Dendrology

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Overview

Many different aspects of urban forestry depend on your knowledge of dendrology. Some examples include tree health problems, species selection, hazard-tree identification, tree inventories, and urban wildlife habitat identification. Your knowledge of dendrology and skill in identifying trees can help you communicate this information and make recommendations to the community.

This unit first defines dendrology and reviews types of trees in the south. The second section is about taxonomy of trees, which includes classification, naming trees, and tree identification. This information provides a foundation for the final section, which describes how the urban environment influences tree identification.

Can You Tell the Difference?

The "Sweet" Smell of Spring
It happens every year at the same time. You would think after so many years that Bob would be prepared for this, but he swears that each spring "it" is worse than ever before. The "it" that Bob is referring to is the Gingko tree that is planted by the entrance to the maintenance yard for the public utility. Working in the local office of the State forestry agency, Bob gets a lot of the complaints, which is putting it nicely, about the SMELL! You see, someone, who could not tell the difference between a male and female Gingko tree, planted a female one. While the leaves are just as golden in the fall as the male gingko's leaves, the fruits of the female gingko have a horrible odor. Since the utility company does not want to cut it down, the most that Bob can do is offer his sympathy to the maintenance supervisor who is worried that he needs to post guards so that someone does not solve the problem with a chainsaw.

The tree did make its point though. It is now in the city tree ordinance that only male gingko trees can be planted in the city.

Trees

Trees are funny
Do you know why?
They change their clothes
The same as you or I

They're green in summer
Red in fall
And when it turns cold
They wear no clothes at all

Molly Dwyer, age 7

Before You Begin

This unit looks at many of the individual parts of a tree, such as the leaf, stem, flower, and fruit that give a tree its unique identity. These questions will help you think about how this information can be used in your job:

- What are some instances when identifying a specific tree has been necessary?

- How do you usually go about identifying the species of a tree you are not familiar with?

- How does being able to name and identify trees help you in your job, particularly when you are working with a property owner or local group?

Think about the work you and others in your office do that involves tree identification, and what part this plays in your job.

What is Dendrology?

Dendrology actually means "the study of trees." In common usage it has come to mean the taxonomy of woody plants (Harlow and others 1979), which is the systematic classification, naming, and identification of trees based on natural attributes and relationships. The study of dendrology also includes knowledge about characteristics of trees and their geographical range.

Dendrology in Urban Forestry

Learning how to identify trees takes time and experience, but once familiar with how to do it, it is a valuable skill for urban foresters. Some activities in which knowing about dendrology will be most useful are noted in table 1.

Table 1. Examples of ways to use dendrology when providing assistance and potential recipients

Technical/Educational Assistance	Planning Assistance	Potential Recipients
• Tree identification • Disease and pest diagnosis • Urban wildlife habitat protection and enhancement • Hazard tree identification • Tree selection • Endangered species identification • Valuation	• Tree inventories • Urban forest assessment • Restoration of ecosystems • Urban forest master plan development • Public awareness programs • Urban habitat management • Urban landscape programs • Construction site planning • Hazard tree management plans	• Tree-care companies • Local governments • Individual homeowners • School groups • Builders and developers • Engineers and architects • Utility companies • Non-profit organizations • Community and civic group

What is a Tree?

A tree is a woody plant with several distinguishing characteristics:

- Often reaches 15 feet or more in height at maturity
- Has a single trunk or dominant multiple trunks
- Has no normal branches on the lower trunk
- Has at least a partially defined crown
- Usually larger than other plants and tend to be long-lived

The growth form or shape, rather than size, is the feature that distinguishes a tree from other plants such as shrubs (Harris 1992). A shrub is a woody plant with multiple stems that is capable of growing to a height of 15 feet.

Trees Common to the South

There are two major classes of trees, Gymnosperms and Angiosperms, both of which are found in the South. The Gymnosperms are often called evergreens or softwoods. The Angiosperms include hardwoods, palms and yuccas.

Softwoods

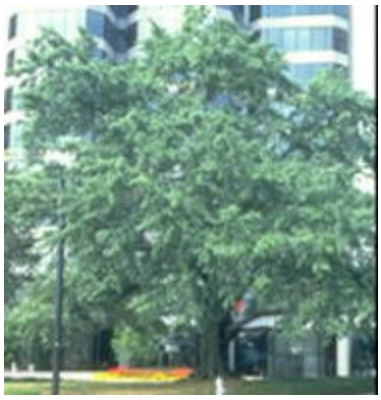
Softwoods belong to a group of plants known as conifers. These trees have needles or scales for foliage and cones for reproduction. This separates them from the hardwood and palm trees. Most softwoods keep their foliage for two or more years. Examples of softwoods include pines, hemlocks, cedars, and cypresses.

Hardwoods

Most tree species found in the South are hardwoods. Usually, they lose their broadleaf foliage in the fall and develop new leaves in the spring. There are exceptions to this, with some hardwoods being classified as evergreens, particularly in tropical and sub-tropical climates. Examples of hardwoods include maple, oak, elm, pecan, and walnut trees.

Palms and yuccas

Palms and yuccas include fewer species than the softwoods and hardwoods. They are most prevalent in semi-tropical and tropical coastal areas, such as the lower peninsular of Florida and the Florida Keys.


Three types of trees that grow in the South are softwoods, hardwoods, and palms.

Taxonomy of Trees

Taxonomy is the categorizing or classifying of trees. There are three components of tree taxonomy:

- Classification, which is the basis for the other two components.
- Naming trees
- Identifying trees

Classification of Trees

Since ancient times, humans have attempted to classify plants. Today, there is no single method of classifying plants because of the complexity of relationships among plants. The U.S. and other countries prefer a system developed by German taxonomists Adolf Engler and Karl Pramtl. This plant classification system provides a systematic way to identify trees based on genetic relationships. It also facilitates the communication between people when they are discussing specific plants. Two principles of this system are important in understanding how plants are categorized:

- The reproductive organs (flowers and fruit) are the basis of the classification system. Other important characteristics are leaves and wood anatomy. Trees can be classified as closely related when they have similar fruits even though they have different leaves and buds..
- The characteristics of a tree in its natural habitat influence its classification.

Classification Definitions

Using the classification system requires knowing the terminology and definitions used in dendrology. The classifications in table 2 divide trees into increasingly smaller groups; each one is given a Latin name. This method of naming natural things is common in science. Knowing the family name helps to understand relationships among trees. The genus and species names are the most important ones to know because a tree's scientific name is made up of these two names, such as *Magnolia grandiflora* (southern magnolia). Table 3 shows an example of the classification structure for the loblolly pine, a gymnosperm, and the Southern red oak, an angiosperm. The definitions in table 4 are often used to describe trees found in urban areas.

Table 2. Definitions of classification taxonomy

Classification	Definition
Kingdom	All living things are classified into kingdoms (e.g. plants and animals). Trees are in the plant kingdom.
Division	This is the first category of the plant kingdom and is based on the plant's means of reproduction. Trees, in the Spermatophyte division, reproduce through seeds.
Class	Trees are then divided into two classes, Gymnosperms and Angiosperms, by the method they use to develop the seeds used for reproduction. Gymnosperms, such as conifers, produce an open seed on a structure such as a cone. Angiosperms are flowering trees that have seeds enclosed in an ovary.
Order	Trees are further classified into orders according to certain other characteristics of seed reproduction. Angiosperms are divided into two major groups, monocotyledons and dicotyledons, based in part on the number of primary leaves (one or two) present in the seed plant. The *Sabal palmetto* is an example of a monocotyledon. Most trees are dicotyledons, such as members of the walnut or oak families.
Family	A group of closely related trees, usually including one or more genera (plural of genus) make up a family. The rose family, Rosaceae, is a family in the dicot group, and includes cherry, apple, and pear trees.
Genus	A collection of closely related species is a genus. The species usually are structurally similar or have common ancestry. Examples are the cherry and plum trees that are a genus, *Prunus*, of the rose family.
Species	A collection of individuals with characteristics so similar that they suggest common parentage, a species is a tree distinct and unlike others. The black cherry, *Prunus serotina,* is a species of the genus *Prunus*. Species is the basic, and probably most important (Dirr 1990) unit of taxonomy or classification of a tree.

A monotype exists when there is only one type of tree in the order, family, or genus. The Oriental ginkgo (Gingko biloba) is a monotype because the order has only one family, and the family has only one genus, and the genus has only one species.

Table 3. Classification structure of the loblolly pine, a gymnosperm, and a southern red oak, an angiosperm

Classification	**Loblolly Pine**	**Southern Red Oak**
Kingdom	Planta	Planta
Division	Spermatophyta	Spermatophyta
Class	Gymnospermae	Angiospermae
Order	Coniferales	Dicotyledeae
Family	Pinaceae	Fagaceae
Genus	*Pinus*	*Quercus*
Species	*Pinus taeda*	*Quercus falcata*
Common name	loblolly pine	southern red oak

Table 4. Definitions related to tree species identification

Term	Definition
Hybrid	A tree produced by crossing two different species is considered a hybrid. Hybridization has been used to create new variations of a species for urban areas. An example is the *Cornus.kousa* x *florida.celestial*, a hybrid of the Kousa dogwood and the flowering dogwood that was developed for greater resistance to disease.
Variety	Within a species, a tree that has distinctive but minor differences from other trees of the same species is a variety. These differences are inheritable and can be reproduced from seed (Dirr 1990). A variety that is significantly different from the standard species is often the beginning of a new species. Variations in the color of the leaves or flowers or a difference in the fruit will distinguish one variety of a tree from others in the species.
Cultivar	Trees that have been cultivated to produce specific, distinguishing characteristics are cultivars. These specimens retain the features created in the development of the cultivar, but they usually can only be reproduced by grafting to maintain the characteristics. This method of reproduction distinguishes it from a variety, although the term cultivar and variety are often used interchangeably (Dirr 1990).
Clone	A population of trees that develops asexually from a single tree is a clone. Sassafras and sweetgum are trees that reproduce as clones.
Natives	Trees that are indigenous to a particular region or environment are considered to be native. This usually suggests that the species originated in the region and has a certain compatibility with it. A native tree, however, may not be compatible in urban locations in that region because of modifications to the habitat, including soil, water, and nutrient cycles.
Exotics	Trees that are not native to the area in which they grow are considered to be exotics. Exotics may be resistant to local insect and disease problems, but may also bring in unexpected and undesirable insect and diseases. They may also become invasive. Exotics become naturalized when they grow and reproduce in an area.

Naming Trees

Naming trees with Latin names is the second component of tree taxonomy. Each species has a scientific Latin name that is used universally. However, every tree also has one or more common names by which it is known in various parts of its range.

Scientific Name

A system of standardized Latin names for plants was developed in the 18th century and is now used throughout the world as a universal system for naming trees. The complete scientific name for a tree consists of three parts:

- Genus; for the loblolly pine it is *Pinus*
- Species; for the loblolly pine it is *Pinus taeda*
- The full or abbreviated name of the person or persons who originally described the species; the full name of the loblolly pine is *Pinus taeda* L (L. is the initial for Linnaeus, the Swedish botanist of the 18th century).

Common Name

The common names of trees often reflect their major characteristics, such as the red maple. Names, however, may originate from other sources, such as the location where the trees grow naturally. Examples are swamp white oak and river birch, trees that grow in low-lying or riparian areas with moist soils. Some of the sources of common tree names are:

- Habitat - swamp white oak, river birch
- Distinctive feature - weeping willow, bigleaf maple
- Locality or region - southern red oak, southern magnolia
- Use - sugar maple, paper mulberry
- In commemoration - Douglas fir, Englemann spruce
- Adaptations from other languages - frijolito, hickory

Using common names of trees often leads to confusion when talking with other people. Two trees, like two humans, may share the same common name while actually being quite dissimilar. Trees may also have multiple names. For example, *loblolly pine* is known in various parts of its range by 25 other names, including juice pine and bull pine. The American Joint Committee on Horticultural Nomenclature has attempted to adopt one common name for each species (Harlow and others 1979).

Refer to the "For More Information" section for a list of resources on scientific and common names of a trees.

Checking Your Understanding of the Classification and Naming of Trees

On a separate sheet of paper, briefly answer the following questions:

1. Why is the classification of trees useful? What is the basic unit of classification that you need to be most familiar with when talking about trees?

2. What are the two major classes of trees? What distinguishing characteristic determines the class a tree belongs in, and why is it important?

3. How can the common names of trees help you select a tree for planting, and where can you find the common and scientific names for a particular tree?

Answers are at the end of the unit.

Tree Identification

The identification of trees is the third aspect of tree taxonomy or classification. Trees are classified into groups primarily by their fruits and flowers, but the leaves and twigs are usually more accessible for identification. Tree identification in urban locations requires knowing many trees because of the numerous exotics that have been introduced from around the country and the world. The most important features to look for in identifying a tree are:

- leaves
- twigs and stems
- bark
- flowers
- fruit and seeds
- cones

Trees are identified by several different methods. Parts of a tree may be compared to illustrations in a manual, although this can be time consuming. A better way is to use keys specifically designed to aid in identifying trees.

Keys
Keys are tools that lead the user through the steps of identification based on the features of the tree. The key often focuses on the fruit or flower since this is the primary means for classifying trees. However, keys have also been developed for other features such as leaves, stems, buds and bark.

Using a key involves making choices at each step in the outline provided. It begins with general, easily observable features and works through to increasingly detailed traits. To do this successfully requires practice, experience, patience and familiarity with the scientific terminology used. A key is intended only to help in tree identification, and should not be the only means used in doing the job (Dirr 1990).

Publications and other resources for identifying plants are listed in the "For More Information" section at the end of this unit.

Leaves

One way to identify a tree is by its leaves. Leaves have many distinguishing characteristics and these characteristics can be used for identification. Each of these features will be defined and illustrated in this unit:

- Part
- Type

- Shape
- Arrangement on the stem
- Venation
- Shape of apex and base
- Margin
- Surface

Leaf parts
Knowing the parts of a leaf will help with tree identification (figure 1).

- The lamina is the blade or broad part of the leaf.
- The leaf is attached to the twig with a supporting stalk called a petiole. It may be either short or long, grow in a variety of different shapes, and may not exist in some trees. Some petioles enclose next season's bud in the base. When the leaf is attached directly to the twig, rather than to the petiole, it is said to be sessile.
- Stipules are a pair of small, scaly or leaf-like organs that may be attached to the twig on either side of the petiole. Some stipules will leave scars that are visible on the twig in the winter. Plants that have stipules are called stipulate, while those without them are called estipulate.

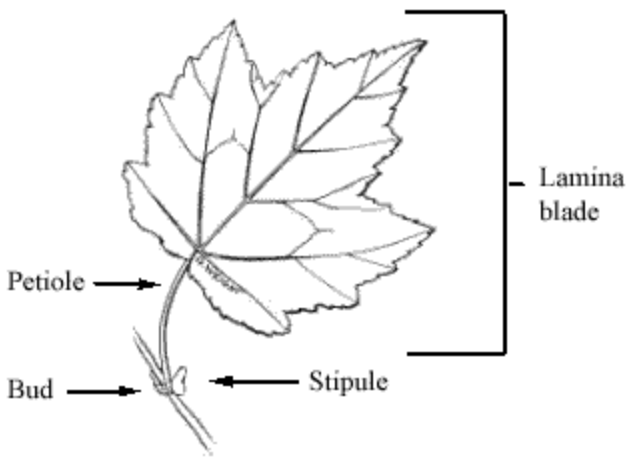


Figure 1. Parts of a simple leaf. (Illustration by Gene Wright)

Leaf types
Determining the type of leaf can be the first step in tree identification. There are two different leaf types, hardwood and softwood.

- Hardwoods can have either a simple or a compound leaf. A simple leaf has a single blade or lamina, as shown in figure 1. A compound leaf has two or more blades that are called leaflets. The stalk to which the blades are attached is called a rachis**.** The arrangement of the leaflets on the rachis determines the particular type of compound leaf. There are several types of compound leaves, which are described in figures 2,3,4, 5 and 6.

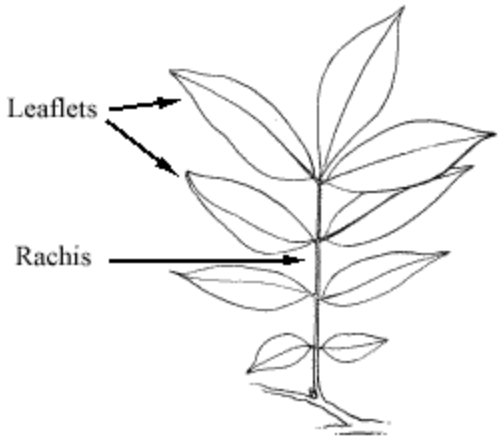


Figure 2. A pinnately compound leaf has leaflets arranged laterally on the rachis. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Figure 3. A leaf with an odd number of leaflets on the rachis is called an odd pinnate leaf. A boxelder tree has odd pinnate leaves. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

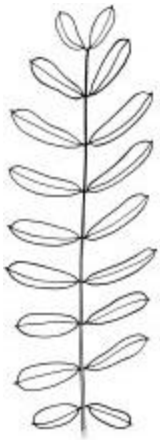


Figure 4. A leaf with an even number of leaflets is called an even pinnate, such as the hornless common honeylocust. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Figure 5. A bipinnately compound leaf has multiple leaflets attached to a leaf-bearing stalk off the rachis, such as the Kentucky coffeetree. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Figure 6. A palmately compound leaf has each leaflet attached to a common point, such as the Virginia creeper. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

- Softwoods, such as conifers, usually have different leaf types than hardwoods. Not all softwoods have evergreen foliage. The three types of softwood leaves are awl-like (figure7), scale-like (figure 8), and needle-like (figure 9).

Figure 7. Awl-like needles are elongated, taper to a fine point, and are usually sharp to the touch. Many Junipers have awl-like shaped foliage. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

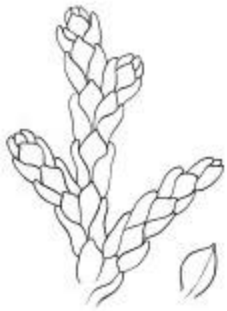


Figure 8. Scale-like foliage overlaps like the shingles on a roof or the scales of a fish. This type of foliage often feels soft when touched. The eastern redcedar has this type of foliage. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Figure 9. Needle-like foliage, like that of the pine family, is found on several evergreen genera and species. Needles may be flat or angular in cross-section. The number of needles and the length of the needles may also help in identification. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf shape

The shape of the leaf is very useful in tree identification and is usually the same on all trees in a species. Determined by the outline of the blade of the leaf, there are several different shapes, some of which are shown in figure 10. Leaflets on a compound leaf may have two different shapes, depending whether they are located on the side or tip of the stalk.

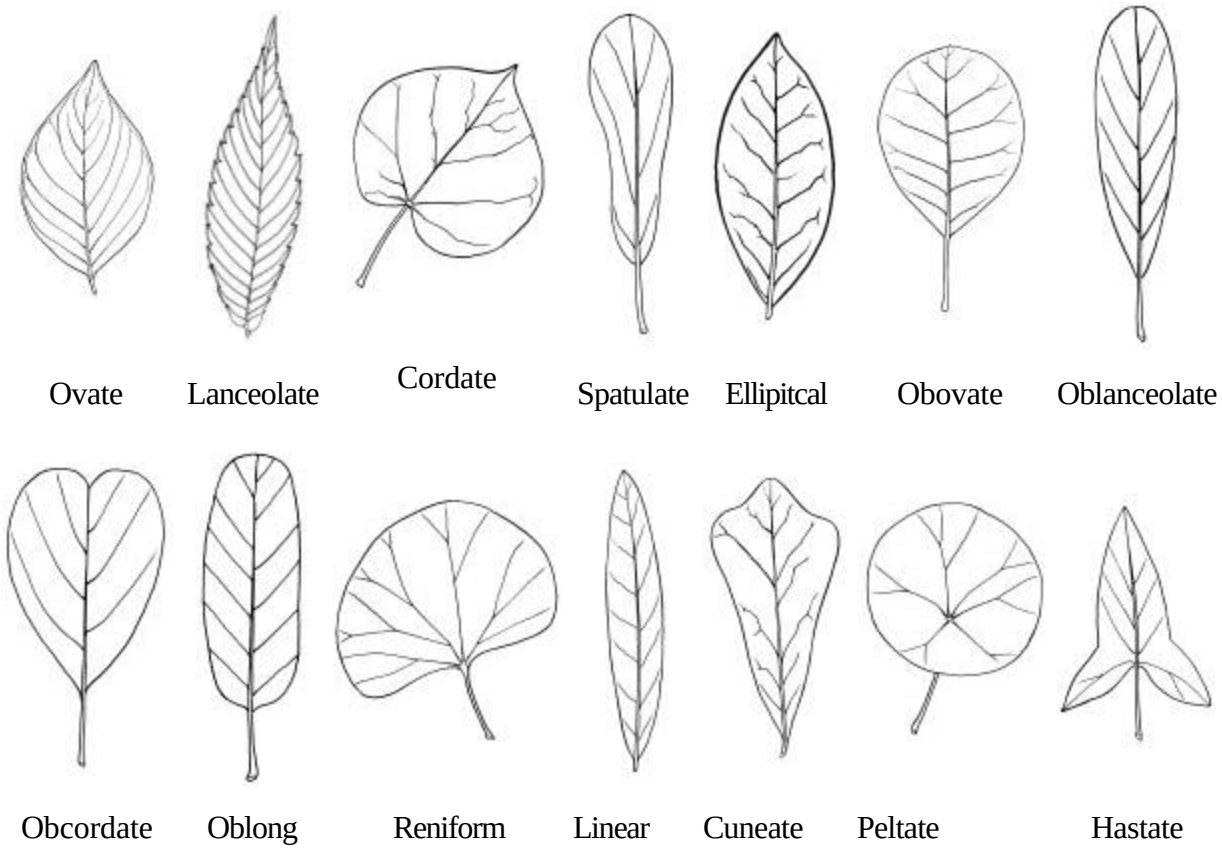


Figure 10. Examples of different types of leaf shapes. (Illustrations adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf arrangement

Observing how leaves are arranged on a twig may assist in tree identification. Hardwood leaves are arranged in one of three ways, opposite (figure 11), whorled (figure 12) and alternate (figure 13).

Figure 11. Opposite leaf arrangement refers to leaves that are even with each other on opposite sides of the twig. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

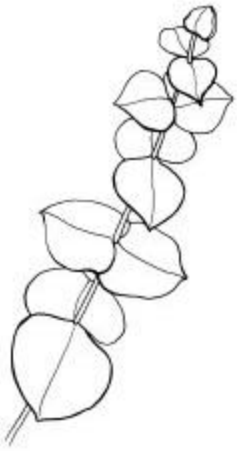


Figure 12. Three or more leaves found at the same node, or bud, on a twig are whorled. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

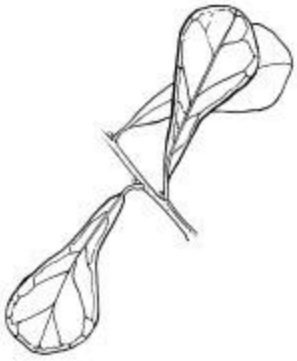


Figure 13. Alternate leaf arrangement occurs when one leaf is attached at each node, arranged in a spiral pattern around the twig. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf venation

The venation, or the pattern of the veins, may help in identifying hardwood trees. The four primary venation patterns are pinnate (figure 14), palmate (figure 15), parallel (figure 16), and dichotomous (figure 17).

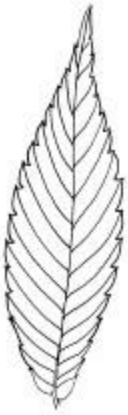


Figure 14. Pinnate venation has a prominent central vein that extends from the base, where the petiole attaches to the blade, to the apex or tip of the leaf. The overall effect is that of a fishbone. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Figure 15. Palmate venation is when three or more veins branch from the base of a leaf. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Figure 16. The veins run parallel to each other along the length of the leaf in parallel venation. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Figure 17. With dichotomous venation the veins extend for a distance forming a "Y" type pattern. It is found in a limited number of leaves. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf apex and base

The tip of a blade that is farthest from the petiole, or stalk, is called the apex. The part of the blade nearest to the petiole is called the base. Examples of common shapes for apices and bases are shown in figures 18 and 19.

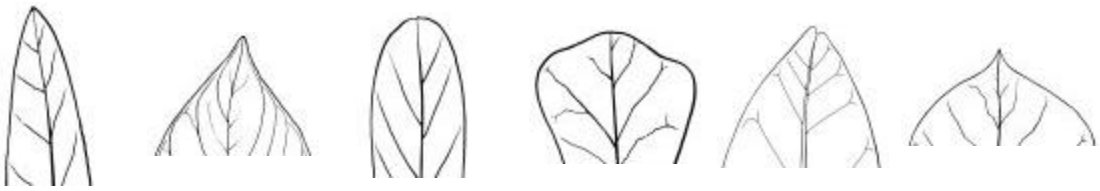


Figure 18. Common shapes for apices of leaves. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

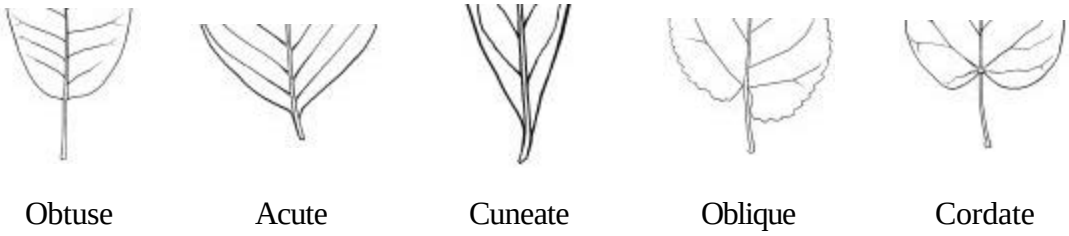


Figure 19. Common shapes for bases of leaves. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf margin

The edge of the leaf is called the margin. The margin is distinctive and may serve to assist in separating closely related forms. Examples of leaf margins are shown in figure 20.

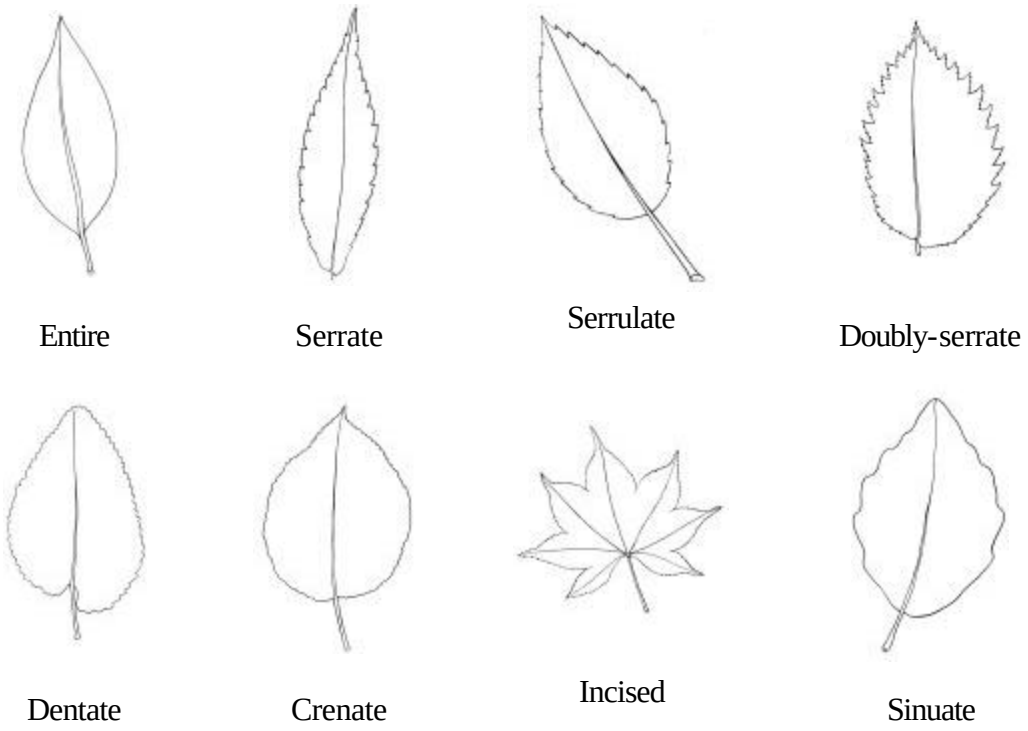


Figure 20. Examples of different types of leaf margins. (Illustrations adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf surface

The surface and texture of the leaf are other means of identification. The hair, resin glands, waxes, blooms, and scales provide valuable clues in naming a tree. The texture of the leaf may feel like leather or like paper.

Twigs and Stem

Twigs are useful in identifying trees except for a short period during the spring when the buds are opening and shoots are elongating on these small branches. Several features of twigs, including buds, leaf scars, lenticels, pith, spurs, thorns, spines, and prickles, can help describe them (table 5 and figure 21). Other factors to consider are color, taste, and odor. The color of the bark can be an most important feature on young stems.

Table 5. Twig characteristics that help with identification

Characteristic	Description
Buds	• Are one location of growth tissue in a tree. • Are usually visible on the twig. • May be either lateral, on the side of the twig, or terminal, at the tip of the twig. • Are scaly or naked, smooth or fuzzy.
Leaf scars	• Are where a leaf falls from the twig. • Vary in size and shape. • Have one or more minute dots or patches that show where the ruptured strands of vascular tissue passed from twig to leaf.
Lenticels	• Are small, normally lens-shaped patches on the stem that facilitate gas exchange. • May be wart-like.
Pith	• Is the central portion of the twig. • Is usually lighter or darker than the wood that surrounds it. • Varies in color. • Is star-shaped or pentagonal in oaks, triangular in alders, terete or cylindrical-like in ash and elms, and chambered in walnuts. • Varies in composition; in most cases is solid, spongy, or hollow.
Spurs	• Are dwarfed twigs with some internodal development. • May grow for several years. • Produce the fruit on many apple varieties
Thorns, spines, and prickles	• Pointed structures that project from the sides of a twig; are important features in some species. • Thorns are modified twigs. • Spines are modified stipules. • Prickles develop from surface tissue and are easily removed.

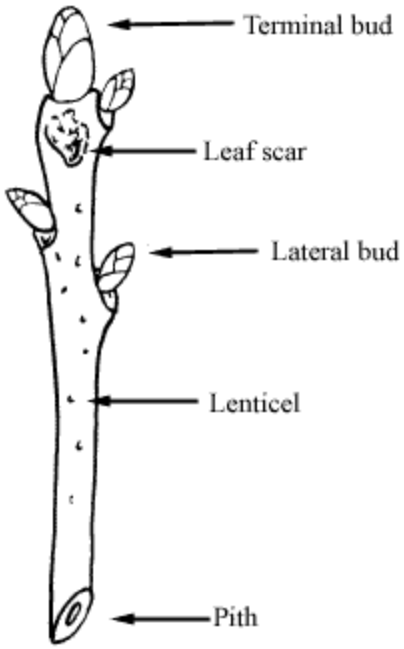


Figure 21. Characteristic parts of a twig that help in the identification process. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Bark

Bark is one of the most important features for tree identification because of its year-round accessibility. It is especially useful when the tree's leaves and twigs are inaccessible or unavailable during the fall and winter. The shape of the bark is characteristic of some species, for example, the small, rectangular plates on flowering dogwood. Bark on young trees differs from that on more mature trees. Experience is the best way to learn bark characteristics. Table 6 describes bark characteristics that can be used for identifying mature trees. Typical bark textures are illustrated in figure 22.

Table 6. Bark characteristics that help with identification

Characteristic	Description
Shape or general appearance	The shape of the bark is often characteristic of some species, for example, the small-rectangular plates on the flowering dogwood.
Texture	The feel of the bark, such as the smoothness of cherry trees or the layering or plating of white oaks, is important.
Thickness	The thickness of the bark can vary within a species as well as between species.
Color	Bark color varies with age, location, site, and light conditions.

Figure 22. The differences in bark can be helpful in tree identification. (Illustrations by Gene Wright)

Flowers

Flowers are best feature for identifying trees, but are available only for a short period each year. Leaves, twigs, and bark are usually available for identification, but if there is doubt about a certain tree, the flower is the surest way to identify it.

Although not always noticeable to the casual observer, all hardwoods bear flowers. Some produce flowers annually, while others flower less often. Flowers are modified leaves that have undergone change to the point that they have become or support the reproductive organs of the plants.

Complete and incomplete flowers

A complete flower has four parts (figure 23). An incomplete flower is one that lacks any of these four parts.

- Calyx (composed of sepals)
- Corolla (composed of petals)
- Stamens
- Pistils

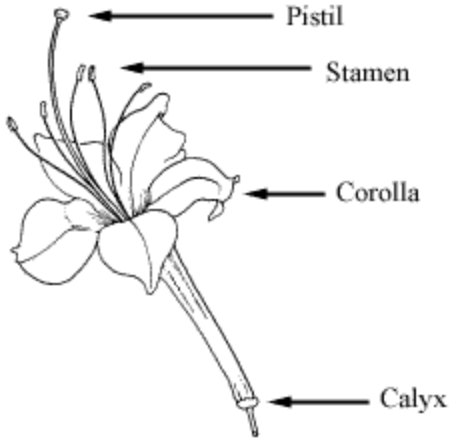


Figure 23. A complete flower has all four parts. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

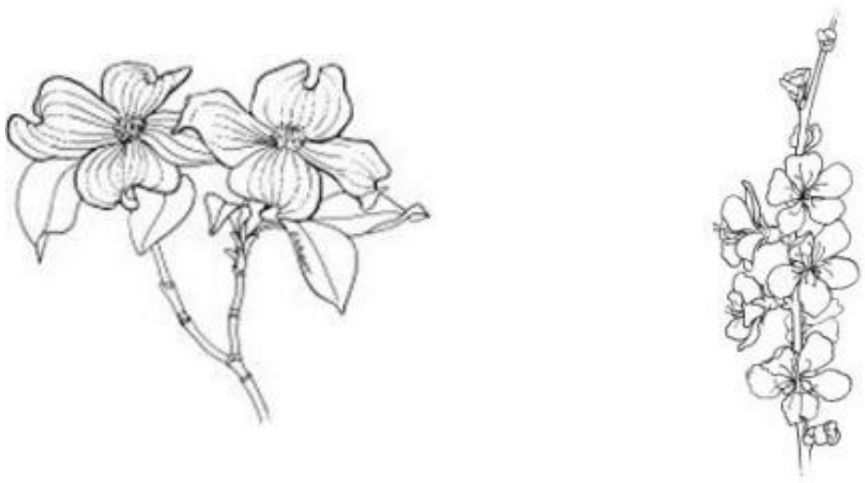
Perfect and imperfect flowers
A perfect flower includes actively functioning organs of both sexes but may lack sepals or petals. The stamen is the male reproductive structure, and the pistil is the female reproductive structure. A perfect flower may be either complete or incomplete.

A flower lacking either functional stamens or pistils is imperfect. These flowers may also be known as unisexual flowers, meaning they are either pistilate (female) or staminate (male). These may occur on the same tree, or the male and female parts may be on separate trees, as in the gingko.

Arrangement of flower blooms
Flowers bloom in different arrangements (figure 24).

- Individual or single bloom flowers are typical of many woody plants, for example the magnolia.
- A cluster or an inflorescence is a collection of individual flowers arranged in a specific pattern (Dirr 1990). One that blooms at the end of a central stalk, or rachis, is referred to as a determinate flower. The dogwood tree has a determinate flower. If the flowers open progressively from the base to the apex or from the outside to the center in flat-topped clusters, the flower is indeterminate. The flowering crabapple has an indeterminate flower.

A flower at the end of a twig is a terminal flower. An inflorescence that appears in a leaf axil, or bud, is described as axillary. Flowers may also appear from separate flower buds, which are normally located near the tips of the twigs.



Determinate Indeterminate

Figure 24. The characteristic inflorescence of a flower is helpful in identification. (Illustrations adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Fruits and Seed

Another key to identifying a hardwood is its fruit or seed. A fruit is the seed-bearing organ of the plant. Using fruit is somewhat limited, however, because some trees do not bear fruit and others do so only for a short time or at irregular intervals. Fruits develop from flowers. Solitary flowers that have a single pistil produce a single fruit. A cluster of flowers with multiple pistils produces a cluster of fruit or a compound fruit. Some fruits have only one seed, others develop many seeds. In most species, pollination and fertilization must occur for fruit to develop. Fruit development can take from a week or two in elms to two growing seasons in red oaks. Examples of different types of fruit are shown in figure 25.

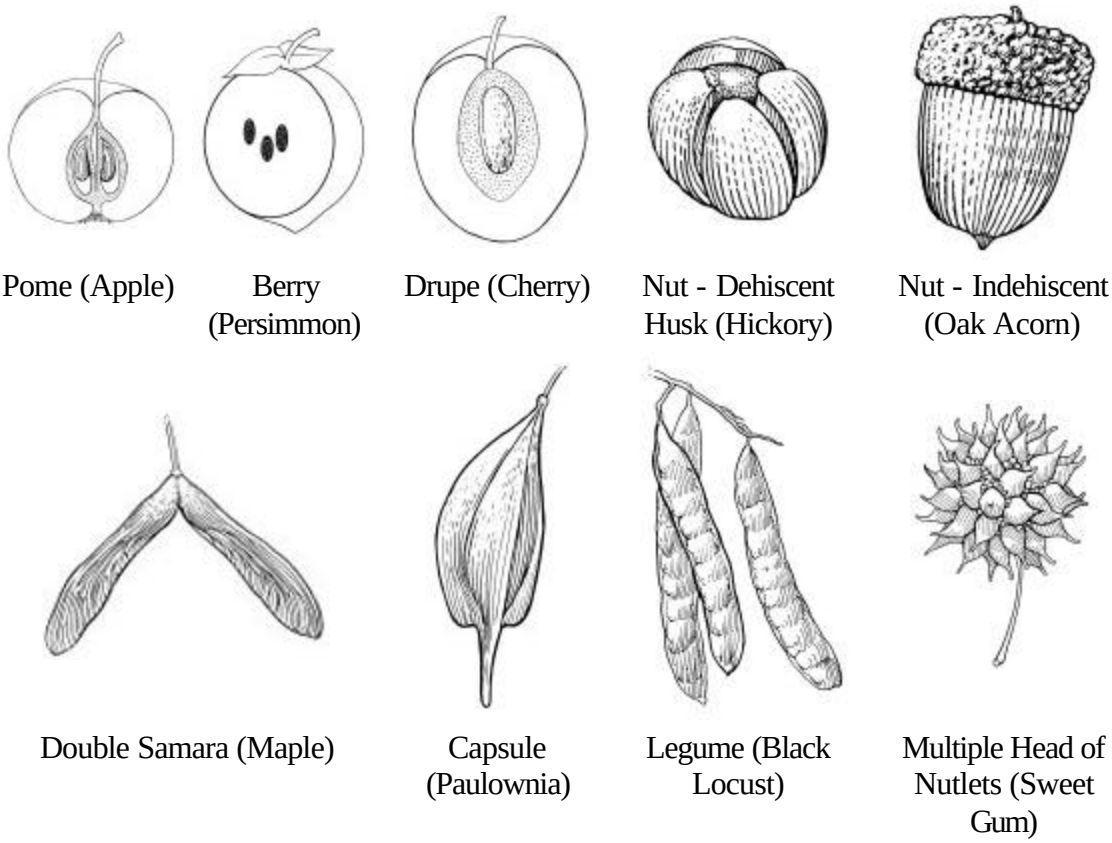


Figure 25. The type of fruit a tree produces can be used in identification. (Illustrations adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Seed production and germination depend on many factors, such as temperature extremes, conditions of the tree, and presence or absence of competition. Seed quality, including germination capacity, can vary greatly and is influenced by factors such as the tree's nutrient storage, availability of water, and temperatures and weather conditions.

Conifers do not bear fruit, they bear cones.

Simple fruits
Simple fruits develop in various forms. There are two basic types, dry and fleshy, each of which has a wide range of variations.

- The two primary forms of dry fruit are indehiscent, which do not split open at maturity, and dehiscent, which do split open when ripe. Indehiscent fruits are usually one-seeded with the seed enclosed in various types of coverings. Species with this type of fruit include maples and oaks. Dehiscent fruits are usually many-seeded and are enclosed in a covering that splits when the fruit is ripe, such as the redbud, magnolia, and rhododendron.
- Fleshy fruits are usually multi-seeded, the seeds are surrounded by a fleshy pulp, or pericarp, which is sometimes edible. These may be classified as a berry (blueberry and persimmon), drupe (cherry, plum, and holly), or pome (apple or pear).

Compound fruits
Fruits that develop from multiple pistils are called compound. Two types of compound fruit are aggregrate and multiple.

- Aggregate fruits develop from a single flower that has many pistils (Dirr 1990) that form many fruitlets in a single mass, such as the magnolia or tulip tree.
- When several flowers together contribute to the development of a single fruit, it is called a multiple fruit (Dirr 1990). The fig tree and the mulberry produce examples of this type of fruit.

Cones

Seeds for softwoods (conifers) are found in cones. Most conifers are monecious. Monecious means that both male and female reproductive parts are located in separate structures on the same tree. A few conifers are dioecious; the male and female reproductive parts are on separate trees. Male and female structures are called cones or stobili (figure 26). Cones consist of an egg or pollen-bearing scales attached to the central stem. The scales may be arranged spirally or they may appear in pairs. Characteristics of three different types of cones are described in table 7.

Figure 26. Seeds are produced on cones in conifers. (Illustration by Gene Wright)

Table 7. Types of cones

Type of Cone	Description
Pollen cones	• Are generally small, non-woody and short lasting. • Emerge from buds, release pollen, wither and drop within a few weeks. • Bear sacs on the bottom of each scale known as *pollen sacs* or *microsporangia*. • Release thousands of pollen grains when the sacs burst. • Are modifications of shoots, and the scales are modified leaves. • Are found in the mid- to lower crown.
Female cones	• Are larger than male cones. • Are usually woody. • May persist for many years. • Develop to maturity in one or more season and release their seeds in late summer to autumn. • Bear two megasporangia on the top of each scale which contains an ovule. This ovule develops into a seed following pollination and develops an embryo. • Are found in the upper crown of a tree in some species.
Seritinous cones	• These cones are closed tightly with pine tar. Heat from a fire is needed to open the cone. The sand pine and pitch pine have this type of cone.

Tree Form or Shape

Tree form and shape can be useful features for identification. There are two primary tree forms, excurrent and decurrent. Trees that are excurrent, such as conifers, have a dominant trunk with smaller side branches. This form gives the tree a conical or triangular shape. Trees that are decurrent, such as oaks, have spreading branches that give the crown a full, round appearance.

A tree may grow differently in various parts of its range so its appearance may vary. A tree that grows large in one part of its range may be shrub-like at the extreme limit of its range.

Remember to take into account the habitat and range of a tree, as well as its physical characteristics, when making an identification.

How the Urban Environment Influences Tree Identification

Tree identification in urban areas can be complicated. There are usually a large number of species in urban areas, including native and exotic trees. And various conditions associated with the urban environment may alter specific characteristics of a tree, such as changing the appearance of the leaves or bark that help in tree identification. Examples of site factors that may alter a tree's appearance include compacted soils, excessive soil moisture, and extreme temperatures.

The capacity of a tree to adapt to new conditions is a measure of its tolerance.

Size, Form, and Shape

In an urban environment, trees are often growing in very different conditions than those species growing in a rural or forested area. Trees in urban locations are often smaller and shaped differently than those in forests for several reasons.

Individual specimens

In urban locations, a tree is often planted as an individual specimen. This exposes it to more light and wind, and usually higher temperatures. Urban trees also will commonly have larger crowns and thicker and shorter trunks than the same species growing in a forest.

Range may change

It is important to remember that a tree's range may change as the environment is altered. One factor that may change the range is the loss of trees when an area is urbanized. Fewer trees may change the temperature and the flow patterns of wind and water. Another factor that alters the range of a species is its introduction to new areas. When a plant foreign to a region becomes established and reproduces, it is said to be "naturalized." These two situations may greatly extend the range of a tree or reduce it to the point of extinction. Planting a tree out of its natural range can also influence its form and shape. For example, planting river birches far from the river may change their appearance.

Soil conditions

Soil conditions, such as limited soil volume, compaction, drainage, poor aeration, and limited nutrients can influence sprouting and twig elongation may be shortened.

Pruning

Pruning can change the natural shape of a tree.

Changing the natural shape of a tree can make it more challenging to identify.

Leaves

The soil conditions at the site can also influence leaf size and color.

- Leaves may be stunted in size.
- Color may be altered.

Bark

The bark of a tree can also be influenced by the urban environment.

- In heavily shaded areas lichen may grow on the bark, changing the color.
- If the bark has been damaged by insects, rodents, or other pests identification in the winter may be difficult.

Flowers

Urban locations may affect the natural cycle of a tree's growth.

- Variations in light and temperature patterns may change the time of year that a tree produces new foliage, flowers, or fruits
- Soil fertility also influences the time that a tree flowers and the number of flowers produced.

Checking Your Understanding of Tree Identification

On a separate sheet of paper, briefly answer the following questions:

1. What parts of a tree can be used for identification? Are there seasonal limitations for the use of each of them? What part of the tree is most commonly used for identification? What part of the tree provides the surest means of identification?

2. What are seven major characteristics of leaves that can be used in identifying trees? Briefly describe each.

3. How can the urban environment affect your efforts to identify a tree?

Answers are at the end of the unit.

Case Study

What's in a Name?

It was wintertime, and cold and wet. The fact that the tree Tom had been asked to look at was in a bottomland made it seem even colder and wetter. Working in the local office of the State forestry agency, he had been asked by a construction company to make some recommendations about a large tree that was on their construction site. They wanted to save the tree if possible and needed to know what steps to take. The tree was more than 45 feet tall, but Tom was surprised that it had survived this long. From the shape of the tree and its bark, he identified it as a white oak. He wanted to help the construction company save the tree, but this was going to take a lot of work. In addition to the impact of the construction work in the area, the soil in which the tree was growing was moist, compacted, and poorly drained.

Tom's recommendations were extensive. A white oak needs moist, but well-drained soil. To maintain the health of this tree after the construction was over, he outlined a series of steps to improve the soil and the drainage at the site. This included aerating and amending the soil and, most importantly, creating a system to keep the soil well drained. In the meantime, he suggested fencing around the tree to protect it from equipment damage during the building. By spring the construction would be finished, and they would be able to implement the maintenance program Tom had suggested.

You and the Oak Tree

If you are called by the construction company, how would you identify the tree, and what recommendations might you make? On a separate sheet of paper, write what you would have done in this case, using these challenge questions as a guideline.

- How would you go about identifying the tree?
- What specific tree characteristics would you consider in making the identification?
- What physical site factors would influence your decision?
- Why is proper identification important?
- How would your recommendations relate to your identification?

The outcome of the real story follows this case study. After you have written the steps you would follow, compare your story with what really happened.

The Rest of the Story

The Switch
Two months later Tom was back at the site, going over plans for the drainage system. He wanted to make sure that water runoff from the site would drain away from the tree so that the soil amendments and aeration would continue to benefit the tree. There was just a hint of spring in the air, and Tom noticed that the tree was in bud, with just the first few leaves of spring beginning to grow. And wasn't he surprised! What he had identified as a white oak based on the bark characteristics was actually a swamp oak, growing exactly where is should be, in poorly drained bottomland. Somewhat sheepishly, he went to the construction managers to say that the concerns about keeping the soil drained were not necessary. The proper care of the tree would be much easier, since the tree was growing where it should. In this case, proper identification of the tree not only saved extra maintenance costs, but also probably saved the life of the tree.

A Tree by Any Other Name

- Were the characteristics that you used in identifying the tree different from Tom's? If so, what were they?
- What biological or environmental factors did you consider when making the identification?
- How might your identification affect things like the time and cost for the care and maintenance of the tree?
- What have you learned from Tom's story that can help with your work in urban forestry?

Next?

The information about tree identification in this unit is essential to the work you do in providing technical and educational assistance. Identification skills take practice and experience. Use the questions on this page to decide how you can improve these skills and your practice of urban forestry.

- How will you use the information about tree identification in your work? Think of specific times or purposes where it will be helpful.

- What are some ways that you can develop your skills in tree identification? In different situations, such as with a homeowner, on a construction site or in different seasons.

- What other sources will you want to use in developing your identification skills? These can include people and other references.

- How can you use your skills and information about tree identification to help others in developing and maintaining the urban forest in your community?

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Checking Your Answers

Checking Your Answers for the Classification and Naming of Trees

1. Why is the classification of trees useful? What is the basic unit of classification that you need to be most familiar with when talking about trees?

The classification of trees has three useful purposes:

- Assists in the identification of trees. This provides a common language for talking about trees.
- Helps determine specific characteristics of a tree that are important in selecting a tree for a specific location, in diagnosing and controlling insects and disease, planning proper care and maintenance, and in dealing with hazard-tree problems.
- Provides an understanding of the inherited relationships among the species of trees.

The basic unit of classification for a tree is the species. This is the level of classification that puts all the trees with the same, distinguishing characteristics together. The scientific name of a tree made up of the genus and species name.

2. What are the two major classes of trees? What distinguishing characteristic determines the class a tree belongs in, and why is it important?

Trees are divided into two major classes based on the way that they develop the seeds used for reproduction. For this reason, the flower or cone that produces the seed and the seed itself are important in the identification of trees.

- Gymnosperms or softwoods - This class of tree produces an open seed on a cone or other similar structure. Most trees in this class are conifers, many of which belong to the pine family. Other trees in this class are cypresses, cedars, redwoods, yews, and gingkoes.
- Angiosperms or hardwoods - These are flowering trees that produce their seed in an enclosed ovary. They are often described as hardwoods. With many thousands of species, they live in a variety of climates with a great variation in size and form.

3. How can the common names of trees help you select a tree for planting, and where can you find the common and scientific names for a particular tree?

The common names of trees often reflect a primary feature of their growth habits, the region where they are commonly found, or the type of land in which they prefer to grow. Attention to these characteristics helps in selecting the proper tree for a specific location.

The same species of tree may have many different common names, with different ones used in different areas, but there is only one scientific name for each species. The publication *Standardized Plant Names* gives you both the scientific name and all the common names for each species.

Checking Your Answers for Tree Identification

1. What parts of a tree can be used for identification? Are there seasonal limitations for the use of each of them? What part of the tree is most commonly used for identification purposes? What part of the tree provides the surest means of identification?

The five main parts of a tree that can help in identifying are:

- Leaves are the most commonly used means for identifying a tree because they are available most of the time, and are often the most prominent and distinctive part of the tree. In evergreen trees, leaves are present year-round. In deciduous trees leaves are only available during spring, summer, and early fall.
- Twigs and stems can be used for identification except during the spring when bud growth and shoot elongation are taking place.
- Bark is one of the most useful identifiers because it is available when many of the other parts are not. Because there tends to be less lichen or moss growing on it in urban area, it can be very helpful for tree identification in cities.
- Flowers appear for only a short time, and therefore are limited in their usefulness for identification. However, because the classification system of trees is based on how trees produce seeds, flowers are the best feature for identifying a tree.
- The fruit and seed can also help in identifying a tree because they are important to the way trees are classified. However, they can appear at irregular intervals and are available for only a short time.

2. What are seven major characteristics of leaves that can be used in identifying trees? Briefly describe each.

- Types - The two different types of leaves are hardwood and softwood. Hardwoods can have either a simple or compound leaf. Softwoods can have a needle-like, scale-like, or awl-like type of foliage.
- Shape - The shape, or outline, of the leaf is usually typical of the species.
- Leaf arrangement - Leaves in hardwoods can be arranged in opposite, whorled, or alternate patterns.
- Venation of the leaf -The pattern of veins in hardwood leaves have four primary patterns: pinnate, palmate, parallel, and dichotomous.
- Leaf apex and base - The leaf apex is the tip of the leaf blade, and the base is the part nearest the petiole, or supporting stalk. Both have shapes common to a species.

- Leaf margin - The edge of the leaf is distinctive, and can be used to distinguish between similar looking leaves.
- Surface of leaf - The texture, or the way that a leaf feels, can help in identification.

3. How can the urban environment affect your efforts to identify a tree?

There are a number of conditions in the urban environment that may change the appearance of a tree. These may include:

- Soil conditions
- Light patterns
- Temperature patterns
- Moisture or water conditions
- Physical damage
- Pruning

Light and temperature conditions can change the time of year that a tree produces new leaves, flowers, and fruits. Site location may affect the form of the tree. Soil and moisture conditions may alter root growth, influencing tree growth and vigor. All these factors may change the appearance of the different parts of a tree used for identification, such as the leaves, twigs, and bark.