**MATE PREFERENCE WITH BACKGROUND COLOR INTERFERENCE IN GUPPIES**

In a variety of species, females choose mates on the basis of traits such as male body size, ornamentation, courtship vigor or morphological symmetry. In general, the two sexes have very different reproductive strategies, females being more discriminating in their choice of mates than males are. For example, Bateman (1948) observed that male fruit flies try to mate with almost any female, whereas females tend to interact with a number of males before they allow one to mate. These sex differences in mating tactics are probably related to sex differences in the costs of making poor mating choices. Compared to males, females typically incur greater reproductive costs (egg production, gestation, incubation, lactation), and as a result, females run the risk of paying a greater cost for making poor mate choices (Trivers 1972). Consequently, females often choose carefully among potential mates, and males display vigorously to attract females. (For further explanation see chapter 6 and 7 in Dugatikin).

Guppies (*Poecilia reticulata*) have been used extensively to gain an understanding of sexual selection and the evolution of mating systems. Several competing and complementary theories can be used to explain the evolution of female choice. Careful empirical studies are important in order to determine which theories apply to which species. Or to uncover the relative importance of different processes in different species.

It has been hypothesized that mate choice should favor individuals that display high symmetry because small random deviations from bilateral symmetry result from developmental "noise" in the morphological traits of individuals (Lens *et al*., 2002). This type of random developmental asymmetry is known as "Fluctuating Asymmetry" (FA). According to these hypotheses, FA is an indicator of reduced genetic quality, or lack of buffering from environmental perturbations during development. However, this theory remains controversial and few robust empirical tests have been conducted.

Despite current research that has shown behavioral lateralization for a great number of species in different contexts, many studies focus on the benefits of symmetry. Therefore, behavioral ecology has largely ignored the potential for compensatory or exploitative behaviors that capitalize upon the subtle asymmetries resulting from developmental instability.

A recent study (Gross et al., 2007) has been the first to demonstrate behavioral responses to subtle fluctuating asymmetry. Gross et al (2007) reasoned that in organisms where symmetry is not a trait targeted by females, one might anticipate that males would attempt to take advantage of their own fluctuating asymmetry and "put their best side forward". They used the guppy as their model organism and demonstrated that male guppies with more symmetric body color display both sides equally to the female during courtship, while those with high asymmetry in body color preferentially display their most colorful side.

Consider how the male would know which side has higher contrast and would therefore be preferred?

## METHODS

### *Animals:*

The guppies used for this lab are a captive reared population obtained from KGA pet suppliers. They have been maintained at Reed for the past 2 months.

### *Materials for each photostation (4/lab):*

1 digital camera (batteries, CF card, download cable)
1 tripod
paper towels
ruler
pencils

### *Materials for each pair of students:*

Animals: 2 female guppies (housed 4 weeks in all female tanks)
2 male guppies (housed 4 weeks in all male tanks)

Setup: 2 five gallon aquaria
2 black plastic dividers
timer

Note: This lab could possibly be scored more accurately with a computerized event recorder such as JWatcher. However, the time required to create the *.gdf, *.fmf and *.faf would preclude an introduction to ImageJ, the image analysis software.

### *Experimental Trial:*

- ☐ Each pair of students will test 2 males, each with a different female.
- ☐ Place an opaque divider in the middle of a 5 gallon observation tank.
- ☐ Place one female on one side and one male on the other side.
- ☐ Allow the fish ~ 10 minutes to acclimate to the observation tank.
- ☐ Begin the trial by lifting the removable black divider and start your timer.
- ☐ Each time that the male displays to the female, record whether his left of his right side is closest to the female.

### *Male coloration photography:*

- ☐ Both sides of each male will be photographed.
- ☐ Each photograph must include a **metric ruler** as well as a piece of paper indicating the identity of each fish according to date_station(A-K)_trial(1/2)_side(L/R) (*e.g.* **20101014_B_2_L** ).
- ☐ Camera instructions will be provided at each photography station.
- ☐ Instructions will be provided for using Image J to measure % orange.

#### *Measuring in ImageJ:*

This is free image analysis software developed by NIH. Several Plugins are available which allow very sophisticated image analysis. It can be downloaded for MAC or PC from http://rsb.info.nih.gov/ij/

***Data Entry:***

1. Drag the file **guppy_data_template.jmp** to your desktop from Courses/Biology/Bio342/Labs/guppy.
2. Rename this file **guppy_data_date_initials.jmp.**
3. Open this file in JMP and enter:
   - The number of right side displays
   - The number of left side displays
   - Calculate a behavioral lateralization as log(#Left/#Right)
   - (why do we use log here?)
   - The %left orange
   - The %right orange
   - The animal's total area (average your two measures)
   - Calculate color lateralization as log(%Left/%Right)
4. Save your data file and put it in 2010_guppy_data so that the class dataset can be combined.

## CONCLUSIONS:

Do Male guppies display more with their "flashier" side?
Working with your partner, write up a one page summary that includes a clear statement of your hypothesis, presents the class data set and a statistical test that reveals whether or not the data support your hypothesis. You need not describe the experimental methods but you must describe statistical methods and any manipulation or filtering of the class data.

We have used "%orange" to describe "flashy". In your summary report, suggest how Principle Component Analysis and additional measures might be used to describe "flashy"

**REFERENCES and additional reading**
**(most of these will be available from the server):**

Alexander, H. J and Breden, F. (**2004**) Sexual isolation and extreme morphological divergence in the Cumana guppy: a possible case of incipient speciation. J. *Evol.Biol*. **17**:1238-1254.

Andersson, M. (**1994**) Sexual selection. Princeton: Princeton University Press. This book is considered the modern reference guide for work on sexual selection.

Bateman, A.J., (**1948**) Intra-sexual selection in *Drosophila*. Heredity **2**, 349–368.

Houde, A. E. (**1997**) *Sex, color and mate choice in guppies.* Princeton University Press.

Dugatkin., L.A. and Godin, J.G.J. (**1998**) How Females Choose their Mates *Scientific American* 56-61.

Gross, M.R., Suk, Y.Y., Robertson, C.T. **2007** Courtship and genetic quality: asymmetric males show their best side. *Poc. Roc. Soc*. B

Janetos, A. C. (**1980)** Strategies of female mate choice: a theoretical analysis. *Behavior. Ecol. Sociobiol.* **7**:107-112

Lens, L., Van Dongen, S., Kark, S., and Matthysen, E. (**2002**) Fluctuating asymmetry as an indicator of fitness: can we bridge the gap between studies? *Biol Rev*. **77**:27-38.

Morell, V. (**2002**) Guppy Sex and Gluttony Guided by Orange Glow. *Science* **295** :1816b. & see response letters *Science* **296**:847-848.

Neff, D. Bryan., Pitcher, E. Trevor. (**2003**) Multiple mating and sequential mate choice in guppies: females trade up. *The Royal Society*., p1623

Panhuis, T.M., Butlin, R., Zuk, M., and Tregenza, T. (**2001**) Sexual selection and speciation. *TREE* **16**:364-371.

Rodd, F.H., Hughes, K.A., Grether, G.F. and Baril, C.T (**2002**) A possible non-sexual origin of mate preference: are male guppies mimicking fruit? *Proc. Roc. Soc. B* **269**:475-481.

## Independent project ideas:

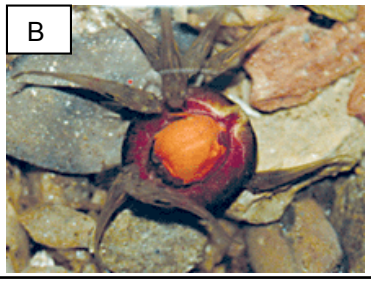
### *Evolution of Mate Choice Signal*

It has been shown that females prefer "showy" males, those with a larger area of orange color (Figure 1A). The orange color on guppies is similar to, and is in part due to, the coloration of a preferred food source, the fruit from the cabrehash tree in Trinidad (Figure 1 B) (Rodd et al., 2002). This color may signal to females that the male is healthy due to efficient feeding capabilities. According to the “Good genes hypothesis” (Andersson, 1994) females benefit indirectly by choosing males based upon "honest signals" that indicate genes for good health.

**Figure 1 Orange coloration of *Poecilia reticulata* (A) is similar to orange color of cabrehash fruits found locally in Trinidad.**

A

B



Is the orange coloration an honest signal of healthy genes in male guppies?

An alternate theory suggests that the male's orange coloration may be a “sensory trap”. According to this theory the males orange color exploits the female's preference for orange that initially evolved for detecting the nutrient rich cabrehash fruits (Christy, 1995). Signals that contrast the environment are more readily detected. Therefore, once established, preference for a color may evolve further due to contrast with the environment.

By determining whether a female's preference varies with the degree of contrast between signal and environment, one could address the relative contribution of these two hypotheses. You would need to measure the strength of a female's preference for showy over drab males on orange (low contrast) and blue (high contrast) backgrounds. You would also measure the coloration of the males in the experiment to determine which body color, blue or orange, affects preference in different environments.

Different experimental results would support the "Good genes" theory or the "Sensory Trap enhanced by Contrast" theory.

### *Female condition-dependent variation in mate preference*

There was a recent study in birds that suggested that females in poor condition actually prefer mates with less accentuated secondary sexual characteristics (Griggio and Hoi, 2010). In that species, the less ornamented males are known to perform more paternal care, thus the females may be choosing direct benefits over indirect benefits.

Griggio and Hoi BMC Evolutionary Biology 2010, 10:261

### *Mate choice copying.*

There have been several studies that demonstrate mate choice copying among female guppies. Younger females tend to copy older females. One could ask if this copying behavior is affected by the contrast with the environment.

### *Fluctuating asymmetry in a fluctuating environment*

If contrast with background color affects female preference and a male has asymmetric coloration, his "best-side" might be different in two different environments. One could test to see if the male will display different lateralization in different environments.