Seasonal Variation of Condition Factor and Length –weight relationship of *Citharinuscitharus* from Anambra River Basin

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Abstract
Seasonal variation of length-weight relationships and conditions of Citharinuscitharus (C. citharus) from Anambra River basin were investigated for ten months, from February 2020 - November, 2020. A total of 62 C.citharus were collected from artisanal fishermen from three sampling stations. Condition factor and length-weight relationship were determined using standard biometric method. Results showed that total number of fish, fresh weight, condition factor and growth pattern vary across the months and seasons. Total number of fish varies across the sampled months and seasons from 3 (May, 2020) – 10 (November, 2020), 20 (dry season) – 42 (wet season), live weight varies from 182.25 (February, 2020) – 815-55 (June, 2020), 292.82 g (dry season) – 515.43 g (wet season) and total length also varies across the samples months and seasons from 21.02 cm (February, 2020) – 25.95 cm (November, 2020), 24.03cm (dry season – 25.62 cm (wet season). Fulton condition factor(K) varies across the months and seasons from 1.45 (November, 2020) – 3.20 (September, 2020) and 1.88 (dry season) – 2.82 (wet season). Growth pattern; b values vary across the months and seasons from 1.42 (May,2020) – 4.70 (March, 2020) and season; 1.97 (dry season) – 2.56 9 (wet season), a-values vary from -3.94 (March, 2020) – 1.60 (September, 2020) and 0.54 dry season – 0.93 wet season, r-values indicate highly correlated between total length and fresh weight variations ranged from 0.90(November, 2020) -0.99 (September, 2020) across the months and 0.91 (wet season) - 0.96(dry season). The results of this study revealed that anthropogenic activities within Anambra River Basin have no negative impacted on wellbeing of C.citharus in the river basin.

Keywords: *Citharinuscitharus*, ichthyofauna, Condition factor, Anambra River, Length-weight

Introduction

Fulton condition factorof fisheries have been widely reported surface water world-wide including Nigeria (Seiyabohet *al*., 2016). Condition factor used to evaluate the general well-being in fish species with respect to water quality and climatic variables in given water body. Condition factor can also be used to assess the status of the aquatic ecosystem in which fish live (Atamaet *al*., 2013). Various ecological and biological factors such as degree of fitness, gonad development, feeding condition and growth are assessed based on condition factor of a fish (Abu *and* Agarin, 2016).

Studies about fish biology and ecology are important in order to improve fishery management and conservation (Atamaet *al*., 2013). Estimation of length-weight relationship (LWR) is of great importance in fishery assessments and management and give information on the stock composition, growth rate, life expectancy, mortality and production of fish species (Jisret *al*., 2018). Moreover, it is useful in determining weight and biomass when only length measurements are available, as indicator of condition, to assess the relative well-being of a fish population and to allow for statistical comparisons of species growth between different populations. Consequently, LWR studies on fish are extensive

Several indices have been widely studied with regard to growth condition including length-weight, length-length relationship, growth factor and condition factor (Seiyabohet *al*., 2016; Abu and Agarin, 2016)

Materials and Methods

Description of the study area

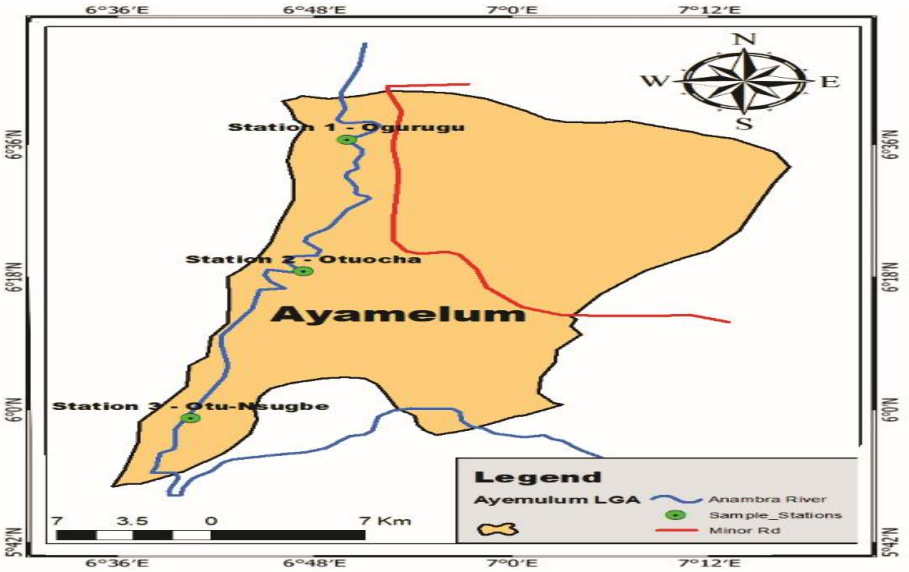

Figure 1: Map of Study Area with Fish landing communities

Anambra River Basin

Anambra River basin lies coordinates of N 06^{O} 47”.285 - N 06^{O}16’’ .713, and E 006^{O} 56”.485 -E 006 ^{O} 48″.738with surface area of approximately 14 014 km^{2} (Awachie and Hare 1977). The River Anambra is approximately 207.4 km in length, rising from the Ankpa hills (ca. 305-610m above sea level) and discharging into the River Niger at Onitsha. There are two main seasons, the dry season (November – March) and the rainy season (April – October) with annual temperature and precipitation range from 24^{o} C to 31^{o} C and 5 cm to 85 cm, respectively (Odo 2004). Lower section of Anambra

Description of Sampled Sites

Sampling was done across three fishing points: Ogurugu ,Otuocha and Otu-Nsugbe. The fishing points are associated with numerous

anthropogenic activities such as daily market along its bank mechanical dredging, laundry, swimming, fishing, extraction of drinking water, extraction of water for irrigation, manual sand mining, and farming (rice, cassava), at flood plain, transportation of different goods and human being and lumbering. The surface was partially canopied with aquatic plants and the flow velocity was moderate.

Fish Sample Collection and Identification:
Sixty-two individual fish of *Citharinuscitharus*were collected from fishermen at the landing sites in Anambra River basin from February - November 2020. These samples were caught with different fishing gears. The collected fish specimens (*Citharinuscitharus)* were identified using monographs and fish identification guide of Idodo-Umeh (2003) and Fish Base databases (Froese and Pauly, 2018).

Laboratory procedure
Total length (TL) and standard length (SL) of each live fish were measured to the nearest cetimeter(cm) using a standard fish measuring rule. An electronic balance (exthech instruments SC600) was used to measure the live weight (g) of all fishes and to the nearest 0.10 gram after removing the adhered water and other particles from the body surface.

Statistical analysis:
The length- weight relationship of fish was computed by equation (Pauly, 1983): $W = aL^b$
Where;
W = the weight (g) of fish in grams
L = The Total length of fish in centimetres
a = Exponent describing the rate of change of weight with length (= the intercept of the regression line on the Y axis)

b = the slope of the regression line

(also referred to as the Allometric coefficient)

The log transformed data gave a regression equation.
Log w = log a + b log L

Where;
a = the slope
b = the regression co-efficient
Fulton condition factor (K) was calculated using the cube law, $K = W \times 100 / L^3$, Where K = condition factor, W = fresh weight of fish in grams and L = standard length of fish in cm
Where;
W = Weight of the fish in grams
L = the total length of the fish in centimetres
b = the value obtained from the length-eight equation formula.

Results

***Citharinuscitharus* abundance by months and seasons**

A total of 62 *C. citharus* were collected from artisanal fishermen from February – November, 2020. Total number of fish varies across the sampled months and seasons from 3 (May), 2020) – 10 (November, 2020). The n umber of *C. citharus* encountered varies; February (6), March (4), April (6), May (3), June (4), July (5), August (7), September (9), October(8) and November 910).Seasonal variations of *C.citharus* in AnambraRiver Basin were presented in table 2. A total number of 20 *C. citharus*was encountered during dry season while 42 *C. citharus* were encountered in wet season with average of 6 (dry season and 7 (wet season).

Table 1: Monthly mean of body weight (BW) and total length (TL), standard length (SL), and Fulton's condition (K) with value of 'b' 'a' and 'r' for *Citharinuscitharus*from Anambra River Basin

	Individual species	Live weight (g)	Standard length (cm)	Total Length (cm)	Condition Factor(K)	b	a	r
Feb	6	182.25	16.90	21.02	1.96	1.89	- 0.24	0.921
Mar	4	263.15	17.90	22.73	2.24	4.70	- 3.94	0.965
Apr	6	459.16	22.36	26.40	2.49	2.54	-0.96	0.967
May	3	662.07	24.00	28.17	3.01	1.42	0.77	0.981
Jun	4	815.55	25.38	29.65	3.11	2.29	-0.46	0.985
Jul	5	594.7	17.08	25.04	3.09	2.23	-0.82	0.978
Aug	7	382.16	19.81	24.6	2.58	2.51	-0.91	0.971
Sep	9	305.60	16.39	20.58	3.20	3.11	-1.60	0.989
Oct	8	332.50	21.43	25.70	1.90	3.16	-1.82	0.925
Nov	10	266.90	16.58	25.95	1.45	2.51	-1.03	0. 901

Length and weight *Citharinuscitharus* in Anambra River Basin by months and seasons

The length and weight range of the 62 *C. citharus* examined in this study are shown in Table 1. Monthly, the mean of total length varies from 20.58 cm (September, 2020) –29.65 cm (June, 2020) and standard length varies from16.39 cm (September, 2020) -.25 .38 cm (June, 2020). The monthly weight mean ranged from 182.25 g (February, 2020) - 815.55g (June, 2020). Both the total length and mean weight were significantly difference ($P < 0.05$) across the months. Mean total lengths were 24.03 cm (dry season) and 25.62 cm (wet season), mean standard lengths were 18.44 cm (dry season) and 20.68 cm (wet season) for *C. citharus*and live weight varies from 292. 87 g (dry season) – 515.43 g (wet season). Mean total length, mean standard length and mean weight were significantly difference ($P < 0.05$) between the seasons.

Length-weight relationships by months

The spatial variation of Fulton Condition Factor (K) values for *C. citharus* from Anambra River Basin River was summarized in Table 1. Seasonal variations in the mean (K) were not statistically significant ($p > 0.05$). The mean values of Fulton Condition Factor (K) vary from 1.45 (November, 2020) - 3.20 (September, 2020). . The lowest condition factor (K) was recorded in the month of November while the highest value was obtained in September (Table 1). *C. citharus*had higher mean K value in rainy season months. The mean Fulton condition factors (K) for *C. citharus* from Anambra River were 1.88 (dry season and 2.82 (wet season). Fulton condition factor (k) in wet season was significantly ($p < 0.05$) higher than that in dry season.

Length- weight relationship of *Citharinuscitharus* from Anambra River Basin by Months and season (dry and wet seasons)

The monthly variation of growth pattern of C. citharus from Anambra River Basin are presented in table 1. The b-values varies from 1.42 (May, 2020) – 4.70 (March, 2020) and ‘’a’’- values ranged from – 3.96 (March, 2020). 1.60 (September, 2020). The b-value of *C. citharus* encountered in March (4.70), July (3.23), September (3.11) and October(3.158) exhibited positive allometric growth pattern ($b > 3.0$) while the species encountered had b-values, 1.89 (February, 2020), 2.54 (April, 2020), 1.42 (May, 2020), 2.29 (June, 2020), 2.51(August, 2020) and 2.51 (November,2020) indicates negative allometric growth pattern ($b < 3.0$) of *C. citharus.* The seasonal variations of the growth pattern are presented in table 2. The b-values varies from 1.97 (dry season) – 2.56 (wet season) and ‘’a’’- values ranged from - 0.54 (dry season) to - 0.93 (wet season).

Table 2: Seasonal mean of body weight (BW) and total length (TL), standard length (SL), and Fulton’s condition

(K) with value of 'b' 'a' and 'r' for *Citharinuscitharus*from Anambra River Basin

	Dry season	Wet season	P-value
Total number of fish catch	20	42	0.02(P < 0.05)
Monthly Average of number of fish catch	6	7	0.01 (P < 0.05)
Live weight(g)	292.87	515.43	0.01 (P < 0.05)
Total length(cm)	24.03	25.62	0.07 (P > 0.05)
Standard length(cm)	18.44	20.68	0.01(P < 0.05)
Condition factor	1.88	2.82	0.00 (P < 0.05
B	1.97	2.56	0.03 (P < 0.05)
A	- 0.54	-0.93	-
R	0.96	0.91	0.01 (P<0.001)
Weight-length relationship	LogW= - 0.54+1.97Log L	Log W= -0.93 + 2.56 Log L	

Discussion

Abundance of C. citharus in Anambra River Basin

The number of *C.citharus* encountered during sampled months were more that than the number of *C. citharus* recorded by Odo*et al*. (2009) that encountered 52 *C.citharus* in the same river basin for a period of 24 months sampling periods, Ezenwaji and Ezenwaji (2009) that encountered 30 *C.citharuns*for six (6) month sampled period (September, 2007 – March, 2008) in the same Anambra River basin and Tut et al (2019) that encountered a total number of 33 *C. citharus in* Gilo River and its Nearby Wetlands in Akobo District, Gambella Region, Ethiopia.

Ezenwaji (2004) encountered no *C.citharus* during his fifty-four months' survey periods (August 1997 to January 2002). The emerging or evolving of *C. citharus*in the river basin in odo*et al*. (2009) and Ezenwaji and Ezenwaji (2009) as well as in this present study may attributed to 2007 and 2012 floods that could have flooded the river basin with numerous species of fish. The seasonal variation experienced in this study may be ascribed to the difference

in sampled months. The higher number of *C. citharus* encountered during the wet season may be ascribed to many factors such low climate temperature, availability of foods and expansion of surface area of the river basin that enable the fish escape from predators and harsh environmental condition.

Length and weight of *C. citharus* in Anambra River Basin

The value of total length recorded in this study within the range reported by Odo*et al*. (2009) that recorded total length of 30 cm and standard length of 23. 10 cm for the same species in the same river basin for the. Both standard length (cm) and live weight (g) in this study were higher than the values by Ezenwaji and Ezenwaji (2009) that reported standard length of *C. citharus* between 15- 17 cm in the same river basin. However, Tut et al. (2019) reported higher total mean total weight (2716.67 g – 2540.00 g) and mean total length range between 51.35 - 53.00 cm for *C. citharus* in Gilo River Akobo District, Gambella Region, Ethiopia. These spatial and temporal variability in *C. citharus* sizes may be attributed to dynamic of climate variables, habitat conditions, mainly water quality, food availability and the level of habitat degradation.

Fulton condition factor (K)

Fulton Condition Factor (K) of *C. citharus* encountered was within the vales recorded by Ezenwaji and Ezenwaji (2009) that reported condition factor between 0.8815 – 2.7575 for the same species in the same river basin, Odo*et al*. (2009) also reported average condition factor of 3.02±0.41 in Ogurugu, 3.62±0.51 in Otuocha and 3.19±0.62 in Nsugbe for the same species in the same river basin. The average condition factors of *C. citharus* encountered in the month of May, June July and September, 2020 were within the range of values obtained by Odo*et al.* (2009). Other studies in the same river basin with high K values are Alestesbaremoze (Ezenwaji and Ezenwaji, 2009), *Alestes nurse*, *Macrolepidotuscuver*, *Distichodusrostatus*, Clariaanguillaris *Synodontisclarias*, *Schilbemystus* and *Tilapia zilli* (Odo*et al*, 2009),

Chromidotilapiaguntheri, *Hemichromisbimaculatus*, *Tilapia zillii*, *Hemichromisfasciatus,Tilapia mariae* and *Oreochromisniloticus* (Atama etal. 2013). These variations in Fulton Condition Factor (K) values of *C.citharus* from Anambra River Basin across the sampled months may be ascribed to abundance of food, changes of climatic variables, and other physiological factors.Bagenal and Tesch, (1978) stated that seasons, locality, age, sampling time, food availability, and gonad development and spawning period had effect on condition factor of fish species.

This higher K- values in some of wet season months agree with the 'b' values and were greater than three (K > 3.0), indicating that the species is in better condition as it is more robust in its increased length

Seasonal variations in these growth parameters particularly Fulton condition factor (K) of fish species in the same river basin has been reported for *C. citharus* and *Alestesbramoze* (Ezenwaji and Ezenwaji, 2009) and *six cichlid species (*Atama*et al*., 2013). Ezenwaji and Ezenwaji (2009) also reported higher condition factor (k) in wet season than dry for *Alestesbramoze* and *C.citharus form Anambra River Basin.* The higher condition factor recorded in this study was in consonant with Atama*et al*. (2013) that recorded higher Fulton condition factor (K) for Tilapia zilli from the same River Basin. Fulton condition factor (K) varied seasonally for *Citharinuscitharus* from Gilo River and Wetlands in Akobo District, Gambella Region, Ethiopia (Tut *et al*., 2019). Other studies reported seasonal variation of Fulton condition factor (K) for *Leuciscuslepidus* (Saliu, 2001), *Synodontisschall*, *Schilbeintermedius*, *Marcuseniussenegalensis*, *Brycinusmacrolepidotus*, *Chromidotilapiaguntheri*, *Hemichromisbimaculatus*, , *Hemichromisfasciatus,Tilapia mariae* and *Oreochromisniloticus* (Imoroue*t al.* 2019) and Synodontisclarias, *Schilbemystus* and *Chrysichthysfurcatus* from Ikoli Creek, Niger Delta (Seiyaboh*et al*., 2016).

However, the results of this present study do not conform some of results by (Atama*et al*., 2013) that reported higher K-

values during the dry season than the wet season for *Chromidotilapia*guntheri, *Hemichromisbimaculatus*, *Hemichromisfasciatus from the same river basin.* Other studies reported K –values higher in dry season than in wet season for *Gnathonemusdeboensis*, *Schilbemystus* and *Chrysichthysfurcatus* (Seiyabohet *al*., 2016), *Heterotisniloticus*, *Clariasgariepinus*, *Distichodusnefasch*, *Oreochromisniloticus* and *Gymnarchusniloticus* (Tut *et al*., 2019) and *Hemichromisfasciatus*, *Brycinusmacrolepidotus*, *Synodontisschall* and *Chromidotilapiaguntheri* (Imoroue*t al*., 2019).The condition factor or wellbeing of *C. citharus* from Anambra River Basin since 2009 – 2020 has not considerable adverse by numerous anthropogenic activities and this pointed out that the species were in good condition and conducive environment. The K-values in this present study disclosed that *C.citharus* were in better condition in wet season than dry season in Anambra River Basin. Ayode (2011) stated that fishes with condition factor value of one (1) are considered to be in good condition. This implies that there is more abundance of foods and nutrient to support the growth of the species in wet season. This result revealed that over the period of ten years, the River Basin had its adequate availability of foods and nutrients for the growth of this fish species (*C. citharus*).

Growth pattern (length-weight relationship)

The monthly correlation results between weight and total length varies from 0.989 (September, 2020) – 0.901 (November, 2020) and were within the high significant relationships (r =0.9115) between body weight and standard length of the same species in the same river basin (Ezenwaji and Ezenwaji, 2009). Atama*et al*. (2013) also reported high degree of relationships between body weight and total length of some Cichlid (*cichilidae: perciformis*) species from the same river basin. The highly significant relationships between the body weight and standard lengths of C. *citharus*indicated that the body weight of the species could be estimated with a fairly high degree of accuracy ($P < 0.001$). The

higher values of b – values registered in wet season verse lower ones in dry season ($P < 0.05$) for *C. citharus* might be linked to the variations in food availability, water parametersand atmospheric temperature during each season. The result of growth pattern revealed that *C. citharus* grows more in length than weight in Month of March and proportional in July, September and October; the rate of increase in body length is proportional to the increase in body weight. However, the species exhibits a negative allometric growth pattern, which means the fish, grows more in length than in weight; the rate of increase in body length is not proportional to the increase in body weight. The result of growth pattern revealed that *C. citharus* grows more in length than weight in all seasons, the rate of increase in body length is not proportional to the increase in body weight.

Conclusion

This study provided a recent information on length-weight relationships and Fulton condition factor (K) for *Citharinuscitharus* sourced from Anambra River Basin. The study revealed monthly and seasonal variations in all the growth parameters and the variations may be attributed to changes in water quality, food availability, climatic variables such as air temperature and precipitation. Although, results of this study disclosed that *C. citharus* wellbeing has not been impacted by anthropogenic activities and changing climate.

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