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## Growth and mortality characteristics of *Otolithes ruber* (Schneider, 1801) exploited off Thoothukudi Coast, Tamil Nadu

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### Abstract

A detailed analysis was undertaken to study the growth and mortality characteristics of the *Otolithes ruber* in Thoothukudi coast from July 2006 to June 2007. The growth parameters  $L_{\infty}$ , K and  $t_0$  were estimated as 37.28 cm, 0.27 and -0.58 respectively. The K value of *O. ruber* was relatively low which inferring slow growth rate of this tropical demersal fish species. The estimated total instantaneous mortality co-efficient (Z) of *O. ruber* was 2.45 and the fishing mortality co-efficient (F) was 1.74. The species are slightly over exploited in this region.

**Keywords:** Growth, mortality, *Otolithes ruber*, Sciaenids, Thoothukudi

### Introduction

Growth and mortality parameters are vital population dynamic tools to assess the stock in the aquatic ecosystem and it helps to formulate effective management measures to sustainably harvest the resource. Thoothukudi is one of the potential areas in Tamil Nadu coast and it covers the coastal length of 163.5 km in the Gulf of Mannar Marine biosphere. Ramanathapuram and Thoothukudi contribute major catches in the Gulf of Mannar region. In Thoothukudi, trawl nets are the most dominant fishing gear used to catch the demersal and pelagic fishes. Among the demersal fishery, sciaenid species are the most important group of fishes caught in bottom trawl net. *Otolithes ruber* contributes dominant catch among the sciaenid fishery next to *Nibea maculata* in Thoothukudi coast [1]. Though the growth and mortality parameters of several sciaenid species have been studied by many authors from different regions of India [2,3,4,5,6,7,8,9,10,11,12,13,14,15], studies on population parameters from Tamil Nadu coast, particularly, from the Gulf of Mannar region are limited. Hence, the present study was undertaken to estimate the growth and mortality parameters of *O. ruber* exploited in 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 of *O. ruber* were collected six times in a month to estimate the age, growth and mortality parameters. A total of 1,587 specimens of *O. ruber* were collected from the mechanised trawlers in Thoothukudi coast. Fishing grounds and study area of *O. ruber* in Thoothukudi coast is shown in Fig. 1.

Age and growth of *O. ruber* was assessed using the FiSAT computer software [16]. The length frequency data were subjected to a modal progression analysis by splitting the modes using Bhattacharya's analysis followed by linking of means. The K value was estimated using K scan. ELEFAN I module in FiSAT II software [17] was used to estimate the growth by using the following von Bertalanffy's growth equation [18]. The equation is as follows,

$$L_t = L_{\infty} * [1 - \exp^{-K*(t-t_0)}]$$

Growth performance index ( $\phi'$ ) or phi-prime and  $t_0$  value were computed based on the calculated K and  $L_{\infty}$  values obtained from the growth equation. The equation used to calculate phi-prime [19] is as follows,

$$\phi' = \log K + 2 \log L_{\infty}$$

The  $t_0$  value [20] was calculated using the following formula

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

The total instantaneous mortality rate (Z) was estimated by length converted catch curve method using FiSAT. The natural mortality (M) of *O. ruber* was estimated using the Pauly's [21] equation by considering the mean annual habitat temperature (27° C),  $L_{\infty}$  and K values. The co-efficient of fishing mortality (F) was derived by using the relationship  $Z = F + M$  and the exploitation rate (E) was obtained by applying the formula  $E = F / Z$  [22].

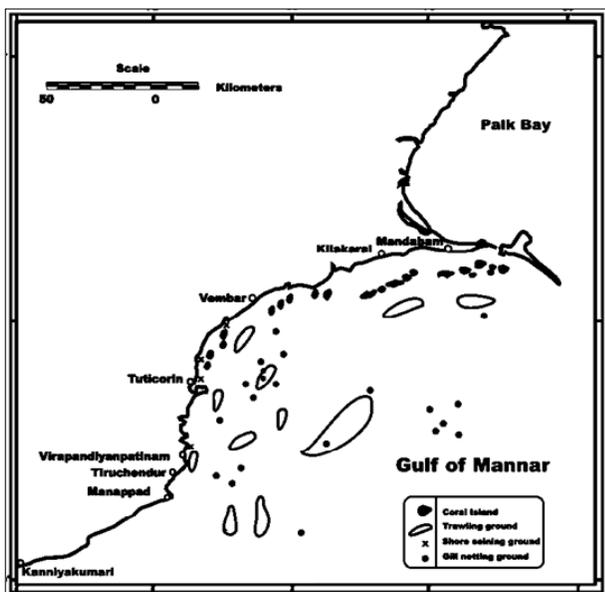


Fig 1: Fishing grounds and study area of Thoothukudi coast

**Results:**

The present study of catch composition of *O. ruber* revealed that this sciaenid species were available throughout the year at Thoothukudi coast. The length composition and length frequency data collected are presented in Fig. 2. The smallest size of *O. ruber* recorded was 11.2cm weighing approximately 20 g while largest size was 42.5 cm (850 g). The length group of *O. ruber* ranged from 16.5 cm to 30 cm constituted the major trawl net sciaenid fishery. Small sized fishes of *O. ruber* represented the dominant catch in the month of September, October and March to June. Throughout study period, adult specimens of *O. ruber* were dominated the catch and it was peak during June to December (Fig. 2).

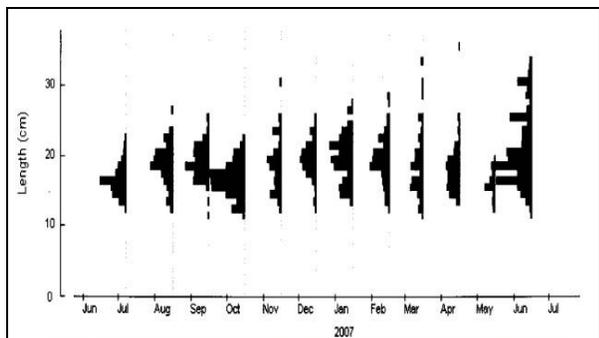


Fig 2: Length frequency distribution and seasonal occurrence of *O. ruber* (July 2006-June 2007)

**Growth characteristics**

Progression of modes of monthly length frequency of various size groups of *O. ruber* obtained using Bhattacharya's method and linking of means and growth curves are represented in Fig. 3.

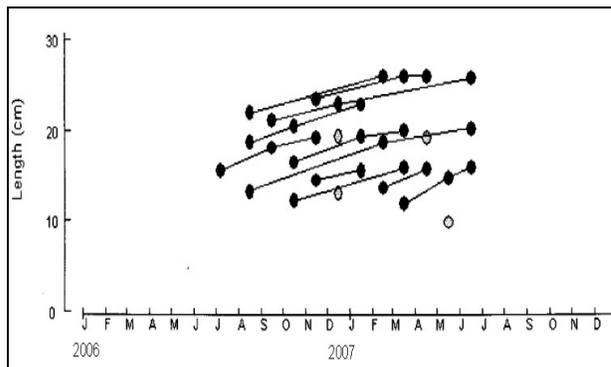


Fig 3: Progression of modes of various cohorts of *O. ruber*.

*Otolithes ruber* attained a relative growth of 11 cm, 17 cm and 21.2 cm at 1.1, 2.2 and 3.3 years respectively and the maximum life span was found to be about 11 years (Fig.4). The potential longevity ( $t_{max}$ ) as estimated by Pauly's equation (Pauly, 1984) ( $3/K$ ) was estimated as 11.11.

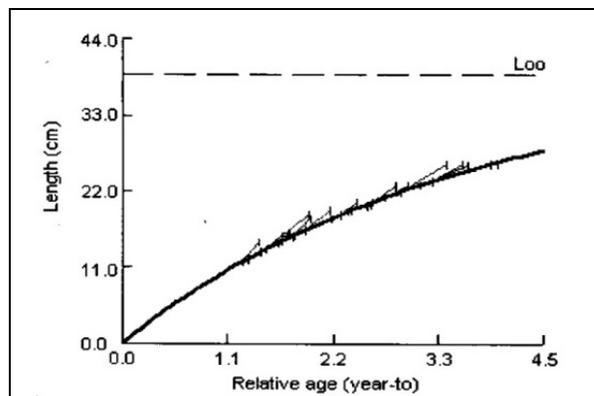


Fig 4: Growth curve of *O. ruber*

The estimated growth parameters of *O. ruber* are shown in Table 1. The asymptotic length ( $L_{\infty}$ ) of *O. ruber* was estimated as 37.28 cm and growth co-efficient (K) was 0.27 using Munro's growth curve. The estimated ' $t_0$ ' value of *O. ruber* was - 0.58. There was no growth oscillation in *O. ruber* and the growth variation was negligible due to the environmental factors. The length base index of growth performance ( $\phi'$  - phi prime) of *O. ruber* was 2.57 (Table 1).

Table 1: Growth parameters of *O. ruber* in Thoothukudi coast

| Asymptotic length ( $L_{\infty}$ ) | Growth Co-efficient (K) | M/K  | Initial Growth ( $t_0$ ) | Phi-prime value ( $\phi'$ ) |
|------------------------------------|-------------------------|------|--------------------------|-----------------------------|
| 37.28 cm                           | 0.27                    | 2.64 | -0.58                    | 2.57                        |

The factor explaining the relationship between natural mortality coefficient and physical factor (M/K) of *O. ruber* was 2.64. The generalized von Bertalanffy's growth equation of *O. ruber* is thus derived as  $L(t) = 32.78 * [1 - \exp \{-0.27 * [t + 0.58]\}]$

### Mortality parameters

The estimated total instantaneous mortality ( $Z$ ) value of *O. ruber* using length converted catch curve method was 2.450. The natural mortality ( $M$ ) of *O. ruber* estimated through Pauly's empirical formula using an annual mean temperature of 27 °C was 0.71. The fishing mortality co-efficient ( $F$ ) of *O. ruber* was thus calculated as 1.74 and the estimated exploitation ratio of *O. ruber* was 0.71.

### M/K value

The factor explaining the relationship between natural mortality co-efficient and growth co-efficient ( $M/K$ ) of *O. ruber* was 2.64.

### Discussion

Sciaenid fishes are mainly caught by trawl net followed by shore seines and gill nets in Thoothukudi region. *N. maculata* and *O. ruber* were locally known as *Vari* or *Pulli kthalai* and *Panna* respectively in Thoothukudi region. *Nibea maculata* (92 %) and *Otolithes ruber* (7.9 %) were the dominant species constituting the sciaenid fishery along the Thoothukudi coast [1].

### Growth characteristics

The estimated growth parameters of  $L_{\infty}$ ,  $K$ ,  $t_0$  for *O. ruber* in the present study were 37.28 cm, 0.27 and -0.58 respectively.  $L_{\infty}$  and  $K$  of *O. ruber* values were estimated as 46.9 cm and 0.47 in Thoothukudi waters using Munro's Plot [1]. The 'K' value was indicator of physiological activity and which was found to be less in *O. ruber* and thus an inverse relationship was evident between " $L_{\infty}$ " and 'K'. The length base index of growth performance ( $\phi'$ ) =  $\log K + 2 \log L_{\infty}$  of *O. ruber* was estimated as 2.57 which is generally comparable for a species, family or similar taxonomic group in this region and the value estimated for *O. ruber* in Thoothukudi [1]. The similar value of  $\phi'$  was observed for the same species in Kuwait waters which ranges between 3.06 – 3.14 [23]. The present study slightly deviates from the earlier observation of  $\phi'$  – prime values which ranged from 6.13 to 6.87 and these values were relatively higher for the sciaenid species like *Johnius macrorhynchus*, *Johnius vogleri*, *Johnius sina*, *Johnius dussumieri*, *Otolithes cuvieri* and *Pennahia macrophthalmus* in Bombay waters [5].

In the present study, based on length based approach, the life span of *O. ruber* was estimated as 11 years. The similar finding (10 years) of life span for *O. ruber* was reported in the Konkan coast [24] and in the African waters the same was estimated using the otolith sagitta as 8 years [25]. From these information, it is evident that *O. ruber* is a long lived demersal fish species.

### Recruitment pattern

During the study period, the analysis of length frequency data revealed that *O. ruber* showed a continuous recruitment pattern throughout the year with two peaks. One major peak falls during January and February and the minor peak in the month of November. This suggested that the major recruitment season for *O. ruber* was in the winter season and minor recruitment during Northeast monsoon seasons. This is in agreement with earlier study which indicated that the majority of sciaenid species spawned during the monsoon and post monsoon months [1]. The *O. ruber* spawns only once a year during July to October in Bombay Coast [27] and the observed spawning season was deviated from the present study.

### M/K value

The M/K value normally found to be ranging from 1.12 to 2.5 which explained the relationship between natural mortality co-efficient and physiological factor M/K [26]. In the present investigation, the estimated M/K value of *O. ruber* was 2.64 which indicated that the fast metabolic rate correlated with fast growth rate of this species. The M/K value for various species of sciaenids like *Pennahia macrophthalmus*, *Nibea maculata*, *Otolithes ruber*, *O. cuvieri*, *Johnius carutta*, *J. glaucus*, *J. macrorhynchus*, *J. aneus*, *J. sina*, *Kathala axillaris* in East and West coast of India ranges from 1.84 to 2.21 [7], present study shows the similar values. The similar values ranging from 1.81 to 2.18 were obtained for six sciaenid species in Bombay coasts [5]. The K value of 0.47 in *O. ruber* which was found to be the same value (0.47) recorded in the present study indicating *O. ruber* of Thoothukudi stock is having same growth rate and there was no growth rate difference when compared with the earlier studies [7].

### Mortality parameters

In the present study, fishing mortality (1.74) of *O. ruber* was found to be higher when compared to the natural mortality (0.71) which indicates that these fishes are relatively over exploited in this region. Hence, the fishing effort should be decreased to get the optimum catch of *O. ruber* without depletion of the stock in future. The estimated 'Z' value of *O. ruber* was 2.45 in Thoothukudi region. The Z value of the present study was slightly higher (3.53) in Thoothukudi region when compared with early study [7] and the same was 5.05 in Madras and 2.70 in Cochin regions for the same species. The 'Z' values of sciaenid species other than *O. ruber* such as *O. cuvieri* (1.20), *J. vogleri* (3.20), *J. sina* (6.56), *J. macrorhynchus* (4.10) and *P. macrophthalmus* (2.00) were estimated in Maharashtra coast [27].

From the present study, it is evident that, the growth and mortality parameters of *O. ruber* are almost similar with other sciaenid species of India. The estimated natural mortality (0.71) of this species is relatively lower than the fishing mortality (1.74), indicating that these fishes are over exploited in Thoothukudi region and the fishing effort could be decreased to achieve the optimum exploitation of these species. The exploitation rate decides the over or less exploitation of stock, on the assumption that optimal value E (Eopt) is equal to 0.5. The use of E value of 0.5 as the optimal value for the exploitation rate is based on the hypothesis that the sustainable yield is optimized when  $F = M$  [22]. The present study indicates that *O. ruber* with an exploitation rate of 0.71 which is slightly higher than the optimal value for sustainable yield and it can be concluded that these species is over exploited in this region.

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