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Growth Performance, Length-Weight Relationship and Condition Factor of Backcross and Reciprocal Hybrid Catfish Reared in Net Cages

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ABSTRACT

This study was designed to investigate the growth performance, Length-Weight Relationship (LWR) and condition factor (k-value) of reciprocal backcross hybrid catfish (RCBC), *Pangasianodon gigas* (female)×F1 hybrid (male) catfish and backcross hybrid catfish (BC), *P. gigas* (male)×F1 hybrid (female) catfish. Moreover, this study also compared the above mentioned species of catfish were compared with *P. gigas* and F1 hybrid *P. gigas* (male)×*P. hypophthalmus* (female) catfish. The fish were reared in net cages for 5 months (October, 2013-March, 2014). The results showed that, Weight Gain (WG) and average daily weight gain (ADG) were the highest among the *P. gigas* (34.45 and 0.20, respectively). The Length Gain (LG), average daily length gain (ADL) and Specific Growth Rate (SGR) were highest among the RCBC (10.66, 0.062 and 2.34, respectively). While the survival rate (55%) was highest among the BC. The Feed Conversion Rate (FCR) showed high numbers in all fish except the hybrids. On the other hand, the hybrid species showed lower results in all growth indices except for the survival rate but which had as high a tendency as the RCBC. The LWR revealed “b” values for the *P. gigas*, RCBC, BC and F1 hybrid that were 2.94, 3.12, 2.67 and 2.03 indicating that *P. gigas* and RCBC displayed isometric growth while others showed allometric growth. The k-values for each month showed significant differences ($p < 0.05$) but the k-values averaged over 5 months were not significant ($p > 0.05$). The results from this study revealed that the RCBC is suitable for the aquaculture industry and moreover, the information collected in this study on LWR and the condition factor of each fish will be useful for fishery management.

Key words: Reciprocal backcross hybrid, backcross hybrid, growth performance, length-weight relationship, condition factor

INTRODUCTION

It was the first study in the world which is succeed in the development of breeding backcross and reciprocal backcross hybrid catfish, F1 Hybrid (female)×*P. gigas* (male) and F1 Hybrid (male)×*P. gigas* (female), respectively. We lack other data on these hybrids, for example: Growth performance indices and biological data. We expect these hybrids will be candidates as fish species in the industrial sector. The study of Length-Weight Relationship (LWR) has its applied value in fish biology and is widely used for the purposes of conversion of the equation of growth-in-length to growth-in-weight for use in stock assessment models and estimations of biomass from length observations (Wootton, 1990; Moutopoulos and Stergiou, 2002). Length-Weight Relationship (LWR) is a useful tool in fish growth patterns or age determination (Pepple and Ofor, 2011) and that

relationship was initially used to obtain information on the growth conditions and to find out whether the isometric or allometric growth measurement was appropriate in the equation as:

$$W = aL^b$$

or if it takes on the linear form:

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

where, a and b are constants estimated by regression analysis. If b has the value b = 3, it indicates isometric growth, while b ≠ 3, larger/smaller shows positive and negative allometric growth, respectively (Ricker, 1975). Fulton (1902) proposes the use of $K = 100 \text{ w/L}^3$ for quantifying or estimating the conditions of fish and is referred to as “Condition factor” according to Stevenson and Woods (2006), who described this k-value as a way to quantify the health of individuals in a population or to tell whether a population is healthy relative to other populations. Anyanwu *et al.* (2007) determined that the k-value provided information on the wellbeing of a fish and is usually influenced by fish, sex, season, maturity stage, feed ingredients, etc. The present study is the first attempt to examine the growth performance indices, length-weight relationship and condition factors of the backcross and reciprocal backcross hybrid reared in net cages under the same environmental conditions and then to compare them with their parental fish species (*P. gigas* and the F1 hybrid, *P. gigas* (male) × *P. hypophthalmus* (female)).

MATERIALS AND METHODS

In the growth performance study, 6.0 cm of total length of four species of fingerling fish were reared in captivity (20 fish m⁻²) for 5 months (October 2013-March 2014). The fish were fed 3% of their body weight two times daily with commercial feed containing 30% protein. At five-month intervals, the fish were sampled to monitor their growth. The growth parameters were calculated following the method described by Bagenal (1978) as follows:

$$\text{Weight Gain (WG)} = \text{Final weight} - \text{initial weight}$$

$$\text{Length Gain (LG)} = \text{Final length} - \text{initial length}$$

$$\text{Average daily weight gain (ADG)} = \frac{\text{Final weight} - \text{Initial weight}}{\text{Days}}$$

$$\text{Average daily length gain (ADL)} = \frac{\text{Final length} - \text{Initial length}}{\text{Days}}$$

$$\text{Specific growth rate} = \frac{\text{Ln final weight} - \text{Ln initial weight}}{\text{Days}} \times 100$$

$$\text{Feed Conversion Rate (FCR)} = \frac{\text{Total feed (g)}}{\text{Weight gain (g)}}$$

$$\text{Survival Rate (SR)\%} = \frac{\text{No. of animals survived (fish)}}{\text{No. of animals leased (fish)}} \times 100$$

For the LWR and condition factor studies at five-month intervals, 30 specimens from each fish were selected at random to be measured for total length (cm) and weight (g) using the nearest 0.1 cm ruler and 0.1 g digital weighing scale, respectively. LWR was estimated by using the equation:

$$W = aL^b$$

where, W is the weight of fish (g), a is the regression constant or intercept, b is the regression coefficient or slope. The equation was linearized by a logarithmic transformation into:

$$\text{Log } W = \text{Log } a + b$$

Log L was computed using Microsoft Excel to estimate the “a” and “b” values. The condition factor was calculated using equation:

$$K = 100 W/L^3$$

where, K is the condition factor, W is the wet body weight (g) and L is the total length (cm). The linear relationship between the length and weight was also estimated by calculating the correlation coefficient (R^2). No differences between both sexes were observed at the fingerling stage.

Data analysis: In the growth performance study, univariate analysis of variance (ANOVA) revealed significant differences at varying degrees between the means of the 4 species using SPSSv.17.0. The LWR and condition factor were determined with the computer program Microsoft Excel v.2003.

RESULTS AND DISCUSSION

Growth performance indices: At the end of the experiment, *P. gigas* showed the highest differences in Weight Gain (WG), Average Daily Growth (ADG) and lower FCR value. Reciprocal backcross (RCBC) reported the highest result in Average Daily Length (ADL), with lower FCR and length gain values (LG); moreover, WG and ADG showed the same high tendency as *P. gigas*. Backcross hybrid showed the highest result in SR% but the hybrid showed high SR%, which was similar to BC (Table 1). This study is the first publication that compares the growth performance

Table 1: Growth performance of four species of catfish after 5 months

Parameters	<i>P. gigas</i>	RCBC	BC	Hybrid
WG	34.45±7.2 ^a	28.21±3.86 ^{ab}	19.29±1.00 ^{bc}	15.54±0.15 ^c
LG	7.50±0.91 ^b	10.66±0.69 ^a	7.92±0.23 ^b	8.35±0.55 ^b
ADG	0.20±0.04 ^a	0.16±0.02 ^{ab}	0.11±0.01 ^{bc}	0.09±0.01 ^c
ADL	0.04±0.01 ^b	0.06±0.004 ^a	0.046±0.00 ^b	0.05±0.01 ^b
SGR (%)	1.13±0.12 ^{bc}	2.34±0.09 ^a	1.33±0.15 ^b	1.01±0.08 ^c
FCR	3.21±0.10 ^a	3.20±0.09 ^a	3.33±0.09 ^a	3.58±0.05 ^b
SR (%)	30.00±13.2 ^b	36.67±5.8 ^{ab}	55.00±5.0 ^a	48.33±10.4 ^{ab}

Values marked with different letters show significant differences in the growth parameters among the four groups (p<0.05), WG: Weight gain, LG: Length gain, ADG: Average daily weight gain, SGR (%): Specific growth rate, FCR: Feed conversion rate, ADL: Average daily length gain and SR (%): Survival rate

of hybrid catfish species, especially the reciprocal backcross hybrid and backcross hybrid species. This results may have been affected by a heterosis/hybrid vigor (Burnside, 2004) consequently, the RCBC showed higher numbers in terms of the growth parameters than the BC and the hybrid, which were caused by maternal effects, females may have a stronger influence than males on the phenotypic expression of many traits of the offspring. These maternal effects may be due to the mother's nuclear and extranuclear genes and her environmental factors (Falconer and Mackay, 1996; Heath and Blouw, 1998) according to this research study, the RCBC were produced by the female Giant catfish, while the BC and hybrid types were produced by the male Giant catfish. In addition, the differences in growth parameters have been reported between the hybrid cross and reciprocal cross breeds in some catfish breeds, for example, Ndimele *et al.* (2011) reported the reciprocal hybrid, female *Clarias gariepinus* (CG)×male *Heterobranchus bidorsalis* (HB), showed higher percentages of weight gain and specific growth rates than with the hybrid HB×CG. The results indicate that the maternal effect can be seen in their offspring. In the present results, the RCBC has shown higher growth rate results than the BC. Additionally, the report by Rahman *et al.* (1995) found that the hybrid form *C. batrachus* (fm)×*C. gariepinus* (m) showed better growth and survival rates than the reciprocal and control sibs. Hassan *et al.* (2011) reported that the hybrid, *P. hypophthalmus* (m)×*P. nasutus* (fm) revealed a shorter of total length after hatching than the reciprocal cross. In this study, all of the hybrids showed higher survival rates than the purebred (*P. gigas*). This was because the fingerlings of *P. gigas* showed the most aggressive behavior and the weak fingerlings were eaten by the stronger fingerlings as the RCBC are known to be more aggressive than the BC, which may be due to the heterosis or hybrid vigor and maternal effect. Moreover, effective protection of the fish's natural predators, such as birds, snakes, etc., can result in higher survival rates.

Length-weight relationship and condition factor study: This study provides new information on the length-weight relationships of the two new hybrid catfishes. The length and weight were observed monthly and were found vary within a range of 8.73-17.11 cm (TL) and 5.6-44.57 g (body weight) for the *P. gigas*, 4.18-15.55 cm and 0.51-31.48 g for the RCBC, 5.41-14.07 cm and 1.76-22.4 g for the BC and 5.15-14.10 cm and 2.83-19.71 g for the F1 hybrid. The LWR equations for the combined sexes of 4 fish that were reared in net cages under the same environmental conditions are shown in Fig. 1(a-h). Length-Weight Relationships (LWR) revealed b-values (regression co-efficient) of 2.94, 3.12, 2.67 and 2.03 for *P. gigas*, RCBC, BC and F1 hybrid type, respectively. The results indicate that *P. gigas* revealed isometric growth (b nearest 3) and RCBC reported positive allometric growth but BC and F1 hybrid types revealed negative allometric growth patterns (b = 2.67 and 2.03, respectively), that they are favour increase in length than in mass under the experimental conditions. Moreover, the equations indicated that the coefficient of the determination of *P. gigas*, RCBC, BC and the F1 hybrid were 89.1, 98.8, 96.7 and 91.9, respectively (Fig. 1b, d, f and h). These values are in accordance with the findings of Naeem *et al.* (2010) who reported b = 3.17 of the hybrid, *Catla catla* (male)×*Aeo rohita* (female) and that the condition factor has a positive influence with increasing length or weight. In some catfish and their hybrid type, *Clarias gariepinus*, *Heterobranchus bidorsalis* and F1 hybrids were fed ad-lib with fish meal three times a day for 7 weeks and showed that the factor of the k-value increased from weeks 2 and 3 above 1 but were less than 1 from the prior week (Ekelemu, 2010). According to Chowdhary and Srivastava (2013), it was reported that Asian catfish (*Clarias batrachus*) under poor availability in natural conditions revealed that the LWR had b-values ranging between

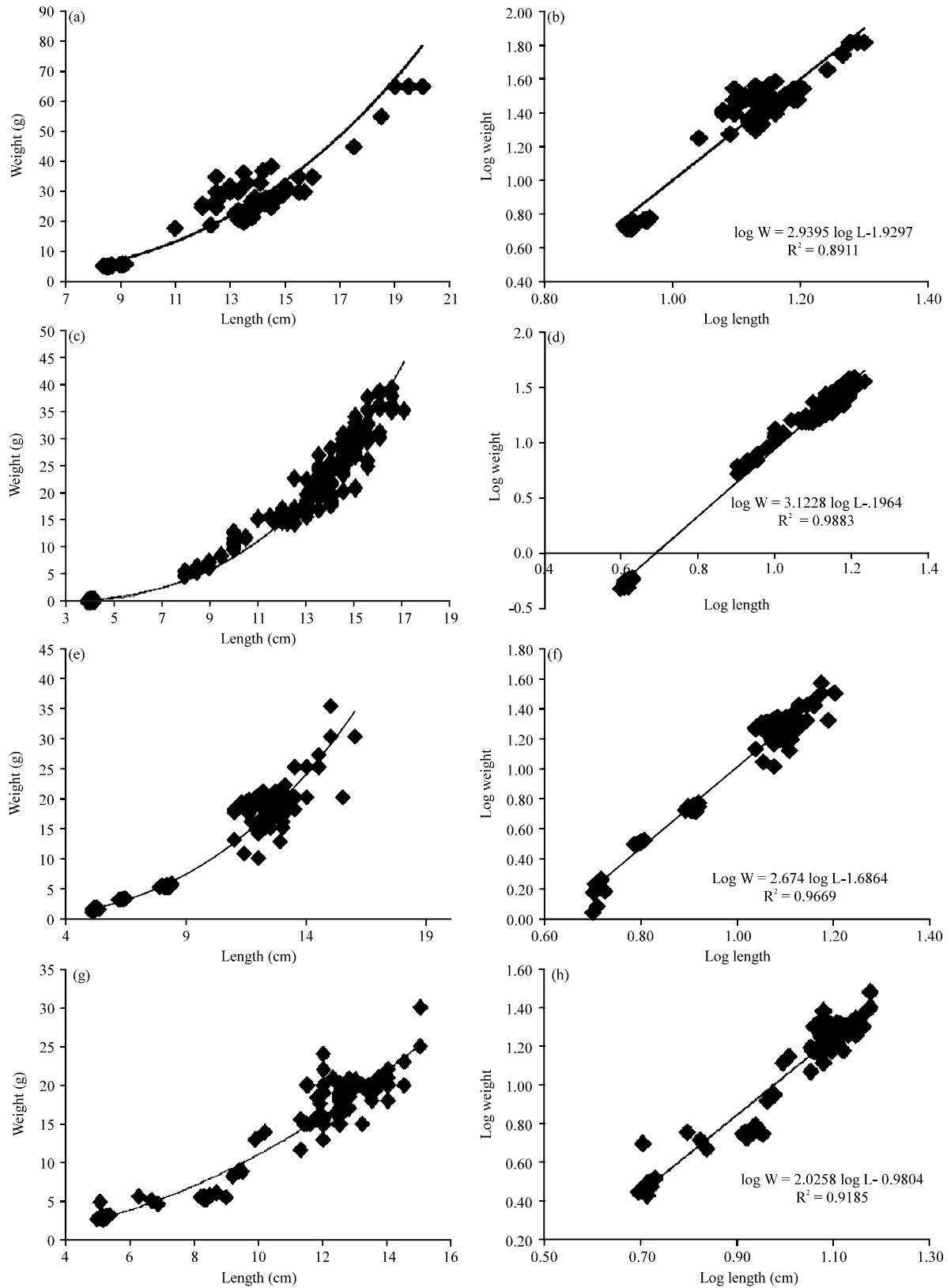


Fig. 1(a-h): LWR recorded over five months for comparison purposes with k-value of (a-b) *P. gigas*, (c-d) reciprocal backcross hybrid, (e-f) backcross hybrid and (g-h) hybrid, respectively

2.01-3.47 and averaged close to the isometric value ($b = 3.48$), whereas the coefficient of determination was highly correlated (92.4). On the other hand, b -values showed strongly positive and negative allometric growth by sex, which was in accordance with the findings of Laghari *et al.* (2009) *Rita rita* reared in cement ponds showed b -values of 3.87 and 2.34 for male and female specimens, respectively. The value of “ b ” may be different due to feeding, sex and state of maturity (Wootton, 1990).

The condition factor (k -value) for 5 months ranging from 0.85-1.01, 0.78-0.90, 0.82-1.16 and 0.78-1.58 for *P. gigas*, RCBC, BC and the F1 hybrid, respectively (Table 2 and Fig. 2). The k -values of 4 fish species that were obtained monthly (October-February) showed significant differences ($p < 0.05$). At the end of the experiment, the average k -value did not reveal significant differences and were less than 1 due to their allometric growth pattern, where the length increased more than the weight. It is note-worthy to state that fish with allometric growth patterns often have k -values of less than 1, which is in accordance with the equation ($100 \times W/L^3$) while the RCBC showed the lowest average k -value because it displayed the highest length gain. Besides, the mean k -values showed that fish is below average condition or lower than one except F1 hybrid during the experiment which indicated not good health condition during the study (Ayoade, 2011). Some catfish species, *Clarias gariepinus*, *Heterobranchus bidorsalis* and their hybrid type, were fed ad-lib with fish meal three times a day for 7 weeks and showed a condition factor from weeks 2 and 3 above 1 but this value was less than 1 from other weeks (Ekelemu, 2010). Remarkably, only one specimen of the BC type revealed a low tendency of k -value in the cold season, which indicated that this hybrid was not prone to adaptation. Other species were found to be more stable which was a

Table 2: Monthly condition factors (k -values) for 5 months of the 4 fish experiments

Months	<i>P. gigas</i>	RCBC	BC	Hybrid
October	0.850±0.017 ^c	0.881±0.200 ^c	1.158±0.131 ^b	1.583±0.718 ^a
November	1.010±0.190 ^a	0.780±0.090 ^c	1.100±0.712 ^a	0.920±0.097 ^b
December	1.010±0.113 ^a	0.910±0.067 ^b	0.880±0.076 ^b	1.020±0.169 ^a
January	0.910±0.057 ^a	0.900±0.104 ^a	0.830±0.083 ^b	0.880±0.085 ^{ab}
February	1.020±0.204 ^a	0.820±0.102 ^b	0.850±0.109 ^b	1.020±0.204 ^a
March	0.860±0.049 ^a	0.870±0.076 ^a	0.820±0.111 ^{ab}	0.780±0.070 ^b
Average	0.943±0.079 ^a	0.860±0.050 ^a	0.940±0.149 ^a	1.034±0.283 ^a

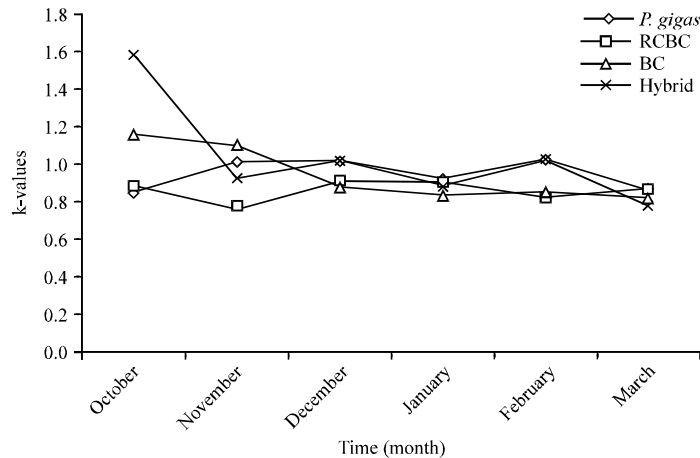


Fig. 2: Monthly condition factors for 4 fish on October-March, 2013-2014

result of an ability to adapt environmentally. All of the species except the RCBC revealed values near 1 and above 1 which suggests that the fish were in good condition; however, the “b” and “K” values are affected by many factors including season, maturity, sex, habitat, diet, stomach fullness, health and preserving techniques (Tesch, 1971).

CONCLUSION AND RECOMMENDATIONS

Based on the results of growth performance, length-weight relationship and condition factor from this study, the reciprocal backcross hybrid has been found to be as suitable candidate for the aquaculture arena. The LWR results indicate that *P. gigas* and the reciprocal backcross hybrid showed the isometric growth pattern, while backcross hybrid and hybrid species showed negative allometric growth patterns for fish that had been reared in net cages. These results can be useful to fishery management practices.

Although the RCBC showed the lowest condition factor, it revealed higher numbers in some parameters of the growth indices. Hence, in the future we intend to study the appropriate conditions for RCBC cultivation.

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