



# Genetic improvement of tilapias in China: Genetic parameters and selection responses in growth, pond survival and cold-water tolerance of blue tilapia (*Oreochromis aureus*) after four generations of multi-trait selection



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## ARTICLE INFO

### Article history:

Received 11 September 2012

Received in revised form 1 January 2013

Accepted 10 February 2013

Available online 17 February 2013

### Keywords:

Blue tilapia

Breeding program

Growth

Survival traits

Genetic parameters

Selection response

## ABSTRACT

Genetic parameters and selection responses were obtained for growth, pond survival and cold-water tolerance of Progift blue tilapia (*Oreochromis aureus*) in China after four generations of multi-trait selection. Blue tilapia from four Chinese hatchery stocks and one from Vietnam were used to compose a synthetic breeding population. About 31,000 tagged fingerlings representing 519 full-sib families in five generations were tested in freshwater earthen ponds in Hainan Province of China. Individual body weights were recorded on 11,000 fish at the expected time of sexual maturation and 22,000 at harvest to estimate genetic parameters for growth rate. An additional 5000 tagged fingerlings representing all families in  $G_3$  and  $G_4$  were challenged to estimate genetic parameters for cold-water tolerance. Heritability ( $h^2$ ) estimates for body weight were relatively stable across time of recordings and generations, and was of similar magnitude ( $0.40 \pm 0.04$ ) when analyzing all harvest data. The  $h^2$  of pond survival was considerably lower ( $0.05 \pm 0.01$  and  $0.08 \pm 0.11$ ), while that of cold-water tolerance was intermediate ( $0.20 \pm 0.04$  and  $0.30 \pm 0.31$ ) when estimated on the observed and underlying scales. Including all data, effects common to full-sibs other than additive genetic effects ( $c^2$ ) accounted for 7% and 1%, respectively, of the total phenotypic variance for body weight at harvest and the two survival traits. Genetic correlation between growth recorded at expected time of sexual maturation and at harvest was very high ( $0.99 \pm 0.01$ ). The genetic correlation between growth and pond survival was positive ( $0.15 \pm 0.08$ ), while that between growth and cold-water tolerance was not significantly different from zero ( $0.02 \pm 0.12$ ). Breeding candidates in the base population ( $G_0$ ) were ranked according to their individual breeding values for growth (recorded as body weight at harvest), while those in later generations ( $G_1$ – $G_3$ ) were ranked according to a selection index including individual breeding values for growth and family breeding values for survival traits. A genetic trend analysis based on all grow-out data predicted an accumulated selection response of 168 g (2.16 phenotypic standard deviation units) and an average selection response of 14.0% per generation of selection when using the LS mean of the  $G_0$  as a base line for the comparison. Genetic trend analyses of survival data predicted accumulated selection responses of 8.4 and 1.2%-units higher survival rates in earthen ponds and cold-water challenge tests, respectively. The average inbreeding coefficient (F) was estimated to be 2.1% in the  $G_4$  generation. The results are discussed in a practical context of adapting selective breeding technology to a new aquaculture species and it is concluded that the ongoing selective breeding of blue tilapia in China has resulted in considerable genetic improvements of both growth (about 70% larger body weight at harvest) and pond survival after four generations of multi-trait selection.

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## 1. Introduction

China is the largest producer of farmed tilapia in the world (Fitzsimmons et al., 2011). The Chinese tilapia production increased very rapidly during a 20-year period until 2005 when the annual

production reached about one million metric tons (Li et al., 2006; Zhao, 2011). In recent years, however, the tilapia production in China has stagnated due to problems related to unstable climatic conditions (i.e., cold winter temperatures, drought etc.) and disease outbreaks. The export oriented Chinese tilapia production is also influenced by fluctuations of international demands and prices of tilapia products.

Chinese tilapia production is mainly based on two species of tilapia: Nile tilapia (*Oreochromis niloticus*) and blue tilapia (*Oreochromis aureus*),

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