NATURAL SELECTION

Concepts
Changes to the environment may affect how an organism may survive in the wild. Occasionally, organisms have the ability to activate different phenotypes in response to its changing surroundings. This lesson uses an endemic Hawaiian tree species, Ohia, to show how this species changes its phenotype in response to different habitat requirements.

HCPS III Benchmarks
SC 7.5.4
SC 7.5.6

Duration
1 full day (fieldtrip)

Source Material
PRISM

Vocabulary
Genotype
Glabrous
Natural selection
Phenotype
Phenotypic plasticity
Pubescent

Exploring the ‘Ohi‘a Common Garden

Summary

After students have a strong understanding of Adaptations and Genetic Variation, they will be introduced to Natural Selection. They will visit the Ohia Common Garden in Volcano, Hawaii to see how Ohia (*Metrosideros polymorpha*) from different elevations have morphological differences.

Objectives

- Students will simulate how genes are passed from one generation to the next.
- Students will understand how traits that are favorable for survival become more common over generations.
- Students will know that both genetic variation and environmental factors causes of evolution and species diversity.

Materials

Background information about Ohia to lecture students before visiting garden
Permission to visit the garden
Dr. Elizabeth Stacy - Can give presentation at garden about Ohia

Making Connections

During this unit, students have covered a variety of evolutionary concepts (e.g. adaptation, genetic variation and natural selection). These topics will all be touched upon with real-life examples during this exploratory fieldtrip to the Ohia Common Gardens plot at Hawai‘i Volcanoes National Park.

Teacher Prep for Activity

Weeks prior to the field trip, Dr. Elizabeth Stacy at the University of Hawaii, Hilo must be contacted for access into the common garden. Dr. Stacy could possibly be available to meet with the students to discuss Ohia and natural selection also. Her contact information is:

Elizabeth Stacy, Ph.D.
Assistant Professor, Department of Biology
University of Hawai‘i – Hilo
200 West Kawili Street
Hilo, HI 96720
Email: estacy@hawaii.edu

Please allow several months to plan for this field trip.

Background

Biological evolution, which is the gradual change to a population of species over many generations, is the process responsible for the diversity of species. **Natural selection** is the process by which favorable traits that are passed on over generations become more common in a population of reproducing organisms. Natural selection is also responsible for how unfavorable traits (not conducive for survival) become less common in the population. This process acts upon the **phenotype** or the morphological characteristics of an organism. Organisms that have favorable phenotypes that allow them to survive and reproduce in the wild are more likely to survive than organisms that have unfavorable phenotypes.

If the phenotype is based on genetics, then the **genotype** associated with that favorable phenotype will increase in frequency in the next generation and generations to follow. Natural selection also acts upon populations, not individuals alone. The changes to the phenotype and genotype must affect the entire populations of organisms, not just select individuals of the population.

Ohia lehua (*Metrosideros polymorpha*) is a Hawaiian endemic plant found in almost all Hawaiian ecosystems. It is present on all Hawaiian islands, except Niʻihau and Kahoʻolawe. Ohia is an extremely variable plant that ranges in elevation from sea level to approximately 7000 feet. In order for Ohia to survive and reproduce at such drastic environments, species at different elevations have morphological differences. Ohia found at low elevations have larger, **glabrous** (smooth with no hair) leaves while ohia at high elevations have smaller, **pubescent** (with short fuzzy hair) leaves. One reason ohia at high elevations have smaller, fuzzy leaves is because they are closer to the sun and the fuzzy hair might protect the leaves from cold temperatures. Lower elevation Ohia are further from the sun and need a larger surface area to collect more sunlight and they are without fuzzy hair because they live at warmer temperatures. Ohia have a given phenotype, but also have the ability to change its phenotype in response to environmental changes. This phenomena is called **phenotypic plasticity**.

Procedure

After finalizing the plans to visit the Ohia common garden, give the students some background information on Ohia before visiting the garden.

At the garden, Dr. Stacy will talk about Ohia and its morphological differences. After the lecture, students will be split into groups and be asked to examine the different trees at the garden. They will be asked to collect a single leaf from a tree from high elevation, mid elevation and low elevation. After they have collected their leaves, they will be asked to explain why they think the leaves they collected belong to their respective habitats. After the field trip is completed, have the students write a reflection about their trip to the garden. They could also be asked to research another organism that displays phenotypic plasticity.

Assessments

Journal writing
Written report of another organism that displays phenotypic plasticity.

Resources

None.

Extension Activities

If the class is unable to visit the common garden or a project extension is needed, a possible class simulation of this exercise would be to grow tomato plants. Before growing the plants, ask the students if they think tomato plants (with the same genotype) grown in sunlight would look different from tomato plants grown without sunlight. Have them write down their predictions. Plant several plants in pots and place half the plants in direct sunlight and place the other half in the classroom, away from any light. Water and feed both sets of plants the same way. The plants grown in direct sunlight should grow upright, reaching for the sun while the plants grown inside should grow low, creeping along searching for sunlight. This simulation shows that different environmental factors can affect how an organism survives.

Culture/Art/Math/Literature Connections

None.

Common-Gardens Comic