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Population dynamics of Malabar sole *Cynoglossus macrostomus* Norman along Calicut coast

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ABSTRACT

The size at first maturity of *Cynoglossus macrostomus* is estimated as 120 mm; the spawning season is from October to May. The von Bertalanffy parameters of growth are estimated as L = 139.9 mm, K = 1.6117 and t 0 = 0.01 year. The length-weight relationship can be described by the equation : W (g) = 0.00003759 $L^{2.6128}$ (mm). The instantaneous rate of total mortality during the period is estimated as 2.5. Length and age at first capture are 85 mm and 0.6 year respectively. The maximum sustainable yield is obtained at an E value of 0.96 when the present E is only 0.4. Along the Calicut coast of North Kerala present average catch is 959.08 tonnes. Estimated MSY is 1 694 tonnes. The present effort can be doubled to harvest 1 646 tonnes.

The flatfishes constitute a major fishery along Calicut coast and enjoy considerable local importance next to oilsardine and mackerel. Norman (1927, 1928) described 91 species, of which only a few form fishery of local importance. The most important species in the commercial fishery is *Cynoglossus macrostomus* Norman, locally known as *mantha.*

MATERIALS AND METHODS

Data collected from commercial trawlers operating off Puthiyappa landing centre, Calicut, during April 1987 - March 1992 formed the basis for this study. Monthly estimates of catch and effort were made based on 20-25 days of observations on landings each month. For biological study, samples were collected once a week. The specimens were examined in fresh condition in the laboratory. The total length from the tip of the snout to the tip of the longest caudal ray nearest to 0.1 cm and weight in grams were taken. The length and weight measurements were taken for 150 fishes and a length-weight relationship of the form

$$W = aL^b$$

was fitted where ;

W = body weight of the fishing fresh weight

L = body length of the fish (mm)

a = constant

b = exponent

The length data were grouped in 5-mm class intervals and raised to the total estimated landings. Modal lengths in the length frequency were plotted in the form of a scatter diagram. The progression of modes were indicated by eye-fitted lines and these lines were extrapolated freehand so that they intersect the time axis indicating the time of brood origin (Fig. 1). These data were further analysed as per the methods of Bagenal (1955) by regressing Lt+1 on Lt to estimate the values of Lα1, K and t_o.

Instantaneous rate of total mortality (Z) was estimated for each year following the length-converted catch curve method of Pauly (1983) and the average of all years considered. The natural mortality coefficient

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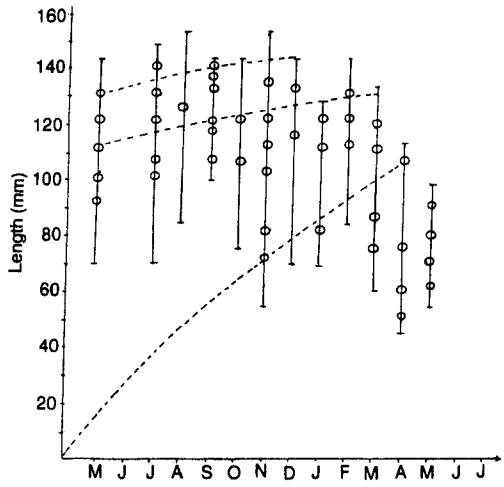

Fig. 1. Tracing of progression of modes by scatter diagram of modal lengths for *Cynoglossus macrostomus* from Calicut.

(M) was estimated by regressing Z on the annual effort as per the relation $Z = M + q f$ where q is the catchability coefficient, f is effort and M is natural mortality rate.

Thus a series of Z values were obtained. These were plotted against their corresponding values of f and a straight line fitted to the points by means of linear regression technique (Fig. 2).

Yield per recruit was estimated using the formula of Beverton and Holt (1957) simplified by Ricker (1958). The average standing stock was estimated by dividing present yield with the fishing mortality (Y/F). The exploitation ratio is E = F/Z. The exploitation rate U is estimated using the formula.

$$U = \frac{F}{Z}\ (1-e^{-z}) \quad \text{(Ricker 1958)}$$

Where F is the fishing mortality.

Total annual stock was estimated by the formula Y/U. The maximum sustainable yield (MSY) from the stock was estimated by the following equation

$$MSY = Re \quad Y/RF \text{ max}$$

where Y/RF max is the yield per recruit at F max and Re is the recruits estimated by the following equation

$$\frac{Y}{Y/R\ PF}$$

where Y/R PF is the yield per recruit at present F.

Fishery

Along Calicut coasts non-mechanized and mechanized craft operate cast net, boat seine etc. A bag type of seine locally known as *paithuvala* is also used for exploiting soles.

Mechanized craft using various types of trawl nets catch Malabar sole in abundance. The trawl nets being competetive, have an advantage over *paithuvala,* as these can be operated in the offshore and deeper waters, and because of this the latter are becoming obsolete. Small mechanized trawlers of less than 14 m size are the main crafts used in the fishery around 20-50 m depth along the coast. The trawl nets used in this fishery have a cod-end mesh size of about 18-25 mm. Among the indigenous gears the bulk of the catch was by *paithuvala.*

During the years 1986-1991 an average of 28 903 t soles were landed in India. The maximum landings were recorded in 1991.

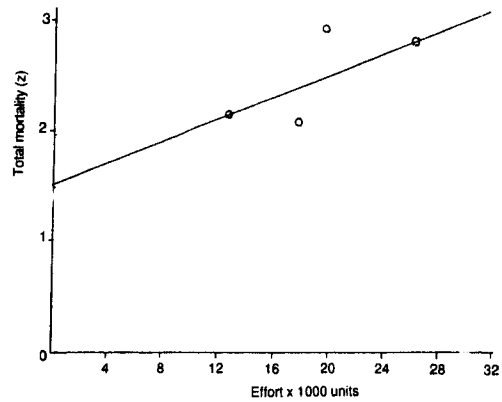

Fig. 2. Plot of total mortality (z) on effort (f) to estimate natural mortality (M) and catchability coefficient in *C. macrostomus* from Calicut.

Table 1. Percentage of sole landings at Calicut to Kerala sole landings, and Kerala's to all-India sole landings

Year	All-India sole landings (tonnes)	Kerala sole landings (tonnes)	Percentage to all-India sole landings	Calicut sole landings	Percentage to Kerala sole landings
1986	27 332	9 392	34.4	124	1.32
1987	27 964	9 917	35.5	526	5.30
1988	25 114	12 655	50.4	600	4.74
1989	31 552	20 061	63.6	449	2.24
1990	26 465	14 505	54.8	943	6.50
1991	34 991	13 885	39.7	2-060	14.80

The Malabar sole is one of the important fisheries in Kerala with an annual average catch of 13 403 tonnes. It is almost exclusively supported by one species *Cynoglossus macrostomus*. At Calicut the landings formed an average of 783 t during the same period forming 5.8% of the Keralas sole landings. The fluctuations in annual sole landings are frequent and wide (Table 1). The major portion of the catch is obtained within a short period immediately after the commencement of the fishing season, commencing from October and extending to January (Fig. 3). The phenomenon of sudden increase and decrease in the landings is typical of the fishery all along the coast, probably suggesting large-scale movement of shoals towards the surface and midwater.

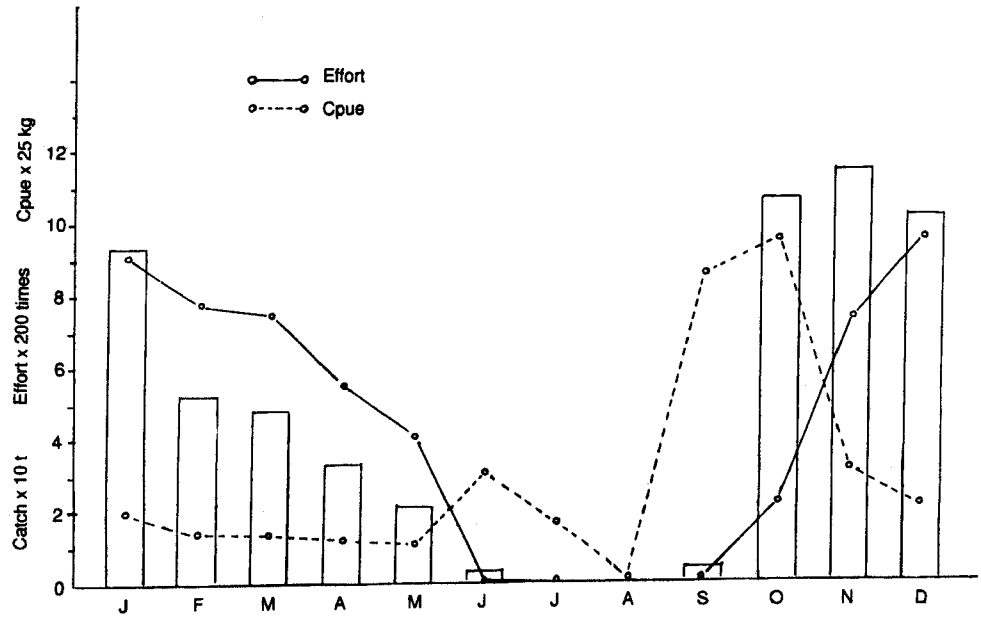

Fig. 3. Monthly effort, catch and CPUE of *C. macrostomus* during 1982 to 1991.

Biology

Detailed studies on the biology of *C. macrostomus* at Calicut were made by Seshappa and Bhimachar (1951, 1954, 1955). Some observations were also made by George (1958) and Seshappa (1964). The bottom feeding habit of this fish is evident from the presence of mud in the guts throughout the year. Polychaetes, amphipods and small lamellibranchs form the major food item. The polychaete worm *Prionospio pinnata* was the dominant item of food in the stomach during some periods. During the monsoon months of June to August the fish is not found in the inshore grounds but appears to be scattered in slightly deeper areas. Large shoals occur at all depths in the inshore waters during September and October, and sometimes in November. After these months the fish does not usually occur in shoals. Spawning seems to take place mainly in the deeper areas of the fishing grounds where fish retreats after September-October. Varying intensities of spawning activities may continue till about the following April-May though the major part of spawning is in the farther regions of the inshore area. Specimens with gonads in ripe and spawning conditions are frequently seen in the inshore catch, particularly of October-November. Spent individuals are also seen in some numbers subsequently (Seshappa 1968). On an average female Malabar sole measuring 15.5 cm is known to produce about 55 000 eggs during a spawning season (Rao 1957).

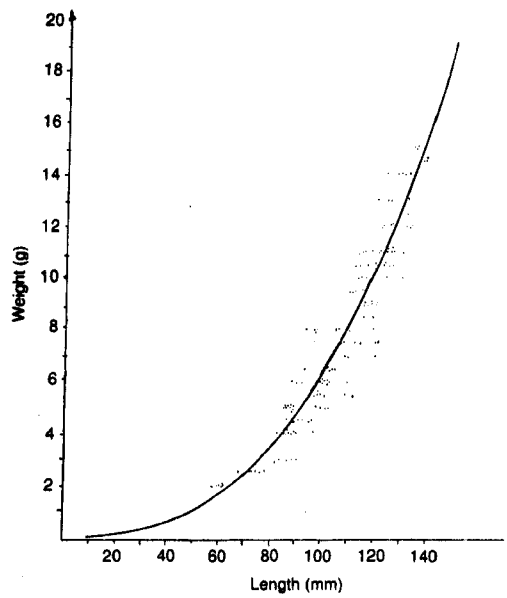

Fig. 4. Length-weight relationship of *C. macrostomus*.

RESULTS

Length-weight relationship

The relationship between total length and weight was determined from a sample of 150 fishes from the commercial catch. The equation is :

$$W = 0.0000\ 3759\ t\ 2.6128\ (mm)$$

Growth

The half yearly growth of this species obtained from the modal progression indicates that the species grows to 63 mm, 106 mm, 124 mm, 131 mm and 138 mm in 0.5, 1.0, 1.5, 2.0 and 2.5 years respectively.

$L\alpha$ and K were calculated as 139.9 and 1.6117 respectively. Substituting L_p in length-weight relationship W_p was also calculated as 15.2 g. The minimum size of Malabar sole which appeared in commercial catch was 85 mm. The corresponding age (tr) was calculated as 0.6 year. The maximum numbers appearing in the catch were of 105 mm size and the corresponding age (tc) being 0.9 year.

Total mortality (z) A plot of $\log_e (N/\Delta t)$ against 't' for different years is shown in Fig. 5.

Only those points which represented the straight descending part of the catch curve (Fig. 5) were considered for the estimation of Z. The total instantaneous mortality was estimated for the period April 1987-March 1992. The average value was 2.5 (Due to insufficient data the period 1988-1989 was not included.)

Natural mortality (M)

The natural mortality coefficient M was estimated in the present study by regressing Z against corresponding effort and the value thus obtained was 1.52. The value of r was 0.72. The catchability coefficient was 0.0489.

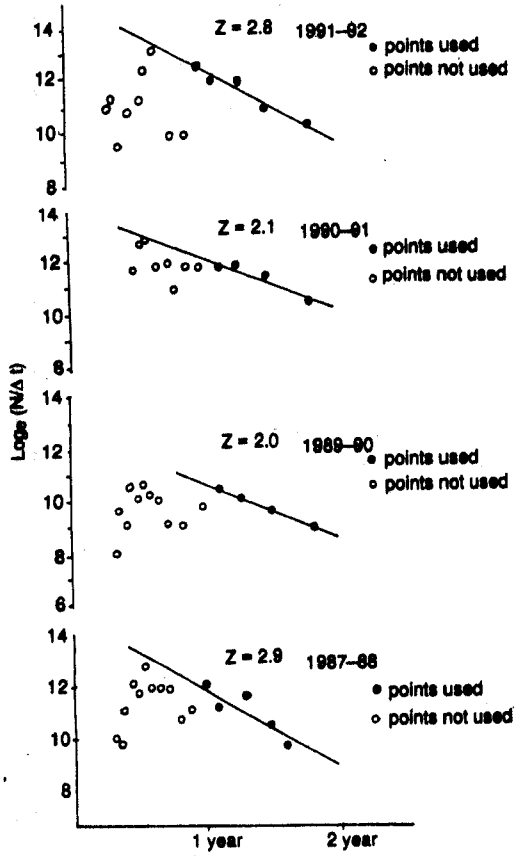

Fig. 5. Length converted catch curve for *C. macrostomus* during 1987 to 1992.

Yield per recruit

For the estimation of yield per recruit Beverton and Holt yield per recruit curve was used with $W\alpha$ = 15.1937 g, K = 1.6117 per year, tc = 0.90 year, tr = 0.60 year and M = 1.52. The expected yield at different levels of fishing mortality shows that the yield increases with increased F suggesting that the yield can be increased by enhancing the effort up to an E value of 0.96. Though it is possible to increase the yield by enhancing the effort, the increment in yield will not be remunerative beyond an E value of 0.87. Hence increase in the yield above 0.87 will not be commensurate with any increase in the effort.

Maximum sustainable yield

Annual average landings of *C. macrostomus* at Calicut for April 1987 to March 1992 were 959.08 t for an F value of 1. The maximum sustainable yield was estimated at 1 694.076 t. This is much above the present yield.

From the present yield (959.08 tonnes) and exploitation ratio (0.37) the total standing stock (Y/U) of *C. macrostomus* was 2 592.1 t at Calicut.

DISCUSSION

Age and growth studies using monsoon rings found in the scales and also by length frequency methods were made by Seshappa and Bhimachar (1951). According to them this species attains 10-12.9 cm in the first year, 14-14.9 cm and 17-18 cm during the second and third years respectively. The present study is in close agreement with the observations of previous authors indicating 10.6 cm in the first and 13.1 cm in the second year. However the largest specimen measured during the last 5 year period showed 15.9 cm in length. Asymptotic length ($L\alpha$) was 139.9 mm.

C. macrostomus spawns for about 8 months, commencing from October and continuing up to May varying intensities in between. The peak spawning season is October-January.

Specialized fishery targetted for this species does not exist along this coast. The bulk of the catch by trawlers is a bycatch in the fishery targetted for prawns. The mortality estimates indicate that the effect of fishing on the stock available is negligible. The study showed an economic yield at an E value of 0.87 and the present E is only 0.4. The maximum yield would be obtained at an E value of 0.96. This shows that the present fishing can be increased two-fold to give a catch from the present 959.08 tonnes to 1 646 tonnes which can be considered as an economic yield. A further increase in E from 0.87 to 0.96 will fetch an additional yield of only 48 t. Therefore an E value of 0.87 may be ideal for the economic exploitation of this species along Calicut coast.

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