# Language Arts Connection

## Patterns in Evolution and Speciation

**FIGURE 14:** The stinging ant *(Pseudomyrmex ferrugineus)* and acacia are an example of coevolution.

Species interact with each other in many different ways. For example, they may compete for the same food source or be involved in a predator-prey relationship. Most of these interactions do not involve evolutionary changes. However, sometimes the evolutionary paths of two species become connected.

### Coevolution

The process of coevolution occurs when two or more species evolve in response to changes in each other. These relationships might be mutually beneficial, or they might be good for one species, but bad for the other, such as predator-prey or parasite-host relationships.

Many types of flowers and pollinators have coevolved to maximize pollination success for the plants and nectar capture for the pollinators. The plant-pollinator dynamic is typically mutually beneficial. The plants gain the pollination necessary for reproduction and the pollinators gain a food source. For example, the hawk moth has an especially long tongue that lets it drink from the narrow, nearly foot-long structure of a star orchid that holds the flower's nectar.

The bullhorn acacia is a plant species found throughout Central America that has branches covered in hollow thorns. Although the thorns protect the plant from being eaten by large animals, small herbivores such as caterpillars can fit between them. A species of stinging ants (*Pseudomyrmex ferrugineus*) is a key part of the plant's defense against these smaller predators. As shown in Figure 14, these wasp-like ants live inside the plant's thorns and feed on its nectar. The ants protect the plant by stinging animals that try to eat the leaves. In turn, the acacia plant provides the ants with both the shelter and food resources they need to survive.

The relationship between the acacia and the ants is much more than a simple cooperation between two species. The acacia and the ants share an evolutionary history. The hollow thorns and nectar-producing leaves of the acacia and the stinging of the ants have evolved due to the beneficial relationship between the two species. Relatives of these species that are not involved in this type of relationship do not have these same traits.

## Evolutionary Arms Race

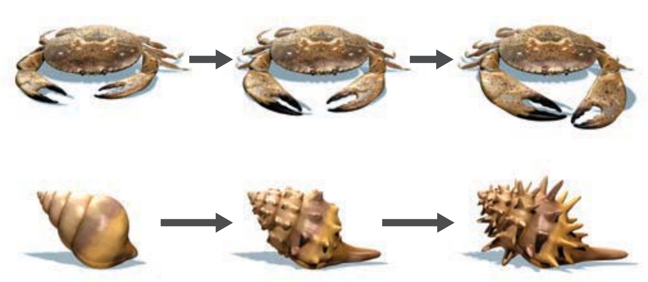
Coevolution does not just occur in species that share a beneficial relationship. It also occurs in two species that have a competitive relationship with one another. These competitive interactions can lead to "evolutionary arms races," in which each species responds to pressure from the other through a series of adaptations over the course of many generations.

For example, many plants produce defense chemicals to discourage plant-eating species from nibbling on them. Natural selection then favors herbivores that can overcome the effects of the chemicals. After many generations, some herbivore species may build up a level of resistance to the chemicals and are again able to safely eat the plant without getting sick. Natural selection then favors plants that have evolved even more potent chemicals to thwart their herbivore predators.

One researcher is using a mustard plant and a fruit fly relative to model coevolution in insects and plants. The research shows that the flies use the plants for all stages in their life cycle. The plant has developed proteins that cause the digestive tract in the flies to malfunction. Now it's up to the fly population to develop a resistance to this latest defense mechanism.

Arms races can be seen in animals as well, as shown in Figure 15. Crabs are predators that feed on snails as their prey. This makes a selective pressure for the snails to develop spines and a harder shell as a defense from crabs. As a result, the crabs then develop bigger claws and more powerful jaws to break into the harder shells. This pattern in speciation continues as evolution is influenced by evolution in another species.

**FIGURE 15:** Evolutionary Arms Race



## Patterns in Speciation

Speciation often occurs in patterns, including gradualism and punctuated equilibrium. Gradualism is the steady, gradual change of species as mutations slowly give rise to variations and adaptations. Gradualism is closest to the type of evolution predicted by Charles Darwin that supports his ideas of descent with modification. That is, each generation is slightly different than the last, individuals with increased fitness preferentially breed, and advantageous alleles slowly build in a population. These small changes add up to become the wide variety of characteristics seen among species on Earth today.

Punctuated equilibrium is characterized by long periods of no change interspersed with short periods of big change. Punctuated equilibrium is often tied to speciation events, such as a natural disaster, in which species are forced to adapt or die off. For example, the isolation of a small population in a new environment with unique selective pressures can drive short bursts of evolution as beneficial and harmful traits are selected for or against.

A new species can arise through either gradualism or punctuated equilibrium. Some lines of evolution show gradualism patterns and some lines of evolution show punctuated equilibrium patterns. Gradualism occurs at a constant background rate, much like the rate of background extinction. Punctuated equilibrium occurs irregularly and is more intense, much like mass extinctions.

**Language Arts Connection** Does evidence support the claim that species can evolve through either gradualism or punctuated equilibrium?

Find support for the information given in this text by researching and finding evidence of gradualism and punctuated equilibrium in Earth's history.

Prepare a one-page blog post that analyzes how two different species evolved (one through gradualism and one through punctuated equilibrium), and include an image that represents the pattern of speciation each species experienced.

CAREER: BIOINFORMATICS | MIMICRY | HYBRIDIZATION | Go online to choose one of these other paths.