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PRELIMINARY INVESTIGATION OF LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF PERIWINKLE (*TYMPANOTONUS FUSCATUS*, LINNAEUS 1758) FROM OKRIKA ESTUARY, NIGER-DELTA AREA OF NIGERIA

Ogunola Oluniyi Solomon, Onada Olawale Ahmed and Dr. Andreas Kunzmann

[1](MSc International Studies in Aquatic Tropical Ecology, University of Bremen, Germany).
[2](Ph.D (Student) Aquaculture and Fisheries Management, University of Ibadan, Nigeria).
[3](Zentrum für Marine Tropenforschung, ZMT, Bremen, Germany).

ABSTRACT: *Assessment of length-weight relationship and condition factor of a commercially important mollusc species, Periwinkle, Tympanotonus fuscatus, from Okrika estuary was conducted from October, 2015 to February, 2016. A total of 120 samples of the species were hand-picked from the mangrove ecosystem of Okrika. The results obtained showed that the gastropod species had negative allometric growth patterns with a growth exponent, b value of 2.18. This value was confirmed as negative allometric, because it was significantly different (p<0.05) from 3 when a t-test was carried out. The mean condition factor, K of the species was 18.9, which indicated that they were in good condition during the sampling period. This study recommends that further research needs to be conducted because the sampling duration was one-third of a year (4 months). Also efforts should be taken to reduce the pollution load in order to safe-guard this valuable resource for the local population.*

KEYWORDS: Length-Weight Relationship, Periwinkle, Condition Factor, Tympanotonus Fuscatus, Nigeria

INTRODUCTION

Periwinkle (*Tympanotonus fuscatus*, Linnaeus 1758) is a univalve, prosobranch gastropod (Mollusca) commonly found in the intertidal zone of brackish ecosystems in the Niger-Delta and other parts of West African coastal waters such as mangrove swamps, creeks, lagoons, estuaries (Nickles, 1950; Dambo, 1993; Jamabo *et al.*, 2009; Moruf and Lawal-Are, 2015). They usually inhabit soft substratum or mudflats rich in decaying organic matter and detritus (Jamabo and Chinda, 2010; Iboh *et al.*, 2015). Deekae (1987) reported that nature of bottom deposit, water depth and current are the major factors controlling the distribution of this shellfish in the estuaries. When in their habitat, they migrate to the coastal edge and usually aggregate under the breathing roots of mangrove plant species such as *Avicenia nitida, Rhizophora mangle and Nypa palm* for protection from the direct heat of sun (Cariton and Cohen, 2002). They have the ability to survive without water or wetting for a long period time especially during dry season but rely on their food reserve (Oyenekan, 1979). They provide a livelihood and nutrition for vast majority of people. They constitute a major food item or delicacy of large number of people living in the Niger-Delta (Jamabo and Chinda, 2010). Millions of *T. fuscatus* are transported in jute bags on a daily basis to the markets for sale. It is a relatively cheap source of animal protein and its shell is commonly used as source of calcium and phosphate in livestock feed and as ornaments (Jamabo *et al.*, 2009; Akwari and Archibong, 2011; Bob-Manuel, 2012). This species also has some medicinal values. For instance, because of its high iodine content, it has been used for the treatment of endemic goitre (Bob-Manuel, 2012).

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No effort has been made to culture this species in captivity, therefore harvest from the wild has mounted high pressure and impact on its abundance, large-size and community structure (Powell *et al*., 1985; FAO/FIDI, 1994).

Length-Weight relationship (LWR) indicates the average weight of fish at a given length by making use of a mathematical equation to show relationships between the two (Beyer, 1987). Fish can attain either isometric or allometric growth (Gayanilo and Pauly, 1997; Sakar *et al.,* 2013). Isometric growth indicates that both length and weight of the shellfish are increasing at the same rate. Allometric growth can either be positive or negative. Positive allometric implies that the shellfish becomes stouter or deeper-bodied as its length increases. Negative allometric implies the shellfish becomes slender as its length increases.

Condition Factor (CF) is an estimation of general well-being of fish (Oribhabor *et al.,* 2011) and is based on the hypothesis or assumption that heavier fish (at a given length) are in better condition than the lighter ones (Bagenal and Tesch, 1978; Ogamba *et al.,* 2014). The condition factor of 1.0 or greater indicates the good condition of fish while less than 1.0 shows bad condition (Abobi, 2015). The condition factor can be influenced by season, sex, type of food organism consumed by fish, age of fish, amount of fat reserved and environmental conditions (Bagenal and Tesch, 1978; Anene, 2005; Abowei, 2009).

Length-Weight relationship and Condition Factor are important tools in fisheries biology, management and stock assessment to support data about standing stock biomass, their well-being, compare ontogeny of fish population and growth pattern studies of fish from different regions, understand their life cycles and span, construct ecosystem modelling and can be used as index to assess the status of the aquatic environment where the fish live (Le Cren, 1951; Beyer, 1987; Bolger and Connoly, 1989; Patrakis and Stergiou, 1995; Montopoulos and Stergiou, 2002; Mendes *et al*., 2004; Anene, 2005; Fafioye and Oluajo, 2005; Imam *et al*., 2010; Lawson *et al*., 2013; Ogamba *et al*., 2014).

Few studies have been conducted on the length-weight relationship and condition factor of periwinkles in some parts of the Niger-delta (Jamabo, 2007; Jamabo and Chinda, 2010; Udoh, 2013; Iboh *et al.,* 2015). Niger-Delta is the crude-oil reservoir of Nigeria and all aspects of the industrial activities, from exploration, production to waste discharge, have adverse effects on the ecosystems (Uzoma and Mgbemena, 2015). The impact of environmental damage in the region cannot be quantified (Baghebo *et al*., 2012).

There is no published research on some of the aspects of the biology of periwinkle (*T. fuscatus)* in the highly polluted, environmental-unfriendly Okrika estuary. This study is therefore aimed at providing first hand and baseline information on the aspects of the ecology (length-weight relationship and condition factor) of this species in the Okrika estuary.

MATERIALS AND METHODS

Description of the Study Area

The study area (**Figure 1**) lies between latitudes 4° 44’ 00” to 4° 46’ 10” N and longitudes 7° 5’ 15” to 7° 6’ 15” with an area of 905.2sq.km. It is located in Okrika Local Government Area of Rivers State with a population of over 150,000 (NPC, 2006). **Okrika estuary** has an average length of 21km and lies in the north bank of the Bonny River with a distance of about 56km

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from the Bight of Benin in Eastern part of the Niger-Delta. It is a mangrove environment characterised by regular salt water inundation as a result of tidal action and flooding and extensive sandy bottom and mud-flat. The tidal amplitude ranges between 1.5-2m in normal tide. It originates from Marine Base and runs through **Okari** and crosses the Mainland to **Ekerekana** Ama and other creeks such as **Sandfilled/Mainland Bridge (Ogoloma**). It is characterized by tropical climate with alternating wet (March to October) and dry (November to February) seasons. Based on the Nigerian Meteorological (NIMET) data, the area is associated with warm temperature ranging from 26^0 to 34^0C, annual bimodal rainfall of 2300-4000 cubic metres and distinct relative humidity and evaporation. It is ecologically endowed with vast biodiversity; fish, mollusc, crustaceans, crabs, *Rhizophora mangle*, *Laguncularia racemosa, Avicennia africana.*

Experimental Design

Three experimental sampling sites along the estuary course were utilized for data collection. Each site is about 1 - 2km from the other. The respective sampling sites were represented as **Ekerekana (EKR)**, **Okari (OKR)** and **Ogoloma (OGL).** These sites were chosen because *T. fuscatus* are mostly found and aggregated in these sections of the mangrove ecosystem and also their proximity to the refinery discharge point and in addition to other activities such as domestic waste and sewage disposal, oil-bunkering and transportation carried out along its course and also due to their abundance, availability, economic importance, mostly eaten by the populace (market survey), feeding habits and prevailing environmental conditions. Sampling was done in October/November, 2015 and January/February, 2016 which represent the peak of both the wet and dry seasons respectively.

Shell-fish = 3 Sites * 20 Replicates * 2 Seasons **= 120 Samples**

Periwinkle collection, Preservation and Identification

The periwinkle samples were hand-picked randomly from each sampling site at low or ebb tide. Sampling was done in accordance with the techniques used by other published literatures (Jamabo *et al.*, 2009; Moruf and Lawal-Are, 2015). All samples collected were placed in polythene bags. They were transported to the laboratory on ice in a cold chest and washed off mud on getting there. In the laboratory, they were identified to the species level using the fish catalogue of FAO (Fischer *et al.*, 1981; FAO, 1990; Schneider, 1990). Their morphometrics of shell total length (STL) and weight (BWt) were measured using a graduated plastic measuring board and a sensitive scale balance (Kern 440-35A model) (Moruf and Lawal-Are, 2015). All lengths and weights were measured in centimetres and grams respectively. The data gathered were used to evaluate the relationship between the shell total length (STL) and weight (BWt) of *T. fuscatus*.

DATA ANALYSIS

Length-Weight Relationship (LWR)

The raw data of shell total lengths (STL) and weights (BWt) of the periwinkles collected were used to compute the length-weight relationship with the formula;

$$W = aL^b \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$ (Le Cren, 1951; Ricker, 1973)

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where W = body weight, L = total length, a = intercept on the length axis, b = slope or regression coefficient which usually ranges from 2 to 4.

Equation (1) is log transformed to give a linear relationship;

Log W = Log a + b Log L .... (2) (Le Cren, 1951; Parson, 1988)

When Log W is plotted against Log L, the regression coefficient or growth exponent, b, and intercept, a are obtained.

For each species, the growth exponent (b) was compared to 3 using student's t-test to ascertain whether species grow isometrically or not (Sokal and Rohlf, 1987). This was achieved by using the formula;

$t_s = b - 3 / s_b$ ……………………… (Zar, 1984; Morey *et al.*, 2003)

t_s = student's t-test, b = slope, s_b = standard error of the slope.

Condition Factor

This was computed for each species with Fulton's equation;

$K = 100 \times W/L^b$ ………………………….. (Ricker, 1971; Pauly, 1983)

where K = condition factor, W = body weight, L = total length

Statistical Analysis

The data obtained from the morphometric analysis were subjected to statistical analysis using R-Studio Version 0.98.1083 (2009-2014) and Excel version. Analysis of variance (ANOVA) was used to test whether the calculated regression line was significant (Ogbeibu *et al*., 2005). All statistical analyses were considered at significant level of 5% ($p<0.05$).

RESULTS

Length-weight relationship

A total of 120 samples of *T. fuscatus* were measured for their morpho-metrics from October 2015 to February 2016. The shell total lengths (STL) and weights (BWt) ranged from 2.5 – 4.8cm (mean of 3.27±0.29) and 1.16 – 5.87g (mean of 2.54±0.57), respectively.

The length-weight relationship was determined using logarithmic transformation. The linear relationship of the log-weight and log-length is shown as;

Log BWt = -1.67 + 2.18 Log STL ………………. (**Table 1**)

The intercept, a, was negative and the growth exponent, b (2.18), when compared with 3 using t-test showed that there was a significant difference (p-value < 0.00001) confirming the growth pattern of *T. fuscatus* to be negative allometric.

The relationship between shell total length and weight showed a highly significant positive correlation, r = 0.81, p < 0.001. The scatter plot or regression graph of the shell total length and

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weight relationship of the species is shown in **Figure 2.** This reflects the exponential growth in weight with increasing length.

The statistics of the regression is shown in **Table 1.**

Condition Factor (K)

The mean K value of *T. fuscatus* for the sampling period in the study area was found to be 18.9 (**Table 1).**

DISCUSSION

The correlation coefficient (r = 0.81) for length-weight relationship (LWR) was high for *T. fuscatus* which indicates a strong correlation and allows a fair prediction of weight for a given length. This agrees with earlier studies involving the same species from different parts of Niger-Delta (Jamabo *et al.*, 2009; Udoh, 2013). The value for growth exponent, b, obtained for the species is within the limit or range of 2 and 4 reported for most shell-fish (Tesch, 1971). The growth pattern of *T. fuscatus* was found to be negative allometric (b = 2.18), which indicates that the mollusc increases in weight faster than the length (Jamabo *et al.*, 2009). This finding agrees with Gabriel (1981), Jamabo *et al* (2009), Udoh (2013) and Moruf and Lawal-Are (2015), who reported the same growth pattern for this species in the Port-Harcourt area, Bonny and Cross River Estuaries (Niger-Delta) and Lagos Lagoon.

The high mean K value of 18.9 shows that the species samples were in favourable conditions although the creek receives refinery effluents in large amounts on a daily basis, but this could have been flushed out from the basin during high tide. Essien *et al* (2013) also reported a better healthy status (K) of range, 24.7-54.7, for this species investigated in oil polluted Qua-Iboe Estuary, Niger-Delta. High mean K values of 8.0 and 16.1 were also obtained for this species in Lagos Lagoon, but contradict the low K value < 1 reported by Udoh (2013) in the Cross River estuary. This mean K value could have been influenced by food abundance and availability, foraging behaviour of this species and dependence on reserved or stored food energy (Moruf and Lawal-Are, 2015). The high K value could also be explained probably because they were sampled when they were not breeding. This statement contradicts Egonmwan and Odiete (1983) and Ajao and Fagade (1990), who reported that their spawning, oviposition and early embryonic development are restricted to the beginning of the dry season months from November to January. During this period, their condition factor is expected to drop as they are spawning or breeding. This good healthy condition could also be attributed to their ability to tolerate and adapt to highly variable contaminated, environmental vagaries due to their genetic make-up and developing a regulatory mechanism for the toxicants by binding them to metallothioneins, converting it to non-toxic, soluble and excretory form (Viarengo and Nott, 1993; Rainbow, 2002). In addition, the mollusc could also retract into shell which provides valuable protection for the tissues from environmental stress of pollution.

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CONCLUSIONS AND RECOMMENDATION

This study provided information on the biology (LWR and condition factor) of a commercially important mollusc, *Tympanotonus fuscatus,* in Okrika creeks which is the first documented report of its kind and would serve as a reference point for future research.

The findings of this study suggest that the condition of the estuary is favourable to the mollusc in terms of availability and abundance of food resources. In addition, they might have developed a strategy to cope and adapt to an environment that receives effluents from a nearby crude oil refining company. Waste effluents disposed into these creeks are flushed out during high tides creating a favourable environment for the species investigated at least during part time. Further studies need to be carried out because sampling duration (4 months) might be too small to justify concrete conclusions.

The brackish ecosystem of Okrika creeks produces a valuable shellfish species for the local population. Therefore, measures must be taken to reduce the pollution impact on the aquatic ecosystem.

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APPENDIX

FIGURES AND TABLE

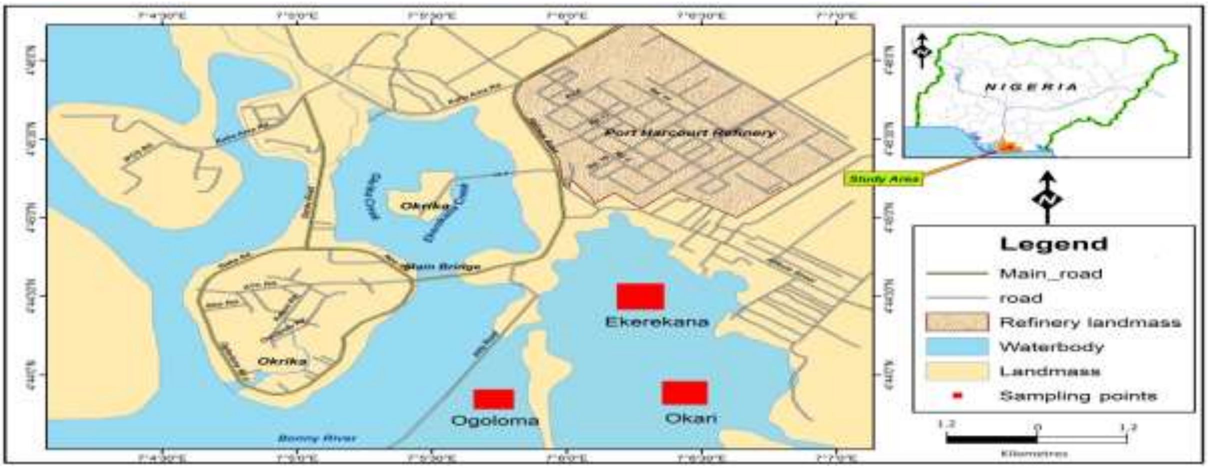

Figure 1: Map of Okrika estuary showing the sampling stations

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Table 1. Morphometrics, Length-weight relationship and Condition Factor of *Tympanotonus fuscatus* from the study area.

Species	Mean STL (cm)	Mean BWt (g)	a	b	Type of growth	r	p-value of r	Mean K	t-value
Tympanotonus fuscatus	3.27±0.29	2.54±0.57	-1.67	2.18	-A	0.81	$2.2x10^{-16}$ ***	18.9	-8.542

BWt = shell or body weight, STL = shell total length, a = intercept of the regression, b = slope of the regression (growth exponent), -A = negative allometric growth, r = correlation coefficient of length weight relationship, p-value of r = significance of correlation, K= Condition Factor, t-value = absolute value of t-test parameter to compare calculated slope to 3. ***p<0.001

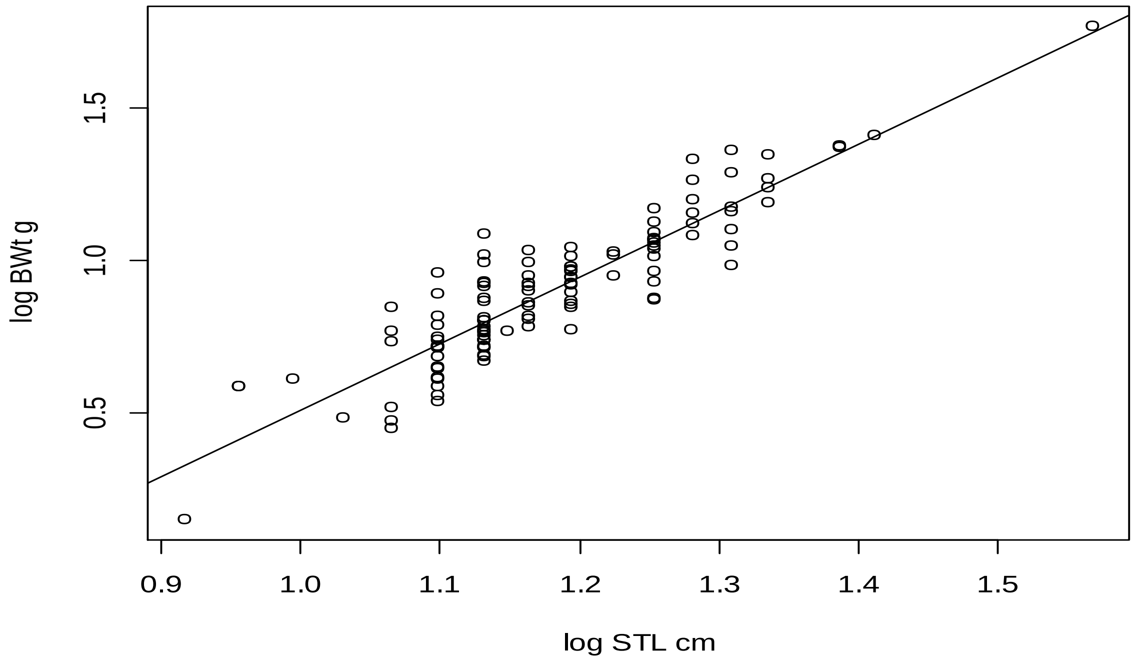

Figure 2. Length-weight relationship of *T. fuscatus*

BWt = Body Weight, STL= Shell Total L

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