

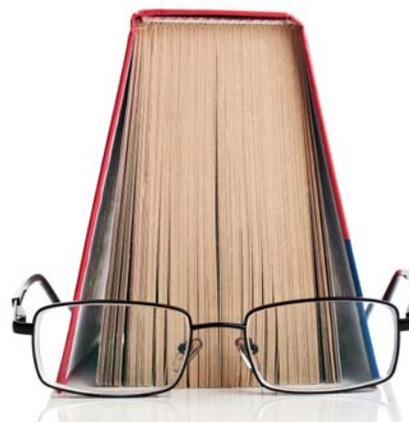
Mutualism: A Textbook Case

by

Eric Ribbens

Department of Biological Sciences

Western Illinois University



The Problem

Textbooks often equate symbiosis with mutualism. Consider, for example, this textbook: *Ecology Theories and Applications*, 3rd ed, by Peter Stiling (Prentice Hall). He writes:

Mutualism: an interaction between two species in which both benefit from the association.

Symbiosis: in a broad sense, the living together of two or more organisms of different species; in a narrow sense, synonymous with 'mutualism'.

Do you agree with Dr. Stiling? Are symbiotic interactions the same as mutualistic interactions?

Interspecific Interactions: In order to answer this question we need to define some terms. Species interact within communities. Often those interactions are indirect (for example, a wolf indirectly affects the clover population by its predation on snowshoe rabbits). Other interactions can be large species groups, such as herbivores grazing in a meadow. But the core subset, and the place interspecific interaction thinking starts, is the interactions between two species.

Question 1: Two-Species Interactions

One way to categorize interactions between two different species is to define the interaction by the outcomes:

- A *mutualism* is an interaction that benefits both species. Almost always, mutualisms involve the exchange of two different types of resources: Food for protection, for example.
- *Competition* is an interaction between two species both attempting to use the same resource, when the resource is in limited supply. Thus, both species are hurt by the interaction.
- *Predation / Parasitism / Herbivory:* We have three terms for interactions in which one species benefits and one species is hurt.
 - *Predators* kill and eat the *prey* species.
 - *Parasites* eat or live on their *hosts*, but do not always kill the host.
 - *Herbivores* are animals that eat plant tissues.

But notice that in each case one species benefits from the presence of the other species, while the other species is hurt.

- *Commensalism* is an interaction in which one species benefits and the other species is not particularly affected. It can be hard to define a commensalism, because interactions tend to affect the species involved, and any effect will shift a commensalism into a mutualism or a predation-type interaction.

Read the interaction scenarios below and decide whether the interaction is competition, commensalism, predation, parasitism, herbivory, or mutualism.

- *Scenario A:* On the edge of an alpine meadow, a beaver cuts down an aspen tree. It eats the bark, uses some of

the timber to shore up its dam, and stores some of the branches underwater for it to eat later in the winter.

- *Scenario B:* You are camping in the meadow. A female mosquito smells you. She finds a piece of exposed skin, drills her proboscis through your skin to find a capillary, and sucks up your blood.
- *Scenario C:* That evening you watch as an elk and a white-tailed deer, both grazing ungulates, eat the same kinds of plants in an alpine meadow.
- *Scenario D:* The next day you notice some colorful flowers. A butterfly walks over a brightly blooming inflorescence. It finds nectar stored inside the flowers and eats the nectar. In the process it gets pollen smeared on its body. When it is finished hunting for nectar, it flies to another flower of the same species a little ways away to find more nectar. Some of the pollen gets scraped off onto the second flower.
- *Scenario E:* A hawk soars over the meadow. Its sharp eyes spot a field mouse. The hawk drops into a steep dive and catches the mouse in its talons. Then it flies away, to feed the dead mouse to its nestlings.
- *Scenario F:* On the edge of the meadow is a large tree. Growing on the tree's bark is a circular gray-green lichen, about 6 inches in diameter. The lichen is using the tree for habitat. The trunk gets sun and the lichen isn't competing with other organisms for space. The tree hardly notices the lichen; it isn't eating the tree or taking resources from the tree.
- *Scenario G:* In the wetter part of the meadow there is standing water. In the shallow water, a cattail (a tall grassy plant) and a rush (another kind of grassy plant) are both growing. The cattail and the rush both prefer the same kind of habitat, both need sunlight, and both are sucking up nitrogen and other nutrients from the marsh mud.

Question 2: Symbiosis

Symbiosis is another type of two-species interaction. It literally means living together, and refers to pairs of species that live in close physical proximity with the other species for a major part of their life cycles. Some examples of symbiosis: You and the microorganisms that live in your intestines; bark beetles burrowing in pine tree trunks; Monarch butterfly caterpillars and milkweed plants; and algae living in coral tissues.

Can you think of any symbiotic interactions that are commensal or parasitic? Fill in examples for each in the blank cells in the table below:

<i>Interaction</i>	<i>Symbiotic</i>	<i>Non-symbiotic</i>
<i>Mutualism</i>		
<i>Commensalism</i>		
<i>Parasitism / Predation</i>		

Question 3: Are the Textbooks Right?

Look up *mutualism* and *symbiosis* in several textbooks. Your instructor may have textbooks available for you to read, or you may have to go the library and find some. Write their definitions down.

Did the textbooks you examined agree that mutualism is an interaction in which both species benefit? Did they define symbiosis as a mutualism? Did they discuss facultative and obligatory mutualisms?

Were some definitions clearer than other definitions? If so, what were the differences? For example, did the definition make it clear that it is an interaction between two different species?

Science is the process of identifying and choosing between ideas about how the world works. Textbooks are supposed to be our current understandings. However, many textbooks do not define mutualism well, or confuse mutualism and symbiosis. Why would so many textbooks be inaccurate?

Question 4: Facultative vs. Obligatory Interactions

Another idea, especially applied to mutualism, is whether the interaction is *facultative* or *obligatory*. A *facultative* interaction is one that is not essential for the survival of the species involved, while an *obligatory* interaction is essential for one or both of the species involved. Fill out the following table with examples.

<i>Mutualisms:</i>	<i>Symbiotic</i>	<i>Non-symbiotic</i>
<i>Facultative</i>		
<i>Obligatory</i>		

Question 5: Definitions

Write your own definitions:

Symbiosis:

Mutualism:

Question 6: Evolution

Evolution, through natural selection, chooses traits that increase the reproductive fitness of the organism. In other words, if some members of a population have trait X, and if trait X means that they produce more offspring that survive to maturity and reproduce, then trait X will become more common in the population.

Given this definition of evolution, consider each of the interaction categories (competition, commensalism, predation, parasitism, herbivory, or mutualism). Predict how each of the species in the interaction might evolve. For example, a parasite might evolve to become less virulent so that it doesn't kill so many of its host.

Did you predict that in each interaction there would be an evolutionary pressure to reduce negative effects or increase positive effects? Those predictions make sense, but why, after 3.5 billion years of evolution, do we still have interactions with negative effects?



Photo in title block © Dimasobko | Dreamstime.com, ID #20385269. Case copyright held by the **National Center for Case Study Teaching in Science**, University at Buffalo, State University of New York. Originally published August 16, 2011. Please see our **usage guidelines**, which outline our policy concerning permissible reproduction of this work.