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Dynamics of *Priacanthus hamrur* (Forsskal) exploited off Saurashtra coast

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ABSTRACT

Bull's eye landings off Saurashtra reached a peak of 3813 tons in 1999 with a catch rate of 4.3 kg per haul. The group is represented by a single species, *Priacanthus hamrur* (Forsskal). Gut content analysis revealed *P. hamrur* to be a carnivorous fish with a preference for pelagic crustaceans and fishes. Spawning females were encountered from March to December and the length at first maturity of female *P. hamrur* was 198 mm. Recruitment to the fishery takes place with two peaks annually - one in January-February and a minor one in October-November. A common length-weight relationship for both sexes was obtained with a = 3.481×10^{5} and b = 2.83498. The von Bertalanffy growth equation was derived as $L_t = 360.35\ [1-e^{-0.56(t+\ 0.1013)}]$ and the length attained by the fish at the end of 1 to 4 years were estimated as 165, 249, 296 and 324 mm. The length growth performance index was obtained as $\Phi' = 4.86$ and the longevity, t_{max} was estimated as 4.44 years. The mortality co-efficient Z, M and F were 2.35, 1.14 and 1.21, respectively and exploitation rate, E was 0.51. Stock assessment studies reveal that the present average annual catch can be increased by 764 t to reach the MSY of 4996 tons.

Introduction

Until the late 1990s, priacanthids were merely a component of the trawl by-catch along the Saurashtra coast and did not have any commercial significance. However, with the conversion of single-day trawl operations into multi-day operations extending from 5 to 7 days and with increase in depth of operation to 80 - 100 m, there was an increase in the landings of fishes like threadfin breams, lizardfishes and priacanthids. An increase in demand for these fishes, especially threadfin breams and priacanthids, from two surumi plants based in Saurashtra encouraged the continuation of multi-day trawl operations in deeper waters in the grounds off Saurashtra. From 1996, priacanthids have become a commercially targeted group along this coast.

Except for stray landings of *Cookeolus boops* at Veraval in 1999, priacanthids are represented in the fishery exclusively by *Priacanthus hamrur* (Forsskal). There is hardly any documentation on the fishery, biology and dynamics of this species from the waters of Saurashtra. However works

have been done on priacanthids from other parts of the Indian coast (Rao, 1984, John and Sudarsan, 1988, Vijayakumaran and Naik, 1988, Sivakami, 1989, Zachariah *et al.*, 1991, Sivakami *et al*., 1998, 2001, Philip, 1994, 1998, Philip and Mathew, 1996 a & b and Premalatha, 1997). Available information on *P. hamrur* from the northwest coast of India (Birader, 1988, Chakraborty and Vidyasagar, 1996, Varghese, 1995, 1998) is mostly confined to the waters off Maharashtra. Moreover, many of these works are based on exploratory surveys. The present paper attempts to assess the dynamics and resource status of *P. hamrur* along the Saurashtra coast based on commercial trawl fishery.

Material and methods

The fishery of *P. hamrur* was observed from the trawl landings at Veraval and Mangrol. Fish samples for length frequency data were collected once every week while samples for analysis of food and feeding and maturity stages were collected once every fortnight.

The length (mm) – weight (g) relationship of the form $W = aL^b$ for male and female *P. hamrur* was estimated by logarithmic transformation from the observations made on 95 males in the length range of 179 – 300 mm and weight range of 75 – 335 g and 153 females in the length range of 164 – 312 mm and weight range of 65 – 365 g. Growth parameters were estimated following the FiSAT package (Gayanilo *et al*., 1996). Separation of modes for Modal Progression Analysis was done on the pooled data by Bhattacharya analysis. Growth parameters estimated using the Powell-Wetherall plot, Gulland and Holt plot, ELEFAN I (without and with correction for gear selection) and Ford-Walford plot as given in Sparre and Venema (1992) were compared before arriving at the final values. The length growth performance index 'Φ' (Pauly and Munro, 1984) was calculated from the final estimates of $L\infty$ and k.

The gut of 507 specimens (203 males and 304 females) in the length range of 160 – 320 mm was examined for assessing food preference. The guts were classified as empty, quarter-full, half-full, full and gorged based on the distension of the stomach and the amount of food. Qualitative and quantitative analysis of the gut contents was done and the Index of pre-ponderence was derived following the method of Natarajan and Jhingran (1961). Size at first maturity (females) was arrived at by plotting the percentage of mature specimens (stages III and above) against total length (Thomas, 1969). Recruitment peaks were identified by using the restructured length-frequency data, as given in the FiSAT package (Gayanilo *et al*., 1996).

The annual total mortality 'Z' was calculated by the length-converted catch-curve method (Pauly, 1983 a). Natural mortality 'M' was calculated by Pauly's empirical formula (Pauly, 1980), assuming the average annual surface temperature to be 27.2°C (Bapat *et al.*, 1982). Fishing Mortality 'F' was estimated from the relationship F = Z – M. The exploitation ratio 'E' and longevity, 't_{max}' was computed following Pauly (1983 b).

Length-based Virtual Population Analysis (Jones, 1984) was carried out to determine the yield and biomass. Thompson and Bell analysis as outlined in Sparre and Venema (1992) was carried out to predict the effect of change in fishing effort on the yield and value. The MSE was arrived at by computing the value of the yield that can be realized at different levels of effort. The value was

computed @ Rs. 6/- per kg, which was the existing market price of the fish.

Results and discussion

Fishery

The annual average landings of *P. hamrur* during the years 1996 – 1998 remained less than 1000 t, with CPUE ranging from 0.4 kg to 1.3 kg per haul (Table 1). The year 1999 saw a dramatic increase in fishing effort and catch (3813 t), with the CPUE increasing to 4.3 kg per haul. In the later years, there was a decline in effort along with a fall in catch and CPUE. In 1999, most of the trawl operations in the waters off Gujarat were converted to multi-day fishing (5 to 7 days) in deeper grounds (upto 80 - 100 m depth). However several factors like labour problem, hike in fuel price, bad weather conditions, political tensions in seafaring operations etc., caused a setback to the fishing industry of the state in the succeeding years. With an overall decrease in trawl landings after 1999, the catch of *P. hamrur* too declined. The average monthly landings during the years 1996 to 2001 was highest in December (25% of annual landings), followed by January (21% of annual landings). This coincides with the increased fishing activity in the post-monsoon and winter seasons. Trawl operations targeting cephalopods is usually maximum during this period.

Biology

Food and feeding : About 20% of the guts observed were empty; females showed better fullness state than males (Table 2). Analysis of the gut contents showed a preference for pelagic shrimps (Table 3), with *Acetes* spp. dominating. Among fishes, only threadfin breams, silverbellies and anchovies were found in the gut. Squids and crabs ranked lowest in the order of preference. The observations indicate the tendency of this carnivorous fish to feed more on pelagic and mesopelagic forms, especially *Acetes* spp., than on benthic forms. Similar observations on food preference have been made on *P. hamrur* (Philip, 1994, 1998 ; Premalatha, 1997; Sivakami *et al.*, 2001) and other priacanthids (Rao, 1984) from other parts of the Indian coast.

Maturation, Spawning and Recruitment : The length at which 50% of the females attain first maturity was estimated to be 198 mm (approximately 16 months of age). Sivakami *et al*. (2001) have reported the length at first maturity

TABLE 1 : *Trend in annual catch and CPUE of* P. hamrur

Year	Catch (t)	Effort (hauls)	CPUE (kg)
1996	154.3	369436	0.42
1997	698.1	523491	1.33
1998	936	732875	1.28
1999	3813	891409	4.28
2000	1628.7	766926	2.12
2001	2115.9	828857	2.55

TABLE 2 : *Stomach condition (%) of* P. hamrur

	No. of guts	Empty	Trace	Quarter-full	Half-full	Full	Gorged
Male	319	33.7	1.0	16.8	39.0	9.5	-
Female	507	11.8	0.6	20.3	35.3	31.4	0.6
Total	826	20.2	0.8	18.9	36.7	23.0	0.4

TABLE 3 : *Index of pre-ponderence of food items in* P. hamrur

Food items	Oi(%)	Vi(%)	ViOi	I	Rank
FISHES					
Silverbellies	4.9	6.75	33.08	1.51	5
Threadfin breams	8.1	6.11	49.49	2.26	4
Anchovies	3.16	4.68	14.79	0.68	7
CRUSTACEANS					
Acetes spp.	30.9	33.16	1024.64	46.86	1
Nematopalaemon tenuipes	14.3	13.5	193.05	8.83	3
Solenocera spp.	4.42	6.78	29.97	1.37	6
Crabs	1.9	0.5	0.95	0.04	9
CEPHALOPODS					
Squid	1.2	1.57	1.88	0.09	8
DIGESTED MATTER	31.12	26.95	838.68	38.36	2

Oi – Occurrence Index, Vi – Volume Index, I – Index of Pre-ponderence

in female *P. hamrur* off Cochin as 191 – 200 mm. The occurrence of spawning females was noticed from March to May (17% of the average monthly landing of females) and from September to December (25% of the average monthly landing of females) (Fig. 1). Maximum abundance of spawning fishes was however during March to May and November-December. Due to closure of trawl operations, data for June - August was not available. Spent females formed 10% of the females caught in September to October, indicating spawning during June to August also. Thus the observations made in the present study indicate protracted spawning (March to December) of *P. hamrur*. While Premalatha (1997) has reported the spawning of *P. hamrur* during March-April along the south-west coast of India, Sivakami *et al.*, (2001) have reported an extended spawning period for the species off Cochin from April-July, and also mentions the possibility of some individuals breeding during November-December. Recruitment to the trawl fishery takes place at about 120 mm length (approximately 7.5 months of age). There are two peaks of recruitment – a major peak in January-February and a minor one in October-November (Fig. 2).

Length-weight relationship : The

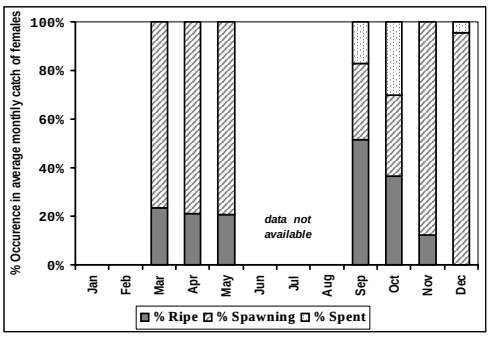

Fig. 1 Month-wise percentage occurrence of ripe, spawning and spent female *P. hamrur* (data of Jan. 2000 – March 2002, pooled)

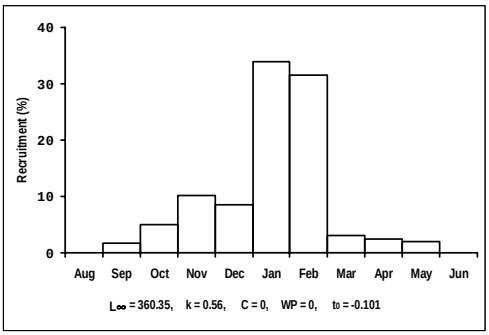

Fig. 2 Annual recruitment peaks of *P. hamrur* in the waters off Saurashtra

length weight equations obtained for male and female *P. hamrur* are as follows

$$\text{Male : } W = 0.00002958\ L^{2.85} \quad (r = 0.917)$$

$$\text{Female : } W = 0.00000815\ L^{2.68} \quad (r = 0.931)$$

ANACOVA, following Snedecor (1961) revealed that the slopes of the two regression lines do not differ significantly (F = 2.76; 1,244 d.f.). The 't'-test on correlation co-efficients by 'z' conversion indicated that the 'r' values were from a common population. Hence, a common length-weight equation was derived as

$$W = 0.00003481\ L^{2.84} \quad (r = 0.953)$$

Growth : Length frequency data for the period January 2000 to March 2002 was pooled for growth studies. The $L\infty$ was estimated as 361 mm from Powell – Wetherall plot (Z/k = 4.312). Using the ELEFAN I program without correction for gear selection, the $L\infty$ obtained was 361 mm ; k = 0.57. After correction for gear selection using the L-50 and L-75 values from probabilities of capture, the $L\infty$ and k values were 360 mm and 0.56, respectively (Fig. 3). These values showed better goodness of fit and were similar to the results obtained from the Ford-Walford plot obtained from modal progression after separation of modes by Bhattacharya analysis. The final

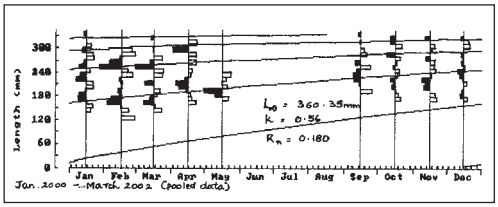

Fig. 3 Restructured length-frequency data of *P. hamrur* (Jan. 2000 – March 2002, pooled) with growth curves (data for the monsoon months of June – August not available)

parameters of the VBGF were : $L\infty$ = 360.35 mm

$$k = 0.56\ yr^{-1}$$

$$t_0 = -0.1013$$

The von Bertalanffy growth equation for *P. hamrur* off Saurashtra can thus be given as -

$$L_t = 360\ [1\text{-}e^{-0.56(t+\ 0.1013)}]$$

These results are similar to the findings of Chakraborty and Vidyasagar (1996) for *P. hamrur* from Bombay waters ($L\infty$ = 360 mm, k = 0.64). The length attained by the fish at the end of 1 to 4 years as estimated from this equation are 166 mm, 249 mm, 297 mm and 324 mm, respectively (Fig. 4). The estimates obtained by Chakraborty and Vidyasagar (1996) for *P. hamrur* (1 to 4 years) from Bombay waters were 171, 260, 308 and 334 mm respectively. The Pauly and Munro's growth performance index, 'Φ' was obtained as 4.86. The

Fig. 4 von Bertalanffy growth curve for *P. hamrur*

fishery is represented by fishes of 1, 2, 3 and 4-year classes, and dominated by the 2 and 3-year classes. The longevity, t_{max} was obtained as 4.4 years.

Mortality and Exploitation : The natural mortality co-efficient, 'M', obtained by Pauly's empirical formula was 1.14. John and Sudarshan (1988) estimated 'M' to be in the range of 1.7 – 1.9 for priacanthids along the Indian

coast. Biradar (1988) reported the natural mortality co-effiecient of *P. hamrur* off Bombay to be 1.0, while Chakraborty and Vidyasagar (1996) estimated it to be 1.13. In the present study, the instantaneous total mortality co-effiecient, 'Z' obtained from the length-converted catch curve was 2.35 (Fig. 5). Chakraborty and Vidyasagar (1996) reported 'Z' as 2.24 for *P. hamrur* off Bombay. The fishing mortality, 'F' was estimated as 1.21 and the exploitation rate 'E' was 0.51. The M/k ratio obtained was 2.04, which lies within the normal range of 1 – 2.5, as suggested by Beverton and Holt (1959).

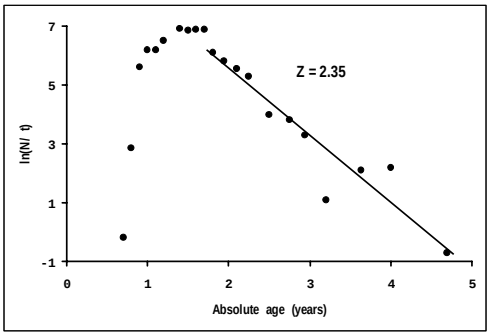

Fig. 5 Estimation of 'Z' for *P. hamrur* off Saurashtra from length-converted catch curve

Virtual Population Analysis and yield prediction by Thompson and Bell Analysis : VPA on the pooled data reveals that 'F' increases to a maximum of 2.36 at 254.5 mm. After this point it decreases to 0.19 at 304.5 mm and abruptly increases to 3.79 at 324.5 mm. Fishing mortality exceeds natural mortality from 224.5 mm onwards. The mean 'F' value was 0.96 and the mean 'E' was 0.4 (Fig. 6).

The average annual catch of *P. hamrur* (January 2000 – March 2002) was 4232 tonnes. The length cohort and Thompson and Bell analysis (Fig. 7) shows that at the present level of fishing

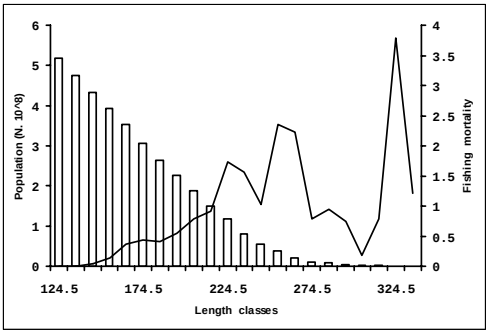

Fig. 6 Output of the length-structured VPA (using FiSAT) for *P. hamrur*

(X=1), there is no decline in the catch and the MSY of 4996 tonnes can be obtained by almost trebling the effort (X=3.2). The MSE of 2.85 million rupees can be obtained at X=2.4. The fishery along the

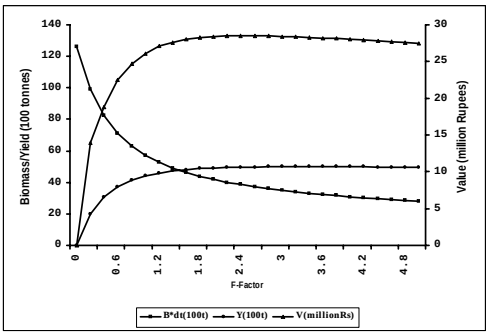

Fig. 7 Maximum sustainable yield (MSY) and maximum sustainable economic yield (MSE) of *P. hamrur* for different F-factors

Saurashtra coast is multi-species, targeting resources like cephalopods, shrimps, ribbonfishes, threadfin breams, croakers, catfishes etc. Changes in the fishing effort cannot be advised based on a resource like *P. hamrur*, which, at present, does not influence the economic value of the fishery. However, the findings of this study is relevant to identify those resources which hold a good potential for exploitation in the, future and *P. hamrur* appears to be one among them.

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