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Growth, mortality and stock assessment of sin croaker *Johnieops sina* (Cuvier, 1830) from Ratnagiri waters, Maharashtra

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ABSTRACT

Growth, mortality and stock parameters of *Johnieops sina* was assessed based on the length frequency data collected from Ratnagiri during 2009-11. The growth parameters were estimated as L_∞ = 266 mm, K = 0.9 y^{-1} and t_0 = -0.002 years. Mortality coefficients Z, M and F were estimated as 7.03, 1.81 and 5.22 respectively. The exploitation rate 'E' was very high at 0.74. Virtual population analysis followed by Thompson and Bell analysis indicated that there is no decline in the catch at the present level of fishing, but further increase in effort may not be good for the stock in the long run.

Keywords : Growth, *Johnieops sina*, Ratnagiri, Sin croaker, Stock assessment

Introduction

Johnieops sina (Cuvier 1830) is a lesser sciaenid abundantly found along the Maharashtra coast. This species grows to relatively small size and forms about 7% of the total sciaenid landings in Maharashtra. The annual average catch of sciaenids in the state during 2001-2012 was about 28455 t, contributing 6.71% to the total catch (Anon., 2001-2012). The total catch of sciaenids from India was about 1,52,914 t for the period 2001-2011 which is about 21.87% of the demersal catch and 5.34% of the total fish catch (CMFRI, 2001-2011).

Shultz (1991) carried out biological investigations and stock assessment of *J. sina* from Sofala bank of Mozambique. Detailed studies have been carried out on the biology (Yousif and Nama, 1992), diet (Hussein and Mahdi, 1999) and stock assessment (Ali *et al*., 2002) of the species from the N.W. Arabian Gulf. From Indian waters, Jayaprakash (1974) reported the unusual occurence of a specimen of *J. sina* with 3 anal spines. Nair (1974) made a prelimnary study on length frequency of *Pseudosciaena* (=*Johnioeps*) *sina* from Bombay waters and Bhusari (1975) studied its biology and fishery from Ratnagiri coast. Chakraborty (1994, 1996) assessed growth, mortality and stock parameters of *J. sina* from Mumbai. Telvekar *et al.* (2006, 2007) studied maturity, spawning, food and feeding, growth, mortality and yield per recruit of *J. sina* from Mumbai. Manojkumar (2011) studied the biology and stock assessment of *J. sina* from Malabar coast. No study has been carried out on the growth and stock assessment of *J. sina* from Ratnagiri waters in recent years. In the last four decades, a series of changes in operation of craft and gear and exploitation patterns have taken place necessitating the present study to acertain the stock status of the species along the coast of southern Maharashtra.

Materials and methods

Length frequency data was collected from Mirkarwada landing centre of Ratnagiri from December 2009 to November 2011. A total of 1031 specimens were measured in the length range of 100 to 232 mm. An eye estimation of the catch for *J. sina* was made at the landing centre. The length frequency data collected was distributed at 10 mm class intervals, raised for the day and subsequently for the month following the method of Sekharan (1962).

Asymptotic length (L_∞) and growth coefficient (K) were estimated by methods given by Bhattacharya (1967) and Gulland and Holt (1959). In Bhattacharya's method the composite distribution was separated to normal distribution, each representaing cohort of fish. The preliminary estimates made by Bhattacharya's method was further refined by Gulland and Holt's plot. The intercept 'a' and slope 'b' provided the K and L_∞ through

the relationship: K = -b and L_∞ = -a/K. The analysis was done using FiSAT programme developed by Gayanilo *et al.* (1996). The third parameter 't_0'of VBGF (von Betalanffy, 1934) was estimated by reverse estimation using the equation: $-\ln [1-L_{(t)} / L_\infty)] = -K*t_0 + K*t$. With a series of length at age data and an estimate of L_∞, the intercept a and b were calculated to obtain the K and t_0 as: K= b and t_o = - a/b.

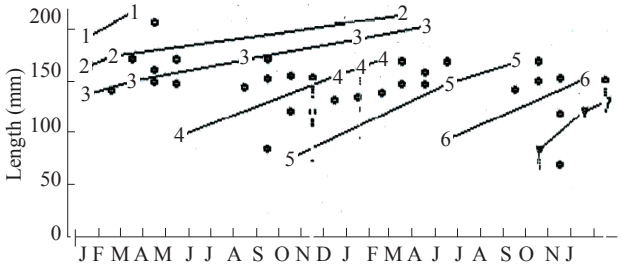
Total mortality coefficient (Z) was estimated by Pauly's (1984) length converted catch curve. The natural mortality coefficient (M) was calculated by Pauly's emperical formula (1980) taking the mean ambient temperature of 28.2°C. Fishing mortality (F) was calculated as F=Z-M and the exploitation rate (E) was estimated as E= F/Z. For stock assessment studies, the length at first capture (L_{c50}) was obtained by selection ogive method using FiSAT (Gayanilo *et al.,* 1996).

Length structured virtual population analysis (VPA) was done following Jones (1984). The output generated was used for Thompson and Bell (1934) long term prediction to predict catch and stock sizes under assumptions on future exploitation levels and mesh size. The yield, value, and biomass for a range of f-factors were estimated to arrive at the maximum sustainable levels of exploitation.

Results and discussion

Employing Bhattacharya's method, seven cohorts could be segregated, which gave estimates of L_∞ and K as 264.05 mm of 0.94 yr^{-1} (Fig. 1). Using Gulland and Holt's plot, the L_∞ was estimated as 266 mm and K as 0.97 yr^{-1} (Fig. 2). The same was taken for further analysis. The t_o was estimated as -0.002 years. The VBGF for this species could thus be written as: $L_t = 266*(1-e^{-0.97\ (t\ +-0.002)})$

Using this formula the length of the fish at the end of 1, 2 and 3 years was estimated as 165, 228 and 252 mm respectively. The total mortality coefficient (Z) was calculated as 7.03 and the natural mortality (M) as 1.81 (Fig. 3). The fishing mortality coefficient (F) was



Pointer's parameters:
Mean : 135.05
No. of pairs : 15
Cohort no. : 8

Preliminary estimates based on G&H plot:
L_∞ : 264.05 mm
K : 0.94^{yr-1}
R : -0.6213

Fig. 1. Linking of means employing model progression analysis (Battacharya's method) for *J. sina* using FiSAT

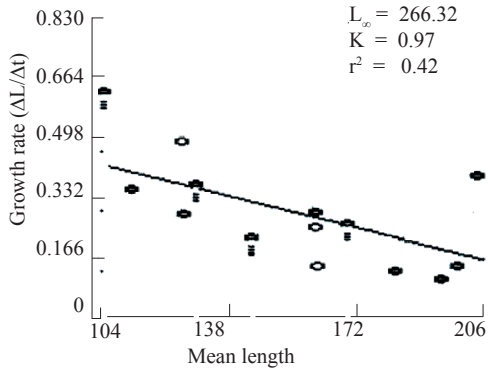
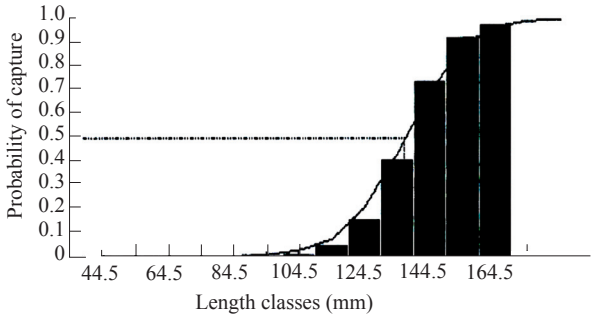


Fig. 2. Gulland and Holt's plot for *J. sina* using FiSAT

Fig. 3. Length converted catch curve for estimation of Z for *J. sina*

calculated as 5.22 and exploitation rate (E) was calculated as 0.74. The length at first capture (L_{c50}) of the trawl net selection was found to be 145 mm (Fig. 4). The 'phi' prime was estimated as 2.82 which compared well with the 'phi' prime estimated for the species from elsewhere (Table 1).

Giving the input parameters of L_∞ (270 mm), K (0.97^{yr-1}), M (1.84^{yr-1}), 'a' and 'b' of the length-



L 25 = 126.248 mm
L 50 = 136.874 mm
L 75 = 147.379 mm

Fig. 4. Trawl net selection curve to determine length at first capture for *J. sina*

Table 1. Estimation of growth parameters from different places

Authors	'Phi' prime	Place
Rao *et al.* (1992)	2.41	Cochin
Chakraborty (1994)	2.64	Mumbai
Chakraborty *et al.* (1997)	2.72	Mumbai
Chakraborty *et al.* (2000)	2.48	Kochi
Telvekar *et al.* (2007)	2.78	Mumbai
Manojkumar (2011)	2.50	Calicut
Present study	2.82	Ratnagiri

weight relationship in g and cm as 0.00751 and 3.17 and terminal F/Z as 0.6, it was found by length cohort analysis that highest F of 8.89 was in the length group of 180-189 mm. Fishing mortality was high for length groups 160-169 to 200-209 mm. Assuming terminal exploitation rate of 0.6, the numbers surviving in highest length group (240-249 mm) was 439000 with a catch weight of 0.312 t (Fig. 5).

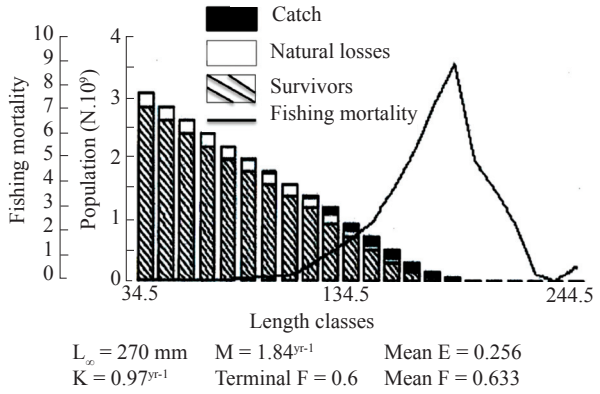


Fig. 5. Length structured VPA indicating the catch, natural losses, survivors and fishing mortality for *J. sina*

The VPA formed the basis for Thompson and Bell long term prediction in which the present level of fishing was shown by f-factor of 1.0. Price was assigned according to the size groups. From the analysis it was observed that at the present level of fishing (F=1.0) the catch has already declined (Fig. 6). Thus, further increase in effort is not desirable.

Nair (1974) reported the growth of this species from Calicut as 135 and 175 mm at the end of 1 and 2 year. The L_∞ and K of this species from Cochin was estimated as 180 and 0.80^{yr-1} by Rao *et al.* (1992) and as 195 mm and 0.80 yr^{-1} by Chakraborty *et al.* (2000). From Bombay waters, the L_∞ and K were estimated as 239 mm as 0.77^{yr-1} (Chakraborty, 1994) and again as 240 mm and 0.91 yr^{-1} (Chakraborty *et al.,* 1997). Later, Telvekar *et al.* (2007) estimated the L_∞ as 258 mm, K as 0.91^{yr-1} and the length at the end of 1, 2 and 3 years of life as 152, 216 and 241 mm respectively in *J. sina* from Mumbai.

In a more recent study from Calicut, Manojkumar (2011) estimated the L_∞ as 268 mm and K as 0.45^{yr-1} based on which the length at the end of 1 and 2 years stood at 99 and 147 mm respectively. The K estimated by him is very much on the lower side as this small-sized species is likely to have a higher K. The growth parameters estimated in the present study is slightly higher than most of the earlier studies. The reason for this may be that there is less fishing pressure at Ratnagiri especially for demersal fishes as compared to Mumbai, Kochi and Calicut.

The natural mortality for *J. sina* was estimated as 1.6 from Maharashtra (Chakraborty *et al.,* 1997) and 1.80 from Cochin waters (Chakraborty *et al.,* 2000). The value of M obtained in the present study is close to these vales and falls within the range of 1.5-2.5 suggested by Beverton and Holt (1959) for M in fishes. The total mortality coefficient (Z) for this species from Cochin waters was estimated at 4.34^{yr-1} by Rao *et al.* (1992) whereas from Mumbai, Chakraborty (1994) estimated the Z as 4.36. Again Chakraborty (1996) found the Z value to be higher at 6.56. In the present investigation it was found to be 7.03 which is higher than the earlier estimates. However, as the study period has a difference of more than 15 years, changes in the fishing methods, craft and gear refinement, area as well as duration of operation are likely to have a bearing on the density and composition

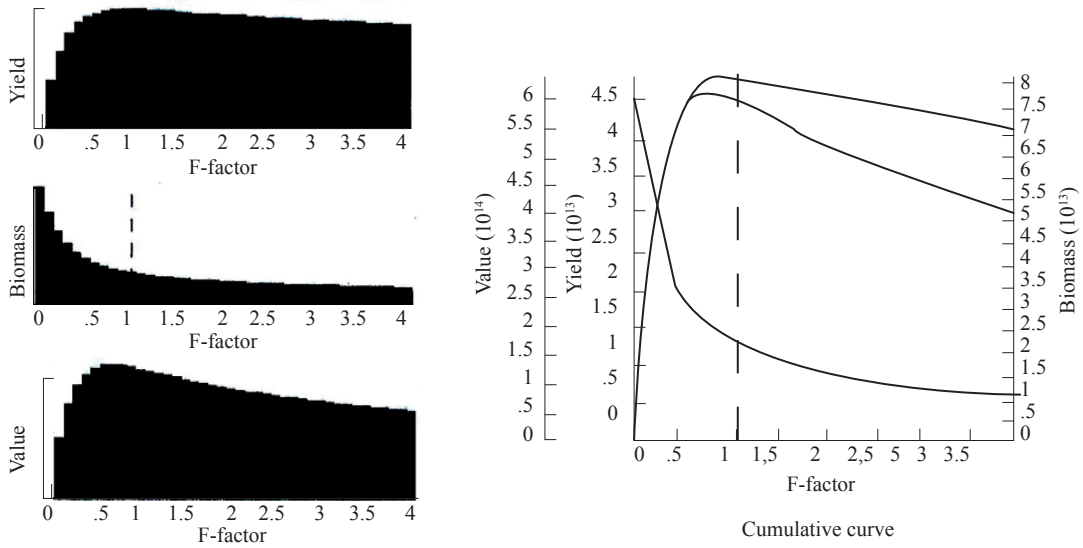


Fig. 6. Graphical representation of Thompson and Bell predictive model for *J. sina*

of catch. More efficient methods of fishing and catching as many fish in a small amount of time spent out at sea is the norm today. Higher fishing pressure has resulted in a higher Z value; similarly, exploitation rate (E) which is 0.74 is much higher than the E of 0.50. The length at first capture for this species is 137 mm which is low as compared to the size at maturity of 157 mm. Telvekar *et al.* (2007) estimated the L_m of 153 mm.

Rao *et al.* (1992) observed that only from the middle length group onwards the species is subjected to fishing mortality and the F increased substantially at about 189.5 mm. Telvekar *et al.* (2007) also observed a similar trend for this species from Mumbai. Observations in the present study indicate a similar trend. Telvekar *et al.* (2007) from Mumbai and Rao *et al.* (1992) from Cochin found that catches of *J. sina* begin to decline at f-factor of 0.8. Thompson and Bell analysis in the present study has similarly indicated that no increase in effort is advisable as it would lead to decline in catch.

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