Fishery, biology and stock assessment of *Cynoglossus macrostomus* (Norman) off Malabar coast

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ABSTRACT

Cynoglossus macrostomus formed 93 % of the annual average landings of flatfishes (3951 t) during 1993-2004 at Calicut. The fishery showed annual fluctuations. Peak landings were recorded during December-April. Growth parameters of this species were L_∞ = 164.5 mm y^{-1} and K = 0.70y^{-1}. The fish grows to 83, 124 and 146 mm at the end of 1-3 years. The total and natural mortality were 3.01 y^{-1} and 0.91 y^{-1} respectively. The length-weight relationship shows that the growth is isometric and there is no significant variation between sexes. The spawning is prolonged with two peaks. The length at first maturity is 102 mm. Females dominated the fishery. The stock is exploited marginally below the optimum level at present. The total and standing stock of this species along the Calicut coast is estimated as 5430 t and 1720 t respectively.

Introduction

Flatfishes constitute an important demersal fishery resource along the Malabar coast and contribute to 6 % to the trawl landings in this region. They are caught by trawlers throughout the year except during the monsoon ban period. Although flatfishes belonging to seven families are landed, those belonging to Cynoglossidae and Psettodidae support the commercial fishery. The Malabar sole, *Cynoglossus macrostomus*, alone contributed to more than 90 % to the flatfish landing. Puthiappa and Beypore are the two major fishing harbours, which account for more than 60 % of the flatfish catch in this region.

Several studies are available on *C. macrostomus* along the west coast of India (Seshappa and Bhimachar, 1951; Feroz Khan and Nandakumaran, 1993; Jayaprakash and Inasu, 1998; Jayaprakash, 1999, 2001 and 2002 and Vivekanandan *et al.*, 2003). Though similar studies are already made on this species along the southwest coast of India including Malabar region, the present account gives updated information on the fishery and status of the stock of this species exploited along this coast.

Materials and methods

The data on the landing of flatfishes at Calicut by trawlers for the period from 1993 to 2004 collected by random sampling technique following Alagaraja

(1984) were used for this study. The data on length frequency distribution of 4413 specimens in the length range of 38-158 mm collected from trawl landings at Puthiappa and Beypore from 2002-03 to 2004-05 formed the material for the stock assessment studies. Length frequencies were raised to correspond to the weight of the catch assessed for the day and subsequently for the month following Sekharan (1962). The length-weight relationship was studied following Le Cren (1951). The maturity stages were determined on the basis of physical appearance of gonads and by observing under microscope, following the standards suggested by I.C.E.S (Lovern and Wood, 1937). The length at which 50% of the fish were mature (stage IV and above) was considered as the length at first maturity. The monthly male: female ratio was estimated and the values were tested for significance using chi-square values (Le Cren, 1951). The growth and mortality parameters, recruitment pattern and yield per recruitment were estimated using FiSAT (Gayanilo Jr, *et al.*, 1996). For estimation of the natural mortality, the t_o was considered as '0' (Sparre *et al.*, 1989) and the surface seawater temperature was taken as (28^0 C). The exploitation rate 'U' was estimated by the formula U = F $(1-e^{-Z})$/ Z. The annual stock and standing stock were estimated by Y/U and Y/F respectively, where 'Y' is the annual average catch of this species.

Results

Fishery of Malabar sole

The average annual landing of Malabar sole during the period was 3690t, forming 5.7 % of the trawl landings. The annual landing has shown a declining trend from 2985 t in 1993 to 1644 t in 1996. The production reached an all time high of 5918 t in 1999 forming 13.9 % of the trawl landing, thereafter the fishery showed a declining trend upto 2002. Towards the end of the study period the production has increased considerably. However, the average contribution of this resource to the total landings remained at around 6% during this period (Fig. 1).
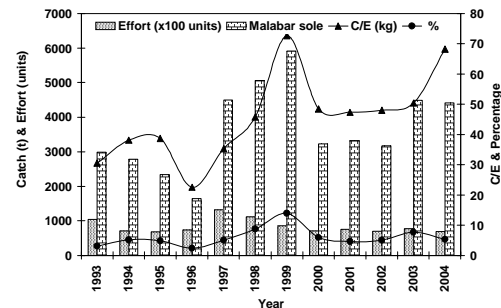

Fig 1. Annual catch and catch rate of Malabar sole at Calicut

The CPUE ranged between 23 kg (1996) and 73 kg (1999) and the average for this period was 46 kg. The reduction in the effort (No. of units) may be the reason for decline in the landing. Although the landing has decreased, the catch rate did not show such a trend. The change in the fishing pattern of trawlers from single day to multi-day operation has extended the area of operation of these vessels to deeper waters. This has resulted in a reduction in the effort expended on this resource, causing a decrease in the landing. The catch was highest during December-April. *C. macrostomus* (93.4%) is the only species forming an independent and full fledged commercial fishery, though other species of flatfishes are landed in small quantities.

Maturity and spawning

Monthly variation in the percentage composition of different stages of maturity in *C. macrostomus* showed that fishes in all stages of maturity were

present in the fishery during most of the months. Availability of gravid and spent fishes in the fishery during most of the months indicates that the spawning period of *C. macrostomus* is prolonged with two peaks in February-May and September- October. The average annual composition of different stages of maturity showed that immature fishes formed 45 % of the commercial catches (Table 1). Females dominated the catch during most of the months. The annual sex ratio between male and female was found to be 1:5.2. The chi-square values indicated that the difference is significant at 5 % level.

Size at first maturity

The pooled data for the years 2002-03 and 2004-05 indicated that the females up to 70 mm were all immature and 50 % of individuals were mature at 102 mm. Therefore, it can be stated that the size at first maturity of females of *C. macrostomus* along the Malabar coast is 102 mm.

Length -weight relationship

A total of 82 males in the range of 66-152 mm (2-22 g weight) and 106 females in the range of 62-158 mm (2-26 g weight) were used for determining the length-weight relationship of *C. macrostomus*. The relationship was estimated by the least square method and since the analysis of covariance showed no significant difference at 5% level between sexes, a common equation is given,

$$W = 0.00005858L^{2.61} \quad (r=0.9853)$$

Growth and mortality parameters

For estimation of growth and mortality parameters, the raised length frequency data for the corresponding months were pooled for the years from 2002-03 to 2004-05. The restructured length frequency distribution and the growth curve obtained using the FiSAT programme is given in Fig. 2. The values of L_{00} and K were estimated as 164.5 mm and 0.70 y^{-1} at an Rn value of 0.281.

The VBGE for *C. macrostomus* is

$$Lt = 164.5 (1-e^{-0.70(t-t_0)})$$

The fish attained 83, 124 and 146 mm at the end of 1st, 2nd and 3rd year respectively. Nearly 65 % of the fishes were in the range of 80-120 mm

TABLE 1: *Percentage occurrence of maturity stages in* C. macrostomus *(females) during 2002 to 2004*

| Month	No. of speciemns examined	Average				
		Immature	Maturing	Mature	Ripe	Spent
Jan	107	49.5	28.0	15.0	3.7	3.7
Feb	128	37.7	11.7	5.2	29.9	15.6
Mar	155	43.9	16.8	3.2	4.5	31.6
Apr	70	52.9	11.4	1.4	18.6	15.7
May	128	35.9	32.0	12.5	0.0	19.5
Jun	99	63.6	27.3	4.0	0.0	5.1
Jul	0	0.0	0.0	0.0	0.0	0.0
Aug	38	52.1	26.1	12.2	9.5	0.0
Sep	162	25.9	9.3	17.3	20.4	27.2
Oct	132	45.5	10.6	10.6	15.9	17.4
Nov	124	43.5	25.0	12.1	9.7	9.7
Dec	148	63.5	10.1	20.9	2.7	2.7
Total	1291	45.4	18.0	10.1	9.7	16.7
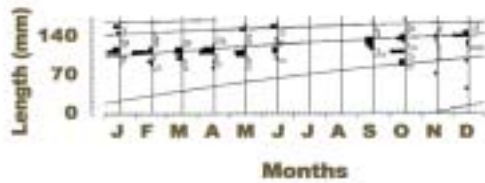
Fig 2. Plot of FiSAT analysis of *C. macrostomus* (Pooled data) off Malabar coast

indicating that major share of the landings of this species is juveniles of '0' and '1' year class from the present area of fishing.

The estimated Z using the growth parameters was 3.01 y^{-1} (r = 0.96) and the instantaneous natural mortality (M) was 0.86 y^{-1} (Fig. 3). The estimate of natural mortality obtained by Pauly's method (Pauly, 1980) was subtracted from the total mortality obtained from the catch curve and fishing mortality thus obtained was 2.15 y^{-1}.
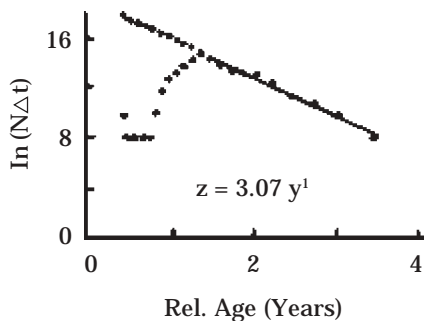

Fig. 3. Catch curve analysis estimating total mortality (Z) of *C. macrostomus*

Recruitment pattern

The recruitment pattern of *C. macrostomus* showed a distinct peak with maximum recruitment during April-August. Highest recruitment was in June (18.6%) and lowest in January (0.5%). The recruitment during April-August alone was 74.5 %.

Length at first capture (Lc) and length at recruitment (Lr)

The length at first recruitment was taken as the smallest length in the length frequency distribution and the length at first capture was obtained by probability of capture analysis. The length at first capture (Lc) and length at recruitment (Lr) of *C. macrostomus* were taken as 38 mm and 95.6 mm respectively.

Yield per recruitment

Beverton and Holt yield recruitment model is diagrammatically presented in Fig. 4. The relative yield per recruit (Y/R) is maximum for an exploitation ratio (E) of 0.79. The current exploitation ratio (E) 0.71 is less than the optimum exploitation ratio indicating that the present level of exploitation is below the MSY level.
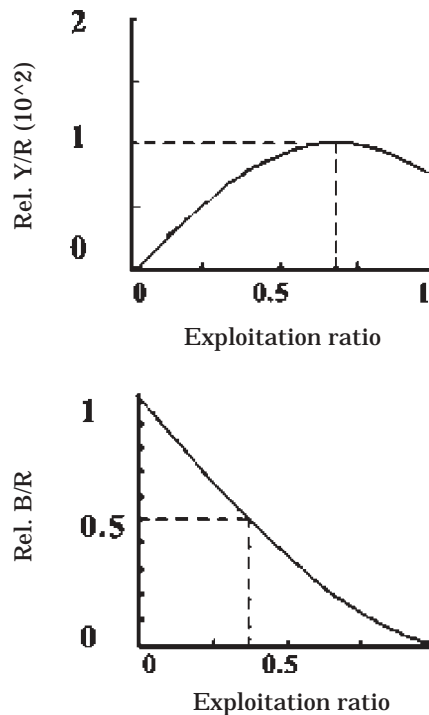

Fig. 4. Relative yield per recruitment of *C. macrostomus* off Malabar coast

Stock estimates

The average annual yield of *C. macrostomus* along the Calicut coast was 3690 t at an exploitation rate (U) of 0.68. The average total and standing stocks were estimated as 5427 t and 1716 t respectively.

Discussion

The flatfishes, though occur along both the costs of India, constitute a fishery of considerable importance along the Malabar coast. Like any other tropical fishery resource, the Malabar sole also exhibited seasonal and annual fluctuation in the landings. Jayaprakash (2002) while studying the fluctuation in abundance of Malabar sole in the Malabar Upwelling Ecosystem observed a clear decadal trend comparable to such trends existing in rainfall, sea level and solar periodicity. Introduction of multi-day trawling along the Malabar coast resulted in decline of the catches of flatfishes during the late 90's and beginning of this century. However, towards the end of this period the fishery has shown some improvement due to the increase in the single day operation by the trawlers in shallow waters.

The fishery is exclusively supported by shoaling species *C. macrostomus*. There is a distinct demarcation in the area of abundance of different species of flatfishes. The Malabar sole dominates the south Karnataka-north Kerala coast but its intensity is reduced in the central part off Kerala; and ceased to be a fishery off the southern part of the state (Vivekanandan *et al.*, 2003). The major portion of the catch of this species is obtained within a short period immediately after the commencement of the fishing season.

Seshappa and Bhimachar (1951) observed that the spawning season of Malabar sole starts by September–October and ceases by June. Only one batch of eggs was present in the ovary. Jayaprakash (1999) reported two spawning seasons with spawning taking place once a year, during a definite short period. As revealed in the present study spawning in this species is prolonged with peaks during February-May and September- October when more gravid and spent fishes were present in the fishery.

Jayaprakash (1999) while studying the sex ratio of Malabar sole observed that males dominated the catches during most of the period. In the present observation females dominated the catches during most of the months. Possible reason for this might be differential migration of males and females from inshore to deeper waters and vice versa, for spawning and feeding respectively (Seshappa and Bhimachar, 1951). In the present investigation the size at first maturity of Malabar sole was found to be 102 mm. This is close to the observation made by Jayaprakash (1999). In this study the length weight relationship between males and females showed that the relationship is not significantly different as reported by Feroz Khan and Nandakumaran (1993), Victor (1978) and Jayaprakash (2001).

Seshappa and Bhimachar (1951) using the growth checks on scales and by length frequency methods indicated that *C. macrostomus* attained a length of 100-129 mm, 140-149 mm and 170-180 mm in the first, second and third years respectively. Studies made by Feroz Khan and Nandakumaran (1993) indicated that this species attained 106 mm in the first year and 131 mm in the second year. Jayaprakash and Inasu (1998) using the same method reported that Malabar sole grows fast in early

part of its life, the fish attaining 114 mm at the end of the first year and 136.5 mm at the end of the second year of its life. The present study showed that the growth was fast in the first two years of life. The fish attained 83 mm at the end of first year showing an average monthly growth of 6.91 mm. The fish attained 124 mm at the end of the second year with a monthly growth of 3.42 mm. At the end of the third year the fish attained 146 mm. The bulk of the annual landings recorded consisted of 0-1 year class with a length range of 80-120 mm. Thus, the products of previous year reached the marketable size and formed the commercial catch during September-April.

The value of 'M' to the extent of 0.86 y^{-1} gives an indication of moderate natural mortality for *C. macrostomus*. The fishing mortality $F=2.15$ y^{-1} is an indication of intensive fishing of this species which is also revealed by a high exploitation ratio of 0.71. Although the current exploitation ratio from the present area of fishing is below the optimum rate, it is close to MSY level. Thus for the benefit of the stock it is better if the efforts are confined at the present level only.

Acknowledgements

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