Diversity and Evolution of Asterids

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

Lecture exam 2: mean = 76.2/80 range = 61-85
Lab exam 2: mean = 37.7/45 range = 21-45

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
- appears to have the fused corolla derived independently via a different floral developmental pathway relative to the Asterid I group

Early vs. Late Sympetaly

euasterids II - campanulids
euasterids I - lamiids

Calendula, Asteraceae
Anchusa, Boraginaceae

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?**

<table>
<thead>
<tr>
<th>DNA phylogeny</th>
<th>Pre-DNA era four families were recognized (as in Gleason/Cronquist)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Caprifoliaceae</strong></td>
<td><strong>Viburnum</strong></td>
</tr>
<tr>
<td><strong>Dipsacaceae</strong></td>
<td><strong>Teasel</strong></td>
</tr>
<tr>
<td><strong>Valerianaceae</strong></td>
<td><strong>Valerian</strong></td>
</tr>
</tbody>
</table>

**DNA phylogeny**

- Post-DNA era up to 7 families can be recognized
- Will use 2 here

**“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

Sambucus canadensis - Common elder

Viburnum davidii

Viburnum opulus (trilobum) - high bush cranberry

Adoxaceae - viburnums

- Elder-berries are opposite, compounded leaved shrubs

Adoxaceae - viburnums

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

Viburnum davidii
Adoxaceae - viburnums

- many viburnums have glands on petioles

Viburnum acerifolium - maple-leaved viburnum

Viburnum lentago - nannyberry

Viburnum rafinesquianum - arrowwood

Adoxa moschatellina - muskroot

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

*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 - 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
- *Lonicera reticulata* - grape honeysuckle
- *Lonicera dioica* - red honeysuckle
- *Lonicera xylosteum* - European fly honeysuckle
- *Diervilla lonicera* - bush honeysuckle
- *Triosteum perfoliatum* - Horse gentian

**Additional Information**

- Invasives: *Lonicera xylosteum*
- Natives: *Lonicera tatarica*, *Lonicera canadensis*, *Lonicera reticulata*, *Lonicera dioica*, *Diervilla lonicera*

- Native leaf miners: *Lonicera xylosteum*

- Pretty honeysuckle: *Lonicera X bella*
**Caprifoliaceae - honeysuckles**

*Linnaea borealis* - twinflower

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

**Caprifoliaceae - honeysuckles**

*Abelia*

- many cultivated ornamentals

**Caprifoliaceae - honeysuckles**

*Valeriana uliginosa* - marsh valerian

- the old ‘Valerianaceae’ and ‘Dipsacaceae’ exhibit features that will be seen in Asteraceae

  - congested inflorescences
  - bracted inflorescences

**Caprifoliaceae - honeysuckles**

*Valeriana edulis* - edible valerian

Knautia

- the old ‘Valerianaceae’ and ‘Dipsacaceae’ exhibit features that will be seen in Asteraceae

  - reduced calyx - pappus
  - one seeded achene
**Caprifoliaceae - honeysuckles**

- the old 'Valerianaceae' and 'Dipsacaceae' exhibit features that will be seen in Asteraceae
- **involucral bracts**

**Dipsacus fullonum** - teasel
- Introduced and adventive

**Apiales**

- 7 families and nearly 5,500 species of herbs and shrubs - Australasia appears to be center of diversity
- **involucral bracts**

- 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

**Aralia hispida** - bristly sarsaparilla
**Aralia nudicaulis** - wild sarsaparilla

**CA 5 CO 5 A 5 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**

*Hedera helix*

*English ivy*

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

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*Panax trifolius*

*Dwarf ginseng*

Rich woods; leaflets are sessile

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*Panax quinquefolius* - American ginseng

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

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*Hedera helix*

*English ivy*

Eurasia - N. Africa; invasive in U.S.
**Araliaceae - ginseng**

Tetrapanax papyrifera - rice paper

*Schefflera* - umbrella plant

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**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*

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**Apiaceae - umbels**

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

*Heracleum lanatum* - cow parsnip

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**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'*
**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

**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

**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. Common species of marshes and streams.
**Apiaceae - umbels**

*Cryptotaenia canadensis* - honewort

*Osmorhiza longistylis* - sweet cicely

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**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

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**Apiaceae - umbels**

*Eryngium yuccifolium* - Rattlesnake master

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

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**Apiaceae - umbels**

The mystery plant from Abilene, Texas

*Eryngium leavenworthii*  
*Dipsacus fullonum* - teasel

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*Eryngium yuccifolium*
*Apiaceae - umbels*

_Heracleum lanatum_
American cow-parsnip
Our most robust species in Wisconsin

*Apiaceae - umbels*

_Pastinaca 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.

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 [Arales]. 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
Recent DNA evidence NOT pervasive parallelisms!

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

- **Asterales**
  - 11 families and nearly 26,000 species
  - Lamiids
  - Campanulids
  - Secondary pollen presentation in Campanula
  - Alternately-leaved
  - Milky latex
  - 5 merous with inferior ovary

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*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

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

Subfamily Campanuloideae

Campanula americana - tall bellflower

Campanula rapunculoides - European bellflower

Campanula rotundifolia - bluebell - circumboreal

Subfamily Lobelioideae

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

*Campanulaceae - bellflowers*

**Triodanis perfoliata** - Venus looking glass

**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)**

*Campanulaceae - bellflowers*

**Lobelia cardinalis** - Cardinal flower

Long considered a cure for syphilis – but probably not true.

*Campanulaceae - bellflowers*

**Lobelia siphilitica** - Great blue lobelia
*Campanulaceae - bellflowers*

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

Nicocure

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**Menyanthaceae - bog buckbean**

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

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**Menyanthaceae - bog buckbean**

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

Nymphoides - convergence!
Stylidiaceae - trigger flowers

Stylidium

Donatia

Goodeniaceae

Scaevola - note opened corolla tube

Calyceraceae

- closest family to Asteraceae - the composites; note biogeography