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Length – weight relationship, Condition Factor and Reproductive Biology of *Scomberomorus tritor* (Cuvier 1832) from Tombo Coastal Water, Sierra Leone.

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Abstract
The length-weight relationships (LWR) and Fulton`s condition factor (K) are important biological relationships that have been widely used in fishery research consequently, this paper present the findings of the study on the length-weight relationship, condition factor and reproductive biology of Scomboromerus tritor in Tombo, Sierra Leone. Fish samples used composed of 19 males and 40 females having body length ranging from 18.32 – 43.42 cm and weighing between 65.32 – 209.24g. The parameter "a" and "b" of the length-weight relationship were estimated using the equation $W=aL^b$ while the condition factor was calculated using Fulton equation $K=100WL^{-3}$. The combined LWR for both sexes showed that a, b and r-values were 0.8689, 1.4491 and 0.8242 respectively. The r-values obtained showed a strong linear relationship between the length and the weight of the species. The K values varied from 0.26 – 1.06 with a mean CF of 0.46 ± 0.302. The species exhibited negative allometric growth (b<3). Mean value of Gonadosomatic index (GSI) and Hepatosomatic index (HIS) was highest in October, November and December respectively indicating that these are the peak spawning period for the species. Males to females sex ratio was 1:2 and a Chi-square test indicated significant difference P (χ^2<3.841) from 1:1 sex ratio.
Keywords: *Length-weight relationship, Hepatosomatic index, Gonadosomatic index, Condition factor, Scomboromerus tritor, Tombo, Sierra Leone*.

Introduction

The length-weight, condition factor and reproductive biology of *Scomboromerus tritor* was studied in Tombo, a coastal fishing community in Sierra Leone. The study was carried out to ascertain the state of the fishery. *Scomberomorus tritor* (West African Spanish Mackerel) is a pelagic, oceanodromous species that inhabits warm waters. The species is known to be native to Benin; Cameroon; Cape Verde; Congo; Democratic Republic of the; Côte d'Ivoire; Equatorial Guinea; France; Gabon; Gambia; Ghana; Italy; Liberia; Mauritania; Monaco; Morocco; Nigeria; Sao Tomé and Principe; Sierra Leone; Spain; Togo; Western Sahara (Collette *et al*., 2011). In Sierra Leone, artisanal fishers exploit the species, and it is of considerable economic importance, and contribute significantly to national food security. It also provide employment and revenue to the larger proportion of the Sierra Leone population. Information on landings of the species in the country is scanty if any and globally, the species is believed to be in good state and of least concern as it is not listed on the IUCN Red List of Threatened Species. However, a rational management of the species is important especially in a country like Sierra Leone where conservation efforts is at low ebb. There is the need to have in-depth knowledge of the biology and ecology of the species. This knowledge is important for sustainable management and rational exploitation of the stock especially within the context of multispecies and multifleet fisheries (Olapade and Tarawallie

2014). For example, Hampton (2000) and Fromentin and Fonteneau (2001) opined that basic biological parameters such as size and weight are crucial for evaluating fishery sustainability and stocks assessment. The length-weight relationships (LWR) and Fulton`s condition factor (K) have been mentioned by Froese (2006) as important biological relationships that are used widely in fishery research. According to Sarkar *et al*. (2008) and Mir *et al*. (2012), length-weight relationship can be used to estimate the growth pattern by establishing a mathematical relation between them. Singh *et al.* (2011) reported that condition factor could be used in setting yield equations for estimating the number of fish landed and comparing the population in space and time. The condition factor is a useful tool that provides important information concerning the structure and function of fish populations. It is an important function that describe the well-being or robustness of an individual fish and has been used to compare individual fish weight of a given length to a standard weight. The aim of this research is to provide information on the length-weight relation, condition factor and reproductive pattern of *Scomboromerus tritor* in Sierra Leone territorial waters.

Materials and Methods

Study area

The study was carried out in Tombo, a coastal fishing community located on the southern coast of the Western Area Rural District of Sierra Leone.

Fish sample collection and treatment

Samples of *S. tritor* used for the study were collected from the landings of artisanal fishers between July and December 2017. Collected fish samples were transported in ice chest box to the Department of Aquaculture and Fisheries Management, Njala University Sierra Leone where the measurement and dissection took place. The 59 specimens used for the study comprised 19 males and 40 females. Fish total length (TL) was measured to the nearest centimeters (0.1cm) from the tip of the snout to the caudal peduncle using meter rule calibrated in centimeters. Weight was determined with a tabletop weighing balance to the nearest gram (0.1g). Separation of fish into either male or female was done between the month of October and December when the gonads of the fish were fully developed. Gonads retrieved from the female fish through dissection were weighed together with the liver to the nearest grams.

Length Weight Relationship

The equation proposed by Wooton (1990) was used to determine the relationship between the length (L) and weight (W) of the fish species:

$$W = aL^b$$

Alternatively, its logarithmic form:

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

Where:

W is the body weight of fish in gram,
L is the total length in centimeters,
‘‘a’’ the intercept and “b” the slope of the regression line.

The Fulton`s Condition Factor

The values of the combined growth exponent were used for the calculation of condition factor (K) and was calculated as prescribed by Froese (2006).

$$K = 100W/ L^3$$

Where:

K is the condition factor,
W is the body weight of fish in grams,
L is the total length in centimeters.

Chi-square test was carried out on the observed male and female specimens to show the level or proportion of differentiation from the expected 1:1 ratio.

Determination of Hepatosomatic and Gonadosomatic Indices

The hepatosomatic index and Gonadosomatic index of the fish was determined by the use of equation cited by Ekanem *et al.* (2004).

$$H.S.I = \frac{\text{Weight of the liver x 100}}{\text{Weight of the body}}$$

$$G.S.I = \frac{\text{Weight of the Gonad x 100}}{\text{Weight of the body}}$$

Results

Length-weight relationships for combined sexes and seasons

Length-Weight relationship was determined for 59 samples of *S. tritor*. The results of the length-weight relationship for the combined sexes *S. tritor* are presented in Fig. 1. The regression equation for the fish was expressed as log W = 0.8689 + 1.49991 log L with a regression coefficient r^2 of 0.8242 for the combined sexes. The results for the combined length – weight relationship for both sexes of *S. tritor* in the dry and rainy seasons are presented in Figs. 2 and 3. Regression slope 'b' for the fish in the dry and rainy season are 0.806 and 1.0141 respectively while the regression coefficient 'r^2' are 0.906 and 0.5659 for both the dry and rainy seasons.

Condition factor

The mean Fulton`s condition factor for the combined sexes of *S. tritor* are presented in Fig. 4. The mean combined sexes from July to December ranged from 0.26 – 1.06. Mean condition factor was highest in July (1.06) and lowest in October (0.26). Mean monthly variations in Hepatosomatic and Gonadosomatic indices of *S. tritor* studied are presented in Figs 5 – 6. From the results, the maturation phases of the fish specifically falls within the months of October and November. The gonadal decline started in December when the dry season is heightened, a scenario that indicated that gonad development synchronized with season. The sex ratio of 59 samples of *S. tritor* showed a ratio of 1:2, male:female ratio. The Chi-square test performed indicated no significant difference ($P<0.05$) from the expected 1:1 ratio. Table 1 provides the details of the results

Discussion

In this study, length-weight relationships were determined only for the combined sexes of *S. tritor*. The relationship between length and weight is used particularly to define the various growth stages in the life of fish. The parameter `a` and `b` in the length – weight relationship equation was used to determine the growth pattern of the fish. LWR for both sexes showed that a, b and r-values were 0.8689, 1.4491 and 0.8242 respectively. Fish that grows isometrically has a `b` value close to 3

while values other than 3 connotes allometric growth. Allometric growth in fish occurs when the fish changes slope during growth and the cube law fails to hold. The exponent b obtained in this study for *S. tritor* is less than 3 indicating negative allometric in this fish, that is, the fish gets relatively thinner as it grows larger (Wooton, 2015). Yankova et al. (2010) reported that allometric growth in fish might be influenced by factors such as food availability, changes in body shape, growth fluctuations, environmental factors and physiology. Other factors that influence allometric growth of fish according to Gayanilo and Pauly (1997) are seasons, sex, time of year and stages of maturity. Different authors have reported different `b` values for different fish species. For example Olapade and Tarawallie (2014) reported positive allometric growth (3.35) for *Pseudotolithus senegalensis*, Abowei and Ezekiel (2013) reported `b` of 3.21 for *Chrysichthys nigrodigitatus*, Simon and Mazlan (2008) reported value of 2.99 in puffer fish while Ahmed et al. (2011) reported b values of 2.278 for *Clarias lazera* and 3.680 for *Bargrus bayad*. The `b` value obtained for the combined sexes of *S. tritor* in the rainy season was 1.0141 and this was better than 0.8061 obtained in the dry season, a result which possibly suggest that fish grow better in season of food abundance.

The mean combined condition factor (K) of *S. tritor* for the six months ranged from 0.26 to 1.06. The condition factors obtained in this study was almost similar to a range of 0.64 – 1.0 reported for *P. senegalensis* in Tombo by Olapade and Tarawallie (2014), but vary from the K of 0.77 – 0.81 reported for *Clarotes filamentosus* in Lake Oguta (Ajayi, 1982) and 0.49 to 1.48 reported for the same species in Adoni River (Nwadiaro and Okotie, 1985). Condition coefficient according to Anni *et al*. (2016) is one of the standard approach in fisheries used as an indicator of the variability attributable to growth coefficient (b). The wellbeing of fishes according to Gayanilo and Pauly (1997) is affected by factors such as pollution, data pulling, sorting into classes, sex, stages of maturity and state of the stomach. The k values may also vary in relation to season and environmental conditions. Results of the k values in this study showed that the fish population was not in good condition, a situation that is capable of depressing the reproductive potential of the fish with attendant low survival.

The results of Gonadosomatic and Hepatosomatic development obtained in this study for *S. tritor* followed the same pattern. These parameters declined progressively from October to December but were highest in October followed by November, which is an indication that the two months are the spawning time for *S. tritor*. These two months were still somehow within the wet season as rainfall pattern in Sierra Leone has changed. Heavy rainfall are obtained especially in the month of October and this start to decline from mid-November. Rise in water levels and increase in food availability in coastal water, which synchronize with high rainfall, is favourable for the spawning of fishes.

The sex ratio of 1:2 obtained for the combined sexes of *S. tritor* in Tombo is significantly different from the expected of 1:1 as shown in Table 1. The calculated value of 6.5112 is greater than the critical value, which connote that the null hypothesis Ho is significantly different ($P<0.05$). The female fish were preponderant throughout the spawning season. A balance in sex ratio is desirable for fertilization and this definitely will increase the recruitment of the fish population.

Acknowledgement

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Table 1: Chi-square test on sex ratio of *S. tritor* in Tombo

Sex	**Observed (O)**	**Expected (E)**	**O - E**	**$(O – E)^2$**	**$(O – E)^2/E$**
Male	19.7	29.5	-9.8	96.04	3.2556
Female	39.3	29.5	9.8	96.04	3.2556
Total					6.5112

The Chi-square test was used to determine if a population contains equal proportions of males and females and it is a test of how well a model fits the observed data, Hypothesis Ho = Male : Female is 1:1, Ha = Male : Female is not 1:1. If n = 2, degree of freedom (df) = 2 – 1 =1. From the critical values of the Chi-square distribution table at df = 1, X^2 0.05.1 = 3.841. The calculate value 6.5112 is greater than the critical value, the null hypothesis Ho is reject meaning significantly different (P<0.05).

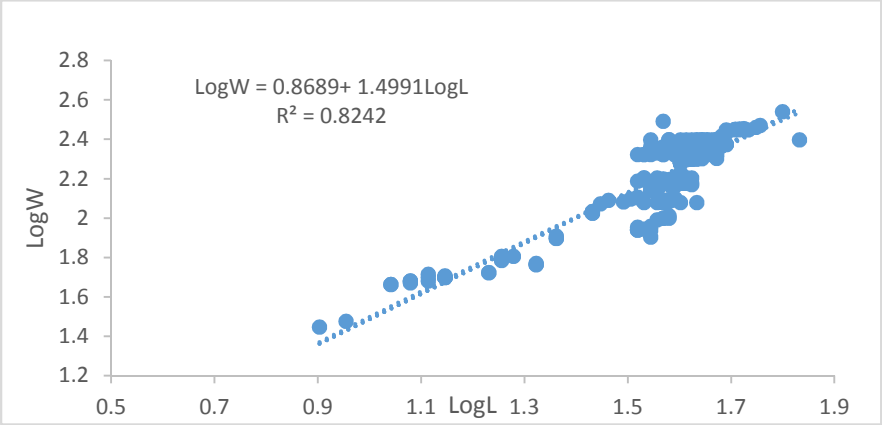

Fig. 1: **Length-Weight relationship of *S. tritor* combined sexes and seasons**

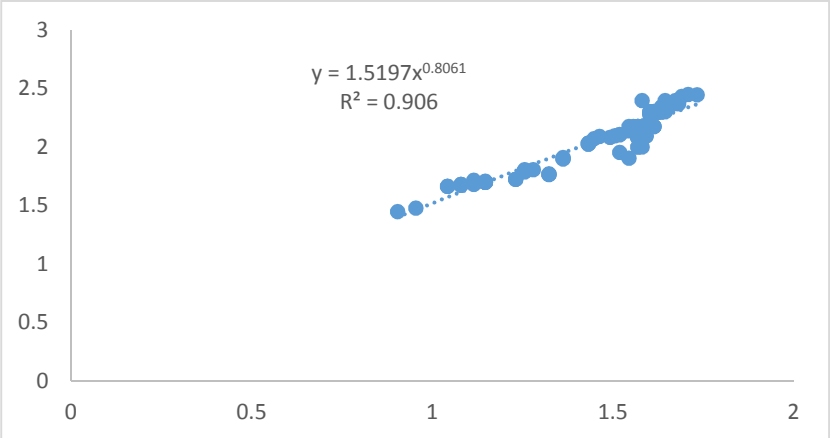

Fig. 2: Length-Weight relationship of combined sexes of *S. tritor* (Dry season)

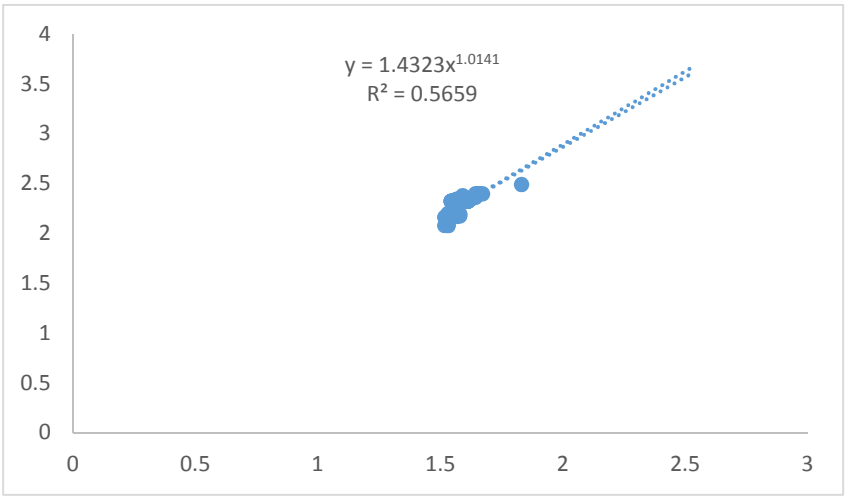

Fig. 3: Length-Weight relationship of combined sexes of *S. tritor* (Rainy season)

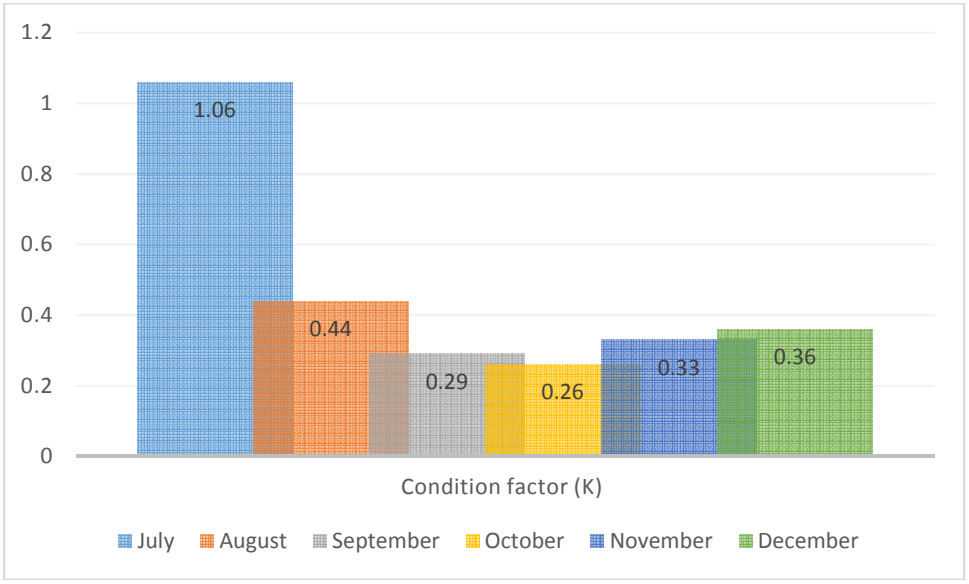

Fig. 4: Mean condition factor for the combined sex of *S. tritor* in Tombo

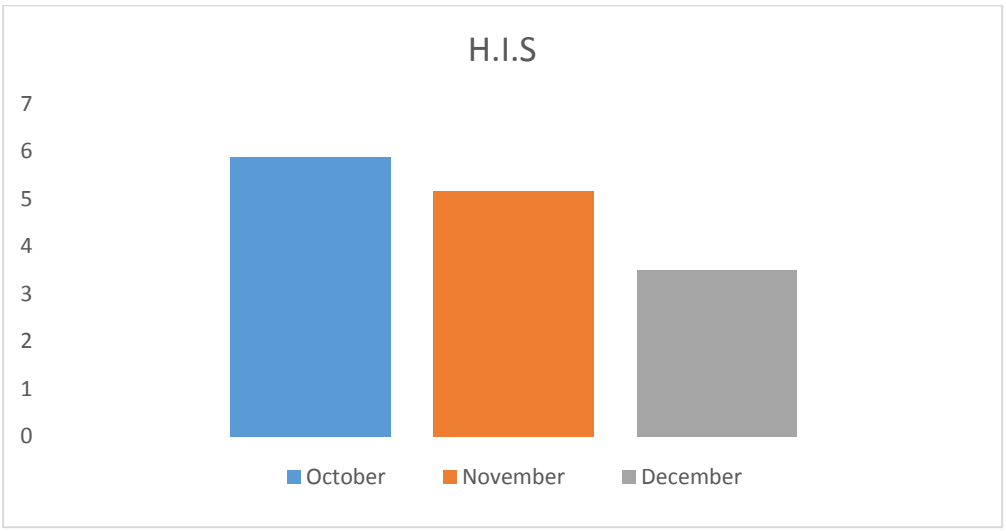

Fig. 5: **Mean Monthly variation of H.S.I of *S. tritor* in the study area**

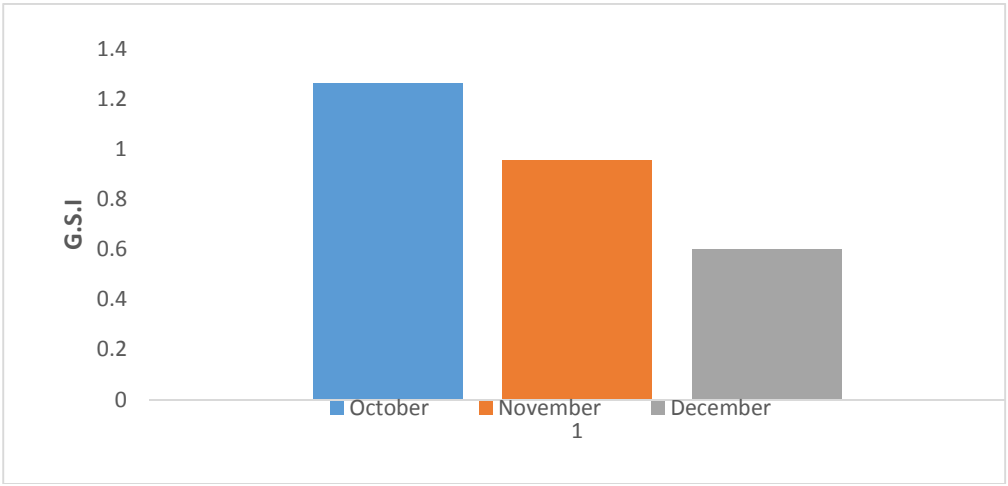

Fig. 6: Mean Monthly variation of G.S.I of *S. tritor* in the study area