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SPAWNING BIOLOGY OF *NEMIPTERUS DELAGOAE* (SMITH) AT VIZHINJAM

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ABSTRACT

Nemipterus delagoae Smith releases its eggs in batches and thus spawns twice in a year. Size at first maturity has been determined as 161-170 mm. This species has extended spawning season at Vizhinjam with peak spawning season from September to January. Males dominated over females during this investigations. Annual fecundity of the individual fish ranged from 86,184 to 497,230 eggs. Fecundity of the fish increases with the increase in the length and weight of the fish while ova per gram of fish body weight has no relationship with the length of the fish.

INTRODUCTION

THE THREADFIN BREAMS (Family Nemipteridae) contributed 114 tonnes as an average annual catch from 1966 to 1979 and accounted for 2.5% of the total annual marine fish landings at Vizhinjam (Luther *et al.*, 1982). In spite of the economic importance of this group of fishes, little has been published concerning the biology of these species from Vizhinjam area.

The authors are not aware of any published information regarding spawning biology of *Nemipterus delagoae* from Indian waters. The only account available on its biology is that of Madan Mohan and Velayudhan (1984). The present account deals with the maturation and spawning of this species from Vizhinjam area.

We wish to express our sincere thanks to Shri K. V. Narayana Rao, Head of the Pelagic Fishery Division for his constant encouragements and guidance during the course of these investigations. We are also grateful to Shri C. Mukundan, Head of Demersal Fishery Division for critically going through the manuscript.

MATERIAL AND METHODS

Specimens of *Nemipterus delagoae* were collected from the hook and line catches at Vizhinjam. Sex and stages of maturation were recorded in fresh condition and ovaries preserved in 5% formalin for further studies. Since observations on these mature ovaries did not reveal differences in the ova diameter between different regions of the ovary. Ova were measured from samples taken from the middle of ovaries. For measurements of diameters about 200 ova were considered in stage I-III and VII and 300 ova in stages IV-VI. Ova of and above 10 md (1 mm = 85 md) were not considered in stages III-VI as these are present in ovaries of all stages of maturation.

Fecundity was estimated taking a sample from stage V ovaries and by the equation

$$\text{Fecundity} = \frac{\text{No. of mature ova in sample} \times \text{total ovary weight}}{\text{Sample weight}}$$

CLASSIFICATION OF THE MATURITY STAGES

Only females were considered for this study as it is easy to assign a maturity stage to a ovary by superficial examination than to a testis. Based on the appearance of ovary in fresh condition and microscopic examination of ova in ovaries the following stages were recognised: Stage I - Immature, Stage II - Immature, Stage III - Maturing, Stage IV - Mature, Stage V - Ripe, Stage VI - Spawning and Stage VII - Spent.

Spawning Habits

As can be seen from Fig. 1 a, only the immature ova with diameter upto 0.12 mm with their mode at 0.07 mm are present in stage I of ovary. These ova can be seen in the ovaries of all the stages and throughout the year.

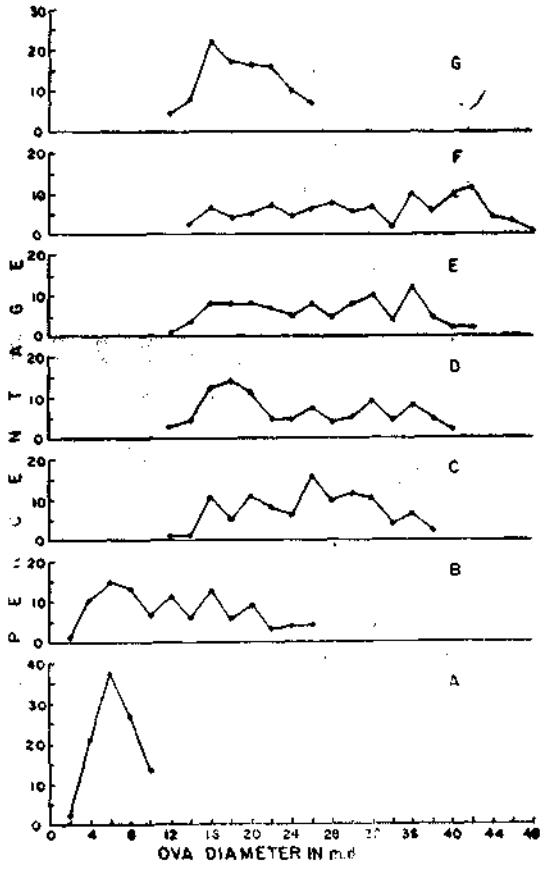

Fig. 1. Ova diameter frequency polygons for various stages of maturity in *Nemipterus delagoae*.

In stage II (Fig. 1 b) immature ova still have their mode at 0.07 mm, but a good number of them have shown their progress in growth and mode of the most advanced ova is at 0.24 mm.

In stage III (Fig. 1 c) ova have shown further progress. At this stage, three groups of ova, immature ova with diameter range upto 0.12 mm, intermediate ova from 0.14 mm to 0.28 mm and maturing ones from 0.29 mm to 0.45 mm can be seen. Mode of the most advanced ova can be seen at 0.42 mm.

In stage IV (Fig. 1 d) maturing ova did not show any progress, but due to heavy yolk deposition majority of the ova have become translucent. Mature ova like maturing ova have three prominent modes at 0.31 mm, 0.38 mm and 0.42 mm.

In stage V (Fig. 1 e) mature ova have shown little progress in diameter, but maintained their three modes at same place as in stage IV. Now ova have come to ripe stage and a few of them have become transparent.

In stage VI (Fig. 1 f) ova have shown progress before getting released for spawning. Mode of the most advanced ova got shifted at 0.49 mm. In most of the ova oil globule can be seen in the centre. In fresh condition, these ova come out on slight pressure on the abdomen of the fish.

In stage VII (Fig. 1 g) all the ripe ova have spawned out. Immature and maturing ova can be seen at this stage with very very few large ova which did not make any percentage seen in the hollow lumen of the ovary.

As in the case of most other fishes, the immature eggs are much more abundant than either the maturing ova or the ripe ova. It should be noted here that even before the ripe ova are spawned out, a group of maturing ova has started to develop and has already completed more than half process of maturation. Now the question is whether these maturing ova would attain maturity within the current spawning period or they will ripen one year later. In other words, does a female fish spawn more than once or only once in a spawning season or a year.

In stage V and VI maturing and ripe ova are present with clear and distinct modes. But both types of ova *i. e.* maturing and ripe ova have more than one mode present. In spent ovary, the ripe ova have been spawned out and maturing ova formed two pronounced modes at 0.19 mm and 0.26 mm which is almost similar to stage II ova diameter distribution. The range of maturing ova in maturing, mature, ripe and spawning stage is almost same.

Since from stage III onwards ova of the most advanced group have three modes which are very clear and distinct and spawning ova also have three clear modes which shows that from the spawning stock of ova, ova are released in small batches. Second batch from the spawning stock of ova may follow the first one quite soon since ovary may not keep itself in stage VI which is supposed to be transitory stage and does not last long. When ripe ova are spawned out in batches, their place is soon taken by the maturing ones which will attain maturity and will be ready for spawning in batches. By progression of ova from maturing stock to ripe stage, it is clear that this species spawns twice in a year. The occurrence of young fishes (91 - 150 mm) in very good percentage from January to May (Table 1) also support the evidence of fish spawning more than once in a year. Once the second group of ova is also spawned out the ovary will contain only immature and intermediate ova and attain the spent stage.

Size at First Maturity

For determining the size at first maturity only females (488 Nos.) in stage III - VII were considered. The smallest specimen met within stage IV and above was 154 mm in length. It can be seen from the Fig. 2 that the majority of the fishes (above 50%) were mature (stage III and above) at the minimum size group of 161-170 mm. Spent fishes were encountered in 181-190 mm size group. All the fishes from 201 mm in length onwards were found mature.

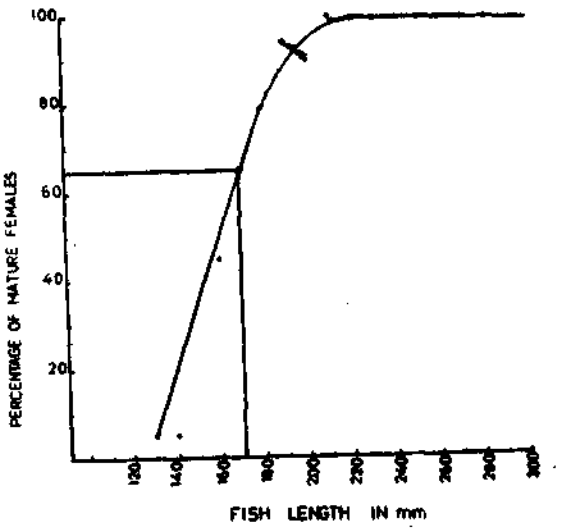

Fig. 2. Percentage frequency distribution of mature females of *N. delagoae* in different length groups.

Spawning Season

For determining the spawning season of this species only females of and above the length at first maturity were considered. Fish of various maturity stages were available in some months of the year. Young fishes of 91 - 100 mm lengths (which are indeterminate in maturity) start appearing in the commercial catches from January onwards and fishes upto 150 mm in length which are still maturing for the first time make very good percentage in the catches (Table 1).

All the female fish of above 161-170 mm length (length at first maturity) range were divided into four major categories based on their maturity stages: immature (stage I), maturing (stage II and III), mature (stage IV,

TABLE 1. *Monthwise percentage frequency distribution of the size groups (Total lengths) of* Nemipterus delagoae *Smith at Vizhinjam from March 1980 to February 1981*

Size range (mm)	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
91–100	–	–	–	–	–	–	–	–	–	–	0.73	0.44
101–110	2.25	–	–	–	–	–	–	–	–	0.27	0.36	5.62
111–120	3.85	–	–	–	–	–	–	–	–	–	4.51	11.94
121–130	14.99	3.83	2.94	–	–	–	–	–	–	–	18.93	23.38
131–140	32.27	12.67	17.65	–	–	–	–	0.56	–	–	28.76	27.63
141–150	16.93	23.92	17.65	–	29.68	–	–	0.57	0.90	1.67	11.06	16.93
151–160	12.29	21.26	11.76	–	–	–	–	3.16	0.74	2.82	1.57	4.24
161–170	5.56	15.33	11.76	–	–	–	–	5.39	11.85	8.72	2.84	2.66
171–180	7.87	10.29	23.53	12.50	7.04	–	–	15.00	13.11	24.09	6.05	1.80
181–190	2.85	8.78	11.76	12.50	14.07	–	15.00	17.29	19.17	27.23	6.05	1.77
191–200	1.16	2.84	2.94	20.83	21.07	–	5.00	19.72	18.80	15.60	10.23	1.17
201–210	–	1.08	–	45.83	14.07	–	–	7.65	8.36	6.70	5.38	0.22
211–220	–	–	–	8.33	14.07	–	10.00	3.95	3.58	2.13	1.09	0.54
221–230	–	–	–	–	–	–	17.50	7.01	2.44	1.60	0.83	0.70
231–240	–	–	–	–	–	–	15.00	5.89	4.53	2.25	0.56	0.22
241–250	–	–	–	–	–	–	30.00	2.52	2.11	0.78	0.46	–
251–260	–	–	–	–	–	–	7.50	5.97	3.20	1.51	0.10	–
261–270	–	–	–	–	–	–	–	3.29	8.16	2.97	0.20	0.22
271–280	–	–	–	–	–	–	–	1.46	1.75	1.05	0.30	0.11
281–290	–	–	–	–	–	–	–	–	1.06	0.62	–	0.11
291–300	–	–	–	–	–	–	–	–	0.25	–	–	0.22
301–310	–	–	–	–	–	–	–	0.56	–	–	–	0.11
Sample size	138	271	34	24	10	–	40	163	157	230	251	251

V and VI) and spent (Stage VII) and results are shown in Table 2. As can be seen from the Table, mature fishes were available in good percentage from September to January with spent specimens also occurring with them. Maturing fish were available in good percentage during all the months of observation and even dominated in some of them (Table 3).

TABLE 2. *Percentage occurrence of female fish (Fishes of and above the size at first maturity) of* N. delagoae *in different stages of maturity from March* 1980 *to February* 1981

Month	No. of Female Fish	Immature	Maturing	Mature	Spent
1980					
March	1	-	100	-	-
April	12	25.00	58.33	16.67	-
May	-	-	-	-	-
June	2	50.00	50.00	-	-
July	-	-	-	-	-
August	-	-	-	-	-
September	7	-	42.86	57.14	-
October	63	-	60.32	36.51	3.18
November	89	2.25	38.20	59.55	-
December	148	-	41.90	56.72	1.35
1981					
January	82	-	40.24	58.54	1.22
February	27	-	62.89	37.04	-

Fishes in stage III of maturity occurred from 121-130 mm length range to 251-260 mm range. Length at first maturity of the species has been taken as 161-170 mm length range. It clearly indicates that from 161-170 mm onwards or so whatever number of fish are available in stage III of maturity, are those in recovering stage after being fully spent.

Therefore based on the occurrence of maturing fish which includes a good percentage of spent recovering fishes, and mature ones during almost all the months of observations and occurrence of juveniles from January onwards, it is clear that this species has an extended spawning season in Vizhinjam area with peak during September to January.

SEX RATIO

Altogether 1524 specimens of *Nemipturus delagoae* were analysed for these studies. Ratio

of males to females was found to be 1 : 0.58 for the period under observation. The percentage occurrence of both the sexes in different months from March 1980 to February 1981 is given in Table 4. As can be seen from the Table males outnumbered females in all months except November and December.

ing and ripe eggs in a ripe ovary (Stage V) were taken into consideration. Altogether 25 fully ripe ovaries of fishes ranging from 175 mm to 272 mm in total length were taken and studied The length and weight of the fish, length and weight of ovary, total number of ripe ova and ova of second batch (maturing) of an ovary

TABLE 3. *Monthwise percentage occurrence of female fish of* N. delagoae *in defferent stages of maturity from March 1980 to February* 1981

Month	No. of Fish	Stages of Maturity						
		I	II	III	IV	V	VI	VII
1980								
March	25	56.00	36.00	8.00	-	-	-	-
April	52	51.92	38.46	3.85	5.77	-	-	-
May	5	40.00	60.00	-	-	-	-	-
June	2	50.00	50.00	-	-	-	-	-
July	-	-	-	-	-	-	-	-
August	-	-	-	-	-	-	-	-
September	7	-	-	42.86	28.57	28.57	-	-
October	73	-	21.92	42.46	30.14	2.74	1.37	1.37
November	80	2.50	21.25	22.50	38.75	13.75	1.25	-
December	152	-	7.24	38.16	37.50	13.82	1.96	1.32
1981								
January	100	17.00	4.00	30.00	31.00	11.00	6.00	1.00
February	60	51.67	10.00	21.67	13.33	1.67	1.66	-

FECUNDITY

Like in other members of Family Nemipteridae, mature ovary of *Nemipterus delagoae* contains three groups of ova namely immature, maturing and mature or ripe ova. For estimating fecundity the total number of matur-

and ripe ova per gram of fish body weight are given in Table 5.

For estimating the number of ova which will be produced in second batch, the total number of maturing ova (0. 14 mm - 0.30 mm) and ripe opaque ova (0.31 mm - 0.49 mm) from

the ova diameter frequency distribution of stage V ovaries (10 No.) were taken and percentage of both were determined as below.

% of maturing translucent ova	% of ripe opaque ova
56.67	43.33
51.00	49.00
59.67	40.33
57.00	43.00
56.67	43.33
48.00	52.00
55.67	44.33
53.33	46.67
59.67	40.33
59.33	40.66
Pooled 55.70	44.30

TABLE 4. *Percentage of males and females of* N. delagoae *from March* 1980 *to February* 1981

Month	No. of Fish	Percentage of Males	Percentage of Females
1980			
March	141	82.27	17.73
April	269	80.67	19.33
May	33	84.85	15.15
June	24	91.67	8.33
July	10	100.00	–
August	–	–	–
September	40	82.50	17.50
October	163	59.51	40.49
November	156	42.95	57.05
December	229	33.62	66.38
1981			
January	240	58.33	41.67
February	219	70.78	29.22

The average ratio of ripe ova which will be released first and maturing translucent ova which will be released in second batch was taken as 44 : 56. Fecundity for the ripe eggs ranged from 37,921 to 218,781 and for the second batch from 48,263 to 278,449. Annual fecundity ranged from 86,184 to 497,230. For relating fecundity (of ripe ova) of *Nemipterus delagoae* to total length and body weight of the fish and ripe ova per gram of fish body weight to fish length, least square method was used.

Relation between fecundity and length of fish

The fecundity (ripe ova) estimates of 25 *Nemipterus delagoae* specimens against total length of fish have been plotted in Fig. 3.

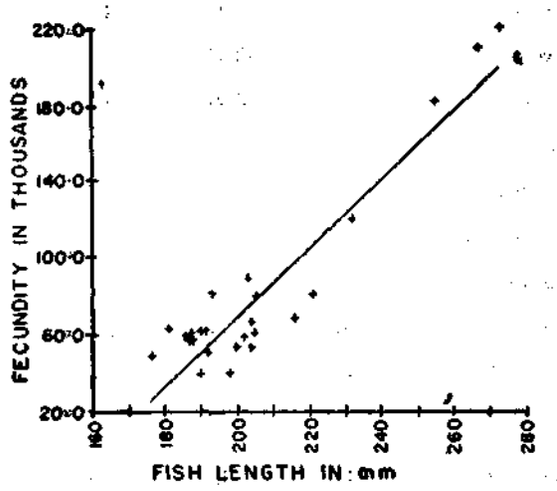

Fig. 3. Relationship between fecundity and length of fish in *N. delagoae*.

It can be seen from the Figure that fecundity of the individual fish increased with the length of the fish. But as can be seen from the Table 5 that the fecundity of the individual fish of the same total lengths showed considerable variations which may be due to the release of a batch of ova from the ovary. The relationship between fecundity and fish length by using

TABLE 5. *Fecundity estimates of* N. delagoae

Length of fish (mm)	Weight of fish (gms)	Length of ovary (mm)	Weight of ovary (gms)	ripe ova (No.)	ova of second batch (No.)	Ripe ova per gram of fish body wt.
175	60.5	35	2.960	46,472	59,146	768
180	77	32	3.220	60,783	77,360	789
185	73	35	2.480	57,153	72,740	783
186	72	34	3.290	54.662	69,570	759
186	77	33	2.670	58,490	74,442	760
187	75	32	3.580	55,185	70,235	736
189	73.5	30	2.250	37,931	48,263	651
189	78	36	2.750	60.500	77.000	776
190	84	36	4.170	59,660	75,931	710
191	81	32	2.270	49,103	62,495	606
192	80	34	4.580	78,814	100,309	985
197	87.5	21	2.275	38,078	48,463	435
199	97	31	3.000	51,780	65,902	534
201	87	33	3.160	57.025	72.577	655
202	103	40	4.800	87,072	110,819	845
203	96	33	3.150	51.914	66,072	541
203	95	33	4.010	64,064	81,536	674
204	96	33	3.350	59,253	75,413	617
204	98	37	4.450	77,741	98,943	793
215	105	37	4.200	66,696	84,886	635
220	110	36	4.075	78,932	100,459	718
231	145	40	5.680	118,352	150,630	816
254	203	45	8.670	180,415	229.619	889
266	230	49	9.510	208,519	265,388	907
272	227	44	10.100	218.781	218,449	964

least square method and formula $Y = a + bL$ where Y is fecundity, L the length of the fish n mm and a and b constants, was as below

$$Y = -291.3357 + 1.8084\ L$$

The correlation co-efficient (r) for this relationship was calculated as 0.9336 which indicates that fecundity of the individual fish increases with the increase in fish length.

Relation between fecundity and fish body weight

Fecundity (ripe ova) estimates of 25 fishes are plotted against their respective body weights in Fig. 4. By least square method and

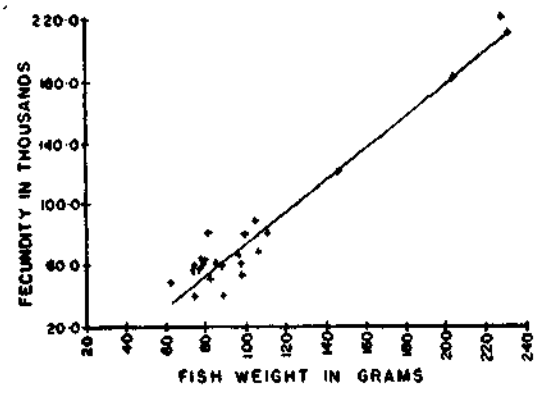

Fig. 4. Relationship between fish body weight and fecundity of *N. delagoae.*

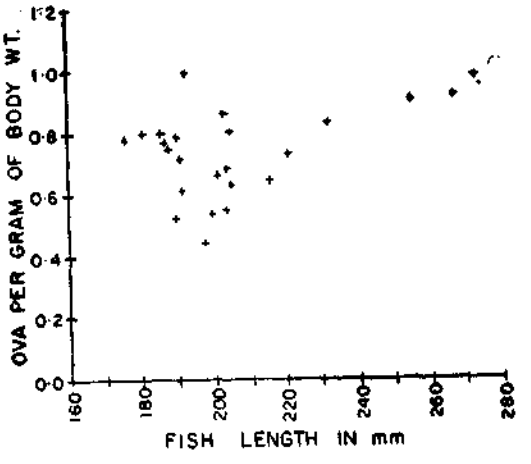

Fig. 5. Relationship between fish length and ripe ova per gram of fish body weight in *N. delagoae.*

by using the formula Y=a+bw, relationship between fecundity and weight of the fish was determined as below

$$Y = -28.6107 + 1.0315\ W$$

The value of correlation coefficient (r) was found as 0.9716 which indicates that fecundity of the fish increases with the increase in fish body weight.

Relation between length of fish and ripe ova per gram of fish body weight

In order to find out whether any relation exists between length of fish and ripe ova per gram of fish body weight, length of the 25 fish are plotted against their respective ripe ova per gram of fish body weight in Fig. 5. As can be seen from the Figure ripe ova per gram of fish body weight of the fish of same length group varied very much.

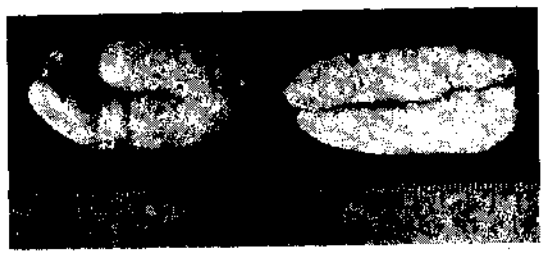

Fig. 6. Ripe ovaries of *N. delagoae.*

By using least square method the following relationship was observed

Fecundity = $-0.2644+0.0023$ ova per gram body weight.

The value of (r) was found to be 0.4200 which indicates that ripe ova per gram of fish body weight does not increase much with the increase in fish length.

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