Original Research Article

Reproductive Performances of *Heterobranchus longifilis* Broodstock Cultured at Different Water Depths in Indoor Concrete Tanks

ABSTRACT

Aims: To determine the pond water depth that elicits the best reproductive performances in of *Heterobranchus longifilis* broodstock.

Study design: Treatments were assigned using complete randomized design.

Place and Duration of Study: Fish Farm Complex of the Akwa Ibom State University (AKSU), Nigeria.

Methodology: Eighteen (18) similarly-sized *H. longifilis* broodstock (2.51-2.53 kg, 64 – 66 cm): comprising six broodstock of three males and three females, were held for six months at 0.50 m, 0.75 m and 1.0 m pond water depth. All males were sacrificed for milt extraction without hormonal inducement; with milt from each treatment diluted with normal saline solution. Female broodstock from each treatment were separately induced with ovaprim hormones at a single dosage of 0.5ml/kg body weight of fish and allowed for 16 hours before manual stripping; 3g of egg from each broodstock and mixed with the diluted milt and activated with 100 ml of normal saline. The fertilized eggs were incubated and thereafter assessed for percentage fertilization, hatchability, survival and fry production success.

Results: Broodstock reproductive parameters significantly increased (P = 0.00) with water depth of broodstock culture tank. Percentage fertilizations were: 49.50±0.78, 68.17±0.93, and 82.50±1.44; respectively. Percentage hatchability of broodstock eggs were: 91.37±1.65 significantly higher for 1.0 m water depth group than 67.79±4.58 from 0.75 m water depth treatment while the least value of hatchability 50.31± 0.78 was recorded for broodstock raised at 0.50 m water depth. The fish group raised at 1.0 m water depth also exhibited highest percentage survival value of 97.02 ± 1.09 and fry production success value of 73.08 ± 0.53 while broodstock raised at 0.50 m water depth indicated the least values: % survival, 8.38 ± 0.48 and fry production success of 2.07 ± 0.07.

Conclusion: In times or places of water scarcity, *H. longifilis* broodstock may be raised at pond water of 0.5 m to 1.0 m. But the water depth that would afford the best breeding and reproductive performance is at 1.0 m depth.

Keywords: Artificial fertilization, breeding, fish stress, hatchery production

1. INTRODUCTION

Insufficient supply of water at different locality of the world, initiated the idea of water management for various agricultural purposes; this consequently influences the level or depth of pond water for fish culture [1]. Water is a natural component indispensable for all living organisms and existing as colourless, tasteless and odourless liquid. It is the natural habitat for aquatic organisms including fish – highly exploited for food by man. Unfortunately, the huge demand of animal protein for human sustenance re-enforces overfishing of wild catches [2] which drastically reduces the supply of fish from capture fisheries [3]; with aquaculture emerging as the only alternative to attaining world demand for fish [4,5].

In Nigeria, African catfish belonging to the family Clariidae (*Heterobranchus* and *Clarias* species) are the most cultivable species of significance [6, 7, 8]. This is due to the unique characteristics of the species such as fast growth rate, good taste, high stocking density, high market price and high resistance to disease and ability to reproduce in captivity, which makes it economical to culture [2,9,10,11,12,13]**.** However, the growth of fish depends on availability of good feed of which a single feed stuff component cannot achieve [4,5**,**14]**.** *Heterobranchus* and *Clarias*, readily accept supplementary feed and grow faster within a short period of culture compared to other species [1,7,15]**.** These species dominate fresh water environments such as lakes, rivers and streams [16].

Sexual maturity of African catfish varies. *Clarias* species mature between 5 to 9 months while *Heterobranchus* species take a longer period of 18 months to attend sexual maturity in the case of females while males attend maturity as from 12 months [17,18,19]. Shallow water tolerance and broodstock maintenance is very crucial mostly in terms of good quality feeds, water parameters and culture environment to achieve the best gametes and success at the hatchery levels. The hopes of the fish farmers lie in adequate care of broodstock to achieve production of fish seeds. Hence, the need to determine the water depth or level for maintenance of broodstock for the best reproductive performances of African catfish is critical where water is in inadequate supply.

Several investigations had been carried out on the reproductive performances of African catfish based on hormonal induction [3,8,15], age of broodstock [6,7,19,20,21], egg batches [22,23], sperm diluents [2,24], influence of feed types [23,25], F1 offspring of [2,21,25], and growth of hybrids[26].

This study models the conditioning of *H. longifilis* broodstock at shallow and deeper ponds in hatchery. The aim being to determine the most suitable pond water depth for conditioning *H. longifilis* broodstock cultured at different water depths by examining their reproductive performances.

2. MATERIAL AND METHODS

2.1 Location of Study

The research was conducted at the Fish Farm Complex of Akwa Ibom State University, Obio Akpa campus in southeast Nigeria. The farm is between latitude 5º17’N and 7º27’N, Longitude 7º27’E and 7º58’E with an annual rainfall ranging from 3500mm-5000mm and average monthly temperature of 25º C. Akwa Ibom State is a coastal state lying between latitude 4º28’N and 5º3’N and between longitude 7º27’E and 8º20’E with a relative humidity `between 60-70%. It is in the tropical rain forest rainforest zone of Nigeria [6,20].

2.2 Acquisition and care of broodstock

Eighteen (18) similarly-sized *H. longifilis* broodstock (2.51-2.53 kg, 64 – 66 cm) were carefully selected from the farm stock for this study. Groups of six broodstock (three males and three females) were stocked in three separate concrete ponds, 1 x 3 x $1m^3$ at water depth: 0.5 m, 0.75 m and 1.0 m; at the rate of 2 fishes m^{-2}. Broodstock were fed twice daily at 5% body weight with Coppens commercial feed for six months.

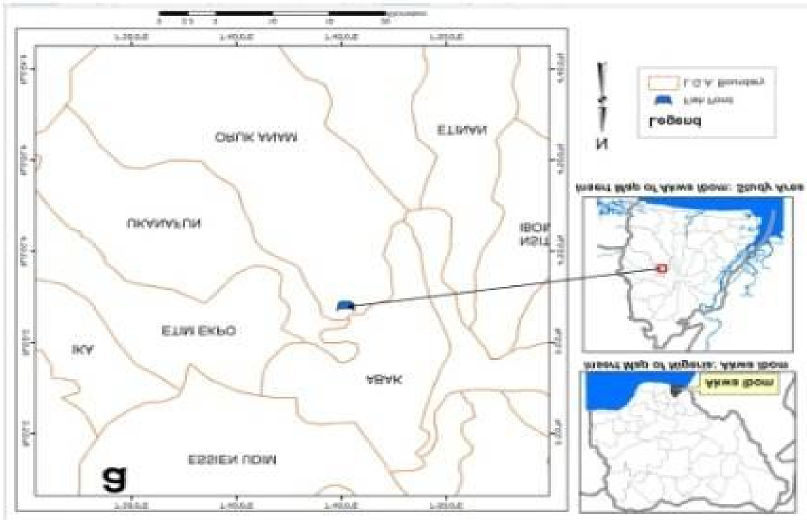

Fig. 1. Map showing the location of the Akwa Ibom State University fish farm complex

2.3 Egg Stripping and Fertilization

Approximately 3g eggs (2000 oocytes) from each broodstock was stripped and mixed with the diluted milt and activated with 100 ml of normal saline in nine separate containers.

2.4 Incubation

The fertilized eggs were spread uniformly in a monolayer on kakaban (shredded nylon sack) and incubated in aerated indoor concrete tanks (2 m x 1 m x 0.5 m at water depth of 10 cm) in three replicates until hatching. The incubation system was maintained within the range of 26 - 27ºC, 6.5 - 7.0 pH and 4.5 - 5.0 mg L^{-1} dissolved oxygen.

2.5 Hatching

The incubated eggs hatched between 26 - 27 hours after incubation at 26ºC. Dead eggs where siphoned from the breeding tanks 35 hours after incubation. Egg fertilization hatching and survival rates were determined as follows:

Fertilization rate (%) of eggs = (No. of eggs fertilized /total number of eggs) x 100
Hatchability (%) = (number of hatchlings / total number of fertilized eggs) x 100.
Percentage hatchability was obtained by direct counting of unhatched eggs as well as the numbers of eggs hatched in each incubating tank.
Hatching rate = (No of healthy fertilized eggs / No of fertilized eggs used) x 10 [24]
Survival rate (Ks) = (number of live larvae / total number of larvae hatched) x 100 during initial feeding [24]

Efficiency of hatching was evaluated as Fs (%) = Kf.Kh.Ks/10,000 where
Fs = Success rate (%) of fry production at 10-day post hatching.
Kf = Fertilization rate (%) of eggs
Kh = Hatching rate (%) of fry
Ks= survival rate (%) of 10-day-old swim-up fry [24]

2.6 Determination of Water Quality Parameters

pH (Vivosun pH meter) and dissolve oxygen (Extech 407510) and temperature (mercury in glass thermometer) readings were taken during the study.

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2.7 Statistical Analysis

Statistical analyses of fertilization, hatching, survival rates at 10-day post hatching and fry production success were carried out using one-way ANOVA; the significant differences in mean were set at 0.05 significant level.

3. RESULTS AND DISCUSSION

3.1 Physicochemical Parameters of Culture Media

The water parameters considered in this study (Table 1), showed no significant difference (P = 0.999) among the treatments. Dissolved oxygen, temperature and pH measurements ranged between 5.21 ± 0.20 – 5.66 ± 0.20 mg l^{-1}, 26.25 ± 0.05 – 26.82 ± 0.04 (ºC) and 6.90 ± 0.02 – 6.95 ± 0.01, respectively.

Table 1. Mean Water Quality Parameters in Egg Incubation Tanks

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Water Parameters	**Water Depth**		
	0.50 m	**0.75 m**	**1.0 m**
Temperature (º C)	26.24± 0.05	26.40± 0.01	26.80 ± 0.02
pH	6.90±0.01	6.92 ± 0.01	6.94 ± 0.25
Dissolved oxygen (mg l^{-1})	5.21 ± 0.20	5.62 ± 0.40	5.64 ± 0.150

3.2 Reproductive Performances of *H. longifilis* Broodstock with Pond Water Depth

Table 2 shows the fertility assessment of *H. longifilis* broodstock reared in concrete aquaculture ponds at different water depths. All the measured reproductive parameters increased significantly with pond water depth at which broodstock was held or conditioned.

Table 2. Fertility assessment of *H. longifilis* broodstock reared in concrete aquaculture ponds at different water depths for six months; Mean ± SE (min – max)

Reproductive Performance	**Water** depth **of broodstock culture tank**			**F-Test**	**P**
	0.50 m	**0.75 m**	**1.0 m**		
% Fertilization	49.50 ±0.76 (48.50-51.00))	68.17 ± 0.93[b] (67.00-70.00)	82.50 ±1.44[c] (80.00-85.00))	232.9	0.00
% Hatching	50.31±4.69[a] (41.18-56.70))	67.79 ±4.58[b] (62.22-76.87)	91.37±1.63[c] (88.24-93.75)	27.94	0.001
% Survival	8.38±0.48[a] (7.45-9.05)	45.66 ±2.30[b] (41.26-49.05)	97.02±1.01[b,c] (95.39-98.87)	905.2	0.00
% Fry Production	2.07±0.10[a] (1.90-2.25)	20.95±0.19[b] (20.60-21.25)	73.08 ±0.53[c] (72.50-74.15)	12250	0.00

a,b,c, Means with different superscript within the same row are significantly different (p<0.05) by Turkey pairwise comparison

The percentage fertilization and hatching of eggs were highest, 82.50 ±1.44% (80.00-85.00 %) and 91.37±1.63 % (88.24-93.75 %), respectively, for broodstock raised in deeper waters at 1.0 m pond water depth. The corresponding values were least in shallower waters at pond water depth of 0.5 m (49.50±0.76%; 48.50-51.00 % and 50.31±4.69 %, 41.18-56.70 %, respectively). Similarly fry survival and fry production success in this study increased significantly (P = 0.00) with increase in the broodstock water depth (1.0 m > 0.75 m > 0.5 m) in that order.

3.3. Discussion

The experimental water quality parameters were in line with the recommended standard for aquaculture operation for catfish breeding [20,22] as significant differences in water quality parameters were not observed in all the batches throughout the duration of the study. The idea of managing water depths in a culture enclosure arises in event of insufficient supply or scarce availability of suitable water. Consequently, fish may be cultured in ponds with low water depth for human sustainability.

Clarias and *Heterobranchus* actually tolerate low and shallow water for culture [1]. Successes of the aquaculture venture also require availability of quality fish seeds; apart from suitable pond environment. This study investigated the effect of water (depth) or pond levels on reproductive performances of *H. longifilis* broodstock. The study reveals reproductive parameters such as fertilization, hatchability and survival rates and fry production successes, significantly (P = 0.00) increased with increase in the water levels of broodstock rearing pond.

The broodstock raised at the higher water level (of 1.0 m) achieved the best reproductive parameters better than values for broodstock raised at 0.75 m. The broodstock raised at 0.75 m pond water depth also outperformed (P = 0.00) those from shallow ponds at 0.5 m. The differences might be attributed to greater energy requirement to swim up for feeding; which equally affect production and viability of gametes [1,23].

Other factors that could contribute to observed variations in the reproductive parameters include: level of egg maturity, hormonal development and overall physiological readiness for reproduction and viability of eggs [2,12]. Larger- sized eggs tend to perform better because of the residual potential energy the eggs possess at less strenuous environment. At normal or ideal level of water (1.0 m in this case), broodstock reserve and utilize energy for egg and immune system development; while they tend to expend their energy for maintenance in strenuous environments as presented the two lower water levels (0.5 m and 0.75 m). It could therefore be summarized that hatchery management system is a critical factor for successful fry production [4, 21,25,26].

4. CONCLUSION

The study reveals that the best reproductive performance is achieved with rearing broodstock at 1.0 m pond water level or depth. Hence, to achieve the best reproductive performance *H. longifilis* broodstock should be reared at 1.0 m for six months before manipulating for fry production. Catfish could still be cultured at lower pond water depths of 0.75 m and 0.5 m, especially for fattening and table-size fish production.

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