

Cyclophysis

What's old and new about phase change and propagation

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Woody Perennial Growth

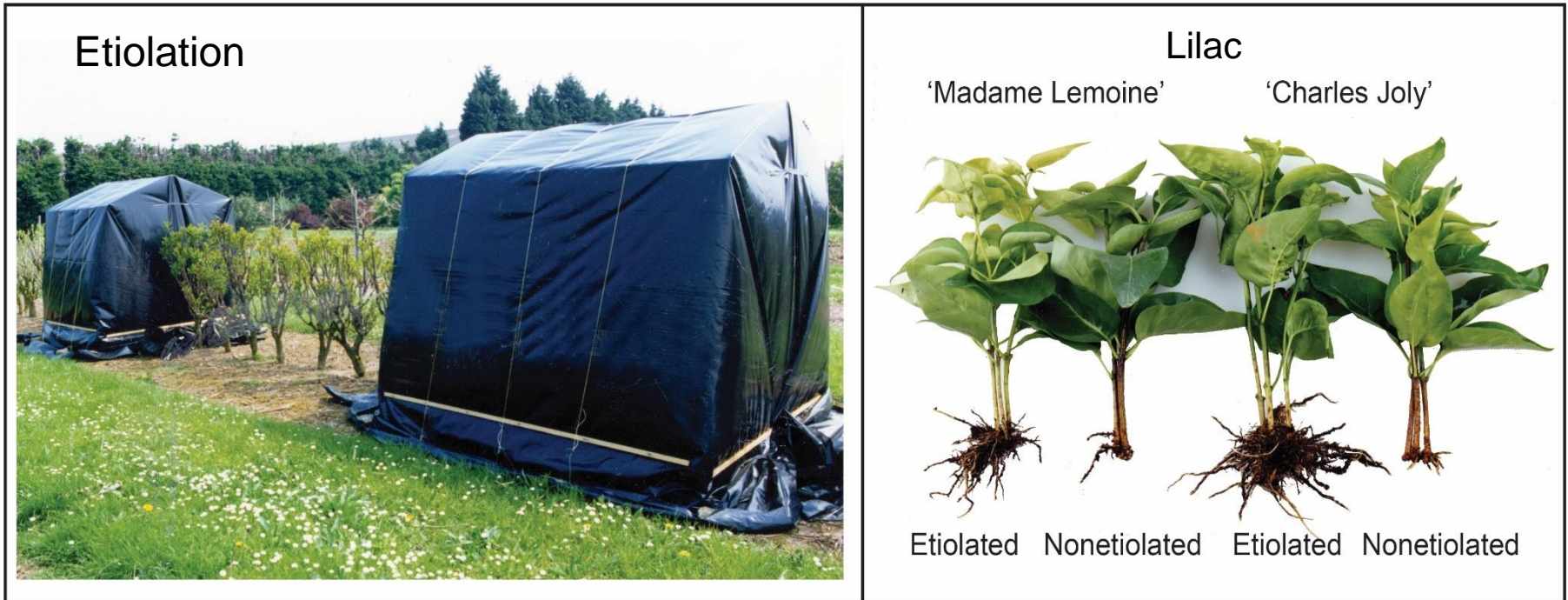
The way a woody plant meristem behaves during its life cycle has been described by the terms:

- Periphysis
- Topophysis
- Cyclophysis



Periphysis

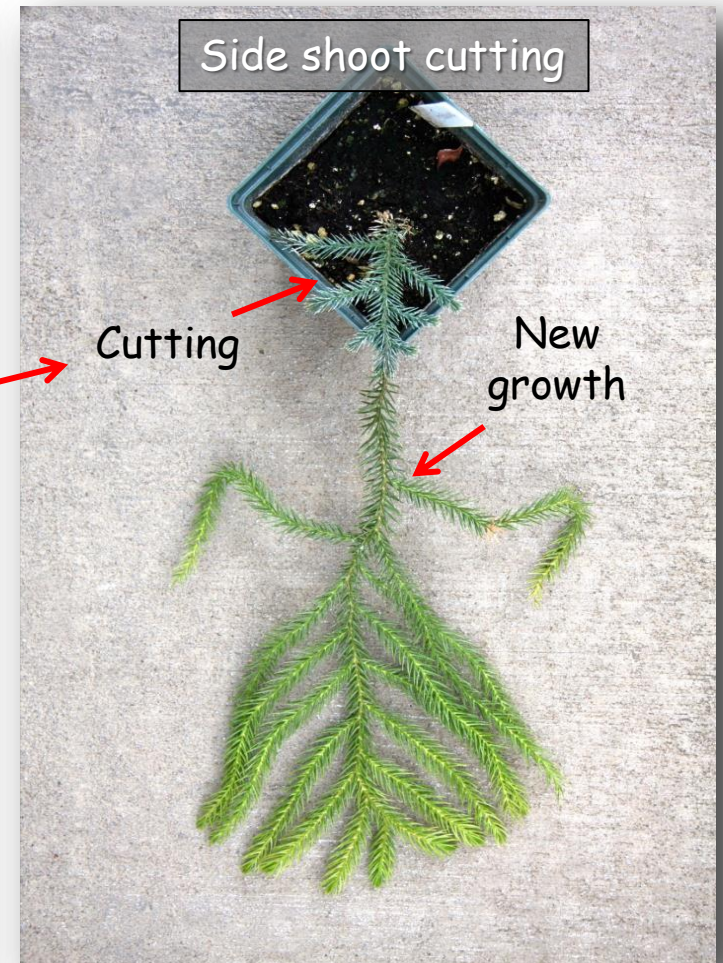
Periphysis: Variation of growth and development due to different environments.



Howard and Ridout, J. Hort. Sci. 1992

Topophysis

Topophysis: the position on the stock plant impacts the growth orientation of the propagule.



Topophysis

The plant continues to put out new growth that remains horizontal. These stems "remember" their original orientation on the mother plant.



Five years of growth

Cyclophysis

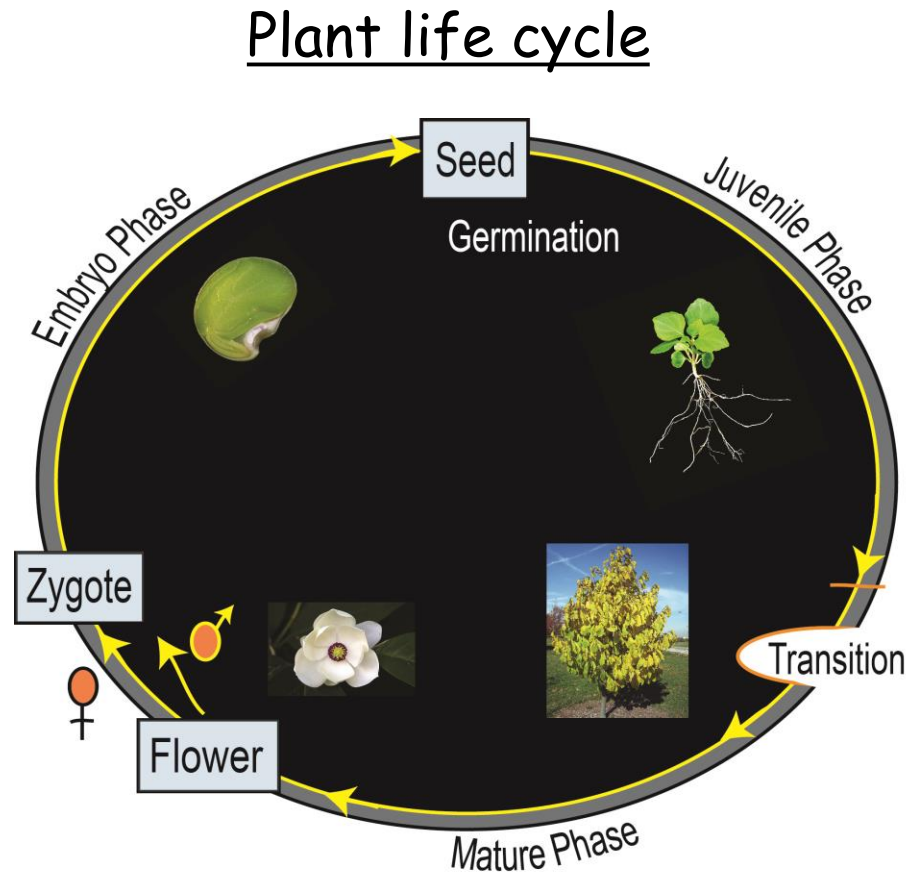
Cyclophysis: is the ontogenetic or physiological aging of the plant meristem.

Cyclophysis

Maturation

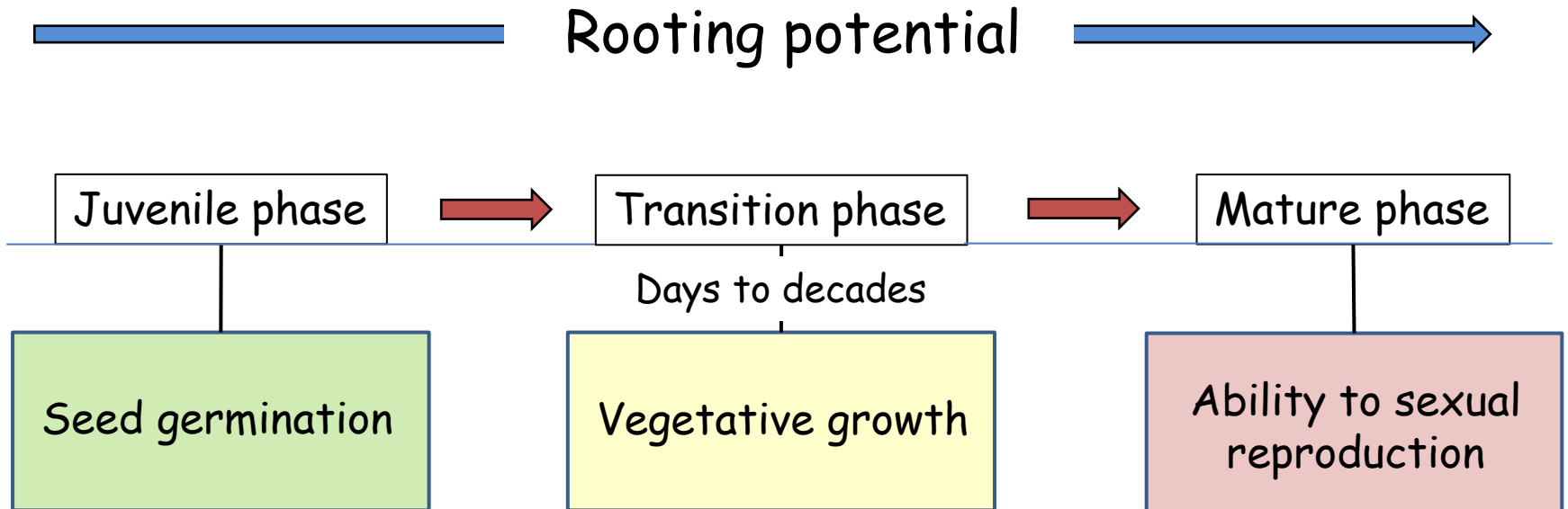
Ontogenetic aging

Phase change



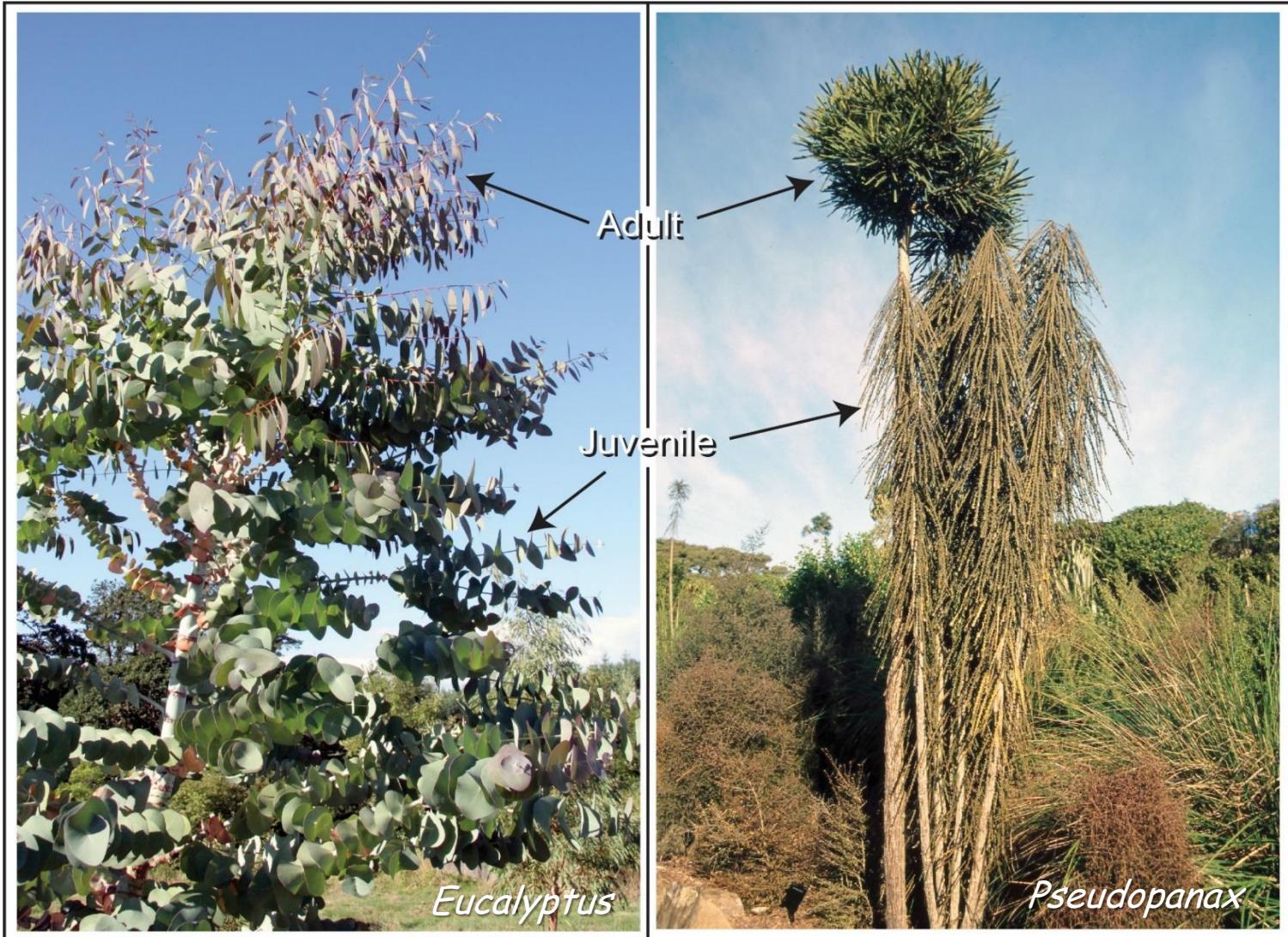
Phase change

Phase change is the progression from a juvenile to mature form.



Phase change

Foliar polymorphism: different leaf shapes.



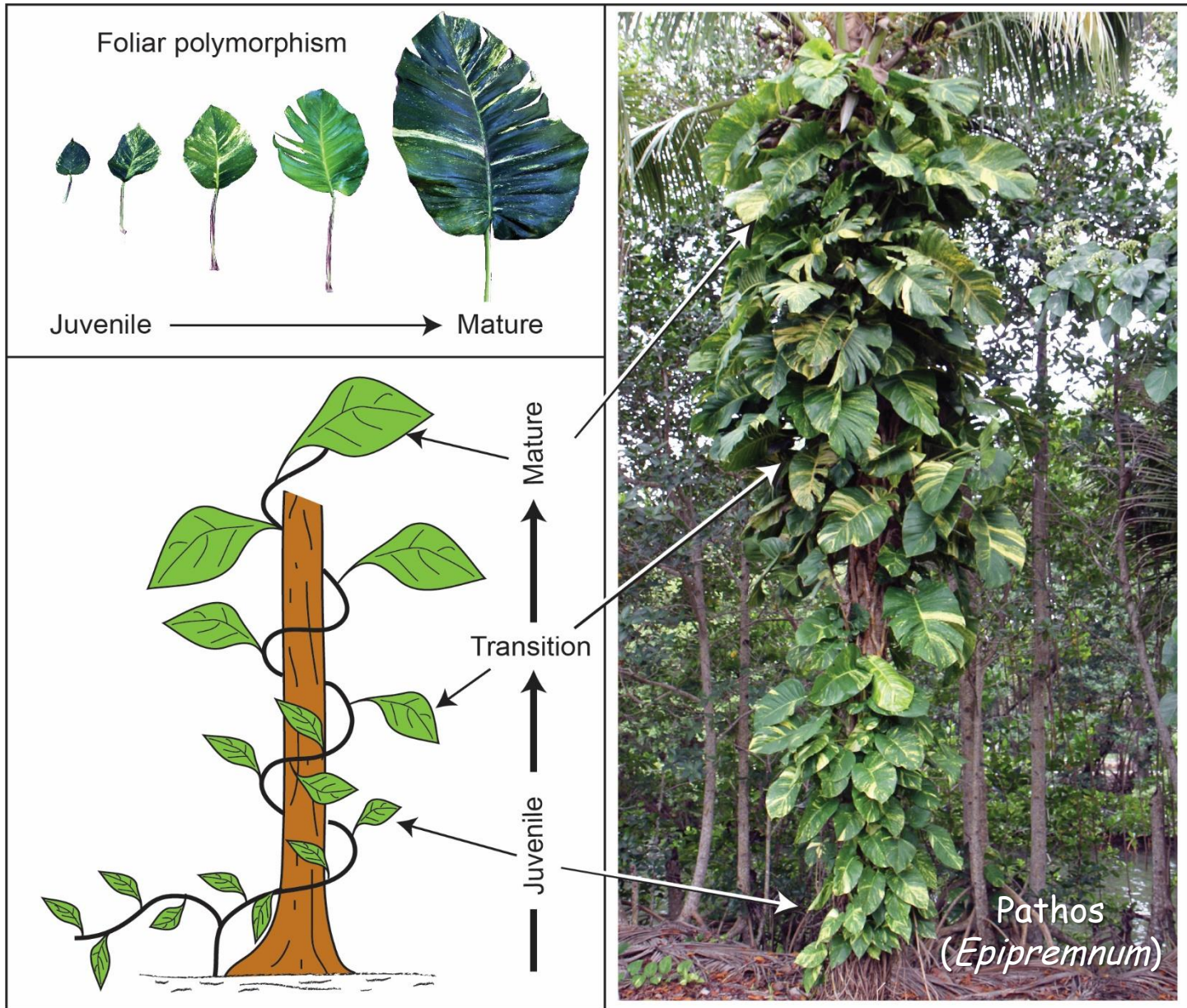
Phase change

Maturation can be
gradual (**homoblastic**)
or
abrupt (**heteroblastic**).

False aralia
(*Pterandra elegantissima*)

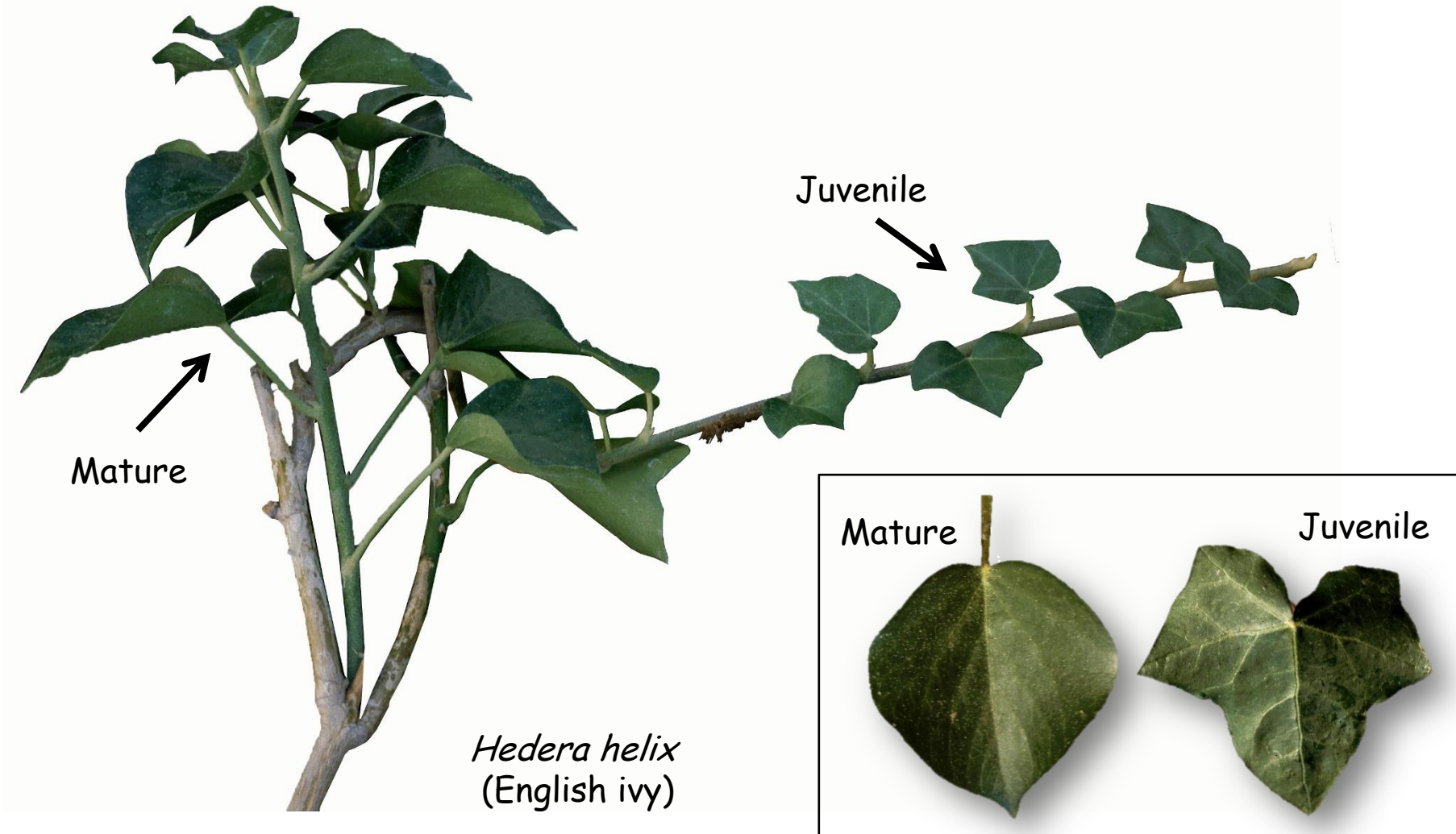


Phase change



Phase change

English ivy has been used historically a model plant for studying phase change because of its distinct growth forms in each phase.



Phase change

Juvenility was the subject of one of the first IPPS presentations published in Volume 1 of the proceedings in 1950.

The Effect of Juvenility on Plant Propagation

By F. L. O'ROURKE

Michigan State College

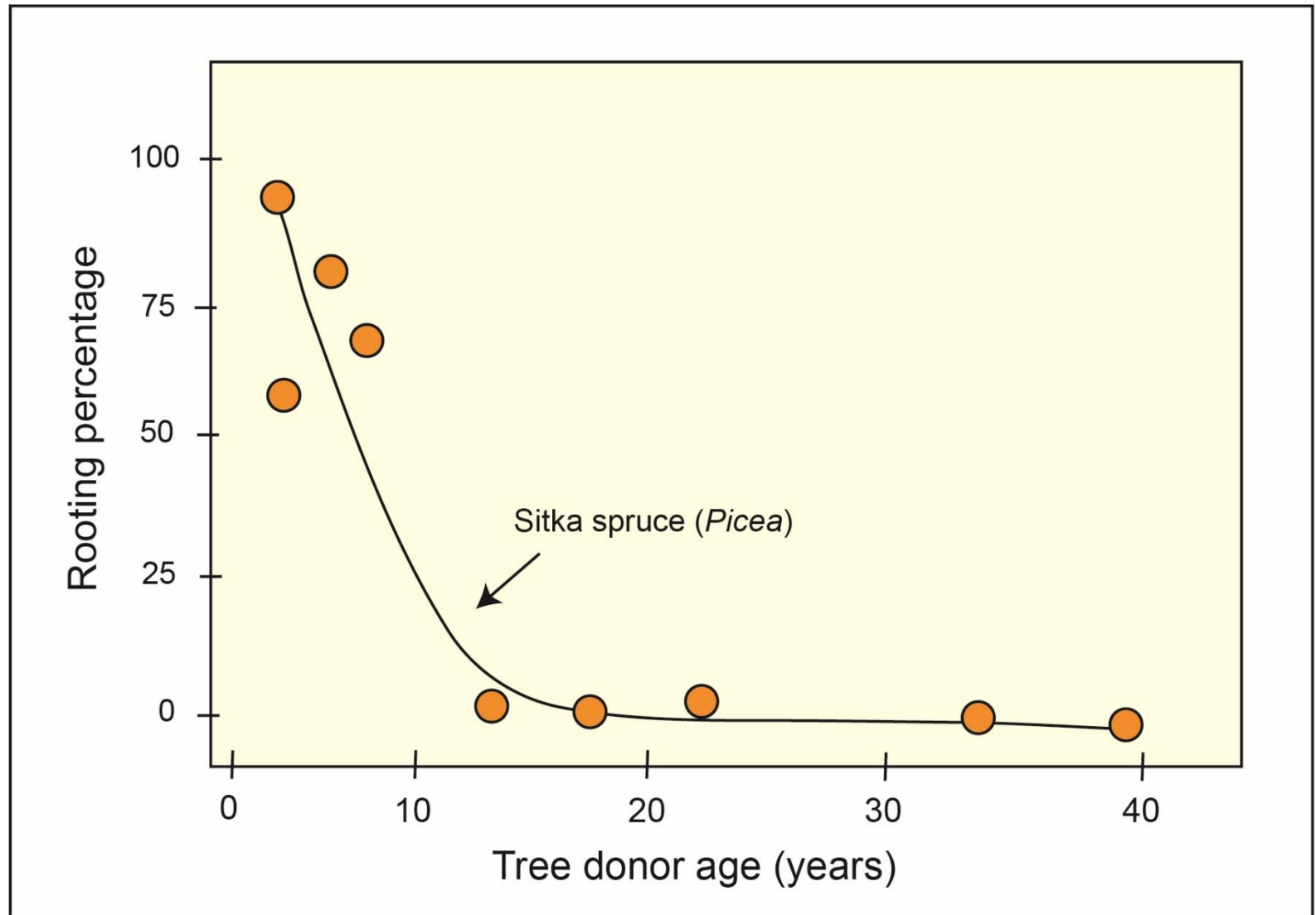
Practical plant propagators have long known that cuttings taken from young seedling plants root much more readily than cuttings from mature plants of the same species. Goebel (11), in 1900 mentioned this relative ease of propagation in younger individuals and established the term "juvenility" to describe the physiological condition involved. Juvenility may or may not be accompanied by morphological differences from the mature individual, such as different leaf shapes, thorniness, or other growth characteristics. In many species, however, the superficial appear-

Phase change



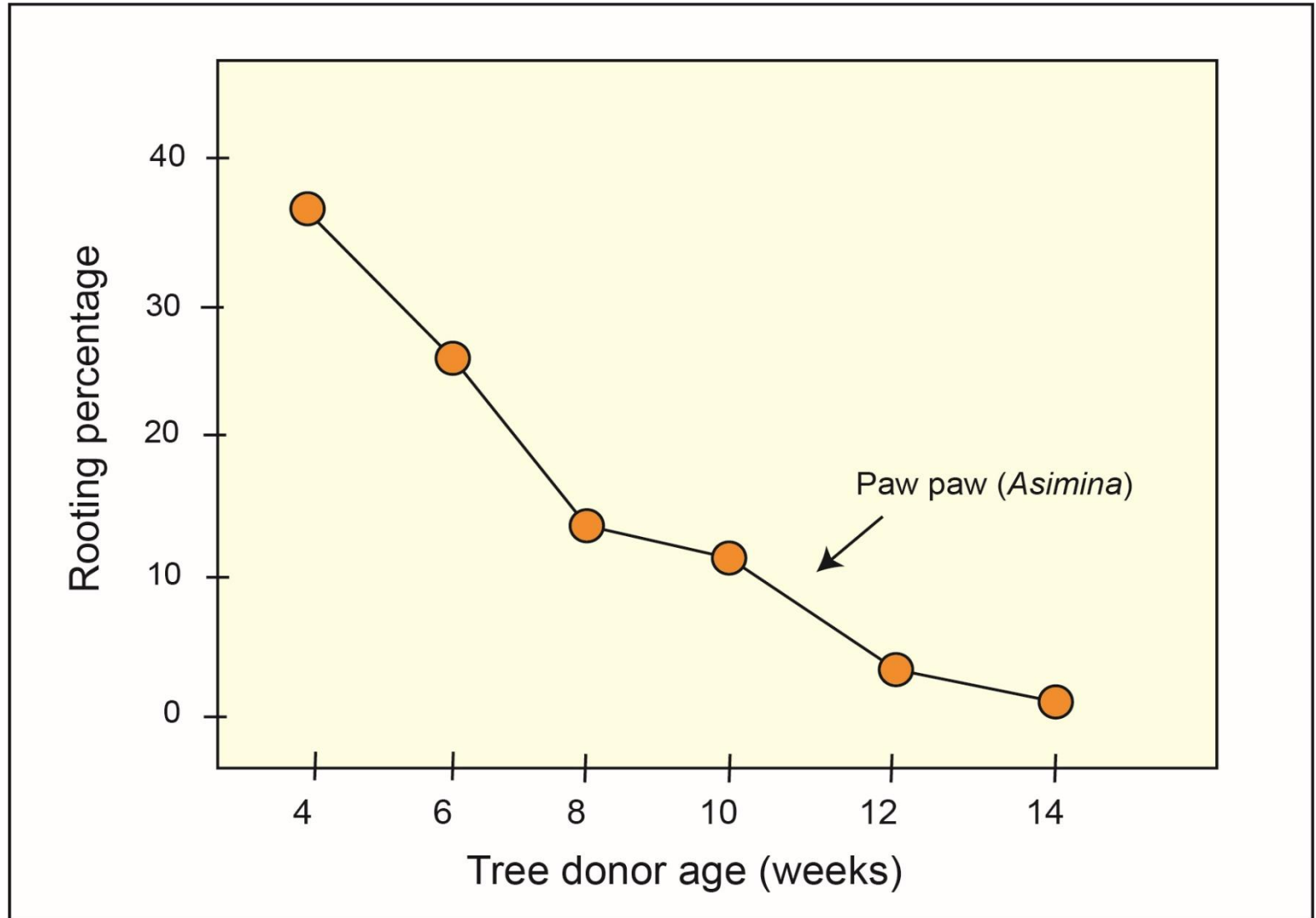
Dwarf Alberta spruce (*Picea glauca* 'Conica')

Phase change

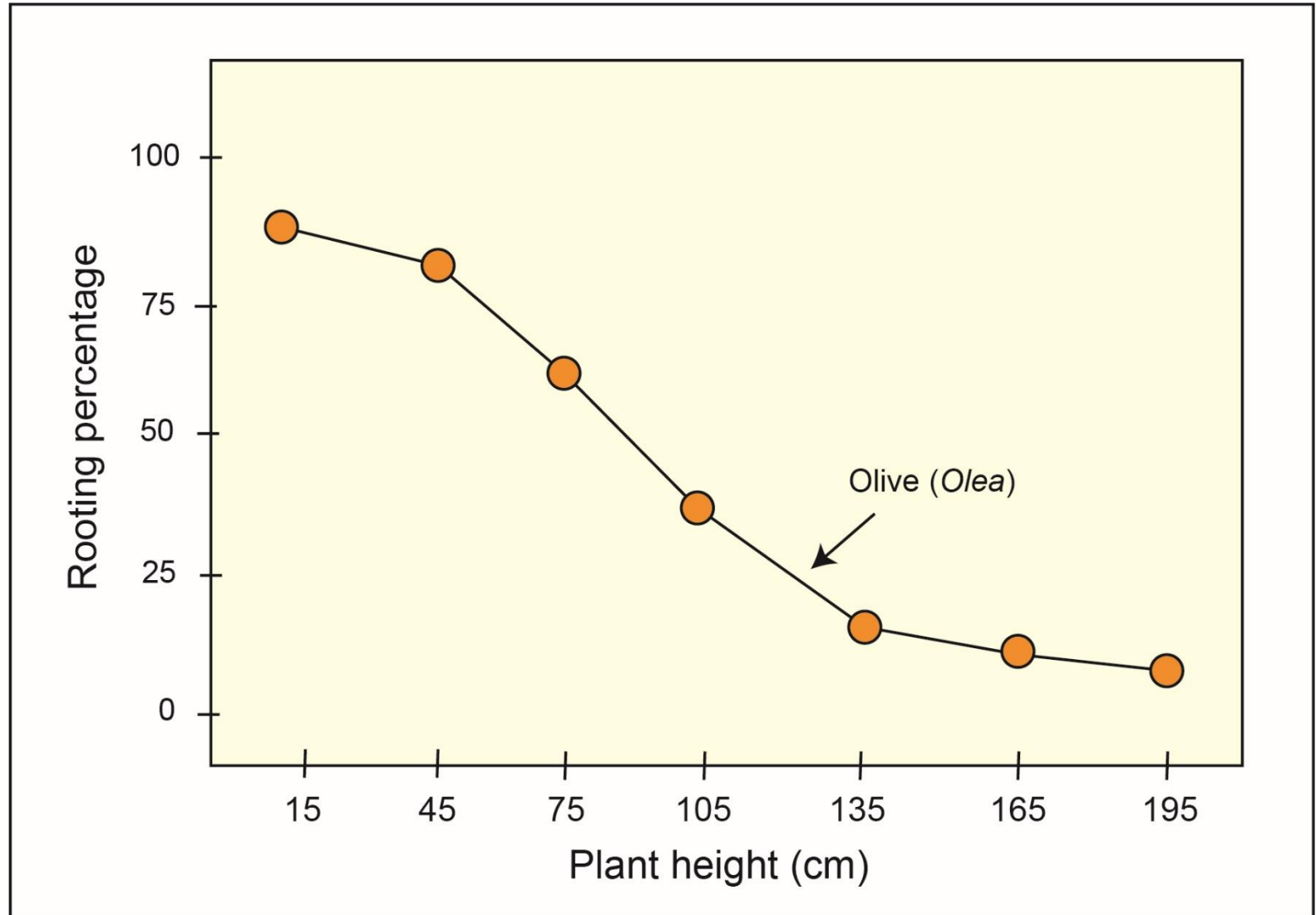


From Greenwood *et al.* 1993, *Clonal Forestry*

Phase change



Phase change



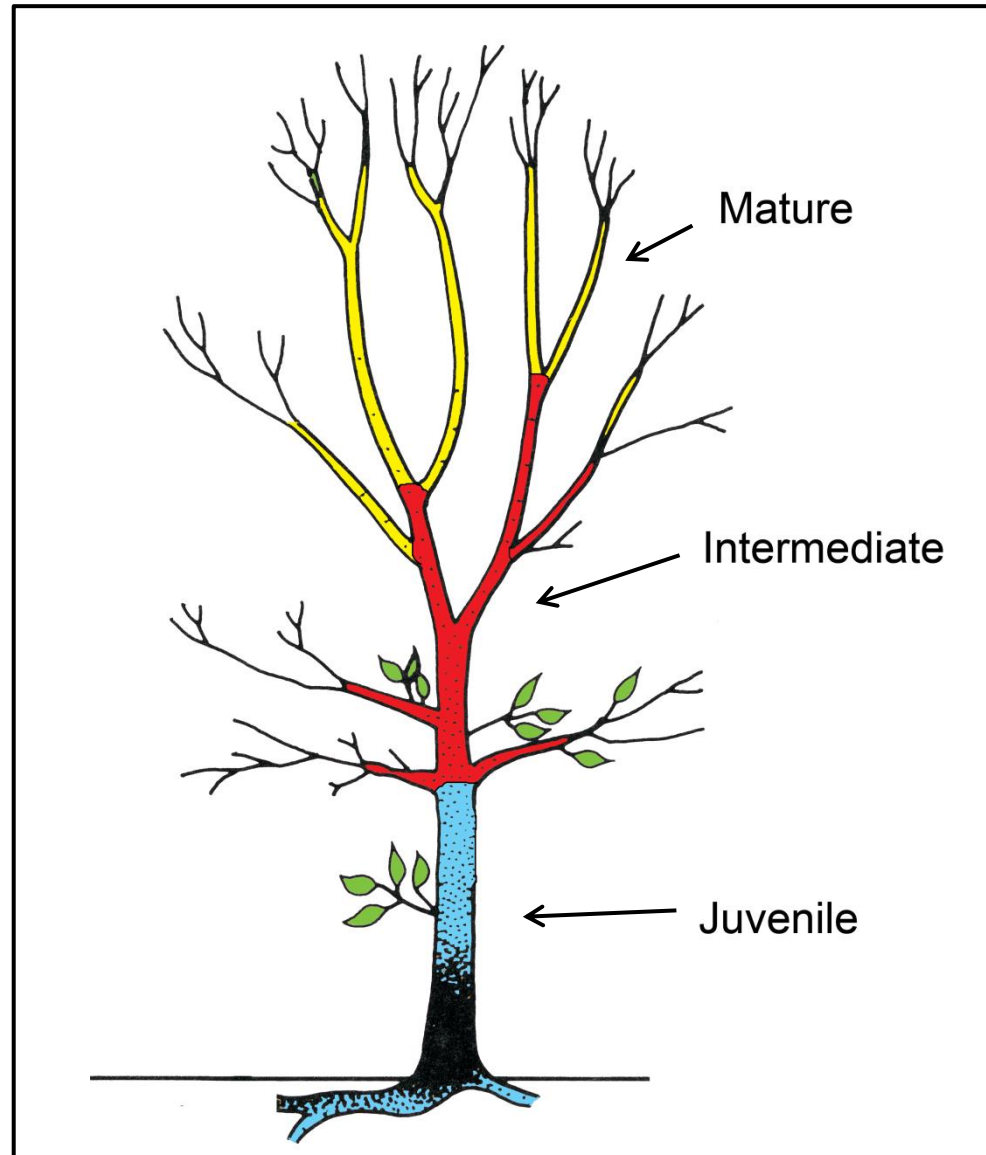
From Porlingis and Therios, *J. Hort. Sci.* 1976.

Phase change

Juvenility

There is a paradox in the way a plant goes through ontogenetic aging.

The most recent or chronologically newest growth is ontogenetically the most mature.

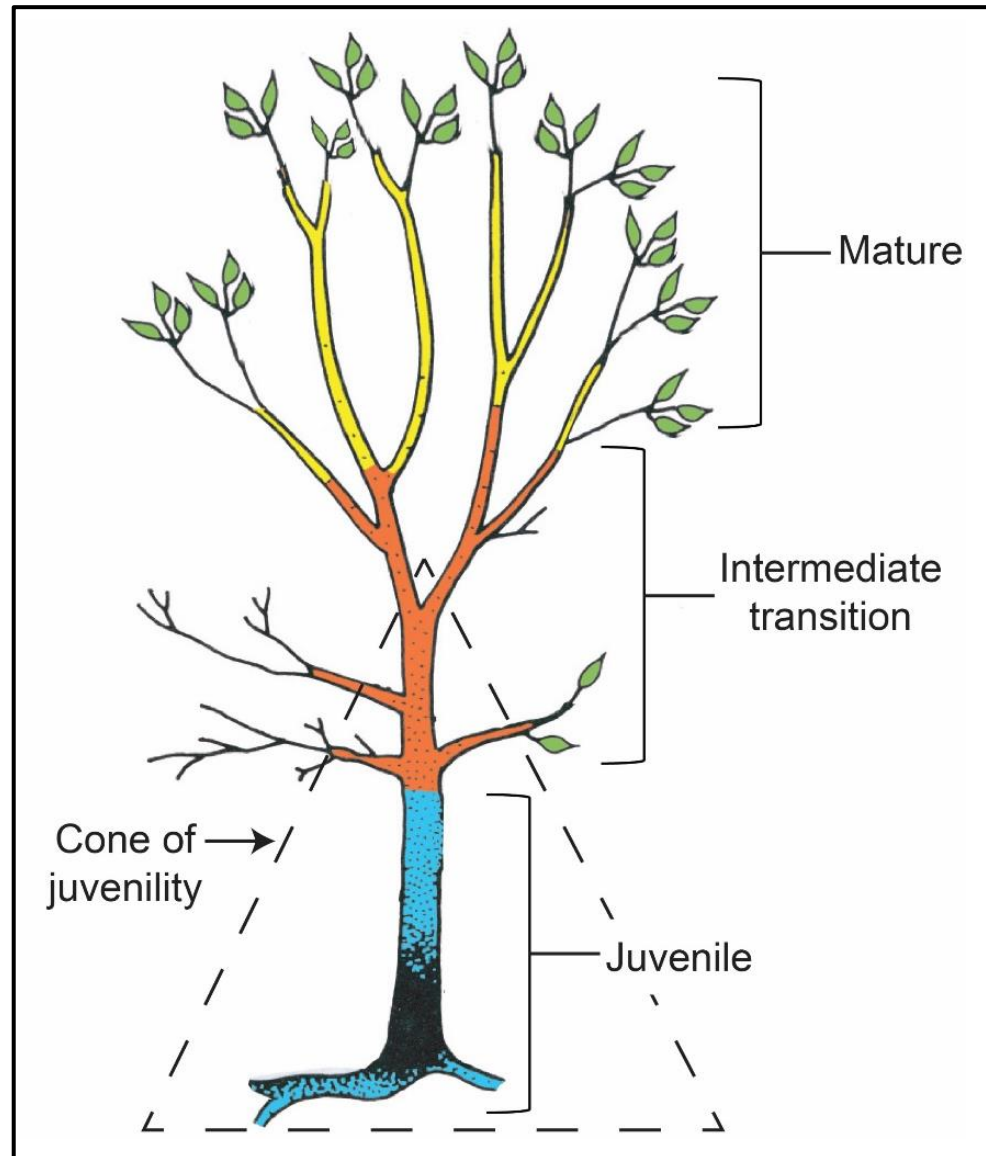


Phase change

Juvenility

The chronologically oldest part of the plant retains its juvenile characteristics.

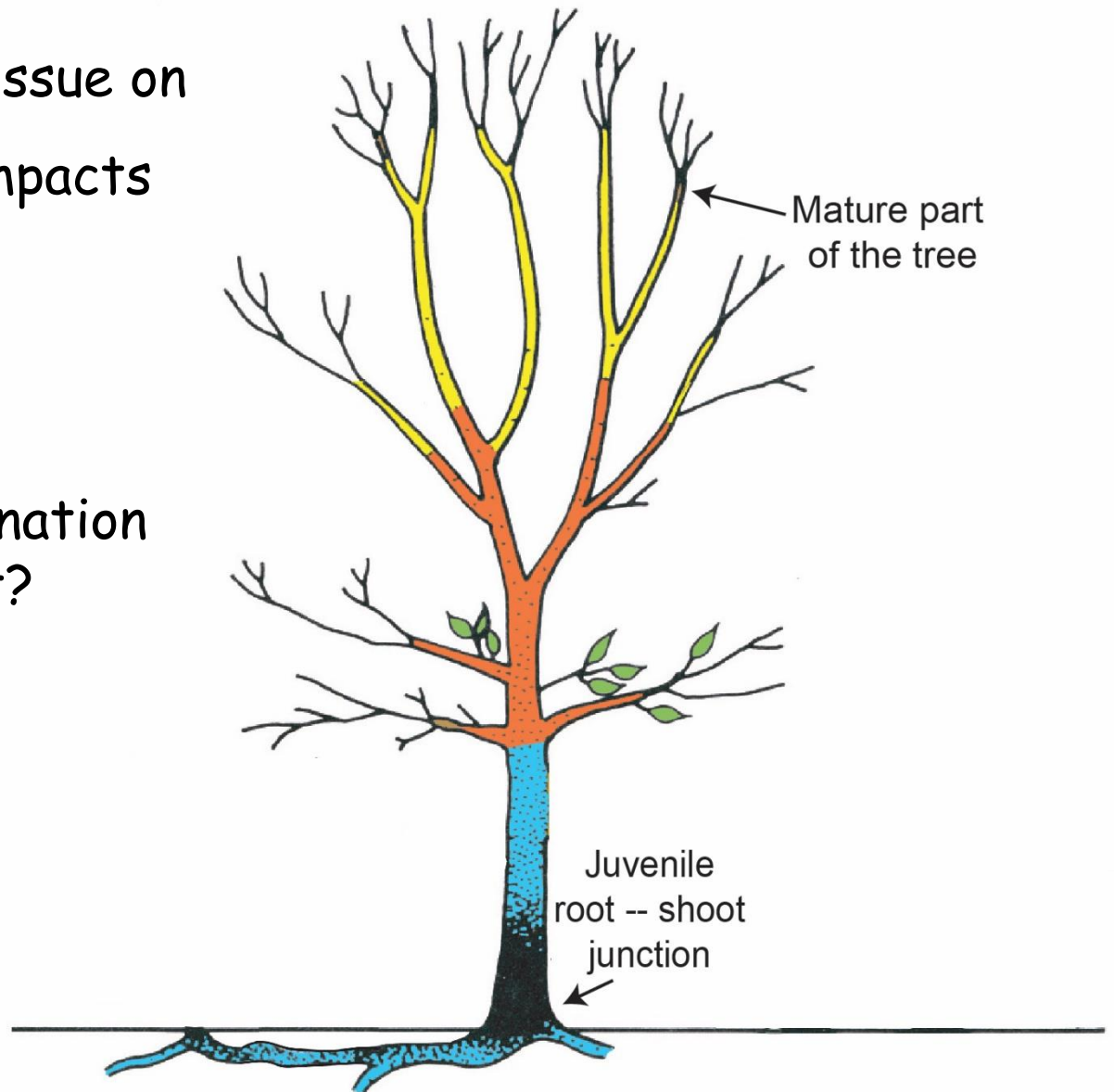
This is termed the cone of juvenility.



Rejuvenation

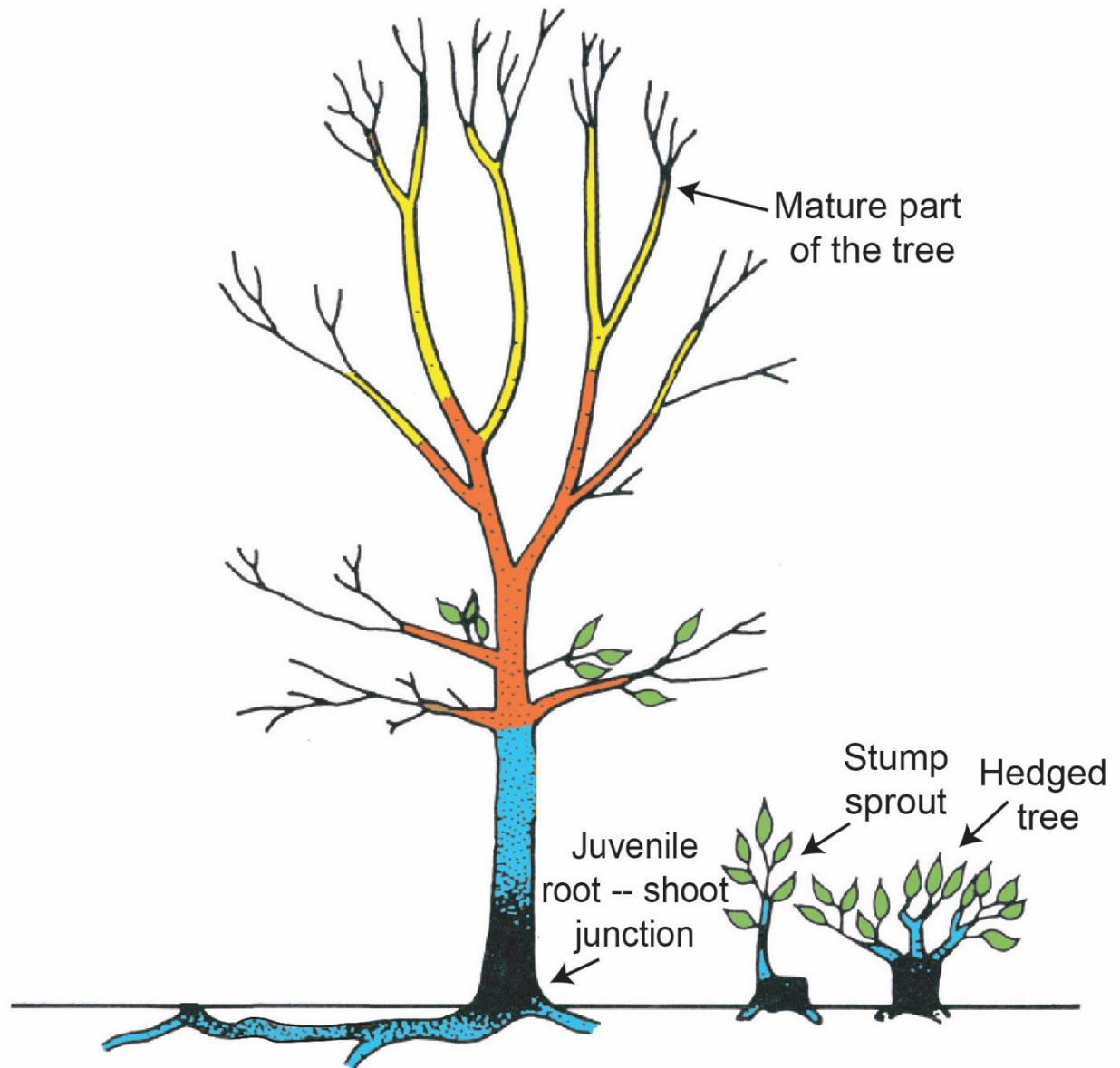
Different source tissue on the mother plant impacts rooting potential.

Can we induce rejuvenation in a mature plant?



Rejuvenation

Stump sprouts

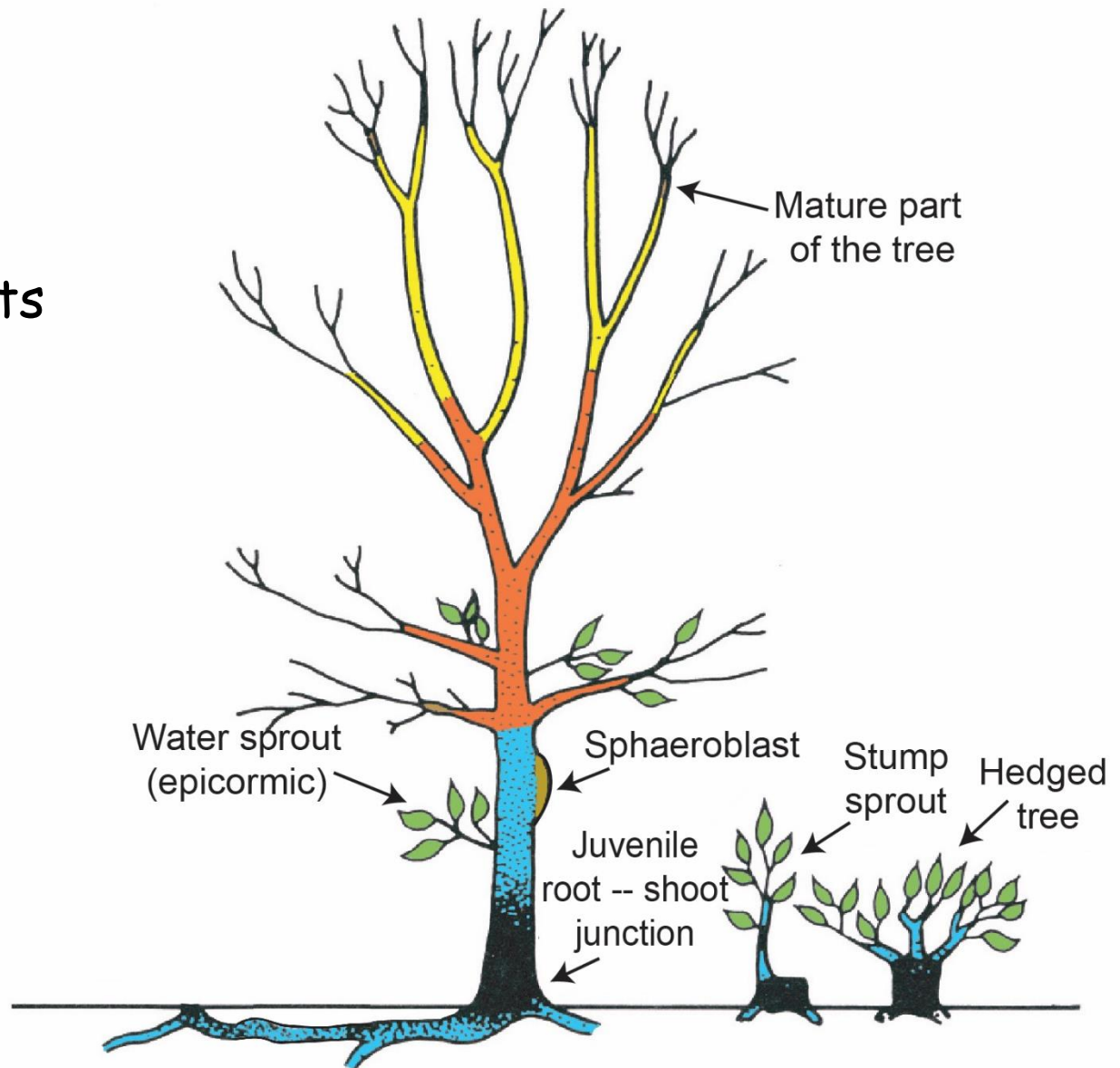


Rejuvenation

Stump sprouts

Epicormic shoots

Sphaeroblasts



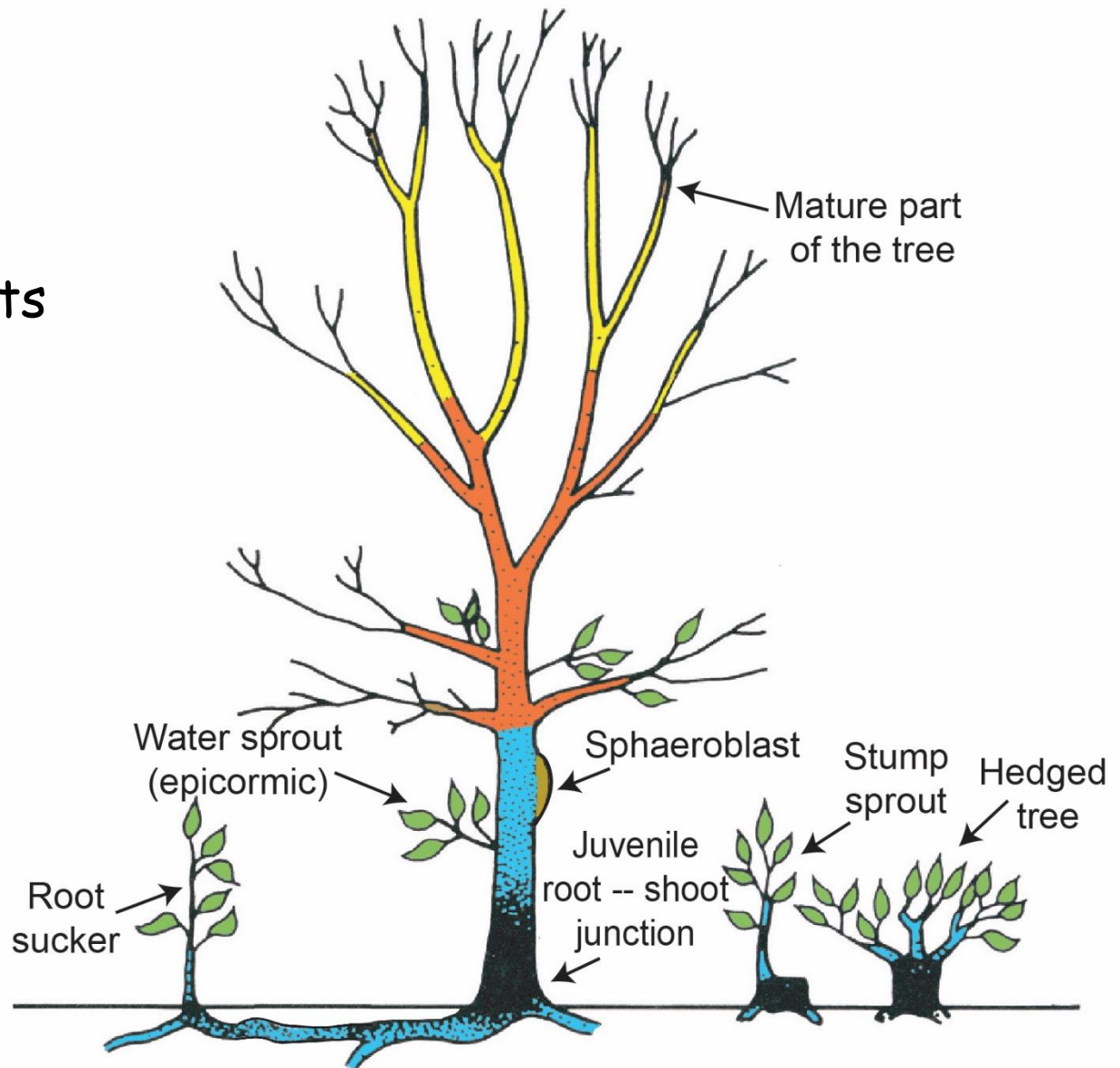
Rejuvenation

Stump sprouts

Epicormic shoots

Sphaeroblasts

Root suckers



Rejuvenation

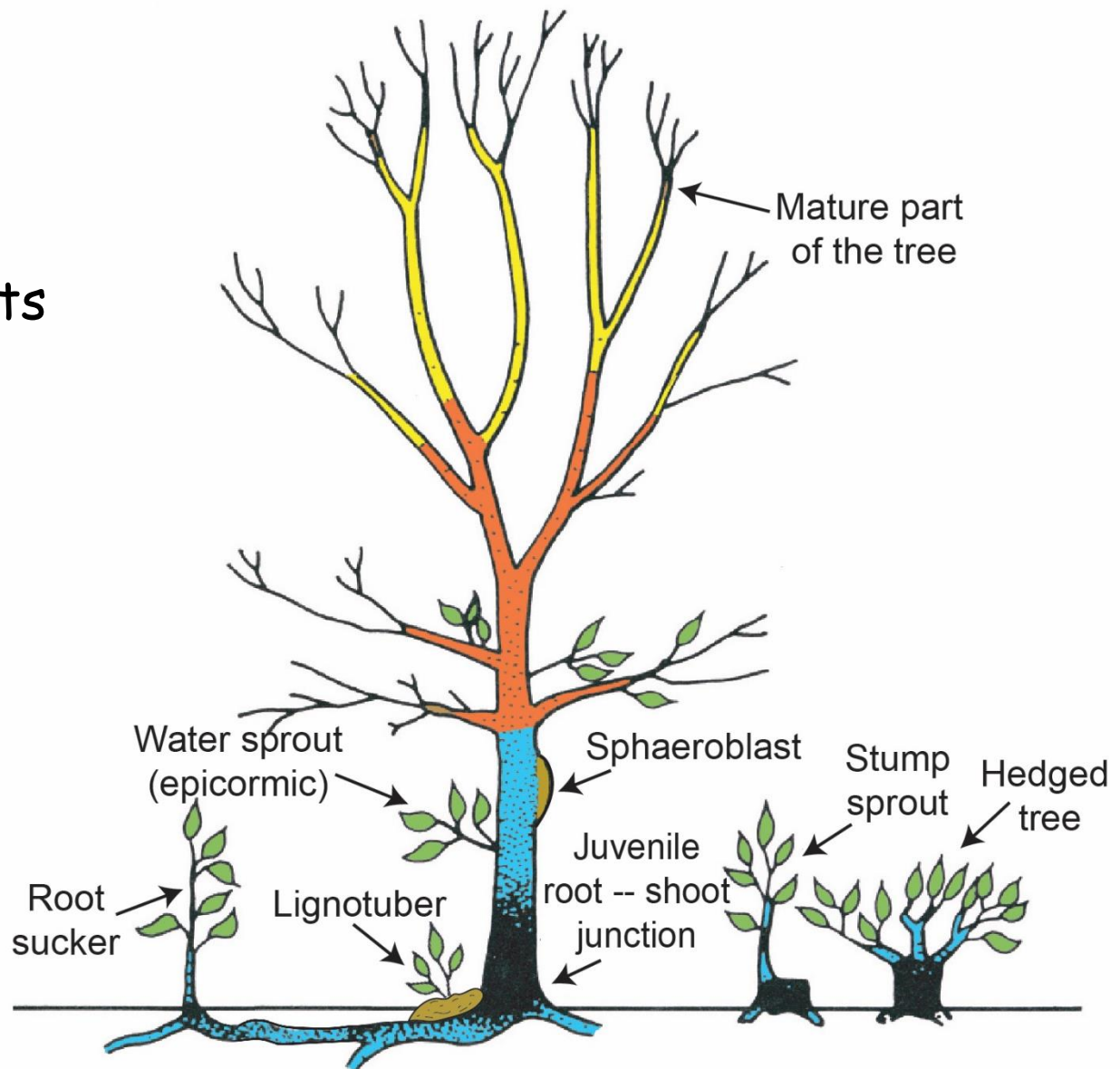
Stump sprouts

Epicormic shoots

Sphaeroblasts

Root suckers

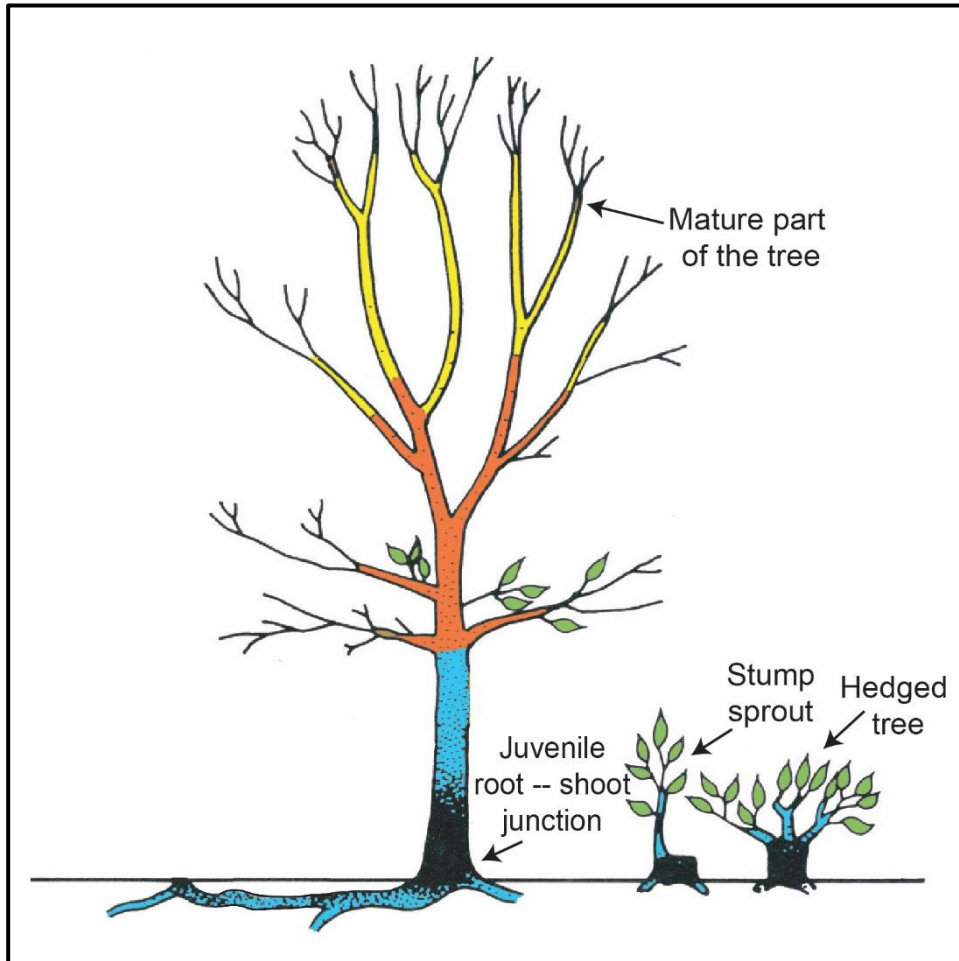
Lignotubers



Rejuvenation

Stump sprouts

Shoots arising around the root shoot junction are juvenile.



Rejuvenation

Stump sprouts

Rooting potential in stump sprouts in elm.

> 10 feet
Rooting - 38%

6 to 10 feet
Rooting - 64%

< 1 foot
Rooting - 83%



Schreiber and Kawase,
Hort Sci. 1975.

Rejuvenation

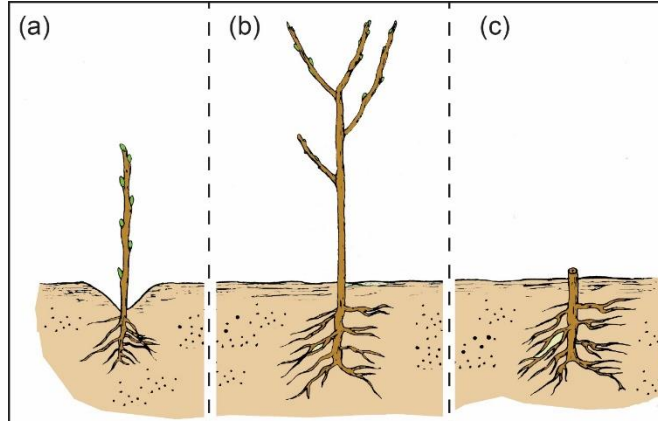
Stump sprouts

Combining etiolation with stump sprout shoot initiation can further enhance rooting capacity.



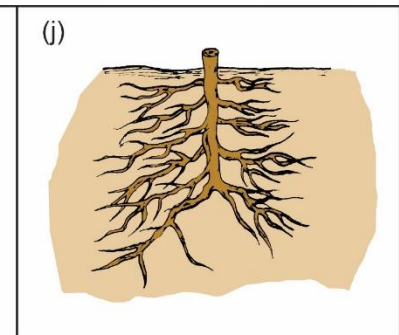
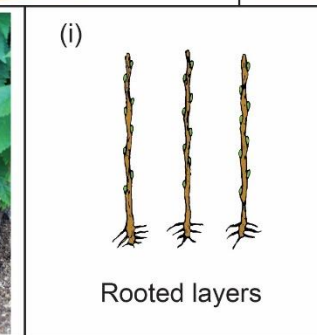
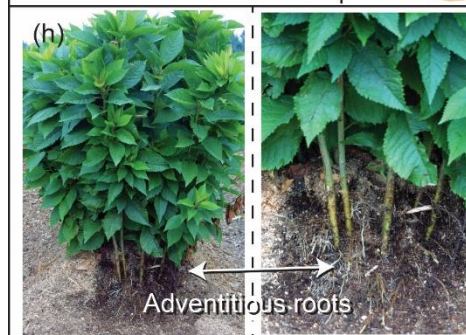
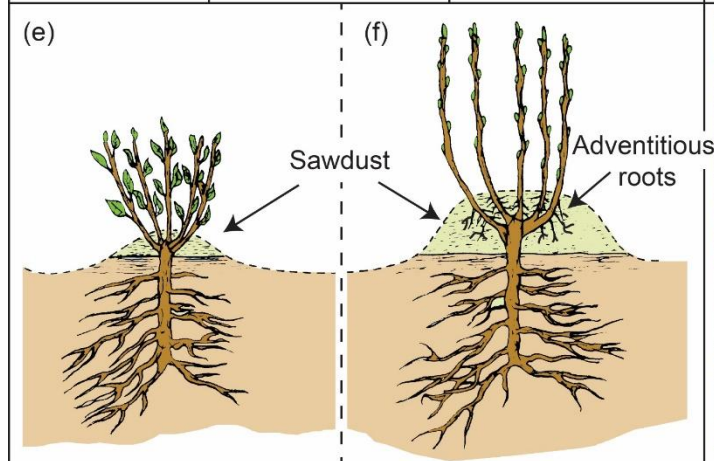
Rejuvenation

Stooling or mound layering.



Juvenile shoots

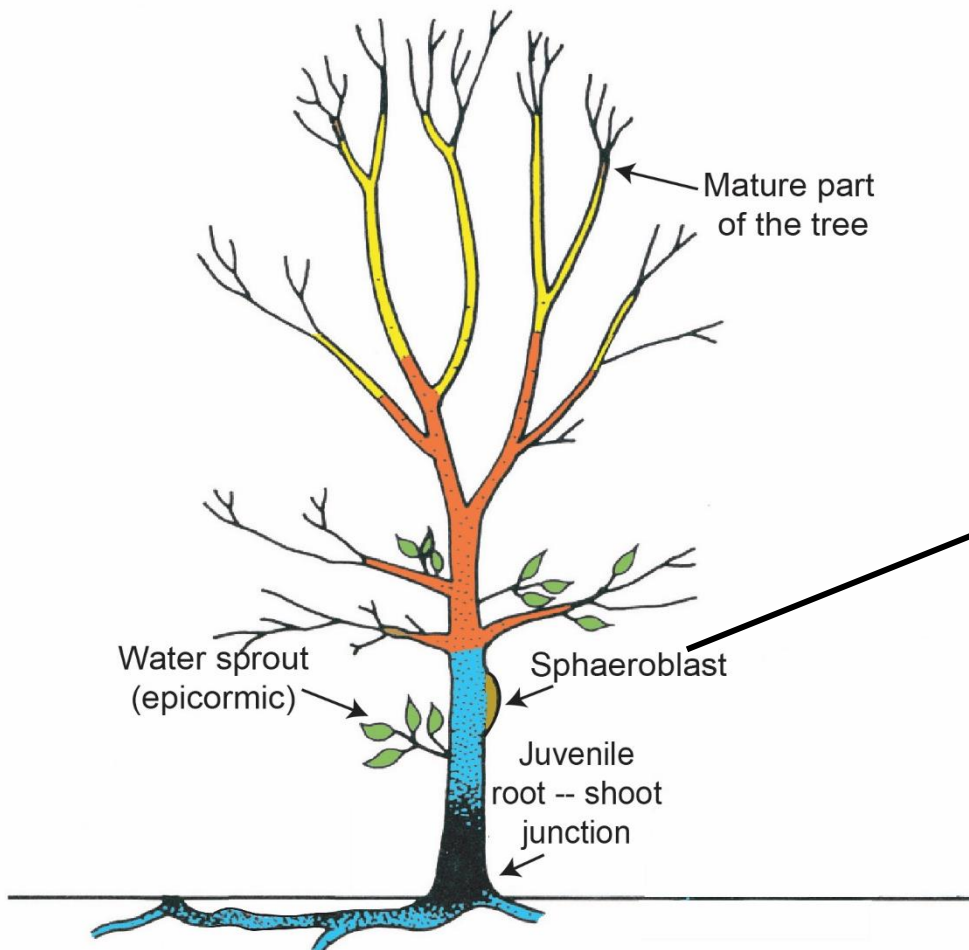
Etiolation



Rejuvenation

Epicormic shoots

Epicormic sprouts form from latent buds just under the bark.



Epicormic shoots in sycamore

Rejuvenation

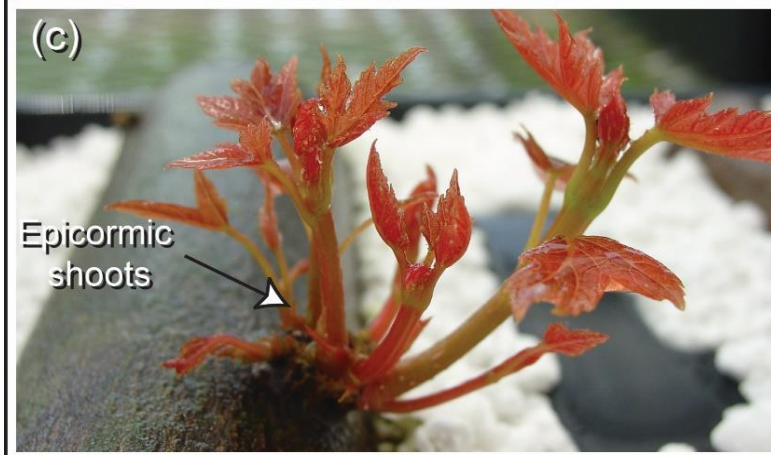
Epicormic shoots

Cut branches can be induced to produce epicormic shoots that can be used as traditional cuttings with a higher rooting potential.



Rejuvenation

Epicormic shoots



Rejuvenation

Epicormic shoots

For red maple

6.5 shoots per hardwood stem

59% rooting

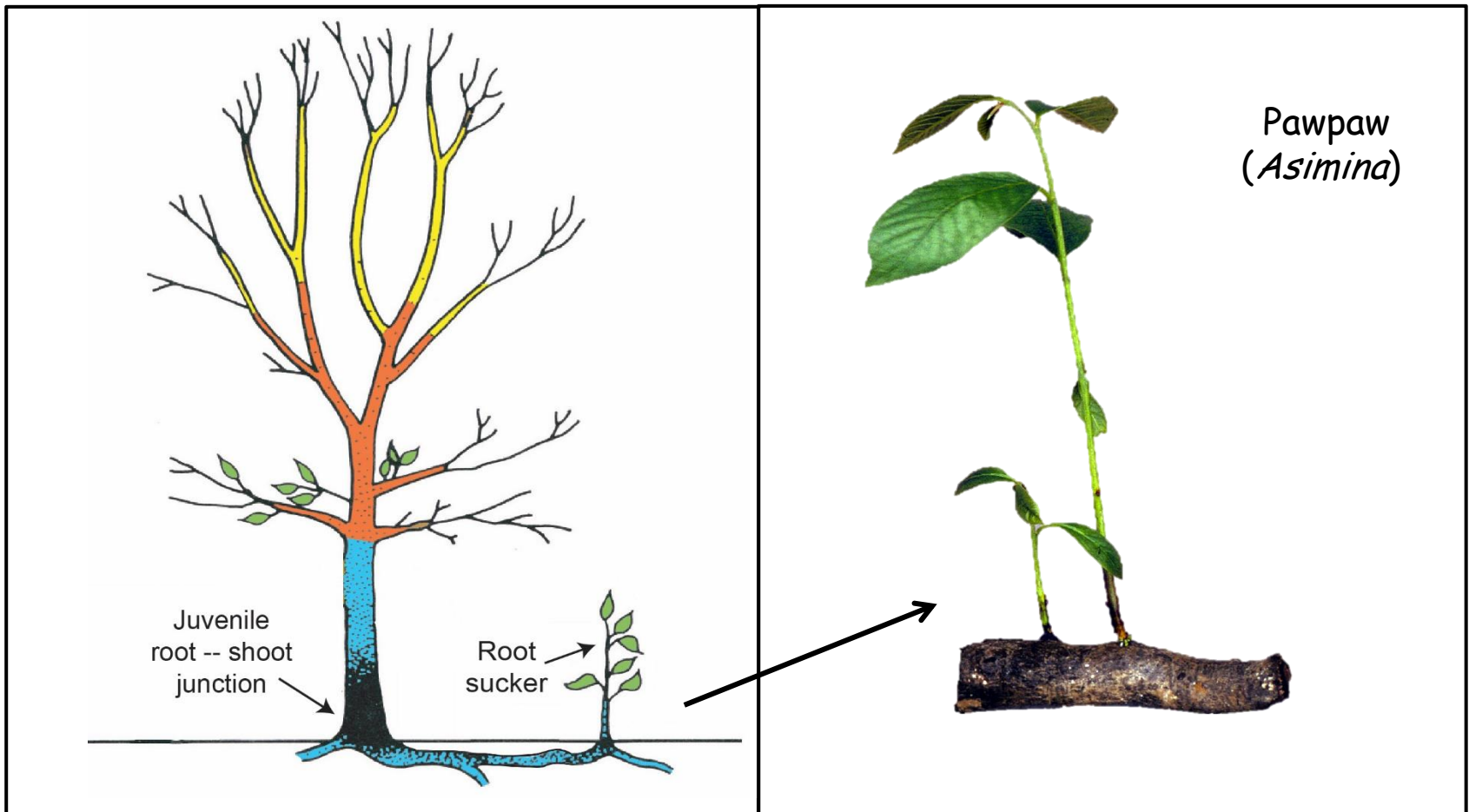


Henry and Preece, HortScience 1997

Rejuvenation

Root suckers

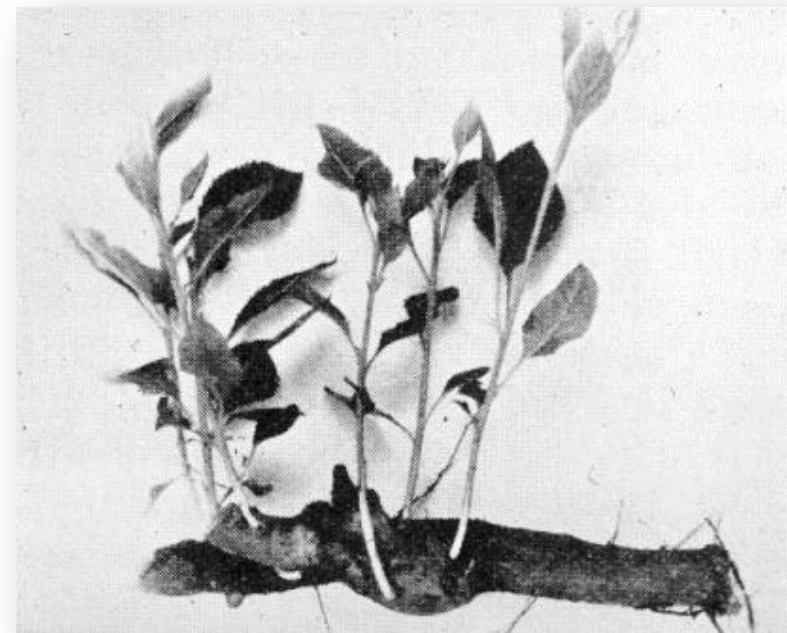
Roots are considered juvenile and therefore, adventitious shoots formed on roots are also juvenile.



Rejuvenation

Adventitious shoots from root cuttings

Shoot induction from roots of crab apple.



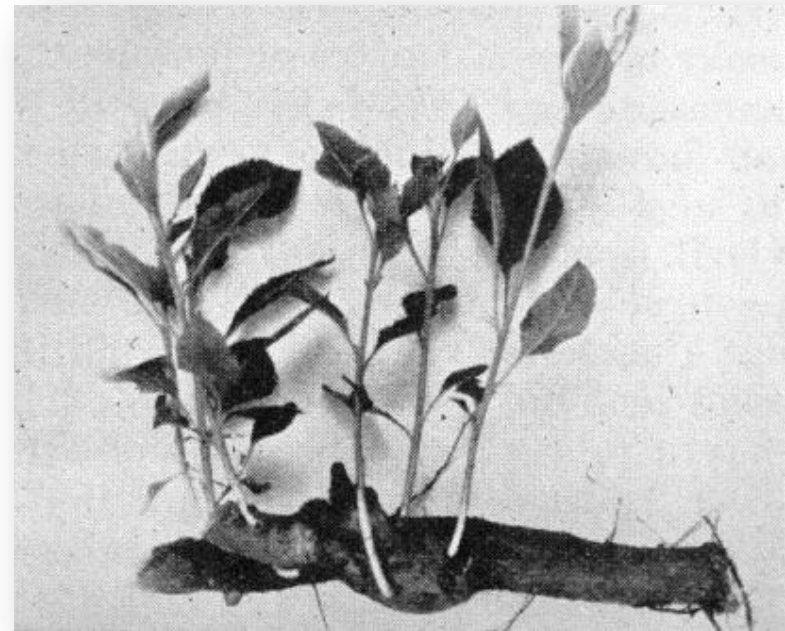
Stoutmeyer, 1937.

Rejuvenation

Adventitious shoots from root cuttings

Cuttings from mature stock plants of crab apple fail to root. However, cuttings taken from shoots induced on roots root well.

Species	Rooting %
Sargent's crab	81
Siberian crab	62
Virginia crab	36

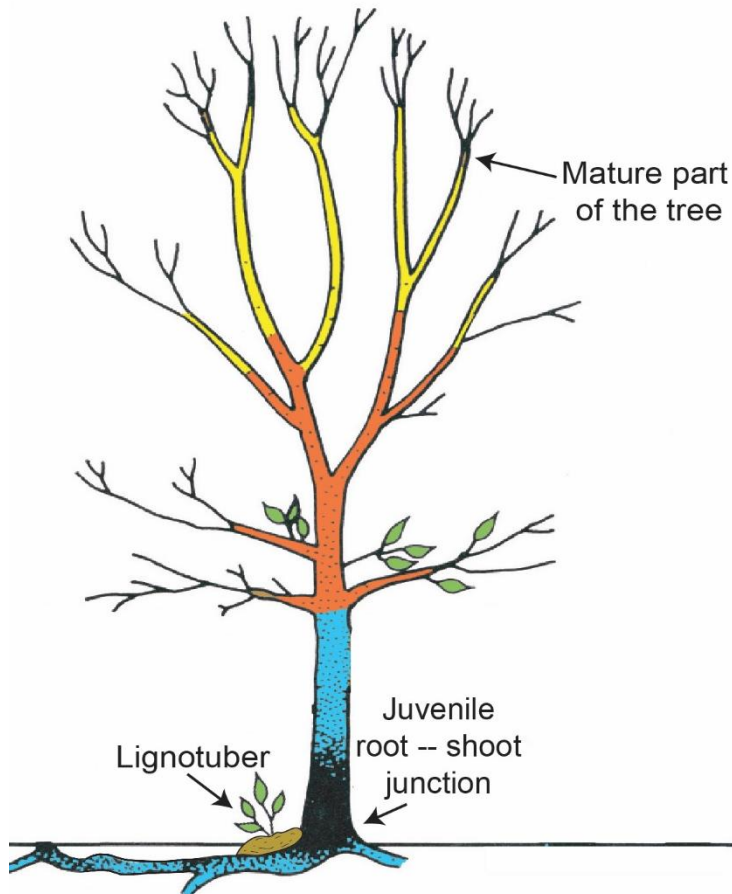


Stoutmeyer, 1937.

Rejuvenation

Lignotubers

A lignotuber is swollen stem tissue at the root/shoot junction.
Lignotubers have a high capacity for shoot formation.



Rejuvenation

Lignotubers



Ginkgo

Rejuvenation

Lignotubers



Redwood
(*Sequoiadendron*)

Rejuvenation

Lignotubers

Eucalyptus lignotubers



Rejuvenation

Micropropagation

Cuttings that are difficult-to-root from mature stock plants often can be rooted from microcuttings.



Rejuvenation

Second Generation Cuttings

This rejuvenation can carryover to new plants for a short time.



Second generation cuttings
in eastern redbud.

Rejuvenation

Second Generation Cuttings

Cuttings from birch before and after micropropagation show a typical rejuvenation / invigoration.

Cutting type	Rooting %
Seedling	87
Mature	31
Microcutting	95
Second generation	75

Struve and Lineberger, Can. J. For. Res. 1988.



Rejuvenation

Micropropagation

Second generation cuttings in red maple.

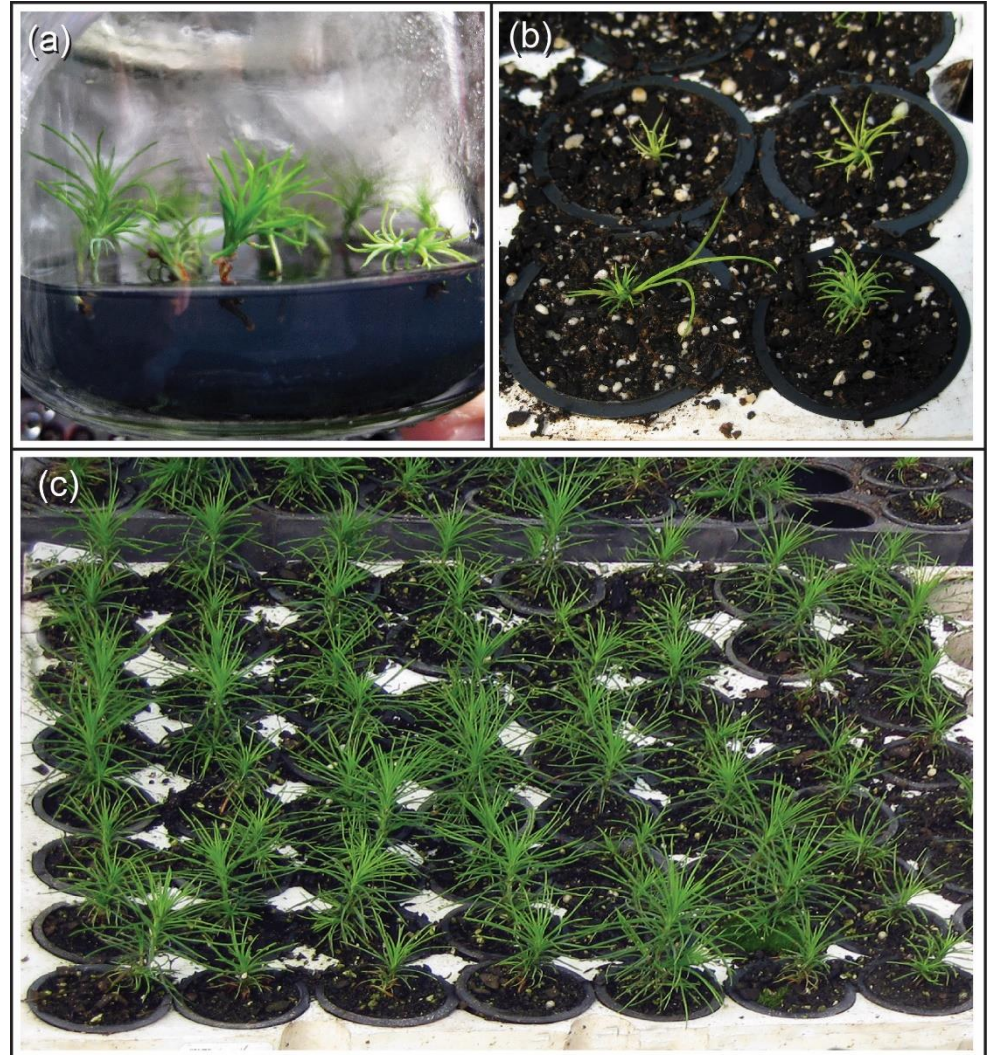


Rejuvenation

Somatic embryogenesis

Rejuvenation via
somatic embryogenesis.

Stock plants for
cutting propagation.



Stock plant management

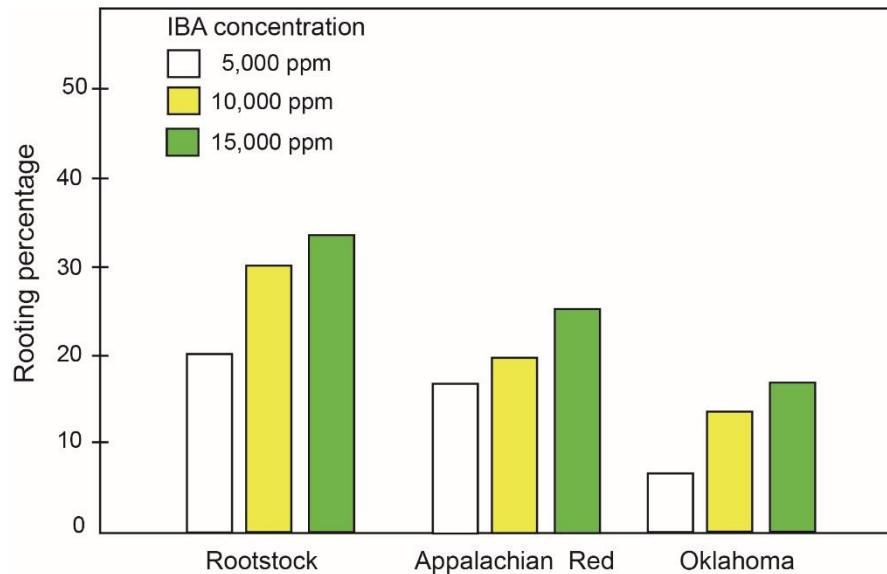
There are three basic stock plant management principles related to phase change that can lead to cutting success.

- Initial selection of juvenile material
(stump sprouts, lignotubers or tissue culture)
- Managed stock plant
(nutrition and hedging)
- Timely removal of cuttings
(to keep cutting wood from maturing)

Stock plant management

Stock plant management

Field stock plant hedging



Stock plant management

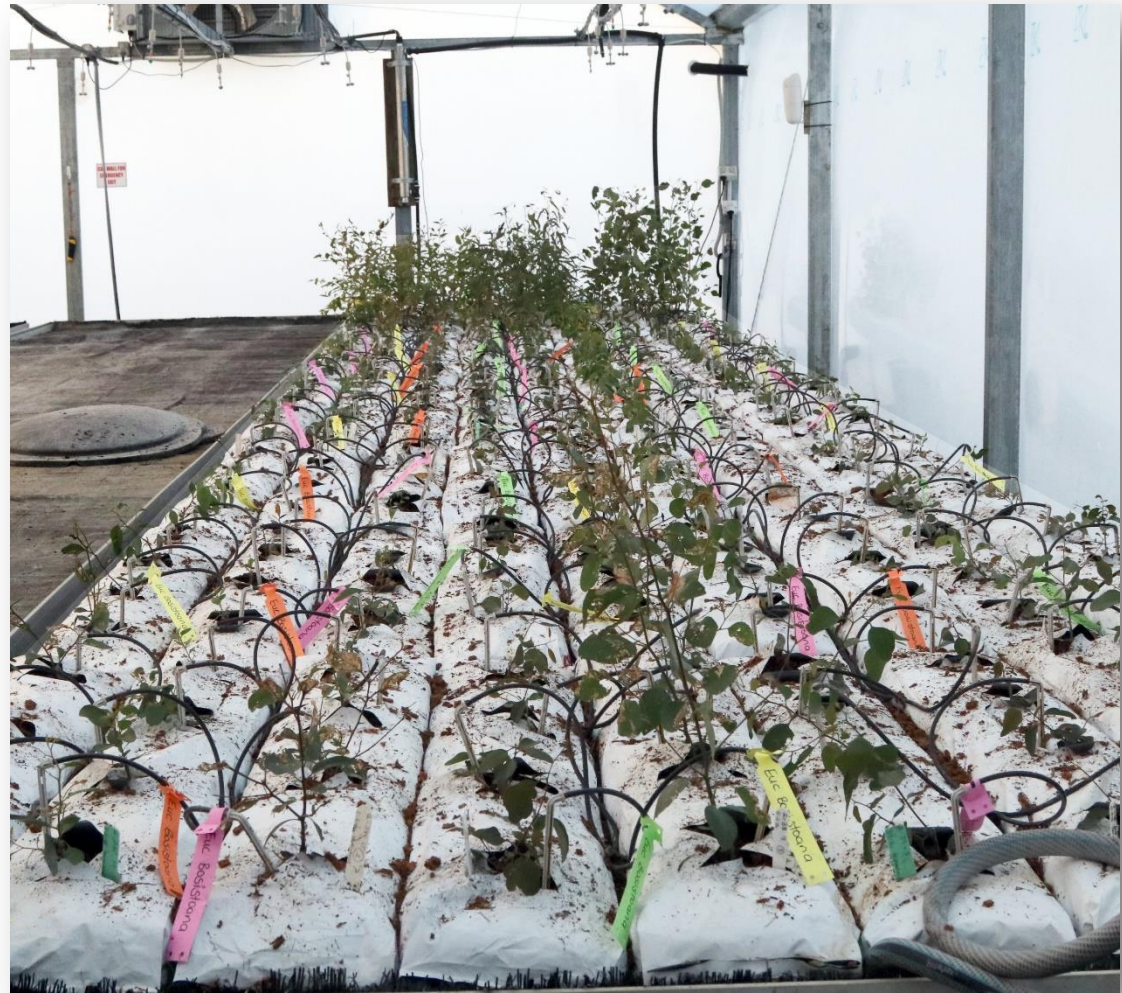
Stock plant management

Eucalyptus

Initial shoots from
lignotubers.

Semi-hydroponic stock
plant management.

Minicuttings.



Stock plant management

Stock plant management



Redbud (*Cercis*)
stock plants

Cyclophysis

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