# Magnoliophyta - Angiosperms

## Survey of Angiosperms — using APG system

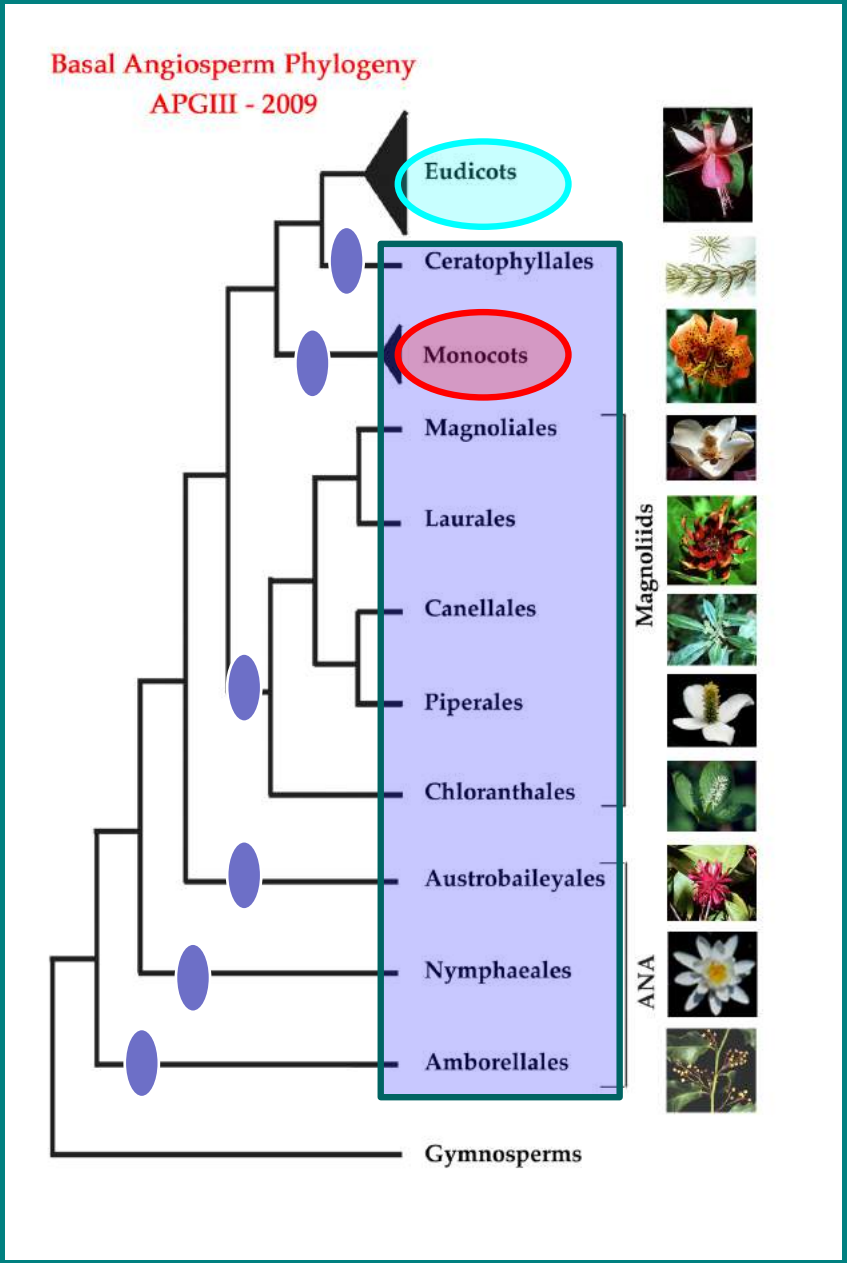
'Basal angiosperms'

- ANA ('basal families')
- magnoliid complex
- monocots

Eudicots or tricolpates (3 pored pollen)

- ranunculids
- caryophyllids
- rosids
- asterids

# Basal Angiosperms




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

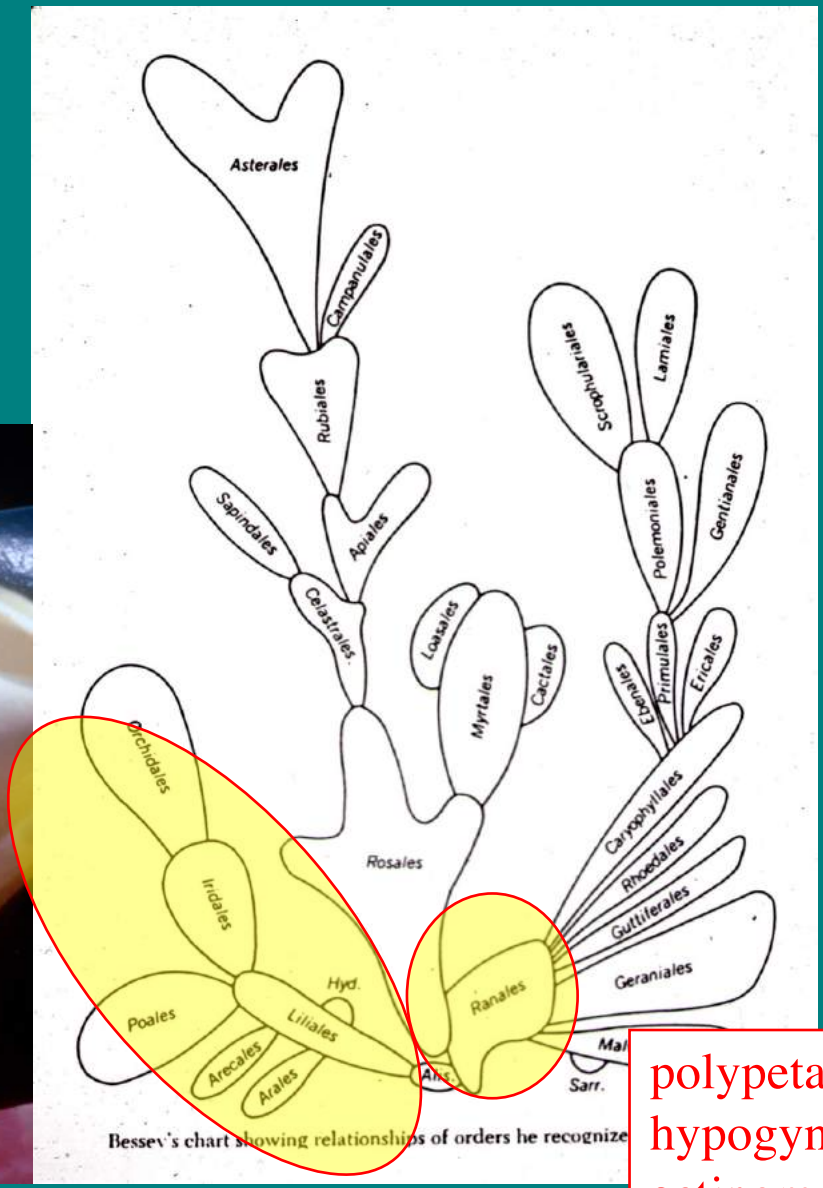
We will look at the monocots - a 'basal angiosperm group' - at the end of the semester

# Basal Angiosperms

What are basal angiosperms?

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

*Magnolia* = primitive




Bessey's chart showing relationships of orders he recognize

polypetaly
hypogyny
actinomorphic

# Basal Angiosperms

What are basal angiosperms?

Exhibit a suite of primitive character states

1. Many parts at each whorl

# Basal Angiosperms

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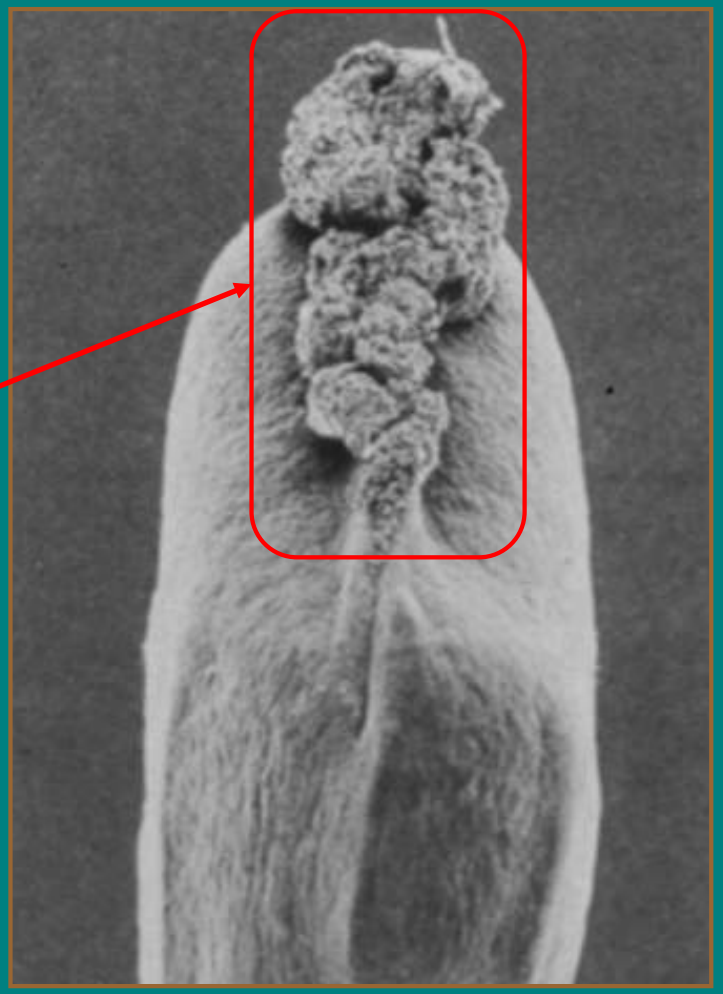
1. Many parts at each whorl
2. Separate, unsealed carpels



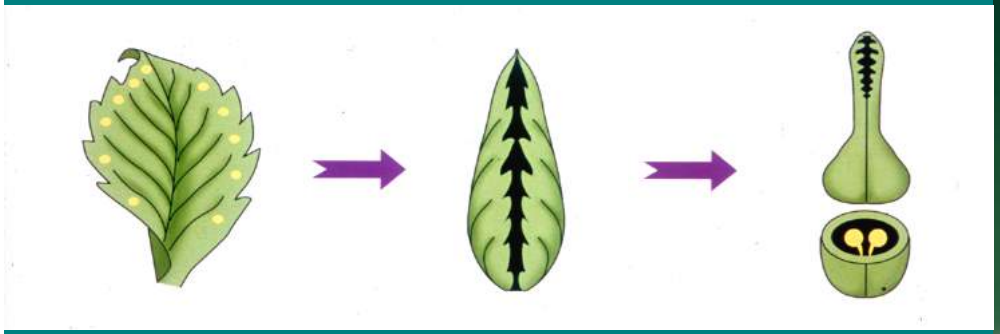
*Drimys* Winteraceae

# 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



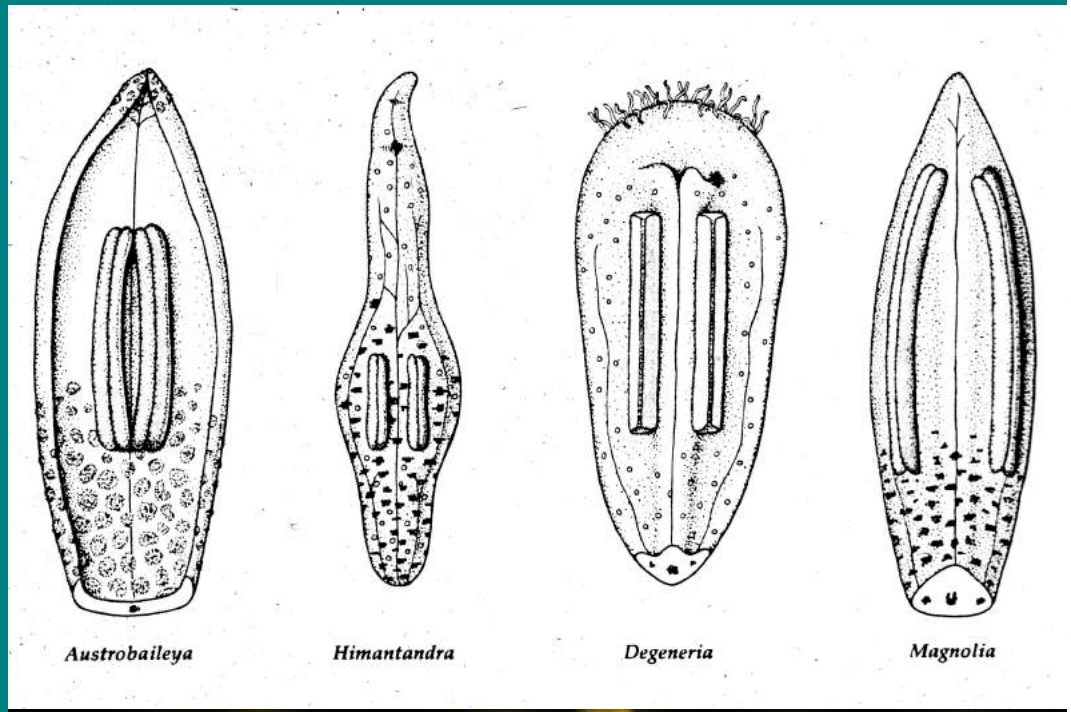
Leaf-like follicles

# 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

# Basal Angiosperms

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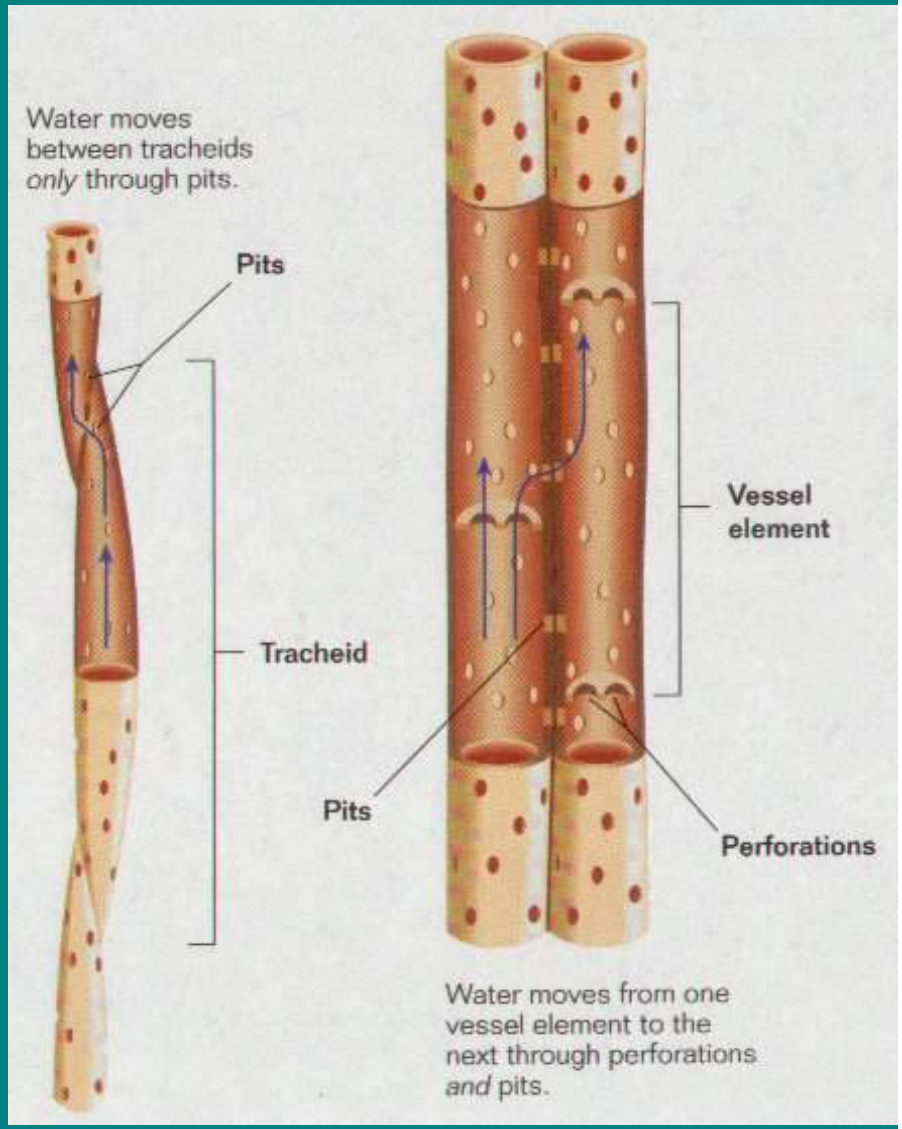
1. Many parts at each whorl
2. Separate, unsealed carpels
3. Follicle fruits
4. Laminar stamens
5. Tracheids, no vessel elements



# Basal Angiosperms

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3. Follicle fruits
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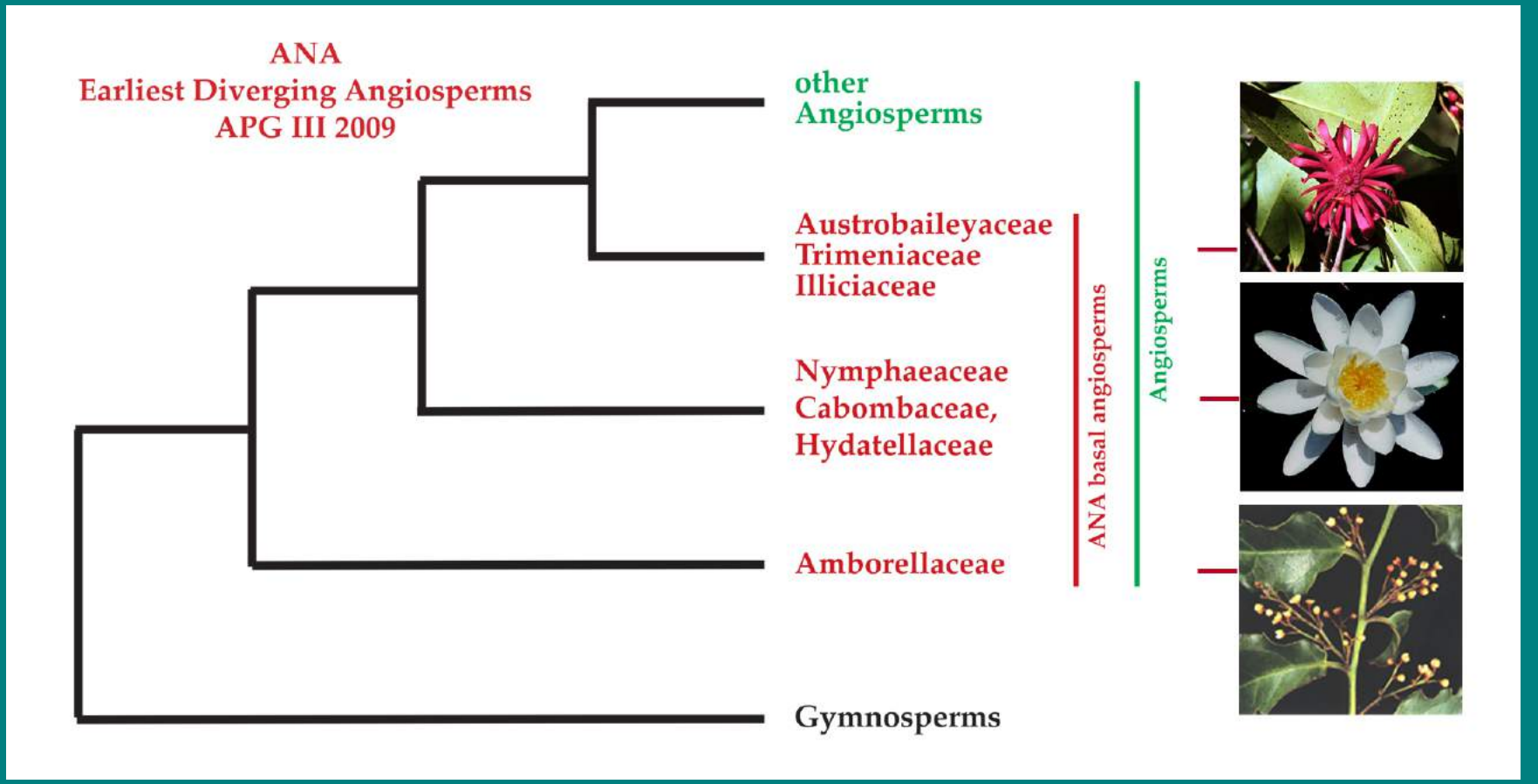
5. Tracheids, no vessel elements
6. Pollen grains single pored, apertured, furrowed; not triaperturate, tricolpate

# ‘ANA’ Basal Angiosperms

The ‘ANA’ group forms a basal grade (paraphyletic)

Name derived from initials of members



# ‘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

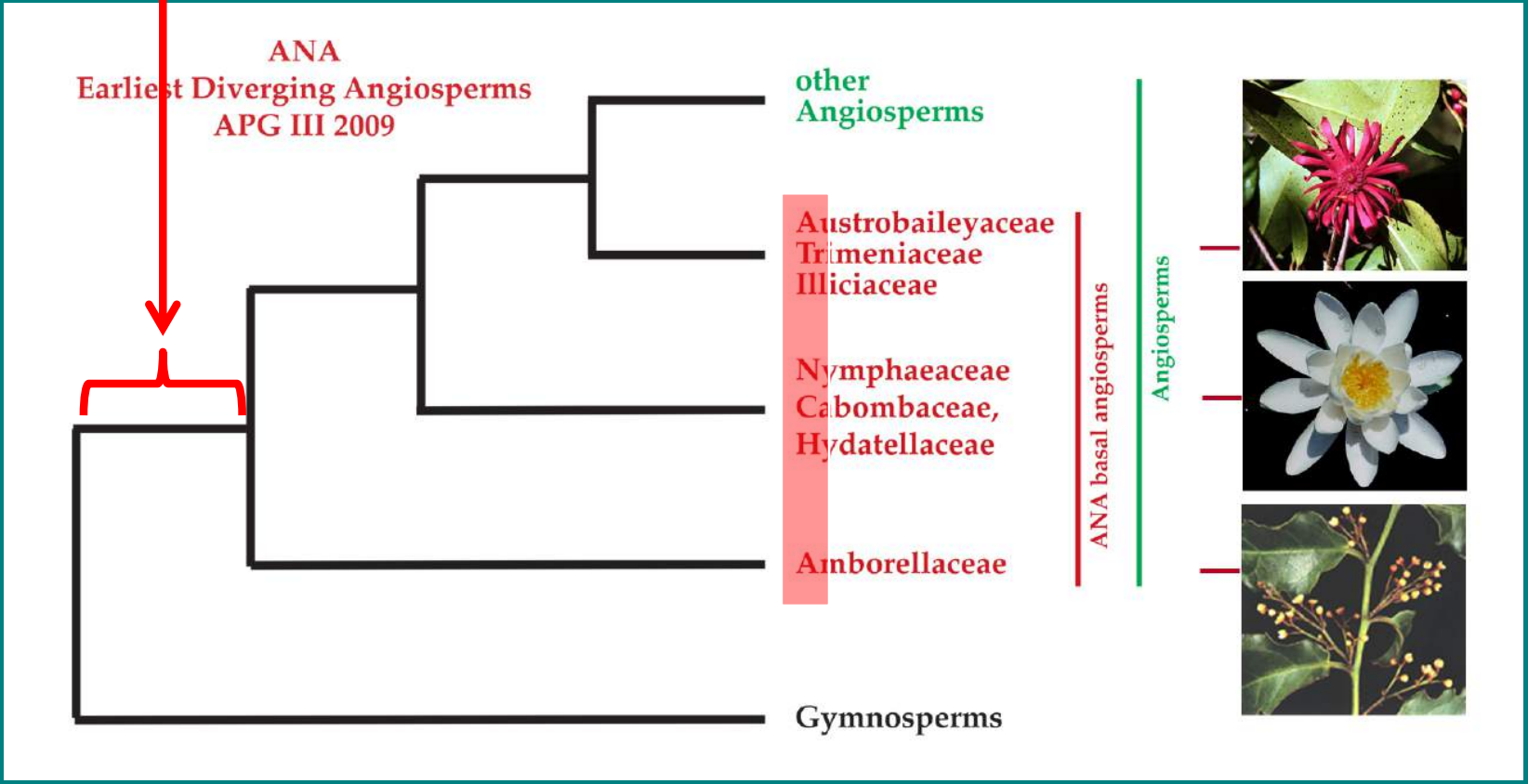
*Amborellaceae (order Amborellales)

- dioecious (unisexual) evergreen shrub with no vessels
- P 5-8 A ∞ 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*?

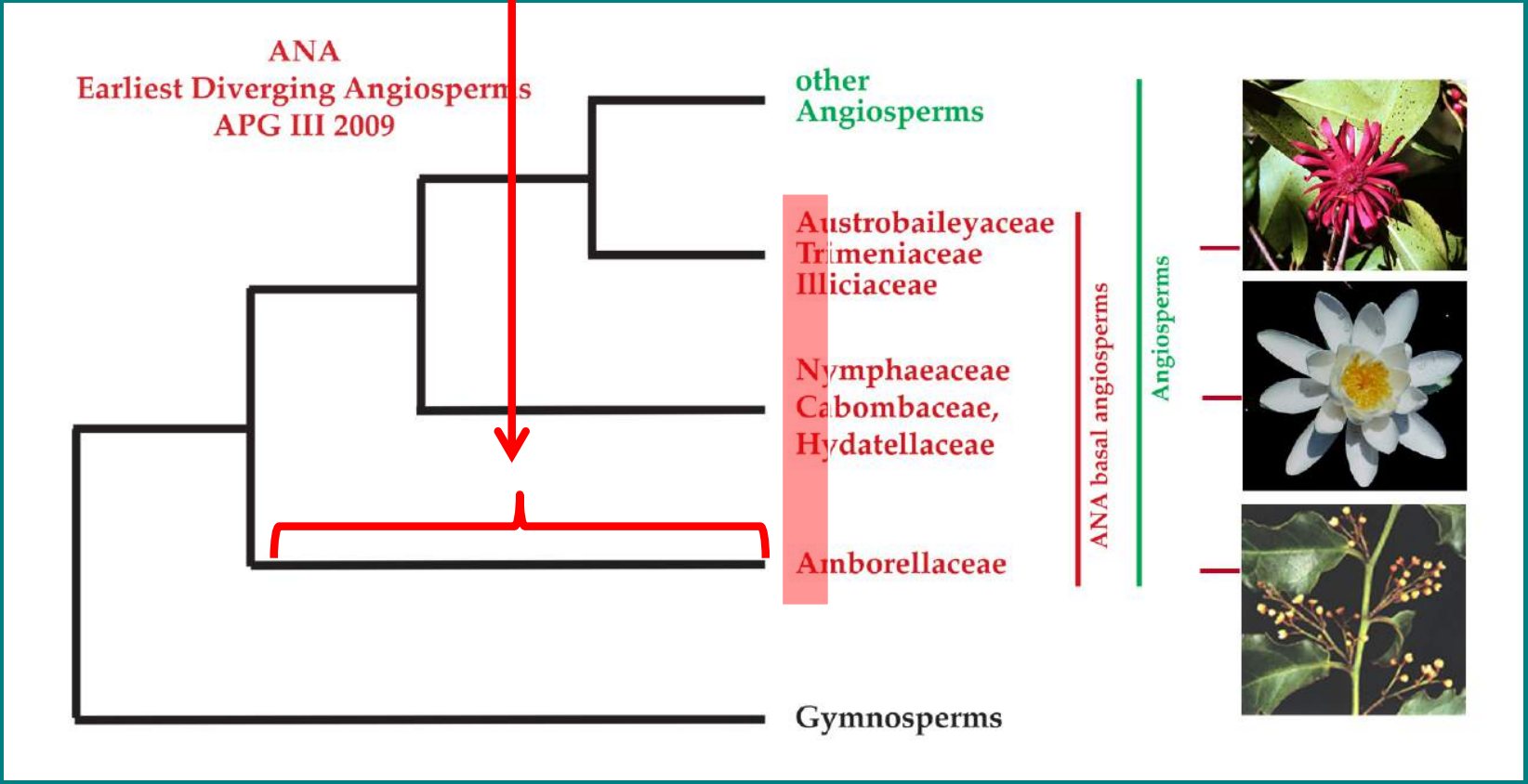


# ‘ANA’ Basal Angiosperms

Answer: not necessarily

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

Read required paper: Sauquet et al. 2017



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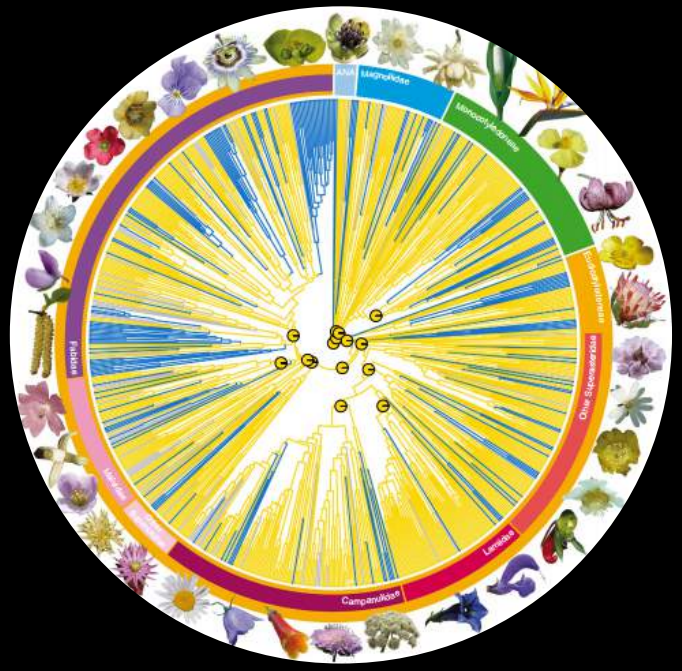
Answer: not necessarily

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

*The ancestral flower of angiosperms and its early diversification.*

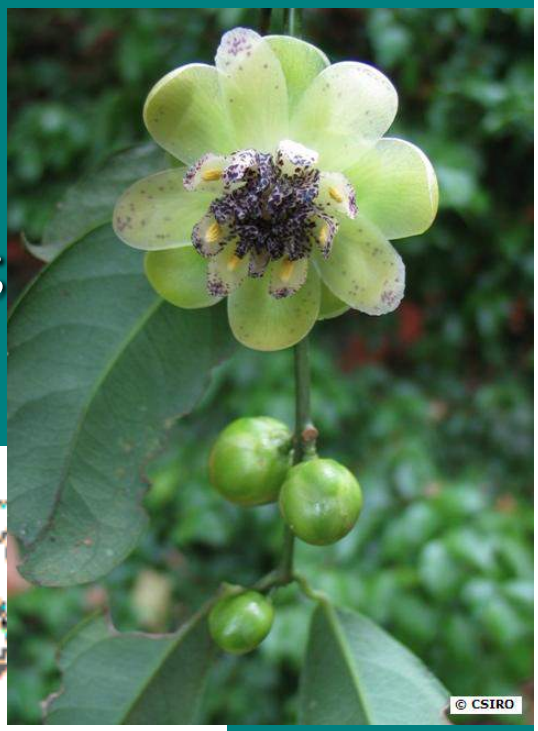


# ‘ANA’ Basal Angiosperms

Austrobaileyaceae: 1 species of tropical Australian evergreen liana

P ∞ A ∞ G ∞

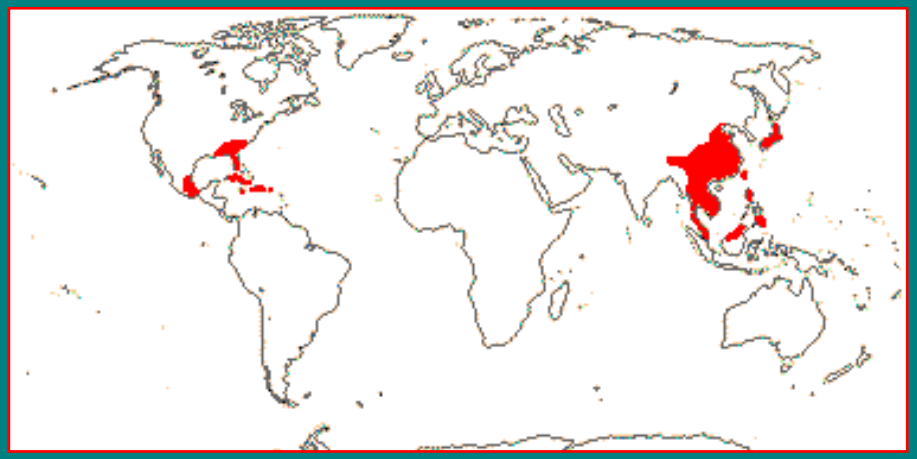
- spiralled tepals; laminar stamens; fly pollinated; apocarpic - berries




# ‘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

P ∞ A ∞ G ∞

- spiralled tepals, not sealed carpels, 1 seeded follicles


# ‘ANA’ Basal Angiosperms

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

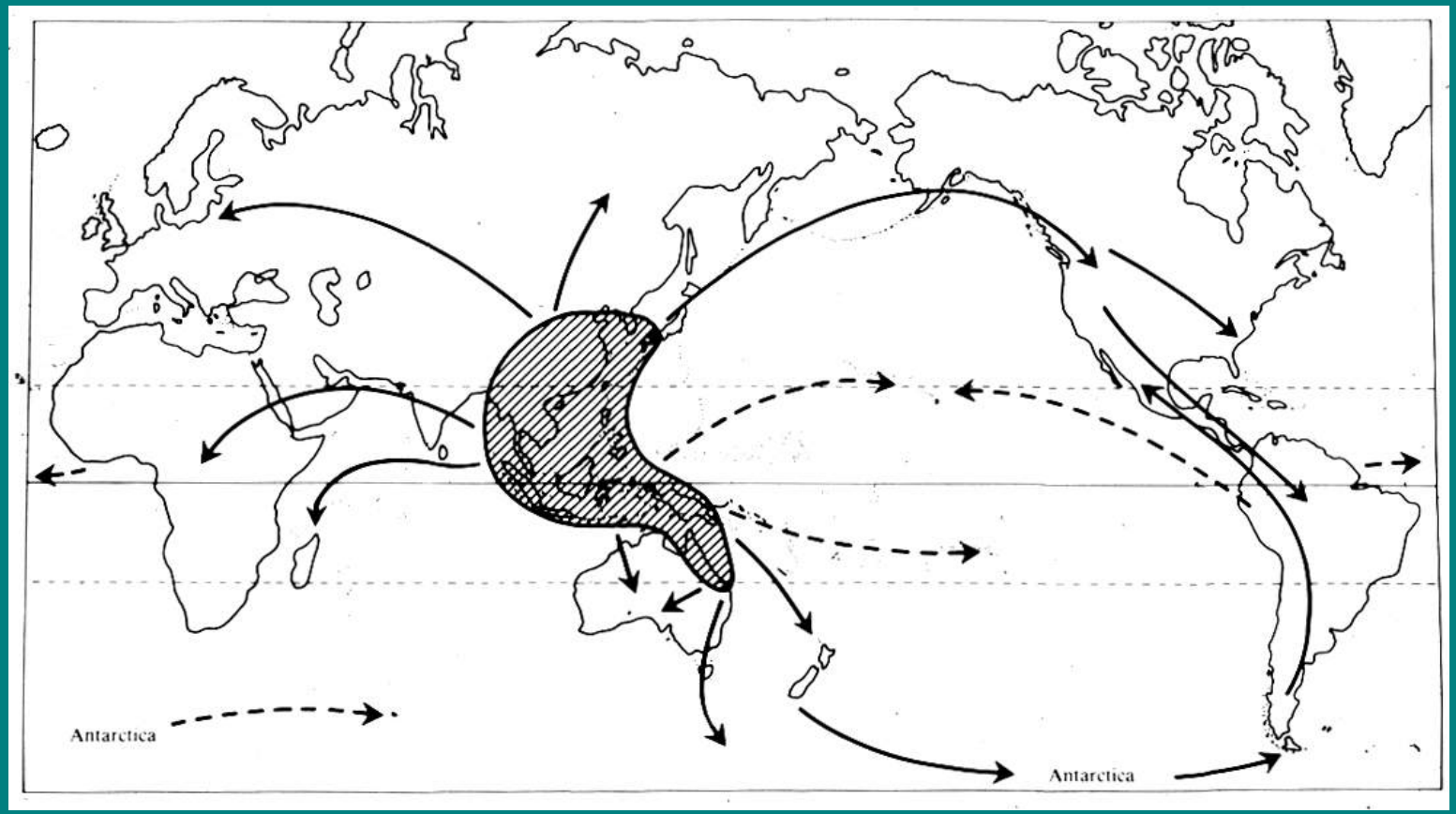
P ∞ A ∞ G 1

- spiralled tepals; filamentous stamens; berry with one ovule


# ‘ANA’ Basal Angiosperms

Biogeographical distributions of the A A 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

Distribution of Nymphaeaceae - water lilies

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

# ‘ANA’ Basal Angiosperms

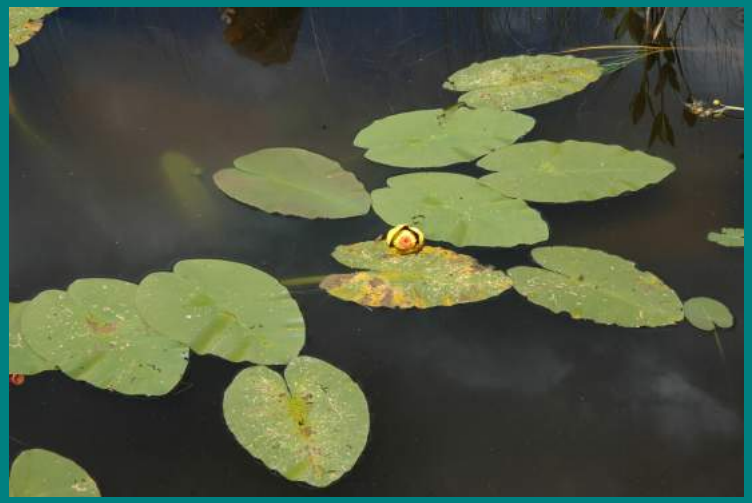
*Nymphaeaceae – water lilies


- 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



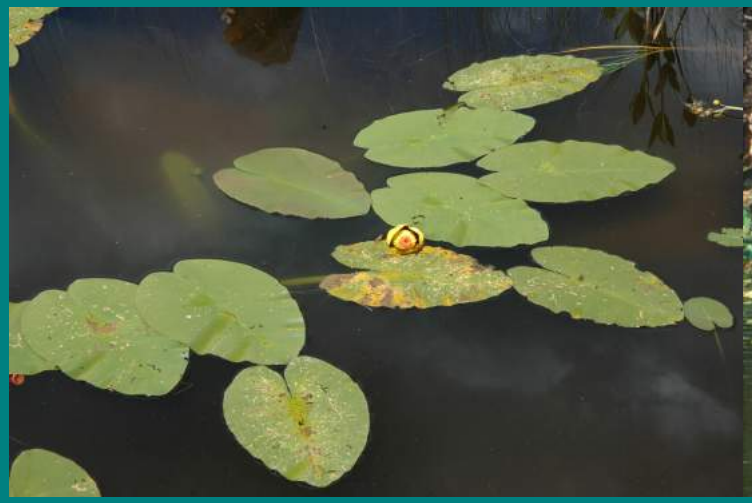
*Nuphar variegatum* -
yellow waterlily
= basal angiosperm

*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


*Ceratophyllum*
= basal angiosperm

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

# ‘ANA’ Basal Angiosperms

*Nymphaeaceae – water lilies

CA 4-∞ CO ∞ A ∞ G (∞)

*Nymphaea odorata* - water lily

- showy flowers with strong scent attracting animals
- many parts at each whorl
- laminar stamens

# ‘ANA’ Basal Angiosperms

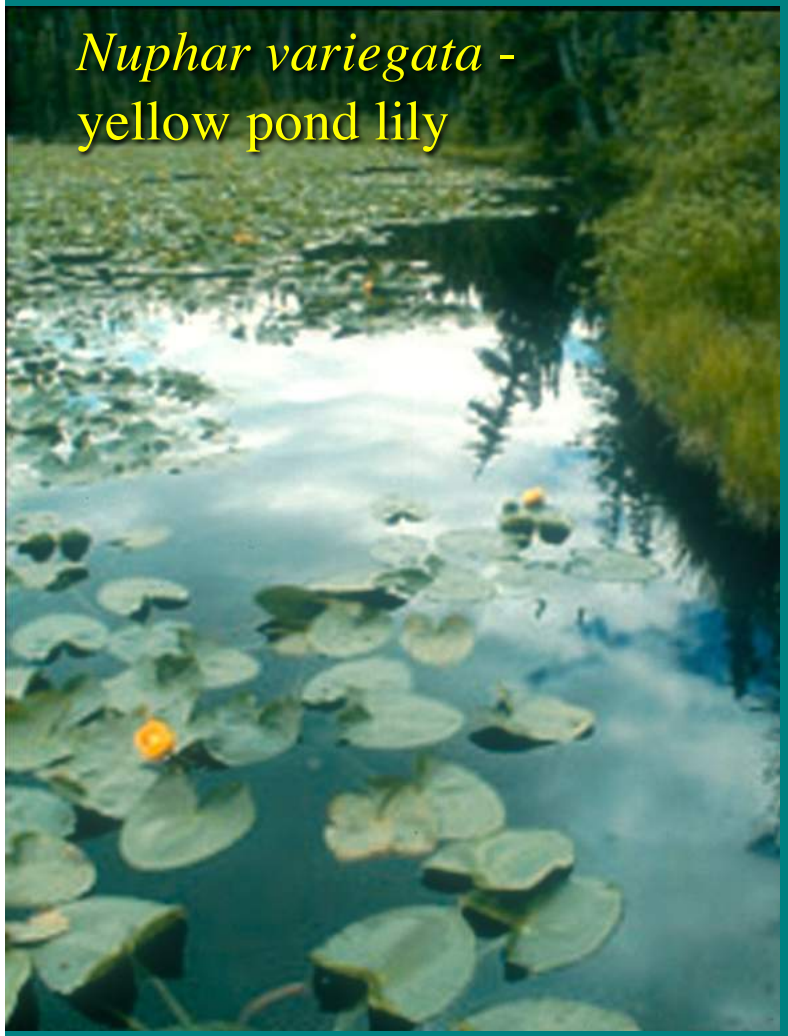
*Nymphaeaceae – water lilies

CA 4-∞ CO ∞ A ∞ G (∞)

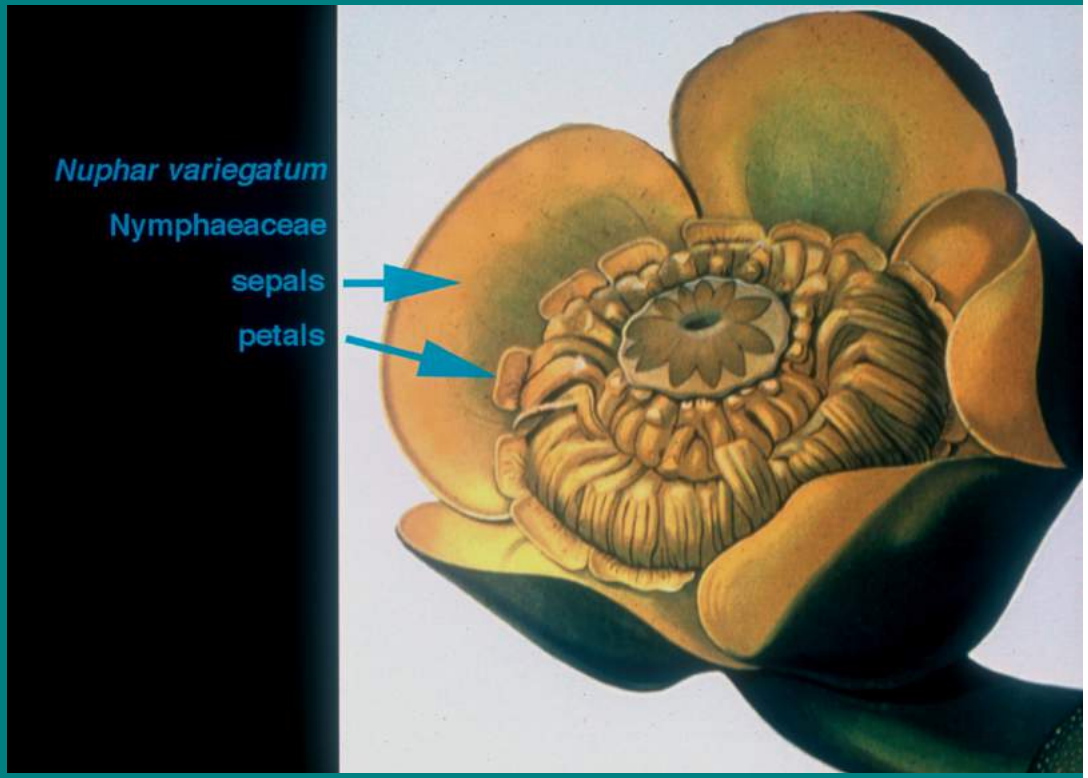
- showy flowers with strong scent attracting animals
- many parts at each whorl
- laminar stamens
- superior, syncarpic pistil !

# ‘ANA’ Basal Angiosperms

*Nymphaeaceae – water lilies




- petaloid sepals, petals reduced



# ‘ANA’ Basal Angiosperms

Amazonian *Victoria* with peltate leaves

# ‘ANA’ Basal Angiosperms

## Cabombaceae - 2 genera often placed in Nymphaeaceae

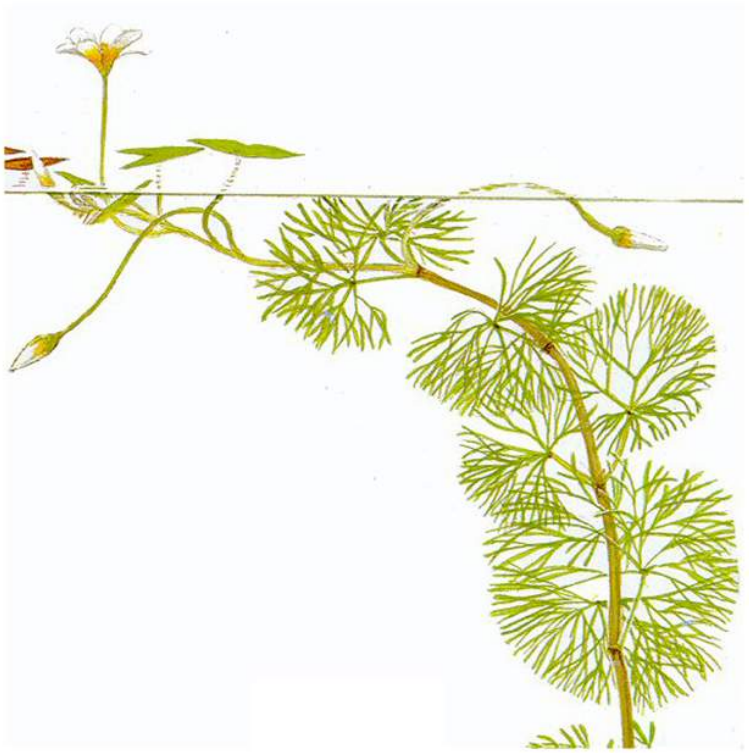
*Brasenia shreberi* - water shield

- small clonal floating aquatic
- peltate leaves
- wind pollinated

# ‘ANA’ Basal Angiosperms

## Cabombaceae - 2 genera often placed in Nymphaeaceae

*Cabomba* - fanwort

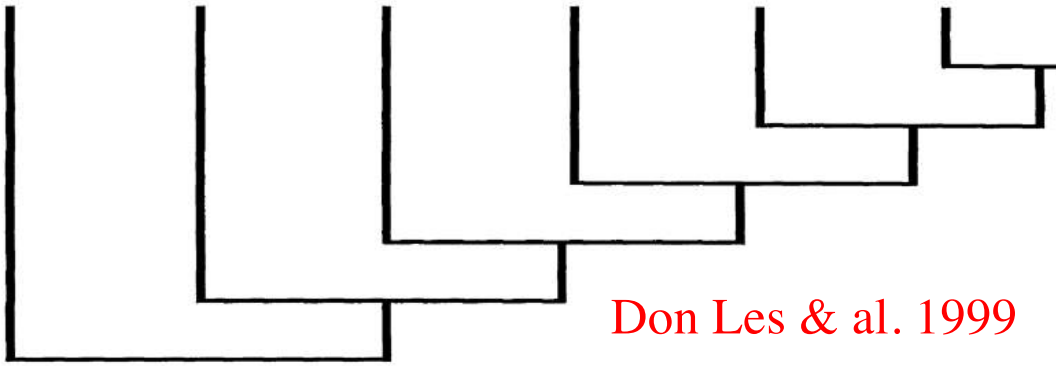


- submersed and floating leaved
- dimorphic leaves
- insect pollinated

# ‘ANA’ Basal Angiosperms

## Molecular phylogeny - secondary increase in floral structures

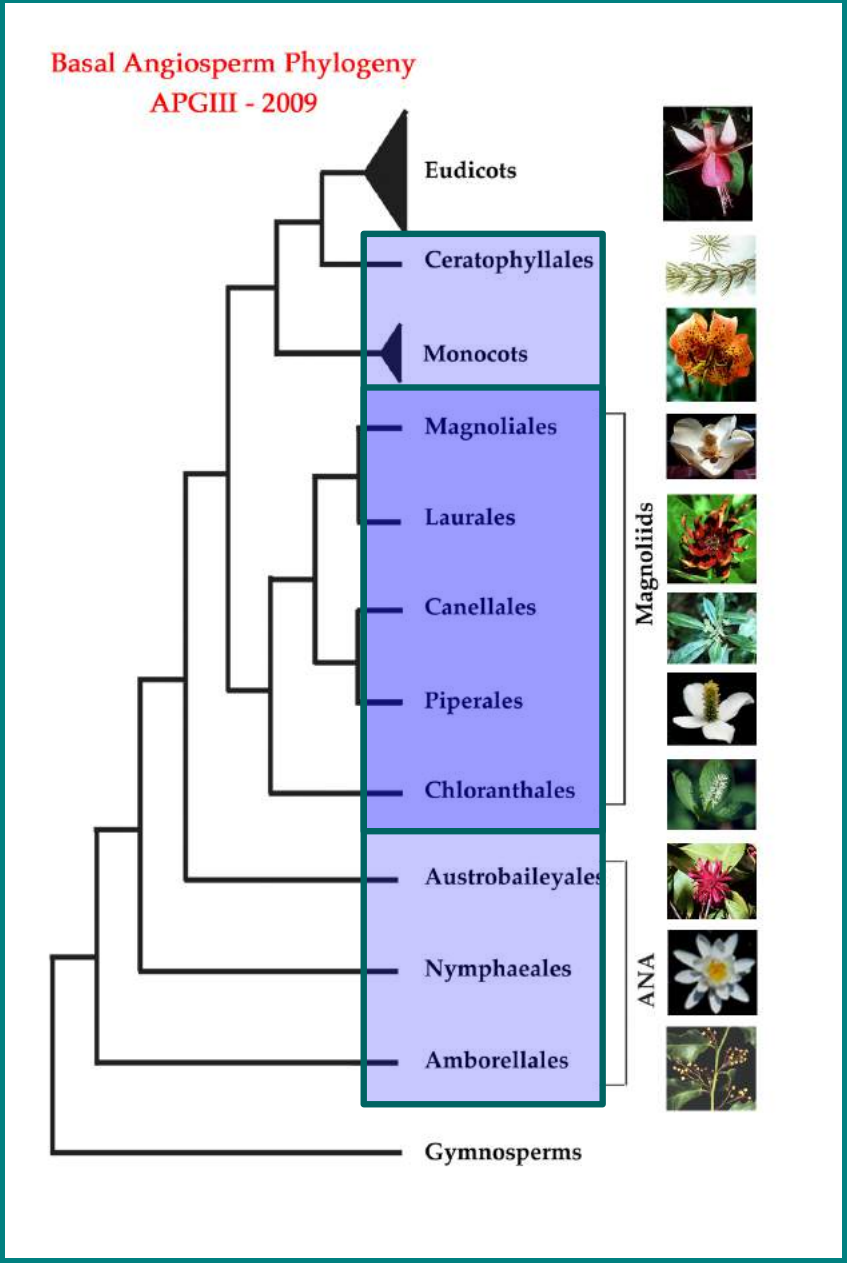
| | *Cabombaceae* | *Nuphar* | *Barclaya* | *Ondinea* | *Nymphaea* | *Victoria* | *Euryale* |
|---|---|---|---|---|---|---|---|
| # sepals | 3 | 5-14 | 4-5 | 4 | 4 | 4 | 4 |
| # petals | 3 | 10-25 | 8-20 | 4-5 | 8-40 | 50-70 | 20-35 |
| # carpels | 4-18 | 5-20 | 8-14 | 3-15 | 8-35 | 30-40 | 8-16 |
| # stamens | 18-36 | 50-100 | 50-100 | 14-34 | 20-750 | 120-250 | 75-100 |



Don Les & al. 1999

FIG. 4. Floral evolution in water lilies. The pleiomerous 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)

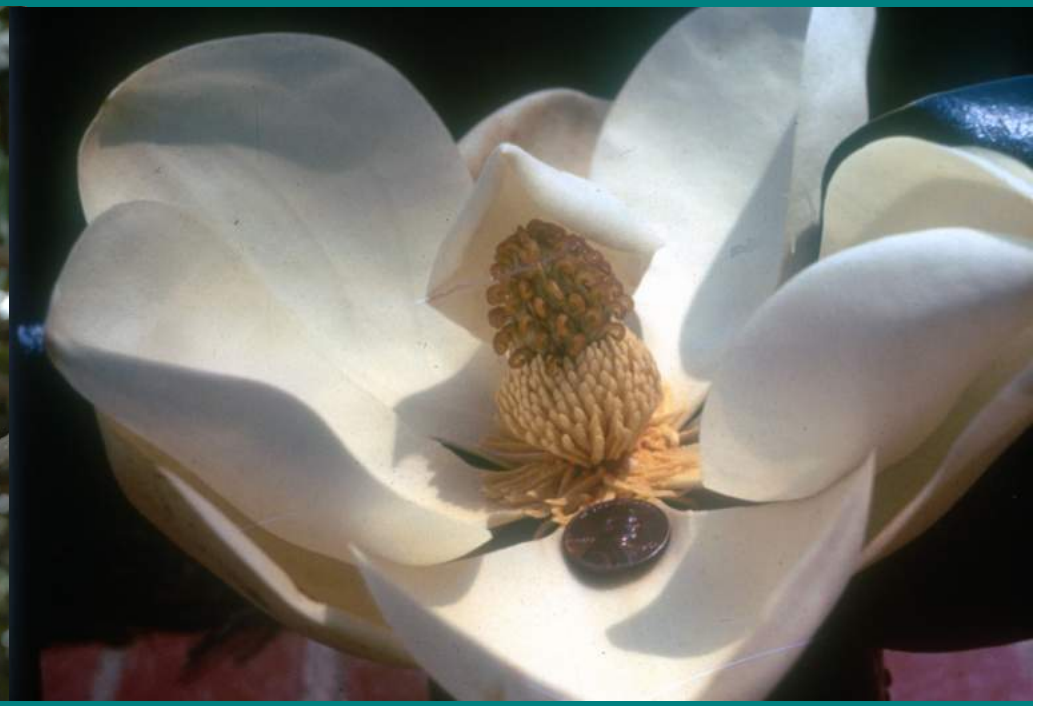
- tropical trees or paleoherbs (cordate leaves)
- aromatic - ethereal oils ("ranalian" smell)
- beetle or fly pollination common


# Magnoliid Basal Angiosperms

*Magnoliaceae (Magnoliales)

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

*Magnolia grandiflora*

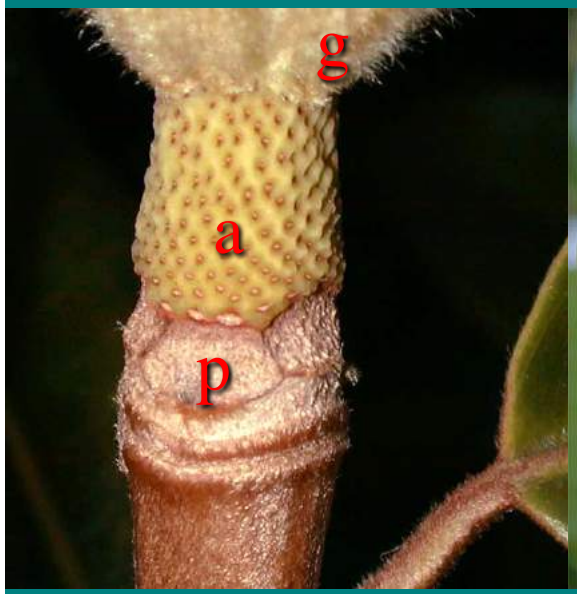


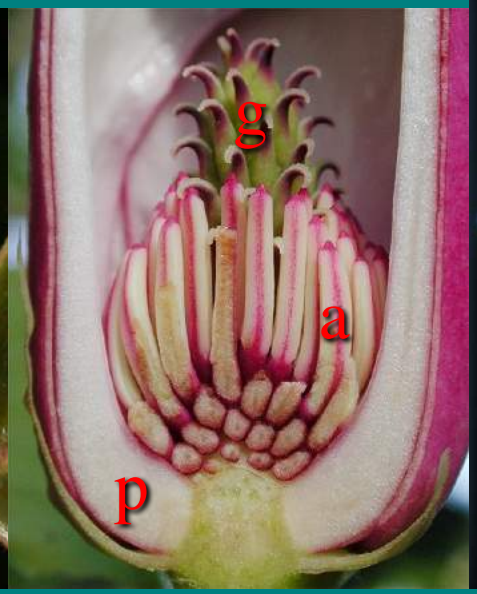
# Magnoliid Basal Angiosperms

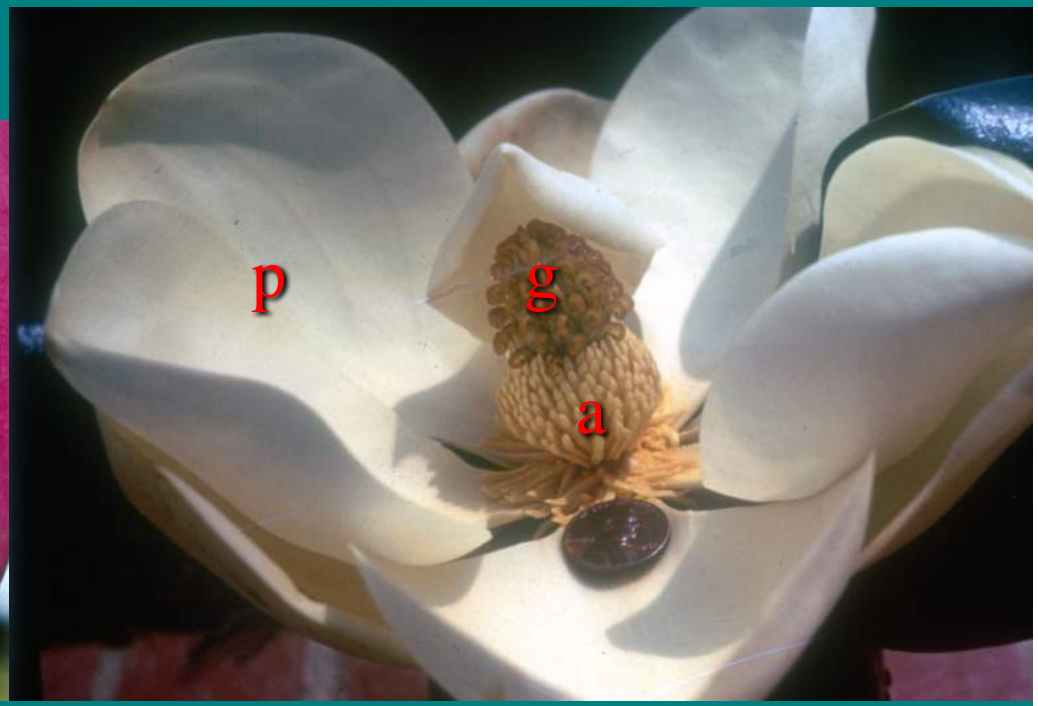
*Magnoliaceae (Magnoliales)

P ∞ A ∞ G ∞

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



# Magnoliid Basal Angiosperms

*Magnoliaceae (Magnoliales)

P ∞ A ∞ G ∞

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



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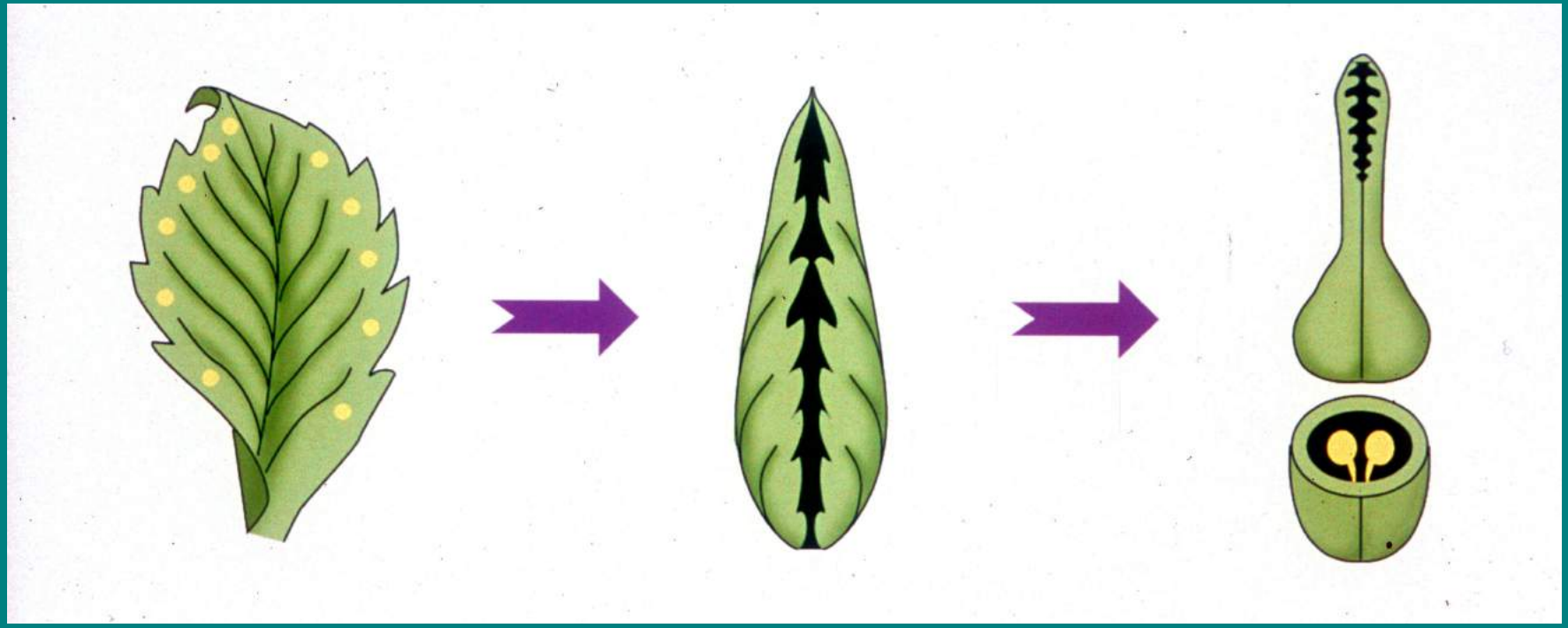
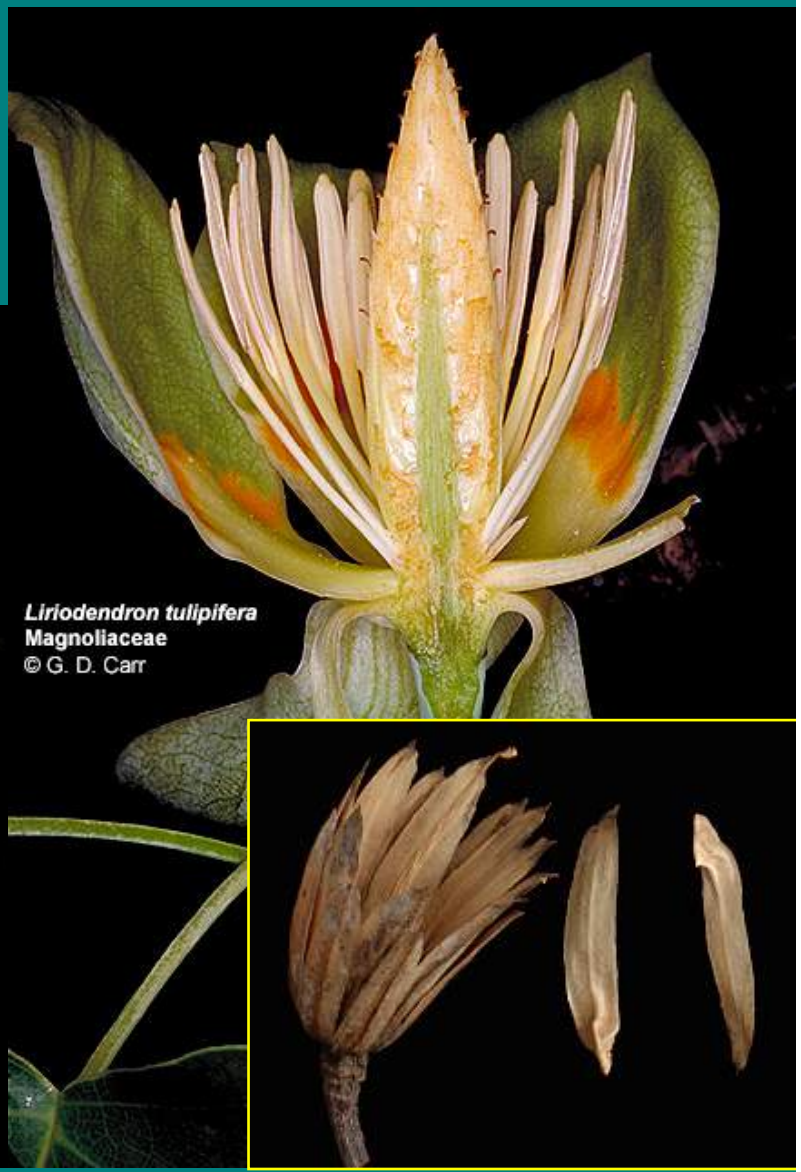


# Magnoliid Basal Angiosperms

*Magnoliaceae (Magnoliales)

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

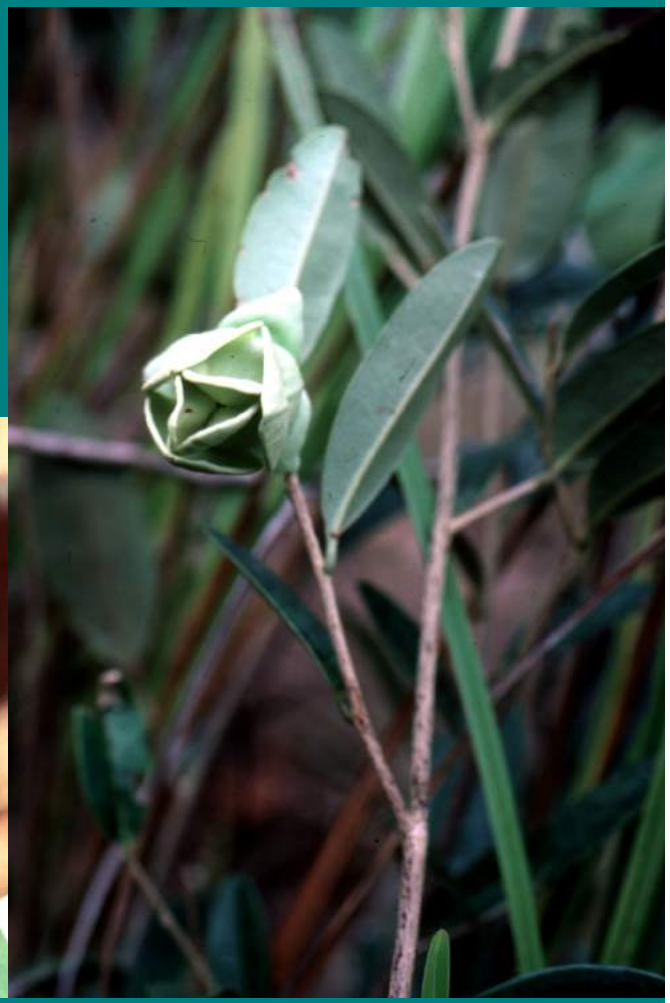



# Magnoliid Basal Angiosperms

*Annonaceae (Magnoliales) - custard apples

P 3+3+3 A ∞ G ∞

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



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*Annonaceae (Magnoliales) - custard apples

P 3+3+3 A ∞ G ∞

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

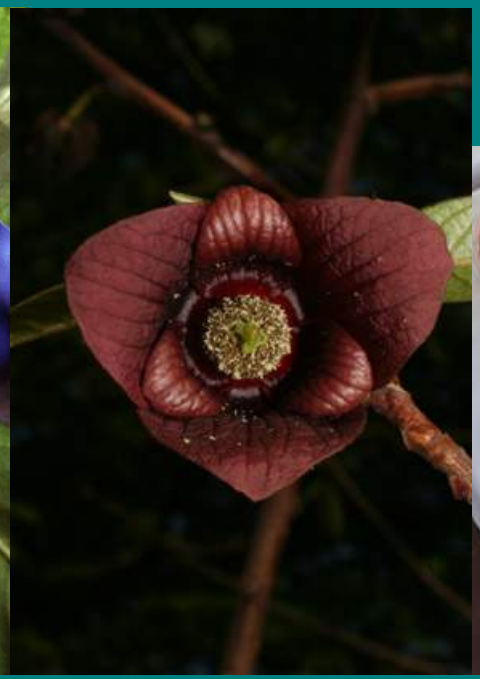
anon, cherimoya, custard-apple


# Magnoliid Basal Angiosperms

*Annonaceae (Magnoliales) - custard apples

P 3+3+3 A ∞ G ∞

- *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

P 3+3 A 3-∞ G 1

- aromatic trees or shrubs
- 3 merous flowers


# Magnoliid Basal Angiosperms

## Lauraceae (Laurales) - cinnamon, laurel

P 3+3 A 3-∞ G 1

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


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]

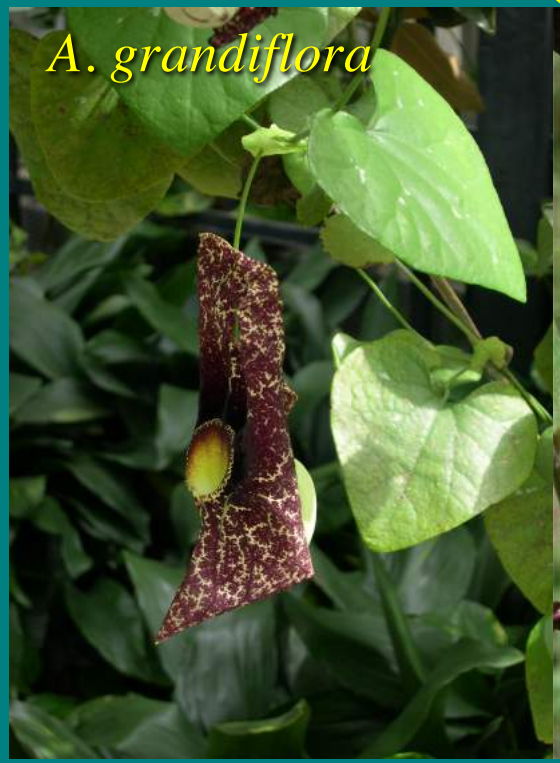

# Magnoliid Basal Angiosperms

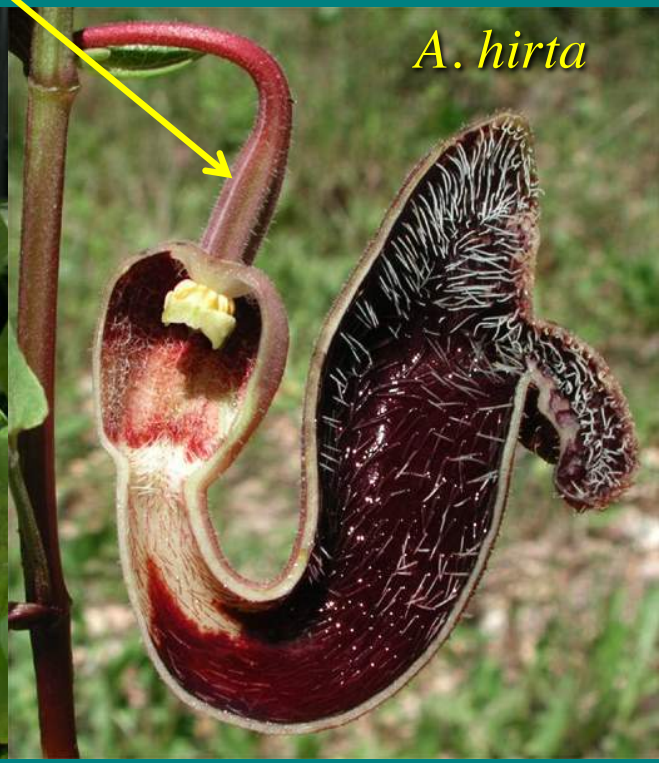
*Aristolochiaceae (Piperales) - birthwort, wild ginger

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

CA (3) CO 0 A 6-∞ G (4-6)

hypanthium

# 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

CA (3) CO 0 A 6-∞ G (4-6)

- 3 petals reduced to scales

# Magnoliid Basal Angiosperms

*Aristolochiaceae (Piperales) - birthwort, wild ginger

CA (3) CO 0 A 6-∞ G (4-6)

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