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Research Note

Growth and Exploitation Level of Black Pomfret, *Parastromateus niger* (Bloch, 1795) off West Bengal Coast

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Introduction

Pomfrets form one of the commercially important fishery all along the Indian coast due to their soaring market price and good foreign exchange value. The black pomfret *Parastromateus niger* (Bloch, 1795) under the family carangidae with a trophic level of 3.0 forms an important fishery in the Indo-West Pacific region (Froese & Pauly, 2011). It is often associated with reef habitats but also found in brackish and marine waters. It contributes about 30 - 40% of the total pomfret production of West Bengal (Srinath & Pillai, 2006). It is harvested effectively by drift gill nets, trawls and dol nets operated by dugout canoes or plank built boats. An accurate estimation of population dynamics parameters is imperative to understand exploitation of fishery stocks and abundance (Seijo, 1986). The basic purpose of fish stock assessment is to provide advice on the optimum exploitation of aquatic living resources. In spite of the commercial and economic importance of the species, the research inputs on the aspects of its population dynamics and stock assessment in Indian waters are scanty (Khan et al., 1992) and no information is available from the coast of West Bengal. However, few studies have been carried out on the population dynamics of the species elsewhere (Herianti et al., 1986; Taghavi et al., 2005; Dadzie et al., 2007). The present study was therefore, envisaged to assess the growth, mortality and exploitation level of *P. niger* off the West Bengal coast of India.

The length-frequency data of *P. niger* was collected fortnightly from the commercial catches (caught by trawlers off West Bengal coast) at Sultanpur fish landing centre and Nagendra Bazar fish market at Diamond Harbour, South 24 Parganas, West Bengal, India from August 2007 to July 2008. A total of 702 specimens were collected. Total length of the specimens was measured to the nearest centimeter using meter scale. The total length ranged from 12.1 to 54.2 cm. The data from different trawlers were then pooled and subsequently grouped into the length classes of three cm interval.

The total length frequency distributions were analyzed using the LFDA (Length Frequency Data Analysis) version 5.0, a Microsoft package developed by MRAG Ltd. under Fisheries Management Science Program (FMSP) (Kirkwood et al., 2001) for establishing growth parameters of the non-seasonal version of the von Bertalanffy growth curve. The von Bertalanffy growth parameters (L_∞, K and t_o) (Von Bertalanffy, 1957) were estimated using the Hoenig seasonal Electronic Length Frequency Analysis (ELEFAN model) (Pauly, 1987). These VBGF parameters were used to fit the VBGF equation as

$$Lt = L_\infty [1 - e^{-K (t - to)}]$$

where, Lt = length (cm) of the fish at age 't', L_∞ = asymptotic length (cm) of the fish, K = catabolic growth co-efficient or curvature parameter (per year), t_o = age at zero length (years) and t = age (year) (Gulland, 1983).

The growth performances index (Φ) of *P. niger* population in terms of growth in length was computed using the index of Pauly & Munro (1984), as given below

$$\Phi = \log K + 2 \log L_\infty$$

where, K = catabolic growth co-efficient or curvature parameter (per year), L_∞ = asymptotic length (cm) of the fish.

The total mortality rate (Z) of *P. niger* was estimated using the Beverton and Holt's Z equation (Beverton & Holt, 1956), as given below.

$$Z = K \left(\frac{L_\infty - \bar{L_C}}{\bar{L_C} - L_C} \right)$$

where, L_C = length (cm) at which 50% of the fish entering the gear retained, $\bar{L_C}$ = average length (cm) of the entire catch for which all fish of L_C and longer are under full exploitation, L_∞ = asymptotic length (cm) of the fish and K = curvature parameter or catabolic growth co-efficient (per year).

The natural mortality rate (M) of *P. niger* was estimated using the concept suggested by Alagaraja (1984) by using the curvature parameter (K) and the longevity of years (t_{max}) as given below

$$M = - \ln 0.001 / t_{max} \quad \text{and} \quad t_{max} = 3/K$$

where, M = Natural mortality; K = catabolic co-efficient; t_{max} = longevity (years).

The fishing mortality rate (F) of *P. niger* was obtained by subtracting M from Z *viz*., F = Z – M

The exploitation ratio of *P. niger* was estimated (Beverton & Holt, 1957; Ricker, 1975) as E = F/Z

The growth parameters L_∞, K and t_0 values of *P. niger* were found to be 63.13 cm, 0.72 per year and - 0.78 years (Table 1) respectively. The computed growth curve of *P. niger* made with these parameters has been shown over the restructured length distribution of individual species in Fig. 2. The growth performance index (Φ) was calculated as 3.456. The mortality rates Z, M and F of *P. niger* were 2.48, 1.39 and 1.09 per year (Table 1) respectively. The exploitation ratio (E) was found to be 0.436 in the study area.

Growth has been one of the most intensively studied aspects of fish biology as it is a good indicator of the health of individuals and population (Sparre et al., 1989). The determination of fish age and growth is fundamental to fish stock assessment and management. The magnitude, dynamics and resilience of fish stocks pose great challenge to their assessment. The VBGF has been discussed and used

Table 1. Population parameters of *Parastromateus niger* along the coast of West Bengal, India (n = 702)

Parameter	Result
Asymptotic length (L_∞) in cm	63.13
Curvature parameter (K) per year	0.72
Initial condition factor (t_0)	-0.78
Growth performance index (Φ)	3.456
Length at first capture (Lc) in cm	34.26
Total mortality rate (Z per year)	2.48
Natural mortality rate (M per year)	1.39
Fishing mortality rate (F per year)	1.09
Exploitation level (E)	0.436

extensively to model fish growth from length frequency data (Pauly, 1987; Galucci et al., 1996; Sparre & Venema, 1998). This study used the VBGF implemented in LFDA (Kirkwood et al., 2001). The L_∞ reported from earlier studies for *P. niger* was in the range 36.1 SL (Herianti et al., 1986) in the East Java Sea and 65 cm TL (Dadzie et al., 2007) in the Arabian Sea. Khan et al. (1992) estimated the L_α values of *P. niger* along the Kerala coast as 56 cm SL and 55 cm SL along the Karnataka coast of India. Taghavi et al. (2005) reported the L_∞ value as 57 cm SL in Oman Sea. The L_∞ is the mean length that the fish would reach if they were to grow to a very old age (Ricker, 1975). As the maximum size recorded in the present study was 54.2 cm, the L_∞ value of 63.13 cm was found to be realistic. The curvature parameter or growth co-efficient (K) determines how fast the fish approaches to L_∞. In general, tropical fish have high K value than temperate regions. Dadzie et al. (2007) estimated the K value of 0.34 in more or less temperate region of Korean water. However, Khan et al. (1992) reported the K

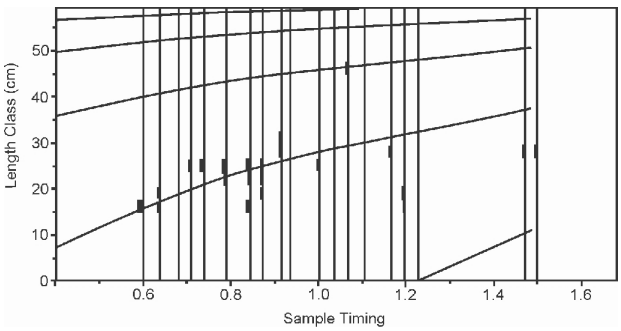

Fig. 1. Growth curve of *Parastromateus niger* along the coast of West Bengal, India

values of 0.73 and 0.69 in the south west coast of India. The initial condition parameter (t_o) is the age if the fish would have had zero length if they had always grown to the VBGF equation. The 't_o' value of *P. niger* reported from earlier workers varied from – 0.0023 years in Oman Sea (Taghavi et al., 2005) to – 0.497 years in the East Java sea (Herianti et al., 1986). The result obtained in the present study (- 0.780) was relatively lower than the earlier reports. Generally, the 't_o' has a positive, or usually, small negative factor (King, 1996). Furthermore, it has been observed that the juveniles with negative 't_o' values grow more quickly than the predicted growth curves of adults and with positive 't_0' values; juveniles grow more slowly (King, 1996).

The growth performance index (Φ) was explained by Pauly and Munro (1984) as the overall growth performance of fish population in terms of growth in length. For comparison of growth reported by various authors, growth performance index was used. In the present observation, the Φ value of *P. niger* was found to be 3.456, which was slightly higher than those reported by Taghavi et al. (2005) in the Baluchestan of Oman Sea (3.0) and Khan et al. (1992) along the Karnataka coast of India (3.35). This might be associated with differences in fishing intensity and environmental conditions that prevailed during the study.

Mortality (fishing and natural mortality) rates are important for understanding the rate of population decay (Beverton & Holt, 1957). The mortality rates Z, M and F of *P. niger* were 2.48, 1.39 and 1.09 per year respectively. Khan et al. (1992) recorded 'Z' as 4.2 and 6.8 per year for pomfret along the Kerala and Karnataka coasts of India respectively. Dadzie et al. (2007) estimated 'Z', M and F values for *P. niger* as 1.20, 0.68 and 0.52 per year respectively along the Kuwaiti water. Discrepencies in mortality rates could be attributed to several factors like variation in length of fish of the same cohort and gear selectivity which were however not accounted for in this study. The exploitation ratio (E) was found to be 0.436 in the present study area. According to Gulland (1971) the yield is optimized when F = M or when 'E' is equal to 0.5. Hence, the present exploitation level can be considered as optimum and should be maintained at the present level to have sustainable yield.

The study showed that the growth performance index (Φ/) was 3.456. The instantaneous rates of total mortality (Z), fishing mortality (F) and natural mortality (M) were found to be 2.48, 1.39 and 1.09 per year respectively. The exploitation ratio (E) of 0.436, indicated that the *P. niger* stock was optimally exploited in the study area and hence it can be said that the effort should be maintained at the present level to maintain sustainable yield.

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