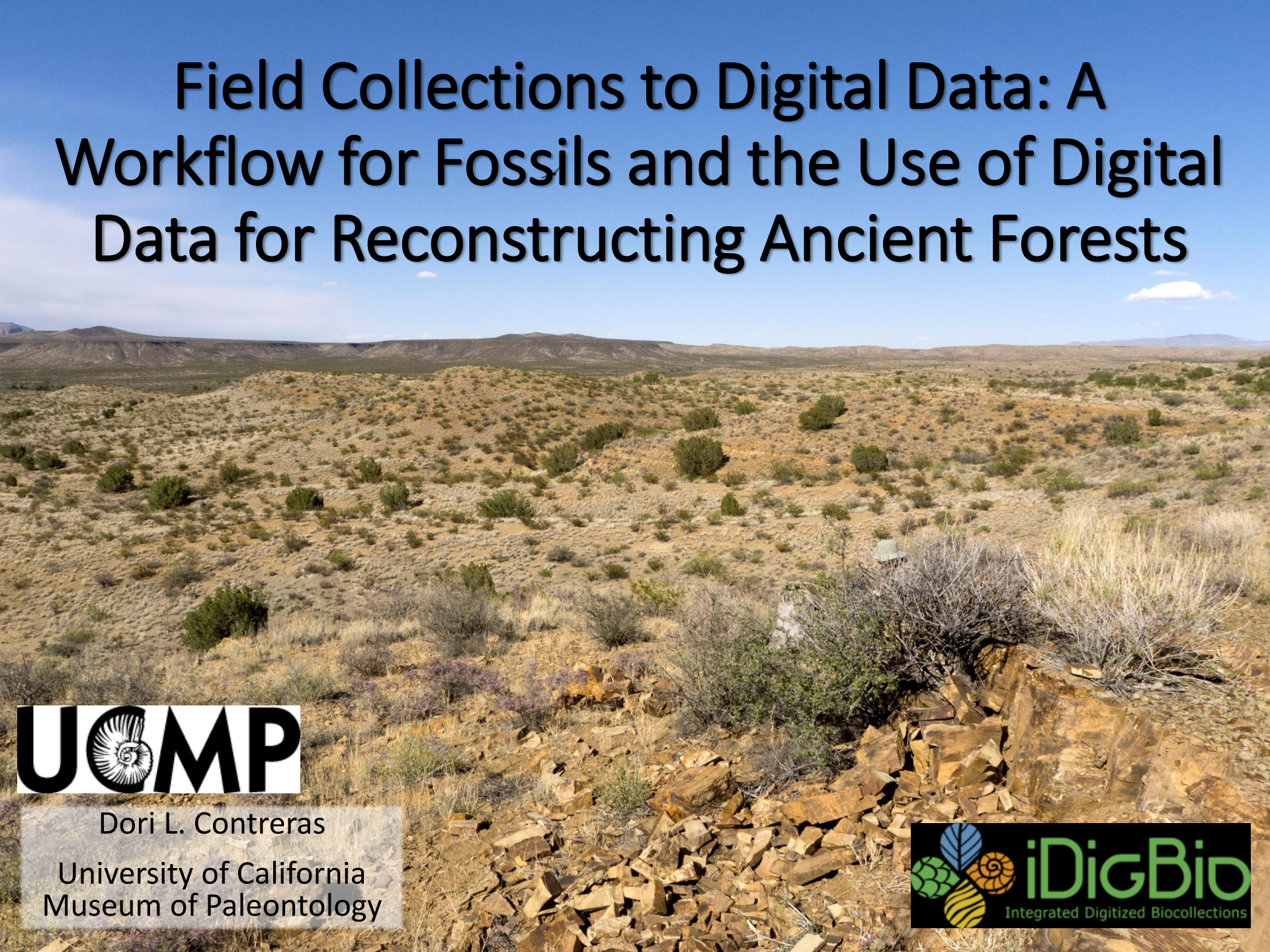
Field Collections to Digital Data: A Workflow for Fossils and the Use of Digital Data for Reconstructing Ancient Forests



Dori L. Contreras

University of California
Museum of Paleontology

iDigBio
Integrated Digitized Biocollections

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)

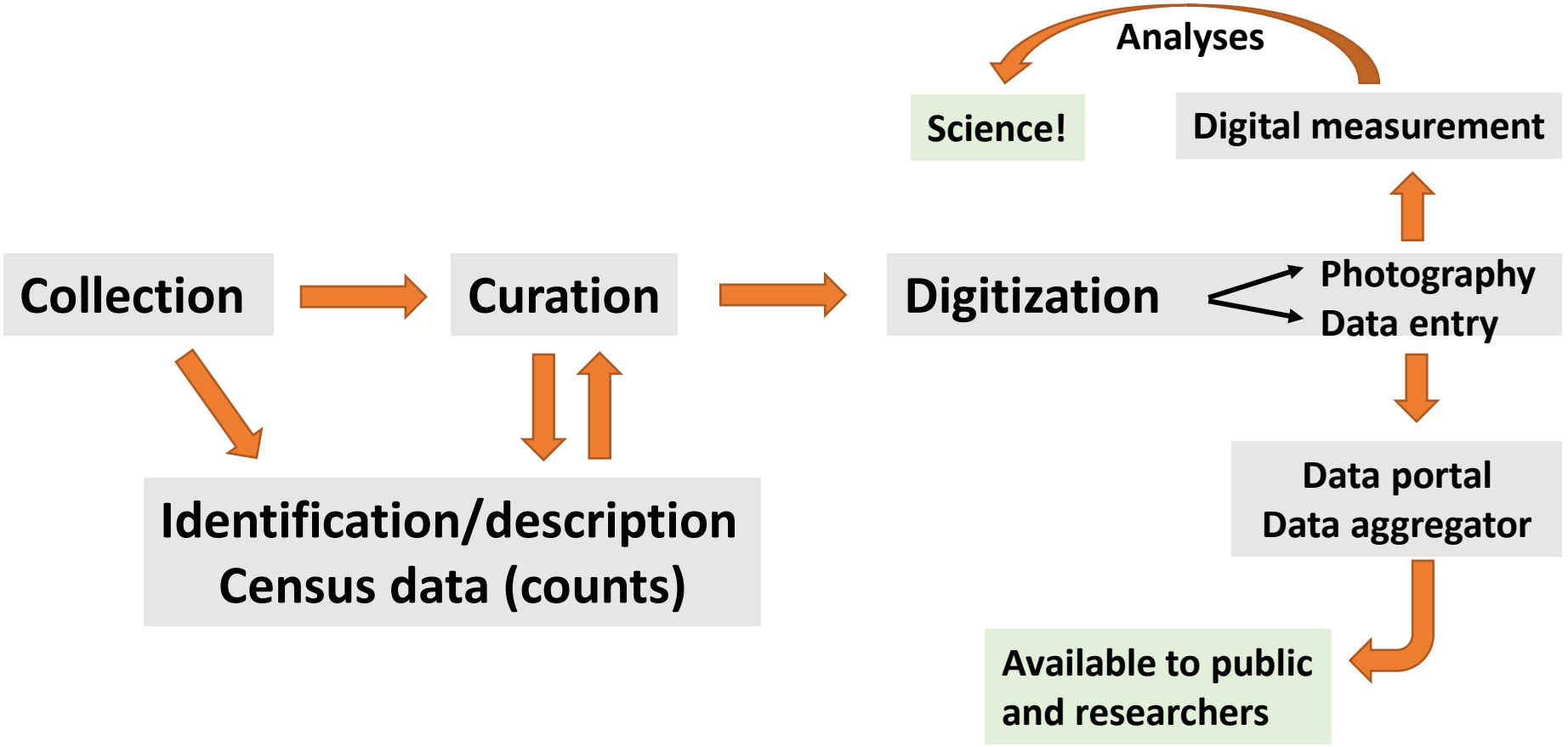
2) Identification/description, etc.

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

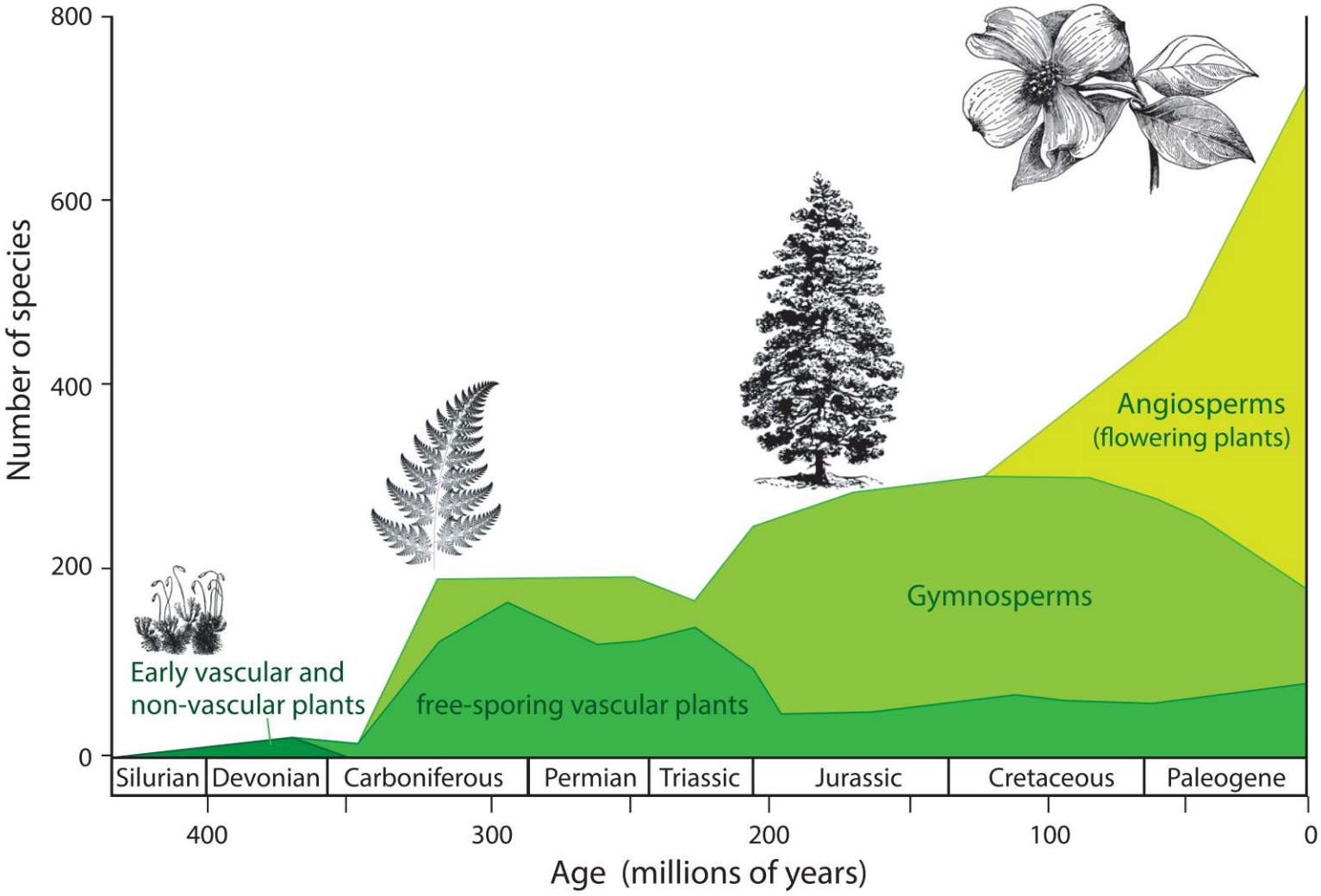
Reconstructing a Cretaceous forest

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



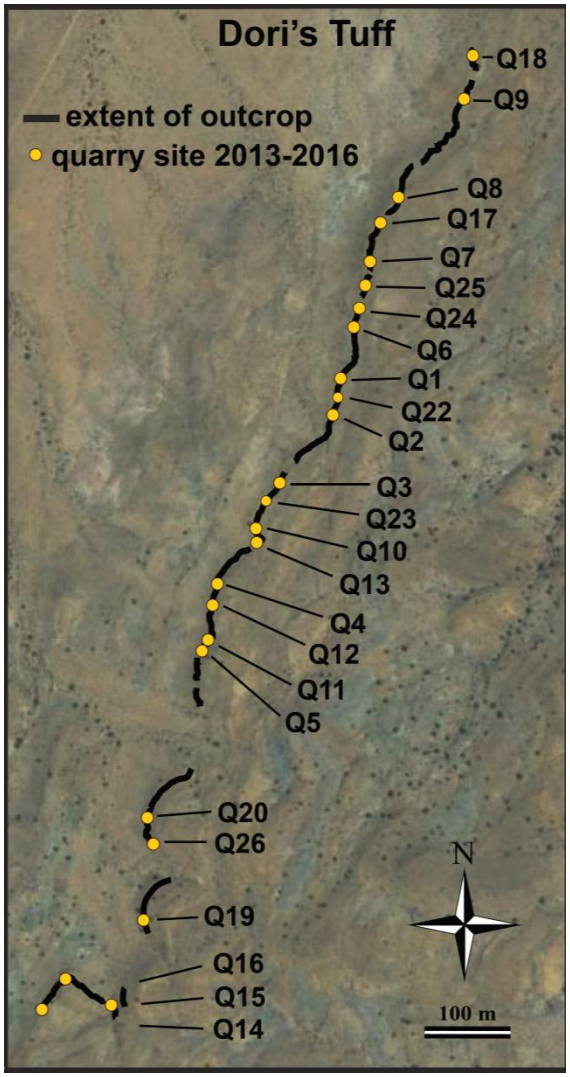
Redrawn from Niklas 1986

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

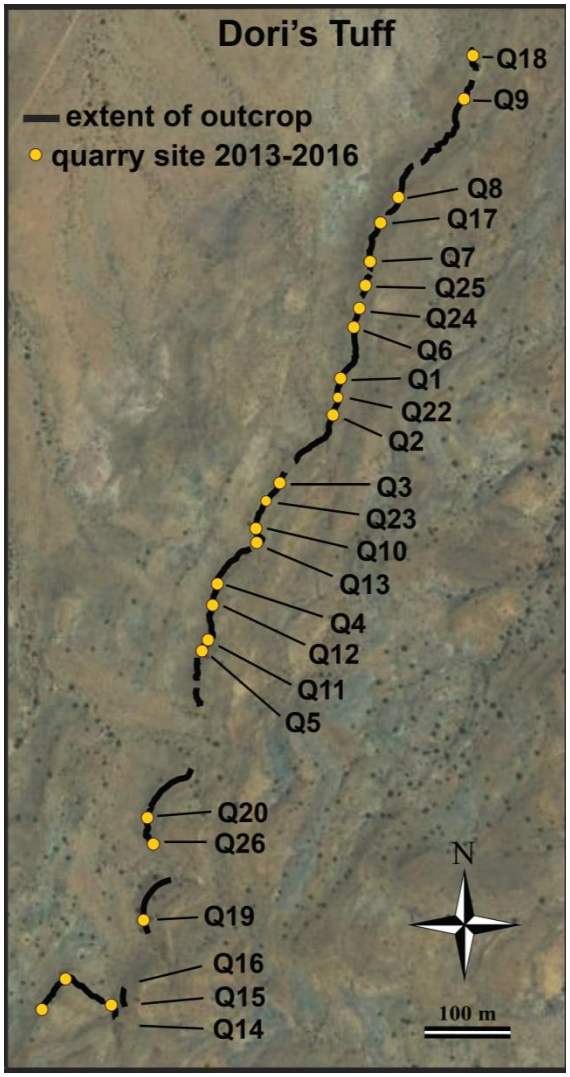
Phase 1. "Build" a forest

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

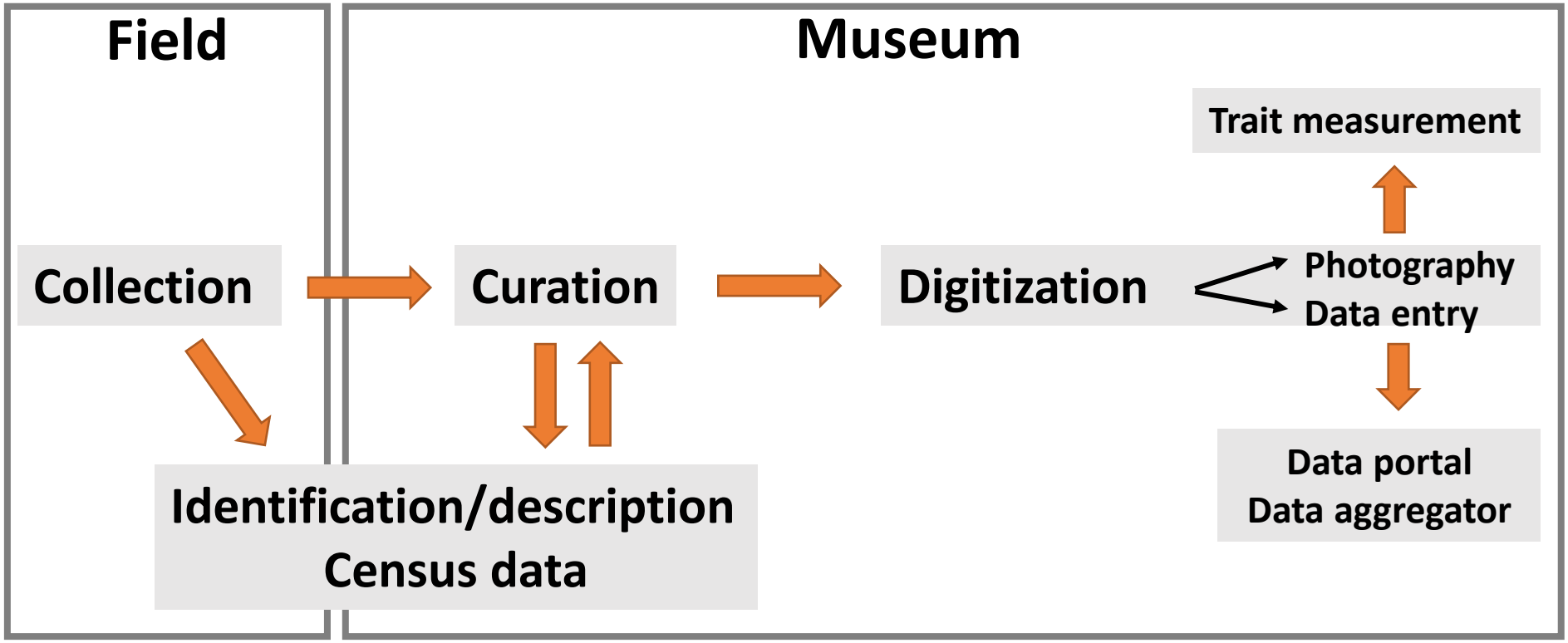
Phase 2. Measure the forest: quantify functional diversity

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

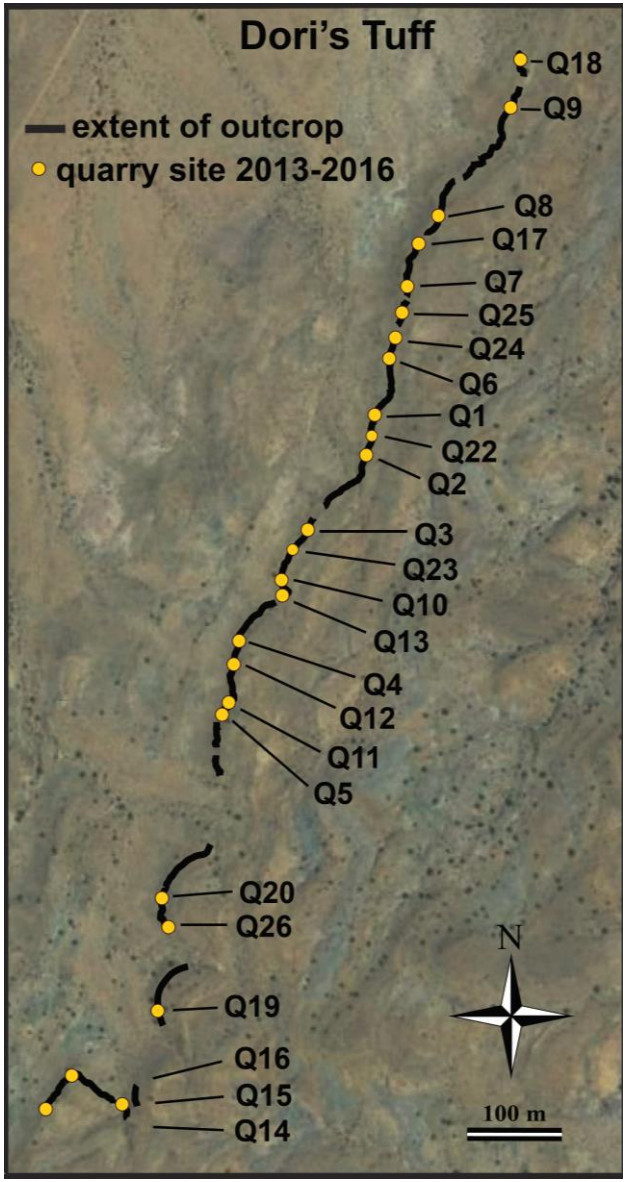
*quantitative and spatial explicit sampling scheme
*large sample sizes
*digital measurements of georeferenced specimens



A workflow from field to digital



Field Work – localities



<u>Established 26 quarry sites spanning deposit:</u>

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

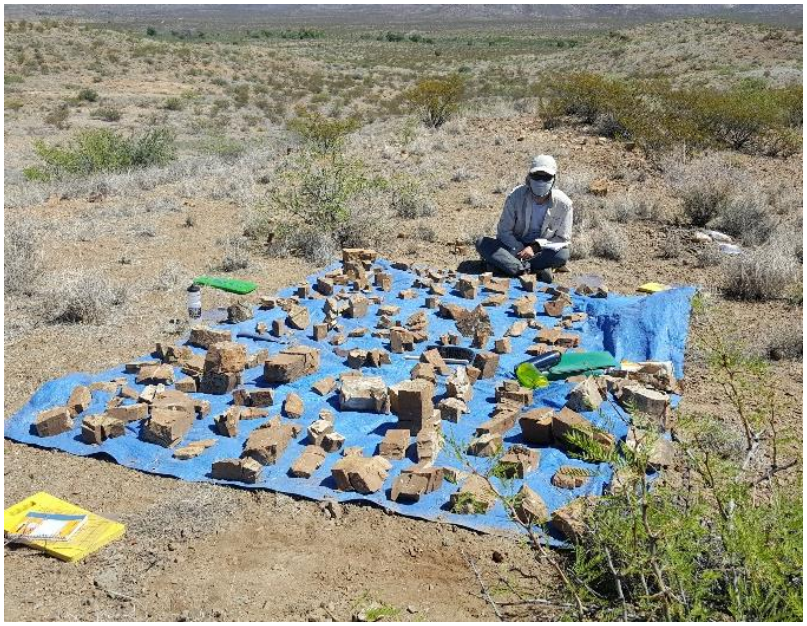
Quarry site:

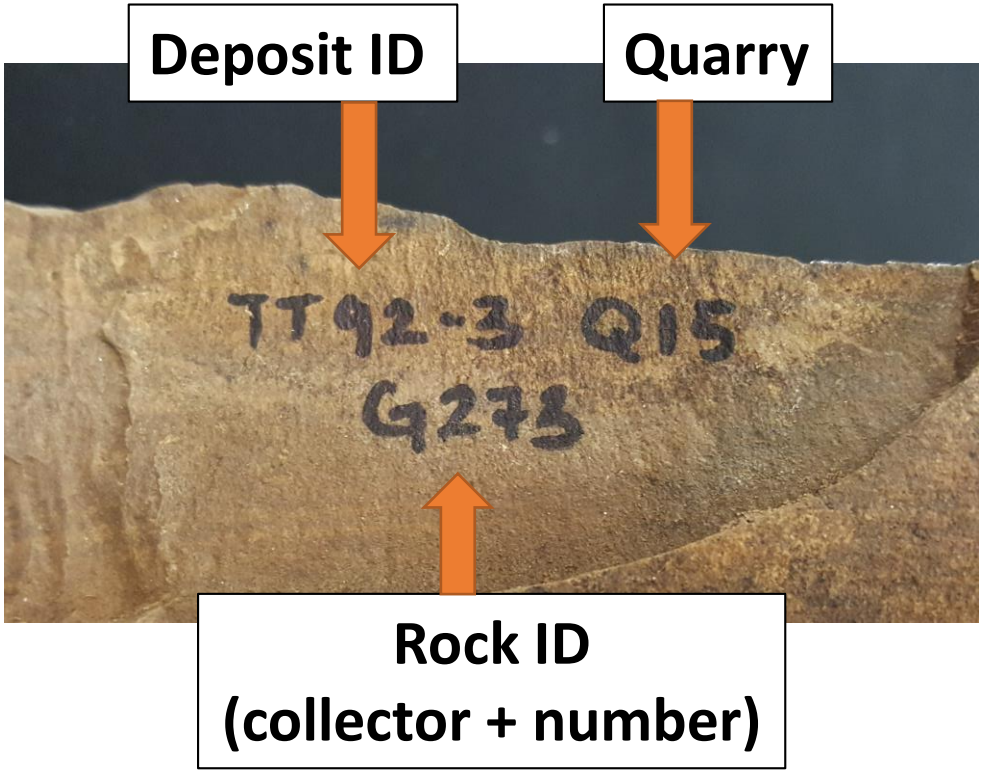
Field Work – collections and census

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

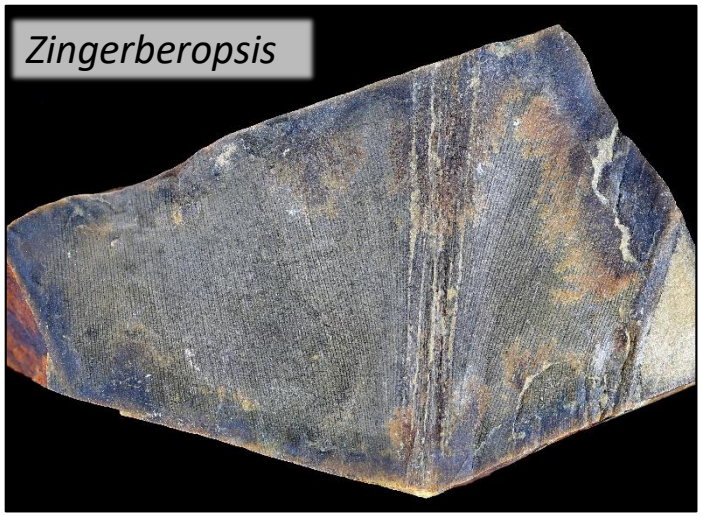
> 6,350 specimens
> 61,718 cm² of rock surface

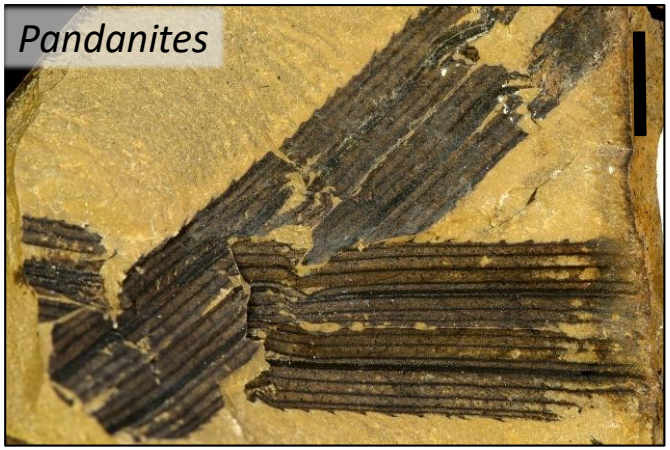
"Keepers" are wrapped and labeled

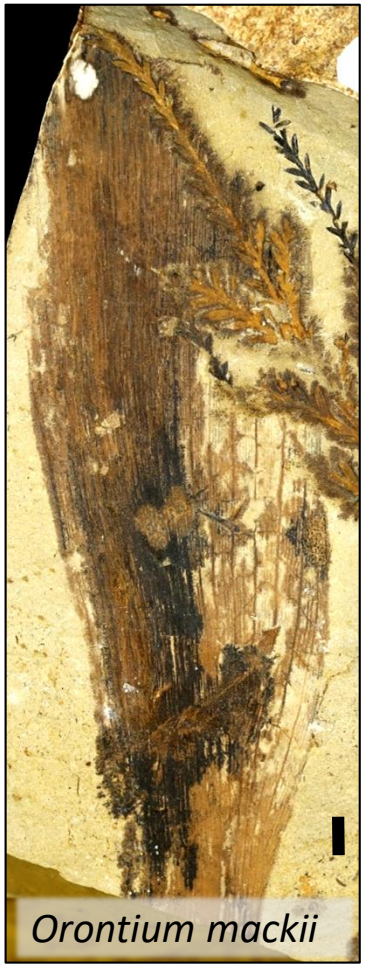
> 1,945 rocks brought to UCMP

Conifers & Cycads

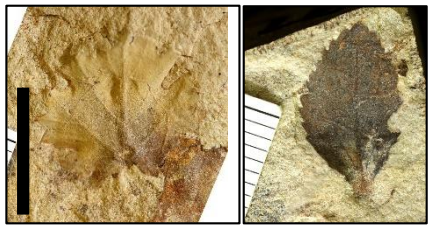
Angiosperms - monocots

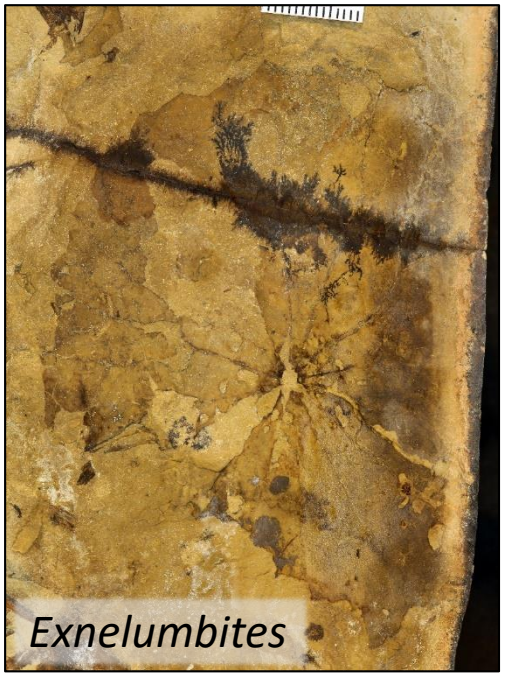


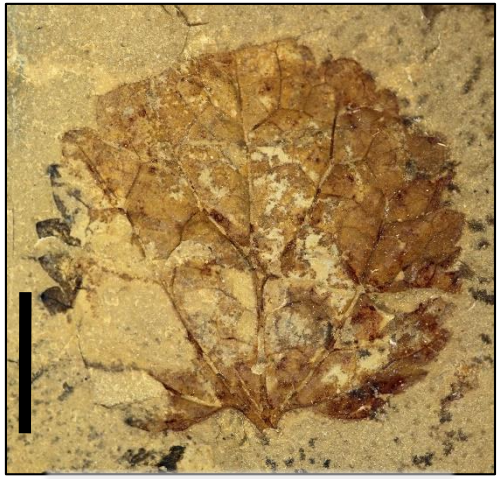




Angiosperms – toothed “dicots”







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** → **Photography** / **Data entry**

Trait measurement

Data portal
Data aggregator

Identification/description
Census data

The transition

Spoils:
Locality info
Census databooks
Boxes of fossils

Museum

Collection

Curation

Digitization

Trait measurement

Photography
Data entry

Data portal
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Identification/description
Census data

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

Museum

The un-censused
-specimens that could not be identified in field
-new morphotypes

Collection → **Curation** → **Digitization** → **Photography** / **Data entry**

Digitization → **Trait measurement**

Collection ↘ **Identification/description**
Curation ↕ **Identification/description**
Identification/description = **Census data**

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

What needs to be done?

1) **Identify and census the difficult specimens**

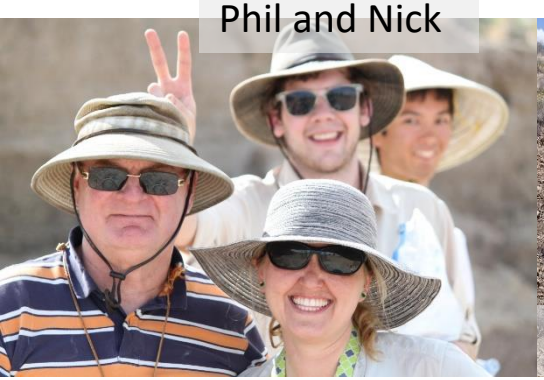
2) **Prep specimens if necessary**

3) **Complete descriptions of taxa**

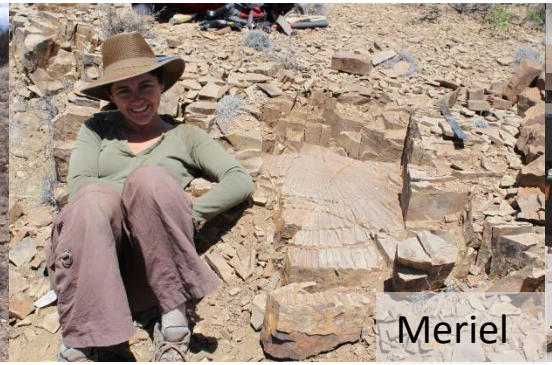
4) **Curation: assign # to each specimen on each rock and label; fill out identification cards; enter data**

5) **Photograph specimens**

People Power


Phil and Nick

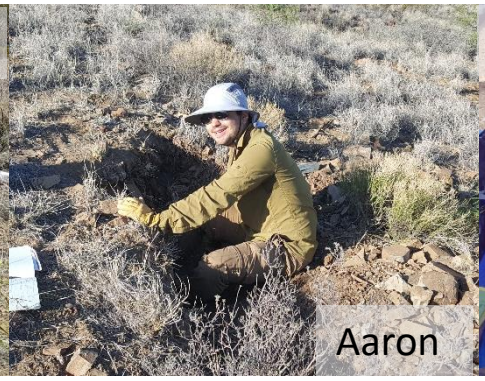

James B.


Meriel

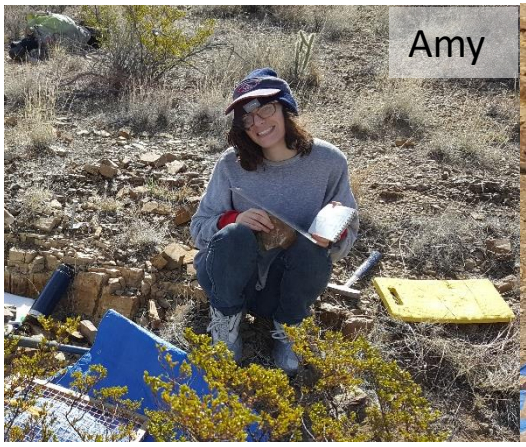

Jae Min


James S.


Yoon

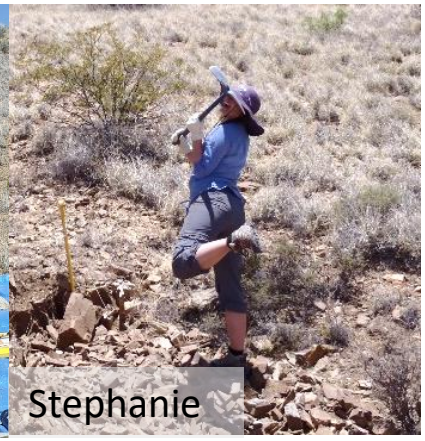

Aaron


Negin


Amy


Mom


Emma


Stephanie

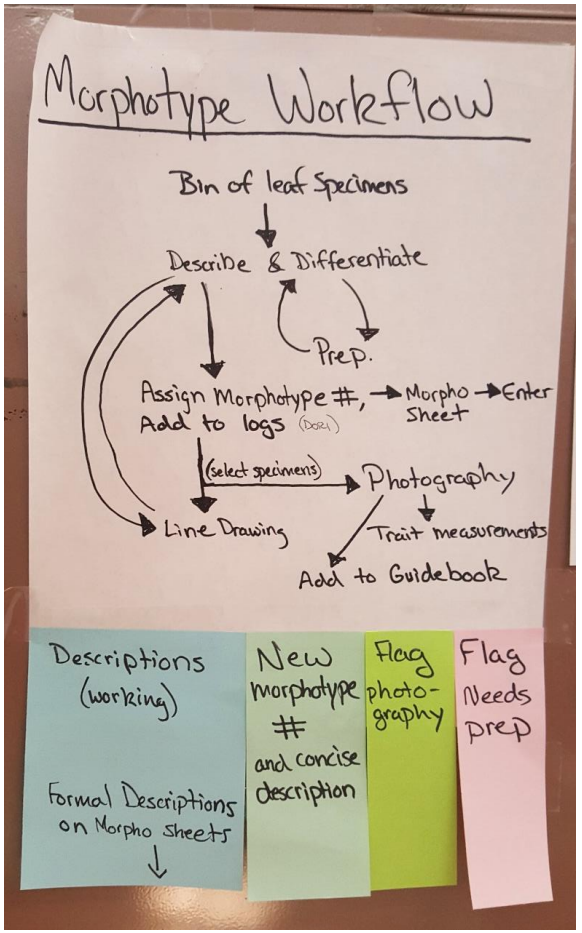
Processing: Two Methods

Batch processing

-one type of task at a time

-flag specimens for different processes

-let specimens build up until have a "batch" to process

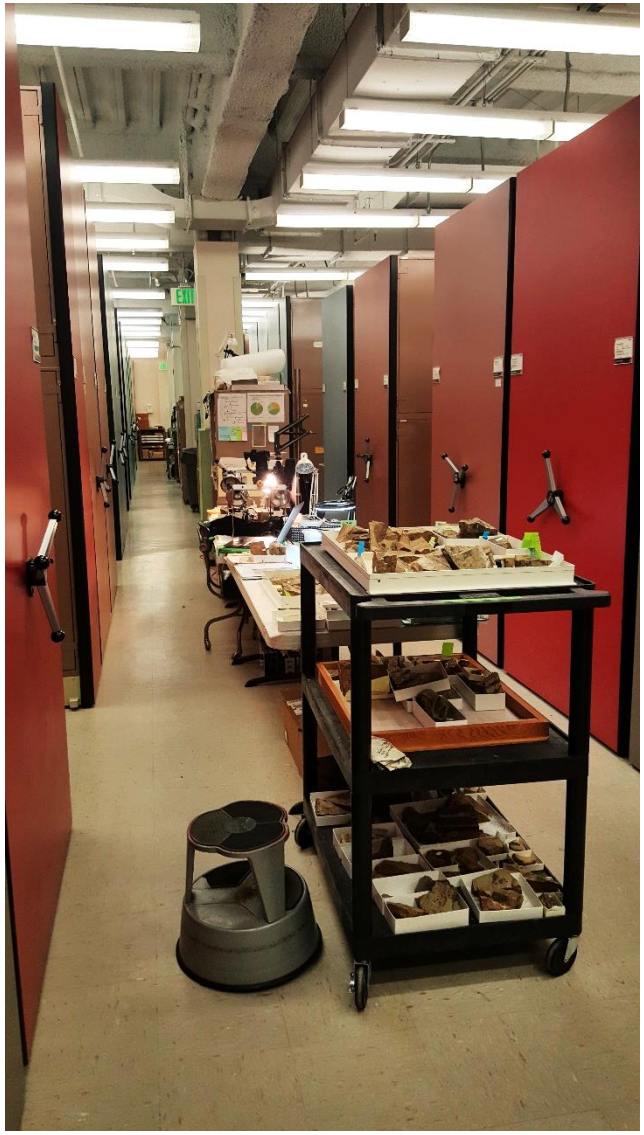


Integration of tasks

-do everything at once!

-drawer by drawer, processing each specimen completely

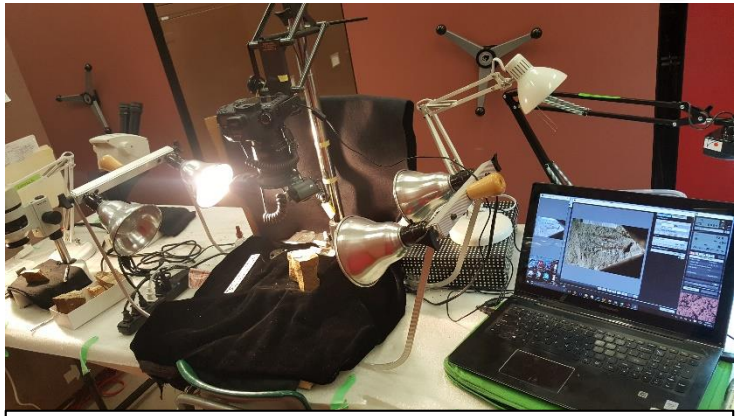
Re-organization and customization of workspace



Re-organization and customization of workspace

Prep station
Descriptions

White-stripe and census station
Data entry, labels



Photography station

Re-organization and customization of workspace

Prep station
Descriptions

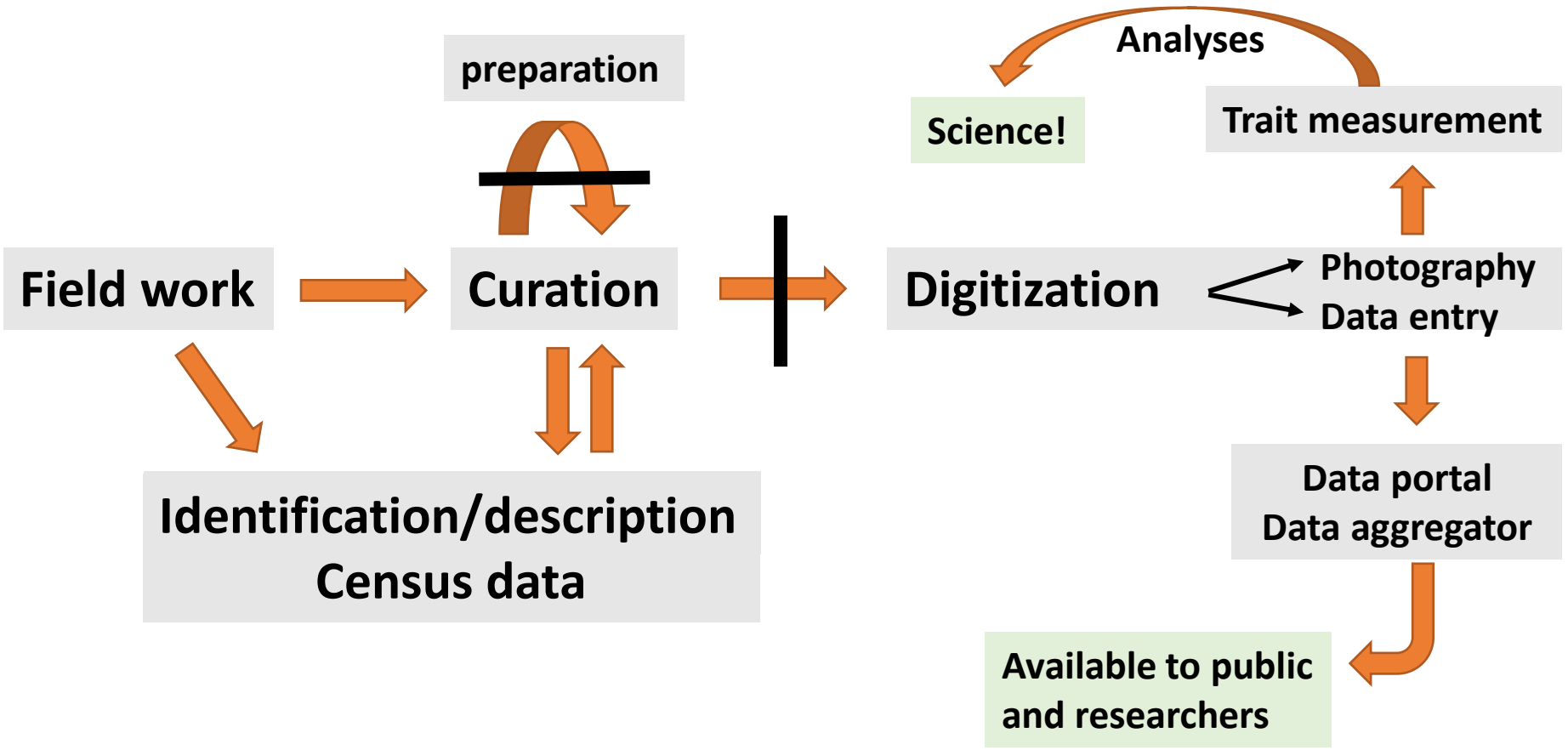
White-stripe and census station
Data entry

Photograph

Re-organization and customization of workspace

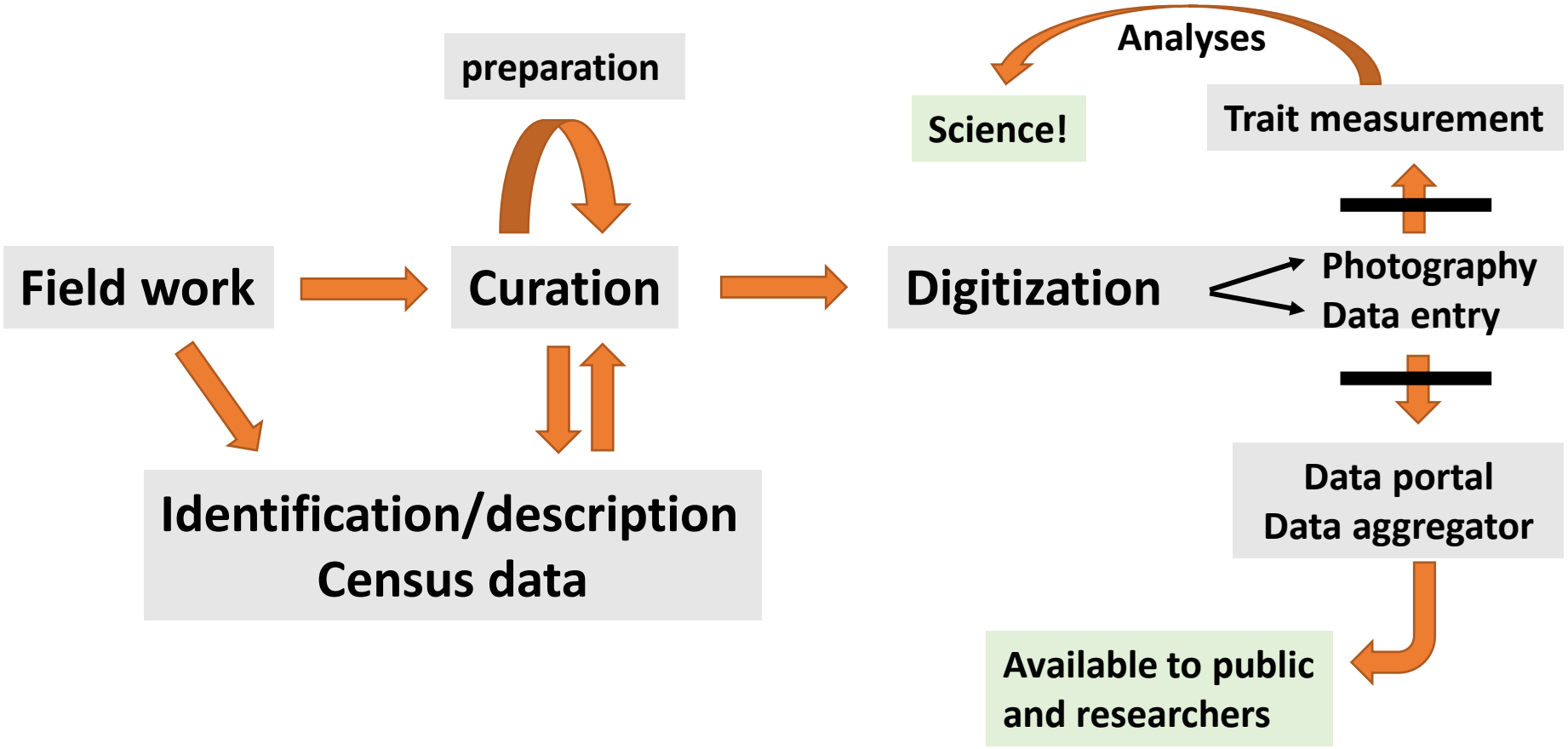
Shifting pinch-points in the workflow

Batch processing



Shifting pinch-points in the workflow

Integrated processing



Project Overview:

Reconstructing functional diversity of a Cretaceous forest

Phase 1. "Build" a forest
-describe taxonomic diversity
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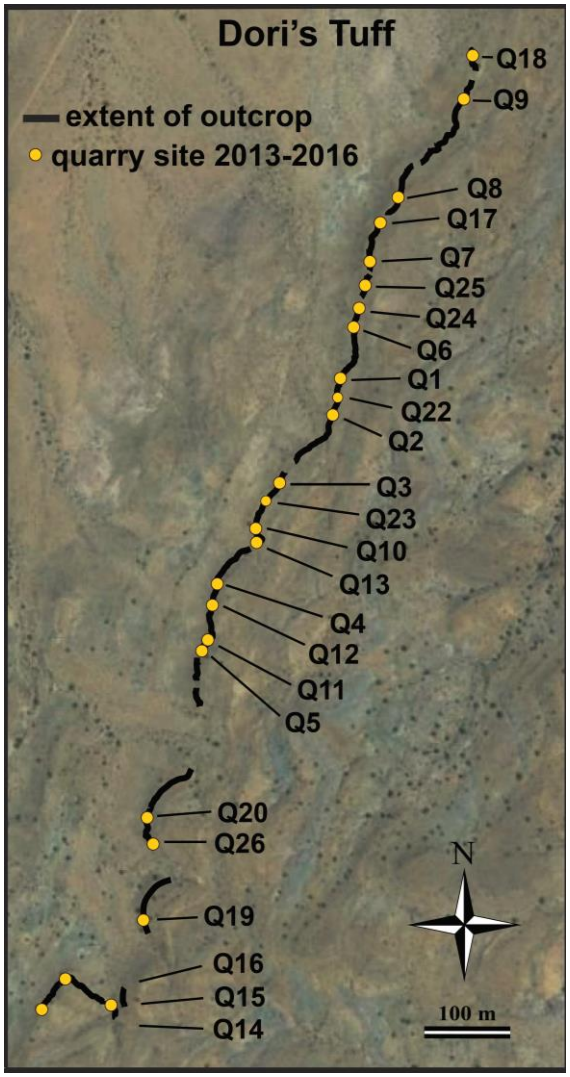
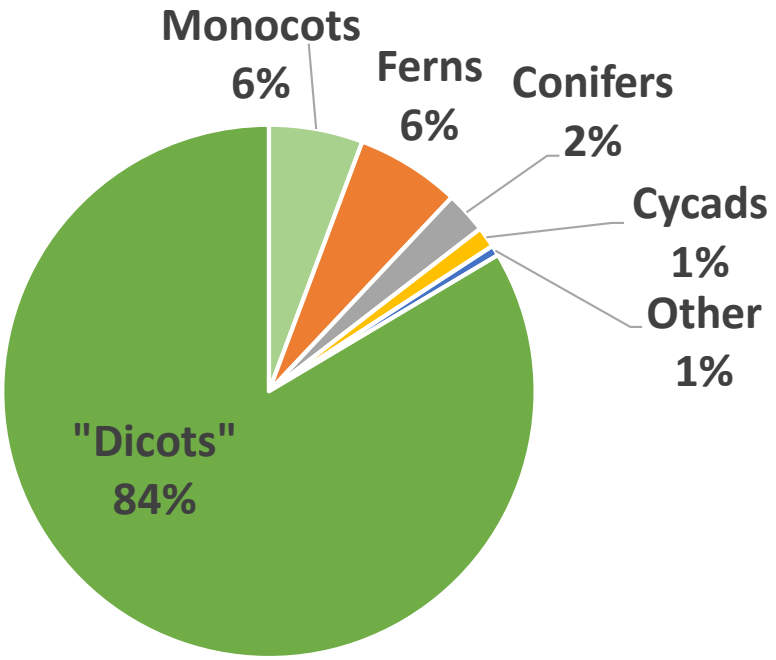
***quantitative and spatial explicit sampling scheme**
***large sample sizes**
*digital measurements of georeferenced specimens

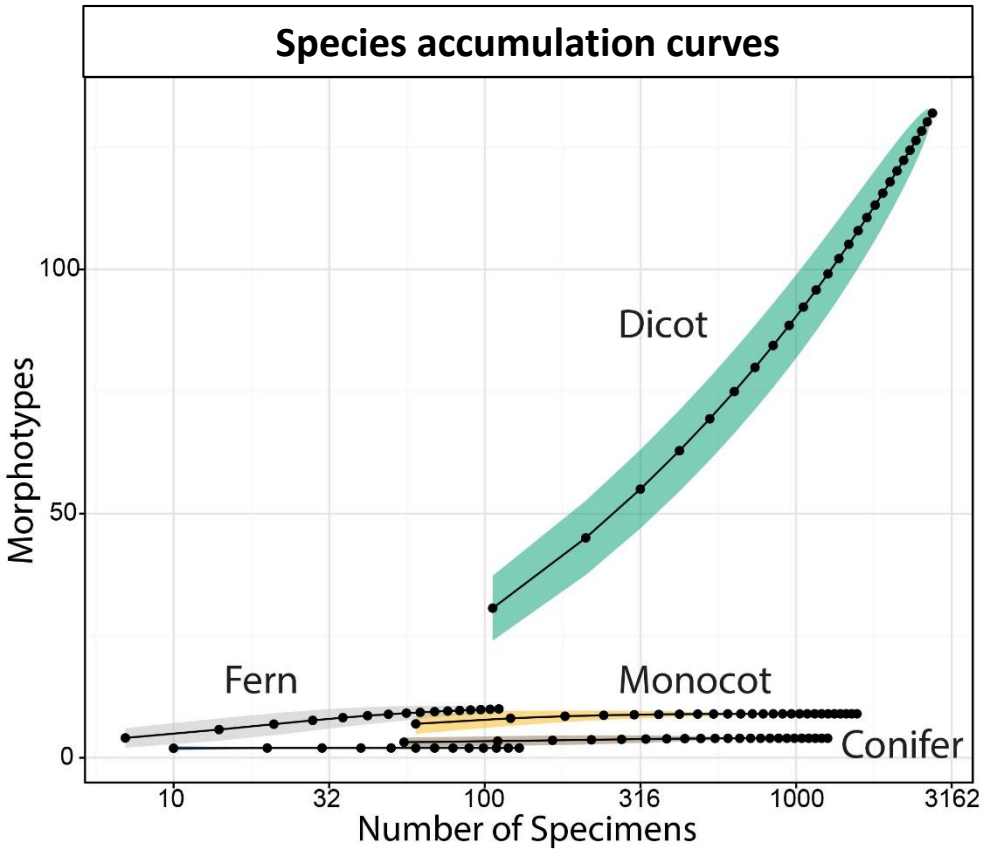


Taxonomic diversity

From census:

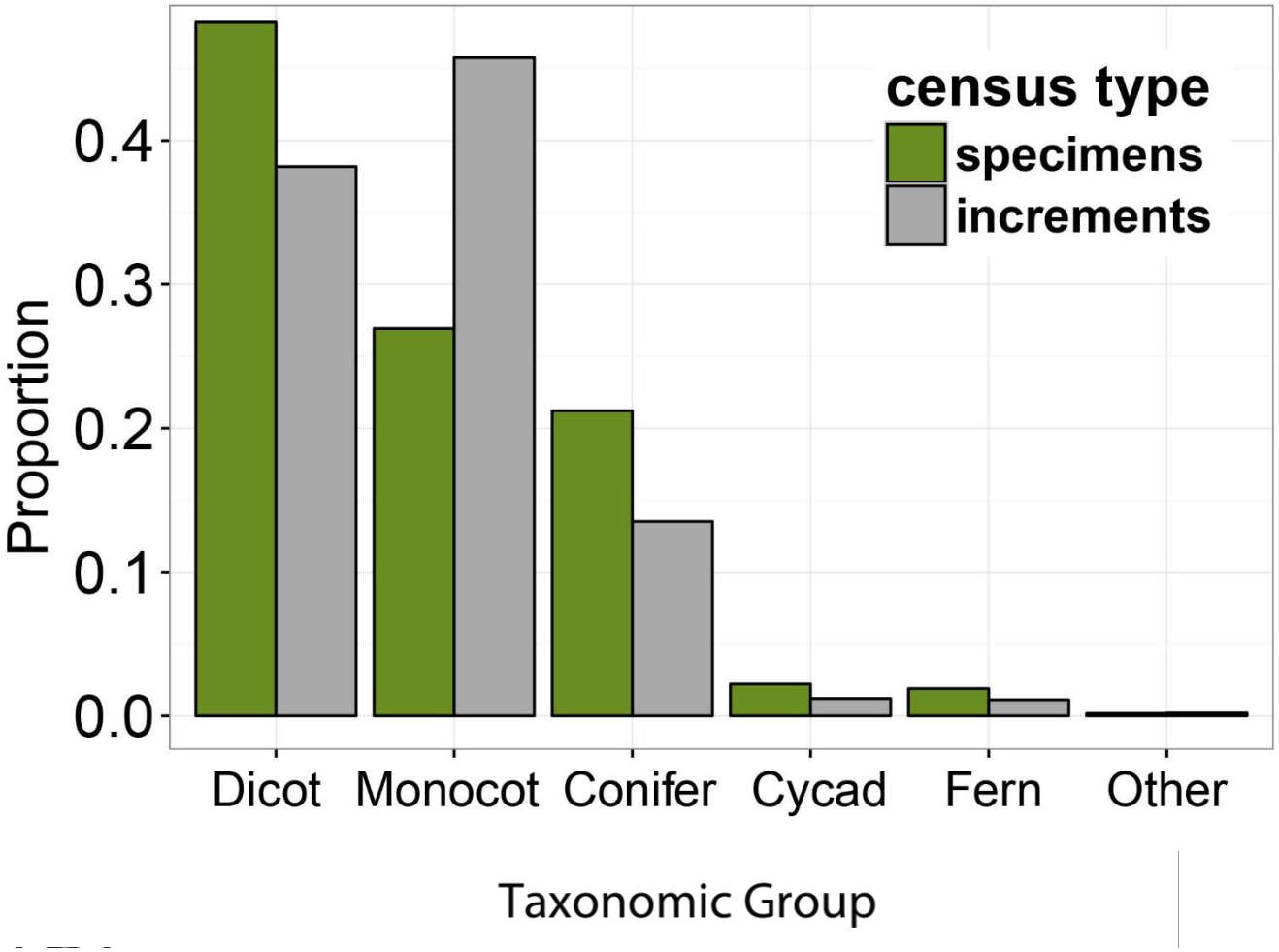
- **158 leaf morphotypes**
- Angiosperms: ~89% of diversity (141 morphotypes)





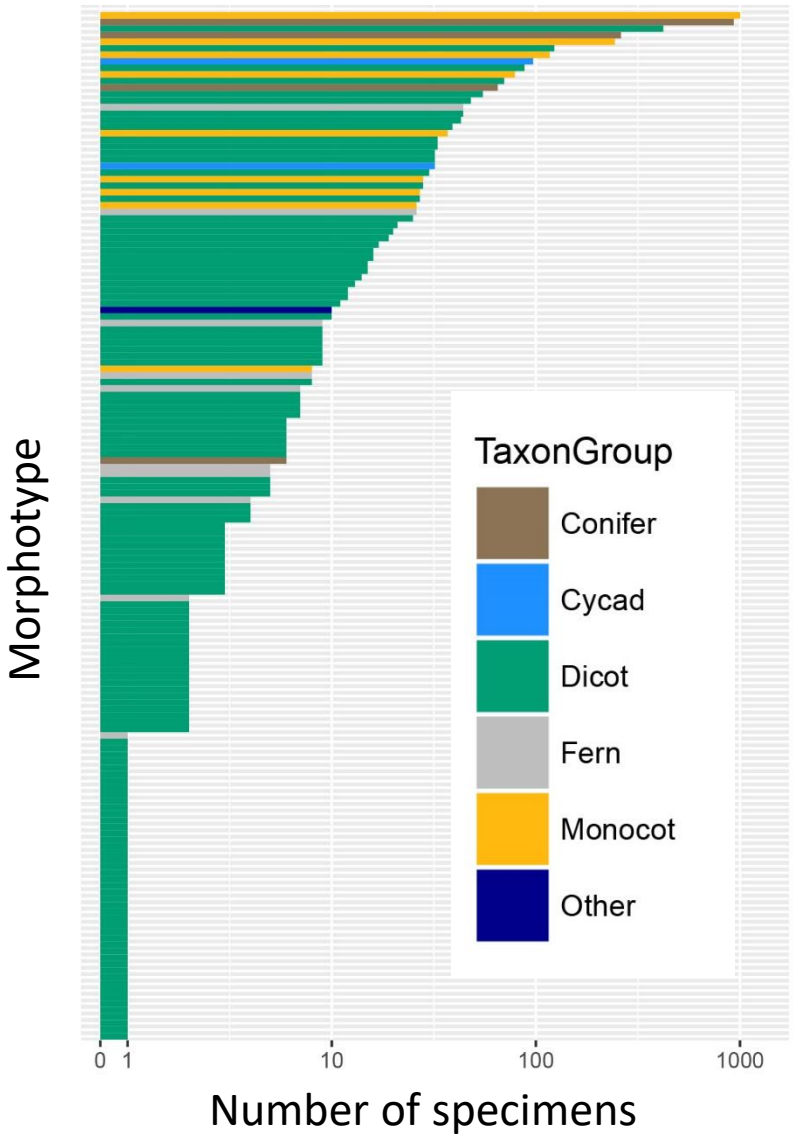
Community composition

Relative abundance and % cover



Community composition

Dominance and rank abundance



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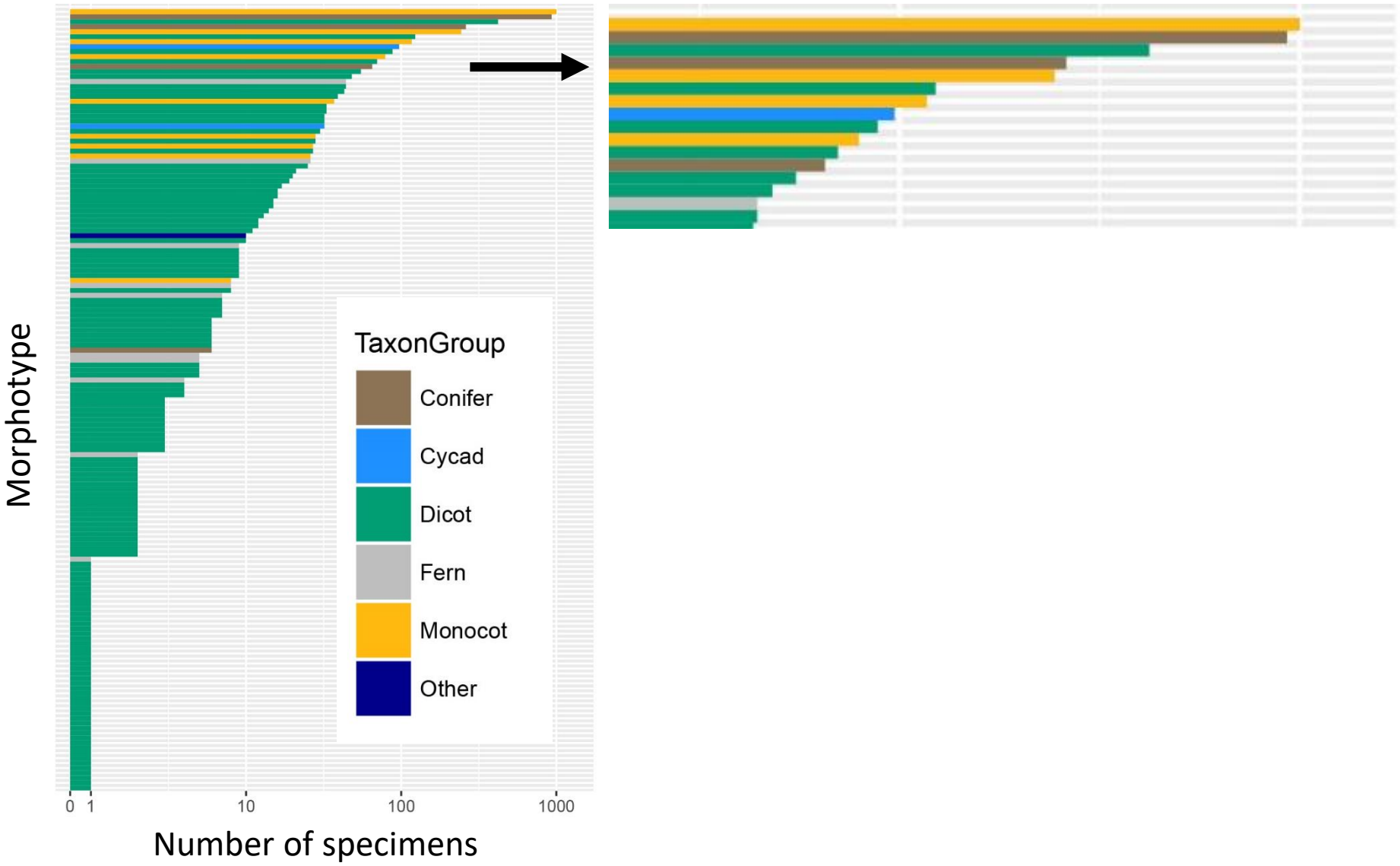

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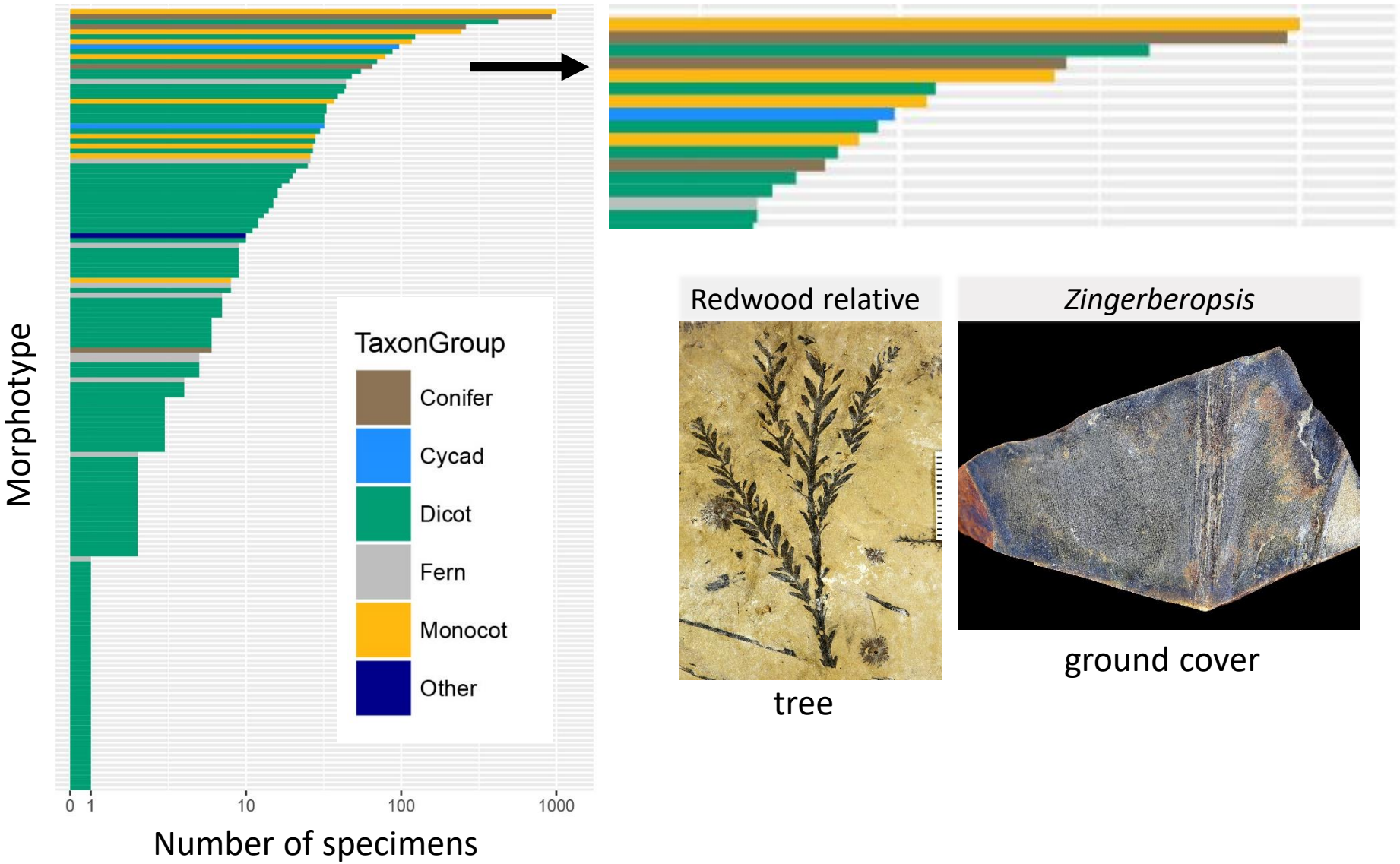


Redwood relative

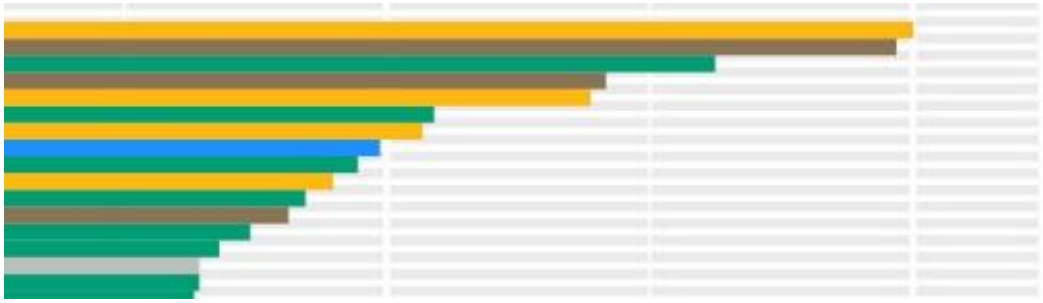
tree

Zingerberopsis

ground cover

Community composition

Dominance and rank abundance

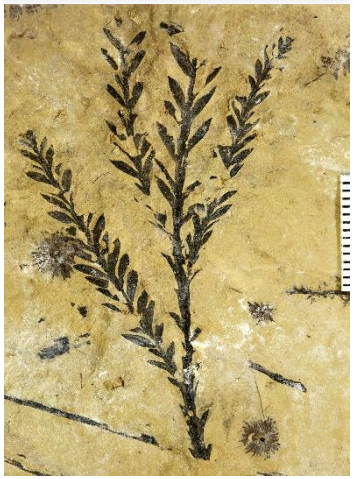


Brachyphyllum sp.

Sabalites sp.

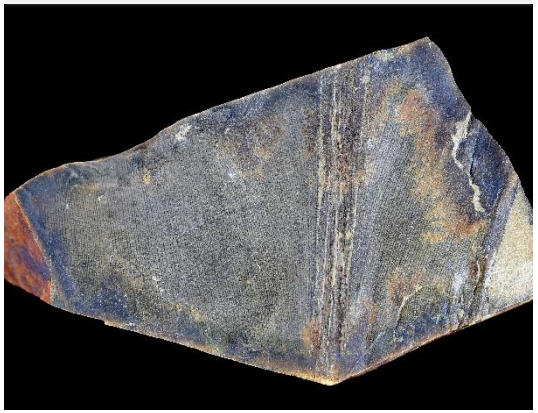
Dryophyllum sp.

Redwood relative



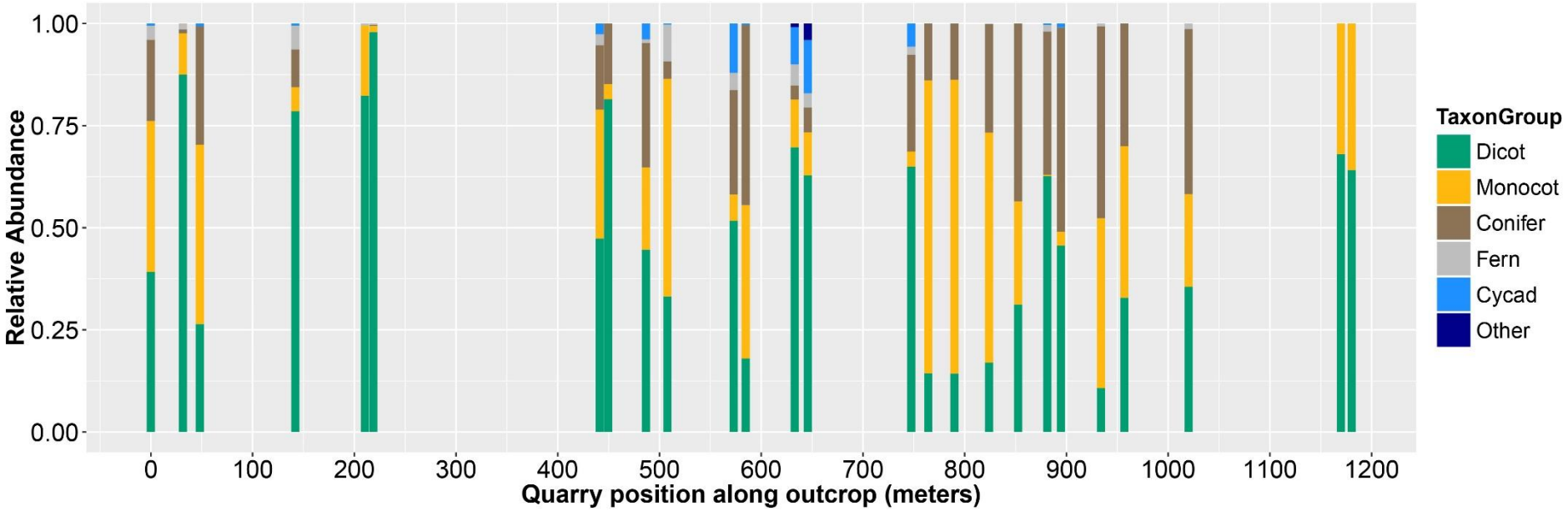
tree

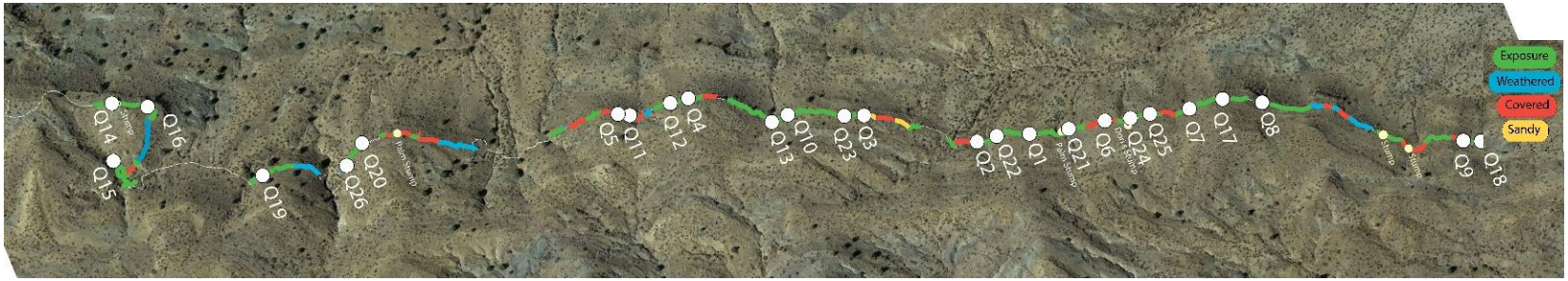
Zingerberopsis



ground cover

Spatial heterogeneity





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

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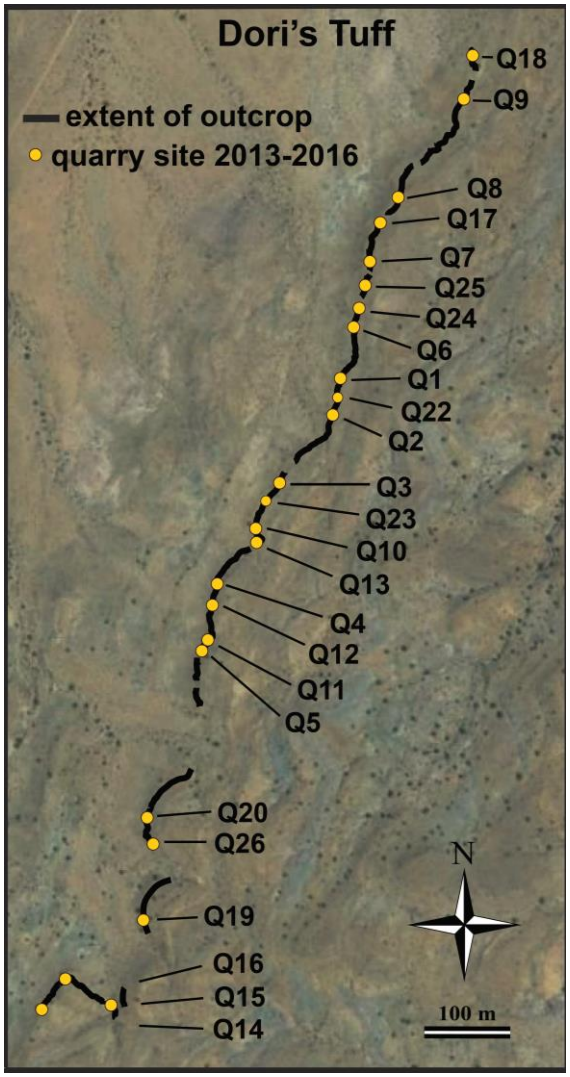
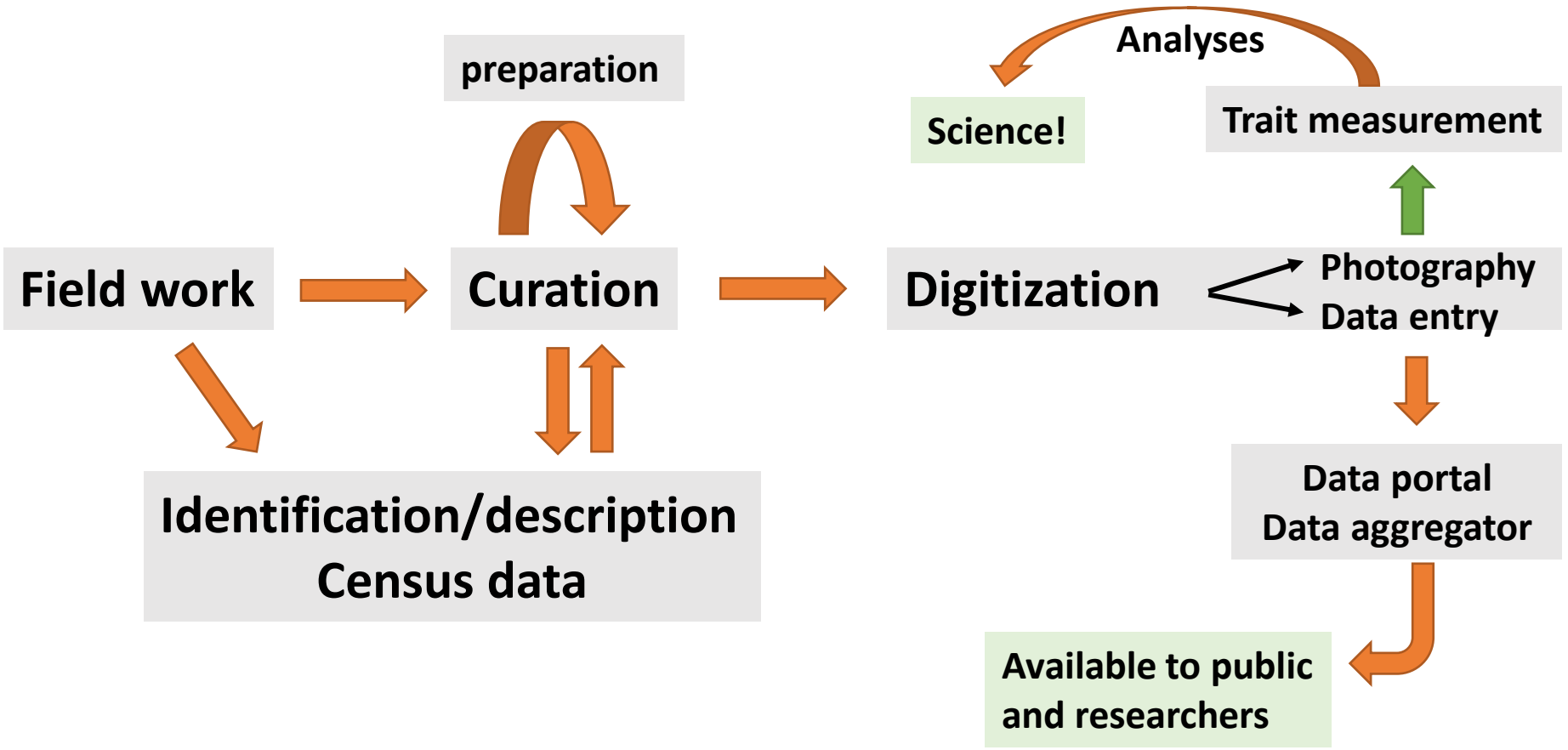
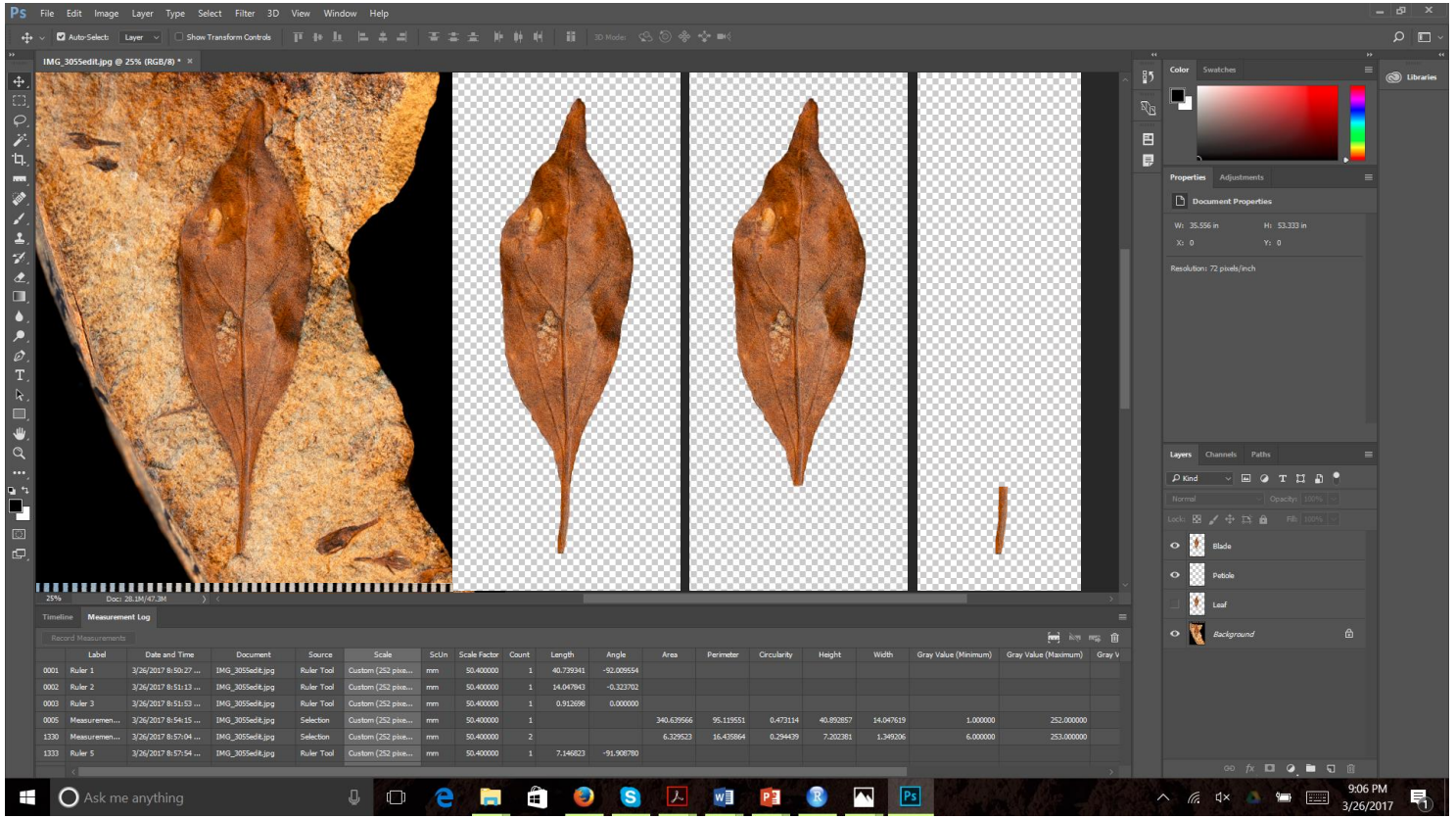


Using the digital data



Digital Trait Measurements

Digitized specimens piped into Adobe Photoshop for image analysis:

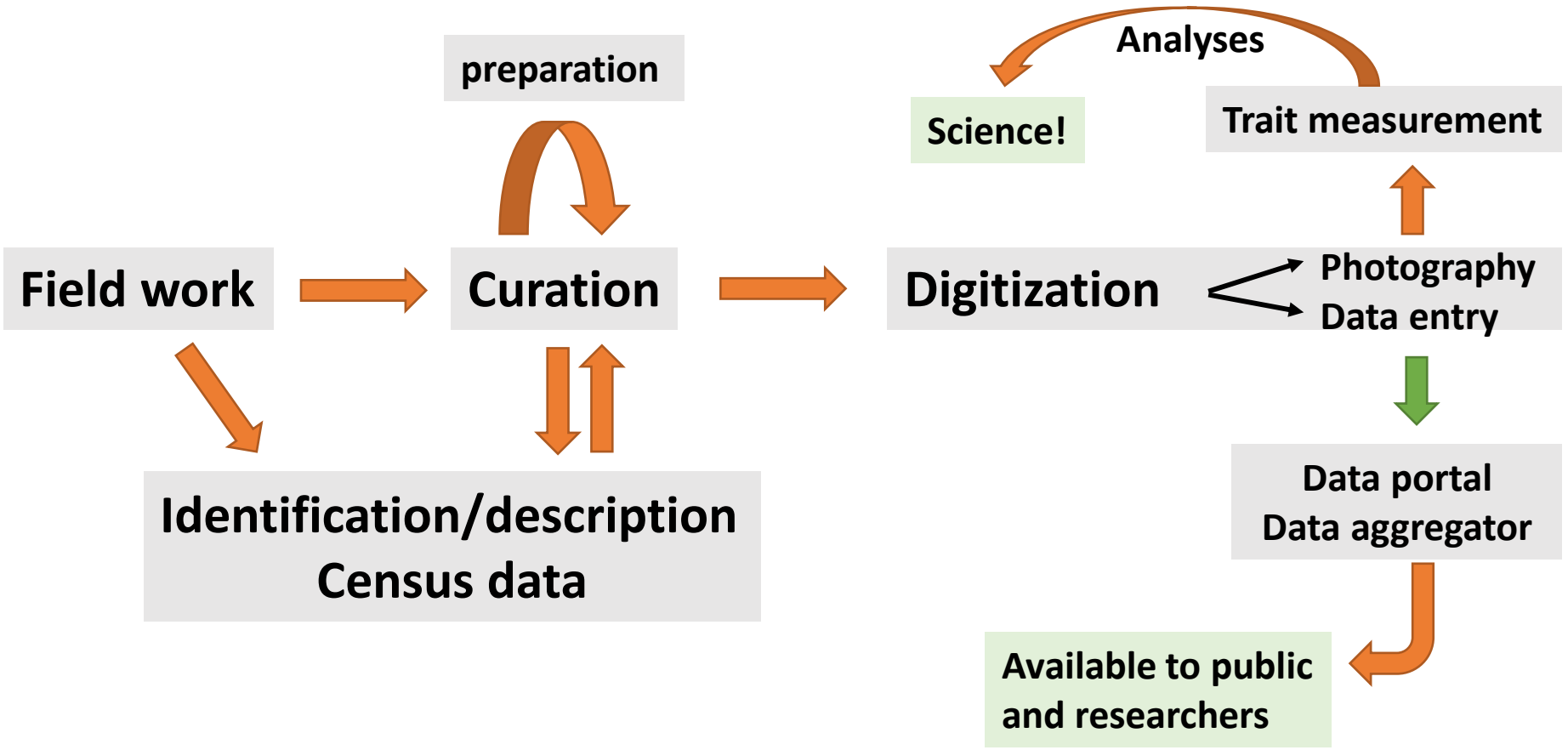


Leaf length
Leaf width
Tooth spacing

Leaf area
Leaf perimeter
Specific leaf area

Petiole length
Petiole width
Petiole area

Using the digital data



The data

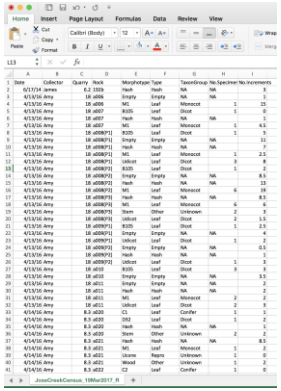
Specimen data

UCMP 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.

Images

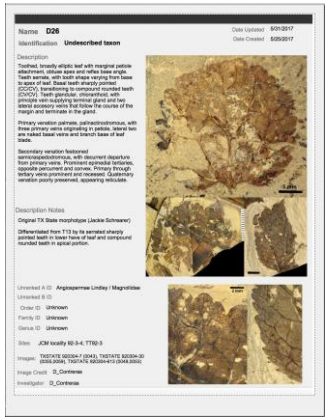
CalPhotos

Census & Trait data



.CSV

Morphotype descriptions



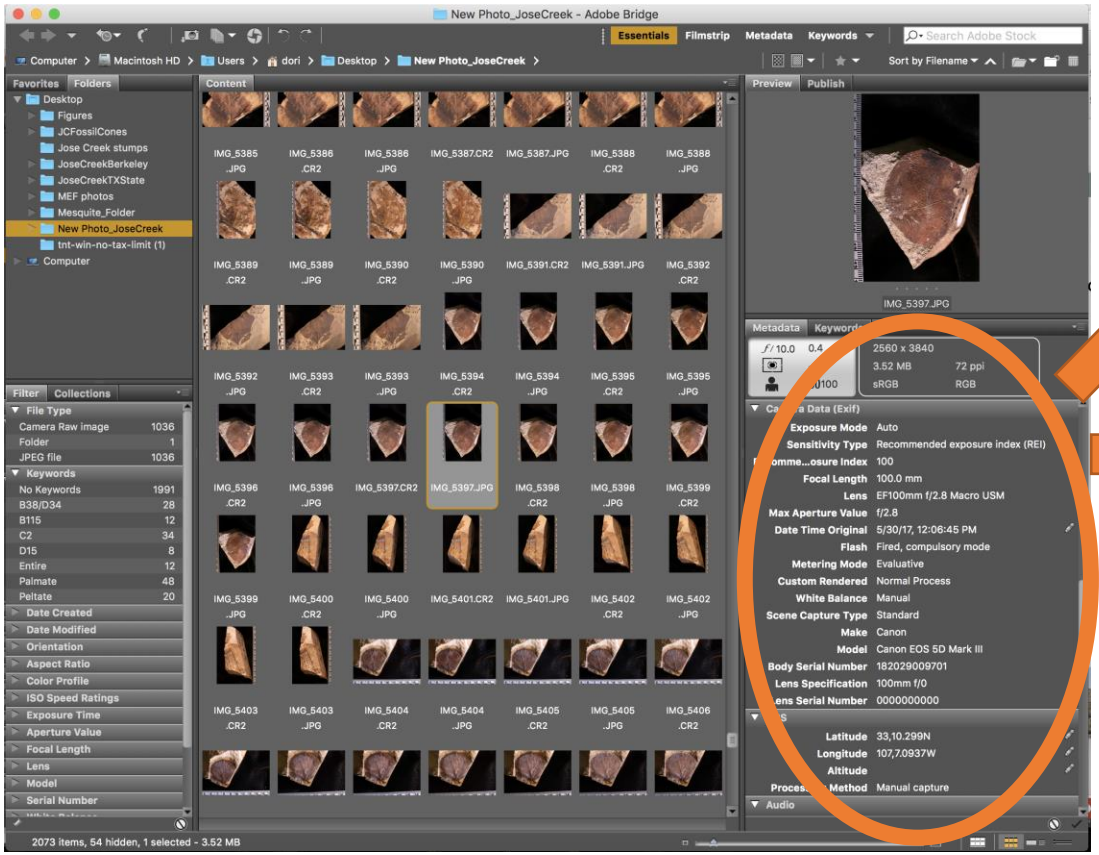
iDigBio
Integrated Digitized Biocollections

DRYAD

Image Data: Adobe Bridge

Images saved as Raw and JPeg

Metadata entered using Adobe Bridge



GPS

Latitude	33,10.299N
Longitude	107,7.0937W
Altitude	
Processing Method	Manual capture

Description	UCMP F115.01
Keywords	B115; Peltate; Entire; Palmate
IPTC Subject Code	
Description Writer	
Date Created	5/30/17, 12:06:45 PM
Intellectual Genre	
IPTC Scene Code	
Sublocation	TT92-3 Quarry 4

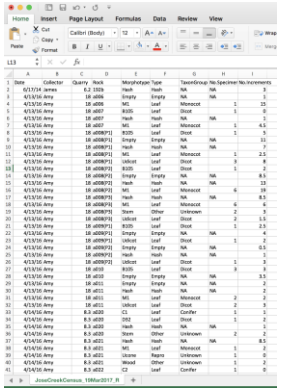
The data

Specimen data

Images

CalPhotos

Census & Trait data



.CSV

Morphotype descriptions

iDigBio
Integrated Digitized Biocollections

DRYAD

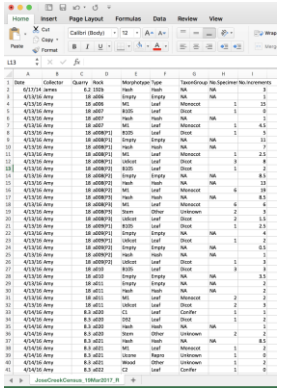
The data

Specimen data

Images

CalPhotos

Census & Trait data



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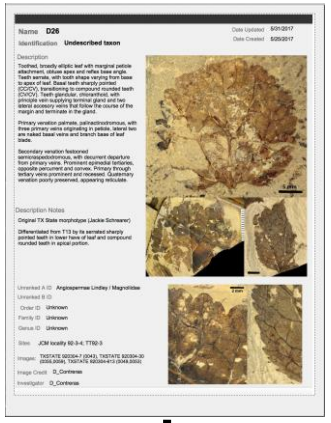
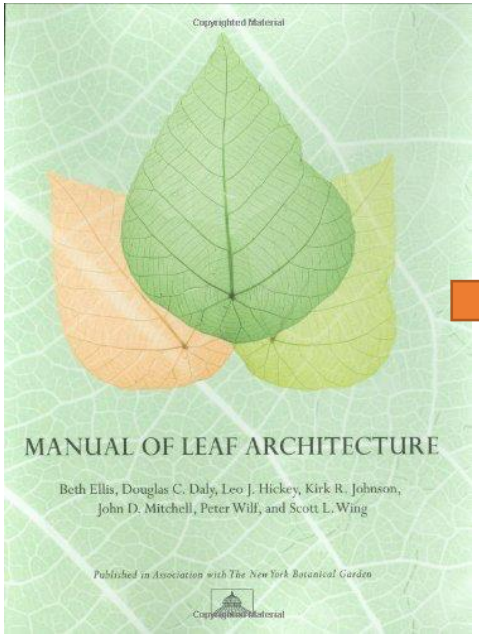
Morphotype descriptions

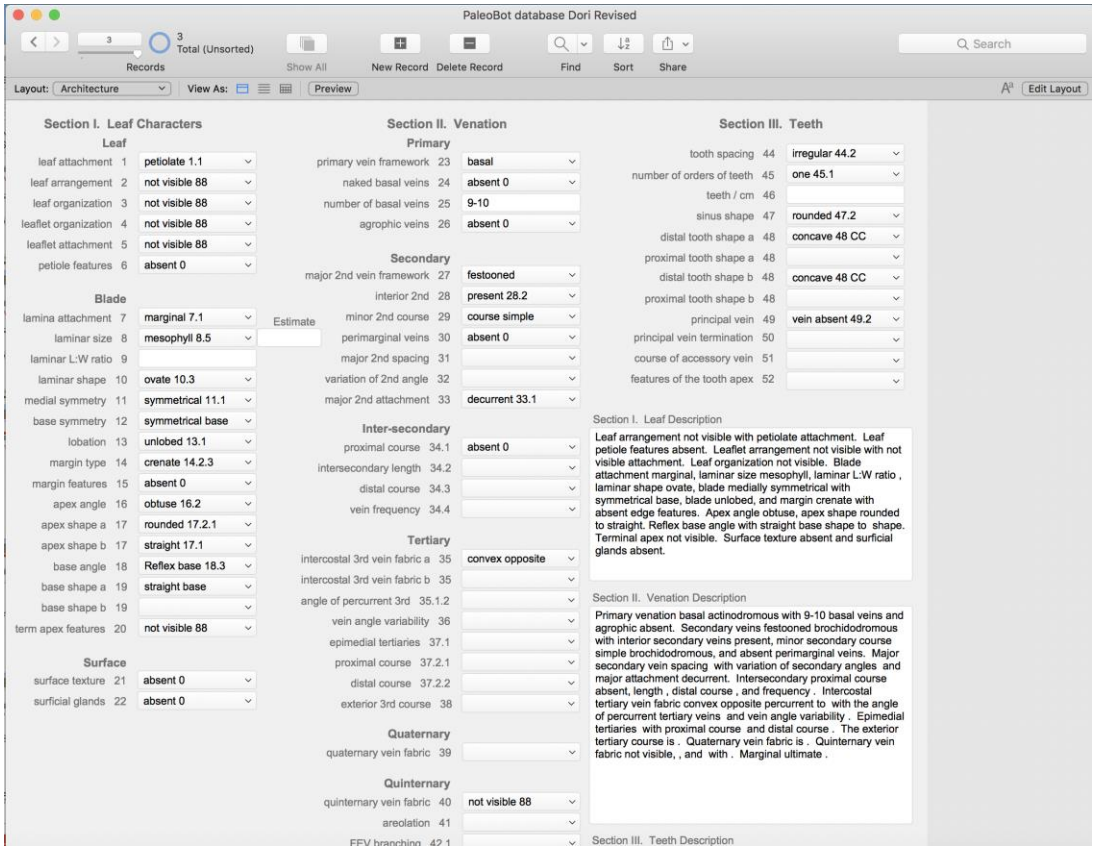


?

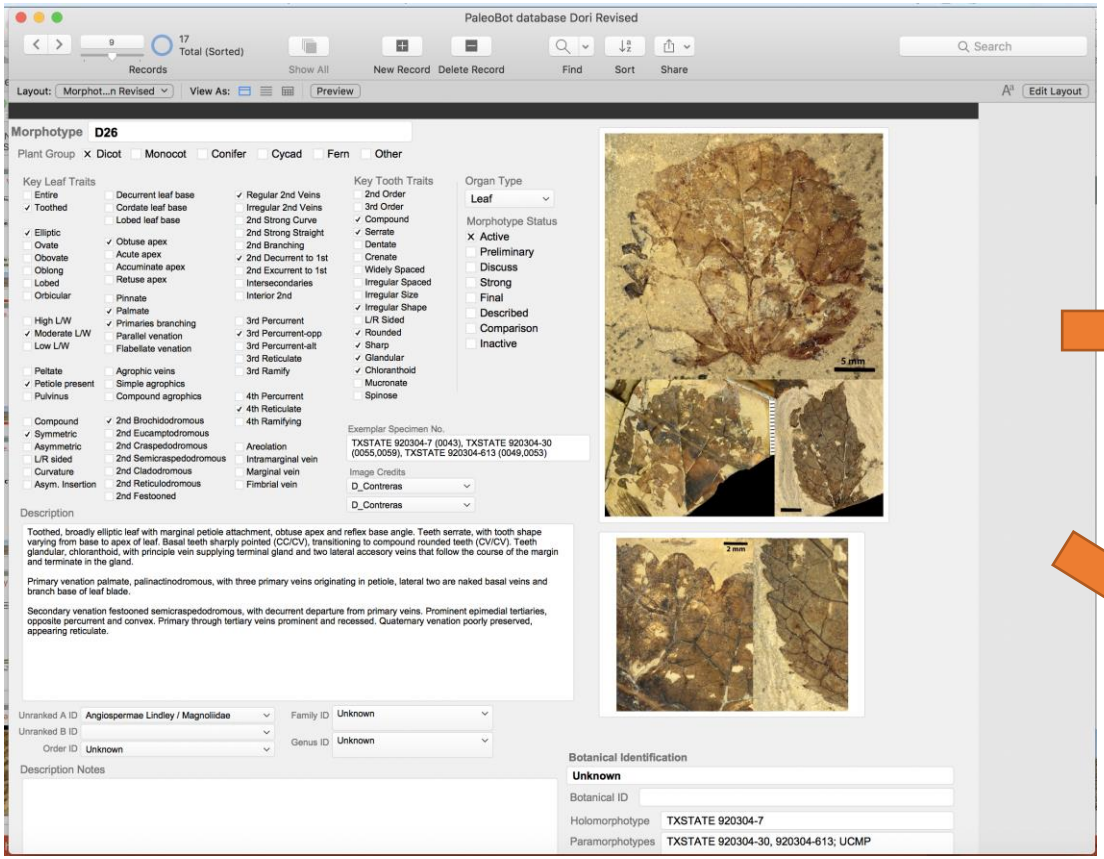
A new database?

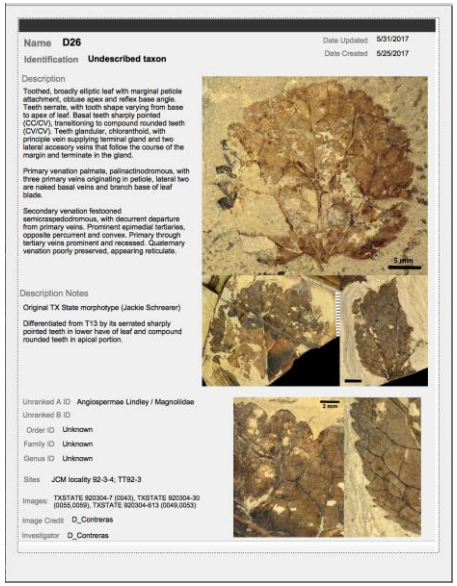
Morphotype Descriptions: Filemaker Pro

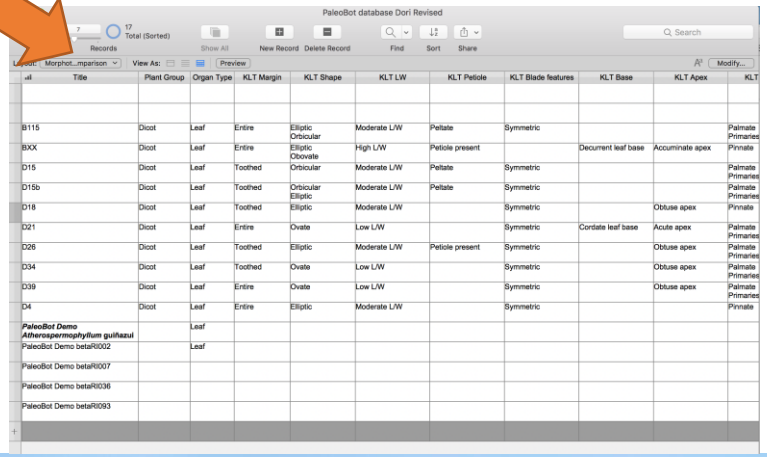




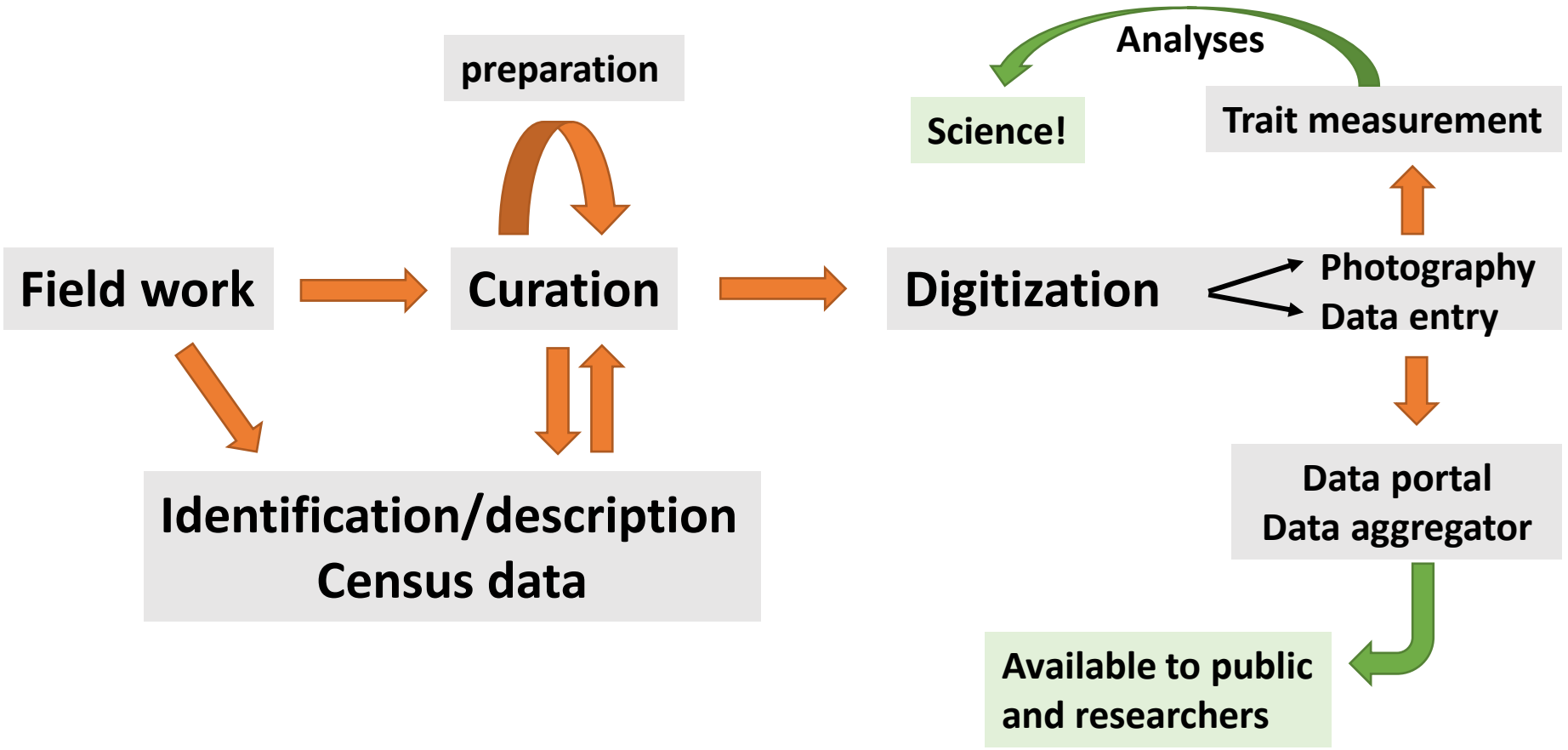
Morphotype Descriptions: Filemaker Pro







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

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