

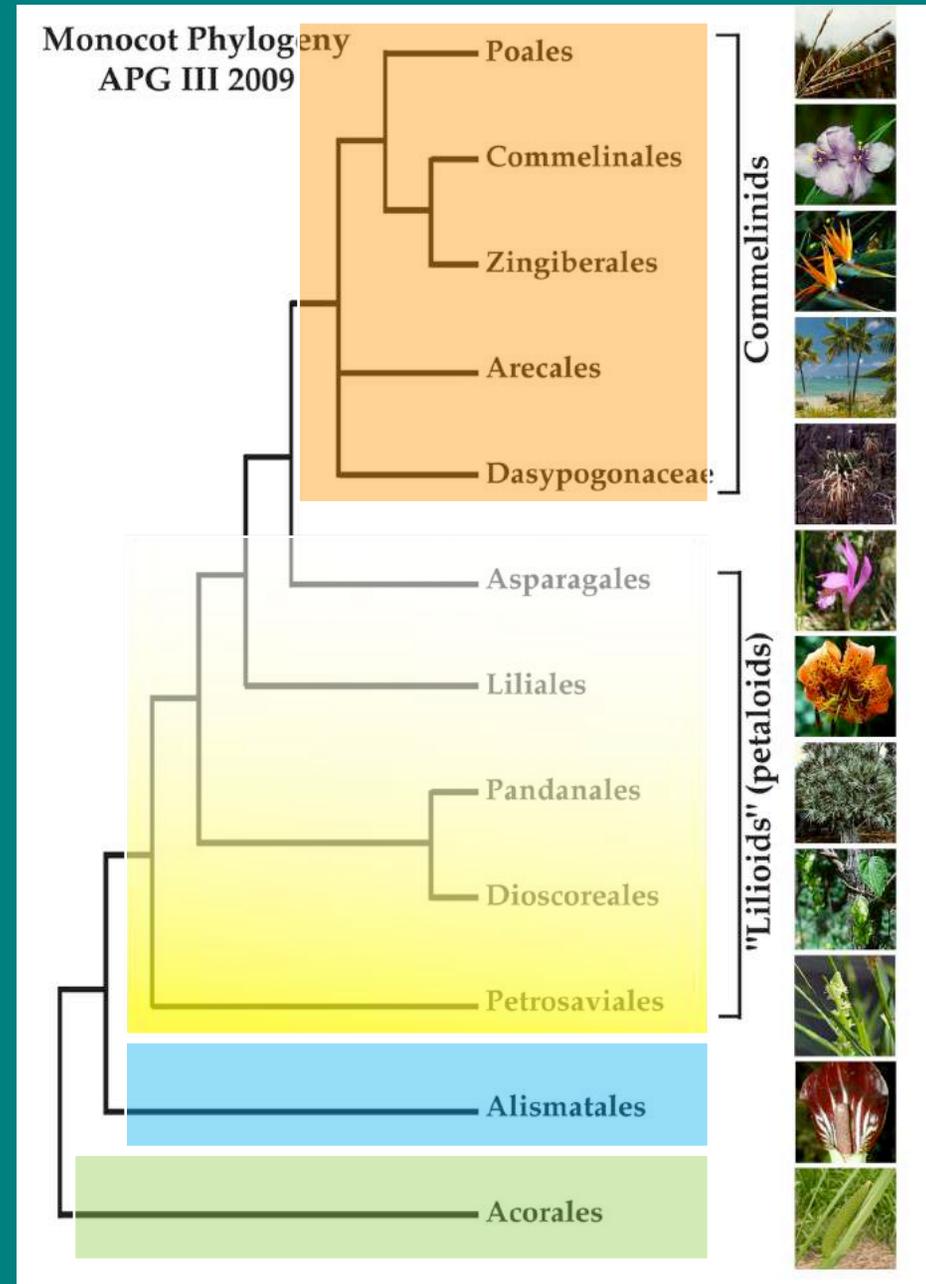
Diversity and Evolution of Monocots

. . . orchids and palms . . .

Lilioids - petaloid monocots

4 main groups:

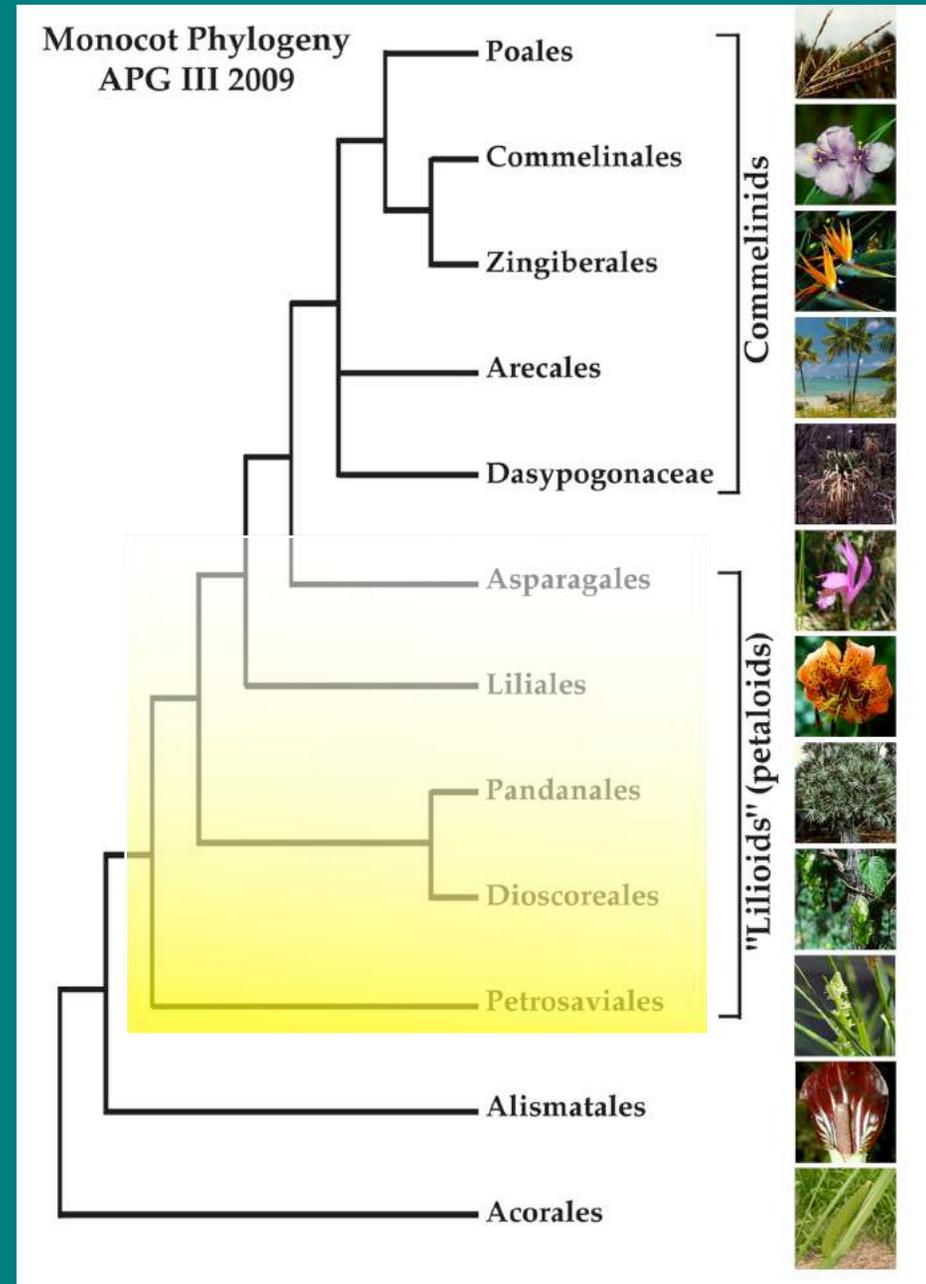
- Acorales - sister to all monocots
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Lilioids - petaloid monocots

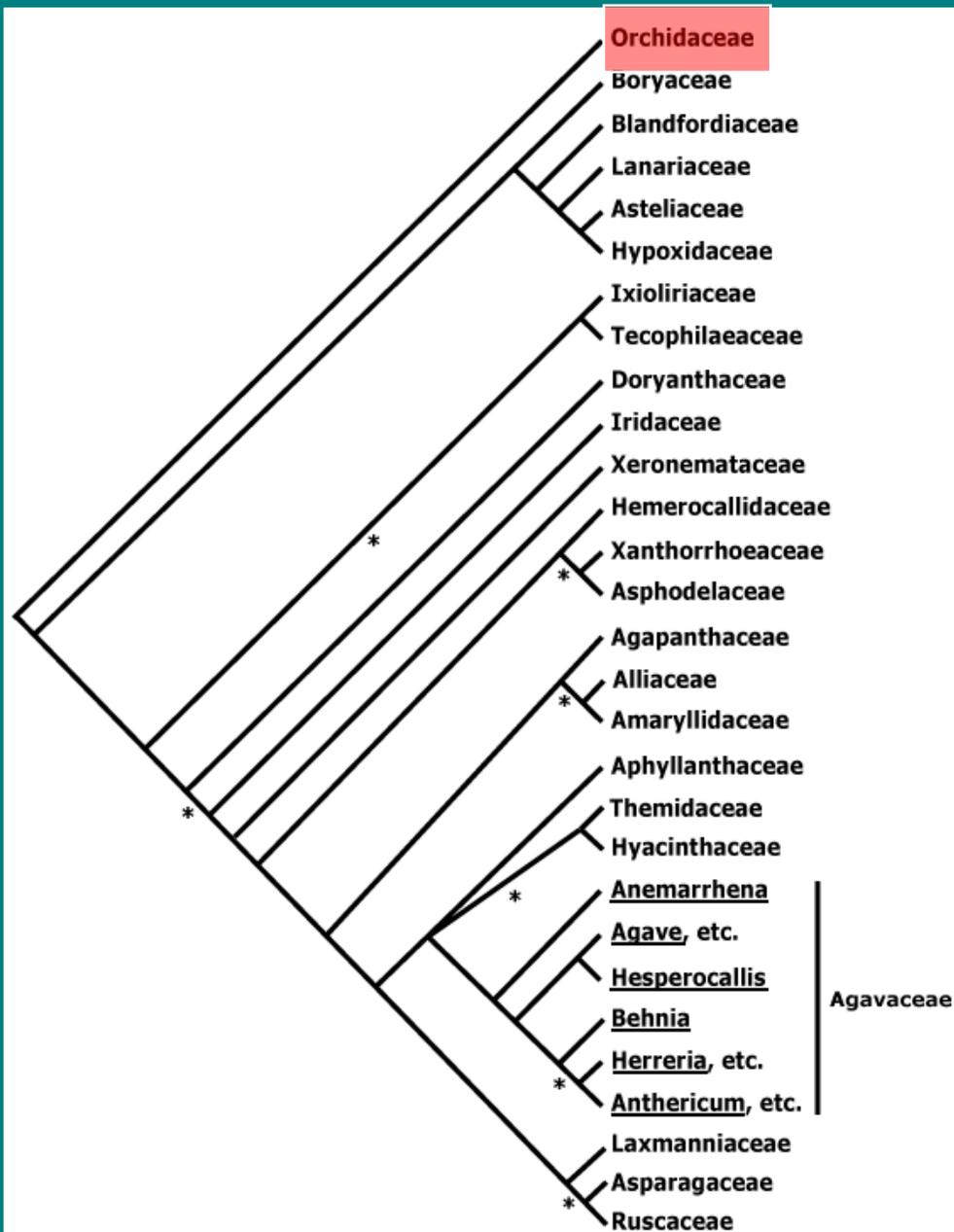


1. **Terrestrial/epiphytes**: plants typically not aquatic

2. **Geophytes**: herbaceous above ground with below ground modified perennial stems: bulbs, corms, rhizomes, tubers

3. **Tepals**: showy perianth in 2 series of 3 each; usually all petaloid, or outer series not green and sepal-like & with **no bracts**

Asparagales: *Orchidaceae - orchids



- finish the Asparagales by looking at the largest family - the orchids



*Orchidaceae - orchids

The family is diverse with about 880 genera and over 22,000 species, mainly of the tropics



Cypripedium acaule
Stemless lady-slipper



Corallorhiza striata
Striped coral root

Orchids are **mycotrophic** (= fungi dependent) lilioids; some are obligate mycotrophs

*Orchidaceae - orchids

All orchids have a **protocorm** - a feature restricted to the family.

- structure formed after germination and before the development of the seedling plant
- has no radicle but instead mycotrophic tissue



Dactylorhiza majalis protocorm



*Orchidaceae - orchids

Cosmopolitan, but the majority of species are found in the tropics and subtropics, ranging from sea level to almost 5000 m in nearly all environments except open water and true desert.



Dendrobium branch
epiphyte



Ionopsis twig
epiphyte

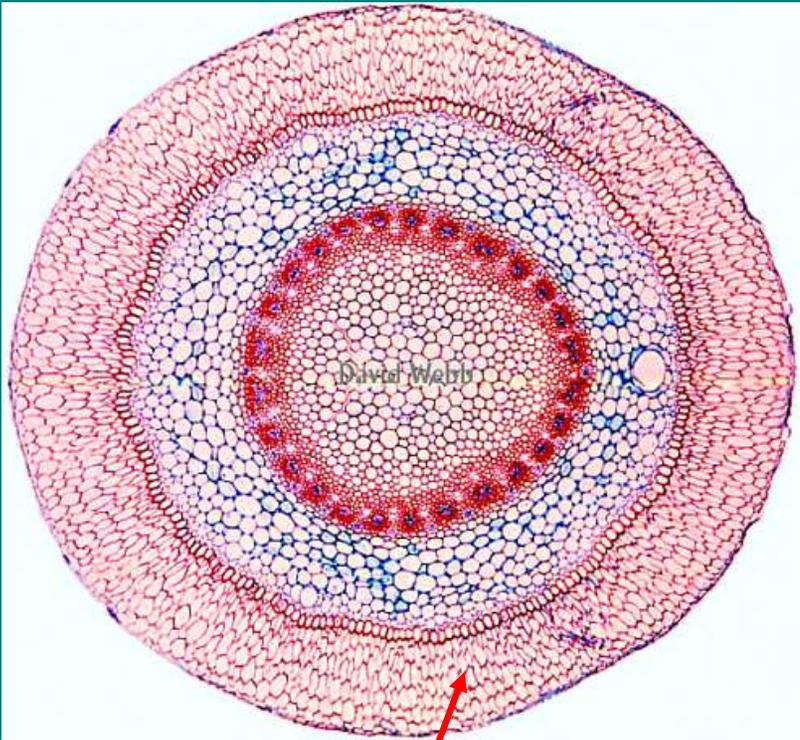


Oncidium trunk
epiphyte

Habit varies from herb to vine, but more than half of the species are **epiphytic**

*Orchidaceae - orchids

Survive in these epiphytic and other harsh environments via **CAM** photosynthesis, **velamen**, and **leaf tubers**, in addition to **mycorrhizal association**



Orchid root **velamen** (water storage)



leaf tubers (water storage)

*Orchidaceae - orchids

Specialized reproductive biology:

- unusual **pollination systems**
- **labellum** petal for landing platform
- **pollen masses**, **reduced stamen** number
- numerous, **dust-like seeds**



Ophrys



Perfume industry



Eulaema (euglossine)

21 November 2011 Last updated at 19:15 ET

Botanists discover 'remarkable' night-flowering orchid

By Mark Kinver and Victoria Gill
Science reporters, BBC News and Nature

A night-flowering orchid, the first of its kind known to science, has been described by a team of botanists.

Experts say the "remarkable" species is the only orchid known to consistently flower at night, but why it has adopted this behaviour remains a mystery.

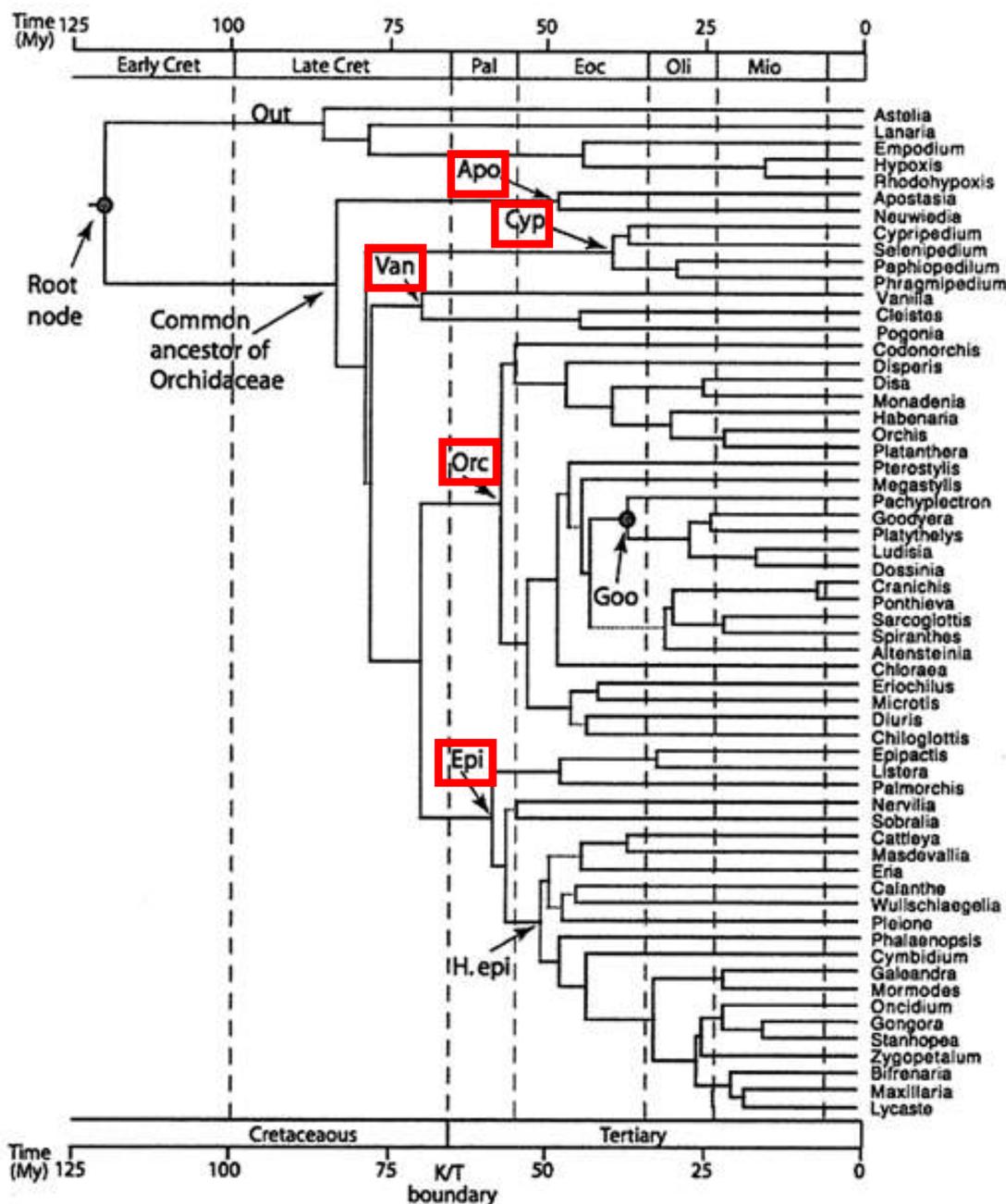
Bulbophyllum nocturnum

Only totally night blooming orchid

Fungal midge pollinated?

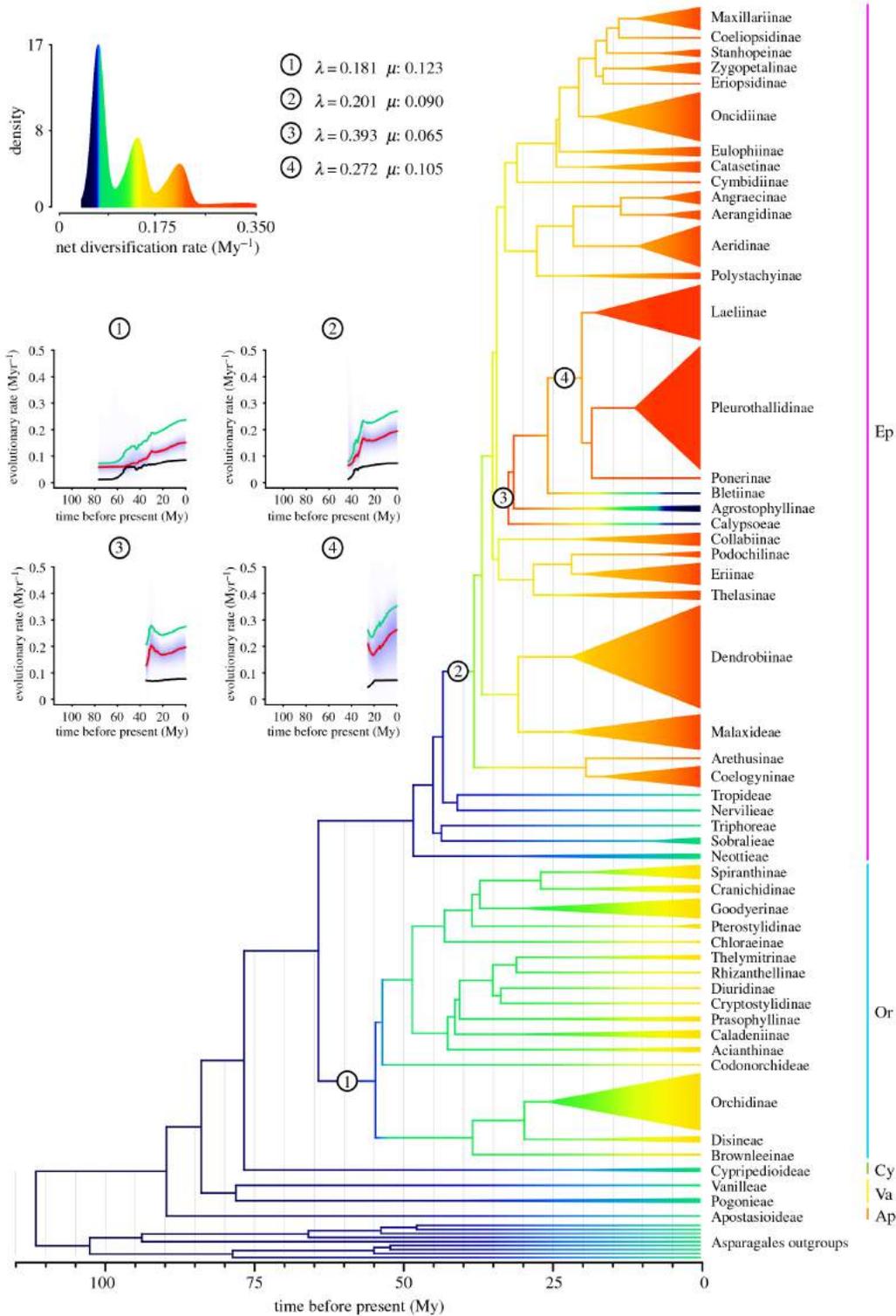


*Orchidaceae - orchids



A 2007 paper in Nature suggests that the orchid family is not recent, but of late Cretaceous origin





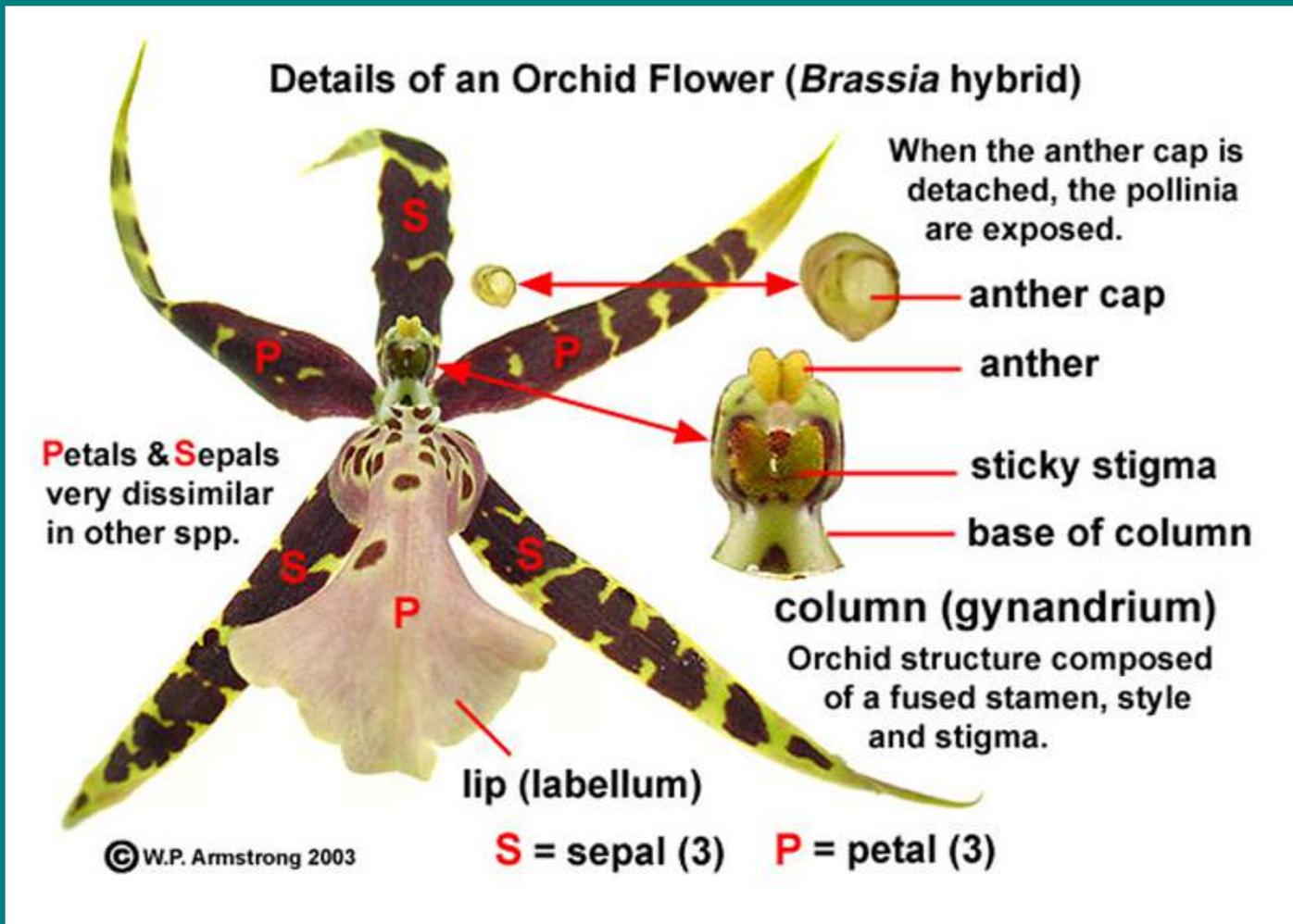
Diversification shifts in orchids

Givnish et al. (2015)



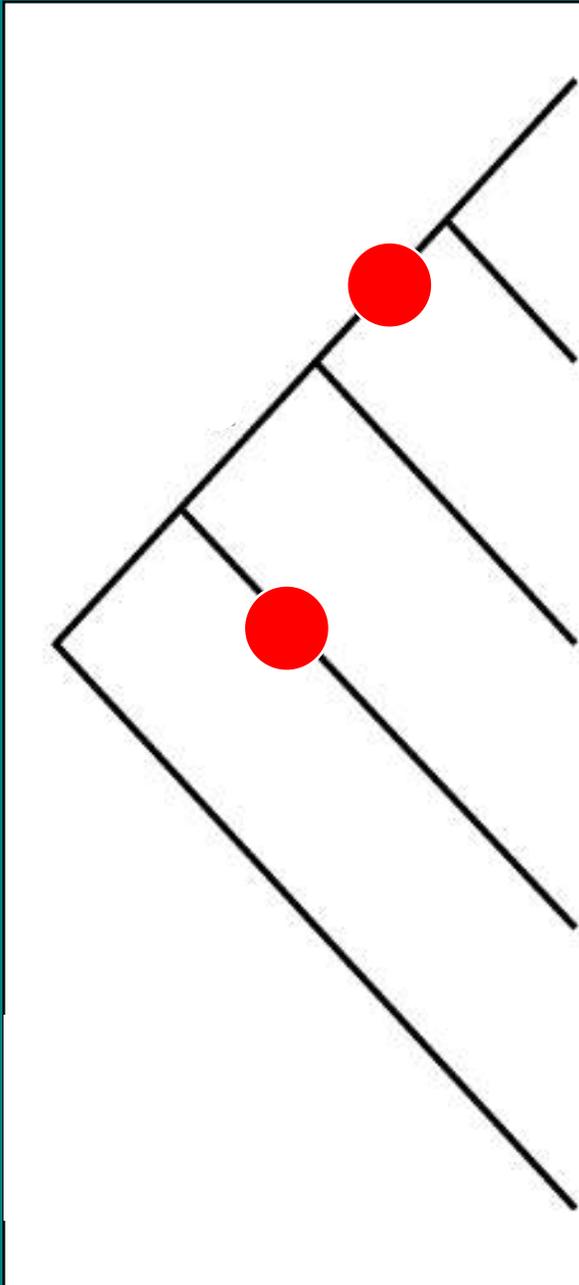
*Orchidaceae - orchids

CA 3 COZ 2+1 A 3,2,1 \overline{G} (3)



- 6 tepals with **labellum** (flower **resupinate** or upside down)
- 3 or fewer stamens
- inferior gynoecium fused at top with stamens to form **column**
- capsule

*Orchidaceae - orchids



Orchidoideae



Five subfamilies

3 stamens

Epidendroideae



2 stamens

1 stamen

Cypripedioideae



Two origins of
reduction to one stamen

Vanilloideae



Apostasioideae



*Orchidaceae - orchids

Apostasioideae (2 genera)

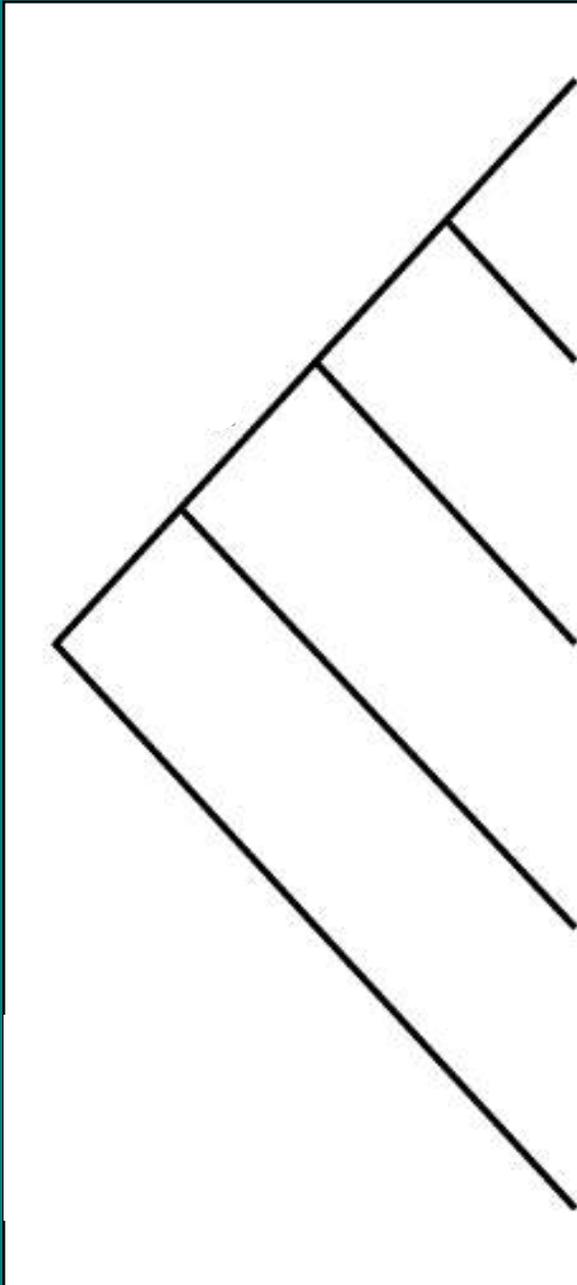
- 3 stamens (usually)
- most primitive of orchids with nearly actinomorphic flowers
- Austral-asian distribution



Neuwiedia veratrifolia



*Orchidaceae - orchids



Orchidoideae

Epidendroideae

Cyripedioideae

Vanilloideae

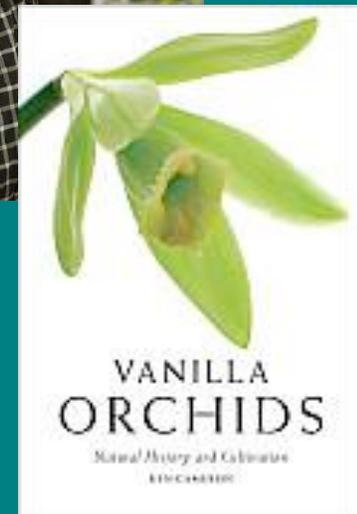
Apostasioideae

Vanilloideae

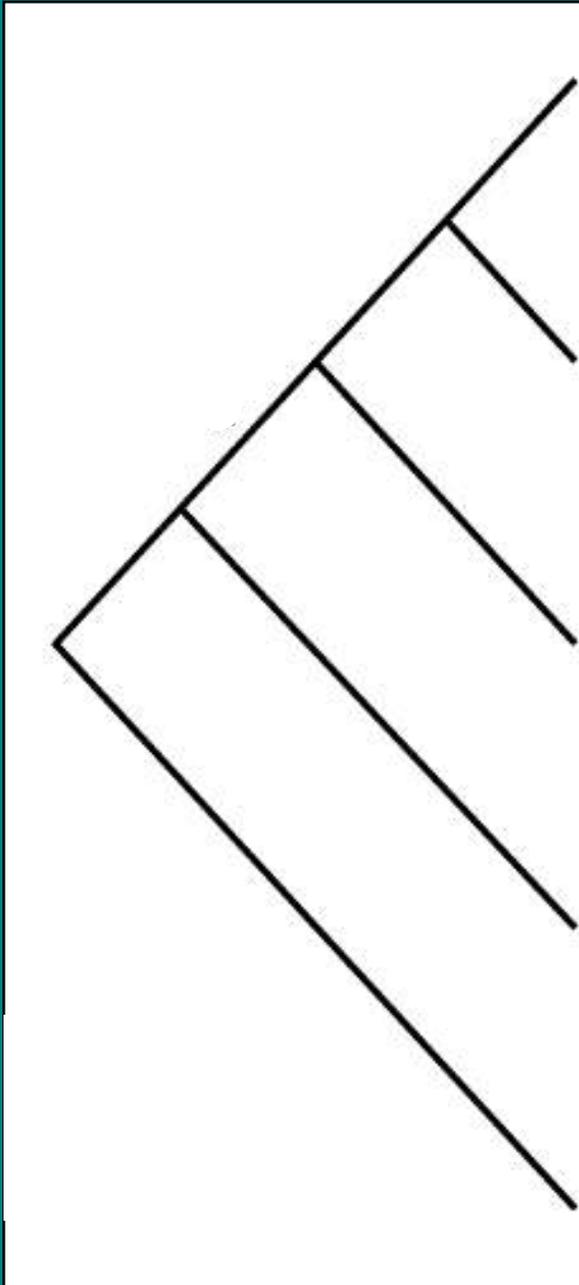
The vanilloid orchids are a small tropical group of lianas, that includes *Vanilla*



Vanilla



*Orchidaceae - orchids



Orchidoideae

Epidendroideae

Cypridioideae

Vanilloideae

Apostasioideae

Cypridioideae (5 genera)

- 2 stamens
- “slipper” labellum
- Northern Hemisphere distribution



*Orchidaceae - orchids



The lower petal is elaborated into the **labellum** - the landing platform



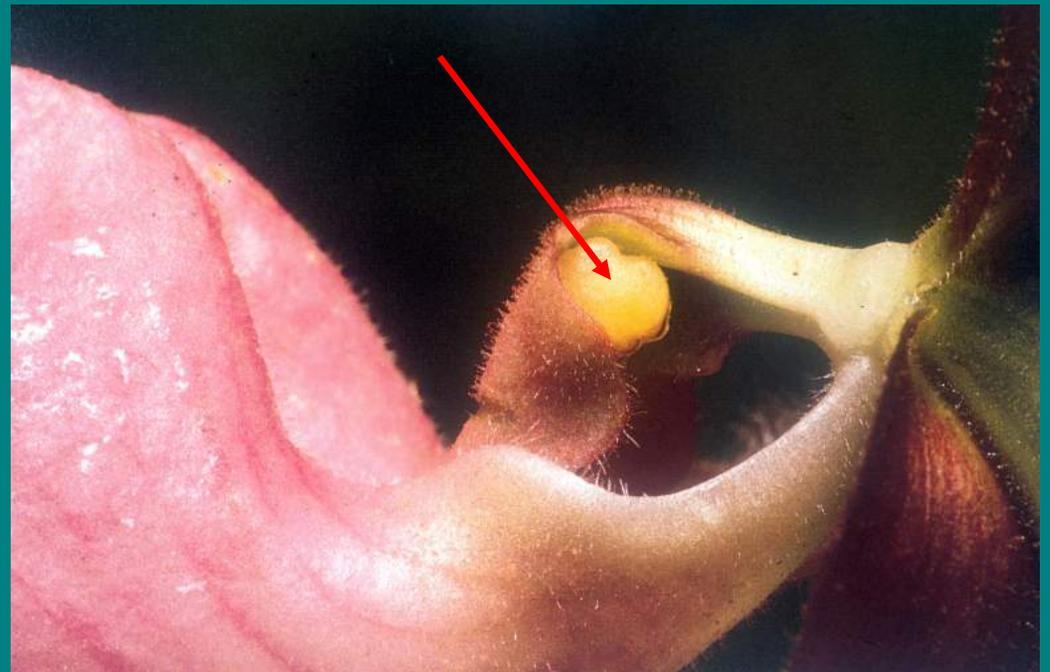
Cyripedium acaule - stemless lady' s-slipper

*Orchidaceae - orchids



Lady' s-slippers have two functional
stamens with pollen masses

Deceptive pollination system for
naïve bumblebees



Cypripedium acaule - stemless lady' s-slipper

*Orchidaceae - orchids

Other lady' s-slippers . . .



Cypripedium arietinum
Ram' s-head lady' s-slipper
threatened



Cypripedium calceolus
Yellow lady' s-slipper



*Orchidaceae - orchids



Cypripedium reginae
showy lady' s-slipper

*Orchidaceae - orchids



Cypripedium candidum

white lady' s-slipper

Threatened, fen or calcareous soils

*Orchidaceae - orchids



Paphiopedilum

Non-native bucket or
slipper orchids

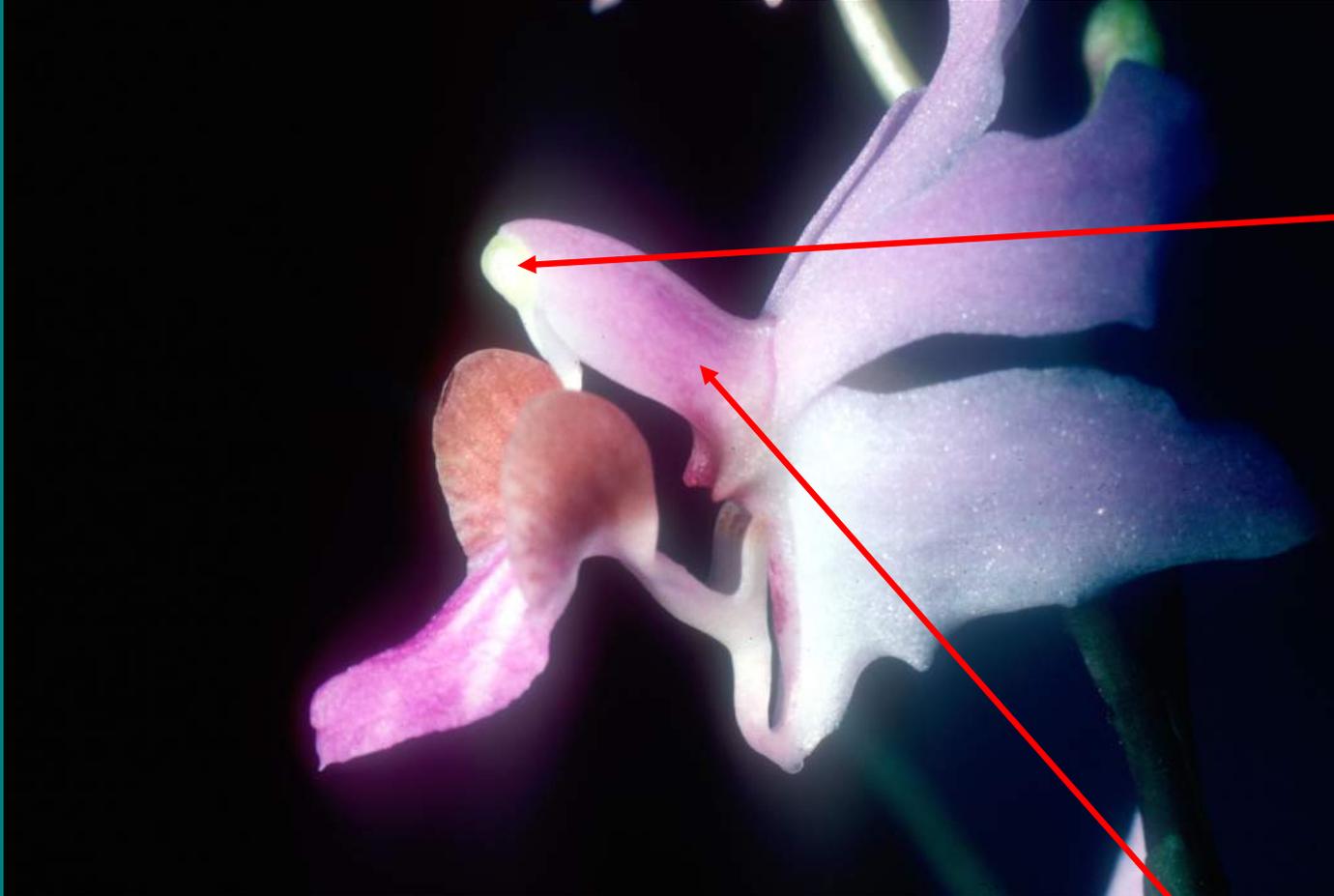


Phragmipedium



Mexipedium

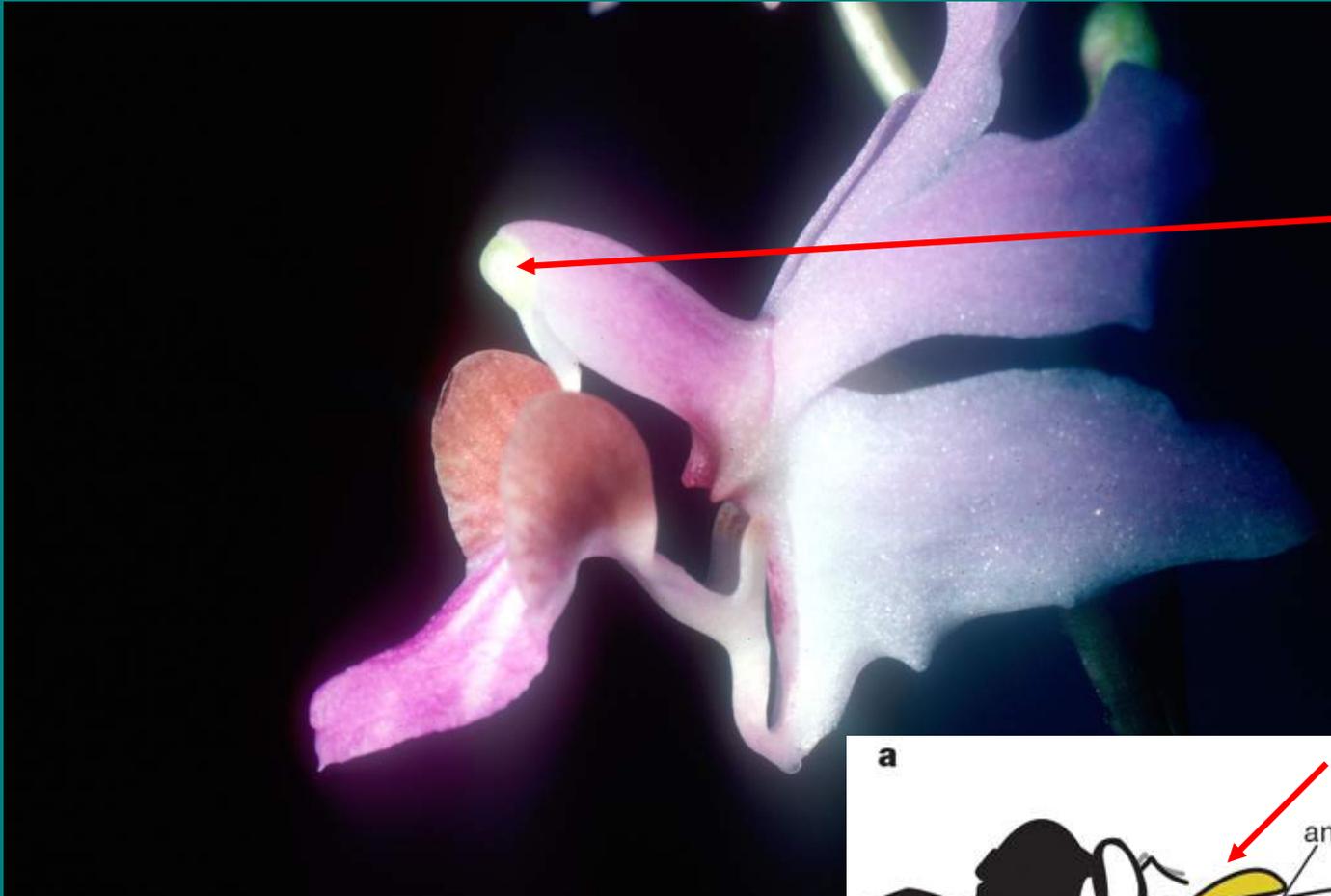
*Orchidaceae - orchids



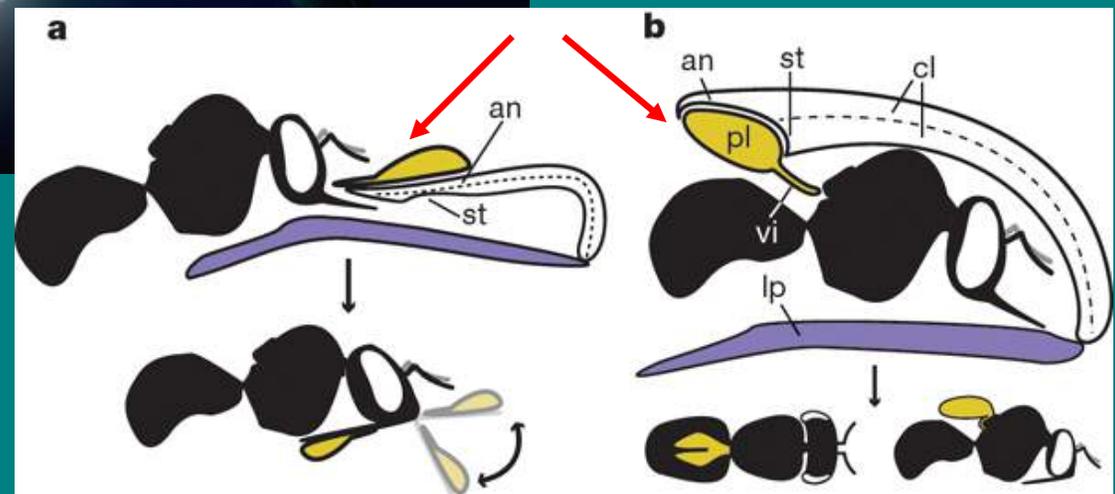
All other orchids have only 1 functional stamen with one or two pollinia

The stamen is situated on a column formed by fusion with the top of the inferior gynoecium

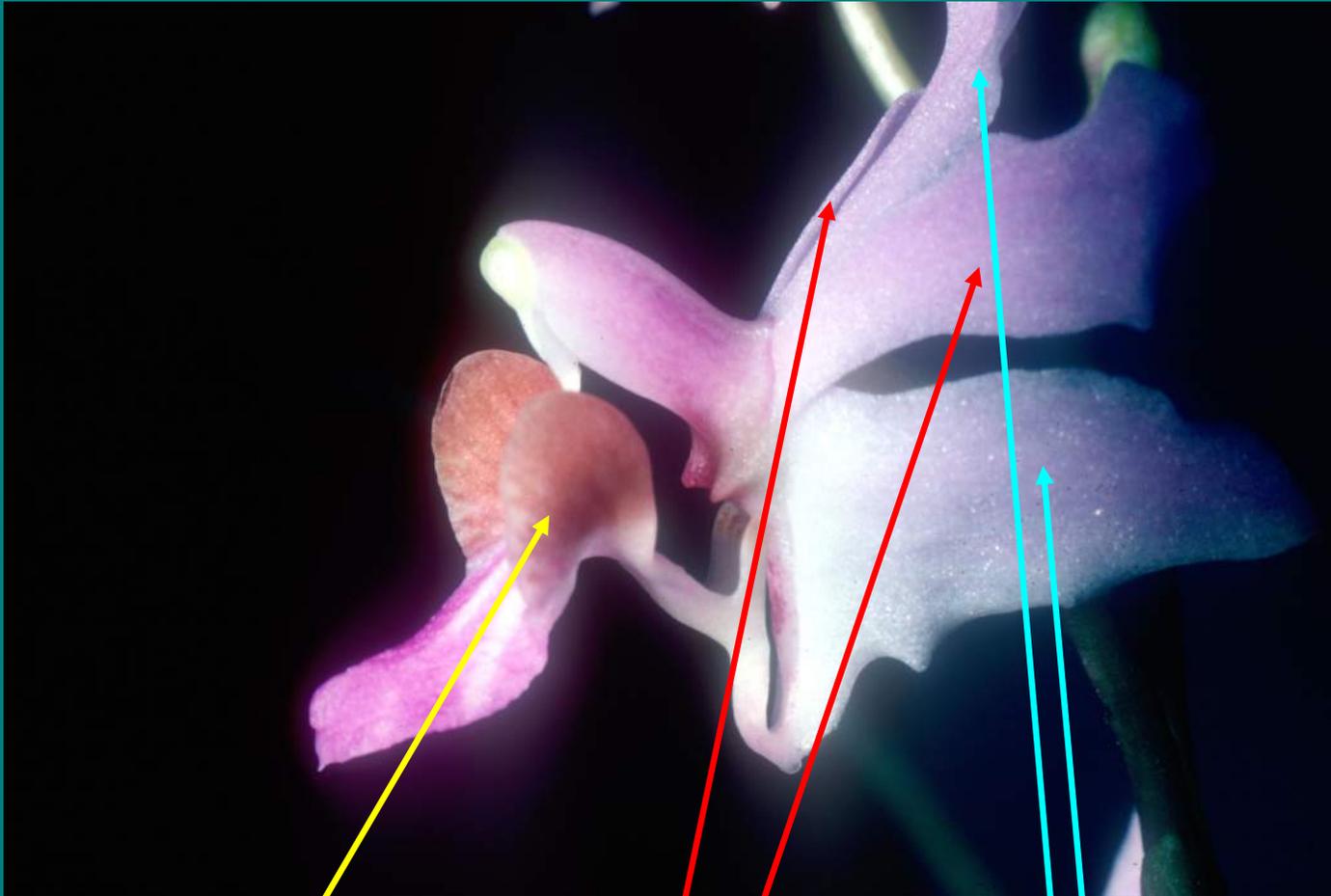
*Orchidaceae - orchids



Structure and position of pollinia and column allow for intricate and differential pollen placement on pollinators



*Orchidaceae - orchids



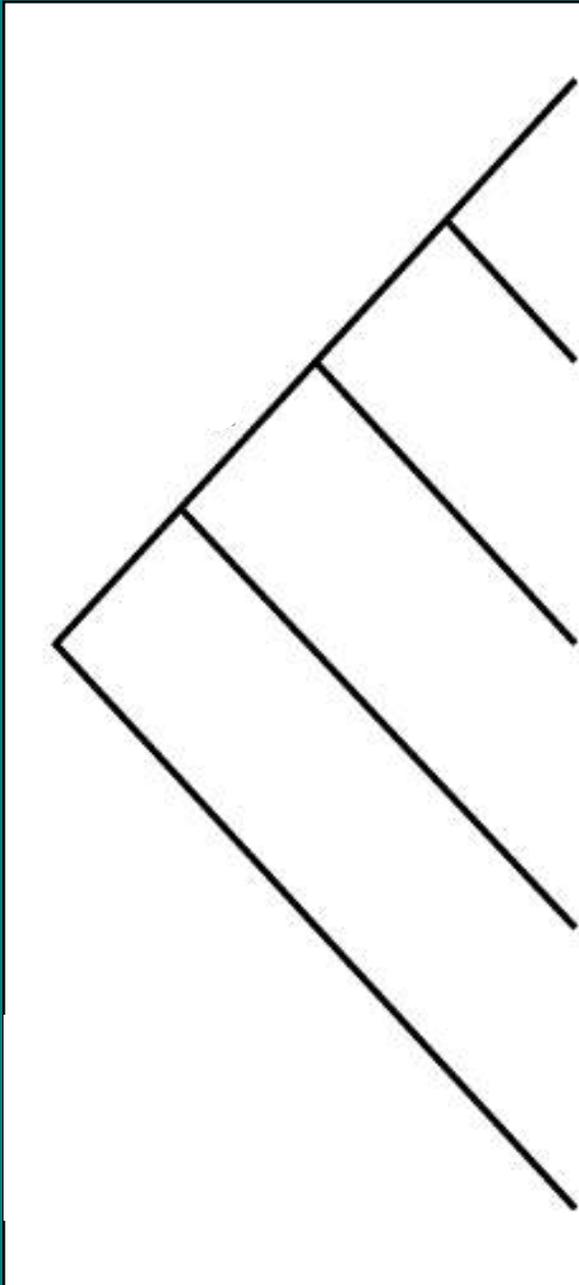
other floral parts

labellum

other 2 petals

3 sepals (one
behind)

*Orchidaceae - orchids



Orchidoideae

Epidendroideae

Cypripedioideae

Vanilloideae

Apostasioideae

Orchidoideae

The orchidoid orchids are mostly terrestrials with tubers or fleshy rhizomes and include most temperate orchids



*Orchidaceae - orchids



Aplectrum hyemale
Putty root, Adam and eve



*Orchidaceae - orchids



Calopogon tuberosus - grass pink
note the labellum on top!



Calypso bulbosa - calypso orchid
[threatened]

*Orchidaceae - orchids



Goodyera pubescens
Rattlesnake plantain

Goodyera tessellata
Rattlesnake plantain



*Orchidaceae - orchids

2 genera of native, non-photosynthetic mycotrophs



Corallorhiza trifida -
Early coral root



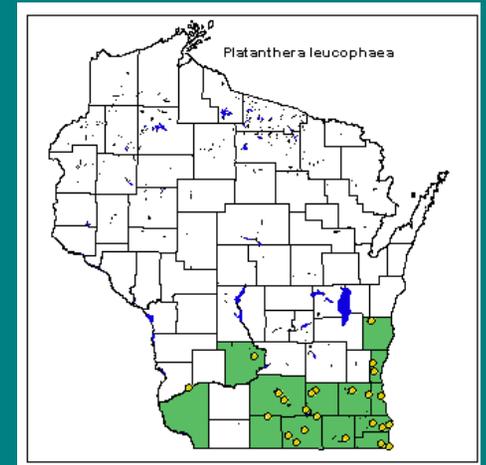
Corallorhiza striata -
Striped coral root

*Orchidaceae - orchids



Platanthera leucophaea
Prairie fringed orchid

State endangered,
Federally threatened



*Orchidaceae - orchids



Pogonia ophioglossoides -
snake mouth

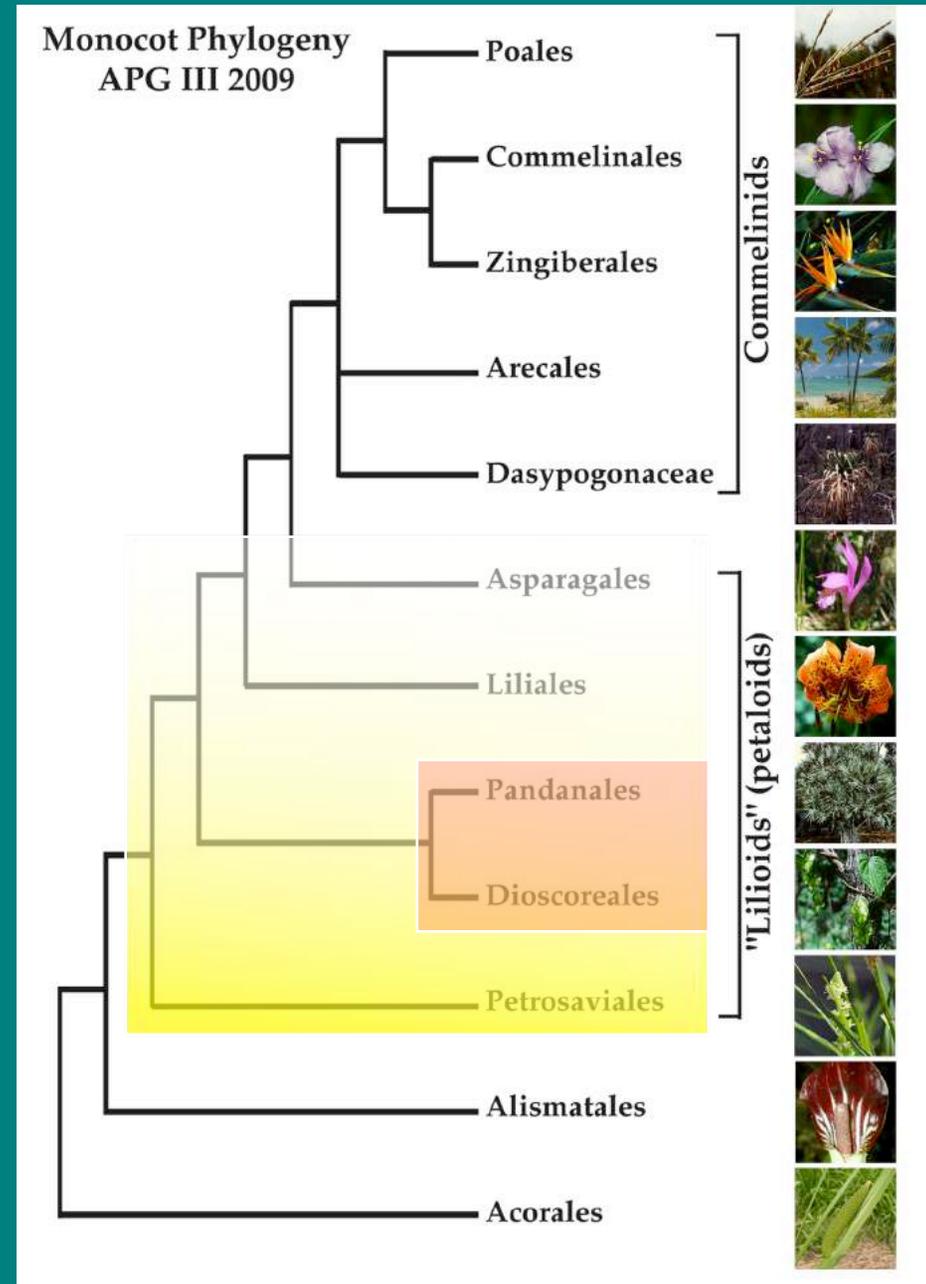


Spiranthes cernua -
nodding ladies' tresses

Lilioids - petaloid monocots

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Dioscoreales: Dioscoreaceae - yams

Small mainly tropical family, with **viney** stems and **net-veined** leaves. Fruits are 3-winged.

Source of edible yam; sources of steroids, cortisones, first oral contraceptives (diosgenin, progesterone)



Dioscorea sp.

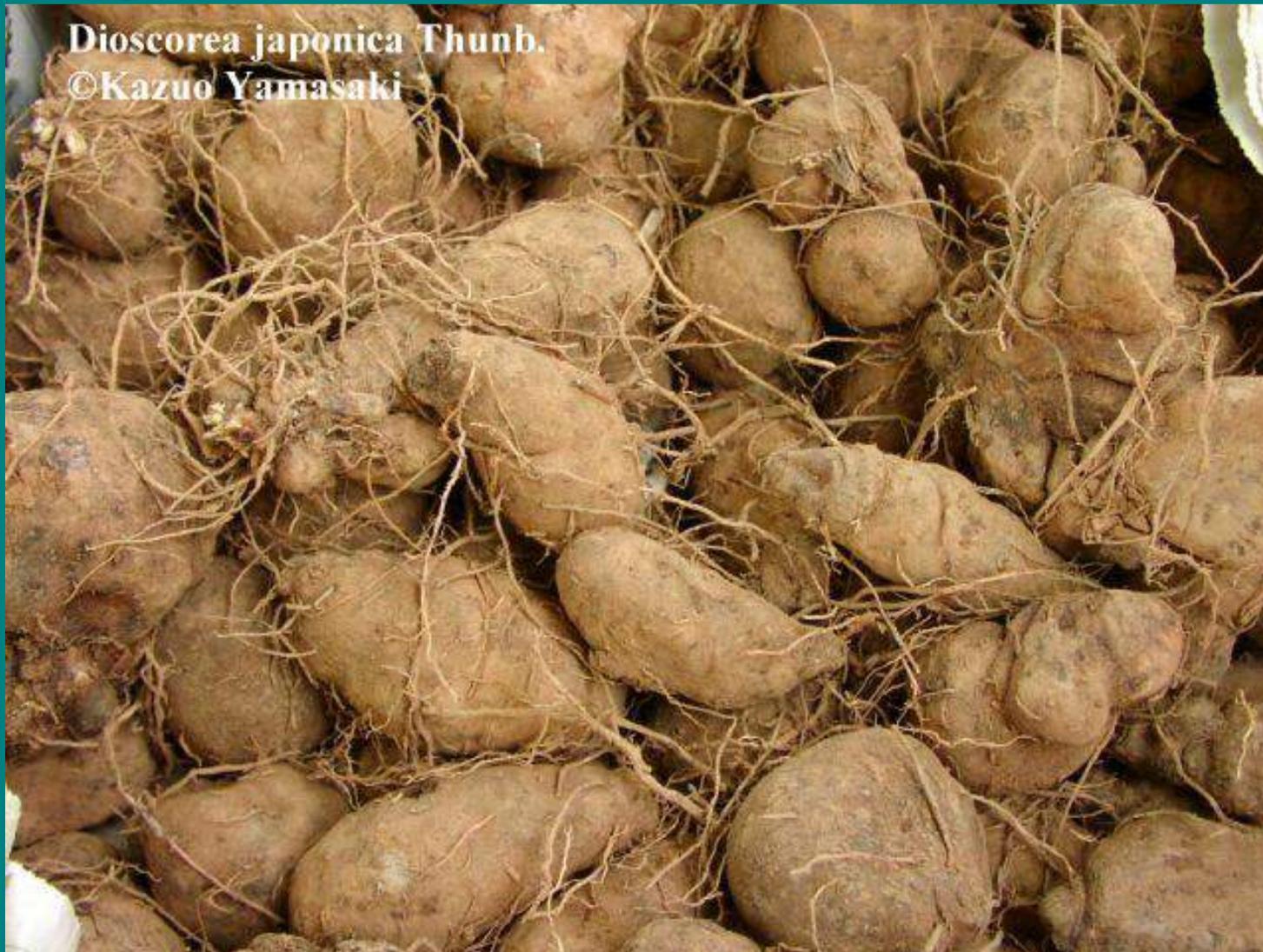


Dioscorea villosa -
wild yam



Dioscoreales: Dioscoreaceae - yams

Not to be confused with sweet potato - which belongs to
what family? **Convolvulaceae - asterid**



Dioscoreales: some mycotrophs!



Burmanniaceae

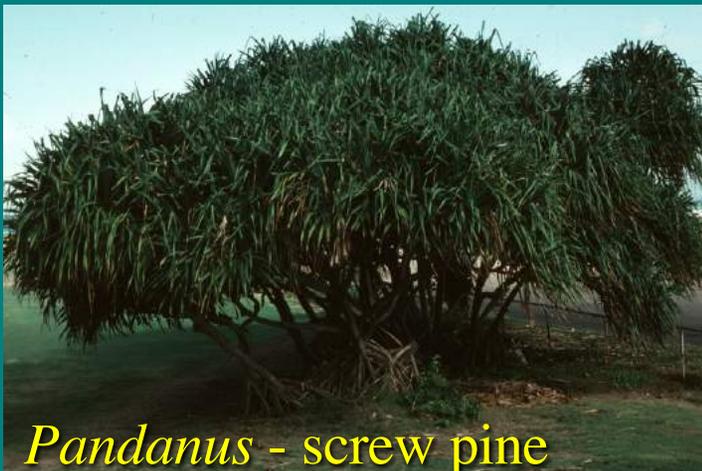


Thismiaceae

Pandanales: Pandanaceae - screw pine



Freycinetia



Pandanus - screw pine

Old world tropical family of trees
and vines - palm like

Pandanales: Cyclanthaceae - Panama Hat



Carludovica palmata
- Panama Hat



Cyclanthus

Neotropical family of 12 woody, palm-like, or liana genera

Unisexual flowers in “spathe/spadix” - mimic palms but 4
merous not 3 merous as in palms

Pandanales: Velloziaceae

Pantropical, often thickened stemmed, adapted to fire

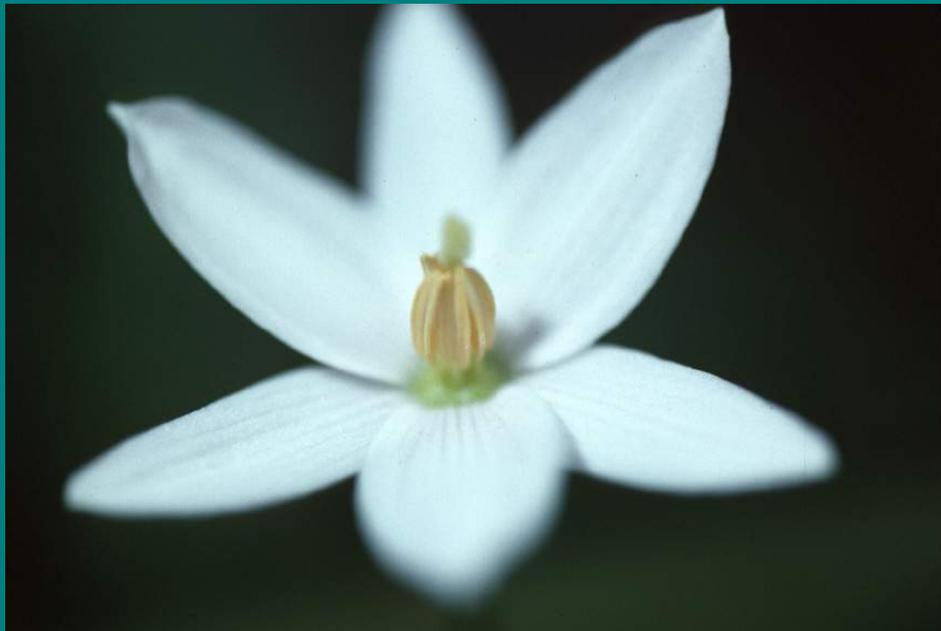
Vellozia



Pandanales: Velloziaceae

Flowers bisexual and “lilioid”

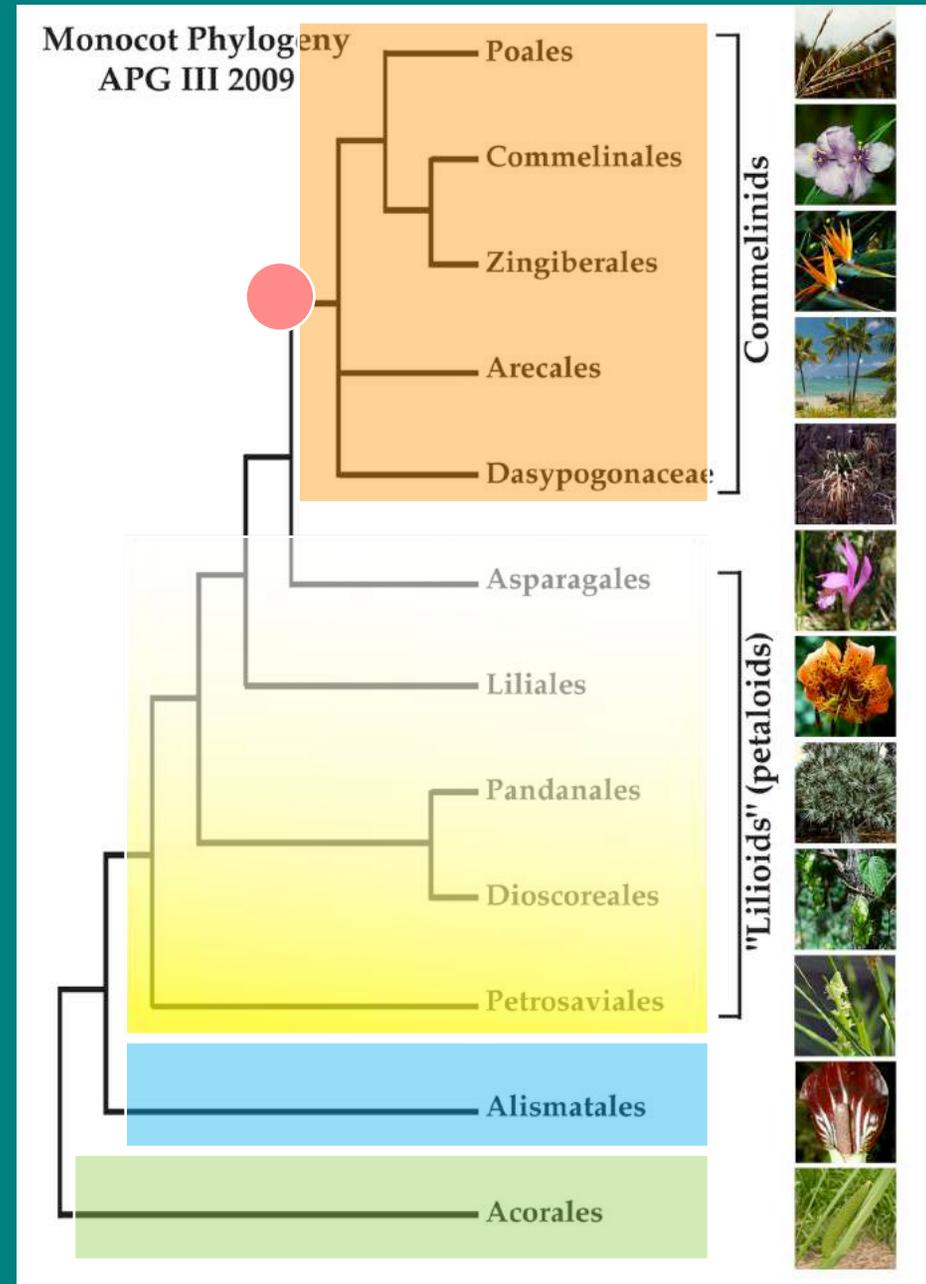
Barbacenia elegans



Commelinids

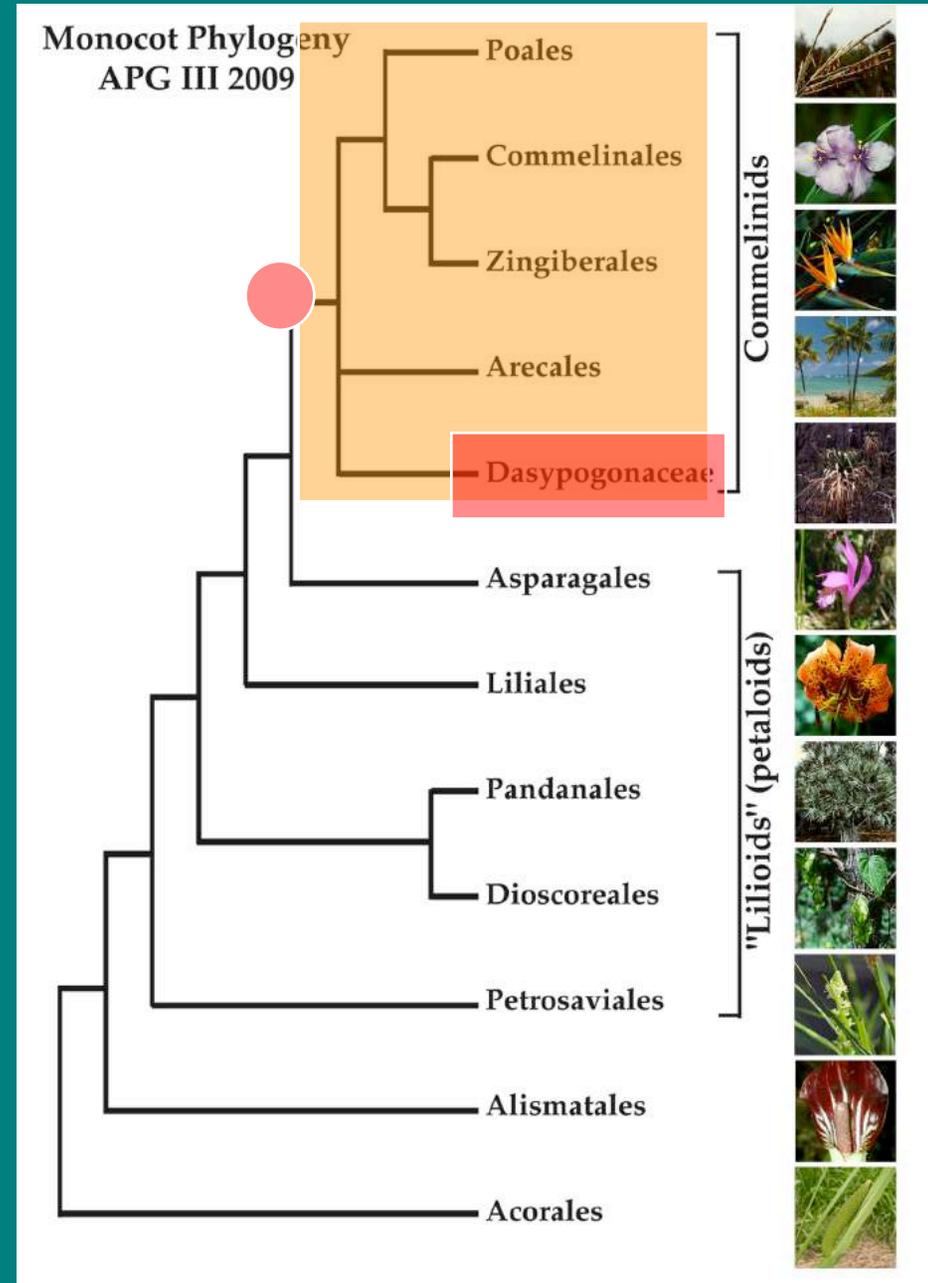
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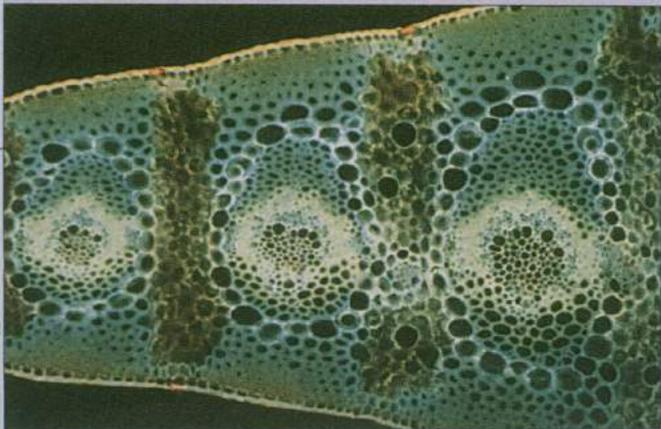
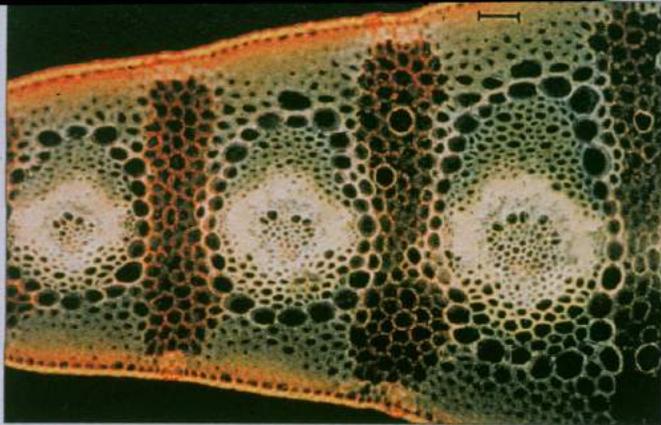
Commelinids

- largest group of monocots ranging from palms to grasses
- strongly monophyletic!
- bound **ferulic acid** in cell walls (fluoresce under UV with ammonium hydroxide added)
- this feature allowed placement of *Dasypogonaceae*



Commelinids

Dasyogonaceae



Thick cross sections of a leaf of *Baxteria australis* viewed by fluorescence microscopy. The change in fluorescence colour of the cell walls from pale blue in distilled water (*above*) to intense green when treated with ammonium hydroxide (*below*) indicates the presence of bound ferulic acid, a feature characteristic of commelinoid monocotyledons. Scale bar = 100 μm .



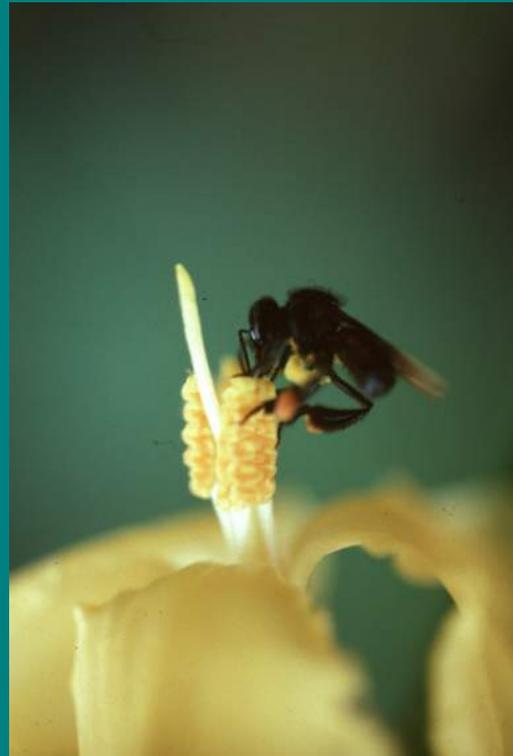
4 genera - W Australia

Commelinids

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



pickeral weed



rapatead



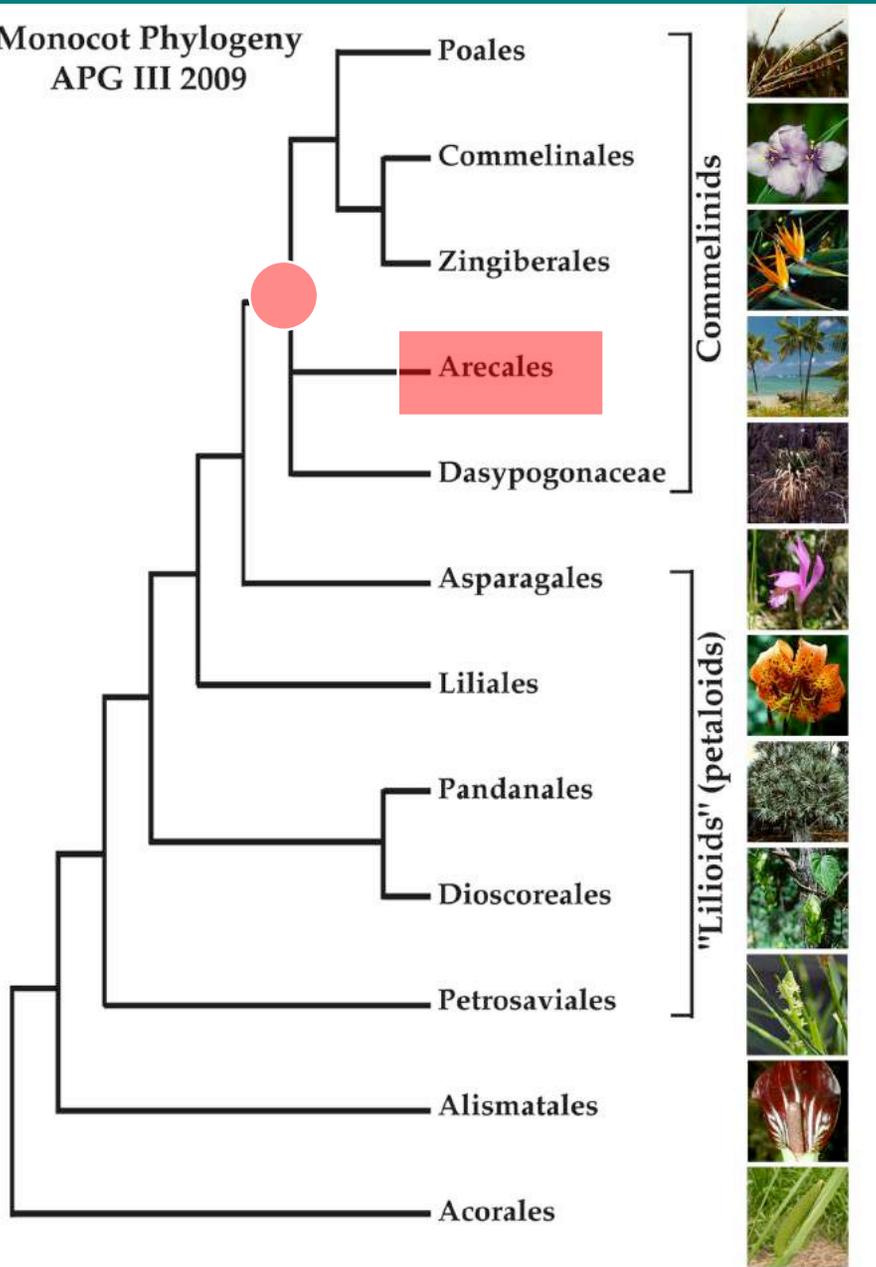
grass



bromeliad

*Arecaceae - palms

Monocot Phylogeny
APG III 2009

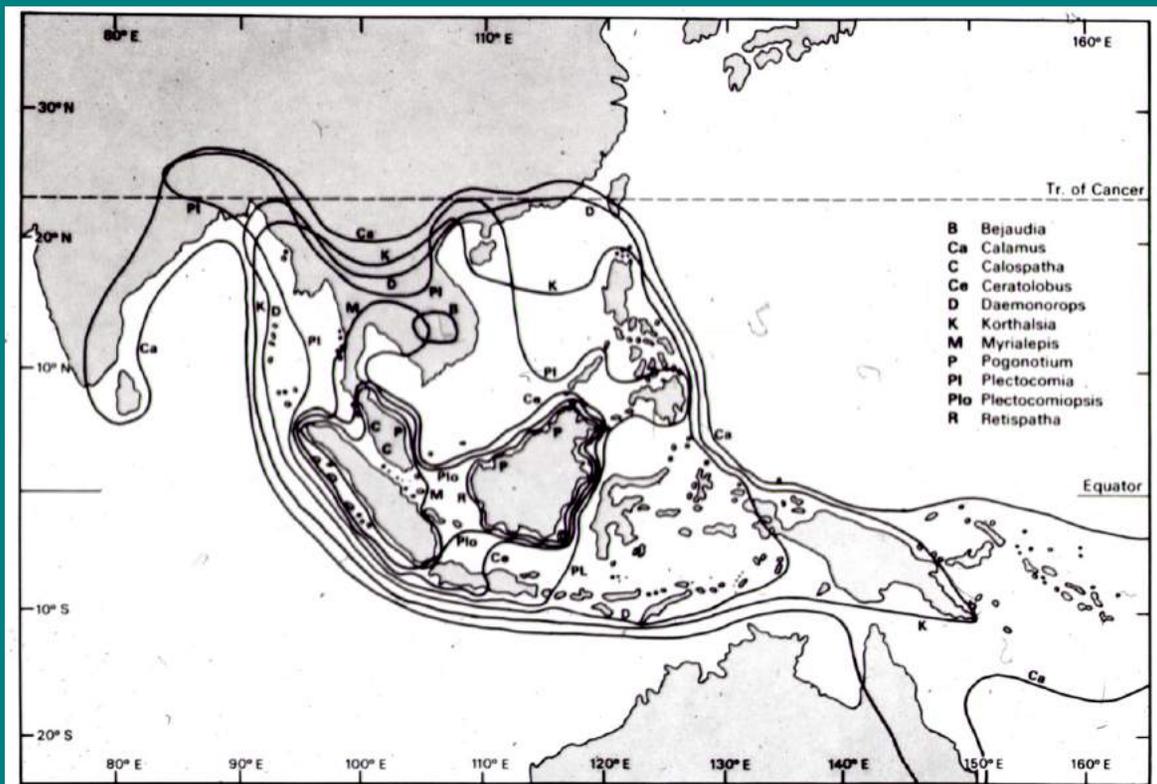


- the order has one family - also called Palmae
- 190 genera and 2400 species of trees and shrubs
- tropics, subtropics, deserts, Mediterranean biomes



*Arecaceae - palms

- Rattan palms - a plant group that honors the **Wallace Biogeographic Line**
- Asian distribution with few species passing through Sulawesi or New Guinea

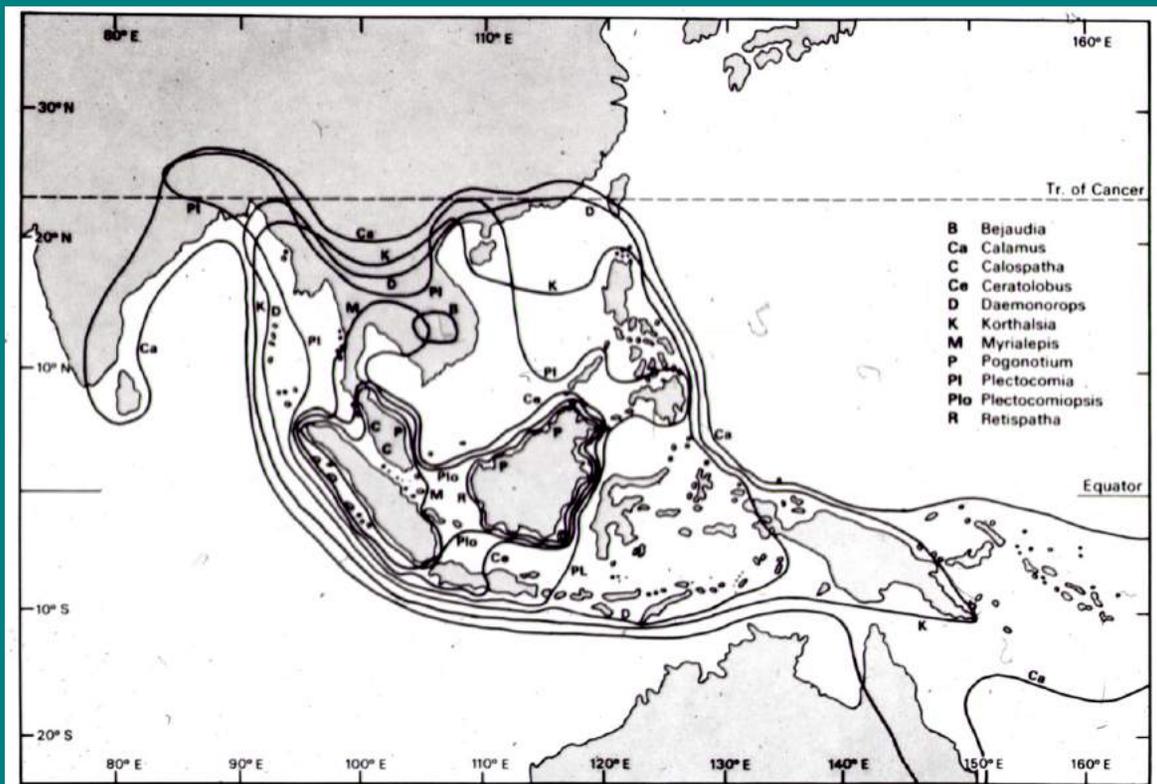


Rattan palm & generic distributions



*Arecaceae - palms

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Rattan palm & generic distributions

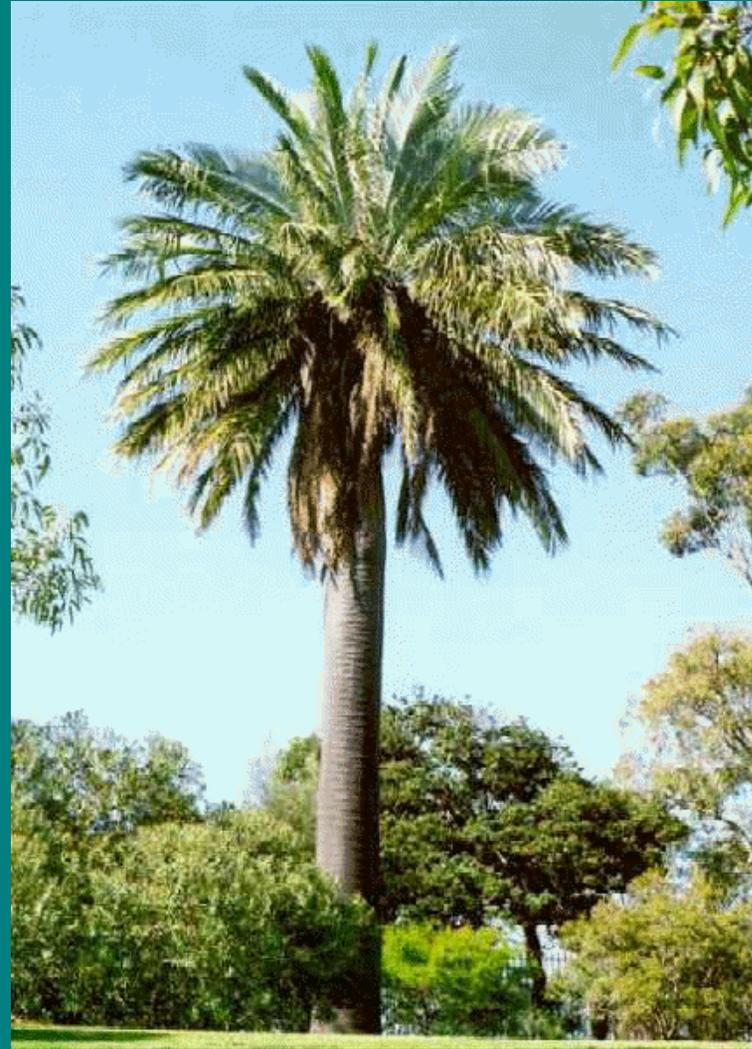


*Arecaceae - palms

Great morphological diversity: **in stature**



Syagrus - lilliput palm of Paraguay



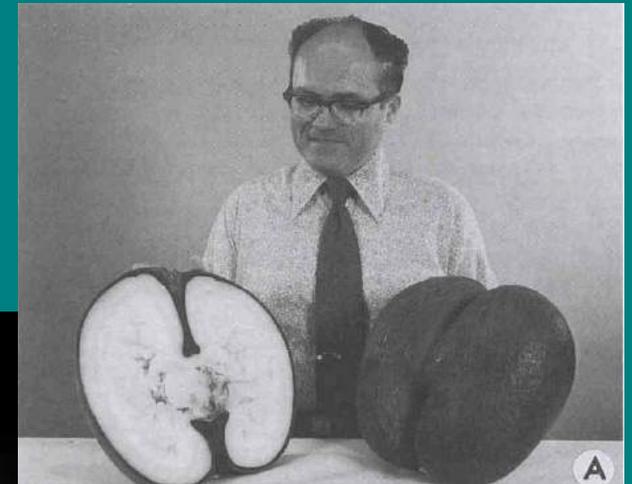
Jubaea - Chilean wine palm

*Arecaceae - palms

Great morphological diversity: largest seed of seed plants



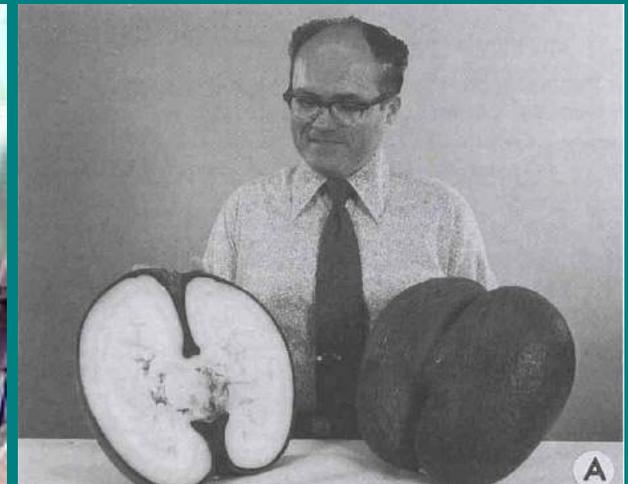
Island gigantism



Lodoicea maldivica - Seychelles palm or double nut

Endemic to the Seychelles has generated interest in having the largest seed, and in the shape of the male and female structures – suggestive of the devil's work or aphrodisiacal properties

(R) fruiting plant;
(B) vendor selling
seed; (BR) Seychelles
palm inflorescence
and seed for gender
bathrooms



*First seen only as
floating seeds by
sailors – described as
parts of mermaids*

Lodoicea maldivica - Seychelles palm or double nut

*Arecaceae - palms

Great morphological diversity: largest leaf



Raffia - rattan



Corypha



. . . and largest inflorescence

*Arecaceae - palms

Vegetative characteristics

- “woody” stems via primary thickening meristem or diffuse secondary growth
- essentially hardened leaf bases
- single apical meristem: susceptible to frost
- oldest known functioning primary xylem and sieve tubes!



Roystonea

*Arecaceae - palms

Vegetative characteristics

- palmate or pinnate “compound”, sheathing, **plicate** or folded



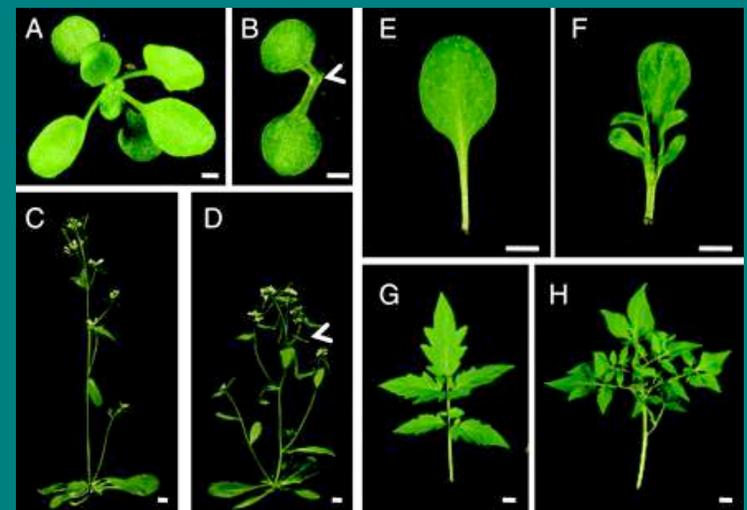
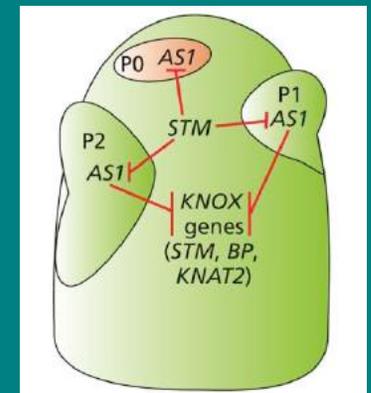
*Arecaceae - palms

Vegetative characteristics

- palmate or pinnate “**compound**”, sheathing, **plicate** or folded
- cell death or abscission forms “**compound**” leaves



KNOX genes involved in making compound leaves **not involved** in palm leaves



*Arecaceae - palms

Floral characteristics

- inflorescence surrounded by **spathe** - once allied with aroids

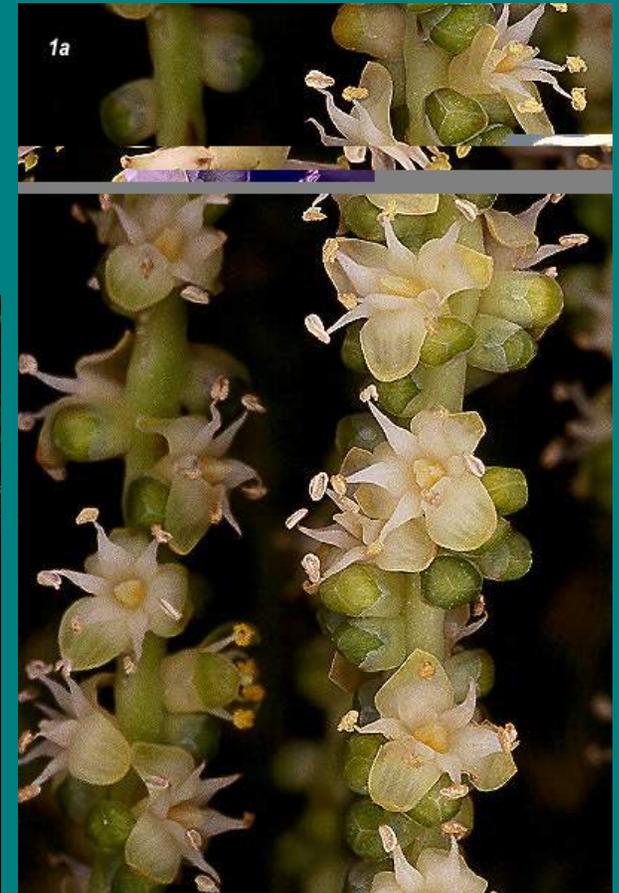


*Arecaceae - palms

Floral characteristics

- flowers unisexual or bisexual

CA 3 CO 3 A 3,6,∞ G 3 or (3)

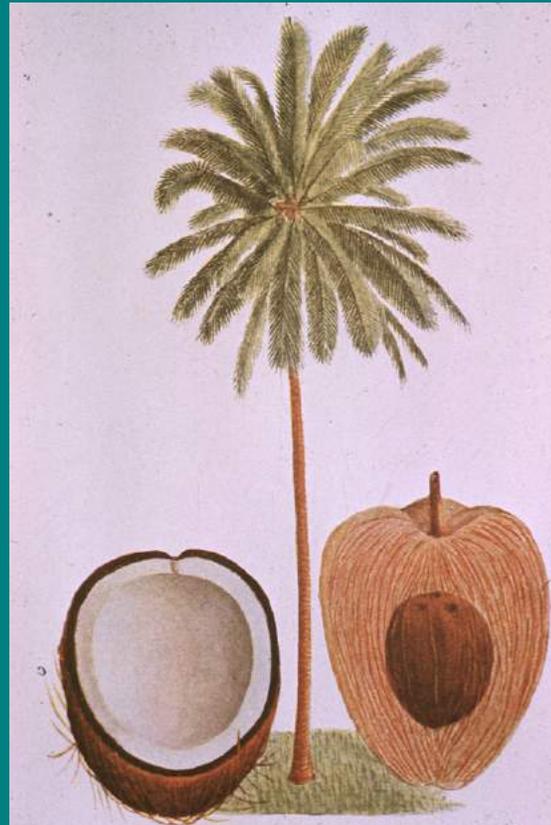


*Arecaceae - palms

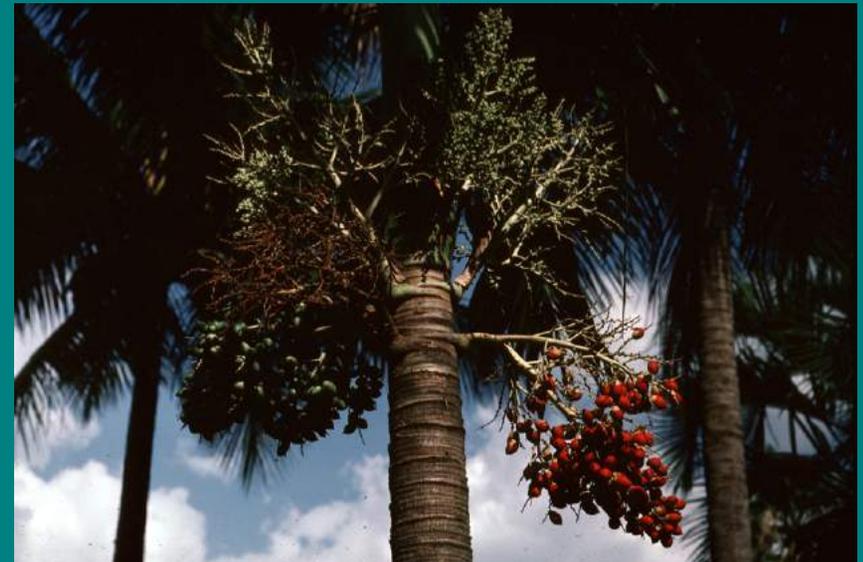
Floral characteristics

- fruit a 1-seeded berry or drupe

Cocos coconut



Areca Betel palm



*Arecaceae - palms

Classification: 5 subfamilies

- Calamoideae and Nypoideae are first diverging



Pantropical spiny genera



Calamus radicalis

Hawaii

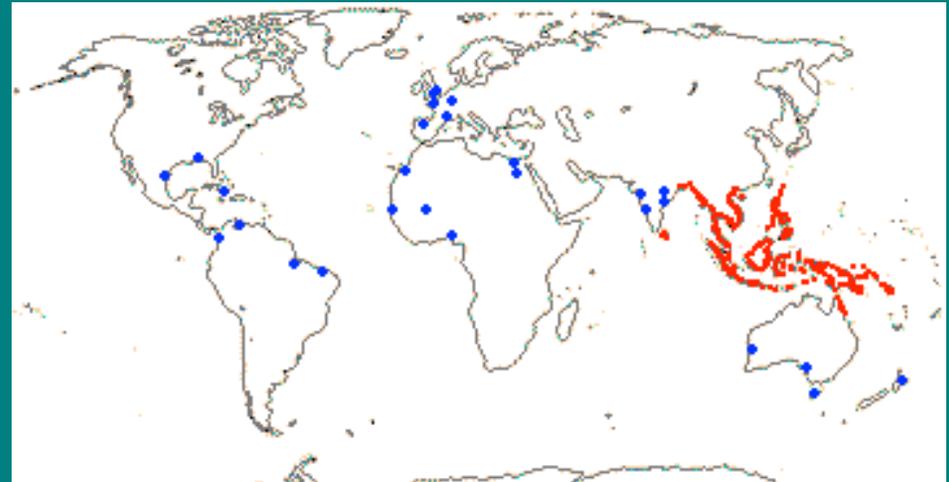
*Arecaceae - palms

Classification: 5 subfamilies

- Calamoideae and Nypoideae are first diverging



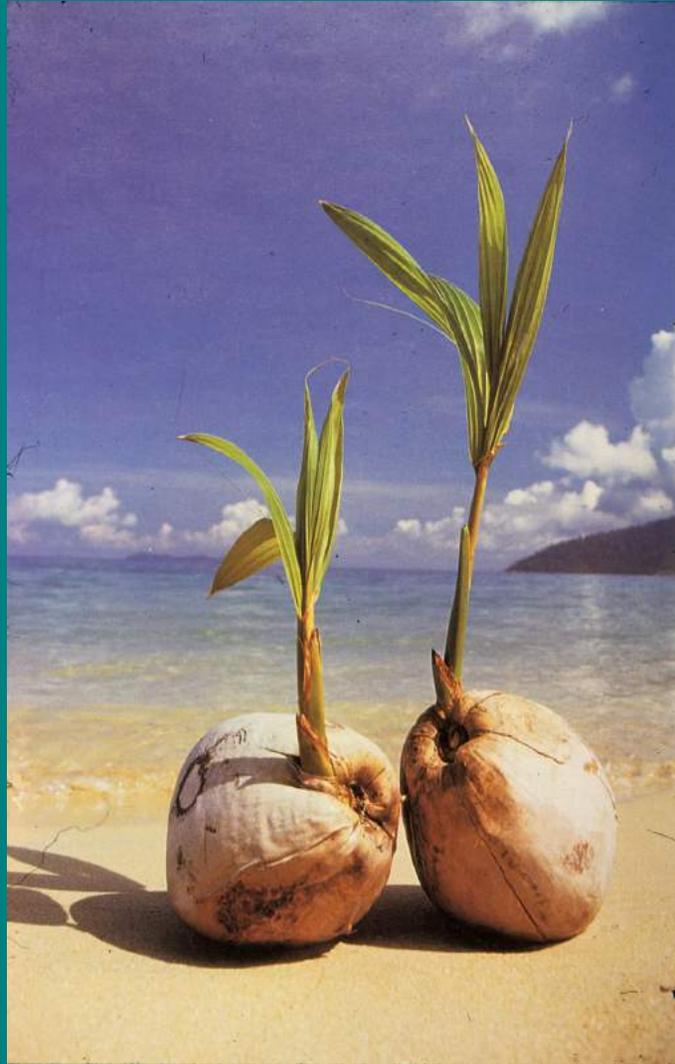
Nypa fruticans
salt marsh



one species but with widespread
early Tertiary fossil occurrences

*Arecaceae - palms

Important palms: food



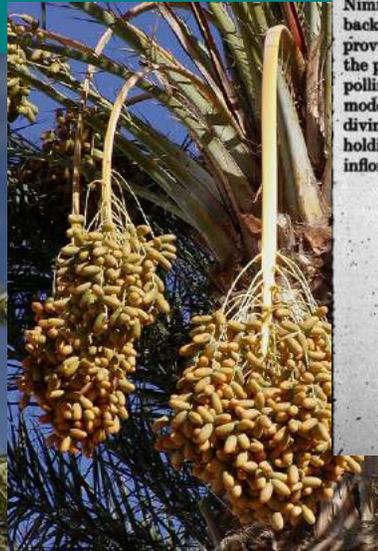
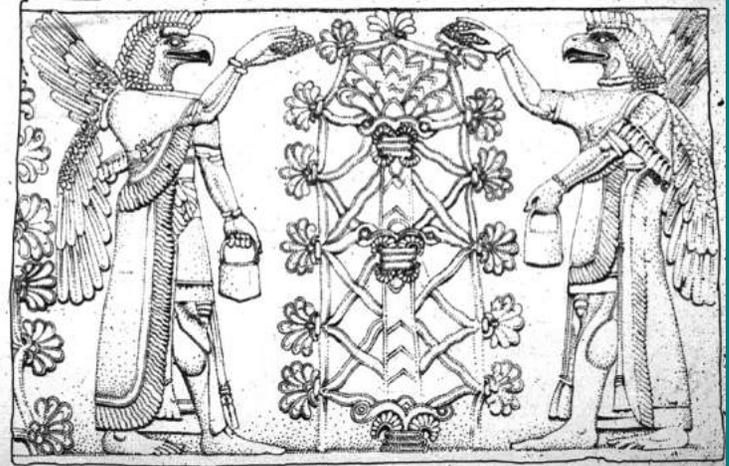
Cocos nucifera -
coconut

*Arecaceae - palms

Important palms: food

Phoenix - Date palm

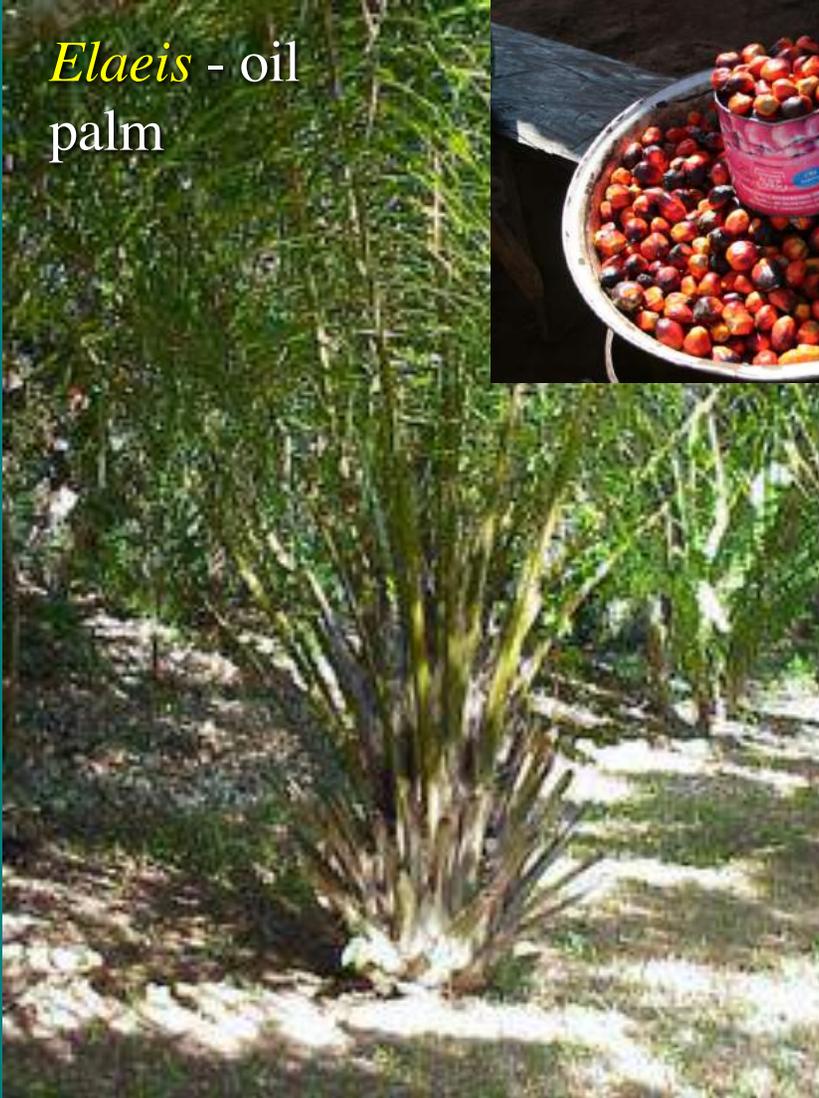
This relief found by Layard at Nimrud in Mesopotamia dates back to about 1500 B.C. providing us with evidence that the practice of artificial pollination is certainly not a modern one. It depicts two divine winged creatures each holding a male date palm inflorescence over a female tree.



*Arecaceae - palms

Important palms: oil, wax

Elaeis - oil palm



Chyrtostachys - sealing wax palm

*Arecaceae - palms

Important palms: horticulture



Roystonea - Royal Palm



Washingtonia –
Mexican fan palm

*Arecaceae - palms

Important palms: horticulture

Palm House at Kew Royal Botanic Garden – one of the largest glass houses in the world with **the largest glass house plant** in the world



*Arecaceae - palms

The largest glass house plant and the largest palm in the world

Jubaea chilensis – Chilean wine palm

