Growth, mortality and yield per recruit of threadfin bream
Nemipterus japonicus (Bloch) off Bombay

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The VBGF parameters in lenth for this species were estimated as $L_\infty = 356$ mm, $K = 0.75576$ per year and $t_0 = -0.0335825$ y. This speics grows to 193, 281 and 322 mm at the end of I-III years of its life. Total, natural and fishing mortality were calculated as 3.58, 1.55 and 2.03 respectively. The exploitation rate and ratios were 0.54 and 0.56 respectively. Total and standing stocks were estimated as 3047 and 810 tonnes as compared to the present yield of 1645 tonnes.

Nemipterus japonicus is one of the most abundant species that roughly contributes 60-65% of the total threadfin breams landed in Bombay. Information on growth, mortality and yield per recruit of this species is available from Visakhapatnam[1], Kakinada[2-4], Madras[5], Cochin[6] and Bombay[7].

Nemipterus catches were poor prior to 1985 period. As the depth of operation of commercial trawlers increased from 40 to 70 m, threadfin breams started making a significant contribution to the demersal catch at Bombay. The study carried out in Bombay[7] deals in data collected from 1983-85 period i.e., at a time when threadfin bream was not a major demersal resource. Present investigation was undertaken during 1989-.92 on growth, mortality and yield per recruit of *N. japonicus* from Bombay waters.

Weekly length frequency data were collected from shrimp trawler at New Ferry Wharf and Sassoon Docks landing centres of Bombay. A total of 6383 fish in length range of 80-324 mm was measured. The length frequency data was distributed in 10 mm class intervals and then raised for the day and subsequently for the month[8]. The 3 methods used for the study of growth were of ELEFAN Programme[9], Bhattacharya[10]/Gulland and Holt[11], and modal progression analysis[12] reading growth at monthly intervals.

Age at birth (t_0) was estimated by regression age t taken as X against $-\mathrm{Log}\, e\,(L_\infty - L_t)$ as Y. The total mortality coefficient Z and natural mortality coefficient M were estimated by Alagaraja[13] and Cushing's[14] models respectively. The exploitation ratio (E) and exploitation rate (U) were calculated by the formula given by Beverton and Holt[15].

The length at first capture (L_c) was calculated[15] and the same was converted to age at first capture (t_c). The yield per recruit was calculated[15,16].

The cod end mesh size of the shrimp trawlers presently in use is 25 mm. Taking length at first capture the selection factor (SF) was determined by $SF = L_c/MS$ the cod end mesh size of the gear in operation. A set of values of length at first capture (L_c) was converted to t_c (age at first capture).

Using the length weight formula $W = 4.74016478 \times L^{2.9300939}$ the asymptotic weight (W_∞) at asymptotic length (L_∞) of 356 mm was calculated as 543 g.

The growth parameters obtained by various methods are presented in Table 1. The asymptotic length (L_∞) obtained by ELEFAN and the growth coefficient (K) obtained by modal progression appears to be on the lower side. The L_∞ and K estimated by Bhattacharya/Gulland and Holt plot appears to be reasonable. (Fig. 1). For further studies these estimates of asymptotic length (L_∞) and growth coefficient (K) of 356 mm and 0.75576 per year were taken into consideration. The value of t_0 was taken as -0.0335825y. The species grows to 193, 281 and 322 mm at the end of I-III

Table 1—Growth parameters estimated by various methods

Method used/source ref	L_∞ (mm)	K/year	t_0 (year)
ELEFAN[9]	335	0.65	—
Bhattacharya[10]/			
Gulland Holt plot[11]	356	0.7557	—
Modal progression[12]	356	0.5902	−0.035

L_∞ = Asymptotic length; K = growth-coefficient; t_0 = age at birth

Table 2—Mortality, yield and stock parameters of *N. japonicus*

Year	Z	M	F	E	U	Yield	Y/F	Y/U
1989-90	3.88	1.55	2.33	0.6	0.59	1625.85	697.78	2755.6
1990-91	3.61	1.55	2.06	0.57	0.55	2101.72	1020.25	33821.3
1991-92	3.25	1.55	1.70	0.52	0.49	1209.73	711.6	2468.8
Average	3.58*	1.55	2.03	0.56	0.54	*1645.76	810.71	3047.7

*Average is for Z and yield only

Z, M and F are instantaneous rates of total, natural and fishing mortality coefficients

U and E are the exploitation rates and ratios respectively

Standing and total stocks have been derived from the relationship Y/F and Y/U where TY is the yield in tonnes

years of its life. The VBGF equation in length for this species could thus be written as

$$L_t = 356 [1 - e^{-0.75576 (t - (-0.35825))}]$$

The L_∞ of 356 mm is close to the largest fish of 324 mm observed in the catch.

The total mortality coefficient (Z) varied from 3.25 to 3.88, the average for three year period being 3.58 (Table 2). The natural mortality coefficient (M) was calculated as 1.55. Thus the fishing mortality coefficient (F) was obtained at 2.03. Using VBGF the age at recruitment (t_r) and age at first capture (t_c) length at recruitment (L_r) of 80 mm and length at first capture (L_c) of 118 mm were calculated as 0.32 and 0.6588 y respectively. (Fig. 2).

At the present fishing mortality (F) of 2.03 the yield per recruit is 25.067 g. Beyond F of 2.2 there is a decline in the catch. By increasing the cod end mesh size by 10% at the present fishing mortality the Y_w/R goes up to 26.095 g, showing an increase of 4.10%. Similarly by increasing the cod end mesh size by 20, 30 and 40% the present yield per recruit (Y_w/R) goes up by 7.26, 9.41 and 10.38% respectively.

Average total and standing stocks were estimated as 3047.7 and 810.7 tonnes as compared to the present yield of 1645.76 tonnes. The exploitation ratio (U) and exploitation rate (E) were calculated as 0.56 and 0.54 respectively.

The growth parameters estimated from different localities (Table 3) shows that there is a wide difference in the parameters arrived at by different researchers. Physiochemical differences do not account for such a vast disparity. The asymptotic length estimated from Bombay is 298 mm. This appears to be very much on the lower side as in the field specimens upto 310 mm are common. The main reasons for this low L_∞ may be that the data pertains to 1983-85 period when the depth of operation of shrimp trawlers was up to 40 m only. Thereafter, it was extended to 70 m and this
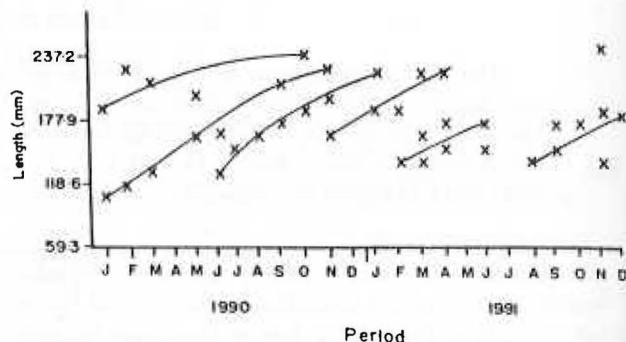

Fig. 1—Mean lengths connected for assumed cohorts for estimation of growth by Bhattacharya's method
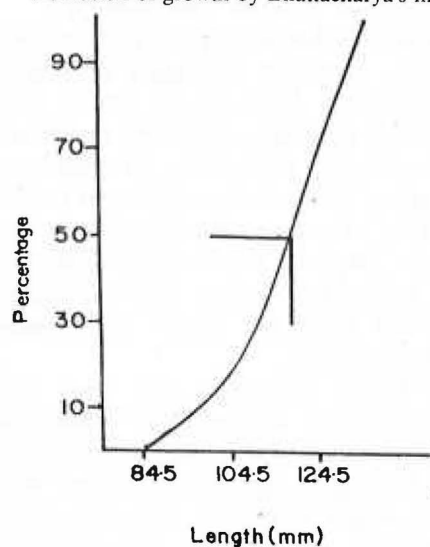

Fig. 2—Calculation of length at first capture for *N. japonicus*

resulted in high catch and larger size of this resource.

The ratio of natural mortality and growth coefficient (M/K) of fish should normally range between 1-2.5. For the present investigation the same was found to be 2.03 which is well within the range suggested[17].

The yield per recruit study shows that at the present age of capture there is little scope for in-

Table 3—Age and growth study of *N. japonicus* from various localities of India

Locality/source	L_∞ (cm)	K (yearly)	M
Visakhapatnam[1]	30.5	0.314	0.504
Kakinada[2]	31.4	0.751	1.142
Kakinada[3]	33.9	0.52	1.11
Madras[5]	30.5	1.004	2.525
Kerala[6]	32.6	0.51	1.0
Bombay[7]	29.8	0.8214	1.31
(Bombay present study)	35.5	0.76675	1.55

L_∞ = Asymptotic length in cm, K = Growth coefficient per year, M = Natural mortality coefficient
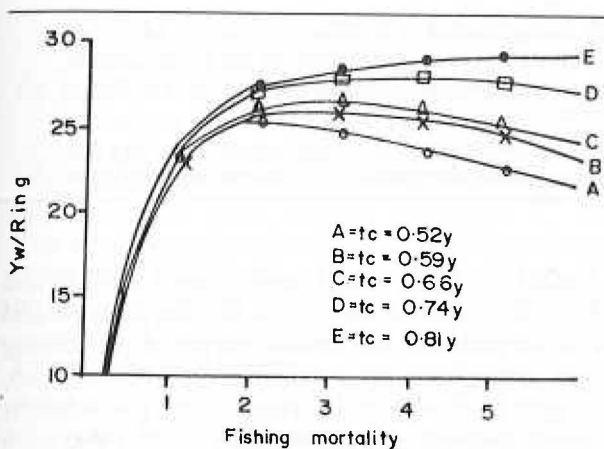
Fig. 3—Yield per recruit in g at various level of 'F' and t_c

creasing the catch by putting up more efforts (Fig. 3). At present fishing mortality of 2.03, the exploitation is 0.5608 which is already beyond the optimum exploitation ratio of 0.5 as suggested by Gulland[19]. Thus the yield can only be increased by changing the cod end mesh size of the commercial trawlers.

For *N. japonicus* Silas[20] and Zupanovic and Mohiuddin[21] have stated that they are more abundant at 75-125 m depth. The present depth of operation of the commercial trawlers off Bombay is up to a 70 m depth. The catches of threadfin breams can perhaps be increased if the fishing efforts are carried out in deeper waters.

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