



Tree Biology and Pruning Basics

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Tree Biology

References:

Dr. Ed Gilman and Scott Jones, University of Florida

Paul Reis, Urban Forester, Oregon Dept. of Forestry

Dr. Alex Shigo, author of A New Tree Biology



Forest conditions are optimum for trees

Streets and urban conditions are *far* from optimum!

However, properly maintained trees add value to your landscape



ARBORICULTURE

**Arboriculture
is the cultivation of trees.**

Tree cultivation is the art and science of developing ways and means to assure long-term, high quality survival.

Arboriculture is much more than tree care. Decisions for treatments must be based on a sound understanding of tree biology that includes chemistry.

Arboriculture is an art and a science. As an art it requires many skills. As a science it requires an understanding of biology.

**TRAINING AND
EDUCATING**

**Training and educating
are essential for
MODERN
ARBORICULTURE.**

**Training without educating
makes robots.**

**Educating without training
makes waste.**

Both are needed now!

Decision making must be based on knowledge and experience.

What is tree biology?

The study of the *Life Processes*
of a tree.

Including a study of the GROWTH,
STRUCTURE, EVOLUTION, etc. of a tree.



Leaves work like solar panels.
They “feed” the tree by converting sunlight into energy; glucose.

- Trees make their food with the energy of sunlight; a process known as photosynthesis.
- Nutrients and water are taken through the roots.
- Carbon is taken from the CO₂ in the air.

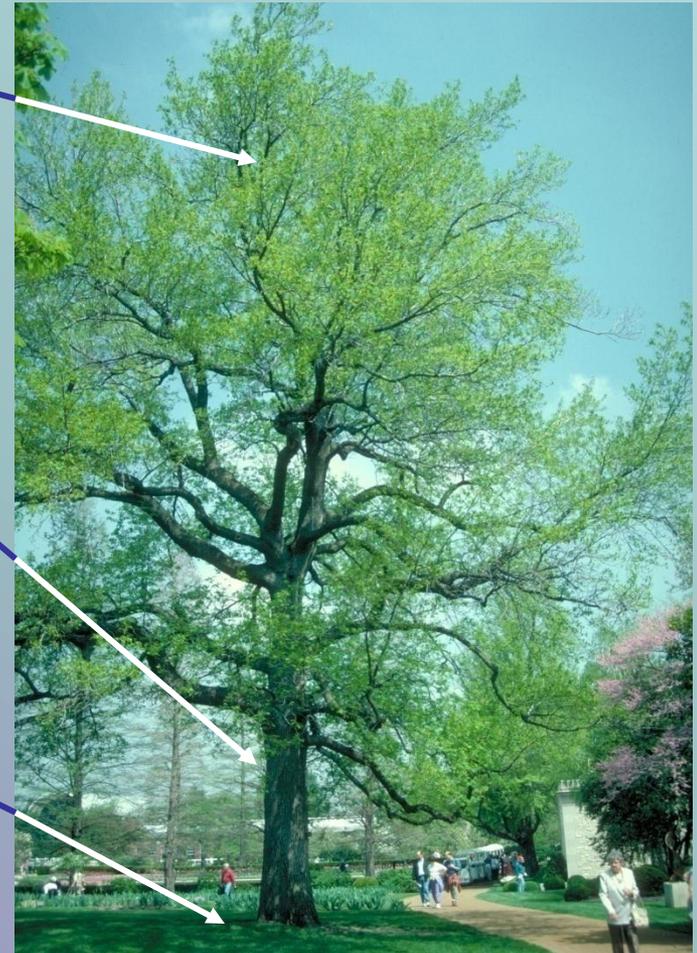
Life processes – some examples:

photosynthesis

a tree's gotta eat!

support

mycorrhizal interactions





The tree below the ground: Roots support and adsorb water and nutrients.

Soil

- Soil is the matrix to support the roots and the community of organisms that are part of a healthy tree.
- All trees need mycorrhizal associations – healthy soils have a huge diversity of organisms including fungi, bacteria
- Must have air spaces and the ability to drain yet hold moisture.
- Often the biggest challenge in urban landscapes.
- Organic matter is the food that feeds the soil food web.

Mycorrhizae
are organs
made up of
tree
and
fungus tissue



Mycorrhizae
are organs
that function
in
synergistic
ways.

In other words, they work
with the roots.





Mycorrhizal fungi assist tree roots in gathering (adsorb) nutrients & are thought to help protect the tree.



Thread-like mycorrhizae hyphae multiple the adsorptive area by a factor of thousands!



Morels, chanterelles, truffles are fruiting bodies of mycorrhizal fungi.

ACTINORHIZAE

**are organ on roots made up of
tree and fungus tissues.**

The organs fix nitrogen.

**The genus Frankia has species that are common
in the organs.**

Fixation takes place under anaerobic conditions.

Because they fix nitrogen they serve a very important role in nature.

Note

**Mycorrhizae are organs that facilitate absorption
of water and elements. Mycorrhizae do not
fix nitrogen.**

**Fixation means that nitrogen from the air is combined
with hydrogen to form ammonia. The ammonia may be
oxidized to positive-charged ammonium ion or be
combined with oxygen by other microorganisms to form
compounds that release negative-charged ions of nitrate
or NO₃.**

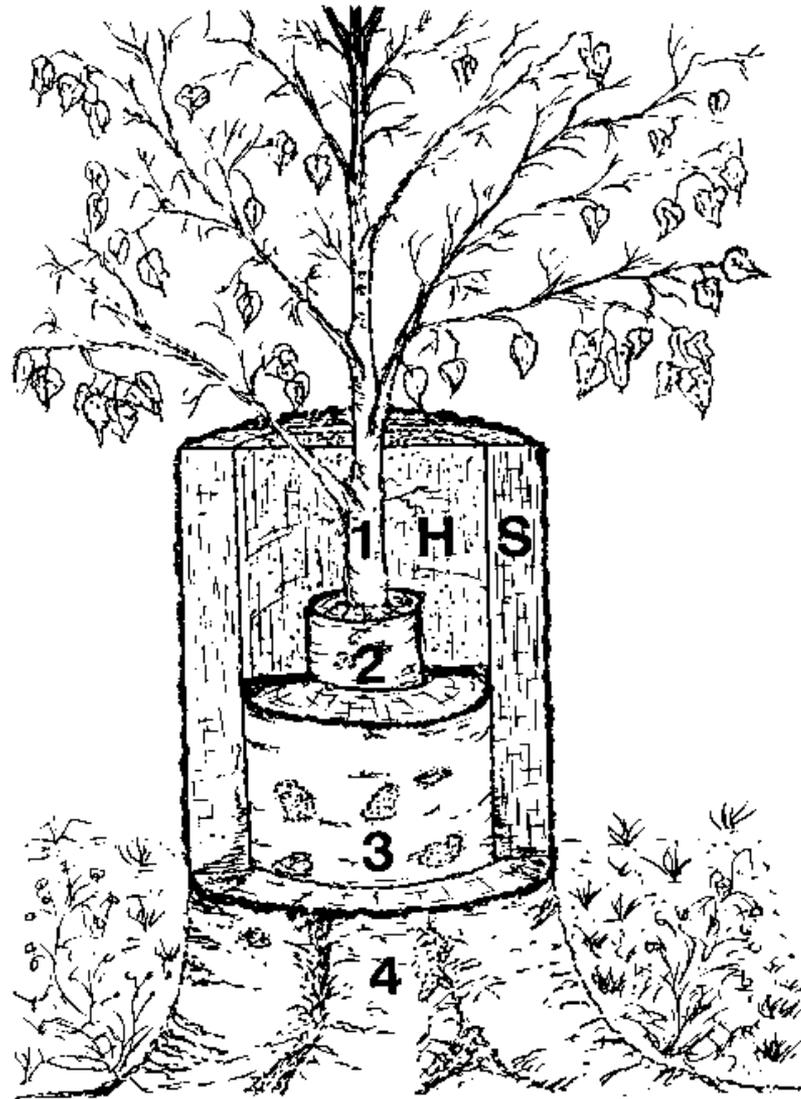
**Alder in the Northwest grow with the Douglas fir. The
alder have many large Actinorhizae on their roots that
bring nitrogen into the system and benefit greatly the
Douglas fir.**

Mycorrhizae
do not
fix nitrogen





Actinorhizal plants, alders and legume family trees, do fix nitrogen (makes nitrogen available in the soil) and are great pioneer species.



50. A MULTIPLE PLANT

Every growth period a "new" tree grows over the older trees; 1,2,3,& 4. H is heartwood, and S is sapwood.

A new tree grows around the old tree with every cycle. Length and height are added and then augmented.

Secondary Growth Anatomy & Tree Rings

By Kim D. Coder, Professor, Silvics/Ecology
Warnell School of Forest Resources
The University of Georgia August, 1999

Dr. Kim D. Coder, 1999

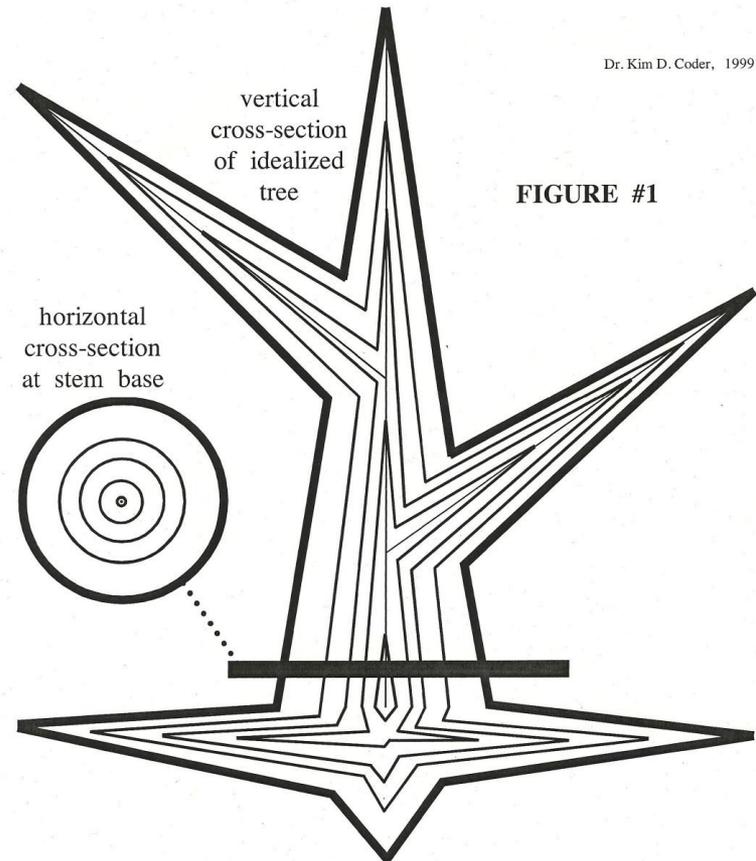
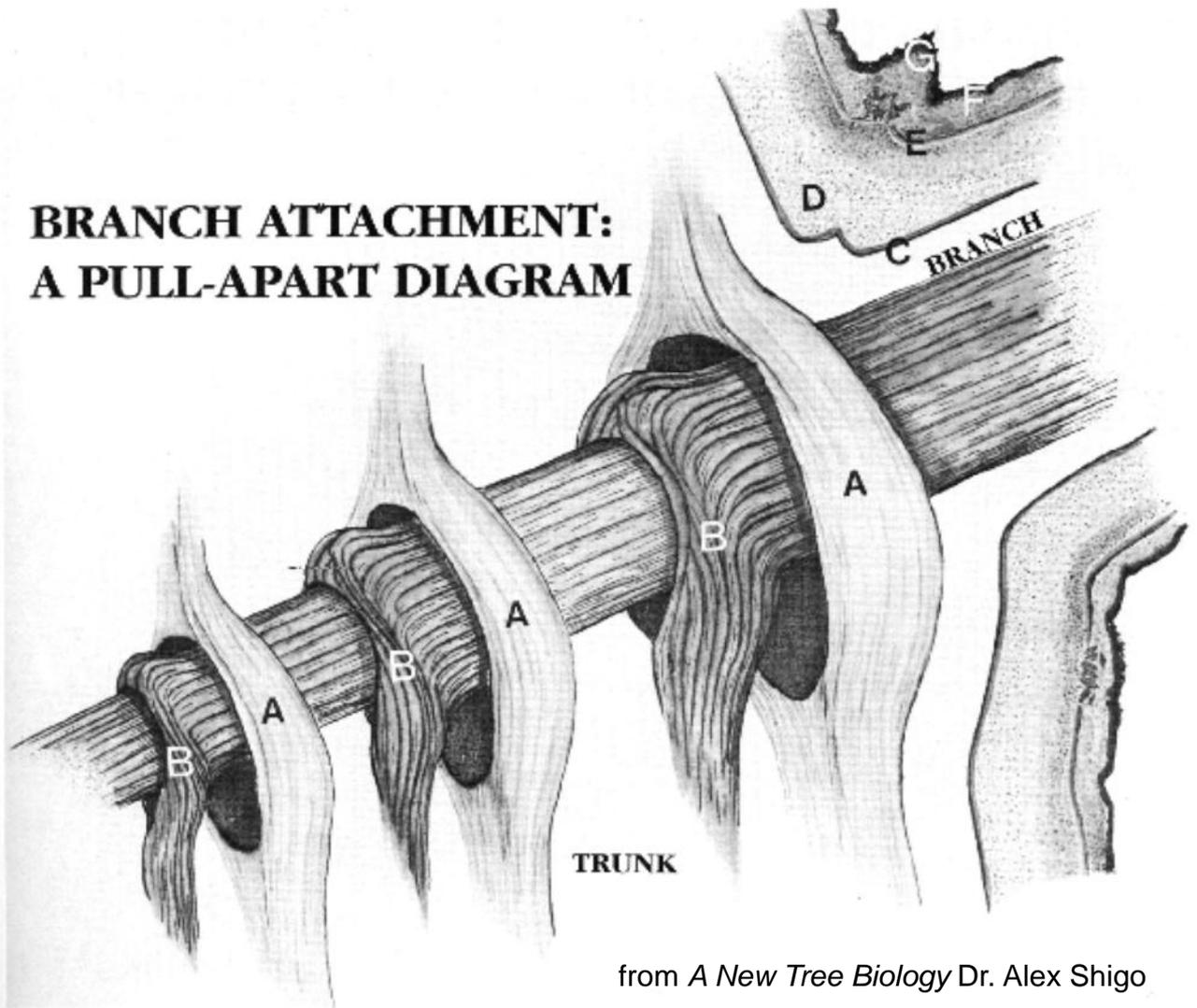


FIGURE #1

Cones of Tree Growth

(generating growth “rings” in cross-section)

BRANCH ATTACHMENT: A PULL-APART DIAGRAM



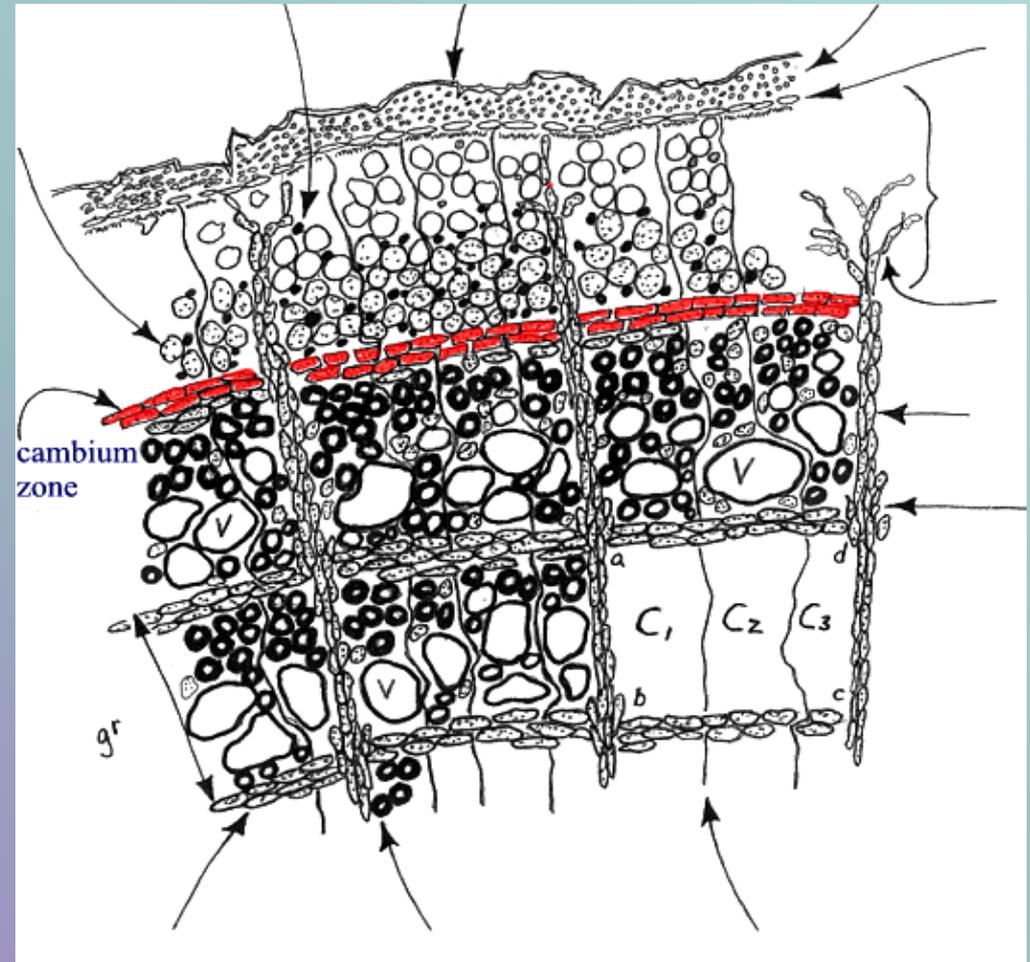
from *A New Tree Biology* Dr. Alex Shigo

The timing of branch and trunk growth creates a strong interlocking structure in branch attachments.

The cambium:

The cambium is the primary meristem producing radial growth.

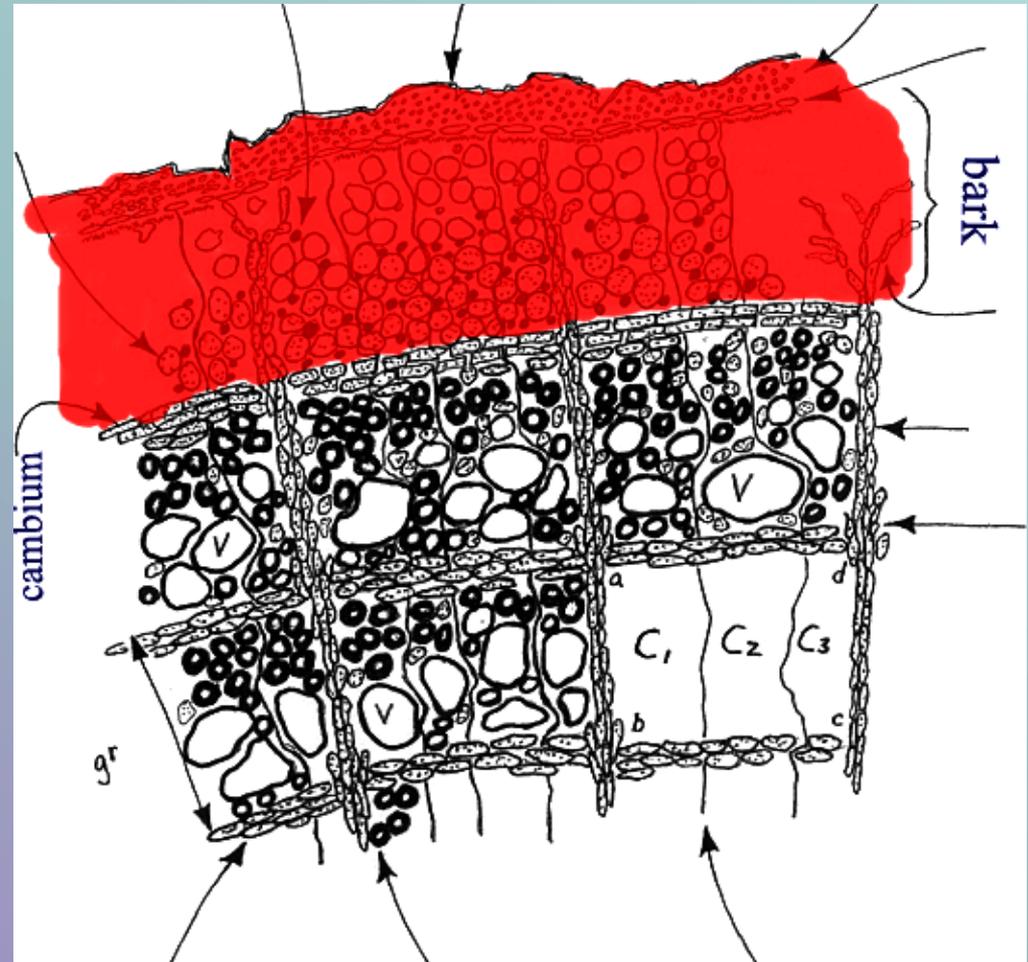
It forms the phloem & xylem.



The Bark:

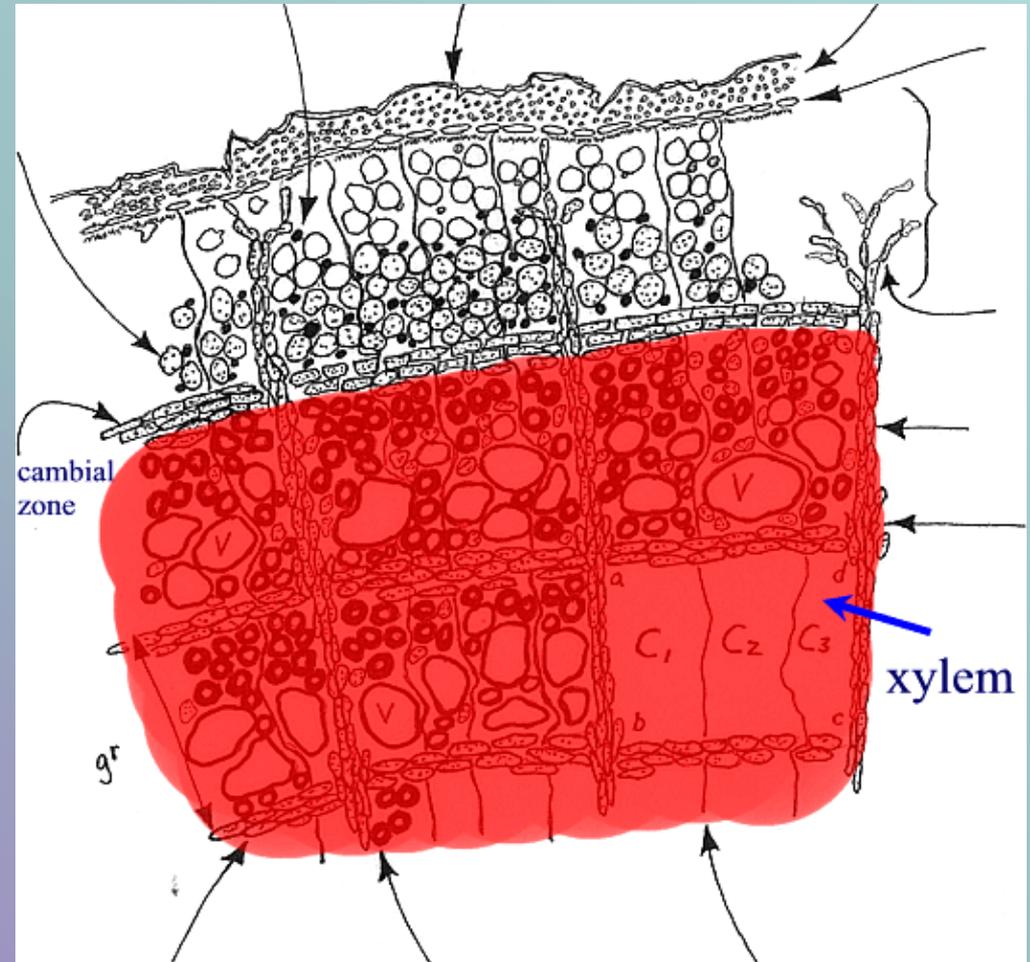
The bark is everything outside the vascular cambium.

As you can see, there is a lot going on in the bark.



The Xylem (wood):

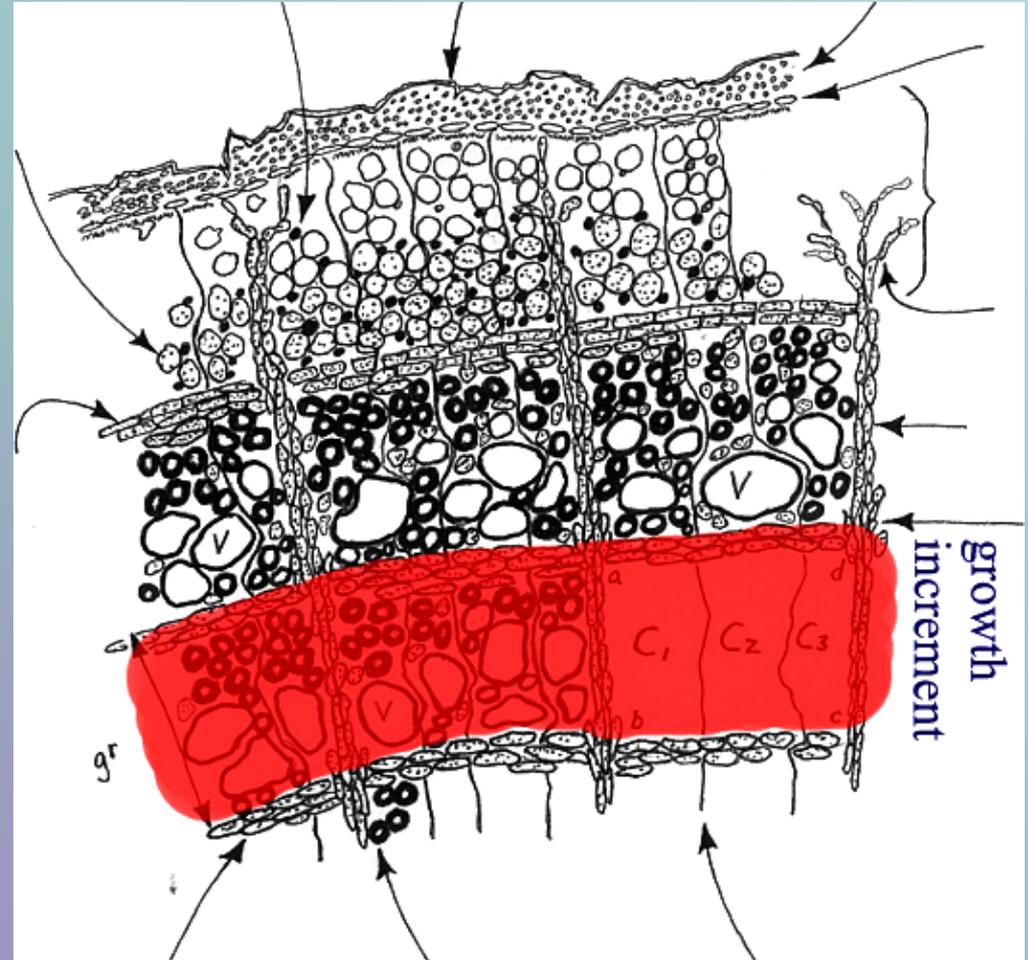
The xylem includes everything inside the vascular cambium.

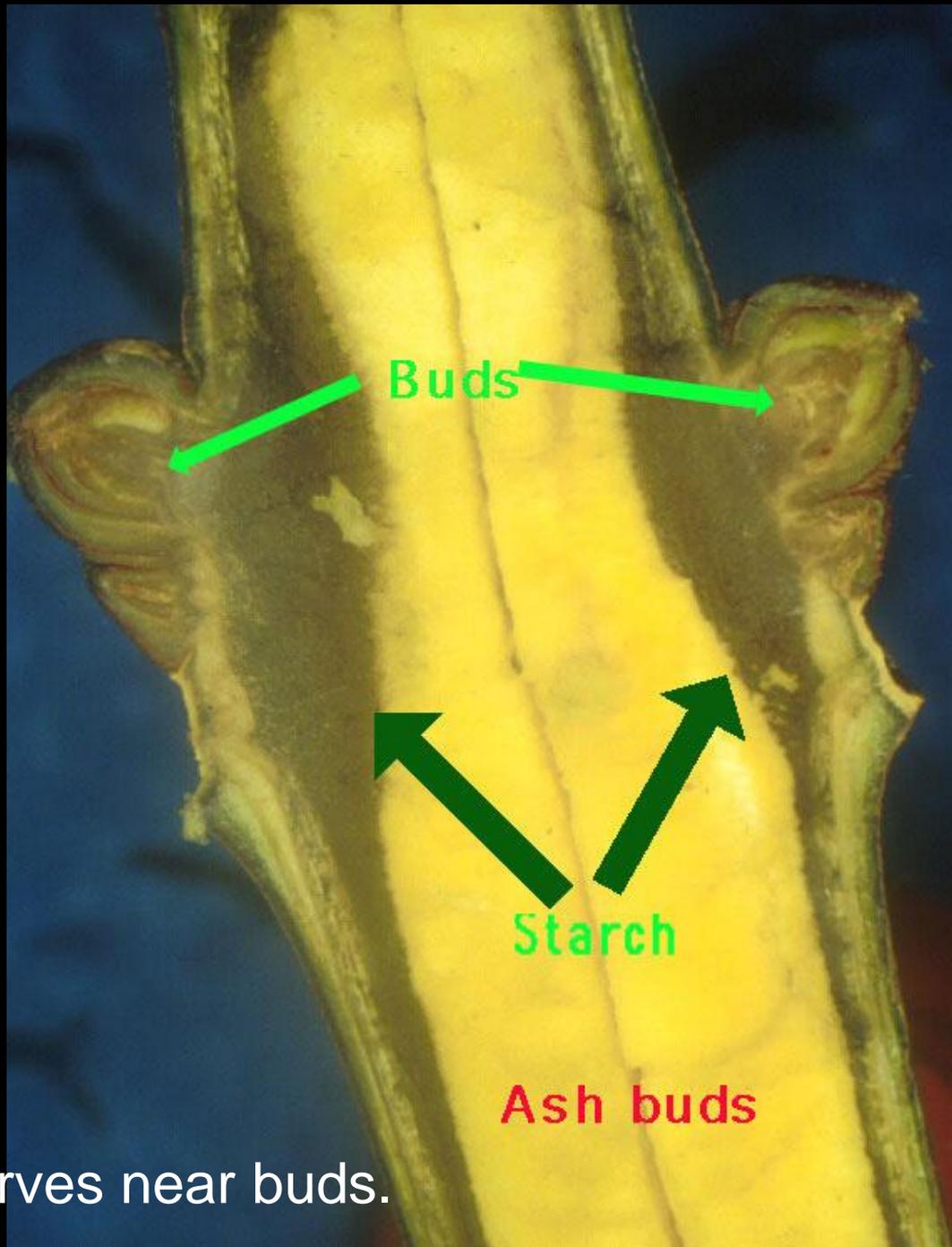


The Xylem: a growth increment (ring):

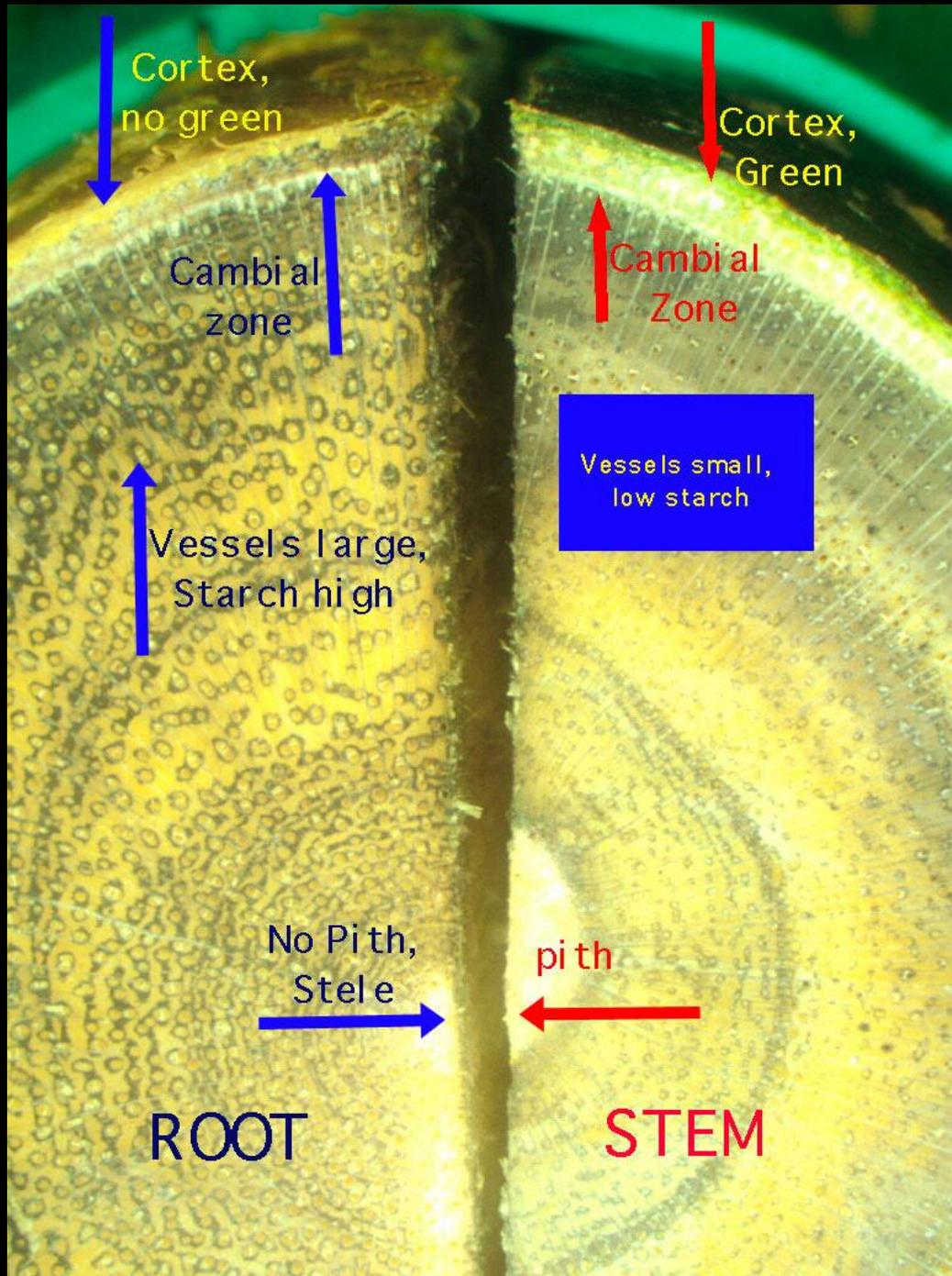
The rings seen in many trees represent one growth increment.

Growth rings provide the texture seen in wood.





Starch reserves near buds.



Roots are not stems.
Note the differences.



Leaves feed the part of the tree nearest them.

Phenology

Timing of life processes

- Seasonal growth generally starts at the buds . The tree parts below follow.
- Stored energy reserves (starches) are used up to push the new growth.
- Roots can grow anytime the soil temps are above 40 F.
- Genetics and climate influence the phenology.
- Auxins are compounds made by the plants that coordinate the growth of different parts of the plant.
- Think about the timing of growth, when making pruning decisions

Tree Growth

- Genetics determine basic form and size of a tree.
- Trees grow towards the sunlight and away from the pull of gravity.
- Roots grow where they can find air and water.
- Trees grow to maintain the dynamic balance of the tree.
- Trees grow new wood around wounds (they don't "heal.")



The basic plant form is dictated by genetics.

The conical form of this evergreen shows strong apical dominance – “excurrent” growth.

The auxins from the top suppress the growth lower down the trunk.

If the top is removed, the lower branches will no longer be suppressed.

Later a new top forms sending the chemical message that suppresses the lower growth.

Apical dominance is exerted the much the same way on later branches.

The branch tip is dominant and suppresses the growth behind it.

If removed latent buds will sprout. The remaining growth will grow longer.





Decurrant form, open and spreading, on an American elm

Why prune trees?

- Prune young trees to establish a sound structure.
 - Establish a strong scaffolding, remove weak or rubbing branches
- For tree health might remove dead and diseased branches.
- For values other than tree health.
 - Clearance for structures, aesthetics, fruit or flower production



A "doughnut maple" pruned for clearance.



Trees may be pruned to promote showy flowers or better fruit yield



Street trees grow in extreme conditions. Early pruning helps avoid future conflicts.

Topping is *not proper* pruning!!
It damages trees and destroys
canopy integrity.



How should trees be pruned?

- With forethought
- With foresight
- According to standards
- With the proper tools
- At the proper time
- With a clearly defined purpost



Not pruning is an option

- In native forest remnant stands, there may not be as much of a need to prune
- Self pruning will occur
- Tree species and growth habits dictate pruning needs
- Not pruning can cause structural problems to go undetected

Training for Structure and Form

- Directs growth to fulfill landscape function
- Reduces structural defects that may lead to failure
- Decreases hazard potential and liability risks



Five Steps for Training Young Trees

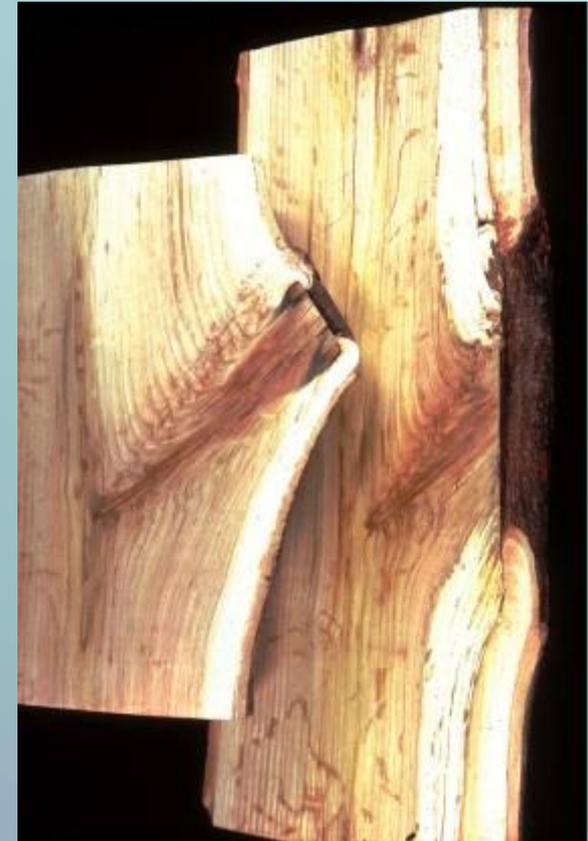
- ✓ Remove broken, dead, dying, diseased, or damaged branches
- ✓ Select and establish a central leader
- ✓ Select and establish the lowest permanent branch
- ✓ Select and establish scaffold branches
- ✓ Select temporary branches below the lowest permanent branch

The Biology Behind Tree Pruning

- Pruning is a form of *wounding*, thus if done incorrectly, can be detrimental
- Correct cuts at branch collar speeds sealing of pruning wounds
- Stubs, topping cuts, and snagged ends are entry points for insect and disease
- Preventive pruning is less stressful for a tree than corrective pruning

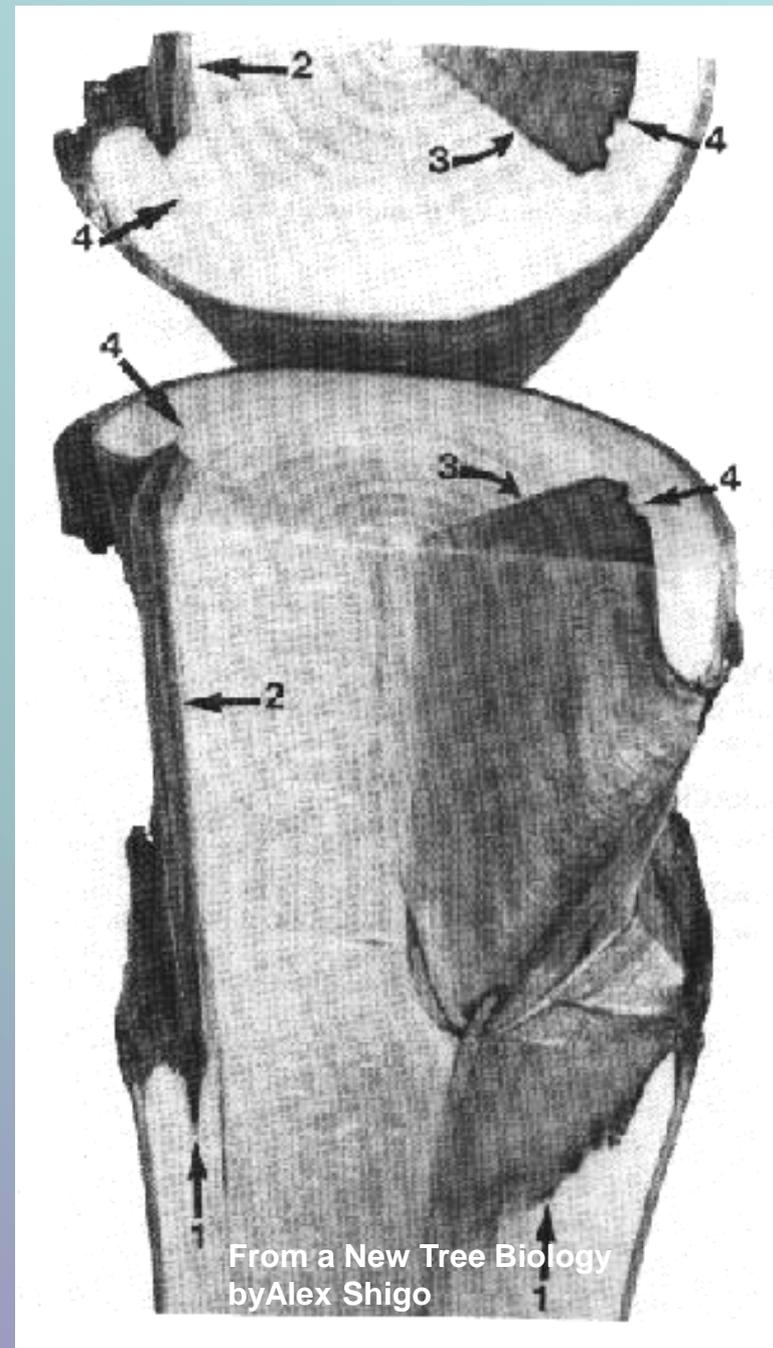
The Biology Behind Tree Pruning

- Successful pruning wound closure is dependent on the quality of the cut
- The larger the pruning cut, the larger the wound, the longer it takes to close



Compartmentalization Of Decay In Trees = CODIT

- Trees are highly ordered, COMPARTMENTED plants, that instead of healing, **COMPARTMENTALIZE** in an orderly way the injured and infected tissues.



Barrier Zone

Trees are generating systems. When trees are injured, boundaries form that resist the spread of infections.

The boundaries that form within the wood present at the time of wounding are called reaction zones. They are chemical boundaries. After injury, the still living cells about the injury begin to form chemical and anatomical boundaries. These boundaries are called

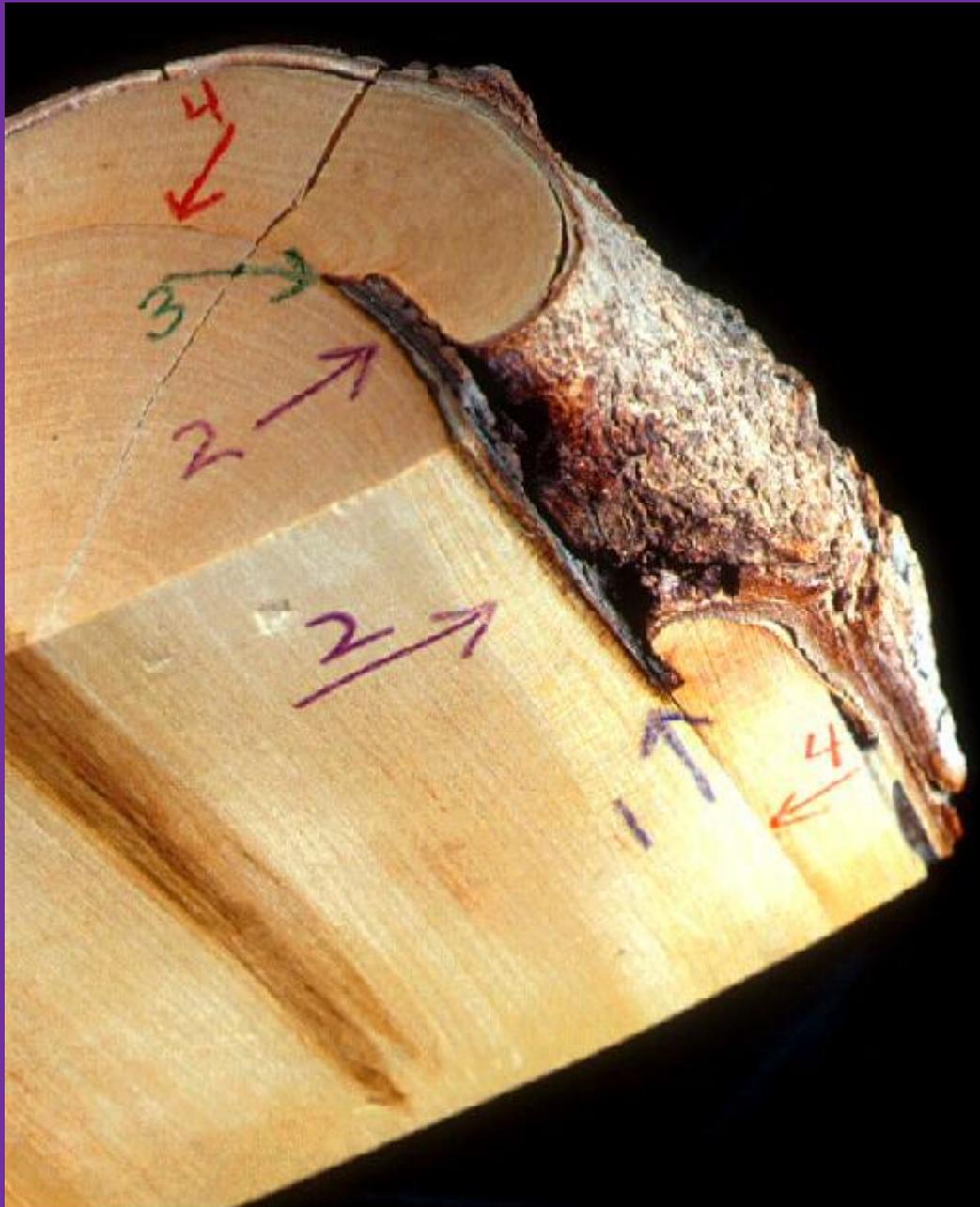
barrier zones.

The reaction zones are constantly being “pushed” by the invading microorganisms. The barrier zone is a very strong boundary and it is rarely breached by microorganisms.

Many people do not understand that the reaction zones are constantly being “pushed.”

The strength of the zones is strongly dependent on the amount of reserve energy available for defense. When energy reserves are low, barrier zones may not form and the microorganisms may invade rapidly and kill the host.

In the Coudit model of compartmentalization, the reaction zones are walls 1, 2 and 3. The barrier zone is **wall 4.**

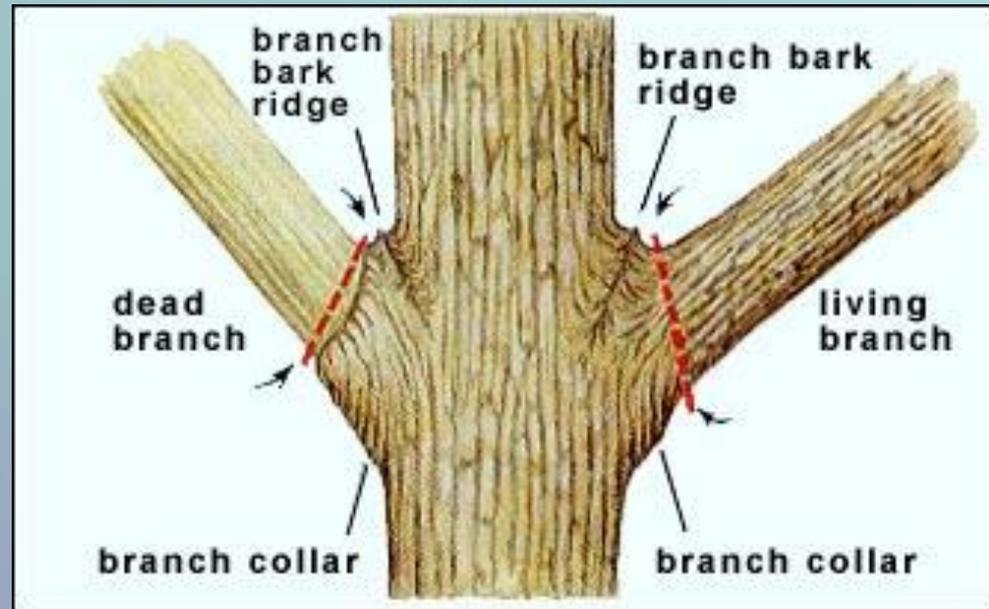


Compartmentalization Styles

- Trees that grow slowly are usually **good** compartmentalizers and **resist decay**
 - Most oaks, some elms, black locust, hornbeam, walnut, sycamore, etc
- Trees that “**live fast and die young**” are usually **poor** compartmentalizers, and often **succumb to decay after injury**.
 - Birch, ash, poplars, beech, crabapples, willows, some oaks, cherries, cottonwoods, aspens, horse chestnut, silver maple, redbud, etc

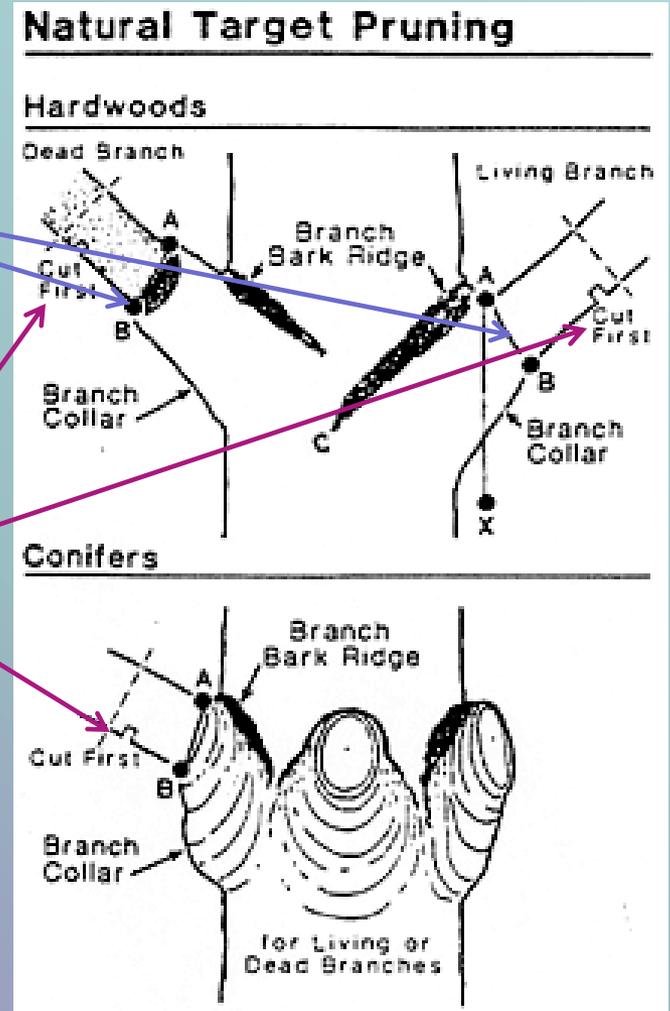
Proper techniques

- Target pruning terms:
 - branch collar
 - branch bark ridge

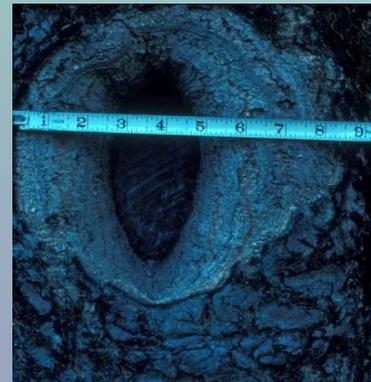


Making proper pruning cuts

- The final cut should be just outside the branch collar
- Often the weight of the branch must first be removed with a preliminary under-cut



Wound closure profile



A good pruning cut will seal quickly and be shaped like a doughnut.

Discarded wood

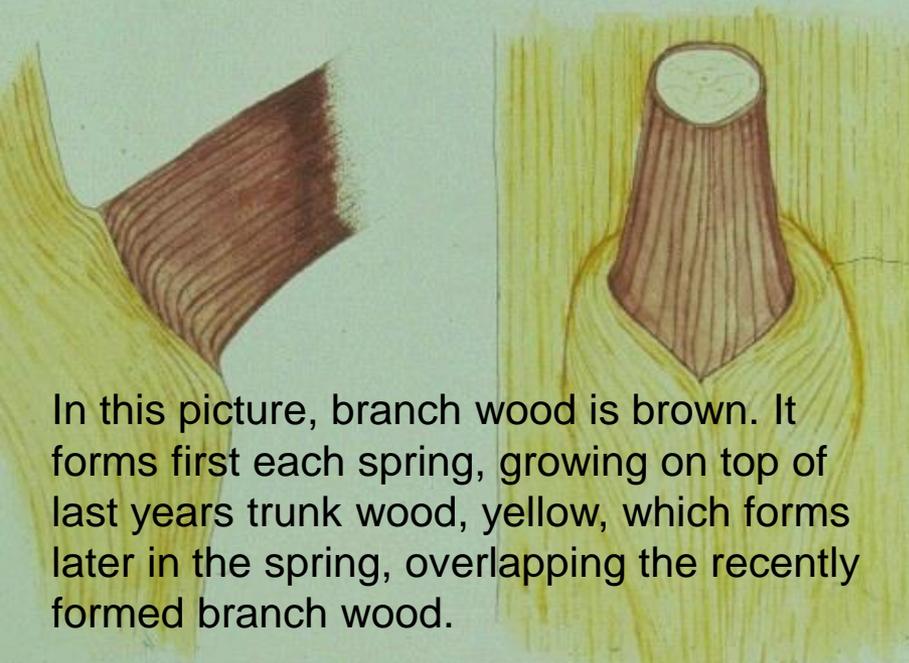
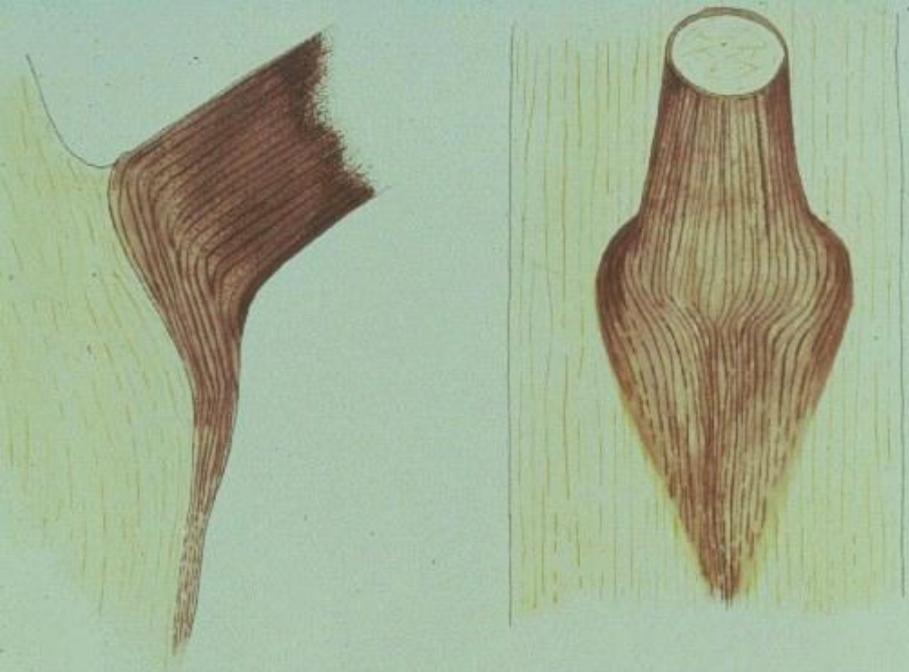
Crack starting

Flush Cut

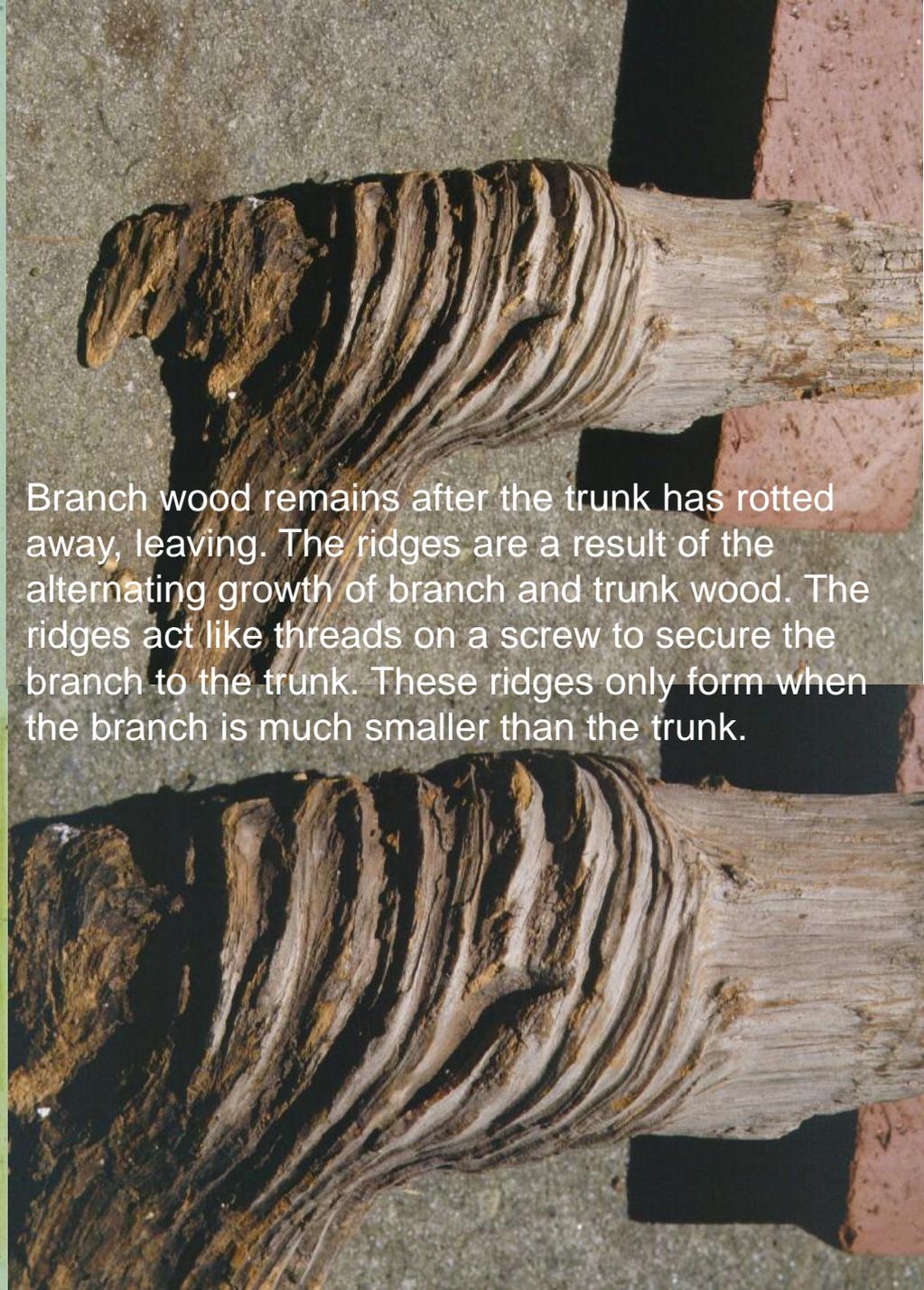
Improper

Proper
Prune

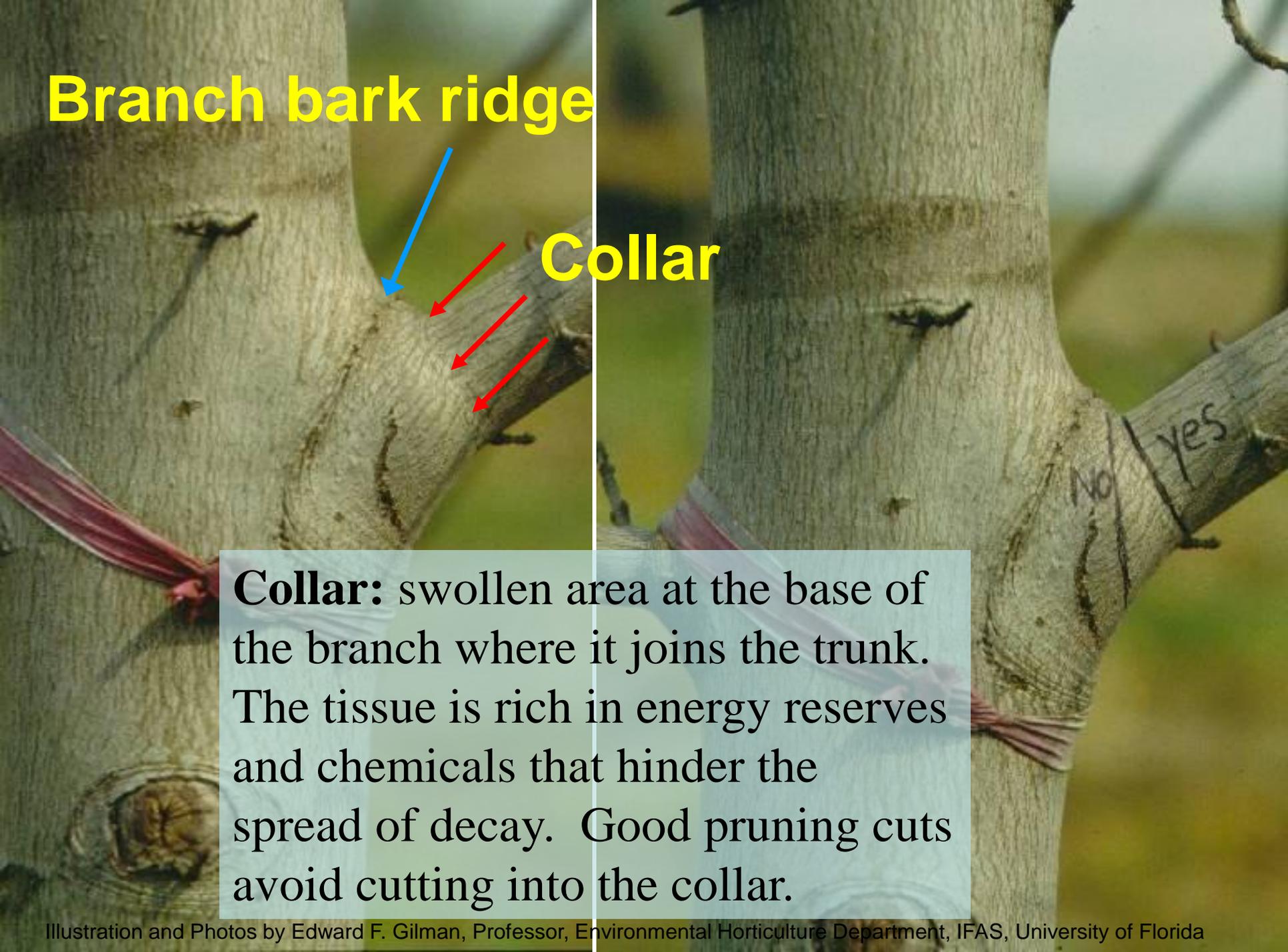




In this picture, branch wood is brown. It forms first each spring, growing on top of last years trunk wood, yellow, which forms later in the spring, overlapping the recently formed branch wood.



Branch wood remains after the trunk has rotted away, leaving. The ridges are a result of the alternating growth of branch and trunk wood. The ridges act like threads on a screw to secure the branch to the trunk. These ridges only form when the branch is much smaller than the trunk.



Branch bark ridge

Collar

Collar: swollen area at the base of the branch where it joins the trunk. The tissue is rich in energy reserves and chemicals that hinder the spread of decay. Good pruning cuts avoid cutting into the collar.

Improper pruning cuts

- Some pruning cuts can cause more damage than if the tree had been left alone
 - Bark Ripping
 - Flush Cutting
 - Stub Cutting

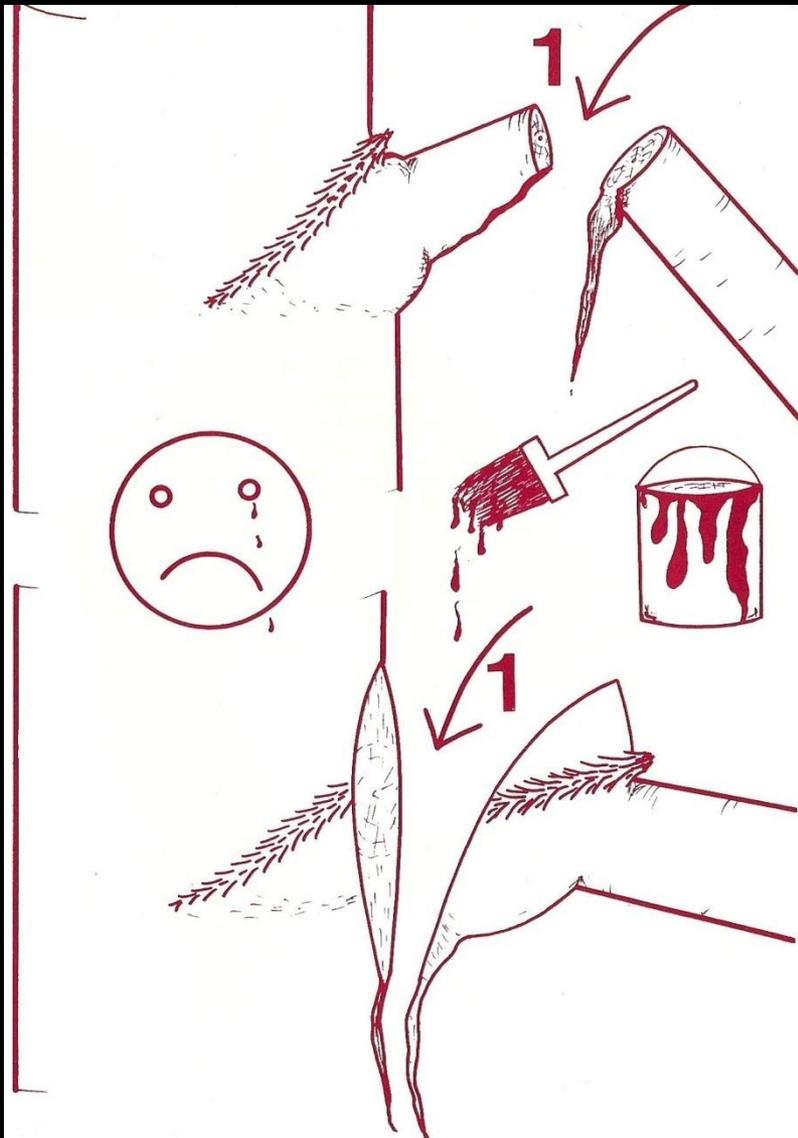


Specific Hazards Related to Topping

- Trees have difficulty in defending a large wound
- Regrown branches are weakly attached



- Poor structure - topping destroys the natural form and taper of a tree



DO NOT REMOVE BRANCH COLLARS OR LEAVE STUBS

- Money is wasted when branches are pruned incorrectly.
- Painting will not help. Wound dressings do not stop rot.
- Incorrect pruning starts a long list of costly problems: cankers, sun scald, frost cracks, insect borers.

Pruning Responses

When pruning, think in terms of the tree's response to the cuts.

- How will the tree react?
 - Wound response
 - Energy needed
- Where will the new growth be ?
- What will be the effect on the whole tree?



What is good structure?

Outline of topics

1. Forest grown vs. open grown tree
2. Codominant stems
3. Good branch attachment
4. Structurally sound tree



Trees grown in natural conditions are usually fine, without us...

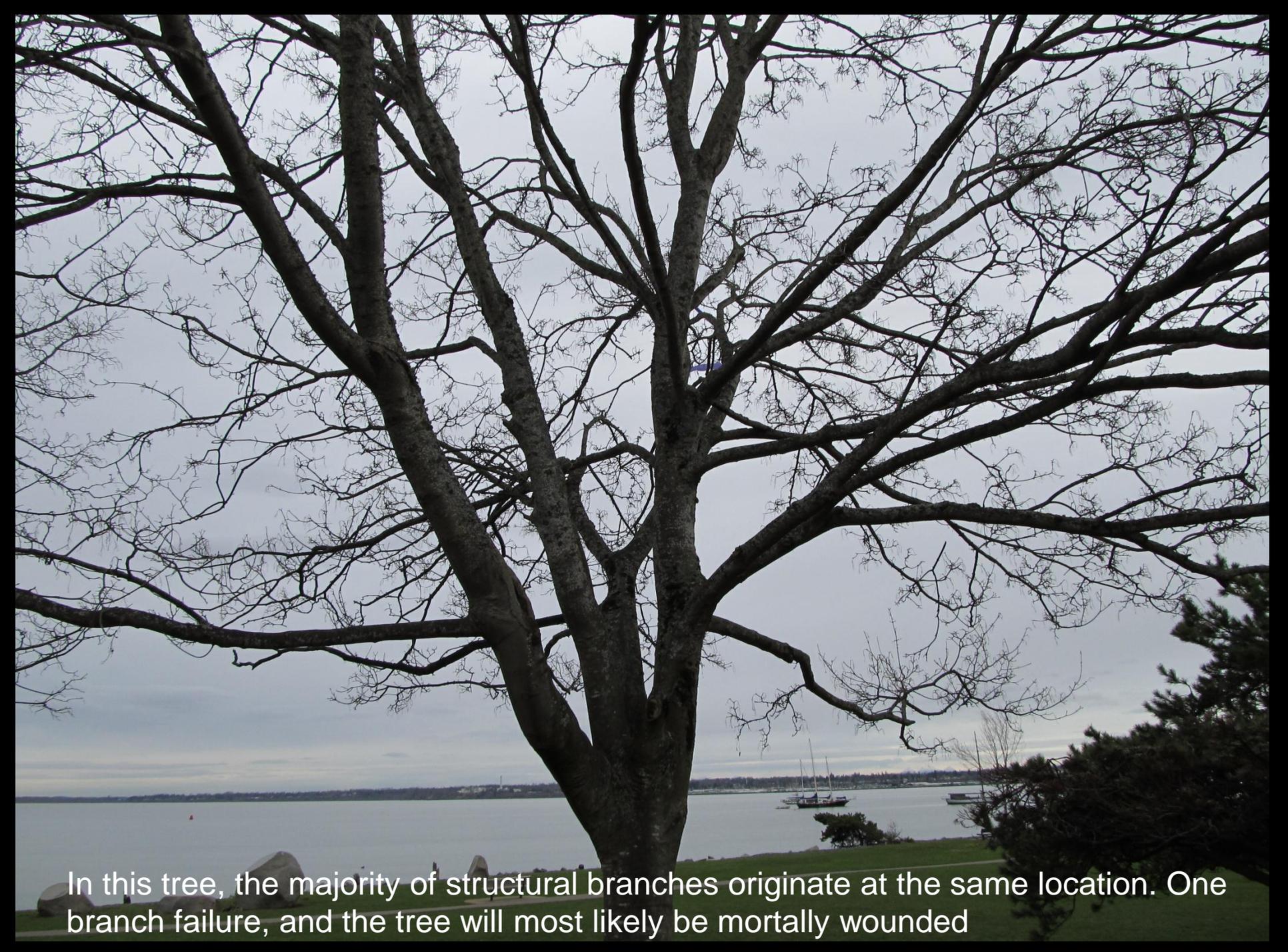


...but conditions change.

Understanding tree structure problems

- Branch angles
- Included bark
- Co-dominant stems





In this tree, the majority of structural branches originate at the same location. One branch failure, and the tree will most likely be mortally wounded

Co-dominant Stems

- Co-dominant stems, unlike branches do not have collars that form protection zones.
- Cracks at co-dominant stems are always a sign of weakness
- Stem bark ridges are a sign of stronger co-dominant stems





Included bark; a weak point.



Bark inclusion

A narrow branch angle is a perfect environment for microorganisms; the area stays moist, warm, and dark

Decay and discoloration from self-wounding and micro-organisms breaking down wood.

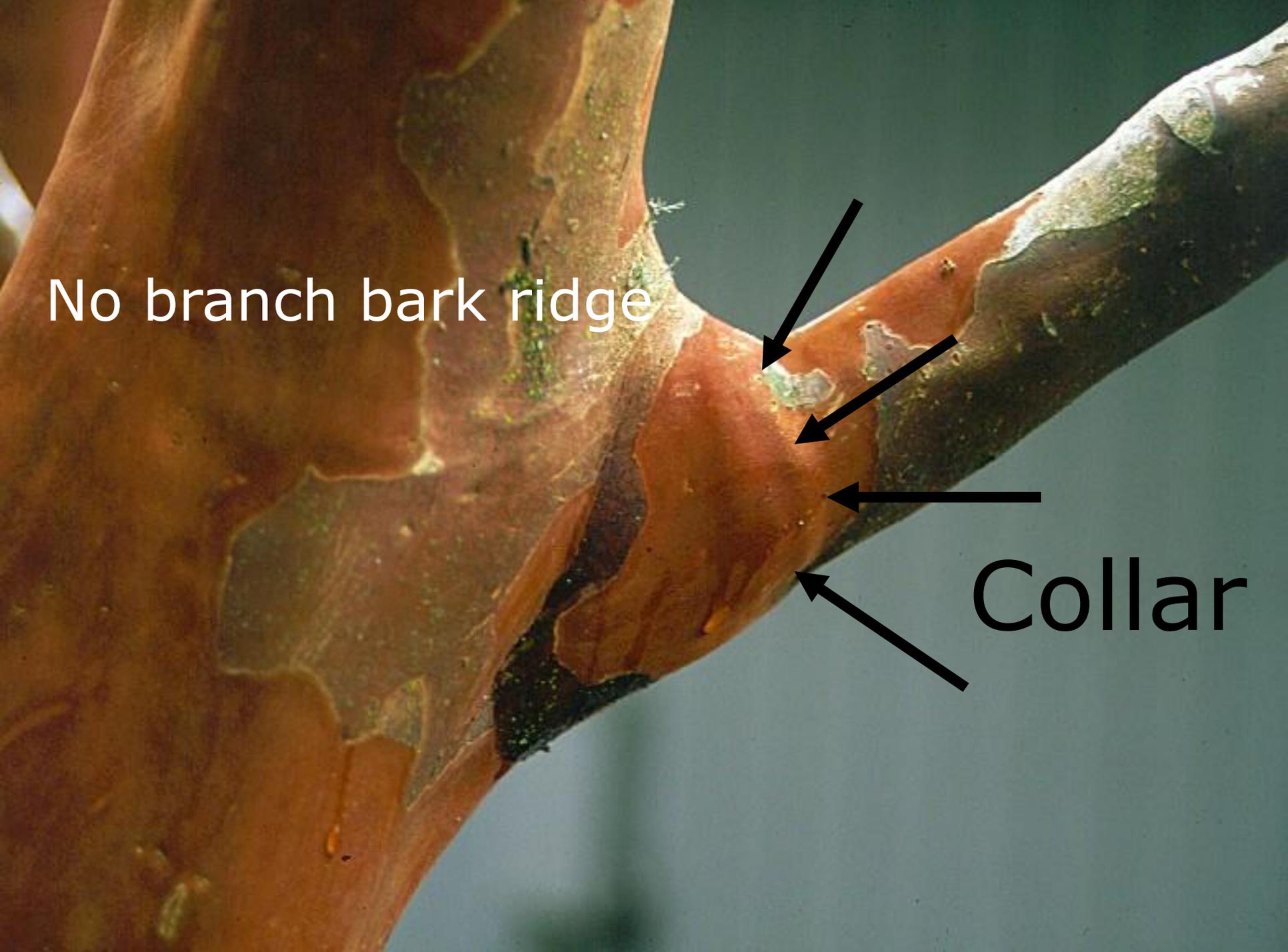


Good branch attachment

- How does a BRANCH form?
- What are the indicators?

No branch bark ridge

Collar



Branch bark ridge present

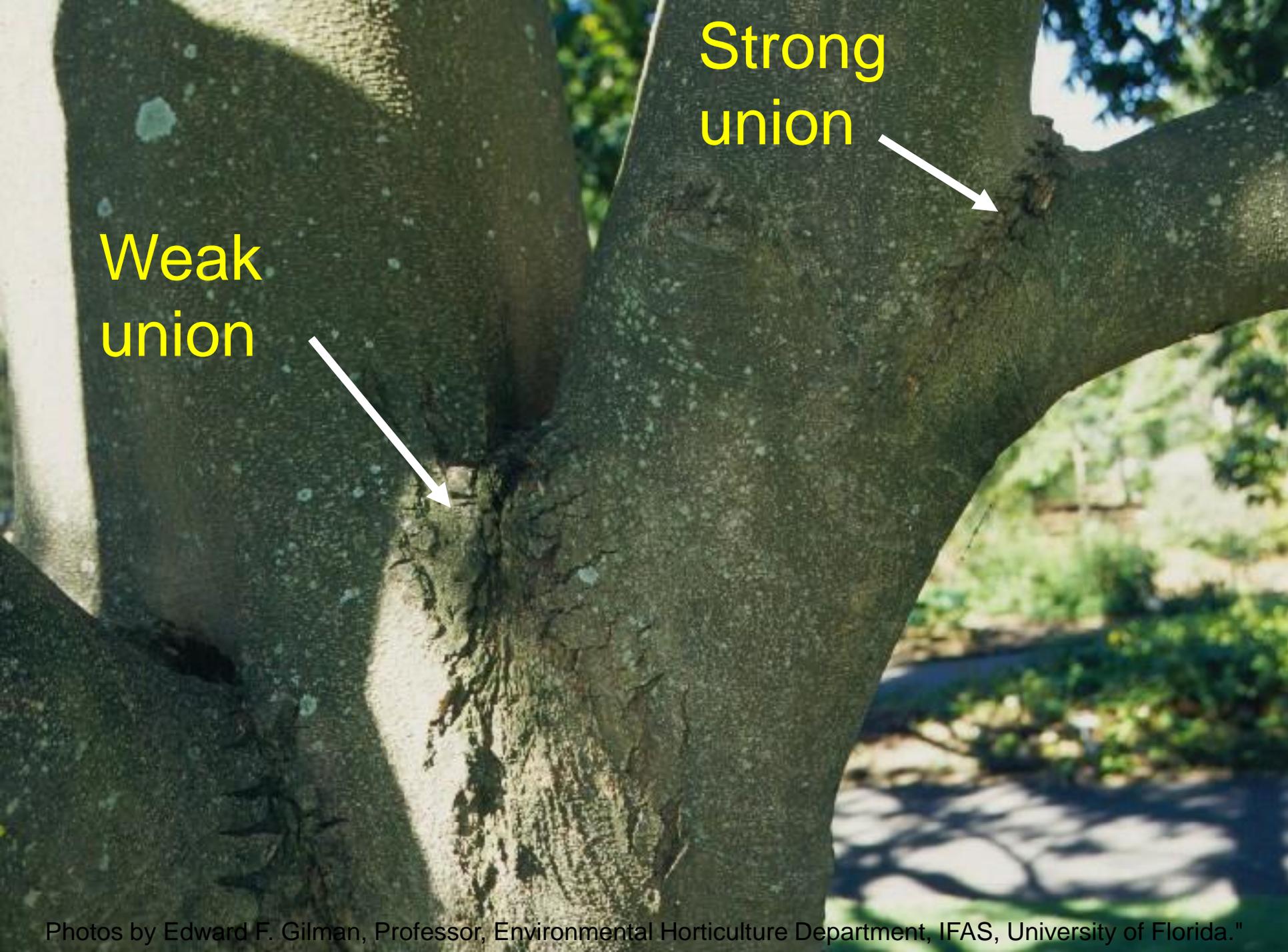
- Some branch unions have a prominent branch bark ridge



Tree Structure Problems: Included bark

- Included bark is defined as bark that is squeezed between stems
- Included bark doesn't necessarily need to be decayed in order to fail





**Weak
union**

**Strong
union**



**Good
structure**



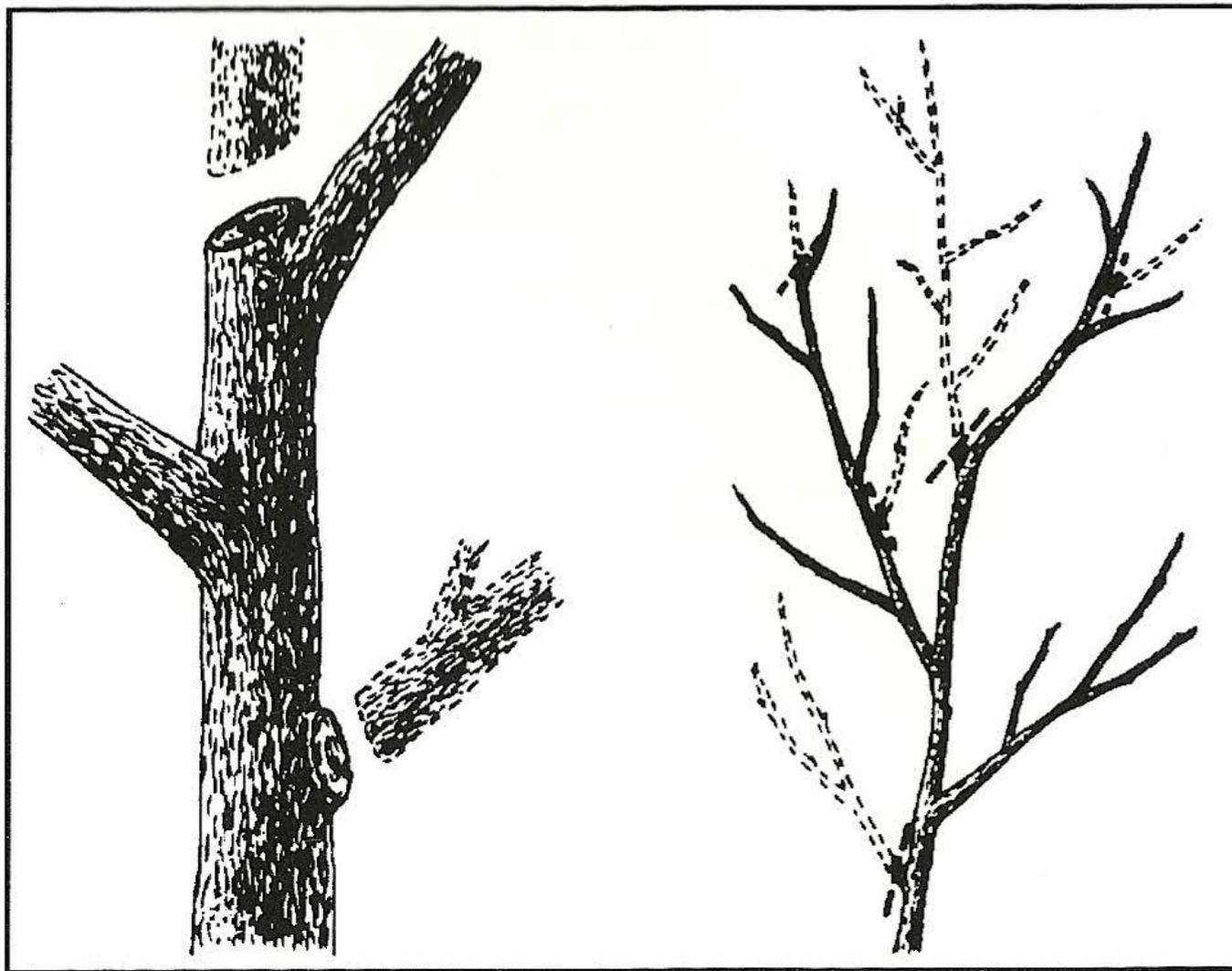
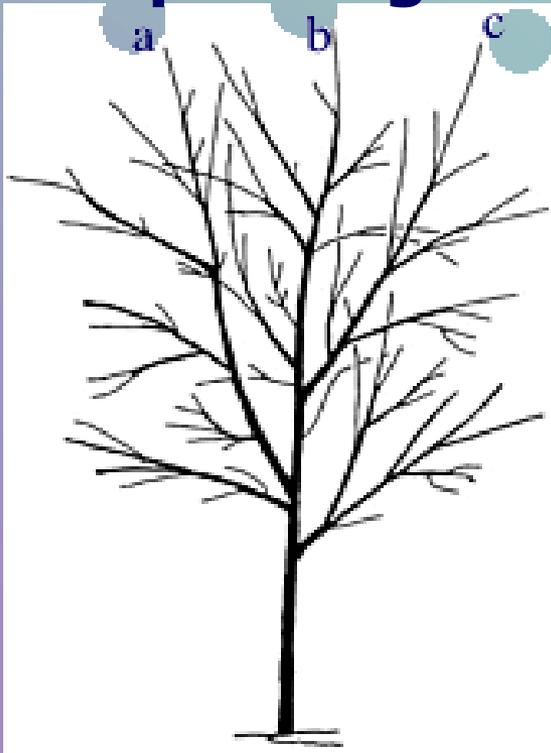


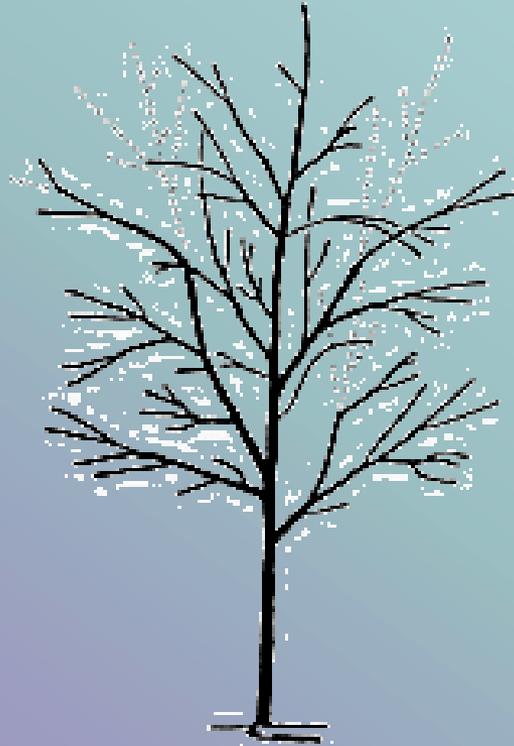
Figure 1. Thinning is removing a branch at its point of origin (lower cut on each) or shortening a branch or leader by cutting to a lateral large enough to assume the terminal role (upper cut on each), commonly called “drop-crotching” in mature trees.

Subordination

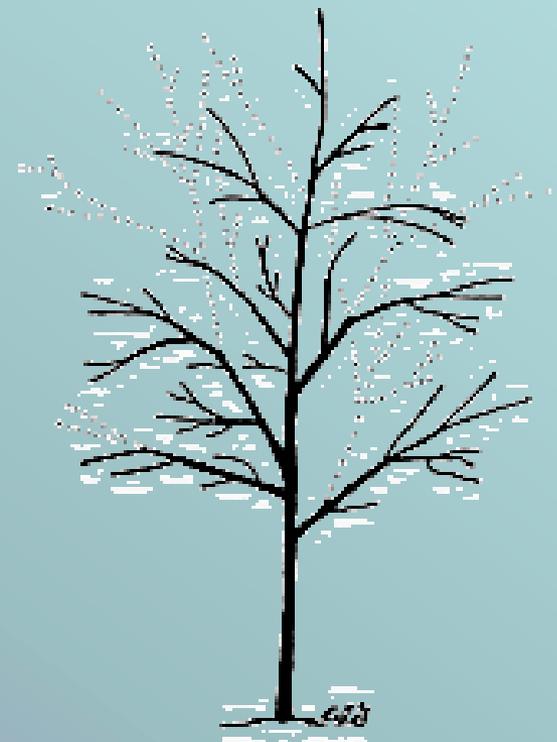
**Before
pruning**



**After light
pruning**

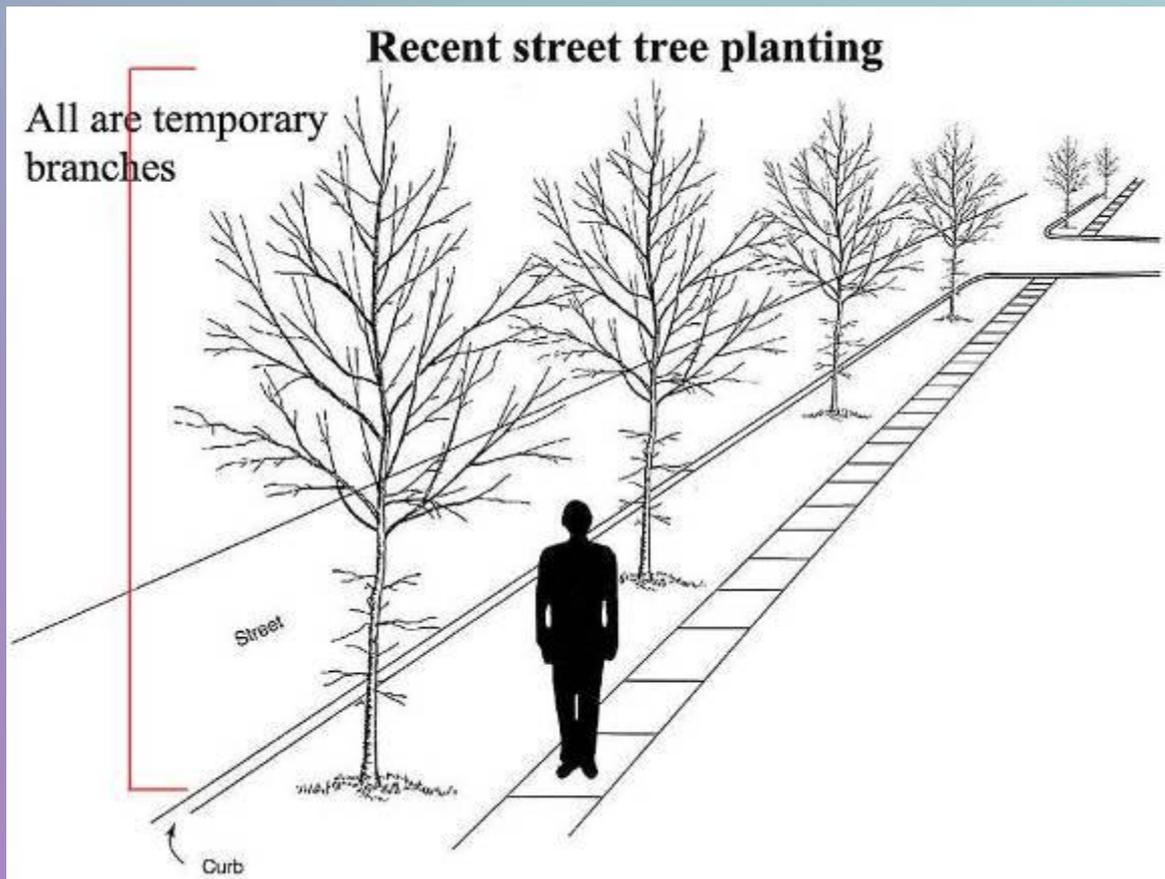


**After moderate
pruning**



The objective of structural pruning is to develop good sustainable branch and trunk form in shade trees by making pruning cuts in the canopy at strategic and planned locations. On many trees structural pruning can be taught as a three step process: **step one** – locate the stem that will make the best leader; **step two** – locate those stems and branches that are competing with this chosen leader; **step three** – decide where to cut these competing stems back to. *Subordination or reduction of competing stems is one of the most important techniques to use to develop good structure in shade trees.* Pruning cuts are indicated as dotted lines.

Temporary vs. permanent branch management (Long Term thinking)



- Keep in mind that all low branches will eventually be removed; they are temporary.

A good pruning program will make sure that temporary branches are removed before they grow larger than about half the trunk diameter.



- Early canopy training to create a branch structure that will provide lift truck access for future maintenance

Large branch removal vs. early structural pruning

- Leaves a huge wound
- No branch protection zone
- Access for decay

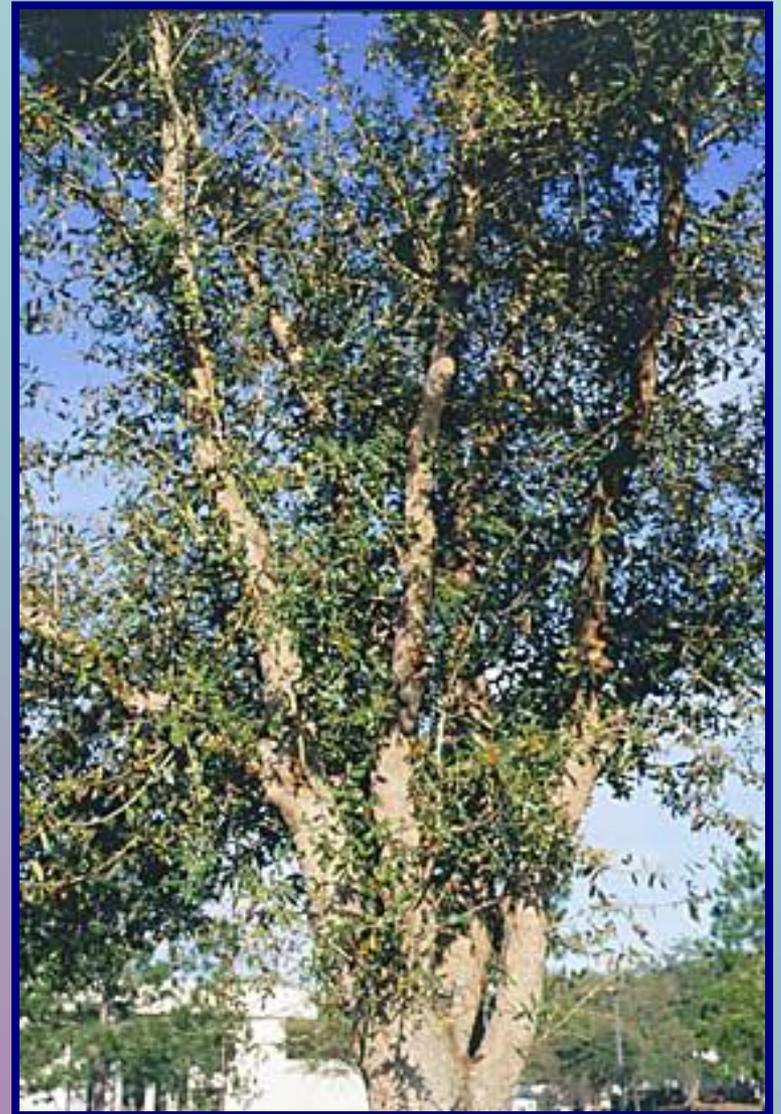


Big wounds can mean management woes



Over-pruning causes sprouting

- This mass of sprouts resulted from removing too many low branches at one time
- Prevent this by pruning regularly so less than 25% needs to be removed at a time



Lions-tailed

thinning



- Over-lifting or over-thinning leaves live branches only at the edge of the canopy
- Tremendous numbers of sprouts often result from this type of tree mutilation

A few words about topping

- Structurally unsound
- Stressful to the tree
- Expensive to maintain
- Ugly

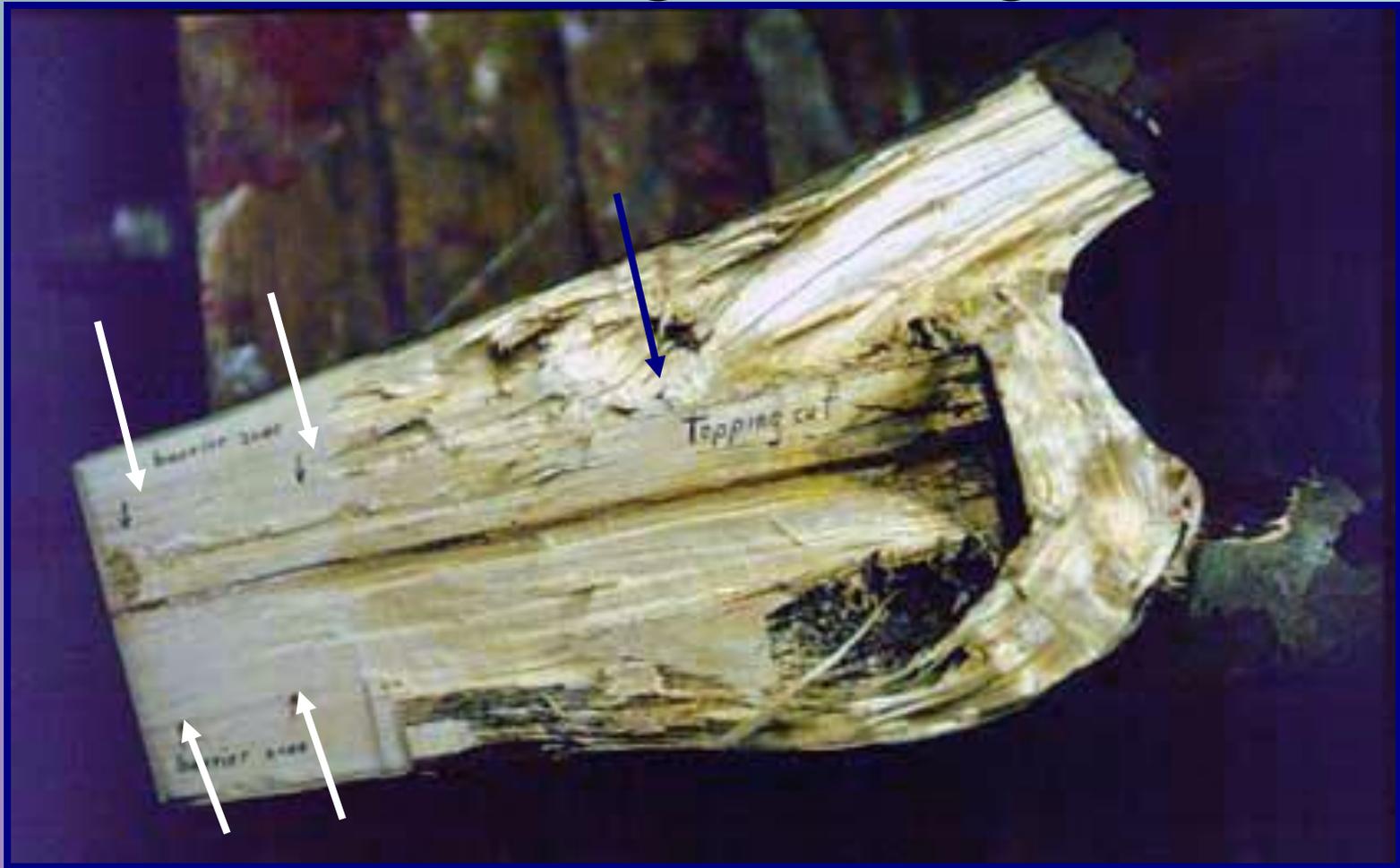


Topping



- Not an appropriate method of reducing canopy size
- Uses heading cuts through several-year-old woody tissue
- Results in decay and weak structure

Topping damage



- A look inside a tree topped several years ago reveals some of the problems with topping

Tree Myths Undone

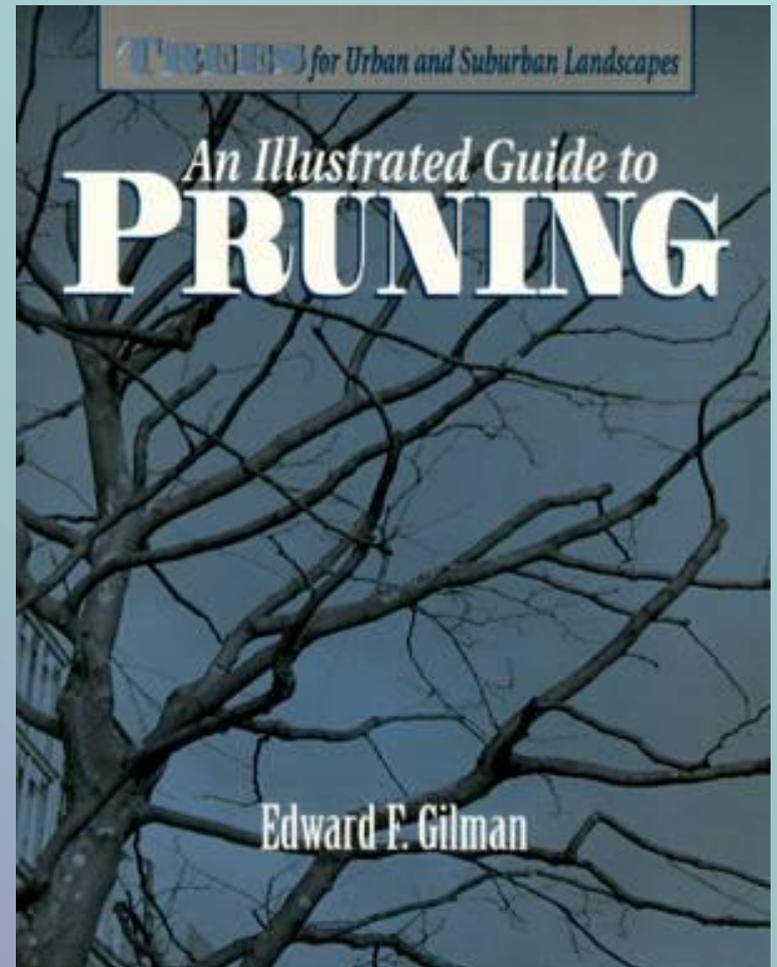
- Trees do not heal wounds. They grow over them.
- Wound dressing are not usually a good thing.
- Sap bleeding from pruning cuts in the spring doesn't hurt the tree.
- Stake new trees only as needed.
- Adding fertilizer may be bad for your trees.
- Not cutting down a tree doesn't mean you haven't killed it. Be kind to root zones.

THINGS THE TREES CAN TEACH US

- **TREES DO NOT MOVE AWAY FROM THEIR PROBLEMS.**
- **TREES, WHEN THREATENED OR INJURED, RESPOND RAPIDLY.**
- **TREES HAVE MANY FRIENDS. THEY ARE CONNECTED IN WAYS THAT PROVIDE SYNERGENIC ASSOCIATIONS.**
- **TREES LIVE WITHIN THEIR MEANS.**

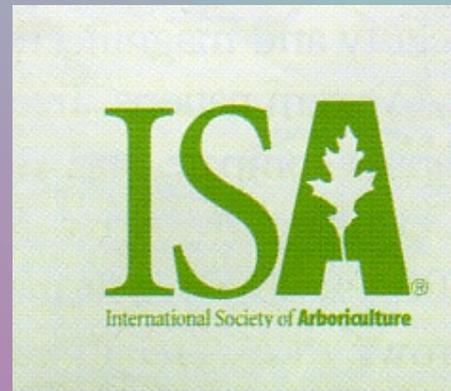
For further reading

- Illustrated Guide to Pruning by Dr. Ed Gilman
- Available from:
The Pacific NW Chapter of the International Society of Arboriculture, P.O. Box 811, Silverton, OR 97381
or www.pnwisa.org

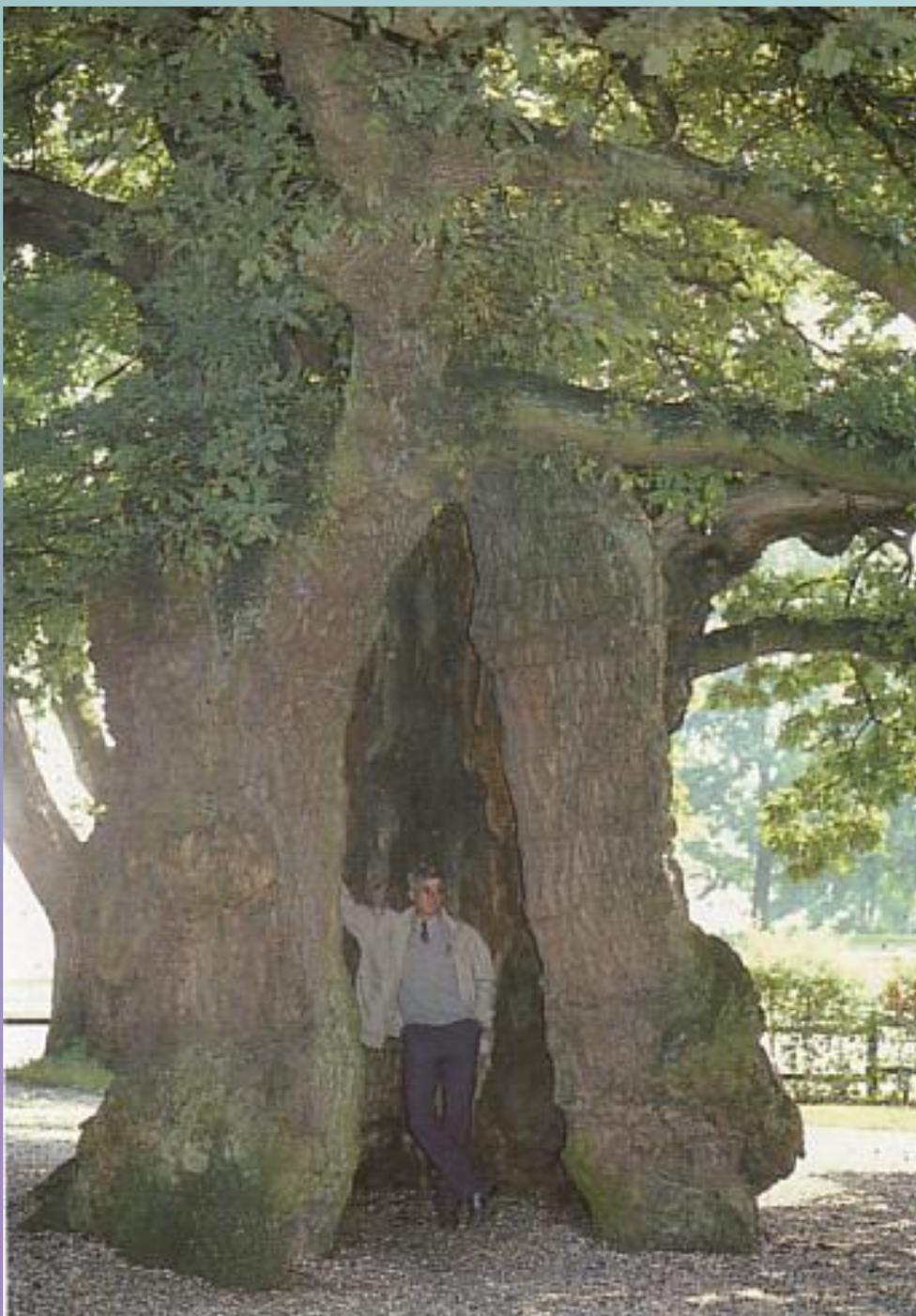




treelink.org



treesaregood.org



**Trees
don't
need
people.**

**People
need
trees.**



Thank you !