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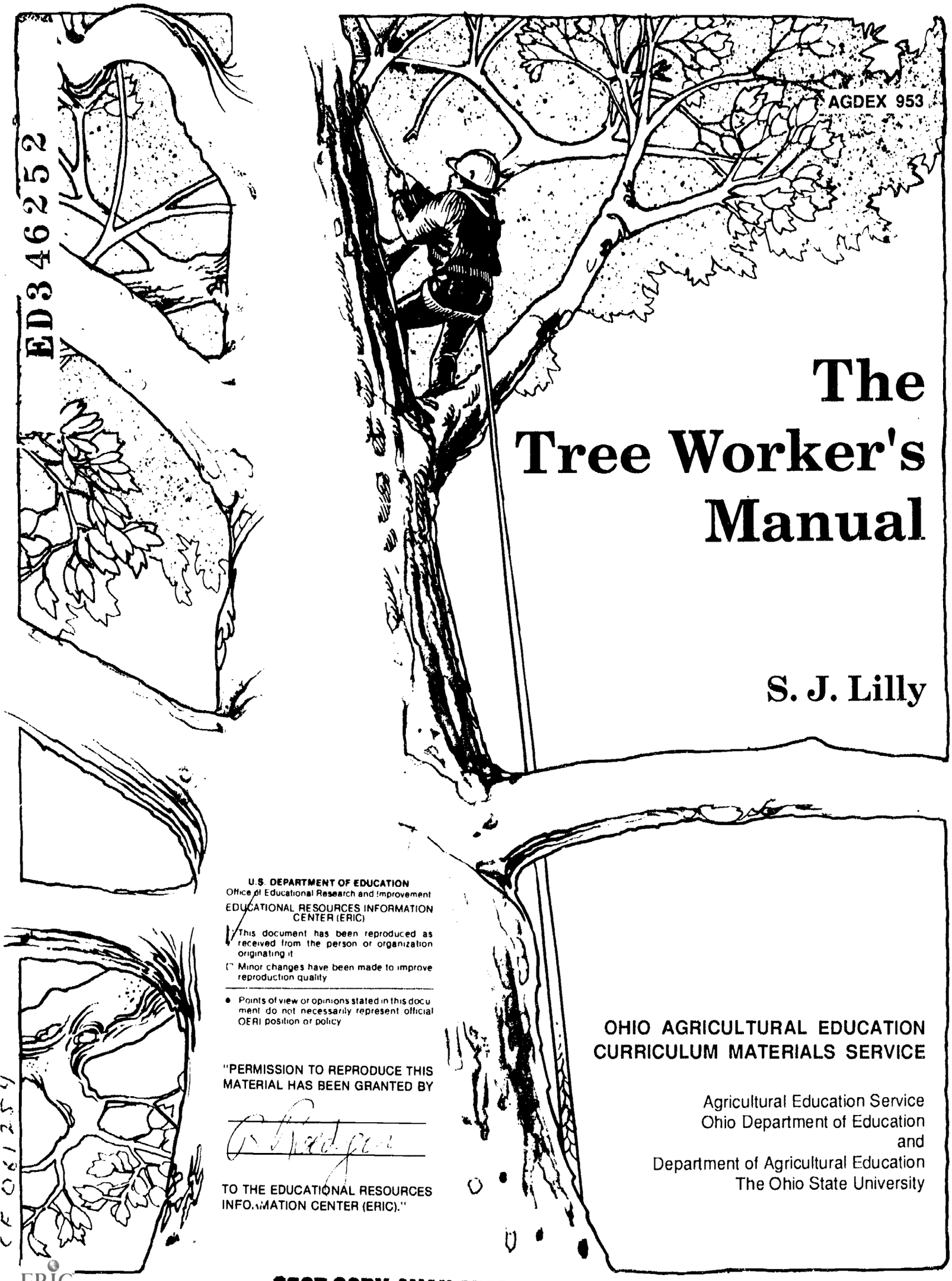
ABSTRACT

This manual acquaints readers with the general operations of the tree care industry. The manual covers subjects important to a tree worker and serves as a training aid for workers at the entry level as tree care professionals. Each chapter begins with a set of objectives and may include figures, tables, and photographs. Ten chapters are included: (1) the tree service industry; (2) clothing, equipment, and tools; (3) the tree workers; (4) basic tree anatomy; (5) pruning; (6) climbing and working in the tree; (7) aerial lifts; (8) tree identification; (9) identification and treatment of tree problems; and (10) other tree care operations. The manual contains two appendices: first aid procedures and scientific and common names of selected common plants of North America. A glossary and index are included. (NLA)



AGDEX 953

# The Tree Worker's Manual

S. J. Lilly



OHIO AGRICULTURAL EDUCATION
CURRICULUM MATERIALS SERVICE

Agricultural Education Service
Ohio Department of Education
and
Department of Agricultural Education
The Ohio State University

# The Tree Worker's Manual

S. J. Lilly

First edition 1985
**Revision 1992**

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# FOREWORD and ACKNOWLEDGMENTS

The purpose of *The Tree Worker's Manual* is to acquaint the reader with the general operations of the tree care industry. The manual covers a wide variety of subjects that are important to a tree worker. Each chapter begins with a set of objectives that should help the student to gain an understanding of the material. This manual is intended to serve as a training aid for workers at the entry level as tree care professionals.

*The Tree Worker's Manual* was written in cooperation with many people in the arboriculture industry. Special recognition and thanks are given to Dr. T. Davis Sydnor, Professor of Horticulture at The Ohio State University, who served in an advisory capacity.

The following people contributed in the preparation of this manual:

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## CONTENTS



*(continued)*

CHAPTER 1

# The Tree Service Industry

### *Objectives*

The major goal of Chapter 1 is to provide students with an overview of the tree service industry, and to acquaint them with the opportunities and requirements for employment.

1. Identify the major divisions within the industry.
2. Learn the various positions within a typical tree crew.
3. Become familiar with the requirements and qualifications for each employment classification.

## Introduction

A career in the tree care industry can be both rewarding and fulfilling. The results of a hard day's work are immediately apparent. It is gratifying to see what can be accomplished with a little skill, proper training, some basic knowledge, and lots of sweat.

Tree care is a profession for people who like to work outdoors. It involves working with nature while enduring the elements. Most people would envy the tree worker on a lovely day, working outside in the trees among the birds and squirrels. Unfortunately, not every day is beautiful, and nature does not always cooperate with the tree worker (figure 1.1).

The tree care professional must be physically fit. Days can be long; endurance is the key to success. Almost every daily task requires strength and stamina. Whether sweltering in the heat or shivering in harsh winter winds, the tree care worker will find it pays to be in shape (figure 1.2).

Tree care is a profession in which daily objectives or career goals can be attained through hard work and perseverance. Whether working your way up a tree, or working your way up the ladder of success, dedication to a job well done is the most important factor. For the person who would rather push a saw than a pen, rather climb a tree than a staircase, and rather stack wood than paper, tree work can be a most rewarding career (figure 1.3).

## Employment Opportunities

The tree service industry can be divided into two major classifications, private and governmental. The latter usually consists of city- or state-operated tree crews. They work exclusively on city- or state-owned property and trees.

FIG. 1.1. Maintaining harmony with nature is not always easy.

FIG. 1.2. A climber must be in good shape to "piece-out" a large tree in the middle of winter.

Private tree companies are somewhat more diversified. Work done by these crews may be residential, commercial, or utility oriented. Residential work involves tree care for the homeowner and is most often done on a job-by-job basis. Commercial work can range from contracts with large businesses for ongoing tree service to simply trimming a small tree for the corner drugstore. As shown in figure 1.4, utility work can involve line clearance, right-of-way clearance, and often emergency removal of trees or limbs from power lines. It is done on a contract basis with power or telephone companies and is often the main thrust of larger tree service companies.

Private tree companies may also contract to work for municipalities to trim or remove city trees. This eliminates the need for city crews and may be more cost effective for smaller cities.

As a rule, the well-trained tree worker does not have difficulty finding employment in any of these

FIG. 1.3. Tree work can be a rewarding career for both men and women.

FIG. 1.4. Line clearance is a major part of many tree care companies.

divisions within the industry. Most employers are always on the look-out for a responsible worker. As long as people want to coexist with trees, there will be jobs for tree trimmers.

The services provided by tree companies are varied. Utility crews may work daily to clear strips of land for utility lines, poles or roads. Other crews trim city trees away from power lines to avoid interruption of service. These crews play a vital role because of the importance of electrical and telephone service to businesses, hospitals, and homes.

Residential tree services provide other services as well. Trees may be trimmed or removed to avoid hazards such as dead or unsafe limbs falling unexpectedly. Also, trees are trimmed to increase the life expectancy of the tree, to remove unhealthy or poorly formed branches, or just to increase the aesthetic value of the tree (figure 1.5).

FIG. 1.5. Thinning can make trees safer and more attractive.

Tree companies provide other services besides trimming and removal. Some companies spray trees to treat diseases and insect problems. Trees sometimes must be cabled or braced to decrease the chance of splitting during storms. Also, trees may be wired to prevent lightning damage. Other services include transplanting, fertilization, and consulting.

Technology is providing the tree care professional with new options. Unhealthy trees can be injected or implanted with fertilizer or chemicals to treat previously difficult-to-treat problems. Growth regulators are being used to limit tree growth below power lines. Work is being done to promote the use of wood chips as an energy source. Research in these areas is important to the tree service industry.

## Job Descriptions

It is important that any potential employee be aware of the requirements of a job before being hired for that position. Many companies have written job descriptions which list the qualifications, requirements, and sometimes the salary or wages for that job. Some sample job descriptions are included in this manual.

## Buckeye Tree Care, Inc.

### JOB DESCRIPTION – **Supervisor**

The supervisor is responsible for a crew. Work assignments must be picked up each morning; the supervisor has the responsibility to complete each job to the satisfaction of the client. The supervisor is the primary customer contact and must provide friendly and efficient service to the public.

**Requirements**

- Supervise work of each crew member
- Climb and work in trees when necessary and appropriate
- Coordinate all tree and ground operations
- Operate chain saws, pole pruners, and chipper
- Drive and care for chipper truck
- Maintain all equipment on truck
- Serve as primary customer contact for crew
- Be responsible for safety of crew

**Qualifications**

- High school diploma
- Full training as climber and in all phases of tree care
- Knowledge of trees and shrubs
- Certification in CPR and first aid
- Driver's license
- Minimum 5 years of experience
- Certified arborist

**STARTING WAGE:** $12.00 per hour (1992)

## Buckeye Tree Care, Inc.

### JOB DESCRIPTION – **Climber**

The climber does most of the actual climbing, trimming, and rigging of trees. The climber works primarily out of a rope and saddle, and at times from an aerial bucket truck. Climbers must be physically fit and competent with all their equipment.

**Requirements**

- Climb, trim, and remove trees
- Be competent and safe with chain saw
- Take primary responsibility for rigging and roping
- Be trained in and aware of all safety procedures
- Have a basic knowledge of pruning principles
- Be responsible to and report to supervisor

**Qualifications**

- Minimum 2 years of climbing experience
- Training in tree care operations
- Training in aerial rescue and other safety procedures
- Training in first aid
- Minimum age 18

**STARTING WAGE:** $7.50 per hour (1992)

## Buckeye Tree Care, Inc.

### JOB DESCRIPTION – Ground Worker

The primary responsibility of the ground worker is to assist the climber. This includes sending up tools, equipment, and extra rope. The ground worker also operates saws, pruners, and the chipper. The ground worker often has to coordinate several ropes at the same time.

**Requirements**

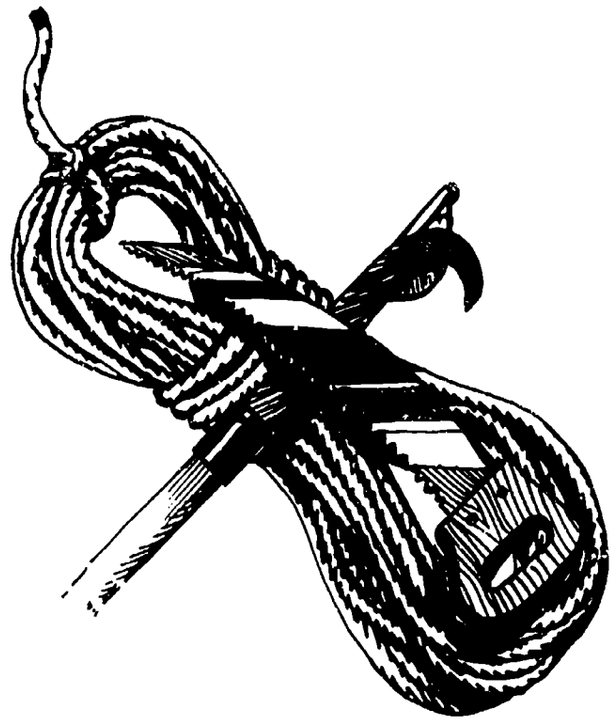
- Assist climbers at all times
- Drag, chip, and cut brush and fallen limbs
- Cut and stack firewood
- Assist in roping limbs
- Rake, sweep, and clean up work area as required
- Assist in maintenance of equipment
- Report directly to supervisor
- Assist in other tree care operations

**Qualifications**

- Proper training in aerial rescue and other safety procedures
- Training in ropes and knots
- Training in equipment operation and maintenance
- Minimum age 16

**STARTING WAGE:** $5.00 per hour (1992)

Some larger tree companies are unionized. Unionization brought standard wage scales, and levels were created within the various job classifications. For example, climbers may be rated from A to E, with A being the top climber. Ground workers may be rated A or B. Normally, a worker starts at the lowest level and works up through the ranks.



CHAPTER 2

# Clothing, Equipment, and Tools

### *Objectives*

The intent of Chapter 2 is to describe and illustrate the equipment that the tree trimmer uses.

1. Become familiar with arborists' equipment and clothing.
2. Know what equipment is required for safety.
3. Learn the various tools and machines that tree professionals use.
4. Become familiar with the different types of rope that are available.

## Clothing and Protective Gear

The most important factor in choosing appropriate clothing for outdoor work is common sense. Pants and shirts should be made of durable material (figure 2.1). Loose-fitting clothing should be avoided, as it may catch in machinery and become a safety hazard. Clothes that are too tight can become very uncomfortable. Jewelry should never be worn when working with equipment outdoors.

Always remember to dress for the weather. In winter, it is better to wear several thin layers than one bulky layer. This allows more freedom of movement, and layers can be removed as the temperature rises. In summer, thin but strong fabrics are usually preferred.

FIG. 2.1. A climber's pants should be strong enough to resist tears without restricting movement.

Head protection (hard hats) must be worn by all tree workers. Figure 2.2 shows several of the hard hats that are available. Safety hats must comply with federal impact and penetration requirements. Protective head gear must conform to ANSI 289.1-1981 Class B helmets when the worker is in proximity to an electrical conductor. Liners are available for winter wear.

Eye protection should also be worn when performing tree work. Safety goggles like those in figure 2.3 will protect eyes from flying debris. Safety glasses are available in many lightweight and fashionable forms.

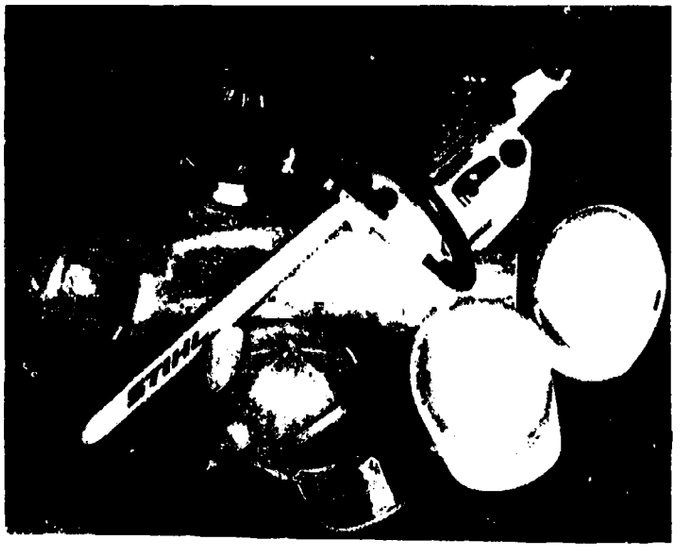


FIG. 2.2. A variety of safety caps and hats

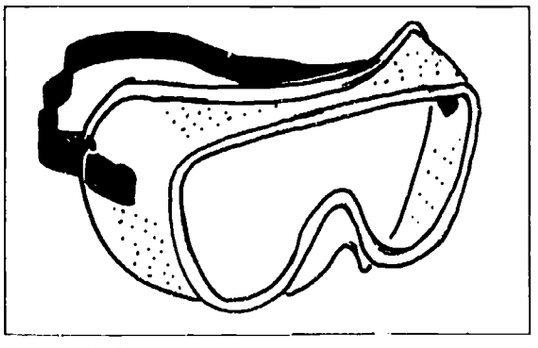


FIG. 2.3. Safety goggles

FIG. 2.4. Ear protection device

It has been demonstrated that continued exposure to the noise of power saws and brush chippers can cause permanent hearing loss. Hearing protection is required when using such equipment for prolonged periods. Yet workers must be able to hear surrounding sounds that may include warning calls or cries for assistance. The best recommendation is to use earplugs or earmuff-type protection (figure 2.4) that cuts down noise levels, yet still allows the worker to hear.

Gloves are optional except, of course, in winter. Heavy leather gloves (figure 2.5) may be worn when chipping brush. Smaller, more close-fitting gloves are often worn for climbing.

When chain saws are used on the ground, leg protectors or chaps can be worn. Leg guards such as the ones shown in figure 2.6 are specially constructed to prevent chain saw cuts on the legs. However, these guards can be bulky and are not appropriate in the tree. Some manufacturers have developed protective leggings and trousers that can easily be worn by climbers.

Boots should be worn by all tree workers. There are many styles and types. Steel-toed boots (figure 2.7) are good for extra protection. But some climbers avoid steel-toed boots, as they sometimes get stuck in crotches. Some climbers prefer high-laced boots (figure 2.8) because of the extra leg protection they provide. Shorter boots are also available (figure 2.9). If climbing spurs are used frequently, a climber may choose boots with a deep square heel (figure 2.7).

## Climbing Saddles and Ropes

A climbing saddle is very important to the climber. There are many styles and types of safety saddles (figure 2.10). A climber may use one type of saddle for many years and will swear by that particular type. Choosing a style of climbing saddle is mostly a matter of personal preference.

The saddle may be constructed of various materials. Many older saddles were made of leather only. They tended to stiffen after exposure to rain, cracking and wearing with age. Newer saddles are often made from 3-inch cotton web belting backed by nylon or other synthetic materials. These double-thick, newer saddles tend to be lighter in weight and are affected less by moisture.

FIG. 2.5. Leather gloves protect the hands when chipping brush.

FIG. 2.6. Special leg protection can reduce the chances of serious injury.

All climbing saddles have an adjustable waist belt. Some seat-type saddles have a second wide strap that creates a seat when the climber is suspended on the climbing rope (figure 2.11). Other saddles have large, adjustable leg loops which serve the same purpose. Some climbing saddles have leather leg straps (attached to the seat strap) that buckle in front. The leg straps help to keep the saddle in place when one is climbing. The climber in figure 2.12 is using a saddle with adjustable leg straps.

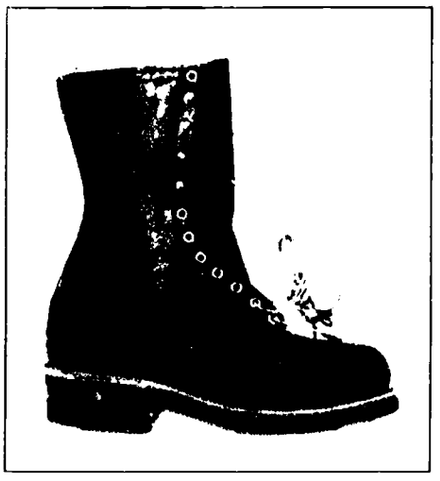


FIG. 2.7. Steel-toed boots

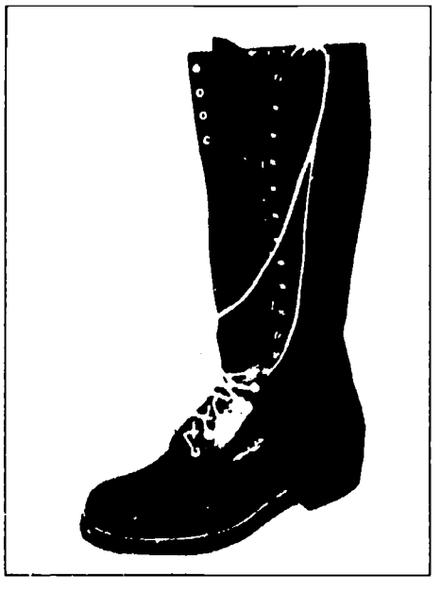


FIG. 2.8. 16-inch high-laced boots

FIG. 2.9. 10 1/2-inch laced boots


FIG. 2.10. Be familiar with your equipment.

FIG. 2.11. The safety saddle should fit snugly but comfortably.

FIG. 2.12. Leg straps should be tight without restricting movement.

FIG. 2.13. A climber must be able to work with many tools in the tree. These tools are often clipped on the safety saddle.

The safety saddle serves a second purpose: it provides a means of carrying equipment. A good saddle should have four D-rings for clipping on the safety line and climbing rope. Additional rings and clips may be used to attach the handsaw and scabbard, a chain saw, or a tool bag. In figure 2.13 the climber has his safety line attached to a side D-ring. Several other rings and snaps can be seen.

Perhaps the most important equipment that tree workers use is rope. Ropes are used to lower large limbs and to pull branches or entire trees in a certain direction. The climber's rope is used not only to insure safety, but also to aid the climber in maneuvering within the tree. The climbing line can help the climber maintain balance when walking out on a limb to make a cut (figures 2.14, 2.15).

Ropes that are generally used in the tree business range from 3/8 inch to 1 inch in diameter. Small hand lines may be used for small branches or to tie off small trees. Large "bull ropes," often 3/4 or 1 inch

FIG. 2.14. The climbing rope helps the tree trimmer maintain balance.

FIG. 2.15. The climber relies on her rope to remain steady and safe while making the cut.

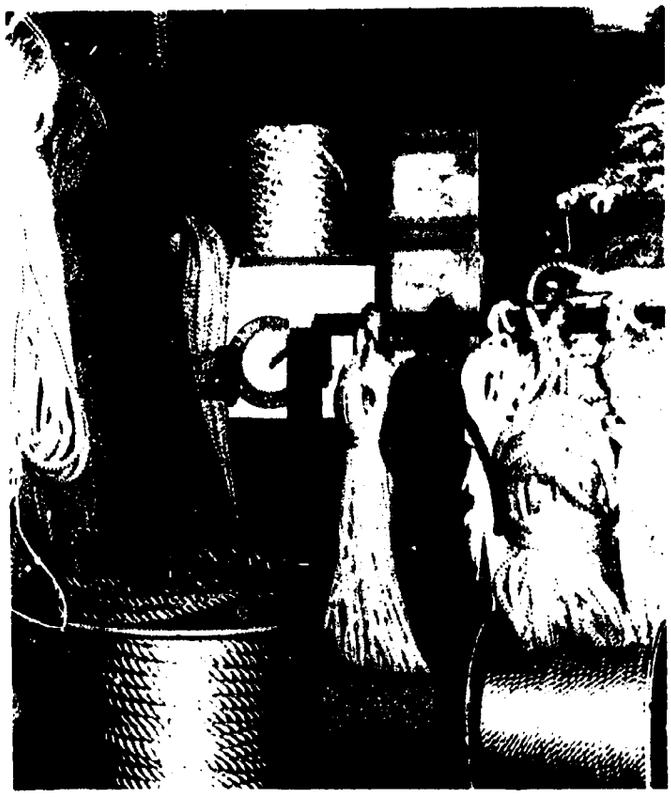


FIG. 2.16. A tree worker uses many types and sizes of ropes.

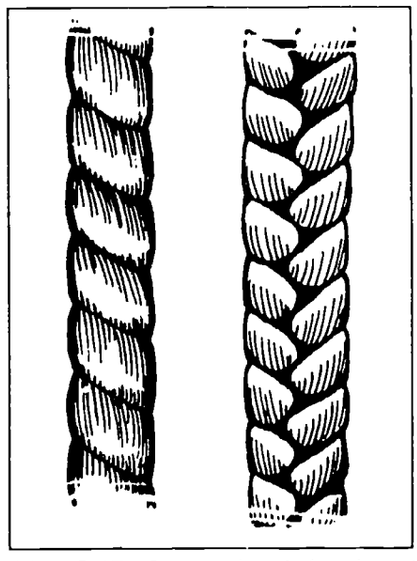


FIG. 2.17. Contrasting twisted and braided rope.

in diameter, are used to lower very large limbs. The climbing line is not less than 1/2 inch in diameter and is typically 120 feet long. It is made of a synthetic fiber. Hand lines and bull ropes are frequently longer. Climbing lines should never be used for anything else, since the climber's life depends on the integrity of the rope.

Ropes can be made of various materials. Manila ropes are made from organic material, which can begin to rot with age and exposure to moisture. Even after treatment of the fibers to reduce rotting, manila ropes must frequently be checked to make sure they are safe to use. Manila ropes are not used as much as they once were.

Most ropes used in the trade today are made of a synthetic fiber such as nylon. Nylon is much stronger and longer lasting than manila, but it has its faults. Since nylon rope tends to be elastic, one must allow for stretching. Also, nylon ropes may glaze from the heat of being run through a crotch when lowering a heavy limb. A better synthetic material for ropes is polyester. Two commonly used materials are Dacron® and Esterlon®. These ropes are stronger than manila, and there is no worry about rotting or mildew. Figure 2.16 shows a variety of ropes constructed of manila and synthetic fibers. A comparison of main characteristics of the different kinds of rope is given in Table 2.1 (page 12).

Many climbers have begun using braided ropes rather than twisted lines (figure 2.17). Braided ropes are more expensive, but they practically eliminate the unwanted twisting and kinking of the line. Braided ropes also provide better knot control.

Selection of the right rope for the job is important. Always choose a rope that is strong enough for the load. Frequently the tree worker must estimate the load a given limb will put on a rope. Experience helps in calculating such things, but accidents rarely occur from using a rope that is *too big*.

Proper care of a rope will help prolong its service life. Ropes should be stored in a dry place away from saws, oil, and gasoline. Care should be taken not to cut ropes with chain saws. Flawed or fraying ropes should be cut back to where they are safe. Ropes should be properly tied when not in use. Figure 2.18 shows how to tie a rope for storage.

## Other Tools and Equipment

A climber in the tree uses several snaps or clips to attach tools to the climbing saddle. Some snaps have been designed to pivot, while others remain stationary. Pivoting snaps are an advantage for carrying a chain saw, since they allow the climber to rotate the saw to a more comfortable position. Some frequently used snaps are shown in figure 2.19. Locking snaps are now used to prevent the snap from opening when twisted on the D-rings.

Another helpful tool for the climber is climbing spikes (figure 2.20). These allow the climber to ascend a branchless trunk without much effort. However, use of spikes on a live tree that is being preserved is ***not*** recommended. Reputable companies allow

**Table 2.1.** Comparison of characteristics of **one-inch rope** made from manila, nylon, Dacron® polyester, and Esterlon® polyester

| DESCRIPTION OF ROPE CHARACTERISTICS | MATERIALS | | | |
|---|---|---|---|---|
| | Manila | Nylon | Polyester | |
| | | | Dacron® | Esterlon® |
| **STRENGTH CHARACTERISTICS** | | | | |
| Tensile strength dry | 9,000 lb | 25,000 lb | 22,000 lb | 20,000 lb |
| Working strength | 1,800 lb | 2,890 lb | 2,450 lb | 2,220 lb |
| Repeat loading | Poor | Good | Excellent | Good |
| **ELASTICITY-STRETCH** | | | | |
| Permanent elongation at working loads | 4.8% | 8.0% | 6.2% | 6.0% |
| Temporary stretch under load | 5.0% | 16.0% | 5.9% | 6.5% |
| Water absorbed into fiber | Up to 100% of weight of rope | Up to 9% | Less than 1% | Less than 1% |
| **RESISTANCE TO ROT, MILDEW, AND MARINE ORGANISMS** | Poor | 100% resistant | 100% resistant | 100% resistant |
| **DETERIORATION** | | | | |
| Due to aging | About 1% per year | Zero | Zero | Zero |
| Due to sunlight exposure | Some slight | Some slight | Almost none | Almost none |
| **RESISTANCE TO CHEMICALS** | | | | |
| To acids | Very poor | Fair | Very good to excellent | Very good to excellent |
| To alkalis | Very poor | Excellent | Very good | Very good |
| To solvents | Good | Good | Very good to excellent | Very good to excellent |
| **WEAR** | | | | |
| Resistance to surface abrasion | Good | Very good | Excellent | Excellent |
| Resistance to internal flexing wear | Good | Excellent | Very good to excellent | Very good to excellent |
| Resistance to cutting | Good | Excellent | Very good to excellent | Very good to excellent |

This table was compiled from "Table of Natural and Synthetic Fiber Characteristics," developed by Wall Rope Works, Beverly, New Jersey. Reprinted with permission from *Weeds, Trees & Turf Magazine* - Sept. 1973, a Harcourt Brace Jovanovich Publication, Cleveland, Ohio.

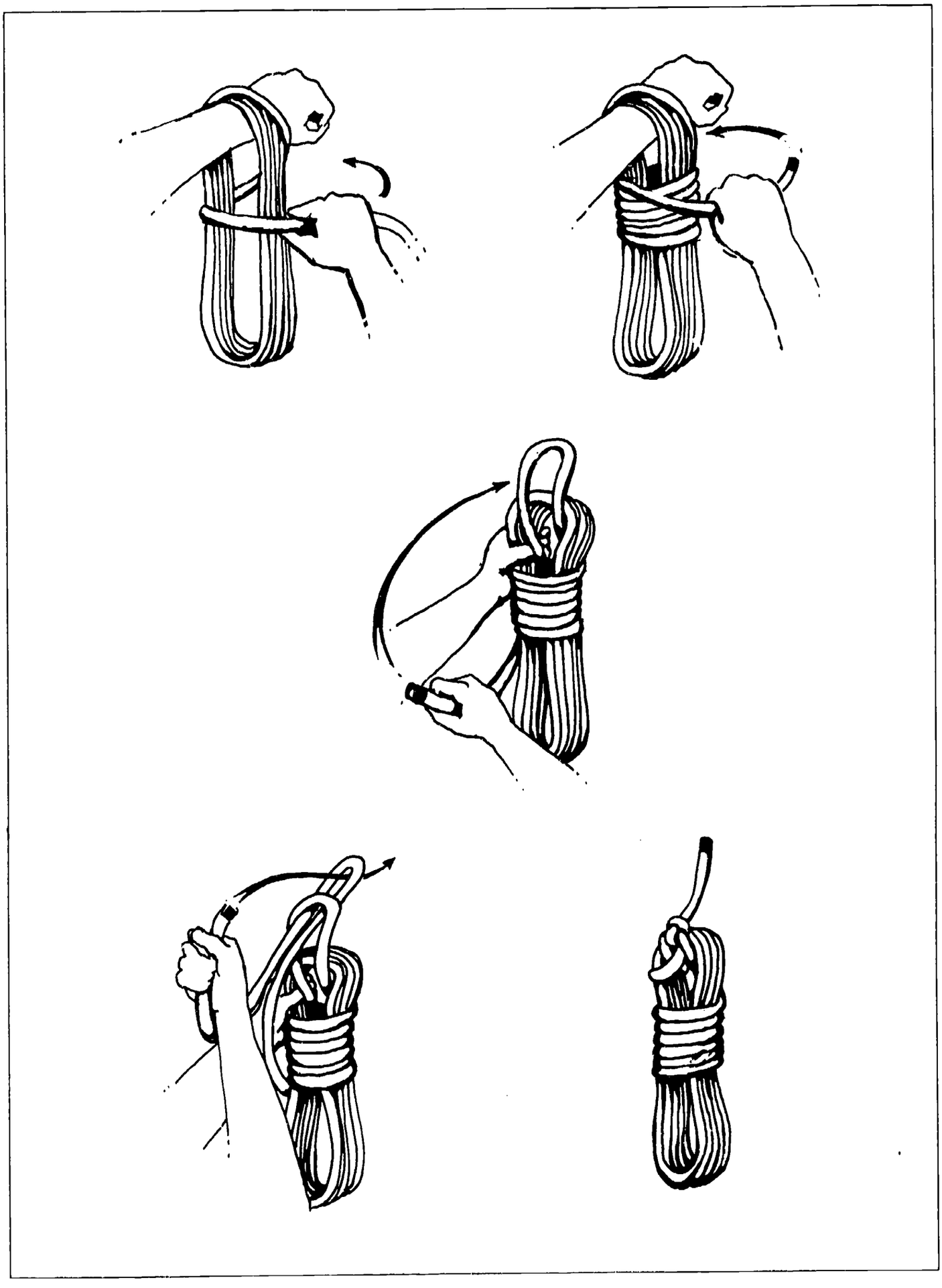


FIG. 2.18. Wrapping a rope for storage

climbers to use spikes only on trees that are being removed. Besides creating unsightly scars in the trunk, climbing spikes cause wounds in the tree which lead to decay and may provide an entry path for insects and diseases.

One of the primary tree-trimming tools is the handsaw. Tree saws are specially designed with the teeth pointed back to cut on the pull stroke. Figures 2.21 and 2.22 show a variety of handsaws. An important accessory of the handsaw is the scabbard–a sheath in which the handsaw is carried and stored (figure 2.23). Scabbards usually have a clip and a ring for attaching to the saddle. The scabbard also helps protect the climber's pants from handsaw cuts and snags.

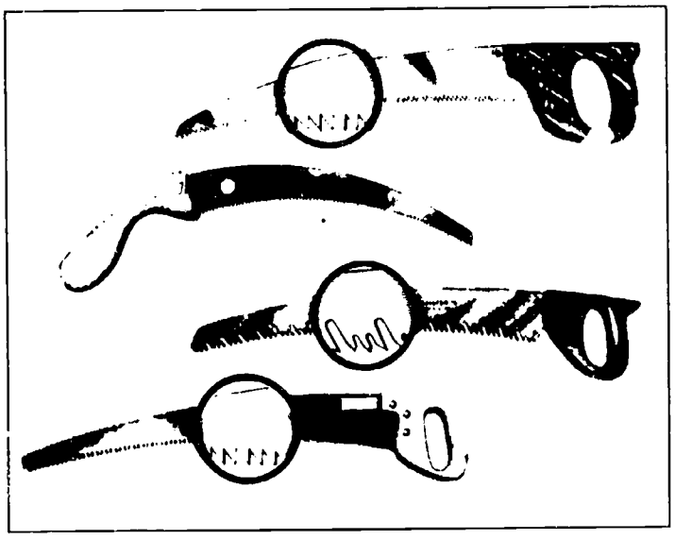


FIG. 2.21. Handsaws

FIG. 2.19. The double snap may be clipped between two D-rings and the climbing rope passed through the center.

FIG. 2.22. Handsaws and scabbards

FIG. 2.20. Climbing spikes should be used only on trees to be removed.

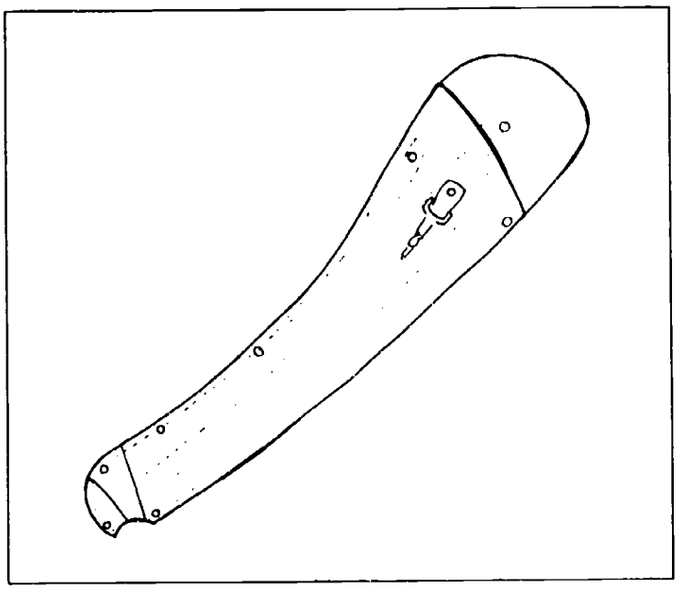


FIG. 2.23. Scabbards must be sturdy to hold up in bad weather.

Pole pruners and pole saws are used to make difficult-to-reach cuts. The pole saw is a pruning saw attached to a long pole (figure 2.24). The pole pruner or pole clip (figure 2.25) can be used to prune twigs up to 1 or 2 inches in diameter, depending on the "bite" of the pruner. Sometimes pole pruners and pole saws are combined into a single tool. Figure 2.26 shows a variety of these tools. Frequently pole pruners are made so that extensions can be added.

Utility crews working from bucket trucks often have the use of hydraulic pruners (figure 2.27). Such a tool reduces the effort needed to make the cuts and usually significantly decreases the time involved.

FIG. 2.24. This worker demonstrates the utility of a pole saw.

FIG. 2.25. A worker is making a cut with a pole pruner.

FIG. 2.26. Pole pruners and pole saws are for difficult-to-reach limbs.

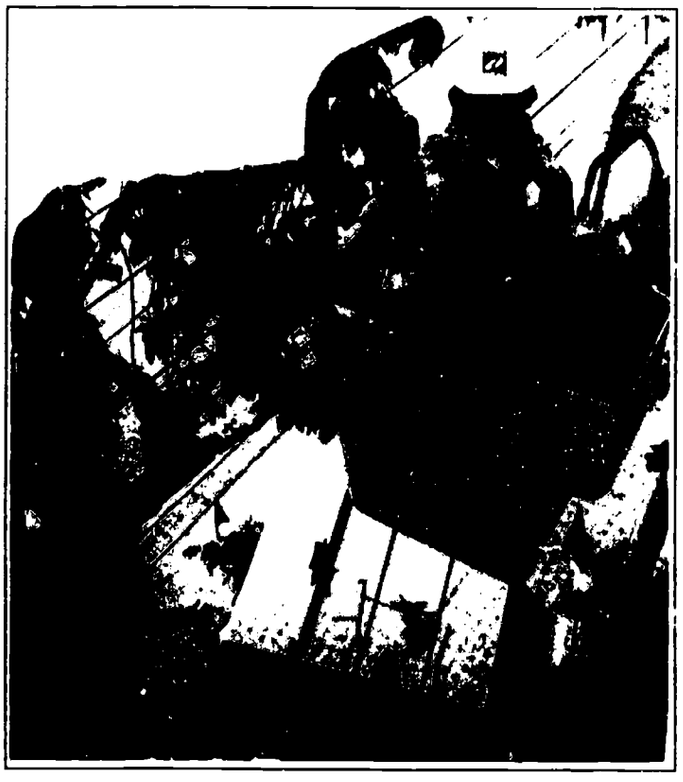


FIG. 2.27. Hydraulic pruners are a great advantage for the utility arborist.

FIG. 2.28. Loppers are good for relatively small cuts.

Other pruning tools include hand pruners and lopping shears, or loppers (figure 2.28). These tools are more frequently used on the ground. Most hand pruners cut up to 1/2-inch twigs. Loppers may cut 1 1/2-inch branches.

Whenever chain saws are used, fuel is usually carried on the truck. It is important that the gasoline be stored only in safe and approved containers (figure 2.29). Gas cans should be carried in such a way that they will not spill or be exposed to possible sparks.

A number of miscellaneous pieces of equipment important to tree workers should also be carried (figure 2.30). A good tool kit for minor repairs should be kept handy. Clean-up tools such as rakes, brooms, and a scoop shovel are needed. Many crews carry a

FIG. 2.29. Gasoline must be stored only in approved containers, clearly labeled.

FIG. 2.30. A good supply of water can be important.

water container, especially during the hot summer months. Certainly a first-aid kit should be carried at all times. Minor cuts are a routine occurrence in the tree business. Finally, the annoyance and irritation of insect and other bites can be warded off with a good supply of insect repellents, as shown in figure 2.31.

## Chain Saws

The chain saw is probably the most often used and most dangerous piece of equipment that a tree worker deals with. On the ground, chain saws are used for cutting down trees and sawing them into firewood-sized logs and branches for chipping or loading. In the tree, chain saws are used for large cuts. Using a chain saw to trim a tree can greatly reduce the time and effort involved, but care must be taken to insure the safety of the climber and the


FIG. 2.31. Insect repellents

FIG. 2.32. A tree service worker uses a variety of chain saws.

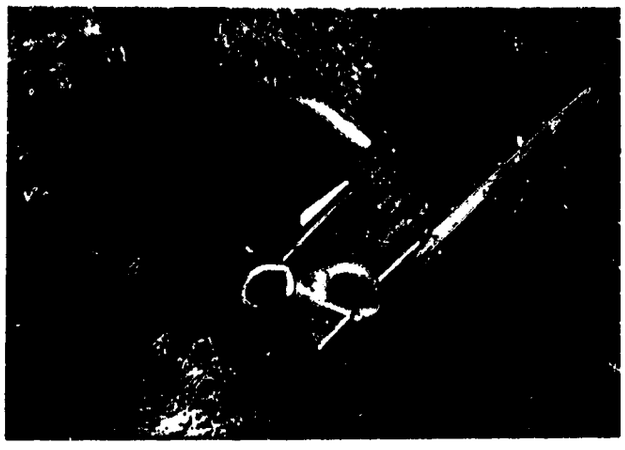


FIG. 2.33. A chain saw equipped for use in the tree.

ground workers. Careless use of a chain saw in a tree can cause considerable damage to the tree. Sloppy cuts and nicks in desirable branches are a common sign of haphazard chain saw use.

Chain saws are made by many manufacturers and are available in a variety of sizes (figure 2.32). It is important to choose a saw that is appropriate for the job. If the saw is to be used in a tree, it should meet the following requirements. It must be lightweight

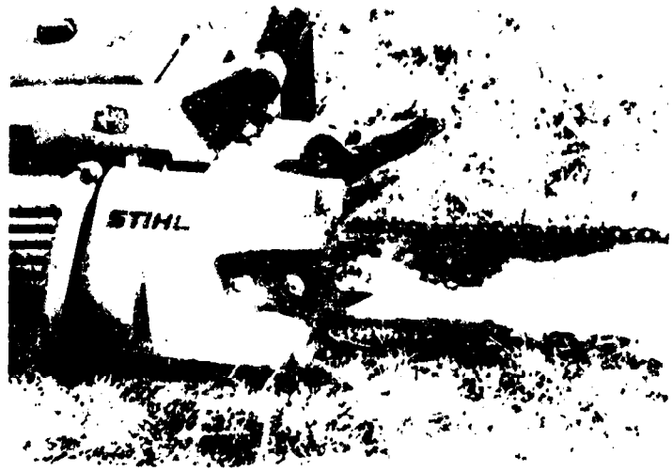



FIG. 2.34. This chain saw has bumper spikes and a hand guard to help protect the user.

and well-balanced to reduce worker fatigue when being toted and used for hours. It should be powerful enough to handle fairly large cuts without bogging down. For easier control, the chain saw should have the rear handle above the engine. Saws with the trigger handle behind the engine are more difficult to use when reaching out on a limb. Chains saws should never be operated with one hand. Figure 2.33 illustrates a chain saw used by climbers in trees. Note that such tree saws are rigged with a snap or other means of attaching the saw to the climber's saddle.

Frequently, larger, more powerful saws are used on the ground. The engine size of these chain saws ranges from about 20cc to 137cc. Bar length usually ranges from 12 to 42 inches. The bar must be long enough to enable the worker to cut through the tree. A 30-inch log can be cut with a 16-inch bar, but a longer bar might be more useful for felling a 30-inch standing tree. Most larger saws have bumper spikes (figure 2.34) which grip the log when the cutting action of the chain saw draws the saw into the cut.

Chain saws require proper maintenance to be effective. A saw that is poorly maintained will be inefficient and will pose a greater risk to the user. Chain saws require a fuel mixture of oil and gasoline. A 2-cycle engine oil is added to the gas to lubricate the piston, cylinder, and bearings. It is very important that the correct mixture ratio be used. If the mixture contains too little oil, the piston may freeze up within the cylinder. Too much oil in the mixture can cause a reduction in power. Care should be taken to keep dirt and sawdust out of the fuel tank. It is recommended that the bar lubricant tank always be filled when the fuel tank is filled, since a properly running saw will empty both in about the same time.

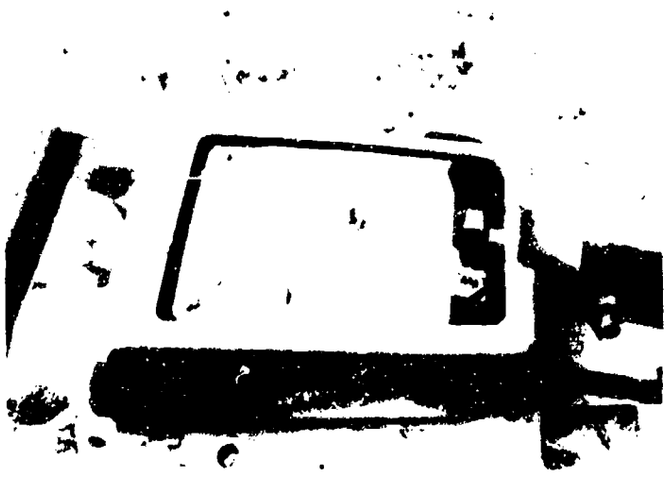


FIG. 2.35. The air filter should be kept clean.

FIG. 2.36. The chain must be filed frequently and correctly.

The air filter should be kept clean and free of dust (figure 2.35). A dirty filter may make the saw difficult to start. If the air filter gets too dirty, the saw will run as if the choke were left open. The air filter can be cleaned with soapy water and rinsed with tap water.

Another cause of difficulty in starting the saw is a worn-out spark plug. This occasionally has to be replaced. A worn-out spark plug may also cause the engine to "cut out" after it has been started.

The guidebar and sprocket may require some maintenance also. The guidebar should be turned occasionally, since the guide rails wear down faster on the bottom side where most of the cutting is done. The sprocket usually needs to be replaced after two to four chains. A new chain should never be installed over a badly worn sprocket. Guidebars and sprockets will last longer if a good bar oil is always used. Bar oil must have a low freezing point and a high flash point so that heat will not cause ignition while cutting. A high tack, low sling oil will help maximize adherence to the bar and chain.

FIG. 2.37. Doing routine maintenance on a chain saw

Before running the chain saw, check to see that the chain is tensioned. To tension the chain, loosen the bar-mount nuts and hold up the bar. Tighten the chain-adjusting screw until the chain is taut. The chain should move freely and snap back when pulled away from the bar. Re-tighten the bar-mount nuts while holding up the bar. A loose chain can cause uneven wear of the chain runners and guide rails of the bar.

If a chain saw has to be forced to cut, the chain is probably dull. Chains are dulled by hitting dirt, metal, or stone, and even by normal cutting. The hard wood near the base of the tree can easily dull a chain saw. Very fine sawdust is another indication of a dull chain.

Chains must be filed frequently to sharpen. Always use the correct size file for the chain and consult the owner's manual for the correct filing angles (figure 2.36). It is important to file both sides of the chain evenly; otherwise, the saw will cut at an angle. After the chain has been sharpened several times, the depth gauges will have to be filed down with a flat tile. It is a good idea to wear gloves when sharpening a chain saw.

In addition to these maintenance factors, some companies do routine maintenance checks on their chain saws (figure 2.37). If possible, all the saws should be cleaned at the end of each day. Also, all bolts should be tightened regularly.

Safety is the most important consideration when using a chain saw. Today, chains and bars have been designed to minimize kickback, the most common cause of accidents. Following are other safety recommendations that can help reduce the risk factors involved in operating a chain saw.

FIG. 2.38. Avoid spilling gas while refueling chain saws.

FIG. 2.39. The rear bed of the truck is raised to dump wood chips.

FIG. 2.40. A truck with storage areas for all equipment carried

FIG. 2.41. Ropes neatly hung in a storage area away from chain saws

### *Safety Recommendations When Operating a Chain Saw*

- Never refuel a saw while it is running (figure 2.38); always wipe up any spilled fuel.
- Never smoke while refueling.
- Always operate a saw with two hands.
- Never cut above shoulder level.
- Avoid letting the tip of the guidebar contact the log, or kickback may result.
- Wear protective clothing and eye protection whenever practical.

## Trucks, Chippers, and Stump Grinders

A tree company may own a variety of trucks including pick-ups, spray trucks, chipper trucks, and bucket trucks. One of the trucks most commonly used by a tree crew is the chipper truck. There are several different body types in use. Most chipper trucks have a hydraulic lift bed for dumping wood chips (figure 2.39). Most are also equipped with storage areas for tools, pole pruners, ladders, and ropes (figures 2.40, 2.41). Chipper trucks also have a hitch to fit the chipper as shown in figure 2.42. Some trucks carry wheel blocks (figure 2.43), which are especially handy when the truck is parked on an incline while chipping brush. A fully equipped truck and chipper outfit is pictured in figure 2.44.

FIG. 2.42. The hitch includes safety chains and electrical hook-up between the truck and chipper.

FIG. 2.43. Metal wedges used to block the wheels of the truck

FIG. 2.44. Truck and chipper

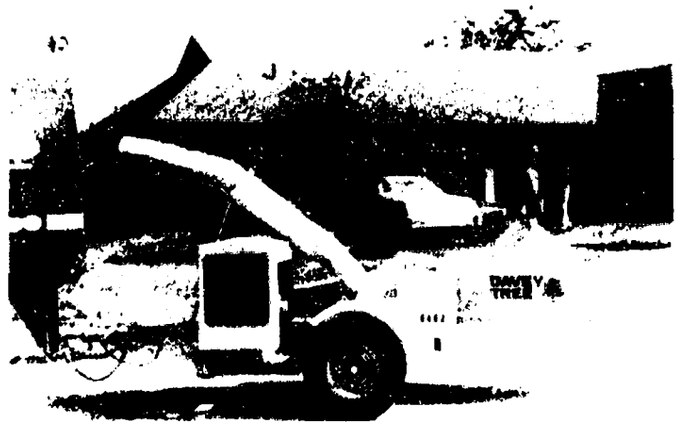


FIG. 2.45. Brush chipper: branches are fed into the rear and wood chips are shot into the truck.

FIG. 2.46. Check the feed chute before starting the chipper.

The **brush chipper** (figure 2.45) is used to grind branches into wood chips. Chippers come in various sizes. Some can process logs up to 8 inches in diameter. Chippers can be dangerous, so carefully follow proper operation procedures. Before starting the engine, be sure there are no foreign objects in the feed chute near the cutting blades (figures 2.46, 2.47). When the engine has been started, let it idle before cranking it up to chipping speed. Engage the clutch at about one-third throttle. Then open the throttle fully after the chipper is warmed up.

### *Safety Recommendations for Chipper Operation*

- Wear gloves, safety glasses, ear protection, and proper clothing. Avoid loose-fitting clothes and do not wear jewelry, as both can easily be caught in the chipper.
- Feed brush from the side of the feed chute to avoid being hit by pieces of wood that may be ejected to the rear.
- Never put anything but branches or brush in the chipper.
- Never reach into the chipper with your hands or try to shove brush in with tools or your feet.
- Always be sure the chipper is safely anchored to the truck.

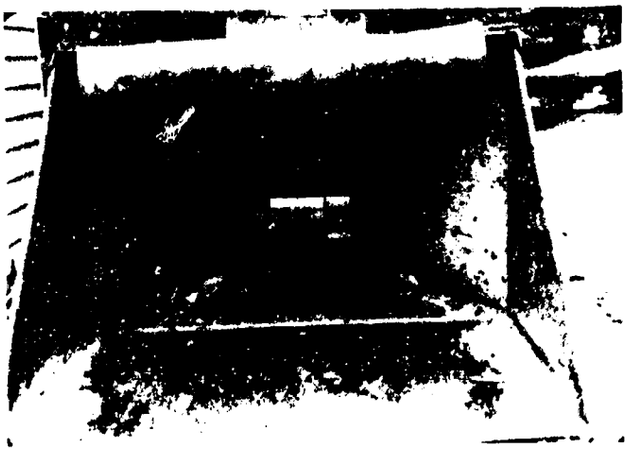


FIG. 2.47. No foreign objects are in the feed chute.

FIG. 2.48. Never make adjustments while the chipper is running.

FIG. 2.49. The cutting knives of the chipper must be removed and replaced when they get dull.

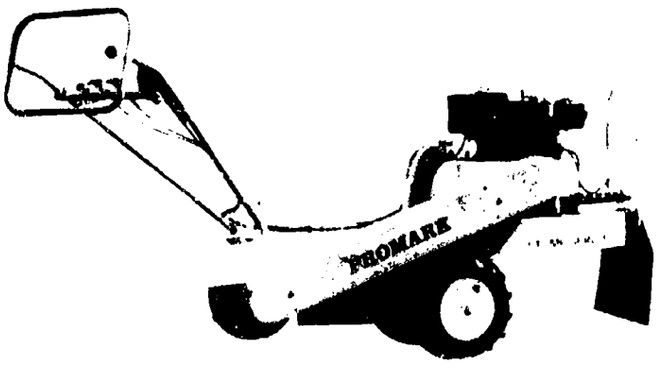



FIG. 2.50. A portable, hand-operated stump grinder

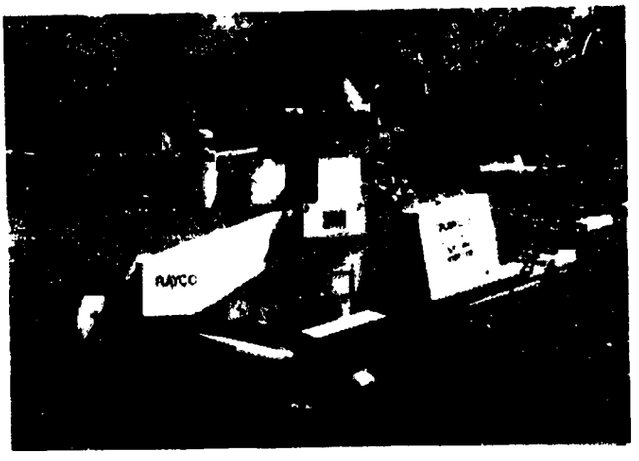


FIG. 2.51. A larger stump machine, lever-operated and pulled behind a truck

- Never make any adjustments or repairs while the chipper is in operation (figure 2.48).

If the chipper is to operate safely and efficiently, the blades must be sharpened occasionally. Figure 2.49 shows a worker removing the cutting knives from the cylinder to replace them with sharp ones. When the bolts are being tightened, make certain they are properly torqued down. The rapid rotation of the cylinder could easily cause a knife that is loose to be dangerously ejected. Finally, make certain that no metal or stones are fed into the chipper, as these will dull the blades.

A **stump grinder** is used to dig out the below-ground portion of a tree stump. The depth that the machine will go depends on the size and make, and varies from 8 inches to 30 inches. Figures 2.50 and 2.51 illustrate two different sizes and types of stump grinders. Operators of these machines should always wear protective goggles, since stones and wood chips can fly out from the stump. As with other equipment, maintenance is important. The teeth or grinders must be sharpened or replaced routinely. Belts should also be checked on a regular basis.

CHAPTER 3

# The Tree Workers

### *Objectives*

Chapter 3 describes the duties, responsibilities, and requirements of the jobs of ground worker and climber.

1. Learn the responsibilities of the ground worker.
2. Become familiar with proper techniques of felling, bucking, and limbing trees.
3. Be able to tie and use all the knots and hitches described in this chapter.
4. Be aware of the requirements of the job of tree climber.
5. Learn and understand all safety precautions outlined in this chapter.

## The Ground Worker

The ground worker has a wide variety of duties and responsibilities. From his or her arrival at the job until the job is completed and the last pile of sawdust is swept up, the ground worker is always busy. The ground worker must be trained to operate and care for all equipment. Safety is the most important consideration in every task encountered.

Perhaps the primary responsibility of the ground worker is to aid the climber. The climber in the tree relies on the ground worker to send up saws, ropes, and other equipment (figures 3.1, 3.2). The ground workers must make sure the area is clear before the climbers can begin cutting. Often the ground workers must handle ropes on the ground when the climbers are lowering limbs.

The ground workers, as well as the climbers, must be familiar with all the knots and hitches commonly used in the trade. It is important to know how to tie and untie these knots and what they are used for (figure 3.3).

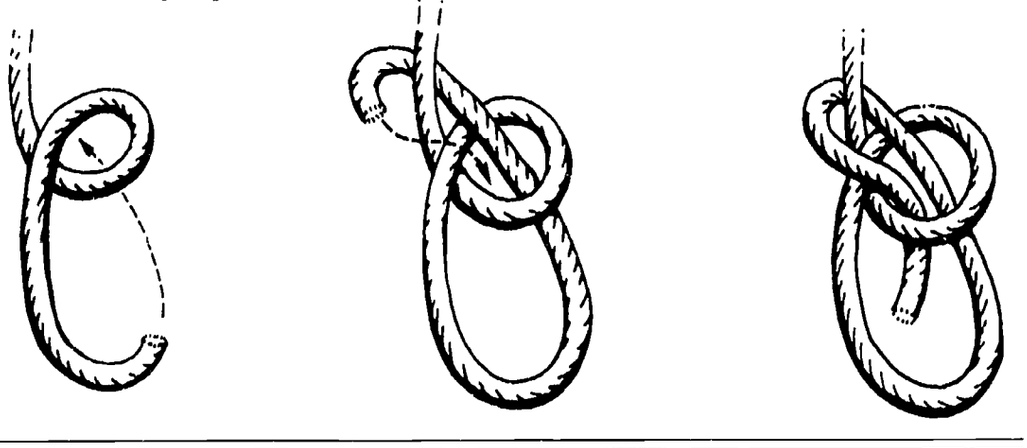
FIG. 3.1. The chain saw is sent up after the climber is set.

FIG. 3.2. The saw is tied to the climber's line and then pulled up.

**A. Bowline**

*Used:*
- to attach snaps, hooks, etc. to ropes
- to attach climbing ropes to saddle

The bowline will not slip or jam and is easily untied.



**B. Running bowline**

*Used:*
- to tie off limbs for lowering
- as slip knot, can be pulled up the rope

The running bowline is similar to the bowline and is easily untied after being strained.

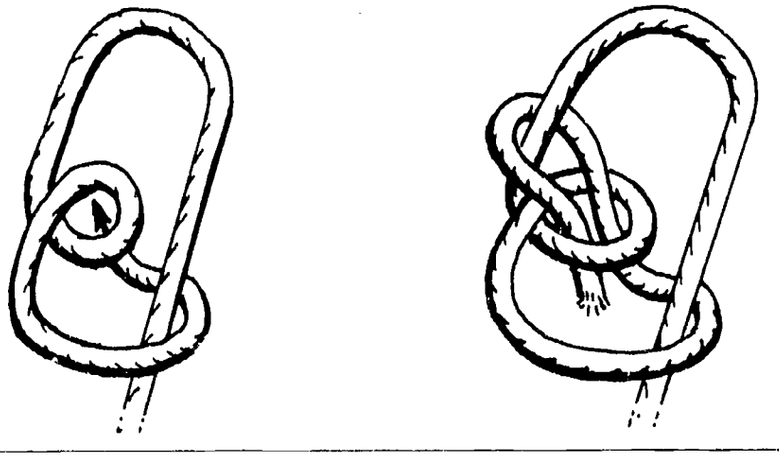
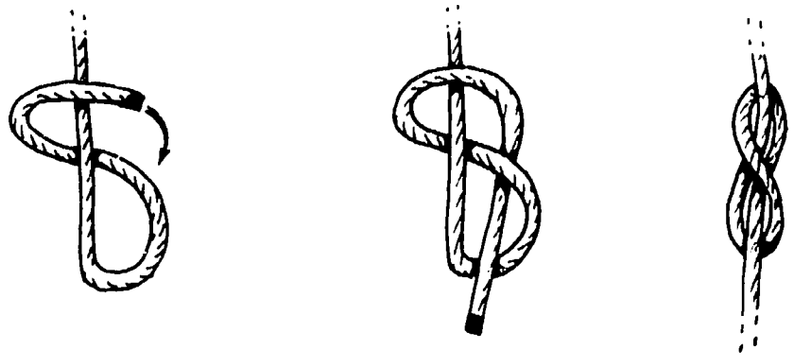


FIG. 3.3. Knots and hitches.

### C. Figure 8

*Used:*
- to tie on the end of a rope to prevent its slipping through a knot or a block
- to identify the line to cut when rescuing a climber

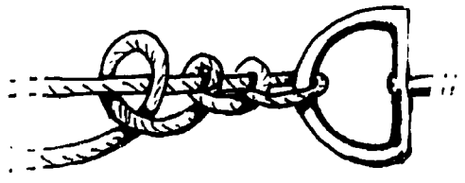
The figure 8 is easy to tie and may also be used to keep the strands of a rope from unlaying.



### D. Half hitches

*Used:*
- to secure rope temporarily
- sometimes in combination with other knots

Half hitches are easy to tie and untie.



### E. Tautline hitch (Climber's knot)

*Used:*
- by climbers as a rappeling knot when tied in to the tree

The tautline hitch must be kept tight.

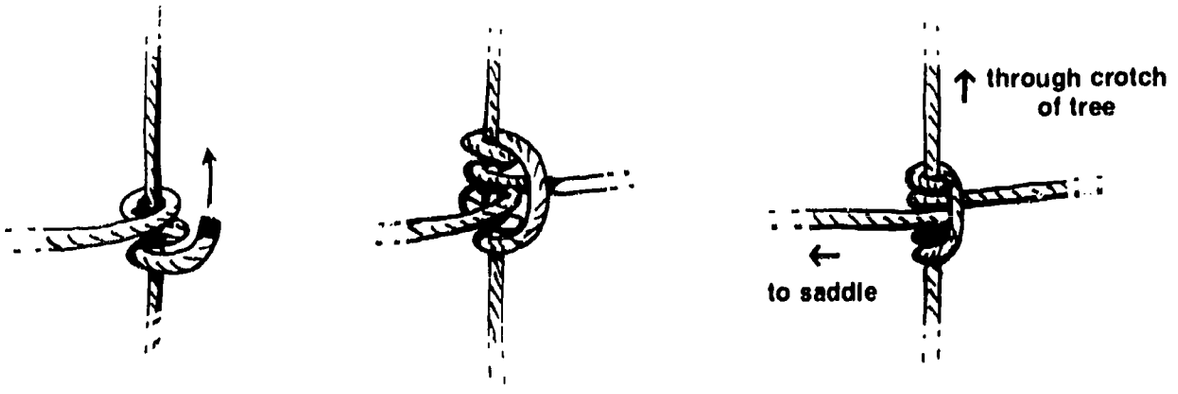
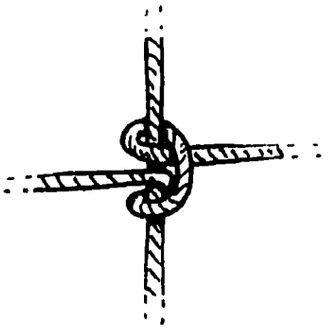


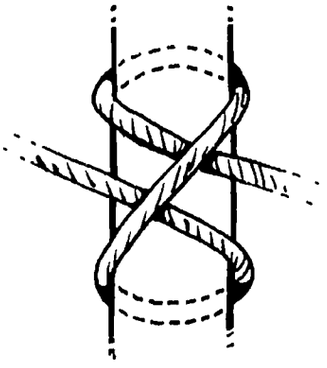

FIG. 3.3. Knots and hitches *(continued)*

**F. Clove hitch**

*Used:*
- to fasten rope to limbs
- to tie on equipment to send up tree
- sometimes in combination with other knots

The clove hitch is frequently used by ground workers.

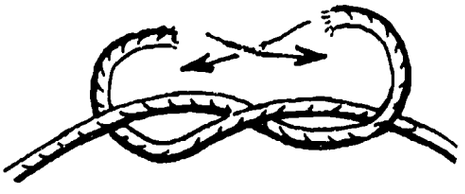


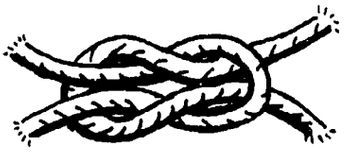


**G. Square knot**

*Used:*
- to join two ropes of equal diameter

The square knot is easily untied after being strained.





**H. Sheet bend**

*Used:*
- to join two ropes of different or equal diameter(s)

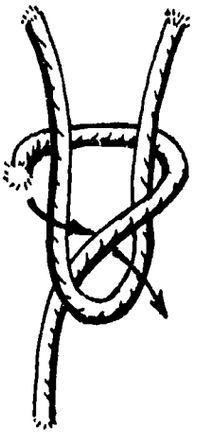


**FIG. 3.3.** Knots and hitches *(continued)*

**I. Timber hitch**

*Used:*
- to lower limbs from trees
- to hoist large limbs
- sometimes in combination with other knots

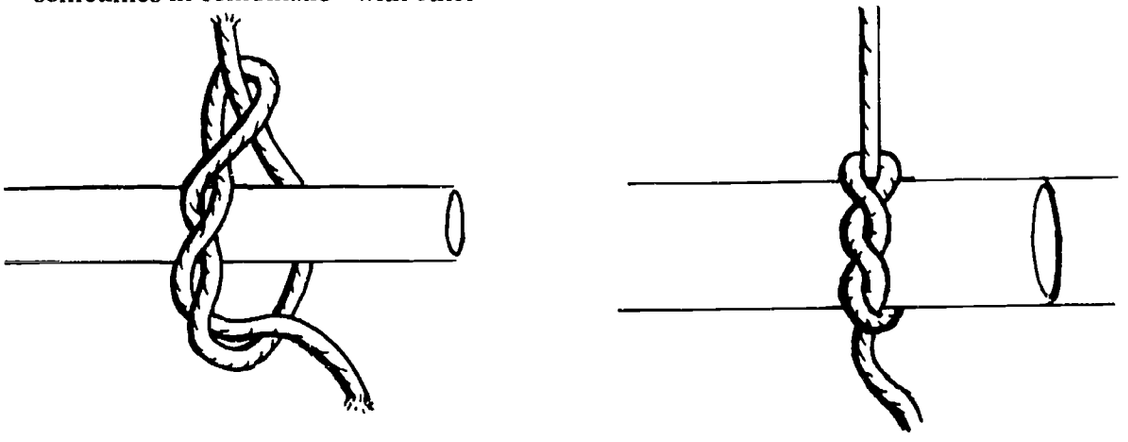


**FIG. 3.3.** Knots and hitches *(conclusion)*

When the tree crew first arrives at the work site, the ground workers begin setting up for the job. This entails getting out the tools that will be used. The chain saws must be gassed and oiled. Chain tension on each saw should be checked and adjusted if necessary. The chains may need to be sharpened (figure 3.4).

If a ladder is to be used, the ground worker can set it up while the climber gets ready. A worker should always steady the ladder while the climber ascends (figure 3.5). Unsteady ladders are a major cause of accidents (figure 3.6). If the climber is using a rope to ascend, the ground worker should anchor, or belay, the other end to insure the safety of the climber.

**FIG. 3.4.** Sharpening chain saws is one of the skills a ground worker should master.

Once the climber is safely tied in, the ground worker's next task is usually to send up certain tools. As demonstrated in figure 3.7, a clove hitch is usually used to tie tools such as saws or pruning poles to the climber's line. The climber can then simply pull up the needed equipment. Before chain saws are sent up, they should first be started and shut off to make it easier for the climber to start the saw in the tree.

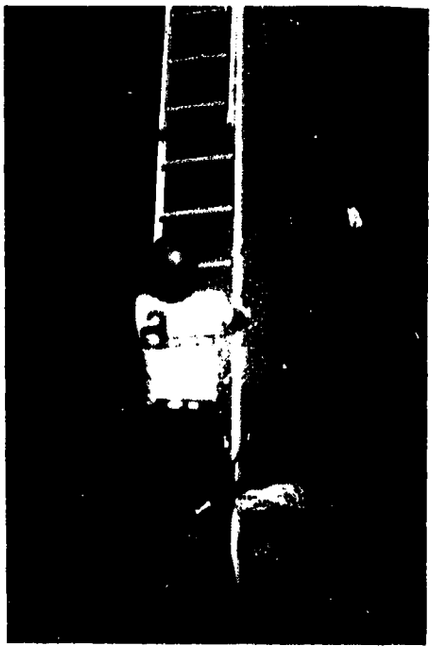


**FIG. 3.5.** Steady the ladder for the climber.

## TREE FELLING, LIMBING, AND BUCKING

Some trees can be cut down without the need of a climber. Tree felling requires the consideration of many factors. The lean of the tree, the wind direction, the shape of the crown, and the condition of the trunk – all must be taken into account. Rarely is a tree situated in the open where it can be dropped in the most favorable direction. More often, obstacles such as houses, power lines, and other trees must be

FIG. 3.6. Unsteady ladders are a major cause of accidents.

FIG. 3.7. Use a clove hitch to attach tools to the climber's line.

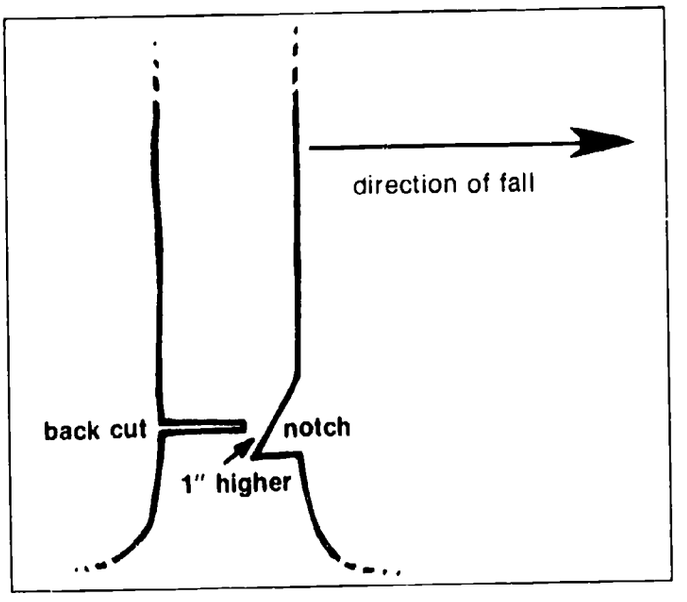



FIG. 3.8. Cut the notch on the "fall" side of the tree.

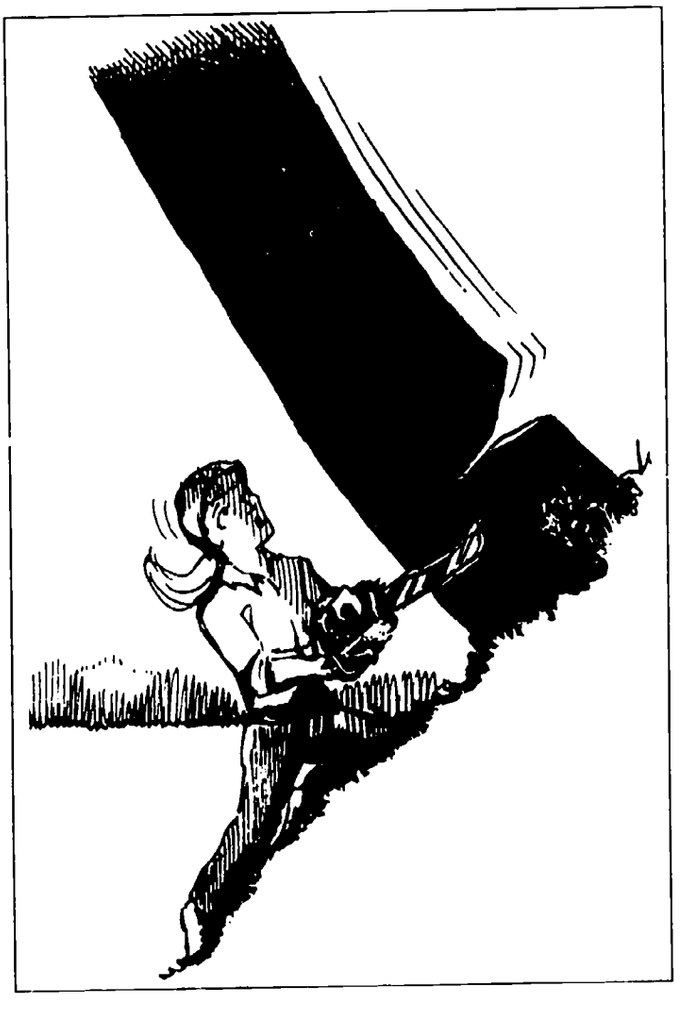


FIG. 3.9. Mental errors are often the most dangerous.

avoided. A pull line can be tied high in the tree to give leverage and allow workers to drop the tree in the desired direction.

Once the direction of fall has been determined, the next step is to cut the notch. The notch is cut on the side of the tree facing the direction of fall (figure 3.8). The top or downward cut should be made first. With the saw at full throttle, cut downward into the tree at about a 60° angle. The cut should go through approximately 1/4 to 1/3 of the tree's diameter. The bottom cut should be made level or parallel to the ground. When the bottom cut reaches the top cut, the slice of wood may fly out, so use caution (figure 3.9).

The back cut or felling cut should be a level cut exactly opposite the notch on the other side of the tree (figure 3.10). The back cut should be about one inch higher than the bottom cut of the notch. Before it reaches the notch, the saw should be removed and shut off, leaving a strip of uncut wood. This section of wood serves as a hinge. If the tree is cut all the way through, the worker will have less control over the direction of fall. If the tree has a rotten or hollow center, its fall will be less predictable. Leave more wood to serve as a hinge, if possible.

When the tree falls, the butt end may kick back. The tree feller should have a preplanned escape route, and should move away without losing sight of the tree. Never attempt to move away with a running chain saw in hand.

Once the tree is on the ground, it must be limbed. This entails cutting off the smaller branches, which will be chipped for mulch. It is safest to keep the trunk between the saw and the legs. In other words, cut the limbs on the far side first, then walk around and cut the other side (figure 3.11). To avoid getting the saw pinched, try to predict before cutting which way the limbs will be under pressure. Some limbs will have to be cut from the bottom upward (figure 3.12). It is helpful to cut the bottom limbs last. Caution is important in cutting these limbs, since the tree may roll or drop to the ground when they are cut.

After the limbs are removed, the tree is ready for "bucking" or cutting into manageable-sized logs. In most cases the tree will be cut into logs for firewood, but more valuable trees may be left in lengths suitable for lumber. Bucking will be easiest if the tree is supported off the ground. This will avoid problems such as getting the saw pinched or nicking the ground. If the saw does get stuck in a cut, do not try to forcibly pull it out, as this could damage the guidebar. It is better to raise the log and open the cut. If the log is not supported, do not attempt to cut all the way through. Cut partially through and finish the remainder from the other side. Always begin a cut with the saw at full throttle. Never cut with the tip of the bar as this will result in kickback. Figure 3.13 illustrates the proper stance for good control of the saw and safety of the legs.

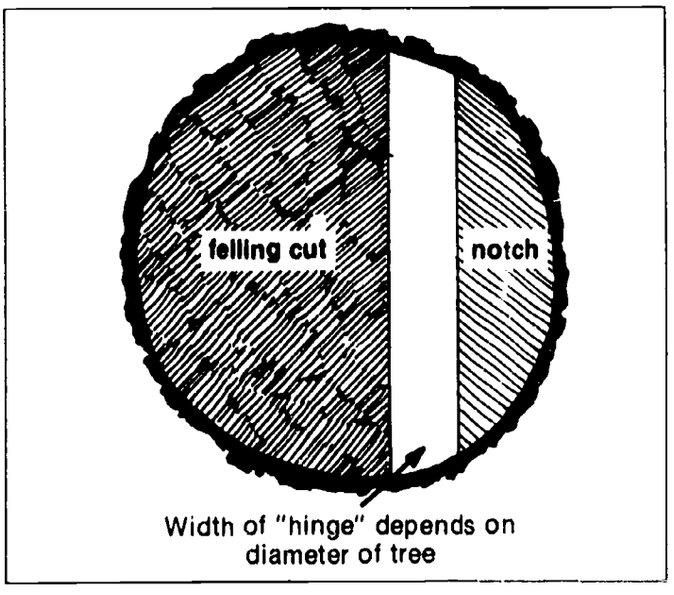



FIG. 3.10. Do not cut the felling cut through to the notch.

FIG. 3.11. Keep the trunk of the tree between you and the saw when limbing a tree.

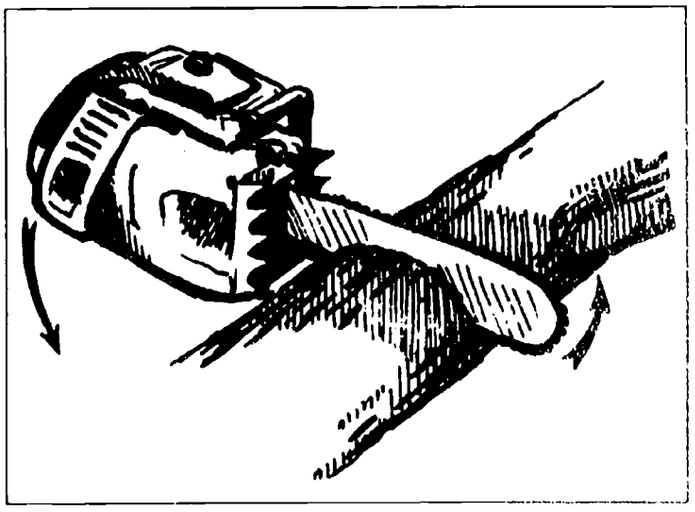


FIG. 3.12. Cut with the tension of the branch to avoid getting the saw stuck.

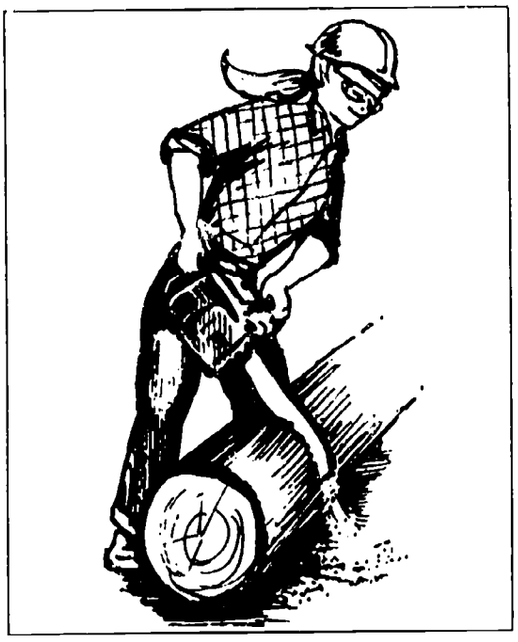


FIG. 3.13. Keep legs out of the path of the saw. Brace the back of the saw against the upper leg to increase control.

## CLEARING, BRUSH CHIPPING, AND CLEAN-UP

Another duty of the ground worker is clearing limbs and brush from the work area (figure 3.14). Limbs should be dragged or carried to the chipper out of the way of workers. Ground workers must stay alert to what the climbers are doing above (figure 3.15). Ground workers should never attempt to clear brush from underneath a climber who is making cuts in the tree. In addition, ground workers must keep traffic and pedestrians from passing under workers in the trees. Most companies have warning signs and safety cones to block off the designated work area.

Ground workers are usually responsible for chipping brush. Brush chippers are dangerous pieces of equipment.

### *Safe Operation Procedures for a Brush Chipper*

- Never operate a trailer-mounted chipper unless it is hitched to the truck or properly stabilized with the jacks down and wheels blocked (figure 3.16).
- Do not chip brush under a tree that is being worked on.
- Move to the side of the feed chute when chipping brush to avoid whipping branches (figure 3.17).
- Push small pieces of brush into the chipper with larger limbs. Never use your hands, feet, or tools to push brush through.

FIG. 3.14. Keep the working area clear of brush.

FIG. 3.15. Timber!

FIG. 3.16. A chipper is hitched to the truck.

- Stay away from the discharge chute while the chipper is in operation.
- Always remove the ignition key if the chipper is not in use and is unattended.
- Never leave the running chipper unattended.
- Never try to back the chipper without assistance, as it cannot be seen in the mirrors.
- Never attempt any repairs on the chipper while it is running.

The final task in every job is clean-up. The yard must be raked to clear it of all clippings, twigs, and leaves (figure 3.18). Then the sidewalks, driveway, and street should be swept clean (figure 3.19). Never run through the chipper any sweepings that may contain metal or stones. Always try to leave the area at least as clean and tidy as it was before the job was started.

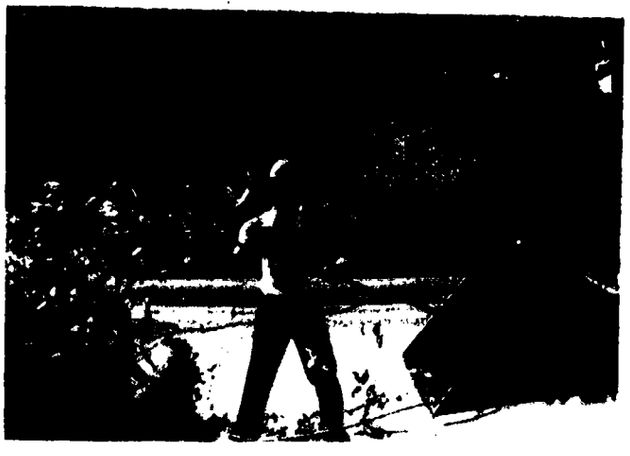


**FIG. 3.17.** Stay to one side when feeding brush into the chipper.

## The Climber

Climbers have a great deal more responsibility than do ground workers. Climbers must be able to do all the work that ground workers do and quite a bit more. Most climbers started as ground workers. In addition to their training in tree climbing, climbers are skilled in pruning, rigging, cabling, and diagnosing tree problems. A good climber is aware of the various characteristics of different types of trees, such as wood strength and branch angles.

Many tree climbers have had formal training at professional or technical schools. They learn arboricultural skills including tree identification, insect and disease problems, safety practices, and tree physiology. In addition, they gain hands-on training in equipment operation and maintenance. This knowledge is coupled with tree climbing and maintenance skills, and the product is a good basic training background. (See figure 3.20.)

Most companies prefer to hire climbers who have had some experience. An experienced climber should know how to prune, cable, and remove trees. Even climbers who have worked many years in the business will often say that they are still learning new techniques and methods.

It takes much more than knowledge and training to become a climber, though. There is still the physical factor. A climber must be in good physical condition

**FIG. 3.18.** Rake the work area to leave it as clean as you found it.

**FIG. 3.19.** A good clean-up job leaves a lasting good impression.

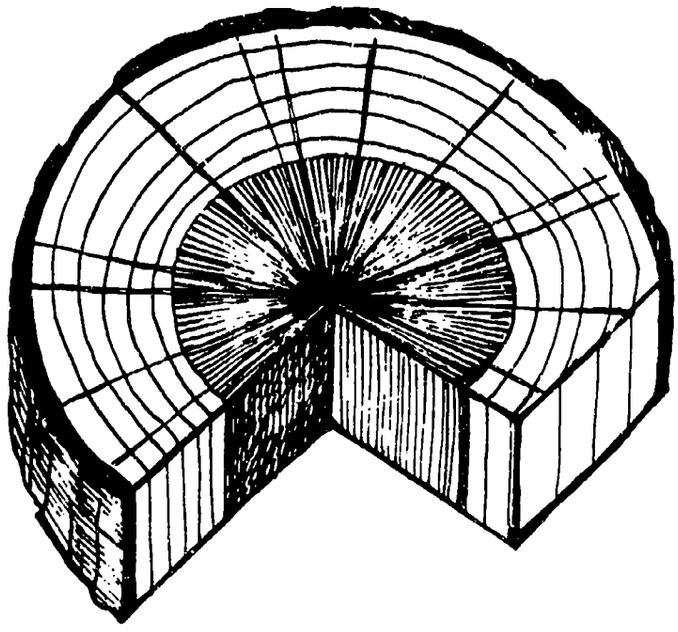
**FIG. 3.20.** A rope and saddle do not make a climber. Many years of experience and training are required.

to work in trees (figure 3.21). Upper body strength is very important, as the climber may have to pull his or her own weight up the tree. Agility, stamina, and endurance are tested constantly in a routine work day.

Apart from all the factors described that go into making a successful tree climber, the most important asset is a healthy, positive state of mind. Tree climbing can be a dangerous and sometimes frightening profession. The climber must have a strong desire to do the job and cannot be afraid of heights. His or her mind must be on the job and safety practices at all times. A climber who is not paying full attention can put all the other crew members in danger.

So far, the basic knowledge and capabilities required for the job of climber have been discussed. Skills and responsibilities of the climber will be dealt with in greater detail in later chapters. Tree trimming can be a complex and involved procedure that requires a combination of knowledge, common sense, and experience. While some aspects can be learned from a book, others can be acquired only by actually doing the work.

**FIG. 3.21.** Strength and agility are important in tree climbing.



CHAPTER 4

# Basic Tree Anatomy

## *Objectives*

The goal of this chapter is to acquaint the reader with the basic parts of a tree and to provide some insight into the function of each major part.

1. Become familiar with the basic anatomy of a hardwood tree.
2. Gain an understanding of the functions of various plant parts.
3. Know why it is important to learn about the biological aspects of a tree.

Many of the jobs performed by a tree care worker require a basic understanding of the parts of a tree and how they function. Learning how to prune, fertilize, and transplant trees can all be made easier with a little knowledge of tree anatomy. Identification of trees and diagnosis of tree problems also depend heavily on knowledge of tree parts.

## Roots

The roots of plants serve four primary functions. These are anchorage, storage, absorption, and conduction. A strong, wide-spreading root system is required to support and anchor a large tree to keep it from blowing over in the wind. Some root cells store carbohydrates and sugar complexes. Roots are also the main point of absorption of water and vital minerals from the soil. These minerals are then conducted with the water up through the stem and throughout the plant.

Root elongation and differentiation occurs primarily at the root tips. Figure 4.1 shows the four zones of specialization in a root tip. The root cap protects the young root as it grows through the soil. The meristematic zone is an area of rapid cell division. Just beyond the meristematic zone is the region of elongation where new cells become larger. The region of differentiation follows. In this region the cells differentiate; that is, they mature and become specialized into conduction cells, storage cells, or support cells. Externally, root hairs begin to develop in this region. Root hairs aid in water absorption by increasing the surface area of the root.

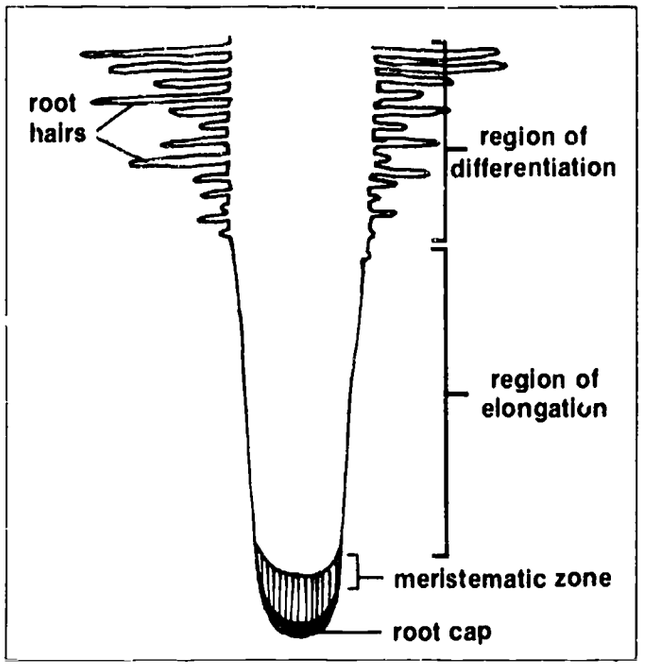



FIG. 4.1. The root tip is divided into four zones of specialization.

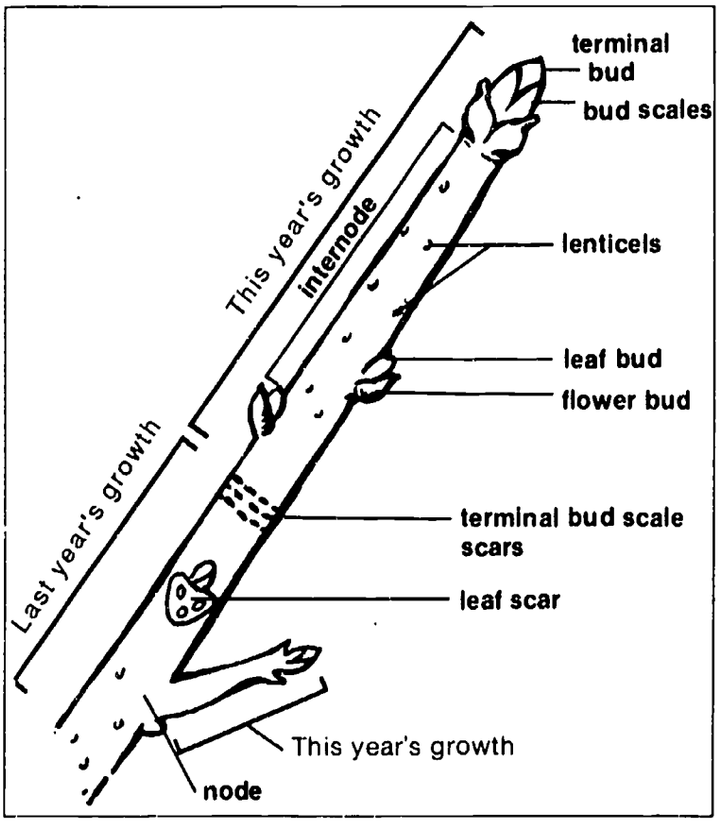



FIG. 4.2. The parts of a twig (stem)

## Stems

The functions of a plant stem include support and conduction. The cells of the stem are specialized into either vascular (conductive) or support cells which strengthen the stem. Stems are different from roots in that stems have nodes (where bud initiation occurs) and internodes (figure 4.2).

It is important to learn the parts of a twig and types of buds in order to understand the principles of pruning. The three main types of buds are terminal, lateral, and flower buds. The **terminal** bud is the site of future branch elongation. **Lateral** (vegetative) buds produce leaves or lateral branches. **Flower** buds, of course, produce flowers and can usually be identified because they tend to be more rounded and plump than the other kinds. If the terminal bud is removed in pruning, growth is usually stimulated in the lateral bud closest to the cut. This stimulation of growth is under hormonal control.

Learning to distinguish between current growth and previous growth can be a good diagnostic tool. Measuring the amount of growth by twig elongation over several years often makes it possible to determine the time of an injury to a tree. Let's say a tree began declining three years ago. You may be able to determine what to do about it when you find out what happened to the tree that year.

The stem is composed of a variety of plant tissues. Figure 4.3 illustrates and locates some of these tissues.

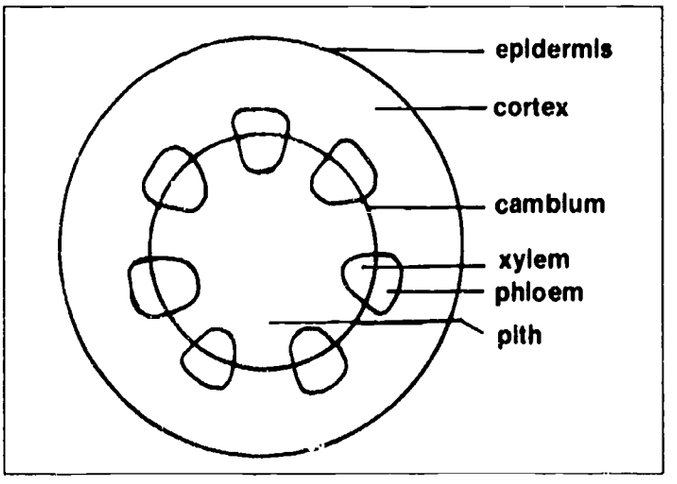



FIG. 4.3. Cross section of a young stem

The young stem is bound externally by epidermal cells which protect the growing tissues. The cortex is composed of support tissue with some conductive tissue. The vascular tissue is composed of the phloem and the xylem. Phloem is the food-conducting tissue and xylem conducts water. The cambium is a layer of meristematic cells that give rise to new cells allowing the stem to increase in width. This is called **secondary growth**. The innermost section of the twig is the **pith**.

As the stem matures, the outer bark is formed. Cork cambium forms cork cells that make up much

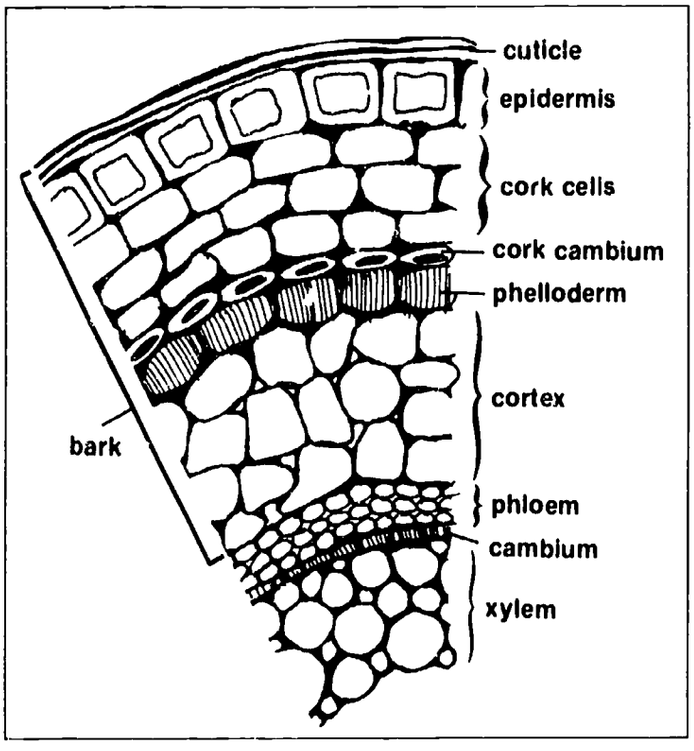



FIG. 4.4. Partial cross section through the maturing stem of a hardwood tree

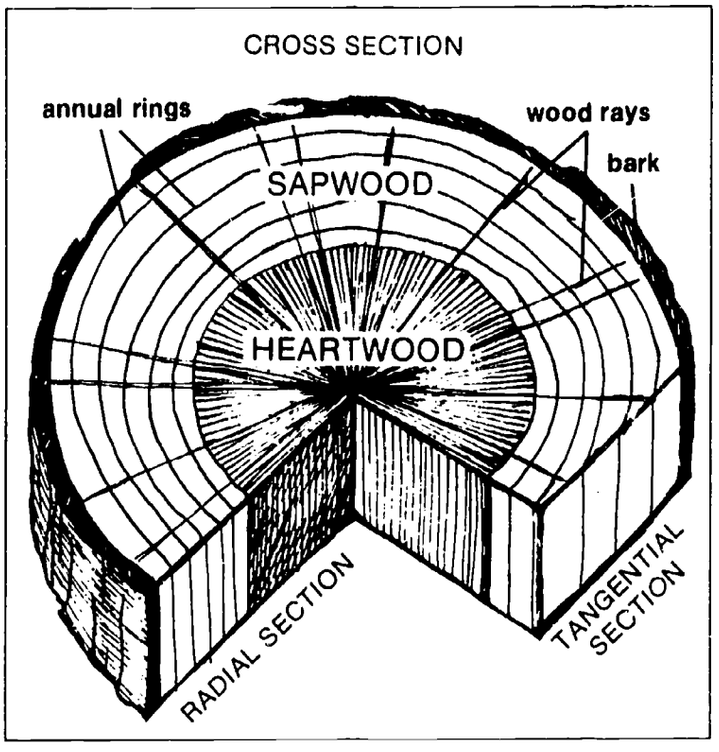



FIG. 4.5. Wood section of a hardwood tree

of the bark. The bark actually includes everything from the phloem out (figure 4.4). Lenticels permit the exchange of gases through the otherwise-impervious corky layer.

A cross section through a tree as illustrated in Figure 4.5 reveals different areas and characteristics of the wood. Annual growth rings are clearly visible because of the rapid growth rate of early wood (spring wood) relative to that of late wood (summer wood). Annual rings can be counted to determine approximately the age of the tree. The width of each ring gives an idea of the growing conditions of that year. Wood rays consist of cells that run across the grain carrying nutrients or storage materials laterally in the tree. Figure 4.5 also shows the three ways to cut sections of wood. These are tangential section, cross section, and radial section.

## Leaves

The leaves (foliage) of the tree are the chief sites of photosynthesis and transpiration. Most of the "food" the plant needs is produced in the leaves. Water transpired from the leaves helps maintain the water transport system. **Transpiration** is the loss of water through the foliage.

A cross section through a leaf reveals various layers of cells (Figure 4.6). The cuticle, the outermost part of the epidermis, is composed of a waxy material that helps prevent desiccation (drying out) of the leaf. Stomata, also located in the epidermis, are small openings located primarily in the lower side of the leaf. Stomata control the exchange of gases – oxygen out and carbon dioxide in. Guard cells, by expanding and contracting, regulate the opening and closing of the stomata. The leaf vein is composed of vascular tissues that conduct carbohydrates and water throughout the leaf.

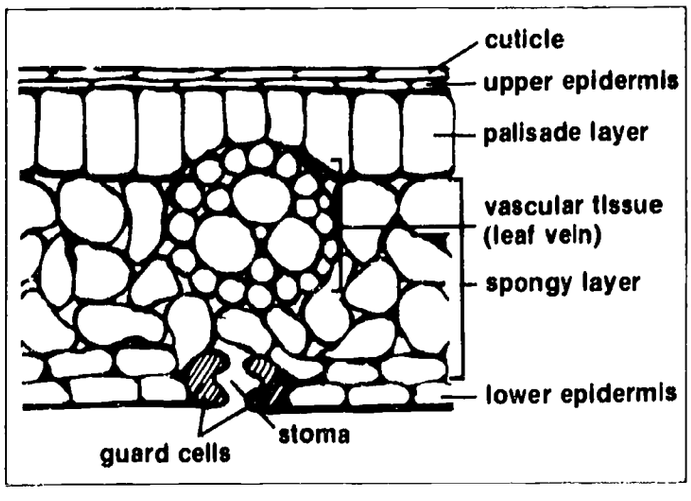



FIG. 4.6. Cross section through a leaf blade

Leaves may be arranged on the stem in several ways (figure 4.7). The most common arrangements are **alternate** and **opposite.** Maples, ashes, dogwoods, buckeyes, and horsechestnuts have leaves arranged opposite on the stem. Most other trees have alternate leaf arrangements. Leaves may be one (simple) or with many leaflets (compound) on each petiole or leaf stem (figures 4.8, 4.9).

Leaf shape is largely under genetic and hormonal control, but it is also influenced by environmental conditions such as light and moisture. Some leaves are modified into bud scales, spines, tendrils, or other plant parts. Leaf characteristics are often used in identification of plants. Leaf morphology (shape), venation patterns (figure 4.10), and margin formation (figure 4.11 ) are some of the important identification characteristics.

Deciduous trees are known in the fall for their color and for their loss of leaves. Leaf drop is caused by cell changes and hormones in the abscission zone at the base of the leaf petiole. Fall foliage color is due to expression of pigments other than chlorophyll. Shorter days and temperature changes trigger the accumulation of sugars and a decrease in chlorophyll production in the leaves, allowing these pigments to be expressed. These pigments are anthocyanins (reds and purples) and carotenoids (yellows, oranges, and reds).

*(continued on page 39)*

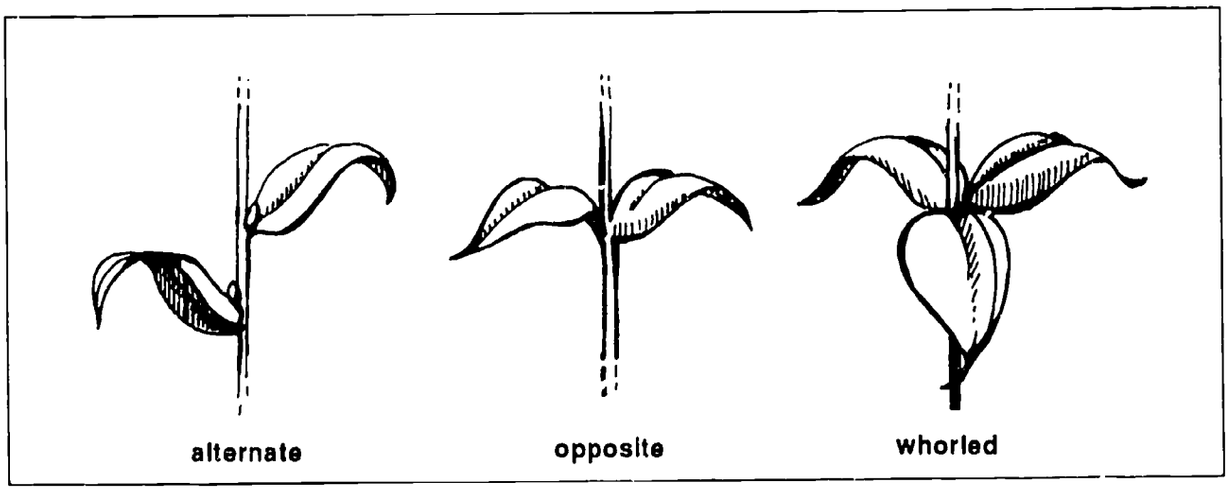



FIG. 4.7. Arrangements of leaves on stems

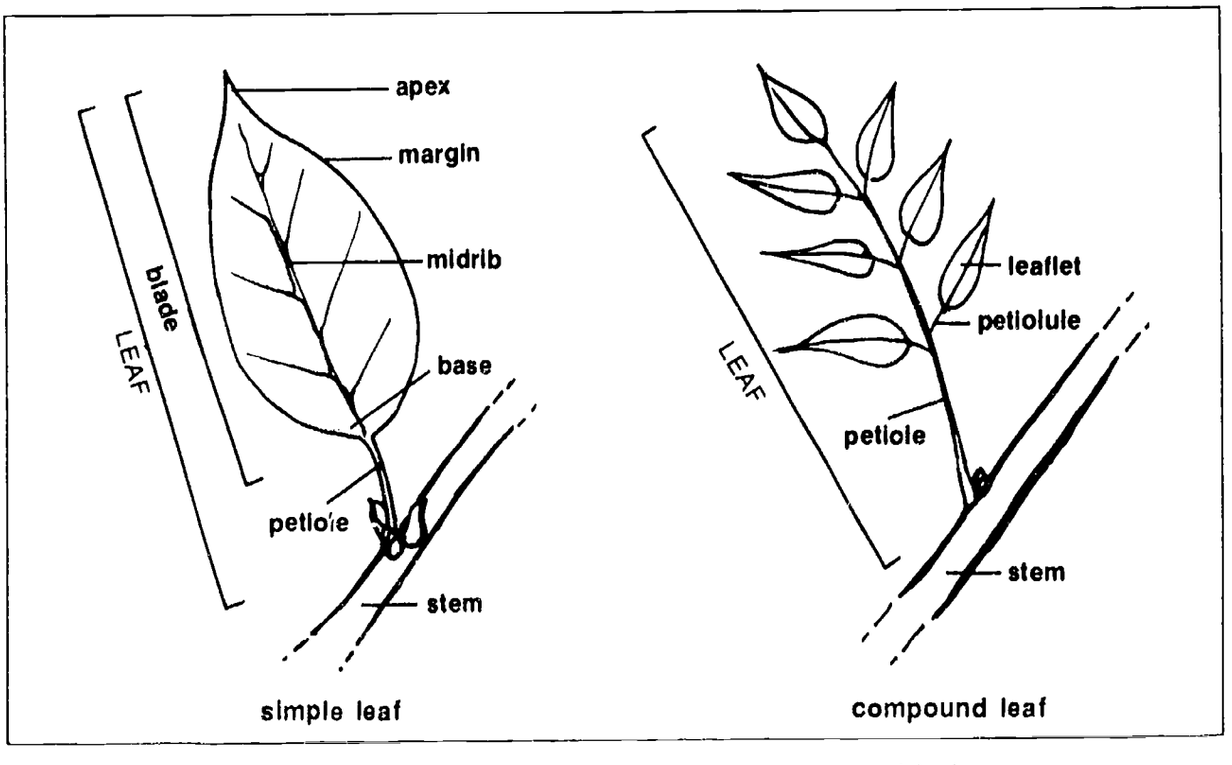



FIG. 4.8. Contrast of a simple leaf with a compound leaf

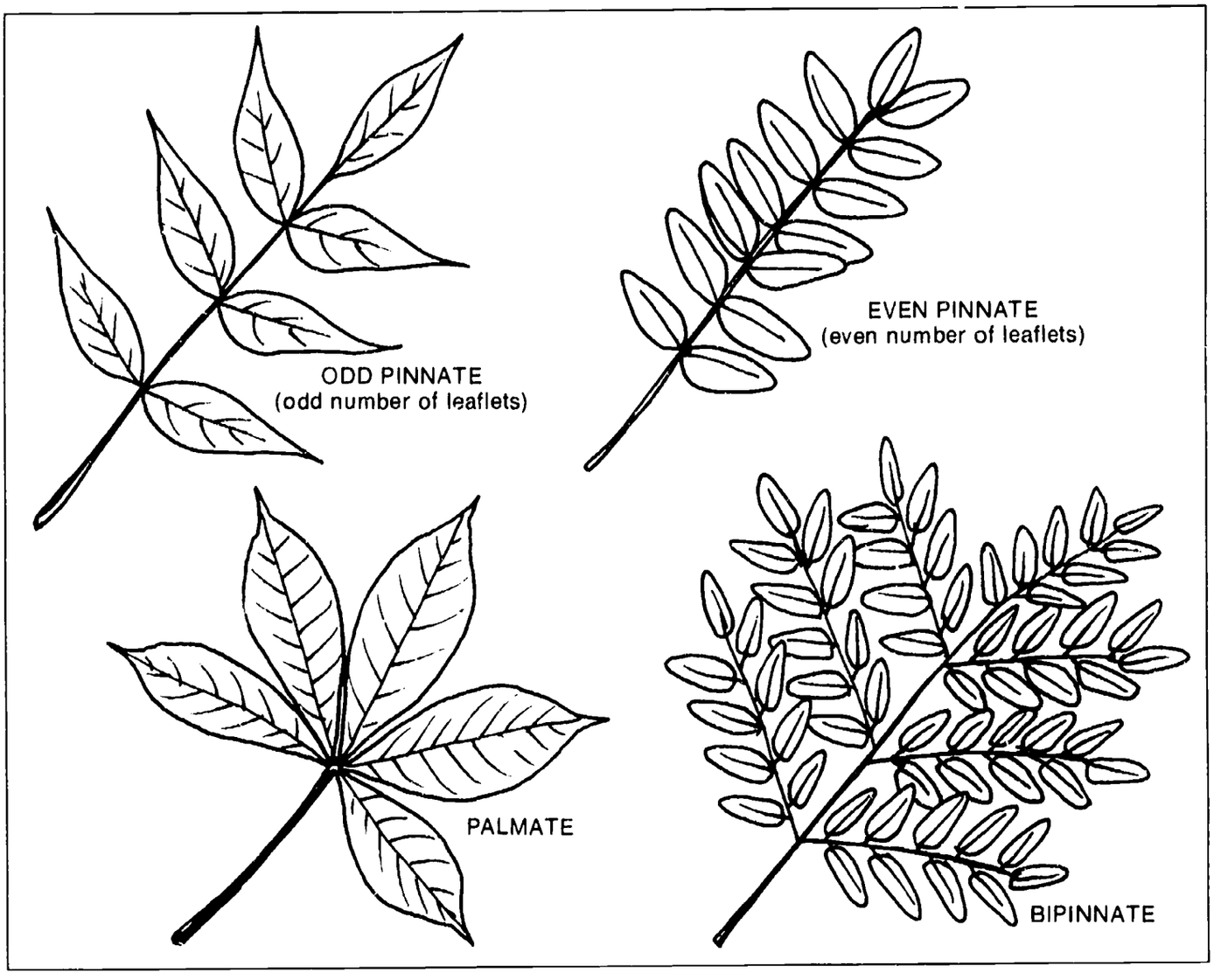



**FIG. 4.9.** Types of compound leaves

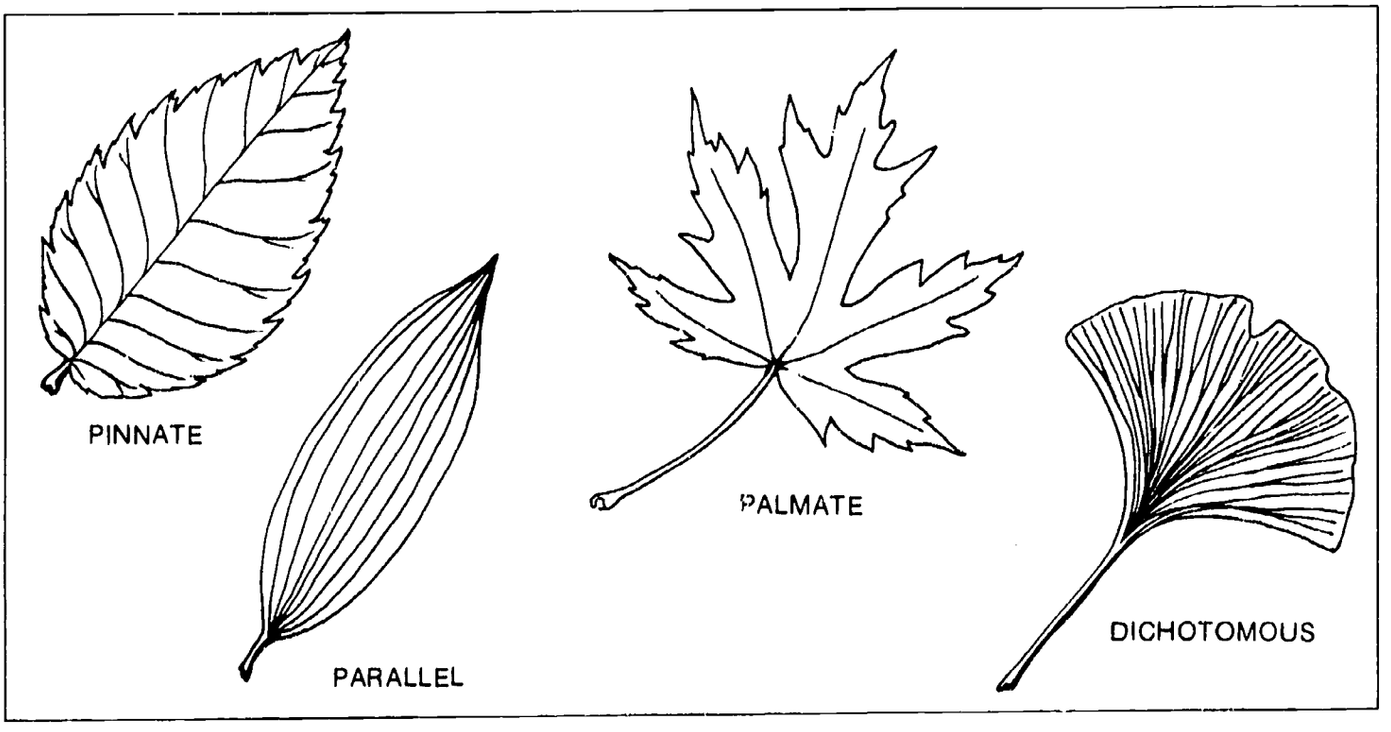



**FIG. 4.10.** Types of venation

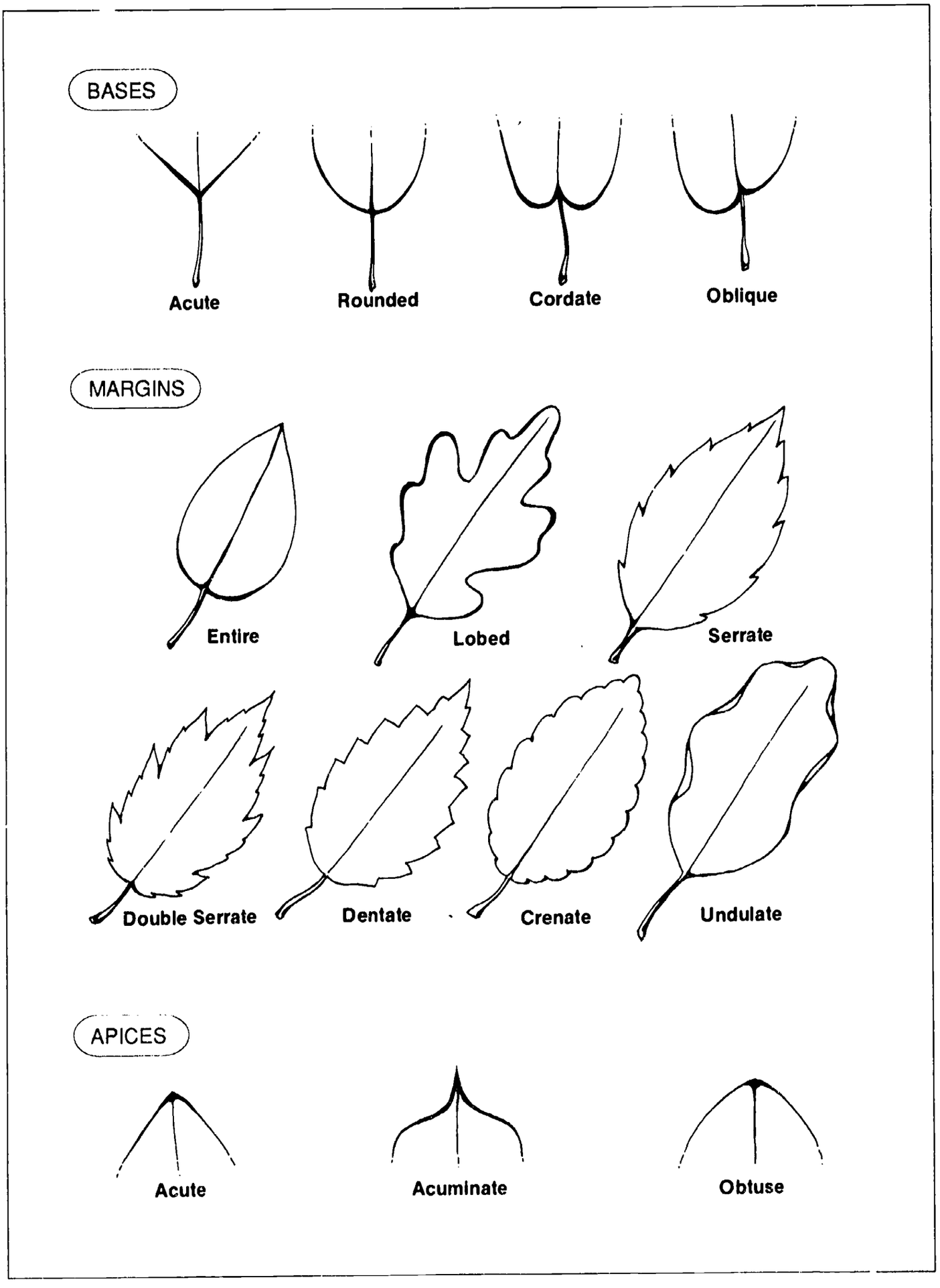



**FIG. 4.11.** Types of leaf bases, margins, and apices

## PHOTOSYNTHESIS AND THE TRANSPORT SYSTEM

Photosynthesis is the process by which light energy is used by plants to produce food – organic sugar compounds. The energy derived from these compounds is used by the plant to power other systems such as nutrient transport and respiration. **Respiration** is the process by which organic sugar compounds are broken down to provide the necessary energy. By contrast, **transpiration,** as already defined, is the process by which matter is drawn up through the stem and roots and is lost through the leaves. Although greatly simplified, these definitions do essentially describe the basic plant functions. Figure 4.12 summarizes photosynthesis and the transport system.

# Flowers and Reproduction

The flower contains the basic reproductive organs of most trees and shrubs. Angiosperms, plants with seeds borne in an ovary, include the common trees that we work with. All hardwood trees do bear flowers, though we do not think of oaks and maples as flowering trees.

Reproduction comes as a result of the union of sperm cells (contained in the pollen from male flower parts) with the egg (produced and remaining in the ovary of the female flower parts). Most trees are **monoecious**; that is, they have both male and female flowers on the same tree. A few are **dioecious,** with

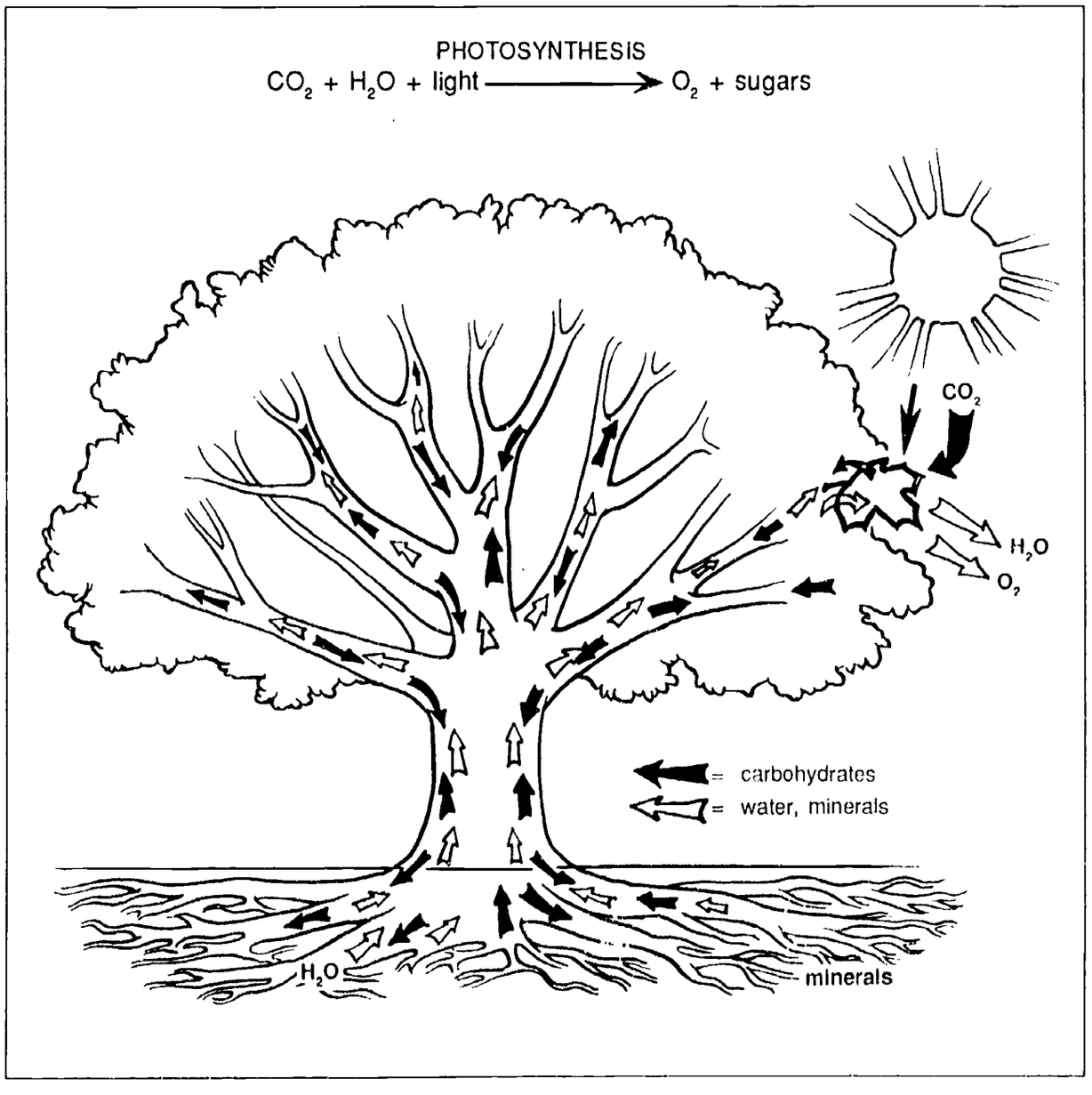



FIG. 4.12. Summary of photosynthesis and the nutrient transport system

separate male and female trees. A dioecious, male tree will not produce fruit or seeds. There are many types of flowers and they are divided into categories by what parts they contain or lack. A complete flower contains all four main parts: petals, sepals, stamens, and pistils (figure 4.13). A **perfect** flower is bisexual, containing both male and female parts. An **imperfect** flower is unisexual, containing either male or female parts.

Following pollination and fertilization, an embryo is formed within the ovary. As it matures, this ovule develops into the seed. Trees and other plants reproduce naturally by seed. Horticulturists, however, have learned and commonly use alternate propagation methods such as grafting and rooted cuttings to reproduce plants. Whatever propagation method is employed, the basic cycle of seedling to seed remains the same.

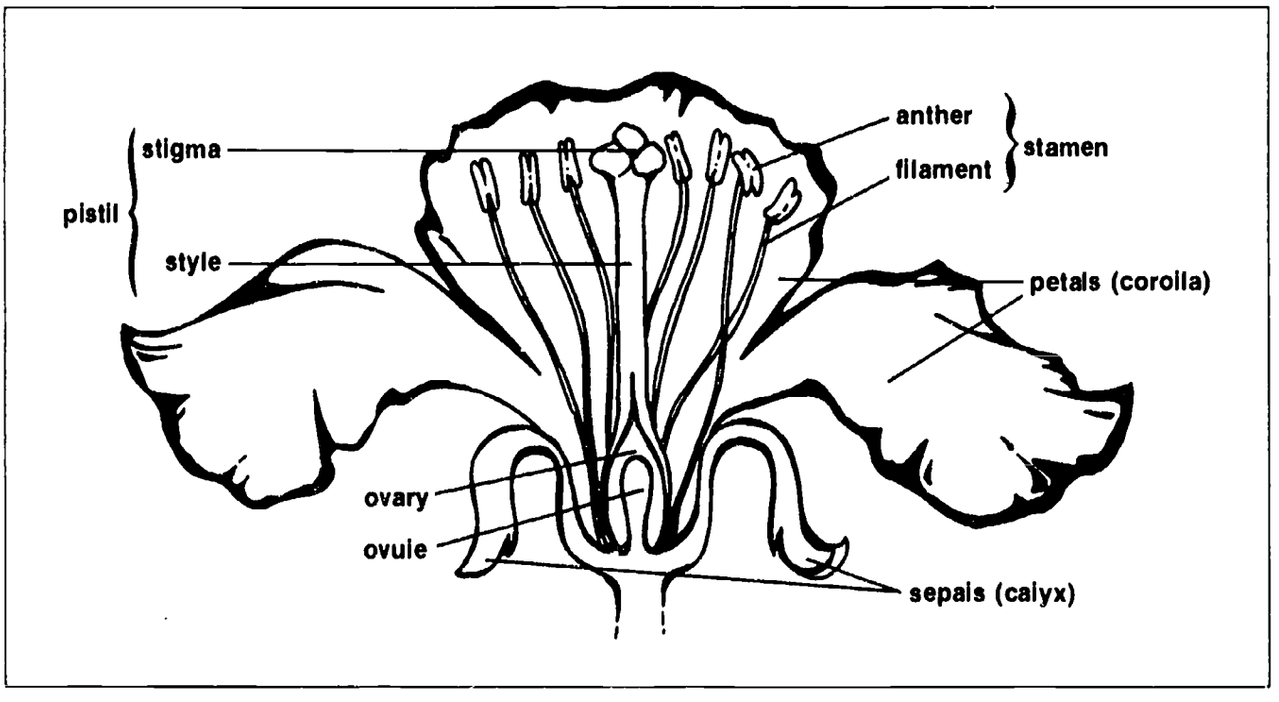
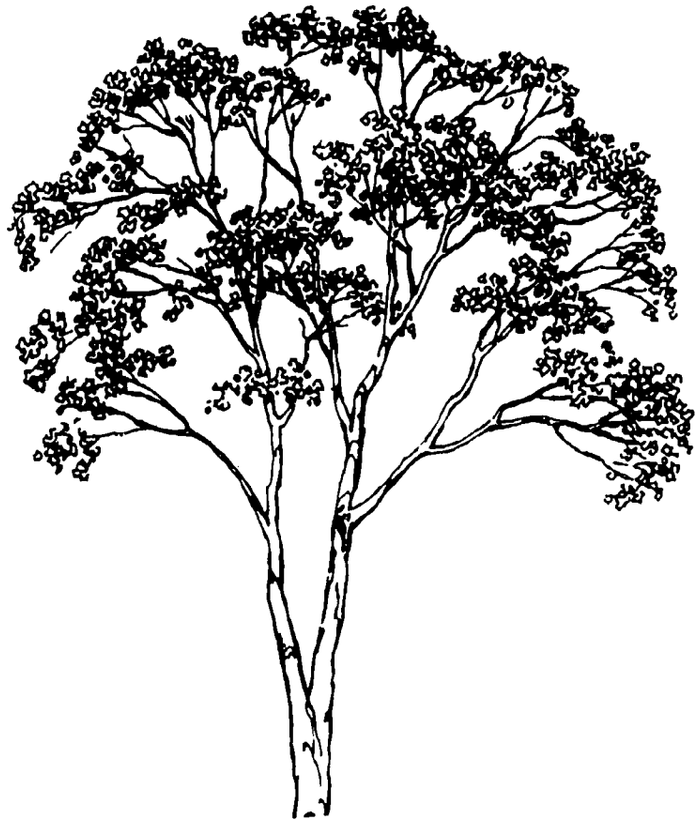



FIG. 4.13. Parts of a complete flower



CHAPTER 5

# Pruning

### *Objectives*

The purpose of this chapter is to introduce the basic principles of pruning.

1. Gain an understanding of the reasons for pruning.
2. Learn what parts to remove when pruning a plant.
3. Become familiar with the general procedures for pruning.

## Reasons for Pruning

Pruning may be defined as the removal of plant parts to improve the health or appearance of the plant. Some reasons for pruning are:

1. To remove dead or damaged plant parts.
2. To preserve plant health by removing diseased and insect-damaged parts.
3. To reduce the safety hazards of weak or broken limbs.
4. To maintain the shape of the plant.
5. To promote better branch structure for the plant as it matures.
6. To promote new growth or rejuvenate old, declining plants.
7. To restrict plant growth.
8. To remove unsightly sucker growth.
9. To improve future flowering or fruiting.
10. To create special effects (figure 5.1).
11. For clearance from utility lines.

In the landscape it is often necessary to prune plants to reduce or restrict growth. All too often plants are inappropriately chosen for planting around a home. They tend to outgrow the beds, hide the windows, and eventually engulf the house. The best preventive measure is to choose plants that will not grow too large. However, if this is not done, trees and shrubs must be contained by pruning.

Large shade trees are not usually trimmed to restrict growth. More often, pruning large trees involves the removal of dead wood, diseased limbs, and broken branches. In most cases, tree trimming is of a corrective or preventive nature. Trees may be thinned to reduce storm damage or increase light penetration to plants or lawns below.

## When to Prune

Many people worry that if they prune at the wrong time of year, they may end up killing or damaging the plant. Generally, it makes little difference what time of year pruning is done, although some plants have recommended seasons or timing for pruning. Pruning at the "wrong" time of year will not kill the plant, but it can temporarily restrict flowering or growth.

Probably the overall best time of year to prune most plants is late winter, before the spring's new growth begins. Some trees, like maple and beech, "bleed" if pruned in the spring. This sap flowing from the cuts does not really damage the plant. Pruning of some plants just *after* the new spring growth can reduce later growth. Since the plant has just expended much of its stored reserves to produce the new flush of growth, any additional growth stimulated by pruning will be limited. A common recommendation is to prune spring-flowering plants right after they have flowered to avoid removing next year's flower buds.

FIG. 5.1. These trees have been pruned to create an archway.

## What to Prune

When one is first learning how to prune, it is difficult to know what branches to cut. With a little knowledge and experience, pruning will become second nature. Most of the principles of pruning are simply common sense. Here are a few rules of thumb for pruning trees and shrubs.

1. Remove all dead or damaged branches.
2. Remove crossed branches (figure 5.2).
3. Remove branches that grow toward the interior of the plant (figure 5.3).

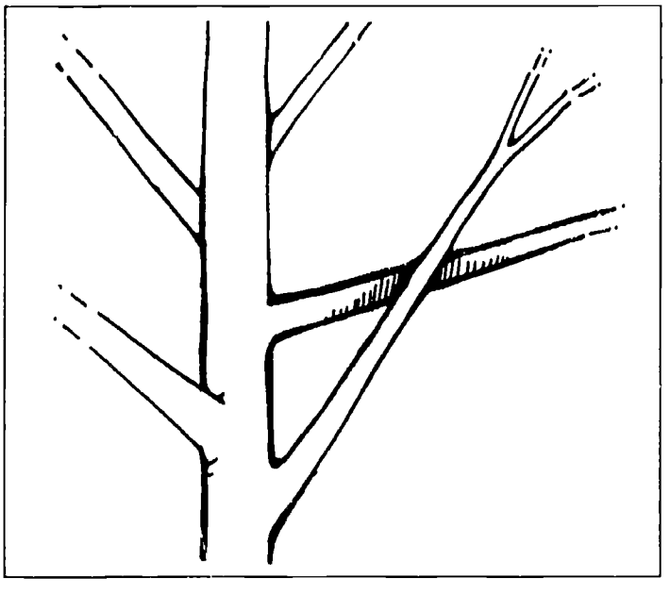


FIG. 5.2. Branches that cross may damage each other and detract from the appearance of the tree.

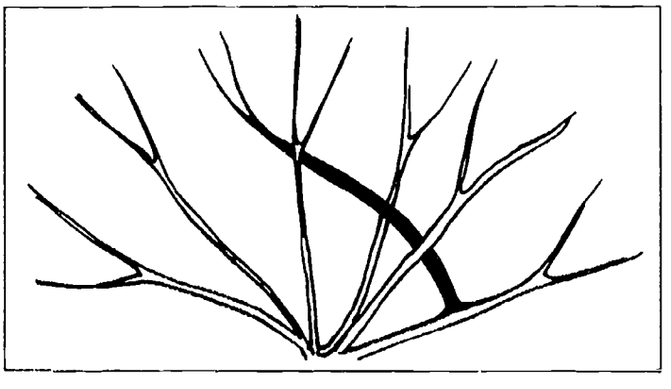


FIG. 5.3. Remove branches that grow through the middle of the plant.

4. Prune suckers and water shoots (figure 5.4).
5. Cut off any old stubs.

## Equipment

Most of the equipment used by tree workers has already been discussed. (See Chapter 2.) However, there are still a few points to be made. One of the most versatile pieces of pruning equipment is a pair of **hand pruners** or hand pruning shears. Properly sharpened hand pruners will easily cut 1/4- to 1/2-inch twigs. If the cut cannot be made without twisting, the twig is too large for the tool being used. There are two types of hand pruning shears (figure 5.5). Double-cut or scissor-cut hand pruners have an upper flat blade and a lower hook blade. These pruners tend to cut very efficiently. Anvil-type clippers are less expensive, but also less efficient; they do not leave as clean a cut as double-cut hand pruners.

FIG. 5.4. Remove suckers and water shoots.

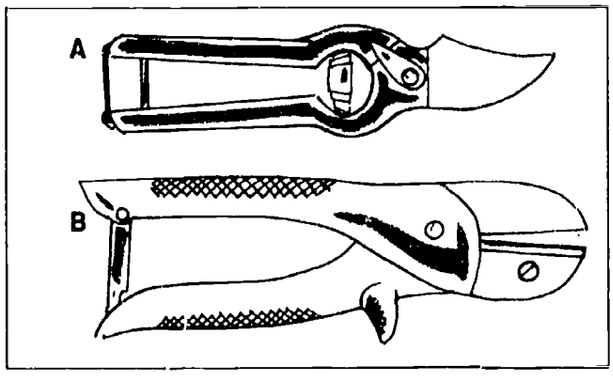



FIG. 5.5. Hand pruning shears: **A** - double-cut; **B** - anvil-type

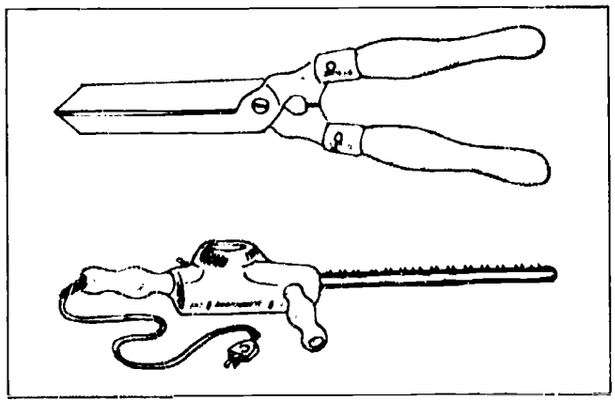


FIG. 5.6. Hedge shears

**Hedge shears** are also commonly used for pruning shrubs (figure 5.6). They are perhaps the most overused and misused pruning tools. Hedge shears are the tools used to clip shrubs and hedges into formal shapes. They are used to create unusual shrub shapes like gumdrops, bowling pins, and match boxes along the front of houses. Although this is certainly a viable pruning option, the trend today is to prune plants in a manner that maintains or enhances their natural form.

## Proper Pruning Techniques

All cuts should be clean – no peeling bark or frayed edges. This requires sharp tools and proper cutting technique. Usually the main cutting blade should cut upward in order to make a good cut with hand pruners (figure 5.7), loppers, or pole pruners. Never twist or tear off a branch. With the correct tool, any cut can be made easily without tearing.

FIG. 5.7. A clean cut is obtained by cutting upward with hand pruners.

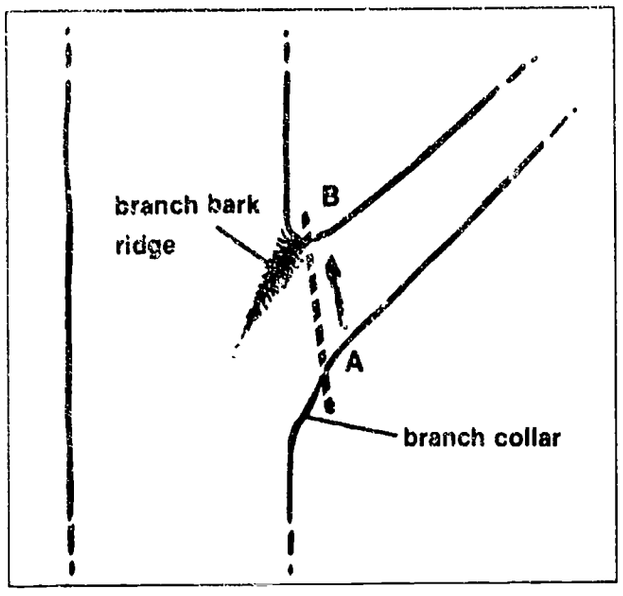



FIG. 5.8. Locate the correct line for the cut.

FIG. 5.9. Never cut through the collar of the branch.

The placement of the cut is the most critical factor in pruning. The cut must be made close to the main limb without cutting into the branch collar or leaving a stub. Figure 5.8 shows the correct placement of the cut. The best way to achieve the desired cut is to cut upward from point A to point B. The angle is equal and opposite to the angle formed by the branch bark ridge. The branch bark ridge is simply a rough, raised area in the bark formed at the crotch. Never cut branches through the branch collar and flush with the parent stem (figure 5.9). Doing this inhibits the tree's natural ability to close the cut and block off decay. A little practice and experience will help in locating the branch bark ridge and the branch collar on many different types of trees. Figure 5.10 shows two incorrect cuts.

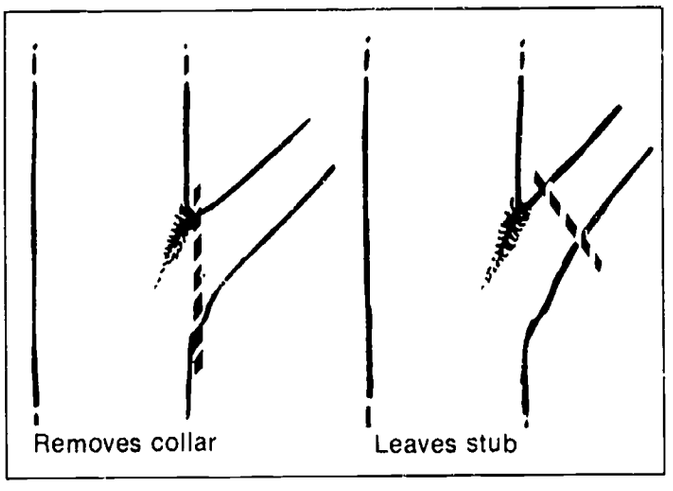



FIG. 5.10. Incorrect branch cuts

When working with larger limbs, it is necessary to remove the main weight of the limb before making the final cut. Figure 5.11 shows the cuts that are used in pruning a large limb. The lower undercut is made to prevent peeling down of the branch into the main trunk (figure 5.12). Never cut too deep in the undercut or the saw will get pinched. The second cut removes the limb.

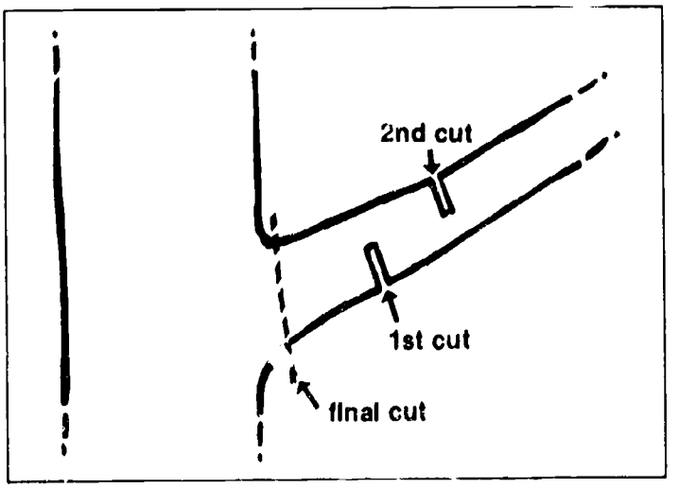



FIG. 5.11. Three cuts are used when removing large limbs.

## Pruning Trees to Direct Growth

Early pruning of young trees is important to direct growth and establish a strong branch scaffold. The strength of the branch structure is dependent upon the angles, relative sizes, and spacing of the limbs. Naturally, this will vary with the growth habit of the tree. Pin oaks and sweetgums have a strong conical shape with a central leader. Other trees, such as lindens and Bradford pears, are densely branched, often without a central leader.

Branches that are to be part of the permanent branch structure should be selected for structural integrity. Branches with very narrow crotch angles may contain included bark which could lead to

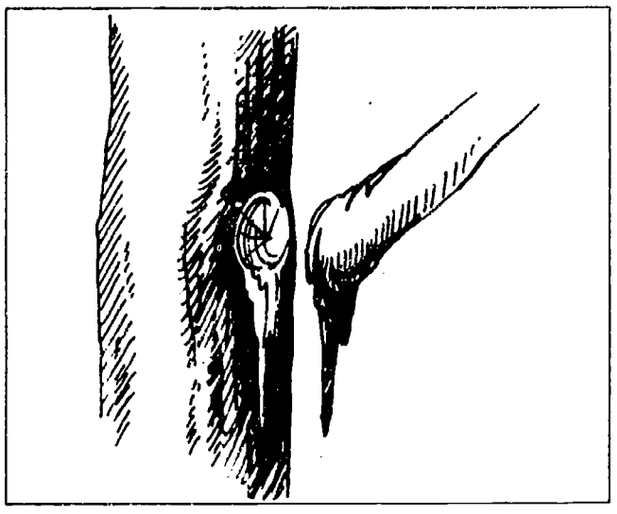


FIG. 5.12. Use of incorrect technique can result in the bark being stripped from the parent stem.

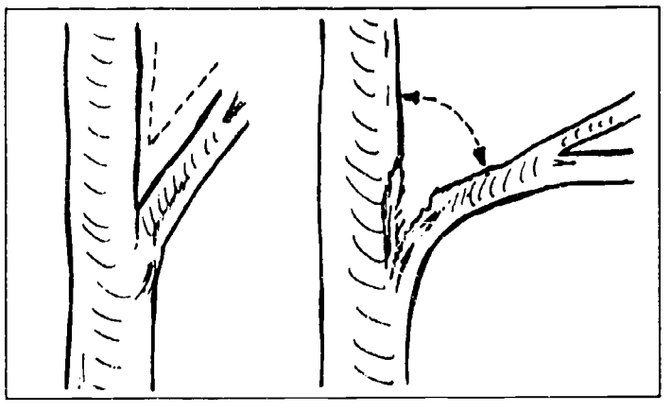


FIG. 5.13. A branch with a narrow angle of attachment may not be sound.

splitting. The spacing of limbs, both vertically and radially in the tree, is also important. Branches spaced too close together not only are less appealing visually, but may break during a storm. Generally, the leader in a tree is not pruned back unless multiple-stemmed plants are desired, or if the leader has become too dominant. If a tree has more than one leader, one should be selected and the others removed. (See figures 5.13, 5.14, 5.15, and 5.16.)

## Drop Crotch Pruning

Topping or "heading back" is an undesirable method of reducing the height of a tree. In order to direct growth and reduce unattractive suckering from top cuts, the drop crotch method should be used (figure 5.17).

Generally, not more than one-third of the total canopy area should be removed in a single pruning operation. Cuts should be made back to a lateral or side branch, no less than one-third the diameter of the cut. Cutting large limbs back to small suckers often results in further dieback of the limb.

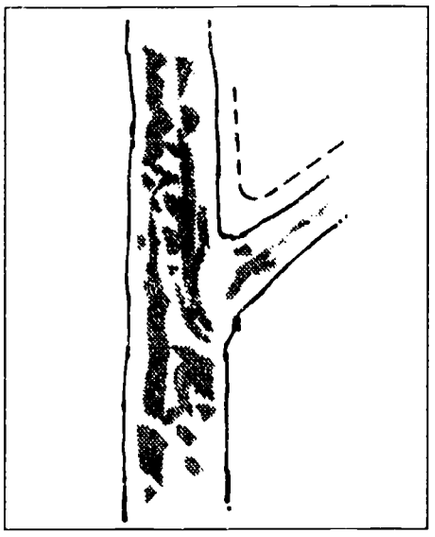


FIG. 5.14. When possible, select scaffold branches with wide, strong angles.

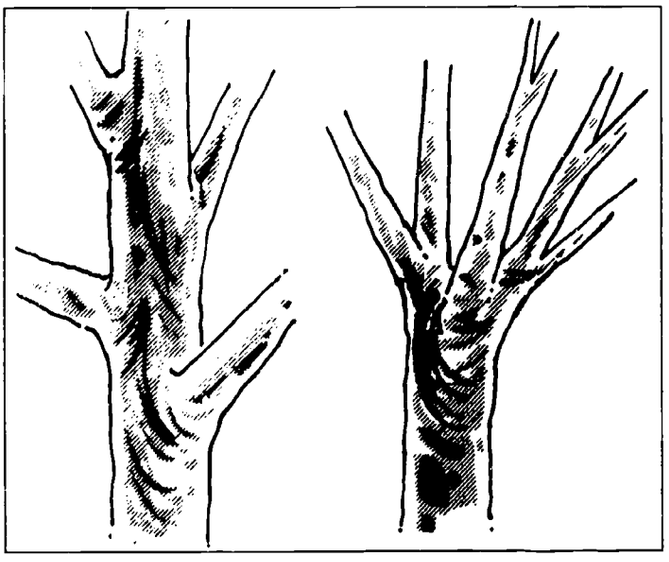


FIG. 5.15. Well-spaced branches have stronger attachments than those growing close together or in a cluster.

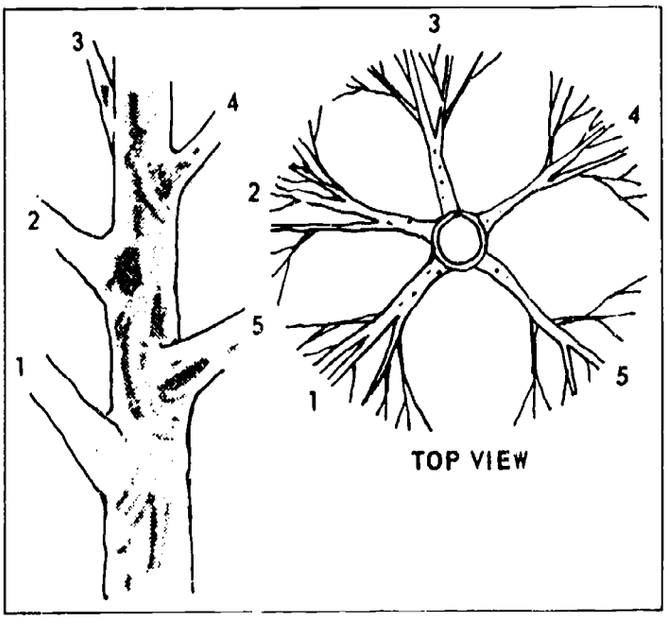



FIG. 5.16. Branches with good scaffolding require proper vertical and radial spacing on the trunk.

Figure 5.18 shows a tree that has been pruned using the drop crotch method. Notice that the standard rounded shape has been maintained. Flat-topped trees are very unappealing to the eye.

There are two steps in making the cuts for drop crotch pruning. First, the weight of the limb is removed several inches above the lateral (figure 5.19). Then the final cut is carefully made diagonally just above the lateral – sufficiently close to it without cutting the branch bark ridge or leaving a stub.

Even when done correctly, drop crotch pruning takes away from the natural form of the tree and may reduce its functional life. For these reasons, this type of pruning is used only under certain special circumstances:

1. Tree interference with utility lines.
2. Unusual or rapid tree growth.
3. Reduction in height of soft-wooded trees to reduce the safety hazard from breaking.
4. Specific topiary training or dwarfing.

## Treatment of Wounds

Lesions in a tree may be caused by splitting of branches or by any kind of mechanical means such as collision from a car or lawn mower. Often the bark is crushed or torn from the wood of the tree.

Loose or damaged bark should be cut away by bark tracing or wound tracing. Using a sharp knife, cut away the loose bark and smooth the jagged edges of the wound (figure 5.20). The shape of the final wound is not important to closure. It is very important not to cut into the wood. Remove as little bark as possible. Excessive bark tracing may enlarge the wound and damage natural decay barriers.

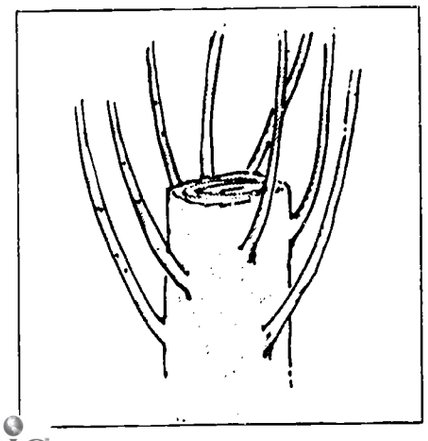


FIG. 5.17. Topped trees produce vigorous water sprouts.

FIG. 5.18. In heading back, all cuts are made at laterals and the shape of the tree is maintained.

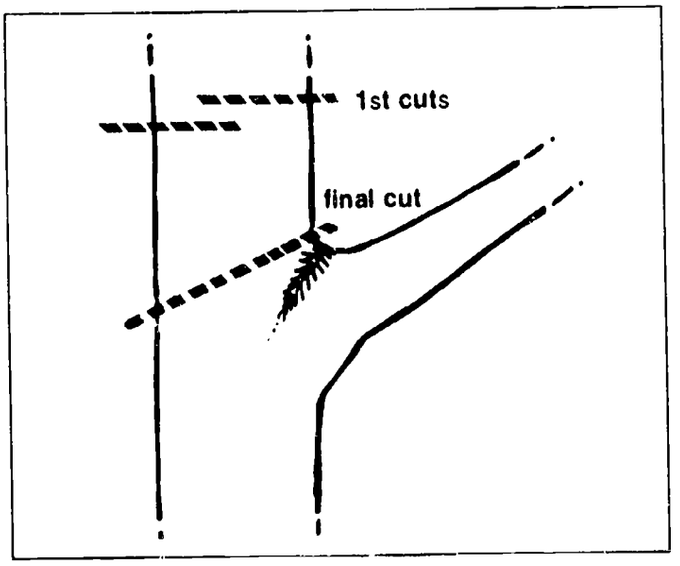



FIG. 5.19. The final cut should run diagonally just above the branch bark ridge.

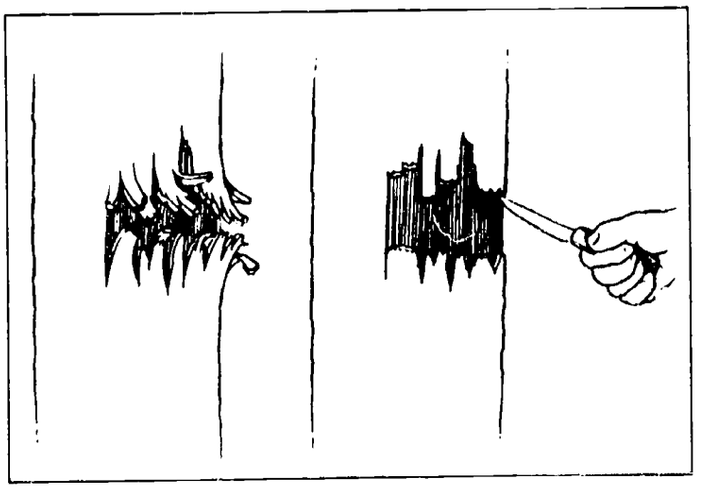


FIG. 5.20. When tracing a wound, remove as little as possible, leaving a smooth edge for closure.

There has been lively debate as to the merit of using wound dressings on pruning cuts and tree wounds. Increasingly, most research indicates that wound dressings do not keep out most insects or diseases, do not aid in wound closure, and do not prevent decay. Wound dressings are applied mostly to color the wound — for cosmetic purposes. A thin layer of a material non-toxic to the cambium may be used.

## Tool Sterilization

When tools are used on a tree known to be diseased, it is often recommended that they be sterilized between cuts and certainly before use on another tree. This helps reduce the spread of disease organisms. Tools may be sterilized with a 70% methyl alcohol (methanol) solution. There remains some doubt as to whether certain diseases can be transmitted via pruning tools and whether alcohol treatment is effective. But tool sterilization for diseased trees is still a recommended procedure in most references.

## Pruning Conifers

Conifers sometimes require different pruning techniques. The timing is usually more important than for deciduous plants. Generally, conifers are pruned while they are dormant, although there are some exceptions.

Pines are pruned in the spring just as the new candle growth has expanded (figure 5.21). Candles may be cut halfway to create dense foliage. Pruning at this time will not prevent bud formation the following year. Pines form buds only in actively growing (twigs with needles) parts of the plant.

Regular pruning techniques apply to the pruning of branches on coniferous trees. Keep in mind that pruning late in the season will result in no growth the following season where buds have been removed. Generally, coniferous trees have a single central leader. If a second leader develops, it generally should be removed (figures 5.22 and 5.23).

Spreading evergreen plants may be pruned to restrict growth and maintain shape. Figure 5.24 shows how these plants might be pruned. Pruning according to natural growth shape is recommended over extensive shearing except where formal, compact forms are desired. An ideal time for pruning evergreens is at Christmas so that the clippings can be used in decorating.

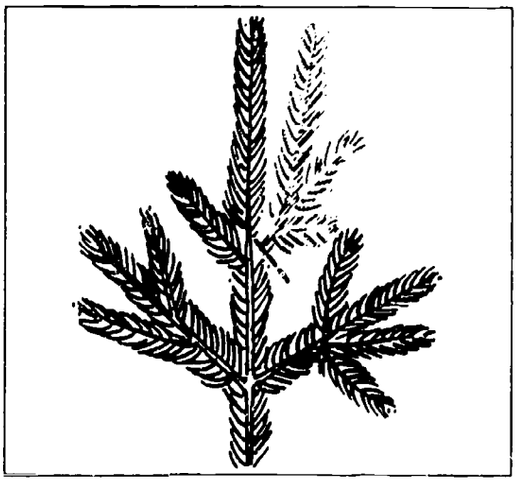


FIG. 5.22. Remove multiple leaders on spruce and pine, leaving the best one to become the new central leader.

FIG. 5.21. Candle growth on a pine tree

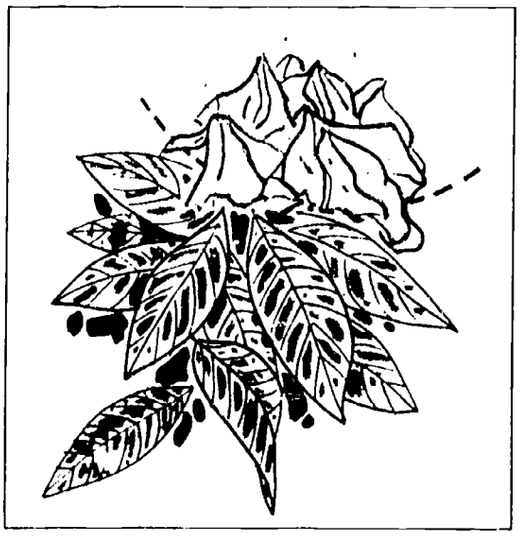


FIG. 5.23. Snap or cut out dead flowers of rhododendron, being careful not to damage new shoot growth.

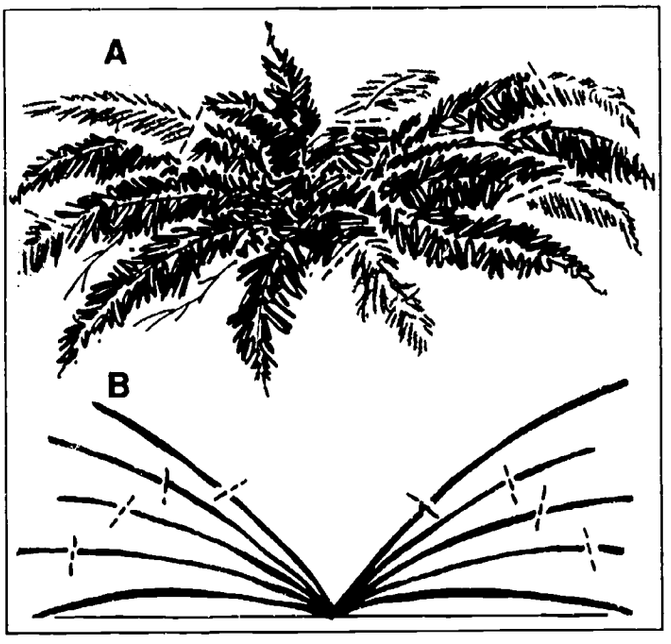



FIG. 5.24. **A** - Prune spreaders by cutting back longer, upper branches. **B** - Cut back the long branches from a few inches to half the branch to prevent shading of lower branches.

## Pruning Hedges

The key to developing a thick formal hedge is to begin pruning when the plants are very young. Continued pruning is required, sometimes several times a year. Whether deciduous or evergreen, the hedge should be pruned so the base is broader than the top, as illustrated in figure 5.25. This provides light for the lower portion of the plants and so helps maintain full foliage near the bottom.

## Pruning for Special Effects

There are a number of special effects that can be created with plants (figure 5.26). With few exceptions, maintenance of these plants requires a great deal of time and effort.

***Bonsai is*** the art of creating miniature trees or shrubs by dwarfing the plant (figure 5.27). This process requires great skill in pruning both the roots and upper portions of the plant. Bonsai plants have been known to survive hundreds of years with proper care.

***Topiary*** work is another example of specialty pruning. Pruning of plants into unusual shapes becomes a specialized art form (figure 5.28). Some European formal gardens contain mazes of formal hedges and animal figures created by careful pruning. Plants with dense foliage such as yew and boxwood are most often used in topiary pruning. Such artwork requires a great deal of constant maintenance.

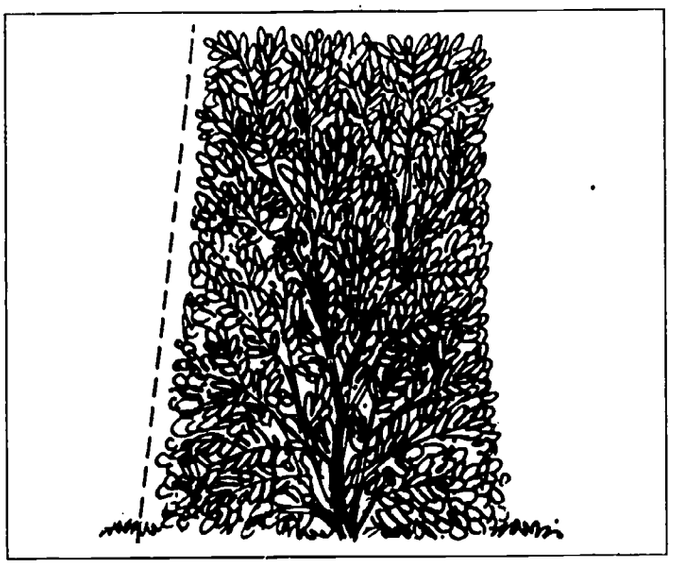


FIG. 5.25. Prune a hedge so the base is broader than the top.

FIG. 5.26. Other special effects can be created with living plants.

*Espalier* is the training of plants to grow in a formal pattern, often on the side of a wall, fence, or trellis. This training is done by pruning those twigs that grow in any direction other than the one(s) desired. The plant is attached to the flat surface with specially designed clips and formed into the beginning pattern. Frequent, careful pruning is required to train and maintain espalier forms (figure 5.29).

FIG. 5.27.
A bonsai plant

FIG. 5.28. Topiary makes an excellent visual attraction in a formal garden.

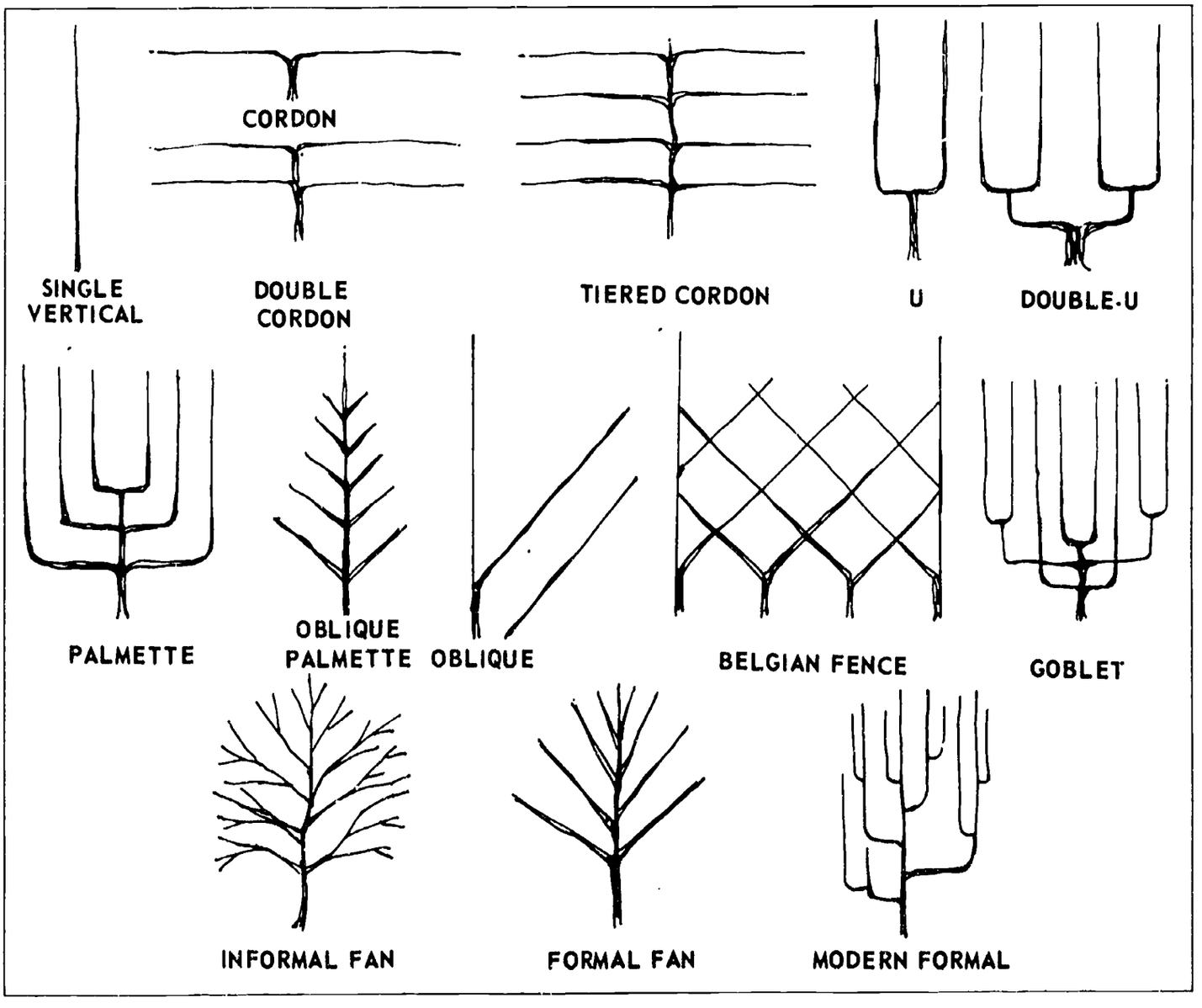
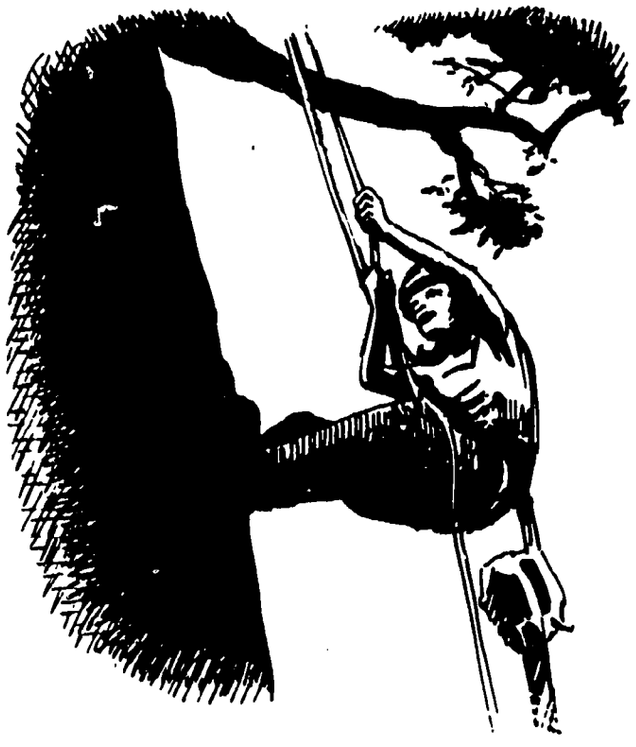



FIG. 5.29. Some espalier patterns. The most commonly used is ***double-U.***



CHAPTER 6

# Climbing and Working in the Tree

## *Objectives*

Certainly the knowledge and experience required for tree work can not be obtained solely from a book. This chapter seeks to provide only the *basic* principles and theories of climbing and working in trees.

1. Know and be able to use the knots and hitches used by a tree climber.
2. Be able to locate and tie into a safe and workable tree crotch.
3. Learn to throw and place a rope in a tree.
4. Be familiar with the various climbing methods.
5. Understand the basics of roping and rigging.
6. Become familiar with the techniques used in aerial rescue.

## Planning Ahead

Before climbing a tree, the climber should always look it over. The climber must first know exactly what is to be done in the tree. Inspection of the tree will then yield information such as the location of major limbs that are dead and broken. The location of any electrical conductors or utility lines should also be noted. An experienced tree worker is familiar with different types of trees and knows how strong or brittle their respective woods are. A good climber will plan ahead what route to take in climbing the tree and where to tie in. A little forethought can save a great deal of time and energy later.

## Ropes and Knots

Climbing ropes should have a minimum diameter of 1/2 inch. The climbing ropes used today are made of a synthetic fiber. Synthetic ropes should have an elasticity of not more than 7 percent. The climber must inspect the climbing rope before use. A rope with any defect at all should not be used. Climbing ropes should never be spliced for repair. If the rope

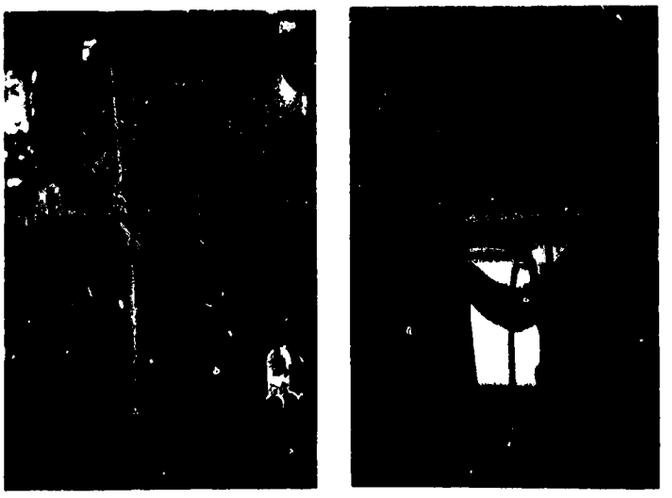


FIG. 6.1. The tautline hitch shown from two angles

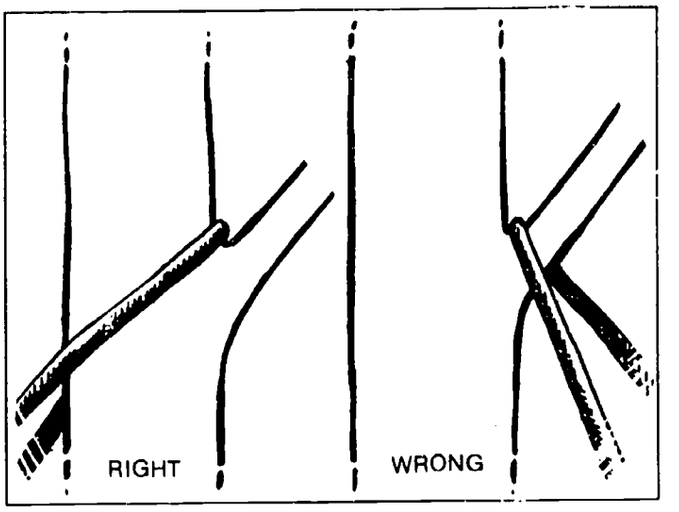



FIG. 6.2. The rope should pass around the main leader, not around the secondary branch.

is worn from the safety snap, the snap may be moved to the other end and the worn part of the rope cut off.

The climber must be familiar with all the knots described in Chapter 3. Many of these knots are used routinely while working in the tree. Of course, the most important knot to the climber is the tautline hitch (figure 6.1). It would be most helpful for the climber to be able to tie this knot with one hand or without looking. This may become necessary in an emergency.

## Choice of Crotch

As mentioned earlier, the choice of where to tie in may be made before climbing the tree. Generally, it is desirable to pick a very high central location in the tree. This allows freedom of movement and easy access to any point below in the tree. It is easiest to work when tied in directly above the working area. Never tie into a crotch that would allow swinging into power lines in case of a fall.

The crotch selected for tying in should be wide enough for the rope to pass easily through. The limbs must be large enough to support the climber with no risk of breaking. When tying in, the rope should pass over the lateral and around the main branch (figure 6.2). Then, if the lateral should break, the climber's line will drop to the next crotch and not completely out of the tree.

## Rope Throw

Frequently the climber cannot use a ladder to get even to the first branch. The climber must be able to throw the climbing line into the tree in order to begin climbing. On short throws, it may be easiest to simply loop the rope over a low limb. For trickier throws, the climber may tie a throwing knot. A throwing knot is simply a series of wraps that hold the rope together to facilitate throwing. These wraps can be made to unwind after the rope passes over the limb. Figure 6.3 illustrates the throwing knot. Whatever method is used, practice is important to gain accuracy.

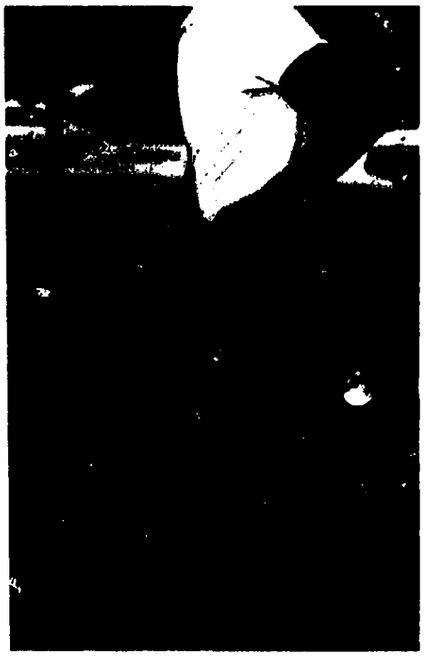


FIG. 6.3. A throwing knot ready to throw

At times the climber must throw the rope to get higher within the tree. In such cases, skill and accuracy will save a great deal of time. The climber sometimes also has the option of placing the rope higher using a pole pruner. The loop of the throwing knot is placed over the lever of the pole pruner (**not** over the cutter!). After the pole is positioned over the desired limb, a quick tug of the pole rope will drop the climbing line in place. This too requires a little practice.

FIG. 6.4. Hold the rope and swing the ball to gain momentum.

FIG. 6.5. Most tree workers prefer to hold the rope this way.

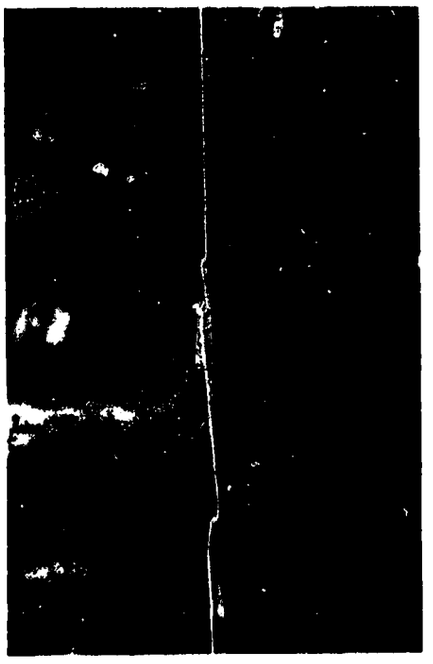


FIG. 6.6. Notice how the climbing rope is tied to the ball rope.

Some climbers choose to set their rope high in the tree with the use of a throwing ball. A throwing ball is a rubber-coated weight in teardrop shape with a very long nylon string attached. The throwing ball can be thrown into a tree with reasonable accuracy up to 60 feet. Figures 6.4 and 6.5 show how the throwing ball is held prior to the toss. After the ball passes through the tree crotch, it comes to the ground. The climber's line is tied to the ball string end (figure 6.6) and pulled through the crotch. If the crotch is tight or V-shaped, the rope should be tied to the throwing ball string using a long series of half hitches. This will keep the climbing rope from getting caught as it reaches the crotch. Use of the throwing ball can save a climber several rope throws in ascending a tree.

## Ascent

There are several ways of ascending the tree. For safety purposes, it is best either to be tied in or to use the safety strap at all times when in the tree. Often a climber uses a ladder to get up into the tree. (Note that ladders made of metal or other conductive materials must **never** be used near an electrical conductor.) The ladder should be steadied by another worker on the ground. The climber should not work from the ladder, as it is not as safe or predictable as working from a rope.

Another method of reaching the first branch is to shinny up the tree. Since this method requires a great deal of strength and energy, a worker should never shinny a distance greater than 15 feet. A safety strap may be used for added security.

Lumberjacks often climb trees with the aid of spurs. Since climbing spurs cause unsightly gashes in the tree, which may become entryways for insects and disease, spurs should be used only on trees to be removed.

The primary means of ascending a tree is the **body thrust** method (figure 6.7). With the rope already in the tree, the climber attaches one end to

FIG. 6.7. The legs and body are just as important as the arms in the body thrust method.

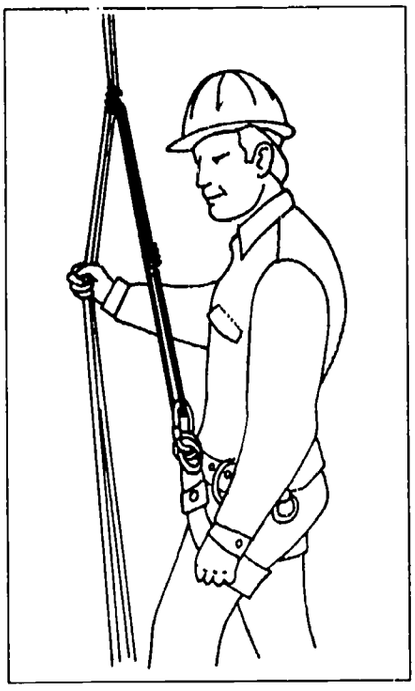


FIG. 6.8. A climber using the secured footlock technique. (from *International Society of Arboriculture Study Guide*, used with permission)

FIG. 6.9. He pulls his feet up under his body.

FIG. 6.10. Notice how the rope is gripped between the feet.

his/her saddle. The climber may or may not tie the tautline hitch. If the climber chooses not to tie in, another worker must hold the other end of the rope as the climber goes up. The ground worker must not release the rope until the climber is safely tied in.

The secret of the body thrust is to use the entire body and not to rely totally on the arms. The trick is to place the feet high on the tree and pull hard with the arms while thrusting the body upward. When done rapidly and efficiently, the climber appears to be simply walking up the tree. If the climber attempts to pull all the way up with the arms, fatigue will become a serious factor.

**Footlocking** is a popular method of climbing a rope. The rope must be up in the tree, usually with both ends on the ground. The climber actually climbs both strands of rope together. The climber holds the rope tightly above the head and pulls the feet up underneath. The rope is then gripped tightly between the feet while the climber "stands" and re-grips the rope higher above the head. Figures 6.8 through 6.10 illustrate the footlocking process.

If the footlocking method is used, the secured footlock technique is recommended. The use of a **Prusik loop** makes footlocking as safe as body thrusting. The Prusik loop is an 8-foot length of rope of a smaller diameter (usually 9 mm) than the climbing rope, that is tied into an endless loop. The Prusik loop is tied with a Prusik knot around both strands of the crotched-in climbing rope (figure 6.11). The climber clips the other end of the loop into the D-rings on the saddle. The rope is then footlocked in a normal manner, sliding the loop up the rope while climbing (figure 6.12). The secured footlock method is intended for safety in ascending. It should not be used for working or descending under a load.

It is also helpful if the rope is over the second branch up, for this allows the climber to land on the lower branch. It is difficult and unsafe to footlock up to the same branch on which the rope is crotched.

Once in the tree, the first step is to tie in. The climber's knot or tautline hitch is tied from the tail of one strand of rope to the other strand (figure 6.13). Figure 6.14 shows the tautline hitch.

If the climber wishes to go higher in the tree to tie in, there are two options: 1) The safety strap can be used while the climber unties and rethrows the climbing rope; 2) The climber can use the other end of the climbing rope to tie in higher and then untie the first knot.

In very high trees, the climber is best advised to tie a figure 8 knot in the far end of the climbing rope. This will prevent slipping of the end of the rope through the tautline hitch as the climber comes down.

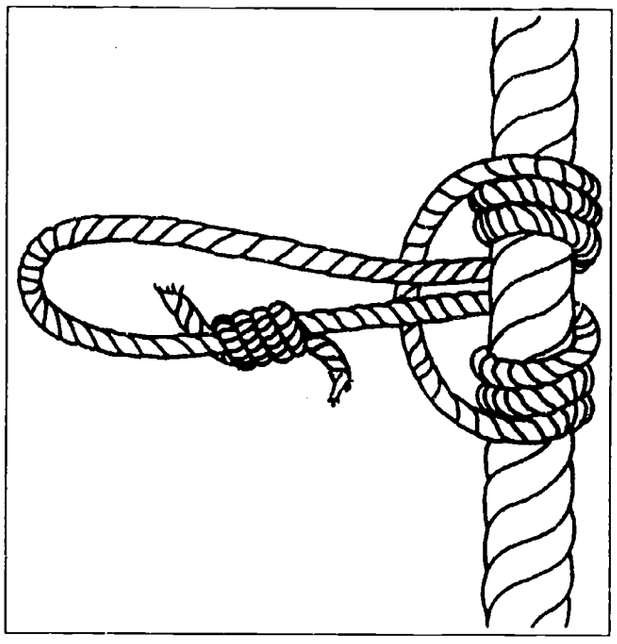


FIG. 6.11. The Prusik knot and loop

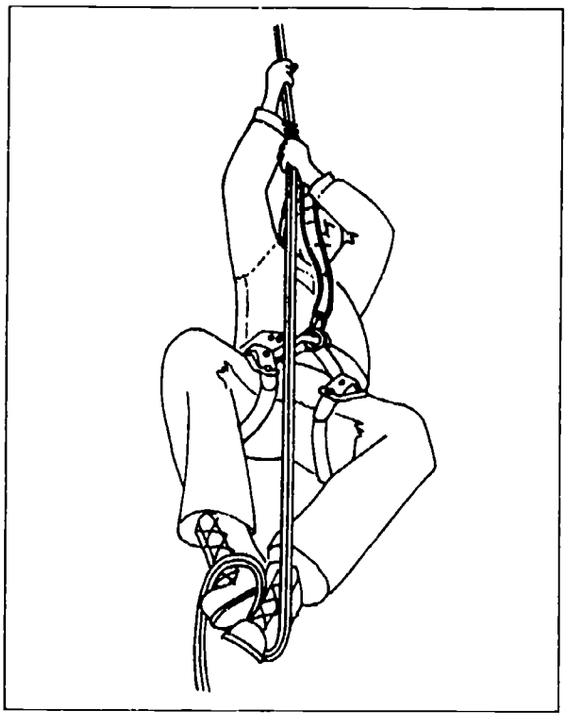


FIG. 6.12. The climber slides the Prusik loop up his climbing rope as he ascends.
(Figures 6.11-6.12 from *International Society of Arboriculture Study Guide*, used with permission)

Some climbers also tie a figure 8 knot in the cross rope between the D-rings of the saddle and the tautline hitch. This is to identify where to cut in an emergency. If the climber must be rescued, a ground worker can hold the other end of the climber's rope while a worker cuts the rope at the figure 8 knot with a pole pruner. The climber can then be safely lowered from the ground. Figure 6.15 shows where the figure 8 knot would be tied.

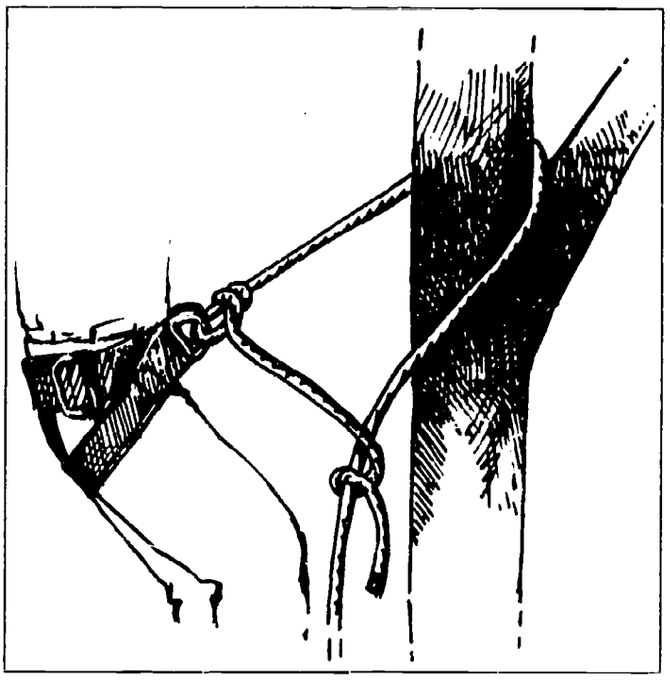


FIG. 6.13. Tie the tautline hitch using the tail of the rope coming from the attachment to the saddle.

FIG. 6.14. Always check the tautline hitch after tying in.

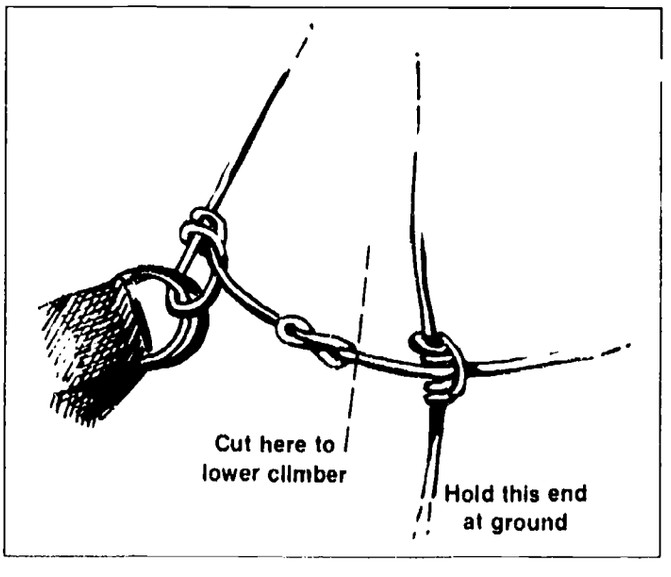



FIG. 6.15. A figure 8 knot and where to cut the rope in an emergency.

FIG. 6.16. Using the climbing line frees the climber's hands for other work.

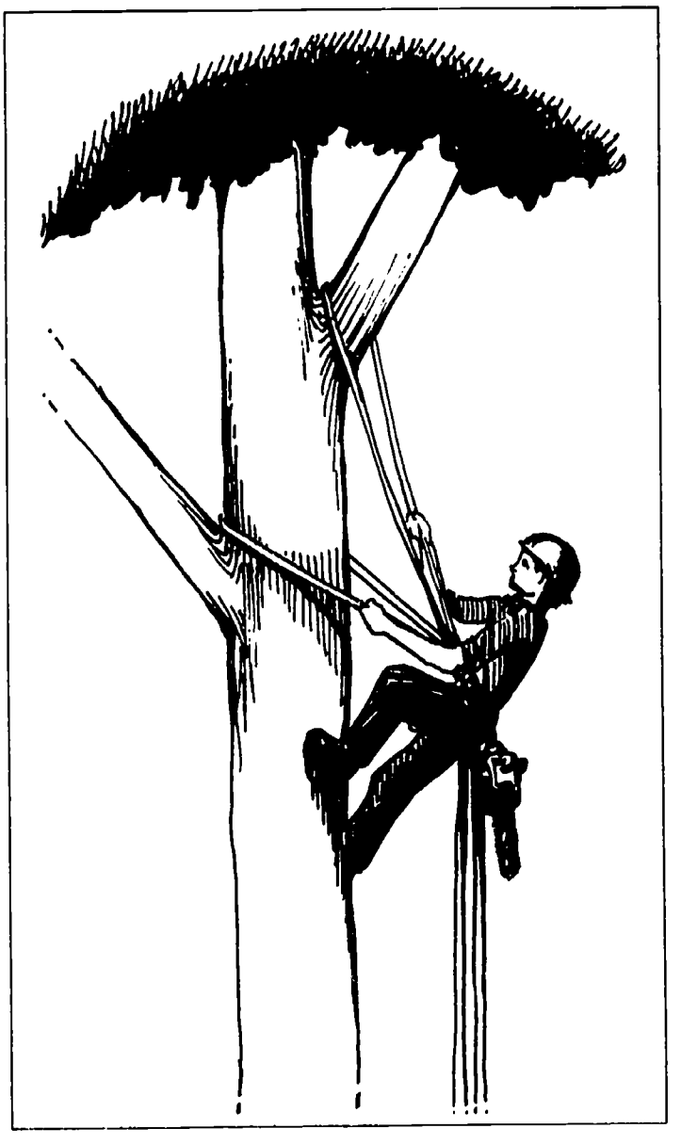


FIG. 6.17. Example of double crotching
1) Take far end of climbing rope through second crotch.
2) Tie bowline at D-rings of saddle, leaving about a 4-foot tail.
3) Tie tautline hitch with tail to other strand of rope

## Working In the Tree

In most cases it is best to climb to the top of the tree and tie in before beginning to work. Some climbers prefer to do some work on the way up, however. Dead limbs may be broken off to reduce risk in climbing. In very dense trees, it is sometimes helpful, while ascending, to remove some inside limbs to facilitate dropping other limbs through from high in the tree. A climber should **never** work in a tree without being tied in safely.

Whenever a limb is going to be cut or a tool dropped to the ground, an audible warning should be sounded for the workers below. Some commonly used warning calls include "Headache!," "Heads up!" and "Timber!"

While working in the tree, the climber has one *most valuable* tool – the climbing rope. One important function of the rope is to catch the climber in the event of a fall. The rope can also be used to help the climber maintain balance and maneuver throughout the tree. For example, when walking far out on a horizontal limb, the climber can walk out backwards, keeping tension on the climbing line. This enables the climber to remain steady on the limb. The climbing rope keeps the climber safe in the tree while freeing the hands for other work (figure 6.16). It takes time and experience before a beginning climber gains enough confidence to rely completely on the climbing rope.

Crotching the rope high in a central location within the tree allows great mobility. Usually the climber can reach most points without re-crotching. If a slip were to occur the climber would swing back toward the center of the tree (though not necessarily so in a wide-spreading tree). Branches often grow a great distance from the center of the tree and are more difficult to reach. Also, if the climber goes too far out on the rope and falls, he or she may reach the ground before the rope pulls taut and stops the fall. So, when working far out from the center of the tree, the climber may choose to double crotch. Double crotching is simply tying in on a second limb with the other end of the climbing line without untying the first tautline hitch (figure 6.17). This affords the climber extra safety and makes it easier to work distant portions of the tree.

There are several disadvantages to double crotching. Freedom of movement can be greatly reduced. Working with two knots simultaneously can become difficult. Also, the remaining portion of the rope may not reach the ground, making it difficult for ground workers to send up tools. Of course, it is usually wise to untie one tautline hitch before attempting to come down from the tree.

## Electrical Hazards

Working in proximity to electrical lines and other equipment can be extremely dangerous. Direct or indirect contact with any energized cables or conductors can be fatal. Such contact can be made through tools, tree limbs, and equipment. Electrical shock will occur if the tree worker provides a path for electrical current to flow to a grounded object. Simultaneous contact with two conductors is almost certain to result in serious injury or death.

Before climbing or working around any tree, a close inspection should be made by the tree worker and the supervisor to locate any electrical conductors. Only trained and qualified line clearance workers should work around electrical conductors. Such training is available through the National Arborists Association and many private companies. A second qualified line clearance worker should be present at all times. This manual in no way prepares or qualifies any tree worker for working around electrical conductors. Table 6.1 gives the minimum working distances from energized conductors for line clearance tree trimmers, as established by the Z133 committee for the American National Standards Institute.

**Table 6.1.** Minimum working distances from energized conductors for line clearance tree trimmers

| VOLTAGE RANGE (phase to phase) kV | MINIMUM WORKING DISTANCE |
|---|---|
| 2.1 to 15.0 | 2 ft. 0 in. (0.6m) |
| 15.1 to 35.0 | 2 ft. 4 in. (0.7m) |
| 35.1 to 46.0 | 2 ft. 6 in. (0.75m) |
| 46.1 to 72.5 | 3 ft. 0 in. (0.9m) |
| 72.6 to 121.0 | 3 ft. 4 in. (1.0m) |
| 138.0 to 145.0 | 3 ft. 6 in. (1.05m) |
| 161.0 to 169.0 | 3 ft. 8 in. (1.1m) |
| 230.0 to 242.0 | 5 ft. 0 in. (1.5m) |
| 345.0 to 362.0 | 7 ft. 0 in. (2.1 m) |
| 500.0 to 552.0 | 11 ft. 0 in. (3.3m) |
| 700.0 to 765.0 | 15 ft. 0 in. (4.5m) |

ANSI Z133.1 - 1988

Adapted from *American National Standards for Tree Care Operations*, American National Standards Institute, 1430 Broadway, New York, NY 10018

Workers who are not trained and qualified in line clearance tree trimming should not work in close proximity to electrical conductors. A minimum of 10 feet clearance should be maintained for energized conductors rated 50kV phase-to-phase or less. A 15- to 20-foot clearance should be maintained for conductors rated more than 50kV. **Caution:** Coated wires, rubber boots and rubber gloves should **not** be considered safe insulation from electrical hazards. Tools and equipment made of non-conductive materials can conduct electricity when dirty or wet.

## Rigging

When pruning or removing trees in an urban or residential area, tree workers must contend with wires, buildings, expensive landscapes, and traffic. Rarely can a climber just cut it and let it drop. To avoid the many environmental obstacles and maximize safety, tree workers use ropes to lower limbs slowly.

Rigging is as much an art as it is a science. It requires skill, finesse, and experience. Although there are many ways to go wrong in rigging, there is no single *right* way. Each company and each climber has his or her own unique way, but the basic principles are the same.

There are a few important rules to remember, no matter how simple the rigging job is. First, always use adequate equipment for the job. Ropes should be long enough and strong enough. Remember that knots and hitches greatly decrease the strength of the rope. Second, always think ahead. It is tough enough to engineer the rigging, but also give serious thought to what might happen if something goes wrong. Finally, make safety the top priority in every operation.

The simplest form of rigging entails tying a rope on the limb to be cut, passing the rope through a crotch above that is strong enough to support the limb, and wrapping the rope around the tree at the base to provide tension (figure 6.18). The number of wraps around the trunk depends upon the weight of the limb. One worker should be able to hold the rope and lower the limb. Always try to be tied in to a crotch lower than the crotch used for lowering the limb.

Naturally, unless the crotch used for lowering the limb is directly above, the limb will tend to swing. The direction of swing can be predicted. In fact, the swing can be used to good advantage to move the limb away from or over obstacles such as houses. The climber must know exactly what the limb will do when it is cut. Rope placement on the limb is important to the weight distribution of the branch after the cut. The climber can control whether the limb will be top or butt heavy.

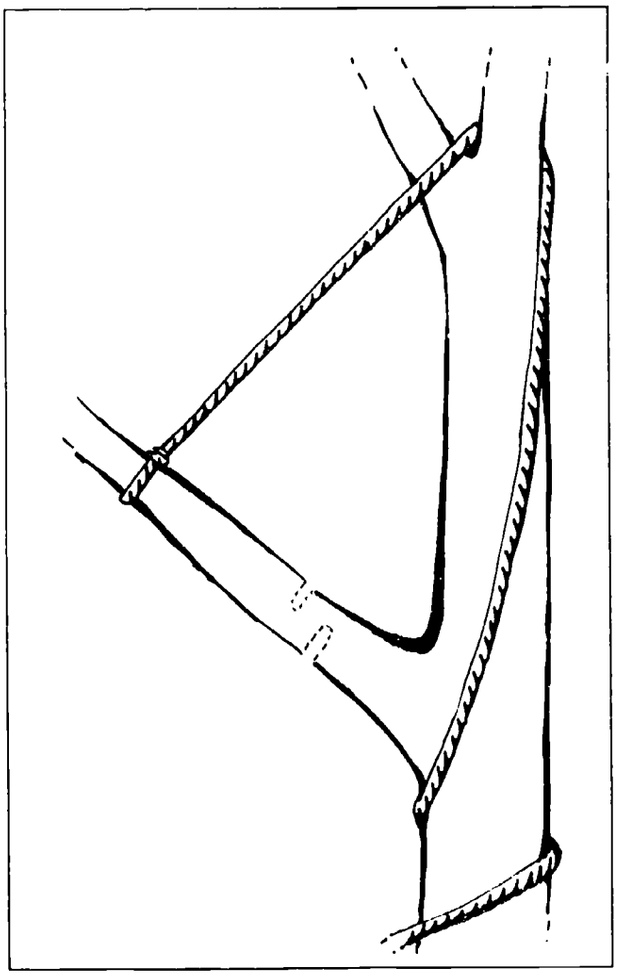


FIG. 6.18. Simple diagram of roping down a limb

Many inexperienced tree workers have been pinned or knocked out when a limb has come back on them. The climber may tie a second (or third) rope on the limb to help control the swing or drop. It is safest to make the cut from above the limb. Always plan an escape route. If using a chain saw, shut it off immediately after the cut has been made.

There can be problems with using other crotches in the tree for lowering limbs. Sometimes there isn't a crotch strong enough or in a good location for the climber's needs. Nylon ropes passing quickly through crotches can damage the tree and the rope. Some arborists use extra equipment for rigging that eliminates the use of tree crotches. A false crotch can be created with the use of a snatch block tied or strapped in the tree. The lowering rope passes freely over the pulley. A side-opening block can save time when using the false crotch to lower many limbs in succession. The rope need not be threaded through each time. Figure 6.19 shows some equipment that might be used in rigging.

In addition to what can be done with ropes, the climber can influence the speed and direction of the limb's fall by the way the cut is made. A notch may be cut at various angles on the limb to make the limb go in a desired direction (figure 6.20). Also, ropes tied on the far end of the limb may be used by ground workers to pull the limb over. Before tying off the limb, the climber must decide whether the limb is to go down brush first or butt first. Experience will tell the climber how far out to tie the rope. Sometimes the climber may intentionally peel the cut (fail to make an undercut) to allow the limb to drop slowly.

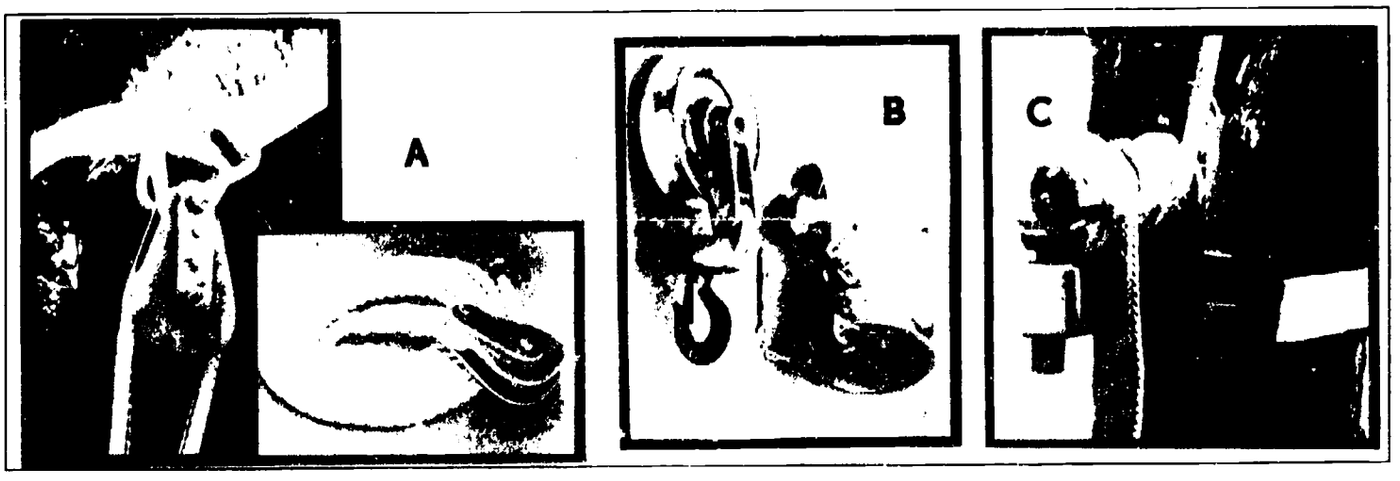



FIG. 6.19. Equipment used in rigging: A) Apparatus that can be used to create a false crotch; B) Snatch blocks that save time and effort in lowering large limbs; C) A lowering device that eliminates need for rope wraps around the tree trunk; saves time and manpower.

The choice of knots to use when tying off a limb is largely a matter of personal preference. Two of the best knots for this are the clove hitch and the running bowline. Both tighten up as tension is applied; this helps keep the rope from slipping. The clove hitch does not decrease the strength of the rope as much as the running bowline. The running bowline is very easy to untie even after a great deal of weight has tightened the knot. If a clove hitch is used, a half hitch or bowline should be used in combination for added security.

The most exciting thing about rigging is that every situation is different. With added experience, the climber can learn new tricks. Yet each limb presents a new set of circumstances. For a climber "piecing out" his or her first large, difficult tree, the experience is similar to a pilot earning his or her wings.

## Aerial Rescue

A tree worker must take many precautions to guard against accidents. But it takes only one lax moment or an unexpected event for an accident to happen. Because of this, every worker on the crew should be trained in first aid, CPR (cardiopulmonary resuscitation), and aerial rescue. Aerial rescue is the process of bringing an injured or unconscious worker down from the tree.

The two most important aspects of aerial rescue are speed and safety. If the victim is not breathing or is bleeding severely, there may be only minutes before death. There is no time for panic. However, a rescuer who fails to take time for the proper precautions may become a second victim.

There are a number of ways a climber can be injured in the tree. Electrocution, heart attack, heat prostration, a blow to the head, or a severe chain saw cut could leave a worker dangling helplessly in the tree. Ground workers should maintain a close watch on climbers. A climber may get hurt and lose consciousness without ever calling for help.

When a climber is injured or unconscious in the tree, the rescue procedure should begin without delay. If there is more than one worker in the area, one should get emergency help immediately. If there is only one rescuer, he or she may shout for assistance, but must stay and help the injured climber.

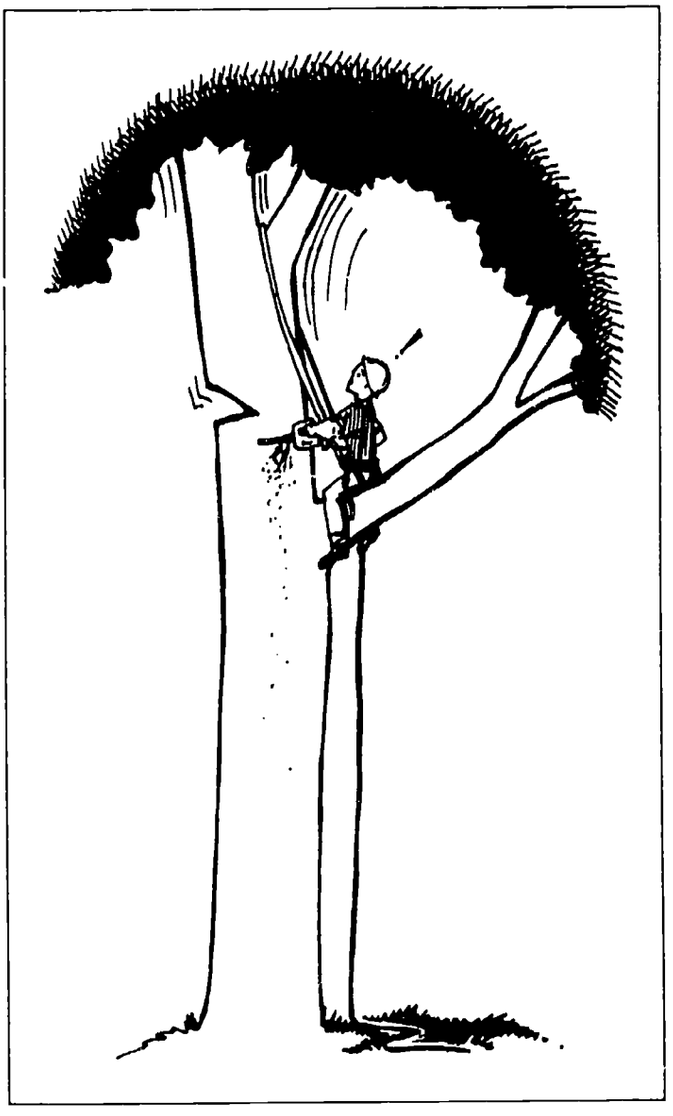


FIG. 6.20. Think ahead!

The first step is to determine whether there is an electrical hazard. If there is, contact must be broken immediately between the wires and the victim, or the wires and the tree. This can be done by either pulling the wires away or the victim away with a clean, dry rope or other non-conductor. **Never attempt to climb a tree that may be energized.**

Once any risk of electrocution has been eliminated, the next step is to get to the victim as fast as possible. The rescuer should wear a climbing saddle with a safety strap. Spurs may be used to get to the victim quickly, or the rescuer may climb the victim's rope if it has not been damaged. Upon reaching the victim, the rescuer must either tie into the tree, or clip into the victim's D-rings using the safety rope or strap. The rescuer should keep the victim across his or her legs and support the head (figure 6.21).

A quick check should be made to determine the condition of the victim. If there is serious bleeding,

steps should be taken to stop it at once. Elevate the wound if possible and apply direct pressure (with a clean cloth, if practical). If there is severe bleeding from the head, do not apply pressure. If the victim is not breathing, use artificial respiration, clearing the airway, pinching the nose, and giving several quick breaths through the mouth. CPR can not be applied in the tree.

If the victim appears to have a broken neck or spinal injury, no attempt should be made to lower him or her. The best thing to do is make sure the victim is safely tied in, and get emergency help. If the victim is not breathing or is bleeding severely, take the necessary steps described previously while jostling the victim as little as possible.

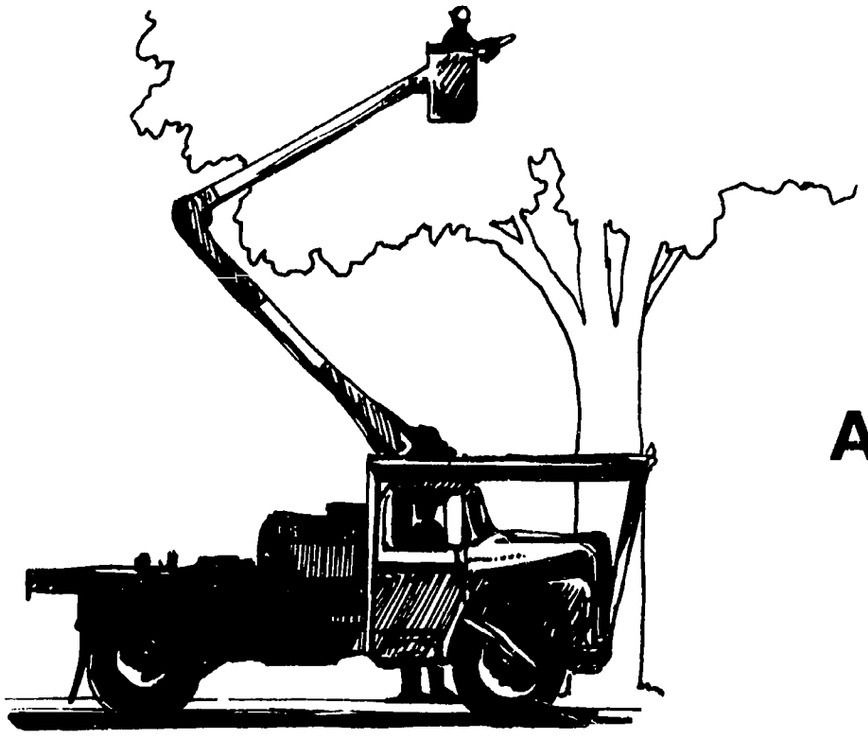
Before lowering the victim, be sure that both rescuer and victim are safely tied in. Check the victim's rope for damage. If it appears safe, both rescuer and victim can come down on the victim's rope. Do not try to come down too fast, or further injury may result. If practical, a ground worker can lower the injured person with the climbing line.

Once the victim has been lowered safely to the ground, the climbing saddle should be removed. If emergency help has not yet arrived, take further first aid steps. Begin CPR immediately if there is no breathing or no pulse (Figure 6.22).

It is not possible to foresee when or where accidents will occur; they usually occur when least expected. The ability to react swiftly and safely to save a life depends on keeping a cool head, using common sense, and being prepared. Proper training and practice can save a few crucial minutes that may mean the difference between life and death.

**FIG. 6.21.** After clipping in, cradle the victim in your lap while supporting the head.

**FIG. 6.22.** CPR can not be done in the tree, but should begin immediately once on the ground, if necessary.



CHAPTER 7

# Aerial Lifts

## *Objectives*

Aerial lifts require special training for all workers. This chapter is intended to acquaint the reader with some of the basic practices involved in aerial lift operation.

1. Become familiar with the steps to be taken before operating the lift truck.
2. Know the basic safety rules for working in or near a bucket truck.
3. Understand the potential hazards of working around electrical conductors.

## Aerial Lift Truck

The aerial lift truck or bucket truck is designed to raise the tree worker into the tree where work can be done without climbing (figure 7.1). The designs of aerial lift trucks vary considerably. There are usually one or two booms that can be operated independently. The worker stands in the bucket and can move the booms up and around.

Bucket trucks are used mostly for line clearance work. From a bucket, trees can easily be cut back below the lines. The bucket and upper boom are both insulated for working around power lines. This helps reduce the electrical hazards of line clearance. Lift trucks are not limited to line work. They can also be used for other trimming jobs and tree removal. The biggest limitation of bucket trucks is the inability to access all areas. The booms cannot always be maneuvered into a tree. Also, the equipment usually cannot be taken behind houses for backyard jobs.

## Daily Inspections

Before starting out for the day, inspect the aerial lift truck (figure 7.2). This inspection is primarily a visual check of the unit. Trouble can be avoided later in the day if problems are found and corrected before leaving the garage.

FIG. 7.1. A lift truck is valuable in line clearance work.

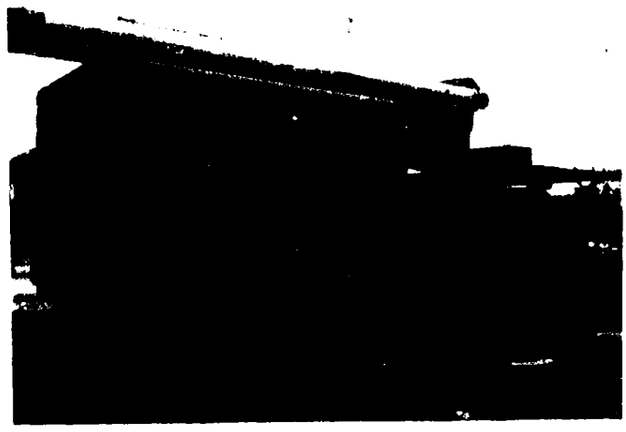


FIG. 7.2. With everything in working order, the lift truck is ready to start the day.

FIG. 7.3. The booms and outriggers can be controlled from the ground.

The insulation on the boom and bucket should be checked for worn or cracked areas that could reduce the dielectric integrity of the unit. The boom cables should not have excessive slack. There should be no oil puddles under the truck. If there are, and the oil traces back to the hydraulic system, the source must be located.

When checking for hydraulic leaks, make a visual inspection only. Never attempt to locate or stop a hydraulic leak with any part of the body. Hydraulic fluid in a wound will cause a large infection that can lead to amputation. If hydraulic fluid reaches the circulatory system, death can result.

Check fluid levels including engine oil, lubricant, and hydraulic oil, and add as necessary. Check each control and watch for pressure drops. Check the power take-off (PTO). Be sure the boom is seated in the boom cradle before starting out.

## At the Job Site

Once at the job site, the tree service workers must control traffic if working near or along the roadway. Traffic pylons (cones) should be set out to divert traffic around the working area. "MEN WORKING IN TREES" signs can be used to alert traffic to overhead dangers. If the boom is to be across the road, a worker should stand by to warn trucks.

The truck should be positioned so as to afford the greatest mobility and access to the trees to be worked on. Careless positioning can waste time and energy and usually results in a poorer trimming job. Utility lines are often the biggest obstacle in positioning the truck.

The outriggers must be down before the booms are raised. These help stabilize the unit. Both can be controlled from the ground (figure 7.3). When the work area is covered with ice, it should be chipped away and cleared where the outriggers sit. If parked on an incline, the wheels of the truck should be chocked. When working on soft asphalt, workers should place large beams under the outriggers to distribute the weight.

FIG. 7.4. Proper positioning of the booms is critical when removing large limbs.

FIG. 7.5. This lift truck allows the operator to cut limbs 70 feet above the ground.

## Working from the Bucket

All buckets should be equipped with a safety belt. Using a safety belt keeps the worker from falling out of the bucket in case of equipment failure or a sudden jolt. Unless specifically intended, the bucket should carry no more than one worker. Also, under no circumstances should weight limits be exceeded. The bucket should not be used to lift or lower heavy objects.

The aerial lift operator should always look in the direction of movement. With experience, the operator should be able to use the control levers automatically without looking or stopping to think which lever controls what. Care should be taken to avoid hitting any objects with the bucket or booms (figure 7.4). The bucket should never land on anything as the insulation may be damaged. Although the bucket is insulated, the worker must still avoid contact with phase-to-phase wires or otherwise grounded electrical paths (figure 7.5).

Many aerial lift trucks are equipped with either hydraulic or pneumatic (compressed air) outlets for tools. Special loppers and saws can be fitted and operated from these outlets. Only one tool should be connected at a time. Tools should be disconnected when not in use or when being serviced. If used correctly, these tools can save time and energy. Once the proper tool is chosen for the pruning cut, the worker should take care to make clean, well-placed cuts. Too often, poor cuts are the result of careless workers not taking the time to get into a good position before cutting.

Electric saws or other electric equipment like drills or lights should never be used from the bucket. Such tools can bypass the insulating capacity of the unit.

If the truck must be moved, the booms should be brought to rest in the cradle position. The outriggers must be lifted. Workers should not ride in the bucket when the truck is in motion.

FIG. 7.6. *Caution* sign on truck

FIG. 7.7. The truck will be energized if the lift is in contact with wires. **Do not go near it.**

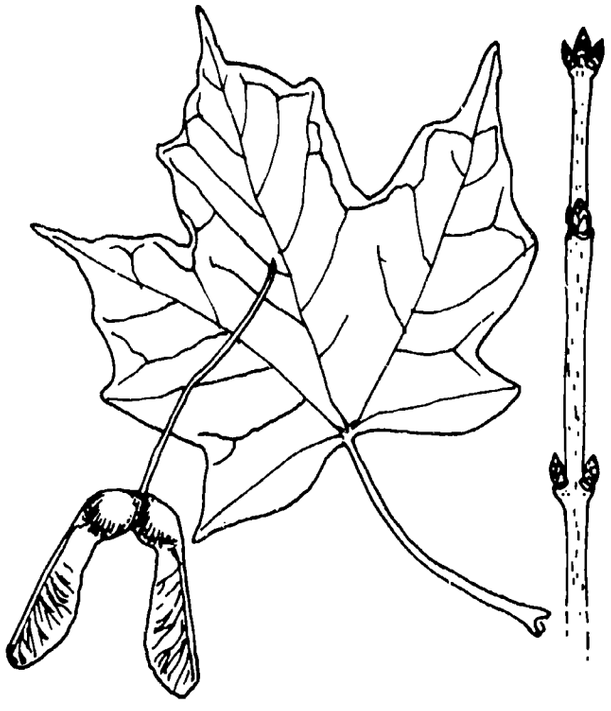
## Electrical Hazards

When the lift is in contact with electrical conductors, the truck must be considered energized (figure 7.6). Anyone standing on the ground and touching the truck simultaneously can be electrocuted (figure 7.7). The ground around the outriggers may also be charged, especially if it is wet. Any worker in or on the truck should remain there until contact is broken.

If the bucket operator is in trouble, the booms can be lowered from below. If the truck is energized, a worker will not be able to operate the controls from the ground. In case of an emergency, a worker could leap from the ground onto the truck, keeping in mind that the ground near the truck may be energized. Since simultaneous contact with both truck and ground may be fatal, this leap should not be attempted unless it is absolutely necessary.

If necessary, the lift system can be bypassed. Workers should be instructed how to lower the booms by releasing the pressure in the lift system. The boom can then be pulled down manually using ropes.

All tree workers who use aerial lifts should have special training. Operation, maintenance, and safety considerations of aerial lifts require extra instruction. Since this equipment is frequently used near electrical hazards, special attention must be given to training in electrical dangers and emergency procedures.



CHAPTER 8

# Tree Identification

## *Objectives*

The purpose of this chapter is to introduce the student to some of the plant features used to identify trees. Selected common trees are included with drawings and descriptions.

1. Learn to look at plants both close up and at a distance when trying to identify them.
2. Become familiar with seasonal characteristics of trees that may help in identification.
3. Learn to use every tool available for identification including the senses of touch and smell.

Accurate identification of trees requires a combination of knowledge and experience. It is important to learn a number of plant characteristics that are used to distinguish one tree from another. Size, habit, texture, and color all help to identify plants. Practice and repeated exposure help one become proficient at identification.

Many trees can be identified from a distance by their form and habit. For example, the American elm, with its vase-shaped form and over-arching limbs, is hard to mistake for other species. An upright or conical form might be an identifying feature of certain other trees. The upper branches of pin oak are upright, while the lower branches droop to the ground, giving it a rather unique form, easy to identify. Some trees, like flowering dogwood, have a horizontal branching habit. This gives the tree a delicate, layered appearance.

Another identification tool is the bark of the tree. Bark varies a lot among tree species. White birch is famous for its white peeling bark (figure 8.1). Sycamores are also known for their peeling bark, gray in color, which exposes a very light inner bark (figure 8.2). Ash trees have a uniformly furrowed bark, while the furrows on cottonwood are deep and corky. American beech has a smooth, shiny gray bark. Sometimes in the forest, the bark is the only part of the tree that can be seen. Knowledge of bark characteristics can be very useful to a tree service worker, as well as to a forester.

The smaller branches and twigs can also be useful in tree identification. Some twigs have wings or ridges. Others have characteristic thorns or spurs (figure 8.3). The lenticels that dot the surface of twigs can be very characteristic of certain plants. Even the type and color of the pith in the center of twigs can help identify trees.

FIG. 8.1. The bark of the European white birch makes it easy to identify.

FIG. 8.2. The outer bark of London planetree flakes off, exposing buff-colored new bark.

FIG. 8.3. Native honeylocust can have thorns that grow up to one foot in length.

The buds, though relatively small, may be the single most important identification tool, as they are available year-round even when leaves are not present. Students can learn to identify many different tree species by learning dormant bud characteristics. Buds can be scaled or valvate, opposite or alternate, single or clustered. They come in various colors and sizes. As buds swell and break in the spring, however, they are difficult to use in identification.

Foliage is the part of the tree most commonly used in identification. Leaves are very characteristic in shape, color, texture, and arrangement. The lobes, margins, and general morphology (shape) can be described in detail to help identify plants. Fall color can also be useful in identifying trees from a distance.

Other parts of the tree are also used in identification. Flowers, though present for a short time, are often very helpful in identifying species. The different characteristics of fruits, nuts, and seeds are also used. Cones are important in identifying conifers.

Sometimes tree identification can be confirmed using other senses besides sight. Certain trees have characteristic odors to their twigs, leaves, flowers, or fruit. The texture of leaves can be felt between the fingers. Some people can even distinguish the characteristic sound of a snapping twig. Of course, taste can be characteristic in edible plant parts, but making taste tests is not recommended for identification.

## Plant Nomenclature

Scientific nomenclature (naming) is based on taxonomy. Taxonomy is the system of classification of all living organisms. The first classification level, **kingdom,** divides plants from animals. The following list shows how each level of classification is subdivided. *Sugar maple is* used as an example.

## CLASSIFICATION SYSTEM

| | |
|---|---|
| Kingdom | Plantae |
| Phylum (Division) | Spermatophyta |
| Subdivision | Angiospermae |
| Class | Dicotyledoneae |
| Order | Sapindales |
| Family | Aceraceae |
| Genus | **Acer** |
| Species | **saccharum** |

Using common names of trees can be confusing, since names vary from region to region. However, every plant has a scientific name (in Latin) that is the same throughout the world. Using the scientific name eliminates the confusion in plant names.

The scientific name of an organism has two parts. The first, which is capitalized, is the **genus.** Plants in the same genus are closely related and show similar characteristics. Maples, for example, are all in the genus *Acer*. The second part, the specific epithet, identifies the **species** and is not capitalized. The scientific name of sugar maple, for example, is *Acer saccharum.*

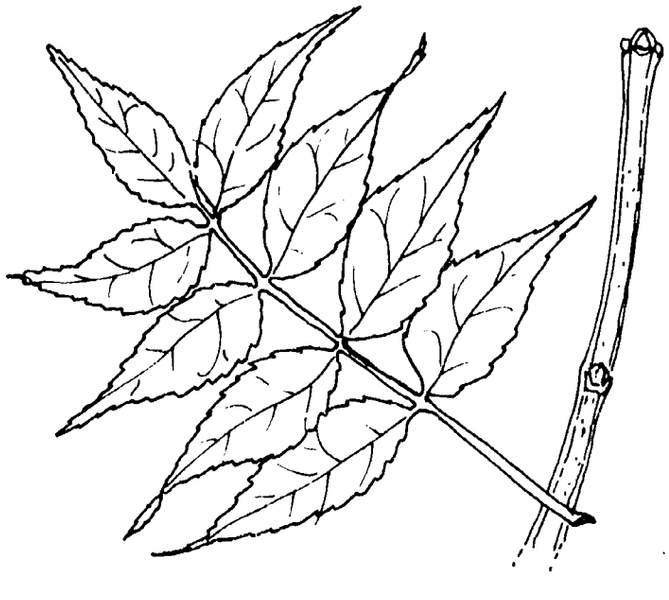
Some species are further divided into genetically unique plants or clones. There may be varieties or cultivars of some plants. Variety names are added to species names and are not capitalized, e.g., *Gleditsia triacanthos inermis*, the complete name for thornless honeylocust. They may be preceded by the abbreviation **var**. Cultivar names are capitalized and enclosed in single quotation marks; for example, *Acer rubrum* 'Red Sunset' is Red Sunset red maple.

Descriptions of some of the more common North American trees have been included in this manual. In the next few pages they are discussed in alphabetical order by common name, since readers may not be familiar with scientific nomenclature.

A final note about choosing appropriate trees for the landscape. It is important to consider all the characteristics of a plant before planting. Size, hardiness, messy fruit — all might be limitations of certain plants in certain sites. Also, check for the plant's sensitivity to salt, pollution, diseases, and pests. Notes on limitations and outstanding characteristics are included in each of the following plant descriptions.

# Descriptions of Some Common North American Trees

## ASH



BLUE ASH - *Fraxinus quadrangulata*

***Leaves:*** opposite, pinnately compound with 5-11 leaflets, dull green in summer, yellow in fall

***Stem:*** yellow-brown, stout, four-sided with corky winged ridges

***Buds:*** tan, pubescent

***Size and form:*** 50-75 feet at maturity; irregular habit

***Flowers:*** panicles appearing with the leaves in spring; not ornamentally important

***Fruit:*** tan-colored samaras ripening in midsummer, persisting through winter

***Comments:*** tolerant of dry alkaline soils

GREEN ASH - *Fraxinus pennsylvanica*

***Leaves:*** opposite, pinnately compound with 5-9 leaflets; dark green and pubescent underneath

***Stem:*** twig pale brown and stout with conspicuous lenticels; large leaf scars

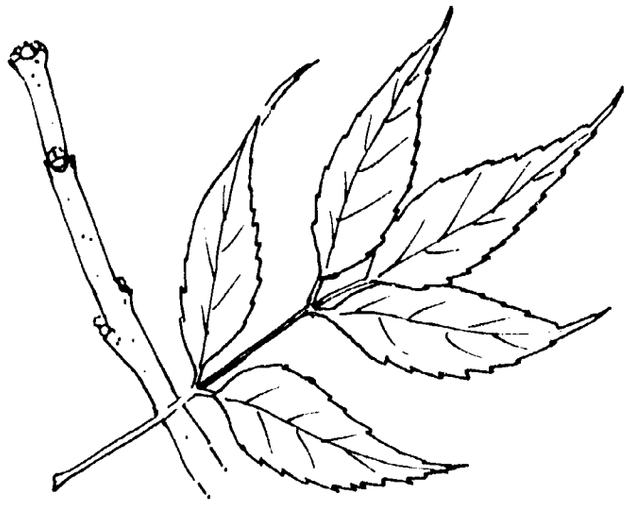
***Buds:*** dark brown, set above leaf scar

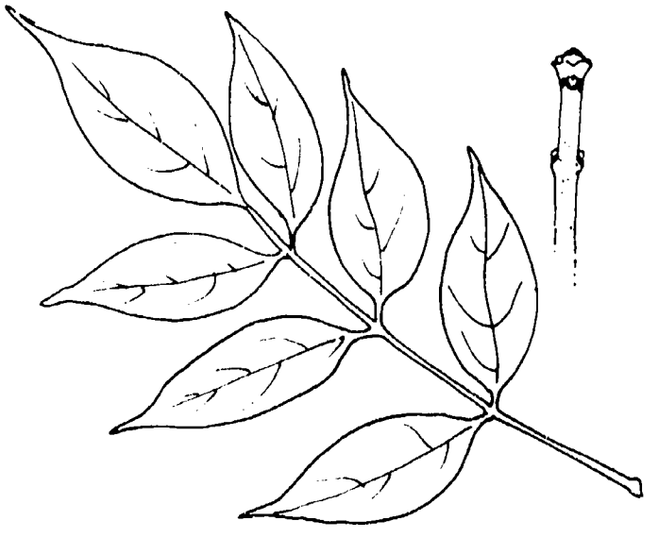
***Size and form:*** 50-70 feet with upright, spreading habit

***Flowers:*** dioecious, purple panicles, blooming before the leaves emerge

***Fruit:*** tan samaras ripening in late summer, persisting

***Comments:*** very adaptable in difficult urban areas; borers a problem; 'Marshall's Seedless' - male, attractive yellow fall color





WHITE ASH - *Fraxinus americana*

***Leaves:*** opposite, pinnately compound with 5-9 leaflets; rich green in spring and summer, golden to purple in fall

***Stem:*** stout, grayish, with U-shaped leaf scars

***Buds:*** dark brown, inset in leaf scar

***Size and form:*** 60-100 feet; open, ovoid habit

***Flowers:*** dioecious, panicles, not ornamentally important

***Fruit:*** tan samaras ripening in midsummer, persisting

***Comments:*** aesthetically excellent when healthy; borers can cause problems; many insect and disease problems on stressed trees

## BEECH

AMERICAN BEECH - *Fagus grandifolia*

***Leaves:*** alternate, dark glossy green; when dry, persisting through winter

***Stem:*** slender gray twigs with zigzag habit

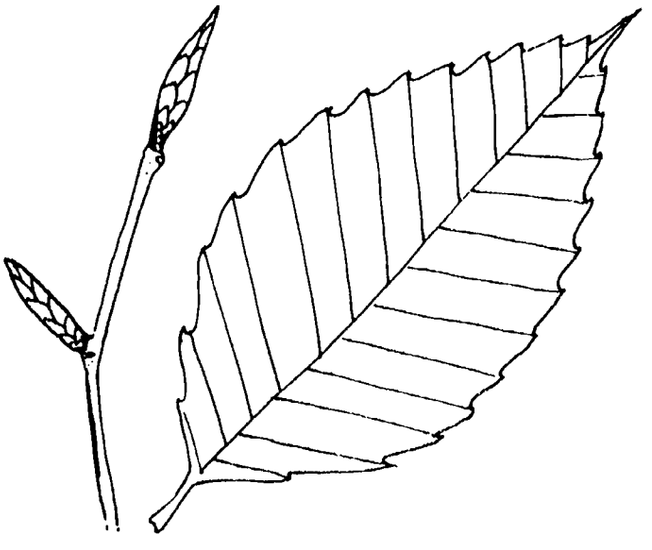
***Buds:*** brown, long, slender, and pointed

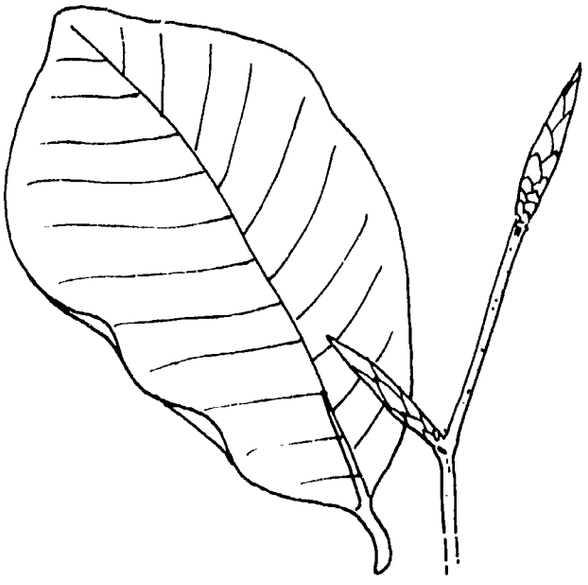
***Size and form:*** 60-90 feet; dense with wide spread

***Flowers:*** male and female separate on same tree; blooms after leaves emerge

***Fruit:*** nut in prickly husk, 1/2-1 inch; ripening in fall

***Comments:*** large native tree with some pests; sensitive to soil compaction and construction injury; beech scale can be a problem





EUROPEAN BEECH - *Fagus sylvatica*

***Leaves:*** alternate, dark, and glossy with wavy margin

***Stem:*** olive-brown twigs

***Buds:*** long, slender, brown

***Size and form:*** 50-60 feet, upright, irregular habit; branches growing down trunk to the ground

***Flowers:*** monoecious; blooming after leaves emerge; ornamentally unimportant

***Fruit:*** nut in husk; ripening in fall

***Comments:*** an excellent specimen tree; lovely cultivars available

## BIRCH

EUROPEAN WHITE BIRCH - *Betula pendula*

***Leaves:*** alternate, dark glossy green, double serrate and pointed; yellow-green in fall

***Stem:*** twigs thin and smooth, brown to gray

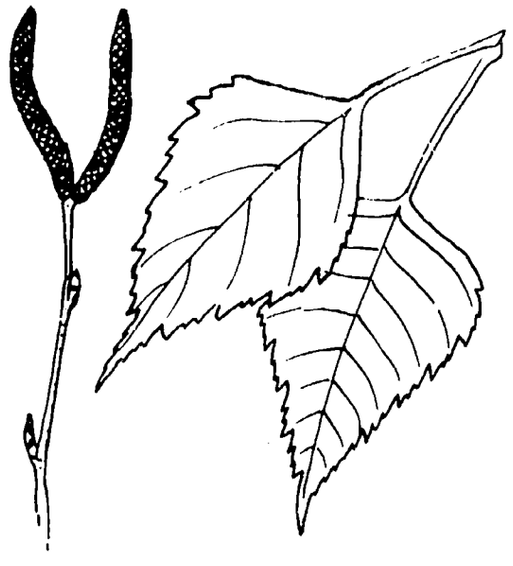
***Buds:*** brownish, curved, with striped appearance

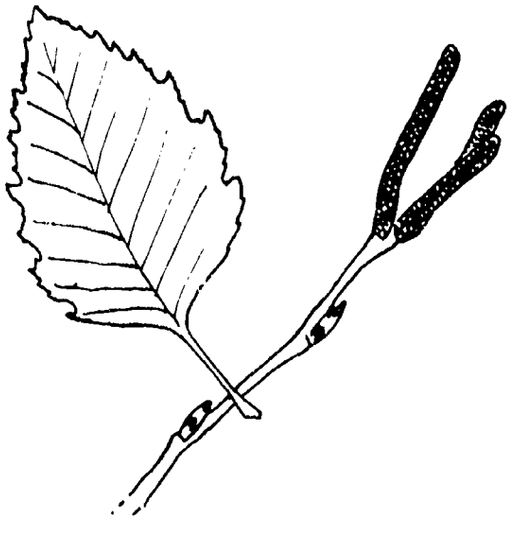
***Size and form:*** 50-75 feet; pyramidal habit opening up with age; pendulous branches

***Flowers:*** long catkins

***Fruit:*** tiny nutlets

***Comments:*** bronze birch borer can be a serious pest; also leaf miner and chlorosis in some areas





RIVER BIRCH - *Betula nigra*

***Leaves:*** alternate, double serrate, glossy green and whitish beneath; golden yellow in fall

***Stem:*** red-brown, slender twigs, conspicuous lenticels

***Buds:*** light brown, stalked, and very small

***Size and form:*** 50-75 feet, pyramidal in youth, rounded at maturity

***Flowers:*** monoecious catkins 2-3 inches long

***Fruit:*** small nutlet

***Comments:*** quite city-tolerant; attractive, cinnamon-colored, peeling bark; chlorosis in high pH soils

## BUCKEYE

OHIO BUCKEYE - *Aesculus glabra*

***Leaves:*** opposite, palmately compound with five leaflets; orange-red in fall

***Stem:*** stout, light brown; disagreeable odor when damaged

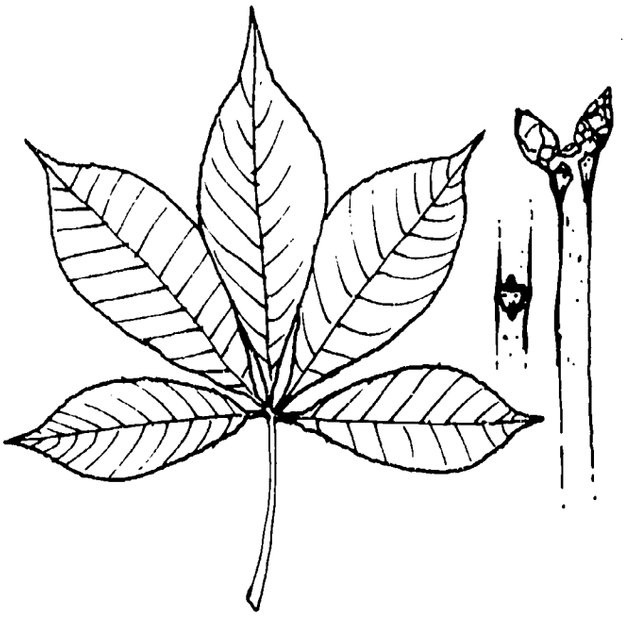
***Buds:*** large, papery, brown, 1/2-3/4 inch long

***Size and form:*** 30-50 feet; rounded form

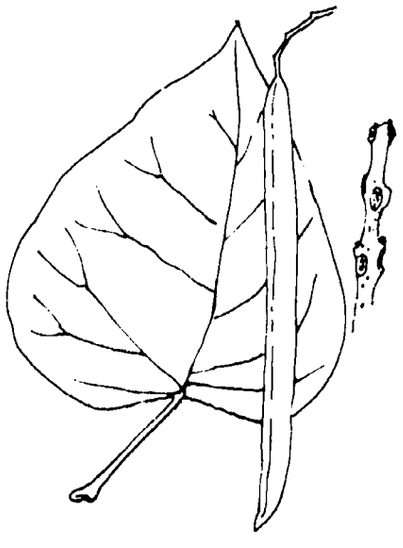
***Flowers:*** perfect; upright panicles, yellow-white; blooming in mid-May

***Fruit:*** glossy nut enclosed in prickly husk; poisonous

***Comments:*** grows well in natural areas, not in urban areas; suffers from scorch, leaf blotch, powdery mildew



## CATALPA



NORTHERN CATALPA - *Catalpa speciosa*

***Leaves:*** opposite to whorled, large, heart-shaped, smooth above, pubescent below; yellow-green in summer, yellowish in fall

***Stem:*** stout, yellow-brown; large leaf scars

***Buds:*** small and brown; terminal bud absent

***Size and form:*** 75-100 feet; open and irregular crown

***Flowers:*** large white clusters blooming in June; monoecious

***Fruit:*** brown cigar-like capsule 10-20 inches long

***Comments:*** coarse-textured tree with few problems; somewhat messy, not well suited to urban areas

## CHERRY

BLACK CHERRY - *Prunus serotina*

***Leaves:*** alternate, glabrous, dark green; yellow to orange in fall

***Stem:*** slender red-brown twigs

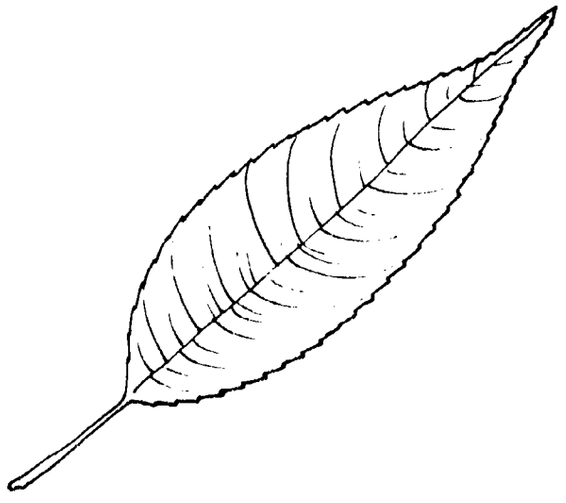
***Buds:*** 1/8 inch, red-brown

***Size and form:*** 50-60 feet; ovoid habit

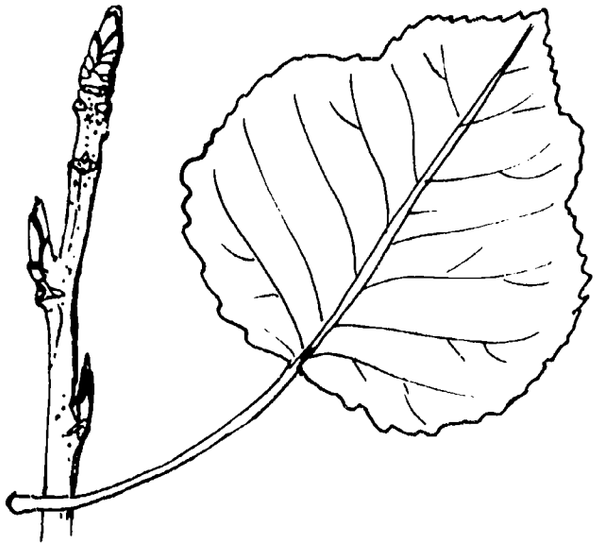
***Flowers:*** white racemes 4-6 inches long, pendulous, blooming in May

***Fruit:*** 1/4-1/2 inch drupe, red, turning black

***Comments:*** high value of fruit for wildlife and for use in jelly-making; pests – fall webworm and borers; interesting platy bark



# COTTONWOOD



EASTERN COTTONWOOD - *Populus deltoides*

***Leaves:*** 3-5 inches, alternate, deltoid-ovate, with curved teeth; bright green in summer, yellow in fall

***Stem:*** stout, gray to yellowish

***Buds:*** large, 3/4 inch long, yellow-brown and pointed, resinous

***Size and form:*** 75-100 feet; pyramidal in youth, opening with age

***Flowers:*** dioecious, 3-inch-long pendulous catkins

***Fruit:*** clustered, drooping capsules which split to release cottony seeds

***Comments:*** a very messy, weak-wooded tree; tolerant of harsh conditions

# CRABAPPLE

CRABAPPLE - *Malus* spp.

***Leaves:*** simple, usually glabrous, alternate; summer color variation from yellow-green to green and red-green; fall color also variable

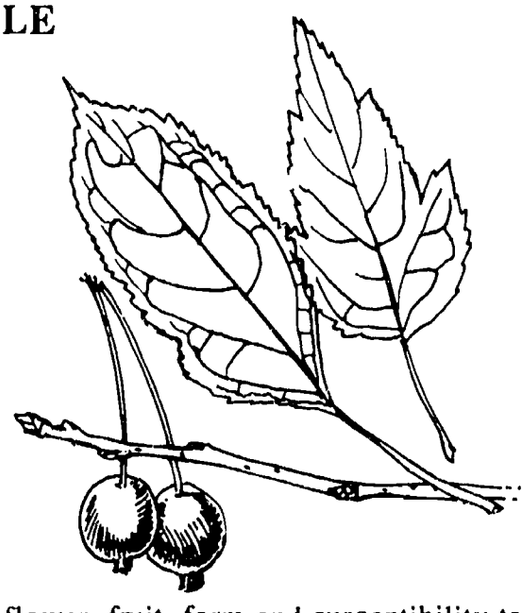
***Stem:*** twigs slender, brown to gray, with spurs

***Buds:*** small and blunt, red to brown

***Size and form:*** extremely variable in size and form depending on species and cultivar; 8-50 feet

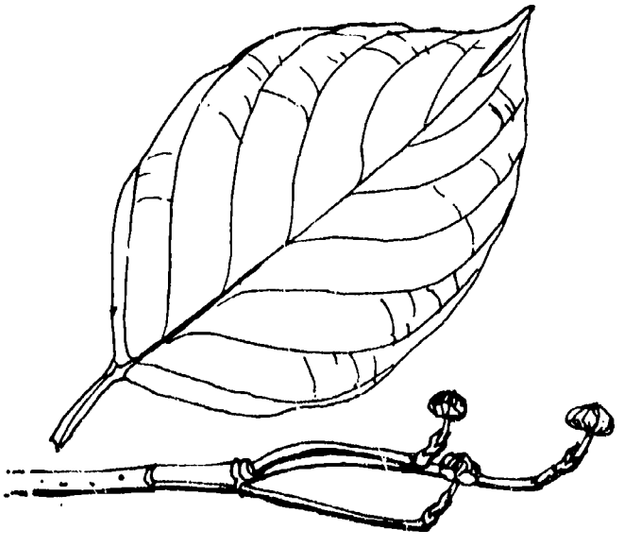
***Flowers:*** pink to white, blooming before or with foliage in spring

***Fruit:*** pome 2 inches in diameter or less; color variation from yellow through red to dark purple



***Comments:*** hundreds of crabapple cultivars vary in size, flower, fruit, form and susceptibility to insects and disease; tolerant of many soil types; disease problems - apple scab, fireblight and rust; crabapples widely used as street trees

# DOGWOOD



FLOWERING DOGWOOD - *Cornus florida*

***Leaves:*** opposite, elliptical, with parallel venation; orange to deep red in fall

***Stem:*** slender twigs with horizontal branching, green to red

***Buds:*** growing upright on twigs; flower buds biscuit-shaped, gray

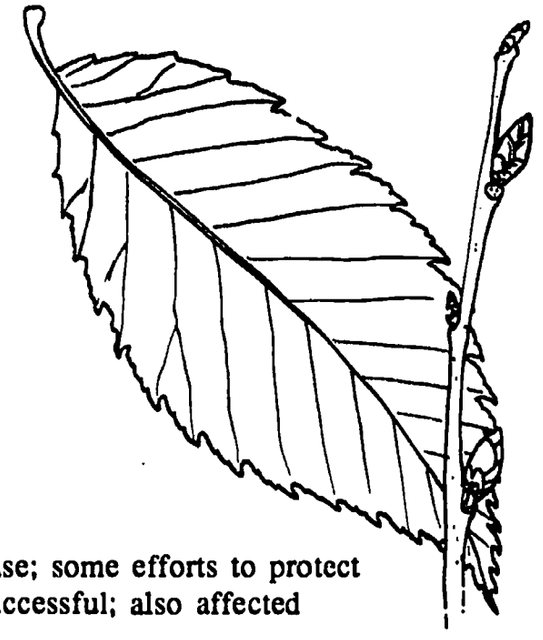
***Size and form:*** 20-40 feet; flat-topped at maturity

***Flowers:*** very small yellow flowers surrounded by four large white bracts 2 inches in diameter, blooming before the leaves

***Fruit:*** glossy red drupe

***Comments:*** grows best in moist, well-drained soil with some shade, low pH; borers can be a problem; outer bracts often freeze before flowering in colder climates

## ELM



AMERICAN ELM - *Ulmus americana*

***Leaves:*** 3-6 inches long, alternate, double serrate, rough-textured; fall color golden-yellow

***Stem:*** slender, red-brown twig; zigzag habit

***Buds:*** 1/8 inch long, brown, adpressed to stem; terminal absent

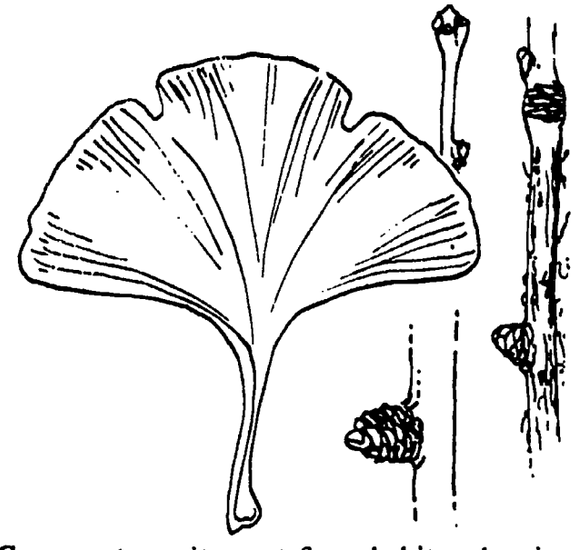
***Size and form:*** 75-100 feet; vase-shaped habit; long overarching branches; spread often larger than height

***Flowers:*** polygamo-dioecious; small red-brown clusters blooming in March

***Fruit:*** 1/2 inch tan samara ripening in May, June

***Comments:*** a grand tree, but devastated by Dutch elm disease; some efforts to protect great, historic specimen trees from the disease have been successful; also affected by many other pests and diseases

## GINKGO



GINKGO - *Ginkgo biloba*

***Leaves:*** 2-3 inches, alternate, fan-shaped; yellow in fall

***Stem:*** stout, tan to grayish; bark peels away in strings

***Buds:*** mounded and brown, often on a spur

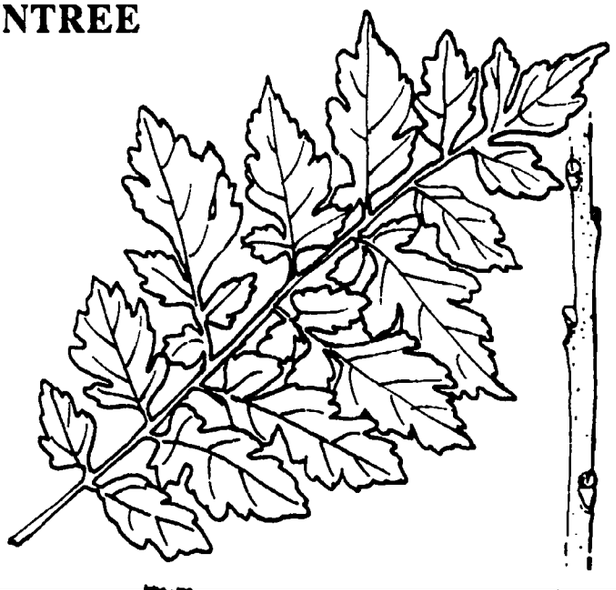
***Size and form:*** 60-80 feet highly variable in form

***Flowers:*** dioecious, not ornamentally important

***Fruit:*** naked seed, orange-brown, 1 inch in diameter; very strong, undesirable odor

***Comments:*** quite pest-free; habit rather irregular; only males should be planted because of malodorous fruit borne on female trees

## GOLDENRAINTREE



GOLDENRAINTREE - *Koelreuteria paniculata*

***Leaves:*** alternate, pinnately or bipinnately compound, 7-15 leaflets; yellow in fall

***Stem:*** stout tan twigs with prominent lenticels

***Buds:*** grayish and teardrop-shaped; terminal absent

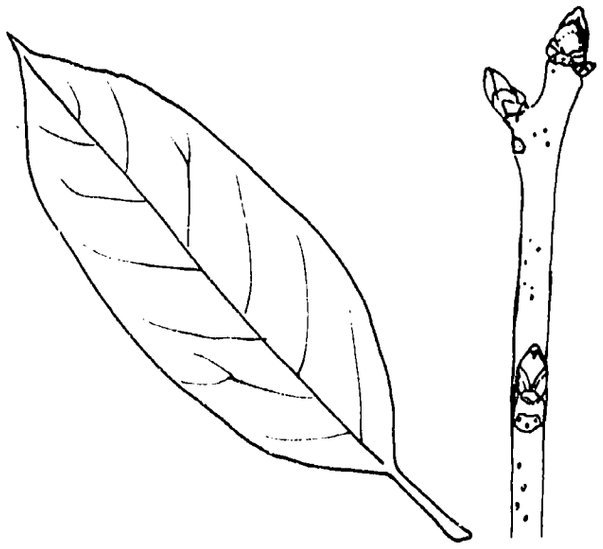
***Size and form:*** 30-50 feet; dense and rounded

***Flowers:*** long yellow panicles blooming in midsummer (July)

***Fruit:*** brownish papery capsules which persist

***Comments:*** tolerant of drought and pollution; one of the few trees that flowers in summer

# GUM



BLACK GUM - *Nyssa sylvatica*

***Leaves:*** 2-5 inches, alternate, long, ovate, dark green and glossy; brilliant color - orange to dark red in fall

***Stem:*** slender, light brown twigs

***Buds:*** reddish brown and pointed

***Size and form:*** 30-60 feet; pyramidal and densely branched, becoming more rounded with maturity

***Flowers:*** polygamo-dioecious, whitish, blooming at the same time as the leaves emerge; not ornamentally important

***Fruit:*** small, black, 1/2-inch drupes, ripening in late September

***Comments:*** does best in acid, well-drained soils; difficult to transplant; excellent fall color; students often frustrated when faced with the task of identifying this tree

# HACKBERRY

HACKBERRY - *Celtis occidentalis*

***Leaves:*** 2-5 inches, simple, greenish yellow, alternate, with serrate edge; yellow in fall

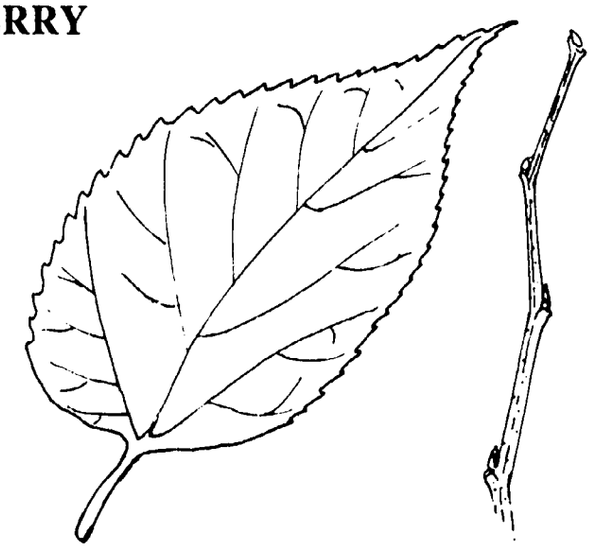
***Stem:*** twigs slender, zigzag, greenish brown

***Buds:*** triangular, gray, adpressed to stem

***Size and form:*** 60-90 feet; branches overarching; round to vase-shaped

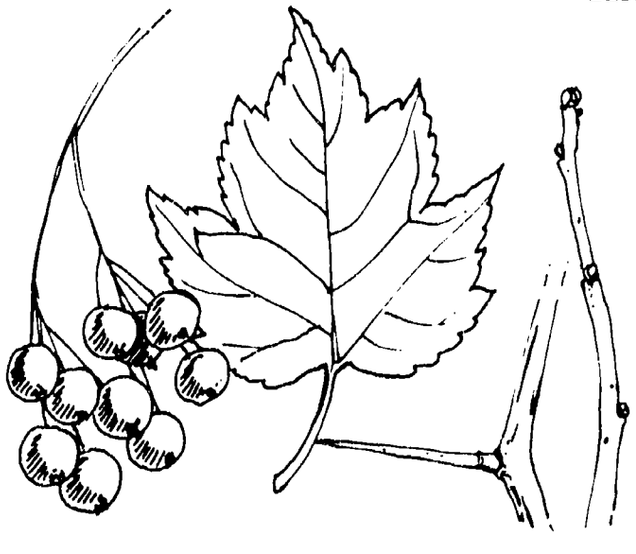
***Flowers:*** small yellowish clusters, blooming in early May

***Fruit:*** 1/3-inch, dark purple drupe, ripening in September and persisting



***Comments:*** tolerant of harsh conditions; pests include hackberry nipple gall and witches' broom

# HAWTHORN



WASHINGTON HAWTHORN - *Crataegus phaenopyrum*

***Leaves:*** alternate, triangular with maple-like lobes, serrate; orange to purple in fall

***Stem:*** slender, brown, with thorns 1-3 inches long

***Buds:*** dome-shaped, red and glossy

***Size and form:*** 25-35 feet, oval to globular

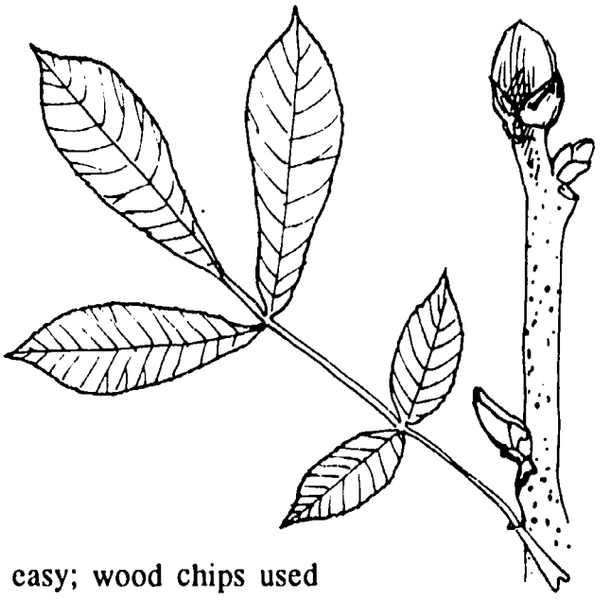
***Flowers:*** white, flat-topped clusters, blooming just after the leaves emerge

***Fruit:*** red 1/4-inch berries, persisting

***Comments:*** attractive tree in all seasons, but thorns restrict planting; problems include rusts, fireblight,

## HICKORY

SHAGBARK HICKORY - *Carya ovata*



***Leaves:*** alternate, pinnately compound, usually 5 leaflets; golden yellow in fall

***Stem:*** stout, grayish brown, smooth; bark shaggy

***Buds:*** large, 1/2-3/4 inch, brown, exfoliating papery scales

***Size and form:*** 60-100 feet; upright

***Flowers:*** yellow-green, pendulous catkins, blooming in mid-May; not ornamentally important

***Fruit:*** globular nut 1 1/2 inches in diameter, in thick, four-sectioned husk

***Comments:*** bark adds character and makes identification easy; wood chips used for smoking meats and cheeses; difficult to transplant due to taproot

## HONEYLOCUST

THORNLESS HONEYLOCUST - *Gleditsia triacanthos* var. *inermis*

***Leaves:*** alternate, pinnately or bipinnately compound, 20-40 leaflets; excellent yellow fall color

***Stem:*** zigzag, reddish brown twigs; enlarged nodes

***Buds:*** small and hidden; terminal absent

***Size and form:*** variable, depending on cultivars; 30-75 feet; globular or irregular in habit; often horizontal branching

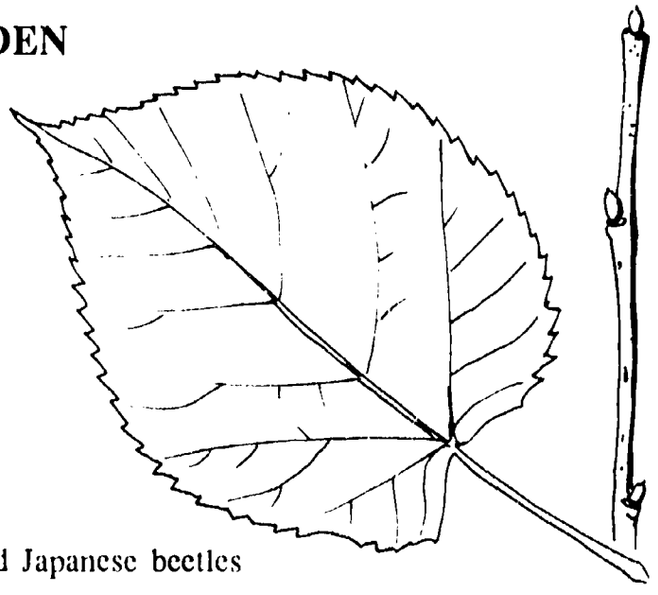
***Flowers:*** polygamo-dioecious, yellow-green, fragrant, 4-inch spike blooming in June

***Fruit:*** brown 8- to 12-inch pods; fruitless cultivars also grown

***Comments:*** tolerant of dry alkaline soils and salt; pests include mimosa webworm, borers, and cankers

## LINDEN

AMERICAN LINDEN - *Tilia americana*



***Leaves:*** 4-8 inches, alternate, cordate, with coarse, dull surface; yellow to brown fall color

***Stem:*** slender, flaky gray to reddish

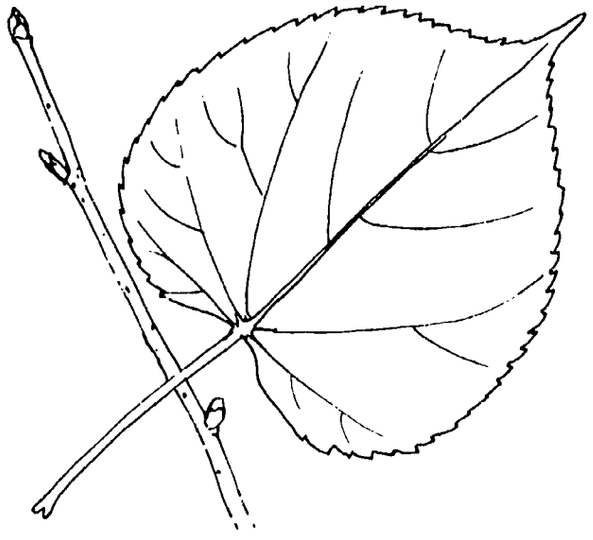
***Buds:*** red, 1/8 inch, two-scaled

***Size and form:*** 50-75 feet, sometimes larger; ovoid, somewhat upright

***Flowers:*** pendulous, yellow, blooming in mid- to late June; fragrant, attractive to bees

***Fruit:*** small woody balls attached to wings

***Comments:*** pH adaptable; problems with aphids and Japanese beetles



LITTLELEAF LINDEN - *Tilia cordata*

***Leaves:*** 2-3 inches, alternate, cordate, finely serrate; dark green in summer, yellow-green in fall

***Stem:*** slender, brownish twigs

***Buds:*** small, smooth; often a colorful yellow-red, otherwise greenish

***Size and form:*** 40-60 feet, pyramidal; densely branched

***Flowers:*** fragrant, yellow, blooming in late June

***Fruit:*** same as *Tilia americana;* not ornamentally important

***Comments:*** excellent street tree; many cultivars available; pest problems with Japanese beetles

## MAGNOLIA

SAUCER MAGNOLIA - *Magnolia soulangeana*

***Leaves:*** 3-6 inches long, alternate; green in summer, yellow turning brown in fall

***Stem:*** twigs gray, stout

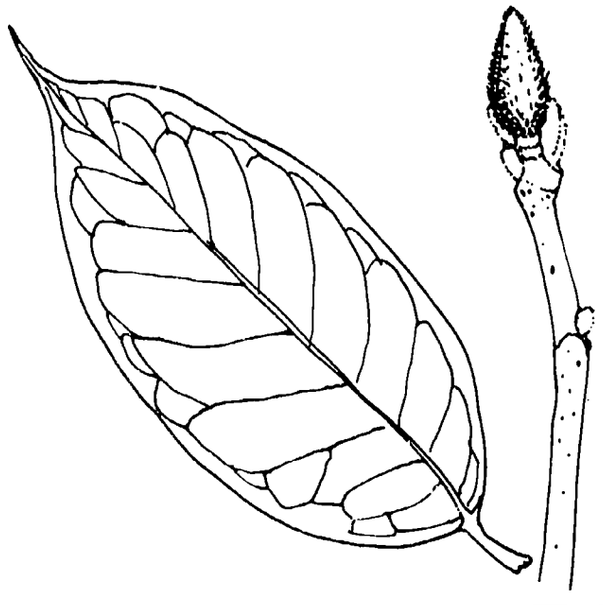
***Buds:*** long, 1/2-3/4 inch, greenish, very pubescent

***Size and form:*** 20-40 feet; spreading; often low branching with multiple trunks

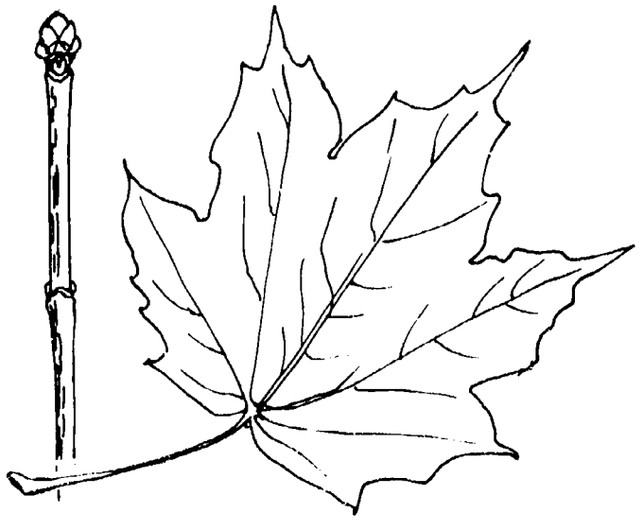
***Flowers:*** large, 6-8 inches in diameter, pinkish white

***Fruit:*** red aggregate of follicles, ripening in August

***Comments:*** nice patio tree; attractive in bloom, but easily damaged by frost; petal and leaf drop a clean-up problem



## MAPLE



NORWAY MAPLE - *Acer platanoides*

***Leaves:*** 3-7 inches wide, opposite, palmate with five lobes, dark green; milky substance appears when petiole is plucked from stem; attractive yellow fall color

***Stem:*** brown, smooth twigs

***Buds:*** plump, 1/4 inch long, reddish brown or green

***Size and form:*** 40-60 feet; rounded habit

***Flowers:*** bright yellow-green, blooming before leaves emerge

***Fruit:*** double samaras spread like wings; ripen in September

***Comments:*** cultivar 'Crimson King' known for maroon summer foliage; verticillium wilt a common problem

RED MAPLE - *Acer rubrum*

***Leaves:*** 2-4 inches wide, opposite, palmate; three- (or five-)lobed; excellent red fall color

***Stem:*** twigs green in summer, red in winter; slender and smooth

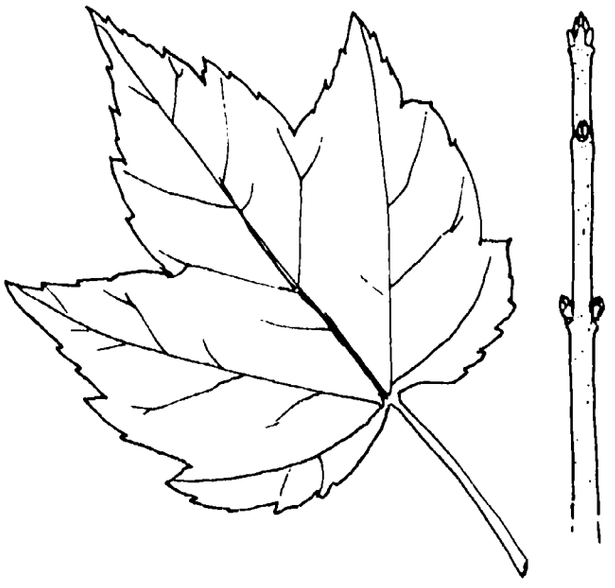
***Buds:*** red, small, clustered

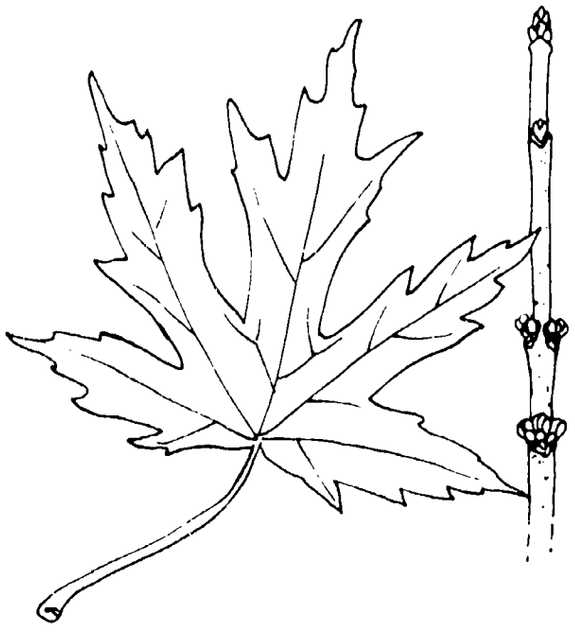
***Size and form:*** 50-75 feet; mostly ovoid, but spreading

***Flowers:*** red clusters, filamentous, blooming in late March

***Fruit:*** paired samaras

***Comments:*** many cultivars available; tolerant of damp soils, but manganese chlorosis develops in high pH





SILVER MAPLE - *Acer saccharinum*

***Leaves:*** 3-6 inches, opposite, five lobes, palmate; yellow-green in fall, sometimes with a hint of red

***Stem:*** twigs smooth, reddish brown to gray

***Buds:*** red, small, clustered

***Size and form:*** 60-90 feet; irregular habit; lower branches pendulous, very fast-growing

***Flowers:*** small clusters, red to yellowish, blooming before the leaves emerge

***Fruit:*** paired samaras

***Comments:*** a much maligned tree (some of it deserved); many pest problems known; often suffers from storm damage

SUGAR MAPLE - *Acer saccharum*

***Leaves:*** 3-6 inches, opposite, palmate, three- to five-lobed; yellow-orange-red fall color, almost glowing

***Stem:*** twigs smooth, tan

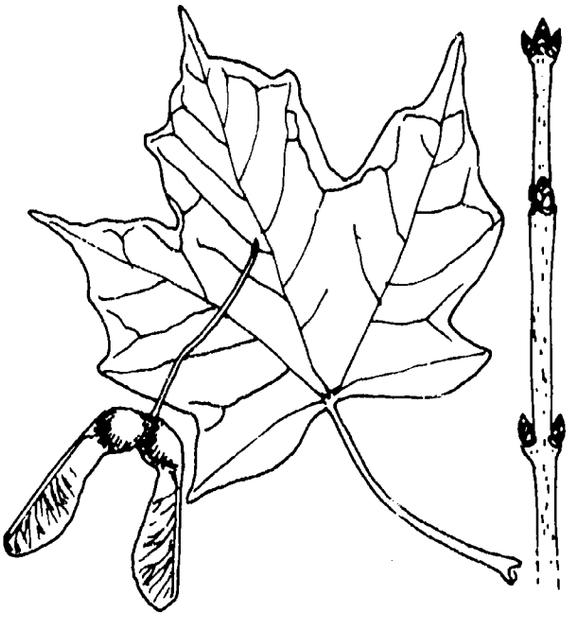
***Buds:*** light brown, very thin and pointed

***Size and form:*** 60-100 feet; variable in habit but usually ovoid

***Flowers:*** small, pendulous clusters, yellow-green, blooming in April-May

***Fruit:*** paired samaras

***Comments:*** among the best for fall color; excellent shade tree, but not very tolerant of city conditions



# MOUNTAINASH

EUROPEAN MOUNTAINASH - *Sorbus aucuparia*

***Leaves:*** alternate, pinnately compound, 7-15 leaflets, serrate at tips; green to yellow-orange in fall

***Stem:*** twigs grayish and pubescent

***Buds:*** 1/2 inch long, maroon, fuzzy; appear stalked

***Size and form:*** 25-50 feet; erect and oval, with pendulous branches

***Flowers:*** white clusters blooming in May; malodorous

***Fruit:*** orange-red clusters ripening in August-September; very attractive

***Comments:*** very attractive specimen tree when healthy; borers and fireblight often serious problems

# OAK

PIN OAK - *Quercus palustris*

***Leaves:*** *3-6* inches long, alternate, pinnately lobed with deep sinuses; deep red in fall

***Stem:*** twigs slender, reddish; branches with spurs (pins)

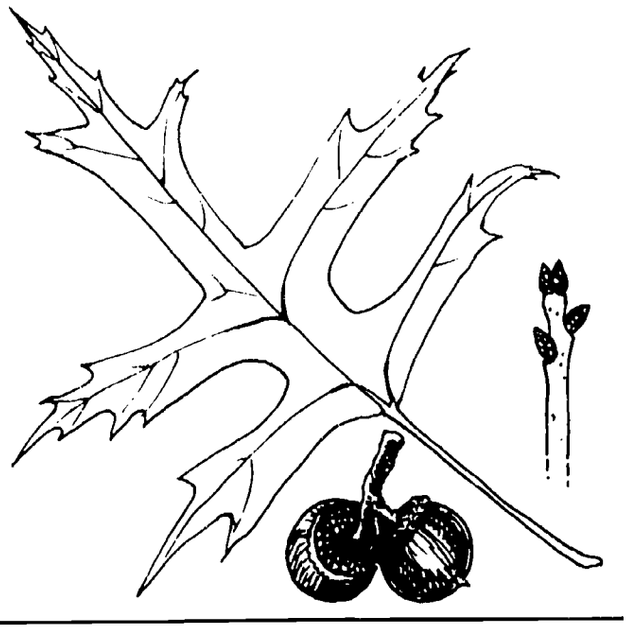
***Buds:*** 1/8 inch, pointed, red-brown, clustered

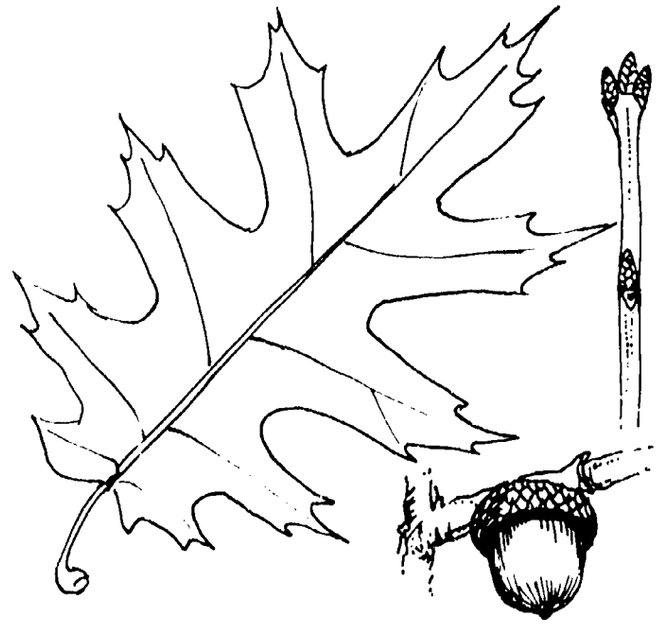
***Size and form:*** 60-100 feet; upright; lower branches pendulous

***Flowers:*** yellow-green catkins blooming in May

***Fruit:*** red-brown acorn, 1/2 inch, ripening in fall

***Comments:*** iron chlorosis very serious in alkaline soils





RED OAK - *Quercus rubra*

***Leaves:*** 4-9 inches long, alternate, 7-9 lobes with pointed tips; russet red in fall

***Stem:*** smooth, reddish brown

***Buds:*** chestnut brown, pointed, clustered

***Size and form:*** 50-100 feet; upright and symmetrical

***Flowers:*** yellow-green, blooming in May, not ornamentally important

***Fruit:*** brown acorn, 3/4-1 inch long, ripening in fall

***Comments:*** one of the faster-growing oaks; excellent shade tree with few serious problems

WHITE OAK - *Quercus alba*

***Leaves:*** 4-9 inches long, alternate, 5-9 lobes that are smooth and rounded; foliage brownish in fall, persists through winter

***Stem:*** twigs stout, brown with purplish bloom

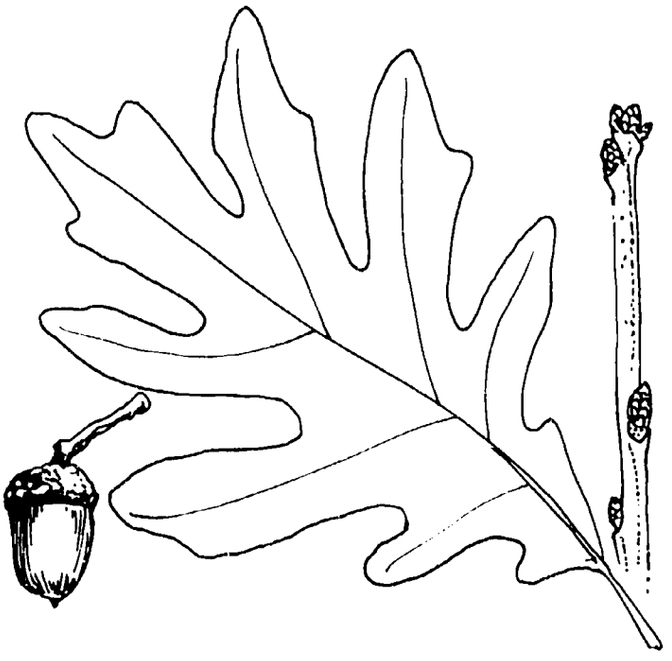
***Buds:*** brown, blunt and clustered

***Size and form:*** 75-100 feet; upright and broadly rounded; stately form

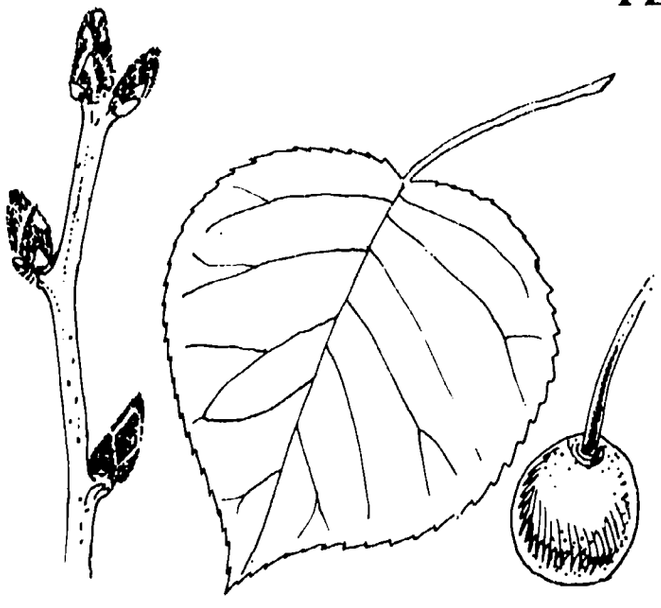
***Flowers:*** yellow-green, blooming in May; not ornamentally important

***Fruit:*** 3/4-inch-long acorn, one-quarter of it enclosed in cap

***Comments:*** among the largest and most beautiful trees in the forest; very sensitive to construction injury (soil compaction and grade change)



## PEAR



BRADFORD CALLERY PEAR - *Pyrus calleryana* 'Bradford'

***Leaves:*** 2-3 inches, opposite; glossy, dark green in summer, scarlet to maroon in fall

***Stem:*** twigs stout and brownish

***Buds:*** tan and fuzzy

***Size and form:*** 20-40 feet; stoutly pyramidal, very dense

***Flowers:*** white, blooming before the leaves emerge; spectacular in bloom

***Fruit:*** 1/2-inch pome; not ornamentally important

***Comments:*** good street tree, but prone to storm damage; many other cultivars now available

## PINE

EASTERN WHITE PINE - *Pinus strobus*

***Leaves:*** needles 3-5 inches long, five per sheath

***Stem:*** twigs slender, green to gray

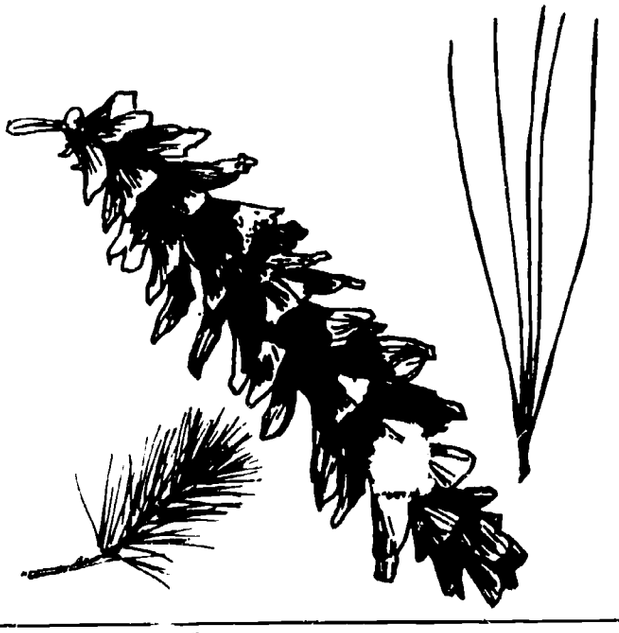
***Buds:*** ovoid, 1/4 inch, resinous, pointed

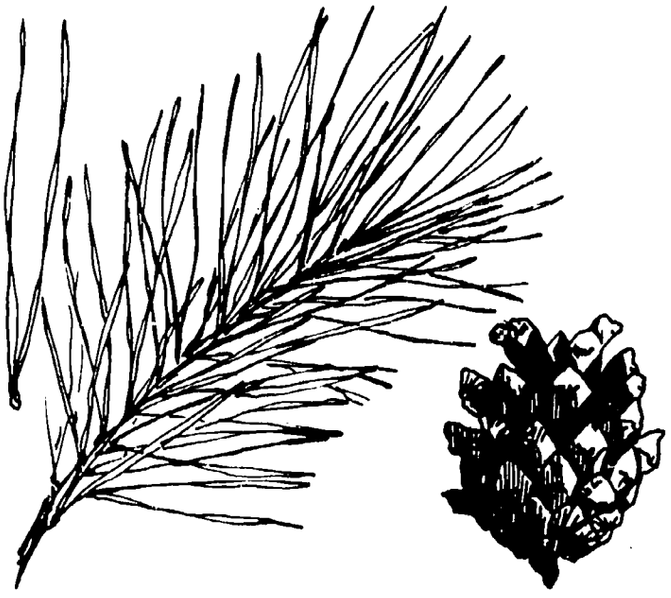
**Size and form:** 60-100 feet; pyramidal, and more irregular-shaped with age

***Flowers:*** monoecious; not ornamentally important

***Fruit:*** brown cone, 6-8 inches long, slightly curved

***Comments:*** fast-growing, fine-textured pine; intolerant of pollution, salts





SCOTCH PINE - *Pinus sylvestris*

***Leaves:*** needles 1-4 inches long, two per sheath, twisted, blue-green

***Stem:*** twigs green to grayish brown; bark with orange tinge

***Buds:*** 1/4 inch, orange-brown, reflexed, resinous

***Size and form:*** 40-75 feet; pyramidal when young, but opening with age

***Flowers:*** monoecious; not ornamentally important

***Fruit:*** cones 2-3 inches long, gray-brown

***Comments:*** tolerates poor soils; some cultivars used as Christmas trees

## REDBUD

EASTERN REDBUD - *Cercis canadensis*

***Leaves:*** 2-4 inches across, heart-shaped, alternate; new growth reddish, dull yellow-green in fall

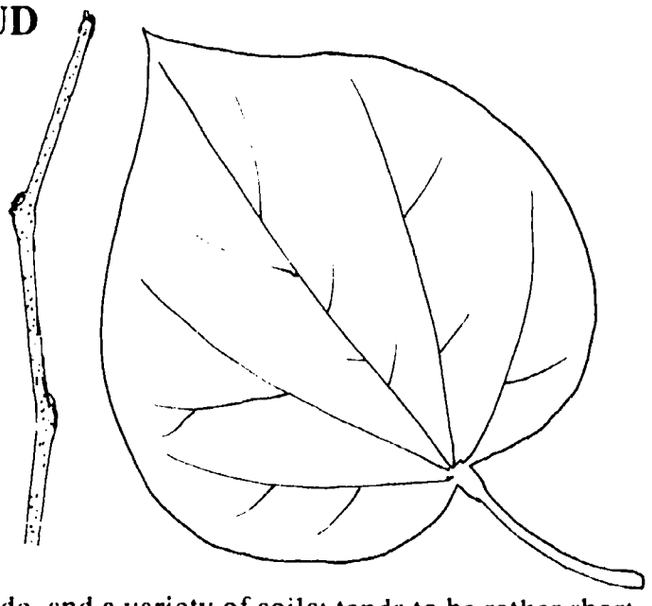
***Stem:*** twigs zigzag, brown with prominent lenticels

***Buds:*** small, dark, glossy; terminal absent

***Size and form:*** 20-40 feet; spreading and flat-topped; often multi-stemmed

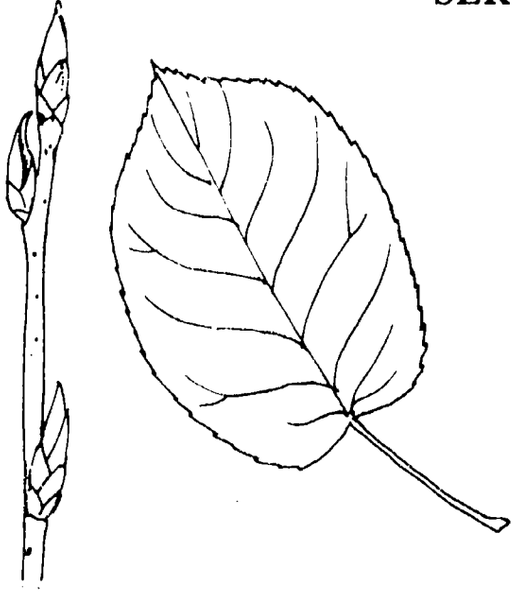
***Flowers:*** purplish pink, blooming before the leaves emerge; often produced on trunk and branches

***Fruit:*** leguminous pod, 2-3 inches long, brown; ripening in October



***Comments:*** an excellent specimen tree; tolerates sun, shade, and a variety of soils; tends to be rather short-lived due to canker problems and verticillium wilt

## SERVICEBERRY



ALLEGHENY SERVICEBERRY - *Amelanchier laevis*

***Leaves:*** 1-3 inches long, simple, finely serrate; dull green in summer, orange to red in fall

***Stem:*** slender, gray, slightly exfoliating

***Buds:*** narrow, cigar-shaped, reddish brown

***Size and form:*** 20-35 feet; often multi-stemmed; rounded habit

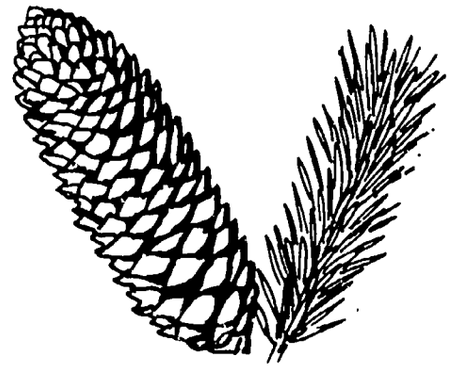
***Flowers:*** white, upright, blooming in late April

***Fruit:*** 1/2 inch; red, turning purple when ripe; edible

***Comments:*** excellent four-season tree; somewhat intolerant of soil compaction

# SPRUCE

COLORADO SPRUCE - *Picea pungens*



***Leaves:*** stiff needles 3/4-11/4 inches long, spirally arranged over stem

***Stem:*** orange-brown

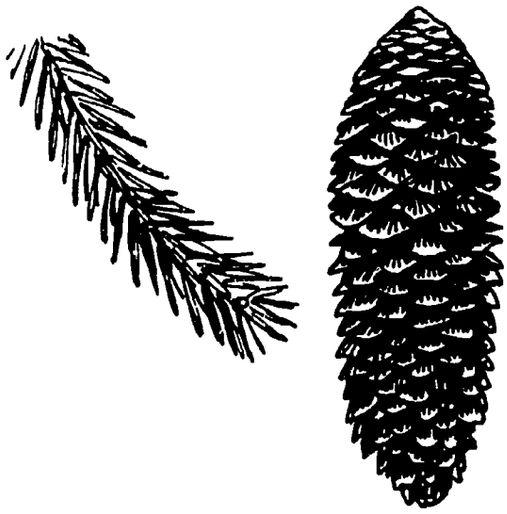
***Buds:*** broadly conical, blunt, tan

***Size and form:*** 75-100 feet; narrow, dense, pyramidal

***Flowers:*** monoecious; inconspicuous

***Fruit:*** light tan, oblong cone, 2-5 inches long

***Comments:*** somewhat drought-tolerant; blue cultivars most widely used in home landscape; some insect problems; sometimes trees are blown over in high winds



NORWAY SPRUCE - *Picea abies*

***Leaves:*** needles 1/2-1 inch long, stiff, bluntly pointed, not as erect as those of Colorado spruce

***Stem:*** twigs slender, orange-brown

***Buds:*** light brown, 1/4 inch long, rosette-shaped

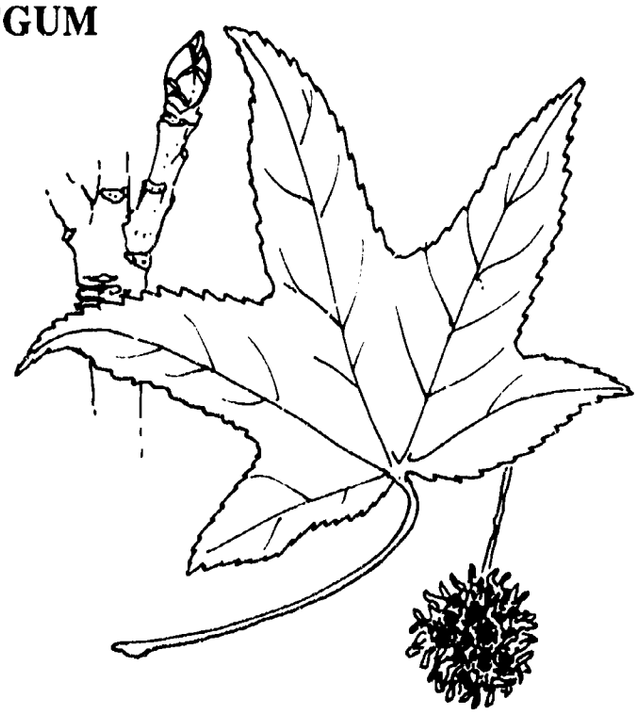
***Size and form:*** 50-75 feet; pyramidal with pendulous branchlets

***Flowers:*** monoecious; inconspicuous

***Fruit:*** cone 4-6 inches long, brown

***Comments:*** somewhat overused in the landscape; scrappy-looking with age

# SWEETGUM



SWEETGUM - *Liquidambar styraciflua*

***Leaves:*** 4-7 inches wide, alternate, palmately lobed, star-shaped; fall color variable - yellow to deep purple

***Stem:*** twigs aromatic, gray, with corky wings

***Buds:*** 1/2 inch, scaly, orange-brown, glossy

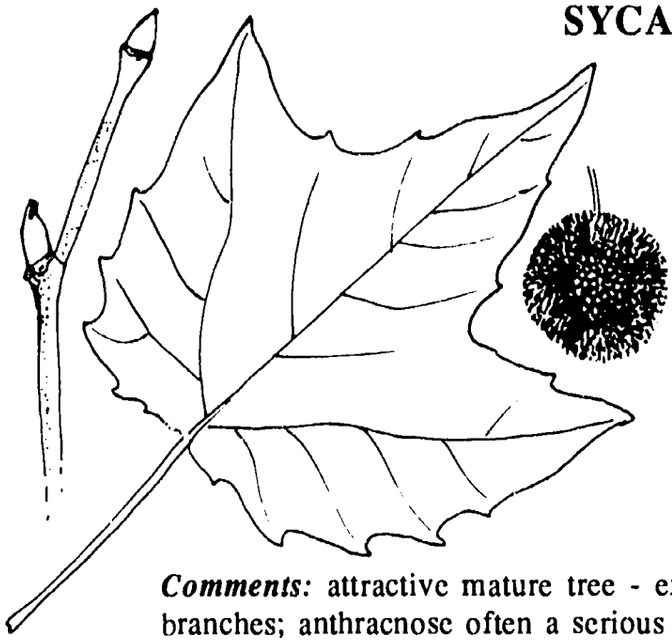
***Size and form:*** 50-75 feet; conical, becoming ovoid

***Flowers:*** monoecious, green, not ornamentally important

***Fruit:*** globular, prickly, 1 inch in diameter

***Comments:*** attractive shade tree when used appropriately; iron chlorosis in alkaline soils; insect/disease problems occur when tree is stressed

# SYCAMORE



SYCAMORE - *Platanus occidentalis*

***Leaves:*** 4-10 inches wide, leathery, hairy, palmately lobed (3-5 lobes), alternate; dull green in summer, yellow-brown in fall

***Stem:*** stout, zigzag, tan-colored

***Buds:*** smooth and blunt, 1/4-1/2 inch long, reddish purple

***Size and form:*** 75-100 feet; wide-spreading

***Flowers:*** small clusters, blooming when leaves emerge; not ornamentally important

***Fruit:*** tan-colored ball, 1-2 inches in diameter

***Comments:*** attractive mature tree - exfoliating bark exposes white patches on trunk and branches; anthracnose often a serious problem; many other insect and disease problems

LONDON PLANETREE - *Platanus acerifolia*

***Leaves:*** 4-8 inches wide, leathery, hairy, palmately lobed (3-5 lobes), alternate; dull green in summer, yellow-brown in fall

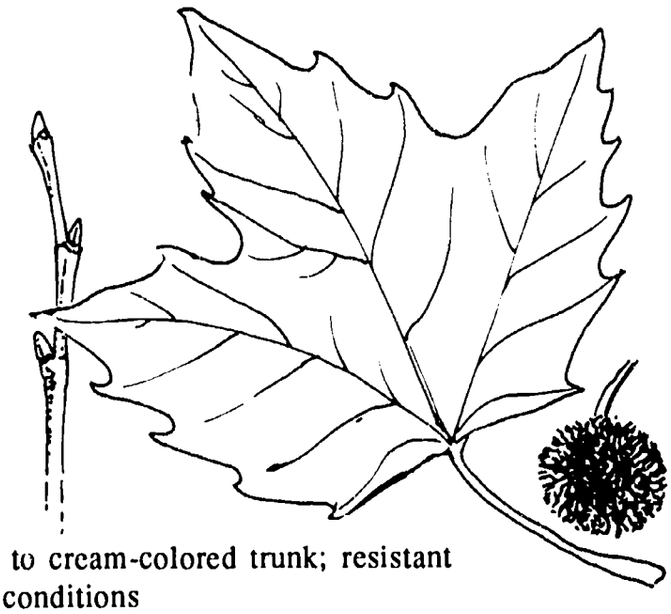
***Stem:*** stout, zigzag, tan-colored

***Buds:*** smooth and blunt, 1/4-1/2 inch long, reddish purple

***Size and form:*** 60-80 feet; upright when young, opening with age

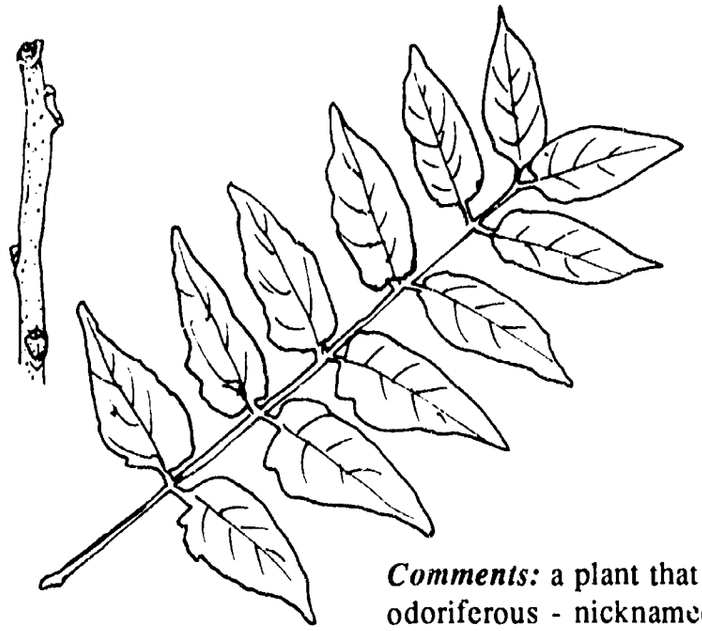
***Flowers:*** small clusters, blooming when leaves emerge; not ornamentally important

***Fruit:*** tan-colored ball, 1-2 inches in diameter



***Comments:*** bark exfoliates, exposing an olive-green to cream-colored trunk; resistant to anthracnose; sometimes rather short-lived in city conditions

# TREE-OF-HEAVEN



TREE-OF-HEAVEN - *Ailanthus altissima*

***Leaves:*** 18-24 inches long, pinnately compound, 15-25 leaflets, alternate; dark green in summer, little fall color, some reddish

***Stem:*** stout, yellow-brown; nasty odor when crushed

***Buds:*** small, semi-spherical, brown; large leaf scar

***Size and form:*** 40-60 feet; spreading, coarse habit

***Flowers:*** dioecious, 8- to 12-inch-long yellow-green panicles, blooming in June

***Fruit:*** samaras in large clusters turning brownish; persisting

***Comments:*** a plant that will grow where nothing else will; weak-wooded; odoriferous - nicknamed "Stink Tree"

## TULIPTREE

TULIPTREE - *Liriodendron tulipifera*

***Leaves:*** 3-6 inches, tulip-shaped, glossy, alternate; rich yellow fall color

***Stem:*** twigs smooth, reddish to light brown, aromatic

***Buds:*** valvate, terminal, red-brown, covered with a bloom

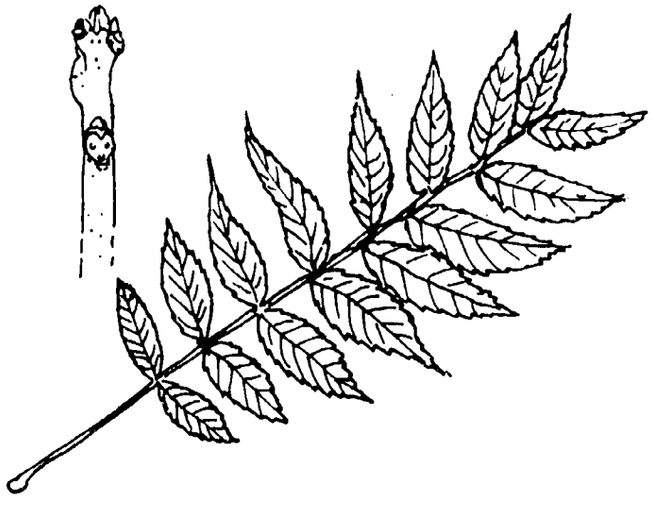
***Size and form:*** 75-100 feet; fast-growing; somewhat columnar

***Flowers:*** large, single, upright, pinkish orange, blooming in June

***Fruit:*** aggregate of tan samaras ripening in October

***Comments:*** can grow to a good size; somewhat weak-wooded; not recommended for landscape plantings

## WALNUT



BLACK WALNUT - *Juglans nigra*

***Leaves:*** alternate, pinnately compound, 15-23 serrate leaflets; late to leaf out in spring and early to drop leaves in fall, yellowish fall color

***Stem:*** stout, tan twigs with large leaf scars

***Buds:*** naked, woolly, dark grayish

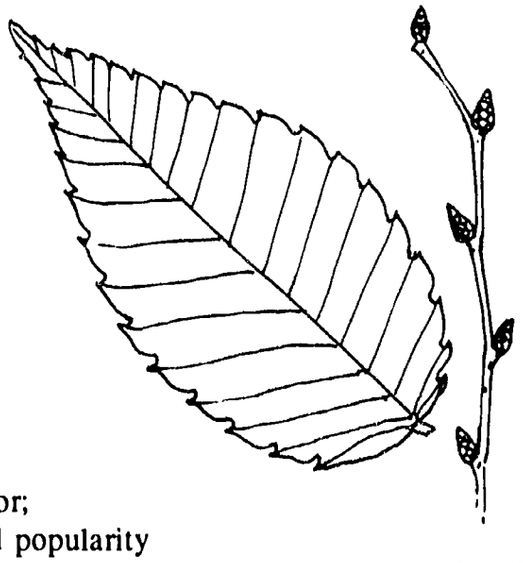
***Size and form:*** 75-100 feet; irregular habit

***Flowers:*** monoecious; yellow-green; not ornamentally important

***Fruit:*** very hard nut enclosed in a 2-inch, bright green, round husk; ripening in September

***Comments:*** hard wood very valuable; not very good as a landscape plant; may cause toxicity problems to nearby plants

## ZELKOVA



JAPANESE ZELKOVA - *Zelkova serrata*

***Leaves:*** 1 1/2-2 inches long, simple, serrate, alternate; deep green in summer, yellow to red in fall

***Stem:*** slender brown twigs, pubescent when young

***Buds:*** brown, pointed, 1/4 inch long, at 45° angle to stem

***Size and form:*** 50-75 feet; low-branching, spreading habit, often wider than tall; sometimes multistemmed

***Flowers:*** in clusters, blooming in April-May, not ornamentally important

***Fruit:*** very small, 1/8-inch drupe, ripening in fall

***Comments:*** attractive for its flaky bark and excellent fall color; introduced to replace the American elm, but has never gained popularity

CHAPTER 9

# Identification and Treatment of Tree Problems

## *Objectives*

This chapter is intended to provide some introductory information on how to diagnose and treat various types of tree disorders.

1. Understand what is meant by tree health management.
2. Learn the basic steps and methods used in diagnosis of disorders.
3. Become familiar with the various signs and symptoms of disease and pest problems.
4. Learn the major classifications of disease, insect damage, and environmental injuries.
5. Understand the principles of Integrated Pest Management.
6. Know how to calibrate a sprayer, and learn the basics of applying pesticides to trees.

## Tree Health Management

For years, doctors have known that stress can predispose a person to illness. Stress can result from physical problems such as poor eating habits, insufficient sleep, or lack of exercise. Other causes of stress can be mental or emotional.

The situation is quite similar with plants. Trees that are under stress are more prone to invasion by insects and disease. Once physiologically weakened, the tree may succumb to secondary pathogens or pests.

It is important to maintain the health and vigor of a tree to help prevent diseases and other disorders. A tree in good health is better able to withstand insects and pathogens that can prove fatal to a weak tree.

The first step in tree health management is to choose plants that are appropriate for the site in which they are expected to grow. One does not expect tropical plants to survive in a Wisconsin landscape. Plants must be hardy to tolerate winter weather. Besides cold, there are many other environmental factors: soil type, pH, annual rainfall, sunlight,

temperature extremes – all are important considerations. Thus a forest understory plant such as dogwood would not be expected to do well as an urban street tree.

Tree health management includes other practices which help maintain the vigor of the tree. Adequate moisture and proper drainage must be provided. Many tree problems stem from poor root health. Since water and minerals are taken up through the roots, any problems such as soil compaction, poor drainage, or drought will affect the entire plant.

Regular fertilization will also help keep the tree actively growing. Trees in an urban or landscape situation frequently do not get sufficient levels of vital elements. A vigorously growing plant will generally be one that is in good health, while a tree that is growing very little is probably just surviving.

Plant pathologists and entomologists agree that the primary step in prevention and treatment of tree problems is maintenance of a tree's health. Minimizing stress is the key to keeping a tree in good health.

## Diagnosis of Tree Problems

Accurate diagnosis of tree problems requires a little investigative work. The tree must be examined from many perspectives. It is important to keep an open mind and not to diagnose the situation prematurely. Remember that tree problems frequently are the result of several contributing factors.

Unlike people, trees cannot tell us "where it hurts" or when the illness started. For this reason, the arborist must rely on the homeowner to provide background information. Unfortunately, most homeowners are not trained in plant care, and they may give inaccurate information. Frequently, all but the final symptoms go unnoticed. The homeowner may report that the tree "just died overnight." The tree specialist must learn to ask key questions that can help to determine what caused the problem. One might discover, for example, that trenching for a pipeline severed 50 percent of the tree roots several years previously.

After gathering background information, the arborist must examine the plant in its environment (figure 9.1). The first perspective to be investigated is from a distance. Look at the condition of other plants in the area. Look for similar symptoms. Notice the climatic conditions, drainage patterns, and soil types. Does the problem appear to be specific to the plant in question or generalized over the entire area? Figure 9.2 shows a group of dead and declining trees from a distant perspective.

**FIG. 9.1.** "*This* tree? No, ma'am. I don't think a little fertilization and pruning will do the trick."

**FIG. 9.2.** Looking at plants within their total environment may provide clues for diagnosis.

The second point of view involves a close examination of the tree as a whole. There are many places to look for symptoms. Check for dieback in the crown and note whether it is universal or limited to particular limbs. Look for injuries to the trunk or branches. Check the foliage color and condition. Measure the twig extension growth over the past five years. This may provide the answer to when the problem began. Look for problems which may affect the root zone. Remember that any one symptom may be caused by a variety of injuries or pests. The correct course of action can be decided only when all the symptoms and clues are combined (figure 9.3).

FIG. 9.3. Close examination may reveal problems such as this scale on a twig.

FIG. 9.4. Leaf spot is one symptom of cedar-apple rust on apples, crabapples, and hawthorns.

Frequently the naked eye cannot catch all the symptoms. Spider mites, insect eggs, and fungal fruiting bodies, for example, cannot be seen without magnification. Most tree professionals carry a pocket hand lens for use in diagnosing tree problems. Such a close-up perspective sometimes yields the final answer. At other times, in order to confirm the presence of a particular disease-causing organism, samples must be sent to a plant disease clinic for laboratory tests.

In diagnostics, knowledge and experience are the most important tools. The professional must be able to identify the plant and know its characteristics and sensitivities. The arborist must be aware of what is "normal" for that species. It helps to know the characteristic problems of each species and what pests and diseases have been severe in a given year.

An experienced diagnostician will carry a number of tools to help diagnose tree problems.

- *pruning saw and hand pruners:* to look at cambium and inner wood
- *knife:* to expose symptoms under the bark or cut small sections for close examination
- *spade:* to dig around the trunk or in the root zone
- *soil auger:* to examine the soil situation in the root zone
- *increment borer:* to look at growth patterns or decay in the wood
- *hand lens:* for magnification of very small organisms or objects
- *binoculars:* to look at foliage and other features that cannot be seen from the ground

## SYMPTOMS AND SIGNS

Many diseases and pests of plants are named for the damage they cause and the plant affected; for example, oak wilt, hawthorn leaf blight, and holly leaf miner. The tree service worker needs to become familiar with the various signs and symptoms of tree problems. Remember that almost never can a problem be diagnosed by a single symptom. Wilting, for example, can be the result of drought, root problems, or various fungal or bacterial organisms. Some symptoms of plant disorders are described in the following section.

***Leaf spot*** - spots of dead tissue on the foliage (figure 9.4). (If the dead area in the center falls out, the spots are called "shot holes.") The shape and size may be characteristic of the causal agent; zonate spots with concentric (bull's-eye-like) areas are frequently of fungal origin.

***Leaf blotch*** - dead areas on the foliage, usually irregular in shape and larger than leaf spots

***Blight*** - necrotic (dead) portions of a plant, especially of young, growing tissues such as leaves and twigs

***Scorch*** - browning and shriveling of foliage around the margin or between the veins due to heat and intense sunlight

***Wilt*** - drooping stems and foliage due to a lack of water within the plant

***Canker*** - localized dead stem tissue, often shrunken and discolored (figure 9.5)

***Damping-off*** - rotting at the base of seedlings

***Stunting*** - reduced plant growth

***Gummosis*** - exudation of sap from wounds or other bark openings

FIG. 9.5. Nectria canker is caused by a fungus with orange fruiting bodies.

*Edema* - watery swelling or gall due to abnormal internal water conditions; after bursting, may appear similar to rust

*Rust* - orange or reddish brown pustules on leaves or stems; cause - a particular group of fungi

*Smut* - black powdery pustules or streaks on soft plant tissues; cause - a particular group of fungi

*Powdery mildew* - white or grayish fungal growth on the surface of stems or foliage

*Downy mildew* - spores and spore-bearing structures from fungal growth beneath the leaf surface; usually darker in color than powdery mildew

*"Water-soaked"* - darkened plant tissue that appears wet or oily

*Galls* - areas of swollen plant tissue that have been invaded by parasites

*Vascular discoloration* - darkening of the vascular elements in wood (figure 9.6)

*Witches' broom* - abnormal growth of a large number of secondary shoots forming a "broom"

*Chlorosis* - yellowing of normally green tissues due to lack of chlorophyll

*Necrosis* - death of tissue

*Dieback* - large portions of dead plant parts

## DISEASE-CAUSING ORGANISMS

### Fungi

The vast majority of parasitic diseases of plants are caused by fungi. This is not to say, however, that most fungi cause disease. Quite the contrary! Most

FIG. 9.6. Vascular discoloration is one of the symptoms of verticillium wilt.

fungi are either beneficial or of little consequence to people. Fungi are used in processing cheeses, breads, wines, and antibiotics. Fungi are also essential in breaking down and recycling organic matter in the soil.

Fungi are non-photosynthesizing plants which must obtain their nutrients from other sources. (They cannot manufacture their own food.) In some cases fungi become parasitic on living plant tissues and thereby cause disease. There is a wide spectrum of fungi which cause disease; most plants are susceptible to at least one. The severity and extent of the disease depends on the resistance of the plant, the fungus, and environmental conditions. Most fungal diseases develop rapidly in a warm, moist environment.

Some fungi invade only the succulent tissues of the plant, such as leaves, stems, and fruit. Leafspots are an example. Other diseases include anthracnose, powdery mildew, tip blight, and scab. (See examples of some of these problems in figures 9.7-9.9.)

Some fungi attack stem tissue and cause girdling of the plant by stopping the upward and downward flow of water and nutrients. These are called *canker diseases*. Some of the most severe fungal diseases are the result of fungal invasion in the vascular elements of the plant. This group includes verticillium wilt, chestnut blight, phloem necrosis, and Dutch elm disease. Each of these diseases usually causes death of the plant.

## Bacteria

Like fungi, many bacteria are important to human beings and vital to the environment. Only a few cause plant disease. Many bacterial diseases cause rot. Soft rot diseases in ornamentals break down and decay tissues. The diseased areas may have a water-soaked appearance or a foul-smelling odor. Two of the most common diseases caused by bacteria are crown gall and fireblight, shown in figures 9.10 and 9.11.

**FIG. 9.7.** Anthracnose on London planetree

**FIG. 9.8.** Apple scab symptoms appear on fruit as well as on the leaves.

**FIG. 9.9.** Powdery mildew is mostly a cosmetic problem, doing little damage to the plant.

## Other Disease-causing Organisms (Pathogens)

In addition to pathogenic fungi and bacteria, other organisms too can cause disease. Certain viruses cause ringspot, yellowing, and stunt diseases. Mycoplasmas have been found to be the cause of some disorders. Certain serious plant problems are caused by microscopic "worms" called nematodes. Most nematodes live in the soil, but some invade aerial portions of plants. Nematodes have long been known to cause problems in warm, southern climates. But now many plant pathologists also expect to see more nematode-caused problems in the North.

## Insects and Other Animal Pests

### INSECTS

Insect pest problems are one of the biggest headaches that an arborist must confront. Insects cause more plant disorders than any other animal does. Insects also often serve as *vectors* or carriers for disease organisms; that is, they provide means of

**FIG. 9.10.** Crown gall is common on euonymus.

**FIG. 9.11.** The "shepherd's crook" is an early symptom of fireblight.

dissemination or invasion. Insects have complicated life cycles, one stage of which may cause problems, while the next does not. Control measures must be properly timed to reach the insect at the problem stage.

Most of the insect damage to plants is the result of feeding. (One notable exception is the damage caused by ovipositing or egg-laying of the cicada.) The nature of feeding damage depends upon the type of mouthparts. Insect mouthparts are adapted for either chewing or piercing and sucking. The damage done can be diagnostic symptoms of certain types of insects.

Chewing insects have mouthparts which rub together and macerate the food material. Some caterpillars, webworms, beetles and weevils are known to chew the foliage of plants. Some insects devour the whole leaf, while others eat only the intervenal tissue and leave a skeletonized leaf. Leaf miners feed between the upper and lower leaf surfaces creating tunnels. Another group of chewing insects is the borers, which feed and tunnel under the bark.

The second type of insect feeding is piercing and sucking. Mouthparts are adapted with a long stylet that pierces the cell and sucks out the contents. Symptoms of this type of feeding include chlorosis, stippling, and sometimes distortion. Sometimes feeding of this type results in gall formation on foliage or stems. Examples of piercing-sucking insects are scales, aphids, mealybugs, and true bugs.

## ORDERS OF INSECTS

Insects are classified much the same as plants, each insect having a genus and a species name. In discussing groups of related insects, however, most often the *order* names are used. The order is the classification level that divides the insects into commonly known types. The orders of insects that are of concern to arborists are listed as follows:

*Hemiptera* - true bugs
*Homoptera* - leafhoppers, aphids, scales
*Coleoptera* - beetles
*Lepidoptera* - butterflies, moths
*Diptera* - flies
*Hymenoptera* - bees, wasps, ants
*Orthoptera* - grasshoppers, locusts
*Thysanoptera* - thrips

### *Hemiptera*

The order Hemiptera includes what are known as the "true" bugs. Two types of bugs are most often the cause of problems for arborists – lace bugs and plant bugs. Lace bug feeding on the lower leaf surface creates a stippled appearance. Two common pests are the hawthorn lace bug and the sycamore lace bug (figure 9.12) Plant bugs that cause damage feed on newly expanding foliage The damage may range from a few holes in the leaves to complete defoliation, depending on the species and severity of infestation.

### *Homoptera*

Many plant pests are included in the order Homoptera. Aphids, leafhoppers, cicadas, psyllids, scales, mealybugs, and whiteflies are all in this group. Each of these insects has the piercing-sucking mouthparts which cause damage to plants by extracting sap from the plant tissues. Leafhoppers feed on the lower leaf surfaces and cause curling or epinasty (distorted growth) of the leaf. Hackberry nipple gall (figure 9.13) is caused by the feeding of a tiny psyllid on the undersides of hackberry leaves.

FIG. 9.12. Sycamore lace bug damage on London planetree

FIG. 9.13. Identifying characteristic of American hackberry: the presence of hackberry nipple gall on the undersides of leaves.

Aphids, which come in many sizes and colors, are pests to hundreds of kinds of plants. Generally, aphids feed on and cause damage to phloem tissue. Due to their potential for rapid reproduction, aphid populations can grow extremely large. It is not unusual to see plants completely covered with aphids. Aphids and other homopteran insects may excrete honeydew when feeding. On this sticky substance, a dark, sooty mold grows, creating a second unsightly problem.

Some aphids cause galls on woody plants. Two examples of galls caused by aphids feeding on shoot tips are the Cooley spruce gall and the eastern spruce gall (figure 9.14).

One of the major insect problems on trees is scales. Scales usually feed on young stems. Some cause merely cosmetic damage, while others can be fatal. Some scales are quite obvious, while others are difficult to spot. Control is often difficult because of the problem of proper timing of spray applications. One very common scale is cottony maple scale, known for its popcorn-like appearance (figure 9.15). Cottony maple scale attacks many shade trees, especially silver maple.

Some of the other scales that are common pest problems are Fletcher scale, San Jose scale, magnolia scale, oyster shell scale, pine needle scale, pine tortoise scale, and euonymus scale. Several of these can be quite serious. Oyster shell scale is sometimes fatal to the plant. Also, severe infestations of euonymus scale (figure 9.16) have been known to wipe out large plantings of euonymus.

FIG. 9.14. Damage to Norway spruce from the eastern spruce gall aphid.

### *Coleoptera*

Another large order of insects is Coleoptera, the beetles. There is a wide diversity of damage done by members of this order, one of which is the infamous Japanese beetle. It has been said that Japanese beetles will eat anything green. Though this is an exaggeration, the pest certainly has a large number of hosts. Figures 9.17 and 9.18 show the beetle and its feeding damage.

FIG. 9.15. Cottony maple scale on hawthorn

FIG. 9.16. The white-bodied males of euonymus scale cover this twig; the females are slightly larger and darker brown.

Another pest beetle is the black vine weevil, a serious problem on yews, many broadleaf evergreens, and other shrubs. Figure 9.19 shows the adult weevil feeding. It leaves a characteristic notch in the foliage. Although the presence of the black vine weevil can be detected by the feeding pattern of the adult, it is the larvae that cause the damage, feeding on roots.

Many beetle larvae cause damage to trees. Some of the wood borers, like the bronze birch borer, are actually beetle larvae. The bronze birch borer leads to the decline and death of white-barked birches that are planted out of their native range. Symptoms include the sudden wilting and death of aerial portions of the tree (figure 9.20). Closer examination of the trunk may reveal characteristic lumps (figure 9.21) and small D-shaped emergence holes.

### *Lepidoptera*

The order Lepidoptera includes butterflies and moths. Larvae of these insects damage trees. The gypsy moth is perhaps the best known in the East, where severe outbreaks have led to complete defoliation of entire forests. Other pests in this group include bagworms, tussock moths, white pine tube moth, pine tip moth, Eastern tent caterpillar, mimosa webworm, and fall webworm (figure 9.22).

Some other Lepidoptera larvae are wood borers. Frequently the adult forms are mistaken for wasps, since their appearance is very similar. One member of this group is the lilac borer, a serious pest to lilac and ash. Figure 9.23 shows the damage caused by the tunneling and feeding of this pest.

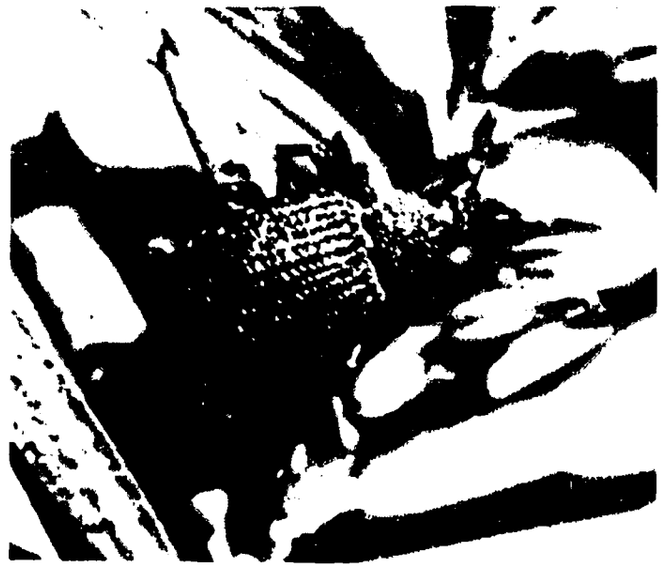


FIG. 9.19. Black vine weevil on yew

FIG. 9.17. The Japanese beetle

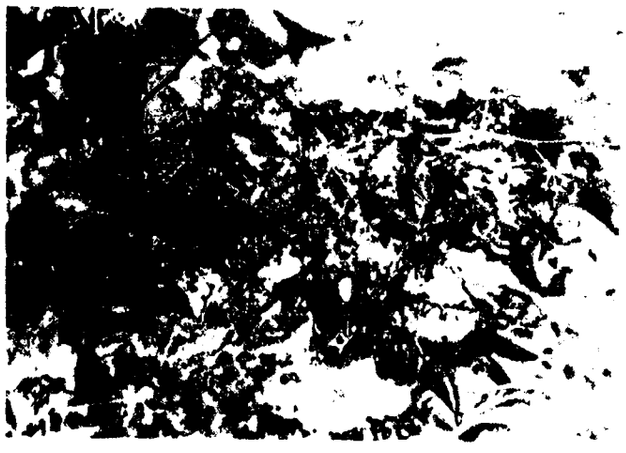


FIG. 9.18. Japanese beetle damage on linden leaves

FIG. 9.20. Typical decline of birch due to the bronze birch borer

### *Diptera*

As with many of the orders previously discussed, the larvae of Diptera are the plant pests. Some of these are holly leaf miner, juniper tip midge, and honeylocust pod gall midge, among others. Most of these pests do not bring about the death of the plant; they do, however, cause serious cosmetic injury.

### *Hymenoptera*

There are a number of plant pests in the order Hymenoptera, which includes bees, wasps, ants, and sawflies. The birch leaf miner is a sawfly larva which attacks white-barked birches. Other sawflies cause injury to new growth on conifers such as spruce and pine. Figure 9.24 shows red-headed pine sawfly larvae on a pine shoot tip. Some wasps in this order cause galls. Many wasp galls infest different oak species, but few cause serious problems.

## INSECT-LIKE PESTS AND SLUGS

A group of insect-like plant pests that are classified in the Class Arachnida rather than the Insecta are the mites. Mites that cause plant injury are either spider mites or gall mites. Feeding by spider mites often causes a bronzing or stippling of the foliage. Gall mites cause various types of small galls. Both types of mites are very small and can usually be identified only with the use of a hand lens.

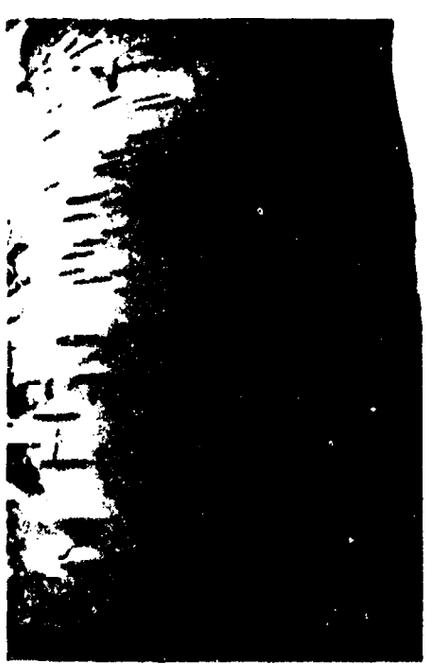


FIG. 9.21. This lumpy appearance indicates the feeding of the bronze birch borer.

FIG. 9.22. Unsightly webs are created by fall webworm on the tips of branches.

FIG. 9.23. Lilac borer damage to ash

FIG. 9.24. Red-headed pine sawfly larvae tend to feed in large groups.

Another plant pest is the slug, a member of the Phylum Mollusca (figure 9.25). Mollusks are not closely related to insects but are frequently discussed with them because of the similar problems caused. Slugs feed on the foliage of several ground cover plants and leave a slimy trail as they move.

FIG. 9.25. The common garden slug, a "snail" without a shell

### OTHER ANIMALS

Many other animals cause injury to plants. Rodents and other small mammals are probably the biggest problem in this category. In winter, when food is scarce, many small animals feed on the bark and cambium of small trees and shrubs. This can girdle and kill the plant. Large animals such as cattle, horses, goats, and deer can also be serious pests in nurseries.

A very common bird pest is the yellow-bellied sapsucker. This bird pecks holes in even rows in the trunks of several species of trees. These holes are wounds that provide an entry for canker fungi and certain insects.

## ENVIRONMENTAL INJURIES

The category of environmental injuries includes plant disorders that are caused by non-living agents. Physiological disorders, weather-related problems, nutritional disorders, chemical injuries, and mechanical damage fall into this category. In some cases these injuries can be prevented, while in others injury cannot be avoided. Since physiological disorders can upset the balance of health in a tree, treatment that reduces the stress on that tree is important. Frequently insect and disease problems are secondary to environmental disorders.

FIG. 9.26. Wind and snow often combine to cause tree breakage.

FIG. 9.27. Frost cracks are common on maples and sycamores.

### *Weather-related Injuries*

Scorch and sunscald are problems related to heat and sun. Sun-scorched foliage will turn brown and die around the margins. The entire plant will be stressed. Sunscald can also heat and kill the cambium of young trees. Shade-loving woodland trees should not be planted in full sun. Plants which tend to scorch, such as sugar maple, buckeye and dogwood, should be planted where reflected light is not severe and moisture is adequate.

Wind can also be very damaging to trees. There are two critical seasons for serious wind damage. In winter, when heavily laden with ice and snow, trees are prone to breakage in storms (figure 9.26). In late spring, with their newly expanded foliage, trees also break in wind storms. In many parts of the country, spring is also the season for tornadoes.

Besides wind damage, several injuries are associated with winter weather. Frost cracks (figure 9.27) are a common problem, especially on young, thin-

FIG. 9.28. Early growth was killed on this evergreen by an early spring frost.

FIG. 9.29. Iron chlorosis is a limiting factor in the use of pin oak in some areas.

FIG. 9.30. Manganese deficiency in red maple

barked trees. Frost cracks occur primarily on the south or west sides of the trunk. They are caused by extreme temperature fluctuations as the sun heats the bark during the afternoon, followed by rapid cooling during the night. Frost cracks usually originate at previous wound sites.

Other frost injury occurs on succulent growth early in the fall or in the spring when frost hits. A temperature drop below freezing is likely to kill young buds, especially flower buds. Figure 9.28 shows frost damage on new evergreen growth.

Winter burn is another problem – the result of water stress and sunscald during the winter months. The susceptible plants are those that hold their foliage throughout the winter. These plants should be well watered and mulched in the fall.

Another weather-related plant injury is lightning strike. Lightning can cause serious damage; it frequently destroys trees. Symptoms range from bark stripped in a spiral pattern to total shattering of the tree.

Moisture stress is a common problem with urban trees. Inadequate moisture may lead to sunscald, wilting, and eventually death. Moisture stress frequently predisposes the plant to other problems. Excess moisture can be as serious as drought. Certain plants, such as yews and broadleaf evergreens, are very sensitive to poor drainage and may be killed outright.

Although most weather-related problems are unexpected, some are avoidable. The best measure of prevention is planning. Plant only stress-tolerant trees in an environment which is stressful.

## Soil Stress

Numerous plant disorders are related to soil stress. Included are physical injuries caused by digging and compaction of soil in the root zone. Als as previously discussed, drainage problems will cause water stress. Some soils have such a rocky or high clay content that they are strictly limited as to the species that will grow in the area.

Soil pH is a measurement of the acidity or alkalinity of the soil. This is important since it can affect the availability to plants of essential elements and micronutrients. Two common deficiencies, iron and manganese, are related to high soil pH. The alkalinity of the soil causes these micronutrients to be "tied up" in a form unavailable to the plant. Iron chlorosis in pin oak, for example, is a common problem in alkaline soils. Chlorotic pin oak foliage is shown in figure 9.29. Notice also the necrotic flecking (small dead spots). Manganese deficiency is a similar problem on maples, hackberry, and spruce. The typical symptom on red maple is intervenal chlorosis (figure 9.30).

### Pollution Damage

As the urban population increases, air pollution damage to plants becomes a more pressing problem. Researchers are looking for plants that can withstand the stresses of a polluted city environment. There are several urban pollutants which can cause plant injury: sulfur dioxide ($SO_2$), ozone ($O_3$), peroxyacetyl nitrates (PAN), and chlorine and fluorine gases. Symptoms of air pollution injury are often similar to symptoms of other disorders. This makes diagnosis difficult. Two of the symptoms are marginal discoloration and defoliation. Intervenal bleaching is also common. When ozone levels are high, susceptible plants can be protected with a spraying of ascorbic acid.

### Chemical Injury

The primary sources of chemical injury to plants are pesticides, which include herbicides, insecticides, and fungicides. If applied correctly, insecticides and fungicides are rarely a problem to plants. Incorrect application may lead to marginal browning or tip dieback of the plant. Herbicide toxicity is a more common problem. With the wide range of chemicals being used, symptoms are varied. Intervenal chlorosis occurs after use of some herbicides. Epinasty and parallel venation are symptomatic of synthetic auxins such as 2,4-D and Dicamba (figures 9.31 and 9.32).

Another type of chemical injury results from the presence of high levels of soluble salts in the soil. These salts may have come from road salt used for de-icing or from overfertilization or chemical dumping. In any case, they cause water to move out of the plant. The results are wilting, scorch, or even death of the plant.

### Mechanical Injury

The sources of mechanical injury are too numerous to discuss them all. One thing common to many is the human element. Construction damage is a very common type of mechanical injury. Another well-known problem is "lawn mower blight," the injury to tree trunks from repeated bumping with the lawn mower (figure 9.33). Other sources of injury are vandalism and children's play. Unfortunately many people do not respect trees in the landscape.

Girdling is another major type of mechanical injury. Most girdling is the result of improper planting technique. Girdling roots can often be avoided if container-grown plants have their roots cut and separated at planting time. Plastic twine tied around balled and burlapped plants can girdle the plant if not cut (figure 9.34). Wire used in staking and guying trees also may girdle the plant if not removed after one year.

FIG. 9.31. An example of 2,4-D injury

FIG. 9.32. Epinasty or cupping of the leaves is another symptom of 2,4-D injury.

FIG. 9.33. Treatment for mechanical injury includes removal of loose bark. Prevention of injury from close mowing can include mulching around the tree.

FIG. 9.34. Wire and plastic twine often are the cause of girdling in young trees.

There are many stresses and disorders which can affect the health of a tree. Frequently prevention and treatment are a matter of basic knowledge and common sense. Remember the old adage, "An ounce of prevention is worth a pound of cure."

## Treatment of Tree Health Problems

To some people, treating a tree disorder automatically means spraying the tree with a chemical. In fact, chemical application is frequently *not* the best control method. The first step is to diagnose the problem and consider all the contributing factors. As previously discussed, tree health is a delicate balance of the species with its environment.

The modern approach to maintaining tree health involves Integrated Pest Management (IPM). The word "pest" in this phrase may refer to problems other than insects. The basic idea of IPM is to use and integrate various prevention and control treatments to maintain the health of the plant.

A good start in obtaining a healthy tree is to choose the right plant for the environment. Many factors must be considered, such as sunlight, rainfall, drainage, soil type and pH, and temperature extremes. All these environmental factors and others must be taken into account when choosing a tree for a given situation. Other important considerations involve the characteristics of the plant – height and spread at maturity, flowers, fruit, foliage, and many others. One of the most important items is selection of cultivars that are resistant to common insects and diseases.

Since the arborist usually must deal with plants already established, it is not always possible to select an ideal plant. Frequently treatment must center around altering the environment (for example, by installing an aeration system) to improve the health of the tree. In many cases it is best to remove the ailing plant and replace it with one that is more suitable.

Another key part of maintaining tree health is proper pruning and sanitation. As discussed in Chapter 5, pruning can remove dead and diseased branches and can help improve air circulation and sunlight penetration. Good sanitation practices involve sterilizing tools that may spread disease, disposal of diseased limbs, and raking fallen leaves and twigs that may harbor disease inoculum.

If the tree problem involves an injury rather than a disease, the treatment is based on reparation. Broken limbs should be carefully pruned. Loose or shredded bark should be removed. If necessary, the edges should be traced with a sharp knife, leaving a clean edge of bark around the exposed inner wood. Wound dressings are not necessary, but a thin coat of an asphalt-based paint may improve appearance.

Another aspect of Integrated Pest Management is finding alternate insect and disease control measures. Several examples are currently being studied and, in some cases, implemented. Dormant oils which kill certain insects without harming trees are a good alternative to insecticides. The use of natural predators and parasites as control measures may be effective. For example, the ladybird beetle feeds on certain scale insects and may be used to keep down their populations. Several bacterial diseases of insects have been found to help control pests such as the Japanese beetle and certain caterpillars. Insect pheromones, or hormones, are being used to trap specific insects, disrupt their mating habits, or time pesticide applications.

Many plant disorders are kept under control with the use of "chemicals," a broad term which includes fertilizers, insecticides, miticides, fungicides, herbicides and anti-desiccants. Many experts recommend that chemical treatments be the *last* line of defense. Some pests, however, cannot be effectively controlled without chemicals. It is important to consider the principles of IPM and employ a variety of treatment measures whenever possible.

## IMPLANTS AND INJECTIONS

Implants and injections are a fairly recent innovation in tree care. Both are methods of applying chemicals *systemically* to the tree. The three types of chemicals currently in use are fertilizers, systemic fungicides, and systemic insecticides. The intent is to get the chemical into the vascular system of the tree where it will be carried throughout the plant. Micronutrients can be applied in this manner to treat deficiencies. A systemic fungicide can provide a protective barrier against infection or retard fungal growth. Systemic insecticides kill insect pests as they feed.

There are several potential problems associated with the use of implants and injections. Improper placement may cause wounds, decay, or toxicity. Arborists should be properly trained and instructed before attempting to apply these treatments. Timing and placement are the important factors. Commercial products recommend the best time of year for application. Some distributors hold workshops to instruct tree care professionals in the proper use of their products.

Proper techniques in application and placement are vital. Most implants and injections are applied at the base of the tree near or at the root buttress or flare. The smaller the wound for implant or injection, the better. Some methods require drilling a small hole, while others come with insertion tools. As a rule, a clean hole will allow better uptake of the material with less damage around the point of insertion. Figure 9.35 illustrates some types of products available.

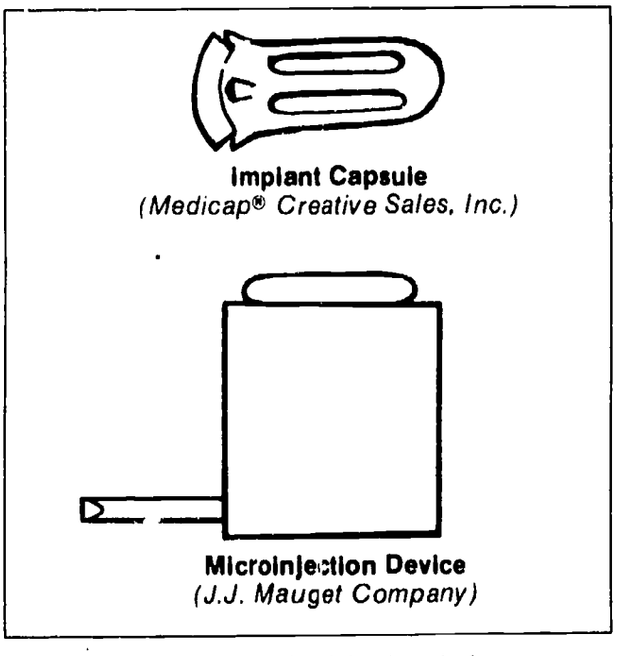



Fig. 9.35. Implant and microinjection devices

Another method of systemic fungicide application currently being studied is pressure injection for use on American elms. It is hoped that this method will help prevent the spread of Dutch elm disease to the remaining valuable elms. As with implants and microinjection, the goal is to get the fungicide to all parts of the tree internally. The difference is the use of pressure to force the chemical throughout the tree. This method is not currently widely employed by commercial arborists.

## SPRAY OPERATIONS

Tree spraying is one of the most visible pesticide applications. It is very important that tree care professionals operate carefully and within the law. Applicators must follow all federal, state, and local regulations. Licensing or certification is at the state level. Pesticide application supervisors must be certified applicators or under the direct supervision of a certified commercial applicator.

### *Pesticide Labels*

The label on a pesticide container bears very important, valuable information. The label lists what pests the chemical will control and on what plants it can be used. Chemicals must not be used for anything that is not specified on the label. The label gives the trade name of the product, the chemical name, form (wettable powder, liquid, etc.), warnings or cautions, and other important information. Chemicals should always be stored in their original, labeled containers in a well-ventilated, secure location.

### *Equipment*

Trucks carrying pesticide application units must be of sufficient capacity to carry the load of the full spray tank and equipment (figure 9.36). The truck should have locked boxes for carrying pesticide concentrates. Each truck should be equipped with the necessary personal protective gear for the applicators: jackets, pants, head gear, footwear, gloves, respirators, eye protection, and a first-aid kit. The truck should be clearly lettered (with 3-inch letters) with the company name and the city and state in which the company is located.

Hydraulic sprayers used in tree care operations for spraying trees over 60 feet in height should have a minimum pump capacity of 50 gallons per minute.

The tank should have a capacity of not less than 400 gallons and should be equipped with either mechanical or jet agitation. The hoses should have a minimum burst pressure of no less than twice the operating pressure of the pump.

The nozzle or gun should have a capacity sufficient to deliver the gallon-per-minute rating of the pump. Most nozzles are adjustable from straight stream, to a fan, to shut-off. Figure 9.37 shows a pesticide applicator wearing protective gear and holding the spray gun.

FIG. 9.36. This truck is fully outfitted for pesticide application to trees.

FIG. 9.37. A pesticide applicator with a spray gun

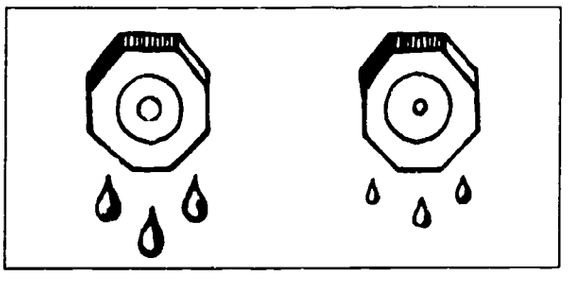


FIG. 9.38. Choose a nozzle disk that will maximize droplet size and still allow adequate spray height.

## *Sprayer Calibration*

The applicator has the responsibility to minimize drift and exposure to non-targets or things not requiring spraying. Good application techniques alone are not enough. Correct equipment must be used. Proper calibration is essential. In calibrating the sprayer, the optimum combination of pressure, nozzle size, and hose is selected to insure complete coverage without waste and with minimal drift.

Many factors influence the amount of drift: air movement, temperature, humidity, nozzle type, spray pressure, and droplet size. The smaller the droplet size, the greater the amount and distance of drift. Ideally, the droplets should be as large as possible, maintaining complete coverage (figure 9.38). If operating pressure is increased with the intent of increasing the height of spray, droplet size will decrease and drift could become a problem.

Sprayer calibration is based on choosing a nozzle disk size and then calculating the necessary operating pressure for the pump. With the nozzle open, the desired pressure at the gun is 400 pounds per square inch (psi). Since some pressure is lost as the liquid flows through the hose and couplings, the operating pressure at the pump will have to be set at a level somewhat higher than 400 psi. The goal in calibration is to calculate the pressure loss in the system.

First, determine the spray height that will be necessary. Use the manufacturer's table (Table 9.1 on page 98) to choose an appropriate disk size.

The amount of pressure loss is affected by several factors: volume of spray, diameter and length of hose, and number of couplings. The pressure loss in a small diameter hose will be greater than that in a larger diameter hose. Frequently tree sprayers are equipped with 100 feet of 1-inch-in-diameter hose near the pump, plus 200 feet of 3/4-inch hose to the nozzle. Charts are available to give pressure loss in the hose if the flow rate in gallons per minute (GPM) and hose size are known (figure 9.39 on page 99). The pressure loss is given per foot of hose. The pressure loss per foot must be multiplied by the length of hose. In addition, 10 percent of the loss for 50 feet must be added for each set of couplings. (See the sample in Table 9.2.)

## TABLE 9.1

### Recommended Tips on Shade Tree Spraying

| Pump GPM | Pump PSI | Hose Size | Gun and Spray | Nozzle PSI | Height Trees to Spray | To Obtain Maximum Height |
|---|---|---|---|---|---|---|
| 60 } 50 | 600-800# w/200' of 3/4" plastic hose | 1/4" | 785 equipped with special kit #22 | 350 to 450 | 65' to 110' | Use 785 Gun equipped with 5254037 kit installed |
| (35) | 600# w/200' plastic hose | 5/8" | 785 & (#16) | 350 to 450 | 50' to 80' | Use 785 Gun equipped with 5254037 kit |
| 25 | 600-700# w/200' hose | 5/8" | 785 & #14 | 350 to 450 | 40' to 65' | **Note:** Pressure and water volume are the factors that allow us to reach our target. For water particles to carry, they must have mass, so there are limits to the maximum pressure used to increase the throw or carry of a water stream. In shade tree spraying, relatively large droplets are necessary to keep outside wind from dissipating or spreading the water stream, hence our recommendation of Nozzle PSI. |
| 20 | 400-500# w/100' hose | 5/8" | 785 & #14 | 300 to 400 | 35' to 50' | |
| 10 | 400# w/100' hose | 1/2" | 785 & #10 | 300 to 350 | 20' to 35' | |
| 5 | 400# w/100' hose | 3/8" | 57 & #7 | 250 to 300 | 10' to 20' | |
| 3 | 400# w/100' hose | 3/8" | 57 & #6 | 300 to 350 | 10' to 20' | |
| 5 | 60# w/15' hose | 5/16" | 45 & #10 | 50 to 60 | 10' to 15' | |

**REMEMBER:**

1. Always use a large enough hose with nozzle disk to permit using as much of the pump capacity as possible.
2. Plastic hose has less friction loss than rubber.

*(Courtesy of FMC Corporation)*

## TABLE 9.2. Sample Calibration

**Desired height of spray = 60 feet**

**300 feet of 1" hose**

**3 sets of couplings**

**Nozzle size #16** (from Table 9.1)

**Flow = 35 gpm**

**Pressure loss in hose = 0.4 psi/foot** (from figure 9.39)
- 0.4 psi/ft x 300 ft = 120 psi

**Pressure loss from couplings:**
- 0.4 psi/ft x 50 ft x 0.10 = 2 psi/coupling
- 2 psi x 3 = 6 psi for 3 couplings

**Total pressure loss** = 120 psi (hose) + 6 psi (coupling) = 126 psi

**Pressure setting needed at pump** = 400 psi (operating pressure at gun) + 126 psi (pressure loss) = 526 psi

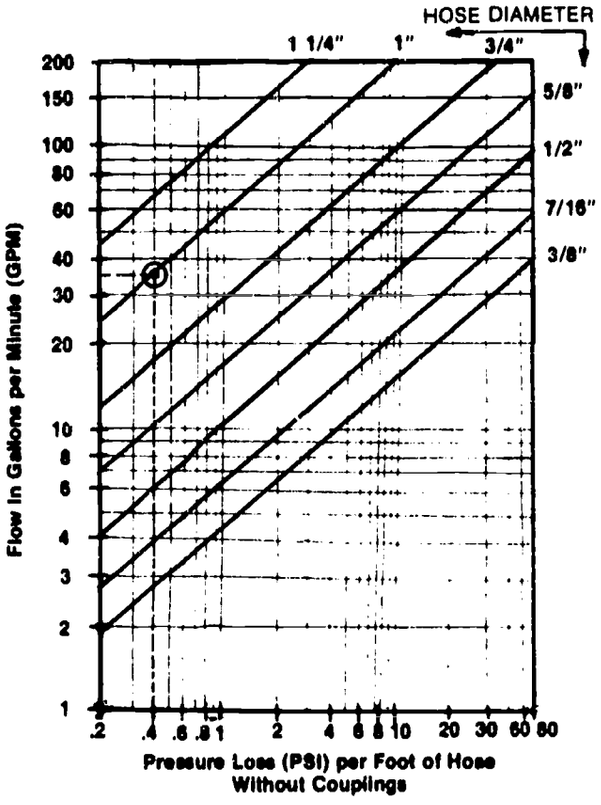



FIG. 9.39. Pressure loss in hose

FIG. 9.40. Wear protective gear when mixing chemicals.

## *Pesticide Application*

Proper pesticide application means using the right material at the right time, obtaining thorough coverage, and avoiding non-target exposure and drift. Pesticide applicators should keep a detailed, accurate log recording the following: date and time, chemical used, plants sprayed, target pest(s), weather conditions, and any additional notes. This log will prove valuable if any questions arise in the future.

When mixing chemicals, remember that you are handling concentrated materials. Be sure to wear the necessary protective gear (figure 9.40). Avoid dust or liquid splashing in the face. Rinse the empty container into the spray tank before disposing of it according to regulations. Pesticide containers must always be disposed of according to the label and existing laws to prevent contamination of the environment.

Before beginning to spray, check all equipment carefully. Be sure that each piece is functioning properly and that there are no leaks.

Pesticides must not be applied unless weather conditions are appropriate. There should be little or no wind. Some labels specify temperature ranges in which the chemicals should be applied. Generally, early morning is the best time for application, when weather conditions are most often cool and calm.

There are a number of points to keep in mind when spraying landscape plants.

- Comply with all federal, state, and local regulations.
- Treat only designated plants.
- Position yourself as applicator so that the drift is carried toward the tree and away from you and non-target areas (figure 9.41).
- Do not spray if there is undue risk to people, food, animals, beehives, or any other sensitive areas.
- Apply the pesticide so that coverage is thorough without drenching (figure 9.42). Check for leaf movement when spraying the tops of trees. Spray both upper and lower leaf surfaces.
- Start at the top of the tree and work down, gradually decreasing volume toward the bottom of the tree.
- When treating foundation plants, spray away from the building.
- Spray from the outer perimeter of the property inward whenever possible to avoid application to neighboring properties.

**FIG. 9.41.** The applicator should be positioned to avoid drift.

**FIG. 9.42.** The goal is thorough, even coverage without drenching.

CHAPTER 10

# Other Tree Care Operations

## *Objectives*

The purpose of this chapter is to acquaint the student with a variety of tree care operations other than pruning and removal.

1. Learn the techniques used in planting and transplanting trees.
2. Become familiar with the specifications for guying and staking trees.
3. Know and understand the methods of fertilizing trees.
4. Learn the techniques involved in cabling and bracing.
5. Gain familiarity with methods used to protect trees from lightning damage and construction injury.

## Planting Trees

Planting a tree is not quite so simple as digging a hole in the ground and sticking in a tree. There are a few rules and specifications that should be followed to help insure that the tree will survive.

The first step in planting a tree is hole preparation (figure 10.1). There is an old expression that goes, "Never put a ten-dollar tree in a five-dollar hole." The point is that an expensive tree could be lost if proper care is not taken in digging the hole. Generally, a 6- to 12-inch gap should be left between the edge of the root ball and the edge of the hole in all directions around the ball. The depth of the hole, however, should not be greater than necessary, since the tree will tend to sink through soft backfill dirt when water is applied.

FIG. 10.1. Dig the hole larger than the root mass of the tree.

Trees may be purchased in one of three forms: bareroot, balled and burlapped, or container-grown. Figure 10.2 shows a bareroot tree. Before planting, the roots of a bareroot tree should be soaked in a tub of water for at least 30 minutes. When planting the tree, first remove all dead or badly damaged roots. Then distribute the remaining roots as evenly as possible in the hole (figure 10.3).

A tree that has been balled and burlapped may be somewhat easier to plant, since the root mass is contained in the soil. Also, burlap is biodegradable; it does not have to be removed before planting. Avoid using non-biodegradable materials such as plastic or nylon. Jute twine used to tie up the ball will also decay in the soil. If the twine is tied tightly around the tree trunk, cut it to avoid girdling. Figure 10.4 shows a balled and burlapped tree that is laced with twine. Larger tree balls are sometimes enclosed in a wire basket (figure 10.5). The basket can be left on to facilitate planting. After the tree is in the hole, the wires can be snipped and folded back.

Container-grown plants should be removed from the container (figure 10.6) unless it is a biodegradable peat container. It may be necessary to cut through the root mass to eliminate twisted or girdling roots (figure 10.7).

FIG. 10.2. A well-branched, viable root system

FIG. 10.3. Distribute the roots evenly in the hole.

FIG. 10.4. A neatly laced, balled and burlapped tree

FIG. 10.5. A wire basket helps to keep the root ball intact on larger trees.

FIG. 10.6. Carefully slide the plant out of the container before planting.

Planting depth may vary slightly with drainage and rainfall. In heavy clay soils, trees are generally planted 4 to 6 inches more shallow than grown in the nursery. In dry or sandy areas, trees are usually planted at ground level. (Never plant trees deeper than they are grown in the nursery.) The bottom of the hole should be firm and flat to avoid sinking.

There is some argument concerning backfill in the hole. Research suggests that if the hole is filled with rich, loose soil, the roots will grow rapidly until they reach the harder, undisturbed soil (figure 10.8). Then the roots may begin to grow around the hole. To avoid this, roughening the sides of the hole should eliminate the smooth, glazing effect. Peat moss or other amendments may be added to the backfill soil, though they are usually unnecessary. It is often helpful to apply water when the hole is half filled to help distribute the soil around the roots. The soil is then lightly tamped around the roots.

After the tree is planted, watering should be completed. A good, slow soaking is best. Figure 10.9 illustrates how a saucer of soil built around the plant can keep the water around the root zone. After watering, a 3- to 5-inch layer of mulch should be applied around the tree. The mulch will help to retain moisture, reduce weeds, and keep away lawn mowers. Mulch also helps unify landscape plantings and adds a decorative touch.

FIG. 10.8. Backfill the hole with the original soil.

FIG. 10.9. The saucer of earth aids in water collection.

## Guying, Staking, and Tree Wraps

It is usually not necessary to stake or guy small trees. A well-tamped backfill may be sufficient to keep the tree upright. If the tree is to be staked, the stakes should extend about two-thirds the height of the tree. Figure 10.10 shows a properly staked tree. The stakes

FIG. 10.7. To avoid twisting and girdling roots, make several vertical slices with a knife through the outer layer of roots and medium.

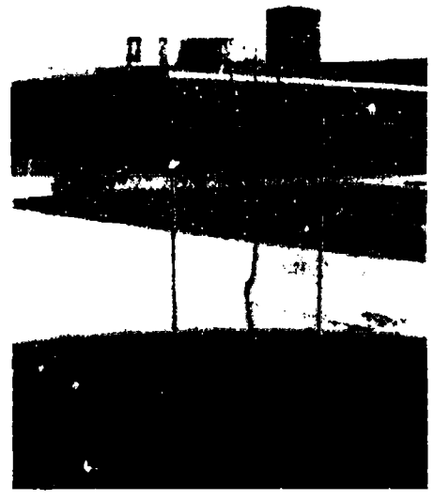


FIG. 10.10. Two vertically placed stakes are recommended in staking a tree.

should not penetrate the root ball. Sections of rubber tubing will protect the tree where the guy wire is passed around the trunk (figure 10.11). Stakes and wires should be removed after one year. Staking wires are a frequent cause of girdling and death in young trees.

Sometimes specifications require tree wrap on young, newly planted trees. The purpose of tree wrap is to help protect the tree from sunscald. However, it is highly questionable whether tree wrap is beneficial. If used, the wrap should be applied from the bottom, working up to allow for water runoff. Twine is used to secure the wrap and is tied from the top down with a series of half-hitch knots (figure 10.12).

## Transplanting Trees

The basic rules for planting also apply for transplanting trees. Transplanting is often done on a larger scale, however. Large equipment such as a mechanical tree spade may be used (figure 10.13). The planting hole might be dug with a backhoe, earth auger, or tree spade. Staking large trees is often not practical. Guying is used to secure trees greater than 3 inches caliper (figure 10.14). Usually three guy wires are used and are spaced equally around the tree.

In tree transplanting, timing is very important. Midsummer is not a good time to transplant trees, since water stress will reduce possibilities of success. It is best to plant and transplant trees when they are dormant. Early spring and late fall are good times as long as the ground is not frozen.

Planting time may be a good time for corrective and formative pruning. The usual rules for pruning apply. Pruning at planting time should be limited to corrective or structural pruning. There is no advantage to removing one-third of the crown. The central leader should not be pruned back.

FIG. 10.11. Proper positioning of the guy wires around the main trunk is shown.

FIG. 10.12. Secure the tree wrap carefully from the top down.

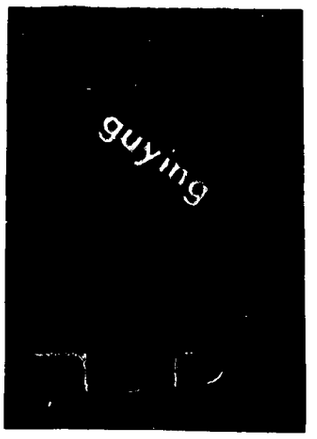



FIG. 10.14. Note the use of turnbuckles on the guy wires to keep the tree tightly anchored.

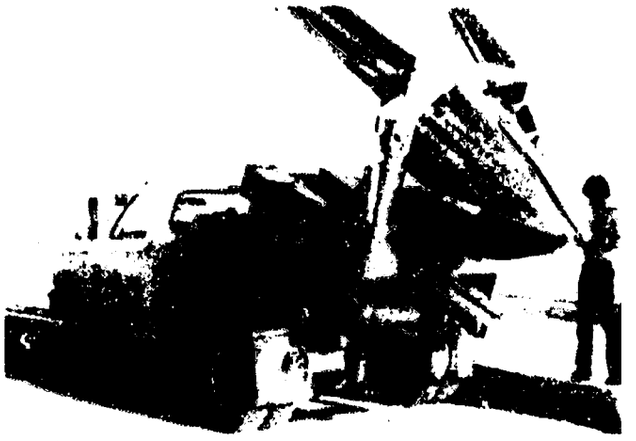


FIG. 10.13. Transplanting of landscape-sized trees is often done with a truck-mounted mechanical spade.

## Fertilization

A tree that is growing in a forest or natural area is naturally fertilized by rich, loamy, organic soils. However, trees in a landscape setting may be growing in suboptimal soils that lack sufficient quantities of essential minerals. For this reason, it is often quite beneficial to fertilize landscape and urban trees.

Trees should be fertilized every two or three years if nutrients are lacking. Timing is fairly important. Fertilizer can be applied in late fall, starting in October and through December or until the ground is frozen. Trees can also be fertilized in the spring any time from March until June.

There are many types of fertilizers. A **complete fertilizer** contains nitrogen, phosphorus and potassium. For trees, a fertilizer that is high in nitrogen is recommended. The **fertilizer analysis** gives the percentage of each: nitrogen, phosphorus, and potassium. For example, a fertilizer bag with an analysis of 10-5-5 contains 10 percent nitrogen, 5 percent phosphorus (expressed as $P_2O_5$ equivalent), and 5 percent potassium (expressed as $K_2O$ equivalent). A 100-pound bag of this fertilizer would contain 10 pounds of actual nitrogen. A good tree fertilizer should have a 2-1-1 or 4-1-2 ratio. Other possible analyses are 24-8-8, 10-6-4, and 24-8-16.

The nitrogen in fertilizer may be water soluble and may leach from the soil after watering or rainfall. For this reason, at least half of the nitrogen should be in an organic or slow-release form. Two slow-release forms of nitrogen are sulfur-coated urea and urea formaldehyde.

Three basic methods of applying fertilizer to trees include surface or broadcast application, liquid soil injection, and drill hole application. Of the three, the surface application is certainly the easiest. This involves the broadcast spreading of fertilizer (usually granular) over the ground where the tree is located. Since the tree roots may extend far beyond the drip line of the tree, the application should be quite widespread. With the majority of the fibrous "feeder roots" located in the upper 6 inches of soil, this method is usually quite effective. But there are two disadvantages to surface application. If phosphorus is a limiting factor, surface application may not be effective, because phosphorus will not penetrate the soil readily. Also, while the lawn may benefit from the high nitrogen fertilizer, it will also compete for it. The levels of nitrogen applied cannot be raised much without "burning" the lawn, so applications have to be more frequent, or a slow-release form employed.

Liquid soil injection is a technique employed by many arborists (figure 10.15). It involves the use of a thin tube or probe which is pointed and perforated at the end. The probe is attached to a hose and sprayer rig (figure 10.16). The liquid fertilizer is injected

**FIG. 10.15.** Liquid fertilizer is injected into the root zone of the tree.

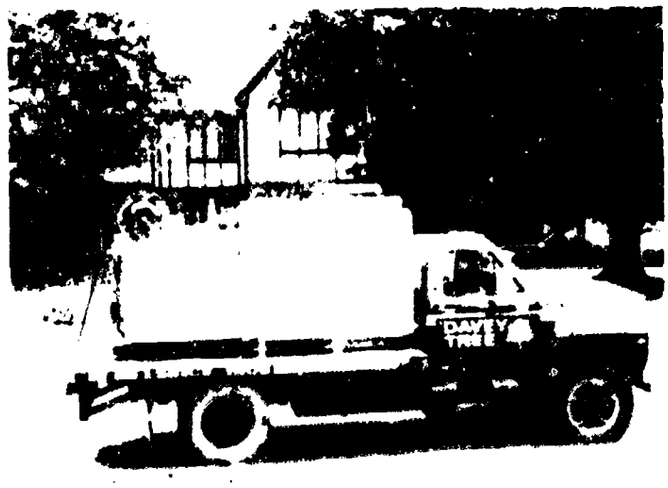



**FIG. 10.16.** Experienced arborists are set up for application of fertilizer.

under pressure to a depth of 6 to 18 inches below the soil surface. The liquid spreads through the soil around the hole. This method obviously requires expensive equipment, but many arborists do have it. One disadvantage of this method is that patches of dark, vigorous growth may result in the lawn. Such a condition can be remedied by an additional broadcast application, however.

The drill hole method of application is similar to the injection technique. Holes are drilled into the soil, and granular fertilizer is placed in the holes. It is better to drill than to poke or punch holes in the soil, since the latter may cause compaction and glazing of the soil around the holes and result in limited penetration. The drill hole method is the most time-consuming one, but is thought to help aerate the soil around the roots. In fact, in compacted areas, sometimes holes are drilled and filled with pea gravel or other amendments to help provide oxygen to the roots. Drill hole fertilization may also create dark patches in the lawn.

In both drill hole and soil injection methods, the fertilizer is applied in concentric circles around the tree (figure 10.17). For liquid soil injection the holes are generally on 2- to 3-foot centers. For drill hole application the spacing is usually 18 to 24 inches. For large trees the holes need not be any closer than 3 to 4 feet from the trunk. With both these methods, as with the broadcast method, application should extend beyond the drip line of the tree in order to cover the feeder roots that often extend further out. Frequently the extent of fertilizer application is limited by the size of the yard in which the tree is located.

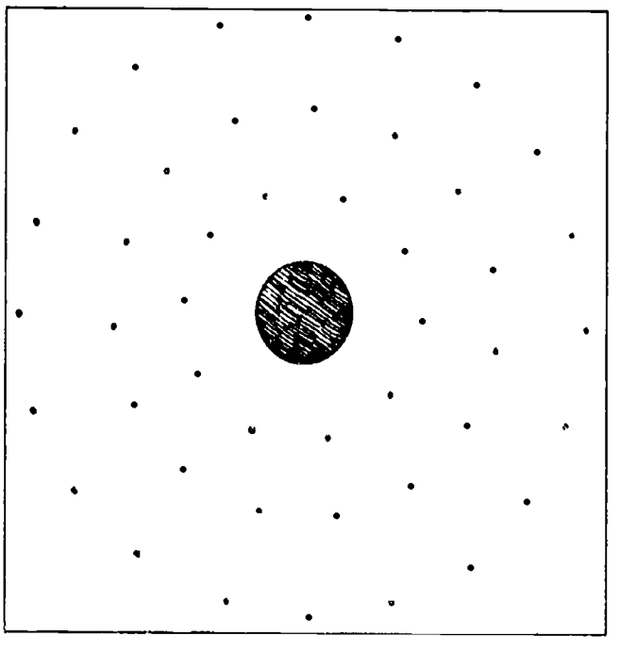


FIG. 10.17. Holes are drilled in concentric circles around the trunk of the tree.

The rate of application depends upon the method of application. For drill hole or liquid soil injection, the recommended rate is 3 to 5 pounds of actual nitrogen per 1,000 square feet of soil surface under the tree. For example, say the fertilizer to be used has an analysis of 20-5-10. In an area calculated to be about 1,000 square feet, one would have to apply 25 pounds of fertilizer. For broadcast application on lawns, 5 pounds of actual nitrogen would be excessive. Two pounds of nitrogen per 1,000 square feet is more practical, but two or three applications per year would be required. For this reason, slow release fertilizer is recommended.

## Cabling and Bracing

Cabling and bracing are methods of installing hardware to help maintain structural strength in trees. Proper cabling and bracing can help prolong the health and safety of a tree. The need for cabling or bracing may be due to split or decayed crotches, tight V-shaped crotches, or inherent dangers from weak-wooded trees. Maple, ash, and elm are some of the species that frequently require cabling or bracing.

Cabling is a means of connecting two or more limbs to help support or strengthen a tree. Figure 10.18 shows much of the hardware used in cabling. It is important to use equipment that is strong enough for the loads being applied. The cable itself is usually 7-strand galvanized wire that ranges in diameter from 3/16 to 1/2 inch. The smaller cable can be used for limbs 3 to 4 inches in diameter. The 1/2-inch cable is used for limbs 12 to 24 inches in diameter.

FIG. 10.18. Proper cabling requires use of the right equipment.

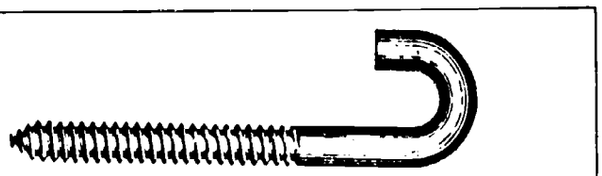


FIG. 10.19. A lag hook

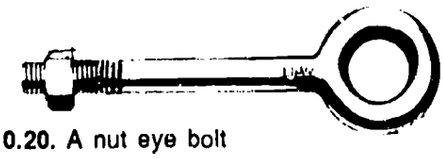


FIG. 10.20. A nut eye bolt

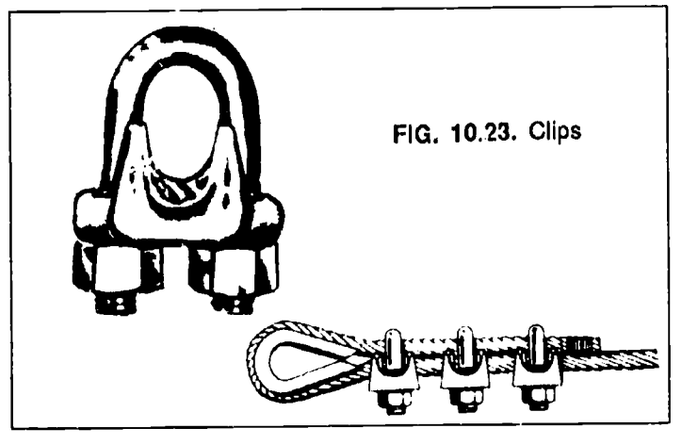


FIG. 10.23. Clips

Intermediate cable sizes include 1/4-, 5/16-, and 3/8-inch diameters. For limbs less than 8 inches in diameter, lag hooks can be used (figure 10.19). Lag hooks come threaded right- and left-handed (one to be used at each end of the cable) and range in size from 1/4 to 5/8 inch. For limbs greater than 8 inches in diameter, eye bolts or threaded rods with amon eye nuts should be used (figure 10.20).

For lag installation, first drill into solid wood a hole that is 1/16 inch smaller than the diameter of the lag (figure 10.21). More leverage is obtained by placing the cable high above the crotch, but there is a trade-off in size and strength of the limbs. If more than one lag is placed in a limb, the lags should be at least one foot apart and not in the same vertical line. Lags at opposite cable ends should line up with each other.

One end of the cable can be wrapped around the thimble and closed before installation. There are three methods of closing the cable upon itself. 1) The cable can be spliced by unwrapping the strands and individually wrapping them around the cable with pliers (figure 10.22). 2) U-bolts or cable clamps (figure 10.23) can be used to hold the cable tightly against itself. 3) Many arborists are now using preformed cable wraps with extra-high-strength (EHS) cable (figure 10.24). This device wraps around the cable and grips it firmly. Cable wraps are easy to install and can be used effectively when working in the tree.

After the required length of cable has been measured, the second cable closure is often done in the tree (figure 10.25). The limbs being cabled should be brought closer together using ropes or a *come along* so that after installation, the cable will be taut

FIG. 10.21. The use of electric drills can be impractical when working in a tree, so holes must be drilled manually.

FIG. 10.22. Pliers are used to wrap the strands of the dead end cable.

(figure 10.26). But the limbs should not be brought so close that undue stress results on both hardware and tree. Cables should be installed perpendicular to a line bisecting the angle of the crotch being supported. Generally, the cable is placed approximately two-thirds the distance from the crotch to the branch tips.

Figure 10.27 shows use of a simple or direct cable. Multiple cables too are often installed. Figure 10.28 illustrates some of the cable systems used with multiple cables.

Bracing may be used to support weak or split crotches or to strengthen decayed areas (figure 10.29).

FIG. 10.24. Twisted cable wrap

FIG. 10.26. A tree worker installing a cable

FIG. 10.25. Once measured, the cable can be attached and closed at the other end.

FIG. 10.27. A simple or direct cable

Bracing is usually done with a threaded steel rod. A hole is first drilled with diameter 1/16 inch larger than the rod. This hole must pass straight through the entire portion to be braced. Do not attempt to drill from opposite ends and meet. The rod must pass clear through and be anchored in solid sound wood. Rods, lags, or eye bolts that dead-end in decaying wood will cause further decay and will not hold. Sometimes a wood screw rod is used without nuts and washers. In this case, a smaller hole is drilled and the rod is cut or broken off.

After the rod has been threaded through the tree, the washers and nuts can be attached. Diamond-shaped washers have been used for some time, but research shows that sound closure may be more readily obtained using round or oval washers. The bark should be traced just enough for the washer to rest against the wood. Do not trace into the wood. Hex bolts can then be tightened onto the rod. If two or more rods are applied in bracing, it is best to place them staggered rather than one above the other.

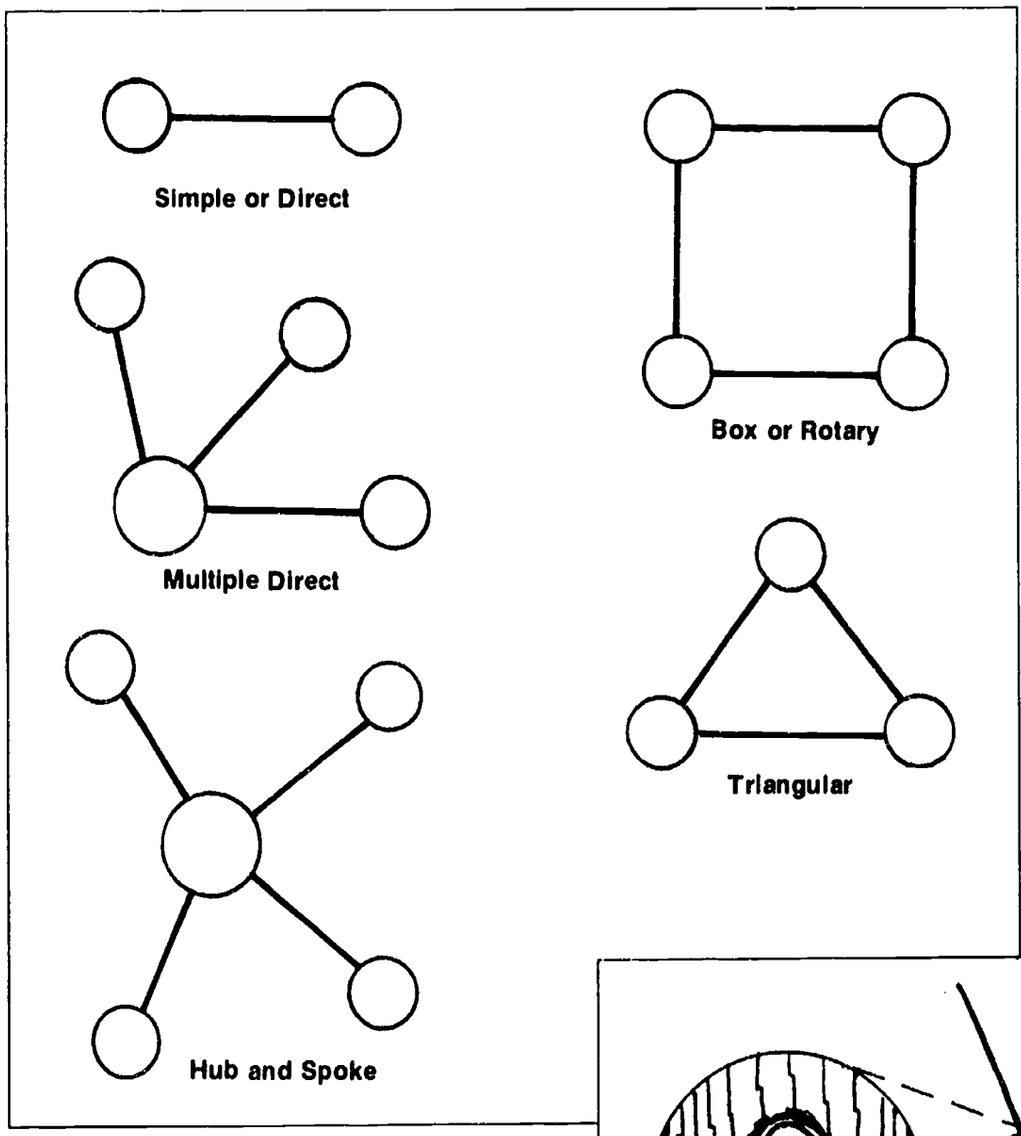



FIG. 10.28. Cabling systems

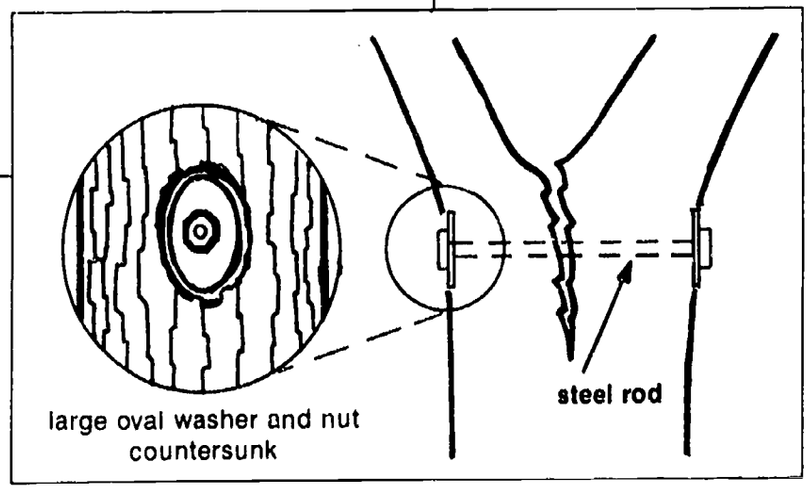



FIG. 10.29. Bracing a split crotch

## Lightning Protection Systems

A bolt of lightning can destroy a tree in less than a second. Trees can be blown apart, stripped of their bark, or caught on fire by lightning strike. People or animals standing under a tree can be killed when lightning strikes the tree. There are many circumstances that may warrant protecting a tree from lightning. Some trees are of historic value. Some trees on a golf course or in a park are popular places for refuge during a storm. Still others have high aesthetic or sentimental value. All these "special" trees should be equipped with lightning protection systems.

A lightning protection system consists of a series of conductors (copper cables) which extend from the top of the tree and down the main branches, and are then grounded (figure 10.30). The air terminals or uppermost points of the cable are installed in 2- to 3-inch branches near the top of the tree. There should be several air terminals on the main branches. The primary leader cable may be looped to allow for extension of the system as the tree grows. The cables are attached to the tree using special copper attachments which hold the conductor off the tree (figure 10.31). The different forks of cable are spliced together using cable splice attachments. The primary conducting cable which extends down the main trunk should be composed of 32 strands of 17-gauge copper wire. For trees greater than 3 feet in diameter, two standard down conductors should be placed on opposite sides of the tree.

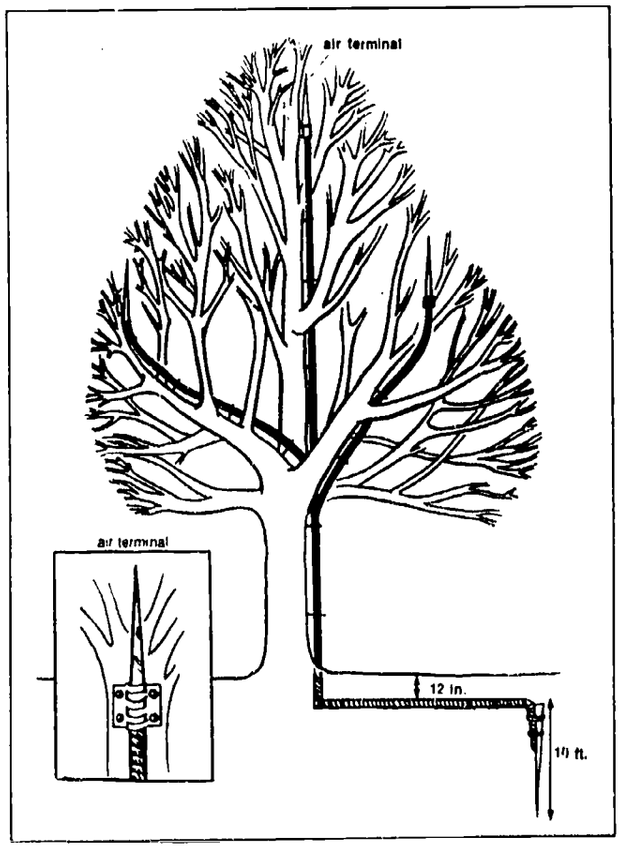



FIG. 10.30. Lightning protection scheme

The conductor must be properly grounded. The cables extend out from the tree beyond the drip line and are buried 18 inches below the surface. The cables are attached to grounding rods which are buried to a depth of 10 feet. In dry, sandy or rocky soils, it is recommended that the cables be forked to several ground rods as shown in figure 10.32. This forking method may also be used when other structures prevent grounding beyond the drip line. If two trees in close proximity are protected, their grounding cables may be connected. Grounding cables can also be attached to metal underground sprinkler systems.

Certainly the installation of a lightning protection system can be quite expensive. For this reason, its uses have been limited. Studies have shown that

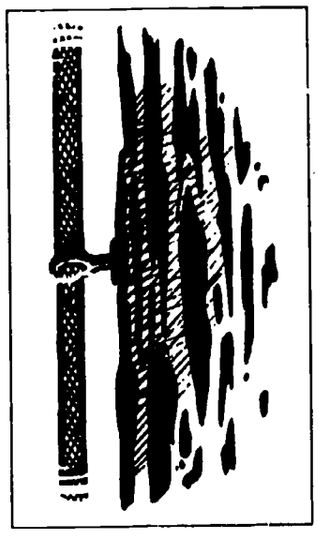


FIG. 10.31. The cable should be attached to the tree at 4-foot intervals.

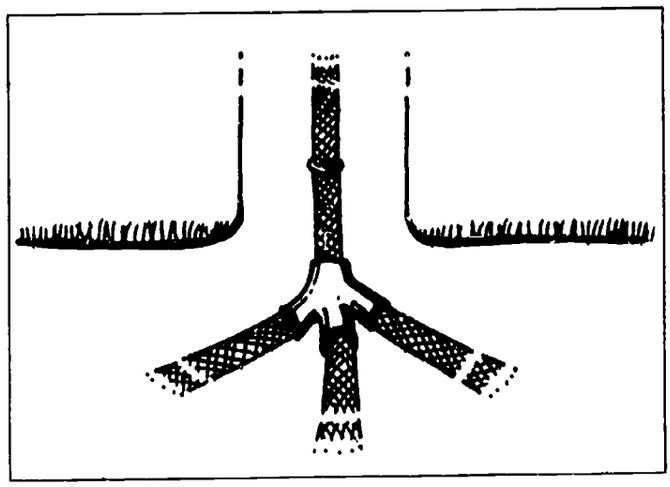


FIG. 10.32. Forked cables for multiple grounding

certain trees are more susceptible to lightning damage and may be candidates for protection. Isolated trees and the tallest tree in an area are highly susceptible to lightning strike. Deep-rooted trees may be more susceptible to injury than shallow-rooted trees with extensive fibrous root systems. Thick, coarse-barked trees are damaged more frequently than thin, smooth-barked trees. Finally, decaying trees make excellent conductors and may be severely damaged.

## Protecting Trees from Construction Damage

One of the major causes of tree decline and death that an arborist deals with is construction damage (figure 10.33). Frequently people purchase houses on wooded lots for the aesthetic value and energy savings that trees provide. Trees can add thousands of dollars to the price of a lot. Unfortunately, many or all of the trees may be lost in subsequent years if proper steps were not taken previously to insure their survival. Symptoms of decline are often not obvious to the homeowner for three to five years after purchase of a property.

Before any construction is started, the decision must be made concerning which trees are to be saved and which removed. This decision should take into account the value, health and life span of each tree. From the builder's point of view, construction needs must also be considered (figure 10.34). Once the decision is made to save a tree, a realistic effort must be put forth to save it.

A fence should be erected around the tree or group of trees to be kept. The fence should be at least at the drip line, and ideally, beyond the drip line. This will help protect the tree from equipment that may break limbs, damage the trunk, and compact the soil. The heavy and repeated pressure of workers and equipment over the root zone of a tree compacts the soil, eliminating the pore spaces and oxygen supply to the roots. If it is not possible to keep traffic off the area, application of a temporary mulch of 6 to 10 inches will help to distribute the force and minimize compaction.

FIG. 10.33. Trees damaged by construction equipment

Excavation is another construction problem for trees. Excavations are made for utility lines and water pipes. If practical, the services should be routed around trees. It is better to tunnel directly under a tree than to cut across the root system. If roots are severed, a clean cut should be made and the soil backfilled immediately to minimize drying of the roots.

By far the biggest cause of construction damage to trees is changes in grade. Even a 4-inch fill can kill forest climax species such as beech, white oak, sugar maple and tulip tree. Fill dirt should be kept

FIG. 10.34. Trees may suffer if the construction worker gets distracted from the job.

off the root zone if possible. When the grade must be changed, steps should be taken to protect the trees. In any case, the drainage pattern should not be changed.

If the grade is to be lowered, the trees may be protected by terracing to maintain some of the roots in their original root zone. This is not applicable in all instances, though. An alternate method is to construct a retaining wall.

For increases in grade, the method of protection depends on the amount of fill to be added. For a minor fill of 1 to 3 inches, the treatment is rather simple. The root zone can be drilled as with fertilization and a coarse aggregate incorporated into the holes. This will help provide oxygen to the roots (figure 10.35).

For moderate fills up to 12 inches, building a dry well is the best procedure. A stone well is built around the trunk of the tree (figure 10.36). Ideally, the diameter of the well should be ten times the diameter of the tree. Certainly the well must be beyond the buttress roots. In addition, vertical tiles 3 inches in diameter should be placed beyond the well at a spacing of 2 feet on center. The tiles should extend to the drip line of the tree. The vertical drain tiles may be filled with gravel.

Major increases in grade require major steps to protect the tree. Since the expense involved is quite high, most builders are reluctant to take these steps unless the tree is valuable. If called in to consult, however, the arborist should insist on an adequate tree protection system if the tree is to be saved.

Figure 10.37 illustrates the system for protecting a tree with a major grade change. As with moderate fills, a dry well should be built around the tree. Additional aeration and drainage tile are required, though. Four-inch-in-diameter tiles are laid on the original grade radiating out from the dry well like spokes of a wheel at 2-foot spacings. One tile should extend out of the fill and serve as a drain. Vertical tiles connect to the horizontal tiles and are covered with "bell caps" at the new grade.

The tiles are covered with sized gravel about 6 to 12 inches in depth. Over the gravel, a soil filter, such as geotextile fabric, separates the new top soil from the gravel. Between the tiles, the fill soil should be in contact with the original grade. The fill soil should be of the same texture as the original.

Protecting trees from construction damage can be time-consuming and costly. Large, stately trees can be worth the trouble involved. An arborist, when called upon to decide which trees should be saved, should also recommend what steps should be taken to protect the trees during construction.

The tree care professional performs a variety of operations to maintain the health and appearance of trees. Frequently, tree workers must remove a tree that is in poor condition or simply unwanted. Yet taking the appropriate steps to save a tree provides true rewards.

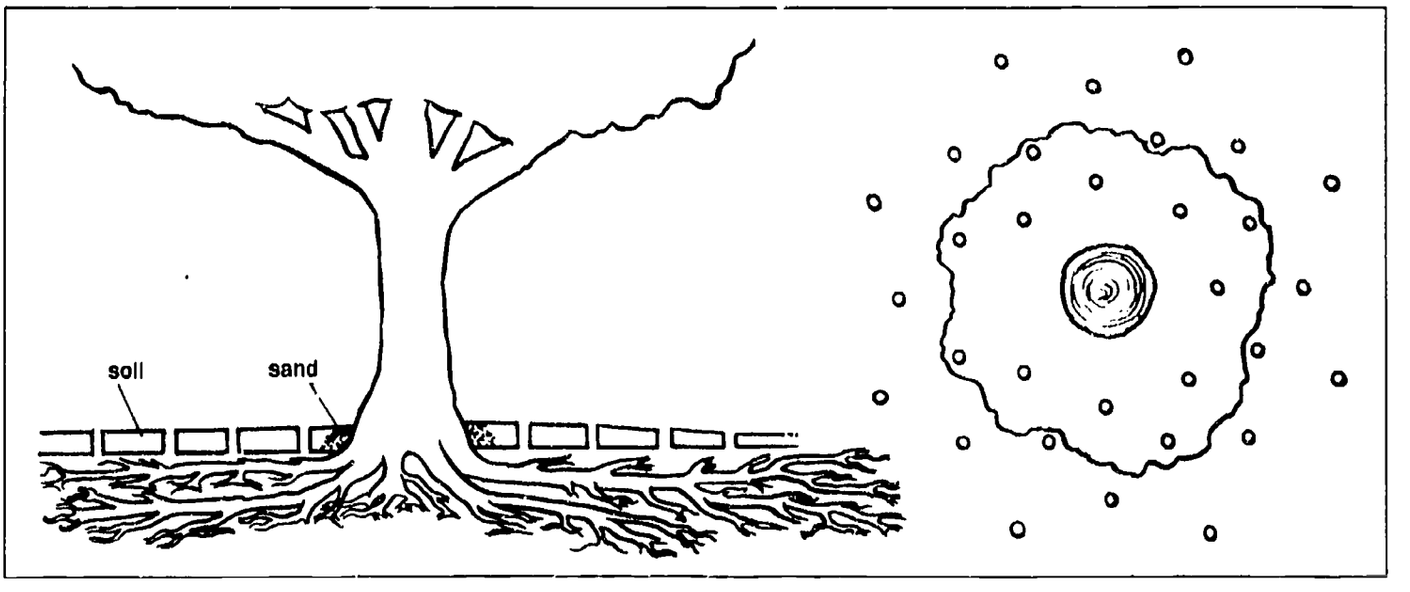



FIG. 10.35. Aerate the root zone for minor raises in grade.

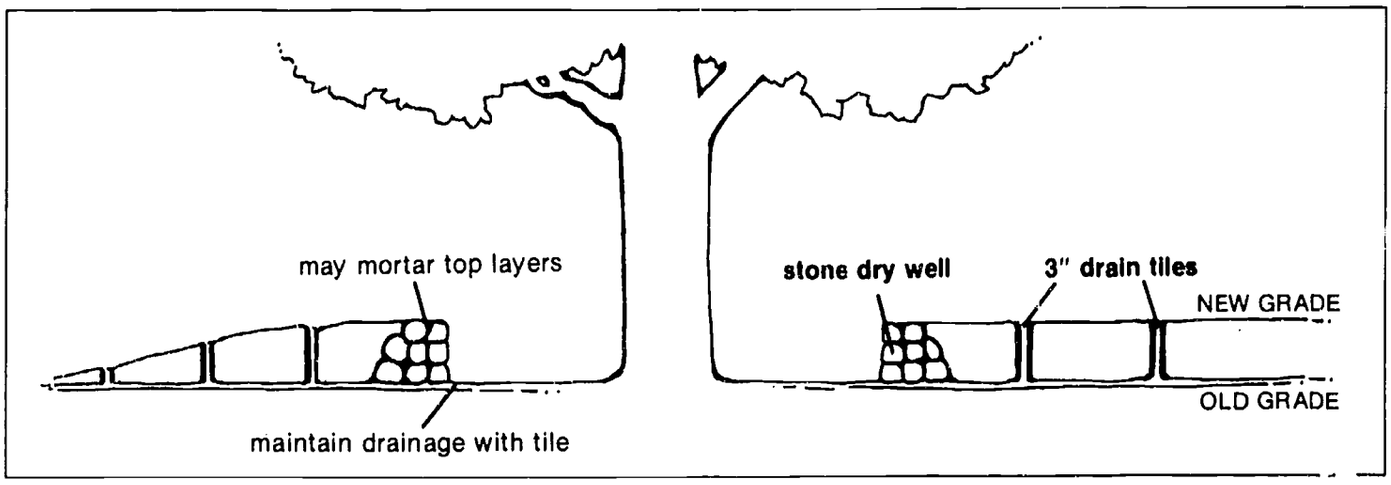



FIG. 10.36. Tree protection system for moderate increases in grade

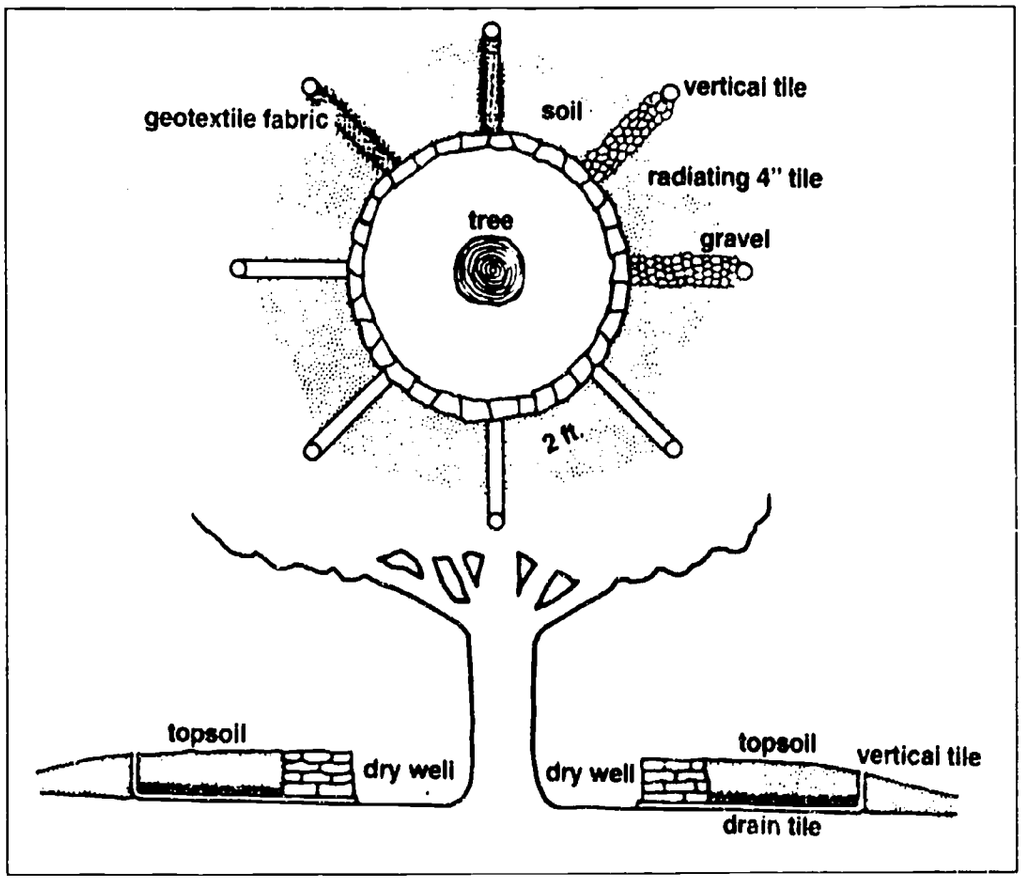



FIG. 10.37. Construction of a tree well with aeration tiles (from *International Society of Arboriculture Study Guide*, used with permission)

# APPENDIX I
# FIRST AID PROCEDURES

## Urgent Care Directions

1. Rescue the victim from any life-threatening situation.
2. If the victim is not breathing, begin artificial respiration.
3. Control severe bleeding.
4. Do not move the victim unless necessary.
5. If the victim has been poisoned, call a doctor or Poison Control Center immediately.
6. Support fractures.
7. Treat for shock.
8. Call or send for medical help.

## Artificial Respiration

1. Tilt the victim's head back with one hand on the forehead. Use your other hand to support the victim's head (figure A-1).
2. Listen and feel for breathing by placing your ear and cheek close to the victim's mouth.
3. Check to see that the air passage is clear; remove obstructions if necessary.
4. Lightly pinch shut the victim's nose.
5. Take a deep breath. Create a tight seal around the victim's mouth with your mouth. Blow air into the victim's mouth (figure A-2). Give four quick, full breaths.
6. Check again for breathing.
7. If victim is unable to breathe without assistance, provide a full breath of air every 5 seconds.

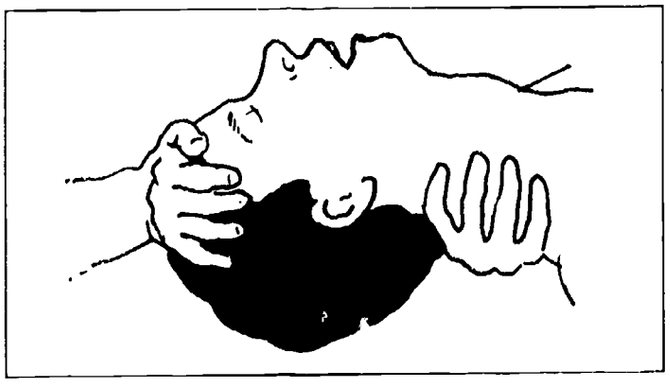


FIG. A-1. Support the neck while tilting the head back.

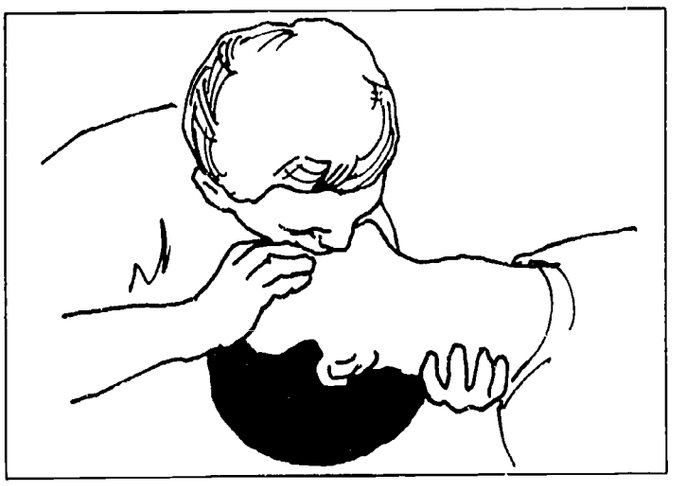


FIG. A-2. Blow gently into the victim's mouth.

## Cardiopulmonary Resuscitation (CPR)

NOTE: **CPR requires special training and should be carried out only by qualified persons.** *(This section is intended to serve as a reminder for trained persons.)*

1. Attempt to arouse the victim.
2. Open the airway by tilting the head back.
3. Look, listen and feel for breathing. If there is no breathing...
4. Apply artificial respiration.
5. Feel for the carotid pulse in the groove of the neck beside the Adam's apple (figure A-3). If the pulse is absent...
6. Place victim on back on a flat, firm, horizontal surface.

*(continued)*

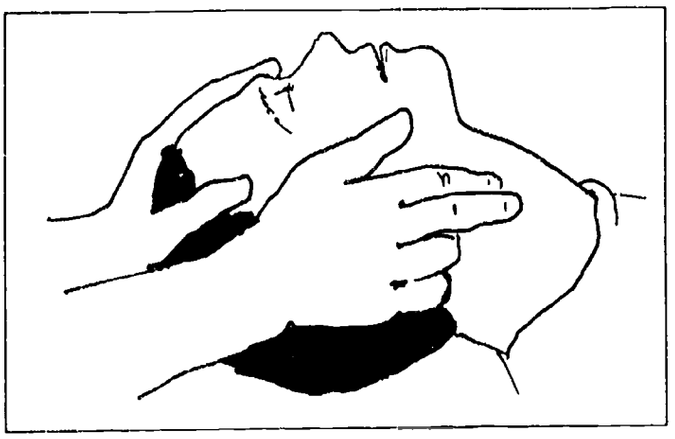


FIG. A-3. Feel the neck for a pulse.

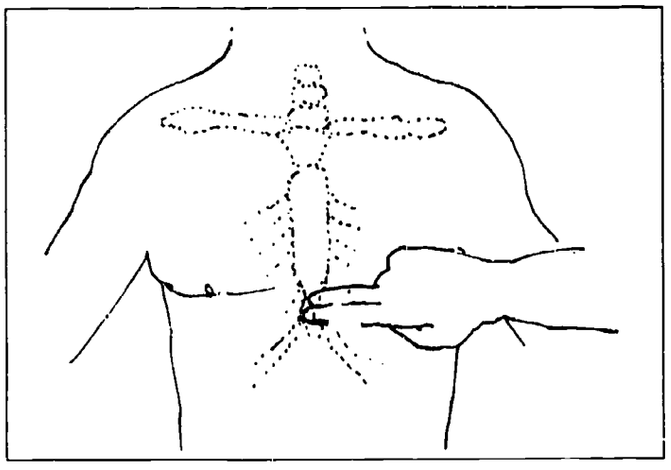


FIG. A-4. Locate the correct position on the chest.

7. Locate the xiphoid tip (the "V" in the center of the chest where the ribs meet). Measure two finger-widths up on the breastbone (figure A-4).

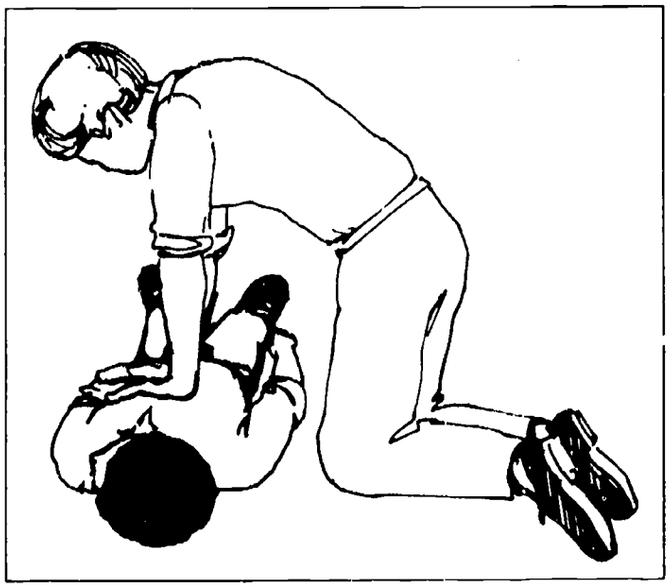
8. Place one hand over the other. Exert pressure vertically and depress the chest 1 1/2 to 2 inches, keeping your arms and elbows straight (figure A-5).

9. After each compression, release pressure completely, but do not remove hands from that position.

   ***Two rescuers:*** 5:1 ratio, 60 compressions per minute, one lung inflation after every five compressions without breaking the count.

   ***One rescuer:*** 15:2 ratio, 80 compressions per minute, 2 quick lung inflations following each 15 compressions. Be sure to reposition hands before resuming compressions.

10. Always continue CPR procedures until the victim is revived or until professional help arrives.



A-5. Keep arms straight as you depress the chest.

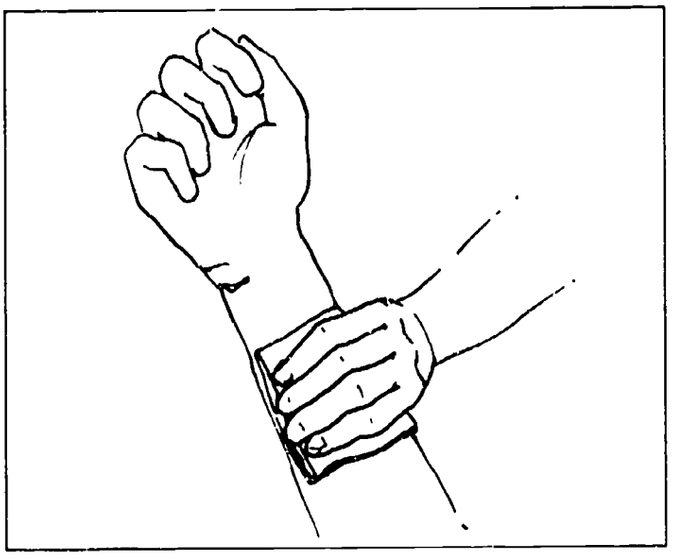


FIG. A-6. Apply firm pressure to a bleeding wound.

## Severe Bleeding

1. Apply direct pressure firmly on the wound. A thick pad of cloth (sterile if possible) between the hand and wound will help control bleeding (figure A-6).

2. Elevate the wound if practical.

3. If bleeding continues, apply direct pressure on a pressure point to help stop bleeding from a wound in an arm or leg (figure A-7). Press the main supply artery against the underlying bone (figure A-8).

4. Do not apply a tourniquet unless medical help is available.

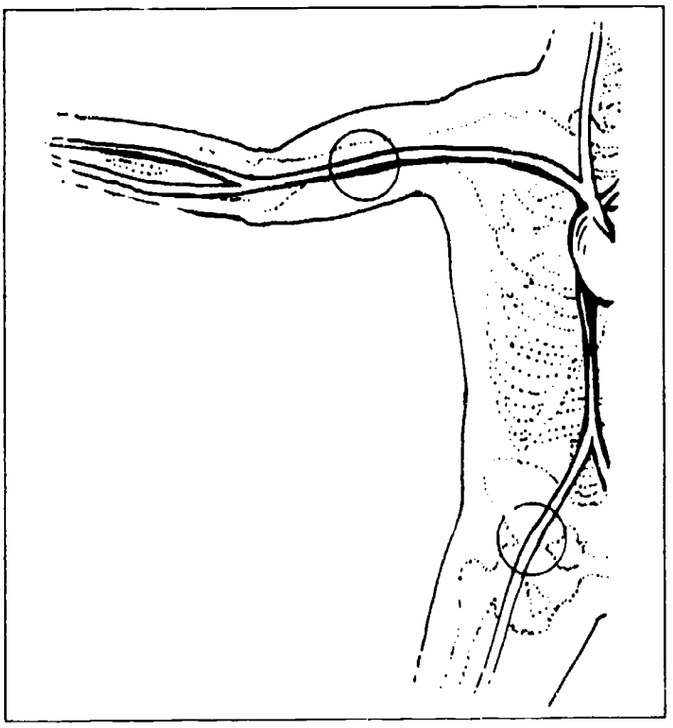


FIG. A-7. Locate pressure points on the body.

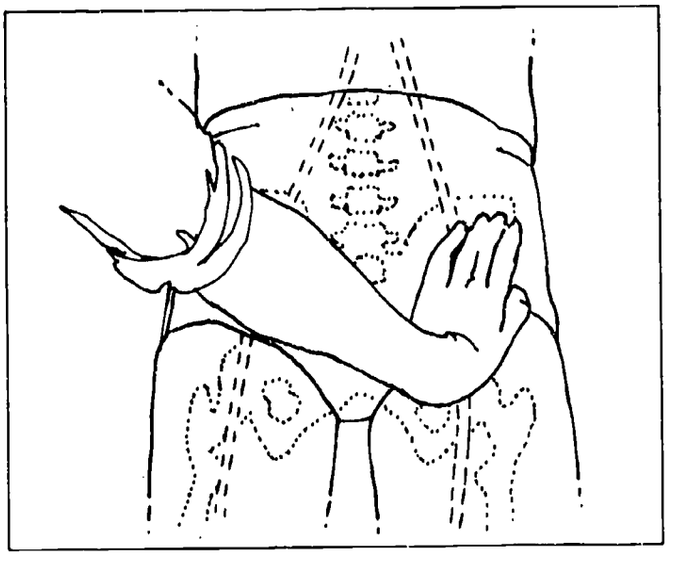


FIG. A-8. Press the artery against the bone.

## Head Injuries

1. Do not attempt to cleanse scalp wounds, as this may cause severe bleeding or severe contamination.

2. Control bleeding by raising the victim's head.

3. Place a sterile dressing on the wound, but do not apply excessive pressure.

4. Do not give the victim fluids by mouth.

5. Record the extent and duration of unconsciousness.

## Burns

1. Minor burns: ***first degree*** (redness, swelling)
   Apply cold water or ice.

2. More serious burns: ***second degree*** (redness, mottled appearance, blisters, swelling)
   Wrap in clean, dry cloth.
   Do not pop blisters.
   Do not apply ointment.
   Seek medical help.

3. Severe burns: ***third degree*** (tissue destruction, glossy white appearance)
   Cover burn with clean, dry cloth.
   Seek medical help immediately.

## Treatment for Shock

SYMPTOMS:
pale, cold, moist and clammy skin
the whole body weak
pulse weak and rapid
irregular breathing, often shallow
nausea, vomiting
pupils dilated

1. Keep the victim lying down. Elevate the feet if this will not aggravate other injuries (figure A-9).

2. Keep the victim warm. Cover with blanket if necessary.

3. Get medical help.

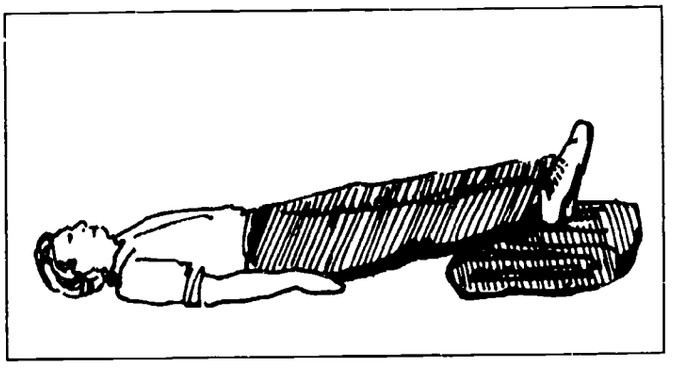


FIG. A-9. The feet of the victim could be elevated when the victim is in shock.

## Heat Stroke, Heat Cramps, and Heat Exhaustion

### *Heat Stroke*

SYMPTOMS:
high body temperature
skin hot, red, and dry
pulse strong and rapid
victim sometimes unconscious

1. Take immediate measures to cool the victim's body.
   - Remove the victim's clothing and cool the body with cool water or rubbing alcohol.
   - Use fans or cold packs if available.

2. Monitor body temperature and reduce if necessary.

### *Heat Cramps*

1. Firmly massage the cramped muscle.
2. Give the victim sips of salt water every 15 minutes for an hour (1 teaspoon of salt per glass).

### *Heat Exhaustion*

SYMPTOMS:
approximately normal body temperature
pale, clammy skin
heavy perspiration
weakness, fatigue
headache or cramps
dizziness, nausea, or vomiting

1. Give the victim sips of salt water every 15 minutes for an hour (1 teaspoon of salt per glass).
2. Keep the victim lying down and raise the feet.
3. Keep the victim cool.
4. If vomiting occurs, discontinue giving fluids.
5. Take the victim to a hospital if symptoms continue.

## Poisonous Insect Bites

### *Minor bites and stings:*

Apply ice to reduce swelling.
Apply soothing lotions.

### *Tick bites:*

Cover the tick with heavy oil to close its breathing pores. If tick does not disengage, leave the oil on for 1/2 hour, then carefully remove the tick with tweezers.

### *Severe reactions to bites or stings:*

1. Give artificial respiration if required.
2. Apply a restricting band above the site, if practical. You should be able to slip your finger under the band when in place.
3. Keep the affected part of the body below the victim's heart.
4. Apply ice and treat for shock.
5. Get medical help if the victim is allergic.
6. In the case of a bee sting, remove the stinger with tweezers. Be careful not to squeeze the attached venom sac, as this would inject more venom.

## Contact with Poisonous Plants

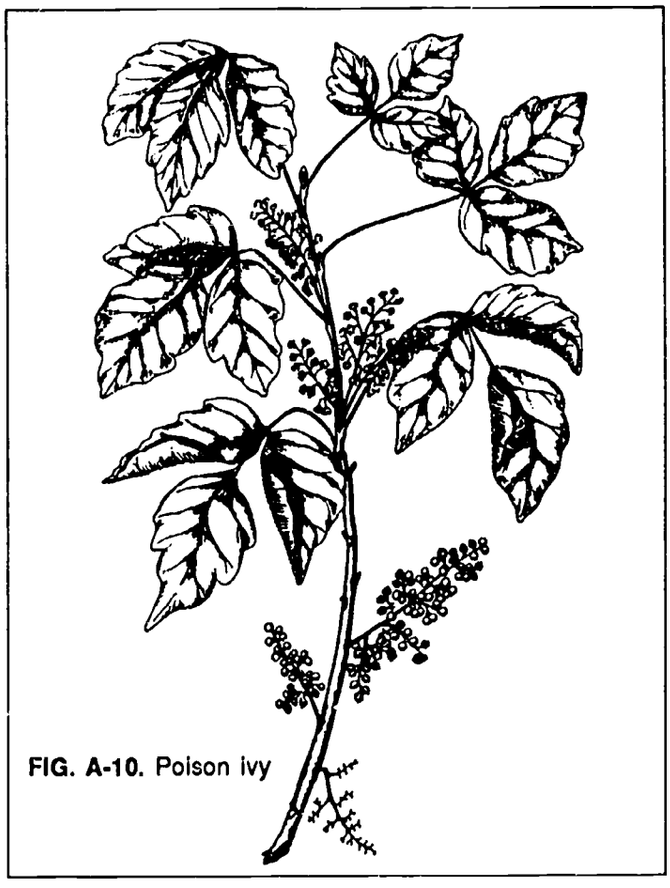


FIG. A-10. Poison ivy

POISON IVY - ***Rhus radicans, Rhus toxicodendron*** (figure A-10)
small shrub or vine
leaves composed of three leaflets, orange-red in fall
fruit - white berries
distribution - most of U.S., although different varieties inhabit different regions

WESTERN POISON OAK - ***Rhus diversiloba***
usually in shrub form, sometimes vine
leaves composed of three leaflets
fruit - white berries
distribution - western North America

POISON SUMAC - ***Rhus vernix***
woody shrub or small tree, 5 to 25 feet tall
compound leaves, 7-11 leaflets
fruit - glossy, pale yellow, pendant when ripe
distribution - predominantly east of the Mississippi River in swampy areas

1. Wash affected area with strong soap and water.
2. Wash with rubbing alcohol.
3. Seek medical help if a severe reaction occurs in the next day or two.

# APPENDIX II

## SELECTED COMMON PLANTS OF NORTH AMERICA

LISTED ALPHABETICALLY BY ***SCIENTIFIC NAME***

| Scientific Name | Common Name | Family |
|---|---|---|
| Abelia x grandiflora | Glossy Abelia | Caprifoliaceae |
| Abies balsamea | Balsam Fir | Pinaceae |
| Abies concolor | White Fir | Pinaceae |
| Abies fraseri | Fraser Fir | Pinaceae |
| Abies procera | Noble Fir | Pinaceae |
| Acanthopanax sieboldianus | Fiveleaf Aralia | Araliaceae |
| Acer buergerianum | Trident Maple | Aceraceae |
| Acer campestre | Hedge Maple | Aceraceae |
| Acer ginnala | Amur Maple | Aceraceae |
| Acer griseum | Paperbark Maple | Aceraceae |
| Acer japonicum | Fullmoon Maple | Aceraceae |
| Acer negundo | Boxelder | Aceraceae |
| Acer palmatum | Japanese Maple | Aceraceae |
| Acer pensylvanicum | Striped Maple, Moosewood | Aceraceae |
| Acer platanoides | Norway Maple | Aceraceae |
| Acer pseudoplatanus | Planetree Maple, Sycamore Maple | Aceraceae |
| Acer rubrum | Red Maple | Aceraceae |
| Acer saccharinum | Silver Maple | Aceraceae |
| Acer saccharum | Sugar Maple, Rock Maple, Hard Maple | Aceraceae |
| Acer tataricum | Tatarian Maple | Aceraceae |
| Aesculus carnea | Red Horsechestnut | Hippocastanaceae |
| Aesculus glabra | Ohio Buckeye, Fetid Buckeye | Hippocastanaceae |
| Aesculus hippocastanum | Common Horsechestnut | Hippocastanaceae |
| Aesculus octandra | Yellow Buckeye | Hippocastanaceae |
| Aesculus parviflora | Bottlebrush Buckeye | Hippocastanaceae |
| Aesculus pavia | Red Buckeye | Hippocastanaceae |
| Ailanthus altissima | Tree-of-Heaven | Simaroubaceae |
| Akebia quinata | Fiveleaf Akebia | Lardizabalaceae |
| Albizia julibrissin | Mimosa, Albizia, Silk-tree | Leguminosae |
| Alnus glutinosa | European Alder, Common Alder, Black Alder | Betulaceae |
| Amelanchier laevis | Allegheny Serviceberry | Rosaceae |
| Amelanchier stolonifera | Running Serviceberry | Rosaceae |
| Ampelopsis brevipedunculata | Porcelain Ampelopsis | Vitaceae |
| Aralia spinosa | Devil's-walkingstick, Hercules-club | Araliaceae |
| Arctostaphylos uva-ursi | Bearberry | Ericaceae |
| Aronia arbutifolia | Red Chokeberry | Rosaceae |
| Aronia melanocarpa | Black Chokeberry | Rosaceae |
| Asimina triloba | Common Pawpaw | Annonaceae |
| Berberis x chenaultii | Chenault Barberry | Berberidaceae |
| Berberis julianae | Wintergreen Barberry | Berberidaceae |
| Berberis koreana | Korean Barberry | Berberidaceae |
| Berberis x mentorensis | Mentor Barberry | Berberidaceae |
| Berberis thunbergii | Japanese Barberry | Berberidaceae |
| Betula lenta | Sweet Birch | Betulaceae |
| Betula maximowicziana | Monarch Birch | Betulaceae |
| Betula nigra | River Birch | Betulaceae |
| Betula papyrifera | Paper Birch, White Birch, Canoe Birch | Betulaceae |
| Betula pendula | European White Birch | Betulaceae |
| Betula platyphylla | Asian White Birch | Betulaceae |
| Betula populifolia | Gray Birch, Poplar Birch | Betulaceae |
| Buxus microphylla | Littleleaf Box, Boxwood | Buxaceae |
| Buxus sempervirens | Common Box, Boxwood | Buxaceae |
| Calycanthus floridus | Common Sweetshrub, Carolina Allspice, Strawberry-shrub | Calycanthaceae |
| Campsis radicans | Common Trumpetcreeper | Bignoniaceae |
| Caragana arborescens | Siberia Peashrub | Leguminosae |
| Carpinus betulus | European Hornbeam | Betulaceae |
| Carpinus caroliniana | American Hornbeam, Blue Beech, Ironwood | Betulaceae |
| Carya cordiformis | Bitternut Hickory | Juglandaceae |
| Carya illinoinensis | Pecan | Juglandaceae |
| Carya ovata | Shagbark Hickory | Juglandaceae |

*(continued)*

| Scientific Name | Common Name | Family |
|---|---|---|
| Castanea dentata | American Chestnut | Fagaceae |
| Castanea mollissima | Chinese Chestnut | Fagaceae |
| Catalpa bignonioides | Southern Catalpa, Common Catalpa, Indian Bear | Bignoniaceae |
| Catalpa speciosa | Northern Catalpa, Western Catalpa, Hardy Catalpa | Bignoniaceae |
| Cedrus atlantica | Atlas Cedar | Pinaceae |
| Cedrus deodara | Deodar Cedar | Pinaceae |
| Cedrus libani | Cedar of Lebanon | Pinaceae |
| Celastrus scandens | American Bittersweet | Celastraceae |
| Celtis laevigata | Sugar Hackberry | Ulmaceae |
| Celtis occidentalis | Common Hackberry | Ulmaceae |
| Cercidiphyllum japonicum | Katsu rat ree | Cercidiphyllaceae |
| Cercis canadensis | Eastern Redbud | Leguminosae |
| Chaenomeles japonica | Japanese Floweringquince | Rosaceae |
| Chaenomeles speciosa | Common Floweringquince | Rosaceae |
| Chamaecyparis lawsoniana | Lawson Falsecypress | Cupressaceae |
| Chamaecyparis nootkatensis | Nootka Falsecypress | Cupressaceae |
| Chamaecyparis obtusa | Hinoki Falsecypress | Cupressaceae |
| Chamaecyparis pisifera | Japanese Falsecypress, Sawara | Cupressaceae |
| Chionanthus virginicus | White Fringetree | Oleaceae |
| Cladrastis lutea | American Yellowwood, Virgilia | Leguminosae |
| Clematis x jackmanii | Jackman Clematis | Ranunculaceae |
| Clethra alnifolia | Summersweet Clethra | Clethraceae |
| Cornus alba | Tatarian Dogwood | Cornaceae |
| Cornus alternifolia | Pagoda Dogwood | Cornaceae |
| Cornus amomum | Silky Dogwood | Cornaceae |
| Cornus florida | Flowering Dogwood | Cornaceae |
| Cornus kousa | Kousa Dogwood | Cornaceae |
| Cornus mas | Corneliancherry Dogwood | Cornaceae |
| Cornus racemosa | Gray Dogwood | Cornaceae |
| Cornus sanguinea | Bloodtwig Dogwood | Cornaceae |
| Cornus stolonifera | Redosier Dogwood | Cornaceae |
| Corylopsis glabrescens | Fragrant Winterhazel | Hamamelidaceae |
| Corylus americana | American Filbert | Betulaceae |
| Corylus avellana | European Filbert | Betulaceae |
| Corylus colurna | Turkish Filbert, Hazel | Betulaceae |
| Corylus maxima purpurea | Purple Giant Filbert | Betulaceae |
| Cotinus coggygria | Common Smoketree, Smokebush | Anacardiaceae |
| Cotoneaster apiculata | Cranberry Cotoneaster | Rosaceae |
| Cotoneaster dammeri | Bearberry Cotoneaster | Rosaceae |
| Cotoneaster divaricata | Spreading Cotoneaster | Rosaceae |
| Cotoneaster horizontalis | Rock Cotoneaster, Rockspray | Rosaceae |
| Cotoneaster lucida | Hedge Cotoneaster | Rosaceae |
| Cotoneaster multiflora | Many-flowered Cotoneaster | Rosaceae |
| Cotoneaster salicifolia | Willow-leaf Cotoneaster | Rosaceae |
| Crataegus crusgalli | Cockspur Hawthorn | Rosaceae |
| Crataegus x lavallei | Lavalle Hawthorn | Rosaceae |
| Crataegus mollis | Downy Hawthorn | Rosaceae |
| Crataegus nitida | Glossy Hawthorn | Rosaceae |
| Crataegus oxyacantha | English Hawthorn | Rosaceae |
| Crataegus phaenopyrum | Washington Hawthorn | Rosaceae |
| Cryptomeria japonica | Japanese Cryptomeria | Taxodiaceae |
| Cunninghamia lanceolata | Common Chinafir | Taxodiaceae |
| Deutzia gracilis | Slender Deutzia | Saxifragaceae |
| Deutzia scabra | Fuzzy Deutzia | Saxifragaceae |
| Diospyros virginiana | Common Persimmon | Ebenaceae |
| Elaeagnus angustifolia | Russian Olive | Elaeagnaceae |
| Elaeagnus umbellata | Autumn Elaeagnus | Elaeagnaceae |
| Enkianthus campanulatus | Redvein Enkianthus | Ericaceae |
| Eucommia ulmoides | Hardy Rubber Tree | Eucommiaceae |
| Euonymus alatus | Winged Euonymus | Celastraceae |
| Euonymus bungeanus | Winterberry Euonymus | Celastraceae |
| Euonymus fortunei | Wintercreeper Euonymus | Celastraceae |
| Euonymus kiautschovicus | Spreading Euonymus | Celastraceae |

| Scientific Name | Common Name | Family |
|---|---|---|
| Fagus grandifolia | American Beech | Fagaceae |
| Fagus sylvatica | European Beech | Fagaceae |
| Forsythia x intermedia | Border Forsythia | Oleaceae |
| Forsythia suspensa | Weeping Forsythia | Oleaceae |
| Forsythia viridissima | Greenstem Forsythia | Oleaceae |
| Fothergilla gardenii | Dwarf Fothergilla | Hamamelidaceae |
| Fothergilla major | Large Fothergilla | Hamamelidaceae |
| Franklinia alatamaha | Franklinia, Franklin Tree | Theaceae |
| Fraxinus americana | White Ash | Oleaceae |
| Fraxinus excelsior | European Ash | Oleaceae |
| Fraxinus pennsylvanica | Green Ash, Red Ash | Oleaceae |
| Fraxinus quadrangulata | Blue Ash | Oleaceae |
| Fraxinus tomentosa | Pumpkin Ash | Oleaceae |
| Gingko biloba | Ginkgo, Maidenhair Tree | Ginkgoaceae |
| Gleditsia triacanthos var. inermis | Thornless Honeylocust | Leguminosae |
| Gymnocladus dioicus | Kentucky Coffeetree | Leguminosae |
| Halesia carolina | Carolina Silverbell | Styracaceae |
| Hamamelis mollis | Chinese Witchhazel | Hamamelidaceae |
| Hamamelis vernalis | Vernal Witchhazel | Hamamelidaceae |
| Hamamelis virginiana | Common Witchhazel | Hamamelidaceae |
| Hedera helix | English Ivy | Araliaceae |
| Hibiscus syriacus | Rose-of-Sharon, Shrub Althea | Malvaceae |
| Hydrangea anomala subsp. petiol aris | Climbing Hydrangea | Saxifragaceae |
| Hydrangea arborescens | Smooth Hydrangea | Saxifragaceae |
| Hydrangea paniculata | Panicle Hydrangea | Saxifragaceae |
| Hydrangea quercifolia | Oakleaf Hydrangea | Saxifragaceae |
| Hypericum prolificum | Shrubby St. Johnswort | Guttiferae |
| Iberis sempervirens | Candytuft | Cruciferae |
| Ilex cornuta | Chinese Holly | Aquifoliaceae |
| Ilex crenata | Japanese Holly | Aquifoliaceae |
| Ilex decidua | Possum haw | Aquifoliaceae |
| Ilex x fosteri | Foster's Holly | Aquifoliaceae |
| Ilex glabra | Inkberry | Aquifoliaceae |
| Ilex x meserveae | Blue Holly, Meserve Holly | Aquifoliaceae |
| Ilex opaca | American Holly | Aquifoliaceae |
| Ilex pedunculosa | Longstalk Holly | Aquifoliaceae |
| Ilex verticillata | Common Winterberry, Black Alder, Coralberry, Michigan Holly | Aquifoliaceae |
| Juglans cinerea | Butternut | Juglandaceae |
| Juglans nigra | Black Walnut | Juglandaceae |
| Juniperus chinensis | Chinese Juniper | Cupressaceae |
| Juniperus communis | Common Juniper | Cupressaceae |
| Juniperus conferta | Shore Juniper | Cupressaceae |
| Juniperus horizontalis | Creeping Juniper | Cupressaceae |
| Juniperus procumbens | Japanese Garden Juniper | Cupressaceae |
| Juniperus sabina | Savin Juniper | Cupressaceae |
| Juniperus scopulorum | Rocky Mountain Juniper | Cupressaceae |
| Juniperus squamata | Singleseed Juniper | Cupressaceae |
| Juniperus virginiana | Eastern Redcedar | Cupressaceae |
| Kalmia latifolia | Mountain Laurel Kalmia | Ericaceae |
| Kalopanax pictus | Castor-aralia | Araliaceae |
| Kerria japonica | Japanese Kerria | Rosaceae |
| Koelreuteria paniculata | Panicled Goldenraintree, Varnish Tree | Sapindaceae |
| Kolkwitzia amabilis | Beautybush | Caprifoliaceae |
| Laburnum x watereri | Goldenchain Tree, Waterer Laburnum | Leguminosae |
| Larix decidua | European Larch | Pinaceae |
| Larix kaempferi | Japanese Larch | Pinaceae |
| Leucothoe fontanesiana | Drooping Leucothoe, Fetterbush | Ericaceae |
| Ligustrum amurense | Amur Privet | Oleaceae |
| Ligustrum obtusifolium | Border Privet | Oleaceae |
| Ligustrum x vicaryi | Golden Privet | Oleaceae |
| Ligustrum vulgare | European Privet | Oleaceae |
| Lindera benzoin | Spicebush | Lauraceae |
| Liquidambar styraciflua | Sweetgum | Hamamelidaceae |
| Liriodendron tulipifera | Tuliptree, Tulip Poplar, Tulip Magnolia, Yellow Poplar | Magnoliaceae |

(continued)

| Scientific Name | Common Name | Family |
|---|---|---|
| Liriope spicata | Lilyturf | Liliaceae |
| Lonicera fragrantissima | Winter Honeysuckle | Caprifoliaceae |
| Lonicera japonica | Japanese Honeysuckle | Caprifoliaceae |
| Lonicera maackii | Amur Honeysuckle | Caprifoliaceae |
| Lonicera sempervirens | Trumpet Honeysuckle | Caprifoliaceae |
| Lonicera tatarica | Tatarian Honeysuckle | Caprifoliaceae |
| Maclura pomifera | Osage-orange, Hedge-apple | Moraceae |
| Magnolia acuminata | Cucumbertree Magnolia | Magnoliaceae |
| Magnolia grandiflora | Southern Magnolia | Magnoliaceae |
| Magnolia kobus | Kobus Magnolia | Magnoliaceae |
| Magnolia liliflora | Lily Magnolia | Magnoliaceae |
| Magnolia macrophylla | Bigleaf Magnolia | Magnoliaceae |
| Magnolia x soulangiana | Saucer Magnolia | Magnoliaceae |
| Magnolia stellata | Star Magnolia | Magnoliaceae |
| Magnolia tripetala | Umbrella Magnolia | Magnoliaceae |
| Magnolia virginiana | Sweetbay Magnolia, Swamp Magnolia, Laurel | Magnoliaceae |
| Mahonia aquifolium | Oregon Grapeholly | Berberidaceae |
| Malus spp. | Flowering Crabapple | Rosaceae |
| Metasequoia glyptostroboides | Dawn Redwood | Taxodiaceae |
| Morus alba | White Mulberry, Common Mulberry | Moraceae |
| Morus rubra | Red Mulberry | Moraceae |
| Myrica pensylvanica | Northern Bayberry | Myricaceae |
| Neviusia alabamensis | Snow-wreath | Rosaceae |
| Nyssa sylvatica | Black Gum, Sour Gum, Black Tupelo, Pepperidge | Nyssaceae |
| Ostrya virginiana | American Hophornbeam, Ironwood | Betulaceae |
| Oxydendrum arboreum | Sourwood, Sorrel Tree, Lily-of-the-valley Tree | Ericaceae |
| Pachysandra terminalis | Japanese Pachysandra, Spurge | Buxaceae |
| Parthenocissus quinquefolia | Virginia Creeper, Woodbine | Vitaceae |
| Parthenocissus tricuspidata | Japanese Creeper | Vitaceae |
| Paxistima canbyi | Canby Paxistima | Celastraceae |
| Phellodendron amurense | Amur Corktree | Rutaceae |
| Philadelphus coronarius | Sweet Mockorange | Saxifragaceae |
| Photinia villosa | Oriental Photinia | Rosaceae |
| Physocarpus opulifolius | Common Ninebark, Eastern Ninebark | Rosaceae |
| Picea abies | Norway Spruce | Pinaceae |
| Picea engelmannii | Engelmann Spruce | Pinaceae |
| Picea glauca | White Spruce | Pinaceae |
| Picea omorika | Serbian Spruce | Pinaceae |
| Picea orientalis | Oriental Spruce | Pinaceae |
| Picea pungens | Colorado Spruce | Pinaceae |
| Picea pungens glauca | Blue Spruce | Pinaceae |
| Pieris floribunda | Mountain Pieris | Ericaceae |
| Pieris japonica | Japanese Pieris, Andromeda | Ericaceae |
| Pinus aristata | Bristlecone Pine | Pinaceae |
| Pinus banksiana | Jack Pine | Pinaceae |
| Pinus bungeana | Lacebark Pine | Pinaceae |
| Pinus cembra | Swiss Stone Pine | Pinaceae |
| Pinus densiflora | Japanese Red Pine | Pinaceae |
| Pinus edulus | Colorado Pinyon Pine | Pinaceae |
| Pinus flexilis | Limber Pine | Pinaceae |
| Pinus mugo | Swiss Mountain Pine | Pinaceae |
| Pinus mugo mugo | Dwarf Swiss Mountain Pine | Pinaceae |
| Pinus nigra | Austrian Pine | Pinaceae |
| Pinus parviflora | Japanese White Pine | Pinaceae |
| Pinus ponderosa | Ponderosa Pine | Pinaceae |
| Pinus resinosa | Red Pine | Pinaceae |
| Pinus rigida | Pitch Pine | Pinaceae |
| Pinus strobus | Eastern White Pine | Pinaceae |
| Pinus sylvestris | Scotch Pine | Pinaceae |
| Pinus thunbergiana | Japanese Black Pine | Pinaceae |
| Pinus virginiana | Virginia Pine, Scrub Pine, Jersey Pine, Spruce Pine, Poverty Pine | Pinaceae |
| Pinus wallichiana | Himalayan Pine | Pinaceae |

| Scientific Name | Common Name | Family |
|---|---|---|
| Platanus acerifolia | London Planetree | Platanaceae |
| Platanus occidentalis | Sycamore, American Planetree | Platanaceae |
| Populus alba | White Poplar, Silver-leaved Poplar | Salicaceae |
| Populus deltoides | Eastern Cottonwood | Salicaceae |
| Populus tremuloides | Quaking Aspen | Salicaceae |
| Potentilla fruticosa | Bush Cinquefoil | Rosaceae |
| Prunus cerasifera | Cherry Plum | Rosaceae |
| Prunus glandulosa | Dwarf Flowering Almond | Rosaceae |
| Prunus persica | Common Peach | Rosaceae |
| Prunus serotina | Black Cherry | Rosaceae |
| Prunus serrulata | Oriental Cherry | Rosaceae |
| Prunus subhirtella | Higan Cherry | Rosaceae |
| Prunus tomentosa | Manchu Cherry, Nanking Cherry | Rosaceae |
| Prunus triloba | Flowering Plum | Rosaceae |
| Prunus virginiana | Common Chokecherry | Rosaceae |
| Pseudolarix kaempferi | Golden-larch | Pinaceae |
| Pseudotsuga menziesii | Douglasfir | Pinaceae |
| Pyracantha coccinea | Scarlet Firethorn | Rosaceae |
| Pyrus calleryana | Callery Pear | Rosaceae |
| Pyrus communis | Common Pear | Rosaceae |
| Pyrus salicifolia | Willowleaf Pear | Rosaceae |
| Quercus acutissima | Sawtooth Oak | Fagaceae |
| Quercus alba | White Oak | Fagaceae |
| Quercus bicolor | Swamp White Oak | Fagaceae |
| Quercus coccinea | Scarlet Oak | Fagaceae |
| Quercus imbricaria | Shingle Oak, Laurel Oak | Fagaceae |
| Quercus macrocarpa | Bur Oak, Mossycup Oak | Fagaceae |
| Quercus muehlenbergii | Chinkapin Oak, Yellow Chestnut Oak | Fagaceae |
| Quercus palustris | Pin Oak, Swamp Oak | Fagaceae |
| Quercus phellos | Willow Oak | Fagaceae |
| Quercus prinus | Chestnut Oak | Fagaceae |
| Quercus robur | English Oak | Fagaceae |
| Quercus rubra | Red Oak | Fagaceae |
| Quercus shumardi | Shumard Oak | Fagaceae |
| Quercus variabilis | Oriental Oak | Fagaceae |
| Quercus velutina | Black Oak | Fagaceae |
| Rhamnus cathartica | Common Buckthorn | Rhamnaceae |
| Rhamnus frangula | Glossy Buckthorn | Rhamnaceae |
| Rhododendron spp. | Rhododendron, Azalea | Ericaceae |
| Rhodotypos scandens | Black Jetbead | Rosaceae |
| Rhus aromatica | Fragrant Sumac | Anacardiaceae |
| Rhus chinensis | Chinese Sumac | Anacardiaceae |
| Rhus copallina | Flameleaf Sumac | Anacardiaceae |
| Rhus glabra | Smooth Sumac | Anacardiaceae |
| Rhus typhina | Staghorn Sumac | Anacardiaceae |
| Ribes alpinum | Alpine Currant | Saxifragaceae |
| Ribes odoratum | Clove Currant | Saxifragaceae |
| Robinia pseudoacacia | Black Locust, Common Locust | Leguminosae |
| Salix alba | White Willow | Salicaceae |
| Salix babylonica | Babylon Weeping Willow | Salicaceae |
| Salix caprea | Goat Willow | Salicaceae |
| Salix discolor | Pussy Willow | Salicaceae |
| Salix matsudana 'Tortuosa' | Corkscrew Willow | Salicaceae |
| Sambucus canadensis | American Elder | Caprifoliaceae |
| Sassafras albidum | Common Sassafras | Lauraceae |
| Sciadopitys verticillata | Umbrella-pine | Pinaceae |
| Sophora japonica | Japanese Pagodatree, Scholar-tree | Leguminosae |
| Sorbus alnifolia | Korean Mountainash | Rosaceae |
| Sorbus americana | American Mountainash | Rosaceae |
| Sorbus aucuparia | European Mountainash | Rosaceae |
| Spiraea arguta | Garland Spirea | Rosaceae |
| Spiraea x bumalda | Bumald Spirea | Rosaceae |
| Spiraea prunifolia | Bridalwreath Spirea | Rosaceae |
| Spiraea thunbergii | Thunberg Spirea | Rosaceae |
| Spiraea x vanhouttei | Vanhoutte Spirea | Rosaceae |
| Staphylea trifolia | American Bladdernut | Staphyleaceae |

(continued)

| Scientific Name | Common Name | Family |
|---|---|---|
| Stephanandra incisa | Cutleaf Stephanandra | Rosaceae |
| Stewartia ovata | Mountain Stewartia | Theaceae |
| Stewartia pseudo-camellia | Japanese Stewartia | Theaceae |
| Styrax japonicum | Japanese Snowbell | Styracaceae |
| Symphoricarpos albus | Common Snowberry | Caprifoliaceae |
| Symphoricarpos x chenaultii | Chenault Coralberry | Caprifoliaceae |
| Symphoricarpos orbiculatus | Indiancurrant Coralberry | Caprifoliaceae |
| Syringa x chinensis | Chinese Lilac | Oleaceae |
| Syringa meyeri | Meyer Lilac | Oleaceae |
| Syringa reticulata | Japanese Tree Lilac | Oleaceae |
| Syringa villosa | Late Lilac | Oleaceae |
| Syringa vulgaris | Common Lilac | Oleaceae |
| Taxodium ascendens | Pondcypress | Taxodiaceae |
| Taxodium distichum | Baldcypress | Taxodiaceae |
| Taxus baccata | English Yew | Taxaceae |
| Taxus canadensis | Canadian Yew | Taxaceae |
| Taxus cuspidata | Japanese Yew | Taxaceae |
| Taxus x media | Anglo-Japanese Yew | Taxaceae |
| Thuja occidentalis | Eastern Arborvitae | Cupressaceae |
| Thuja orientalis | Oriental Arborvitae | Cupressaceae |
| Tilia americana | American Linden | Tiliaceae |
| Tilia cordata | Littleleaf Linden | Tiliaceae |
| Tilia x euchlora | Crimean Linden | Tiliaceae |
| Tilia x europaea | European Linden | Tiliaceae |
| Tilia heterophylla | Beetree Linden | Tiliaceae |
| Tilia platyphyllos | Bigleaf Linden | Tiliaceae |
| Tilia tomentosa | Silver Linden | Tiliaceae |
| Tsuga canadensis | Canadian Hemlock, Eastern Hemlock | Pinaceae |
| Tsuga caroliniana | Carolina Hemlock | Pinaceae |
| Ulmus americana | American Elm | Ulmaceae |
| Ulmus glabra | Scotch Elm | Ulmaceae |
| Ulmus parvifolia | Chinese Elm, Lacebark Elm | Ulmaceae |
| Ulmus pumila | Siberian Elm | Ulmaceae |
| Ulmus rubra | Slippery Elm | Ulmaceae |
| Vaccinium angustifolium | Lowbush Blueberry | Ericaceae |
| Vaccinium corymbosum | Highbush Blueberry | Ericaceae |
| Viburnum x burkwoodii | Burkwood Viburnum | Caprifoliaceae |
| Viburnum x carlcephalum | Fragrant Viburnum | Caprifoliaceae |
| Viburnum carlesii | Koreanspice Viburnum | Caprifoliaceae |
| Viburnum dentatum | Arrowwood Viburnum | Caprifoliaceae |
| Viburnum dilatatum | Linden Viburnum | Caprifoliaceae |
| Viburnum farreri | Fragrant Viburnum | Caprifoliaceae |
| Viburnum x juddii | Judd Viburnum | Caprifoliaceae |
| Viburnum lantana | Wayfaringtree Viburnum | Caprifoliaceae |
| Viburnum lentago | Nannyberry Viburnum, Sheepberry | Caprifoliaceae |
| Viburnum macrocephalum | Chinese Snowball Viburnum | Caprifoliaceae |
| Viburnum opulus | European Cranberrybush Viburnum | Caprifoliaceae |
| Viburnum plicatum tomentosum | Doublefile Viburnum | Caprifoliaceae |
| Viburnum prunifolium | Blackhaw Viburnum | Caprifoliaceae |
| Viburnum x rhytidophylloides | Lantanaphyllum Viburnum | Caprifoliaceae |
| Viburnum rhytidophyllum | Leatherleaf Viburnum | Caprifoliaceae |
| Viburnum rufidulum | Southern Blackhaw | Caprifoliaceae |
| Viburnum setigerum | Tea Viburnum | Caprifoliaceae |
| Viburnum sieboldii | Siebold Viburnum | Caprifoliaceae |
| Viburnum trilobum | American Cranberrybush Viburnum | Caprifoliaceae |
| Vinca minor | Common Periwinkle, Myrtle | Apocynaceae |
| Weigela florida | Old-fashioned Weigela | Caprifoliaceae |
| Wisteria floribunda | Japanese Wisteria | Leguminosae |
| Wisteria sinensis | Chinese Wisteria | Leguminosae |
| Zelkova serrata | Japanese Zelkova | Ulmaceae |

Adapted from Dirr, Michael A. *Manual of Woody Landscape Plants, Their Identification, Ornamental Characteristics, Culture, Prop. ation and Uses.* Stipes Publishing Co., 10-12 Chester St., Champaign, IL 61820. 1980.

# SELECTED COMMON PLANTS OF NORTH AMERICA

LISTED ALPHABETICALLY BY ***COMMON NAME***

| Common Name | Scientific Name |
|---|---|
| Abelia, Glossy | Abelia x grandiflora |
| Akebia, Fiveleaf | Akebia quinata |
| Albizia | Albizia julibrissin |
| Alder | |
| Black | Alnus glutinosa *and* Ilex verticillata |
| Common | Alnus glutinosa |
| European | Alnus glutinosa |
| Allspice, Carolina | Calycanthus floridus |
| Almond, Dwarf Flowering | Prunus glandulosa |
| Althea, Shrub | Hibiscus syriacus |
| Ampelopsis, Porcelain | Ampelopsis brevipedunculata |
| Andromeda | Pieris japonica |
| Aralia, Fiveleaf | Acanthopanax sieboldianus |
| Arborvitae | |
| Eastern | Thuja occidentalis |
| Oriental | Thuja orientalis |
| Ash | |
| Blue | Fraxinus quadrangulata |
| European | Fraxinus excelsior |
| Green | Fraxinus pennsylvanica |
| Pumpkin | Fraxinus tomentosa |
| Red | Fraxinus pennsylvanica |
| White | Fraxinus americana |
| Aspen, Quaking | Populus tremuloides |
| Azalea | Rhododendron spp. |
| Baldcypress | Taxodium distichum |
| Barberry | |
| Chenault | Berberis x chenaultii |
| Japanese | Berberis thunbergii |
| Korean | Berberis koreana |
| Mentor | Berberis x mentorensis |
| Wintergreen | Berberis julianae |
| Bayberry, Northern | Myrica pensylvanica |
| Bearberry | Arctostaphylos uva-ursi |
| Beautybush | Kolkwitzia amabilis |
| Beech | |
| American | Fagus grandifolia |
| European | Fagus sylvatica |
| Birch | |
| Asian White | Betula platyphylla |
| Canoe | Betula papyrifera |
| European White | Betula pendula |
| Gray | Betula populifolia |
| Monarch | Betula maximowicziana |
| Paper | Betula papyrifera |
| Poplar | Betula populifolia |
| River | Betula nigra |
| Sweet | Betula lenta |
| White | Betula papyrifera |
| Bittersweet, American | Celastrus scandens |
| Black Gum | Nyssa sylvatica |
| Blackhaw, Southern | Viburnum rufidulum |
| Bladdernut, American | Staphylea trifolia |
| Blue Beech | Carpinus caroliniana |
| Blueberry | |
| Highbush | Vaccinium corymbosum |
| Lowbush | Vaccinium angustifolium |
| Box | |
| Common | Buxus sempervirens |
| Littleleaf | Buxus microphylla |
| Boxelder | Acer negundo |
| Boxwood | Buxus microphylla *and* Buxus sempervirens |
| Buckeye | |
| Bottlebrush | Aesculus parviflora |
| Fetid | Aesculus glabra |
| Ohio | Aesculus glabra |
| Red | Aesculus pavia |
| Yellow | Aesculus octandra |
| Buckthorn | |
| Common | Rhamnus cathartica |
| Glossy | Rhamnus frangula |
| Butternut | Juglans cinerea |
| Candytuft | Iberis sempervirens |

| Common Name | Scientific Name |
|---|---|
| Castor-aralia | Kalopanax pictus |
| Catalpa | |
| Common | Catalpa bignonioides |
| Hardy | Catalpa speciosa |
| Northern | Catalpa speciosa |
| Southern | Catalpa bignonioides |
| Western | Catalpa speciosa |
| Cedar | |
| Atlas | Cedrus atlantica |
| Deodar | Cedrus deodara |
| Cedar of Lebanon | Cedrus libani |
| Cherry | |
| Black | Prunus serotina |
| Higan | Prunus subhirtella |
| Manchu | Prunus tomentosa |
| Nanking | Prunus tomentosa |
| Oriental | Prunus serrulata |
| Chestnut | |
| American | Castanea dentata |
| Chinese | Castanea mollissima |
| Chinafir, Common | Cunninghamia lanceolata |
| Chokeberry | |
| Black | Aronia melanocarpa |
| Red | Aronia arbutifolia |
| Chokecherry, Common | Prunus virginiana |
| Cinquefoil, Bush | Potentilla fruticosa |
| Clematis, Jackman | Clematis x jackmanii |
| Clethra, Summersweet | Clethra alnifolia |
| Coffeetree, Kentucky | Gymnocladus dioicus |
| Coralberry | Ilex verticillata |
| Chenault | Symphoricarpos x chenaultii |
| Indiancurrant | Symphoricarpos orbiculatus |
| Corktree, Amur | Phellodendron amurense |
| Cotoneaster | |
| Bearberry | Cotoneaster dammeri |
| Cranberry | Cotoneaster apiculata |
| Hedge | Cotoneaster lucida |
| Many-flowered | Cotoneaster multiflora |
| Rock | Cotoneaster horizontalis |
| Spreading | Cotoneaster divaricata |
| Willowleaf | Cotoneaster salicifolia |
| Cottonwood, Eastern | Populus deltoides |
| Crabapple, Flowering | Malus spp. |
| Creeper | |
| Japanese - see *Japanese Creeper* | |
| Virginia - see *Virginia Creeper* | |
| Cryptomeria, Japanese | Cryptomeria japonica |
| Currant | |
| Alpine | Ribes alpinum |
| Clove | Ribes odoratum |
| Deutzia | |
| Fuzzy | Deutzia scabra |
| Slender | Deutzia gracilis |
| Devil's-walkingstick | Aralia spinosa |
| Dogwood | |
| Bloodtwig | Cornus sanguinea |
| Corneliancherry | Cornus mas |
| Flowering | Cornus florida |
| Gray | Cornus racemosa |
| Kousa | Cornus kousa |
| Pagoda | Cornus alternifolia |
| Red Osier | Cornus stolonifera |
| Silky | Cornus amomum |
| Tatarian | Cornus alba |
| Douglasfir | Pseudotsuga menziesii |
| Elaeagnus, Autumn | Elaeagnus umbellata |
| Elder, American | Sambucus canadensis |
| Elm | |
| American | Ulmus americana |
| Chinese | Ulmus parvifolia |
| Lacebark | Ulmus parvifolia |
| Scotch | Ulmus glabra |
| Siberian | Ulmus pumila |
| Slippery | Ulmus rubra |
| Enkianthus, Redvein | Enkianthus campanulatus |

*(continued)*

| Common Name | Scientific Name |
|---|---|
| Euonymus | |
| Spreading | Euonymus kiautschovicus |
| Winged | Euonymus alatus |
| Winterberry | Euonymus bungeanus |
| Wintercreeper | Euonymus fortunei |
| Falsecypress | |
| Hinoki | Chamaecyparis obtusa |
| Japanese | Chamaecyparis pisifera |
| Lawson | Chamaecyparis lawsoniana |
| Nootka | Chamaecyparis nootkatensis |
| Fetterbush | Leucothoe fontanesiana |
| Filbert | |
| American | Corylus americana |
| European | Corylus avellana |
| Purple Giant | Corylus maxima purpurea |
| Turkish | Corylus colurna |
| Fir | |
| Balsam | Abies balsamea |
| Fraser | Abies fraseri |
| Noble | Abies procera |
| White | Abies concolor |
| Firethorn, Scarlet | Pyracantha coccinea |
| Flowering Quince | |
| Common | Chaenomeles speciosa |
| Japanese | Chaenomeles japonica |
| Forsythia | |
| Border | Forsythia x intermedia |
| Greenstem | Forsythia viridissima |
| Weeping | Forsythia suspensa |
| Fothergilla | |
| Dwarf | Fothergilla gardenii |
| Large | Fothergilla major |
| Franklin Tree | Franklinia alatamaha |
| Franklinia | Franklinia alatamaha |
| Fringetree, White | Chionanthus virginicus |
| Ginkgo | Ginkgo biloba |
| Goldenchain Tree | Laburnum x watereri |
| Golden-larch | Pseudolarix kaempferi |
| Goldenraintree, Panicled - see *Panicled Goldenraintree* | |
| Grapeholly, Oregon - see *Oregon Grapeholly* | |
| Gum | |
| Black - see *Black Gum* | |
| Sour - see *Sour Gum* | |
| Hackberry | |
| Common | Celtis occidentalis |
| Sugar | Celtis laevigata |
| Hawthorn | |
| Cockspur | Crataegus crusgalli |
| Downy | Crataegus mollis |
| English | Crataegus oxyacantha |
| Glossy | Crataegus nitida |
| Lavalle | Crataegus x lavallei |
| Washington | Crataegus phaenopyrum |
| Hazel | Corylus colurna |
| Hedge-apple | Maclura pomifera |
| Hemlock | |
| Canadian | Tsuga canadensis |
| Carolina | Tsuga caroliniana |
| Eastern | Tsuga canadensis |
| Hercules-club | Aralia spinosa |
| Hickory | |
| Bitternut | Carya cordiformis |
| Shagbark | Carya ovata |
| Holly | |
| American | Ilex opaca |
| Blue | Ilex x meserveae |
| Chinese | Ilex cornuta |
| Foster's | Ilex x fosteri |
| Japanese | Ilex crenata |
| Longstalk | Ilex pedunculosa |
| Meserve | Ilex x meserveae |
| Michigan | Ilex verticillata |
| Honeylocust, Thornless | Gleditsia triacanthos var. inermis |
| Honeysuckle | |
| Amur | Lonicera maackii |
| Japanese | Lonicera japonica |
| Tatarian | Lonicera tatarica |
| Honeysuckle *(cont'd)* | |
| Trumpet | Lonicera sempervirens |
| Winter | Lonicera fragrantissima |
| Hophornbeam, American | Ostrya virginiana |
| Hornbeam | |
| American | Carpinus caroliniana |
| European | Carpinus betulus |
| Horsechestnut | |
| Common | Aesculus hippocastanum |
| Red | Aesculus carnea |
| Hydrangea | |
| Climbing | Hydrangea anomala subsp. petiolaris |
| Oakleaf | Hydrangea quercifolia |
| Panicle | Hydrangea paniculata |
| Smooth | Hydrangea arborescens |
| Indian Bear | Catalpa bignonioides |
| Inkberry | Ilex glabra |
| Ironwood | Carpinus caroliniana *and* Ostrya virginiana |
| Ivy, English | Hedera helix |
| Japanese Creeper | Parthenocissus tricuspidata |
| Jetbead, Black | Rhodotypos scandens |
| Juniper | |
| Chinese | Juniperus chinensis |
| Common | Juniperus communis |
| Creeping | Juniperus horizontalis |
| Japanese Garden | Juniperus procumbens |
| Rocky Mountain | Juniperus scopulorum |
| Savin | Juniperus sabina |
| Shore | Juniperus conferta |
| Singleseed | Juniperus squamata |
| Kalmia, Moutain Laurel | Kalmia latifolia |
| Katsuratree | Cercidiphyllum japonicum |
| Kerria, Japanese | Kerria japonica |
| Laburnum, Waterer | Laburnum x watereri |
| Larch | |
| European | Larix decidua |
| Japanese | Larix kaempferi |
| Laurel | Magnolia virginiana or see *Mountain Laurel Kalmia* |
| Leucothoe, Drooping | Leucothoe fontanesiana |
| Lilac | |
| Chinese | Syringa x chinensis |
| Common | Syringa vulgaris |
| Japanese Tree | Syringa amurensis japonica or S. reticulata |
| Late | Syringa villosa |
| Meyer | Syringa meyeri |
| Lily-of-the-valley Tree | Oxydendrum arboreum |
| Lilyturf | Liriope spicata |
| Linden | |
| American | Tilia americana |
| Beetree | Tilia heterophylla |
| Bigleaf | Tilia platyphyllos |
| Crimean | Tilia x euchlora |
| European | Tilia x europaea |
| Littleleaf | Tilia cordata |
| Silver | Tilia tomentosa |
| Locust | |
| Black | Robinia pseudoacacia |
| Common | Robinia pseudoacacia |
| Magnolia | |
| Bigleaf | Magnolia macrophylla |
| Cucumbertree | Magnolia acuminata |
| Kobus | Magnolia kobus |
| Lily | Magnolia liliflora |
| Saucer | Magnolia x soulangiana |
| Southern | Magnolia grandiflora |
| Star | Magnolia stellata |
| Swamp | Magnolia virginiana |
| Sweetbay | Magnolia virginiana |
| Tulip - see *Tulip Magnolia* | |
| Umbrella | Magnolia tripetala |
| Maidenhair Tree | Ginkgo biloba |
| Maple | |
| Amur | Acer ginnala |
| Fullmoon | Acer japonicum |
| Hard | Acer saccharum |

| Common Name | Scientific Name |
|---|---|
| Maple *(cont'd)* | |
| Hedge | Acer campestre |
| Japanese | Acer palmatum |
| Norway | Acer platanoides |
| Paperbark | Acer griseum |
| Planetree | Acer pseudoplatanus |
| Red | Acer rubrum |
| Rock | Acer saccharum |
| Silver | Acer saccharinum |
| Striped | Acer pensylvanicum |
| Sugar | Acer saccharum |
| Sycamore | Acer pseudoplatanus |
| Tatarian | Acer tataricum |
| Trident | Acer buergerianum |
| Mimosa | Albizia julibrissin |
| Mockorange, Sweet | Philadelphus coronarius |
| Moosewood | Acer pensylvanicum |
| Mountain Laurel Kalmia | Kalmia latifolia |
| Mountainash | |
| American | Sorbus americana |
| European | Sorbus aucuparia |
| Korean | Sorbus alnifolia |
| Mulberry | |
| Common | Morus alba |
| Red | Morus rubra |
| White | Morus alba |
| Myrtle | Vinca minor |
| Ninebark | |
| Common | Physocarpus opulifolius |
| Eastern | Physocarpus opulifolius |
| Oak | |
| Black | Quercus velutina |
| Bur | Quercus macrocarpa |
| Chestnut | Quercus prinus |
| Chinkapin | Quercus muehlenbergii |
| English | Quercus robur |
| Laurel | Quercus imbricaria |
| Mossycup | Quercus macrocarpa |
| Oriental | Quercus variabilis |
| Pin | Quercus palustris |
| Red | Quercus rubra |
| Sawtooth | Quercus acutissima |
| Scarlet | Quercus coccinea |
| Shingle | Quercus imbricaria |
| Shumard | Quercus shumardi |
| Swamp | Quercus palustris |
| Swamp White | Quercus bicolor |
| White | Quercus alba |
| Willow | Quercus phellos |
| Yellow Chestnut | Quercus muehlenbergii |
| Oregon Grapeholly | Mahonia aquifolium |
| Osage-orange | Maclura pomifera |
| Pachysandra, Japanese | Pachysandra terminalis |
| Pagodatree, Japanese | Sophora japonica |
| Panicled Goldenraintree | Koelreuteria paniculata |
| Pawpaw, Common | Asimina triloba |
| Paxistima, Canby | Paxistima canbyi |
| Peach, Common | Prunus persica |
| Pear | |
| Callery | Pyrus calleryana |
| Common | Pyrus communis |
| Willowleaf | Pyrus salicifolia |
| Peashrub, Siberian | Caragana arborescens |
| Pecan | Carya illinoinensis |
| Pepperidge | Nyssa sylvatica |
| Periwinkle, Common | Vinca minor |
| Persimmon, Common | Diospyros virginiana |
| Photinia, Oriental | Photinia villosa |
| Pieris | |
| Japanese | Pieris japonica |
| Mountain | Pieris floribunda |
| Pine | |
| Austrian | Pinus nigra |
| Bristlecone | Pinus aristata |
| Colorado | Pinus edulus |
| Dwarf Swiss Mountain | Pinus mugo mugo |
| Eastern White | Pinus strobus |
| Himalayan | Pinus wallichiana |
| Jack | Pinus banksiana |

| Common Name | Scientific Name |
|---|---|
| Pine *(cont'd)* | |
| Japanese Black | Pinus thunbergiana |
| Japanese Red | Pinus densiflora |
| Japanese White | Pinus parviflora |
| Jersey | Pinus virginiana |
| Lacebark | Pinus bungeana |
| Limber | Pinus flexilis |
| Pitch | Pinus rigida |
| Ponderosa | Pinus ponderosa |
| Poverty | Pinus virginiana |
| Red | Pinus resinosa |
| Scotch | Pinus sylvestris |
| Scrub | Pinus virginiana |
| Spruce | Pinus virginiana |
| Swiss Mountain | Pinus mugo |
| Swiss Stone | Pinus cembra |
| Virginia | Pinus virginiana |
| Planetree | |
| American | Platanus occidentalis |
| London | Platanus acerifolia |
| Plum | |
| Cherry | Prunus cerasifera |
| Flowering | Prunus triloba |
| Pondcypress | Taxodium ascendens |
| Poplar | |
| Silver-leaved | Populus alba |
| Tulip - see *Tulip Poplar* | |
| White | Populus alba |
| Yellow - see *Yellow Poplar* | |
| Possumhaw | Ilex decidua |
| Privet | |
| Border | Ligustrum obtusifolium |
| European | Ligustrum vulgare |
| Golden | Ligustrum x vicaryi |
| Quaking Aspen - see *Aspen, Quaking* | |
| Redbud, Eastern | Cercis canadensis |
| Redcedar, Eastern | Juniperus virginiana |
| Redwood, Dawn | Metasequoia glyptostroboides |
| Rhododendron | Rhododendron spp. |
| Rockspray | Cotoneaster horizontalis |
| Rose-of-Sharon | Hibiscus syriacus |
| Rubber Tree, Hardy | Eucommia ulmoides |
| Russian Olive | Elaeagnus angustifolia |
| St. Johnswort, Shrubby | Hypericum prolificum |
| Sassafras, Common | Sassafras albidum |
| Sawara | Chamaecyparis pisifera |
| Scholar-tree | Sophora japonica |
| Serviceberry | |
| Allegheny | Amelanchier laevis |
| Running | Amelanchier stolonifera |
| Sheepberry | Viburnum lentago |
| Silk-tree | Albizia julibrissin |
| Silverbell, Carolina | Halesia carolina |
| Smokebush | Cotinus coggygria |
| Smoketree, Common | Cotinus coggygria |
| Snowbell, Japanese | Styrax japonicum |
| Snowberry, Common | Symphoricarpos albus |
| Snow-wreath | Neviusia alabamensis |
| Sorrel Tree | Oxydendrum arboreum |
| Sour Gum | Nyssa sylvatica |
| Sourwood | Oxydendrum arboreum |
| Spicebush | Lindera benzoin |
| Spirea | |
| Bridalwreath | Spiraea prunifolia |
| Bumald | Spiraea bumalda |
| Garland | Spiraea arguta |
| Thunberg | Spiraea thunbergii |
| Vanhoutte | Spiraea x vanhouttei |
| Spruce | |
| Blue | Picea pungens glauca |
| Colorado | Picea pungens |
| Engelmann | Picea engelmangii |
| Norway | Picea abies |
| Oriental | Picea orientalis |
| Serbian | Picea omorika |
| White | Picea glauca |
| Spurge | Pachysandra terminalis |
| Stephanandra, Cutleaf | Stephanandra incisa |

*(continued)*

| Common Name | Scientific Name |
|---|---|
| Stewartia | |
| Japanese | Stewartia pseudo-camellia |
| Mountain | Stewartia ovata |
| Strawberry-shrub | Calycanthus floridus |
| Sumac | |
| Chinese | Rhus chinensis |
| Flameleaf | Rhus copallina |
| Fragrant | Rhus aromatica |
| Smooth | Rhus glabra |
| Staghorn | Rhus typhina |
| Sweetgum | Liquidambar styraciflua |
| Sweetshrub, Common | Calycanthus floridus |
| Sycamore | Platanus occidentalis |
| Tree-of-heaven | Ailanthus altissima |
| Trumpetcreeper, Common | Campsis radicans |
| Tulip Magnolia | Liriodendron tulipifera |
| Tulip Poplar | Liriodendron tulipifera |
| Tuliptree | Liriodendron tulipifera |
| Tupelo, Black | Nyssa sylvatica |
| Umbrella-pine | Sciadopitys verticillata |
| Varnish Tree | Koelreuteria paniculata |
| Viburnum | |
| American Cranberrybush | Viburnum trilobum |
| Arrowwood | Viburnum dentatum |
| Blackhaw | Viburnum prunifolium |
| Burkwood | Viburnum x burkwoodii |
| Chinese Snowball | Viburnum macrocephalum |
| Doublefile | Viburnum plicatum tomentosum |
| European Cranberrybush | Viburnum opulus |
| Fragrant | Viburnum x carlcephalum *and* Viburnum farreri |
| Judd | Viburnum x juddii |
| Koreanspice | Viburnum carlesii |
| Lantanaphyllum | Viburnum rhytidophylloides |
| Leatherleaf | Viburnum rhytidophyllum |
| Viburnum *(cont'd)* | |
| Linden | Viburnum dilatatum |
| Nannyberry | Viburnum lentago |
| Siebold | Viburnum sieboldii |
| Tea | Viburnum setigerum |
| Wayfaringtree | Viburnum lantana |
| Virgilia | Cladrastis lutea |
| Virginia Creeper | Parthenocissus quinquefolia |
| Walnut, Black | Juglans nigra |
| Weigela, Old-fashioned | Weigela florida |
| Willow | |
| Babylon Weeping | Salix babylonica |
| Corkscrew | Salix matsudana 'Tortuosa' |
| Goat | Salix caprea |
| Pussy | Salix discolor |
| White | Salix alba |
| Winterberry, Common | Ilex verticillata |
| Winterhazel, Fragrant | Corylopsis glabrescens |
| Wisteria | |
| Chinese | Wisteria floribunda |
| Japanese | Wisteria sinensis |
| Witchhazel | |
| Chinese | Hamamelis mollis |
| Common | Hamamelis virginiana |
| Vernal | Hamamelis vernalis |
| Woodbine | Parthenocissus quinquefolia |
| Yellow Poplar | Liriodendron tulipifera |
| Yellowwood, American | Cladrastis lutea |
| Yew | |
| Anglo-Japanese | Taxus x media |
| Canadian | Taxus canadensis |
| English | Taxus baccata |
| Japanese | Taxus cuspidata |
| Zelkova, Japanese | Zelkova serrata |

Adapted from Dirr, Michael A. *Manual of Woody Landscape Plants, Their Identification, Ornamental Characteristics, Culture, Propagation and Uses.* Stipes Publishing Co., 10-12 Chester St., Champaign, IL 61820. 1980.

# GLOSSARY

**abscission** - leaf or fruit drop

**abscission zone** - area at the base of the petiole where cellular breakdown leads to leaf or fruit drop

**absorption** - taking up; sucking up

**acorn** - thick-walled globular nut with a cup-like base; the fruit of oak

**acuminate** - having an apex the sides of which are gradually concave and taper to a point

**acute** - having an apex the sides of which are straight and taper to a point

**adpressed** - in close, tight proximity

**aeration** - provision of ample oxygen

**aerial lift (bucket truck)** - truck with booms and bucket used to put a worker in proximity to the tree work to be done

**aerial rescue** - method used to bring an injured person down from a tree

**aesthetic** - relating to artistic, pleasing characteristics

**aggregate** - close cluster

**air terminal** - the portion of a lightning protection cable that extends beyond the top of the tree

**alternate leaved** - having leaves situated one at each node and alternating in position on the stem

**angiosperm** - plant with seeds borne in an ovary

**annual ring** - ring of xylem in wood that indicates a year of growth

**anther** - portion of the stamen where pollen is borne

**anthocyanin** - red or purplish pigment

**apex** (plural, **apices**) - the tip or point of a leaf or stem

**arboriculture** - the study of trees and other plants

**arborist** - person devoted to the care, maintenance and study of trees

**aromatic** - fragrantly scented

**artificial respiration** - forcing air into the lungs of a person who has stopped breathing

**auxin** - plant hormone

**backfill** - the soil and amendments put back into a hole following planting or transplanting

**bacterium** (plural, **bacteria**) - one of a group of microscopic plants, some of which cause disease

**balled and burlapped** - having the root system and soil wrapped in burlap for moving and planting

**bareroot** - having the root system exposed without soil or protective wrap

(continued)

**bark** - stem tissues from the cambium outward

**bark tracing** - cutting away torn or injured bark to leave a smooth edge

**bell cap** - device used to cover the exposed portion of an upright tile

**berry** - fleshy, multi-seeded fruit

**biodegradable** - capable of decaying and being absorbed by the environment

**bipinnate** - doubly pinnate

**blade** - the expanded part of a leaf

**blight** - disease that kills young growing tissue

**body thrust** - method of ascending a tree using a rope

**bonsai** - the art of culturing dwarfed plants grown in pots

**boom** - long, movable arm(s) on which the bucket is mounted in a bucket truck

**bowline** - looped knot used to attach clips (snaps) to a rope, and to lower limbs from a tree

**bracing** - installation of a rod through a weak portion of a tree for added support

**bract** - modified leaf from which an inflorescence arises

**branch bark ridge** - area of a crotch where the bark is rippled due to the joining of the two branches

**branch collar** - swollen area where one branch meets another

**broadleaf evergreen** - non-coniferous plant that maintains its foliage throughout the year

**brush chipper** - piece of equipment used to grind branches into wood chips

**bucket truck (aerial lift)** - truck equipped with apparatus for placing worker in proximity to high limbs

**bucking** - cutting a tree into logs of usable length

**bud** - undeveloped swelling composed mostly of meristematic tissue

**bud scale** - modified, protective leaf of a bud

**bull rope** - large rope, usually 3/4 inch in diameter, used to lower large limbs from a tree

**bumper spikes** - metal spikes on larger chain saws that grip the log as the saw is drawn in

**butt end** - end of a branch where the cut was made

**buttress roots** - roots at the base of the trunk; trunk flare

**CPR** - cardiopulmonary resuscitation; procedure used to force air into the lungs and to force blood circulation in a person who has suffered cardiac arrest

**cable wrap** - device used in cabling trees; replaces the U-bolt and splice

**cabling** - method of installing hardware (cables and lag hooks) in a tree to help correct weak crotches

**caliper** - diameter of a tree

**calyx** - collective term for the sepals

**cambium** - layer(s) of cells that gives rise to new xylem and phloem

**candle growth** - new growth on a conifer

**canker** - localized diseased area on stems and wood

**canopy** - the entire branch scaffolding and foliage of a tree

**capsule** - dry fruit produced from a compound pistil

**carbohydrate** - compound combining forms of carbon and water

**carotenoid** - a yellow, orange, or red pigment

**catkin** - spike-like inflorescence

**cell** - smallest unit of an organism that is capable of self-reproduction

**chaps** - heavy material worn over the pants to protect the legs when using a chain saw

**chlorophyll** - green pigment of plants, found in chloroplasts

**chlorosis** - whitish or yellowish discoloration; lack of chlorophyll

**class** - the taxonomic division under the phylum

**climber's saddle** - safety harness worn by tree climbers

**climbing rope** - rope used by tree climbers for safety and maneuverability (usually 1/2 inch in diameter and 120 feet long)

**climbing spurs (climbing spikes)** - long, pointed spurs that are strapped to the inside of the legs to aid in climbing trees

**clone** - group of plants derived vegetatively from a parent plant and genetically identical to the parent plant

**clove hitch** - knot used to secure an object to a rope

**"come-along"** - device used to draw two things closer together

**complete fertilizer** - fertilizer that contains nitrogen, phosphorus and potassium

**compound leaf** - a leaf with two or more leaflets

**conductive (vascular) tissue** - parts of the plant which carry water or nutrients

**conductor** - any object that can carry an electric current

**cone** - the fruit of a conifer with woody or leathery scales

**conifer** - cone-bearing tree

**cordate** - heart-shaped

**cork cambium** - the cambium from which cork develops

**cork cells** - external stem tissue that is impermeable to water and gases

**corolla** - collective term for the petals

**cortex** - the cells between the epidermis and conducting tissues

(continued)

**coupling** - device for joining two things together such as wire, cable or pipes

**crenate** - having rounded marginal teeth

**cross section** - section cut perpendicular to the axis of longitudinal growth

**crown** - the upper mass of a tree

**cultivar** - a cultivated variety

**cuticle** - waxy layer outside the epidermis

**D-rings** - large, D-shaped metal rings attached to the safety harness and used to attach ropes and tools

**damping-off** - disease of seedlings characterized by dying stem and root tissues

**deadwooding** - pruning to remove dead limbs from trees

**deciduous** - trees and shrubs that lose their leaves in the fall

**deficiency** - lack or insufficient quantity of a required nutrient

**defoliation** - loss of leaves from a plant

**deltoid** - triangular

**dentate** - having marginal teeth which are perpendicular to the margin

**desiccation** - drying up

**dichotomous venation** - pattern of leaf venation in which vascular bundles fork in pairs

**dieback** - condition in which the ends of branches are dying

**dielectric integrity** - an unimpaired condition of non-conductivity

**differentiation** - developmental specialization of plant tissues

**dioecious** - plant with unisexual flowers with each sex confined to separate plants

**dissemination** - spreading or dispersal

**dormant** - state of reduced physiological activity

**double-crotching** - a method of working in a tree, which involves tying the climbing line into two separate crotches

**double-serrate** - toothed margin of leaf with smal' r teeth within

**drainage tile** - large clay or plastic pipes used to collect and reroute subsurface water

**drift** - spray droplets carried by air movement to non-target areas

**drip line** - the full extension of a tree's canopy over the ground below

**drop crotch pruning** - cutting each limb back to a desirable lateral branch

**drop line** - a rope used to lower limbs from a tree

**drupe** - fleshy fruit with a stony covering over the seed

**dry well** - large well constructed around a tree to maintain aeration in the root zone

**egg** - female gamete

**electrocution** - fatality caused by electric shock

**elliptical** - oval; shaped like an ellipse

**energized** - carrying an electric charge

**entire** (leaf) - having a margin without teeth

**entomology** - the study of insects

**epidermis** - outer tissue of leaves, stems, roots, flowers, fruits and seeds

**epinasty** - distortion of growth

**espalier** - a plant trained to grow against a wall or other support

**evergreen** - having green foliage throughout the year

**exfoliating** - peeling off in shreds or layers

**exudation** - oozing out

**false crotch** - device used to lower limbs from a tree when there is no convenient crotch

**family** - the taxonomic division under *order*

**feeder roots** - small, fibrous roots which are active in the uptake of water and minerals

**felling** - the act of cutting down a tree

**fertilization** - union of sperm with egg—the start of a new individual

**fertilizer** - a substance added to a plant or its surrounding soil to supplement the supply of required nutrients

**fertilizer analysis** - the percentage of nitrogen, phosphorus and potassium in a fertilizer

**figure 8 knot** - knot used to prevent slipping of the end of the rope through the knot

**filament** - stalk of the stamen

**filamentous** - thread-like

**flower bud** - a bud that will develop into a flower (reproductive tissues)

**foliage** - the leaves of a plant

**follicle** - dry fruit which opens along one side, produced from a single carpel

**footlock** - method of climbing a rope by wrapping the rope around one's feet

**fungus** (plural, **fungi**) - non-photosynthetic plant, in certain cases causing disease

**gall** - swelling in plant tissues frequently caused by insects

**gamete** - sex cell

**genus** - a group of species having similar fundamental traits

**girdling** - inhibition of the flow of water and nutrients by "choking" the vascular elements

**glabrous** - smooth, not hairy

**grafting** - method of propagation by which parts (twigs) of separate plants are joined

(continued)

**grounded** - electrically connected to the earth

**guard cells** - pair of cells which control the opening and closing of the stoma

**guide bar** - bar of chain saw around which the cutting chain rotates

**gummosis** - exudation of sap often in response to disease or insect damage

**guying** - securing a tree with ropes or cables fastened to stakes in the ground

**gymnosperm** - plant with seeds borne exposed

**half hitch** - simple wrap of a rope used to secure the line temporarily

**hand pruners** - small pruning tool for pruning limbs less than 1/2 inch in diameter

**heading back** - cutting each limb back to a lateral branch when pruning

**heartwood** - inner, darker wood that is not active in water transport

**hedge shears** - scissor-like tool for formal pruning of shrubs and hedges

**honeydew** - substance secreted by certain insects when feeding upon plants

**hydraulic** - operated by forced fluids

**hydraulic tools** - tools (pole pruners, saws) powered by hydraulics; mostly used from aerial lifts

**IPM - Integrated Pest Management** - a combined approach to controlling plant pests utilizing alternative methods

**imperfect flower** - a flower with only stamens or pistils, not both

**implant** - device or pellet which can be inserted into a tree to treat disorders

**increment borer** - device used to take core samples from trees for the purpose of determining age or detecting problems

**inflorescence** - flower or group of flowers; disposition of flowers on the plant

**injection** - forcing of chemical fluids into the vascular elements of a tree for the purpose of treating disorders

**inoculum** - pathogen or disease-causing substance; material which introduces disease

**insulation** - non-conducting material placed over a conductor

**internode** - the region of the stem between two successive nodes

**intervenal tissue** - leaf tissue between the veins or vascular bundles

**kickback** - sudden backward or upward thrust of a chain saw

**kingdom** - in taxonomy, the primary division into which all organisms are classified: either plant or animal

**lag hook** - device used in cabling trees; it has threads at one end for anchoring in the tree and a hook at the other end for attaching the cable

**larva** - immature life stage of an insect

**lateral** - side or offshoot branch

**lateral bud** - vegetative bud on the side of a stem

**leach** - wash through and out of the topsoil

**leader** - the primary terminal shoot or trunk of a tree

**leaf blotch** - irregularly shaped areas of disease on plant foliage

**leaf scar** - scar left on the twig after the leaf falls

**leaflet** - separate part of a compound leaf blade

**leafspot** - patches of disease or other damage on plant foliage

**legume** - dry fruit opening on both sides and produced from a single carpel

**leguminous** - relating to legume plants

**lenticel** - opening in the bark that permits the exchange of gases

**limbing** - removing the side limbs of a tree

**line clearance** - removal of trees or limbs that may interfere with utility lines

**lobed** - having a shape with projecting segments or lobes

**lopping shears (loppers)** - long-handled pruning tools for limbs less than 1 1/2 inches in diameter

**malodorous (odoriferous)** - having an unpleasant odor

**margin** - the outer edge of the leaf blade

**mechanical tree spade** - machinery used to dig large trees for transplanting

**meristem** - undifferentiated tissue where active cell division takes place

**micronutrients** - essential elements required by plants in relatively small quantities

**midrib** - the central vascular bundle of a leaf

**mildew** - fungus disease superficial to or penetrating leaf tissues

**monoecious** - plant with unisexual flowers and both sexes on the same plant

**morphology** - study of the form or shape of an object

**mulch** - material used as a covering over soil to maintain even soil temperature, reduce evaporation, reduce erosion, reduce weeds, enrich the soil, or unify the landscape

**mycoplasma** - microscopic, parasitic organism some forms of which cause disease

**necrosis** - localized death of tissue in a living organism

**needle** - slender conifer leaf

**nematode** - microscopic eelworm that often feeds on plant tissues and may cause disease

**node** - slightly enlarged portion of the stem where leaves and buds arise

**nomenclature** - a system of naming

**notch** - wedge-shaped cut in a tree to help control the felling direction

**nutlet** - a small nut

**oblique** - lop-sided, with one side larger than the other

(continued)

**obtuse** - rounded, approaching semi-circular

**oedema** (or **edema**) - watery swelling in plant tissue due to abnormal water conditions

**opposite leaved** - leaves situated two at each node across from each other on the stem

**order** - taxonomic division of *class*

**outriggers** - projecting structures on boom trucks and other large vehicles; used for stabilization

**ovary** - lower part of carpel which becomes the fruit

**ovate (ovoid)** - egg-shaped

**ovule** - structure which encloses the egg

**pH** - a measure of acidity or alkalinity

**PTO** - power take-off; a supplementary mechanism enabling the engine power to be used to operate non-automotive apparatus

**palisade layer** - elongated leaf cells found just beneath the upper epidermis

**palmate** - radiating in a fan-like manner

**panicle** - type of inflorescence with the primary axis bearing branches of flowers

**parallel venation** - pattern of leaf venation in which the veins extend through the leaf side by side

**parasite** - organism living in or on another organism from which it derives nourishment

**pathogen** - causal agent of disease

**perfect flower** - a flower with both pistils and stamens

**petal** - the flower "leaf"; usually colorful

**petiole** - stalk of a leaf

**petiolule** - stalk of a leaflet

**phase-to-phase wires** - type of electric utility lines that carry high voltage

**phelloderm** - layer of cells in the stem of some plants; formed from the inner cells of the cork cambium

**pheromone** - chemical substance produced by insects; serves as a stimulus to other insects of the same species

**phloem** - food-conducting tissues

**photosynthesis** - the process in green plants by which light energy is used to form organic compounds from water and carbon dioxide

**phylum** - the primary taxonomic division within *kingdom*

**pigment** - a substance that appears colored due to the absorbance of certain light wave lengths

**pinnate** - compound leaf with leaflets along each side of a common axis

**pistil** - floral organ where the egg is produced; usually composed of ovary, style and stigma

**pith** - soft tissue in the center of the stem

**plant anatomy** - the study of the structure and composition of plants

**plant hormone** - compound produced by a plant that affects physiological processes such as growth

**plant pathology** - the study of plant diseases

**plant physiology** - the study of life functions of plants

**pneumatic** - operated by air pressure

**pole pruner (pole clip)** - long pole with pruner attached; used for pruning difficult-to-reach limbs

**pole saw** - long pole with pruning saw attached; used for cutting difficult-to-reach branches

**pollen** - fine dusty substance from which the sperm arise in seed plants

**pollination** - transfer of pollen to a receptive stigma or ovulate cone

**polygamo-dioecious** - having male and female flowers on separate plants, but having perfect flowers as well

**pome** - fleshy fruit produced from a compound ovary

**pressure loss** - drop in fluid pressure due to friction in hose or pipe

**propagation** - multiplication of plants by sexual or asexual reproduction

**pruning** - cutting away unwanted parts of a plant

**pruning saw** - saw used for pruning plants; often arched and frequently with teeth arranged for cutting on the pull stroke

**pubescent** - covered with short, soft hairs

**radial section** - longitudinal section cut to coincide with the radius of the stem (trunk)

**ray** - tissues that extend radially in the xylem and phloem of a tree

**reflexed** - bent abruptly backward

**resinous** - secreting a sticky substance

**respiration** - process by which sugars and other compounds are broken down

**respirator** - device worn over the mouth and nose for protecting the respiratory tract

**rigging** - the art of using ropes to lower limbs from a tree

**root hairs** - thin, hairlike projections of root tissue that increase water absorption

**running bowline** - bowline used as a slip knot

**rust** - disease caused by a certain group of fungi and characterized by reddish brown spotting

**safety rope (safety line)** - a short (approx. 6 feet) length of rope with snaps at each end, used to temporarily secure the climber in a tree

**samara** - dry fruit having a wing

**sanitation** - practice of removing dead or diseased plant parts to reduce the amount of inoculum and avoid further disease spread

**sapwood** - outer wood that actively transports water and nutrients

**scabbard** - sheath for pruning saw (hand saw)

**scale** - one of a group of insects that attach themselves to plant parts and suck the juices

(continued)

**scorch** - browning and shriveling of leaves, especially at the margins

**seed** - the mature ovule

**seedling** - young, germinated plant

**sepals** - leaflike structures that enclose the other flower parts

**serrate** - sawtooth margin of leaf with the teeth pointed forward

**sheet bend** - knot used to tie together two ropes of unequal diameter

**shinny** - to move up a limb or pole by clinging to it alternately with arms and legs

**simple leaf** - a single, one-part leaf not composed of leaflets

**sinus** - the space between two lobes or segments

**slow-release tertilizer** - fertilizer formulated to release nitrogen gradually over a long period

**smut** - disease caused by a certain group of fungi and characterized by small, black, spore-filled pustules

**snaps** - metal clips on the climbing saddle, climbing rope, or safety line

**soil amendment** - material added to soil to improve its physical or chemical properties

**soil auger** - device for removing soil cores for inspection or testing

**species** - a group of organisms composed of similar individuals which can produce similar offspring

**sperm** - male gamete

**spongy layer** - leaf cells that contain a large number of chloroplasts and substantial intercellular space

**sprayer calibration** - calculation of the appropriate pressure setting for the sprayer pump, once the disk size, height of spray, hose diameter, and length of hose are known

**sprocket** - toothed wheel which engages the chain on a chain saw

**square knot** - a knot used to tie together two ropes of equal diameter

**staking** - supporting a newly planted tree with stakes

**stamen** - floral organ in which pollen is produced; usually composed of anther and filament

**standard down conductor** - length of copper cable used in lightning protection systems on trees

**stigma** - portion of the style to which pollen adheres

**stippling** - speckled or dotted areas

**stoma** (plural, **stomata**) - small pore between two guard cells on leaves and stems, through which gases are exchanged

**stump remover (stump grinder)** - machinery used to grind out tree stumps

**stunting** - reduction of growth

**style** - stalk of the pistil

**stylet** - portion of the sucking mouthparts of an insect

**sucker (water shoot)** - shoot arising from the roots

**systemic** - acting throughout the entire organism

**tangential section** - longitudinal section cut at right angles to the radius

**tautline hitch** - the "climber's knot" used by tree climbers to secure the climbing rope

**taxonomy** - the classification and naming of organisms

**tendril** - slender, coiling offshoot of the stem that aids in support

**terminal bud** - bud at the end of a stem

**throwing ball** - device consisting of a long string with a padded weight attached; used for placing a rope high in a tree

**tied in** - condition in which the climber's rope is secured in the tree with a tautline hitch

**timber hitch** - a knot used to secure a rope to a log

**topiary** - the art of training and pruning trees and shrubs into ornamental shapes

**topping** - cutting each limb back

**transpiration** - loss of water from the surface of leaves

**transplant** - move a plant to a new location

**undulate** - in leaves, having a wavy margin

**valvate** - meeting by the edges without overlapping

**variety** - subdivision of a species having a distinct difference, and breeding true to that difference

**vascular discoloration** - darkening of the vascular tissues of woody plants in response to disease

**vascular tissue** - tissue that conducts water or nutrients

**vector** - organism that transmits a pathogen

**vegetative bud** - bud that will develop into non-reproductive parts (leaves, branches)

**venation** - arrangement of veins

**virus** - microscopic causative agent of disease

**water shoot** - a secondary, upright shoot arising from the trunk, branches or roots of a plant

***water-soaked*** - oily appearance symptomatic of bacterial disease

**wheel blocks** - devices used to block the tires of a vehicle to keep it from rolling

**whorled** - leaves arranged in a circle around a point on the stem

**wilt** - loss of turgidity and subsequent drooping of soft tissues

**winged twigs** - twigs with thin, dry, membranous appendages

**witches' broom** - plant disorder in which a large number of accessory shoots develop

**wound dressing** - compound applied to tree wounds or cuts

**xylem** - water-conducting tissue

# INDEX

*(continued)*