Available online at: www.mbai.org.in doi: 10.6024/jmbai.2016.58.1.1888-10

Studies on growth and mortality of Malabar tongue sole, *Cynoglossus macrostomus* (Norman, 1928) along the Ratnagiri coast of Maharashtra India

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Received: 22 Jan 2016, Accepted: 15 Jun 2016, Published: 30 Jun 2016

Original Article

Abstract

Growth and mortality parameters of Malabar Tongue sole, *Cynoglossus macrostomus* were estimated on the basis of length frequency data collected during April 2014 to March 2015 by using ELEFAN software employing FiSAT-I. The asymptotic length L∞ and growth coefficient K were estimated at 192mm and 0.9 year^{-1} respectively. The t_o was estimated by VBGF plot to be - 0.0022 yr. By using the von Bertalanffy Growth Formula (VBGF), it is observed that *C. macrostomus* attains a length of 107mm, 151mm and 163mm at the end of six, twelve and fifteen months respectively. The values of Z, M and F were calculated as 5.20, 1.008 and 4.192 per year respectively. The Lc_{50} was estimated to be 114.22mm. The exploitation ratio (E) was found to be 0.806. Relative yield per curve was found to be maximum for an exploitation ratio E_{max} of 0.77. To sustain the catches of *C. macrostomus* from Ratnagiri coast the fishing pressure should be reduced from present E of 0.806 to E_{max} of 0.77.

Keywords: *Malabar tongue sole, Ratnagiri, Growth, mortality, VBGF Plot.*

Introduction

The Malabar tongue sole, *C. macrostomus* is an important component of flatfishes landed as bycatch along the west coast of India. The total production of flatfishes including *C. macrostomus* in the country stood 63,264 tonnes during the year 2012 (CMFRI, 2013). In Maharashtra the sole fishes are mainly landed by the trawlers with a catch of 3916 tonnes and catch rate of 0.55 kg/hr. The relative species abundance of *C. macrostomus* is 11.4% in the state. Growth and mortality studies of Malabar tongue sole, *C. macrostomus* are reported by Jayaprakash and Inasu (1998); Vivekanandan *et al.* (2003); Khan and Nandakumaran (1993); Manojkumar (2006) and Nair (2007) from Indian coastal waters. As no reports of biological works on the species are reported from Ratnagiri, the present investigation was undertaken to study the growth and mortality of *C. macrostomus* from the Ratnagiri coast. The information will be helpful in sustainable exploitation of the species from Ratnagiri coast.

Methodology

Catch and effort data was collected weekly from the Mirkarwada landing centre (16.98° N, 73.30° E) of Ratnagiri from April 2014 to March 2015. Commercial trawl catches were sampled for the purpose. A total of 5724 fish specimens

were measured for length frequency analysis. The total length was measured to the nearest millimeter. The length frequency data were grouped into 5mm class interval, then raised and pooled month wise (Sekharan, 1962). The asymptotic length L_∞ and growth coefficient K were estimated by FiSAT-II (FAO-ICLARM Stock Assessment Tools) computer software package developed by Gayanilo *et al.* (1996).

Age at length zero t_0 was estimated by employing von Bertalanffy plot.

$$-\ln (1- Lt/ L_\infty) = - K^* t_0 + K * t$$

The total instantaneous mortality rate (Z) was calculated by length converted catch curve (Pauly, 1984). Natural mortality coefficient was estimated by Pauly's empirical formula (Pauly, 1980) given as:-

$$\ln (M) = - 0.0152- 0.279 \ln(L_\infty) + 0.6543 \ln(K) + 0.463 \ln(T)$$

in the usual notations.

Fishing mortality (F) was determined by the relationship,

$$F = Z-M.$$

The L_c is estimated by backward extrapolation of length converted catch curve used for estimation of Z by Pauly (1984) using ELEFAN - I employing FiSAT - II.

The longevity of the species was calculated by using the inverse von Bertalanffy growth equation (Sparre and Venema, 1998) as given below:

$$t(L) = t_o - (1/K) X \ln (1 - (L_{max}/L_\infty)$$

The relative yield/recruit was estimated from the relative yield/recruit model represented by the equation (Beverton and Holt, 1957)

$$Y/R' = E^* UM/K * (1-3U/ 1+ m + 3U^2 /1 + 2m- U^3/1 + 3m)$$

where, E = F/Z the exploitation ratio or fraction of deaths caused by fishing.

$$m = K/M$$

$U = 1- L_c/L_\infty$ the fraction of growth to be completed after entry into the exploited phase.

Y/R' is considered a function of U and E and the only parameter is M/K.

Results and discussion

Growth and mortality

In the present study the growth parameters L_∞ and K were estimated as 192mm and 0.9 $year^{-1}$ respectively by ELEFAN- I employing FiSAT-II. (Fig. 1)

The t_o was estimated to be - 0.0022 years by VBGF plot. By using the von Bertalanffy's Growth Formulae (VBGF), it was noted that *C. macrostomus* attains a length of 107mm, 151mm and 163mm at the end of six, twelve and fifteen months respectively. Life span of the species is estimated to be 2.55 years. The maximum size recorded during the study period was 163mm, at an estimated age of 1.27 years. The length data of both males and females have been pooled and therefore the present estimates are an average for both the sexes. The varying values of estimates of L_∞ and K are reported by different workers along the Indian coast for *C. macrostomus*. The growth parameters L_∞ and K were determined as 166mm

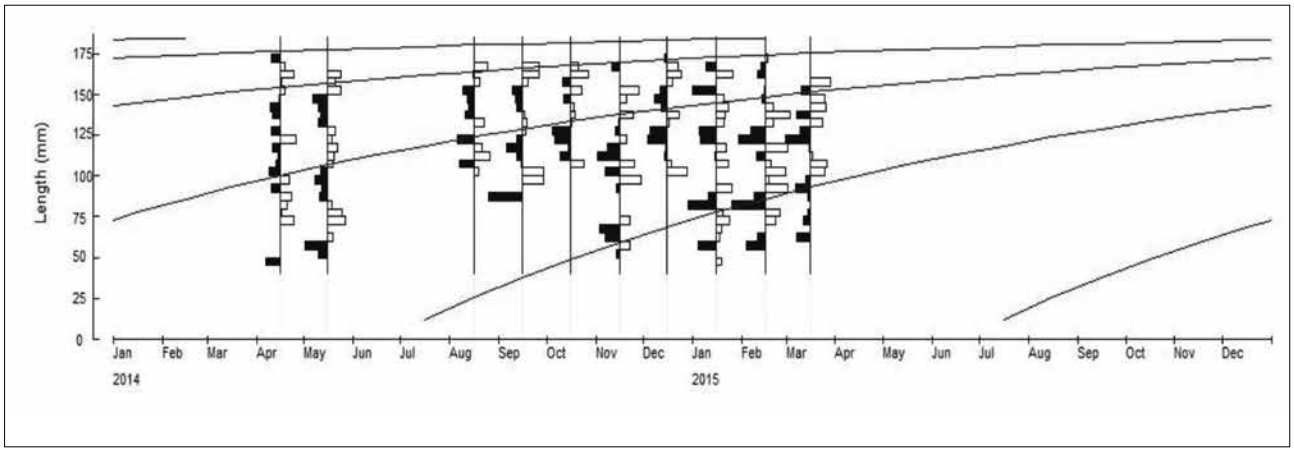

Fig.1. Growth curve fitted by ELEFAN method

and 0.714 per year respectively by Jayaprakash (1998) from Kerala coast. They further reported the values of L_∞ and K to be 170mm and 0.9 per year by ELEFAN - I. The L_∞ and K were estimated to be 139.9mm and 1.6117 per year respectively for *C. macrostomus* by Khan and Nandakumaran (1993) along the Calicut coast. Nair (2007) reported K and L_∞ to be 0.79 per year and 212mm respectively for *C. macrostomus* from Cochin waters, while Manojkumar (2006) determined the growth parameters of this species as L_∞ and K to be 164.5mm and 0.7 per year respectively from the Malabar Coast. The values of asymptotic length and growth coefficient reported by various workers ranged from 139.9mm to 212mm and 0.7 to 1.611 per year respectively mainly from southwest coast of India. It can be inferred from the findings reported by different workers including present study that this species is having fast growth rate. The fast growth rate is reported to be 1.6 per year by Khan and Nandakumaran (1993) from Calicut coast. The different estimates of asymptotic length and growth coefficient reported by different workers may be attributed to the presence of distinct stocks, availability of food and favorable environmental factors.

In present study the t_o estimated by VBGF plot was found to be - 0.0022 year. Jayaprakash (1998) reported the value of t_o to be - 0.46968 year for *C. macrostomus* from Kerala coast. Khan and Nandakumaran (1993) reported the value of t_o as 0.01 year from Calicut coast while Nair (2007) found the value of t_o to be - 0.014 year from Cochin coast. With negative t_o value it can be interpreted that juveniles of *C. macrostomus* grow more quickly than the predicted growth curve for the adults. It was noted that *C. macrostomus* attains 107, 151 and 163mm length at the end of six, twelve and fifteen months respectively (Fig. 2). Sheshappa and Bhimachar (1951) reported that this species attains a length of 100 - 129, 140 - 149 and 170 - 180mm at the end of one, two and three years respectively. Khan and Nandakumaran (1993) indicated *C. macrostomus* attains a length of 106mm in the first and 131mm in the second year respectively. Jayaprakash (1998) reported that the fish attains a length of 114, 136.5, 152.5, and 159.5mm at the end of 1 to 4 years. Manojkumar (2006) reported that *C. macrostomus* attains length of 83mm, 124mm and 146mm at the end of one to three years. Vivekanandan *et al.* (2003) reported that *C. macrostomus* attains a size of 110mm and 135mm at the end of first and second year respectively. The results on the length attained by *C. macrostomus* in the present study were higher than those recorded by some of the earlier workers while almost conform t_o those reported by Khan and Nandakumaran (1993) and Vivekanandan (2003). The rate of growth varies in distinct stocks and is influenced by the existing environmental factors.

The value of total mortality Z obtained from length converted catch curve is 5.20 (Fig. 3). The natural mortality coefficient M was estimated to be 1.008 per year by Pauly's empirical formula. While the annual fishing mortality F was estimated to be 4.192.

The Z, M & F were reported to be 2.5, 1.52 & 0.98 from Calicut coast. (Khan and Nandakumaran, 1993). The value of Z, M & F is reported to be 3.01, 0.86 & 2.15 per year respectively by Manojkumar (2006) from Malabar Coast. Similarly Z, M and

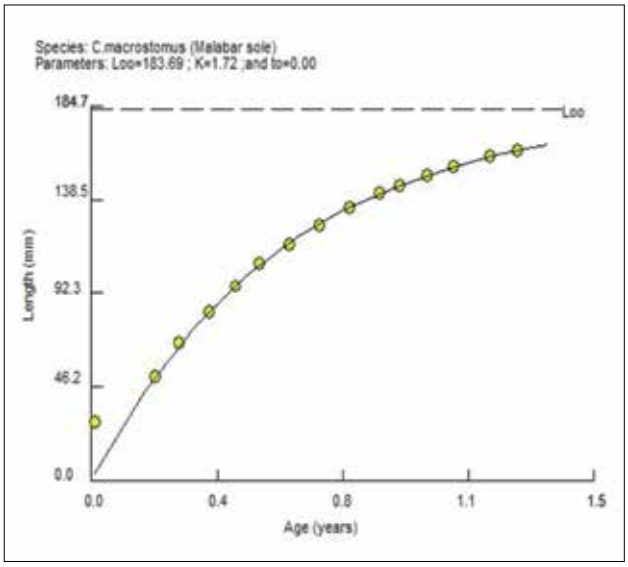

Fig. 2. Length of *C. macrostomus* at different age

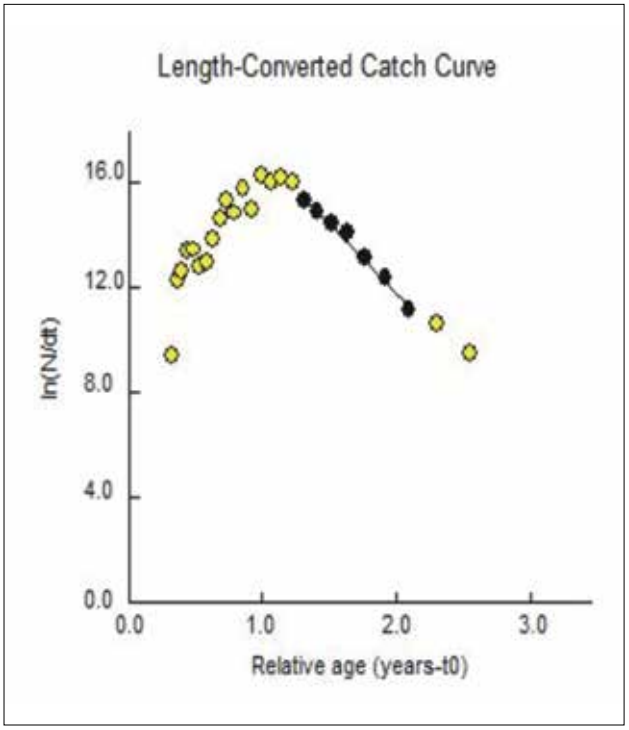

Fig. 3. Length converted catch curve for estimation of mortality (Z)

F were estimated as 7.78, 1.7 and 6.08 by Nair (2007). The value of fishing mortality in the present study is found to be on higher side conforming to the earlier reports except the value reported by Khan and Nandakumaran (1993). The catch of *C. macrostomus* is landed as bycatch from trawlers in Ratnagiri region. Higher value of F indicates higher fishing intensity of trawlers in Ratnagiri region. Also it suggests that effective fishing effort has increased due to improved catchability.

Length at first capture

The length at which 50% of the species became vulnerable to the gear was estimated to be 114mm. (Fig. 4). Manojkumar (2006) reported the length at first capture of this species as 38mm from Malabar Coast. While Nair (2007) found it as 45mm from Cochin waters and Khan and Nandakumaran (1993) found the same as 85mm from Kerala coast. The length at first capture in the present study is higher than earlier estimates reported by various workers. The length at first capture is a function of selectivity of the gear operated on the stock. The mesh size of cod end determines the length at first capture which is based on the selectivity of the trawl. The varying estimates of length at first capture reported earlier may possibly indicate that trawlers landing *C. macrostomus* as bycatch in different regions are using different cod end mesh sizes. Most of the Malabar tongue sole is landed by the shrimp trawls along the Ratnagiri coast. However there no published reports on specific cod end mesh sizes of trawlers landing *C. macrostomus* at different regions.

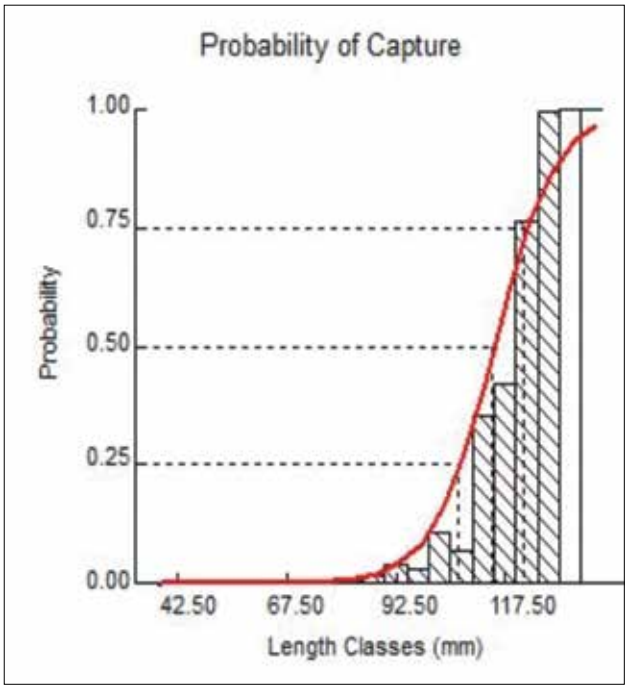

Fig. 4. Probability of capture of *Cynoglossus macrostomus*

Exploitation ratio (E) and relative yield per curve

Exploitation ratio (E) was found to be 0.806 and relative yield per curve is maximum for an exploitation ratio (E_{max}) of 0.77. The values of L_c/L_∞ and M/K taken for estimation of Y/R are as 0.5937 and 1.120 respectively (Fig. 5).

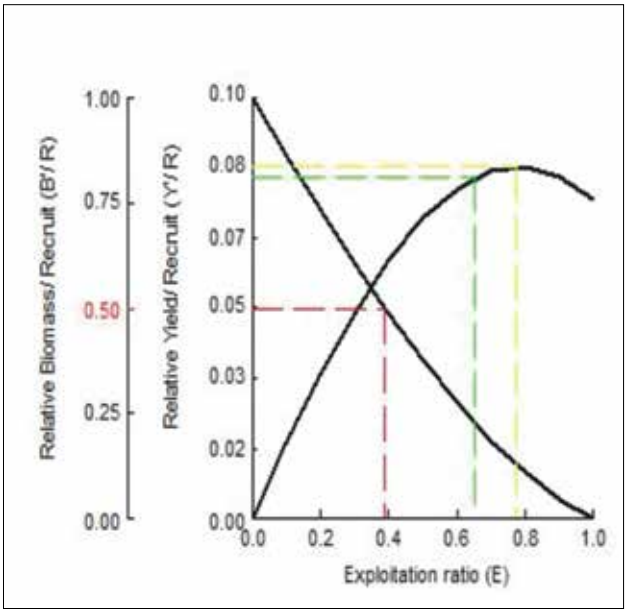

Fig. 5. Relative yield per recruit of *C. macrostomus*

The exploitation ratio (E) and E_{max} was reported to be 0.71 and 0.79 respectively by Manojkumar (2006) indicating the exploitation was below MSY level. Nair (2007) estimated the exploitation ratio for this species to be 0.78 and reported that the current exploitation ratio is much higher than E_{max} from Cochin waters. The exploitation ratio in the present study is slightly higher than E_{max}. and the fishing level should be reduced accordingly to sustain the maximum catches of this species from the Ratnagiri coast.

Acknowledgements

Authors are thankful to the Associate Dean, College of Fisheries, Ratnagiri and authorities of Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli for providing necessary facilities for carrying out the research work.

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