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Determination of Morphometric Relationship and Condition Factors of Four Cichlids from Golinga Reservoir in Northern Region of Ghana

Elliot Haruna Alhassan, Daniel Nsoh Akongyuure and Francis Asumang

Department of Fisheries and Aquatic Resources Management,
University for Development Studies, P.O. TL 1882, Tamale, Ghana

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Correspondence Author:
Daniel Nsoh Akongyuure
Department of Fisheries and Aquatic Resources Management, University for Development Studies, P. O. TL 1882, Tamale-Ghana
E- mail: akongyuure2012@gmail.com

Abstract: Length-weight relationship and condition factor have severalapplications on fish biology, physiology, ecology and fisheries assessment. A six-month study was conducted from November 2013 to April 2014 to determine the length-weight relationship and condition factor of four major cichlids namely *Oreochromis niloticus* (Nile tilapia), *Hemichromis fasciatus* (Banded jewelfish), *Sarotherodon galilaeus* (Mango fish) and *Tilapiazillii* (Red-belly tilapia) to fill a knowledge gap and provide useful information for fisheries management and conservation in the Golinga reservoir using the length-weight based model. Samples were collected twice every month with gillnets from commercial fishermen. The length-weight relationship had a strong positive correlation (r>0.8) for the four species. *Oreochromis niloticus* exhibited isometric growth (b = 3.07) whilst *Hemichromis fasciatus* (b = 2.81), *Sarotherodon galilaeus* (b = 2.91) and *Tilapia zillii* (b = 2.75) showed negative allometric growth. Mean condition factor (K) values were greater than one (3.66-4.88) for all the species and varied monthly. The study provided new information on length-weight parameters for the four cichlids.

Keywords: Cichlids, Fisheries Management, Length-Weight, Condition Factor and Reservoir

Introduction

The natural fishery resources in Ghana are declining (Ofori-Danson *et al*., 2012), so there is a need to considerably increase fish production through strict management measures to bridge the widening gap between demand and supply. According to Le Cren (1951), knowledge of the length weight relationship of a fish is essential, since various important biological aspects, viz, general well-being of fish, appearance of first maturity, onset of spawning, etc., can be assessed with the help of condition factor, a derivative of this relationship. Moreover, the length-weight of fish is an important fishery management tool because it allows the estimation of the average weight of the fish of a given length group by establishing a mathematical relationship between the two (Beyer, 1987). As length and weight of fish are among the important morphometric characters, they can be used for the purpose of fish stock assessment. The objective of study was to generate current information on the length-weight relationship and condition factor of major cichlid species for sustainable exploitation and management of the Golinga reservoir fishery.

Materials and Methods

Study Area

The study was conducted in the Golinga community reservoir in the Tolon District of the Northern Region of Ghana. Golinga is about 12 km north-west of Tamale, the regional capital. The dugout has an area of about 18 ha. It is in the Guinea Savannah agro-ecological zone characterized by short trees with grass undergrowth. It experiences a unimodal rainfall regime which greatly influences the water level of the dugout. The annual rainfall averages between 950 mm and 1100 mm. The maximum temperature is 42°C in March and April and a minimum of 15°C in January. The area falls within latitude 9° 34' 15.75" N and longitude 1° 01' 21.13"W. Farming is the main occupation of the people but others engage in petty trading and fishing.

Data Collection

Fish samples were collected from commercial gill net catches of fishermen twice in a month, from November 2013 to April 2014. The mesh size of the gill nets ranged from 4 cm to 7 cm. The fishermen set their gill nets by 18 00 GMT and retrieved them by 08 00 GMT the following morning. Fish species were identified using keys provided by Dankwa *et al*. (1999). Each fish was measured for Standard Length (SL) in cm and weighed to 0.1 g accuracy with a calibrated fish measuring board and a spring balance respectively. Monthly length-weight frequency (SL cm) was compiled from the length-weight measurements of fish samples. In all, a total of 321 individuals were sampled for *O. niloticus*; 89 for *H. fasciatus;*265 for *S. galilaeus* and 112 for *T. zillii.*

Determination of Length-Weight Relationship

Estimation of species length-weight relationship was calculated using the formula $W = a L^b$ (Le Cren, 1951). Where *W* is weight (g) and *L* is length (cm), *a* is a co-efficient related to body form and *b* is an exponent indicating isometric/allometric growth.

Determination of Condition Factor

Condition factor (K) is the state of well-being of the fish, which was computed using the formula $K = 100 w/L^3$ (Pauly, 1983); where W = weight (g) of a fish, L= total fish length (cm).

Data Analysis

A least square regression plot was drawn using Microsoft Excel 2007 to compute for the *b* value which was used to calculate for the condition factor (K).

Results

Length-Weight Relationship

The scatter plots of length-weight relationship of the population of the fish species in the Golinga reservoir during the period of study are shown in Fig. 1-4. The standard Length (SL) of *O. niloticus* ranged between 6.2 cm and 19.0 cm and weighed between 5.1 g and 225.00 g; SL of *H. fasciatus* ranged between 5.0 cm and 12.0 and weighed between 9.0 g and 76.0 g. The standard length of *S. galilaeus* varied between 5.5 and 14 cm and the weight ranged between 12 and 120 g and the standard length of *T. zillii* varied between 6 and 12.5 cm and the weight ranged between 13.0 and 70.0 g. An exponential relationship was revealed between the Standard Length (SL) and body Weight (W) of *O. niloticus, H. fasciatus, S. galilaeus* and *T. zillii* and the equations describing these relationships were $W = 0.035L^{3.073}$(r = 0.889), $W = 0.129L^{2.554}$(r = 0.938), $W = 0.061\ L^{2.908}$ (r = 0.975) and $W = 0.0808\ L^{2.753}$ (r = 0.959) respectively Fig. 1-4. The correlation coefficient (r) was very strong in all four fish species. Table 1 shows the summary of length-weight relationship parameters and condition factor of the cichlid fishery of Golinga reservoir.

Table 1. Summary of length-weight relationship parameters and condition factor of the cichlid fishery from Golinga reservoir

Species	Regression equation	a	b	Growth	r	Number of individuals (N)	Mean condition factor (K)
Oreochromisniloticus	$W = 0.035L^{3.073}$	0.035	3.073	Isometric	0.889	321	3.66
Hemichromisfasciatus	$W = 0.129L^{2.554}$	0.129	2.554	Allometric	0.938	89	4.88
Sarotherodongalilaeus	$W = 0.061L^{2.909}$	0.061	2.909	Allometric	0.975	265	4.29
Tilapiazillii	$W = 0.081L^{2.753}$	0.081	2.753	Allometric	0.959	112	4.51

W = Weight (g), a = Intercept, b = Slope, L = Standard length (cm), r = Correlation coefficient

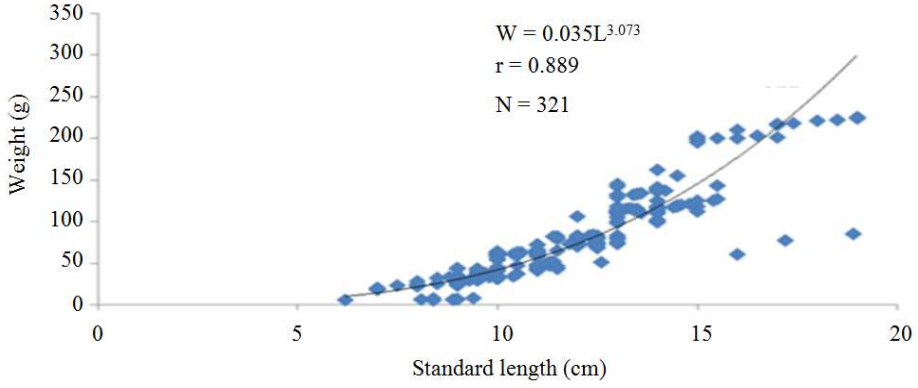

Fig. 1. Length-weight relationship of *O. niloticus* from the Golinga reservoir

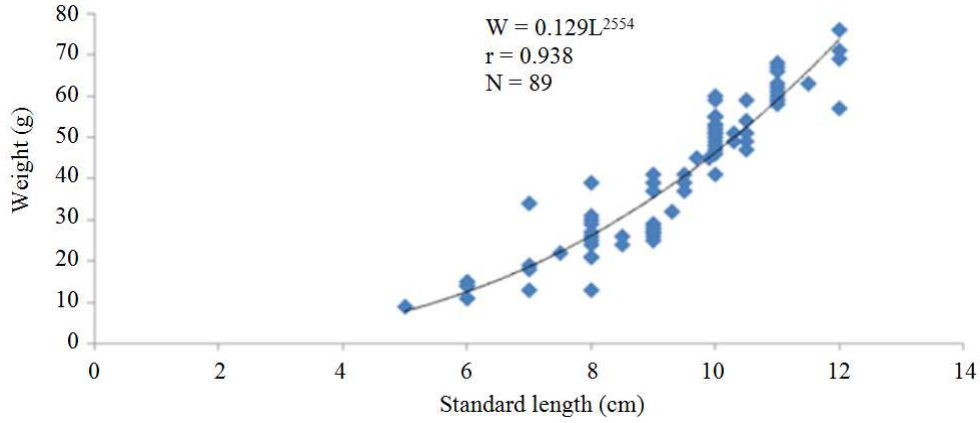

Fig. 2. Length-weight relationship curve of *H. fasciatus* from the Golinga reservoir

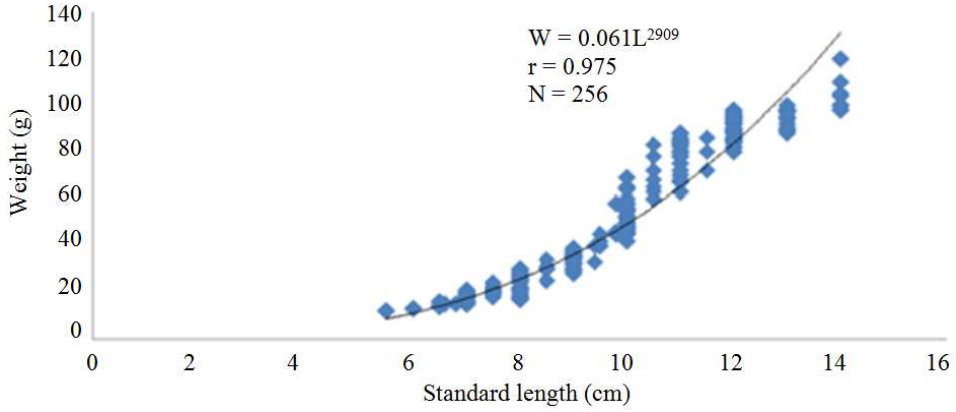

Fig. 3. The length-weight relationship curve for *S. galilaeus* from the Golinga reservoir

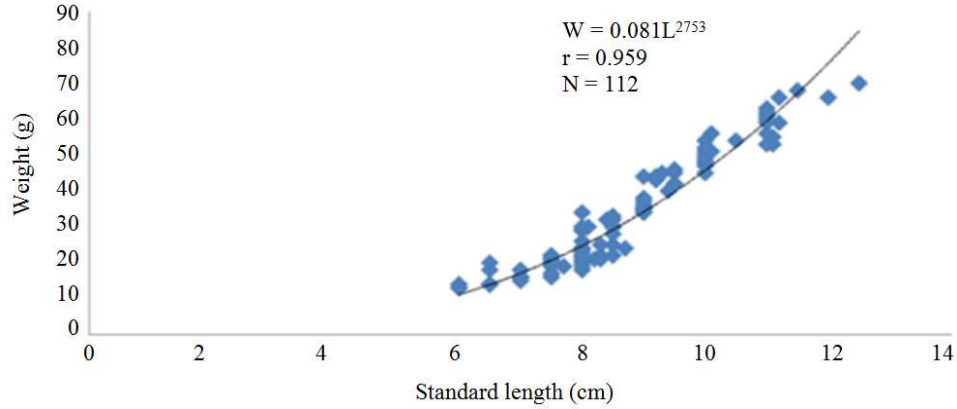

Fig. 4. The length-weight relationship curve for *T. zillii* from the Golinga reservoir

Condition Factor

Figure 5 shows the variation in the mean monthly (November, 2013-April, 2014) condition factors of the major cichlids studied in the Golinga reservoir. The condition factor of *O. niloticus* ranged from 2.45 to 4.65; those of *H. fasciatus* varied from 4.50 to 5.69; *S. galilaeus* ranged from 3.44 to 4.75 and *T. zillii* ranged from 3.07 to 4.95. Comparatively, *H. fasciatus* was in the best condition whilst *O. niloticus* was only good. All four species were in their good condition during the period of study.

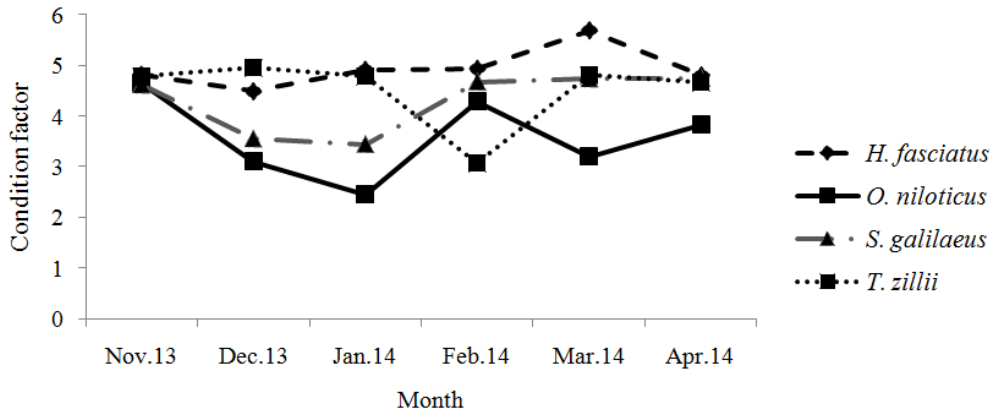

Fig. 5. Mean monthly variation in condition factor of major cichlids in the golinga reservoir during the study period

Discussion

Length-Weight Relationship of Major Cichlids from Golinga Reservoir

The length- weight relationship is very important for proper exploitation and management of the population of fish species (Pervin and Mortuza, 2008) and allows prediction of weight from length in yield assessment (Pauly, 1983). In fish, the weight is considered to be a function of length (Weatherley and Gill, 1987). In the present study, the regression equations and values of the correlation coefficient 'r' of the four fish species were suggestive of a close relationship between length and weight of the species (Table 1). For an ideal fish that shows isometric growth, the regression co-efficient (b) is 3.0 and populations in which the exponent differs significantly from 3.0 exhibit allometric growths (Beverton and Holt, 1966). Gayanilo and Pauly (1997) suggested that 'b' values may range from 2.5 to 3.5 which support the results of this study. Within the same species, variation in the exponent of length-weight relationships could be due to different stages in the ontogenetic development, differences in sex and differences in geographical location with the associated environmental conditions (Froese, 2006; Kraljevic *et al*., 1996).The length-weight relationship for *O.niloticus* was described by the relation $W = 0.035L^{3.073}$ from the Golinga reservoir. The regression coefficient of 3.07 indicated isometric growth in *O. niloticus* as against allometric growth (1.2-1.4) reported by Imam *et al*. (2010) from Wasai reservoir in Kano, Nigeria. The finding from this study was also closely similar to the findings of Fafioye and Oluajo (2005) with bvalue of 3.04. Gayanilo and Pauly (1997) suggested that b values may range from 2.5 to 3.5 which support result of this study.

The negative allometric b value (2.55) obtained for *H. fasciatus* was similar to the study of Agboola and Anetekhai (2008). Koffi *et al*. (2014) reported positive allometric growth (b = 3.16) for *H. fasciatus* from Aby Lagoon, Southeastern Côte d' Ivoire. The b value (2.91) in the length-weight relation, $W = 0.061L^{2.909}$ for *S. galilaeus*indicated allometric (negative) growth. In agreement, Mahomoud *et al.* (2011) reported similar growth of this species in Rosetta branch of the Nile River, Egypt. Again, *T. zillii*showed allometric (negative) growth (b = 2.75). In agreement, allometric (negative) growth (b = 2.69) was recorded in Lake Qauran and Edko as reported by Shalloof (2009). Similarly, negative allometric growth (b = 2.30) of *T. zillii* was observed by Dan-Kishiya (2013) from Lower Usuma reservoir located in Abuja the federal capital territory of Nigeria and by Koffi *et al*. (2014) (b = 2.93) in Côte d' Ivoire. In contrast, isometric growth was reported for *T. zillii* in the Betania Reservoir in Colombia by Cala and Bernal (1997) and in the Guarapiranga Reservoir in Brazil by Krebs (1984). The length-weight relationship is a practical index of the condition of fish and may vary over the year according to several factors such as food availability, feeding rate, health, sex, gonad development, spawning period and preservation techniques (Begenal and Tesch, 1978).

Condition Factor

Condition factor studies describe the health and general well-being of a fish as related to its environment; hence it represents how healthy or plump the fishes are (Reynold, 1968). The condition factor of fishes has been reported to be influenced by a number of factors such as the onset of maturity (Hoda, 1987), spawning (De-Silva and Silva, 1979; Al-Daham and Wahab, 1991), sex and maturity (Gowda *et al*., 1987; Doddamani and Shanbouge, 2001) and pollution (Bakhoum, 1999; Devi *et al*., 2008). Condition factor is influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish live (Anene, 2005).

The monthly fluctuations in condition factor observed in this study in all the four species appeared to be influenced by gonadal development, availability of food and gastral activity. Changes in condition factor of fishes could be used to interpret various biological features such as fatness, food availability, reproductive activities and environmental health (Dadzie *et al*., 2000).

The condition factor mean values for *O. niloticus* (K = 3.66), *S. galilaeus* (K = 4.29), *T. zillii* (K = 4.51) and *O. niloticus* (K = 3.58) recorded in this study were higher than values reported by Imam *et al*. (2010) and Achionye-Nzeh (2011) from reservoirs in Nigeria.

Conclusion

The length-weight relationship for *O. niloticus*and *H. fasciatus*in the Golinga reservoir were described by the relation $W = 0.035L^{3.073}$, r = 0.889 and $W= 0.129L^{2.554,}$ r = 0.938 respectively which shows that *O. niloticus* population in the Golinga reservoir were growing isometrically (b = 3.07) and that of *H. fasciatus* were growing allometrically (b = 2.554).

Also, the length-weight relationship for *S. galilaeus*and *T. zillii*in the Golinga reservoir were shown by the relation $W = 0.061L^{2.9085}$ with r = 0.9753 and $W= 0.0808L^{2.7534}$ with r = 0.9595 respectively. This indicates that both the population of *S. galilaeus*and *T. zillii* were growing allometrically with b values of 2.909 and 2.753 respectively.

The well-being of the four species studied was good since their condition factors were greater than one.

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Author Contributions

Elliot Haruna Alhassan: Conception and design of research plan, Funding of research, Analysis and interpretation, Statistical analysis Critical revision of the article, Overall responsibility and Final approval of article.

Daniel Nsoh Akongyuure: Writing the article,Analysis and interpretation, Statistical analysis, Critical revision of the articleOverall responsibility and Final approval of article.

Francis Asumang: Funding of research, Data collection, Analysis and interpretation and Final approval of article.

Conflict of Interest

There is no conflict of interest that exists between authors.

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