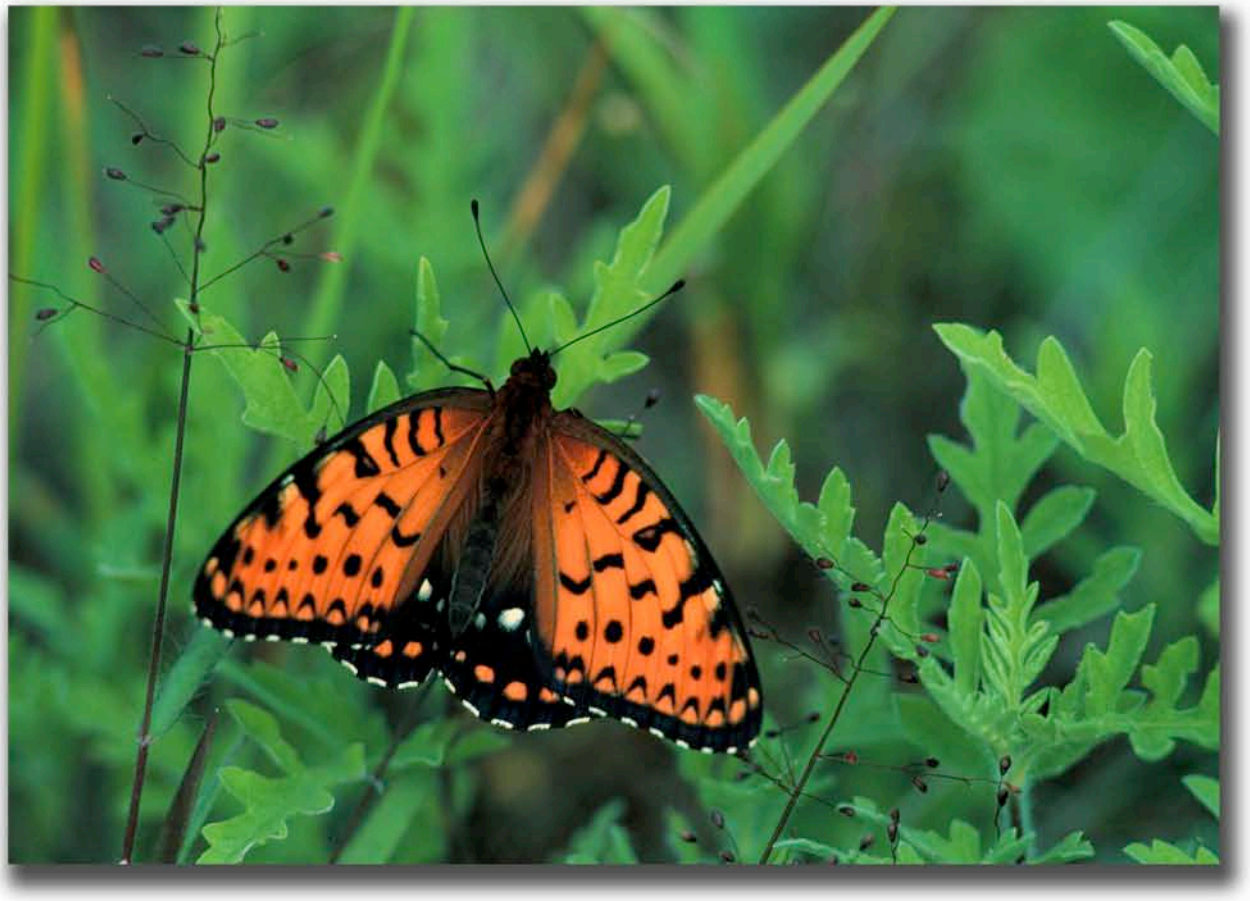
The Key to Them All

Overview

Identification is the most important step in biology. Students are introduced to dichotomous keys, learn how to create them, and use sample keys to identify certain groups of plants and animals



Title
The Key to Them All

Investigative Question
What are dichotomous keys and how are they used to identify organisms?

Overview
Identification is the most important step in biology. Students are introduced to dichotomous keys, learn how to create them, and use sample keys to identify certain groups of plants and animals.

Objective
Students construct a dichotomous key to identify an object or an organism and use other keys to identify small groups of plants and animals.

Materials
Student Pages 1,2,3,4; five familiar objects from the classroom; Tree branches with leaves for the Assessment Activity, The branches must be from trees that are found in the key (Student Page 2).

Time
Two 50-minute class periods (Less if part done as homework assignments).

Advance Preparation
1. Choose five objects (a book, a pencil, a chalkboard eraser, etc.) in your classroom to introduce the lesson.

2. Copy the student pages.

3. Collect tree branches, with leaves attached, as noted above.

Introducing the Activity
Hand out copies of Student Page 1 and allow students to read. To familiarize students with dichotomous keys and key writing, choose five items in the classroom and together write a key to those items. Each couplet must include statements of the opposite condition—wings present, wings absent; legs fuzzy, legs smooth. When working through a key, the reader will either identify the object from a given couplet, continue down to the next couplet, or jump ahead to another designated couplet. Each character in the key must be directly observable. For example, can fly is not a character, but presence of wings is. An easy way to begin is to make five separate lists on the board of observable characters about the objects you have chosen. Use those characters in constructing your key.

Example: book, pencil, chalkboard eraser, chalk, box of colored pencils

1. object has a square or rectangular shape with corners 2
   object not as above (cylindrical or round)..... 3
2. object cannot be opened and has a soft, porous surface ..... eraser
   object can be opened 4
3. object flat on both ends, usually white, has no core,
   leaves residue on hands ..... chalk
   object usually comes to a point on one end, has a
   central core of dark material, does not leave residue on hands ..... pencil
4. object has a number of paper sheets between hard covers ..... book
   object not as above* ..... box of pencils

*Notice in this key that the final statement need not be very specific because it applies only to the object that has not been identified.

For an example of how to construct a more complicated key, consider the taxonomy of the caterpillar of the monarch butterfly, the Illinois state insect. The monarch belongs in the animal kingdom (kingdom Animalia). It has an exoskeleton and paired jointed legs. All organisms with these characteristics—including lobsters, millipedes, and insects—belong to the phylum Arthropoda. Further, the monarch has six legs and two antennae (very small in caterpillars) and thus belongs to the class Insecta. It has no more than five pairs of fleshy prolegs on the abdomen (order Lepidoptera), has smooth skin, eats only milkweed, and has cross bands of black and yellow on its body (family Danaidae). In addition, these caterpillars have long filaments (threadlike structures) on their bodies (genus *Danaus*). The monarch caterpillar has only two such filaments (species *plexippus*). As you can see, by the time we reach the species level, we have accumulated considerable information about the monarch.

The information presented in the previous paragraph can be summarized by the following sample key. Note that paired choices reflect opposite characters (with wings or without wings; antennae present or antennae absent). Also note that a character can be any feature that allows you to separate organisms, or groups of organisms, from one another.

1. Motile and free-living ..... go to 2
   (Animal Kingdom)
   Nonmotile ..... Plant Kingdom

2. Exoskeleton with paired, jointed legs ..... go to 3
   (Phylum Arthopoda)
   Other.....numerous other phyla

3. Six legs, 2 antennae.....go to 4
   (Class Insecta)
   Other.....numerous other classes

4. Up to 5 fleshy prolegs on abdomen.....go to 5
   (Order Lepidoptera)
   No prolegs or more than 5 on abdomen.....other orders

5. Body smooth, crossed bands of black and yellow on body
   (Family Danaidae).....go to 6
   Not as above.....numerous other families
   (Note: We cannot use "feeds on milkweed" as a character because other caterpillars also eat it.)

6. Body has long filaments.....go to 7
   (Genus *Danaus*)
   Body without long filaments.....other genera

7. Body has 2 long filaments .....species *plexippus*
   Body without 2 long filaments.....other species

Procedure

1. Distribute copies of **My, How You've Grown!** (Student Page 2). Students match the young on the left with the adults on the right. Field guides or other references may be used to complete the matching.

Answers: 12-duck-H, 8-frog-A, 7-caddisfly-G, 10-dragonfly-J, 2-osprey-D, 9-mosquito-K, 5-beaver-I, 1-June beetle-C, 6-grasshopper-B, 11-oak tree-E, 4-butterfly-L, 3-mussel-F

2. Discuss the difficulties of matching adults and young in natural settings such as a rainforest, a tropical jungle, or even a relatively well-known place like Illinois. Ask students how they would go about determining what the young and adults of various groups of organisms look like.

For example, they might collect immature insects and rear them to adults or observe adult birds feeding their nestlings. Explain that they will now construct two biological keys, one for the adults and another for the young. These keys will allow the 12 organisms to be distinguished from each other.

3. Present your own version of the material in the background information on Student Page 1. A good place to start is to list characteristics of each organism that could be used to construct a key. Explain that a valid character must hold true in all situations. "Lives in water" and "flies in the air" are not good characters because if the animal is dead, the character is useless. Alternatives to these characters would be "the presence of gills or fins" and "wings."

Students must construct their keys based on the information they observe from the pictures of the organisms. Characters such as "warm-blooded" or "lays eggs" cannot be determined from the pictures and are not valid. Students' keys will be different, depending on the characters they choose. Sample keys are provided below.

4. Exchange keys among individuals or small groups. Can students find invalid (unacceptable) characters in each other's keys? Discuss why these characters fail to distinguish among species or do not hold true in all situations.

If time permits, create a key on the chalkboard that represents commonly used characters. For example, did all students use the presence or absence of fur or hooked vs. flat beaks as characters? For older students, conclude the evaluation by showing actual keys to species of organisms. The point here is not to introduce the technical vocabulary and refinements used in these keys but to help students understand that their keys represent a very simple example of a biological key.

Assessing the Activity

1. Distribute Student Page 3 and allow time for students to complete it. You may elect to have students work in pairs or do this as a homework assignment. Circulate about the room and be available to answer questions. The three unknown trees should be identified as oak, maple, elm.

2. Ask each student to make a key to the five animals shown on Student Page 4. (This could be done as a homework assignment) They should devise their own characters. If time permits, exchange the keys and test them. If a key fails, is the fault with the key or with the student-attempting to make the identification?

3. Display the tree branches with leaves that you have brought in. Ask students to use the key on Student Page 3 to identify the trees from which the branches came. Make sure you have brought in examples that are used in the key!

Extending the Activity

Bring in field guides and other books that contain keys. Have students look through them to get an idea of the complexity of some keys. Help them to develop an appreciation for the terminology with which they must become familiar in order to use biological keys. List some of these terms on the chalkboard and offer definitions.

State Goals

11,12

Concept

Biological classifications are based on how organisms are related. Organisms are classified into a hierarchy of groups and subgroups based on similarities. The characteristics that separate organisms can then be used to develop a key that will identify each organism (white oak tree) or group of organisms (all oak trees).

Safety and Waste Disposal

Compost the branches and leaves.

Sample Key to Adults

1. Plant.....oak tree
   Animal.....go to 2
2. Feathers present.....go to 3
   Feathers absent.....go to 4
3. Hooked beak.....osprey
   Flat beak.....duck
4. Antennae present.....go to 5
   Antennae absent.....go to 10
5. Hind legs larger than other legs.....grasshopper
   Hindlegs same size as other legs.....go to 6
6. Wings with hairs.....caddisfly
   Wings without hairs.....go to 7
7. Wings held out from body or easily visible.....go to 8
   Wings held against body or hidden.....June beetle
   (Note: June beetles' wings are hidden except during flight.
   The drawing shows one wing extended in an artificial pose.)
8. Two wings.....mosquito
   Four wings.....go to 9
9. Antennae half as long as body.....butterfly
   Antennae less than half as long as body.....dragonfly
10. Body covered with fur.....beaver
    Body naked.....go to 11
11. Body with legs and obvious head.....frog
    Body legless without obvious head.....mussel

Sample Key to Young

1. Beak present.....go to 2
   Beak absent.....go to 3
2. Beak hooked.....osprey
   Beak flat.....duck
3. Body without appendages (legs, etc.).....go to 4
   Body with appendages.....go to 5
4. Body V-shaped.....mussel
   Body not V-shaped.....oak tree (acorn)
5. Fur present.....beaver
   Fur absent.....go to 6
6. Rear of body encased in a shell.....caddisfly
   Rear of body not encased in a shell.....go to 7
7. Small tufts of hair on body.....mosquito
   Body naked.....go to 8
8. Wormlike body.....go to 9
   Body not wormlike.....go to 10
9. Body comma-shaped.....June beetle
   Body not comma-shaped.....butterfly
10. Six legs present.....go to 11
    Other than six legs.....frog
11. All legs same size.....dragonfly
    Hind legs larger than other legs.....grasshopper

Student Page 1 – Background Information

Scientists who locate, describe, name, and determine the relationsips among species are called taxonomists or systematists. The two terms as used here are synonomous. In biology, the purpose of classification is to provide a system for organizing a large body of information about living organisms. We rely on a hierarchical system, a series of levels that become increasingly exclusive. As information becomes more specific, fewer organisms can be included (and more excluded) until an individual unit, the species, has been identified.

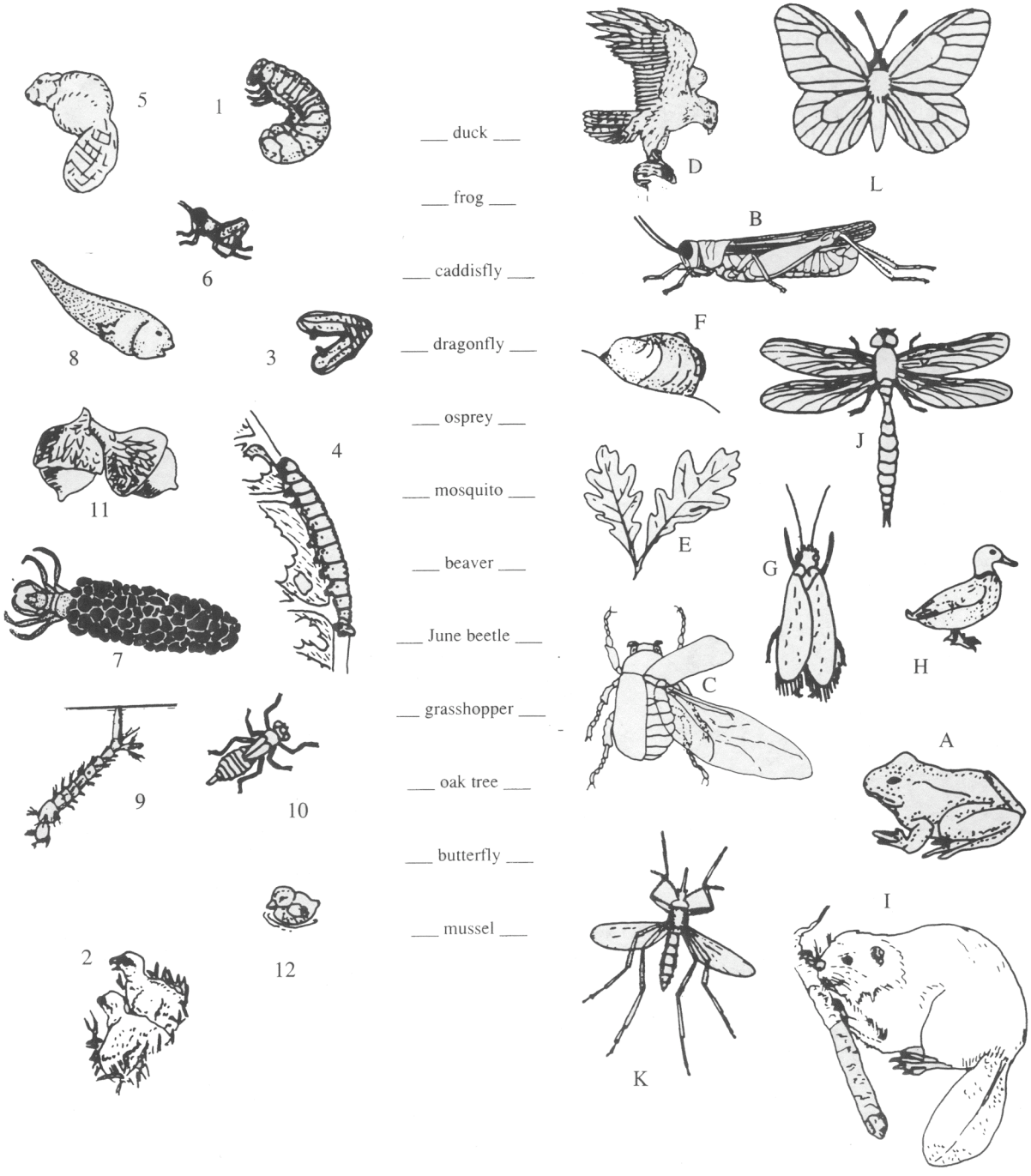
During the early days of the science of taxonomy, the young and the adults as well as males and females of a single species were often described as different species. Thanks to modern techniques, this mistake is not often made today. The following activity has two parts. The first is the relatively simple task of matching the adult with its young. The second introduces the more complex concept of biological keys.

To identify organisms, scientists assemble taxonomic information, and arrange it in a logical form called a key. Although there are dozens of types of keys, we will use a dichotomous key: *dich* meaning two parts, and *tomous,* to divide. Thus, each step in a dichotomous key requires the observer to choose between two alternatives, each associated with other alternatives.

Keys are usually written to particular groups of organisms. Thus, while you will not likely find a key to all the beetles, you will find keys to families of beetles or perhaps a key to species of beetles that occur in the same family, subfamily, or genus. It is very important to use the proper key so that you correctly identify the organism in question. A silly example would be an attempt to identify a snake by using a key to the trees!

Student Page 2: My How You've Grown!

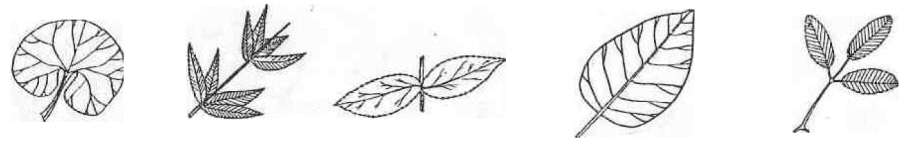
Match the young on the left with its adult on the right.



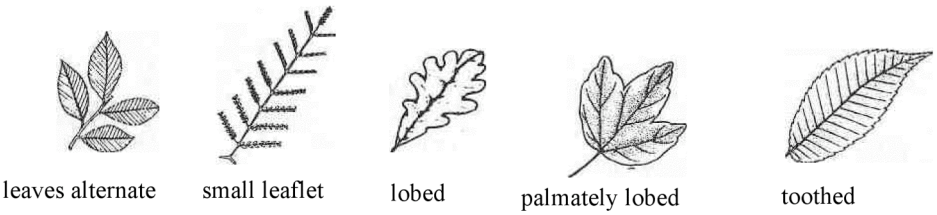
Student Page 3: What Tree Is That? Name _____

Use the key to identify the three unknown trees whose leaves are shown below.

1. Leaves alternate 2
   Leaves opposite or whorled 7
2. Leaves simple 3
   Leaves compound..... 6
3. Leaves fan-shaped with notch at tip .....gingko
   Leaves not fan-shaped, lacking notch at tip 4
4. Leaves entire ..... magnolias
   Leaves lobed or toothed 5
5. Leaveslobed ..... oaks
   Leaves toothed..... elms
6. Leaflets small..... honeylocust
   Leaflets large ..... yellowwood
7. Leaves whorled ..... catalpa
   Leaves opposite..... 8
8. Leaves simple..... ……...9
   Leaves compound .....:..... 10
9. Leaves palmately lobed..... maples
   Leaves entire..... dogwoods
10. Leaves palmately compound ..... buckeyes
    Leaves pinnately compound.....ashes



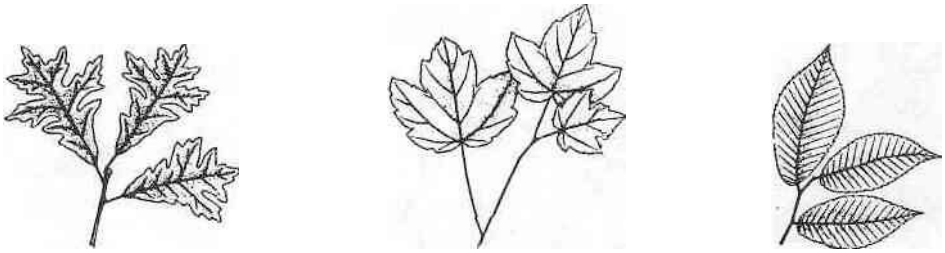
simple whorled opposite entire compound



leaves alternate small leaflet lobed palmately lobed toothed

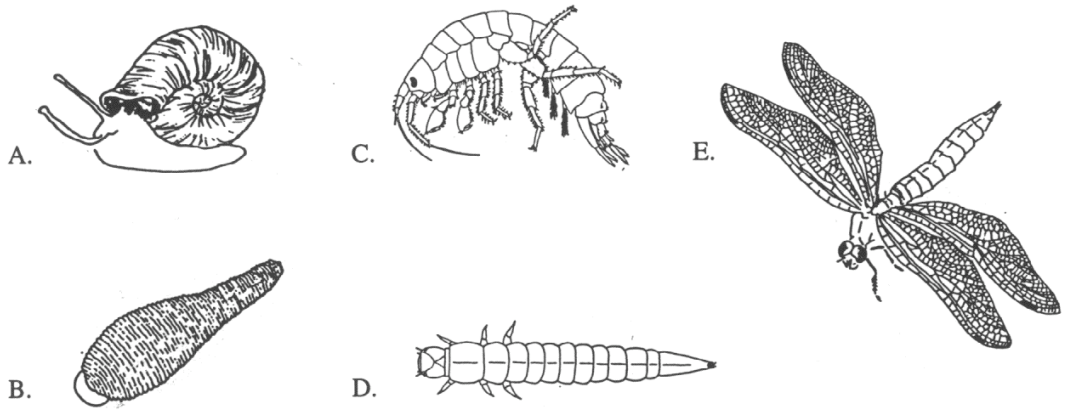
fan-shaped palmatelycompound pinnately compound large leaflet

Unknowns:



Student Page 4: Aquatic Macroinvertebrate Key **Name**_____

Below are drawings of five organisms and a key. Write a key to identify these animals.



Questions to think about:

1. For which group of animals would it be easier to write a key, all the mammals found in Illinois or all the rodents found in Illinois? Explain your choice.

2. Is it easier to write a key to organisms that are very different from each other or to organisms that are very similar? What difficulties would you encounter in each case?

3. If you were to write a key to all the mammals found in Illinois, what kind of information would you need to create a useful, accurate key?

a useful, accurate key?