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Original Research Article

A preliminary assessment of the length-weight relationship and condition factor of *Hydrocynus vittatus* and *Oreochromis niloticus* in Lake Kariba, Zimbabwe

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ABSTRACT

Background: *Hydrocynus vittatus* and *Oreochromis niloticus* are two economically important fish species in Zimbabwe. The length-weight relation can be employed to assess the health and well-being of fish so as to assist fish farmers. The objective of the study was to investigate the length-weight relationship and condition factor of these fish species.
Methods: Thirty-four fish of each species (*Hydrocynus vittatus* and *Oreochromis niloticus*) were collected by seine netting in the Sanyati Basin, Lake Kariba in August 2019. The total length (TL) and standard length (SL) were measured in centimetre (cm), and the body weight (BW) was measured in grams (g). The body weight (BW) was measured using a digital top-loading electronic weighing balance.
Results: The value of the exponent *b* in the LWR for *H. vittatus* was 2.984, indicating negative allometry ($b<3$). The exponent value of *O. niloticus* in the LWR was 3.04 ($b>3$) implying positive allometry. The r^2 values for *H. vittatus* and *O. niloticus* were 92.3% and 97.3% respectively, indicating that there was a high degree of positive correlation. The condition factor for both fish species were greater than 1.60 implying good physiological conditions for both fish species.
Conclusions: This study provides preliminary information on length-weight parameters of *O. niloticus* whose data was previously not available in the take.

Keywords: Isometric growth, Feeding intensity, Biomass, Morphometric comparison

INTRODUCTION

The length-weight relationship of fish is widely recognized as an important tool in fisheries science and stock management.[1] In production models, this key is used to predict the biomass of the stock using fish lengths.[2] Apart from predicting fish biomass, length-weight regressions have been used frequently to estimate the weight from length because direct weight can be time consuming in the field.[3] The length-weight relationship can be extended for the estimation of fish condition assuming that a heavier fish of a given length is in a better condition.[4] Higher value of the condition factor shows that the fish is healthy and growing positively.[5]

According to Fagade, condition factor decreases with increase in length and also influences the reproductive cycle in fish.[6,7] This factor is calculated from the relationship between the weight of a fish and its length, with the intention of describing the "condition" or the "well-being" of that individual fish.[8]

Despite the importance of length-weight relationship and condition factor in fisheries science, information about the length-weight relationship and condition factor of fishes in Lake Kariba is very scarce and incomplete. A once off - study of the length-weight relationship of *Hydrocynus vittaus,* by Torres on data obtained from Balon et al indicated an isometric growth in the fish species.[9,10] However during the study by the later, *O. niloticus* had not yet been introduced into the lake. Almost five decades after the study, the limnology of the lake is presumed to have changed; hence some changes in the length-weight relationship of the tiger fish are also anticipated. *Oreochromis niloticus* and *H. vittatus* are two important fish species in Lake Kariba as they support the recreational, commercial and subsistence fishery sectors in Zimbabwe. The objective of the present study was therefore to provide preliminary information on the length-weight relationship and condition factor of *H. vittatus* and *O. niloticus* in Lake Kariba.

METHODS

Study area

Lake Kariba is a shared water body located on the border between Zimbabwe and Zambia around 17ºS and 28ºE. The lake is 320 km long, 40 km in maximum width, mean depth of 29.5 m, maximum depth 120 m and a surface area at average water level of 5250 km^2. The Sanyati basin occupies about one fifth of Lake Kariba (Figure 1) and drains a large proportion of Zimbabwe's farming areas.[10]

Fish collection

Fish samples were collected randomly using seine in August 2019. Collected fish were identified (using the key by Marshall 2011), placed in holding tanks containing fresh lake water from the locality and immediately transported to the laboratory. In the laboratory, the fish were killed by severing the spinal cord behind the head. The total length (TL) and standard length (SL) were measured in centimetre (cm), and the body weight (BW) was measured in grams (g). The body weight (BW) was measured using a digital top-loading electronic weighing balance.

Data analysis

The length and weight relationship were analyzed by using the mathematical model $W=aL^b$ as was proposed by Pauly.[11] Whereby W=fish weight (gram), a=intercept, L=standard length, and b=regression coefficient or growth constant and represents the growth pattern of fish.

The values of constants "a" and "b" were estimated using the least-square method applied to the log transformed data as given below.[12]

$$log\ W = log\ a + b\ log\ L$$

All the statistical analyses were considered at significance level of 5% ($p<0.05$).

The degree of correlation between the length and weight was computed by the determination coefficient "r^2". The significance level of r^2 was estimated by analysis of variance (ANOVA) test. The condition factor 'K' was calculated using the model, $K= W\times100/L^3$ where: W is the weight of the fish (g) and L is the standard length of the fish (mm).[11]

RESULTS

Thirty-four fish were collected from each species (Table 1). *Hydrocynus vittatus* lengths ranged from 9.2 to 38.4 cm, and the weights ranged between 10.0 to 1100 g. The lengths of *O. niloticus* ranged from 8.7 to 25.5 cm, and weights ranged from 26.0 g to 566.0 g.

Table 1: Length and weight values of *Hydrocynus vittatus* and *Oreochromis niloticus*.

Fish species		Total length (cm)		Total weight (g)	
	N	Min	Max	Min	Max
H. vittatus	34	9.2	38.4	10	1100
O. niloticus	34	8.7	24.5	26	566

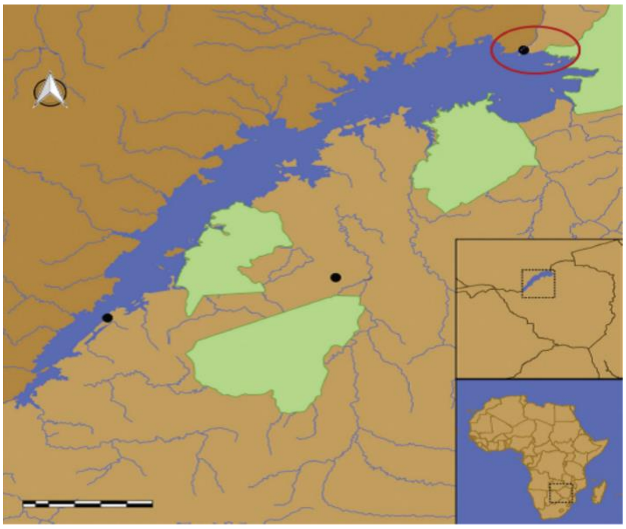

Figure 1: A map of Lake Kariba showing the location of the Sanyati basin.[23]

Length-weight relationship for Hydrocynus vittatus

The relationship between total length and total weight for *H. vittatus* was derived as given below (Figure 2).

$$Log\ W = -4.098 + 2.984\ LogL$$

The regression constant "a' was -4.098. The slope *b* was 2.984 and this value indicating that *H. vittatus* had negative allometry (*b*<3) in its natural habitat. The length-weight relationship in *H. vittatus* was highly correlated (r^2=92.3) indicating that more than 92% of weight variability was explained by the model hence the model gives a good fit for the data (Figure 2).

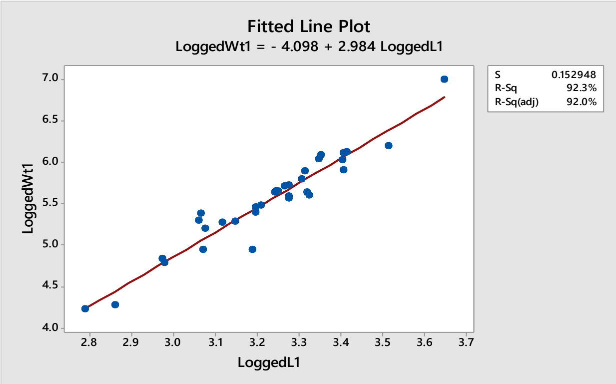

Figure 2: Length-weight relationship of *Hydrocynus vittatus.*

Length-weight relationship for Oreochromis niloticus

The relationship between total length and total weight for *O. niloticus* was derived as given below (Figure 3).

$$Log\ W = -3.437 + 3.046\ LogL$$

The regression constant "a' was -3.437. The regression coefficient was 3.046. This value indicates positive allometric growth (*b*>3) of the species in its natural habitat. The length-weight relationship for *O. niloticus* was also highly correlated as r^2=97.3 implying that more than 97% of weight variability was explained by the model hence the model gives a good fit for the data (Figure 3).

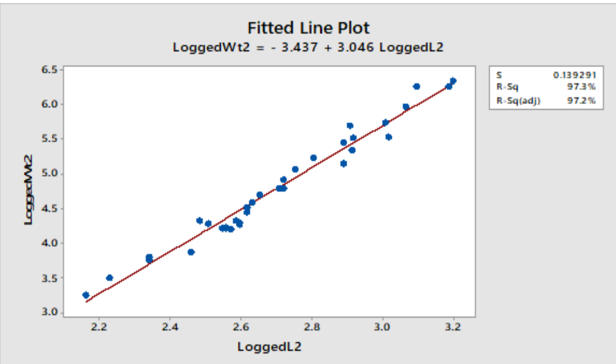

Figure 3: Length-weight relationship of *Oreochromis niloticus.*

Condition factor

The mean condition factors of the two fish species are shown in Figure 4. The mean condition factor for *O. niloticus* was statistically higher (p>0.05) than that of *H. vittatus*.

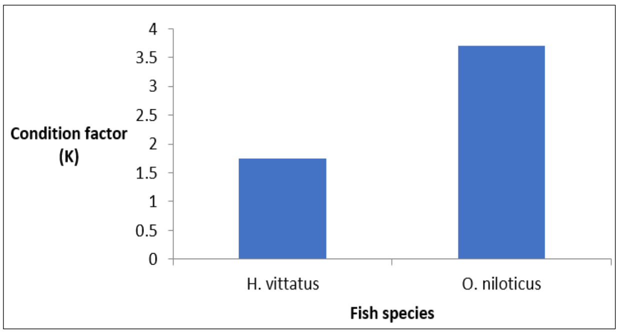

Figure 4: Mean condition factors of *Hydrocynus vittatus* and *Oreochromis niloticus.*

DISCUSSION

When the weigh-length exponent *b* is equal to 3.0, the body form maintains a constant proportion to the length and the fish grows isometrically, resulting in an ideal shape.[11] However, when *b* is less than 3.0, the fish shows negative allometric growth, and when the *b* value is greater than 3.0, the fish shows positive allometric growth.[13] In this current study, the *b* value for *H. vittatus* was 2.984 (*b*<3.0); indicating negative allometric growth. However, a study by Torres in the same lake reported an exponential value of 3.302.[9] This difference can be ascribed to one or a combination of factors including differences in the number of specimens examined, food availability, water quality, seasonal effects and distinctions in the observed length ranges of the specimens caught and the duration of sample collection[14]. However, the *b* value for *H. vittatus* observed in the current study agrees with the findings by Dalu et al and Nhiwatiwa in which the reported *b* values were 2.81 and 2.99 respectively in small reservoirs in Zimbabwe.[15,16]

Oreochromis niloticus had a positive allometric growth (b=3.046), indicating that the fish grows more rapidly in weight than in length. This observation compares favorably with the findings by Fafioye et al, who reported a regression coefficient of 3.04.[17] Similar findings were also reported by Bankole in which the regression coefficient was 3.10 from Tiga lake, Nigeria.[18]

The coefficient of determination (r^2) for length-weight relationship was higher than 92% in both fish species. This confirms with the findings by Dalu et al, in which they reported a coefficient of determination of 94% in *H. vittatus*.[15] Another similar finding was by Karar et al, who reported a coefficient of determination (r^2) of 94% in *Hydrocyon forskalii.*[19] However, the coefficient of determination observed in the current study for *O. niloticus* was much higher than those reported by Echi et al in which the r^2 for female fish was 0.578, male fish 0.384 in Anambra River.[20] The difference could also be explained by the fact that the food items and conditions in lentic and lotic water bodies are different.

According to Barnham et al, if the K value is 1.00, the condition of the fish is poor, long and thin.[21] A 1.20 value of K indicates that the fish is of moderate condition and acceptable to many anglers. A good and well-proportioned fish would have a K value that is approximately 1.40. The mean condition factor of *H. vittatus* and *O. niloticus* recorded in this study were 1.74 and 3.70 respectively. Therefore, based on Barnham et al criterion, the two fish species were in good condition within the lake.[21] In addition, K value range of 2.9-4.8 are recommended as suitable for matured fresh water fish.[22] However, the K value for *H. vittatus* did not fall within this range recommended as suitable for matured fish in fresh water. This could probably be attributed to the sampling procedure. *Hydrocynus vittatus* is a pelagic species; however, the seine netting methods used to sample the fish collected in the shallow habitats, thus sampling more juveniles than mature fish. Therefore, the K values could be assumed to represent the juvenile tigerfish.

CONCLUSION

The lengths of *H. vittatus* ranged from 9.2 to 38.4 cm, while that of *O. niloticus* ranged from 8.7 to 25.5 cm. These sizes may be attributed to the selectivity of the mesh size of the nets used for sampling and the depth of sampling. Consequently, some fish sizes were probably missed. So, for more precise weight estimations, the application of these length-weight relationships should be limited to the observed length ranges. However, the study provided preliminary information on length-weight parameters *of O. niloticus* whose data was previously not available. The once-off sampling gave preliminary results; it is therefore recommended to carry out more studies to assess a seasonal trend of the LWR of these two fish species.

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