Omni-Akuatika, 18 (1): 62 - 71, 2022
ISSN: 1858-3873 print / 2476-9347 online

Research Article

journal homepage: http://ojs.omniakuatika.net

Morphometric Assessment and Condition Factor of the Mangrove Oyster from a Tropical Mangrove Swamp, off Lagos Lagoon, South-West, Nigeria

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Received 1 March 2022; Accepted 2 June 2022; Available online 24 June 2022

ABSTRACT

The size composition, growth pattern and condition factor of One thousand, two hundred and sixty (1260) mangrove oyster - *Crassostrea tulipa* (*C. tulipa*) from the mangrove swamp, Lagos Lagoon were studied using recommended morphometric methods. The total shell length ranged from 1.5 cm to 18.4 cm, maximum width ranged from 1.5 cm – 10.4 cm and the total weight was between 1.92 g – 132.1 g. The oysters showed a unimodal size distribution. Also, there is strong significant correlation between the shell total length and the total flesh weight suggesting that an increase in length gives a corresponding increase in weight of an individual oyster. The total length-total weight and total weight-flesh weight relationships were positively correlated with calculated "b" of 0.5826 and 0.5887 for combined sexes respectively. Negative allometric growth observed was verified from the b < 3 value. The condition factor of the oysters ranged between 6.5 and 10.5 for both female and male species indicating that the species are in good condition despite reported contaminations of the lagoon water.

Keywords: Bivalve, *C. tulipa*, Lagos Lagoon, length-weight.

ABSTRAK

Komposisi ukuran, pola pertumbuhan dan faktor kondisi seribu dua ratus enam puluh (1260) tiram mangrove - *Crassostrea tulipa* dari rawa mangrove, Laguna Lagos dipelajari dengan menggunakan metode morfometrik yang direkomendasikan. Panjang total cangkang berkisar antara 1,5 cm hingga 18,4 cm, lebar maksimum berkisar antara 1,5 cm – 10,4 cm dan berat totalnya antara 1,92 g – 132,1 g. Tiram menunjukkan distribusi ukuran unimodal. Ada korelasi signifikan yang kuat antara panjang total cangkang dan berat total daging yang menunjukkan bahwa peningkatan panjang memberikan peningkatan yang sesuai pada berat individu tiram. Hubungan total panjang-total berat dan total berat-berat daging berkorelasi positif dengan nilai b sebesar 0,5826 dan 0,5887 untuk masing-masing jenis kelamin. Pertumbuhan alometrik negatif terverifikasi berdasarkan nilai b < 3. Faktor kondisi tiram berkisar antara 6,5 dan 10,5 untuk spesies jantan dan betina yang menunjukkan bahwa spesies tersebut dalam kondisi baik meskipun dilaporkan adanya kontaminasi pada air laguna.

Kata kunci: Bivalvia, *C. tulipa*, Laguna Lagos, panjang-berat

1. Introduction

Awareness of some quantitative aspects of the fin or shell fishes such as length-weight relationship is imperative in studying fish biology and ecology. The investigating and managing of the fisheries species often times entail the utilization of fundamental tools and biometric interactions to convert data collected in the field into appropriate indexes for evaluation purposes (Ecoutin and Albaret, 2003; Turker et al., 2018; Akinjogunla and Moruf, 2019). Growth activity depends on sexual category, stages of development and ecological factors such as salinity, water temperature parameters, food quantity and quality (Akinjogunla & Moruf, 2018). One of the most universally accepted tools in conversion of any fishery data is the length-weight relationships. Length and weight relationship

http://dx.doi.org/10.20884/1.oa.2021.18.1.957

(LWR - W=aLb) is a fundamental indicator for stock assessment (Akinjogunla and Moruf, 2019), the conversion of growth equation in length into a growth equation in weight and is essential for the computation of biomass of a fishery population (Moutopoulos and Stergiou, 2002). The condition factor which shows the degree or state of wellbeing of the fish (fin fish and shell fish) in their habitat is expressed by 'coefficient of condition'. The Co-efficient of condition is a measure of various ecological and biological factors such as gonad stages, degree of fitness and suitability of the environment with regards to the feeding condition (Gomiero and Braga, 2005).

The mangrove oysters of the genus *Crassostrea* are bivalve molluscs, belonging to Phylum Mollusca, Family Ostreidae, Order Dysonta and Class Lamellibranchiate (Miossec et al., 2009). They are nutritious, commercially obtainable in some parts of Nigeria (Western and Southern parts), possesses exoskeleton (outer skeleton) called shells on both sides of the body, which functions as defensive layers for the animal. They are comparatively a cheap source of animal protein and the shells have been affirmed as good feedstuff in animal feed formulation (Moruf and Akinjogunla, 2018). Fisheries management strategies need to be implemented if there is still continuous collection of bivalves' molluscs from their natural habitats if we do not want them to go into extinction in the nearest future (Kumar et al., 2018). The comprehension of growth pattern of these commercially important molluscs will be needed in developing sustainable aquaculture and fishery management practices.

Various studies have been carried out regarding the mangrove oysters in Nigeria waters but limited information on the species found in the Lagos Lagoon. In Lagos Lagoon, its shores and adjacent creeks are surrounded in undeveloped areas by mangrove swamps with trees. Although human (erecting houses, cutting down mangrove trees) and industrial (construction of jetties, harbors, etc) activities along the shores have distorted the flora in many places, the fauna inhabiting the estuary have remained distinctive of the West Africa mangrove swamps. During the dry season and at low ebbs, the oysters being attached to various substrates (stones, plastics, mangrove branches, roots, etc) are exposed.

In Nigeria, a lot of information exists on the environmental factors affecting Oyster larvae settlement in Lagos Lagoon (Ajana 1978), fishery of the mangrove oyster (Ajana, 1980), cultivation and potential of the mangrove oyster (Afinowi, 1985), fishery and culture potential of the mangrove oyster (Ansa and Bashir, 2007), growth performance of Mangrove Oyster in Badagry Creek, Lagos (Ajani, 2008) and the use of the mangrove oyster (*Crassostrea gasar*) as a bio-indicator for chemical element contamination (Wangboje et al., 2014). Other research works on shellfishes in Nigerian waters include seasonal variation of heavy metals in selected sea foods from Buguma and Ekerekana Creeks, Niger Delta (Akinrotimi et al., 2015); Effect of size on proximate composition and heavy metal content of the Mangrove Oyster, *Crassostrea gasar* from the Andoni River, Nigeria (Woke et al., 2016) and Proximate composition and mineral contents of Mangrove Oyster (*Crassostrea gasar*) from Lagos Lagoon (Akinjogunla et al., 2017). Also documented are reports from Akinjogunla and Lawal-Are, 2020 on the Seasonal assessment of the impacts of heavy metal deposits in *Crassostrea gasar* (Adanson, 1757) from the mangrove swamp of the Lagos Lagoon, Lagos, Nigeria) and Akinjogunla et al., 2021 on the biochemical profile of the mangrove oyster - *Crassostrea gasar* (Adanson, 1757) from the Mangrove Swamps, South-West, Nigeria) but no documented literature exist on the morphometric assessment (length- weight relationship, growth pattern, condition factor) of the Mangrove oysters from Lagos Lagoon despite its economic, nutritional importance and future potentials of the species.

The increasing awareness and need of mollusk as food in western and southern part of Nigeria, together with the dearth of information on growth dimensions of mangrove oysters in Nigeria has prompted this study. This study was embarked on aiming at providing valuable information on the growth patterns and the state of wellbeing of the mangrove oysters from the Lagos Lagoon, Lagos State, Nigeria where such study was lacking. Hence, the present contribution aims to balance for this lack of information and gives important inputs into fishery management practices upon which the sustenance, management and development of the resources could be achieved.

2. Material and methods

2.1. Description of Study Area

The Lagos Lagoon lies between Latitude 6 26' - 637' N and Longitude 3 23' - 4 20' E in the western part of Nigeria, covering a surface area of 208 km (Akinjogunla & Lawal-Are, 2020). Two seasons (dry season between December and

Plate 1. *Crassostrea tulipa* (exposed Oyster flesh in its shell) X 10MP

Plate 2. Oysters attachment to the roots exposed at low tides X 10MP

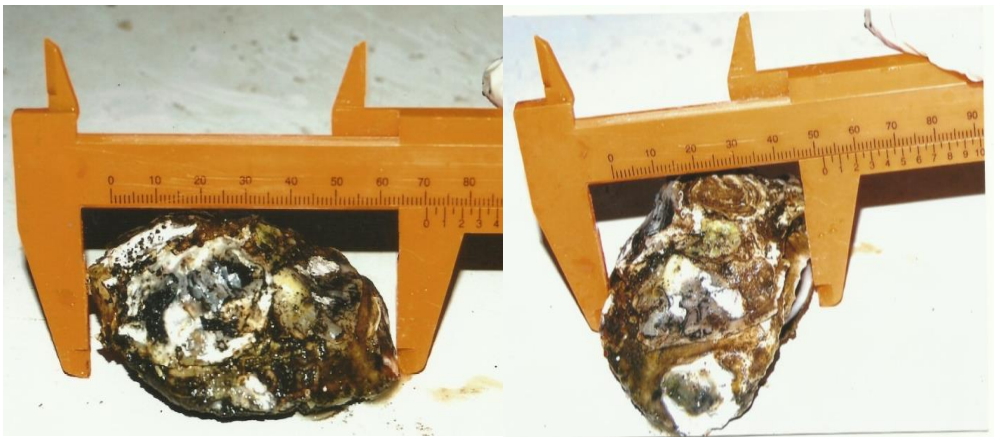

Plate 3. *Crassostrea tulipa* with the Vernier caliper for measuring MgX 8.0MP

May and wet season between June and November) exists in the lagoon which causes fluctuation in physico-chemical parameters (Lawal-Are and Akinjogunla, 2012).

Agala creek where the sampled oysters were collected from lies between latitude N05° 41'. 2° 66' and longitude E07° 09'. 9°01'7. It receives industrial and domestic wastes with fecal matters and oil spills as it is surrounded by residential and industrial layouts with the presence of ships and boats at the jetty.

2.2. Sampling and samples collection

Sampling was carried out on monthly basis between July 2019 and February 2020, consisting of wet season months (August – October) and dry season months (November- January). A total of One thousand, two hundred and sixty (1260) *C.*

Table 1. Total Length/ Maximum Width of *Crassostrea tulipa* by size group

Parameters	Size Groups		Frequency
Total Length Frequency (cm)	Small	1.5 – 7.4	800
	Medium	7.5 – 12.4	419
	Large	12.5 – 18.4	41
Total			1260
Maximum Width Frequency (cm)	Small	1.5 – 4.4	745
	Medium	4.5 – 7.4	487
	Large	7.5 – 10.4	28
Total			1260

tulipa (Plate 1) were handpicked randomly from the roots of the mangroves (Plate 2) at low tides with the assistance of artisanal fishermen. The collected samples were immediately preserved in troughs filled with ice and transported to the Department of Marine Sciences Post-Graduate laboratory, University of Lagos, Nigeria where they were kept for analysis.

2.3. Morphometric Measurements

Four (4) measurable morphometric characters were used in this study. These morphometric characters were measured and recorded in proformas for each oyster. The length and width were measured in centimeter (cm) using a Grip Vernier Caliper of 0.5 cm precision (Plate 3) while the weights (total weight and flesh weight) were measured to the nearest 0.01 in gram (g) using Electronic Compact Scale Atoms -110C.

2.4. 2.4Growth Patterns of *C. tulipa*

a) Shell Width/ Length - Width Frequency Distributions

The statistical width / length – weight relationships were established using the parabolic equation:

$$W = aL^b \quad (1) \quad \text{(Pauly 1983)}$$

Where: 'W' and 'L' are the independent and dependent variables of allometric parameters, respectively. W is total weight of the oyster's shell in gram (g); L is length of the oyster's shell in centimetre (cm); a is rate of change of weight with length (intercept); and b is weight at unit length (slope)

The equation 1 above and data obtained were transformed into natural logarithms and this gave a linear (straight line) relationship

$$\text{Log } W = \log a + b\ (\text{Log } L) \quad (2) \quad \text{(Parsons, 1988)}$$

b) Condition Factor (CF):

The condition factor (CF) of the oysters indicates the state of general wellness of the oyster and was estimated from the relation:

$$CF = \frac{\text{Ls}}{Ws} \times 100$$

where CF is Condition Factor; Ls is Length of the oyster (g); and Ws is Weight of the oyster (cm)

2.5. Statistical Analysis

Data generated were presented as descriptive statistics using Microsoft Excel 2010 and SPSS software while coefficient of determination (r^2) was used to determine quality of linear regression. Lines and scattered graphs were used to depict trends in the distribution and relationships between length, width and weights of *Crassostrea tulipa* using Minitab 14. The log of lengths and weights were obtained and plotted in order to establish the relationship between them.

3. Results and Discussion

3.1. Total length – Maximum Width relationship of *Crassotrea tulipa*

The size of the mangrove oyster from Agala creek ranged from 1.5 cm – 18.4 cm total length, maximum width of 1.5cm – 10.4 cm and between 1.92 g and 132.1 g body weight. The values of shell morphometric (length and width) of *C. tulipa* are presented in Table 1 and illustrated in Figures 1 and 2. The total length frequency of *C. tulipa* polygon (Figure 1) showed that size group 5.5 cm – 6.4 cm was more abundant with 20.5% (369) and small size of 1.5 cm – 7.4 cm (Table 1) with 66.3% (1203) while the maximum width frequency polygon (Figure 2) showed that size group 4.5 cm – 5.4 cm was most abundant with 31.8% (573) and medium size of 4.5 cm – 7.4 cm (Table 1) with 49.6% (894).

3.2. Log Total Length / Log Total Weight Distribution of *Crassostrea tulipa*

The relationships between Log Total length and Log Total weight of *C. tulipa* in the regression equation is illustrated in Figure 3. *C. tulipa* exhibited positive allometric growth. Medium correlation value of $r^2 = 0.5826$ is indication that an increase in the total length of the species gave a corresponding increase in the body weight.

Male: Log Y = 0.3168 + 0.3855 Log X
n = 800, $R^2 = 0.6883$

Female: Log Y = 0.2257 + 0.4809 Log X
n = 460, $R^2 = 0.3989$

Combined sexes: Log Y = 0.2864 + 0.4172 Log X
n = 1260, $R^2 = 0.5826$

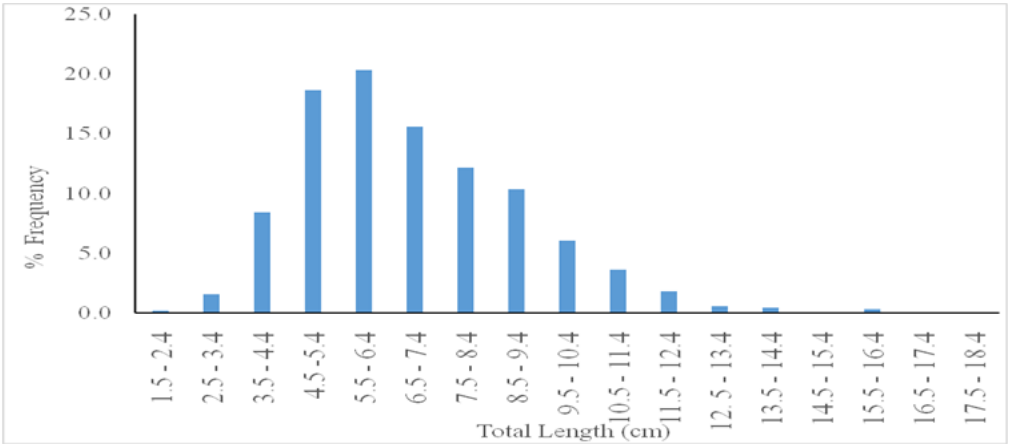

Figure 1. Total Length frequency distribution of *Crassostrea tulipa*

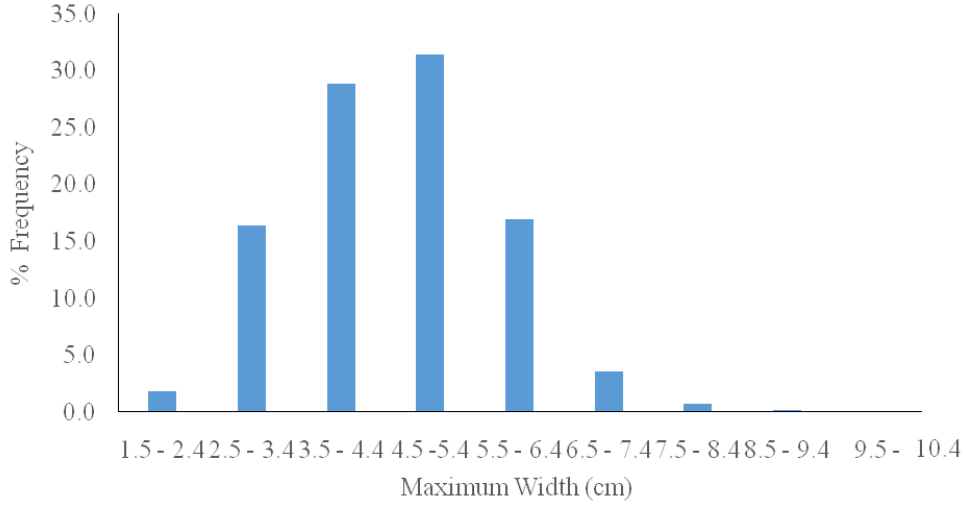

Figure 2. Maximum Width Frequency distribution of *Crassostrea tulipa*

3.3. Log Maximum –Width / Log Total Weight Distribution of C. tulipa

The relationship between the maximum width and total weight of *C. tulipa* is illustated in Figure 4 for the combined sexes. *C. tulipa* exhibited positive allometric growth in the mangrove swamp. The correlation value of 0.0756 is an indication that an increase in the maximum width of the oysters gave a corresponding increase in the body weight.

Male: Log Y = 0.6253 + 0.9205 Log X
n = 800, R2 = 0.1016
Female: Log Y = 0.4084 + 1.0825 Log X
n = 460, R2 = 0.031
Combined sexes: Log Y = 0.5657 + 0.9671 Log X
n = 1260, R2 = 0.0756

3.4. Flesh weight / Total weight relationship of *Crassostrea tulipa*

The relationship between the weight of the soft part (flesh) and total weight of *C. tulipa* are presented in Figure 5.

Medium correlation value of 0.5887 showed a strong indication that an increase in the body weight of the species gave a corresponding increase in the weight of soft part (flesh).

Combined sexes: Log Y = 0.7591 + 0.8495 Log X
n = 1260, R^2 = 0.5887

3.5. Condition factor of *C. tulipa*

The condition factor values (K-values) of males and females *C. tulipa* combined together (Table 2) were greater than 10 (> 10), implying that the *C. tulipa* were healthy and the K- value of *C. tulipa* (males) was higher than *C. tulipa* (females). The K- value of *C. tulipa* (males, n = 800) was 10.5, while *C. tulipa* (females, n = 460) with size group of 7.5 - 12.4cm had K- value of 6.5 and *C. tulipa* (females, n = 20) with size group of 12.5-12.4cm had K- value of 8.1.

4. Discussion

Length Weight Relationship (LWR) is defined as a means to determine or evaluate the weight gain of most fishes (fin, shell and other

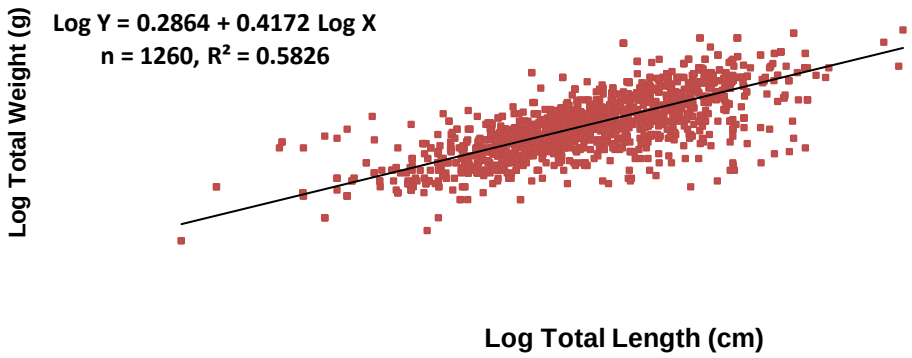

Figure 3. Log total length / Log total weight distribution of combined sexes of *Crassostrea. tulipa*

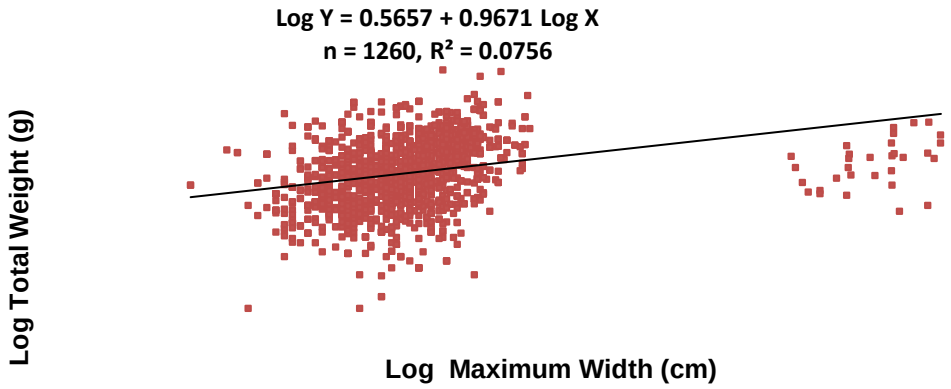

Figure 4. Log Maximum Width- Log Total Weight relationship of *Crassostrea.tulipa*

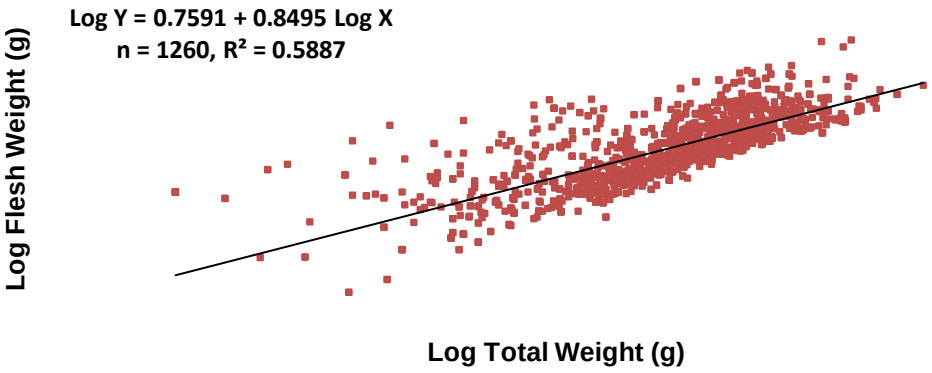

Figure 5. Log total weight / Log flesh weight relationship of *Crassostrea tulipa*

invertebrates) and tends to be Isometric when the 'b' value is equal to 3.0 while it is allometric when the 'b' is determined to be greater (positive allometry) or lesser (negative allometry) than 3.0 (Bagenal and Tesch, 1978). The Length – Weight Relationship is one of the benchmarks used to generate justifiable biological information. It establishes the mathematical parabola between the two parameters (length and weight), so that unidentified parameter can be readily computed from the known parameter (Ayoade and Ikulala, 2007). The connections between shells length and other proportions (width, height, weight) in bivalves could predict the outline of shell growth or its proportional changes as reported by De - Paula and Silveira (2009).

The Length frequency and width frequency relationship showed that size groups 5.5 – 6.4 cm and 4.5 – 5.4 cm respectively were more abundant in the creek, thus indicating that small size oysters were predominant. From this study, the results of the Log Total Length – Log Total weight relationship showed the "b"

Table 2. Condition Factor (CF) by Sex and Size Group of *Crassostrea tulipa*

Size Group	Male				Female			
	N	TL(cm)	TW(g)	CF	N	TL(cm)	TW(g)	CF
1.5 – 7.4	800	5.5	17.4	10.5	-	-	-	-
7.5 – 12.4	-	-	-	-	423	9.1	49.3	6.5
12.5 –18.4	-	-	-	-	37	14.63	254.0	8.1
Total	800				460			

Keys: N – Number ; TL – Total Length ; TW – Total Weight; CF – Condition Factor

value of *C. tulipa* from Agala with a medium correlation value (0.5826) indicating that the creek is moderately suitable for this species. The present results indicated a strong positive correlation between the various shell dimensions and their relation to the shell length, reflecting a general increase in total length with increase in shell width. These results were in conformity with the studies of *T. fuscatus* from different lagoons in Nigeria (Jamabo et al., 2009 (Port-Harcourt); Moruf and Lawal-Are, 2015 (Lagos Lagoon). The reports from this study and in comparison with related literatures cited above could be attributed to the environment, rations or water characteristics of the area where these populations were collected as cited by Addadi et al., (2006) and Dauphin et al., (2008).

Further observations of the total length / total weight, maximum width / total weight and flesh weight / total weight relationships on logarithms showed that growth of the *C. tulipa* from the Lagos Lagoon was positively allometric with the values of b (regression coefficients) being positive. The correlation coefficients (r) of the mangrove oysters, (0.0756), though low, indicated positive correlation between their Log maximum width and Log total weights. The positive "b" value of 0.5887 obtained for the flesh weight and total (flesh and both shells) weight relationship implies that there is a strong indication that the body weights of the oysters increase with increase in body length. Similar positive allometric growth patterns have been reported by previous studies such as Abowei and Ezekiel (2013) who worked on *Chrysichthys nigrodigitatus* from Amassoma flood plains. Similar result have been drawn by Fafioye and Oluajo (2005) who worked on five (5) finfish species collected from the Epe Lagoon. Unlike this positive value of "b" reported from this work and other cited references above, negative allometric growth has also been reported by Offem et al., (2009) who researched on forty six (46) important fishes in a tropical flood river; Kumolu-Johnson and Ndimele (2010) who worked on twenty-one (21) fish species from Ologe Lagoon in Lagos State and Kareem et al., (2015) who reported on the data on *Chrysichthys nigrodigitatus* and *Schilbe mystus* from the Erelu Lake in Oyo State, Nigeria.

In this study, it was observed that specimens with similar total lengths tend to exhibit the same body weights which are related with the condition factor of the species. The condition factor (CF) which is used to determine the state of the habitat and general well being of the oysters varied according to the numerous sizes of the species collected from Lagos Lagoon. The high mean "K" value of 10.5 obtained from this study showed that the species evaluated were in favorable environmental conditions even though the mangrove swamps are daily loaded with the influx of domestic and industrial effluents from surrounding jetties, shipping companies and residential buildings. From this study also, it was observed that the CF decreased as the oysters increased in size and weight. Etim and Taege (1993) used the condition factor to depict the well-being of *Egeria radiata* of the Cross River at Itu creek. The mean condition factor for different sizes in this study ranged from 6.5 to 10.4. It was noticed that the values changed with increase in length.

The (K) values were highest in females (7.5 – 18.4 cm) of *C. tulipa* from Agala (14.6) compared to 10.5 reported in males species with size bracket 1.5 – 7.4 cm. Similar result to these observations was reported by Lawal et al., (2010). This implied that the female species of the mangrove oysters did enjoy a better environmental conditions and robustness since their CF values were found to be higher than the males. Condition factor (K) has also been strongly correlated with reproductive phase in aquatic organisms in other water bodies (Ugwumba, 1990) and also on the presence and availability of food, foraging behavior of the species and their reliance on reserved or stored food energy (Moruf and Lawal-Are, 2015). It could as well be attributed to food deprivation or their (in) ability to adapt to the highly unpredictable polluted environments (Saliu, 1997). These factors are known to impact the growth data and could lead to high or low

physiological conditions in species (Kamaruddin et al., 2011; Kareem et al., 2015).

5. Conclusions

Current study provided information on the morphometric assessment and condition factor of a commercially important mollusc, *Crassostrea tulipa* in Agala mangrove swamp off the Lagos Lagoon which is the first documented report of its kind. This is expected to serve as an orientation point for future investigations. The condition factor values of the species in this study suggest that the state of the mangrove swamp is beneficial to the mollusc in terms of availability, quality and quantity of food resources. In addendum, they might have developed a tactic to help in adapting to a habitat that receives residues from crude oil refining companies, shipping activities and domestic wastes. Residues deposited into these areas are flushed out at high tides, thereby creating a favorable environment for the species. Further studies with longer research periods need to be carried out to justify existing conclusions. Also, there must be enforcement measures taken to reduce the deposit of toxic waste on the aquatic ecosystem because this mangrove swamp produces a valuable shellfish species for local population.

Acknowledgments

The authors are grateful to the Nigerian Institute of Oceanography and Marine Research, Victoria Island, Lagos Nigeria for the availability of their seamen and sea equipment to help at the sites of collection and the Department of Marine Sciences, Faculty of Science, University of Lagos for the laboratory facility in supporting our research.

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