THE IDENTIFICATION OF TREES BASED ON WINTER TWIGS

In this course you will learn, among other things, what kinds of organisms constitute the highly visible and important group known as vascular plants. One of the skills you are expected to learn in this course is how to identify plants — how to tell to what major group a plant belongs and how to determine which species it represents. Once you know to what species a particular plant belongs, much information about that plant becomes available to you because botanical books contain a great deal of information about known species. Botanists (and you may consider yourself an apprentice botanist during this course) identify plants through the use of keys.

Example of a key enabling you to determine whether a certain tree in leaf is a sugar maple, or shagbark hickory, or tulip tree (for explanation of compound vs. simple leaves and alternate vs. opposite leaves, see lab manual page 3).

1. Leaves compound ................................................................. Shagbark Hickory
   1. Leaves simple ................................................................................................. 2
   2. Leaves opposite ............................................................................................... Sugar Maple
   2. Leaves alternate ............................................................................................... Tulip Tree

An identification key is a written device consisting of sets of contrasting or contradictory statements, and keys for the identification of plant species have been published for many areas of the world. You compare the characteristics of your material (in today’s lab exercise a twig with particular morphological markings and features) with a set of two contrasting statements and choose the statement that best fits the material being examined. The chosen statement then directs you to another set of two contrasting statements, and so forth, until the statement chosen leads to the name of the species to which your specimen belongs (see boxed example of a simple key above). In order to use a key successfully, you must understand how keys are constructed and you must be able to analyze and interpret the morphology, the visible structure, of the plant you wish to identify. In the first lab session of this course you will learn how keys are constructed and you will learn how to use them by identifying native tree species that grow in our area. The lectures and other aspects of the laboratories in this course will help you to learn how to analyze and interpret the morphology and reproductive biology of the diverse groups of vascular plants, and you will use this information in later lab sessions to key out specimens in nearly all the major groups of plants.

The keys we will use during the first two weeks of the course are found in the publication entitled *A Key to Missouri Trees in Winter*. The keys in this booklet apply equally well to Indiana trees, and copies of this booklet will be provided for your use during the lab sessions. **PLEASE NOTE that these booklets are the property of the Department of Biology and must be used repeatedly by all students in this course. They must therefore be left in the laboratory, and you should not make any marks in them.** If you wish to consult one of these booklets outside of laboratory time, please refer to the copy on e-reserve in the Life Sciences Library.

In order to complete these exercises, you must successfully identify 10 species by keying out the twigs provided by the Associate Instructor (AI) teaching your lab. If you do this keying thoughtfully, you will learn not only *how to key* but also *how to recognize* on sight these commonly encountered species of trees, even in the winter when they are devoid of leaves. Learning how to use keys to identify plants is a useful, practical skill this course hopes to impart.
Some students will learn to key more easily than others. To accommodate this diversity of ability, there will be time during next week’s lab to complete this keying project, so do not feel stressed or rushed simply to ‘get through it’ this week. **Take the time to learn and understand** what you are doing. If you master this skill through the careful practice these exercises provide, you should have no difficulty in recognizing these species and keying out different species during the first lab practical exam. A dissecting microscope will be available for you to use in lab, but you may wish to purchase a hand lens (also called a 10x loupe; available at the bookstores) for your use in and out of class.

The following points will make your keying work easier, more efficient, and more accurate and satisfying. Remember that statements in dichotomous keys always come in sets of two — you are presented with a series of choices between two contrasting statements. By always making the correct choice, you arrive at the name of the species to which your specimen belongs. Which of the two statements you choose as you progress through the key will depend on the characteristics you observe in the specimen you wish to identify. Thus you analyze your material to determine which of the two statements is correct with regard to your specimen. Using a key is like traveling a well-marked road that forks repeatedly, each fork bearing signposts. If the traveler is correctly informed and follows directions carefully, he/she will always arrive at the proper destination. If his/her information or the directions along the way are inaccurate, the traveler will become lost. We will assume that the directions along the way (the choices offered in the keying booklet) are accurately written. It then becomes your responsibility to be correctly informed by interpreting the features of your twigs correctly. The following suggestions will help. 1) Always read both of the two contrasting key choices. Even if the first seems the logical one to take, the second may be even better. 2) Be sure you understand the meaning of the words involved in the choices. Don’t guess at the meanings. If they aren’t familiar to you, look the terms up in the glossary on pp. 38–39 of the keying booklet and/or ask your laboratory instructor for help. 3) When measurements are involved in the choices, do not guess — use a ruler (a scale in inches is provided on the back cover of the booklet). 4) When minute objects are concerned, use a lens of sufficient magnifying power (dissecting microscope) to be able to see clearly and inform yourself correctly. 5) Since living things are always more or less variable, don’t base your conclusions on a single observation. Instead look at several parts of the specimen. 6) Just as when traveling a forking road, if the choice is not clear or if you can’t choose because of insufficient information, try both choices and arrive at two possible answers, then compare your specimen with the final choices and pictures.

**Winter Twigs**

A winter twig (see drawing below) is a portion of a tree branch or stem that has developed during one or more previous growing seasons and from which (in the case of deciduous trees) the leaves have fallen. The site at which a leaf is attached to a stem is called a **node**. When a leaf falls from a stem, it leaves a scar at the node where it was attached, and such a scar is called a **leaf scar**. The shape, size, and arrangement of leaf scars along a stem vary from species to species. (For a more detailed presentation of plant morphology see text Chapter 9, e.g., pp. 355–356, 359–361, 396–397.)
In some species there is one leaf (and thus one leaf scar) at a node, in which case leaves and leaf scars are said to be *alternate*. In other cases leaves and leaf scars may be produced two at a node on opposite sides of the stem, in which case leaves and leaf scars are said to be *opposite*. In some cases leaves and leaf scars are produced in groups of three or more around the stem at a node, in which case leaves and leaf scars are said to be *whorled* or in *whorls* of whatever number. The shape, size, arrangement, and number of leaf scars along a stem may be characteristic of a given species and may be important features to note in keying out winter twigs. *Simple leaves* usually consist of two parts (see illustration, below right), the expanded flat green part called the *blade* and the little stalk-like part called the *petiole* by which the blade may be attached to the stem. In some species, the petiole may be lacking and the blade may be attached directly to the stem. Some species have *compound leaves*, in which case the blade is divided into leaflets, often with each leaflet having its own little stalk (*petiolule*) attaching the leaflet to the central axis (or *rachis*) of the leaf. In certain species, leaves consist of three parts: 1) petiole, 2) blade, and 3) *stipules*. Stipules are small appendages of leaf-blade-like material at the base of the petiole. When present, stipules usually occur in pairs, one stipule at each side of the petiole base, and they may be attached either directly to the petiole or to the stem. If stipules are present and attached to the stem, they too will leave scars (*stipule scars*) when they fall from the stem. The number, shape, and orientation of stipule scars may be characteristic of a given species and may be important features to note in keying out winter twigs.

The *xylem* and *phloem* tissue (= the *vascular tissue* through which water, dissolved minerals, the products of photosynthesis, etc. are transported throughout the plant) of the stem is necessarily connected with the vascular tissue of the leaves (the xylem and phloem vascular tissue in a leaf constitutes the veins of the leaf). The connection between the vascular tissue of the stem and that of the leaf is made by a *leaf trace* consisting of one or more vascular strands or *vascular bundles*. The vascular connection between stem and leaf becomes sealed off before a leaf falls, and the sealed ends of the vascular bundles visible within the area of the leaf scar are called *bundle scars*. The number and arrangement of bundle scars may be characteristic of a given species and may be important features to note in keying out winter twigs.
Prominent features at certain points along a winter twig are the buds from which the next growing season’s new growth may emerge. Trees make such buds in the angles formed where a leaf is attached to a stem. That angle is called an axil, and a bud that forms in the axil of a leaf is called an axillary bud or a lateral bud (‘lateral’ from the Latin latus meaning ‘side,’ because such buds are along the side of the stem). Another bud, often larger, is formed at the tip of each stem toward the end of each growing season and is called an apical bud or terminal bud. Buds are extremely important for a plant because they contain the embryonic leaves and stems that will produce the new growth of the next growing season and the meristematic tissue whose cells divide repeatedly to produce the new tissue of subsequent years. Buds are therefore very important to the continued growth of the plant, and plants commonly protect their buds by enclosing them in bud scales. When the dormancy of a bud is broken at the beginning of a new growing season, the swelling bud causes the enveloping bud scales to fall off, and the places where the bud scales were formerly attached is marked by bud scale scars. Thus the distance between one set of bud scale scars and the next set toward the stem’s tip is the distance that stem grew during its growing season. The shape, size, and color of bud scales and their scars may be characteristic of a given species and may be important features to note in keying out winter twigs.

Lenticels are small dots of loose corky tissue on the bark of twigs of many species of trees and shrubs that permit gas exchange between the inner tissues of the bark and the atmosphere. The shape, size, orientation, and color of lenticels may be characteristic of a given species and may be important features to note in keying out winter twigs.

Background on the Anatomy of Stems Such As Twigs

As seen in cross section, a stem usually consists of several concentric layers of tissue. At the center of the stem, may or may not be an area of soft tissue called the pith, a storage tissue composed of thin-walled parenchyma cells. In some species, the pith appears to be partitioned into chambers in longitudinal section. The key may require you to determine whether the pith in your specimens is continuous, diaphragmed, or chambered.

Around the pith (or in the very center of a stem or a root when pith is lacking) is a cylinder (or other shape) of xylem (primary xylem). The function of the xylem is conduction or transport of water and dissolved mineral salts from the roots throughout all parts of the plant body. The actual conducting cells of the xylem are dead and their walls are heavily impregnated with a complex reinforcing substance called lignin. The highly specialized conducting cells of most flowering plants are called vessel members and are like short hollow tubes (the cells are dead and the protoplasts have disintegrated — the empty lumen representing the former place of the protoplast), and these cells are connected end to end to form a ‘pipeline’ (or vessel) that is continuous from the tips of the roots to the tips of the leaves. Phloem (primary phloem) is a food-conducting tissue typically found outside of the xylem in the
stem cross section. Its cells are alive and contain protoplasts when they are mature and functioning in food transport. Between the xylem and phloem in certain species is found a layer of tissue one cell thick called the **vascular cambium**. When vascular cambium is present, it produces new xylem called secondary xylem to its inside, i.e., around the outside of the primary xylem. It is by this means, for the most part, that trees increase in diameter. Many of the primitive vascular plants and many of the modern herbs lack a vascular cambium, and the xylem in the stems and roots of these plants is entirely primary xylem formed directly from primary tissues arising from the apical meristems. When present, the vascular cambium produces secondary phloem tissue to its outside, i.e., just inside the primary phloem, and this secondary phloem tissue together with the secondary xylem pushes outward against the surrounding primary phloem. In roots and in many primitive stems there is a thin layer of tissue outside of the phloem called the **pericycle**, and immediately outside of the pericycle is a single layer of cells called the **endodermis**. The **stele** is everything within and including the endodermis.

In a young stem or root, there is a **cortex** around the stele. The cortex is a storage tissue, although sometimes some of the cells near the outer periphery of the cortex may be modified with thickened secondary walls to add strength to the stem or root. The outermost layer of a young stem or root is a single-cell-thick, skin-like **epidermis**. As a stem gets older, some of the cells in the outer cortex may undergo divisions to form a **cork cambium** (sometimes called **phellogen**) that gives rise to **cork cells** to its outside and at times to more loosely arranged cells called **phelloderm** to its inside. The cork, cork cambium, and phelloderm (when present) are spoken of collectively as the **periderm**. As the stem increases in diameter, largely as a result of the activity of the vascular cambium and the secondary xylem and phloem to which it gives rise, the epidermis is ruptured and eventually the periderm with its waterproofing cork cells becomes the outer protective layer of the stem. Many of these anatomical features may be seen in commercially prepared microscope slides of young **Tilia** (basswood) stems that may be available as demonstration stations. (See also text Figs 5.4 and 5.5.)

**Textbook Readings**

The textbook contains two types of information: 1) relatively short passages that present information about particular plant groups; page numbers of these passages are associated with lecture topics on the course syllabus, and 2) more lengthy passages that provide the rationale, history, and conceptual foundations of this area of biology. Your knowledge of the plant groups presented in lectures and ‘type 1’ readings and experienced in the weekly labs, will be more meaningful when enriched by the conceptual background provided by the ‘type 2’ readings. Laboratory time will often be used to discuss assigned type 2 readings from the textbook. Some of these type 2 readings relate primarily to flowering plants or to phylogenetic analysis and are more appropriately read in conjunction with specific parts of the course. Thus we will skip around a bit with regard to pages of assigned type 2 readings. Note that there is a glossary of terms on text pp. 547–578. **For Lab 2, read and be prepared to discuss with your AI text pp. 69–77.**
**FOR NEXT WEEK:**  
To prepare for Lab 2, you should read textbook pp. 78–82 in advance.

At the start of the Lab 2, you will discuss with your AI your reading of textbook pp. 69–77. Be prepared to answer the following questions:

1. How are the eight major apomorphies of the extant vascular plants (lignified secondary walls, sclerenchyma, xylem, phloem, endodermis, independent sporophyte generation, shoot system, and roots) conceptually related?

2. Why is the perforation plate of vessels more efficient for conducting water than the pit-pairs of tracheids?

3. What are the similarities and differences of the sieve elements of phloem versus the tracheary elements of xylem?

4. What is the significance of the Casparian strip in the endodermis?

*** You must submit typed answers to these questions at the end of the discussion. ***

During the second laboratory session, you will have time to key any winter twigs that you may not have finished this week.

As noted in the Table of Contents, the Monday lab section that is canceled by the MLK holiday meets instead on the following Friday from 1:00 to 4:00 p.m.