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Comparative analyses of growth parameters of pure Clarias gariepinus and its hybrid in monosex culture

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Abstract

This study compared sexual differences in growth parameters of pure and hybrid African catfishes (Clarias gariepinus and Clariabranchus) raised in a monosex culture. The two species were obtained from 281 fishes comprising 150 pure breed and 131 hybrids in an earlier study and grouped by sex separately as male and female in four separate plastic tanks, representing two replicates per sex. Ten each of the pure clarias and its hybrid were reared in each tank. In all, 40 male and 40 female fish comprising 20 each of the pure clarias and its hybrid for each sex were evaluated for the growth parameters. A total of 80 fish were included in this study and the study lasted nine (9) weeks. The fish were fed commercially compounded feed twice daily throughout the period of the experiment. Length-weight relationship and growth parameters such as Mean Growth Rate (MGR), Specific Growth Rate (SGR), Absolute Growth Rate (AGR), Relative Growth Rate (RGR), Condition Factor (CF) were computed and evaluated for sex effect. All statistical analyses involving descriptive, general linear model analysis of variance (ANOVA) and post hoc test were done using Minitab® 17 Statistical Software. Sex had significant (P<0.05) effects on all growth parameters except Absolute Growth Rate (AGR) albeit at different levels, but specie only had significant (P<0.05) effect on Mean Growth Rate (MGR), while the interaction of sex x specie exerted significant (P<0.05) effects on all growth parameters except Condition Factor (CF). This study revealed that growth performance is significantly (P<0.05) affected by sexual dimorphism and also by interaction of sex and specie.

Keywords*: Growth parameters, African Catfish, Monosex culture, Sexual dimorphism*

Introduction

Food, no doubt is the most basic of all human needs to survive and despite all efforts made at improving its quality, as well as production and world food supplies, food insecurity remains prevalent globally, with its attendant consequences of malnutrition that has resulted in death of many citizens (Matemilola and Elegbede, 2017).

Increase in human population led to increased demand of animal protein in human diet, consequently resulting in over exploitation of fish in their natural habitat in other to meet the demand, because fish serves as a very good source of protein in human diets (Amosu, *et al.*, 2017 and Abiwon, 2017). In order to augment this deficiency, aquaculture has been exploited as a veritable and sustainable means of enhancing food security, satisfying local protein needs, source of foreign exchange earnings, and a source of indirect and direct employment and income generation (Olorunwa, *et al.*, 2017). It could also serve as an alternative to the oil-based economy of the country. Fish farming, the commonest branch of aquaculture is highly

exploited as it allows for the production of cheap source of protein. (Torrissen *et al*., 2011), and it has evolved to where input and output in farm practice are done concurrently (Adewuyi, *et al.,* 2010).

Africa catfishes are found in freshwater environment though mostly shallow and running waters, they exhibit a cylindrical and scale-less body with a flattened ventrum (Ekunwe and Egwake, 2015). The hardiness and adaptability to adverse environment changes, tolerance to high density, resistance to diseases, fast growing rate, capacity to reproduce under captivities, high consumption ranking and its ability to feed them with cheap feed (Olanrewaju, *et al.*, 2016) has endeared African Catfishes to aquaculturists.

Hybridization, the mating of hereditarily differentiated groups of individuals, involves crossing individuals within a specie or crossing individuals between separate species, with the goal to produce offspring that perform better than average of both parental species as a consequence of hybrid vigour. The adaptation of *Clarias gariepinus* (Burchell, 1822) and *Clariabranchus* hybrid from *Clarias gariepinus* and *Heterobranchus bidorsalis* (Geoffroy, 1809) to artificial breeding and rearing methods and its potential to sustain itself on artificially produced commercial feed informs the decision to further explore the potentials of these two species.

Growth is observed throughout the fish life cycle and differs between species, strains or populations within the same species and different individuals within the same population (Magbowon, *et al.,* 2013). It expresses the manifestation of the net outcome of energy increases and losses within a framework of both biotic and abiotic conditions (Nwipie *et al.,* 2015). Consequently, several growth parameters intended to appraise and assess the growth of fish has been identified and recommended for proper fish assessment and appraisal.

Some of these growth parameters included but not limited to length-weight relationship, (Pepple and Ofor, 2011; Datta *et al*,.2013), condition factor (Abanikannda *et al*., 2019; Mansor, *et al.,* 2010), relative growth rate (Pepple and Offor, 2011), mean growth rate, absolute growth rate and specific growth rate (Abanikannda *et al*., 2019; Ricker, 1979; Datta *et al.,* 2013).

Fish growth is typically dependent on the size of the fish, while small and large fish have low absolute growth rates, fish of intermediate sizes have higher absolute growth rates (Yakubu, *et al.,* 2014). Aside external factors, some internal factors such as genetic variation, sex and behavioral differences affect growth rate and hence annular deposition within the otoliths (Vincenzi *et al.,* 2014). Each individual in a population possess a particular genetic makeup that to some extent controls its growth profile, but physical and biological processes modified the growth rate (Shelton *et al.,* 2013). Growth therefore is simultaneously due to individual response to variability (individual genotype), and behavioral differences in reproduction, habitat selection and forage-based migration between sexes (DeAngelis and Grimm, 2014). Thus, a very good growth model takes account of individual variations at a variety of levels (Weisberg, *et al.,* 2010).

This study therefore aims to comparatively evaluate the growth performances of the species under similar rearing condition, investigate if there is/are differences between the growth performances of the two sexes and assess which of the various growth parameters is best in estimating the differences in performance between the species and sexes.

Materials and Methods

Study Site: The experiment started at the hatchery complex of the Department of Fisheries and Aquatic Biology, Lagos State University, Ojo where hybridization of the fish

took place (Abanikannda *et al*., 2019). This current study was conducted at a private fish farm around Abesan area, along Ipaja road, Lagos. It ran for nine weeks.

Experimental Animal: The experimental animal used were pure *Clarias gariepinus* and *Clariabranchus* obtained from a previous research on hybridization of African Catfishes, *Clarias gariepinus* x *Heterobranchus bidorsalis* (Abanikannda, *et al*. 2019).

Experimental Design: The *Clarias gariepinus* and *Clariasbranchus* (male and female) used were randomly selected from the earlier study and randomly assigned to the two treatment groups (Male and Female). Eighty 2-months old fishes comprising 40 *Clarias gariepinus* and 40 *Clariasbranchus* were recovered from a previous study involving 281 fishes comprising 150 pure breed and 131 hybrids (Abanikannda *et al*., 2019) and are separated based on sex in four different plastic tanks comprising 20 fish each. There are two replicates for each of the male and female groups and all tanks are run as monosex. Each of the tanks was subjected to the same experimental treatments, vis a vis feed and feeding regimen. The male group (Tanks A and C) and the female group (Tanks B and D) comprises 10 fish each of *Clarias gariepinus* and *Clariasbranchus* male and female respectively and were reared for a period nine weeks.

The fish were fed commercially compounded feed (Aller Aqua) with a proximate analysis as presented in Table 1.

Table 1: Proximate analysis of feed

Constituents	Proximate Content (%)
Crude Protein	43
Crude Fat	13
Crude Fiber	3.4
Crude Ash	6
Calcium	1
Sodium	0.3
Phosphorus	0.8

The experimental fishes were fed with 100 grams twice daily (morning and evening), the water was monitored for physicochemical properties and changed at three days intervals.

Measurements: Weight and morphometric measurements were taken, which included total length, standard length, head length, dorsal fin length, anal fin length and heart girt depicted in Figure 1.

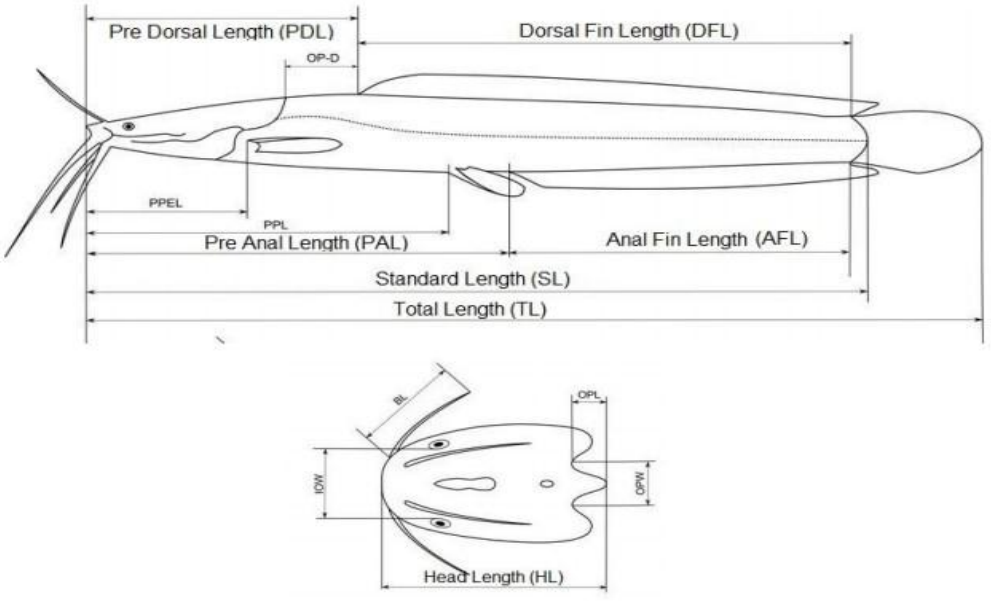

Figure 1: Morphometric measurements adapted from Agnese *et al*., 2007

Data Collection and Handling: The fish body weights were taken using a professional digital scale sensitive to 0.00 gram. Other measurement included body measurements using a flexible meter rule. Each fish in a tank were measured for all variables discussed above and measurements were recorded based on the tank the fish were drawn. Morphometric measurements are as described by Abanikannda *et al*., (2019), based largely on the work of Agnese *et al*., (2007).

Biological Evaluation: Indices computed based on the measurements included; Length-Weight Relationship (LWR), Condition Factor (CF), Specific Growth Rate (SGR), Relative Growth Rate (RGR), Absolute Growth Rate (AGR) and Mean Growth Rate (MGR) as described by Abanikannda *et al*., (2019) from earlier researches (Varela *et al*., 2010; Bagenal, 1978; Ricker, 1975 Tesch, 1968; Brown, 1957 and Fulton, 1904) using the formular below;

$W = aL^b$ which is transformed as $Log\ W = Log\ a + b\ Log\ L$.

$CF = \left(\frac{W.100}{L^3}\right)$ where W = Weight in gram, L = length in (cm), a = a constant being the initial growth index, and b = growth coefficient.

$$AGR = \left(\frac{W_f - W_i}{t}\right)$$

$$SGR\ (\%) = \left(\frac{Ln\ W_f - Ln\ W_i}{t}\right) x\ 100$$

$$RGR\ (\%) = \left(\frac{W_f - W_i}{W_i}\right) x\ 100$$

$$MGR\ (g/day) = \left(\frac{W_f - W_i}{0.5(W_f + W_i)t}\right) x\ 100$$

Where W_f is final weight (g), W_i is initial weight (g), t is time (days), and Ln is natural logarithm.

Data manipulation and Statistical Analyses: An initial descriptive statistic of all measurements and computed indices was conducted to test the data for normality and outliers prior to detailed statistical analyses. In all, 80 records on fishes comprising 40 males and 40 females were evaluated, with each sex made up of 20 pure and 20 hybrid respectively.

All statistical tests and analysis were done using the Minitab® 17 statistical software and the modules used included, descriptive analysis, general linear model of analysis of variance and post hoc multiple comparison of means after a significant ANOVA.

The statistical model describing the parameters for all variables studied is given as;

$Y_{ijk} = \mu + a_i + b_j + (ab)_{ij} + e_{ijk}$.

Where Y_{ijk} is the observed value of parameter on a particular fish

μ = the overall mean

a_i = the i^{th} effect of sex

b_j is the j^{th} effect of specie

$(ab)_{ij}$ is the interaction effect of specie x sex, and e_{ijk} is residual random error

Results and Discussion

Initial Weight: There was no significant ($P>0.05$) difference in the initial weights between the two sexes studied at the commencement of the experiment, this revealed that there were no outliers in both sexes (Figure 2), and that initial mean body weight in both sexes were fairly close, ranging from 134g to 820g for the male and 144g to 816g for the female, and a mean weight of 419.9±21.5g and 429.4±23.9g respectively.

There was no significant difference ($P>0.05$) in the initial weights between the two sexes under investigation, which was deliberately intended by the randomization in the selection and assignment of fish to treatments. The essence of this is to ensure that the two groups were not statistically different prior to commencement of the experiment, and also establish that whatever difference is recorded subsequently must have been due to the treatment effect, which in this instance is the difference in sex.

Condition Factor (K): The mean value for condition factor across both sexes was 0.68±0.01, with mean of 0.66±0.01 and 0.70±0.01 respectively for male and female fish (Table 2). Sex of fish was significant ($P<0.05$), with the female fish recording greater values than the male. Interaction of sex x specie was not statistically significant ($P>0.05$) (Table 3). This observation is in line with earlier reports (Owodeinde *et al.,* 2011; Naeem *et al.,* 2010) but contradicted the work of Madu *et al.,* (1994).

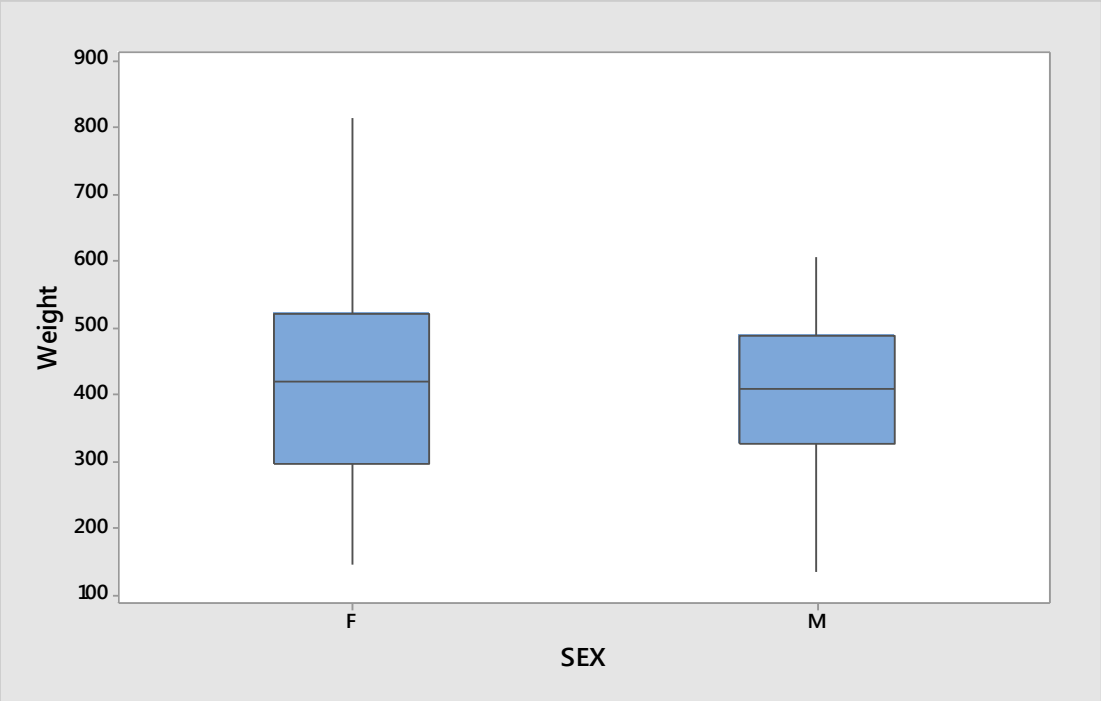

Figure 2: Boxplot of initial fish weight (g) by sex at the commencement of experiment

Table 2: Growth Parameters by Sex of Fish across Species

Sex	Specie	N	SGR	AGR	MGR	RGR	CF
Male	Combined	40	1.08±0.05[a]	6.20±0.44	1.04±0.05[a]	85.37±5.31[a]	0.66±0.01[b]
	Pure	20	1.16±0.08	6.89±0.66	1.11±0.07	94.60±8.57	0.64±0.01
	Hybrid	20	0.99±0.06	5.51±0.56	0.96±0.06	76.15±5.77	0.67±0.02
Female	Combined	40	0.81±0.07[b]	4.87±0.71	0.78±0.07[b]	61.88±6.86[b]	0.70±0.01[a]
	Pure	20	0.58±0.07	3.08±0.53	0.57±0.07	40.21±6.00	0.71±0.01
	Hybrid	20	1.05±0.10	6.74±1.23	1.00±0.09	84.70±10.4	0.68±0.02

Means with different superscripts within the same column differs significantly (P<0.05)

Absolute Growth Rate (AGR): The mean absolute growth rate across both sexes was 5.52±0.42, while 6.20±0.44 and 4.87±0.71 was recorded for male and female respectively (Table 2). While sex of fish did not significantly (P>0.05) affect absolute growth rate, it is noteworthy that the interaction of sex and specie was highly significant (P<0.01) (Table 3). This can be explained by the huge disparity within the female group as a consequence of differences due to species. The hybrid had mean AGR that was more than twice of what was recorded for pure Clarias in the female subgroup. Results of this study were in accordance with earlier findings of Abanikannda *et al*., (2019), Martins *et al.* (2005), Sundstrom *et al.*, (2003), Aluko and Ali (2001) and Valente *et al.*, (2001).

Table 3: ANOVA of Growth Parameters by Sex across Species

Source	df	SGR MS	AGR MS	MGR MS	RGR MS	CF MS
Sex	1	1.38***	32.89	1.25***	10374**	0.035*
Specie	1	0.46	25.71	0.42*	3342	0.000
Sex x Specie	1	1.99***	125.17**	1.69***	19537***	0.017
Error	76	0.12	12.13	0.10	1213	0.006
R-Squared (%)		30.43	16.89	31.25	26.95	10.00

*= P<0.05 ** = P<0.01 *** = P<0.001

Specific Growth Rate (SGR): The mean specific growth rate across both sexes was 0.94±0.05, while 1.08±0.05 and 0.81±0.07 was recorded respectively for male and female (Table 2).

Sex and interaction of sex x specie were highly significant (P<0.01) sources of variation on specific growth rate of the fishes. Male had significantly higher values than female (Table 3). Although the influence of specie was not statistically significant on SGR but it was very close to being significant (P=0.053). This observation is in consonance with reports of Abanikannda *et al*., (2019), Naeem *et al.,* (2010) and Aluko and Ali (2001), but however contradict the earlier report of Falaye *et al.,* (2011) who also worked on Comparative growth performance of monosex and mixed sex population of African catfish.

Mean Growth Rate (MGR): The average value for mean growth rate across both sexes was 0.91±0.06, while the mean growth rate for male and female was 1.04±0.05 and 0.78±0.07 respectively (Table 2).

Sex, along with sex by specie interaction were highly significant (P<0.01), and specie was also significant (P<0.05) on the MGR. Male fish across sexes had significantly higher mean growth rate than female (Table 3), but female hybrid outperforms the pure female fish (Table 2). This may be due to the fact that males tend to convert consumed food into fat, leading to higher weight gain than female. This observation supports earlier findings of Abanikannda *et al*., (2019), Akinwande *et al.,* (2017), Aluko and Ali (2001) and Madu *et al.,* (1991).

Relative Growth Rate (RGR): Relative growth rate across both sexes was 73.63±6.09 while 85.37±5.31 and 61.88±6.86 was respectively recorded for male and female (Table 2).

Sex and sex by specie interaction were highly significant (P<0.01) sources of variation on relative growth rate and the model explained almost 27% of the total variation observed (Table 3). Male fish had significantly higher relative growth rate than female in the entire study, however, hybrid fish in the female group had better mean values that double the values recorded on the pure in the female group (Table 2). This observation is in accordance with the findings of Abanikannda *et al*., (2019), Akinwande *et al.,* (2017) and Megbowon *et al.,* (2014).

Conclusion and Recommendations

Based on the results of this study, it could be concluded that

1. Weight differentials significantly (P <0.05) impacted the variables (sex, specie, sex x specie) from initial measurements to final measurements.
2. The effect of sex was highly significant (P<0.01) in all growth parameters; Condition factor, Specific growth rate, Mean growth rate and Relative growth rate, except in Absolute growth rate, where

it was not significant (P>0.05).

3. There was superiority of the male over the female in all growth parameters except for the condition factor.
4. There was need for further research on the potentials of sexual dimorphism of growth parameters in *Claris garipienus* and its hybrid.

It could therefore be recommended:

- That as much as possible, fish should be reared as monosex as soon as their sexes can be anatomically differentiated as this aside from improved growth performance, will also minimize cannibalism within the pond.
- That the female hybrid should be further investigated for their potentials in greater weight gain.
- That male can be reared for marketing purpose by fattening them, while female be deliberately bred for reproduction purpose.

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