Length-weight relationship and condition of five marine fish species collected by shrimp trawls in Bushehr coastal waters, Northern Persian Gulf

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The length-weight relationships (LWR) and relative condition factor were calculated for five marine fish species collected by shrimp trawls from Iranian waters of the Persian Gulf. Sampling was carried out with bottom trawl net (with 40 and 50 mm mesh size (stretched length) in the cod-end and panel) during June to August 2011. Trawling took place at depths ranging from 7 to 30 m. The values of the exponent $b$ varied between 2.7300 ($Sillago sihama$) and 3.0156 ($Netuma thalassinus$). Relative condition factor ($K_{rel}$) did not differ significantly (analysis of variance (ANOVA) test, $P > 0.05$) and ranged from $0.98 \pm 0.14$ ($Pelates quadrilineatus$) to $1.03 \pm 0.17$ ($N. thalassinus$).

Key words: Length-weight relationship, marine fish, condition factor, Persian Gulf.

INTRODUCTION

Length-weight relationships are very important in fisheries management for comparison of growth studies (Garcia et al., 1998; Haimovici and Velasco, 2000; Moutopoulos and Stergiou, 2002; Hossain et al., 2006). Data on length-weight is applied to estimate the weight of an individual of given length or total weight from length-frequency distribution (Forese, 1998; Koutrakis and Tsikliras, 2003). Also, data of length-weight and age can give knowledge on the stock composition, length at maturity, lifetime, mortality, growth, and production (Beyer, 1987; Bolger and Connoly, 1989; Fifioye and Oluajo, 2006).

The condition factor also expresses the physical and environmental conditions of fish (Le Cren, 1951). It is used for comparing the condition, fatness, or well-being of fish (Tesch, 1968).

In this study, length-weight relationships and relative condition factor ($K_{rel}$) of $Netuma thalassinus$ (Ruppel, 1837), $Parastromateus niger$ (Bloch, 1795), $Sillago sihama$ (Forsskal, 1775), $Pelates quadrilineatus$ (Bloch, 1790), and $Nematolosa nasus$ (Bloch, 1795) are presented (this species are abundant in the Persian Gulf). Results of this study for most species (except $N. nasus$) are reported for the first time from the Persian Gulf waters (Froese and Pauly, 2011).

MATERIALS AND METHODS

Study area

The Persian Gulf is a subtropical sea which is separated from the Gulf of Oman by the Strait of Hormuz (Figure 1). The surface area of the Persian Gulf is approximately $2.39 \times 10^5$ km², and the average depth and volume of the Gulf is 36 m and $8.63 \times 10^3$ km³, respectively (Reynolds, 1993). The study area included Bushehr coastal waters which extends from $50^\circ\ 6'$ to $52^\circ\ 58'$ E and $27^\circ\ 14'$ to $30^\circ\ 16'$ N, and covers the fishing grounds of shrimp. Trawling was carried out between depths of 7 to 30 m during June to August 2011 (shrimp fishing season).

Data collection

Sampling was conducted by R/V SHANAK (Outrigger bottom trawler equipped with two bottom trawl nets with 40 and 50 mm mesh size (stretched mesh) in the cod-end and body net,
Figure 1. Map of Persian Gulf showing the study area and 44 sampling sites.

Figure 2. Mean relative condition factor (± SD) of 5 fish species in Bushehr coastal waters (Northern Persian Gulf) during June to August, 2011.
Table 1. The Length characteristics and parameters of the length-weight relationships of five marine fish species in Bushehr coastal waters (Northern Persian Gulf).

<table>
<thead>
<tr>
<th>Family/Species</th>
<th>Length</th>
<th>N</th>
<th>Length characteristic</th>
<th>Parameter of the relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>Ariidae/N. thalassinus</td>
<td>FL</td>
<td>67</td>
<td>18.0</td>
<td>64.0</td>
</tr>
<tr>
<td>Carangidae/P. niger</td>
<td>FL</td>
<td>73</td>
<td>13.5</td>
<td>43.0</td>
</tr>
<tr>
<td>Sillaginidae/S. sihama</td>
<td>TL</td>
<td>123</td>
<td>15.0</td>
<td>23.5</td>
</tr>
<tr>
<td>Teraponidae/P. quadrilineatus</td>
<td>TL</td>
<td>98</td>
<td>14.0</td>
<td>29.5</td>
</tr>
<tr>
<td>Clupeidae/N. nasus</td>
<td>FL</td>
<td>207</td>
<td>12.5</td>
<td>21.5</td>
</tr>
</tbody>
</table>

N: number of individuals, FL: fork length, TL: total length, Min. and Max.: minimum and maximum length (cm), SD: standard deviation.

respectively. Sub-samples were collected after each haul and data on length (total length or fork length, cm) and body weight (g) were recorded for each species. The length and weight of fishes were measured to the nearest value (0.1 mm or g) using measuring board and a digital scale, respectively.

Data analysis

For each species, the parameters a and b of the length-weight relationship was obtained using the linear regression based on logarithmic transformation of the formula (Zar, 1984):

\[ W = a L^b \]

where \( W \) is the body weight (g) and \( L \) is the total length or fork length (cm). The 95% confidence limits (CL) of parameters \( b \) were also used:

\[ 95\% \text{ CL} = b \pm t_{0.05 \cdot n-2} \cdot S_b \]

where \( n \) is the number of specimens.

\[ t_s = \frac{(b-3)}{S_b} \]

where \( t_s \) is the t-test value, \( b \) is the slope and \( S_b \) the standard error of the slope (b). These t-tests allowed the classification of length-weight relationships in isometric (\( b = 3 \)), negative allometric (\( b < 3 \)) and positive allometric (\( b > 3 \)).

For each individual, relative condition factor (\( K_{rel} \)) was computed by this equation:

\[ K_{rel} = \frac{W}{aL^b} \]

where \( W \) is the whole body wet weight (g), \( L \) is the total length or fork length (cm) and \( a \) and \( b \) are the parameters of length-weight relationship (Le Cren, 1951).

ANOVA test was used for comparison of relative condition factor (\( K_{rel} \)) between caught species.

RESULTS

A total of 568 specimens were measured. The length-characteristics and parameters of the length-weight relationships of the selected species are shown in Table 1. All regressions are highly significant (\( P < 0.01 \)) and the \( r^2 \) values range from 0.85 (\( S. sihama \)) to 0.96 (\( P. quadrilineatus \)). The mean value of \( b \) for all species was 2.7673.

The 95% confidence limits (CL) values of exponent \( b \) for all the species were mostly sets within the range of 2.5 to 3.5. Therefore, these parameters can be securely utilized in the pointed out length range (Froese, 1998).

The growth was isometric for \( N. thalassinus \) and \( P. niger \) (\( b = 3 \), \( P > 0.05 \)). \( S. sihama \), \( P. quadrilineatus \) and \( N. nasus \) showed negative allometric (\( b < 3 \), \( P < 0.05 \)). Relative condition factor (\( K_{rel} \)) did not differ significantly between species (\( P > 0.05 \)) and ranged from 0.98 ± 0.14 (for \( P. quadrilineatus \)) to 1.03 ± 0.17 (for \( N. thalassinus \)) (Figure 2).

DISCUSSION

This study can be of help to fishery managers of the Persian Gulf, because of the lack of documentation about length-weight relationship of the selected species in the Iranian waters of the Persian Gulf.

Isometric growth (\( b = 3 \), \( P > 0.05 \)) in \( N. thalassinus \) and \( P. niger \) indicated that the small specimens have the same form and condition as large specimens. Negative allometric growth (\( b < 3 \), \( P < 0.05 \)) in \( S. sihama \), \( P. quadrilineatus \) and \( N. nasus \) also indicated that large specimens changed their body shape to become more elongated or small specimens were in better nutritional condition at the time of sampling.
Table 2. The parameters $a$ and $b$ of the length-weight relationship of selected species in the Fish base.

<table>
<thead>
<tr>
<th>Species</th>
<th>Location</th>
<th>Length type</th>
<th>Length</th>
<th>Sex</th>
<th>$a$</th>
<th>$b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N. thalassius$</td>
<td>Kuwait (Bawazeer, 1987)</td>
<td>-</td>
<td>-</td>
<td>Unsexed</td>
<td>0.0088</td>
<td>3.022</td>
</tr>
<tr>
<td></td>
<td>Indonesia; Western region (Pauly et al., 1996)</td>
<td>TL</td>
<td>13.0-87.0</td>
<td>Unsexed</td>
<td>0.0097</td>
<td>3.040</td>
</tr>
<tr>
<td>$P. niger$</td>
<td>Indonesia; Pulau sea, South Kalimantan (Hadisubroto and Subani, 1994)</td>
<td>TL</td>
<td>-</td>
<td>Unsexed</td>
<td>0.0625</td>
<td>2.642</td>
</tr>
<tr>
<td></td>
<td>Bangladesh; Bay of Bangal (Mustafa, 1999)</td>
<td>FL</td>
<td>-</td>
<td>Unsexed</td>
<td>0.0211</td>
<td>3.012</td>
</tr>
<tr>
<td></td>
<td>India; Godavary estuary (Rao, 1972)</td>
<td>TL</td>
<td>32.0-56.0</td>
<td>Unsexed</td>
<td>0.0100</td>
<td>3.062</td>
</tr>
<tr>
<td></td>
<td>Indonesia; Western region (Pauly et al., 1996)</td>
<td>TL</td>
<td>5.0-38.0</td>
<td>Unsexed</td>
<td>0.0073</td>
<td>3.319</td>
</tr>
<tr>
<td>$S. sihama$</td>
<td>India; Palicat lake (Krishnamurthy and Kaliyamurthy, 1978)</td>
<td>TL</td>
<td>4.0-10.0</td>
<td>Unsexed</td>
<td>0.0069</td>
<td>3.028</td>
</tr>
<tr>
<td></td>
<td>India; Palicat lake (Krishnamurthy and Kaliyamurthy, 1978)</td>
<td>TL</td>
<td>10.1-33.0</td>
<td>Unsexed</td>
<td>0.0041</td>
<td>3.089</td>
</tr>
<tr>
<td></td>
<td>New Caledonia; lagoon (Letourneur et al., 1998)</td>
<td>FL</td>
<td>3.5-29.0</td>
<td>Unsexed</td>
<td>0.0059</td>
<td>3.130</td>
</tr>
<tr>
<td>$P. quadrilineatus$</td>
<td>Turkey; Eastern Mediterranean (Taskavak and Bilecenoglu, 2001)</td>
<td>TL</td>
<td>7.9-12.1</td>
<td>Unsexed</td>
<td>0.0134</td>
<td>2.958</td>
</tr>
<tr>
<td>$N. nasus$</td>
<td>China Main; Daya Bay, Guangdong (Xu et al., 1994)</td>
<td>SL</td>
<td>7.0-16.0</td>
<td>Unsexed</td>
<td>0.0108</td>
<td>3.105</td>
</tr>
</tbody>
</table>

SL: Standard length, TL: total length.

(Froese, 2006). In this study, efficient sampling was conducted to include the widest possible range of lengths, which were generally obtained with large samples and non-selective fishing gear. Differences in fish lengths show that the fish population ranged from small specimens to adults. The comparison of the $b$ values obtained in this study and some previously reported results in other locations of the world mostly indicate variation in the $b$ values (Table 2). This variation can be affected by sex, gonad maturity, health, season, habitat, nutrition, environmental conditions (such as temperature and salinity), area, degree of stomach fullness, differences in the length range of the caught specimen, and fishing gear (Tesch, 1971; Froese, 2006), although, they are not considered in the present study.

Conclusively, it is suggested that further study should be conducted on the composition of LWRs of both sexes of the caught species. Also, the relationship between data of physico-chemical parameter of water (Hydrology data) and the parameters of LWRs should be estimated.

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REFERENCES


