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Growth response and survival of *Heterobranchus longifilis* cultured at different water levels in outdoor concrete tanks

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Abstract. Thirteen-day-old hatchery-raised fry obtained from hormonally-induced spawns of mature African catfish *H. longifilis* broodstock were introduced to three different water levels (0.35, 0.50 and 0.65 m) in four replicates in 12 units of $2x2x1m^3$ outdoor concrete tanks. The fry were similarly stocked initially at 50 fry m^{-2} and later thinned down to 5 fish m^{-2} and cultured for 6 months. Fish were fed twice daily with commercial pellet feeds (Coppens™) while adjusting the feeding rate from 10 to 4% body weight and pellet size from 0.2 to 4.5 mm. The effects of pond water levels were evaluated in growth responses and survival. Water quality variables were similar ($p > 0.05$) in all compartments. Temperature, dissolved oxygen and pH were at the optimum level for fish. The results reveal significant ($P < 0.05$) treatment effects on growth performances. Fish kept at the highest pond water depth (0.65m) were heavier ($P < 0.05$) and had a higher specific growth rate ($P < 0.001$) than the others. Food conversion ratio and survival rate were unaffected by the experimental treatments. ANOVA revealed significant differences ($P<0.05$) with culture period. The lowest water depth (0.35 m) favored fish growth in the first 3 months while the highest water depth (0.65 m) favored fish growth from the fourth month upwards ($P<0.05$). These results are important because they indicate the optimum water depths for the culture of *H. longifilis* from fry to sub-adult and from the grow-out/fattening of sub-adult to adult, respectively, in outdoor concrete tanks.
Key words: catfish culture, water levels, growth, *Heterobranchus longifilis.*

Introduction. Air-breathing catfish, particularly *Clarias* and *Heterobranchus* species, are among of the well-priced and most-accepted fish culture species because of their good taste, fast growth and ability to withstand adverse conditions in shallow ditches and small ponds (Viveen et al 1985). *Heterobranchus* species has some advantages over *Clarias* species such as higher growth rate, feed conversion (Anibeze & Eze 2000) and remarkable yield (Legendre 1986; Anibeze 1995); while *Clarias* species mature earlier (5 – 9 months) and has higher fecundity (Viveen et al 1985; Egwui 1986; Legendre et al 1992; Nwadukwe & Nawa 2000).

Fish growth rates and feed conversion are significantly affected by feeding level (Henken et al 1987; Samad et al 2005) and fish culture environment (Almazán-Rueda 2000). *Clarias* fry require very shallow water level (2 to 3 ft) because at deeper water they could not swim to the surface for gulping air and died (Sidthimunka & Edura 1959). Although many authors have investigated several factors affecting *Heterobranchus* culture such as dietary protein requirement (Dada et al 1999; Eyo 1995), stock density (Dada et al 2000), feeding frequency (Kerdchuen & Legendre 1991), nutritional requirement and water parameters, it is still beset with low survival during fry rearing stage in outdoor nursery management operations (Dada et al 2002). Little information is available on the optimum water level required for its successful rearing from fry to market size. Therefore, this is a comparative study of the culture of *Heterobranchus longifilis* at three different pond water depths in outdoor concrete tanks to determine growth performance and survival.

Material and Method

***Experimental Fish**.* Mature African catfish *H. longifilis* broodstock (3kg) were hormonally-induced with Ovaprim® at 0.5ml kg^{-1} of fish and allowed to spawn after a 15-hour latency period at room temperature - 26 °C (Davies et al 2006). The eggs were artificially stripped, inseminated and incubated in an aerated concrete tank (2 x 1 x $0.5m^3$) at 10cm water depth and managed as described by Viveen et al (1985). After three days the hatchlings were fed to satiation with *Artemia* nauplii at 3 hourly intervals for 10 days.

The thirteen-day-old hatchery-raised fry were randomly introduced to three different water levels (0.35, 0.50 and 0.65 m) in four replicates in 12 units of $2x2x1m^3$ outdoor concrete tanks (Fig. 1) and stocked at 50 fry m^{-2} (in week 1 to 12) and later thinned down to 5 fish m^{-2} (in week 13 - 24). The fry were fed, under similar condition of water parameters, twice daily in split-rations at 10% body weight initially and gradually reduced to 4% over the experimental period, and raised till adult. One PVC pipe (1.5 inch diameter) each, equal in length to experimental water depth, was fitted to each compartment to drain excess water from rainfall or gauge water loss through evaporation. The entire concrete tanks were screened with mosquito nets to exclude predators like toad and others. Water temperature, pH and dissolved oxygen were monitored using mercury-in-bulb thermometer, digital pH meter, and Microprocessor Oximeter®, respectively, were monitored in each compartment.

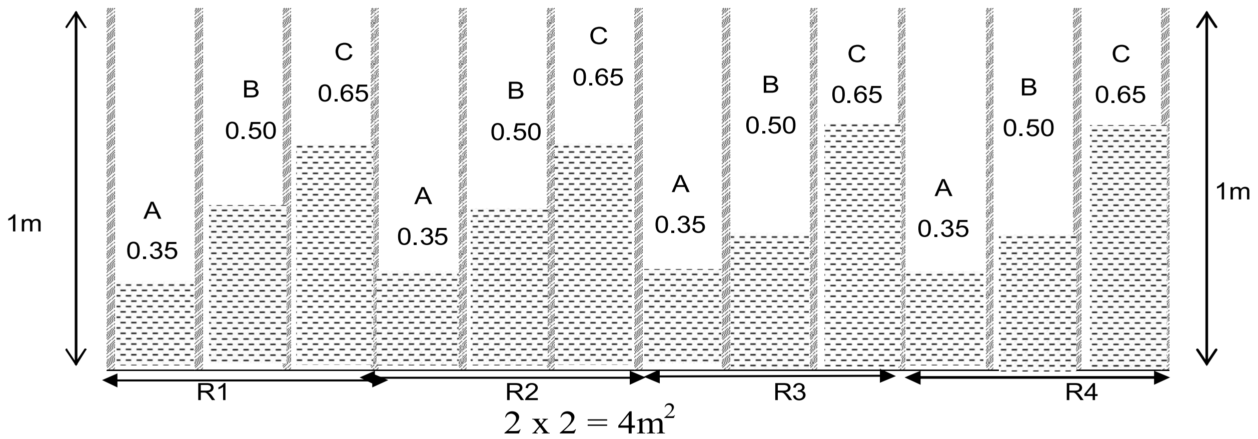

Figure 1. Diagram showing the design of experimental tanks comprising 12 units of 2 x 2x1 m^3 concrete tanks maintained at three different water depths (A = 0.35m, B = 0.50m and C = 0.65m).

***Growth studies**.* Feeding began a day after stocking the fry. Throughout the study, experimental fish were fed commercial pellet feeds (Coppens™) while adjusting the pellet size from 0.2mm initially and gradually increasing to 0.8, 2.0, and 3.0mm, finally, 4.5mm size was used from fourth month till end of experiment.

During the 6-month experiment, random samples of 20 fish were measured and weighed weekly from each tank for the first three months and four fishes thereafter till end of the experiment. Fish were weighed in grams using electronic digital balance and total length taken in centimeters using meter rule, after being scooped out with a net and drained. The initial mean weight and length of the *H. longifilis* fry were 0.0250g and 1.2cm, respectively. Food conversion ratio (FCR), growth rate (GR), specific growth rate (SGR), total live-weight gain (TWG) and percentage weight gain (PWG) were calculated as in Davies et al. (2006):

GR (g day^{-1}) = (Final weight, W_2 – Initial weight, W_1) . Culture interval (day), t^{-1}

SGR (% body weight, W) = (Ln W_2 – Ln W_1) t^{-1} . 100 (where Ln is natural log)

F.C.R. = Total weight of dry feed offered, F (g) TWG^{-1}

TWG = W_2 – W_1

$PWG = (W_2 – W_1)\ W_1^{-1}\ .\ 100$

Survival (%) = no. of fish stocked – no. of mortalities/ no. of fish stocked x 100

The growth and survival data among pond water depths were analyzed using one-way ANOVA and Duncan's Multiple Rang Test, DMRT and significance levels set at $P < 0.05$ (Zar 1984).

Results

Water quality parameters in ponds. Water parameters during the study period are presented in Fig. 2a-c. Dissolved oxygen (DO), temperature and pH ranged between 3.9 and 4.30 mg L^{-1} DO, 27.0 and 27.3 ^{0}C and 6.5 - 7.1, respectively. There was no significant difference ($P > 0.05$) in the water parameters among the treatments except for variations in DO between second and third month.

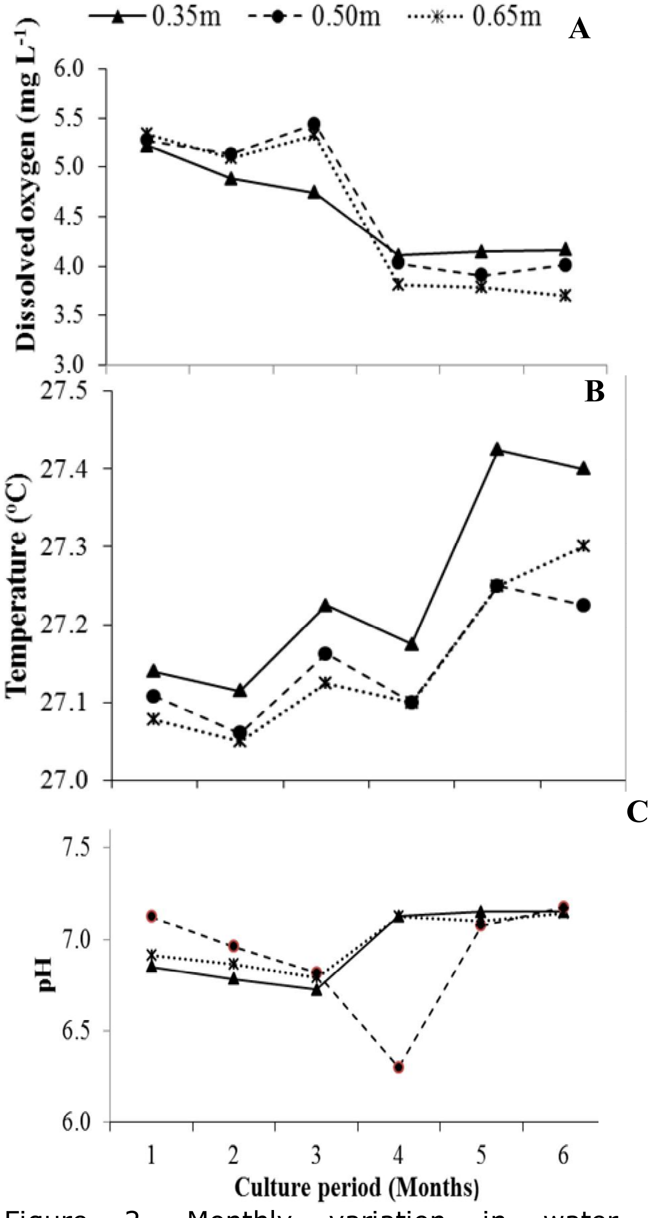

Figure 2. Monthly variation in water parameters: dissolved oxygen (A), temperature (B) and pH (C) at different water levels in outdoor concrete tank.

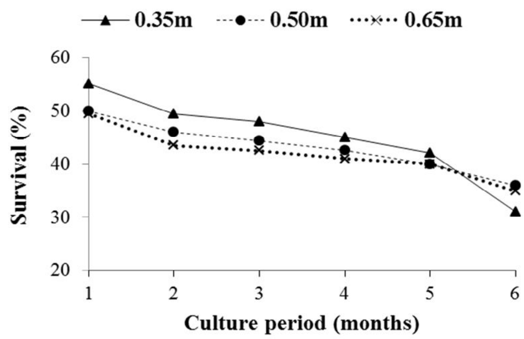

Figure 3. Monthly percentage survival of *H. longifilis* fry cultured at different water depths in outdoor concrete tanks for six months.

Growth performances. The result on growth performances of *H. longifilis* in outdoor concrete tanks for 6 months is presented in Table 1. Growth increment in mean final length of *H. longilis* revealed treatment effects (P < 0.05). Comparison of pooled treatment means by DMRT showed that 0.65m pond water depth gave the highest mean difference (P < 0.05) of 187.98 cm while mean values at 0.50 and 0.35 m water depths were not significantly different (P > 0.05) from each other. Table 1 also shows that starting from an initial weight of 0.0250g, *H. longilis* fry showed growth increment in mean final weight which were significantly different (P < 0.05) from each other, the highest being 1106.06g, followed by 700.200g and 558.975g, at pond water depths of at 0.65, 0.50 and 0.35 m, respectively.

Table 1

Growth performance and survival of *Heterobranchus longifilis* cultured at different water depths in outdoor concrete tanks for six months

	Water Levels		
Growth parameters	**0.35m**	**0.50m**	**0.65m**
Initial mean wt (g)	0.0250 [a]	0.0251 [a]	0.0250 [a]
Mean final wt (g)	559.000 [a]	700.200 [b]	1106.0600 [c]
Mean final weight gain (g)	558.975 [a]	700.1749 [b]	1106.0350 [c]
Mean final length (cm)	29.21 [a]	31.54 [a]	36.51 [a]
Mean final growth rate (g/day)	3.3272 [a]	4.1677 [a]	6.5835 [a,b]
Mean final specific growth rate (SGR)	5.9613 [a]	6.0930 [a]	6.3675 [a]
Mean final food conversion ratio (FCR)	0.2461 [a]	0.2532 [a]	0.2815 [a]
Mean final survival, %	58.35 [a]	71.77 [a]	77.50 [a]
Mean pooled length	4.12[a]	28.43[a]	187.98[b]
Mean pooled weight	4.41[a]	14.80[b]	23.72[c]
Mean pooled SGR	9.55[a]	14.03[a,b]	14.36[a,b]
Mean pooled survival	66.64[a]	59.18[a]	61.95[a]

a, b, c and d denote significantly different values in a row at P < 0.05 level by one-way ANOVA and Duncan's Multiple Range Test.

The pond water depth at which fish were cultured significantly (P < 0.05) affected the mean final length, final body weight, growth rate (GR), specific growth rate (SGR), total live-weight gain (TWG) and percentage weight gain (PWG), except food conversion ratio (FCR) (Table 1). Fish kept at high pond water depth were heavier (P < 0.05) and had a higher SGR (P < 0.001) than the others. Lower water depths at the initial stage enhanced survival which increased significantly (P < 0.05) in the first three months of culture in the order: 48.0% (at 0.35m water depth) > 44.31% (0.50m) > 42.51% (0.65m). At the end of the study, final FCR and survival rate showed increase with increase in pond water depth (Table 1; Figs. 3 and 4a), but without significant difference (P > 0.05).

ANOVA revealed significant differences (P<0.05) in growth performance with culture period. DMRT revealed that the pooled monthly growth parameters were initially similar (P > 0.05) in the first three months and increasingly exhibited significant differences (P<0.05) from the fourth month. The lowest water depth (0.35 m) favored fish growth in the first three months while the highest water depth (0.65 m) favored fish growth (P<0.05) from the fourth month on (Figs. 4b-d).

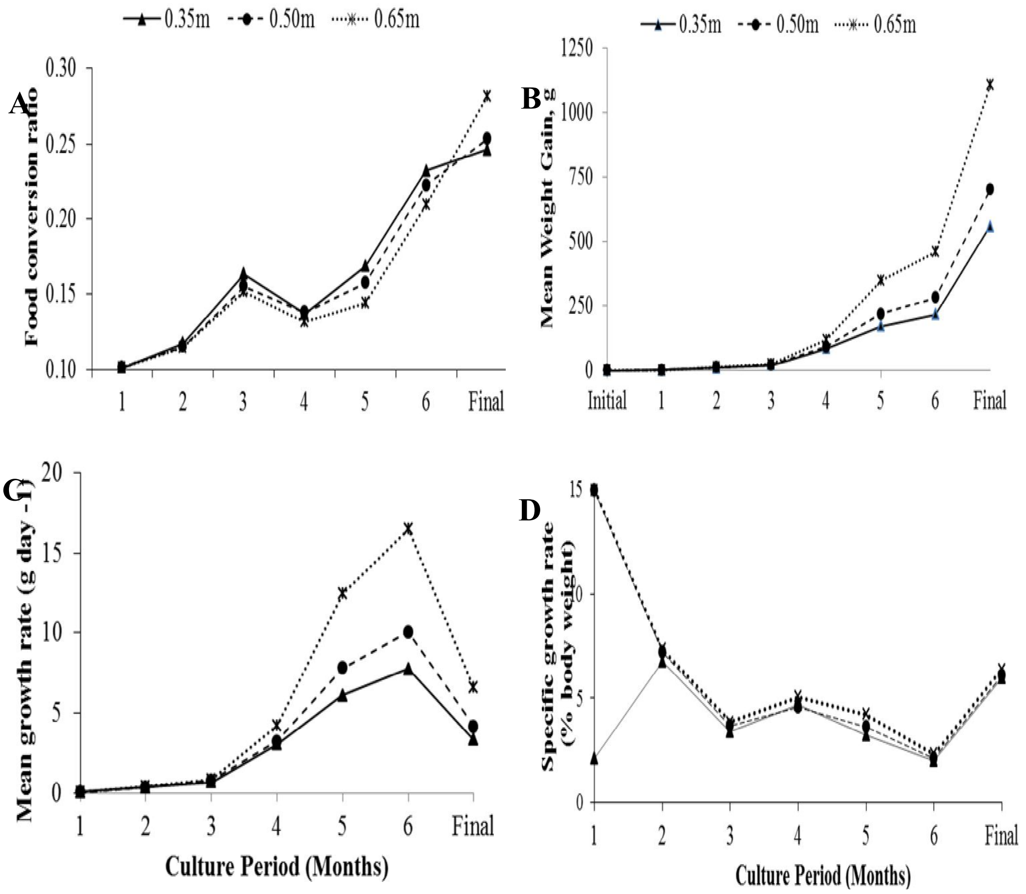

Figure 4. Growth performance of *H. longifilis* cultured at different water depths in outdoor concrete tanks for six months showing mean food conversion ratio (a), weight gain (b), growth rate (c) and specific growth rate (d)

Discussion

There is no evidence (P > 0.05) that water quality of the treatment affected growth or survival of experimental fish. Water quality variables were similar (P > 0.05) in all compartments and were at the optimum level for fish (Boyd 1979).

Optimum pond water depth for the culture of *H. longifilis* in outdoor concrete tanks for fry to sub-adult stage was found to be 0.35m for the first three months and, thereafter, increased to 0.65m (Figs. 4b-d). This could be attributed to the fact that at smaller sizes, the fish require minimal space and swim-up fry dash to the water surface to gulp air with less energy demand. The lowest water depth of 0.35m also allow for light penetration and complete mixing of surface and bottom water thereby enhancing primary productivity, with resultant higher DO level than in deeper water (P > 0.05; Fig. 2a). The influence of water level therefore, gets more pronounced as the fish grows bigger. Survival decreased significantly (P < 0.05) from 48.0 to 42.51% with increasing water depth (Fig. 3), hence, lower water depths at the initial stage, within the first three months, enhanced survival. Mean survival in this study were higher than that (33%) recorded by Nlewadim et al (2004) for 6 months culture of same species. Cannibalism by fast growers (jumpers) also contributed to mortality in all the treatments (Nlewadim et al 2004).

This study is important in many respects. Although Sub-Saharan Africa is moderately -supplied with water from rainfall and river discharge, this study would be useful in areas experiencing seasonal fluctuations in pond-water availability (PWA) in shallow wetlands, non-uniform rainfall distribution throughout the year and water storage capacity under different climatic and topographical conditions (Committee on Characterization of Wetlands, National Research Council 1995). This study would also be useful for modeling PWA in homestead outdoor concrete fish tanks, when broadened to include other salient variables as done by Kam & Hoanh (2008). Water is pre-requisite for raising fish and is also important for the growth and development of rice. The depth of water requirement for rice-fish culture, 16-20 cm (Hora & Pillay 1962; Khoo & Tan 1980; Ali et al 2004) is similar to the lowest water depth in this study. This makes *H. longifilis* a promising candidate for rice-fish culture.

Fish culture environments impose conditions which influence the behavior and productivity of the fish (Almazán-Rueda 2000). Bigger fish become exposed to higher predatory risk as water became shallow (<28 cm) (Gelwick et al (1997). Lower water depth of 25 or 50 cm induced natural spawning success in *Clarias gariepinus* broodfish (El Naggar et al 2006). Lower water depths also elicit territorial and aggressive behavior in *C. gariepinus* larvae (Britz & Pienaar 1992; Kaiser et al 1995ab; Hecht & Uys 1997; Almazán-Rueda 2000) such as erratic swimming activity, especially between third and fourth months in *H. longifilis* stocked at 0.35m pond water level, in this study. This in turn resulted in fish bites and skin bruises as a result of multiple encounters between individuals (Appelbaum & McGeer 1998) and increases their susceptibility to disease thereby weakening the fish and making them more liable to further cannibalism or death as a consequence of their wounds (Kaiser et al 1995a). This may therefore result in stock losses, depressed food conversion efficiency and growth due to the higher energy requirement (Hecht & Uys 1997).

In conclusion, the phased culture of *H. longifilis* from fry to sub-adult and from the growth-out/fattening of sub-adult to adult, in outdoor concrete tanks are best done at 0.35 and 0.65 m pond water depths, respectively.

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