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Population dynamics of sciaenid *Johnius macrorhynus* (Pisces/Perciformes/Sciaenidae) from Bombay waters*

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von Bertalanffy's growth equation was used to describe growth of *Johnius macrorhynus* (Mohan). The values estimated were $L_\infty = 331$ mm, $K = 0.5415$ (annual) and $t_0 = -0.07876$ y and $W_\infty = 323$ g. This species reached 143, 224 and 270 mm at the end of I, II and III years of its life respectively. The average total, natural and fishing mortality coefficients were 2.87, 1.18 and 1.69 respectively. Exploitation rate and ratio were 0.555 and 0.588 respectively. Yield per recruit study showed that at the present level of age of capture (t_c) of 0.9261 years and fishing mortality (F) 1.69 the Y_w/R is 17.71 g. Average total and standing stocks were estimated as 2286.50 and 750.89 ton respectively as compared to the present average yield of 1269.01 ton.

Sciaenids roughly contributes 8-10% of the total fish catch at Bombay. Various aspects of sciaenids have been studied from different localities of India[1-8]. The present communication deals with the age, growth, mortality, yield per recruit and stock assessment of *Johnius macrorhynus* (Mohan) from Bombay coastal waters.

Materials and Methods

The study is based on the length frequency data collected from 7007 specimens (length range 90-310 mm) from the commercial landings. Data were grouped in 10 mm class intervals for the study of growth parameters and raised for the day and subsequently for the month[9]. For the study of growth modal progression analysis[10] was used. Growth was expressed by von Bertalanffy's[11] equation:

$$L_t = L_\infty\,[1 - e^{-K(t-t_0)}]$$

L_∞ and K were estimated by Ford-Walford[12,13] plot and t_0 was calculated by regression of $\log_e[(L_\infty - L_t)/L_\infty]$(Y) against age t(X). The instantaneous rate of total mortality coefficient Z and the natural mortality rates (M) were calculated[14,15]. Fishing mortality rate was calculated by subtracting M from Z. The exploitation ratio (E) and exploitation rate (U) were calculated following Beverton and Holt[16].

Total and standing stocks were derived from the formula Y/U and Y/F respectively. The maximum sustainable yield (MSY) was calculated[17]. Here a multiplicative factor of 0.4 was used instead of 0.5. Asymptotic weight (W_∞) was calculated at asymptotic length (L_∞) using the length weight relationship. The smallest fish recorded in the catch was taken as length at recruitment (L_r). Using VBGF the same was converted to age at recruitment (t_r). The length at first capture was derived as per Beverton and Holt[16]. The yield in weight per recruit (Y_w/R) was calculated by Beverton and Holts[16] formula given as

$$Y_w/R = Fe^{-M(t_c - t_r)}W_\infty\left(\frac{1}{Z} - \frac{3S}{Z+K} + \frac{3S^2}{Z+2K} - \frac{S^3}{Z+3K}\right)$$

where $S = e^{-K(t_c - t_0)}$

The selection factor (SF) of the gear in question was calculated as per Jones[18] formula given as SF = present length at first capture (L_c)/present cod end mesh size. The cod end mesh size of the shrimp trawl in operation was 25 mm.

Results and Discussion

Eleven growth curves of almost identical shapes were obtained in the scattergram (Fig. 1). Taking average of the same, growth was read at quarterly intervals for fitting the Ford-Walford[12,13] plot. By applying the method of least square the L_∞ and K were calculated as 331 mm and 0.5415 (annual).

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The t_0 was calculated as -0.07876 years. This species attains 143, 224 and 270 mm at the end of I, II and III years respectively of its life. The VBGF formula for this species could thus be written as

$$L_t = 331\left[1 - e^{-0.5415(t-(-0.07876))}\right]$$

The Ford-Walford plot and growth curve of this species are presented in Figs 2 and 3.

The total mortality coefficient (Z) varied from 2.19 to 3.78 with average being 2.87. The natural mortality coefficient (M) was calculated as 1.18. Fishing mortality coefficient varied from 1.01 to 2.60 with an average of 1.69. The average exploitation rate and ratios were 0.555 and 0.588 respectively. Average total and standing stocks were estimated as 2286.50 and 750.89 ton respectively, as compared to the present yield of 1269.01 ton and MSY of 862.02 ton (Table 1).

The length at first capture were 90 mm and 135 mm at which, employing VBGF, the ages were calculated as 0.561 and 0.9261 Y respecti-

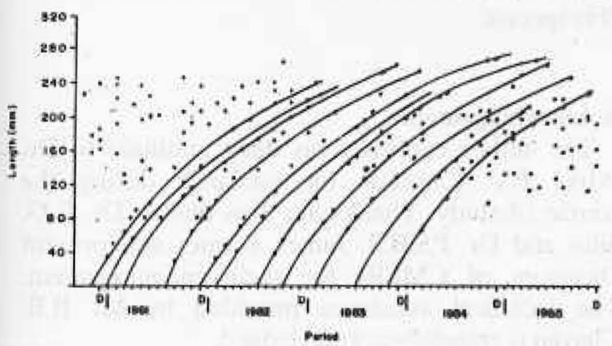

Fig. 1 – Scattergram of modal length of *J. macrorhynus*

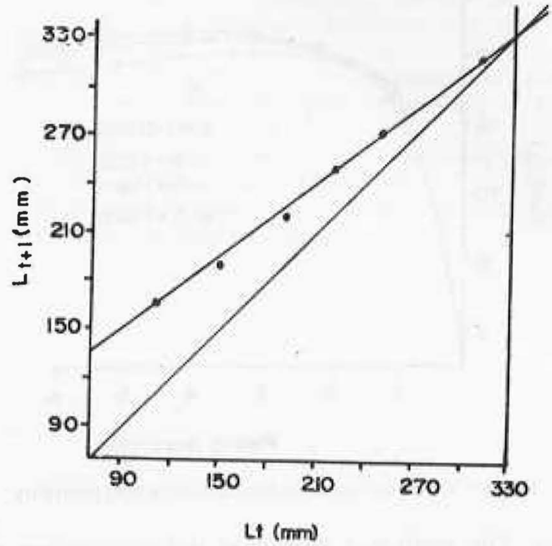

Fig. 2 – Ford-Walford plot for *J. macrorhynus*

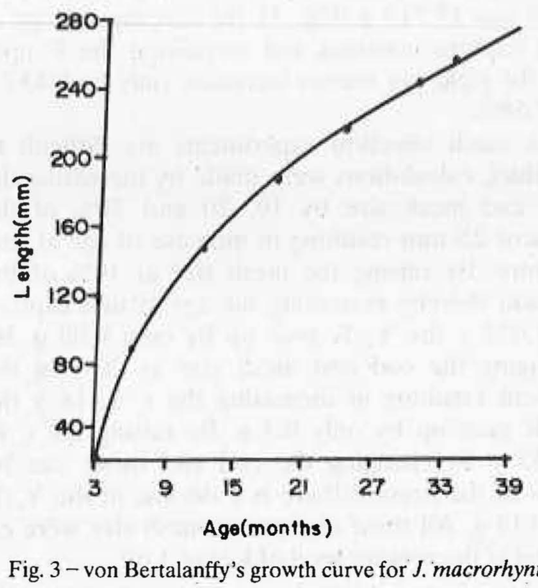

Fig. 3 – von Bertalanffy's growth curve for *J. macrorhynus*

Table 1 – Mortality, yield and stock parameters of *J. macrorhynus*

Year	Z	M	F	U	E	Yield (ton)	Total stock (Y/U) (ton)	Standing stock (Y/F) (ton)	MSY
1979-80	2.72	1.18	1.54	0.528	0.566	1239.20	2346.97	804.67	875.48
1980-81	2.19	1.18	1.01	0.409	0.461	1325.79	3241.54	3209.44	2045.17
1981-82	2.87	1.18	1.69	0.555	0.588	1746.59	3147.00	1862.13	1577.56
1982-83	2.77	1.18	1.59	0.538	0.574	1173.67	2181.54	1372.03	1117.06
1983-84	3.78	1.18	2.60	0.672	0.688	888.48	1322.14	508.51	595.41
1984-85	2.94	1.18	1.76	0.566	0.598	1240.33	2191.39	1245.10	1083.82
Average	2.87*	1.18	1.69	0.555	0.588	*1269.01	2286.50	750.89	862.02

* Average is for Z and yield only

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

E and U are the exploitation ratio and exploitation rate respectively.

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

MSY is the maximum sustainable yield in ton.

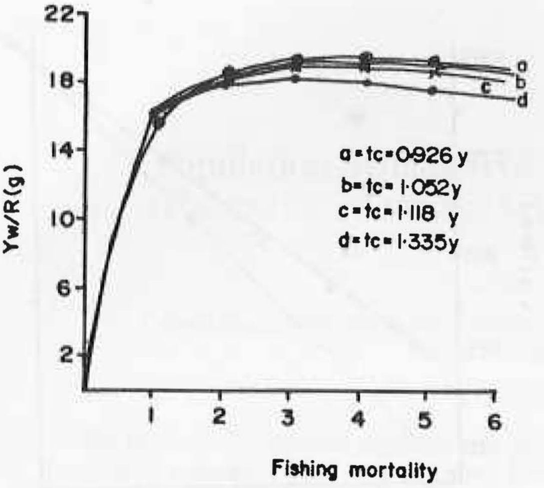

Fig. 4 – Yield per recruit as function of fishing mortality

vely. The yield per recruit at the present age of first capture of 0.9261 y and fishing mortality of 1.69 was 17.719 g (Fig. 4). By keeping the age at first capture constant and increasing the F upto 2.6 the yield per recruit increased only by 0.457 g or 2.58%.

As mesh selection experiments are difficult to conduct, calculations were made by increasing the cod end mesh size by 10, 20 and 30% of the present 25 mm resulting in increase of age at first capture. By raising the mesh size at 10% of the present thereby increasing the age at first capture to 1.052 y the Y_w/R goes up by only 0.08 g. By changing the cod end mesh size at 20% of the present resulting in increasing the t_c 1.118 y the Y_w/R goes up by only 0.3 g. By raising the t_c to 1.335 y by changing the cod end mesh size by 30% of the present there is a decline in the Y_w/R by 0.14 g. All these changes in mesh size were effected at the present level of F at of 1.69.

In tropical multispecies multigear systems estimation of M is the most difficult one. As precise data on effective efforts of a particular species is not available the conventional method of estimation of natural mortality by Z against efforts often gives erroneous results including negative ones[19]. The rough generalization is that fish with a high K value would have high M and *vice versa.* The argument behind this concept is that slow growing fish (with a low K) cannot bear high natural mortality and if it happens the species would soon be extinct[20].

The M/K ratios of a fish[21] mostly range from 1-2.5. In the present study it was found to be 2.18 which is within the values of M/K ratios suggested. From Kakinada waters[7] M of *J. carutta* has been estimated as 1.

That species has L_∞ of 333 mm which is very close to that of 331 mm obtained for *J macrorhynus* in the present study.

The selection factor of 5.4 obtained in the present study is within the range of 2-6 suggested by Jones[18]. From the Gulf of Thailand[18] the selection factor of 3.2 was obtained for *J. carutta* with a cod end mesh size of 3.2. However, if SF of 3.2 is taken for the present study L_c would come to 80 mm which would be less than the length of recruitment obtained in the present study.

Increasing the F to 2.6 results in increase of yield per recruit by only 0.457 g or 2.58% and changing cod end mesh size thus resulting in age at first capture also does not raise the Y_w/R appreciably.

Gulland[22] suggested that a species appears optimally exploited (Eopt) if the exploitation ratio is upto 0.5. The E of this species is 0.588 which is already beyond the Eopt and increasing F and t_c does not result in corresponding higher yields. Thus it would be better if the fishing efforts are brought down slightly from the present level so that there is no detrimental effect to the stock of this species.

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