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Age, Growth, Mortality, Yield per Recruit and Stock Assessment of *Atropus atropus* (Bloch and Schneider)

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Abstract

Age and growth, mortality rates, yield per recruit and the stock assessment of *Atropus atropus* have been studied from the length frequency data collected from trawlnet landings during 1981-84. The $L \infty$ K and t_0 have been estimated to be 453 mm, 1.1430 (annual basis) and -0.0390 yr respectively. This species attains a fork length of 214, 321, 378 and 412 mm in 0.5,1.0,1.5 and 2.0 years respectively. The length-weight relationship of this species is described by the linear regression equation Log W = -1.7116 + 2.8980 Log L (r = 0.9790). The total mortality rates (Z) by trawlnet increased progressively from 5.53 in 1981-82 to 8.97 in 1983-84 with annual average of 6.45. The natural mortality rate (M) is estimated to be 1.76. Higher fishing mortality rates and exploitation rates indicate that this species was exposed to higher fishing pressure by trawlnet suggesting either a reduction in effort or an increase in the age at first capture. The average annual standing stock and average standing stock were estimated to be 81.5 and 12.7 t respectively. The MSY was estimated to be 40.9 t for this species.

Introduction

Carangid resource is one of the important pelagic fishery resources off Saurashtra coast in Gujarat (Rao and Kasim, 1985; Kasim and Mohammad Zafar Khan, 1986). No information is available on the fishery, biology and population dynamics of the component species of carangid resource of Gujarat coast. Trawl and gillnets are the only two gears which exploit different pelagic and demersal fishery resources off Veraval coast. Many species support the carangid fishery by trawlnet and among them *Atropus atropus* is the dominant species. Present study has been initiated in 1981 and it attempts to provide a detailed information of the fishery, biology, age and growth, mortality rates, yield per recruitment and stock assessment of *A. atropus*. These information will be useful for proper management of the carangid fishery in general.

Materials and Methods

The data on the catch, effort, species composition of carangid resource exploited by trawlnet and length frequency of *A. atropus* were collected at random once in a week. Monthly estimates were obtained by raising the basic data to the sampling days and then to respective months with respective raising factors. A sample 3824 specimens varying in fork length from 100 to 424 mm were measured of which 322 were weighed to obtain length-weight relationship as per the least square method (Snedecor, 1961). The progression of the modes obtained from the length frequency data in 25 mm class intervals were traced as per the integrated method of Pauly (1980) and the average sizes attained in subsequent months by this species were obtained as per George and Banerji (1968). The growth in length was estimated as per Alagaraja (1984) method. The natural mortality rate (M) was estimated as per Sekharan (1974) and Pauly (1980) and the total mortality rate (Z) as per Beverton and Holt (1956). The yield per recruit was estimated as per Beverton and Holt (1957) simplified by Ricker (1958). The optimum age of exploitation and the potential yield per recruit were estimated as per the equation proposed by Krishnankutty and Qasim (1968).

Results and Discussion

Catch statistics: The trawlers landed on an average 172.3 t of carangids at the catch rate of 3.9 kg/unit which formed 0.9% of the all fish catch during 1981-84. In all the three years there was no landing of carangids during June-September either due to non operation of units in view of monsoon or the carangids were totally absent in the catch. Better abundance of carangids were observed during October - December as indicated by the average monthwise catch rate.

Species composition: Many species constituted the carangid fishery by trawlnet and among them the dominant species were *Atropus atropus* (34.5%), *Caranx spp* (27.9%), *Decapterus russelli* (15.7%), *Chorinemus spp* (12.9%), *Megalaspis cordyla* (8.9%) and other carangids (0.1%).

Age and growth: As there were one or two modes present in all the months except in April 1982 and modes in higher size groups were absent except one in December 1981 at 412.5 mm and another in April 1982 at 337.5 mm in the length frequency, the progression of modes could not be traced continuously in subsequent months. Lack of data during south west monsoon period from June to September in all the years has further hampered the tracing of the modes. However, a mode at 187.5 mm in October 1981 could be traced to 262.5 mm in January 1982. Another mode at 187.5 mm in October 1982 was traced to 237.5 in February 1983 and the third one at 162.5 mm in November 1982 could be traced to 237.5 in February 1983. The time of origin o the modes available at the lower size ranges have been traced by extrapolating the curves back to the time axis.

The average size attained by this species in subsequent months have been obtained by tabulating the traced modes. A single smooth empirical growth curve was obtained by fitting a free hand curve through the plots of the average sizes plotted on an arithmetic graph. From this empirical growth curve, this species attains a length of 214, 321, 378 and 412 mm in 0.5, 1.0, 1.5 and 2.0 years respectively. These data were used to estimate the growth parameters $L\infty$, K and t_0. The growth in length of this species may be expressed as per the von Bertalanffy growth equation as followed:

$$lt = 453\ (1 - e^{-1.1433\ (t + 0.0390)}).$$

Based on this equation *A. atropus* is estimated to attain a size of 208, 315, 375, 409 and 428 mm in 0.5, 1.0, 1.5, 2.0 and 2.5 years respectively.

Length-weight relationship and growth in weight: The length-weight relationship of this species may be expressed as per the following equation: Log W = -1.716 + 2.8980 Log L (r = 0.9790). Based on this equation the growth in weight of this species was estimated from the data on cube root of the weight attained by this species at an interval of 0.5 years. The growth in weight of this species may be expressed as per the von Bertalanffy growth equation as followed:

$$wt = 10.6765\ (1 - e^{-1.1592\ (t - 0.0120)})3.$$

Total mortality coefficient (Z): Total mortality rate generated by trawlnet for *A. atropus* increased progressively from 5.53 in 1981-82 to 8.97 in 1983-84 with annual average of 6.45.

Natural mortality coefficient (M): The natural mortality coefficient can be estimated from the life span (T_{max}) of the species concerned. The T_{max} may be derived from the relation 3/K and it is 2.62 years for *A. atropus* and the estimated M is 1.76. In addition to this, independent estimate of M was also obtained by the method of Pauly (1980) and it is 1.74.

Age at first capture and recruitment: The size at first capture for *A. atropus* was estimated indirectly from the left side of the length converted catch curve. The average size at first capture is 201.4 mm and the corresponding age at first capture is 0.4754 yr. The minimum size at which the fish suffers mortality by the fishing gear is taken as the size at recruitment. The size at recruitment for *A. atropus* was 100 mm and the age at recruitment was 0.1792 year.

Yield per recruit: The yield per recruit estimates keeping the age at first capture constant at the prevailing level and varying the fishing mortality rate for 3 different M/K ratios are shown in Fig 1. The yield per recruit increases with the increase in the F to a particular level and then it tends to decline with higher F in all the 3 M/K ratios. The respective F_{max} which can produce the Y_{max} are indicated in Fig 1. For the prevailing M/k ratio of 1.52, the F_{max} which can produce the Y_{max} of 74.62 g is 3.0 for this species.

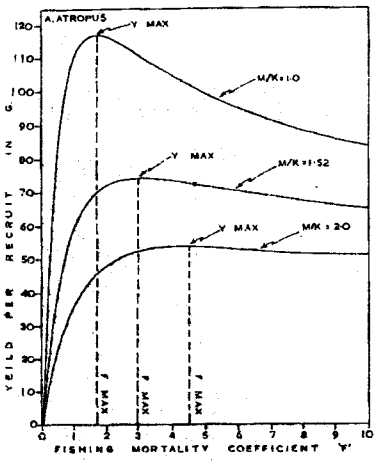

Fig. 1. Yield per recruit of Atropus atropus obtained at different fishing mortality rates and prevailing age at first capture for three different M/K ratios in Veraval waters.

The yield isopleth diagram drawn from the estimates of yield per recruit in g at varying ages at first capture and different values of exploitation ratio E for the prevailing M/K ratio 1.52 for *A. atropus* is shown in Fig.2. The exploitation ratio E is obtained from the relation E = F/Z. The corresponding F for different values of E are indicated in the Fig 2 . The Y_{max} generated by the F_{max} for the prevailing age at first capture which falls on the MSY curve is indicated by open circle and the yield generated by the prevailing F by closed circle in the yield isopleth diagram.

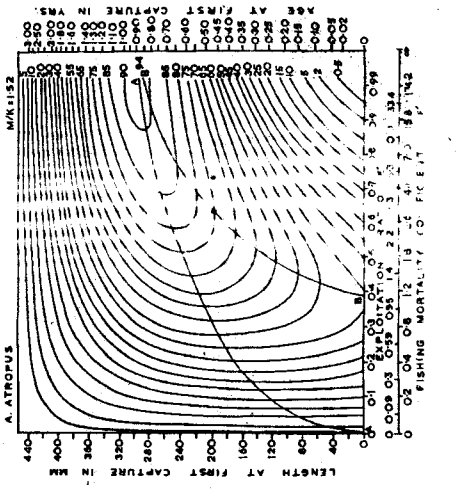

Fig. 2. Yield isopleth diagram drawn from the estimates of yield per recruit obtained at different combinations of fishing mortality rates and varying age at first capture for the M/K ratio 1.52 for Atropus atropus in Veraval waters.

Optimum age of exploitation and potential yield per recruit: The optimum age of exploitation (t_y) is estimated to be 0.9877 yr and the potential yield per recruit is 94 g for this species.

Exploitation rate (U): The exploitation rate is estimated from the from the relation U = F/Z (1 - e $^{-z}$). The annual average exploitation rate for this species is 0.7260 yr.

Stock assessment: The average annual standing stock (P) is estimated to be 81.5 t from the relation P = Y/U where Y is the annual yield in tones and U is the exploitation rate. The average standing stock (B) is estimated to be 12.7 t from the relation B = Y/F.

Maximum sustainable yield: The MSY is estimated to be 40.9 t from the equation MSY = 0.5 x Y + (MxB).

The length frequency of *A. atropus* indicates a single spawning season from May to September. In an unexploited phase, the oldest fish of the stock grows to reach 95% of their asymptotic length (Taylor, 1962; Beverton, 1963). Assuming the largest size recorded (424 mm) for *A. atropus* to be 95% of the asymptotic length, then the Land may be 446 mm and the present estimate of 453 is very close to this estimate.

The average annual F and *A. atropus* is estimated to be 4.69 which can produce an yield of 73 g and it is higher than the F_{max} 2.9 which produces an yield of 74.62 g for the prevailing M/K ratio 1.52 (Fig 2). The annual average exploitation rate is also high 0.73. The MSY is estimated to be 40.9 t in a year whereas the annual average yield by this species is 59.5 t. These observations clearly indicate that the fishery of this species is exposed to higher fishing pressure. Easing the prevailing higher fishing pressure by trawlnet on *A. atropus* is not at all possible as the main aim of the gear is for shrimps and fish form only a by-catch. An alternative to counter the excess effort input is to increase the prevailing low age at first capture if not close to the optimum age of exploitation atleast to a considerable extent so as to realise higher yield and permit higher effort input also. Increasing the age at first capture means increasing the cod end mesh size. This suggestion is also not tenable as this will drastically affect the shrimp catch as the prevailing cod end mesh size is 20 mm. In such a condition, it is possible that a part of the trawlers may be encouraged to operate fish trawlnets with larger mesh size, provide that the component species of prawns also exhibit a similar condition of over fishing.

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