Growth parameters and mortality rates of *Liza klunzingeri* in the Iranian waters of the Persian Gulf and Oman Sea, using Length Frequency Data

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Abstract

The aim of the present study was to investigate the population dynamics of *Liza klunzingeri*, in Hormouzgan province waters located in northern coasts of the Persian Gulf and Oman Sea. This study was carried out from October 2007 to September 2008. samples were collected from commercial stake traps. The relationship between weight and fork length was found to be W= 0.0214 $F.L^{2.8233}$ suggesting that *Liza klunzingeri* shows isometric growth. Length-based stock assessment using the FiSAT software package showed an asymptotic length ($L\infty$) of 20.3cm FL and growth coefficient of $0.6.yr^{-1}$. These results gave a growth performance index (ø) of 2.39. The total mortality coefficient was estimated to be 2.31, a natural mortality of 1.09 and fishing mortality of 1.22. The estimated total mortality which, in relative terms, is considered average ($2.31.yr^{-1}$), coupled with the currently observed exploitation rate of 0.52 for *L. klunzingeri*, estimated from the mortality rates, suggested that the species is moderately exploited.

Keywords: Keeled mullet, *Liza klunzingeri*, Growth, Mortality, Iranian waters, Persian Gulf, Oman Sea

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Introduction

The dynamic mathematical models (e.g. Beverton & Holt, 1957, 1966), are useful for predicting future yields and aid in defining management strategies in fisheries.

Knowledge on growth and mortality of fish populations is an essential prerequisite for the derivation of these models. In tropical and sub-tropical waters, despite the difficulty in determining age of fish, the dynamic pool models have, unfortunately, been under-utilized for defining management strategies. However, with the development of the length-based stock assessment methodologies, it is possible to investigate population dynamics of fish stocks in tropical waters (Pauly, 1984; Pauly & Morgan, 1987).

The multispecies fishery in the Persian Gulf is dominated by many commericially important species including *Liza klunzingeri*, *Pampus argenteus*, *Acanthopagrus* spp., *Epinephelus tauvina*, *Formio niger*, *Tenualosa ilisha*, *Pomadasys kaanan*, *Otolithes argenteus*, *O. ruber* (Al-Husaini *et al*., 2001; Al-Husaini, 2002; Bishop, 2002,2003).

Despite their commercial importance, it is only recently that some of the species have been a subject of biological investigations: Reproduc-tion (Abou-Seedo & Al-Khatib, 1995; Dadzie *et al*., 1998, 2000a; Abou-Seedo *et al*., 2003; Abou-Seedo & Dadzie, 2004, 2008; Dadzie, 2007a; Dadzie & Abou-Seedo, 2008), community structure and fish assemblages (Abou-Seedo, 1992; Wright *et al*., 1996), food and feeding habits (Dadzie *et al*., 2000b; Dadzie, 2007b), length-weight relationships (Dadzie *et al*., 2000c; Abou-Seedo *et al*., 2002; Dadzie *et al*., 2008). From the above, only the studies by Abou-Seedo & Al-Khatib, 1995 and Abou-Seedo & Dadzie, 2004 targeted specifically *L. klunzingeri*.

There are few pioneering reports concerning population dynamics (Morgan, 1981,1982, 1985; Ali & Mahmood, 1993; Al-Husaini *et al*., 2001; Al-Husaini, 2002) ignored *L. klunzingeri*. It was against this background of information scarcity on the biology of *L. klunzingeri*, coupled with the need to provide much-needed scientific data for the management and rational exploita-tion of this valuable resource, that the present study was undertaken to evaluate the growth characteristics of this species in the Iranian waters, using FiSAT II on size composite data from 2007 to 2008. The objectives of this study were therefore to provide information pertaining to growth parameters, mortality rate of this species in the Iranian waters of the Persian Gulf and Oman Sea.

Materials and methods

In total, 1400 specimen were collected from landing sites (Jask, Kong and Salakh) of the Hormouzgan province waters of the Persian Gulf and Oman Sea (Fig. 1), using stake traps (Abou-Seedo, 1992). Fork lengths of all samples were recorded to the nearest 0.1cm. The length measurements were grouped into 1cm-length classes for the construction of monthly length distribution from October 2007 to September 2008. The data analyzed using the FAO ICLARM Stock Assessment Tools II (FiSAT II) (Gayanilo & Pauly, 1997). The entire 12 month data were

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merged by months and considered as a single file representing one theoretical year, and analyzed accordingly.

The relationship between fork length (FL) and total weight (TW) was estimated using linear regression analysis. To linearize the power curve ($W = aL^b$) that best described this relationship; both variables were transformed using natural logarimns. The line of best fit for the linear relationship as described by Pauly, 1983 by the formula, ln TW = lna + blnFL, was applied.

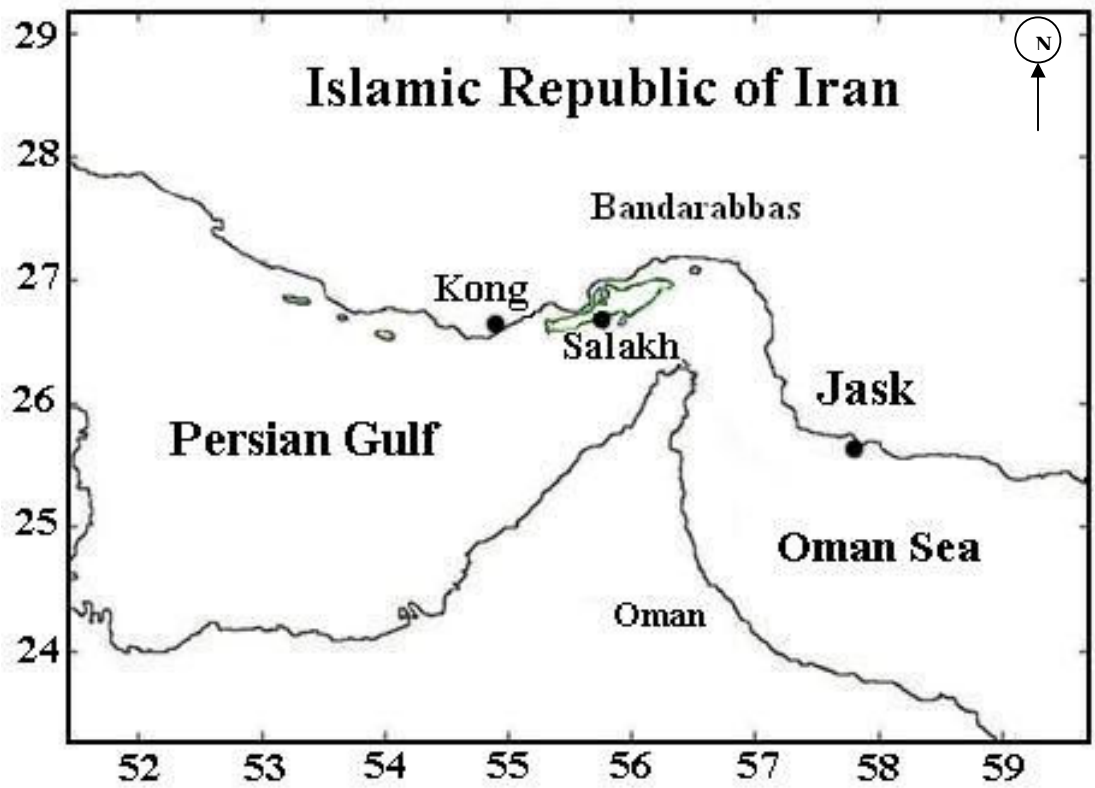

Figure 1: Map of Iranian waters, showing the sampling locality of *Liza klunzingeri*

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From the length-frequency distribution of the samples, ELEFAN 1 was used to obtain preliminary estimates of asymptotic length ($L\infty$) and growth constant (K) of the von Bertalanffy Growth Function (VBGF) following Gayanilo *et al*., 2002. Based on these preliminary estimates, a length-converted catch curve was constructed. Through the detailed analysis of the left (ascending) part of the length-converted catch curve, the mean selection curve of the fishing gear was estimated. New estimates of L_∞ and K were obtained using the FiSAT software from the analysis of the corrected length-frequency data. The best growth curve was then fitted on the basis of a non-parametric scoring from the goodness of a fit index, the so-called 'Rn value' (Gayanilo *et al*., 2002). t_0 was estimated by employing the equation of Pauly, 1980:

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

The seasonalzed catch-curve applied to the summed length-frequencies was of the form: $\ln(N) = a + b.t'$, where N is the number of fish in a given length-class, obtained as a pseudo-cohorts by "slicing" away the polynomial frequency distribution using successive growth curves, t' is the relative age of the fish in that pseudo-cohort, while b, with sign changed, provides an estimate of Z (Pauly, 1984a). For obtaining an independent estimate of the natural mortality (M), Pauly's equation (Pauly, 1980) was employed. The mean annual environmental temperature used in the estimation was 26.5ºC (reproduce with permission from Iran Environmental Organization).

Fishing mortality (F) was derived as the difference between Z and M. Following the estimations of Z, M and F, the routine was also used to obtain the exploitation rate (E) as F/Z.

Results

The length range for adult males was 100-160mm and for females, 92-183mm. The relationship between length and weight was shown in Fig. 2. Linear regression analysis of the length-weight data showed a relationship of $W = 0.0214\ F.L^{2.8233}$ with a regression coefficient $R^2=0.87$. The minimum, maximum and mean weights were 10.03, 73.62 and 36.4g (SD = 9.89), respectively.

The K-scan technique (Dadzie *et al*., 2005), indicated an $L\infty$ of 20.3cm FL and a K value of $0.60.yr^{-1}$ for the original dataset. These results gave a growth performance index (ø) of 2.39. From growth analysis of data corrected by incorporating the probabilities of capture, the K-scan technique did not indicate any important change. The estimates of $L\infty$ and K originating from the raw data were, therefore, considered for other analyses. The yearly growth curve is shown in Figure 3. The value of t_0 was taken as -0.52 and the growth performance index (ø) was 2.39. Total mortality coefficients from a length-converted catch curve indicated an annual estimate, for animals aged 1-5 years, of $2.31.yr^{-1}$ (Fig. 4). Natural mortality was $1.09.yr^{-1}$. The total fishing mortality was therefore $1.22.yr^{-1}$ and the estimated current exploitation rate was 0.52.

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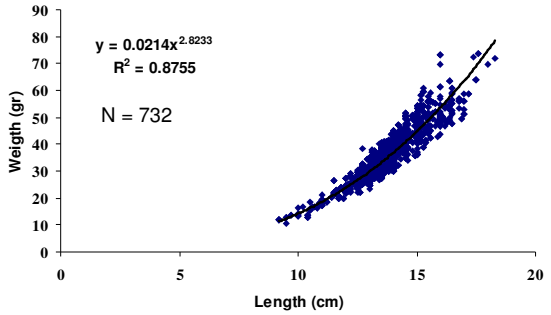

Figure 2: Length-weight relationship among *L. klunzingeri* in Iranian waters of the Persian Gulf and Oman Sea (2007-2008)

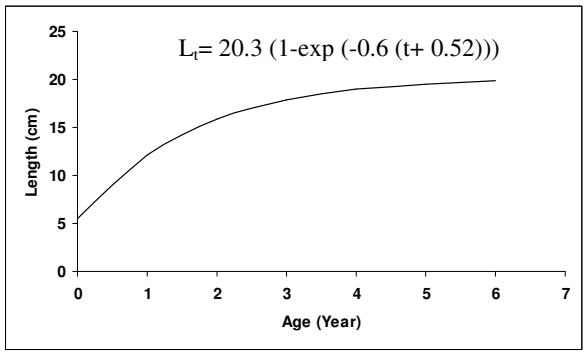

Figure 3: Growth curve of *L. klunzingeri* in Iranian waters of the Persian Gulf and Oman Sea (2007-2008)

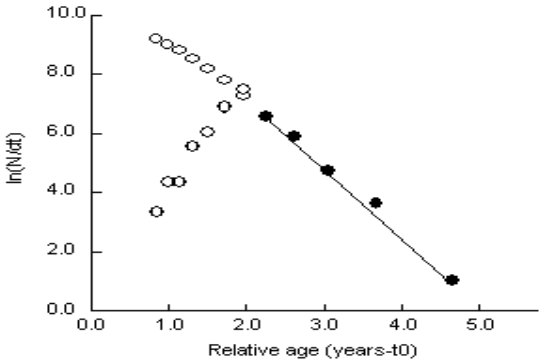

Figure 4: Length-converted catch curve for *Liza klunzingeri* in Iranian waters
Note: only black dots have been considered for computation of total mortality.

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Discussion

The keeled mullet, *Liza klunzingeri*, has been reported from various parts of the Indian Ocean, the Mediterranean Sea as well as coastal waters of Japan and China (Golani, 2002). It is reported that there are significant stock numbers in the waters of the Persian Gulf (Valinasab *et al*., 2006).

The maximum recorded length in the present study was 183mm, although lengths of 200mm and 150mm have been reported by Carpenter *et al*., 1997. Maximum lengths of 225mm for this species have been reported by Valinasab *et al*., 2006 in Khouzestan waters.

The length-weight relationship found in the present study was: $W= 0.0214\ F.L^{2.8233}$, indicating these animals exhibit isometric growth (King, 1995).

Uncertainties exist when using FiSAT for growth performance estimates; due to the fact that several combinations of $L\infty$ and K values might give the same value of Rn, keeping in mind that $L\infty$ and K are negatively correlated (Moreau *et al*., 1986; Pauly & Morgan, 1987). *Liza klunzingeri* is native to the Arabian Sea, Indian Ocean and the Persian Gulf (Randall, 1995). It is, therefore, a shared marine fish resource comprising several stocks. Unfortunately, there is scarcity of information on growth parameters of the species locally or regionally (Dadzie *et al*., 2005), and only a few reports are available on closely-related species (Morgan, 1981,1985; Al-Husaini, 2002). From comparative data on growth performance of *L. klunzingeri* with other teleosts from the other regions in the Persian Gulf (Table 1), the present results suggest that the species exhibits a lower growth performance than all species so far studied, and that the $L\infty$ of 20.3cm FL (equivalent to 22cm TL) is rather low.

Sparre & Venema, 1998 have suggested that correlated parametric values adjust themselves to provide a similar growth pattern represented by φ. Notably, the φ' values estimated for Iranian south coast stock were comparable to those for other stocks of *L. klunzingeri* in Kuwaiti waters, suggesting a similar growth pattern across different populations. Dadzie *et al*., 2005 have reported a growth performance index of 2.45 for *L. klunzingeri* in Kuwaiti waters.

The study found that the age at zero length (t_0) was -0.52 indicating that juveniles grow more quickly than the predicted growth curve for adults (King, 1995).

The total mortality coefficient of $2.31.yr^{-1}$ estimated for *L. klunzingeri* in this study is an average value when compared with a very high value of $4.61.yr^{-1}$ for the same species from Kuwait Bay, where the fish is over-exploited (Dadzie *et al*., 2005), and low values in other studies in the region: 1.499 to $1.618.yr^{-1}$ (Morgan, 1985), $1.20.yr^{-1}$ (Dadzie *et al*., 2007) and 0.24 to $0.36.yr^{-1}$ (Al-Husaini *et al*., 2001). The currently observed exploitation rate of 0.52 for *L. klunzingeri* in this study, estimated from the mortality rates, is low compared with corresponding values for this species in other regions of the Persian Gulf: 0.75 for *L. klunzingeri* (Dadzie *et al*., 2005) in the Kuwaiti waters. The low exploitation rate, coupled with an

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average total mortality coefficient estimated in this study, leads to the suggestion that the species is moderately exploited in the Hormouzgan waters of the Persian Gulf and Oman Sea.

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Table 1: Comparison of growth parameters of *Liza klunzingeri* with other fish species in the Persian Gulf

Species	L∞ (TL, cm)	Growth Curvature (yr^{-1})	Growth performance	Sources
Liza klunzingeri	22*	0.60	2.39	Present study
Parastromateus niger	65	0.34	3.16	Dadzie *et al*. (2007)
Pomadasys kaakan	62.2	0.27	3.004	Al-Husaini *et al*.(2001)
Pampus argenteus	32.5	0.50	2.72	Morgan (1985)
Liza klunzingeri	24.8	0.46	2.452	Dadzie *et al*. (2005)

*** Since FL was used in our study, the value (20.3 cm FL) was converted to TL using the conversion factor derived by Randall, 1995.**

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بررسی پارامترهای رشد و نرخ مرگ و میر ماهی گاریز در آبهای ساحلی ایران (خلیج فارس و دریای عمان) با استفاده از اطلاعات فراوانی طولی

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چکیده

برخی از خصوصیات پویایی جمعیت ماهی گاریز در آبهای استان هرمزگان طی یک دوره یکساله بررسی شدند. طول (چنگالی) و وزن کل ماهی گاریز بصورت $W = ۰/۰۲۱۴ F.L^{۲/۸۲۳۳}$ محاسبه شد که نشاندهندهٔ رشد ایزومتریک ماهی گاریز است. با استفاده از اطلاعات فراوانی طولی ماهانه پارامتر رشد (K) ۰/۶ در سال و طول بی نهایت ۲۰/۳ سانتیمتر تخمین زده شد. فای‌پریم مونرو برای پارامترهای رشد محاسبه شده ۲/۳۹ محاسبه گردید. مرگ و میر کل ۲/۳۱ (در سال)، مرگ و میر طبیعی ۱/۰۹ (در سال)، و مرگ و میر صیادی ۱/۲۲ (در سال) برآورد گردید. با توجه به اینکه ضریب بهره‌برداری در تحقیق حاضر ۰/۵۲ در سال محاسبه شده است، بنظر می‌رسد که بهره‌برداری از ذخایر در حالت بهینه می‌باشد.

کلمات کلیدي: ماهی گاریز، ضریب رشد، ضریب مرگ و میر، آبهای ساحلی ایران، خلیج فارس، دریای عمان

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