Growth and Survival of Intergeneric Hybrids of *Clarias anguillaris* and *Heterobranchus bidorsalis* in Semi Arid Zone of Nigeria

1M.Y. Diyaware and 2L.U. Onyila
1Department of Fisheries, Faculty of Agriculture, University of Maiduguri, Nigeria
2Department of Fisheries and Fisheries, Federal University of Technology, Yola, Nigeria

**Corresponding Author:** M.Y. Diyaware, Department of Fisheries, Faculty of Agriculture, University of Maiduguri, Nigeria
Tel: 08034922858

**ABSTRACT**

Growth and survival of *C. anguillaris*, *H. bidorsalis* and their hybrids fingerlings were investigated under semi arid condition. Thirty five days old fingerlings (32.03±0.69-44.57±1.47 g and 4.70±0.04-5.74±0.12 cm) stocked at 5 fish m⁻² were reared for 9 months in polyethylene-lined fish pond (2.5×2×1.2 m deep) in triplicates (♀Ca×♂Ca, ♀Ca×♂Hb, ♂Hb×♀Hb and ♂Hb×♀Ca as treatments I, II, III and IV, respectively). The results showed that final mean weights were higher (pooled 82.22.00±29.82 g = 509 g fish⁻¹) in the reciprocal hybrids (♀Hb×♂Ca), followed by pure breeds, ♂Hb×♀Hb (7632.70±321.88 g = 508 g fish⁻¹) and ♀Ca×♂Hb (5980.30 g = 352 g fish⁻¹). Lowest (4191 g = 232.83 g fish⁻¹) mean final weight was recorded in the pure breeds of ♀Ca×♂Ca. Mean Weight Gain (MWG) and Mean Daily Weight Gain (MDWG) were also higher in ♀Hb×♂Ca. No significant (p>0.05) variation was observed in the final mean weight and mean daily weight values of the reciprocal hybrids compared to those of their paternal pure breeds ♀Hb×♂Hb*. Survival was higher (70.67±1.33%) in pure line ♀Ca×♂Ca followed by ♀Ca×♂Hb, ♂Hb×♀Ca (69.33±10.91, 65.33±2.67 and 61.33±7.06%, respectively). Positive percentage heterosis was observed in both hybrids progenies. Based on the result of this study, the hybrids of ♀H. bidorsalis×♂C. anguillaris performed better than hybrid ♀C. anguillaris×♂H. bidorsalis and the two parental progenies. This indicates that, there are great potentials for exploiting hybrids of African catfishes in the semi arid zone of Nigeria. The performances of the hybrid fingerlings to adult stage in the study area needs to be re-examined to confirm the performance of hybrid species in the harsh weather conditions of the zone.

**Key words:** Growth and survival, intergeneric hybrids, *C. anguillaris×H. bidorsalis*, semi arid condition

**INTRODUCTION**

The African catfish, *Clarias* and *Heterobranchus* species are considered as a highly priced fish in Nigeria and Africa at large. *Heterobranchus* grows faster and attains bigger size than *Clarias* which matures earlier (Oladosu et al., 1993). The hybrids of *Clarias* and *Heterobranchus* exhibit fast growing quality of *Heterobranchus* reaching up to 1.0 kg under eight months in ponds. (Hogendoorn, 1981; Hecht and Lublinkhof, 1985).

Hybridization has been used in numerous species of fish to increase growth rate, manipulation of sex ratios, production of sterile fish, improve flesh quality, increase disease resistance, improve environmental tolerance and to improve a variety of other traits to make fish more profitable. 398
(Bartley et al., 2001). They lamented the desired goal of hybridization is to produce offspring that performs better than both parental species (hybrid vigour or positive heterosis). The crossbreeding improves the heterozygosis of non-additive genes causing the heterosis which is important in the adverse environmental conditions (Keambou et al., 2010). In fact, crossings constitute one of the tools for the exploitation of the genetic variation and the hybrid vigour by combination of the different important characteristics of each breed and for the exploitation of maternal genetic effects or sex-linked effects, associated to particular combinations between breeds or lines (Hanafi and Iraqi, 2001).


Growth and survival African catfish and their hybrids reared to table size have been reported by Owodeinde et al. (2013), Aluko (1995) and Madu et al. (1993). Legendre et al. (1992) reported high final weights of 908 g for Heterobranchus longifilis×C. gariepinus and 749 g for C. gariepinus×Heterobranchus longifilis reared for 256 day. Heterosis among hybrids of Clarias and Heterobranchus fish species have been documented by Madu et al. (1992), Salami et al. (1993), Nwadukwe (1995) and Aluko (1998).

Information on growth performance of intergeneric hybridization between Clarias and Heterobranchus to table size in the semi arid condition has not been reported. The objective of this study therefore is to investigate the potentials of F, hybrid of Clarias anguillaris and Heterobranchus bidorsalis with respect to their growth, survival and heterosis in semi arid condition with the view to developing fast growing hybrid within the region.

MATERIALS AND METHODS

The study was conducted in the Department of Fisheries, University of Maiduguri, Nigeria from September 2011 to May, 2012. Alau (Lake Alau) is situated between latitude 13°86’ N and 14°N and longitude 12°E and 13°E. Raining season begins in July and lasts till October.

Experimental fish: Clarias anguillaris (male and female) broodfish were obtained from Kwantan Bunduram, 2 km away from Baga located at longitude 13°04’ N and latitude 13°48’ E in Kukawa local government area of Borno state while Heterobranchus bidorsalis (male and female) were obtained from Lake Geriyo, located at longitude 12°25’ E and latitude 9°17’ N in Yola North local government of Adamawa State. Both fish were transported to the hatchery unit of the Department of Fisheries, University of Maiduguri in 50 L Jeri can cut one quarter (¼) horizontally. The fish were packed in perforated nylon bags before inserting them into the Jeri can half filled with fresh
water. The fish were conditioned for 2 days before the hybridization exercise. The follow mating combinations were performed:

- Female *Clarias anguillaris* × male *Clarias anguillaris* (♀Ca×♂Ca)
- Female *Clarias anguillaris* × male *Heterobranchus bidorsalis* (♀Ca×♂Hb)
- Female *Heterobranchus bidorsalis* × male *Heterobranchus bidorsalis* (♀Hb×♂Hb) and
- Female *Heterobranchus bidorsalis* × male *Clarias anguillaris* (♀Hb×♂Ca)

Each mating combination was repeated three times. The hatchlings were fed with shell-free *Artemia* for twelve days and thereafter with Coppens assorted starter diets (0.20-0.30, 0.50-0.8 and 1.00 mm) and reared for 35 days.

Twenty-five 35-day old fingerlings of each combination of *Clarias anguillaris, Heterobranchus bidorsalis* and the two hybrids were stocked in polyethylene lined fish pond (2.5×2.0×1.2 m deep) in triplicates. The fingerlings were conditioned for 5 days. They were fed with locally formulated diet of 40% crude protein (Table 1) at 3% of their body weight two times daily (8.00 am and 3.00 pm).

The fish were weighed monthly to adjust the feeding rate per their body weight. At the end of the culture period, final weight (g), final length (cm), survival rate, for each treatment were recorded. Final mean weight, mean weight gain (g), final mean length, mean daily weight gain (g), specific growth rate (percent/day), survival rate (%) for each treatment were estimated as follows (Adewolu et al., 2008):

- **Weight gain (g):** \( W_f - W_i \) Where, \( W_i = \) Final weight and \( W_i = \) Initial weight
- **Mean daily weight gain (g day\(^{-1}\)):** \( \frac{W_f - W_i}{t} \), where, \( W_i = \) Mean final body weight (g), \( W_o = \) Initial mean body weight (g) and \( t = \) Culture period (days)

| Table 1: Proximate composition of experimental diet used for rearing the experimental fish |
|---------------------------------|----------------|
| **Parameters**                  | **Percentage inclusion** |
| Fish meal                       | 18.30            |
| Groundnuts cake                 | 12.10            |
| Soy meal meal                   | 18.10            |
| Millet                          | 37.00            |
| Wheat offal                     | 6.40             |
| Vitamin premix                  | 1.00             |
| Salt                            | 0.50             |
| Bone meal                       | 0.50             |
| Lysine                          | 1.00             |
| Methionine                      | 1.00             |
| Vitamin C                       | 1.00             |
| Groundnut oil                   | 0.50             |
| Binder                          | 2.00             |
| Total                           | 100.00           |

**Proximate composition (%)**
Calculated analysed:
- Crude protein 40.0
- Crude fibre 2.00
- Fats 1.00
- Ash 1.00

<table>
<thead>
<tr>
<th>Percentage inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.08</td>
</tr>
<tr>
<td>4.00</td>
</tr>
<tr>
<td>2.00</td>
</tr>
<tr>
<td>1.60</td>
</tr>
</tbody>
</table>
Specific growth rate (percent day\(^{-1}\)):

\[
\text{Specific growth rate} = \frac{\log_e W_f - \log_e W_i}{t} \times 100
\]

where, \(W_i\) = Mean initial body weight of fish (g), \(W_f\) = Mean final body weight of fish (g), \(\log_e\) = Natural logarithm and \(t\) = Culture period (days)

Survival (%):

\[
\text{Survival (\%)} = \frac{\text{No. of fingerlings at the end of culture}}{\text{No. of fingerlings stocked}} \times 100
\]

**Heterosis:** Percentage heterosis was determined for the two hybrids at the end of the culture period after Nguyen et al. (2000):

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

where, \(C_1\) and \(C_2\) are the mean final weight and survival of crossbreeds, respectively while \(P_1\) and \(P_2\) are the mean final weight and survival of the purebreds, respectively.

**Water quality parameters:** Dissolved Oxygen (DO) was recorded using Digital DO/temperature meter (820 Sanxin China) while pH and Temperature (°C) was taken with means of digital portable pen pH meter (AC-pH/Temp meter) weekly morning and evening (08.00 am and 16.00 pm) for each treatment.

**Statistical analysis:** Data obtained from the experiment were subjected to one way analysis of variance while differences between the means were determined using Least Significant Difference (LSD) at 95% confidence level (\(p = 0.05\)) with the aid of Statistix 8.0.

**RESULTS**

Table 2 shows mean growth and survival of intergeneric hybrids of *C. anguillaris*×*H. bidorsalis* and their hybrids reared for 9 months under semi arid condition. Final Mean Weights (FMW) were higher (8322.00±29.82 g = 500 g fish\(^{-1}\)) in the reciprocal hybrids (♀Hb×♂Ca) followed by pure breeds of ♀Hb×♂Hb (7632.70±321.88 g). Lowest mean weight was recorded in the purebred of ♀Ca×♂Ca. Mean Weight Gain (MWG) and Mean Daily Weight Gain (MDWG) were also higher in ♀Hb×♂Ca. No significant (\(p>0.05\)) variation was observed in the PMW, MWG and MDWG values.

<table>
<thead>
<tr>
<th>Growth parameters</th>
<th>♀Ca×♂Ca</th>
<th>♀Ca×♂Hb</th>
<th>♀Hb×♂Ca</th>
<th>♀Hb×♂Hb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final weight (g)</td>
<td>4191.06±325.96a</td>
<td>5980.30±139.67ab</td>
<td>7632.70±321.88a</td>
<td>8322.00±29.82a</td>
</tr>
<tr>
<td>Final length (cm)</td>
<td>24.36±0.47c</td>
<td>24.63±0.40a</td>
<td>29.92±0.38a</td>
<td>27.50±0.59a</td>
</tr>
<tr>
<td>Mean weight gain (g)</td>
<td>3652.30±527.29a</td>
<td>5935.80±139.29ab</td>
<td>7000.60±621.35a</td>
<td>8280.40±29.18a</td>
</tr>
<tr>
<td>Mean daily weight gain (g day(^{-1}))</td>
<td>14.68±1.24a</td>
<td>21.18±0.53a</td>
<td>27.31±2.37a</td>
<td>29.72±0.11a</td>
</tr>
<tr>
<td>Specific growth rate (percent day(^{-1}))</td>
<td>0.47±0.12a</td>
<td>0.76±0.13ab</td>
<td>0.65±0.11ab</td>
<td>0.54±0.09ab</td>
</tr>
<tr>
<td>Survival (%)</td>
<td>70.67±1.93a</td>
<td>69.33±10.91a</td>
<td>61.33±7.06a</td>
<td>65.33±2.67a</td>
</tr>
</tbody>
</table>

Means in the same column having different superscript are significantly different (\(p<0.05\)).
of the reciprocal hybrids compared to that of their paternal parents (♀Hb×♂Hb). However, there was significant (p<0.05) variation between PMW, MWG and MDWG values of ♀Ca×♂Ca compared to that of their maternal hybrids (♀Ca×♂Hb).

Specific Growth Rate (SGR) was observed to be higher (0.76±0.13 percent day⁻¹) in hybrids of ♀Hb×♂Ca. There was no significant difference (p>0.05) between the SGR values of ♀Hb×♂Ca compared to those of ♀Hb×♂Ca and ♀Hb×♂Hb. However, SGR was significantly (p<0.05) lower in pure line ♀Ca×♂Ca.

The highest survival was recorded in ♀Ca×♂Ca, followed by their maternal hybrid. The lowest survival rate was observed in pure line ♀Hb×♂Hb. There was no significant variation between percentage survival rates of the entire treatments.

Figure 1 shows mean monthly growth patterns of C. anguillaris, H. bidorsalis and their hybrids under semi arid zone of condition. At the early growth stage (months 1-2), the entire mating combinations showed slight variation in their parallel growth pattern. However, as from the second month, clear growth pattern was observed. By the third month, growth of offspring of ♀Hb×♂Ca was low due to mortality. High mortality was also observed at the 8th month of culture.

Table 3 shows percentage heterosis for growth and survival for C. anguillaris, H. bidorsalis and their hybrids after 9 months of culture. Positive heterosis for growth and survival were observed in both ♀Ca×♂Hb and ♀Hb×♂Ca hybrids. Higher heterosis for both growth and survival were observed in ♀Ca×♂Hb while lower heterosis values for growth and survival were recorded in the reciprocal hybrids (♀Hb×♂Ca).

Table 3: Heterosis percent for growth and survival of C. anguillaris, H. bidorsalis and their hybrids under semi arid condition

<table>
<thead>
<tr>
<th>Combinations</th>
<th>♀Ca×♂Hb</th>
<th>♀Hb×♂Ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth</td>
<td>29.55</td>
<td>8.27</td>
</tr>
<tr>
<td>Survival</td>
<td>41.95</td>
<td>9.00</td>
</tr>
</tbody>
</table>

Fig. 1: Mean monthly growth pattern of Clarias anguillaris, Heterobranchus bidorsalis and their hybrids under semi arid zone condition
Table 4: Mean water quality parameters during rearing of fingerling of *Clarias anguillaris*, *Heterobranchus bidorsalis* and their hybrids under semi-arid zone for 9 months

<table>
<thead>
<tr>
<th>Combinations</th>
<th>Temperature (°C)</th>
<th>pH</th>
<th>DO (mg L⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>♂Ca × ♀Ca</td>
<td>30.40±0.12</td>
<td>8.03±0.37</td>
<td>4.50±0.38</td>
</tr>
<tr>
<td>♂Ca × ♀Hb</td>
<td>30.16±0.00</td>
<td>7.94±0.35</td>
<td>5.02±0.64</td>
</tr>
<tr>
<td>♂Hb × ♀Hb</td>
<td>29.48±0.90</td>
<td>7.55±0.01</td>
<td>4.36±0.42</td>
</tr>
<tr>
<td>♂Hb × ♀Ca</td>
<td>30.12±0.29</td>
<td>7.81±0.11</td>
<td>5.14±0.82</td>
</tr>
</tbody>
</table>

**Water quality parameters:** Table 4 shows water quality parameters during growth trials of *C. anguillaris*, *H. bidorsalis* there hybrid under semi-arid condition. Temperature ranged from 29-30.40°, pH was 7.8-8.03 while dissolved oxygen was between 4 and 5.14 mg L⁻¹.

**DISCUSSION**

The higher growth rate (8322.00 g pool weight = 509 g mean individual weight) obtained after 9 months of culture in this study is lower than 1.5 kg reared for 1 year by Aluko and Ali (2001), 846 g fish⁻¹ for *C. gariepinus* reared for 8 months and 880 g fish⁻¹ for hybrid (*C. gariepinus × H. bidorsalis*) reared for 8 months in earthen ponds and 908 g for *Heterobranchus longifilis × C. gariepinus* (Legendre et al., 1992) and 749 for *C. gariepinus × H. longifilis* reared for the period of 256 days. The variation in final weight values may be due to differences in the species used for the hybridization.

Mean daily weight gain observed in this study is higher than those reported by previous studies. This variation may be due to the difference in both species used for the hybridization for the fact that *H. bidorsalis* and *C. gariepinus* grow faster than *H. longifilis* and *C. anguillaris*, respectively.

The higher specific growth rate of ♂Ca × ♀Hb recorded in this study is higher than those reported by Owodeinde et al. (2012). According to Kerby et al. (1987) specific daily growth rate decreases with increase in biomass and consequent increase in metabolic activities.

The survival rates (69.33 and 65.33%) recorded in this study for both hybrids after 9 months culture were lower than 72% reported by Muthukumaran and Sukumaran (2005) for hybrid between *Heteropeustes fossilis × Clarias gariepinus*. The crosses between female *C. anguillaris* and male *H. bidorsalis* inherited the fast growth of *H. bidorsalis* coupled with the high survival trait of *C. anguillaris* but did not inherit the poor survival of *H. bidorsalis*. Madu and Aluko (1999) reported similar trend in which the hybrid between male *C. gariepinus* (Netherlands) × *H. bidorsalis* imbibed fast growth of *H. bidorsalis* coupled with the growth trait of *C. gariepinus* but did not also inherit poor survival of *H. bidorsalis* but was not better in growth rate as the *C. gariepinus* (Dada and Olarewaju, 1996).

The higher heterosis for both growth and survival for the two hybrids observed in this study was better than 8.4 and 10.9%, respectively for juvenile and adult Bay scallop, *Argopecten irradians* reported by Zheng et al. (2003). Nguenga et al. (2000) reported a net positive heterosis of 89.5% for crosses between two strains of *Heterobranchus longifilis*. Heterosis among hybrids of *Clarias* and *Heterobranchus* fish species have also been reported by Madu et al. (1992), Salami et al. (1993), Nwadukwe (1995) and Aluko (1998).

Based on the result of this study, the hybrids of female *H. bidorsalis* × male *C. anguillaris* performed better than hybrid of female *C. anguillaris* × male *H. bidorsalis* and the two parental progenies. This indicates that, there are great potentials in exploiting hybrid African catfishes in
the semi-arid zone of Nigeria. The performance of the hybrid fingerlings to adult stage in the study needs to be re-examined to confirm the performance of hybrid species in the harsh weather conditions of the zone.

The water quality parameters recorded during these studies were within the acceptable ranges for fish culture and as suggested by Boyd (1981) and Viveen et al. (1986).

REFERENCES


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