Reproductive Performance and Short-Term Growth Pattern of The Progenies of the Reciprocal Hybrids of *Clarias gariepinus* and *Heterobranchus bidorsalis*

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Received:- 06 October 2022/ Revised:- 18 October 2022/ Accepted:- 24 October 2022/ Published: 31-10-2022

Abstract— *The hybrids of Clarias gariepinus with Heterobranchus species are economically very important. The reciprocal interspecific progenies of Clarias gariepinus♀ x Heterobranchus bidorsalis♂ (Cgf x Hbm) and H. bidorsalis♀ x C. gariepinus♂ (Hbf x Cgm) were produced in the Fish Farm Demonstration Unit of the University of Port Harcourt. At Two weeks, mean weights were 7.0mg±0.0008 and 6.5mg±0.0006 for CGm x HBf and HBm x CGf, respectively with the corresponding total lengths of 1.01cm ±0.011 and 0.97cm±0.008. At the end of the experiment, mean weight of 10.77±1.65/11.04±1.79 and total length of 11.08±0.38/ 10.96±0.54 were observed for Cgm x Hbf/Hbm x Cgf, respectively. The total length was significantly different (P< 0.05) at the commencement of the experiment, which leveled off by the third week. All the parameters including the Head length, Head width, Dorsal fin length and adipose fin length did not differ significantly (p>0.05) for the reciprocal progenies. The condition factor was 1.27 for Cgm x Hbf and 1.28 for Cgf x Hbm*.

Keywords— Heterobranchus dorsalis, Clarias gariepinus, progenies, allometric growth.

I. INTRODUCTION

Global food-fish production based on capture from the wild, natural resource is now known to be limited in its capacity in meeting the demands for fish protein. This is evidentially due to degradation of the aquatic environment, increasing global population and resultant pressure on aquatic resources and increased dietary advices recommending the consumption of more fish visa-vis livestock flesh (Thustean and Roberts, 2014) and aquaculture is the viable alternative. Aquaculture production in Nigeria has witnessed increased production in the last two decades, growing 14.24 times from 1998 to 291,233 tons in 2018 (FAO, 2018; Adeleke et al., 2021). This growth is driven by the declining capacity of the nations' natural fishery resource to meet the demand for fish and destruction of critical habitats, discovery of candidate aquaculture species, population growth, changing dietary patterns, removal of regional barriers to movement of goods and services, development of new technologies and innovations resulting in intensification among others. From year 2000, Nigeria's contribution to global aquaculture production increased marginally from 0.07% to 0.44% in 2015. Currently, Nigeria is the leading producer of farmed fish in sub-saharan Africa and second to Egypt in Africa (Adeleke *et al*., 2021).

To improve growth and sustain the successes recorded in the industry, production of fast growing strains are needed. Hybridization is a breeding technique used to generate genetic diversity from different individuals of different species, genus or populations of the same species. The aims of hybridzation include improving growth performance, flesh quality and tolerance to adverse rearing environmental conditions; increasing disease resistance, producing sterile animals, and manipulating sex ratios as well as various other traits. The technique is also a viable alternative to selective breeding when there is little additive genetic variation in the desired traits of pure stocks to be exploited. Intergeneric hybridization is the crossing of different species belonging to different genus with the aim of producing offspring that will exploit heterosis and combine useful characteristics of both species. However, hybrids must be properly characterized, identified and classified (Akinwande et al., 2013). Part of the phases in intergenerc hybridization is the morphological description of the resulting hybrids. The detailed characteristics of the morphometric features of the hybrids between C. gariepinus and Heterobranchus species may be needed to distinguish it from the different species within the clariidae. The aim of this study is to compare the short-term growth, survival, and morphological characteristics of the progenies of the early stage of reciprocal hybrids of

Clarias gariepinus x *Heterobranchus bidorsalis*. It is expected that the present study will generate information that will contribute to the development of Nigerian aquaculture.

II. MATERIALS AND METHODS

Collection of broodstock: Sexually matured males (♂) and Females (♀) of *Heterobranus bidorsalis* and *Clarias gariepinus* weighing 1000-2000g were procured from two commercial farms in Port Harcourt, Rivers state. The history of the broodstock could not be traced.

To enable release of eggs, the females were injected with Ovaprim® hormone at a dosage of 0.5 ml per kg weight and the males sacrificed to obtain the milt. The reciprocal hybrids were produced by fertilizing female *H. bidorsalis* with milt from male *C. gariepinus* (♂CGm x ♀HBf) and male H. bidorsalis fertilized with milt from female *C. gariepinus* (♂HBm x ♀CGf). The larvae were reared for two weeks in two tanks before separation into experimental tanks. Thus a total of 600 two-weeks old hybrid catfish (♀HBf x ♂CGm and ♀CGf x ♂HBm) fry were used. Two weeks after hatching, 50 fry of each cross in 5 replicates were were randomly chosen and reared for 8weeks in transparent rectangular tanks of 44 x 29 x 24 cm.

2.1 Reproductive performance parameter

The numbers of eggs released in each experimental unit was determined by subtracting the weight of the brood stock after stripping (Wb) in grams from the weight of the broodstock before stripping (Wa) in grams and multiplying the difference by 700(1g=700eggs) (Viveen et al.,1985).

In determining fertilization rate, 150eggs were taken from each experimental unit about 20 minutes after fertilization in a container containing water and translucent eggs containing embryonic eyes were counted as fertilized; while opaque eggs were considered as unfertilized. This was then calculated according to Adebayo and Popoola (2008) as follows:

$$\text{Percent fertilization} = \frac{Number\ of\ fertilized\ aggs}{Total\ number\ of\ Eggs\ counted} \times 100$$ (Adebayo and Popoola, 2008)

2.2 Determination of Hatchability

Hatchability was determined by direct counting of fry in each experimental unit according to Akinwande et al (2013) as follows:

$$\text{Hatchability} = \frac{Number\ of\ hatchlings\ (two-day\ old)}{Total\ number\ of\ fertilized\ eggs} \times 100$$

Survival rate was calculated as follows:

$$\text{Percentage Survival} = \frac{Number\ of\ fish\ at\ the\ endof\ the\ experiment}{Initial\ number\ of\ fish} \times 100$$

Specific growth rate,

$$\text{SGR} = \frac{Ln\ W2 - Ln\ W1}{T2 - T1} \times 100$$

Where

Ln W2 : Natural log of final Weight, W2

Ln W1: Natural log of initial weight, W1

T1 and T2: Duration of experiment in Days

2.3 Condition factor

The condition factor (K) was estimated for each genetic cross to determine the state of wellbeing of the fish according to the equation:

$$\text{Fulton condition factor (K)} = \frac{W}{L^3} \times 100$$ (Lagler, 1956)

Where: W= weight and L= length

Paired data were analysed by Student's t-test and when necessary, analyses were performed after logarithmic transformation for weights or angular transformation for survival rates in order to stabilize residual variance. In text and tables, means are given with the confidence interval at 5% probability. To reduce variation, shooters or jumpers were culled to eliminate outliers that may influence the results.

III. RESULTS

3.1 Fertilization, Hatchability and Survival

The percentage fertilization and hatching rate of eggs and survival rate of fry differed significantly ($P<0.05$) in each of the genetic crosses (Table 1). The highest percentage fertilization, hatchability and survival rate of 85.00%, 91.07% and 98.67%, respectively occurred in ♂HBm x ♀CGf cross.

TABLE 1
GROWTH CHARACTERISTICS OF RECIPROCAL HYBRIDS BETWEEN CLARIAS GARIEPINUS AND HETEROBRANCHUS BIDORSALIS AT 82 DAYS

Characteristics	♂CGm x ♀HBf	♂HBm x ♀CGf	Level of Significance
Condition Factor	1.27	1.28	NS
Initial weight	0.00708±0.0008	0.00625±0.0006	NS
Final Weight	10.77±1.65	11.04±1.79	NS
Initial length	1.01±0.011	0.967±0.008	**
Final length	11.08±0.376	10.96±0.54	NS
Head length at 84 days	3.15±0.116	3.32±0.172	NS
Head width at 84 days	2.22±0.086	2.25±0.129	NS
Dorsal fin length at 84 days	5.68±0.278	5.48±0.304	NS
Adipose Fin length at 84 days	1.03±0.066	0.978±0.098	NS
Fertilization Rate	73.70±1.66	85.00±2.94	**
Hatchability %	67.33±3.60	91.07±4.83	**
Survival rate %	89.00±8.04	98.67±8.70	**
Specific growth Rate (%day^{-1})	2.45	2.47	NS

3.2 Body weight

The hybrid ♂CBm x ♀HBf recorded non-significantly higher mean weights ($p > 0.05$) compared to the alternative genetic type up to the 70th day and during the last weeks the mean weight of ♂HBm x ♀CGf cross was non-significantly higher than ♂CBm x ♀HBf (Fig. 1).

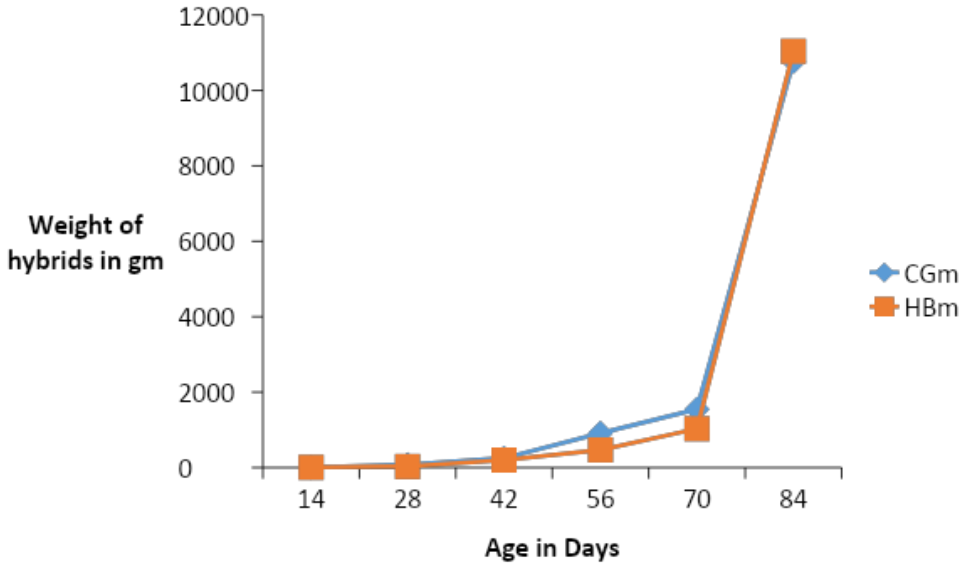

FIGURE 1: Growth in weight of reciprocal hybrids of *Heterobranchus bidorsalis* and *Clarias gariepinus* reared for 84 days in transparent rectangular plastic tanks

3.3 Specific growth rate

The corresponding Specific growth rates were 2.45 and 2.47% per day for ♂CBm x ♀HBf and ♂HBm x ♀CGf cross, respectively. The CV associated with weight was very high especially during the last two weeks of the 84 day experiment.

3.4 Linear Morphometric characters

The total length differed significantly between the reciprocal hybrids at 2 weeks ($P<0.05$) but levelled off at the close of experiment ($P>0.05$), growing from 1.01±0.011 to 11.08±0.386 cm in ♂CGm x ♀HBf and 0.987±0.008 to 10.96±0.54 cm in ♂HBm x ♀CGf. The linear growth in total length continued to be higher until week 5 when TL for ♂HBm x ♀CGf was 6,41±0.48 cm compared to 5.94±0.41cm ($P>0.05$). The trend in linear growth of total length of the hybrids is as shown in Fig. 2. The ♀HBf x ♂CGm hybrids displayed an even faster growth in linear terms than HBm x ♀CGf though insignificant ($P>0.05$).

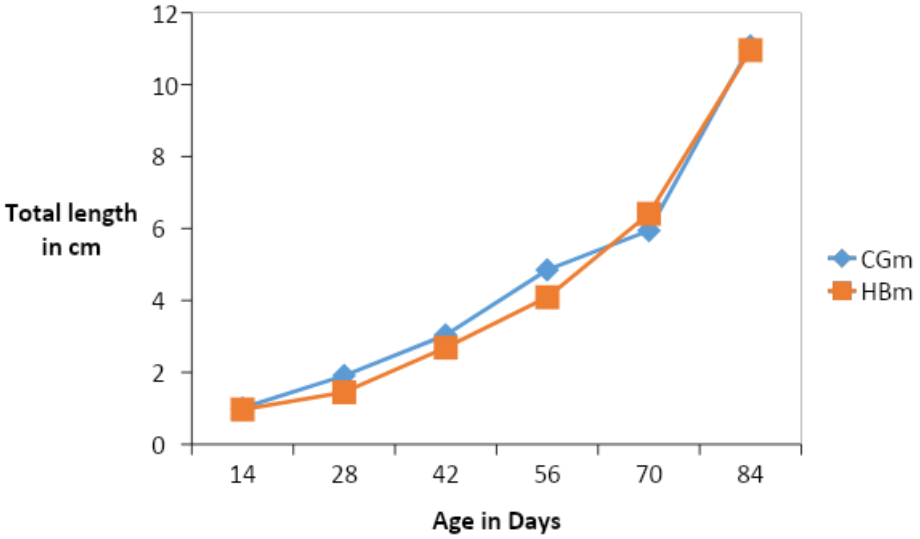

FIGURE 2: Growth in total length of genetic cross of ♂CGm x ♀HBf and reverse cross reared for 82 days in transparent rectangular plastic tanks.

The head length increased linearly from 0.246 ±0.002 cm in ♂CGm x ♀HBf and 0.248 ±0.005 in ♂HBm x ♀CGf to 3.15 cm and 3.32 cm, respectively ($P>0.05$).

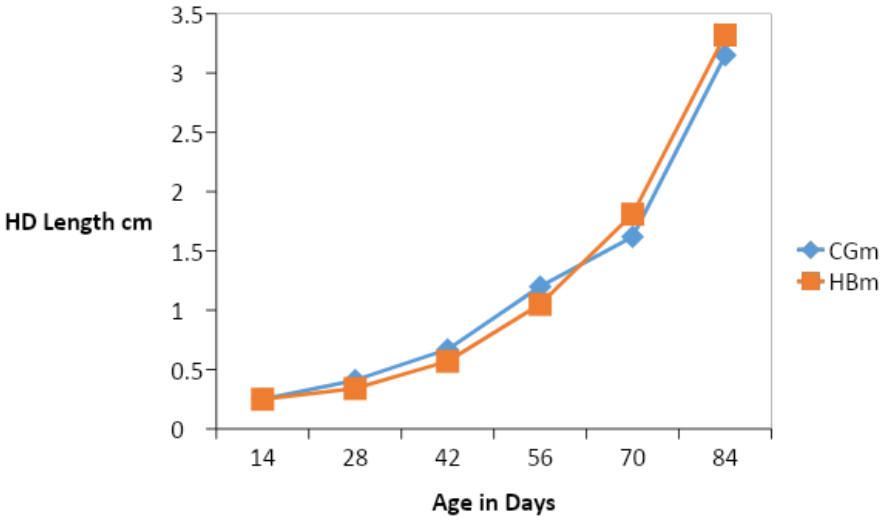

FIGURE 3: Growth in Head length of genetic cross of ♂CGm x ♀HBf and reversed cross reared for 82 days in transparent rectangular plastic tanks.

The dorsal fin length, DFL and adipose fin length, AFL and head width, HDW were measured from the 56th day. Table 2 shows the variations in the DFL, AFL and HDW, which were non-significantly different in ages. The AFL in this study represented 9.30 and 8.92% of the total length for ♂CGM x ♀HGF and ♂HBM x ♀CGF, respectively.

TABLE 2
MEAN DORSAL FIN LENGTH (DFL), ADIPOSE FIN LENGTH (AFL) AND HEAD WIDTH (HDW) OF GENETIC CROSS OF *HETEROBRANCUS BIDORSALIS* AND *CLARIAS GARIEPINUS*.

Age in Days	Character	♂CGm x ♀HBf			♂HBm x ♀CGf			Level of sign.
		X±SE	Variance	SD	X±SE	Variance	SD	
56	DFL	2.37±0.09	0.05	0.22	2.47±0.22	0.30	0.55	NS
70		2.94±0.22	0.28	0.53	3.29±0.22	0.30	0.55	NS
84		5.68±0.28	3.17	1.78	5.48±0.30	2.97	1.72	NS
56	AFL	0.49±0.04	0.01	0.12	0.23±0.04	0.01	0.09	NS
70		0.67±0.06	0.02	0.14	0.53±0.06	0.02	0.15	NS
84		1.03±0.07	0.18	0.42	0.98±0.10	0.30	0.55	NS
56	HDW	0.9±0.04	0.01	0.10	0.77±0.09	0.04	0.21	NS
70		1.25±0.14	0.11	0.33	1.25±0.12	0.08	0.29	NS
84		2.22±0.09	0.31	0.55	2.25±0.13	0.53	0.73	NS

NS means Not significant at 5% confidence level.

3.5 Condition Factor

The Condition factor of 1.27 for CGm and 1.28 for HBm were recorded for the genetic types.

IV. DISCUSSION

The reciprocal interspecific progenies of ♀CGf x ♂HBm and ♀HBf x ♂CGm were produced in the Demonstration Fish Farm Unit of the University of Port Harcourt to determine reproductive performance and growth pattern of different body parts. The high rate of fertilization of about 85% for ♂HBm x ♀CGf in this study is comparable to 87.5% obtained by Ipinjolu et al. (2013) and Ola-Oladimeji (2015) in similar hyridisation studies between *H. bidorsalis* (male) and exotic *Clarias gariepinus* (female) in a different ecological zone. This suggests a maternal influence on hatchability and fertilization. The hybrid fry produced using the eggs of *C. gariepinus* had significantly higher survival (85.00±0.00%) than the fry of hybrid derived from the eggs of *H. bidorsalis* (75.50±2.12%), thus indicating maternal inheritance of survival (Ola-Oladimeji (2015) Nwadukwe (1995) made similar conclusion for the hybrid of *C. gariepinus* and *Hetrobranchus longifilis.* Maternal inheritance could result from innate differences in egg quality due to age, size, and condition at the time of spawning (Butts et al., 2014; Dunham, 2011).

The mean length of fry at the start of measurement was close to those of *C. gariepins* at 10 days in Verreth et al. (1993). The mean length and mean weight obtained for ♂CGm x ♀HBf and ♂HBm x ♀CGf, respectively at 84 days were close to values obtained by Okeke (2014) at 112 days for the cross between *Clarias gariepinus* female and *Heterobranchus spp*. male. Sanda et al (2015) reported superior growth of the hybrids *Clarias anguillaris*♀x *Heterobranchus bidorsalis*♂ to *Heterobranchus bidorsalis*♀ x *Clarias anguillaris*♂. However, Ola-Oladimeji (2015) observed that growth in total length of ♀ *C. gariepinus* x ♂ *H. bidorsalis* cross was not significantly different from ♀*H. bidorsalis* x ♂*C. gariepinus* cross .

The SGR recorded in this work concurs with 2.44 observed by Angahar (2017) for hybrids reared under similar conditions and falls within the range of 2.12%.day^{-1} to 3.96%.day^{-1} obtained for various strains of *H. longifilis* by Nguenga *et al* (2000). Akinwande *et al* (2009) obtained highest SGR of 2.11% for reciprocal hybrids of *H. longifilis* (♀) and *H. bidorsalis*(♂). It appears that there is a paternal effect on SGR because the Cross between ♂ *H. bidorsalis* and (♀) *C. gariepinus* produced the highest SGR in the present study. Olaniyi and Omitogun (2018) showed the the superiority of the hybrid ♀ *C. gariepinus* × ♂ *H. bidorsalis* with respect to SGR and other parameters. However, the influence of broodstock size cannot be dismissed (Odedeyi, 2007; Uedeme-Naa and Nwafili, 2017), The CVs for the various characters were high. Fleuren (2007) confirms large variation in body weight of hybrids between *C. gariepinus* and *H. longifilis* in agreement with this s Ponzoni study. High CVs are usually associated with various fish species in the range of 20-35% (Gjedrem, 1997). The emergence of shooters or jumpers

have been identified in clariid hatcheries (Abdulraheem et al 2019). The sharp increase in weight (Fig. I) was due to the emergence of shooters in both genetic types. To deal with these problems, shooters were culled during the initial selection of individuals and thereafter on weekly basis until the end of the experiment. Young fish exhibit allometric growth patterns, high growth potentials than the older ones, the intensity of cannibalism would reach a maximum in the early weeks or months of the history when the variability of individual growth would be maximum (David et al., 2010).

Onyekwelu et al (2021) in their 6 weeks study of fingerlings of *Clarias gariepinus* obtained HDL 1.05-1.50 cm. The HDL represented 28.42% of of TL in CGm x ♀HBf and 30.29% in HBm x CGf. Olaniyi et al (2017) reported that the HDL was 29.9% of the standard length in adult H. bidorsalis captured from Kainji Lake while the AFL was 23.4%. The HDW was 20.04% and 20.53%, respectively for CGm x ♀HBf and HBm x ♀CGf. In *C. gariepinus* from Lake Nubia, the HDL corresponded to 24.9% of the standard length (Hamad, 2014).

The HDW obtained in this study is close to one-half reported by Akinwande *et al.* (2013) for hybrids of *C. gariepinus* and *H. longifilis*. These values are close to midpoint values reported by Agbebi et al. (2009) for diploid and triploid progenies of *H. bidorsalis*. Intermediate values have been reported for some morphometric characters between hybrids of *C. gariepinus* and *Heterobrancus* species (Nwadukwe, 1995; Legendre et al., 2006).

The condition factor is a quantitative parameter the state of well-being and it reflects recent feeding condition of the fish. The result implies that the two genetic types were in the same physiological condition. Therefore, many factors such as sex, age, state of maturity, size, state of stomach fullness, sampling methods and sample sizes and environmental conditions affect fish condition and parameters of length-weight relationships in fish (Khan et al., 1991; Anene, 2005; Yem et al., 2007).

V. CONCLUSION

In the selection of breeding pairs, considering maternal influence on fertilization, hachability and growth rate, hybridization between *male heterobranchus* mating and female *Clarias gariepinus* would be desirable.

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