Indian J. Fish., 61(1) : 12-15, 2014

Growth and mortality of *Osteogeneiosus militaris* (Linnaeus 1758) from Mumbai waters

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ABSTRACT

Based on the length frequency data collected during the period January 2002 to August 2004, the growth and mortality parameters of *Osteogeneiosus militaris* was estimated. The asymptotic length (L_∞), growth coefficient (K) and t_o were estimated as 583 mm, 0.67 yr^{-1}, and -0.0396 years respectively. Based on the von Berttalanffy growth (VBG) parameters, the growth of the fish during 1 to 5 years of its age works out to be 292, 426, 487, 516, and 529 mm respectively. The growth performance index was estimated as 3.55. The instantaneous rate of total mortality was estimated as 3.55, natural mortality as 1.04 and fishing mortality as 2.51. The phi prime was estimated as 3.35. The exploitation ratio (U) and exploitation rate (E) were worked out as 0.67 and 0.70 respectively. The vulnerability of catfish in general and *O. militaris* in particular with respect to over-exploitation, destruction of eggs, incubating males and the inherent low fecundity of the family are discussed in the present communication.

Keywords: Asymptotic length, Growth coefficient, Growth parameters, *Osteogeneiosus militaris*

Introduction

Marine cat fish belonging to the family Ariidae (Tachysuridae) is one of the important fish resources of the country. Growing to a size of nearly 50 – 60 cm, the average annual total marine fish catch in India during 2002-2011 period was about 2.92 mmt and during the same period, the annual average catch of marine catfish was 71000 t which was 9.35% of the demersal catch and 2.24% of the total marine fish catch of the country (Anon, 2002-12). From the fisheries point of view, five species of marine catfish are important *viz.*, *Netuma thalassina, Netuma dussumieri, Plicofollis tenuispinis Arius jella* and *Osteogeneiosus militaris.*

The major catfish producing states in India are Gujarat, Maharashtra, West Bengal and Odisha. The annual average catch of catfish during the period 2002-2012 in Maharashtra was around 11827 t contributing 2.78% to the total catch (Anon, 2002-2012). A good number of researchers have worked on the catfish fishery resources of India (Pantulu, 1963; Dan, 1980, 1981; Gulati *et al*., 1996; Chakraborty *et al.,* 1997; Menon, 1979; Krishna, 1981; Menon *et al*.. 1992; Raje *et al*., 2008). Raje and Vivekanandan (2008) discussed about the vulnerability of catfish especially with reference to growth overfishing and low fecundity.

Osteogeneiosus militaris is distributed along the Indo-Pacific region from the west coast of India to Bangladesh, Myanmar, Singapore, Malacca, Indonesia, Brunii, Darussalam, Malaysia and Pakistan. In the present communication, the growth and mortality parameters of *O. militaris* is reported. This study is based on the length frequency data collected from New Ferry Wharf, Sassoon Docks and Versova during the period from January, 2002 to August, 2004.

Materials and methods

Weekly length frequency data were collected from the three landing centres of Greater Mumbai *viz*., New Ferry Wharf, Sassoon Docks and Versova. Total length of the fish was taken from the tip of the snout to the tip of the caudal fin in mm. During the period of study, 2635 specimens in the length range of 154 to 489 mm were measured. The total catch was estimated on the day of observation. The data thus collected were distributed into 20 mm groups and was raised for the day and subsequently for the month following Sekharan (1962). The growth was expressed using the von Betrtalanffy's formula given as : $Lt = L_\infty*(1-e^{-K(t-}t_o)$. Growth parameters like L_∞ and K were estimated employing the Bhattacharya's (1967) method which involves separating the normal distribution each representing a cohort of fish from the overall distribution. By this method, a rough estimate of asymptotic length (L_∞) and growth coefficient (K) was made. These two parameters were further refined using Gulland and Holt's plot (1959) where the pair of data used for regression are mean length $\bar{L}$ and difference in length at different age $\Delta L/\Delta t$, which gives the value of L_∞ and K as K = - b, and L_∞ = -a/b. The t_o was estimated by von Bertalanffy (1938) plot which is given as $– L_n(1\text{-lt}/L_\infty) = -K*to + K*t$ where 't' is the independent variable. The equation becomes linear and the values of 'a' and 'b' gives b = K and t_o = -a/K. The total mortality coefficient was estimated by Pauly's (1984) length converted catch curve given as: Log e (N/ t) = a + b.t, where 'b' with the sign changed gives the estimate of Z.

The natural mortality was estimated by Cushing's (1968) formula :

$Z = M = 1/(T_{max}-1) \times \log_e Nt/Nt_{max}$

where, N_t is the number of one year old fish, and N_{tmax} the number of maximum age of fish in the population. In the unexploited state, if the number of one year old fish is taken as 100, then the number surviving to an age of T_{max} may be written as : $Z = M = 1/(T_{max} -1) \times \log e\ 100/1$. Here T_{max} is taken and 1 is not subtracted from T_{max}. The growth performance index, phi prime (Ø) was estimated by the formula of Munro and Pauly (1983) given as : $Ø = 2_* \log L_\infty + \log K$ where L_∞ is in cm and K is annual. The exploitation ratio (U) and exploitation rate (E) were estimated by the formula $U = F/Z_*(1-e^{-z})$ and E= F/Z respectively.

Results and discussion

The asymptotic length (L_∞) and growth coefficient (K) estimated using Bhattacharya-Gulland and Holt plot was 583 mm and 0.67 yr^{-1} respectively. The t_o was estimated as -0.0036 years (Fig. 1 and 2). Using VBGF, the growth of this species was found to be 292, 434, 507, 544 and 563 mm at the end of 1, 2, 3, 4 and 5 years respectively. The maximum length recorded during this period was 489 mm at which, employing VBGF the age of the fish works out to be 2.68 years. The phi prime was estimated as 3.35. (Table 1). The VBGF for this species can be written as : $L_t = 583*(1-e^{-0.67} (t--0.0396)$

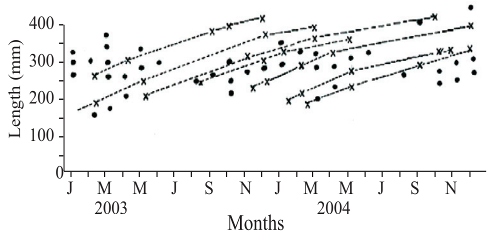

Fig. 1. Growth curve of *Osteogeneiosus militaris* from Mumbai waters, derived by Bhattacharya method using FiSAT

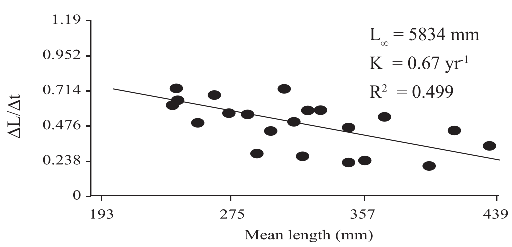

Fig. 2. Gulland and Holt's plot for *Osteogeneiosus militaris*

The total mortality coefficient was estimated as 3.55 per year (Fig. 3) and the natural mortality as 1.04 per year and the fishing mortality as 2.51 per year. The exploitation ratio (U) and exploitation rate (E) were estimated as 0.67 and 0.70 yr^{-1} respectively.

Table 1. Phi prime (F) of *Osteogeneiosus militaris* based on growth parameters calculated by various authors.

L_∞	K	F	Authors
54.0	0.65	3.27	Pantulu (1963)
47.0	0.51	3.00	Gulati *et.al.* (1996)
60.0	0.65	3.36	Chakraborty *et al.* (1997)
58.3	0.67	3.35	Present study

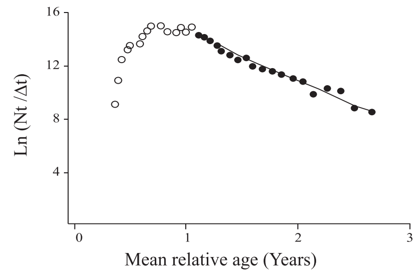

Fig. 3. Length converted catch curve for estimation of Z for *Osteogeneiosus militaris*

The earliest report on the growth of *O. militaris* is perhaps by Pantulu (1963) from the Hooghly-Matlah estuarine system, who estimated L_∞ as 540 mm and K as 0.65 per year. Based on this, the fish grows to about 292, 426, 487, 516 and 529 mm at the end of 1- 5 years of its life span. Chakraborty *et al.* (1994, 1997) reported L_∞ as 600 mm and K as 0.65 per year from the north-west coast of India. Gulati *et al.* (1996) studied the growth pattern of this species and estimated L_∞ and K as 476 mm and 0.51 per year.

The L_∞ estimated by earlier workers (Pantulu, 1963; Gulati *et al.,*1996) appears to be slightly lower, whereas that of Chakraborty *et al.* (1994, 1997) appears slightly higher. Gulati *et al.* (1996) also have based their study on data collected during 1985-87 periods. Considering the fact that during nineteen eighties when the fishing pressure was comparatively low, there were chances of getting higher L_{max}. Similarly, the L_∞ estimated by Chakraborty *et al.* (1994, 1997) appears to be slightly over estimate considering the fact that if the stock is subjected to only natural mortality which is not so in the present study, then at least 95% of the fish would reach near to their maximum size. Taking that the simple assumption $L_{max}/0.95 = L_\infty$, 95% of fish would be dead before reaching their $L_{max,}$ the L_∞ should be around 570 mm. Again the limitation of this method is that the fish is subjected to fishing and natural mortality and mostly the 'F' is double of 'M' in Indian species. As far as problems of the length frequency method for the estimation of growth is concerned, it is well known that most of the methods are subjective. The hard parts of catfish like spines have markings, but the periodicity of formation of these rings is not very authentic. It is for this reason that we need to depend totally on the length frequency data for determination of age. The rate of growth with K of 0.67 per year appears to be faster as compared to earlier studies except that of Pantulu (1963). The 'Z' of 3.55 per year obtained during the present study was also higher as compared to the value of 0.88 reported by Gulati *et al.* (1996), but lower than the report of Chakraborty *et al.* (1997) who estimated it as 5.0.

Natural mortality is one of the most essential yet difficult parameter to estimate in population dynamics studies. It was estimated as 1.04 for *O. militaris* in the present study. In tropical multispecies, multigear groups, the most classical method of 'Z' against effort (Paloheimo, 1958) cannot be used. It is for this reason a number of methods have to be tried to arrive at a reasonable estimate of M. It is well known that 'M' varies with age (Boiko, 1964) and also with predator abundance (Pauly, 1980, 1982; Jones, 1982; Munro, 1982) and also with size, K and the mean ambient temperature of the ecosystem. As larger fish will have less number of predators and the natural mortality would be low. A fast growing fish will have higher K and low L_∞, and the 'M' for such species would be high. The M/K has been worked out for some of the families of fish by Beverton and Holt (1959) for groups like Pleuronectiformes, Clupeoidei, Salmonoidei, and Gadiformes. In most of the fishes it is found to range between 1 – 2.5. In the present investigation, it was found to be 1.55 which is well within the range suggested by Beverton and Holt (1959). One more factor through which the growth parameters of fish can be related is the phi prime which is again nearly same for similar species or taxonomic groups. Based on the growth parameters estimated for the species by various authors, the phi prime (Ø) of this species was found to range from 3.06 to 3.36 and for the present investigation it was 3.36. The average phi prime for all these investigations comes to 3.36. This also substantiates the fact that the growth parameters arrived at are reasonable.

The exploitation rates of 0.70 are certainly more than the optimum of 0.5 suggested by Gulland (1971). A fast growing high fecund species has more chances of survival as compared to a slow growing low fecund fish. Though in catfish, the low fecundity, to a greater extent is compensated by parental care, with advent of purse seines, ring seines, and trawlers, sometimes a complete shoal of catfish is captured along with males with incubating young ones. The decline in the catch and catch rate have been discussed in detail by Raje and Viveknanadan (2008). Oral gestation mortality of the males and consequently disproportionate sex ratio has also been highlighted by them. They have evidently proved that the decline in population is due to a combination of low fecundity, destruction of large number of eggs along with male parent and that is seriously affecting the recruitment. The absence of males or their drastic decline in numbers has negated the supposedly advantageous strategy adopted by catfish for protecting eggs and larvae which is no more relevant to the present period of intense fishing, and has become counterproductive for sustaining the population (Raje and Vivekanandan, 2008). It is for this reason, that catfish faces greater risk of depletion as compared to other species found in India and it is clearly seen by the decline of the catch and catch rate of catfish in different parts of India, where once it formed major fishery.

Some of the inherent deficiencies associated with the methods used in tropics cannot, however, be ruled out. The estimate of natural mortality is one such aspect. It is taken as constant from the young age to adulthood through old age. But the fact is that predation mortality being the main component of natural mortality, the young ones of the species would certainly have higher rates of M. The other aspect is that catfish with a fairly broad body and strong dorsal and pectoral spine, as a rule would have less number of predators. In spite of this, there is hardly any difference in the rates of natural mortality of this species over the years, say from late eighties of last century to early part of 21st century. There is no logical reason for such an explanation as it is well known that many of the large predators feeding on medium and smaller fish have declined in the north-west. coast of India. The decline of once famous ghol, dara, koth, wam and karkara fishery of north-west coast are significant. Similarly, the numbers of the bigger serranids and sharks have also declined in the ecosystem.

The present study would add to the knowledge of catfish resources in general and would encourage more researchers to work on the reasons behind the decline of many bigger species in the ecosystem and may try to rectify some of the defects/limitations in the methods used for estimation of growth and mortality of catfishes.

Acknowledgements

The study formed part of the thesis work for the award of Ph. D. degree of the first author by the Central Institute of Fisheries Education (Deemed University), Mumbai. The authors are grateful to Dr. S. C. Mukherjee, former Director of CIFE, Mumbai for providing all the facilities during the course of study. The authors are offering their sincere thanks to Dr. W. S. Lakra, Director, CIFE, Mumbai for the encouragement. The first author is grateful to ICAR for providing financial support during the period of study.

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Date of Receipt : 04.06.2013
Date of Acceptance : 01.11.2013