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Full Length Research Paper

Preparatory enquiry on cephalic abnormality in hatchery raised *Heterobranchus longifilis* and its aquacultural consequence

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Cephalic abnormality (gill arch malformation) in four mating combinations involving cephalic and non-cephalic male and female *Heterobranchus longifilis* broodstocks were investigated in order to assess its frequency of level of occurrence in the offsprings and if it has any genetic basis. Percentage fertilization and hatchability were not significantly different ($P>0.05$) in all the mating combinations. Weight gain (4.4 g) and survival (75%) were highest in mating combinations involving the non-cephalic male × non-cephalic female and non-cephalic male × cephalic female respectively which were significantly different ($P<0.05$) at the end of six weeks in outdoor growth studies. The offsprings of the cephalic male × non-cephalic female had the highest frequency of cephalic abnormality (2%) which was very low and not significantly different ($P>0.05$) from the other mating combinations. The very low level of cephalic abnormality observed in the offspring of all the mating combinations at 12 weeks possibly indicate the involvement of other factors rather than genotype in the occurrence of this morphological aberration.

Key words: Broodstocks, genotype, environment, cephalic abnormality, *Heterobranchus longifilis*.

INTRODUCTION

Morphological abnormalities decreased the product quality and biological performance of reared fish, negatively affecting both the market value and product cost. Andrades et al. (1996) reported that only a few percent (>15%) of larvae affected by skeletal malformation can survive after larval development, thus leading to significant economic loss in the hatchery. The quality of malformed fish can also be negatively affected by low resistance hatchery in reared fish larvae (Fushimi, 2001).

Morphological abnormalities have been reported in both the wild and reared species of fishes with variable range of expression. Cephalic deformities are frequently found in hatchery produced (MacConnell and Barrows, 1993) and wild fish (Honna, 1999; Lindesjoo and Thulin, 1992; Lagardere et al., 1993). Cephalic abnormalities includes: gill cover anomalies (Francescon et al., 1998; Chatain, 1994), pugheadness (Daoulas et al., 1991; Chatain, 1994), cross bite (Barahona-fernandes, 1982), lower jaw reduction (Chatain, 1994) and pike jaw deformity in which there is upward bending of the anterior part of the frontal bones and this has been mainly reported in wild *Esox lucius* (Lindesjoo and Thulin, 1992).

Several factors have been attributed as been the causes of morphological deformities in fishes which include: environmental factors such as presence of pollutants in the water, radiation, salinity, oxygen depletion and light intensity (Caris and Rice, 1990); nutritional deficiencies due to dietary ascorbic levels and tryptophan (Akiyama et al., 1986; Cahu et al., 1995); stressed conditions in the ecosystem (Heupel et al., 1999; Villeneuve et al., 2005; Boglione et al., 2006); and genetic factor (Tave, 1993; Aluko et al., 2001).

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Heterobranchus longifilis belongs to the family *Clariidae* and it is one of the commonly cultured catfishes in Nigeria, because of its high commercial value. Since Clariid catfishes fingerlings for commercial purposes are mostly produced in the hatchery, fish breeders hardly have room for exchange of genes with collection from the wild (Aluko et al., 2001), thus the incidence of morphological abnormalities in hatchery bred catfishes are high. Deformities as a result of inbreeding have been observed in many hatchery reared fishes in aquaculture (Tave, 1999). There has not been any documented report on the cause of cephalic abnormality (gill arch malformation) in *H. longifilis*. In order to increase the commercial production and product value of this fish, this study was therefore carried out to ascertain if there is any genetic basis for the occurrence of cephalic abnormalities in *H. longifilis*.

MATERIALS AND METHODS

Experimental broodstocks

Four hatchery raised broodstocks of *H. longifilis* (1.1 kg ± 0.7) which consist of two males (♂), one with cephalic abnormality (CA) and the other with no cephalic abnormalities (NC), and two females (♀) also, one with cephalic abnormality (CA) and the other with no cephalic abnormalities (NC) were randomly selected and used for the experiment.

Artificial induced breeding and fertilization

The female broodstocks were administered ovaprim intramuscularly at a dosage of 0.5 ml/kg (Madu et al., 1992) and the female were stripped after 15 h latency period (Olufeagba, 1999). The eggs and milt of the parent were mixed together to generate four different mating combinations as shown thus:

NC (♂) × NC (♀)
NC (♂) × CA (♀)
CA (♂) × NC (♀)
CA (♂) × CA (♀)

Two hundred stripped eggs were used for dry fertilization in each mating combination in duplicate batches. The fertilized eggs in each mating combination was transferred to continuously aerated plastic trough (60 cm × 30 cm × 30 cm) filled with water to two-third of its volume. Hatching was observed in all the four mating combinations within twenty four hours and percentage hatchability was estimated according to the method described by Akinwande et al. (2012) as:

$$\text{Percentage hatchability (\%) was calculated from: } \frac{\text{Number of hatchlings}}{\text{Total number of eggs fertilized}} \times 100$$

Siphoning of uneaten food was carried out daily and 1/3 of water in the plastic trough was exchange with freshwater daily.

Forty-three days old fry from each mating combinations were stocked in duplicate batches in concrete tank (1 m × 1 m × 1 m). Fry were fed *ad-libitum* for the first two weeks with shell free Artemia indoor and with artificial feeds (Coppens) ranging from 0.3 - 2 mm pellet size for another six weeks outdoor based on their mouth size at 5% of their biomass. Growth parameter and survival of the fishes were assessed weekly as described by Madu et al. (1992) which are:

(i) Weight gain (WG) = Final weight - Initial weight;

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

Where N_i = initial number of fish stocked, and N_f = Final number of fish.

The percentage of fishes with cephalic abnormalities and non-cephalic abnormalities in each mating combi-nation was counted at the 12th week of the experiment. Growth parameters were analyzed using one-way Analysis of Variance (ANOVA) and fisher's LSD at 95% Probability level to determine significant difference between mean values.

RESULTS

Percentage hatchability estimated thirty hours during incubation in all the four mating combinations, the initials and final weights and survival is shown in Table 1. Percentage hatchability was above 80% in all the four mating combinations, with the highest value of 95% in the crosses involving non-cephalic male and cephalic female (NC ♂ × CA ♀). Hatchability was not significantly different (P>0.05) in all the mating combinations. Highest weight gain (0.4 g) was obtained in NC (♂) × NC (♀) while survival was highest (85%) in those involving NC (♂) × CA (♀).

The weight increase and survival of fry for six weeks in outdoor concrete tanks is shown in Table 2. Highest weight gain of 4.4 g was obtained in the crosses between NC (♂) × NC (♀). Survival was highest (75%) in the cross between NC (♂) × CA (♀). The genetic cross between CA (♂) × CA (♀) had the least percentage survival of 55% and was significantly different (P>0.05) from all

Table 1. Percentage hatchability, growth and survival of hatchlings in all the four mating combinations for the first two weeks of growth studies.

Parameter	Mating combinations			
	NC (♂) × NC (♀)	NC (♂) × CA (♀)	CA (♂) × NC (♀)	CA (♂) × CA (♀)
Hatchability (%)	94^{a}	95^{a}	93^{a}	90^{a}
Initial weight (g)	0.003^{a}	0.0028^{a}	0.0031^{a}	0.0029^{a}
Final weight (g)	0.403^{a}	0.383^{a}	0.373^{a}	0.353^{a}
Weight gain (g)	0.4^{a}	0.38^{a}	0.37^{a}	0.35^{a}
% Survival	82^{a}	85^{a}	78^{a}	80^{a}

Means with dissimilar superscript within the row are significantly different (P<0.05).

Table 2. Growth performance and percentage occurrence of cephalic abnormal fishes in all the four mating combinations after six weeks in outdoor rearing tanks.

Parameter	Mating combinations			
	NC (♂) × NC (♀)	NC (♂) × CA (♀)	CA (♂) × NC (♀)	CA (♂) × CA (♀)
Initial weight (g)	0.44^{a}	0.45^{a}	0.42^{a}	0.43^{a}
Final weight (g)	4.64^{a}	4.85^{a}	4.32^{ab}	3.83^{b}
Weight gain (g)	4.2^{a}	4.4^{a}	3.9^{ab}	3.4^{b}
% Survival	70^{ab}	75^{a}	70^{ab}	68^{b}
% Abnormality	1^{a}	1^{a}	2^{a}	1^{a}

Means with dissimilar superscript within the row are significantly different (P<0.05).

other mating combinations. The percentage of the offsprings with cephalic abnormality at 12 weeks from the four mating combinations is also shown in Table 2. Highest percentage of 2% was obtained in the cross between CA (♂) × NC (♀).

DISCUSSION

The progeny from the non-cephalic (♂) × non-cephalic (♀) had the highest growth and survival at the end of the growth studies. However, the high survival of progenies from the parental cephalic abnormal (♂) × abnormal (♀) at two weeks indoor and for the six weeks outdoor suggest that these mating combinations do not have viability problems. This varies with the results reported by Aluko et al. (2001) in the mating combinations of *Clarias gariepinus* and *H. longifilis* with pectoral fin abnormalities in which 98% of hatchlings died within 24 h after hatching.

Cephalic abnormalities in the offsprings of the various mating combinations could not be deduced until the 10th week. This is because the malformed gills in the affected fishes were not distinct at the early stages of development. The proportion of cephalic abnormal fishes did not vary much among the mating combinations but rather it was randomly distributed. Unexpectedly, the mating combination involving the cephalic abnormal (♂) × cephalic abnormal (♀) did not have the highest frequency of cephalic abnormalities. The mating combination involving the cephalic abnormal (♂) × non-cephalic (♀) had the highest frequency (2%) of cephalic abnormal progeny which shows that this abnormality is not completely heritable and therefore may not be genetically controlled. Since there was no similarity of offsprings to their parental phenotype, it is very likely that the causes of cephalic abnormality (gill arch malformation) in *H. longifilis* may be environmental rather than genetically induced. This result differs from that obtained by Berra and Au (1981) and Aluko et al. (2001), in which the progenies of morphological abnormal mating combinations clearly demonstrated similarity to their parent.

Several environmental factors have been reported to cause morphological deformities in fishes (Caris and Rice, 1990; Pavlov and Moksness, 1997), during embryo development. The result obtained in this study is similar to that observed by Dunham and Smitherham (1987) in which the progeny resulting from mating of parental tailless catfish *Ictalurus punctatus* were all normal.

Conclusion

This study shows that cephalic abnormality (gill arch malformation) does not affect the growth and survival of *H. longifilis* at the early stage of life. Also since the frequency of occurrence of this trait in the offspring from the parentals with cephalic abnormalities is very low, this suggests that other factors associated with the mechanisms of gene action or in combination with other environmental factors may influence the expression of this trait in *H. longifilis*. Further studies could be carried out to deduce the effect of inbreeding from cephalic abnormal full siblings of *H. longifilis* broodstocks in the expression of these traits.

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