

# BIO 45 -- SEXUAL SELECTION THEORY -- BASIC IDEAS

## For Lectures 9-11 2002

In the last 20 years there has been a dramatic growth in sexual selection theory to the evolution of behavior and associated morphology. Historically men have done most of the work and male behavior has been over-emphasized; not just because male aggressive and courtship behaviors tend to be more obvious than those of females are. Now more behavioral ecologists are women, the theory is gradually being re-examined, and there is a growing emphasis on "the female perspective".

### I. Darwin's dilemma and Sexual Selection

- A) **Darwin** (1859 and 1871) was explaining morphology and behavior, usually found in males, that seemed to put individuals at a survival disadvantage (high energetic costs, risk of predation). He argued that these traits must, therefore, be maintained by their advantage in obtaining more matings. This advantage, worked either through mate choice (attracting more mates) or intrasexual competition (excluding others from mates or resources needed for mating). He noted that it was mostly males who displayed and females who chose but did not fully explain why.
- B) **Darwin's Definition** (1859) - "This form of selection depends not on a struggle for existence in relation to other organic beings or to external conditions, **but on a struggle between individuals of one sex**, generally the males, for the possession of the other sex. The **result is not death to the unsuccessful competitor, but few or no offspring.**" (my emphasis)
- C) Classification of Sexual Selection (bold items added since Darwin)
- I. Intrasexual Competition
    - A. Precopulatory - dominance, territoriality, or scramble competition
    - B. Postcopulatory** - sperm competition (remove, dilute or displace rival gametes before fertilization)
    - C. Post-zygotic** - induced abortion or infanticide (kill other's offspring and replace with own)
  - II. Mate Choice
    - A. For resources, protection, or aid needed for reproduction
    - B. For genetic quality of offspring**

### II. Why are there Males and Females? – back to the beginning.

Sexual reproduction does not always involve two sexes. There are quite a few species that produce essentially identical haploid gametes (**isogamy**) that are released and fuse with other gametes to form a zygote. These species do not have males and females. Only when there are different kinds of haploid gametes (**anisogamy**) produced do we have sexes. Interestingly, all anisogamous species have only two sexes: 1) those that produce eggs – females, and 2) those that produce sperm – males.

Why did anisogamy evolve and why are there only two sexes in isogamous species? These are two intriguing questions. The evolution of sperm and eggs is the evolution of male and female. The difference between these two gametes has a lot to do with the theory of sexual selection. We will briefly look at two hypotheses for the evolution of anisogamy: A game theory model with a two tactic ESS and a model involving cell organelle competition. They will give us different perspectives on male and female.

### III. Trivers' (1972) Parental Investment Theory of Sexual Selection

- A) **The parental investment theory** of sexual selection says that **if** one sex invests more time and energy per offspring than the other sex, **then** the high investment sex cannot reproduce as often (rapidly) as the other can. The high investing sex thus becomes a limiting resource for the reproductive potential of the other sex. This results in competition among the low investing sex for mates (fertilizations) which produces the selection. The competition is over 1) access to mates or mating opportunities and 2) differential attraction of mates (mate choice).
- B) Prevailing view of sexual selection theory:
- The concept of differential investment is easiest to visualize for mammals. A female dog can produce a number of litters during her lifetime, but a second litter of puppies cannot be started until the first is weaned. During the same time period, how many offspring could a male dog, **if given the**

**opportunity**, father? The point is that the potential for reproduction may sometimes differ greatly for males and females - mammals being an extreme case.

- In many, **but not all**, animals, females **invest more per offspring** than males. In these animals, competition is expected among males for mating opportunities (intrasexual competition). Females, having more to gain or lose per mating and having more control over mating, are predicted to be more selective about when, where and with whom to mate (mate choice) Mate choice, in turn, selects for male display and morphology. The theory predicts that if males invest more per offspring than females their behaviors will be reversed (= **role reversal** in competition and choice).
- When females are the limiting resource for male reproduction -- any male can only produce more offspring (have more mates) at the expense of other males. Since the population sex ratio is usually 1:1, if a male has two mates someone else gets none. Competition among males would lead to high variance in their reproductive success -- some have lots, some have less and many have none. Since females are not limited by finding males to mate with, there will be less variance in female reproductive success (relative to that of males). This difference in the variance in reproductive success between females and males is a way to measure the opportunity for sexual selection. The more intense the selection, the greater should be the variance for the sex being selected.
- If males, in our hypothetical species, offer female more than just sperm (e.g., food, care of young, nest sites), then females who mated only with those males who would provide more (mate choice) might be favored. Notice the potential for "evolutionary conflict of interest" here. Males might profit more by mating a lot and not helping with the offspring, but females might do better if they had help. The compromise (the mating system) depends on a lot on ecological conditions. For example, if males can produce many kids but each kid has a low chance of surviving if cared for only by the mother, then males who mate and leave offspring with a series of females might gain less than males who mate with one female and help her raise their offspring to adulthood. What ecological conditions would temper this conflict of interest between the sexes?
- I am simplifying a complex theory here. Male and female can be interchanged in the paragraphs above for many animals and plants -- making the core of the theory gender neutral. Parental investment theory only says whenever one sex invests more per offspring than the other, then that sex is will be a limited resource and we expect it to be more selective and to be competed for by the other. Which sex that is depends on biology not biologists. Examples of "role reversal" (when males are choosy and females compete) becomes an important test of the investment theory. Why?
- In most animals, females often do invest more per offspring than males. This generality has caused us to focus on male display and competition. This has led to a tendency to describe males as active and aggressive and females as passive, thus perpetuating stereotypes and missing the point. The theory clearly says that the reason males are doing all this has to do with what females are doing. This realization has begun to produce more work on "the female perspective" in sexual selection.
- Despite the gender neutrality of the theory, generalizations are often made about male and female, even for humans. Generalizations cannot logically be used to justify moral or legal decisions of our species. Science can explain and inform; it cannot morally or ethically justify. This doesn't mean that people won't try. It pays to understand this theory because of the potential for its misuse! Remember that the only consistent, general distinction between the sexes is the kinds of gametes they produce.

#### IV. Yet another Perspective – Anisogamy = Asymmetric Influence over Offspring

Making high investments in offspring also means a **high degree of influence over the production and quality of offspring**. It also means that **competition among females for the resources** necessary for offspring production may be more important than previously realized. These insights are leading to changes in sexual selection theory.

#### V. Three 'take-home messages' about sexual selection theory

1. Reproduction may involve competitive interactions within and between sexes due to different evolutionary "interests" or "investment patterns" of the sexes.
2. Females generally are the "high investing" sex. Therefore, female evolutionary perspectives are important for understanding the evolution of male and female reproductive biology and behavior.
3. Whether females or males will invest more or in different ways usually depends on physiology, ecological conditions and phylogenetic history. We should pay more attention to these factors and less to producing and reinforcing stereotypes about males and females.