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Sex distributions and growth response in different populations of catfish (*Clarias gariepinus*)

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Abstract

This study evaluated the gender ratio in Clarias gariepinus production from five different populations. 300 Juveniles fish each were sourced from five (5) fish farms. The fish were grouped based on the farms into five populations (i.e. treatments) and were replicated thrice with each replicate stocked with 100 fish in a square shaped experimental plastic tanks of 1m x 1m x 1m. Data obtained from the experiment were subjected to one-way analysis of variance. Significant differences ($p<0.05$) were recorded in the values of final weight, mean weight gain, specific growth rate, percentage survival and daily growth rate. The male-female ratio showed that the females were more in number compared to their male counterpart. There was no significant difference in the number of males, number of females and weight of males across the populations. The female C. gariepinus in population 5 had the highest value (246.41±2.73g) of final weight while those in population 3 had the least value (205.95±13.17g) of weight. The fish in population 2 displayed a better growth curve compared to other populations while fish in population 3 displayed the least curve. The curve revealed that the fish grows at almost the same rate from day 0 to day 42 after which their growth pattern changed. This study showed that the number of female fish in any production outweighs the number of males.

Keywords: *C. gariepinus*, gender ratio, growth, survival

Introduction

Nigeria is the leading producer of *C. gariepinus* in the world with a production of 89,193 tons in 2009 (FAO, 2011). The involvement of the private sector in the seed production and formulation of feed paved the way for this growth in production (Adewumi and Olaleye, 2011). Production of the African catfish has risen tremendously from a mere 5,013 tons in 1992 to 181,601 tons in 2012 (FAO, 2014). Development of seed production and growth technologies, the species ability to withstand high densities, its high growth rate, its ability to feed on a wide array of feed and its high demand in the market can be ascribed to its increased production in the world (Ponzoni, 2008). Seed production is the critical aspect of any aquaculture practice. *C. gariepinus* is been produced in the hatchery using hormones. Sex reversal can be induced by various factors, including temperature changes or exposure to hormone active substances (Wallace *et al*., 1999; Devlin and Nagahama, 2002; Baroiller *et al*., 2009). The within-population variance in family sex ratio can be very high due to variance in the micro-ecological conditions that affect eggs or larvae (Wedekind, 2012). In most reptiles, sex is not determined at conception but later during a specific window of time during embryonic or larval development. The window is often called "the thermosensitive period" because incubation temperature is often the most important sex-determining factor in these species (Valenzuela and Lance, 2004). Purely environmental sex determination has been assumed to be quite common also in fish. Though, sex determination is genetic but in many fishes and amphibians, sex is reversible by environmental factors during a sensitive period that is typically very early in life.

Risks of extinction are therefore increased if population sex ratios deviate from 1:1 (Wedekind, 2012). Furthermore, coupled with the fact that the artificial propagation of catfish usually requires that the male fish is sacrificed to obtain spermatozoa. This could pose a danger of depletion to male catfish which will indirectly affects the female populations (Egwui and Nwankwo, 2015). Therefore, this study was aimed at investigating the sex distribution and growth performance of different populations of C. gariepinus.

Materials and method

Location of study

This experiment was conducted at the Nursery Unit of Motherhood fish farm, Alogi area, Obantoko, Abeokuta, Ogun state, Nigeria

Experimental procedure

Five populations of *Clarias gariepinus* juvenile sourced from five different fish farms in Ogun state otherwise referred to as the treatments were used for this experiment. The fish average initial weight ranged between 18.38 - 18.98g. Each population comprised of 300 pieces of juvenile and replicated thrice, each replicate was stocked with 100 fish in a square shaped experimental plastic tank (1m x 1m x 1m). Commercial feed of sizes 2mm, 3mm, 4mm and 6mm were fed to the fish twice daily at 5% body weight for 98 days under a flow through water system. Dirt, fecal matters and uneaten feed were siphoned out daily. Batch weighing was carried out at 2 weeks (14days) intervals during the experimental period using electronic weighing balance (Torbal AGZN120) to monitor the growth and feeding rates. Water quality parameters monitored during the experiment include Temperature using a mercury in glass thermometer, pH using a pocket-sized pH meter (model-PHeP), Dissolved Oxygen using digital oxygen meter (model H1-9146). Conductivity was determined using JENWAY 9071 model electrode. Ammonia contents of the experimental water was determined with the use of Hack kit model PO19A that measures from 0-50 mg/l.

Growth performance indices were measured using the following formulae.

$$\text{Specific growth rate (SGR, \% per day)} = \frac{(Loge\, W_f - Loge\, W_i) \times 100}{Time\ (days)}$$

$$Survival\ \% = \frac{Initial\ number\ of\ fish\ stocked - mortality}{Initial\ number\ of\ fish\ stocked} \times 100\%$$

$$\text{Daily growth rate (\%)} = \frac{(W_f - W_i)}{Time}$$

Wf = Final average weight of fish at the end of the experiment

Wi = Initial average weight of fish at the beginning of the experiment

Loge = Natural logarithm

Time = Number of days of experiment

The sex was determined by examining the gonads with the naked eye in large specimens and by using a microscope for smaller ones. Differences between sex ratios were based on secondary characteristics (males develop external genital papillae).

Statistical analysis

Data obtained from the experiment were subjected to one-way analysis of variance (ANOVA). The difference between the means were determined using Least Significant Difference (LSD) at 95% confidence level ($P<0.05$). Statistical software SPSS 20 was used for the analysis.

Results

The growth parameters of different population of *C. gariepinus* juvenile are presented in Table 1. There was no significant difference ($p>0.05$) in initial weight among the populations. Significant differences ($p<0.05$) were recorded in final weight, mean weight gain, specific growth rate, percentage survival and daily growth rate. The fish in population 2 had the highest final weight gain, mean weight gain, specific growth rate percentage survival and daily growth rate while the fish in population 3 had the least values for these parameters.

The sex distribution and ratio of *C. gariepinus* juvenile is presented in Table 2,

Figure 1 and Figure 2. The male-female ratio shows that the females are more in number compared to their male counterpart. There was no significant difference in the number of males, number of females and weight of males across the population. Significant differences exist ($p<0.05$) in the weight of female *C. gariepinus* at the end of the experiment. The female *C. gariepinus* in population 5 has the highest value of final weight while those in population 3 has the least value of weight. Among the males, the fish in population 2 has the highest mean weight while those in population 5 has the least value. The growth pattern of *C. gariepinus* from different population raised for 98 days is presented in Figure 3. The fish in population 2 displayed a better growth curve compared to other populations. While fish in population 3 displayed the least curve. The curve revealed that the fish grows at almost the same rate from day 0 to day 42 after which their growth pattern changed.

Table 1: Growth parameters of different population of *C. gariepinus* juvenile

	P1	P2	P3	P4	P5
IW (g)	18.38±0.16	18.52±0.82	18.42±0.20	18.98±0.25	18.63±0.21
FW (g)	403.19±9.59 ^{ab}	423.94±13.99 ^{a}	352.21±23.34 ^{b}	384.83±13.87 ^{ab}	393.12±22.02 ^{ab}
MWG	384.80±9.62 ^{ab}	405.42±13.32 ^{a}	333.79±23.34 ^{b}	365.85±13.69 ^{ab}	374.50±22.15 ^{ab}
SGR	3.15±0.03 ^{ab}	3.20±0.03 ^{a}	3.01±0.07 ^{b}	3.07±0.03 ^{ab}	3.11±0.07 ^{ab}
Survival (%)	77.00±4.04 ^{ab}	80.00±4.36 ^{a}	63.33±3.53 ^{c}	67.00±3.21 ^{bc}	71.33±2.03 ^{abc}
DGR	0.22±0.01 ^{ab}	0.23±0.01 ^{a}	0.18±0.01 ^{b}	0.20±0.01 ^{ab}	0.21±0.01 ^{ab}

^{abc}Means with different superscript on the same row are significantly different ($p<0.05$), IW = Initial Weight, FW = Final Weight, MWG = Mean weight gain (g), SGR = specific growth rate, DGR = daily growth rate

Table 2: Sex distribution and ratio

	P1	P2	P3	P4	P5
Final stock	77.00±4.04 ^{ab}	80.00±4.36 ^{a}	63.33±3.53 ^{c}	67.00±3.21 ^{bc}	71.33±2.03 ^{abc}
Final Wgt (g)	403.19±9.59 ^{ab}	423.94±13.99 ^{a}	352.21±23.34 ^{b}	384.83±13.87 ^{ab}	393.12±22.02 ^{ab}
Number of males	26.00±3.51	35.33±3.38	25.00±3.79	28.00±2.08	25.67±4.48
Number of Females	51.00±6.08	47.00±4.36	38.33±0.33	39.00±2.00	45.67±3.53
Weight of Male(g)	166.27±9.94	191.67±16.33	146.27±10.32	168.00±4.89	144.31±22.74
Weight of Female (g)	236.78±6.17 ^{ab}	232.27±18.91 ^{ab}	205.95±13.17 ^{b}	216.83±9.46 ^{ab}	246.41±2.73 ^{a}
Ratio (M:F)	1:1.96	1:1.34	1:1.52	1:1.39	1:1.80

^{abc}Means with different superscript on the same row are significantly different ($p<0.05$)

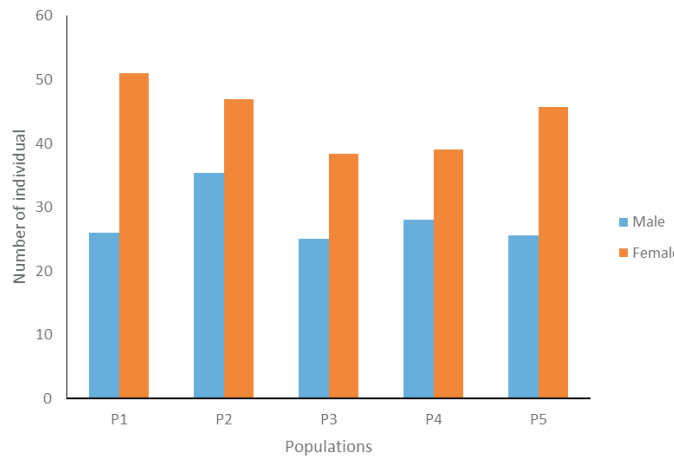

Figure 1: Male and female ratio in each population

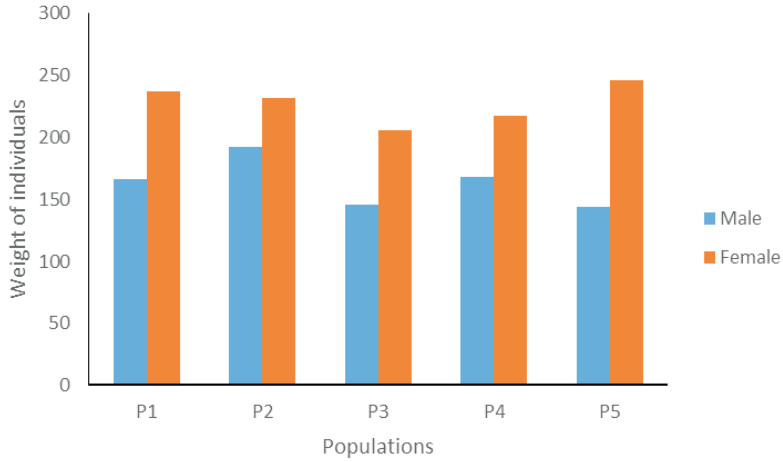

Figure 2: Male and Female ratio based on individual mean weight

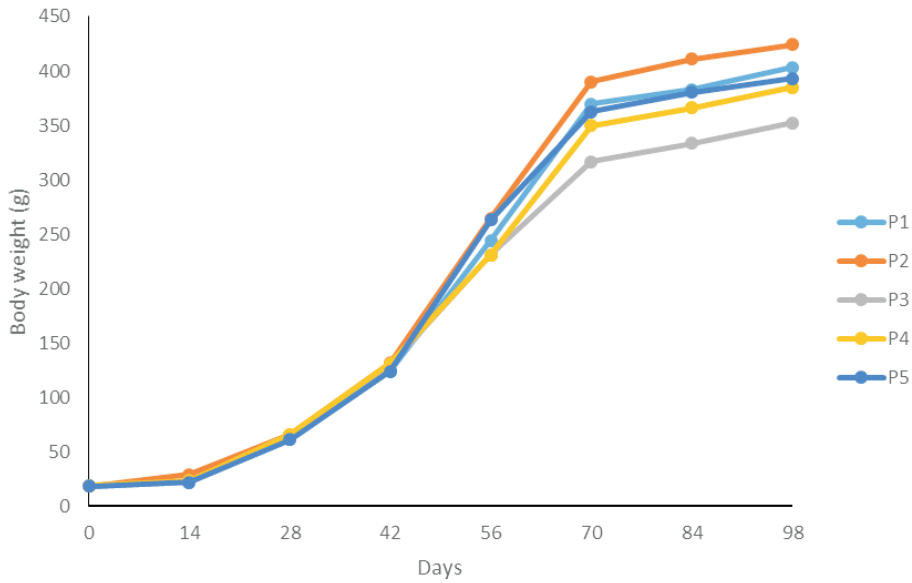

Figure 3: The growth pattern of *C. gariepinus* from different population

Table 3: Mean water parameters

Parameters	Values
Temperature (°C)	29.08±1.47
pH	6.83±0.21
Dissolved Oxygen (mg/L)	6.74±0.43
Ammonia (mg/L)	0.35±0.41
Conductivity(µS/cm)	76.5±4.7

Discussion

The sex ratio for male to female observed in this study ranged from 1:1.34 to 1:1.96. This indicates that there are more female fish in the population than the male counterpart. On the contrary, Anyanwu *et al*. (2007) recorded a sex ratio of 1:1.08 from a population of fish which is highly desirable for broodstock development and hatchery operations for C. gariepinus especially in Nigeria where the practice is to sacrifice the male fish to obtain milt from the male testis during induced breeding operations. The difference may be due to time and location. The present study is an indication that production of male broodstock for fingerling production of C. gariepinus is under threat. In their experiment, Cek and Yilmaz (2007) also recorded a sex ratio 1:1.2 for Sharptooth catfish cultured under laboratory conditions Willoughby and Tweddle (1978) reported that males were more than females in the natural environment. These may be attributed to endocrinal contamination in their study area and the effects of environmental contaminants on the endocrine system of C. gariepinus, as their study was conducted in the natural environment (Cek and Yilmaz, 2007). Tyler *et al*. (1998) concluded that a large amount of androgen and oestrogen released into the environment has the potential to disrupt the endocrine system of fish.

The SGR observed in this study ranged from 3.01 – 3.15. this is similar to the observation of Agokei *et al*. (2010) who recorded a range of 2.71 – 3.19%/day when C. gariepinus fingerlings were fed with five different commercial feeds. On the contrary, Okomola *et al*. (2017) recorded SGR range of 1.05 – 1.26 %/day in C. gariepinus fingerlings fed diets containing varying levels of groundnut oil. The difference may be due to the difference in the size of fish used (fingerlings of average weight 1.86g), compared to juvenile fish used in this study. From this study, the weight of female fish ranged from 205.95 – 246.41 g while that of their male counterpart ranged from 144.31 – 191.67 g. This means that the females grow bigger in weight than the males. This observation disagreed with the observation of Cek and Yilmaz (2007) who recorded a higher weight for males than their female counterpart in Sharptooth catfish.

Conclusion

This study established that fish from different hatchery exhibit different growth performance and growth patterns. Differences were also recorded for gender ratios in all the populations (Hatcheries). Also, this study revealed that there are more female than male fish the all the populations examined. Therefore, it can be concluded that the success of fish culture depends largely on the source of the fish seed. It is recommended that further research should be carried out using more populations and that alternative to male sacrificial in catfish breeding should be sourced.

References

Adedeji, O. B. and Okocha, R. C. 2011. Constraint to aquaculture development in nigeria and way forward. *Veterinary Public Health and Preventive Medicine*, University of Ibadan, Nigeria.

Adeogun, O. A., Ajana, A. M., Ayinla, O. A., Yarhere, M. and Adeogun, M. O. 2008. Application of Logit Model in adoption decision: A study of hybrid *Clarias* in Lagos State, Nigeria. *American-Eurasian J. Agric. Environ. Sci.* 4(4):468-472.

Agokei, E. O., Oparah, C. A., Aranyo, A. A., Alozie-Chidi, V. C. and Apapa, U. A. 2010. Growth of Clarias gariepinus Juveniles fed five commercial feed. Fisheries Society of Nigeria, FSN-NU 0007.

Anderson, J. L. 2009. *Fisheries*. Microsoft

Encarta, Redmond, W.A, Microsoft Cooperation, 2008.

Anyanwu, P. E., Okoro, B. C. Anyanwu, A. O., Matanmi, M. A., Ebonwu, B. I., Ayaobu-Cookey, I. K., Hamzat, M. B., Ihimekpen F. and Afolabi, S. E. 2007. Length-Weight Relationship, Condition Factor and Sex Ratio of African Mudcatfish (*Clarias gariepinus)* Reared in Indoor Water Recirculation System Tanks. *Research Journal of Biological Sciences,* 2(7): 780-783.

Baroiller, J.bF., D'Cotta, H. and Saillant. E. 2009. Environmental effects on fish sex determination and differentiation. *Sexual Development,* 3:118-135.

Bjerkeng, B., Storebakken, T. and Liaaen-Jensen, S. 1992. Pigmentation of rainbow trout from start feeding to sexual maturation. *Aquaculture* 108:333–346. DOI:10.1016/0044-8486(92)90117-4.

Britton, G., Liaaen-Jensen, S. and Pfander, H. 2008. *Carotenoids: Natural functions*. Berlin: BirkhauserVerlag of Germany.

Cek, P. and Yilmaz, E. 2007. Gonad Development and Sex Ratio of Sharptooth Catfish (Clarias gariepinus Burchell, 1822) Cultured under Laboratory Conditions. *Turkish Journal of Zoology*, 31 35-46

Chatzifotis, S., Pavlidis, M., Jimeno, C. D., Ardanis, G. V., Sterioti, A. and Divanach, P. 2005. The effect of different carotenoid sources on skin coloration of cultured red porgy (Pagruspagrus). *Aquaculture Research* 36:1517–1525. DOI:10.1111/j.1365-2109.2005.01374.x.

Devlin, R. H. and Nagahama, Y. 2002. Sex determination and sex differentiation in fish: an overview of genetic, physiological, and environmental influences. *Aquaculture* 208:191-364

Edge, R., McGarvey, D. J. and Truscott, T. G. 1997. The carotenoids as antioxidants"—a review. Journal of Photochemistry and Photobiology B: *Biology* 41:189–200. doi:10.1016/S1011-1344(97)00092-4.

Egwui, P. C. and Nwankwo, J. N. 2015. Suturing as an alternative to sacrificing male catfish in Artificial fish breeding: short communication. *International Journal of Fisheries and Aquaculture Research* Vol.1, No.1, pp.31-33

FAO, 2007. Food and Agriculture Organization of the United Nations. *The state of World Fisheries and Aquaculture*. FAO Fisheries Department, Rome Italy. 2007;30.

FDF, 2015. Federal Department of Fisheries 2008. *Fisheries Statistics of Nigeria Projected human population; fish demand and supply in Nigeria* from 2000 – 2015; 2008;56.

Foss, P., Renstrom, B. and Liaaen-Jensen, S. 1987. Natural occurrence of enatiomeric and mesoastaxanthin in crustaceans including zooplankton. *Comparative Biochemistry and Physiology* 86:313–314.

Gjedrem, T. 2000. Genetic improvement of cold-water fish species. *Aquaculture Research* 31:25–33. doi:10.1046/j.1365-2109.2000.00389.x.

Goodwin, T. W., Chapman, M. H. and Hall, P. P. 1986. The biochemistry of the carotenoids: Plants and animals. *Biochemical Systematics and Ecology* 14:353–354. doi:10.1016/0305-1978 (86)90114-

6.

Grung, M., Svendsen, Y. S. and Liaaen-Jensen, S. 1993. The carotenoids of eggs of wild and farmed cod (Gadusmorhua). *Comparative Biochemistry and Physiology* 106:237–242.

McGraw, K. J., Adkins-Regan, E. and Parker, R. S. 2005. Maternally derived carotenoid pigments affect offspring survival, sex ratio, and sexual attractiveness in a colorful songbird. Naturwissenschaften 92:375–380. DOI:10.1007/s00114-005-0003-z.

Mikulin, A. E. 2000. *Functional significance of pigments and pigmentation in fish ontogenesis. Moscow*: Russian Federal Research Institute of Fisheries and Oceanography.

Moller, A. P., Biard, C., Blount, J. D., Houston, D. C., Ninni, P., Saino, N. and Surai, P. F. 2000. Carotenoid-dependent signals: Indicators of foraging efficiency, immune competence or detoxification abilityfl *Poultry and Avian Biology Reviews* 11:137–159.

Okomoda, V. T., Tiamiyu, L. O. and Chado, R. T. 2017. Growth performance of *Clarias gariepinus* fingerlings fed diets containing varying levels of groundnut oil. *Ege Journal of Fisheries and Aquatic Sciences,* 34(1): 111-114. doi:10.12714/egejfas.2017.34.1.15

Ozigbo Emmanuel, Anyadike Chinenye, Forolunsho Gbadebo, Okechuckwu Richardson, Kolawole Peter. 2013. Development of an Automatic Fish Feeder" International Institute of Tropical Agriculture Postharvest Unit, Ibadan – *African Journal of Root and Tuber Crop*, 10(1):27-32.

Promya, J. and Chitmanat, C. 2011. The effects of *Spirulinaplatensis* and Cladophora algae on the growth performance, meat quality and immunity stimulating capacity of the African sharptooth catfish (*Clarias gariepinus*). *International Journal of Agricultural and Biological Engineering* 13:77–82.

Rajasingh, H., Øyehaug, L., Våge, D. I. and Omholt, S. W. 2006. Carotenoid dynamics in Atlantic salmon. *BMC Biology* 4:10–13. DOI:10.1186/1741-7007-4-10.

Selong, J. 2005. Cichlid coloration control and enhancement. Available: http://www.cichlid-forum.com/articles/color_control.php. Accessed Oct 2014 25.

Valenzuela, N. and Lance, V. A. 2004. Temperature-dependent sex determination in vertebrates. Smithsonian Institution, Washington.

Vassallo-Agius, R., Imaizumi, H., Watanabe, T., Yamazaki, T., Satoh, S. and Kiron, V. 2001. The influence of astaxanthin supplemented dry pellets on spawning of striped jack. *Fisheries Science* 67:260–270. doi:10.1046/j.1444-2906.2001.00248.x.

Wallace, H., Badawy, G. M. I. and Wallace, B. M. N. 1999. Amphibian sex determination and sex reversal. *CMLS Cellular and Molecular Life Sciences* 55:901-909.

Wedekind, C. 2012. Managing Population Sex Ratios in Conservation Practice: How and Whyfl, *Topics in Conservation Biology*, Dr. Tony Povilitis (Ed.), ISBN: 978-953-51-0540-4, InTech, Available from: http://www.intechopen.com/books/topics-in-conservation-biology/managing-population-sex-ratio-why-and-how.

Willoughby, N. G. and Tweddle, D. J. 1978. The ecology of the catfish *Clarias gariepinus* and *Clarias ngamensis* in the Shire valley. Malawi. *Journal of Zoology* (London) 186: 507-534.

Woutersen, R. A., Wolterbeek, A., Appel, M. J., van den Berg, H., Goldbohm, R. A. and Feron, V. J. 1999. Safety evaluation of synthetic β-Carotene. *Critical Reviews in Toxicology* 29:515– 542. doi:10.1080/10408449991349267.

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