LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF SIX CICHLID (CICHLIDAE: PERCIFORMIS) SPECIES OF ANAMBRA RIVER, NIGERIA


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Received: June 10, 2013; Accepted: July 11, 2013

Abstract- The length-weight relationship and condition factor of six cichlid fish species inhabiting Anambra River were studied. The cichlid fish species were Chromidotilapia guntheri Sauvage 1882, Hemichromis bimaculatus Gill 1862, Tilapia zillii Gervais 1848, Hemichromis fasciatus Peters 1857, Tilapia mariae Boulenger 1899 and Oreochromis niloticus (Linnaeus 1758), obtained from fish landing sites of the river at Ogurugu, Nsugbe and Otuocha. C. guntheri, H. bimaculatus and T. zillii exhibited positive allometric growth with b = 3.452, 3.828 and 3.210, respectively, while H. fasciatus, T. mariae and O. niloticus exhibited negative allometric growth with b = 2.667, 2.272 and 2.792, respectively. There was difference in the condition factors for the combined fish species and the monthly factor for each fish species studied: C. guntheri was 3.44 ± 0.39, H. fasciatus (2.85 ± 0.30), H. bimaculatus (3.52 ± 0.20), T. zillii (3.77 ± 0.30), T. mariae (2.69 ± 0.28) and O. niloticus (2.91 ± 0.31). All species studied were in good condition. Relatively high condition factors of cichlid species estimated in the present study indicated that the physicochemical and biotic variables in the river were within acceptable limits for fish production freshwater ecosystem.

Keywords- Length-weight relationship, Condition factor, Cichlids, Anambra River

Running Title- Length-weight relationship and condition factor of cichlids


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Introduction

Inland open water fishery resources play a significant role in the economy, culture, tradition and food habits of the people of a nation. Fish can be a cheap source of highly nutritious protein, and they also contain other essential nutrients required by the body [1-3]. Hence studies about fish biology and ecology are important in order to improve fishery management and conservation. In this sense, studies about length-weight relationship (LWR) are of great importance in fishery assessments and management [4]. The LWR can give information on the stock composition, growth rate, life expectancy, mortality and production of fish species and it is an important tool in fish biology, stock composition, physiology, ecology and fisheries assessment [5-12]. Moreover it is useful in determining weight and biomass when only length measurements are available, as indicator of condition, to assess the relative well-being of a fish population and to allow for statistical comparisons of species growth between different populations. Consequently, LWR studies on fish are extensive [9,10,13-16].

On the other hand, the condition factor (K) is a parameter of the state of well-being of the fish based on the hypothesis that heavier fish of a particular length are in a better physiological condition [17]. The condition of a fish reflects recent physical and biological circumstances, as it is strongly influenced by both biotic and abiotic environmental variables, and fluctuates by interaction among feeding habits, parasitic burden and fish physiological conditions [5]. It can be used to compare the inter- and intra- specific “condition”, “fattness” or wellbeing of fish from the same or contrasting habitats, it is a useful index for the monitoring of feeding intensity, age and growth rates in fish [18], and it can be used as an index to assess the status of the aquatic ecosystem in which fish live. In a similar way to LWR, studies about K on fish are extensive (e.g. condition factors of different tropical finfish species have been reported [9,10,19-30]. A lot of studies have been conducted on the length-weight relationship and condition factor of cichlids in Nigeria waters thus: Chromidotilapia guntheri of Anambra river [31], Eleiyele Lake, Southwestern Nigeria [32], Ntak Inyang stream, Akwa Ibom State [33] and Epe Lagoon, Lagos [16]; Hemichromis bimaculatus of Anambra river [30], Eleiyele Lake, Southwestern Nigeria [32] and Wasai reservoir, Kano [34]; H. elongatoides of Ntak Inyang stream, Akwa Ibom State [33]; H. fasciatus of Anambra river [30] and Ntak Inyang stream, Akwa Ibom State [33]; H. niloticus of Ntak Inyang stream, Akwa Ibom State [33]; Oreochromis niloticus of Anambra River [30], Sanni Luba Fish Farm, Ijebu-Ode, Ogun State [35], Gbedikere Lake, Bassa, Kogi State [36], Wasai reservoir, Kano [34] and Sarotherodon melanochromus of Eleiyele Lake, Southwestern Nigeria [32] and Tilapia mariae of Ethiope River, Nigeria [37] among many others. Reassessment of length-weight relationship and con-
Length-Weight Relationship and Condition Factor of Six Cichlid (Cichilidae: Perciformis) Species of Anambra River, Nigeria

The Anambra River is about 14,010 km² [38]. The Anambra River is the largest tributary of river Niger below Lokoja, and is often regarded as a component part of the lower Niger lowlands [38]. Essentially, the river has a southward course up to the Kogi/Enugu State boundary; it then meanders through Ogunruru to Otoucha and Nsugbe from where it flows down to form a confluence with the Niger River at Onitsha. The Anambra River basin lies between latitudes 6°10’ and 7°20’N and longitudes 6°35’ and 7°40’E [38]. Ichthyofaunally, the water bodies had 52 fish species belonging to 17 families. Two families, Characidae, 19.5%, and Mochokidae, 11.8%, constituted the dominant fish families in the river. The dominant fish species were Cítherinus cítherius, 9.02% and Aílestes nurse, 7.1%. Other fish species with significant abundance were Synodontis clarias 6.9%, Macrolepidotus curvier 5.7%, Labeo coubie 5.4%, Distichodus rostratus 4.9% and Schilbe mystus 4.5%. The cichlids although recorded were not significantly abundant. The least abundant animals utilizing the basin was Ardea cinerea with 22.2% occurrence, Capríni sp. with 13.51% occurrence and Varanus niloticus with 10.04% occurrence. The least abundant animals utilizing the basin were Chéphalophus ruthíllus and Erythrócebus patas with 0.58% occurrence, respectively [28]. The sampling areas were located around the major landing sites of the main river and the adjacent floodplain of Nsugbe, Otoucha & Ogunruru [Fig-1].

Materials and Methods

The Anambra River was sampled for cichlids, Sampling was done fortnightly from January to December 2010. Fish were caught using various fishing gears used include, fish fences, hooks and line, set lines, lift nets, dragnets, beach seines and cast nets. Fish species were identified to species level [39], labeled and preserved in ice. Differences in the species size composition and abundance in the sampling locations were compensated for by sorting into length classes [40-42]. The total length (TL) of each freshly caught fish was measured to the nearest millimeter using a measuring board. A weighing balance was used to measure the fresh weight of the fish to the nearest gram. The sex (male or female) of each cichlid fish was determined after dissection to see the gonad. The parameters a (intercepts) and b (slopes) of the LWR estimated from: W = aLb

where W = weight (g), L = standard length (cm), a = constant and b = growth exponent. The equation was linearised by a logarithmic transformation thus: Log W = Log a + b Log L. In order to test if the obtained b values in the linear regression models were significantly different (allometric growth) from 3 (isometric growth), a t-test with confidence level of 95% was performed [43]. The value of the growth exponent was used to calculate the condition factor using the formula: K = 100W / L where K = condition factor, W = total body weight (g), L = standard length (cm) and b = growth exponent.

Results and Discussion

A total of 7091 individuals belonging to six species of the cichlid family were used in the study. The most abundant species were the Tilapia species, while the least abundant was H. bimaculatus. The number of specimens, length ranges (minimum and maximum), parameters of length-weight relationships (a and b), the coefficient of relationship (r) and the condition factor (K) are given in [Table-1] and [Table-2]. Even though the change of b values depends primarily on the shape and fatness of the species, various factors may be responsible for differences in the observed b value for the length-weight relationships of Anambra River cichlids. These factors may include seasons, water temperature, salinity, food (quantity, quality and size), sex and stage of maturity [40-44-46]. The values obtained for the length-weight relationship showed that none of the cichlid species exhibited isometric growth. C. guntheri, H. bimaculatus and T. zillii exhibited positive allometric growth, whereas H. fasciatus, T. mariae and O. niloticus exhibited negative allometric growth [Table-1]. In line with the findings of this study, several authors [16,30,34,47-52] have reported negative allometric growth for different cichlid fish species from varied water bodies [Table-3]. This implies that the fish becomes less rotund as it grows in length [53]. The mean condition factors for the six cichlid species in Anambra River showed temporal (sex) variations. The condition factor for all the species in wet season was significantly (p <0.05) higher than that in dry season. Seasonal variation in the condition factor of fish has been reported for Leuciscus lepidus and Brycinus nurse [20,54]. However, the results of this study do not conform to those published for Tilapia guineensis, C. guntheri and T. mariae [22,23] in which no seasonal changes were observed in condition factor. Afamdi [27] recorded a disparity in condition factor from his study, where K for C. guntheri and T. mariae for dry season were higher than that of wet season, but similar result for T. zillii. Despite these differences in observation, Oni, et al. [18] noted that condition factor was not constant for a species or population over a time interval and might be influenced by both biotic and abiotic factors such as feeding regime and stage of gonadal development. In fish, the condition factor reflects information on the physiological state of the fish in relation to its welfare. From nutritional and reproductive points of view, condition factor reflects the accumulation of fat and gonadal development [5]. From a reproductive perspective, the highest K values were attained in some species during gonad maturation stages [55]. Condition factor also gives information when comparing two populations living in certain feeding, density, climate and other

Fig. 1- Map of Anambra river basin showing the sampling locations 1, 2 and 3

All the major fish landing sites were sampled for cichlids. Sampling was done fortnightly from January to December 2010. Fish were purchased from local fishermen, by prior arrangement. The identified fishing gears used include, fish fences, hooks and line, set lines, lift nets, dragnets, beach seines and cast nets. Fish species were identified to species level [39], labeled and preserved in ice. Differences in the species size composition and abundance in the
conditions; when determining the period of gonadal maturation and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source [56]. Braga [57] showed that values of the condition factor may vary according to seasons as influenced by environmental conditions. Temporal variations in condition factor recorded this study was influenced by many biotic and abiotic factors such as phytoplankton abundance, predation, water temperature and dissolve oxygen concentrations among others which may of may not favour the survival of all the species in the ecosystem.

**Table 1- Sexual dimorphism in length-weight relationship and condition factor (K) of six cichlid species in Anambra River, Nigeria between January and December 2010**

<table>
<thead>
<tr>
<th>Species</th>
<th>a</th>
<th>b</th>
<th>Number examined</th>
<th>r</th>
<th>Min. Length (cm)</th>
<th>Max. Length (cm)</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Combine Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. guntheri</td>
<td>-1.907</td>
<td>3.341</td>
<td>1169</td>
<td>0.92</td>
<td>7.2</td>
<td>12.7</td>
<td>2.68 ± 0.02</td>
</tr>
<tr>
<td>H. bimaculatus</td>
<td>-0.221</td>
<td>1.266</td>
<td>890</td>
<td>0.16</td>
<td>7.6</td>
<td>7.9</td>
<td>1.75 ± 0.01</td>
</tr>
<tr>
<td>H. fasciatus</td>
<td>0.372</td>
<td>0.738</td>
<td>912</td>
<td>0.3</td>
<td>2.9</td>
<td>2.9</td>
<td>1.79 ± 0.25</td>
</tr>
<tr>
<td>O. niloticus</td>
<td>-0.826</td>
<td>2.059</td>
<td>1211</td>
<td>0.73</td>
<td>6.1</td>
<td>14.4</td>
<td>1.93 ± 0.06</td>
</tr>
<tr>
<td>T. mariae</td>
<td>-1.357</td>
<td>2.604</td>
<td>1340</td>
<td>0.93</td>
<td>6.9</td>
<td>16.3</td>
<td>1.76 ± 0.02</td>
</tr>
<tr>
<td>T. zillii</td>
<td>-1.66</td>
<td>3.038</td>
<td>1569</td>
<td>0.89</td>
<td>7.7</td>
<td>16.7</td>
<td>2.47 ± 0.03</td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. guntheri</td>
<td>-1.878</td>
<td>3.317</td>
<td>671</td>
<td>0.955</td>
<td>7.2</td>
<td>12.7</td>
<td>2.69 ± 0.03</td>
</tr>
<tr>
<td>H. bimaculatus</td>
<td>-0.441</td>
<td>1.508</td>
<td>423</td>
<td>0.175</td>
<td>7.6</td>
<td>7.8</td>
<td>1.73 ± 0.01</td>
</tr>
<tr>
<td>H. fasciatus</td>
<td>0.766</td>
<td>0.32</td>
<td>405</td>
<td>0.262</td>
<td>2.9</td>
<td>40</td>
<td>1.84 ± 0.46</td>
</tr>
<tr>
<td>O. niloticus</td>
<td>-0.118</td>
<td>1.325</td>
<td>628</td>
<td>0.487</td>
<td>6.0</td>
<td>14</td>
<td>2.20 ± 0.14</td>
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<tr>
<td>T. mariae</td>
<td>-1.366</td>
<td>2.612</td>
<td>694</td>
<td>0.923</td>
<td>6.9</td>
<td>16.3</td>
<td>1.74 ± 0.03</td>
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<tr>
<td>T. zillii</td>
<td>-1.617</td>
<td>2.999</td>
<td>858</td>
<td>0.891</td>
<td>7.1</td>
<td>16.5</td>
<td>2.49 ± 0.04</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. guntheri</td>
<td>-1.942</td>
<td>3.373</td>
<td>498</td>
<td>0.88</td>
<td>7.2</td>
<td>12.1</td>
<td>2.67 ± 0.04</td>
</tr>
<tr>
<td>H. bimaculatus</td>
<td>0.93</td>
<td>0.913</td>
<td>467</td>
<td>0.121</td>
<td>7.6</td>
<td>7.9</td>
<td>1.77 ± 0.01</td>
</tr>
<tr>
<td>H. fasciatus</td>
<td>-0.525</td>
<td>1.682</td>
<td>507</td>
<td>0.651</td>
<td>3.0</td>
<td>19.7</td>
<td>1.75 ± 0.18</td>
</tr>
<tr>
<td>O. niloticus</td>
<td>-1.589</td>
<td>2.818</td>
<td>583</td>
<td>0.957</td>
<td>6.2</td>
<td>14.4</td>
<td>1.71 ± 0.02</td>
</tr>
<tr>
<td>T. mariae</td>
<td>-1.351</td>
<td>2.6</td>
<td>646</td>
<td>0.932</td>
<td>7.4</td>
<td>13.6</td>
<td>1.77 ± 0.02</td>
</tr>
<tr>
<td>T. zillii</td>
<td>-1.7</td>
<td>3.075</td>
<td>711</td>
<td>0.882</td>
<td>7.4</td>
<td>16.7</td>
<td>2.46 ± 0.04</td>
</tr>
</tbody>
</table>

**Table 2- Seasonal variation in length-weight relationship and condition factor (K) of six cichlid species in Anambra River, Nigeria between January and December 2010**

<table>
<thead>
<tr>
<th>Species</th>
<th>a</th>
<th>b</th>
<th>Number examined</th>
<th>r</th>
<th>Min. Length (cm)</th>
<th>Max. Length (cm)</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dry Season</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>C. guntheri</td>
<td>-1.999</td>
<td>3.441</td>
<td>783</td>
<td>0.938</td>
<td>7.2</td>
<td>12.7</td>
<td>2.70 ± 0.03</td>
</tr>
<tr>
<td>H. bimaculatus</td>
<td>-0.622</td>
<td>1.721</td>
<td>510</td>
<td>0.216</td>
<td>7.6</td>
<td>7.9</td>
<td>1.75 ± 0.01</td>
</tr>
<tr>
<td>H. fasciatus</td>
<td>0.548</td>
<td>0.549</td>
<td>602</td>
<td>0.344</td>
<td>7.1</td>
<td>40</td>
<td>2.02 ± 0.50</td>
</tr>
<tr>
<td>O. niloticus</td>
<td>-1.499</td>
<td>2.736</td>
<td>827</td>
<td>0.962</td>
<td>6.1</td>
<td>14.4</td>
<td>1.75 ± 0.02</td>
</tr>
<tr>
<td>T. mariae</td>
<td>-1.401</td>
<td>2.648</td>
<td>973</td>
<td>0.933</td>
<td>6.9</td>
<td>16.3</td>
<td>1.76 ± 0.02</td>
</tr>
<tr>
<td>T. zillii</td>
<td>-1.061</td>
<td>2.454</td>
<td>892</td>
<td>0.726</td>
<td>7.1</td>
<td>16.7</td>
<td>2.51 ± 0.08</td>
</tr>
<tr>
<td><strong>Wet Season</strong></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>C. guntheri</td>
<td>-1.818</td>
<td>3.244</td>
<td>386</td>
<td>0.896</td>
<td>7.2</td>
<td>12.6</td>
<td>2.66 ± 0.03</td>
</tr>
<tr>
<td>H. bimaculatus</td>
<td>0.459</td>
<td>0.497</td>
<td>380</td>
<td>0.059</td>
<td>7.6</td>
<td>7.9</td>
<td>1.74 ± 0.01</td>
</tr>
<tr>
<td>H. fasciatus</td>
<td>0.893</td>
<td>0.233</td>
<td>310</td>
<td>0.159</td>
<td>2.9</td>
<td>34.2</td>
<td>1.51 ± 0.06</td>
</tr>
<tr>
<td>O. niloticus</td>
<td>-1.481</td>
<td>2.717</td>
<td>384</td>
<td>0.959</td>
<td>6.1</td>
<td>14.4</td>
<td>1.75 ± 0.02</td>
</tr>
<tr>
<td>T. mariae</td>
<td>-1.303</td>
<td>2.551</td>
<td>596</td>
<td>0.922</td>
<td>6.9</td>
<td>16.3</td>
<td>1.76 ± 0.03</td>
</tr>
<tr>
<td>T. zillii</td>
<td>-1.584</td>
<td>2.977</td>
<td>448</td>
<td>0.879</td>
<td>7.5</td>
<td>16.7</td>
<td>2.54 ± 0.04</td>
</tr>
</tbody>
</table>
### Table 3: Variations in length-weight relationship and condition factor (K) of cichlid species in varied aquatic ecosystems between 2004 and 2012

<table>
<thead>
<tr>
<th>Species</th>
<th>Length (cm)</th>
<th>Weight (g)</th>
<th>a</th>
<th>b</th>
<th>r</th>
<th>K</th>
<th>Habitat</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. guntheri</td>
<td>12.42</td>
<td>62.57</td>
<td>-0.44</td>
<td>2.046</td>
<td>0.64</td>
<td>-</td>
<td>Epe Lagoon Lagos, Nigeria</td>
<td>Soyinka and Ebigbo, 2012</td>
</tr>
<tr>
<td>C. guntheri</td>
<td>8.4 - 10.1</td>
<td>-</td>
<td>0.0001</td>
<td>3.452</td>
<td>0.88</td>
<td>-</td>
<td>Anambra River, Nigeria</td>
<td>This study</td>
</tr>
<tr>
<td>C. guntheri</td>
<td>10.38 ± 1.33</td>
<td>-</td>
<td>0.0252</td>
<td>2.895</td>
<td>0.939</td>
<td>-</td>
<td>Anambra River, Nigeria</td>
<td>Ezenwaji, 2004</td>
</tr>
<tr>
<td>C. guntheri</td>
<td>16.60 ± 4.10</td>
<td>125.60 ± 11.20</td>
<td>-</td>
<td>-</td>
<td>2.7</td>
<td>C. mariae</td>
<td>Tomato River Akwa</td>
<td>Imam, et al. 2010</td>
</tr>
<tr>
<td>H. bimaculatus</td>
<td>7.85 ± 1.36</td>
<td>-</td>
<td>0.0577</td>
<td>2.481</td>
<td>0.979</td>
<td>-</td>
<td>Anambra River, Nigeria</td>
<td>Ezenwaji, 2004</td>
</tr>
<tr>
<td>H. bimaculatus</td>
<td>-</td>
<td>-</td>
<td>0.6</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>Waissi Reservoir, Kano, Nigeria</td>
<td>Imam, et al. 2010</td>
</tr>
<tr>
<td>H. bimaculatus</td>
<td>7.6 - 7.9</td>
<td>-</td>
<td>0.0032</td>
<td>3.828</td>
<td>0.771</td>
<td>3.70 ± 0.21</td>
<td>Anambra River, Nigeria</td>
<td>This study</td>
</tr>
<tr>
<td>H. elongatus</td>
<td>11.70 ± 3.40</td>
<td>30.00 ± 5.50</td>
<td>-</td>
<td>-</td>
<td>1.8</td>
<td>-</td>
<td>Tomato River Akwa</td>
<td>Imam, et al. 2010</td>
</tr>
<tr>
<td>H. fasciatus</td>
<td>9.67 ± 2.08</td>
<td>-</td>
<td>0.0294</td>
<td>2.779</td>
<td>0.905</td>
<td>-</td>
<td>Anambra River, Nigeria</td>
<td>Ezenwaji, 2004</td>
</tr>
<tr>
<td>H. fasciatus</td>
<td>10.10 ± 3.20</td>
<td>46.80 ± 6.80</td>
<td>-</td>
<td>-</td>
<td>1.2</td>
<td>-</td>
<td>Tomato River Akwa</td>
<td>Imam, et al. 2010</td>
</tr>
<tr>
<td>H. fasciatus</td>
<td>7.4-14.8</td>
<td>-</td>
<td>0.0311</td>
<td>2.667</td>
<td>0.916</td>
<td>3.16 ± 0.18</td>
<td>Anambra River, Nigeria</td>
<td>This study</td>
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<td>6.60 ± 2.60</td>
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<td>-</td>
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<td>Imam, et al. 2010</td>
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<td>10.8 ± 3.42</td>
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<td>0.0267</td>
<td>3.1817</td>
<td>0.9797</td>
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<td>0.0033</td>
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<td>Ezenwaji, 2004</td>
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<td>1.4</td>
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<td>Waissi Reservoir, Kano, Nigeria</td>
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<td>P. pulcher</td>
<td>9.40 ± 3.00</td>
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<td>-</td>
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<td>S. macrocephala</td>
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<tr>
<td>T. dageti</td>
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</table>

### Acknowledgements

We are indebted to Department of Zoology and Environmental Biology, University of Nigeria, Nsukka for providing full laboratory facilities during the study periods. We are also thankful to Mr. Simon Ugwu and Mr. Sabestine Ali who assisted in fish collection. There is no conflict of interest among the authors for the publication of this research article.

### References

Atama C.I., Okeke O.C., Ekeh F.N., Ezenwaji N.E., Onah I.E., Ivoke N., Onoja U.S. and Eyo J.E.


Journal of Fisheries and Aquaculture
ISSN: 0976-9927 & E-ISSN: 0976-9935, Volume 4, Issue 2, 2013