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Fishery and stock assessment of *Fenneropenaeus indicus* (H.Milne Edwards) from Kozhikode, south west coast of India.

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ABSTRACT

The average annual catch of *Fenneropenaeus indicus* in the trawl landing of Puthiappa, Kozhikode was 197 t with a CPUE of 15 kg. Peak fishing period was April-May. About 28% of the average annual shrimp catch was constituted by *F. indicus*. The stock assessment studies indicated that the fishery is still under-exploited and the effort can be increased to obtain the maximum sustainable yield.

Introduction

Fenneropenaeus indicus forms one of the most commercially important species due to its large size, quality meat and high export value. As a result, exploitation of this resource is intense both from estuary and sea. Puthiappa harbour at Kozhikode is one of the major trawl landing centers of North Kerala coast and observation on the shrimp fishery from here gives a general picture for the Malabar area. Prawn fishery in general have been dealt with from Kerala by Anon (1975), from Malabar area by Panikkar (1937), and from Kannur coast by Kuthalingam (1970). Aspects on biology, growth and population characteristics of *F.indicus* were studied from Cochin and Alleppey coast by George (1961) and George *et al.* (1963); and from Ambalapuzha by Kurup and Rao (1974). Maturation and spawning of this species from south-west coast have been dealt with by Rao (1968). Population dynamics and stock position of the species from Kakinada have been studied by Lalithadevi (1986) and from east coast by Rao *et al.* (1995). However published work on the Indian white shrimp fishery from Kozhikode coast especially on stock position is lacking.

In view of its importance in the fishery and absence of any published information on this species from this area, the present study was undertaken based on the data collected during the period, August 2002 - July 2004 from the trawlers landed at Puthiappa. In this paper besides the fishery, the population dynamics covering the aspects such as stock, MSY etc of the species have been described.

Materials and methods

Data on catch, effort and species composition of shrimp fishery were

collected twice in a week from Puthiappa landing center during 2002-03 and 2003-04 and the days' catch was estimated to that month. Random samples of *F.indicus* were collected twice in a month and analysed for size and maturity condition sex-wise. As the main gear operated for shrimps was trawl, the data collected from shrimp trawl was used for this study. To avoid break in data in July due to the ban on trawling, August to June was taken as one year. FISAT computer program and stock assessment manual (Sparre and Venema, 1992) were used for calculating the population characteristics and stock assessment. The details of methodology used are given in the respective aspects under result.

Results

Annual catch, effort and CPUE

Trawlers contributed 96 % of the total shrimp catch of this center and the rest by discovala (minitrawl) and ring net (mini purse-seine). The indigenous gears were operated mainly during monsoon seasons. In 2002-03 the total shrimp catch by trawl net was 889 t with a CPUE of 58.4 kg. This formed 6.7% of that gear's catch. Among the 11 species of shrimps caught during this period, F.*indicus* was the dominant species (27.9%) followed by *Metapenaeus dobsoni* (27.7%) and *Parapenaeopsis stylifera* (25.5%). In the next year, 2003-04, the shrimp catch declined to 505 t with a CPUE of 46 kg. The effort expended had also reduced from 15233 units to 10961 units. But the percentage of shrimps in the total catch increased to 6.9. This year *M.dobsoni* dominated (46.9%) the catch followed by *F.indicus* (28.9%) and *P.stylifera* (16.6%). The annual average shrimp catch was 697 t and the CPUE was 52 kg.

In the case of *F.indicus*, the catch was 248 t and the CPUE was 16.3 kg in 2002-03. But in 2003-04, the catch declined to 146 t reducing the CPUE to 13.2 kg. The average annual catch of *F.indicus* for the period, August 2002 – June 2004 was 197 t and the CPUE was 15 kg. The annual average percentage of *F.indicus* was 28.2

Seasonal catch, effort and CPUE

Though the shrimp fishery was from August to June, the *F.indicus* fishery was only from October to June with a peak during April-May. The catch of *F.indicus* in 2002-03 showed a gradual increase from October to May. From an initial catch of 327 kg in October it increased to 99.5 t in May and then it decreased in June. Corresponding with the catch, the CPUE also showed a continuous increase from October (0.28kg) to May (42.17kg). In 2003-04, the catch showed wide fluctuation. It increased from 3 kg in October to 27.8 t in January. But the catch decreased in the following two months and recorded 8.6 t in March. The catch then increased to a maximum of 39.6 t in April. Again it showed a decrease in the next two months. Just as the catch, the CPUE also fluctuated. October recorded the minimum CPUE (0.01 kg) but June recorded the maximum (32.12kg) followed by April (26 kg). The average monthly catch of these two years showed a gradual increase from October (165 kg) and reached the maximum in May (64 t). The average monthly CPUE also showed a similar pattern of fluctuation with a minimum in October (0.2kg) and a maximum in May (30.81 kg) followed by April (30.72kg). Percentage composition of *F.indicus* in total shrimp catch during 2002-03 varied from 2.1 in October to 59.4 in May. In 2003-04, it varied from 20.7 in November to 57.4 in April. The percentage of *F.indicus* in the average monthly shrimp catch varied from 2.1 in October to 53.7 in April.

Estimation of growth parameters

The maximum length recorded was 170 mm for males and 180mm for females. The asymptotic length (L∞) was calculated by using Powell-Wetherall method (Wetherall et al., 1987) and the value was 178.8 mm in males and 183 mm in females. The growth constant (K) was calculated by using ELEFAN as 1.4 for males and 1.2 for females. On applying von Bertalanffy growth equation based on these values and on assuming 'to' as '0', females reached total length of 128 mm in the first year and 168mm in the second year. Males attained a length 133 and 168 mm respectively for first year and second year.

Estimation of mortality rates

Total mortality coefficient (Z) was estimated from linearized length converted catch curve. The 'Z' was estimated as 6.6 for males and 6.7 for females.

Natural mortality coefficient (M) (Rikhter and Effanov, 1976) was 1.5 for females and 1.7 for males. The age of massive maturation (the age at which 50% of the population matures –Tm50) was calculated as 0.8 for males and 0.9 for females. The Lm 50 (size at first maturity) was at 118mm in males and 123mm in females.

Fishing mortality (F) was calculated as 4.9 in males and 5.2 in females.

Trawl net selectivity

The gear selectivity was found out from the ascending limb of length converted catch curve. The age and size group thus obtained at first capture (t50% and L50%) in males were 0.73 years and 116-120 mm respectively. In females, these values were 0.9 years and 121-125 mm respectively.

Virtual population analysis:

Virtual population analysis was done by using Jones' length - based cohort analysis. Here, the terminal F/Z was assumed to be 0.5. The fishing mortality and total mortality were maximum in the size group of 126 –130 mm (males) and 131-135 mm (females). Mean number of *F.indicus* (number of survivors) in the sea and their biomass for the period 2002-2004 were 329.063 million and 95 t respectively for males and 536.84 million and 155t respectively for females.

Prediction analysis

The future yields and stock biomass levels were predicted by using the predictive models such as yield per recruit model and Thompson and Bell model.

Beverton and Holt's yield per recruit analysis:

The values taken for the analysis of males were K=1.4, to =0, Tc=0.73, Tr=0.37, W∞ = 33.6, M =1.7, Z = 6.6 and present F= 4.9. The values taken for females were K=1.2, t0=0, Tc=0.9, Tr=0.3, W∞ = 37.2, M= 1.5, Z=6.7 and present F= 5.2.

The yield per recruit for the present F was 5.03 g in male and 4.29 g in female. Y/R curve for different fishing mortalities did not show a maximum but after a certain stage the rate of increase of Y/R became very slow and that was taken as the F-MSY. Thus obtained F-MSY (relative) in males was 7 and females was 8.5.The corresponding yield per recruits were 5.1 and 4.38 g. As the Y/R – curve did not have a maximum, the average biomass per recruit (B/R)were also calculated and plotted along with Y/R. It showed that for *F. indicus*, the biomass corresponding to the optimum F- level (F-MSY) was 5.41 % and 4 % of the virgin

stock biomass (Bv) of male and female respectively (Fig.1)

Thompson and Bell model

Length based Thompson and Bell model was also used to predict the yield and stock biomass by size group as a function of fishing mortality. The analysis used 14 different F-array by raising the F-value with 14 factors starting from zero to 2.6. The present F-factor was taken as 1. The present average annual yield was 96.1 t in males and 100.9 t in females. The total yield was 197 t. The mean biomass available for the factor -1 was 47.4 t in males and 75.7 t in females and the total was 123.1 t. The virgin stock biomass was 345.3 t (148.5 t male and 196.8 t female). The yield was maximum (MSY) for the F-factor 1.6 in the case of males and 2 in the case of females and the yields were 97.9 t and 109.2 t respectively. The total yield (males and females combined) for factor 1.6 was 205.6 t and it was maximum (206.9 t) for the F-factor 2.0 and the corresponding mean biomasses were 98.9 t and 90.4 t. (Fig. 2).

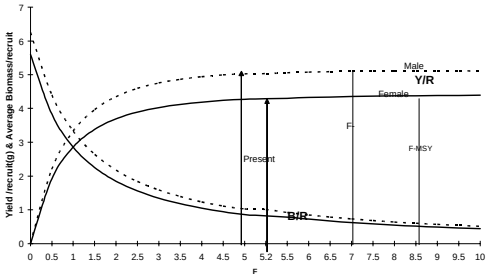

Fig.1. Yield per recruit and Biomass per recruit curve of *F.indicus* as a function of F

Discussion

F. indicus is one of the most commercially important species of shrimps. It occurs in trawl catch from October to June with a peak in April-May. Though in the average annual shrimp catch this species formed 28 %, during April - May, it formed more than 50% of the shrimp catch. The increase in F.*indicus* catch compared to earlier years was mainly due to the introduction of multi-day trawlers fishing in deeper grounds and the catch was mainly constituted by large sized *F.indicus*.

The age and growth study showed that males grew to133 mm in the first year and females to 128 mm, whereas in the second year both the sexes reached 168 mm. Males grew faster than females and it reached L∞ earlier. The 'K' value of males (1.4) was higher than females (1.2) which is also observed by Kurup and Rao (1974), though Jayawardane (2002) and Lalithadevi (1986) observed a higher value of 'K' for females .In the

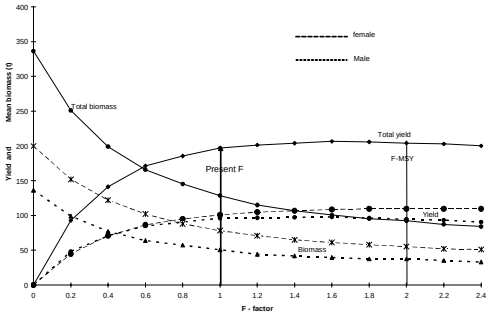

Fig.2. Yield and biomass curve of the length-based Thompson and Bell analysis

present study majority of the male catch (82%) was caught between the size groups of 103 and 133 mm and the age of which varied from 7 months to11.6 months. In the case of females 84 % of the catch was caught between the size groups of 103 mm and 138 mm. The age of this size groups ranged from 8 to 14 months. But the age of massive maturation was at 9.6 months in male and 11 months in female. The size at first capture was also at the age of 9 months

in male and 11months in female which means more than half of the catch (male- 52% and female- 61%) did not get the opportunity to spawn at least once before capture.

The mortality studies showed that the natural mortality is slightly higher in males than females but the fishing mortality is higher in females. In the case of species caught by trawlers, which are having low K-value will have lower M-value but the F-value will be higher (EJF, 2003). The present natural mortality was 1.7 for males and 1.5 for females. Jayawardane et al. (2002) had reported a natural mortality of 1.73 for both males and females by using the same method. In the present study total mortality was estimated as 6.6 and 6.7 for males and females respectively. Though the value of Z seems to be high, the prediction studies such as yield per recruit and Thompson and Bell model revealed that the fishing level is below optimum. The yield per recruit analysis indicated that fishing mortality (fishing effort) could be increased from the present level of 4.9 to 7 in males and 5.2 to 8.5 in females. Thompson and Bell model also showed that the present level of fishing is below optimum and to obtain maximum sustainable yield fishing effort can be increased by 1.6 times in male and two times in female. When the yield of males and females were pooled, the maximum yield was obtained at F- factor 2.0. The biomass at the current level of fishing is 22.3% of the virgin biomass. The biomass at the MSY level (B-MSY) is 14.8% of the virgin biomass. This study shows that there is scope to increase the fishing effort twice to get the MSY.

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