THE SNAKESKIN BODY TRAIT IN GUPPY: FROM X TO Y

I.V. Petrescu-Mag[1], B. Păsărin[1], G. Hoha[1], Valerica Gîlcă[1], Ruxandra Mălina Petrescu-Mag[2,3]

[1]U.S.A.M.V. Iaşi
[2]Babes-Bolyai University, Cluj-Napoca
[3]SC Bioflux SRL, Cluj-Napoca
e-mail: zoobiomag2004@yahoo.com

Abstract

In this paper we report on a special case of crossing-over in Poecilia reticulata. It was known fact that Snakeskin body trait (Ssb) can be both X-linked, or Y-linked, and also that the percent of recombination between Y and X chromosomes is 0.36, while reciprocal recombination, from X to Y, is 0.00; in other words, the gene was not known to recombine from X to Y. The aim of the current work was to present an accidental observation about the occurrence of crossing-over events from X chromosome to Y chromosome in our guppy broodstock. The results based on crossbreeding and progeny testing showed that Ssb recombination by crossing-over or gene conversion is possible both from X to Y and Y to X. These events have numerous evolutionary implications as long the color traits and behavior are very close interrelated in many animal taxa and not only in the guppy fish.

Key words: crossing-over, Poecilia, Snakeskin body, progeny test

INTRODUCTION

Interdisciplinary research on: genetics, behavior, evolution, ecology and guppy research have always demonstrated to reveal results plenty of new information [5-7].

In this paper we report on a peculiar case of crossing-over in the guppy (*Poecilia reticulata*, Peters 1859), which is one of the best fish model for classical genetics [22-23, 14, 16]. Snakeskin body trait is encoded by a gene *Ssb* or by group of genes functioning as a unit in guppy [15, 17, 24]. It is known fact that *Ssb* can be both X-linked, or Y-linked [11], and also that the percent of recombination between Y and X (for this gene) is 0.36, while reciprocal recombination, from X to Y, is 0.00 (in other words, the gene is not known to recombine [19-21]). The scope of the current work is to present an accidental observation about the occurrence of crossing-over events from X chromosome to Y chromosome in our guppy broodstock.

MATERIAL, METHODS, RESULTS

We always had our own biobasis and guppy strains for research during 2003-2009 due to the numerous guppy research projects and patents we coordinated. Our traditional strains were Red Snakeskin, Blue Metallic, Red Blond (to not be confused with Full Red), Yellow Snakeskin, Half-Black Red, Half-Black Black known also as Full Black guppy and Micariff.

During 2003 we first time tested our Red Snakeskin strain if the males are X- or Y-linked snakeskins. Ten adult males were mated individually with ten wild type adult virgin females and the progeny tests revealed an X-linkage for all the ten cases. No snakeskin male was observed in the progeny of the ten females (see table 1); all the F1 male generation was wild type. All the products resulted in the progeny test were removed from broodstock.

In 2005 an infusion with fresh genetic material (wild type females) was necessary to avoid the excessive inbreeding of our Red Snakeskin strain. Simultaneously, we intended to make a second repetition of the previous test from 2003. One of the ten males of the second test produced only snakeskin males (seven Y-linked males) while the other nine males produced exclusively wild type

males (X-linked males; table 1). We supposed that the one male as its male progeny were Y-linked snakeskin guppies so futher investigation was necessary. The seven males were kept for reproduction in the next year and they replaced all the old Red Snakeskin male broodstock of the biobasis. The third set of tests was made at the end of 2006 using ten wild type females and ten males of the first generation produced by the seven Y-linked males. The third progeny testing revealed 100% snakeskin males, suggesting that all the males produced were Y-linked Red Snakeskin guppies.

During 2003-2009 two bottlenecks affected the guppy population: the first one in 2003-2004, and the second one, artificial induced, when the seven spontaneous Y-linked males were detected during the progeny tests, in 2005-2006 (see figure 1). We replaced all the male broodstock with the seven Y-linked males.

DISCUSSION

The events presented above show us how a bottleneck (=temporarily low populational number) combined with other factors like genetic drift or artificial selection can affect the inheritance of one specific trait in vertebrates. This fact has numerous evolutionary implications as long the color traits, morphology, body size and animal behavior are close interrelated in many species and not only in guppy [1-4, 8-10, 12-13, 18).

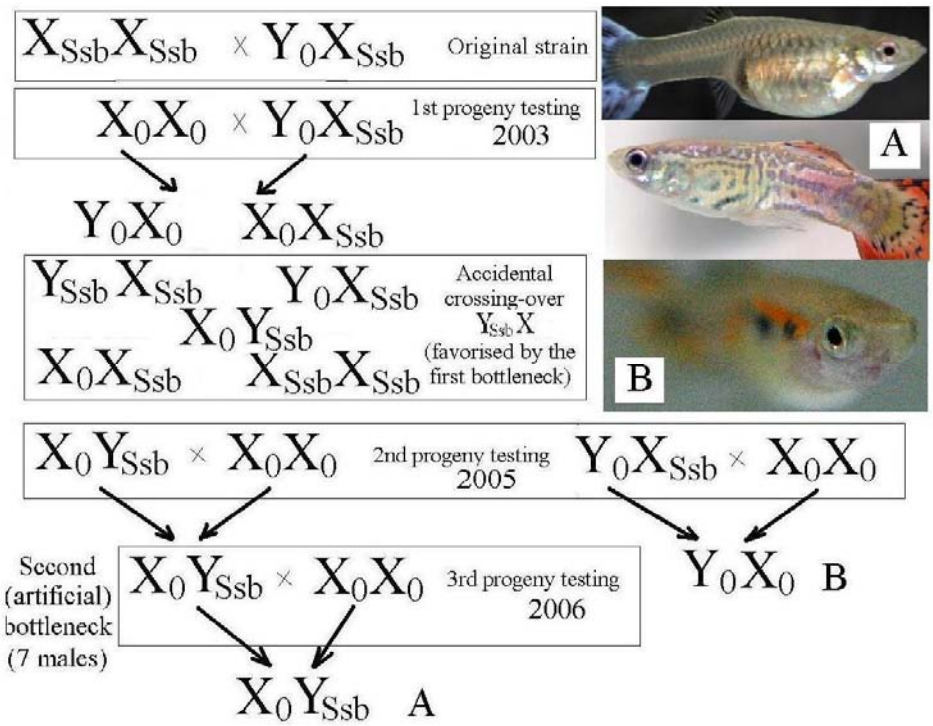

Fig. 1 A chronological scheme of the three progeny tests.

Table 1 Events of recombination by crossing-over and evolution of the male genotype in broodstock

Chronological data	Genetic constitution; parents; cross	Results of the cross or test
Initial constitution of a presumably X-linked Snakeskin guppy	♀$X_{Ssb}X_{Ssb}$ x ♂Y_0X_{Ssb}	♀$X_{Ssb}X_{Ssb}$ and ♂Y_0X_{Ssb}
1st progeny test, 2003	♀X_0X_0 x ♂Y_0X_{Ssb}	♂Y_0X_0 and ♀X_0X_{Ssb}
1st bottleneck	Old and new constitution of the male: ♂Y_0X_{Ssb} and ♂$Y_{Ssb}X_{SSb\ or\ 0}$	
2nd progeny test , 2005	♀X_0X_0 x ♂$Y_{Ssb}X_{SSb\ or\ 0}$ ♀X_0X_0 x ♂Y_0X_{Ssb}	♂$Y_{Ssb}X_0$ (in one case) and ♀ ♂Y_0X_0 (in nine cases) and ♀
2nd bottleneck (artif.induced)	The male having the old constitution was replaced by ♂$Y_{Ssb}X_{SSb\ or\ 0}$	
3rd progeny test, 2006	♀X_0X_0 X ♂$Y_{Ssb}X_{SSb\ or\ 0}$	♂$Y_{Ssb}X_0$ (100%) and ♀

Notes: X= the X chromosome; Y= the Y chromosome; Ssb= the Snakeskin body gene (or group of genes); 0= the recessive allele of Ssb gene (other, wild type, color patterns)

CONCLUSIONS

The Snakeskin body color pattern (*Ssb*) can be both X-linked, or Y-linked in guppy, and moreover, its recombination by crossing over or gene conversion is possible both from X to Y and Y to X. These events have numerous evolutionary implications as long the color traits and behavior are very close interrelated in many animal species and not only in the guppy fish.

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