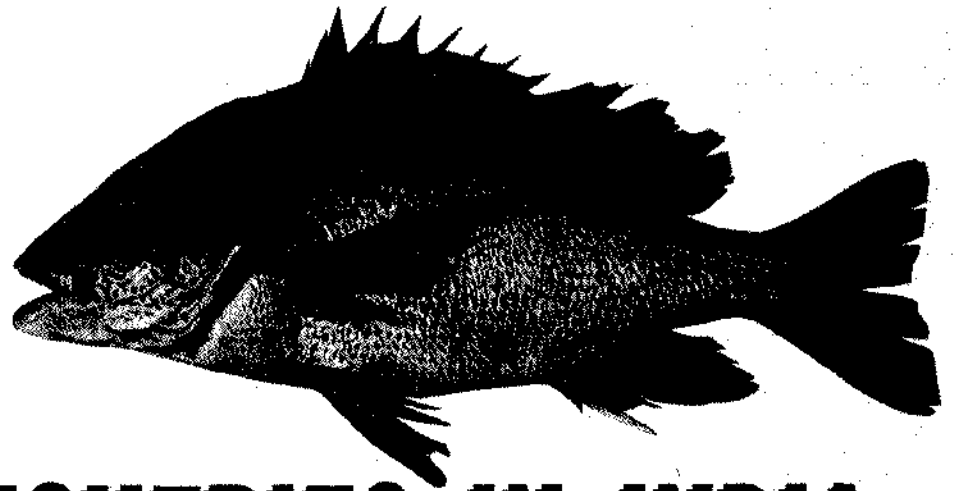
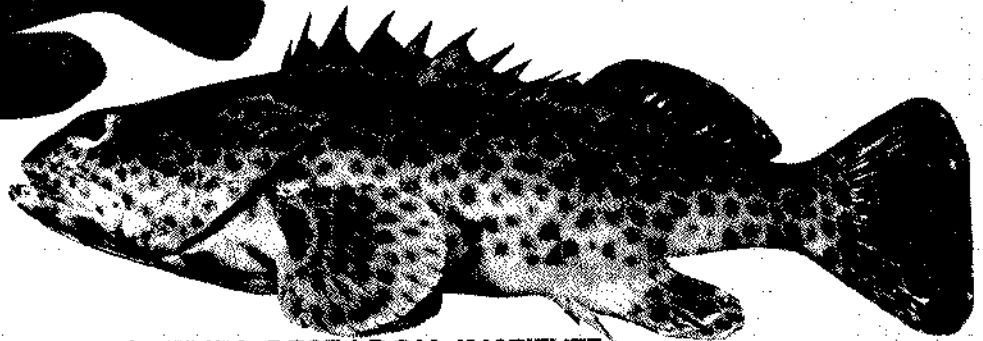


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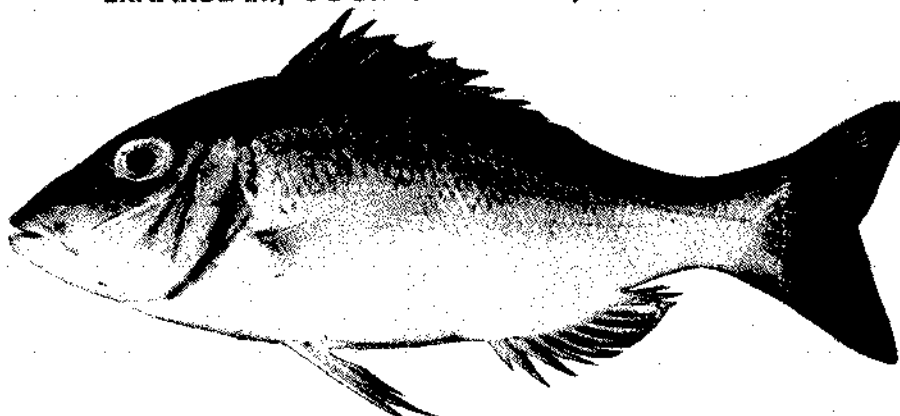


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AGE, GROWTH, MORTALITY AND STOCK ASSESSMENT OF *EPINEPHELUS DIACANTHUS* (VALENCIENNES) FROM BOMBAY WATERS

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ABSTRACT

The age, growth, mortality, yield and stock estimates of *Epinephelus diacanthus* is reported in this communication. Using the length frequency data 1989 to 1992, the L_{∞} was estimated as 502 mm and K as 0.16 on annual basis. This species grows to 229, 354, 421, 458, 478 mm at the end of I - V years of its life span. The total, natural and fishing mortality coefficients were estimated as 1.94, 1.15 and 0.79 respectively. The exploitation rate and ratio was found to be 0.3486 and 0.4072 respectively. The total and standing stocks were estimated as 1815.54 and 801.13 t and MSY 368.5 t as compared to the present yield of 632.9 t.

The age at first recruitment (t_r) and the age at first capture worked out to be 0.4054 and 0.67 years respectively. The W_{∞} was estimated as 1870 gm. The yield per recruit was estimated as 84.25 gm at the present level of $F = 0.79$. The yield per recruit study indicate that the 'F' can almost be doubled to 1.46 to get an Y_w/R of 91.906 gm. But as the gain in Y_w/R would be only 7.45 gm increasing the fishing efforts to that level is not advisable.

INTRODUCTION

Perches are one of the most important resources on the Northwest coast of India. Occurring as by-catch of shrimp trawl, the exploitation of this resources is restricted upto the depth of 70 m. During 1982 - 85 the total catch from Maharashtra Coast was 6508 t contributing 11% in the all-India perch catch. Species of the family Serranidae are widely distributed in the Indian Seas. At Bombay amongst the roughly half a dozen species of *Epinephelus*, *E. diacanthus* is the most dominant and occurs regularly in catch atleast for nine months barring the monsoon months of June - August.

The work on the age, growth and stock assessment on the members of the family from Indian waters is perhaps very scanty. From other places work on this family has been done - *Diacanthus labrax* from Southern Ireland

by Holden and William (1974), *E. guttatus*, *E. striatus*, *Cephalopholis fulva* and *Mycteroperca veneosa* by Thompson and Munro (1977) from Jamaican Reefs and *E. sexfaciatus* from Visayansca by Ingles and Pauly (1984).

In the present communication the age, growth, mortality yield and stock parameters of *Epinephelus diacanthus* (Valenciennes) is reported.

MATERIAL AND METHODS

Weekly length frequency, catch and effort data were collected from Sassoon Dock and New Ferry Wharf landing centres of Greater Bombay from 1989 to 1992. After grouping them in 10 mm class intervals, the length frequencies in each length groups were raised for the day and subsequently for the month using the method of Sekharan (1962). The growth parameters were estimated Elefan programme (Gayanilo *et al.*, 1988). This method does not give an estimate of t_0 . The instantaneous rate of total mortality Z was calculated by length converted catch curve method of Pauly (1982) using the relationship.

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$$\text{Log } e (N/\Delta t) = a + b.t$$

Where "Δ t" is the time taken to grow from the lower limit to the upper limit in each length class and N is the numbers caught in each length group, a is the Y-axis intercept, b = Z with the sign changed and t is the mid point in each length group. Here only the descending right limb of the curve is taken for the estimation of Z. The length frequency distribution was smoothened by a three point moving averages in each length groups. The natural mortality coefficient (M) was estimated by Cushing's (1968) formula. Here in the unexploited state if the number of one year olds are taken as 100 and numbers surviving to maximum age (T_{max}) as one, then the formula could be written as

$$M = \frac{1}{T_{max} - 1} \log e \frac{100}{1}$$

The largest fish observed in the catch in the present study was 478 mm. Using VBGF the age of that fish was determined as 4.98 years. By taking this as T_{max} the M was estimated as

$$M = \frac{1}{4.98 - 1} \log e \frac{100}{1} = 1.15$$

$$E = \frac{F}{F + M} \text{ and } U = \frac{E}{Z} (1 - e^{-Z})$$

as given by Beverton and Holt (1957).

The smallest fish observed in the present study was 110 mm. Using VBGF the age of this fish was calculated as 0.4406 year. This was taken as age at first recruitment (t_r). The age at first capture (t_c) was estimated by plotting cumulative percentages as the mesh selection operates in fishes whose size is lower than the first mode (Beverton and Holt, 1957). Using the length - weight formula the W_{∞} at L_{∞} of 502 mm was calculated as 1870 gm. The per recruit was calculated by using the formula.

$$Y = F.R.w_{\infty} e^{-M(t_c - t_r)} \left[\frac{1}{F+M} - \frac{3eK^{(t_c - t_r)}}{F+M+K} + \frac{3e^{-2K(t_c - t_r)}}{F+M+2K} - \frac{e^{-3K(t_c - t_r)}}{F+M+3} \right]$$

as given by Beverton and Holt (1957) and Gulland (1956, 1969). This calculation was done on computer using LFSA programme as given by Sparre (1987). The maximum sustainable yield was estimated by Gulland's (1971) formula given as $MSY = 0.4 \times M.Bv$. Here 0.4 was used as multiplier instead of 0.5.

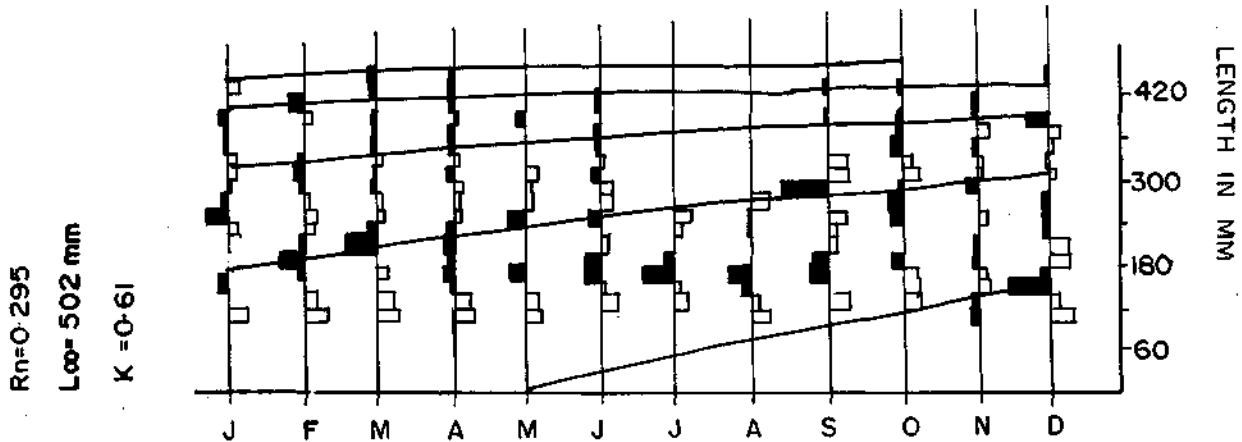


Fig. 1. Growth curve of *E. diacanthus* as estimated using Elefan programme.

The instantaneous rate of fishing mortality F was obtained by subtracting M from Z given as $F = Z - M$. The exploitation ratio E and exploitation rate U were calculated by the formulae

RESULTS AND DISCUSSION

Using Elefan method the L_{∞} and K for *E. diacanthus* were estimated as 502 mm and 0.61 on annual basis ($R_n = 0.295$) (Fig. 1). This

species in Bombay waters grows to 229, 354, 421, 458 and 478 mm at the end of I-V years

The natural mortality coefficient was estimated as 1.15 and the fishing mortality coefficient as 0.79.

TABLE 1. The mortality, yield and stock parameters for *E. diacanthus*

Year	Z	M	F	U	E	Yield in tonnes	Total stock	Standing stock	MSY
1989-90	2.16	1.15	1.01	0.4135	0.4675	768.15	1643.1	760.54	349.84
1990-91	1.55	1.15	0.40	0.2032	0.258	435.99	2145.62	1089.97	501.38
1991-92	2.10	1.15	0.95	0.3969	0.4523	694.57	1749.98	1842.08	847.35
Average	1.94	1.15	0.79	0.3486	0.4072	632.9	1815.54	801.13	368.51

of its life. The L_{∞} of 502 mm is close to the largest fish of 478 mm observed in the catch.

The exploitation ratio (E) and exploitation rate (U) were calculated as 0.4072 and 0.3486 respectively.

The VBGF growth formula in length for this species could thus be written as

$$L_t = 502 (1 - e^{-0.61(t-t_0)})$$

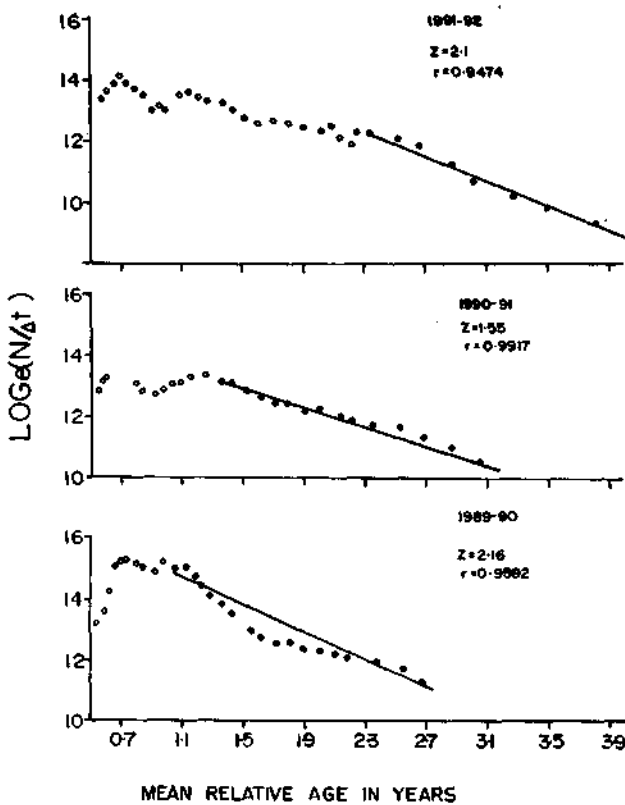


Fig. 2. Length converted catch curve for the estimation of Z for *E. diacanthus*.

The total mortality coefficient varied from 1.55 in 1990 - 91 to 2.16 in 1989 - 90 (Fig. 2). The average Z for three years being 1.94 (Table 1).

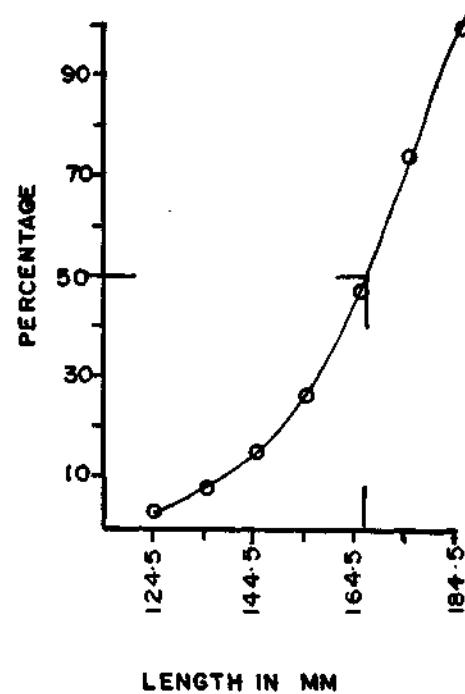


Fig. 3. Selection curve to determine at first capture.

The total and standing stocks were estimated as 1815 and 801 t as compared to present average yield of 632.9 t, the combined yield of Sassoon Dock and New Ferry Wharf taken together (Table 1). The MSY was estimated as 368.51. Using the length-weight relationship the W_{∞} at L_{∞} of 502 mm was calculated as 1870 gm. By applying VBGF, the age at recruitment (t_r) and capture (t_c) were estimated as 0.4406 and 0.67 year respectively (Fig. 3). The yield per recruitment is given in Fig. 4.

The Yw/R at the present level of F 0.79 is 84.45 gm as compared to 91.9 gm at F_{max} of 1.46. But a steady decline in the biomass per recruit is observed.

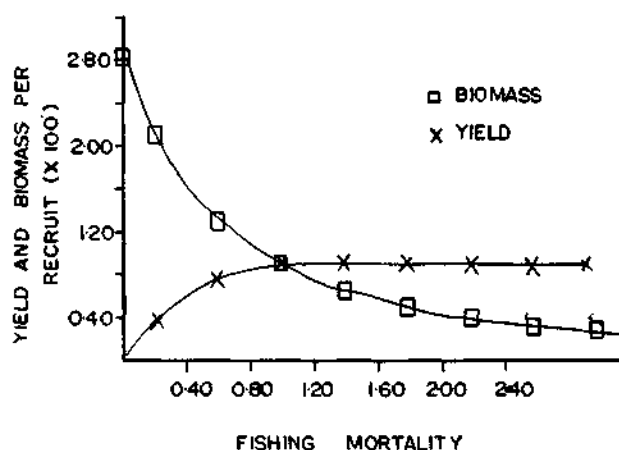


Fig. 4. Yield and biomass per recruit for *E. diacanthus*.

Published account on the age, growth and stock studies on this species from Bombay waters is not available for comparison with work done by other workers on this species. For *E. guttatus* reported by Thompson and Munro (1977) from Jamaican Reefs the L_{∞} is 520 mm, $K = 0.24$, $M = 0.68$ and W_{∞} is 1880 gm. While the length and weight infinities obtained are comparable to that obtained in the present study, the M and K appear to be on the lower side. As the other species of Serranidae worked out either grows much smaller or larger than *E. diacanthus* of Bombay, the parameters cannot be compared. FAO (1984) reports that *E. diacanthus* grows to a maximum size of 520 mm which is well within the limits of L_{∞} of 502 mm and largest fish of 478 mm observed in the catch.

The total mortality coefficient Z was found to be low in 1990-91 whereas in the other two years viz. 1989-90 and 1991-92 it was more or less same. The chief reason for low value of Z may be declined in the catch in 1990-91 (Table 1).

The estimate of natural mortality in tropical multispecies, multigear system presents a large number of problems. As this species is highly carnivorous, growing to large size, having

a broad girth and strong dorsal spine, the possibility of this being predated upon by other species is rare. The M of 1.15 appears to be reasonable.

The MSY of 368.5 t was estimated taking a multiplication factor of 0.4. Gulland (1971) has suggested the use of 0.5 as the multiplier. But the usage of 0.5 as multiplier has been criticised by many authors (Francis, 1974; Buddington and Cooke, 1983; Caddy and Crsike, 1983; Garcia *et al.*, 1987). Garcia and Le Reste (1981) used values ranging from 0.32 to 0.44. Sparre (1988) suggested a factor of 0.2. Thus the estimate of MSY arrived at is subjective and there is no hard and fast rule on the multiplicative factor.

The yield per recruit study shows that the fishing efforts could be nearly doubled to 1.46 from the present 0.79 to Yw/R of 91.9 gm. However, by doubling the efforts the Yw/R would increase only by 7.45 gm which would not give much economic returns. The optimum value of exploitation ratio (E_{opt}) is about roughly equal to 0.5 (Gulland, 1971). This gives a rough idea if the stock of a fish is optimally exploited or not. For *E. diacanthus* the exploitation ratio appears well below the E_{opt} . So there appears to be no threat as to the depletion of stock for this species. At present the fishing operation of most of the commercial trawlers is restricted to the depth of 70 m. Joseph and John (1986) have suggested good grounds of perches in 75-225 m range along NW coast and along upper east coast. They have also computed that perches have an estimated potential of around 2.5 lakh tonnes and the present production of perch is only 26% of that. Thus increase of this resource could be achieved by going for fishing beyond 70 m.

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