ORIGINAL ARTICLE

COMPARATIVE STUDIES OF CANNIBALISM ON DIPLOID AND TRIPLOID AFRICAN CATFISH – *Heterobranchus longifilis*

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ABSTRACT

Background: Fish often defend their food and territory just like other animals. These activities are inherent in the desire to eat and not be eaten and manifest as aggressive and cannibalistic behaviour. Cannibalism is the act of one individual of species devouring all or part of another individual of the same species as food and can be influenced by many factors. Triploidy is one of the biotechnological methods applied to enhance the production of *Heterobranchus longifilis* which involve chromosome manipulation. **Objective:** This study compared the rates of cannibalism in the diploid and triploid hatchlings of *H. longifilis*. **Materials and methods:** Hatchlings of *H. longifilis* were produced from broodstock of mean weight 2.5±0.3kg. Triploidy induction was achieved by cold shock of the eggs 5 minutes post fertilization at 5°C over 40 minutes period. Incubation of eggs and fry rearing followed standard protocol. Two experiments were conducted. In experiment 1, 100 healthy fry were randomly selected from the diploid and triploid sets each and cultured in a 40 litres vat for 14 days, with 4 replicates in each case. In the second experiment, 20 diploid and triploid fingerlings were respectively cultured for 84 days in separate 1 x 0.98 x 0.4m^3 concrete tanks, with 4 replicates in each case. The fish were monitored for aggressive behaviour and cannibalism in both experiments. Weight and number of fingerlings were monitored every 2 weeks in the second experiment. The survival rates and growth performance were determined at the end of the experiment. **Results:** The results of both experiments showed that survival rates were similar in the diploid (45±6.455) and triploid (42.5±8.539) fish ($p>0.05$) for experiment 1. In experiment 2, the growth indices: specific growth rate (diploid, 2.8±0.70 and triploid, 2.63±0.14) and mean weight gain (diploid, 22.248±1.100 and triploid, 17.675±2.020) were also not significantly different ($p>0.05$) in both diploid and triploid fingerlings. **Conclusion:** It was concluded that the level of cannibalism in the diploid and triploid *H. longifilis* was the same.
Keywords: *fry, fingerlings, eggs, survival rate, growth performance*

1. INTRODUCTION

Fish often defend their food and territory just like other animals [1]. These activities are inherent in the desire to eat and not be eaten [2] and manifest as aggressive and cannibalistic behaviour. Aggressive activities could be an exhibition of social dominance arising from size heterogeneity, and can attract much energy investment at the expense of growth [3]. Aggression and cannibalism in fish often culminate in skin lesion, fin damage increase susceptibility to diseases and further cannibalism, and ultimately death [4]. Concomitantly, stock losses, poor food conversion efficiency and slower growth are often the other effects of aggressive activities.

According to Boeuf and Le Bail (1999), cannibalism is the act of one individual of species devouring all or part of another individual of the same species as food [5]. Nwosu and Holzlohner (2000), and Baras and Jobling (2002) noted cannibalism to be ubiquitous particularly, in aquatic communities involving about 90% of organisms at certain points in their life cycles [6,7]. Many predisposing factors have been identified to prompt cannibalism [8,9,10]. These may be genetic, behavioural and environmental factors [11]. They include food availability [12]; light intensity [13], size variation, type of feed [14]; density [15]; turbidity/refuge [16] amongst others. A cannibalistic fish may be reluctant in accepting other types of feed.

Cannibalism could have a very strong moderating influence on both wild population and stock of culture species [17]. The implication of this would exert a severe destabilizing influence on the economy of fish farming with concomitant frequent disinvestment from the aquaculture sub-sector. This can particularly be a critical concern in the culture of *Heterobranchus* species. Legendre (1989) and Oteme et al. (1996) had noted that *Heterobranchus longifilis* remains one of the most suitable species for culture in West Africa because of its very high growth rate [18,19], amongst other biological and ecological features [20]. Many strategies have been adopted to optimize production efficiency in this catfish supply chain to enhance the economy of the fish culturists and ensure the supply of affordable high quality

proteins [21,22,23,24,25,26,27]. Coulibaly et al. (2007) noted that the main constraint to the culture of the African catfish, *H. longifilis* remains the high mortality rate due to cannibalism [28]. This and similar observations have been recorded on the diploid *H. longifilis*. It has not yet been recorded if triploidy in anyway could modify the conservative behaviour of this fish as regards cannibalism.

Triploidy is one of the biotechnological methods applied to enhance the production of *H. longifilis* which involve chromosome manipulation [23-26]. Triploidy is the genomic state of having three full sets of chromosomes. Triploidy is the most popular form of polyploidy. Polyploids are not viewed as genetically modified forms [29]. In some invertebrates and vertebrates such as reptiles, amphibians and teleosts, viable offspring can be produced with ease in the laboratory via triploidy. In fish, the inhibition of the second meiotic division of the egg, soon after fertilization, is practically obtained by administering shock on the eggs [30,31]. These shock treatments could be pressure, thermal or chemical shocks that disorganize the microtubules thereby upsetting centrosomes needed in the formation of mitotic spindle [32]. This interrupts cell division effecting the production of a triploid (3n) endowed with two sets (2n) of maternal chromosomes and a set (1n) of paternal chromosome. Triploids germ cells are incompetent of conducting meiosis successfully, hence are often genetically sterile. Sterile fish may invest a greater part of nutritional energy on growth and thereby attain a superior growth rate. Appropriate treatment conditions for induction of triploidy are species dependent. It is deemed crucial to determine the appropriate combination of type of shock, duration and timing post fertilization to be applied for each fish species [31-33-32-29]. According to Olufeagba et al. (1999), triploidy induction in *H. longifilis* was successful by exposing the eggs to cold shock at 5°C for 40 minutes [23]. Similarly, 100% *H. longifilis* triploids on verification of triploidy induction had been produced using cold shock at 5°C for 20 minutes [23]. Successful induction of triploidy in many species of fish and the occurrence of natural triploid fish indicate that triploids can survive and grow [34]. Nwachi and Ekokotu (2013) however noted that triploids are less viable relative to their diploid counterpart due to their low rate of survival in the early stage [35]. They attributed this to the shock applied on to them to prevent extrusion of the second polar body. Triploidy as a method of producing sterile fish is believed to hold potentials for the rearing improvement of aquacultural species [36]. This sterile condition may induce better growth performances in triploids than those for diploids [31-34-37]. Nevertheless, this should not be generalized for all fish species.

One of the greatest challenges in the culture of clariid catfish, *H. longifilis* had been identified by Coulibaly et al. (2007) to be cannibalism [28]. *H. longifilis* being a very important cultured fish in the Sub-Saharan Africa represents the hope of aquaculture in this region. The high level of cannibalism exhibited by this fish and its attendant high mortality rate under culture and low level of recovery at harvest would greatly deprive the people of this sub-region of the capacity to meet their protein needs as well as a potential profitable means of livelihood. It becomes necessary to check cannibalism in the cultured stock of this species before it checks the people. The biotechnological advances in aquaculture has made possible the production of triploid fish with the advantages of controlled breeding and improved growth performance. It is yet to be demonstrated if triploidy also has effects on cannibalism in the African catfish, *H. longifilis*.

This work was carried out to evaluate ontogenic variation in cannibalism in the diploid and triploid strains of *Heterobranchus longifilis*.

2. MATERIALS AND METHOD

2.1 Study site: This study was conducted in the fish hatchery complex of the Department of Fisheries and Aquatic Environmental Management, University of Uyo, Akwa Ibom State, Nigeria.

2.2 Procurement of broodstock: Gravid broodstocks of *Heterobranchus longifilis* were obtained from Heritage Farms, Sapele, Delta State, Nigeria. They were brought to the study area where they were acclimatized for one week in indoor concrete tanks.

2.3 Induced breeding protocols: Induced breeding was carried out according to methods of [24-38-35]. One female and one male broodstock with a mean weight of 2.5 ± 0.3 kg were used. Gravid characteristics such as well-rounded swollen and soft abdomen which would freely release eggs on gentle strolling of fingers on the abdomen were considered. The selection of the male was based on the presence of elongate genital papilla with a dark tip. The female was injected with Ovaprim (Syndel, Canada) at 0.5ml/kg body weight. Ovulated eggs were obtained from the female after 12-hours latency period by stripping. The male was sacrificed and milt obtained by dissection of the testes about thirty minutes before the expiration of the latency period. The milt was diluted with 0.9% normal saline and kept in a small plastic bowel till needed. The stripped eggs were fertilized with the milt and immediately divided into two equal parts.

2.4 Triploidy induction: Triploidy induction by cold shock was carried out according to the protocols of [23-30-35]. Five minutes after fertilization, one part of the fertilized eggs placed on spawning mats of mosquito net was

introduced into a cold chamber maintained at 5°C for 40 minutes. The cold chamber consisted of a 31.5cm x 51cm x 33cm plastic cooling box containing crushed ice and water. Temperature was monitored with a mercury-in-glass thermometer (0-50°C). Fresh ice was used to ensure that the desired operational temperature was maintained throughout the shock duration.

2.5 Incubation of eggs: The unshocked fertilized eggs were placed on spawning mats and incubated directly in 1m x 0.98m x 0.4m concrete tanks filled with fresh water to 0.3m depth. The shocked eggs were transferred into similar water troughs separately to complete their incubation.

2.6 Rearing of hatchlings: At 30 hours post fertilization, the kakabans were gently shaken for the hatched larvae to go down to the bottom of the tanks. The kakabans were carefully removed with the undesirable mass from the incubation chamber. The water in the tank was gently flushed. The newly hatched larvae were not fed until the third day when about 75% of their yolk sack must have been depleted. Exogenous feeding was ensured using artemia shellfree (Inve Aquaculture Inc Utah, USA) lightly sprinkled on the surface of the water four times daily (8:00-8:30; 12:00-12:30, 16:00-16:30 and 20:00-20:30hrs). The hatchlings were weaned from artemia to 0.3mm coppens fry marsh (starter) feed after two weeks. The feed size progressively changed as the size of fish increased. Partial flow through was allowed to ensure adequate water quality. Within the first one week, all deformed and dead hatchlings were removed from the tanks by siphoning. The fish were fed to satiation each time. Excess feed were siphoned out. Fingerlings were obtained six weeks after hatching.

2.7 Observation of fry cannibalism: One week after hatching, some healthy (actively swimming) young fry were randomly transferred from both the diploid and triploid sets. They were stocked in 40 litres plastic vats containing 25 litres of water randomly at 4 fry per litre. The fish were stocked at 100 fry/25 litres of water. There were a total of 4 sets each for the diploids and triploids respectively. These fry were in these tanks for a period of two weeks.

During this period, the fry were fed lightly, using Coppens commercial pellets of 56% crude protein content, twice daily (8:00-8:30hrs and 16:00-16:30hrs). They were allowed to feed for 30 minutes after which the left over feeds were siphoned out. Water was exchanged daily after feeding using rubber tubing from a supply tap adjusted to match the outflow rate during siphoning. The lighting conditions were normal. Water quality was monitored twice daily (7:30-8:00hrs and 15:30-16:00hrs) and the means reported. The behavior of the fish and mortality were monitored regularly until 20:30hrs daily throughout the experimental period. Every dead fish was carefully examined. The number of fish at the end of the experiment was noted in each tank and the survival rate determined. This was experiment 1 and the culture lasted 14 days.

2.8 Observation of cannibalism in the fingerlings: Six-week old diploid and triploid fingerlings of *H. longifilis* obtained were used in this study. 20 of each type of fingerlings were stocked separately in indoor concrete tanks each measuring 1m x 0.98m x 0.4m and the water column maintained at 0.3m. The top was covered with a mosquito net to prevent the fish from jumping out. Each set had 4 replicates and were stocked at the rate 20 fingerlings per 0.3 M^3. Each set of 20 fish had sundry sizes. The weight of each fingerling was taken with a digital weighing scale. The fish were placed in pre-zeroed 2 litres transparent plastic container containing 1.5 litres of water during the weighing exercise. The mean weights of fish in all the tanks were kept close to one another. Each set of fingerlings were randomly stocked in the various tanks. The fish in each tank were fed at 2% body weight divided into two rations administered at 8:00-8:30 hours and 20:00-20:30 hours daily except on the day of measurement when they were fed once only between 20:00hours and 20:30hours. Any leftover feed was removed daily immediately before the next feeding. The ration size was adjusted on the basis of the 2% body weight every two weeks. Intermittent flow through was used to ensure adequate water exchange and quality. Weight measurements of all fish in each replicate of the two treatments were conducted and recorded bi-weekly. The number of the fish was also noted. The behavior and morphological changes of the fish and mortality were monitored regularly between 8:00 and 20:30hours each day. Any dead fish noticed was removed immediately and the body carefully examined. Water quality parameters (temperature, pH and dissolved oxygen) were monitored once daily and the means recorded bi-weekly. The experiment 2 lasted for 84 days. At the expiration of this period, the number of fish in each replicate of a treatment was ascertained and the survival rate of the two set of fingerlings determined. The final weights of fish in each replicate of the two treatments were also taken.

2.9 Monitoring of water quality: The parameters measured were: temperature using mercury-in-glass thermometer (0^0C-50^0C), Dissolved Oxygen (mg/l) using a digital DO meter (Hana, HI 9461) and pH using pH pen meter (009 111).

2.10 Data collection: Growth data such as specific growth rate (SGR), survival rate and mortality rate were determined fortnightly while mean final weigh (MFW) and mean weight gain (MWG) were determined at the end of the experiment. The following formulae were employed for data calculation:

$$\text{Survival rate (SR) [38,39]} = 100\% \frac{\text{Number of fish surviving to the end}}{\text{Total No. of fish at the beginning of the experiment}} \quad (1)$$

$$\text{Mean Weight Gain (MWG) [40]} = W_2\text{-}W_1 \quad (2)$$

Where
W_1 = Initial mean weight
W_2 = Final mean weight

$$\text{Specific Growth Rate (SGR) [37]} = 100 \frac{(LnWt - LnW1)}{t} \quad (3)$$

Where
Ln = Natural log
Wt = Final weight of fish at time t
W_1 = Initial weight of fish at beginning of t
t = Growth period in days

2.11 Statistical analyses: The student's t-test based SPSS (Ver. 19) was used to analyze the data collated in this experiment for significant differences at 0.05 level of probability.

3. RESULTS

The results obtained were as shown in tables 1 – 6 and figures 1 – 3. Mean water quality during the experiment is depicted in Table 1. Table 2 gives the survival rate of diploid and triploid fry of *Heterobranchus longifilis* after 14 days. The survival rate was found to be higher in the diploid fry than in the triploid fry (Table 2), and conversely, the mortality values. These values were however not significantly different ($p>0.05$). Same case occurred in *H. longifilis* fingerlings (Table 3) after 84 days and were not significantly different ($p>0.05$). The results in Table 4 and Figures 1 and 2 show that mortality/cannibalism rates were more serious between the first and the sixth weeks in both types of fingerlings and decline in latter weeks. By the end of the sixth week about 25% of the diploid and 32.5% of the triploid had already suffered cannibalism related mortality.

Table 1: The table presents the mean water quality parameters in the rearing tanks.

Parameters	Fry	Fingerlings
Temperature (°C)	28.48±0.41	26.10±0.03
Dissolved Oxygen (mg/l)	7.04±0.04	8.02±0.01
pH	7.01±0.00	7.09±0.01

Table 2: The table shows the mean survival of diploid and triploid fry of *H. longifilis* over a period of 14 days.

Fry	Diploid	Triploid
Initial number	100	100
Final number	45±6.46[a]	42.5±8.54[a]
Survival rate (%)	45±6.46[a]	42.5±8.54[a]

Means on the same row with similar superscripts are not significantly different ($p>0.05$)

Table 3: The table presents the mean survival of diploid and triploid fingerlings of *H. longifilis* after 84 days (12 weeks).

Fingerlings	Diploid	Triploid
Initial number	20	20
Final number	14.5±1.50[a]	12.5±2.21[a]
Survival rate (%)	72.5±7.50[a]	62.5±11.09[a]

Means on the same row with similar superscripts are not significantly different ($p>0.05$)

Table 4: The table shows the mean biweekly survival and mortality/cannibalism rates of diploid and triploid fingerlings of *H. longifilis* after 84 days (12 weeks)

Time (weeks)	Diploid				Triploid			
	No. surviving	Survival rate (%)	Mortality/cannibalism rate (%)	Mortality/cannibalism rate (%)	No. surviving	Survival rate (%)	Mortality/cannibalism rate (%)	Mortality/cannibalism rate (%)
0	20	100	0	0	20	100	0	0
2	18.5 ±1.50	92.5±7.50	16.5 ± 3.50	7.50	17.5 ± 1.50	87.5 ± 7.50	12.5 ±4.35	12.50
4	17.5±2.50	87.5±12.50[a]	17.5 ± 2.50	12.50	16 ± 2.45	80 ± 12.25[a]	14 ± 3.56	20
6	15±1.73	75±8.66[a]	5 ± 1.73	25	13.5 ± 1.71	67.5 ± 8.53[a]	6.5 ± 1.71	32.50
8	15±1.73	75±8.66[a]	5 ± 1.73	25	13.5 ± 1.71	67.5 ± 8.53[a]	6.5 ± 1.71	32.50
10	14.5±1.50	72.5±7.50[a]	5.5 ± 1.50	27.50	13.5 ± 1.71	67.5 ± 8.53[a]	6.5 ± 1.71	32.50
12	14.5±1.50	72.5±7.50[a]	5.5 ± 1.50	27.50	12.5 ± 2.22	62.5 ± 11.08[a]	7.5 ± 2.22	37.50

Means on the same row with similar superscripts are not significantly different ($p>0.05$)

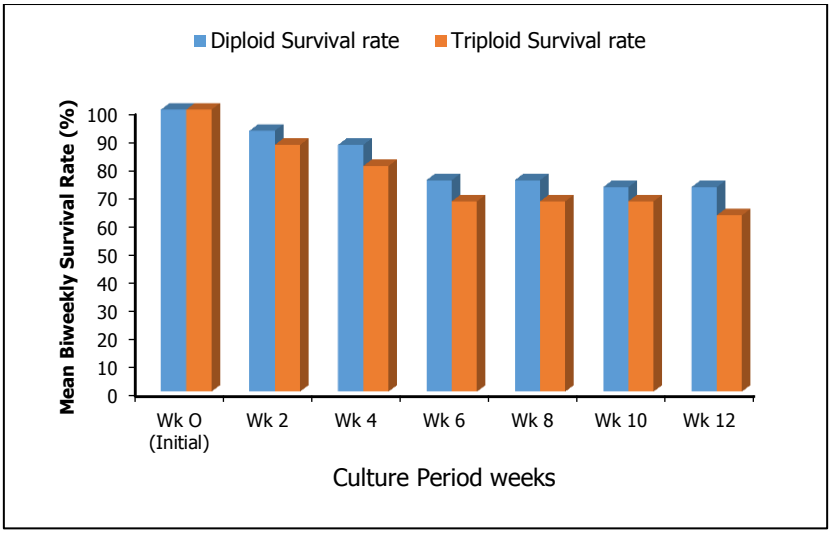

Figure 1: Mean biweekly survival rate of diploid and triploid fingerlings of *H. longifilis* after 84 days (12 weeks)

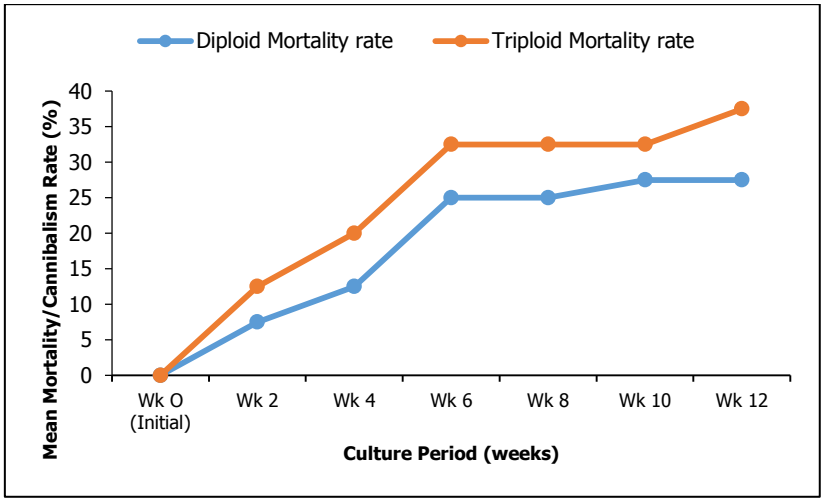

Figure 2: Mean cumulative mortality/cannibalism rate of diploid and triploid *H. longifilis* after 84 days (12 weeks).

The two growth performance indices examined, mean growth rate and specific growth rate (Table 5) did not show any significance difference between the diploid and triploid fingerlings ($p>0.05$). Numerically however, the performances of the diploid appeared better than those obtained for the triploid fingerlings. This is highlighted in the growth trend observed in the cumulative weight gain (Table 6 and Figure 3).

Table 5: Mean growth performance of diploid and triploid *H. longifilis* fingerlings after 84 days (12 weeks).

Growth Performance	Diploid	Triploid
Initial Mean Weight	2.323 ± 0.07^a	2.258 ± 0.05^a
Final Mean Weight	24.571 ± 1.05^a	19.933 ± 2.01^a
Mean Weight Gain	22.248 ± 1.10^a	17.675 ± 2.02^a
Specific Growth Rate (SGR)	2.8 ± 0.70^a	2.63 ± 0.14^a

Means on the same row with similar superscripts are not significantly different ($p>0.05$)

Table 6: Table presents the an biweekly weight gain of diploid and triploid *H. longifilis* after 84 days (12 weeks).

Time (weeks)	Diploid		Triploid	
	Weight gain	Cumulative weight gain	Weight gain	Cumulative weight gain
W0 (Initial)	0	0	0	0
W2	3.193 ± 0.44^a	3.19	3.023 ± 0.29^a	3.02
W4	4.376 ± 0.97^a	7.57	3.791 ± 0.53^a	6.81
W6	2.144 ± 0.67^a	9.71	2.431 ± 0.56^a	9.25
W8	2.335 ± 0.30^a	12.05	1.745 ± 0.29^a	10.99
W10	2.642 ± 0.37^a	14.69	2.078 ± 0.89^a	13.07
W12	7.558 ± 0.99^a	22.25	4.607 ± 0.91^a	17.68

Means on the same row with similar superscripts are not significantly different ($p>0.05$)

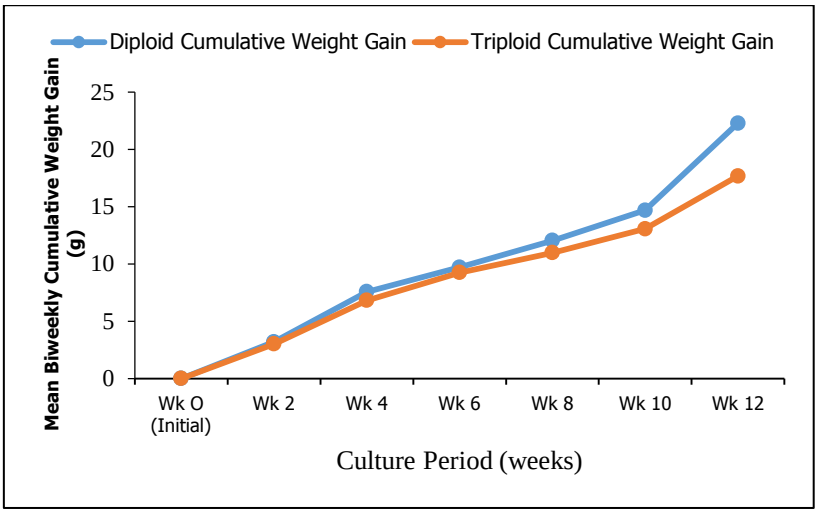

Figure 3: Mean biweekly cumulative weight gain of diploid and triploid *H. longifilis* after 84 days (12 weeks).

Careful observation of both the diploid and triploid fry revealed strong aggressive and cannibalistic behaviours. Frequent spontaneous attacks were observed within the first week of the experiment. Some fry were observed to be pecking at the tail of others causing mutilation that resulted to death. As the second week was approaching, some fry were observed to be distinctly larger in size than others. These bigger fry were more aggressive and had sharp bursts. They often attempted to peck at the head of others and even swallowed its victim from the head down. However, where the size difference between the cannibal and the prey was not quite distinct, the attempt to swallow became lethal to both. Aggressive and cannibalistic strikes were noticed in both diploid and triploid fingerlings of *H. longifilis.* The attacks were directed at the fins and body resulting to lesions on the body, mutilation of the fins, and death in some cases. The dead victims were latter consumed first by degutting them, then biting the entire flesh leaving the vertebral column in some and the head in most. This type of cannibalism was mostly observed where the sizes of the prey and the predator were close. Where the difference in size between the prey and the cannibal was remarkable, the preys were swallowed whole from the head.

4. DISCUSSION

The induction of triploidy by the cold shock was successful though the yield was low. This low yield however was not at variance with the observations of [41-37-23]. There was no doubt about the triploids produced in this experiment having followed the protocols of Olufeagba et al. (1999) on the same species and the fish obtained were verified to be 100% triploids. The viability of triploid one week after hatching was also believed to be similar to that of diploid [23].

The water quality prevalent throughout the period of the experiment was quite suitable for the reproductions, survival and growth of warm water fishes. Duncan (2002) had given the permissible limit standards for temperature, dissolved oxygen and pH as 20-33°C, 6.8ppm and 6-9 respectively [16]. The handling of the fish during the experiment was such that minimized stress. The mortalities recorded therefore were cannibalism related. Evidence of this were very obvious in the form of lesions and/or mutilations occasioned by sustained bites on the bodies of wounded preys and carcasses found. Kaiser et al. (1995) had observed similarly that aggression and cannibalism in fish could result in skin lesion, fin damage and lethality in extreme cases [4].

The survival rates of the diploid (45±6.46%) and triploid (42.5±8.54%) fry of *Heterobranchus longifilis* were not significantly different ($p>0.05$). These demonstrated that the fry of the African catfish, *H. longifilis* naturally exhibit a high level of cannibalism which according to Baras (1999) even started at the larval stage at the age of four days [42]. In the first week of this experiment, tail first cannibalism was more pronounced which coincided with the period with less size variation. Swallowing up of the prey whole from the head by the cannibal fry (head first cannibalism) gradually became prominent as the experiment entered its second week and became more common among the fingerlings. Hecht and Appelbaum (1988) attributed this to differential growth rate of the fish that would lead to a higher growth rate and greater disparity in the size of fish of the same age [8]. The diploid and triploid fingerlings with mean survival rates of 72.5±7.50 and 62.5±11.09 did not show any significance difference ($p>0.05$) implying that rates of cannibalism in both were similar. These values however, numerically still portrayed the triploids as having more cannibalistic tendency.

The cumulative mean mortality/cannibalism rate indicated that by the sixth week, 32.5% of the triploid and 25% of the diploid fingerlings had already suffered cannibalistic related mortalities. In the subsequent weeks the

mortality/cannibalism rates declined in both groups of fingerlings. This observation seems to be in consonance with the results of Coulibaly *et al.* (2007) on *H. longifilis* reared in floating cages where the rates of cannibalism progressively decreased after two weeks of culture [28]. Combining the mortality/cannibalism rates in the fingerlings and fry, the results of this experiment appeared similar to the observations of De Kimpe and Micha (1974) and Van der Waal (1978) on *Clarias gariepinus* [44,45]. These authors asserted that the African catfish can lose about 65% of its young to cannibalism. However, the reduced survival rate of the triploid fingerlings implies that at least more space was available following a slight reduction in density. Better growth performance would have been expected but this was not the case, suggesting a somewhat poorer food conversion efficiency of the triploid in this experiment. This was evident in the marginal variations in mean specific growth rate (SGR) (triploid 2.63±0.14 and diploid 2.8±0.71) and mean weight gain (triploid 17.675±2.02, diploid 22.248±1.10) though not significantly different ($p>0.05$). With the triploid fingerlings being a little more cannibalistic, the poor growth performance might follow the explanation of Hecht and Uys (1997) that aggression can cost a lot of energy which could otherwise have been used for growth [3]. Following the observation in this experiment, it could be seen that the diploid and triploid *H. longifilis* exhibited no real growth superiority over each other ($p>0.05$). It might therefore be expected that the superlative growth performance of triploid would come after the age of sexual maturity is attained. It is believed, at such a time the diploid would have started investing vital energy and nutritive resources in reproduction while the sterile triploid keeps on growing [34,29]. However, the triploid state may not automatically confer superior growth capability on all species. Kerby et al. (2002) had shown that the growth performance of triploid sunshine bass was inferior to that of diploid mature female [46].

The possible superior or continual growth of the triploid after the attainment of sexual maturity may not benefit those commercial fish culturists who rear table fish, especially where fish with a long life cycle such as *Heterobranchus longifilis* is involved. The aquacultural significance of triploid *Heterobranchus longifilis* could therefore be relevant where controlled reproduction is required [34] and/or if the effects of cannibalism on survival were negligible.

5. CONCLUSION

Cannibalism has been variously reported to be a major production constraint in *Heterobranchus longifilis* and *Clarias gariepinus* culture. In this work, the survival rates of both the diploid and triploid fry and fingerling of *H. longifilis* were affected by cannibalism. The survival rates of the fry were less than obtained in the fingerlings indicating higher level of cannibalism at the younger age of the fish. Survival rates and growth performance indices appeared better in the diploid than in the triploid fry and fingerlings but these were not significantly different ($p>0.05$). The rates of cannibalism were therefore believed to be similar in both diploid and triploid. Going by these results, it can be deduced therefore that there seemed to be no special benefits in culturing the triploid *H. longifilis* except, 1. where controlled reproduction is required to avoid interbreeding of the cultured *H. longifilis* with wild stock or even some stock that the farmer may bring from other sources and 2. to prevent its perpetuation in the natural environment, especially where it is an exotic species.

It is recommended that further researches on diploid and triploid *H. longifilis* should be at much higher densities than those employed in this study. Further works on this subject should continue till table fish size is reached. In the absence of superior reasons, farmers should continue to produce and rear diploid *Heterobranchus longifilis* since the advantages (in terms of growth performance and recovered number) of the triploid fish culture do not supersede those of diploid.

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