SEASONAL VARIATION OF PHYSICOCHEMICAL PARAMETERS AND LENGTH-WEIGHT RELATIONSHIP OF SELECTED FISH SPECIES FROM RIVER DONGA, NIGERIA

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ABSTRACT
An 18-month study (March 2018 to August 2019) investigated the seasonal variation of physicochemical parameters and length-weight relationships of Clarias gariepinus and Oreochromis niloticus from River Donga. Physicochemical analysis revealed stressful conditions in both dry and wet seasons, with phosphate (1.17-3.57 mg/l and 1.36-2.73 mg/l), ammonia (0-0.37 mg/l and 0-0.33 mg/l), and turbidity (2.67-76.25 mg/l and 11.67-121.25 mg/l) levels indicating stress. Length-weight relationship analysis of 524 fish samples revealed b-values ranging from 0.335-3.254 and 1.440-2.862, and K-values ranging from 0.481-0.803 and 1.298-2.460 for C. gariepinus and O. niloticus, respectively. Results revealed negative allometric growth (b<3) for all O. niloticus and some C. gariepinus, as well as positive allometric growth (b>3) for male and female C. gariepinus in the dry season. Seasonal trends in condition factor (K-value) indicated that both rain-fed and dry conditions favoured the wellness of O. niloticus. The high coefficient of determination (R^2) values suggested that fish weight was largely determined by length. The study highlights the importance of length-weight relationships and condition factor in evaluating fish growth and well-being, and underscores the need for sustainable fisheries management practices to ensure the long-term health of River Donga's fish populations.

Keywords: Condition factor, Fish biology, Growth, Water quality.

INTRODUCTION

Fish and fishery products are generally regarded as important part of a healthy diet. In developing world, fish and fishery products apart from being a source of cheap animal protein, are widely consumed since they have high quality protein, essential nutrients are low saturated fat and contain omega 3 fatty acids (FAO, 2014). In many parts of Nigeria, the demand for fish and fishery product has continuously outweighed the supply. The annual consumption/demand in Nigeria has been estimated to be over 3.6 million metric tons while the total domestic production is just about 1.2 million metric tons per annum leaving import with 2.4 million metric tons (WorldFish Center, 2024). Chukwuemeka *et al*. (2017); Anko and Eyo, (2006) reported that Nigeria has vast potentials for fisheries development, being endowed with marine area of 36,300km^2 an exclusive economic zone (EEZ) area of 210,900km^2 and inland waters of 12.5million hectares. Amazingly, despite the huge endowment, the current production level of 400,000 metric tons is at 50% deficit to meet Nigeria's fish needs per annum of at least 1.5 million metric tons.

Nigeria is blessed with abundant natural resources in marine, estuarine and freshwater environments. The freshwater bodies of Nigeria, with over 270 fish species, are the richest in fish diversity in West Africa (Tobor, 1992). Fish diversity comprises of species richness (number of species in a defined area), species abundance (relative number of species) and phylogenetic diversity (relationships between different groups of species) (Gorman and Karr., 1978; Negi and Mamgain, 2013). Today the fish diversity and associated habitats management is a great challenge and the ability to evaluate effects of habitat change and other impacts on the fish population required extensive surveying of the fish population before and after the change occur (Lester *et al.,* 1996; Dudgeon *et al.,* 2006; Negi and Mambain, 2013)

The studies on the biology of fish are an indispensable aspect of sustainable management and conservation of fish biodiversity. The length-weight of a given fish population is an important fishery management tool valuable for the estimate of the average weight of a given length group and in estimating the relative wellbeing or condition factor of that given fish population (Abowei and Ezekiel, 2013). Fishes are said to exhibit Isomeric growth when length increased in equal proportions with body weight for constant specific gravity (Abowei and Ezekiel, 2013). The regression co-efficient for isomeric growth is 3 and values greater than 3 indicate allometric growth. Condition factor studies take into consideration the health and general well-being of a fish as related to its environment (Golam and Fahad, 2013). The condition factor is useful as an index of growth, feeding and breeding duration (Abowei, 2006). The biology of reproduction must be properly understood in order to formulate any rational management policy for fishery. Thus, comprehensive knowledge of production of fish populations is important for increased fish production in natural waters and in aquaculture.

This study investigates the biology of *Oreochromis niloticus* and *Clarias gariepinus* and assesses the water quality of River Donga, Taraba State, Nigeria, providing crucial baseline data to fill the existing knowledge gap and support informed management decisions.

MATERIALS AND METHODS

Study Area

The River Donga is located in Taraba State, Nigeria, and originates from the Mambilla Plateau in Northeast Nigeria. It forms part of the international border between Nigeria and Cameroon before flowing northwest to join the River Benue as a tributary. It meets the River Benue at latitude 8° 19′ 00″ N and longitude 9° 58′ 00″ E. The Donga watershed covers an area of 20,000 square kilometres (7,700 sq mi). At its peak, the river delivers 1,800 cubic meters (64,000 cu. ft.) of water per second. The river's water colour varies between brownish during the wet season and clear during the dry season. It is situated at an elevation of 113 meters above sea level. The communities surrounding the river rely on it for various purposes, including drinking, irrigation, fishing, laundry, bathing, and transportation. The Donga River Basin is home to three forest reserves: Baissa, Amboi, and Bissaula River. These reserves are located on the slopes and at the foot of the Mambilla Plateau, southwest of the Gashaka Gumti National Park. The coordinates of the landing sites along the River Donga are: - Gidin Dorowa: 8° 2′ 49.66″ N, 8° 5′ 47.203″ E, Tsokundi: 10° 1′ 54.206″ N, 7° 51′ 10.67″ E, Donga: 7° 39′ 17.117″ N, 10° 5′ 3.156″ E, Manya: 7° 16′ 28.261″ N, 10° 15′ 29.695″ E. Global Positioning System (GPS), GERMIN 76.

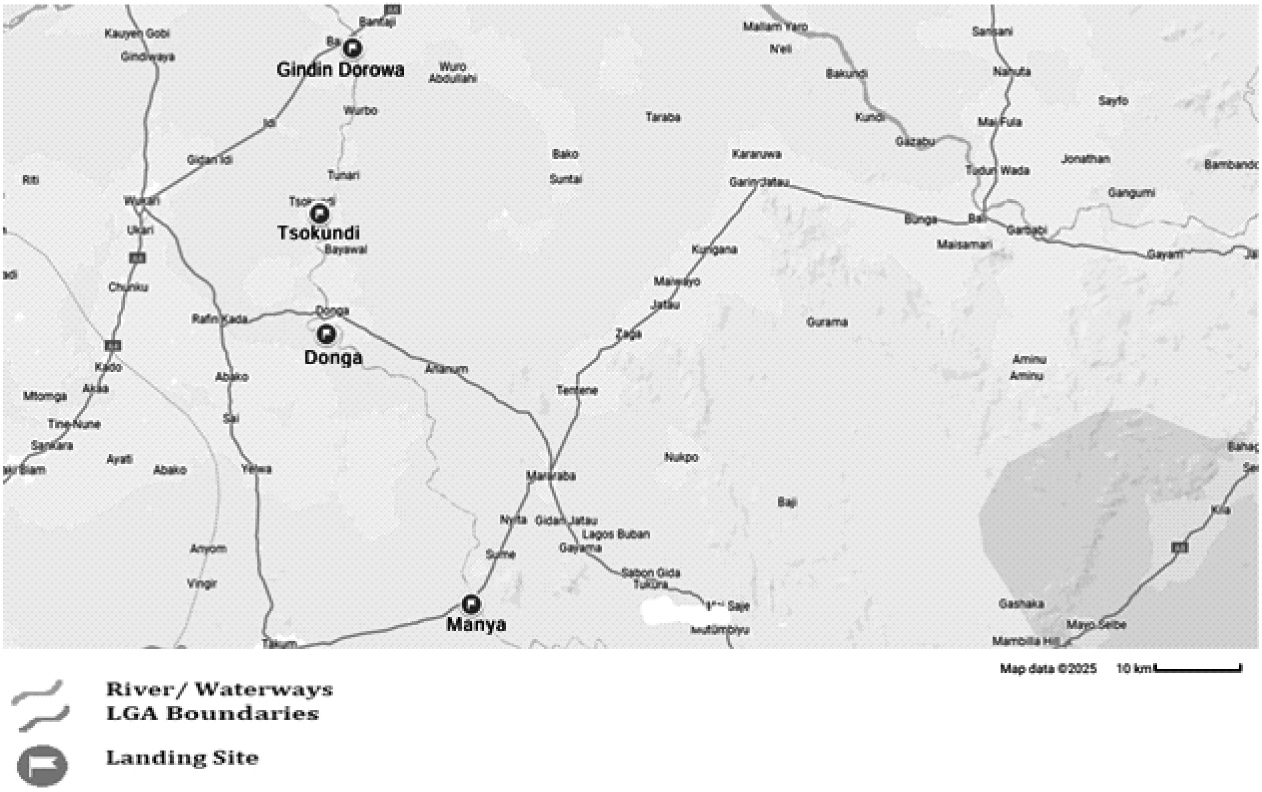

Figure 1: A base map of River Donga Showing the Study Areas

Methods

Water sampling and analysis: Collected monthly from 4 sites between 7:00 am - 11:00 am. Used 1-liter plastic containers and 250 mL reagent bottles. Containers were washed and rinsed with nitric acid before use. Temperature reading was recorded *in-situ* at the four different sampling site using mercury bulb thermometer. The bulb was placed in water and allowed for about two (2) minutes to achieve equilibration. Water pH was also determined *in-situ* at four sampling sites using a calibrated Hanna instruments portable pH meter (model HI8014). The pH probe was dipped into the river, and the readings were recorded. Other parameters (nitrate, phosphate, ammonia, etc.) were analysed in the laboratory using a LaMotte test kit. Dissolved oxygen; measured using a dissolved oxygen bottle and test tablets. Biological oxygen demand; measured by storing samples in the dark for 5 days and then analysing using dissolved oxygen test tablets. Conductivity; measured using a Hanna conductivity meter. Turbidity; measured using a LaMotte turbidity kit.

Fish sampling and analysis: All fish species found in the river were collected in a plastic jar containing ice to the Federal University Wukari, biology laboratory for identification using Field Guide to Nigerian Freshwater Fishes keys prepared by Olaosebikan and Raji (2013). The biology of *Oreochromis niloticus* and *Clarias gariepinus* were determined monthly. A total of 531 fish samples for both species were collected from the four landing sites. The total length, TL (distance between snout and the tip of caudal fin) and standard lengths SL, (the tip of the fish mouth to the hidden base of the tail fin rays) of each fish were measured in centimetres using meter rule to the nearest 0.1 centimetre, while the weight of each fish was measured in grams using an electronic weighing balance to the nearest 0.1gram and their condition factors were calculated.

Monthly collections were made, and fish were identified using a field guide. Morphometric measurements (total length, standard length, and weight) were taken, and condition factor was calculated.

Length-weight relationship mathematical expression: W = aL^b; where W is body weight (g), L is standard length (cm), 'a' is the regression constant, and 'b' is the slope of the regression line.

Logarithmic expression for the length-weight relationship is given by: Log W = loga + blogL.

The Condition factor, K = (W / L^b) × 100, where K is the condition factor, W is body weight (g), and L is total length (cm), Pauly (1983) as adopted by Ja'afaru and Tashara (2009).

Data analysis

Linear regression analysis was used for length-weight relationship and condition factor. While ANOVA was used to analyse the physicochemical parameters. Microsoft Excel was used for organising, manipulating and visualising data.

RESULTS

Seasonal variation of physicochemical parameters:

The result for seasonal variation of physicochemical parameters is shown in Table 1, Nitrite in dry season was 2.75 ± 0.17 (mg/L) and wet season 2.40 ± 0.24 (mg/L), Phosphate in dry season 2.24 ± 0.36 (mg/L) and wet season 1.92 ± 0.16 (mg/L), Ammonia in dry season 0.09 ± 0.06 (µmol/L) and wet season 0.08 ± 0.03 (µmol/L), DO in dry season 3.63 ± 0.11 (mg/L) and wet season 3.51 ± 0.08 (mg/L), BOD in dry season 1.67 ± 0.20 (mg/L) and wet season 1.61 ± 0.11 (mg/L), Alkalinity in dry season 69.58 ± 9.74 (mg/L) and wet season 56.16 ± 7.11 (mg/L), Hardness in dry season 55.63 ± 12.92 (mg/L) and wet season 54.64 ± 8.51 (mg/L), TDS in dry season 9.00 ± 1.05 (mg/L) and wet season 12.21 ± 0.55 (mg/L), CO_2 in dry season 2.17 ± 0.05 (mg/L) and wet season 2.02 ± 0.17 (mg/L), TSS in dry season 0.73 ± 0.27 (mg/L) and wet season 1.43 ± 0.19 (mg/L), Turbidity in dry season 35.61 ± 12.32 (mg/L) and wet season 87.04 ± 9.35 (mg/L), Electrical Conductivity (EC), in dry season 14.99 ± 0.82 (S/m) and wet season 17.39 ± 0.84 (S/m), pH in dry season 6.80 ± 0.09 and wet season 6.94 ± 0.34. There was no significant difference (P>0.05) in both season for temperature, Nitrate, Phosphate, Dissolved Oxygen Demand, Alkalinity, Hardness, Total Dissolved Solid, Total Suspended Solute, Turbidity, EC, and Hydrogen ion Concentration (pH).

The result for seasonal variation of length-weight relationship regression analysis for *Clarias gariepinus and Oreochromis niloticus* is shown in Tables 2 and 3, a total of 531 fish samples were obtained from artisanal fishers from four different landing sites along the river bank, 231 were *Clarias gariepinus* and 293 were *Oreochromis niloticus.* The fish species were examined, and 7 fish sample sexes were unidentified. Thus, the results obtained were as follow:

The dry seasonal variation of length-weight relationship regression analysis for *Clarias gariepinus* and *Oreochromis niloticus* is shown in Table 2 and Figures 2, 3, 7 & 8:

The results for dry season (March 2018 – April 2018) female *C. gariepinus* showed mean value for weight (w) = 2.1150 ± 0.0024, length (l) = 1.480 ± 0.0042 and b = 0.357; male results showed mean value w= 2.2400 ± 0.00687, l= 1.5189 ± 0.00539 and b = 0.335. Combined *C. gariepinus* result showed mean value w = 2.1600 ± 0.01257, l = 1.4940 ± 0.005. and b = 2.013 and the linear regression is given in Figure 2 as Log W= Log 2.013L – Log 0.848. While the results for dry season (November 2018 – April 2019) is shown in Figure 3**,** Female *C. gariepinus* result showed mean value w = 2.1083 ± 0.07985, l = 0.4883 ± 0.02366 and b = 3.254; male result showed that mean w = 1.8920 ± 0.05536 and l = 1.3949 ± 0.01677 and b = 3.243. Combined *C. gariepinus* result showed that mean w= 1.9375 ± 0.0480, l= 1.4118 ± 0.0147 and b = 3.197. Combined *C. gariepinus* result showed that mean w= 1.9375 ± 0.0480, l= 1.4118 ± 0.0147 and b = 3.197. The linear regression is given in Figure 3 as Log W= Log 3.197L – Log 2.575.

The results for seasonal variation of length-weight relationship of *O. niloticus* for dry season (March 2018 – April 2018) as shown in Figure 6, Female *O. niloticus* result showed that mean w = 1.8996 ± 0.4204, l= 1.1970 ± 0.01891 and b = 2.214. Male result shows that mean w = 1.6960 ± 0.03628, l = 1.1040 ± 0.01400 and b = 2.571. Combined *O. niloticus* result showed that mean w= 1.8678 ± 0.0381, l= 1.1825 ± 0.0171 and b = 2.215. The linear regression is given in Figure 6 as Log W= Log 2.215L – Log 0.752. While the results for *O. niloticus* for dry season (November 2018 – April 2019) as shown in tables 3: Female *O. niloticus* result showed that mean w= 1.8283 ± 0.04591, l = 1.2388 ± 0.01731 and b = 2.591. Male result showed that mean w = 1.9828 ± 0.06358, l = 1.2876 ± 0.02170 and b = 2.862. Combined *O. niloticus* result showed that mean w = 1.8743 ± 0.03798, l = 1.2533 ± 0.01391 and b = 2.665. The linear regression is given in Figure 7 as Log W = Log 2.665L – Log 1.466.

The wet seasonal variation of length-weight relationship regression analysis for *C. gariepinus* and *O. niloticus* is shown in Table 3 and Figure 4, 5, 8 & 9:

The results for wet season (May 2018 – October 2018) is shown in Table 3, female *C. gariepinus* result shows that mean w = 2.0721± 0.03037, l = 1.4129 ± 0.00991 and b = 2.103. Male result shows that the mean value weight= 1.9289 ± 0.04306, L= 1.3650 ± 0.01946 and b = 1.887. Combined *C. gariepinus* result shows that mean w= 1.9952 ± 0.0280, l= 1.3872 ± 0.0117 and b = 1.977. The linear regression is given in Figure 4 as Log W= Log 1.977L – Log 0.748.

While the results for wet season (May 2019 – August 2019) is shown: Female *C. gariepinus* result showed that mean w = 1.9133 ± 0.0412, l = 1.4117 ± 0.0134 and b = 2.851. Male *C. gariepinus* result showed that mean w = 1.9686 ± 0.02184, l = 1.4386 ± 0.0679 and b = 2.544.

Combined *C. gariepinus* result showed mean value w = 2.1600 ± 0.01257, l = 1.4940 ± 0.005. and b = 2.013. The linear regression is given in Figure 5 as Log W = Log 2.674L – Log 1.873.

The results for *O. niloticus* for wet season (May 2018-October 2018) is shown: Female *O. niloticus* result showed that mean w= 1.8566 ± 0.03530, l = 1.2220 ± 0.01481 and b = 2.041. Male showed that mean w = 1.7451 ± 0.0212, l = 1.1765 ± 0.0112 and b = 1.440. Combined *O. niloticus* result showed that mean w = 1.8105 ± 0.0232, l = 1.2023 ± 0.0101 and b = 1.935. The linear regression is given in Figure 8 as Log W = Log 1.935L – Log 0.517. The results for *O. niloticus* for wet season (May 2019 – August 2019) is shown in Table 3: Female *O. niloticus* result showed that mean w = 1.9759 ± 0.0255, l = 1.2910 ± 0.0101 and b = 2.156. Male result showed that mean w= 1.9612 ± 0.03925, l= 1.2813 ± 0.02218 and b = 1.560. Combined *O. niloticus* result showed that mean w = 1.9695 ± 0.0222, l = 1.3584 ± 0.0112 and b = 1.712. The linear regression is given in Figure 9 as Log W = Log 1.712L – Log 0.234.

Table 1: Seasonal Variation in Physicochemical Parameters of River Donga

Parameters	Season	Minimum	Maximum	Mean ± SD
Temperature (°C)	Dry	23.75	29.25	26.75 ± 0.81
	Wet	26.50	28.75	28.03 ± 0.24
Nitrate	Dry	1.83	3.50	2.75 ± 0.17
	Wet	1.03	4.00	2.40 ± 0.24
Phosphate	Dry	1.17	3.57	2.24 ± 0.36
	Wet	1.36	2.73	1.92 ± 0.16
Ammonia	Dry	0.00	0.37	0.09 ± 0.06
	Wet	0.00	0.33	0.08 ± 0.03
DO	Dry	2.95	3.94	3.63 ± 0.11
	Wet	3.11	3.90	3.51 ± 0.08
BOD	Dry	1.20	2.63	1.67 ± 0.20
	Wet	1.30	2.43	1.61 ± 0.11
Alkalinity	Dry	38.33	100.00	69.58 ± 9.74
	Wet	20.75	93.33	56.16 ± 7.11
Hardness	Dry	33.33	133.33	55.63 ± 12.92
	Wet	21.38	100.00	54.64 ± 8.51
TDS	Dry	5.53	12.32	9.00 ± 1.05
	Wet	9.56	13.76	12.21 ± 0.55
CO_2 (mg/l)	Dry	1.99	2.43	2.17 ± 0.05
	Wet	1.47	3.00	2.02 ± 0.17
TSS	Dry	0.00	1.59	0.73 ± 0.27
	Wet	0.16	2.06	1.43 ± 0.19
Turbidity (cm)	Dry	2.67	76.25	35.61 ± 12.32
	Wet	11.67	121.25	87.04 ± 9.35
EC (µs/cm)	Dry	11.64	17.71	14.99 ± 0.82
	Wet	12.93	19.61	17.39 ± 0.84
pH	Dry	6.47	7.20	6.80 ± 0.09
	Wet	6.78	7.12	6.94 ± 0.34

Table 2: Dry seasonal variation of Length - Weight Relationship of *Clarias gariepinus* and *Oreochromis niloticus* of River Donga

Species	Year	Sex	N	R	Length Mean ± SD	Weight Mean ± SD	a	b	R^2	K
C. gariepinus	2018	Female	16	0.619**	1.480 ± 0.004	2.115 ± 0.002	1.586	0.357	0.383	0.481 ± 0.011
C. gariepinus	2018	Male	9	0.263^{ns}	1.519 ± 0.005	2.240 ± 0.007	1.731	0.335	0.069	0.484 ± 0.021
C. gariepinus	2018	Combined	25	0.801**	1.494 ± 0.005	2.160 ± 0.013	-0.848	2.013	0.641	0.482 ± 0.009
O. niloticus	2018	Female	27	0.996**	1.197 ± 0.019	1.899 ± 0.004	-0.75	2.214	0.991	2.059 ± 0.071
O. niloticus	2018	Male	5	0.992**	1.104 ± 0.014	1.696 ± 0.036	-1.143	2.571	0.985	2.460 ± 0.062
O. niloticus	2018	Combined	32	0.996**	1.183 ± 0.017	1.868 ± 0.038	-0.752	2.215	0.992	2.122 ± 0.066
C. gariepinus	2019	Female	12	0.964**	1.475 ± 0.819	2.108 ± 0.799	-2.692	3.254	0.964	0.488 ± 0.023
C. gariepinus	2019	Male	45	0.983**	1.395 ± 0.017	1.892 ± 0.055	-2.632	3.243	0.966	0.518 ± 0.013
C. gariepinus	2019	Combined	57	0.981**	1.412 ± 0.015	1.938 ± 0.048	-2.575	3.197	0.961	0.511 ± 0.011
O. niloticus	2019	Female	59	0.977**	1.239 ± 0.017	1.828 ± 0.046	-1.381	2.591	0.954	1.332 ± 0.045
O. niloticus	2019	Male	25	0.977**	1.288 ± 0.022	1.983 ± 0.064	-1.702	2.862	0.954	1.340 ± 0.044
O. niloticus	2019	Combined	84	0.976**	1.253 ± 0.014	1.874 ± 0.038	-1.466	2.665	0.953	1.334 ± 0.034

Table 3: Wet seasonal variation of Length - Weight Relationship of *C. gariepinus* and *O. niloticus* of River Donga

Species	Year	Sex	N	R	Length Mean ± SD	Weight Mean ± SD	a	b	R^2	K
C. gariepinus	2018	Female	38	0.686**	1.413± 0.009	2.072 ± 0.030	-0.899	2.103	0.471	0.719 ± 0.039
C. gariepinus	2018	Male	44	0.853**	1.365 ± 0.019	1.929 ± 0.043	-0.647	1.887	0.727	0.803 ± 0.102
C. gariepinus	2018	Combined	82	0.821**	1.397 ± 0.012	1.995 ± 0.028	-0.748	1.977	0.675	0.764 ± 0.058
O. niloticus	2018	Female	61	0.821**	1.857 ± 0.035	1.857 ± 0.035	-0.637	2.041	0.733	1.669 ± 0.695
O. niloticus	2018	Male	43	0.735**	1.177 ± 0.011	1.745 ± 0.021	0.051	1.440	0.540	1.748 ± 0.087
O. niloticus	2018	Combined	104	0.839**	1.203 ± 0.010	1.811 ± 0.023	-0.517	1.935	0.705	1.702 ± 0.054
C. gariepinus	2019	Female	24	0.938**	1.412 ± 0.014	1.913 ± 0.041	-2.111	2.851	0.881	0.481 ± 0.017
C. gariepinus	2019	Male	43	0.791**	1.439 ± 0.007	1.969 ± 0.218	-1.691	2.544	0.626	0.457 ± 0.015
C. gariepinus	2019	Combined	67	0.872**	1.429 ± 0.007	1.949 ± 0.020	-1.873	2.674	0.760	0.466 ± 0.011
O. niloticus	2019	Female	41	0.855**	1.291 ± 0.010	1.976 ± 0.026	-0.807	2.156	0.732	1.298 ± 0.044
O. niloticus	2019	Male	32	0.882**	1.281 ± 0.022	1.961 ± 0.039	-0.038	1.560	0.777	1.436 ± 0.097
O. niloticus	2019	Combined	73	0.861**	1.287 ± 0.011	1.969 ± 0.022	-0.023	1.712	0.742	1.358 ± 0.049

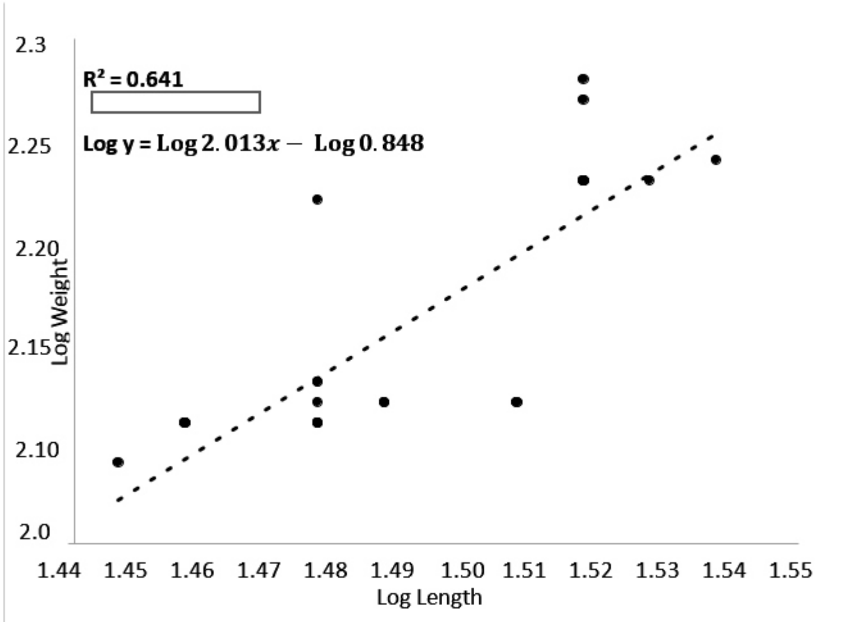

Figure 2: Combined *Clarias gariepinus* for dry season (March 2018 – April 2018)

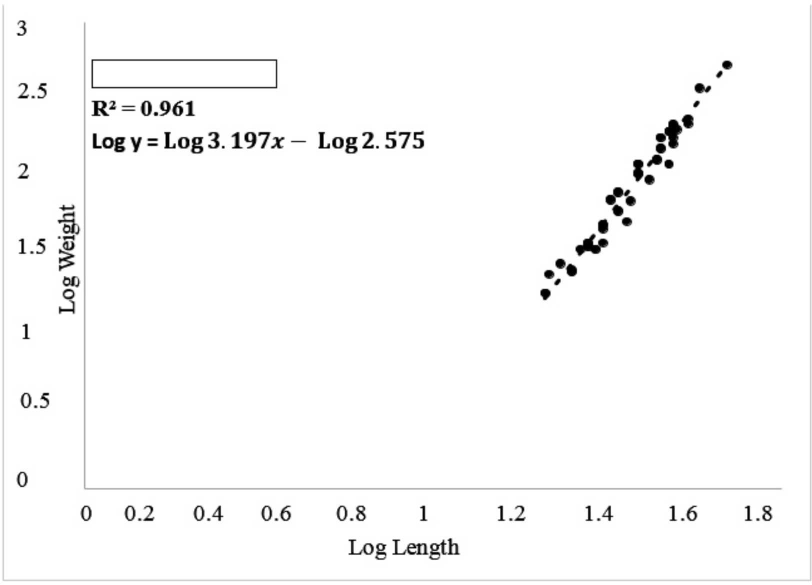

Figure 3: Combined *Clarias gariepinus* for dry season (November 2018 – April 2019)

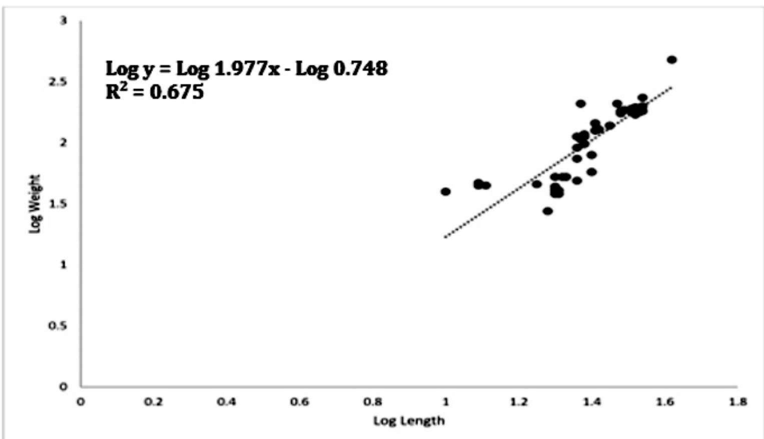

Figure 4: Combined *Clarias gariepinus* for wet season (May 2018 – October 2018)

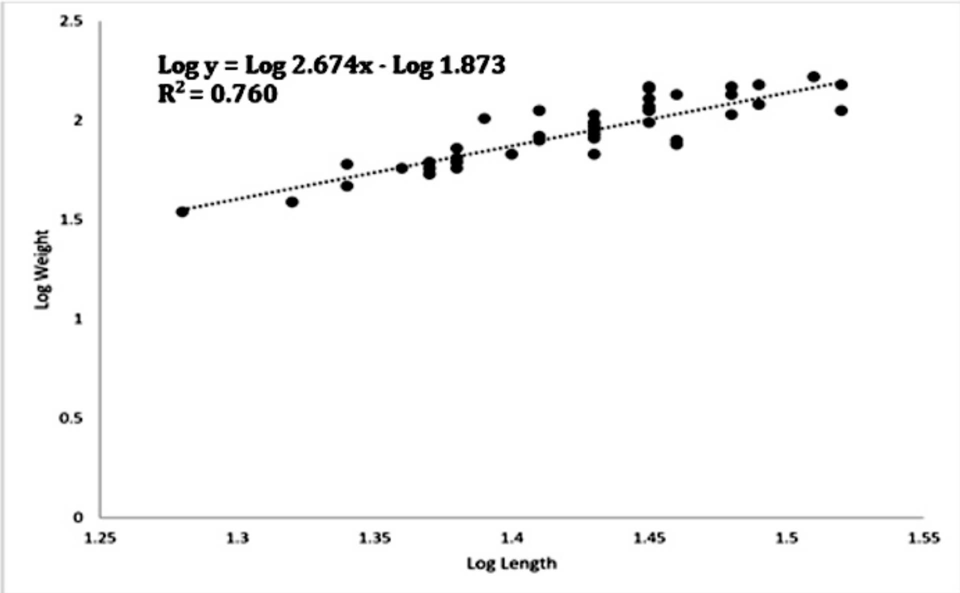

Figure 5: Combined *Clarias gariepinus* for wet season (May 2018 – August 2019)

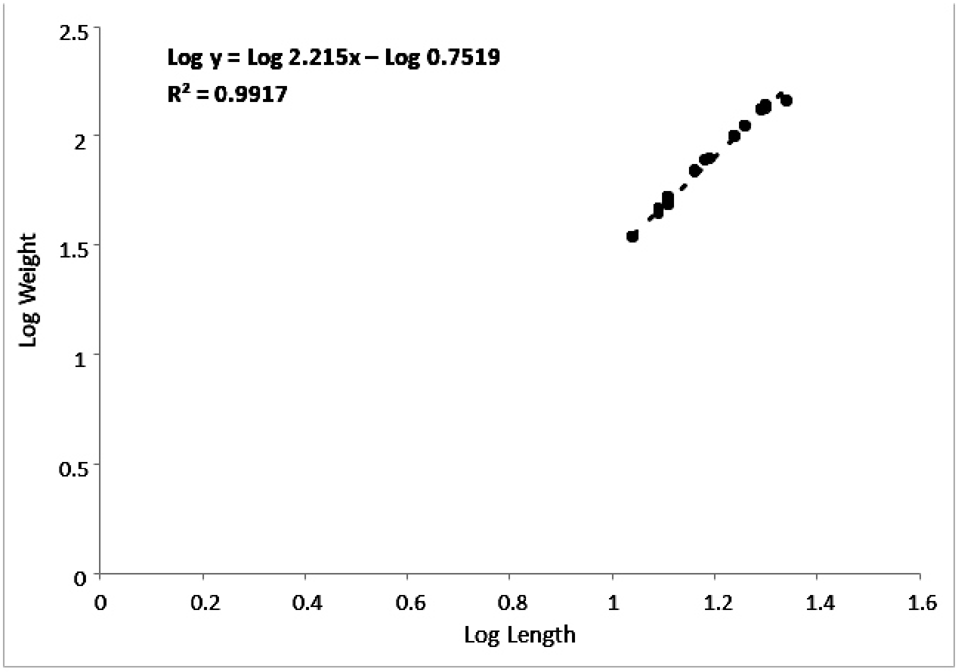

Figure 6: Combined *Oreochromis niloticus* dry season (March 2018 – April 2018)

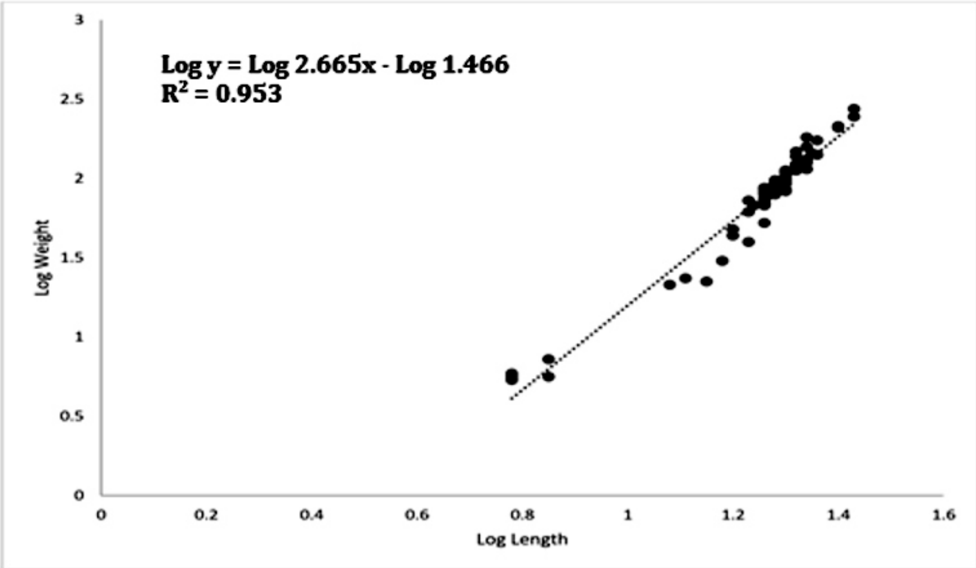

Figure 7: Combined *Oreochromis niloticus* dry season (November 2018 – April 2019)

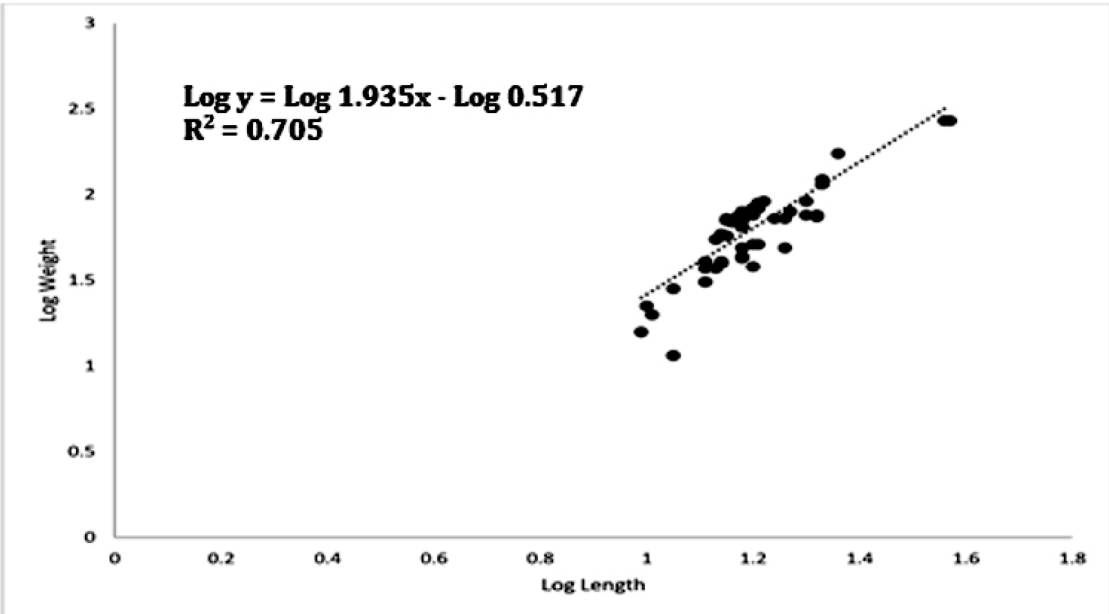

Figure 8: Combined *Oreochromis niloticus* wet season (May 2018 – October 2018)

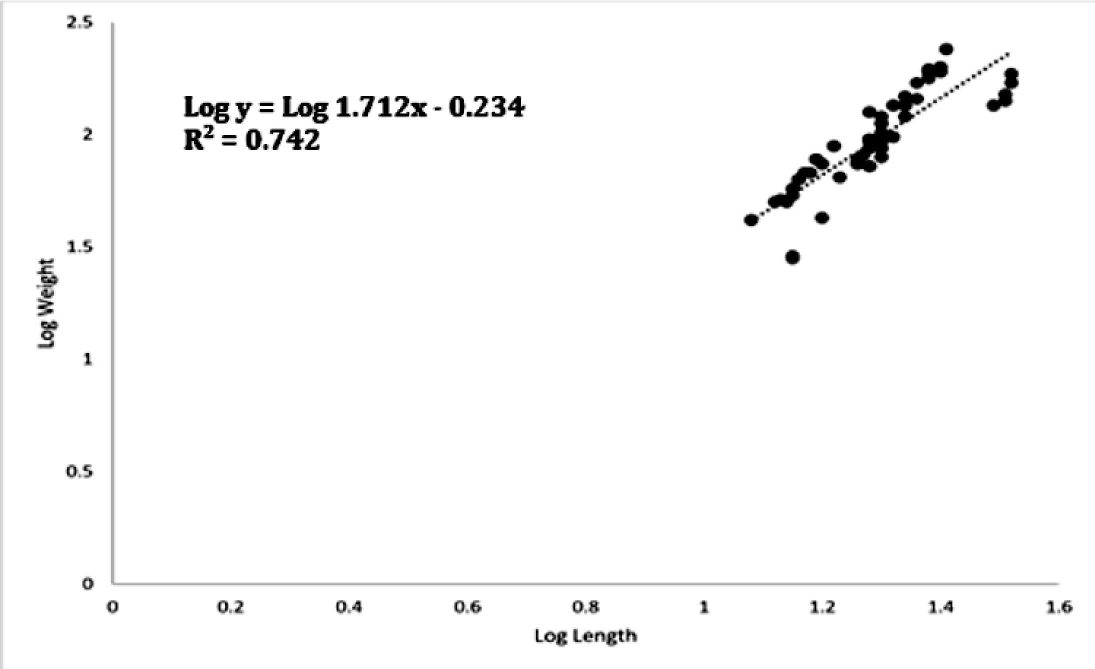

Figure 9: Combined *Oreochromis niloticus* wet season (May 2019 – August 2019)

DISCUSSION

Physicochemical Parameters

Water quality is vital for aquatic ecosystems. The physico-chemical parameters were within acceptable ranges, supporting the survival, metabolism, and physiology of aquatic organisms. The water temperature was generally lower in the wet season, likely due to cloud cover and rainfall, which reduced the thermal effect of the sun. Ayo-Olalusi and Ayoade (2017) recorded relatively uniform temperature for both water and air in Lagos Lagoon, and attributed this to the conservative nature of these parameters in the Lagoon. This finding suggests that seasonal variations in temperature can impact aquatic ecosystems. However, Phosphate levels showed slight range differences between the dry and wet seasons. In the dry season, phosphate levels were above the normal range, while in the wet season, they were within the desirable range. Elevated phosphate levels can lead to algae blooms, which can deplete oxygen and harm aquatic life as observed in this study. These findings contradict Durojaiye *et al*. (2018) who recorded values were within the Federal environmental protection agency recommended standard of 2.2-1.37 mg/l and also disagrees with the records of Santhosh and Singh (2007) of 0.1 mg/l. While, Ammonia concentrations were slightly above desirable ranges in both seasons, potentially causing stress and vulnerability to aquatic organisms. This finding contradicts previous studies (Durojaiye *et al*., 2018; Santhosh & Singh, 2007), which reported lower ammonia levels within recommended standards. High ammonia levels can cause stress to aquatic organisms, making them vulnerable or even leading to extinction.

The DO levels were within acceptable ranges (WHO, 2006), supporting aquatic life. This agrees with Durojaiye *et al*. (2018) and Bhatnagar *et al*. (2004), emphasizing DO's crucial role in aquatic ecosystems. BOD levels were within desirable ranges, indicating minimal pollution. Kigbu and Mohammed (2014) support this, noting optimal BOD levels (3.0-6.0 ppm) for fish. Moreso, Alkalinity and pH were within desirable ranges, while hardness was within acceptable ranges. Durojaiye *et al*. (2018) highlights the importance in maintaining buffer capacity. TDS levels were within acceptable limits (Kigbu *et al*., 2017; Pandey, 1997), ensuring a safe environment for aquatic organisms. CO2 levels were within acceptable ranges, agreeing with Kigbu *et al*. (2017), who noted tropical fishes can tolerate CO2 levels over 100 mg/l. This suggests aquatic life in River Donga wasn't stressed by CO2 levels.

Turbidity levels were slightly above desirable ranges, indicating cloudiness or haziness. This was more pronounced during the rainy season, given River Donga's naturally brownish cloud nature. Kigbu and Mohammed (2014) reported contrasting findings, with values within recommended ranges. Electrical conductivity was within acceptable ranges for both seasons, indicating manageable salinity hazards. This contradicts Kigbu and Mohammed (2014), who reported lower-than-recommended values. Turbidity was higher during wet season due to natural characteristics while CO2 and electrical conductivity were within acceptable ranges for both seasons. This comparison highlights seasonal variations in water quality parameters and their potential impact on aquatic life in the river.

Length-Weight Relationship and Condition Factor of *Clarias gariepinus* and *Oreochromis niloticus*

The length-weight relationships observed for both *C. gariepinus* and *O. niloticus* indicate significant positive correlations, suggesting that as length increases, weight also increases. These findings are consistent with previous studies by (Oboh & Olowo, 2016). The strong predictive power of length on weight, as evidenced by the high R^2 values, particularly in *O. niloticus* ($R^2 = 0.992$), underscores the importance of length-weight relationships in understanding fish growth patterns. The growth patterns exhibited by the two species differ, with *C. gariepinus* showing a mix of growth patterns and *O. niloticus* exhibiting negative allometric growth ($b < 3$). This suggests that *O. niloticus* grows faster in length than in weight. The observation of negative allometric growth in *O. niloticus* is consistent with the findings of previous studies on freshwater fish species (King, 1996). The "b" values obtained in this study, particularly for *O. niloticus*, fall within the ranges reported by Oboh and Olowo (2016) and Bagenal and Tesch (1978) for freshwater fishes, further validating our findings. The differences in "b" values between males and females, with males having higher values, may be attributed to various factors such as sex-specific growth patterns. The length-weight relationships in *C. gariepinus* and *O. niloticus* exhibit significant positive correlations, indicating strong relationships between length and weight. These findings are consistent with previous studies (Pepple and Ofor, 2011). The regression models for both species demonstrate that length significantly predicts weight, with R^2 values of 0.675 for *C. gariepinus* and 0.705 for *O. niloticus*. These results suggest that length is a reliable predictor of weight in both species. The agreement with Pepple and Ofor's (2011) findings on "b" values further validates our results. Overall, this study highlights the importance of understanding length-weight relationships in fish populations, providing valuable insights for fisheries management and conservation.

The length-weight relationships in *C. gariepinus* and *O. niloticus* demonstrate strong positive correlations, indicating significant relationships between length and weight. The regression models for both species show that length significantly predicts weight, with high R^2 values of 0.961 for *C. gariepinus* and 0.953 for *O. niloticus*. Notably, *C. gariepinus* exhibits strong positive allometric growth ($b > 3$), indicating faster weight growth than length growth. This finding agrees with Pepple and Ofor (2011), who reported "b" values greater than 3 in both males and females. In contrast, *O. niloticus* shows a strong positive correlation between length and weight, consistent with Oboh and Olowo's (2016) reported "b" value ranges. These findings highlight the importance of understanding length-weight relationships and growth patterns in fish populations, providing valuable insights for fisheries management and conservation. The length-weight relationships in *C. gariepinus* and *O. niloticus* exhibit significant positive correlations, indicating strong relationships between length and weight. The regression models for both species demonstrate that length significantly predicts weight, with R^2 values of 0.760 for *C. gariepinus* and 0.742 for *O. niloticus*. The findings for *C. gariepinus* show a 2.674-unit change in weight per unit change in length, while *O. niloticus* exhibits a significant relationship between length and weight. These results are consistent with previous studies, including Pepple and Ofor (2011), who reported higher "b" values in females than males, and Oboh and Olowo (2016), who reported "b" value ranges of 2.097-2.979.

CONCLUSION

This study provides valuable insights into the water quality and aspect of fish biology of River Donga. The assessment of physico-chemical parameters reveals generally acceptable ranges for most parameters, but highlights concern regarding elevated phosphate levels and ammonia concentrations. The study also investigates the length-weight relationships of *C. gariepinus* and *O. niloticus*, demonstrating significant positive correlations and species-specific growth patterns. The findings have important implications for fisheries management and conservation, emphasizing the need for sustainable practices to maintain aquatic ecosystem health. Overall, this contributes to our understanding of River Donga's water quality and fish biology, informing efforts to conserve and manage this vital ecosystem effectively.

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