.5-42.4 cm varied from 29 to 82. It increased with increasing size. The linear relationship between weight and fecundity was more valid than that of length and fecundity. The fish breed once a year during May-September. The minimum size at first maturity was 27.5 cm total length. The females dominated the commercial catch and the male: female ratio was 1:1.79. Parental care noticed in males is described.

INTRODUCTION

Catfishes form an important fishery along the north-east coast of India contributing 20.8% of the demersal-fish catches (Sekharan et al. 1973) and about 4% of the annual fish landings of the Andhra coast (Anon 1972). *Tachysurus tenuispinis* alone forms 60.7% of the total catfish catches along the Andhra coast (Sekharan 1973). The depth distribution of the catfishes along the north-western part of the Bay of Bengal (Sekharan 1973) and the age and growth of this species (Dan 1974a) have been studied. The present investigation deals with the fecundity and breeding habits of *T. tenuispinis*.

MATERIAL AND METHODS

503 fish, collected from the landings of the Government of India trawlers operating off Visakhapatnam during March 1973 to February 1974, formed the material for this study. The total length, weight, sex and maturity of the fish were recorded and their gonads preserved in 10% formalin for ova-diameter measurements and study of fecundity. The preserved ovaries were weighted to an accuracy of 10 mg. The diameters of ova of 0.5 mm and above were measured with vernier calipers to an accuracy of 0.01 mm and those less than 0.5 mm with ocular micrometer, each division measuring 0.016 mm. The procedures adopted were basically similar to those suggested by Hickling and Rutenberg (1936), DeJong (1940) and Prabhu (1955, 1956). For fecundity, total count of all the fully matured eggs were taken as they would be liberated in the succeding spawning season.

MATURITY

Stages of Ova

Mature eggs of *T. tenuispinis* were large, attaining a size of about 13.5 mm in diameter, with heavy yolk deposit. The mature ovaries contained ova of all stages of maturity. The following classification, which was in close agreement with that of Graham (1924), Hickling (1930), Hickling and Ruthenberg (1936) was found convenient for the present study.

Stage-I (Immature ova): Ova transparent with distinct nucleus and devoid of any yolk deposition, and varying in size from 0.03 to 0.07 mm.

Stage-II (Maturing): Small, transparent, yolk deposition started as a central semitransparent portion. Varies from 0.07 to 0.25 mm.

Stage-III (Maturing): Small, 0.25 to 0.60 mm, centre fully yolked and opaque, periphery transparent.

Stage-IV (Mature): Opaque and tully yolked, but still contained in the follicles. The size ranges from 0.6 to 3.5 mm.

Stage-V (Fully matured): Large, translucent, burst free from the follicles, the diameter range being 4.0-10.5 mm.

Stage-VI (Ripe): Free and large eggs, a clear transparent portion has appeared at one side; ready for liberation. The size ranges from 10.5 to 13.5 mm.

Stages of Ovary

Seven stages of maturity, similar to those recommended by International Council for the Exploration of the Sea (Wood 1930) were recognised.

Stage-I: Small, slender, transparent, ovary occupying less than 1/3 of the body cavity. Ova not visible to the naked eye, having a maximum diameter of 0.20 mm with a peak at 0.00-0.05 mm.

Stage-II: Ovary slightly enlarged and occupying less than 1/3 of the body cavity. Majority of ova still transparent and not visible to the naked eye. Yolk deposition has commenced in larger ova. Most advanced ova measure 0.30 mm is diameter with a mode at 0.15-0.20 mm.

Stage-III: Ovary further enlarged but still occupies less than 1/3 body cavity. The ova are not opaque but just visible to the naked eye. The most advanced ova measure 0.60 mm with a mode at 0.40-0.45 mm.

Stage-IV: Enlarged ovary occupying 1/3 of the body cavity, ova white and completely opaque. Most advanced ova measure 3.5 mm in diameter with a peak at 1.5-2.0 mm.

Stage-Va: The ovary larger than stage IV, yellowish in colour, occupying more than 1/3 but less than 1/2 of body cavity. Most advanced ova measure 6.0 mm with a mode at 4.0-4.5 mm.

Stage-Vb: The ovary further enlarged occupying between 1/2 to 3/4 of body cavity, and yellowish in colour. The most advanced ova measure 7.5 mm with a mode at 6.0-6.5 mm.

Stage-Vc: Very large ovary, yellow in colour occupying 3/4 or more of body cavity. The most advanced ova attain 11.0 mm in diameter with a mode at 9.0-9.5 mm.

Stage-VI: Ovary occupies almost the whole of the body cavity and is deep yellow in colour. The most advanced ova have a size of 13.5 mm with a mode at 12.0-12.5 mm.

Stage-VII: Spent ovary; flabby and contracted.

Ova-diameter frequency

In Fig. 1, curves A, B, C, D, E, F, G and H represent the ova-diameter frequencies in maturity stages I, II, III, IV, Va, Vb, Vc and VI respectively.

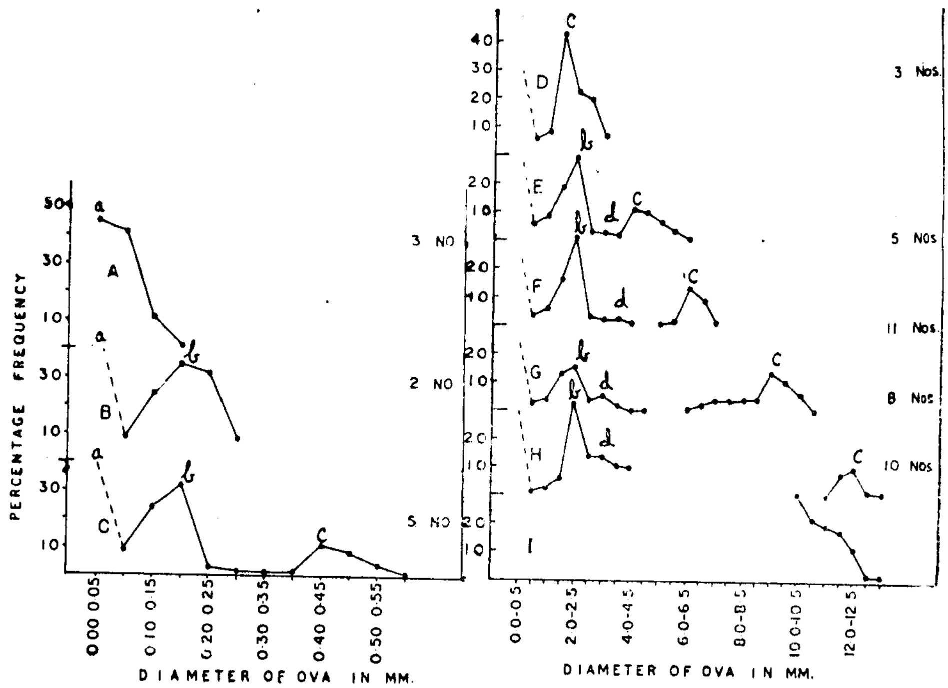

FIG. 1. Frequencies of ovadiameters in immature ovaries (figure left) and mature ovaries (figure right) of *T. tenuispinis*. In the left figure curves A, B, and C represent ovaries in stage I, II and III respectively. In right figure curves D, E, F, G, and H, represent ovaries in stages IV, Va, Vb, Vc and VI respectively. Curve I represents frequency of 72 eggs collected from fish ranging in size from 27.8 to 34.5 cm. The numbers at extreme right in each figure represent the number of ovaries taken into consideration.

In curve A, there is only one mode a at 0.00-0.05 mm representing ova of stage I. In curve B (Stage II ovary) besides the mode a of immature ova, another mode b representing stage II ova has separated out at 0.15-0.20 mm from the general stock. In curve C a new mode c at 0.40-0.45 mm representing stage III ova is seen. With advance in maturity stage, c shifts to the right and stands at 12.0-12.5 mm in stage VI ovary. Ovaries in stages Va, Vb, Vc and VI all have two additional modes in respect of ova-diameter, namely b and d. Perhaps b belongs to the same group as the batch designated b in curve B and C. However, it may be noted that the single batch of maturing and ripe ova represented by mode c is completely separated from the smaller ova, in stages Vb, Vc and VI. It is, therefore, quite probable that spawning in an individual is restricted to a definite perod.

Relative Condition Factor

The formula Kn = $W/\hat{W}.100$, where Kn = Relative condition factor, W = observed weight and $\hat{W}$ = weight calculated from the equation for length-weight relationship as suggested by Le Cren (1951) has been used. The length-weight relationship worked out earlier is given by the formula,

Log W = -4.4507 + 2.7816 Log L, for females.

In the present study 182 females have been considered. The average relative condition factor through the various months of the year as well as in relation to size are presented in Fig. 2. The monthly average value of Kn

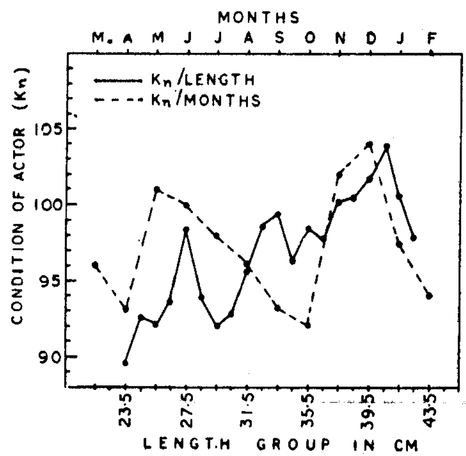

FIG. 2. Mean Kn values in *T. tenuispinis* during various months and various sizes.

increase up to May followed by a steep fall in subsequent months. This fall is probably indicative of the onset of spawning and so the month of May may mark the commencement of spawning in *T. tenuispinis*. The average Kn value increased sharply again in November and attained a peak in December followed by a sharp fall in January. Preliminary studies on the food and feeding of this species (Dan, MS) indicated that the feeding intensity was at its highest in November. So the second rise in Kn value was probably due to high feeding intensity after breeding season. The relative condition factor in relation to size shows three peaks at 27.5, 33.5 and 40.0 cm. The peak at 27.5 cm indicates the onset of maturity.

Spawning

Specimens in stage V and VI of maturity condition (Table 1) were observed during the period May to September. Specimens in stage VII were observed in June. This indicated May-September is the period of spawning of *T. tenuispinis*. During this period males exhibit parental care and carry fertilised eggs in their mouths. The seasonal variation in condition factor also supports the view that the period of spawning commences in May.

TABLE 1. *The Percentage frequency distribution of maturity stages in various month of the year* 1973-74.

Months	Total No. of females examined	Maturity stages						
		I	II	III	IV	V	VI	VII
March 73	-3	30.77	38.46	30.77				
April	4	25.00	50.00	25.00				
May	49		32.65	26.53	34.69	2.04	4.08	
June	33		3.03	12.12	18.18	57.58	3.03	6.07
July	51		56.86	23.52	29.80	5.88	3.92	
August	37		89.29	2.70	5.41	—	2.70	
September	24		83.33	8.33	—	4.17	4.17	
October	25		100.00					
November	19		100.00					
December	5		100.00					
January 74	4	25.00	75.00					
February	17	70.59	29.41					

Minimum size at first maturity

For this study too, only females were considered, their total number being 279. The number of mature specimens in stages IV-VI were noted in each cm-group and scaled down to percentages. The results are presented in Fig. 3. The percentage of mature fish increased gradually up to the size group of 31 cm (94%) and above 31 cm all were mature. The size at which 50% are mature was 27.5 cm, which confirms the conclusion drawn regarding the onset of maturity from the studies on relative condition factor in relation to size.

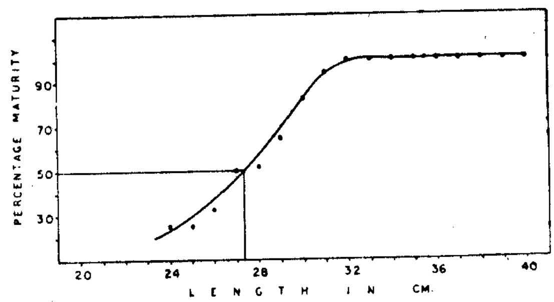

FIG. 3. Percentage-frequency distribution of mature individuals of *T. tenuispinis* in relation to size.

FECUNDITY

The average fecundity, average number of ova per gram-weight of body and the number of ova per gram-weight of the ovary in respect of each group of fish are given in Table 2. Ovaries in stage V only were considered for this study. The maximum fecundity was 82 from a fish measuring 38.6 cm in total length and the minimum 29 from a fish 34.6 cm long. There was an increase in fecundity with increase in size of the fish. Fecundity in relation to unit weight of fish, however, shows an inverse relationship, Thus, although the older fish are more fecund it is the younger fish that produce more ova per gram-weight of body. On an average, 0.1214 ova are produced per gram-weight of body.

TABLE 2. *Average of fecundity counts at various length ranges.*

Frequency	Length range in cm.	Average length of the fish in cm.	Average of the fish in g.	Average of the ovary in g.	Average No. ova	No. of ova per wt. of body	No. of ova per wt. of ovary
1	27.0-28.9	28.5	220	27.630	31	0.1419	1.4331
1	29.0-30.9	29.0	225	27.830	40	0.1777	1.4373
3	31.0-32.9	32.2	347	27.805	46	0.1325	1.6543
12	33.0-34.9	34.2	386	26.914	48	0.1243	1.7834
10	35.0-36.9	35.7	470	33.700	58	0.1234	1.7210
8	37.0-38.9	37.9	545	33.532	66	0.1211	1.9068
5	39.0-40.9	39.9	638	35.842	69	0.1081	1.9251
4	41.0-42.9	42.0	727	38.540	74	0.1017	1.9200

Fecundity was plotted against length and also weight (Fig. 4, A and B). It was seen by inspection that a straight line or a curve could describe the data and, therefore, the following formulae (Clark 1937, Simpson 1951, Lehman 1953, MacGregor 1957, Kandler and Dutt 1958, Dan 1974b) were fitted by the method of least squares.

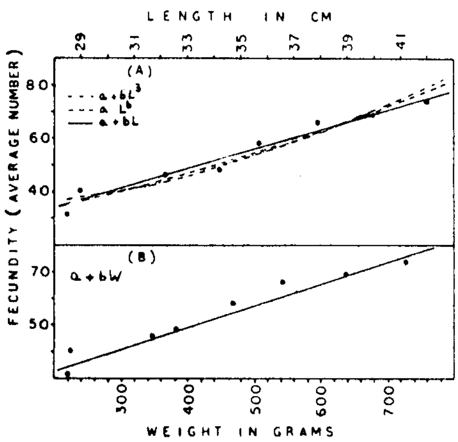

FIG. 4. Regression lines relating fecundity to (A) length and (B) weight of *T. tenuispinis.*

(i) $F = f(L) = a + bL$

(ii) $F = f(L^3) = a + bL^3$

(iii) $F = f(L^b) = a \,.\, L^b$

$\log F = \log a + b.\log L$

(iv) $F = f(W) = a + b.W$

Where F = fecundity; L = length of the fish; W = weight of the fish and a and b are constants.

The equations obtained are given below:

(i) $F = -51.5515 + 3.0244\ L$

(ii) $F = 18.0265 + 0.000804\ L^3$

(iii) $F = 0.03661\ L^{2.0485}$

$\log F = -1.4364 + 2.0485 \log L$

(iv) $F = 18.1265 + 0.08003\ W$

The goodness of the fit was tested by calculating the following values (Table 3):

1. *Mean square deviation*:

$$\frac{\Sigma\,(y\ \text{obs.} - y\ \text{calc.})^2}{n - 1}$$

2. *Mean deviation in %* (Kandler and Dutt 1958):

$$\pm \frac{100\ n \sqrt{\frac{\Sigma (y\ obs,\ y\ calc.)^2}{n-1}}}{\Sigma (y\ calc.)}$$

3. x^2 i.e., sum of the squares of deviation divided by calculated values:

$$\sum \frac{(y\ obs. - y\ calc)^2}{y\ calc.}$$

The calculated values more or less agree with the observed onces. All thee values for mean square deviation, mean deviation in % and x2 were least for the equation F = a + b W among the four sets of formulae. Hence, fecundity-weight relationship is more valid than fecundity-length relationships.

TABLE 3. *Relation between fecundity and length/weight Mean values for centimetre groups observed and calculated and differences between them.*

Frequency	Length range cm.	Average Length cm.	Average Weight g.	Mean No. of eggs (obs)	Calculated No. of eggs, differences obs. - calc.							
					f(L)	Diff.	f(Lb)	Diff.	(L3	Diff.	f(W)	Diff.
1	27.0-28.9	28.5	220	31	35	−4	35	−4	37	−6	35	4
1	29.0-30.9	29.0	225	40	36	4	36	4	38	2	36	4
3	31.0-32.9	32.2	347	46	45	1	44	2	44	2	46	0
12	33.0-34.9	34.2	386	48	52	−4	51	−3	50	−2	49	1
10	35.0-36.9	35.7	470	58	56	2	56	2	55	3	56	_2
8	37.0-38.9	37.9	545	66	63	3	63	3	62	4	62	4
5	39.0-40.9	39.9	638	69	69	0	70	−1	69	0	69	0
4	41.0-42.9	42.0	727	74	75	−1	77	−3	78	−4	76	2
		Mean square of deviation:				9.00		9.71		12.71		8.14
		Mean diation %			:	5.56		5.77		6.57		5.31
					:	1.45		1.51		1.92		1.30

SEX RATIO

The percentage of the two sexes in each 2cm class was calculated. Also in order to know the distribution of the two sexes during different months, the data were further analysed month by month for the year 1973-74. It was found that of the total of 503 fish collected during the entire period of investigation, 36% were males and 64% females, the ratio being 1:1.79. It could be seen from Table 4 that up to a size range of 29.9 cm, males and females are more or less in equal ratio but the percentage of males steadily fell and that of females increased as the fish grew more than 30 cm in length. Because of the oral gestation mortality among adult males is possibly more.

Monthly analyses showed (Table 5) that females formed a high percentage during most of the months except in September and October. In September, towards the close of the breeding season, males and females were almost equal in number, while in October the males predominated.

TABLE 4. *Percentage occurrence of males and females of* T. tenuispinis *in 2 cm length groups.*

Length-ranges	16.0-17.9 cm	18.0-19.9 cm	20.0-21.9 cm	22.0-23.9 cm	24.0-25.9 cm	26.0-27.9 cm	28.0-29.9 cm	30.0-31.9 cm	32.0-33.9 cm	34.0-35.9 cm	36.0-37.9 cm	38.0-39.9 cm	40.0 41.9 cm
No. of fish observed	21	18	6	5	26	50	76	84	71	70	49	16	8
Percentage of males	52	50	50	40	58	60	50	43	31	11	4	7	—
Percentage of females	48	50	50	60	42	40	50	57	69	89	96	93	100

TABLE 5. *Percentage occurrence of males and females of* T. tenuispinis *in different months.*

Months	Apl. 73	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 74	Feb.	Mar.	Annual 73-74
No. of fish observed	5	58	52	79	45	45	66	33	7	4	29	80	503
Percentage of males	20	17	36	35	18	47	62	42	28	—	41	30	36
Percentage of females	80	83	64	65	82	53	38	58	72	100	59	70	64

PARENTAL CARE

Males of *T. tenuispinis* exhabit parental care. Similar parental care of catfishes has been observed in *Osteogeneiosus militaris* (Pantulu 1963), *Arius jella,* (Chidambaram 1941) and *Tachysurus thalassinus* (Mojumder, personal communication). Oral gestation has been recorded in South American catfishes, *Galychthys felis* (Lee 1937) and *Felichthys felis* (Gudger 1918). The fertilised eggs are kept in the buccal cavity for hatching. Some fertilised eggs were recorded from the stomachs also. These eggs might have been swallowed accidentally during the process of capturing the fish, as all the eggs recovered from the stomachs were found intact and fresh. Altogether 72 eggs (size range 10.0-13.5 mm) could be recorded from the mouth and stomachs during June-September from 6 fish ranging 27.8 to 34.5 cm in length. Their diameter frequency is given in Fig. 1, (I). The maximum number of eggs recorded from the mouth of a fish of 27.8 cm size was 28. In all cases embryonic streak was clearly formed excepting for the 11 eggs from the mouth and stomach of a fish of 28.0 cm, where development had advanced further although fins and eyes were yet to appear. It would appear from the size range of the eggs with embryonic streak observed in the present study that the minimum size at which the egg of *T. tenuispinis* is fertilised is 10.0 mm.

REMARKS

It is found from the present study that *T. tenuispinis* has a prolonged breeding period from May to September. The spawning period of *T. thalassinus,* another important species of catfish along the northeast coast, is also prolonged, extending from April to August (Mojumder 1972). According to Chidambaram (1942) the breeding season of *A. jella* along the Madras coast extends from August to March. From this it would appear that the catfishes so far studied in Indian waters exhibit a prolonged spawning except probably *Osteogeneiosus militaris* in which species spawning has been observed to be short i.e., from March to May (Pantulu 1963).

Fecundity in *T. tenuispinis* is low (29-82) as in other catfishes, viz., *A. jella* (30-40) (Chidambaram 1941) and *O. milataris* (18-63) (Pantulu 1963). This low fecundity in *T. tenuispinis* and other catfishes mentioned above is probably associated with parental care.

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