

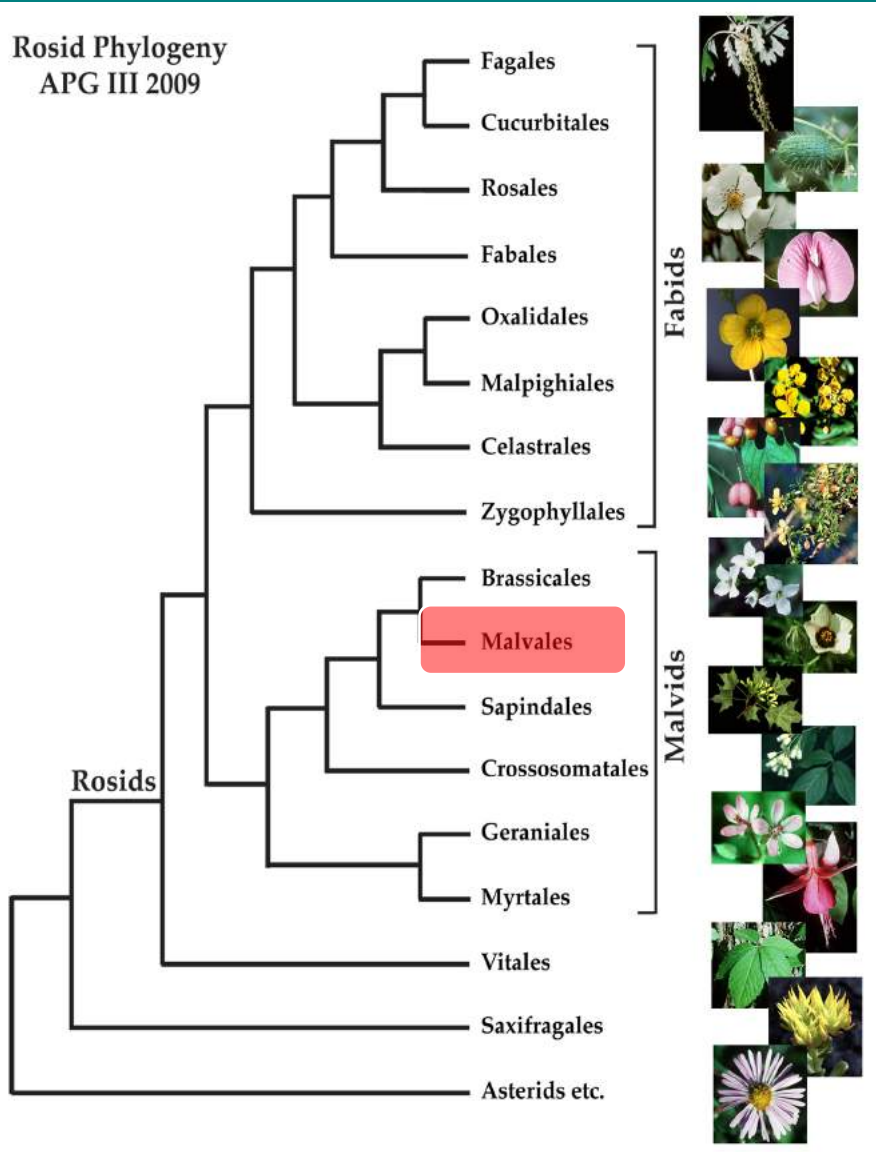


# Diversity and Evolution of Rosids

. . . cacao, mustard, and capers . . .

# \*Malvales

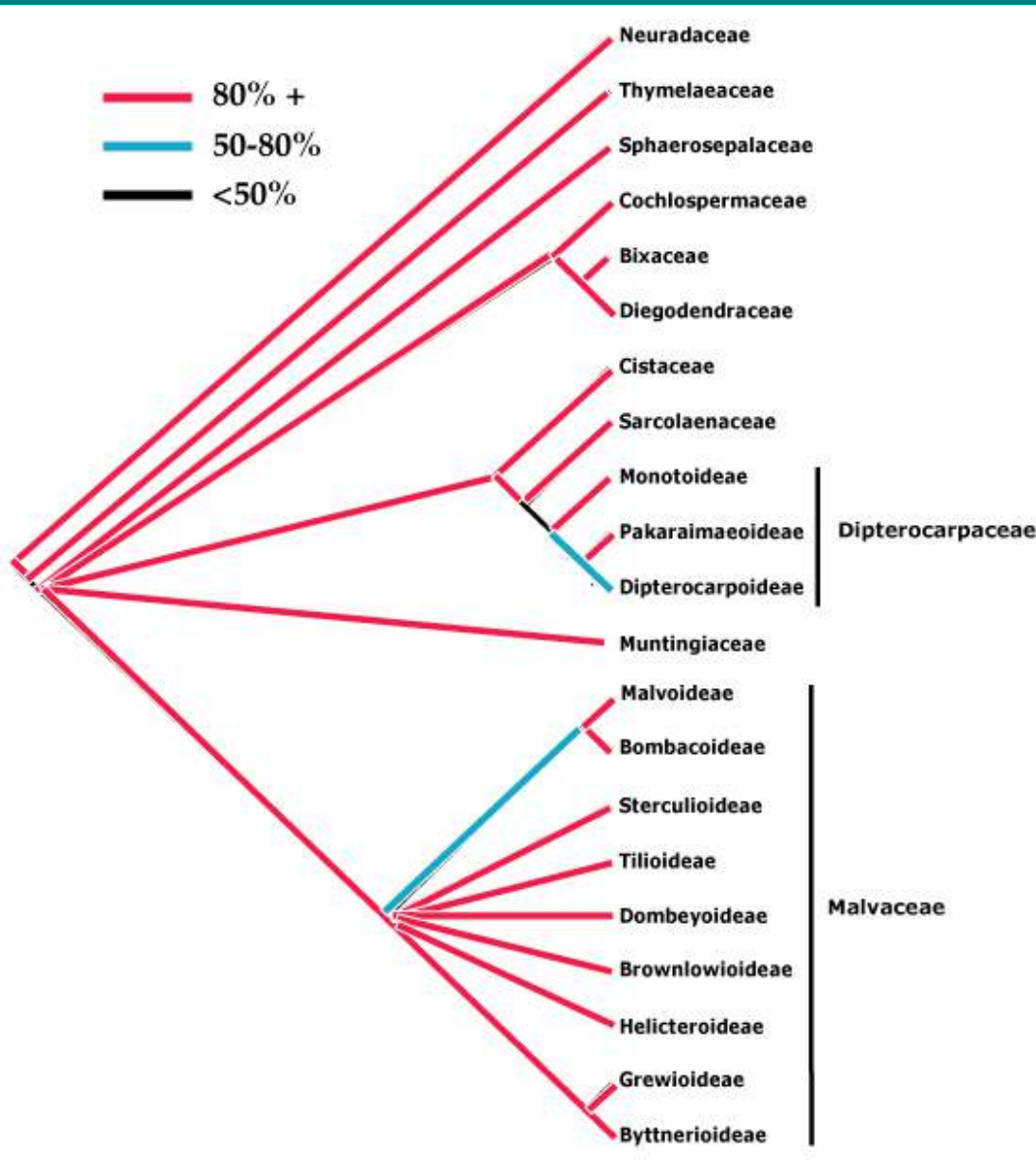
- strongly supported order of 11 families



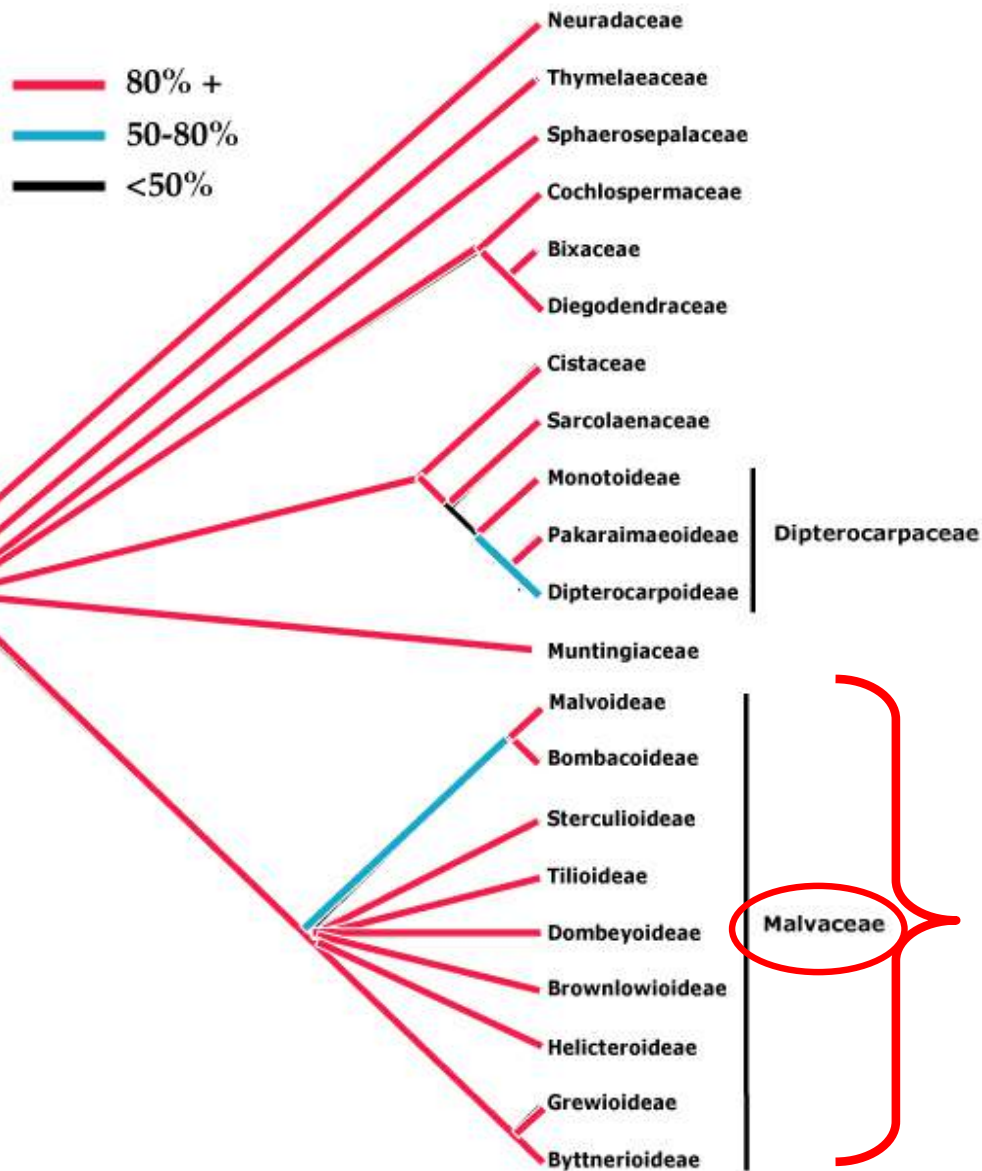


# \*Malvales

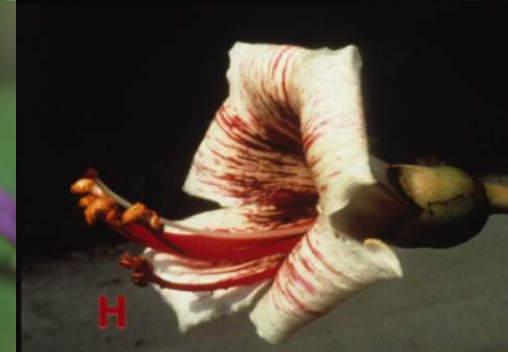
- strongly supported order of 11 families
- (+/-) suite of wood, hair, leaf, and chemical features



# \*Malvaceae - mallows



- Malvaceae is now “broadly” defined (includes Tiliaceae, Sterculiaceae, Bombacaceae)
- 243 genera / 4300 species





# \*Malvaceae - mallows

1. leaves palmately veined

(simple or compound)

2. sepals valvate - not overlapping

3. stellate hairs



*Trichospermum*



*Sphaeralcea*



*Hibiscus trionum*



*Hibiscus tiliaceus*

# \*Malvaceae - mallows

4. Many stamens, often bundled, sometimes **monadelphous** into a staminal tube

CA 5 CO 5 A ( $\infty$ ) G (5- $\infty$ )



*Sparmannia*



*Grewia*



*Hibiscus*



# \*Malvaceae - mallows

“malvoids”



*Malva* - mallow,  
cheese

*Althaea* - hollyhock,  
marsh mallow



*Hibiscus*



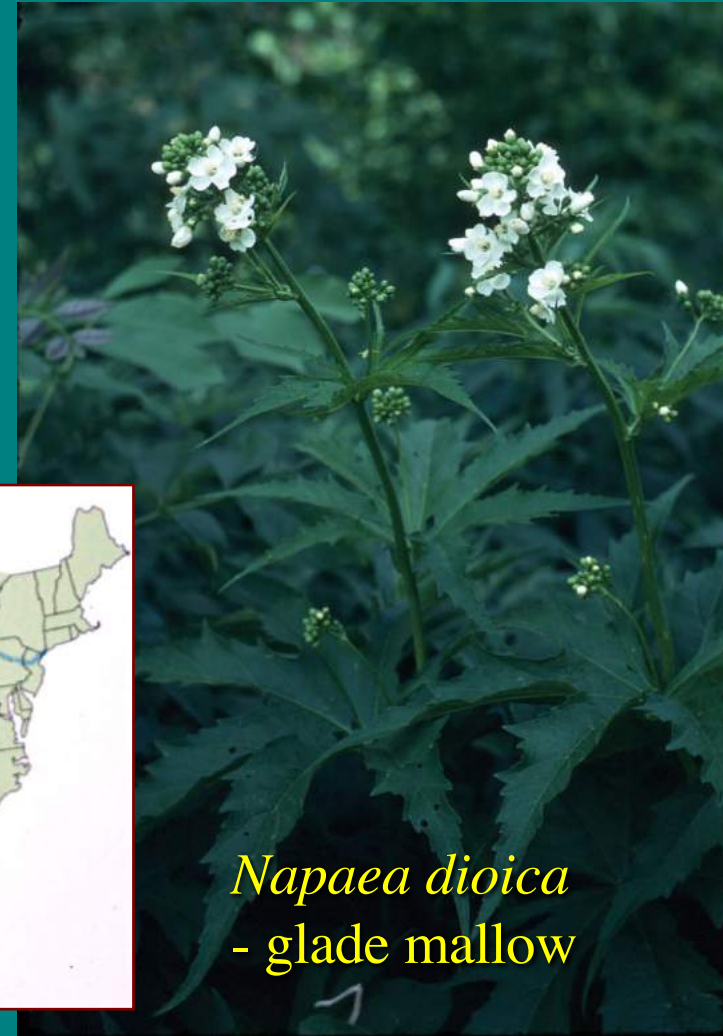


# \*Malvaceae - mallows

“malvoids”



*Gossypium* - cotton



*Napaea dioica*  
- glade mallow

- only Midwestern endemic genus



# \*Malvaceae - mallows

“tilioids”



*Tilia americana* -  
basswood, linden



*Trichospermum*  
Central America



*Grewia*  
Madagascar



# \*Malvaceae - mallows

“bombacoids”



*Pseudobombax*

*Adansonia - baobabs*





# \*Malvaceae - mallows

“sterculoids”



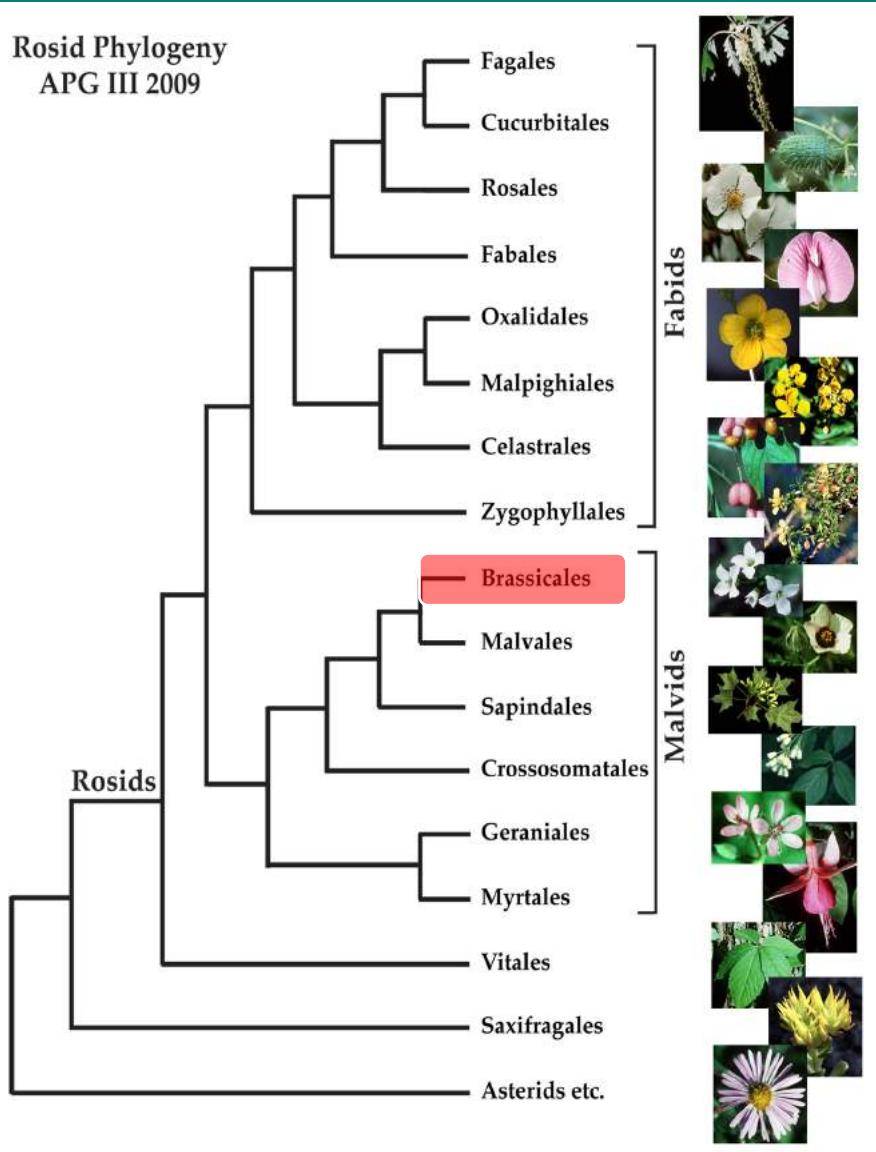
*Theobroma* - “food of the gods,” cacao, chocolate



*Cola*

# \*Brassicales

- 17 families
- morphologically diverse!

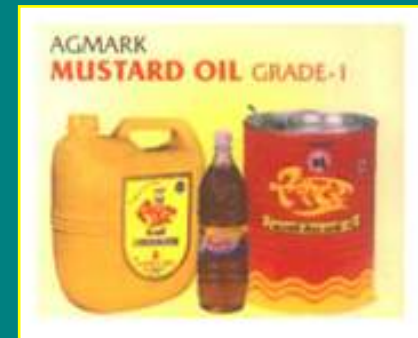


glucosinolates



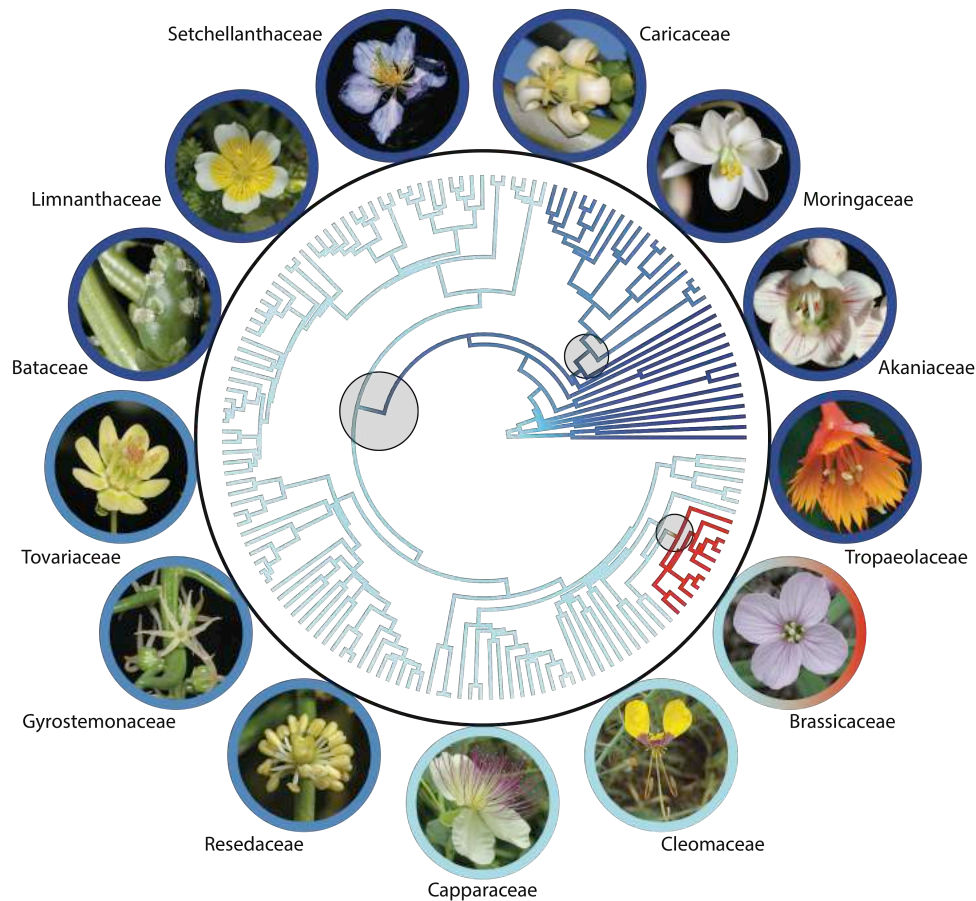
myrosinase  
enzyme

isothiocyanates  
mustard oils

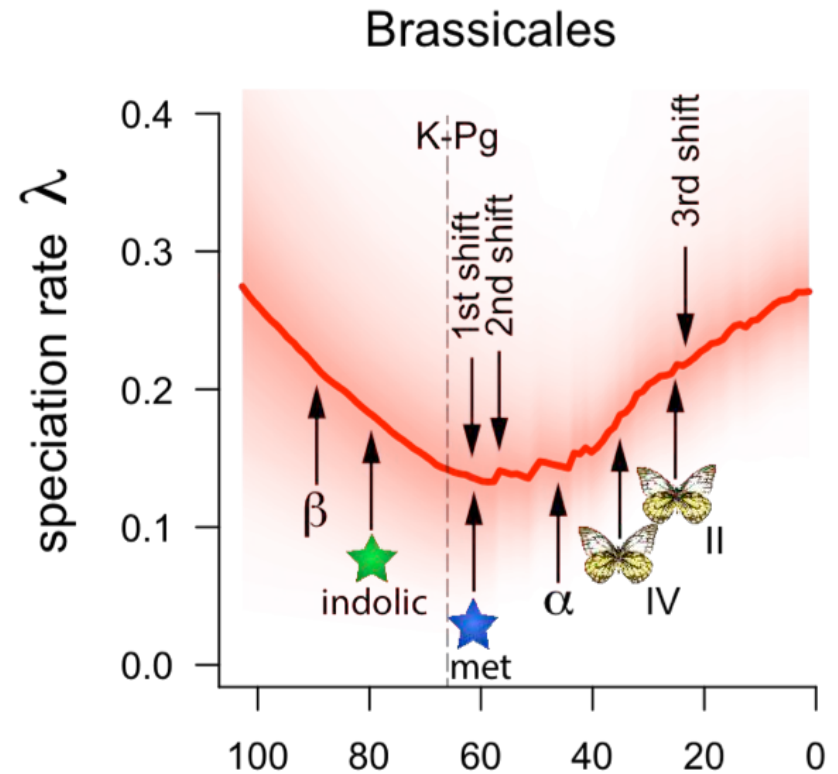




# \*Brassicales



C.



Cardinal-McTeague, W. M., K. J. Sytsma, J. C. Hall. 2016. Biogeography and diversification of Brassicales: a 103 million year chronicle. *Molecular Phylogenetics and Evolution* 99: 204-224

# \*Brassicales

Capparaceae - capers

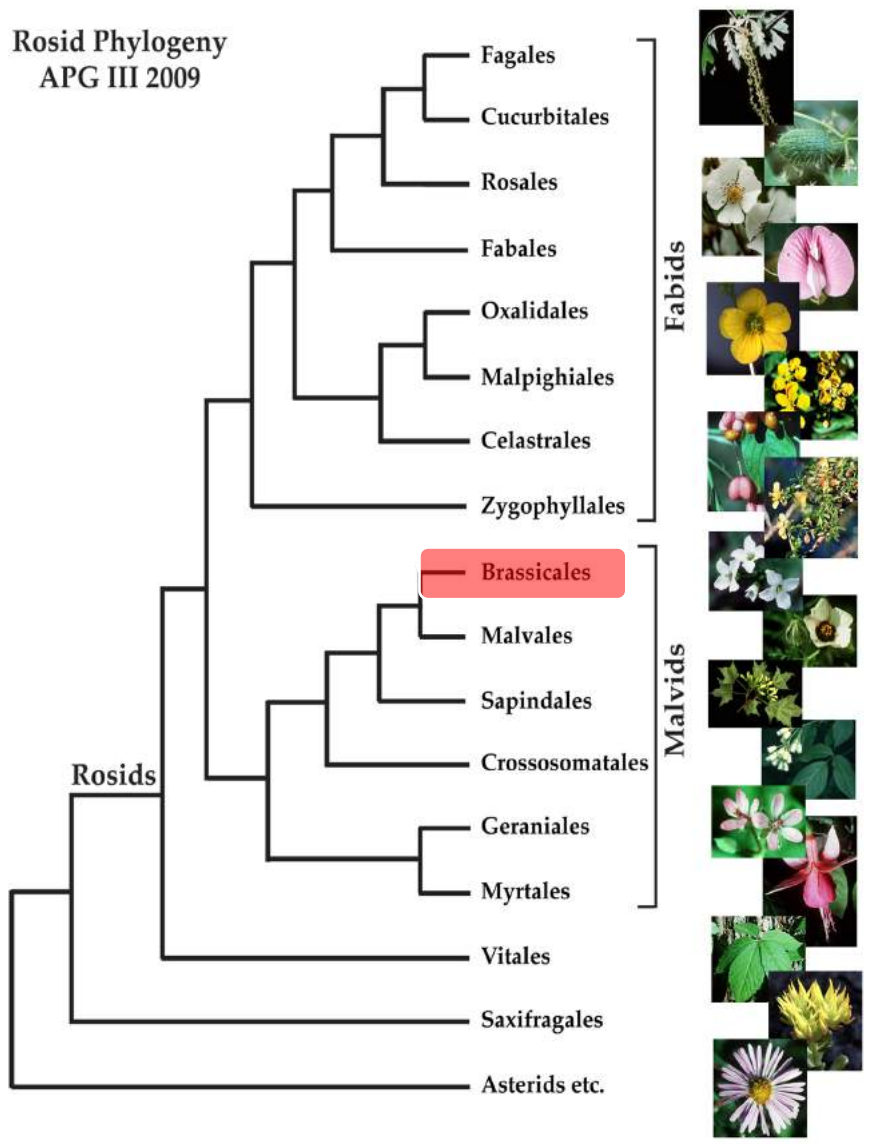


Caricaceae -  
papaya



Tropaeolaceae - garden nasturtium

Rosid Phylogeny  
APG III 2009





# \*Brassicaceae - mustard

Large (338 genera / 3710 species), complex family of mustard oil producing herbs (broccoli, brussel sprouts, cauliflower, kale, cabbage); *Arabidopsis* - genetic/genome model plant species



*Brassica* spp.

mustard

broccoli

kale



*Arabidopsis thaliana*



# \*Brassicaceae - mustard

CA 4 CO 4 A 4+2 G (2)

- flowers “cross-like” with 4 petals, six stamens with 2 outer ones shorter - derivation of “Cruciferae” or “cross-bearing”



*Cardamine concatenata* -  
cut leaf toothwort



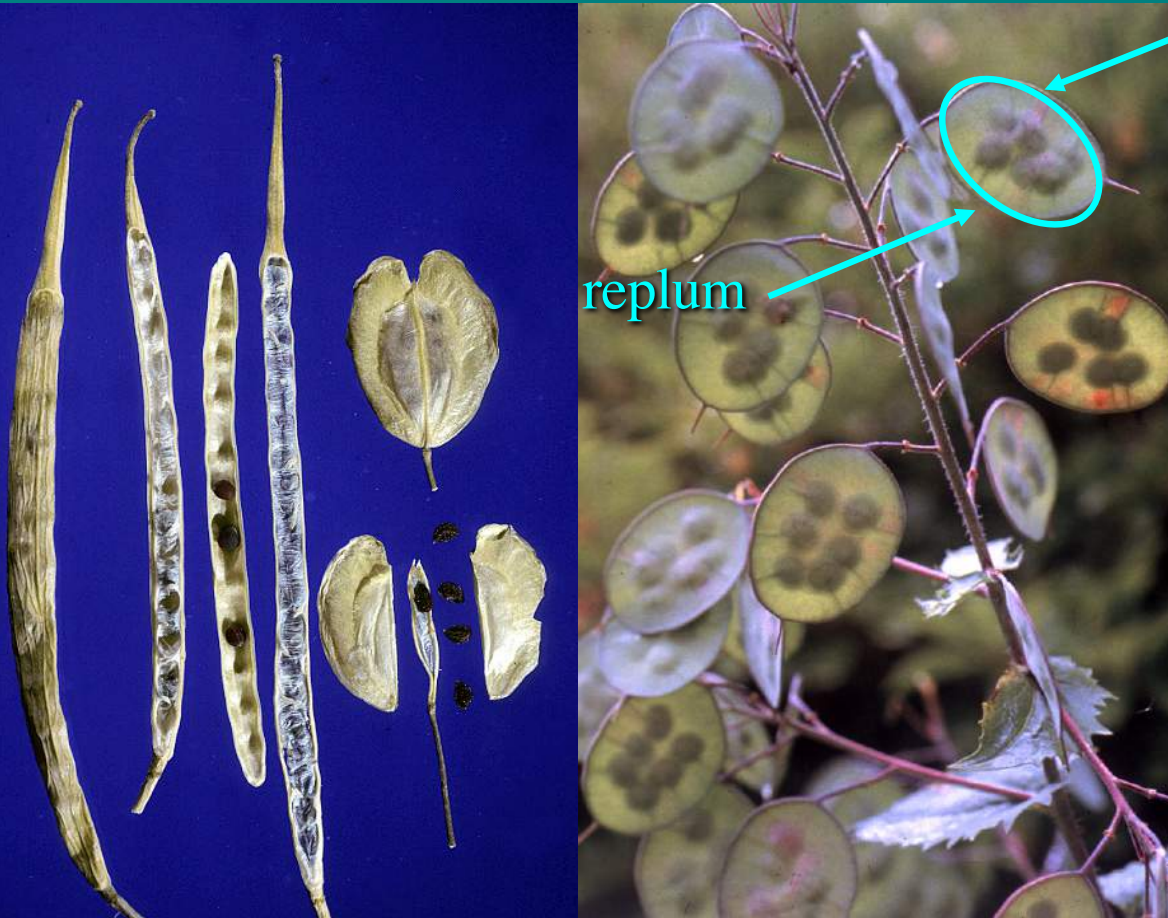
*Cardamine pratensis* -  
cuckoo flower



# \*Brassicaceae - mustard

CA 4 CO 4 A 4+2 G (2)

- gynoecium of 2 fused carpels separated by thin membrane with ovules in a parietal fashion



- fruit is a **capsule** that peels off the two outer carpel walls exposing the papery membrane or **septum** attached to the persistent **replum**

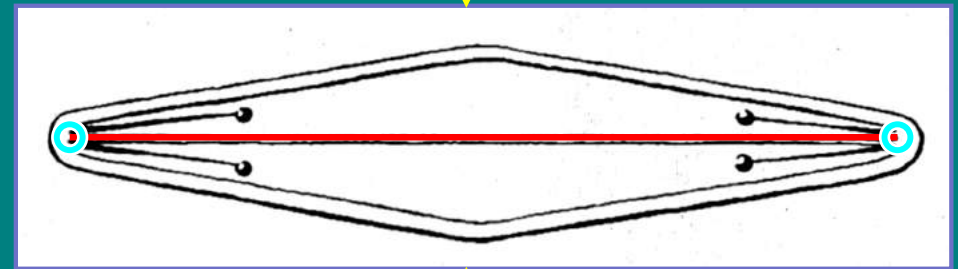
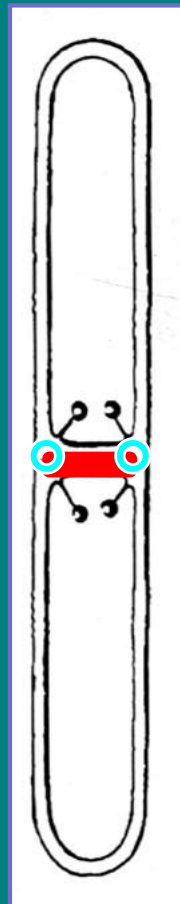
# \*Brassicaceae - mustard

CA 4 CO 4 A 4+2 G (2)

- fruits are called **siliques** or **silicles** based on how the fruit is flattened relative to the septum

- **siliques** flattened contrary to **septum**

- **silicle** flattened parallel to **septum**

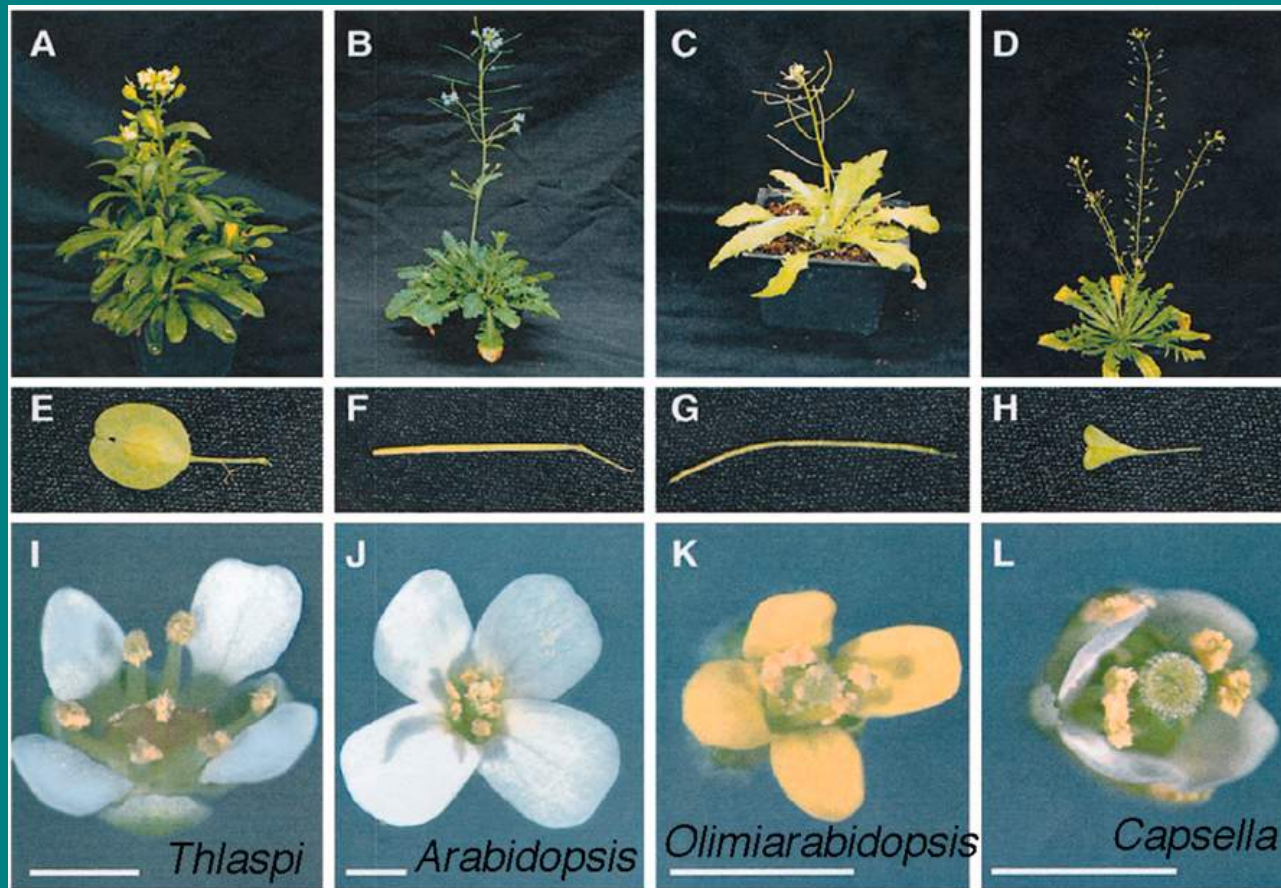


- x section -



# \*Brassicaceae - mustard

- shape of fruits appear to have diversified rapidly in the family - unfortunately infra-familial classification has been largely based on the fruit



# \*Brassicaceae - mustard



- *Aethionema* - Mediterranean region - is sister to rest of family





# \*Brassicaceae - mustard



*Cardamine concatenata* -  
cut leaf toothwort

- Common spring flowering woodland herbs

*Cardamine douglasii* -  
purple spring cress



# \*Brassicaceae - mustard



*Nasturtium officinale* - water cress

- edible aquatic native with a mustard zing





# \*Brassicaceae - mustard



*Hesperis matronalis* -  
Dame's rocket



*Barbarea vulgaris* - yellow  
rocket, winter cress

- Introduced or spreading

# \*Brassicaceae - mustard

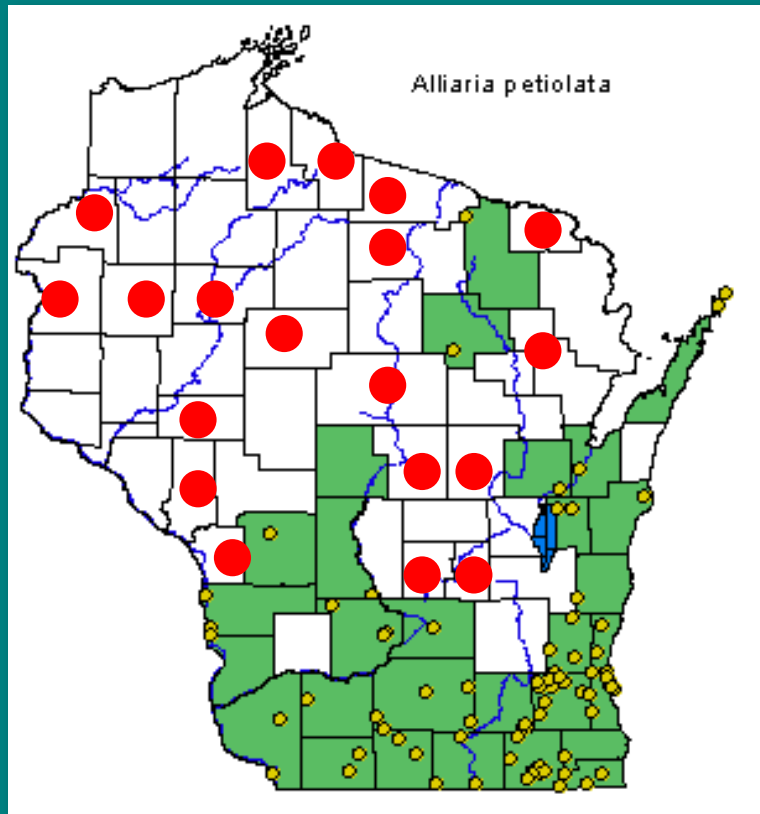


*Alliaria petiolata*  
- garlic mustard





# \*Brassicaceae - mustard

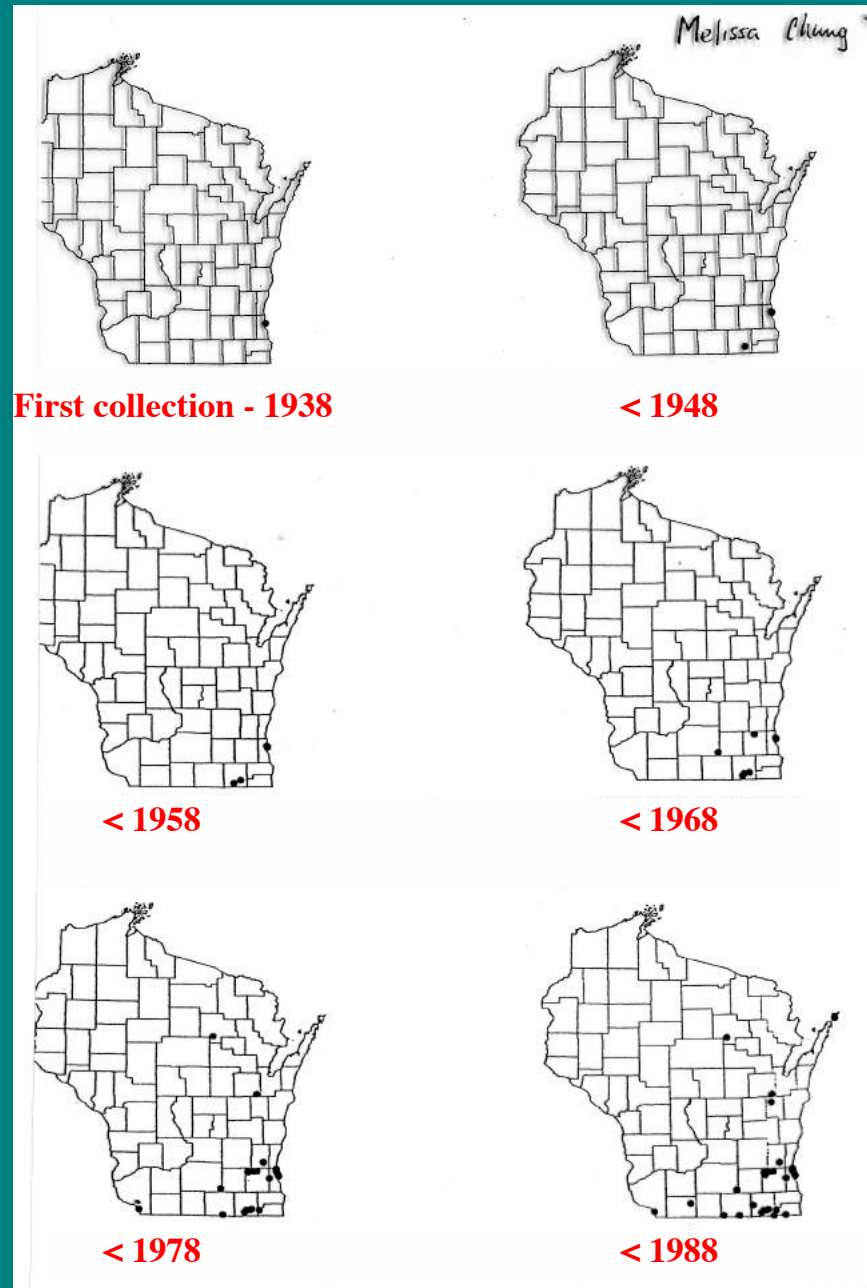


Garlic mustard distribution - 2006

Garlic mustard distribution - 2007

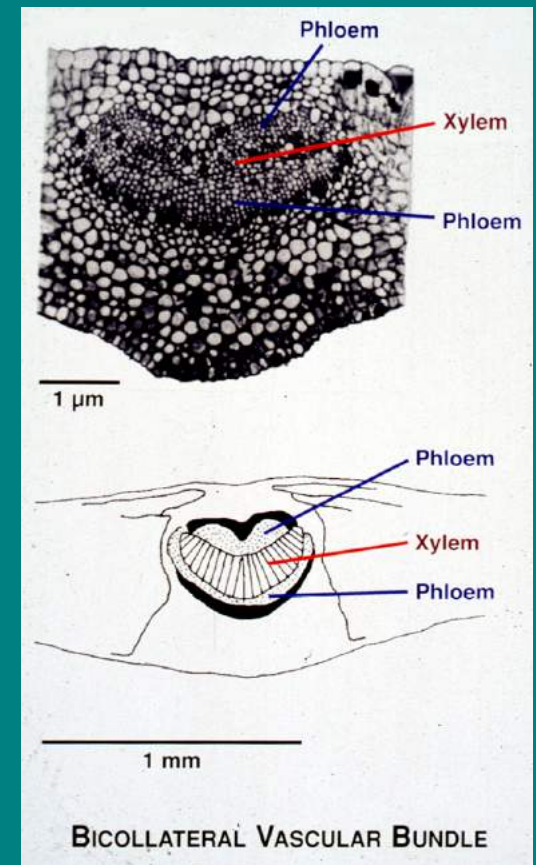
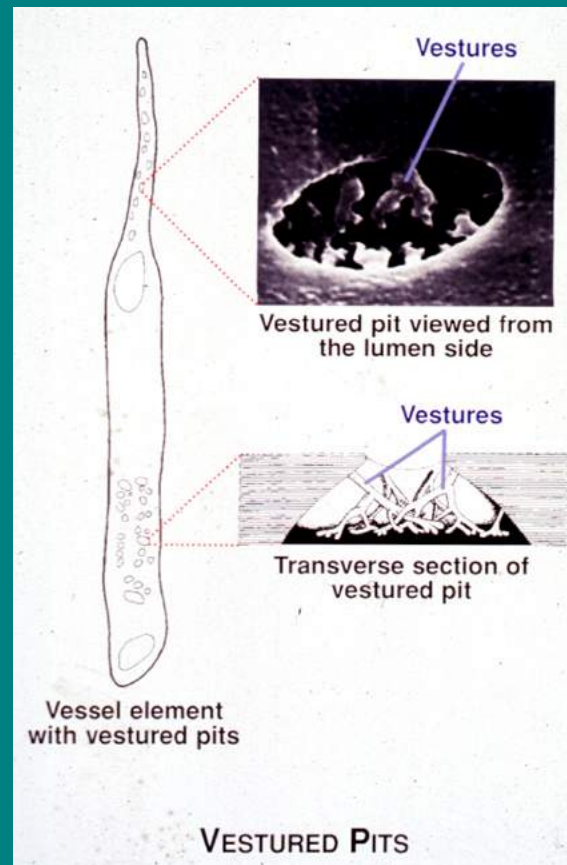
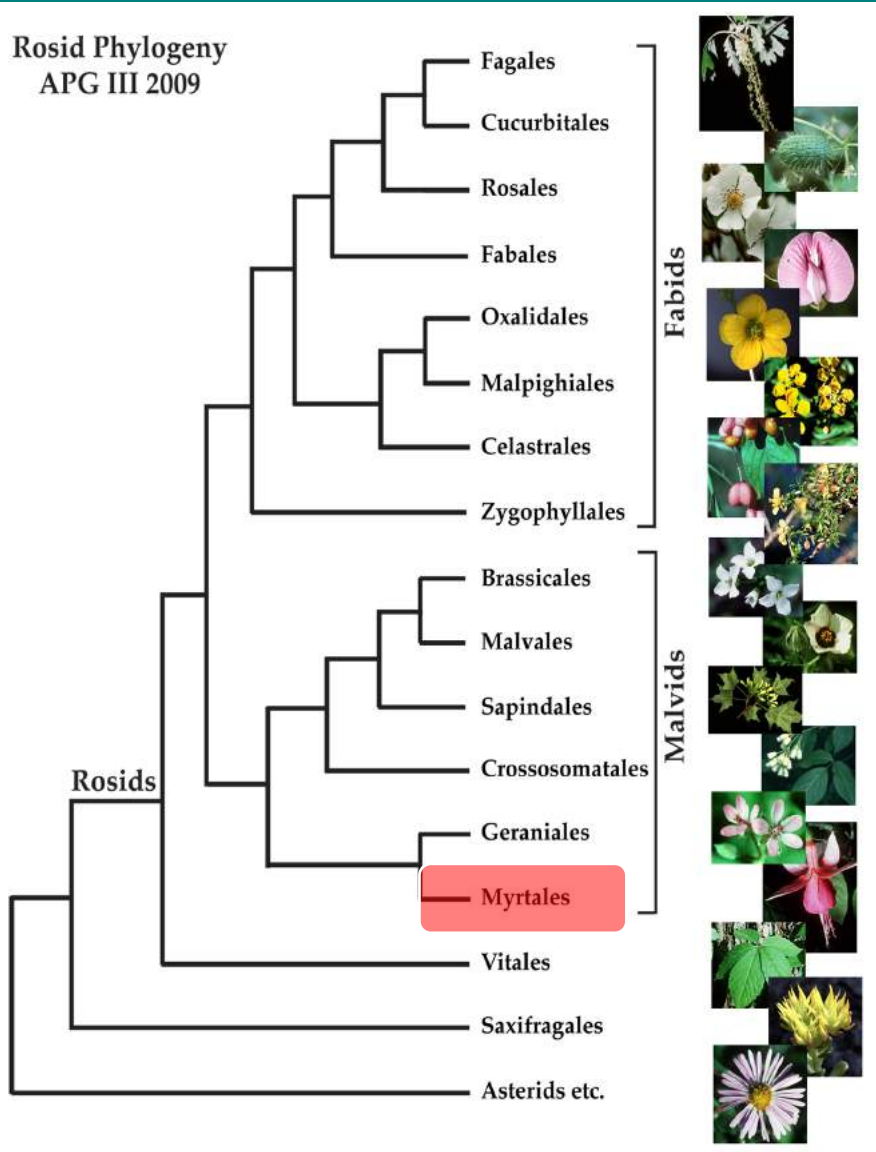
Garlic mustard distribution - 2008

Garlic mustard distribution - 2009-2016



# \*Myrtales

- strongly supported order of 12 families
- defined by 2 anatomical features





# \*Myrtales

- this combination placed the anomalous Vochysiaceae within Myrtales
- 3 very large tropical families



*Vochysiaceae*



*Blakea*

*Melastomataceae*



*Heterotrichum*



*Myrtaceae*

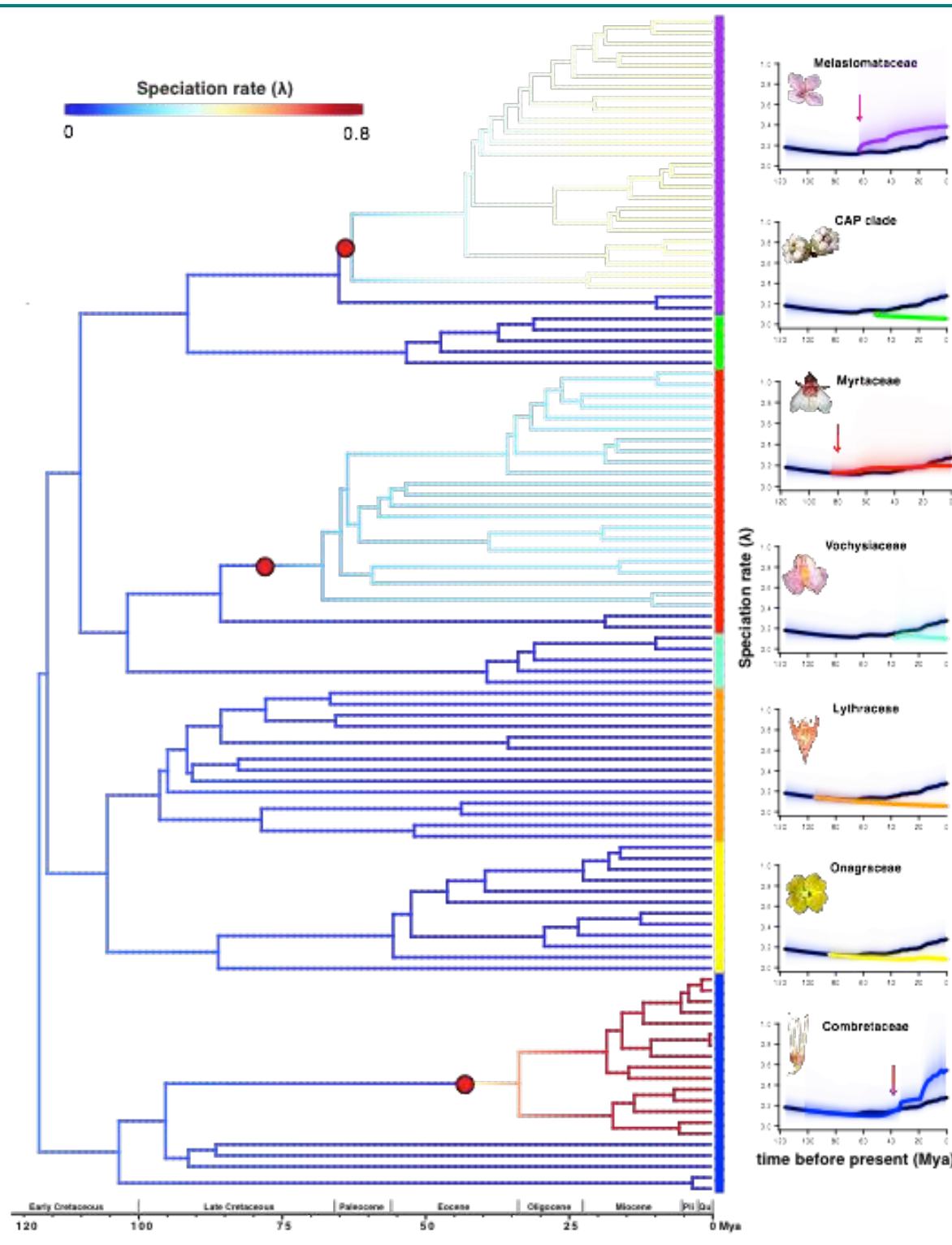
*Psidium* - guava



*Metrosideros* - o'hia



*Combretaceae*



- Diversification analyses identify three significant shifts in speciation
- Near or just within the crown radiations of these three families



# \*Onagraceae - evening primrose



A moderate sized family of 17 genera and about 650 species - most diverse in western N. America

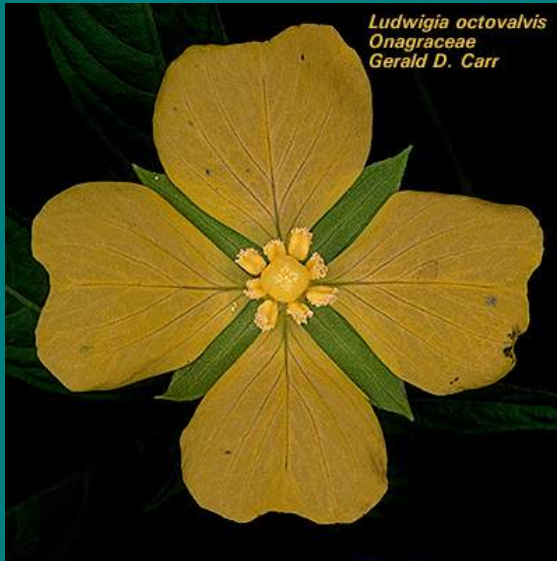
CA 4 CO 4 A 4,8  $\bar{G}$  (4)

- 4 merous flowers, epigynous, and often well developed **hypanthium**



*Oenothera biennis* - evening primrose

# \*Onagraceae - evening primrose



- *Ludwigia* is sister to remainder of the family

- tropical *Fuchsia* is diverse in South America



# \*Onagraceae - evening primrose



*Epilobium hirsutum* -  
willowherb



# \*Onagraceae - evening primrose



- Circumboreal *Circaea* is sister to woody southern hemisphere *Fuchsia*



*Circaea lutetiana* - enchanter's nightshade



*Fuchsia*

- 2 merous flowers; fruit is one-seeded and bristly



# Lythraceae - loosestrife

Close relative of the evening primrose family; mainly tropical in distribution

CA 4-6 CO 4-6 A 8-12 G (4)

- flowers 4, 5, or 6 merous with stamens double the number of sepals and in two distinct sets
- exhibits **tristylous heterostyly**
- **hypanthium** well developed but with superior pistil = **perigynous**



*Lythrum alatum* - winged loosestrife



# Lythraceae - loosestrife



*Lythrum salicaria*  
purple loosestrife

Ecologically invasive  
in wetlands; from  
Europe



*Cuphea* -  
cigar plant



*Trapa* - water  
chestnut



# Geraniales: Geraniaceae



**Geranium family:** 800  
species of temperate  
herbs

Poorly understood order of 6 families  
– now placed next to Myrtales



*Geranium maculatum*- wild geranium

# Geraniaceae - geranium



*Geranium maculatum*-  
wild geranium

CA 5 CO 5 A 10 G (5)

- 5 merous flowers with a superior pistil made up of 5 carpels each with a single ovule

- fruit is a **schizocarp** = dehiscing fruit into one-seeded **mericarps**





# Geraniaceae - geranium



*Erodium cicutarium* - stork' s-bill

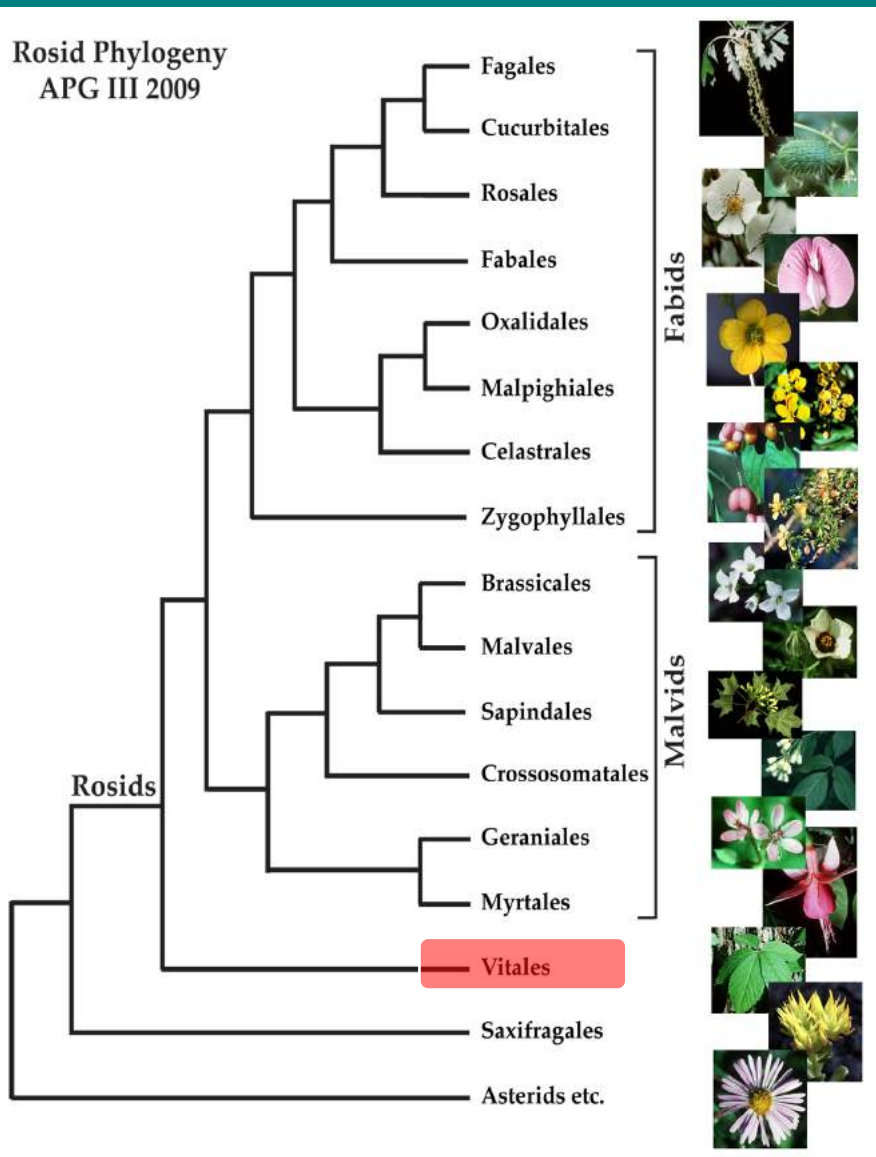
The stork' s-bills of genus *Erodium* drill their mericarps into the ground

*Geranium robertianum*

Herb robert

# Vitales: Vitaceae - grapes

Order with one family: sister to all other Rosids



*Vitis* - grape



# Vitales: Vitaceae - grapes

Small family (800 species) of vines in the tropics and temperate areas - includes *Vitis vinifera* the wine grape

- flowers small and clustered in more showy inflorescences
- fruits: **berries** with several seeds



*Parthenocissus tricuspidata* - Boston ivy



*Vitis* - grape



# Vitaceae - grapes

*Vitis* - grape

- leaves simple or compound; venation and lobing usually strongly palmate

- plants climb by **tendrils** = modified inflorescences, or by **holdfasts**

*Parthenocissus* - Boston ivy





# Vitaceae - grape



*Parthenocissus quinquefolia* - Virginia creeper, woodbine



# Vitaceae - grape

*Vitis riparia* (+ *V. vulpina*)  
River, frost grape



*Vitis aestivalis*  
Summer grape