ISSN 1330–061X
CODEN RIBAEG

UDK 597.58:591.15.08
Original scientific paper

ANOPHTHALMIA: A NON–HERITABLE EYE DEFORMITY IN *Oreochromis mossambicus*

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Summary

Seven male *Oreochromis mossambicus* with anophthalmia were found in a hatchery population. The deformity was not observed in either the F_1 or F_2 generations; consequently, it was a non–heritable congenital deformity.

Key words: tilapia, anophthalmia, non–heritable deformity.

INTRODUCTION

Abnormal phenotypes, while rare, can be observed in many populations of fish. Dawson (1964, 1966, 1971) and Dawson and Heal (1976) compiled a bibliography of 1,499 papers that described abnormalities in fish; 63 of these papers (4.2%) described eye abnormalities. Abnormal fish are more likely to be observed in hatchery populations, because fish are handled regularly, which facilitates the observation of thousands of fish, and because fish culturists eliminate predators, provide food, and control diseases, which improve the survival of abnormal fish (Tave, 1993).

While determining the genetics of body color in *Oreochromis mossambicus* (Tave et al., 1990), fish with several abnormalities were observed. One of the most striking was anophthalmia, the congenital absence of one or both eyes. Fish with this deformity were observed when they were very young, and they showed no signs of injury or trauma.

Anophthalmia either can be heritable or can be caused by environmental disturbances. Bilateral anophthalmia in Mexican cave characins (*Astyanax fasciatus*) has a polygenic basis (Sadoglu, 1957, 1975; Wilkens, 1970, 1971; Peters and Peters, 1973). Rogers (1956) and Ingalls and Murakami (1962) produced anophthalmic mummichog (*Fundulus heteroclitus*) and zebra fish (*Brachydanio rerio*) teratogenically by subjecting developing embryos with chemicals or by using heat or hypoxic conditions.

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The objective of this study was to determine if anophthalmia was heritable in *O. mossambicus*.

MATERIALS AND METHODS

Description of the phenotype

Fish with anophthalmia (Figure 1) were produced without the use of chemicals or physical trauma. The deformed fish were the result of matings that were used to produce fish for other genetic projects.

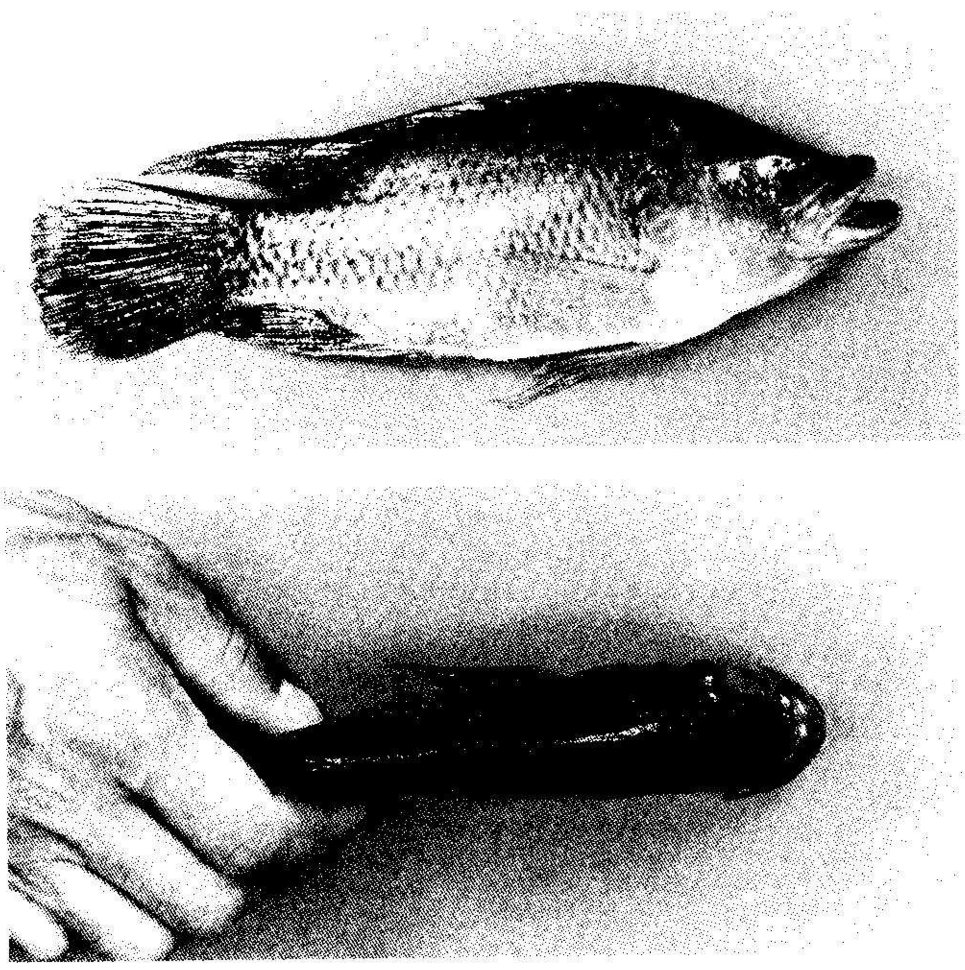

Figure 1. Oreochromis mossambicus with anophthalmia.
Slika 1. Tilapija Oreochromis mossambicus s anoftalmijom

Seven *O. mossambicus* males with only one eye were observed in a population of 36,000 fish at the Fisheries Research Unit, Auburn University, Alabama. Five were missing the left eye, and two were missing the right eye. The side with the missing eye did not appear to be damaged in any way. The place where the eye should have been was slightly depressed and covered with scales.

Matings

In June, 1989, the anophthalmic males and normal *O. mossambicus* were transferred from Auburn University to the Aquaculture Research Station, University of Arkansas. In July, 1991, one anophthalmic male and seven normal female brood fish were stocked in each of three 2–m^3 hapas that were suspended in a 0.1–ha earthen pond.

Eleven F_1 families were produced. Females incubated their offspring until swim–up. Each family was then harvested and transferred to individual 2–m^3 hapas where the fry were fed a ground 32% protein catfish feed five times per week for 2 weeks. At that point, the fish were harvested, phenotypes of the F_1 progeny were determined, and a randon sample of 50 fish transported to the University of Maryland Eastern Shore.

The F_1 fish were raised in 205–L indoor tanks (water exchange rate of 1 L/min). In February, 1992, four 15.3–cm–diameter nesting containers were placed in a 121–cm x 243–cm x 25–cm trough containing 631 L of water. A single F_1 male and four F_1 female brood fish were stocked in the trough.

A single F_2 family was produced. The female incubated her offspring until swim–up, when phenotypes of the F_2 progeny were determined. At that point, several genetic groups of fish were accidently mixed. Because it was impossible to accurately identify each fish, the experiment had to be terminated.

RESULTS AND DISCUSSION

Eleven P_1 normal ♀ x P_1 anophthalmic ♂ matings were produced. A total of 3,762 F_1 offspring was produced; no F_1 offspring with anophthalmia was produced (Table 1). A single F_2–generation family of 42 fish was produced. No F_2–generation fish had anophthalmia.

These results strongly suggest that anophthalmia was not heritable. The deformity was observed only in males, which suggested that it might be a sex–linked phenotype, because such an occurrence would be unlikely (P = 0.0078) if the trait were equally probable in males and females. Since *O. mossambicus* has the XY sex–determining system (Chen, 1969), the absence of F_1–generation males with anophthalmia suggests that the deformity was not Y–linked; additionally, since all F_2–generation males were normal, it is equally unlikely that the trait was X–linked. The data also suggest that

Tablica 1. Odnos potomstva F_1 generacije kod križanja normalne P_1 ženke X anoftalmični P_1 mužjaci, te odnos potomstva F_2 generacije kod križanja F_1 X F_1

Table 1. F_1 progeny ratios for normal P_1 ♀ X anophthalmic P_1 ♂ matings, and F_2 progeny ratio for one F_1 X F_1 mating.

Mating/Križanje	Progeny ratio/Odnos potomstva Normal: Anophthalmia/Normalni: Anoftalmični
Normal P_1 X ♀ Anophthalmic P_1 #1 ♂	211:0
Normal P_1 X ♀ Anophthalmic P_1 #1 ♂	370:0
Normal P_1 X ♀ Anophthalmic P_1 #1 ♂	586:0
Normal P_1 X ♀ Anophthalmic P_1 #1 ♂	442:0
Normal P_1 X ♀ Anophthalmic P_1 #1 ♂	408:0
Normal P_1 X ♀ Anophthalmic P_1 #2 ♂	340:0
Normal P_1 X ♀ Anophthalmic P_1 #2 ♂	415:0
Normal P_1 X ♀ Anophthalmic P_1 #2 ♂	139:0
Normal P_1 X ♀ Anophthalmic P_1 #3 ♂	502:0
Normal P_1 X ♀ Anophthalmic P_1 #3 ♂	349:0
F_1 ♀ X F_1 ♂	42:0

anophthalmia was not controlled autosomally: if the deformity were controlled by a dominant autosomal allele, it would have been observed in 50% of the F_1 generation; if it were controlled by a recessive autosomal ellele and occurred as a result of inbreeding, it would have been observed in 25% of the F_2 generation; if it were controlled by some type of epistasis, it would have been observed in the F_2 generation. Because anophthalmia was not observed in either the F_1 or the F_2 generation, the only logical explanation is that it was a non-heritable congenital defect.

Many assume that most deformities have a genetic basis; the sudden occurrence of deformities often causes aquaculturists to assume that inbreeding has occurred in their stocks, and this is a logical assumption because an increase in the percentage of deformities is a clinical sign of inbreeding depression. However, inbreeding usually is not the reason for the appearance of the deformity, because most abnormalities are non-heritable (Tave, 1993).

Non-heritable congenital defects have also been described in *O. aureus* (Tave et al., 1982), *O. mossambicus* (Handwerker and Tave, 1994), *O. niloticus* (Tave and Handwerker, 1994), and channel catfish (*Ictalurus punctatus*) (Dunham et al., 1991). As the causes of more deformities are understood, the number that are known to be non-heritable congenital deformities will increase dramatically.

Sažetak

ANOFTALMIJA: NENASLJEDNA DEFORMACIJA OČIJU KOD TILAPIJE *Oreochromis mossambicus*

U populaciji uzgajanih tilapija *Oreochromis mossambicus* nađeno je sedam mužjaka s izraženom očnom deformacijom anoftalmijom. Oni su upotrijebljeni u križanjima koja su proizvela 11 porodica F_1 generacije, te porodicu F_2 generacije s 42 ribe. Kako niti kod jednog potomka ova deformacija nije utvrđena, može se zaključiti da je anoftalmija nenasljedna kongenitalna deformacija.

Ključne riječi: tilapija, anoftalmija, nenasljedna deformacija

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Received 24th September, 1998
Accepted 14th November, 1998