

Field Collections to Digital Data: A Workflow for Fossils and the Use of Digital Data for Reconstructing Ancient Forests



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University of California
Museum of Paleontology



New collections: meeting multiple needs

Research project goals:

- Collect new fossils
- Identify/describe
- Collect data/measure
- Analyze data
- Publish research
 - (Wait! Need repository info and specimen numbers!)

Museum & archival goals:

- Care and house specimens
- Manage and store associated data
- Accessibility
 - *Digitization of collection records and specimen photos



Research based on new collections: integrating short and long-term needs

- 1) Collection**
- Finding and collecting fossils
 - Locality data and samples
 - Field data (e.g. census counts)



- 2) Identification/description, etc.**

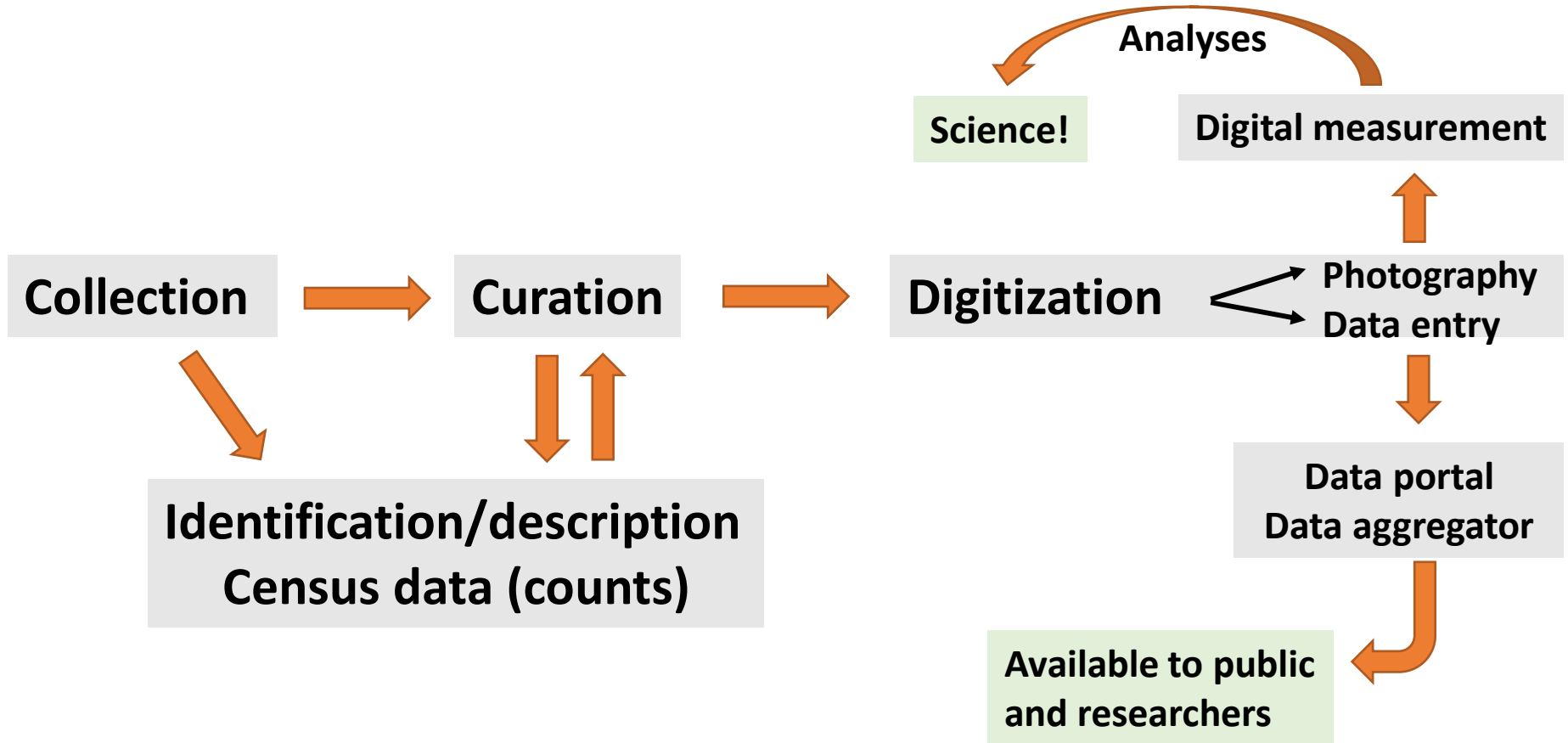
- 3) Curation**
- Specimen preparation
 - Labels & specimen numbers
 - Organize and storage

- 4) Digitization**
- Photography
 - Data entry



- 5) Digital data**
- Management
 - Further research use

Research based on new collections: integrating short and long-term needs



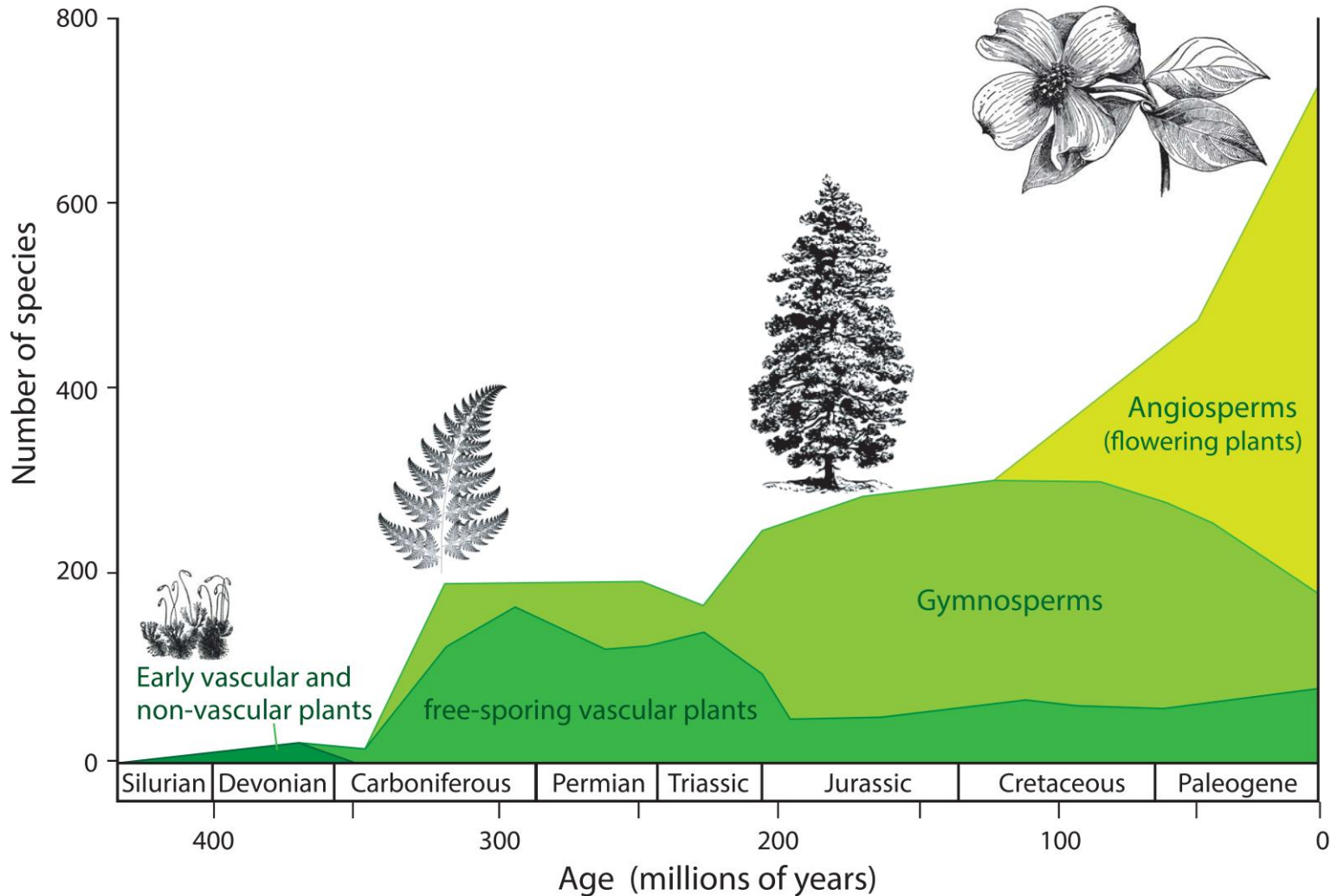
An example from ongoing project

Reconstructing a Cretaceous forest

- 1) Project description**
- 2) Methods & Workflow**
-roadblocks and solutions
- 3) Research and use of digital data**



AIM: to address fundamental questions about the structure, diversity, and functioning of forests during the Late Cretaceous ecological radiation of angiosperms

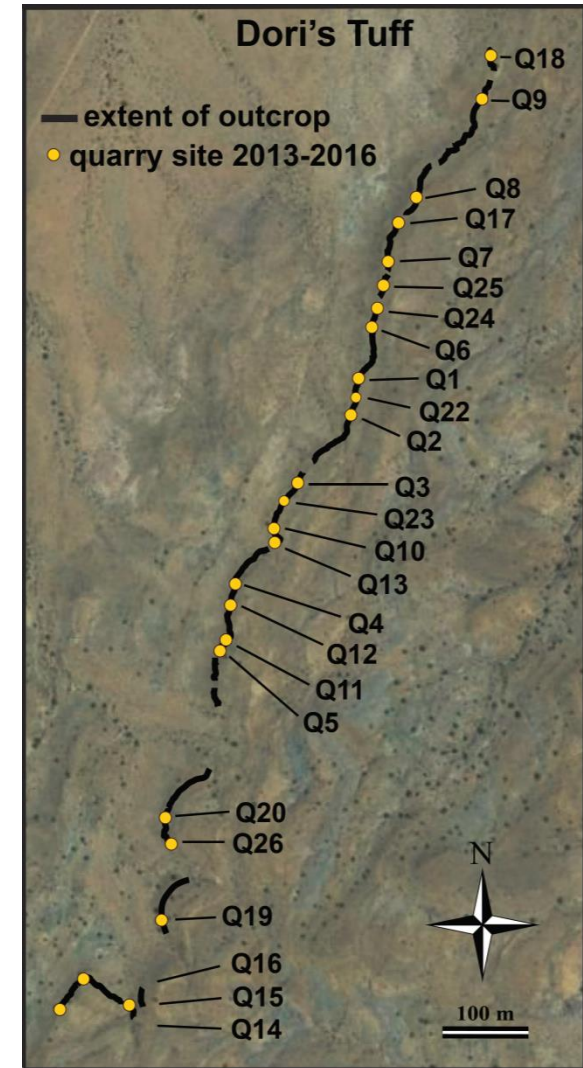


Current Project:

Reconstructing structure & functional diversity of a Cretaceous forest

“Dori’s Tuff” deposit

- South-Central New Mexico; McRae Fm.
- Late Campanian; 74.7 Ma (U-Pb, Amato et al. 2017)
- Ashfall bed with little to no transport
 - Single depositional event on stable floodplain
- ~1.2 km!



Project Overview:

Reconstructing structure & functional diversity of a Cretaceous forest

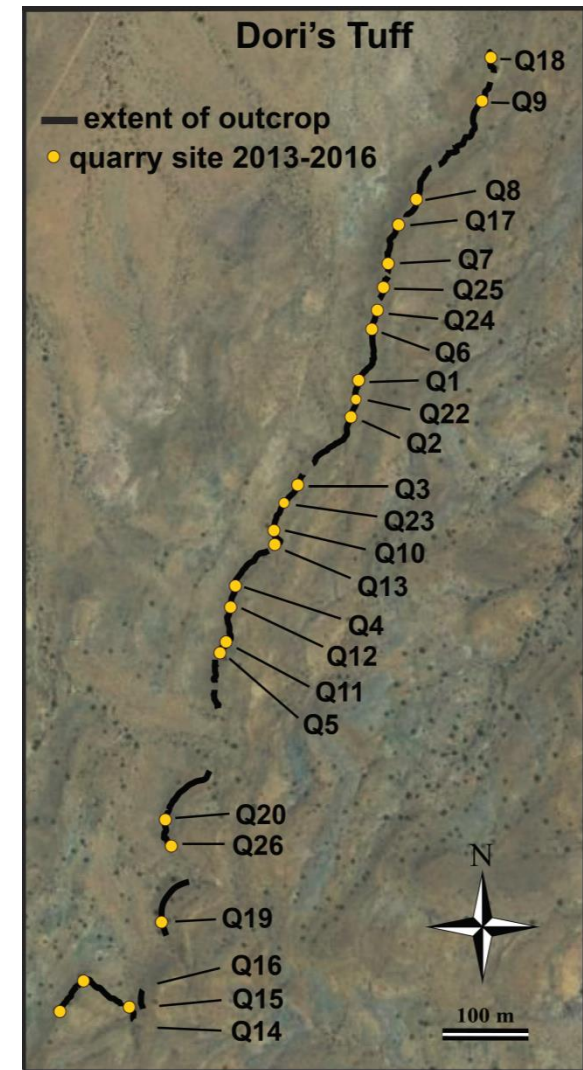
Phase 1. “Build” a forest

- describe taxonomic diversity
- relative abundance of taxa
- spatial structure of community

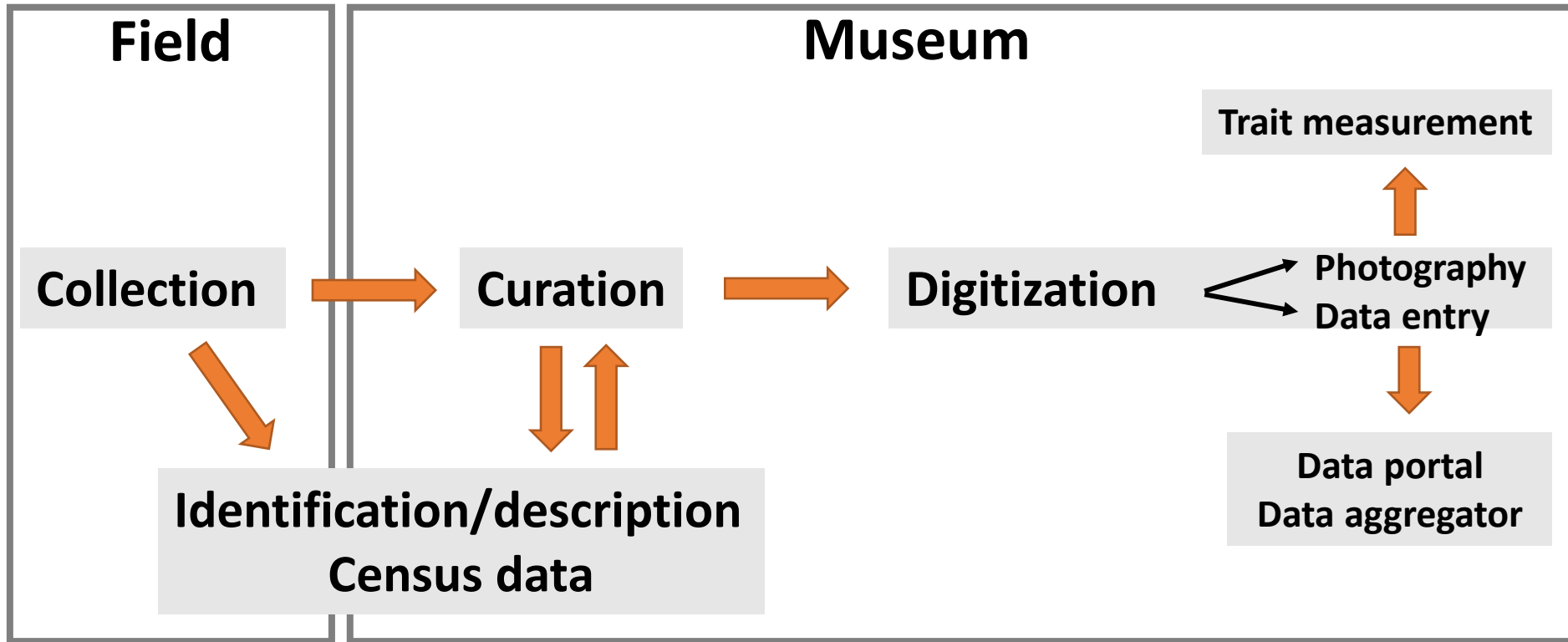
Phase 2. Measure the forest: quantify functional diversity

- measure functional leaf traits of all taxa
- reconstruct trait diversity across transect

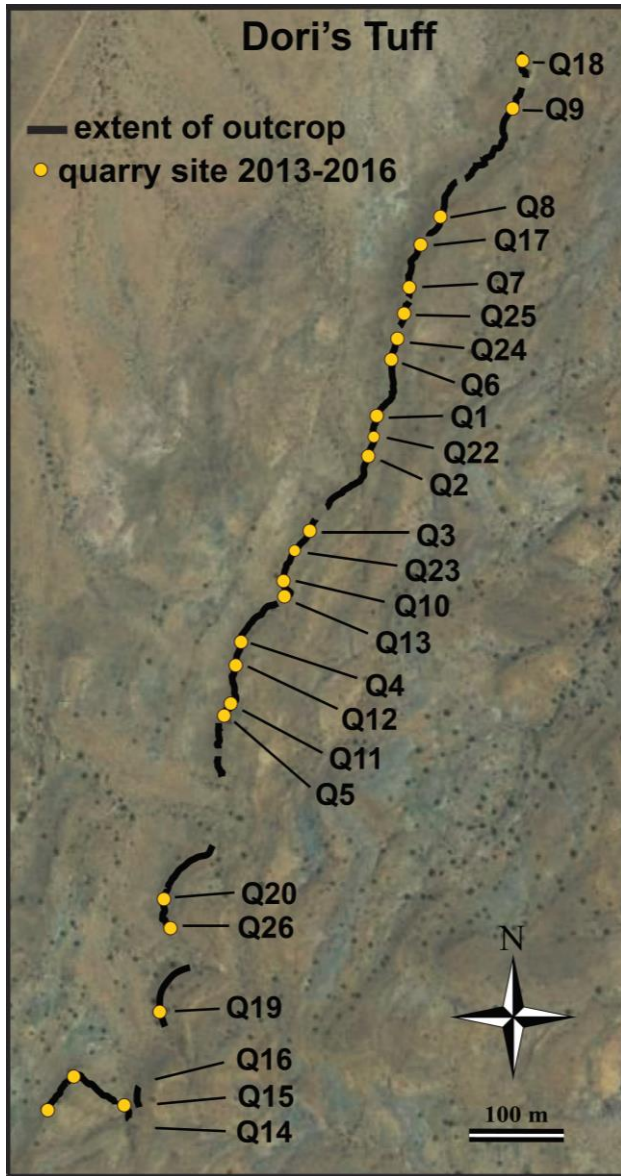
- *quantitative and spatial explicit sampling scheme
- *large sample sizes
- *digital measurements of georeferenced specimens



A workflow from field to digital



Field Work – localities



Established 26 quarry sites spanning deposit:

- each treated as separate locality
- collected relevant site data for each:
 - GPS coordinates
 - sedimentological info and samples, quarry dimensions
 - photographs

Quarry site:

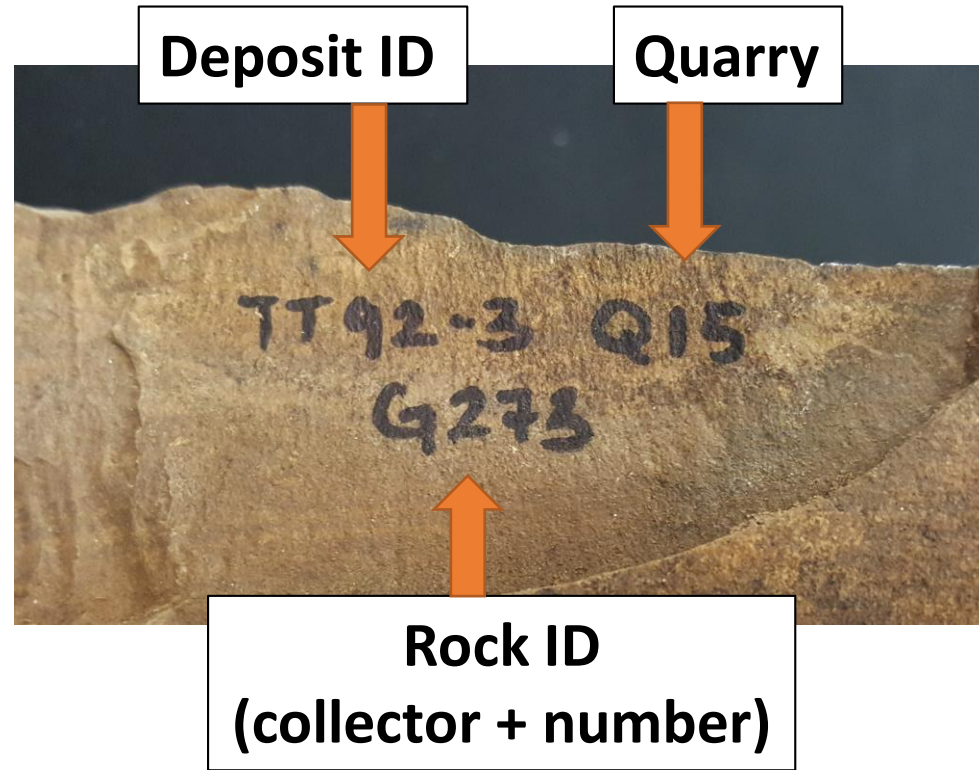


Field Work – collections and census

At each quarry:

- Bust out rock and expose fossils

****each rock gets a unique field ID number***



Field Work – collections and census

At each quarry:

- Bust out rock and expose fossils
 - *each rock gets a unique field ID number***
- Census: Identify and record leaf morphotypes by:
 - 1) Relative abundance: number of leaf specimens
 - 2) Percent cover: # of 2-cm line increments crossed (Wing *et al.* 1993, 2012)



Census: line increments



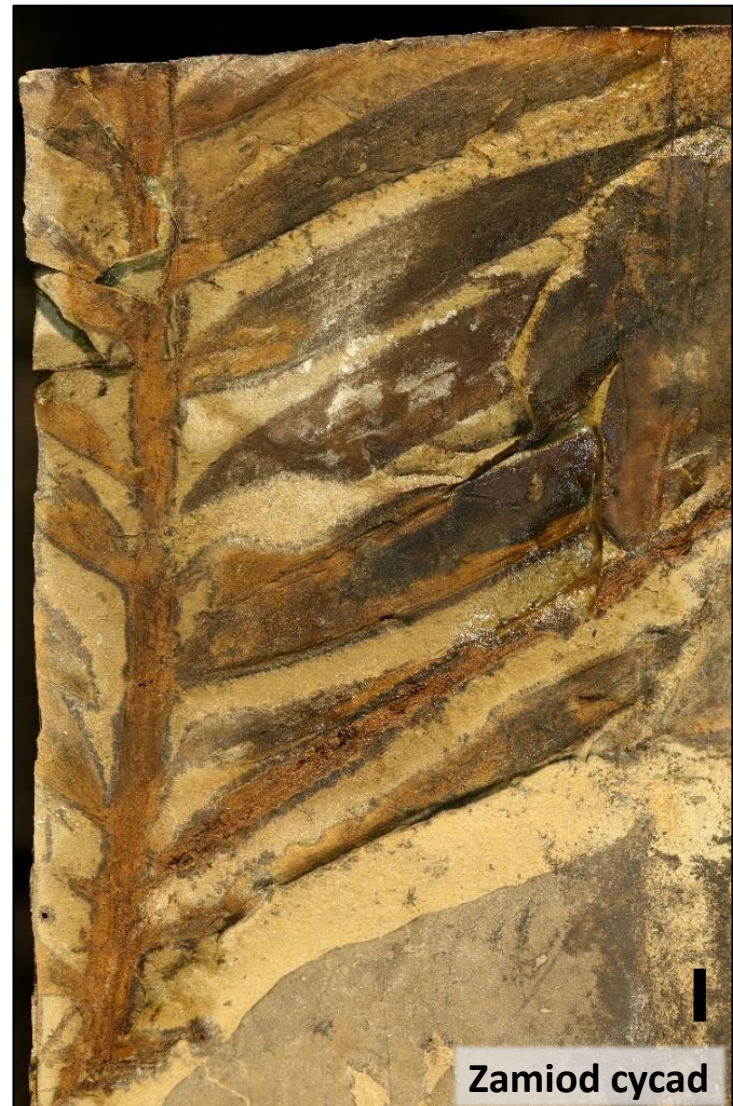
> 6,350 specimens
> 61,718 cm² of rock surface

“Keepers” are wrapped and labeled

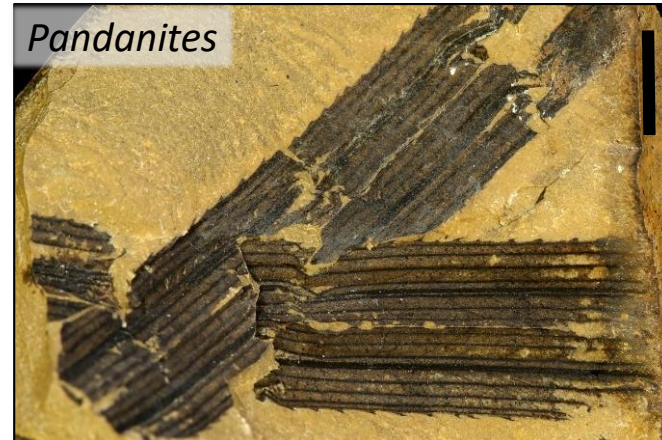


> 1,945 rocks brought to UCMP

Conifers & Cycads



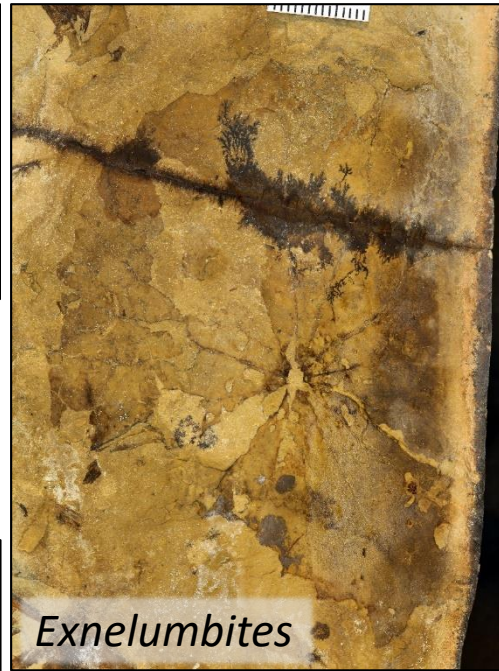
Angiosperms - monocots



Angiosperms – toothed “dicots”



basal eudicot



Exnelumbites



Platanoid



Trochodendroides

scale = 5 mm

Angiosperms – pinnate “dicots”



scale = 5 mm

The spoils of field work

Spoils:

Locality info
Census databooks
Boxes of fossils

Collection

Curation

Digitization

Identification/description
Census data

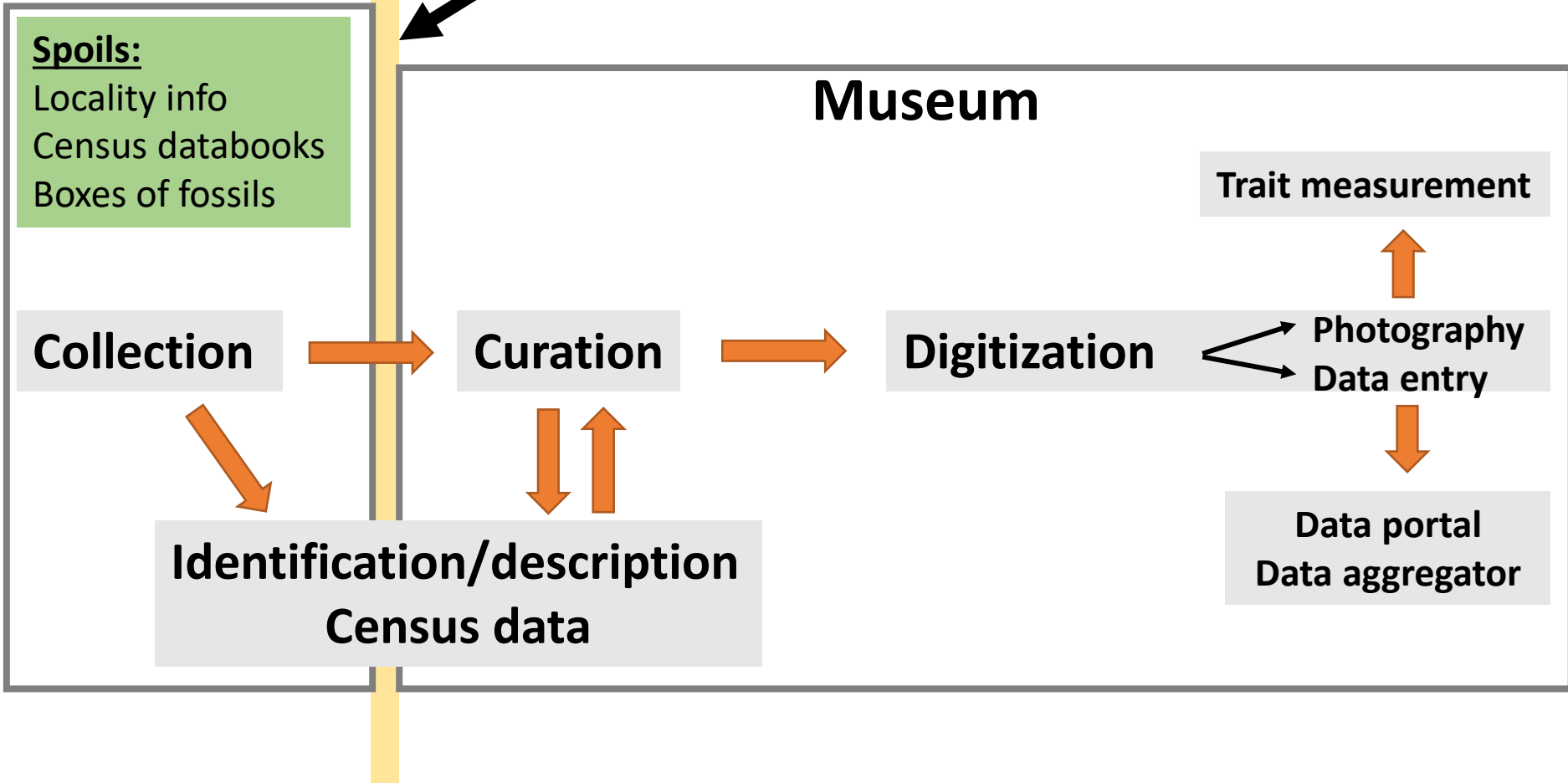
Trait measurement

Photography
Data entry

Data portal
Data aggregator



The transition



Museum and Lab: the transition

1) Data entry: census data

2) Unpacking fossils

Matching parts and counterparts

Boxing and organizing into drawers

Curatorial log
*Rock ID



Museum and Lab: the transition

1) Data entry: census data

2) Unpacking fossils

*Reconcile for
printing labels
with species
identifications

Matching parts and
counterparts

Boxing and organizing
into drawers

Curatorial log
*Rock ID



101 Drawers to process....

Field

Spoils:

Locality info
Census databooks
Boxes of fossils

Collection

Identification/description
Census data

Museum

The un-censused

-specimens that could not be identified in field
-new morphotypes

Curation

Digitization

The censused

-specimens ID'ed & well-preserved enough for trait measurements

Trait measurement

Photography
Data entry

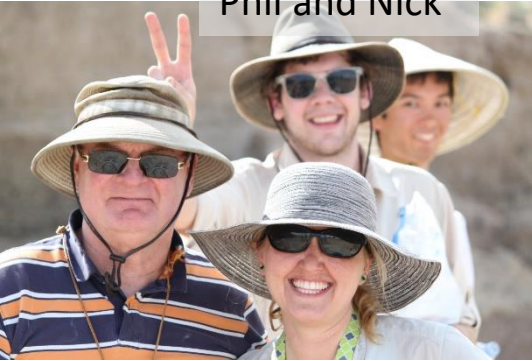


What needs to be done?

- 1) Identify and census the difficult specimens**
 - 2) Prep specimens if necessary**
 - 3) Complete descriptions of taxa**
- 4) Curation: assign # to each specimen on each rock and label; fill out identification cards; enter data**
 - 5) Photograph specimens**

People Power

Phil and Nick



James B.



Meriel



Jae Min



James S.



Yoon



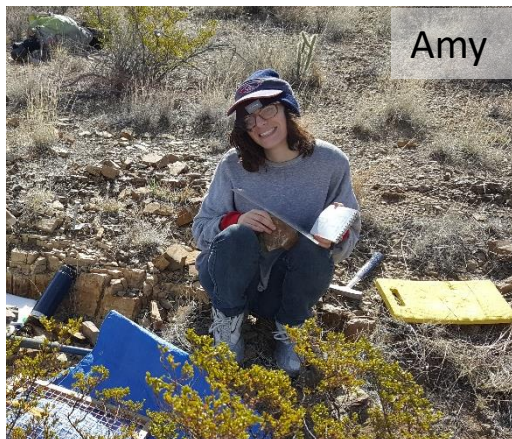
Aaron



Negin



Amy



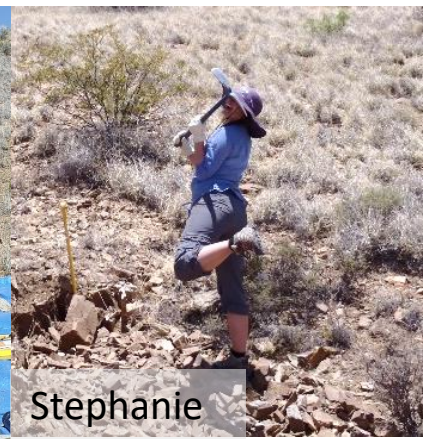
Mom



Emma



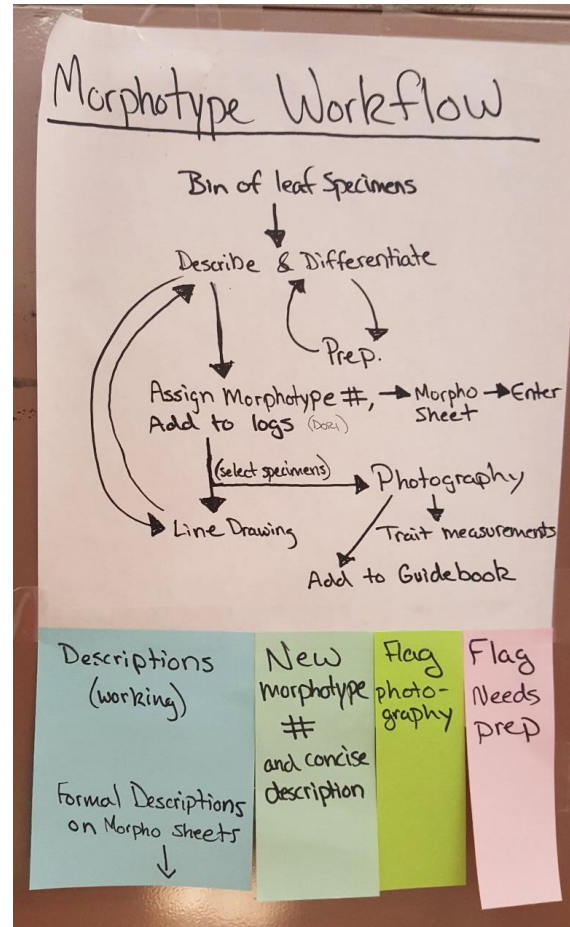
Stephanie



Processing: Two Methods

Batch processing

- one type of task at a time
- flag specimens for different processes
- let specimens build up until have a “batch” to process

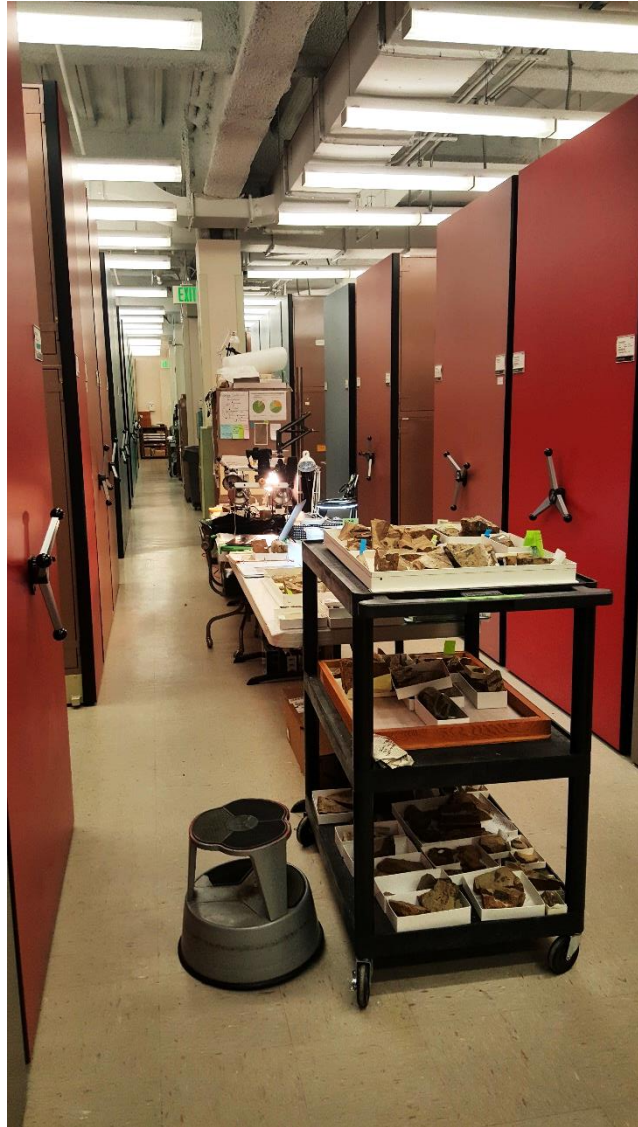


Integration of tasks

- do everything at once!
- drawer by drawer, processing each specimen completely



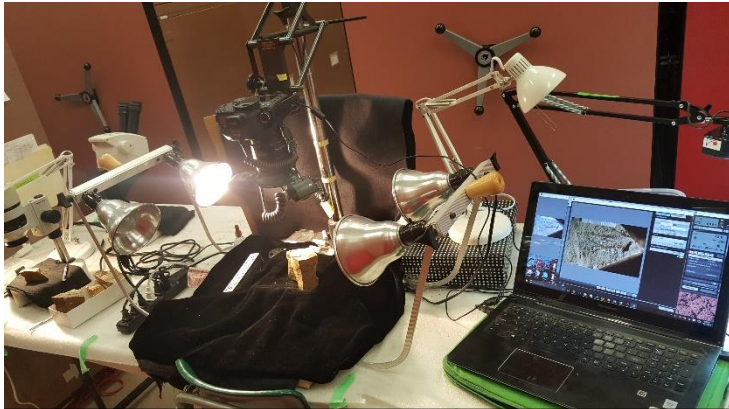
Re-organization and customization of workspace



Re-organization and customization of workspace



**Prep station
Descriptions**



Photography station



**White-stripe and census station
Data entry, labels**

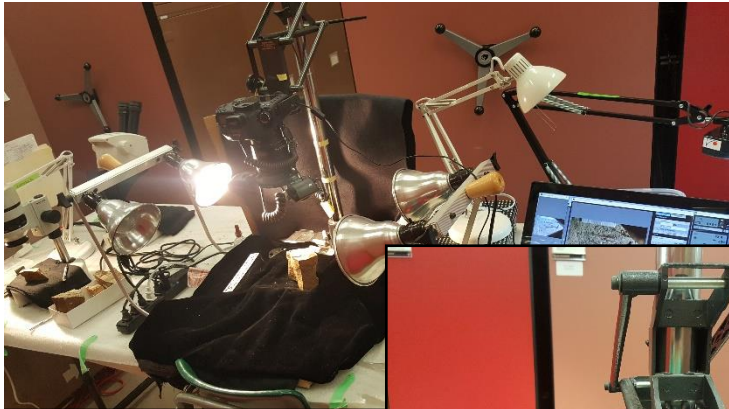
Re-organization and customization of workspace



**Prep station
Descriptions**



**White-stripe and census station
Data entry**



Photograph

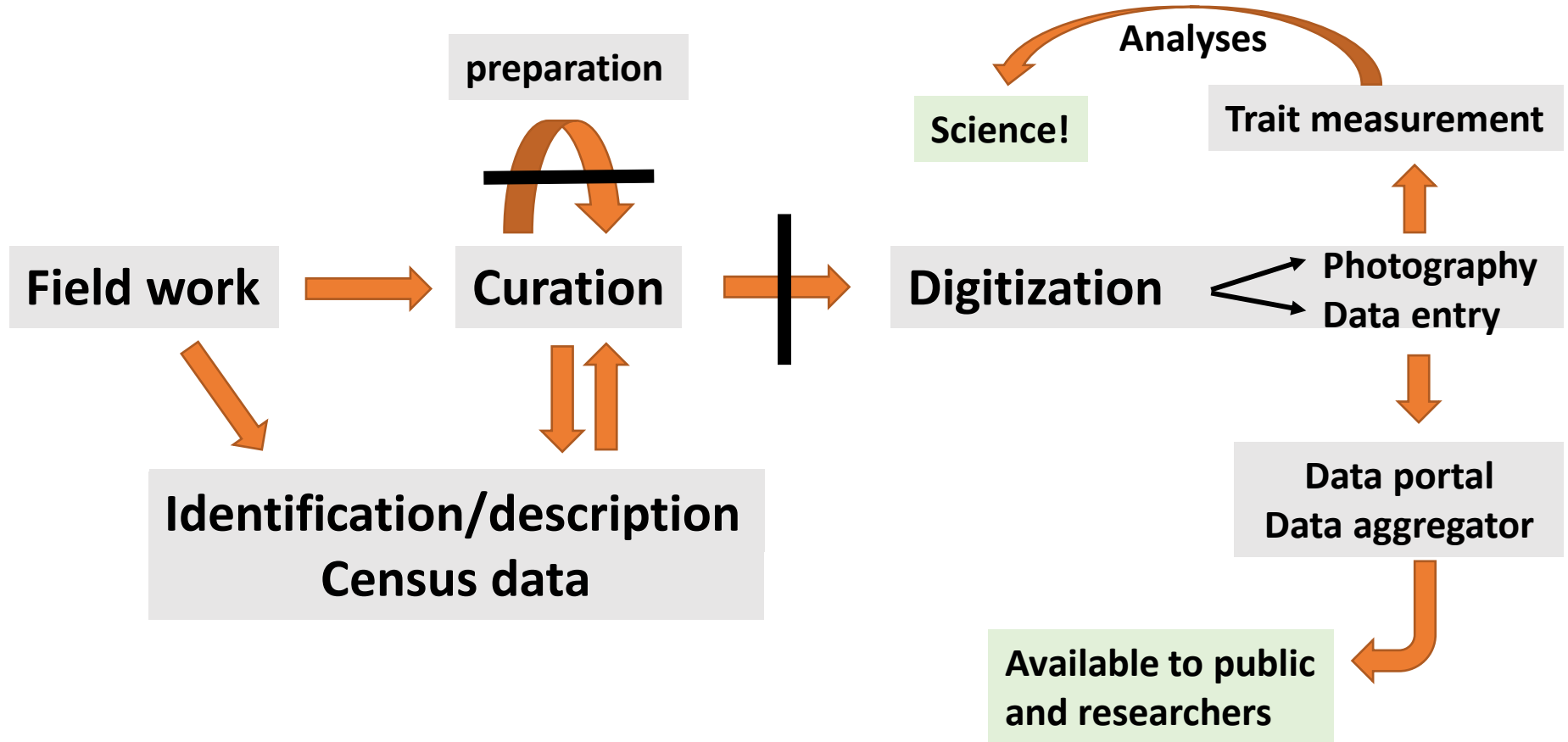


Re-organization and customization of workspace



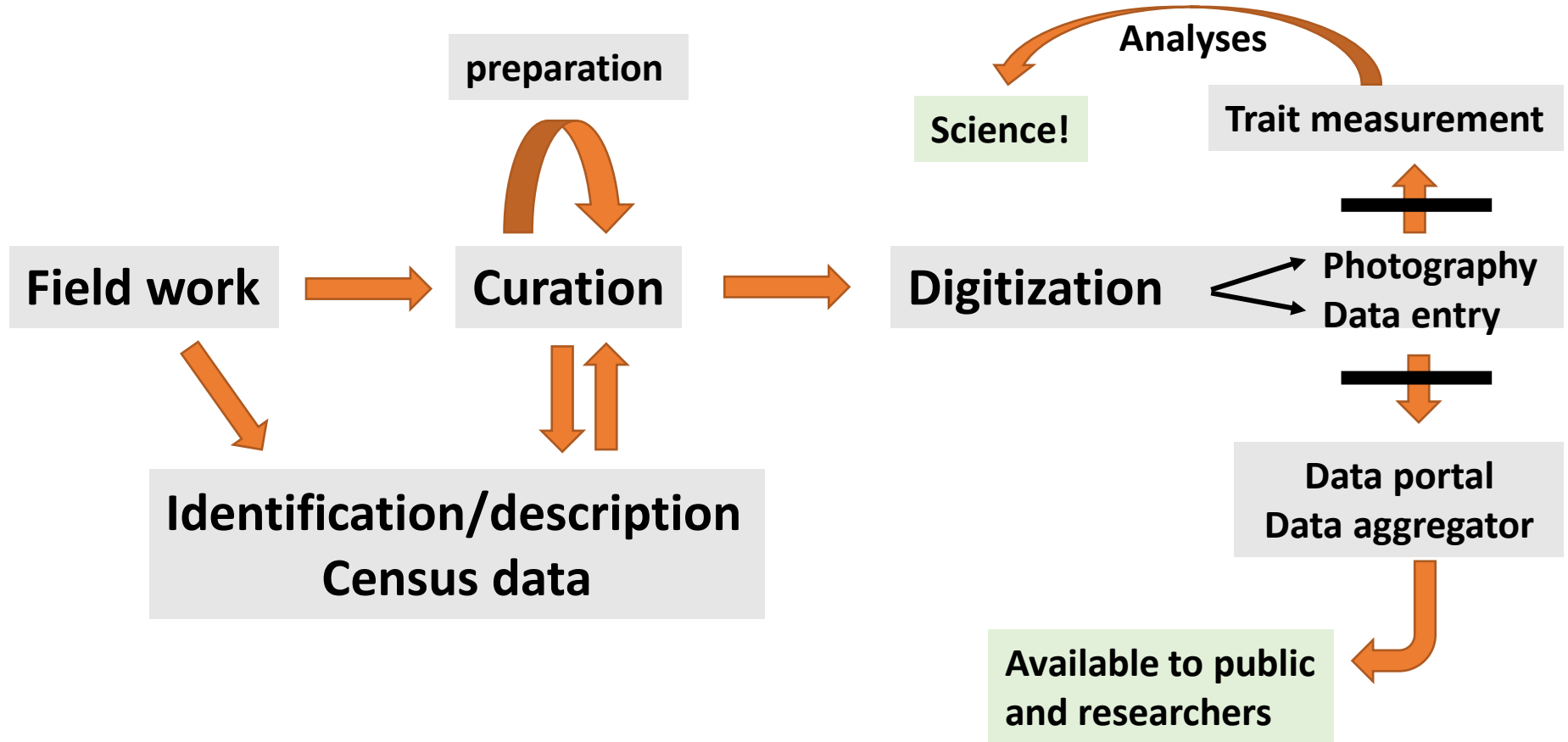
Shifting pinch-points in the workflow

Batch processing



Shifting pinch-points in the workflow

Integrated processing



Project Overview:

Reconstructing functional diversity of a Cretaceous forest

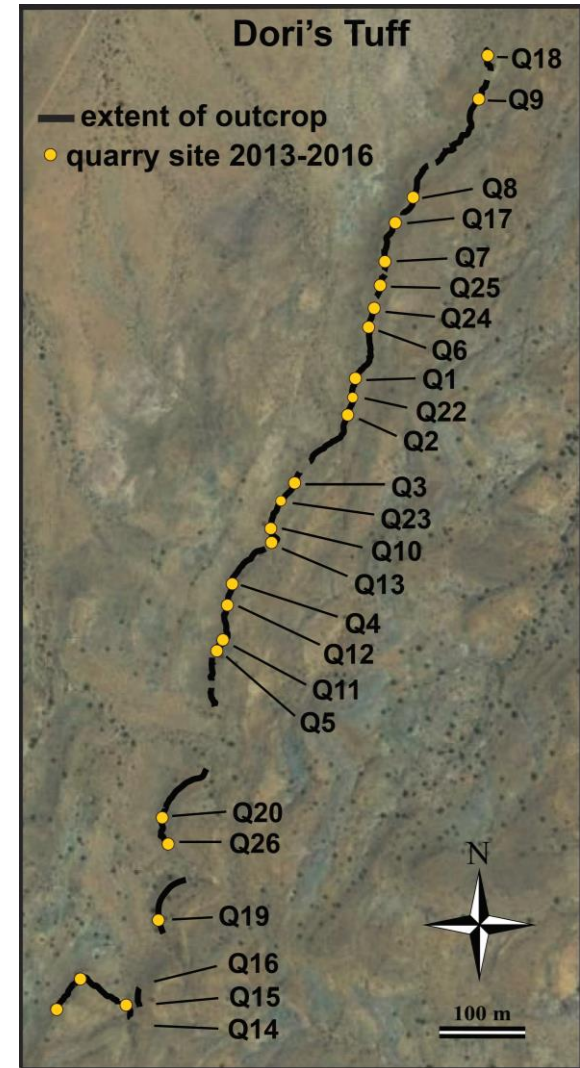
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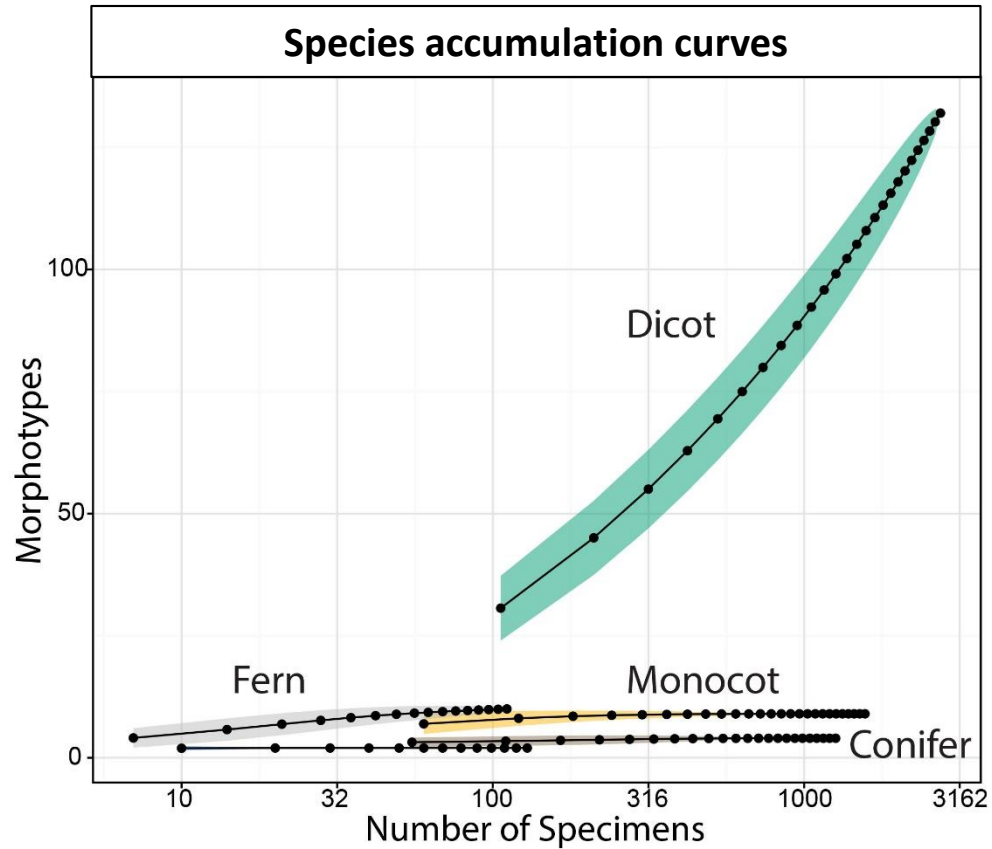
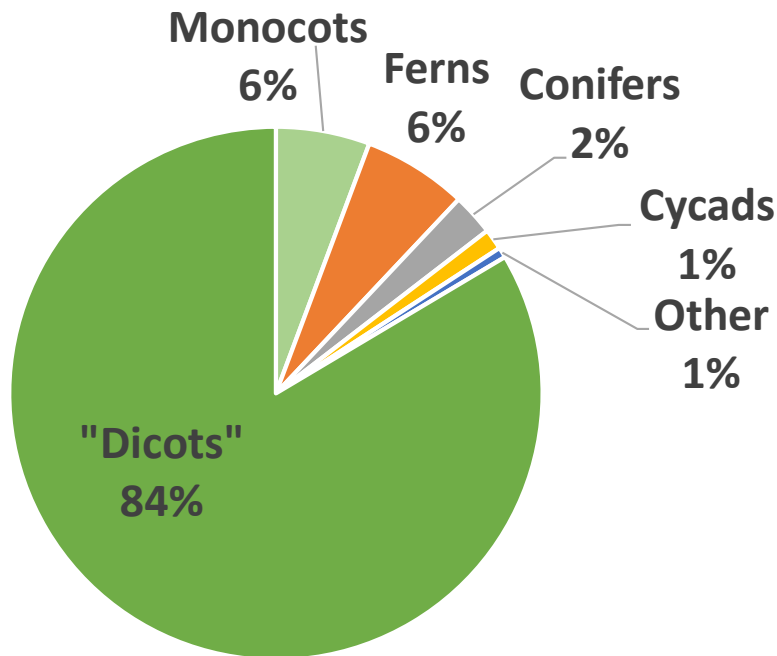
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- *large sample sizes
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Taxonomic diversity

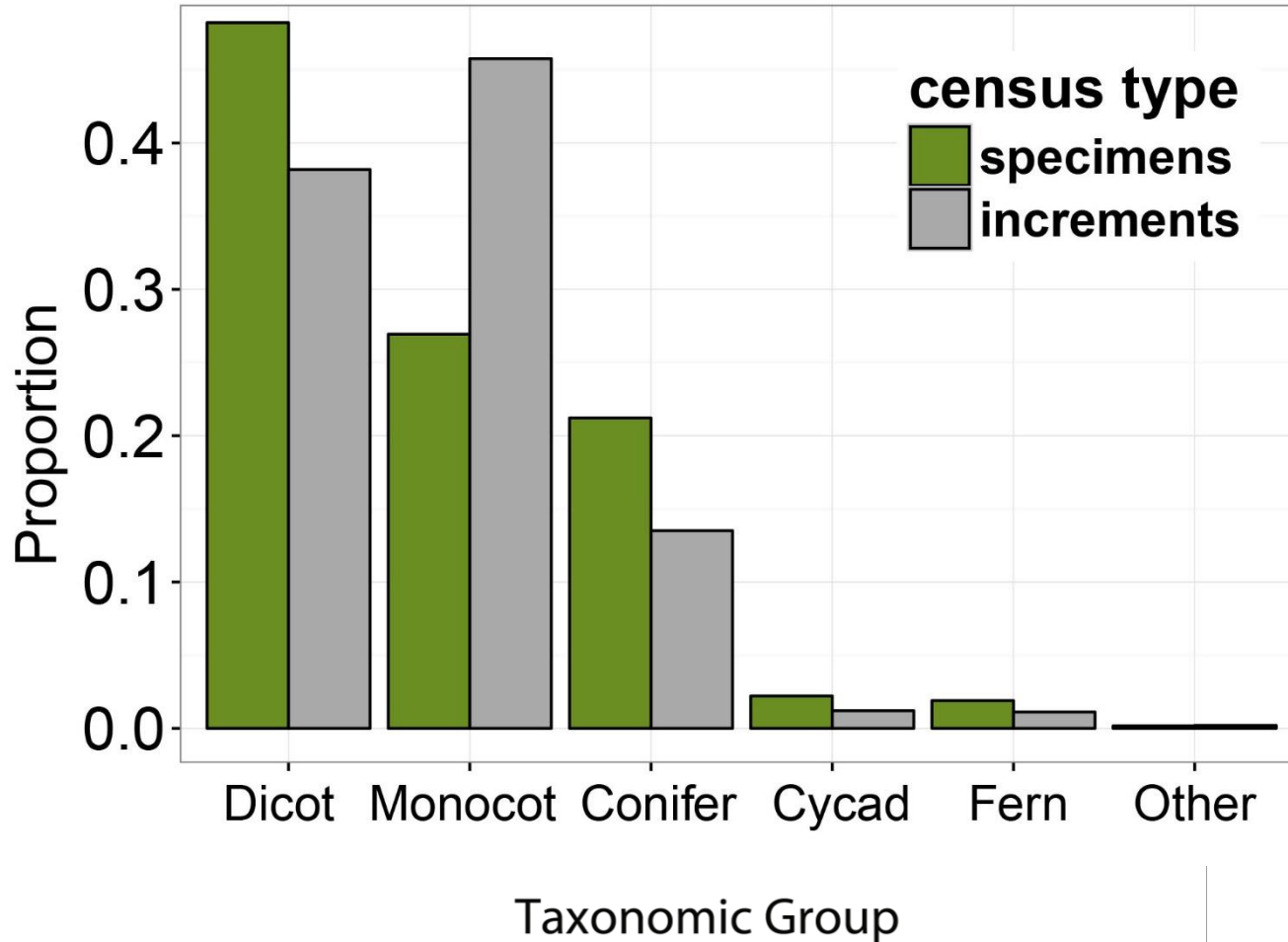
From census:

- **158 leaf morphotypes**
- **Angiosperms: ~89% of diversity (141 morphotypes)**



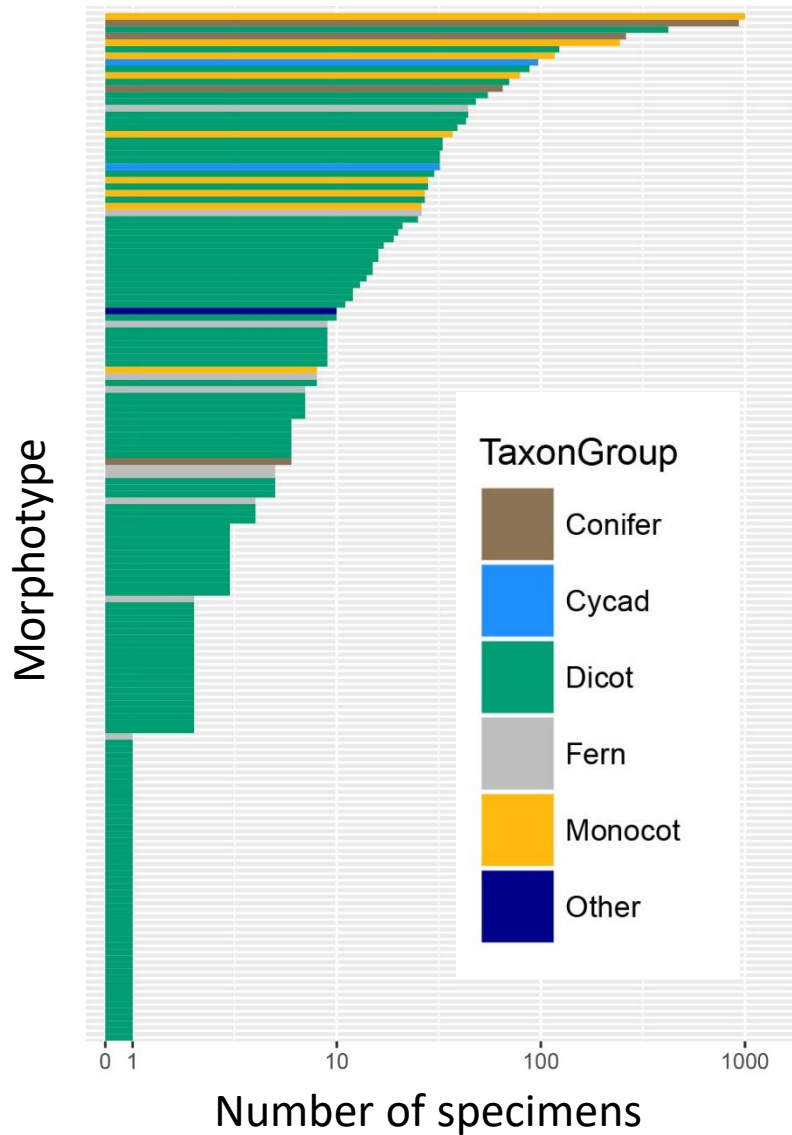
Community composition

Relative abundance and % cover



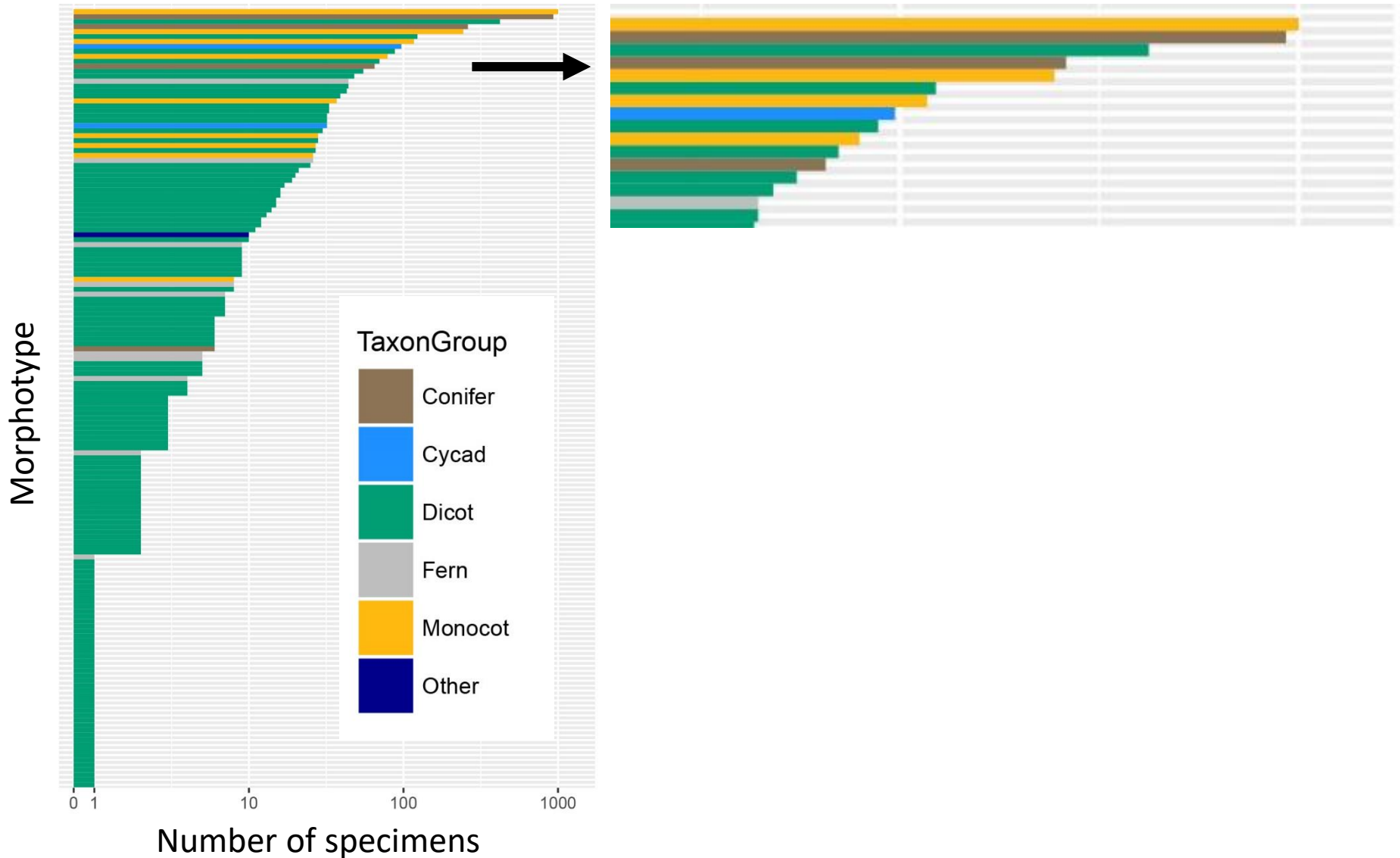
Community composition

Dominance and rank abundance



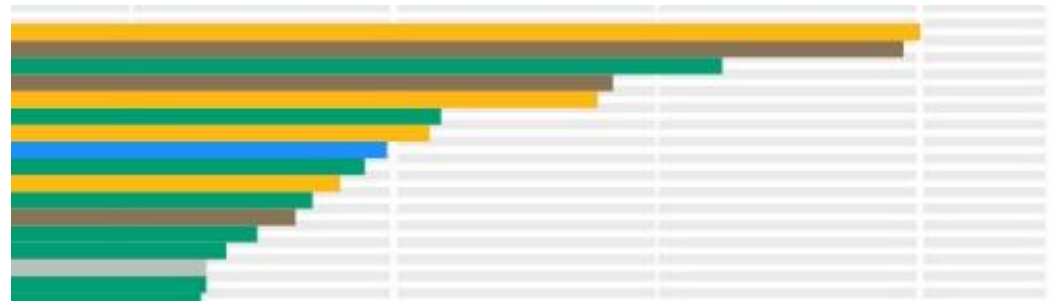
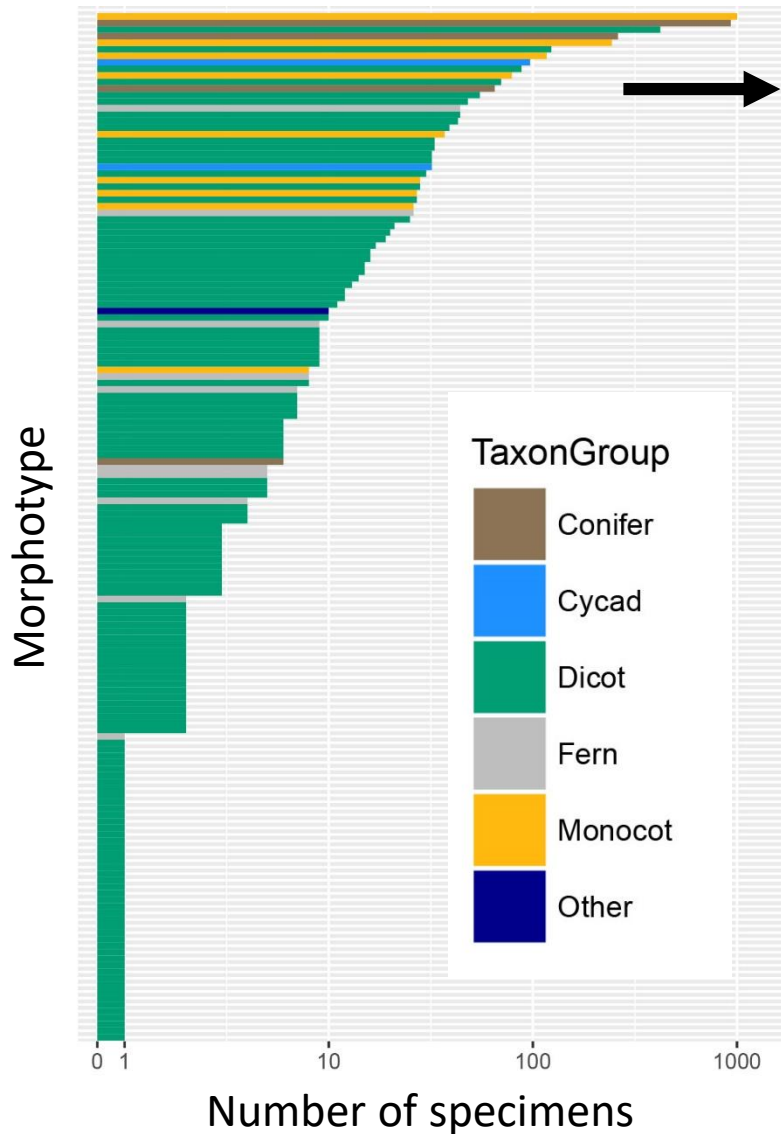
Community composition

Dominance and rank abundance

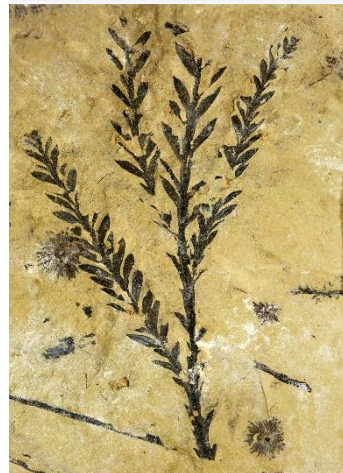


Community composition

Dominance and rank abundance

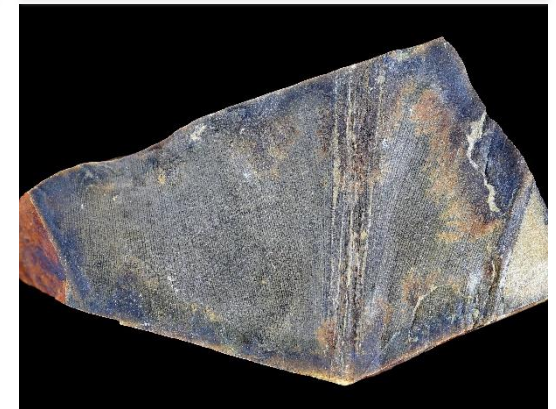


Redwood relative



tree

Zingerberopsis

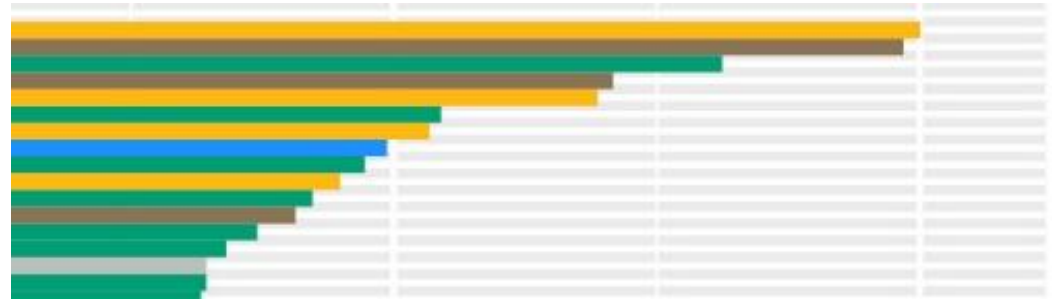


ground cover

Community composition

Dominance and rank abundance

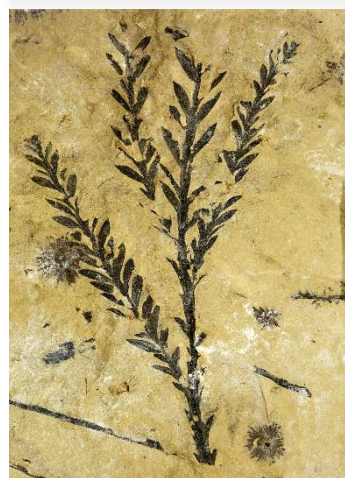
Brachyphyllum sp.



Dryophyllum sp.



Redwood relative



tree

Zingerberopsis

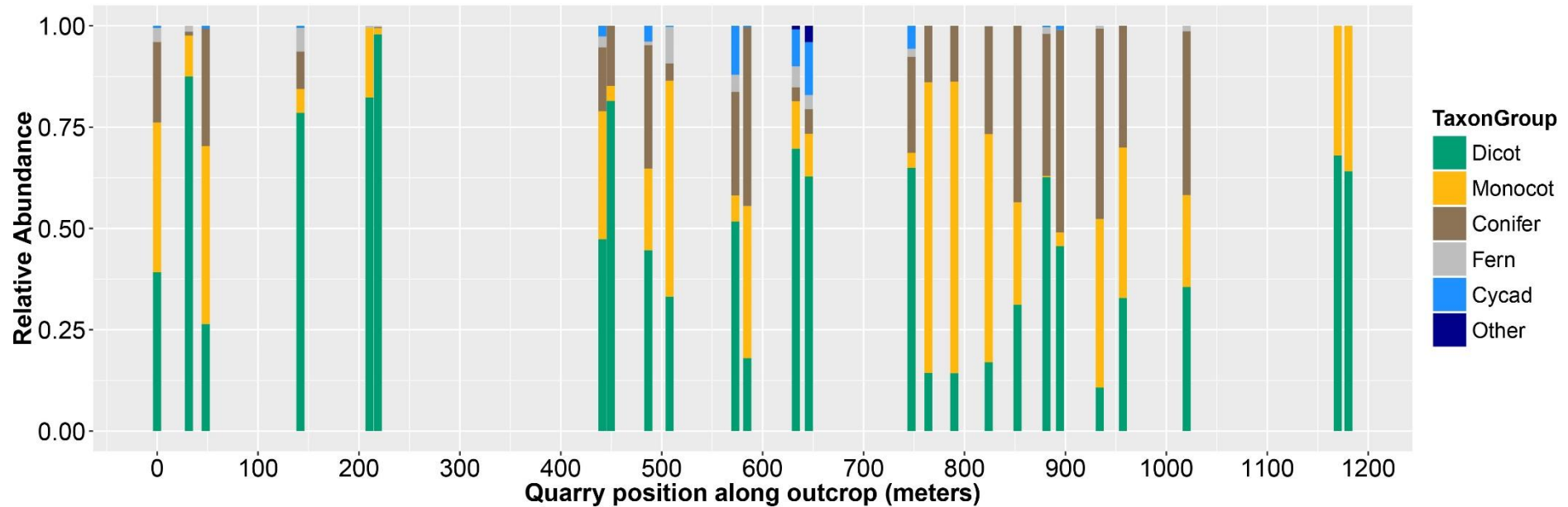


ground cover

Sabalites sp.



Spatial heterogeneity



*Also beta diversity; Sorenson's index by quarry distance

Project Overview:

Reconstructing functional diversity of a Cretaceous forest

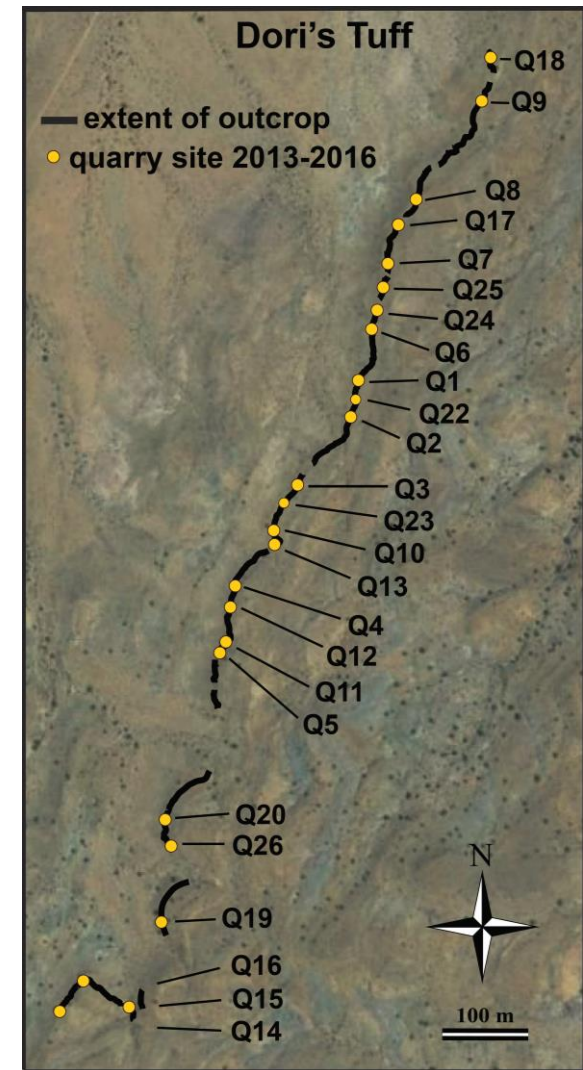
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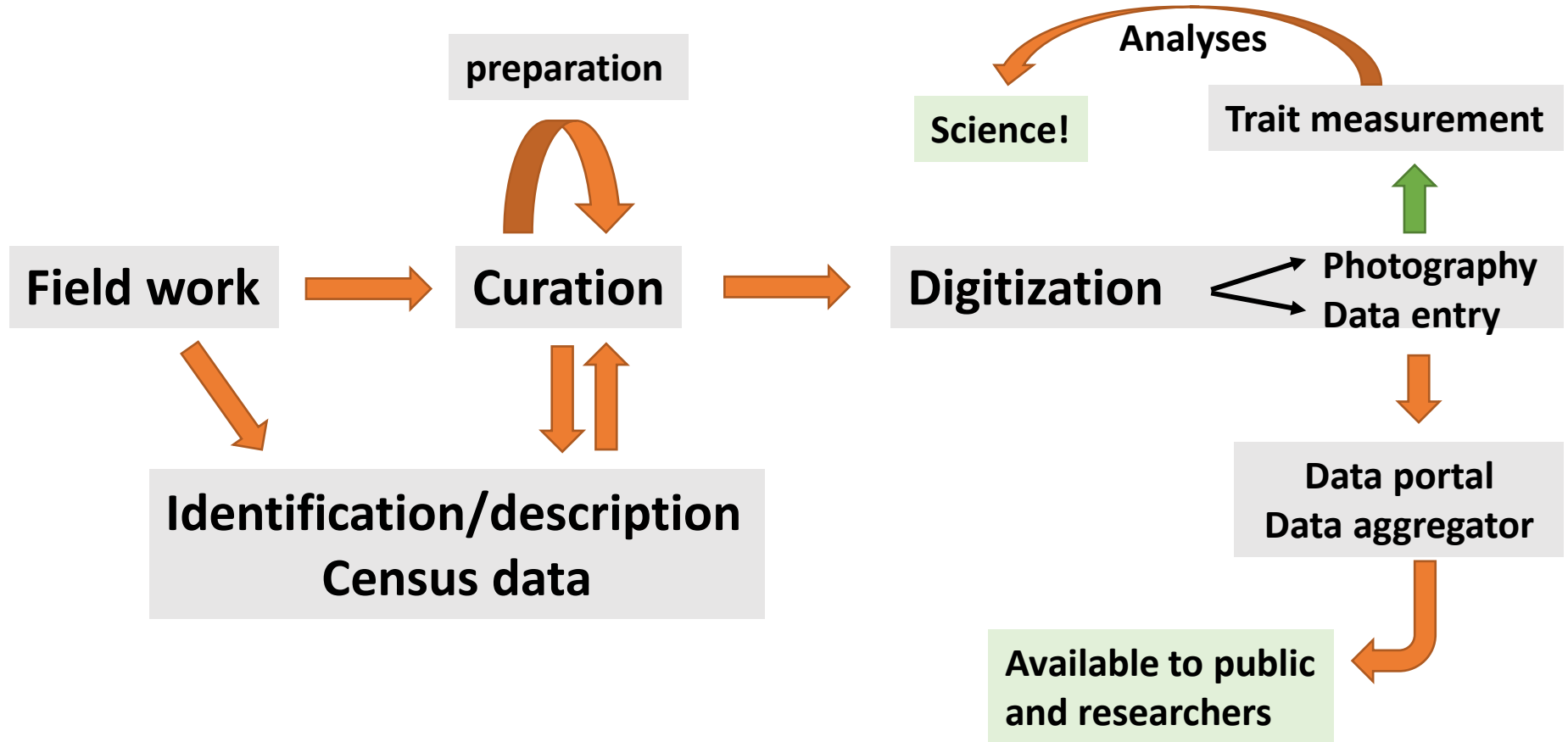
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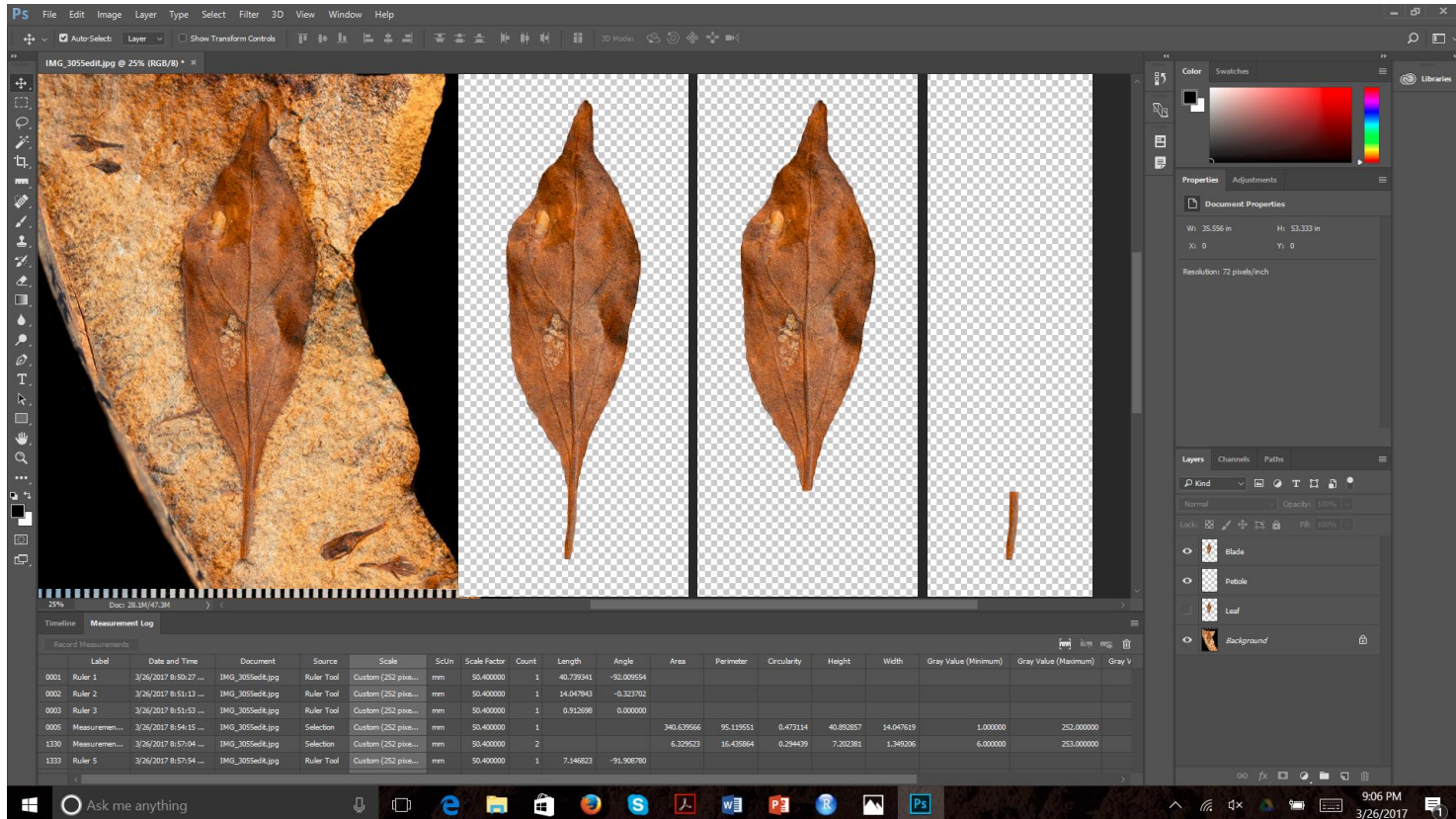


Using the digital data



Digital Trait Measurements

Digitized specimens piped into Adobe Photoshop for image analysis:



The screenshot displays the Adobe Photoshop interface with a digitized leaf specimen. The main canvas shows the leaf in its original context (left), and then isolated on a transparent background (middle and right). A measurement log table is visible at the bottom of the Photoshop window, providing detailed data for various measurements.

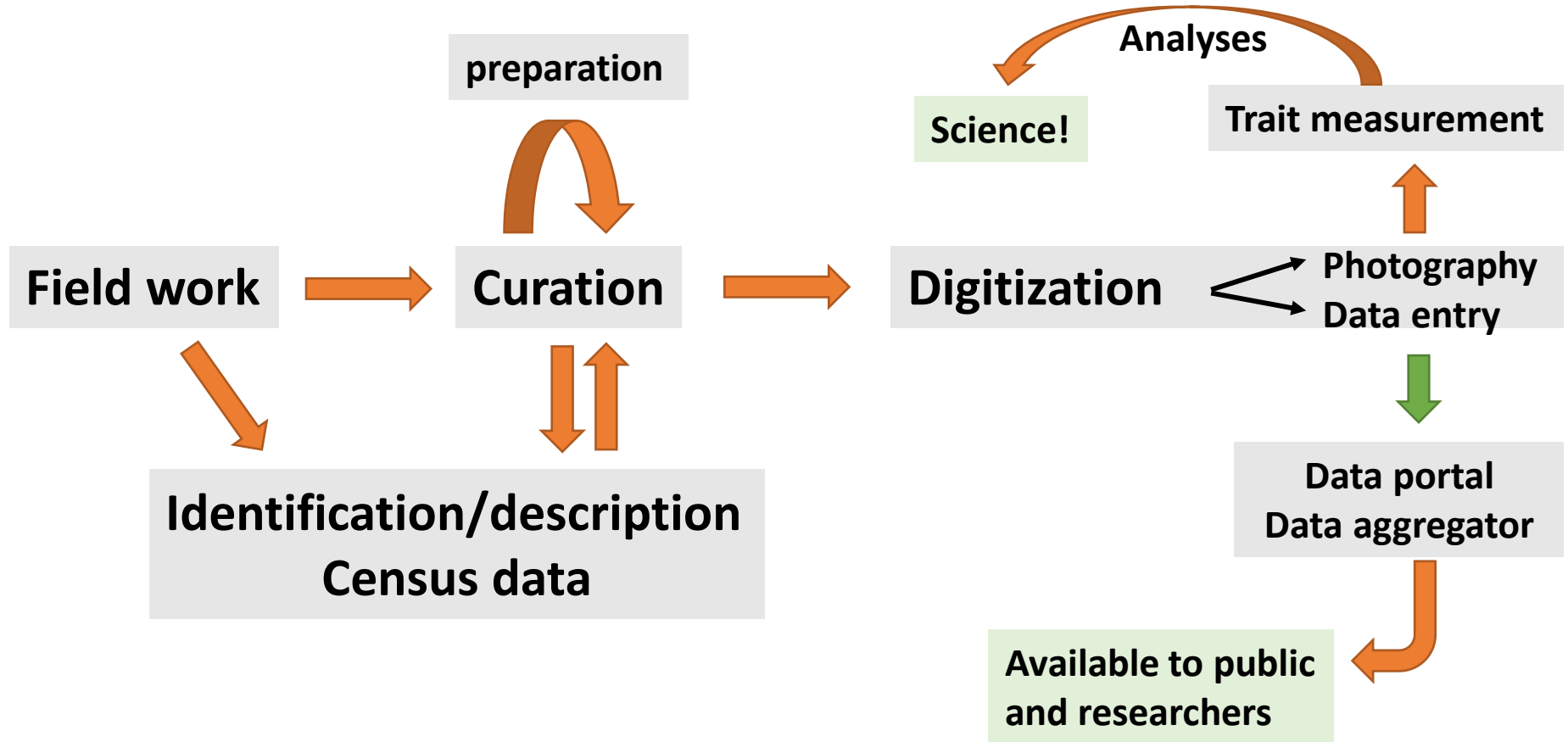
Label	Date and Time	Document	Source	Scale	Scale Unit	Scale Factor	Count	Length	Angle	Area	Perimeter	Circularity	Height	Width	Gray Value (Minimum)	Gray Value (Maximum)	Gray %
0001	3/24/2017 8:50:27 ...	IMG_3055ed4.jpg	Ruler Tool	Custom (252 pixe...	mm	50.400000	1	40.729341	-92.005554								
0002	3/24/2017 8:51:13 ...	IMG_3055ed4.jpg	Ruler Tool	Custom (252 pixe...	mm	50.400000	1	14.047943	-0.323762								
0003	3/26/2017 8:55:53 ...	IMG_3055ed4.jpg	Ruler Tool	Custom (252 pixe...	mm	50.400000	1	0.912698	0.000000								
0005	3/26/2017 8:54:15 ...	IMG_3055ed4.jpg	Selection	Custom (252 pixe...	mm	50.400000	1			340.629566	95.119551	0.473114	40.892857	14.047619	1.000000	252.000000	
1330	3/26/2017 8:51:04 ...	IMG_3055ed4.jpg	Selection	Custom (252 pixe...	mm	50.400000	2			6.329523	16.435864	0.294439	7.202381	1.349206	6.000000	253.000000	
1333	3/26/2017 8:51:54 ...	IMG_3055ed4.jpg	Ruler Tool	Custom (252 pixe...	mm	50.400000	1	7.146823	-91.906780								

Leaf length
Leaf width
Tooth spacing

Leaf area
Leaf perimeter
Specific leaf area

Petiole length
Petiole width
Petiole area

Using the digital data



The data

Specimen data

COLLECTIONS

UCMPC has the largest paleontological collection of any university museum in the world. These well-curated and computerized collections include fossil and modern organisms representing prokaryotes to vertebrates collected from all continents. The Museum serves the University community in various research projects and provides support for instruction at Berkeley and other UC campuses. In addition, the collections are used by paleontologists, biologists and geologists throughout the world.

POLICIES & CONTACTS

UCMPC collections and facilities are available for use by qualified researchers. Follow this link for policies on using the collections, or for contact information.

UCMPC COLLECTIONS

Read more about UCMPC's paleontological collections.

[Microfossils](#)
[Invertebrates](#)
[Vertebrates](#)
[Plants](#)

ON-LINE COLLECTIONS DATABASE

Visitors can search the on-line database for information about specimens housed at UCMPC.
[UCMPC On-line Database](#)

RELATED ITEMS

[Archives/Supplementary Data Collection](#)
Research reports and supplementary data sets.

[UCMPC Archival Collections](#)
Information about library holdings, images, and memorabilia.

[UCMPC Data Model](#)
About modeling data for collections management.

[Pacific Rim Catalog](#)
Database on Pacific Rim biodiversity.

Credits **UCMPC** ©

Images



CalPhotos

Census & Trait data

Site	Collector	Number	Bank	Morphotype	Type	Terminology	No. Specimens
1	UCMPC Area	10 2094	Empty	NA	NA		9
2	UCMPC Area	10 2096	Empty	NA	NA		3
3	UCMPC Area	10 2098	Empty	NA	NA		2
4	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
5	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
6	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
7	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
8	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
9	UCMPC Area	10 2097	Empty	NA	NA		1
10	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
11	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
12	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
13	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
14	UCMPC Area	10 2097	Empty	NA	NA		1
15	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
16	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
17	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
18	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
19	UCMPC Area	10 2097	MSL	Other	Unknown		1
20	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
21	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
22	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
23	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
24	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
25	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
26	UCMPC Area	10 2097	MSL	Leaf	Mesocot		1
27	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
28	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
29	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
30	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
31	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
32	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
33	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
34	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
35	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
36	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
37	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
38	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
39	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
40	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
41	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
42	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
43	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
44	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
45	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
46	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
47	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
48	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
49	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1
50	UCMPC Area	10 2098	MSL	Leaf	Mesocot		1

.CSV

Morphotype descriptions

Name: **D28**
ID: **UCMPC**
Date Collected: **03/20/17**
Date Created: **03/20/17**

Identification: **Undescribed leaf**

Description:
Treated, mostly light leaf with marginal pale veins. Upper part of the leaf has single long narrow lobes. Small leaflets are present (UCMPC). The leaflets are somewhat flattened (UCMPC). The leaflets are somewhat flattened (UCMPC). The leaflets are somewhat flattened (UCMPC). The leaflets are somewhat flattened (UCMPC).

Primary vascular system (phloem/secondary xylem) is visible. Several leaflets are attached to the leaflets at the base of the leaflets.

Secondary vascular system (phloem/secondary xylem) is visible. Several leaflets are attached to the leaflets at the base of the leaflets.

Differential from T13 by retained venation and primary vascular system (phloem/secondary xylem) is visible. Differential from T13 by retained venation and primary vascular system (phloem/secondary xylem) is visible. Differential from T13 by retained venation and primary vascular system (phloem/secondary xylem) is visible. Differential from T13 by retained venation and primary vascular system (phloem/secondary xylem) is visible.

Original T13 State morphotype (Lacina Schwartz)

Differential from T13 by retained venation and primary vascular system (phloem/secondary xylem) is visible. Differential from T13 by retained venation and primary vascular system (phloem/secondary xylem) is visible. Differential from T13 by retained venation and primary vascular system (phloem/secondary xylem) is visible. Differential from T13 by retained venation and primary vascular system (phloem/secondary xylem) is visible.

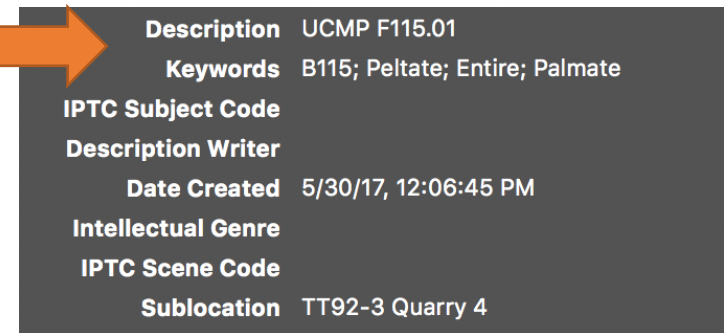
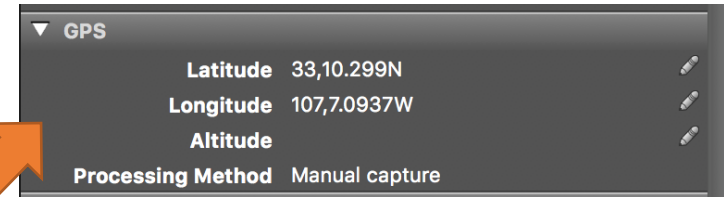
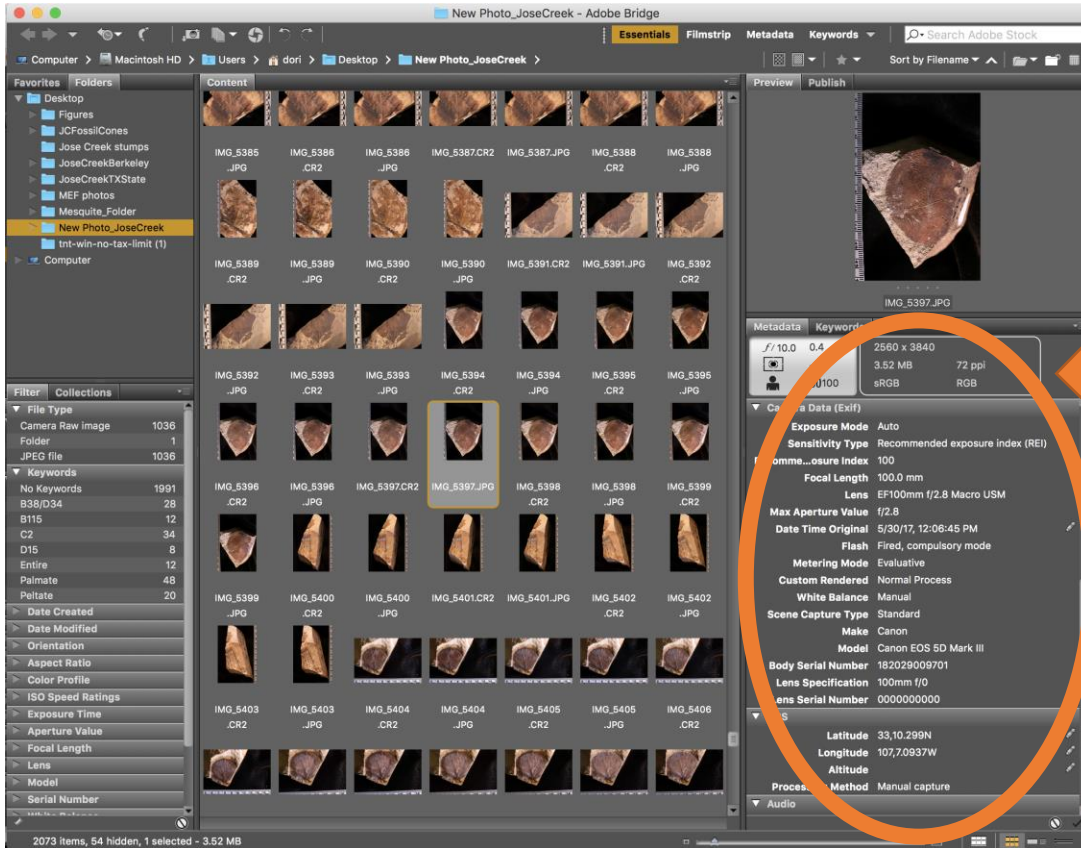
UCMPC ID: **UCMPC**
Name: **UCMPC**
Family: **UCMPC**
Genus: **UCMPC**
Site: **UCMPC**
Image Date: **UCMPC**
Image Count: **UCMPC**
Image Size: **UCMPC**



Image Data: Adobe Bridge

Images saved as Raw and Jpeg

Metadata entered using Adobe Bridge



The data


Specimen data

Images

Census & Trait data

Morphotype descriptions

COLLECTIONS



POLICIES & CONTACTS
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Database on Pacific Rim biodiversity.

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CalPhotos



Date	Collector	Quarry	Bank	Morphotype	Type	Transformation	No. Specimens	No. Measurements
1	UCMP	18-2384	Rock	NA	NA		3	0
2	UCMP	18-2386	Empty	NA	NA		1	0
3	UCMP	18-2388	NA	Leaf	Branch		2	0
4	UCMP	18-2407	Rock	Leaf	Branch		1	0
5	UCMP	18-2407	Rock	NA	NA		1	0
6	UCMP	18-2407	NA	Leaf	Branch		1	0
7	UCMP	18-2407	NA	Leaf	Branch		1	0
8	UCMP	18-2407	NA	Leaf	Branch		1	0
9	UCMP	18-2407	NA	Leaf	Branch		1	0
10	UCMP	18-2407	NA	Leaf	Branch		1	0
11	UCMP	18-2407	NA	Leaf	Branch		1	0
12	UCMP	18-2407	NA	Leaf	Branch		1	0
13	UCMP	18-2407	NA	Leaf	Branch		1	0
14	UCMP	18-2407	NA	Leaf	Branch		1	0
15	UCMP	18-2407	NA	Leaf	Branch		1	0
16	UCMP	18-2407	NA	Leaf	Branch		1	0
17	UCMP	18-2407	NA	Leaf	Branch		1	0
18	UCMP	18-2407	NA	Leaf	Branch		1	0
19	UCMP	18-2407	NA	Leaf	Branch		1	0
20	UCMP	18-2407	NA	Leaf	Branch		1	0
21	UCMP	18-2407	NA	Leaf	Branch		1	0
22	UCMP	18-2407	NA	Leaf	Branch		1	0
23	UCMP	18-2407	NA	Leaf	Branch		1	0
24	UCMP	18-2407	NA	Leaf	Branch		1	0
25	UCMP	18-2407	NA	Leaf	Branch		1	0
26	UCMP	18-2407	NA	Leaf	Branch		1	0
27	UCMP	18-2407	NA	Leaf	Branch		1	0
28	UCMP	18-2407	NA	Leaf	Branch		1	0
29	UCMP	18-2407	NA	Leaf	Branch		1	0
30	UCMP	18-2407	NA	Leaf	Branch		1	0
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49	UCMP	18-2407	NA	Leaf	Branch		1	0
50	UCMP	18-2407	NA	Leaf	Branch		1	0

.CSV



The data

Specimen data

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Images



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Census & Trait data

ID	Collector	Quantity	Bank	Measurement Type	Terminology	No. Observations	
1	KC1516	Area	2.2 2584	Area	NA	3	
2	KC1516	Area	18 4098	Empty	NA	3	
3	KC1516	Area	18 4086	Empty	NA	3	
4	KC1516	Area	18 4085	ML	Miscotax	1	
5	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
6	KC1516	Area	18 4087	Leaf	Shoot	NA	1
7	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
8	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
9	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
10	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
11	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
12	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
13	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
14	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
15	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
16	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
17	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
18	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
19	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
20	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
21	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
22	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
23	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
24	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
25	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
26	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
27	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
28	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
29	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
30	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
31	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
32	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
33	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
34	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
35	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
36	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
37	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
38	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
39	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
40	KC1516	Area	18 4087	S&S	Leaf	Shoot	1
41	KC1516	Area	18 4087	ML	Leaf	Miscotax	1
42	KC1516	Area	18 4087	S&S	Leaf	Shoot	1

.CSV

Morphotype descriptions

Name: **D26** Date Uploaded: 8/25/2017
 Identification: **Undescribed leaf** Date Created: 8/25/2017

Description:
 Truncated, broadly elliptic leaf with marginal pinnule...
 Secondary venation...
 Origin of Taxonomic Authority: Lichen (Schwartz)



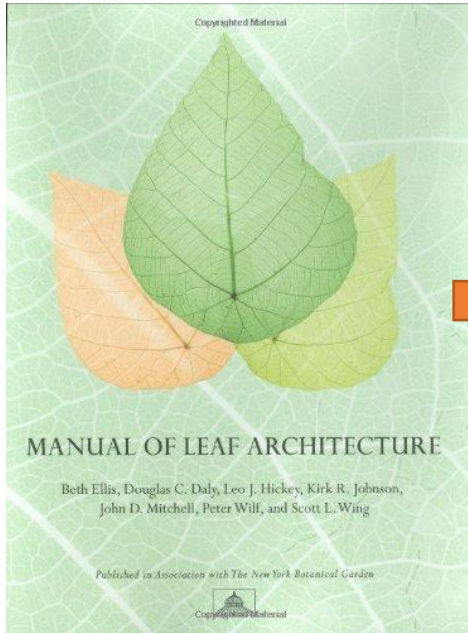
Underscore ID: Agavepinnus Lindley | Magnoliata
 Created: Unknown
 Family: Unknown



A new database?



Morphotype Descriptions: Filemaker Pro



PaleoBot database Dori Revised

Records: 3 Total (Unsorted)

Layout: Architecture View As: [Icons] Preview

Search: Q Search

Buttons: Show All, New Record, Delete Record, Find, Sort, Share

Section I. Leaf Characters

Leaf

- leaf attachment 1: **petiolate 1.1**
- leaf arrangement 2: **not visible 88**
- leaf organization 3: **not visible 88**
- leaflet organization 4: **not visible 88**
- leaflet attachment 5: **not visible 88**
- petiole features 6: **absent 0**

Blade

- lamina attachment 7: **marginal 7.1**
- lamina size 8: **mesophyll 8.5**
- lamina L:W ratio 9:
- lamina shape 10: **ovate 10.3**
- medial symmetry 11: **symmetrical 11.1**
- base symmetry 12: **symmetrical base**
- lobation 13: **unlobed 13.1**
- margin type 14: **crenate 14.2.3**
- margin features 15: **absent 0**
- apex angle 16: **obtuse 16.2**
- apex shape a 17: **rounded 17.2.1**
- apex shape b 17: **straight 17.1**
- base angle 18: **Reflex base 18.3**
- base shape a 19: **straight base**
- base shape b 19:
- term apex features 20: **not visible 88**

Surface

- surface texture 21: **absent 0**
- surficial glands 22: **absent 0**

Section II. Venation

Primary

- primary vein framework 23: **basal**
- naked basal veins 24: **absent 0**
- number of basal veins 25: **9-10**
- agrophic veins 26: **absent 0**

Secondary

- major 2nd vein framework 27: **festooned**
- Interior 2nd 28: **present 28.2**
- minor 2nd course 29: **course simple**
- perimarginal veins 30: **absent 0**
- major 2nd spacing 31:
- variation of 2nd angle 32:
- major 2nd attachment 33: **decurrent 33.1**

Inter-secondary

- proximal course 34.1: **absent 0**
- intersecondary length 34.2:
- distal course 34.3:
- vein frequency 34.4:

Tertiary

- intercostal 3rd vein fabric a 35: **convex opposite**
- intercostal 3rd vein fabric b 35:
- angle of percurrent 3rd 35.1.2:
- vein angle variability 36:
- epimedial tertiaries 37.1:
- proximal course 37.2.1:
- distal course 37.2.2:
- exterior 3rd course 38:

Quaternary

- quaternary vein fabric 39:

Quinternary

- quinternary vein fabric 40: **not visible 88**
- areolation 41:
- FFV branching 42.1:

Section III. Teeth

- tooth spacing 44: **irregular 44.2**
- number of orders of teeth 45: **one 45.1**
- teeth / cm 46:
- sinus shape 47: **rounded 47.2**
- distal tooth shape a 48: **concave 48 CC**
- proximal tooth shape a 48:
- distal tooth shape b 48: **concave 48 CC**
- proximal tooth shape b 48:
- principal vein 49: **vein absent 49.2**
- principal vein termination 50:
- course of accessory vein 51:
- features of the tooth apex 52:

Section I. Leaf Description

Leaf arrangement not visible with petiolate attachment. Leaf petiole features absent. Leaflet arrangement not visible with not visible attachment. Leaf organization not visible. Blade attachment marginal, lamina size mesophyll, lamina L:W ratio, lamina shape ovate, blade medially symmetrical with symmetrical base, blade unlobed, and margin crenate with absent edge features. Apex angle obtuse, apex shape rounded to straight. Reflex base angle with straight base shape to shape. Terminal apex not visible. Surface texture absent and surficial glands absent.

Section II. Venation Description

Primary venation basal actinodromous with 9-10 basal veins and agrophic absent. Secondary veins festooned brochidodromous with interior secondary veins present, minor secondary course simple brochidodromous, and absent perimarginal veins. Major secondary vein spacing with variation of secondary angles and major attachment decurrent. Intersecondary proximal course absent, length, distal course, and frequency. Intercostal tertiary vein fabric convex opposite percurrent to with the angle of percurrent tertiary veins and vein angle variability. Epimedial tertiaries with proximal course and distal course. The exterior tertiary course is. Quaternary vein fabric is. Quinternary vein fabric not visible, and with. Marginal ultimate.

Section III. Teeth Description



Morphotype Descriptions: Filemaker Pro

PaleoBot database Dori Revised

Records 17 Total (Sorted)

Layout: Morphot...n Revised View As: [Icons] Preview

Morphotype **D26**

Plant Group: Dicot Monocot Conifer Cycad Fern Other

Key Leaf Traits

- Entire
- Toothed
- Elliptic
- Obovate
- Oblong
- Lobed
- Orbicular
- High LW
- Moderate LW
- Low LW
- Peltate
- Petiole present
- Pulpinus
- Compound
- Symmetric
- Asymmetric
- L/R sided
- Asym. Insertion

Key Tooth Traits

- Regular 2nd Veins
- Irregular 2nd Veins
- 2nd Strong Curve
- 2nd Strong Straight
- 2nd Branching
- 2nd Decurrent to 1st
- 2nd Excurent to 1st
- Intensecondaries
- Interior 2nd
- 3rd Percurrent
- 3rd Percurrent-opp
- 3rd Percurrent-alt
- 3rd Reticulate
- 3rd Ramify
- 4th Percurrent
- 4th Reticulate
- 4th Ramifying

Organ Type: **Leaf**

Morphotype Status: Active

- Preliminary
- Discuss
- Strong
- Final
- Described
- Comparison
- Inactive

Exemplar Specimen No.

TXSTATE 920304-7 (0043), TXSTATE 920304-30 (0055,0059), TXSTATE 920304-613 (0049,0053)

Image Credits: D_Conteras

Description

Toothed, broadly elliptic leaf with marginal petiole attachment, obtuse apex and reflex base angle. Teeth serrate, with tooth shape varying from base to apex of leaf. Basal teeth sharply pointed (CC/CV), transitioning to compound rounded teeth (CV/CV). Teeth glandular, chloranthoid, with principle vein supplying terminal gland and two lateral accessory veins that follow the course of the margin and terminate in the gland.

Primary venation palmate, palinaclindromous, with three primary veins originating in petiole, lateral two are naked basal veins and branch base of leaf blade.

Secondary venation festooned semiraspedodromous, with decurrent departure from primary veins. Prominent epimedial teritaries, opposite percurrent and convex. Primary through tertiary veins prominent and recessed. Quaternary venation poorly preserved, appearing reticulate.

Unranked A ID: *Angiospermae* Lindley / Magnoliidae Family ID: Unknown

Unranked B ID: Unknown Order ID: Unknown Genus ID: Unknown

Botanical Identification

Unknown

Botanical ID: _____

Holomorphotype: TXSTATE 920304-7

Paramorphotypes: TXSTATE 920304-30, 920304-613; UCMP

Name **D26** Identification Unranked taxon

Date Updated: 9/31/2017 Date Created: 5/25/2017

Description

Toothed, broadly elliptic leaf with marginal petiole attachment, obtuse apex and reflex base angle. Teeth serrate, with tooth shape varying from base to apex of leaf. Basal teeth sharply pointed (CC/CV), transitioning to compound rounded teeth (CV/CV). Teeth glandular, chloranthoid, with principle vein supplying terminal gland and two lateral accessory veins that follow the course of the margin and terminate in the gland.

Primary venation palmate, palinaclindromous, with three primary veins originating in petiole, lateral two are naked basal veins and branch base of leaf blade.

Secondary venation festooned semiraspedodromous, with decurrent departure from primary veins. Prominent epimedial teritaries, opposite percurrent and convex. Primary through tertiary veins prominent and recessed. Quaternary venation poorly preserved, appearing reticulate.

Description Notes

Original TX State morphotype (Jackie Schreiner)

Differentiated from T13 by its serrated sharply pointed teeth in lower half of leaf and compound rounded teeth in apical portion.

Unranked A ID: *Angiospermae* Lindley / Magnoliidae

Unranked B ID: Unknown

Order ID: Unknown

Family ID: Unknown

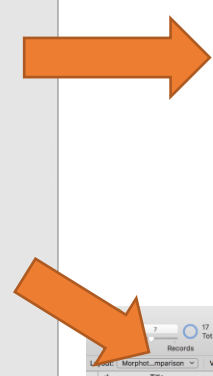
Genus ID: Unknown

Sites: JCM locality 92-3-4; T192-3

Images: TXSTATE 920304-7 (0043), TXSTATE 920304-30 (0055,0059), TXSTATE 920304-613 (0049,0053)

Image Credit: D_Conteras

Investigator: D_Conteras



PaleoBot database Dori Revised

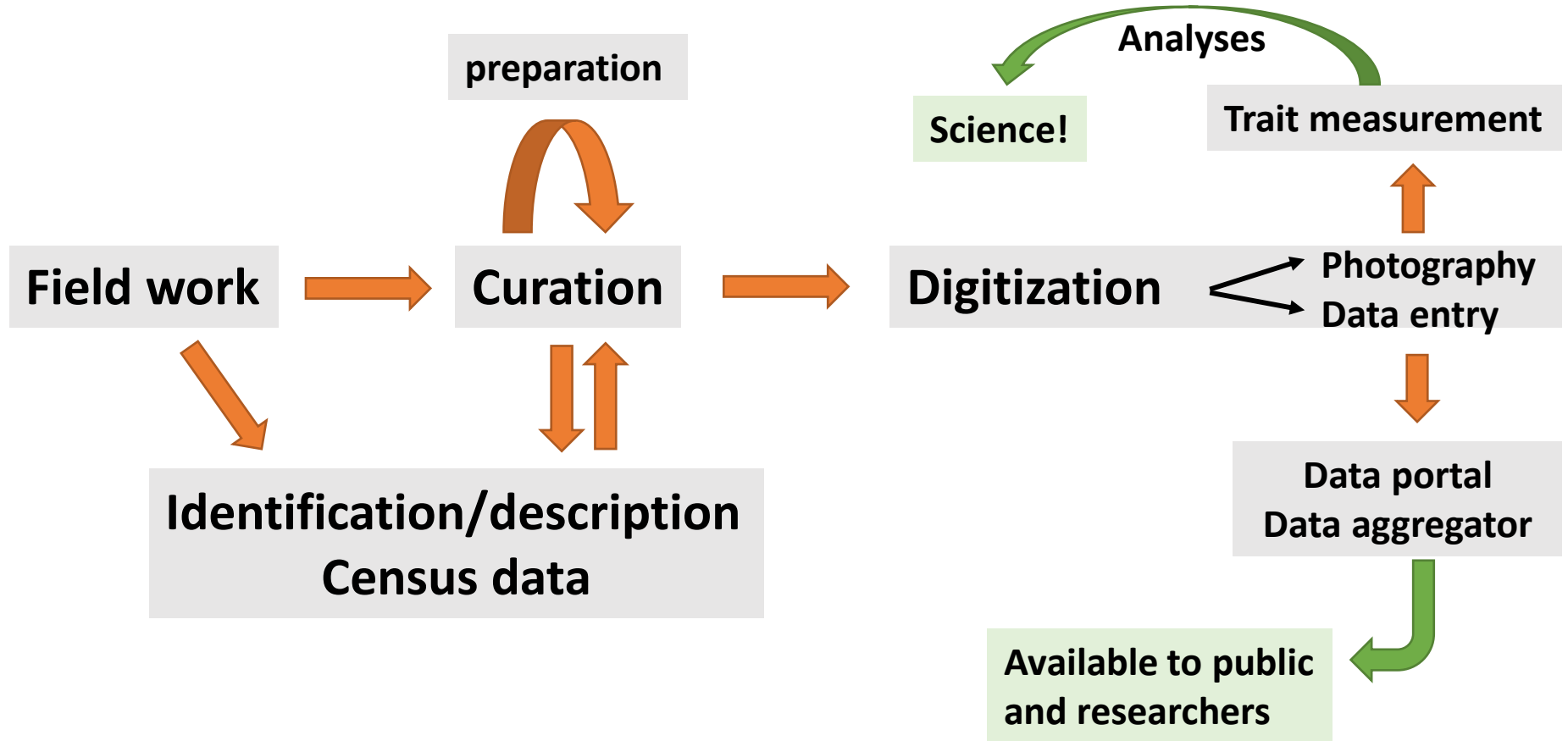
Records 17 Total (Sorted)

Layout: Morphot...n Revised View As: [Icons] Preview

ID	Title	Plant Group	Organ Type	RLT Margin	RLT Shape	RLT LW	RLT Petiole	RLT Blade Features	RLT Base	RLT Apex	RLT
B115		Dicot	Leaf	Entire	Elliptic	Moderate LW	Peltate	Symmetric			Palmate Pinnate
BXX		Dicot	Leaf	Entire	Elliptic	High LW	Petiole present		Decurrent leaf base	Accuminate apex	Pinnate
D15		Dicot	Leaf	Toothed	Orbicular	Moderate LW	Peltate	Symmetric			Palmate Pinnate
D15b		Dicot	Leaf	Toothed	Orbicular	Moderate LW	Peltate	Symmetric			Palmate Pinnate
D18		Dicot	Leaf	Toothed	Elliptic	Moderate LW		Symmetric		Obtuse apex	Pinnate
D21		Dicot	Leaf	Entire	Ovate	Low LW		Symmetric	Cordate leaf base	Acute apex	Palmate Pinnate
D26		Dicot	Leaf	Toothed	Elliptic	Moderate LW	Petiole present	Symmetric		Obtuse apex	Palmate Pinnate
D34		Dicot	Leaf	Toothed	Ovate	Low LW		Symmetric		Obtuse apex	Palmate Pinnate
D39		Dicot	Leaf	Entire	Ovate	Low LW		Symmetric		Obtuse apex	Palmate Pinnate
D4		Dicot	Leaf	Entire	Elliptic	Moderate LW		Symmetric			Pinnate
PaleoBot Demo											
			Leaf								
			Leaf								
			Leaf								
			Leaf								
			Leaf								
			Leaf								



Going public!



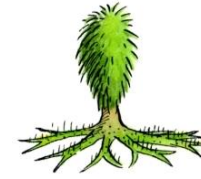
Take-home points

- Workflows should integrate project-based data collection with curation and digitization
- Use of effective links (field-assigned Rock IDs) to bridge field data with museum specimens
- Reorganize/customize workspace for integration of tasks to increase efficiency
- Person-power! Importance of involving students and volunteers in research





Acknowledgements



LOOY LAB

Paleobotany, Palynology & Paleoecology
at University of California, Berkeley



IDigBio and NSF

Amazing students and volunteers!

Looy Lab
UC Museum of Paleontology
Armendaris Ranch, Tom Waddell, Ted Turner

Diane Erwin, Cindy Looy, Pat Holroyd, Gary
Upchurch, Greg Mack

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