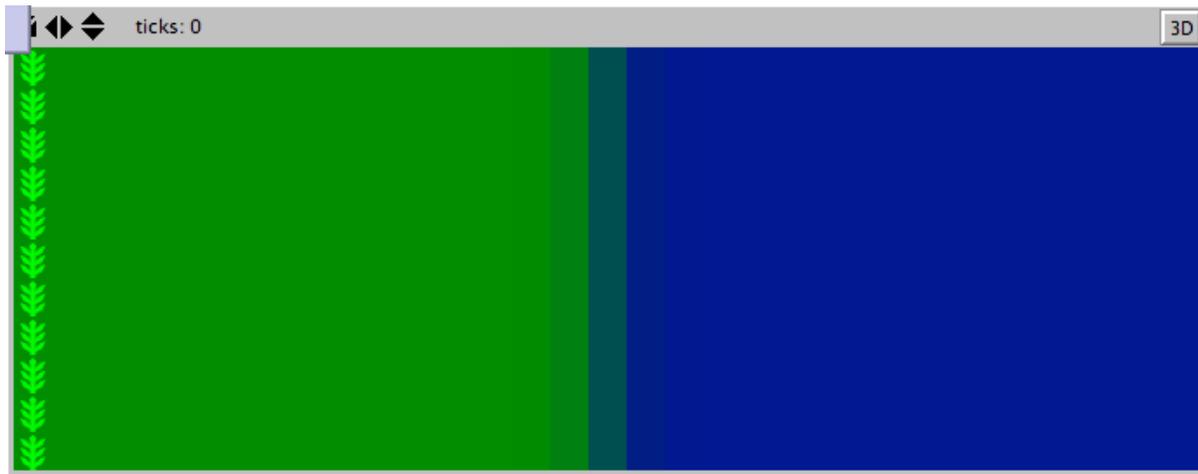


## Reading 8.1 – Speciation

Jumpstart: In the computer model you used in class, you saw how a single population of plants evolved its reproductive behavior so that it became two separate populations that didn't interbreed with each other anymore. Do you think this same sort of evolutionary outcome happens in the everyday world?

As the plants evolved in the model, plants on the left side of the ecosystem adapted to have a low tolerance for metal in the soil, since a low tolerance in the normal soil helps them grow better in that location. Plants on the right side of the ecosystem adapted to have a high tolerance for metal in the soil, since a high tolerance in the contaminated soil helps them grow better in that location.



**Question 1:** If you were a plant growing in metal contaminated soil, why would having the same flowering time as other plants that grow in this contaminated soil give you a competitive reproductive **advantage**?

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Once both populations evolve behaviors, structures, or substances that prevent them from interbreeding, they are said to be separate **species**. When evolution pushes a population to split into two or more different species, this is called **speciation**.

This scenario, where one plant species evolves into two separate new species, is one that has been extensively studied by scientists. In one example, scientists have determined how speciation occurred for a native grass growing over the past hundred years for at the site of the Trelogan Arsenic Mine in Flintshire, North Wales, UK.

At this mine, a stone wall was erected between the “contaminated soil” from arsenic mine and the

uncontaminated soil. This wall was built to help hold back the movement of soil washed away by water, but was not designed to keep plants from reseeding across either side of it.

It is believed that 100 years ago, no plants could have been found that could grow in the contaminated soil, as that soil was being contaminated with heavy metal tailings being dumped on the ground as the nearby underground mine was being excavated. Over time however, some plants began to evolve the ability to tolerate the contaminated soil. These metal tolerant plants did not grow very well in regular soil. At first both populations would have had nearly identical flowering times, since this was a trait in the parent population that would have been selected for (due to sexual selection). But due to pattern of inheritance in sexual reproduction and mutation, some variation in flowering time developed in all plants. Therefore the average flower-time of the plants with a soil tolerance trait was slightly different than the average flower-time of the plants with no soil tolerance.

Individuals with tolerance to contaminated soil who had similar flowering times, would have had a better chance of having offspring that had tolerance to that soil. This is because their offspring would be more likely to have been pollinated by two parents from the contaminated soil, and therefore also received the metal tolerance genes from parents with a competitive advantage for this environment.

By evolving reproductive isolation, 2 separate species emerged. Each one was now "specialized" in a survival advantage for a separate environment. In each type of soil environment there is no competitive advantage to being to grow in partially contaminated soil, since there is very little "partially contaminated soil", due to the wall that separates the two areas of the mine.

In any ecosystem there is variation in the physical conditions at different locations. Some spots of the ecosystem may have more water, sunlight, shelter, soil, etc... than others. In a forest, there are very different physical conditions at the bottom of the forest floor than under the tree tops, and there are very different physical conditions at spots where a tree fell down compared to a spot where trees are growing. These "separate areas" within the ecosystem each have their own local environmental conditions that are often different from one another. Such separate areas may lead to speciation, just like the separate areas in the mine.

Describe what physical conditions might be different at each of these locations in the following ecosystems.

Ecosystem: a deep lake

**Question 3:** How would the physical conditions change the deeper in the lake you go?

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Ecosystem: a mountain

**Question 4:** How would the physical conditions change on the mountain, the higher up you travel

the mountain?

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Different environmental pressures in different areas within an ecosystem could lead to speciation of a population so that it can take advantage of these different environmental conditions.

**Question 5:** Which do you predict is more likely to evolve more species of fish: a small shallow lake with little variation in the amount of light or rocks on the bottom of the lake OR a large lake with some deep spots that gives large variation in the amount of light and rocks in the bottom of the lake?

**Question 6:** In a small forest, there is only one species of frog. In a large forest, there are two species of frogs. What might be different about the variation in the physical conditions in both forests that would lead to different number of species evolving in each?

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Evolution can cause populations of the same species to develop into separate species, if enough changes occur in two isolated populations to make interbreeding impossible. Those changes can be in natural breeding patterns, physical structures, or mechanism for gene copying and meiosis.

The exact combination of selective forces that led to the speciation of each species on our planet is hard to determine. We are unable to directly observe events of the past and must do other sorts of comparisons to determine how current and extinct species that live(d) on our planet evolved from their parent population. Comparing the structure of the phenotypes of species is one way to determine how species evolved over time. Another way is to determine how closely related different species are is to compare the genotypes of the species (both alive and extinct).

What is well understood, however, is that the longer that separate populations are under the forces of natural selection, sexual selection, mutation, and genetic drift, the more their characteristics will be different from one another over time. And, that these interacting forces can drive the characteristics of a single species to the point that the separate populations become separate species.

One instance of creation of new species in the laboratory was performed in the late 1980s. Rice and Salt bred fruit flies (which produce a new generation every 48 hours), *Drosophila melanogaster*, using a maze with three different choices such as light/dark and wet/dry. Each generation was placed into the maze, and the groups of flies which came out of two of the eight exits were set apart to breed with each other in their respective groups. After thirty-five generations, the two groups and their offspring would not breed with each other even when doing so was their only opportunity to

reproduce.

**Question 8:** Describe another experimental setup that you could envision designing, that you believe would lead to the creation of two separate species of bird:

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Lions and tigers are considered separate species since they have never been observed interbreeding in the wild. In fact in the wild, there is currently only one small region of overlap in their ranges and shared ecosystems, the Gir National Forest in India.

But they are still similar enough in physical structure and gene copying mechanisms in both species to allow them to generate offspring (Ligers). If forced to mate in non natural settings (e.g. zoos) they will develop offspring that can survive and reproduce. Their offspring are called **Ligers**.



A liger

[http://news.nationalgeographic.com/news/2005/08/0804\\_050804\\_ligers\\_2.html](http://news.nationalgeographic.com/news/2005/08/0804_050804_ligers_2.html)

Horses and Donkeys are considered separate species. Their gene copying mechanisms are different in some important ways that do not permit them to generate a fertile offspring. So though the gene information that results in the offspring when a horse and donkey interbreed together is still similar to create an offspring that can survive, it is not similar enough for it also to produce its own offspring. Since it can't produce offspring it is considered **sterile**. This animal is known as a mule.

Foxes and dogs are separate species. Some species of foxes have 36 chromosomes and some have 34 in their somatic cells, while gray wolves and domestic dogs have 78 chromosomes. This chromosome difference is one barrier to producing viable offspring.

**Question 9:** Give an example of two animals that you think might be the same species, but look and act very differently?

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**Question 10:** Give an example of two animals that look and act very similarly, but may be different species?

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