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Growth, mortality and stock assessment of *Nemipterus mesoprion* (Bleeker) from Mumbai waters

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ABSTRACT

Growth, mortality, stock and yield parameters of *Nemipterus mesoprion* (Bleeker), based on the data collected from 1989-'94 is reported here. The VBGF parameters in length for this species were estimated as follows. L_{00} = 274 mm, K = 0.7628 (annual) and t_0 = -0.0011764 years. This species grows to 147, 216 and 252 mm at the end of I-III years of its life. The average total, natural and fishing mortalities were calculated as 2.55, 1.57 and 0.98 respectively. The average exploitation ratios and rates were calculated as 0.384 and 0.354 respectively. The total stock, biomass and MSY were estimated as 3991.5, 1413 and 887 t respectively. The yield per recruit study shows that it can be raised by increasing the age at first capture and fishing efforts.

Introduction

Among the three species of threadfin breams, *Nemipterus japonicus* (Bloch), *N. mesoprion* (Bleeker) and *N. delagoa* (Smith) available in Bombay water *N. mesoprion* ranks second in order of abundance. This species roughly contributes to 35-40% of the total threadfin breams landed in Bombay. Work on the biology and population dynamics of this species is however, meagre. From the east coast of India biology, age and growth have been worked out by Murty (1981) and at all India level by Murty *et al.* (1992). Mortality and stock parameters of this species has been worked out by Chakraborty *et al.* (1997) based on data collected during 1989-'91 period. However, the present communication is one of the detailed study on this species based on six year data from 1989-'94.

Materials and methods

The length frequency data were collected from New Ferry Wharf and Sassoon Docks landing centres of Greater Bombay at regular intervals. The length frequency was distributed in 10 mm class intervals for the growth study and were raised for the day and subsequently for the month following Sekharan (1962).

The four methods used for the study of growth were

a) ELEFAN programme (Gayanilo

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et al., 1988)

b) By Bhattacharya (1967), Gulland and Holt plot (1959).

c) By modal progression reading the growth at quarterly intervals using Ford-Walford plot (Ford, 1933; Walford, 1946).

d) Wetherall *et al.* (1987) plot which gives an estimate of L_{00} and Z/K.

The t_0 was calculated by Von Bertalanffy's plot and total mortality coefficient 'Z' by Alagaraja's (1984) method. The natural mortality coefficient 'M' was estimated by Cushing's model (1968), Pauly's empirical formula (1980) and Srinath's empirical formula (1998).

Fishing mortality coefficient was calculated by substracting M from Z. The exploitation ratio 'E' was calculated by the formula

$$E = \frac{F}{M+F}$$

and the exploitation rate 'U' was calculated by the formula

$$U = \frac{F\ (1-e^{-z})}{M+F}$$

as given by Beverton and Holt (1957), Ricker (1965).

The length at first capture (L_0) was estimated by plotting cumulative percentage of numbers of fish against their length intervals and selecting at 50% of their cumulative percentage as the mesh selection operates in fish whose size is lower than the first mode (Beverton and Holt, 1957). This L_0 was converted to t_0 using VBGF. The smallest fish recorded in the the catch was 43 mm. This was taken as L_1 and employing VBGF it was converted to t_1. The yield per recruit was done by the formula given by Beverton and Holt (1957) and Ricker (1958).

$$Y_{W/R} = F^{-e-M(t_0-t_1)} W_{oo} \left\{\frac{1}{Z} - \frac{3S}{Z+K} + \frac{3S^2}{Z+2K} - \frac{S^3}{Z+3K}\right\}$$

where $S = e^{-K(t_0 - t_1)}$ in the usual notations.

The yield isopleth diagram (Beverton and Holt, 1957) depicting isolines of yield for varying levels of t_0 on the Y-axis and E and F on the X-axis was prepared. The eumetric fishing curve and the MSY curve were constituted accordingly.

The cod end mesh size (stretched) of shrimp trawlers presently in use is 25 mm. Taking the length at first capture, the selection factor was determined by the formula S.F. = L_0/M.S. A set of values of cod end mesh sizes (MS) were taken giving corresponding values as L_0 = SF x MS. The L_0 values were converted to t_0. The total stock and biomass were estimated by the formula Y/U and Y/F respectively. Using the length-weight relationship the W_{00} at asymptotic length of 274 mm was calculated as 329 g. The maximum sustainable yield (MSY) was calculated by the formula given by Gulland (1971) as MSY = 0.4 x Bv.M where Bv is the virgin biomass. Here a multiplicative factor of 0.4 was used instead of 0.5.

Results and discussion

A total of 8,680 fish in the length range of 43 to 256 mm were measured. The growth parameters obtained by various methods are persented in Table 1. The asymptotic length obtained by the four methods do not vary much. However, the L_{00} of 292 appears slightly on the higher side. The growth coefficient 'K' obtained by the first three methods is more or less same. The fourth method gives an estimation of Z/K only. However, for further calculations, L_{00} of 274 mm and K of 0.76289 year obtained by modal progression analysis was taken (Fig.1). The t_0 was calculated as -0.01764 year by

TABLE 1. *The estimation of growth parameters of* N. mesoprion *by various methods.*

Method	L∞(mm)	K^{-year}	Z/K	t_0
Bhattacharya and Gulland and Holt plot	292	0.7839	-	-
ELEFAN	286	0.71	-	-
Modal Progression	274	0.76289	-	-0.011764
Wetherall *et al.*	280	-	3.614	-

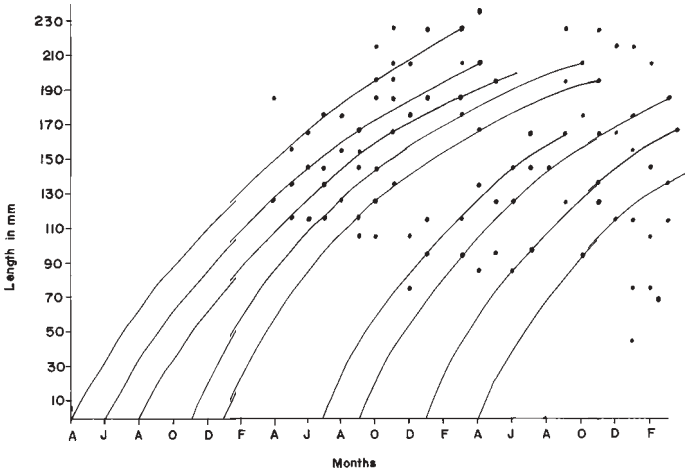

Fig.1. Scattergram of modal lengths of *N.mesoprion*

von Bertalanffy's plot. This species grows to 147, 215 and 252 mm at the end of I-III years of.

The von Bertalanffy equation for growth in length for this species could thus be written as

$$Lt = 274\ [1-e^{-076259\ (t\ -\ (-0.0011764)}]$$

The L_{00} is close to the largest fish of 256 mm observed in the catch. The total mortality coefficient 'Z' varied from 2.24 to 2.86 with an average of 2.55 for the six year period (Table 2). The natural mortality coefficient was estimated as 1.57 by Cushing's method, 1.53 by Pauly's formula and 1.28 by Srinath's method. For further calculation, M of 1.57 obtained by Cushing's method was taken. The average rate of fishing mortality was obtained as 0.98. The length at first capture was 110 mm which was converted to age (t_0) by employing VBGF and found to be 0.6789 years. The yield per recruit study indicated that at the present level of F (0.98), the YW/R is

TABLE 2. *Mortality and stock parameters of* N. mesoprion

Year	Z	M	F	U	E	Yield(t)	Y/F(t) (Biomass)	Y/U(t) (Total stock)	M.S.Y. (t)
1989	2.24	1.57	0.67	0.267	0.299	1261	1882.08	4722.8	1181.9
1990	2.83	1.57	1.26	0.418	0.445	1149	911.9	2748.8	572.6
1991	2.57	1.57	1	0.359	0.389	1370	1370	3816.1	860.3
1992	2.52	1.57	0.95	0.345	0.376	1448	1524	4417.3	957
1993	2.3	1.57	0.73	0.285	0.317	1440	1972.6	5052.6	1238.7
1994	2.86	1.57	1.29	0.425	0.451	1644	1274.4	2997.6	800.3
Average*	2.55	1.57	0.98	0.354	0.384	1385	1413	3991.5	887.3

*Average is for Z and yield only.

around 11.215 g.

As mesh selection experiments are difficult to conduct, calculations were done by increasing the cod end mesh size by 20, 40 and 60% of the present level, thus increasing the t_0 proportionately. It is seen that at the same level of F, increasing t_0 results in lower yield per recruit. But by increasing the 'F' to 2 (slightly more than double of present level) and t_0 by 20%, the yield per recruit can be increased by 20.66% of the present. By increasing the t_0 by 40% of the present, the Yw/R increases by 14.85%. Further increase in t_0 is of no significance as the catch does not show any improvement (Fig. 2).

In the second stage Y_W/R was composed at various levels of t_0 or l_0 keeping the F constant, to obtain the optimum length/age of capture. It was found that at the present 'F', maximum Y_W/R of 11.526 g can be obtained at length of 115 mm or age of 0.7198 years (Fig.3). The eumetric curve AA and MSY curve BB' meet vertically at F_{00} giving potential yield per recruit of 15.365 g at optimum age of exploitation of 1.0725 years (Fig. 4).

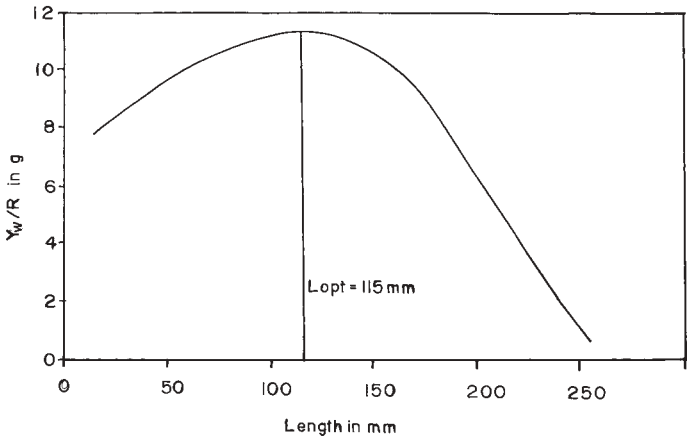

Fig.2. Yield per recruit at various lengths keeping the F constants for calculation of Lopt.

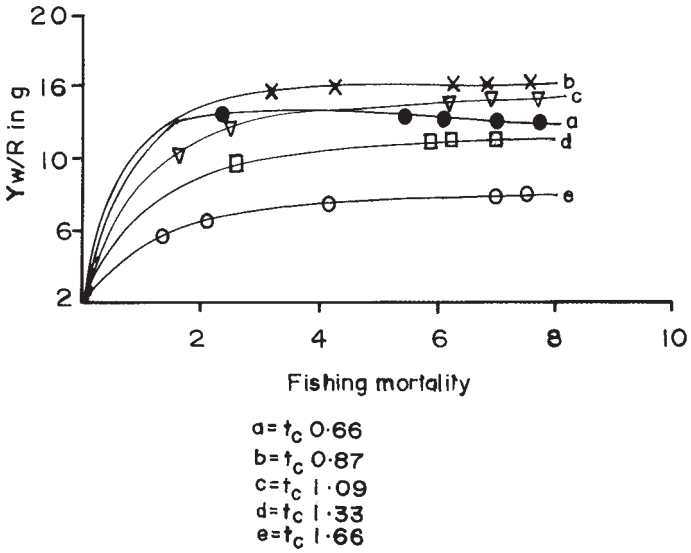

Fig.3. Yield-per-recruit at varying lervels of age at first capture.

The average exploitation ratio (E) and exploitation rate (U) was calculated as 0.384 and 0.354 respectively. The average total and standing stocks were estimated as 3991 and 1413 t as compared to the present average yield of 1385t. The maximum sustainable yield was calculated as 887.3 t.

From Indian waters the study on the growth of this species has been reported by Murty (1981). The L_{00}, K and t_0 estimated by him are 219 mm, 0.83248/year and -0.256198 years respectively. The aysmptotic length obtained in the present investigation is

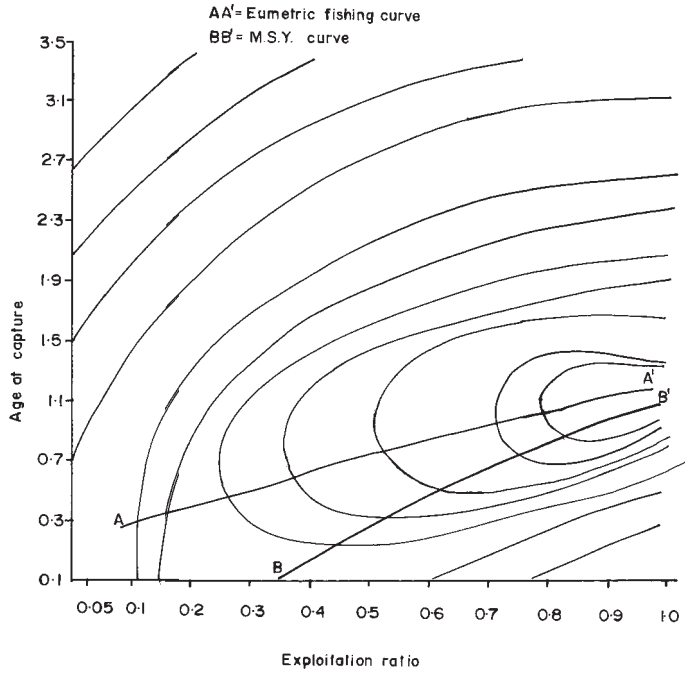

Fig.4. Yield isopleth diagram of *N.mesoprion*

higher when compared to that reported by Murty from Kakinada. The growth attained by this species from Kakinada is 140, 185 and 205 mm at the end of I-III years of life, whereas, the same from Bombay works out to be 147, 216 and 252 mm in the present investigation.

Using ELEFAN programme, Murty *et al.* (1992) reported the L_{00} and K of this species from Mumbai as 255 mm and 0.77 respectively while Chakraborty *et al.* (1995) using the same programme reported the asymptotic length and K of this species as 286 & 0.71 respectively. Weber and Jothy (1977) working on this species from Malaysia stated that this species attains 50-60, 125 and 156 mm in length at the end of I-III years of its life.

In the present investigation, four methods have been employed for the estimation of growth of which the growth parameters obtained by Bhattacharya and Gulland Holt gave slightly higher estimate of L_{00}. The other three methods gave more or less identical values of L_{00} and K.

The problems of estimating the natural mortality coefficient is well known in tropical multispecies multigear system. Thus a number of methods are to be tried to arrive at a reasonable estimate of 'M'. In the present investigation more or less same values were obtained by Pauly's and Cushing's method. Dwinponggo *et al.* (1986) obtained M of 1.73 for this species from Java Seas. Chakraborty (1996) estimated the 'M' of this species as 1.40, whereas Murty *et al.* (1992) estimated the values of M as 1.56 and 1.24 with lower L_{00} and higher L_{00} respectively.

Jones (1976) observed that selection factor of fish tend to range from 2-6 and once the selection factor has been determined for a given species and a particular cod end mesh size, it can be used to calculate L_0, the length at first capture for a given mesh and *vice versa*. The selection factor of 4.4 obtained in the present investigation is within the range suggested by Jones (1976).

Gulland (1971) has suggested the use of 0.5 as multiplication factor for the estimation of MSY. Garcia and Le Reste (1981) used values ranging from 0.32 - 0.44. Thus there appears to be no set rules for the estimation of MSY and the figures arrived at are subjective (Biradar, 1989).

The optimum age of exploitation of

this species at the present F is 0.7198 years which is slightly higher than the present t_0 of 0.6789 years. The yield per recruit study shows that increasing tc at the present level of fishing shows a decline in catches. If F is doubled and tc is increased by 20% the Yw/R goes up by 20.66%.

Commercial trawlers in Bombay at present operate up to a depth of 70 m. Silas (1969) and Zupanovic and Mohluddin (1976) have suggested that threadfin breams are more abundant at depths of 75-125 m. Thus instead of doubling the efforts or increasing the cod end mesh size it is better if fishing operations are carried out in deeper waters which may result in higher yield.

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