Length-weight relationship and condition factor of the progenies of pure and reciprocal crosses of *Pangasianodon hypophthalmus* and *Clarias gariepinus*

[1]Victor T. Okomoda, [2]Ivan C. C. Koh, [2]Anuar Hassan, [3]Thumronk Amornsakun, [2,4] Sherif M. Shahreza

[1] Department of Fisheries and Aquaculture, University of Agriculture, Makurdi, Nigeria; [2] School of Fisheries and Aquaculture Science, Malaysia Terengganu University, Malaysia; [3] Department of Technology and Industries, Prince of Songkla University, Pattani Campus Thailand; [4] Institute of Tropical Aquaculture (AQUATROP), Malaysia Terengganu University, Malaysia. Corresponding author: M. S. Shahreza, shahreza@umt.edu.my

Abstract. The length-weight relationships of the progenies of *Clarias gariepinus* (CG), *Pangasianodon hypophthalamus* (PH), their reciprocal crosses Pangapinus (♀PH×♂CG) and Clariothalmus (♀CG×♂PH with two observed morphotypes Clarias-like and Panga-like) were investigated in this study. Result obtained shows isometric growth in Clarias-like Clariothalmus and *P. hypophthalmus* (b = 2.99 vs 2.93) while negative allometric growth were recorded for the other progeny groups (b ranges from 2.57 to 2.84). In addition, condition factor was highest for the Pangapinus and pure *P. hypophthalmus* progenies (0.80 and 0.79 respectively), while pure *C. gariepinus* recorded the least value (0.57). The condition factor of the progenies of Clariothalmus (both Clarias-like and Panga-like) recorded intermediate values (0.74). Intercept (a) and regression value (r^2) of the length-weight relationship graph ranges from -1.641 to -2.135 and 0.850 to 0.946 respectively. This result would be relevant for the management of the novel hybrids in future studies.
Key Words: African catfish, Asian catfish, morphotype, "k".

Introduction. Aside the conversion of measurements into weight, and the ability to ascertain associated growth characteristics (Rodriguez et al 2017), length-weight relationships has found its purpose for the estimation of the condition factor of fishes (Le Cren 1951; Froese 2006). The importance of these variable cannot be over emphasized because they reflect the physiological state of the fish as they are affected by intrinsic (gonadal development, organic reserves, presence or absence of food in the gut) and extrinsic (food availability, environmental variability) factors (Nikolsky 1969) hence, could be used to access the general wellbeing (Gaspar et al 2012). Froese et al (2011) and Giarrizzo et al (2015) had also added that the knowledge obtained from length-weight relationships is essential for environmental monitoring programs and to assess fish/fisheries stocks. Establishing a relationship between weight and length is essential for the calculation of production and biomass of a fish population (Dulcic & Kraljevic 1996; Moutopoulos & Stergiou 2002). This is particularly important for newly introduced fish for aquaculture either through domestication of wild fishes or hybridization of different aquaculture species (Freitas et al 2014).

Progenies of intergeneric crosses usually possesses phenotypic and genetic variation which could be disadvantageous or advantageous. Based on the different genetic composition as well as pattern of inheritance, performance of progenies could differ even within the same hybrid cross (Okomoda et al 2017b). We recently hybridize two important catfishes (*Pangasianodon hypophthalmus* and *Clarias gariepinus*) with the aim of producing a novel aquaculture candidate for culture (Okomoda et al 2017a, b). The cross ♀*C. gariepinus* × ♂*P. hypophthalmus* (aka Clariothalmus) resulted in two distinct body forms (Clarias-like and Panga-like) signifying different inheritance pattern. However, all the progenies of ♀*P. hypophthalmus* × ♂*C. gariepinus* (aka Pangapinus) had same Panga-like look. It is important to say that all progenies of the latter fishes and those of the Clarias-like Clariothalmus were phenotypically indistinguishable from their maternal parents. In view of the perceived aquaculture potential of these hybrids, this study was designed to evaluate the length-weight relationship and condition factor of the different fish groups reared in a re-circulatory aquaculture system.

Material and Method. Pure *P. hypophthalmus* (PH), *C. gariepinus* (CG) and reciprocal crosses Clariothalmus (♀CG × ♂PH) and Pangapinus (♀PH × ♂CG) were obtained and maintained as described by Okomoda et al (2017b) in a re-circulatory aquaculture system. Water quality parameter was kept optimum (temperature = 35.0±2.0^{0}C; pH =7.52±0.18; conductivity = 230±0.18 mgL^{-1}; total dissolved solids = 85.0±1.83 mgL^{-1}; dissolved oxygen = 5.2±0.43 mgL^{-1}) and checked daily using a YSI professional plus multi-parameter water quality meter (Model 13M10065, Made in the USA). Fifty fishes each of the different morphotypes per crosses obtained from the same breeding history between the ages of four and six months were used for length-weight relationship data collection. Their length and weight were taken using a sensitive weighing balance and a meter rule respectively.

The length-weight relationship of the fishes from each group was calculated using the equation given by LeCren (1951) and Ricker (1973) as follows:

$$\text{LogW} = \text{a} + \text{b logL}$$

The function condition factor (K) for each species was calculated from the equation:

$$K = \frac{100w}{L^3}$$

Where K = condition factor, L = Standard length (cm), W = Weight (g).

Results and Discussion. Many authors had earlier opined that length-weight relationships can vary significantly even within the same species as it is affected by factors such as sexes, season variation, growth phases, stomach contents, gonadal development, as well as health (Kawamura 1972; Bagenal & Tesch 1978; Hossain et al 2006; Leunda et al 2006; Gaspar et al 2012). Hence, the level of variation between progenies of the different crosses in this study was expected. The values of "a" and exponent "b" for the five group of fish in this study were within the limits reported by Froese (2006), Pervin & Mortuza (2008). From the result of the present study, most of the fishes had a negative allometric growth except the *Clarias*-like *Clariothalmus* and the pure *P. hypophthalmus* which came incredibly close to the reference value of "3" (b = 2.99 vs 2.93) (Figures 1, 2, 3, 4, 5 and Table 1).

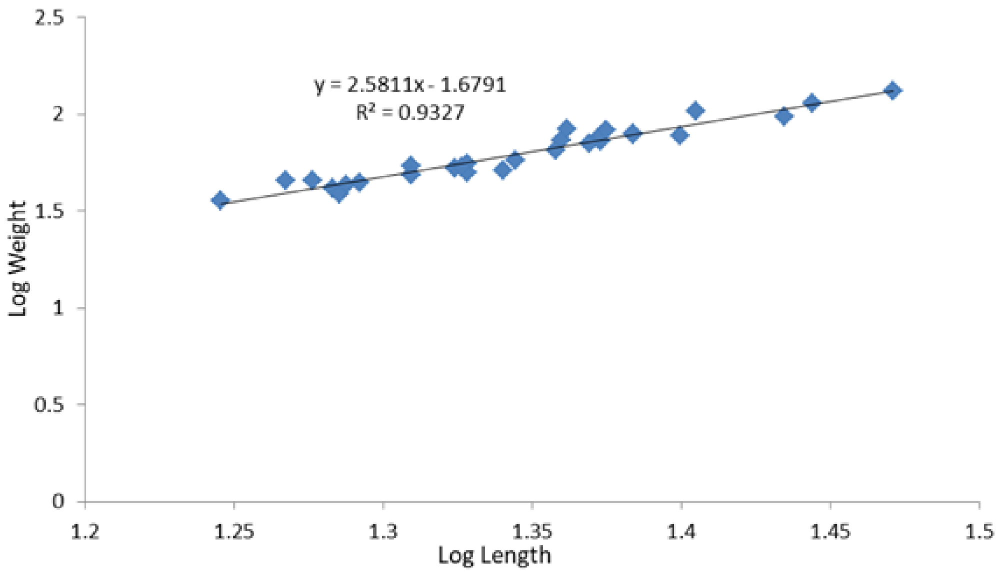

Figure 1. Length-weight relationship of pure *Clarias gariepinus*.

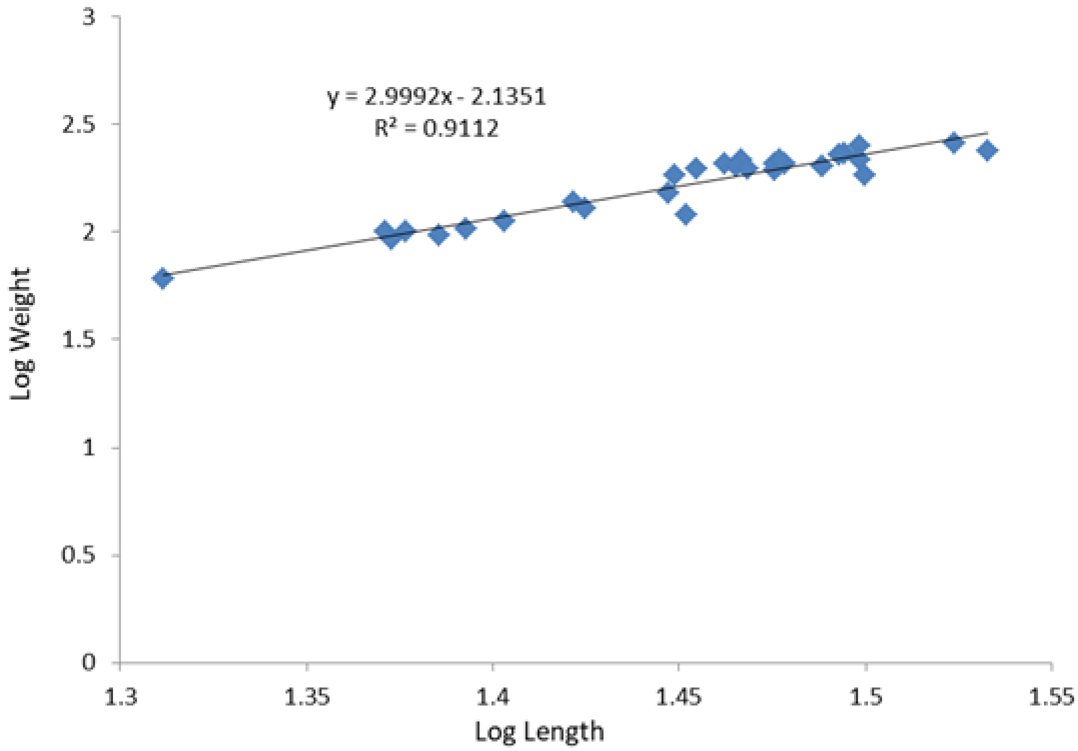

Figure 2. Length-weight relationship of pure Clarias-like Clariothalmus.

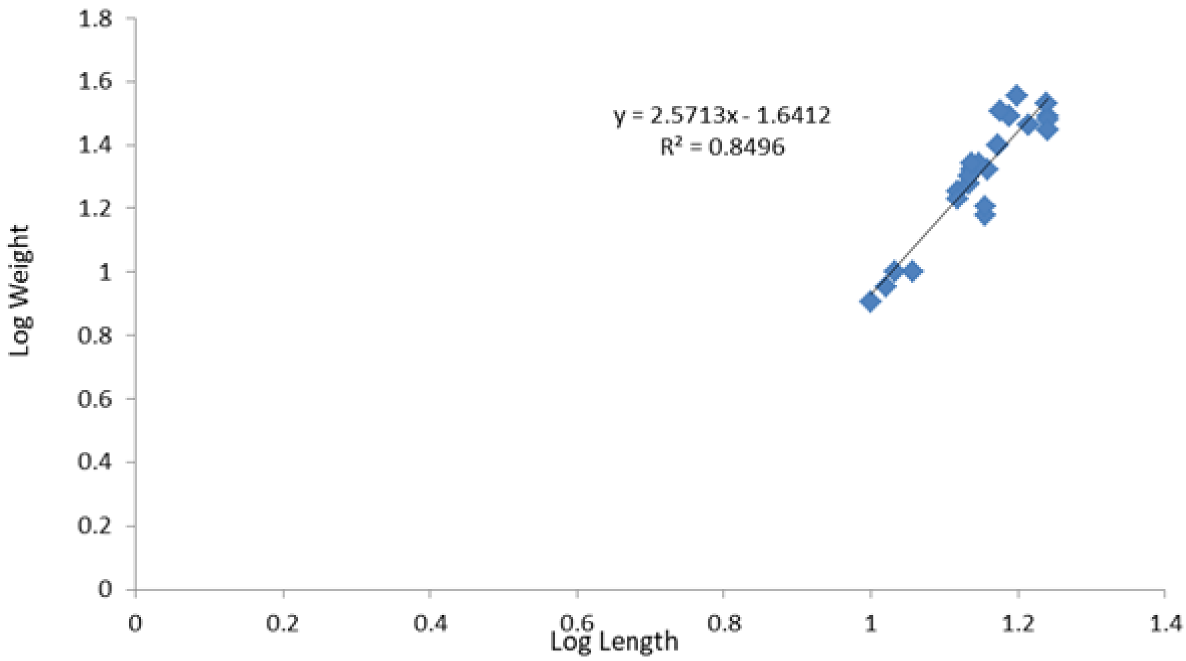

Figure 3. Length-weight relationship of Panga-like Clariothalmus.

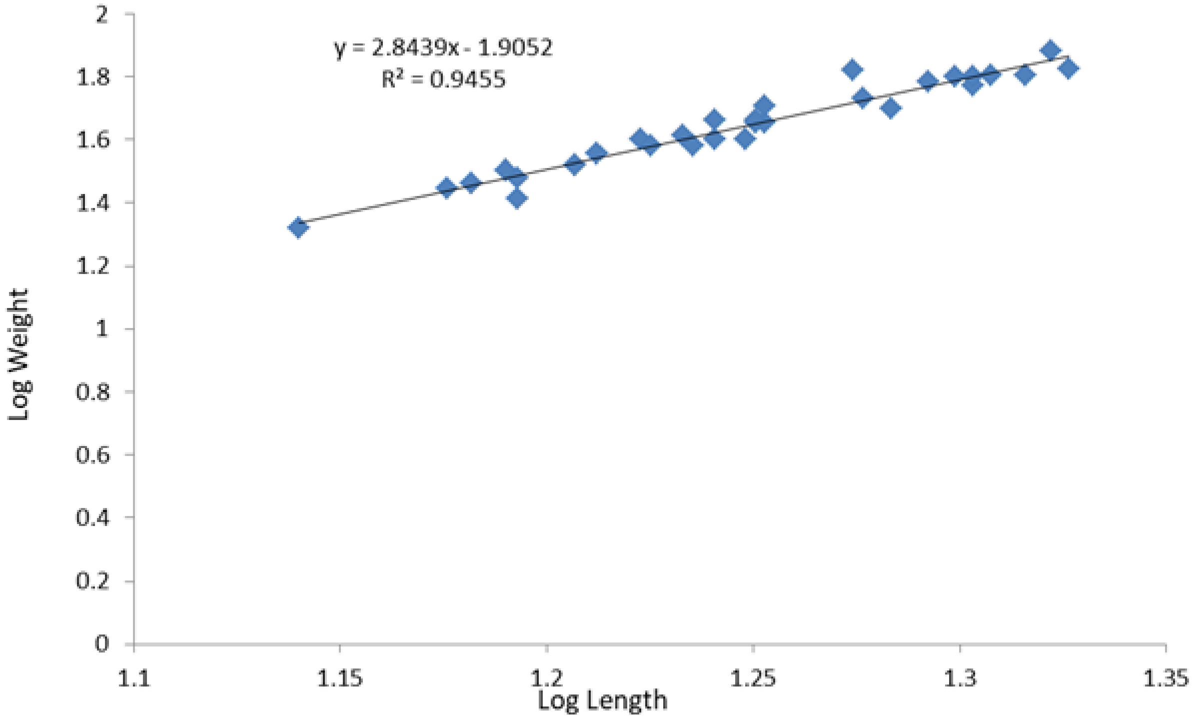

Figure 4. Length-weight relationship of Pangapinus.

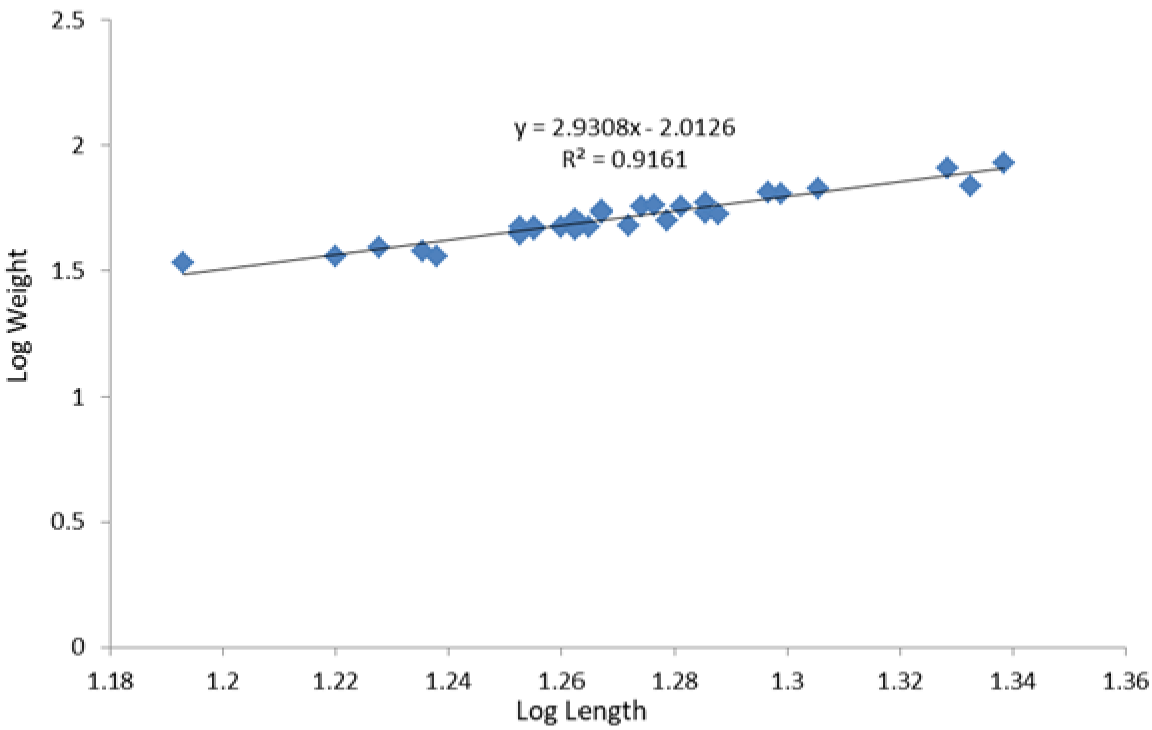

Figure 5. Length-weight relationship of pure *Pangasionodon hypophthalmus*.

Table 1
Length-weight relationship and condition factor of pure and reciprocal crosses of *Pangasianodon hypophthalmus* and *Clarias gariepinus* (n=50)

Parameter	*♀CG × ♂CG*	*♀CG × ♂PH*		*♀PH × ♂CG*	*♀PH × ♂PH*	*P-Value*
		Clarias-like	*Panga-like*			
a	-1.679	-2.135	-1.641	-1.905	-2.013	-
b	2.581	2.999	2.571	2.844	2.931	-
r^2	0.933	0.911	0.850	0.946	0.916	-
k	0.57±0.01[c]	0.74±0.01[b]	0.74±0.02[b]	0.80±0.01[a]	0.79±0.01[a]	0.001

Mean in the same row with different superscript differ significantly (P<0.05).

According to Riedel et al (2007), a negative allometric growth implies that the fish is becoming tinnier as it increases in weight; hence, the fishes become slender. An isometric length-weight relationship on the other hand implies that the weight of these fishes increases at approximately the same rate as the length (Olufeagba et al 2016). However, variations in the value of "b" within the same habitat could be linked to so many factors. Some of which includes differences in the physiology of different fishes (Le Cren 1951), feeding rate (Tarkan et al 2006), degree of stomach fullness (Hossain et al 2009, 2012), sexes, sensitivity to water quality parameters (Khallaf et al 2003), differences in the observed length ranges of the specimens sampled (Wooten 1998), or behavior (Muchlisin et al 2010). It could be rightly said that one or more of these factors must have interplayed to cause the current observation made on the length-weight relationship in this study.

The isometric performance of Clarias-like Clariothalmus over its pure parent *C. gariepinus* could be linked to high cannibalism on the Panga-like Clariothalmus in the progeny pool. Hence, they must have obtained more extra protein source in addition to the regular feeding done twice throughout the study period. Although, cannibalism also occurred within the progenies of the *C. gariepinus*, larger size discrepancies occurred in the Clariothalmus, hence, could have resulted into more successful cannibalism acts in the former than the latter. This is justified by many unobserved mortality in the Clariothalmus than in the *C. gariepinus* (Note reported scientifically in the present study). Hence, separating the two observed morphotypes may be a good management practice of interest for better survival of the Panga-like morphotype. However, this scenario may not be the case when the *P. hypophthalmus* is compared with the values of Pangapinus or the Panga-like Clariothalmus. The growth pattern reported in this study is similar to the value reported by Shahririar Nazrul et al (2011) for GIFT (b = 2.69) and GIFU (b = 2.72) Tilapia. Narejo et al (1999) had also reported "b" value of 2.68 for male *Tenualosa ilisha*. However the value gotten by Al-Baz & Grove (1995) for females of the same species (b = 3.16) was higher than any of the values reported in this study. The most logical explanation for the differences in these studies are largely linked to differences in species, strain, stock, sexes, and possibly environmental factors.

According to Shinkafi et al (2013) and Solomon et al (2017), condition factor (k) is often used to describe the "well-being or condition of fatness of the fish". This is based on the assumption that fatness in relation to a particular length implies better physiological conditions in the fish (Bagenal 1978). It usually gives information about the physiological state of the fish in relation to some environmental changes (King 1996). Hence, this phenomenon has been exploited in many studies as an important index for monitoring feeding intensity as well as growth rates in many fishes (Oniye et al 2006). Generally, a condition factor close to, or above 1 is desirable (Olufeagba et al 2016). However, the condition factor recorded in this study ranged from k = 0.57 in *C. gariepinus* to 0.80 in the Pangapinus. According to Khallaf et al (2003) condition factor of fish are affected by many of the factors previously highlighted earlier for the variations in the values of "b" in this study (i.e. strain, species, stress, sexes, availability of feeds, water quality etc.). Hence, this could justify the differences between the observation of the present study and those of previous studies on different fishes under different experimental conditions (Tsoumani et al 2006; Karakulak et al 2006; Fontoura et al

2010; Solomon et al 2012; Olufeagba et al 2016; Solomon et al 2017; Rodriguez et al 2017; Freitas et al 2017).

Conclusions. This study shows significant differences in the length-weight relationship and condition factor of pure and reciprocal crosses of *C. gariepinus* and *P. hypophthalmus* progenies. These findings would be relevant for the management of the novel hybrids in future studies.

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Authors:
Victor Tosin Okomoda, University of Agriculture, Department of Fisheries and Aquaculture, Nigeria, Makurdi, PMB 2373, e-mail: okomodavictor@yahoo.com
Ivan Chong Chu Koh, Malaysia Terengganu University, School of Fisheries and Aquaculture Science, Malaysia, Terengganu, 21030 Kuala Terengganu, e-mail: ivankcc@umt.edu.my
Anuar Hassan, Malaysia Terengganu University, School of Fisheries and Aquaculture Science, Malaysia, Terengganu, 21030 Kuala Terengganu, e-mail: anuar@umt.edu.my
Thumronk Amornsakun, Prince of Songkla University, Department of Technology and Industries, Thailand, Pattani Campus, e-mail: thumronk.a@gmail.com
Sherif Md. Shahreza, Malaysia Terengganu University, School of Fisheries and Aquaculture Science, Malaysia, Terengganu, 21030 Kuala Terengganu; Malaysia Terengganu University, Institute of Tropical Aquaculture (AQUATROP), Malaysia, Terengganu, 21030 Kuala Terengganu, e-mail: shahreza@umt.edu.my

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