Natural Plant ID Motifs: Examples from Selected Plant Families

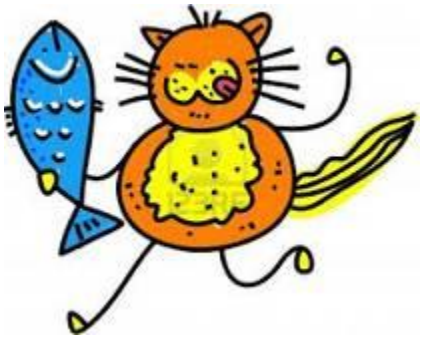
LAST TIME

- imprinting vs. diagnosing
- 5 basic plant ID features (& a little more)
- natural vs. "artificial"
- ID "motifs": e.g., "BA" "Bberry" "CoAl"

THIS TIME

- natural groups (clades/lineages):
- larger groups -- angiosperm, monocot, dicot
- orders -- Ranunculales, Sapindales, Gentianales, Lamiales
- families too obvious: Apiaceae, Asteraceae, Caryophyllaceae...
- families 'just right': Campanulaceae, Gentianaceae, Lauraceae, Lythraceae, Polemoniaceae, "Portulacaceae" s.l.

imprinting vs. diagnosing



cat vs. dog

day vs. night

run vs. walk

moth vs. butterfly

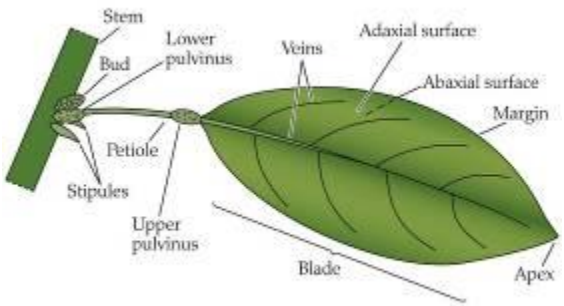
fruit vs. vegetable

“fish” vs. ??

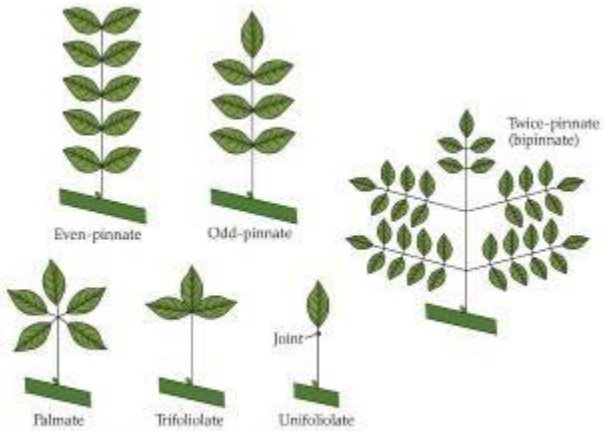
Basic Plant ID features

-- habit
-- leaves simple vs. compound
-- alternate vs. opposite
-- entire vs. toothed (or lobed)
-- stipules present or not
-- pellucid dots (or punctations or stellate hairs)
-- latex present or not
-- foliage with distinct smell or not
-- veins pinnate or palmate (or plinerved)

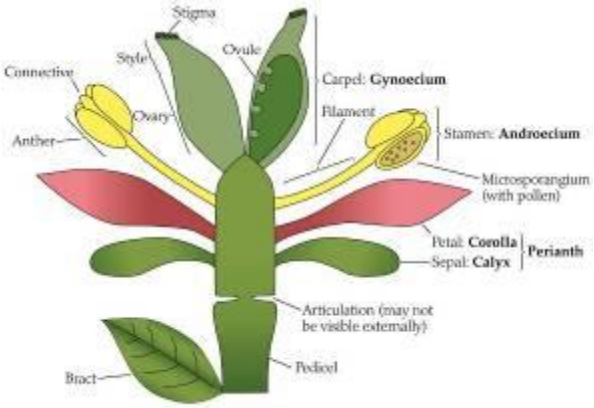
-- flowers sympetalous or apopetalous
-- hypanthium present or not
-- stamen number & arrangement
-- carpel number
-- gynoecium syncarpous or apocarpous
-- ovary inferior or superior



PLANT SYSTEMATICS, Third Edition, Figure 4.3



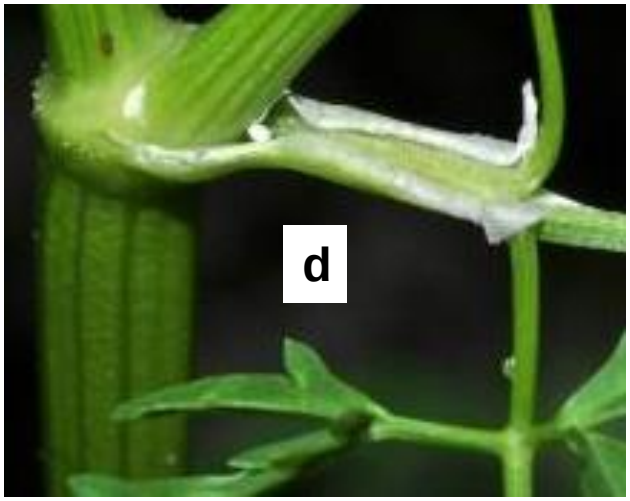
PLANT SYSTEMATICS, Third Edition, Figure 4.5



PLANT SYSTEMATICS, Third Edition, Figure 4.16

motifs work best if kept simple, e.g., tied to basic features -- details in the eye of the beholder

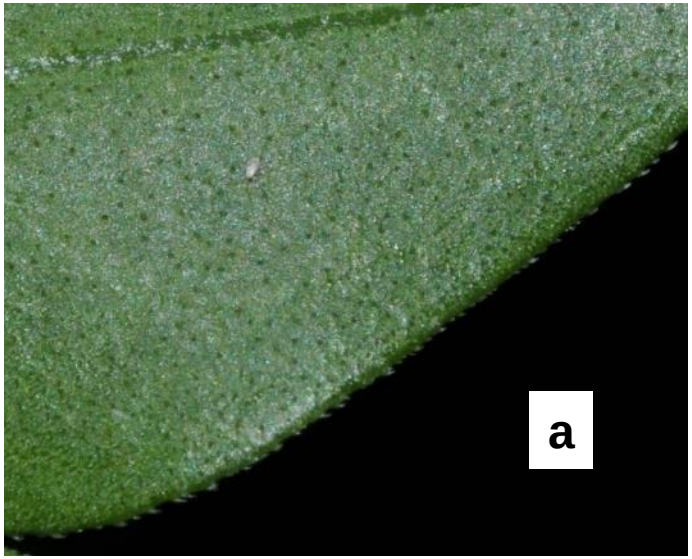
5 Plant ID Basics



-- habit: growth form (woody vs. herbaceous)
-- leaf composition: simple vs. compound
-- leaf arrangement: alternate vs. opposite
-- margin: entire vs. toothed or lobed
-- stipules: present or not

but a few extra features are also very useful, e.g.:

a) cuticular pits, b) pulvinulus, c) sap, d) sheath, e) tendrils; smell, venation



- motifs (patterns tied to phylogeny & vocab)

"**BA**" (basal angiosperms): woody, simple, alternate, entire, no stipules, strong/spicy smell

monocots: linear blade, parallel veins, sheath

grasses: swollen node, open sheath

dicots: broad blade, reticulate veins, no sheath

"**Bberry**": woody, simple, alternate, no stipules

"**CoAl**": compound, alternate

"**MADCap**": woody, opposite

polygonaceae: ocrea

"**rosy**": woody, simple, alternate, stipules

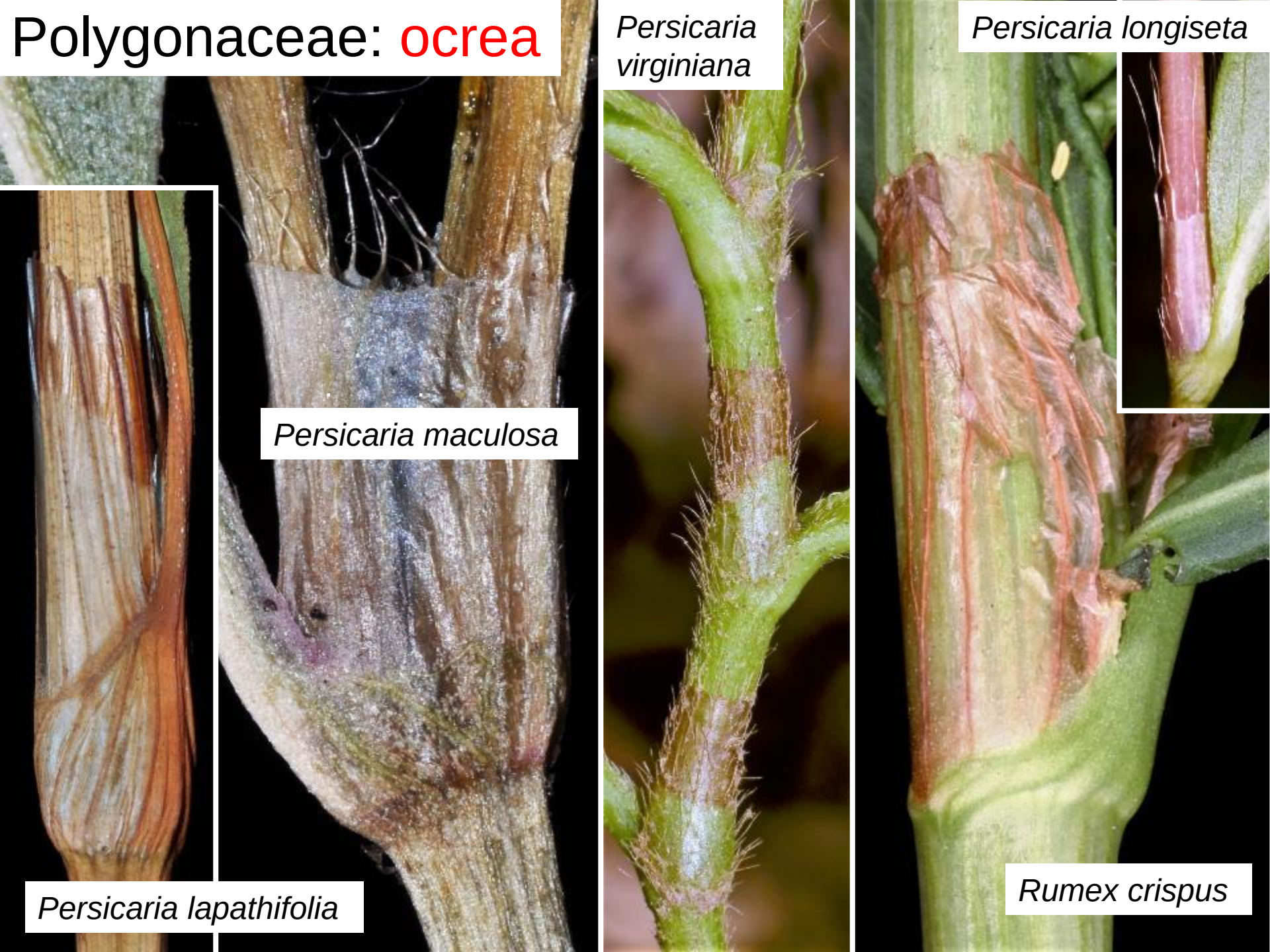
"**VD**": dicots with sheathing petiole base

"milky" - latex/sap

"palmate" - veins; alt

"TAN" - nodal tendrils

Polygonaceae: ocrea



"TAN": tendril at node

motif templates -- **Vines/Lianas**:

Dioscoreac, Smilacac; *Toxicodendron radicans*, some apocs (*Cynanchum*, *Matelea*, *Vinca*), *Hedera*, some asteracs (*Mikania*), bignons (not *Catalpa*), some caprifols (some *Lonicera*), some celastracs (*Celastrus*, some *Euonymus*), most convolvs, cucurbits, some fabacs (*Amphicarpaea*, *Apios*, some *Desmodium*, *Pueraria*, *Vicia*, *Wisteria*), [rare/cultivated hydrangeacs], menisperms, passifloracs, some polygonacs (ocrea), some ranunculacs (*Clematis*), [rare rhamnacs (*Berchemia*)], some rosacs (several stoloniferous so kinda viny; some *Rosa* & *Rubus* kinda viny), *Cardiospermum*, [rare solanac (an introduced weedy *Solanum*)], vitacs

Compound:

Toxicodendron, bignons, fabacs, *Clematis*, rosacs (not usually good vines), [balloon vine], some vitacs (*Ampelopsis arborea*, *Parthenocissus*)

Opposite:

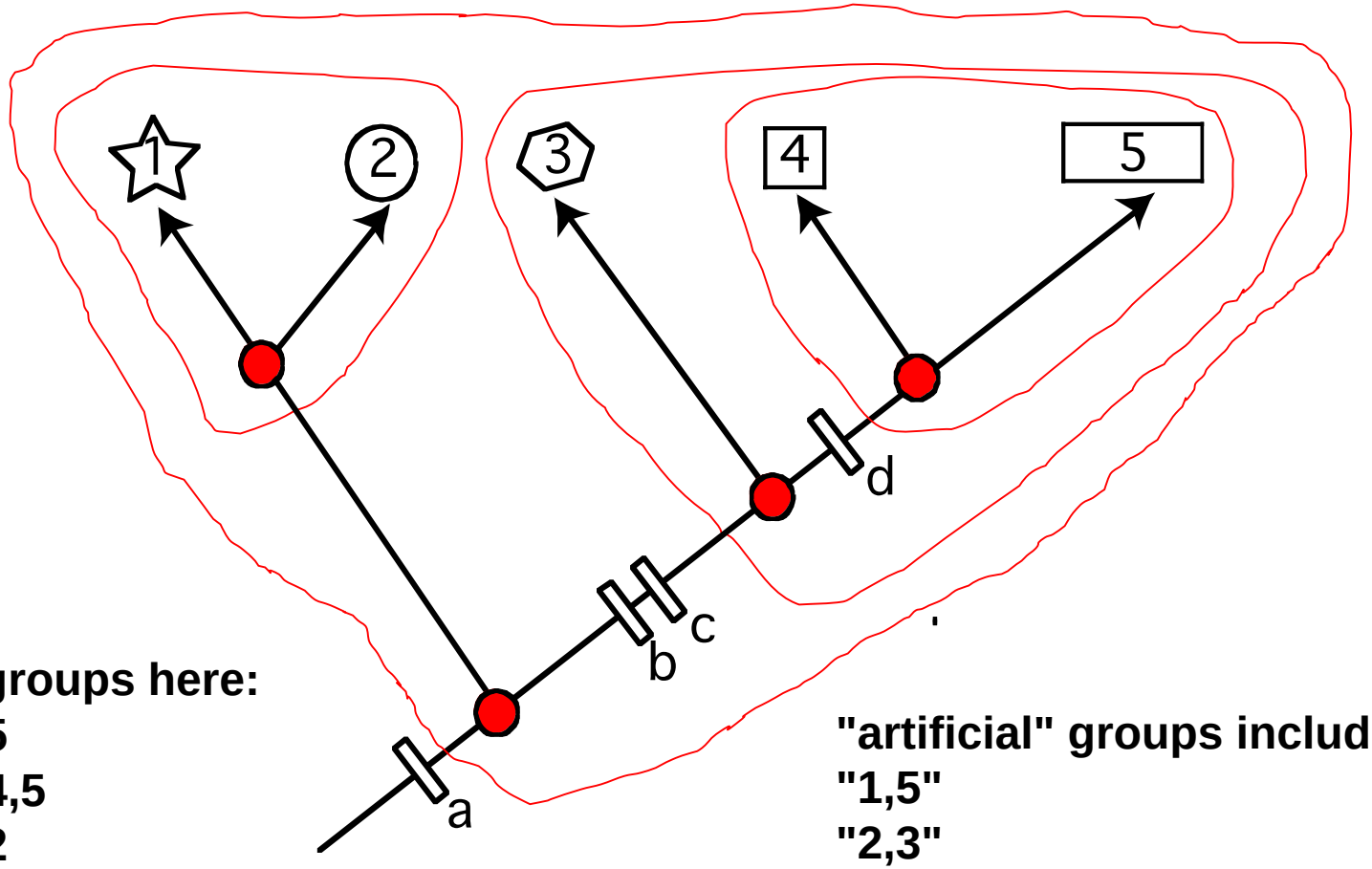
some *Dioscorea*, apocs, *Mikania*, bignons, caprifols, *Euonymus*, *Clematis*

Alternate/Simple/& Entire:

some *Dioscorea*, *Smilax* (some prickly margined but not toothed), some *Hedera* (usually shallowly lobed though), most convolvs (some lobed), some menisperms (almost always lobed), polygonacs

"**TAN**" (**tendril** at node): grapes, passionflowers, squashes, [balloon vine]

Monophyletic group = common ancestor + ALL descendents = **clade**

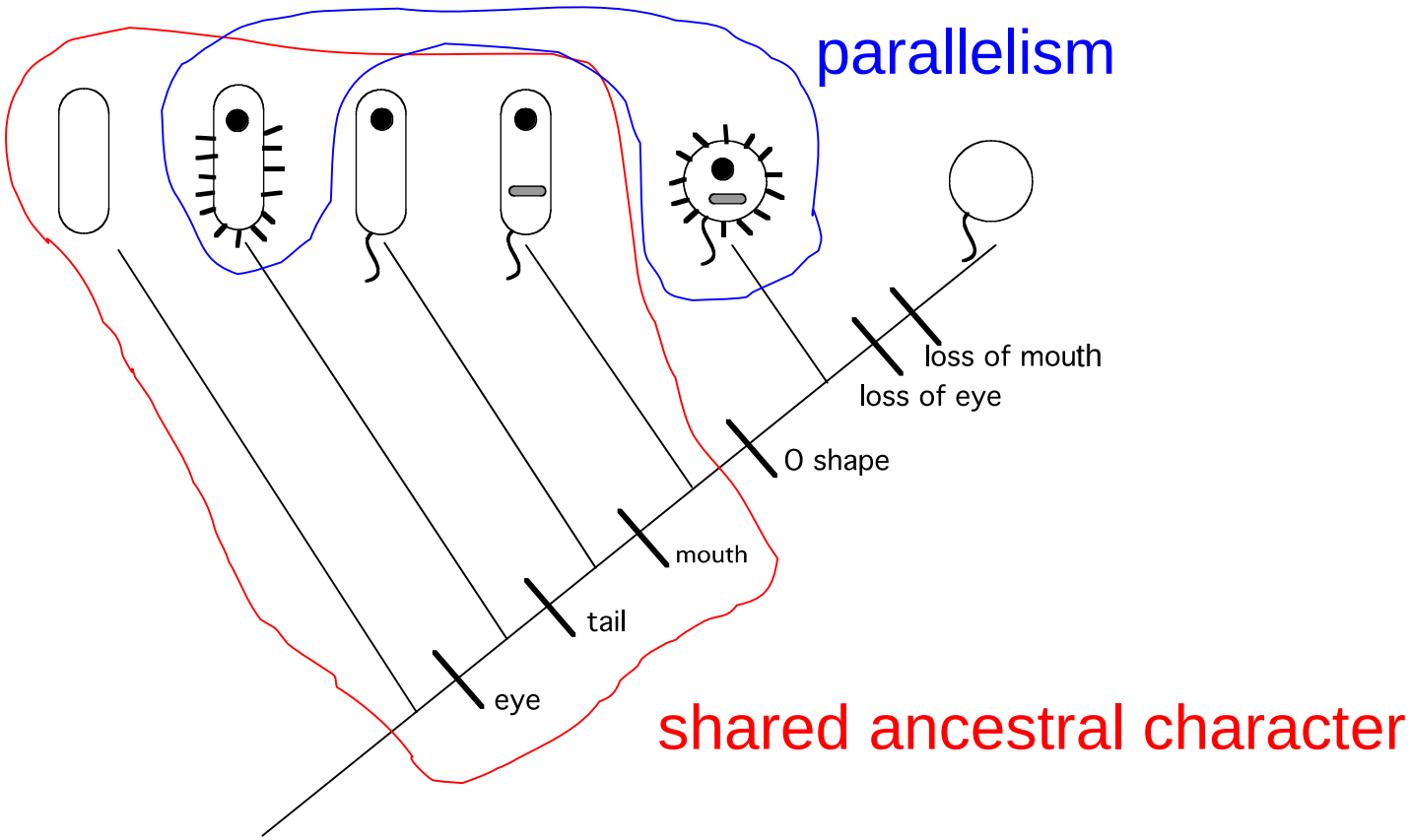


natural groups here:
clade 4,5
clade 3,4,5
clade 1,2
clade 1,2,3,4,5

"artificial" groups include:
"1,5"
"2,3"
"1,2,3"
"2,3,4,5"

clade = lineage = **natural group**

Misleading characters →
(= **homoplasy / homoplasious characters**)



do NOT group organisms based on overall similarity!
-- we want to tease apart convergence (false similarity)
& retained ancestral features

Even though they might be useful for identification, we want to avoid "artificial" groups for classification

i.e., my "motifs" are great for ID, not so good for classification; natural groups match classification!

Warning:
many natural groups are not readily identified

- cryptic features
- no known morphology (DNA-based studies)
- overlap/intergrade with other groups
- false similarities & false differences (homoplasy)

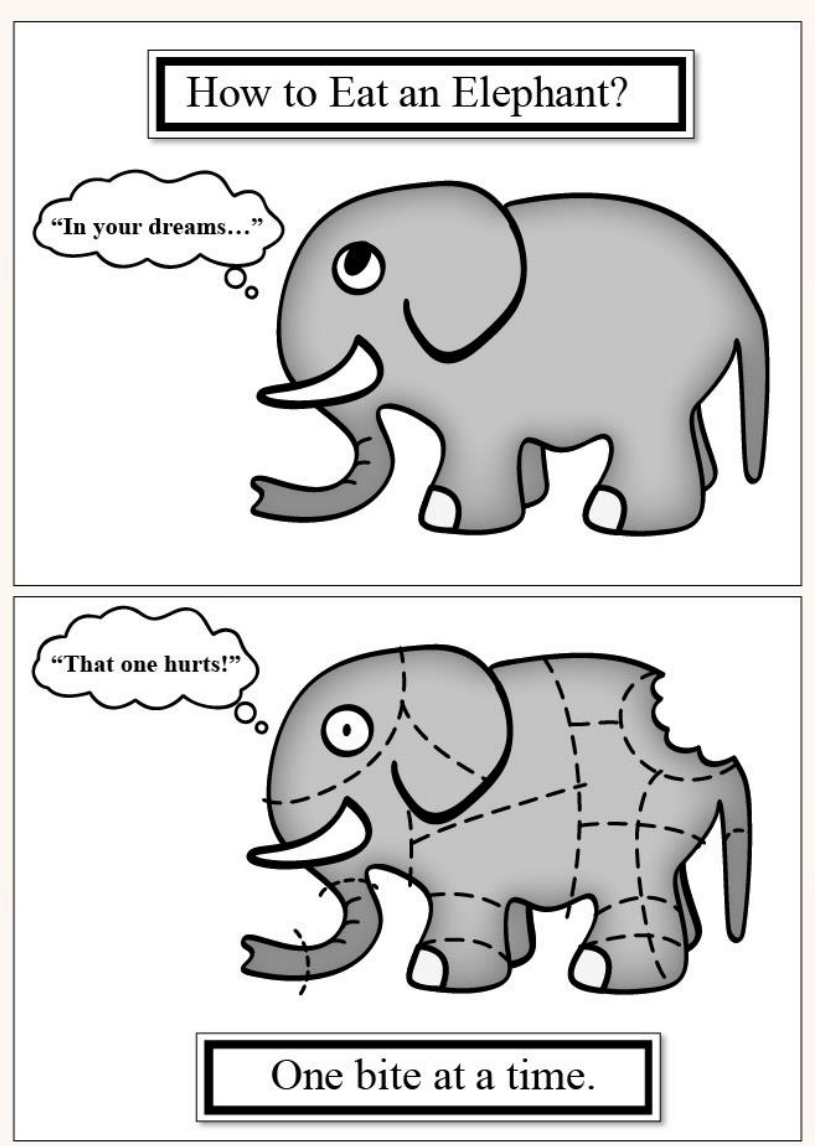
Understanding relationships is NOT always predictive for ID

Natural Plant ID Motifs: Examples from Selected Plant Families

~300,000 extant vascular plant species globally -- ~20,000 in North America, ~3,000 in a state, ~1,000 spp. in a county

~16,000 genera, & 250-400(-600) families of plants; ~160 families in a state

~64 orders of extant flowering plants



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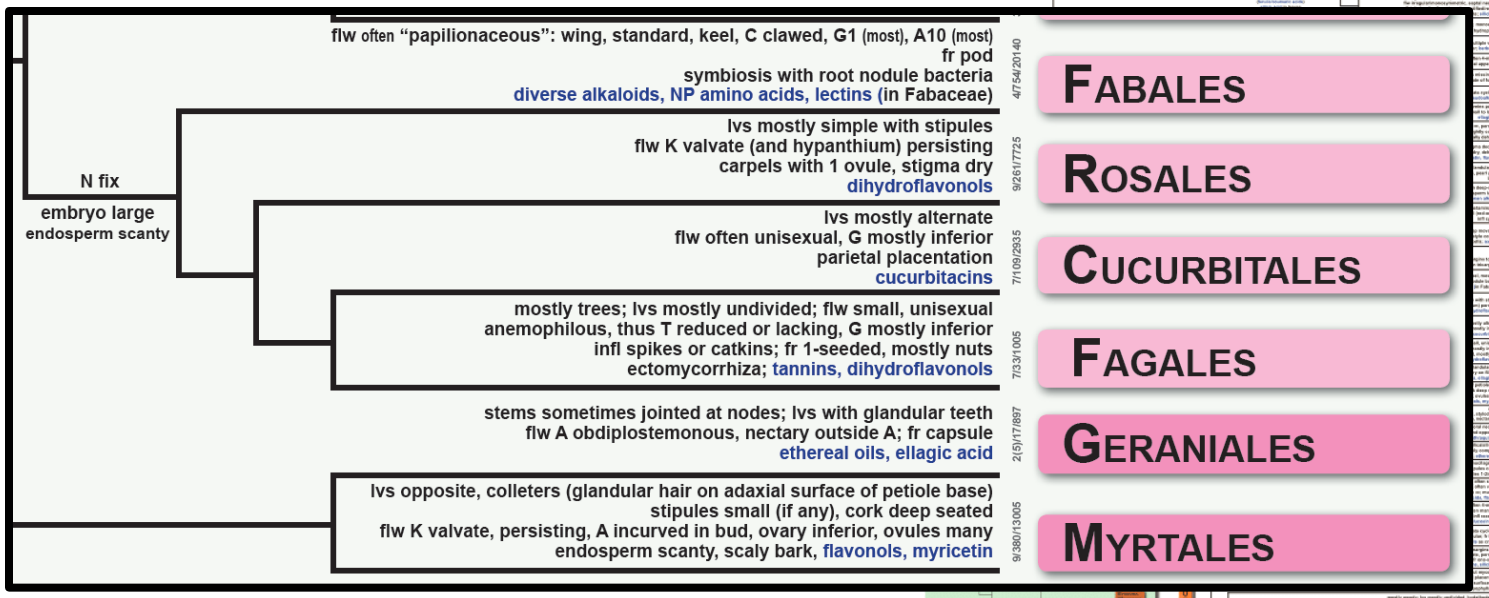
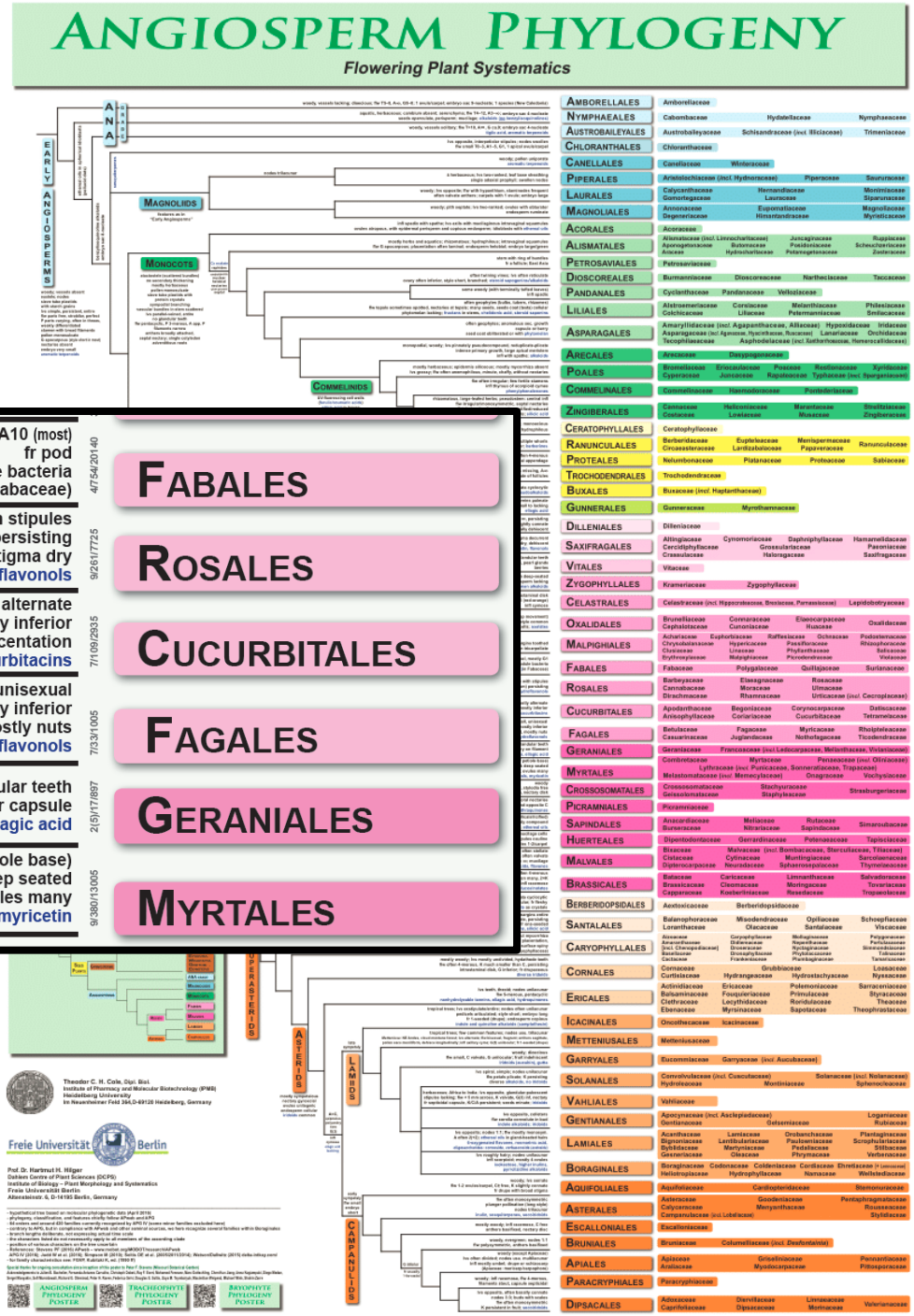
https://www.researchgate.net/publication/330379214_Angiosperm_phylogeny_poster_APP_-_Flowering_plant_systematics_2019

poster that presents morphology (& more) for the orders of flowering plants





also explore:

http://www.mobot.org/MOBOT/research/APweb/

https://monativeplants.org/monps-webinars/

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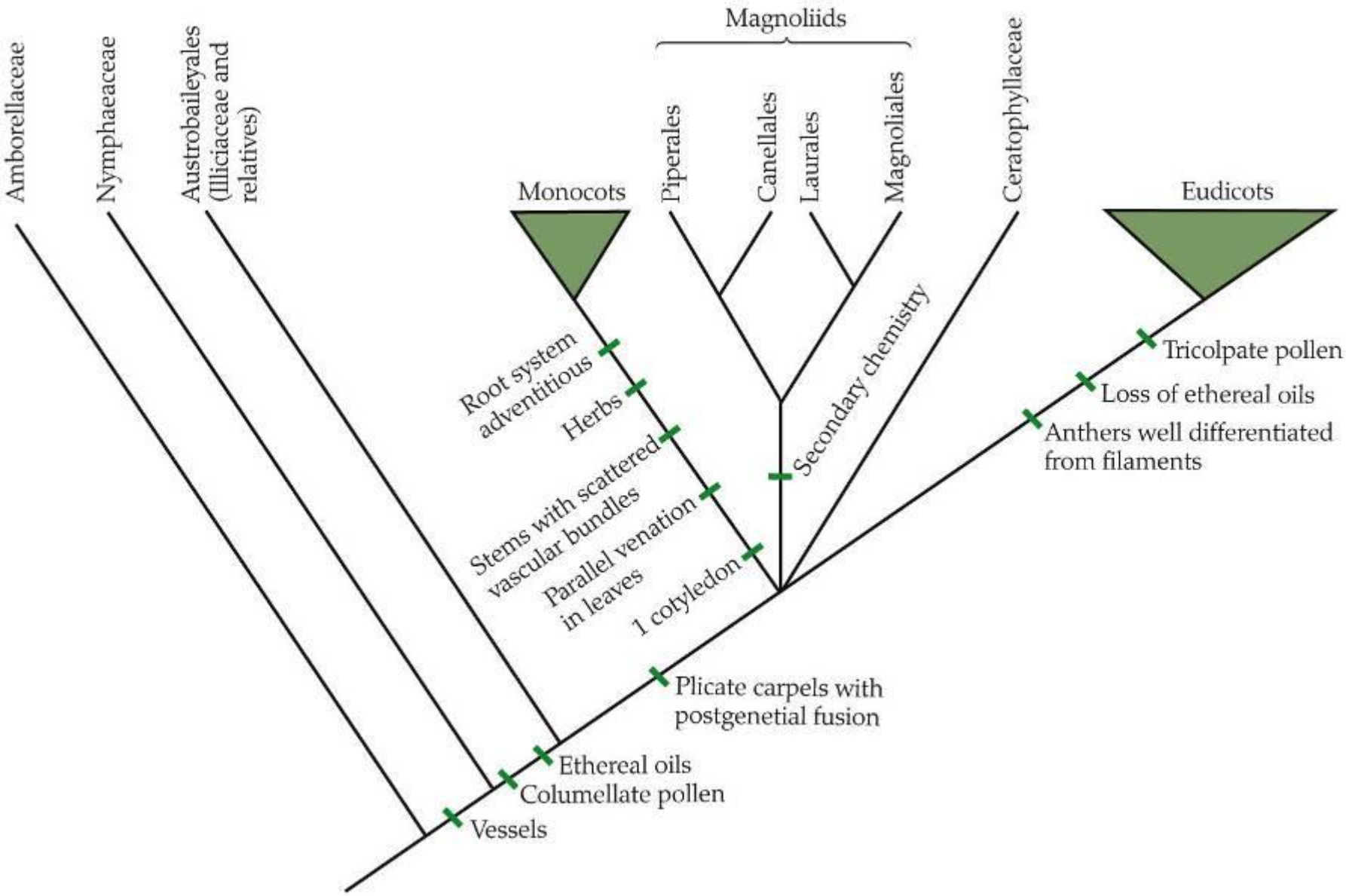
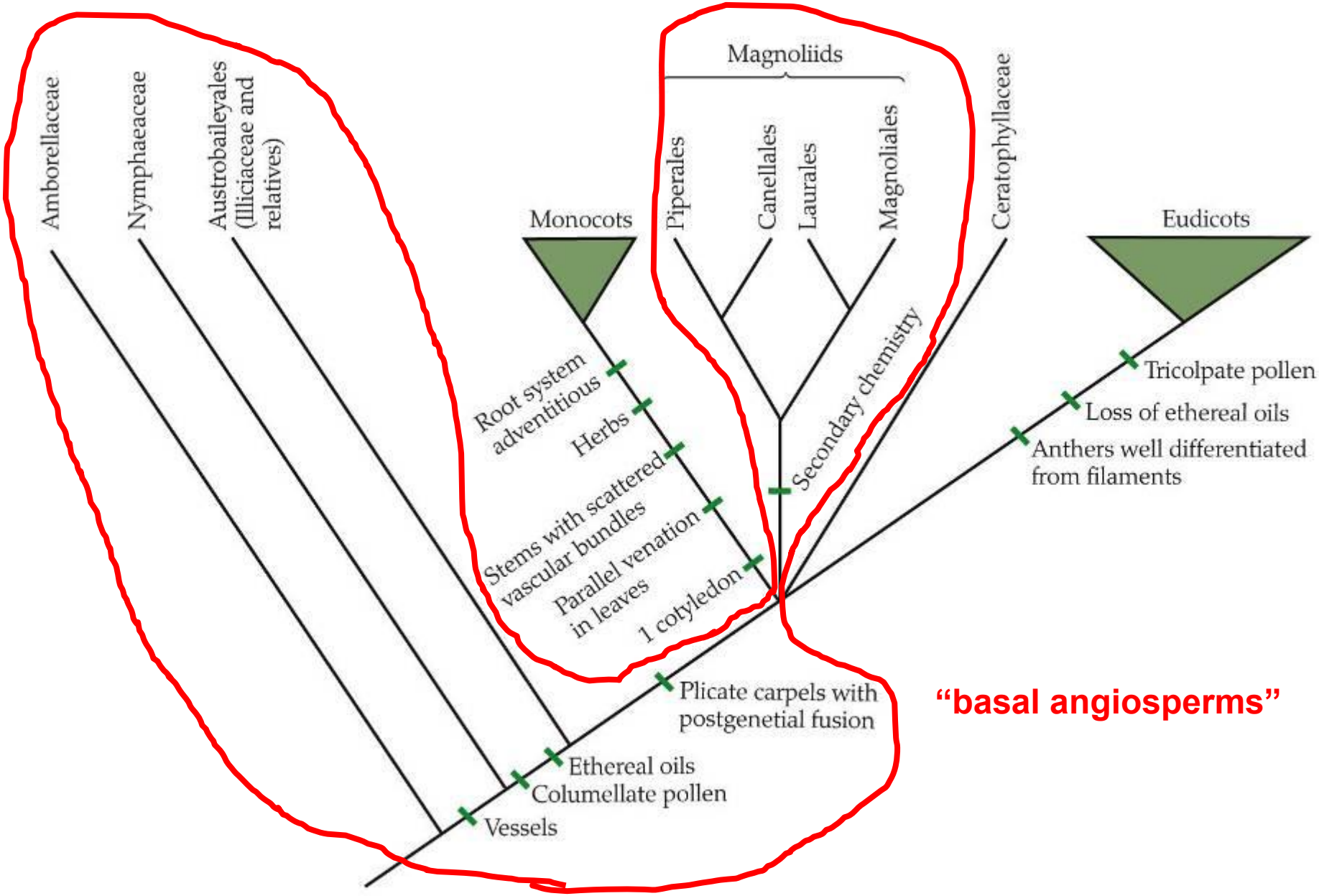


ANGIOSPERMS – plants with flowers & fruits



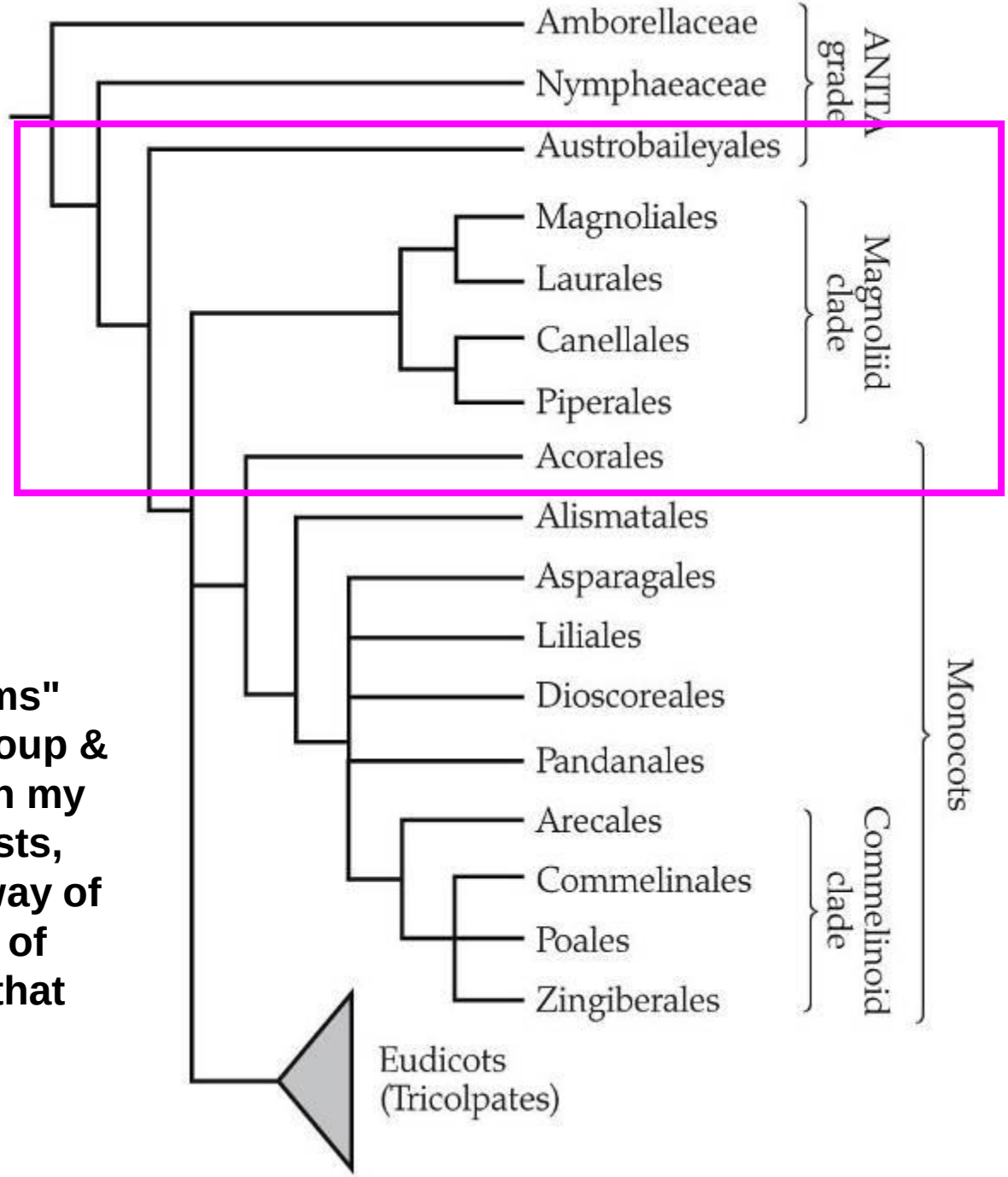
ANGIOSPERMS – phylogenetic overview

ANGIOSPERMS

"BA": woody, simple, alternate, entire, no stipules, strong spicy smell

ethereal oils!

"basal angiosperms" are an artificial group & more variable than my "BA" motif suggests, but it is a useful way of dealing with most of the angiosperms that are not dicots or monocots



"basal angiosperms"

magnolia

sassafras

water lily

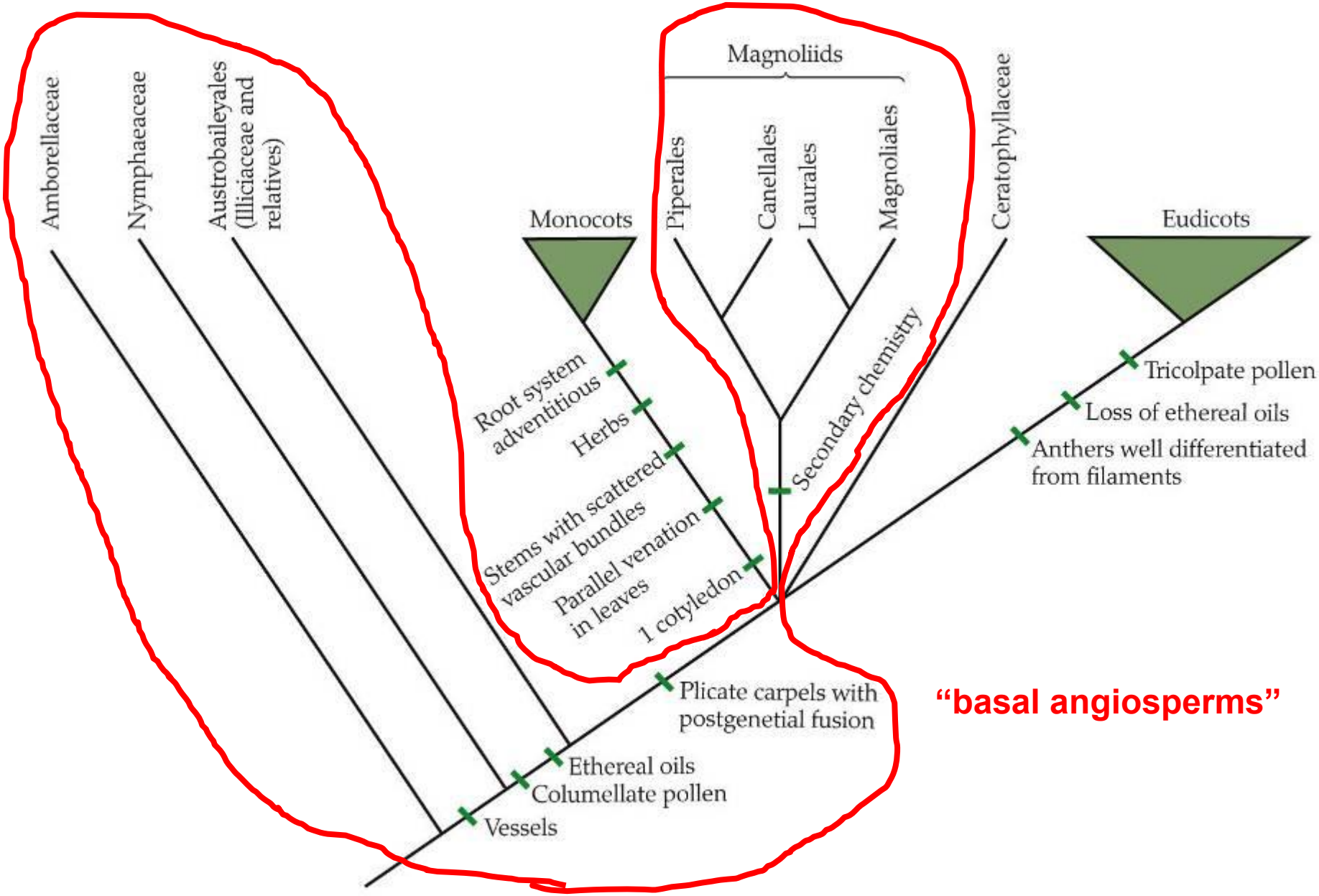
amborella

illicium

pawpaw

Characteristics of early angiosperms

- Carpels with **poorly developed styles** and an **elongate stigmatic region**
- Carpels not fused shut, but sealed by a secretion layer
- Floral parts are either spirally arranged or in whorls of three
- Many of them have **ethereal oils**
- seeds have a tiny embryo and copious endosperm
- Motif (spicy smell):
  - woody
  - simple
  - alternate
  - entire
  - no stipules



some people don't like me using "BA" -- it's not natural...

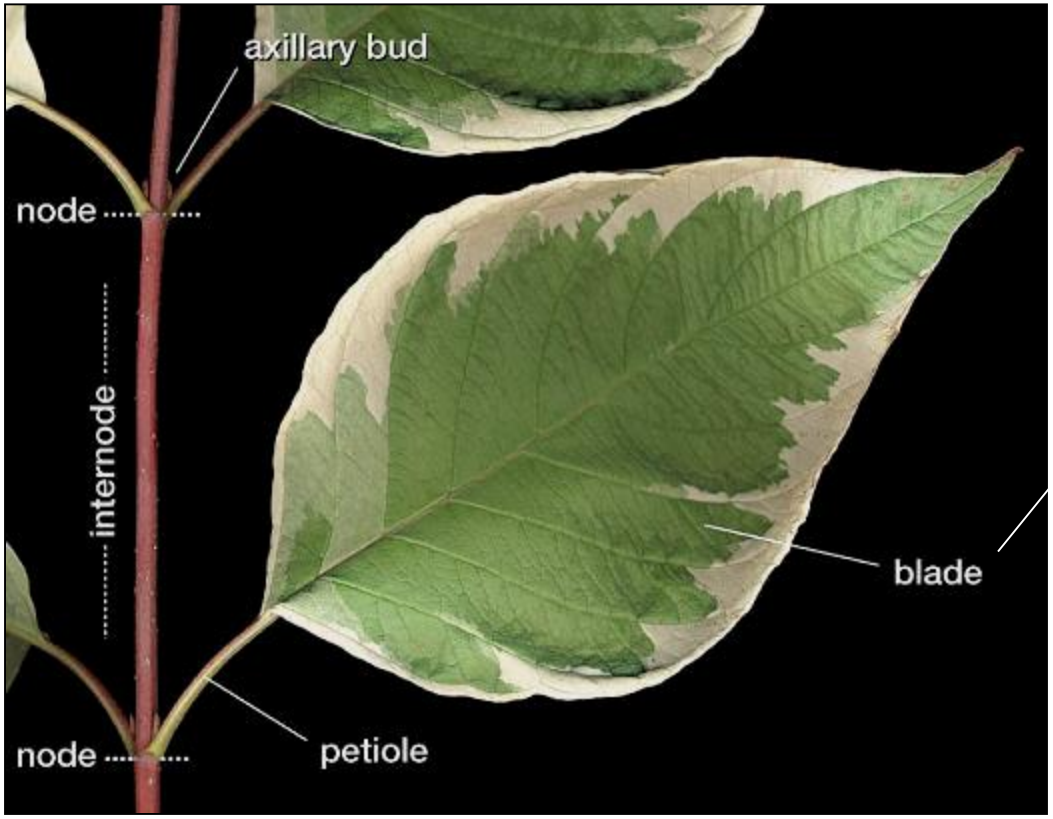
Monocot vs. dicot motifs

these are natural groups, but are they invariant?

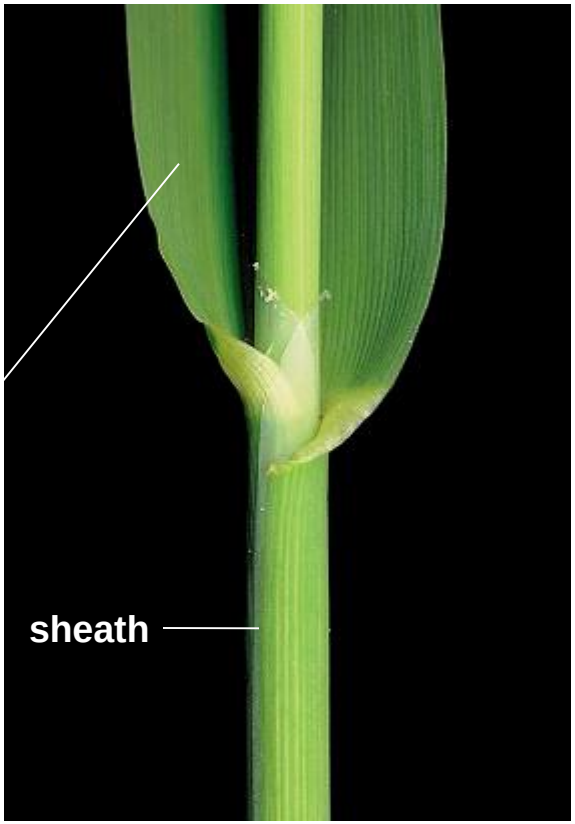
- Monocots
  - linear blades (broad in some, e.g., gingers, aroids)
  - parallel veins (reticulate in some, esp. forest understory)
  - sheathing leaf base (only rarely with petiole-like part)
  - [adventitious roots, scattered vascular bundles, 3-merous fls]
  - herbs [anomalous woody], usu. simple, alternate, entire, no stipules --- "graminoids" & grasses (Poaceae)
- Dicots
  - broad blades (rarely linear)
  - net-like (reticulate) veins
  - non-sheathing leaf base
  - [primary taproot, vascular bundles in ring, 4-5-merous fls]
  - [herbs or woody, simple or compound, alternate or opposite, entire or toothed, stipules or not]

Leaf Morphology

dicot:
reticulate (net-like) veins



monocot:
parallel veins



Leaf venation = pattern of vascular bundles

- **parallel**

monocots

dicots

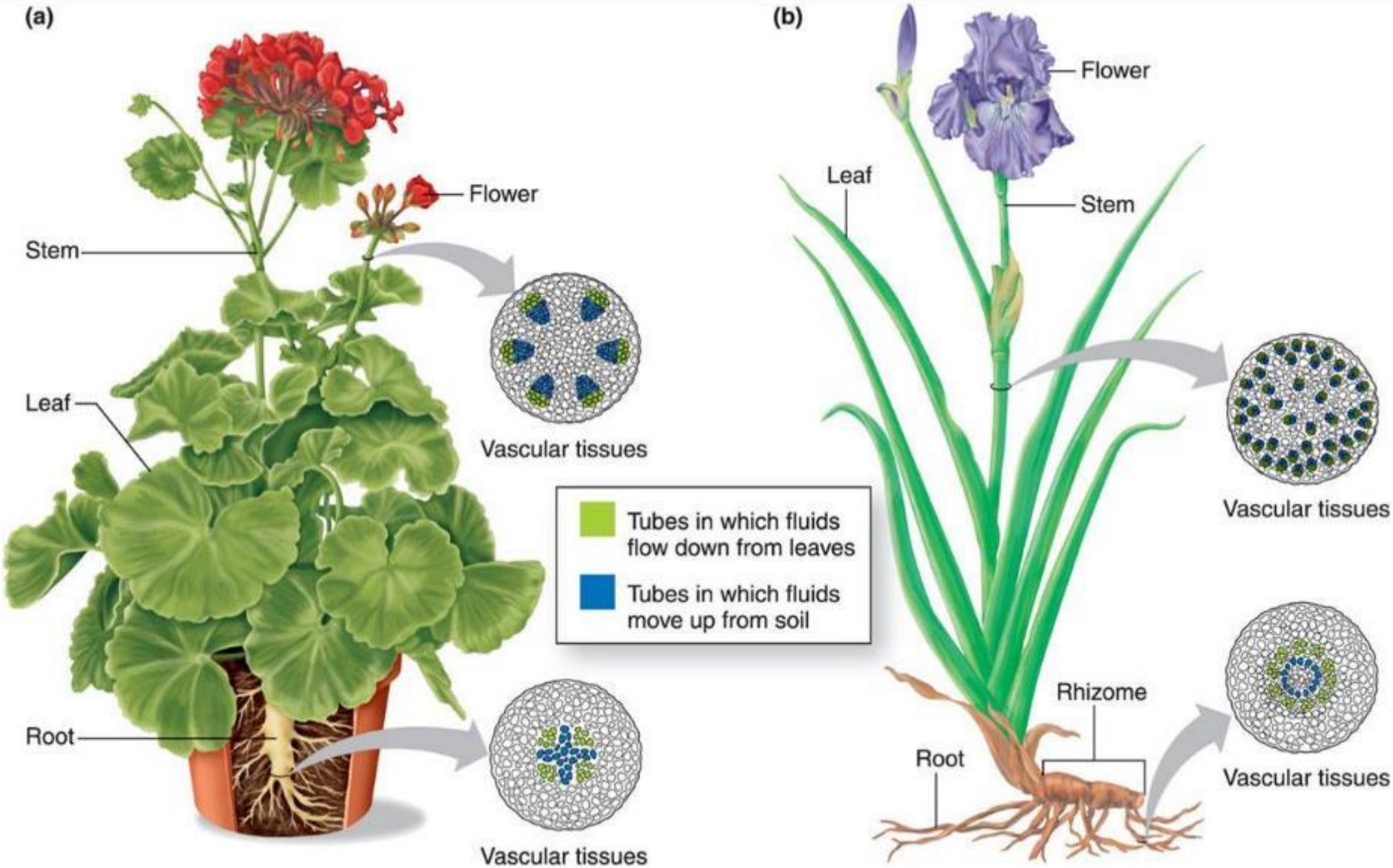
- **reticulate/net-like (pinnate & palmate patterns)**

dicots > 2/3

oak, rose, poppy, soybean

monocots ca 1/4

orchid, lily, corn, palm, iris



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  - larger groups -- angiosperm, monocot, dicot
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True Leaf/Root Clade

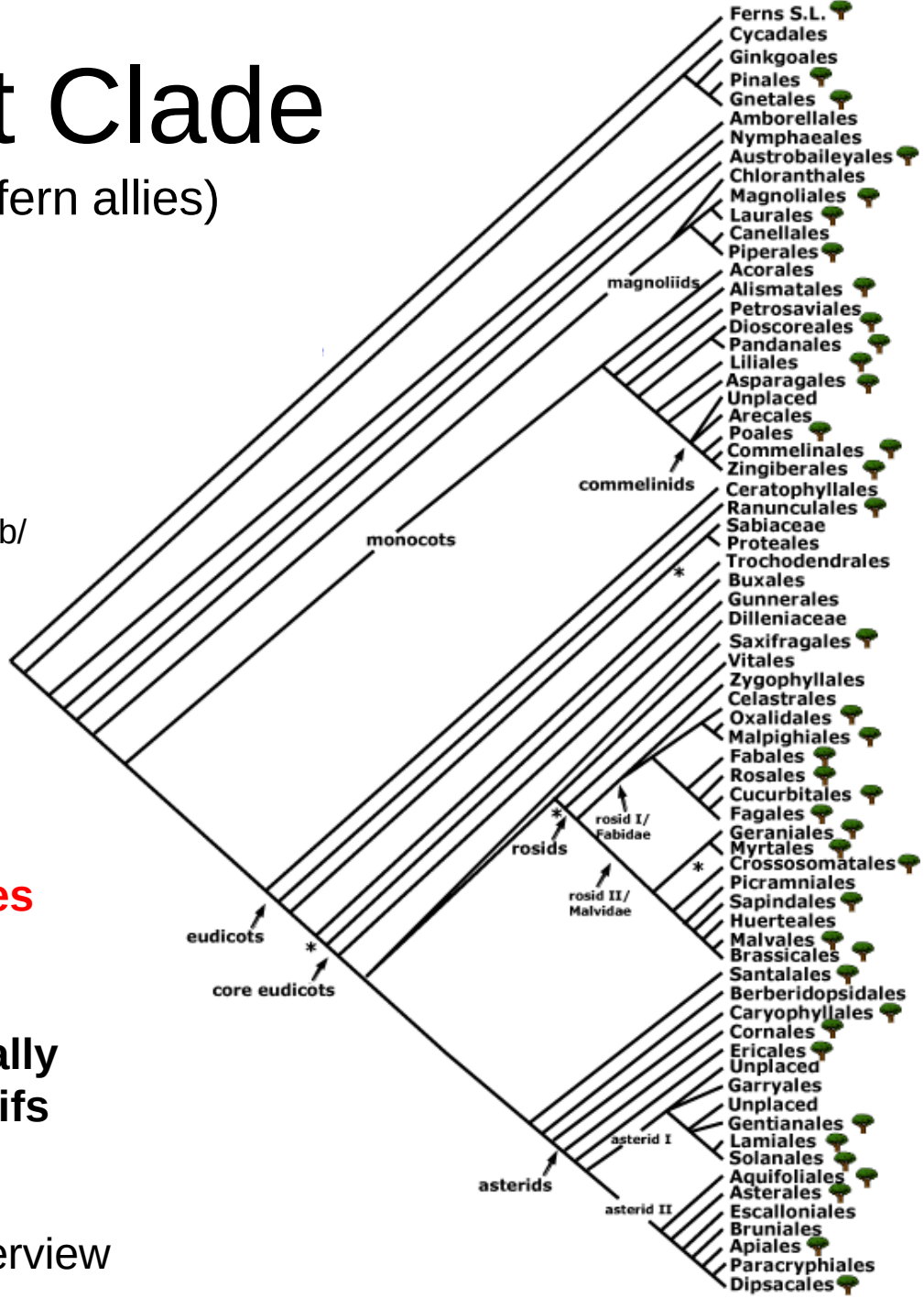
(~vascular plants except for the fern allies)

Angiosperm Phylogeny Website

http://www.mobot.org/MOBOT/research/APweb/

-ales = order
= group of related families

~64 orders of angiosperms
-- most are NOT morphologically cohesive enough to ID as motifs



ANGIOSPERMS – phylogenetic overview

“**basal angiosperms**”

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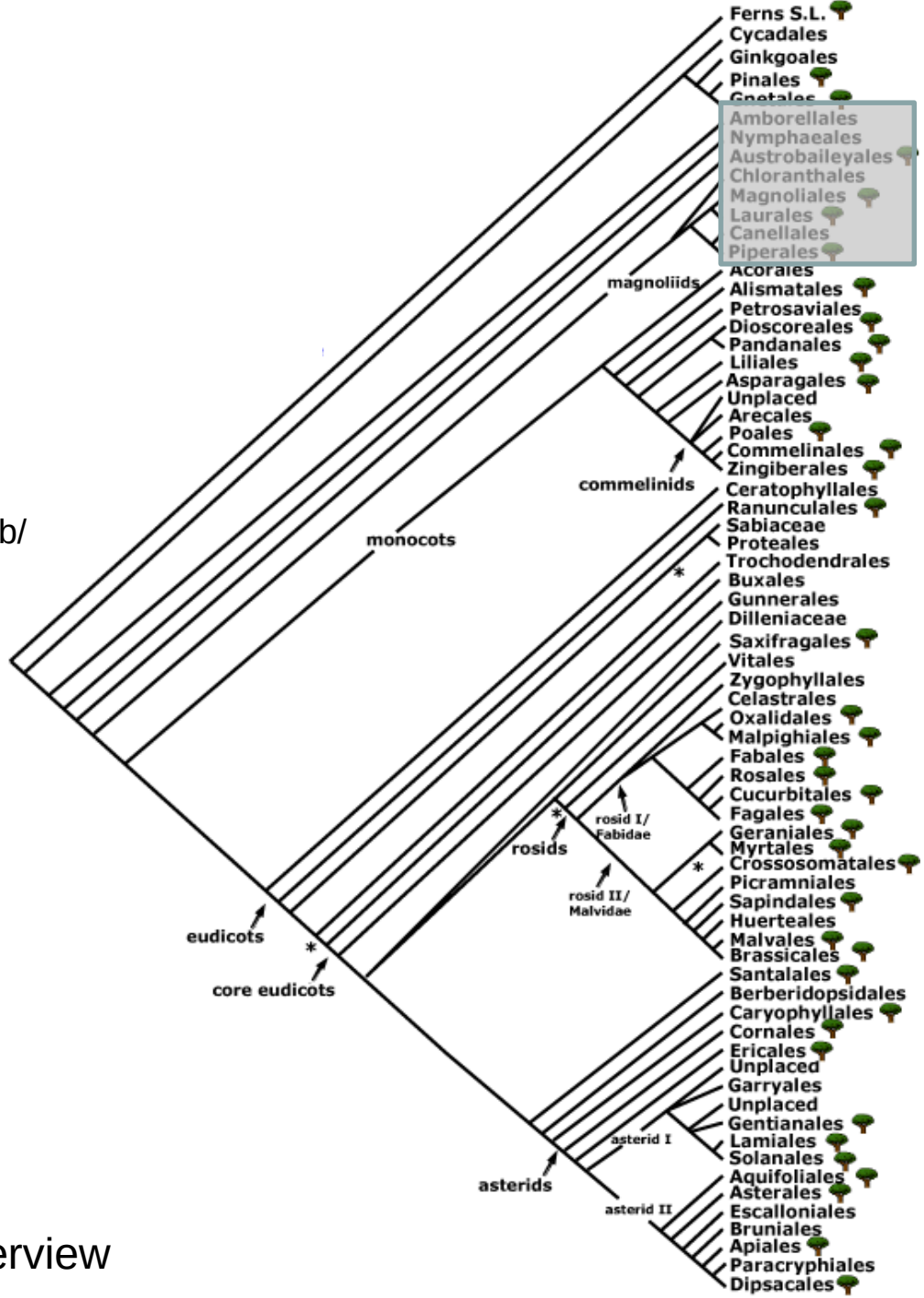

ANGIOSPERMS – phylogenetic overview

“basal angiosperms”
monocots

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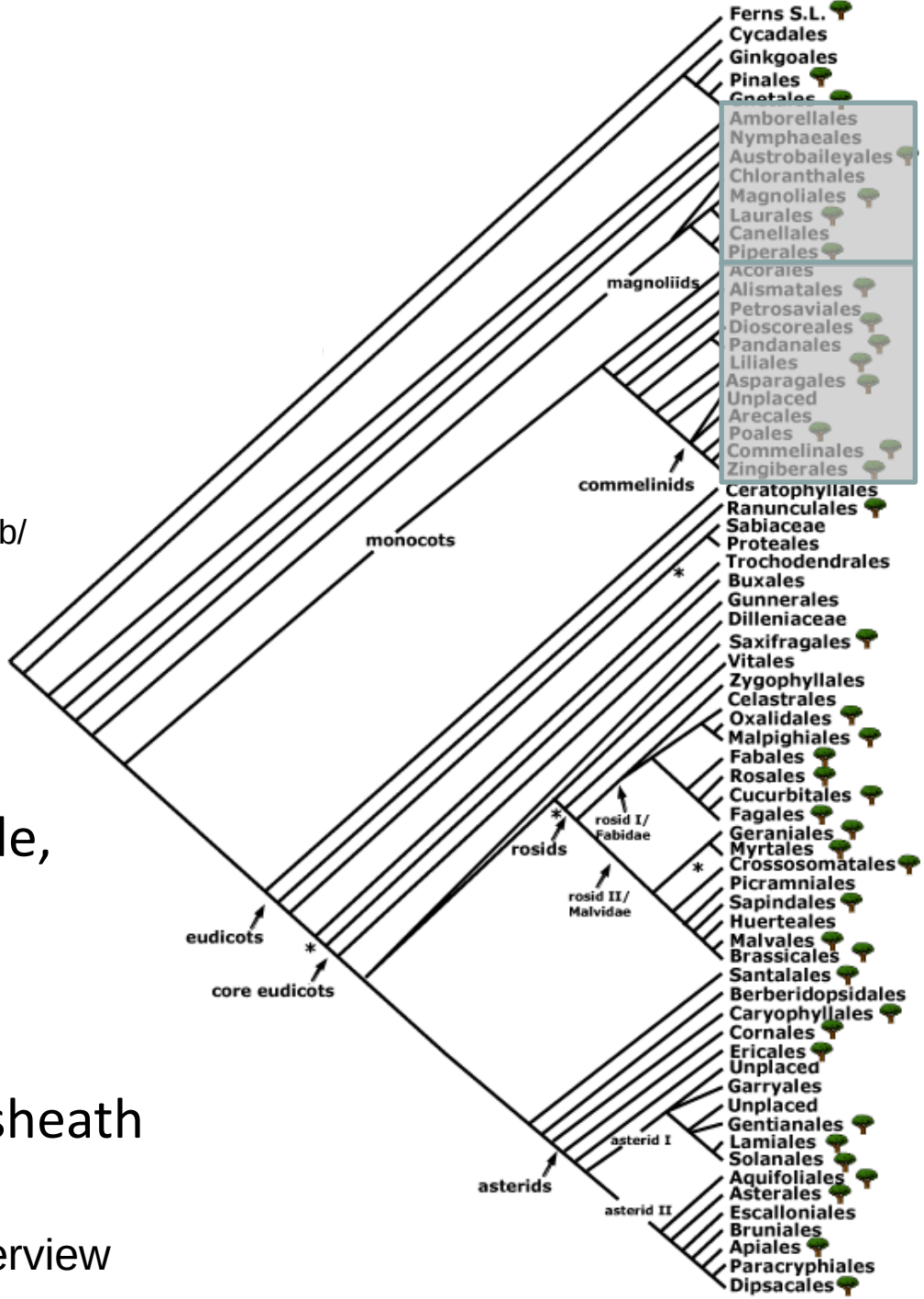
monocots: sheath, linear blade, parallel veins

"graminoids" (grass-like)
grasses: swollen node, open sheath

ANGIOSPERMS – phylogenetic overview



“basal angiosperms”
monocots
sympetalae

Angiosperm Phylogeny Website

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sympetalae:
petals fused (corolla tube)

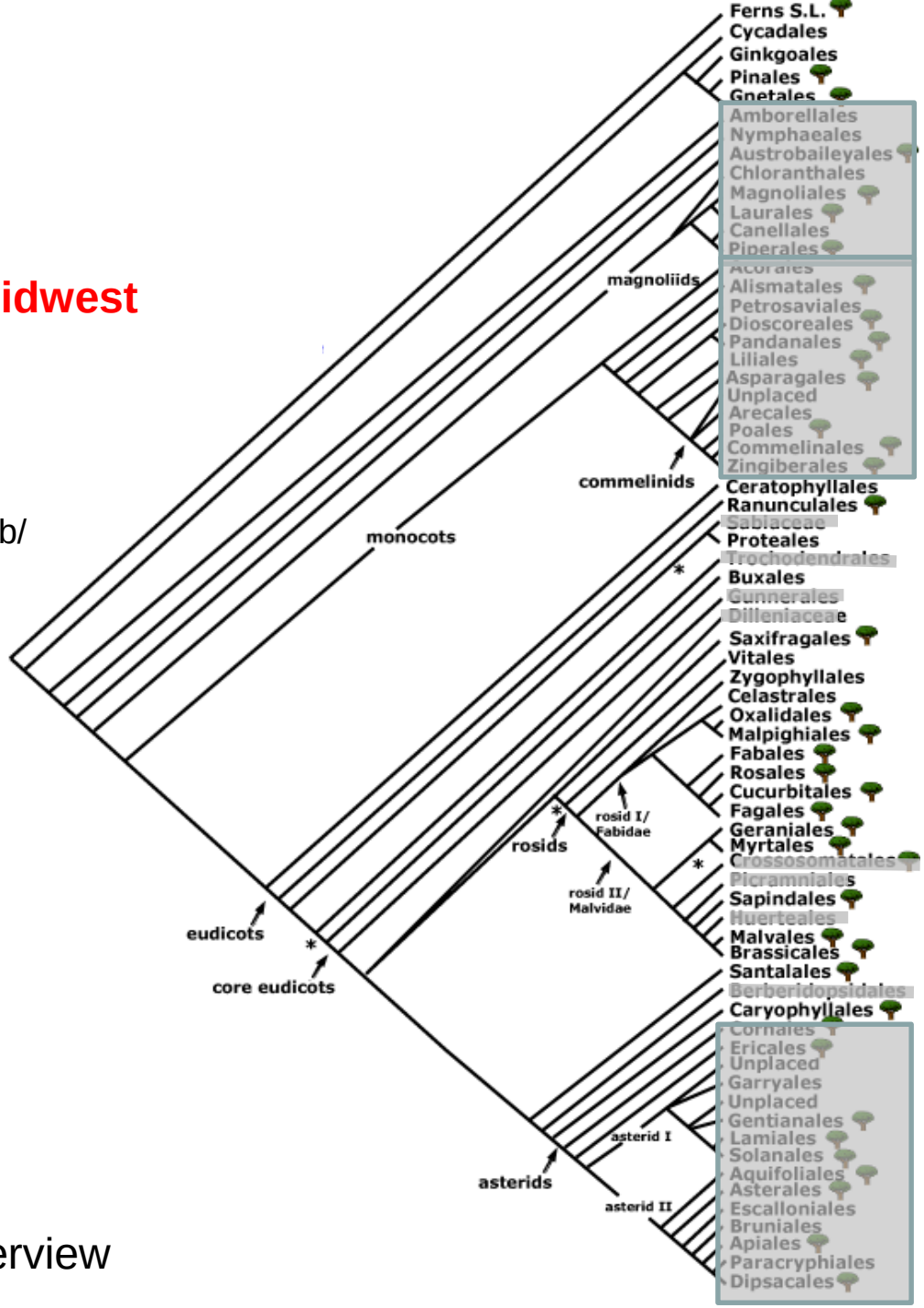
ANGIOSPERMS – phylogenetic overview

“basal angiosperms”
monocots
sympetalae
-- orders & families not in US midwest

Angiosperm Phylogeny Website

http://www.mobot.org/MOBOT/research/APweb/

Sabiaceae
Trochodendrales
Gunnerales
Dilleniaceae
Crossosomatales
Picramniales
Huerteales
Berberidopsidales



ANGIOSPERMS – phylogenetic overview

“basal angiosperms”
monocots
sympetalae
-- orders & families not in US midwest
-- orders w/1-few spp.

Angiosperm Phylogeny Website

Ceratophyllales: ceratophyllum
Proteales: sycamore,
water lotus
Buxales: buxaceae
Vitales: grape
Zygophyllales: tribulus
Celastrales: celastraceae
Oxalidales: oxalis
Cucurbitales: squash
Geraniales: geranium
Santalales: mistletoe

a 'motif' of 1 is just something to learn on its own

“basal angiosperms”
monocots
sympetalae
-- orders not in US midwest
-- orders w/1-few spp.
-- only 1-2 families in US midwest

Angiosperm Phylogeny Website

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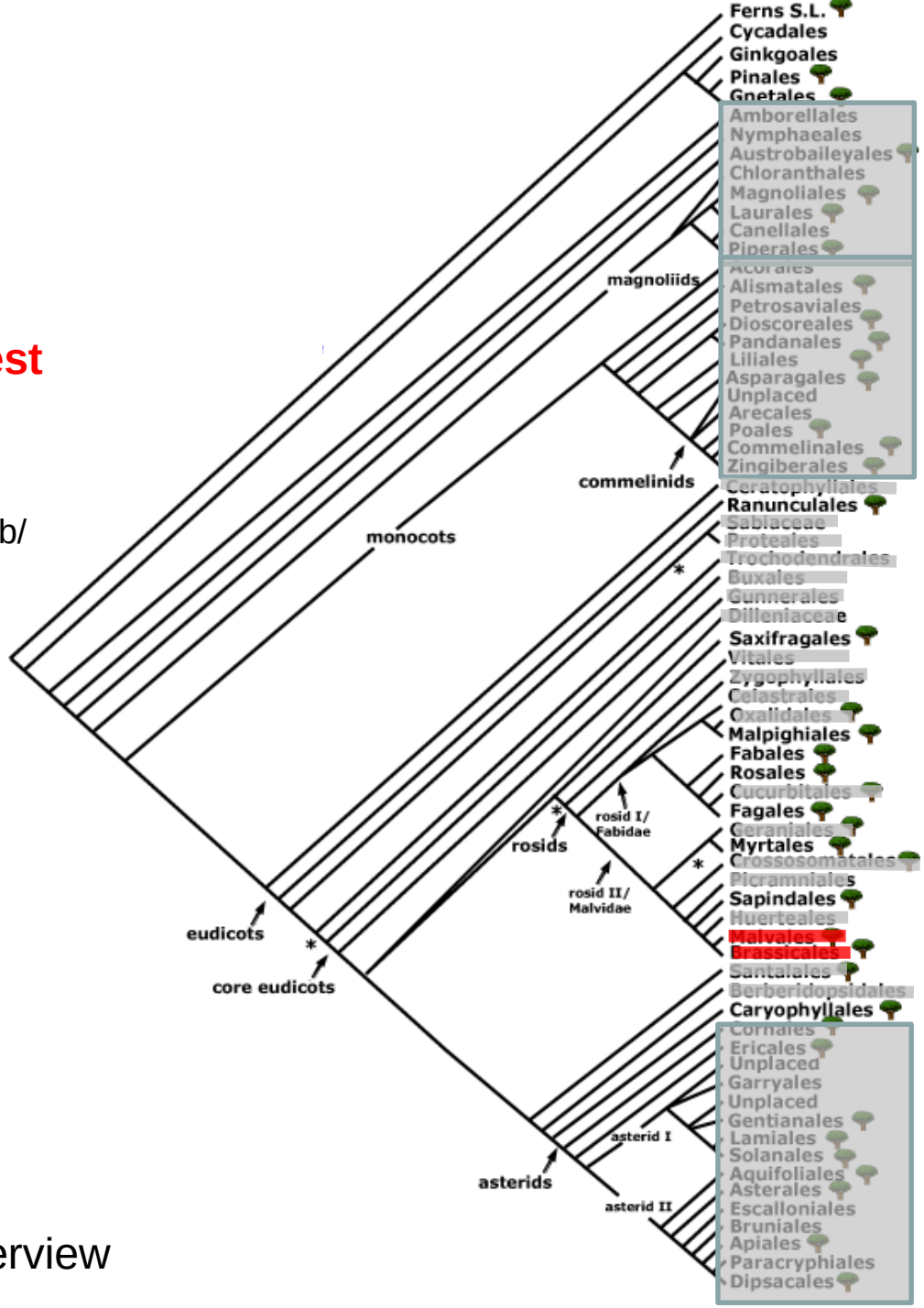
Malvales: malvaceae
Brassicales: brassicaceae,
cleomaceae



ANGIOSPERMS – phylogenetic overview

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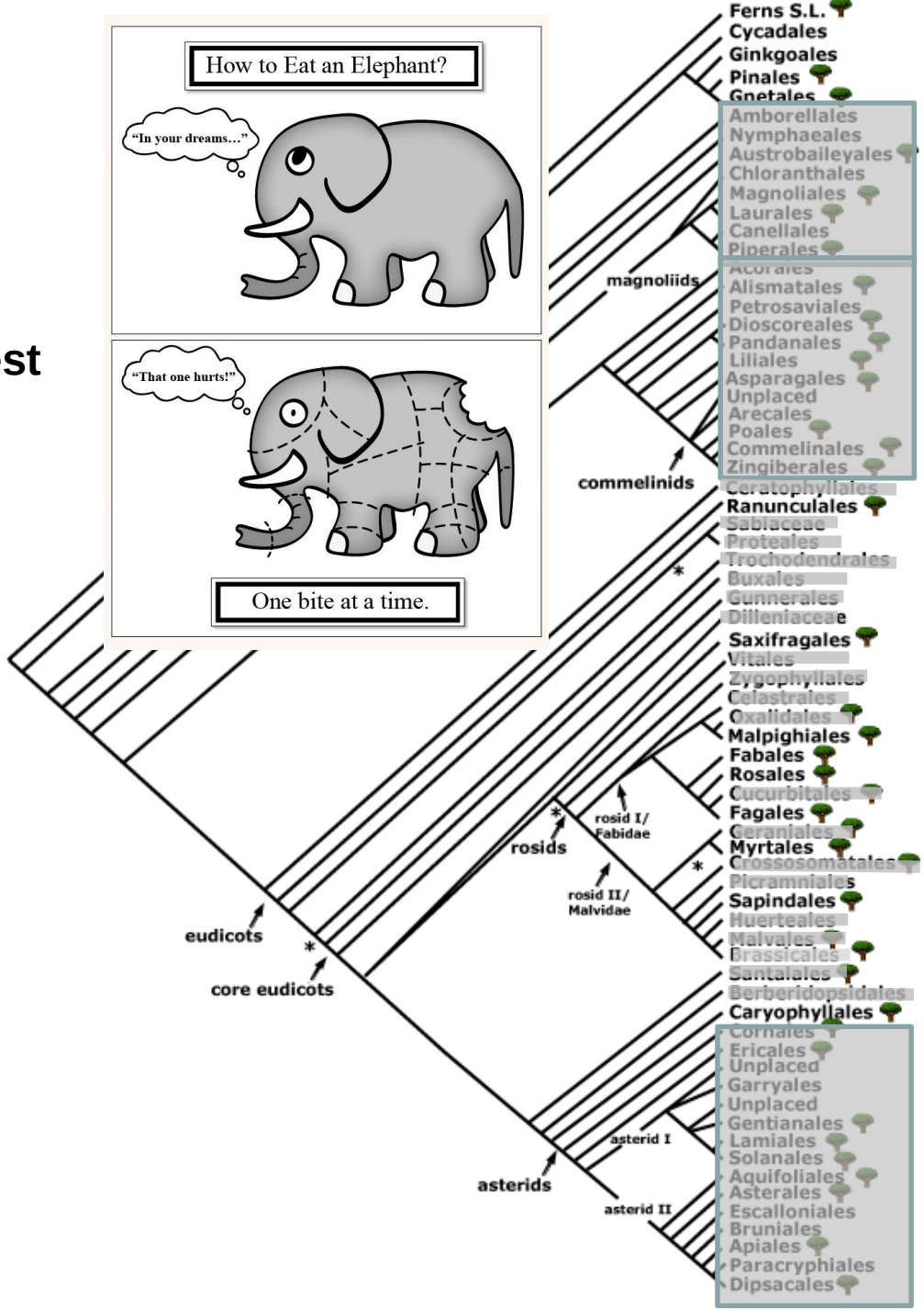


Ranunculales: ∞
Saxifragales: ∞
Malpighiales: ∞
Fabales: legumes, milkworts
Rosales: ∞
Fagales: ∞
Myrtales: ∞
Sapindales: ∞
Caryophyllales: ∞

Caryophyllales: amaranths, cacti, chickweeds, knotweeds, mollugo, nyctages, pokeweeds, purslanes, sundews

some already fit into "motifs" or are readily characterized by basic features

Fabales: legumes, milkworts

Fagales: beeches/chestnuts/oaks, birches, hickories/walnuts

Malpighiales: elatine, flaxes, hypericum, passionflowers, podostemum, spurges, violets, willows

only a couple fit easy ordinal motifs

Myrtales: lythraceae, onagraceae, rhexia

Ranunculales: barberries, buttercups, menisperms, poppies; part of "**VD**"
-- often with slightly sheathing petiole base & yellow wood

Rosales: buckthorns, cannabaceae, elaeagnus, elms, mulberries, nettles, roses

Sapindales: anacardiaceae, rutaceae, sapindaceae, simaroubaceae; part of "**CoAl**"
-- mostly woody, compound, alternate, no stipules

Saxifragales: gooseberries, itea, saxifrages, stonecrops, sweetgum, witch-hazel

Ranunculales: barberries, buttercups, menisperms, poppies

part of "**VD**" (vaginate/sheathing dicots)
-- no smell (carrots), no stipules (roses)

-- often with slightly sheathing petiole base & yellow wood

Sapindales - Rutaceae - *Zanthoxylum*

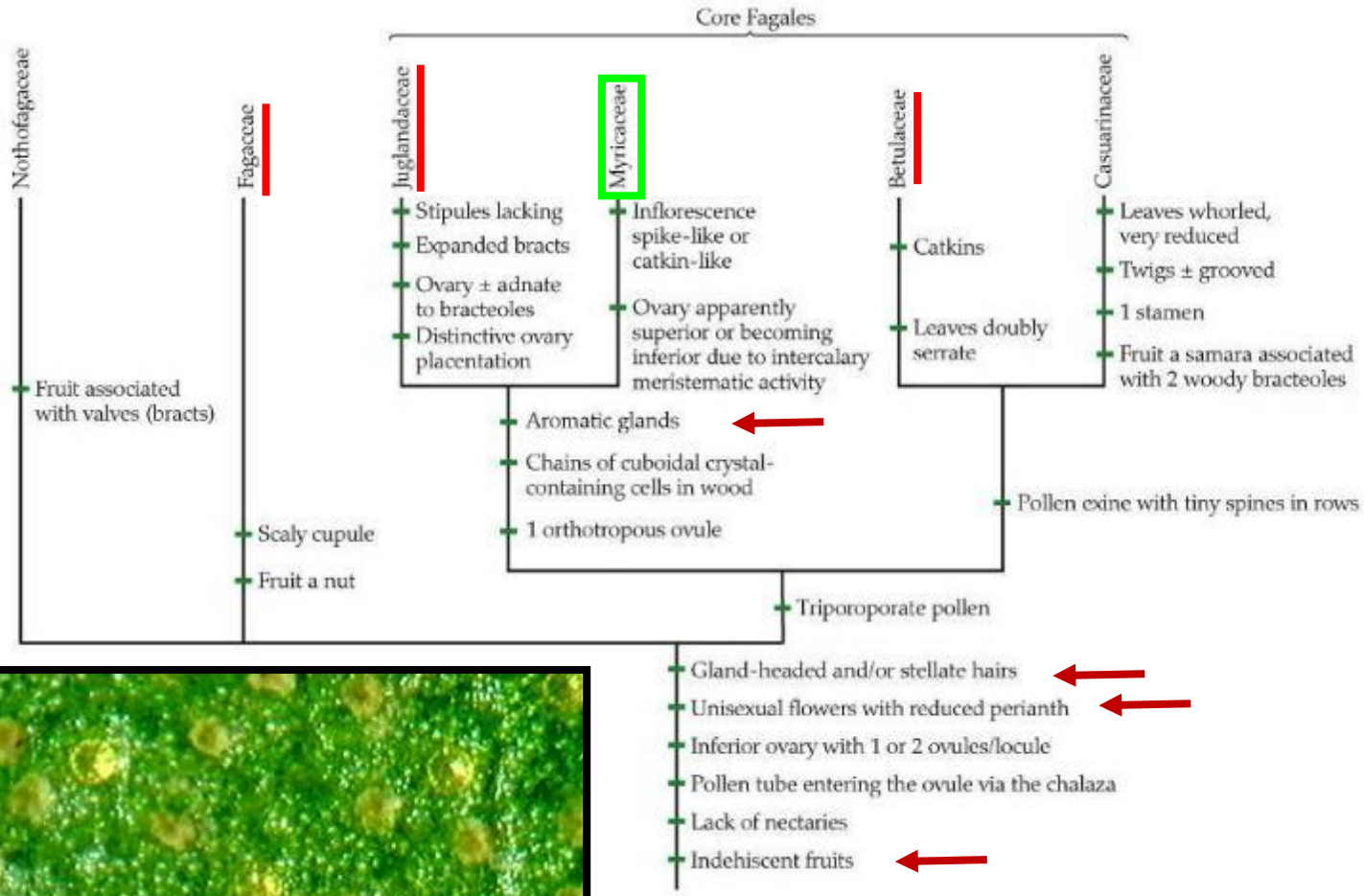
Sapindales

woody, compound, alternate, no stipules

part of "CoAl"

Sapindales - Anacardiaceae - *Rhus*

Fagales



Juglandaceae are part of "CoAl"

the rest are part of "Rosy" or "Bberry"

so, natural or "artificial"??

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Apiaceae: "VD"; herbs, usu compound, usu alternate, usu toothed/lobed, no stipules; umbel, schizocarp; stylopodium, inferior ovary, petals fused (but look free)

Asteraceae: involucrate head; woody or herbs, compound or simple, opposite or alternate, toothed/lobed or entire, usually no stipules; sympetalous, achene, inferior ovary, usually pappus

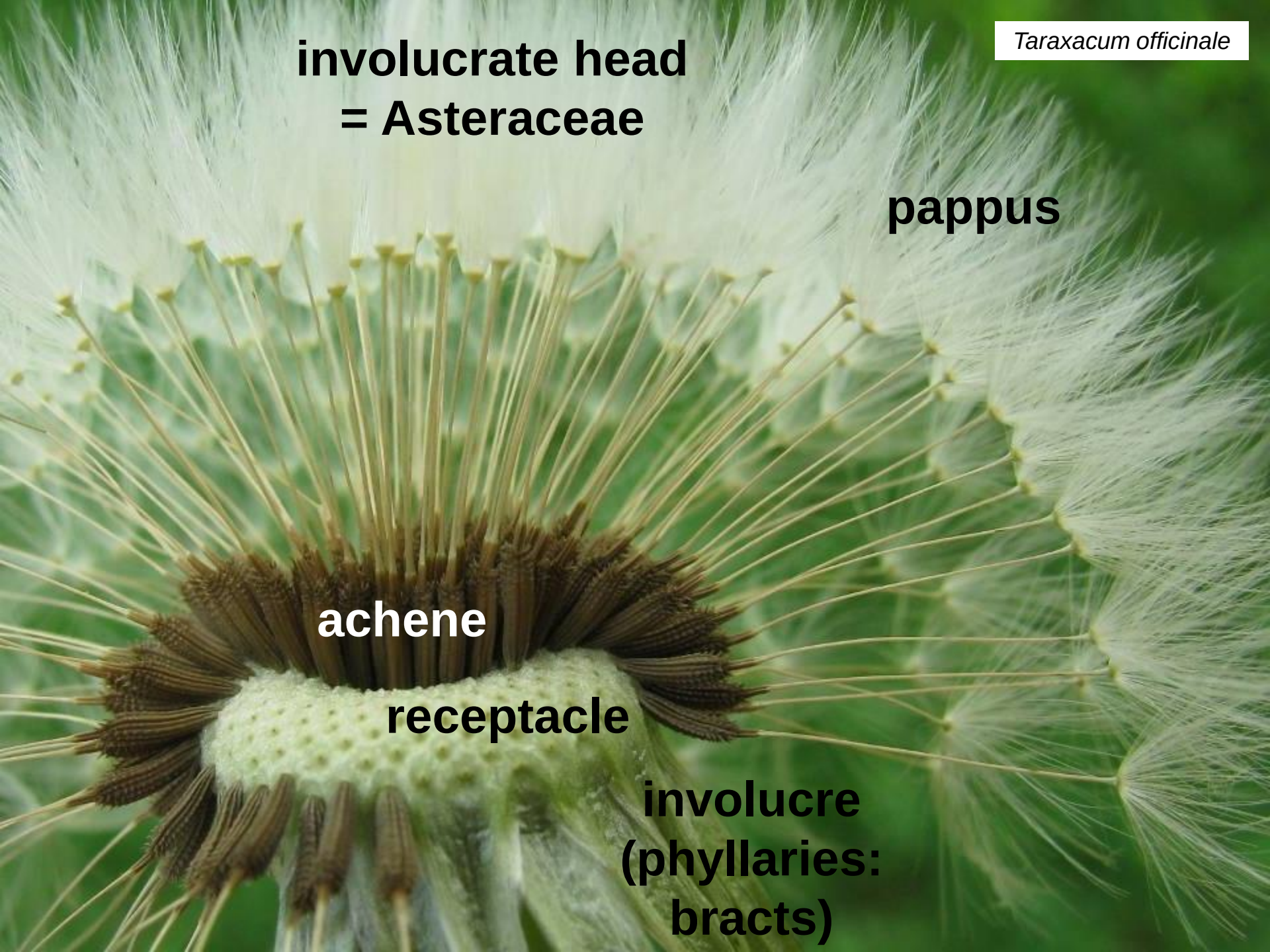
Lactuca graminifolia

Matricaria discoidea

Hypochaeris glabra

Asteraceae: involucrate head -- 30K spp.


Erigeron annuus


Taraxacum officinale
involucrate head
= Asteraceae
pappus
achene
receptacle
involucre
(phyllaries:
bracts)

Caryophyllaceae: herbs, opposite, simple, entire, petioles fused across swollen node; petals free; ovary superior; 2.2K spp.

Saponaria officinalis

Arenaria serpyllifolia

Stellaria media

Geraniaceae: "VD" or "rosy"; schizocarp with sterile 'beak'

Geranium carolinianum

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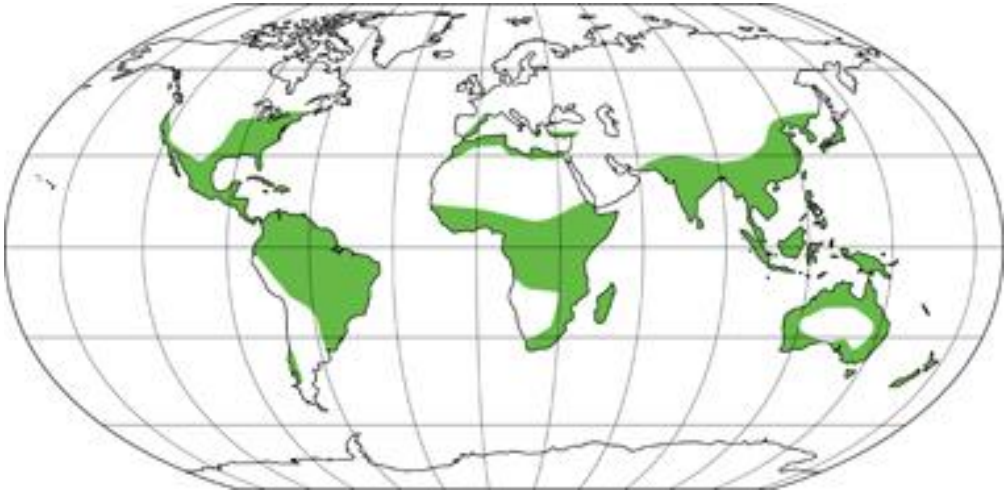
Natural Plant ID Motifs: Examples from Selected Plant Families

THIS TIME

- **families 'just right'**
  - **"basal angiosperm": Lauraceae**
  - **dicots:**
  - **Campanulaceae**
  - **Gentianaceae**
  - **Lythraceae**
  - **Polemoniaceae**
  - **"Portulacaceae" s.l. vs. Portulacaceae s.str.**

Lauraceae part of "BA"

68 genera and 2,978 species worldwide



10 genera & 18 species native or naturalized in North America

Cassytha
Cinnamomum
Laurus
Licaria
Lindera
Litsea
Nectandra
Persea
Sassafras
Umbellularia

Economic plants

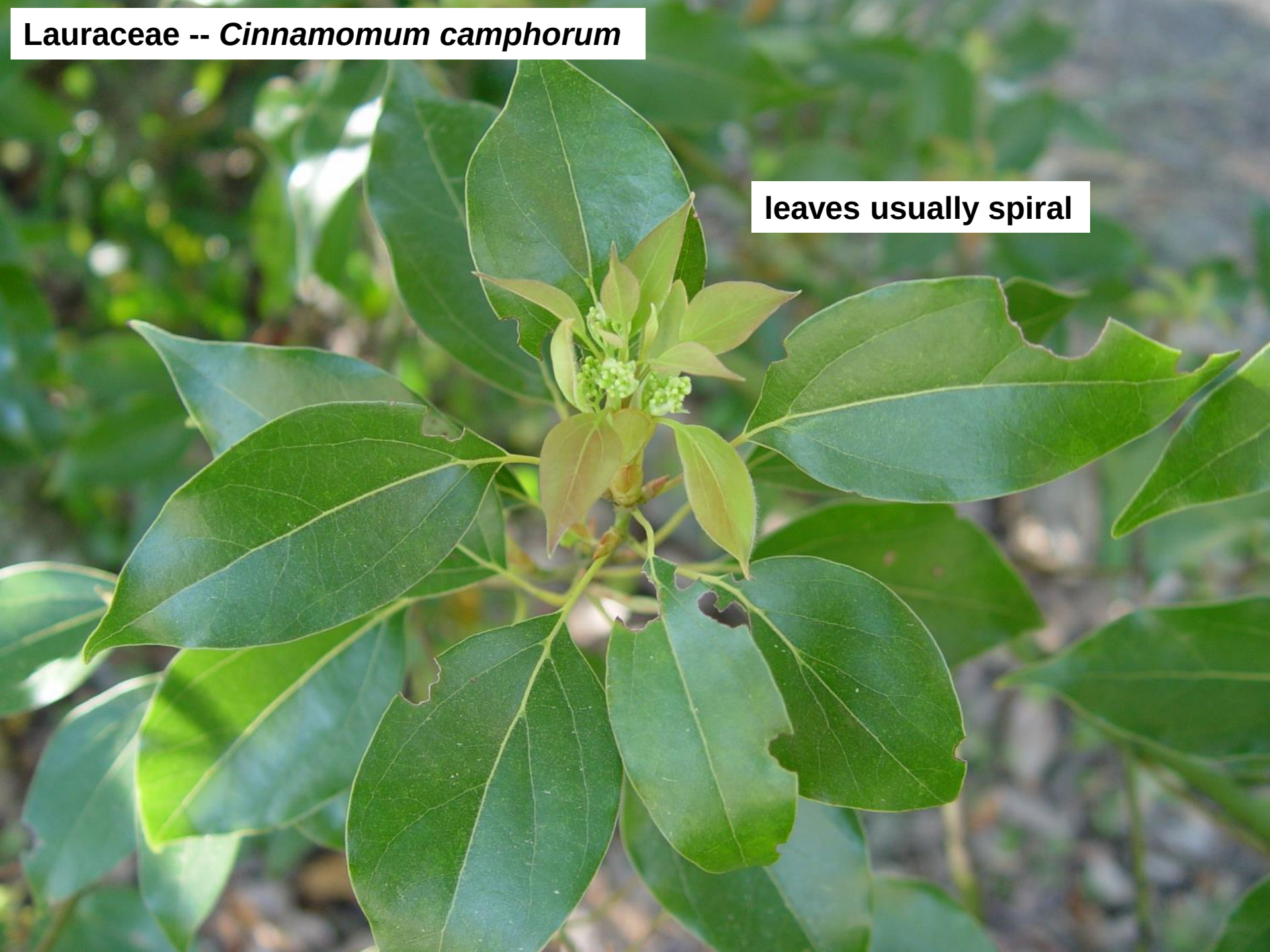
Avocado – *Persea americana*
Cinnamon – *Cinnamomum verum*
Cassia – *Cinnamomum cassia*
Camphor – *Cinnamomum camphora*
Sassafras – *Sassafras albidum*
Bay leaves / bay laurel – *Laurus nobilis*
Numerous important timber trees

Lauraceae

- **Woody**: trees, shrubs (one parasitic climber herb, *Cassytha filiformis*)
- Leaves **simple**, **alternate** & usually **spiral** (infreq opp), **entire**; often glaucous below;; **secondary venation unevenly spaced & at different angles, decurrent along midvein**, sometimes triplinerved and arcuate (e.g., *Cinnamomum*); **higher order veins usually finely reticulate**
- **No stipules**
- **Aromatic** (spicy/resinous) due to ethereal oils; **in small cavities** (minute glands)
- Flowers 3-merous, usually bisexual, (sometimes also unisexual on same plant); actinomorphic; free petals (usually similar to sepals)
- Ovary superior, 1-locular; 1 carpels
- Filaments often with enlarged glandular appendages near the base; anthers with 4, upwardly opening flaps
- Ovary superior, 1-locular; 1 carpel
- Fruit drupe, usually with a cupule - persistent fleshy receptacle that often contrasts in color with the fruit

with old dried specimens, spiral & smell no use

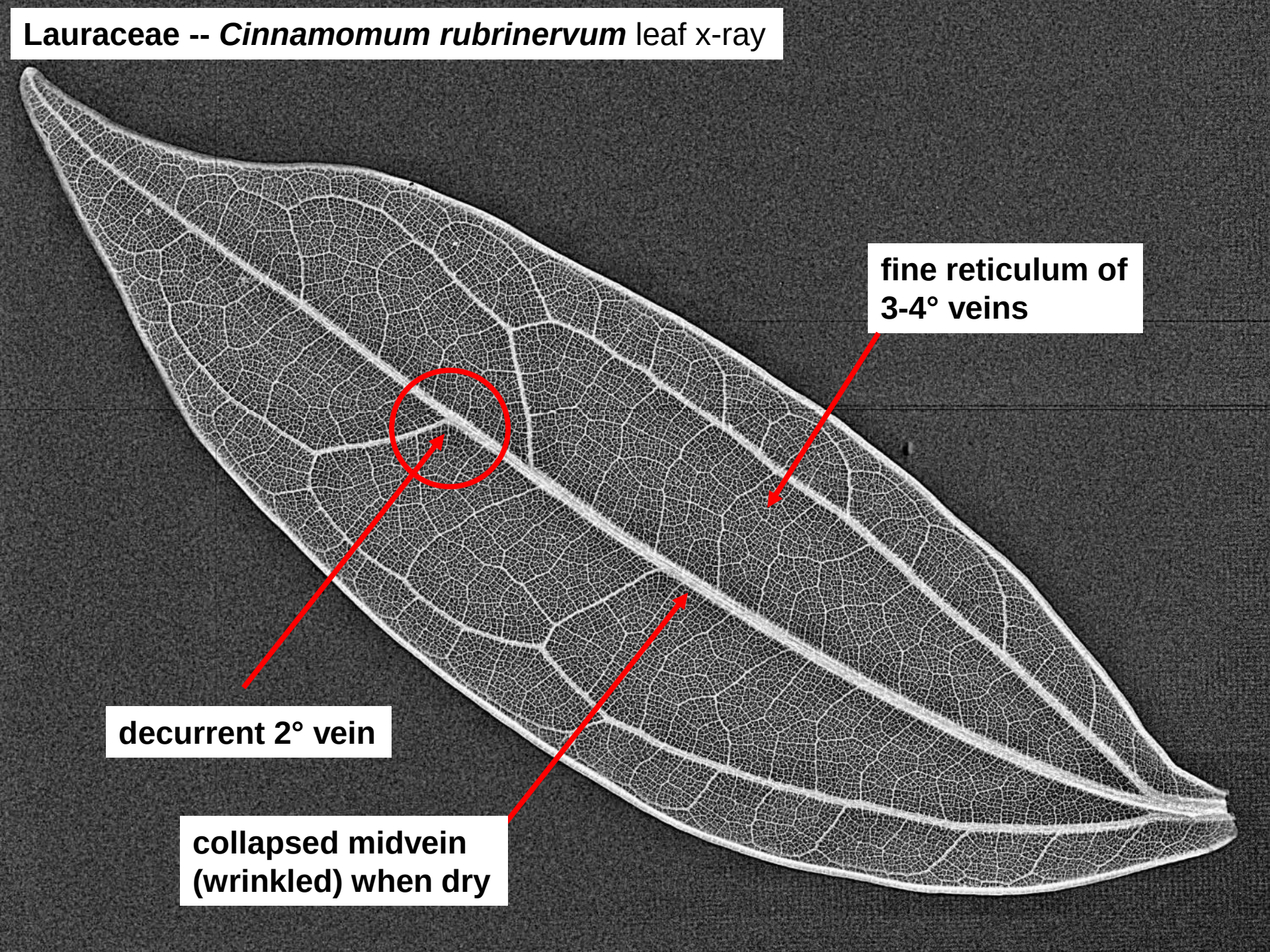
key motif features


Lauraceae -- *Cinnamomum camphorum*
leaves usually spiral

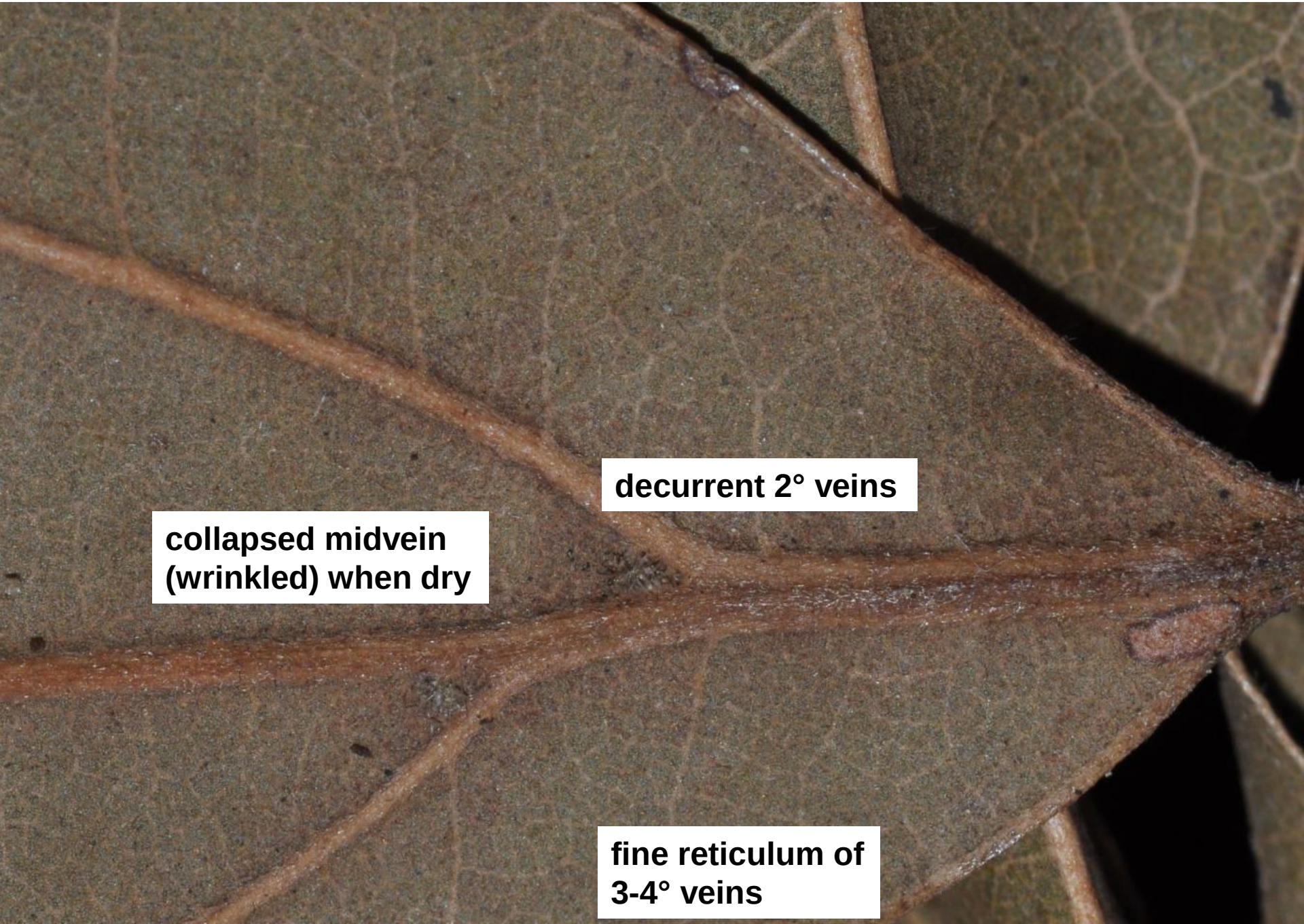

Lauraceae -- *Persea borbonia*
2° veins irregular & unevenly spaced


Lindera benzoin

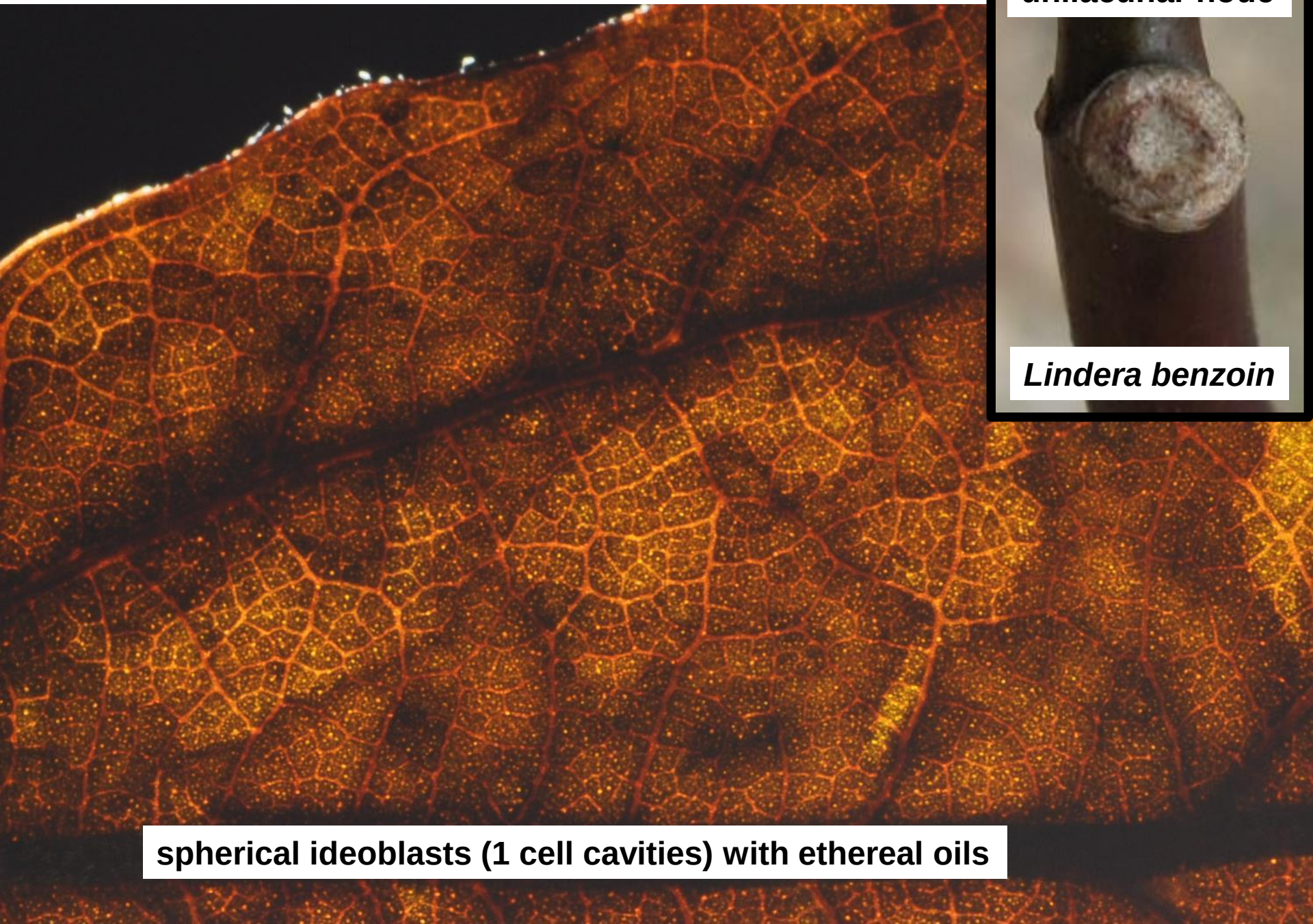
Lauraceae -- *Cinnamomum rubrinervum* leaf x-ray



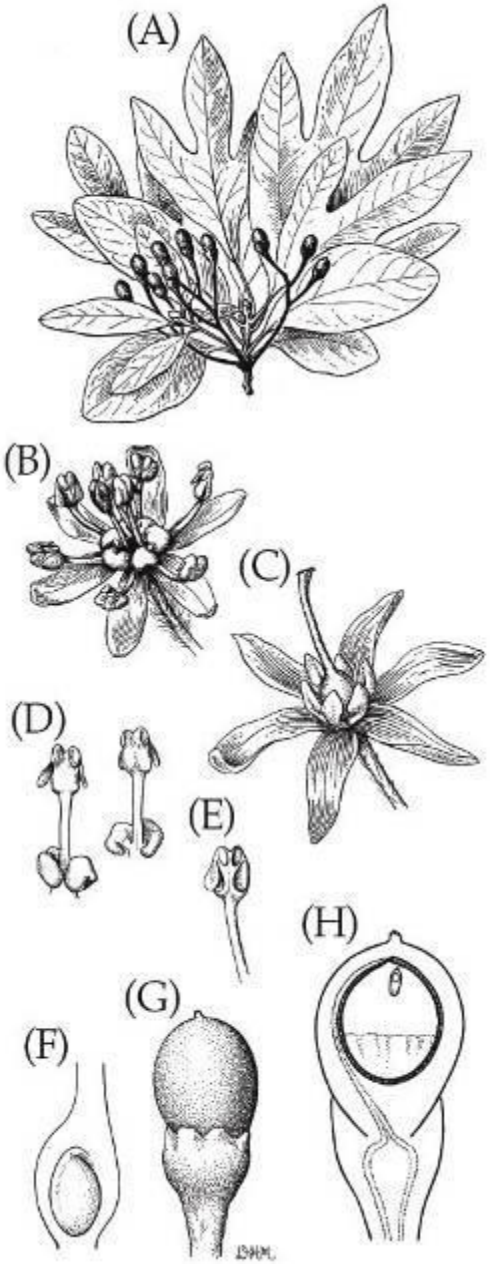
Lauraceae -- *Cinnamomum bladenense*



Lauraceae -- *Cinnamomum bladenense*



Lauraceae. *Sassafras albidum*



"basal angiosperm":

woody, simple, alternate, entire, no stipules; spicy smell

-- oops, lobed here

- **Flowers 3-merous**
- **Petals and sepals not well differentiated**
- **Anthers with 4, upwardly opening flaps**
- **Filaments with enlarged glandular appendages**


Umbellularia californica
Lauraceae
© G. D. Carr

Note anther flaps and glandular appendages at base of filaments


Sassafras albidum
Fruit with cupule: swollen receptacle in color contrasting the fruit


Persea americana - avocado


Ocotea pomaderroides

Cinnamomum glanduliferum

Beilschmiedia dalzellii © Biotik.org

C. zeylanicum

Litsea mysorensis


Lauraceae -- *Cassytha filiformis*
-- superficially like dodder (*Cuscuta*)

Campanulaceae (bellflower or lobelia)
-- part of "milky" (white sap)

- Herbs with milky sap; leaves simple, alternate, toothed, no stipules; filaments usually attached to disk at apex of ovary; capsule with numerous seeds (in MO)

- vegetatively most confusable with the lettuce tribe of Asteraceae, as they also have all of the same features in red (but have achenes, often with pappus); most lettuce relatives start out as rosettes (only a few of our Campanulaceae do that)

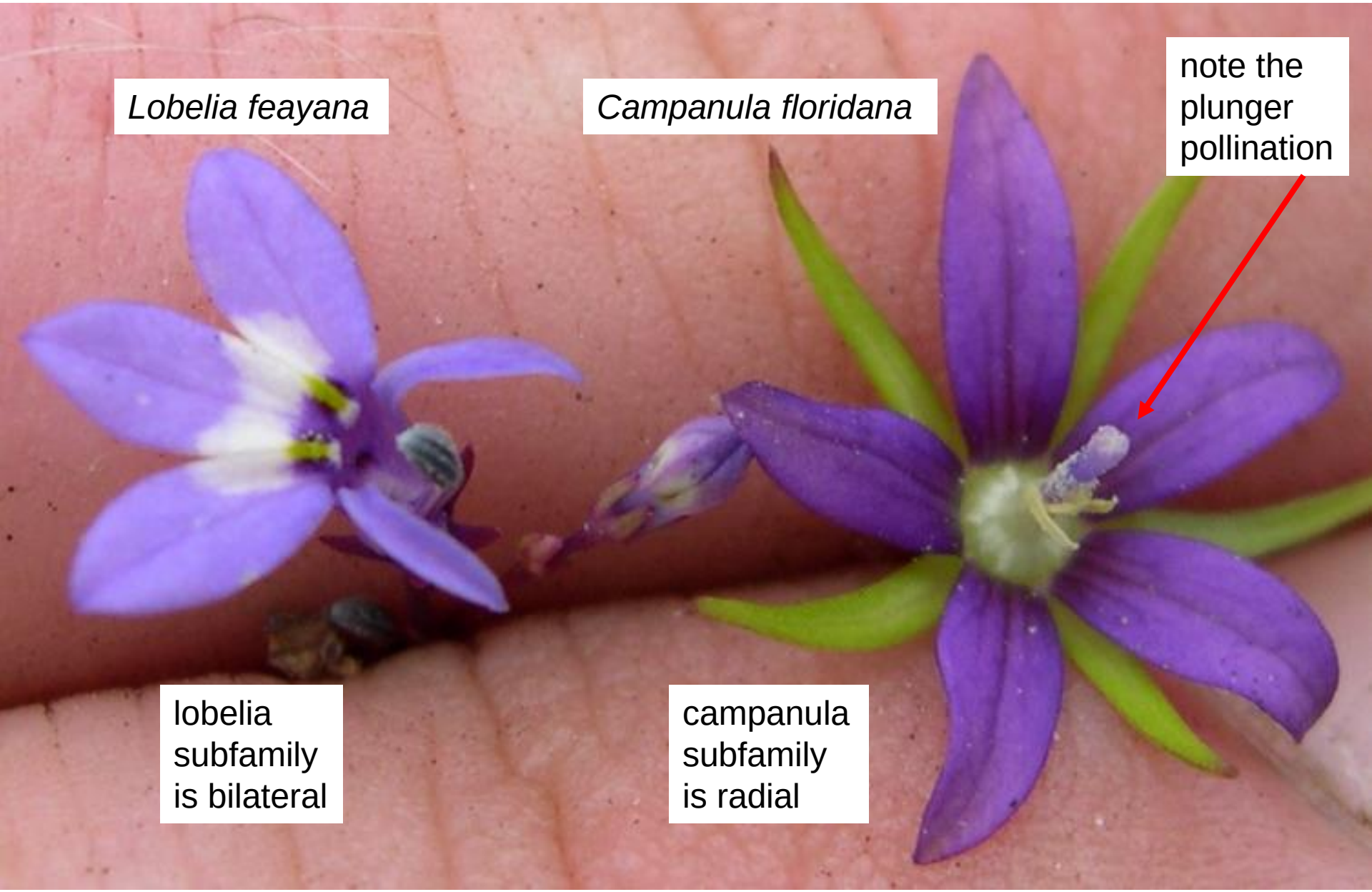
- <u>part of Asterales</u> (or Campanulids): a lot of cryptic features (& retained ancestral features, like sympetaly) support this group, but plunger pollination is the only one that is readily visible (stamens held together, release pollen onto modified style with secondary pollen presentation by the style); in MO herbs with no stipules

Hippobroma longiflora

Campanulaceae

Campanulastrum americanum

Campanulaceae -- *Campanulastrum americanum*



"basal angiosperms"
monocots
sympetalae
-- orders not in US midwest
-- orders w/1-few spp.
-- only 1-2 families in US midwest

Ranunculales: ∞
Saxifragales: ∞
Malpighiales: ∞
Fabales: legumes, milkworts
Rosales: ∞
Fagales: ∞
Myrtales: ∞
Sapindales: ∞
Caryophyllales: ∞

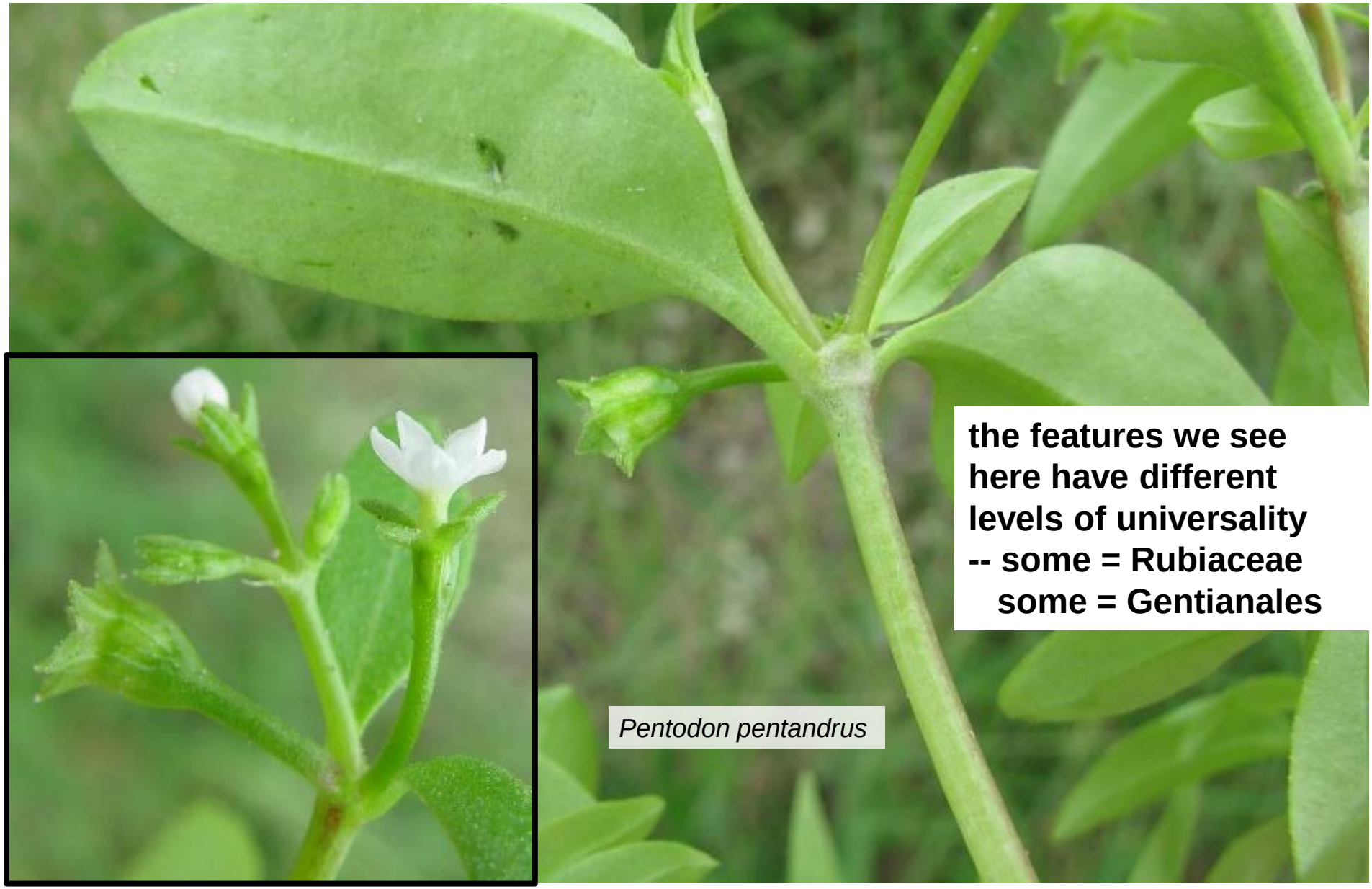
within the Sympetalae are several recognizable groups

within the Sympetalae are several recognizable groups, as well as some groups that have free petals

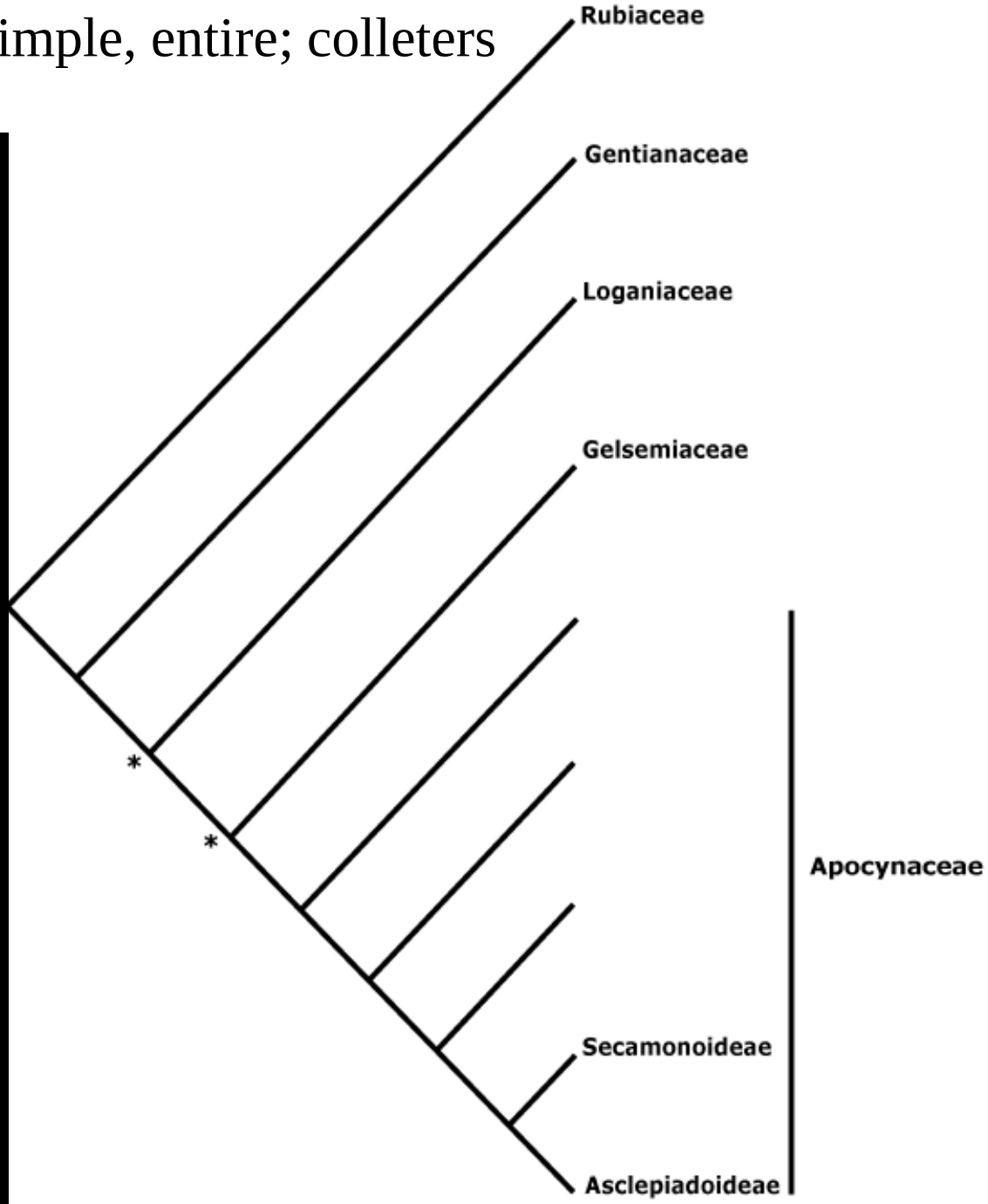
dicot: lvs broad, reticulate/net-like veins, non-sheathing base, 4-5-merous fls

1) **Asteraceae**: involucrate head; sympetalous, inferior ovary; phyllary, pappus...
2) **Ebenaceae**: woody, simple, alternate, entire, no stipules; dioecious; cristate calyx
3) **Gentianales**: leaves simple, opposite, entire, with colleters; sympetalous, radial
   -- **Rubiaceae**: interpetiolar stipules; inferior ovary
4) **Lamiales**: square stem, opposite leaves; sympetalous, bilateral
5) **Solanales**: sympetalous, radial, plications; leaves alternate
   -- **Convolvulaceae**: vine, milky sap, calyx lobes overlap [vs. Solanaceae]

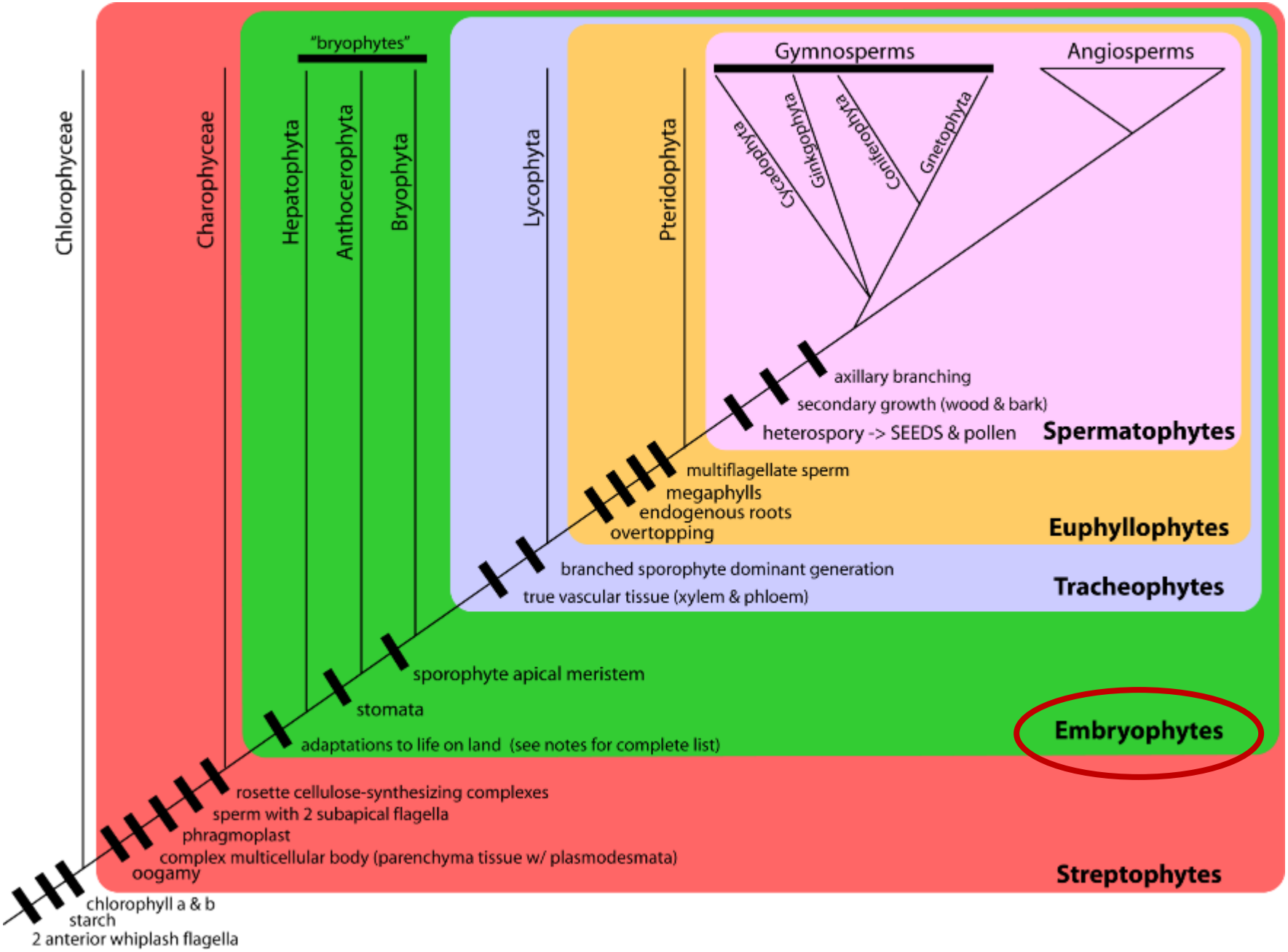
Rubiaceae: simple, opposite, entire, interpetiolar stipules; radial, sympetalous; inferior ovary -- 13.5K spp.



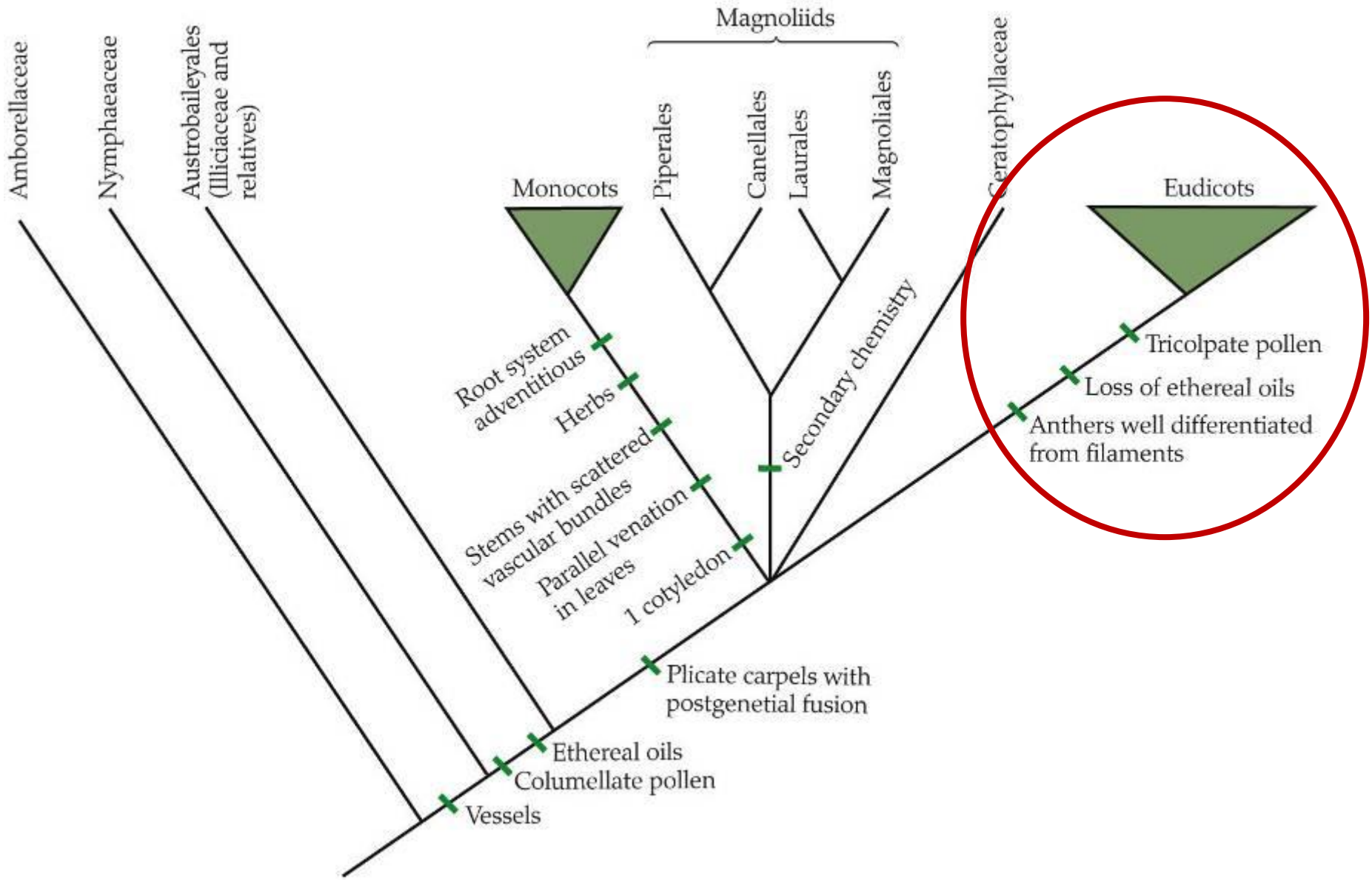
Gentianales - lvs opposite, simple, entire; colleters



Gentianales are a group of land plants, etc., etc., etc.

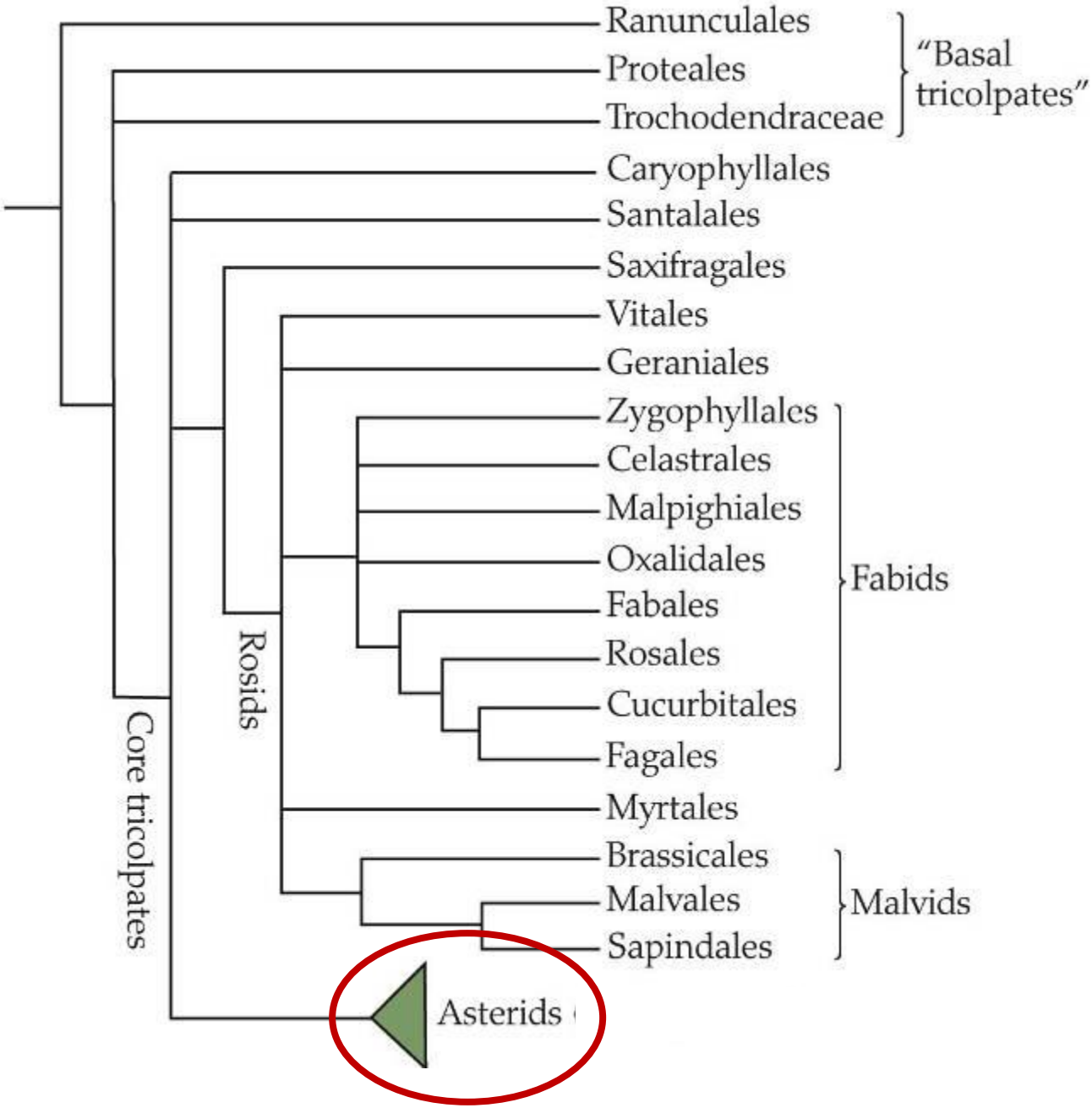


Gentianales are a group of eudicots

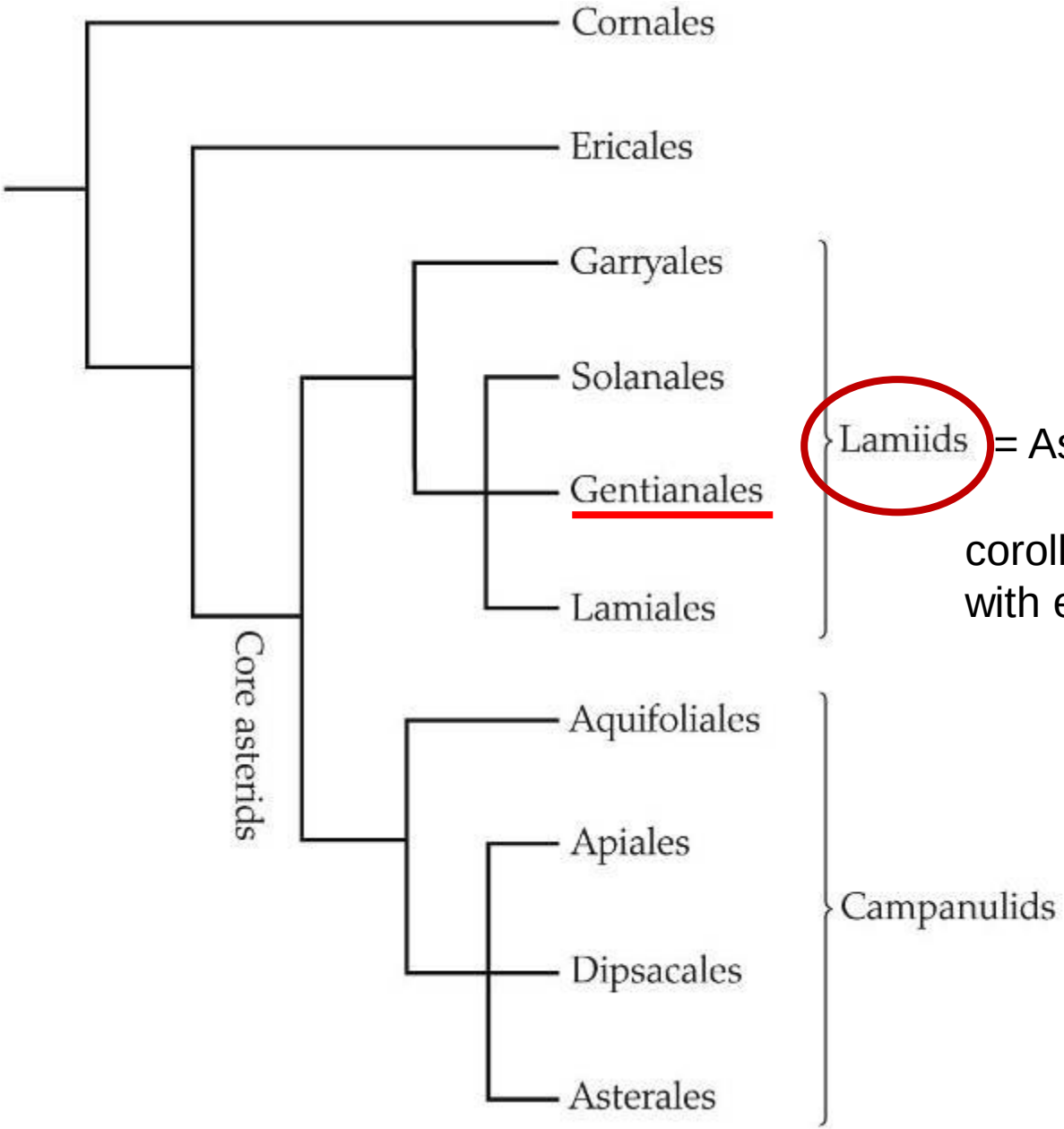


ANGIOSPERMS – phylogenetic overview

Gentianales are a group of asterids (sympetalous)



Gentianales are a group of lamiids



= Asterid I

corolla forming distinct tube,
with epipetalous stamens

Gentianales overview

leaves opposite, simple, entire

colleters often present

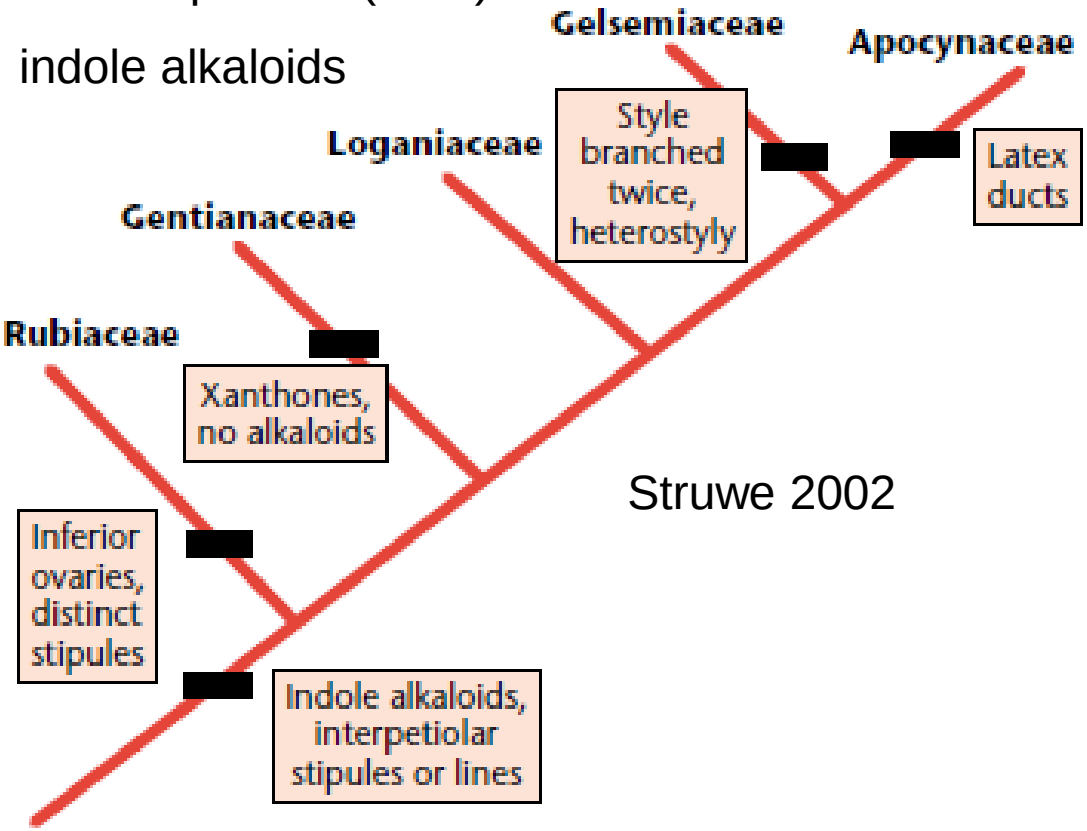
nodal line or interpetiolar stipules

4-5 merous flowers with epipetalous stamens

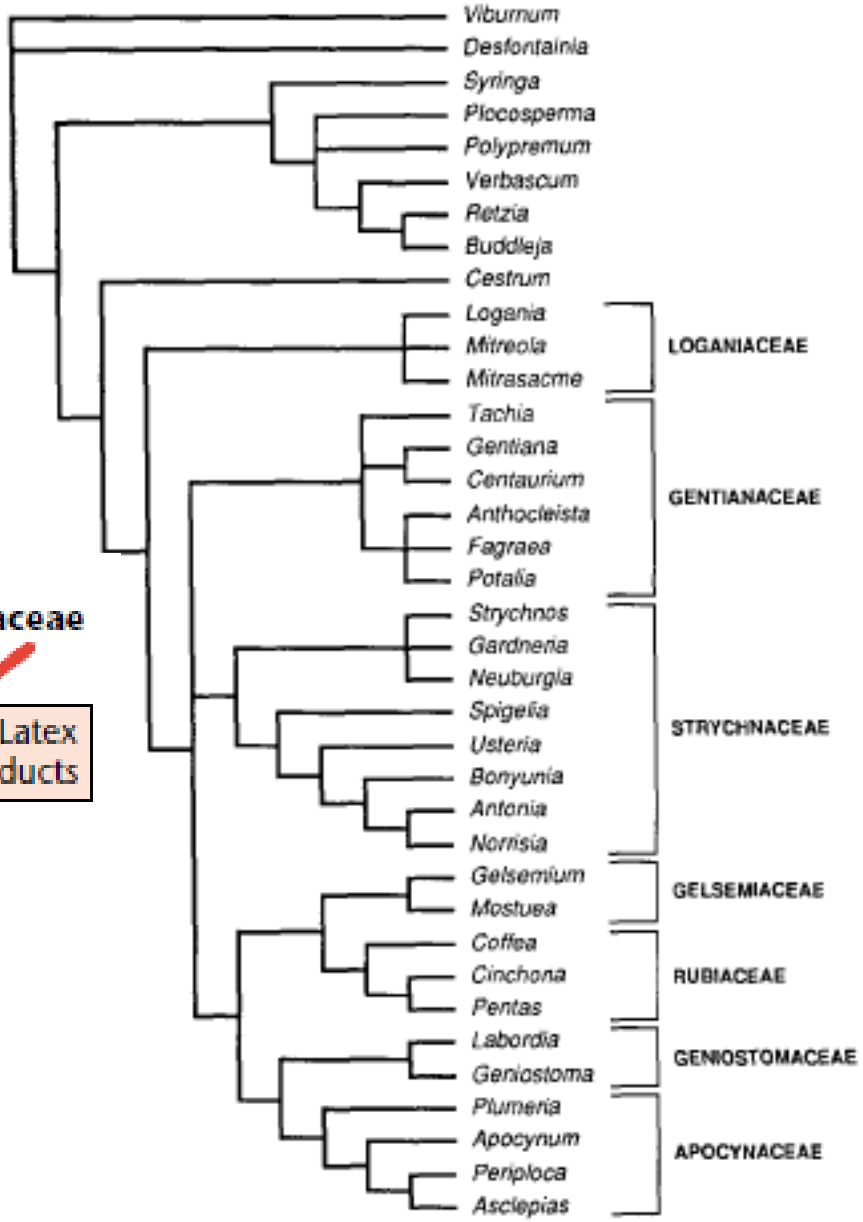
endosperm formation nuclear

internal phloem (- rub)

indole alkaloids



Struwe 2002



Struwe et al. 1994

opposite, simple, entire; sympetalous & epipetalous stamens

colleters in *Macrocarpaea*

<u>Gentianales overview</u>

Gentianaceae

Loganiaceae

Gelsemiaceae

Rubiaceae

Apocynaceae s.l. (incl. Asclepiadaceae)

Spigelia marilandica

colleters in *Spigelia marilandica*

colleters in ***Spigelia humboldtiana***

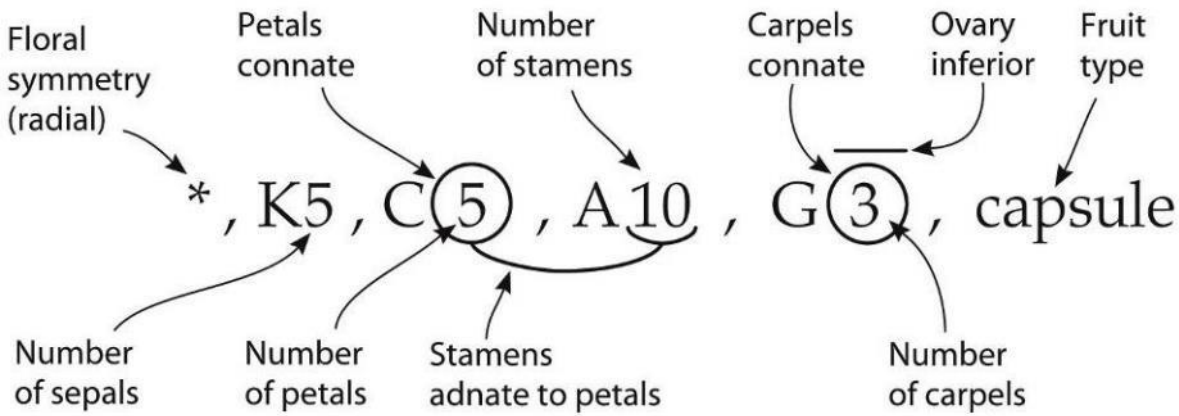
Gentianaceae (gentian) part of Gentianales

- Leaves usually more or less sessile; stems often winged; stamens open by pores
- Superior ovary with parietal placentation; usually capsule with many seeds
- Petals contorted in bud; anthers often twisted; stigma 2-lobed

- vegetatively readily confusable with the rest of the order
  - Gelsemiaceae: liana; styles branched twice into four stigmas
  - Loganiaceae: ovary sometimes semi-inferior; placentation ± axile; stigma capitate
  - Apocynaceae: milky sap; also has petals contorted in bud, stylar head
  - Rubiaceae: interpetiolar stipules; inferior ovary

- vegetatively also confusable with (but all lack colleters)
  - Caryophyllaceae: free petals
  - Hypericaceae: pellucid dots
  - Polemoniaceae (*Phlox*): 3-lobed style
  - Tetrachondraceae: corolla 2-3 mm long, 4-merous; placentation axile; stigma capitate; 1/2 inferior
  - some Caprifoliaceae s.l. (Dipsacaceae, Valerianaceae): inferior ovary

floral formulas don't really cut it in Gentianales



*4-5, 4-5, 4-5, 2 -- Gentianaceae — petals contorted in bud; anthers often twisted; placentation parietal; stigma 2-lobed

*4-5, 4-5, 4-5, 2 -- Loganiaceae — ovary s.t. semi-inferior; placentation ± axile; stigma capitate (often very small)

*5, 5, 5, 2 -- Gelsemiaceae — styles branched twice into four stigmas

*5, 5, 5, 2 -- Apocynaceae — petals contorted in bud; stylar head

*4-5, 4-5, 4-5, 2 -- Rubiaceae — ovary inferior

Gentianales overview

Gentianaceae

Loganiaceae

Gelsemiaceae

Rubiaceae

Apocynaceae s.l. (incl. Asclepiadaceae)

MO Gentianaceae overview

Bartonia

Frasera (= *Swertia*)

Gentiana

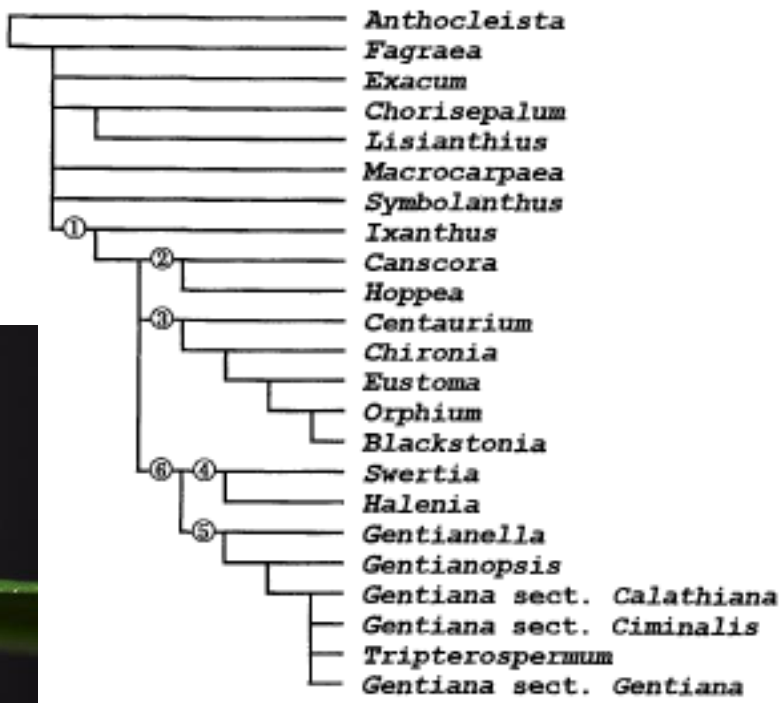
Gentianella

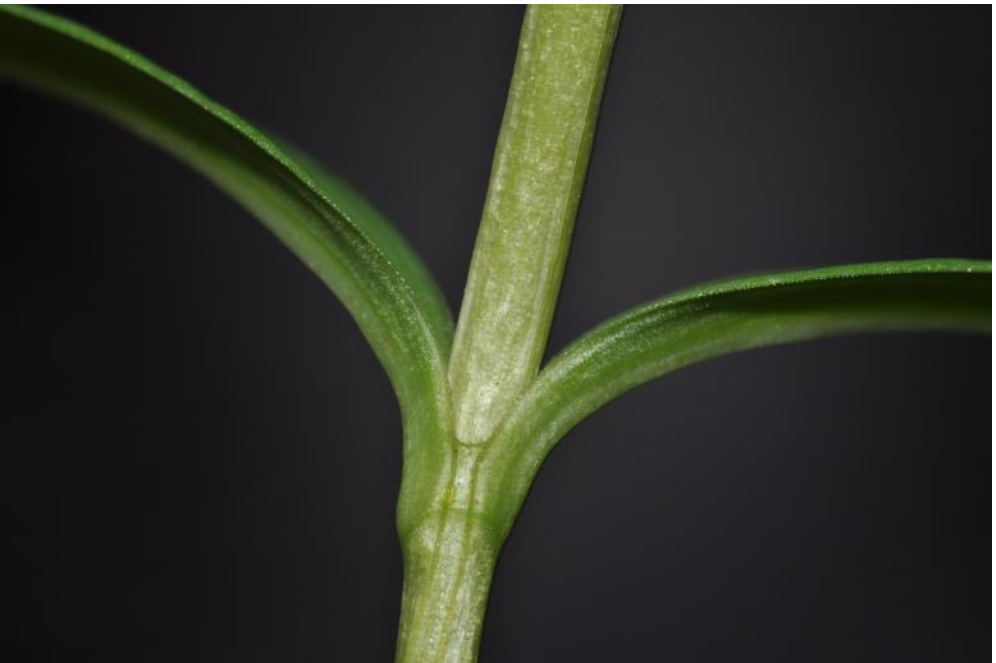
[*Gentianopsis* – nearby, but not in MO]

Obolaria

Sabatia

Zeltnera (= *Centaurium*)





Gentianaceae -- Gentianales mini-course in March 2013

1 Leaves whorled; flowering stems 1 m or more tall... ***Frasera***

1’ Leaves opposite (rarely alternate); flowering stems < 1 m tall

2 Sepals 2, free; petiole bases strongly decurrent... ***Obolaria***

2’ Sepals 4-5, fused (at least basally); petioles rarely weakly decurrent

3 Leaves reduced to scales < 3 mm; corolla < 5(-7) mm... ***Bartonia***

3’ Leaves not scale-like (except s.t. at very base), > 5 mm; corolla > 7 mm

4 Lobes of the corolla longer than the tube; stems usually 4-angled... ***Sabatia***

4’ Lobes of the corolla as long as or shorter than the tube; stems terete

5 Corolla pink (rarely white), the tube up to 2 mm in diameter; style filiform; ovary sessile; anthers spirally twisted or coiled... ***Zeltnera***

5’ Corolla bluish purple, white, or greenish, the tube 5+ mm in diameter; style stout or absent; ovary stalked; anthers not spirally twisted nor coiled

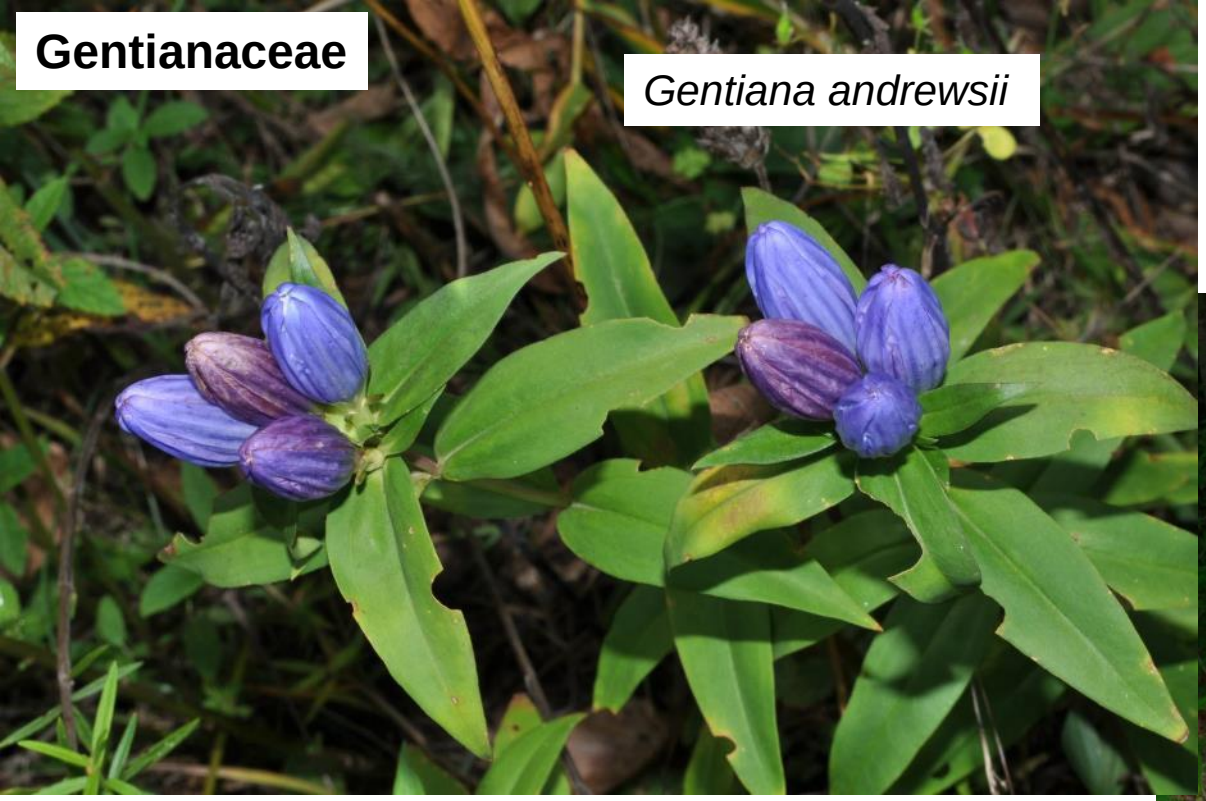
6 Corolla with petaloid outgrowths between the lobes... ***Gentiana***

6’ Corolla lacking petaloid outgrowths between the lobes

7 Corolla entire at the apex... ***Gentianella***

7’ Corolla fringed or dentate at the apex... [***Gentianopsis*** – not known in MO]

Gentianaceae



Gentiana andrewsii

Frasera caroliniensis

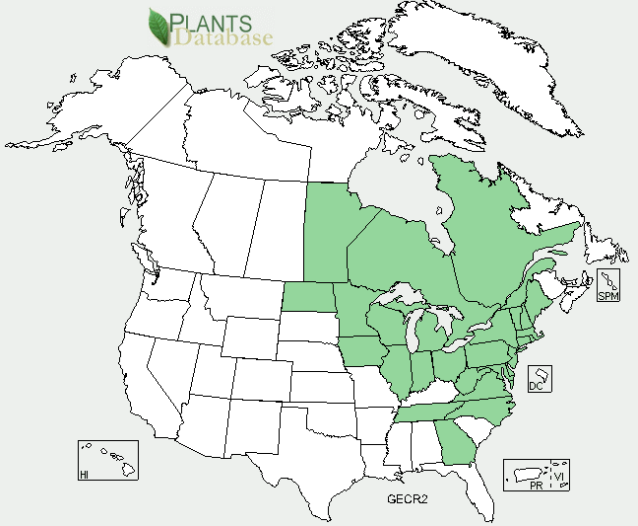
Bartonia spp.

Gentianella quinquefolia

Obolaria virginica

Gentianaceae

Sabatia angularis

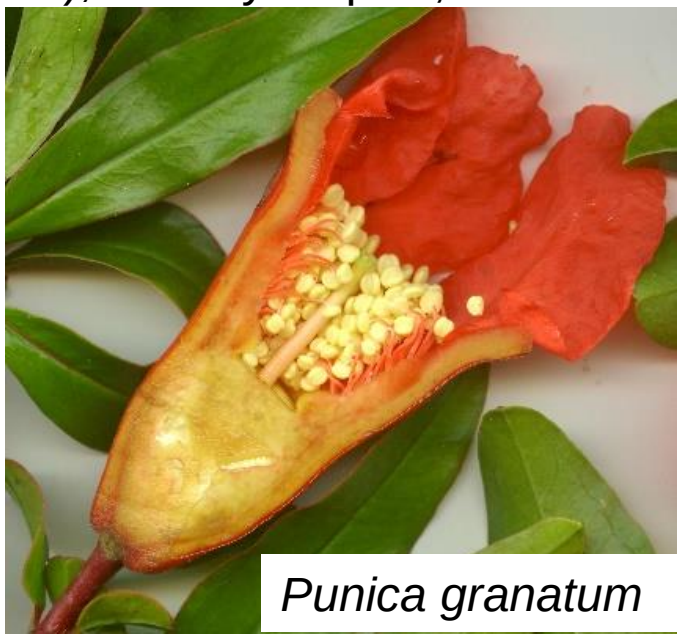


Gentianopsis crinita -- genus not known from MO yet

Zeltnera texensis

Lythraceae (loosestrife) part of Myrtales

- Herbs (to woody), simple, opposite or alternate, mostly entire, no stipules
- Stamens (usually 10 or more?) attached below the top of ribbed hypanthium (on different-length filaments)
- Petals crumpled in bud, wrinkled; ovary superior (in MO), 2-many carpels; flowers mostly 5-merous
- Often in or near water



Punica granatum

- Myrtales: hypanthium; many with opposite, entire leaves (some alternate, some toothed or lobed)
- Single style (carpels completely connate); flowers mostly showy (large; if small, petals still colored in MO)
- Capsules in most; mostly herbs in MO

- sister group to Onagraceae: herbs to shrubs, usually opposite and quite often toothed leaves, often with small stipuliform structures; flowers usually 4-merous flowers with an inferior ovary and a well-developed floral tube; calyx usually rather thin, reflexed, and deciduous; usually eight stamens, pollen has viscin threads, so conspicuously clumped

MO Lythraceae overview

Ammannia

Cuphea

Decodon

Didiplis

Lythrum

Rotala

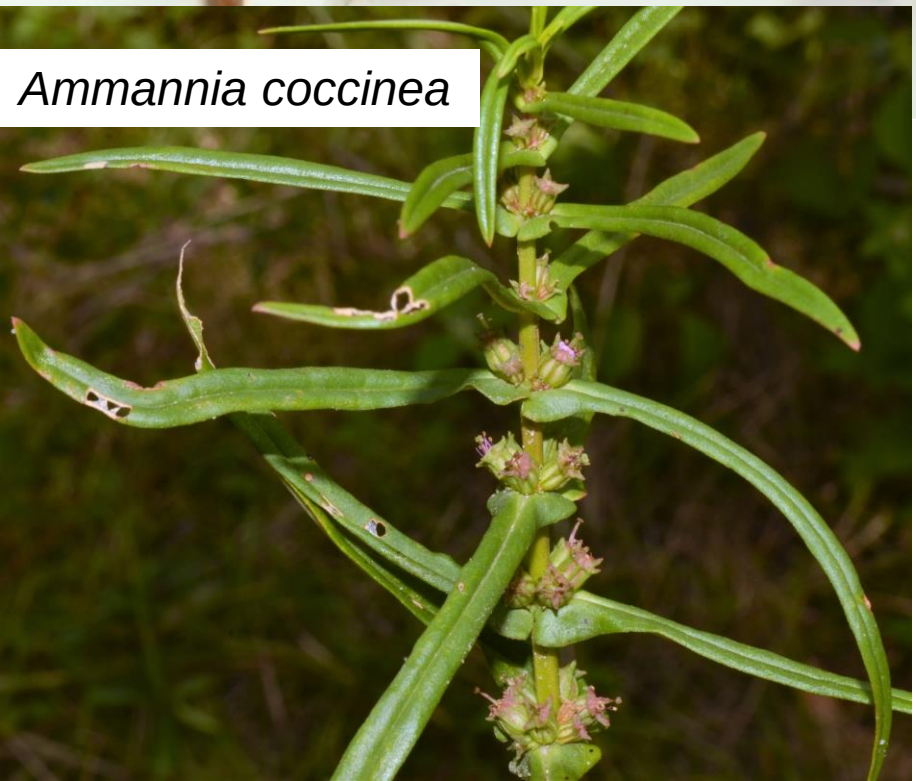
Lythrum alatum

Rotala ramosior

Lythrum salicaria

Lythraceae -- *Decodon verticillatus*

Ammannia coccinea



Cuphea carthagenensis

Lythraceae

1 Stems with glandular hairs; flowers bilateral... ***Cuphea***

1’ Stems glabrous or if hairy not glandular; flowers radial

2 Submerged aquatic; petals absent; leaves 1-3 mm wide... ***Didiplis***

2’ Terrestrial or emergent aquatic; petals present; leaves (2-)3-40 mm wide

3 Fls 4-merous; petals 1-3 mm long; annuals (not woody), often branched from base

4 All lvs truncate to cordate at base; sepal appendages ± linear... ***Ammannia***

4’ At least upper lvs tapered at base; sepal appendages triangular... ***Rotala***

3’ Fls (4-)5-7-merous; petals 3-15 mm long; perennials (often woody at base), usually branched well above the base

5 Leaves mostly in whorls of 3-4; hypanthium about as long as wide... ***Decodon***

5’ Leaves opposite or at least the upper lvs alternate (lowermost rarely whorled); hypanthium much longer than wide... ***Lythrum***

Polemoniaceae (phlox, Jacob's ladder) part of Ericales

- Herbs (woody elsewhere), leaves (simple or compound), opposite (to alternate), entire or deeply lobed, no stipules
- Showy flowers with well-developed often very narrow tube; calyx ± connate, lobes often with a green central portion, the rest whitish
- Stamens = & opposite 5 sepals, frequently inserted at different levels in the tube (not in all the western genera)
- Style usually 3-lobed (3 carpels)
- Capsule; seeds mucilaginous when wetted

- Vegetatively variable; in flower most readily confusable with other radial sympetalae, most of which only have 2 carpels/styles/stigmas, or are bilateral and/or have broader funnelform corolla tube

MO Polemoniaceae

Ipomopsis

Phlox -- leaves simple, entire

Polemonium

Phlox drummondii

Polemoniaceae

Ipomopsis rubra

Polemonium reptans

Phlox divaricata

"Portulacaceae" s.l. (purslane)

Herbs (shrubs), leaves succulent;
5 free tepals/petals, 2 “sepals”

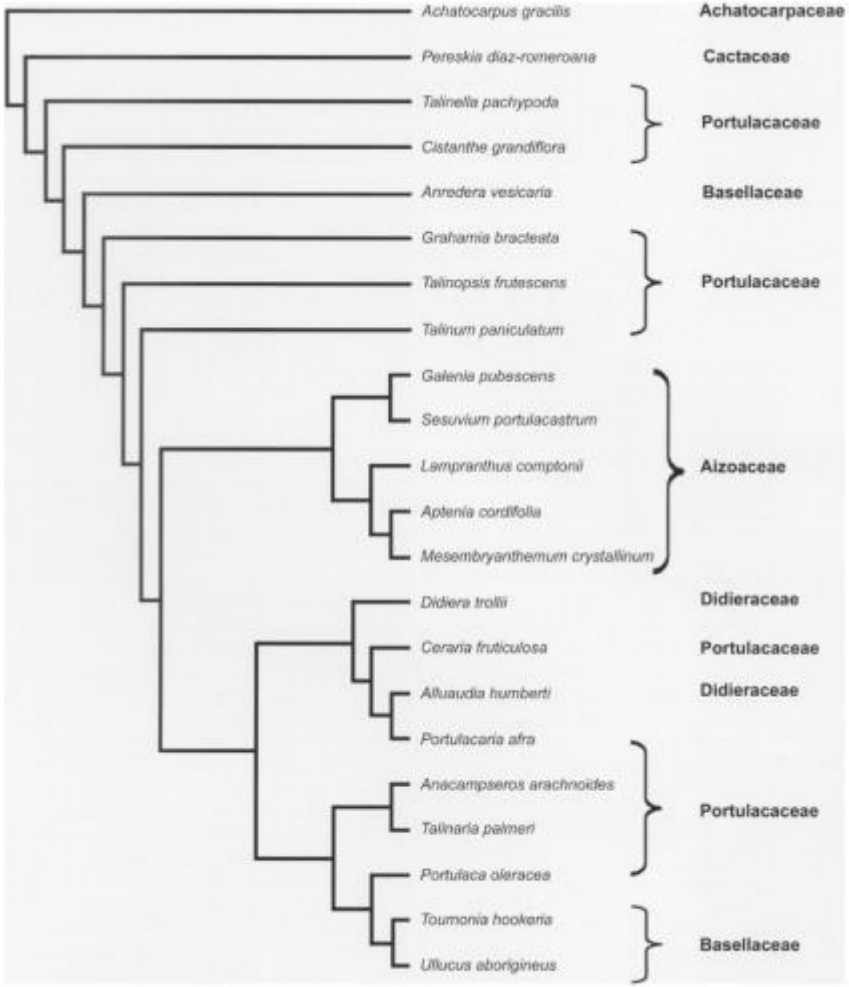
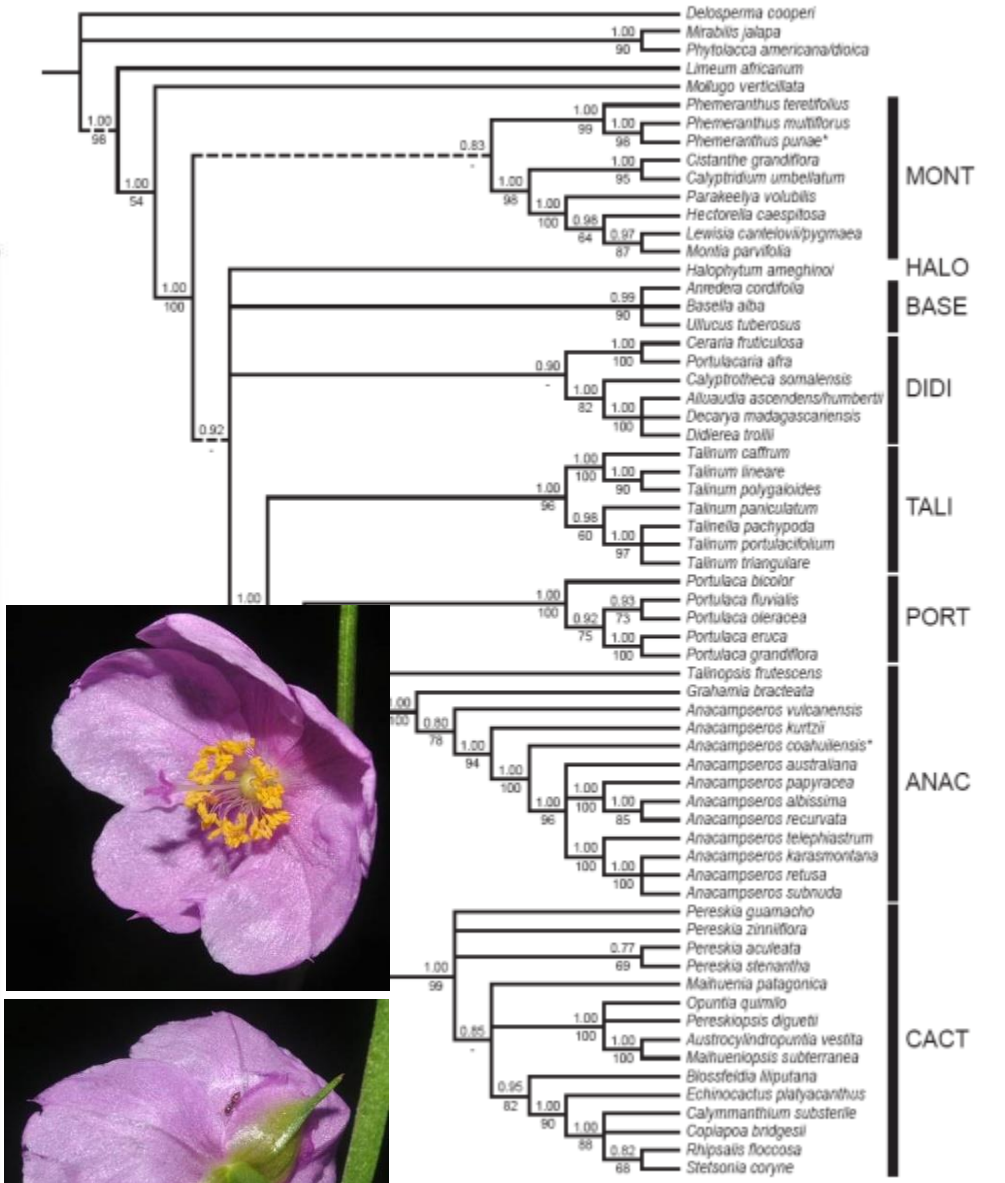


Fig. 1. Single most parsimonious tree found using anatomical and morphological characters of four succulen lies: Aizoaceae, Cactaceae, Didiereaceae, and Portulacaceae.

Nyffeler & Eggli • New familial classification of Portulacineae TAXON 59 (1) • February 2010: 227–240



l from a Bayesian inference (BI) analysis of the suborder Portulacineae. Dashed branches
imum parsimony (MP) analysis. Numbers above branches denote posterior probabilities
ootstrap values of the MP analysis. Eight distinct major clades are marked with character
milies Anacampserotaceae (ANAC), Basellaceae (BASE), Cactaceae (CACT), Didierea-
ONT), Portulacaceae (PORT), and Talinaceae (TALI). An asterisk marks new species

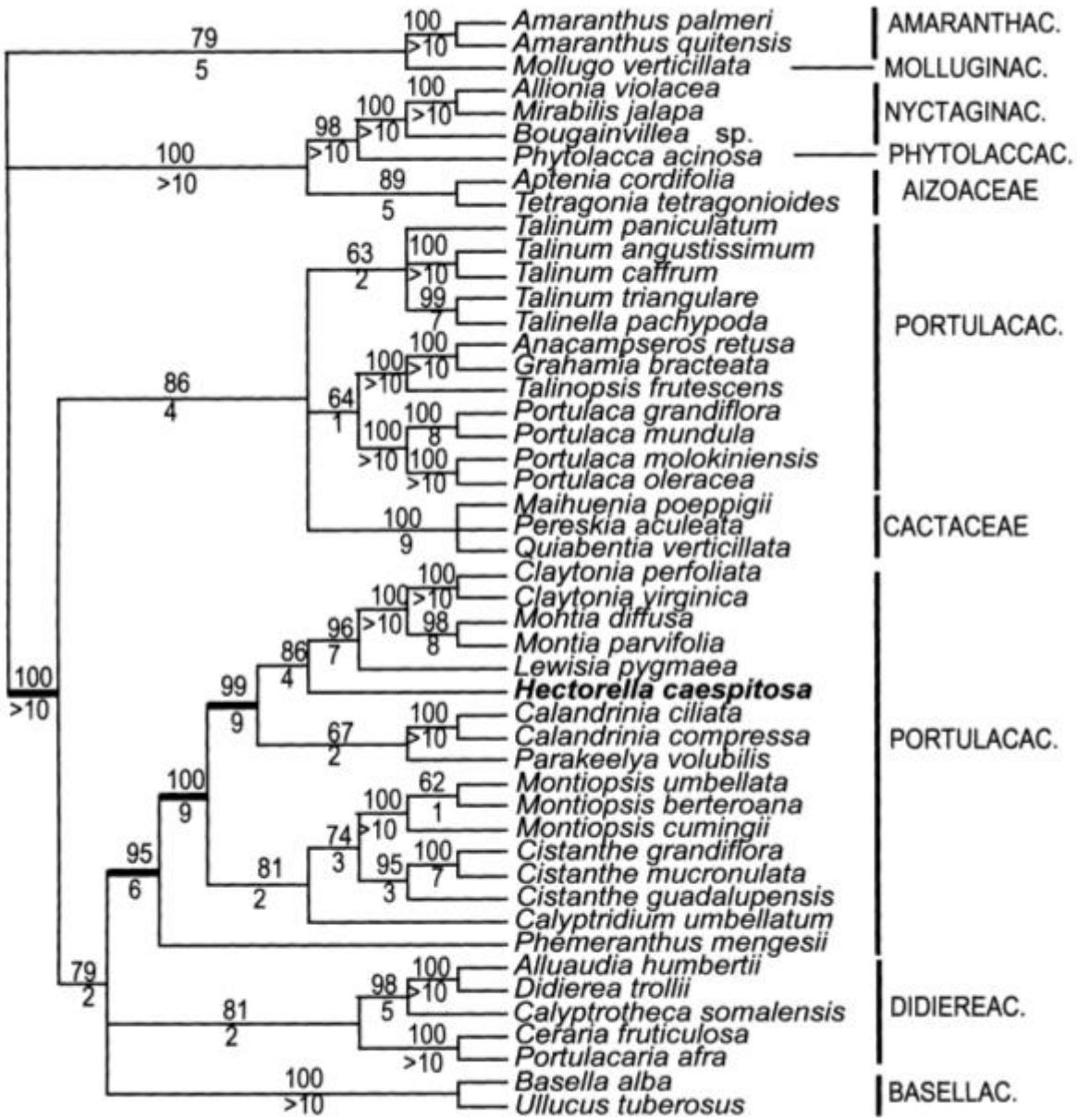
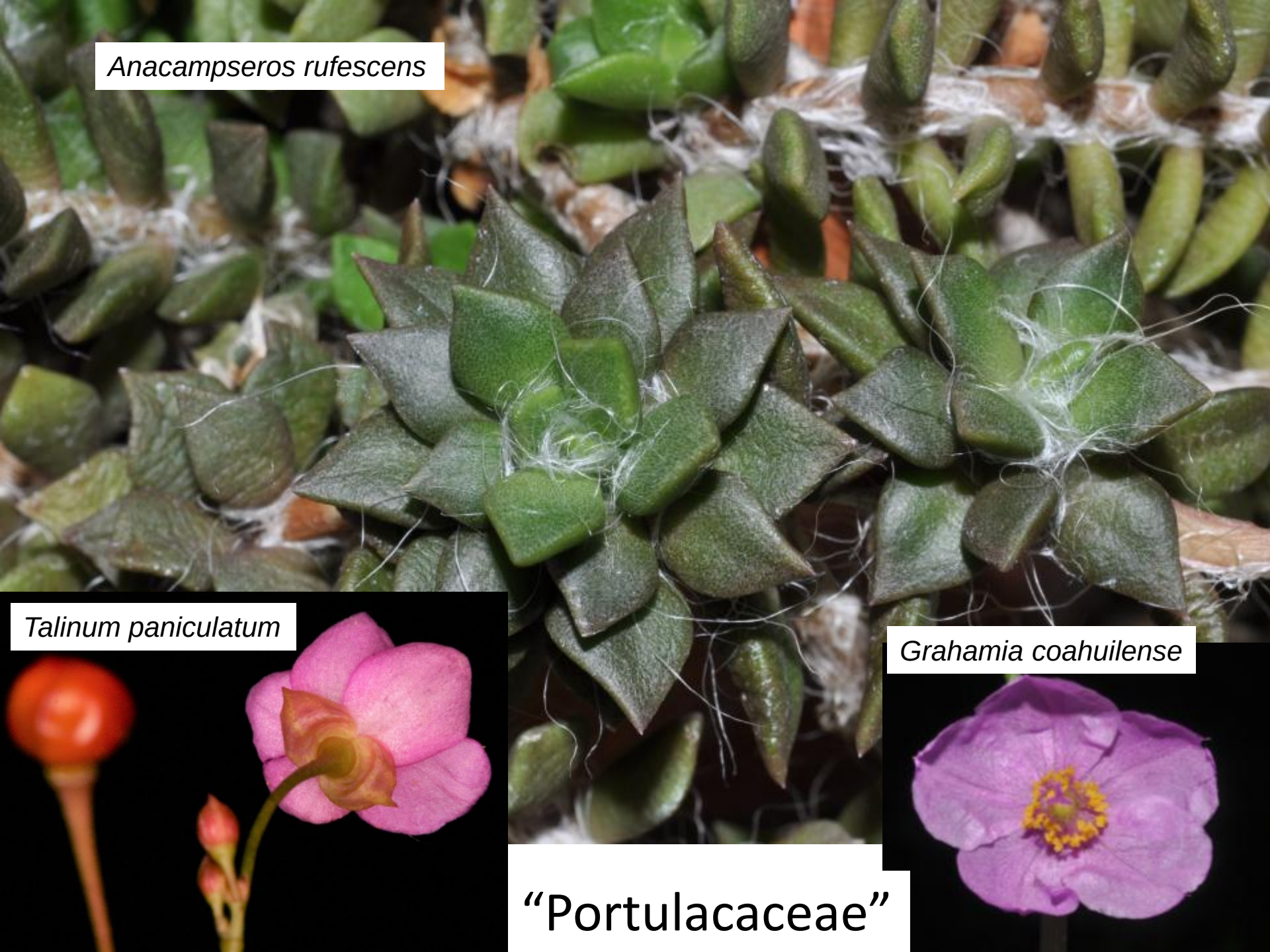


FIG. 1. *ndhF* maximum parsimony (MP) analysis, strict consensus of 33 most parsimonious trees, with MP bootstrap percentages above branches, decay indices below branches. Length (L) = 1958; restriction index (RI) = 0.708; rescaled consistency index (RC) = 0.419; consistency index (CI) excluding uninformative characters = 0.525. Thickened branches represent well-supported clades (>95% bootstrap support) that confirm the placement of *Hectorella* within Portulacaceae.

cacti evolved from within traditional "Portulacaceae"

-- so did Basellaceae & Didiereaceae

-- lump or split?


Anacampseros rufescens
Talinum paniculatum
Grahamia coahuilense
“Portulacaceae”

Grahamia coahuilense

Portulaca amilis

Claytonia virginica

Plantaginaceae -- Lamiales (BUT...) difficult to distinguish from Scrophulariaceae s.str., Gesneriaceae, Stilbaceae, etc., all having largish, monosymmetric flowers. However, two features common in Plantaginaceae, the frequent absence of regular vertical partitions in the heads of the glandular hairs and septicidal capsule dehiscence, are not that common in other Lamiales.

Plantago lanceolata

Veronica peregrina

Veronica polita

Callitriche heterophylla

knowing natural groups can be very useful

but, it is best learned in conjunction with imprinting 'difficult' species or groups & also learning "artificial motifs"

thank you!