Hormonal profile of growing male and female diploids and triploids of the blue tilapia, *Oreochromis aureus*, reared in intensive culture

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Abstract

Triploidy as a result of thermal shock exposure of fertilized eggs decreases the growth rate of *Oreochromis aureus* as compared to their diploid controls, but this is due to the higher female ratio present in triploids (86%) and the lower growth rate of females. When females and males are considered separately, the growth rate is not significantly different in diploids and triploids. Since triploidy results in a malfunctioning steroidogenesis in females (mainly testosterone (T) and 17β-estradiol (E₂)), but does not affect the growth rate, it is concluded that female gonadal steroids do not influence growth unless in pharmacological concentrations. These low levels of gonadal steroids are generally accompanied by higher levels of gonadotropin (GtH), but the difference is not always significant.

Despite their lower growth rate diploid females have higher plasma concentrations of growth hormone (GH) during several months compared to the triploid females and diploid males. 3,5,3'-triiodo-L-thyronine (T₃) levels, however, are comparable between diploid and triploid females (except for 1 month), but higher in diploid males in 4 of the 5 months studied. 11-ketotestosterone (11kT) is always higher in males. These results indicate that the higher growth rate of males may be related to the high circulating levels of T₃ and 11kT.

Introduction

Induced polyploidy as a way to mitigate maturational effects in aquaculture has attracted considerable attention. Triploidy provides functional sterility, because the pairing of chromosomes during meiotic division results in a hampered separation of chromosomal triplets. In females, maturation of gonads is suppressed (Lincoln and Scott 1984; Solar et al. 1984), whereas in male triploids, testes can fully develop, but sperm fertilising normal eggs gives no viable fry (Thorgaard and Gall 1979; Lincoln and Scott 1984; Benfey et al. 1986; Penman et al. 1987b). The use of induced triploidy as a way of reproduction control and consequently improvement of growth is especially indicated in tilapian...
species which are of great potential importance in aquaculture but reproduce early, often below market weight.

Triploids of the blue tilapia, *Oreochromis aureus,* were successfully obtained by Chourrout and Itskovich (1983), Don and Avtalion (1986), Penman *et al.* (1987a, b) and Chang *et al.* (1991). However, information concerning growth of triploid tilapia is rare and contradictory so far (Penman *et al.* 1987b; Chang *et al.* 1991). It is expected that inhibition of gonadal development may allow an increased somatic growth (Wolters *et al.* 1982). However, since in salmonids juvenile triploids exhibit inferior growth relative to diploids (Chourrout *et al.* 1986; Quillet *et al.* 1987), the benefit of induced triploidy on growth enhancement is not realised until after the normal period of maturation in diploids.

At least three groups of hormones are implicated in growth of teleost fish: growth hormone (GH) and insulin-like growth factor (IGF), thyroid hormones, and gonadal steroids (Donaldson *et al.* 1979; Sumpter 1992). In rainbow trout (*Oncorhynchus mykiss*) gonadal steroids, GtH and GH are similar in diploid and triploid males, but, contrary to diploid females, in triploid females levels of GtH, testosterone and 17β-estradiol are suppressed, and GH and 17α-hydroxy-20β-dihydro-progesterone do not increase at the time of ovulation (Lincoln and Scott 1984; Benfey *et al.* 1989b; Sumpter *et al.* 1991). The present study reports a hormonal profile in growing diploid and triploid *O. aureus* and discusses the relationship between circulating hormones and growth, and the possible involvement of hormones in the sexual growth dimorphism.

**Materials and methods**

**A. Triploidy induction and determination of growth parameters**

Animals and gamete collection
The stock of *O. aureus* used in this work originated from the Aquaculture Research station, Dor (Israel), and was raised in the Laboratory of Fish Demography and Aquaculture, University of Liège, Belgium, since 1980. Pairs of fish were placed each in 300l-aquaria with a layer of gravel for nest building. Each pair consisted of a territorial male and a ripe female. The females were stripped and eggs were fertilized with 1–2 ml of milt diluted in a small quantity of 26°C water. After 1 min, the eggs were rinsed and divided into control and experimental batches.

Induction of triploidy, survival rate and ploidy determination
The eggs were exposed to thermal shock 3 min after incubation at 26°C by immersion at 39.5°C for 4 min (Don and Avtalion 1986). After treatment, eggs were returned to 26°C until hatching. Control and treated eggs were incubated in "Zuger-glasses" and the surviving larvae were counted at the pelagic stage just before feeding. Survival rates were expressed as percentage of inseminated egg number and as percentage of diploid survivor number. Chromosome preparations from 48h old embryos were obtained using a modification of the method of Kligerman and Bloom (1977). Eggs were incubated in 0.5% colchicine, dissected in 0.8% NaCl and put in 0.8% trisodium citrate for 20 min. After fixation (30 min) in a 3:1 (v/v) solution of ethanol/acetic acid, epithelial cells were dissociated in ten drops of 50% acetic acid for 2 min. Cells precipitated onto slides at 48°C were stained in 5% Giemsa for 15 min, washed in water and air dried before examination of five smears for each embryo. Chromosome preparations of adult fish were obtained from regenerating fins (Streisinger *et al.* 1981). Triploid and diploid fish were sexed by examination of the urogenital papilla and the produced gametes.

Rearing facilities and growth parameters
Diploid and triploid groups used for the growth experiment consisted of the mixed progenies from two different pairs. The fry were transferred at the feeding stage for 38 days into 0.2 m³–1 m² square tanks in a closed water system at 26.2°C, then for 90 days in 0.5 m³–2 m² tanks, and for the rest of the experiment in 1.5 m³–4 m² tanks in an open system supplied with a mixture of water from the river Meuse and the cooling system of the nuclear plant of Tihange to attain a temperature range between 23° and 27°C.