GROWTH AND YIELD PER RECRUIT OF *JOHNIUS* (*JOHNIUS*) *CARUTTA* BLOCH IN THE TRAWLING GROUNDS OFF KAKINADA

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ABSTRACT

The growth of *J. carutta* can be described by the von Bertalanffy growth formula, with parameter values: L_{∞} = 333.3 mm; K = 0.44 per year; and t_0 = —0.0002 year. The Instantaneous rates of mortality are estimated at Z = 5.07, M = 1.0 and F = 4.07. The Yield per recruit analysis shows that the yield can be increased by increasing the cod-end mesh size of the trawl nets.

INTRODUCTION

Among the sciaenids landed by commercial trawlers at Kakinada, *Johnius* (*Johnius*) *carutta* Bloch is one of the most dominant species. In an earlier paper, Murty (1984) has considered some aspects of biology of this species. The present paper deals with the estimation of growth parameters, mortality and Yield per recruit on the basis of data collected from commercial trawlers during 1980-83.

Among the past attempts to estimate age and growth of sciaenids from India, those which have estimated the parameters of growth are confined to two species, namely *Pseudosciaena diacanthus* (K. S. Rao 1971, K. V. S. Rao 1961, 1971a, 1971b) and *Otolithoides brunneus* (Kutty 1961, Jayaprakash 1978) from the west coast of India. There is practically no information on age and growth of *J. carutta* from anywhere along the Indian coast. Further, except for the work of Rao, K. V. S. (1971b) on mortality and Yield per recruit of *P. dicanthus* from Bombay, there is no information on the population dynamics of any sciaenid species of India.

MATERIAL AND METHODS

Data on catch and effort from the commercial trawlers were obtained for 18-20 days in a month and samples for biological studies were collected at weekly intervals. Data on length-frequency distribution collected on all the observation days in a month were weighted to get the monthly length-frequency distribution in the catch.

The length-data were grouped into 10 mm-class intervals and the mid-point in each group was taken to study growth. Growth in length was estimated using the integrated method of Pauly (1980a) drawing growth curves passing through several modes in the monthly length-frequency distribution. The von Bertalanffy equation for growth in length:

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

where L_∞ is asymptotic length, K is growth coefficient and t_o is origin of growth curve, was used to estimate parameters of growth. Estimates of L_∞ and K were made using the relation:

$$L_{t+1} = L_\infty (1-e^{-K}) + e^{-K} L_t$$

and t_o was estimated using the relation:

$$-\log e \left(\frac{L_\infty - L_t}{L_\infty} \right) = -Kt_o + Kt$$

Instantaneous rate of total mortality (Z) was estimated by the length-converted catch-curve method of Pauly (1982) using the relation: $\log_e (N/\triangle t) = a + bt$, where $\triangle t$ is the time taken to grow from the lower limit to the upper limit of each length class, N = numbers caught in each length group, a = y-axis intercept, b = Z with sign changed and t = age of midpoint of each length group.

The natural mortality rate (M) was estimated using the relation Z = M + qf, where q is catchability coefficient and f the fishing effort, and also using the equation of Pauly (1980b):

$$\text{Log } M = -0.0066 - 0.279 \log L_\infty + 0.6543 \log K + 0.4634 \log T,$$

where L_∞ is in cm, K per year and T in °C. The value of T was taken as 27.2°C from Ganapati and Murthy (1954) and La Fond (1958).

The yield in weight per recruit (YW|R) was estimated from the equation of Beverton and Holt (1957):

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

where $S = e^{-K(t_c - t_o)}$, t_c = age at first capture and t_r = age at recruitment to the fishing ground.

Estimation of Growth Parameters

In total, 8540 specimens ranging from 75 to 225 mm were measured during 1980-83. The monthly length-frequency distribution in *J. carutta* (**Fig. 1**) showed that modal lengths in different months varied from 95 to 215 mm. While drawing the growth curves, the modal lengths which were likely to fall in a curve were joined first and then the line was extended both upwards and downwards to complete the curve. Six growth curves (A-F; Fig. 1) were identi-

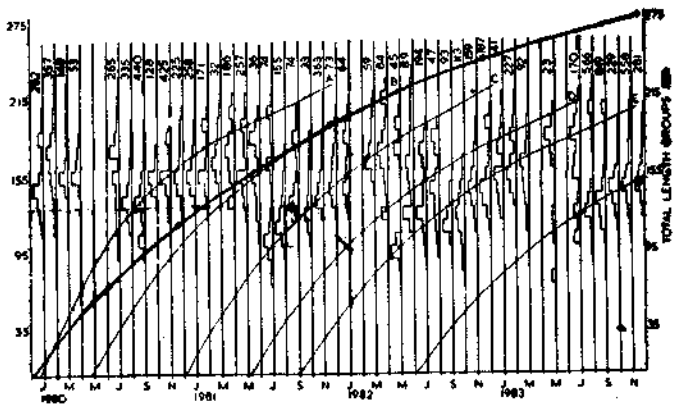

FIG. 1. Monthly length-frequency distribution of *J. carutta* showing the growth traced by growth curves. The von Bertalanffy growth curve is shown by thick line (Numerals indicate the number of specimens measured in each month).

fied in the data of the 4-year period and they were of the same shape. For studying the growth, the smallest modal length in a curve was taken as the starting point (shown by small dots in Fig. 1) and from there the curve was marked at intervals of six months and the lengths attained at half-yearly intervals were taken. Care was however taken to include in the analysis the portion of growth curves only when there was a mode between two half-year intervals or beyond. The values thus taken (Table 1) were used to estimate the parameters of von Bertalanffy growth equation.

A plot of L_{t+1} against L_t as read off the different growth curves showed that the observed points were wall-represented by the straight line ($r^2 = 0.97$). From the value of the slope ($= e^{-K}$) of the regression, the value of K was estimated as 0.22 per half year and then as 0.44 per year. The estimated value of L_∞ was 333.3 mm. The value of t_0 was estimated as −0.0002 year.

The estimated lengths of *J. carutta* at the completion of I, II, III and IV years were 119, 195, 244 and 276 mm, respectively (Fig. 1). Since the maximum length observed in the catch was 255 mm, the maximum age in the fishery worked out to 3.3 years.

TABLE 1. *Details of lengths (mm) read off different growth curves in figure 1 at intervals of 6 months.*

Curve	Initial length	Length at six months	Length at 12 months	Length at 18 months
A	135	181	215	—
B	142	183	215	—
C	100	150	188	—
D	125	165	193	—
E	95	140	175	201
F	121	157	—	—

ESTIMATION OF MORTALITY RATES

Total mortality rate (Z): The points that represented the straight, descending part of the length-converted catch curve (Fig. 2) were taken into account for estimating total mortality rates. The estimated values of Z during different years and the average worked out are as follows:

	Z
1980	5.0589
1981	4.4247
1982	5.6504
1983	5.1651
Average	5.0748

Estimation of natural mortality rate (M): A plot of Z against effort (Fig. 3) showed that there was good correlation (r^2 = 0.50) between effort and Z with the estimated value of M at 2.05 and q at 0.000059533. But the above value of M gave M|K value of 4.66, a value much beyond the range (1.0-2.5) known in fishes (Beverton and Holt 1959). This value, thus appearing to be an over-estimate, was considered to be unrealistic and, therefore, the value of M estimated by the formula of Pauly, being 1.0 with M|K at 2.3, was taken.

Fishing mortality rate: The present fishing mortality rate, derived from the values of Z and M estimated above, was 4.07.

ESTIMATION OF YIELD PER RECRUIT

Using the length-weight relationship (Murty 1984) of the species and the L_∞ value obtained, the value of W_∞ was estimated to be 529 g. The

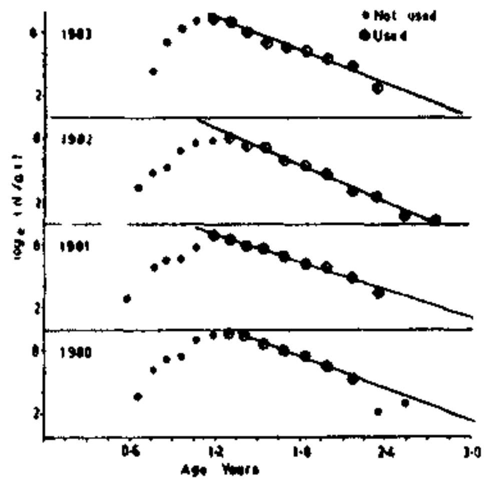

FIG. 2. Estimation of 'Z' by length-converted catch curve method in *J. carutta.*

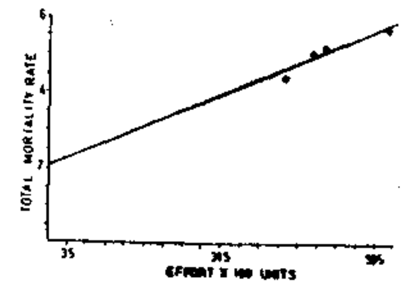

FIG. 3. Plot of Z against effort to estimate M in *J. carutta.*

smallest fish observed in the catch was 70 mm and therefore the age, estimated of it, i.e., 0.536 year, was taken as the age at recruitment (t_r). The annual length-frequency distribution of catch during the 4-year period showed the smallest mode at 135 mm and, hence, 130 mm (lower limit of 135 mm-group) was taken as the length at first capture. The t_c was calculated as 1.123 years.

The Yield per recruit with M at 1.0 and the five values of t_c ranging from 1.014 to 1.486, respectively representing l_c values at 120, 130, 140, 150 and 160 mm (Fig. 4A), showed that the Yield per recruit increased with increased t_c. It was also observed that, with t_c at 1.014, the Yield per recruit reached its maximum (20.6 g) when F was 1.6, and then on slowly decreased with further increase in F. With t_c at 1.123 (present value), the Yield per recruit reached its maximum (21.5 g) when F was 2.0. With the t_c values at 1.238 and 1.359, maximum Yield per recruit (22.3 and 23.1 g, respectively) was at F = 2.4 and 3.0, respectively. With t_c at 1.486, the yield increased with increasing F and reached maximum (23.7 g) when F was 4 and decreased slowly with further increase in F. Thus, the Yield per recruit not only increased with greater values of tc, but also reached its maximum at higher values of F if t_c was higher. The estimated values of present F and t_c were 4.07 and 1.123, respectively; and the Yield per recruit had already shown a decline.

The Yield per recruit with M at 1.0 and F at 4.07, as a function of age at first capture (Fig. 4B), showed that it increased, reaching maximum (24.1 g) at t_c 1.7, and declined with further increase in t_c.

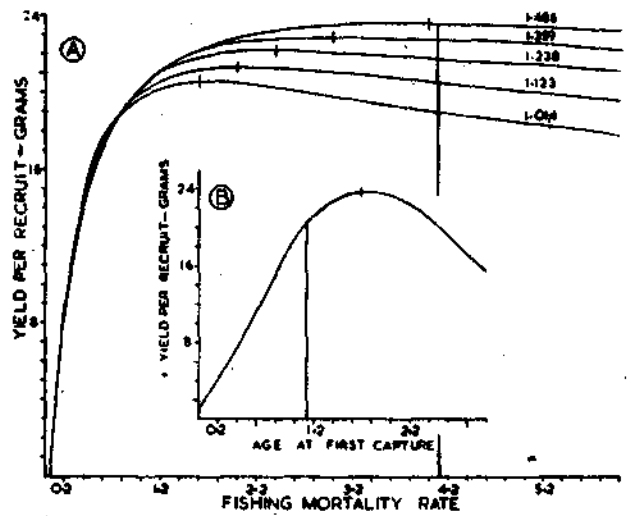

FIG. 4. A. Yield per recruit as a function of fishing mortality in *J. carutta.* The numerals indicate the tc values and the vertical line the present F. B. Yield per recruit as a function of age at first capture in *J. carutta.* The vertical line shows the present tc. (The small vertical lines on the curves in A and B indicate maximum YW|R values).

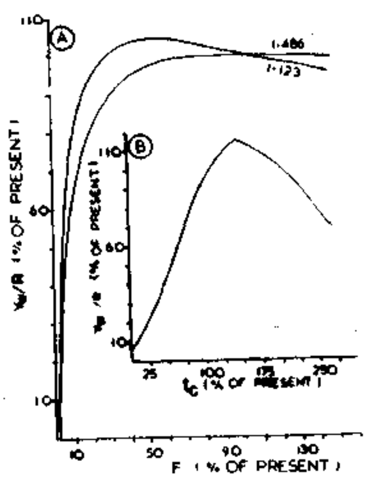

FIG. 5. Yield per recruit (as percent of present value), as A. function of fishing mortality (also as percent of present value), for two values of age at first capture. B. function at first capture (also as percent of present value).

It was observed (Fig. 5A) that if the fishing mortality rate was about 49% of the present value (of 4.07) and tc was 1.123, the Yield per recruit was 104.3% of the present value, and if the F was about 98% of the present value and tc 1.486, the Yield per recruit was about same as the present value (see also fig. 4A). It was also observed (Fig. 5B) that if the tc was 151% of the present value (1.123) and F was at 4.07 (also the present value), the Yield per recruit was 117% of the present value (Fig. 5B). It was thus clear that higher Yield per recruit could be obtained by one of the following:

i: decreasing the fishing mortality to 49% of the present value (by decreasing the fishing effort) without changing the cod-end mesh size

ii: increasing the age at first capture to 150% of the present value (by increasing the cod-end mesh size) without changing the fishing effort

iii: increasing both effort and cod-end mesh size.

Discussion

The study of growth in *Johnius carutta* is rendered difficult by the entry into the fishery of several broods over an extended period, and estimation of growth by following the modal progression in successive months is likely to lead to erroneous results, because there is no evidence to show that the modes interconnected really belong to the same brood. According to Pauly (1980a), however, the integrated method makes it quite hard to trace "wrong" growth curves, and the parameters obtained from such curves will describe the growth of at least the exploited part of a population well enough for most purposes.

Estimation of M of a particular species in a multi-species fishery by regression of Z on effort is not likely to lead to reliable results because of lack of knowledge on the effective effort for the species under consideration. It is perhaps for this reason that, though the correlation is good (Fig. 3), the M value obtained by the regression method is very much higher, particularly when viewed against the estimated growth parameters. The value obtained using the equation given by Pauly (1980b) appears to be a reasonable one for reasons mentioned above.

The yield per recruit analysis shows that under the current values of F (4.07) and tc (1.123) the yield has already shown decline, and that maximum yield can be obtained by reducing the effort to about 49% of the present. It also shows that greater YW|R is obtained at higher F for greater tc, which indicates that the yield can be maximised by increasing the cod-end mesh size without further increasing the effort (Figs 4 and 5).

In an earlier study (Murty 1984) the author had shown that the length at 50% maturity of this species was 155 mm and whose age was 1.422 years. In the present study the tc is at 1.123 years (lc = 130 m). Thus the need is apparent to increase the cod-end mesh size to get tc value above 1.4 years, so that the fish will get at least one chance to spawn before being caught in large numbers and it will help avert the possibility of recruitment overfishing at higher levels of F.

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