Diversity and Evolution of Asterids

- Asters, ragweeds, and goldenrods

Asterales

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

Asteraceae - composites

- One of the most successful of all flowering plant families with over 1,500 genera and 23,000 species
- composites found throughout the world but most characteristic of the grassland biomes
- but also diverse in arctic to tropical and subtropical regions
Asteraceae - composites

Family has 3 specialized features important in this radiation:

1. Special inflorescence “head” - pseudanthia
2. Pollen presentation
3. Diverse secondary chemistry

Pathway to Asteraceae Head?

Menyanthaceae  Goodeniaceae  Calyceraceae  Asteraceae

How did this happen morphologically?

Pseudanthia in the Asterids

Pathway to Asteraceae Head?

Menyanthaceae  Goodeniaceae  Calyceraceae  Asteraceae

A: No internode elongation + Presence/absence of cymose branches
B: Internodes differentiated

Pozner et al. 2012 (Amer J Bot)
Pollination Syndromes
- wasp
- flies
- moths
- bees
- butterflies
- wind

Pollen Presentation
- Cross pollination on inner receptive surfaces
- Self pollination by curling of stigmas
- Anthers fused forming a tube for pollen release
- Pollen pushed out by a style that acts as a plunger
- Stigma makes contact with self pollen if necessary

Chemical Diversity
- Polyacetylenes, sequiterpene lactones, terpenes, alkaloids, latex

Chemical Diversity
- Packera
- Agoseris
- Tanacetum

- Sequiterpene lactones poisonous to sheep in the southern Rockies
- "Spewing" disease

- Helium hoopesii – Sneezeweed, Owl’s-claw
**Chemical Diversity**

*Artemisia annua* = Sweet wormwood

- sequiterpene lactones used in antimalarial treatment
- Chinese herbal medicine

**Asteraceae - composites**

The head or capitulum is a cluster of 1 or 2 distinct flower types. The family is also called "Compositae" referring to this clustering.

The head is surrounded by special bracts called the involucre or phyllaries.

The involucre is important in the classification and identification within the family.

**Asteraceae - floral diversity**

- Calyx is reduced to a pappus of scales, awns, bristles, or absent
- Corolla has 5 petals but variously fused or zygomorphic
- Anthers (only) fused in a ring

The fruit is a one-seeded achene with the pappus serving as the fruit disperser (e.g., barbs for animal dispersal, hairs for wind dispersal)
Asteraceae - floral diversity

The family exhibits a diverse array of floral types:
- these three corolla types are seen in Wisconsin.

Main floret types

1. Disk or tubular florets are actinomorphic
2. Ray florets are usually 3 long fused petals + 2 obsolete petals
3. Ligulate florets are 5 fused petals but split open
Asteraceae - head diversity

These various types of florets combine to form a number of different looking heads.

- **Radiate head**: disk florets in the center, ray florets along the edge (these usually pistillate).
  
  *Symphyotrichum - aster*

- **Discoid head**: only disk or tubular florets comprise the entire head.
  
  *Liatris - blazing star*

- **Ligulate head**: only ligulate florets comprise the entire head.
  
  *Cichorium - chicory*

Asteraceae - phylogeny

- Early DNA-based work surprisingly placed a small group of South America genera as sister to the rest of the family and recognition of 3 subfamilies and many tribes.
Asteraceae - phylogeny

- early DNA based work surprisingly placed a small group of South America genera as sister to the rest of the family and recognition of 3 subfamilies and many tribes

47.5 million-year-old from Patagonia

Extant member of an early branching lineage of Asteraceae (Mutisioideae), Cnicothamnus lorentzii

Asteraceae - phylogeny

- later DNA based work questioned the monophyly of subfamily Cichorioideae - classification still in progress

Asteraceae - tribes

Tribe Barnadesiinae

Small South American tribe with bilabiate (C) or pseudolabiate (D) corolla - similar to some other families of Asterales

Barnadesia lanceolata

disk ligulate

ray
**Asteraceae - tribes**

**Tribe Mutisieae**

South American tribe usually with bilabiate flowers; characteristic of tepuis in northern South America

Stomochaeta  
Duidaea  
Cerro Autana

**Asteraceae - tribes**

**Tribe Lactuceae (Cichorieae)**

Only have ligulate heads, milky latex in vegetative parts, pappus of filaments

Dandelion, goat's-beard, chickory, hawkweed

Taraxacum - dandelion

**Asteraceae - tribes**

**Tribe Lactuceae (Cichorieae)**

Cichorium intybus - chickory

Eurasian weed - totally naturalized and distributed widely even to Botany 400 plant collections

**Asteraceae - tribes**

**Tribe Lactuceae (Cichorieae)**

Hieracium - hawkweeds

Krigia biflora - false dandelion
**Asteraceae - tribes**

**Tribe Cardueae (Cynareae)**

- **Cirsium** - thistles
  - spiny phyllaries and often leaves and stems
  - heads never radiate
  - petals white or cyanic colors (blues, purples)
  - thistle, knapweed, burdock

**Centaurea maculosa** - Spotted knapweed

**Arctium** - burdock

**Tribe Vernoniaceae**

- Alternate leaves
- Purple flowers generally

**Vernonia fasciculata** - ironweed

**Hesperomannii** - Hawaii

**Vernonia fasciculata - ironweed**

**Tribe Inuleae (Gnaphalieae)**

- Plants usually covered with white hairs, pappus of bristles or hairs
- Pussy toes, cudweed, pearly everlasting

**Antennaria plantaginifolia** - pussy toes
**Asteraceae - tribes**

**Tribe Inuleae (Gnaphalieae)**

*Anaphalis margaritacea* - pearly everlasting

**Tribe Astereae**

*Symphyotrichum pilosus* - frost aster

*Symphyotrichum novae-angliae* - New England aster

**Tribe Astereae**

*Solidago rigida* - stiff goldenrod

*Erigeron annuus* - daisy fleabane

**Tribe Anthemideae**

*Leucanthemum vulgare* - ox-eye daisy, chrysanthemum

*Tanacetum bipinnatum* - Lake Huron tansy

Aromatic plants, with dissected, alternate leaves; pappus of awns or scales or missing.

Ox-eye daisy, yarrow, wormwood, tansy, dog fennel.
Asteraceae - tribes

**Tribe Anthemideae**

- *Achillea millefolium* – yarrow (Botany 400 plant collections)
- *Matricaria discoidea* – pineapple weed

**Tribe Senecioneae**

- *Packera aurea* – golden ragwort

**Tribe Helenieae**

- *Helenium autumnale* – common sneezeweed
- *Gaillardia aristata* – common blanket-flower

**Tribe Heliantheae**

- *Ratibida pinnata* – coneflower
- *Helianthus annuus* – sunflower

Alternate or basal leaved, phyllaries in 1 row, capillary pappus; ragwort, Indian plantain.

Alternate leaved, radiate heads, 3-lobed ray flowers always widest at tip.

Large tribe with radiate, multi-layered phyllaries, rays mostly yellow, tendency for opposite leaves.

Coneflower, sunflower, rosinweed, ox-eye, black-eyed Susan, prairie dock, coreopsis, Peruvian daisy.
**Asteraceae - tribes**

**Tribe Heliantheae**
- *Biden cernua* - bur marigold
- *Echinacea pallida* - purple coneflower

**Tribe Ambrosieae**
- *Ambrosia artemisiifolia* - ragweed
  - Unisexual and wind pollinated, rays absent, stamens not fused
  - Ragweed, cocklebur
  - Male flowers
  - Female flowers

**Tribe Eupatorieae**
- *Eutrochium maculatum* - Joe-pye weed
- *Eupatorium perfoliatum* - Boneset
  - Opposite or whorled leaves
  - Discoid heads
  - Corolla never yellow
  - Joe-pye weed, boneset, snakeroot, blazing star