Y-LINKED QUANTITATIVE TRAITS IN GUPPIES (*Poecilia reticulata* Peters, 1859)

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Abstract.

Guppy males exhibit many elaborate secondary sexual characters, and in the wild, populations exhibit extreme polymorphic characters. Several of these characters have been shown to be attractive to females: conspicuous coloration, especially bright orange and black spots, large caudal fins and body size, high courtship display rate and so on. Knowing the Y-linkage of many quantitative traits, the work of selection of domesticated strains of guppy is easier. Excepting the body-base colour and other one-locus sex-linked but recombining colour patterns, the characters of interest in guppy culture can be selected on father and sons only.

Key words: Y-linked, quantitative traits, guppy.

Ornamental fish production for the aquarium industry is a multimillion-dollar industry in many countries. The guppy is considered by many to be the most popular aquarium fish and in 1992, it alone accounted for nearly 26% of the total number of freshwater ornamental fishes imported into the United States (TAMARU & AKO 1998). It is important for studies of genetics, behavioural ecology, ecotoxicology, evolutionary ecology, and conservation, being an invasive species (MAG *ET AL.* 2005). Guppy is native of Venezuela, Guyanas, northern Brazil, Trinidad and Barbados (BUD 2002, 1995). They exhibit a marked sexual dimorphism due to the more pigmented bodies and larger fins usually observed in males. Because of that there is a price discrepancy between the two sexes on the market.

Guppy males exhibit many elaborate secondary sexual characters, and in the wild, populations exhibit extreme polymorphic characters. Several of these characters have been shown to be attractive to females: conspicuous coloration, especially bright orange and black spots, large caudal fins and body size, high courtship display rate and so on (FARR 1980; BISCHOFF *ET AL.* 1985; REYNOLDS & GROSS 1992; NICOLETTO 1993; ENDLER & HOUDE 1995; BROOKS & ENDLER 2001). Colour patterns, caudal fin size, caudal fin shape, courtship rates, and a composite measure of attractiveness are primarily sex linked in guppies. Quantitative genetic analyses of colour and shape traits indicate a Y-linked component. Many other traits recombine between the X and Y chromosomes, revealing a partial homology between guppy sex chromosomes. It has been shown that there is some cytological and molecular differentiation between the

X and Y-chromosomes in the guppy (TRAUT & WINKING 2001). Only a half of the Y chromosome pairs with homologous regions of the X in synaptonemal complexes. Furthermore, the orientation of the sex chromosomes allowed for recombination in only 2 of 49 synaptonemal complexes observed, suggesting that recombination is greatly reduced even in the homologous region. Comparative genomic hybridization (CGH) indicates a large part of the nonhomologous region of the Y that comprises malespecific repetitive DNA (TRAUT & WINKING 2001). There is structural variation among Y-chromosomes in that region. This agrees with results from an in situ hybridization study showing that only Y chromosome of domesticated guppies carry large numbers of simple repetitive sequences (NANDA *ET AL.* 1990). These male-specific repeats were not observed in recent descendants of feral guppies (HORNADAY *ET AL.* 1994). Degeneration of the Y chromosome is supported by the observation that inheritance of Y-chromosomes bearing alleles for attractive male traits leads to increased mortality (BROOKS 2000). The buildup of simple repetitive sequences and deleterious mutations on Y-chromosomes that produce male guppies highly attractive to females would provide a mechanism for the result that more attractive males produce sons of lower viability (LINDHOLM & BREDEN 2002).

Table 1.

Quantitative traits in guppies

Trait	Reference
Orange area	HOUDE 1992; BROOKS & ENDLER 2001
Black area	BROOKS & ENDLER 2001
Fuzzy black area	BROOKS & ENDLER 2001
Iridescent area	BROOKS & ENDLER 2001
Mean brightness	BROOKS & ENDLER 2001
Brightness contrast	BROOKS & ENDLER 2001
Mean chroma	BROOKS & ENDLER 2001
Attractiveness	BROOKS 2000
Tail area	BROOKS & ENDLER 2001
Courtship	FARR 1983

BROOKS & ENDLER (2001) analyzed male ornamentation (table 1) both from the point of view of single ornamental traits (e.g., the area of each colour) and of composite measures of the way the entire pattern is likely to be perceived by females (e.g., the mean and contrast in chroma). They demonstrated that there is substantial additive genetic variation in almost all measures of male ornamentation and that much of this variation may be Y linked. HOUDE (1992), using standard quantitative genetic techniques (father-son regressions, half-sib analyses, selection experiments) found that one such quantitative measure, the

relative area of orange pigment in a colour pattern, has high heritability (at least 0.70) and shows evidence of Y linkage.

Knowing all these things the work of selection of domesticated strains of guppy is easier. Excepting the body-base colour (normal grey body tone, albino, blond, Asian blue and European blue) and other one-locus sex-linked but recombining colour patterns, the characters of interest in guppy culture can be selected on father and sons only.

Body size is a quantitative trait and it seems to have high heritability in guppies too (REYNOLDS & GROSS 1992), but it is not sex-linked in spite of size discrepancy between the two sexes.

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