Growth and mortality characteristics of *Nibea maculata* (Bloch & Schneider, 1801) exploited off Thoothukudi coast, Tamil Nadu

S. SANTHOSHKUMAR, P. JAWAHAR, C.B.T. RAJAGOPAL SAMY*  
AND M. VENKATASAMY  
Department of Fisheries Biology and Resource Management, Fisheries College and Research Institute  
Thoothukudi - 628 008, Tamil Nadu, India  
*Department of Aquaculture, Fisheries College and Research Institute, Thoothukudi - 628 008, Tamil Nadu, India  
e-mail: santhoshkumar2001@gmail.com

**ABSTRACT**

A detailed investigation was undertaken to study the growth and mortality characteristics of *Nibea maculata* off Thoothukudi coast from July 2006 to June 2007. The growth parameters $L_\infty$, $K$ and $t_0$ were estimated as 26.78 cm, 0.810 and -0.204 respectively. The $K$ value of *N. maculata* was relatively higher inferring faster growth rate of this tropical demersal fish species. The estimated total instantaneous mortality co-efficient ($Z$) of *N. maculata* was 2.73 and the fishing mortality co-efficient ($F$) was 1.06. The species is under-exploited in this region.

Keywords: Growth, Mortality parameters, *Nibea maculata*, Sciaenids

**Introduction**

Growth and mortality parameters are the basic population parameters to assess the stock in the aquatic system which helps to formulate effective management strategies for the valuable fishery resources. Thoothukudi is one of the most potential fishing areas along Tamil Nadu coast. It covers 163.5 km in the Gulf of Mannar Marine Biosphere. Ramanathapuram and Thoothukudi districts contribute to the major sciaenid fishery in the Gulf of Mannar. Sciaenid fishes are commonly known as croakers, grun ters, drum fishes and jew fishes. Trawl nets are the dominant fishing gears in the Thoothukudi region. Among the demersal fishery resources, sciaenids form an important group caught in bottom trawl net. *Nibea maculata* (92%) followed by *Otolithes ruber* (7.9%) are the dominant species constituting the sciaenid fishery at Thoothukudi (Mohanraj et al., 2003). Though the growth and mortality parameters of several sciaenid species have been studied by many authors from different regions of India (Manojkumar et al., 1992; Chakraborty, 1993, 1996, 2001; Chakraborty et al., 1994, 2005; Kamat and Devaraj, 1995; Murty and Ramalingam, 1986, 1996; Manojkumar, 2005; Mohanraj et al., 2005), studies on population parameters from Tamil Nadu coast, particularly, from the Gulf of Mannar region are limited. Hence, the present study was undertaken with the objective of estimating the growth and mortality parameters of *N. maculata* exploited off Thoothukudi coast.

**Materials and methods**

The study was carried out for a period of 12 months from July 2006 to June 2007. Length frequency data were collected six times in a month for *N. maculata* to estimate the age, growth and mortality parameters. A total of 2,246 specimens of *N. maculata* were collected mainly from mechanised fish landing centers along Thoothukudi coast during the 12 months study period. Age and growth were assessed using the FiSAT computer software (Gayanilo et al., 1996). The length frequency data were subjected to model progression analysis by splitting the modes using Bhattacharya’s analysis followed by linking of means. The $K$ value was estimated using $K$ scan.

As the data were collected for one year, general von Bertalanffy’s growth equation was used to fit growth curves. The equation is as follows,

$$L_t = L_\infty \times \left[1 - \exp \left( -K(t - t_0) \right) \right]$$

Pauly and Munro’s (1984) growth performance index ($\phi'$) was computed (phi-prime $\phi' = \log K + 2 \log L_\infty$) using $K$ and $L_\infty$ for comparison with previous studies. The $t_0$ value was calculated using the formula (Pauly, 1980a)

$$\log (-t_0) = -0.3922 - 0.2752 \log L_\infty - 1.038 \log K$$

The total instantaneous mortality rate ($Z$) was estimated by length converted catch curve method using FiSAT. The natural mortality ($M$) was estimated by Pauly’s (1980b) equation considering the mean annual habitat
temperature (27 °C), L∞ and K for N. maculata. The co-efficient of fishing mortality (F) was derived using the relationship Z = F + M. The exploitation rate (E) was obtained by dividing F by Z (Gulland, 1971).

Results

The analysis of catch composition on sciaenid fishery revealed that Nibea maculata was available throughout the year at Thoothukudi coast. The length composition and length frequency data collected are presented in Fig. 1. The minimum size recorded was 10 cm weighing approximately 10 g, while maximum size was 25.8 cm (240 g). Small sized fishes were more abundant in the month of October, November and January to March (Fig. 1) whereas, the adult specimens dominated in the fishery during the remaining months.

Growth characteristics

Progression of modes of monthly length frequency of N. maculata obtained using Bhattacharya’s method and linking of means and growth curves are given in Fig. 2 and 3 respectively. Nibea maculata attains a length of 11.1 cm, 17 cm and 21.2 cm at 0.6, 1.2 and 1.8 years respectively and the maximum life span was found to be around 3.7 years (Fig. 4). The potential longevity (tmax) estimated by Pauly’s equation (Pauly, 1984) (3/K) was estimated as 3.70.

Fig. 1. Length frequency distribution and seasonal occurrence of Nibea maculata (July 2006 - June 2007)

Fig. 2. Progression of modes of various cohorts of Nibea maculata

The estimated growth parameters of N. maculata are shown in Table 1. The asymptotic length (L∞) of N. maculata was estimated as 26.78 cm and growth co-efficient (K) was 0.81 using Munro’s growth curve (Fig. 3). The estimated ‘t0’ value of N. maculata was -0.20. The von Bertalanffy’s equation is thus derived as L(t) = 26.78*[1 - exp (-0.81 [t – (-0.20)])] for N. maculata.

Fig. 3. Growth curve of Nibea maculata

Table 1. Growth parameters of N. maculata from Thoothukudi coast

<table>
<thead>
<tr>
<th>Asymptotic length (L∞)</th>
<th>Growth co-efficient (K)</th>
<th>Initial growth (t0)</th>
<th>Phi prime (φ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.78 cm</td>
<td>0.81</td>
<td>-0.20</td>
<td>2.76</td>
</tr>
</tbody>
</table>

Fig. 4. von Bertalanffy's growth function plot of Nibea maculata

Mortality parameters

The estimated ‘Z’ value of N. maculata by length converted catch curve method was 2.73 (Fig. 5) and the natural mortality (M) estimated through Pauly’s empirical formula using mean annual temperature of 27 °C is 1.67. The fishing mortality co-efficient (F) of N. maculata was calculated as 1.06 and the estimated exploitation ratio of N. maculata was 0.39. The factor explaining the relationship between natural mortality co-efficient and growth co-efficient (M/K) of N. maculata was 2.06.

Discussion

Growth characteristics

The estimated growth parameters of L∞, K and t0 for N. maculata in the present investigation were 26.78 cm,
0.81 and -0.20. Mohanraj et al. (2003) reported the $L_\infty$ and $K$ values as 31.4 cm, 0.72 of *N. maculata* in Thoothukudi waters using Munro’s Plot. The length based growth performance index (phi-prime $\phi' = \log K + 2 \log L_\infty$) of *N. maculata* was estimated as 2.76 during the present investigation which is generally comparable for a species, family or similar taxonomical group in this region (Mohanraj et al., 2003). The present observation deviates from the earlier observation of Chakraborty (2001) who recorded phi – prime values of 6.13 to 6.87, relatively elevated values, for the sciaenid species like *Johnius macrorhynus*, *Johnius vogleri*, *Johnius sina*, *Johnius dussumieri*, *Otolithes cuvieri* and *Pennahia macrophthalmus* in Bombay waters.

In the present study, based on length based approach, the life span of *N. maculata* was estimated as 3.7 years. Murty and Ramalingam (1996) reported almost similar values (4.02 years) as life span of *N. maculata* and it is evident that *N. maculata* is a short lived demersal fish species.

**Recruitment pattern**

During the study period, the analysis of length frequency data revealed that *N. maculata* showed a continuous recruitment pattern throughout the year with a single peak in December and higher percentage of recruitment (>10%) was noticed in December, January and February. This is in accordance with Mohanraj et al. (2003), who reported that the majority of sciaenid species spawned during the monsoon and post-monsoon months. Jayasankar (1989) observed that *N. maculata* spawn during the period extending from April to August in Mandapam waters.

**M/K value**

Beverton and Holt (1959) stated that the M/K value normally found to be ranging from 1.12 to 2.5 which explains the relationship between natural mortality co-efficient and physiological factor ‘M/K’. In the present investigation, it was found to be 2.0557 in *N. maculata*. Chakraborty (2001) also obtained similar values ranging between 1.81 and 2.18 for six sciaenid species of Bombay coasts. Murty and Ramalingam (1996) observed K value of 0.61 in *N. maculata* which was found to be lower than the value (0.810) recorded in the present study indicating *N. maculata* of Thoothukudi stock is having faster growth when compared to that of the Kakinada stock.

**Mortality parameters**

In the present study, fishing mortality (1.06) of *N. maculata* was found to be lower when compared to the natural mortality (1.67) which indicates that these fishes are relatively under-exploited in this region. Hence, the fishing effort could be increased to increase the yield of this group without depletion of the stock. The estimated ‘Z’ value of *N. maculata* was 2.73 in Thoothukudi region and almost similar ‘Z’ value (2.93) was estimated by Murty and Ramalingam (1996) in Kakinada coast. Chakraborty et al. (1992) assessed the ‘Z’ values of sciaenid species other than *N. maculata* such as *O. cuvieri* (1.20), *J. vogleri* (3.20), *J. sina* (6.56), *J. macrorhynus* (4.10) and *P. macrophthalmus* (2.00) in Mumbai waters.

From the results, it is evident that, the growth and mortality parameters of *N. maculata* are almost similar with other sciaenid species of India. The estimated natural mortality (1.67) of this species is relatively higher than the fishing mortality (1.06), indicating there is a possibility of increasing the fishing effort to capture these group. The exploitation rate measures if a stock is over fished or not, on the assumption that optimal value $E (E_{opt})$ is equal to 0.5. The use of $E$ value of 0.5 as optimal value for the exploitation rate is based on the hypothesis that the sustainable yield is optimized when $F = M$ (Gulland, 1971). The present study indicates that *N. maculata* with an exploitation rate of 0.39 which is lower than the optimal value for sustainable yield, is under-exploited in this region.

**Acknowledgements**

The authors are extremely thankful to the Dean, Fisheries College and Research Institute, Thoothukudi, for the facilities provided and for his encouragement during the period of study.

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Date of Receipt : 14.12.2010
Date of Acceptance : 15.12.2011