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A study of Intra-cohort Cannibalism in Juveniles of the African Catfish, (*Clarias gariepinus*) under Controlled Conditions

Obirikorang, K.A[1]., Madkour, H.A[2]., Adjei-Boateng, D[1]

[1] Department of Fisheries and Watershed Management, Faculty of Renewable Natural Resources, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana

[2] National Institute of Oceanography and Fisheries (NIOF), Red Sea Branch, Hurghada – Egypt

ABSTRACT

This laboratory study was conducted to study the phenomenon of intra-cohort cannibalism among juveniles of the African catfish (*Clarias gariepinus*) of the same full-sibling group (pure progenies). At the start of the 8-week experiment, each catfish fingerling weighed approximately 10g. The fingerlings were randomly assigned to two 80-litre aquaria (Tank 1 and Tank 2) at a stocking density of 20 fingerlings per tank. Mean weight of the fingerlings in tanks 1 and 2 at the end of the study were 52.65g ±5.21g and 73.27 ±15.15g. There was uniform weight gain among all the fingerlings in the two tanks, with the exception of one fingerling, which recorded a significant differential growth of 93.90g. This high individual growth resulted in the higher mean final weight recorded in tank 2. The size disparity between the relatively larger fingerling that exhibited the abnormal growth pattern and the other fingerlings resulted in more than half of the mortality due to cannibalism (58.3%) in tank 2. Group cannibalism among relatively similar size classes was however, the commonest form of cannibalism within the two tanks, representing 58.82% of the total cannibalism recorded during the study. Overall it is clear from the study that cannibalism in juvenile catfishes cannot be completely eliminated just by adequate feeding although its rate can certainly be reduced.

Keywords: *Intra-cohort, Cannibalism, African catfish, Clarias gariepinus, full-sibling group*

1. INTRODUCTION

With an annual production output of about 370 000 tonnes, catfish aquaculture contributes 17.5 % of the overall production of freshwater fish culture. Globally, 15 catfish species from seven families are exploited for food, but only two families, the Ictaluridae and Clariidae, represent more than 95% of the total global catfish production. Cultured catfishes have a fast growth, an omnivorous regime, a high tolerance to poor water quality and a non-bony flesh (Cacot and Hung, 2011) which makes them a popular aquaculture species. A major problem however facing the wide spreading of catfish culture is intra-specific cannibalism. Cannibalism in catfishes has been noted by Abdelhamid *et al*., (2010), in their study on improving survival rates of the African catfish to be mainly associated with wide variations in sizes of the individuals in the population, shortage or limited food supply, high population densities and limited hiding areas for the smaller individuals.

Smith and Reay, (1991) defined cannibalism as an act of killing and consuming the whole or major part, of an individual belonging to the same species, irrespective of its stage of development. A number of authors, including Smith and Reay, (1991; Elgar and Crespi, (1992) and Abdelhamid et al., (2010) have documented cannibalism in a wide range of fish species. Cannibalism has been commonly reported among most of the well-studied fish species, and according to Smith and Reay, (1991) can be classified according to the following; developmental stage of prey, the genetic relationship of cannibal to prey, and/or the age relationship of cannibal and prey. In the context of this present study, intra-cohort cannibalism is defined as cannibalism involving members of the same year class or same full-sibling group.

Cannibalism in fish is of special concern to because it can influence both aquaculture production and general fisheries output. In fish it is generally a size-selective process, usually limited by the mouth size of the cannibal (Hecht and Appelbaum, 1988). Intra-cohort cannibalism is of critical concern, and according to Folkvord and Ottera, (1993), the process can selectively eliminate the smallest individuals and this effect can be very dramatic, especially when the size differences in the population is significantly wide.

In restricted spaces such as aquaria and concrete tanks, the African catfish tends to exhibit changes in behavioural patterns. Rueda, (2004) observed that in restricted spaces, the African catfish exhibits behavioural problems such as reduced feed intake, aggression, death and cannibalism. Studying fish behaviour under farming conditions is extremely difficult due to the high number of fish and large pond surface areas, which

make unambiguous observations almost impossible. It is in the light of the above that this study was carried out under laboratory conditions to closely observe sibling cannibalism and aggression in juveniles of the African catfish (*Clarias gariepinus*) and suggest ways of reducing this phenomenon.

2. MATERIALS AND METHODS

Adaptation Period and Experimental Conditions

Juveniles of African catfish were obtained from a commercial hatchery in Kona Odumase, Ghana and held in glass aquaria for a few days to adapt to their new environment. Care was taken to ensure the selected catfish juveniles were of the same full-sibling group (pure progenies) and were of the same size class. During this period fish were fed a pelleted feed (with a size of 2 mm). The study of the behaviour of *Clarias gariepinus* was done under experimental conditions in 80 litre glass aquaria to mimic farming conditions and observe intra-cohort cannibalism.

At the start of the 8-week experimental period, the selected catfish fingerlings each weighed approximately 10g and were randomly assigned to two aquaria (50x40x40 cm) at a stocking density of 20 fingerlings per tank. Each tank was covered with a mesh to prevent the catfish juveniles from jumping out. The experimental aquaria were within a recirculation system and the average water flow through each aquarium during the experiment was maintained at approximately 7 $l\text{min}^{-1.}$ and water depth was maintained at approximately 30 cm. Average water temperature over the study period was 26.56 ± 0.06 ºC; oxygen concentration 5.60 ± 0.3 mg.l^{-1}, and pH ranged between 6.35 and 7.45. Daily measurements of temperature, pH, and dissolved oxygen (DO) of the two tanks were taken *in-situ* using a Hanna (HI 9028) multi-parameter probe.

Experimental Set-Up

A Light : Dark regime of 12h : 12h was maintained in the laboratory during the experimental period using an artificial lighting system consisting of six paired 40-watt fluorescent lamps (Bajaj FLD40W, India) and eleven 60W incandescent lights (Tungeraflex R80, Hungary). The lights were on from 07:00 to 19:00 h each day of the experiment.

During the experiment, the fingerlings were fed to satiation (*ad-libitum*) three times daily using formulated feed (Raanan Grower Feed, Raanan Fish Feed, Miluot, Israel) in the form of floating 2.5mm pellets. On dry matter basis, the nutritional content of the formulated diet was; crude protein: 33%, crude fat: 6%, ash: 7.2% and fiber: 5.5%. Dead or eaten fish were not replaced during the experiment and cannibalism was calculated by recording the difference in fish numbers between the initial count and the final count. Most of the visual observations of fingerling aggression and cannibalism were done between the periods of 0700 and 1900 hours during the 8-week period.

At the end of the study the following parameters were evaluated; *Mean weight gain* = (Final mean weight – Initial mean weight), *Mortality Rate* (MR) = (Number of dead fingerlings / Initial number of fingerlings) x100, *Cannibalism Rate* (CR) = (Number of fingerling missing or consumed/ Initial number of fish) x 100, *Survival Rates* (SR) = (Final number of fingerlings / Initial number of fingerling x 100).

Naturally-occurring mortality was distinguished from mortality due to cannibalism and each parameter separately tallied for the two tanks. Inflicted mortality without subsequent ingestion of the victim was not considered as cannibalism in the context of this study.

3. RESULTS AND DISCUSSION

Growth Responses and Cannibalism

Growth responses of African catfish fingerlings are presented as initial and final mean weights, percentage weight gain total mortality and survival values in Table 1 and shown graphically in Figure 1 a and b. The high weight gain of tank 2 was as a result of the relatively higher weight gain of one of the catfish juveniles (Fig 1b).

Table 1 Growth, mortality and cannibalism parameters of the juvenile African catfish for the two tanks

Parameters	Tank 1	Tank 2
Initial Mean Weight (g)	10.10±2.10	10.25±1.90
Final Mean Weight (g)	52.65±5.21	73.27±15.15
Weight gain (%)	421.28	614.83
Initial Number of Fingerlings	20	20
Final Number of fingerlings	15	7
*Mortality (Natural)**	0	1
Mortality (Cannibalism)	5	12
Total Mortality	5	13
MR (%)	0	5
CR (%)	25	60
SR (%)	75	35

**Natural mortality in this context refers to all other forms of mortality other than that caused by cannibalism*.

During the experimental period, there was uniform weight gain among all the fingerlings with the exception of one, which recorded a significant differential growth. This high individual growth resulted in the higher mean final weight recorded in tank 2.

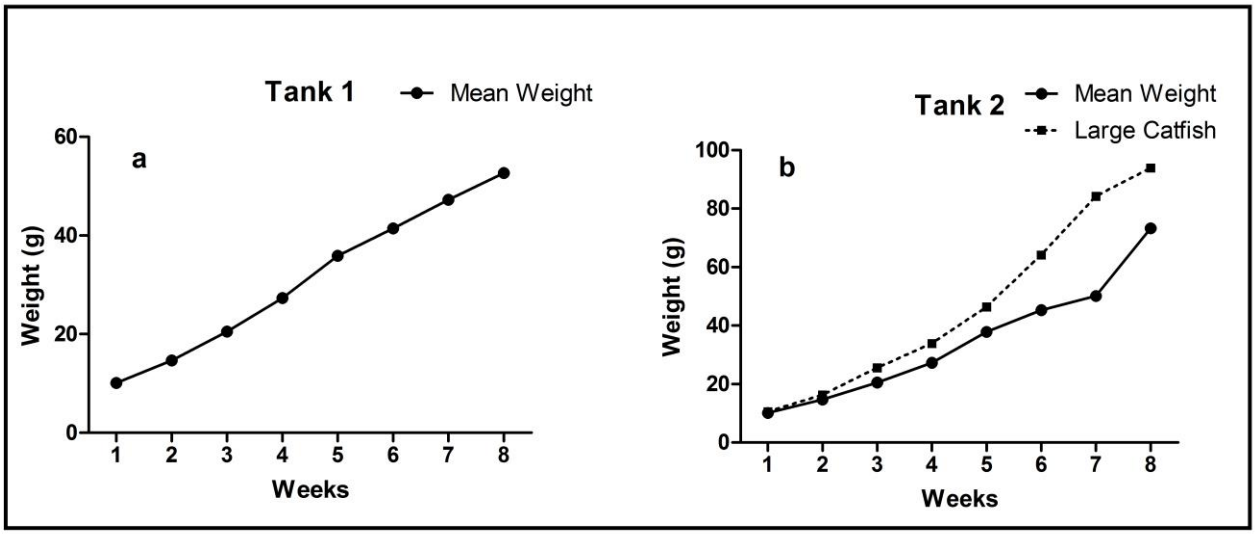

Figure 1 Growth responses of the juvenile catfishes in the two tanks for the 8 weeks

Two forms of cannibalism were observed and recorded over the study period; *Group cannibalism*, where individuals of approximately the same size attacked and consumed a weaker, injured or dead fingerling and *complete ingestion*, where a larger individual wholly swallowed smaller fingerlings. The size disparity between the relatively larger fingerling that exhibited the abnormal growth pattern and the other fingerlings resulted in an increased incidence of cannibalism in the catfish population of tank 2 (Table 1). The larger catfish juvenile alone accounted for more than half of the mortality due to cannibalism (58.3%) in tank 2. The larger catfish juvenile usually swallowed the smaller fingerlings wholly which resulted in its belly exhibiting marked distension and abnormal swelling which usually lasted for about 24hrs. The importance of the largest individuals in the cannibalism process indicates that the relative size difference between the largest and smallest individual in a co-occurring group of catfishes may be a better measure of cannibalism. Size variation is viewed as both a cause and effect of cannibalism, and social dominance is one of the causes of size variation (Barton et al., 2002) which in turn results in hierarchical territoriality and aggressive behavioral pattern. Several environmental factors, particularly when these are limiting have been found to influence the behavioural pattern of African catfish juveniles, thereby affecting the rate and extent of cannibalism. These include the availability of alternative prey, availability of food, feeding frequency, density, light, refuge, size variation, feed distribution (Reddy et al., 1995)

Even though in fishes, cannibalism is usually associated with heterogeneous size variation, group cannibalism among relatively similar size classes was the commonest form of cannibalism within the two tanks, representing 58.8% of the total cannibalism in the two tanks. In the restricted confines of the glass aquaria, the catfishes exhibited highly aggressive behaviours towards each other, often chasing each other as an expression of territorial dominance. The aggression often resulted in skin lesions and other superficial damages which increased their susceptibility to diseases and weakened them, making them more liable to cannibalism or death as a consequence of their wounds. The group cannibalism was often as a result of the communal consumption of weak, injured or dead fingerlings. According to Hecht and Ulys (1997), aggressive activities also cause a lot of energy which otherwise could be used for growth to be expended. Aggression can result in stock losses, reduced food conversion efficiency and slower growth.

Feeding Habits and Cannibalism Trends

The first incident of cannibalism was observed during the second week in tank 2. Over the 8-week period, cannibalism accounted for 42.5% of the total juvenile catfish population for the study. This represented a very significant proportion of the initial catfish population and might have been largely influenced by the limited spaces of the aquaria. The size disparity between the relatively larger fingerling that exhibited the abnormal growth spurt and the other fingerlings, however accounted for the higher rate of cannibalism in tank 2 and in the whole research in general. Abdelhamid et al., 2010) in their study on improving the survival rate of the African catfish, prescribed the grading technique of separating of the biggest fry from the general population as a means of reducing the cannibalism phenomena.

An interesting observation in early juvenile African catfish is that as food availability and acceptability starts to decline, territoriality and aggressive behaviour appears to increase. In the first two weeks of the study, there was a failure of the catfish fingerlings to accept the formulated feed. This phenomenon might have resulted in a semi-starvation situation which probably accounted for the recorded cannibalism

incidents in the early stages of the study. Although feed acceptability and consumption of the formulated feed increased after the first two weeks, feeding aggression among the catfish juveniles slowly decreased over the study period. This was a general trend that was observed in the two experimental tanks. According to Limbery, (2002), the relationship between the rate of cannibalism and food availability is generally is an inverse one. This study corroborates his findings, although it must be added that feed palatability and acceptability are also important factors that have to be encompassed under the general food availability-cannibalism relationship model.

One remarkable observation during the study was the tendency of highly cannibalistic individuals to become solely reliant on cannibalism and never learn to accept formulated diets. This was the case of the very large juvenile catfish which displayed a general disinterest toward the formulated feed. This juvenile however benefitted directly from obtaining a meal of high nutritional value through the complete ingestion of its smaller siblings.

4. CONCLUSION

From the study, it follows that intra-cohort cannibalism will selectively remove the smallest, weaker or injured individuals within a population and the effect can be very dramatic when the size variation in the population is sufficiently large. In a culture situation, this can easily be resolved or sufficiently reduced by satiation feeding with suitable feeds and size-grading of the fish to remove larger individuals from the population.

The genetic component of cannibalistic behaviour also has to be considered when stocking ponds with catfish fingerlings. According to Knutsen and Tilseth, (1985) and Folkvord et al., (1994) inherent size variations within full-sibling groups tend to be lower than that between mixed-sibling groups and results in reduced incidents of cannibalism. It is thus imperative to stock similar-sized, full-sibling catfish juveniles in production facilities to reduce cannibalism.

Overall it is clear from the study that cannibalism in juvenile catfishes cannot be completely eliminated by adequate feeding although its rate can certainly be reduced.

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REFERENCES

Abdelhamid, A.M., I.A. Radwan, A.I. Mehrim and A.F.B. Abdelhamid, 2010. Improving the survival rate of the African catfish, *Clarias gariepinus*. Journal of Animal and Poultry Production, Mansoura University., 1: 409-414.

Barton, B.A., J.D. Morgan and M.M. Vijayan,. 2002. Physiological and condition-related indicators of environmental stress in fish. In: Biological Indicators of Aquatic Ecosystem Health. Adams S.M. ed. American Fisheries Society, Bethesda, M.D. pp. 111-148.

Cacot, P. and L.T. Hung, 2011. Overview of catfishes aquaculture. Fisheries and Aquaculture-Vol III Encyclopaedia of Life Support Systems (EOLSS).

Elgar, M.A. and B.J. Crespi, 1992. Cannibalism: Ecology and Evolution among Diverse Taxa. Oxford University Press, Oxford, ISBN: 0198546505, Pages: 361.

Folkvord, A. and H. Ottera,. 1993. Effects of initial size distribution, day length and feeding frequency on growth, survival and cannibalism in juvenile Atlantic cod *(Gadus morhua* L.). Aquaculture, 114, 243-260.

Folkvord, A., V. Oiestad and P.G. Kvenseth, 1994. Growth patterns of three cohorts of Atlantic cod larvae (*Gadus morhua* L.) studied in a macrocosm. ICES Journal of Marine Science, 51: 325-336.

Hecht, T. and W. Uys,. 1997. Effect of density on the feeding and aggressive behaviour in juvenile African catfish, *Clarias gariepinus*. South African Journal of Science 93, 537-541.

Hecht, T. and S. Appelbaum, . 1988. Observations on intraespecific aggression and coeval sibling cannibalism by larval and juvenile *Clarias gariepinus* (Clariidae: Piscis) under controlled conditions. Journal of Zoology London 214, 21-44.

Knutsen, G.M. and S. Tilseth, 1985. Growth, development and feeding success of Atlantic cod larvae *Gadus morhua* related to egg size. Transactions of American Fisheries Society, 114: 507-511.

Limbery, P., 2002. In too deep-the welfare of intensively farmed fish. A Compassion in World Farming Report, Petersfield, Hampshire.

Reddy, P.K., M.M. Vijayan, J.F. Leatherland and T.W. Moon, 1995. Does RU486 modify hormonal responses to handling stressors and cortisol treatment in fed and fasted rainbow trout? Journal of Fish Biology, 46: 341-359.

Rueda, P.A., 2004. Behaviour patterns of the African catfish (*Clarias gariepinus*) under controlled conditions. Ph.D. Thesis, University of Wageningen, Netherlands.

Smith, C. and P. Reay, . 1991. Cannibalism in teleost fish . Reviews in Fish Biology and Fisheries, 1, 41-64.