Ife Journal of Agriculture, 2019, Volume 31, Number 3

EMERGENCE OF NEW SHOOTERS FROM THE POPULATIONS OF SELECTED SHOOTERS OF AFRICAN MUDCATFISH *Clarias gariepinus* (BURCHELL, 1822)

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ABSTRACT

In a fish population, shooters are the biggest size group with extremely high growth rate than the other size groups in the same population. Four different groups of shooters of Clarias gariepinus of 1 week old, 3 weeks old, 6 weeks old and 9 weeks old were seleted from three different bred population and raised for another 6 weeks for emergence of new shooters. The growth response, survival, emergence of new shooters and fish lost from the four groups were studied and statistically analysed. The growth and survival rates, mean feed intake (MFI) and feed conversion ratio (FCR)) in the same group of the different populations were insignificantly different. New shooters were observed in all the groups with significant growth rates and the mean emerging number per week in each group was insignificant (p>0.05), with a total mean value of 21.00±1.06 for group1, 18.00±1.13 group2, 11.00±0.80 group3 and 9.00±0.64 for group4. Percentage survival was higher in older shooter group with a range of 18% - 50%. Mean percentage mortality range was 12 - 20% and percentage cannibalism range was 18 - 24%. The mean range of water quality parameters were: Temperature (^oC) 27.8 - 29.5, DO (mg/L) 4.7 - 5.3, pH value 6.8 - 6.85, ammonia 0.0175 - 0.0177 and nitrite values ranged from 0.421 - 0.428. Therefore, the occurrence of shooters in a population of Clarias gariepinus is a natural phenomenon, the older the shooter's group the lower the emergence of new shooters and the higher the percentage survival.

Keywords: ***shooters, emergence, new shooters, population and Clarias gariepinus.***

INTRODUCTION

Aquaculture has been accepted as a means of increasing fish production in Nigeria. It has grown to the extent of exceeding that of capture fisheries and other animal food production systems (FAO, 1999). However, the African Catfish (*Clarias gariepinus*) is widely considered as the leading cultured fish in Nigeria, as it accounts for 70% of the fish production from aquaculture (Williams *et al*., 2008). It is very popular in Nigeria due to its adaptable culture characteristic which has endeared it to many fish farmers. Some of the culture qualities of African catfish are: high growth rate reaching market size of 1 kg in 5–6 months under intensive management conditions; highly adaptable and resistant to handling and stress; can be artificially propagated by induced spawning techniques for reliable mass supply of fingerlings; commands a very high commercial value where it is highly cherished as food in Nigerian homes and hotels (Olaleye, 2005).

However, there are various challenges facing the fish farmers, part of which is procuring good and viable fish seeds. Many farmers have in times past fallen victim of procuring bad fish seeds, leading to failure as they either died or refused to grow. This could be attributed to bad parent stocks, poor water management, poor stocking density, poor feeding etc. on the producer part except for those from farms with credibility which perform well and grow to good sizes. The fast-growing fish may continuously prey on slow growing ones due to growth advantage through cannibalism (Ribeiro and Qin, 2016).

Catfish size distributions often lead to social dominance, which in turn results in aggressive behaviour and cannibalism (Hecht and Appelbaum 1988). Cannibalism is the act of killing and consuming the whole or major part of an individual belonging to the same species, irrespective of its stage or development. It is a common and widespread phenomenon throughout the animal kingdom (Hecht and Pienaar, 1993; Smith *et al*., 1991).Young fish exhibit allometric growth patterns, high growth potentials than the older ones, the intensity of cannibalism would reach a maximum in the early weeks or months of the history when the variability of individual growth would be maximum (David *et al.*, 2010). Cannibalism is thus facilitated by size heterogeneity. But it also affects size heterogeneity, since the smallest fish are consumed by the larger ones, and thus been viewed as a cause or consequence of heterogeneity (Baras, 1999 and Haylor,1989). Cannibalism among *Clarias gariepinus*, fry and fingerlings have been identified as one of the major problems by small-scale hatchery operators (Royle, 2001). Despite the increasing interest in this species, cannibalism among cultured *Clarias gariepinus* has received little attention and the factors underlying it have not much been investigated in detail thereby resulting into emergence of shooters in the stocked fish. This can lead to severe losses of stock. Losses are caused not only by fish eating each other, but also by an increase in the number of emerging shooters. Hence, it is important to understand the phenomenon of shooters emergence in order to prevent and reduce stock loss. Therefore, this study was carried out to determine the growth variations and emergence of shooters from three different populations of *Clarias gariepinus* fry.

MATERIALS AND METHOD

Collection and Sampling of Experimental Fish

Three sets of one male and one female of 1kg each were sourced from a private fish farm and used to produce three *Clarias gariepinus* populations (p1, p2 and p3) used for this experiment through the induced breeding methods described by Abdulraheem *et al.* (2016). Each bred population with estimated number of hatchlings of 67,000 per kg body weight (Haylor and Muir 1998) lasted for 9 weeks of rearing period. Shooter groups otherwise referred to as the treatments were selected out from each population at age 1week, 2weeks, 3weeks, 6weeks and 9weeks. For each group, 150 pieces of the shooters were randomly selected and weighed for their initial weight, stocked into triplicate in a transparent rectangular plastic tank (L x B x H, 52 x 33 x 33 cm^3) and reared for another 6 weeks using a flow-through culture system of bore-hole water. Weekly, weighing of fish was carried out, new shooters were removed from each treatment, counted, weighed and kept outside the initial stock in a rectangular glass tank of 40 x 20 cm^2. Dead fish were also removed and counted as mortality. However, some of the fish were eaten up by others, hence, fish cannibalism and water quality parameters values were also recorded.

FEEDING OF EXPERIMENTAL FISH

Each treatment was fed *ad-libitum* at 4 hours interval with commercial artificial feed of a range of 0.5-2.0 mm with crude protein content of 45 % for a period of 6 weeks in a completely randomized design. Uneaten feed, feacal materials and other dirts were siphoned daily before feeding.

DETERMINATION OF GROWTH, SURVIVAL AND CANNIBALISM OF EXPERIMENTAL FISH

At the end of every week, fish were weighed with sensitive scale (Model: EHA 501, specification: 0.001 to 100g) for growth parameters: Mean weight gain (MWG), Final weight gain (FWG), and Percentage weight gain (PWG) according to the method of (Castell and Tiews ,1980)

MWG (g) = Final mean body weight – Initial mean body weight

$$\textbf{PWG (\%)} = \frac{\text{Final mean weight}}{\text{Initial mean weight}} \times 100\%$$

Cannibalism = Initial population – (Mortality + Survival)

$$\textbf{\% Cannibalism} = \frac{\text{Cannibalism}}{\text{Initial population}} \times 100\%$$

$$\textbf{\% Mortality} = \frac{\text{Mortality}}{\text{Initial population}} \times 100\%$$

FEED UTILIZATION OF EXPERIMENTAL FISH

Utilization of feed by the experimental fish were monitored every week. Mean feed intake (MFI) and feed conversion ratio (FCR) were analyzed:

$$\textbf{MFI} = \frac{\text{Total feed intake}}{\text{Total body weight}}$$

$$\textbf{FCR} = \frac{\text{Feed intake}}{\text{Weight gain}}$$

EMERGENCE OF NEW SHOOTERS

During the research and at the end of every week, new shooters were picked, counted, weighed and kept separately as they emerged in each group.

WATER QUALITY PARAMETERS OF EXPERIMENTAL SET-UP

Water quality parameters monitored were temperature (using mercury in glass thermometer), dissolved oxygen, pH, nitrate and ammonia were monitored using water quality kit made by (AQUA, PONDLAB 200)

STATISTICAL ANALYSIS OF DATA

The data obtained from the Growth, survival, emergence of shooters and feed utilization were subjected to one-way analysis of variance (ANOVA) while the difference among the means were separated using Duncan Multiple Range Test (DMRT) at $p<0.05$. The analysis were done using Statistical Package for Social Sciences (SPSS version 16).

RESULTS

Generally, growth parameters of the same group in the three populations were insignificantly different ($p>0.05$). The mean weight gained (MWG) of group 1 ranged from 1.58±0.10 to 1.62±0.15, group 2 ranged from 1.49±0.01 to 1.71±0.21 group 3, from 1.25±0.15 to 2.33±0.03 and group 4 ranged from 3.58±0.10 to 3.97±0.12 (Figure 1). Specific growth rate (SGR) of group 1 ranged from 1.09±0.13 to 1.15±0.13, group 2 ranged from 0.95±0.15 to 1.28±0.04, group 3 ranged from 0.53±0.10 to 2.01±0.10 and group 4 ranged from 3.04±0.02 to 3.28±0.02 (Table 1).

Nutrient utilization of experimental fish in terms of mean feed intake (MFI) and feed conversion ratio (FCR) showed no significant difference ($p>0.05$) across the same group. MFI (g) of group 1 ranged from 1.68 to 1.78, group 2 ranged from 1.50±0.01 to 1.81±0.03, group 3 ranged from 1.2±0.03 to 2.4±0.23, and MFI for group 4 ranged from 3.89±0.01 to 4.8±0.01.

New shooter emergence was observed in all the groups and the number emerged per week in each group of the three bred population was insignificant ($p>0.05$) in group 1 and 2 and inconsistenely significant in group 3 and 4 (Table 2).

The mean percentage survival of the experimental fish in all groups ranged from 18 - 50% with a Percentage mortality range of 12 - 20% and percentage cannibalism ranged of 18 - 24% (Table 3).

The mean water quality parameters measured during the experimental period included temperature, pH, dissolved oxygen (DO), ammonia and nitrite (Table 4). Temperature (^{o}C) ranged from 27.8 to 29.5, DO (mg/L) ranged from 4.7 to 5.3, pH values ranged from 6.8 to 6.85, ammonia ranged from 0.0175 to 0.0177 and nitrite values ranged from 0.421 to 0.428.

TABLE 1: GROWTH RESPONSE OF FOUR GROUPS OF *CLARIAS GARIEPINUS* SHOOTERS OBTAINED FROM THREE DIFFERENT BREEDING POPULATIONS

	Group 1			Group 2			Group 3			Group 4		
Parameter	**p1**	**p 2**	**p 3**	**p 1**	**p 2**	**p 3**	**p 1**	**p 2**	**p 3**	**p 1**	**p 2**	**p 3**
IMW	0.31±0.01	0.34±0.01	0.37±0.02	0.56±0.01	0.52±0.02	0.50±0.01	1.12±0.03	0.99±0.02	1.18±0.20	3.24±0.01	3.21±0.10	3.24±0.02
FMW	1.89±0.01	1.93±0.02	1.99±0.01	2.24±0.03	2.01±0.02	2.21±.01	3.24±0.02	3.20±0.01	3.51±0.02	7.21±0.23	6.88±0.12	6.82±0.13
MWG	1.58±0.10	1.59±0.12	1.62±0.15	1.68±0.02	1.49±0.01	1.71±0.21	1.25±0.15	2.21±0.11	2.33±0.03	3.97±0.12	3.67±0.02	3.58±0.10
SGR	1.09±0.13	1.10±0.20	1.15±0.13	1.24±0.03	0.95±0.15	1.28±0.04	0.53±0.10	1.89±0.01	2.01±0.10`	3.28±0.02	3.10±0.10	3.04±0.02
MFI	1.68±0.01	1.71±0.02	1.78±0.01	1.81±0.12	1.5±0.01	1.74±0.03	1.20±0.03	2.4±0.25	2.2±0.23	4.8±0.01	4.1±0.02	3.89±0.01
FCR	1.06±0.01	1.08±0.01	1.10±0.02	1.08±0.03	1.01±0.02	1.02±0.01	0.96±0.01	1.09±0.01	0.94±0.02	1.21±0.02	1.12±0.03	1.09±0.01

No significant difference (p>0.05) across all populations in each group.

Group 1 = Shooters obtained from breeding population of 1 week old, Group 2 = Shooters obtained from breeding population of 3 weeks old,

Group 3 =Shooters obtained from breeding population of 6 weeks old, Group 4 = Shooters obtained from breeding population of 9 weeks old.

TABLE 2: EMERGENCE OF NEW SHOOTERS STOCK FROM FOUR DIFFERENT GROUPS OF SHOOTERS OF *CLARIAS GARIEPINUS*

	No of new shooters per group			
Rearing period (wk)	**Group 1**	**Group 2**	**Group 3**	**Group 4**
One	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Two	4.00±1.15[a]	4.00±2.00[a]	2.00±1.00[a]	1.00±0.58[b]
Three	4.00±2.00[a]	3.00±2.51[a]	3.00±1.15[a]	3.00±1.00[a]
Four	5.00±0.58[a]	4.00±0.58[a]	3.00±0.58[a]	1.00±0.58[b]
Five	5.00±1.15[a]	4.00±1.15[a]	1.00±1.53[b]	3.00±1.15[a]
Six	3.00±1.53[a]	3.00±0.58[a]	2.00±0.58[a]	1.00±0.58[b]
Total	21.00±1.06	18.00±1.13	11.00±0.80	9.00±0.64

Means of different superscripts are significantly different ($p<0.05$) along the column.
Group 1 = Shooters obtained from breeding population of 1 week old,
Group 2 = Shooters obtained from breeding population of 3 weeks old,
Group 3 =Shooters obtained from breeding population of 6 weeks old,
Group 4 = Shooters obtained from breeding population of 9 weeks old.

TABLE 3: MEAN FISH LOSS THROUGH MORTALITY AND CANNIBALISM

Parameter	**Group 1**	**Group2**	**Group 3**	**Group 4**
Initial stock	50	50	50	50
Mortality	08	7	07	06
Cannibalism	12	10	09	10
Survival	9	15	23	25
% Survival	18	30	46	50
% Mortality	16	14	20	12
% Cannibalism	24	20	18	20

Group 1 = Shooters obtained from breeding population of 1 week old,
Group 2 = Shooters obtained from breeding population of 3 weeks old,
Group 3 =Shooters obtained from breeding population of 6 weeks old,
Group 4 = Shooters obtained from breeding population of 9 weeks olds.

TABLE 4: MEAN WATER QUALITY VALUES OF THE EXPERIMENT

Parameter	**Group 1**	**Group 2**	**Group 3**	**Group 4**
Temperature (°C)	29.00	29.50	27.80	29.00
Dissolved oxygen (mg/L)	5.30	4.70	5.10	5.00
pH	6.80	6.83	6.85	6.80
Ammonia (mg/L)	0.0175	0.0177	0.0176	0.0175
Nitrite (mg/L)	0.428	0.424	0.426	0.421

Group 1 = Shooters obtained from breeding population of 1 week old, Group 2 = Shooters obtained from breeding population of 3 weeks old, Group 3 =Shooters obtained from breeding population of 6 weeks old, Group 4 = Shooters obtained from breeding population of 9 weeks old.

DISCUSSION

This research studied various patterns of growth, survival, cannibalism, mortalities and new shooters emergence in four groups of *Clarias gariepinus* shooters from three different breeding populations. The mean weight gained (MWG) and specific growth rate (SGR) in each group were the same across the populations. This could be due to fact that shooters were removed as soon as they emerged from the population. New shooter emergence was observed in all the groups. And according to Wohlfarth, (1977), Skewness is an undesirable lack of symmetry in the frequency size distribution of a population, and is often found in common carp populations, as well as other species, and has both genetic and environmental components or origins. Skewness values of 1.0 are considered moderate, those greater than 2.0 are considered large. Nakamura and Kasahara (1955, 1956, 1957, 1961) conducted a series of classical experiments that demonstrated the cause of skewness and the factors affecting skewness in common carp. Eggs and sac-fry demonstrated normal distributions for size. They reported that the emerged jumpers/shooters in the population were removed from the population so as to regenerate a normal stock distribution devoid of shooters, but new jumpers re-emerged in the populations. The introduction of large artificial jumpers, such as goldfish of a larger size, prevented the emergence of skewness and the common carp population remained normally distributed. Skewness is a result of competition for food. Individuals with slightly larger body size and consequently larger mouth size are able to magnify these initial size differences into extreme advantages. Wohlfarth (1977) later eloquently illustrated that this magnification effect had both environmental and genetic components.

A comparative study between fish loss through mortality and cannibalism showed that more fish were lost through cannibalism than mortality, which could be due to the fact that young fishes preferred live food than artificial diets (Koueta *et al*., 2002). Relatively, Cannibalism has been known to be facilitated by size heterogeneity, but also it affects size heterogeneity, since the smallest fish are consumed by the larger ones, and thus be viewed as a cause or consequence of heterogeneity (Dadebo, 2009 and Yalcin *et al*, 2002). Cannibalism among cultured *Clarias gariepinus*, *Tilapia*, *Heterobranchus longifilis* fry and shooters have been identified as one of the major problems by small – scale hatchery operators, despite the increasing interest in this species. Cannibalism among cultured *Clarias gariepinus* especially, has received little attention and the factors underlying it have not totally been investigated in details. Hence, frequent sorting could reduce the cost of fish lost due to cannibalism, which will encourage farmers and unemployed persons to take part in the fish production, processing and entrepreneurship as means of job creation (Abubakar, 2015). Small initial differences in size of fry that are caused by genetic or environmental advantages can be magnified through competition thereby allowing a subpopulation of larger individuals – shooters or jumpers – to gain exaggerated size advantages over their cohorts (Dunham, 2004).

Percentage survival of the shooters population in the different groups was generally low, probably the new emerged shooters cannibalized on the small ones more frequently before they were removed from the population. Hence, frequent sorting could be adopted to reduce the rate of fish lost due to emergence of shooters and cannibalism in other to increase the economic turnover in fingerlings production business.

Mean water parameters recorded during and after the experimental period showed that temperature, pH, dissolved oxygen (DO), ammonia and nitrite were within the range of optimal levels for good growth and survival of *C. gariepinus* seeds (Loyd, 1992 and Lawson, 1995).

It was observed in this study that emergence of shooters is a natural phenomenon in fish culture because new shooters were still found to emerged in all the groups of shooters selected for culture

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