

## Asterids

- continue survey through the eudicots or tricolpates after completing Rosids
- the Asterids are the second of the two large groups of dicots and the easier one to define morphologically

## Asterid Characteristics

- fused petals - sympetaly
- stamen number  $\leq$  petal number
- stamens fused to corolla tube

## Asterid Characteristics

- iridoid compounds (with losses)
- 'basal asterids' have them (previously not placed with asterids)

**Rubiaceae**  
coffee family

*Gardenia*

**Plantaginaceae**  
snapdragon family

*Pterorhiza kurroa*

Iridoid glycosides of *Gardenia* fruit:

CC(=O)O[C@@H]1[C@@H](O)[C@H](O[C@@H]2[C@@H](CO)O[C@H]2O)[C@H](O)[C@H](O)[C@H]1O

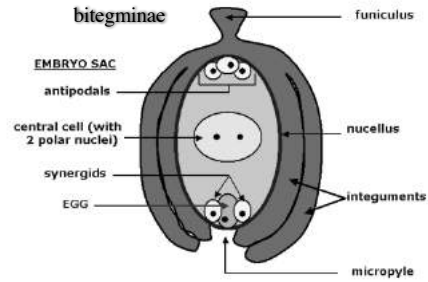
genposide

CC(=O)O[C@@H]1[C@@H](O)[C@H](O[C@@H]2[C@@H](CO)O[C@H]2O)[C@H](O)[C@H](O)[C@H]1O

gardenoside

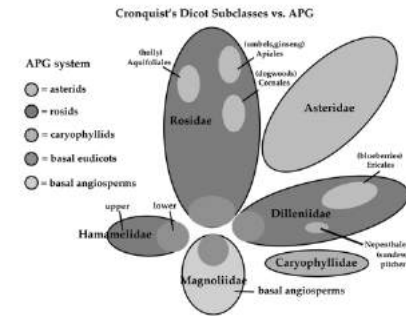
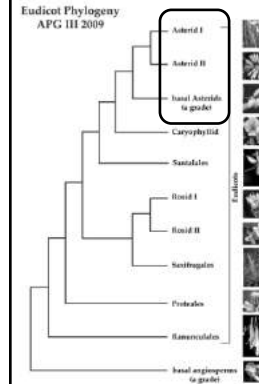
## Asterid Characteristics

- one layer of integuments in ovule vs. two in other groups
- the “unitegminae” (vs. bitegminae) of van Tieghem in 1901 = new Asterid group!



## Asterid Composition

- composition of Asterids is largely congruent with previous morphology



## Asterid Composition

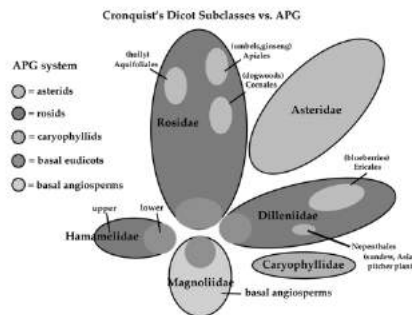


Apiaceae - carrot family

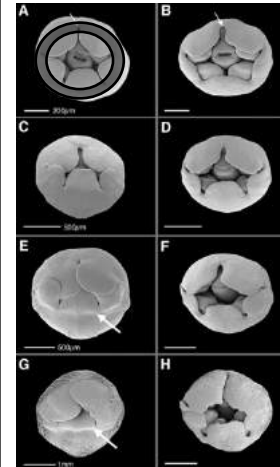


Aquifoliaceae - holly family

- exceptions include the ‘basal asterids’ and separate petal or small flower orders



## Asterid Composition



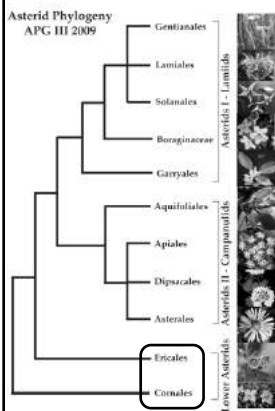
- exceptions include the ‘basal asterids’ and separate petal or small flower orders

- some of these “non” sympetalous Asterids (e.g., order Cornales) have “early” petal ring primordia in development

- subsequent petal development is separate, so appear to be polypetalous!

Early ring primordia of 5 petals in snapdragon (a true asterid) [EMBO Journal (2003) 22: 1058-1066]

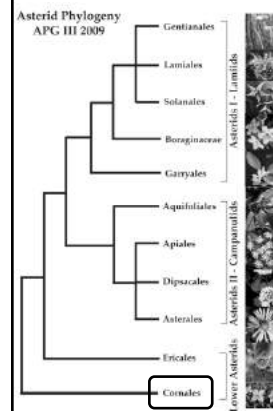
## Basal Asterids



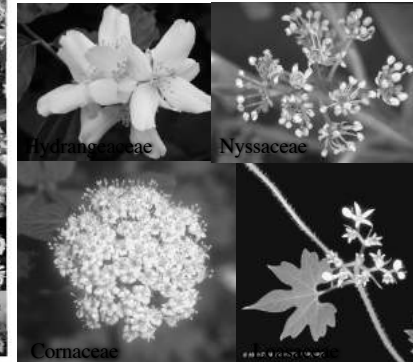
- basal asterids represent a grade towards the core asterids
- great variation in floral form in the two orders Cornales and Ericales
- the “standard” Asterid flower has not been fixed



## Cornales

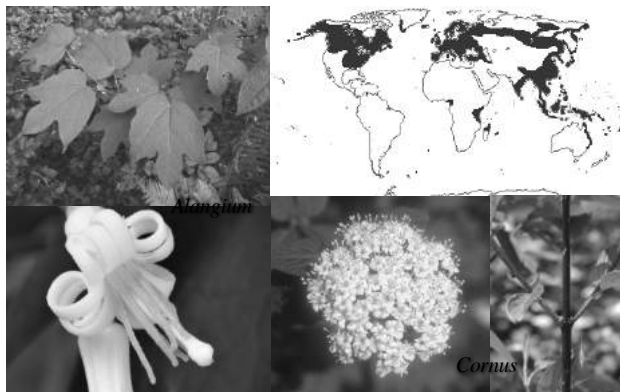


- order sister to remainder of Asterids, comprises 7 small families (diverse)



## \*Cornaceae - dogwoods

- mainly north temperate shrub family of 2 genera and 85 species



## \*Cornaceae - dogwoods

- opposite, simple leaves
- arcuate venation



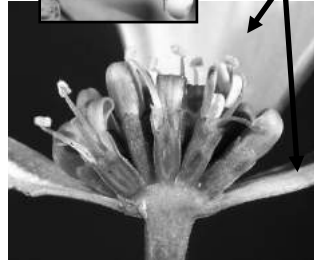
## \*Cornaceae - dogwoods



CA 4 CO 4 A 4  $\bar{G}(2)$



bracts



- 4 merous, small flowers with separate petals
- 2 carpellate inferior ovary
- fruit a 2-seeded 'drupe'
- some inflorescences surrounded by showy bracts
- "head" or "pseudanthium" (false flower)

## 'Pseudanthia' in the Asterids – remember this !



## \*Cornaceae - dogwoods



Eastern North American  
small tree with 4  
conspicuous white bracts



*Cornus florida* - flowering dogwood

## \*Cornaceae - dogwoods



*Cornus canadensis* - bunch berry

Low to ground boreal  
subshrub, appears to have a  
whorl of leaves, and has 4  
showy bracts below flowers



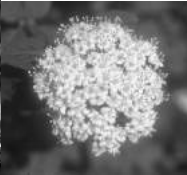
## \*Cornaceae - dogwoods



*Cornus sericea*  
Red-osier



*Cornus foemina*  
Gray dogwood  
Common component of  
shrub carr



Common in wet places,  
distinctive with red stems

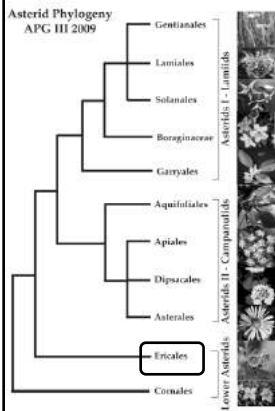
## Hydrangeaceae - hydrangeas

Another small family of trees, shrubs, and vines from North Temperate region - many ornamental woody plants

- most recently placed in Saxifragaceae



## Ericales



- large, important order of 23 families, >11,000 species

- will focus on just a few families and learn \*Ericaceae (blueberries) and \*Primulaceae (primroses)



blueberry



primrose

## Ericales

- Ericales represent less than 6% of eudicot diversity, and 1/3 of these belong to Ericaceae alone . . . but

- 10% of the understory species in tropical rainforests
- and about 22% of the total stems in these forests



## Ericales

- Ericales exhibit great diversity in habit and nutrient uptake strategies



- mycorrhizal associations
- mycorrhizal parasites (mycotrophs)



*Arctostaphylos* - bearberry

## Ericales

- Ericales exhibit great diversity in habit and nutrient uptake strategies



- parasitism
- carnivory

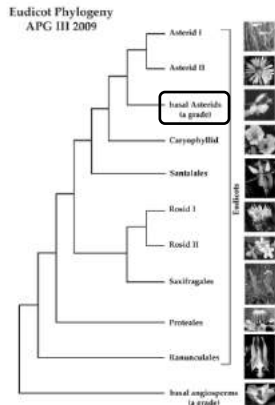


*Mitostylis* - parasitic

*Sarracenia* - pitcher plant

## Ericales

- as early diverging Asterids, Ericales exhibit a bewildering mixture of Rosid and Asterid features



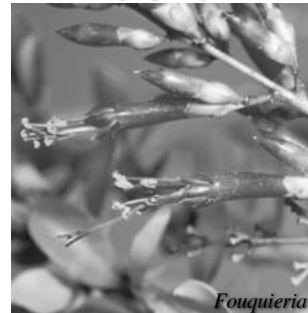
Rosid



core Asterid

## Corolla Structure

sympetal



*Fouquieria*

polypetal



*Couroupita*

for instance in ...

Fouquieriaceae  
Primulaceae

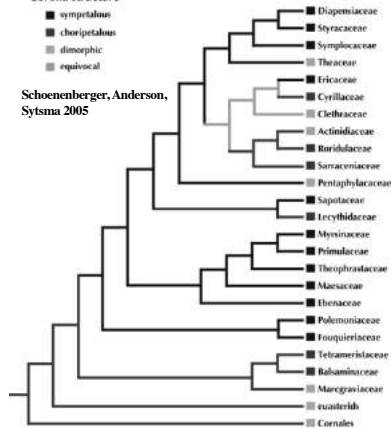
Lecythidaceae  
Roridulaceae

## Corolla Structure

### Corolla structure

- sympetalous
- choripectalous
- dimorphic
- equisocial

Schoenberger, Anderson,  
Sytma 2005



Re-examined in light of  
DNA based relationships

- corolla evolution is still complicated
- perhaps one or two separate origins of sympetaly and two or three reversals to choripectaly

## Integument Number

unitegmic



Clethraceae  
Symplocaceae

bitegmic



Theophrastaceae  
Marcgraviaceae

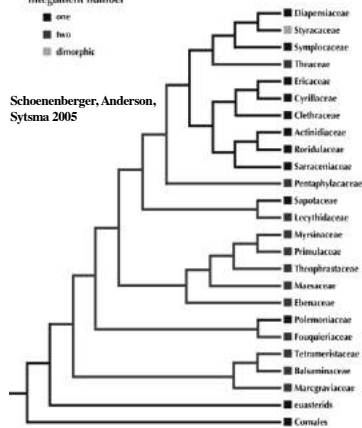
for instance in ...

## Integument Number

### Integument number

- one
- two
- dimorphic

Schoenberger, Anderson,  
Sytma 2005



Re-examined in light of  
DNA based relationships

- ovule integument evolution is still complicated
- multiple switches from the derived asterid condition of unitegmic to bitegmic and back again

## Stamen Number

1 whorl



Polemoniaceae  
Roridulaceae

2+ whorls



Theaceae  
Actinidiaceae

for instance in ...

## Theaceae - tea, camellia

North Temperate family of evergreen, serrate leaved shrubs (7 genera and up to 400 species)

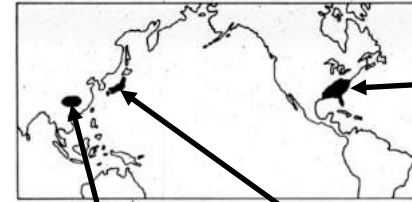


*sinensis*



- flowers have separate petals and many stamens

## Theaceae - tea, camellia



*Stewartia malacodendron*



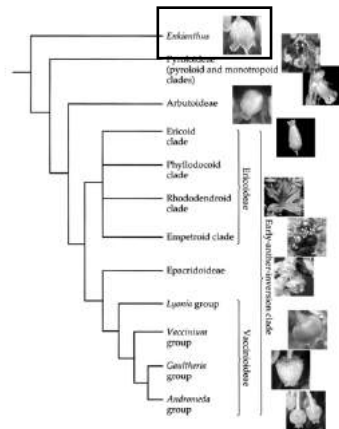
*Stewartia sinensis*



*Stewartia pseudocamellia*

Eastern North America and Eastern Asia is the "classic" north temperate disjunction pattern

## \*Ericaceae - blueberries



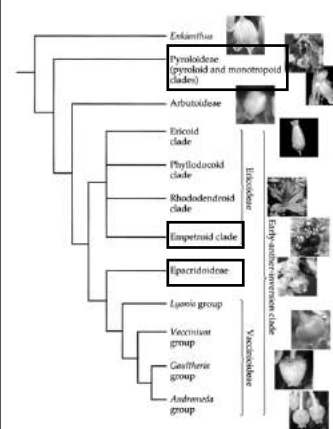
Worldwide woody family, except lowland tropics, of 126 genera and nearly 4,000 species

- the E. Asian genus *Enkianthus* is sister to the rest of the family



*Enkianthus*

## \*Ericaceae - blueberries



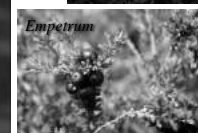
• comprises the former families Pyrolaceae, Monotropaceae, Empetraceae, Epacridaceae



*Monarda*



*Epacris*



*Empetrum*



## \*Ericaceae - blueberries

- characteristic of nutrient poor soils - bogs, acidic pine dominated forests, tropical epiphytes, or sandy soils
- mycorrhizal relationship, forming haustoria - root to fungus connection, permits nutrient uptake by plants, carbon uptake by fungus



## \*Ericaceae - blueberries

- mycotrophs - lacking chlorophyll and totally parasitizing the fungus for food, nutrients, and water
- former family Monotropaceae, derived from within mycorrhizal Ericaceae

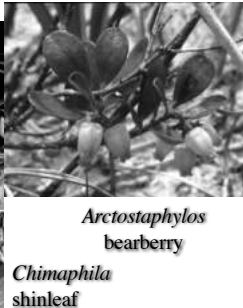


## \*Ericaceae - blueberries

- evergreen, tough, leathery leaves
- often revolute or inrolled
- sunken stomata, and bottom of leaves often covered with protective hairs



*Rhododendron (Ledum)*  
Labrador tea  
Note revolute leaves



*Arctostaphylos*  
bearberry  
*Chimaphila*  
shinleaf

## \*Ericaceae - blueberries

CA (4-5) CO (4-5) A 8,10  $\bar{G}$  (4-5)

- calyx and corolla are fused, the corolla tube bell or vase shaped
- stamens are 2X the number of petals;
- often exhibit terminal pores for pollen release for buzz pollination by bees



## \*Ericaceae - blueberries

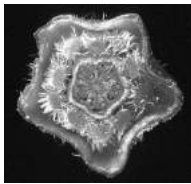


CA (4-5) CO (4-5) A 8,10  $\bar{G}$  (4-5)



Inferior pistil

- pistil is superior, but inferior in blueberries and relatives
- fruit a berry or capsule with 4-5 partitions and many seeds



## \*Ericaceae - blueberries



*Andromeda polifolia*  
bog rosemary



*Rhododendron groenlandicum*  
Labrador tea



*Kalmia polifolia*  
pale laurel



*Chamaedaphne calyculata*  
leatherleaf

## \*Ericaceae - blueberries



*Arctostaphylos uva-ursi*  
Bearberry

Creeping subshrub often seen on beaches  
"uva-ursi" translates as bearberry, indicating at least one dispersal agent of the plant



## \*Ericaceae - blueberries



*Vaccinium myrtilloides*  
Velvet-leaf blueberry



*V. macrocarpon*  
cranberry



*Vaccinium angustifolium*  
Lowbush blueberry

Blueberries and cranberries are inferior ovaried and berry fruited

**\*Ericaceae - blueberries**

Chancellor Blank and Dean VandenBosch at Cranberry Creek



*V. macrocarpon*  
cranberry



**\*Ericaceae - blueberries**

Major family of the harsh  
Mediterranean climate regions of  
the world



*Arbutus* in Europe



*Arbutus menziesii* – CA madrone



**\*Ericaceae - blueberries**

rhododendrons and  
azaleas are prized  
ornamentals - greatest  
species diversity in  
Himalayas

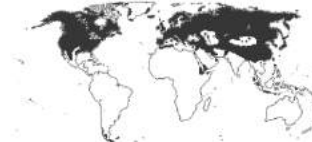


*Rhododendron lapponicum*  
lapland rosebay



**\*Primulaceae - primroses**

Chiefly north temperate family of scapose herbs (or  
opposite leaved) - 9 genera and about 900 species



*Primula*  
*palinurose*



*Primula*  
(*Dodecatheon*) -  
shooting star

## \*Primulaceae - primroses



*Primula* - shooting star

CA (5) CO (5) A 5 G (5)

- 5 merous, stamens attached unto petals, and opposite the petals rather than the sepals



*Lysimachia* - loosestrife

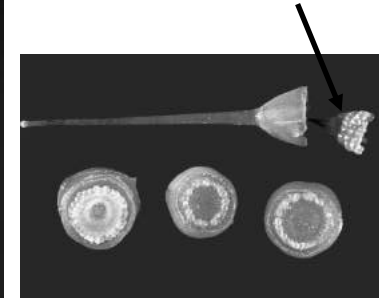
## \*Primulaceae - primroses



*Dodecatheon* - shooting star

CA (5) CO (5) A 5 G (5)

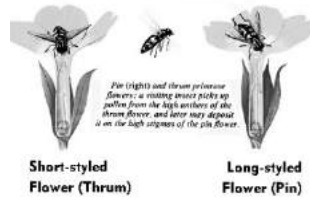
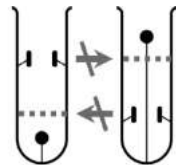
- pistil is unilocular and free-central
- fruits are capsules



## \*Primulaceae - primroses

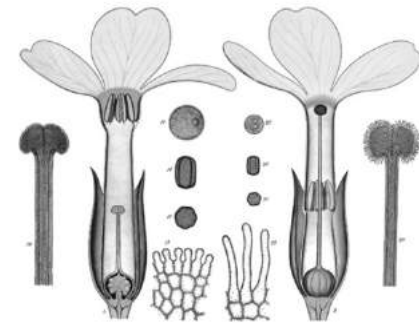


*Primula* - the classic study organism for dimorphic heterostyly - Darwin



## \*Primulaceae - primroses

1. *On the various contrivances by which British and foreign orchids are fertilised by insects, and on the good effects of intercrossing.* (1862)
2. *Variation of plants and animals under domestication.* (1868)
3. *Movement and habits of climbing plants.* (1875)
4. *Insectivorous plants.* (1875)
5. *The effects of cross and self fertilization in the vegetable kingdom.* (1876)
6. *The different forms of flowers on plants of the same species.* (1877)
7. *The power of movement in plants.* (1880)

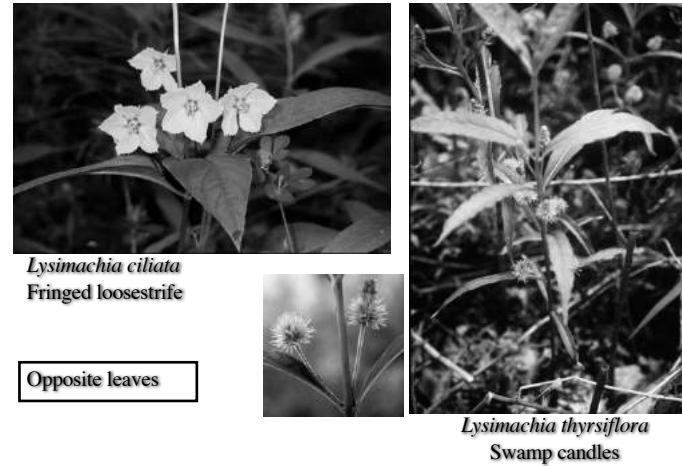


Pollen and stigmatic differences in thrum and pin flowers

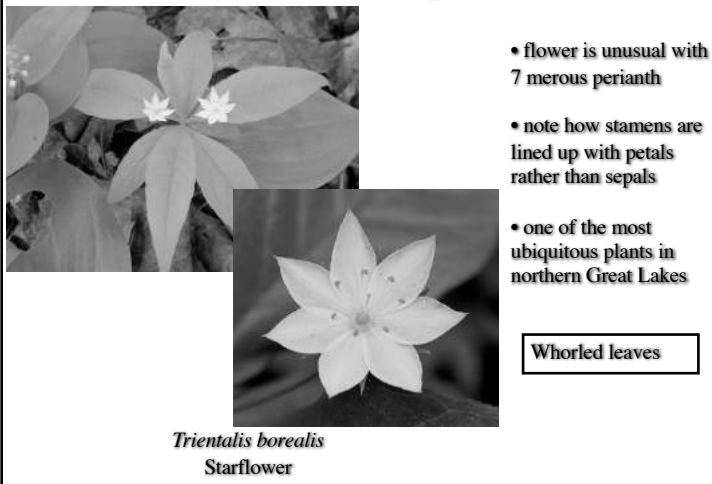
## \*Primulaceae - primroses



## \*Primulaceae - primroses

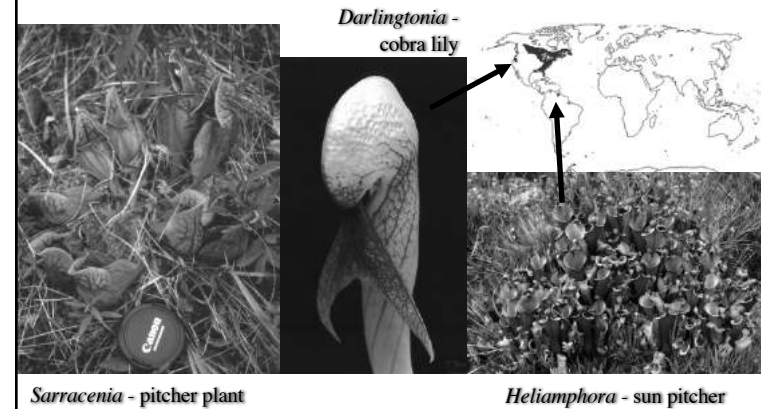


## \*Primulaceae - primroses



## Sarraceniaceae - pitcher plants

Insectivorous family of 3 genera - New World; related to South African carnivore Roridulaceae



## Sarraceniaceae - pitcher plants



*Sarracenia purpurea* - pitcher plant

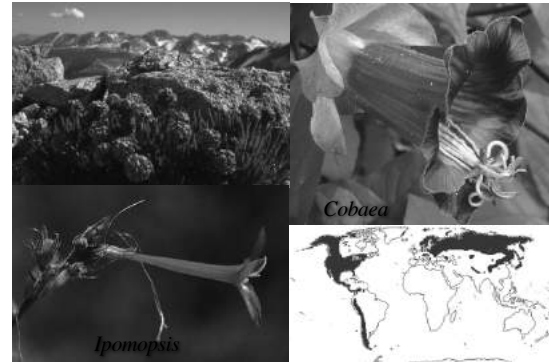
CA 5 CO 5 A ∞ G (5)

5 merous flower; unusual peltate stigma; flower structure ensures outcrossing by bees



## Polemoniaceae - phlox

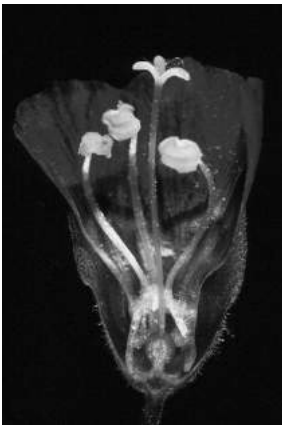
Primarily North Temperate family of 18 genera and 385 species, but with radiations in xeric SW North America and in the Andes



*Cobaea*

*Ipomopsis*

## Polemoniaceae - phlox



CA (5) CO (5) A 5 G (3)

- 5 merous flowers
- stamens at different heights
- 3 fused carpels and 3 styles



## Polemoniaceae - phlox



*Phlox divaricata* - woodland phlox

- woodland species

## Polemoniaceae - phlox



*Phlox pilosa* - prairie phlox

- prairie species

## Polemoniaceae - phlox



- Alternate leaved spring flowering plant of woodlands and openings



*Polemonium reptans* - Jacob's ladder

## Foquieriaceae - ocotillo



11 species of weird xeromorphic trees and shrubs from N American deserts - related to Polemoniaceae



*Foqieria splendens* - ocotillo



*Foqieria columnaris* - boom tree

## Balsaminaceae - jewelweed

Small family of juicy-stemmed herbs with spurred sepals



*Impatiens capensis*  
orange jewelweed



*Impatiens pallida*  
yellow jewelweed



## Balsaminaceae - jewelweed



- fruit is explosive to the touch, touch-me-nots

- OW tropical *Impatiens* are diverse (nearly 1000)



*Impatiens* – touch me not