Some Morphological Characteristics of Five Marine Fish Species of Hormozgan coastal waters (Northern Persian Gulf)

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Length-weight relationships, condition factors and optimum length were estimated for five fish species of Hormozgan coastal waters, namely Leiognathus bindus, Platyccephalus indicus, Pseudorhombus arsius, Upeneus sulphureus and Arius thalassinus. Collection of samples was conducted on bimonthly basis from January 2010 to January 2011 using bottom trawl net from depths of 5–28m. All length-weight relationships were highly significant and the parameter b ranged between 2.584 in U. sulphureus and 3.146 in L. bindus. Relative weight (W_r) had significant differences between caught species (Kruskal-Wallis test, χ²=36.342 and P<0.001) and ranged from 59.42% (L. bindus) to 134.00% (P. indicus). Relative condition factor (K_c) also ranged from 0.98 ± 0.11 and 0.98 ± 0.17 (A. thalassinus and P. arsius, respectively) to 1.07 ± 0.35 (P. indicus). The optimum length (L_0pt) were calculated for all species and ranged from 8cm in L. bindus and 68cm in A. thalassinus. Present study provides basic information for fisheries management in the Persian Gulf.

Key words: Length-weight relationship, Condition factor, L_0pt, Hormozgan waters, Persian Gulf

1. INTRODUCTION

The Persian Gulf is a semi-enclosed, marginal sea that is lying in sub-tropical climate and located between latitudes 24° - 30° N and longitudes 49° - 61° 25′ E (Kampf and Sadrinasab, 2006; Valinassab et al., 2006). The major freshwater source in the Persian Gulf is the Arvand Roud river (called Shatt-Al-Arab by some countries), being located between Iran and Iraq countries. The Persian Gulf is connected to the Oman Sea through the Strait of Hormuz, which is 56 km wide at its narrowest point. The maximum width of the Gulf is 640 km and the waters are overall very shallow, with a maximum depth of 100 meters and an average depth of 60 meters (Reynolds, 1993).

The Persian Gulf has many good fishing grounds but its ecology has come under pressure from industrialization and in particular exploitation of oil and gas. In the last decade, fish landing has been declined from 110,000 tonnes in 2002 to 87,240 tonnes in 2003 in the Persian Gulf (Valinassab et al., 2006; Planning and Development Department, 2003).

Although fishing industry in Iranian waters of the Persian Gulf has been important since ancient times, studies on fish biology and fishing management in the region are few (Hosseini et al., 2002; Shokri et al., 2005; Taghavi Motlagh et al., 2010; Racisi et al., 2011; Daliri et al., 2012).

Subsequently, the purpose of this research was to report the information on fisheries biology (including Length-weight relationships (LWRs), condition factors and the optimum size (L_0pt)) of Leiognathus bindus (Valenciennes, 1835), Platyccephalus indicus (Linnaeus, 1758), Pseudorhombus arsius (Hamilton, 1822), Upeneus sulphureus (Cuvier, 1829) and Arius thalassinus (Rüppell, 1837) from Hormozgan coastal waters of the Persian Gulf.

2. MATERIALS AND METHODS

2.1. Data used

Sampling was performed on bimonthly basis from January 2010 to January 2011 with a small-scale fishing research vessel in the waters of Hormozgan (Northern Persian Gulf) (Fig. 1). Samples were collected with bottom trawl nets of mesh sizes of 25 mm and 36 mm (stretched length) in the cod-end and body, respectively. Fishing took place at depths ranging from 5 to 28 m.

Sampled small fishes were fixed with 10% formalin and transferred to the laboratory. For all specimens, total length (TL in cm) was measured to the nearest millimetre. In addition, body weight was taken on a digital balance with 0.01 g accuracy.
2.2. Statistical analysis and data presentation

Length-weight relationships of caught species were calculated by equation (Ricker, 1975)

\[ W = a L^b \]  

(1)

Where \( W \) is the total weight in grams, \( L \) the total length in centimeters, \( a \) the intercept and \( b \) the exponent.

The parameters \( a \) and \( b \) were obtained by the least-squares method based on logarithms (Zar, 1999):

\[ \log(W) = \log(a) + b \log(L) \]  

(2)

The 95% confidence limits of exponent \( b \) and standard error \( a \) and \( r^2 \) (the coefficient of determination) also were computed.

A t-test was used for the comparison of \( b \) values obtained in the linear regression with isometric values (Sokal and Rohlf, 1987):

\[ t_c = \frac{b - 3}{s_b} \]  

(3)

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

For each specimen, relative weight \( (W_r) \) and relative condition factor \( (K_{rel}) \) was calculated using following formula:

\[ W_r = 100 \frac{W}{W_s} \]  

(4)

Where \( W_r \) is the relative weight, \( W \) is the weight of a specimen and \( W_s \) is a standard weight representing the 75th percentile of observed weights at that length (Wege and Anderson, 1978; Froese, 2006).

\[ K_{rel} = \frac{W}{alb} \]  

(5)

Where \( W \) is the body weight \( (g) \), \( L \) is total length \( (cm) \) and \( a \) and \( b \) are the parameters of the length-weight relationships (Le Cren, 1951).

A non-parametric Kruskal–Wallis test \( (\alpha=0.05) \) was used to determine whether \( W_r \) significantly differed between caught species.

For each species the optimum length \( (L_{opt}) \) also was calculated:

\[ L_{opt} = 10^{1.0421 + logL_{inf} - 0.2742} \]  

(6)

\[ L_{inf} = 10^{0.044 + 0.9841 log L_{max}} \]  

(7)
Where $L_{\text{inf}}$ is the asymptotic length (cm) and $L_{\text{max}}$ is the mean length of the three largest specimens caught over the previous 10 years (Froese and Binohlan, 2000; and Froese, 2006).

3. RESULTS

A total of 1956 specimens of five species belonging to different families were collected during the present study. The length ranges of caught species are presented in Figure 2. The slopes of the regressions ($LWRs$) were all significantly different from 0 ($P < 0.05$) and $r^2$ values were all higher than 0.89. Parameters $a$ and $b$ of the $LWRs$, confidence limit of $b$, standard error of $a$ and $r^2$ and correlation coefficient ($r$) are shown in Table 1. The $b$ values ranged from 2.584 (95% CL = 0.242), for $U. sulphureus$ to 3.146 (95% CL = 0.041), for $L. bindus$.

![Graph showing length frequency distribution of five fish species](image)

**Fig. 2**: Length frequency distribution of five fish species caught in Hormozgan coastal waters (northern Persian Gulf) during January 2010 to January 2011. The box includes 50% of the data values. The central line shows the median and the vertical line represents the range of values.

**Table 1**: Relationship between length (TL, cm) and weight (g) of five fish species from Hormozgan coastal waters (January 2010 to January 2011).

<table>
<thead>
<tr>
<th>Families/Species</th>
<th>N</th>
<th>$a$</th>
<th>S.E ($a$)</th>
<th>$b$</th>
<th>95% CL ($b$)</th>
<th>$r^2$</th>
<th>S.E ($r^2$)</th>
<th>$r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leiognathidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Leiognathus bindus</em></td>
<td>631</td>
<td>0.012</td>
<td>0.000</td>
<td>3.146</td>
<td>0.041</td>
<td>0.98</td>
<td>0.189</td>
<td>0.99</td>
</tr>
<tr>
<td>Platyccephalidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Platyccephalus indicus</em></td>
<td>302</td>
<td>0.004</td>
<td>0.000</td>
<td>3.139</td>
<td>0.052</td>
<td>0.99</td>
<td>0.190</td>
<td>0.99</td>
</tr>
<tr>
<td>Paralichthyidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pseudorhombus arsius</em></td>
<td>371</td>
<td>0.015</td>
<td>0.001</td>
<td>2.887</td>
<td>0.061</td>
<td>0.98</td>
<td>0.164</td>
<td>0.99</td>
</tr>
<tr>
<td>Mullidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Upeneus sulphureus</em></td>
<td>298</td>
<td>0.034</td>
<td>0.009</td>
<td>2.584</td>
<td>0.242</td>
<td>0.89</td>
<td>0.088</td>
<td>0.94</td>
</tr>
<tr>
<td>Ariidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Arius thalassinus</em></td>
<td>354</td>
<td>0.016</td>
<td>0.004</td>
<td>3.056</td>
<td>0.122</td>
<td>0.97</td>
<td>0.109</td>
<td>0.99</td>
</tr>
</tbody>
</table>

N: The number of samples, S.E: Standard error and CL: Confidence limits.
Positive allometric growth was established for *Leiognathus bindus* (*t*=6.95) and *Platycephalus indicus* (*t*=5.35), *Pseudorhombus arsius* and *Upeneus sulphureus* showed negative allometric growth (*t*=3.65 and *t*=3.38, respectively), while *Arius thalassius* showed isometric growth (*t*=0.90) (All calculation were considered at α=5%).

Relative weight (*W*) ranged from 59.42% (95% CL = 54.09% - 64.75%), for *L. bindus* to 134.00% (95% CL = 87.00%-181.00%), for *P. indicus* (Table 2). In this study, *W* differed significantly between species (Kruskal–Wallis test, $\chi^2$=36.342 and P<0.001).

<table>
<thead>
<tr>
<th>Species</th>
<th>$W_s$ (g)</th>
<th>Relative weight ($W_r$)</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>S.E ($W_r$)</th>
<th>95% CL ($W_r$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Leiognathus bindus</em></td>
<td>8.8</td>
<td>1.13%</td>
<td>260.23%</td>
<td>59.42%</td>
<td>2.17%</td>
<td>54.09% - 64.75%</td>
<td></td>
</tr>
<tr>
<td><em>Platycephalus indicus</em></td>
<td>64.7</td>
<td>0.15%</td>
<td>1824.7%</td>
<td>134.00%</td>
<td>23.70%</td>
<td>87.00%-181.00%</td>
<td></td>
</tr>
<tr>
<td><em>Pseudorhombus arsius</em></td>
<td>58.1</td>
<td>0.34%</td>
<td>380.72%</td>
<td>66.65%</td>
<td>5.92%</td>
<td>48.65%-84.65%</td>
<td></td>
</tr>
<tr>
<td><em>Upeneus sulphureus</em></td>
<td>9.3</td>
<td>16.13%</td>
<td>440.86%</td>
<td>113.80%</td>
<td>14.70%</td>
<td>84.80%-142.80%</td>
<td></td>
</tr>
<tr>
<td><em>Arius thalassius</em></td>
<td>1430</td>
<td>9.80%</td>
<td>346.15%</td>
<td>81.09%</td>
<td>7.00%</td>
<td>67.09%-95.09%</td>
<td></td>
</tr>
</tbody>
</table>

Relative condition factor ($K_{rel}$) is indicated in Figure 3. In the present study, the $K_{rel}$ was ranged from 0.98 ± 0.11 and 0.98 ± 0.17 (*A. thalassius* and *P. arsius*, respectively) to 1.07 ± 0.35 (*P. indicus*) (Fig. 3).

<table>
<thead>
<tr>
<th>Species</th>
<th>$L_{opt}$ (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Leiognathus bindus</em></td>
<td>8.0</td>
</tr>
<tr>
<td><em>Platycephalus indicus</em></td>
<td>43.5</td>
</tr>
<tr>
<td><em>Pseudorhombus arsius</em></td>
<td>23.0</td>
</tr>
<tr>
<td><em>Upeneus sulphureus</em></td>
<td>19.5</td>
</tr>
<tr>
<td><em>Arius thalassius</em></td>
<td>68.0</td>
</tr>
</tbody>
</table>

The optimum length ($L_{opt}$) of all caught species also is presented in Table 3 ($L_{max}$ values were considered based on reports of Carpenter et al. (1997) and local reports).
4. DISCUSSION

Among biometric relations in fishes, the length-weight relationships (LWRs) are greatly presented by scientists and researchers as useful tools in fish biology (Pauly, 1993; King, 1995; Petrakis and Stergiou, 1995; Santos et al., 2002; Ferreira et al., 2008). Calculating of the parameters of LWRs is useful for the prediction of weight from length values, condition of fish, stock assessment, and estimation of biomass (Petrakis and Stergiou, 1995; Vaslet et al., 2007).

LWRs also can give information about the stock composition, growth, life span, production and mortality (Erkoyuncu, 1995; Stergiou and Moutopoulos, 2001).

For some of the species included in this study there is little biological information and the LWRs are reported for the first time in the Persian Gulf. In the present study, the b value ranged from 2.584 (Upeneus sulphureus) to 3.146 (Leiognathus bindus). These results are in accordance with the range of values of this parameter usually encountered in fishes, which should be $2.5 < b < 3.5$ according to Froese (2006), thus the parameters can be used safely within the indicated length range. Since sampling was taken in various seasons, the LWRs parameters obtained consider hypothetic seasonal variations in the populations studied.

Table 4 indicates the previous studies on the characteristics of length-weight relationship of selected species in other location of the world. These may vary significantly due to biological and environmental conditions (sex, stage of maturity, food, temperature and salinity), spatial temporal position, degree of stomach fullness, differences in the length range of the caught specimen and sampling procedure (Bagenal and Tesch, 1978; Froese, 2006).

<table>
<thead>
<tr>
<th>Species</th>
<th>Authors</th>
<th>Study area</th>
<th>Length (cm)</th>
<th>$a$</th>
<th>$b$</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Leiognathus bindus</em></td>
<td>Schroeder (1982)</td>
<td>Philippines</td>
<td>SL- 6.6 - 9.4</td>
<td>0.0518</td>
<td>2.740</td>
</tr>
<tr>
<td></td>
<td>Murty (1983)</td>
<td>India</td>
<td>TL- 5.4 - 12.2</td>
<td>0.0167</td>
<td>2.962</td>
</tr>
<tr>
<td></td>
<td>Letourneur et al. (1998)</td>
<td>New Caledonia</td>
<td>FL- 3.0 - 9.0</td>
<td>0.1060</td>
<td>2.190</td>
</tr>
<tr>
<td><em>Platycephalus indicus</em></td>
<td>Bawazeer (1989)</td>
<td>Kuwait</td>
<td></td>
<td>0.0022</td>
<td>3.322</td>
</tr>
<tr>
<td></td>
<td>Harrison (2001)</td>
<td>South Africa</td>
<td>SL- 2.8 - 45.0</td>
<td>0.0102</td>
<td>2.950</td>
</tr>
<tr>
<td><em>Pseudorhombus arsius</em></td>
<td>Bawazeer (1987)</td>
<td>Kuwait</td>
<td></td>
<td>0.0030</td>
<td>3.418</td>
</tr>
<tr>
<td></td>
<td>Willing and Pender (1989)</td>
<td>Australia</td>
<td>TL- 8.5 - 25.0</td>
<td>0.0068</td>
<td>3.076</td>
</tr>
<tr>
<td></td>
<td>Harrison (2001)</td>
<td>South Africa</td>
<td>SL- 2.1 - 13.8</td>
<td>0.0068</td>
<td>3.076</td>
</tr>
<tr>
<td><em>Upeneus sulphureus</em></td>
<td>Pauly et al. (1996)</td>
<td>Indonesia</td>
<td>TL- 5.5 - 24.5</td>
<td>0.0081</td>
<td>3.213</td>
</tr>
<tr>
<td></td>
<td>Willing and Pender (1989)</td>
<td>Australia</td>
<td>FL- 8.0 - 17.0</td>
<td>0.0346</td>
<td>2.900</td>
</tr>
<tr>
<td></td>
<td>Boraey and Soliman (1987)</td>
<td>Egypt</td>
<td>SL- 5.0 - 12.5</td>
<td>0.0412</td>
<td>2.890</td>
</tr>
<tr>
<td><em>Arius thalassinus</em></td>
<td>Bawazeer (1987)</td>
<td>Kuwait</td>
<td></td>
<td>0.0088</td>
<td>3.022</td>
</tr>
<tr>
<td></td>
<td>Pauly et al. (1996)</td>
<td>Indonesia</td>
<td>TL- 13.0 - 87.0</td>
<td>0.0097</td>
<td>3.040</td>
</tr>
</tbody>
</table>

TL: Total length, SL: Standard length and FL: Fork length

The condition factor of fish can be very important to fisheries managers. High condition factor values may be shows of favorable environmental conditions (such as: habitat conditions, much prey availability) and low values indicate less favorable environmental conditions (Blackwell et al., 2000). Fish condition can be estimated via three procedures: (a) Fulton’s condition factor ($k$) that it assumes isometric growth ($b = 3$) (Carlander, 1950). Since fish have different shapes and researches are conducted on different value ranges for each species, comparing $K$ values between various fish species is practically impossible (Anderson and Neumann, 1996). (b) Relative condition factor ($K_{rel}$), defect of $K_{rel}$ is that comparisons between fish species must be restricted to those homogeneous for exponent $b$ in their length-weight relationship (Bolger and Connolly, 1989; Blackwell et al., 2000) because $b$ values can change from one geographical range to another (Anderson and Neumann, 1996). (c) Relative condition factor ($W_r$), $W_r$ would have several avails over $K$ and $K_{rel}$: (1) calculating of $W_r$ is easier than other fish condition measures, (2) $W_r$
values can be compared between fish of different lengths and various populations and (3) Wᵢ does not change with different measurement units (Wege and Anderson, 1978; Blackwell et al., 2000). At present study Platycephalus indicus (Wᵢ=134.00%) had best performance, while Wᵢ values in Leiognathus bindus and Pseudorhombus arsius demonstrate the bad environmental condition for them.

Froese (2006) introduced the idea of the optimum length (Lₒpt) for estimating fit size of fish species for catch. For most fishes Lₒpt falls between the first and second spawning, thus making overfishing theoretically impossible, because all fish had a chance to spawn before being caught (Myers and Mertz, 1998; Froese, 2006). Most fish species of the Persian Gulf are in IUCN red list, thus estimating of Lₒpt of species can be useful for fisheries management in the region.

5. CONCLUSION

In order to access a sustainable management in the Persian Gulf is essential collecting of biological data and biomass estimates. This study provides basic information for fishery biologists and managers in the Persian Gulf.

REFERENCES


