

Diversity and Evolution of Rosids

. . . hemp, figs, and legumes . . .

... hemp, figs, and legumes ...

Rosid Phylogeny
APG III 2009

N₂ fixing clade

Phylogenetic tree showing the relationships among Rosid orders. The tree is rooted at the bottom left and branches out to the right. The orders are listed on the right side of the tree, grouped into two main clades: Fabales and Malvales. The N₂ fixing clade is highlighted in a grey box, encompassing the orders Fabales, Cucurbitales, and Rosales. The tree also shows the relationships between the Rosids and other orders, including Brassicales, Malvales, Sapindales, Crossosomatales, Geraniales, Myrtales, Vitales, Saxifragales, and Asteroide etc.

Orders listed (from top to bottom):

- Fagales
- Cucurbitales
- Rosales (highlighted in the N₂ fixing clade)
- Fabales
- Orderales
- Mulphigiales
- Celastrales
- Zygophyllales
- Brassicales
- Malvales
- Sapindales
- Crossosomatales
- Geraniales
- Myrtales
- Vitales
- Saxifragales
- Asteroide etc.

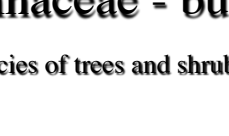
Clades indicated by brackets on the right:

- Fabales (includes Fagales, Cucurbitales, Rosales, Fabales, Orderales, Mulphigiales, Celastrales, Zygophyllales)
- Malvales (includes Brassicales, Malvales, Sapindales, Crossosomatales, Geraniales, Myrtales, Vitales, Saxifragales, Asteroide etc.)

-

Rhamnaceae - buckthorns

52 genera 925 species of trees and shrubs in the tropics and temperate areas



- many of our species are armed with thorns
- leaves are simple and alternate or opposite, often with arcuate venation (arching along the edge), and serrated edges

Rhamnus cathartica - European or common buckthorn [invasive]

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Rhamnus cathartica - European or common buckthorn [invasive]

Rhamnaceae - buckthorns

CA 4,5 CO 4,5 A 4,5 G (3)



- flowers 4 or 5 merous (4 merous shown in common buckthorn)
- stamens opposite the petals - unusual in flowering plants!

Rhamnus cathartica - European or common buckthorn

CA4,5 CO4,5 A4,5 G(3)

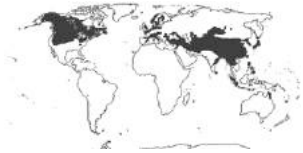


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Rhamnus cathartica - European or common buckthorn

Elaeagnaceae - Russian olive

3 genera 45 species of trees and shrubs largely in north temperate areas



Elaeagnus angustifolia - Russian olive



- N_2 -fixing small trees and shrubs easily recognized by silvery or reddish glandular hairs covering bottom leaves and/or stems

Elaeagnaceae - Russian olive

3 genera 45 species of trees and shrubs largely in north temperate areas



Elaeagnus angustifolia - Russian olive

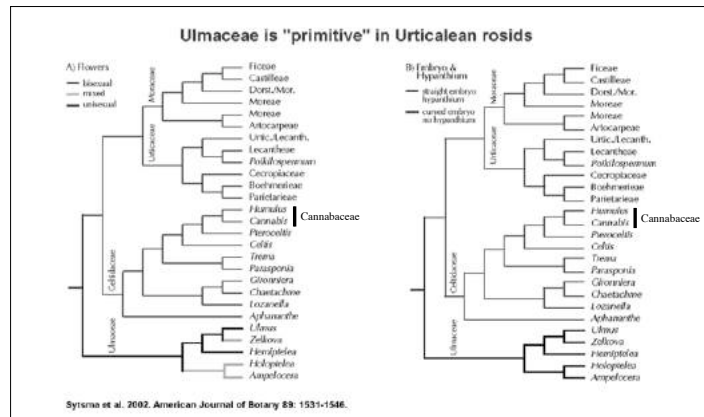


- 4 merous flowers and berry fruits

Shepherdia - buffalo berry

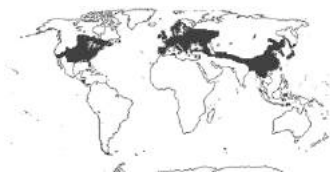
Rosales - Urticalean Families

The remainder of the Rosales show the transition to reduced, unisexual flowers and one-seeded fruits - "Urticales"



*Ulmaceae - elms

6 genera 35 species of North Temperate trees



- best known for the American elm with its distinctive vase shaped growth form. Dutch Elm disease, caused by the fungus *Ceratostomella umli*, has destroyed most large adults.



Ulmus americana - American elm

*Ulmaceae - elms



Ulmus americana - American elm

- leaves are distichously arranged - 2 ranks in one plane - and pinnately veined; leaf bases are strongly asymmetric



Zelkova serrata - European

*Ulmaceae - elms

CA 4-8 CO 0 A 4-8 G (2)

- flowers are bisexual but reduced and wind pollinated; they appear before the leaves

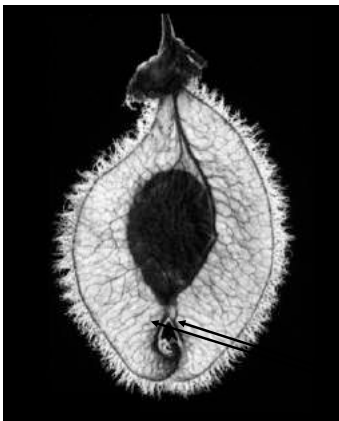


Ulmus americana - American elm

*Ulmaceae - elms

CA 4-8 CO 0 A 4-8 G (2)

- pistil is made of two fused carpels but only one seed matures; fruit is a samara - a winged achene in this case

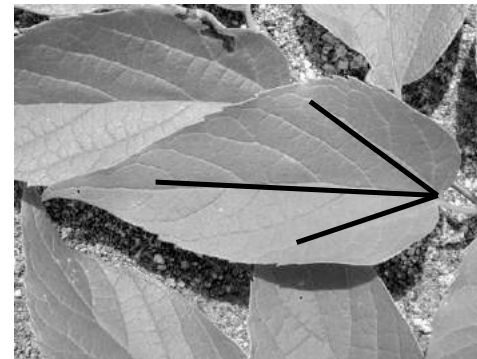


Ulmus americana - American elm

Note 2 styles on samara

Cannabaceae - hackberry, hops

- *Celtis* (hackberries) and relatives are tropical and temperate small trees with unisexual flowers



- leaves are strongly palmately-pinnate - with 3 main veins at base

- this leaf features defines all the other remaining urticalean families

Celtis occidentalis - hackberry

Cannabaceae - hackberry, hops



Celtis occidentalis - hackberry

- note distinctive warty bark
- fruit is a one-seeded drupe



Cannabaceae - hackberry, hops



Cannabis sativa
Hemp, marijuana

- *Cannabis* with one species is a coarse herb native to Eurasia
- two subspecies are recognized: one the source of the drug Δ^9 tetrahydrocannabinol (THC) and the other the source of hemp fiber/oil



hemp rope



manila rope

Cannabaceae - hackberry, hops



Female inflorescence
Seeds 1-seeded

- *Cannabis* is either dioecious or monoecious

Cannabis sativa
Hemp, marijuana



Male inflorescence

Cannabaceae - hackberry, hops



Humulus lupulus
American hops



male flowers



female flowers

- *Humulus* has two viney hop species: one is the source of lupulin used in the brewing industry

Urticaceae - nettles

54 genera, 2600 species - largely a tropical family of herbs, shrubs, or treelets

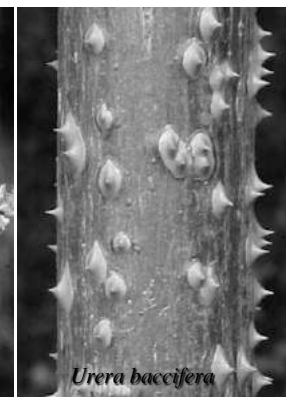
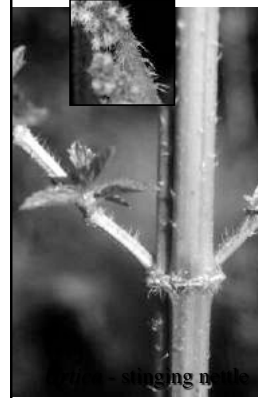
- leaves have palmi -pinnate venation; either alternate or opposite



Urticaceae - nettles

54 genera, 2600 species - largely a tropical family of herbs, shrubs, or treelets

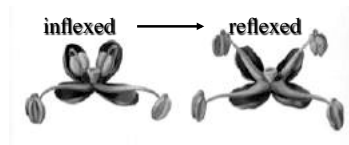
- some species are a source of irritants found in specialized hair-like cells on stems and leaves



Urticaceae - nettles

54 genera, 2600 species - largely a tropical family of herbs, shrubs, or treelets

- flowers are reduced, unisexual, congested, wind-pollinated, and form one-seeded drupelets
- stamens have a peculiar elastic spring-like mechanism that flings pollen further out from the plant



Urticaceae - nettles

Urtica dioica - stinging nettle
[opposite leaves, stinging]



Laportea canadensis - wood nettle
[alternate leaves, stinging]



Urticaceae - nettles



Boehmeria cylindrica
false nettle



Parietaria pensylvanica
pellitory



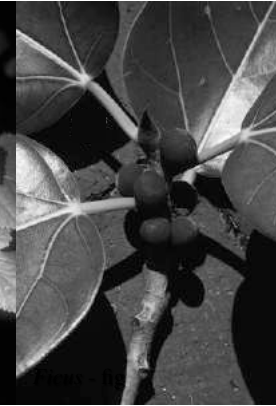
Pilea pumila
clearweed

*Moraceae - mulberry, fig

Large tropical family of 38 genera, 1100 species of trees or vines



Morus - mulberry



Ficus - fig



*Moraceae - mulberry, fig

Large tropical family of 38 genera, 1100 species of trees or vines



Morus - mulberry



Ficus - fig

- sister family to the nettle family
- latex system well-developed
- leaves are alternate, strongly palmi-pinnately veined

*Moraceae - mulberry, fig

CA 4 CO 0 A 4 G (2)



- flowers reduced, unisexual, no petals, single seeded ovary



Morus alba - white mulberry
female right - male left

*Moraceae - mulberry, fig

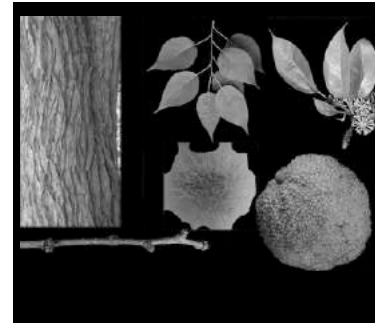


- single seeded fruits from many flowers coalesce to form one fleshy, multiple fruit [e.g., mulberry, fig, breadfruit]



Morus rubra - red mulberry

*Moraceae - mulberry, fig

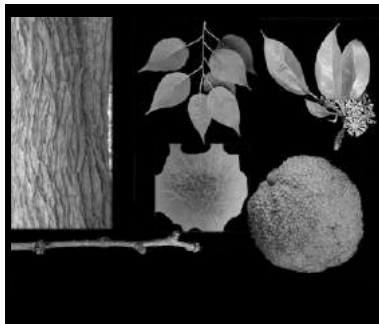


Osage orange is not native but often seen escaped; note the large grapefruit sized multiple fruit



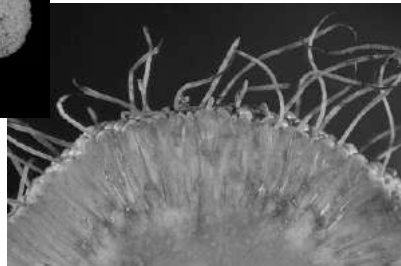
Osage orange multiple fruits rolling down to University Avenue behind Birge Greenhouses

*Moraceae - mulberry, fig



Osage orange is not native but often seen escaped; note the large grapefruit sized multiple fruit

Cross section of multiple fruit showing individual one-seeded fruitlets



*Moraceae - mulberry, fig



Ficus (figs) represent 750 of the 1100 species



*Moraceae - mulberry, fig



Ficus (figs) represent 750 of the 1100 species

- the fig (multiple) fruit or syconium is a “key innovation” for fig species radiation

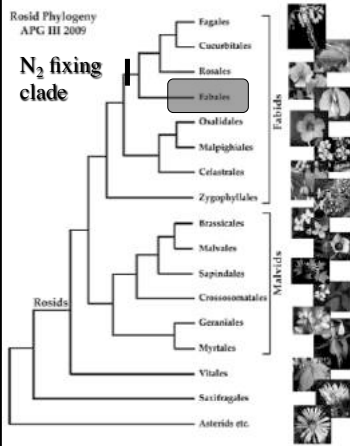


Fabales the legumes



Fabales

Rosid Phylogeny
APG III 2009
N₂ fixing
clade



- Fabales is an order in the Eurosoid I or fabid lineage of Rosids (N₂ fixing)

- contains 4 families, but Fabaceae - the legumes - comprise the vast majority of the 20,000+ species



*Fabaceae - legumes



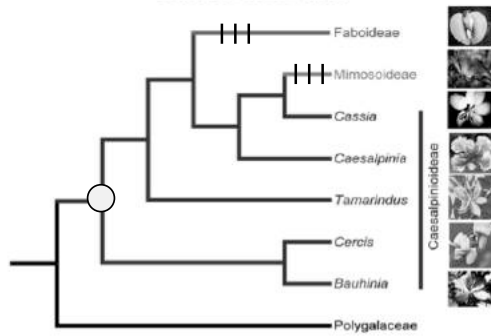
- 730 genera, 19,400 species of herbs, shrubs, and trees that produce specialized follicles - legumes - that open along two lines of dehiscence
- Fabaceae = Leguminosae
- worldwide, N₂ (*Rhizobium*) fixers



*Fabaceae - legumes

3 subfamilies previously recognized

Relationships of Three Legume Subfamilies
Based on DNA Evidence



- faboid (beans, peas) and mimisoid (acacia, mimosa) legumes are highly modified

- but descended from the common ancestor of caesalpinoids

*Fabaceae - legumes

Three major characteristics

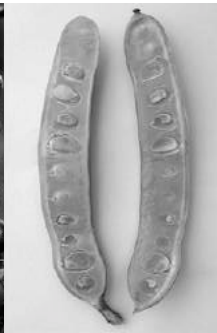
1. Monocarpic - single superior carpel



*Fabaceae - legumes

Three major characteristics

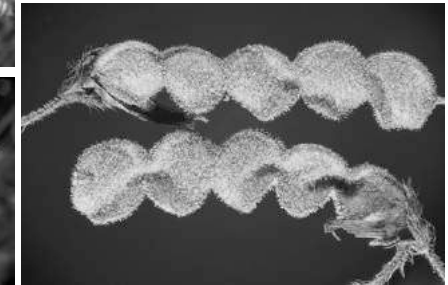
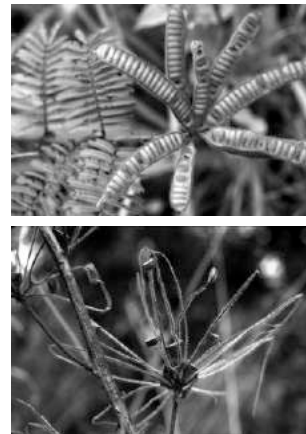
2. Legume - follicle but with 2 lines of suture



*Fabaceae - legumes

Three major characteristics

2. Legume - or modified as one-seeded fruitlets (loment, articles)

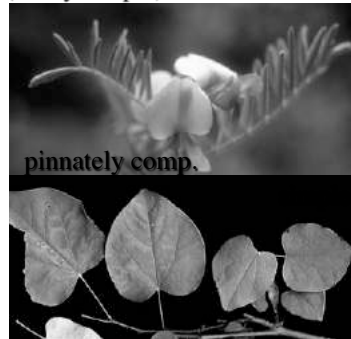


*Fabaceae - legumes



Three major characteristics

3. Alternate, compound leaves - (rarely simple)



*Caesalpinoid legumes



Bauhinia

Caesalpinoid legumes form a paraphyletic grade at base of family - the tropical *Bauhinia* is one of the first



Caesalpinia

*Caesalpinoid legumes

CA 5 CO 5 A 10 G 1



• flowers 5 merous with 10 unequal stamens

• topmost petal = banner sits in front of the 2 lateral or wing petals

banner

carpel

*Caesalpinoid legumes

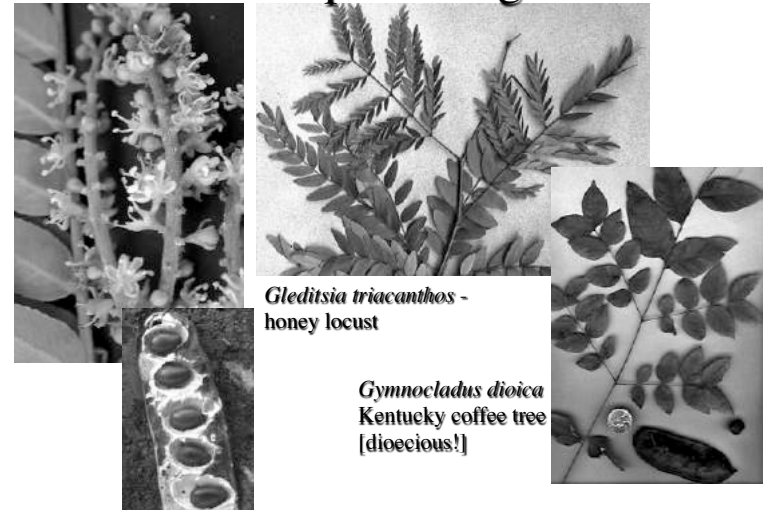


Senna marilandica - southern wild senna

*Caesalpinoid legumes



*Caesalpinoid legumes



*Mimosoid legumes



Mimosoid legumes are tropical or subtropical shrubs and trees, often with doubly compound leaves - large genera are taxonomically messy



*Mimosoid legumes



CA (5) CO (5) A (∞) G 1

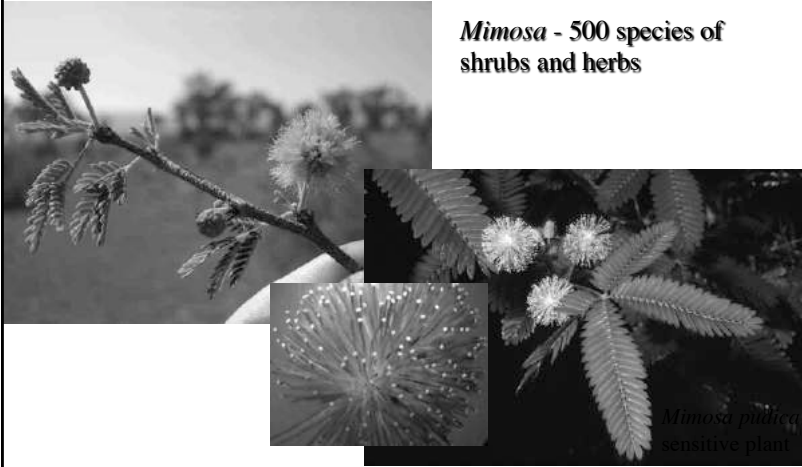


- flowers small, but in showy “powder puff” inflorescences
- calyx, corolla, and numerous stamens each show connation

Albizia

*Mimosoid legumes

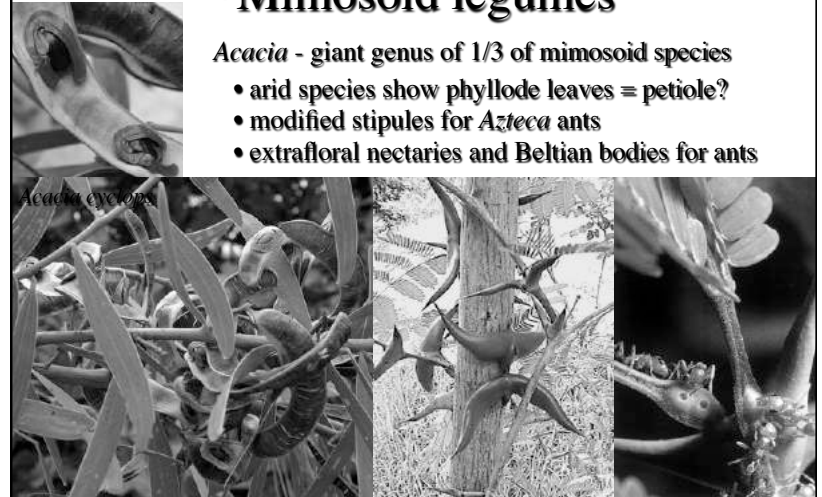
Mimosa - 500 species of shrubs and herbs



*Mimosoid legumes

Acacia - giant genus of 1/3 of mimosoid species

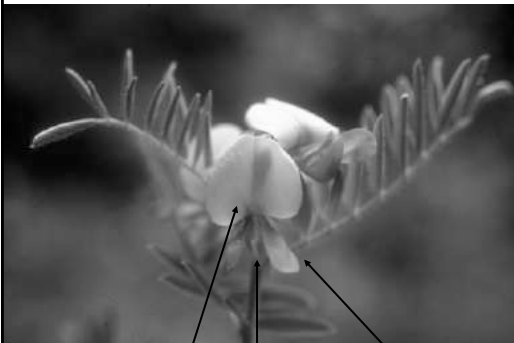
- arid species show phyllode leaves = petiole?
- modified stipules for *Azteca* ants
- extrafloral nectaries and Beltian bodies for ants



*Faboid legumes

CA (5) CO 3+(2) A (9)+1 G 1

- calyx often fused
- banner petal behind lateral (wing) petals
- bottom keel petals often fused
- stamens diadelphous = 9 fused + 1 separate



*Faboid legumes

Apios americana -
groundnut



*Faboid legumes



Lathyrus japonicus - beach pea



Lupinus perennis -
lupine, blue bonnet

*Faboid legumes



Robinia pseudo-acacia - black locust

- native to further south, but
invasive in Great Lakes
region

*Faboid legumes

- three important legume crops



Pisum sativum -
pea



Phaseolus vulgaris -
common bean



Glycine max -
soybean

*Faboid legumes

- three important "clover" or "alfalfa"
species from Eurasia - now naturalized



Melilotus alba
White sweet clover



Trifolium pratense
red clover



Medicago sativa
alfalfa

***Faboid legumes**



- other Eurasian species brought in for soil stabilization - and now naturalized

