Aquaculture 416–417 (2013) 354–366

Contents lists available at ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aqua-online

Genetic improvement of tilapias in China: Genetic parameters and selection responses in growth, survival and external color traits of red tilapia (*Oreochromis* spp.) after four generations of multi-trait selection

Jørn Thodesen (Da-Yong Ma) [a,*], Morten Rye [a], Yu-Xiang Wang [b], Shi-Jia Li [b], Hans B. Bentsen [c], M. Hossein Yazdi [a], Trygve Gjedrem [a,c]

[a] Akvaforsk Genetics Center (AFGC), N-6600 Sunndalsøra, Norway
[b] Hainan Progift Aqua-Tech Co. Ltd, Dingan, Hainan Province, China
[c] Nofima Marin, P.O. Box 5010, N-1432 Ås, Norway

ARTICLE INFO

Article history:
Received 23 May 2013
Received in revised form 23 September 2013
Accepted 26 September 2013
Available online 2 October 2013

Keywords:
Red tilapia
Breeding program
Growth
External color
Genetic parameters
Selection responses

ABSTRACT

Genetic parameters and selection responses were obtained for growth, survival and external color traits of Progift red tilapia (*Oreochromis* spp.) in China after four generations of multi-trait selection to increase all traits except black spots, which should, ideally, be eliminated from the breeding population. Red tilapia from four Asian and four South-American hatchery stocks were used to compose a synthetic breeding population. About 45,000 tagged fingerlings representing 610 full-sib families in five generations were tested in freshwater earthen ponds, freshwater floating cages and brackish water tanks in Hainan Province of China. About 30,000 fish were recorded at the expected time of sexual maturation (170 days) and at harvest (250 days) to estimate genetic parameters. Heritability (h^2) estimate for body weight was 0.42 ± 0.03 when analyzing all harvest data, while h^2 of survival was 0.05 ± 0.01 and 0.09 ± 0.12, respectively, when estimated on the observed and underlying scales. The h^2 of external color traits at harvest was 0.24 ± 0.04, 0.51 ± 0.03 and 0.14 ± 0.02, respectively, for black spots, pigmented area and skin/scale color. Including all data, effects common to full-sibs other than additive genetic effects (c^2) accounted for 3–5%, 2–3% and 5–13%, respectively, of the total phenotypic variance for body weight, survival and external color traits. Genetic correlations between observations at expected time of sexual maturation and at harvest were generally high in magnitude (0.9–1.0) for all recorded traits except black spots (0.78 ± 0.06). The genetic correlation between growth in freshwater earthen ponds and floating cages was very high (0.92 ± 0.06), while that between freshwater earthen ponds and brackish water tanks (0.33 ± 0.14) suggests considerable genotype by environment interaction. The genetic correlation between growth and survival was favorable (0.42 ± 0.11), while those between growth and black spots (0.28 ± 0.09), pigmented area (−0.25 ± 0.06) and skin/scale color (−0.09 ± 0.07) were all unfavorable. Breeding candidates in G_0–G_3 were all ranked according to selection indices including individual breeding values for growth (recorded as body weight at harvest) and color traits, while those for G_2 also included family breeding values for survival. A genetic trend analysis based on all grow-out data predicted an accumulated selection response of 175 g larger harvest weight (2.13 phenotypic standard deviation units) and an average selection response relative to each parent generation of 12.3%, using the LS mean of the G_0 as a base line for the comparison. Similar genetic trend analyses predicted accumulated selection responses of 5.0%-units higher survival rate, 0.6 scores less black spots, 0.9 scores larger pigmented area and 0.1 scores better skin/scale color on scales of 5, 6 and 6 scores, respectively. The average inbreeding coefficient (F) was 1.5% in the G_4 generation. It is concluded that the ongoing selective breeding of red tilapia in China has resulted in considerable genetic improvements of growth (59% larger body weight at harvest), survival and external color traits after four generations of multi-trait selection.

1. Introduction

China is the largest producer of farmed tilapia in the world (Fitzsimmons et al., 2011), and tilapia farming has been encouraged to further increase the Chinese seafood export. A large proportion of the Chinese tilapia production is exported to international markets as frozen whole fish or fillets. Chinese tilapia production is mainly based on two species; Nile tilapia (*Oreochromis niloticus*) and blue tilapia (*Oreochromis aureus*). The hybrid of these species (i.e. offspring of Nile tilapia females x blue tilapia males) is commonly preferred due to a high male percentage (Lovshin, 1982) and better survival at low water temperatures (Hulata et al., 1993).

* Corresponding author. Tel.: +47 7169 5300; fax: +47 7169 5301.
E-mail address: jorn.thodesen@afgc.no (J. Thodesen).

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http://dx.doi.org/10.1016/j.aquaculture.2013.09.047