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FISHERY, GROWTH, YIELD PER RECRUIT AND STOCK ASSESSMENT OF *SPHYRAENA OBTUSATA* CÚVIER OFF TUTICORIN, GULF OF MANNAR

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ABSTRACT

Annual average catch of 612.2 t of barracudas were landed at the catch rate of 17.1 kg/unit which constituted 3.9% in the total catch landed by trawlers during 1987 - '89 at Tuticorin. Higher effort input during certain months did not coincide with better abundance of barracudas. *Sphyraena obtusata* Cuvier constituted on an average 69.6% of the total catch of barracudas. Based on the length-frequency data, the growth parameters have been estimated to be L_∞ 470.0 mm, K 1.0364/year and t_o -0.0098 ye. The natural mortality coefficient (M) is 1.591, the average annual total mortality coefficient (Z) is 2.8317 and the average exploitation rate (U) is 0.4123. The average standing stock is estimated to be 343.2 t and average annual stock 1,032.7 t. Yield per recruit studies indicate that *S. obtusata* is not exposed to higher fishing pressure as the average fishing mortality coefficient (F), 1.2407, for the prevailing age at first capture, 0.4709 ye is lower than the respective F_{max} which can yield the Y_{max} in both the M/K ratios 1.0 and 1.535. There is scope for increasing the effort of trawl net with a view to increase the catch of this species at the prevailing conditions.

INTRODUCTION

Barracudas are considered as one of the commercially important resources by virtue of their good quality as delicious food fishes. Virbadhra Rao (1973) has reported that during 1961 - '65, the barracudas *Sphyraena commersoni* (B1), *S. obtusata* Cuv. and *S. jello* Cuv. formed 1,471 t in a year constituting 0.2% of total marine fish catch in India. Later in 1974 it increased to 4,862 t and during 1980's it fluctuated between 1,782 t in 1980 to 3,907 t in 1984 - '85. In spite of the magnitude of the barracuda landings and its commercial importance, but for a few account on the taxonomy and biology (Jones and Kumaran, 1968; Kothare, 1973; Kothare and Bal, 1975; De Sylva, 1974; Mahadevanpillai, 1981), virtually there is no information available on the growth, rate of exploitation and stock assessment of barracudas except a single account by Somavanshi (1989). In view of this, a study on the fishery and biology of barracudas was initiated in 1987 - '88 at C. M. F. R. I., and this account contains the information on the fishery, growth, mortality rates, yield per recruit and stock assessment of *Sphyraena obtusata* Cuv., one of the dominant species of barracudas mostly exploited by small mechanised trawlers along the Tuticorin and other coasts of India.

MATERIALS AND METHODS

Out of the 103 trawl net units operated at Tuticorin fishing harbour atleast 10% were observed at random once in a week and basic data on the catch, effort, species composition and length-frequency of *Sphyraena obtusata*, the dominant species, were collected.

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Monthly estimates were obtained by raising the basic data to the sampling days and then to respective months with respective raising factors. A sample of 3,870 specimens varying from 110 to 435 mm in fork length were measured of which 284 specimens were also weighed to obtain length weight relationship as per Snedecor (1961). Various modes obtained from the length- frequency data in 10 mm class interval are given in the form of scatter diagram in Fig. 1.

The growth in length was estimated as per Pauly (1980), George and Banerji (1968) and Alagaraja (1984). The natural mortality coefficient (M) was estimated from the life span of the species as per Sekharan (1974) and the total mortality rate (Z) as per Beverton and Holt (1956). The age at first capture was obtained from the length converted catch curve as per Pauly (1984). The yield per recruit was estimated as per Beverton and Holt (1957) modal simplified by Ricker (1958). The optimum age of exploitation and potential yield per recruit were estimated as per the equation proposed by Krishnankutty and Qasim (1968).

Results

Catch and effort

An estimated 617.2 and 607.1 t of barracudas were landed by 38,820 and 33,023 units of small mechanised trawlers at the catch rate of 15.8 and 18.38 kg per unit during 1987 - '88 and 1988 - '89 respectively (Table 1) with an annual average of 612.2 t and average catch rate of 17.1 kg/unit which constituted on an average 3.9% of the total catch by trawlers. Peak period of abundance of barracuda was observed in almost all months in 1987 - '88 except in April '87 and January '88 whereas during 1988 - '89, the abundance was poor in October, December, 1988, January and March ,1989. Higher effort input has been recorded from July to December, 1987 and June to September, 1988 and better catch has been observed from August to November, 1987 and March to September, 1988. The fishery was extremely good in November '87, March, July and September, 1988 due to better abundance of barracudas. However, the effort input has not coincided with good abundance of barracudas in some of the months as observed in March, 1988. This deviation from the usual exploitation strategy i.e., increasing the effort during the period of better abundance in order to realise enhanced catch is mainly due to the reason that the aim of trawl net is not only to exploit barracuda but also some other commercially important resources.

Species composition

Sphyraena obtusata, S. picuda, S. jello and *S. forsteri* have been observed to sustain the barracuda fishery at Tuticorin in which *S. ob-*

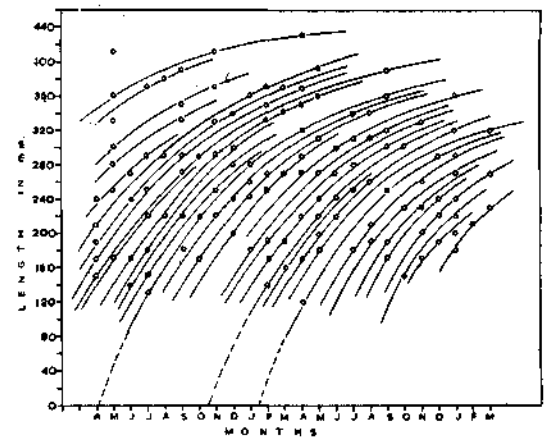

Fig. 1. Tracing of the progression of modes by scatter diagram of modal length - month for *Sphyraena obtusata* from Tuticorin.

TABLE 1. *Estimated catch (kg), effort (units), catch per unit of effort (kg) and percentage composition of barracudas landed by small mechanised trawlers at Tuticorin during 1987 - '88 and 1988 - '89*

Months	1987 - '88				1988 - '89			
	Effort	Catch	CPUE	Percentage	Effort	Catch	CPUE	Percentage
April	2,717	22,108	8.1	4.4	3,483	64,148	18.4	4.5
May	2,100	40,515	19.3	7.6	2,881	43,997	15.2	2.8
June	2,488	27,475	11.0	4.6	4,290	74,061	17.2	3.1
July	3,712	38,421	10.4	3.5	5,289	166,650	31.5	7.0
August	5,025	60,795	12.1	3.4	4,905	61,623	12.5	3.0
September	4,095	73,405	17.9	5.0	4,209	12,5606	24.2	4.6
October	3,510	68,958	19.6	4.1	1,376	9,270	6.7	1.7
November	4,062	102,156	25.1	4.6	2,115	36,997	17.4	3.6
December	4,160	45,516	10.9	2.2	2,270	7,955	3.5	1.2
January	2,925	11,004	3.7	0.8	954	4,196	4.4	1.0
February	1,738	26,147	15.0	3.3	468	5,892	12.5	2.3
March	2,288	100,700	44.0	8.0	783	6,723	8.5	1.5
Total/Mean	38,820	617,200	15.8	4.0	33,023	607,118	18.4	3.8

tusata was the dominant species constituting 69.6% of the barracuda catch, followed by *S. picuda* (14.1%), *S. jello* (12.3%) and *S. forsteri* (4.0%) (Table 2). Though the dominant species occurred throughout the year, the peak period of the fishery was observed to be during July - September. The dominant and continuous occurrence of *S. obtusata* prompted a detailed study of its population dynamics .

Age and growth

The progression of different modes in subsequent months was traced by a scatter diagram (Fig. 1) drawn by plotting the multi-modes present in each month. The months of origin of a few modes available at the lower size ranges could be found out by back tracing to the time axis as indicated by broken lines. The size attained by this species in subsequent months was obtained by arranging the traced modes chronologically in a tabular form (George and Banerji, 1968) and are given in Fig. 2 wherein a smooth growth curve is fitted through the plots to obtain a series of size at different months afresh. These data were used to estimate the $L\infty$, K and t_0. The growth in length of this species may be expressed as per von Bertalanffy Growth Equation as follows : $it = 470 (1 - e^{-1.0364 (t + 0.0098)})$. According to this equation *S. obtusata* may attain a size of 192.9, 305.0, 371.7, 411.5 and 435.1 mm when it is 0.5, 1.0, 1.5, 2.0 and 2.5 years old.

Length -weight relationship

The fork length in mm and wet weight in g of 284 specimens have been used to estimate the length-weight relationship of *S. obtusata* and this may be expressed as per the regression equation, Log W = -3.7274 + 2.3815 Log L (r = 0.9558). The test of significance of b value by dividing the b value by standard deviation of the regression coefficient sb has yielded a t value of 37.23 and this indicates that the relationship of length and weight of

TABLE. 2 *Monthwise average species compositon (kg) of barracudas landed by trawl net operated off Tuticorin during 1987-'89*

Month	*Sphyraena obtusata*	*S. jello*	*S.picuda*	*S. forsteri*	Total
April	17,070	22,770	3,258	30	43,128
May	32,560	2,676	3,180	3,840	42,256
June	38,163	3,237	7,633	1,736	50,769
July	66,250	11,064	16,424	8,798	102,536
August	54,909	1,269	2,169	2,862	61,209
September	48,758	6,145	39,204	5,399	99,506
October	15,395	21,069	2,500	151	39,115
November	67,517	96	1,196	778	69,587
December	22,312	3,838	448	138	26,736
January	7,195	174	224	9	7,602
February	14,404	1,358	258	-	16,020
March	41,283	1,828	9,547	1,054	53,712
Total	425,816	75,524	86,041	24,795	612,176
Percentage	69.6	12.3	14.1	4.0	

this species is highly significant. Based on the length-weight relationship W ∞ of this species is estimated to be 432.7 g.

Natural mortality coefficient (M)

The M is estimated to be 1.591 from the life span (T_{max}) of this species. The T_{max} of this species is estimated to be 2.8946 yrs from the relation $T_{max} = \frac{3}{K}$ (Pauly, 1980).

Total morality coefficient (Z)

The Z of this species has been estimated from the average size ($\bar{l}$ in mm) and size at first capture (l_c in mm) and the estimates are 2.8441 and 2.8215 in 1987 - '88 and 1988 - '89 respectively. The average Z is 2.8317 (Table 3).

Fishing mortality coefficient (F)

The F is estimated from the relation F = Z - M and it is 1.2531 and 1.2305 in 1987 - '88 and 1988 - '89 respectively with an average F of 1.2407 (Table 3).

Exploitation rate (U)

The exploitation rate U, estimated from the relation $U = \frac{F}{Z}(1 - e^{-Z})$ is 0.4150 and 0.4102 in 1987 - '88 and 1988 - '89 with an average of 0.4123 (Table 3).

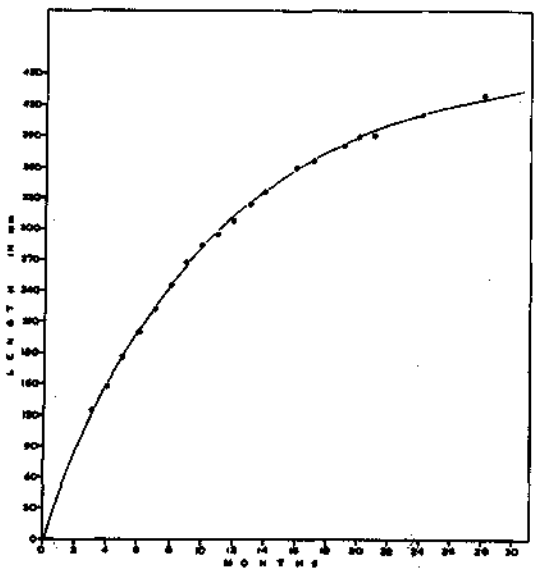

Fig. 2. Fitting a growth curve through the plots of mean lengths obtained from the scatter diagram for *Sphyraena obtusata*.

Age at first capture and recruitment

The size at first capture is estimated to be 193.3 and 169.6 mm in 1987 - '88 and 1988 - '89 respectively with an average of 181.5 mm (Table 3). The corresponding age at first capture is 0.5014 and 0.4221 yr in 1987 - '88 and 1988 - '89 and the average is 0.4709 yr. The smallest fish which sufferred mortality by trawl net was measuring 100 mm which is taken as the size at recruitment and the corresponding age at recruitment is 0.2210 yr.

Yield per recruitment

When the survival rate in the population is assumed as 5%, one gets an M/K ratio of 1.0 and when it is taken as 1% the M/K ratio is 1.535. The estimates of yield per recruit obtained for these two different M/K ratios keeping the age at first capture constant at the prevailing 0.4709 year and varying the F are given in Fig. 3. The yield increases with the increase in F to a certain level and then it tends to decline thereafter. The F_{max} which can produce the highest yield of 42.4 g in M/K ratio 1.0 is 1.4 and the F_{max} which can produce the highest yield of 27.2 g in M/K ratio 1.535 is 2.4 which are indicated in Fig. 3. The prevailing average F is 1.2407 which is lower than the F_{max} obtained for both the M/K ratio indicating roughly that under the prevailing conditions *S. obtusata* is not exposed to higher fishing pressure.

The yield isopleth diagram drawn from the yield estimates obtained from different combinations of different age at first capture and varying F for the prevailing M/K ratio 1.535 is given in Fig. 4, wherein the line A - A indicates the eumetric fishing curve and line B - B the MSY curve.

Stock assessment

An estimated 466.8 and 384.8 t of *S. obtusata* was landed in 1987 - '88 and 1988 - '89 with an average of 425.8 t. The average standing stock, B is estimated to be 343.2 t from the relation B = Y and the annual average stock is estimated to be 1032.7 t as per the equation $P = \frac{Y}{U}$.

TABLE 3. *Estimates of average size, l size at first capture l_c, total mortality coefficient Z, fishing mortality coefficeint F and exploitation rate U for* Sphyraena obtusata *in Tuticorin waters during 1987-'89*

Year	Average size l	Size at first capture l_c (mm)	Z	F	U
1987-'88	267.2	193.3	2.8441	1.2531	0.4150
1988-'89	250.3	169.6	2.8215	1.2305	0.4102
Mean	258.8	181.5	2.8317	1.2407	0.4123

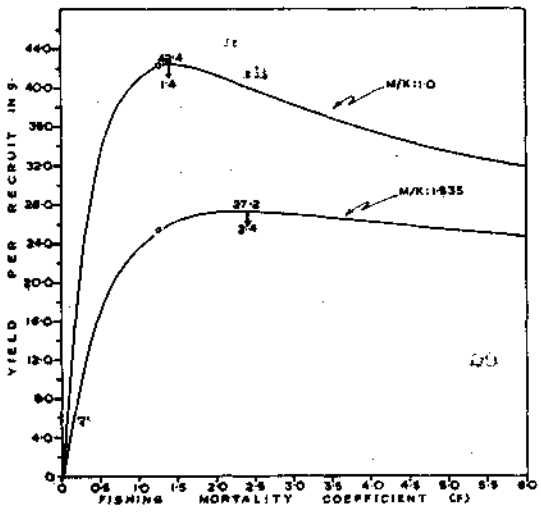

Fig. 3. Yield per recruit of *Sphyraena obtusata* at two different M/K ratios and various fishing mortality coefficients for the prevailing age at first capture. The corresponding yield max and F_{max} are indicated for each curve.

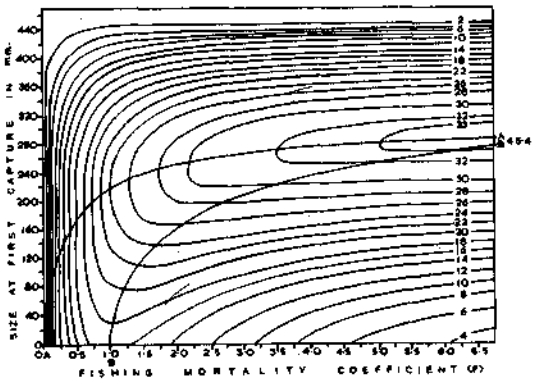

Fig. 4. Isopleth diagram for yield per recruit in gram of *Sphyraena obtusata* population from Tuticorin waters. The line A-A indicates the eumetric fishing curve and the line B-B the maximum sustainable yield curve. The potential yield per recruit of 45.4 g is also shown.

Optimum age of exploitation and potential yield per recruit

The optimum age of exploitation and potential yield per recruit are estimated to be 0.8939 yr and 45.4 g for this species. Though the prevailing age at first capture of this species is not close to the optimum age of exploitation, there is no urgent need to increase the age at first capture as the fishery is exposed to lower fishing pressure presently.

Discussion

Diurnal variations have been observed by Somavanshi (1989) in the distribution of barracudas as they move in schools at night and congregate at the bottom in considerable concentrations at day time. Further, they are found in shallow waters during the south-west monsoon (June-August) and in deeper waters (100 - 300 m) during September to May. This may be one of the valid reasons for the barracuda fishery being better during July - September in Tuticorin as most of the commercial trawlers operate well within 100 m depth range.

Kothare (1973) has proposed a length-weight relationship of $W = 0.0000008104\ L^{3.4541}$ for males and $W = 0.000001328\ L^{3.3542}$ for females of *S. obtusata* whereas Somavanshi (1989) has given a combined equation of $W = 0.00413\ L^{3.1316}$. All the three values of regression coefficient (b) are higher than the value obtained in the present study. Since the confidence limits of 'b' are not given by these authors, it is not possible to ascertain whether the differences are significant or not.

Somavanshi (1989) has obtained a growth estimate of L_∞ 39.8 cm and K 0.54/ year from exploratory trawl survey data col-

lected in Gulf of Mannar which was supplemented by the length-frequency data collected by Kothare and Bal (1975) since the Gulf of Mannar data have length groups above 50% of L ∞. Present estimates of L ∞ and K are higher than that of Somavanshi (1989) and the difference in the estimates may be attributed to the sample strength and size range as the size range reported by Somavanshi (1989) was 15 - 39.5 cm and the sample strength was 1,177 which were lower than the size range and sample strength observed in this study. Further, occurrence of modes in higher size ranges is also a reason for higher L ∞ obtained in this study.

The natural and total mortality coefficients reported by Somavanshi (1989) are 1.0 and 2.24 respectively which are lower than the estimates obtained in this study. The difference in Z-M is not accounted for fishing mortality by Somavanshi (1989), but is attributed to migration out of the study area. This may not be true, because in nature, emigration is being equalised by immigration. Further, on an average 425.8 t of *S. obtusata* are caught by trawlers though the fishery is not aimed at exploiting *S. obtusata* exclusively. Therefore, the fishing mortality is taken as Z-M which is 1.24 in this study.

The F_{max} 0.76 and Y_{max} 14.3 g for M/K ratio 1.85 given by Somavanshi (1989) are lower than the F_{max} 1.4, Y_{max} 42.4 g for M/K ratio 1.0 and F_{max} 2.4 and Y_{max} 27.2 g for M/K ratio 1.535 given in this study. As already pointed out, there is no urgent need to increase the age at first capture by enlarging the cod end mesh size of the trawl net as the fishing mortality rate generated by trawl net at Tuticoin during 1987 - '89 happens to be lower than the F_{max} in both M/K ratios. On the other hand there is scope for increase in the effort of trawl net to match the F_{max} so as to realise enhanced production of this species. Similar observations have been made by Krishnamoorthi (1976) for *Nemipterus japonicus*, Murthy (1983), Kasim *et al.*, (1989), Kasim and Hamsa (MS) for *Caranx leptolepis* . The above said observations will be valid only when other resources also exhibit similar trend in the exploitation by trawl net with a scope for increase in the effort input.

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