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Population parameters and length-weight relationship of deep flounder *(Pseudorhombus elevatus*) in northwest of Persian Gulf (Khuzestan coastal waters, Iran)

[1]S. A. R. Hashemi; [2]S. A. Taghavimotlagh ; [3]R. Ghorbani; [4]A. Hedayati

[1] Department of Fishery, Faculty of Fisheries and Environment, Gorgan University of Agricultural Science and Natural Resources, Gorgan, Iran
[2] Fisheries Research Organization, Tehran, Iran
[3] Department of Fishery, Faculty of Fisheries and Environment, Gorgan University of Agricultural Science and Natural Resources, Gorgan, Iran
[4] Department of Fishery, Faculty of Fisheries and Environment, Gorgan University of Agricultural Science and Natural Resources, Gorgan, Iran

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ABSTRACT: During this study from December 2009 to November 2011, 363 Deep flounder fish were caught and their weight and length were measured. The caught fish included 18 males, 200 females and 155 immature fishes. The mean, maximum and minimum total lengths were 264 ± 57 (mean ± SD), 415 mm and 115 mm respectively. The mean, maximum, and minimum total weights for this species were 238 ± 150 g, 827 g and 14 g respectively. The calculated length-weight relationships were $W=0.000007FL^{3.09}$ (n=200, R^2= 0.96) for the female, $W=0.00002FL^{2.90}$ (n=18, R^2=0.94) for the male and $W=0.000009FL^{3.04}$ (n=363, R^2 =0.96) for total fish. With a verified calculated b as 3 Student t-test showed no significant difference between calculated b and 3 (P>0.05), demonstrating that the growth pattern is isometric. Population parameters calculated for total fish were L_∞= 42 (cm); K= 1 ($year^{-1}$); t_0= -0.14 and Φ'= 3.24. Based on the results, this species is classified as mediate vulnerable group fish.

Keywords: *Population parameters; P. elevatus; Persian Gulf*

INTRODUCTION

The Persian Gulf is a semi enclosed sea lying almost between the latitudes of 25^0-32^0 N and longitudes of 48^0-56^0 E. This water basin is a shallow continental shelf with a depth average of 35m increasing from Arvend estuary reaching to its maximum in strait of Hormuz. This locale is considered as one of the richest areas in fishery resources where large quantities of fish and shrimps are concentrated in different locations, particularly in the territorial waters of Iran (Hashemi *et al*., 2011).

The Deep flounder, *Pseudorhombus elevatus* (ogilby, 1912), is a member of the family Paralichthyidae and is widely distributed throughout the Indo-West Pacific, from the Red Sea and East Africa to Japan and New Caledonia (Fischer and Bianchi, 1984; Carpenter *et al*.,1997). Adults are found in shallow coastal waters and the diet of this species consists of bottom-living animals. Consequently it is exploited throughout its range with a variety of gears, including trawels (Fischer and Bianchi, 1984). This species has a gonochoristic reproductive mode and spawning occurs annually with one clear seasonal peak during April to June (Hashemi *et al*., 2011).

Overall purpose of fisheries science is to provide decision-makers with advice on the relative merits of alternative management. Demography rates are fundamental to fisheries stock assessment and estimated of potential yield (King, 2007). In tropical waters, lack of distinct seasonality has made such analyses more difficult (Spare and Venema, 1998).

Different aspects of biological parameters of Deep flounder have been studied in Persian Gulf by Bawazeer (1989) in Kuwait waters. However, no study, so far, has been made on this species biology in Khuzestan Coastal Waters (northwest of Persian Gulf). In this context, the aim of the present study was twofold: (i) to estimate its population parameters via length frequency methods, (ii) to determine the length-weight relationship of the population of this species in Khuzestan Coastal Waters (northwest of Persian Gulf). Results will

*Corresponding Author Email: *Seyedahmad83@yahoo.com*,
Tell: +989177055568

greatly contribute to elaborate management programs for this economically important fish species of the region under study.

MATERIALS AND METHODS

The main fishing areas of *P. elevatus* in the northwest of Persian Gulf are located in Liphe-Busafe and Bahrekan fishing area between 29° 44' to 07 'N and 48° 45' to 49° 50' (Fig. 1).

A total number of 469 *P. elevatus* were caught during 2009 to 2011 using bottom trawl and gill net. There were also some samples collected from recreational fishermen that were transferred in icebox to the laboratory. In the laboratory, fork length (±1.0 mm), sex, and weight (±0.001 g wet weight) were recorded for each fish. Parameters of the length weight relationship were obtained by fitting the power function $W = a \times FL^b$ to length and weight data where: W is the total wet weight, a is constant determined empirically and FL is the fork length (Biswas, 1993). In order to verify if calculated b was significantly different from 3, the Student t-test was employed (Zar, 1996).

The data were then pooled monthly from different landing sites and subsequently grouped into classes of three centimeter intervals. The data were analyzed using FiSAT II (FAO-ICLARM Stock Assessment Tools) as explained in detail by Gayanilo *et al.* (1996).

The growth was calculated by fitting the von ertalanffy growth function to length frequency data. The von Bertalanffy growth equation is defined as follows (Sparre and Venema, 1998): $L_t=L_\infty [(1\text{-}\exp (-K (t-t_0))]$, where L_t is length at time t, L_∞ the asymptotic length, K the growth coefficient and t_0 is the hypothetical time at which length is equal to zero. The t_0 value was estimated using the empirical equation (Pauly, 1979).

$\text{Log}_{10} (-t_0) = - 0.3922 - 0.2752 \text{ Log}_{10}L_\infty - 1.038 \text{ Log}_{10}K$

Fitting the best growth curve was based on the ELEFAN I programm (Pauly and David 1981), which allows fitting the curve through the maximum number of peaks of the length-frequency distribution. With the help of the best growth curve, growth constant (K) and asymptotic length ($L\infty$) were estimated.

The growth performance (Φ') of Deep flounder population in terms of length growth was computed using the index of Pauly and Munro (1984).

$\Phi' = \text{Log}_{10} K + 2 \text{ Log}_{10}L_\infty$

Statistical analyses were performed with SPSS 14 software package and a significance level of 0.05 was adopted.

RESULTS AND DISCUSSION

The caught fish included 18 males, 200 females and 155 immature fishes. The mean, maximum and minimum total lengths were 264 ± 57 (mean ± SD), 415 mm and 115 mm respectively. The mean, maximum, and minimum total weights for this species were 238 ± 150 g, 827 g and 14 g respectively (Table 1).

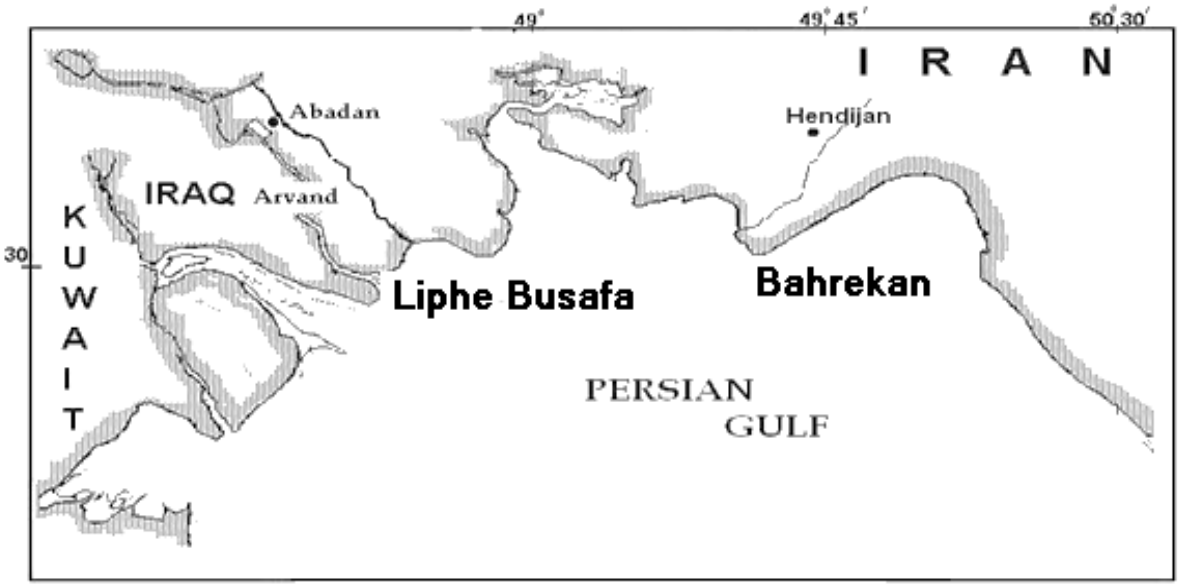

Fig. 1: Location of two landing sites of Deep flounder in Khuzestan Coastal Waters (Iran)

Length frequency distribution

The total length of 369 fish were 110 to 410 mm (Fig. 2), (2±mm). Maximum and minimum lengths of caught fish were in range of 250-270 and 390-410 mm respectively. Length frequency percentage groups of *P. elevatus* during April 2009 to March 2011 are presented in Fig. 2.

Length-weight relationship

The calculated length-weight relationships were $W=0.000007FL^{3.09}$ (n=200, R^2= 0.96) for the female, $W=0.00002FL^{2.90}$ (n=18, R^2=0.94) for the male and $W=0.000009FL^{3.04}$ (n=363, R^2 =0.96) for total fish.

With a verified calculated b as 3 Student t-test showed no significant difference between calculated b and 3 (P>0.05), demonstrating that the growth pattern is isometric. (Fig. 3).

Table 1: Average values (±S.D.) of size corresponding of Deep flounder in Khuzestan Coastal Waters (2009-11)

Month	N	Male	Female	Immature	MeanW ±S.D (g)	Min – max	MeanTL ±S.D (mm)	Min– max
January	44	-	30	13	183±135	41-518	245±54	165-370
February	26	5	18	3	224±133	73-507	260±41	198-335
March	46	7	30	9	201±132	42-827	256±41	171-396
April	25	3	20	2	338±141	112-629	306±40	225-380
May	23	1	14	8	315±169	128-581	300±54	222-375
July	63	-	50	13	287±135	110-693	285±39	205-375
August	35	-	5	30	96±60	14-785	180±63	115-415
September	9	-	5	4	250±88	162-378	272±26	245-312
October	31	-	25	6	310±151	77-532	293±56	190-380
November	27	-	9	18	237±86	93-345	273±31	210-305
December	33	-	23	10	208±128	85-479	258±44	202-342
Average	-	-	-	-	150±238	14-827	57±264	115-415

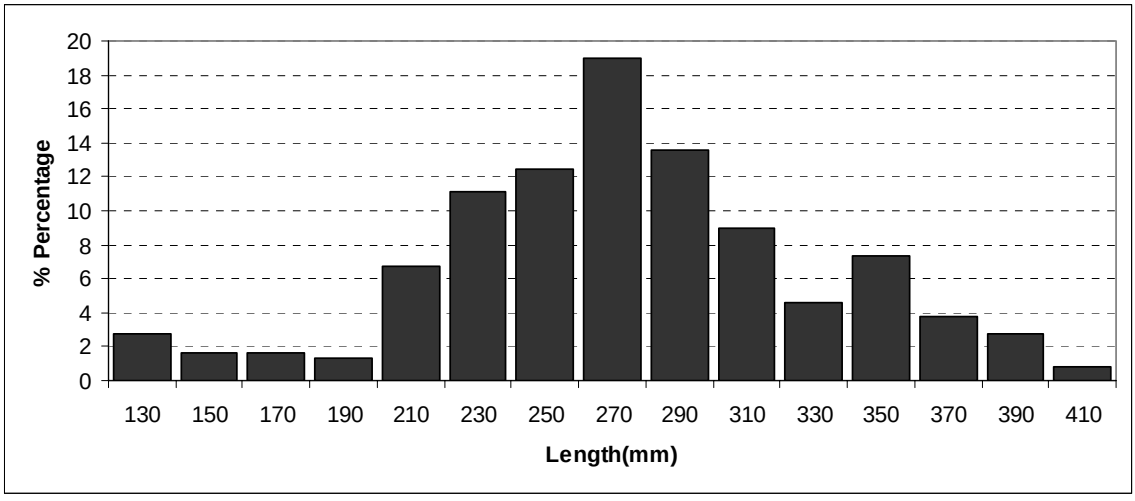

Fig. 2: Percentage frequency length of *P. elevatus* in Coastal Waters of Iran during 2009-11

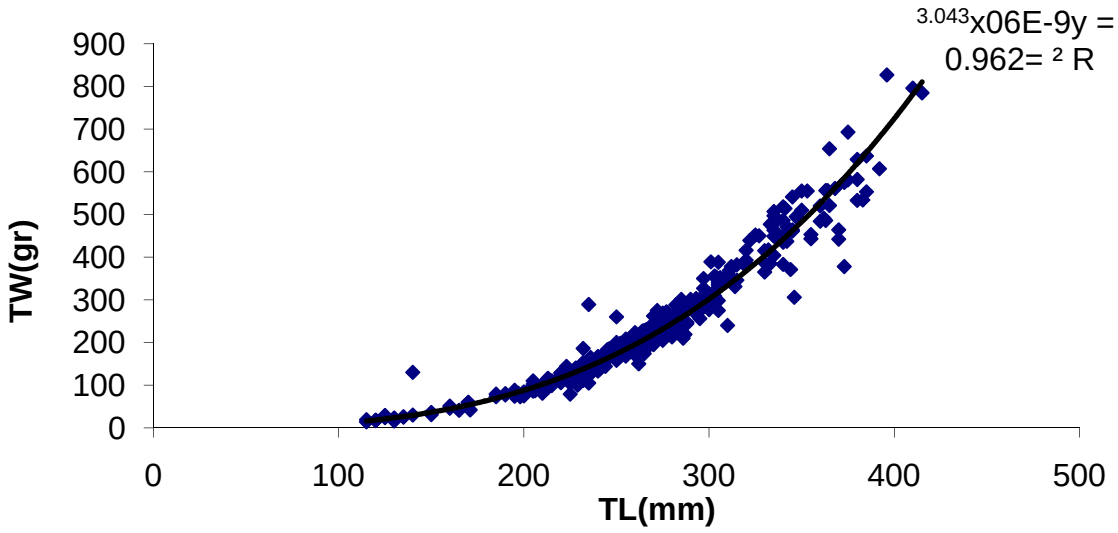

Fig. 3. The length-weight relationship curve for total fish of Deep flounder in Khuzestan Coastal Waters (Iran, 2009-11).

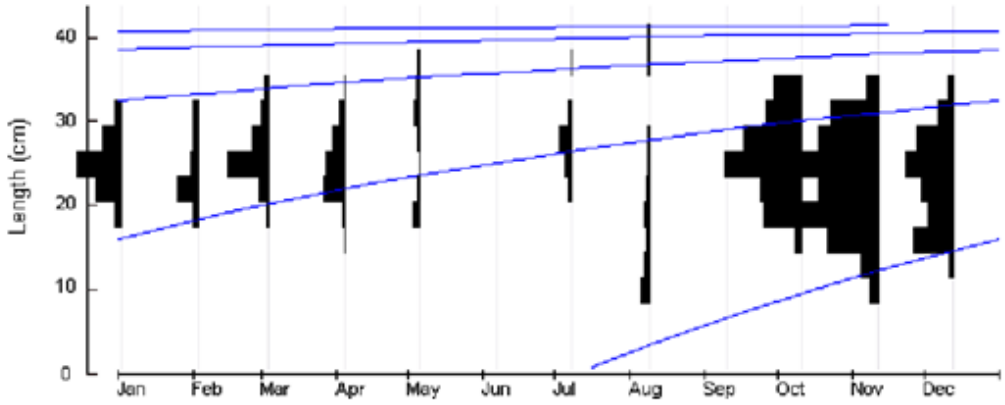

Fig. 4: Growth curve of *P. elevatus* from Iran by ELEFAN I superimposed on the restructured length-frequency diagram ($L\infty$ = 42 cm and K = 1 yr^{-1}).

Growth Studies

Growth parameters of von Bertalanffy growth formula for *P. elevatus* were as follows: $L\infty$ = 42cm and K = 1 yr^{-1} (Fig. 4). For these values obtained through ELEFAN I, the response surface (Rn) was 0.178. The growth curves are shown over its restructured length distribution in Fig. 3. The Φ' and t_0 were found to be 3.24 and -0.14 year respectively (Fig. 4). Based on the results, this species is classified as mediate vulnerable group fish.

CONCLUSION

The length-weight relationship in fish is of great importance in fishery assessments (Haimovic and Velasco, 2000). Length and weigh relationship in conjunction with age data can give information on the stock composite, age at maturity, life span, mortality, growth and production. The relative robustness or degree of well-being of a fish expressed as the coefficient of condition (condition factor) is an important tool for the study of fish biology, mainly when the species lies at the base of the higher food web (Diaz *et al*., 2000).

The b values in the weight-length model were measured to be close to 3 for *Penaeus indicus* indicating that weight increased isometrically with length (King, 2007). However, no study, so far, has been done on some of species length-weight relationships (*Pseudorhombus elevates*) in Khuzestan Coastal Waters (northwest of Persian Gulf).

Length–weight relationship is a practical index of the condition of fish, and may vary over the year according to several exogenous and endogenous factors such as food availability, feeding rate, health,

sex, gonad development, spawning period and preservation techniques (Bagenal, 1978; Tesch, 1968). According to Marthin (1994) the range of "b" could be from 2.5 to 4 and Tesch (1968) believed "b=3 in fish with isometric growth".

The values of L∞ and K were calculated as 42cm and 1 ($year^{-1}$). L∞ and K of Deep flounder were calculated in Kuwait waters for both male and female, which were 44 and 0.16, respectively (Bawazeer, 1989). These parameters for *Euryglossa orientalis* were reported to be 41.9 and 0.2 in Khuzestan (Mohamadi and Khodadadi, 2007) .

The difference between L∞ and K influenced by ecological characteristics, population size and gene frequency of species which is affected by their habitat and natural selection causes different adaptation patterns(Hashemi *et al*., 2011). L∞ and K values have reverse correlation, whilre with decreasing L∞, K value increases and vice versa (Sparre and Venema, 1998). Differences in growth rates between regions indicated a stock separation (Devaraj, 1981) which has, in some cases, supported a genetic difference (Begg and Sellin, 1998).

Φ' was reported to be 2.43 in researches made in Kuwait waters (Bawazeer, 1989). In general, the correlated parametric values adjust themselves to provide a similar growth pattern represented by Φ' (Sparre and Venema, 1998). Age at zero length (t_0) was as -0.14 year. With negative t_0 values, juveniles grew more quickly than the predicted growth curve for adults, and with positive t_0 values, juveniles grew more slowly (Sparre and Venema, 1998).

Regarding T_{max}= 3/k (King, 2007), the maximum age for this species was found to be 3 year. Absorbed energy is used for body maintenance, activity, reproduction and less than 1/3 for growth. In different species, growth ratio and life cycle is different (King, 2007). The results indicated that this species has a short life span.

According to biological characteristics and American Fisheries Society (AFS) indices (Chenung *et al*., 2005), Deep flounder is classified as mediate vulnerable group fish. Further stock assessment research is needed to obtain an adequate and comprehensive understanding of biology and ecology in this important order.

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