CHAPTER 3: PLANT IDENTIFICATION

TARGET QUESTIONS: **Why are plants important?**
How do you identify plants?

PREREQUISITES: Team Plot Selection

CORE ACTIVITIES:

LESSON 1

Beginning with Plants

Activities

- Describing Oak Leaves
- Twig Twins
- Responsible Collecting

Optional Activity

- The Blindfolded Walk

LESSON 2

Observing and Collecting Plants/ Measuring Environmental Factors

Field Trips

- Close Observations
- Collecting
- Measuring Environmental Factors

LESSON 3

Identifying and Preserving Plants

LESSON 4

Comparing Data

Optional Activity

- Mapping

ASSESSMENTS:

Baseline Observational Skills

Checkpoint

WEB COMPONENTS:

FOR TEACHERS

- Guide to Finding Local Specialists
- Who Are the Plants?
- A Listing of Herbaria

FOR STUDENTS

- Dichotomous Keys
- How to Use a Dichotomous Key
- Some Clues to Describing and Understanding Organisms
- Plant Report/Weather Report (available in the Reproducibles section of the Teacher's Guide)
- How to Press and Preserve Plants
- How to Mount Dried Plants
- Types of Oak Leaves (available in the Reproducibles section of the Teacher's Guide)
- Responsible Collecting*
- Collecting Plants*
- Plant Identification*
- Plant Inventory*
- Profile of Liz Johnson*
- Profile of Brian Boom*

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

OVERVIEW OF CHAPTER 3

As preparation for identifying plant specimens in the field, students discuss the important characteristics of plants, work at developing observational skills, and become familiar with resources that will help them with identification. They learn about the system of binomial nomenclature in common use and how to use a dichotomous key.

Collecting is a recommended activity, and there are numerous resources available on-line for classes that are able to collect and preserve plants. The optional mapping activities also continue.

The fieldwork focuses on three activities: making close observations, collecting plant specimens, and measuring abiotic and environmental factors. Later, students preserve specimens and continue working to identify the plants in their plots. Finally, students compare their data and record them on the class map (optional).

BACKGROUND INFORMATION FOR THE TEACHER

Why begin with plants? Plants hold a primary place in the world of living organisms because of their ability to manufacture their own food from simple inorganic materials (carbon dioxide and water). This process, called photosynthesis, is powered by energy that plants capture from the sun. Thus plants feed not only themselves, but are food for herbivorous animals and indirectly for the carnivores that feed on the herbivores. They also produce virtually all of the oxygen in the atmosphere, since they give off oxygen as a by-product of photosynthesis.

In many ways, plants determine the numbers and kinds of other organisms that can live and thrive in an area. In addition to food, they supply protection from the elements, nesting sites, and homes for small creatures. They are host to a wide range of mammals, birds, fish, worms, arthropods, fungi, and bacteria.

Finally, plants are enormously important to human welfare. They are a source of food, clothing, housing materials, medicines, and dyes. They replenish the air we breathe, cool the atmosphere that surrounds us, hold our soils in place, and please our senses. They contribute not only to our physical but also to our emotional well-being.

CLASSIFICATION: GETTING TO THE SPECIES LEVEL

Biological scientists around the globe are working to discover, describe, and classify species. In order to communicate clearly with one another, they all use the same hierarchical classification system and the same naming system (binomial nomenclature).

Classification System

Animals	Plants
Kingdom	Kingdom
Phylum	Division
Class	Class
Order	Order
Family	Family
Genus	Genus
Species	Species

As you move through the categories from kingdom to species, each category contains fewer organisms, and the organisms in each category have more features in common. The fundamental unit of all biology is the species; thus, every individual can be described as belonging to a distinct species. Scientific research on biodiversity focuses primarily on species and it is the unit that scientists use to discuss biodiversity. Identification to the species level is a difficult process and may require special equipment.

BINOMIAL NOMENCLATURE

In binomial nomenclature, an organism is given two Latin or latinized names. Latin is the recognized language of science. It has the advantage of being a language that belongs to no single country or culture and one that is no longer changing. The first name of the organism (a noun) is its genus, always capitalized. The second name (an adjective) is its species, always written in lower case. Both are usually italicized but are sometimes underlined or written in bold type. Most conventional keys and identification guides use this system.

For example, the white willow belongs to the genus *Salix*, along with more than 200 other species such as the weeping willow, the crack willow, and the black willow. Its full name, *Salix alba*, distinguishes it from the other willows in the genus by adding the species name *alba*, or white. (Not all species names are so conveniently descriptive.)

It is a challenge to identify plants all the way to the species level (and even more challenging to identify arthropod species). But it is important that students engage in the process. They will become more familiar with the language of science, and they will be working the same way that scientists do to describe and identify organisms.

USING DICHOTOMOUS KEYS

A dichotomous key (from the Greek *dicho* meaning "two" and *tomous* meaning "to cut") is a system for identifying organisms based on a series of choices between two alternative descriptions. It is an extremely useful tool for identification. Unfortunately, keys do not exist down to the species level for all the plants or for all the arthropods your students may discover, and there is much work yet to be done in that field. You will find some dichotomous keys to conifer genera and arthropod orders on the Web site in the Resources Area. They may be used on-line or printed out and placed in plastic sheet protectors for students to carry into the field.

Keys are fun to use—and quite simple, once you get the idea. It's like solving a mystery from the clues. No two species are exactly alike, so by following a series of clues and eliminating suspects along the way, you can arrive at a positive identification (most of the time).

Please see *How to Use a Dichotomous Key* on the Web for more information. Most standard biology textbooks also have information on dichotomous keys.

Morphospecies

A morphospecies may be described as a group of organisms that, based on external form and structure, appears to be distinct from other groups of organisms. The group of individuals is recognized solely on the basis of similarities in external characteristics.

When faced with a bewildering array of organisms, it is useful to begin by sorting them into groups based on their observable characteristics. At the most basic level, species may be defined as a unique entity. This entity, or population of individuals, is genetically distinct, and its genetic distinctions are reflected by form and structure (or morphology). In fact, new species are described because they demonstrate observable and inheritable differences in morphology or shape.

Thus, the amateur or student scientist may legitimately begin the process of classification by sorting organisms into categories based on what they look like. Using observable attributes such as shape, color, size, texture, numbers of structures, and the absence or presence of structures, students can make a good start on the road to identification. Later, as more data are collected, the original identification may be either verified or disproved.

In the process of sorting, students will have to observe the organism in great detail in order to discover how it is similar to or different from the others—a useful exercise in itself. Even if the observation does not lead to identification of the species, it may well lead to identification at a higher taxonomic level, such as order or family. This is a real accomplishment!

TEACHING TIP: IDENTIFICATION IS A CHALLENGE

It is not always possible to reach the species level of identification—for students or scientists. Recognize that it will be a challenging task and that students may often be frustrated in their attempts. While identification to the species level is important, it is not the main objective of the study.

On the Web site, you will find a wealth of resources aimed at helping students identify the plants and arthropods they discover in their plots. Help students get into the habit of consulting the on-line resource sections often. Some areas that you and your students will find useful are the external links to botanical gardens, education programs, environmental organizations, entomological societies, herbaria, natural history museums and science centers, national parks, and zoological parks.

Your most important resources may be local specialists. Many organizations are quite willing to help students on a project such as this. If you haven't already done so, contact a nature center, museum, university, botanical garden, botanical society or garden club, or conservancy group. Most states also have a Natural Heritage office with a botanist trained to help with specimen identification. Please see the article called *Guide to Finding Local Specialists* in the Resources Area on the Web.

Do the best you can to direct students to multiple resources, but when it becomes obvious that they have reached an impasse, help them to decide on an alternate naming scheme for the unknowns. They may have to use alternatives such as the genus followed by something like mystery species #1 or genus species #1, or if they identify a plant to genus, Salix species #1, for example. They may also use the common name of a plant like grass, or a temporary made-up name that describes the plant.

MEASURING ENVIRONMENTAL FACTORS

Much of what scientists do is look for patterns in nature. They may look for patterns of plant and arthropod distribution, patterns of evolutionary relationships, or correlations between one variable and another to try to understand the factors that determine biodiversity.

Scientists have observed that the occurrence of many plants and arthropods is determined by environmental factors. There is a correlation between the presence of a particular plant, for example, and the environmental conditions that favor its survival. These conditions include temperature range, light levels, soil composition, and average rainfall.

By recording these environmental factors over a long period of time, we could expect to see patterns that show which factors are important to a species.

1 LESSON

LESSON 1 BEGINNING WITH PLANTS

TIME 3 or more class sessions

MATERIALS

- ❑ 1 copy of the "Types of Oak Leaves" activity sheet per team
- ❑ Reference materials such as field guides and keys to identification
- ❑ Some Clues to Describing and Understanding Organisms

WEB COMPONENTS

Dichotomous Keys

Parts of Plants

Plant Identification

Some Clues to Understanding and Describing Organisms

Types of Oak Leaves

OPTIONAL: Profiles of Brian Boon and Liz Johnson

1. ***Explain to the class that they will begin a study of the plants at their site. Ask why plants are a good starting point for a study of biodiversity.***

2. ***To review students' prior knowledge of plants, ask some of these questions:***

Questions	*Possible Responses*
What factors determine the number and kinds of plants you will find at the site?	Factors include: Rainfall, humidity, temperature, soil composition, hours of sunlight, activities of people and other animals.
How do plants provide for the needs of other living things?	They provide food, shelter, homes, nesting places.
How can you tell one plant from another? What features could you look for?	By leaf or needle size and shape, arrangement of plant parts on the stem, smell, texture, vein patterns, flower and bud types, bark, seeds, cones fruits, or overall growth patterns.

3. ***Ask students what tools and equipment they will need to take measurements of the environmental factors at their site. Ideally, they should plan to use thermometers, a soil test kit, a light meter, and a rain gauge.***

4. ***Distribute copies of* Some Clues to Describing and Understanding Organisms *to your students and go over it to help prepare for the field activities.***

OBSERVATIONAL ACTIVITY

ACTIVITY **DESCRIBING OAK LEAVES**

To help students hone their observational skills and to build plant-related vocabulary, do the following activity.

- Distribute copies of the activity sheet "Types of Oak Leaves" and divide the class into small groups. One person in each group selects an oak leaf from the activity sheet, and the rest of the group asks questions to figure out which one they have selected. They might ask, for example: Does it have just one vein? Are the edges smooth? Is it lobed?

Other leaf descriptors include:

LEAF SHAPE narrow, oval, heart-shaped, arrow-shaped

LEAF MARGIN OR EDGE smooth, lobed, toothed, spiny

VEINS parallel, branching, netted

OPTIONAL: Using the Types of Oak Leaves sheets to identify oak trees

For your information, we have identified the oak leaves on this sheet. Please note, to make a positive identification of any tree species, you will need to look at additional structures including twigs with buds and fruits—in the case of oak trees, acorns.

Types of Oak Leaves: Common Name, *Scientific Name*

1.	Turkey oak	*Quercus laevis*
2.	Black oak	*Quercus velutina*
3.	Willow oak	*Quercus phellos*
4.	Chinquapin oak	*Quercus muehlenbergii*
5.	Bur oak	*Quercus macrocarpa*
6.	Blackjack oak	*Quercus marilandica*
7.	Myrtle oak	*Quercus myrtifolia*
8.	Pin oak	*Quercus palustris*
9.	Post oak	*Quercus stellata*
10.	Basket oak	*Quercus prinus*
11.	Durand oak	*Quercus durandii*
12.	White oak	*Quercus alba*

OBSERVATIONAL ACTIVITY

ACTIVITY	**TWIG TWINS**
PREPARATION	Collect two or more twigs about 12 inches long from a variety of bushes, shrubs, or trees. You need two matching twigs per student, but it is fine to have multiple sets of the same type. When collecting, place one twig of each kind into two separate bags. There are a number of ways to get twigs: prune your own plants or those around the school building, ask the grounds people to save clippings for you, call a landscaper or nursery for donations, or ask students and parents to contribute.

1. This activity helps students become aware of the structural patterns of twigs that aid in their identification.

- Set up two tables or two areas on the floor. Empty one bagful of twigs in the first area and the matching bagful in the other. Spread them out so there is room for everyone to work.
- Have students pick one twig from the first pile and find its twin in the second.
- Ask them to give reasons for their match. Why do they think both twigs came from the same plant? They should mention such features as the color and texture of the bark; the arrangement of leaves or buds on the stem (alternating or opposite each other); the color, size, and shape of leaves or buds; the color or ring pattern of the wood.

2. You can extend the activity by letting students take the twigs outdoors to match them to living plants or adapt the activity to focus on leaves or seeds instead of twigs. Keep a plant guide handy so students can begin identifying them.

ASSESSMENT: BASELINE OBSERVATIONAL SKILLS

The two observational activities above will give you an indication of students' baseline observational skills. If they need further practice, do the following optional activity.

OPTIONAL OBSERVATIONAL ACTIVITY

ACTIVITY	**THE BLINDFOLDED WALK**
NOTE	Students might benefit from an additional observational activity to make them more aware of their senses of smell, touch, and hearing as aids to describing and identifying.

1. Divide the class into small teams. One person at a time will be blindfolded; the others will guide the blindfolded person to objects or areas and ask the person to describe what he or she is sensing. For example, the blindfolded person might be asked to describe or identify the texture of a tree trunk, the smells coming from the cafeteria, the sounds of different-sized balls bouncing, or the feel of sunlight and shade.
2. Be sure to discuss the safety of the blindfolded person before the teams set off.

CLASSIFICATION AND BINOMIAL NOMENCLATURE

1. Ask students to explain what they already know about how to classify plants. (Note: Their level of understanding may be limited at this point.)

Use this exercise to help students understand the binomial system of classification that is used most commonly in keys and identification guides. Show the "Types of Oak Leaves" illustration and ask:

- What is the common name for all of these types of leaves? (oak)
- Point out a few of the leaves and ask students to recall their full common names, such as turkey oak, willow oak, post oak.
- Write out the following: *Quercus laevis* (turkey oak), *Quercus phellos* (willow oak), *Quercus stellata* (post oak). Ask: Why do you think scientists prefer to use this system of naming?

  (Students might mention that scientists need a common language to communicate no matter what their native language, and that some plants are known by more than one common name.)
- Look at the names themselves and point out that all the oaks share the same "surname" or genus, *Quercus*. Within that genus there are 450 different species, like *laevis*, *phellos*, *stellata*, and no two species are exactly alike.

2. Have students use field guides and identification keys to find other examples of the genus and species names of common plants (such as dandelion, crabgrass, and cattail) in your area. They may also be able to identify some plants in their plots based on the drawings and descriptions they have already recorded in their journals.

3. Encourage students to become familiar with the resources for plant identification available on the Web. Have them work with the* Dichotomous Keys *and read the selection "Plant Identification."

ACTIVITY

ACTIVITY	**RESPONSIBLE COLLECTING**
TIME	1 class session
MATERIALS	❑ 1 sheet of chart paper
WEB COMPONENTS: READING SELECTIONS	
	Responsible Collecting
	Plant Identification
	Plant Inventory
	Collecting Plants
WEB COMPONENTS: RESOURCES	
	A Listing of Herbaria (by regions)
	How to Press and Preserve Plants
	How to Mount Dried Specimens

1. Introduce the topic of collecting plant specimens to use as a class reference collection. Mention that students may also want to display their collection as part of an exhibit at the end of the unit. Discuss what students already know about the value of collections and about the techniques and tools involved in collecting plants.

   Note: It is recommended that students collect; however, in some cases that may not be practical. For example, if your site is in a park or community garden, collecting would not be allowed. Discuss other alternatives, such as taking photographs or videos and making illustrations.

2. Then give students time to gather more information. Direct them to the on-line reading selections and ask them to be prepared to discuss the following questions after they have completed the readings:

- Why do museums keep collections? Of what value are they? What could you learn from a collection of specimens?
- Should we start a class collection? Why or why not?
- What are the alternatives to collecting living specimens?

- What are your responsibilities when you collect specimens?
- How will you preserve them? What tools and materials will you need?
- Then discuss the reading selections, focusing on the questions above.

3. Have the class brainstorm its own list of recommendations for responsible collecting. Here is a sample list:

Responsible Collecting

- Find out which plants in your area are endangered or threatened and do not collect, harm, or disturb any of those.
- If you take the whole plant, try not to disturb anything else around it; replace the soil in the hole.
- Preserve the plant properly in a collection.
- Take only what you need. Do not over collect.
- Use other means to record data, such as drawings and photos.

4. Emphasize that students have a responsibility to preserve the plants properly. Specimens that are properly preserved can last for many years. Many museums, botanical gardens, and universities maintain reference collections of preserved plants, called herbaria. Plant scientists use herbaria much the way we use libraries.

   There is a listing of herbaria in the Resources Area on the Web site. If possible, plan to visit a local one. You may also be able to enlist the help of a botanist there.

   Have students read the on-line selections about preserving and mounting plants to find out what equipment is involved. They will want to refer to them again in later lessons.

   Then give the class time to get and make the equipment they will need to collect plant specimens.

LESSON 2

LESSON 2	**OBSERVING AND COLLECTING PLANTS/MEASURING ENVIRONMENTAL FACTORS**
TIME	3 or more field sessions
NOTE	Three activities are recommended for field trips: Close Observations, Measuring Environmental Factors, and Collecting. You may decide to have the class focus on just one activity per trip, or use the activities in various combinations. Another option is to have team members divide up the tasks, with each focusing on a different one. They can later combine their information. The three activities and the materials they require are described separately below. Before all trips, check that students have the equipment they need. Review and add to the safety rules as necessary.

FIELD TRIP A

FIELD TRIP	**CLOSE OBSERVATIONS**
MATERIALS	❑ Journals ❑ Hand lenses ❑ $2m^2$ frames or markers ❑ Some Clues to Describing and Understanding Organisms ❑ Camera and drawing materials ❑ Field guides and keys to identification

1. Tell students that they are to make close observations of at least one plant each. If possible, they should try to identify the plant. Have them use the "Some Clues to Describing and Understanding Organisms" to guide their observations. Ask them to record their observations by drawing and writing in their journals.
2. Circulate among the teams as they work and use some of the questions on the next page to prompt them to make more detailed observations.
3. While still in the field, encourage students to use field guides and keys to try to identify their plants. Later they may use additional on-line resources as well. In many cases, students will be able to identify only fertile specimens.
4. Continue the process until students have recorded all the plants in their plot and identified them to the best of their ability. Identification is an ongoing process, and although students may not be able to identify a specimen right away, they may be able to do so at a later date.

Tasks	Focus Questions
To prompt students to use more than one sense to make observations	Which of your senses have you used to observe? Have you touched the plant, smelled it, looked at it with a hand lens?
To seek patterns	What patterns have you noticed on the plant? How are the leaves or needles arranged along the stem? What patterns do the veins make? Do all the blossoms have the same shape and the same number of petals?
To encourage measurement	Have you measured the plant? What parts have you measured?
To focus on plant processes	What is the plant doing right now? Is it producing buds, seeds, fruits, leaves, or blossoms?
To look for relationships	Do you think the plant may have an ecological relationship to another plant, or to an animal? Why do you think so?
To ensure record keeping	Where have you recorded your observations? Have you included written descriptions, measurements, and drawings?
To measure and record environmental factors	What environmental factors are you measuring? What tools are you using to take the measurements?

FIELD TRIP B

FIELD TRIP — **COLLECTING**

MATERIALS

- ❑ Hard-sided containers (food storage containers, margarine tubs, etc.)
- ❑ Plastic bags in assorted sizes
- ❑ Pencils and waterproof markers
- ❑ Scissors or pruning shears
- ❑ Plant press
- ❑ Specimen labels
- ❑ Field guides
- ❑ Dichotomous Keys

1. Before the trip, remind students of their own list of rules for responsible collecting, go over safety rules, and check that you have all the equipment needed. Students could also review the on-line reading selections that refer to collecting.

TEACHING TIP: USING A PLANT PRESS AT THE SITE

You may find it easier to take a plant press into the field, rather than have students carry specimens back to class. The advantage is that you can supervise what goes into the press, make sure that specimens are properly identified, and limit the amount the class collects.

2. At the site, encourage student teams to work together to decide what to collect. They should select the most complete specimens in their plot.

3. Continue the process until students have identified as many of the plants in their plot as possible. When they are unable to identify a plant, they should keep a record of the plant's characteristics and assign it a working name, such as mystery species #1. Remind students to keep a numbered list (in their journals) of specimens they collect and to label each plant specimen as they go. The label should tell the location where the plant was found, the date, and the name of the collector. Have students use field guides and keys to try to identify the plant while still in the field.

FIELD TRIP C

FIELD TRIP — **MEASURING ENVIRONMENTAL FACTORS**

MATERIALS

- ❑ Journals
- ❑ Thermometers
- ❑ Soil test kit
- ❑ Light meter
- ❑ Rain gauge
- ❑ Humidity indicator

1. Ideally, students should measure and record the environmental factors every time they go out into the field.
2. After students have measured the environmental and abiotic factors, have them record their findings in their field journals.
3. Remind students to continue entering new questions in their journals. Prompt them to think about how the environmental and abiotic factors influence the plants in their plot.

3

LESSON

LESSON 3

IDENTIFYING AND PRESERVING PLANTS

TIME several class sessions

MATERIALS

- ❑ Journals
- ❑ Reference materials such as field guides and identification keys

WEB COMPONENTS

Dichotomous Keys

Plant Report

Weather Report

1. ***Students will need additional time in the classroom to work on identifying the plant species in their plots. If, after using all the resources available, they are still unable to identify a plant down to the species level, the class will need to decide on some alternative strategies.***

   Ask for their ideas on how to treat the unidentified plant(s). These might include simply calling the plant by its common name (e.g., daisy), or giving the plant a temporary name such as Unknown #1, followed by a complete description of the plant. For example, the plant might be described as 2 feet tall with pink blossoms having four petals, alternating leaves, and growing in full sun. This kind of description will make it possible for students to conduct a search on the Web and to ask other students or botanists for help in identification. They should continue to observe the unknown plant. Sometimes identification becomes possible later as the plant continues to grow and develop in the field.

TEACHING TIP: IDENTIFICATION HELP

This is a crucial time to call on plant specialists for help with identification. Help may be available from local and regional experts.

1. ***Ask students to enter their data in the* Plant Reports *and* Weather Reports *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.***

ACTIVITY

ACTIVITY	**PRESERVING PLANTS**
TIME	several class sessions
MATERIALS	Equipment for pressing, mounting, and preserving plant specimens: ❑ Plant press ❑ Newspaper ❑ Blotting paper ❑ Corrugated cardboard ❑ Good quality white paper and glue ❑ Plastic bags ❑ Opaque envelopes ❑ Mothballs (Caution: Mothballs are poisonous. Handle with care and wash your hands afterwards.) ❑ Plant labels
WEB COMPONENTS	How to Press and Preserve Plants How to Mount Dried Plants

1. If necessary, have students review the information available on-line about preserving and mounting specimens.
2. Then give them time to organize, press, and later mount their plants. Tell them that they may continue to add to the collection on future field trips.

4

LESSON

LESSON 4 **COMPARING DATA**

TIME 1 class session

MATERIALS ❑ Journals

When identifications of plant species are as complete as possible, have students compare the data they collected in each plot.

Hold a discussion about the diversity of plant species in each plot. Use some of these questions:

- In which plots did you find the most diversity of plant species? The least?
- Why do you think that is so?
- What does this data tell you about how plants are adapted to different environmental conditions? For example, do you find the same species of plant growing in different conditions (shade/sun, wet/dry)?
- How many different species are there in all the plots combined?
- Does this data represent an accurate picture of the whole area? Why or why not?

OPTIONAL MAPPING ACTIVITY

ACTIVITY	**MAPPING**
TIME	1 class session
MATERIALS	❑ 1 clean copy of Map Number Two

Show the duplicate of Map Number Two and let students add the following data to the map:

- The total number of plant species they found in their plot, listed by name or some other agreed upon designation if the species has not been identified.

ASSESSMENT: CHECKPOINT

1. This is a good checkpoint. Students have begun to learn and apply skills for observing, recording, identifying, and classifying plants. Check students' journals to assess their growth in these areas.

2. In this chapter, students have had experiences dealing directly with the diversity of plant species in their plots. Ask students to draw parallels between their work in the field and the work being done by scientists they read about who are engaged in biodiversity studies. What methods, techniques, and tools are similar? What kinds of problems are similar or different? Why do biologists need to know which species occur in the areas they study?

3. Return to students' explanations of biodiversity. Ask students to expand it to include what they have learned about plants.