STUDIES ON THE GROWTH AND POPULATION DYNAMICS OF SILVERBELLY *LEIOGNATHUS BINDUS* (VALENCIENNES) IN THE TRAWLING GROUNDS OFF KAKINADA

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ABSTRACT

Leiognathus bindus attains average lengths of 72, 110 and 132 mm at the completion of first, second and third years, respectively. The parameters of von Bertalanffy growth equation are estimated as: Loc =; 158.4 mm, K = 0.58 per year and t, •= —0.024 year. Instantaneous rates of mortality are estimated as Z = 5.2, M = 1.5 and F = 3.7. The yield per recruit analysis shows that the yield of *L. bindus* can be increased by increasing the cod-end mesh size of trawl nets.

INTRODUCTION

Among the silverbellies landed by private trawlers at Kakinada, *L. bindus* is the most abundant species forming about 41% by weight. Aspects of biology of this species were studied earlier (Murty 1983). The present paper gives the results of investigations on age and growth, mortality rates and stock assessment of this species on the basis of data collected from private trawlers during 1979-81.

MATERIAL AND METHODS

Based on samples collected at weekly intervals, data on species composition of silverbellies and lengths of *L. bindus* were obtained on each observation day. These were raised to the day's catch, and were further raised to get monthly estimates of cath of different species and length composition in the catch. From these data, annual estimates of species composition and length composition of catch were obtained.

Growth and age were estimated from the modal progression in the monthly length-frequency distribution of catch. Parameters of growth in length were estimated using the von Bertalanffy growth equation, which is of the form:

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

where L_∞ = asymptotic length of fish, L_t = length at age 't', K = growth coefficient and t_0 = arbitrary origin of growth curve.

Instantaneous rate of total mortality (Z) was estimated using the equation of Beverton and Holt (1956):

$$Z = K(L_{\infty} - T)/(7 - lc)$$

where lc is the length at first capture and 7 is the average length of fishes including and above lc •

Estimate of instantaneous rate of natural mortality (M) was obtained using the equation of Pauly (1980):

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

where L_{∞} is in cm, K per year and T in °C. Value of temperature was taken as 27.2°C from Ganapati and Murthy (1954) and La Fond (1958). The value of M was also estimated taking the life-span of the species into account.

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

$$YW/R = F e^{-M(t_c - t_0)} W_{\infty} \left(\frac{1}{Z} - \frac{3S}{Z+K} + \frac{3S^2}{Z+2K} - \frac{S^3}{Z+3K} \right)$$

where $S = e^{-K(t_c - t_0)}$. t_c - age at first capture, t_r = age at recruitment and W_{∞}, K and t_0 are parameters of von Bertalanffy growth equation.

GROWTH AND AGE

A total of 7452 specimens ranging from 17 to 129 mm were measured during February 1979-December 1981. The data (Fig. 1) did not show progression of modes over a period of several successive months to facilitate determination of growth. Nevertheless, a few modes (Fig. 1) whose progression can be traced for periods ranging from 2 to 5 months are present. A mode at 32 mm in December 79 can be traced to 37 mm in January 80, giving a monthly growth of 5 mm (Fig. 1). Three modes at 37 mm in February 79, May 79 and July 80 can be traced respectively to 47 mm in April 79, 52 mm in August 79 and 47 mm in September 80, showing an average growth of 5 mm per month. Further, the modes at 47 mm in September 79, February 80, October 80 and February 81 have shifted respectively to 52 mm in October 79, 52 mm in March 80, 57 mm in December 80 and 57 mm in April 81 again all the modes showing an average monthly growth of 5 mm. The mode at 52 mm in November 79 has shifted to 72 mm in March 80 and another mode at 57 mm in August 80 has shifted to 67 mm in October 80, showing, once more, a monthly growth of 5 mm. It is therefore clear that the monthly growth rate is about 5

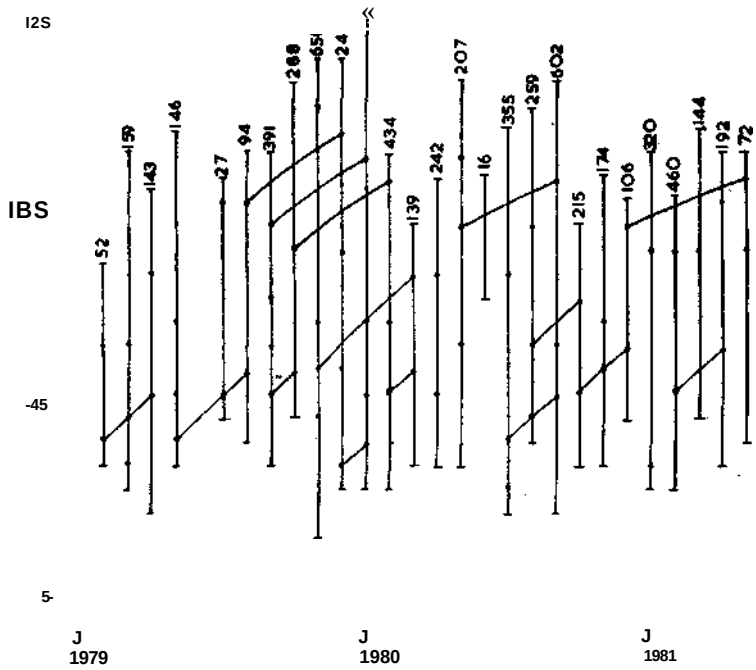

FIG. 1. Length range and modal lengths in *L. bindus* and their progression in different months during 1979-'81 (vertical lines show the length range, the points indicate the modal lengths and numerals indicate sample size).

mm in fish ranging from 32 to 72 mm length. The mode at 77 mm in October 79 is traceable to 92 mm in February 80 showing a growth of 15 mm in 4 months, with a monthly average of 3.75 mm. Similarly, the mode at 82 mm in September 79 has progressed to 97 mm in January 80 again showing a monthly growth of 3.75 mm. Two modes at 82 mm in May and December 80 have shifted to 92 mm in September 80 and May 81, respectively, giving an average monthly growth of 2.5 and 2 mm. The mode at 87 mm in August 79 has shifted to 102 mm in December 79 in four months, giving a monthly growth of 3.75 mm. Thus, the modal progression between 77 and 102 mm length has given three different monthly growth rates: 3.75 mm in 3 cases, 2.5 mm in one case and 2.0 mm in one case. Hence the average of these values was taken as the monthly growth between 77 mm and 102 mm length.

Since a monthly growth of 5 mm between 32 and 72 mm length and 3.1 mm between 77 and 102 mm length were observed, fish with the smallest modal length at 32 mm (from which growth could be traced) can be reasonably taken as 4 months old with an average monthly growth of 8 mm.

The Ford-Walford plot (Ford 1933, Walford 1946) of l_{t+i} against l_t on the basis of lengths attained at intervals of 3 months (Fig. 2) shows that

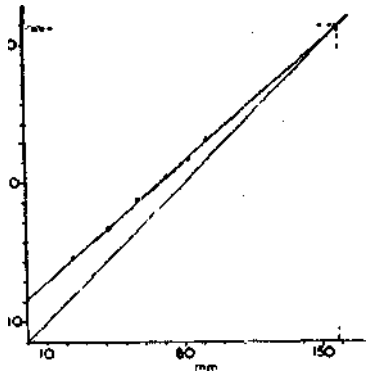

FIG. 2. Ford-Walford plot in *L. bindus.*

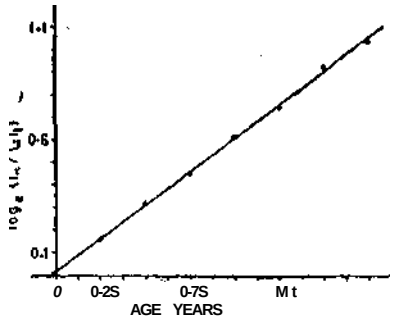

FIG. 3. Estimation of t. graphically.

the points are well represented by the straight line. The L* was estimated at 158.4 mm and K per year at 0.58. The value of t„ was estimated (Fig. 3) as —0.024 year. The calculated lengths of *L. bindus* at Kakinada are 72, 110 and 132 mm at the completion of first, second and third years of life respectively (Fig. 4). Since the maximum length recorded in the present study is 129 mm, the maximum age works out to 2.9 years.

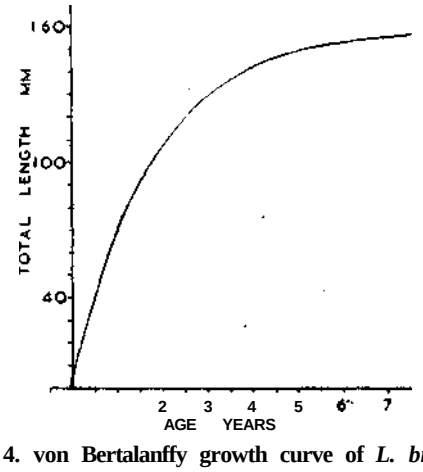

FIG. 4. von Bertalanffy growth curve of *L. bindus.*

MORTALITY RATES

The monthly length-frequency distribution (Fig. 1) shows that the smallest modal length in any year is at 32 mm. However, the annual length composition of the catch during the period shows dominant mode at 57 mm. Hence this length was taken as length at first capture (Lc). The estimated values of Z in different years (Table 1) varied from 4.4 to 6.0 with an average of 5.2.

TABLE 1. *Estimated values of length at first capture* (lc) *mean length* (1) *and total mortality rate* (Z) *during different years in* L. bindus.

Particulars	1979	1980	1981
lc(mm)	57	57	57
f(mm)	65.9	68.9	67.1
Z	6.0281	4.3622	5.2423

The value of M was estimated as 1.5 on the basis of the equation of Pauly (1980). If it is assumed that there is no exploitation and that 99% of this species by numbers die by the time they attain the maximum age of 2.9 years, the M value can be calculated as 1.6 (Ln 100 ÷ 2.9), which is almost the same as the one obtained by Pauly's formula. The M value is taken as 1.5 and the average F during the period works out to 3.7.

YIELD PER RECRUIT

The value of Wœ was estimated at 54.7 g on the basis of length-weight relationship and L «. Taking 57 mm as lc, the value of tc was estimated as 0.75 year. The smallest fish in the catch measured 17 mm. Hence this length was taken as length at recruitment (Lr) whose age (tr) was estimated as 0.18 year.

The yield per recruit as a function of fishing mortality rate was calculated taking four values of tc ranging from 0.59 to 1.13. (Fig. 5) representing lc values ranging from 47 to 77 mm. It is observed that with tc at 0.59 the yield increases to a maximum at F = 2.0 and then declines with further increases to a maximum at F ~- 2.0 and then declines with further increase in F. With tc at 0.75 (the present value) and 0.93 the value of yield per recruit is maximum at F = 3.0 and 4.5 respectively and show decline with further increase in F. With tc at 1.13, the yield per recruit increases with increased F and does not show any fall. It is also observed that yield per recruit is greater for higher values of lc (Fig. 5). The yield curves show that under the current value of F (3.7) and tc (0.75) the yield per recruit already showed a decline and further increase in F will result in further decline of yield.

The yield per recruit as a function of tc shows that maximum yield can be obtained at tc = 1.1 (Fig. 6) with F at 3.7 (present value) indicating that yield can be maximised by increasing the age at first capture (i.e., by increase of codend mesh size) without further increasing the effort.

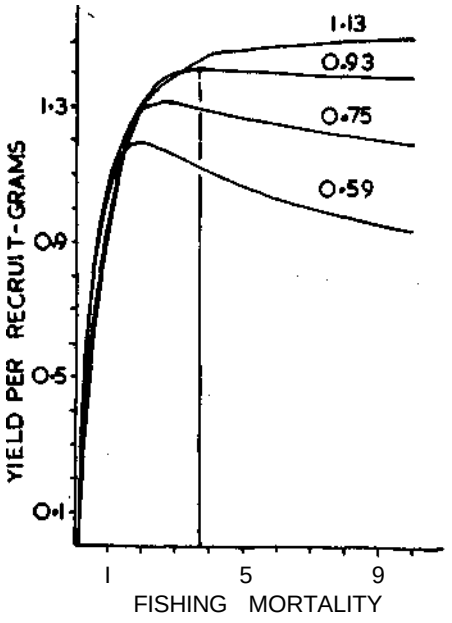

FIG. 5. Yield per recruit **(YW|R)** of *L, bindus* in relation to Fishing mortality rate **(The** vertical line indicates the present F). Numerals indicate the values of age at first capture.

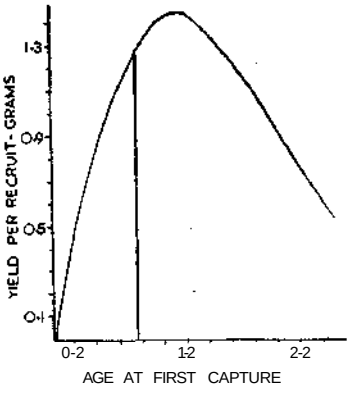

FIG. 6. Yield per recruit of *L. bindus* in relation to age at first capture. (The vertical line indicates the present tc).

DISCUSSION

It is well known that estimation of growth and age of tropical fishes is difficult for a variety of reasons. Since in the present study there is no clear-cut progression of modes in the length-frequency distribution in each successive month in a year (Fig. 1), the modal progression during shorter intervals was taken into account, assuming that the modes considered belong to the same brood, and the parameters of growth obtained in the study seem to be realistic because the estimated value of La at 158.4 mm is close to the maximum recorded length of the species: at Madras the maximum length recorded is 155 mm (CMFRI, 1977) though the maximum length recorded during the study period at Kakinada is only 129 mm. The estimated values of K and M obtained also show that the M|K value is just about the upper limit of the range known for fishes (Beverton and Holt 1959). Pauly and David (1981), however, estimated the values of Li and K in *L. bindus* on the basis of data from Calicut (of Balan, 1967) as 12.2 cm and 1.3 per year, respectively.

An attempt to estimate M on the basis of regression of Z on effort did not prove successful probably because, the fishery being a multispecies one,

effective effort for the species under consideration could not be obtained. Hence the value obtained by using the formula of Pauly (1980) was taken.

The regression coefficient in the length-weight relationship of *L. bindus* from Kakinada (2.96182; Murty 1983) was tested against the theoretical value of 3 by t-test and it was found that the observed value was not significantly different from 3. Hence the results of yield-per-recruit study, using Beverton-Holt equation, (which takes growth to be isometric) can be taken as reliable even to arrive at etimates of absolute yield.

The yield curves (Fig. 5) show that the value of F, where the fall in the yield per recruit occurs, is greater if t_c is greater, indicating that there is a possibility of growth overfishing under lower values of tc and that higher yield can be obtained by increasing tc . When t_c is 1.13, hte yield curve does not show a fall with increased F. It was shown earlier (Murty, 1983) that *L. bindus* attains first maturity at 80 mm (1.19 year). Thus, it appears that increasing tc up to age at first maturity will not only result in increased yield out also give scope for increasing the effort. This is possible because increasing tc up to age at first maturity will not hamper the reproduction by removing prospective spawners, thus averting recruitment overfishing also. In *L. bindus* at Kakinada, hence, increasing the cod-end mesh size of trawl nets results in higher yields without adversely affecting the stock.

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