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# Population dynamics and size stratification in 75-day old bred juvenile African Catfish (*Clarias gariepinus*, Burchell, 1822) raised in concrete tanks

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***Target Audience:*** Aquaculturist, Fish Breeders and Researchers

## Abstract

*Cannibalism and aggressiveness exhibited more frequently by Catfish has been linked to disparity in sizes, sex ratio and/or stocking density, this study was carried out to investigate population dynamics and size stratification within the Clarias population bred in 4m x 4m x 1m artificial concrete tanks. A total of two hundred and fifty (250), 75-day old juveniles were randomly selected and measured for live body weight and linear body measurements which include, Total Length (TL), Standard Length (SL), Head length (HL), Pre-Dorsal Length (PDL), Dorsal Fin Length (DFL), Pre-Anal Length (PAL) and Anal Fin Length (AFL). Two indices (length-weight relationship and Fulton's condition factors) were also computed for predictive assessment of future performances and wellbeing of the fish. The fish weight ranged between 3.30g and 20.30g with an overall mean body weight of 10.61 ± 0.28g. Based on the weight, the Sturge's formula was used to construct nine class intervals of 2.0g width each, with the grouping resulting in disproportionate frequency distribution which was statistically (P<0.0001) significant. Of all the variables measured, weight had the highest variability within the population with a CV of 41.88%, while other measures had Coefficient of Variation of between 13.82% and 16.65%. It was observed that based on the mean body weight of the fish studied, only 6.4% are within the 95% Confidence Interval (CI) of the Mean, while 53.2% and 40.4% are respectively below and above the CI. This stratification and population structure provides a good discriminatory tool in separating the fish into fairly homogenous sizes for further rearing to minimize cannibalism and optimize profit.*

***Keywords:*** Catfish, Cannibalism, Measurements, Fish wellbeing

## Description of Problem

Protein from animal sources are in short supply in Nigeria as a result rapid increase in human population (1), which has led to increase in the demand for fish, the cheapest and most available source of animal protein to supplement the needed animal protein intake. Fish remains the highest contributor of animal protein in Nigeria accounting for over 34% of all the animal protein sources in the country (2).

Due to the reckless fishing methods and destruction of the natural environment, there is need to artificially propagate fish seeds. Thus, the culture of fish has become an innovative technology aimed at producing large quantity of fish as food for the ever-increasing human population in Nigeria. In order to meet the high demand for fish, aquaculture which is the rational rearing of fish in an enclosed and fairly shallow body of water remains the best option to bridge the wide gap between fish demand and domestic production in most countries of the world especially Sub-Saharan Africa (3). Aquaculture, which could be practiced by artificial methods, most especially to produce fish on large-scale basis in and out of season to ensure regular supply all year round, constitute the major practicable means of providing enough quality seeds for rearing in confined fish enclosure such as fish ponds, reservoirs and lakes (4).

Catfish, *Clarias gariepinus*, is one of the most commonly cultivated species of fish that provides food for the populace and allows for improved protein nutrition because it has a high biological value in terms of high protein retention in the body, higher protein assimilation when compared to other protein sources, low cholesterol content and one of the safest sources of animal protein (5). The greatest cause of economic losses in aquaculture has been traced to cannibalism and aggressive behaviour which have been exhibited more frequently by catfish due to its omnivorous nature, as a result of disparity in sizes, sex ratio and/or stocking density. The aim of the fish farmer is to produce fast growing fry and fingerlings of comparatively uniform sizes in order to reduce cannibalism in the hatchery, discourage financial losses and encourage uniformity in sizes of fish at harvest. In order to produce fish that grows to table size using most minimal inputs, to maximise profit, it is necessary to know which cluster of fingerlings to pick as brood stock for the production of fast-growing fry and fingerlings of comparative uniform sizes and also reduce cannibalism in the hatchery. This study was carried out to investigate growth dynamics and size stratification within the *Clarias* population bred in artificial concrete tanks.

## Materials and Methods

**Study Site:** The study was carried out at SEJ Farm Ventures in Torikoh, Badagry, Lagos State, Nigeria, located at latitude 6° 28.598’ N and longitude 02° 54.440’ E. The study site has an average rainfall of 1693mm and temperature of 27.0°C annually. All measurements were taken at the farm and further analyses were conducted at the Department of Zoology and Environmental Biology, Lagos State University, Ojo, Lagos, Nigeria.

**Experimental Unit:** African catfish, *Clarias gariepinus* broodstocks (one male ♂ and one female ♀) used in the production of the new seed (hatchling) were selected from diverse lineage to avoid inbreeding. The hatchlings were raised for 75 days in artificial concrete tanks under intensive management.

All hatchlings were subjected to the same experimental conditions and were fed 2mm commercially formulated (Aller Aqua) feed until satisfaction thrice daily throughout the study period.

**Data Collection:** A total of 250 juveniles were randomly collected from the tank using a hand net and isolated for measurements. Each fish sample was measured for the variables under study.

**Measurements:**_ Data was collected on live body weight and linear body measurements. The weight of the fish was taken using a professional digital mini scale (Model XTR-650) sensitive to 0.01 grams. A flex graduated tape was used to obtain the linear body measurements (Figure 1).

Aside Body Weight (BW), seven morphometric measurements were taken on each fish (6), which included, Total Length (TL), Standard Length (SL), Head length (HL), Pre-Dorsal Length (PDL), Dorsal Fin Length (DFL) Pre-Anal Length (PAL) and Anal Fin Length (AFL).

**Computed Indices:** Based on the various measurements taken on individual fish, two distinct indices were computed to aid in the appraisal of the wellness of the fish and its potential for later growth and development. The indices were Length weight relationship (LWR) and Condition factor (CF).

**Length Weight Relationship:** Length-weight relationship was expressed as $W = aL^b$, the logarithm transformation of which gives the linear equation $LogW = a + b\log L$.

Where W = Weight in gram, L = length in (cm), a = a constant being the initial growth index, and b = growth coefficient. Constant 'a' represents the point at which the regression line intercepts the y-axis and 'b' the slope of the regression line.

**Condition Factor:** The condition factor (K) which is defined as the well-being of the fish was calculated. K is a useful index for monitoring of feeding intensity, age, and growth rates. The condition factor is to quantify the health of individuals in a population or to tell whether a population is healthy relative to other populations in their environment and presence of food (7). The Condition Factor (K) was determined by;

$$K = \frac{W.100}{L^3}$$

Where W= length of fish in grams

L= Length of fish in centimeters.

**Statistical Analyses:** A preliminary exploratory statistical analysis was conducted on each of the eight variables measured to test for normality and outlier values.

Based on the values obtained on body weight which was the most important attribute of fish in economic terms, the entire population was classified into nine categories of fairly homogenous weights. This classification is based on Sturges' rule (8) of K = 1+3.322($log10_n$) where K is the number of class intervals and n is the sample size. The classes were labelled A – I with each class having a width of 2.0g as follows; A (3.1 – 5.0), B (5.1 – 7.0), C (7.1 – 9.0), D (9.1 – 11.0), E (11.1 – 13.0), F (13.1 – 15.0), G (15.1 – 17.0), H (17.1 – 19.0) and I (19.1 – 21.0) respectively.

Descriptive statistical measures of all variables were obtained along with a multivariate correlation matrix for all variables. Due to the correlation between weight and total length, a regression analysis was conducted to examine the length-weight relationship. A non-parametric was also done to evaluate the deviation of the disproportionate nine categories from an expected uniform sample sizes per category. A one-way analysis of variance using group as the predictor variable was done for all variables and a Tukey test was conducted for further mean separation.

All statistical analyses were done using the Minitab 17® Statistical Software (9).

***Table 1a. Mean ± Standard Error of some measured variables[1].***

| Group | N | Weight (g) | Total Length (cm) | Standard Length (cm) | Head Length (cm) |
|---|---|---|---|---|---|
| **A** | 12 | $4.61\pm0.15^{i}$ | $8.88\pm0.11^{h}$ | $7.67\pm0.13^{g}$ | $2.13\pm0.05^{g}$ |
| **B** | 62 | $6.06\pm0.07^{h}$ | $9.54\pm0.05^{g}$ | $8.41\pm0.05^{f}$ | $2.35\pm0.03^{d}$ |
| **C** | 44 | $8.03\pm0.09^{g}$ | $10.21\pm0.06^{f}$ | $9.00\pm0.06^{e}$ | $2.55\pm0.04^{e}$ |
| **D** | 28 | $9.95\pm0.11^{f}$ | $11.09\pm0.08^{e}$ | $9.87\pm0.07^{d}$ | $2.77\pm0.04^{d}$ |
| **E** | 24 | $12.09\pm0.12^{e}$ | $11.71\pm0.07^{d}$ | $10.44\pm0.06^{c}$ | $2.99\pm0.04^{c}$ |
| **F** | 22 | $13.95\pm0.13^{d}$ | $12.48\pm0.09^{c}$ | $11.18\pm0.08^{b}$ | $3.16\pm0.04^{bc}$ |
| **G** | 30 | $16.16\pm0.09^{c}$ | $12.97\pm0.08^{b}$ | $11.61\pm0.11^{a}$ | $3.32\pm0.04^{ab}$ |
| **H** | 23 | $17.80\pm0.10^{b}$ | $13.37\pm0.08^{a}$ | $11.87\pm0.09^{a}$ | $3.22\pm0.08^{b}$ |
| **I** | 5 | $19.66\pm0.23^{a}$ | $13.54\pm0.28^{ab}$ | $12.14\pm0.23^{a}$ | $3.64\pm0.05^{a}$ |
| **Overall** | 250 | 10.61±0.28 | 11.11±0.10 | 9.86±0.09 | 2.78±0.03 |

[1] Means with different superscript within the same column differs significantly (P<0.05)

***Table 1b. Mean ± Standard Error of some measured variables[1] (Contd.).***

| Group | N | Pre-Dorsal Length (cm) | Dorsal Fin Length (cm) | Pre-Anal Length (cm | Anal Fin Length (cm) |
|---|---|---|---|---|---|
| **A** | 12 | 2.55±0.04$^h$ | 4.85±0.08$^g$ | 3.99±0.05$^g$ | 3.39±0.06$^g$ |
| **B** | 62 | 2.76±0.02$^g$ | 5.35±0.03$^f$ | 4.34±0.03$^f$ | 3.77±0.03$^f$ |
| **C** | 44 | 3.00±0.02$^f$ | 5.79±0.04$^e$ | 4.68±0.04$^e$ | 4.03±0.04$^e$ |
| **D** | 28 | 3.24±0.03$^e$ | 6.28±0.05$^d$ | 5.10±0.07$^d$ | 4.31±0.04$^d$ |
| **E** | 24 | 3.45±0.03$^d$ | 6.71±0.06$^c$ | 5.47±0.05$^c$ | 4.56±0.05$^c$ |
| **F** | 22 | 3.64±0.04$^c$ | 7.15±0.05$^b$ | 5.81±0.05$^b$ | 4.84±0.05$^b$ |
| **G** | 30 | 3.83±0.03$^b$ | 7.43±0.06$^a$ | 6.14±0.05$^a$ | 5.06±0.04$^a$ |
| **H** | 23 | 4.01±0.05$^a$ | 7.58±0.06$^a$ | 6.17±0.09$^a$ | 5.20±0.04$^a$ |
| **I** | 5 | 4.20±0.08$^a$ | 7.74±0.12$^a$ | 6.48±0.10$^a$ | 5.28±0.11$^a$ |
| **Overall** | 250 | 3.26±0.03 | 6.30±0.06 | 5.13±0.05 | 4.34±0.04 |

[1] Means with different superscripts within the same column differ significantly (P<0.05)

***Table 2. Correlation amongst morphometric variables studied[1].***

| | Total Length | Standard Length | Head Length | Pre-Dorsal Length | Dorsal Fin Length | Anal Fin Length | Pre-Anal Length |
|---|---|---|---|---|---|---|---|
| Weight | 0.9696 | 0.9590 | 0.8503 | 0.9438 | 0.9561 | 0.9246 | 0.9432 |
| Total Length | | 0.9847 | 0.8705 | 0.9485 | 0.9636 | 0.9296 | 0.9516 |
| Standard Length | | | 0.8812 | 0.9456 | 0.9630 | 0.9220 | 0.9522 |
| Head Length | | | | 0.8902 | 0.8687 | 0.8055 | 0.8787 |
| Pre-Dorsal Length | | | | | 0.9251 | 0.9069 | 0.9169 |
| Dorsal Fin Length | | | | | | 0.9210 | 0.9398 |
| Anal Fin Length | | | | | | | 0.8535 |

[1] All correlations are highly statistically significant (P<0.01)

**Results and Discussion**

The weight of fish in this study ranged between 3.30g and 20.30g with a mean ± SE of 10.61±0.28g (Tables 1a and 1b). The nine class intervals have a width of 2.0g and the histogram with a fitted normal curve for both weight and total length is presented in Figure 2. Expectedly, all values significantly increase as we go down the various groups with the first group having the least, while the last group had the highest values.

Only 6 percent of the fish studied have weights within 95% Confidence Interval of the entire population, while 53.2% and 40.8% were below and above the Confidence Interval respectively. This implies that variability in fish weight was more pronounced in the lower class intervals than the higher class intervals.

The differences between the groups for all measured variables were highly significant (P<0.01) except for some measured variables such as standard length, dorsal fin length, pre-anal length and anal fin length in the heavier categories (Tables 1a and 1b) that were not statistically different (P>0.05) after a post-hoc test.

Group alone accounted for more than 70% of variability in measured variables with the highest effect recorded in fish weight (98.50%) and the least recorded in Head Length (74.73%).

The very high positive correlation amongst the variables (Table 2) was indicative of the strength of relationship between the variables and calls for caution in modelling for weight in order to avoid multicollinearity in the model. All the pair wise correlations were high, direct (positive) and are highly significant (P<0.01).

The disproportionate subclass sizes recorded across the nine groups was statistically significant (P<0.01) with the largest deviation recorded in groups A, B, C and I (Figure 3). While groups A and I fell short of expected frequencies, groups B and C contributed far beyond and above the expected frequencies accounting for almost 64% of the deviation from expected values. This is an indication that the growth rate within that population is non-uniform and as such the sizes are highly heterogenous which consequently poses a big threat to the growth and development of the small sized fish and encourage cannibalism within the tank.

The length-weight relationship revealed a and b values to be -2.18 and 3.04 respectively, indicating a positive allometric growth with an $r^2$ of 0.94 which is close to earlier reports (10). The condition factor (K) range between 0.66 and 0.80 across the nine groups with an overall mean value of 0.73, implying that the larger fishes had higher values compared to the fishes in the lower groups. This is indicative of the fact that the larger fishes are performing better metabolically compared to the smaller fishes despite the fact that all were reared under similar conditions and corroborated earlier work (11).

**Conclusions and Application**

The following can be concluded from this study:

1. The weight of fish sampled in this study varied widely between 3.30g and 20.30g with coefficient of variation of 41.88 percent and a mean of 10.61g.
2. Majority of the fish (53.2 %) had weight below 95 percent confidence interval of the mean weight, implying that less than half of the fish are at or above mean weight.
3. There is very high positive and significant correlation between all morphometric variables studied, implying that any of the variable can be used to predict or model another variable.
4. The length-weigh relationship indicated a positive allometric growth (b = 3.04) with an average Fulton's Condition Factor (K) of 0.73.
5. The population structure in the study is inimical to profitable fish rearing as it encourages cannibalism and/or under-development of the weaker groups.
6. Thus, it is therefore recommended that the fish be separated into groups of fairly homogenous sizes. This stratification and population structure therefore provide a good discriminatory tool in separating fish into fairly homogenous sizes for further rearing to reduce feed wastage, minimize cannibalism and optimize profit.

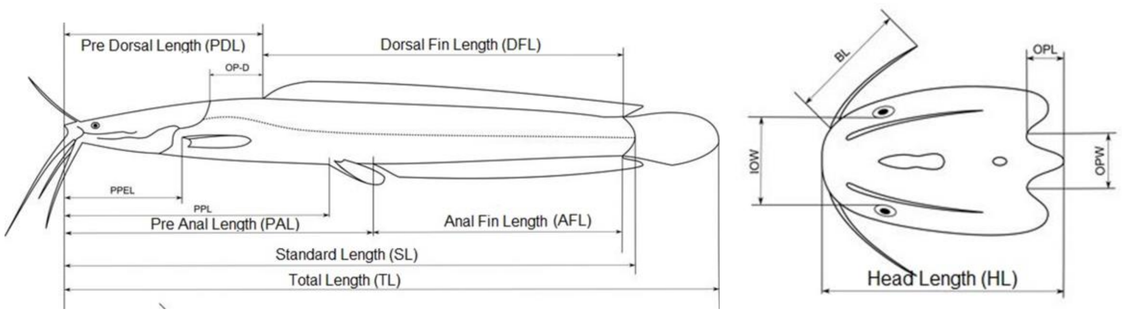


*Figure 1. Diagram of Morphometric Measures Studied (Adapted from Agnese et al., 1997).*

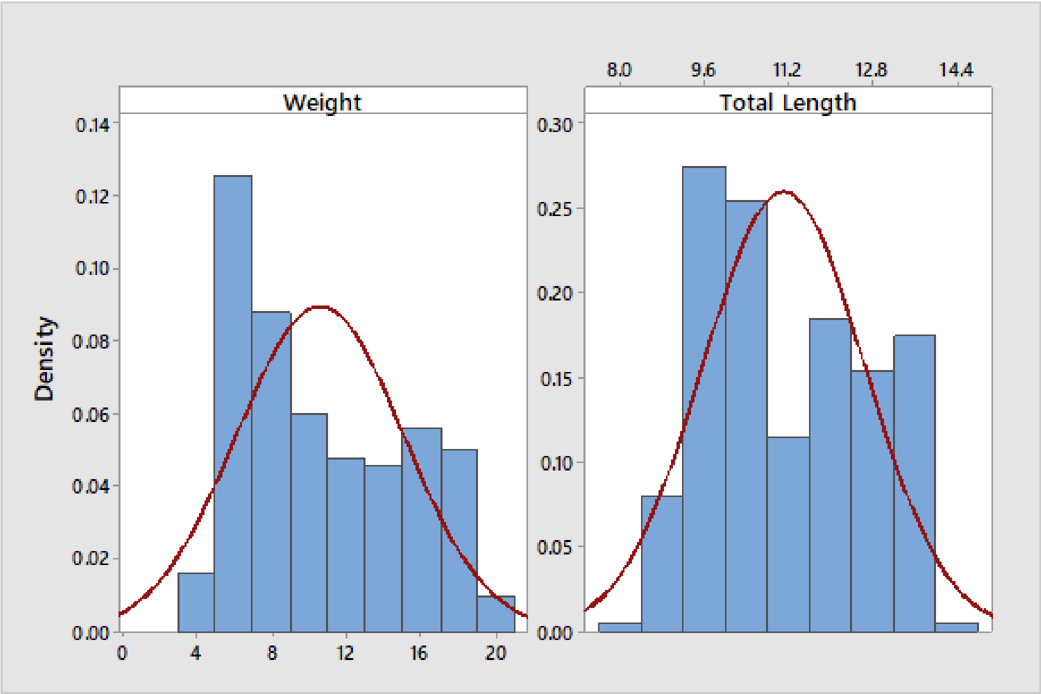


Figure 2. Histogram of weight (g) and total length (cm) with normal curve across the nine groups.

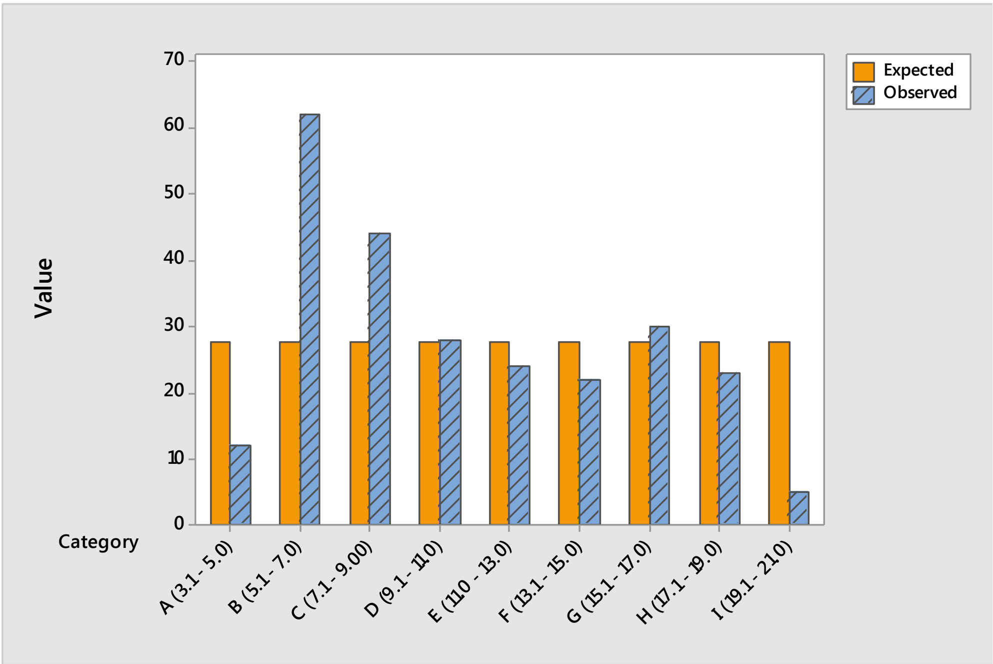


Figure 3. Chart of observed and expected counts across the nine groups.

**References**


1. FAO (2006). Food and Agricultural Organisation. *Year Book of Fishery Statistics*.
2. Edwin, H. Robinson, Meughe, H. Li and Martin, W. Bruson (2009). Feeding Catfish in Commercial Ponds. *In SRAC 181 Technical Article on Aquacultural Nutrition. Oklahoma State University Cooperative Extension*. 181:1-5.
3. Dauda A.B., Yakubu S.O. and Kabir I. (2013). Determinants of Fish Consumption in Dutsin-Ma LGA, Katsina State. In J.A. Adediran, J.O. Saka, A.G. Ibrahim, V.A. Adeyemi, A.O. Atere and M.O. Adenekan (eds). Revamping Nigeria Agriculture through Transformation Agenda: The Way Forward. *Proceedings of the 47th Annual Conference of the Agricultural Society of Nigeria*, page 1106-1109.
4. Charo H, and Oirere W (2000). River-based artificial propagation of the African catfish (*Clarias gariepinus*). An option for the small fish farmer. *Naga, The IQLARM Quarterly* 23 (1):14-16.
5. Anoop K.R, Sundar K.S.G, Khan B.A. and Lal S (2009).Common Moorhen Gallinula chloropus in the diet of the African catfish (*Clarias gariepinus*) in Keoladeo Ghana National Park, India. *Indian Birds*. 2:22-23.
6. Agnese, J.F., Teugels, G.G., Galbusera, P., Guyomard, R., and Volckaert, F. (1997). Morphometric and genetic characterization of sympatric populations of *Clarias gariepinus* and *Clarias anguillaris* from Senegal. *Journal of Fish Biology*, 50: 1143–1157.
7. Stevenson, R.D. and Woods, W.A. (2006). Condition indices for conservation: New uses for evolving tools. *Integrative and Comparative Biology*. 46: 1169-1190.
8. Sturges, H.A. (1926). The Choice of a Class Interval. *Journal of the American Statistical Association*, 21 (153): 65-66.
9. Minitab 17$^{(R)}$ Statistical Software (2013). Minitab Inc. USA
10. Torres, F.S.B. (1992). Length–weight relationships of Lake Kariba fishes. *Naga, The ICLARM Quarterly*, 15:42-43.
11. Keyombe, J.L., Waithaka, E. and Obegi, B. (2015). Length–weight relationship and condition factor of *Clarias gariepinus* in Lake Naivasha, Kenya. *International Journal of Fisheries and Aquatic Studies*. 2(6): 382-385.