

Lilioids - petaloid monocots


4 main groups:

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

Monocot Phylogeny
APG III 2009

The tree shows Acorales as the sister group to all other monocots. Alismatales is the next group. The Lilioids (petaloids) clade includes Asparagales, Liliales, Pandanales, Dioscoreales, and Petrosaviales. The Commelinoids clade includes Poales, Commelinales, Zingiberales, and Arecales. Dasygongonaceae is shown as a sister group to the Lilioids.

Lilioids - petaloid monocots

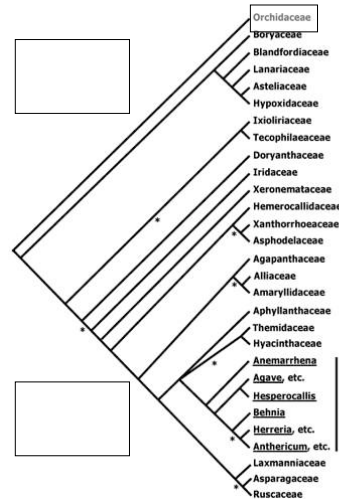


1. Terrestrial/epiphytes: plants typically not aquatic

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



The tree lists the following families from top to bottom: Orchidaceae, Boryaceae, Blandfordiaceae, Lanariaceae, Asteliaceae, Hypoxidaceae, Ixioliriaceae, Tecophilaeaceae, Doryanthaceae, Iridaceae, Xeronemataceae, Hemerocallidaceae, Xanthorrhoeaceae, Asphodelaceae, Agapanthaceae, Alliaceae, Amaryllidaceae, Aphyllanthaceae, Themidaceae, Hyacinthaceae, Anemarrhena, Agave, etc., Hesperocallis, Behnia, Hecreria, etc., Anthericum, etc., Laxmanniaceae, Asparagaceae, and Ruscaceae.

- 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



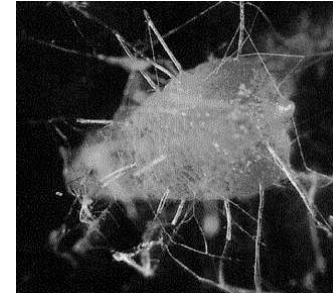
Corallorhiza striata
Striped coral root

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



Dactylophiza 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

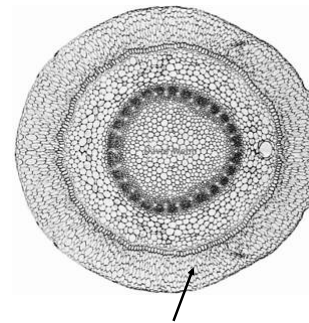


Oncidium trunk epiphyte

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



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.

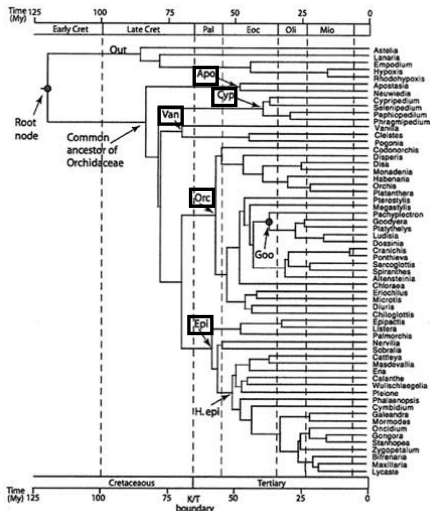
Bulbophyllum nocturnum

Only totally night blooming orchid

Fungal midge pollinated?



*Orchidaceae - orchids

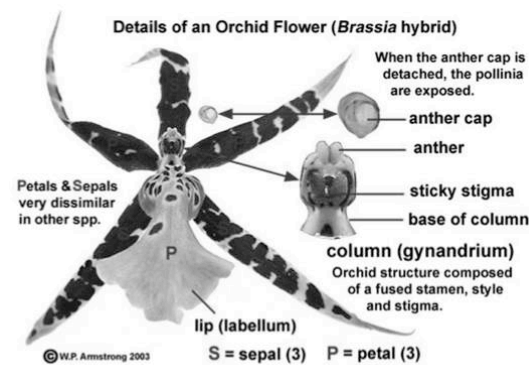


A 2007 paper in *Nature* suggests that the orchid family is not recent, but of late Cretaceous origin



*Orchidaceae - orchids

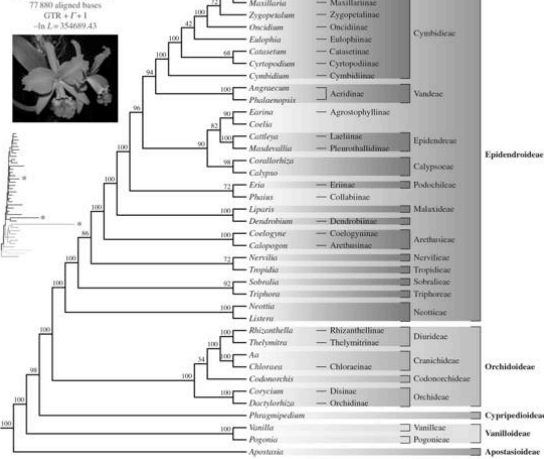
CA 3 COZ 2+1 A 3.2.1 G (3)



- 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

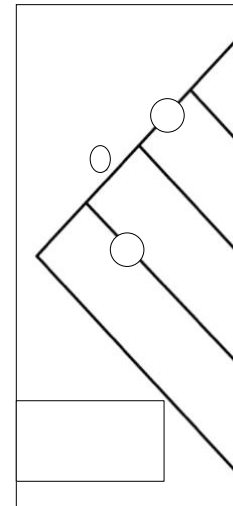
ML plastome phylogeny
77 880 aligned bases
GTR + I + G4
50 L = 354000 (3)



Givnish et al. (2015) plastome tree



*Orchidaceae - orchids



Orchidoideae



Five subfamilies

Epidendroideae



3 stamens

2 stamens

1 stamen

Cypripedioideae



Two origins of reduction to one stamen

Vanilloideae



Apostasioideae



*Orchidaceae - orchids

Apostasioideae (2 genera)

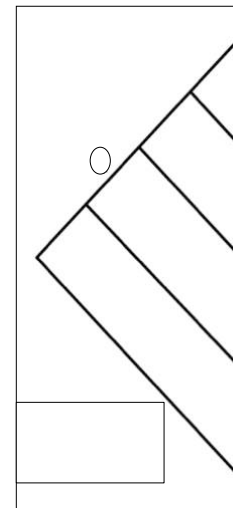
- 3 stamens (usually)
- most primitive of orchids with nearly actinomorphic flowers
- Austral-asian distribution



Neuwiedia veratrifolia



*Orchidaceae - orchids



Orchidoideae

Vanilloideae

Epidendroideae

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

Cypripedioideae



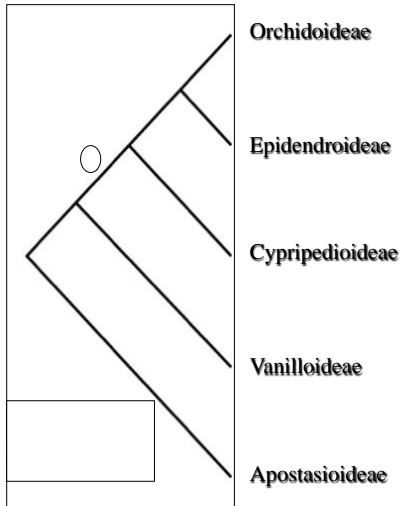
Vanilla

Vanilloideae

Apostasioideae

VANILLA ORCHIDS
State/History of Cultivation

*Orchidaceae - orchids



Orchidoideae

Epidendroideae

Cypripedioideae

Vanilloideae

Apostasioideae

Cypripedioideae (5 genera)

- 2 stamens
- "slipper" labellum
- Northern Hemisphere distribution



*Orchidaceae - orchids



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



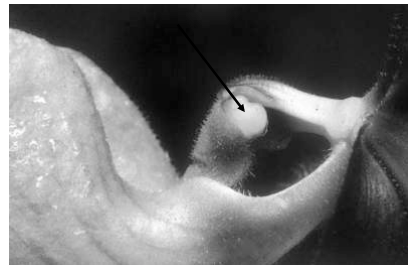
Cypripedium acaule - stemless lady's-slipper

*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



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



Cypripedium calceolus
Yellow lady's-slipper

Other lady's-slippers . . .



***Orchidaceae - orchids**



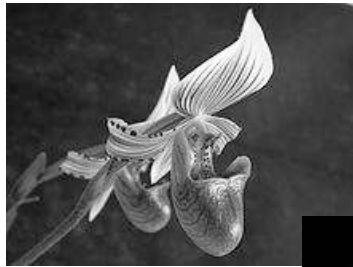
Cypripedium reginae
showy lady's-slipper

***Orchidaceae - orchids**



Cypripedium candidum
white lady's-slipper
Threatened, fen or calcareous soils

***Orchidaceae - orchids**



Paphiopedilum

Non-native bucket or
slipper orchids

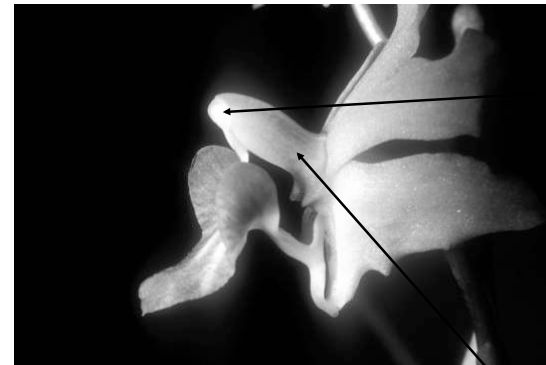


Phragmipedium



Mexipedium

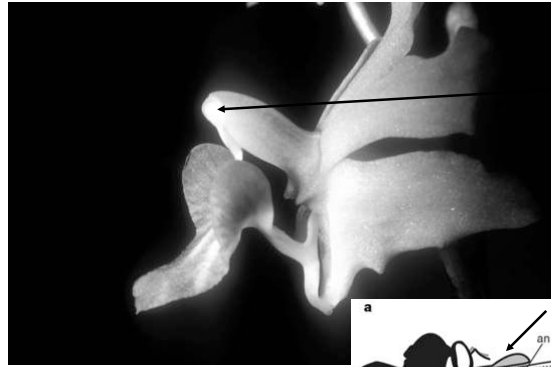
***Orchidaceae - orchids**



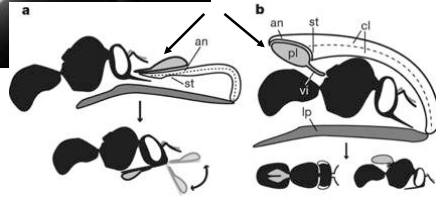
All other orchids
have only 1
functional stamen
with one or two
pollinia

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

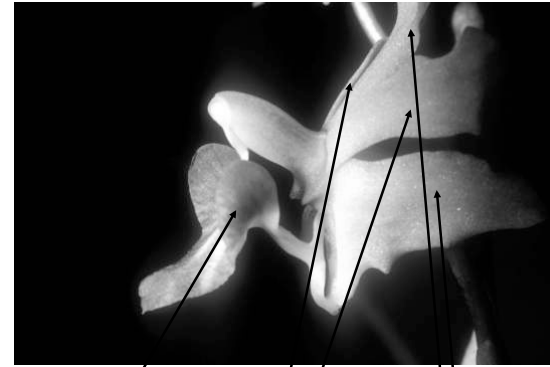
*Orchidaceae - orchids



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



*Orchidaceae - orchids



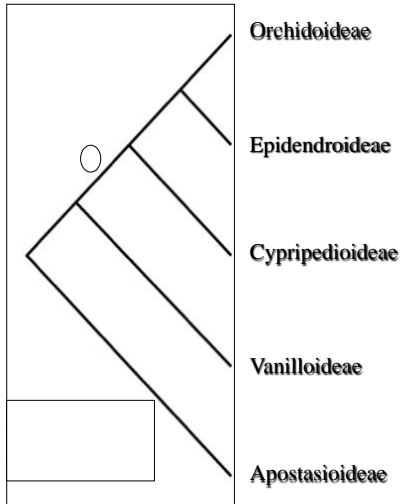
other floral parts

labellum

other 2 petals

3 sepals (one behind)

*Orchidaceae - orchids



Orchidoideae

Epidendroideae

Cypripedioideae

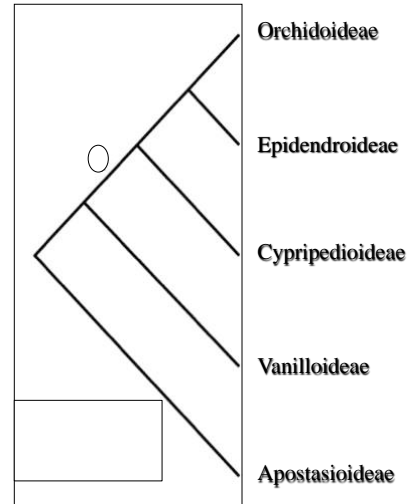
Vanilloideae

Apostasioideae

Epidendroideae
The epidendroid orchids, the largest group, are predominantly epiphytes or lithophytes and include all the showy tropical genera



*Orchidaceae - orchids



Orchidoideae

Epidendroideae

Cypripedioideae

Vanilloideae

Apostasioideae

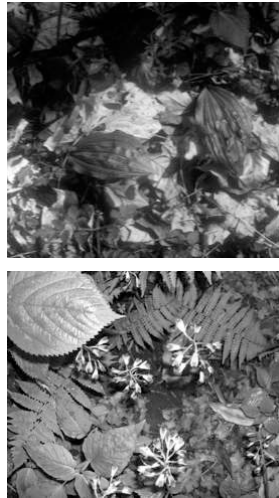
Orchidoideae
The orchidoid orchids are mostly terrestrials with tubers or fleshy rhizomes and include most temperate orchids



***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**



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

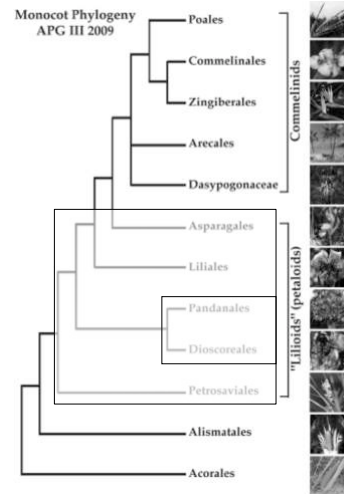


Spiranthes cernua -
nodding ladies' -tresses

Lilioids

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



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)



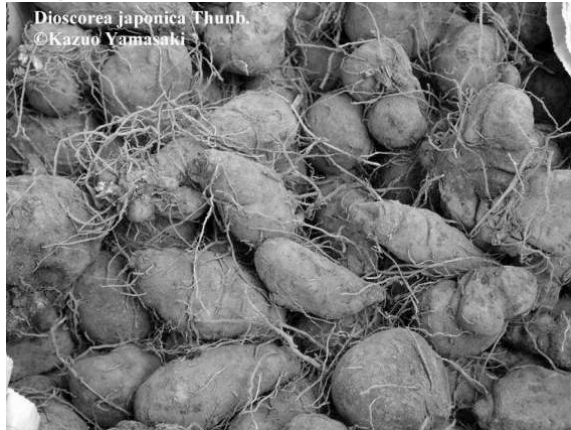
Dioscorea villosa -
wild yam



Dioscorea sp.

Dioscoreales: Dioscoreaceae - yams

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



speaking of the holidays . . .

sweet potatoes & yams



Dioscoreales: some mycotrophs!



Burmanniaceae



Thismiaceae

Pandanales: Pandanaceae - 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"

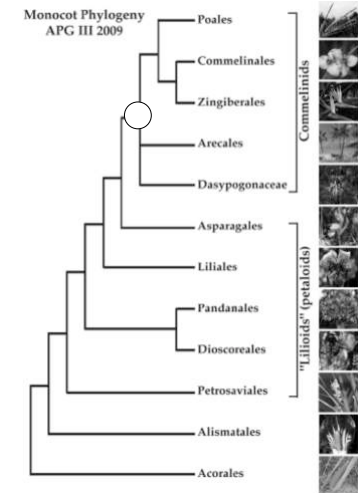


Barbacenia elegans

Commelinids

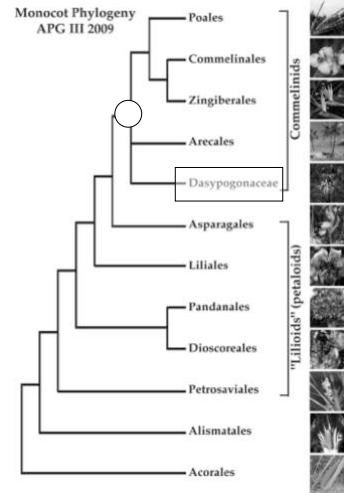
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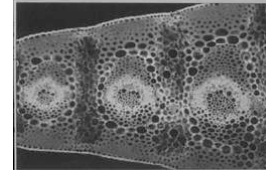
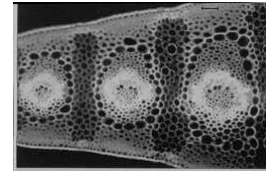


Commelinids

- 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



Thick cross sections of a leaf of *Bacteria 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 μ m.



Dasypogonaceae



4 genera - W Australia

Commelinids

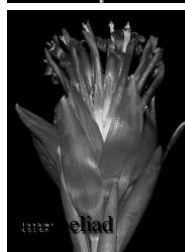
- theme: reduction of flower, loss of nectar, loss of zoophily, evolution of bracts



pickeral weed



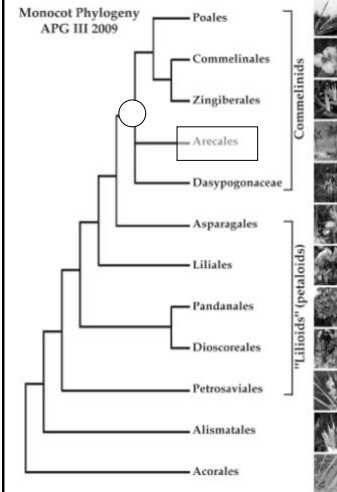
rapatead



eliad

*Arecaceae - palms

Monocot Phylogeny
APG III 2009

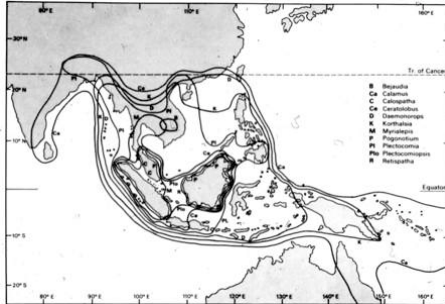


- the order has one family - also called Palmae
- 190 genera and 2400 species of trees and shrubs
- tropics, subtropics, deserts, Mediterranean biomes



*Arecaceae - palms

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

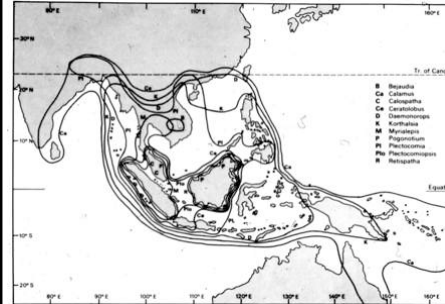


Rattan palm & generic distributions



*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



*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



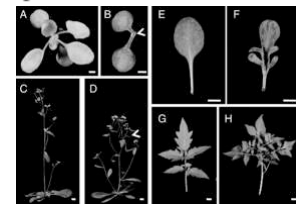
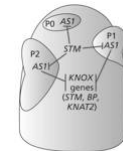
*Arecaceae - palms

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



*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

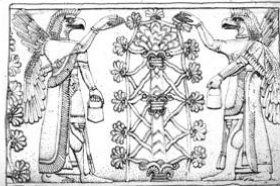
*Arecaceae - palms

Important palms: food

Phoenix - Date palm



This relief found by Layard at
Nineveh in Mesopotamia dates
back to about 1800 B.C.
providing us with evidence that
the practice of artificial
pollination is certainly not a
modern one. It depicts two
Old Testament characters each
holding a male date palm
inflorescence over a female tree.



*Arecaceae - palms

Important palms: oil, wax



Elaeis - oil
palm



Chrysolepis -
sealing wax palm

*Arecaceae - palms

Important palms: horticulture



Roystonea - Royal Palm



Washingtonia -
Mexican fan palm

*Arecaceae - palms

Jubaea chilensis - Chilean wine palm

