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Full Length Research

Length-weight relationship and condition factor of *Labeo niloticus, Synodontis schall* and *Auchenoglanis occidentalis,* in Upper Atbara and Setit Dam Complex, Gadarif State, Sudan

Hozifa Adam Suliman Adam[1]* and Ahmed El-Aabid Hamad[2]

[1]Department of Animal Production, Faculty of Veterinary Sciences, University of Gadarif, Sudan.
[2]Department of Fisheries Sciences and Wildlife, College of Animal Production Science & Technology, Sudan University of Science & Technology, Sudan.

*Corresponding author. Email: adam_hozifa@yahoo.com; Orchid: https://orcid.org/0000-0002-9139-8426.

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ABSTRACT: This study was undertaken to assess the length-weight relationship and condition factor of *Labeo niloticus*; *Synodontis schall* and *Auchenoglanis occidentalis*, in Upper Atbara and Setit Dam Complex, Gadarif State, Sudan from September 2019 to January 2020. Samples of fish were collected monthly for a 5 months period. A total of 1475 specimens of *L. niloticus* (500 samples), *S. schall* (500 samples) and *A. occidentalis* (475 samples). Fish species sampled in the study area had size range of 17 to 37 cm, 11.6 to 30.5 cm and 16.7 to 38.8 cm, for *L. niloticus, S. schall* and *A. occidentalis*, respectively. The weight ranged from 88 to 927 g, 49 to 682 g and 94 to 1334 g, for *L. niloticus*, *S. schall* and *A. occidentalis*, respectively. The LWRs for the combined sexes had the (r) values of 0.974, 0.902 and 0.906, respectively. The mean condition factor (K) was 3.121±0.262, 2.902±0.435 and 2.366±0.292 for the combined sexes, respectively. The regression coefficient b was 2.848, 2.619 and 2.823 for the combined sexes, respectively indicating negative allometric growth pattern for all species.

Keywords: Allometric growth, combined sexes, condition factor, fish species.

INTRODUCTION

The main freshwater fisheries in Sudan are located in the River Nile and its tributaries, major dam reservoirs and man-made lakes (FAO, 2014). Sudan is one of the largest countries in Africa with area of 1861500 km^2 (FAO, 2014).

Because of its high protein content, fish is an essential dietary component. Unfortunately, many fish stocks are plummeting worldwide notably in Mediterranean Sea for example, mainly because of two factors: the overexploitation of certain fish species and the environmental degradation caused, among other things, by pollution (Zhou et al., 2010; Coll et al., 2010). Some quantitative aspects such as length weight relationship (LWR) and condition factor (K) of fishes is an important tool for the study of fishing biology. In fishery assessments and in fish biology, the LWR is of great importance (Tesfaye and Tadesse, 2008; Dan-Kishiya, 2013).

Several indices are used in assessing the condition of a fish with regard to factors that affect their distribution and abundance, alteration in food, spawning and breeding grounds. Some common indices used to assess fish status are the length-weight, length-length relationship, growth factor and condition factor (Kings, 2007; Mahmood et al., 2012). Length-weight relationship (LWR) of fishes is important in fisheries and fish biology because they allow estimation of the average weight of the fish of a given length group by establishing a mathematical relationship between them (Sarkar et al., 2008; Mir et al., 2012). In length-weigh relationship, fishes can attain either isometric

or allometric, when b = 3, increase in weight is isometric. When the value of b is other than 3, weight increase is allometric (positive if b>3, negative if b<3) (Nehemia et al., 2012; Riedel et al., 2007; Weatherly and Gill, 1987).

The condition factor is a parameter of the state of well-being of fish based on the hypothesis that heavier fish of a particular length is in a better physiological condition (Bagenal, 1978). Also condition factor reflect the interactions between biotic and abiotic factors in the physiological condition of the fishes (Lalrinsanga et al., 2012). Condition factor is also a useful index for monitoring of feeding intensity, age, and growth rates in fish (Ndimele et al., 2010). Condition factor shows the degree of wellbeing of the fish in their habitat and measures the deviation of an organism from the average weight in a given sample. It assesses the suitability of a specific water environment for growth of fish (Yilmaz et al., 2012; Mensah, 2015).

Abdalla et al. (2021) recorded the mean condition factor for *L. niloticus* in Khashm El-Girba Reservoir and Atbara River; Eastern Sudan as 1.671±0.273, 1.953±0.644 and 2.548±0.516 in Um Aswad, El-Remila and El-Monaba sites, respectively. Ahmed et al. (2017) reported a condition factor of *S. schall* in Roseires reservoir to be 0.7018. Therefore, this study intents to investigate the length-weight relationships and condition factors for better management of fisheries resources in the study area.

MATERIALS AND METHODS

Study area

The Upper Atbara and Setit Dam Complex is a twin dam complex comprising Rumela Dam on the Upper Atbarah River and Burdana Dam on the Setit (Tekezé) River in eastern Sudan. It is located on latitude 14°16′36″N and longitude 35°53′49″E (Plate 1). The site of the twin dam is located about 20 kilometres upstream from the junction of the Atbarah and Setit rivers and about 80 kilometres south of the Khashm el-Girba Dam (Wikipedia, 2015).

Rumela Dam on the Atbarah is 55 metres in height and Burdana Dam on the Setit is 50 metres in height. The two dams are connected and have a total length of 13 kilometres. The twin dam complex has a joined reservoir with a storage capacity of about 2.7 billion cubic metres of water. The maximum filling level is 517.5 metres above sea level (Wikipedia, 2015).

Sample collection

A total of 1475 individuals of *L. niloticus* (500 samples), *S. schall* (500 samples) and *A. occidentalis* (475 samples) were randomly sampled monthly for five months, four time a month, 25 samples for each species per week. The fish specimens used for the study were obtained from fishermen operating along Upper Atbara and Setit Dam Complex. These fishermen use various fishing gears including hooks, traps and a set of multifilament gill nets. The collected fish were identified down to the species level using identification keys published by Sandon (1950), Abu Gideiri (1984) and Bailey (1994).

Morphometric measurements

Total length (TL) of fish was measured to the nearest 0.1 cm from the tip of snout to end of the upper lobe of the caudal fin, and standard length (SL) from the tip of the snout to the flexure between caudal peduncle and caudal fin, using a measuring board. Body weight (BW) was recorded to the nearest 0.1 g using a digital balance (SF-400A). All measurements of the collected samples of *L. niloticus, S. schall*; and *A. occidentalis* were taken at the sampling sites.

Length-weight relationship:

The relationship between length and weight of studied fish species was calculated according to Bagenal and Tesch (1978), using the equation below:

$W = al^b$ ----------Eqn. 1

Where: W = total weight, L= standard length, a and b are constants, were estimated by converting the logarithmic linear function (Sparre and Venema, 1992).

Log (W) = log (a) + b log (L) ----------Eqn. 2

(a) and (b) were obtained using least square regression according to Sparre and Venema (1992), where (b) is the regression coefficient.

Excel package was used to plot the curve of the relationship between length and weight, and the values of the constants (a) and (b) for each species were estimated.

Condition factor (FCF)

Condition factor (K) was calculated according to the formula:

$FCF = \frac{w}{L^b} \times 100$ ----------Eqn. 3

Where; W = total weight of the fish in grams and L = the standard length of the fish in cm.

The value of (b) usually ranges from 2.5 to 4.0 for mature freshwater fish.

Statistical analysis

Data was analyzed using the statistical package (Past

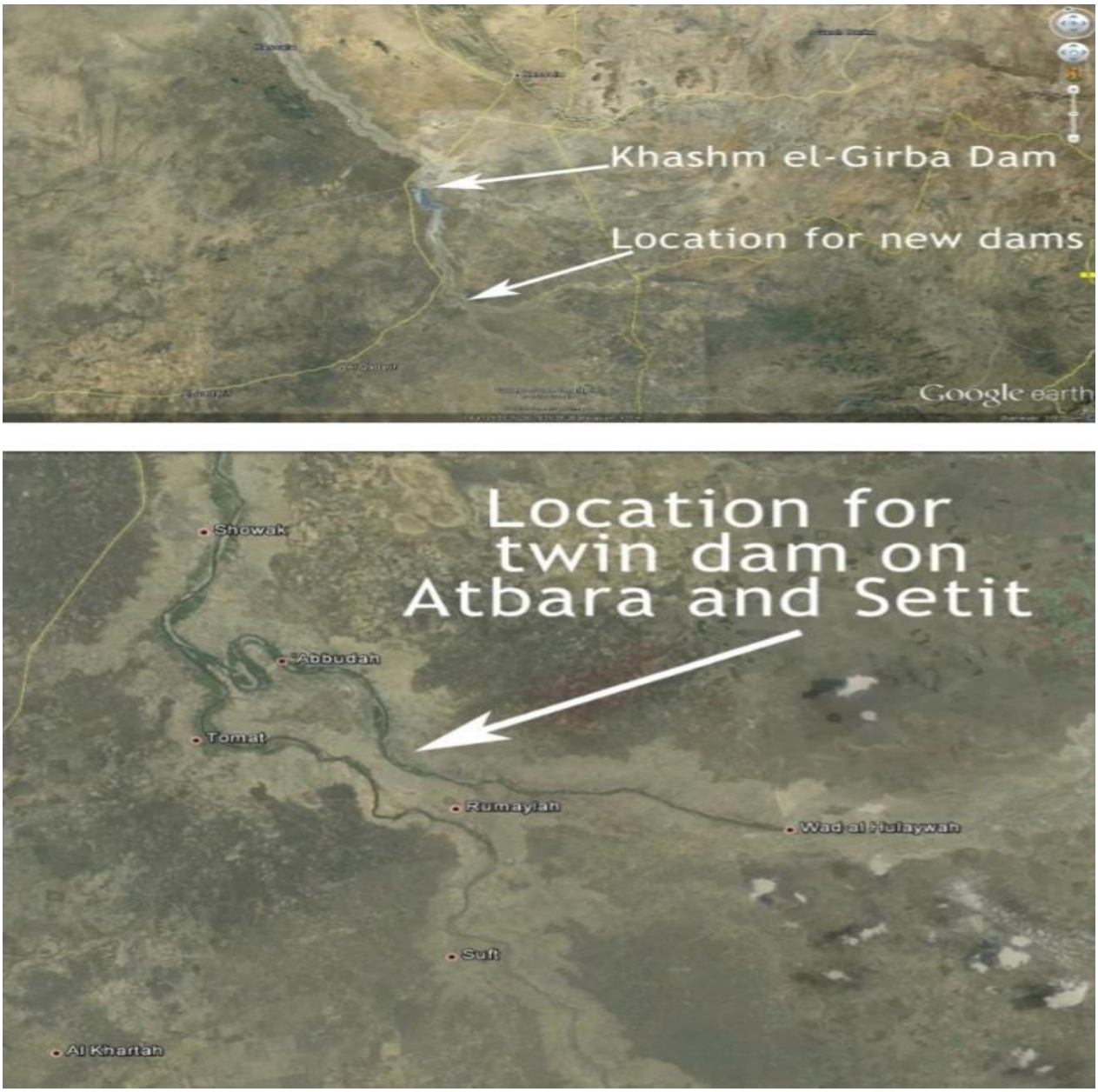

Plate 1. A map of location for twin dam on Atbara and Setit, and the sampling site (source preservethemiddlenile.com, 2012).

statistical package version 3.14) to obtain liner regression and correlation and Microsoft office Excel 2007 to calculate average and standard deviation.

RESULTS

Morphometric measurements

The morphometric measurements showed minimum length of 17.0, 11.6 and 16.7 cm while the maximum length of 37.0, 30.5 and 38.8 cm; with an average value (± SD) of 23.557±3.903, 18.511±2.377 and 29.367±3.680 cm for *L. niloticus*, *S. schall* and *A. occidentalis* respectively, as shown in Table 1.

Length-weight relationship

The length-weight relationship (LWR) of *L. niloticus*; *S. schall* and *A. occidentalis*, for the combined sexes had the (r) values of 0.974, 0.902 and 0.906, respectively. The regression coefficient b was 2.848, 2.619 and 2.823 for the combined sexes, respectively indicating negative allometric growth pattern for all species, as shown in Table 2, Figures 1, 2 and 3.

Table 1. Data observation, minimum, maximum and average of Standard length and weight for all species in the study.

Parameter		*L. niloticus*	*S. schall*	*A. occidentalis*
Length	Min	17	11.6	16.7
	Max	37	30.5	38.8
	Aver.	23.557 ± 3.903	18.511 ± 2.377	29.367 ±3.680
Weight	Min	88	49	94
	Max	927	682	1334
	Aver.	258.472 ±139.411	189.978 ± 73.362	632.417 ± 203. 714

Table 2. Linear fit of length-weight relationship for species of *L. niloticus*, *S. schall* and *A. occidentalis* in Upper Atbara and Setit Dam complex during the study period (2019/2020).

Species	L-W Relationship	Equation	No.	value		r
				(a)	(b)	
L. niloticus	SL - W	Log W= -1.507 + 2.832 Log SL	500	-1.507	2.832	0.975
S. schall	SL - W	Log W=-1.102 + 2.651 Log SL	500	-1.102	2.651	0.907
A. occidentalis	SL - W	Log W= -1.012 + 2.854 Log SL	475	-1.012	2.854	0.871

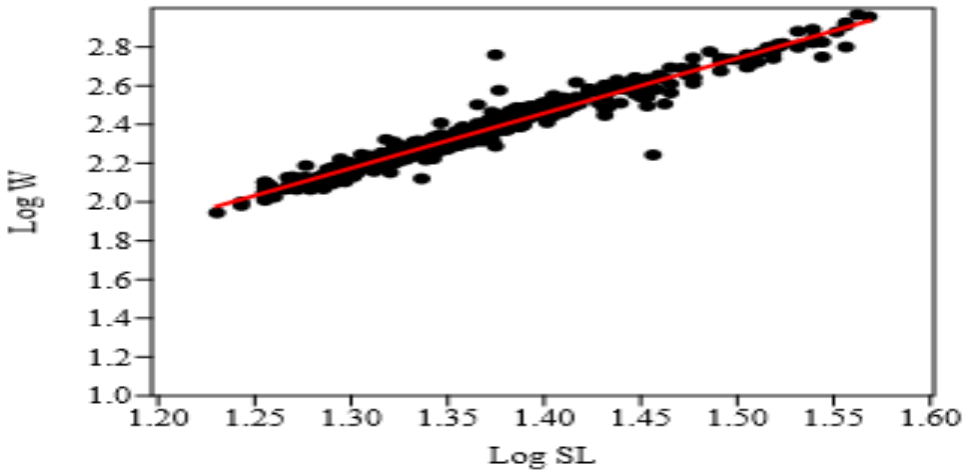

Figure 1. Linear fit of standard length-weight of *L. niloticus* in Upper Atbara and Setit Dam during the study period (2019/2020).

Condition factor of studied fish species

Very high values of condition factor were recorded for *L. niloticus* during study period; value of condition factor fluctuated between 3.048±0.181 and 3.241±0.235, with an average 3.121±0.262, as shown in Table 3.

Values of condition factor recorded for *S. schall* in Upper Atbara and Setit Dam Complex ranged between 3.253±0.293 and 3.253±0.293; while mean value of (K) calculated are 2.902±0.435, as shown in Table 3.

Minimum value of (K) recorded for *A. occidentalis* in the fishing sites was 2.151±0.162, and the maximum value was 2.484±0.456; with average value of 2.366±0.292. Generally, very high values of condition factor (> 1.0) were recorded for *S. schall* in Upper Atbara and Setit Dam Complex, as shown in Table 3.

DISCUSSION

Analysis of the regression coefficients obtained indicated negative allometric growth of *L. niloticus, S. schall* and *A. occidentalis*, where the slope (b) of the (LWR) was highly significant ($p<0.001$) and ranged from 2.848, 2.619 and

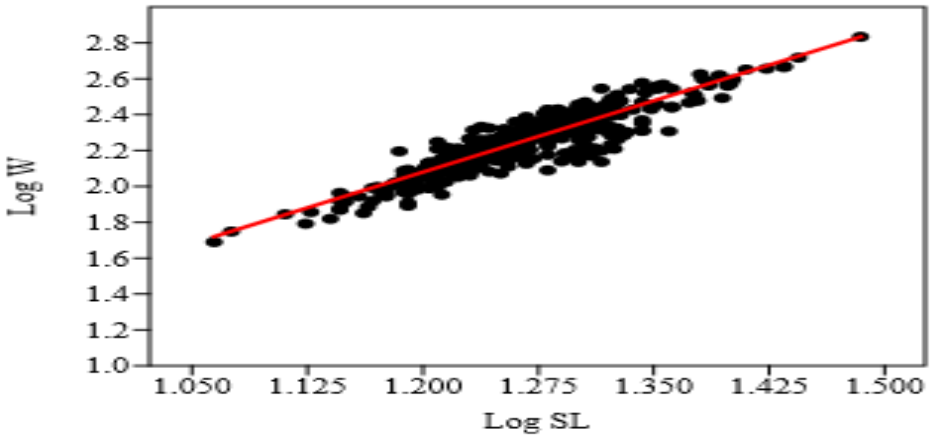

Figure 2. Linear fit of standard length-weight of *S. schall* in Upper Atbara and Setit Dam during the study period (2019/2020).

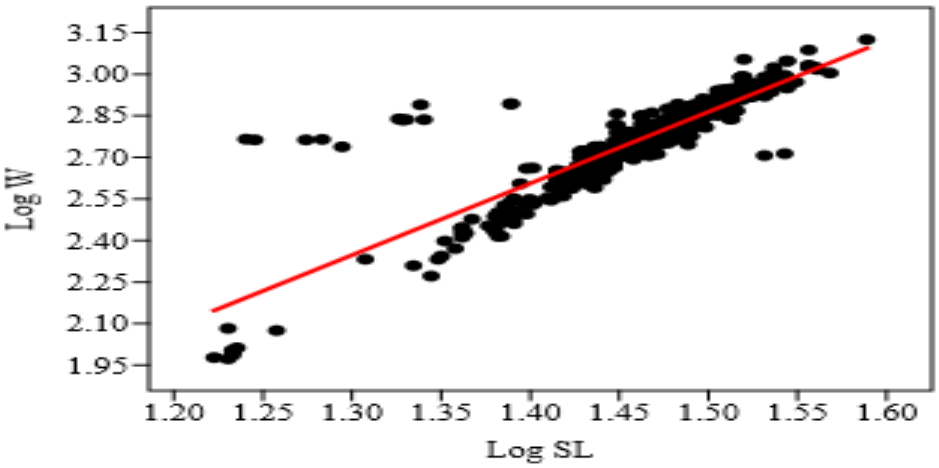

Figure 3. Linear fit of standard length-weight of *A. occidentalis* in Upper Atbara and Setit Dam during the study period (2019/2020).

Table 3. Average condition factor for species of *L. niloticus*, *S. schall* and *A. occidentalis* in Upper Atbara and Setit Dam complex during the study period (2019/2020).

Month	*L. niloticus*	*S. schall*	*A. occidentalis*
Sep - 2019	3.096 ± 0.331	2.781 ± 0.347	2.484 ± 0.456
Oct - 2019	3.095 ± 0.281	2.543 ± 0.499	2.337 ± 0.231
Nov - 2019	3.123 ± 0.281	3.098 ± 0.313	2.433 ± 0.150
Dec - 2019	3.241 ± 0.235	3.253 ± 0.293	2.444 ± 0.190
Jan - 2020	3.048 ± 0.181	2.837 ± 0.303	2.151 ± 0.162
Mean	3.121 ± 0.262	2.902 ± 0.435	2.366 ± 0.292

2.823 for the combined sexes respectively. This result agrees with the findings of Abdalla et al. (2021) who recorded negative allometric growth pattern with regression coefficients of 2.178 to 2.885 for *L. niloticus* in Khashm El-Girba reservoir and Atbara River, Sudan. Similarly, several authors who worked on *L. niloticus* from the White Nile, Khashm El-Girba reservoir, Atbara River, Roseirs Reservoir after heightening of the Dam reported negative allometric growth pattern of this species (Ahmed et al., 2011; Hamid, 2018).

Also, the result in present study for *S. schall* agrees with many authors (Laleye et. al., 2006; Akombo et al., 2014; Ahmed et al., 2017) in Nigeria, Benin, and Roseires reservoir- Sudan. Ikongbeh et al. (2013) recorded negative

allometric growth of both male and female *A. occidentalis* in Lake Akata and Edward (2018) who recorded negative allometric growth also for *A. occidentalis* in Upper River Benue (Nigeria).

The mean condition factor recorded for *L. niloticus, S. schall* and *A. occidentalis* in the study area were 3.121±0.262, 2.902±0.435 and 2.366±0.292 for the combined sexes, respectively. Similar studies were carried out on condition factor of *L. niloticus*; *S. schall* and *A. occidentalis*in different inland waters in Sudan and some African rivers. Abdalla et al. (2021) concluded that mean condition factor of *L. niloticus* in Khashm El-Girba Reservoir and Atbara River; Eastern Sudan, ranged between 1.671±0.273, 1.953±0.644 and 2.548±0.516 in Um Aswad, El-Remila and El-Monaba sites respectively. A similar result was obtained by Ahmed et al. (2011) showing that the condition factor (K) of *L. niloticus* ranged from 1.595±0.912 to 2.536±0.070 in Khasm El-Girba reservoir.

On the other hand, Ahmed et al. (2017) reported that the condition factor for *S. schall* in Roseires reservoir was 0.7018. This result disagrees with the result in present study. The marked difference in the high values of condition factor recorded in Upper Atbara and Setit Dam complex and Khashm E-Girba may be due to differences in location of the collection site, sample size, seasonal variation in water temperature, turbidity, photoperiod and food availability in the two freshwater ecosystems.

Akombo et al. (2014) recorded that mean condition factor of *S. schall* in River Benue (Nigeria), fluctuated between 2.838 to 2.874 for female, male and combined sex. While Laleye et al. (2006) reported a mean condition factor of 1.513 for *S. schall* in Oueme River (Benin).

Ikongbeh et al. (2013) reported that the mean condition factor of *A. occidentalis* in Lake Akata, Benue (Nigeria) varied between1.53±0.02; while Edward (2018) reported average value of condition factor of 1.21 for *A. occidentalis*is in Upper River Benue, Nigeria. This result disagrees with the result in present study for *A. occidentalis*is. This may be due to the difference in location of the collection sites, where environmental conditions are different in the Khashm El-Girba reservoir and Upper Atbara and Setit Dam complex.

Conclusion

The result obtained in this study showed general negative allometric growth among the fish species under study (*Labeo niloticus*, *Synodontis schall*; and *Auchenoglanis occidentalis*). Very high values of condition factor (>1.0) were recorded for *Synodontis schall* in all three sampled fishing sites in Upper Atbara and Setit Dam complex.

CONFLICT OF INTEREST

The authors of this paper declare that competing interests do not exist.

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