Competition, Mutualism, and More

Overview

Students will:
- Learn about diverse interactions among organisms in an ecosystem, including competition and mutualism.
- Distinguish between different types of mutualistic relationships and their implications.
- Create a diagram that uses individual relationships in their own lives as analogies for mutualism, competition, and other evolutionary relationships in nature.

Introduction

Scientists believe that species have evolved over time, based on evidence from the fossil record. They have also been able to observe natural selection in action, as species with very short lifespans (such as fruit flies or the AIDS virus) have changed genetically over the course of multiple generations.

Ever since Charles Darwin published The Origin of Species, competition has been heavily studied. Darwin’s theory stated that “survival of the fittest” was the rule that governed relationships among individuals and species: the strongest competitors survive to pass on their genes to the next generation. However, scientists are now learning that competition is just one of many different relationships among organisms in the natural world. Sometimes, mutualism exists between organisms, like the survival-enhancing partnerships between the elk and the jay noted in Terrain.

Recent work in biology and ecology has begun to impress scientists with how diverse, widespread, and crucial mutualism is. Mutualistic relationships are extremely common; often entire ecosystems depend on them.

For example, a bird lands on a blackberry bush and eats a berry, which contains many seeds. The plant provides a meal, and the bird disperses the seed, greatly expanding the plant’s range.

Another example is the family of fungi called mycorrhizae. Mycorrhizae cover the tips of oak, pine, willow, maple, and birch tree roots with a thick layer of tendrils. The fungus tendrils absorb carbon and amino acids from the tree’s roots, all the while helping the tree absorb other nutrients. The fungus can stimulate the tree’s growth by as much as 300%. It is now thought that the relationship between these mutualists may be as ancient as land plants themselves.

Illustration by Eric Drooker

CA BIOLOGY/LIFE SCIENCES STANDARDS, GRADES 9-12: Ecology 6g. Students know how to distinguish between the accommodation of an individual organism to its environment and the gradual adaptation of a lineage of organisms through genetic change. Evolution 8a. Students know how natural selection determines the differential survival of groups of organisms.
Niche Theory

This worksheet deals with the different ways in which species occupying the same niche relate to each other.

Originally, UC Berkeley ecologist Joseph Grinnell defined *niche* as a “place” in nature or the “habitat” in which a species lives. This concept has since expanded; now niche can apply to every aspect of how an organism lives. The food niche or the behavioral niche are two examples. The full array of an organism’s niches is called its **multidimensional niche**.

Competition occurs when there is niche overlap between species, and the overlapping resource (such as food or nest sites) is limited. Species can be categorized by their niche widths: a **generalist** has a broad niche (its needs may be met in a variety of ways) and a **specialist** has a narrow niche (its needs must be met in a very particular way). Answer key on page 6.

1. When a common resource is limited, who will compete harder, a generalist or specialist? _______________________

2. Which one has more alternatives to competition? ______________________________________________________

In Newport Bay, California, the red fox, an introduced species from England and a stealthy, highly successful hunter, has become the primary predator of two endangered native coastal birds: the California least tern and light-footed clapper rail. The coyote in Newport Bay eats an array of foods, including the least tern and clapper rail, vegetation, small mammals, and small predators such as red foxes. The native coyote has a wider home range and is an average hunter.

3. In Newport Bay, which species is a predatory generalist and which a specialist? ____________________________

4. To what degree might each of these species compete? ______________________________________________________

5. Programs have aimed to increase coyote populations in Newport Bay. How might these programs affect fox and endangered bird populations?

Other Relationships

Are competition and mutualism the only types of relationships that exist between species in nature? Actually, there are many types. A few of them are listed below. The table below may also help you understand the different relationships. To read the table, choose a term from one of the boxes. That term describes a relationship between two species, Species A and Species B. The symbol at the top of that vertical column describes what kind of effect the relationship has on Species A. The symbol to the left of that horizontal row describes the effect the relationship has on Species B. The key below the table explains the meaning of the symbols.

**Amensalism:** One participant is harmed while the other participant is unaffected. Example: A seedling growing deep in the shade of an adult tree can’t get the sunshine it needs to grow, while the adult tree is unaffected.

**Commensalism:** One organism benefits while the other is unaffected. Example: Old Man’s Beard is a lichen that hangs from California oaks like a light green curtain. The oak offers support while the lichen absorbs the moisture it needs from the air.

**Predation:** One organism kills and/or consumes another for food. Example: Peregrine falcons prey upon pigeons. California gulls eat the brine shrimp in Mono Lake.

**Parasitism:** Two organisms have an intimate association in which one (the parasite) benefits and the other (the host) is harmed. Example: In Death Valley, some desert shrubs are infected with a bright orange parasite called Devil’s Gut, which sucks the juices of the shrub, causing dehydration and often death.

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<th>Effect on Species A</th>
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<td>Predation, Parasitism, etc.</td>
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<td>Amensalism</td>
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Key: + = positive effect  
− = negative effect  
0 = neutral or no effect
Niche Theory, continued

Worksheet

In your own multidimensional niche, you have interactions with many other people. You may not directly compete for food or shelter, but perhaps you compete for TV time. The questions below ask you to use your own life as an analogy for relationships between species in an ecosystem. For example, a classmate may copy your homework and take credit for it (parasitism). You may teach a friend basketball in exchange for her teaching you to paint (mutualism).


7. Do you have mutualistic interactions with anyone in your life? How do you both benefit? Give one example.

8. Give two more examples from your own life to exemplify other interaction types from the table on page 4.

9. Through your interactions, do you notice any patterns in your life? Do you tend to be a giver, receiver, competitor, helper, etc?

10. Which interactions may change as you grow into adulthood?

11. Create a diagram representing aspects of your multidimensional niche. An example is provided below.

Directions: Draw your name in the middle. Around it, write the names of at least 8 people with whom you interact in various ways: classmates, friends, family members, landlords, teachers, neighbors, etc. Draw lines connecting yourself with each other person in your diagram. Each line represents an interaction that takes place over a limited resource, such as dessert, free time, or use of the family car. Along each line, write the interaction type from the table on page 4. Draw lines that connect other people in your diagram and describe their interactions. Share your diagram with 2 other students. Explain to them the limited resource that defines each interaction.
The Feeling is Mutual

In this section, students will delve deeper into the ways mutualistic relationships vary.

In mutualism, both partners benefit, but rarely do they receive the same rewards from each other. For example, ants protect plants from predators so that the plants can support aphids. Ants eat the sweet honeydew excreted by the aphids. Mutualistic rewards can include nutrients, protection, shelter, pollination, and seed dispersal.

Mutualists vary by how much they need the interaction.

Mutualism may be

OBLIGATORY when an organism cannot survive or reproduce without mutualism. Examples: pollinator systems, protzoans in termite guts, algae in lichen partnerships.

— or —

FACULTATIVE when the mutualistic relationship is more “Take it or leave it” for the organisms. Both parties are independent and can survive without the other. Example: the elk and the jay.

Mutualists also vary by how specific their needs are.

One or both partners can be a

SPECIALIST when only one or a few species can participate. Example: Soaptree yucca depends on one particular pollinator, the yucca moth, to cross-pollinate the flowers. The relationship is often obligatory.

— or —

GENERALIST when “any old species will do.” Example: The toyon plant relies on birds to eat its berries and distribute its seed. Any kind of bird will do.

Questions

1. What might happen to a mutualist if the population of its partner declined?

2. Would the impact vary depending on whether the mutualist was an obligatory specialist or a facultative generalist?

3. In a mutualistic relationship between two species, when might competition become a factor?

4. Which mutualists have higher likelihoods of extinction: obligatory specialists or facultative generalists? Why?

Answer Key

Niche Theory Worksheet, page 5

1. Specialist. They have a more intense need for that particular resource.

2. Generalists. They have more ways to satisfy their needs, so they may have fewer conflicts with potential competitors.


4. The fox will compete harder for the birds they specialize in eating. Although they do eat birds, coyotes will compete less over them, because they will eat a variety of prey.

5. If there are enough coyotes, there will be fewer foxes. Coyotes take fewer birds because they are less successful hunters and they eat a wider range of foods. Therefore, increasing coyotes may help protect the endangered birds. Some birds will still become prey, but fewer will die than if there are lots of foxes.

The Feeling is Mutual, page 6

1. If the mutualist is very dependent on its partner, its population will probably decline, too. Or, it must find another way to meet its needs or change its needs.

2. Yes. If it’s an obligatory specialist, it will be highly dependent on its partner. Facultative generalists have more options.

3. If there is a resource they both need that is limited or declining relative to the mutualists’ populations. Also, if the number of one species is too low to satisfy the needs of its mutualistic partner, competition may break out among the species with the larger number.

4. Specialists. They have fewer options and more specific needs.