

31st Annual John J. Dwyer Public Lecture in Biology

The *Philodendron* Family (*Araceae*):
Diverse, Interesting and Still Growing

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Paul A. Schulze Curator of Botany
27 April 2018

Forest canopy on Barro Colorado Island with a view
of the Panama Canal shipping channel



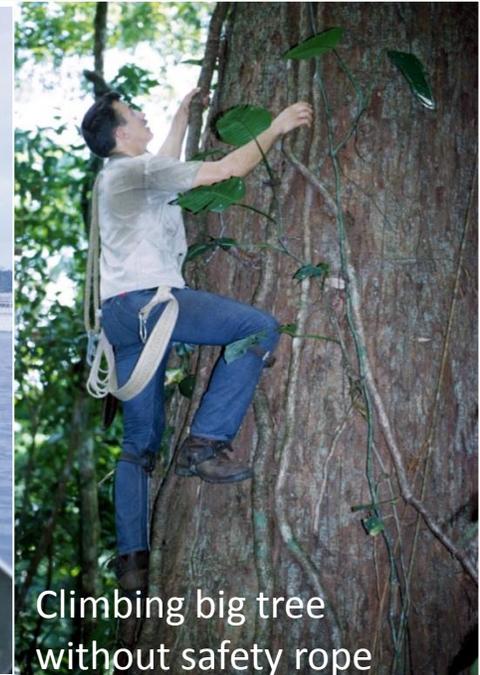
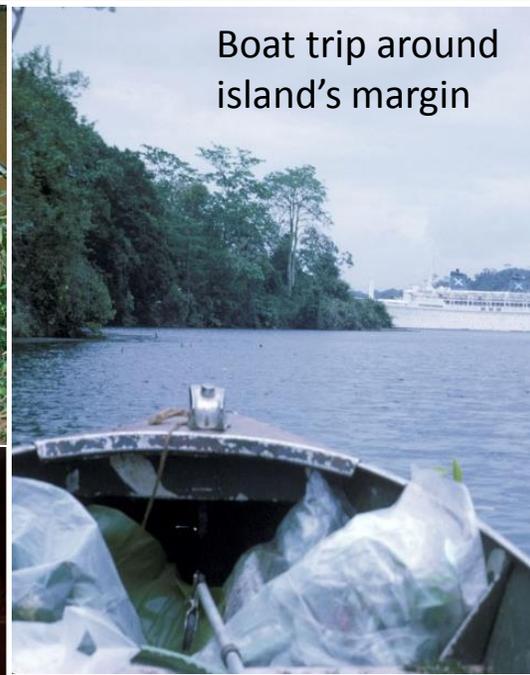
Madagascar



Rio Jurua Mirim, Brazil
Flora of Acre Project

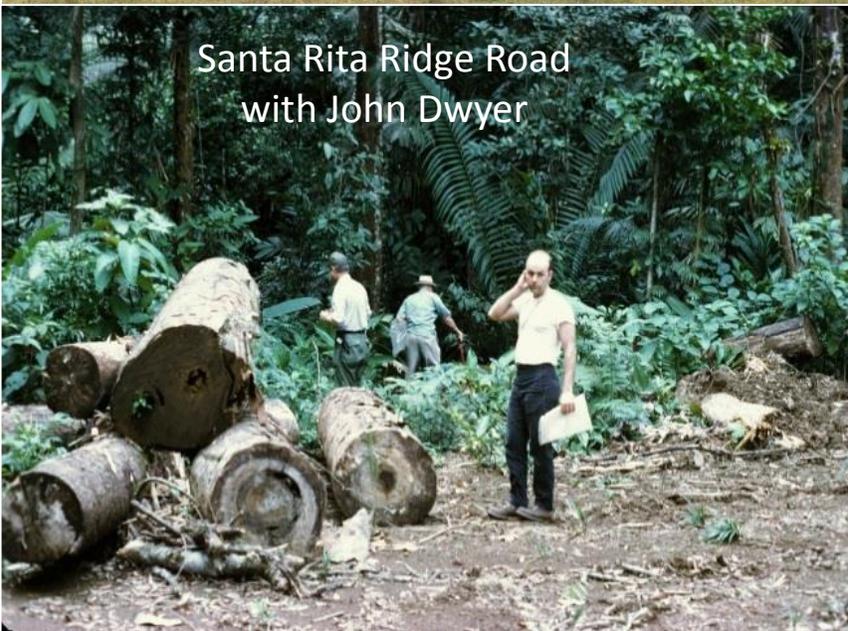


Boat trip around
island's margin

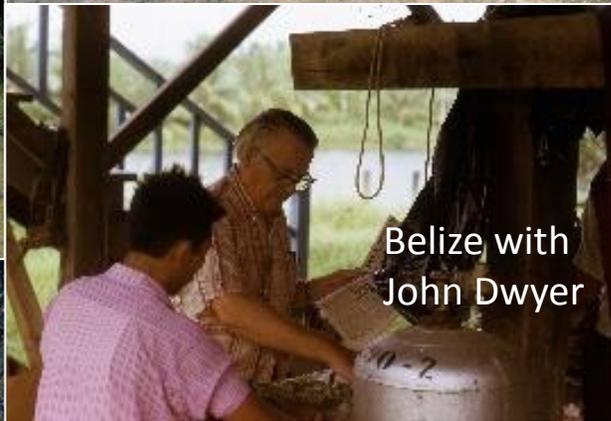


Climbing big tree
without safety rope

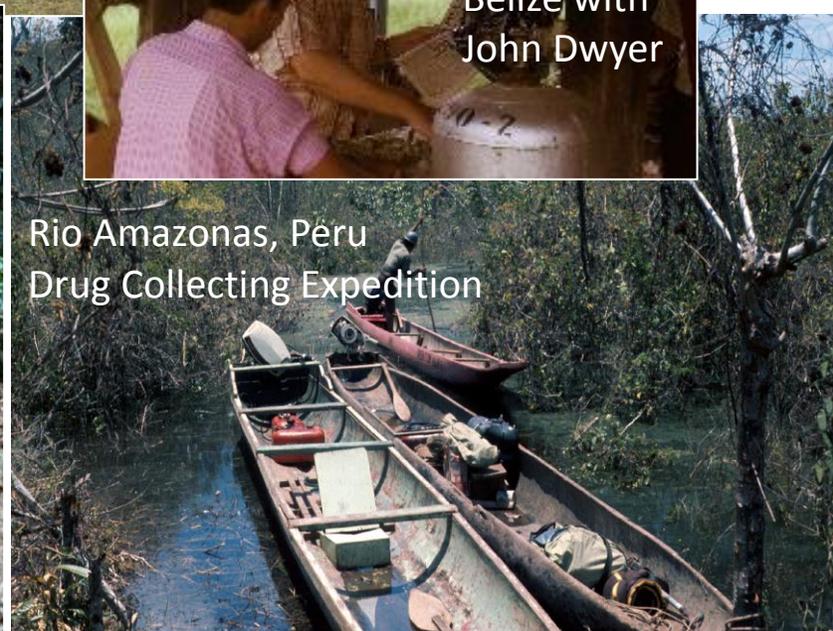
Santa Rita Ridge Road
with John Dwyer



Belize with
John Dwyer



Rio Amazonas, Peru
Drug Collecting Expedition



Panama,
Rio
Tuquesa,
Kittridge
gold mine

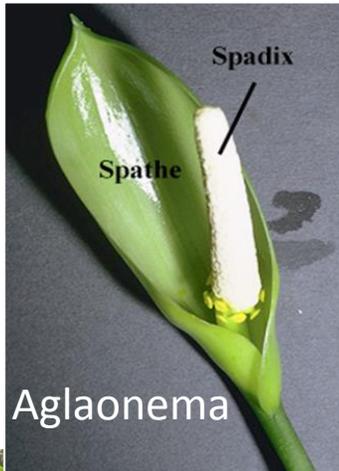


Collecting built up the world's largest aroid herbarium and the most species - rich living collection

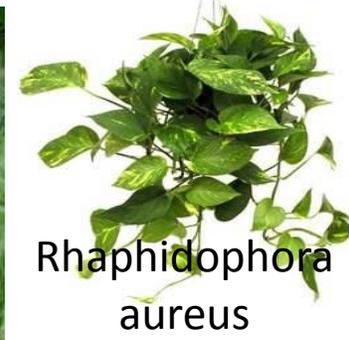


What is an AROID (Araceae)?

Unifying Characteristics: Flowers arranged in dense spikes (spadix); spadix is initially enclosed in a leaf-like spathe. Plants typically associated with aroids.



- Anthurium
- Dieffenbachia (dumb cane)
- Monstera (split leaf Philodendron)
- Philodendron (*P. hederaceum*)
- Peace Lily (*Spathiphyllum*)
- Golden Pothos (*Rhaphidophora aurea*)
- Syngonium (*S. podophyllum*)



Important characteristics of aroids

- High **species diversity**
- High **habit diversity**
- High rates of **endemism**
 - Mexico 69%, Guatemala 22%, Costa Rica 50%, Panama 95%
- High numbers of **undescribed species**
 - Most new species seem to be narrow endemics
 - Causes of high speciation?
 - **Co-evolution with** species-diverse **insects**, beetles & bees
 - Fruit **dispersal** by territorial **birds**



Euglossa



Eulema



Trigona



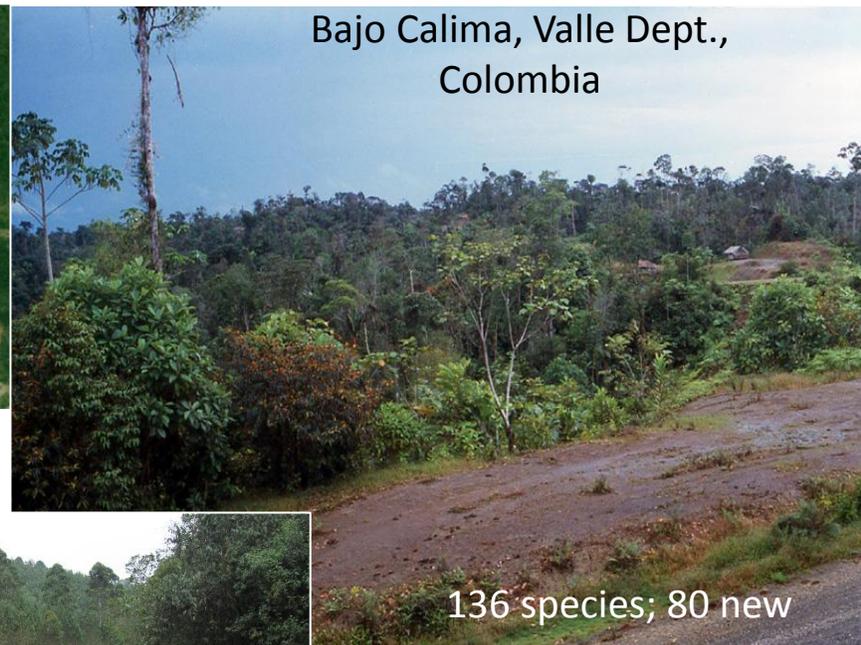
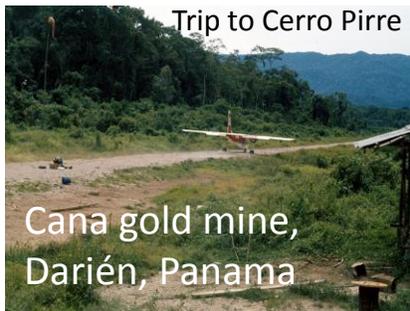
Cyclocephala



Cyclocephala
pollinating Philodendron

High Species Diversity

- Cerro Pirre, Panama
267 collections in a single day, 70 Araceae, 20 of which were new
- Chocó, Colombia
- Bajo Calima, Col.
- Alto Tambo, Ecuad.
- El Chical, Ecuador
- Río Medellín, Col.
- Sucre Department, Colombia

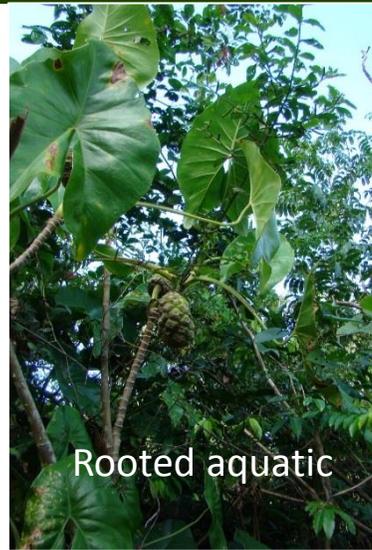


Rio Mira vs.
Rio San Juan



High Habit Diversity

- Free-floating aquatics
- Tree-like rooted aquatics
- Tuberos, rhizomatous, cauline
- Understory terrestrial herbs
- Epiphytes
 - True epiphytes →
 - Primary hemiepiphytes
 - Secondary hemiepiphytes
 - Vines vs. appressed climbers



Rooted aquatic



Dracontium



Pistia- rooted aquatic



Lemnaceae



Tubercules

Dracontium



Anthurium gracile



Understory herb- Dieffenbachia



Anthurium clidmioides



Philodendron vine

Root climber with intermodal roots



Philodendron secondary hemiepiphyte

Anthurium apressed climber



Aroids Are Ecologically Diverse



Tuberous growth
preadapted to dry
environs

*Sauromatum
venosum*



Rheophytes in
Borneo



Appressed-climbing
juvenile leaves

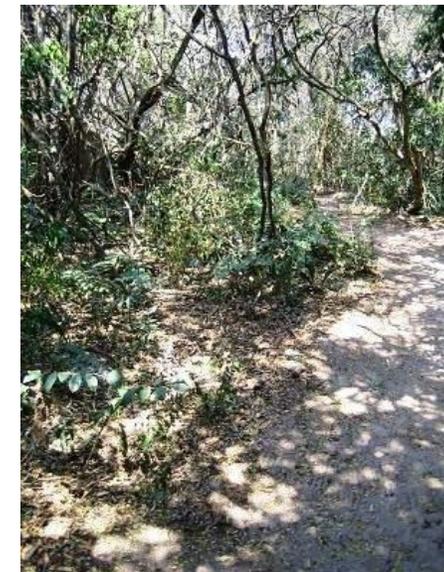


Anubias, underwater aquatic,
Western Africa



Thermogenesis
heats up spadix
and this melts
snow

Symplocarpus foetidus
emerging from snow, Michigan

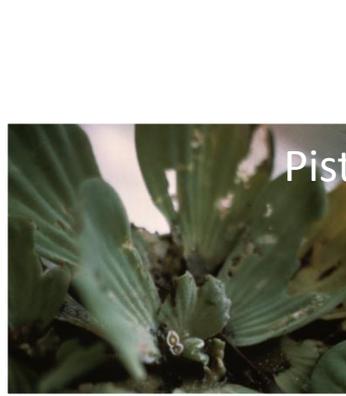


Zamioculcas
in dry forest
in South
Africa

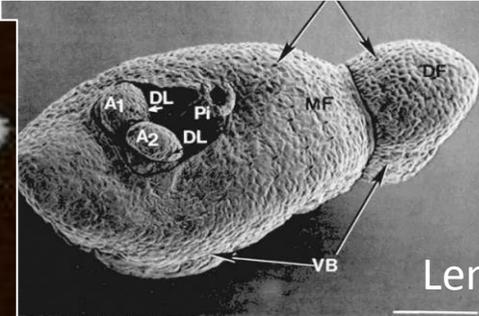
Diversity of Size



Amorphophallus titanum



Pistia



Lemna



Spathe >2 m long
vs. < 1 cm long



Dracontium pittieri



Alocasia robusta



Plants to
4 m tall

Amorphophallus titanum



The plant world's largest Inflorescence

Infructescence

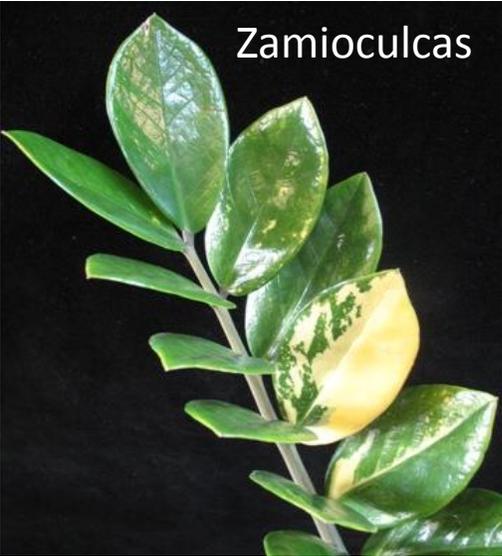
Amorphophallus titanum



High leaf shape diversity



Taccarum



Zamioculcas



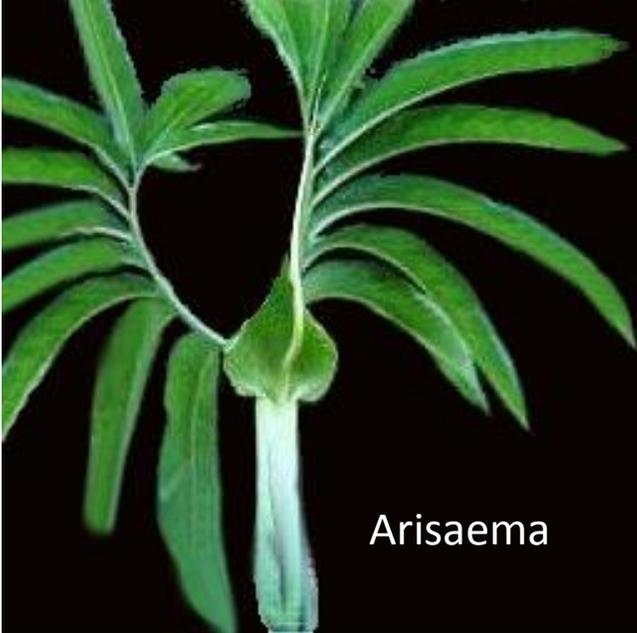
Anthurium



Alocasia

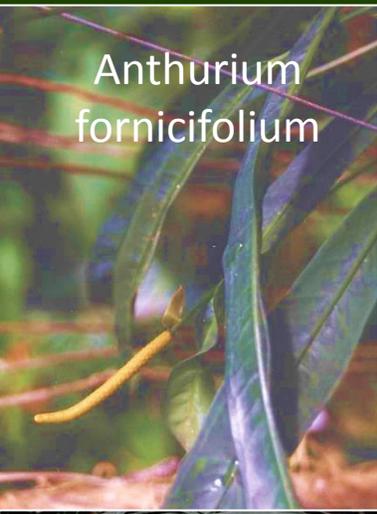


Monstera



Arisaema

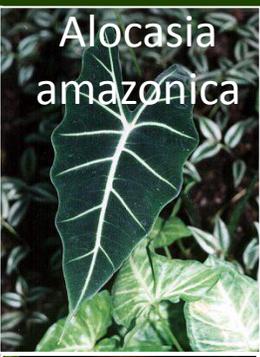
Leaf Shape Diversity



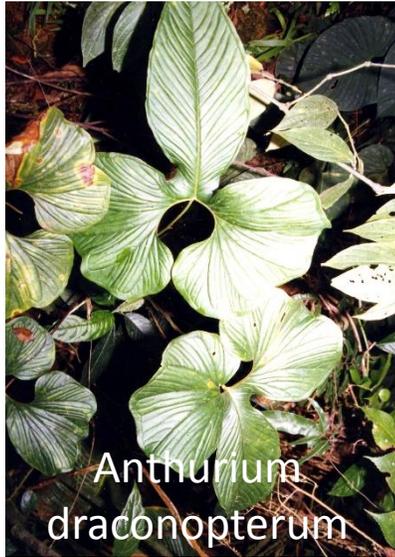
Anthurium fornicifolium



Anthurium friedrichstalii



Alocasia amazonica



Anthurium draconopterum



Anchomanes



Anthurium dressleri



Anthurium vietchii



Philodendron tortum



Syngonium hoffmanii



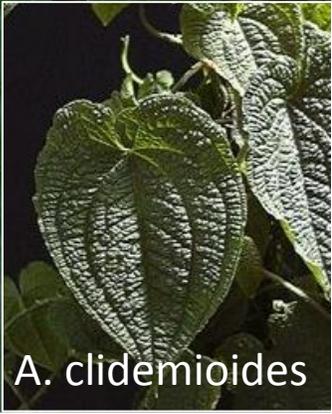
Chlorospatha ilensis



Philodendron pedatum



Philodendron tripartitum



A. clidemioides



Anthurium clavigerum



Philodendron goeldii

Diverse Systems of Reproductive Biology



Taccarum

Amorphophallus



Amorphophallus
titanum



Arisaema



Anthurium wendlingeri



Pollinators

Fungus, gnats, beetles, flies



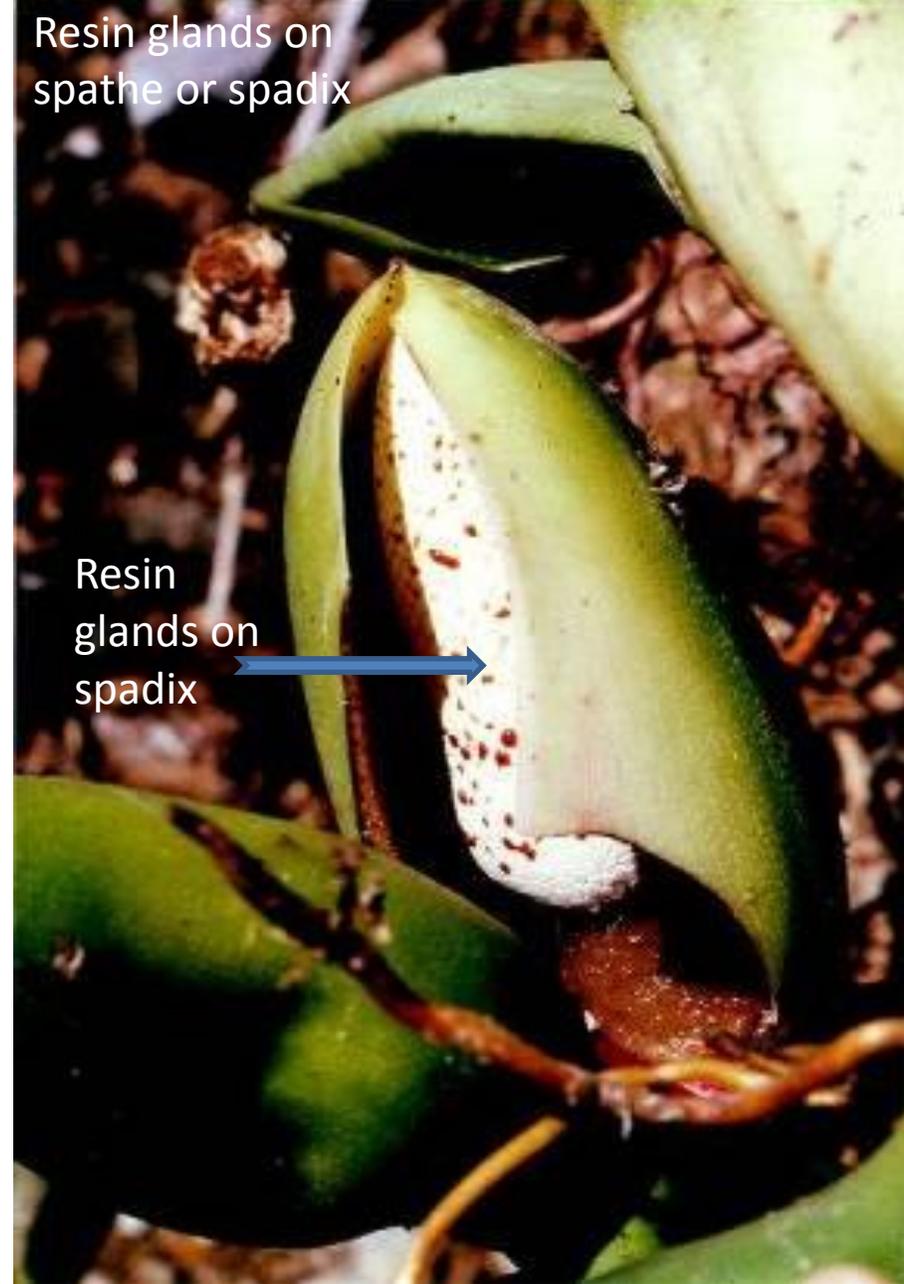
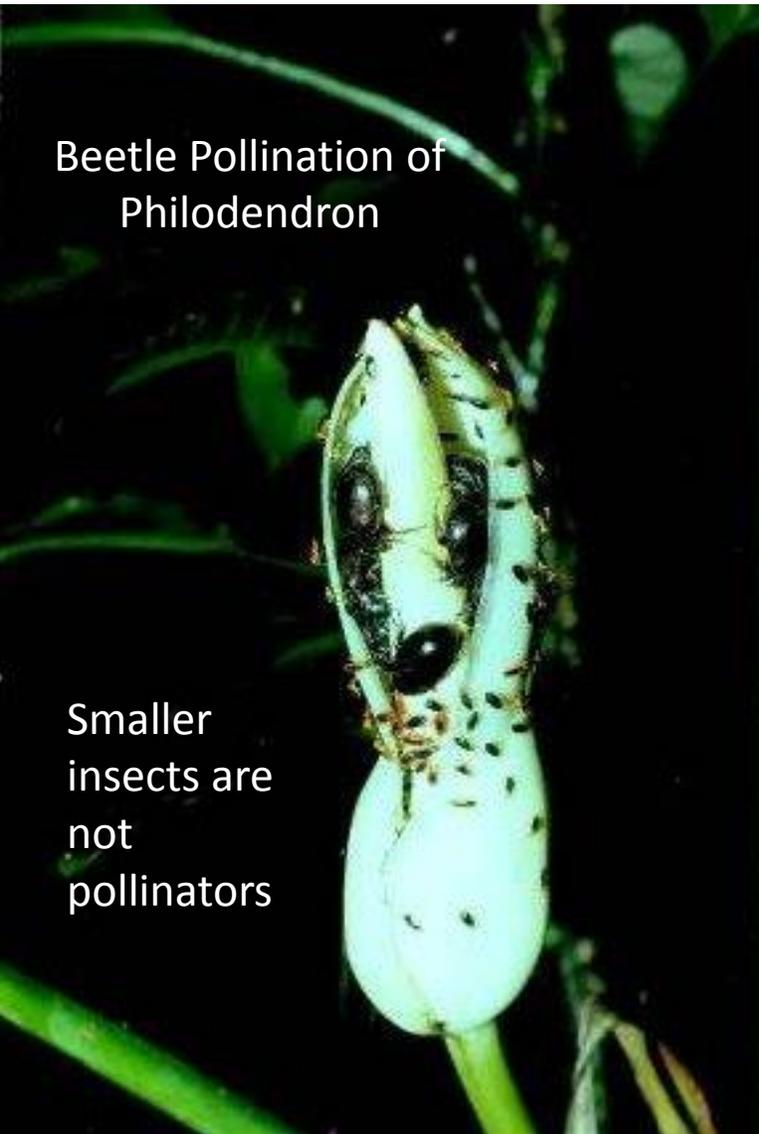
Helicodisceros muscivorus



Beetle pollinators of aroids with unisexual flowers

Beetle Pollination of Philodendron

Smaller insects are not pollinators



Bees on *Anthurium formosum*



Female phase

Photo D. Beath

Amorphophallus johnsonii female phase



Post-anthesis above

Pre-anthesis above, male phase at left 3 photos D. Beath

Xanthosoma mexicanum



Ethnobotanical Value

Primary Use

Ornamental plants

Top in sales in North America

Secondary Use

Food crops

Alocasia macrorrhizos, *Colocasia esculenta*,
Cyrtosperma merkusii, *Xanthosoma sagittifolium*

Aroid Crops



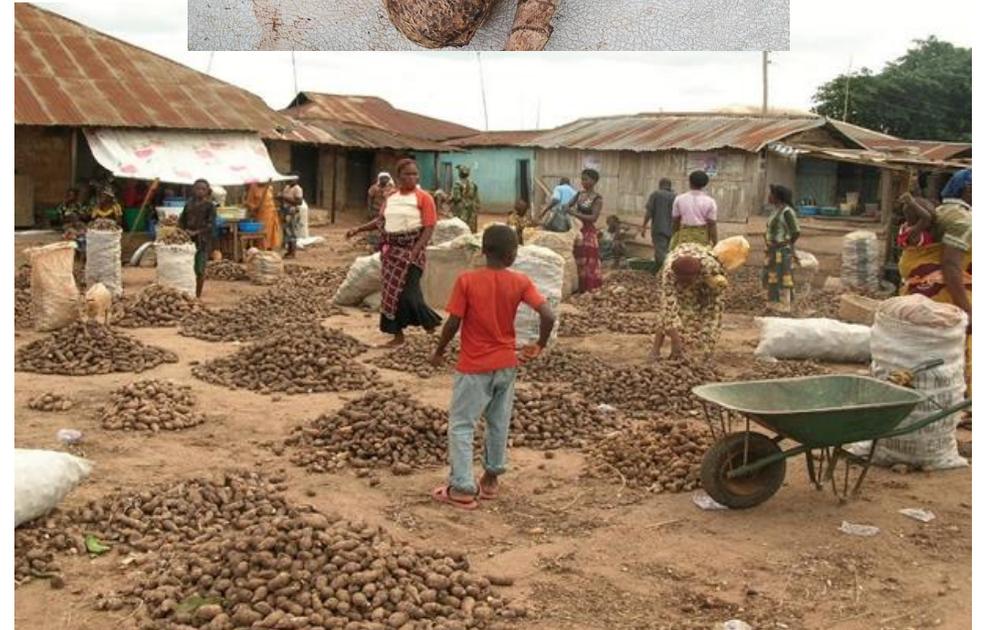
Cyrtosperma merkusii – Giant Swamp Taro - S.E. Asia

Xanthosoma sagittifolium - Cocoyam

3rd largest root and tuber crop in Nigeria

3rd largest starch food in Nicaragua

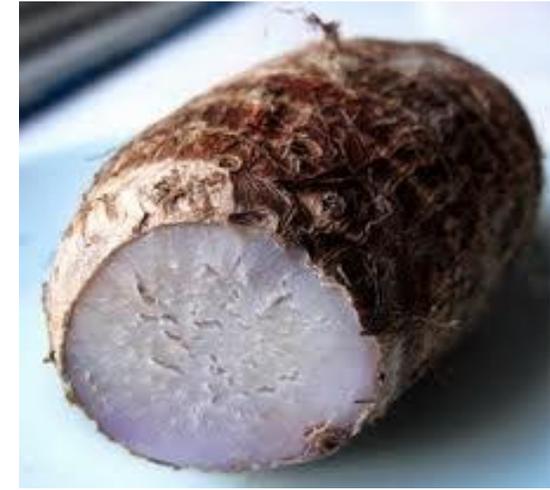
Nutritionally superior to yam and cassava



Colocasia esculenta – “Taro”

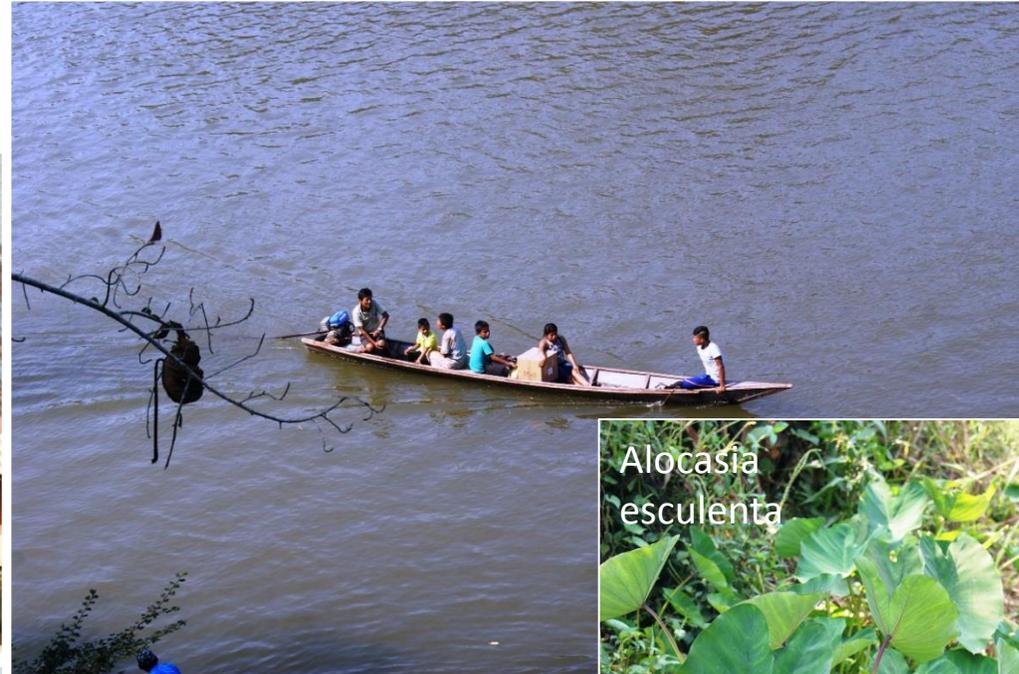
14th most consumed
vegetable worldwide

Florida, Cuba, Egypt, Hawaii,
Papua New Guinea, Thailand,
South China, Vietnam



Edible Aroids in a small jungle town

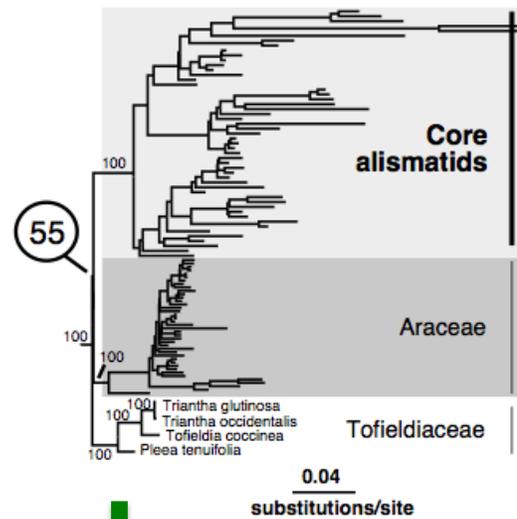
Puerto Bermudez



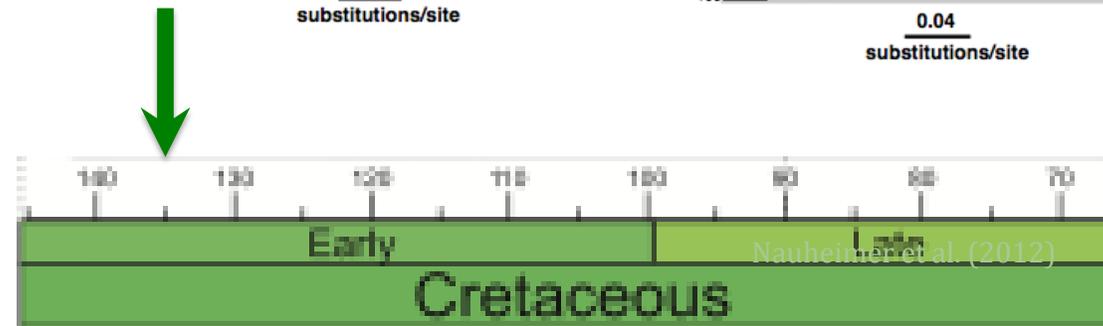
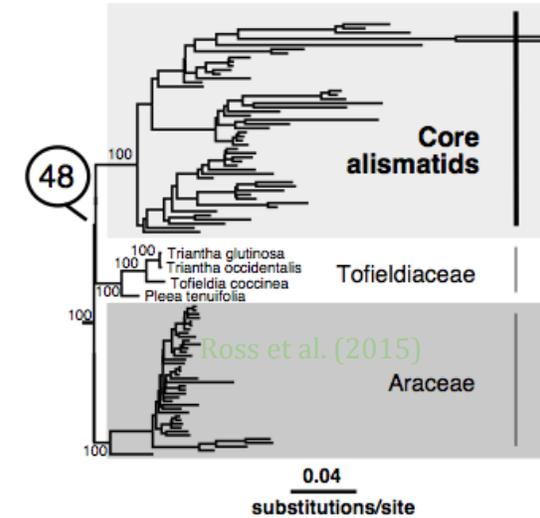
Early Evolution of Araceae



f. ML-GxC-n: Tofieldiaceae sister



e. ML-GxC: Araceae sister



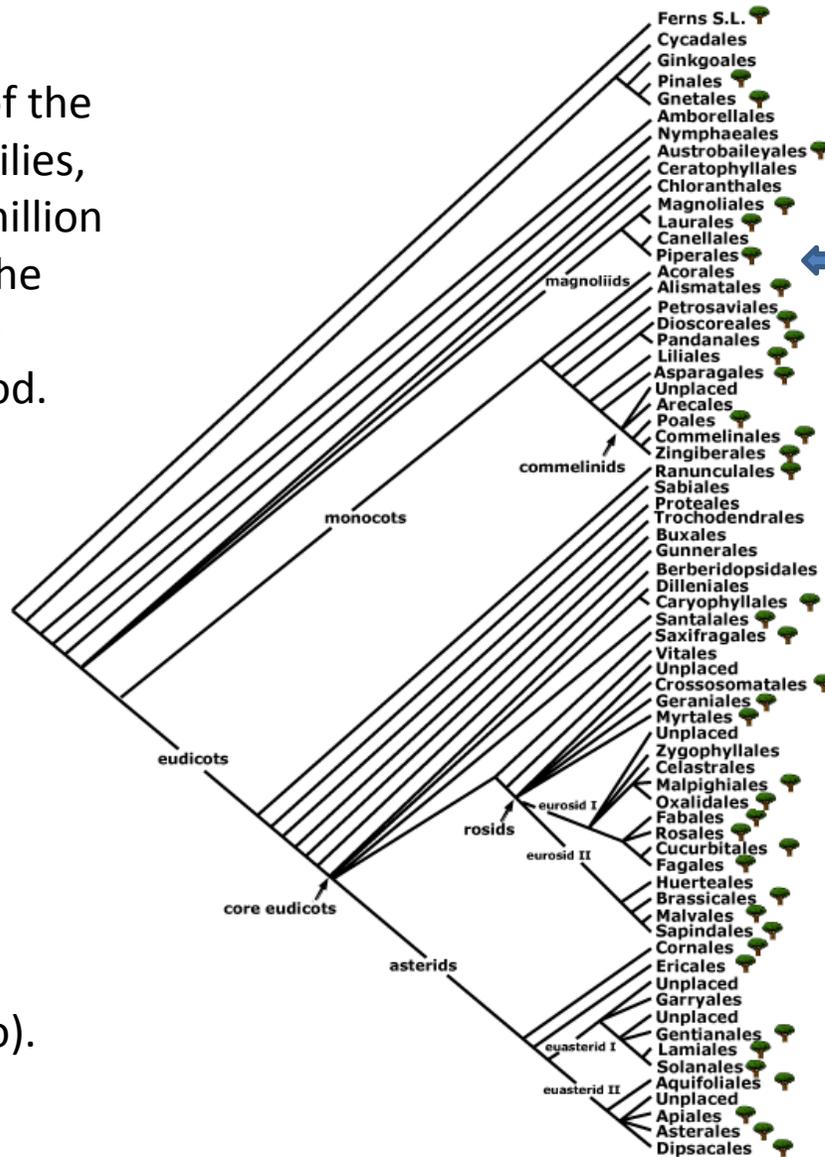
Araceae evolved with Order Alismatales and sister to Tofieldiaceae

Stevens, 2001 onwards

Phylogenetic Context

Araceae is one of the oldest plant families, arose 128-133 million years ago near the beginning of the Cretaceous Period.

All 8 subfamilies were present before the K-T boundary (65.5 million years ago).

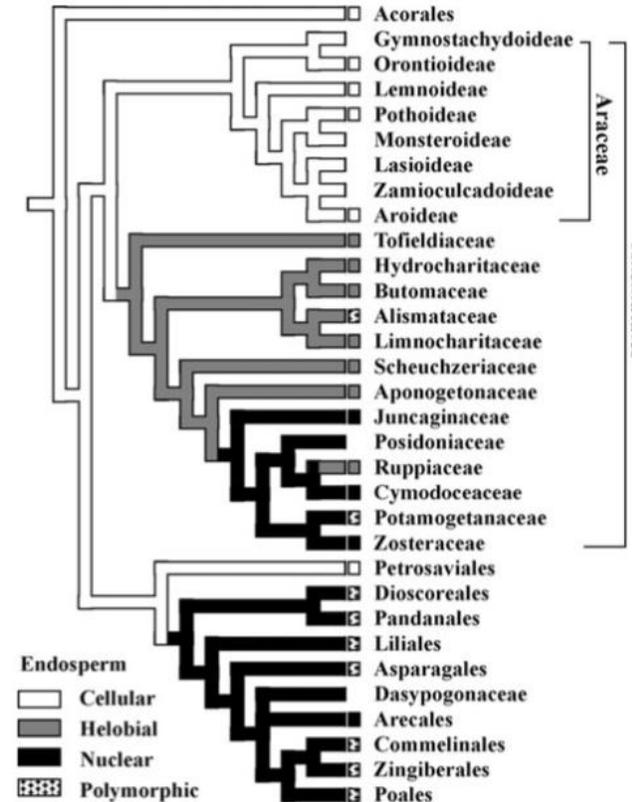


Basal monocot

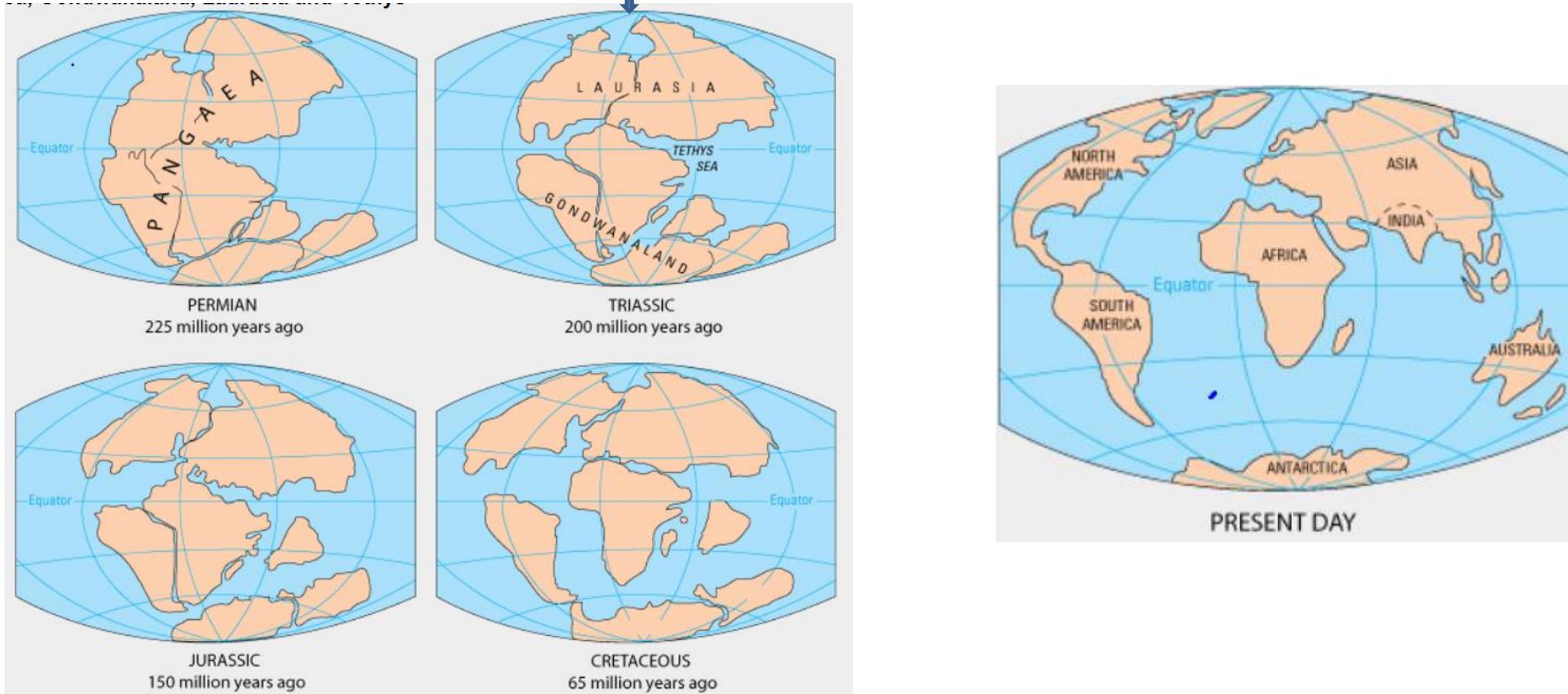
ALISMATALES



Acorus (Acorales)



Araceae first evolved in Laurasia after break up of super planet Pangaea



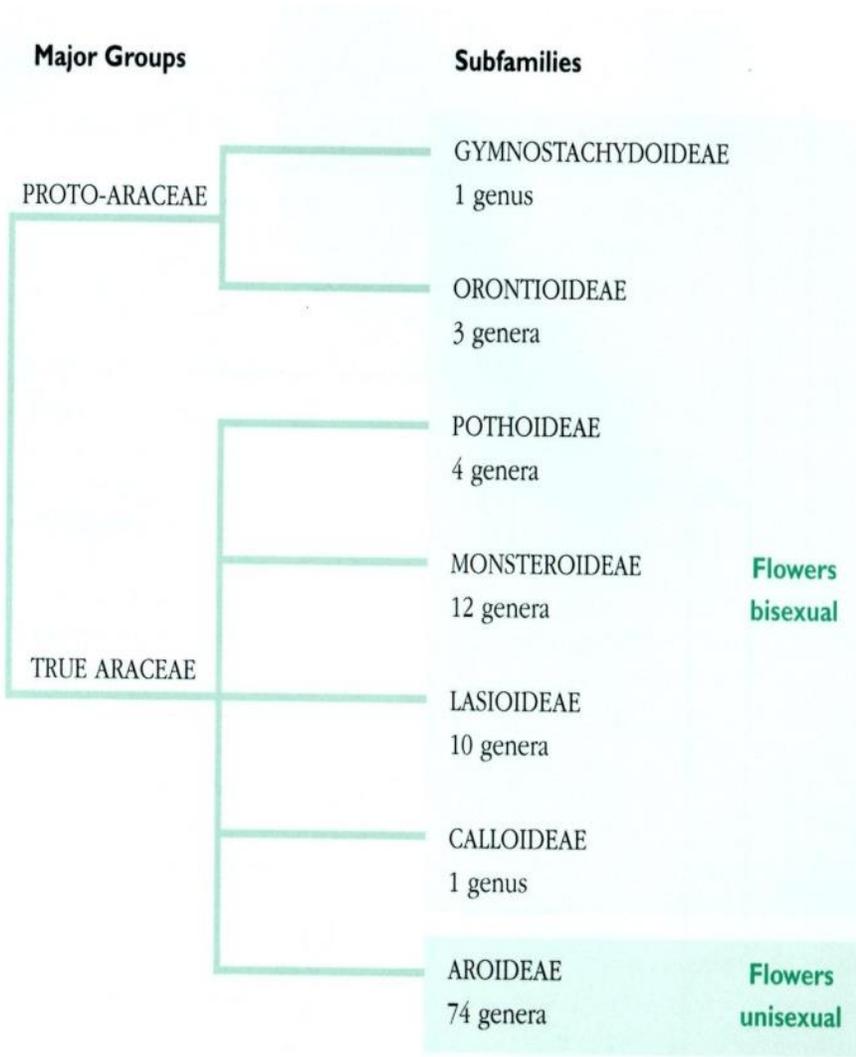
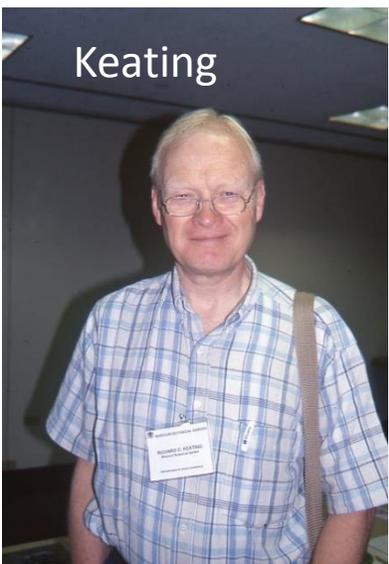
144 genera

3645 species (Predicted estimate 6500)

- 3rd Largest Family of Monocots after Orchidaceae and Gramineae (Poaceae) (grasses)
- Eight subfamilies



Phylogenetic Context



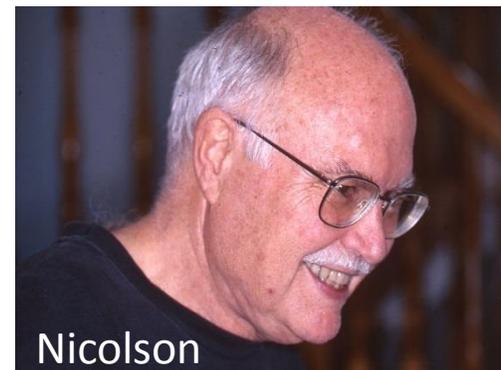
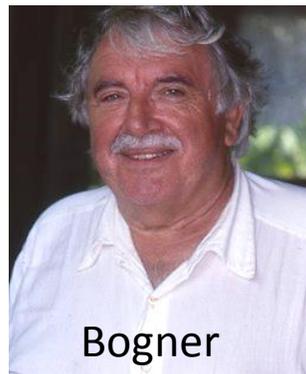
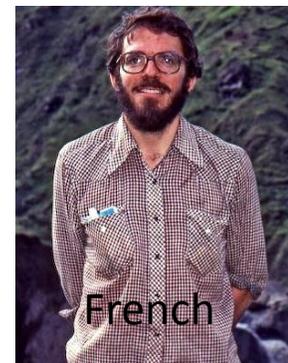
Grayum-First to reject separation of Colocasoideae and merge with other genera with unisexual flowers



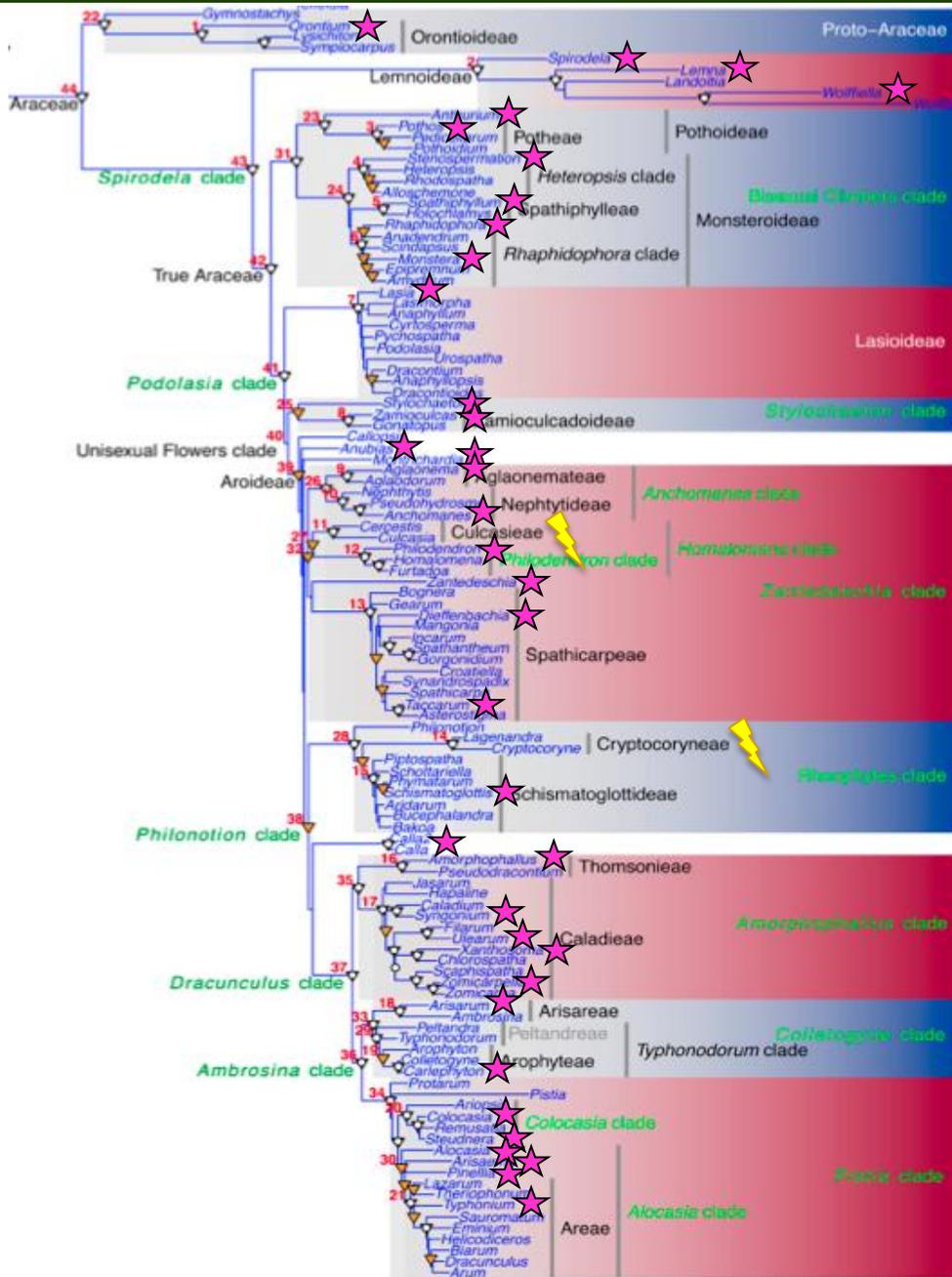
Mayo et al 1997 - French et al 1995

Morpho-anatomical & restriction site

7 subfamilies (Lemnaceae not incl.)



1991



Next Generation Sequencing

by Claudia Henríquez, Wash. Univ.

37 genera, 42 of 44 clades, Illumina data.

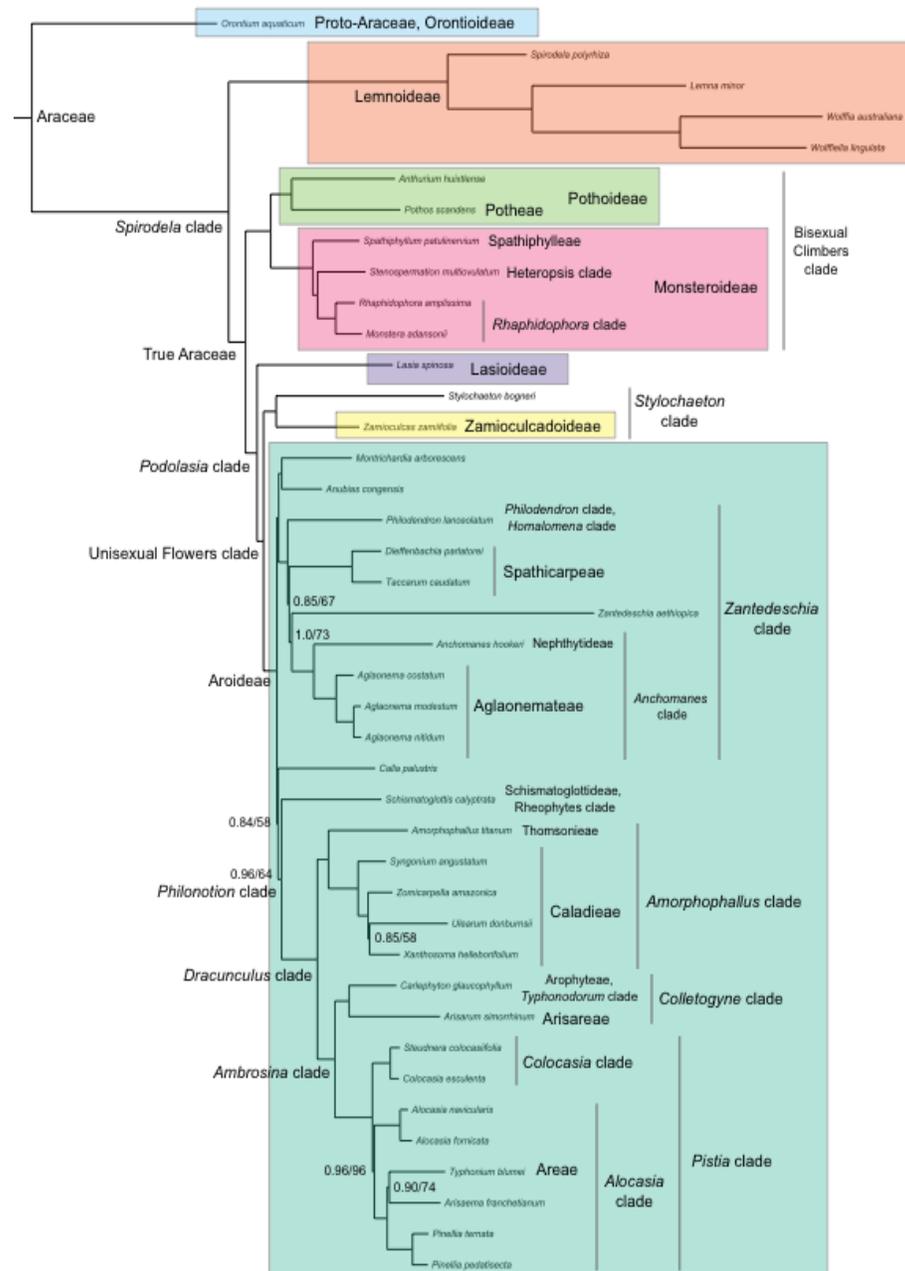
Reference based – *Lemna*



Monica Carlsen-Krause
Molecular studies
Anthurium subgenera



Other Phylogenetic Studies



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Molecular Phylogenetics and Evolution

journal homepage: www.elsevier.com/locate/ympev

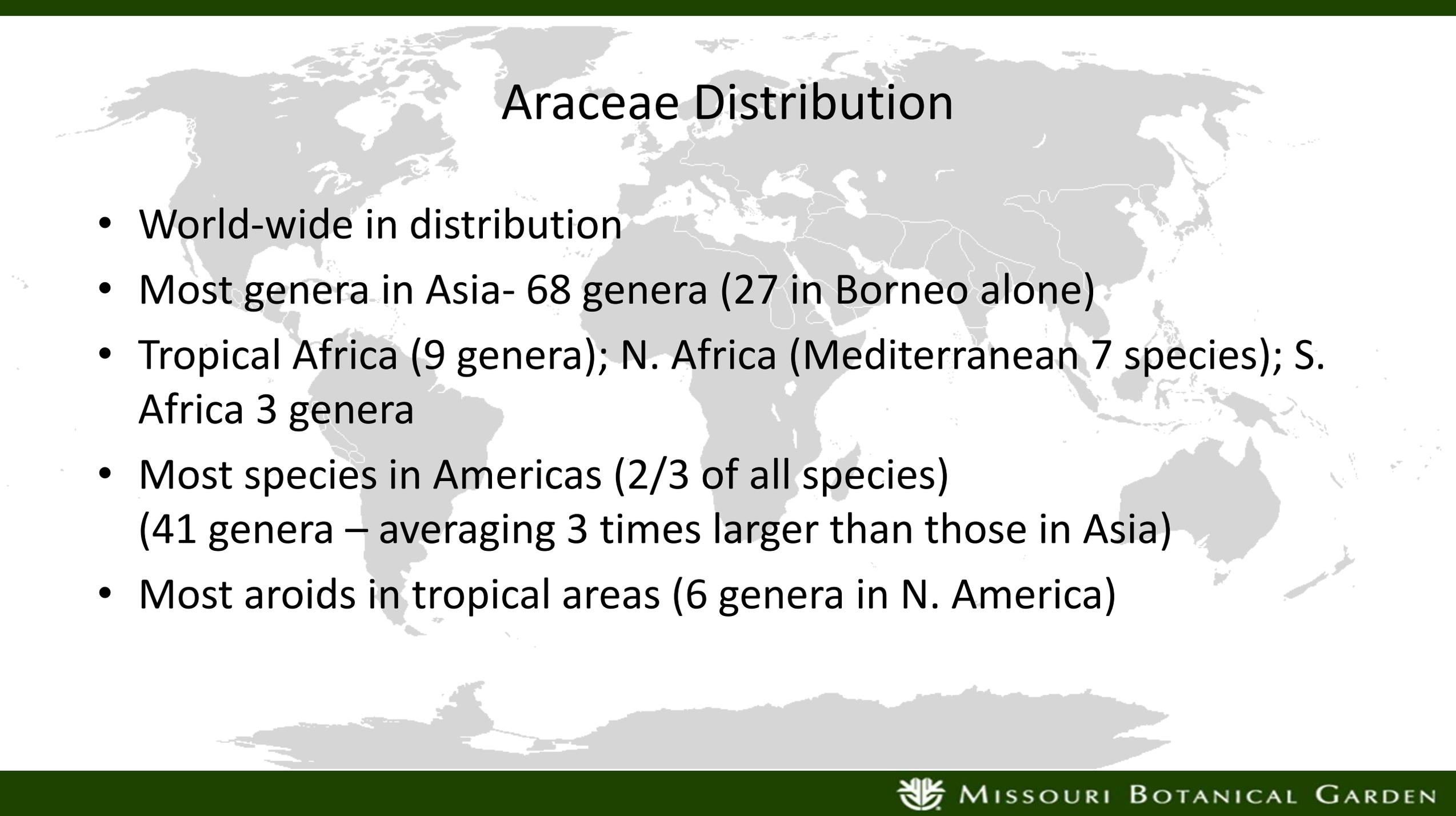
Phylogenomics of the plant family Araceae

Claudia L. Henriquez^{a,b,*}, Tatiana Arias^d, J. Chris Pires^c, Thomas B. Croat^b, Barbara A. Schaal^a

70 protein-coding genes

>9,000 Parsimony informative

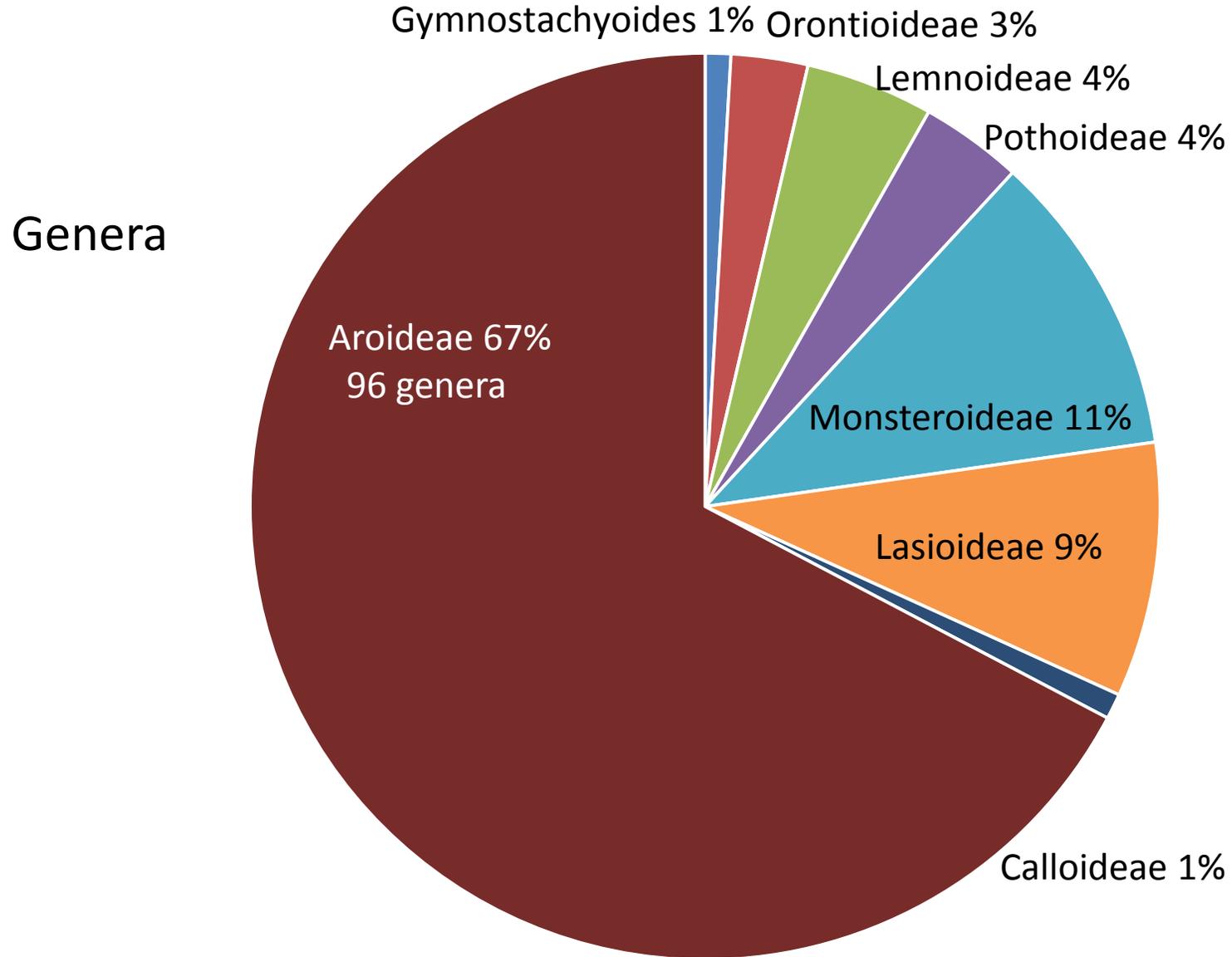


A light gray world map is visible in the background, showing the outlines of continents and countries. The map is centered on the Atlantic Ocean.

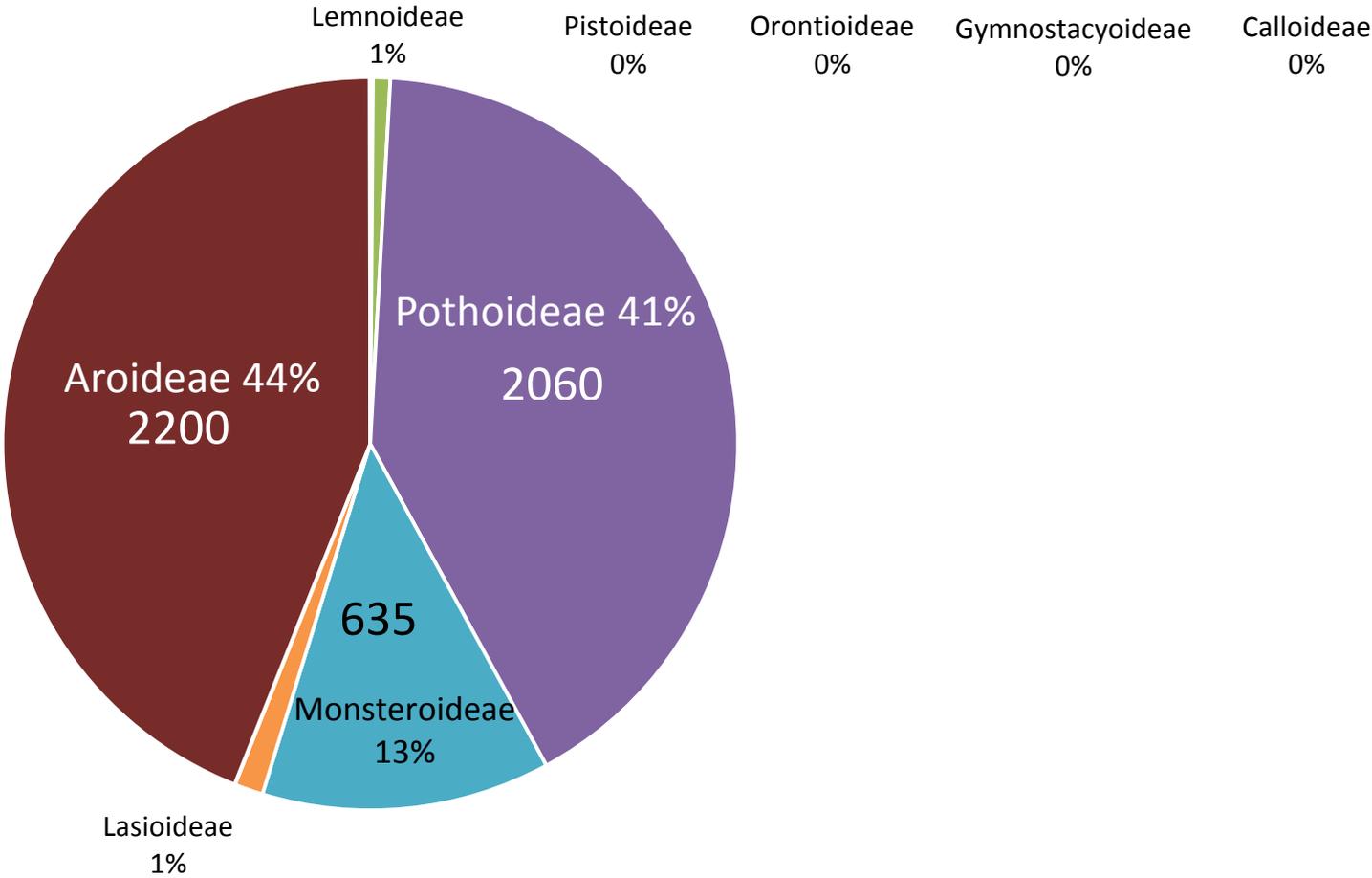
Araceae Distribution

- World-wide in distribution
- Most genera in Asia- 68 genera (27 in Borneo alone)
- Tropical Africa (9 genera); N. Africa (Mediterranean 7 species); S. Africa 3 genera
- Most species in Americas (2/3 of all species) (41 genera – averaging 3 times larger than those in Asia)
- Most aroids in tropical areas (6 genera in N. America)

Respective Sizes of Subfamilies in Genera



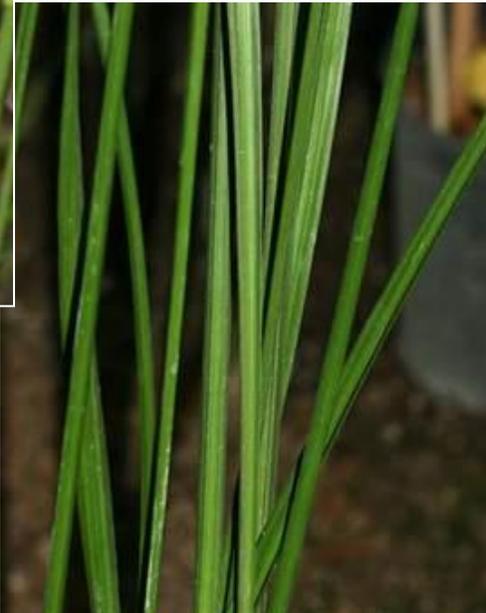
Respective Size of Subfamilies in Species



Araceae 7 subfamilies



*Gymnostachys
anceps*



Subfamily

Gymnostachyoides, 1 sp.,
temperate Australia



Orontium aquaticum

Subfamily Orontioideae
3 genera, 6 species



Lysichiton americanus

2 spp.,
Pacific NW
US & E.
Russia



Symplocarpus foetidum

3 spp., E/
N. Amer. &
E. Asia

Subfamily Lemnoideae

Pantropical distribution

5 genera

Landoltia, Lemna, Spirodela, Wolffia, Wolffiella



Lemna globosa



Lemna valdiviana

Earliest aroids were probably aquatics

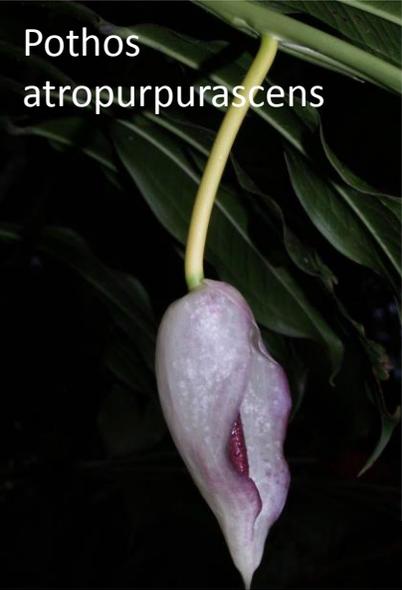
Many modern day genera (or tribes) have reverted to aquatic habitat.

(Red = New World Black = Old World)

- **Anaphyllopsis**
- Anubias
- **Calla**
- Cyrtosperma
- **Dieffenbachia**
- **Dracontioides**
- Lasia
- Lasiomorpha
- **Montrichardia**
- **Philodendron**
- **Philonotion**
- **Spathiphyllum** & **Holochlamys**
- **Urospatha**
- Schismatoglottidae – 6 genera
- Cryptocoryneae (2 genera)

Subfamily Pothoideae

4 genera, 3 in Asia, 1 Neotropical



Pothos atropurpurascens



Pothos scandens



Anthurium veitchii



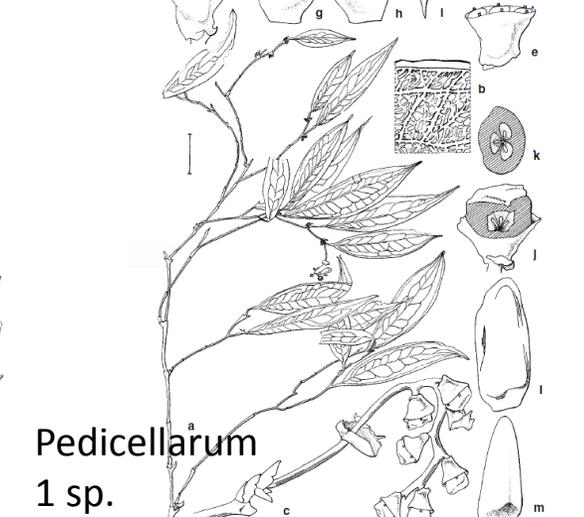
Anthurium podophyllum



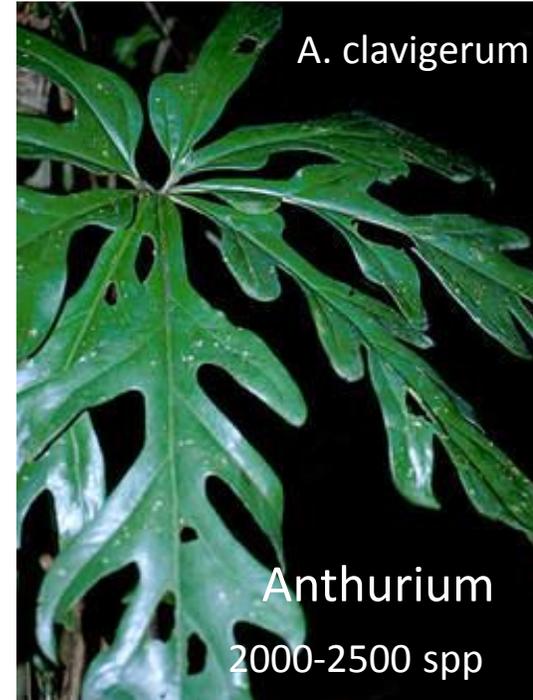
Pothos 58 spp.



Pothoidium 1 sp.



Pedicellarum
1 sp.



A. clavigerum

Anthurium
2000-2500 spp



Anthurium sect. *Pachyneurium*



Spathiphyllum Ca.
145 spp

S. dressleri



A. medium



R. tetrasperma



Scindapsus
35 spp

S. officinalis



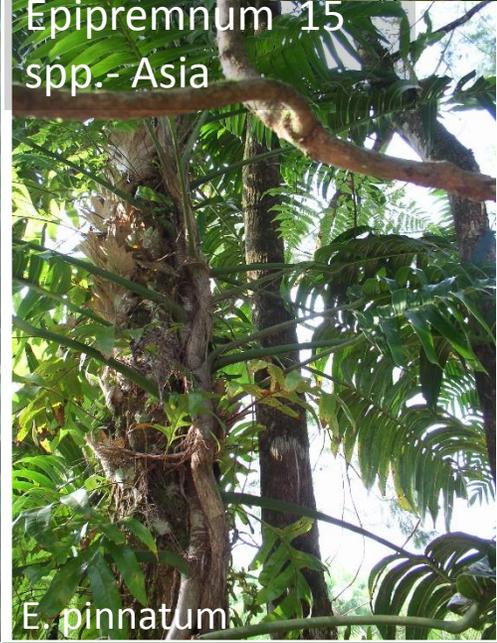
Monstera- 120 spp.

M. deliciosa



Epipremnum 15
spp.- Asia

E. pinnatum



Stenospermaton
Ca. 220 spp.

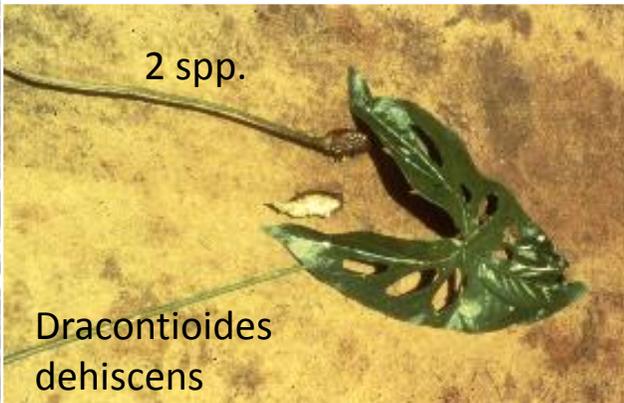
Subfamily Monsteroideae

12 genera

Lasioideae-11 genera



Anaphyllopsis- 3
spp. NE S. America



2 spp.
Dracontioides
dehiscens



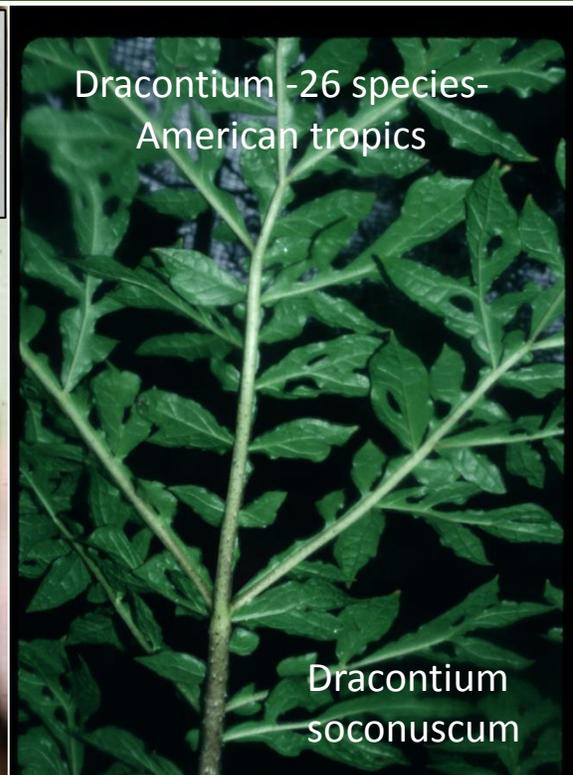
Dracontium
prancei



Dracontium
soconusum



seed

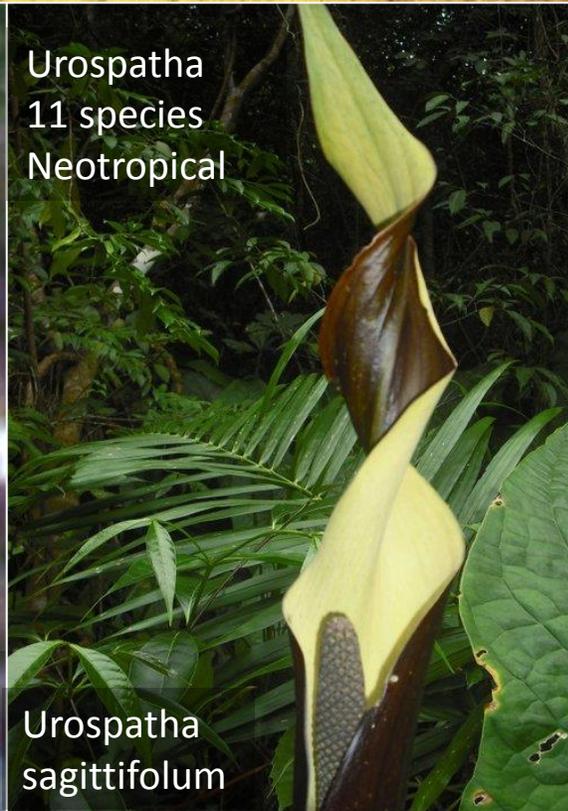


Dracontium -26 species-
American tropics

Dracontium
soconusum



Lasiomorpha
senegalense-
Monogeneric, Africa



Urospatha
11 species
Neotropical

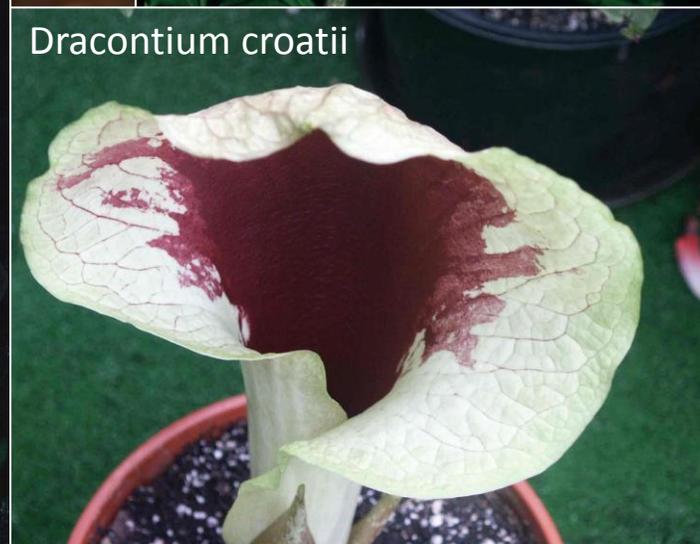
Urospatha
sagittifolium



Urospatha
sagittifolium

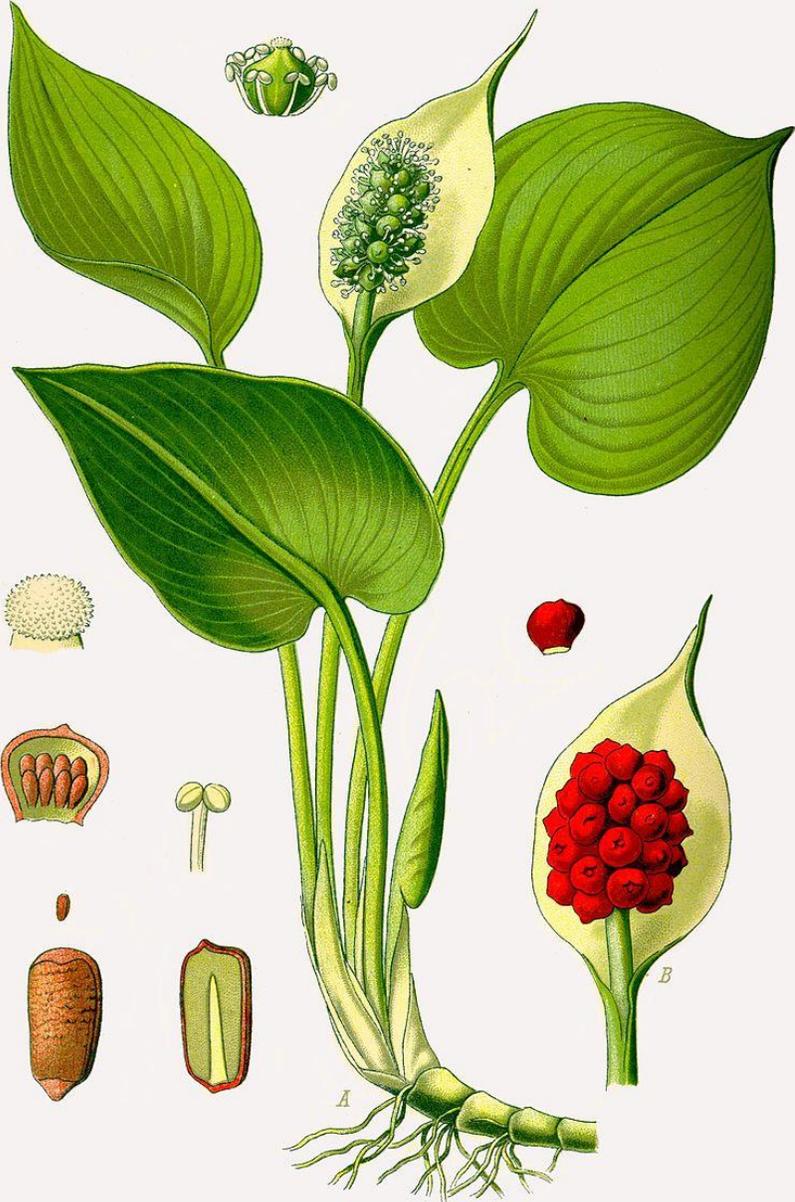


Dracontium grayumii



Dracontium croatii

Subfamily Calloioideae



Calla palustris, monotypic 1 pan boreal species -

Subfamily Calloioideae

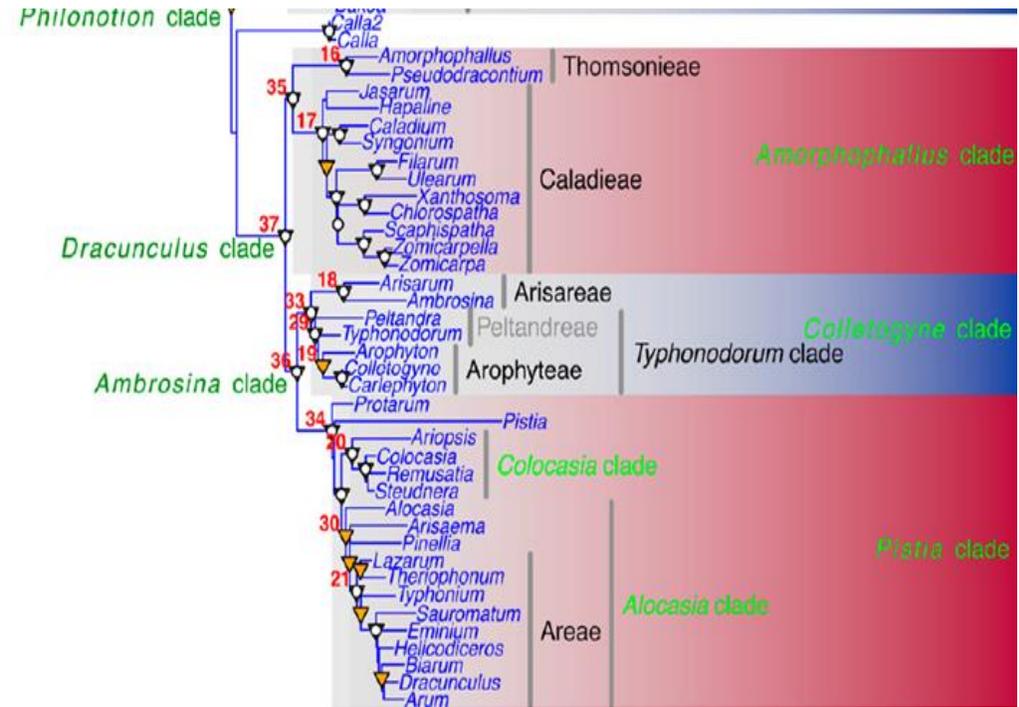
Bisexual flowers

Aperturate pollen

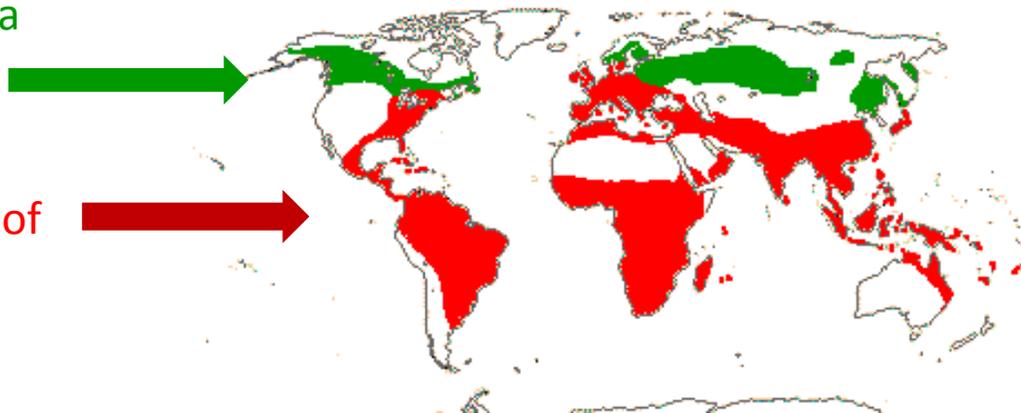
Massive sporopollenin

But also...

Laticifers



Distribution of
Calleae (*Calla
palustris*)



Distribution of
subfamily
Aroideae



Subfamily Zamioculadeae

2 Genera: *Gonatopus* & *Zamioculcas*

Group unusual in having unsexual flowers with a perianth (with tepals)



Subfamily Aroideae – Tribes (26)

Stylochaetoneae

Dieffenbachieae

Spathicarpeae

Philodendreae

Homalomeneae

Anubiadeae

Schismatoglottideae

Cryptocoryneae

Zomicarpeae

Caladieae

Nephtytideae

Aglaonemateae

Culcasieae

Montrichardieae

Zantedeshieae

Callopsideae

Thompsonieae

Arophyteae

Peltandreae

Arisareae

Ambrosineae

Areae

Arisaemateae

Colocasieae

Pistieae

Tribe Stylochaetoneae

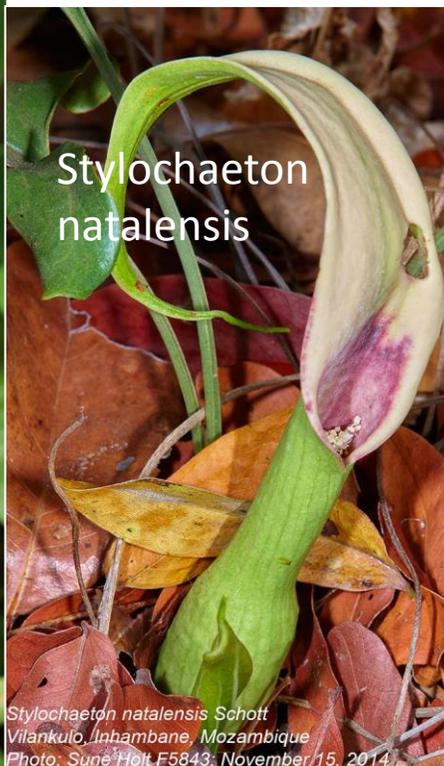
Stamens with long filaments; perigone a single cup-like structure.

Some species flower underground



Stylochaeton natalensis

25 species
Tropical Africa



Stylochaeton natalensis

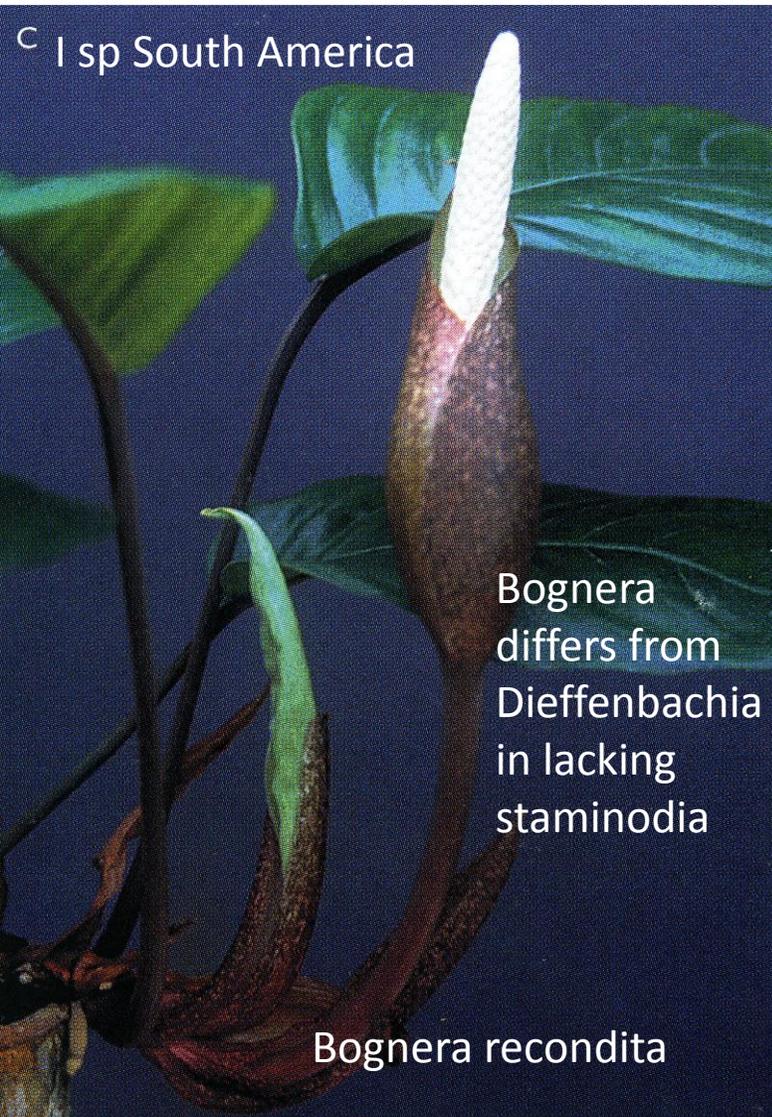
Stylochaeton natalensis Schott
Vilankulo, Inhambane, Mozambique
Photo: Sune Holt F5843; November 15, 2014



Stylochaeton natalensis



Tribe Dieffenbachieae- 120 sp. Neotropics



Spathe falls off to expose red berries.



Spadix of Dieffenbachia
Yellow pistils
White staminodia



Tribe Spathicarpeae

Also includes Asterostigma, Mangonia

9 Genera - S. America (32 spp)



Monogeneric,
Ecuador

Croatiella integrifolia



8 spp.

*Gorgonidium
vermicidum*

Spathicarpa hasifolia 4 spp.



Taccarum warmingii
6 spp. S.Amer.



Tribe Philodendreae

3 subgenera - Pteromischum
Meconostigma
Philodendron

Adelonema - 13 spp.,
Philodendron - 1000 spp.
Neotropics



P. goeldii



P. campii



Adelonema peltata



P. hylaeae



P. albovirescens



P. alatiundulatum



Adelonema orientalis



P. subg Meconostigma



P. callosum

Homalomena punctulata



Tribe Homalomeneae

98 spp. Asia

All photos P. Boyce

Homalomena statiopetolatum



H.omalomena scutata



Homalomena velutipedunculata



Homalomena velutipedunculata

Homalomena scutata



Tribe Anubiadeae

Anubias - Africa, mostly aquatic



Tribe Schismatoglottideae- 7 genera

New World Schismatoglottis
are now Philonotion



Schismatoglottis petradoxa



Schismatoglottis 119 spp. Asia



Schismatoglottis calyptrata



Philonotion americanum



Philonotion
3 spp. P. spruceana

Schismatoglottideae - Rupicolous group

Borneo endemics

Splash cup seed dispersal

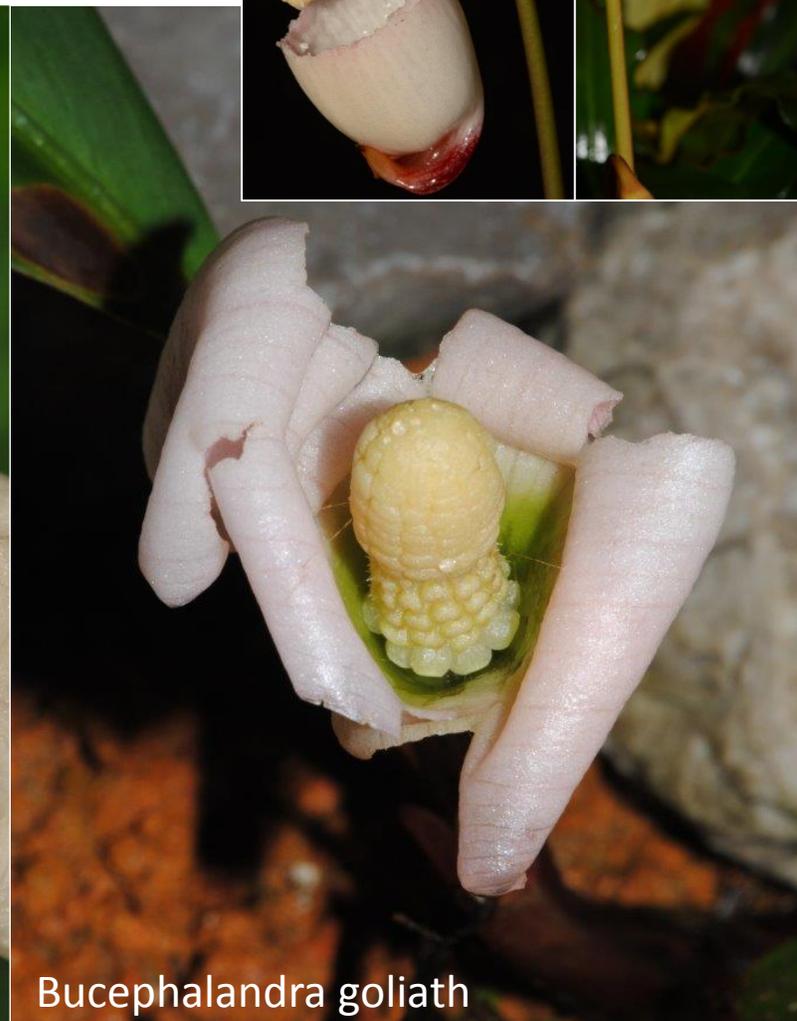
All photos P.
Boyce



Burttianthus hansenii



Bucephalandra goliath

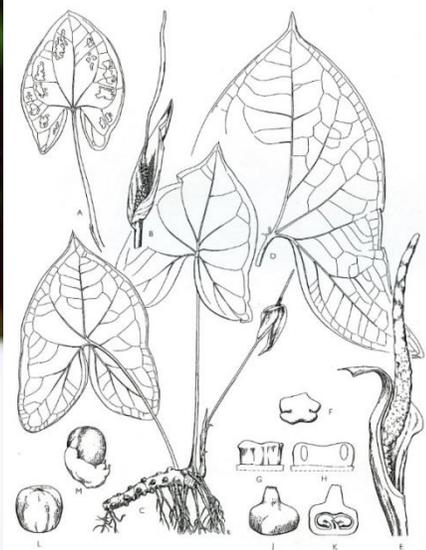


Bucephalandra goliath



Galantharum kishii, 1
sp. Borneo

Tribe Zomicarpeae 2 genera



Genera of Araceae



Zomicarpella 2 spp., *Z. amazonica*

Zomicarpa 3 species, *Z. steigeriana*



Tribe Caladieae

12 sp. Neotropical

Caladium humboldtii



Caladium palaciosii



Caladium lindenii



Tribe Nephthytideae

Nephthytis 5 ssp. 1 Asia, 4 Africa



Nephthytis bintuluensis



Borneo



Nephthytis afzelii



Africa

Tribe Aglaonemateae

25 spp. Asia



Aglaonema brevispathum



Aglaonema costatum



Aglaonema nitidum

Tribe Culcasieae
Culcasia 28 spp. Africa



Culcasia scandens



Culcasia mannii



Zambia



Mozambique

Tribe Montrichardieae

2 spp.

American Tropics



Montrichardia arborescens



Montrichardia linifera

Tribe Zantedeschieae

Gartenflora 1898.

1456.



*R. du Bois-Reymond
ad. nat. del.*

ZANTEDESCHIA
PENTLANDII R. WHYTE

Ökonom. Fl. Eugen Köhler, Gera - Osterhaus

8 species
South Africa



Callopsis volkensis
Juni 2007
Hortus botanicus Leiden



Tribe Callopsideae

Callopsis - Kenya, Tanzania



Titan's Garden



Amorphophallus

197 species; Africa and Asia

Tribe Thompsonieae

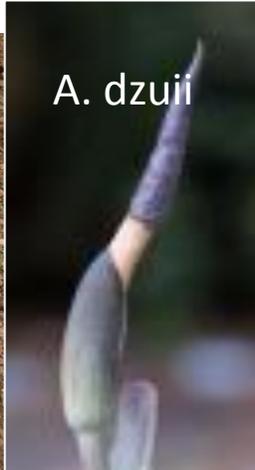
Pseudodracontium
Cambodia, Laos, Thailand, Vietnam



A. croatii



A. dracontoides



A. dzuii



A. sylvaticus



A. prainii



Emily Colletti with
Amorphophallus titanum

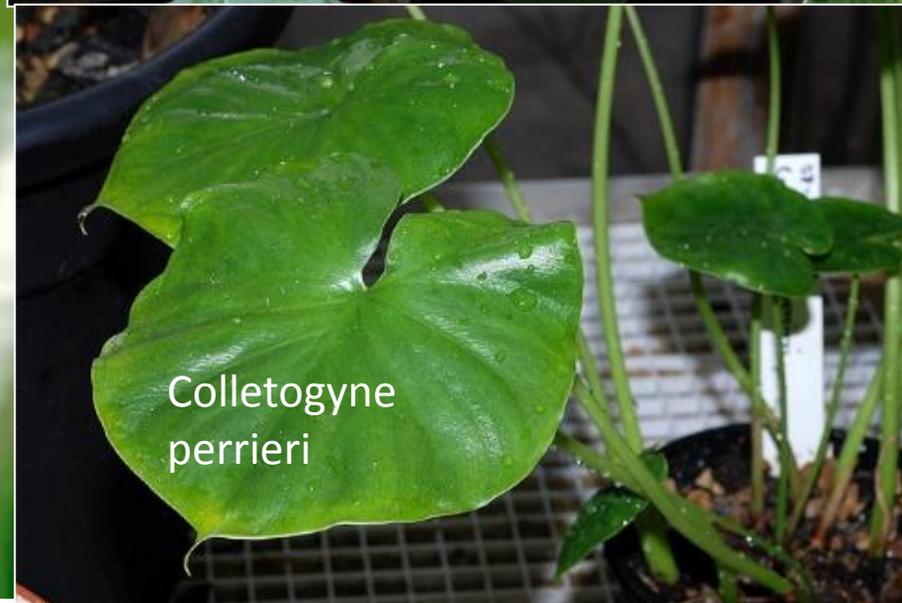


Recently merged with
Amorphophallus

Tribe - Arophyteae

Endemic to Madagascar

- Arophyton - 7 species
- Carlephyton - 3 species
- Colletogyne - 1 species



Tribe Peltandreae

Peltandra – 2 spp
Eastern North America

Typhonodorum 1 sp.
Africa – Madagascar



Peltandra virginica

Typhonodorum - Madagascar



Tribe Arisareae

Arisarum- Circum-
Mediterranean- 3 spp



Arisarum vulgare



Arisarum simorrhinum



Arisarum proboscideum

Tribe Ambrosineae

Ambrosina, N. Africa, Sicily, S. Italy, 1 sp.



Tribe Areae

7 genera, mostly
Mediterranean

Arum- Europe, Middle
East, India- 7 spp.

Eminium- Middle East to
Afghanistan- 9 spp.

Dracunculus- N. edge of
Mediterranean- 2 spp.

Helicodisceros- Sardinia,
Balearic Is., Corsica- 1 sp.

Typhonium- Asia,
Melanesia, Australia- 65
spp.

Sauromatum- Central
Africa, India to China- 9
spp.

Biarum- Circum
Mediterranean, Middle
East- 23 spp



Arum maculatum



Biarum carduchorum



Eminium lehmannii, Iraq



Dracunculus vulgaris



Helicodisceros
muscivorus



Typhonium
croatii



Sauromatum venosum

Tribe Arisaemateae

Arisaema - E. N. America, Mexico, E. Africa,
India to Japan, Eastern Melanesia



Ovary several ovulate;
female spadix free from
spathe; septum lacking

A. macrophyllum



A. dilatatum



A. heterophyllum



Pinellia - N. Asia

Ovary 1 - ovulate;
female spadix fused to
spathe; septum
separating male and
female flowers



Arisaema
dracontium



Pinellia cordata



Pinellia
tripartita



Tribe Colocasieae



Appendix
Male spadix
Female spadix



Monotypic
- Seychelles



Tribe Pistieae

Circum-tropical

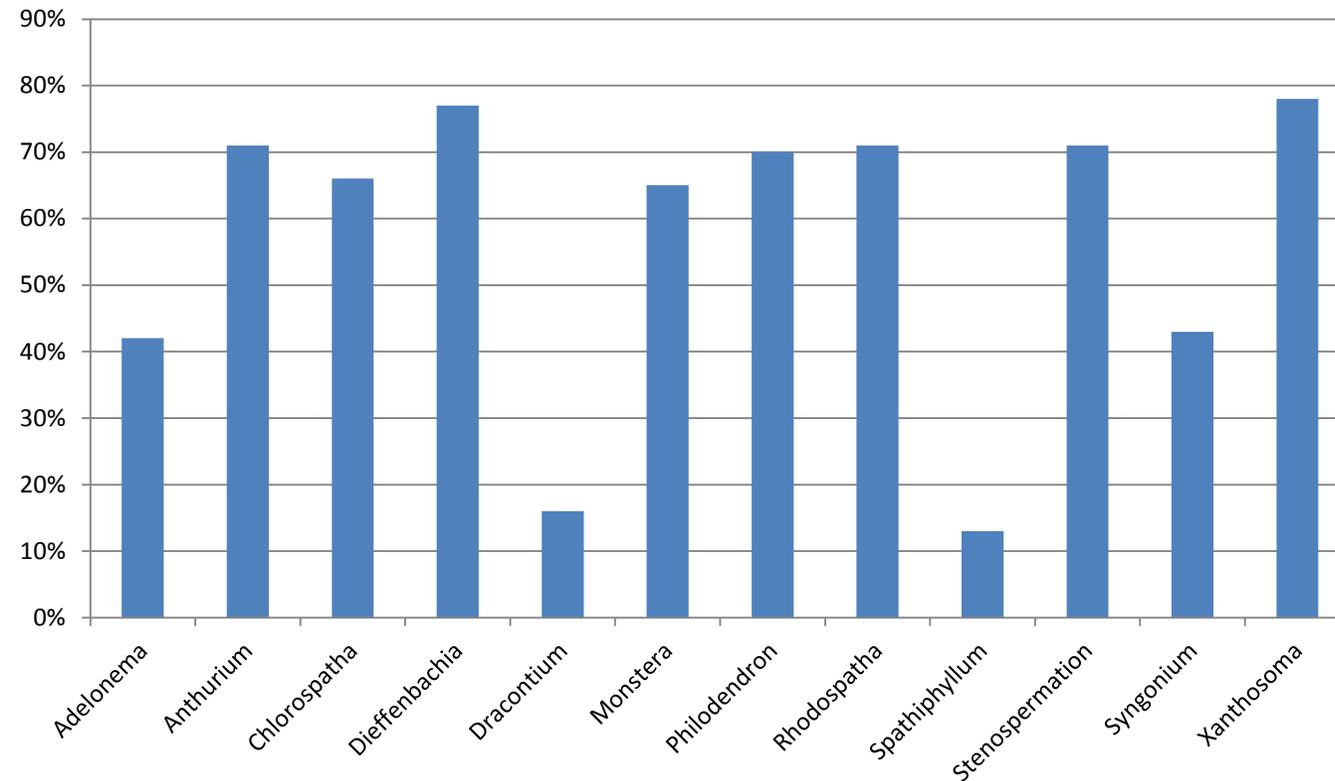
Pistia stratiotes



Most growth in the size of Araceae has occurred in the past 40 years

- *Adelonema* (42%)
- *Anthurium* (71%)
- *Chlorospatha* (66%)
- *Dieffenbachia* (77%)
- *Dracontium* (16%)
- *Monstera* (65%)
- *Philodendron* (70%)
- *Rhodospatha* (71%)
- *Spathiphyllum* (13%)
- *Stenospermatum* (71%)
- *Syngonium* (43%)
- *Xanthosoma* (78%)

Evidence of great increases in the number of species in these genera



The case for an even much larger Araceae

- Development of electronic keys (Lucid) enables greater confidence in determination.
- Lucid Anthurium Key has 1530 species present with each species compared on many characters. Hundreds of specimens fail to key out (determined) in Lucid.
- Perhaps as many as 500 seemingly distinct and new species have not yet been entered into Lucid owing to incomplete descriptions. Most of these undescribed species are from South America.

Lucid Menu of Characters

LucidPlayer - 2Key to Anthurium - G:\ATOM\Lucid keys\Anthurium Key.lk4

Key Features Entities View Window Help

Features Available: 69

- Ecology
- Growth habit
- Geographic distribution
 - Elevation
- Genus Section
 - Andiphilum
 - Belolonchium
 - Calomystrium
 - Cardiolonchium**
 - Chamaerepium
 - Cordatum-punctatum
 - Dactylophyllum
 - Decurrentia
 - Digitinervium
 - Episeiostenium
 - Gymnopodium
 - Leptanthurium
 - Multinervium
 - Pachyneurium
 - Polyneurium
 - Polyphyllum
 - Porphyrochitonium
 - Schizoplacium
 - Semaeophyllum
 - Tetraspermium
 - Urospadix
 - Xialophyllum
 - Novo
- Stem
 - Stem habit
 - Internodes
 - Size proportions
 - Internode length
 - Internode/Stem diameter
 - Roots
 - Cataphylls
 - Persistence
 - Cataphyll length
 - Leaves
 - Leaf vernation
 - Petiole
 - Blades
 - Inflorescences
 - Length in proportion to leaves
 - Peduncle
 - Spathe
 - Spadix
 - Infructescence
 - Spathe persistence
 - Berries color
 - Seed number

Entities Remaining: 204

- aguariocense Croat
- aguillariae Croat
- aguirrei Croat
- albanese Croat
- alfaroi Croat
- algebisense Croat
- alstonii Croat
- alvinii Croat & Ortiz
- angamarcanum Sodiro
- angelopolisense Croat
- apiense Croat
- apurimacense Croat
- aramangoense Croat
- arcabucoense Croat
- archillae Croat
- areolatum Croat
- aripoense N.E.Br. Bull.
- arteagae Croat
- asquerosense Croat
- avilaense Croat
- aylwardianum Croat
- balaoanum Engl.
- baldinii Croat & Ortiz
- benktsparrei Croat
- berrioense Croat
- besseae Croat
- bimarginatum Sodiro

Entities Discarded: 1296

- abelardoi Croat
- acaimense Croat
- acanthospadix Croat & Oberle
- acaulis (Jacq.) Schott
- acebeyae Croat
- achupallense Croat
- aciculare Croat
- acrondolichon Croat
- acutangulum Engl.
- acutapicum Croat
- acutibacca Croat & M.M.Mora
- acutifolium Engl.
- acutissimum Engl.
- acutum N.E.Br.
- affine Schott
- alatiattenuatum Croat
- alatipecunculatum Croat & R.Baker
- alatum Engl.
- albertiae Croat & Bay
- albertsmithii Croat
- albessei Croat
- albidum Sodiro
- albispatha Sodiro

LucidPlayer - 2Key to Anthurium - G:\ATOM\Lucid keys\Anthurium Key.lk4

Key Features Entities View Window Help

Features Available: 81

- Ecology
- Stem
- Roots
- Cataphylls
- Leaves
- Inflorescences
 - Length in proportion to leaves
 - Peduncle
 - Spathe
 - Spathe length
 - Spathe width (if boat-shaped then the width when flattened)
 - Spathe shape (when flattened)
 - Spathe 3-dimensional shape
 - Spathe disposition at anthesis
 - Spathe color
 - green to greenish
 - violet-purple to purple to magenta
 - white to cream
 - yellowish to yellow to orange
 - pinkish
 - reddish to red
 - brownish
 - purple-black
 - spathe punctations, porphyrochitonium
 - Spadix
 - Shape
 - Spadix length
 - Spadix diameter
 - Spadix color
 - green
 - white to cream
 - yellow to yellowish
 - orange to orangish
 - magenta to purplish to maroon
 - brown
 - reddish to red
 - pinkish
 - bluish
 - Stipe
 - present
 - absent
 - Stipe length
 - Infructescence
 - Spathe persistence
 - Berries color
 - white to cream
 - greenish white to olive-green
 - brown
 - yellow to orange
 - reddish to red or pinkish
 - purplish

Entities Discarded: 1494

- abelardoi Croat
- acaimense Croat
- acanthospadix Croat & Oberle
- acaulis (Jacq.) Schott
- acebeyae Croat
- achupallense Croat
- aciculare Croat
- acrondolichon Croat
- acutangulum Engl.
- acutapicum Croat
- acutibacca Croat & M.M.Mora
- acutifolium Engl.
- acutissimum Engl.
- acutum N.E.Br.
- affine Schott
- alatiattenuatum Croat
- alatipecunculatum Croat & R.Baker
- alatum Engl.
- albanese Croat
- albertiae Croat & Bay
- albertsmithii Croat
- albessei Croat
- albidum Sodiro
- albispatha Sodiro
- albobivrescens Sodiro
- alcatrazense Nadruz & Catharino
- alcogolloi Croat
- alegriasense Engl.
- alejandroi Croat
- alex-espinosae Croat
- alfaroi Croat
- algecirasense Croat
- algentryi Croat
- algebisense Croat
- alluriquinense Croat
- alstonii Croat
- altenberndianum Croat
- alticola Croat
- altobueyense Croat
- altogalapense Croat
- alturaense Croat
- alvinii Croat & Ortiz
- amacayaense Croat
- amargalense Croat & M.M.Mora

Entities Chosen: 14

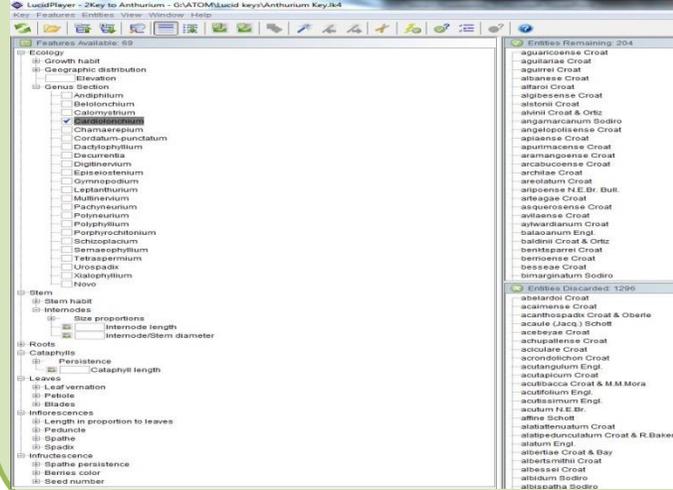
- Ecology
- Geographic distribution
 - Colombia

Determination Tool For Anthurium & Philodendron

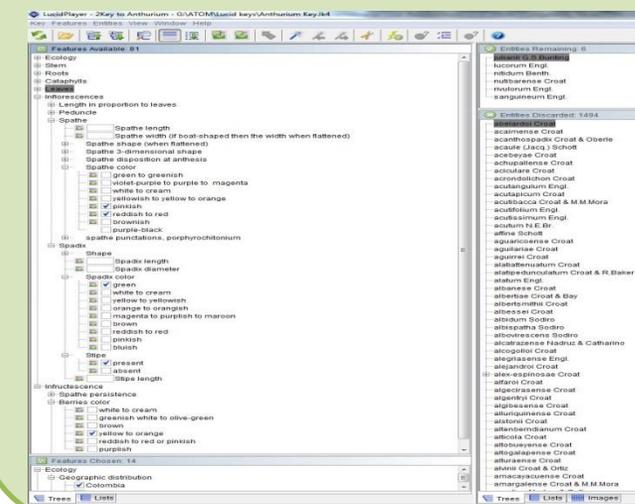
Step 1: Specimen to determine



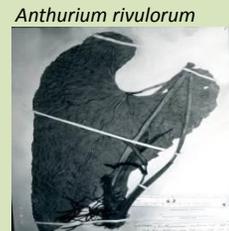
Step 2: Lucid Player, section selected



Step 3: Lucid Player, certain characters used to reduce species to 6



Step 4: Look up species selected in Determination Tool



Result: Species confirmed as *Anthurium sanguineum*



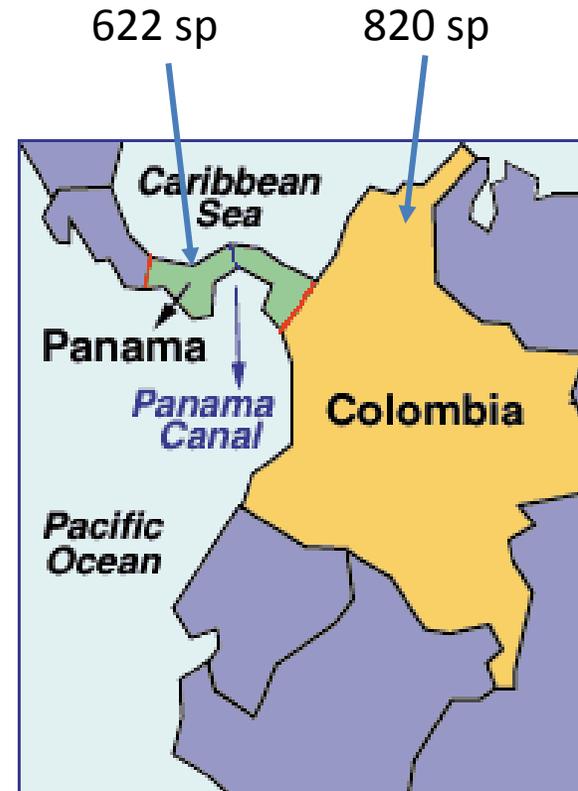
Steve Aylward
Volunteer Research Associate

Araceae Checklist for Central America

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W																		
1	CHECKLIST OF ARACEAE OF CENTRAL AME																						Mexic	Guat.	Bel.	El Sal	Hond.	Nic.	CR	Pan	Middle	Mexic	Guat.	Belize	El Sal	Hond.	Nic	CR	Pan	COL	Ec
23	X. robustum Schott	1			1	1	1	1	1	1	1																														
24	X. sagittifolium (L) Schott Introduced	1			1	1	1	1	1	1	1											1																			
25	X. cerrosapense Croat & O. Ortiz	1										1									1																				
26	X. undipes C. Koch	1									1	1																													
27	X. violaceum Schott	1																																							
28	X. wendlandii (Schott) Standley	1			1	1		1	1	1																															
29	X. yucatanense Engler	1			1									1																											
30	Total Xanthosoma	18	0	0	6	4	3	4	3	4	8	10		2	0	0	0	0	0	2	6																				
31																																									
32	ZANTEDESHIA																																								
33	Z. aethiopica										1	1																													
34	TOTAL ZANTEDESHIA	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0																			
35	Grand Total Species	781	35		135	90	53	30	67	103	311	622		94	14	2	0	4	2	154	591	85																			
36			816		17%	12%	7%	4%	9%	13%	40%	80%		70%	16%	4%	0%	6%	2%	50%	95%	90%																			
37	Total Genera	25																																							

Floristic Comparisons of Central and South America

- A complete list of aroid species exists for Central America (781 species).
- Most explored parts of Central America are reasonably well-known [Probably 10% of the flora is still not yet collected].
- Endemism and Species Diversity increases dramatically as one approaches South America.
- Panama (with 80% of all the species in Central America) has 622 species, 95% of them presently believed to be endemic.
- Colombia, **15 times larger** in area and many times more diverse, has only 820 named species (Panama currently has 4/5 as many as Colombia).



Conservative extrapolation assures great increases

- Colombia alone must have between 8,000 and 12,000 undiscovered species.
- Collecting has essentially stopped or is progressing too slowly to prevent mass extinction before these species are collected, studied and described.
- Experts must be encouraged to collect for greatest efficiency.
 - Jatun Sacha Biological Station: great increases with less than 6 hours of collecting

Study in England found that most new species were discovered by less than 3% of all collectors.

Megacollectors had 3 characteristics.

- Collected throughout most of their professional lifetime (58 yrs)
- Collected in many different areas (> 5000 localities; 142 countries - collected in 42 of these)
- Have a special taxonomic group that keeps them searching. Keeps them going to the field (Araceae)



Carl Luer
Missouri Botanical Gardens
Orchids



Peter Davis
University of Edinburgh
Collected in Turkey

Important Need for Inventory Studies

- Collecting is no longer considered important
- Too few students are doing floristic studies where they learn large and complex groups of plants
- Floristic studies are considered unimportant-can't even be published
- Floristic studies are often the basis for in-depth collecting and understanding
- Without initial collecting activity experts don't even know where to go

Legal and Logistical Impediments

- Most countries have serious impediments to collecting
- Some countries allow only experts permission and disallow general collecting despite the inefficiencies
- Requirements for permits discourage all but most persistent from getting permits
- In country movement of plants is prohibited creating even more obstacles



Forest Destruction in the Tropics



Conservation measures don't prevent forest destruction

- Most forested area are NOT in parks or preserves
- Roads lead to destruction and roads are leading EVERYWHERE
- In my 50-year career of collecting virtually all of my collecting localities have disappeared
- Rates of forest destruction is increasing, not slowing, despite laws
Owing to high endemism this means extinction everywhere

Role of the Missouri Botanical Garden in the Process of Discovery

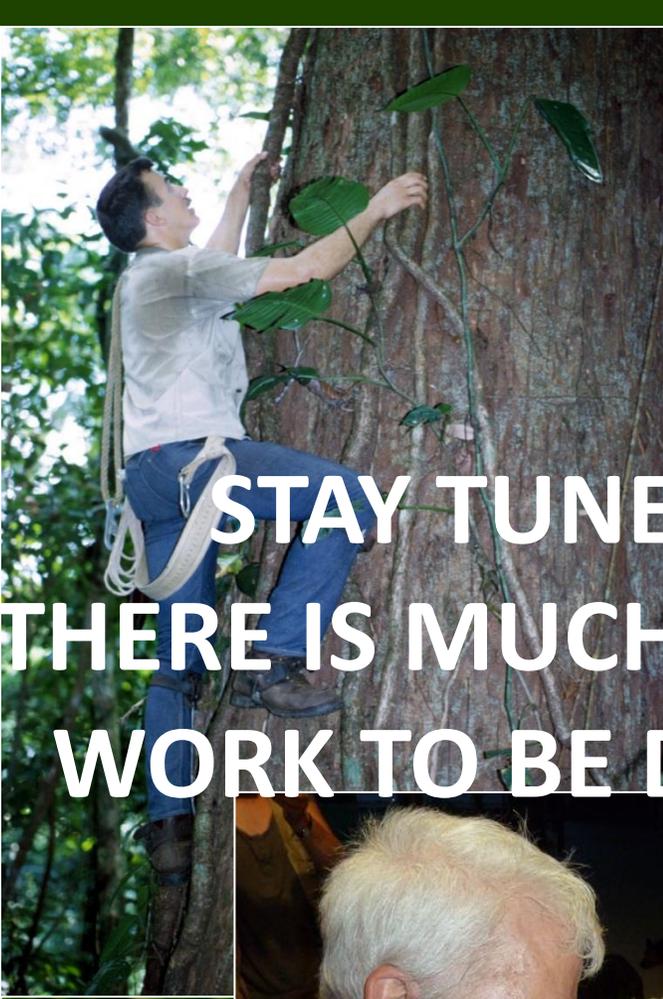
- Newly Described Species
- The Importance of Field Work
- The Importance of Exploring New Areas when they first become accessible



Conclusions

- Araceae have **vast potential for new species**, especially in NW South America, Panama, Andean countries of South America but even in mesic and dry habitats not previously studied.
- Efforts should be made to **increase collecting activities**.
- Local **floristic studies should be encouraged** in the tropics and such studies should be published to encourage such studies.
- Tropical **florulas develop expertise**, interest and eventual specialists. These are ideal studies for Latin American students.





**STAY TUNED.
THERE IS MUCH MORE
WORK TO BE DONE.**

