



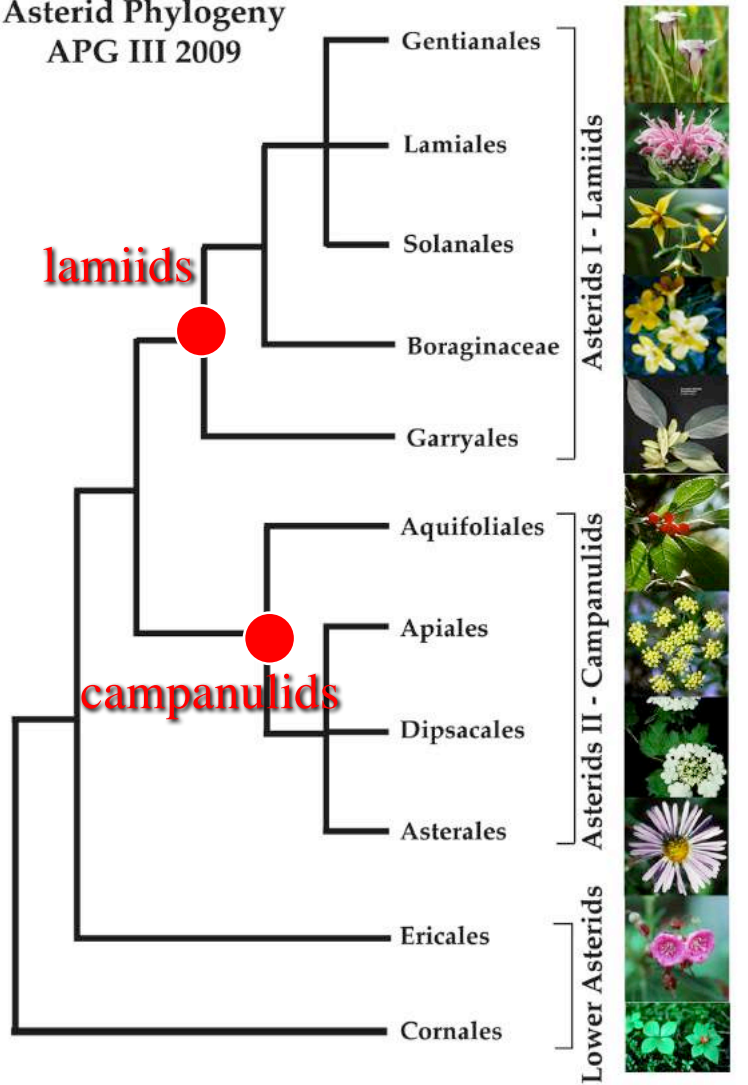
Diversity and Evolution of Asterids

. . . viburnums, umbels, and
lobelias . . .

Reminder: pollination biology project due this Wednesday

Core Asterids

Asterid Phylogeny
APG III 2009

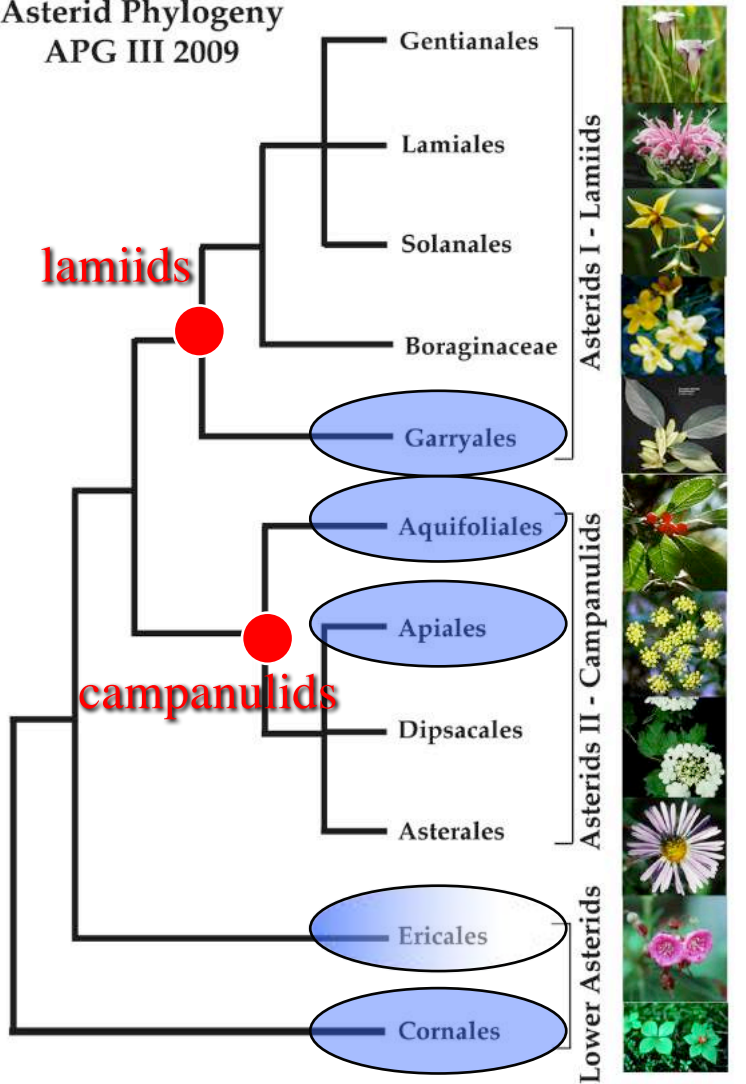


- will examine the **second** of the two well supported lineages of the core asterids

- ‘lamiid’ or Asterid I group
- ‘**campanulid**’ or **Asterid II** group

Core Asterids

Asterid Phylogeny
APG III 2009



- will examine the second of the two well supported lineages of the core asterids

- ‘lamiid’ or Asterid I group
- ‘campanulid’ or Asterid II group

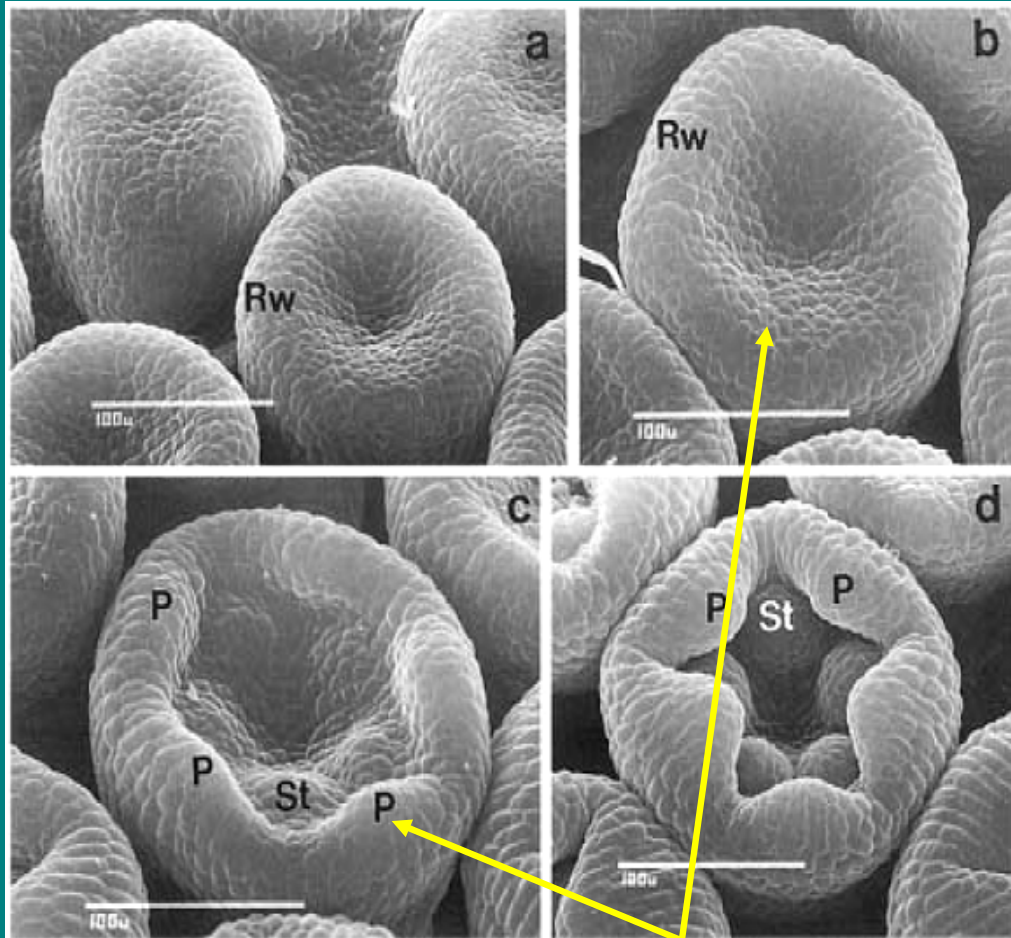
 = NOT fused corolla tube

- Asterids gained fused corolla several times

- 2 separate origins of fused petals in “core” Asterids (plus several times in Ericales; Cornales start fused)

Early vs. Late Sympetaly

euasterids II - campanulids

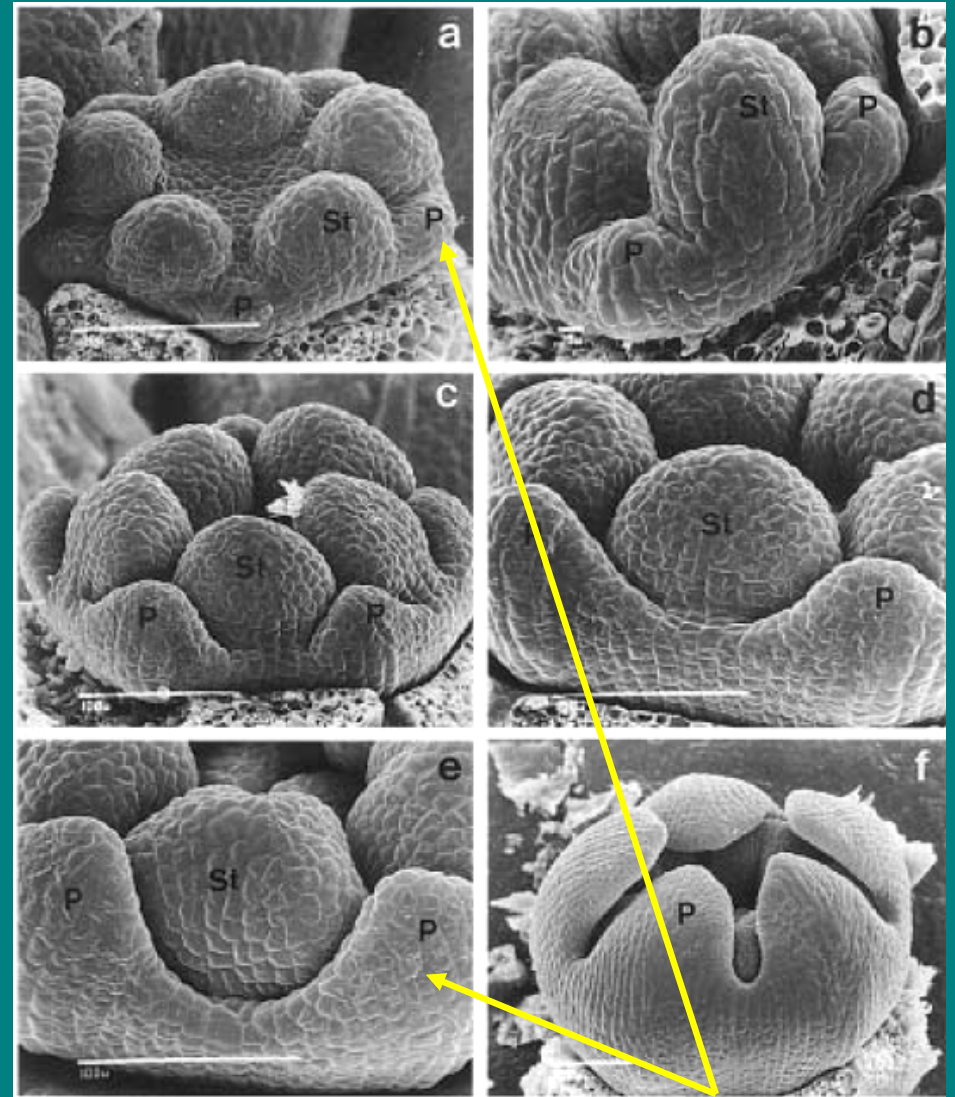


Calendula, Asteraceae

early

also in Cornaceae of
"basal asterids"

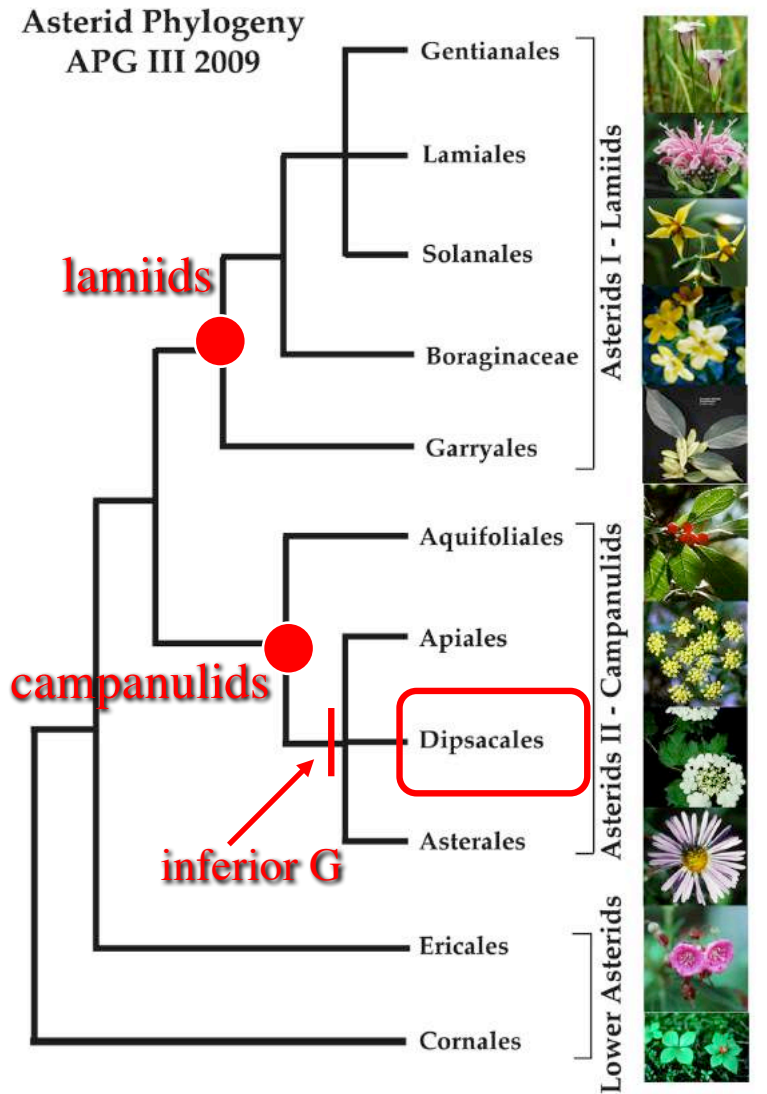
euasterids I - lamiids



Anchusa, Boraginaceae

late

Dipsacales

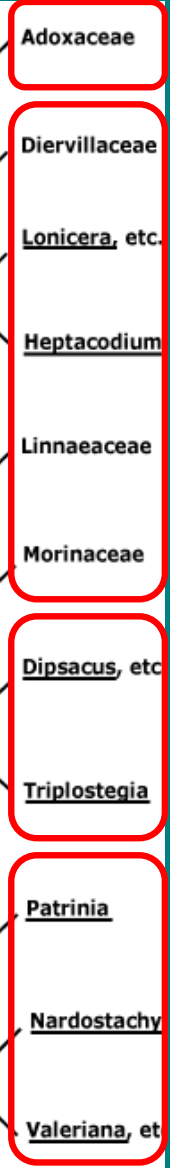


- order within ‘**campanulids** or **Asterid II** group
- 2 (or 7) families and nearly 1,100 species of herbs and shrubs largely from North Hemisphere
- **iridoids**, **opposite leaves**, **inferior gynoecium**



“Caprifoliaceae” - what is it ?

DNA phylogeny



Adoxa



• pre-DNA era four families were recognized (as in Gleason/Cronquist)

Caprifoliaceae – paraphyletic!

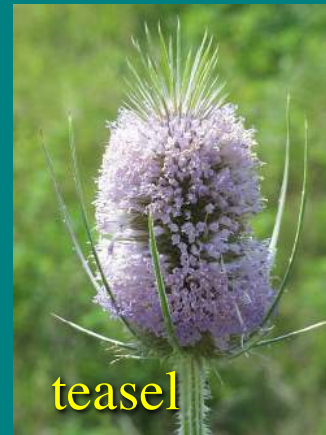


viburnum



honeysuckle

Dipsacaceae



teasel

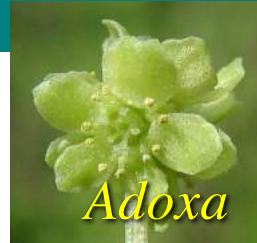
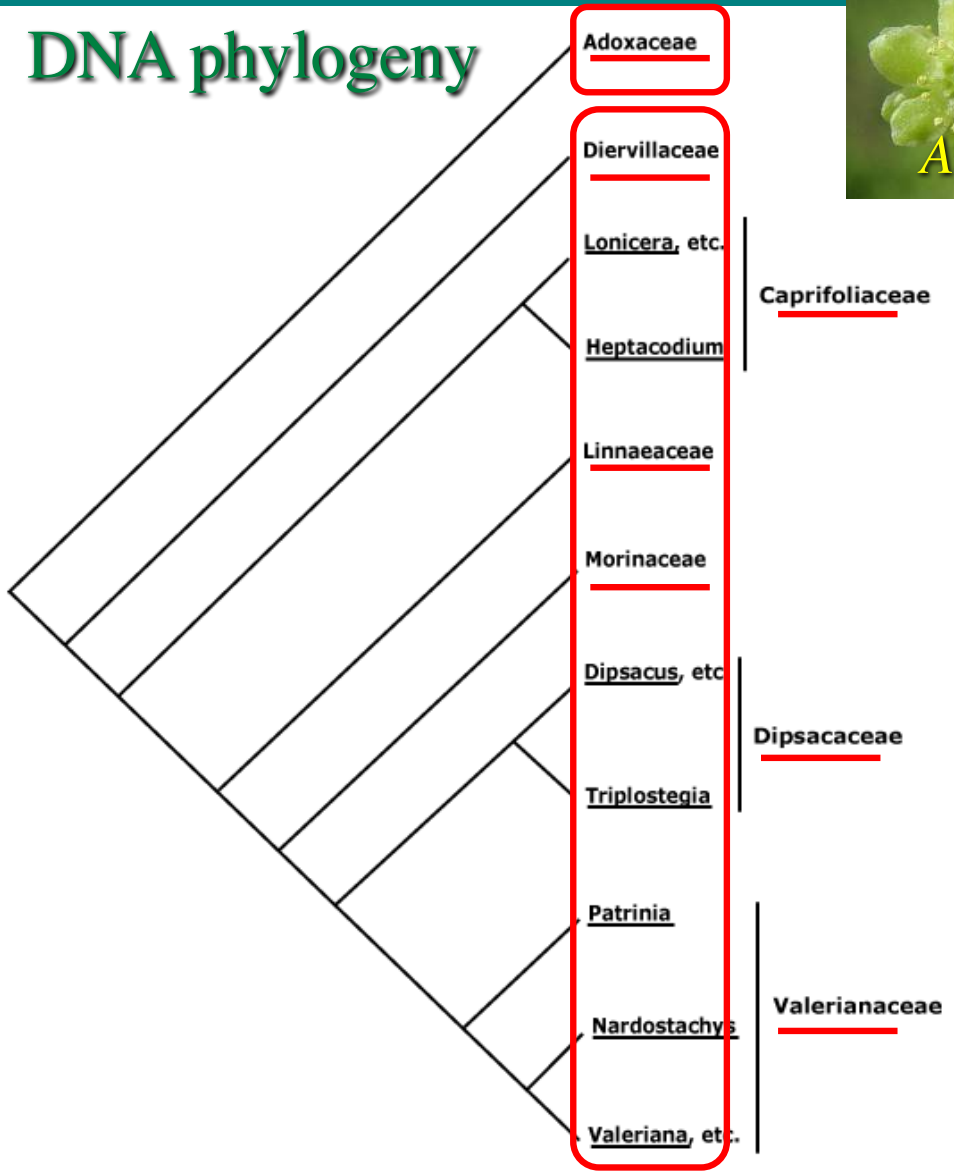
Valerianaceae



valerian

“Caprifoliaceae” - what is it ?

DNA phylogeny



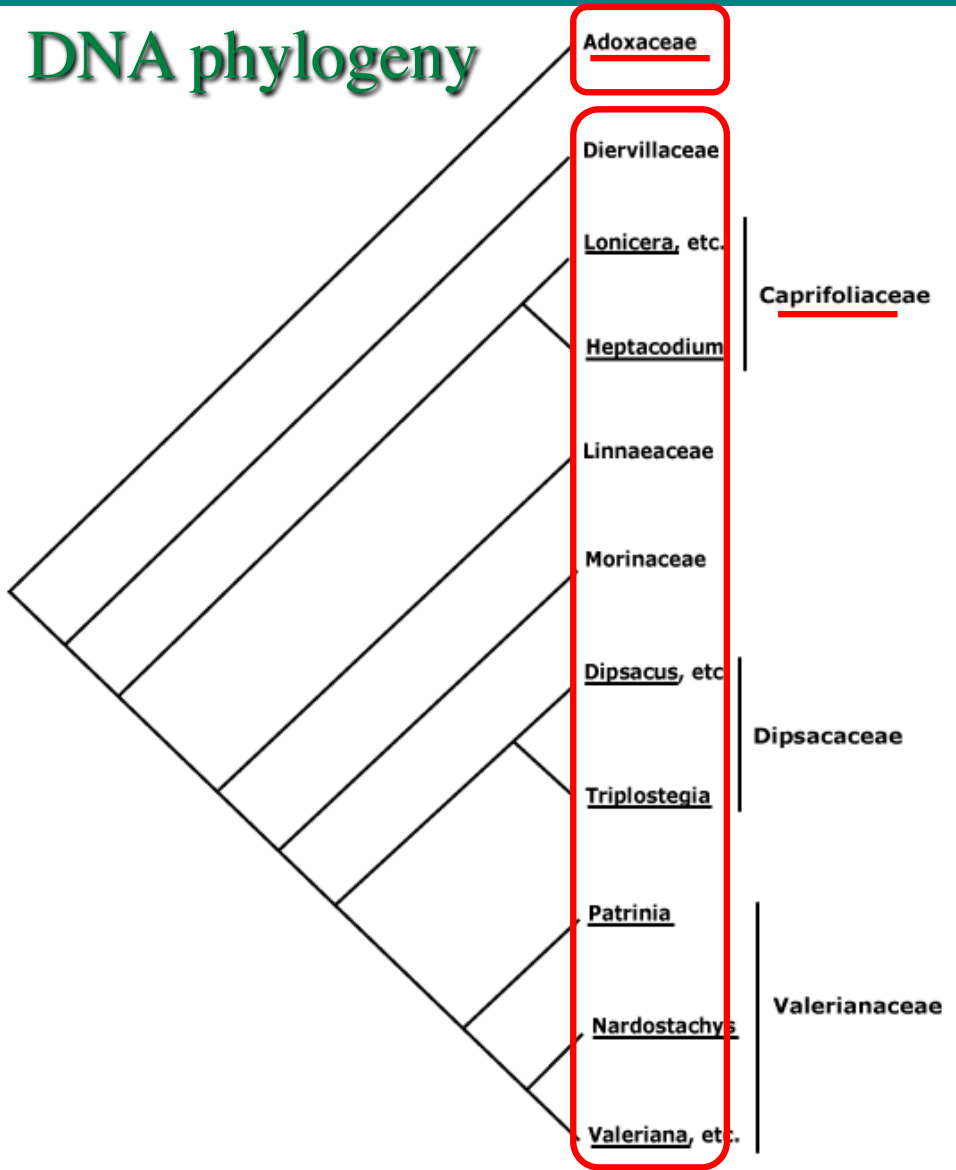
- post-DNA era up to 7 families can be recognized

- will use 2 here [MI flora differs!]

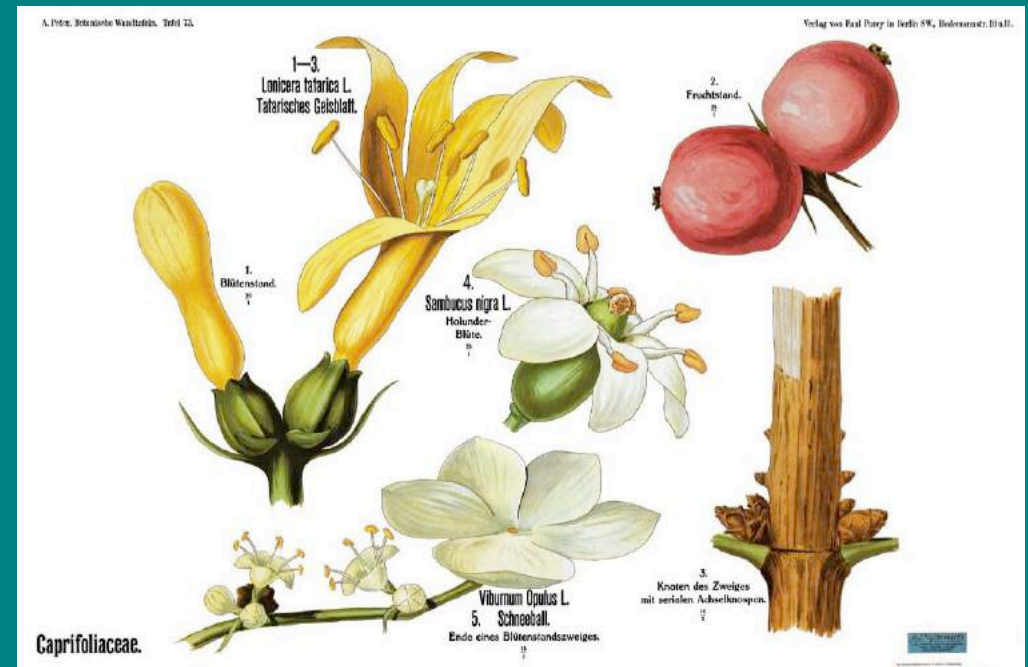


“Caprifoliaceae” - what is it ?

DNA phylogeny



- the two families can be differentiated by flowers:
 - short styled (Adoxaceae)
 - long styled (Caprifoliaceae)



“Caprifoliaceae” - what is it ?

- the two families can be differentiated by flowers:

- short styled (Adoxaceae)
- long styled (Caprifoliaceae)



Viburnum - viburnum



Lonicera - honeysuckle

Adoxaceae - viburnums

5 genera and 200 species of opposite leaved shrubs and some herbs - mainly North Temperate

- **flowers small** and usually in flat-topped **cymes**
- 5 merous with up to 5 fused carpels and **short style**
- **berry** or drupaceous fruits



Sambucus canadensis - Common elder

Adoxaceae - viburnums



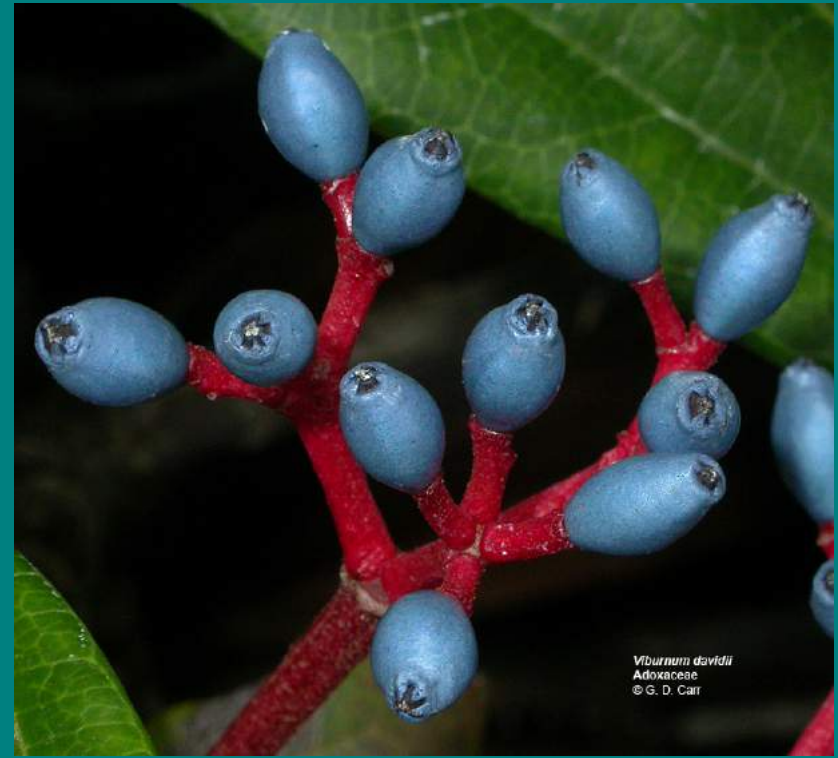
Sambucus racemosa - red-berried elder



- elder-berries are opposite, compounded leaved shrubs

Adoxaceae - viburnums

- viburnums are simple leaved shrubs, but often lobed, or coarsely toothed



Viburnum davidii

Adoxaceae - viburnums

- note enlarged, **sterile flowers** on edge of ‘**head**’ inflorescence for pollinator attraction

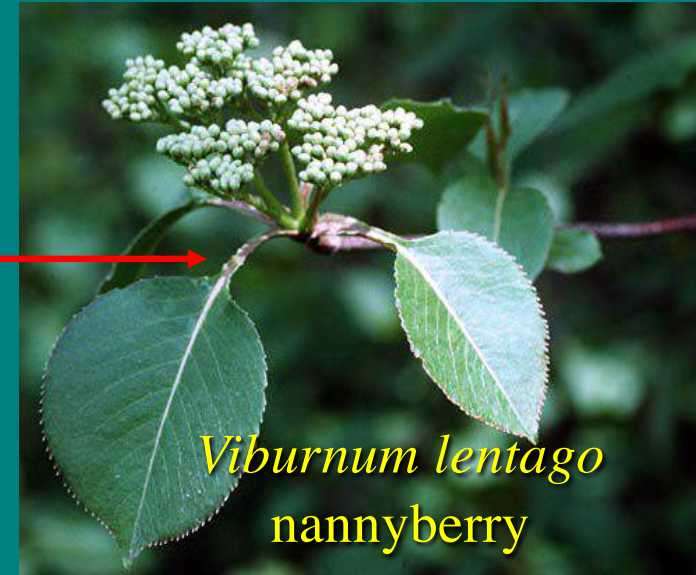


Viburnum opulus (trilobum)
high-bush cranberry

another “**pseudanthium**”
or false flower

Adoxaceae - viburnums

- many viburnums have glands on petioles



Adoxaceae - viburnums



- unusual reduced woodland herb with musky scent and trifoliate, spiralled leaves

Adoxa moschatellina - muskroot

*Caprifoliaceae - honeysuckles

Northern hemisphere family (and tropical mountains) of 43 genera and about 900 species of shrubs, subshrubs, vines and herbs



Lonicera - honeysuckle



Linnaea - twinflower



Dipsacus - teasel

*Caprifoliaceae - honeysuckles

CA (5) CO (5) A 4-5 G (2-5)

- 5 merous. **long styled**, and bell-shaped or strongly zygomorphic
- **inferior ovary** forms **berry** (or reduced to achenes)



Lonicera - honeysuckle



Triosteum - horse gentian

*Caprifoliaceae - honeysuckles

- honeysuckles include native (right) and introduced aggressive shrubs (below) or vines



Lonicera tatarica -
tartarian honeysuckle



Lonicera canadensis -
fly honeysuckle

*Caprifoliaceae - honeysuckles



Lonicera reticulata - grape honeysuckle

natives



Lonicera dioica - red honeysuckle



*Caprifoliaceae - honeysuckles



invasives

Lonicera xylosteum -
European fly honeysuckle

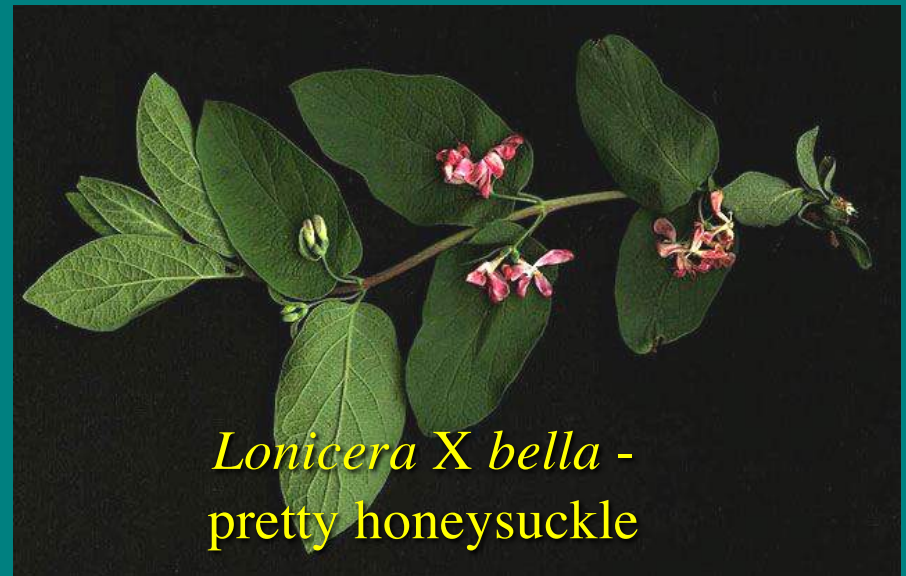


native leaf miners



Lonicera japonica
Caprifoliaceae
© G. D. Carr

Lonicera japonica



Lonicera X bella -
pretty honeysuckle

*Caprifoliaceae - honeysuckles



Diervilla lonicera -
bush honeysuckle



Triosteum perfoliatum
Horse gentian



*Caprifoliaceae - honeysuckles

Linnaea borealis - twinflower

- Characteristic subshrub of (circum)boreal forests where it forms large colonies. Two flowers form per inflorescence.



*Caprifoliaceae - honeysuckles

- many cultivated ornamentals



Abelia



Kolkwitzia

*Caprifoliaceae - honeysuckles

- the old ‘Valerianaceae’ and ‘Dipsacaceae’ exhibit features that will be seen in Asteraceae [“**pseudanthium**” or head]
- **congested** inflorescences
- **bracted** inflorescences



Valeriana uliginosa -
marsh valerian



Valeriana edulis -
edible valerian



Knautia
blue-buttons



*Caprifoliaceae - honeysuckles

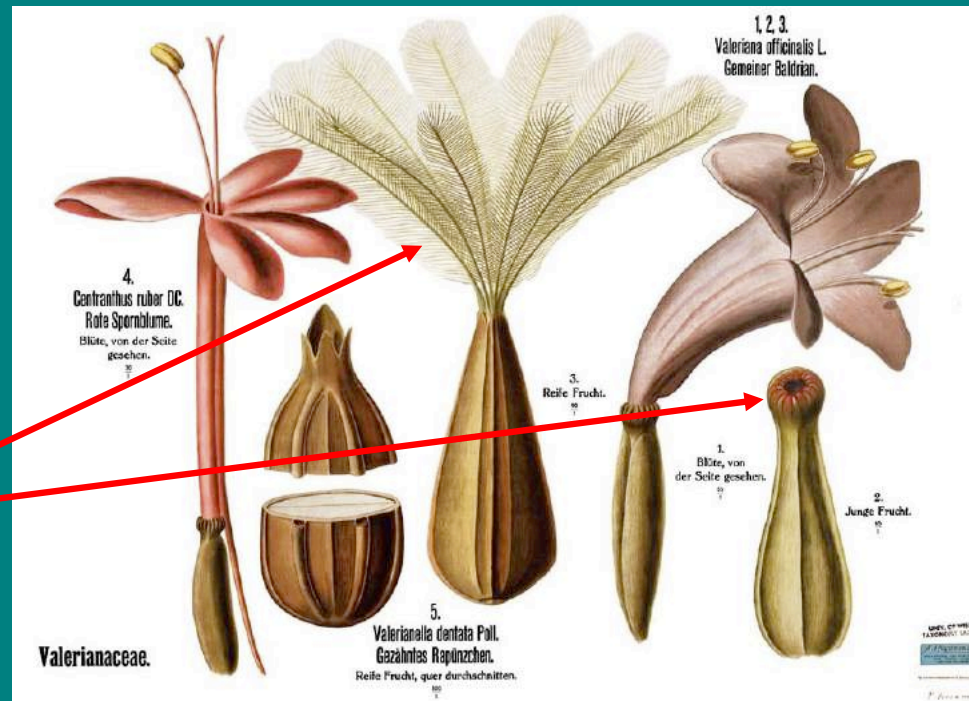
- the old ‘Valerianaceae’ and ‘Dipsacaceae’ exhibit features that will be seen in Asteraceae [“pseudanthium” or head]



Knautia

pappus

- reduced calyx - pappus
- one seeded achene



*Caprifoliaceae - honeysuckles

- the old 'Valerianaceae' and 'Dipsacaceae' exhibit features that will be seen in Asteraceae ["pseudanthium" or head]
- involucral bracts



Dipsacus fullonum - teasel
Introduced and adventive



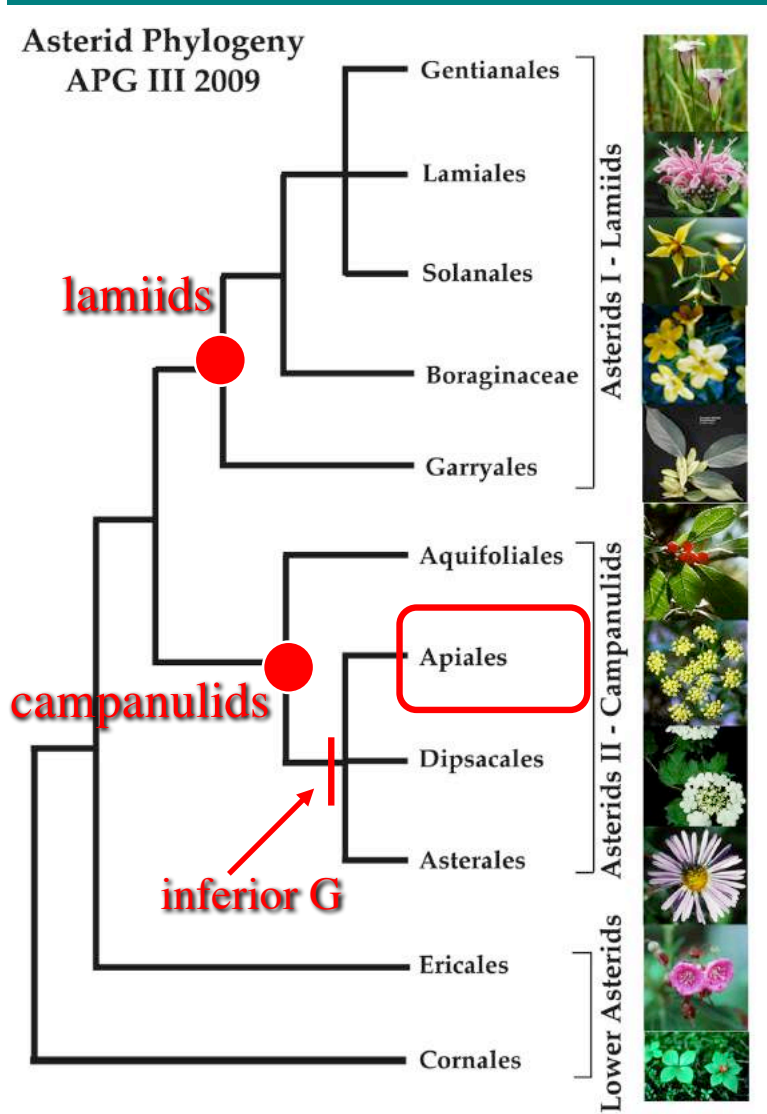
Involucral bracts



pappus

Apiales

- 7 families and nearly 5,500 species of herbs and shrubs - **Australasia** appears to be center of diversity
- **iridoids, aromatic, alternate compound leaves, umbels, corolla separate, inferior gynoecium**



ginseng - Araliaceae



parsnip - Apiaceae

Araliaceae - ginseng



Aralia hispida - bristly sarsaparilla

- tropical family of trees, shrubs, or herbs (temperate)
- leaves divided or up to **3 times or more compound**
- distinctive aroma and chemicals

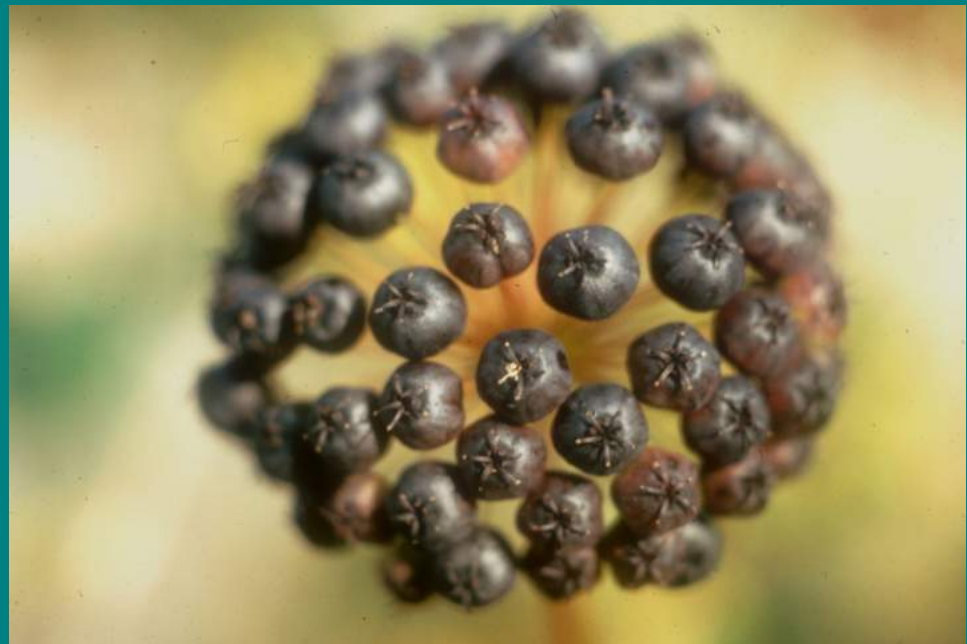


Aralia nudicaulis - wild sarsaparilla

Araliaceae - ginseng

CA 5 CO 5 A 5 \overline{G} (5)

- umbels
- flowers small, non-asterid like (no corolla tube)
- 5 merous, with 5 fused carpels forming inferior ovary & berries



Aralia hispida - bristly sarsaparilla : note 5 styles

Araliaceae - ginseng



Aralia elata
Hercule's club, Devil's
walking stick



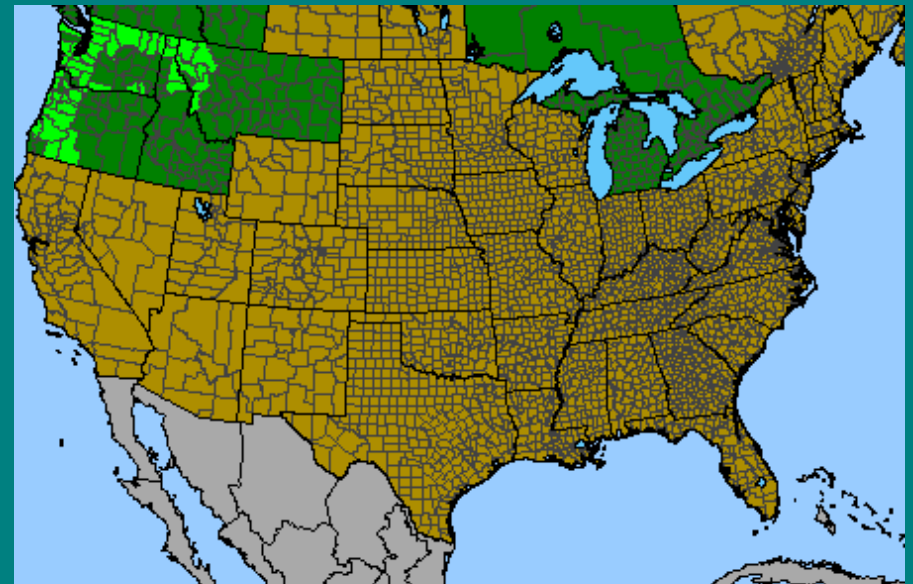
Aralia racemosa
spikenard

Araliaceae - ginseng



Oplopanax horridus
Devils club

Western N Am. – Great Lakes disjunction
only Isle Royale in Lake Superior



Araliaceae - ginseng



Panax quinquefolius - American ginseng

Rich woods; leaflets are stalked. Heavily collected woodland species for roots.

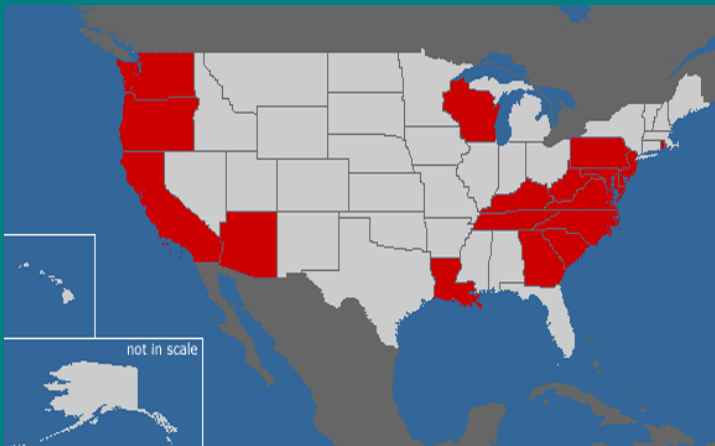


Araliaceae - ginseng



Hedera helix
English ivy

Eurasia - N. Africa; invasive in U.S.



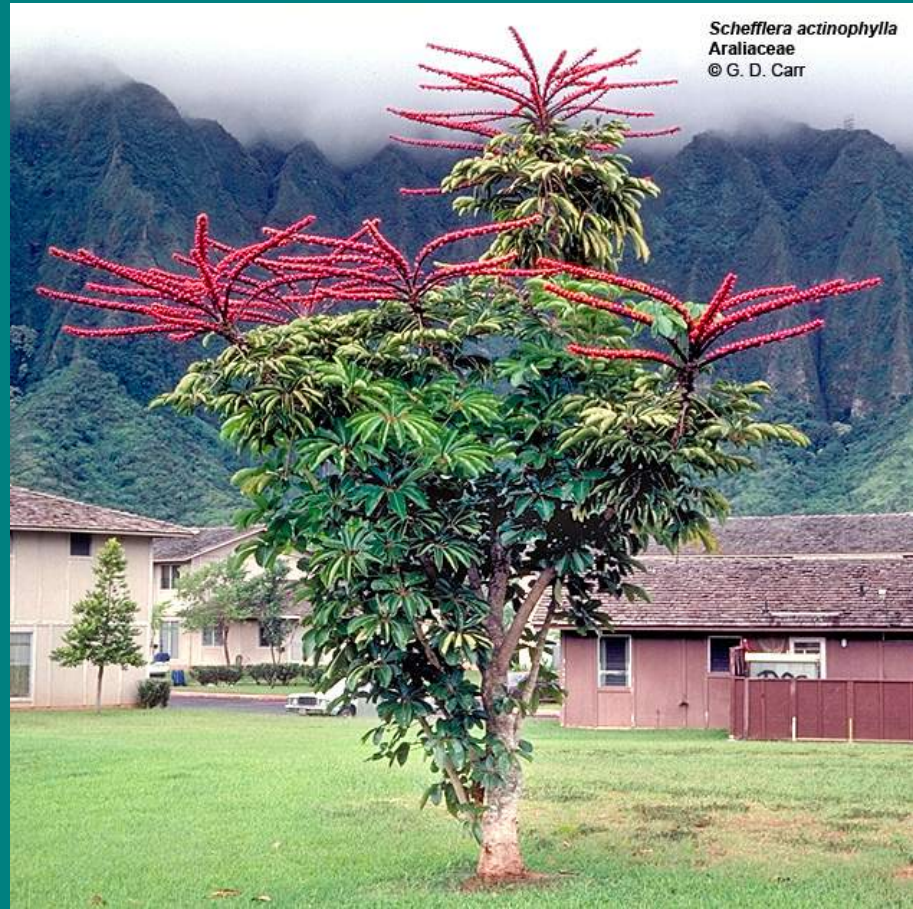
Araliaceae - ginseng



Tetrapanax papyrifera -
rice paper



*Schefflera
actinophylla*
Araliaceae
© G. D. Carr

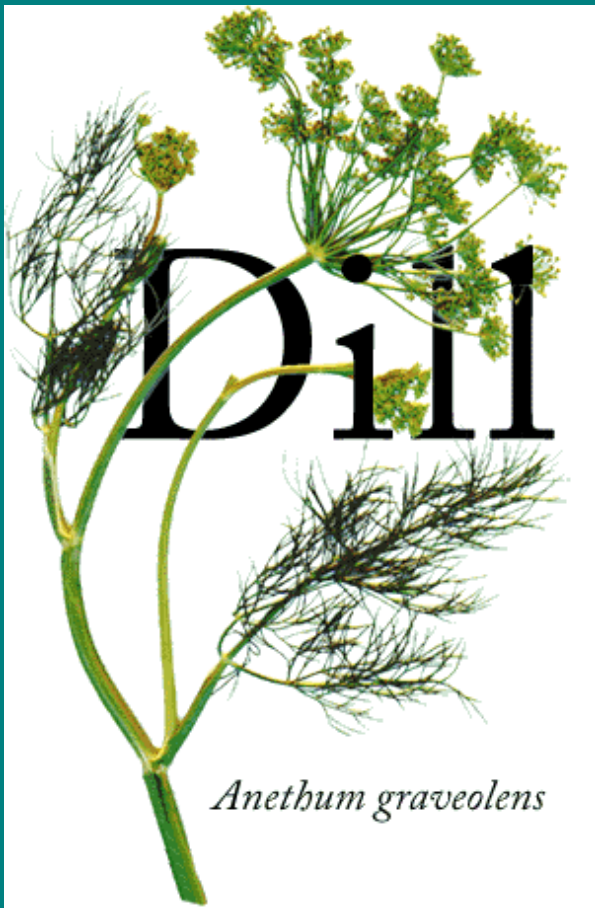


Schefflera actinophylla
Araliaceae
© G. D. Carr

Schefflera - umbrella plants

*Apiaceae - umbels

Large family of 430 genera and over 3700 species most common in north temperate regions. Economically important (carrot, parsnip, parsley, celery, dill, caraway).



parsnip



carrot

*Apiaceae - umbels

- aromatic herbs with hollow stems
- dissected or compound leaves
- leaves strongly sheathing



sheath



Heracleum lanatum - cow parsnip

*Apiaceae - umbels

CA 5 CO 5 A 5 \overline{G} (2)

- flowers small in **umbels**, often compound
- female flowers often along edge of each umbellet

common feature in Asterids
with the formation of a **'head'**



*Apiaceae - umbels

CA 5 CO 5 A 5 \overline{G} (2)

- flowers small in **umbels**, often compound
- **female flowers often along edge** of each umbellet
- 5 merous with **no corolla tube**
- inferior gynoecium of **2 carpels** separating at maturity



*Apiaceae - umbels

CA 5 CO 5 A 5 \overline{G} (2)

- fruit dehiscent and splitting - **schizocarp**
- 2 dry, 1-seeded **mericarps** held together by **carpophore**
- fruits 5-ribbed separated by oil canals - taxonomic character for separating genera



*Apiaceae - umbels



Angelica atropurpurea - great angelica

- Large coarse herb of wetter areas

*Apiaceae - umbels



Cicuta bulbifera
Bulblet water hemlock

Cicuta maculata
spotted water hemlock



Although containing nasty compounds, *Cicuta* is not the hemlock that Socrates took (*Conium*). Common species of marshes and streams.

*Apiaceae - umbels



Cryptotaenia canadensis - honewort



Osmorhiza longistylis - sweet cicely

*Apiaceae - umbels

Daucus carota - wild carrot, Queen Anne's lace

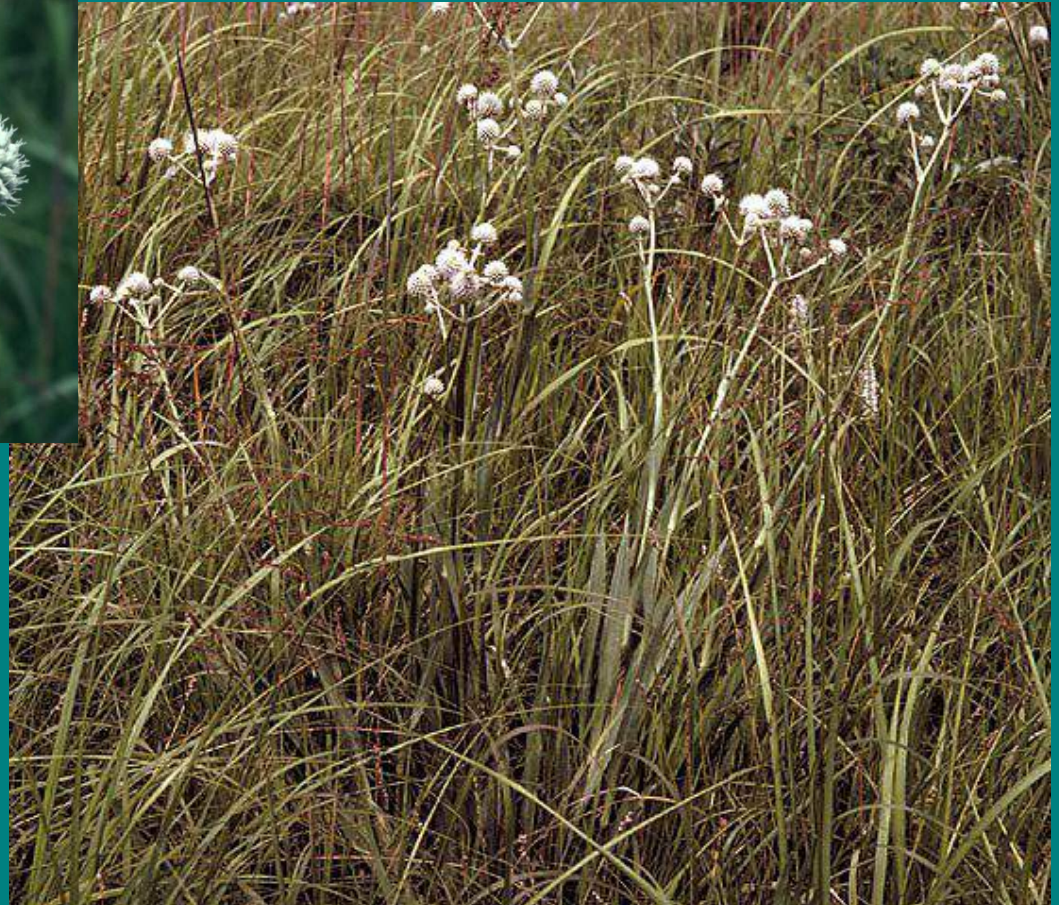
Note umbel with **involucral bracts**; larger **female flowers** along edge of umbel; the progenitor of cultivated carrot (same species); common weed



*Apiaceae - umbels



Eryngium yuccifolium
Rattlesnake master



Dry prairie species with sword-shaped leaves with spiny edge. Umbels has become literally a “head” as in Asteraceae.

*Apiaceae - umbels

The mystery plant from Abilene, Texas

Eryngium leavenworthii

Dipsacus fullonum – teasel (*Carduus*) *Eryngium yuccifolium*



*Apiaceae - umbels

Heracleum lanatum

American cow-parsnip

Our most robust species in Wisconsin



*Apiaceae - umbels

Pastinca sativa - wild parsnip

Introduced and spreading along roadsides. Dermatitic reaction from leaves is rapid but only in presence of UV light which causes precursor to change to phototoxin.



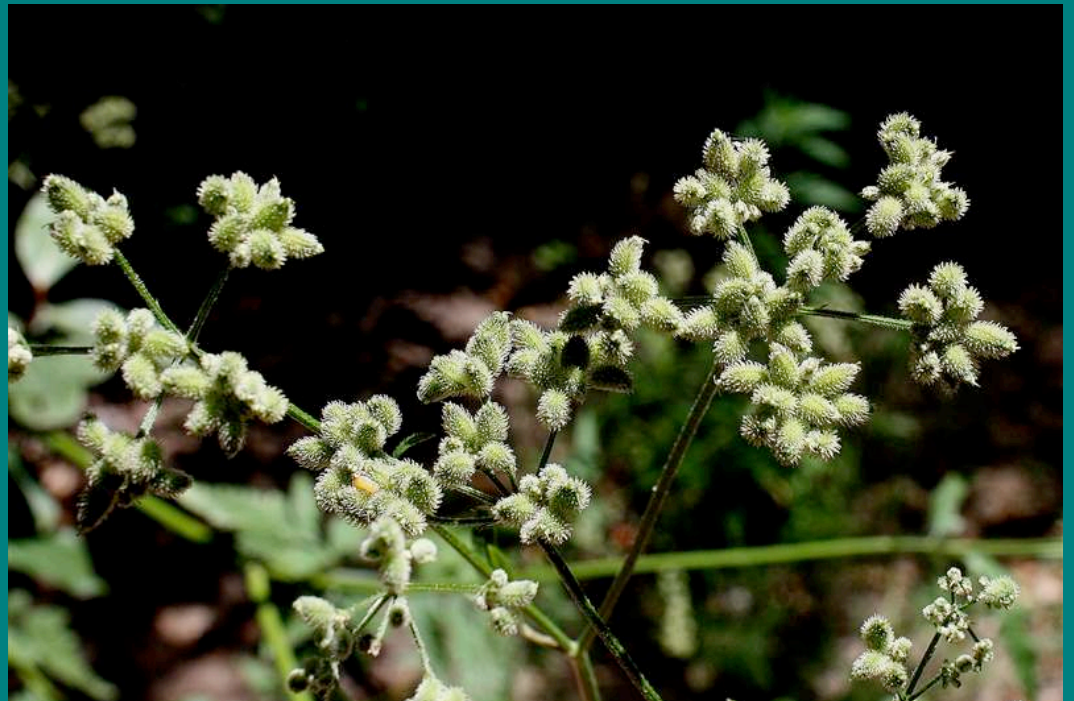
*Apiaceae - umbels



Torilis japonica- hedge parsley

Introduced and spreading in forests. If collected, mount it!

Torilin - effective blocker of **testosterone** to **DHT** conversion (5 alpha-reductase) ["pseudo-hermaphroditism", no male pattern baldness, no prostate cancer]



Pittosporaceae

“The **secretory canals** and some of the chemical features, notably the presence of **polyacetylenes**, have led some authors to propose a close relationship between the Pittosporaceae and the Araliales [Apiales]. The **ovular structure** would also be consistent with such a relationship.” Cronquist, 1981



Pittosporaceae

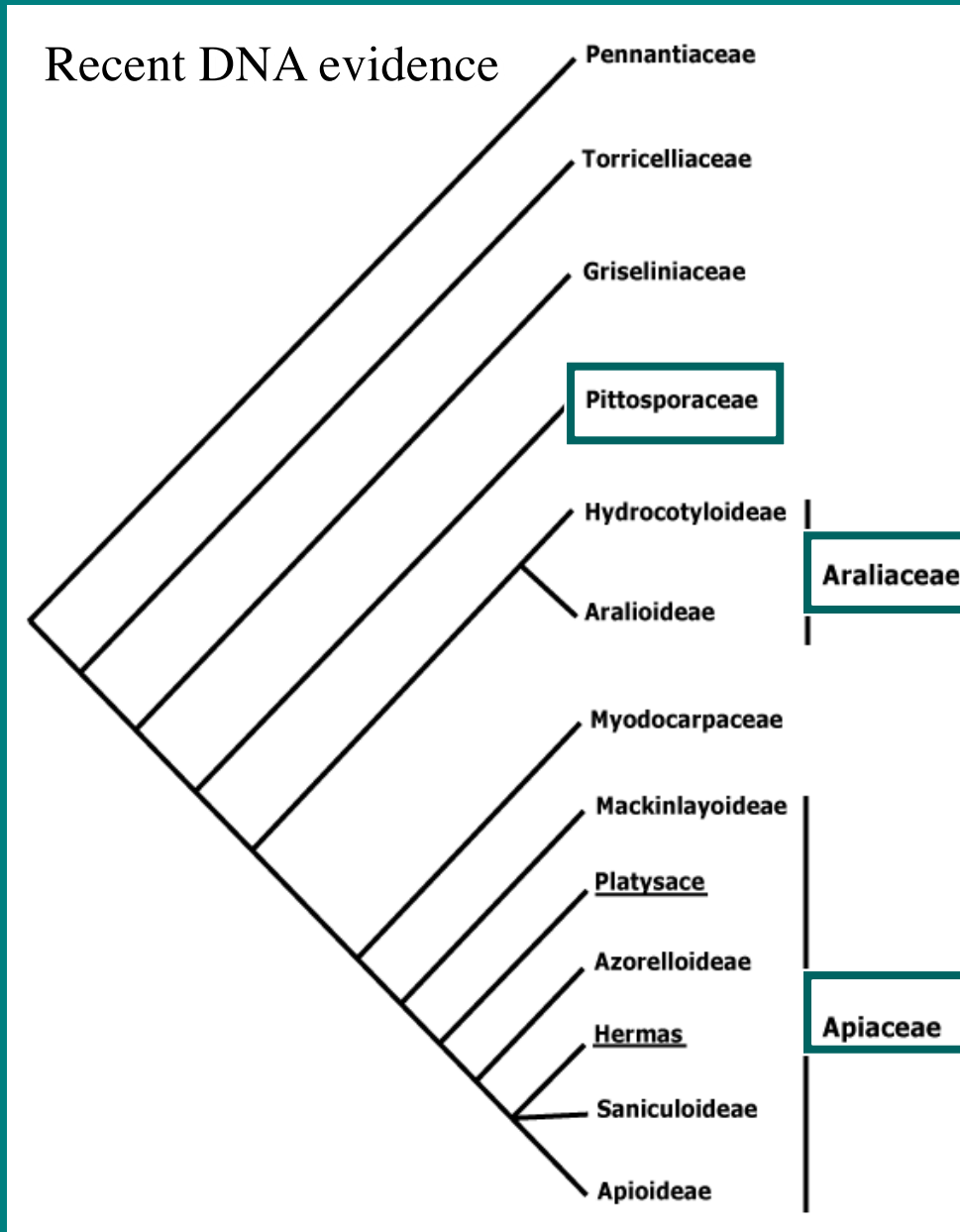
“Rather we must suppose that the anatomical and chemical similarities between the Pittosporaceae and Araliales illustrate the **pervasive parallelism** that besets efforts to establish phylogenetic relationships among the angiosperms”

Cronquist, 1981



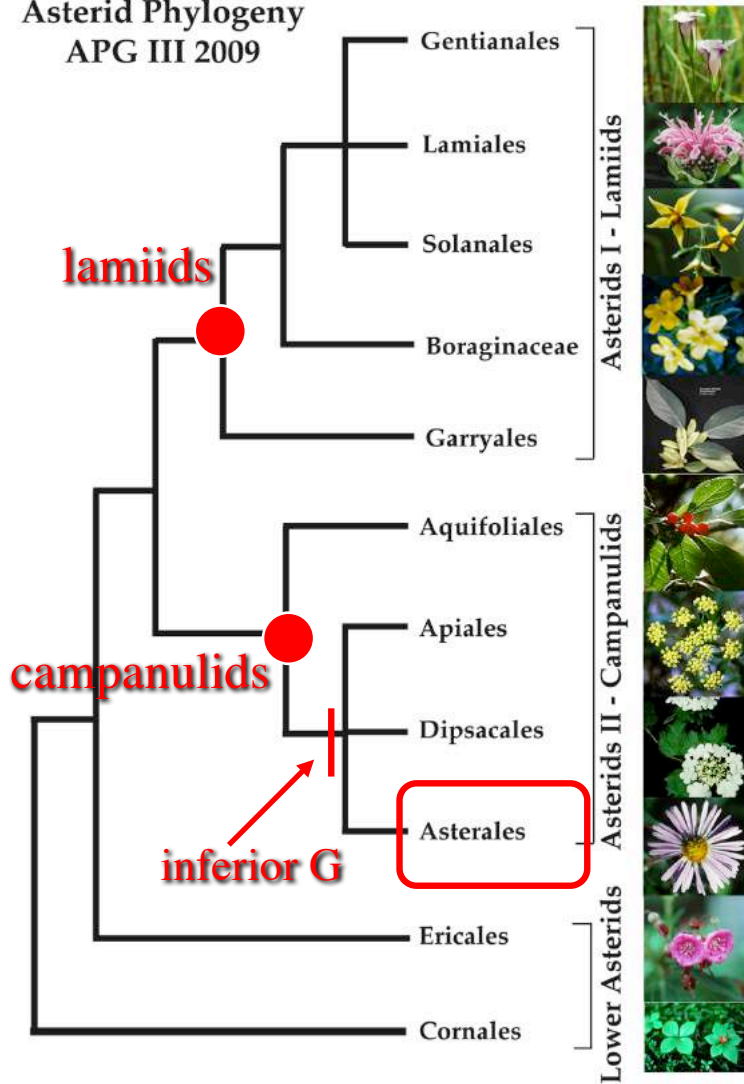
Pittosporaceae

NOT pervasive parallelisms!



Asterales

Asterid Phylogeny
APG III 2009



- 11 families and nearly 26,000 species - **Australasia** appears to be center of diversity
- no iridoids, latex common, inferior gynoecium, pollen presentation



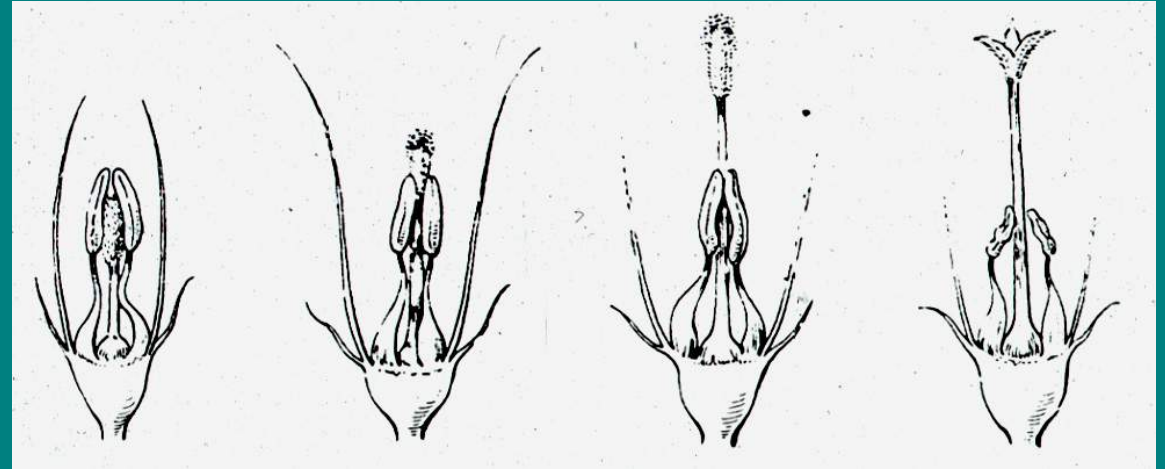
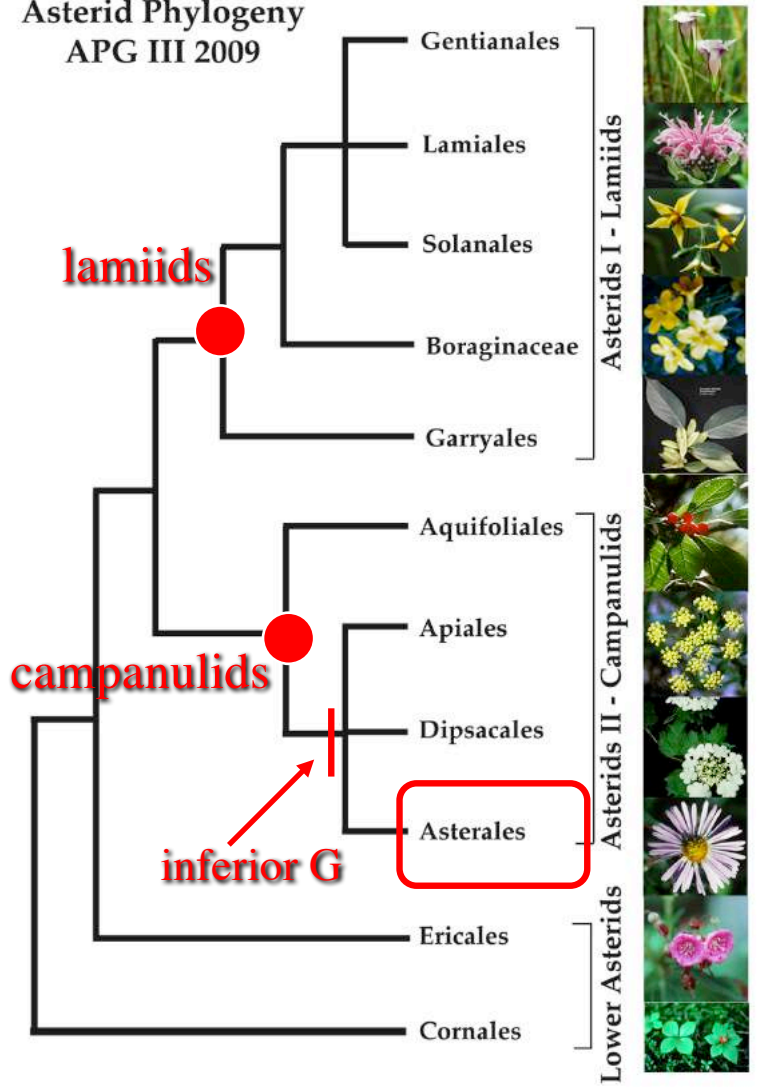
bellflower -
Campanulaceae



chickory -
Asteraceae

Asterales

Asterid Phylogeny
APG III 2009



Secondary pollen presentation in *Campanula*



bellflower -
Campanulaceae



chickory -
Asteraceae

*Campanulaceae - bellflowers

A family mostly of herbs, but some secondarily woody, widely distributed in the temperate regions and in the montane tropics. Contains 65 genera and over 2200 species, with half belonging to *Campanula* and *Lobelia*.



- alternate leaves
- milky latex
- 5 merous with inferior ovary



*Campanulaceae - bellflowers

The family is divided into two distinct subfamilies - Campanuloideae and Lobelioideae - distinguished by floral symmetry, staminal fusion, and carpel number



Campanula - bellflower
Subfamily Campanuloideae



Lobelia - lobelia
Subfamily Lobelioideae

*Campanulaceae - bellflowers

Subfamily Campanuloideae

$\underline{CA (5)} \quad \underline{CO (5)} \quad \underline{A 5} \quad \overline{G (3-5)}$

Campanula and relatives have actinomorphic flowers, stamens not fused, and 3-5 fused carpels. Note the 3 styles of *Campanula* to the left.



This is a 5 carpellate species

*Campanulaceae - bellflowers



Campanula americana - tall bellflower

*Campanulaceae - bellflowers



Campanula rotundifolia
Bluebell - circumboreal



Campanula rapunculoides
European bellflower

*Campanulaceae - bellflowers



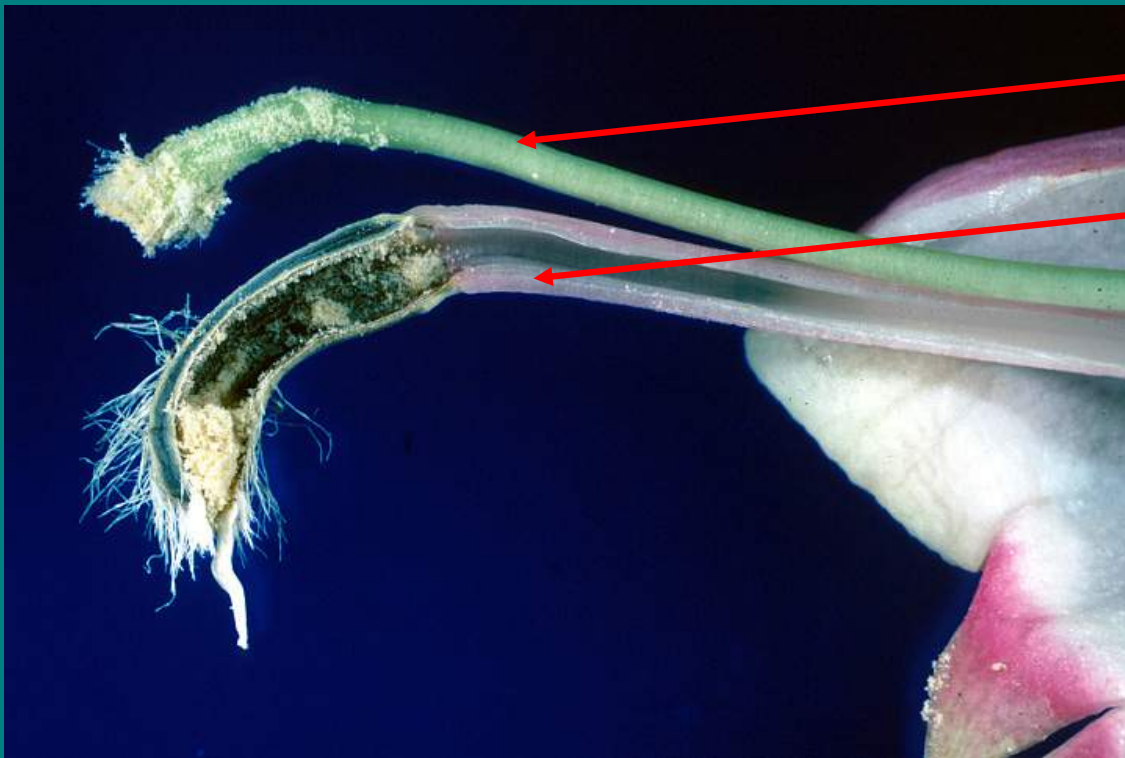
Triodanis perfoliata - Venus looking glass

*Campanulaceae - bellflowers

Subfamily Lobelioideae

CA (5) COZ (5) A (5) \overline{G} (2)

Lobelia and relatives have **zygomorphic** flowers, **stamens fused** into a tube in which the pollen is shed, and 2 fused carpels. **Style pushes pollen** out through the tube.



Style

Staminal tube



*Campanulaceae - bellflowers



Lobelia cardinalis
Campanulaceae
© G. D. Carr

Lobelia cardinalis
Cardinal flower

*Campanulaceae - bellflowers



male phase "beard"



female phase

Lobelia cardinalis
Cardinal flower



*Campanulaceae - bellflowers

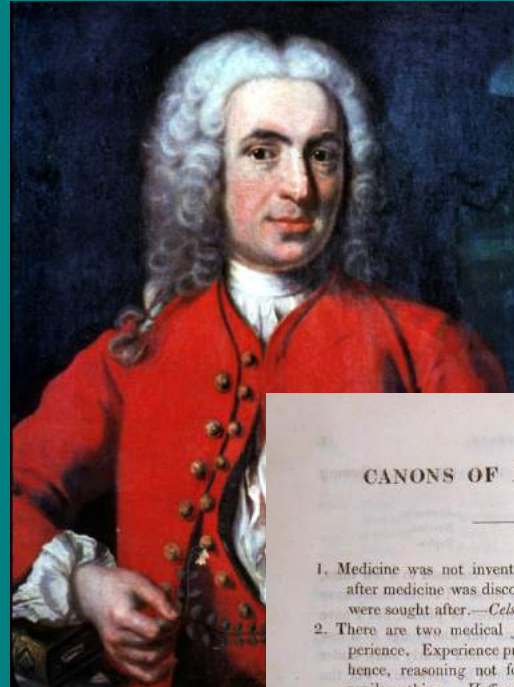


Long considered a cure for syphilis – but probably not true



Lobelia siphilitica L. - Great blue lobelia

*Campanulaceae - bellflowers



CANONS OF LINNÆUS.

1. Medicine was not invented after reasoning, but after medicine was discovered, then the reasons were sought after.—*Celsus*.
2. There are two medical *fulcra*—reason and experience. Experience precedes, reason follows: hence, reasoning not founded on experience, avails nothing.—*Hoffman*.
3. I had rather commit my health to a famous empiric, than to a subtle mechanic.—*Goelik*.
4. Barbarians have more conduced to the augmentation of medicine, than the schools of all ages.—*Bruno*.
5. He who knows many useful things, is truly wise.—*Contra Esculap*.
6. The physician uses a few remedies, but those are select.—*Trit*.
7. Select remedies ennoble a physician.
8. He who can cure by simples, need not seek for compounds.—*Villanov*.
- 9.—He who prescribes a farrago of medicine, sins either by design or ignorance.
- 10.—He who mingles contraries, sins against the pharmacopœa.
- 11.—Chemistry has elaborated many medicines, but has detected none formed out of plants.
- 12.—The physician *destitute of a knowledge of plants*, can never properly judge of the power of a plant.
- 13.—The uses of plants are discovered by system and experience.
14. The vegetable kingdom is the most noble in medicines; stones are too hard; and animals afford the fewest medicines.
15. Esculent plants preserve, poisons restore health.
16. Aliments are produced from esculent plants, as medicines are from poisons; which not their nature, but their doses, distinguish.
17. Too much of any thing, however good, is inimical to nature.
18. *Mild* medicines preserve—whilst *violent* ones destroy nature.
19. Contraries cure contraries; and thus diseases cure diseases.
20. To use medicine, except in violent disorders, is useless.—*Celsus*.
21. Heroic medicines in the hands of an unskilful man, are like a sword in the hands of a madman.—*Trit*.
22. Where there is only one road to health, this must be tried, even with danger to the patient.
23. It is better to try a doubtful remedy than none.
24. Those who cannot be cured rationally, are often cured by temerity.—*Celsus*.
25. The rich man oftentimes gives up the power over his life to a wise physician.
26. Nature, assisted by art, sometimes effects miracles.
27. Fortunate is that power which comes at a critical time.
28. Nature objecting, medicine hath no avail. *Celsus*.
29. It is the part of a wise physician to decline prescribing in a lost case.—*Celsus*.

Lobelia siphilitica L. - Great blue lobelia

*Campanulaceae - bellflowers

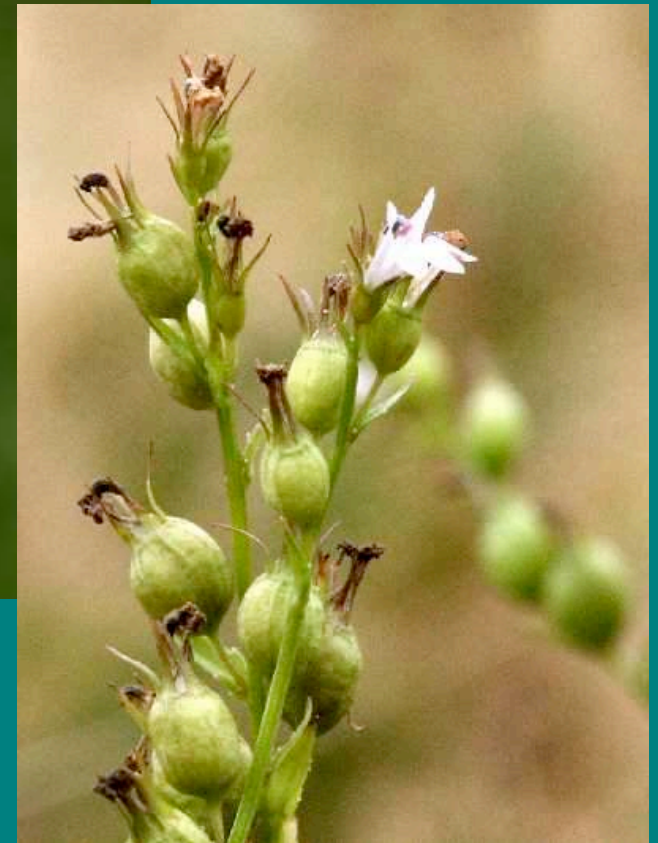
Indian tobacco

- asthma
- muscle disorders
- food poisoning
- nicotine replacement

- piperidine alkaloids
- lobeline primarily



Lobelia inflata
Indian tobacco
(vomit-wort)



Nicocure



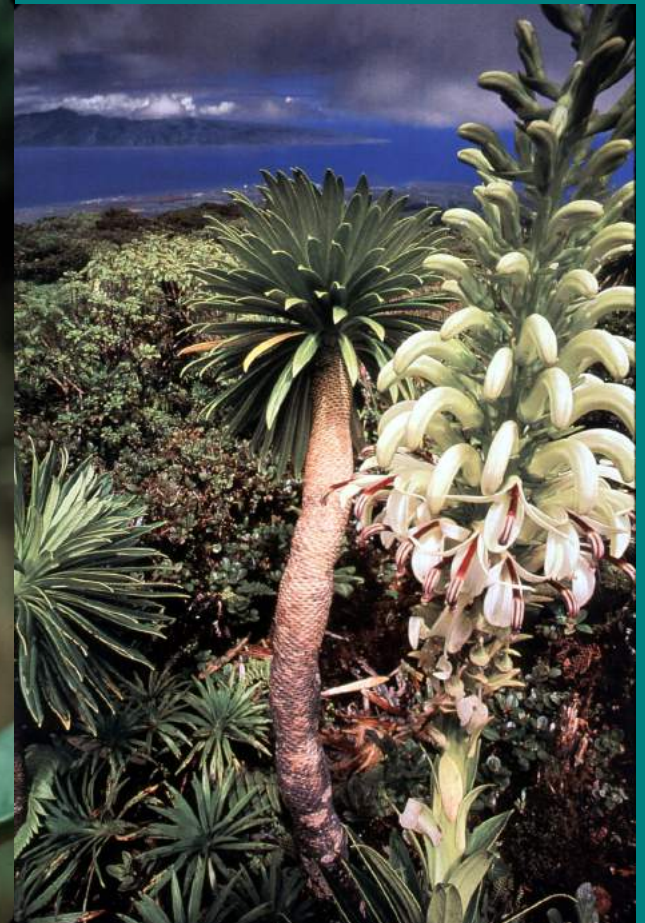
*Campanulaceae - bellflowers



Lobelia - Mt. Kenya



Centropogon - Andes



Lobelia - Hawaii

Menyanthaceae - bog buckbean

Aquatic, or semi-aquatic family. Flowers 5 merous with fringed petals. Gynoecium of 2 fused **superior** carpels. – long placed in Gentianaceae!



Menyanthes trifoliata

Bog buckbean

Menyanthaceae - bog buckbean

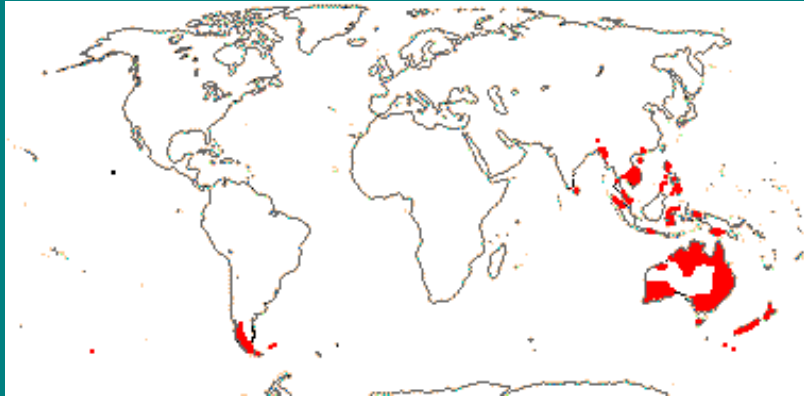
Aquatic, or semi-aquatic family. Flowers 5 merous with fringed petals. Gynoecium of 2 fused **superior** carpels.



The DNR forced the Botany Dept in 2010 to dig up the Botany Garden pond that had *Nymphoides*

Nymphoides - convergence!

Stylidiaceae - trigger flowers



Australasian and South American



Stylidium



H Loots



Donatia

Goodeniaceae



Australasian – and beaches!



Scaevola gaudichaudiana
Goodeniaceae
© G. D. Carr

Scaevola - note opened corolla tube

Calyceraceae

- closest family to Asteraceae - the composites; note biogeography



South American only



Acicarpa tribuloides

photo by Dennis Woodland
University of Wisconsin