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# MORPHOMETRIC CHARACTERISTICS, FOOD OF *TARPON ATLANTICUS* AND WATER QUALITY TRENDS IN THE OGUDU CREEK LAGOS, NIGERIA

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## ABSTRACT

The morphometric characteristics and the food of *Tarpon atlanticus* as well as the water quality trend in Ogudu Creek, Lagos, Nigeria, where the fish was caught, were studied between January and May 2011. The air temperature ranged between 24 and 32 °C with mean value of 30.5 °C and surface temperature between 28.5 and 33.5 °C with mean value of 31.0 °C. The pH varied from being alkaline (8.3) and acidic (3.97) with mean value of 6.13. Salinity at lowest was (12.80‰), the highest (24‰) with mean value of 18.4‰ while dissolved oxygen ranged between 4.3 mg/L and 8.6 mg/L with mean value of 6.45±1.01 mg/L. The total length of specimens ranged from 11.0 – 25.9 cm (Standard length 5.1 – 16.0 cm) and weight 1.97 – 76.93 g. The specimens showed a unimodal distribution. The length – weight relationship for the combined sexes exhibited a negative allometric growth (0.911). The fish stomach had fish parts, fish scales and unidentified mass. The condition factor ranged from 0.475 and 1.046. The morphometric analysis exerted a highly positive correlation among the body parts; the total length and body weight (r = 0.92), total length and standard length (r = 0.92). The results of the present study also suggest that *T. atlanticus* living in the same place showed morphological divergence.

**Keywords**: Stomach content, Condition factor, Fish length, Morphology, Unimodal distribution

## INTRODUCTION

Fish is a protein source which helps in the repair of worn out tissues and replacement of dead cells in human beings. The Atlantic Tarpon *(Tarpon atlanticus*) is a tropical/sub-tropical and warm temperate fish abundant in the Atlantic Ocean; in the Eastern Atlantic area of Africa, which extends from Mauritania to Angola concentrating around the Gulf of Guinea zone where the thermocline is always close to the surface (Schneider, 1990). In the Western Atlantic, the species occurs from Nova Scotia to Brazil although more abundant in the warmer coastal waters of Florida, Gulf of Mexico and West Indies (Irvine, 1947; Fischer *et al*, 1981; Whitehead *et al*, 1984). According to Zerbi (1999), Tarpon (*Megalops atlanticus*) are widely distributed in warm temperate, subtropical and tropical waters ranging from Nova Scotia to Argentina in the western Atlantic Ocean, from Senegal to Angola in the eastern Atlantic Ocean, and proximate to Panama Canal terminus in the eastern Pacific Ocean.

*T. atlanticus* is a carnivorous species as stated by Zale and Merrifield (1989). Bond (1979) reported that such species including pikes and sharks are equipped with large mouths that mark them as predators for large prey which may be swallowed whole. Most piscivorous species according to Lagler *et al.*, (1962) have developed adaptation for predatory habit in their skull bones essentially for increasing the gape of the mouth. Both *Tarpon atlanticus* and the ten pounder- *Elops* sp. have gular plates in their lower jaws on the underside of their head. The gular plate is used for crushing preys that are not consumed whole (Bond, 1979).

The studies of food and feeding habits of fishes have been carried out by various workers (Munro, 1967; Fagade and Olaniyan, 1973; Kusemiju and Olaniyan, 1977; Ekpo, 1982). Ugwumba (1984) reported that *Elops lacerta* fed mostly on fish, crustaceans, insects and gastropods. Piscivorous fishes are known to consume a lot of their prey when they are most available. Adult *Tarpon* as revealed by Whitehead and Vergara (1978), Hureau, (1984) and Chaverri-Charcon (1994) feed on fishes especially those forming schools like sardines, mugilidae, cichlidae and invertebrates including shrimps and crabs. The juveniles feed on zooplankton, insects and small fish.

The stomachs of piscivorous are thickened, muscularised and have gastric acidity of pH 2.4-

3.6 to aid protein digestion (Largler *et al.*, 1962). However, the intestine is short in contrast to the long, coiled intestines of the herbivores like tilapia. In other fish species (e.g. minnows or parrot fishes), the stomach is lacking, and the oesophagus empties directly into the intestine (Bond, 1979).

The study of age and growth of many fish species have been carried out by many workers but in the tropics, growth interpretation on the hard parts is difficult as there are no marked seasons that cause cessation of growth as evident in the temperate regions. However, Bayagbona (1969), Kusemiju (1973), Fagade (1974), Ezenwa and Kusemiju (1981) and Ugwumba (1984) have used various methods to age tropical fishes with some levels of success. Fagade (1974) carried out age determination in *Sarotherodon melanotherodon* in Lagos Lagoon with emphasis on environmental and physiological basis of growth marking in the tropics. On the other hand, Ezenwa and Kusemiju (1981) used the dorsal spine of the catfish *Chrysichthys nigrodigitatus* for the determination of the age of the species.

Observation made by Fischer *et al* (1981) indicated that *T. atlanticus* moved into open waters to spawn late April to August and passed through a leptocephalus larval stage before metamorphosing into juvenile stage (Crabtree *et al.*, 1995). *Tarpon atlanticus* as observed by Crabtree *et al* (1995) is dimorphic with the females growing larger than the males.

In Nigeria, this species plays a major role in the commercial artisanal fisheries. Not much work has been done on the biology of this species in Nigeria. Anyanwu, (2004) carried out work on the biology, fishery and culture potentials of the Atlantic *Tarpon* in coastal waters of Western Nigeria. It is necessary to fully analyze and document the aspects of *T. atlanticus* food and feeding habit in relation to its occurrence in the wild. Therefore, this study is aimed at examining the occurrence, morphometric characteristics and food preference based on the different sizes of *Tarpon atlanticus* in Ogudu Creek Lagos Lagoon, Nigeria.

## MATERIALS AND METHODS

### Description of the Study Area

Ogudu Creek is adjacent and connected to the Lagos Lagoon around Oworonsoki. The Lagos Lagoon is the largest brackish water body of the lagoon systems south western, Nigeria with an area of 208 km (Webb, 1958; Hill & Webb, 1958). The Lagos Lagoon extends from the coast of Lagos about 37 km North and about 48 km East where it narrows and continues as the Lekki Lagoon. It stretches for about 257 km from Cotonou in the Republic of Benin to the Western edge of the Niger Delta (FAO, 1969). It is linked with the Atlantic Ocean (Gulf of Guinea) via the Lagos Harbor which serves as the major outlet of freshwater from the lagoon system during the rainy season.

The lagoon is situated in the rain forest belt of Nigeria which experiences two different seasons, i.e. the wet season (May – October) and dry season (November – April) (Fagade, 1969). Two peaks of rainfall linked with excessive floods are generally associated with the major peak in June and a lesser peak in September. The Lagos Lagoon has a diurnal tidal system (two high tides and two low tides each day). At high tide, sea water enters the lagoon from the Atlantic Ocean via the harbor and five cowrie creeks, while the water recedes at low tide (Fagade, 1969). Being open all through the year, the brackish environment is therefore a consequence of the influence of tidal sea water incursion and freshwater discharge from adjoining creeks and rivers such as Badagry, Majidun, Ogudu, Yewa, Ogun and Osun.

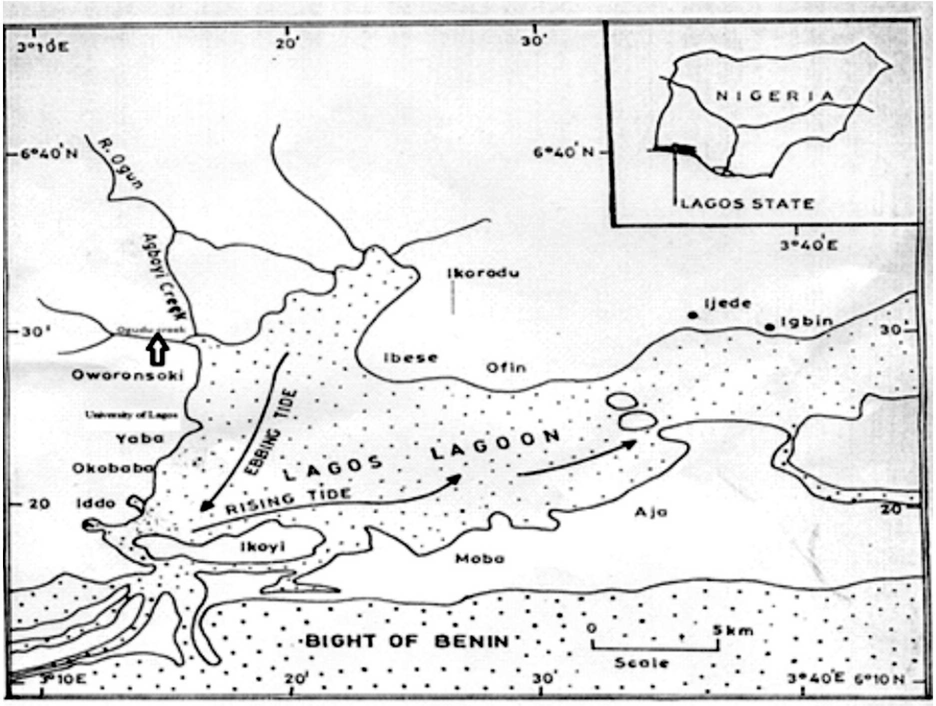


Figure 1: Lagos Lagoon map showing the Sampling Station

## Sample Collection

### Fish Collection

The specimens used for this study were collected between January and May 2011 from the Ogudu Creek using a cast net (0.5 mm mesh size net) operated along the sides of the creek between 0700 hr and 0900 hr every sampling day. Specimens were preserved in a freezer to prevent decomposition prior to analysis in the laboratory. In this study, combined sexes were used because the gonadal stages of the specimens were not visible to be identified. The sexual maturation of *T. atlanticus* is determined primarily with the length of the fish. In males it occurs between 90 and 117.5 cm and in females at approximately 128.5 cm. This maturation can occur between the ages of 6 and 13 years for both sexes (Hill, 2002).

### Water Sample Collection
### Physico-chemical Parameters

Water samples were taken with a Niskin bottle at the depth of 0.5 m below the surface from January to May 2011. Once collected, all samples were stored on ice and immediately transported to the laboratory. Temperature, pH, salinity and dissolved oxygen (DO) were measured *in situ* using the HI 9828 pH /ORP/EC/DO multiparameter Instrument (Hanna). Water transparency was also determined *in situ* using a Secchi disc.

### Laboratory Analysis of Fish
### Fish Measurement

In the laboratory, fish samples were thawed in the open air in the laboratory and body wiped dry. The standard length, total length, fork length, body depth, eye size, head length, post orbital length, pre-orbital length, pectoral fin length, mouth agape were determined using a measuring board and the weight determined using a weighing balance. The length measurement was recorded in centimeters while the weight measurements were recorded in grams. The total weight of each fish was achieved by placing each *Tarpon atlanticus* on an electronic weighing balance and the result was recorded to the nearest decimal point in grams. The stomach was split open using a pair of dissecting scissors to determine its content.

### Stomach Content Analysis

The stomach content was analyzed to establish the feeding habit of the fish. Since the fish were frozen immediately after catching, their stomach contents were representative of their last meals. The fish was dissected from the anus to the head and the alimentary canal was traced from the anus to the mouth. A sac-like structure (stomach) was traced along the tube. The stomach was detached from the other internal structures and placed on a Petri dish. Three drops of the mixture (stomach content) were placed on a glass slide using a dropper. The slide was covered with a cover slip and viewed under a light microscope in order to identify the various food items. This method is referred to as the numerical method (Hyslop, 1980). The total of each kind of food was recorded and expressed as a percentage of the total number of all food items as reported by Hyslop (1980).

### Length-weight Relationship

The length – weight relationship of each fish was studied and represented by the equation:

$W = a + bL$

Where:

W = weight in grams
a = regression constant
b = regression coefficient
L = length in centimeter (cm)

The equation was further transformed into a linear regression equation as:

$$\text{Log}W = \text{Log}\, a + b\, \text{log}L$$

Scattered diagrams were plotted to illustrate the relationship between the fish length and weight of fish.

### Condition Factor (K)

This shows the state (well-being) of the fish i.e. the leanness or fattiness of a fish, (Gomiero and Braga, 2005). It is calculated as:

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

Where W = weight of fish in grams
L = length of fish in centimeters
K = condition factor

### Morphometric Analysis

Morphometric analysis of the body parts such as the head length, total length, body depth, standard length etc. were analyzed using a scattered diagram and the regression coefficients.

## RESULTS

### Physico –chemical Characteristics

The lowest air temperature occurred in May, while the highest temperature occurred in January. The highest temperature was recorded in March while the lowest temperature was recorded in January; the mean surface water temperature during the sampling period was 31.0 ± 1.31 ºC. The pH reading varied from 3.97 to 8.3 and the mean pH value for the sampling period was 6.13 ± 0.32. The salinity values during the sampling period varied. The lowest salinity (12.80‰) was recorded in January and the highest salinity (24‰) was recorded in May. The mean salinity value for the sampling duration was 18.4±5.6‰.

The dissolved oxygen values ranged between 4.3 mg/L and 8.6 mg/L. The highest value (8.6 mg/L) was recorded in February while the lowest value (4.3 mg/L) was recorded in March. The mean value of dissolved oxygen was 6.45 ± 1.01 mg/L. The physico–chemical parameters of water from the Ogudu Creek is shown in table 1.

**Table 1:** Physico-chemical Parameters of Water from the Ogudu Creek

| | **January** | **February** | **March** | **April** | **May** | **Mean ± SD** |
|---|---|---|---|---|---|---|
| Air Temperature (ºC) | 32 | 31 | 29 | 25 | 24 | 30.5 ±1.21 |
| Surface water temperature (ºC) | 28.5 | 29.5 | 33.5 | 32 | 32 | 31.0 ± 1.31 |
| pH | 3.97 | 5.05 | 7.2 | 7.6 | 8.3 | 6.13 ± 0.32 |
| Salinity (‰) | 12.8 | 17.5 | 20 | 15.2 | 24 | 18.4±5.6 |
| Dissolved Oxygen (mg/L) | 4.8 | 8.6 | 4.3 | 5.6 | 7.48 | 6.45 ± 1.01 |
| Transparency (cm) | 69 | 80 | 61 | 39 | 12 | 52.2± 40.2 |

## Length – frequency Distribution

The total length of 192 specimens ranged from 6.0 cm to 21.9 cm (standard length 5.1 cm – 16.0 cm). The Length - frequency distribution is presented in table 2. The length frequency distribution of *Tarpon atlanticus* showed a uni-modal distribution.

## Length – weight Relationship

The total lengths of *Tarpon atlanticus* examined in Ogudu Creek ranged from 11.0 cm to 25.9 cm while the weights ranged from 1.97 g to 76.93 g. The scattered diagrams of the length – weight relationship are shown in figures 2 and 3. The log-transformed length fitted over weight gave linear growth pattern. The combined sexes gave this relationship equation: Log wt. = 0.654 + 1.504L with correlation coefficient value (r = 0.911). The value of 'b' for combined sexes was 1.504.

**Table 2:** Length – Frequency Distribution of *Tarpon atlanticus* of the Ogudu Creek.

| Total length (cm) | Frequency | Percentage Frequency |
|---|---|---|
| 11.0 – 15.9 | 143 | 74.4 |
| 16.0 – 20.9 | 41 | 21.4 |
| 21.0 – 25.9 | 8 | 4.2 |
| **Total** | **192** | **100** |

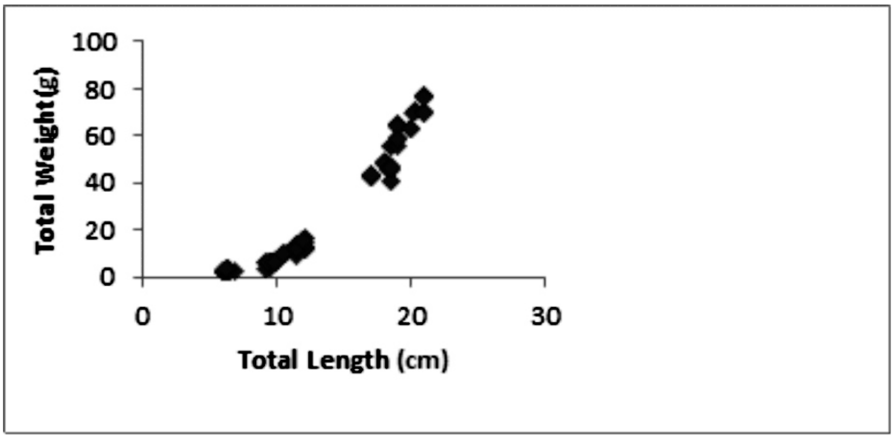


**Figure 2:** Length – Weight Relationship of *Tarpon atlanticus* in the Ogudu Creek

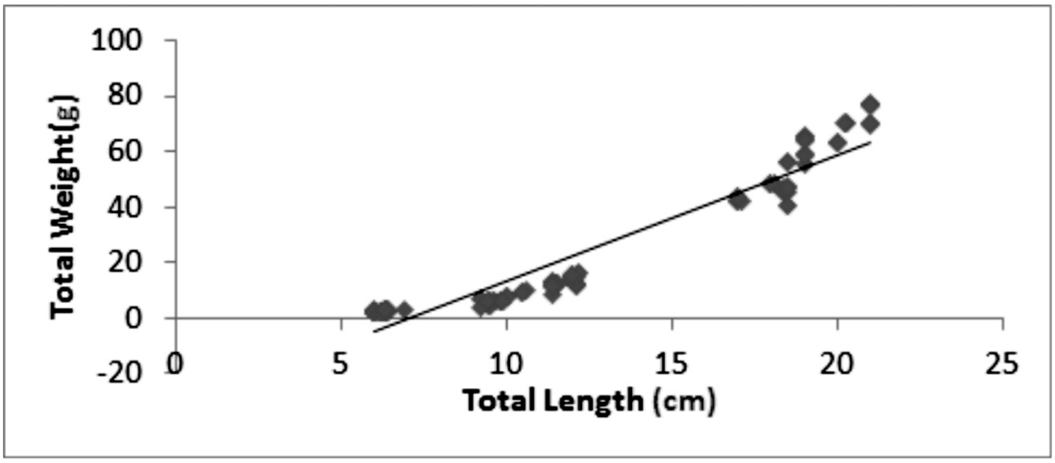


**Figure 3:** Length – Weight Linear Relationship of *Tarpon atlanticus* of the Ogudu Creek

## Stomach Condition

The stomach content analyzed shows the food habit of the fish. The stomach condition and content of *T. atlanticus* in Ogudu Creek is shown in table 3 and 4. Out of total 192 specimens analysed, 31.1% had empty stomach, 31.8% had their stomach filled with food. The stomach content of *T. atlanticus* in relation to percentage food composition is shown in figure 4.

**Table 3:** Stomach Condition of *Tarpon atlanticus* in the Ogudu Creek

| Condition | Frequency | Percentage |
|---|---|---|
| 0/4 | 60 | 31.1 |
| ¼ | 26 | 13.5 |
| 2/4 | 61 | 31.8 |
| ¾ | 22 | 11.5 |
| 4/4 | 23 | 11.9 |
| **Total** | **192** | **100** |

**Table 4:** Summary of the Stomach Content of *T. atlanticus* in Ogudu Creek.

| Food item | Numerical method | Numerical percentage | Occurrence method | Percentage of occurrence |
|---|---|---|---|---|
| Fish | 93 | 54.0 | 47 | 38.2 |
| Fish scale | 79 | 45.9 | 65 | 52.8 |
| Unidentified mass | | | 11 | 8.94 |
| Total | 172 | 100 | 123 | 100 |


**Figure 4:** Stomach Content of *T. atlanticus* in Ogudu Creek.

## Condition Factor

The condition factor for both sexes varied from 0.658 to 0.897. The lowest K value was obtained from the size group range of 21.0 – 25.9 cm and the highest K value was obtained from the size group range of 6.0 – 10.9 cm (Table 5).

**Table 5:** The Condition Factor, Range and Mean of *Tarpon atlanticus* in Ogudu Creek

| Size group (cm) | Range of condition factor | Mean of condition factor |
|---|---|---|
| 6.0 – 10.9 | 0.48 – 1.30 | 0.90 |
| 11.0 – 15.9 | 0.08 – 0.99 | 0.76 |
| 16.0 – 20.9 | 0.06 – 0.96 | 0.72 |
| 21.0 -25.9 | 0.08 – 1.05 | 0.66 |

## Morphometric Analysis

Five months of morphometric analysis of *T. atlanticus*, exerts a highly positive correlation (r = 0.927) between body weight and total length. March samples exhibit a highly positive correlation of r = 0.967 between standard length and total length. Similarly head length versus total length exhibited a highly positive correlation, r = 0.78 in January. Correlation between body depth and total length was highly positive in January, r = 0.785. Significant positive correlation was noted between pectoral fin length versus total length in May, r = 0.72. In March, anal fin length and total length when correlated gave a correlation coefficient of r = 0.94.

In the morphometric analysis, all the characters assumed as Y, show a positive correlation with total length (X). It would indicate the growth of individual organs in relation to overall growth of the fish. But the varying significance at different levels indicates the disproportionate growth of these organs studied, when compared to total length.

Relationship between the total length parameters and body weight exhibited high level of relationship in March, moderate level in January and February and low level in April and May (Table 6i). In total length versus standard length, January, February, March, April and May show high level of relationship (Table 6 ii). There was no high level of relationship between total length and head length whereas moderate level was exhibited in January and low level by February, March, April and May (Table 6iii). No maximum level of relationship was observed in total length versus body depth but moderate level was observed in January and March and minimum level in February, April and May (Table 6 iv). Low level of relationship was shown between total length and pectoral fin length throughout the study except in January and moderate level was recorded (Table 6v). Total length and anal fin length relationship showed maximum level in January and April, moderate level in May and minimum level in February and April (Table 6 vi).

**Table 6:** Summary of the Regression Analysis

| S. no | Y | X | Months | N | Y= a+bx | R |
|---|---|---|---|---|---|---|
| i | Total length | Body weight | January<br>February<br>March<br>April<br>May | 192 | Y=2.059+12.31x<br>Y=8.340+101.0x<br>Y=1.041+3.921x<br>Y=2.782+19.46x<br>Y=2.413+16.84x | 0.825<br>0.828<br>0.927<br>0.285<br>0.154 |
| ii | Total length | Standard length | January<br>February<br>March<br>April<br>May | 192 | Y=0.789+0.024x<br>Y=0.609+3.228x<br>Y=0.677+0.857x<br>Y=1.079+3.251x<br>Y=1.254+4.584x | 0.973<br>0.928<br>0.967<br>0.990<br>0.904 |
| iii | Total length | Head length | January<br>February<br>March<br>April<br>May | 192 | Y=0.147+0.680x<br>Y=0.228+0.627x<br>Y=0.107+1.010x<br>Y=0.091+1.587x<br>Y=0.021+1.911x | 0.786<br>0.437<br>0.554<br>0.000<br>0.003 |
| iv | Total length | Body depth | January<br>February<br>March<br>April<br>May | 192 | Y=0.240+0.307x<br>Y=0.069+3.085x<br>Y=0.164+0.370x<br>Y=0.211+0.093x<br>Y=0.254+0.404x | 0.785<br>0.134<br>0.690<br>0.029<br>0.188 |
| v | Total length | Pectoral fin length | January<br>February<br>March<br>April<br>May | 192 | Y=0.137+0.070x<br>Y=0.114+0.436x<br>Y=0.038+0.649x<br>Y=0.151+0.134x<br>Y=0.482+3.421x | 0.707<br>0.281<br>0.124<br>0.261<br>0.720 |
| vi | Total length | Anal fin length | January<br>February<br>March<br>April<br>May | 192 | Y=0.154+0.026x<br>Y=0.141+0.363x<br>Y=0.123+0.234x<br>Y=0.303+1.769x<br>Y=0.273+1.187x | 0.891<br>0.587<br>0.945<br>0.535<br>0.727 |

## DISCUSSION

The observed variations in the physico-chemical features of the water from Ogudu Creek agreed with earlier records in Lagos lagoon (Nwankwo 1991, Solarin 1998; Ladipo *et al*. 2011; Lawson 2011).

The length frequency distribution of *T. atlanticus* showed that the fish exhibited unimodal distribution in the Ogudu Creek. The frequency distribution study is one of the methods used for determining age of fishes. This method has been successfully used by Fagade and Olaniyan (1972) to age the Bonga fish (*Ethmalosa fimbriata*) in which three age groups were reported off the Lagos coast and by Kusemiju (1976) who reported several modes in *Chrysichthys walkeri* in Lekki Lagoon. The total length for most of the specimens ranged between 6.0 cm to 21.9 cm. The logarithmic plot of weight against length showed a linear relationship. This relationship indicates that an increase in length leads to increase in weight. This agreed with what Kusemiju and Osibona (1998) reported *in Pentanemus quinquarius* off Aiyetoro Coast. The species showed a negative allometric growth.

The mean condition factor increased as the fish length increases. The condition factor values are useful in comparing the healthiness of fish from different habitats or to indicate the sustainability of the environment in which the fish are caught. Kusemiju and Osibona (1998) also reported that the mean condition factor increased as the fish length increased in *P. quinquarius* off Aiyetoro coast.

The food items found in the stomach of the *T. atlanticus* indicated that the species is carnivorous. Bond (1979) reported that species in this category which include pikes and sharks are equipped with large mouths that mark them as predators for large prey which may be swallowed whole. The fullness of the stomach of this species suggests that its environment contained abundant food organisms as reported by Emmanuel (2008).

There were no distinct changes in the food preference relative to size of the fish. This disagreed with what was reported by Lawal-Are and Kusemiju (2000) and Chindah *et al* (2000) where they reported changes in the food items in relation to size differences in crabs. Of the 6 morphometric characters examined, all exhibited a significantly positive correlation ($p<0.01$) among the different parts of the fish body. This showed that growth occurs in all organs of the fish but with different level of significance and these indicate that different organs grow differently in different months. The conventional approach for such analysis is based on measurement along the antero - posterior body axis and the depth measurement. In this study variation in the various morphological characters of five different months of the fishes was found. The results of the present study also explain that *T. atlanticus* living in the same place showed morphological divergence as noted by Manimegalai, *et al.* (2010) and this indicates the possibility for microhabitat restriction that may influence this variation. Population differentiation may occur despite extensive gene flow between fish populations and strong differential selective pressure exerted on the different fish population by local environmental factors such as temperature. It is not possible to confirm whether the observed variation is associated with environmental conditions, as the present analysis does not include environmental data for the sample localities and therefore, further environmental comparisons of these areas would be worthwhile.

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