What has happened to Scrophulariaceae?
From one to many...

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Why Systematics?

- Awareness of the world's diversity
- Grouping of similar species
- Stability in those groups
- Facilitates the study of particular topics
Why Evolutionary Systematics?

- Comparative studies
- Relationships between groups of interest
- Evolutionary history of traits
- New and more variable characters
- Stability to our classification
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Why NOT Evolutionary Systematics?

- Harder characters to “see”
- More expensive
- At the moment: confusion
Scrophulariaceae
(Figwort or Snapdragon Family)

• Lamiales (23 families / 18,000 spp.)
• Was the largest family in the order (200/2800)
• Trashcan family
• Easy to recognize before 1995
• Absence of synapomorphies from closely related families
Scrophulariaceae very s.l.
(Figwort or Snapdragon Family)

- Vegetative features
  - Herbs or small trees
  - Lvs various (alternate, opposite)
  - Exstipulate
Scrophulariaceae very s.l.

- **Floral features**
  - Ca - 5 sepals, connate
  - Co - 5 petals, connate
  - usually bilabiate (2+3)

[Link to image](http://www.meemelink.com/prints%20pages/13822.Scrophulariaceae%20-%20Lophospermum%20scandens.htm)
Scrophulariaceae very s.l.
Mimulus sp.

Digitalis purpurea

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Antirrhinum majus
Scrophulariaceae very s.l.

- Floral features
  - A - 2 or 4 stamens
  - Epipetalous, 4 may be didynamous
  - A 5th stamen can be sterile → Staminode
  - e.g. Penstemon
Lamium sp.
Scrophulariaceae very s.l.

- Floral features
  - G - syncarpous
  - superior ovary
  - 2 carpels (1 Style)
  - Axile placentation
  - Flowers Zygomorphic
Scrophulariaceae very s.l.

- Fruit: Capsule
- Floral formula

\[ A^{2, 2+2, 4+1} \]
\[ Caz^5, Coz^5, G^2 \]

Capsule, Axile Plac.
Scrophulariaceae very s.l.

- Miscellaneous
  - Ornamental: *Penstemon, Mimulus, Digitalis*
  - Weed: *Linaria vulgaris*
  - Name of the family comes from *Scrophularia*, common figwort.
  - Digitalin, medicine obtained from *Digitalis*, is used to treat heart failure.
Scrophulariaceae
After 1995

Tank et al. 2006
Scrophulariaceae

After 1995

Tank et al. 2006
Scrophulariaceae
After 1995

- After many phylogenetic studies
- Polyphyletic
- 7 families
- Some work to do...
Scrophulariaceae
After 1995

- Scrophulariaceae s.s.
- Veronicaceae/Plantaginaceae
- Phrymaceae
- Orobanchaceae
- Stilbaceae
- Linderniaceae
- Calceolariaceae
Scrophulariaceae
After 1995

- Scrophulariaceae s.s.
- Veronicaceae/Plantaginaceae
- Phrymaceae
- Orobanchaceae
Scrophulariaceae s.s.

- “Small” family (65/1700)
- 8 tribes
- Distributed mainly in the southern hemisphere (4 tribes in southern Africa, 1 in Australia)
- Scrophularieae is the only tribe that has radiated in the northern hemisphere
- *Scrophularia* and *Verbascum* ca. 400-500 spp.
Verbascum macrurum (Mullein)
Scrophularia auriculata

Scrophularia nodosa

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Veronicaceae/Plantaginaceae

- Largest family to emerge from former Scrophs
- ca. 90 genera / 2000 spp.
- Intergeneric relationships still blurry
Veronicaceae/Plantaginaceae
Veronicaceae or Plantaginaceae?

Tank et al. 2006
Veronicaceae/Plantaginaceae

- Penstemon, Veronica, Digitalis, Aragoa, Plantago

Penstemon sp.

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Veronicaceae/Plantaginaceae

- *Penstemon, Veronica, Digitalis, Aragoa, Plantago*

*Veronica comosa*
Veronicaceae/Plantaginaceae

- *Penstemon, Veronica, Digitalis, Aragoa, Plantago*

**Digitalis purpurea**

[Images of Digitalis purpurea]

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Veronicaceae/Plantaginaceae

- Penstemon, Veronica, Digitalis, Aragoa, Plantago

Aragoa cundinamarcensis

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Veronicaceae/Plantaginaceae

- Penstemon, Veronica, Digitalis, Aragoa, Plantago

Plantago major

Plantago australis
Phrymaceae

- Easy family!
- 1) Tubular toothed calyces
- 2) Loculicidal capsules
- 3) Bilamellate stigmas receptive only on the inner part
Phrymaceae
Phrymaceae

- Easy family??
- 1) Tubular toothed calyces: shared with several taxa, e.g. Orobanchaceae, Paulowniaceae
- 2) Loculicidal capsules: shared with several taxa, e.g. Orobanchaceae, Paulowniaceae
- 3) Bilamellate stigmas receptive only on the inner part: shared with several taxa, e.g. Paulowniaceae

Although only Phrymaceae is receptive in inner part

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Phrymaceae

*Mimulus*

*M. ringens*

Mimulus sp.

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Mimulus lewisii

Bradshaw & Schemske, Nature 2003

Mimulus cardinalis
Phrymaceae

Tank et al. 2006
Orobanchaceae (90/1800)  
Broomrape family

- Awesome family
- Traditionally only holoparasites
- Now is the largest parasitic family
- Good synapomorphies
Orobanchaceae (90/1800)

- Castilleja, Pedicularis, Orobanche, Bartsia

**Castilleja integrifolia**  [Image](http://upload.wikimedia.org/wikipedia/commons/thumb/d/db/Orobanche_flava.jpg/250px-Orobanche_flava.jpg)

**Pedicularis groenlandica**  [Image](http://www.fs.fed.us/wildflowers/regions/intermountain/SilverMeadow/images/pedicularis_groenlandica_lg.jpg)

**Orobanche flava**  [Image](http://www.simonuribe.com)
Orobanchaceae

Bartsia L.

- Herb
- Hemiparasite (Generalist)
- Alpine and High elevation taxon ~ 9000 - 13000 ft
- Decussate leaves
- Pubescent
- Purple bracts
Hemiparasitism

Torres et al., 2005

http://www.parasiticplants.siu.edu/Santalaceae/images/PyrulariaHaustoria.jpg

http://www.inhs.uiuc.edu/~kenr/prairiephotos/pedicana.haustoria2.jpg

Torres et al., 2005

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Where can we find these wonderful plants?
- 2 Afromontane spp. (Mt. Kilimanjaro)
- 1 European-Skandinavian sp.
- ca. 45 spp In South America!
Back in 1990...

Molau, 1990

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Back in 1990...
Bennett & Mathews, 2006

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Uplift of the Andes

6.9 - 4.4 MYA

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S. Am. Bartsia
3.5 - 2.0 MYA
Orobanchaceae

*Bartsia* L.

- *Bartsia* polyphyletic
- S. American *Bartsia* will likely be called something else
- We need more variable genes for intrageneric relationship
- More sampling
Questions?

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