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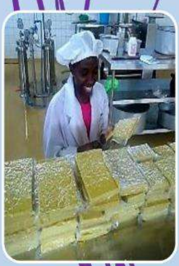




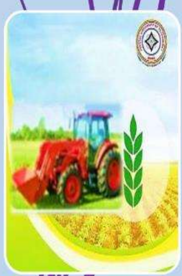

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TABLE OF CONTENTS

68 EVALUATION OF ADAPTIVE PLASTICITY IN WILD *Sarotherodon Galilaeus AND Coptodon Zillii* IN CONCRETE POND

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Abstract

This experiment evaluates the adaptive plastic responses of wild Sarotherodon galilaeus and Coptodon zillii from Tagwai Dam Reservoir in concrete pond. Fifteen (15) adult samples of each species were collected via baited Malian traps and transferred to the experimental facility at Bosso Campus Fish Farm, Federal, University of Technology, Minna. The samples were held in hapas-in-concrete-pond for 243 days (8-months). somatic and breeding data such as: mean survival rates: 0.27 (27%) and 0.33 (33%), mean final body weights gain: 76.62 ± 26.48 and 43.92 ± 17.08, breeding (fry produced): 201 and 379, progressive breeding trendline (polynomial) equation: $y=15.56x^2-160.58x+387.86$, $R^2=0.7861$ and $y=10.143x^2-101.21x+230.71$, $R^2=0.7534$ were calculated for S. galilaeus and C. zillii, respectively. Survivorship was low (<50 %) for both species in contrast to growth performance (weight gain) by which S. galilaeus was significantly ($p<0.05$) better. Statistical significances were determined by means of Independent-Samples t-test analysis in IBM SPSS 21. The length-weight regression analysis showed b>3.0 (positive allometric growth) for both species with high regression coefficient (R^2 > 90 %). The condition factor (K) for S. galilaeus and C. zillii were 3.07g/cm3 and 3.45g/cm3, respectively, are good indications of wellbeing of the species in captivity. The survival, growth, and breeding in the captive fishes are precursors to the aquaculture potentials of local strains of S. galilaeus and C. zillii. A comprehensive study of the adaptation processes of the species are hereby recommended.

Keywords: Survivorship, breeding trendline, hapas-in-concrete-pond, polynomial equation, condition factor, Growth Pattern, Tagwai Dam Reservoir.

Introduction

Domestication is described to be a selection operation for adaptation to human agro-ecological niches on one hand, and to human orientations at certain point. Expectedly, the wild parents of domesticated species must have possessed the potency to live in human ecologies, and expressed traits favourable for human uses (Larson *et at*., 2014).

Some ten thousand years ago, Homo sapiens, approximately four million of them, were all hunter-gatherers. However, to avoid roaming, in search for naturally occurring food, humans resolved to manipulate the natural world and surround themselves with their needs closer at hand (Scott, 2011).

Aquaculture is often seen as the only key for providing more fish products, given that harvesting wild stocks have reached the upper limit. In aquaculture, only a few species, are considered truly domesticated, like cattle or sheep. Telethon (2014) suggested two scenarios for the future of aquaculture: focusing on few truly domesticated species, like the path taken by agriculture, but avoiding its negative impacts, or aquaculture proceeds with species diversification primarily focusing on domesticating wild strains/species.

Tilapia are fishes with outstanding aquaculture attributes. Their commercial place value has been purportedly occupied by *Clarias spp.* in Nigeria. Their advantages as warm water species include low cost of production; in terms of fry and feeds, high quality flesh, resistance against unfavourable conditions, flexibility of breeding, fast growth rate, ability to efficiently convert organic and domestic waste into high quality protein and good taste (Watanabe*et al al.,* 2002; Fuentes-Silva *et al*., 2013).

This research was undertaken to study the adaptability of wild *Sarotherodon galilaeus* and *Coptodon zillii,* which is known for its adaptability to captivity.

Materials and Methods

Recruitment Site: Fish samples for the research were recruited from Tagwai dam in Tagwai village, Bosso Local Government Area, Niger State.

Experimental Site: The experiment was conducted at the Department of water Resources, Aquaculture and Fisheries Technology, Teaching and Research Farm, Bosso Campus, Federal University of Technology, Minna, Niger State.

Experimental Facilities: The experiment was conducted in Hapas-in-concrete-pond system comprising a concrete pond and six (6) net hapas made of 0.5″ mesh size net knitted on 10x5x1.5 m squared cylindrical plastic pipes.

Pond preparation for introduction of experimental fishes: In line with Adigun (2005), the pond was drained and allowed to dry before letting in water two weeks ahead of introduction of the experimental fishes. Fertilization was done in compliance with the National Agricultural Extension Liaison Services (2003) and Adigun (2005) to stimulate the production of natural fish food, using organic manure (poultry droppings) at 0.1kg/m^2. Thereafter, the same rate was applied for weekly fertilization throughout the 8-month study.

Recruitment of the Specimens: Thirty adults (fifteen adult samples of each species) were collected from Tagwai Dam by means of Malian traps. The samples were kept in two cages (assigning each species to a cage) at the dam and transferred to the experimental pond between 6 and 8 pm.

Water quality Parameters: Water quality of Tagwai Dam and the experimental pond were determined as recommended by APHA (2014).

Transportation of Experimental fishes: The samples were transported in aerated polythene bags to the experimental pond. Water in the transportation bags was prepared in line Emmanuel *et al.* (2013).

Stocking of Experimental Fishes: The stocking procedures took place between 5h00 pm and 7h00 pm. Samples were randomly distributed into six hapas–in–concrete-pond in three replicates of five (5) specimens each by species. The fishes were released in to the hapas by allowing the water in the vessel to gradually mix with water from the receiving environment (pond) to equilibrate temperatures and water chemistry to avoid sudden fluctuations (Michael *et al*., 2012).

Feeding of Experimental Fishes: Apart from the natural food materials available in the pond, supplemental feed (MULTI FEED) at 5% body weight twice daily (morning and afternoon).

Cumulative Survival and survival Rate: Records of cumulative survival from each replicate were taken with notes on the number and cause of mortality as well as number of survivors. Survival rate expressed as follows:

Survival rate: $lx = \frac{nxi}{nx2}$ adapted from Weistein (2015)

Where lx = proportion surviving over time (survival rate)

nxi = Number alive initially (at previous time)

nx2 = Number alive at the given time

Cumulative survival was computed as: Survival = $N_0 - N_1$

Where N_0 = Number alive initially (at time t_0)

N_1 = Number alive at time t

Morphometrics of the experimental samples: Morphometrics assessment was conducted fortnightly when all samples were removed and returned after taking their body weight, total length, standard length. The body weight was read to the nearest 0.01g. The standard and total length of individual samples were taken with a meter rule to the nearest 0.1cm.

Measurement of growth performance: The growth performance was measured using indies which include growth rate, growth pattern and condition factor.

Measurement of growth rate: The growth was calculated as:

$$GR = \frac{WF - W1}{W1} \times 100$$

Where, GR = growth rate, WF = final weight (cm) and W1 = initial weight (cm)

Growth Pattern and Condition Factor:

W = aLb

Where, W =weight (g), L= standard length (cm).

The length-weight relationship (LWR) was expressed by the equation:

Log weight = Log a + b Log length

Where 'a' and 'b' are regression constants (Mensah, *et al*., 2014).

The condition factor was calculated using the Formula:

Kn = [100 W] / L3 (adopted from, Mensah, *et al*., 2014).

Where Kn = condition factor, L = standard length (cm) and W =weight (g).

Data Analysis: significant differences between the treatments in terms of weight gain, increase in total and standard lengths, body width and depth were determined via Independent Sample t-test using SPSS IBM Version: 21. Length-weight relationship was determined using linear regression Microsoft 365 Excel.

Results

Table 1: Mean values of the t-test analysis of quality variables of the source water in Tagwai Dam and the Experimental Pond for captive *S. galilaeus C. zillii*

Variable	Tagwai Dam Reservoir	Experimental pond
Dissolved oxygen (mg L-1)	8.04 ± 0.11^a	7.65 ± 0.39^a
pH	6.79 ± 0.10^a	7.99 ± 0.04^b
Conductivity (µS/cm)	58.50 ± 8.24^a	163.33 ± 4.36^b
Transparency (cm)	36.00 ± 2.00^a	28.00 ± 0.46^b
Hardness (mg L-1)	25.00 ± 0.21^a	38.00 ± 0.05^b
CO_2 (mg L-1)	0.21 ± 0.06^a	0.23 ± 0.07^a
Temperature (˚c)	26.00 ± 1.26^a	26.67 ± 0.82^a

Table 1: shows the mean values of quality variables of water samples taken from Tagwai Dam and the experimental pond during recruitment, pre and after stocking. Statistical differences between transparency, hardness, pH, and conductivity of water samples from the two sights were significant ($p < 0.05$).

Table 2: Analysis of the weights, and standard lengths of captive *S. galilaeus* and *C. zillii* held (243 days) in concrete pond culture environment

Species	Survival rate	Mortality	Mean final Std. Length (cm)	Mean final Weight (g)	Mean weight gain
S. galilaeus	0.27±4.21[a]	11	20.99±0.34[a]	382.5±2.71[a]	76.62±26.48[a]
C. zillii	0.33±10.17[a]	10	16.93±0.56[a]	169.425±5.53[b]	43.92±17.08[b]

Survivorship of *S. galilaeus* and *C. zillii*

Table 2 contains the survival rate of the species in captivity. At age 1 (2-weeks after stocking). Survivorship suddenly dropped at the rate of 0.27 (27 %) and 0.33 (33) respectively. No further mortality was recorded after age 1 to the termination of the study. That was an indication of adjustment to the pond environment.

Mean weight gain

In figure 1: The mean weight gain, increase in total and standard lengths of the samples showed continuous weight increase to the last month of captivity. C. zillii was relatively steady in gaining weight early but proceeded at decreasing rate at later period of captivity. Overall, S. galilaeus was significantly ($p < 0.05$) superior in its final somatic indices which include mean final mean weight and weight gain.

Table 3: Growth function and Condition factor (Kn) of captive *S. galilaeus* and *C. zillii*) in concrete pond culture environment

Sample	a	b	SE of b	R^2	K (±SD)
S. galilaeus	-10.421	5.5044	2.49	0.9302	3.07±0.28[a]
C. zillii	-11.229	6.006	2.45	0.09767	3.45±0.22[b]

Table 3: Shows 'a', 'b' and 'R^2' derivatives of the logarithmic length-weight interaction analysis expressed as polynomial growth trendlines of the experimental *S. galilaeus* and *C. zillii*. The expressions entail positive allometric coefficient 'b' for both species with emphatically strong correlation coefficients: R^2 0.93 and R^2 0.97 respectively. The R^2 values suggest sublime fitness of the regression model in accounting for the interactive effect of the length-weight variables of the samples assessed.

Furthermore, the K value (3.07 and 3.45), imply positive allometric growth and a state of healthy living condition for both *S. galilaeus* and *C. zillii* in the pond.

Reproductive Performance of the experimental fishes

Figure 1 is a graphical representation of the breeding accounts (numbers of fry produced) of *S. galilaeus* and *C. zillii* over the period of captivity. Both species expressed similar breeding pattern (February - May) in captivity as shown by the regression curve. *Tilapia zillii* had higher fecundity all through their breeding interval. In both species, peak fecundity was recorded f at the onset of captivity. Subsequently, fecundity declined along the months until complete cessation of breeding after the fourth month.

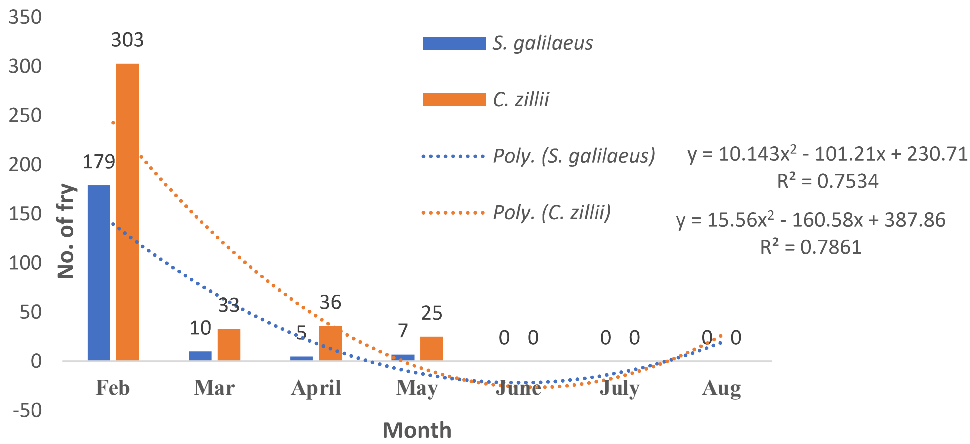

Figure 1: Simple curves describing the progressive polynomial breeding trendline of captive *S. galilaeus* and *C. zillii* through 8-month captive period in hapas-in-concrete pond environment.

Discussion

Water quality parameters of Tagwai Dam and the experimental pond

The major or perhaps, the most critical quality parameters of water (DO, pH, CO_2, and temperature) were within desirable limits for both the river and pond environments (Bhatnagar and Devi, 2013; Costa-Pierce, 2003; FishBase, 2008) despite significant variations ($p < 0.05$).

Reproductive performance of the experimental fishes

The lower fecundity of *S. galilaeus* in captivity may be linked to its mouth brooding strategy which proceeds with low fecundity as observed by Achionye-Nzeh (2011).

Survivorship of experimental fishes

Both species were severely affected with barely (27%) and (33%) survivorship of *S. galilaeus and C. zillii.* The is instructive of their stress sensitivity as observed by Liao and Huang (2000) that, certain stress-sensitive species are affected by nutritional-immunity-endocrine problems resulting from stress. This may be linked to jumpiness upon introduction to the captivity (Zeder, 2012).

Mean Weight gain and growth rate

The significant variation ($p<0.05$) observed between the species mean weight gain may have resulted from factors such as species, genetic variation, and response to captivity (Mensah, *et al*., 2014).

Length–weight relationship

Continuous growth, according to Saha, *et al*. (2009), indicates abundance of food supply and other conditions of wellbeing, whereas slow growth potentially indicate non-availability of food. Saha, *et al*. (2009) postulated that the values of 'a' and 'b' differs between species depending on sex, stage of maturity and food habits. The exponent values for *S. galilaeus* and *C. zillii* were positively allometric. The higher values of Kn in this study is useful as a tool for measuring the relative robustness or wellbeing of spaces in pond environment (Bake, *et al.*, 2014).

Conclusion

Most cases of mortality resulted from stress related incidences, hence, both *S. galilaeus* and *C. zillii* are highly susceptible to (handling) handling stress.

The use of hapas-in- concrete pond does not encourage free movement of the wild species in captivity with consequent interference threat to biological activities such as survival, feeding and even breeding of the species in captivity.

With assurance of survival, growth, and breeding, it is reasonable to conclude that the two species could be truly domesticated for the enhancement of local aquaculture production, through species diversification, crossbreeding and other research endeavours of aquacultural benefits.

Recommendations

Introduction and domestication of local *S. galilaeus* should be encouraged for diversification of local aquaculture production since assurance of the survival and growth of the species in captivity has been verified.

A holistic study of local strains *S. galilaeus* should be conducted to provide research template for possible domestication of the cichlid.

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