Chapter 8 Notes: Social Relations

**Behavioral ecology**: relationships between organisms and environments that are mediated by behavior.

**Sociobiology**: branch of biology concerned with study of social relations.

**Evolutionary fitness**: number of offspring (genes) contributed to future generations. Fitness can be substantially influenced by social relations within a population.

Q: Biologically, what defines male and female? Females usually produce fewer, larger, and more expensive gametes. Males usually produce more, smaller, less expensive gametes.

Thus, female reproduction is generally limited by access to necessary resources, while male reproduction is limited by access to reproductive females, leading to the dichotomy of actively courting males and highly selective females.

**Hermaphrodites**: individuals who combine both male and female functions into one individual. (fig 8.2) Consider perfect flowers, for example.

8.1 Mate Choice vs. Predations
The effects of female mate choice on the evolution of ornamentation in males can be reduced by other sources of natural selection.

**Sexual selection**: results from differences in reproductive rates among individuals as a result of differences in their mating success.

**Intrasexual selection**: individuals of one sex compete among themselves for mates.

**Intersexual selection**: members of one sex (usually female) consistently choose mates from among members of the opposite sex on the basis of a particular trait.

Sexual selection will favor elaboration of the trait. (fig 8.3)

Darwin proposed – sexual selection will continue to elaborate a trait until balanced by other sources of natural selection, such as predation.

**In Guppies**
In many habitats, adult guppies are preyed on by several species of carnivorous fish. Male guppies show a broad ranged of coloration. Female guppies, if given a choice, will mate with more brightly colored and behaviorally dominant males. The characteristics reflect the male’s health and access to food, which is passed down, will increase the female’s inclusive fitness.

BUT, these characteristics are also risky. Most brightly colored males are found in lower preyed upon populations, indicating coloration is also affected by predation.
CR8.1.1. Why did John Endler take great care to put all the same colors of gravel in the same proportions into all of the greenhouse ponds?

CR8.1.2. In Endler’s field experiment, why did male colorfulness increase in the absence of effective predators and not just remain unchanged?

CR8.1.3. What do female guppies potentially gain by mating with colorful males?

**Concept 8.1 Review Answers**

1. The influence of prey color on vulnerability to predators is strongly influenced by the background against which the predator views the prey.
2. The observed increase in colorfulness among male guppies in the absence of effective predators suggests that colorful males have some selective advantage, probably related to how female guppies choose their mates.
3. One advantage to females mating with colorful males is that it increases the chances of their giving birth to colorful sons who will be attractive to prospective mates.

### 8.2: Mate Choice and Resource Provisioning

Females of some species select mates based on male’s ability to provide resources.

Thornhill’s scorpionflies –
Flies feed on dead crickets on the forest floor. Since supply is limited, competition is intense, especially intersexual by males.

When a male fly secures a food item, he secretes a pheromone, attracting females. Without a food item, they will secrete a saliva mass. Thirdly, forced copulation

Q. Is there a difference in mating success among males using different strategies?

Experiment – males competed for different sized crickets. Some males won, some offered saliva, some had none

A. males with a medium or large cricket had a clear advantage over small or no crickets.

What here is the potential benefit to the females? What are they selecting for and why?

1. Females do not have to engage in risky foraging behavior. 2. Nutritional benefit allows females to lay more eggs. 3. If ability to provide food is controlled genetically (and is thus a heritable trait), it can increase a female’s inclusive fitness

Q. What factors determine whether males compete successfully for food offerings or resort to less desirable alternatives?

Experiment – males competed for crickets, some won, some offered saliva. Winners were removed, losers thieved the crickets.

Battles can be dangerous – damaging to limbs and wing parts. Male body size varies

Q: Do larger males compete more successfully for crickets?
Experiment – small, medium, large males, crickets, and females were maintained at natural densities for one week.

A. most small males had no crickets, medium offered saliva, and large often offered crickets. Large males got 60% of matings.

CR 8.2.1 What evidence is there that the availability of dead insects for scorpionfly feeding is limited
CR 8.2.2 What led Thornhill to conclude that mating success by male scorpionflies is tied to the quality of nuptial offerings presented by males?

CR 8.2.3 Which results clearly show the influence of intrasexual selection on male scorpionfly mating success?

**Concept 8.2 Review Answers**
1. Male scorpionflies fight over dead arthropods and even steal arthropods from spider webs where they may be trapped.
2. Males guarding large and medium sized dead insects have greater mating success than males guarding small dead insects or salivary masses.
3. The largest male scorpionflies, and presumably the best at defending resources, are able to maintain possession of the highest quality nuptial offerings.

8.3 Nonrandom mating in plants

Mating in wild plants can be non random. (Consider why this should be news..)

- maternal control over fertilization
- competition among pollen
- some combination

Diane Marshall
Pollen donors vary widely in performance

CR 8.3.1 What roles did greenhouse and field studies play in the investigation of mating patterns by wild radish?

CR 8.3.2 What would you expect to see in figure 8.15 if performance were equal across pollen donors?

**Concept 8.3 Review Answers**
1. The greenhouse environment allowed the researchers to keep environmental conditions constant for all plants, which meant they could isolate the influences of male pollen donor on mating success. Meanwhile, the field conditions provided evidence that nonrandom mating occurs even where maternal plants are exposed very different environmental conditions.
2. If performance were equal, the heights of the bars would be approximately equal for all pollen donors. An expectation of no difference is called a “null hypothesis.”

8.4 Sociality

Sociality is driven by the need for group defense of high quality territories and/or defense of mates and young.
Cooperation – exchanges of resources between individuals or various forms of assistance, such as defense against predators.

Cooperation + group living = sociality

Eusociality – complex level of social behavior, pinnacle of social evolution, societies
1. more than one generation living together
2. cooperative care of young
3. division into reproductive status castes

Apparent restriction of reproductive opportunities that comes with sociality would challenge the idea that the fitness of an individual is determined by the number of offspring it produces, because some individuals not only do not reproduce, but actually help others to do so. Because this behavior persists, we have to assume that benefits of society must outweigh the costs.

Cooperative breeders
Some individuals function as helpers – defense, construction, childcare, etc.

WHY?
There must be some benefit to those individuals – many (especially close relatives) share genes, so increasing fitness of one’s relatives is a useful backup plan to one’s reproductive success, when one cannot reproduce on its own.

Inclusive fitness – overall fitness is determined by its own survival and reproduction plus the survival and reproduction of individuals with whom the one shares its genes

So by helping, an individual contributes to its overall fitness = kin selection

Hamilton’s rule: \( R_g B - C > 0 \)
Genetic relatedness per reproductive benefit must be greater than the missed reproductive cost in order to help.

Selection will favor diverting resources to kin under conditions where its benefit to the helper, measured as improved survival and reproduction of kin, exceeds the cost to helper.

CR 8.4.1
The Ligons found that most of the young woodhoopoes tended by helpers were either full siblings or half siblings of the helpers. If full siblings were genetically related to the helpers by 50%, what was the genetic relationship between helpers and half siblings?

CR 8.4.2
According to Hamilton’s rule, would helpers derive greater benefit through kin selection by contributing the same amount of help toward raising a full sibling or a half sibling?

CR 8.4.3
What are the coevolutionary implications of the fact that larger coalitions of male lions consist almost entirely of close relatives?
Concept 8.4 Review Answers
1. Helpers and their half siblings would be related genetically by an average of 25%.
2. The helper would derive more benefit through kin selection by helping raise a full sibling, since, on average, the genetic similarity between a helper and a full sibling is twice as high as that between a helper and a half sibling.
3. This pattern suggests that male lions avoid the risk of helping without gaining in inclusive fitness.

8.5 Eusociality

Kin selection and ecological constraints have led to the evolution of eusociality.

Compared to other ant species, leaf-cutter ant colonies have a larger number of castes that engage in a wider variety of behaviors. In contrast to these colonies where all workers are females, both males and females work in naked mole rat colonies. The work in the mole rat colonies is divided by size.

Haplodiploidy – males are all haploid, increasing genetic relatedness immensely. Females are diploid, controlling the genetic variation of the population. Any male that mates with the single queen contributes to the overall inclusive fitness of every other male, leading to the acceptance of the fate as a worker.

8.5.1
How would mating a queen ant or other eusocial hymenopteran queen, mating with several males affect the relatedness of workers within a colony? If common in social hymenopterans, how would queens mating with several males affect the potential of kin selection to account for the evolution of eusociality in the hymenoptera?

8.5.2 What are two major ecological challenges favoring colony living that are shared by leaf cutter ants and naked mole rats?

8.5.3 What evidence does colony structure offer in support of the idea that both leaf cutter ants and naked mole rats must vigorously defend the colonies from predation and invasion?

Concept 8.5 Review Answers
1. A hymenopteran queen mating with several males would reduce the relatedness of workers. Reduced relatedness among workers would decrease the potential of kin selection to account for evolution of eusociality in the Hymenoptera.
2. The two major ecological challenges are the need to excavate and maintain large burrow systems and the need for defense.
3. The colonies of both leafcutter ants and naked mole rats include soldier castes, specialized for defense.
Chapter 8 Review Questions

1. The introduction to chapter 8 included sketches of the behavior and social systems of several fish species. Using the concepts that you have learned, revisit those sketches and predict the forms of sexual selection occurring in each species.

2. One of the basic assumptions of the material presented in chapter 8 is that the form of reproduction will exert substantial influence on social interactions within a species. How might interactions differ in populations that produce asexually versus ones that engage in sexual reproduction? How might having separate sexes versus hermaphrodites affect the types of social interactions within a population? How should having several forms of one sex, for example, large and small males influence the diversity of behavior interactions within the population?

3. Endler pointed out that though field observations are consistent with the hypothesis that predators may exert natural selection on guppy colorations, some other factors in the environment could be affecting variation in male color patterns among guppy populations. What other factors, especially physical and chemical factors might influence male color?

4. Endler set up two experiments, one in the greenhouse and one in the field. What are the advantages of the greenhouse experiments? What were the shortcomings of the greenhouse experiments? Endler also set up field experiments along the Aripo River. What were the advantages of shortcomings of these experiments?

5. Discuss the scorpionfly mating systems. Pay particular attention to the potential roles of intersexual and intrasexual selection in scorpionflies.

6. The results of numerous studies indicate nonrandom mating among plants at least under some conditions. These results lead to questions concerning the biological mechanisms that produce these nonrandom matings. How might the maternal plant control or at least influence the paternity of her seeds? What role might competitions between pollen determine in the nonrandom pattern observed?

7. The details of experimental design are critical for determining the success or failure of both field and lab experiments. Results often depend on some small details. For instance, why did Jennifer Jarvis wait one year after establishing her lab colony of naked mole rats before attempting to quantify the behavior of the colony soon after it was established?

8. Behavioral ecologists have argued that naked mole rats are eusocial. What are the major characteristics of eusociality and which of these characteristics are shared by naked mole rats?

(skip 9)

Answers

1. The idea here is to use the descriptions of mating behavior and physical characteristics of species described in the introduction to make predictions about sexual selection. For instance, the chapter opens with schooling fish that are identical in morphology. The absence of obvious features that distinguish males and females suggests that predation
on the species overrides potential sexual selection for dimorphism. In the second example, damselfish males compete with other males for territories, which suggests intrasexual competition for spawning territories. This competition should act as a source of intrasexual selection. Though the example doesn't mention how females choose males, they may distinguish between males on the basis of territory quality and/or male characteristics, such as coloration, size, and so forth. Female choice of male damselfish should create the conditions for intersexual sexual selection. Use a similar approach to predict the forms of sexual selection occurring in each of the remaining species described in the introduction.

2. Within a population of a species that reproduces sexually, there are often complex social behaviors associated with either attracting or choosing mates. These behaviors are unlikely to occur within an asexual population except, perhaps, as a remnant of a previous time when the ancestors of the population engaged in sexual reproduction. In a species having separate sexes, there are often male-specific and female-specific mating behaviors. However in a hermaphroditic species all individuals should exhibit male and female forms of social behavior. As the number of forms of males or females increase in a population, the diversity of behavioral interactions within the population will likely increase.

3. Physical factors that might influence the color of male guppies include the turbidity of the water, the color of the materials forming the bottom or banks of the stream, and the quantity and quality of light shining onto the stream.

4. The greenhouse experiments provided the opportunity to control several factors within the experimental environment, while varying the factor of interest, intensity of predation. The shortcomings of the greenhouse experiments were that many other factors of potential importance to guppy coloration, for instance a wide variety of invertebrate predators or a diverse diet that includes a wide variety of invertebrate prey, were absent in the greenhouse environment. Field experiments give the scientist less control over environmental conditions. However, if carefully designed, field experiments reduce the chances of experimental artifact. Ideally, the ecologist uses several sources of evidence when exploring a natural phenomenon.

5. There is evidence for intrasexual and intersexual selection in scorpionflies. For example, competition among male scorpionflies can result in injuries during fights, a strong indicator of intrasexual selection among males in competition for nuptial offerings. Intersexual selection is suggested by mate selection by female scorpionflies, which appears to be mostly mediated by the quality of nuptial offerings presented by males from which females get nutritional benefit.

6. The maternal plant may influence the rate of growth by pollen tubes of different genotypes, creating conditions that increase the probability of successful mating by some pollen types over others. The maternal plant may also invest more energy resources into some seeds pollinated by particular pollen genotypes, while reducing energy allocated to other seeds. Maternal plants may even selectively abort seeds based on their paternity. Competition among pollen may take the form of a race, determined by rate of pollen tube growth, or involve some type of interference among pollen on the stigma.

7. Jennifer Jarvis waited one year after establishing her laboratory colony of naked mole rats before attempting to quantify the behavior of the laboratory population so that she could be sure that the colony had adjusted to the laboratory environment. If Jarvis had begun her studies soon after the colony was established, her results may have been strongly influenced by atypical behaviors associated with adjustment to the new environment.
8. Eusociality is generally thought to include three major characteristics: 1) Individuals of more than one generation living together, 2) cooperative care of young, and 3) division of individuals into sterile, or nonreproductive, and reproductive castes. Naked mole rats show all three of these characteristics.

9. Use the many case histories of laboratory and field studies discussed in this chapter as models for your proposed study.
### Vocabulary

- Behavioral ecology
- Caste
- Comparative method
- Dependent variable
- Environmental enrichment
- Eusociality
- Female
- Hamilton’s rule
- Haploidy
- Hermaphrodite
- Inclusive fitness
- Independent variable
- Intersexual selection
- Intrasexual selection
- Kin selection
- Lifetime reproductive success
- Male
- Natal territory
- Philopatry
- Pistil
- Regression coefficient
- Regression line
- Self-incompatibility
- Sexual selection
- Sociality
- Sociobiology
- Stamen