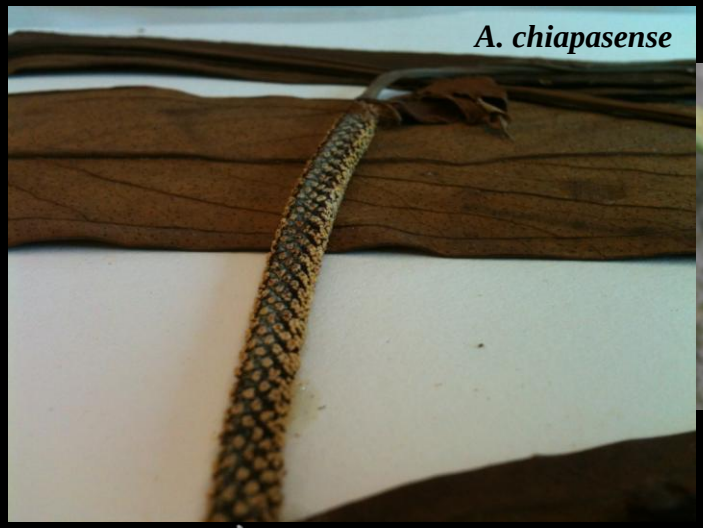
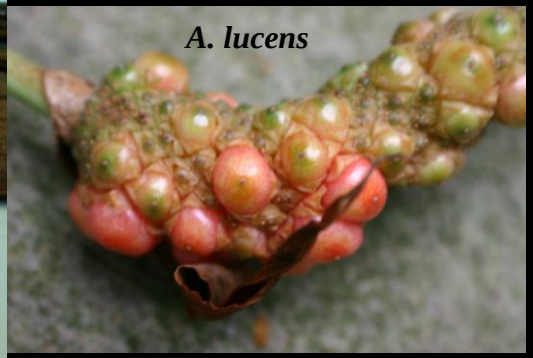
The genus *Anthurium* in Central America—morphology, ecology, and evolution

A. umbrosum



A. chiapasense



A. lucens

A. salvadorense

A. huixtlense

A. chiapasense

5 µm

Angie Macias, Cornell University
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Mentor: Dr. Mónica Carlsen

REU Coordinator:
David Bogler

Outline

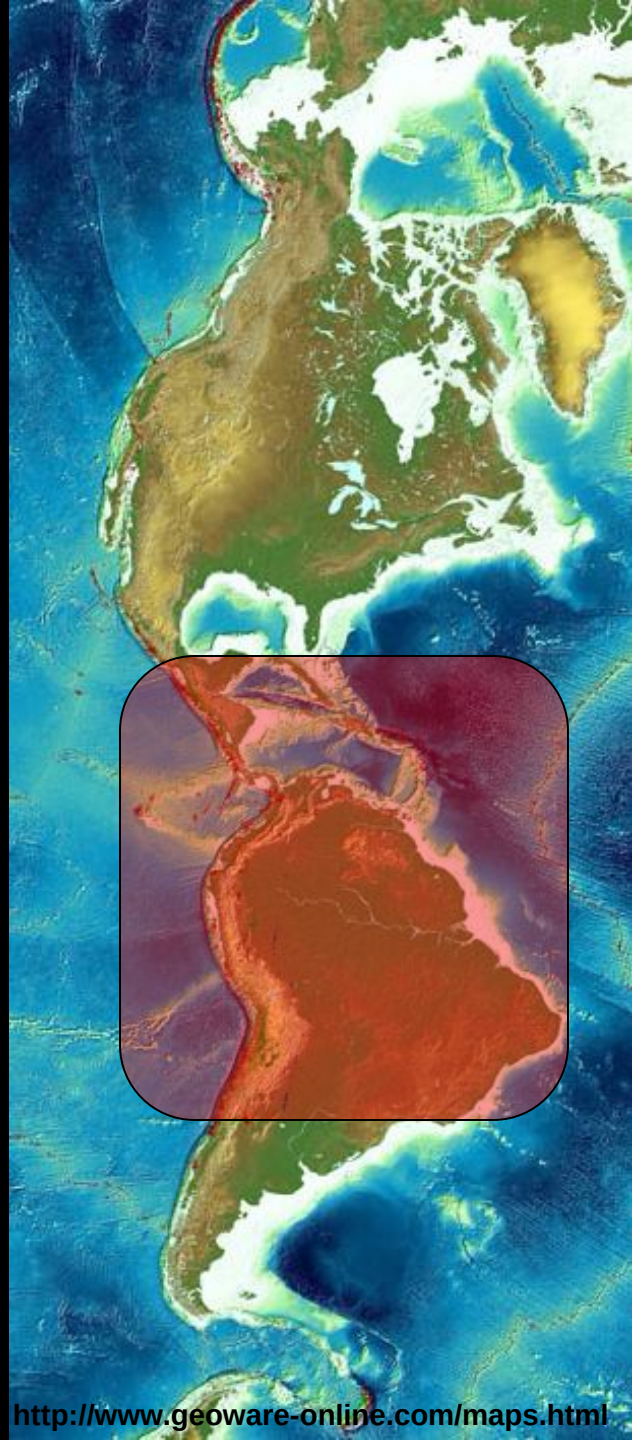
A. verapazense

A. pedatoradiatum

- ✓Introduction
- Pollen
- Lucid Key
- Species Distribution Models
- Conclusion

Introduction

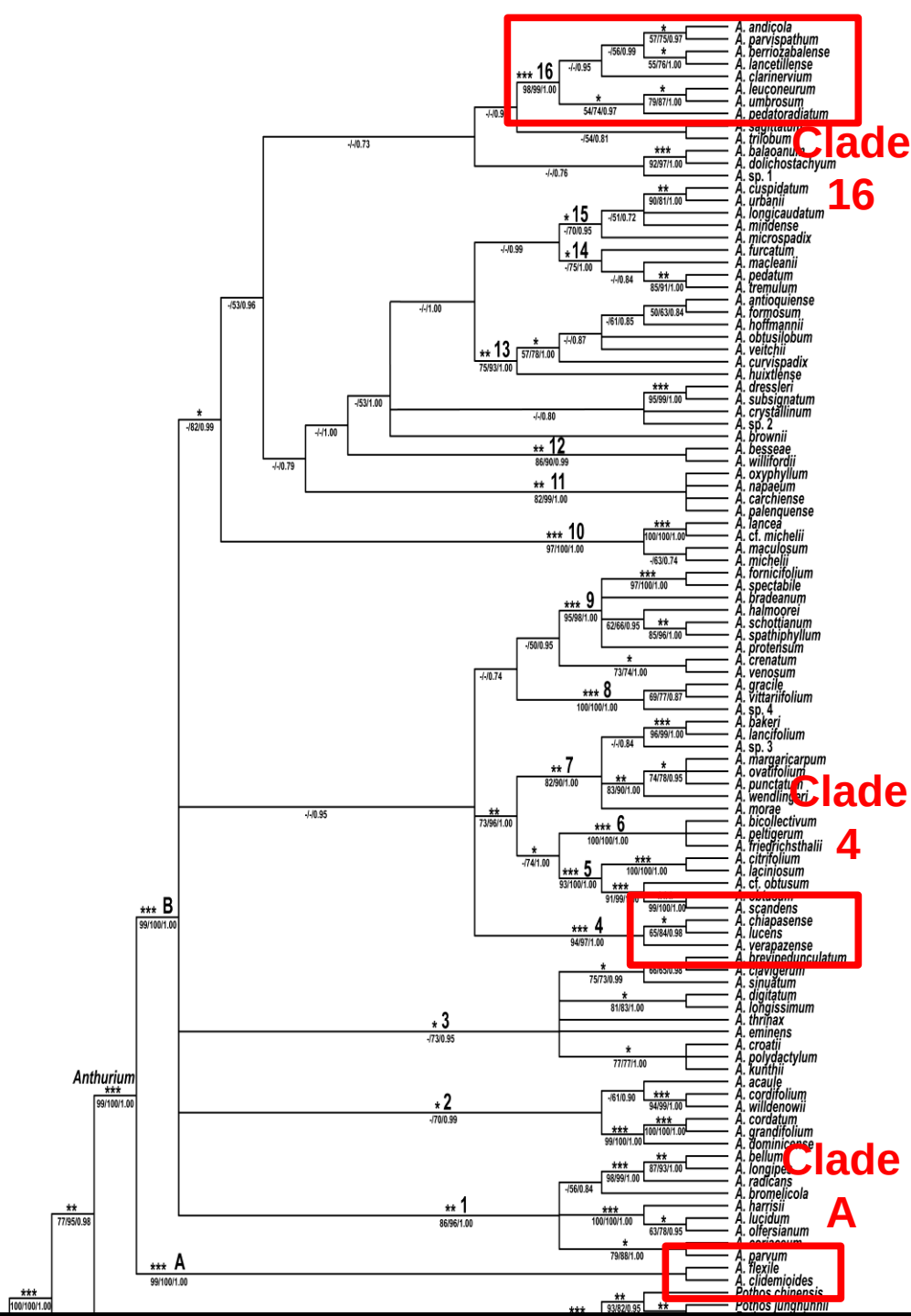
- Neotropical genus in family Araceae
- Est. 1000 species, 912 currently described
- Morphology extremely variable



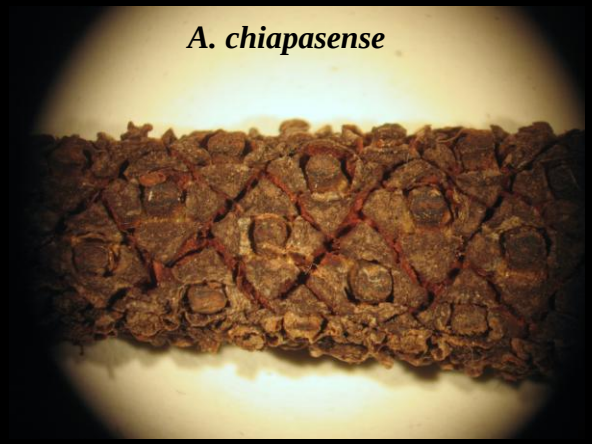
http://www.geoware-online.com/maps.html

Introduction

- *Anthurium* was divided into 18 sections (Croat & Sheffer 1983)
- Molecular phylogeny sampling ~11% of species (Carlsen & Croat 2013)
- Three clades are restricted to Central America, others are more widespread



Introduction


A. chiapasense


A. chiapasense


A. clarinervium

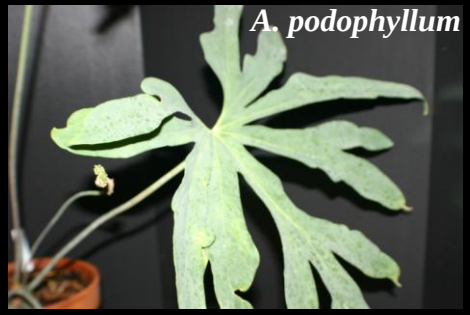

A. clidemioides


A. berriozabalense


A. guatemalense


A. huixtlense

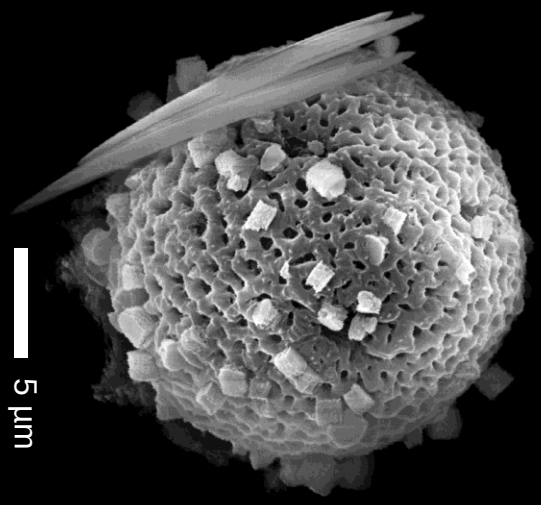

A. verapazense


A. podophyllum

Objectives

1. Examine pollen to look for characters that provide morphological evidence for the molecular phylogeny.
2. Produce a Lucid Key for the group of *Anthurium* species endemic to Central America.
3. Identify differences in ecological preferences between species and/or clades.

Outline



A. lezamae

- Introduction
- ✓Pollen
- Lucid Key
- Species Distribution Models
- Conclusion

Methods

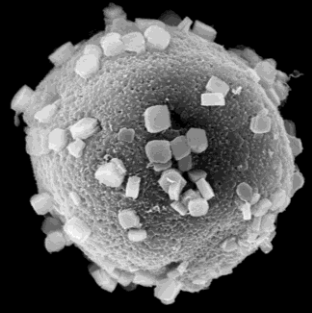
The Missouri Botanical Garden SEM

1. Collect pollen from 16 species in the Missouri Botanical Garden greenhouses
2. Prepare samples for and view in SEM
3. Describe pollen characters for each species

Results

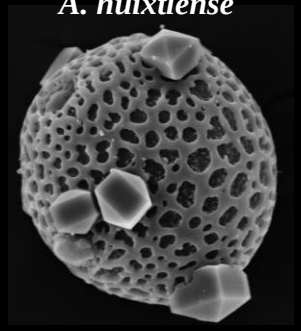
- Strange crystals!
- Some are certainly calcium oxalate because of their crystal structure
- Most are unknown

A. berriozabalense



Some are attached to pollen…

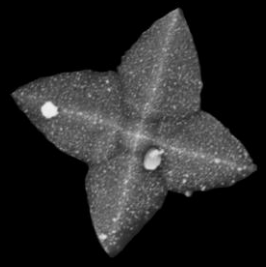
A. huixtlense



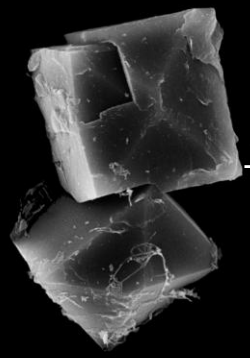
Others are embedded in the outer layer…

5 µm

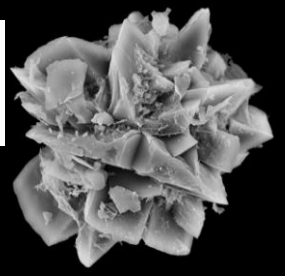
20 µm



1 µm



5 µm

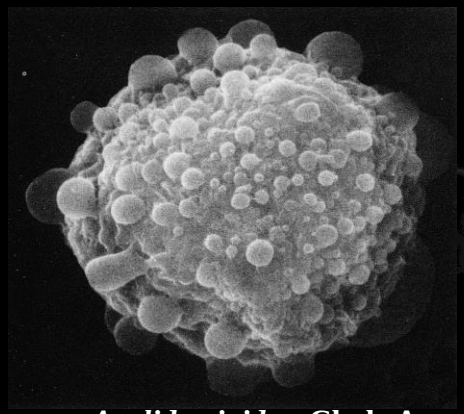


5 µm

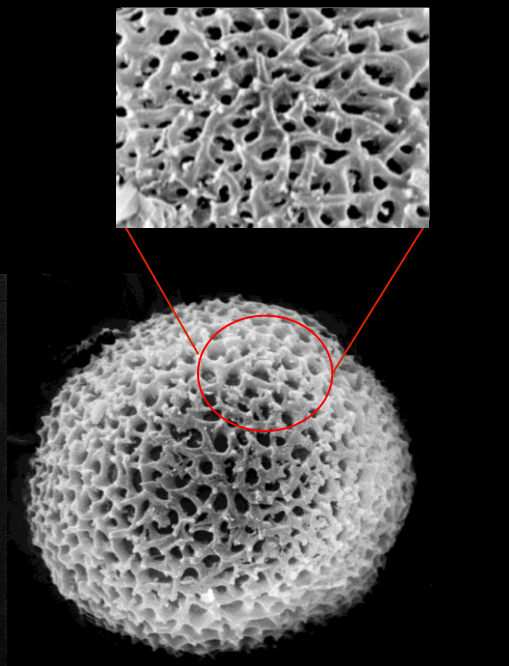
And more are “free”…

Results

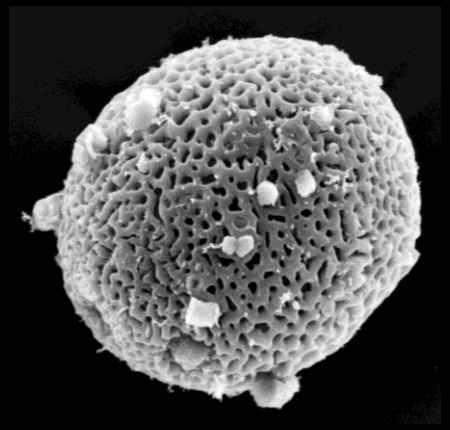
- Gemmate exine ornamentation occurs in Clade A
- Spiny, reticulate “criss-cross” ornamentation occurs in Clade 4
- Fine reticulation with smooth walls and apparent apertures occur in Clade 16 (most similar to outgroups)
- Other *Anthurium* species have reticulation, but holes are usually larger.



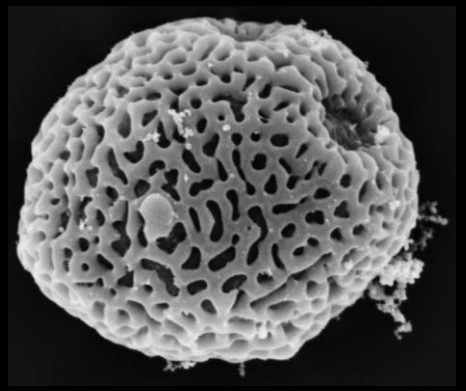
***A. clidemioides,* Clade A (Grayum 1992)**



***A. verapazense,* Clade 4**



***A. podophyllum,* Clade 16**



***A. salvadorense,* Clade 9 (outgroup)**

5 µm

Outline

A. salvadorense

- Introduction
- Pollen
- ✓Lucid Key
- Species Distribution Models
- Conclusion

Methods

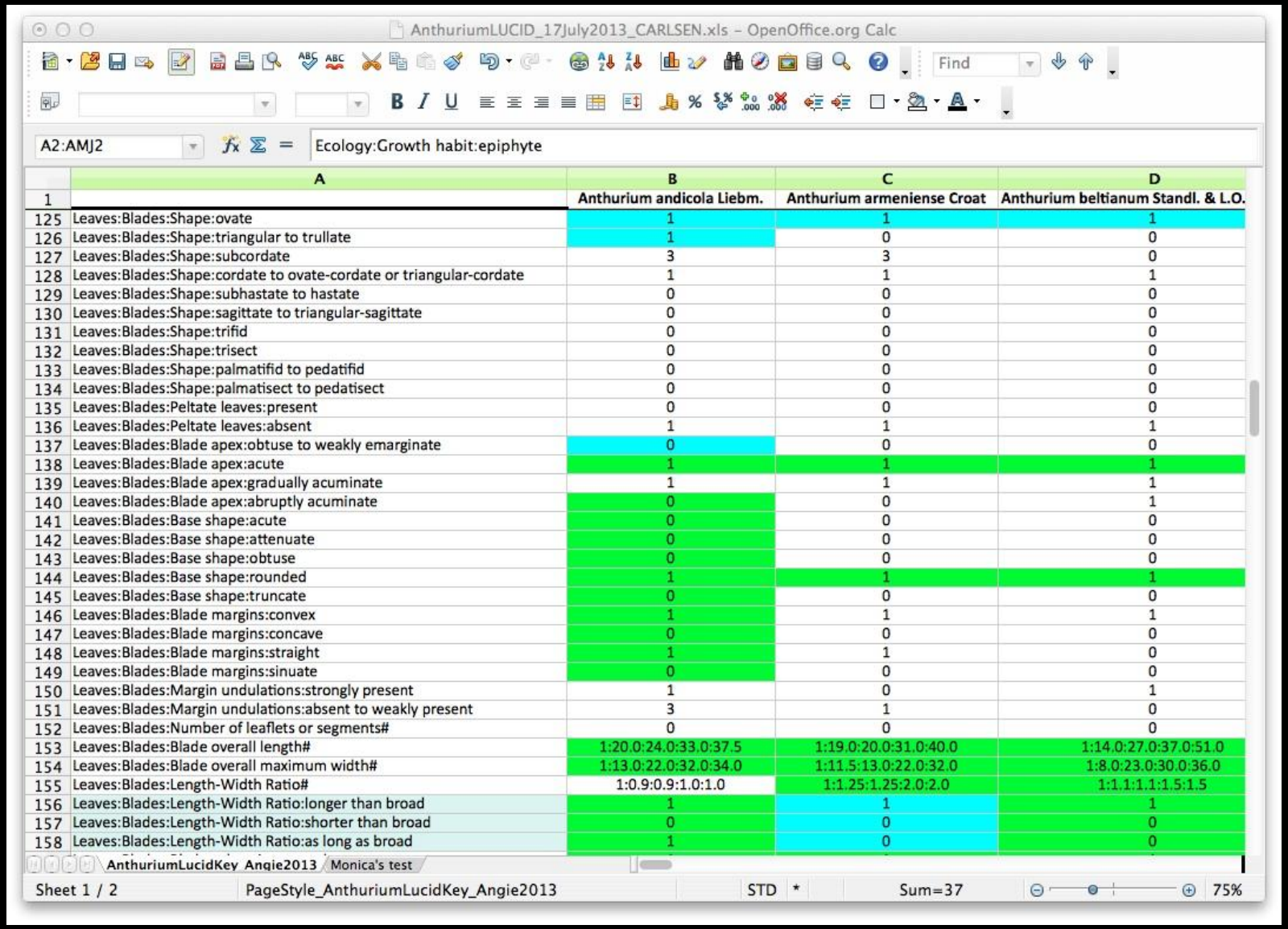
- Revise Lucid Key developed originally by Tom Croat
- Scored 92 characters for 47 species (184 herbarium specimens) from Central America
- Also scored 16 living species, but data still incomplete
- Look through literature to find detailed taxonomic descriptions of the species

Herbarium specimen of *Anthurium yetlense*

But what is a Lucid Key?

- Digital keys that aid in species identification
- Allow users to select the characters they want to use instead of following those chosen in a dichotomous key
- Good for plant groups with many species and many important characters

Raw Data


AnthuriumLUCID_17July2013_CARLSEN.xls – OpenOffice.org Calc

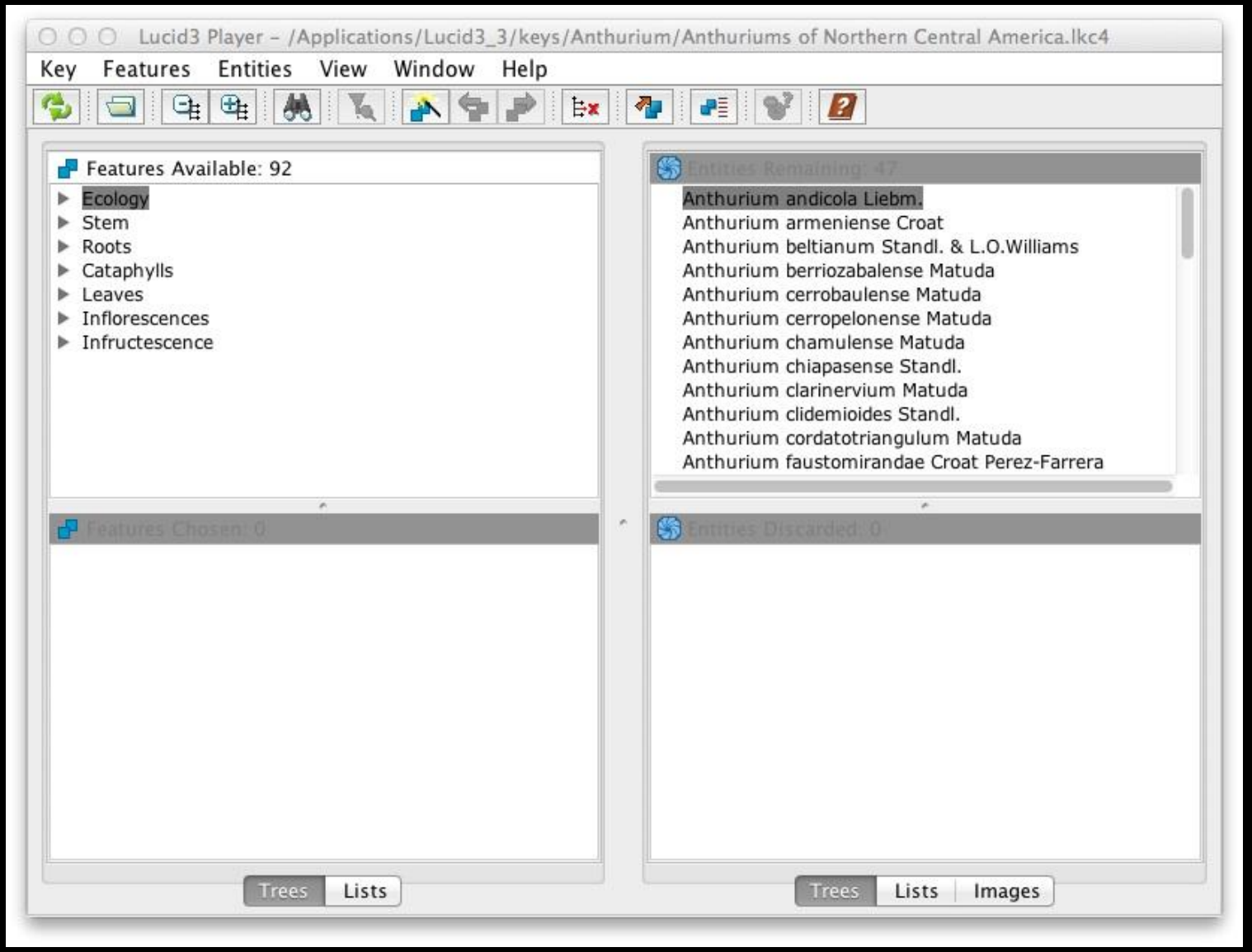
A2:AMJ2 | Ecology:Growth habit:epiphyte

	A	B	C	D
1		Anthurium andicola Liebm.	Anthurium armeniense Croat	Anthurium beltianum Standl. & L.O.
125	Leaves:Blades:Shape:ovate	1	1	1
126	Leaves:Blades:Shape:triangular to trullate	1	0	0
127	Leaves:Blades:Shape:subcordate	3	3	0
128	Leaves:Blades:Shape:cordate to ovate-cordate or triangular-cordate	1	1	1
129	Leaves:Blades:Shape:subhastate to hastate	0	0	0
130	Leaves:Blades:Shape:sagittate to triangular-sagittate	0	0	0
131	Leaves:Blades:Shape:trifid	0	0	0
132	Leaves:Blades:Shape:trisect	0	0	0
133	Leaves:Blades:Shape:palmatifid to pedatifid	0	0	0
134	Leaves:Blades:Shape:palmatisect to pedatisect	0	0	0
135	Leaves:Blades:Peltate leaves:present	0	0	0
136	Leaves:Blades:Peltate leaves:absent	1	1	1
137	Leaves:Blades:Blade apex:obtuse to weakly emarginate	0	0	0
138	Leaves:Blades:Blade apex:acute	1	1	1
139	Leaves:Blades:Blade apex:gradually acuminate	1	1	1
140	Leaves:Blades:Blade apex:abruptly acuminate	0	0	1
141	Leaves:Blades:Base shape:acute	0	0	0
142	Leaves:Blades:Base shape:attenuate	0	0	0
143	Leaves:Blades:Base shape:obtuse	0	0	0
144	Leaves:Blades:Base shape:rounded	1	1	1
145	Leaves:Blades:Base shape:truncate	0	0	0
146	Leaves:Blades:Blade margins:convex	1	1	1
147	Leaves:Blades:Blade margins:concave	0	0	0
148	Leaves:Blades:Blade margins:straight	1	1	0
149	Leaves:Blades:Blade margins:sinuate	0	0	0
150	Leaves:Blades:Margin undulations:strongly present	1	0	1
151	Leaves:Blades:Margin undulations:absent to weakly present	3	1	0
152	Leaves:Blades:Number of leaflets or segments#	0	0	0
153	Leaves:Blades:Blade overall length#	1:20.0:24.0:33.0:37.5	1:19.0:20.0:31.0:40.0	1:14.0:27.0:37.0:51.0
154	Leaves:Blades:Blade overall maximum width#	1:13.0:22.0:32.0:34.0	1:11.5:13.0:22.0:32.0	1:8.0:23.0:30.0:36.0
155	Leaves:Blades:Length-Width Ratio#	1:0.9:0.9:1.0:1.0	1:1.25:1.25:2.0:2.0	1:1.1:1.1:1.5:1.5
156	Leaves:Blades:Length-Width Ratio:longer than broad	1	1	1
157	Leaves:Blades:Length-Width Ratio:shorter than broad	0	0	0
158	Leaves:Blades:Length-Width Ratio:as long as broad	1	0	0

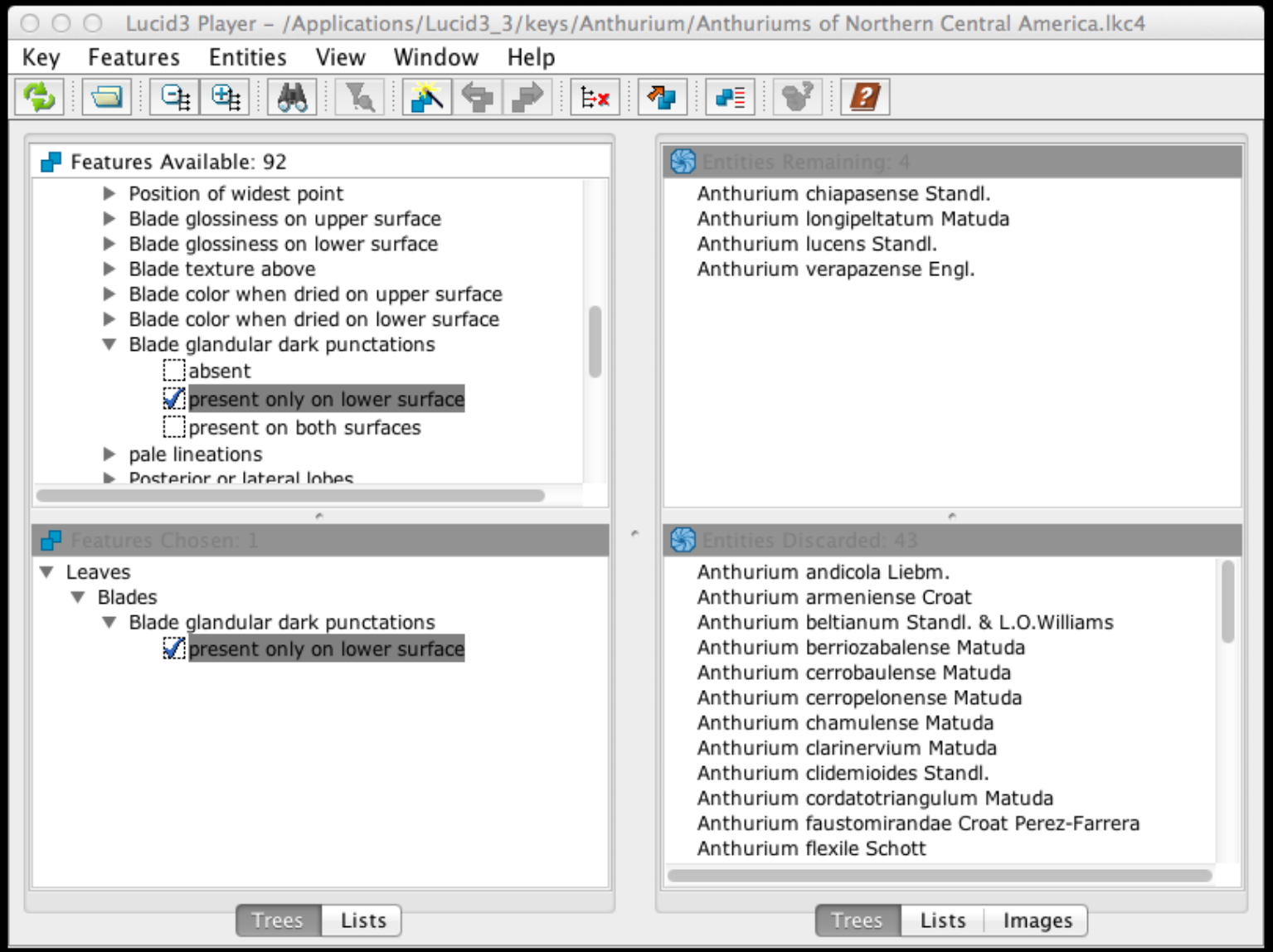
AnthuriumLucidKey_Angie2013 | Monica's test

Sheet 1 / 2 | PageStyle_AnthuriumLucidKey_Angie2013 | STD | Sum=37 | 75%

Lucid


Lucid3 Player - /Applications/Lucid3_3/keys/Anthurium/Anthuriums of Northern Central America.lkc4
Key
Features
Entities
View
Window
Help
Features Available: 92
Ecology
Stem
Roots
Cataphylls
Leaves
Inflorescences
Infructescence
Entities Remaining: 47
Anthurium andicola Liebm.
Anthurium armeniense Croat
Anthurium beltianum Standl. & L.O.Williams
Anthurium berriozabalense Matuda
Anthurium cerrobaulense Matuda
Anthurium cerropelonense Matuda
Anthurium chamulense Matuda
Anthurium chiapasense Standl.
Anthurium clarinervium Matuda
Anthurium clidemioides Standl.
Anthurium cordatotriangulum Matuda
Anthurium faustomirandae Croat Perez-Farrera
Features Chosen: 0
Entities Discarded: 0
Trees
Lists
Trees
Lists
Images

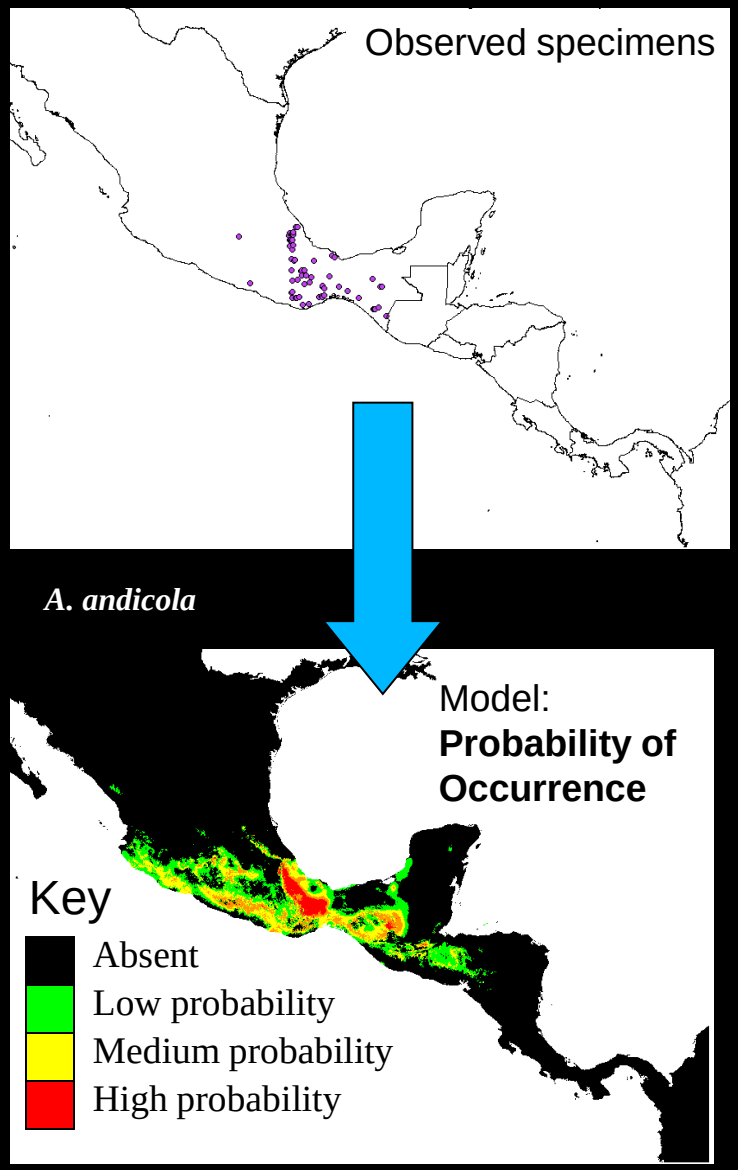
Lucid


Lucid3 Player - /Applications/Lucid3_3/keys/Anthurium/Anthuriums of Northern Central America.lkc4
Key
Features
Entities
View
Window
Help
Features Available: 92
Position of widest point
Blade glossiness on upper surface
Blade glossiness on lower surface
Blade texture above
Blade color when dried on upper surface
Blade color when dried on lower surface
Blade glandular dark punctations
absent
present only on lower surface
present on both surfaces
pale lineations
Posterior or lateral lobes
Features Chosen: 1
Leaves
Blades
Blade glandular dark punctations
present only on lower surface
Trees
Lists
Entities Remaining: 4
Anthurium chiapasense Standl.
Anthurium longipeltatum Matuda
Anthurium lucens Standl.
Anthurium verapazense Engl.
Entities Discarded: 43
Anthurium andicola Liebm.
Anthurium armeniense Croat
Anthurium beltianum Standl. & L.O.Williams
Anthurium berriozabalense Matuda
Anthurium cerrobaulense Matuda
Anthurium cerropelonense Matuda
Anthurium chamulense Matuda
Anthurium clarinervium Matuda
Anthurium clidemioides Standl.
Anthurium cordatotriangulum Matuda
Anthurium faustomirandae Croat Perez-Farrera
Anthurium flexile Schott
Trees
Lists
Images

Outline

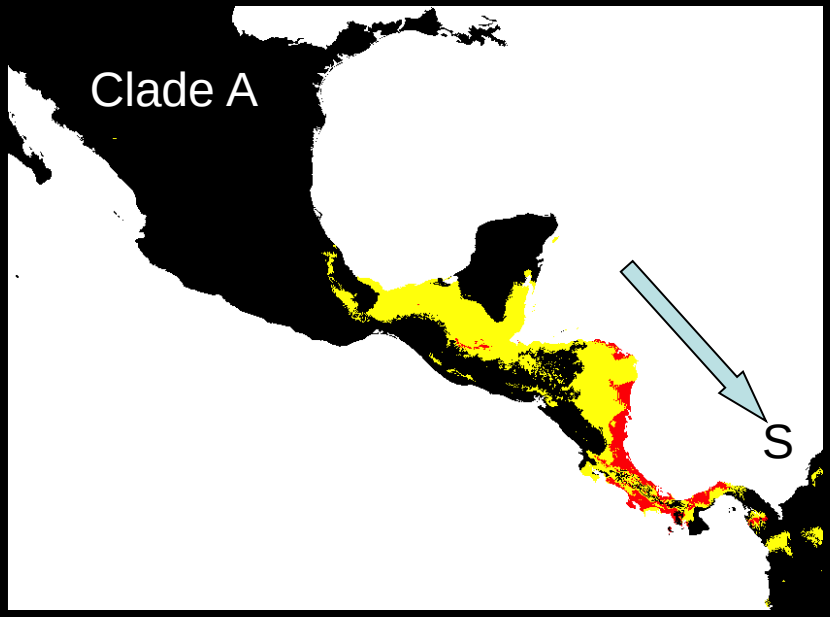
- Introduction
- Pollen
- Lucid Key
- ✓Species Distribution Models
- Conclusion

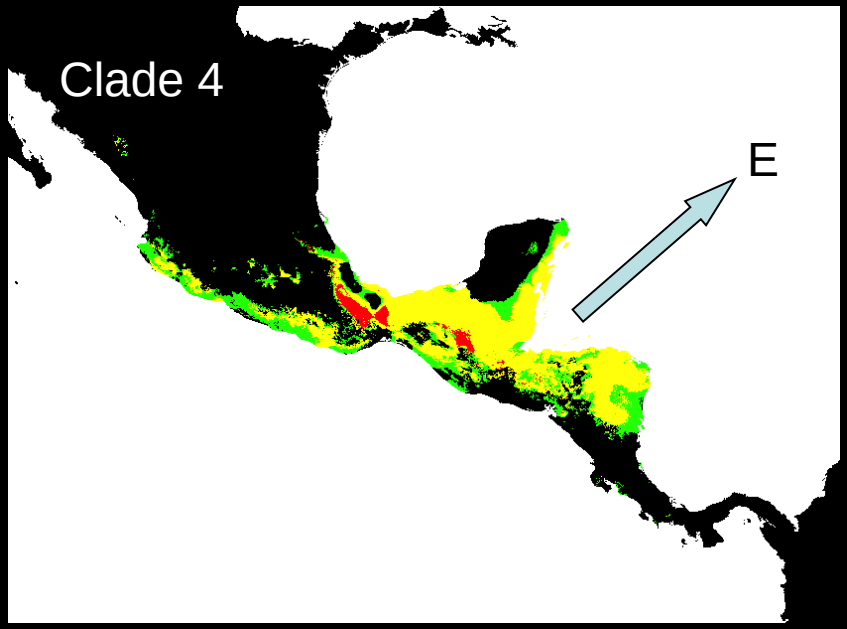
Methods

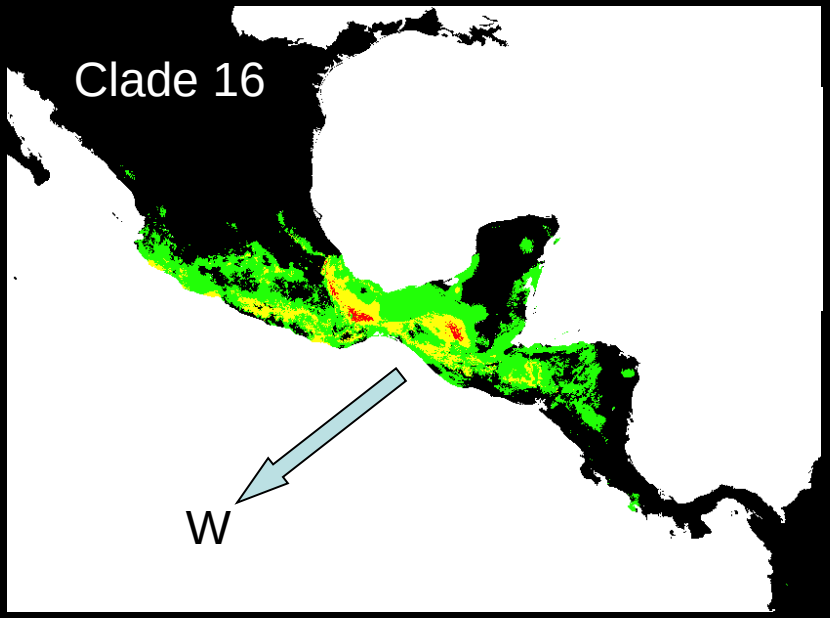


- Collect localities and coordinates for 56 species (~5800 specimens) through TROPICOS and georeferencing
- Clean data
- Use MaxEnt & DivaGIS to produce distribution models

Results







Key

- Absent
- Low richness
- Medium richness
- High richness

Outline

A. verapazense

- Introduction
- Pollen
- Lucid Key
- Species Distribution Models
- ✓Conclusion

Conclusion

- In general, the three clades restricted to Central America (Clade A-section *Polyphyllium*, Clade 4, and Clade 16-*Anthurium andicola* alliance) (Carlsen & Croat 2013) are very distinct from each other, and from other more widespread groups, in their overall morphology and ecological needs.

Conclusion

- All the programs used (Lucid, DivaGIS, MaxEnt) are freely available online
- All the results will be freely available online!

  -Pollen images: PalDat

  -Lucid Key: Kew eMonocots webpage

  -Species Distribution Models: Smithsonian

Acknowledgements

- MBG
- NSF
- Mónica Carlsen
- David Bogler
- Tom Croat
- Justin Zweck
- Erika Belmont
- MBG Library
- CCSD
  (esp. Adam Smith)

Thanks for listening!

- My email address is amm369@cornell.edu if you have any questions!

Missouri Botanical Garden, Araceae greenhouse