Magnoliophyta - Angiosperms

Survey of Angiosperms — using APG system

‘Basal angiosperms’

• ANA (‘basal families’)
• magnoliid complex
• monocots

Eudicots or tricolpates (3 pored pollen)

• ranunculids
• caryophyllids
• rosids
• asterids
We will begin our survey of angiosperms by examining the ‘basal angiosperms’ - those groups that are now shown to be the first diverging – paraphyletic!

These include all those shown here except the eudicots which are the bulk of dicots.

We will look at the monocots - a ‘basal angiosperm group’ - at the end of the semester.
Basal Angiosperms

What are basal angiosperms?

(1) Charles Bessey’s order Ranales with most of the dicot basal angiosperms and (2) monocots

*Magnolia* = primitive
Basal Angiosperms

What are basal angiosperms?

Exhibit a suite of primitive character states

1. Many parts at each whorl
What are basal angiosperms?

Exhibit a suite of primitive character states

1. Many parts at each whorl
2. Separate, unsealed carpels

*Drimys Winteraceae*
What are basal angiosperms?

Exhibit a suite of primitive character states

1. Many parts at each whorl
2. Separate, unsealed carpels
3. Follicle fruits

Leaf-like follicles
Basal Angiosperms

What are basal angiosperms?

Exhibit a suite of primitive character states

1. Many parts at each whorl
2. Separate, unsealed carpels
3. Follicle fruits
4. Laminar stamens

Laminar stamens in yellow waterlily
What are basal angiosperms?

Exhibit a suite of primitive character states

1. Many parts at each whorl
2. Separate, unsealed carpels
3. Follicle fruits
4. Laminar stamens
5. Tracheids, no vessel elements
Basal Angiosperms

What are basal angiosperms?
Exhibit a suite of primitive character states

1. Many parts at each whorl
2. Separate, unsealed carpels
3. Follicle fruits
4. Laminar stamens
5. Tracheids, no vessel elements
6. Pollen grains single pored, apertured, furrowed; not triaperturate, tricolpate
‘ANA’ Basal Angiosperms

The ‘ANA’ group forms a basal grade (paraphyletic)
Name derived from initials of members

Diagram:
- ANA Earliest Diverging Angiosperms
  - APG III 2009
  - Austrobaileyaceae
  - Trimeniaceae
  - Illiciaceae
  - Nymphaeaceae
  - Cabombaceae
  - Hydatellaceae
  - Amborellaceae
- Other Angiosperms
- Gymnosperms
‘ANA’ Basal Angiosperms

*Amborellaceae (order Amborellales)

*Amborella trichopoda — only 1 species from New Caledonia

* = know this family or group!
‘ANA’ Basal Angiosperms

*Amborellaceae (order Amborellales)

- dioecious (unisexual) evergreen shrub with no vessels
‘ANA’ Basal Angiosperms

*Amborellaceae (order Amborellales)*

- dioecious (unisexual) evergreen shrub with no vessels
- $P\ 5-8\ A\ \infty\ G\ 0$ male
- $P\ 5-8\ A\ 0\ G\ 5-6$ female
- perianth spiralled – tepals
- laminar stamens
- apocarpic, not sealed
- fruits 1 seeded, drupe-like
‘ANA’ Basal Angiosperms

Question: would the “first angiosperm” have had features like *Amborella*?
‘ANA’ Basal Angiosperms

Answer: not necessarily

Amborella features could be derived later (over last 100my +)

Read required paper: Sauquet et al. 2017
‘ANA’ Basal Angiosperms

Answer: not necessarily
Amborella features could be derived later (over last 100my +)

The ancestral flower of angiosperms and its early diversification.
‘ANA’ Basal Angiosperms

Austrobaileyaceae: 1 species of tropical Australian evergreen liana

- spiralled tepals; laminar stamens;
- fly pollinated; apocarpic - berries
‘ANA’ Basal Angiosperms

Illiciaceae

- aromatic shrubs/vines, used in anise liquers
- Asian tropics and subtropics & disjunct in Eastern North America

Illicium  
Schisandra + Kadsura
‘ANA’ Basal Angiosperms

Illiciaceae

- Spiralled tepals, not sealed carpels, 1 seeded follicles

Japanese anise

Illicium sp.
Illiciaceae
George K. Limney

Schisandra
‘ANA’ Basal Angiosperms

Trimeniaceae: *Trimenia* with 5 spp. (Australasian trees, shrubs, vines)

- spiralled tepals; filamentous stamens; berry with one ovule
‘ANA’ Basal Angiosperms

Biogeographical distributions of the AA members of ANA support old notion that tropical Australasia was center of origin of extant angiosperms

Liberty Hyde Bailey
‘ANA’ Basal Angiosperms

Nymphaeales: 2nd lineage after *Amborella* to diverge

- water lilies and relatives
- worldwide distribution except arid regions
- little biogeographic structure

Distribution of Nymphaeaceae - water lilies
‘ANA’ Basal Angiosperms

*Nymphaeaceae – water lilies

- floating or submersed leaves
- air cavities in tissue
- mucilaginous coverings
- lack of vessels

8 genera with specialized ecological aquatic niche
‘ANA’ Basal Angiosperms

*Nymphaeaceae – water lilies

Nuphar variegatum - yellow waterlily = basal angiosperm

Nymphoides peltata - water gentian = asterid dicot

Obvious ecological convergence in floating aquatics is the rule!
Check out live aquatic plant display in Birge lobby.
‘ANA’ Basal Angiosperms

*Nymphaeaceae – water lilies

Nuphar = ANA

Nelumbo = eudicot

Order Nymphaeales once included all these 3 genera
all are unrelated!

Ceratophyllum = basal angiosperm
‘ANA’ Basal Angiosperms

*Nymphaeaceae – water lilies

Nymphaea odorata - water lily

- showy flowers with strong scent attracting animals
- many parts at each whorl
- laminar stamens
'ANA’ Basal Angiosperms

*Nymphaeaceae – water lilies

CA 4∞ CO ∞ A ∞ G (∞)

• showy flowers with strong scent attracting animals
• many parts at each whorl
• laminar stamens
• superior, syncarpic pistil!
‘ANA’ Basal Angiosperms

*Nymphaeaceae – water lilies

*Nuphar variegata - yellow pond lily

- petaloid sepals, petals reduced
‘ANA’ Basal Angiosperms

Amazonian *Victoria* with peltate leaves
‘ANA’ Basal Angiosperms

Cabombaceae - 2 genera often placed in Nymphaeaceae

Brasenia shreberi - water shield

- small clonal floating aquatic
- peltate leaves
- wind pollinated
‘ANA’ Basal Angiosperms

Cabombaceae - 2 genera often placed in Nymphaeaceae

*Cabomba* - fanwort

- submersed and floating leaved
- dimorphic leaves
- insect pollinated
‘ANA’ Basal Angiosperms

Molecular phylogeny - secondary increase in floral structures

| # sepals | 3 | 5-14 | 4-5 | 4 | 4 | 4 | 4 |
| # petals | 3 | 10-25 | 8-20 | 4-5 | 8-40 | 50-70 | 20-35 |
| # carpels | 4-18 | 5-20 | 8-14 | 3-15 | 8-35 | 30-40 | 8-16 |
| # stamens | 18-36 | 50-100 | 50-100 | 14-34 | 20-750 | 120-250 | 75-100 |

*Fig. 4.* Floral evolution in water lilies. The pleiomorous flowers of water lilies such as *Nymphaea* are often cited as examples of the unspecialized (primitive) angiosperm floral condition. However, a phylogenetic evaluation of floral morphology in the Nymphaeales indicates several instances of secondary increase. Two highly specialized water lily genera (*Nymphaea, Victoria*) have low sepal number but the highest number of petals, stamens and carpels in the order. Flowers of *Euryale* show a similar pattern but they are adapted for self-pollination. Phylogenetic sequence follows Fig. 2.
Magnoliid Basal Angiosperms

Remainder of basal angiosperms (except monocots & hornwort)

• = Magnoliids (monophyletic)
Magnoliid Basal Angiosperms

Remainder of basal angiosperms (except monocots & hornwort)

- tropical trees or paleoherbs (cordate leaves)
- aromatic - ethereal oils ("ranalian" smell)
- beetle or fly pollination common
Magnoliid Basal Angiosperms

*Magnoliaceae (Magnoliales)

- tropical or warm temperate trees or shrubs with large, pinnate netted, stipulate leaves
- flowers large and solitary

Magnolia grandiflora
Magnoliid Basal Angiosperms

*Magnoliaceae (Magnoliales)

- perianth = tepals spirally arranged
- androecium of laminar stamens
- gynoecium of many separate pistils or carpels

\[ P \infty \quad A \infty \quad G \infty \]
Magnoliid Basal Angiosperms

*Magnoliaceae (Magnoliales)

- fruits of one flower = ‘cone’ or ‘aggregate’ of follicles
- dehiscent along one suture, derived from one carpel (leaf)

![Magnolia grandiflora](image)
Magnoliid Basal Angiosperms

*Magnoliaceae (Magnoliales)

- fruits of one flower = ‘cone’ or ‘aggregate’ of follicles
- dehiscent along one suture, derived from one carpel (leaf)
Magnoliid Basal Angiosperms

*Magnoliaceae (Magnoliales)

*Liriodendron* - tulip tree, yellow poplar - *samara* (winged) fruits
Magnoliid Basal Angiosperms

*Annonaceae (Magnoliales) - custard apples

- large, woody pantropical family
- perianth in 3 sets of three tepals
Magnoliid Basal Angiosperms

*Annonaceae (Magnoliales) - custard apples

- large, woody pantropical family
- perianth in 3 sets of three tepals
- fruits aromatic, aggregates of one carpeled berries

P 3+3+3  A ∞  G ∞

anon, cherimoya, custard-apple
Magnoliid Basal Angiosperms

*Annonaceae (Magnoliales) - custard apples

- *Asimina triloba*: paw-paw
- native to eastern North America
- flowers fly pollinated; fruits banana-like

Ohio paw-paw fair
Magnoliid Basal Angiosperms

Myristicaceae (Magnoliales) - nutmeg

- *Myristica fragrans* - nutmeg, mace
  - mace from aril
  - nutmeg from seed
Magnoliid Basal Angiosperms

Lauraceae (Laurales) - cinnamon, laurel

- aromatic trees or shrubs
- 3 merous flowers

P 3+3 A 3-∞ G 1
Magnoliid Basal Angiosperms

Lauraceae (Laurales) - cinnamon, laurel

- aromatic trees or shrubs
- 3 merous flowers
- fruit 1 seeded berry or drupe

Persea americana
Lauraceae
© G. D. Carr

avocado
Magnoliid Basal Angiosperms

Piperaceae (Piperales) - pepper, pepperomia

- herbs, vines, shrubs, epiphytes, cordate leaves, bi- or unisexual

P 0   A 3+3   G 1
Magnoliid Basal Angiosperms

*Aristolochiaceae (Piperales) - birthwort, wild ginger

- climbing or rhizomatous herbs, cordate leaves
- aromatic, medicinal compounds [“well born” family]

*Aristolochia clematis*
Magnoliid Basal Angiosperms

* Aristolochiaceae (Piperales) - birthwort, wild ginger

- calyx corollloid
- petals absent
- fly pollination
- inferior, syncarpic

CA (3) CO 0 A 6-∞ G (4-6)

hypanthium

A. grandiflora

A. hirta

A. lindneria
Magnoliid Basal Angiosperms

*Aristolochiaceae (Piperales) - birthwort, wild ginger

- *Asarum canadensis* - wild ginger
- creeping rhizome, paired leaves, flowers basal
- rhizome makes candied ginger
- North American Indians used for contraceptive
Magnoliid Basal Angiosperms

*Aristolochiaceae (Piperales) - birthwort, wild ginger

- 3 petals reduced to scales

CA (3) CO 0 A 6-∞ G (4-6)
Magnoliid Basal Angiosperms

*Aristolochiaceae (Piperales) - birthwort, wild ginger

- 3 petals reduced to scales
- seeds with arils, dispersed by ants

CA (3) CO 0 A 6-∞ G (4-6)