

Lesson Plan Five (Dichotomous Keys)

Overview: This exercise will provide students with the important identification skills that can be applied to many organisms.

Audience: This activity is designed for middle school students in grades 5-8.

Background:

There are over 1 million species of insects identified worldwide with an estimate of 9 million unidentified (due to secluded and tropical places in the world). The diversity among this Arthropod class is amazing and widespread with a single order, Coleoptera (beetles), dominating 350,000 species of the aforementioned one million. The beetles alone have more than eight times the number of all the world's vertebrate animal species. Given the extraordinary amount of adaptation and speciation, it is important to know what roles they play in our environment and how to correctly identify them.

Insects live almost everywhere and are very successful. They consume a large amount of food that consists of plants, other insects, vertebrates, detritus, fungi, and even some household goods. Some are beneficial to humans (recycling of organic matter and preying on harmful species), while others are not (crop pests and disease vectors). In addition, some species are known for their aesthetic value, such as, butterflies, dragonflies and beetles. Despite their success, there are some that are in danger of extinction. As with all organisms, it is in our best interests to try to protect and conserve these species, especially when it is our actions that are directly threatening their survival. Some ways that extinctions can be harmful are the loss of biodiversity and food web shifts. Diversity is important because it indicates a healthy ecosystem. Food webs are sometimes very complex and need to stay within a balance for the whole community to stay healthy. It is very hard to predict if and when a disappearance of a single species will disrupt that balance. The risk is environmentally unacceptable. Therefore, there are many advantages to being able to identify an insect, especially when many mimic each other, despite very different ecological roles.

The animal kingdom breaks down into smaller phylum groups, which are made of several classes. The class Insecta is placed in the arthropod phylum within the animal kingdom. The major distinctions that lead to these classifications are insect's lack of a backbone (invertebrates), their joint appendages with outer covering exoskeleton (arthropods), and their segmented body (3 main parts: head, thorax, and abdomen) including three pairs of legs (six total). Some other characteristics that most insects can be identified by are their two wings and a pair of antennae.

The identification of this numerous group, along with most other species of animals, plants, fungi and bacteria, is facilitated by the use of dichotomous keys. A dichotomous key consists of couplets that a researcher can choose from that describe the organism. When one of the couplets is agreed upon, it directs you to the next set of descriptions until the organism is fully identified. Dichotomous keys are used worldwide and can be found in field guides, on the internet and in journals. Sometimes they are very technical, while other times they are more user friendly for the layman.

Time requirements: This activity can be completed in two 50-minute periods.

Objectives:

1. List identifying characteristics used in invertebrate identification.
2. Use a dichotomous key to identify organisms based on their characteristics.

National Science Education Standards:

Unifying concepts and processes in science.

- Systems, order and organization

Life science.

- Structure and function in living systems
- Diversity and adaptations of organisms

History and nature of science.

- Nature of science

Materials:

- Two pictures for anticipatory set found on website given in Anticipatory Set instructions
- Computers with access to the internet for the teacher to access website
- Numbered jars or vials of fifteen various insects (insects can be obtained using pitfall traps outside previously)
- Lab or counter space to look at insects
- Petri dishes for easy sorting of insects
- Forceps or tweezers to handle the insects
- Possible dissecting microscope if small insects are used

Anticipatory set: Present students with two pictures of similar looking insects. One insect that is threatened/endangered and the other an abundant. Two great examples can be found on a Nebraska website about ants, butterflies, carrion beetles and tiger beetles (<http://cgi.unk.edu/mcgahansj/index.htm>). There is the endangered American burying beetle (carrion beetle) and a few similar looking ones to contrast. Also, the Salt Creek tiger beetle only found in Lancaster county by some dwindling saline habitats, has a couple of similar looking relatives. Do not point out to the students which is the threatened species. Using the information on the website, explain that one of the insects are few in numbers, limited to specific habitats and are threatened/endangered, while the other one is abundant and can utilize many habitats. Once they know that one needs to be saved or preserved ask them if they can tell which one is the one to save.

Procedure:

1. Present the above scenario. Ask the students why it might be important to be able to identify which species is which. Tell the students that many insects look very similar, but they have different roles in the environment. Most often they have different habitat/food requirements and react differently to changes in their native range. Those species that do not handle change well and thus are at risk of extinction. There are many reasons to prevent species from extinction, such as food web shifts, beneficial predation, and diversity.

2. Ask the students to brainstorm ideas on how to identify which is the endangered species.
3. If no one has suggested it yet, introduce the use of a dichotomous key to identify species. Tell students that “dichotomous” means there are two choices, and that by choosing which of the two choices best describes the organism, one works through the “key” to find the name of the organism. Provide examples of some keys found on the internet or in books. The best way for them to understand how a dichotomous key works is to make one themselves.
4. Explain that the class will demonstrate how to start a dichotomous key using themselves and then they will be provided with a sample of insects for which they will construct a dichotomous key.
5. Have all of the students stand up and ask them how they could divide themselves into two groups (they do not have to be equal) by a distinguishing characteristic. Some suggestions for this could be to separate boys and girls. Have the students form two groups based on their distinguishing characteristic. Ask the students what characteristic was used to make the groups.
6. Tell them that they have just formed their first couplet and write it on the board. For example, if they used gender write “1a. Boys....go to 2,” and “1b. Girls.....go to ___(undecided until all boys are identified).” Next, they will focus on the “Boys” group and must again split into two groups. Anyone can make suggestions for this split which may vary from glasses vs. no glasses to right vs. left handed. If students suggest a characteristic such as hair color, point out that some people have hair that is neither blond nor brown, but somewhere in between. Encourage them to make distinctions that are clear and physical (vs. non-physical such as, likes pizza/doesn’t like pizza) like those that would be used in identifying organisms in nature.
7. When there is only one student that fits the description for a couplet statement, write that student’s name at the end of the statement. This would read, “4a. Not wearing glasses....Jim. 4b. Wearing glasses.....go to 7.” Continue this process creating several couplets, then begin separating the girls to illustrate how the numbering will proceed with many distinctions until students understand how to build the key.
8. Hand out the jars/vials containing an assortment of approximately fifteen insects of different species/families/orders. This part may be performed in groups if the teacher prefers.
9. Tell students that they need to organize and describe these insects by constructing a dichotomous key. Instruct them to write down the number of their jar/vial on their key (this is so you know which jar/vial they have described). They do not need to know the real names of the insects, but it might help to use some commonly seen insects. Before they begin, some basic structures of insects should be discussed such as six legs, three body parts, and wings. Remind them that it is best to use structural features versus color/size or changeable features. A dissecting microscope may be needed if small insects are used, such as ants.
10. Invite them to swap keys once they are done with other students to ensure that the key is understandable. This will reinforce the idea that a key written by one person can be used by others. This is how people with little knowledge of how to tell one species from another can use a key developed by an expert.
11. Have the students turn in their keys to be verified by you (the expert).

Closure:

1. Go over the different insects used and discuss the various characters described. Without picking on anyone in particular, discuss the positives and negatives of the characteristics used.
2. Make sure that students understand that this method of classification is used for all organisms, not just insects.

Extension: Collect a sample of one order or family of insect and instruct students to find and use online keys to identify the organisms to family, genus or species. This activity could also be used for a number of other organisms beyond insects.