Connecting Biodiversity Research and Collections with Education and Outreach through CITIZEN SCIENCE

Special Thanks to Our Partners:
Crowd-sourced science: digitized natural history collections extends its branches to education and outreach
Collection Connection:

MicroPlants

http://microplants.zooniverse.org
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NEIU
Beth Sanzenbacher, Audrey Aronowsky
BioSynC, Field Museum
Matt von Konrat
Field Museum
Connecting Collections to Education & Outreach

- Phase I) 12 month pilot study involving almost 750 undergraduate students (2012-13)

- Phase II) A model engagement including general public, high school and undergraduate students (2013-14)

- Demonstration of web-based online tool (MicroPlants 2.0)
A matter of scale

Zoopsis

Frullania
Importance of Liverworts in the Environment

- Form microhabitats for other organisms.
- Contribute to food chains & the Web of Life.
- Absorb excess water like a sponge, preventing erosion and floods.
- Protection from land slides
Early Land Plants: Environmental Indicators

• Potential indicators of global warming & climate change.
• Used to assess the “health” of forests.
• Indicators of pollution and heavy metals in the atmosphere.
Intersection of ADBC and ARTS

North American Lichens and Bryophytes: Sensitive Indicators of Environmental Quality and Change

- NSF ADBC funding 2011
  - ~ 2.3 million specimens
  - 65 non-governmental US herbaria
  - 16 digitization centers (collaborators)

PI's Corinna Gries, Thomas H. Nash III
The Taxonomic Impediment

Advancing Revisionary Taxonomy and Systematics (ARTS)

“ARTS encourages collaborations that would broaden the human resource base available to tackle the taxonomic impediment, such as partnerships with undergraduate institutions, community colleges, and other institutions…….”
The taxonomic impediment ..... 

Diversity is disappearing worldwide at unprecedented rates

Worldwide shortage of taxonomists
• to identify species,
• describe species that are new to science,
• determine their taxonomic relationships,
• to make predictions about their properties

Advancing Revisionary Taxonomy and Systematics (ARTS)
“ARTS encourages collaborations that would broaden the human resource base available to tackle the taxonomic impediment, such as partnerships with undergraduate institutions, community colleges, and other institutions.......”
"We collaborate, I'm an expert, but not an authority, and Dr. Gelpis is an authority, but not an expert."
Welcome to Frullania.org - a Collaborative Research Network

This portal has been created to facilitate the sharing of data, synthesizing existing web resources and databases into a single streamlined resource for experts working on the liverwort genus Frullania. A major goal is to provide a dynamic forum to accelerate taxonomic research as well as education. Liverworts (Marchantiophyta) are pivotal in our understanding of early land plant evolution and are ecologically significant, existing as important and conspicuous components of the vegetation in many regions of the world.

Modern monographic treatments of liverworts are rare, and comprehensive treatments for species-rich genera currently are lacking. Frullania represents an exceptionally hyper-diverse, taxonomically complex genus with a worldwide distribution. There are over 2000 published names, of which almost 800 are currently accepted. Yet, conservative estimates that no more than 350–375 species may exist. Many Frullania species have interesting biological properties. For example, chemical compounds from some species show cytotoxicity against certain cancer cell lines.

The portal advocates a community approach to help yield high quality data and to expedite taxonomic research. The network is in direct synergy with the Early Land Plants Today? (see http://www.elpt.fieldmuseum.org) seeking to synthesize the vast amount of information on the taxonomy, nomenclature and distribution. The Frullania.org - Collaborative Research Network – is supported by the Symbiota Virtual Biota project (http://symbiota.org) promoting collaboration on biodiversity projects.

The portal is under development and currently contains modules for physical specimens and their associated data, taxonomy, interactive keys and checklists. The project is looking towards creating linked modules including sequences, and microsatellite profiles, morphological and biochemical data modules and the ability to automatically generate descriptions to be used as the basis for the monographs.

Please contact either Matt von Konrat (mykonrat@fieldmuseum.org), Blanka Shaw (blanka@duke.edu), Juan Larrain (jlarrain@fieldmuseum.org).
ARTS: Collaborative Research: A model systematic treatment of a hyper-diverse lineage descended from early land plants (Frullania, Frullaniaceae, Marchantiophyta).

Principal investigators Matt von Konrat, Juan Larraín, Matt Greif, Blanka Shaw, Ben Carter & Jon Shaw
Microfrullania
27 taxa (17/10)
Frullania Raddi

- More than 2000 published names (300-375 valid species?)
- Worldwide distribution, with centers of diversity in the humid and warm temperate regions
- Common as epiphyte
Subg. Microfrullania

Hentschel et al. 2009
Connecting Biodiversity Research and Collections with Education and Outreach through CITIZEN SCIENCE

Special Thanks to Our Partners:
Research Team

Herbarium Collections & Digitized Labels

Production of Digital Microscopic Images & Web Tool

The Connection Collection: MicroPlants Network
Undergraduate students (ca. 1,500 students)

Families, general public (ca. 4,000 participants)

Data Analysis (54,000+ measurements)

The Leaf Project Network (Post K-12)

Review by independent evaluation
1. Leaf lobule (inflated sac)

2. Cell anatomy
   - Cell size
   - Oilbodies

3. Spores
   - Size
   - Number of “rosettes”
- BIO150 *Essential Skills for Biologists*

Course Catalog description

“A practical approach to providing students with the basic skills they will be expected to have in upper-division biology courses, including lab safety; methods and units of scientific measurement; scientific record-keeping, communication and library research skills; and summarizing and presenting data. This course has both lecture and lab, with a significant web-based component.”
### Exercise 1

<table>
<thead>
<tr>
<th>Distance in pixels</th>
<th>Known distance</th>
<th>Unit of Length</th>
<th>Scale (pixels/ unit of length)</th>
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### Exercise 2

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<th>Species A</th>
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<th>Species B</th>
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<th>Species C</th>
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“As you can see, we run a completely paperless office.”
Results: How well did it work?

Mean lobule width measurements from NEIU from 2 different classes. Black diamonds, class 3; white squares, class 4; red circle, control; orange line: best fit of class 4; blue line, best fit of class 3. Mean lobule width measurements +/- SE for classes 3 & 4. Orange bar represents mean measure of classes 3 & 4, black bars represents +/- 1 standard deviation.
But did the students like it?
What did you learn from this exercise?

Liverworts are nonvascular land plants; interesting chemical properties

How to use imageJ!

How to enter data into Excel
Phase II: pilot of online tool

Help discover biodiversity!

Scientists from the Field Museum, Duke University and international researchers need your help.

Measure a critical morphological feature, a modified leaf (lobule), from early land plants to help scientists document and describe new species.
Great! There’s one more modified leaf fully visible in this image.

Mark the axes of the other modified leaf. Show me

Measure the modified leaves
Look for round bulges representing sac-like structures and measure the longest and widest axes.

Finish this Image

If you need some help, restart the tutorial or read frequently asked questions.

When you’d like to stop, please fill out a short survey.

Remember: Mark the long and short axes, like this:
I'm a Citizen Scientist!

MicroPlants Collection Connection

ZoOniverse

The Field Museum

microplants.zooniverse.org
Help discover biodiversity!

The world’s biodiversity is diminishing rapidly and undergoing an extinction crisis. Scientists from the Field Museum, Duke University and international researchers need your help.

Get Started    Learn More
Life on Earth is undergoing a mass extinction crisis. The world’s biodiversity is diminishing rapidly and undergoing an extinction crisis. Biological collections of museums and academic institutions, documenting the fossilized and living members of the world’s ecosystems and their changes over time, are uniquely poised to inform the stewardship of life on Earth.

Taxonomy – the branch of science classifying biodiversity. Researchers at The Field Museum and partnering institutions are conducting a taxonomic treatment of a hyper-diverse group of early land plants in the liverwort genus Frullania. This includes documenting, describing and discovering new species to science. Liverworts (Marchantiophyta) are pivotal in our understanding of early land plant evolution and exist as important components of the vegetation in many regions of the world. Taxonomic conclusions will be drawn from a multi-faceted data set, including morphology, fieldwork, experimental growth studies, as well as DNA sequence data, and population studies using DNA
Microplants – About Bryophytes

http://microplants.zooniverse.org

About Bryophytes

What is a bryophyte?

Bryophytes are a diverse group of early land plants that includes liverworts (Marchantiophyta), hornworts (Anthocerotophyta), and mosses (Bryophyta). They are considered to be the living descendants of the first terrestrial plants that evolved here on Earth. While much remains to be discovered about their biodiversity, biology, and geographic distribution, they are widespread throughout the globe and have important evolutionary, ecological, and medicinal characteristics that make them critically important to document, identify, and study. Some bryophytes might be confused
Why Study Bryophytes

Why are bryophytes important?

Together, bryophytes are the second largest group of land plants after flowering plants, and are pivotal in our understanding of early land plant evolution. Bryophytes are an important component of the vegetation in many regions of the world, constituting a major part of the biodiversity in moist forest, wetlands, mountain, and tundra ecosystems. Liverworts and mosses offer microhabitats that are critical to the survival of a tremendous diversity of organisms such as single-celled eukaryotes, protozoa, and numerous groups of invertebrates. Their structural contribution to levels of diversity might be as significant as that of vascular plants, albeit at a smaller scale.
Where are these images from?

Liverworts grow all over the world, but these Frullania images have typically been collected from the southern hemisphere in areas like Fiji, New Caledonia, and Chile. Specimens were collected in the field, brought back to the museum, and painstakingly mounted onto slides. From there, they imaged with a microscope by our many interns. Images were taken by interns at the Field Museum from Northeastern Illinois University, DePaul University, Harold Washington Chicago City College, and The Ohio State University. You might be the first person ever to study and analyze a particular image!
Undergraduate students express their experience!

"All together" Past Field Museum undergraduate interns, explain their experiences using MicroPlants as well as the ImageJ software used in some of our activities!
Microplants – Education

http://microplants.zooniverse.org

Overview

Activities

**Biological Illustrations.pdf**

Learn how to make scientific illustrations and record your observations, a great tool to help you to remember all the features of an observed specimen.

**Early Land Plants Today.pdf**

This activity focuses on morphology, the study of form and structure of organisms and specific structural features. Students can investigate morphological characteristics of early land plants.

**ImageJ Instructions.pdf**

ImageJ is a free program developed by the National Institute of Health (NIH) that has given the scientific community a way of generating data from images.
Welcome to the Leaves Project!
This quick tutorial will guide you through your first classification.

Continue
Oops! I made a mistake. How do I undo a mistake?

First off, don’t panic! Simply, select the “X” that appears in the grey box after each measurement to delete that set of measures. In any event, if you make a mistake, we will be able to sort that out when all the data is collected.

How do I differentiate a lobule from the rest of the image?

Usually the structures in clear focus within the image will be the lobules; it will generally be toward the center of the image. We will measure only lobules (modified leaves) that are clearly focused and fall entirely within the image. Here are some pictures to help guide you.

How many lobules are on each image?

Each image will have at least one lobule; however, some images will have several.

The app is not loading, what should I do?

The website may be affected by your connection speed. If you’re able to connect to the internet, check to see if you’re using the latest version of the browser. If you still can’t access the website, try refreshing or clearing your cache.
Measure the modified leaves

Look for round bulges representing sac-like structures and measure the longest and widest axes.

Finish this image

If you need some help, restart the tutorial or read frequently asked questions.

When you'd like to stop, please fill out a short survey.

http://microplants.zooniverse.org
Location and information

Collector, Date collected, Habitat, Links to Symbiota
Measurements Recorded!

If you want, you can discuss this on Talk or share it with the world!

Favorite  Discuss  Share

We ask each person to mark 5 images. You have marked 3 so far!

Ready to Move on?
Weekly data dumps
Sunday July 27, 54,209 measurements!
The data returns as \((x, y)\) coordinates for the points where people mark the lines as beginning and ending.

**Omit from analysis –**

How?
Juan’s length data falls both within range and within a 95% CI of the mean length.
The bad and the ugly
Connection Collection: Microplants – Survey
http://microplants.zooniverse.org

Welcome
Thank you for participating in this brief evaluation of your experience with Collection Connection: MicroPlants. This survey should take approximately 8 minutes.

Tell us about yourself

Please enter your year of birth (YYYY):

Before today, when did you last visit a museum?

- Less than 3 months ago
- 3-6 months ago
- 6-12 months ago
- More than a year ago
After completing this activity, I have a better understanding of the processes scientists use in research.

- Strongly disagree: 14 (5%)
- Disagree: 3 (1%)
- Neutral: 39 (14%)
- Agree: 131 (48%)
- Strongly agree: 86 (32%)

After participating in the project, I am likely to read more about science.

- Strongly disagree: 8 (3%)
- Disagree: 22 (8%)
- Neutral: 97 (36%)
- Agree: 87 (32%)
- Strongly agree: 56 (21%)
Prior to this activity were you aware that the Field Museum has 25 million specimens and objects that are helping scientists at the museum and worldwide to help document biodiversity on earth?

- Yes: 32%
- No: 68%
Conclusion

• What motivates users during participation?
  - Northwestern University, University of Illinois, Chicago

Program and Student Feedback Evaluation
• Objective review by professional staff & Learning Science students
  • University of Illinois at Chicago

Social Science Of Learning

Post K-12
• Wilbur Wright College
• NEIU
• Roosevelt University On-line courses

Public
• Museum Campus
• Stanley Field Hall

Data Generation (detail)

K-12
• Field Museum Education Department
• Chicago Public Schools

Data Analysis
• NEIU (Math Dept. & Students) & Roosevelt University (Bioinformatics, graduate students)
Visions for the immediate Future

- Reach out to Zooniverse users (>{100,000 participants).
- Apply to other character sets.
- Apply to other organisms.
- Model for developing meta data associated with digitized images.
- Build learning modules.
The Field Museum
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Juan Larrain (Post Doctoral Research Scholar, Science & Education)
Beth Crownover (Director, Education Department)
Jessica Hankey (School Partnerships and Programs Manager, Education Department)
Kristina Lugo (Annual Fund Coordinator, Institutional Advancement)
Juan Larrain (Post Doctoral Research Scholar, Science & Education)
Beth Sanzenbacher (Outreach Coordinator, BioSynC)
Audrey Aronowsky (Outreach Coordinator, BioSynC)
The Adler Planetarium
Arfon Smith, Co-Principal Investigator (Director of Citizen Science)
Michael Parrish
Brian Carstensen
David Miller
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Northeastern Illinois University
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John Kasmer (Associate Professor and Chair, Department of Biology)
Oana Vadineanu (Intern, Field Museum)

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Leilah Lyons (Assistant Professor Computer and Learning Sciences)
Tia Shelley (Research Assistant, Computer and Learning Sciences)
Roosevelt University
Mike Bryson (Associate Professor of Humanities and Sustainability Studies)
Duke University
Blanka Shaw (Database Manager)
Smithsonian Institute, Jose Gudino (Collaborator, photos, keys)
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Charlie D'Lavoy (Northeastern Illinois University)
Alex Vizzone (Northeastern Illinois University)
Xenia Alava (Northeastern Illinois University)
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