

Artificial Plant ID Motifs: Simple and Useful Patterns for Field Identification of Plants

- ❖ imprinting vs. diagnosing
- ❖ 5 basic plant ID features (& a little more)
- ❖ natural vs. "artificial"
- ❖ which plants?
- ❖ ID motifs
 - more stuff?

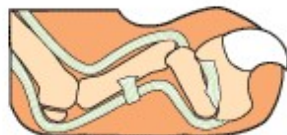
3 modules:

~19 slides on basic vocab review

~48 slides overview of natural groups

~27 slides on big pic plants

cat claws



sheathed
(tendons and
muscles relaxed)

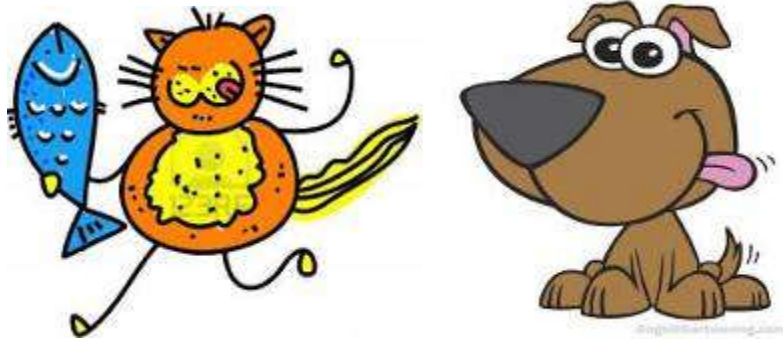


unsheathed
(tendons and
muscles tightened)

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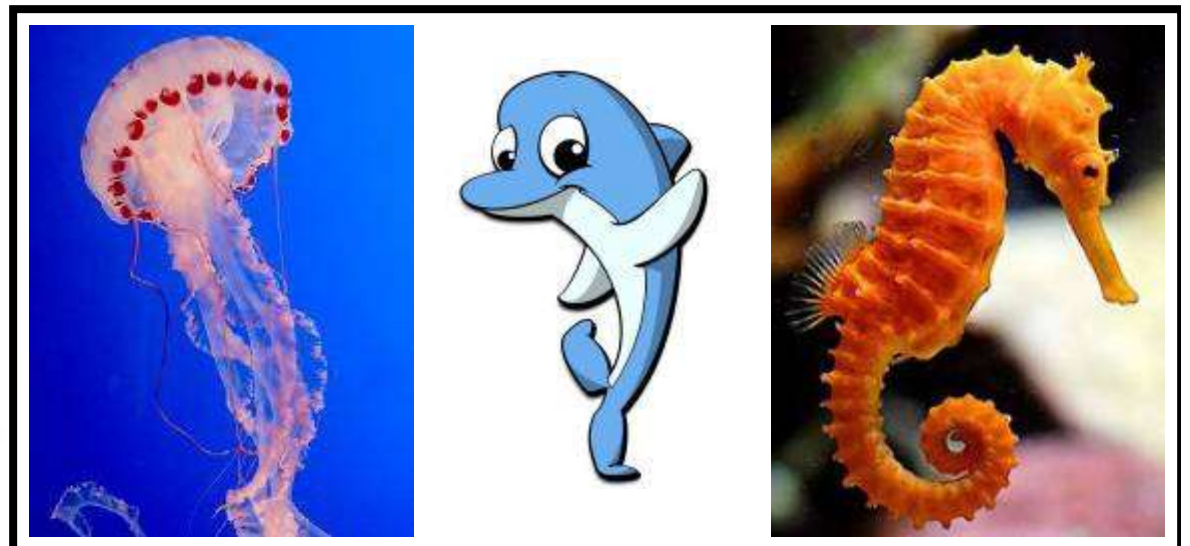
imprinting vs. diagnosing



cat vs. dog
day vs. night
run vs. walk

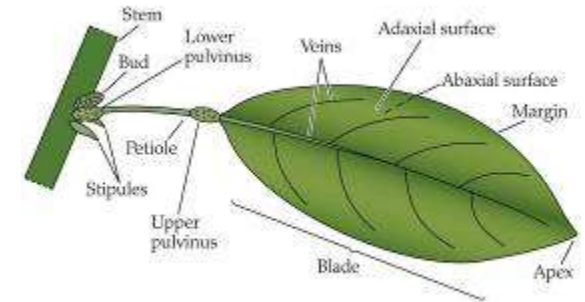


moth vs. butterfly
fruit vs. vegetable
“fish” vs. ??

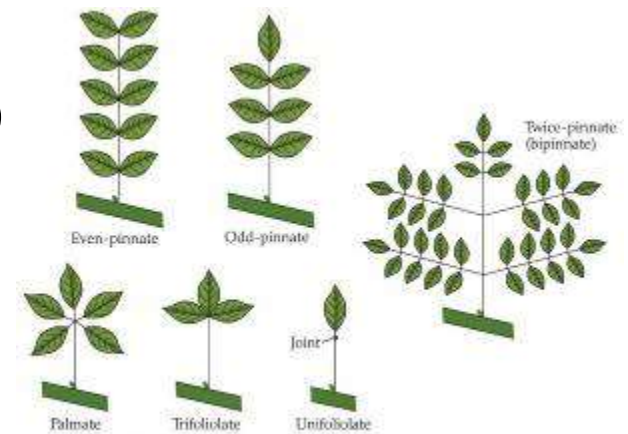


Basic Plant ID features

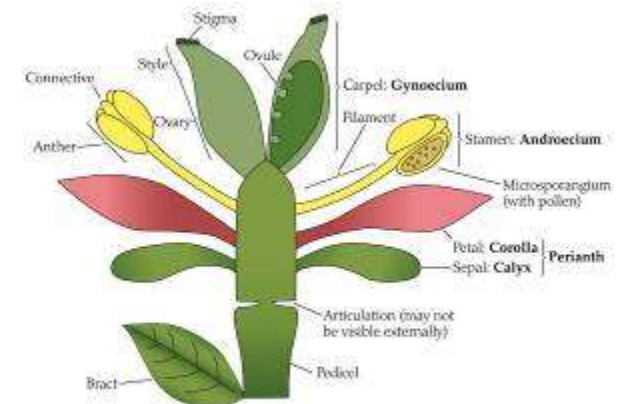
- habit
 - leaves simple vs. compound
 - alternate vs. opposite
 - entire vs. toothed (or lobed)
 - stipules present or not
 - pellucid dots (or punctations or stellate hairs)
 - latex present or not
 - foliage with distinct smell or not
 - veins pinnate or palmate (or plinerved)
-
- flowers sympetalous 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 4.18

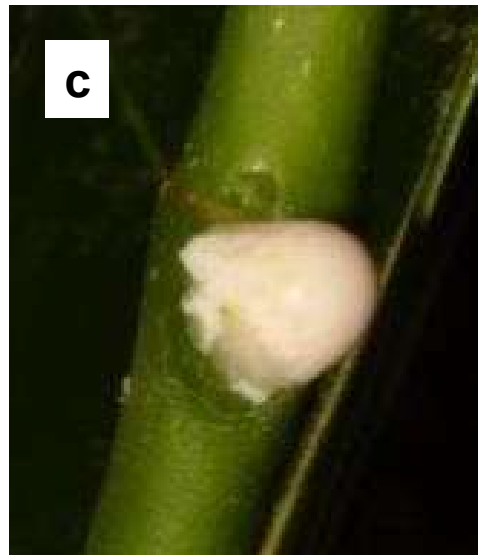
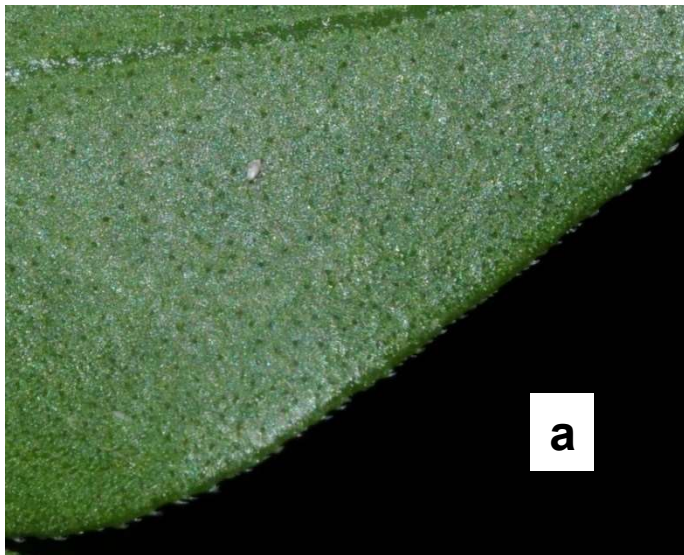
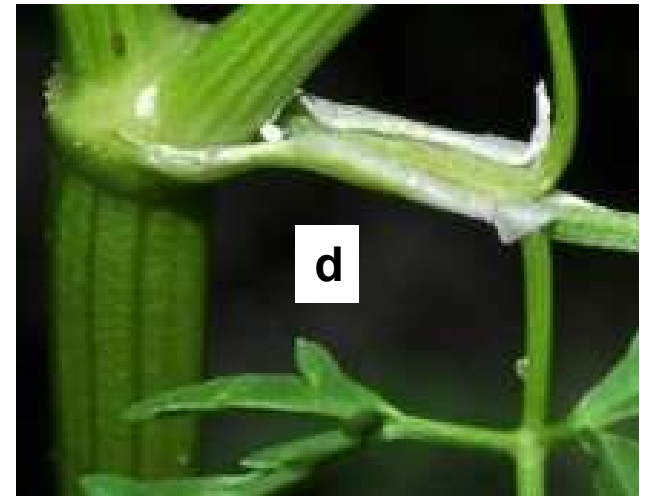
motifs work best if kept simple, e.g., tied to basic features -- details in the eye of the beholder

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.:

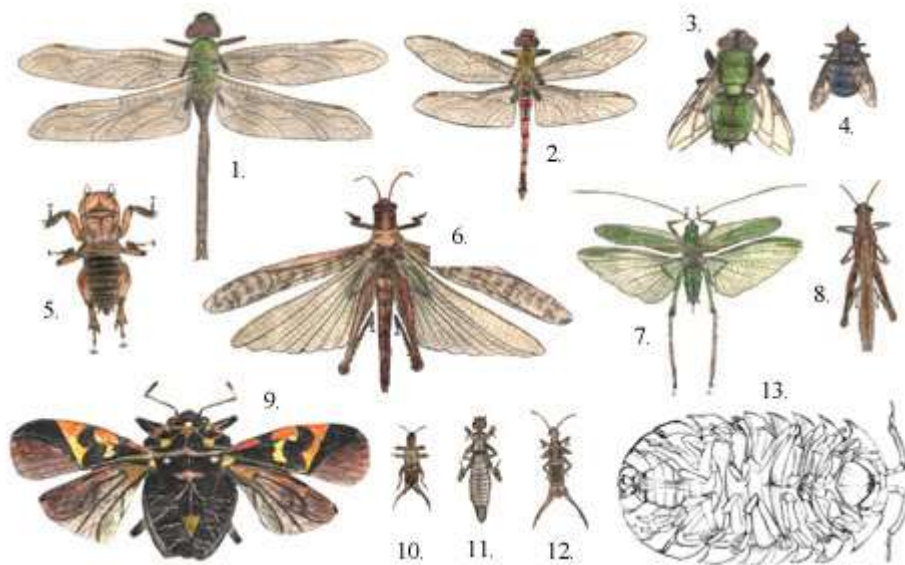
a) cuticular pits, b) pulvinulus, c) sap, d) sheath, e) tendrils; smell, venation

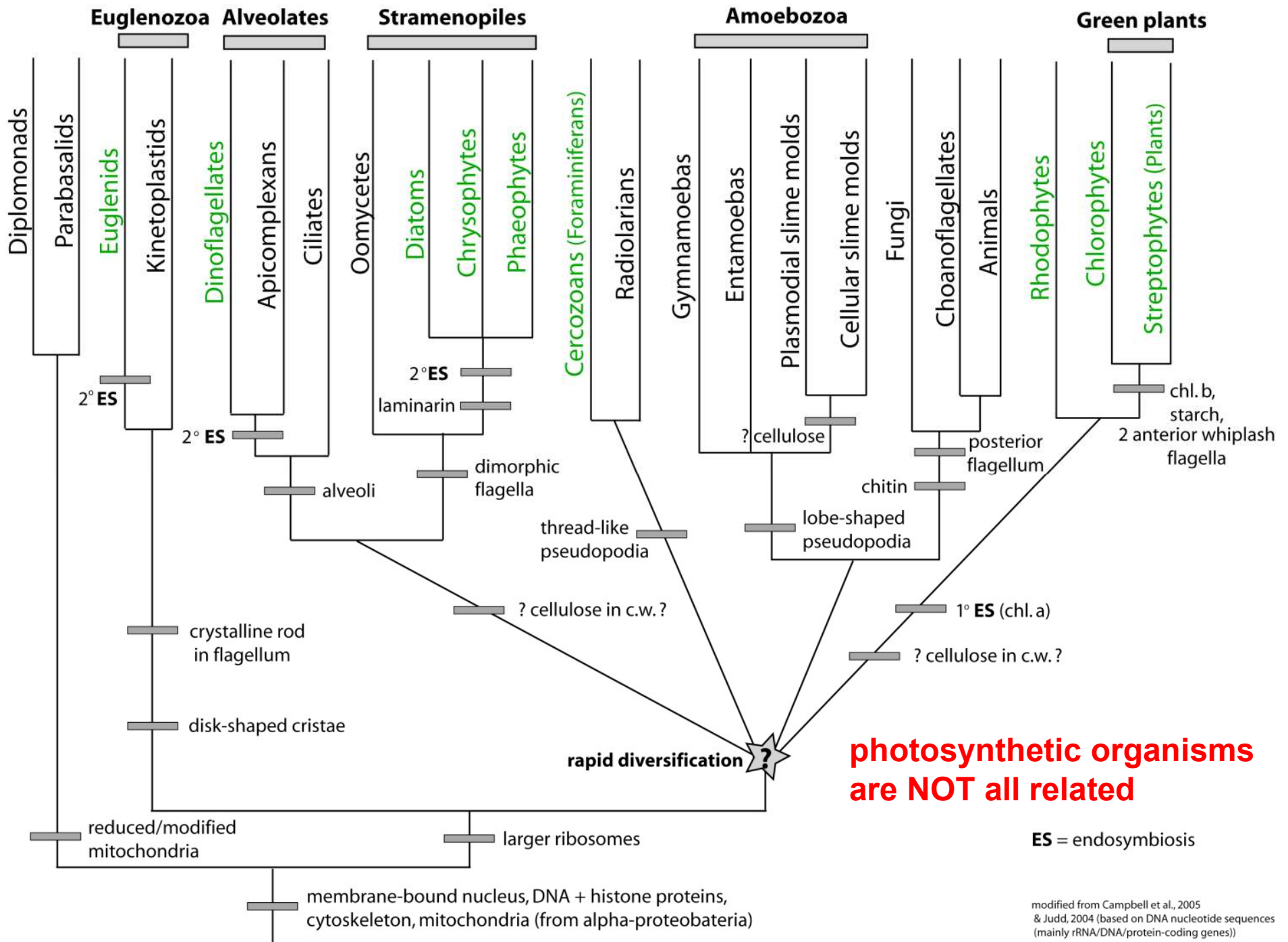




"group name" in quotes = artificial (non-natural, unrelated) group

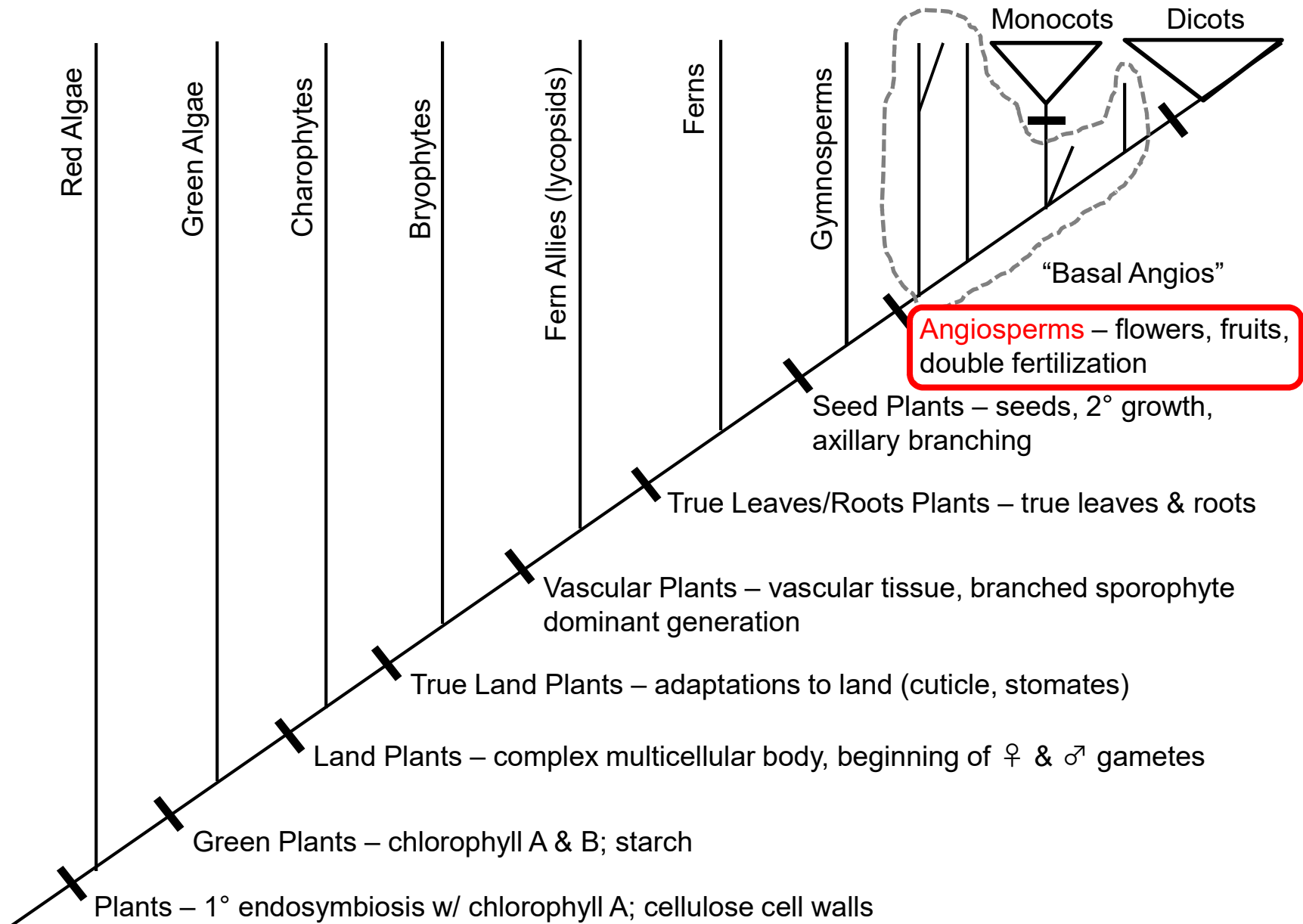
imagine a "group" that included all winged animals. natural? useful?





modified from Campbell et al., 2005
& Judd, 2004 (based on DNA nucleotide sequences
(mainly rRNA/DNA/protein-coding genes))

by plants, we'll focus primarily on angiosperms



True Leaf/Root Clade

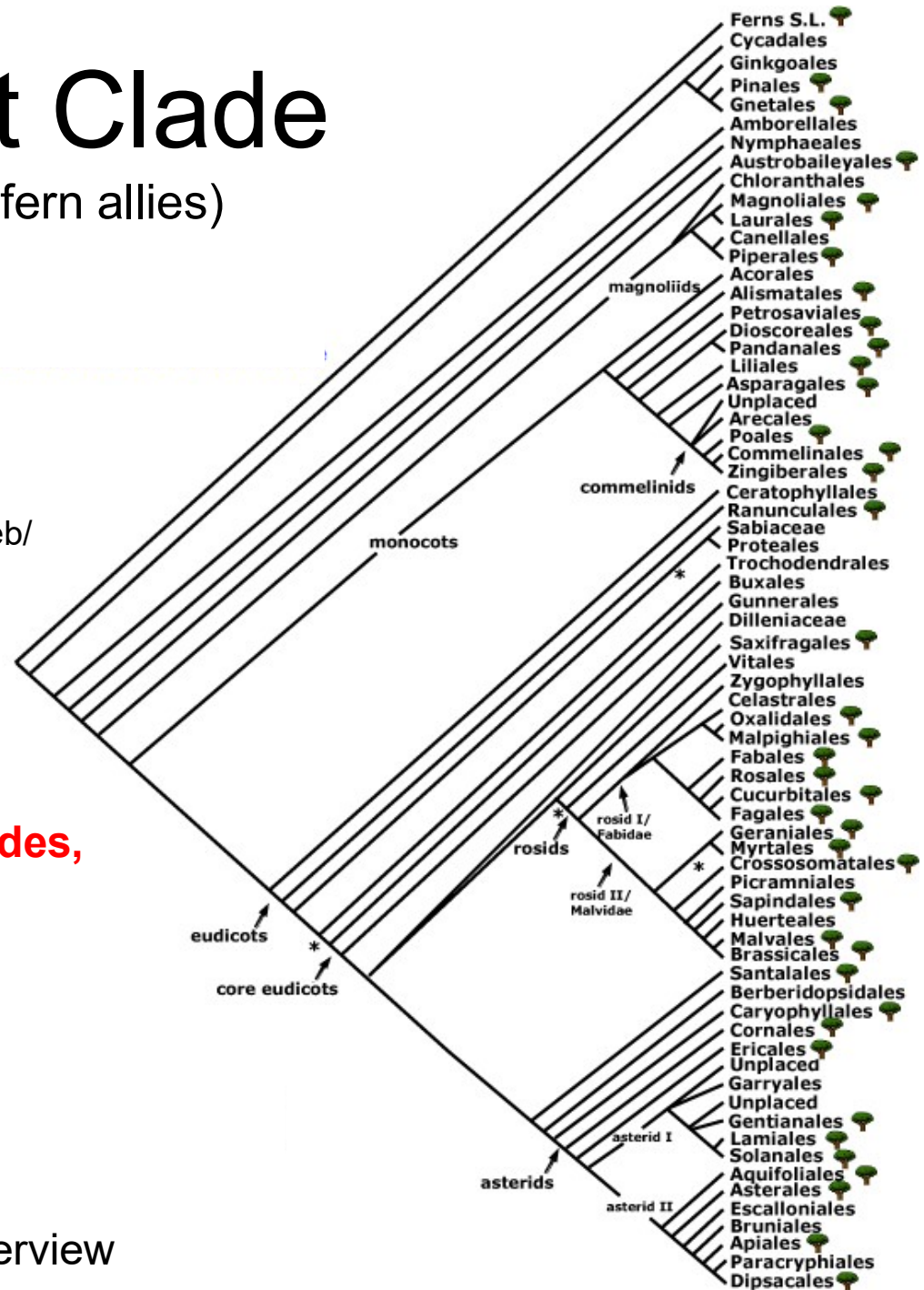
(~vascular plants except for the fern allies)

Angiosperm Phylogeny Website

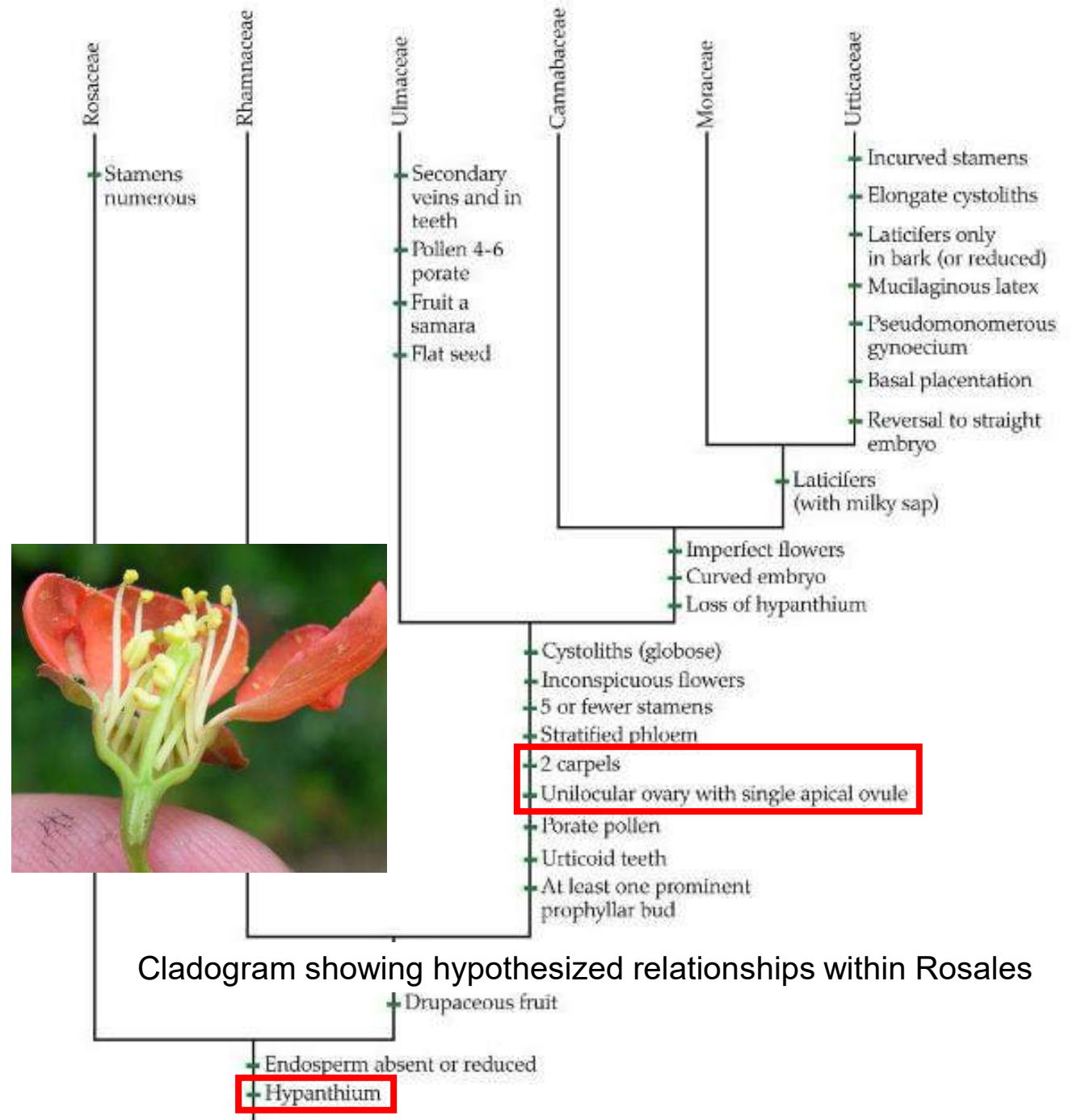
<http://www.mobot.org/MOBOT/research/APweb/>

**natural approaches focus on clades,
e.g., orders & families**

ANGIOSPERMS – phylogenetic overview



Rosales



Euphorbiaceae



Euphorbiaceae (spurges): separate male & female flowers closely associated on same plant
-- which other families/genera can do this? could create artificial "spurge" motif...

Lamiaceae



Lamiaceae (mints): square stem, opposite leaves; sympetalous, bilateral; schizocarpic nutlets
-- some relatives also do this, so can talk about mint (order) motif...

brief plant family descriptions

Alliaceae (onion/garlic): bulb, scape, onion/garlic smell

Apiaceae (carrot): lvs alternate, compound, sheathing base; umbel; inferior ovary

Asteraceae (daisy, sunflower, dandelion): involucrate head; inferior ovary

Boraginaceae (borage): lvs scabrous; 4 nutlets

Brassicaceae (mustard): lvs alternate; fl 4-merous; stamens 4+2; mustard taste

Caryophyllaceae (chickweed): lvs opposite, basally fused across stem; petals free

Fabaceae (legume): lvs alternate, compound, entire (toothed in clovers); stipules

Geraniaceae (geranium): lvs palmate; petals free; fr with apical sterile portion

Lamiaceae (mint): lvs opposite; stems square; fl fused, bilabiate; 4 nutlets

Oxalidaceae: lvs trifoliate, entire, emarginate; fl radial, yellow in most; capsule

Plantaginaceae s.str. (plantain): scapose rosettes

Poaceae (grass): sheath open; node swollen; stem round [vs. sedges & rushes]

Polygonaceae (knotweed): ocrea (sheath above petiole on stem)

Portulacaceae (purslane): succulent; 2 “sepals”

Rubiaceae (coffee): lvs opp, entire; interpetiolar stipule; fl fused; inferior ovary

Scrophulariaceae s.l. (snapdragon): stems usually round(ish); fl fused; capsules

Natural approach: 200+ families, 1000+ spp.

Plant ID Motifs

-- patterns tied to phylogeny & vocab

Context for practicing/learning terminology

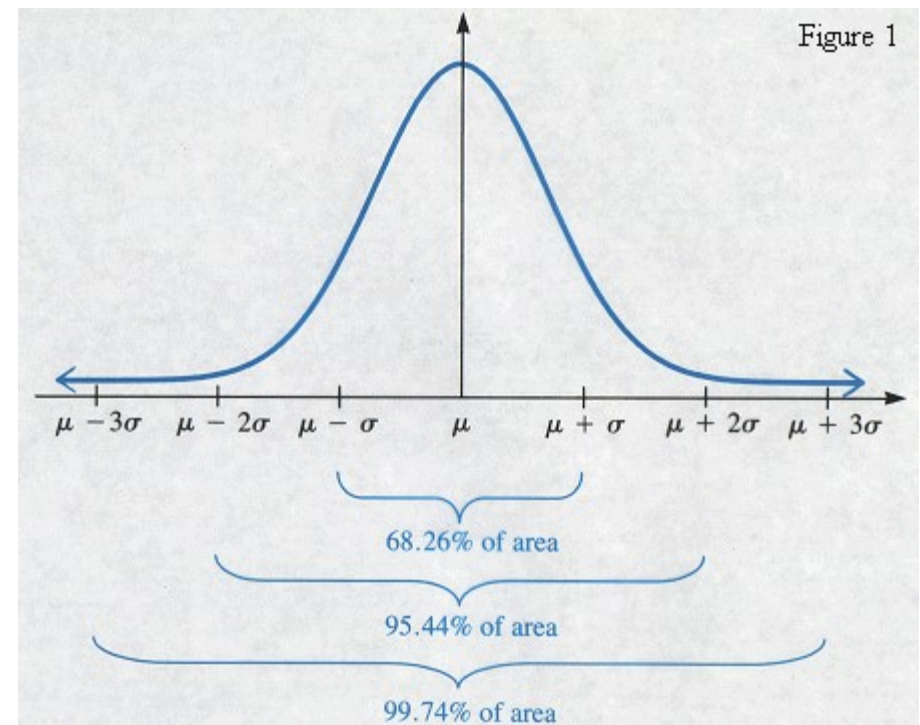
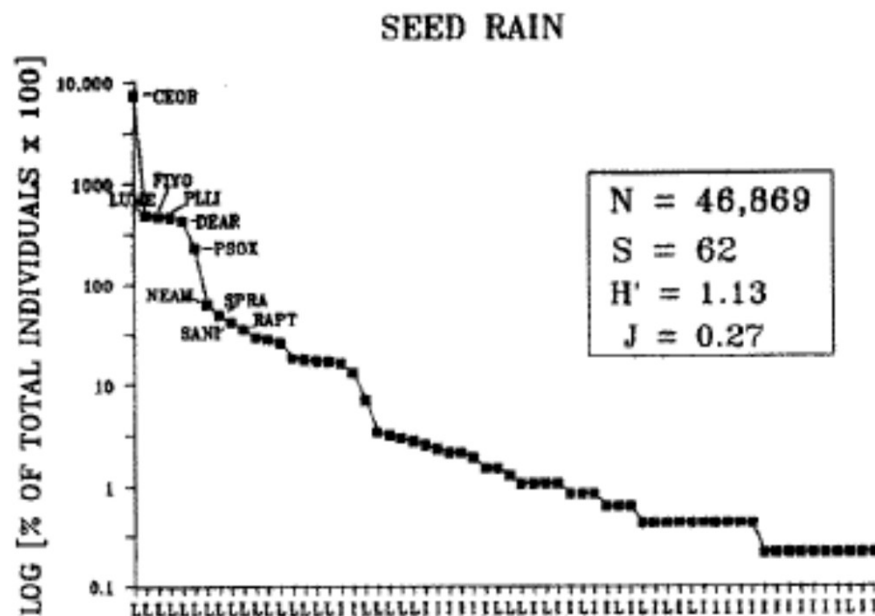
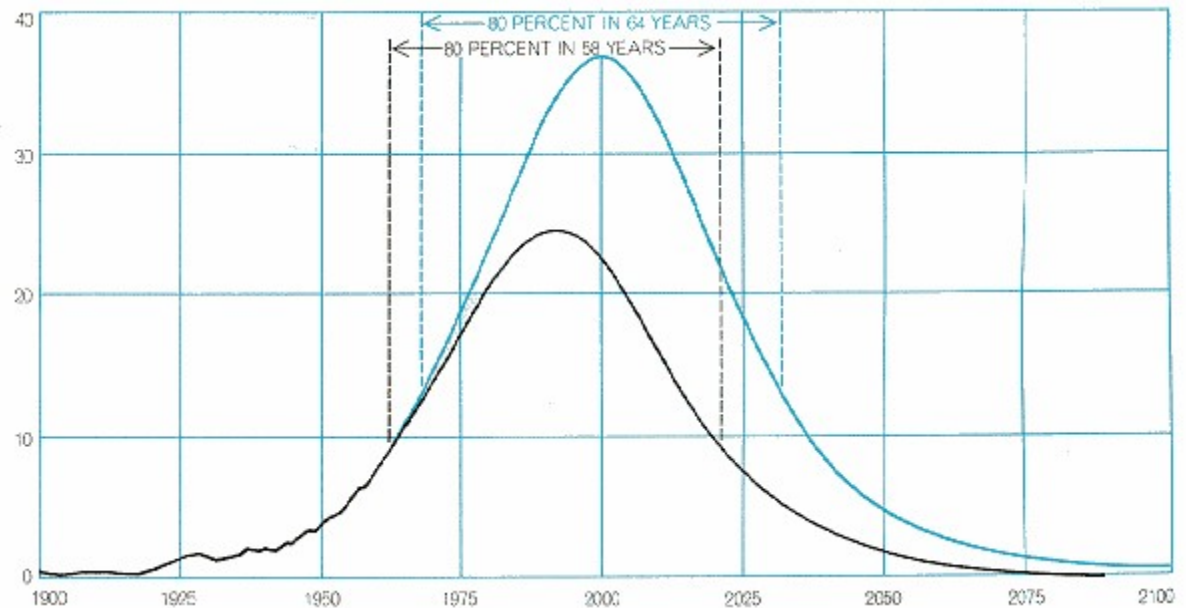
Break diversity into learnable chunks

-- let's turn that sea of green into
recognizable entities

Blend of imprinting/diagnosing & phylogeny

“norm” important (depends on question being addressed), but the tails are where most of the weird, “cool” stuff happens.

modern, family-based approach to plant taxonomy is analagous -- teach the norms...



- 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

"**milky**" - latex/sap

"**palmate**" - veins; alt

polygonaceae: ocrea

"**TAN**" - nodal tendrils

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

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

"BA" (basal angiosperms):

woody, simple, alternate, entire, no stipules, strong/spicy smell



Magnoliaceae: "BA" with stipules forming nodal ring

dicots: broad blade, reticulate veins, no sheath

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

autumn olive

(peltate scales)

blackgum

blueberries

persimmon

"basal angios"



natural motifs

monocots: linear, parallel veins, sheath; 3-merous flowers

Alliaceae (**onion/garlic**): bulbs, umbels, scapose, onion/garlic smell

Iridaceae (**iris**): lvs equitant; 3 stamens; inferior ovary
[vs. lilies with 6 stamens & superior ovary]

Smilacaceae (**greenbrier**): vines, paired stipular tendrils; umbels, dioecious



"**graminoids**" (grass-like plants)

Cyperaceae (**sedge**): stems triangular, lvs 3-ranked, sheaths closed, no jointed nodes; achene

Juncaceae (**rush**): stems rounded, sheaths open (may be closed at base), no jointed nodes; capsule; tepals

Poaceae (**grass**): stems rounded (or compressed), lvs 2-ranked, sheaths open, nodes jointed; grain; bamboo ('woody')



It's a "graminoid," but is it a grass?



'sedges have edges'
Triangular stem
Pithy



'rushes are round'
Round stem
Pithy

grasses
elliptic to round stem
Hollow (usually)



grass

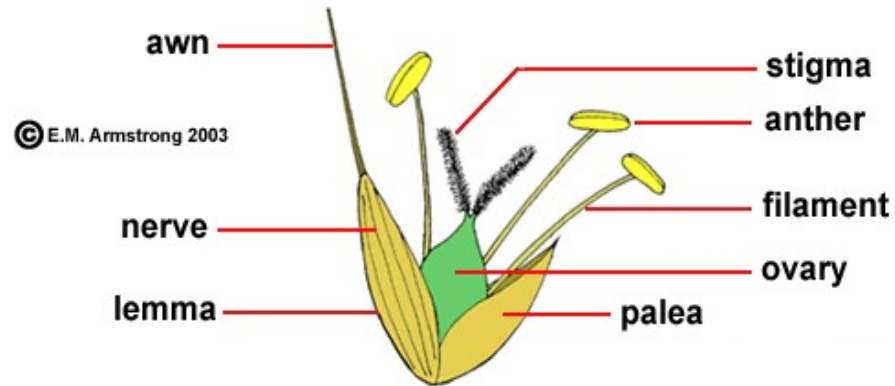
Open leaf sheath
Swollen node
Round stem (or elliptic)



sedge

Closed leaf sheath
No jointed node
Triangular stem



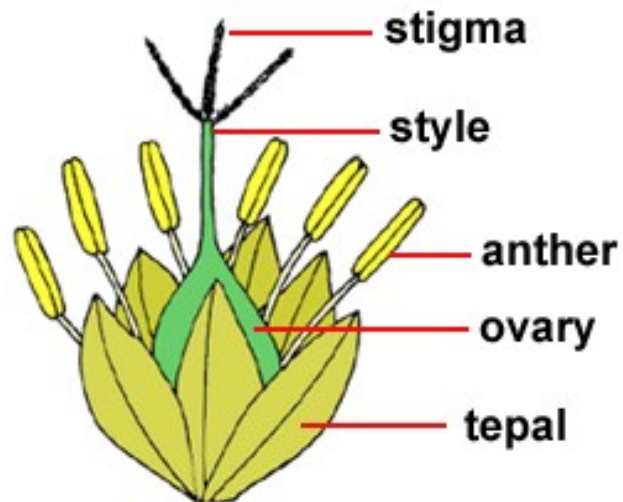
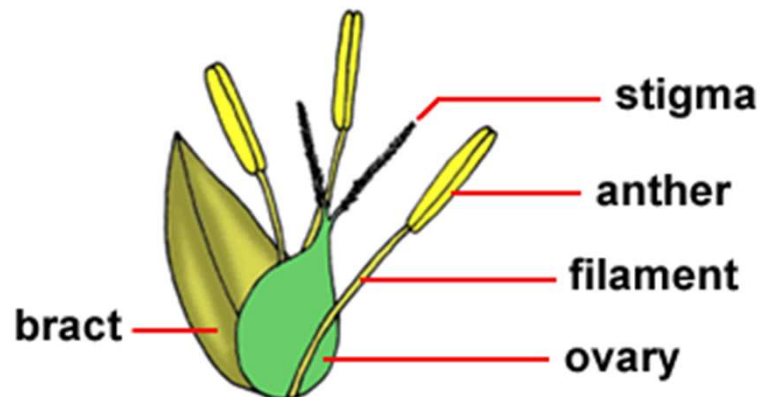


grass

Florets (usu perfect, with lemma & palea) in distichous spikelets subtended by 2 glumes

sedge

Florets (perfect or not, with single bract) in spikelets (sometimes distichous) without glumes



rush

Flowers (perfect, with tepals) solitary or in clusters (glomerules)

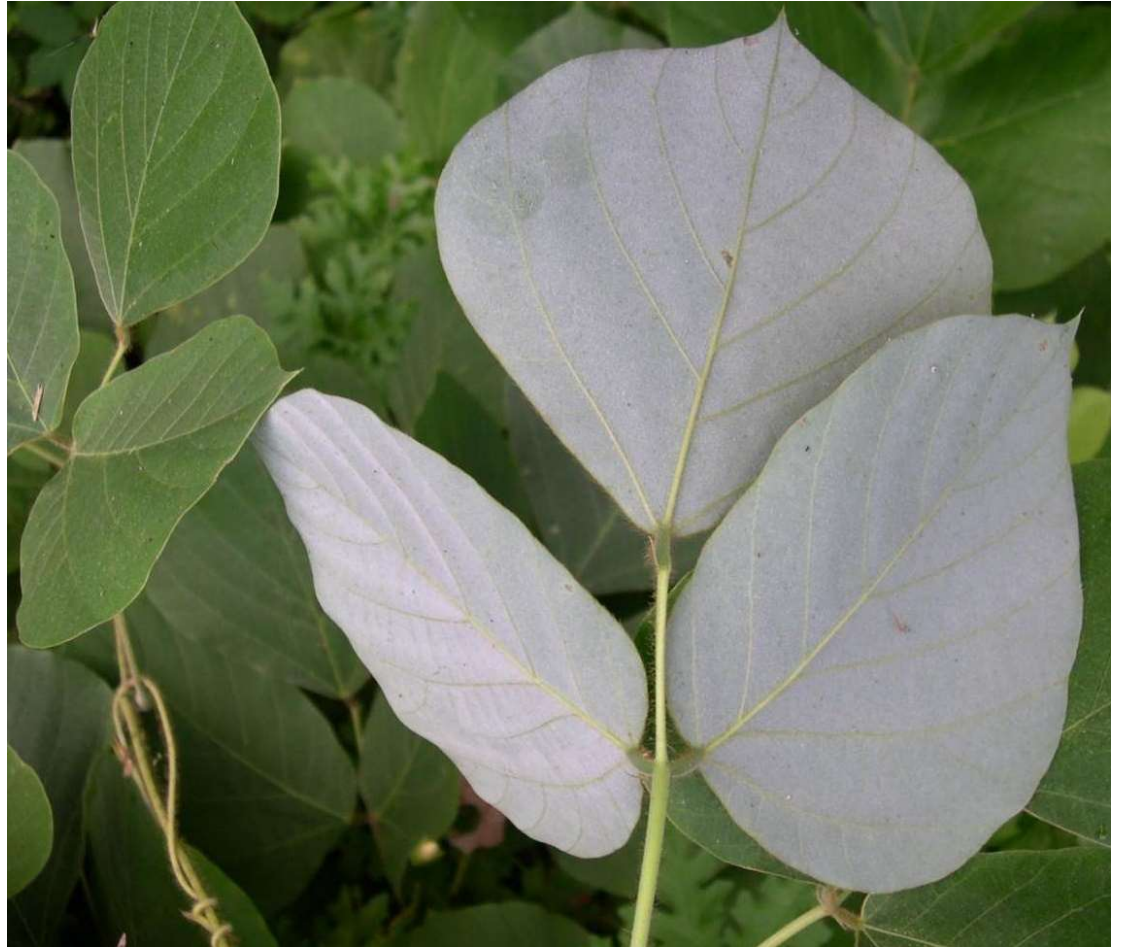
"**CoAl**": compound, alternate

[often woody, lots of herbaceous legumes though]

legumes: stipules, usually entire, thick pulvinuli

juglandaceae: finely evenly toothed, glands/smell

sapindales



"CoAl": compound, alternate

compound, alternate

1) **legumes** (Fabaceae): herbs or woody, stipules, entire (except clovers & relatives & honey locust with teeth); rarely with simple lvs (like redbud); pulvinus, pulvinuli swollen & discolored with respect to adjacent midvein (best seen abaxially); vetches (terminal leaflet a tendril)

-- woody, no stipules

2) **Sapindales** (soapberry, citrus, poison ivy): usually entire or bluntly irregularly toothed, no golden glands on abaxial blade (if have smell, it is spicy & resinous); leaves sometimes bipinnately compound (or more)

3) **Juglandaceae** (walnut, hickory, pecan): finely evenly serrate and have golden to brownish glandular hairs with distinctive smell; never more than once pinnate

"**MADCap**": woody, opposite

maple: palmate

ash/olive: compound or cuticular pits

dogwood: arcuate

caprifoliaceae (honeysuckles)



woody, opposite

BEMADCap

b
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r
r
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c e
e
a
e

B

palmately compound



buckeyes are related
to maples (palmate)

Aesculus

E

pinnately compound



elderberries are
related to
honeysuckles

Sambucus

M palmately veined/lobed

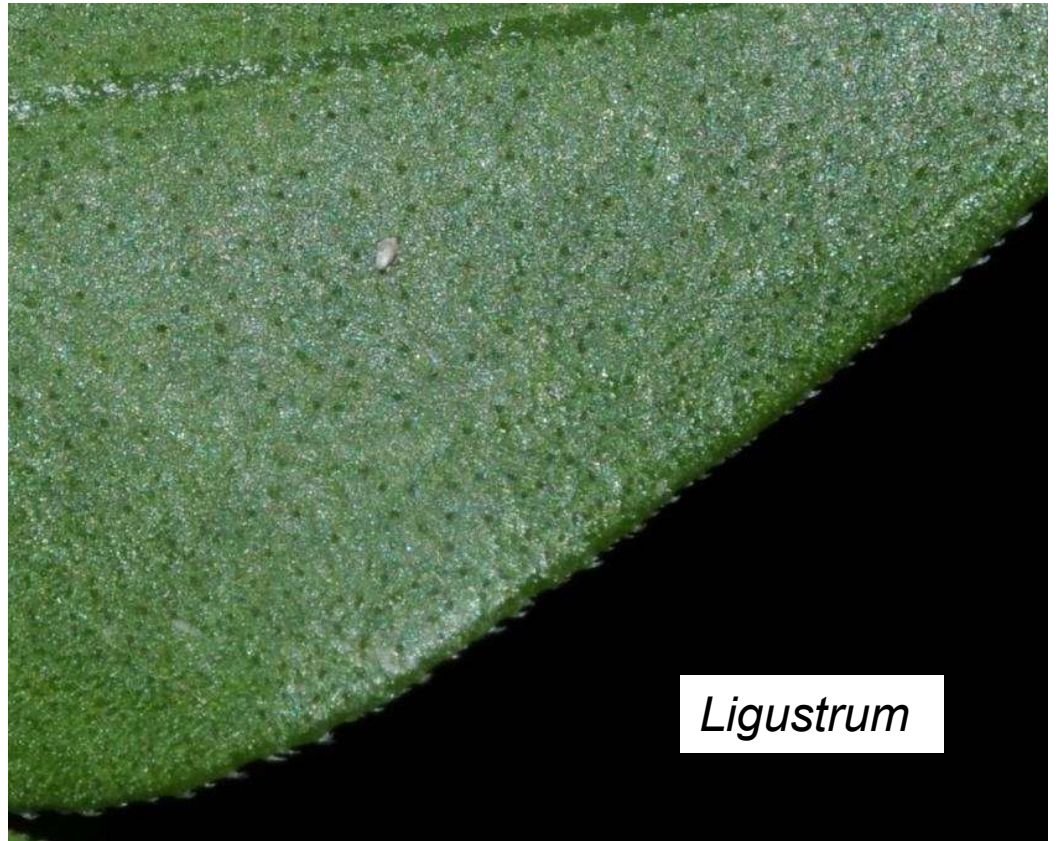


Acer

A pinnately compound
or cuticular pits



Fraxinus



Ligustrum

D arcuate veins



Cornus

Caprifoliaceae -- honeysuckles
[related to elderberry, viburnum]

rule out rest

Cap



Viburnum



Symphoricarpos

(BE)MADCap is a mnemonic motif

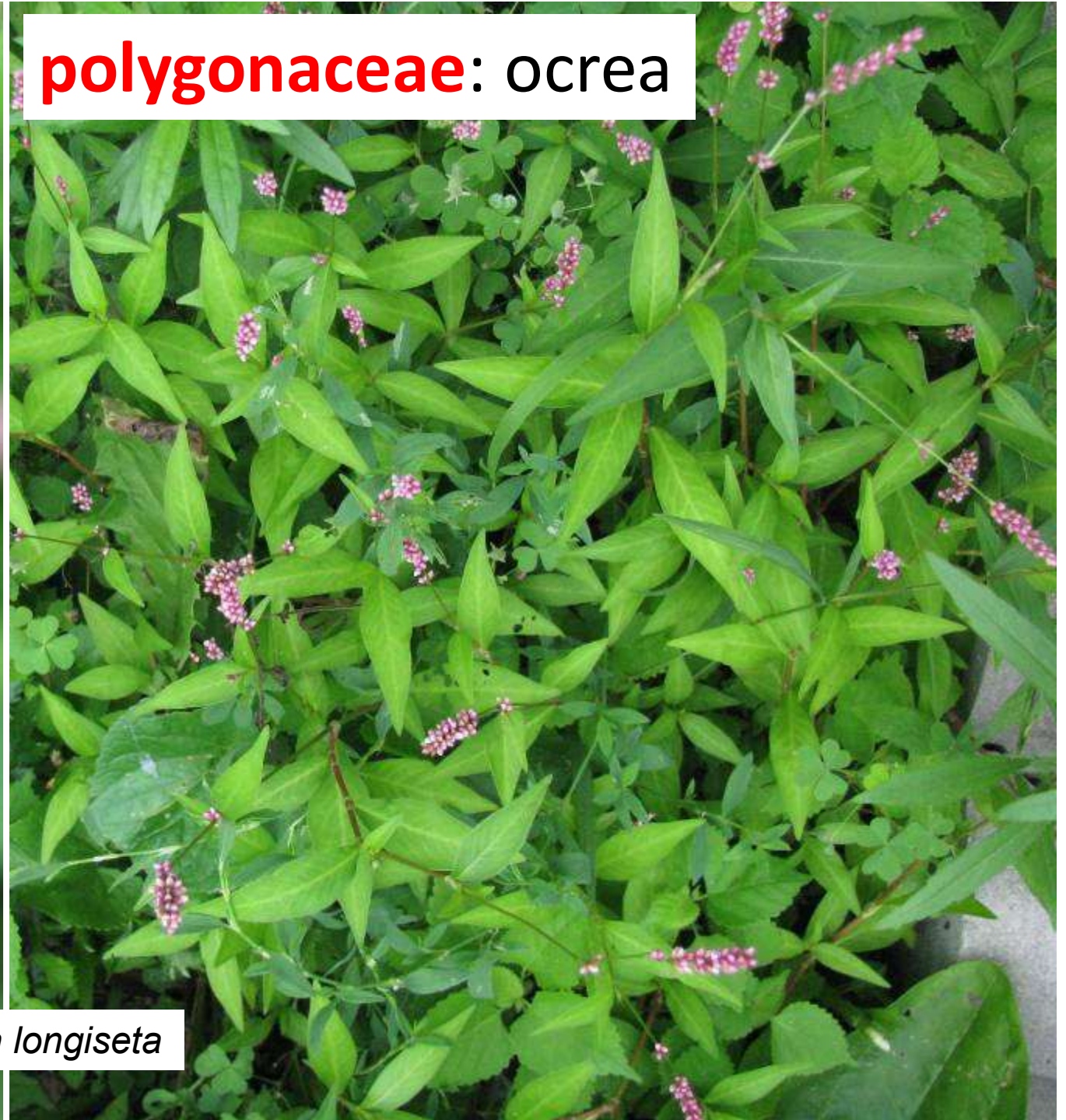
-- there are a few others out there: *Euonymus*, *Hydrangeaceae*, *Staphylea*, *Cephalanthus*



MADCapSECH??

polygonaceae: ocrea

Persicaria longiseta



polygonaceae: ocrea



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

-- mostly toothed. can expand to include herbaceous? compound?
i.e., restrict to just alternate & stipules?

elm & birch: doubly serrate

oak: lobed, clustered

holly: small dark triangular stipules, dioecious,
sessile capitate stigma

mallow: palmate

mulberry: milky sap

willow: lanceolate

rose:



"**VD**": vaginate dicots, i.e., with sheathing petiole base

carrot: umbel, schizocarp, smell, inferior ovary

herbaceous roses: stipules

buttercups: no stipules, no smell, no umbels



"milky"
only a few
others

Moraceae



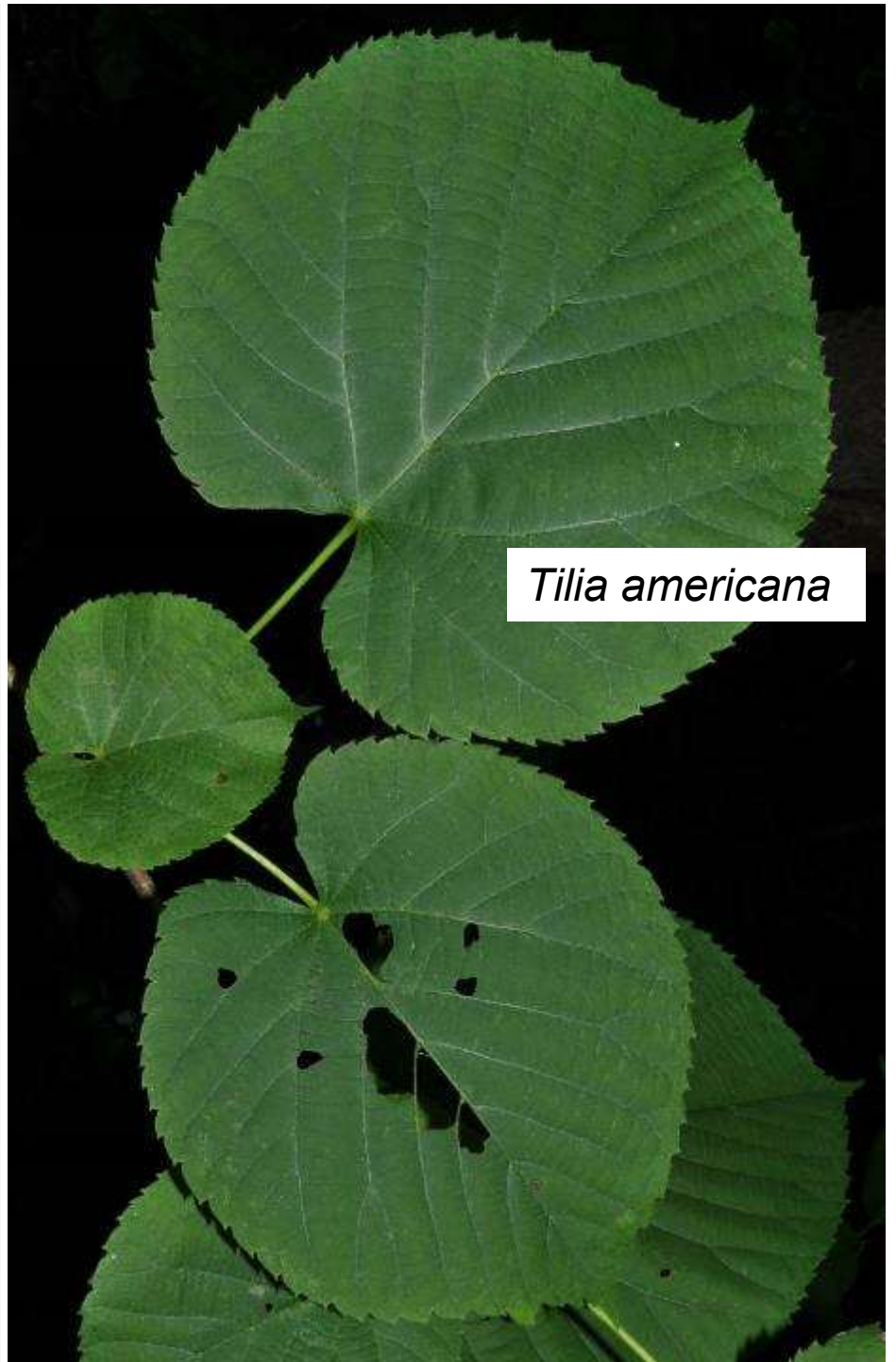
Campanulaceae

"palmate"

Morus rubra



Tilia americana





Morus rubra



Tilia americana

"TAN": tendril at node



Cucurbitaceae

Passifloraceae

Vitaceae

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" (**tendr**il at node): grapes, passionflowers, squashes, [balloon vine]

motif templates -- Woody (include lianas if you can't always tell them apart):

gymnosperms; "basal angiosperms" (not *Saururus*); NOT monocots (except *Arundinaria*, *Agave/Yucca*, *Smilax*); Sapindales (aceracs, anacards, rutacs, simaroubs), adoxacs, altingiacs, aquifoliacs, araliacs (some herbs), [some cultivated berberidacs], betulacs, bignons, cannabacs, caprifoliacs, celastracs, cornacs, ebenacs, elaeagnacs, ericacs, some fabacs (*Albizia*, *Amorpha*, *Cercis*, *Gleditsia*, *Gymnocladus*, *Robinia*, *Wisteria*), fagacs, hippocastanacs, hydrangeacs, some *Hypericum*, juglandacs, *Vitex*, moracs, *Nyssa*, oleacs, *Paulownia*, *Platanus*, some *Clematis*, rhamnacs, some rosacs (*Amelanchier*, *Prunus*, *Pyrus*, *Rosa*, *Rubus*), *Cephalanthus*, salicacs, *Staphylea*, ulmacs, vitacs

Woody & Compound: "CoAl" addresses the common alternate ones

Sapindales, *Sambucus*, *Aralia*, [some cultivated berberidacs], bignons (not *Catalpa*), [some cannabacs (*Cannabis* & *Humulus*) have palmately compound leaves, but they're not really woody, although they may seem so late in the growing season], most fabacs (not *Cercis*), hippocastanacs (palmate), juglandacs, *Vitex* (palmate), *Fraxinus* (& some other oleacs from other places), *Clematis*, some rosacs (*Rosa*, *Rubus*, *Sorbus* (only cultivated here)), *Staphylea* (trifoliolate), some vitacs (*Ampelopsis arborea* (bipinnate), *Parthenocissus quinquefolia* (palmate))

Woody & Opposite: "MADCap" picks up most (& could be modified for the rest)

Juniperus (& *Metasequoia*, a cultivated gymnosperm); *Acer*, adoxacs (*Sambucus*, *Viburnum*), bignons, [some Cannabacs (*Cannabis* & *Humulus*)], some celastracs (*Euonymus*), *Cornus*, [some elaeagnacs elsewhere], [rarely some ericacs elsewhere], *Aesculus* (palmate), *Hydrangea*, *Hypericum*, *Vitex* (palmate), sometimes opposite in one introduced morac (*Broussonetia*), oleacs, *Paulownia*, *Clematis*, some rhamnacs from elsewhere, *Cephalanthus*, *Staphylea*

Woody & Alternate/Simple/& Entire: "Bberry" (pulls out those with no stipules, may have teeth)

some gymnosperms (*Pinus*, *Taxodium*, *Ginkgo* (the latter sometimes lobed)); *Arundinaria*, *Agave/Yucca*; rarely some *Ilex* (mostly toothed), rarely *Cornus* (*C. alternifolia* & some cultivated species from Asia), *Diospyros*, *Elaeagnus*, some ericacs (some *Vaccinium*), *Cercis*, rarely some *Quercus* (*Q. imbricaria*, *Q. phellos*), *Maclura*, *Nyssa*, some *Pyrus* (sometimes with teeth; couple other cultivated genera of rosacs also lack teeth)

Woody & Alternate/Simple/Toothed: "rosy" (for those with stipules) picks up most

Liquidambar, most *Ilex*, betulacs (doubly serrate), *Celtis* (plinerved), fagacs, *Morus* (& some branches of introduced *Broussonetia*), *Platanus* (palmate), most rhamnacs, some rosacs (*Amelanchier*, *Prunus*, *Pyrus* (sometimes with no teeth); other rosacs may have compound leaves & some are actually herbs!), salicacs (*Salix* (lanceolate), *Populus* (most with laterally flattened petioles)), ulmacs; following are **NOT** rose motif because no stipules -- *Hedera* (liana; sometimes some leaves with no teeth nor lobes), *Celastrus* (liana), *Oxydendrum*, rarely *Nyssa* has a few teeth/lobes at apex of leaf

motif templates -- Herbaceous (include vines if you can't always tell them apart):

ferns; Saururus; most monocots; acanthus, amaranths, apiacs, apoc, asteracs, balsaminacs, berberidacs (some woody), borages, brassicacs, campanulacs, caryophylls, ceratophyllum, convolv, crassulacs, cucurbits, many fabacs, *Geranium*, some *Hypericum* (others woody), lamiacs (except *Vitex*), *Utricularia*, logans, malvacs, [one weedy morac, *Fatoua*], *Nelumbo*, onagracs, *Oxalis*, *Passiflora*, *Phytolacca*, plantaginacs, polemoniads, polygalacs, polygonacs, ranunculacs, some rosacs, most rubiacs (not *Cephalanthus*), scrophs, solanacs, urticacs, verbs, violacs [-- anything here not re-listed below can be assumed to be simple, alternate, & toothed (with or without stipules)]

Herb & Compound:

most ferns (not *Equisetum*); *Arisaema*; apiacs; some asteracs (*Ambrosia* (some only deeply lobed), some *Coreopsis*), brassicacs (some very deeply lobed, rarely compound), fabacs, some *Geranium* (most just very deeply lobed), some malvacs (most just palmately lobed, rarely palmately compound), *Oxalis*, some polemoniads, some ranunculacs (many just deeply lobed), most rosacs (*Geum* simple & compound on same plant often), rarely scrophs, rarely solanacs (tomato itself), some verbs (some *Verbena/Glandularia*), some violacs (usually just palmately lobed)

Herb & Opposite (including whorled):

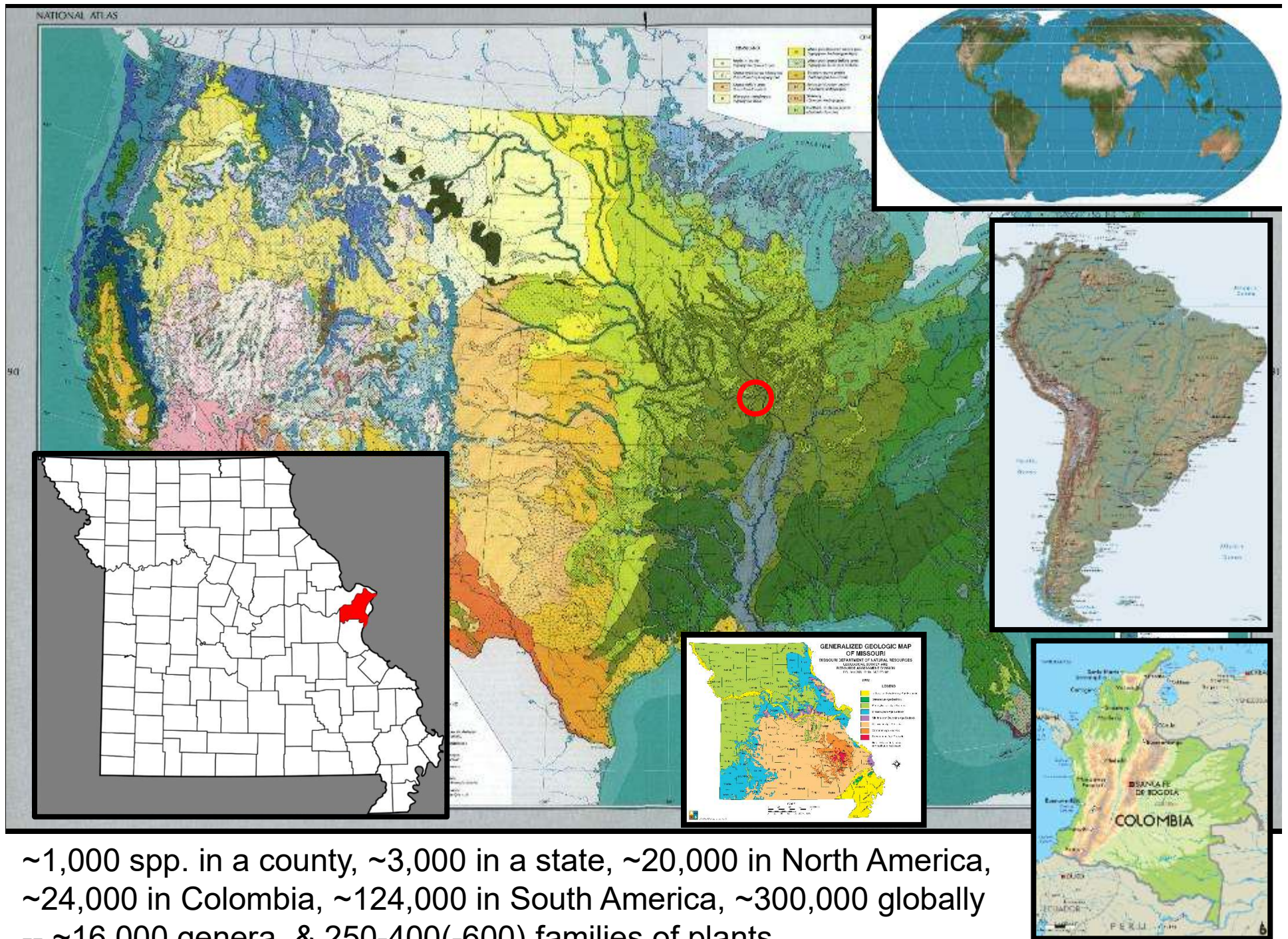
Dioscorea (some nodes on some plants); acanthus, some amaranths (*Alternanthera*), most apocyns (not *Amsonia*, not some nodes of *Asclepias tuberosa*), some asteracs (*Ambrosia*, *Coreopsis*, *Eupatorium* (some whorled), *Helianthus*, *Mikania* (vine), some *Verbesina*), caryophylls, crassulacs (some *Sedum*); some *Geranium* (some nodes on some plants), *Hypericum*, lamiacs, loganiacs, polemoniads (some *Phlox*), some polygalacs (rarely opposite or whorled), some ranunculacs (*Clematis* usually vines; bracteal leaves in many genera are opposite), rubiacs, many scrophs (often opposite below & alternate above), some solanacs (not really opposite, but some genera/species have 2 leaves at one node with <90 degree angle between petioles), some urticacs (*Boehmeria*, *Pilea*, *Urtica*), verbs

Herb & Alternate/Simple/& Entire:

most monocots (not *Arisaema*, not some nodes of *Dioscorea* with opposite or whorled leaves); *Saururus*; borages, convolvulacs (some lobed or compound), crassulacs (*Sedum* (also sometimes opposite)), *Plantago* (in rosettes so hard to see phyllotaxy), Polygonaceae, some Asteracs (*Gnaphalium*, some *Erigeron*, etc.)

-- most of the basic motifs i start with in intro botany are based on woody plants, because they are generally more visible/present year-round & because most people are more comfortable with them. herb motifs, for me, would include "rosettes" (asters, evening-primroses, mustards, & ??), but i haven't made names for most of the herb "patterns" (yet?), except students voted for:

"VD": dicots with sheath (carrot, herbaceous rose, buttercup), mostly alternate & compound; [many asteracs (involucrate heads) also have sheathing petiole bases, but they are often simple or opposite or have strong resinous smell; Geraniaceae can look similar and have stipules; Saxifragaceae, too, can be similar, and need to be imprinted vegetatively, have hypanthium in flower but usually no stipules]



~1,000 spp. in a county, ~3,000 in a state, ~20,000 in North America,
 ~24,000 in Colombia, ~124,000 in South America, ~300,000 globally
 -- ~16,000 genera, & 250-400(-600) families of plants