AllAsia: Bringing Asian plant diversity to digital life

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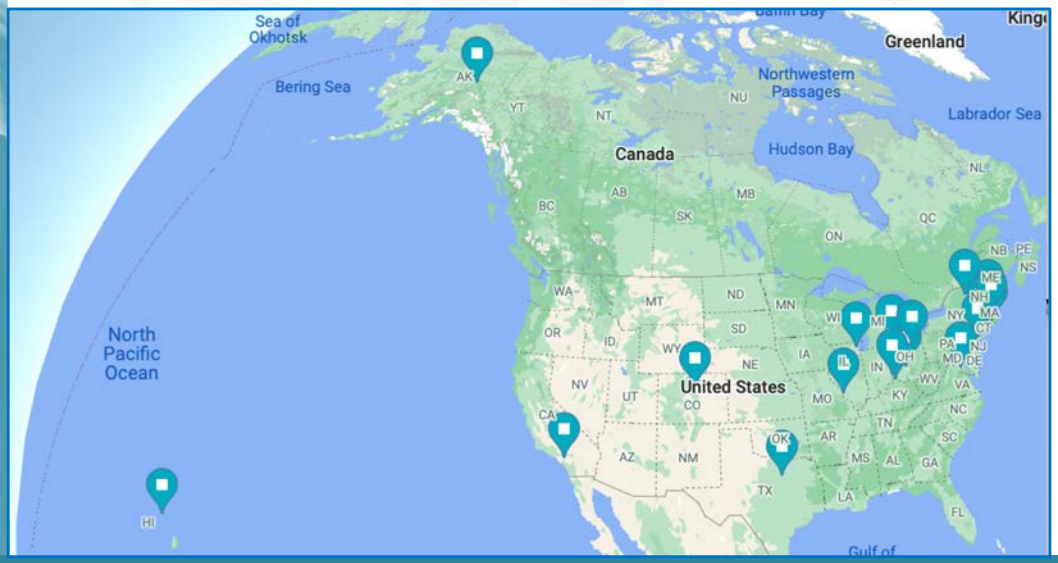
iPlant Collaborative™

iDigBio Integrated Digitized Biocollections

NSF

Core Objective

- **Digitize** 3 million Asian vascular plant specimens from 19 U.S. herbaria with special attention on Southeast Asia and the Himalaya-Hengduan mountains.



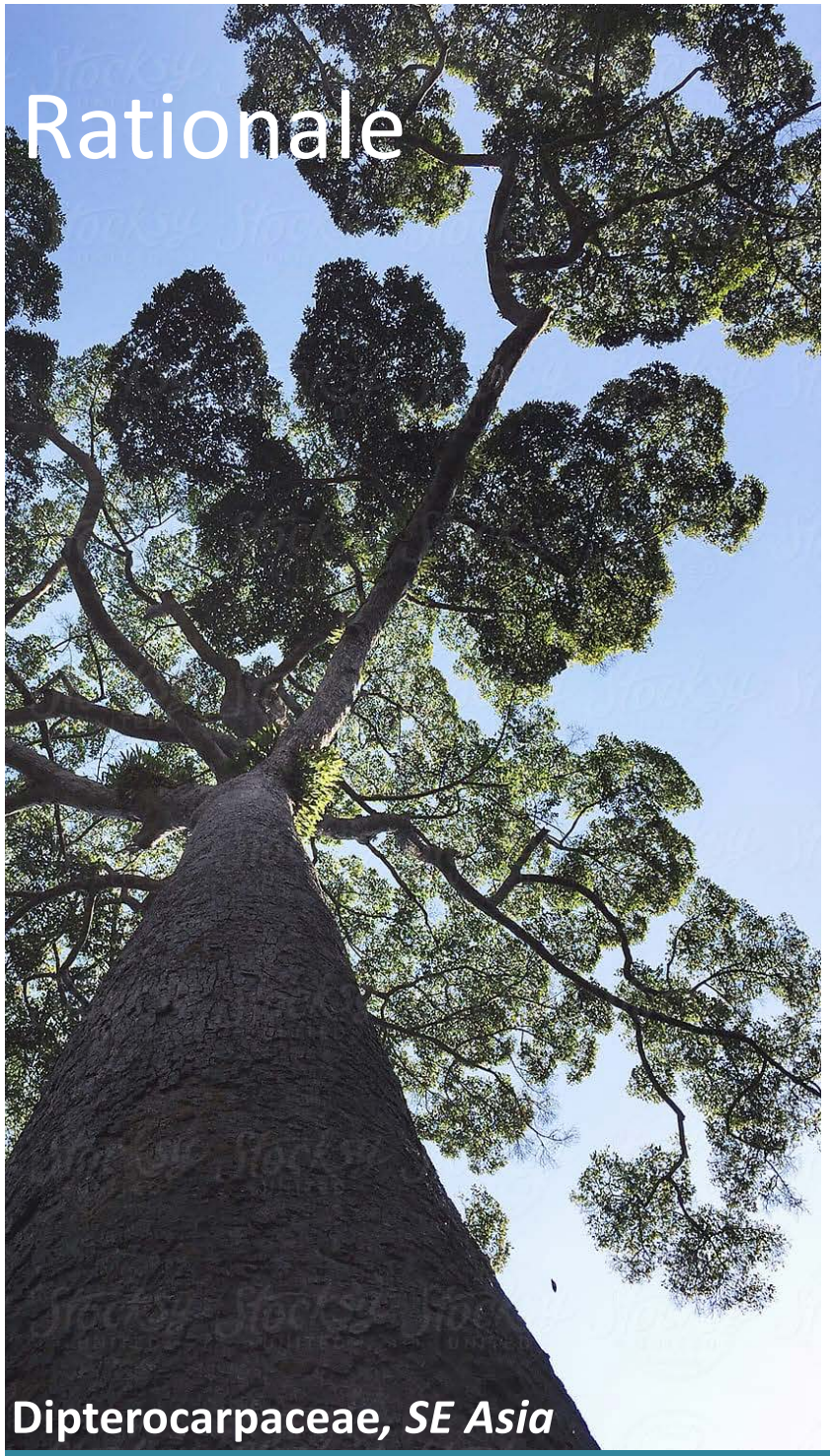
Rationale

- Our main goal is to mobilize data to support basic biodiversity discovery and facilitate ecological and evolutionary **investigations** especially in **hyperdiverse regions of Asia**

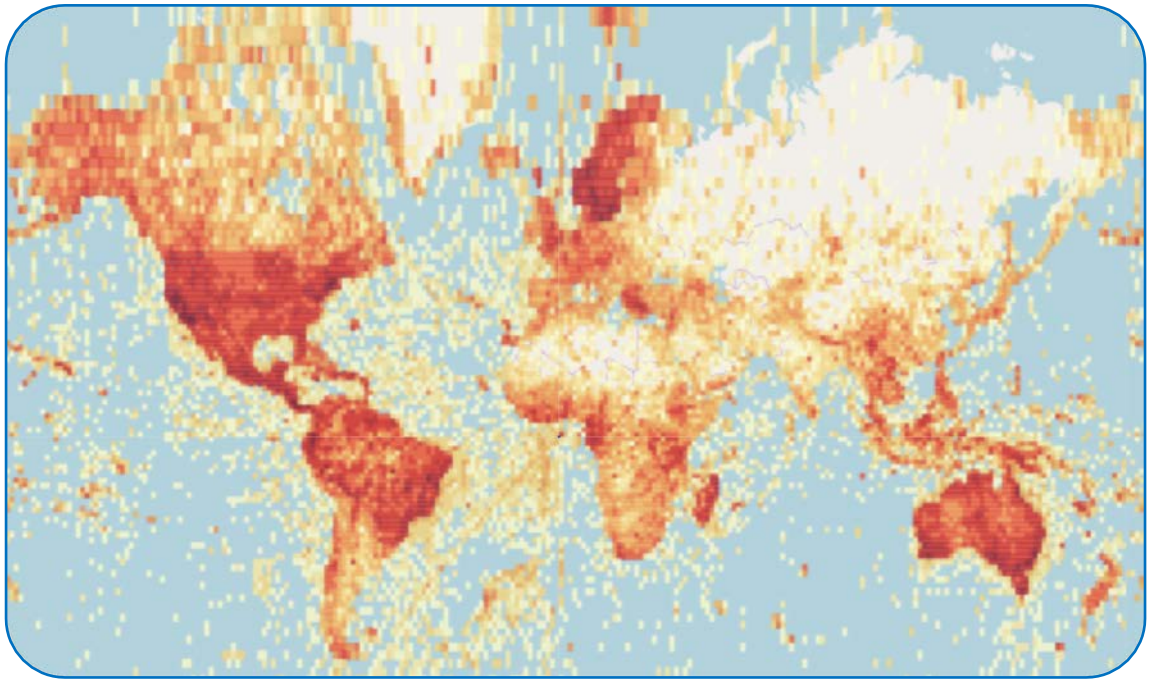
Rationale: Why Asia?

- Largest continent on Earth;
- Complex terrain;
- 90,000–100,000 species of vascular plants;
- Astonishing functional diversity.

Rationale



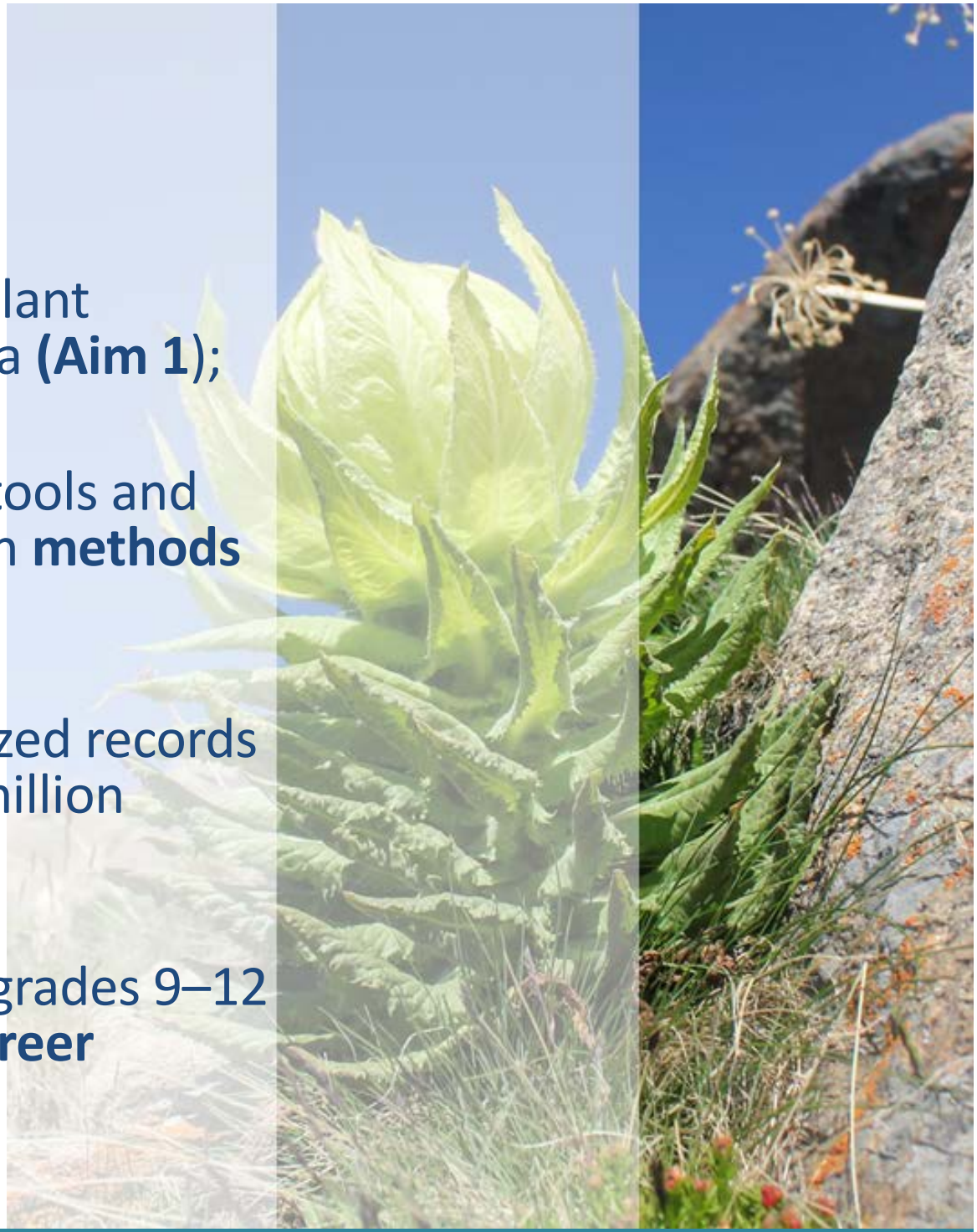
Dipterocarpaceae, *SE Asia*



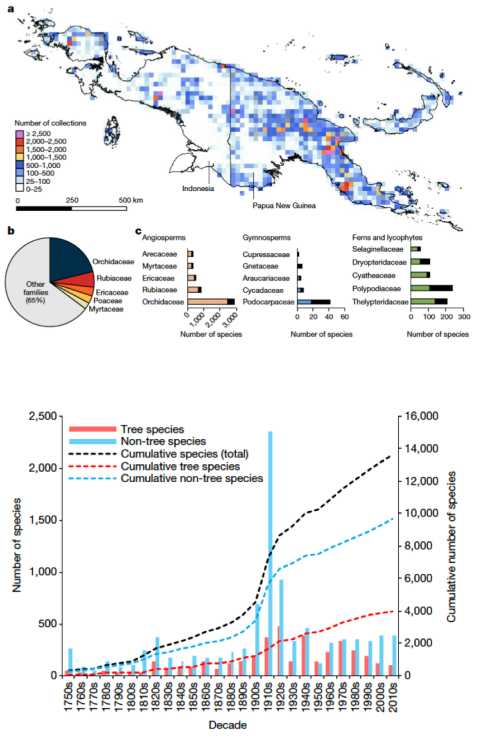
- **54 million** herbarium specimens in iDigBio;
- 4.5% are from Asia and 2% from US institutions;
- GBIF = 78 million; 12% from Asia **very few with images**.

Rationale: **AIMS**

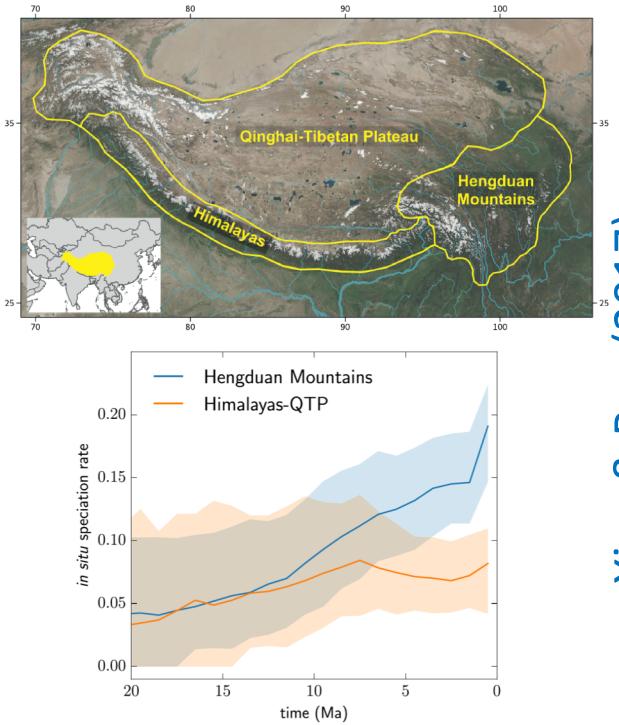
- **Digitize** 3 million vascular plant specimens from US herbaria **(Aim 1)**;
- Develop novel informatics tools and high-throughput digitization **methods (Aim 2)**;
- Aggregate and link all digitized records into an **All Asia** portal, 15 million specimens **(Aim 3)**;
- Enhance opportunities for grades 9–12 STEM learners and **early career** scientists **(Aim 4)**.



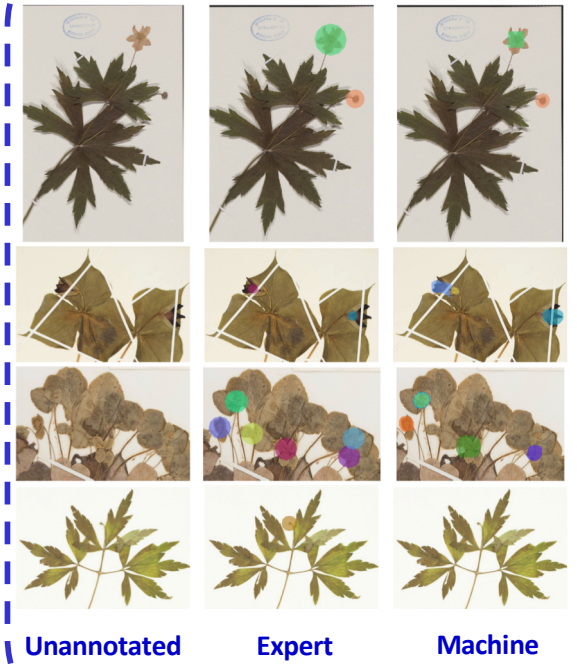
Rationale: **Research**



Cámara-Leret et al. (2020)



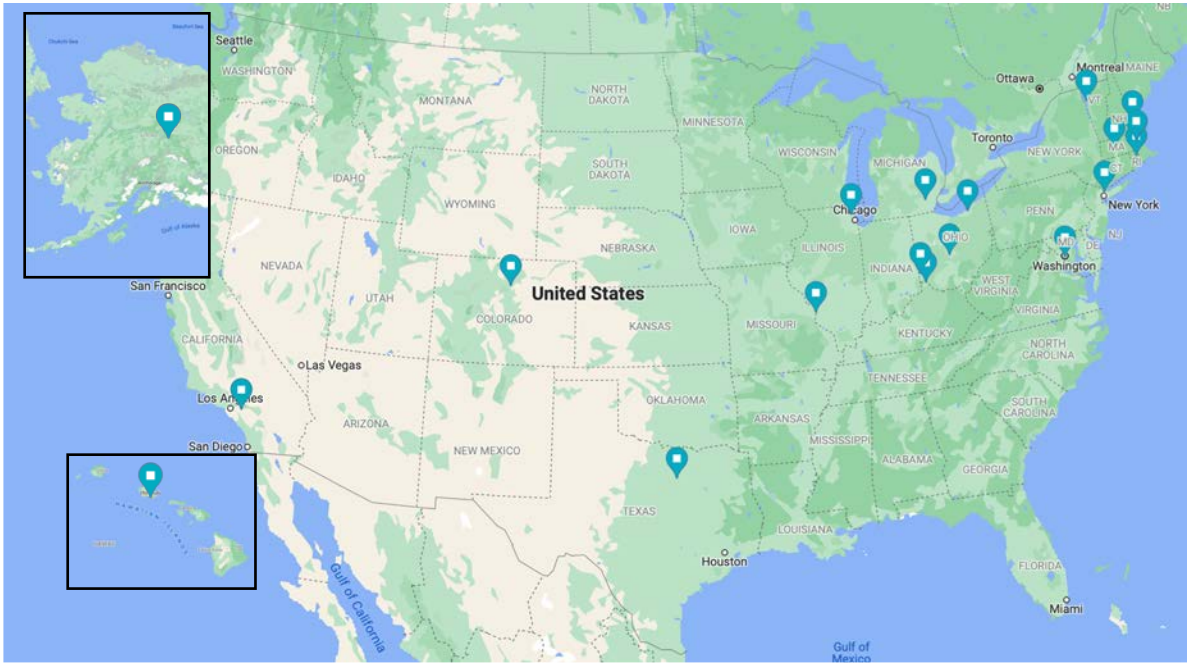
Xing & Ree (2017)



Davis et al. (2020)

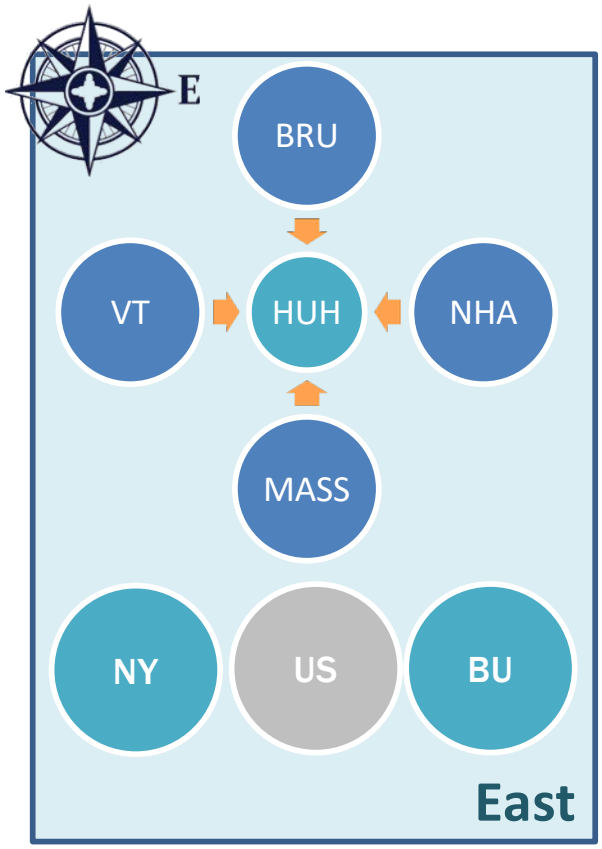
- Species discovery and biogeography in iconic biodiversity hotspots;
- Elucidating eco-evolutionary drivers of diversification in contrasting temperate and tropical biomes;
- Investigating species phenological response to climate;
- Protecting and forecasting biodiversity across imperiled biomes;
- Creating next-generation herbarium digitization via innovative design solutions.

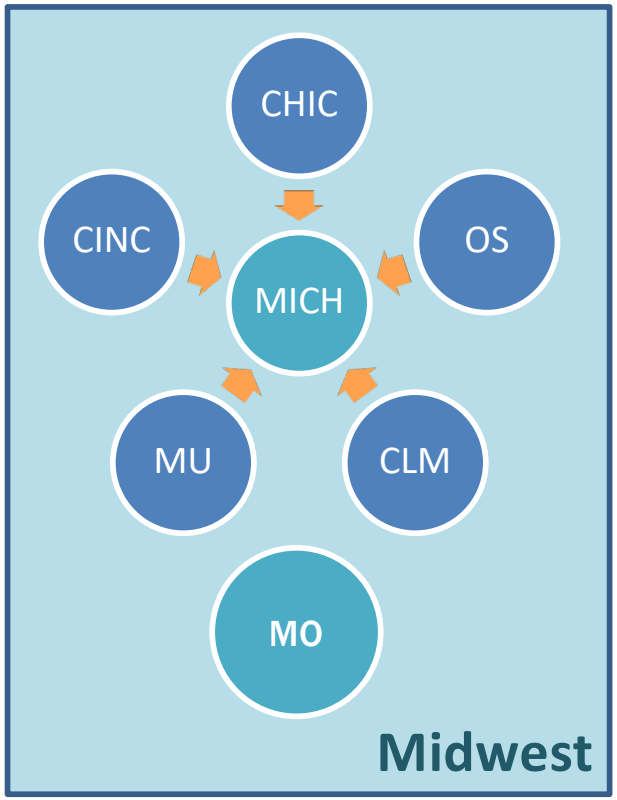
Digitization Plan: **Consortium Organization**

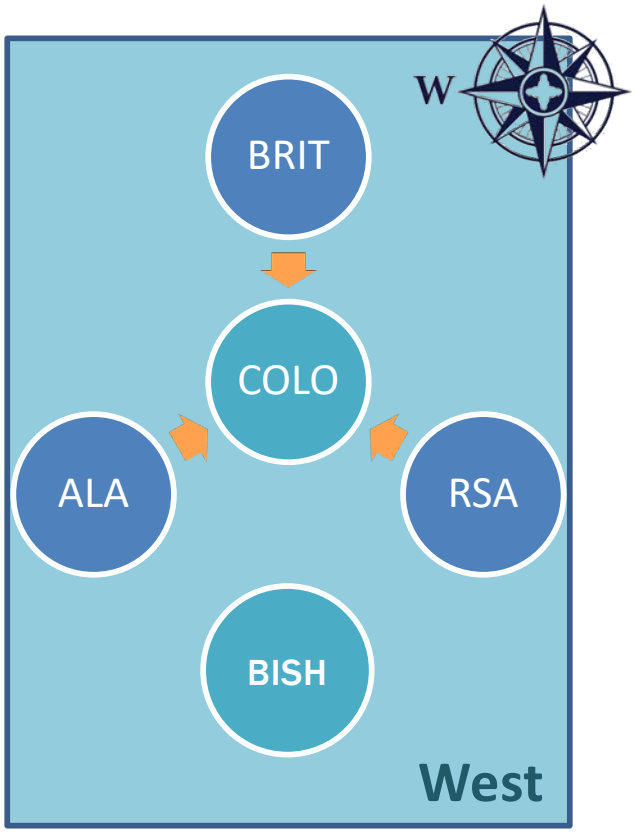


- Harvard University (HUH)
- Bishop Museum (BISH)
- Brown University (BRU)
- U. of Alaska (ALA)
- Botanical Research Inst. Texas (BRIT)
- Chicago Botanic Garden (CHIC)
- U. of Cincinnati (CINC)
- Cleveland Museum of Natural History (CLM)
- U. of Colorado (COLO)
- U. of Massachusetts Amherst (MASS)
- U. of Michigan (MICH)
- Missouri Botanical Garden (MO)
- Miami University (MU)
- U. of New Hampshire (NHA)
- New York Bot, Garden (NY)
- Ohio State Uni. (OS)
- California Bot. Garden (RSA)
- U. of Vermont (VT)
- Smithsonian (US; not funded)

Digitization Plan:
Organization







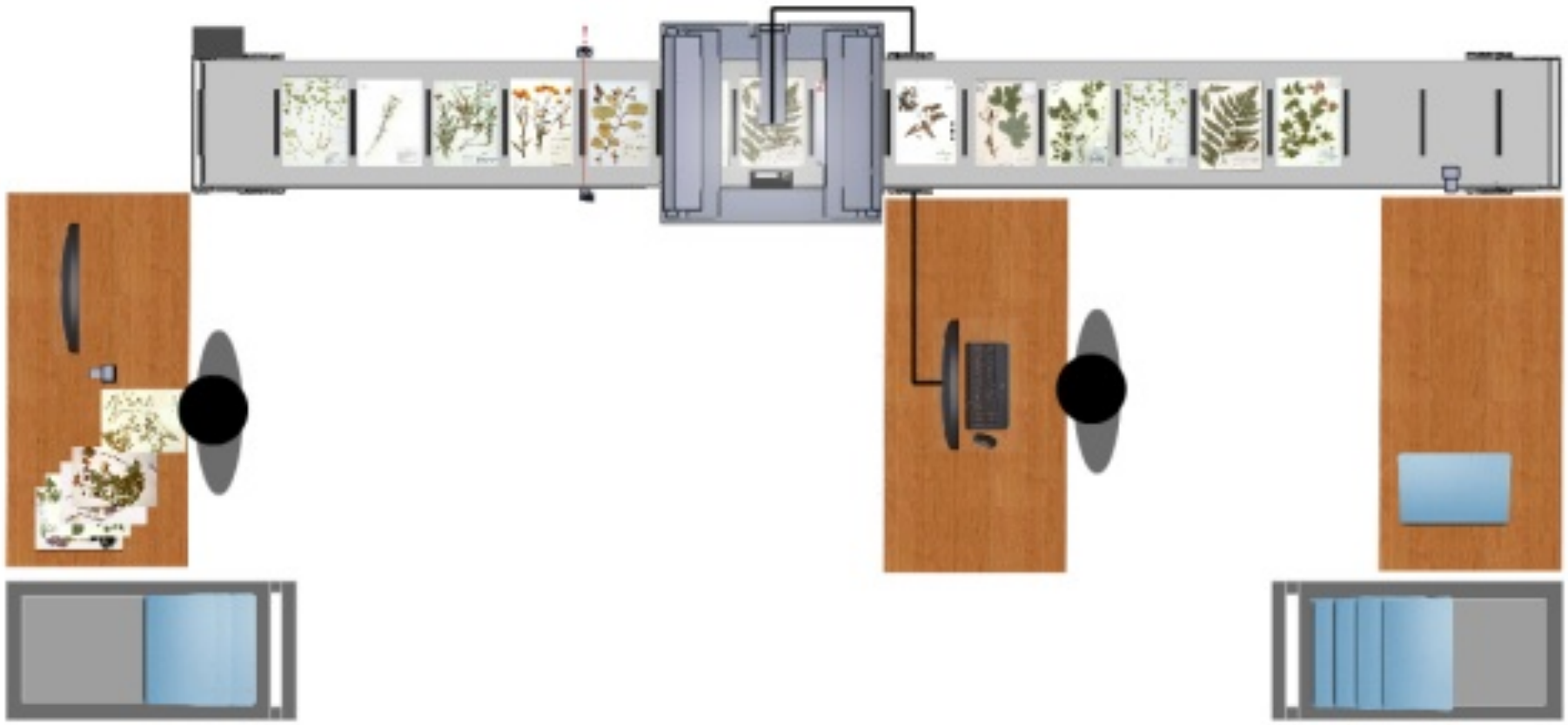
Hedrick et al. (2020)

Mobilizing New England Vascular Plant Specimen Data to Track Environmental Changes

Innovation:
HUH Conveyor Belt


Patrick Sweeney


Binil Sarly



Sweeney et al. (2018)

Back to the future:

next generation imaging

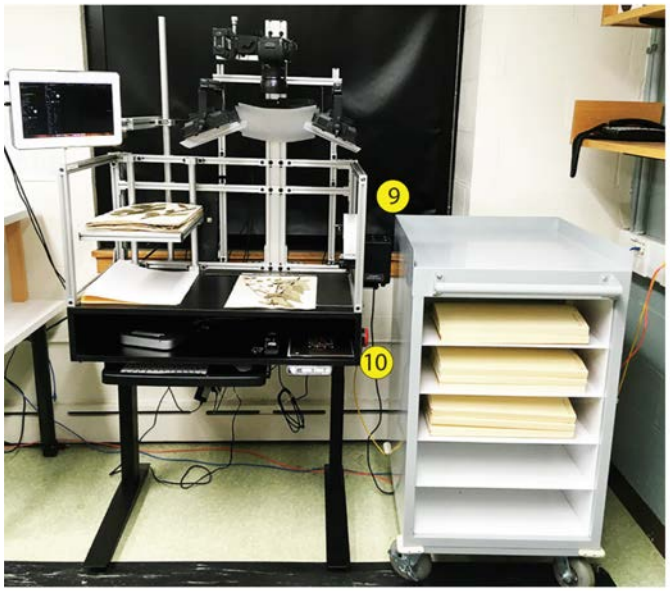
- Single station workflow
- Ergonomic design customized for herbarium sheets
- Separate imaging from transcription

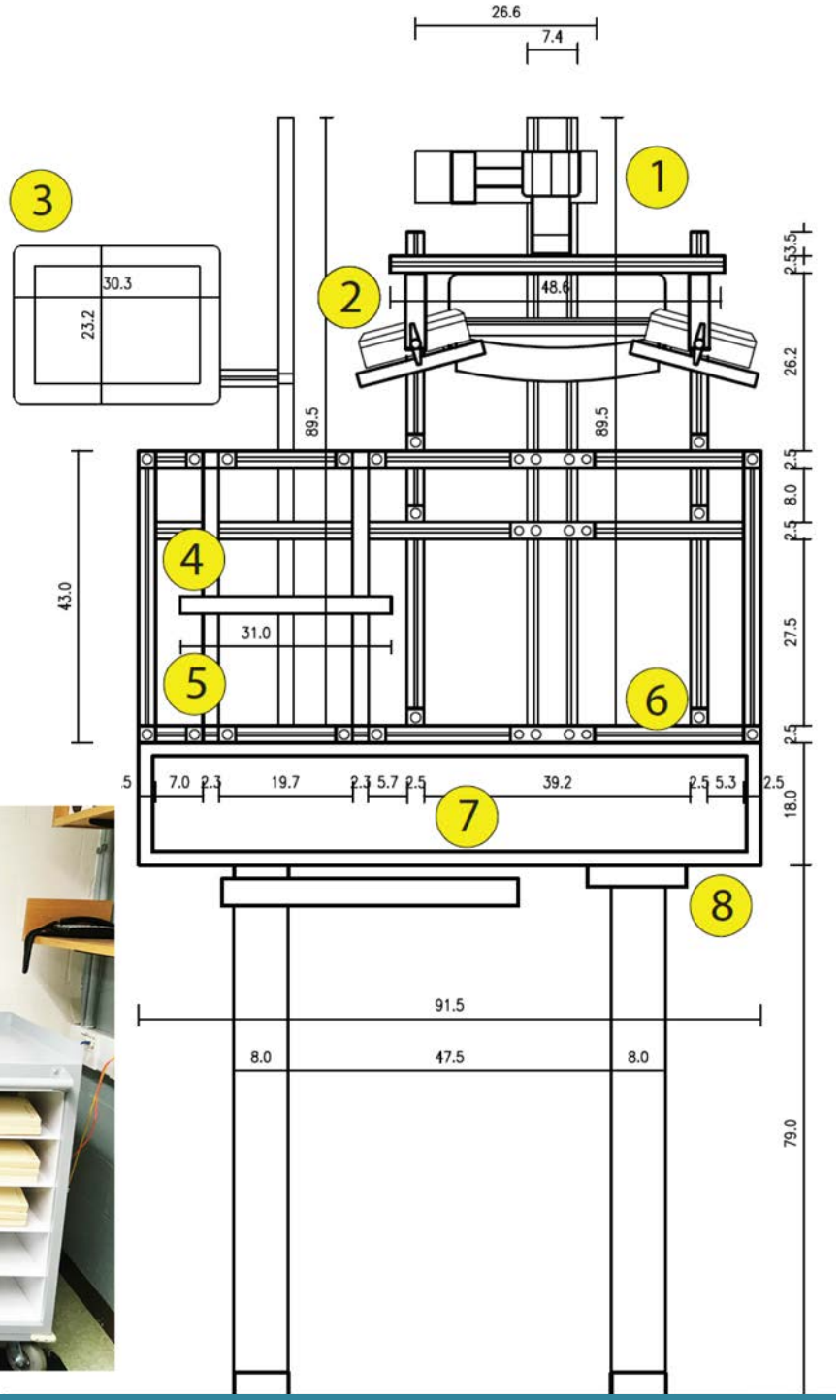
- 8 seconds per image! (down from 20 sec)

- Transcription virtual, separated from imaging (40% reduction)

Key design features:

1. Camera and mount
2. LED lighting
3. Tablet-sized monitor with adjustible arm
4. Adjustable queue tray
5. Receiving area
6. Imaging surface
7. Cubby
8. Height-adjustable legs
9. Barcode dispenser
10. Easy-fire button





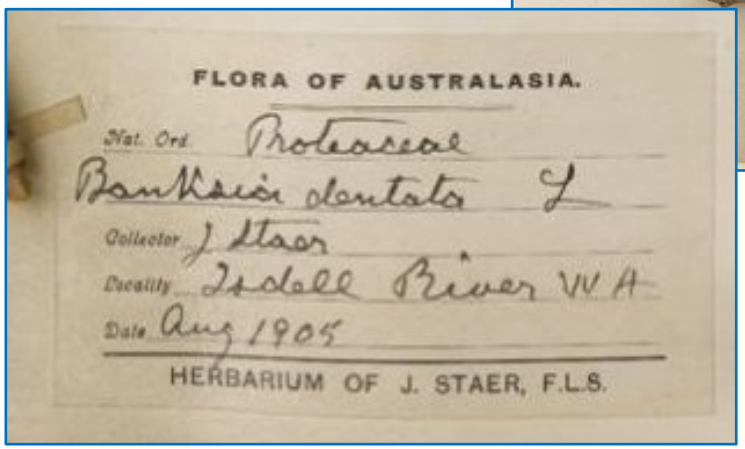
Davis et al. (2021)

Innovation: Machine learning and label transcription

❖ Label transcription still **largely completed** by human workers; plenty of room for automation

❖ Goal: Use the **LSTM-RNN tool** to generate **automate transcription** of handwritten herbarium specimens labels

❖ Code will be made available through **an opensource license** for broad use

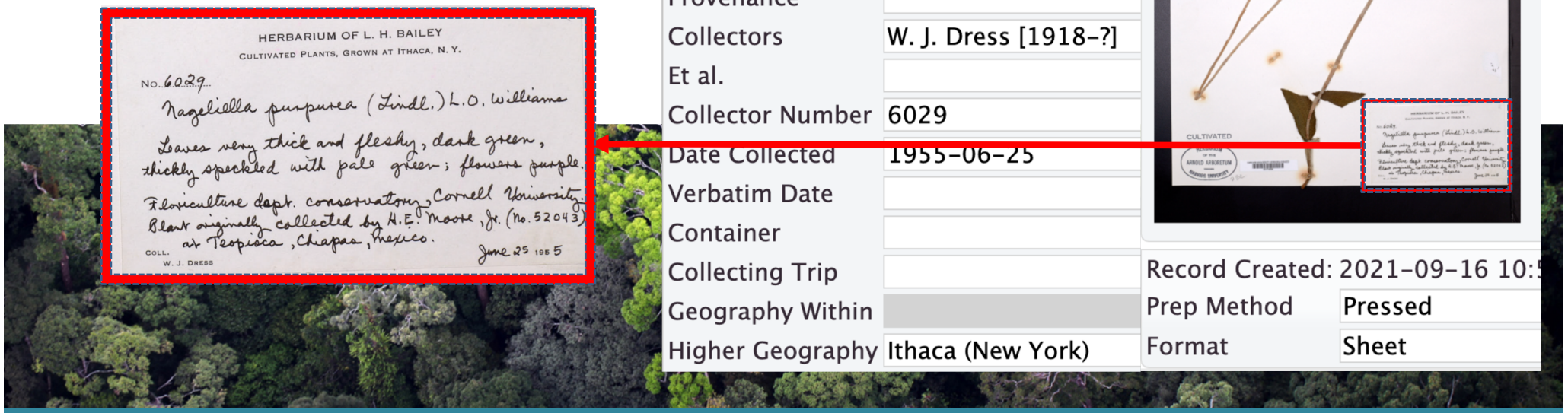



Ziba Cranmer


Dharmesh Tarapore

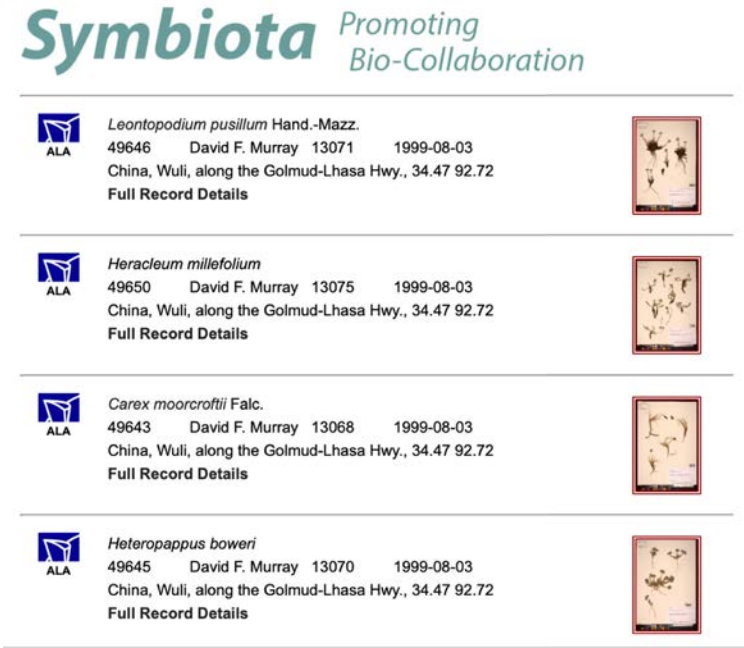
Innovation: Rapid data entry

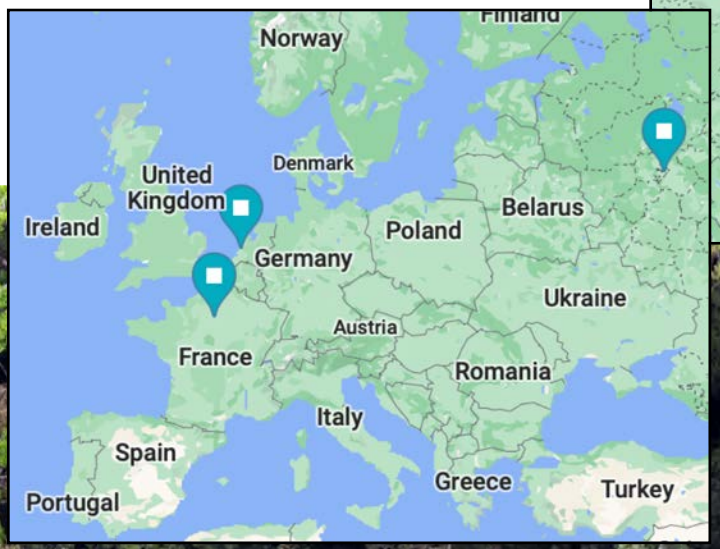
- Enhanced Symbiota for rapid data entry workflow
- Leveraging lessons learned from HUH rapid entry tool
- Automatic label detection
- Text suggestions from AI-based automatic transcription

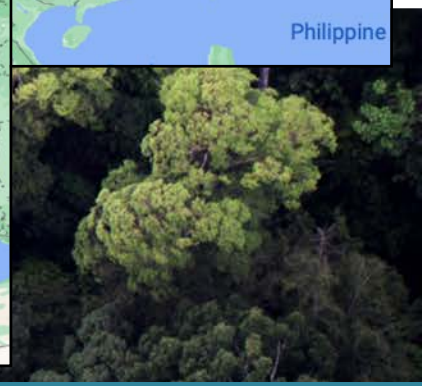


Mobilization

- All data and images will be **available to public** through *All Asia* Symbiota portal
- 12 million records contributed by international partners (including P, France; L, Netherlands; MW, Russia; CNH, China);
- 15 million records total







Outreach: Bringing biodiversity and computer scientists together

Planned Workshops:

- Plant Biodiversity in Asia: promises and challenges (Boston, MA)
- Collections and the digital herbarium (Ann Arbor, MI)
- Novel applications of digital collections (Fairbanks, AK)

Overarching question:
What does the herbarium of the future look like?

OUTREACH: HACKATHONS

FROM PROBLEMS TO PROTOTYPES TO PRODUCTION

ideathons, hackathons, and experiential learning centered around interdisciplinary collaboration and innovation

1

Identify problems to be solved to advance research and on-the-ground impact

2

Match teams to problems & mentors to build prototypes through virtual and in-person hackathons

3

Continue development on promising prototypes with student development teams & mentors

Fostering diversity and inclusion through interdisciplinarity

Charles C. Davis | **AllAsia:** Bringing Asian plant diversity to digital life | cdavis@oeb.harvard.edu

Acknowledgements

National Science Foundation

iDigBio
Integrated Digitized Biocollections

Symbiota2
Mobilizing Biodiversity Data

SPARK!
BUSpark!

iPlant Collaborative™