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Lizardfish fishery of Kerala with some aspects of the stock characteristics of the greater lizardfish *Saurida tumbil* (Bloch, 1795)

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ABSTRACT

The fishery of lizardfishes and population dynamics of the dominant species *Saurida tumbil* landed in Kerala by mechanised trawlers were studied for the period 2007-2011. Annual landings of lizardfishes in Kerala during the period ranged between 6,715 to 10,600 t with an average annual landing of 8,992 t, which formed 5.2% of the total landings of the state. The seasonal peak in catch was recorded during August – October. Three species contributed to the lizardfish fishery of Kerala, of which, *S. tumbil* formed 59%. The overall sex ratio of *S. tumbil* was 1:1.2 with mature females encountered in most months with a peak during September – November. The von Bertalanffy growth parameters (VBGF) estimated using ELEFAN were L_{∞} = 517.0 mm, K = 0.40 year^{-1} and t_0 = -0.1879. The length attained at the end of 1, 2, 3, 4 and 5 years were 195.5, 301.5, 372.6, 420.2 and 452.1 mm, respectively. Recruitment was round the year with peaks during May-June and October-November accounting for 55% of the total recruitment. The average instantaneous rate of total, natural and fishing mortalities were 1.34, 0.44 and 0.90 respectively. The length at first capture was 285 mm at which the age works out to be 1.6 years. The optimum length for exploitation (L_{opt}) was 378 mm at the age (t_{opt}) of 3.1 years. Mean size in the catch was lower than optimum size for exploitation; which necessitates caution to increase the minimum mesh size from the present level. The resource is being exploited at a level (E = 0.67) almost equal to the maximum exploitation (E_{max} = 0.69), indicating overexploitation of the resource. As the annual average yield is 33% higher than the MSY estimated, there is a need for reducing the fishing effort to sustain the fishery.

Keywords: Exploitation, Growth, Population dynamics, *Saurida tumbil*

Introduction

Lizardfishes belonging to the Family Synodontidae, are an important demersal fishery resource the world over. They were caught mainly as bycatch in shrimp trawlers in the early periods, but are now being targeted and harvested mainly by trawls (96%). India ranks fourth in the world lizardfish production. The global annual average production of lizardfish during the last two decades was 1,29,880 t, of which India's share was 8.9% (FAO, 2012). National production of lizardfishes was 70,004 t in 2012, of which 34% was contributed by Karnataka followed by Gujarat (25%) and Kerala (18%). The lizardfish landings of India is comprised mainly of two species *Saurida tumbil* and *Saurida undosquamis,* with the former being dominant in the west coast and the latter along the east coast.

Earlier reports on the fishery of lizardfishes along the Indian coast included Rao (1983; 1984) and Nair and Raghu (1990). Nair *et al.* (1992) attempted to correlate the lizardfish fishery of south-west coast of India with monsoon. Muthiah (1994), Muthiah and Neelakantan (1997), Sivakami (1999), Sivakami *et al*. (2003), and Raj Kumar *et al*. (2003) studied the lizardfish fishery at selected centers along the Indian coast. The biology and stock characteristics of *S. tumbil* at Mumbai and Veraval waters were studied by Jaiswar *et al.* (2003) and Manojkumar and Sivakami (2005) respectively. Information on the fishery and population dynamics are essential pre-requisites for developing appropriate scientific management strategies for regulating the fishery in order to sustain the stock and production. The present study was aimed to understand fishery of lizardfishes and the biology and population characteristics of the dominant species contributing to the fishery along the Kerala coast.

Materials and methods

The data on catch and effort expended for lizardfishes at different centres along the Kerala coast during the period 2007-11, collected and estimated by Fishery Resources Assessment (FRA) Division of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), Kochi formed the base data for describing the fishery of lizardfishes in the state. The species composition of

lizardfishes was obtained from Cochin and Neendakara Fisheries harbours by weekly observations. *Saurida tumbil,* the dominant species landed by trawl nets were collected at fortnightly intervals during the period (n=3900) and raised to monthly length frequency data. The data on length, weight, sex and stages of maturity in females were taken from fresh specimens.

For estimating von Bertalanffy growth parameters *viz.,* asymptotic length (L_∞) and growth co-efficient (K), the length measurements of five years were pooled and grouped into 10 mm class interval, month-wise and analysed using the ELEFAN I module of FiSAT software (Gayanilo *et al.,* 1996). The probability of capture and size at first capture (L_c) were estimated as in Pauly (1984) and the age at zero length (t_0) from Pauly's (1979) empirical equation, Log ($-t_0$) = - 0.392 - 0.275 Log L - 1.038K. Natural mortality (M) was estimated using Pauly's empirical formula (Pauly, 1980), using 27°C as the mean sea temperature. Total mortality (Z) and exploitation rate (E) were estimated from the catch curve and exploitation ratio (U) from the relation; $U = F/Z_*(1-e^{-Z})$; where, F is the fishing mortality as in Pauly (1983).

The L_c value was converted to t_c value using the inverse von Bertalanffy growth equation. The midpoint of the smallest length group in the catch was taken as length at recruitment (L_r). The relative yield per recruit (Y'/R) and biomass per recruit (B'/R) at different levels of F were estimated using LFSA package (Sparre, 1987).

Total stock (P) and biomass (B) were estimated from the ratios Y/U and Y/F respectively; where, Y is the yield in tonnes and U the exploitation ratio. E_{max} was estimated graphically as per Corten (1974). The t_{max} was estimated from t_0 using the formula $t_{max} = t_0+3/k$. The length of maximum possible yield in the fishery was calculated following Beverton (1992) as:

$$L_{opt} = L_\infty \left[\frac{3}{3 + \frac{M}{K}} \right]$$

Maximum sustainable yield (MSY) of *S. tumbil* was estimated using the equation (Gulland, 1979): MSY = Z*0.5*B.

Results and discussion

Fishery

Annual landings of lizardfishes in Kerala ranged between 6,715 to 10,600 t with an average annual landing of 8,992 t which formed 5.2% of the total landings of the state during 2007-11. Kerala contributed 34.2% to the all India landings of lizardfishes during the period. The seasonal peak in catch was recorded during August - October. The catch was highest during 2008, which gradually declined in 2009 and 2010 and then increased to 10,444 t during 2011 (Fig. 1). The catch rate (CPH) for lizardfishes landed in trawlers ranged from 1.82 kg h^{-1} in 2007 to 2.72 kg h^{-1} in 2011 with annual average of 2.34 kg h^{-1}. The gear-wise analysis indicated that the multi-day trawl net units (MDTN) with a share of more than 90% contributed towards the bulk of the landings followed by single day mechanised trawl net units (MTN) and other mechanised gears (MOTHS) which include the mechanised crafts that carry various types of fishing gears (Fig. 2). A small fraction of landing during the period was contributed by outboard beach seine units (OTHERS)

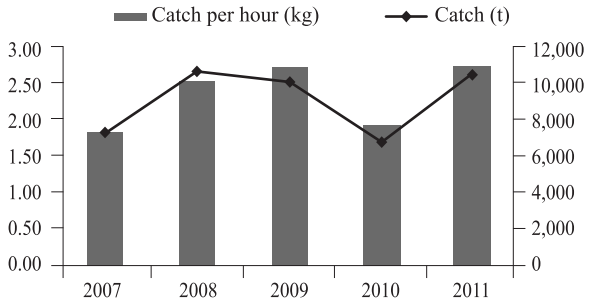

Fig. 1. Catch and catch rate (CPH) of lizardfishes landed by trawlers in Kerala during 2007-11

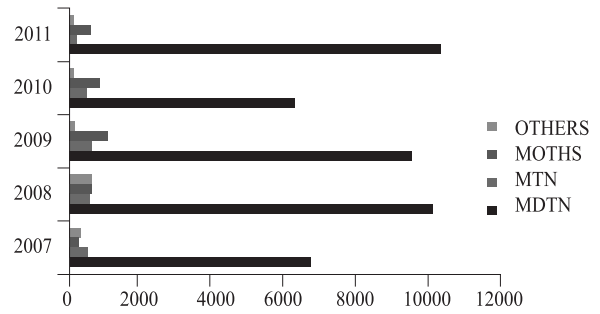

Fig. 2. Gearwise landings of lizardfishes landed in Kerala during 2007-11

Seasonal abundance

The highest landings of lizardfishes were observed during the post-monsoon season, immediately after lifting of the seasonal fishing ban in August (Fig. 3). The highest catch as well as catch rate was recorded during August - October period with peak landings in August. The average monthly landings during 2007-11 ranged from 1,394 t in December to 11,015 t in August. The catch rate in terms of catch per hour also followed the same trend. The catch rate ranged from 0.98 kg h^{-1} during January-December to 6.60 kg h^{-1} in August with an average of 2.5 kg h^{-1}. The monthly catch and catch rate followed a uni-modal peak during 2007-11.

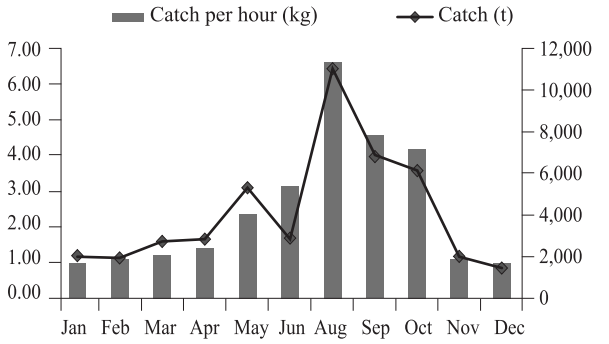

Fig. 3. Seasonal abundance of lizardfishes landed by trawlers in Kerala during 2007-11

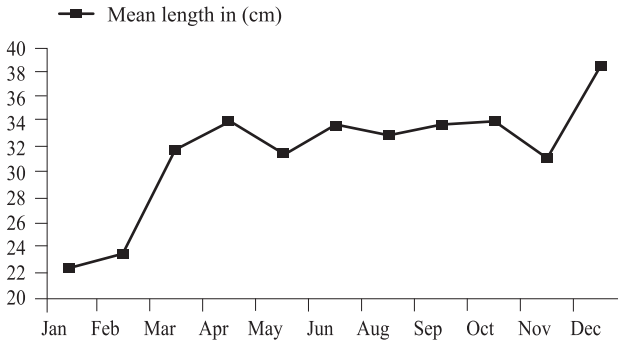

Fig. 5. Average monthly mean length of *S. tumbil* landed by mechanised trawlers in Kerala

Species composition

The lizardfish fishery was constituted by three species in Kerala during 2007-11 (Fig. 4). *S. tumbil* dominated with a contribution of 59% followed by *S. undosquamis* (37%) and *Trachynocephalus myops* (4%). The contribution of *S. undosquamis* increased in 2010 (44%) and 2011 (38%) compared to that of *S. tumbil* (51% and 54% in 2010 and 2011 respectively).

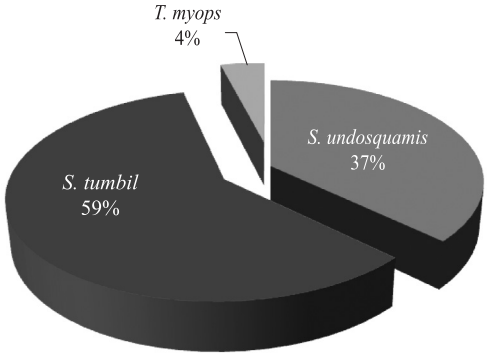

Fig. 4. Average annual species composition of lizardfishes landed in Kerala

Length composition

The length range of *S. tumbil* landed in trawl nets were 165 - 495 mm during 2007-11 with an annual mean length of 318 mm. The higher mean lengths were recorded during December and the lower during January - February months (Fig. 5). There were no significant variation in the mean lengths recorded during the period March to October. The dominant size group of *S. tumbil* in Kerala was 195 - 415 mm.

Sex ratio and spawning season

A total of 2062 fishes were examined, of which 1053 were males and 1009 were females. Males dominated the commercial catches in the months of February, March, August, September and November, while the females out numbered during the rest of the months. The overall sex ratio of *S. tumbil* was 1:1.2. The chi-square values indicated no significant difference in sex ratio from the expected ratio of 1:1 ($p > 0.5$). Mature females were encountered in most months with a peak during September – November. Mature specimens of *S. tumbil* dominated in November (76%), followed by October (60%), December (41%) and September (28%). This indicates that *S. tumbil* at Cochin had peak breeding period form September to December during the period 2007-11.

Growth, mortality and other population parameters

A total of 3900 fishes in the length range of 165-495 mm total length were used for the estimation of growth parameters. The von Bertalanffy growth parameters (VBGF) estimated using ELEFAN were: asymptotic length L_∞ = 517 mm and the growth coefficient K = 0.40 year^{-1} (Fig. 6). The growth performance index Ø' was found to be 5.029 and the age at zero length t_0 = -0.1879. The VBGF for *S. tumbil* is given by:

$$L_t = 517\ [1\text{-}e^{-0.4(t + 0.1879)}]$$

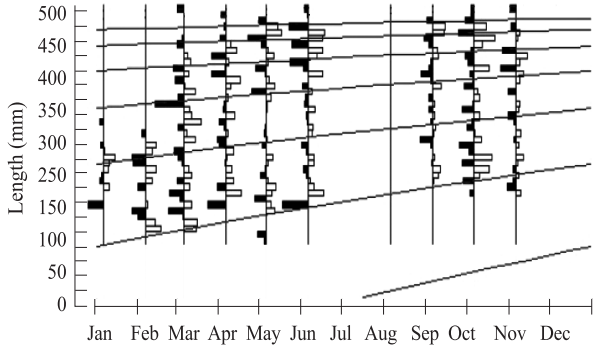

Fig. 6. Restructured growth curve of *S. tumbil*

The length attained by *S. tumbil* at the end of 1, 2, 3, 4 and 5 years were 195.5, 301.5, 372.6, 420.2 and 452.1 mm, respectively. Gulati *et al.* (1984) and Manojkumar and Sivakami (2005) reported faster growth rates

viz., 0.96 and 0.70 year^{-1} respectively for *S. tumbil* from north-west coast of India. Jaiswar *et al.* (2003) observed L_∞ and K for the species to be 605 mm and 0.73 year^{-1} from Mumbai waters. In all the above studies, however, the asymptotic length reported was more than 550 mm. In the present study along the south-west coast of India, the L_∞ estimated was only 517 mm. The value of K estimated for *S. tumbil* by Rao (1984) along the north-western part of Bay of Bengal was only 0.247 year^{-1}. The largest maximum size recorded by Rao (1984)along Visakhapatnam waters was 450 mm. The regional differences in growth rate for the fish stocks of the same species were reported by Wright *et al.* (1989).

The average instantaneous rate of total, natural and fishing mortalities were 1.34, 0.44 and 0.90 respectively (Fig. 7). The natural mortality obtained in the present study is much lower than that reported by Jaiswar *et al.* (2003) in Mumbai waters. They reported a natural mortality of 1.2 and very high fishing mortality of 3.39 with a high exploitation rate of 0.73. However, in the present study, the exploitation rate E is estimated at 0.67, which is marginally lower than the E_{max} of 0.69. The optimum length for exploitation (L_{opt}) was 378 mm at the age of (t_{opt}) of 3.1 years.

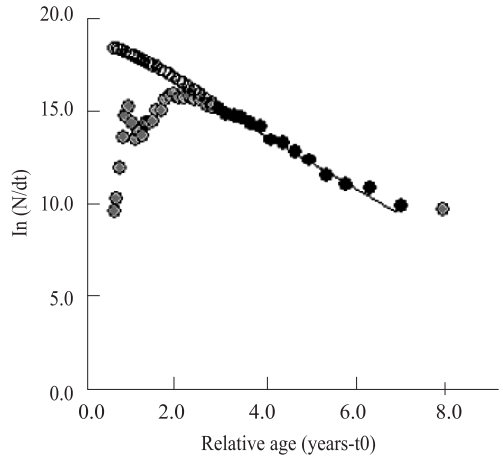

Fig. 7. Length converted catch curve for *S. tumbil* landed by mechanised trawlers along the Kerala coast

Recruitment pattern

The recruitment pattern obtained from FiSAT indicates a protracted period almost round the year with peaks during May-June and October-November accounting for 55% of the total recruitment (Fig. 8). The recruitment pattern of *S. tumbil* reported by Manojkumar and Sivakami (2005) at Veraval was only uni-modal with peak recruitment in January. The peak spawning season of *S. tumbil* in Kerala extend from September to December.

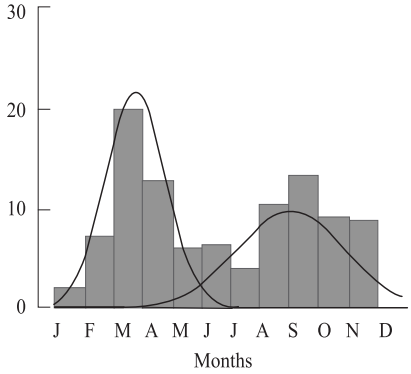

Fig. 8. Recruitment pattern of *S. tumbil* landed by mechanised trawlers along the Kerala coast

The yield per recruitment against different values of F keeping t_c and M constant, shows that Y_w/R increases with F reaching the maximum of 67.2 g for the corresponding B/R of 62.2 g (Fig. 9). The optimum Y_w/R and B/R can be obtained by marginally increasing the present effort by 20%. The biomass per recruit also declined sharply at this exploitation rate. Maximum yield of *S. tumbil* could be 5,308 t at 20% of the present effort, but the increase in relative yield will be only 0.07% of the present yield (Fig. 10). The present exploitation rate is beyond the

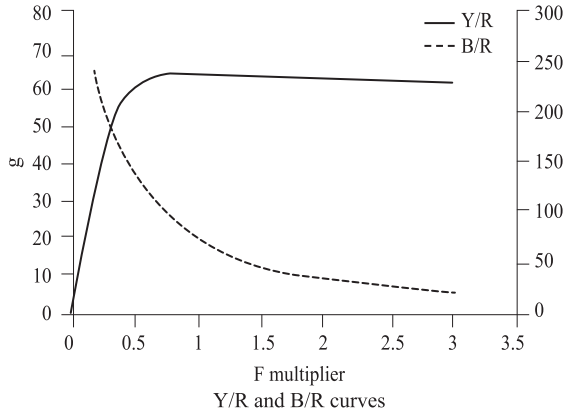

Fig. 9. Yield per recruit and biomass per recruit of *Saurida tumbil* for different multiples of F

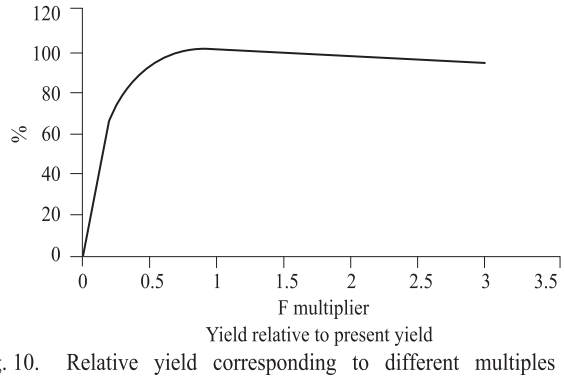

Fig. 10. Relative yield corresponding to different multiples of F in *S. tumbil*

optimum E of 0.5. Similar exploitation pattern for *S. tumbil* along Maharashtra and Gujarat coasts were reported (Jaiswar *et al.,* 2003; Manojkumar and Sivakami, 2005). The present study indicates that there is no significant increase in yield and yield per recruit by increasing the present fishing effort, instead the biomass per recruit reduces with increase in the present fishing effort.

Length at first capture L_c for *S. tumbil* was 285 mm with the corresponding age (t_c) of 1.6 years. The L_c for *S. tumbil* at Veraval was only 202 mm (Manojkumar and Sivakami, 2005), which was much lower compared to the present value. The length at first recruitment (L_r) is taken as the smallest mid length in the length frequency distribution and it was 105 mm in the case of *S. tumbil*. The corresponding age at first recruitment (t_r) was 0.38 years. Similar to the L_c, the L_r reported for *S. tumbil* was also much lower (75 mm).

The annual total stock of *S. tumbil* was estimated at 10,742 t along the Kerala coast. The standing stock or the biomass was estimated at 5,894 t. The MSY of *S. tumbil* estimated using Gulland (1979) formula was 3,978 t, which is 25% lower than the present annual average yield of the species along Kerala coast.

The annual landings of lizardfishes of the state show a fluctuating trend over the last five year period. Though there is increasing catches during some years, the maximum size and mean size of the dominant species *S. tumbil* has registered a decline compared to that reported by the previous studies along various coasts of India (Rao, 1982; Gulati *et al*, 1994; Jaiswar *et al*., 2003; Raje *et al*, 2004; Manojkumar and Sivakami, 2005). Mean size of *S. tumbil* in the catch during 2007-11 was 318 mm, which is much lower than the optimum size for exploitation (378 mm). This necessitates caution to increase the minimum mesh size from the present level. The resource is being exploited at a level above the optimum (E=0.5) and reached the maximum exploitation level (E_{max}= 0.69), indicating overexploitation of the resource. (The spawning stock biomass estimated is more than 30% of the resource at its unexploited level, which is a good indicator of regeneration capacity of the resource). The annual average yield of *S. tumbil* being 33% higher than the MSY estimates and the higher exploitation rate suggests that the stock is under high fishing pressure, which invariably necessitates the reduction in fishing effort for optimally exploiting this resource.

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