

LIKING LICHENS IN GEORGIA

How does energy flow within an ecosystem?
What factors affect survival and extinction of lichens?
What would happen if lichens disappeared from the ecosystem?

Essential Questions

1. Where does energy come from and what happens to it as it moves within an ecosystem?
2. What causes an organism to change?

Georgia Performance Standards

Characteristics of Science-Habits of Mind

S4L1. Students will describe the roles of organisms and the flow of energy within an ecosystem.

a. Identify the roles of producers, consumers, and decomposers in a community.

b. Demonstrate the flow of energy through a food web/food chain beginning with sunlight and including producers, consumers, and decomposers.

c. Predict how changes in the environment would affect a community (ecosystem) of organisms.

d. Predict effects on a population if some of the plants or animals in the community are scarce or if there are too many.

S4L2. Students will identify factors that affect the survival or extinction of organisms such as adaptation, variation of behaviors (hibernation), and external features (camouflage and protection).

b. Identify factors that may have led to the extinction of some organisms.

Questions to the author can be sent to the project administrator, Dr. Bob Hill at bobhill@uga.edu.
What the Student Should Know
Students will know:
♦ The role of lichens in the environment.

What the Student Should Be Able to Do
Students will:
♦ Identify the various members of an ecosystem.
♦ Describe how energy moves through an ecosystem and how living things depend on each other to live.
♦ Identify the role of lichens in an ecosystem.

Enduring Understandings
♦ In all ecosystems, life is interdependent among organisms.

Background
“An ecosystem is a living community which depends on each member and its surrounding environment. The living part of an ecosystem is sometimes called a food chain” (http://www.planetpals.com/foodchain.html). Food webs and chains are a common science lesson in text books at this level. The emphasis in this lesson should focus on the flow of energy from the Sun and its’ transfer among organisms.

Energy is necessary for survival. As humans, we get energy from the food we eat. Other living organisms also get energy from the food they eat or nutrients they absorb. A food chain is a model that illustrates how energy moves through an ecosystem and depicts how each living organism gets its food.

The following is an excerpt about food webs/chains from http://www.vtaide.com/png/foodchains.htm.

“A food chain shows how each living thing gets its food. Some animals eat plants and some animals eat other animals. For example, a simple food chain links the trees & shrubs, the giraffes (that eat trees & shrubs), and the lions (that eat the giraffes). Each link in this chain is food for the next link. A food chain always starts with plant life and ends with an animal.

1. Plants are called producers because they are able to use light energy from the Sun to produce food (sugar) from carbon dioxide and water.
2. Animals cannot make their own food so they must eat plants and/or other animals. They are called consumers. There are three groups of consumers. There are three groups of consumers.
   a. Animals that eat ONLY PLANTS are called herbivores (or primary consumers).
   b. Animals that eat OTHER ANIMALS are called carnivores.
      ▪ carnivores that eat herbivores are called secondary consumers
      ▪ carnivores that eat other carnivores are called tertiary consumers e.g., killer whales in an ocean food web ... phytoplankton → small fishes → seals → killer whales
3. Animals and people who eat BOTH animals and plants are called omnivores.
4. Then there are decomposers (bacteria and fungi) which feed on decaying matter. These decomposers speed up the decaying process that releases mineral salts back into the food chain for absorption by plants as nutrients.

In a food chain, energy is passed from one link to another. When a herbivore eats, only a fraction of the energy (that it gets from the plant food) becomes new body mass; the rest of the energy is lost as waste or used up by the herbivore to carry out its life processes (e.g., movement, digestion, reproduction). Therefore, when the herbivore is eaten by a carnivore, it passes only a small amount of total energy (that it has received) to the carnivore. Of the energy transferred from the herbivore to the carnivore, some energy will be "wasted" or "used up" by the carnivore. The carnivore then has to eat many herbivores to get enough energy to grow. Because of the large amount of energy that is lost at each link, the amount of energy that is transferred gets lesser and lesser ...

1. The further along the food chain you go, the less food (and hence energy) remains available.

The above energy pyramid shows many trees & shrubs providing food and energy to giraffes. Note that as we go up, there are fewer giraffes than trees & shrubs and even fewer lions than giraffes ... as we go further along a food chain, there are fewer and fewer consumers. In other words, a large mass of living things at the base is required to support a few at the top ... many herbivores are needed to support a few carnivores.

2. Most food chains have no more than four or five links. There cannot be too many links in a single food chain because the animals at the end of the chain would not get enough food (and hence energy) to stay alive. Most animals are part of more than one food chain and eat more than one kind of food in order to meet their food and energy requirements. These interconnected food chains form a food web.”

Another excellent source concerning energy transfer within ecosystems and organisms may be found at: http://www.roomd113.com/TAKS%20NOTES/Objective%203%20Ecosystem%20and%20Interaction.pdf. On this site is more information and diagrams illustrating the flow of energy through the ecosystem from autotrophs (produce their own food) through heterotrophs (use other sources of food) and decomposers.

Habitats change over time. Sometimes the change is slow, while at other times a catastrophe such as a hurricane or tornado can alter the habitat quickly. Organisms have
developed the ability to change over time. In natural selection, those organisms with traits that better help them cope with environmental stressors and pressures will overcome a changing habitat and survive. The surviving adults will produce offspring that have the advantageous trait that are able to survive too. Some species go extinct because the group is unable to cope with a changing habitat. Human-induced causes such as overharvesting, introduced exotic/non-native species, destruction of habitat, and/or pollution have resulted in the extinction of many species.

Lichens are an example of living organisms that live in a variety of environments, especially harsh environments. Lichens are organisms composed of either algae or cyanobacteria living in a relationship with a fungus. By living together, the fungus is able to colonize in many different environments that they could not live alone.

“The fungus can live in places lacking the organic matter that they would normally need as a source of nutrients. Algae and cyanobacteria, which usually live in aquatic or moist habitats, can live in drier places. They can also be affected adversely by high light intensity and, given the protection of the fungus, they can expand into environments where light intensity is high” (Purvis, 2000, p. 7).

Lichens are important to an ecosystem. They can live in adverse conditions and in locations were plants cannot thrive. They are early colonizers after disturbances and have a role in soil formation. Lichens provide a food source to some mammals such as reindeer living in the Arctic. However, more common they are used by birds as nesting material. Humans harvest lichens to make dyes, healing aids and tonics.

For more information on lichen morphology and ecology, visit

- Introduction to Lichens: An Alliance between Kingdoms at http://www.ucmp.berkeley.edu/fungi/lichens/lichens.html
- Lichens of North America at http://www.lichen.com
- 10 Things You Should Know About Lichens at http://ohioline.osu.edu/sc195/029.html
- What is a Lichen? at http://www.earthlife.net/lichens/lichen.html
- Lichenland: Fun with Lichens from Oregon State University at http://ocid.nacse.org/lichenland

However, like most organisms, when the environment is altered, lichens become stressed and may die. Air pollution occurs when air moves across the Earth and picks up harmful gases and particles produced from human activities. When some lichens are exposed to certain pollutants, especially to sulfur dioxide (SO2) emitted from coal-burning power plants, lichens are injured and die. Lichens have also shown sensitivity to some other pollutants, such as heavy metals, nitrous oxides, and ozone, but for the most part lichen damage can be attributed to SO2. The effect of these pollutants may be observed on lichen distribution (arrangement of lichens over a set area) and diversity (the presence of different lichen species and their relative abundance).

Humans can improve air quality for lichens by limiting pollutants from vehicles and industries and altering the way they live. Some ways to reduce air pollution is:
• Check car emissions. Make repairs to emission systems.
• Drive less. Take mass transit, carpool, and bike.
• Pump gasoline in the evening and early morning.
• Convert vehicles to alternative fuels.
• Support scrubbers and other pollution-control devices that remove noxious substances from industrial and coal-burning operations.

Materials
♦ Computer with Internet access (per group)

The Activity
1. In small groups, have the students select one lichen listed in *A Guide to Twelve Common & Conspicuous Lichens of Georgia’s Piedmont* [http://www.crms.uga.edu/lichens/Georgia_Lichen_Guide.pdf](http://www.crms.uga.edu/lichens/Georgia_Lichen_Guide.pdf) and research its life cycle. Find out how the lichen gets energy and produces energy for other organisms. (The Dixie reindeer lichen would be an excellent choice).
2. Refer to particular food chains and predict what would happen to other organisms if a link in the chain disappeared, such as lichens disappeared. Write a story about a year without lichens or without plants (and their products such as wood, bread, shade, rubber, etc.) to explain the importance of this energy source.
3. Use what you know about food chains and food webs to explain the energy cycle.

Extension
Make a terrarium and observe the diversity of organisms that it supports. Be sure to include one or more Lichen in the habitat. Design an experiment to determine the effect of changing the habitat to show benefits or harmful effects. Choose only one change to monitor. This is called controlling variables. When you vary one thing to get a new result, it is called a variable. Choose one variable such as change in temperature, addition of fertilizer, change in the amount of light, change in the number of organisms, change in the kind of organisms, change in the amount of water, etc. Keep a journal to record your observations. Share your findings with the class.

Performance Assessment
Students will:
♦ Create a terrarium and share it with the class.
♦ Create one food chain/web and show the flow of energy within the system.
♦ Select one organism and keep a daily log in order to document any change in the organism for a period of one semester.
LIKING LICHENS PROJECT - www.georgialichens.org

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