Flatfish fishery off Cochin and some aspects of the biology and stock of Malabar sole *Cynoglossus macrostomus* (Norman)

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ABSTRACT

Flatfish landings increased from an estimated 58 t in 2000 to 299 t in 2002, but declined to 65 t in 2003 and 61 t in 2004 at Cochin. August and September were the months of peak landings, which were also the peak spawning months. The optimum length of exploitation was 124 mm. Annual growth coefficient (K) and Lα were 0.79 and 212.5 mm respectively. The resource is being exploited at a level (E = 0.78) higher than the optimum (Emax = 0.458). Appropriate management measures are discussed.

Introduction

Among flatfishes occurring along the west coast, the Malabar sole *Cynoglossus macrostomus* form a major trawl fishery along the coastal region from Mulki in Karnataka to Kollam in Kerala. Though there is no targeted fishery for the species, it is obtained as a by-catch in shrimp trawls. With the increase in targeted fishery for shrimps, this species is also being heavily fished. Market demand for fresh flatfishes is only in the Malabar area; towards South Kerala, the fish is being dried and sold through consumer markets. The fish costs Rs.40 /kg in fresh and 50/kg in dried condition. Decayed fish from multi-day shrimp fishing vessels are being dried and sold as ingredient for poultry feed at Rs. 20/kg. Studies on the fishery, biology and stock characteristics of flatfishes along the Indian coasts have been carried out by Vivekanandan *et al.* (2003), Jayaprakash

(1998), Khan and Nandakumaran (1993), Grace Mathew *et al.* (1992), Seshappa and Chakrapani (1983), Victor (1978), Seshappa (1964,1974, 1978) and Seshappa and Bimachar (1955, 1954, 1951).The present paper gives an insight into the flatfish fishery and stock of *C. macrostomus* based on investigations at Cochin from 2000-2004.

Materials and methods

Data on landings of flatfishes and effort expended by trawlers were collected from weekly observations in the fishing harbours at Cochin and Munambam. To estimate catch (weight and numbers) of each species, the data collected at the observation centres were weighted to get estimates for each centre. Samples of the dominant species, *C. macrostomus,* were collected, length–weight measurements taken and length–weight relationship calculated by the method of least squares using the

formula

Log W = log a + b Log L

where, W = weight in grams, L= length in mm, a = constant and b = exponent. W^{α} was calculated using the L^{α} value and the length–weight relationship. For studies on reproductive biology, gonads of female were examined microscopically and classified into four stages - immature (Stages I and II), developing (Stages III and IV), mature/ gravid (Stage V) and spent (Stage VI). Fishes in Stage III and above were considered for the purpose of estimating length at first maturity. For determination of spawning period, only fishes in Stages V and VI were considered. Length frequency data were grouped at 5 mm interval to estimate the growth parameters. The parameters of growth in length were estimated following the ELEFAN method (Gayanilo *et al.,* 1988) using the monthly length frequency data for the years 2000-2004. The estimates of instantaneous mortality (Z) were made using length converted catch curve method (Pauly, 1982) with the combined data for five years.

The natural mortality rate (M) was estimated using the empirical formula of Pauly (1980) by taking into account the mean annual temperature off Cochin as 28.5oC. The fishing mortality F was estimated as Z – M. The optimum length of exploitation (Lopt) was estimated from the empirical equation of Froese and Binohlan (2000) using the relationship

Lopt = 3 x Lα / (3 + M/K)

The life span was estimated using the equation Tmax = 3/K (Pauly, 1983)

To assess the long-term impact of fishing, yield per recruit analysis (Y/R) was carried out following Beverton and Holt (1957). From the exploitation ratio, E, the yield (MSY) was estimated. Average standing stock (Y/F) and the annual stock or biomass (Y/U) were estimated for the five year period. The exploitation rate, U was estimated as F/Z (1 – e-Z). Recruitment pattern was obtained by backward projection on the length axis of the set of length–frequency data (seasonal growth curve) by using the routine ELEFAN II.

Results

The total annual effort decreased from 14,803 units in 2000 to 2,980 units in 2003, but increased to 6,709 units in 2004. The catch per unit effort, however, increased from 3 kg in 2000 to 38 kg in 2002, but decreased to 9 kg in 2004. Flatfish landings increased from an estimated 58 t in 2000 to 299 t in 2002, an increase of 241 t in two years, followed by a drastic decline to 65 t in 2003 and 61 t in 2004. Generally, maximum trawl effort was expended in the pre and post-monsoon months (May and August). During 2000-04, August and September were the months of peak production (Fig 1). Landings were poor during the pre
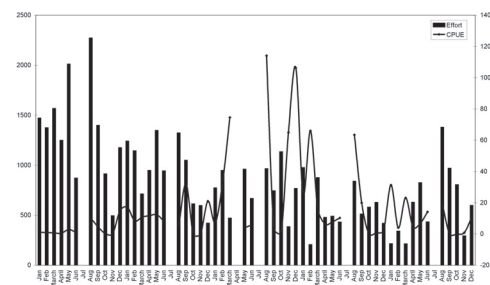

Fig. 1. Seasonal production of flatfishes by trawlers at Cochin during 2000-2004

monsoon months of April - June. During 2002 and 2003, however, good landings were observed during February and March also.

Fourteen species of flatfishes were recorded in the fishery. Of these, *C. macrostomus* dominated the landings

contributing over 65 %, followed by *C. macrolepidotus* with 18 %. The other species, which contributed to the fishery, were *C. puncticeps, C. bilineatus, C. dubius, Psettodes erumei, Synaptura commersoniana, Bothus myriaster, B. ovalis, Pseudorhombus elevatus, P. javanicus, Aesopia cornuta and Zebrias quagga.*

A total of 500 specimens ranging from 50 -160 mm in total length were used for the estimation of length –weight relationship. The data for both sexes were pooled to get the estimates of a and b. The length –weight relationship for *C. macrostomus* is

$$Log W = -5.16 + 3 Log L$$

Using the availability of mature and spent gonads in the samples, the spawning season off Cochin was found to be January –April and August – October, with the peak during August- September. The predominant maturity class is Stage IV when the commercial fishery commences after the trawl ban at Cochin

Growth parameters were estimated assuming that the growth in length of the species follows von Bertalanffy equation. The length at first capture is 45 mm. A total of 5,289 fishes in the range 45 -190 mm total length were used for the estimation. (Fig. 2).
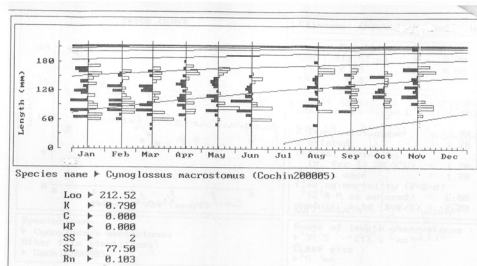

Fig. 2. Growth of *C. macrostomus* at Cochin.

The growth parameters estimated was L^{α}212.5 mm using Powell – Weatherall plot, K at 0.79 year -1 and to

at -0.014. Using these results the VBGF equation for *C. macrostomus* can be written as

$$Lt = 212.5 (1 - e - 0.79 (1- (-0.014)).$$

Optimum length of exploitation (Lopt) was estimated as 124 mm and the maximum life span Tmax as 3.8 years. Natural mortality M was estimated as 1.7. Instantaneous mortality Z was estimated using length–converted catch curve method at 7.78. (Fig. 3). Using Z and M, fishing mortality F was estimated at 6.08 and exploitation rate E at 0.78. The cutoff length L' was estimated at 117.5 mm and the mean length in the fishery at 131.5 mm. Using E values, and
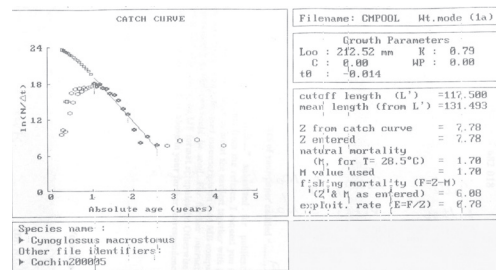

Fig. 3. Length converted catch curve of *C. macrostomus* at Cochin

taking the present average yield at 60 t, the MSY was estimated at 99 t. The standing and total stocks were estimated at 16 t at 126 t respectively.

Discussion

The fluctuations in the landings of flatfish noticed during 2000 - 2004 were similar to the results of Jayaprakash (1998). The fluctuations in the flatfish fishery may be attributed to the large scale shoaling of the species in the surface and subsurface waters of the inshore areas in enormous numbers (Jayaprakash, 1998). In the present study, the peak production period was during August and September immediately after the monsoon trawl ban, followed January -March. The results are different

TABLE 1. *Length weight relationship for* C. macrostomus *worked out by various authors*

Area	Sex	No.	a	b	Author
Mangalore	M	761	0.000004327	3.04	Victor (1978)
	F	657	0.00001415	2.7886	-do-
	P	1418	0.000007872	2.9145	-do-
Calicut	P	150	0.00003759	2.618	Khan and Nandakumaran (1993)
Cochin	M	340	0.000002194	3.163	Jayaprakash (1998)
	F	329	0.0000002953	3.10	-do-
	P	669	0.000002576	3.13	-do-
Cochin	P	500	0.005737108	3	Present study

from those reported by Grace Mathew *et al.* (1990) that the peak flatfish landings was during May and June during 1984 –1988 at Cochin. Khan and Nandakumaran (1993) also reported similar landing pattern at Calicut. It appears that the difference in the months of peak landings may be due to change in the fishery pattern after the implementation of trawl ban.

Seshappa and Bimachar (1955) observed the spawning season of the Malabar sole as September – October off Calicut. . However, in the present study, two spawning seasons (January-April, August-October) were noticed; these results agree with that of Jayaprakash (1998) from the same area. The commercial catches consist of fishes in different maturity stages and belong to two recruitment batches.

The length weight relationship for *C. macrostomus* worked out by various authors is given in Table 1. The growth in weight is isometric for this species. Jayaprakash (1998) reported size at first maturity to be 97 mm. Results of the present study, however, point to a higher size at first maturity (118.5 mm). Similarly, results on the length of the fish attained at the end of the first and second year were higher than that recorded by Khan and Nandakumaran (1993). The largest specimen they obtained was 159 mm which was much lesser than that of the present study.

The optimum length of exploitation in the present study point to the fact that fishes over one year class alone should be exploited. The length at first capture in the trawl (45 mm) is much below the optimum length as well as the cut off length. The present exploitation rate E is much higher than E max; this value along with the high F value shows that this species is being heavily exploited and there is need for reducing the trawl effort.

Acknowledgements

References

Beverton R.J.H and S.J. Holt 1957. *On the dynamics of the exploited fish populations.* Fishery Investigation Series, London 19: 533 pp.

Froese, R and C. Binohlan 2000. Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes with a simple method to evaluate length frequency data. *J. Fish Biol.,* 56: 758 -772.

Gayanilo, F.C Jr., M. Soriano, and D. Pauly

1988. A draft guide to COMPLETE ELEFAN. *ICLARM Software Project* 2: 65 pp.

Grace Mathew, M. Feroz Khan and K. Nandakumaran 1992. Present status of exploitation of fish and shell fish resources: Flatfishes and flatheads. *Bull. Cent. Mar. Fish. Res. Inst.,* 45: 197 -204.

Jayaprakash, A.A 1998. *Studies on the fishery, biology and population dynamics of flatfishes (Cynoglossus spp; Family Cynoglossidae) along Kerala coast.* Ph.D Thesis, University of Calicut. 307 pp.

Khan M.F and K. Nandakumaran 1993. Population dynamics of Malabar sole Cynoglossus macrostomus Norman along Calicut coast. *Indian J. Fish.,* 40 (4): 225-230.

Pauly, D. 1982. *Studying single –species dynamics in a tropical multispecies context. Theory and Management of Tropical Fisheries pp* 33 – 70. (Eds) Pauly, D and Murphy C.I, ICLARM, ISIRO.

Pauly, D. 1983. Some simple methods for the assessment of tropical fish stocks. *FAO Fish. Tech. Paper,* 234:52 pp.

Seshappa, G. 1978. Some observations on the size distribution and the occurrence of growth rings in the scales of three species of *Cynoglossus* at Calicut. *Indian. J. Fish.,* 25 (1 & 2): 188-196.

Seshappa, G. 1974. Flatfish resources of west coast of India. *Proc. Sym. Liv. Res. Seas around India.* CMFRI Spec. Publ.: 470 - 482.

Seshappa, G. 1964. Length frequency studies on the Malabar sole *Cynoglossus semifasciatus* Day at West Hill, Calicut during the years 1959 -60 to 1962 -63. *Indian J. Fish.,* **11** (2): 533-546.

Seshappa, G and B.S. Bimachar 1955. Studies on the fishery and biology of Malabar sole *Cynoglossus semifasciatus* Day. *Indian J. Fish.,* 2 (1): 180 -230.

Seshappa, G and B.S. Bimachar 1954. Studies on the age and growth of the Malabar sole *Cynoglossus semifasciatus* Day. *Indian J. Fish.,* **1 (1 & 2)**: 145 -162.

Seshappa, G and B.S. Bimachar 1951. Age determination studies in fishes by means of scales with special reference to Malabar sole *Cynoglossus semifasciatus* Day. *Curr. Sci.,* 20: 260 -262.

Seshappa G and B.K. Chakrapani 1983. Length frequency distribution in *Cynoglossus semifasciatus* Day on the West Coast during 1980-81. *Indian. J. Fish.,* 30 (1): 74-86.

Victor A.C.C 1978. Length weight relationship in the Malabar sole, *Cynoglossus macrostomus* Norman. *Indian J. Fish.,* 25(1 & 2): 259 -262.

Vivekanandan, E., P.U. Zacharia, M. Feroz Khan and Rekha J. Nair. 2003. Flatfishes In: Mohan Joseph, M and Jayaprakash A.A (Eds.) *Status of Exploited Marine Fishery Resources of India,* CMFRI: 164 – 170.