Herbivory

Grade Level: Elementary, Middle School, High School
Ecological Concepts: Interspecific interactions, Herbivory, Food preferences, Behavior, Resource acquisition, Competition
Arizona Science Standards: Science as Inquiry; Life Science

Materials:
1) Collecting trays, vials*
2) Forceps*
3) Aspirators
4) Netting*
5) Writing/drawing materials
*May be borrowed from SCENE

BACKGROUND
Plants are the primary source of energy (food) on this planet for the majority of animals. Eating a plant or part of a plant is called herbivory. Plants have a variety of defenses against herbivory, and herbivores use many strategies to get around plant defenses. Differences in plant structure, taste (plant chemistry), life span, and other plant characteristics can influence which herbivores eat which plants. Some herbivores are very particular and eat only one plant species, others are less finicky and eat a variety of plants. Besides actually eating plants, many insects lay their eggs on plants. The eggs hatch into larvae that then eat the plant material.

All organisms require certain resources for growth and reproduction. How well an organism accomplishes these goals depends on many factors such as the quality of the habitat, nutrient availability, and the make-up of the community. Organisms that live in a resource-poor habitat, or are living with more organisms than the habitat can sustain, are not likely to do as well as those in better habitats with more resources.

Any resource that is essential for growth and reproduction is a limiting factor. Too little of it will result in death, or at the least, very minimal growth. Organisms of the same species are most likely to compete for essential limiting factors. If there is enough food (plant material) for all herbivores in a population in a habitat, then the animals should not have to compete with each other for food. If there is not enough food, competition between herbivores could result. The outcome could be death of some individuals due to either actual fatal struggles with another organism or starvation. Organisms can compete for other resources as well, such as water, light, and space. (See Plant Competition activity)

GUIDED INQUIRY
Observation/Exploration: Examine the habitat for signs of herbivory and the animals that may be eating plants. Signs of herbivory include whole or partially eaten leaves, insect eggs on plant leaves or stems, mines on the leaf surface, galls on leaves or stems, exoskeletons, dead insects, and insect frass (feces).

Group Discussion and Question Period: Why are some plants more prone to herbivory than others? Do some herbivores prefer certain plant species? How many herbivores of a particular species can coexist in a habitat?

Important aspects of guided inquiry are encouraging students to generate multiple hypotheses, and letting students make decisions about what data are important and create their own data sheets. Keeping these ideas in mind, the sample in the box below illustrates how ONE OF MANY possible investigations around this topic might develop.

Sample Hypothesis : Let's use the question, "How many herbivores of a particular species can coexist in a habitat?" and change it to, "Will an increase in herbivores increase competition among herbivores?"

Our hypothesis could be, "As the number of herbivores increases in a habitat, the competition for food will increase."

Sample Experiment Design: Determine which animals in the habitat are herbivores. For our purposes, insects are the most easily used. (You will run into problems with care and proper handling with vertebrates such as mammals, birds, and reptiles.) Determine which plant species shows the most herbivory and which insects are herbivores. Collect as many insects as possible in this group, using **collecting trays**, **nets**, **forceps** or **aspirators**, as needed. Split the insects into at least four groups, with two groups having twice as many individuals as the other two groups (e.g. Groups A and B have six insects each and Groups C and D have twelve each). The number of insects per group is the **independent variable**. The treatment levels can be called Low insect number and High insect number. Having two or more groups with the same number of insects gives at least two **replicates** of the **experimental unit**.

Next choose either whole plants or branches of plants to use as the food source for the insects. Choose the plant species the insects were observed to be eating. Use only one plant species to **control** for this variable. Use whole plants if they are very small, use branches if the plant itself is large. Cut fine **mesh netting** to enclose the plants or branches. Try to keep the number of leaves within a net bag the same for each bag to control for amount of plant material. Tag each net to identify which group of insects it contains. Place the insects inside the netting, one group per plant or branch. Observe the bags daily, counting the number of insects still alive. Do this by looking through the bag, if possible. After a set time, such as one week, remove the bags carefully and recapture the insects. Count the number of survivors, the **dependent variable**.

Sample Prediction: The number of insects surviving will be less in the group with more insects.

Record Results: If counting insects daily, record the number alive each day per group. Record the final number of survivors per treatment. Total the number of survivors for Groups A and B, and total Groups C and D.

Sample Analysis of Data and Presentation: Make a **bar graph** of the treatment levels, Low insect number and High insect number, on the horizontal axis, and number of surviving insects on the vertical axis. For students who can divide, calculate the **average** number of survivors for each treatment level. Graph the average number on the vertical axis.

Discussion: Was your hypothesis supported? If yes, go on to test other hypotheses. If not, why not? What did happen? Why? This is a great opportunity to revise your hypothesis and do another test.

MORE:
(1) Elementary:
(a) Collect one species of insect that you identified as being herbivorous. Collect leaves from two (or more) different plant species. Using an enclosed area (box, cage), place the leaves in separate groups equally distant from each other. Place the insects together equally distant from all the piles of leaves. Observe which leaves the insects go to. This is a preference test.

(2) Middle School:
(a) Find the **mode** and **range** of the data.

(3) High School:
(a) Calculate the **variance** and **standard deviation** of the averaged data.

(b) Compare **intraspecific** and **interspecific** competition. Conduct experiments similar to the one described in the sample experimental design, using one species of insect only, and then combining equal numbers of two insect species.