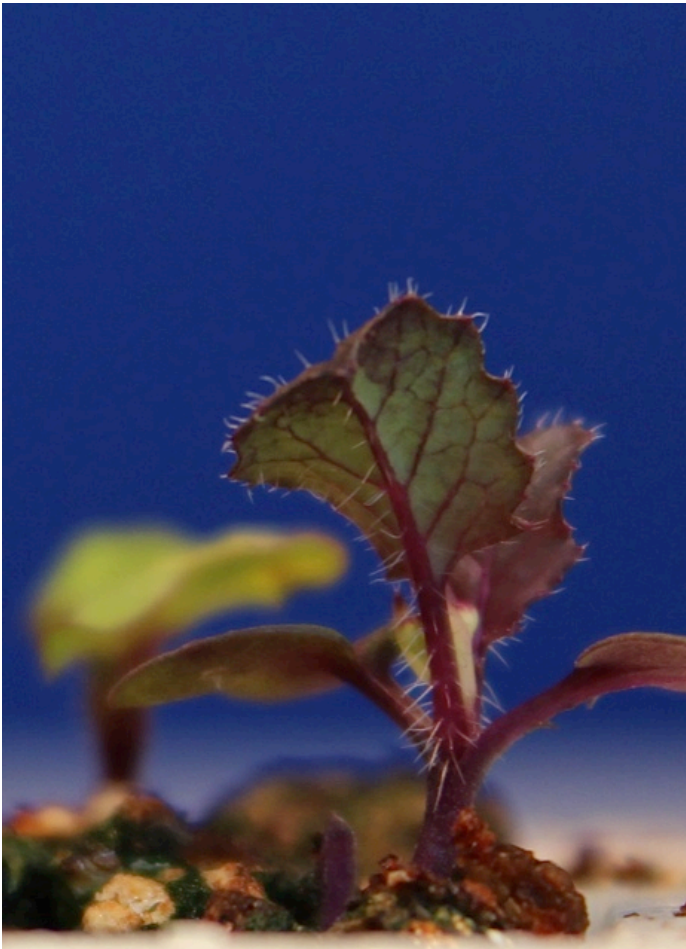


## Experiments in Evolution

Ever wonder about the diversity of life? How can there be so many different kinds (species) of organisms? What's even more surprising is that new species arise and that many species die and go extinct. Evolution explains how new species can arise. There are two fundamental mechanisms. The first is that the population of a species is composed of many variants, so that what we call a species is a central tendency of these variants. The variation comes from random genetic recombination and occasional mutation, often from sexual reproduction or from processes like it in organisms such as bacteria. The expression of these genetic variants is also determined by the ecosystem or environment in which the population of a species lives. The second mechanism is that of natural selection. Usually, the distribution of variants does not change much from generation to generation, because the variants are well adapted to the ecosystems in which the population lives. For example, generations of bacteria live in the intestines of people and the distribution of variants of any particular species is about the same (morphologically, genetically) from generation to generation. But, if the person takes antibiotics, these may kill or extinguish a species, removing it from the mix of species in the intestine. Or, the antibiotic can kill all but a few of the variants that have some resistance to the antibiotic, perhaps due to a slight difference in the structure of their cell walls. These bacteria will live to grow and reproduce, and so successive generations of the species will be more resistant to that antibiotic. This is called antibiotic resistance. The antibiotic "selects" those members of the population that have the genes that produce the resistant cell wall structures—only these variants survive to reproduce. This means that the distribution of the variants of the population changes, more than one would expect by random genetic recombination.

Scientists at the University of Wisconsin conduct experiments on a form of cabbage that grows very quickly. They use these cabbage plants for their studies much in the way that people who study animals often use mice. Both mice and these cabbages, called Wisconsin Fast Plants, help scientists learn about animals and plants more generally, because each shares much in common with other animals and plants.

Dr. Hedi Baxter Lauffer, a scientist at the University of Wisconsin-Madison, investigated whether or not the number of "hairs" on the leaves and stems of Fast Plants could be selected for in one generation. Hairs are spikes on the edges of the leaves and stems. Hairs are shown on the next page for two plants, one with a few spikes and one with many spikes.



Because it takes more energy to grow these spikes, it does not seem to make much sense for a plant to have the genes that make the proteins that regulate this kind of growth. But Wisconsin Fast Plants are a species of cabbage, and in their natural

ecosystem, other organisms, especially cabbage white caterpillars, eat them. Imagine if you were a cabbage white caterpillar trying to get your mouth on a stem or leaf with those spikes. A lot like climbing a fence topped with barbed wire!

To conduct her experiment, Dr. Lauffer grew a batch of 100 plants. These plants had a lot of natural variation, with some plants having more hairs and other plants having fewer hairs. To measure the number of hairs, Dr. Lauffer used a technique invented by Dr. Paul Williams. Scientists often use techniques and ideas invented by other scientists. Dr. Williams cuts the first true leaf of the plant, then presses it. He then counts the number of hairs and laminates the leaf to save it (do you see why he saves the leaf?). So this is what Dr. Lauffer did for every plant. Then she took the seeds only from the plants with the greatest number of hairs and planted 100 of these seeds. She acted like an ecosystem in that she selected only the hairiest plants. In nature, the caterpillars would do the selection—they would eat all of the plants that they could, leaving only the hairiest survivors to grow and reproduce.

Dr. Lauffer wanted to know how much the population of offspring (children) would change. Would it be any more than one might expect just by chance? The theory of evolution says that it should be, but sometimes it takes a few generations or even many generations for the effects of selection to show up. So, Dr. Lauffer again counted the hairs on the plants. Her measurements for parents and the next generation (called FirstGen in her data) are in SelectionExperiment.tp

Using Dr. Lauffer's data, how large is the difference in central tendencies for plant hairs between the parent generation and the first generation? Is this difference about what you would expect by chance? Or, has Dr. Lauffer's selection actually affected the distribution of the first generation plants? Build and run a model to help you decide. One model is found in HairDataModel.tp. Was Dr. Lauffer an effective agent of evolution?