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Age, growth, mortality and stock assessment of *Priacanthus hamrur* (Forsskal, 1775) from Mumbai waters

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Abstract

Based on the data collected for two years from Sassoon Docks and New Ferry Wharf landing centers of Mumbai (2006-2008), the growth, mortality and stock of *Priacanthus hamrur* were assessed. The von Bertalanffy growth functions were L_∞ =360 mm, K = 0.69 per year and t_0 = -0.00065 years. Based on this, the growth at the end of I - IV years of its life was worked out to be 180, 269, 315 and 337 mm. The mortality coefficients Z, M, and F were 3.09, 1.19, and 1.9 respectively. The exploitation ratio (E) and exploitation rate (U) were calculated as 0.61 and 0.58 respectively. Length cohort analysis indicated that F was high in 259.5 - 289.5 mm length groups. Thompson and Bell predictive model shows that there is no decline in the catch at the present level of fishing which stood at 414 t. Even if the fishing pressure is increased up to f-factor of 1.6, there will be no decline in the catch. However, it is suggested to maintain effort at the present level in order to maintain the sustainable catches of the species in future.

Keywords: Bullseye, growth, mortality, exploitation, stock assessment

Introduction

The annual average landing of bullseyes along the west coast of India was estimated as 16,871 t during 2000 – 2004. Nearly 63.5% production was from southwest coast and the remaining from northwest region (Sivakami *et al*., 2005). The production indicated fluctuating trend in all the states. In Maharashtra, the catch increased from 580 t in 2000 to 2028 t during 2002 but declined thereafter to 272 t during 2004. *Priacanthus hamrur* (Forsskal, 1778) is the most dominant species among the bullseyes landed by trawl, contributing up to 100% of the priacanthid catch in Goa, Karnataka and Kerala, while it ranged between 83% to 100% in Gujarat and Maharashtra. Other species recorded were *P. cruentatus* (15%) in Gujarat and *P. tayenus* (0.1%) in Maharashtra. Priacanthids contributed 4% to the total demersal landings in the region. In recent years, priacanthids have assumed economic importance and hence stock assessment of the species was made from Mumbai coast. The present paper reports on growth, mortality and stock parameters of *P. hamrur.*

Material and Methods

Weekly length frequency data on *P. hamrur* were collected at New Ferry Wharf and Sassoon Docks landing centres of Mumbai during 2006-2008. Total length was measured from the tip of the snout to the end of caudal fin to the nearest mm. The weight of measured fish was taken to the nearest gram. Total catch of the species on the day of observation was noted. This data was grouped into 10 mm class interval and raised for the day and subsequently for the month (Sekharan, 1962). Growth was estimated using von Bertalanffy's (1938) equation given as $L_t = L_\infty (1\text{-}e^{-K(t-t_0)})$ and the growth parameters (L_∞ and K) were estimated using FiSAT package (Gayanilo *et al.*, 1996). The mean lengths were decomposed by Bhattacharya's method (1967) using FiSAT programme and were connected applying modal progression analysis used for estimation of

growth parameters. The initial estimates of the growth parameters by Powell-Wetheral plot, Gulland and Holt plot (1959) and ELEFAN were compared before arriving at the final values. Phi prime (ϕ) (Pauly and Munro, 1984) was calculated from the final estimates of L_∞ and K. The total mortality rate (ϕ) was estimated by length converted catch curve method (Pauly, 1983). Natural mortality rate (M) was estimated following Cushing's formula (1968), $Z = M = (1/T_{max} - 1) \log_e 100/1$, in which $(T_{max} - 1)$ was not taken for calculating M value, instead (T_{max}) was used. Fishing mortality rate (F) was estimated as Z - M. The t_0 estimated using von Bertalanffy plot (1934). The exploitation rate (U) was estimated by the formula, $U = (F/Z) * (1-e^{-z})$. The exploitation ratio (E) was estimated as E = F / Z.

Length based virtual population analysis (Jones, 1984) was carried out to determine the yield and biomass. Thompson and Bell analysis (1934) was carried out to predict the effect of change in fishing effort on the yield and value.

Results

Growth parameters were estimated by different methods using computer based FiSAT programme (Windows version). Asymptotic length (L_∞) and Z/K ratio were estimated as 361 mm and 4.103 respectively by Powell and Wetherall plot, and 368 mm and 0.70, respectively by Gulland and Holt plot (1959). By ELEFAN technique L_∞ was estimated as 360 mm and K as 0.69 / year with r_n value of 0.171. Pauly and Munro's (1984) phi-prime (ϕ) value of growth performance was 2.95. Employing von Bertalanffy's plot, the t_0 was estimated as -0.00065 year.

The values of L_∞ and K estimated by ELEFAN were considered for the calculation of lengths attained by *P. hamrur* using von Bertalanffy's growth formula. The lengths attained were 180, 269, 315, 337 mm at the end of I, II, III and IV years, respectively. The maximum size recorded during the period of study was 335 mm, and using inverse VBGF plot the corresponding age was estimated as 3.87 years. Total mortality obtained by length converted catch curve was 3.09 (Fig. 1). Using Cushing's formula the M was estimated as 1.19. Fishing mortality was estimated by subtracting natural mortality M from total mortality coefficient Z as 1.9. The exploitation rate (U) was calculated as 0.58 and exploitation ratio (E) as 0.61.

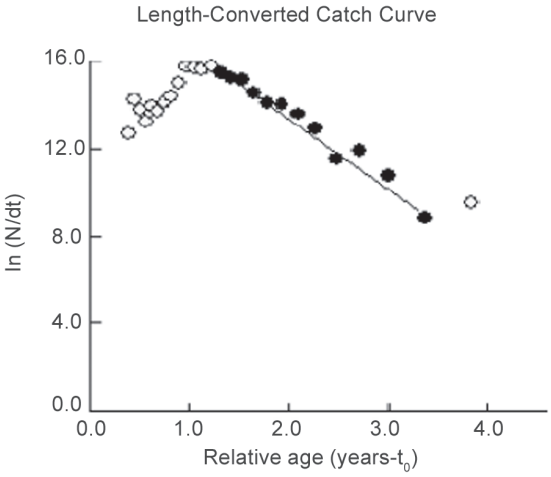

Fig. 1. Length converted catch curve for estimation of Z of *P. hamrur*

The input parameters used for VPA were L_∞ of 360 mm, K of 0.69 / year, M of 1.19, 'a' as 0.0186 and 'b' as 2.8578 from length-weight studies in cm and g (Fig. 2). The terminal fishing mortality was assumed to be 0.65. The highest fishing mortality was found to be 3.72 in the length group of 299.5 – 309.5 mm followed by 2.83 in the length group 279.5 - 289.5 mm indicating high fishing mortality in larger length groups. Small length groups showed low fishing mortalities. The largest number of fish caught (6, 38, 949) were from the length group 199.5-209.5 mm with fishing mortality of

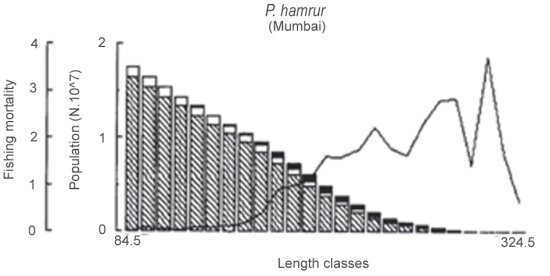

Fig. 2. Length structured VPA indicating the catch, natural losses, survivors and fishing mortality of *P. hamrur*

1.59. The F was high in 259.5 – 289.5 mm length groups. The mean F from the fully recruited groups (199 – 329 mm) was 1.98.

The result of length Cohort Analysis (VPA) was used for Thompson and Bell long-term predictions which show the array of f-factor for which the yield, biomass and prices are indicated. The f-factor of 1.0 indicates the present level of fishing (Fig. 3) which shows no decline in the catch and stood at 414 t.

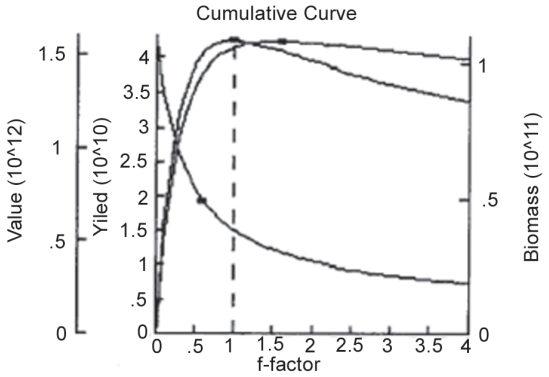

Fig. 3. Thompson and Bell predictive analysis of *P. hamrur*

Discussion

Chakraborty (1994) estimated von Bertalanffy's growth parameters of *P. hamrur* off Mumbai as L_∞ as 360 mm, K as 0.73 / year and t_0 as – 0.009116/ year and calculated the growth as 193, 283, and 323 mm at the end I, II, and III years. The largest length recorded by him was 341 mm. Chakraborty and Vidyasagar (1996) reported L_∞ of 360 mm, K of 0.641 / year for the same species. They estimated the length attained at the end of I to IV years as 171, 260, 308, 334 mm and maximum length reported as 346 mm. Philip and Mathew (1996) using Ford–Walford plot and von Bertalanffy's plot calculated L_∞ as 297mm, K as 0.3585 / year and t_0 as – 0.0206 for males recording a maximum length 265 mm. For females the L_∞ was calculated as 300mm and K as 0.3826 and t_0 -0.0244 with maximum length 288 mm. For both sexes taken together L_∞ was calculated as 284 and K 0.3722 and t_0 0.1122 from northeast coast of India. Varghese (1999) using Gulland and Holt plot estimated L_∞ as 34.76 cm, K as 0.63, t_0 as 0.083 year and phi prime (ϕ) as 2.88. Sivakami *et al.* (2005) estimated L_∞ 410 mm, K 0.59 / year and they found this species to attain 182.7, 284, 340.2 and 371.3 mm during I – IV years along west coast. The largest specimen collected by them measured 368 mm and the age of same was estimated as 3.86 years with phi prime of 2.99. Kizhakudan and Zala (2006) derived von Bertalanffy's growth parameters L_∞ as 360.35 mm, K as 0.56, and t_0 as 0.1013 years, and estimated the lengths attained by the species at the end of I to IV years as 165, 249, 296 and 324 mm with phi prime value of 2.86. The values of growth parameters estimated during the present investigation are in agreement with the findings of earlier workers. It is also confirmed by phi prime value estimated in present study (2.95).

The M/K ratio in the present study was 1.72, Beverton and Holt suggested that this ratio usually ranges from 1 to 2.5 which shows that the present M/K ratio is within the suggested range (Beverton and Holt, 1959). The E and U values were estimated as 0.61 and 0.58, respectively. Gulland and Holt (1959) suggested that if the E value is more than 0.5, the stock is overexploited. John and Sudarsan (1988) estimated M to be in the range of 1.7 – 1.9 for priacanthids along the Indian coast. Chakraborty (1994) estimated total, natural and fishing mortality as 3.08, 1.52 and 1.56, respectively, and exploitation ratio (E) and exploitation rate (U) as 0.506 and 0.482, respectively. Chakraborty and Vidyasagar (1996) calculated mortality parameters Z, M and F as 2.24, 1.13 and 1.11 respectively. Philip and Mathew (1996) derived the natural mortality M, Z, F for male as 0.9, 2.4514 and 1.5514 and for female as 0.9363, 1.7686 and 0.8323, for both sexes 0.9341, 2.5047, and 1.5706 respectively. The exploitation ratio (E) and exploitation rate (U) were obtained for male as 0.6329 and 0.5783 and for female as 0.4706 and 0.3903 and for both sexes as 0.6271 and 0.5758, respectively. Sivakami *et al.* (2005) calculated total mortality coefficient (Z) off northwest and southwest coasts of India between 4.46 to 6.14 and 3.99 to 5.45, respectively. The natural mortality was 1.14 for west coast while the fishing mortality ranged between 5 and 3.32 off northwest coast and between 4.31 and 1.13 off southwest coast with exploitation ratio of 0.78. M/K value for west coast was 1.93. They estimated exploitation ratio and exploitation rate as 0.73 and 0.719, respectively with E_{max} 0.802 from southwest coast, from northwest coast E and U estimated as 0.78 and 0.77 respectively with E_{max} 0.893. Kizhakudan and Zala (2006) estimated Z, M,

and F as 2.35, 1.14 and 1.21, respectively. The exploitation rate (E) was 0.51, and the M/K ratio obtained by them was 2.04.

There is little difference in the estimate of M and Z as compared to the earlier studies from Mumbai. E obtained in the present study (0.61) which is lower than that obtained by Philip and Mathew (1996) (0.6271) and Sivakami *et al.* (2005) (0.78), but higher than that of Chakraborty (1994) (0.506) and Kizhakudan and Zala (2006) (0.51). The low exploitation ratio of 0.506 obtained by Chakraborty (1994) may perhaps be due to the fact that at that time the priacanthids were a resource with moderate exploitation.

The length cohort analysis shows an increasing trend of F for large size groups. The main reason for this may be that the smaller size groups are discarded or they are not represented in the fishing ground and the death for this group may partly be due natural cause also.

Chakraborty (1994) estimated standing stock Y/F and total stock Y/U as 331.92 t and 1074.28 t, respectively as compared to the combined yield of 517.81 t from New Ferry Wharf and Sassoon Docks. Chakraborty and Vidyasagar (1996) showed that there is no decline in the catch at the present rate of exploitation, however even if the efforts are tripled the increase in the catch will not be proportionate and returns will not be remunerative. The parameters for length cohort analysis and Thompson and Bell are $L_{\infty} = 360$, K = 0.61, M = 1.13, F/Z = 0.5, a = 0.025, and b = 2.7715. At the present level of fishing (X=1) there is no decline in the catch, but even by increasing the effort three times the catches can go up only by 47 tonnes. Kizhakudan and Zala (2006) using VPA and Thompson and Bell model showed that F increases to a maximum of 2.36 at 254.5 mm, and decreases thereafter to 0.19 at 304.5 mm, but abruptly increases to 3.79 at 324.5 mm. The reason for this sudden increase in F is not explained. Fishing mortality exceeds natural mortality from the mid-length of 224.5 mm onwards. The mean F value was 0.96 and the mean E was 0.4, so they concluded that at the present level of fishing (X=1), there is no decline in the catch and the MSY can be obtained by almost tripling the effort (X=3.2) and the MSE at X = 2.4. Thompson and Bell (1934) long term prediction model indicates that at the present level of fishing (f-factor of 1) there is no decline in the catches; even if f-factor is increased to 1.6, the catch will not decline and beyond that the catch will decline. However, the yield at f = 1.60 can add up by only 9 tonnes which is not remunerative. The maximum economic yield in terms of value is obtained at present level of fishing, however, the biomass was declined to 35.8% as compared to the virgin biomass.

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References

Beverton, R. J. H. and S. J. Holt. 1959. A review of the life span and mortality rates of fish in nature and their relation to growth and other physiological characteristics. CIBA Foundation Colloquia on Ageing: The Life Span of Animals, 5: 142 - 180.

Bhattacharya, C. G. 1967. A simple method of resolution of a distribution into Gaussian components. *Biometrics*, 23: 115 - 135.

Chakraborty, S. K. 1994. Fishery, age, growth, mortality and stock assessment of *Priacanthus hamrur* Forsskål from Bombay waters. *Bull. Cent. Mar. Fish. Res. Inst.*, 47: 121 - 127.

Chakraborty, S. K. and K. D. Vidyasagar. 1996. Growth, mortality and stock assessment of two perches Moontail bullseye *Priacanthus hamrur* (Perciformes/Pricanthidae) and thorny-cheek grouper *Epinephelus diacanthus* (Perciformes/Serranidae) from Bombay waters. *Ind. J. Mar. Sci.,* 25(4): 312 - 315.

Cushing, D. H. 1968. *Fisheries Biology: A Study in Population Dynamics.,* Univ. Wisconsin Press, Madison, 200 pp.

Gayanilo, F. C. Jr., P. Sparre and D. Pauly. 1996. FAO-ICLARM Stock Assessment Tools (FiSAT) users guide. FAO Computerized information Series (Fisheries) No.8. FAO, Rome, 3 diskettes and 124 pp.

Gulland, J. A. and S. J. Holt. 1959. Estimation of growth parameters for data at unequal time intervals. *J. Cons. CIEM,* 25(1): 47 - 49.

John, M. E. and D. Sudarsan. 1988. Assessment of the stock of big eye snappers (Fam. Priacanthidae) in Indian seas with a note on their pattern of abundance. Abstract no. 232, *Symposium on Tropical Marine Living Resources, January 1988. Cochin*, p. 12 -16.

Jones, R. 1984. Assessing the effects of changes in exploitation pattern using length composition data (with notes on VPA and cohort analysis). *FAO Fish.Tech. Pap.*, 256: 118 pp.

Kizhakudan, S. J. and M. S. Zala. 2006. Dynamics of *Priacanthus hamrur* (Forsskal) exploited off Saurashtra coast. *Indian J. Fish.,* 53(4): 409 - 416.

Pauly, D. 1983. Length-converted catch curves: a powerful tool for fisheries research in the tropics (Part I). ICLARM Fishbyte, 1(2): 9 - 13.

Pauly, D. and J. L. Munro. 1984. Once more on the comparison of growth in fish and invertebrates. ICLARM Fishbyte, 2(1): 21 pp.

Philip, K. P. and K. Mathew. 1996. Growth, mortality and exploitation of *Priancanthus hamrur* from the north east coast of India. *J. Mar. Biol. Ass. India,* 38(1&2): 106 - 113.

Sekharan, K. V. 1962. On oil sardine fishery of the Calicut area during the year 1955-56 to 1958-59. *Indian J. Fish.,* 9A(2): 679 - 700.

Sivakami, S., S. G. Raje, K. V. S. Nair, P. P. Manojkumar and K. Ramani. 2005. Fishery potential of bullseye along the west coast of India. *J. Mar. Biol. Ass. India*, 47(2): 185 - 192.

*Thompson, W. F. and F. H. Bell. 1934. Biological statistics of the Pacific halibut fishery. 2. Effect of changes in intensity upon total yield and yield per unit of gear. *Rep. Int. Fish. (Pacific Halibut) Comm.*, 8: 49 pp.

Varghese, J. 1999. Further Studies on Biology of *Prianthus hamrur* (Forsskal) with Comparison to Species Co-existing Along the North-West Coast of India. Fishery Survey of India, Mumbai, *Ph. D. Thesis*, University of Mumbai, 220 pp.

*von Bertalanffy, L. 1934. Unterschunger iiber die Gesetzlichkeiten des wachstums. 1. Allge meine Grundlagen der theorie, *Roux. Arch. Entwick-lungsmech. Org.,* 131: 613 - 653.

* von Bertalanffy, L. 1938. A quantitative theory of organic growth. *Hum. Biol.,* 10: 181 - 213.

* Not referred to in original.

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