Length-Weight Relationships and Condition Factors of Three Tilapine Species in an Abandoned Gold Mine Reservoir, Igun, Southwestern Nigeria

Oluwadamilare E. OBAYEMI*, Olusola O. KOMOLAFE, Oluwakemi V. OKUNOLA, Sakirat T. ASAFA, Mary A. AYOADE

Obafemi Awolowo University, Faculty of Science, Department of Zoology, Ile-Ife, Nigeria; obayemioluwadamilare@yahoo.com (*corresponding author); neykomolafe2002@yahoo.co.uk; oluwadokem@gmail.com; ashafamrs@gmail.com; ayoade_mary@yahoo.com

Abstract

This study investigated the length-weight relationships and condition factors of three fish species in an abandoned gold mine reservoir. The fishes were caught on monthly basis between August 2015 and July 2016 using gill nets and traps. The results showed that Coptodon zillii, Oreochromis niloticus and Sarotherodon galilaeus had a mean total length and mean weight of 15.52±4.64 cm and 95.80±66.27 g; 15.27±4.18 cm and 89.54±63.20 g; 15.57±4.80 cm and 102.0±85.81 g respectively. Also, the mean condition factor obtained for the fish species are 2.24±0.52 in C. zillii; 2.26±0.62 in O. niloticus and 2.27±0.46 in S. galilaeus. Similarly, the slope (b) values and correlation coefficient for the three fish species are 2.018 and 0.969 for C. zillii; 1.977 and 0.926 for O. niloticus and 2.436 and 0.965 for S. galilaeus. Furthermore, the total length, weight and condition factor between C. zillii, O. niloticus and S. galilaeus differ significantly (p>0.05). The study concluded that despite being an abandoned gold mine reservoir, the environment is well suitable for the fishes.

Keywords: condition factor; fish; Igun; length/weight; reservoir

Introduction

The Cichlidae family is the most rich in species fish family in inland waters worldwide. It is one of the most vertebrate families with at least 1300 species and an estimates potential of 1900 species (Kullander, 1998). The geographical distribution of this family includes freshwaters of Africa, Jordan valley in the Middle East, North America and South America. Fish from tropical regions are well-known to experience changes which could be as a result of environmental changes, diet composition changes, food chain competition, physical and chemical parameters changes of the aquatic environment (Adediji and Araoye, 2005; Abowei and Davies, 2009). The length-weight relationship study is widely used in the management of fisheries since it gives information on fish condition (Bagenal and Tesch, 1978). This relationship plays an important role to determine the weight from the length of a fish and also to compare the mean associated parameters between fish groups spatially (Muzzalifah et al., 2015). Christopher et al. (2013) reported that fish size is mostly more biologically significant than age. According to the authors, this may be due to several ecological and physiological aspects which are more size-dependent than they are age-dependent. Length-weight relationship and condition factor of fish have been well documented in other inland water bodies of Nigeria (Adeyemi, 2010; Dan-kishiya, 2013; Amoo and Komolafe, 2016). Also, the parameters of length-weight relationship are important in fisheries to determine the weight of an individual fish from its length, to compare the life history and morphology of populations in different areas (Sani et al., 2010).

Condition factor is useful in understanding the life phase of fish species and it helps in adequate management of these species, thus, providing equilibrium in the ecosystem (Imam et al., 2010). This factor is mathematically calculated from the relationship between the weight and length of a fish with the aim of describing the condition of the fish (Froese, 2006). The differences in the values of condition factor of a fish might indicate the stage of sexual maturity, degree of food sources availability, age and sex (Anibeze, 2000). McGlashan and Hughies (2001) observed that an ever increasing number of industrial, agricultural and commercial chemicals discharged into the aquatic environment had led to various deleterious effects on the aquatic organisms. Recent evidence on the level of heavy metals in Igun gold mine reservoir has shown high concentrations of heavy metals pollution (Lawal and Komolafe, 2012). Information on the length-weight relationship and condition factor of fish species in a polluted freshwater environment is scarce. Therefore, this study aimed at determining the length and weight relationships and conditions factors of some fish species in an abandoned gold mine reservoir.

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Materials and Methods

Study area
The study area is an abandoned gold mine reservoir in Igun village in Atakumosa West Local Government Area of Osun State. It extends over longitude 004° 30' E to 004° 45' E and latitude 07° 35' N to 07° 38' N (Fig. 1). Streams such as Oka, Eleripon and Osun which serve the community were impounded to form reservoirs in order to meet the mining needs of Nigeria. The Nigeria mining corporation later carried out a feasibility study in 1982, and it was evident that better mining and recovery methods could rework the earlier grounds. The temperature of the area during the season ranged between 22 °C to 32 °C. Igun village is characterized by two seasons which are rainy and dry season, with the dry season extending from November to February while March to October marks the rainy season. Presently, illegal miners engage in small scale gold mining around the reservoirs which has resulted in scattered open pits and has destroyed the landscape of the area.

Collection of fish samples
Fish samples were collected from Igun reservoir in Osun State on monthly basis between August 2015 and July 2016 with gill nets and traps. Fish caught were brought into the laboratory for identification using standard keys prepared by Paugy et al. (2003) and Adesulu and Sydenham (2007). Total length and standard length of the fish were taken, using meter-rule in centimeters and the sex of each fish samples were determined by visual inspection. Weights of the fish were taken using Denward weighing balance instrument in grams.

Length-weight relationship of Coptodon zillii, Oreochromis niloticus and Sarotherodon galilaeus in Igun reservoir
Fish length is a more reliable indicator of growth than weight because the length obtained by a fish cannot be lost unlike weight due to environmental factors. Fish length can also be obtained easily when compared to weight. The relationship between length and weight of fish can be adequately represented by the equation:

\[ W = aL^b \]  
(Bagenal, 1978), where: \( W \) = weight of fish (g); \( L \) = standard length of fish (cm); \( a \) = constant; \( b \) = an exponent (values between 2 and 4). By Log transformation the equation \( W = aL^b \) becomes: \( \log W = \log a + b\log L \).

Condition factor of Coptodon zillii, Oreochromis niloticus and Sarotherodon galilaeus in Igun reservoir
The condition factor expresses the well-being, fatness or robustness of a fish in the habitat (Mir et al., 2012). Condition factor is expressed mathematically thus,

\[ K = \frac{100W}{L^3} \]  
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Statistical analysis
One-way Analysis of Variance was used to determine the differences between the mean values for the Total Length, Weight and Condition factors of C. zillii, O. niloticus and S. galilaeus in Igun Reservoir. T-test was used to evaluate the differences in the mean values for the condition factors of C. zillii, O. niloticus and S. galilaeus between the seasons. The significant differences were considered to be significant at \( p<0.05 \).

Results
Length-weight relationship of Coptodon zillii, Oreochromis niloticus and Sarotherodon galilaeus in Igun reservoir
The total length values recorded for fish species varied with respect to size and age. The total length of C. zillii varied between 8.1 cm and 25.1 cm. Similarly, the weight varied between 16.0 g and 310.0 g (Table 1). The mean total length and weight was 15.52±4.64 cm and 95.80±66.27 g respectively. In O. niloticus, the total length was between 8.1 cm and 24.2 cm. The weight was between 19.0 g and 300.0 g. Also, the mean total length and weight were 15.27±4.18 cm and 89.54±63.20 g respectively as presented in Table 1.

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Furthermore, the total length of S. galilaeus varied between 8.0 cm and 28.9 cm. Similarly, the weight varied between 18.0 g and 308.0 g. The mean total length and weight was 15.57±4.80 cm and 102.0±85.81 g respectively. There was no significant difference (p>0.05) in the total length of C. zillii, Oreochromis niloticus and Sarotherodon galilaeus (Table 5). Also, the weight of the three fish species differs significantly (p>0.05) as shown in Table 6.

Condition Factor of Coptodon zillii, Oreochromis niloticus and Sarotherodon galilaeus in Igun reservoir

The condition factor ‘K’ for Coptodon zillii, Oreochromis niloticus and Sarotherodon galilaeus in Igun reservoir is presented in Table 2. The condition factor of C. zillii ranged between 1.36 and 3.38 with a mean of value 2.24±0.52. Also, O. niloticus condition factor varied between 1.50 and 3.63. The mean condition factor of O. niloticus was 2.26±0.62. Similarly, the condition factor of S. galilaeus ranged between 1.21 and 3.52. The mean value recorded for O. niloticus was 2.27±0.46 as shown in Table 2. There was significance difference (p<0.05) in the condition factor of the three fish species during the rainy and dry seasons with S. galilaeus significantly higher compared to C. zillii and O. niloticus as shown in Table 4. However, the condition factor differs significantly (p>0.05) between the three fish species (Table 6).

Growth type and variations in the parameters of the length-weight relationship of Coptodon zillii, Oreochromis niloticus and Sarotherodon galilaeus in Igun reservoir

The correlation coefficients ‘r’ of the length-weight relationship of the fish is presented in Table 3. The three species exhibited negative allometric growth. In C. zillii, ‘r’ value recorded was 0.969; the b-value estimated from the length-weight relationship was 2.018. Also, b-value of O. niloticus was 1.977 and a correlation coefficient of 0.977. Similarly, the exponent ‘b’ obtained for S. galilaeus was 2.436 with an ‘r’ value of 0.965. The logarithm graph of C. zillii, Oreochromis niloticus and Sarotherodon galilaeus are shown in Figs. 2, 3 and 4.

Discussion

The values obtained for the length-weight relationship showed that Coptodon zillii, Oreochromis niloticus and Sarotherodon galilaeus in Igun reservoir exhibited negative allometric growth. According to Bagenal and Tesch (1978), length-weight relationship gives information on the growth patterns and condition of fish. Also, the current study found that the b-values obtained for the fishes was similar to Adeyemi (2010) who worked on Synodontis resupinatus in Idah area of River Niger. Similarly, Ndimele et al. (2010) recorded b-values of 2.38 in Sarotheron melanochiron of

### Table 1. Length-weight relationship of Coptodon zillii, Oreochromis niloticus and Sarotherodon galilaeus in Igun Reservoir

<table>
<thead>
<tr>
<th>Fish species</th>
<th>N</th>
<th>Total length range (cm)</th>
<th>Mean ± SD</th>
<th>Weight range (g)</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coptodon zillii</td>
<td>161</td>
<td>8.1 – 25.1</td>
<td>15.52±6.4</td>
<td>16.0 – 310.0</td>
<td>95.80±66.27</td>
</tr>
<tr>
<td>Oreochromis niloticus</td>
<td>57</td>
<td>8.1 – 24.2</td>
<td>15.27±1.18</td>
<td>19.0 – 300.0</td>
<td>89.54±63.20</td>
</tr>
<tr>
<td>Sarotherodon galilaeus</td>
<td>44</td>
<td>8.0 – 28.9</td>
<td>15.57±4.80</td>
<td>18.0 – 308.0</td>
<td>102.0±85.81</td>
</tr>
</tbody>
</table>

### Table 2. Condition factor of C. zillii, O. niloticus and S. galilaeus in Igun Reservoir

<table>
<thead>
<tr>
<th>Fish species</th>
<th>N</th>
<th>Condition factor range</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coptodon zillii</td>
<td>161</td>
<td>1.36 – 3.88</td>
<td>2.23±0.52</td>
</tr>
<tr>
<td>Oreochromis niloticus</td>
<td>57</td>
<td>1.50 – 3.63</td>
<td>2.26±0.62</td>
</tr>
<tr>
<td>Sarotherodon galilaeus</td>
<td>44</td>
<td>1.21 – 3.52</td>
<td>2.27±0.46</td>
</tr>
</tbody>
</table>

### Table 3. Growth type of C. zillii, O. niloticus and S. galilaeus in relation to length/weight relationship in Igun Reservoir

<table>
<thead>
<tr>
<th>Fish species</th>
<th>N</th>
<th>A</th>
<th>b</th>
<th>r</th>
<th>GT</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. zillii</td>
<td>161</td>
<td>-0.259</td>
<td>2.018</td>
<td>0.969</td>
<td>-ve</td>
</tr>
<tr>
<td>O. niloticus</td>
<td>57</td>
<td>-0.227</td>
<td>1.977</td>
<td>0.926</td>
<td>-ve</td>
</tr>
<tr>
<td>S. galilaeus</td>
<td>44</td>
<td>-0.721</td>
<td>2.436</td>
<td>0.965</td>
<td>-ve</td>
</tr>
</tbody>
</table>

N = Number; a = intercept; b= slope; r = correlation coefficient; GT = Growth type; +ve = Positive allometric; -ve = Negative allometric

### Table 4. T-test for the condition factors of C. zillii, O. niloticus and S. galilaeus in Igun Reservoir between the seasons

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Fish species</th>
<th>Seasons</th>
<th>N</th>
<th>Condition factor range</th>
<th>Mean ± SD</th>
<th>t</th>
<th>df</th>
<th>Sig. (one-tail)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition factor</td>
<td>C. zillii</td>
<td>Rainy</td>
<td>74</td>
<td>1.36 – 3.88</td>
<td>2.05±0.46</td>
<td>4.705</td>
<td>159</td>
<td>2.74E-6^*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dry</td>
<td>87</td>
<td>1.37 – 3.50</td>
<td>2.41±0.52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>O. niloticus</td>
<td>Rainy</td>
<td>16</td>
<td>1.60 – 2.27</td>
<td>1.90±0.21</td>
<td>-4.165</td>
<td>54</td>
<td>5.64E-5^*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dry</td>
<td>41</td>
<td>1.50 – 3.63</td>
<td>2.40±0.66</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S. galilaeus</td>
<td>Rainy</td>
<td>12</td>
<td>1.21 – 2.69</td>
<td>2.01±0.37</td>
<td>-2.660</td>
<td>24</td>
<td>6.85E-3^*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dry</td>
<td>32</td>
<td>1.70 – 3.52</td>
<td>2.37±0.46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N=Number of Fish; SD=Standard Deviation; t= T-test value; df = degree of freedom; sig. = Significant *Significant at p < 0.05
Ologe lagoon. In Ibiekuma stream, the b-values of *O. niloticus* was 1.94 as recorded by Obasohan et al. (2012) while Imam et al. (2010) recorded b-values of 2.5 for *C. zillii* in Wasai Reservoir. Similar b-values in fish species of Igun reservoir with other fresh water bodies suggested that the environment is suitable for the fish. Variation in the values of 'b' might be attributed to differences in age, stage of maturity as well as environmental conditions (Hossain, 2010). The three fish species showed a high correlation coefficient 'r' ranging from 0.926 to 0.969. This result can be compared with *O. niloticus* and *S. galilaeus* in Strabag Lake where r = 0.944 and r = 0.911 respectively (Amoo and Komolafe, 2016). The result also indicated that as the fish species increases in length, the weight also increases. The condition factor (K) can be used to compare the well-being of fish in an environment as stated by Ahmed et al. (2011). The condition factor of the tilapine fish varied from 1.21 to 3.88 in the habitat. The results compared favourably with

<table>
<thead>
<tr>
<th>Morphometric parameter</th>
<th>Fish species</th>
<th>N</th>
<th>Total length range (cm)</th>
<th>Mean ± SD</th>
<th>ANOVA</th>
<th>F-Ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total length</td>
<td><em>C. zillii</em></td>
<td>161</td>
<td>8.1 – 25.1</td>
<td>15.52±4.64</td>
<td></td>
<td>0.0761</td>
<td>0.9267</td>
</tr>
<tr>
<td></td>
<td><em>O. niloticus</em></td>
<td>57</td>
<td>8.1 – 24.2</td>
<td>15.27±4.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>S. galilaeus</em></td>
<td>44</td>
<td>8.0 – 28.9</td>
<td>15.57±4.80</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N=Number of fish; SD=Standard Deviation; *Significant at p < 0.05

<table>
<thead>
<tr>
<th>Morphometric parameter</th>
<th>Fish species</th>
<th>N</th>
<th>Weight range (g)</th>
<th>Mean ± SD</th>
<th>ANOVA</th>
<th>F-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td><em>C. zillii</em></td>
<td>161</td>
<td>16.0 – 310.0</td>
<td>95.80±66.27</td>
<td></td>
<td>0.4059</td>
<td>0.6668</td>
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<tr>
<td></td>
<td><em>O. niloticus</em></td>
<td>57</td>
<td>19.0 – 300.0</td>
<td>89.54±63.20</td>
<td></td>
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<tr>
<td></td>
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<td>0.0531</td>
<td>0.9483</td>
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<tr>
<td></td>
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<td>57</td>
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Fig. 2. Length-weight relationship of *C. zillii* in Igun Reservoir

Fig. 3. Length-weight relationship of *O. niloticus* in Igun Reservoir

Fig. 4. Length-weight relationship of *S. galilaeus* in Igun Reservoir
Kumolu-Johnson and Ndimele (2011) who obtained a K-value between 0.91 and 8.46 for nine fish species from Ologe Lagoon in Lagos. Thus, the difference in the condition factor of this study when compared with other findings could be attributed to differences in the ecological states of the fresh water bodies. However, Gayanilo and Pauly (1997) had observed that certain factors such as sex, stage of maturity and stomach content often affect the wellness of a fish in their habitats.

In conclusion, the present study had provided basic information on length-weight parameters of C. zillii, O. niloticus and S. galilaeus in Igun reservoir. The three fish species exhibited negative allometric growth. The growth pattern of fish in the reservoir might be attributed to the effect of pollution as a result of gold mining in the environment.

Conflicts of interest
The authors declare that there are no conflicts of interest related to this article.

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