Bio 45 – Lect., II-13 - Female Choice -- Runaway & Good Genes Model

I. The Big Question:

A. Why choose among males, in a group (lek) or alone, if all you get are sperm? **Hypotheses:**

1) **Runaway selection models:** genetic co-evolution of trait and choice genes – female programmed to choose
2) **Good genes models:** male behaviors and traits reveal high quality genes for offspring.
3) **Direct Gain**: choice not of males but of safe mating places within leks or bower bird bowers
4) **Direct Gain**: low cost mate choice -- compare males easily, or copy choices of other females

II. Simple version of the Runaway Selection Model:

A. Assume two genes are involved: Female choice gene (**C** = choose males with exaggerated trait, c = mate randomly) and Male trait gene (**T** = have exaggerated trait, t = normal trait)

1) When **C** allele is common, **T** is favored - **C** females do better since their offspring have both **C** allele(s) for daughters and **T** trait for sons.
2) **T** increases not because it directly benefits females but because it gets chosen (it pays to have sons with trait and daughters who chose it).
3) This leads to runaway selection and the T allele increases until:
   - It is fixed in the population
   - Natural selection against T carriers halts it

   T mutants may appear and lead to further exaggeration

It is the co-evolution of the trait and choice loci that drives the process. They become "linked" and self-reinforcing. The result is an ongoing exaggeration of the trait; held in check only by natural selection. Females gain success by just having the tendency to choose for certain traits.

III. Two Problems with Runaway Models

A. **First Problem** = how can the **C** allele get common enough for a runaway to start?
- **C** may increase at first due to a direct gain to females from mating with T males
- **C** may increase at first due to T males being easier to find = lower female search cost.
- **C** may be high due to **sensory exploitation** (see Alcock pp 292-298)

B. **Second problem** = if there is a **cost of choosing** the process doesn't work as well.
- This is not easy to explain without models. Consider a case where there is an equilibrium between gain from having **T** and loss in viability due to having **T** (sexual selection balanced by natural selection). Then choosy and randomly mating females have the same fitness gain. But, if there is a cost to choosing , random mating females have a net advantage and "c" allele will increase. As c increases the frequency of **C** may get too low to maintain **T**.
- The instability of the runaway and some good genes models when a cost of choice is added makes them less useful.

C. The problems and possible solutions outlined above have lead to new models that blend gain and cost better and to newer ways of looking at the whole question. Even though it is now clear that the cost of choice for females has a large impact on all of these models they are still popular and being tested in nature.

Good Genes Models:

I. The Question - Why choose among males if all you get are sperm?

A. What if male traits indicate underlying genetic quality? Then females might choose to get good genes for their offspring (all offspring).

II. The first problem for females when choosing genes via displayed traits

A. Which male characteristics give reliable information about genetic quality?

B. Possible solutions for honest traits:

1. Handicap or costly traits - male has genetic quality to maintain trait despite cost or handicap
2. Indicator of disease resistance - ability to display trait means disease or parasite resistence
3. Trait Symmetry (called Fluctuating Asymmetry, **FA**) - symmetrical trait means genetic quality to guide development

III. The Second problem with Good Genes Models:

A. "Lek Paradox" (see Alcock, pp.390) = If females favor the more showy or viable males, then genetic variation among males may disappear.

B. **The solution**—how to maintain genetic variability in viability genes in the population despite the selection that continually removes it.

- <u>Viability</u> is multigenic so mutation rates can maintain the needed genetic variability.
- <u>The viability genes</u> are involved in parasite or disease resistance cycles which keeps genetic variability high (another frequency dependence model)
- <u>The trait</u> is conditionally expressed (only healthy or resistant males can express it).

IV. Hey, what about the females?

Our view of female choice so far has been about the evolution of male traits! We tend to think of female reproductive decisions in the context of what they gain from males – resources & genes.

A. Reproductive Success - Female Perspective

- Acquire resources needed for reproduction
- Time reproduction relative to resources and female competitors
- Find and/or choose mate
- Minimize costs of male tactics for reproductive success
- Balance short and long term reproduction

B. Example from bowerbirds – design of bower suggests cost reduction for female

C. Female success often seen as maximizing gain. E.g., picking Mr. Goodgenes. **But,**

Net Fitness = fitness gain - fitness cost

1. gain maximization - focus of sexual selection theory (e.g., mate choice) until recently
2. cost minimization - profit can also be increased (relatively) by reduction of costs (including those to future reproduction)

V. Major Take Home Messages

A. Most choice by females is in relation to direct gains.

B. Female reproductive success is more than maximizing gains by mate choice.

- Fitness Profit = gain in fitness - cost to fitness.
- Relative fitness can be increased by **<u>cost minimization</u>**
- Costs are to present and future reproduction.

C. Not all reproductive decisions by females cause sexual selection! (affect male traits)

D. Who to mate with is only **<u>one of many</u>** important reproductive decisions females make.