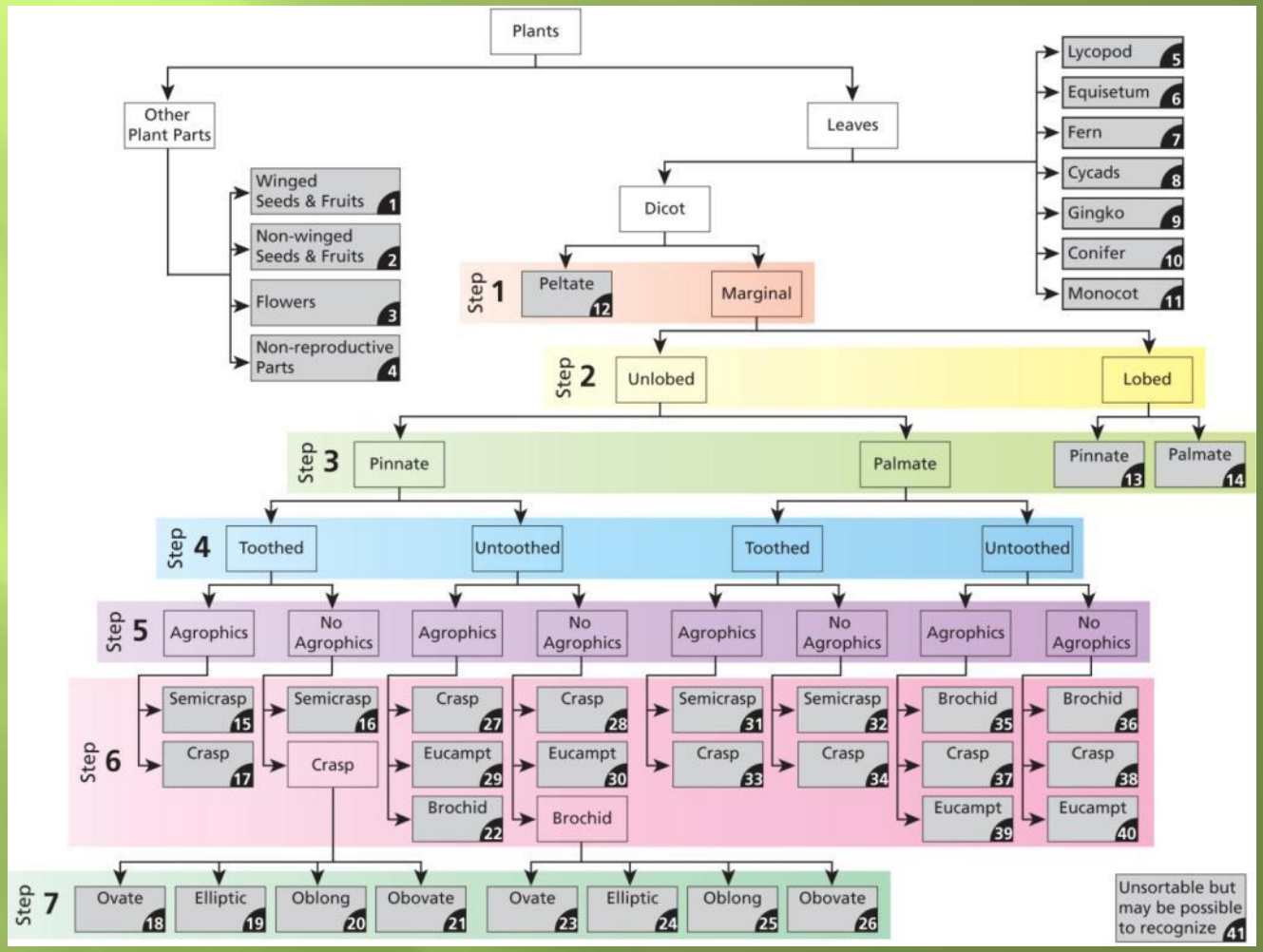
Leaf Classification



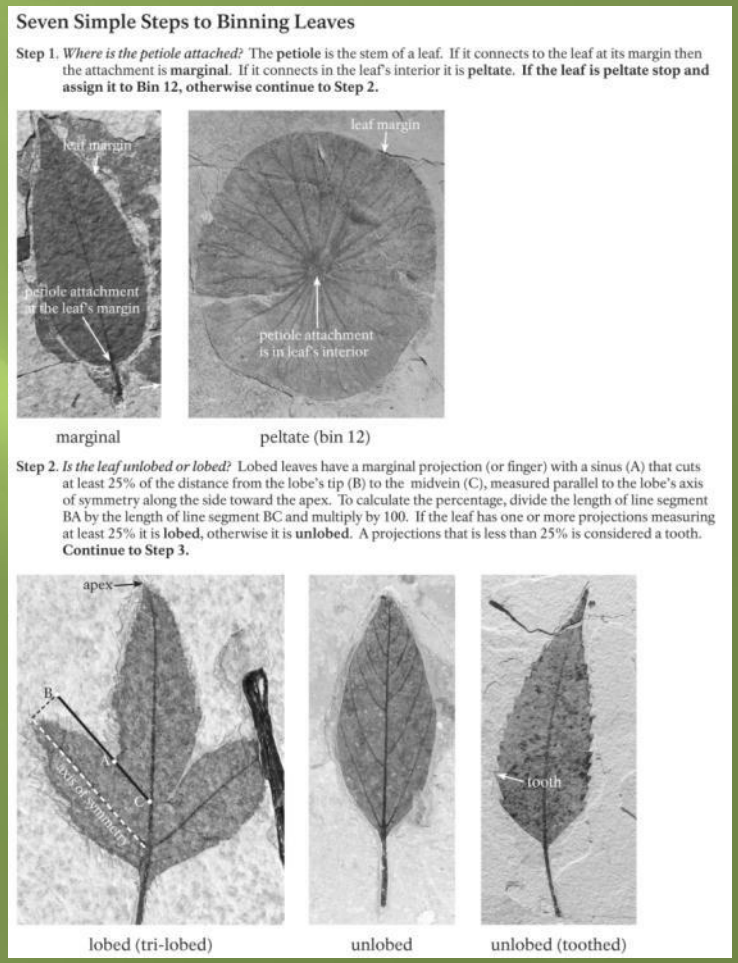
Materials

You will need:

- ✓ *Demo leaf photo sheet*

You will need:

- ✓ *Demo leaf photo sheet*
- ✓ *Seven Simple Steps to Binning Leaves*



Seven Simple Steps to Binning Leaves

Step 1. *Where is the petiole attached?* The **petiole** is the stem of a leaf. If it connects to the leaf at its margin then the attachment is **marginal**. If it connects in the leaf's interior it is **peltate**. **If the leaf is peltate stop and assign it to Bin 12, otherwise continue to Step 2.**

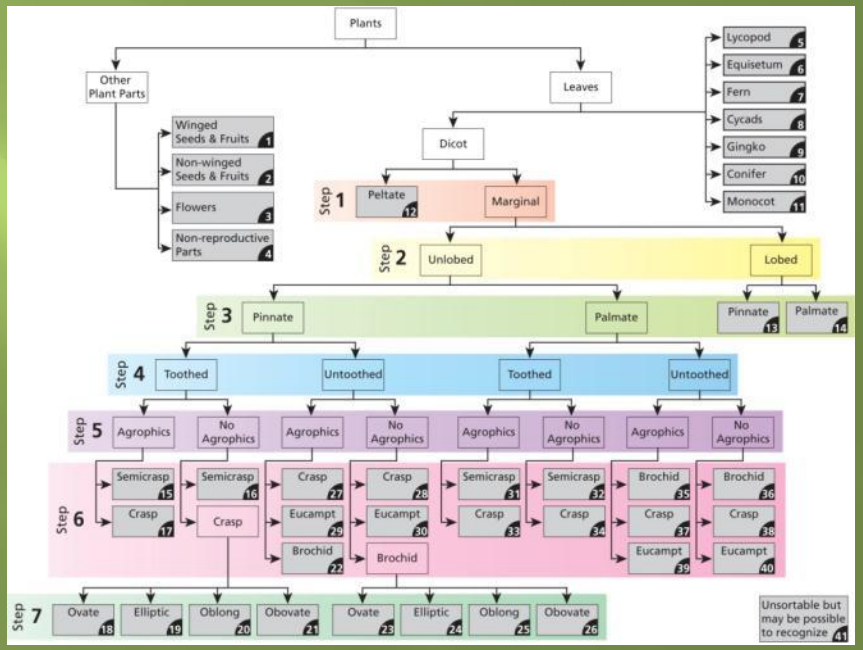
marginal peltate (bin 12)

Step 2. *Is the leaf unlobed or lobed?* Lobed leaves have a marginal projection (or finger) with a sinus (A) that cuts at least 25% of the distance from the lobe's tip (B) to the midvein (C), measured parallel to the lobe's axis of symmetry along the side toward the apex. To calculate the percentage, divide the length of line segment BA by the length of line segment BC and multiply by 100. If the leaf has one or more projections measuring at least 25% it is **lobed**, otherwise it is **unlobed**. A projections that is less than 25% is considered a tooth. **Continue to Step 3.**

lobed (tri-lobed) unlobed unlobed (toothed)

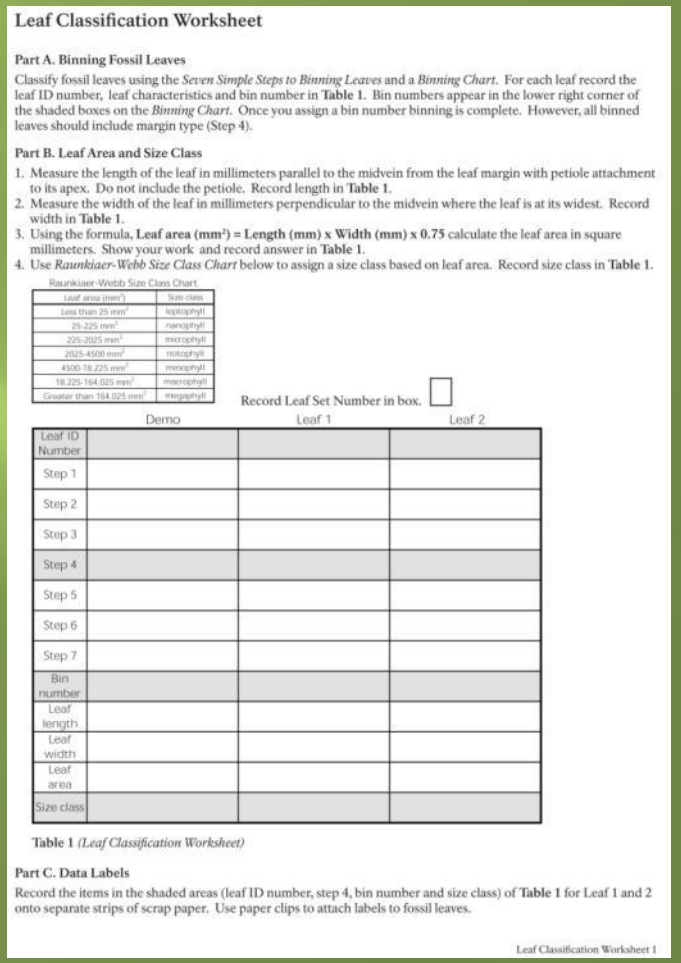
You will need:

- ✓ *Demo leaf photo sheet*
- ✓ *Seven Simple Steps to Binning Leaves*
- ✓ *Binning Chart*



You will need:

- ✓ *Demo leaf photo sheet*
- ✓ *Seven Simple Steps to Binning Leaves*
- ✓ *Binning Chart*
- ✓ *Leaf Classification Worksheet*



Leaf Classification Worksheet

Part A. Binning Fossil Leaves

Classify fossil leaves using the *Seven Simple Steps to Binning Leaves* and a *Binning Chart*. For each leaf record the leaf ID number, leaf characteristics and bin number in **Table 1**. Bin numbers appear in the lower right corner of the shaded boxes on the *Binning Chart*. Once you assign a bin number binning is complete. However, all binned leaves should include margin type (Step 4).

Part B. Leaf Area and Size Class

1. Measure the length of the leaf in millimeters parallel to the midvein from the leaf margin with petiole attachment to its apex. Do not include the petiole. Record length in **Table 1**.
2. Measure the width of the leaf in millimeters perpendicular to the midvein where the leaf is at its widest. Record width in **Table 1**.
3. Using the formula, **Leaf area (mm^2) = Length (mm) x Width (mm) x 0.75** calculate the leaf area in square millimeters. Show your work and record answer in **Table 1**.
4. Use *Raunkiaer-Webb Size Class Chart* below to assign a size class based on leaf area. Record size class in **Table 1**.

Raunkiaer-Webb Size Class Chart

Leaf area (mm^2)	Size class
Less than 25 mm^2	leptophyll
25-225 mm^2	nanophyll
225-2025 mm^2	microphyll
2025-4500 mm^2	notophyll
4500-18,225 mm^2	mesophyll
18,225-164,025 mm^2	macrophyll
Greater than 164,025 mm^2	megaphyll

Record Leaf Set Number in box. ☐

	Demo	Leaf 1	Leaf 2
Leaf ID Number			
Step 1			
Step 2			
Step 3			
Step 4			
Step 5			
Step 6			
Step 7			
Bin number			
Leaf length			
Leaf width			
Leaf area			
Size class			

Table 1 *(Leaf Classification Worksheet)*

Part C. Data Labels

Record the items in the shaded areas (leaf ID number, step 4, bin number and size class) of **Table 1** for Leaf 1 and 2 onto separate strips of scrap paper. Use paper clips to attach labels to fossil leaves.

Leaf Classification Worksheet 1

You will also need:

Ruler with centimeter scale (1 centimeter equals 10 millimeters, so each tick mark on the ruler is equal to 1 millimeter)

Calculator

Scrap paper

Paper clips

Pencil, or pen

Leaf Basics

Words you will need to know.

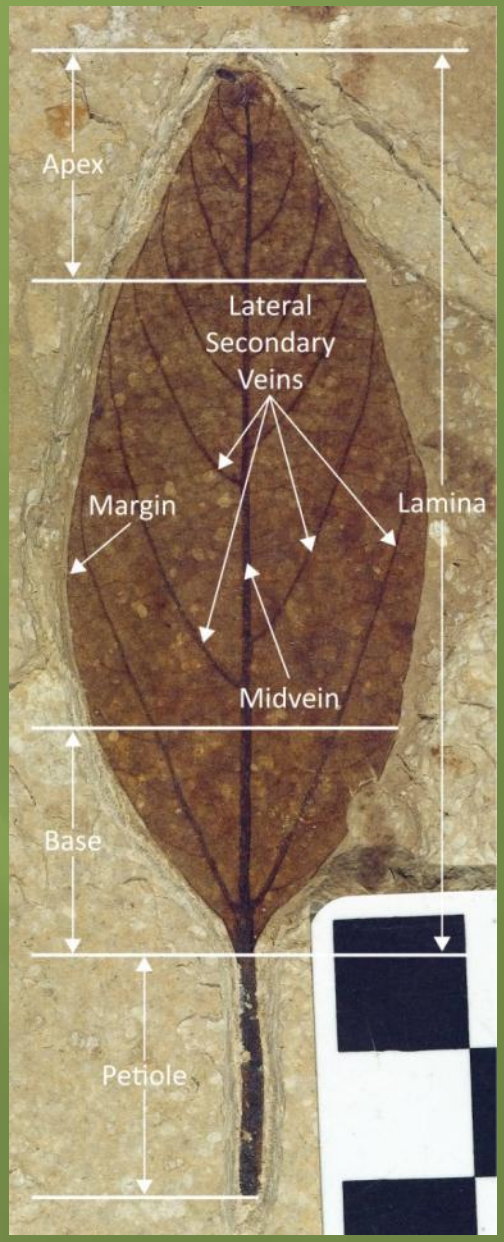
Leaf parts 1

Petiole: the leaf stalk or stem

Lamina: the fleshy portion of the leaf connected to the petiole containing a network of veins

Base: the lower quarter of the lamina nearest the petiole

Margin: the edge of the lamina

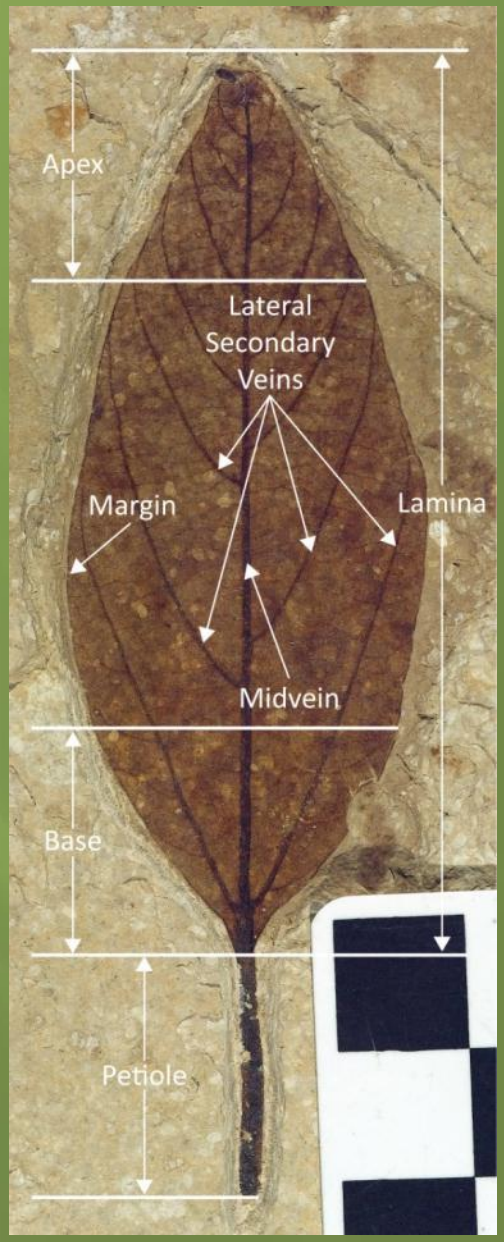


Leaf parts 2

Midvein: a primary vein running through the center of the lamina; generally the thickest vein

Lateral secondary veins: veins branching outward from the midvein, other primaries, or secondaries like limbs on a tree

Apex: the upper quarter of the lamina where the midvein ends



Leaf veins 1

Veins in leaves are classified first to seventh order. In most photographs the fourth to seventh order veins are not visible.

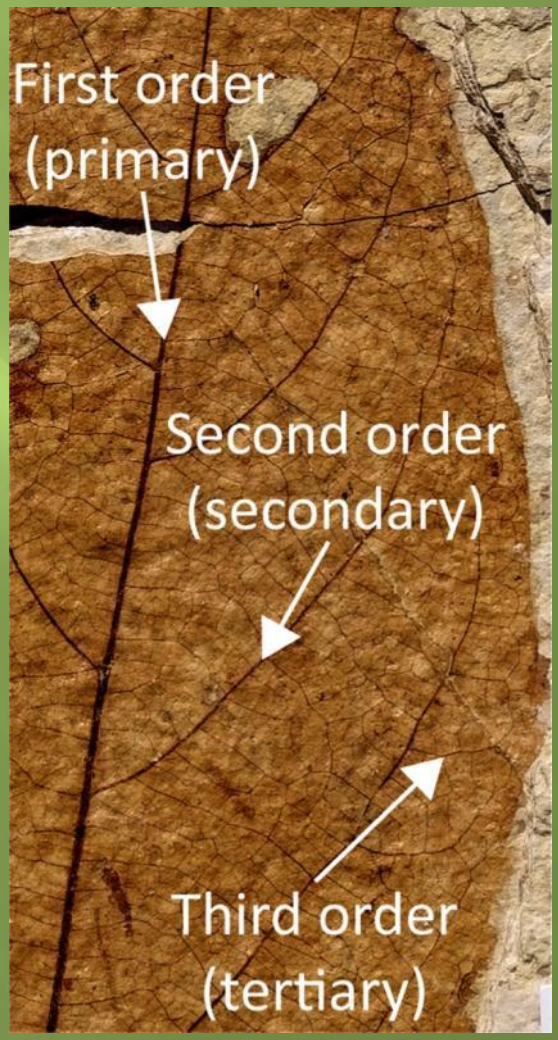
Vein orders are based on gauge (thickness or diameter). The leaf's thickest veins are first order.

First order = Primary vein or veins

Second order = Secondary veins

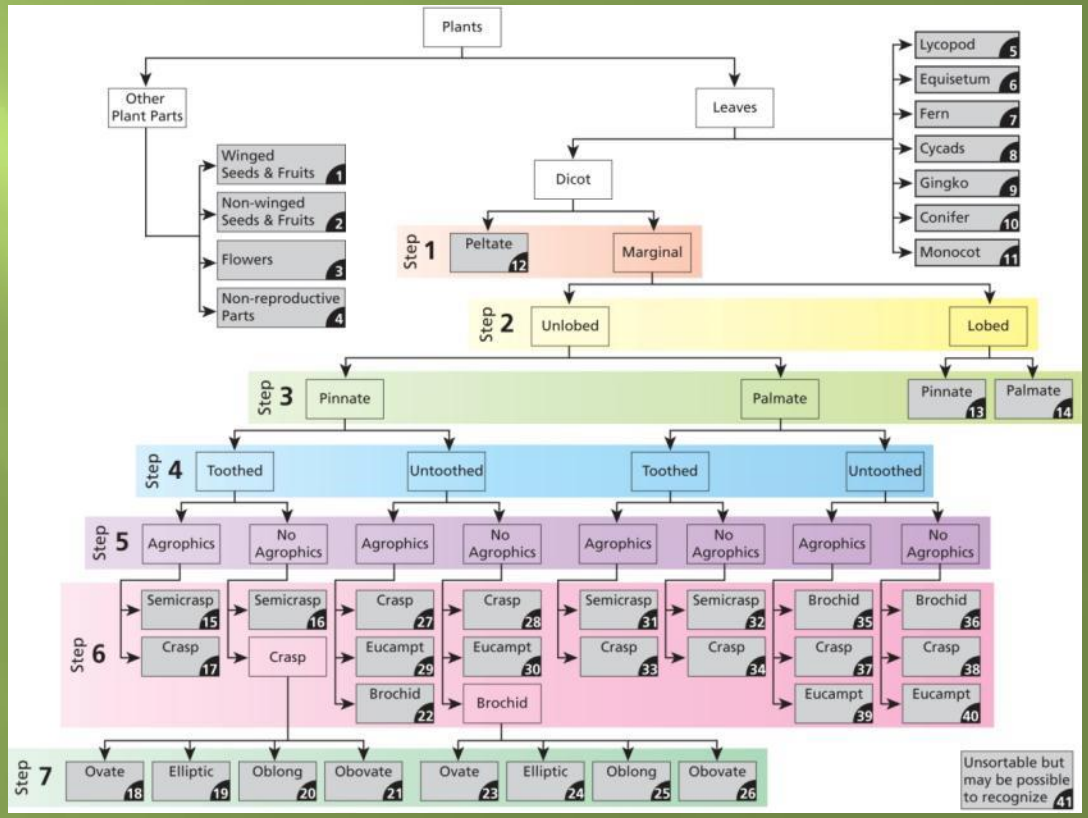
Third order = Tertiary veins

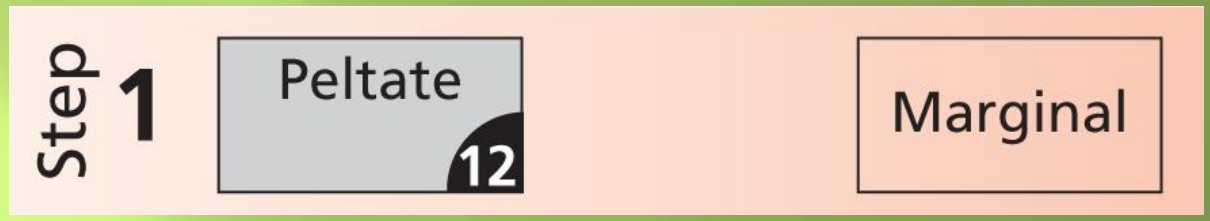
Leaf veins 2


First order
(primary)
Second order
(secondary)
Third order
(tertiary)

Leaf Classification

Steps to Binning





Where does the petiole connect to the lamina?

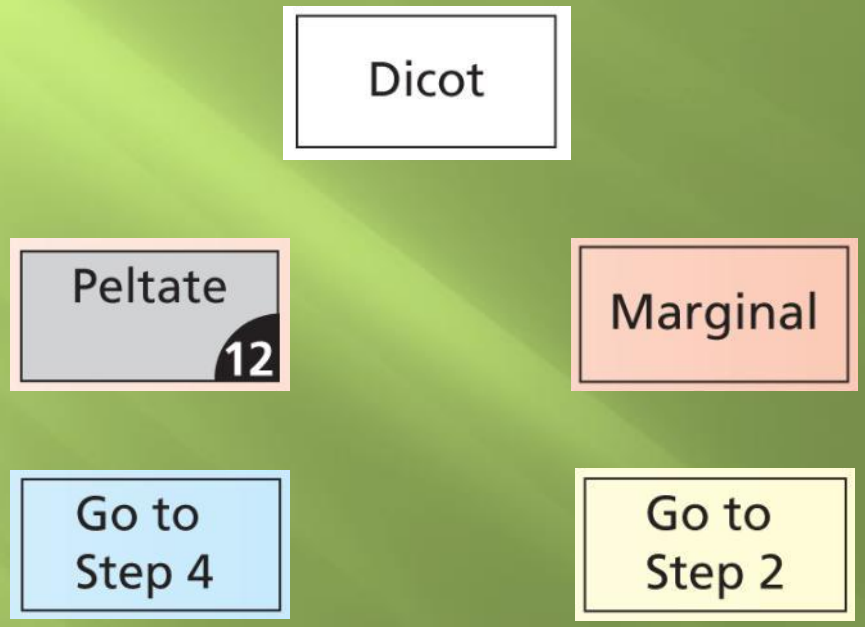
Peltate

The petiole connects in the interior of the lamina.

Marginal

The petiole connects at the margin.

Step1



Step 2

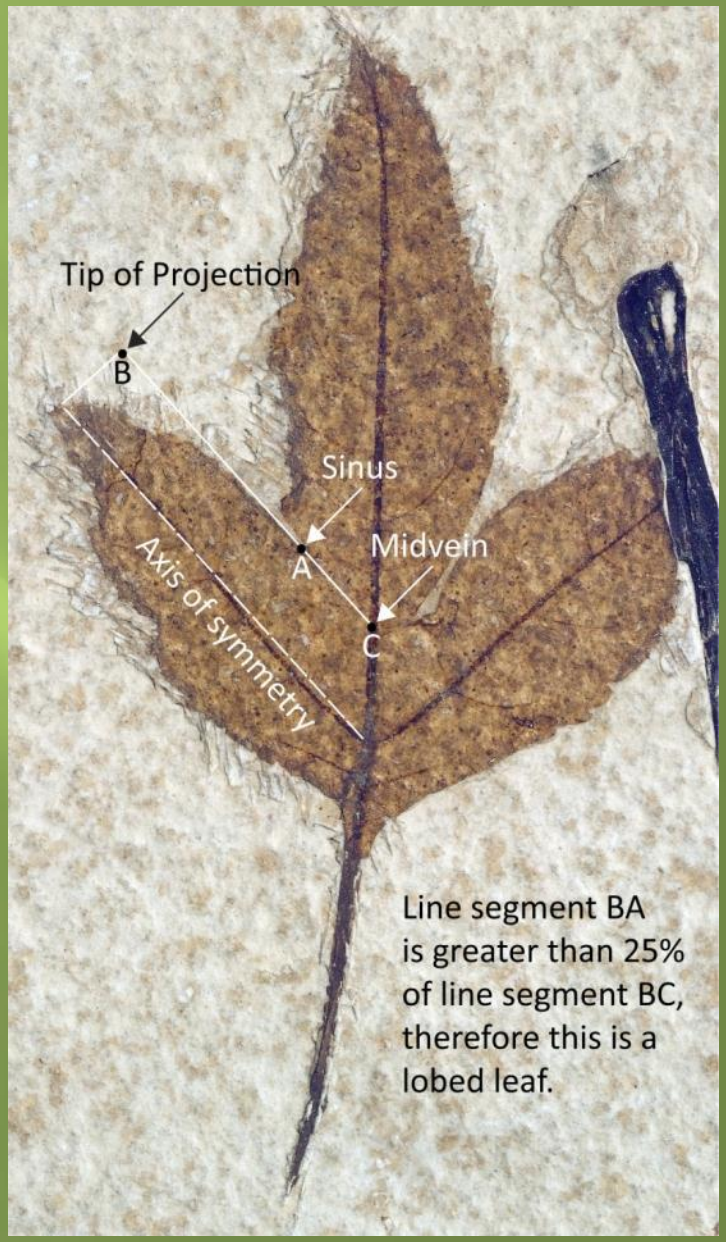
Unlobed

Lobed

Is the leaf unlobed or lobed?

What is a lobe?

A **lobe** is a finger-like projection of the leaf margin. A **sinus** is an indentation in the leaf margin. To be lobed, the sinus must cut inward at least 25% of the distance from the projection's tip to the midvein.



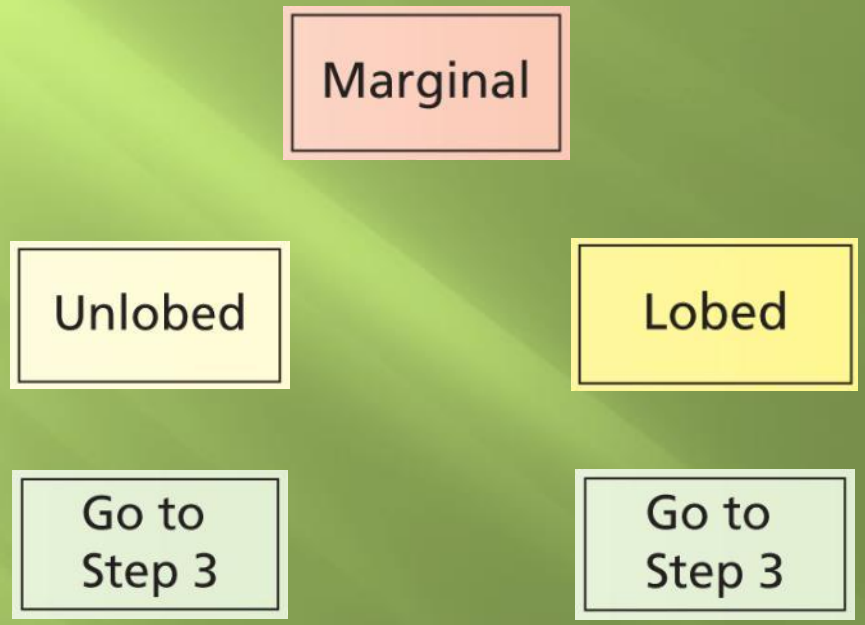
Unlobed

A leaf with no lobes

Lobed

A leaf with two or more lobes

Step 2



Step 3

Pinnate

Palmate

Pinnate 13

Palmate 14

How many primary veins does the leaf have?

What is a primary vein?

Primary veins are the thickest order of veins. The midvein is always a primary vein. Any other vein that is at least 75% of the midvein's thickness, and branches from it at or near the base is also considered a primary vein.

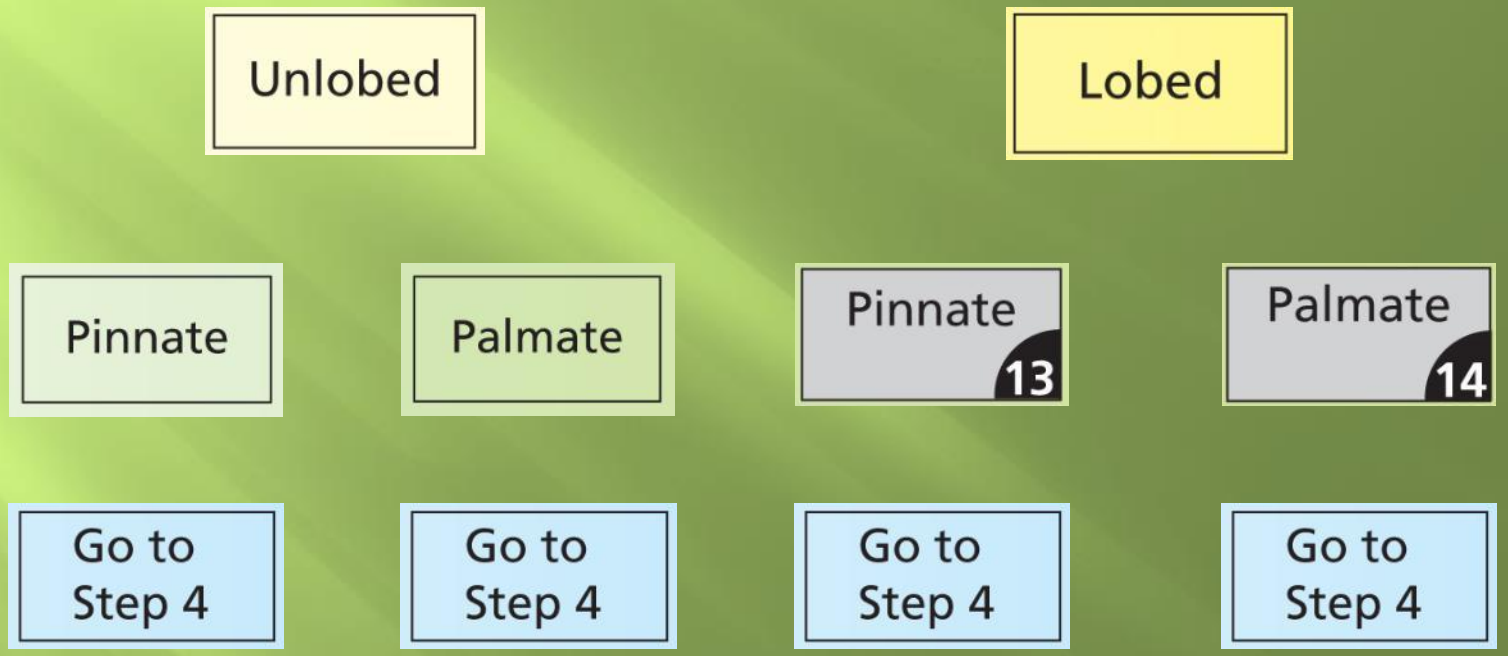
Pinnate

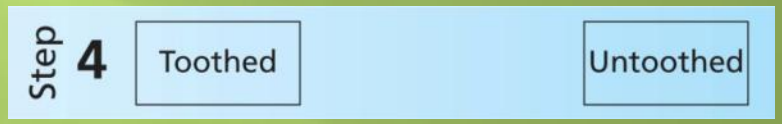
A leaf with only one primary vein

Palmate

A leaf with two or more primary veins.

Step 3


Unlobed
Lobed
Pinnate
Palmate
Pinnate
13
Palmate
14
Go to Step 4
Go to Step 4
Go to Step 4
Go to Step 4



Is the leaf toothed or untoothed?

What is a tooth?

A tooth is a vein-bearing projection of the margin. It has a sinus that cuts inward less than 25% of the distance from the projection's tip to the midvein.

What does a tooth look like?

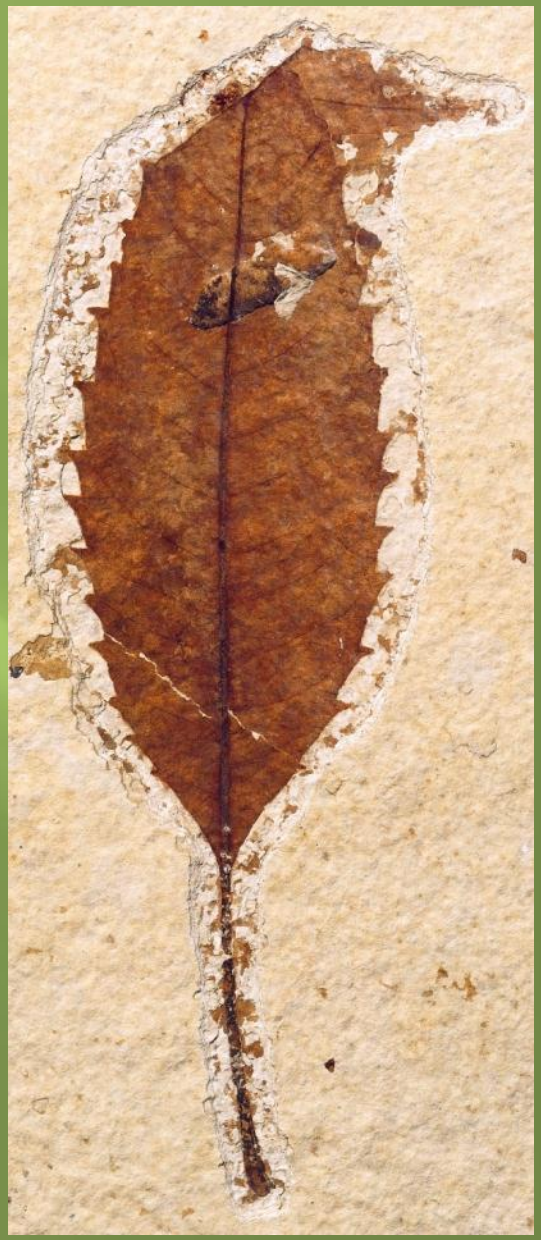
dentate

Serrate

crenate

Toothed

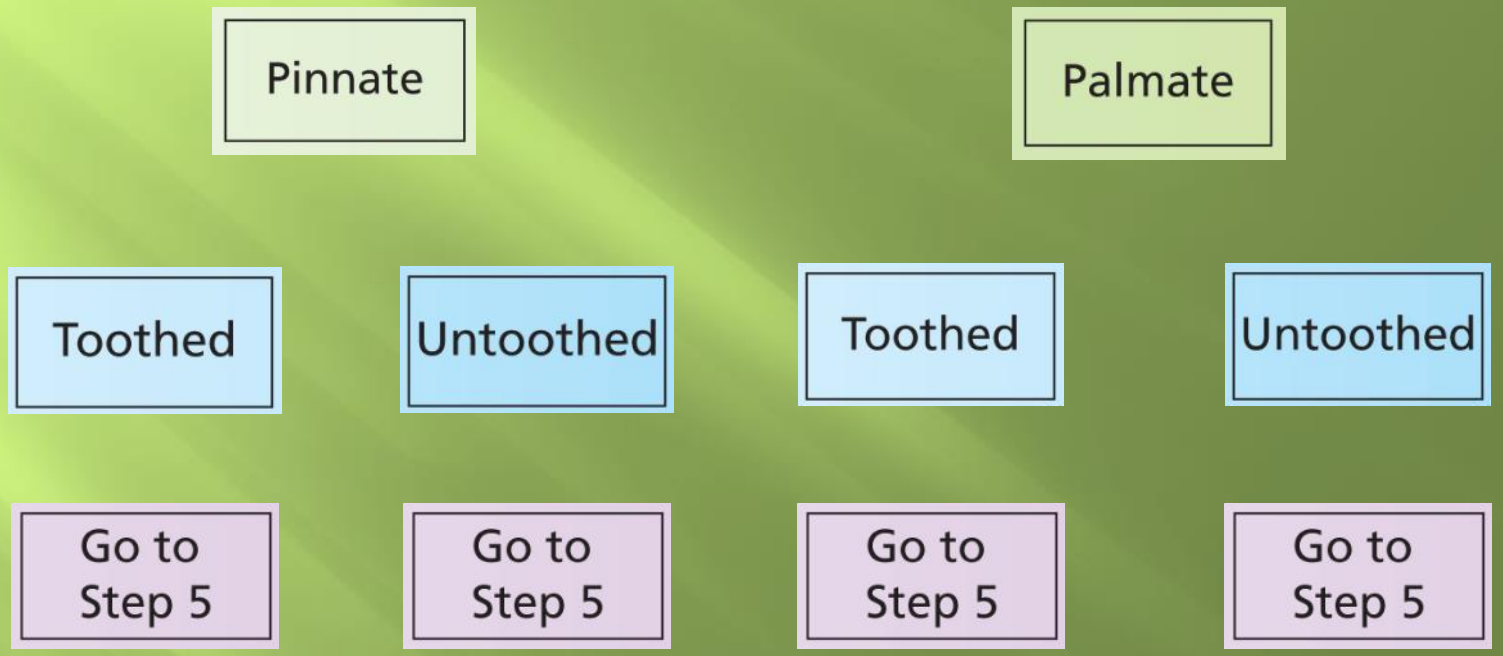
A leaf with one or more teeth



Untoothed

A leaf without a tooth

Step 4


Pinnate
Palmate
Toothed
Untoothed
Toothed
Untoothed
Go to Step 5
Go to Step 5
Go to Step 5
Go to Step 5

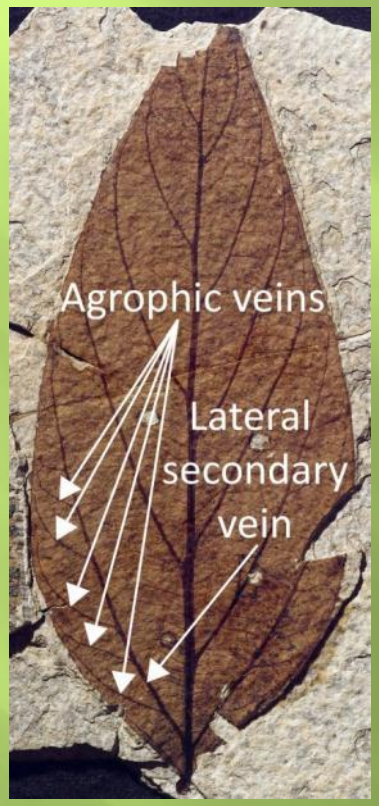
Does the leaf have agrophic veins?

What are agrophic veins?

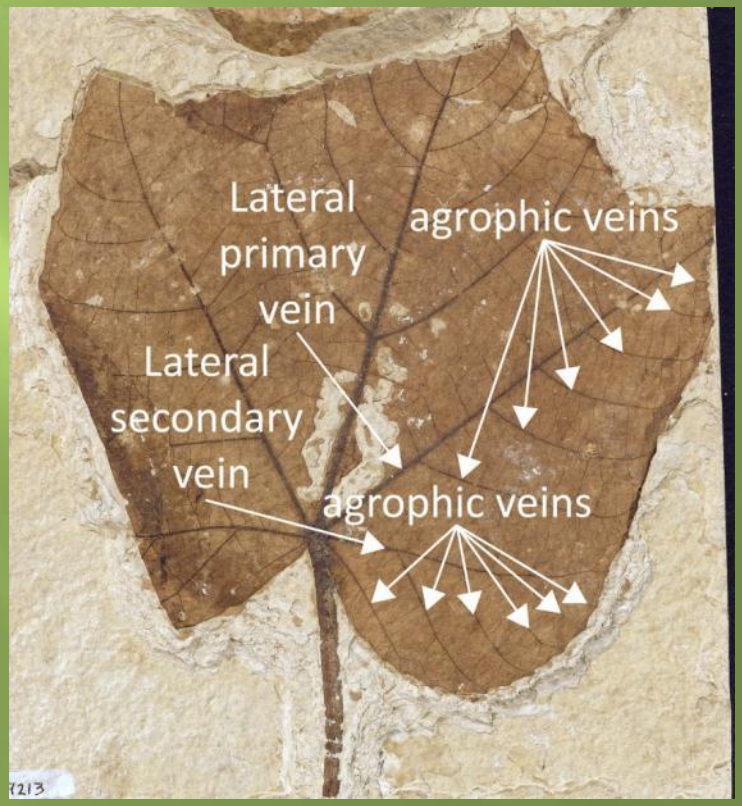
Agrophic veins are a comb-like arrangement of second order veins branching from a lateral primary or secondary vein.

An agrophic vein is not paired with a second order vein on the opposite side of the lateral vein it branches from.

What do agrophics look like?



simple agrophics



compound agrophics

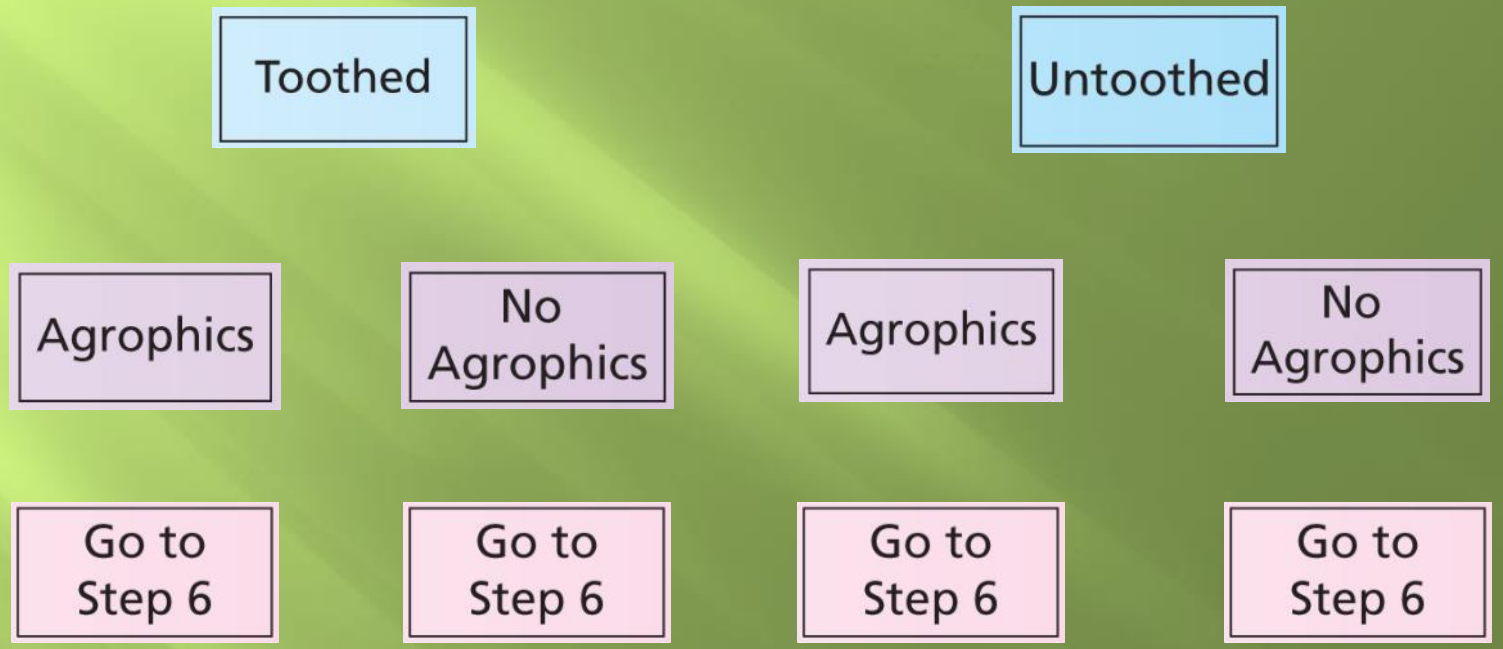
Agrophics

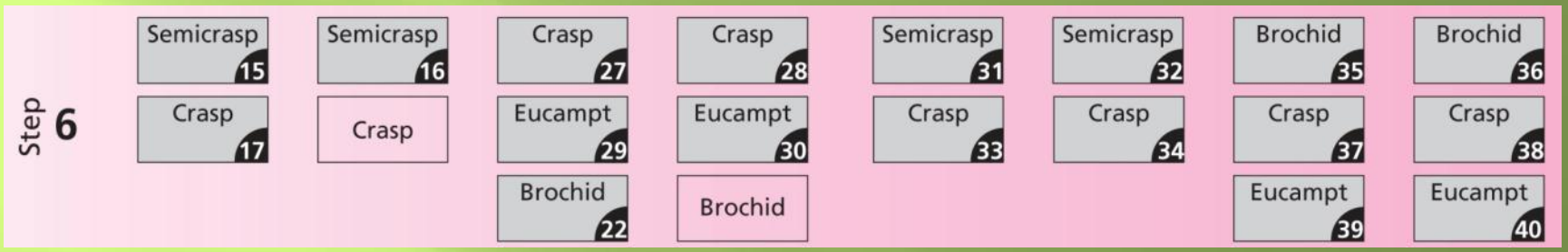
A leaf having agrophic veins

No Agrophics

A leaf having no agrophic veins.

Step 4


Toothed
Untoothed
Agrophics
No Agrophics
Agrophics
No Agrophics
Go to Step 6
Go to Step 6
Go to Step 6
Go to Step 6



What path do the secondary veins take?

What are secondary veins?

Secondary veins are laterally branching second order veins. With the primary veins they form a framework that gives the leaf its structural integrity.

If the leaf were a tree, the midvein and other primaries would be its trunk or trunks. The secondaries would be the largest limbs branching from the trunk.

There are four basic secondary vein pathways

Craspedodromous (Crasp)

Semicraspedodromous (Semicrasp)

Eucamptodromous (Eucampt)

Brochidodromous (Brochid)

Crasp

In a **craspedodromous** leaf, the secondary vein ends at the margin almost always in a tooth, or at a marginal vein.

Semicrasp

In a s**emicraspedodromous** leaf, the secondary vein branches near the margin; one branch ends in a tooth and the other joins with a nearby secondary.

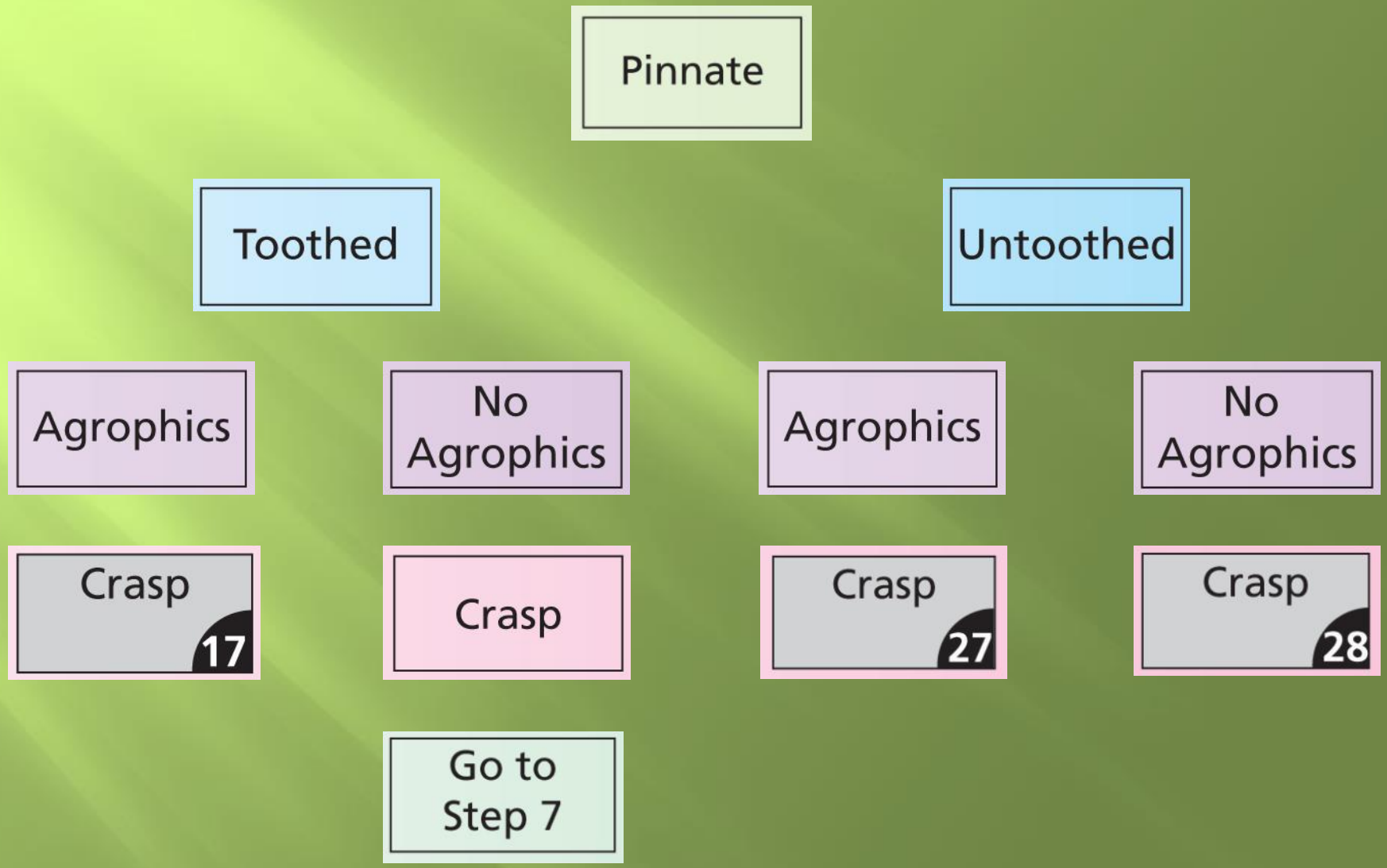
Eucampt

In a **eucamptododromous** leaf, the secondary vein never reaches the margin. It loses gauge as it nears the margin. No longer a second order vein, it curves away from the margin and links to a nearby secondary as a tertiary vein.

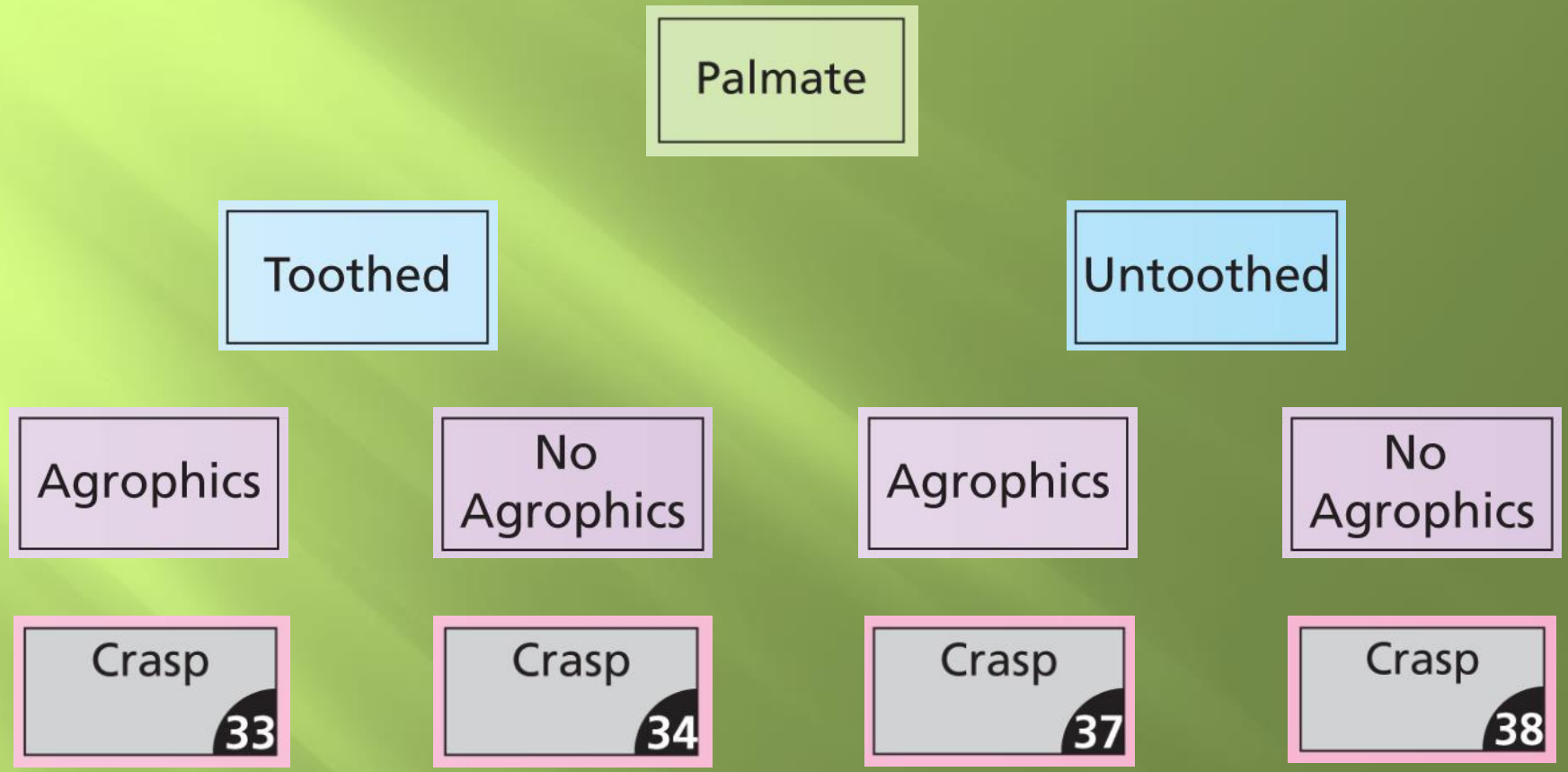
Brochid

In a **brochidodromous** leaf, the secondary vein never reaches the margin, but curves to join with a nearby secondary vein forming second order loops and arches.

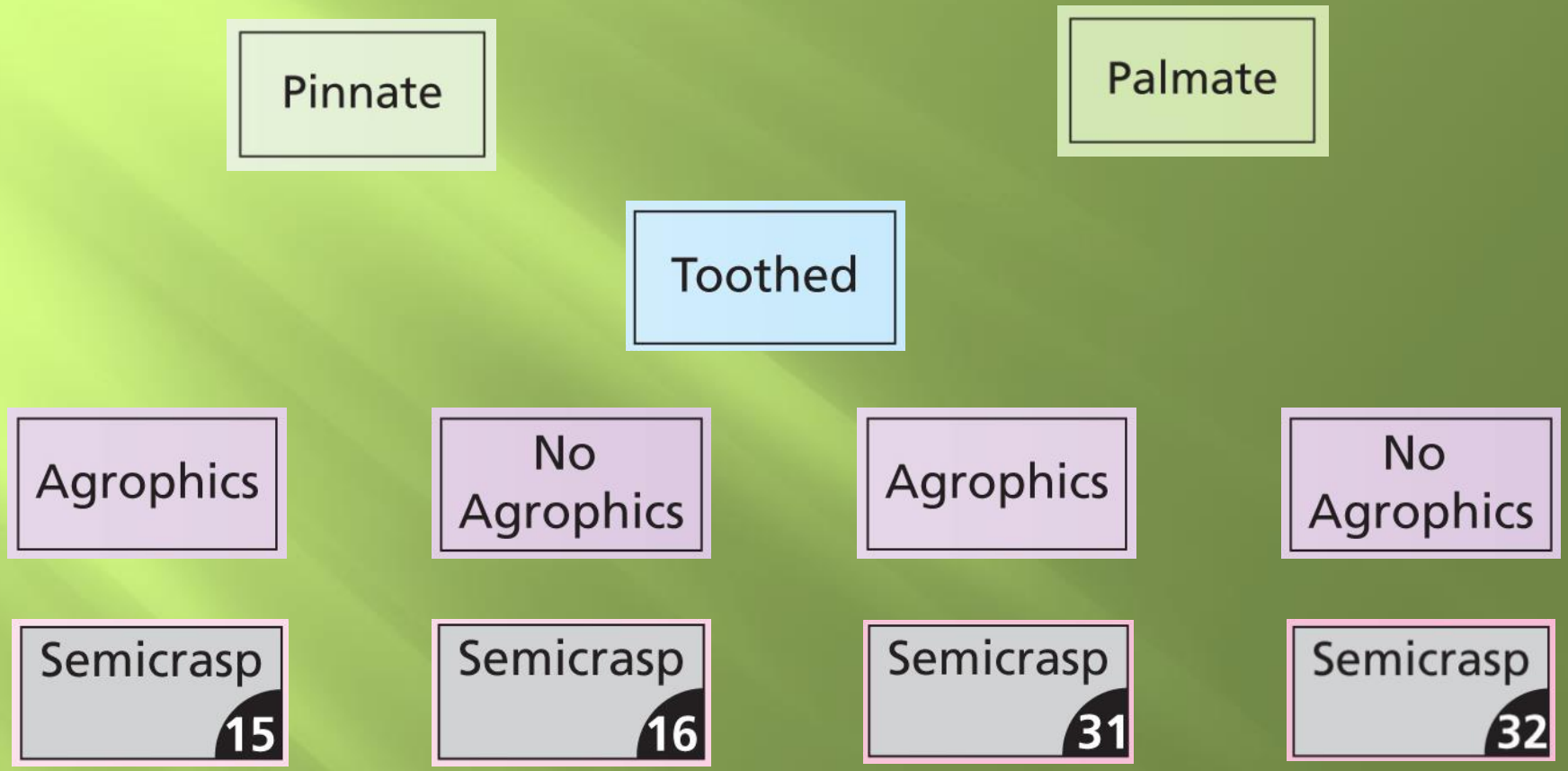
Step 6: Craspedodromous



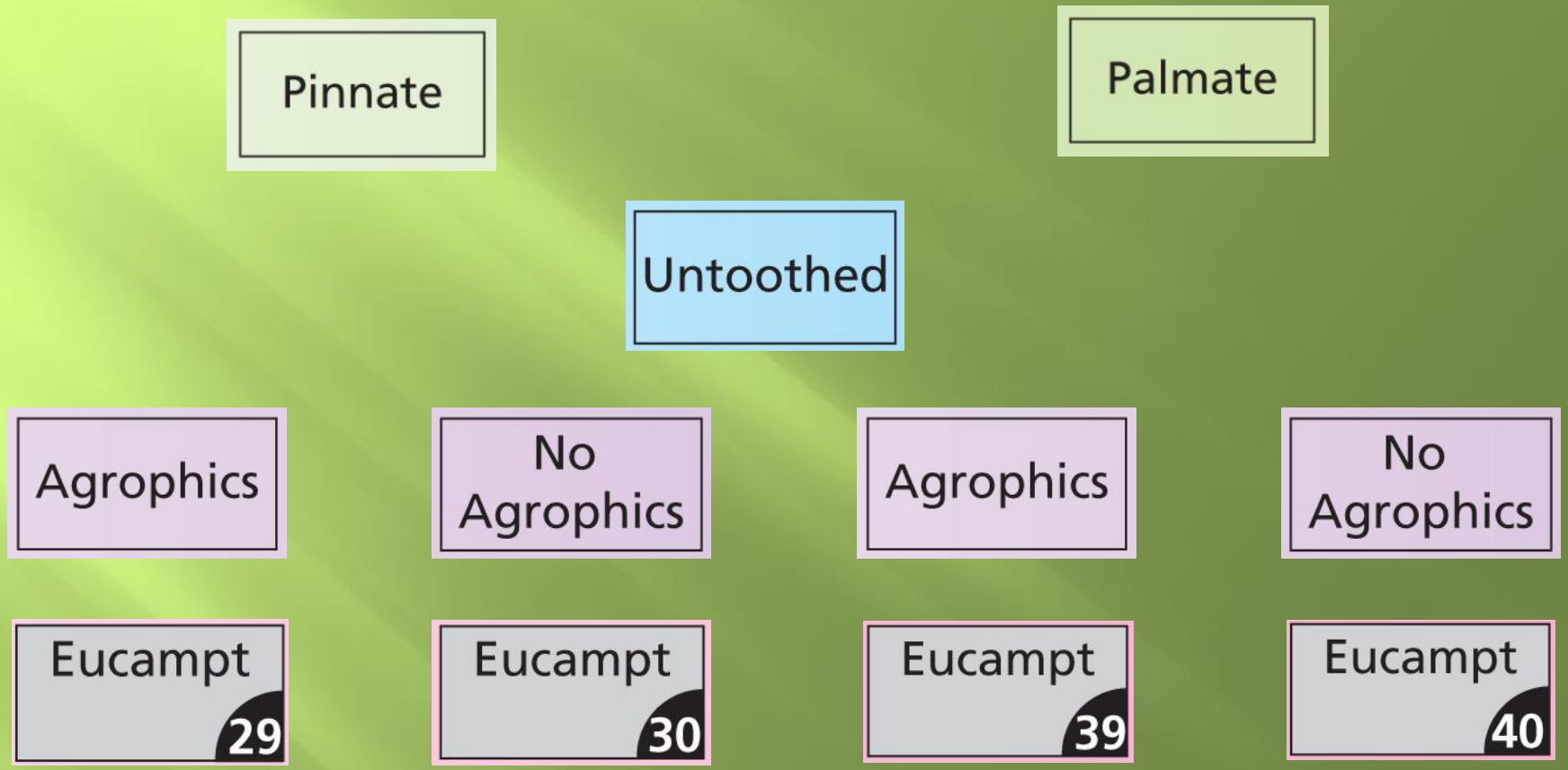
Step 6: Craspedodromous (continued)



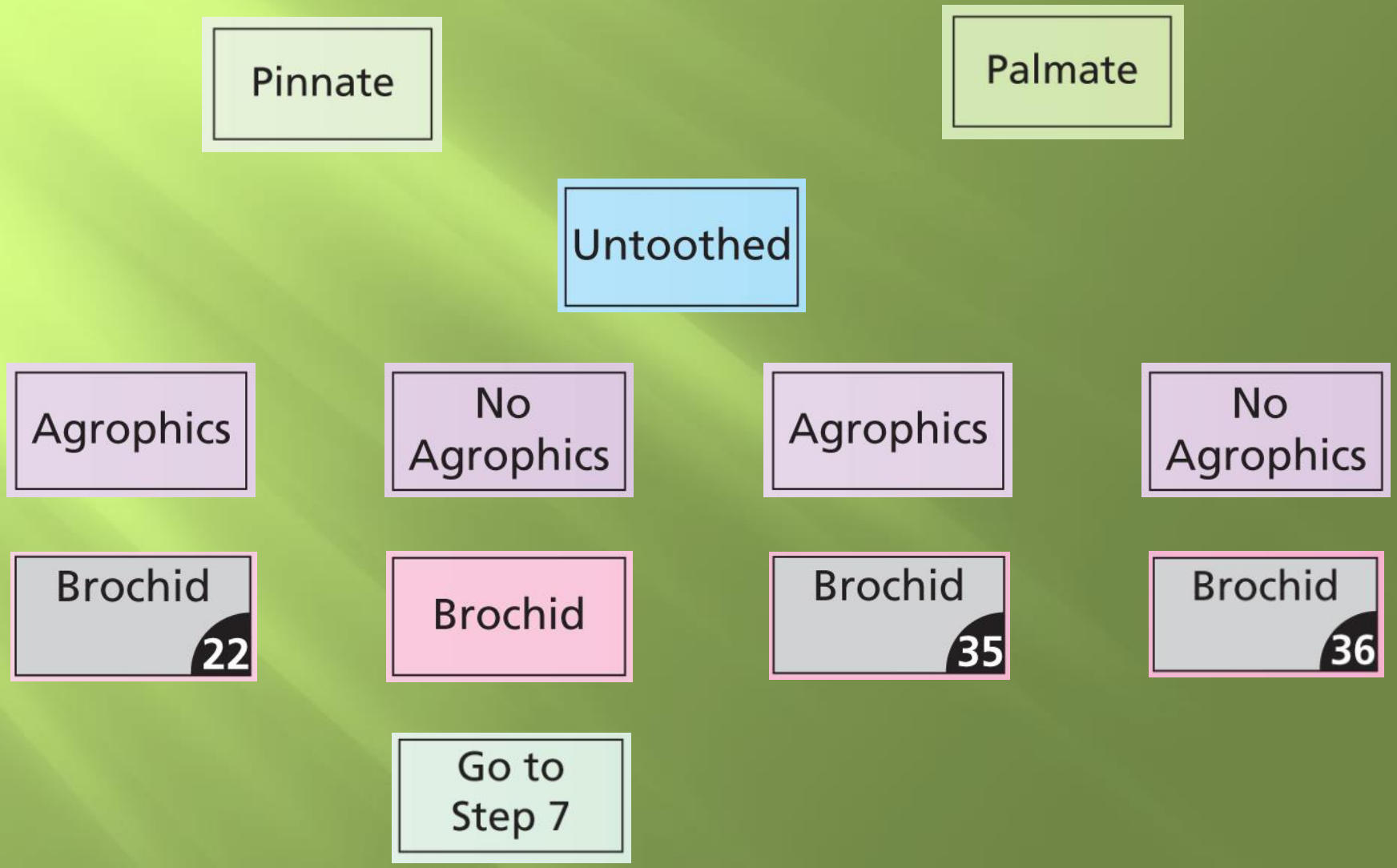
Step 6: Semicraspedodromous



Step 6: Eucamptodromous



Step 6: Brochidodromous



Step 7

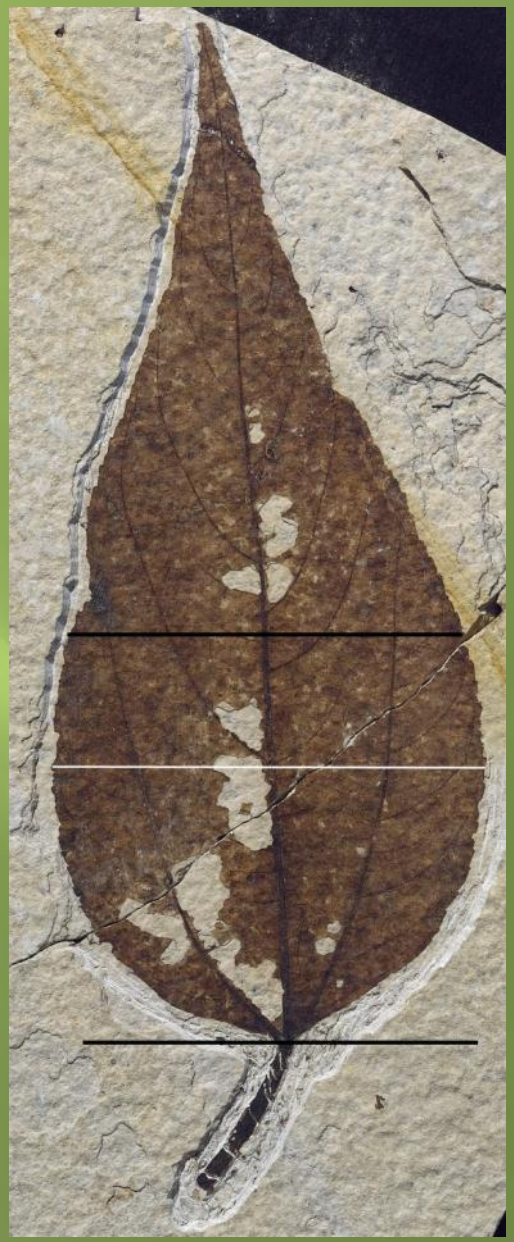
Ovate 18	Elliptic 19	Oblong 20	Obovate 21	Ovate 23	Elliptic 24	Oblong 25	Obovate 26

What shape is the leaf?

Leaf Shape:

Ovate

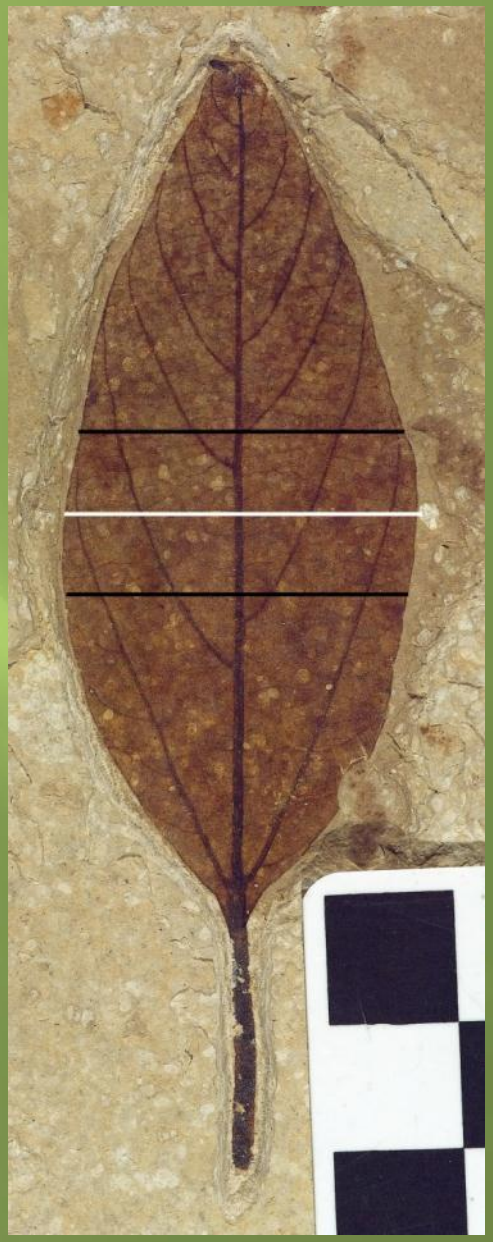
The widest part of the leaf is in the bottom 2/5 of the lamina (nearer the base).



Leaf Shape:

Elliptic

The widest part of the leaf is in the middle 1/5 of the lamina (nearer the middle).



Leaf Shape:

Oblong

The margins through the middle 1/3 of the lamina are nearly parallel.

Leaf Shape:

Obovate

The widest part of the leaf is in the upper 2/5 of the lamina (nearer the apex).

Step 7: Leaf Shape

Pinnate

Toothed

No Agrophics

Crasp

Ovate 18

Elliptic 19

Oblong 20

Obovate 21

Step 7: Leaf Shape (continued)

Pinnate

Untoothed

No Agrophics

Brochid

Ovate 23

Elliptic 24

Oblong 25

Obovate 26

Leaf Area

How to calculate the surface area of a leaf and assign a size class

Estimating Leaf Area

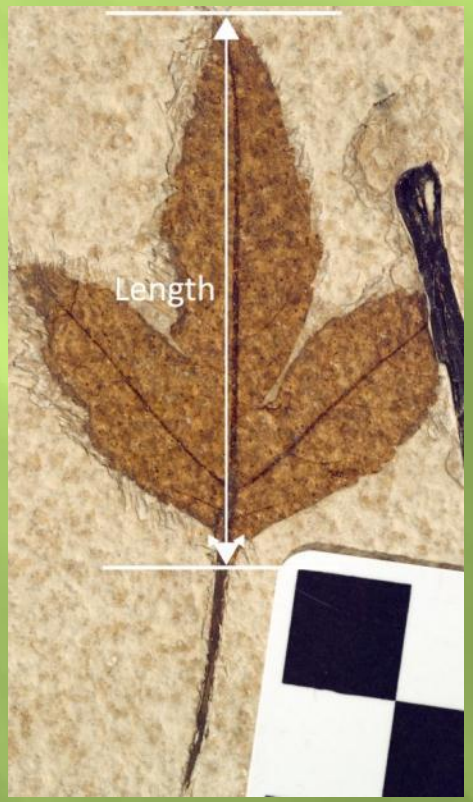
To estimate the surface area of the leaf, measure the length and width of the lamina.

Use the fossil leaf photograph labeled **Actual Size** to make the measurements of leaf length and width.

Some fossil leaves are not complete. Measure only what you can see.

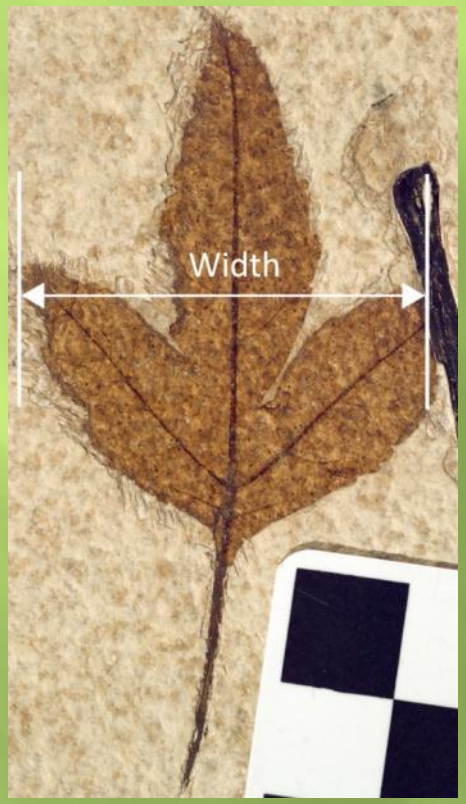
Measuring Length

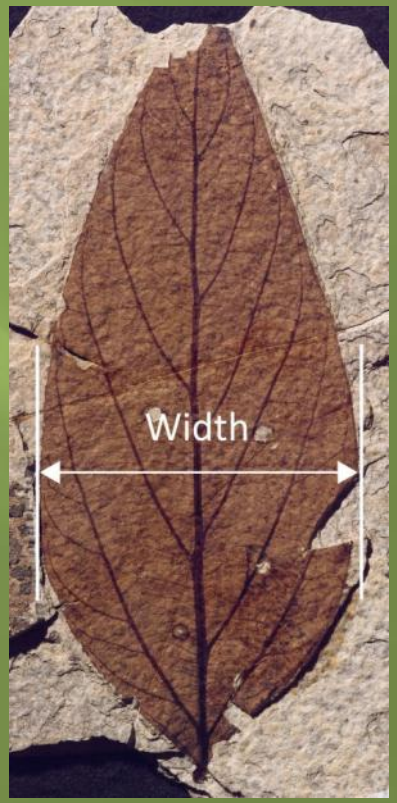
Measure the length of the lamina parallel to the midvein in millimeters. Do not include the length of the petiole in your measurement.



Measuring Width

Measure the width of the lamina perpendicular to the midvein in millimeters.





Calculating Leaf Area

The surface area of a rectangle is calculated by multiplying length times width. Given that leaves are not rectangular, the surface area of a leaf is estimated using the formula:

Leaf Area (mm^2) = Length (mm) x Width (mm) x 0.75

Assigning a Size Class

After estimating the leaf area, use the Raunkiaer-Webb Size Class Chart to assign the leaf a size class.

Raunkiaer-Webb Size Class Chart	
Leaf area (mm^2)	Size class
Less than 25 mm^2	leptophyll
25-225 mm^2	nanophyll
225-2025 mm^2	microphyll
2025-4500 mm^2	notophyll
4500-18,225 mm^2	mesophyll
18,225-164,025 mm^2	macrophyll
Greater than 164,025 mm^2	megaphyll