

Persons complain that the thinning of fruit is expensive and laborious, and this is true; but it is a fair question whether there is anything worth the having of which the same may not be said.

—Liberty Hyde Bailey, *The Principles of Fruit Growing* (1897)

CHAPTER 5

Care of the Orchard

The year-round tasks of orcharding lead to a perennial friendship with our trees. Caring for the orchard is about what we can give these good friends, so that they in turn can offer us the bounty of many fruitful years.

INTUITIVE PRUNING

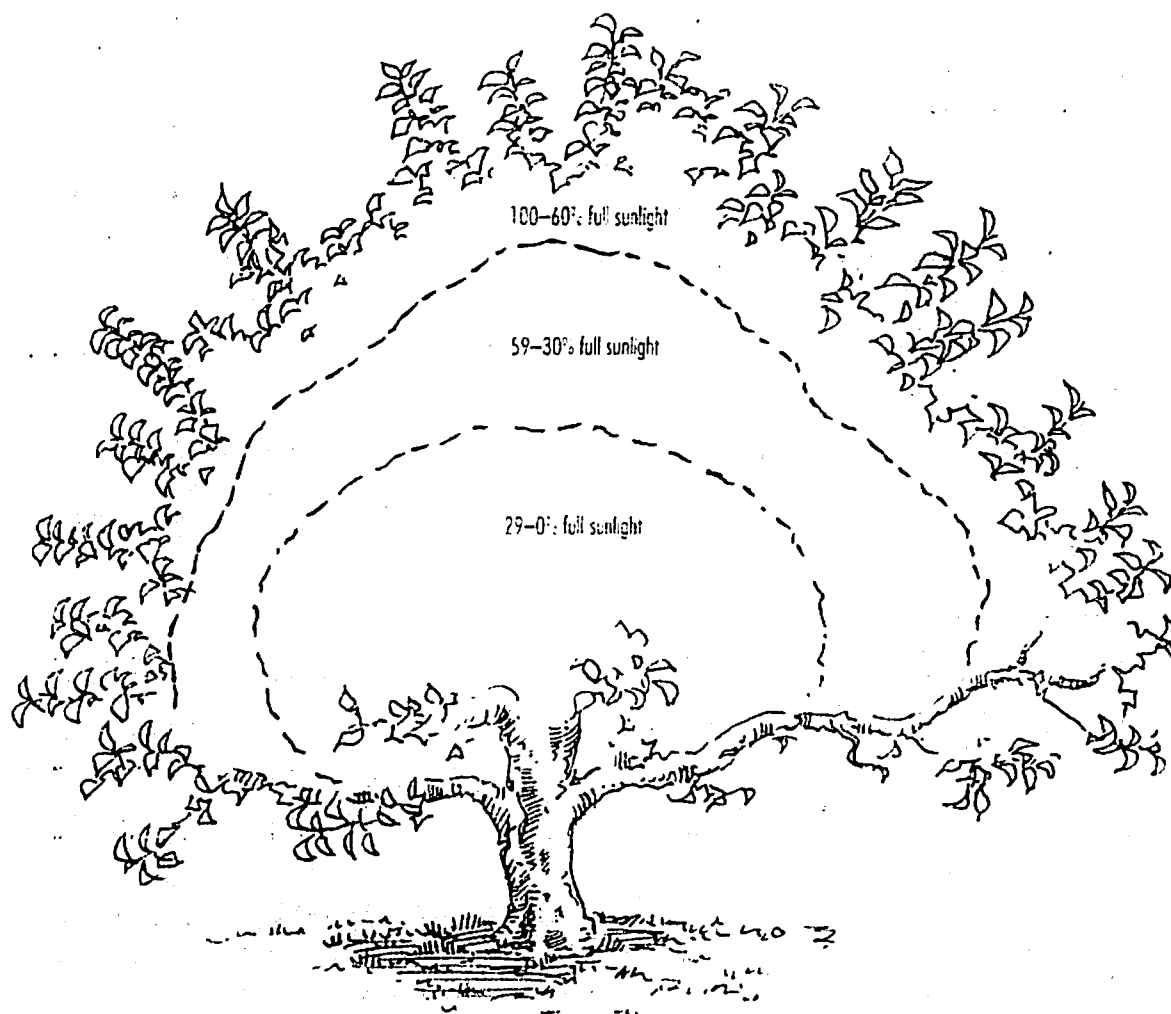
I expect to fully master the art of pruning by the time I'm eighty years old. You get only one shot at improving each year, the effects of which might not be fully understood till three more growing seasons have passed. An intuitive pruner works in several years at once: Seeing the fruiting prospects of the current year; training a new scaffold branch to eventually replace old wood; making a stubbing cut to encourage laterals farther back on a polelike branch; visualizing how the sunlight will reach within the tree when the leaves are full; and providing good access when it comes time to pick the fruit. These things aren't deliberately thought

through as much as felt. This oneness with the tree can come only with years of experience and confidence.

Approach each tree with an introductory intake of the breath. This meditative pause is when you take in the tree's framework and overall shape. How does it fit within the row? Are some branches too low? Is the leader beyond reach? Are the scaffolds properly spaced? Where does a new branch need to be trained or induced to fill an empty hole? These questions answer themselves quickly in a well-worked orchard. Restoring years of neglect is another matter.

There's a directing order to my pruning mantra: "Framework first, then the thinning, lastly see the fruit and how it grows." Nothing too mystical, but it's a beat that keeps me to task and includes all the important details. Thinning from the top down is a good idea, as this way you follow the path of the sun's rays to the fruit. It's easier to thin the lower scaffolds—they're within reach—but more critical to achieve the topwork.

Sunlight interception is a function of tree spacing



Distribution of sunlight within the tree is a primary goal of the intuitive pruner.

and height. Pruning affects light distribution within each tree's canopy within the orchard layout as a whole. The light environment throughout the canopy must be no lower than 30 percent of the available sunlight to produce high-quality fruit and spurs for successive cropping throughout the tree. Probably no other statement better describes why we prune apple trees annually.

Pruning 101

We start with a vision of tree shape and branch spacing. An orchardist will speak of maintaining a central leader within a framework of three scaffolds.

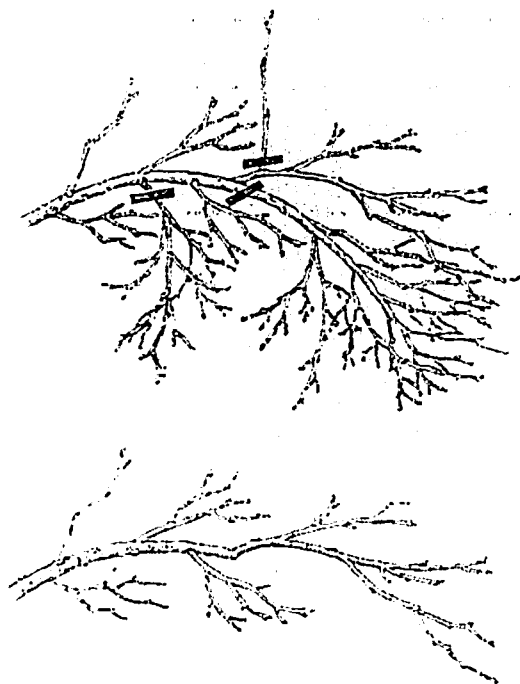
As with a conifer, the base is kept broad and the top more upright to allow sunlight to reach the fruit buds on the lower branches. A scaffold consists of three to five limbs radiating out from the trunk within a 1- to 2-foot span of the trunk. Having approximately 3 feet between scaffolds is a goal on larger rootstock, with the first scaffold starting 3 feet or so above the ground on a semidwarf tree kept to 12 feet high. Branches kept any lower than this are too much in the "fungal zone" to produce high-quality fruit, and they will also interfere with mowing. Good tree structure ultimately is as much about seeing the space left between scaffolds—so that sunlight can

reach every apple—as it is about considering the limbs themselves.

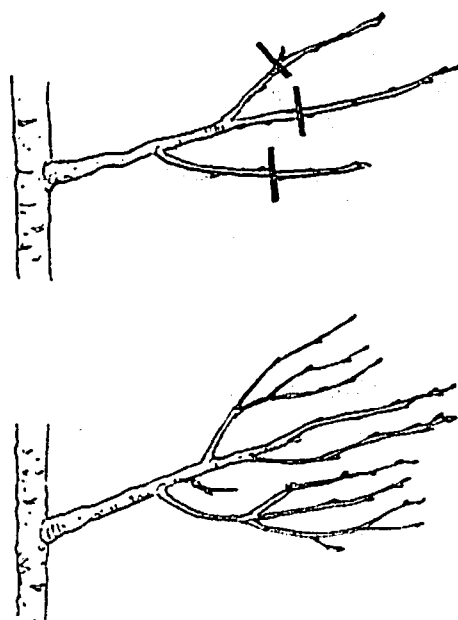
Broken or infected branches should always be removed. Overly tall leaders, crossing branches, and those limbs growing back toward the center or with narrow crotch angles also make the hit list. You want branches radiating out from the trunk in the horizontal plane up to a 45-degree angle. Limbs that develop with narrower crotches form a weak union with the trunk because of included bark, and years later, be it under a heavy fruit load or in an ice storm, severe injury to the trunk is likely when the two split apart. Another problem situation develops when too many limbs radiate off one section of the trunk. Crossing side branches then tend to be trimmed off in order to maintain each scaffold member, resulting in polelike limbs where the fruit buds are found farther and farther out from the trunk. Learning to get rid of excess limbs early will save you a series of painful decisions later on.

The tree responds to different cuts in different ways, and an understanding of these variables is what will make you a good pruner. Use a *thinning cut* to remove a branch that is no longer desirable because of excessive crowding. Anytime a branch is removed at its juncture to another branch, the resulting vegetative response is considerably reduced from that of shearing the branch midway. Such cuts will help in maintaining "calm trees" that do not put excessive energy into shoot development . . . thus keeping fruit production to the fore. A properly made thinning cut will readily compartmentalize to form a barrier zone within the wood, thus preventing rot organisms from entering further. A *heading cut* is made across the branch, out from the branch union, thereby exposing the vascular flow of the tree straight-on. This type of pruning cut elicits an entirely different hormonal response.

Buds nearest a cut made across a one-year-old shoot are substantially invigorated and shoot up vertically as



A thinning cut is made at the juncture of a branch to its parent limb. Vertical shoots are removed with this pruning cut as well as "spent" bearing limbs that droop beneath younger laterals.



A heading cut shears a branch midway, and by doing so interrupts the flow of auxin hormone, thereby inducing lateral bud development.

PRUNING LINGO

Apical dominance—the ability of the growing tip of a shoot to produce the auxin hormone, which prevents lateral buds (found at the base of single leaves along the shoot) from developing. The dominance of the apical bud determines a tree's branch habit and its response to pruning.

Central leader—a style of pruning that develops one strong trunk in the center of the tree from which branches radiate at strong, wide angles that can safely bear heavy loads of fruit.

Dormant pruning—all large branch cuts and some thinning are done when the buds are at rest for the winter, generally after risk of a deep freeze is past in order to avoid winter injury.

Fruiting spurs—short shoots on wood two years or older that bear the fruit.

Heading cut—the shearing of a shoot or branch along its length and thus out from the point of attachment with another branch. This type of cut induces hormonal responses that are best reserved for specific horticultural purposes.

Latent bud—a bud, more than a year old, that lies dormant in the bark tissue, usually concealed until such time as severe pruning or bark injury causes that bud to grow.

Modified central leader—a style of pruning that allows the central leader to eventually branch off

to form several tops; it's often easier to maintain than other forms of pruning, because trees naturally grow this way.

Root suckers—shoots from the roots of the tree, which, being below the graft union, will grow into a wild tree within your tree if not cut away.

Scaffold—the framework layers of the bearing tree, each composed of three to five main branches, which allow for better sunlight penetration and airflow than could be had in an unlayered tree.

Stubbing cut—a heading cut made into three-year-and-older wood to reduce the length of a limb and encourage replacement laterals.

Summer pruning—the removal of watersprouts after terminal bud set helps light reach the interior fruit, while at same time checking vegetative regrowth.

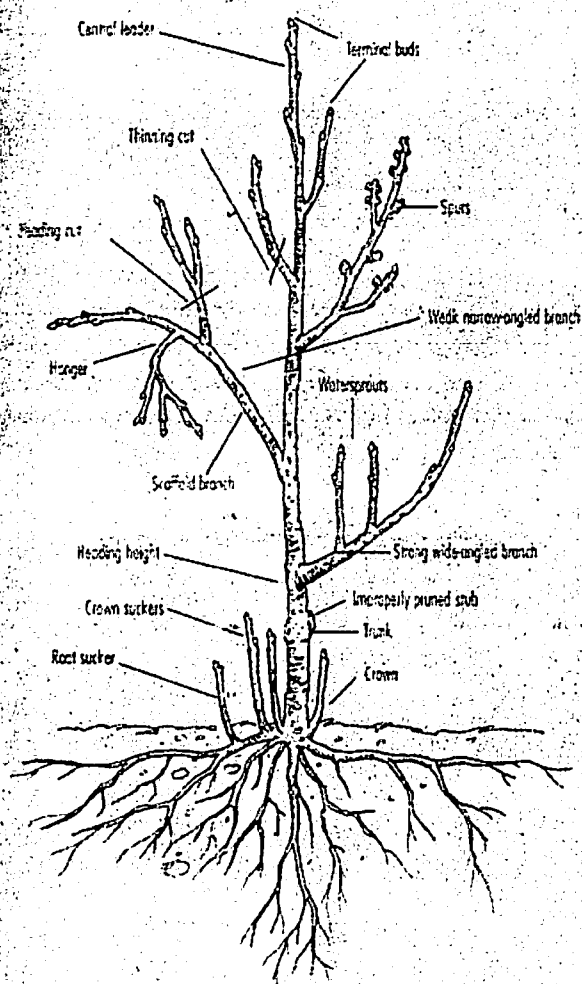
Terminal bud—the growing point of the tree at the very tip of every shoot.

Thinning cut—the removal of an entire branch at its junction with another branch. These noninvigorating cuts are used to open up airflow and increase sunlight penetration to interior fruit buds.

Watersprout—a vertical shoot arising from the trunk or main branches of the tree.

a consequence of the terminal bud having been removed. Heading plays a role in training the leader on young trees. Making a heading cut into the two-year-old section of the branch causes a moderate invigoration of existing spurs and shoots, with surprisingly little stimulation of dormant leaf buds. An intuitive pruner uses this response to shorten branches that reach too far into neighboring trees, knowing that lateral branch response won't be too bushy. Heading cuts

made into wood three years old and older will further invigorate the remaining spurs and shoots. Such a *stubbing* cut is done to replace an old branch in order to renew fruiting potential on the invigorated side branches that essentially will take its place. Don't make a heading cut if you can't envision a specific need to promote tree vigor in these ways. Healthy closure of the pruning wound becomes far less likely as the diameter of the heading cut increases.⁴



A fruit tree subject to pruning lingo.

Focus primarily on making thinning cuts once the basic tree framework is in place: Excess branches up high block sunlight to those precious fruit buds in the interior of the tree. Remove branches that tend to veer away from the horizontal—the vigorous watersprouts that shoot directly upward to the sun as well as older wood drooping downward—and thereby fill the “light space” allotted to scaffold branches above and below. Spent wood results when bearing

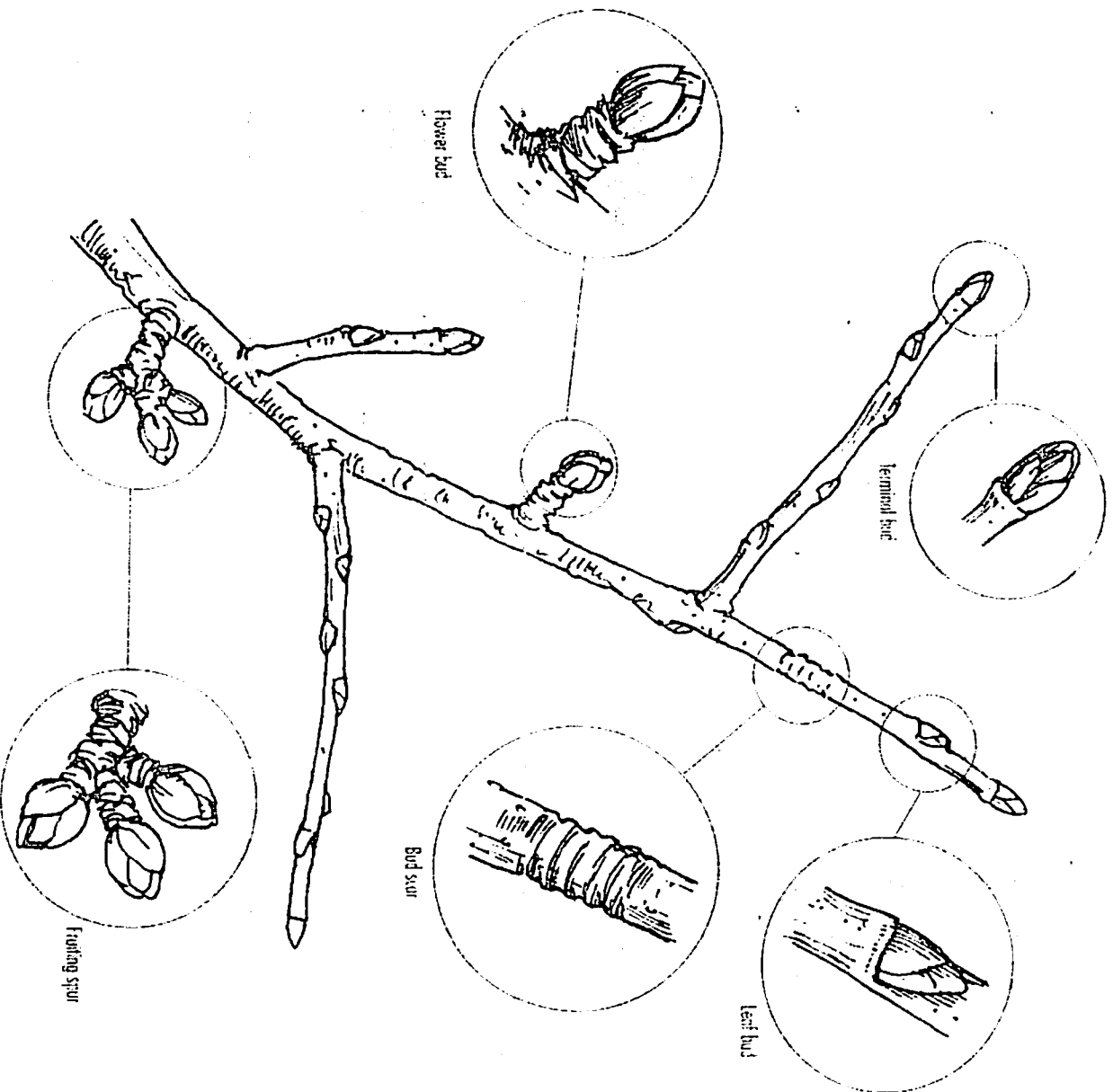
branches bend under the load of successive harvests. The most obvious thinning cuts are these understory branches, which have become too shaded to fruit well. The newer growth naturally arising over these branches keeps the fruiting canopy renewed.

Zeroing in on the Fruit

Flower buds are larger than those that leaf, whether placed on the end of a spur or the longer shoot of a tip-bearing variety.⁵ Next year's potential crop can be seen throughout the winter months strictly by attuning your eyes to these rounded buds distributed throughout the tree. Leaf buds, on the other hand, are triangular-shaped and appear of little consequence from a distance.

Most apple trees are spur-bearing or a combination of spur and tip-bearing, with only 1 percent being strictly tip-bearers. Cortland and Golden Russet are classic examples in the latter category, with apples hanging off the ends of twiggly shoots. Apically dominant cultivars such as Red Delicious set heavily on stubby spurs radiating off the interior branch structure. A spur is simply a shoot that stays short (less than 2 inches) for the extent of its bearing life. Most varieties utilize both spurs and terminal-bearing longer shoots for fruiting. Mutation sports of some of these intermediate varieties have been discovered that tend toward being strictly spur-bearing. Nurseries promote these *spur-type strains* over the original strain as being far more compact and easier to maintain.⁶

Understanding how a fruiting spur develops teaches us more about how to prune. A current-season shoot bears single leaves along its length, with a dormant leaf bud nestled above each leaf. This bud will do one of three things in succeeding years. It may remain dormant, especially when near the terminal bud of the shoot. Or it may grow out an inch (if not less) to form a terminal flower bud soon after petal fall and thus become a fruiting spur. Or it may grow out several inches to initiate a new branch entirely.⁷ Bud differentiation depends entirely on hormonal influence, location within the tree canopy, and sunlight penetration.



Types of buds on an apple tree.

Fructing spurs are best developed by a light pruning touch rather than invigorated into long, unfruitful shoots by heavy pruning.

Be aware of overall fruit bud distribution as you decide which branches to thin. You don't need every fruit bud to ensure a full apple crop in a mature tree — not even half will bring that about — but you also don't want to get so overly involved with pruning

basics that nothing is left to flower. Be very generous about leaving the pencil-thin laterals radiating off structural wood that will bear in future years. The delicate balance of pruning allows enough such shoots while at the same time opening the tree up the right amount to encourage fruit development. It's a balance that can actually be quantified mathematically. Forty leaves are required per fruit for best fruit

size and yield. Shoot leaves, likely to be in direct sun, are more efficient at feeding the developing fruit than spur leaves located in the interior of the tree.

Spur pruning becomes necessary with trees that are heavy spur-bearers. A tree produces its highest-quality apples on spurs that are two to four years old. Spurs five years and older set less often, and the fruit tends to be smaller. Such a spur should be removed, even though it may well continue to flower another ten to fifteen years. The age of a spur can be judged by its size. Removing nonvigorous spurs that jut upright or hang down from the fruit-bearing limb will help keep heavy-setting varieties such as Fuji in balance.

Growth Habits

Different varieties of apples have different growth habits that somewhat correlate to where their fruit buds can be found. Cortland and Jonathan tend to be twiggy and want lots of thinning out at the branch tips. Sweet Sixteen, Winesap, and Gala grow more upright, requiring attentive training to prevent weak crotch angles. Vigorous diploids such as Northern Spy branch heavily and seem to turn toward the sun even after initial training. Shizuka grows like a house on fire. Strong, spreading trees such as McIntosh, Jonagold, and Mollie's Delicious grow just as you might hope, though long branches often need to be braced under a full crop. Varieties like Liberty and Macoun that bear heavily can stand to lose more than a few fruit buds when pruned. Working with one variety at a time helps me focus on those trees' particular growth habit.

When pruning a tip-bearer, pay attention to how many fruit buds are removed, since it is easy to thin out too many with this type. Limbs that droop should be cut back to a horizontal shoot to reduce excessive shading. First-year shoots with fruit buds at their tips are generally left untouched. Branch leaders may be headed back to a bud facing in a desirable direction to encourage branching and thus more tip-bearing shoots.

Much of the fruit-bearing surface on spur-bearing trees is located within the tree canopy. These trees

often have an upright growth habit as well. Both of these conditions lead to excessive shading of the fruit. So, what to do? The tops on such apically dominant trees can be slowed down by delaying pruning until three weeks after bud break. Tall shoots should be snipped back to weak laterals. "Spur-bound" trees result when tree vigor is low, so remove older spurs every year to encourage some shoot growth. Heading back older limbs will encourage the growth of renewal shoots. Spur-type strains have a stiff, upright growth habit that minimizes limb breakage when trees carry a heavy crop load, often eliminating the need to tie or prop up limbs.

Pears are worked in much the same way as apples—trained to a central leader followed by years of annual yet moderate thinning. Anjou is one exception, in that heavy pruning induces higher set in this variety. The degree of pruning for the pome fruits depends upon the vigor in a particular orchard. Annual shoot growth of 8 to 16 inches is a good indicator of balance. Much more than this and you're either pruning excessively or overfertilizing.

Trees on dwarf and semidwarf rootstock can be pruned more severely than standard trees, because the danger of invigorating excess vegetative growth is less (such being the genetically weakened nature of the root). Ninety percent of the pruning and training on dwarf trees should take place between May and early August, with only 10 percent of the corrective surgery left for the dormant season. A major concern with dwarfing stock in snow country is the breakage of limbs necessarily kept low—an icy crust will often pull such shoots off the trunk. M.26 rootstock held by a rigid supporting pole is trained much the same as larger trees, just more compactly. Use of a trellising system for dwarf trees at high-density spacing introduces new considerations, but the basics of why you prune what you prune remain the same.

Onward and Upward

Renewal pruning in the top portion of the tree is an ongoing process of removing a larger lateral or two

OLD-TIME ADVICE ABOUT PRUNING

You done a good job at pruning if afterward you can take the family cow and fling her between the branches.

Such advice certainly paints a vivid image of just how much to open up an apple tree to the sunshine. The Vermont hill farmer who told me this was speaking of a standard-size tree. Today, we have to tailor this wisdom to the vigor of the rootstock in question. A goat sounds about right for an MM.111 tree, with a medium-size dog providing good measure on M.7. An M.26-size tree just begs for an ol' fat cat. A covey of quail will probably best suit high-density growers with hundreds of M.9 trees to the acre. And if anyone is still taking me literally by this point, come on by and I'll toss you!

each year, while at the same time growing out replacement branches to take their place.¹⁷ Watersprouts emanating from the trunk can be spread to become such replacements. Renewing the bearing surface of the tree in this way avoids the stress of having to remove a disproportionately large limb later on. The primary tenet of diameter-based pruning is to remove any lateral branch that gets to be one-half the size of the trunk where it joins. While this may sound severe at first reading, it's a sure way of judging when higher laterals have got to go.

Nor does the central leader get a reprieve from eventual trimming. Either it reaches too high, or, under a heavy fruit load, it droops down and totally shades the interior of the tree. Once the tree extends beyond a desired height, cut back the dominant



Step one in working in the top of the apple tree often involves pruning back an overly tall leader to a weaker lateral. Photo by Frank Stemer

leader to a weak, upward-pointing lateral. This is all the more devigorating when done around the longest day of the year. Letting this new leader grow a few years can help in the development of laterals from which to choose the next central leader.

Apical dominance plays a guaranteed role when working up high in the apple tree.¹⁸ We're not trying to eliminate all vertical branches in one fell swoop when we take back the central leader and/or thin out the top of the tree. Some shorter vertical shoots are always necessary to satisfy the tree's desire to reach toward the sun. Scalping a tree in its entirety subsequently calls forth a forest of watersprouts. If you remove all of the watersprouts, just as many come back. Some vertical growth is necessary to apically dominate the branch structure below in order to keep

the tree calm. The modified-central-leader style of pruning accommodates this very need when seedling trees reach full height.

Tools of Choice

Every orchardist has his or her preferred pruning tools. Bypass hand shears are a must for training work and useful for thinning cuts. Felco shears fit the requisites for me: easy on the wrist, replaceable parts, and a handy holster for the belt. The Wheeler pruning saw¹² is well known in New England for making branch cuts $1\frac{1}{2}$ inch in diameter or more. The standard blade is okay, but Arthur Harvey¹³ offers some refined options made from bandsaw stock that make the Wheeler my absolute favorite. Short-handled loppers might be a wise choice for those of us with too heavy a cutting hand—just right for making the prime thinning cuts of whole branches but too big for getting involved with overly fine detail work. Long-reach shears more often than not prove awkward in achieving a flush-cutting position, in my opinion. A pole pruner goes a long way in vigorous trees like MM.111 and can be used to drag out most of the fallen branches beneath the tree into the aisleway for a springtime flail-chopping. However, the pneumatic pruning equipment used in larger orchards is rather expensive to justify on a small acreage.

Equipment sanitation is recommended for preventing the spread of fire blight throughout an orchard whenever you continue pruning past bud break.¹⁴ Pruning tools can be wiped down with rubbing alcohol or dipped into a pail containing a 1:10 bleach solution between trees. Removing an obviously infected limb means a wipe-down right after such a cut.

Prunings need to be either removed and burned or chipped and spread beneath the trees. The extra effort required to chip branches abets the fungal environment we want to encourage in an apple orchard. Larger operations make good use of a flail-chopper to run over the piled prunings right in the aisleways. Pruned twigs can become heavily colonized by the



Chuck Southard, Apple Hill Farm, Concord, New Hampshire. A pole pruner saves much climbing in these semidwarf apple trees. Chuck is quite adept at rapid-fire decisions to open up each tree, using the pole as he goes to pull branches out into the aisleway for flail-mowing come spring.
Photo by Michael Filipe

fungi that cause the various rot decays if simply left piled along the wood's edge. Rot spores may continue to be produced for six years on such discarded branches. However, if the brush is chopped, the pieces are quickly decomposed by other fungi before rots can affect the fruit. Branches with blackened cankers and outright deadwood are best pulled away after pruning and burned in areas where frog eye leaf spot is a perennial problem.

Hardiness Considerations

Dormant pruning should be done in late winter when the risk of subzero temperatures has passed. A branch cut stimulates cell activity at the wound, causing the tissues to lose hardiness for seven to ten days after the cuts are exposed. Prune the hardiest varieties on the more vigorous rootstocks first to lessen the likelihood of winter injury. Orchardists with large acreage begin pruning in January, if not December, depending on the size of the job and availability of a professional pruning crew. They're taking a calculated risk that dieback at the wound will turn out to be minimal, particularly on the larger cuts. Those of us with fewer trees are well advised to wait till February and March

TREE CLOSURE

A proper pruning cut should be made flush with the branch collar on the trunk or parent limb in order that it can completely close over. Leaving a branch stub is an invitation to disease and rot, because the uncovered deadwood will serve as a point of entry for years to come. Shearing off the branch collar, on the other hand, removes the protective tissue necessary to create a callus ring.

A tree cannot actually restore, repair, or regenerate tissue. We cannot say it heals, according to Alex Shigo, as this implies being restored to a previous state of health. To be precise, a tree "closes" itself by compartmentalizing a wound. The boundary zone thus formed resists the spread of wood-rotting microorganisms from going any farther. Whenever we make a pruning cut—thereby injuring the tree—the resulting wound becomes infected. Yet 95 percent of all insects and fungi are good guys. *Penicillium notatum* is one of the first organisms to get on any tree wound. This fungus does not have the enzyme system necessary to go into tree's vascular system and actually deters other organisms that might.

Trees have evolved to protect themselves in many ways. Wound dressings, whether tar or aloe gel, can cause normal protection bound-



A full callus ring ensures healthy tree closure. Photo by Michael Phillips

aries not to form, or to form so slowly that pathogens get the upper hand. Please don't butcher the tree when you prune, and don't nurse it afterward.

to get out the pruning saws, once the days of deep cold become less likely.

Black rot cankers develop primarily on trees where xylem tissue has been sequentially damaged by cold injury and by basidiomycete wood-invading fungi. The barrier zone that should normally develop within any pruned branch is set back by the cold, allowing these fungi to colonize the wound when the weather warms. A few growing seasons pass, but eventually

the stressed cambium can barely support the life functions of the limb. It is at this stage that *Botryosphaeria obtusa* fungi move in and complete the killing of the living tissue to form a visible black rot canker."

Summer Pruning

Watersprouts can be removed in vigorous trees during the first ten days of August to allow better sunlight penetration to the ripening fruit, resulting in better

color and size in certain varieties. The color development in red apples is due to the formation of red pigments, called anthocyanins, that synthesize only where light shines directly on the fruit. Summer pruning of watersprouts (especially in the top third of the tree) can be used very effectively to improve light penetration, thereby increasing fruit color throughout the canopy. I'll often thin back a few upturned shoots as well on a variety like Cortland if many apples are hanging behind a curtain of dense growth.¹⁶

Summer pruning differs from dormant pruning in that leaves actively involved in photosynthesis are being removed. Timing is very critical here: The trees have entered physiological dormancy by the end of July and therefore do not respond with renewed growth. The shoots being thinned out have contributed starch and sugar to terminal bud formation by this point, so taking away these "excess growing tips" leaves photosynthates primarily for the fruit-manufacturing end of the tree.¹⁷ The sun has been granted time enough to reach those fall-ripening apples.

Light-colored fruit may benefit from summer pruning by virtue of the fact that drying breezes can better get into the tree canopy. Research at the University of Massachusetts has shown that timely removal of watersprouts consistently reduced the incidence of flyspeck (a summer fungal disease) on apple fruit by approximately 50 percent in trees where no midseason fungicides were applied.

Varieties susceptible to bitter pit can be summer-pruned earlier in order to redirect the flow of calcium from shoot leaves to developing fruit. See page 199 to understand this technique completely. New shoot growth will definitely be induced by this summer snapping of green shoots in the post-petal-fall window. Ultimately, though, it's far better to achieve a nutrient balance in the soil, because early-summer pruning alters the critical leaf-to-fruit ratio just when the fruit is developing, resulting in decreased fruit size and/or soluble solids content.

Summer pruning can be invaluable in restoring an

overgrown apple tree back to fruiting balance. Large-branch removal in the dormant season invariably results in rampant sucker growth in the healing tissue around the wound and wherever latent buds are exposed to direct sunlight on the remaining limbs. This explosion of vegetative response is best reversed by back-to-back years of snipping out watersprouts in midsummer when the tree no longer devotes energy to continued shoot development.

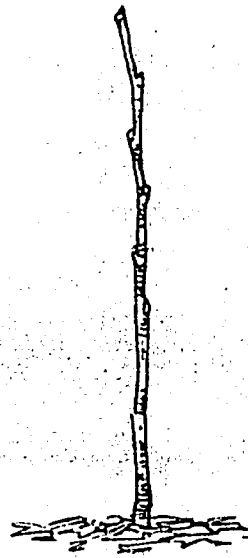
TRAINING THE APPLE TREE

Sereno Edwards Todd in his 1871 *The Apple Cultivator* had a knack of speaking to the truth of a matter: "The man who purposes to produce a profitable orchard of beautiful trees, which will yield bountiful crops of fruit for an age after he has passed away, must begin right, plant right, train right, and cultivate right. Then his reward will be as certain as the vicissitudes of the seasons."

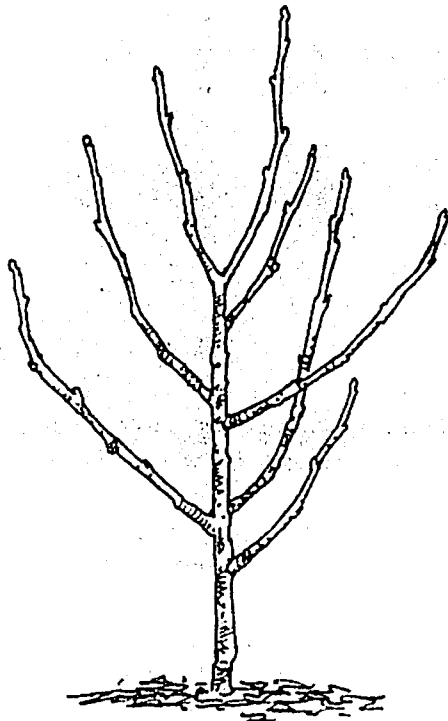
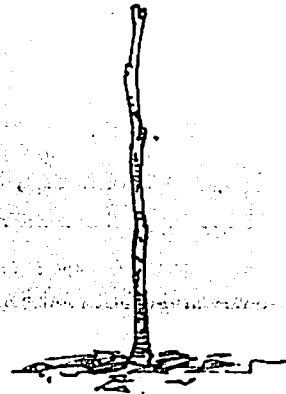
Tree training in the nonbearing years is critical to the long-term performance of a productive orchard. Branch manipulation plays a major role in how quickly the trees will give those acclaimed first apples. Simply put, branches spread to a horizontal position set fruit buds sooner. Minimal corrective pruning of tree structure early on has its place, as we shall see, but nevertheless stimulates the tree toward continuing in vegetative mode. Therefore we focus on training rather than pruning in order to develop good tree structure that ultimately will require less pruning throughout an orchard's life.

The Early Years

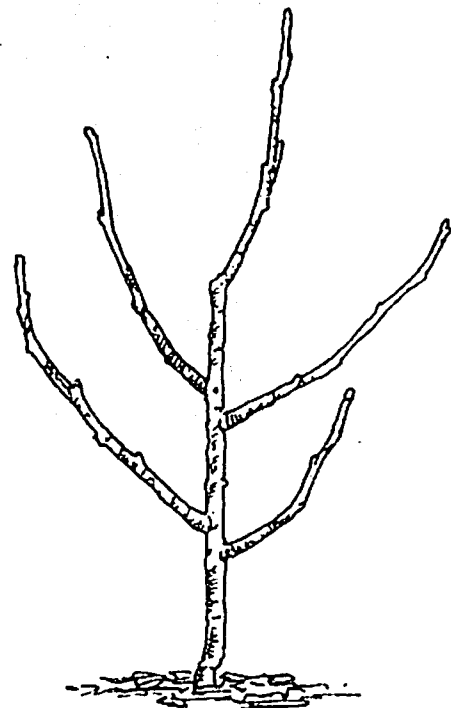
Training the young tree starts in Year One. The developing whip should have all growth kept rubbed off its bottom 20 inches once 3 to 4 inches of new growth shows up top. The height from the ground to the eventual lowest branch can be more with MM.111 and standard rootstock (30 inches if not more), but even that whip needs to grow this first year before laterals



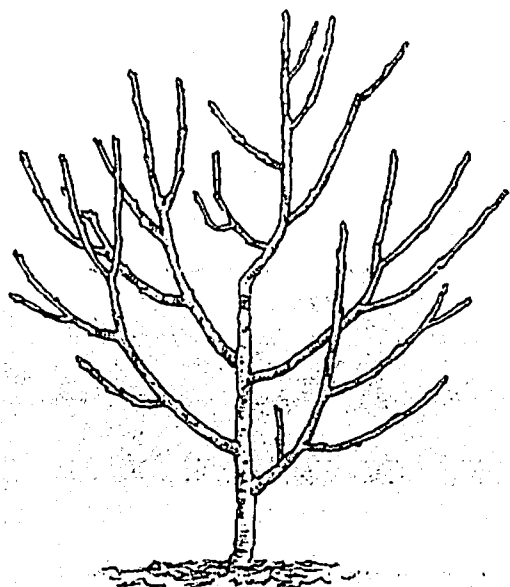
Year 1



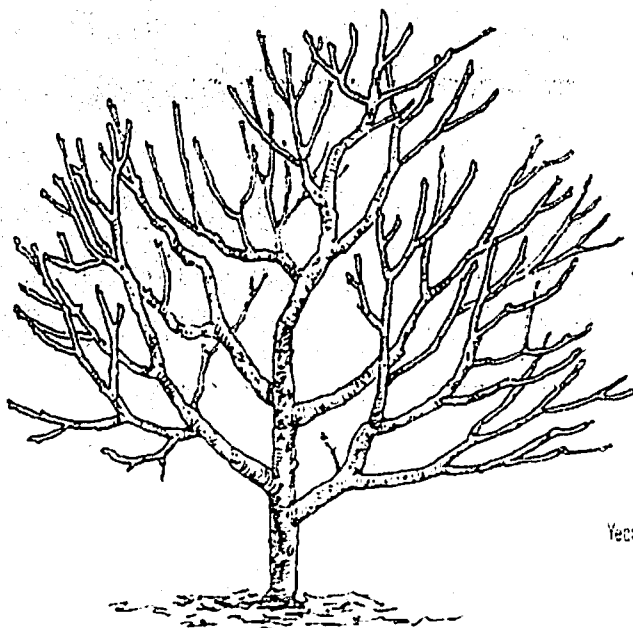
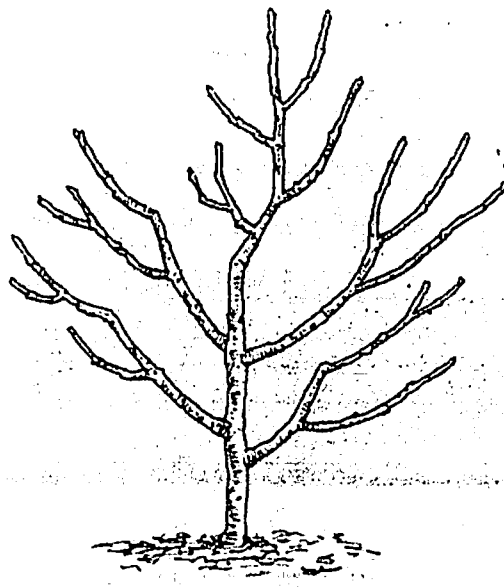
Year 2



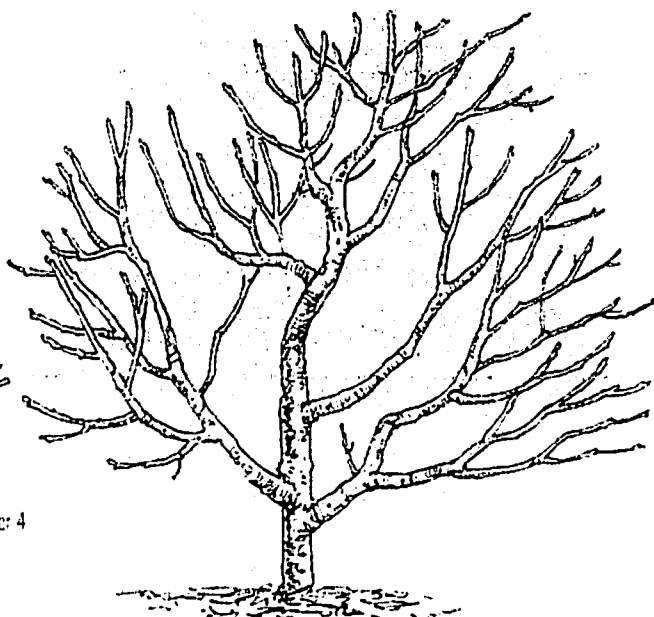
Training trees in the early years of an orchard makes for strong scaffold branches capable of bearing a full crop. Head back a lanky leader on vigorous stock when necessary, but leave dwarf trees alone. Good training minimizes the use of pruning cuts until the trees start to bear.



Year 3



Year 4



TOOLS OF THE TRADE: LIMB SPREADERS

Lateral branches are best spread in spring when flowing sap makes the wood tissue more pliable. Orchardists spread branches in a young (non-bearing) tree in lieu of pruning to establish a scaffold framework. Jutting a clothespin off the central leader just above a short shoot sets a wide crotch angle. Red plastic wyes in incremental lengths from 3 to 12 inches work well to spread slightly longer shoots. Hardwood spreaders (up to 3 feet long) set with double-ended nails prevent scaffold branches from turning back to the vertical despite a good initial crotch angle. Lathe boards notched on each end achieve the same result without leaving puncture marks in the bark. Numerous ways have been devised to attach branches directly to trellis wires in high-density blocks.

I like to include a few "rockpins" in my kit—I attach a clothespin to clean rocks about the size of a fruit with Liquid Nails. Once dry, these can be clipped onto lanky shoots to simulate crop loading. Small canvas bags filled with sand and fastened with a clothespin are a variant on this idea, allowing you to adjust the amount of weight on a sapling branch where it will do the most good. U-shaped branches on less precocious varieties may insist on even more weight to hold to a fruit-inducing position before the first harvest arrives. Insert a foot-long piece of bendable wire into wet mortar in red plastic cups (then allow it to cure) to create a colorful rendition of weighty apples to come.

Gently bending down recalcitrant shoots to stretch bark tissue along the upper surface works surprisingly well, too. Though the shoot likely will spring back to place, the bending influence has been established for when fruit comes.



Limb spreaders come in incremental lengths. Photo by Michael Phillips

Replacement limbs in the upper scaffolds of a mature tree can be tied into position off a lower branch with poly twine. Leave a loop around all branches so bark growth is never constricted. Bottom branches can be tied down to concrete blocks or a discarded tire. Any branch tied down in spring stays in place upon being untied in the fall.

are removed too far up. Midsummer is the time to snip back the three or so invigorated top shoots caused by heading a freestanding whip at planting time to one chosen leader. Lateral shoots that developed below these sharp-angled upper shoots are the scaffold candidates for years to come. Dwarfing trees, never having been headed at planting, are shooting skyward at this time (see page 100), and any feathered laterals could actually be setting their first fruit buds.

It helps to understand the role of hormones in training a young tree. Auxin is produced in the growing tip of vigorous shoots. Its flow down the trunk helps widen crotch angles by causing greater cell growth on the upper side of lower branches. Heading a vertical shoot (such as a newly planted whip) stimulates the three or four buds immediately below the cut to make a vigorous turn toward the sky. These become growing tips themselves, producing even more hormones. Buds farther down respond by developing out laterally from the trunk. The influence of auxin further inhibits upward curvature in these shoots.

In the spring of Year Two, before growth resumes, select the first scaffold branches at the desired heading height and remove any others from the lower span of the trunk. The three to five remaining laterals should be as evenly spaced around the trunk as the growth whorl allows. Clip on a clothespin above a shoot if a crotch angle isn't close to the horizontal. Don't head scaffold branches unless one is way ahead of the others and needs reining back. Remember that doing as little pruning as possible these first few years gets the tree into fruit production that much sooner. Shorter laterals up high should be left to provide that good green foliage necessary for photosynthesis. Plan on returning in early summer to pinch off sharp-angled shoots that develop along the upper portion of the leader. Stripping off this upright growth (within 6 inches of the growing tip) will prevent competition and stunting of the central leader, which you generally want to protect—whether growing a central-leader, slender-spindle, or vertical-axis tree. The technique is used in first-, second-, and sometimes

third-leaf trees to keep the leader rapidly growing upward.

The permanent framework of the tree begins to show itself in the third growing season. Lanky leaders on freestanding trees may need heading again (though hopefully not as regards fruit production). Each scaffold branch should be of equal vigor and have a strong crotch angle between 45 and 60 degrees. Keep an ample supply of limb spreaders on hand. Go easy with stouter shoots, which will tear off the tree if spread too far. Paying heed to crotch angles now will save split trunks years down the road. Scaffolds are separated by 1 to 3 feet of trunk growth depending on rootstock. Interim laterals can be left in trees trained to a wider spacing until the permanent scaffold fills its envisioned space. Notching into

Trust your instinct to the end, though you can render no reason.

RALPH WALDO EMERSON

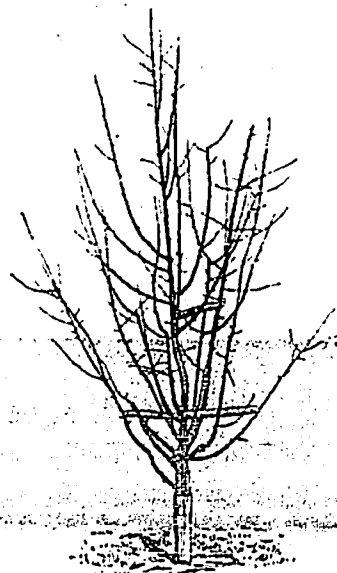
the bark on the central leader with a sharp knife above a bud in April (around the time of bud break) in this third season will promote branching should an open spot on the trunk be in need of a limb. Such a cut into the cambium breaks the flow of growth hormones coming down from above, thereby "forcing" the bud to begin shoot growth.

The fourth and/or fifth and sixth growing seasons are the teenage years of the tree. The first crops are light compared with the harvests that will come at full maturity. Continue to allow scaffold branches and the leader to grow with as little pruning as possible. Dwarf and semidwarf trees will have started to bear, and the weight of their fruit will add greatly to the spread of the tree. Spreading laterals up high in standard trees helps the scaffold branches below reach outward in search of sunlight until annual crop-loading begins.

A properly trained tree will need only minimal corrective pruning over the years to maintain this "naturally spreading" shape that you've diligently trained



A neglected young apple tree.

Source: *The Principles of Fruit Growing*, C. H. Bailey, 1897, 1926.

The tree pruned and branches spread.

from Year One. The fruiting wood of a productive tree is continuously pulled downward by annual cropping. A limb never regains its full height once bent by the weight of fruit, even after it's picked. Ultimately we need to have faith in even the most vertical-growing of trees. Branches will go down beneath a full harvest; the spreading look we aspire to in an apple tree will come.

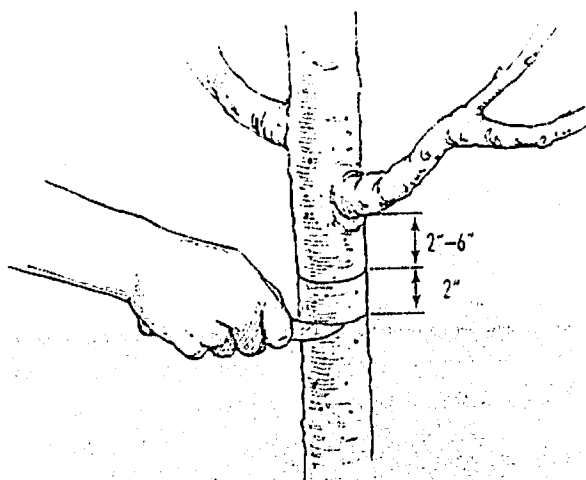
Advanced Techniques

That said, some varieties are real bugaboos as regards upright growth habit and take a long time before they begin fruiting. Northern Spy and its progeny are very responsive to early limb spreading to form good crotch angles. However, each branch then curves straight up beyond this initial influence, giving the trees a slightly candelabrum-like appearance. I let these young branches straighten until they are almost long enough to fill their envisioned lateral space and then use long spreaders (on the order of 3 to 4 feet) or tie-down strings to aggressively bring my vision of branch structure to the fore. Nonprecocious wood is ready at this point for horizontal prompting of those

first fruit buds. There's nothing like a good crop of apples in the long run to settle the notorious Northern Spy.

Have you ever encountered scaffold limbs that are too big to bend back down? This situation often happens when you are taking over an existing orchard where early training just wasn't up to snuff. Try sawing three or four undercuts slightly more than halfway through the diameter of the branch to allow spreading. Make the cuts $1\frac{1}{2}$ to 2 inches apart (otherwise the bark between will die out) in the first foot or so of the branch at its trunk end. This can even be done with a small chain saw. Successful surgery depends entirely on the cuts being held tightly together (under pressure) with a stout spreader. The inner bark from cut to cut will "graft over" and actually close the wound in a year's time. Undercutting must be done early in the season, before fire blight conditions are prevalent.

Soring comes into play with vigorous trees that just don't want to break out of vegetative mode. A single cut is made through the cambium with a knife (a linoleum knife works very well) completely around



Scoring seems severe—trees would certainly agree—and yet this narrow wound to the cambium slows down the flow of photosynthates and in turn gives a stubborn tree a clear message to break free of the vegetative mode.

the trunk of the tree some inches below the lowest scaffold branches. Do this within the first ten days following petal fall, and no later. This circumferential cut temporarily breaks the flow of nutrients, photosynthates, and growth regulators between the growing shoots and the roots. The score will close quickly, but first it sets back any additional growth for that season. More important, it will initiate flower bud formation for the next season.

Spigold is one variety (according to Ed Fackler) that just insists on being scored in its fourth year in order to get commercial production in gear. Cultural methods that check the growth of the tree are effective in hastening flowering only when a certain stage of development has been reached. Scoring Spigold in its third year won't work. Some folks resort to double or even triple cuts (2 inches apart) when Mutsu proves reluctant.

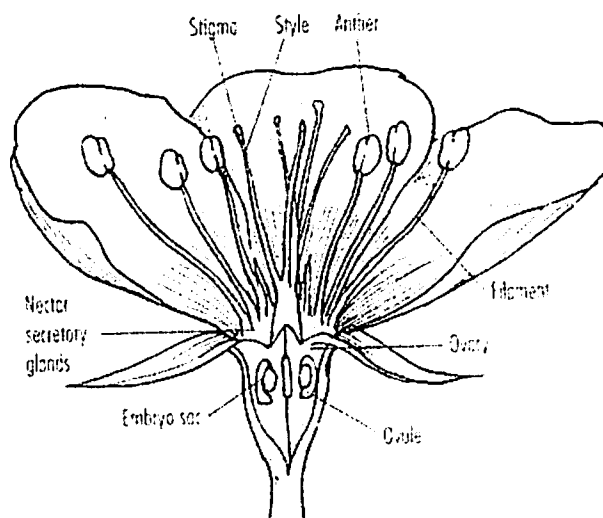
Growers with an itch to seriously put a tree on notice can consider an *inversion graft*. Make parallel cuts $\frac{3}{4}$ inch apart, lift out the bark, reverse it, and replace; then cover with grafting wax. The inverted bark slows down tree growth significantly for about three years, after which the polarity of the vascular

system begins to regenerate. Flowering will be induced, but man, this better have been one vigorous tree to call for such drastic action!

POLLINATION AND FRUIT SET

Fruit trees grow to produce seed. The fruit is merely part of the package from the tree's perspective. Seed development hinges on pollination. That transfer of pollen from the male anther to the female stigma can be done by either wind or insects. The cross-pollination required by most fruit trees is performed by bees, wasps, and syrphid flies, which are attracted to the showy flowers. Upon reaching the stigma, the pollen grain germinates and grows a tube down the style to the ovule. Each seed that grows in an apple or pear is the result of the separate pollination of five stigmas leading to two egg cells apiece. Cultivars may be self-fertile, partially self-fertile, or self-sterile. Triploid apples such as Jonagold, Crispin (Mutsu), and Gravenstein have defective pollen. Placement of pollinizers (the "guy trees," so to speak) within the orchard to provide viable pollen becomes more critical when you are growing such cultivars.

Large orchards must have bees brought in to get the



The anatomy of an apple blossom.