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Influence of African catfish (Clarias gariepinus) brood stock size on fingerlings growth rate.

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A B S T R A C T

This work was undertaken to investigate the effects of brood stock size on growth performance of C. gariepinus. In a 4×3 factorial design, four different brood stock sizes (0.7, 0.8, 1 and 1.75 kg - ♂) were crossed with three different sizes of female brood stock (0.8, 1, and 1.75 kg (♀) and 6 experimental treatments**.** Brood-fish were bred at a sex ratio of one female to one male (1♀:1♂). The experimental treatments were assigned according the factorial design with two replicates per treatment giving total number of 12 spawning tanks. C. gariepinus brood stock size significantly ($P\leq0.05$) affected the natural sizes of fingerlings. Considering brood stock size, the larger brood fish had the highest jumpers (167- 21.30%) and second to the last in the number of runts (367 – 46.81%) when compared with other treatments. Treatment 5 had the highest number of medium sized fingerlings while treatment 2 had the highest number of runts and least number of jumpers. Treatment 1 had the least number of medium sized fish while treatment 4 had the least number of runts. The best growth performance in terms of the number of jumpers was found in treatment 6 spawned by larger brood fish. It is recommended to use larger brood fish during the propagation season in hatcheries if more jumpers are major targets of production.

Key words: *Temperature, dissolved oxygen, ammonia, nitrite, nitrate, jumpers, treatment and runts*

Introduction

African mudfish (Clarias gariepinus) is a good fish for warm-water aquaculture. They are easily spawned, use a wide variety of natural foods as well as formulated feeds, tolerate poor water quality, and grow rapidly at warm temperatures. These attributes, along with relatively low input costs, have made this species of fish the most widely cultured freshwater fish in tropical and subtropical countries (Biswas et al., 2005; El-Saidy and Gaber 2005; Fasakin et al., 2005; Peña-Mendoza et al., 2005 Borgeson et al., 2006; Tsadik and Bar, 2007 and Tahoun, 2007). For fish culture activities in Egypt as in many parts of the world, the necessity of dependedable supply of Clarias gariepinus, fingerlings is therefore imperative, but the problem of mass production still remains. There are many possible reasons for the low production of Clarias gariepinus fingerlings. These include too low density of broodstock, inappropriate sex ratios, inadequate spawning techniques, broodstock nutrition and high fry mortality (Salama, 1996). Poor broodstock productivity, owing to low fecundity and asynchronous spawning cycles, remains one of the most significant outstanding constraints upon commercial Clarias gariepinus production and its future expansion. Broodstock productivity clearly represents the most significant constraint on commercial Clarias gariepinus production. Increased knowledge of the factors regulating broodstock productivity is therefore of great importance to the further development of Clarias gariepinus culture (Coward and Bromage, 2000). Maximizing seed productivity in hatcheries is the ultimate aim of broodstock management. Traditional Clarias gariepinus seed production systems suffer from productivity problems that are associated with its unique reproductive traits such as early maturity, low frequency spawning, high fecundity and poor investment in parental care. Improvements in our understanding of the appropriate culture conditions and management procedure for the brood-fish are essential if we are programming reproductive development to produce reliably the numbers of eggs and fry required by grow-out farms. The aim of the present work therefore was to investigate the effects of broodstock size on fingerlings and to see whether this identifies possible broodstock management strategies that may be adopted by hatcheries to improve seed production.

Materials and methods

The experiment was carried out at the University of Port Harcourt Demonstration Farm. Containers used for breeding have uniform size measuring 40cm x 30cm x26cm (length, width and depth) each. The construction made was a simple flow-through system with an overhead reservoir. Matured males (♂) and gravid females (♀) broodfish of different sizes (Table 1) were obtained from Aqualife Consult, Rukpokwu in Port Harcourt and acclimatized for seven days in the hatchery before use in University of Port Harcourt Demonstration Farm.

The water in the reservoir was regulated into the hatching troughs at half liter per minute. In spawning the method used was artificial insemination where synthetic hormone (ovaprim) is administered with syringe into the gravid female at 0.5ml for 1kg fish depending on their respective body weight. Broodstock was held in a plastic basin with sufficient water for 10 hours (latency period) for gonads to fully mature, after which eggs were stripped from each female into a dry container. Sexually matured males were sacrificed and milt extracted to fertilize the eggs. One gram of egg was collected from each set of fish using sensitive scale. The eggs were fertilized with the milt and spread on kakabans where hatching is expected to take place after 24hours. The data collected were analyzed for significant differences ($P<0.05$) by Analysis of Variance (ANOVA) and Pearson Correlation using computer statistical package for social sciences (SPSS) for windows (V.15.0).

Results

The mean water quality parameter of pH, temperature, dissolved oxygen, ammonia; nitrite and nitrate of the various concentrations did not vary significantly ($P < 0.05$). The mean value recorded for the various treatment levels were within the same range as shown in Table 1. Generally, there were statistical differences ($P < 0.05$) in all the treatments levels (Jumpers, Medium and runts), Table 2. The first treatment (0.7 kg (♂) x 0.8 kg (♀)) reveals that jumpers are 2.40% < medium fingerlings and 71.20% < that of runts while medium sized fingerlings were 68.80% < that of runts; in treatment 2(0.8 kg (♂) x 0.8 kg (♀)), it was observed that jumpers were 13.86% < medium size fingerlings and 77.06% < that of runts while medium sized fingerlings were 64.20% < that of runts; runts were 27.85% > that of medium and 57.59% > that of jumpers while medium sized fingerlings were 31.74% > that of jumpers at treatment 3 (0.8 kg (♂) x 1 kg (♀)); In treatment 4 (1 kg (♂) x 1 kg (♀)) it was noticed that medium sized fingerlings were 30.83% < that of runts and 27.10% > that of jumpers while jumpers were 57.93% < that of runts; jumpers were about 4x < that medium and 10x < that of runts while medium sized fingerlings were 26.05% < that of runts in treatment 5 (1.75 kg (♂) x 1 kg (♀)); Table 2 shows that the quantity of runts fingerlings are 14.92% > that of medium and 10.59% > that of jumpers while medium sized fingerlings are 25.51% > that of jumpers at treatment 6 (1.75 kg (♂)x1.75 kg (♀).

Discussion and conclusion

The results of the water quality of the media used in the present study are within the range reported by Viveen et al. (1985) as optimal requirement for African catfishes and did not vary significantly ($p < 0.05$) in the respective treatment levels. All were within the tolerance ranges of warm water fish species (Boyd, 1979; Adeniji and Ovie, 1989). This suggests that the parameters did not seem to negatively influence the test fish in this study.

There were evidences that broodstock size significantly ($P \leq 0.05$) affected the success in the variations of the 3 levels of fingerlings observed in this work (Table 2). The results on fish seed production under the condition of the present work are in accordance with those of Ridha and Cruz (1999) who indicated that, seed production of Nile tilapia reared in re-circulating tank hatchery system was not different from those reported by other workers that used aquaria, ponds, hapas and pools. Thus, the present result shows that the increase broodstock size led to a higher percentage of jumpers. The use of smaller sized fish would maximize production of seeds of the hatchery and lead to efficient utilization of the limited hatchery space (Uedeme-Naa and Ibim 2011).

Several researchers studied the effects of different fish sizes on the reproductive performance particularly, on Nile tilapia O. niloticus and have observed that larger stock significantly ($P \leq 0.05$) increases spawning success and in turn mass production (Little, 1989; Ernst et al. 1991; Ridha and Cruz, 1999; Bhujel, 2000). In this behalf, Brummett (1995) reviewed the environmental factors which influence and regulate maturation and reproduction in tilapia brood-fish and stated that, photoperiod, temperature and population density are predictive cues which affect the onset of sexual maturation and reproduction.

The increased seed production per unit of area (1 m^3) with the increase of the of broodstock size in the present work, agreed with the findings of Obi and Shelton (1988) who found that fingerlings production per unit of area (m^2) in tilapia, O. hornorum (Trewavas) tended to increase with the increase of broodstock stock size. It can be said that, there are great discrepancies among investigators even for fish of the same species and size and this may be attributed to differences in feeding husbandry, limitations in experimental design and other prevailing culture conditions (Tahoun, 2002 and 2007). Bhujel (2000) reported that, an inverse relationship between broodstock size and the percentage of spawning females has been found in production hybrids of tilapia, O. niloticus and O. hornorum, probably due to some chemical or behavioural factors. Mair et al. (2004) confirmed that, the age fecundity relationships are in line with expectations with regard to absolute fecundity although based on findings with other species, admittedly over large age differences, relative fecundity have been expected to decline with age (Siraj et al. 1983 and Ridha and Cruz, 1989). Smith et al. (1991) compared production of Florid red tilapia seeds (eggs, sac-fry and fry) between year class I and year class II in brackish-water tanks under commercial scale conditions and found that, that older red tilapia females produced more seed per clutch but fewer seed per unit weight than younger females. However, despite a large average clutch size, seed production was lower in females due to lower spawning frequency, suggesting fewer reproductively active individuals, or longer inter-spawning periods. Greater proportion of eggs and non-swimming sac-fry in broodstocks also suggest longer inters-pawning periods for older fish. The seed production in Florida red tilapia declined dramatically by age of 2 years, the importance to replace broodstock with yearling breeders each year is recommended. In contrast, Little and Hulata, (2000) stated that, Larger, older fish can perform well in intensive hatchery systems, although frequency of spawning and relative clutch size decline with size and age. Poor handling efficiency of large fish is also a problem in hapa and tank based hatchery systems, in which broodstocks are individually handled to harvest mouth-brooded seed. In practice fish larger than 300g for tilapia and 4kg for Clarias gariepinus are difficult to handle quickly and efficiently. Small female produce more eggs per unit body weight. Since adverse environmental conditions encourage early maturity at smaller size in tilapia and C. gariepinus, relatively higher fecundity in smaller fish further enhances the chances of species survival under such conditions (Watanabe and Kuo, 1985). Bhujel (2000) cited that, relative size of males and females may be more important as there are often hierarchies in catfish/tilapia populations based on the social dominance, which is partially determined by fish size. Siddiqui et al. (1997) cited that, fecundity is positively related to the size of fish, the growth of fish decreases with increasing density of fish. It appears that social interaction and social stress are responsible for inefficient food utilization, poor growth and consequently low fecundity with respect to size. At high densities, there is a competition for space which increases social interaction and in turn, causes social stress, thereby affecting reproductive efficiency. The superiority in growth performance found in the fingerlings produced by larger broodstock group (1.75 kg (♂)x1.75 kg (♀)), which had the highest average initial weight was confirmed by the results of Ahmed et al. (2004) who found that growth performance was significantly ($P \leq 0.05$) affected by fish size. Comparable results were obtained by Akbulut et al. (2003) who found that, the growth rate and final biomass of rainbow trout Oncorhynchus mykiss fingerlings were significantly ($P \leq 0.05$) affected by brood stock size. Duston et al. (2004) obtained similar results on the growth of fingerlings striped bass which was significantly ($P \leq 0.05$) affected by the size of the parent stock. This work is attesting to the fact that the growth of fish fingerlings is highly influenced by the size of parent stock and as such larger broodstock (1.75 kg (♂) x 1.75 kg (♀)) and above is recommended for use when more jumpers are desired by fish breeders during fish seed multiplication in hatcheries.

Table 1: The effect of water quality parameters treatments

Treatments		pH	Temp ^{0}C	DO (mg/l)	NH_3 (mg/l)	NO_2 (mg/l)	NO_3 (mg/l)
1	0.7 kg (♂) x 0.8 kg (♀)	6.60	26.17	6.17	0.02	0.11	0.013
2	0.8 kg (♂) x 0.8 kg (♀)	6.50	25.97	5.37	0.02	0.02	0.017
3	0.8 kg (♂) x 1 kg (♀)	6.97	26.17	5.27	0.02	2.23	0.02
4	1 kg (♂) x 1 kg (♀)	7.00	26.97	5.77	0.02	0.02	0.02
5	1.75 kg (♂) x 1 kg (♀)	7.00	26.33	5.97	0.02	0.48	0.02
6	1.75kg (♂)x1.75 kg (♀)	6.70	26.19	5.30	0.02	2.10	0.02

Table 2: The effect of broodstock on the size of fingerlings

Treatments		Jumpers	%	Medium	%	Runts	%	Total
1	0.7 kg (♂) x 0.8 kg (♀)	55.00^c	8.80	70.00^b	11.20	500.00^a	80.00	625
2	0.8 kg (♂) x 0.8 kg (♀)	20.00^c	2.69	123.00^b	16.55	600.00^a	80.75	743
3	0.8 kg (♂) x 1 kg (♀)	30.00^c	4.89	200.00^b	32.63	383.00^a	62.48	613
4	1 kg (♂) x 1 kg (♀)	28.00^c	4.99	180.00^b	32.09	353.00^a	62.92	561
5	1.75 kg (♂) x 1 kg (♀)	50.00^c	6.00	283.00^b	33.97	500.00^a	60.02	833
6	1.75 kg (♂)x1.75 kg (♀)	167.00^c	21.30	250.00^b	31.89	367.00	46.81	784

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

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