POPULATION DYNAMICS OF *NEMIPTERUS JAPONICUS* (BLOCH) IN THE TRAWLING GROUNDS OFF MADRAS

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ABSTRACT

Nemipterus japonicus matures at 145 mm total length and has an extended spawning season from June to March with maximum spawning activity in December-March. The length-weight relationship of fish can be expressed as: log W = —4.8665 + 2.9661 log L. The von Bertalanffy parameters of growth are estimated thus: $K = 1.004$; $t_o = 0.2257$; $L_\infty = 305$ mm. The natural mortality and fishing mortality rates are estimated at 2.5254 and 0.4599, respectively. Both the annual stock (2300 t) and the standing crop (731 t) are higher than the estimated annual catch (336 t), indicating that the present fishing effort can safely be increased without the stock being affected.

INTRODUCTION

Information on growth and mortality rates of threadfin bream *Nemipterus japonicus* (Bloch) of Madras coast was not available despite the threadfin breams all together forming about 15% of the trawl catch, and *N. japonicus* forming 51% of the threadfin bream catch. Work on the species was therefore taken up in 1980, and the result of the study based on data collected from commercial trawlers are presented in this paper. An attempt was also made at estimating the Yield per recruit of the species.

MATERIAL AND METHODS

Data on catch and effort of commercial trawlers operating from Kasimedu landing centre, as well as the samples for length and other studies, were collected twice a week. The data were weighted for monthly values. Data on total length (measured from tip of snout to tip of lower caudal lobe), weight and sex and stage of maturation were had from specimens while they were still fresh. The length data obtained on each observation day were raised to the day's catch and these were further raised to get monthly length composition of the catch.

The parameters of growth were estimated using the von Bertalanffy equation:

$$l_t = L_\infty \left(1 - e^{-K(t - t_o)}\right)$$

where L_∞ is the asymptotic length; K the growth coefficient, t_o the theoretical age when length is zero and lt the length at age t. The L_∞ was estimated from the Ford-Walford plot (Ford 1933; Walford 1946) of lt + 1 against lt on the basis of lengths attained at intervals of 3 months.

Total mortality rate (Z) was estimated following the Beverton and Holt (1956) method using the equation:

$$Z = \frac{K (L_\infty - \bar{L})}{\bar{L} - L'}$$

where L_∞ and K are the parameters of von Bertalanffy growth equation, L is the mean length in the catch and L' is the smallest length of members that are fully represented in catch samples. In the present study, L' = 85 mm and the individuals < 85 mm were not considered for calculating $\bar{L}$ values.

The following equation was used for estimating natural (M) and fishing (F) mortality rates:

$$Z = M + qf$$

where q is the catchability coefficient, f the fishing effort and F = qf (Widrig 1954).

The rate of exploitation (U) for different years was estimated from the equation (Beverton and Holt 1957, Ricker 1975):

$$U = \frac{F}{Z} (1-e^{-Z})$$

The yield in weight per recruit was calculated from the formula of Beverton (1953):

$$Y_{W} / R = FW_\infty \; e^{-M (tp'-tp)} \sum_{n=0}^{3} \frac{\Omega e^{-nK (tp'-t_o)}}{F+M+nK} (1-e^{-(F+M+nK)\lambda})$$

and the yield in numbers per recruit from the formula:

$$Y_N / R = \frac{F}{Z} (1 - e^{-(Z)\lambda})$$

Potential yield per recruit (Y') was estimated from the equation developed by Kutty and Qasim (1968):

$$Y' = ae^{-M (ty-tr)} (L_\infty - (L_\infty - l_o) \; e^{-Kty})^{b}$$

where ty, the optimum age of exploitation, was estimated from the relation:

$$e^{Kty} = \frac{(L_\infty - l_o)(bK+M)}{ML_\infty}$$

and l_o from

$$l_o = L_\infty (1 - e^{-K(t-t_o)})$$

The a and b values are as in the length-weight relationship and K, the growth coefficient, as estimated from von Bertalanffy's equation for growth.

RESULTS

Maturation and Spawning

Only females (480 Nos.), ranging from 75 to 245 mm in total length, collected during 1982 and 1983, were considered for this study.

Length at first maturity: Only females in Stages III and above were considered as mature for this purpose. In each 10-mm-length group, the number of mature females was noted and was scaled to percentage (Fig. 1). Fish above 120 mm had mature ovaries; but 50% fish were mature at 145 mm, which was considered to be the length at first maturity of female of *N. japonicus*, though Krishnamoorthi (1971) and Murty (1984) had observed the length at first maturity of female *N. japonicus* as 165 mm (Stages V and above) and 125 mm (Stages III-VI), respectively.

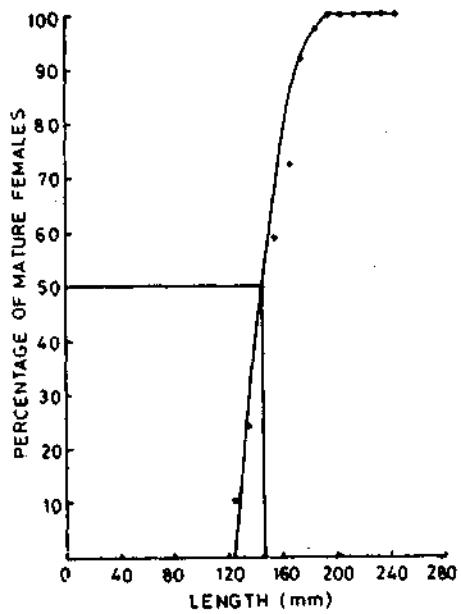

FIG. 1. Percentage-frequency distribution of mature females of *N. japonicus* in relation to length.

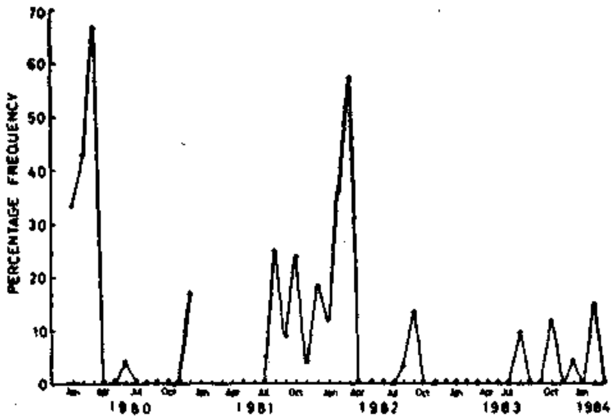

FIG. 2. Monthly percentage-frequency distribution of mature (Stage V and VI) females of *N. japonicus.*

Period of spawning: For determining the spawning period, only females (N = 1135) above length at first maturity collected during January 1980-March 1984 were taken into account. The numbers of mature females of corresponding months of study period were pooled and the monthly percentage-frequency distribution obtained, which is shown in Table 1. Though there was difference in the occurrence and the abundance of Stages V and VI females in different years (Fig. 2), the spawning season of *N. japonicus* off Madras could be taken in general as extending from June to March with maximum spawning activity from December to March. Previous authors (Dan 1980, Murty 1984) also had observed December to February as peak spawning period of *N. japonicus* on the east coast of India.

Length-Weight Relationship

A sample of 345 females, ranging from 85 to 224 mm total length, and 225 males, ranging from 95 to 215 mm, collected during 1981 was used. The relationship was calculated separately for the sexes by the method of least squares, using the formula $\log W = \log a + b \log L$, where W = weight in g; L = length in mm and a and b are constants. The regression equation for the sexes are:

Males: $\log W = -4.8057 + 2.9654 \log L$
Females: $\log W = -4.9780 + 2.9665 \log L$

The significance of difference between b values of the sexes was tested by Analysis of covariance (Snedecor and Cochran 1967). The difference was not significant at 5% level (Table 2). Therefore, pooling all the data, a common relationship was obtained thus:

$$\log W = -4.8665 + 2.9661 \log L$$

TABLE 1. *Monthly percentage-frequency distribution of adult females of* N. japonicus *at different stages of maturation (data from January* 80 *to March* 84, *pooled).*

	No. of specimens	% of maturation stages		
		II	III & IV	V & VI
Jan.	109	47.6	31.0	21.4
Feb.	77	18.0	55.7	26.2
Mar.	74	29.1	34.5	36.4
Apr.	57	86.7	13.3	—
May	44	84.6	15.4	—
June	91	89.8	8.5	1.7
July	99	28.1	68.8	3.1
Aug.	102	59.7	28.4	11.9
Sept.	126	37.1	50.0	12.9
Oct.	144	32.4	55.0	12.6
Nov.	103	39.0	58.5	2.4
Dec.	109	17.1	63.4	19.5

Vinci and Nair (1974) had analysed the length-weight relationship of *N. japonicus* along the Kerala coast and Hoda (1976) from the Pakistan coast and concluded that the Regression coefficients of males and females were not significantly different. Krishnamoorthi (1971) and Murty (1984), however, had found significant difference between males and females of *N. japonicus* off Visakhapatnam and Kakinada coasts, respectively.

Growth

A total of 2916 specimens of *N. japonicus* of the length range 55-301 mm were measured during the period January 1980-February 1984 and the modes in the length-frequency distribution of each month were plotted (Fig. 3). By connecting the maximum number of modes, it was possible with the data in hand to obtain 9 growth curves. The lengths attained at quarterly intervals read off from each curve (starting from the minimum modal length) were used to estimate the von Bertalanffy parameters of growth.

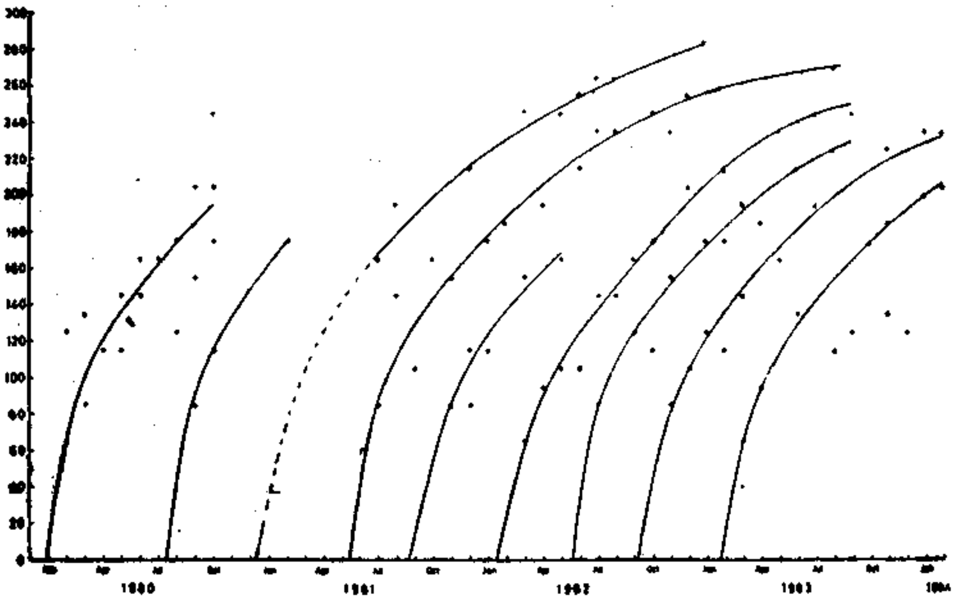

FIG. 3. Growth in length of *N. Japonicus* on the basis of modal progression; since length frequency data were not collected for 5 months in 1981, the growth curve during that period is represented by dotted line.

TABLE 2. *Comparison of Regression lines of length-weight relationship of males and females of* N. japonicus.

	df	Σx^2	Σxy	Σx^2	Regression coefficient	Deviation from Regression df	SS	MS
Males	224	6.5946	19.5556	59.3428	2.9654	223	1.352703	
Females	344	10.6190	31.5017	94.5501	2.9665	343	1.099012	
						566	2.451715	0.00433
Pooled	568	17.2136	51.0573	153.8929	2.9661	567	2.451721	0.00432
		Difference between slopes				1	0.000006	0.000006

F = 0.00231; df = 1 and 566; not significant at 5% level.

The values of K, L_∞ and t_0 thus estimated were 1.004, 305 mm and 0.2257, respectively. The lengths were 165, 254, 286 and 302 mm respectively at the completion of 1, 2, 3 and 4 years (Fig. 4). Krishnamoorthi (1971) had observed *N. japonicus* off Visakhapatnam attaining 150, 210 and 240 mm at the end of 1, 2 and 3 years, respectively. Murty (1984) had reported the lengths as 185, 255 and 285 mm for the corresponding ages from Kakinada. The L_∞ values obtained by us were 305 mm (off Visakhapatnam) and 314 mm (off Kakinada).

Estimation of Mortality Rates

The total mortality rates (Z) ranged from 2.8181 to 3.2008, with an average of 2.9853 (Table 3). The values of Z are plotted against the corresponding fishing effort in Figure 5. The estimated natural mortality (M) was 2.5254 (value of Y intercept in Fig. 5), which was higher than those reported from Andhra|Orissa coast (0.5037) by Krishnamoorthi (1978) and from Kakinada (1.1418) by Murty (1983). Since *N. japonicus* at Madras had a higher value of K (1.004) than those from the other two regions (0.6 and 0.75), the natural mortality of the species from Madras was higher (see also Gulland 1969). Fishing mortality rate (F) obtained in the present study was 0.4599.

TABLE 3. *Estimation of total stock and standing crop of* N. japonicus.

Year	Catch (tonnes) (Y)	F	M	Z	U	Total stock (tonnes) (Y|U)	Standing crop (tonnes) (Y|F)
1980	76.8	0.2927		2.8181	0.0977	786	262
1981	187.7	0.3600		2.8854	0.1178	1593	521
1982	598.6	0.6754		3.2008	0.2024	2957	886
1983	482.7	0.5116		3.0370	0.1604	3009	943
Average	336.4	0.4599	2.5254	2.9853	0.1463	2300	731

Fishery Status

The status of the fisheries for *N. japonicus* at Madras was appraised, estimating the rate of exploitation and Yield per recruit. The estimated values of total annual stock (Y|U) and average standing crop (Y|F) are presented in Table 3. Whereas the average annual stock and standing crop at Madras for the 1980-83 period were respectively 2300 and 731 tonnes, the average estimated annual catch of *N. japonicus* was only 336 tonnes at the existing F value of 0.4599. The present fishing effort along Madras coast can therefore be increased, so that higher catch could be achieved. Under the present conditions, such an increase in fishing effort may not adversely affect the stock of *N. japonicus* at Madras as had been reported of stocks of this species off Kakinada (Murty 1983). Analysing the exploratory trawling data obtained off north Tamil Nadu|

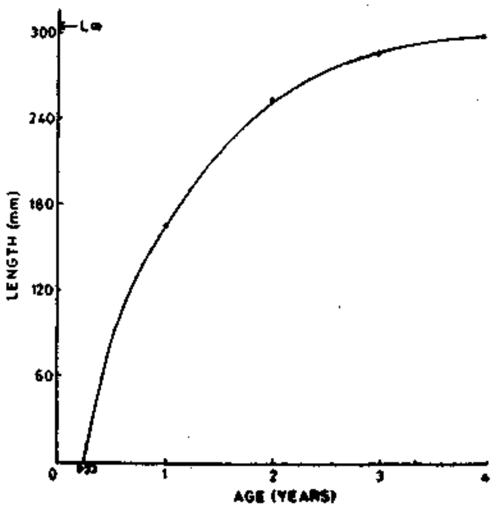

FIG. 4. Von Bertalanffy growth curve for *N. japonicus.*

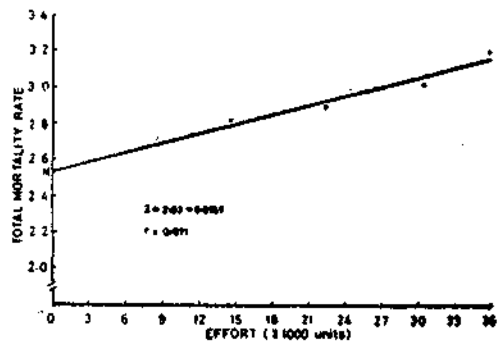

FIG. 5. Plot of total mortality (Z) on effort (f) to estimate natural mortality (M) and catchability coefficient.

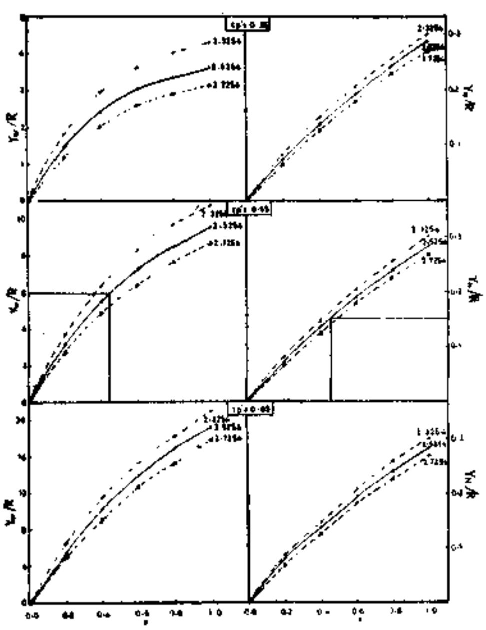

FIG. 6. Yield per recruit in terms of weight in g (Y_W/R) and number (Y_N/R) in relation to fishing mortality (F) at different ages of exploitation (tp') and natural mortality rates (M); the vertical lines indicate the yield per recruit at the present F, M and tp' values.

south Andhra coast for a 10-year period from 1973 to 1982 to estimate Maximum sustainable yields, Vivekanandan has observed (unpublished data) that there is scope to increase the present fishing intensity (f) by 9.5 times and to obtain 72% more sustainable yields of threadfin breams.

The Yield per recruit calculated at three natural mortality rates, 2.3254, 2.5354 and 2.7254, and at three ages of exploitation (tp' = 0.25, 0.55 and 0.85) against various fishing mortality rates ranging from 0.2 to 1.0 are shown in Figure 6. Yield per recruit in terms of both weight (Y_W/R) and number (Y_N/R) increased with increasing F, suggesting that the yield might reach an asymptote and decline only at a very high F value.

The length at first capture of *M. japonicus* off Madras coast was presently 85 mm, which meant that the fish was 0.55-year old at the time of first capture (tp'). At the existing rate F = 0.46, M = 2.5254 and tp' of 0.55 year, the Y_W/R = 6 g (Fig. 6). If Y_W/R was to increase as recommended in this study, it becomes apparent that the optimum age of exploitation and the potential yield per recruit (Y') (Ricker 1945) be estimated to establish an economically viable fishery. The Y' could be obtained by "allowing an year class to reach its greatest total weight, and then catching all of it at once" Beverton and Holt 1957).

The Y' and ty (optimum age of exploitation) values thus estimated for *N. japonicus* were 16.28 g and 1.002 year, respectively, which were higher than the present values of 6 g and 0.55 year. It may, therefore, be concluded that, presently, the stocks of *N. japonicus* are underexploited. So one possible management policy towards obtaining better yields might be to suggest to increase the size of the mesh so as to increase the age of exploitation from 0.55 year to 1.002 year. Whether this is practical under the circumstances existing at Madras of most of the effort being directed towards exploitation of prawns is beyond the scope of this paper.

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