Journal of Fisheries International 6 (3): 67-70, 2011
ISSN: 1817-3381

Growth and Heterosis in Reciprocal Clarias Hybrids Between *Clarias gariepinus* and *Clarias anguillaris*

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Abstract: Interspecific hybrids of *Clarias gariepinus* and *Clarias anguillaris* were produced by employing the technique of hypophysation and dry stripping. Investigations on their aquaculture potential in terms of growth and survival were carried out. About 2 weeks old fry (0.06±0.02 g) of the parental Clarias species and their interspecific hybrids were stocked in hapa nets (1 m^2) suspended in outdoor earthen ponds (16 m^2) in triplicates for a rearing period of 56 days. Weight increase in the parentals and the reciprocal hybrids were assessed fortnightly. Studies revealed that the growth of the hybrids were intermediate to the parental *Clarias gariepinus* but higher than *Clarias anguillaris*. The weight gain attained by *Clarias gariepinus*, *Clarias anguillaris*, *C. gariepinus* (♂) x *C. anguillaris* (♀) and *C. anguillaris* (♂) x *C. gariepinus* (♀) were 3.18, 2.99, 3.16 and 3.05 g, respectively. Among the interspecific hybrids, the growth of *C. gariepinus* (♂) x *C. gariepinus* (♀) was higher than its reciprocal hybrid cross of *C. anguillaris* (♂) x *C. gariepinus*(♀). Survival of the reciprocal hybrid crosses at 8 weeks were also intermediate to that of the parental *Clarias gariepinus* but higher than *C. anguillaris*. Hybrids displayed positive heterosis for weight gain (0.65%) and survival (0.80%). The superiority of these growth traits of the hybrid groups at least over one of the parentals indicates hybrid vigor. Hence, hybrids in both directions appear to have considerable potential for use in aquaculture.

Key words: Hybrids, heterosis, *Clarias gariepinus*, *Clarias anguillaris*, growth, Nigeria

INTRODUCTION

Hatchery production and culture of species belonging to the Clariidae family is fast gaining global attention (Adewolu *et al*., 2008). In Africa, especially in Nigeria, the species mostly cultured are *Clarias gariepinus*, *Clarias anguillaris* and *Heterobranchus longifilis* (Ayinla and Nwadukwe, 1992). Comparative studies on the growth and survival of *Clarias gariepinus* and *C. anguillaris* revealed that *C. gariepinus* grow faster than *C. anguillaris* both at the fry and fingerlings stages of development (Madu and Ita, 1991).

The USDA (1988), pointed out that the lack of reliable estimates of genetic parameters such as genetic and phenotypic variances, covariance and genetic and phenotypic correlations for commercially important traits and the lack of designed selection programs to test their validity are the major constraints to rapid development of stocks for commercial production of aquaculture species. Superior performance of hybrids (i.e., hybrid vigor or heterosis) is a result of gene interactions and differences among alleles contributed by two distinct populations, inbred lines or species. The amount of heterosis gained from particular crosses depends on the degrees of genetic difference (i.e., allele frequencies) and their gene interactions (Falconer, 1989). Interspecific hybridization and intraspecific crossbreeding may improve a farm animal by non-additive genetic effects. However, the maximum dominance advantage is present in the first generation (F_1) and will be partially lost in future generations (Grant and Grant, 1994).

The hybrids between the white bass (*Morone chrysops*) and striped bass (*M. saxatilis*) referred to as the sunshine bass, grows faster with better overall characteristics than either parent species (Smith, 1988). The hybrid between African (*Clarias gariepinus*) and Thai (*C. macrocephalus*) catfish combines the fast growth of the African catfish and the desirable flesh characteristics of the Thai catfish (Na-Nakorn, 1999).

The hybrid of the cross between Heterobranchus and Clarias is receiving considerable attention in Africa, particularly Nigeria. These hybrids have been reported to show heterosis (Madu *et al*., 1993; Salami *et al*., 1993; Aluko, 1999). There has however, not been any documented report on the aquaculture potentials of the interspecific hybrids of *Clarias gariepinus* and

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C. anguillaris. This research was therefore aimed at assessing the growth performance of the interspecific hybrids of this mating combinations at the fry to fingerlings stage of development.

MATERIALS AND METHODS

Hypophysation and artificial fertilization in *C. gariepinus* and *C. anguillaris* broodstocks was carried out to produce the following mating combinations:

Parentals (Putative):
Clarias gariepinus (♂) x *Clarias gariepinus* (♀)
Clarias anguillaris (♂) x *Clarias anguillaris* (♀)

Interspecific hybrids:
Clarias gariepinus (♂) x *Clarias anguillaris* (♀)
Clarias anguillaris (♂) x*Clarias gariepinus* (♀)

where (♀) is for male and (♂) is for female. Hybrids and control groups were produced on the same day in each experiment. About 102 weeks old fry from the four mating combinations were stocked in duplicated batches (50 fry m^{-2}) in nylon net hapas (1 m^3) suspended in prepared experimental earthen nursery pond (4×4×1 m^{-3}) with the bottom of the net touching the substratum. Initial average weights from pooled weight of fry were taken before stocking, using a sensitive ACCULAB 333 weighing balance to the nearest 0.1 g. The fry were fed daily *ad libitum* with 40% crude protein formulated diet and also have access to mixed plankton from the already fertilized pond.

Random samples of 30 fry of each group were weighed fortnightly in the outdoor earthen nursery ponds. Hapas were washed clean fortnightly to remove algae that must have attached themselves to the net hapa. The experiment lasted 8 weeks. Growth parameters were estimated using the following formulae as described by Fagbenro:

$$\text{Weight Gain (WG)} = (W_f - W_i)\ g$$

Where:
W_f = Mean final body weight of fish
W_i = Mean initial body weight of fish

Specific Growth Rate (SGR %) is:

$$SGR = \frac{\text{Log}\, W_f - \text{Log}\, W_i}{t} \times 100$$

where, t is no. of days of experiment.

$$\text{Survival rate}(\%) = \frac{N_i - N_f}{N_i} \times 100$$

Where:
N_f = Final number of fish at end of experiment
N_i = Initial number of fish at beginning of experiment

The mean weight, specific growth rate and survival of the interspecific hybrids and the putative Clarias species were used to estimate heterosis. Heterosis here refers to the performance whether in terms of growth or survival of the hybrids relative to that of the parentals, expressed in percentage as described by Nguenga *et al.* (2000):

$$\text{Heterosis}(\%) = \frac{[(C_1 + C_2)/2 - (P_1 + P_2)/2]}{(P_1 + P_2)/2} \times 100$$

Where:
C_1 and C_2 = The mean weight, specific growth rate or survival of hybrids
P_1 and P_2 = The mean weight, specific growth rate or survival of the parentals

Growth parmeters were compared using One-way Analysis of Variance (ANOVA) and Fisher's LSD to determine significant differences between means.

RESULTS

The mean weight gain of the fry and fingerlings of the various mating combinations is shown in Table 1. At the end of 8 weeks of culture of offspring of the parental groups; *C. gariepinus* had the highest mean final weight of 3.19 g while those of *C. anguillaris* had lower mean weight gain of 3.00 g and were significantly different ($p<0.05$) from each other.

The interspecific hybrids of *C. gariepinus* (♂) x *C. anguillaris* (♀) had a mean final weight of 3.27 g while its reciprocal hybrid *C . anguillaris* (♂) x *C. gariepinus* (♀) had a mean weight of 3.06 g and were not significantly different ($p>0.05$) from each other (Table 1) . The weekly weight increase of fishes in the various mating combination for 8 weeks of culture is shown in Fig. 1.

Table 1: Growth performance of fingerlings of the various mating combinations at 8 weeks

Mating combination	Weight (g) Initial	Final	Weight gain	SGR (% day^{-1})	Survival (%)
Parentals					
C. gariepinus (♂) x *C. gariepinus* (♀)	0.007^a	3.19^b	3.18^b	10.93^a	68^b
C. anguillaris (♂) x *C. anguillaris* (♀)	0.006^a	3.00^a	2.99^a	11.11^a	61^a
Interspecific hybrids					
C. gariepinus (♂) x C. anguillaris (♀)	0.006^a	3.17^{ab}	3.16^b	11.20^a	65^{ab}
C. anguillaris (♂) x *C. gariepinus* (♀)	0.007^a	3.06^a	3.05^{ab}	10.86^a	64^{ab}

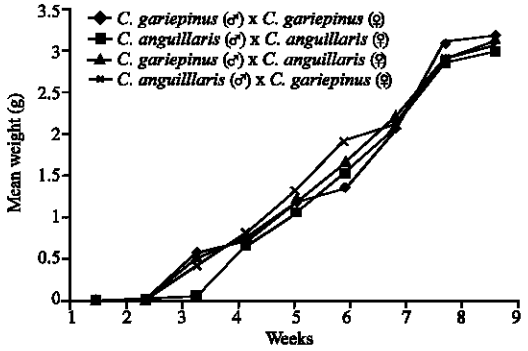

Fig. 1: Weekly weight increase of fry and fingerlings of the various mating combinations for 8 weeks

Table 2: Estimation of heterosis of F_1 hybrids (*C. gariepinus* (♂) x *C. anguillaris* (♀), *C. anguillaris* (♂) x *C. gariepinus* (♀)) fingerlings at the end of culture period of 56 days

Parameters	Heterosis (%)
Weight gain (g)	0.65
Specific growth rate (% day^{-1})	-5.00
Survival (%)	0.80

Heterosis for growth in term of weight gain was positive (0.65%) for the interspecific hybrids as shown in Table 2. The Specific Growth Rate (SGR) of offspring of the various mating combinations were compared. In the parental mating combinations, *Clarias anguillaris* had higher SGR value of 11.11 compared to 10.93 for *Clarias gariepinus* but not significantly different ($p>0.05$).

The interspecific hybrids of *Clarias gariepinus* (♂) x *Clarias anguillaris* (♀) was slightly higher than its reciprocal cross *C. anguillaris* (♂) x *C. gariepinus* (♀) with SGR values of 11.20 and 10.86, respectively. There was however, a negative heterosis for specific growth rate (-0.5%). The parental *C. gariepinus* recorded higher survival value of 68% which was significantly different ($p>0.05$) from value of 61% obtained in *C. anguillaris*. The interspecific hybrids of *C. gariepinus* (♂) x *C. anguillaris* (♀) and *C. anguillaris* (♀) x *C. gariepinus* (♀) had survival values of 66 and 64%, respectively. Survival was not significantly different ($p<0.05$) and these hybrids diplayed positive heterosis for survival (0.8%) .

DISCUSSION

A comparison of the weight gain, specific growth rate and survival of all the mating combination indicates that the interspecific hybrids shows intermediacy in a number of growth indicators at the end of 8 weeks of growth studies. However, they generally exhibited improved performance than *C. anguillaris*. The offspring of the interspecific hybrids had weight gain and survival intermediate to *C. garepinus* but higher than that of *C. anguillaris*. According to Chevassus (1983), growth of hybrids mostly appears to be intermediate between that of parental species, the faster growing parent partially transmitting this potential to hybrids. Similar observations are recorded in this present study.

Evidence for superior performances and hybrid vigor has been reported in a wide variety of finfish and catfish (Khan *et al*., 1990; Tidwell *et al*., 1992; Salami *et al*., 1993; Basavaraju *et al*., 1995; Hulata, 1995; Nwadukwe, 1995; Rahman *et al*., 1995). Hybrids among various species of tilapia also exhibited positive heterosis in respect of growth, production and other desirable traits (Earnst *et al*., 1991; Hulata *et al*., 1993; Lim *et al*., 1993; Wohlfarth, 1994; Verdegem *et al*., 1997). The hybridization between *C. gariepinus* and *C. anguillaris* in this present study resulted in the production of F_1 hybrids with promising potential.

The hybrid between male *C. gariepinus* and female *C. anguillaris* in this present study grew faster than *C. anguillaris*. Interspecific hybrids of *C. batrachus* (♂) x *C. gariepinus* (♀) and *C. gariepinus* (♀) x *C. batrachus* (♀) hybrids has also been reported to show superior growth performance compared to the parental *C. batrachus* in 6 months of culture. The positive heterosis for weight gain and survival of the hybrids in this present study is a result of the improved growth but they displayed after 56 days of rearing. Nguenga *et al*. (2000) also reported a net positive heterosis for crosses between two strains of *Heterobranchus longifilis*.

The negative heterosis value for specific growth rate shows that a negative interaction has occurred between the parental genes found at different loci in the interspecific hybrid genome as reported by Sheridan (1981). The phenotypic variance of a quantitative trait such as growth and survival is governed by the genetic variance, environmental variance and the interaction between the genetic and environmental variance (Tave, 1993). A negative interaction between the genetic variance of the hybrid and the environment may have led to poor phenotypic expression of specific growth rate. The hybrids is to be of considerable importance in improving the aquaculture potentials of the indigenous *Clarias anguillaris* by propagating its interspecific hybrids. This study is the first demonstration of hybridvigor between two closely related species of Clarias in Nigeria.

CONCLUSION

The result of this study suggest that the aquaculture potentials of *C. anguillaris* can be improved upon by producing its interspecific hybrids for grow-out purpose. The advantage of the increase in growth rate of the interspecific hybrids over the parental *C. anguillaris* in pond culture indicates an advantageous trait.

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