Length-Weight relationship and condition factor for 22 freshwater fish species from Solomougou Dam Lake (Korhogo, Côte d'Ivoire)

Kouassi Koffi Dongo, Diaby Moustapha, Amon Yao Nicolas and N’da Konan

Abstract
Fishery biologists use models that incorporate allometric growth coefficient of Length-Weight relationship. Also, Fulton's condition factor gives information about overweight's status of fish in their habitat. These parameters have been studied for 22 fish species from Solomougou Dam Lake. Samplings were conducted from October 2018 to September 2019. Standard length (cm) and weight (g) have been recorded in situ on each specimen from commercial catches. The equation $W = aL^b$ was used. Allometric growth coefficients $b$ and theoretical value 3 were compared using Student's t-test. The equation $K = W / L^b$ allowed calculating Fulton's condition factor. Results indicated that allometric growth coefficients $b$ obtained varied between 2.104 and 3.046. Six species out of the twenty-two ones studied showed isometric growth: Brycinus imberi, Clarias gariepinus, Hemichromis fasciatus, Labeo coubie, Labeo parvus and Marcusenius furcidens. However, Only Heterobronchus longifilis had positive allometric growth. At the opposite, all the others species showed negative allometric growth: Chrysichthys maurus, Chrysichthys nigrodigitatus, Chromidotilapia guntheri, Heterotis niloticus, Marcusenius ussheri, Moronurus rume, Oreochromis niloticus, Petrocephalus bovei, Sarotherodon galilaeus, Sarotherodon melanotheron, Schilbe intermedium, Synodontis schall, Tilapia guineensis, Tilapia mariae and Tilapia zillii. Fulton's condition factors ranged from 0.884±0.085 to 8.968±1.818. These values, higher than 2.9 for 59.09% of the species, indicate a good adaptation of the majority of them in this Lake.

Keywords: Allometry, Fulton’s condition factor, Fish, Lake Solomougou, Côte d'Ivoire

Introduction
Stock assessment involves using mathematical models for best management in fisheries studies. Many of these models incorporate growth parameters including allometric growth coefficient of Length-Weight relationship. According to Britton and Davies (2007) [1], this last parameter can be used to evaluate natural populations. It also helps to understand the growth pattern, allowing estimating the average weight at a given length and vice versa. The advantage is that direct weight measurements can take a lot of time (Sinovcic et al., 2004) [2]. Another parameter, Fulton's condition factor, provides information on the state of overweight of fish species in their environment (Paugy and Lévêque, 2017) [3]. It is largely influenced by biotic and abiotic parameters, so evaluating the level of disturbance in an aquatic ecosystem (Baby et al., 2011) [4].

Allometric growth coefficients of Length-Weight relationship and Fulton's condition factor data for fish species living in northern hydro systems in Côte d'Ivoire are rare. In this part of the country, fishing, source of fish proteins for local populations, is mainly practised in Dam Lakes (Da Costa et al., 2004) [5]. Today, this activity, more than a subsistence one, becomes commercial and therefore deserves to be better managed. This involves studies of biology, ecology and evaluation of exploitation levels of fish stocks. So, this work focuses on the study of these parameters for the main species caught in the Solomougou Dam Lake. This reservoir is the fifth largest Dam Lake in the north of the country (Traoré, 1996) [6]. The results obtained will therefore constitute an important basis for any policy management of this fishery.
Materials and Methods

Study area

This study was conducted on the Solomougou Dam Lake. It is located in northern Côte d'Ivoire, precisely in the department of Korhogo. Its watershed is located between the meridians 5°30' and 6°W and the parallels 9° and 9°30’N (Anonymous, 1962) [7]. It was built in 1973 by Rice Development Society (SODERIZ) and covers a maximum area of 500 hectares of water (Traoré, 1996) [6].

Data collection

This study was conducted from October 2018 to September 2019 with weekly sampling at the beginning of each month. Fish have been caught by six fishing gears types including gillnets, hawk nets, traps, bamboo traps, longlines and seines. Samples from commercial catches were collected in situ randomly. Then, fish were grouped according to species and their identification was made using Stiassny et al.’s keys (2008) [8]. Then, each specimen has been measured taking standard length (Ls) to the nearest millimeter and weighted to their identification was made using Stiassny et al.’s keys (2008) [8]. Then, each specimen has been measured taking standard length (Ls) to the nearest millimeter and weighted to the nearest gram.

Data processing

Only species with sample size more than 10 specimens were studied (Lalèye, 2006) [9]. Length-Weight relationship was established using equation $W = aL^{3}$ (Le Cren, 1951) [10] where $W$ is total weight of the fish in grams (g), Ls standard length in centimeters (cm), a is a constant and b the allometric growth coefficient. Parameters a and b were calculated after logarithmic transformation of the equation into $\log W = \log a + b \log Ls$. The allometric growth coefficient b, slope of the linear regression, expresses relation between weight gain and growth in length. Thus, Length-Weight relationship reflects isometric growth when b=3, allometric growth in favour of weight when b>3 and allometric growth in favour of body length when b<3 (Froese, 2006) [11]. Student's t-test was used to test the differences between b values and the theoretical value 3 with student's t-test, only six (06) species out of the twenty-two (22) ones studied show isometric growth. Those are Brycinus imberi, Clarias gariepinus, Hemichromis fasciatus, Labeo coubie, Labeo parvus and Marcusenius furcident. Also, Heterobronchus longifilis is the only species with positive allometric growth. All the others species show negative allometric growth.

Fulton's condition factor

Analysis of Table 1 indicates that Fulton's condition factor K calculated vary from 0.884±0.085 to 8.968±1.818. However, the lowest value, less than 1, was recorded for Heterobronchus longifilis, followed by Clarias gariepinus and Marcusenius usssheri which had respective k values of 1.241±0.554 and 1.875±0.220. On the other hand, the highest values of this parameter were noted for Heterotis niloticus (k=8.968±1.818), Mormyrus rume (k=7.185±1.1566) and Tilapia guineensis (k=6.991±0.352), followed by Sarotherodon galilaeus, Tilapia zillii, Sarotodon melanotheron and Tilapia mariae with condition factor values between 5 and 6.

Table 1: Allometric growth coefficients and Fulton's condition factor values for the 22 fish species studied. N, number of specimens; Min., minimum; Max., maximum; a, constant; b, allometric growth coefficient; SE(b), standard error of b; $r^2$, determination coefficient; CL, confidence limits; t, Student's t-test; A, allometry; A-, negative allometric growth; A+, positive allometric growth; I, isometric growth; K, Fulton's condition factor.

<table>
<thead>
<tr>
<th>Family/Espèces</th>
<th>Length (cm)</th>
<th>Weight (g)</th>
<th>a</th>
<th>b</th>
<th>SE(b)</th>
<th>$r^2$</th>
<th>95%CL of b</th>
<th>t</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alestiidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brycinus imberi</td>
<td>798</td>
<td>5.8</td>
<td>15.5</td>
<td>4</td>
<td>92</td>
<td>0.022</td>
<td>3.027</td>
<td>0.018</td>
<td>0.907</td>
</tr>
<tr>
<td>Cichlidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromidotilapia guantheri</td>
<td>88</td>
<td>6</td>
<td>15.5</td>
<td>5</td>
<td>120</td>
<td>0.039</td>
<td>2.860</td>
<td>0.086</td>
<td>0.876</td>
</tr>
<tr>
<td>Hemichromis fasciatus</td>
<td>219</td>
<td>5.6</td>
<td>17.3</td>
<td>5</td>
<td>168</td>
<td>0.025</td>
<td>3.046</td>
<td>0.060</td>
<td>0.977</td>
</tr>
<tr>
<td>Oreochromis niloticus</td>
<td>560</td>
<td>6.5</td>
<td>25.4</td>
<td>9</td>
<td>548</td>
<td>0.048</td>
<td>2.878</td>
<td>0.023</td>
<td>0.965</td>
</tr>
<tr>
<td>Sarotherodon galilaeus</td>
<td>475</td>
<td>6.5</td>
<td>19.6</td>
<td>11</td>
<td>233</td>
<td>0.060</td>
<td>2.790</td>
<td>0.028</td>
<td>0.970</td>
</tr>
<tr>
<td>Sarotherodon melanotheron</td>
<td>18</td>
<td>7.1</td>
<td>18.4</td>
<td>14</td>
<td>191</td>
<td>0.057</td>
<td>2.782</td>
<td>0.179</td>
<td>0.987</td>
</tr>
<tr>
<td>Tilapia guineensis</td>
<td>21</td>
<td>7.6</td>
<td>11.5</td>
<td>17</td>
<td>52</td>
<td>0.070</td>
<td>2.727</td>
<td>0.082</td>
<td>0.981</td>
</tr>
<tr>
<td>Tilapia mariae</td>
<td>228</td>
<td>6.8</td>
<td>15.8</td>
<td>11</td>
<td>160</td>
<td>0.051</td>
<td>2.814</td>
<td>0.036</td>
<td>0.861</td>
</tr>
</tbody>
</table>
Discussion

Allometric growth coefficients of Length-Weight Relationship calculated for twenty-two (22) species from Solomougou Dam Lake vary between 2.104 and 3.046. These values are within the required interval, usually between 2 and 4 in fish, according to Bagenal and Tesch (1978) [14]. The limits of our values are also close to those obtained by Tah et al. (2012) [15], between 2.173 and 3.472, for 36 freshwater fish species in Ayamé I and Buyo Lakes in Côte d'Ivoire.

Three growth models have been noted according to b values. Six species, represented by Brycinus imberi, Clarias gariepinus, Hemichromis fasciatus, Labeo coubie, Labeo parvus and Marcusenius furcident showed isometric growth. This means that for them, weight gain increases proportionally to growth in length. Heterobronchus longifilis is the only species with positive allometric growth, indicating relative weight growth faster than growth in length. In contrast, for all other species that showed negative allometric growth, their growth in length is faster than weight gain during their growth.

Tah et al. (2012) [15] calculated allometric growth coefficients of Length-Weight Relationship for 36 species in two Ivorian inland waters. However, only eleven (11) of our species showed growth patterns similar to theirs: Chrisyichthys nigrodigitatus, Chromidotilapia guntheri, Chrisyichthys maurus, Heterobronchus longifilis, Labeo coubie, Marcusenius ussheri, Mormyrus rume, Oreochromis niloticus, Sarotherodon galilaeus, Sarotherodon melanotheron and Schilbe intermedius. At the opposite, seven (07) other species represented by Brycinus imberi, Hemichromis fasciatus, Labeo parvus, Marcusenius furcident, Petrocephalus bovei, Synodontis schall and Tilapia zillii, showed different allometric growth coefficients values. For example, Brycinus imberi, Hemichromis fasciatus, Labeo parvus and Marcusenius furcident have isometric growth in the Solomougou Dam Lake, while Tah et al. (2012) [15] reported allometric growth for these species. For Petrocephalus bovei and Tilapia zillii, our results indicate negative allometric growth against positive allometric growth noted by Tah et al. (2012) [15].

Four of our species have not been studied by Tah et al. (2012) [15]. These are Clarias gariepinus, Heterobronchus longifilis, Tilapia guineensis and Tilapia mariae. A negative allometry was noted by Ecoutin and Albaret (2003) [16] for Tilapia guineensis in Ebrie lagoon in Côte d'Ivoire (b=2.847), also in this study (b=2.727). As for Clarias gariepinus, Coulibaly (2008) [17] and King (1996) [18] reported a positive allometry in the Sourou River in Burkina Faso (b=3.14) and in Nigeria (b=3.14) respectively, in contrast to isometric growth for this species in our study (b=2.934). For Tilapia mariae, King (1996) [18] reports two different allometric growth coefficients (b=2.852 and b=3.169) in two inland waters in Nigeria, while our results indicate negative allometric growth (b = 2.832). It is generally accepted that differences in allometric growth coefficients of the Length-Weight relationship for a same species in different areas are attributable to factors such as sampling procedure (size and length of the sample) (Ecoutin and Albaret, 2003) [16], sexual dimorphism (Artigues et al., 2003) [19], water quality or food availability (Henderson, 2005) [20].

Fulton's condition factor (K) allowed evaluating physiological status of fish, based on the principle that specimen of a given length with a higher mass are in better condition. Bagenal and Tesch (1978) [14] reported K values between 2.9 and 4.8 for freshwater fish. On this basis, only 27.27% of species sampled in Solomougou Dame Lake have mean values of K while 31.82% and 40.91% are respectively above and below this interval. Thus, 59.09% of species, with K values greater than 2.9, is an indication of good adaptation for the majority of them to the conditions of life in the Solomougou Dam Lake.

Conclusion

The present study allowed calculating allometric growth coefficients of Length-Weight Relationship for the twenty-two (22) representative fish species in the Solomougou Dam Lake catches. The results indicated isometric growth in six of them, positive allometric growth for one species and negative allometric growth for fifteen others. These data could be used for models for any management program in this fishery.

Acknowledgements

Authors acknowledge administrative authorities in charge of the Management of Animal and Halieutic Resources in the Department of Korhogo, who facilitated our relations with fishermen, as well as fishermen exercising on the Solomougou Dam Lake for their perfect collaboration.
References


