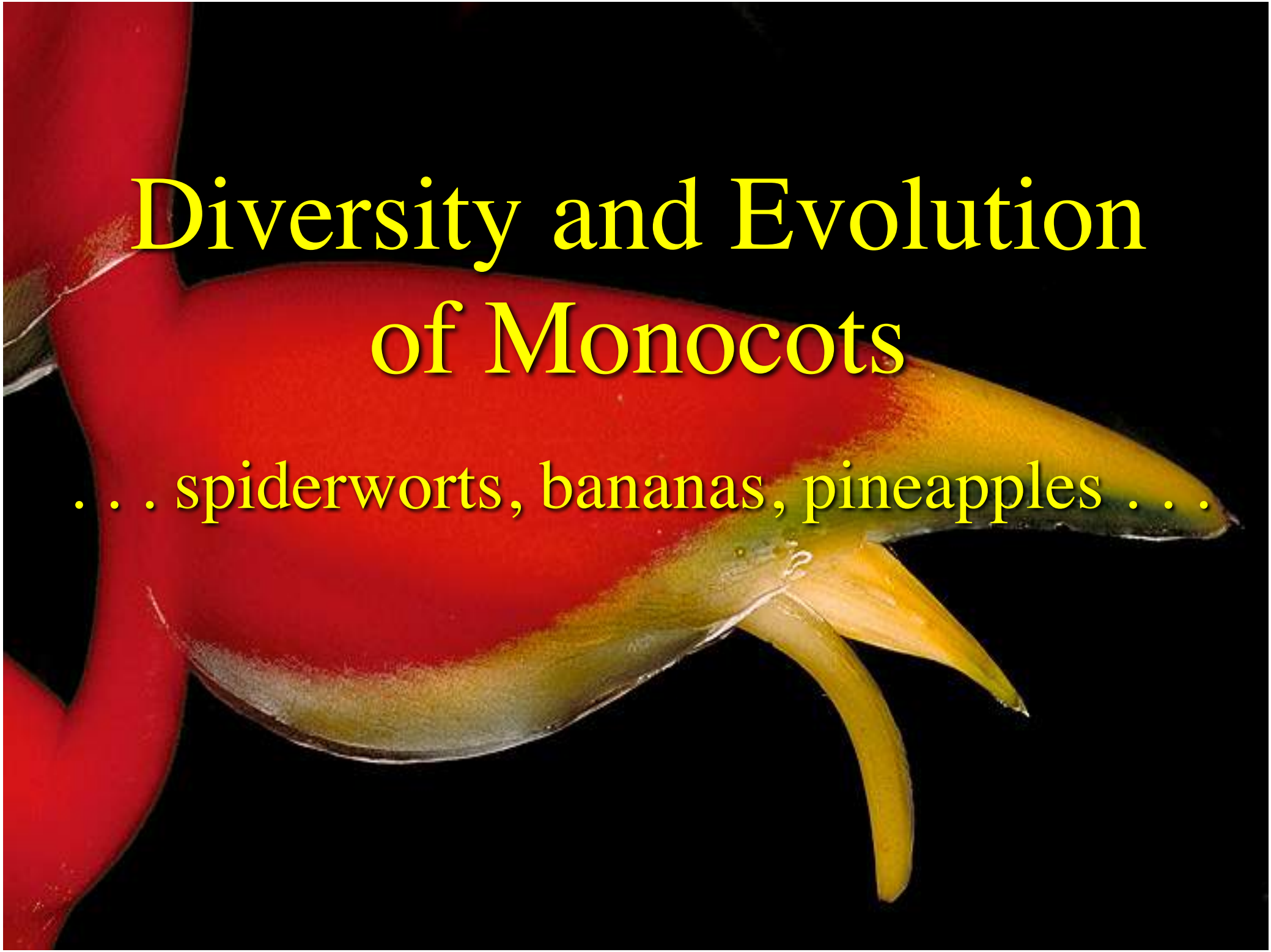


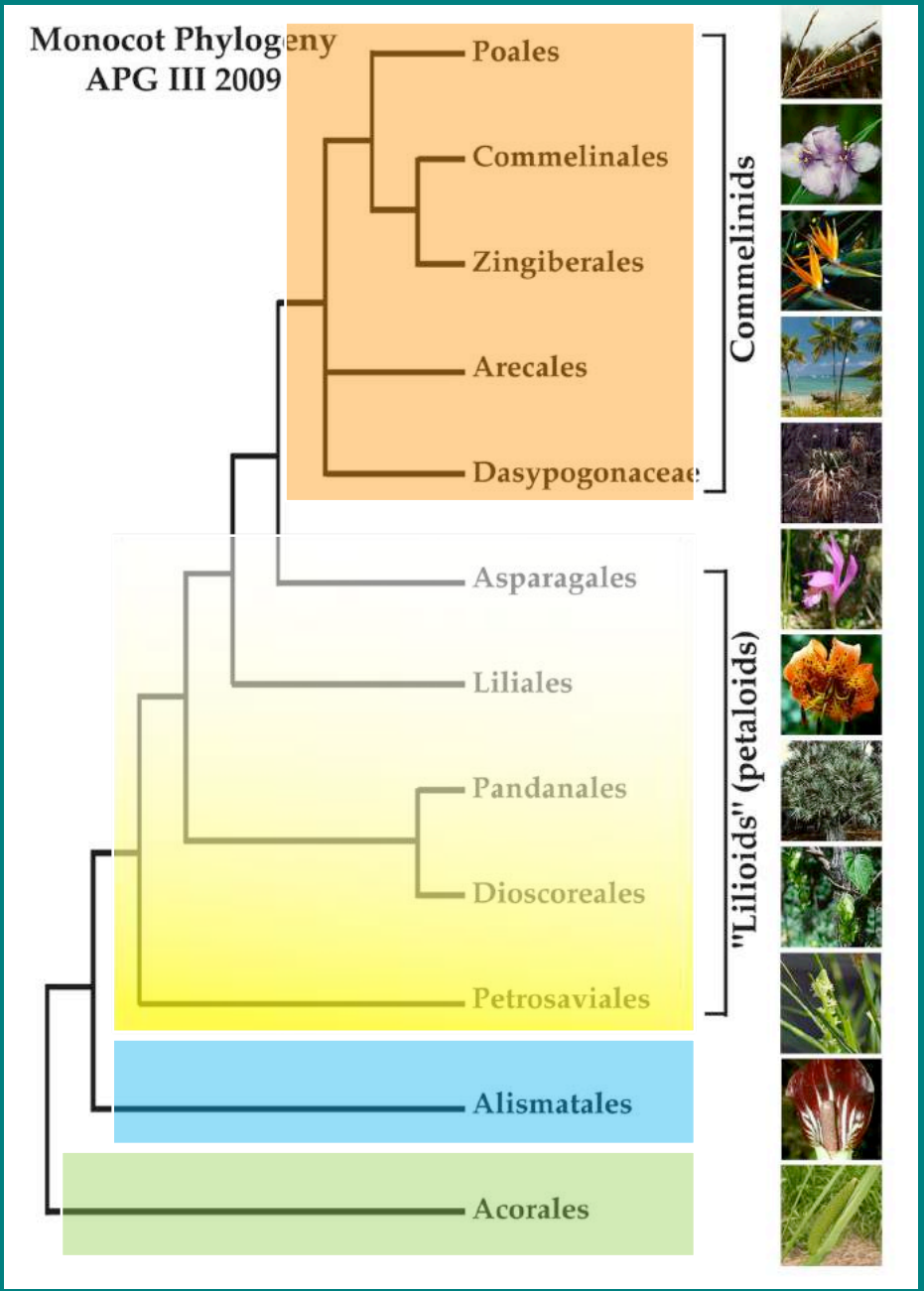
Diversity and Evolution of Monocots

. . . spiderworts, bananas, pineapples . . .

Commelinids

4 main groups:

- Acorales - sister to all monocots
- Alismatids
  - inc. Aroids - jack in the pulpit
- Lilioids (lilies, orchids, yams)
  - non-monophyletic
  - petaloid
- Commelinids
  - Arecales – palms
  - Commelinales – spiderwort
  - Zingiberales –banana
  - Poales
    - pineapple
    - grasses & sedges



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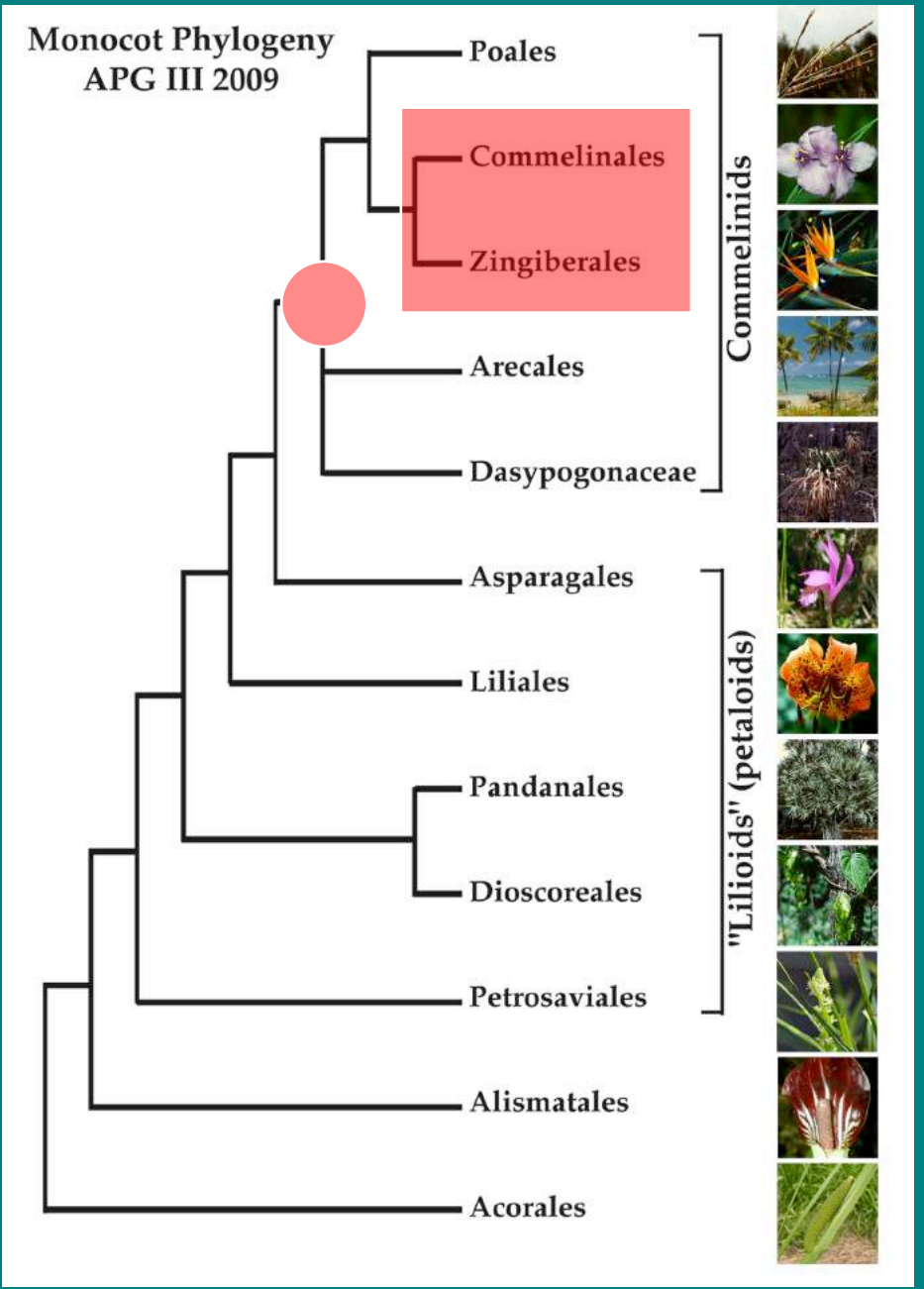
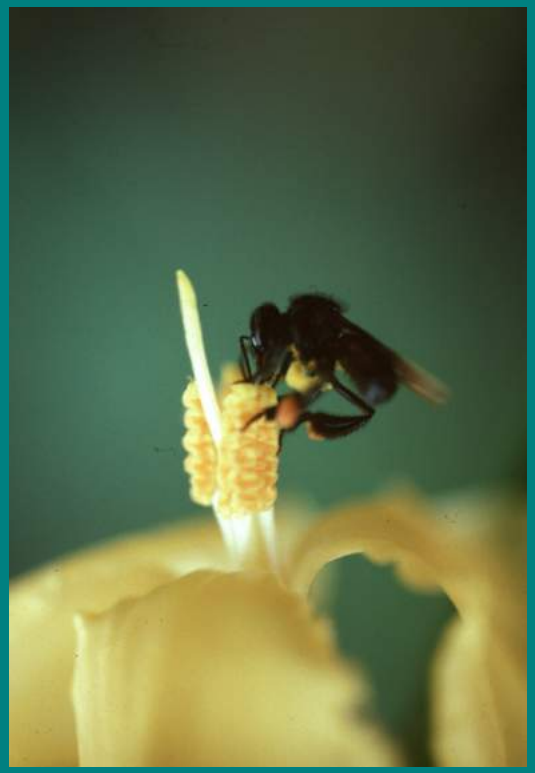


Commelinids

- theme: reduction of flower, loss of nectar, loss of zoophily, evolution of bracts

pickeral weed



rapatead

Commelinales + Zingiberales

- 2 closely related tropical orders
- primarily nectar bearing but with losses
- bracted inflorescences

pickeral weed

nectar

spiderwort

pollen only

heliconia

bracts

Commelinaceae - spiderwort

Commelina erecta - Erect dayflower

Family of small herbs with succulent stems, stems jointed; leaves sheathing. Family does not produce nectar, but showy flowers for insect pollen gathering.

Tradescantia ohiensis - spiderwort

Commelinaceae - spiderwort

Rhoeo - Moses in a cradle

Inflorescence often bracted

Tradescantia ohiensis - spiderwort

Commelinaceae - spiderwort

Flowers actinomorphic or zygomorphic

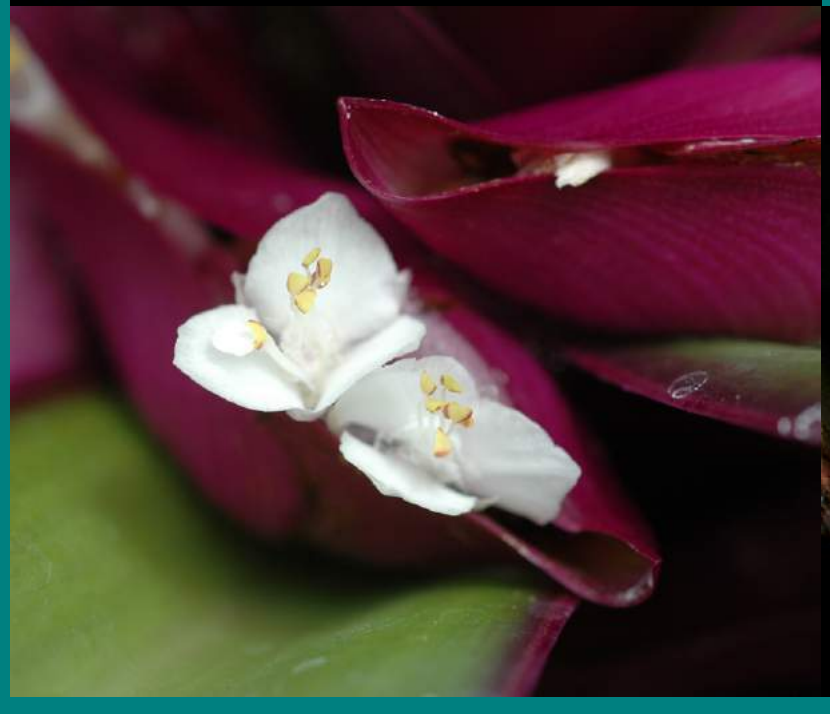
CA 3 CO 3 A 6 G (3)

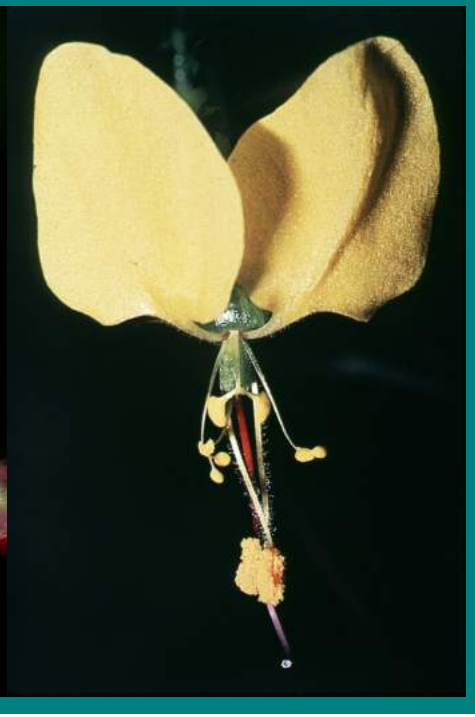
Commelina communis - day flower

Tradescantia ohiensis - spiderwort

Commelinaceae - spiderwort

- species rich in pantropics, especially Africa
- floral diversity is enormous





Pontederiaceae - pickerel weed

Aquatic family of emergents or floaters. Water hyacinth (*Eichhornia*) from tropical America is invasive species in subtropical areas of the world.

Eichhornia crassipes
Water hyacinth
invading Florida

Pontederiaceae - pickerel weed

Pickerel weed has glossy heart-shaped leaves,
superficially like *Sagittaria* but without net venation.
Flowers are in congested showy purple inflorescences.

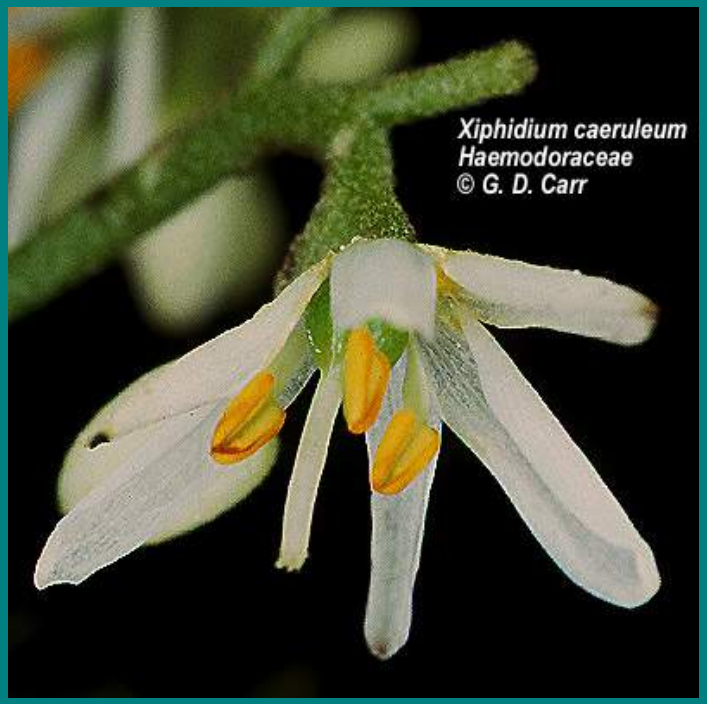
Pontederia cordata - Pickerel weed

Pontederiaceae - pickerel weed

Pontederia cordata - Pickerel weed

Flowers are showy, insect pollinated with nectar glands - previously placed in Liliales!

Haemodoraceae - kangaroo paw



Anigozanthus - kangaroo paw

Small family with floral nectar, species radiations in Australia and South Africa

Zingiberales

- strongly supported group of 8 tropical families
- rhizomatous monocots with showy, nectared, but highly bracted flowers
- 3 shared features:

1. Parallel-pinnate leaves, often distichous

Zingiberales

- strongly supported group of 8 tropical families
- rhizomatous monocots with showy, nectared, but highly bracted flowers
- 3 shared features:

2. Bracted flowers and inflorescences

Zingiberales

- strongly supported group of 8 tropical families
- rhizomatous monocots with showy, nectared, but highly bracted flowers
- 3 shared features:

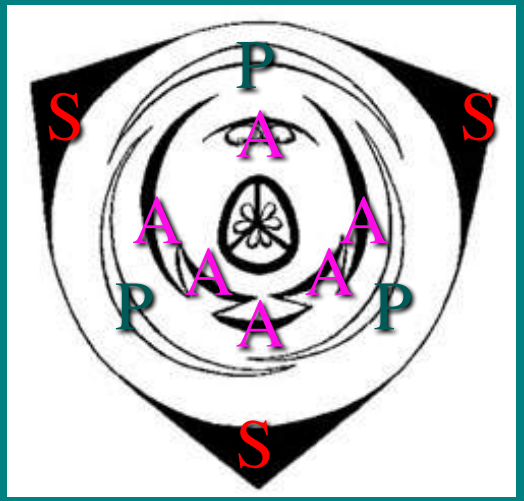
3. Inferior ovary

Zingiberales

- order fairly well known based on DNA and morphology
- show interesting trends in (1) fusion of perianth and (2) stamen loss and staminode development

DNA-based Zingiberales "rhizogram" by John Kress

Costus floral pattern



3 fused sepals

3 separate petals

5 fused sterile anthers (labellum)

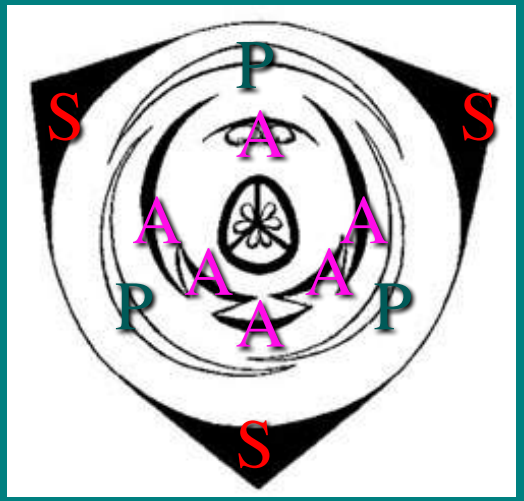
1 fertile anther

Zingiberales

- order fairly well known based on DNA and morphology
- show interesting trends in (1) fusion of perianth and (2) stamen loss and staminode development

Chelsea Specht has rearranged the rhizogram

Costus floral pattern



3 fused sepals

3 separate petals

5 fused sterile anthers (labellum)

1 fertile anther

Zingiberales

Musaceae - banana

- robust herbs with spiralled phyllotaxy
- fleshy fruits

Musa X *paradisica*
(sterile triploid)
cultivated banana

Zingiberales

Musaceae - banana

- unisexual flowers
- "tubular" flowers [3 sepals + 2 petals]
- 5 fertile stamens

Zingiberales

Strelitziaceae - bird of paradise

- woody trunks (usually) with distichous leaves
- 2 fused petals (elaborated flowers for different pollination systems: bird, lemur, bat)
- 5 or 6 fertile stamens

Zingiberales

Strelitziaceae - bird of paradise

- 3 genera of Gondwanan distribution

Phenakospermum
Guayana Shield

Ravenala
Madagascar

Strelitzia
South Africa

Zingiberales

Lowiaceae - orchidantha

- 1 genus
- perianth tube = 3 sepals
- 1 petal = "labellum"
- 5 fertile stamens

Orchidantha of SE Asia and Pacific

Zingiberales

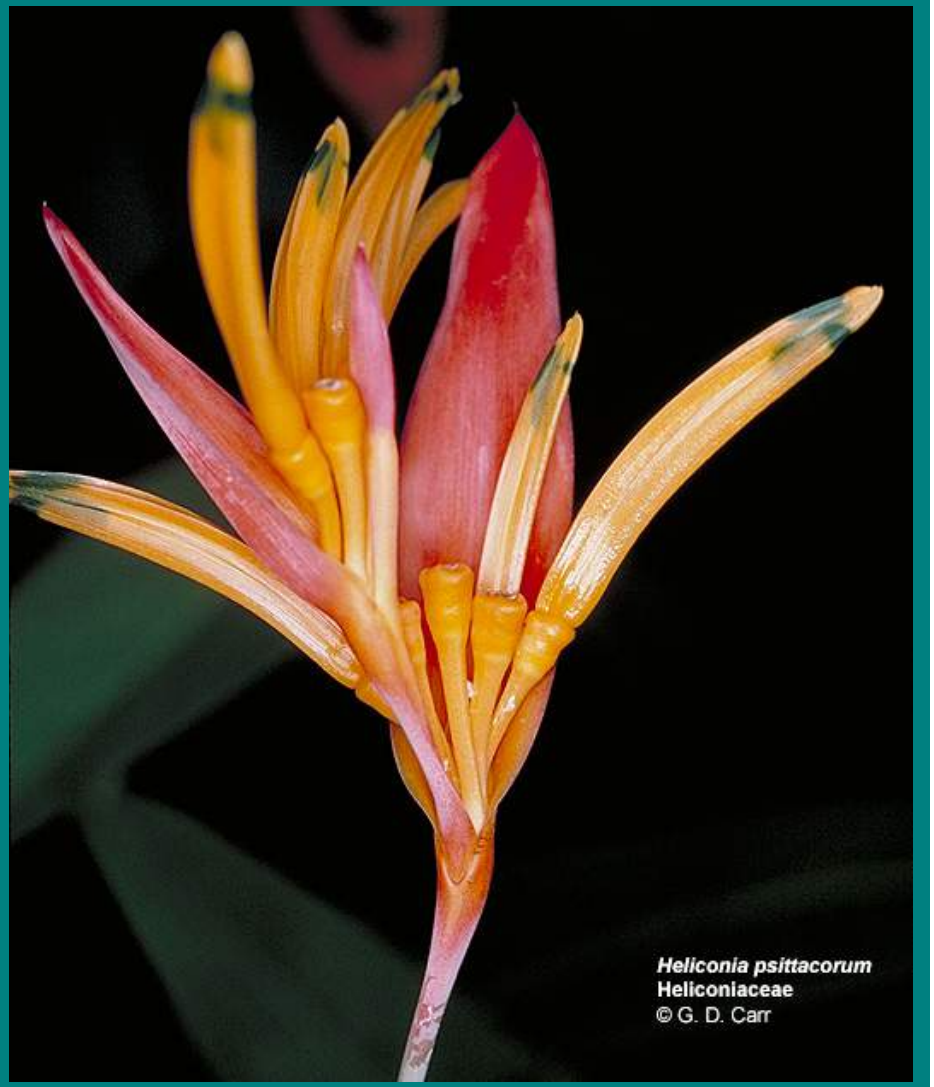
Heliconiaceae - heliconia

- primarily Neotropical
- robust herbs with distichous phyllotaxy
- showy bract system

Zingiberales

Heliconiaceae - heliconia

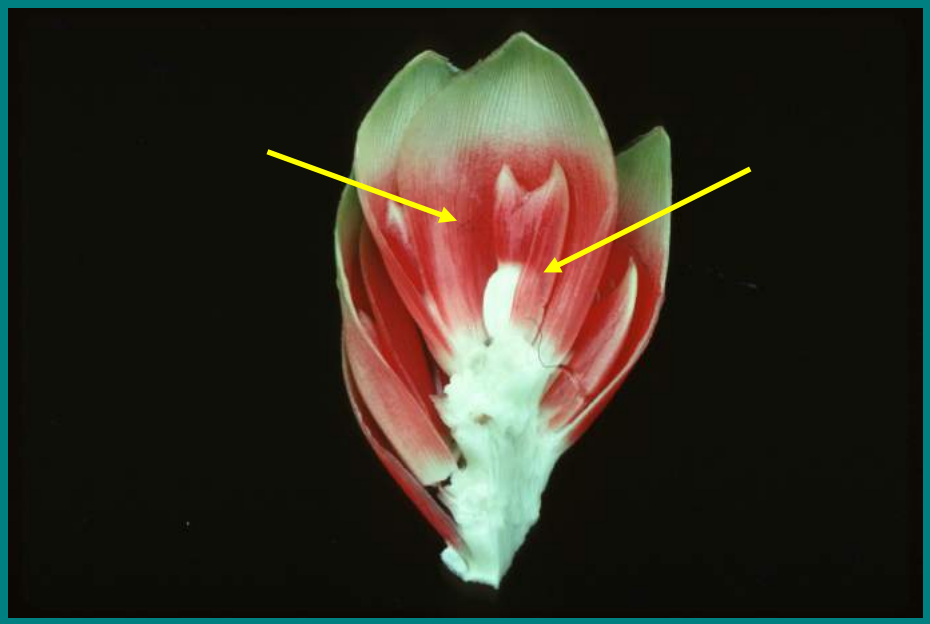
- flowers inverted (resupinate)
- 5 stamens + staminode
- flower mites



Zingiberales

Costaceae - costus

- robust herbs with spiral phyllotaxy
- double bracted flowers



Zingiberales

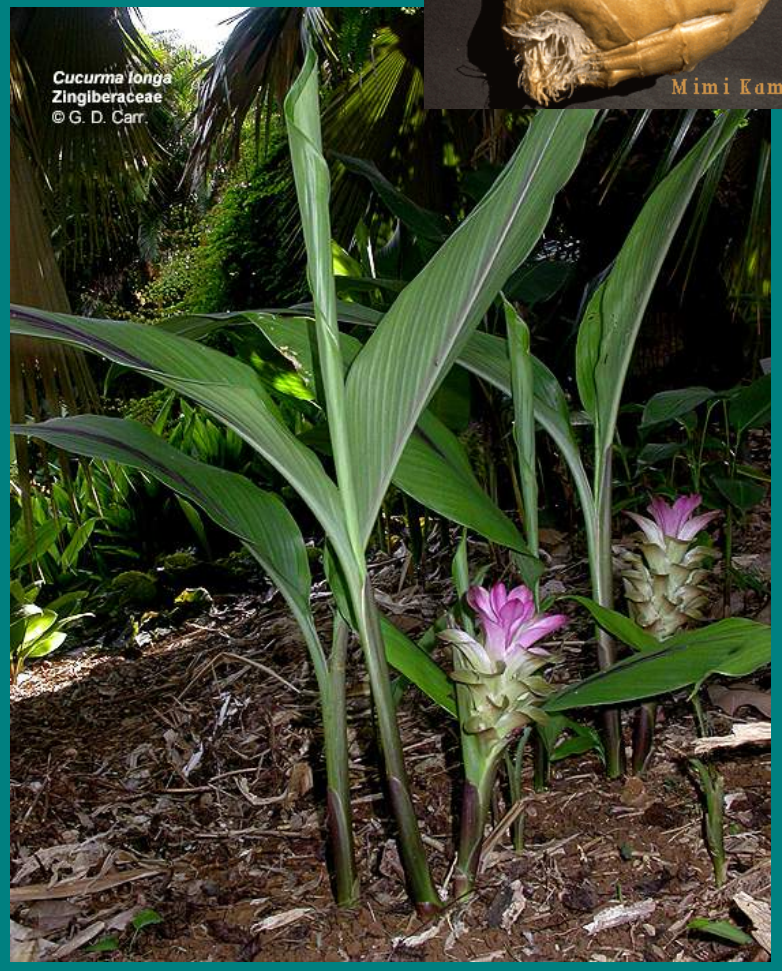
Costaceae - costus

- two major groups - insect pollinated and bird pollinated
- “labellum” formed from 5 sterile stamens

Zingiberales

Zingiberaceae - ginger

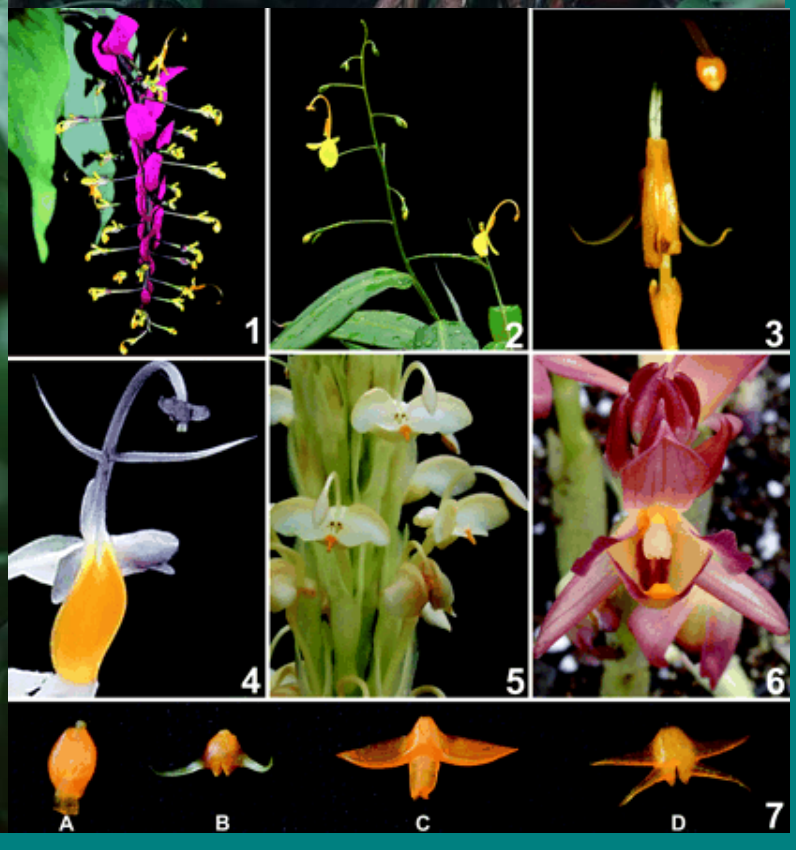
- robust herbs with distichous phyllotaxy
- ethereal aromatic (ginger)



Zingiberales

Zingiberaceae - ginger

- striking floral diversity and pollinators



Zingiberales

Cannaceae - canna

- only *Canna* of Neotropics
- asymmetrical flowers

Zingiberales

Marantaceae - prayer plant

- pantropical, petiolate leaved
- pairs of asymmetrical flowers

Poales I - showy flowers

4 main groups:

- Acorales - sister to all monocots
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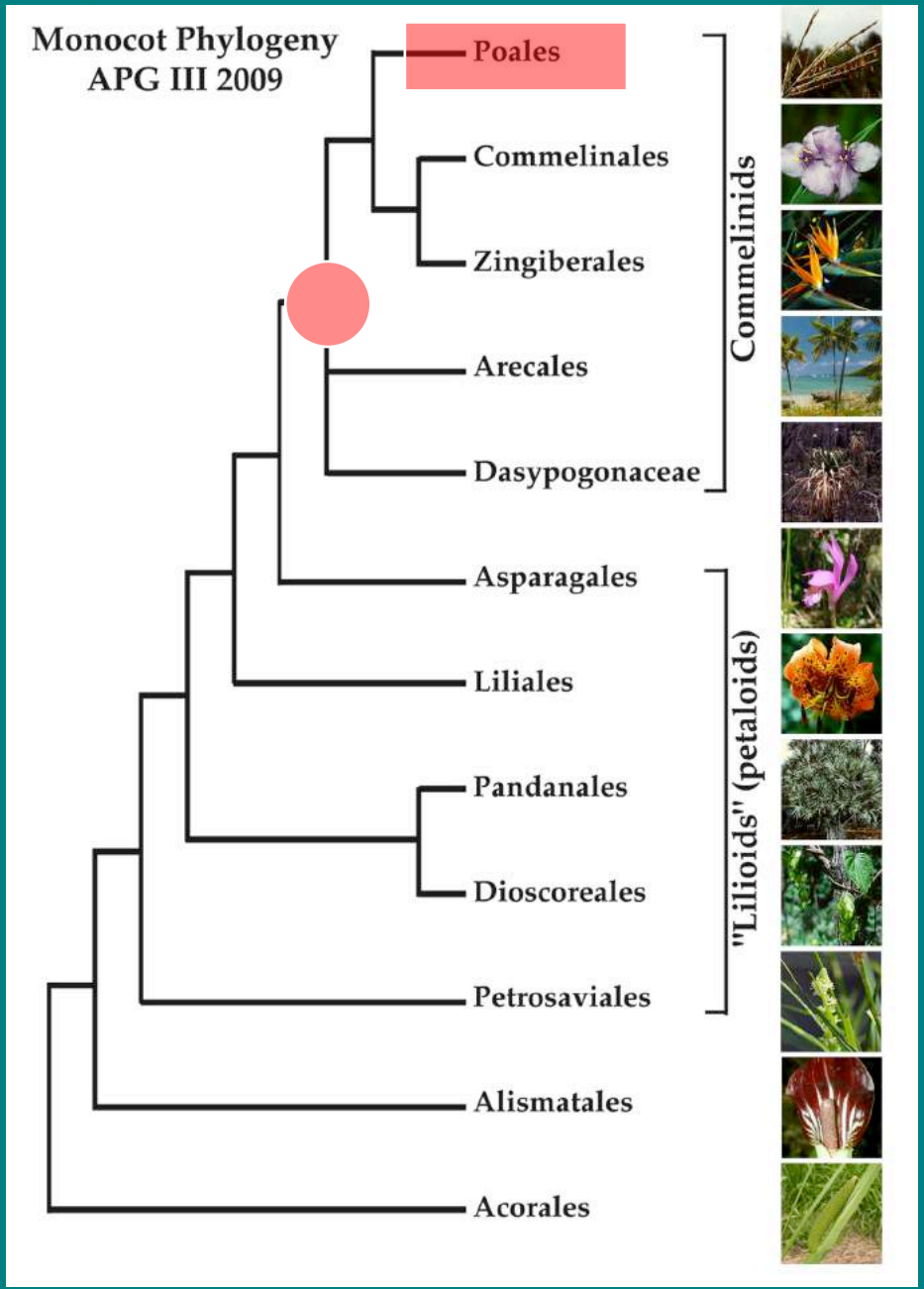
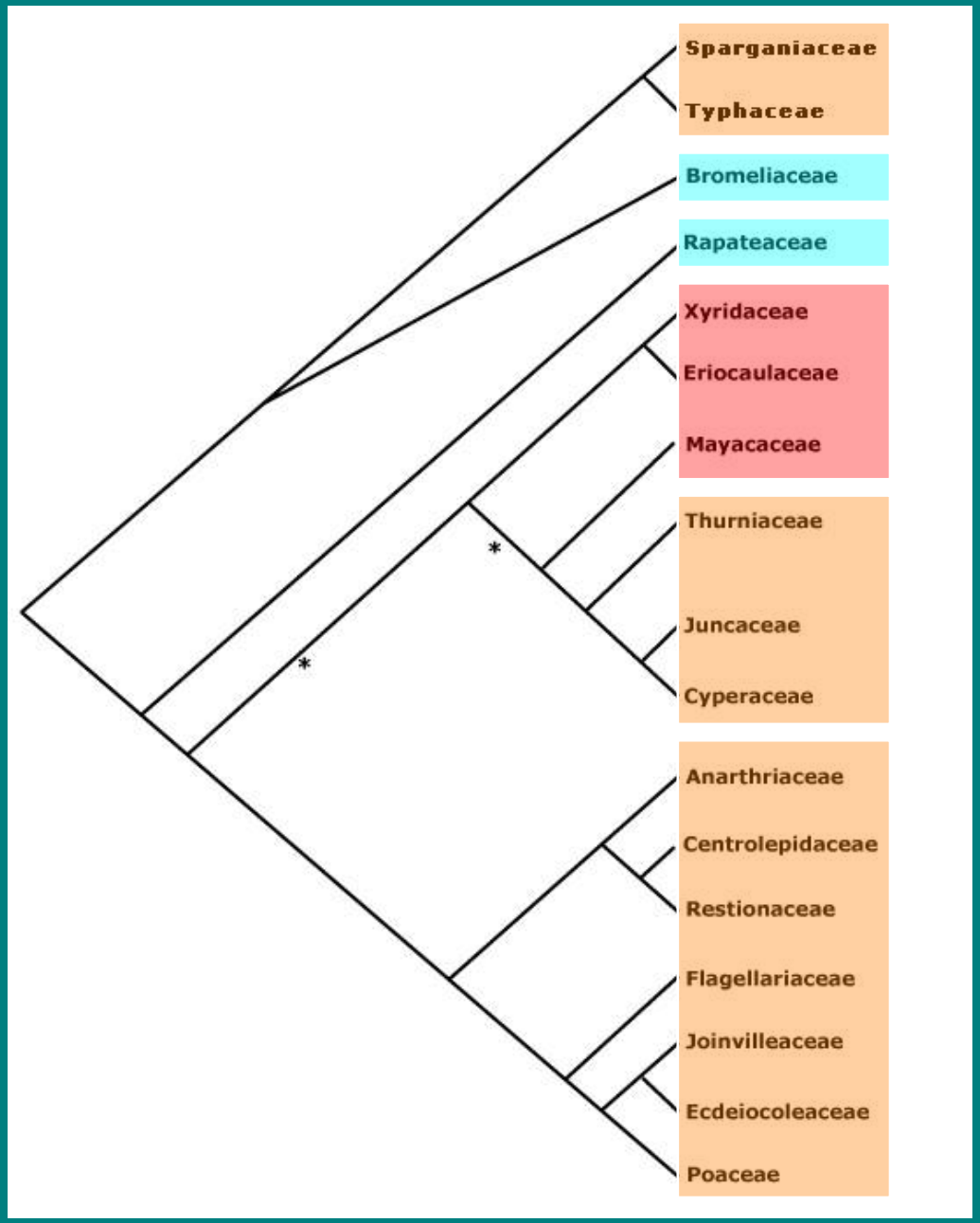
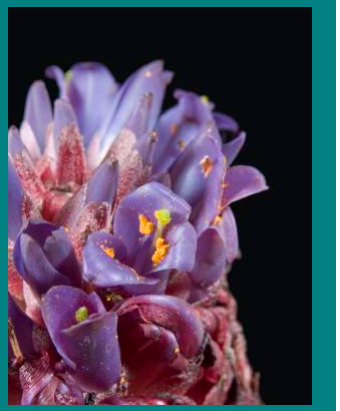


Poales I - showy flowers



- showy flowers, insect or bird pollinated

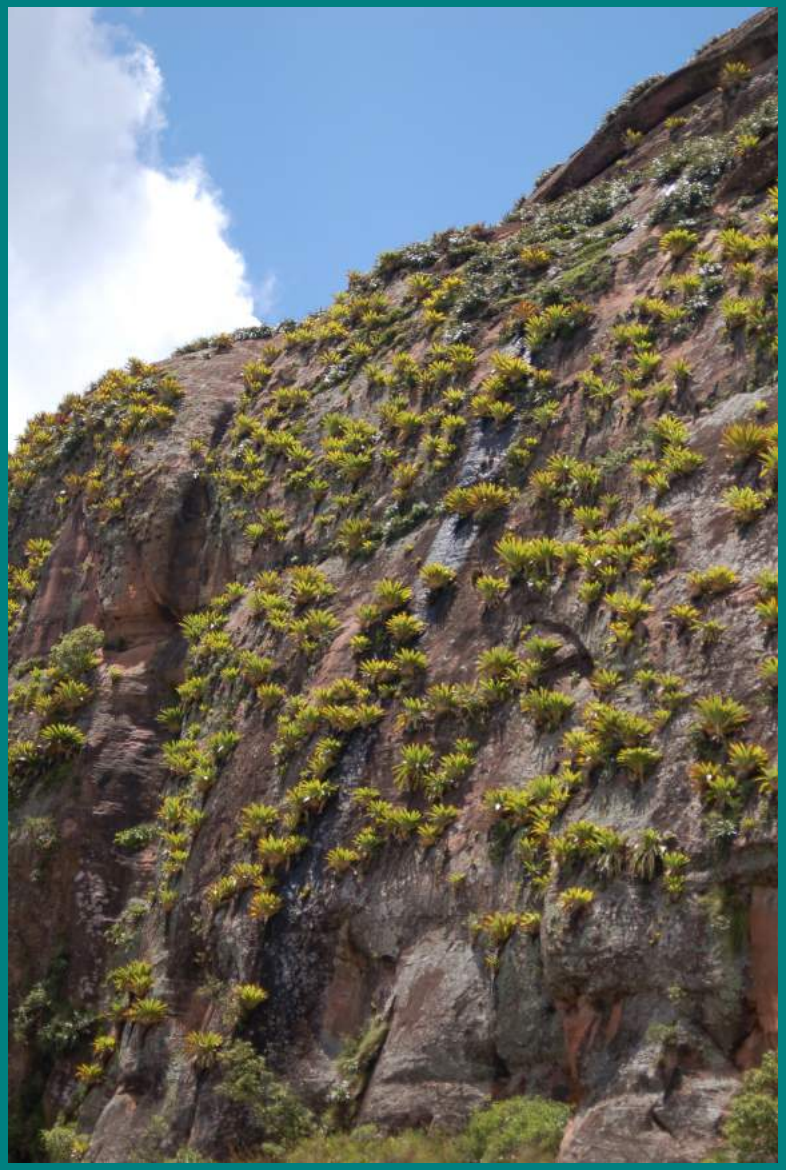


- +/- reduced flowers, insect or wind pollinated

- reduced flowers, wind pollinated

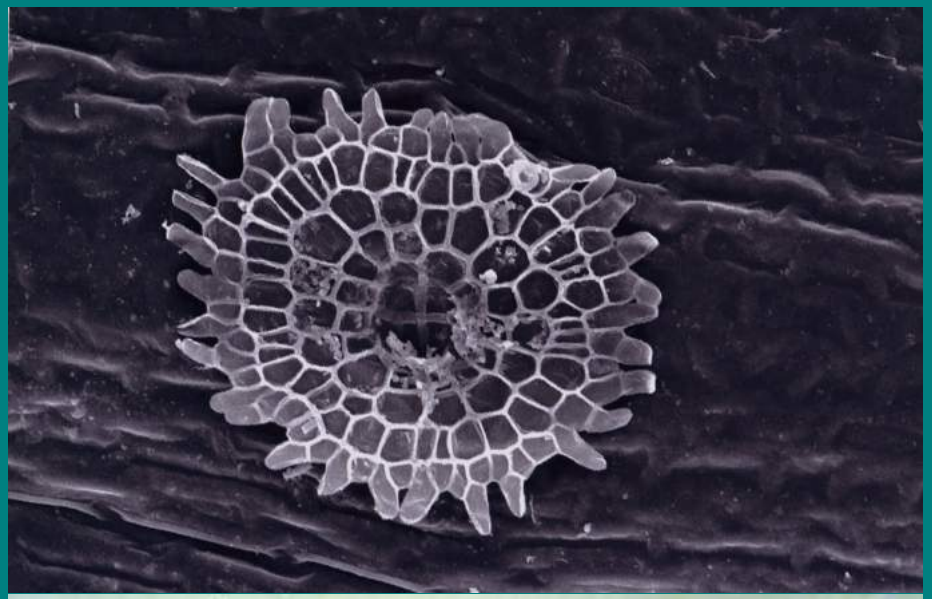
*Bromeliaceae - pineapples

- mainly epiphytic, but terrestrial as well in inhospitable regions



*Bromeliaceae - pineapples

- key adaptations: CAM photosynthesis, modified trichomes or scales, "tank" formation



Tank (water impounding)

Scales (water & nutrient uptake)

*Bromeliaceae - pineapples

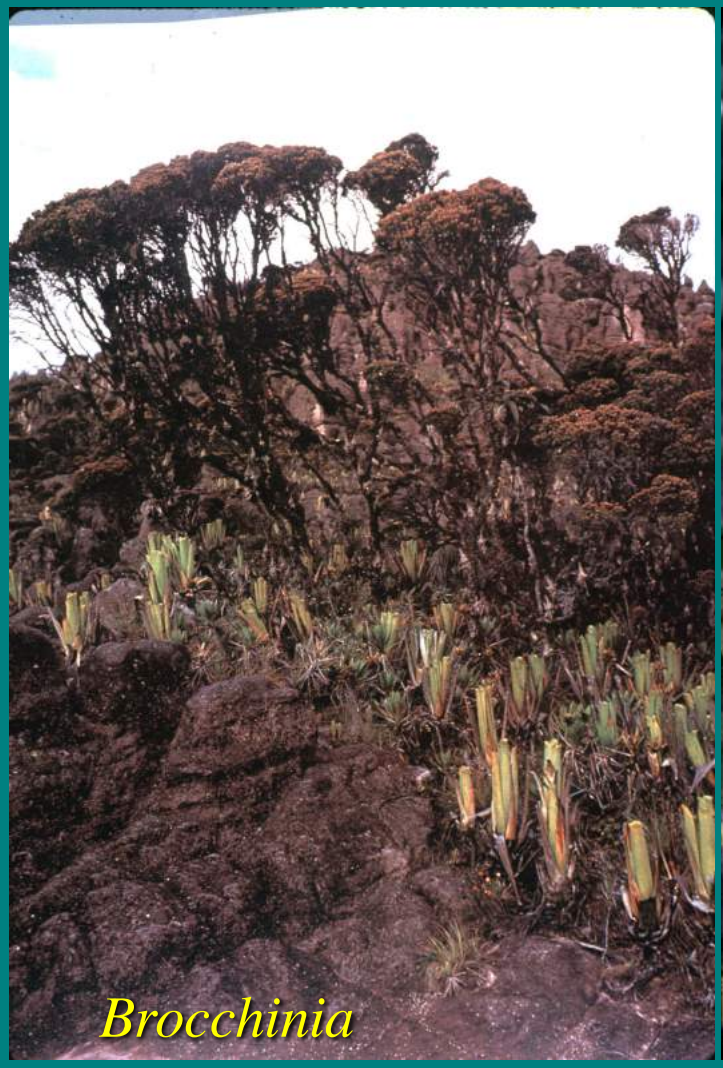
- key adaptations: CAM photosynthesis, modified trichomes or scales, "tank" formation

- scales very visible in Spanish moss

Tillandsia usneoides in South Carolina live oaks

*Bromeliaceae - pineapples

- preadaptations to carnivory in *Brocchinia* and *Catopsis*


Brocchinia


Catopsis

Amino acids radioactively labeled being incorporated into the scales of *Brocchinia*

*Bromeliaceae - pineapples

- inflorescence heavily bracted and often the attractant

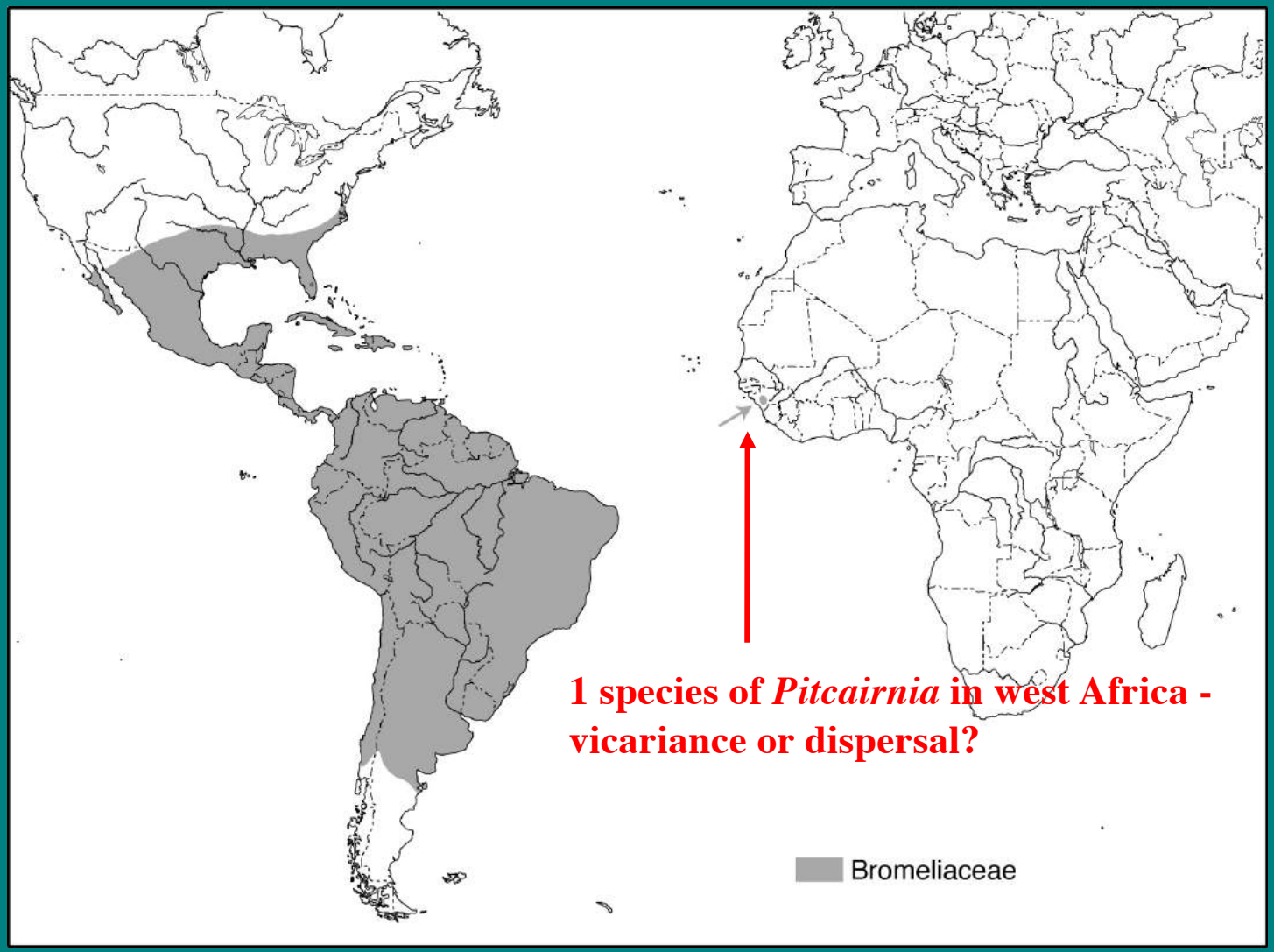
*Bromeliaceae - pineapples

CA 3 CO 3 A 6 $\underline{G}$ (3) or $\overline{G}$ (3)

- petals showy, but not the sepals
- 2 sets of 3 stamens
- superior or inferior ovary, with twisted styles
- berry or capsule

*Bromeliaceae - pineapples

- bromeliads are an American family: 2600 species, 56 genera



*Bromeliaceae - pineapples

- pineapple not native to Hawaii - along with two other ingredients of Hawaiian Punch


guava


passion fruit

*Bromeliaceae - pineapples

- classification traditionally had three subfamilies

tillandsioids pitcairnioids bromelioids

Incan ceremonial dance

*Bromeliaceae - pineapples

- tillandsioids

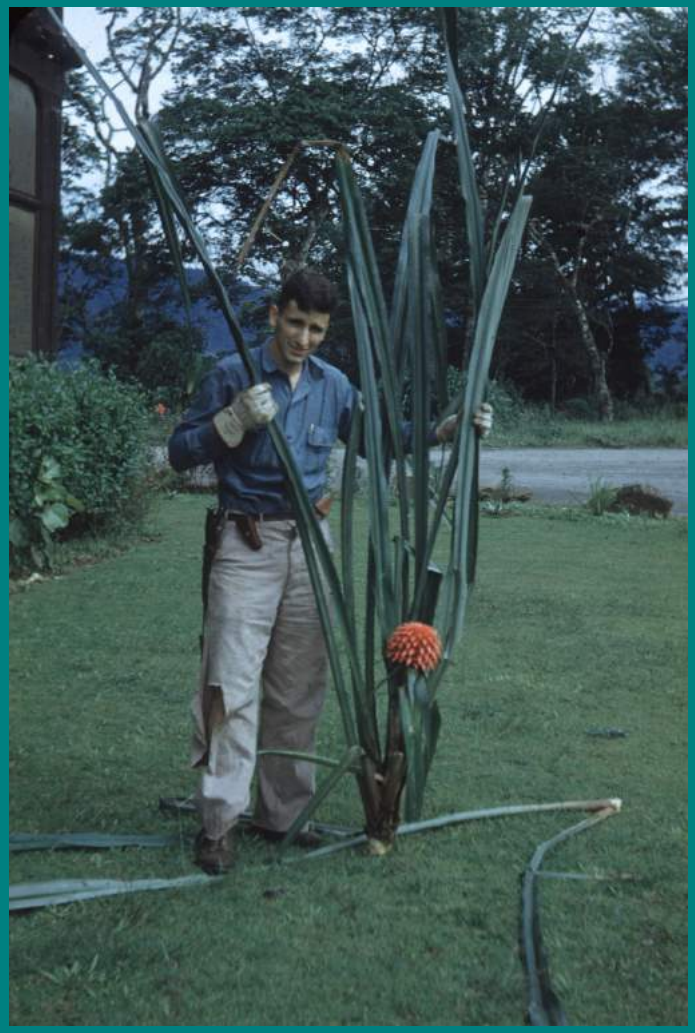
Tillandsia usneoides and *T. grandis*

[spanish moss & large epiphyte]

Vriesea

*Bromeliaceae - pineapples

- bromelioids



Achmea

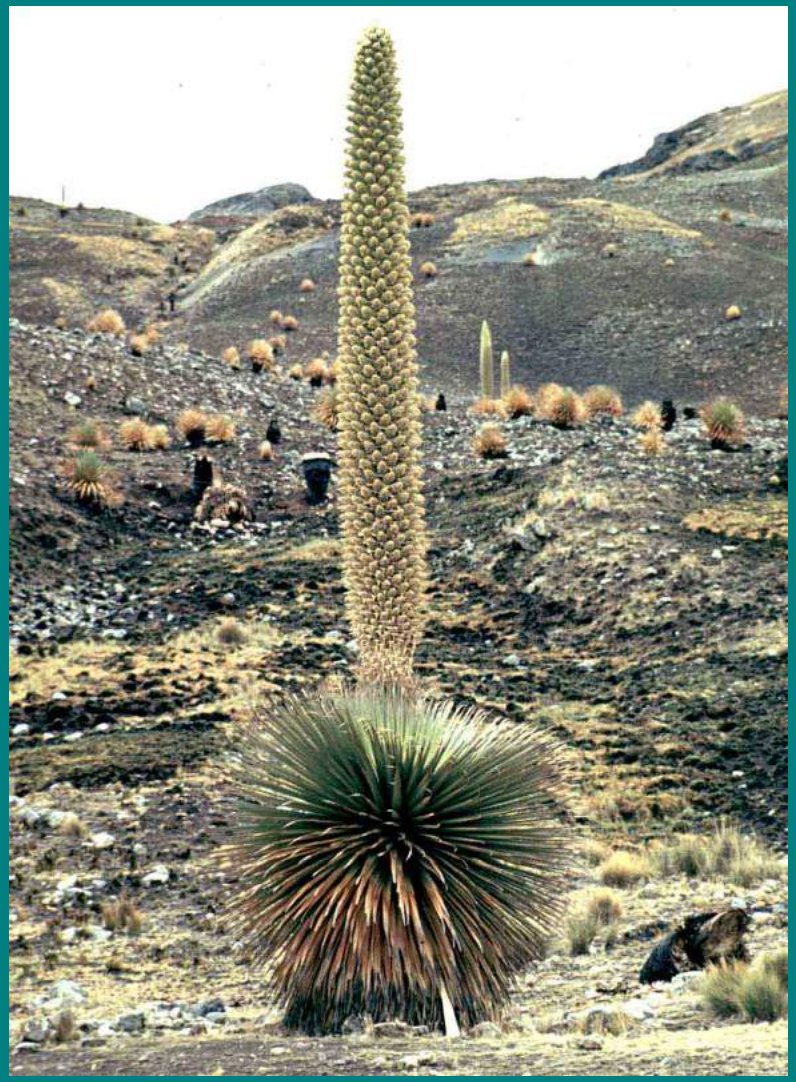
Ananas - pineapple

Neoregelia

*Bromeliaceae - pineapples

- pitcairnioids

Brocchinia

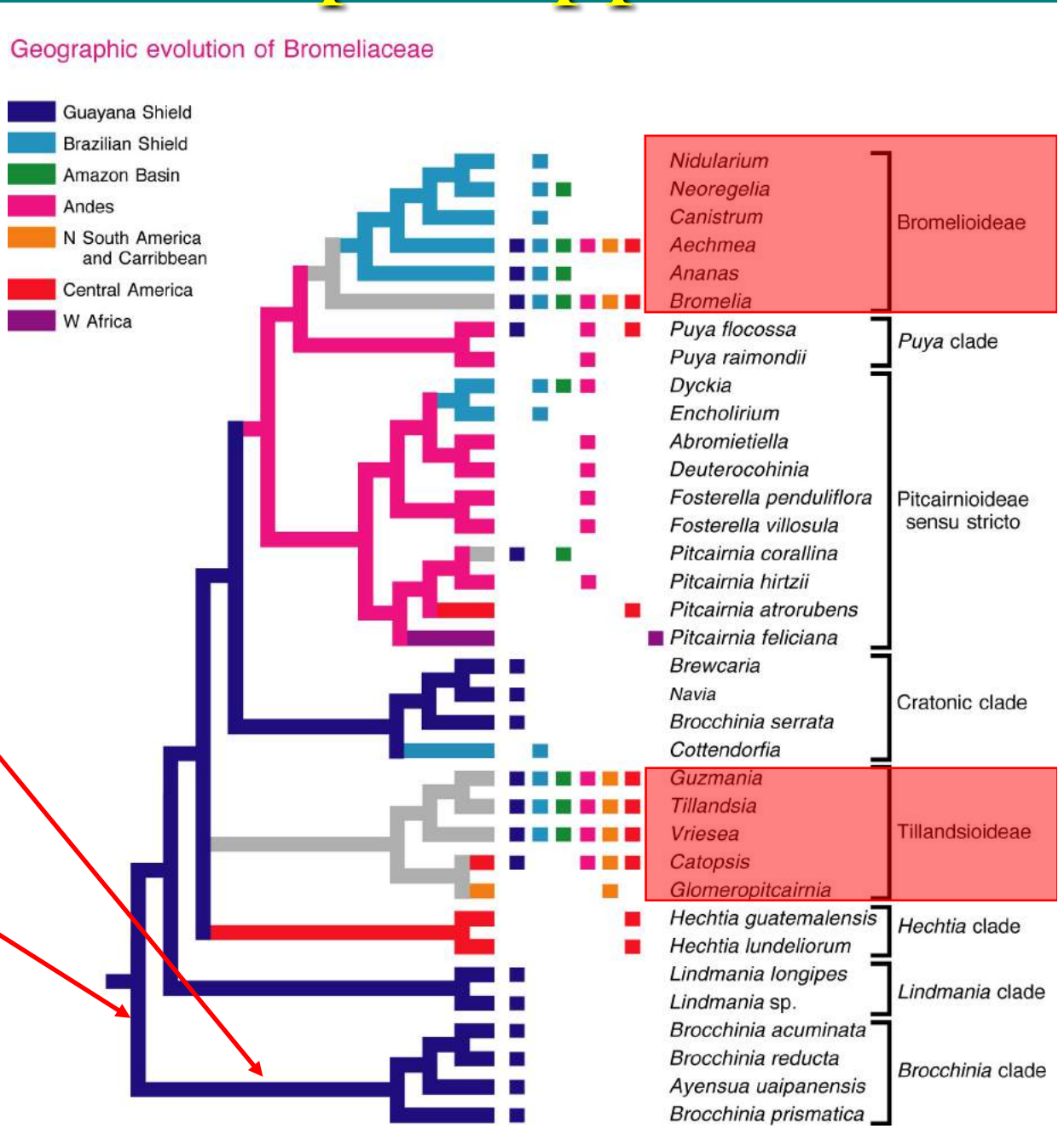


Puya

Navia

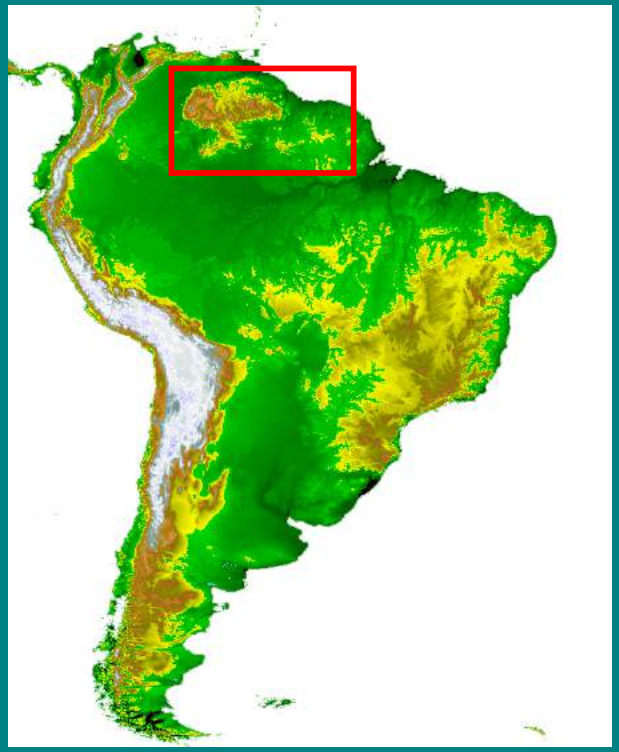
*Bromeliaceae - pineapples

- 2 subfamilies natural based on DNA
- pitcairnioids broadly paraphyletic
- *Brocchinia* sister to rest of family
- origin of family in Guayana Shield of South America



*Bromeliaceae - pineapples

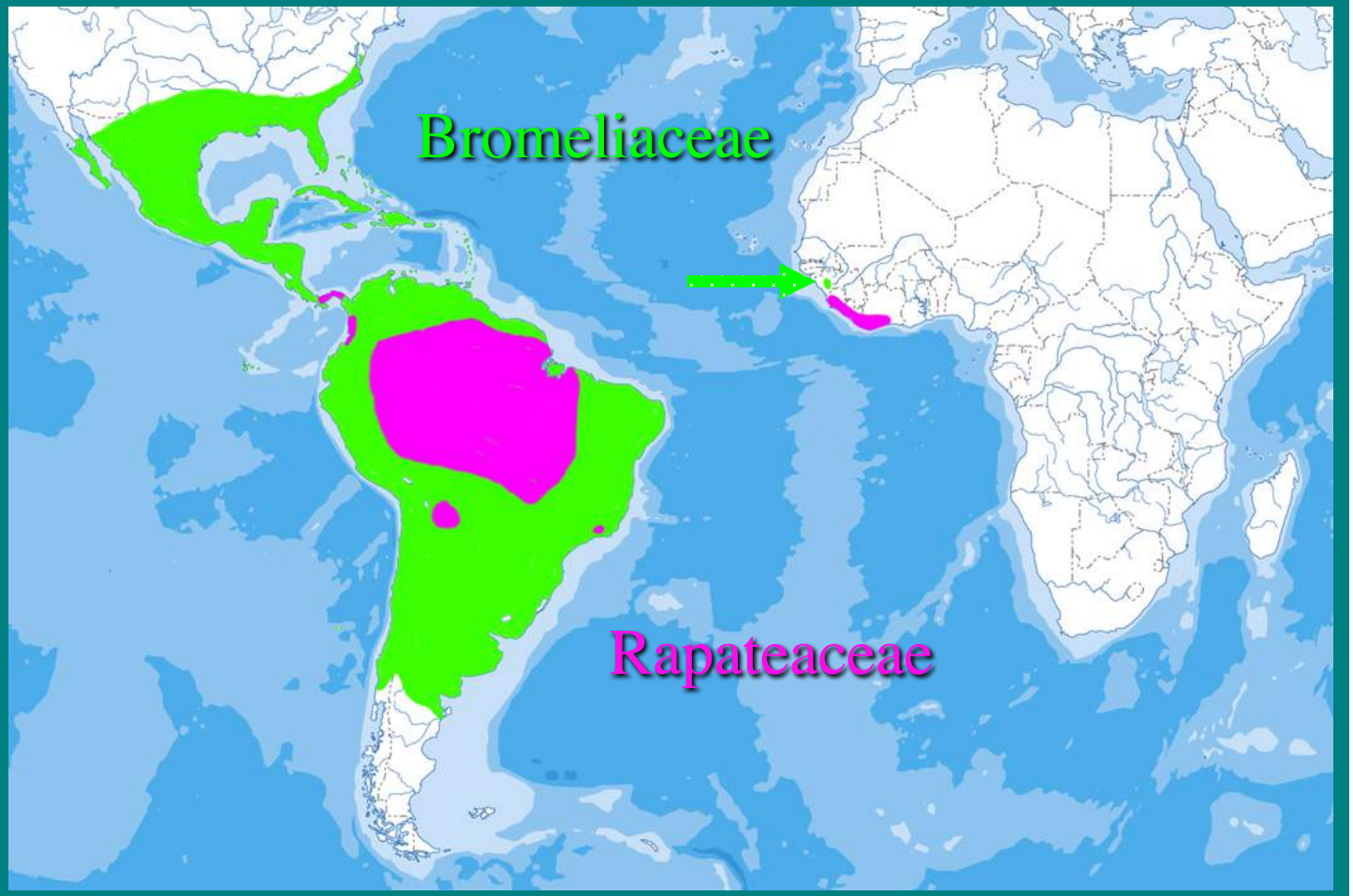
Guayana Highlands of southern Venezuela and adjacent areas of Brazil and Colombia - the higher elevation "tepuis" are rain drenched and extremely nutrient poor



*Bromeliaceae - pineapples

When did the Atlantic disjunction occur?

Pitcairnia saxicola
Costa Rica



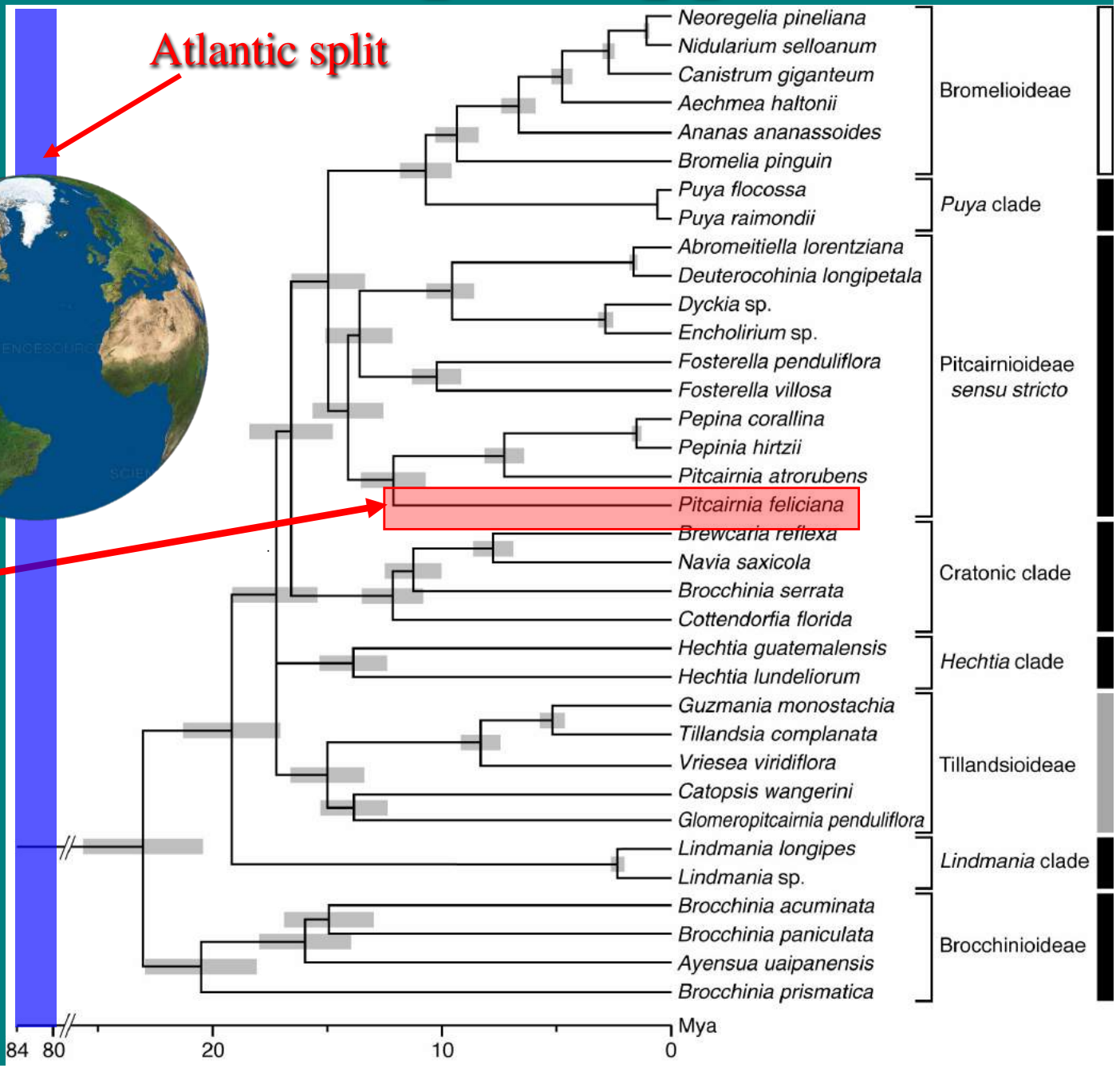
Picairnia feliciana in west Africa

*Bromeliaceae - pineapples

When did the Atlantic disjunction occur? before or after continents split?

Long distance dispersal to Africa! African species divergence is 15-13 mya

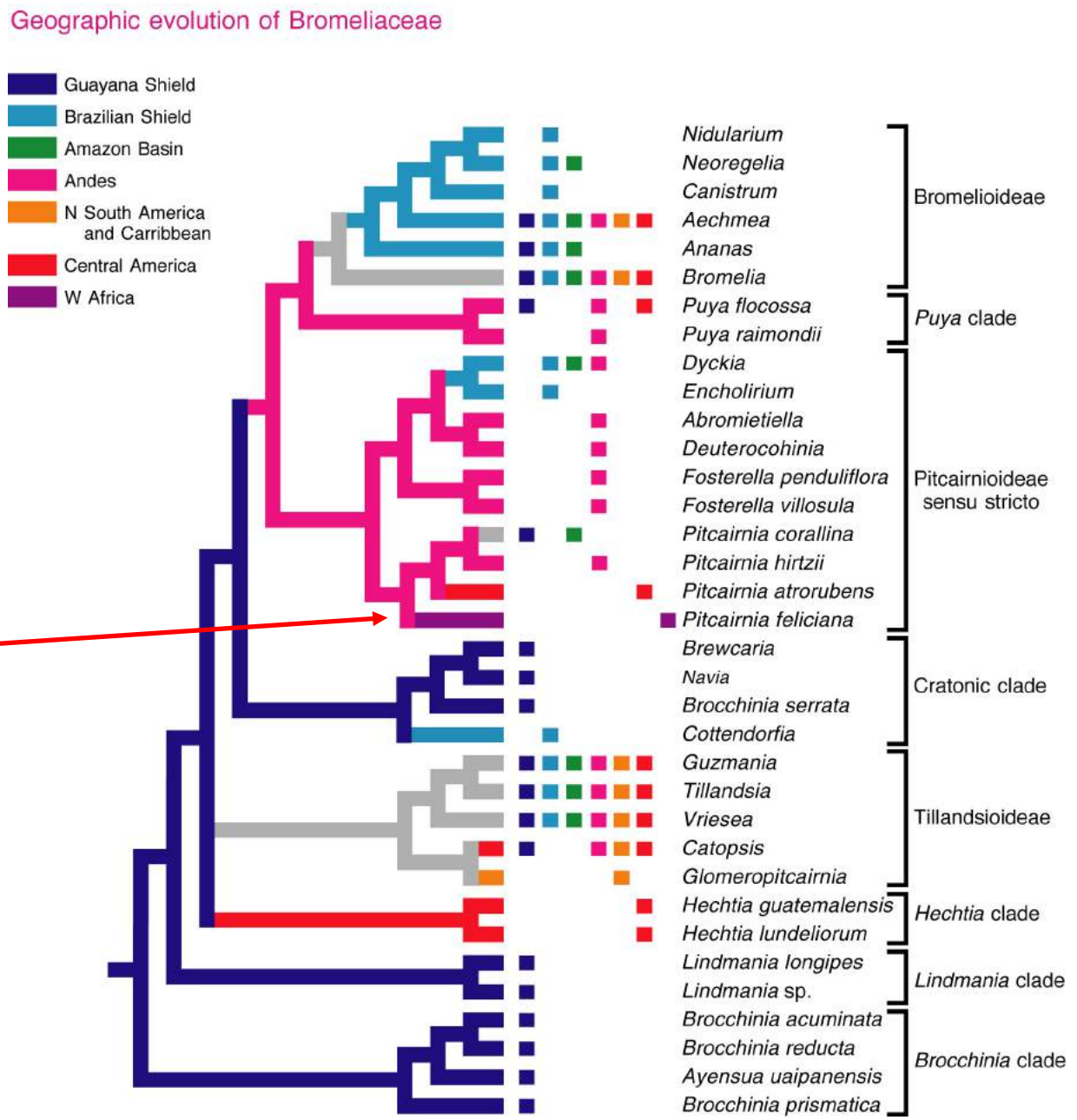
DNA tree calibrated with monocot fossils



*Bromeliaceae - pineapples

Where did the African species come from?

- African species originated from Andes!



Rapateaceae - a tepui family

- 16 genera and nearly 100 species from the Guayana Shield

Rapateaceae - a tepui family

- most species are pollinated by pollen-gathering bees
- hummingbird pollination has evolved once in a clade of two genera

Rapateaceae - a tepui family

- most species in the Guayana Shield but one in west Africa

Is the African *Mascolocephalus* a product of Atlantic vicariance with closest Guayana Shield relatives, or a product of long distance dispersal?

Rapateaceae - a tepui family

Recent long distance dispersal to Africa!

African species divergence is 8-6 my

whereas Atlantic separation is 80+ mya