

## CHAPTER 5: ARTHROPOD IDENTIFICATION

*“If you are able, for example, sort all the things that appear to be beetles. Next separate the long, narrow beetles from the round beetles. Then take a closer look at the long, narrow beetles and see characteristics that some share.”*

—KEFYN CATLEY (*Sorting Arthropods for Identification*, p.195)

### TARGET QUESTIONS:

**What is an arthropod? How do you tell one arthropod from another?**

### PREREQUISITES:

Team Plot Selection



### CORE ACTIVITIES:

#### LESSON 1

#### What is an Arthropod?

#### LESSON 2

#### Developing a Plan for Studying Arthropods

#### LESSON 3

#### Responsible Collecting

#### Optional Activity

- Keeping a Live Collection

#### LESSON 4

#### Observing and Collecting Arthropods

- Field Trip A: Close Observations
- Field Trip B: Collecting

#### LESSON 5

#### Identifying, Preserving, and Taking Care of the Arthropod Specimens

#### LESSON 6

#### Comparing Data



### ASSESSMENTS:

Habitat Requirements

Arthropod Overview



### WEB COMPONENTS:

#### FOR STUDENTS

- Key to Arthropod Orders
- Arthropod Report (available in the Reproducibles section of the Teacher's Guide)
- Some Clues to Describing and Understanding Organisms (available in the Reproducibles section of the Teacher's Guide)
- How to Make a Killing Jar
- How to Set up Guest Quarters for Visiting Arthropods
- Other Methods to Capture Arthropods
- How to Set up a Berlese Funnel
- How to Make a Yellow Pan Trap
- How to Make a Net
- How to Set a Pitfall Trap
- Collecting Arthropod Specimens\*
- Sorting Arthropods for Identification\*
- Maintaining an Arthropod Collection\*
- Profile of Christine Johnson\*
- Profile of Kefyn Catley\*

\* All Web reading selections for students are available as blackline masters.

## OVERVIEW OF CHAPTER 5

Students do research to discover the characteristics of arthropods, then they develop a plan for studying and identifying the arthropods in their plots. They find that they must develop additional safety guidelines and anticipate potential problems in the field.

Students read about and discuss the responsibilities involved in collecting and keeping arthropod specimens, both live and preserved. They will need to bring in, invent, and construct the appropriate equipment for collecting, trapping, preserving, and housing specimens.

In the field, students implement their plan. The recommended activities include observing and recording physical characteristics and behaviors, looking for interactions, and collecting. As an optional activity, students may also develop a live collection. It will take several expeditions to complete all the recommended activities. After the fieldwork, students record, analyze, and compare their data.

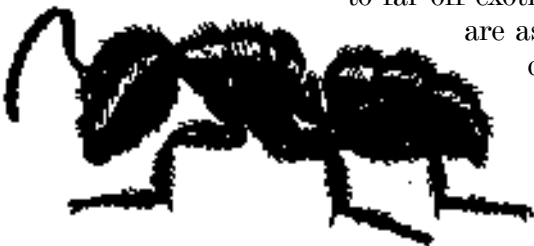
## BACKGROUND INFORMATION FOR THE TEACHER

### WHAT IS AN ARTHROPOD?

Some of the characteristics that define arthropods (from the Greek *arthron* meaning “joint” and *pod*, “foot”) are: pairs of jointed appendages, a segmented body, and a hard exoskeleton. The exoskeleton is a tough protective outer layer that arthropods must shed or molt in order to continue to grow. The body is divided into segments. Some segments bear sets of jointed appendages, and depending on the arthropod, these may be adapted to locomotion, eating, mating and reproduction, or respiration.

Arthropods are ubiquitous and are more widely distributed around the globe than are the members of any other animal phylum. Terrestrial forms exist in the extremes of both tropic and polar regions and virtually everywhere in between. Aquatic forms are variously adapted to salt, fresh, or brackish water all over the globe. Arthropods can fly, crawl, hop, swim, burrow, and walk. Most are plant eaters, but others specialize in such fare as blood, meat, carrion, dung, or bacteria.

Arthropods are the most abundant, the most widely distributed, the most diverse, and the most successful animals on Earth. About three-quarters of all known animal species on Earth are arthropods, but estimates of how many species of arthropods exist vary widely. The latest data record 875,000 described species, but this figure increases almost daily. You don't have to go to far-off exotic places to find new species. It is estimated that there are as many as 100,000 species of arthropods still awaiting discovery in the AMNH collection. The estimated number of all undescribed species ranges from 10 to 100 million, and scientists believe most of these undescribed species are arthropods.



Identification presents real challenges. Many arthropods are very small, so access to a stereo/dissecting microscope is extremely helpful. Many appear radically different at different stages in their life cycle. The egg, larva, pupa, and adult stages bear no resemblance to one another and may seem to be very different animals when they are actually the same animal at different stages of development. And since their needs differ during these stages, they may be found in quite different habitats in successive stages.

As with the plants, guides and keys do not exist for all the arthropods students may find, and of the ones that do exist, few take identification to the species level. Challenge your students to go as far as possible in their search for species level identification, but let them know that getting to the order and family levels will be a real accomplishment.

### **WHO ARE ARTHROPODS?**

A list of all the known arthropods would go on for many pages. Below is only a partial listing of some of the more familiar ones to help you appreciate how very diverse they are.

The phylum Arthropoda is divided into four subphyla: Trilobita, Chelicerata, Crustacea, and Atelocerata. Here are some examples of animals from each subphylum.

**Trilobita** The trilobites are all extinct.  
We know of them only through fossil records.

**Chelicerata** Some common representatives include:

- horseshoe crabs
- sea spiders
- spiders
- scorpions
- harvestmen
- mites and ticks

**Crustacea** Some familiar crustaceans are:

- lobsters
- shrimp
- crabs
- water fleas
- copepods
- barnacles
- sowbugs

**Atelocerata** This is the largest category and includes:

- millipedes
- centipedes
- all hexapods, which include the insects

Because there are more species of insects than there are species of all other kinds of animals combined, they warrant further description here. Insects have all the characteristics that define arthropods and additional features that define them as insects. These additional features are: a body arranged into three distinct regions (head, thorax, and abdomen), three pairs of legs, one pair of antennae, and one pair of mandibles. The following is only a partial list of the orders in the class.

**Class Hexapoda**

<b>Examples</b>	<b>Order</b>
springtails .....	<i>Collembola</i>
mayflies .....	<i>Ephemeroptera</i>
dragonflies .....	<i>Odonata</i>
grasshoppers and crickets .....	<i>Orthoptera</i>
cockroaches .....	<i>Blattaria</i>
mantids .....	<i>Mantodea</i>
walkingsticks .....	<i>Phasmida</i>
termites .....	<i>Isoptera</i>
sucking lice .....	<i>Anoplura</i>
true bugs .....	<i>Heteroptera</i>
cicadas, hoppers, and aphids .....	<i>Homoptera</i>
beetles .....	<i>Coleoptera</i>
butterflies and moths .....	<i>Lepidoptera</i>
flies .....	<i>Diptera</i>
fleas .....	<i>Siphonaptera</i>
ants, wasps, and bees .....	<i>Hymenoptera</i>



# 1 LESSON

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**LESSON 1      WHAT IS AN ARTHROPOD?**

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**TIME**                      1 class session

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- MATERIALS**       Mystery list
- Reference materials on arthropods such as field guides, identification keys, charts, films, encyclopedias
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**WEB COMPONENT**

Key to Arthropod Orders

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- 1. Give students a mystery list of 10 or more arthropods, without divulging the fact that they are arthropods. You can use the following list or put together one of your own (using information from the Background section) that better reflects what students may discover in your area. Ask them to find out what all the animals in the list have in common.**

**SAMPLE**

#### **Mystery List of Arthropods**

What do all of these animals have in common?

Lobsters, cockroaches, ticks, honey bees, butterflies, spiders, centipedes, horseshoe crabs, scorpions, and shrimp

- 2. After students have researched the question, hold a discussion on what they found out. Elicit from the discussion the characteristics of arthropods and record these on a chart.**

#### **Characteristics of Arthropods**

**SAMPLE**

segmented bodies

pairs of jointed appendages

bilateral symmetry

chitinous exoskeleton

- 3. Ask what else students found out about arthropods in the course of their research. For example, what does their name mean? How many species of arthropods are there? Where do they live? Why are they so successful? Record these responses on the chart too. Save the list for the closing discussion and to evaluate progress.**
- 4. Explain that their next job is to study the different kinds of arthropods in their plots. They have already made quite a few observations in the field. Ask what kinds of arthropods they have already seen in their plots. Have them predict what else they might find and record the predictions in their journals.**
- 5. Allow time for students to familiarize themselves with the reference materials, field guides, identification keys, and on-line resources before they go out into the field. Recognize that identification will be difficult, and that identifying down to the species level may not be possible in most cases. Challenge students to get as close to the species level as possible.**

To help students build their skills, you could present them with a set of arthropods to identify. Try to collect a set of suitable pictures or get a sampling of pinned specimens for them to use. Students could also develop a game such as Name That Arthropod or Arthropod Charades to try to stump each other.

# 2 LESSON

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**LESSON 2      DEVELOPING A PLAN FOR  
STUDYING ARTHROPODS**

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**TIME**                      1 class session

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**MATERIALS**           Student-generated list of safety rules

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**WEB COMPONENT**  
Arthropod Report

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- 1. Work with the class to develop a plan for studying the arthropods in their plots. Begin by reviewing the class safety rules and adding new ones that apply to arthropods. For example:**

#### **Additional Safety Rules**

Find out which arthropods in your area are poisonous.

Find out if anyone in your class is allergic to stings or bites.  
Decide how that person can participate safely.

Do not touch any dangerous, unknown, or questionable arthropods.  
Don't take chances.

Be careful where you step and where you put your hands.

Wear gloves or use tools to collect them.

Be gentle.



- 2. Distribute copies of the Arthropod Report and go over it with the class. Tell students that the form is a useful tool for guiding their observations. Many of the features listed on the form (such as behavior, description of arthropod, and relationships to plants and other arthropods) will steer them toward identifying the arthropods they observe on their field trips. Ask students to add other ideas to the list. Here are a few tips to bring up in the discussion:**

#### **Tips on How to Observe Arthropods in the Field**

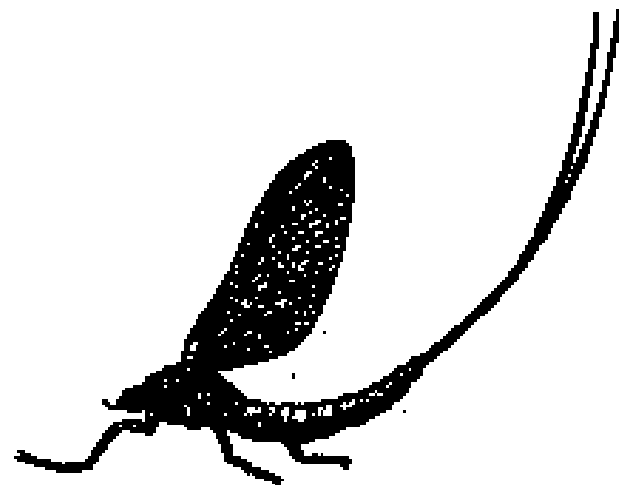
- Do some quick counting. Note the number of body segments, number of legs, and the number of wings, if any.
- Look at the overall body plan. Record shapes, sizes, patterns, and colors.
- Focus on structural details. Make detailed observations of antennae, legs, wings, and any distinctive features such as bristles, spines, snouts, or stingers.
- Listen for sounds. Sniff for odors.
- Collect as much data on behavior as possible. Take enough time (at least 3 to 5 minutes, but much more if possible) to observe the animal's behavior. Look for interactions between the arthropod and another animal, either of the same kind or of a different kind. Look for interactions with plants. Watch the animal feeding and notice what is being eaten. Observe how the arthropod moves and where it is going. Record your observations.
- Find and record evidence of an arthropod's activities, such as munched leaves, webs, tunnels, nests, eggs, excrement, sticky residues, molted exoskeletons.
- Record exactly where you found the arthropod. Note, for example, on what kind of plant it was and on what part of the plant. If it was flying, note how far off the ground it was, its flight pattern (zigzag, flutter,

hover), and where it landed. If it was in dead vegetation, note what kind of plant it was and where on the plant you found it.

**3. Discuss strategies for coping with new problems that may arise in the field. Ask:**

- What new problems might you have studying creatures that can move?
- What if you find a non-arthropod animal (squirrel, bird, worm, etc.)? Tell students that they should record anything they see in their plot, just as they have been doing all along, but try to keep focused on arthropods.

Decide on one solution the whole class can adopt for each type of problem. Agree that you will all discuss new situations as they arise in the field and try to reach decisions on how to handle them.



# 3 LESSON

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**LESSON 3      RESPONSIBLE COLLECTING**

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**TIME**                      1 or more class sessions

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**WEB COMPONENTS**

Reading Selections

Collecting Arthropod Specimens

Maintaining an Arthropod Collection

OPTIONAL: Profiles of Kefyn Catley  
and Christine Johnson

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**OTHER RESOURCES**

How to Make a Killing Jar

Other Methods to Capture Arthropods

How to Set up a Berlese Funnel

How to Make a Net

How to Set a Pitfall Trap

How to Make Yellow Pan Trap

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### TEACHING TIP: USING ON-LINE RESOURCES FOR ARTHROPODS

It will be useful for students to familiarize themselves as soon as possible with all of the on-line resources listed above. The readings will help to prepare them for the field work ahead. Later, they can return to specific articles, as needed.

**1. Bring up the subject of collecting and preserving arthropods in a class collection. Although students have already had this discussion with respect to plants, they need to be aware of how much more is involved in responsibly collecting arthropods.**

**2. To gather more information on the topic, ask students to read "Collecting Arthropod Specimens" and "Maintaining an Arthropod Collection," available on-line. Use the readings as a basis for a discussion focusing on some of these questions:**

- How is making an arthropod collection similar to making a plant collection? How is it different?
- Describe some of the collection techniques you might use. (These are aerial netting, sweep netting, beating, hand collecting, pitfall trapping, yellow pan trapping, and using a Berlese funnel.)
- Make a list of the equipment you will need to collect and preserve arthropods. How can you get, make, and invent these things?
- Have students brainstorm their own list of recommendations for responsible collecting. Here is a sample list:

#### Collecting Arthropods in a Responsible Way

Find out which arthropods are endangered or threatened in your state and learn to recognize them. Do not collect or harm any of them.

Don't overcollect. Once you are familiar enough with the arthropods to recognize which ones you have already collected, do not continue to collect the same ones.

Kill the arthropod as quickly and as humanely as possible.

Preserve it properly in a collection.

**SAMPLE**



### TEACHING TIP: LETTING STUDENTS CHOOSE

There will be some students who, for whatever reasons, choose not to kill arthropods. This is a personal decision and one that the whole class will need to understand and respect. Assure those individuals that they can still make a meaningful contribution to the project, and that they will still be involved in doing real science. Listen to their ideas on how they plan to participate within the boundaries of their decision.

## OPTIONAL ACTIVITY

ACTIVITY	KEEPING A LIVE COLLECTION
TIME	1 class session
WEB COMPONENT	
How to Set up Guest Quarters for Visiting Arthropods	

- In addition to a preserved collection, encourage students to keep a temporary live collection. The advantage is that students can study an animal's behavior for a short time and then return the creature to its home. Again, students need to understand the responsibilities involved. Ask for their ideas on how they would care for arthropods in captivity.
  - What do arthropods need?
  - How can we provide for those needs?
- Then have students read "How to Set Up Guest Quarters for Visiting Arthropods" for more practical information on keeping and caring for captive arthropods. Make them aware that if they plan to keep living specimens, they need to set up containers before their collecting trip.

# 4 LESSON

**LESSON 4****OBSERVING AND  
COLLECTING ARTHROPODS**

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**TIME**4 or more field sessions

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**NOTE**

Two activities are recommended for the focus of your field trips to study arthropods: Close Observations and Collecting. They are described separately below. You may decide to focus on just one activity per trip, or you may mix and match the activities to take advantage of opportunities to observe and collect as they arise.

Note that collecting is recommended after observing. This sequence gives the class time to observe carefully and learn something of behaviors and habitat requirements first. Thus students can later make better decisions on where and how to collect, and on how to keep arthropods in captivity.

Before you go out, check that students have brought in, invented, and constructed all the equipment they need for the expedition. There is a lot of equipment involved in observing, recording, identifying, catching, killing, and transporting arthropods.

For all trips, remind students of the safety rules, go over the plan for the day, and plan to circulate among the groups to help them resolve new dilemmas.

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## FIELD TRIP A

FIELD TRIP	CLOSE OBSERVATIONS
<b>MATERIALS</b>	<input type="checkbox"/> Journals <input type="checkbox"/> Hand lenses <input type="checkbox"/> Field guides and keys <input type="checkbox"/> Rulers
<b>WEB COMPONENTS</b>	
Copies of <i>Some Clues to Describing and Understanding Organisms</i>	

1. Give student teams ample time to make close observations of at least one arthropod each. Using *Some Clues to Describing and Understanding Organisms* as a guide, have them observe both physical characteristics and behavior.

Circulate among the groups and prompt them to observe specific details. Use some of these questions:

<b>Focus Questions</b>	<b>Possible Responses</b>
<b><i>What is the first thing you noticed about this animal?</i></b>	Shape, color, size, method of locomotion
<b><i>How do you know it is an arthropod?</i></b>	Jointed appendages, segmented body, hard exoskeleton
<b><i>What can you count?</i></b>	Legs, wings, body segments
<b><i>Where exactly did you find it?</i></b>	On a plant, in the soil, in the air, under a rock
<b><i>What was it doing?</i></b>	Eating, moving, resting
<b><i>How does it move?</i></b>	Walk, hop, fly
<b><i>Have you observed it interacting with a plant or with another animal?</i></b>	Responses will vary

2. Suggest that they use field guides and keys to try to identify the arthropods while still in the field. They will be able to use additional on-line resources later.

## FIELD TRIP B

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### FIELD TRIP

### COLLECTING

#### MATERIALS

- Journals
  - Nets
  - Equipment to set up traps
  - Sheet, tablecloth, large piece of paper or umbrella, and a heavy stick
  - Specimen labels
  - Containers
  - Killing jars
  - Reference materials: field guides and keys
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1. During two or more of the expeditions, students should have the opportunity to use the equipment they have brought in, built, and invented for capturing arthropods.

Before going out, check that students are prepared to provide for the needs of any captives they take. If you plan to set up a living collection (optional), be sure that there are containers set up to receive the arthropods before you leave. If you plan to set up a preserved collection, prepare the killing jars. Both living and preserved specimens would make interesting additions to the class exhibit at the end of the unit.

2. Outside, remind students of the additional safety rules concerning arthropods and of the guidelines they developed for responsible collecting. Then let them begin.

3. As students work, circulate and ask some of these questions:

<b>Tasks</b>	<b>Focus Questions</b>
<b>To focus on collecting techniques</b>	Where did you find the arthropod? How did you capture it?
<b>To encourage planning</b>	What will you do with it: release it, keep it for a while, or kill and preserve it? If you are going to keep it alive, how will you provide for its needs? If it will become part of the preserved collection, how will you preserve it?
<b>To record data</b>	What data will you record on the specimen label? What data will you record in your journal?
<b>To discourage overcollecting</b>	Has anyone else already captured an arthropod like yours? How do they compare? Which one should we keep for the collection?

4. Encourage students to use reference materials to identify the arthropods in the field. They will be able to use on-line references later.

# 5 LESSON

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**LESSON 5 IDENTIFYING, PRESERVING,  
AND TAKING CARE OF  
ARTHROPOD SPECIMENS**

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**TIME** Several class sessions, repeated as necessary

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- MATERIALS**
- Hand lenses
  - Stereo/dissecting microscope
  - Supplies for preserving arthropods
  - Living accommodations for captive arthropods (optional)
  - Reference materials
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**WEB COMPONENTS**

Key to Arthropod Orders

Arthropod Report

Weather Report

Some Clues to Describing and Understanding  
Organisms

Sorting Arthropods for Identification

Maintaining an Arthropod Collection

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- 1. As soon as you return indoors, give students time to see to the needs of any arthropods they captured. This means either setting up living quarters or preserving the specimens properly. Have students review the on-line article “Maintaining an Arthropod Collection” for details.**



### **ASSESSMENT: HABITAT REQUIREMENTS**

In order to set up and maintain habitats for live arthropods, students will have learned about their basic requirements. This is a good opportunity to assess their understanding of how a particular arthropod lives, what it eats, where it lives, and how to replicate its habitat requirements.

- 2. Build in additional time for students to work on identifying the arthropods they found in their plot. Provide hand lenses and microscopes, if possible. Have students read the article “Sorting Arthropods for Identification” and then follow the suggested technique for sorting specimens by observable characteristics.**
- 3. As with plants in the previous activities, students need to decide how to treat arthropods they cannot identify. They may decide to use the common name or a temporary name, complete with detailed descriptions. Urge them to continue to look for help in identifying their specimen and suggest other resources in the community and on-line. Local specialist help with identification will be invaluable to students at this point.**
- 4. Have students teams work together to fill in the Arthropod Report referring to Some Clues to Describing and Understanding Organisms. Also, ask students to enter their data in the Weather Report for the day. For each field trip, make sure that the journal entry/observation date for that day’s Weather Report correlate with the journal entry/observation date of all Plant and/or Arthropod Reports filled out on the same day. This information can be used later to analyze data generated by your class.**

# 6 LESSON

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**LESSON 6      COMPARING DATA**

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**TIME**                      1 class session

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**MATERIALS**           Journals

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**1. Discuss the findings. Use some of these questions:**

- How many different kinds of arthropods have we identified? How many have we been unable to identify? Where can we get more help?
- In which plots did we find the most arthropod diversity? The least?
- Why do you think that is so?
- Have you noticed any relationships between plant and arthropod abundance and diversity?



**ASSESSMENT: ARTHROPOD OVERVIEW**

1. Return to the Characteristics of Arthropods chart that students generated in Lesson 1. Ask students to summarize what they now know about arthropods, their distinguishing characteristics, and their behaviors. Ask students which features were most useful for providing clues to the identity of the arthropods. Add new information to the chart. This new information is a good gauge of student progress.
2. What questions do students still have about arthropods? How might they continue to work toward finding their own answers?
3. Finally, return to the explanation of biodiversity that students have been developing. How has the explanation expanded because of their work with arthropods? Ask the class to refine their explanation once again. Record it on the chart or concept web.