Diversity and Evolution of Asterids

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

Reminder: pollination biology project due this Wednesday

Core Asterids

- 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

- 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
- euasterids I - lamiids

Calendula, Asteraceae early
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?

- pre-DNA era four families were recognized (as in Gleason/Cronquist)
- Caprifoliaceae - paraphyletic!
- Dipsacaceae
- Valerianaceae

DNA phylogeny

- post-DNA era up to 7 families can be recognized
- will use 2 here [MI flora differs!]

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)

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

Viburnum - viburnum

Lonicera - honeysuckle

Sambucus canadensis - Common elder

Adoxaceae - viburnums

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

Sambucus racemosa - red-berried elder

Viburnum davidii

• elder-berries are opposite, compounded leaved shrubs
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

Viburnum lentago - nannyberry

Viburnum acerifolium - maple-leaved viburnum

Viburnum rafinesquianum - arrowwood

Adoxaceae - viburnums

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

Adoxa moschatellina - muskrout

*Caprifoliaceae - honeysuckles

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

Linnaea - twinflower

Lonicera - honeysuckle

Dipsacus - teasel
**Caprifoliaceae - honeysuckles**

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

---

Lonicera tatarica - tartarian honeysuckle

Lonicera canadensis - fly honeysuckle

---

Lonicera reticulata - grape honeysuckle

Lonicera dioica - red honeysuckle

---

Lonicera xylosteum - European fly honeysuckle

Lonicera X bella - pretty honeysuckle

---

Lonicera japonica
*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

- Abelia
- Kolkwitzia

- many cultivated ornamentals

*Caprifoliaceae - honeysuckles

- Valeriana uliginosa - marsh valerian
- Valeriana edulis - edible valerian
- Knautia - blue-buttons

- the old 'Valerianaceae' and 'Dipsacaceae' exhibit features that will be seen in Asteraceae ['pseudanthium' or head]
  
  • congested inflorescences
  • bracted inflorescences
*Caprifoliaceae - honeysuckles*

- the old 'Valerianaceae' and 'Dipsacaceae' exhibit features that will be seen in Asteraceae ("pseudanthium" or head)
- reduced calyx - pappus
- one seeded achene

**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

**Araliaceae - ginseng**

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

*Knautia* - pappus

*Involucral bracts* - pappus

*Knautia* - pappus

*Dipsacus fullonum* - teasel

Introduced and adventive

*Involucral bracts* - pappus

*Aralia hispida* - bristly sarsaparilla

*Aralia nudicaulis* - wild sarsaparilla
Araliaceae - ginseng

- 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

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

Aralia racemosa - spikenard

Oplopanax horridus - Devils club

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

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.

Tetrapanax papyrifera - rice paper

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).

_Heracleum lanatum_ - cow parsnip

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

Dill

parsnip
carrot
**Apiaceae - umbels**

- Flowers small in umbels, often compound
- Female flowers often along edge of each umbellet
  
  Common feature in Asterids with the formation of a 'head'

**CA 5 CO 5 A 5 G (2)**

**Apiaceae - umbels**

- 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

**CA 5 CO 5 A 5 G (2)**

**Apiaceae - umbels**

- 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

**CA 5 CO 5 A 5 G (2)**

*Angelica atropurpurea* - great angelica
- Large coarse herb of wetter areas
Although containing nasty compounds, *Cicuta* is not the hemlock that Socrates took (*Conium*). Common species of marshes and streams.

*Cicuta bulbifera* - Bulblet water hemlock
*Cicuta maculata* - Spotted water hemlock

Common species of marshes and streams.

*Cryptotaenia canadensis* - Honewort
*Osmorhiza longistylis* - Sweet cicely

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

*Daucus carota* - Wild carrot, Queen Anne's lace

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

*Eryngium yuccifolium* - Rattlesnake master
*Apiaceae - umbels

The mystery plant from Abilene, Texas

Eryngium leavenworthii  Dipsacus fullonum – teasel (Capparidaceae)  Eryngium yuccifolium  Eryngium leavenworthii

Dipsacus fullonum – teasel

Our most robust species in Wisconsin

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.

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

Asterales

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

bellflower - Campanulaceae
goddess - Asteraceae
Asterales

*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

Subfamily Campanuloideae

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

Campanula rotundifolia - Bluebell - circumboreal
Campanula rapunculoides - European bellflower

*Campanulaceae - bellflowers

Triodanis perfoliata - Venus looking glass

*Campanulaceae - bellflowers

Subfamily Lobelioideae

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.

CA (5) COZ (5) A (5) G (2)

Style
Staminal tube
Campanulaceae - bellflowers

Lobelia cardinalis
Cardinal flower

Lobelia siphilitica L. - Great blue lobelia

Long considered a cure for syphilis – but probably not true.
*Campanulaceae - bellflowers

Indian tobacco
- asthma
- muscle disorders
- food poisoning
- nicotine replacement
- piperidine alkaloids
- lobeline primarily

Nicocure

Lobelia inflata
Indian tobacco (vomit-wort)

*Campanulaceae - bellflowers

Centropogon - Andes

Lobelia - Mount Kenya

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.

Nymphoides - convergence!

The DNR forced the Botany Dept in 2010 to dig up the Botany Garden pond that had Nymphoides
Stylidiaceae - trigger flowers

- Stylidium
  - Australasian and South American

Goodeniaceae

- Scaevola - note opened corolla tube
  - Australasian - and beaches?

Calyceraceae

- closest family to Asteraceae - the composites; note biogeography
  - South American only