Research article

Biometry, condition factors and length-weight relationships of sixteen fish species in Iwopin fresh-water ecotype of Lekki Lagoon, Ogun State, Southwest Nigeria

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ABSTRACT

Study on biometry, length-weight relationships and condition factors of 139 fishes covering 11 families and 16 species inhabiting Iwopin fresh water ecotype of Lekki Lagoon, were provided. The fish species were obtained from the major landing sites of Iwopin from July to September, 2017. As a result, Chrysichthys nigrodigitatus was the most abundant while Polypterus senegalus, Sphyraena barracuda and Dagetichthys lakdoensis constituted the least groups of populations. The Fulton condition factor (K) values significantly (P < 0.001) ranged between 0.80 and 1.28 while b values varied from 1.067 to 3.41. The values of b indicated negative and positive allometric growth patterns. The highest mean total length value (33.2 ± 1.55) cm was found in Papyrocranus afer while the least mean total length value (7.9 ± 0.60) cm was found in Sarotherodon galilaeus. S. barracuda had the highest mean weight value (187.0 ± 72.9) g while S. galilaeus had the least mean weight value.

1. Introduction

Fisheries remain one of the reliable subsectors of agriculture that contributed significantly to the nation’s Gross Domestic Product through agriculture (Federal Department of Fisheries –FDF, 2007). The importance of Fisheries in a country cannot only be measured by the contribution to the GDP, one must also take into consideration that fisheries resources and products are fundamental components of human feeding and employment (Emygdio, 2003). Inland open water fishery resources play a significant role in the economy, culture, tradition and food habits of the people of a nation. Fish for instance, plays an important role in the development of a nation. Apart from being a cheap source of highly nutritious protein, it also contains other essential nutrients required by the body (Sikoki and Ootobekere, 1999; Ross et al., 2003). For instance, Ohen and Abang (2007) noted that fish also serve medicinal purposes due to its replenishment of human body with vitamins A and D; calcium, phosphorus and lysine; sulphur and amino acids. Hence studies about fish biology and ecology are important in order to improve fishery management and conservation (Atama et al., 2013). The knowledge of biology particularly biometric parameter is of utmost importance not only to fill up the lacuna of our present day technological efficiencies of the fishery entrepreneurs for evolving judicious pisciculture management (Swain and Foote, 1999). The study of differences and variability in morphometric and meristic characters of fish stocks is important in phylogenetics as it provide information for subsequent studies on the genetic improvement of stocks (Umaru et al., 2015). The length-weight relationship is very important for proper exploitation and management of the population of fish species (Anene, 2005) also, it is very much essential for stabilizing the taxonomic characters of the species (Pervin and Mortuza, 2008). Data obtained from length and weight analyses are a useful and standard result of fish sampling programs. These data are needed to estimate growth rates, length and age structures, and other components of fish population dynamics (Kolher et al., 1995). Estimations of length-weight relationships allow fisheries scientists to convert growth-in-length equations to growth-in-weight in stock assessment models (Morato et al., 2001; Stergiou and Moutopoulos, 2001), calculate fish condition (Petrakis and Stergiou, 1995), compare life history and morphological aspects of populations inhabiting different regions (Stergiou and Moutopoulos, 2001), and estimate biomass from length frequency distributions (Petrakis and Stergiou, 1995; Dulcic and Kraljevic, 1996).

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Condition factor (K) on the other hand, is the parameter indicating the state of well-being of the fish based on the hypothesis that heavier fish of a given length are in a better physiological condition (Bagenen and Tesch, 1978). It can be used to compare the inter- and intra-specific “condition”, “fatness” or well-being 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 (Oni et al., 1983), and it can be used as an index to assess the status of the aquatic ecosystem in which the fish live (Anene, 2005). Although strongly influenced by both the biotic and abiotic environmental variables, and fluctuates by interaction among feeding habits, parasitic burden and fish physiological conditions yet, the condition factor reflects recent physical and biological circumstances of a fish (Le Cren, 1951). It decreases with an increase in length (Bakare, 1970; Fagade, 1979) and also influences the reproductive cycle in fish (Welcome, 1979).

Quite a lot of studies have been conducted in Nigerian waters on the length-weight relationships, condition factor and biometry of different fish species and they include but not limited to: Fagade (1978, 1979 and 1983); Alfred-Ockiya and Njoku (1995) studied four species of grey mullet in New Calabar River; Observation on the condition factor of Beycinus nurser from Asa Reservoir, Ilorin, Nigeria (Salu, 2001) and Length-weight relationship of Sarotherodon melanatheron and Tilapia guineensis in Elechi creek, Nigcr Delta, Nigeria (Diri, 2002). Length-weight relationships of five fish species in Epe lagoon, Nigeria (Fafiyi and Olubanjo, 2010); Length-weight relationship, condition factor and age of ten fish species from the lower Nun river, Niger Delta, Nigeria (Hart and Abowei, 2007); Agboola and Anetekhai (2008), Length-weight relationships of 35 fish species from Badagry creek, Lagos, Nigeria and Abwe and Abowei (2009), Study of length-weight relationship, condition factor of five fish species from Nkoro River, Niger Delta, Nigeria. Also, Umaru et al. (2015) studied some biometric parameters of four selected fish species in Domu Dam, Nassara State, Nigeria; Length-weight relationships and condition factor of 21 fish species in Ologe Lagoon, Lagos, Nigeria (Kumolu-Johnson and Ndimele, 2010) and Atama et al. (2013), Length-weight relationship and condition factor of six Cichlid (Cichlidae: Perciformis) species of Anambra River, Nigeria. By consequence, studies of length-weight relationships, condition factor and biometry are extensive.

Despite the importance of length-weight relationship, condition factor and biometry in fisheries science and numerous contributions of the Iwopin freshwater eco-type of Lekki Lagoon to the fisheries of Ogun state, Nigeria, information on the biometry, length-weight relationships and condition factors of fish species in this water body is currently non-existent. This study is therefore aimed at ending the paucity of this information and also to provide useful information which is capable of helping greatly in the management of Iwopin freshwater eco-type of Lekki Lagoon, Ogun State, Nigeria.

2. Materials and methods

2.1. The study area

This study was carried out in Iwopin area of Lekki Lagoon, Ogun water side Local Government Area of Ogun State, Southwestern Nigeria. It is situated between longitude 4° 15’ – 4° 30’ and latitude 6° 20’ N – 6° 45’ N and bounded in the East by Lekki Lagoon and down South by Bight of Benin. The Lagoon covers an area of 26km² (Sentengo and Larkin, 1973) and connected by tri-axis called “Are” to the Lagos and Lekki Lagoon and also to some Creeks (Adekoya, 1995). The Lagoon empties into the Atlantic Ocean via Lagos habour. The Lagoon is essentially freshwater which is open to saltwater intrusion, at times. Natural resources found in Iwopin freshwater Eco-type of Lekki Lagoon include extensive fertile soil, rocks and mineral deposits (Adekoya, 1995).

Hydrologically, the Lagoon falls into the western littoral area with semi-diurnal offshore tides. Rips and ocean currents which are products of seasonal upwelling with summer intensification and windy influence normally occur between July and September. The two air masses, south-western and north-east harmattan, alongside the oscillations of the Intern Tropical Discontinuity (ITD) promote heavy rainfall. The climate is tropical with rainy (April–November) and dry (December–March) seasons.

The major pre-occupation in Iwopin area of Lekki Lagoon is fishing. Only the indigenes are allowed to fish on the Lagoon. Other ethnic groups in the community are engaged in some other means of livelihood such as farming, transportation and lumbering. The major fish landing areas are Ilamo, Agbalegiyo, Imosiri, Imeki, Pipeline, Oni, Oriwu, Origbe and Oriyarni (Adekoya, 1995) (Figure 1). Some of the forest tree species used by the fishermen to make different boat sizes—for fishing and transportation include: “Eru”, “Akorko”, Lophira atala, Corilis millenii, and Terminalia ivorensis.

2.2. Collection of specimens

Specimens used for this study were collected at various landing areas of the Lagoon (Agbalegiyo, Ebute Oni, Fishery, Ebute Imeki, and Iwopin) (Figure 1), from different fishermen from July to September, 2017. It was discovered, in the course of this study that the landing area, Fishery, is one of the major landing areas where the market folks come to purchase their fish from the fish farmers. Specimens were caught with different types of gears such as cast net, gill net (nylon), seine net, hook and line, and fish aggregator. The gill net mesh sizes ranged from 5.08 cm (2”) to 10.00 cm (4”). The collected specimens were rapidly labeled and packed inside a big white plastic bucket containing big size ice blocks to prevent post-harvest spoilage and later stored in a deep freezer, in the Depart-ment of Aquaculture and Fisheries Management, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria, to avert posthumous micro-bial deterioration.

2.3. Laboratory procedure

Prior to length-weight and other meristic measurements, the fishes were taken out in batches from the freezer and allowed to thaw. The fish species were identified with the aid of available literature (Boulenger, 1909; Pellegrin, 1912; Reed et al., 1967; Levesque et al., 1990; Olubese-bikan and Raji, 1998). Total lengths (±0.1cm) of the fish were taken from the tip of the snout (mouth closed) to the extended tip of the caudal fin using a measuring board. The body weights of the fish were measured with a top loading Metler balance (Fafiyi and Olubanjo, 2005) and recorded to the nearest ±(0.01) gram. The sex (male or female) of each of the sample was recorded for all the fishes of the sample collected.

Meristic features of fish species less than ten (10) samples were all counted while ten (10) samples were randomly selected from fish species that are more than ten (10) in numbers and their meristic features were counted. For Chrysiptihys nigrodigitatus with ninety (90) samples, twenty five (25) randomly selected samples had their meristic features counted.

2.4. Statistical analysis of data

The relationship between the length (L) and weight (W) of the fish samples were expressed by the equation (Le Cren, 1951):

\[ W = aL^b \]  

(1)

Where:\n
- \( W \) = Weight of fish in gram (g);
- \( L \) = Total Length (TL) of fish in centimeter (cm);
- \( a \) = Constant (intercept).
- \( b \) = Slope (i.e. change in weight per unit change in Length).

The parameters ‘a’ and ‘b’ were obtained from a least square linear regression (Zar, 1984) of the length and weight of Eq. (1), to obtain:

\[ \log_{10} W = \log_{10} a + b \log_{10} L \]  

(2)
The Fulton's condition factors (K) of fish as expressed by Bagenal and Tesch (1978) were used to estimate the well-being of the fishes, that is, compare the health or fattening of the fishes. They were estimated using the relationship:

\[ K = \frac{100 \times W}{L^3} \]  

Where:
- \( K \) = condition factor.
- \( W \) = weight of fish (g).
- \( L \) = length of fish (cm).

Apart from the meristic measurements, the data collected were analysed using mean, standard error of mean, frequency distribution and analysis of variance (ANOVA) at 5% level of significance. SPSS (15.0 version) software was used to analyze the condition factors while the LWRs were analyzed using FISAT II.

Ethical approval and consent to participate is not applicable to this work, as dead fish were collected from the local fishermen.

3. Results and discussion

The results of the biometry, condition factors and length-weight relationships were obtained from the research conducted on one hundred and thirty-nine (139) fish samples. The samples consist of sixteen species and belong to eleven (11) families. Bagridae and Cichlidae constituted the dominant families in the samples experimented on and in the Lagoon. Among the Bagridae, *Chrysichthys nigrodigitatus* (Lacepede, 1803) is the most abundant fish species with 38.8% of specimens while among the Cichlidae, *Sarotherodon galilaeus* (Linnaeus, 1758) was the most abundant species with 4.3% of the total forty (40) fishes. Table 1 shows the classification, relative abundance and percentage occurrence by sex of fish species caught in the lagoon. In all the families, the females were more abundant than the males. One possible factor capable of influencing sex ratio is the availability of food. Nikolsky (1963) reported that when food is abundant, female predominate, with the situation inverting in regions where food is limited. Feeding activity, in this case, would be influencing metabolism through hormonal activity, resulting in changes in production of individuals of sex. In their work, Vicentini and Araijo...
(2003) stated that, some research has reported that females require better environmental conditions than males, suffering in their development when environmental conditions deteriorate. Nikolsky (1963) cited the example of Perca fluviatilis which apparently under worsening feeding conditions, showed a high proportion of atrophied females which served as food for several faster growing individuals of the same species. In the case of Iwopin area of Lekki Lagoon, the female predominance in all the fish families fits this theory, since much of organic materials influxes from the inland rivers (e.g. Rivers Oni, Saga, etc. (Figure 1)), into the Lagoon favour high food availability (Vicentini and Araújo, 2003), and coupled with the period of this study which falls into the rainy season (April–November). Also, differentiation in growth rate between sexes can cause an unbalanced proportion since the sex presenting faster growth rate will go through the most vulnerable smaller size phase quickly and, therefore, diminish the predation proportion. On the other hand, the sex with slower growth rate will be more likely to undergo predation, with its abundance decreased disproportionately in next development phases (Vicentini and Araújo, 2003). In addition, if male size differed from that of females, the mean fish size for commercial fisheries would be displaced towards one direction resulting in differentiated captures of a determined sex and modifying the stock sexual composition (Nikolsky, 1963). Although, growth rate aspects were not investigated in this study, it is not impossible that the females of the fishes sampled present a higher growth rate than the males, since female predominance occurred in all the fish families.

Table 2 shows the data for meristic features of the fish species. The numerals represent the number of spines present on the fins of those fish species that have spines. Investigation of morphometric variation, particularly of meristic series, in wide-ranging species of fishes has in many cases disclosed a lack of homogeneity with respect to certain characters (Hulb, 1934). The existence of racial stock within a large river system has been extensively used as a basis of conservation measures for Sockeye Salmon (Oncorhynchus nerka) of the Fraser River British Columbia (Royal, 1953). In tropical countries, literature on the social studies of individual fish species are scarce. This is in sharp contrast to temperate species where detailed information is available. However, this called for more studies and research work on the Nigerian Inland waters in order to bridge this gap which insufficient information has created. Also, the fact that most of these fish species (such as

| Species | No. of fishes | D. fin | A. fin | C. fin | P. fin | V. fin |
|---------|--------------|-------|-------|-------|-------|-------|
| Chrysichthys nigrodigitatus | 50 | i, 8 | 13 | 26 | i, 8 | 6 |
| Schilbe ranaruscus | 6 | i, 4 | 58 | 17 | i, 7 | 6 |
| Polypoetes senegalus | 4 | ix | 10 | 16 | 34 | 8 |
| Sarotherodon galilaeus | 10 | xvi, 12 | iii, 9 | 14 | 15 | i, 5 |
| Pelmatolatia mariae | 8 | xvi, 12 | ii, 10 | 18 | 13 | i, 5 |
| Hemichromis fasciatus | 5 | xiv, 10 | iii, 9 | 18 | 13 | i, 5 |
| Heterotis niloticus | 10 | 24 | 27 | 12 | 5 | 5 |
| Tilapia sili | 8 | xvii, ix | 10 | 17 | 13 | i, 5 |
| Pappysurus afzelius | 6 | 140 | 21 | 16 |
| Pellonula afzeliusi | 10 | 21 | 16 | 18 | 9 | 12 |
| Sarotherodon melanotheron | 9 | xvi, 12 | iii, 10 | 36 | 13 | i, 5 |
| Synodontis nigrina | 10 | i, 7 | 10 | 18 | i, 8 | 7 |
| Mormyrops deliciousus | 10 | 26 | 39 | 22 | 10 | 6 |
| Hyperopisus bece occultus | 10 | 13 | 62 | 22 | 11 | 6 |
| Sphyraena barracuda | 4 | ix, 6 | 9 | 17 | 12 | 5 |
| Dagecichthys lakdoensis | 4 | 103 | 103 | 17 | 9 | 6 |
| Oligosomus fluvius | 10 | 24 | 27 | 12 | 5 | 6 |
| Tilapia sili | 8 | xvii, ix | 10 | 17 | 13 | i, 5 |
| Pappysurus afzelius | 6 | 140 | 21 | 16 |
| Pellonula afzeliusi | 10 | 21 | 16 | 18 | 9 | 12 |
| Sarotherodon melanotheron | 9 | xvi, 12 | iii, 10 | 36 | 13 | i, 5 |
| Synodontis nigrina | 10 | i, 7 | 10 | 18 | i, 8 | 7 |
| Mormyrops deliciousus | 10 | 26 | 39 | 22 | 10 | 6 |
| Hyperopisus bece occultus | 10 | 13 | 62 | 22 | 11 | 6 |
| Sphyraena barracuda | 4 | ix, 6 | 9 | 17 | 12 | 5 |
| Dagecichthys lakdoensis | 4 | 103 | 103 | 17 | 9 | 6 |

The mean, minimum and maximum range values of the morphometric features of the fishes are presented in Table 3. Pappysurus afzelius (Günther, 1868) had the highest mean total length (TL) value (33.2 ± 1.55 cm) and minimum and maximum range values of 28.1 and 38.0cm respectively. Sarotherodon galilaeus had the least mean length value (7.9 ± 0.60 cm) with 4.9–11.0 cm as its minimum and maximum range values. Length-weight relationship is greatly affected by many factors related to pollution (Masoud et al., 2006; Rafia et al., 2007; Abdullahi and Ahmad, 2013), population variability (Kimmerer et al., 2005; Al-Nahdi et al., 2016), sampling season (Kimmerer et al., 2005 and Miller et al., 2015) and estimation methods (Kimmerer et al., 2005). Also, availability of food, feeding intensity, fish size, age, sex, stage of maturation (e.g. degree of gonad development), data pulling, sorting into classes, fullness of the gut, degree of muscular development, the amount of reserved fat and life history have been reported by various authors, to greatly affect the values one can obtain for K (Heincke, 1908; Crozier and Hecht, 1915; Le Cren, 1951; Bagel and Tesch, 1978; Gayando and Pauly, 1997; Olim and Borges, 2006; Ujjania et al., 2012; Gupta and Banerjee, 2015). The highest mean body depth (BD) was observed in Dagecichthys lakdoensis (6.0 ± 0.14 cm) and automatically had the highest mean body girth (BG) value (13.0 ± 0.55 cm) of the fishes. The least mean body depth value was observed in Pellonula afzeliusi (2.5 ± 0.20 cm) with (5.7 ± 0.51 cm) mean body girth value as the fish species with the least body girth value (Table 3).

Froese (2006) reported that length-weight data are often used to study the indication of fatness or general well-being of fish. However, small sample size may lead to over estimation of length-weight relationship allometric coefficient, b (Frontal et al., 2004) as observed in C. cadineti (n = 3), P. jubelini (n = 5), S. tritor (n = 5) and C. hippos (n = 3). Sphyraena barracuda (Edwards, 1771) had the highest mean weight value (187.0 ± 72.90g) of all the fishes sampled with minimum and maximum 68.0–395.0g range values. The least mean weight value was found in Sarotherodon galilaeus (9.0 ± 0.42g) and 6.0–10.0g as the minimum and maximum range values (Table 3). Díaz et al. (2000) found similar results in demersal fishes from upper continental slope of Colombia. The variations in fish sizes indicate that the fish population

| Species | No. of fish | D. fin | A. fin | C. fin | P. fin | V. fin |
|---------|------------|-------|-------|-------|-------|-------|
| Chrysichthys nigrodigitatus | 50 | i, 8 | 13 | 26 | i, 8 | 6 |
| Schilbe ranaruscus | 6 | i, 4 | 58 | 17 | i, 7 | 6 |
| Polypoetes senegalus | 4 | ix | 10 | 16 | 34 | 8 |
| Sarotherodon galilaeus | 10 | xvi, 12 | iii, 9 | 14 | 15 | i, 5 |
| Pelmatolatia mariae | 8 | xvi, 12 | ii, 10 | 18 | 13 | i, 5 |
| Hemichromis fasciatus | 5 | xiv, 10 | iii, 9 | 18 | 13 | i, 5 |
| Heterotis niloticus | 10 | 24 | 27 | 12 | 5 | 5 |
| Tilapia sili | 8 | xvii, ix | 10 | 17 | 13 | i, 5 |
| Pappysurus afzelius | 6 | 140 | 21 | 16 |
| Pellonula afzeliusi | 10 | 21 | 16 | 18 | 9 | 12 |
| Sarotherodon melanotheron | 9 | xvi, 12 | iii, 10 | 36 | 13 | i, 5 |
| Synodontis nigrina | 10 | i, 7 | 10 | 18 | i, 8 | 7 |
| Mormyrops deliciousus | 10 | 26 | 39 | 22 | 10 | 6 |
| Hyperopisus bece occultus | 10 | 13 | 62 | 22 | 11 | 6 |
| Sphyraena barracuda | 4 | ix, 6 | 9 | 17 | 12 | 5 |
| Dagecichthys lakdoensis | 4 | 103 | 103 | 17 | 9 | 6 |
### Table 3. Morphometric features of sixteen fish species caught from Iwopin freshwater Ecotype of Lekki Lagoon, Ogun State, Nigeria.

| Species                          | No. of fishes Measured | TL (range, cm) | SL (range, cm) | HL (range, cm) | BD (range, cm) | BG (range, cm) | FL (range, cm) | Wt (range, cm) |
|----------------------------------|------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Chrysichthys nigrograndis        | 25                     | 27.2 ± 1.0     | 140.0 ± 0.74   | 4.0 ± 0.21     | 3.3 ± 0.16     | 7.5 ± 0.27     | 15.5 ± 0.81    | 56.0 ± 10.61   |
| Schilbe uranoscopus              | 6                      | 16.8 ± 0.46    | 14.4 ± 0.41    | 2.5 ± 0.08     | 3.4 ± 0.08     | 8.1 ± 0.15     | 13.5 ± 0.46    | 28.5 ± 1.07    |
| Polypterus senegalus             | 4                      | 22.4 ± 0.92    | 18.7 ± 0.72    | 3.2 ± 0.03     | 3.1 ± 0.03     | 7.9 ± 0.29     | 58.5 ± 1.4     |
| Sarotherodon galileus            | 10                     | 7.9 ± 0.60     | 6.9 ± 0.50     | 2.5 ± 0.25     | 3.1 ± 0.11     | 7.0 ± 0.29     | 9.0 ± 0.42     |
| Pelmatolapia mariae              | 8                      | 16.7 ± 0.82    | 12.4 ± 0.76    | 4.4 ± 4.82     | 5.8 ± 0.37     | 12.6 ± 0.71    | 16.2 ± 0.82    | 127.0 ± 0.84   |
| Hemichromis fasciatus           | 5                      | 13.1 ± 0.83    | 10.6 ± 0.87    | 3.8 ± 0.15     | 3.7 ± 0.11     | 9.2 ± 0.39     | 27.2 ± 1.03    |
| Heterotis niloticus             | 10                     | 22.2 ± 1.15    | 18.2 ± 1.15    | 6.1 ± 0.26     | 3.8 ± 0.06     | 11.2 ± 0.06    | 109.0 ± 2.61   |
| Tilapia zillii                   | 8                      | 15.8 ± 0.95    | 11.9 ± 0.93    | 3.8 ± 0.18     | 5.4 ± 0.30     | 11.9 ± 0.58    | 79.1 ± 0.97    |
| Papyrocranus afer               | 6                      | 33.2 ± 1.55    | 31.2 ± 1.55    | 5.8 ± 0.27     | 5.6 ± 0.42     | 12.2 ± 0.85    | 144.0 ± 13.48  |
| Pelmelurus afzelii              | 10                     | 14.0 ± 1.77    | 9.8 ± 1.44     | 3.0 ± 0.24     | 2.5 ± 0.20     | 5.7 ± 0.51     | 29.6 ± 4.71    |
| Sarotherodon melanotheron       | 9                      | 13.5 ± 1.59    | 9.8 ± 1.40     | 3.7 ± 0.33     | 4.9 ± 0.56     | 10.6 ± 1.21    | 104.8 ± 11.83  |
| Symodontis nigra                | 10                     | 17.7 ± 2.08    | 10.7 ± 1.82    | 3.8 ± 0.28     | 3.9 ± 0.19     | 8.7 ± 0.39     | 89.0 ± 9.16    |
| Mormyrops deliciousus          | 10                     | 25.6 ± 2.59    | 21.6 ± 2.45    | 6.9 ± 0.51     | 5.3 ± 0.27     | 11.3 ± 0.55    | 29.9 ± 14.77   |
| Hyperopodus bebe occidentalis   | 10                     | 24.8 ± 3.09    | 22.0 ± 2.93    | 4.3 ± 0.63     | 4.8 ± 0.57     | 10.5 ± 1.21    | 133.3 ± 24.56  |
| Sphyraena barracuda             | 4                      | 25.0 ± 7.60    | 19.0 ± 6.67    | 6.7 ± 1.69     | 3.4 ± 0.83     | 8.5 ± 2.32     | 187.2 ± 72.90  |
| Dagetichthys lakoensis          | 4                      | 22.0 ± 6.07    | 19.1 ± 5.72    | 4.7 ± 0.69     | 6.0 ± 0.14     | 13.0 ± 0.55    | 92.0 ± 21.82   |

TL = Total Length; SL = Standard Length; HL = Head Length; BD = Body Depth; BG = Body Girth; FL = Fork Length; Wt = Weight; No. = number; cm = centimeter.

The values obtained for length-weight relationships, b, significantly (P < 0.001) rose from 1.067 to 3.411 in Sarotherodon melanotheron and showed high variations during the months. The student’s test showed that the fish species, except for seven (S. uranoscopus, P. senegalis, T. zillii, P. afer, S. melanotheron, S. baraccuda, D. lakoensis), had negative allometric growths. That is, the rate of increase in body length of the fish species is not proportional to the rate of increase in their body weight. This is similar to b values of 2.667 and 1.76–2.56 recorded for H. fasciatus (Atama et al., 2013) and Chrysichthys nigrograndis (Kareem et al., 2015) respectively. When b is not equal to 3, allometric pattern of growth occur, which could be positive if > 3 or negative if < 3 (Gayanod and Pauly, 1997; Imam et al., 2010). According to Adeyemi et al. (2009), negative allometric growth pattern in fish implied that the weight increases at a lesser rate than the cube of the body length. Near isometric growth patterns were recorded for H. bebe occidentalis (2.970), S. uranoscopus (3.012) and P. afer (3.013). Kumolu-Johnson and Ndimele (2010) recorded a b value of 2.722 for H. bebe occidentalis in their study of length-weight relationships of twenty-one fish species in Ologe Lagoon, Lagos, Nigeria, Olele (2013) recorded 2.68 for males and 1.76 for females while, Onimisi et al. (2013) recorded 3.814 for the males, 4.019 for females and 4.124 for the combined sexes. Regression coefficient of 3 of an ideal fish or other aquatic fauna is indicative of maintenance of dimensional equality as the organism grows (isometric growth) (Thomas et al., 2003; Olurin and Adelribigbe, 2006). The range of values of b (1.067–3.411) obtained in this study was outside the 2.5–3.5 range recommended by Carlander (1969) and Froese (2006). The result contradicts the reports of Pauly (1983) whose study recorded b value range of 2.5–4.0 for many fish species and Fafoye and Olubanjo (2005) whose study recorded b value range of 2.790–3.210 for fish species including Bagridae and Clupeidae, in Epe Lagoon. It also contradicts the range of values of b (2.012–2.991) recorded by Kumolu-Johnson and Ndimele (2010) and (2.607–3.254) obtained by Agboola and Anekethik (2008) in their study of length-weight relationships of thirty-five fish species in Badagary Creek, Nigeria. The b value of 1.067 recorded for T. mariae in this study is similar to 1.54 and 1.4–1.6 recorded by Obasohan et al. (2012) and Dan-Kishiyi (2013), and may be attributed partly to a narrow number of specimen or largely, environmental factors (including pollution) (Olurin and Adelribigbe, 2006). In line with the findings of this study, several authors have reported negative allometric growths (b < 2.5) which are outside the expected range of 2.5 < b < 3.5 (Carlander, 1969; Pauly and Gayanod, 1997) for
different cichlid fish species from various water bodies, despite using a large number of specimen. For instance, Gato et al. (2017) reported a range of values of $b$ (0.14–0.8) for Oreochromis niloticus in their study conducted on Wudil River, Kano, Nigeria. In the study of Atama et al. (2013), wherein a total 7091 individual specimen were used, recorded $b$ values of 0.32 for male H. fasciatus, 1.682 for female and 0.738 for the combined sexes; 0.549 in the dry season and 0.233 in wet season. This range of values (0.233–1.682) for $b$ was far below the one (2.42) recorded in this study. However, Ezenwaji (2004) recorded $b$ value of 3.066 for P. mariae in his studies on the Atalla Fisheries of the lower Anambra River, Nigeria. Although the change of $b$ values depends primarily on the shape and fatness of the fish species, different other factors may also be responsible for the range of values of $b$ observed in Iwopin freshwater ecotype of Lekki Lagoon cichlids (1.067–3.411) and the rest of the species. These include food availability (quality, quantity and size), seasonal variability of the environment, salinity, water temperature, sex and stage of maturity or sampling size and the length interval within different areas (Ricker, 1975; Pauly, 1983; Sparre and Venema, 1992; Mommsen, 1998; Morey et al., 2003; Henderson, 2005; Obasohan et al. 2012) or habitat suitability (Nieto-Navarro et al., 2010).

The regression coefficient ($b$) values of fish species less than 3 indicate negative allometric growth, and this shows that as the fish species increase in length, they become slenderer while, those species with $b$ values greater than 3 denote positive allometric growth, a situation whereby the organisms (fish species) become stouter as they increase in length (Sandon, 1950; Ibrahim, 1984; Gayando and Pauly, 1997; Khaironizam and Norma-Rashid, 2002). Most fish species often deviate from isometric growth as the shape of their bodies change with growth (Thomas et al., 2003) and there is no existing theory that says the $b$-value must be negatively or positively allometric (Pauly, 1983).

Meanwhile, an observation of absolute isometric growth ($b = 3$) in nature is occasional (Bagenal and Tesch, 1978; Bassey and Ricardo, 2003). Deviation from isometric growth is often observed as most aquatic organisms change shape as they grow (Thomas et al., 2003). The direction and degree of deviation of $b$ is largely influenced by the productivity of the immediate environment of the organisms. Highly productive zones tend to promote positive allometric growth while low productive ones such as deep sea zone enhance negative allometric growth (Phillip and Tesch, 1978). Condition factor ($K$) tends to promote positive allometric growth while low productive ones tend to promote negative allometric growth. Therefore, many factors such as sex, age, state of maturity, size, state of stomach fullness, sampling methods and sample sizes and environment affect condition and parameters of length-weight relationships in fish (Khan et al., 1991; Anene, 2005; Ama-Abasi, 2007; Yem et al., 2007; Adeyemi et al., 2009).

| Species                  | No. of Samples | $a$       | $b$       | Mean $[\text{100WXe}]^2$ (g/cm$^3$) | $r$ | c. f. $(K)$ |
|--------------------------|----------------|-----------|-----------|-------------------------------------|-----|------------|
| Chrysichthys nigrodigitatus | 25             | 0.0035 ± 0.0012 | 2.87 ± 0.1169 (0.45–0.98) | 0.5962 ± 0.1169 (0.45–0.98) | 0.989 | 0.80 ± 0.20 |
| Sarotherodon galilaeus     | 10             | 0.064 ± 0.0361 | 2.27 ± 0.003 | 1.7229 ± 0.7116 (0.75–5.10) | 0.953 | 0.82 ± 0.15 |
| Pelmatochromis mariae      | 8              | 0.016 ± 0.0614 | 1.676 ± 0.002 | 2.8945 ± 0.6865 (2.10–4.57) | 0.954 | 0.92 ± 0.27 |
| Hemichromis fasciatus      | 5              | 0.015 ± 0.0022 | 2.42 ± 0.10 | 1.3325 ± 0.5648 (0.89–2.26) | 0.518 | 1.28 ± 0.89 |
| Heterotis niloticus        | 10             | 0.0198 ± 0.0021 | 2.791 ± 0.002 | 1.1390 ± 0.58 (0.50–2.63) | 0.958 | 0.81 ± 0.18 |
| Sillibue uranoscopus       | 6              | 0.0059 ± 0.0209 | 3.025 ± 0.14 | 0.6355 ± 0.1795 (0.46–0.87) | 0.539 | 1.19 ± 0.85 |
| Polypterus senegalus       | 4              | 0.0045 ± 0.0200 | 3.048 ± 0.14 | 0.5253 ± 0.0914 (0.45–0.65) | 0.510 | 1.27 ± 0.99 |
| Tilapia zillii             | 8              | 0.0082 ± 0.0024 | 3.212 ± 0.001 | 2.0322 ± 0.4593 (1.60–3.01) | 0.819 | 0.89 ± 0.34 |
| Pargocephalus aequatorius  | 6              | 0.0037 ± 0.0018 | 3.103 ± 0.12 | 0.3945 ± 0.0578 (0.33–0.50) | 0.542 | 1.15 ± 0.91 |
| Pellonius affinisii        | 10             | 0.0081 ± 0.0022 | 2.282 ± 0.003 | 1.6586 ± 1.7445 (0.52–6.25) | 0.951 | 0.83 ± 0.16 |
| Sarotherodon melanotheron  | 9              | 0.0174 ± 0.0036 | 3.411 ± 0.002 | 7.5423 ± 9.1715 (2.27–30.82) | 0.864 | 0.85 ± 0.14 |
| Synodontis nigrita         | 10             | 0.0033 ± 0.0032 | 2.794 ± 0.001 | 2.6722 ± 2.3961 (0.64–7.62) | 0.950 | 0.90 ± 0.19 |
| Mummerys delicaudus        | 10             | 0.200 ± 0.0034 | 2.872 ± 0.001 | 1.2287 ± 2.7153 (0.49–7.81) | 0.959 | 0.86 ± 0.13 |
| Hyperridos bebe occidentalis| 10            | 0.0107 ± 0.0033 | 2.970 ± 0.003 | 1.9012 ± 3.5613 (0.53–12.00) | 0.957 | 0.88 ± 0.16 |
| Sphyraena barracuda       | 4              | 0.0112 ± 0.0021 | 3.099 ± 0.14 | 2.7925 ± 3.6297 (0.43–8.19) | 0.511 | 1.26 ± 0.98 |
| Deagetichthys lakdoensis   | 4              | 0.0079 ± 0.0016 | 3.109 ± 0.15 | 1.44 ± 1.3735 (0.26–2.77) | 0.512 | 1.25 ± 0.98 |

$a$, $b$ = regression coefficients; $c. f.$ = condition factor; $r$ = correlation coefficient; $W_x$ = weight; $L$ = length; No. = number.
Morphological parameters and biometrical characteristics including morphometric measurement and meristic count have been used to identify fish stocks and remain the simplest and most direct way among methods of species identification (Turran et al., 2004).

4. Conclusion

In this study, the knowledge on fish biometry, length-weight analysis and condition factor, has contributed greatly to the understanding of the population structure of these species in Iwopin fresh water ecotype of Lekki Lagoon. It has also provided useful information on the optimum exploitation of these fish species. The total weight of one hundred and thirty-nine (139) fishes analyzed is 11,152.1g with Mormyrops deliciousus having the highest percentage (17.53%) and Sarotherodon galilaeus having the least (0.20%). From the study, the fish species caught from this water body showed negative allometric growth patterns and had low condition factors. This has great implication on the stock in the fishery and it could be attributed to anthropogenic, biotic and abiotic factors such as over-exploitation of these species, environmental influences and, or state of gonadal development. More details on biometry, length-weight and condition factor should be encouraged for a better overview of these parameters, for other species in this water, for the knowledge of growth and population dynamics. Also, the detailed study on species composition of this water body is essential, to help in the sustainable utilization of its resources. In addition, in order to maintain a sustainable fishery, the fisher-folks should be allowed to actively participate in decision making process otherwise, artisanal fishermen whose major means of livelihood is fishing will ignore or contravene rule and regulations guiding fishing. To assess the biology of the various fish species and other aquatic fauna present in Iwopin water body, a research into its physico-chemical parameters is recommended.

Declarations

Author contribution statement
O. O. Famoofo: Performed the experiments; Wrote the paper.
W. O. Abdul: Conceived and designed the experiments; Analyzed and interpreted the data.

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