

Estimatin of growth parameters and mortality rates of Psettodes (erumei in the Persian Gulf and Oman sea) Hormozgan province

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ABSTRACT: The growth parameters, mortality rates and exploitation population dynamic parameters and exploitation rate of *Psettodes erumei* were assessed between July 2010 to June 2011 using length frequency analysis. The data were collected from landing sites of Jask, Bandar Abass, Kong and Qeshm Hormozgan province waters. Using total weight (W) and total length (TL) data, the length- weight relationship of this fish species was described as $W=00037/L33652/$ pertaining to allometric growth. Asymptotic length (L_{∞}) = 74.55 cm, coefficient growth (k)= 0.23 year⁻¹, $t_0 = - 0.61$, longevity (t_{max})= 12.43 years and the growth performance index (Φ')= 3.10 were estimated through the ELEFAN I routine and other modules from the FISAT program. Total mortality (Z), natural mortality (M), and fishing mortality (F) were then calculated as 1.2 year⁻¹, 0.51 year⁻¹, 0.69 year⁻¹ respectively. Although, the estimated exploitation ratio (E= 0.57) was well fitted with the optimum level, careful examination of exploitation rate (U) revealed that the major part of the stock (> 48% length frequency) is being fished out of the defined optimum length. Consequently, the need to improve fishing methods seems mandatory in the future to ensure that total landings do not exceed 525 tons predicted maximum constant yield (MCY).

Keywords: Indian halibut (*Psettodes erumei*); growth parameters; mortality rates; Hormozgan, Persian Gulf; Oman Sea

INTRODUCTION

Psettodidae Known as a demersal fish family, living in the Persian Gulf and Oman Sea. In addition to domestic consumption, this demersal species has an export value as well. The main characteristic of *Psettodidae* family is their body shape so that both eyes are on the right side and rarely on the left side with a large mouth and the lower jaw is longer than the upper jaw. Their Color's is usually brown or grey, sometimes with broad, dark crossbars. Blind side colored white. (Blgvad and Lopentin, 1988).

The swimming behavior of the species with considering the movements of the body and caudal fin was reported as eel-shape. The species is found on sand and muddy bottoms to a depth of 25 meters (Kuitert and Tonzuka, 2001).

Indian halibut often swims in an upright position and nourish from carnivorous and mainly piscivorous (Ramamathan and Natarjan, 1980), and

it is a valuable fish in fisheries.

The fishing gears for these species are mainly Bottom trawl and Gill net (Hensley, 1997).

According to official statistics provided by the Iranian Fisheries Organization (IFO) the catch quantity of *Psettodes erumei* was reported as 2942/9 metric tons in the Persian Gulf and Oman Sea in 2010. (IFO fisheries statistics data center, 2011).

Based on research carried out on *Psettodes erumei* in other regions of the world, the maximum length of the species in china waters was 28/9 cm , Gulf of Thailand 48 cm ; Gulf of Aden 49 cm ; Indonesia 60 cm; Persian Gulf and Oman Sea 60 cm; West Coast of India 64 cm.

This study was intended to investigate length-weight relationship, growth and mortality rates of the *Psettodes erumei* in the Persian Gulf and Oman Sea (Hormozgan Province) to collect and improve the data needed for optimal fisheries management.

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MATERIALS AND METHODS

The study was conducted in different landing sites from east to west of the Oman Sea and Persian Gulf including Jask, Bandar Abbas, Kong, and Qeshm landing sites. Monthly samples, at least 100 *Psettodes erumei* were obtained from artisanal fishermen's captures (primarily caught with traps and gill net) for a period of 12 months (July 2010 to June 2011). Total Length (TL) and Total Weight (TW) of each fish were measured to the nearest millimeter and gram, respectively. The relationship between total length and total weight were adjusted by using the power equation:

$W = aL^b$ for each specimen, where W is weight in grams, TL is the total length (cm), 'a-value' is intercept and 'b' is the slope (King, 1995). Estimated length measurements were grouped into 3cm class intervals by applying the equation $K = 1 + 3/332 \log N$, where N is total observations (Biswass, 1993). The growth parameters of the von Bertalanffy growth function (VBGF) were then estimated from the monthly distribution of total length (TL) of *P. erumei*, using the ELEFAN I routine of the program FISAT. In order to do this, K-Scan routine was first conducted to assess a reliable estimate of the K value and Powell Wetherall's plot was made to estimate L_∞ . Then, the Shepherd's method was applied to calculate actual K value. Age of fish at zero length (t_0) was estimated in due order according to Pauly (1983):

$\text{Log}(-t_0) = -0.3922 - 0.2752 \text{Log } L_\infty - 1.830 \text{Log } K$
 Where L_∞ is the asymptotic length and K refers to the growth coefficient of the VBGF. These parameters including K, L_∞ , and t_0 were estimated according to VBGF: $L_t = L_\infty [1 - \exp(-K(t - t_0))]$.

The estimates of L_∞ and K were used to compute the growth performance index (Φ') of the species by the formula:

$$\Phi' = \log K + 2 \log L_\infty \text{ (Pauly and Munro, 1984)}$$

And longevity (t_{\max}) was estimated using the following equation:

$$t_{\max} = t_0 + 3/K \text{ (Pauly, 1983)}$$

Total mortality (Z) was estimated by the length-converted catch curve procedure of ELEFAN I

according to Pauly's (1983) formula:

$$\text{Ln} [f / dt] = a - Z.t$$

And natural mortality (M) was estimated by Pauly's (1980) empirical formula:

$$\text{Log}_{10} M = 0.0066 - 0.279 \text{Log}_{10} L_\infty + 0.6543 \text{Log}_{10} K + 0.4634 \text{Log}_{10} T$$

In which a mean annual surface temperature (T) of 26.5°C was used (Ebrahimi et al., 1996). The fishing mortality rate (F) was then calculated by the difference between (Z) and (M) from the equation;

$F = Z - M$ Sparre and Venema (1998) and the exploitation ratio (E) was calculated by the quotient between fishing and total mortality: $E = F/Z$ (Pauly, 1984)

The exploitation rate (U) for 2010 fishing year were then calculated and plotted by $U = F/Z (1 - e^{-z})$ according to Beverton and Holt (1957) and maximum constant yield (MCY) was achieved by the formula: $\text{MCY} = cY_{\text{av}}$ (Ministry of New Zealand Fisheries, 2002)

Where Y_{av} is the mean annual catch of several years (10 years in the current study) and C is a natural mortality dependant constant.

RESULTS AND DISCUSSION

The total length and weight of 1019 fish during one year survey ranged from 18.6 to 70.5 cm and 65 to 3558 g averaging at 39.2 cm and 968.49 g respectively. The calculated length-weight equation was $W = 0.0037L^{3.3652}$ (Fig. 1).

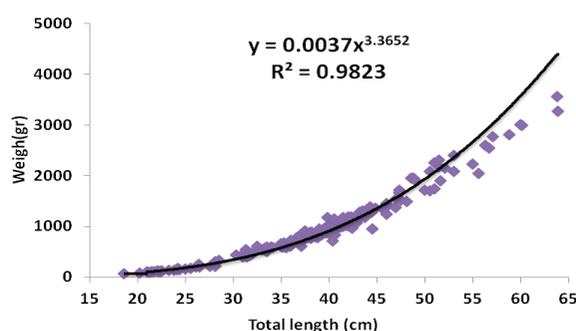


Fig. 1: Length-weight relationship of *Psettodes erumei* caught in the Hormozgan coastal waters 2010-11

The computed parameter (b) significantly differs from the proposed amount of 3 ($P < 0.05$).

When distributed in 3-cm classes, a nearly unimodal length frequencies distribution was obtained, with 33, 36, and 42 cm length classes dominating (Fig. 2).

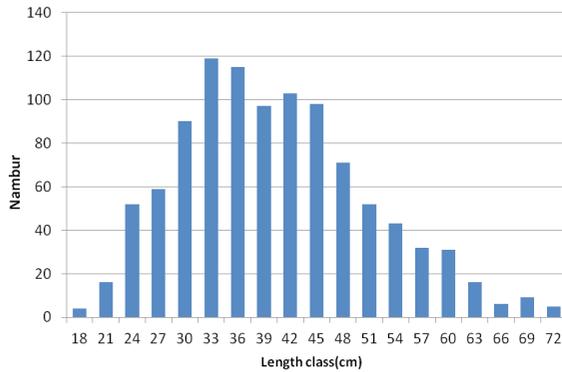


Fig. 2: Distribution of different length classes of *Psettodes erumei* caught in the Hormozgan coastal waters.

The best set of growth parameters obtained using ELEFAN I routine were $L_{\infty} = 74.55$ cm, $k = 0.23$ year⁻¹ and t_0 was adjusted at -0.61. Using estimated growth parameter, the VBGF for *Psettodes erumei* was plotted as $L_t = 74.55 [1 - \exp(-0.23(t + 0.61))]$ as presented in Fig. 3.

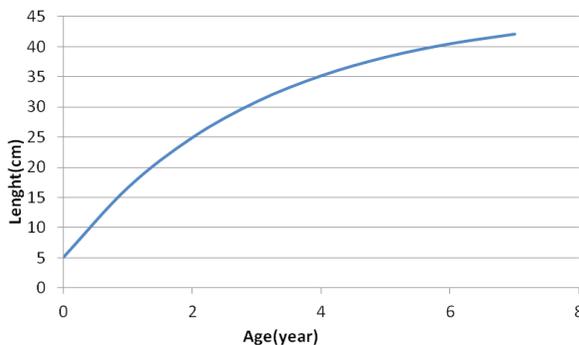


Fig. 3: The von Bertalanffy growth model for *Psettodes erumei*

The estimated values for t_{max} , Φ' , Z , E , M and F were 12.43 years, 3.10, 1.2, year⁻¹ (Fig. 4), 0.51 year⁻¹ and 0.69 year⁻¹, respectively.

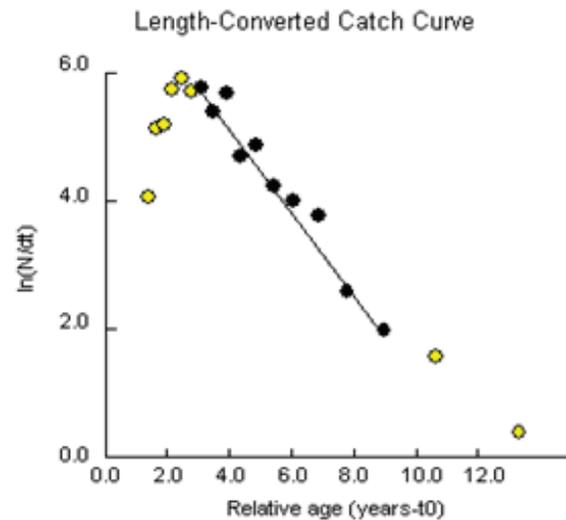


Fig. 4: Length converted catch curve for *Psettodes erumei*

The exploitation rate (U) as 0.57 showed that high percentages of annual landings include beyond-optimum size catch (>17% of length frequency and >48% of total weight frequency).

Considering $M = 0.51$ year⁻¹, the C value was taken at 0.6 (according to Predicted C values for different natural mortality rates, Ministry of New Zealand Fisheries (2002) and by multiplying this by average of 875 metric tons annual catch (10 years) in the area, maximum constant yield (MCY) for the species were predicted as 525 metric tons.

Table 1: Comparison of estimated 'a' and 'b' with previous studies

A	b	Sex	Length (cm)	Length type	Country /Locality	Reference
0.0120	3.011	Male	15.0-34.0	TL	Thailand/ Gulf of Thailand	(Kühlmorgan-Hille, 1976)
0.0110	3.100	unsexed			Yemen/ Gulf of Aden, 1983-87	(Edwards and Shafer, 1991)
0.0080	3.174	Female			Indonesia/ Tanjung Selatan, South Kalimantan	(Rusmadji and Nugroho, 1987)
0.0039	3.214	Female	9.4-49.1		India	(Das and Mishra, 1989)
0.0039	3.216	Male	9.5-41.0		India	(Das and Mishra, 1989)
0.0047	3.295	unsexed			Yemen	(Druzhinin and Petrova, 1980)
0.0042	3.367	Male			Indonesia	(Rusmadji and Nugroho, 1987)
0.0034	3.397	Female	13.0-43.0	TL	Thailand/ Gulf of Thailand	(Kühlmorgan-Hille, 1976)

CONCLUSION

Given the broad spectrum of fishing methods in the area, nearly all amplitudes of length frequency ranging from 18.6 to 70.5 cm TL were covered in the current study and 33 and 36 cm length classes constituted the maximum catches and the mean length of caught fish was estimated 39.2 cm. The calculated length–weight relationship ($W = 0.0037TL^{3.3652}$) fitted well ($R^2 = 0.98$) with a generally accepted power equation (Biswass, 1993). The estimated ‘b’ value by the non-linear regression analysis of the length-weight relationship was significantly different from the proposed value (3), which in turn revealed the allometric growth of the species in the studied area (King, 1995). However, previous studies were reported different ‘a’ and ‘b’ values for the same species in Yemen, India, Indonesia and etc... (Table 1), that might be due to the sampling or population errors since suggested amounts are out of proposed range (King, 1995).

Moreover, these values not only differ among different species but can also vary among local populations of the same species due to seasonal physicochemical fluctuations and physiological status of fish (Biswass, 1993). Beside length-weight relationship, knowledge on asymptotic length (L_{∞}) and coefficient growth (K) could help to achieve more details of population dynamics of fish species. Using ELEFAN I routine the L_{∞} and K were 74.55 and 0.23 year⁻¹ respectively which coincide well with the previous study ($L_{\infty} = 62.20$; $K = 0.38$) in Gulf of Aden in Yemen. The Von Bertalanffy growth function of *P. erumei* shows that these species grow very fast during first half of its life span and after that the fish grow slowly until reaching infinite length (Jennings *et al.*, 2002). Growth parameters can also be affected by physicochemical properties of water such as temperature Jones, (1981), pollution, stock density, and behavioral adjustments which can exhibit

spatial and temporal modifications (King, 1995). It has been demonstrated that an increase in water temperature could result in increase in K amounts and suppressed asymptotic length (Sparre and Venema, 1998). Estimated age at zero length (t_0) was similar to the previous study conducted in Thailand bay. With negative t_0 values, juveniles seem to grow more quickly than the predicted growth curve for adults (King, 1995). The t_0 value was considered by several researchers as a figurative parameter but its calculation was mandatory for successful establishment of VBGF (Sparre and Venema, 1998). The longevity ($t_{max} = 12.43$ years) of *P. erumei*, on the one hand, was slightly different from the previous estimations (8.6 years) given by Mathews and Samuel (1991) which may be due to different K and t_0 values between two sites (Gulland, 1991). On the other hand, comparison of Φ' values in the current study with that of Mathews and Samuel (1991) revealed that different populations of the same species show similar growth rates which can result in fixed consequent growth performance index (Sparre and Venema, 1998). Of mortality parameters, natural mortality (M) was recorded in higher in the southern parts of the Persian Gulf (Mathews and Samuel, 1991) that might be due to different environmental conditions and/or predation risks (Gulland, 1991). The estimated exploitation ratio of 0.57 showed that the fish was moderately exploited. Accordingly, it was found that more than 48.8% of the length frequency was being fished out of the defined optimum length range. This might be due to the usage of nets with different mesh sizes leading to dramatic changes in the fish stocks and consequent economical crashes of the fisherman in the future.

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