Poeciliid Research

Sex chromosomes and genetic plasticity in Poeciliid fishes

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Nature has made numerous attempts throughout evolution to differentiate sex chromosomes. In fact, the differentiation of sex chromosomes occurs inevitably, due to the accumulation on the Y or W chromosome of genes that are useful for heterogametic sex (Lindholm & Breden 2002), that is, those genes responsible for secondary sexual characters. Sexually antagonistic genes (that benefit the heterogametic sex and are detrimental to the other) are more likely to increase in number when linked closely to the sex-determining locus (Fisher 1931; Bull 1983; Rice 1984; Lindholm & Breden 2002).

Because ingenious nature makes more than one attempt, multiple mechanisms of sex chromosomes differentiation will emerge or disappear, be tested, undone, and retried, depending on the ecological context. For each ecological context, nature has a different ideal solution to the problem, and as environmental factors are constantly changing, nature will oscillate between the most suitable solutions.

For instance, species with either male heterogamety (XX/XY) or female (WZ/ZZ) heterogamety exist within the Poeciliid fish group and in some cases even three types of sex chromosomes (W, Y, X) coexist within the same population (this is the case of platyfish, *Xiphophorus maculatus*) (Mag & Petrescu 2006; Oroian et al 2019).

Among vertebrates, fish are said to have been the first to differentiate their sex chromosomes, and they illustrate the steps by which autosomes become heterosomes. Specifically, we have zebrafish (*Danio rerio* Hamilton, 1822) with an all-autosome karyotype, platyfish (*Xiphophorus maculatus* Günther, 1866) with genetically defined sex chromosomes, but no differentiation between X and Y visible in the SC or with CGH in meiotic and mitotic chromosomes, and guppyfish (*Poecilia reticulata* Peters, 1859) with genetically and cytogenetically differentiated sex chromosomes (Traut & Winking 2001) (Figure 1).

It appears that, as with the placenta (Petrescu-Mag et al 2019; van Kruistum et al 2020; Furness et al 2021), sex chromosomes have appeared, disappeared, and reappeared numerous times within the Pisces group, due to the genetic plasticity of the group. A particularly high plasticity is found in poecilid fishes. In other groups of vertebrates, such as mammals, highly advanced differentiation and specialization do not allow taxa to reverse evolutionary paths to a large extent, either chromosomally or anatomically.

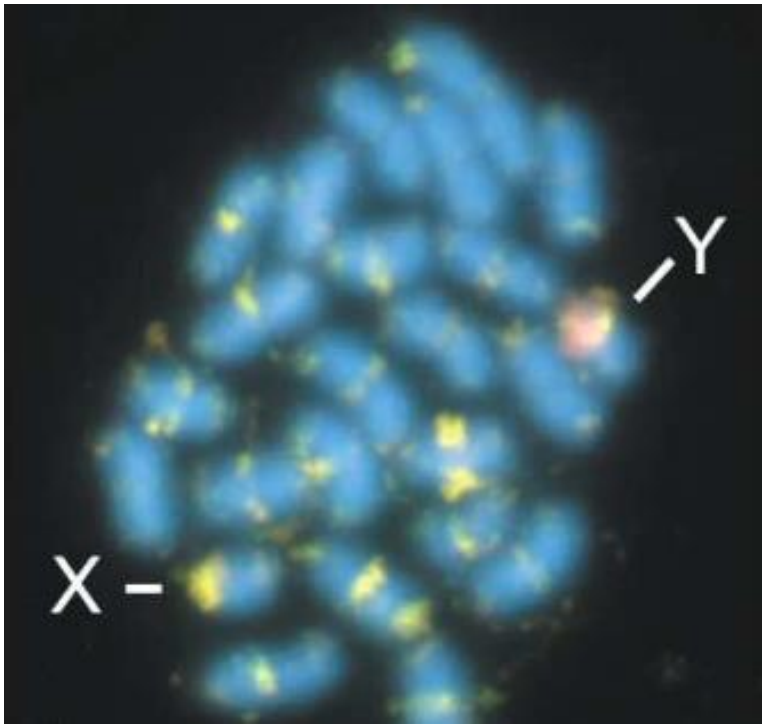

Figure 1. Comparative genomic hybridization of guppy chromosomes (Traut & Winking 2001).

Conflict of Interest. The authors declare that there is no conflict of interest.

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