iDigBio
Integrated Digitized Biocollections

2015 Annual Summit

Arlington, Virginia

November 4-6, 2015

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Welcome

Dear colleagues,

Welcome to the 5th annual iDigBio-hosted summit for ADBC scientists and students! This year, the summit is a super-summit with an anticipated 150 participants, including those from the 15 TCNs, international colleagues working with biodiversity collections data, guests from the NSF and the Smithsonian Institution, and iDigBio. As in past years, we have a packed agenda of presentations and discussion groups, but we also have plenty of opportunities for networking. The latter include daily morning and afternoon breaks, lunches, an evening reception at the U.S. Botanic Garden, a free evening to organize your own discussion group, and breakout sessions that are open for small groups to organize and discuss any topics of interest to them.

The national effort to digitize information in biocollections as outlined in the NIBA Strategic Plan has been successfully catalyzed by funding from NSF and activities of the TCNs and iDigBio. As a community, we have defined digitization priorities, integrated best practices into workflows, provided cyberinfrastructure resources including a search portal, addressed major challenges via working groups and built collaborations with data providers/users. We have improved digitization practices, increased involvement in digitization and training and adopted informatics tools that improve the efficiency and scalability of digitization in all types of collections.

In its 5th year, iDigBio is working with staff in 482 collections in 250 institutions. We have communicated with our stakeholders to increase access to collections data through workshops, webinars, the *iDigBio Spotlight* and social media. During its first 4 years, iDigBio sponsored attendance of 2,200 participants from 511 institutions to 63 workshops that targeted digitization-related topics. iDigBio has ingested 638 recordsets containing almost 46 million records and 13 million images. All data ingested are indexed so that queries and other types of index-based access are supported. Searches can be done through a Web-based graphical interface or through APIs. Search and analytical tools enable users to mine diverse data such as taxonomy, location, images, traits and vocalizations.

As we move forward and TCNs generate increasingly complete and valuable data, iDigBio will continue its successful strategies with a greater emphasis on data improvement and use in research and outreach. The national resource created by NSF through ADBC is increasingly recognized as essential for digitized information on biodiversity. Our work is continuing, and the results are increasingly visible to the scientific community. Let's make Summit V a catalyst for even greater success!

Larry Page, Director
iDigBio

Contacts for Questions or Problems

If you encounter logistical issues prior to or upon your arrival in Arlington and require assistance, contact Cathy Bester at 352-214-5043 or David Jennings at 352-870-7562.

Travel to Arlington, Virginia

As an iDigBio-supported participant, your travel arrangements have been coordinated and finalized by Cathy Bester; you should have already received all travel details in a separate email. If you have any remaining travel questions, please contact Cathy at cbester@flmnh.ufl.edu. If your travel is not being supported by iDigBio, you are responsible for your own travel and expenses.

Hotel and Conference Location

Lodging and conference facilities are located at the Hilton Arlington, 950 N. Stafford St, Arlington VA 22203. The Hilton's telephone number is 703-528-6000, and the website is **http://www3.hilton.com/en/hotels/virginia/hilton-arlington-DCAVAHF/index.html**. See map on page 4.

Rail from Reagan National Airport to the Hilton Arlington

There is a Metro rail station at Reagan National Airport. We recommend you take the Blue line heading toward Largo Town Center. Get off at Rossyln. Switch to the Orange line heading toward Vienna. Get off at Ballston-MU. The trip should take 30 – 40 minutes. At Ballston, you will travel on foot eastbound, one block, along N. Fairfax Drive to N. Stafford St. At Stafford St, you will walk southbound until reaching the Hilton Arlington at 950 N. Stafford St. For reference, the Hilton Arlington is located across from the National Science Foundation. For more info on the Metro please visit their website at: **http://www.wmata.com/** and **http://www.wmata.com/rail/frequency.cfm**

Hotel and Conference Check-In

A block of rooms has been reserved for Summit participants; you are responsible for making your own reservations at our discounted group rate ($189/night plus taxes). Conference materials (including a printed agenda and name tag) may be picked up from David Jennings or Jillian Goodwin during the informal welcome reception at the Lounge at Dan & Brad's (cash bar) located inside the Hilton during the evening of November 3 for those arriving that day. Guests arriving on November 4 may pick up these materials that evening from Cathy Bester or Jillian Goodwin at the Hilton Conference Desk between 5:30pm and 6:30pm or during the informal welcome reception at the Lounge at Dan & Brad's (cash bar) located inside the Hilton that evening. Late summit check-in will be available on November 5 between 8:00am and 9:00am in the Pre-Function Space. Wireless network access will be available onsite through the Hilton Arlington for all Summit participants.

iDigBio Summit V Wiki

For the most up-to-date information regarding the Summit agenda, participants, logistics and other items of interest, please visit the event wiki page at **https://www.idigbio.org/wiki/index.php/IDigBio_Summit_2015**. Recorded presentations and reports will be posted on this site following the Summit for future reference.

Meals and Other Activities

An informal welcome gathering will be held at the Hilton's Lounge at Dan & Brad's (cash bar) beginning at 7:00pm on both November 3 and November 4. Breakfasts and lunches, along with break refreshments, will be provided at the Hilton on November 4, 5 and 6 during the Summit sessions and related activities. There will be a catered reception on November 5 from 6:30 - 9:00pm at the U.S. Botanic Garden located at 100 Maryland Ave. SW, Washington DC. Dinner is on your own during the evenings of November 4 and 6. Meals not provided as workshop functions will qualify for reimbursement at our per diem rate; see below for reimbursement procedures.

United States Botanic Garden Reception - November 5, 6:30 - 9:00pm

You can reach the USBG by Metrorail from the Ballston-MU metro stop via the Orange line toward New Carrollton or the Silver line toward Largo Town Center. Get off at the Federal Center SW station. Exit the station, walk north (left) along Third Street SW for two blocks, cross Independence Avenue and continue one more block to Maryland Avenue. Look toward the Capitol and you will see the glass dome of the Conservatory. The Conservatory entrance is on Maryland Avenue. The trip should take about 30 minutes. Guests are welcome to tour the entire Conservatory (with the exception of one gallery that will be under exhibit construction). To return to the Hilton, get on the Orange line toward Vienna or the Silver line toward Wiehle-Reston East and get off at the Ballston-MU stop.

Rail from the Hilton Arlington to the Reagan National Airport

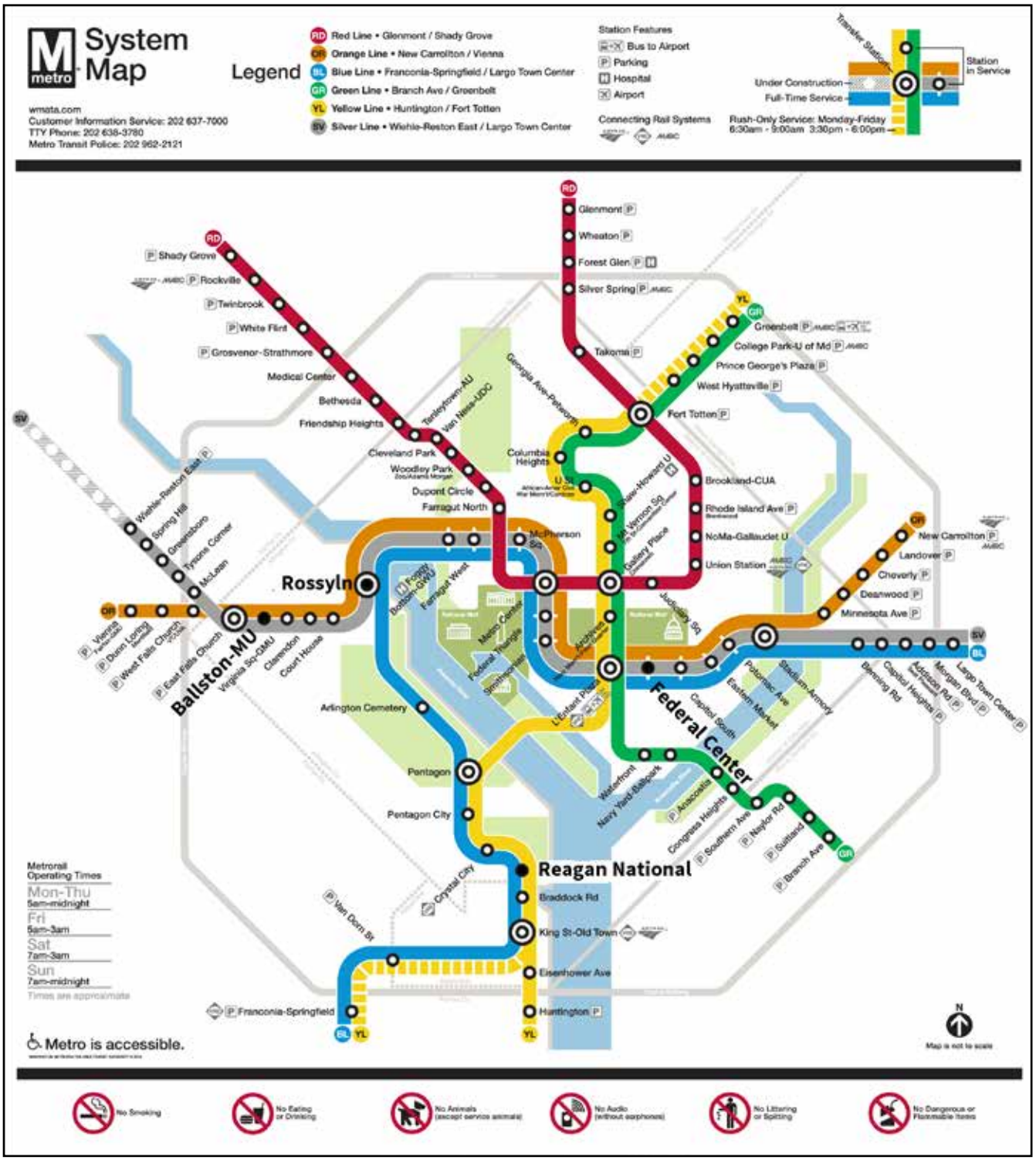
To return to Reagan National Airport, travel on foot northbound from the Hilton Arlington on N Stafford St. to N Fairfax Dr. Walk westbound on N Fairfax Dr until you reach the Ballston-MU stop. Take the Orange line heading towards New Carrollton to Rossyln. At Rosslyn, switch to the Blue line heading towards Franconia-Springfield; exit at the airport. For more info on the Metro and Metrorail frequency, please visit their website at: **http://www.wmata.com/** and **http://www.wmata.com/rail/frequency.cfm**

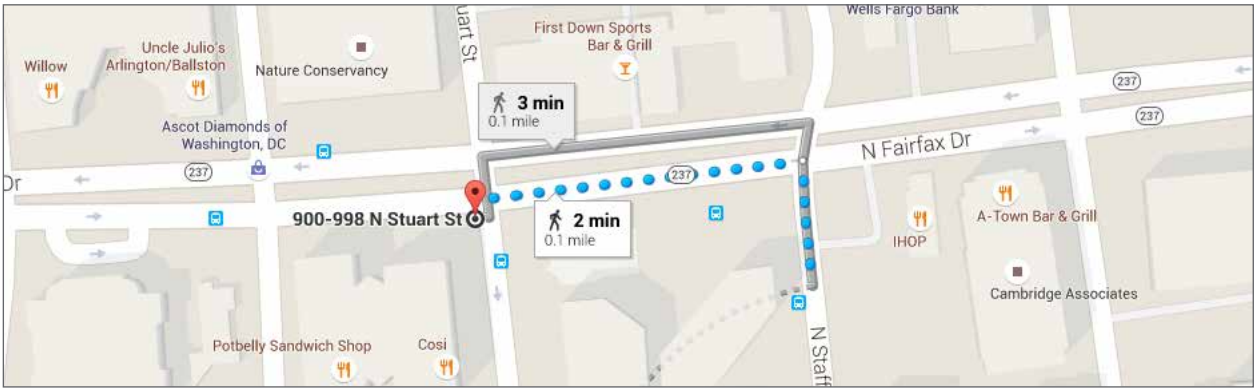
Reimbursements

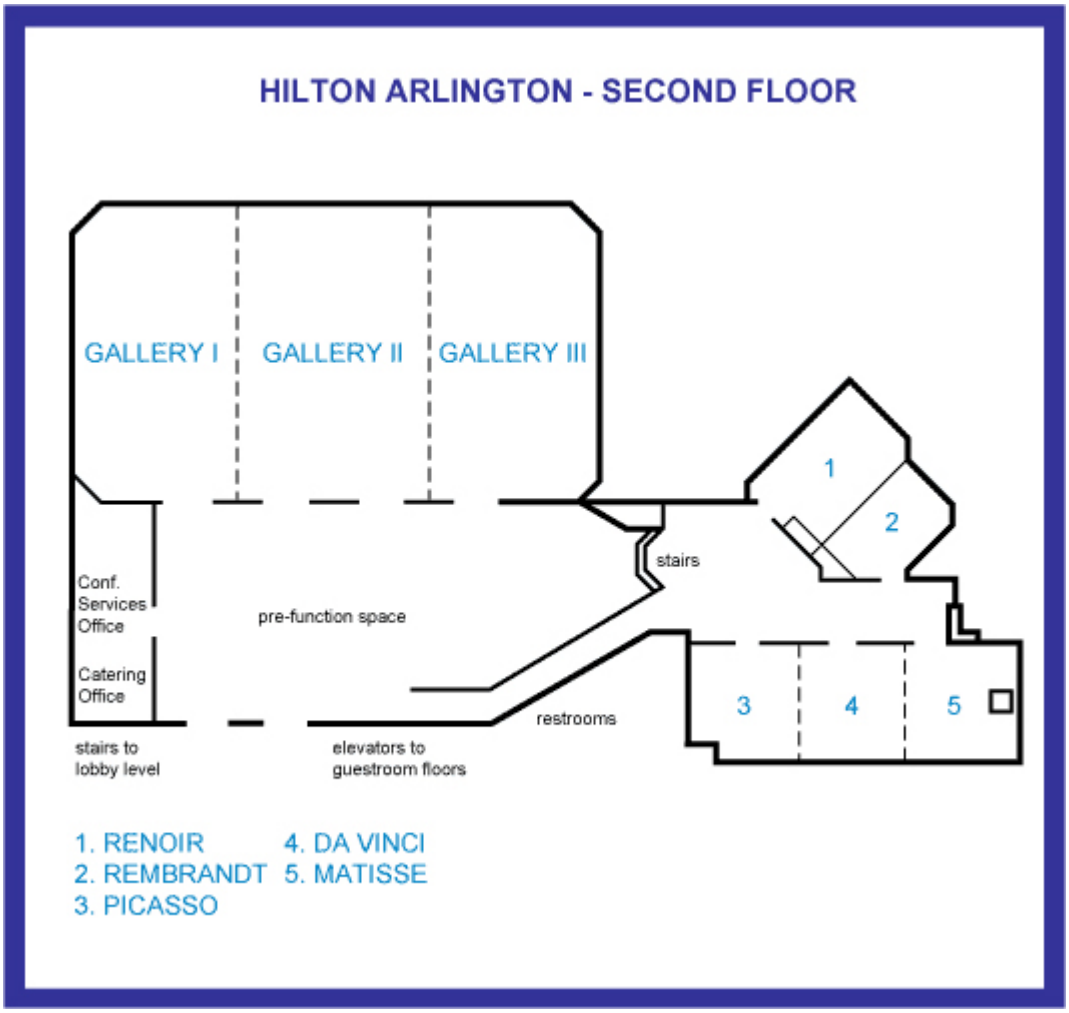
Project Assistant Cathy Bester will send out an email to all participants during the week following the Summit regarding reimbursement. Any meals not provided as Summit functions will be reimbursed at the State of Florida per diem rate (breakfast $6, lunch $11, dinner $19); no receipts are needed for meals. Mileage, metro fares, parking fees, and baggage fees may qualify for reimbursement. Please retain your original receipts showing form of payment; copies will not be accepted by UF. If you have any questions, please contact Cathy at 352-249-1949 or cbester@flmnh.ufl.edu.

Adobe Connect

To the extent possible, the Summit sessions will be broadcast and recorded using Adobe Connect, and the meeting hosts will monitor the chat to address questions/concerns. To connect, go to **https://idigbio.adobeconnect.com/summit5/** and choose Enter as Guest, type your first and last name, and then click Enter Room. Remote participants are encouraged to visit the iDigBio Web Conferencing Wiki prior to connecting. **https://www.idigbio.org/wiki/index.php/Web_Conferencing**


System Map
Legend
Red Line • Glenmont / Shady Grove
Orange Line • New Carrollton / Vienna
Blue Line • Franconia-Springfield / Largo Town Center
Green Line • Branch Ave / Greenbelt
Yellow Line • Huntington / Fort Totten
Silver Line • Wiehle-Reston East / Largo Town Center
Station Features
Bus to Airport
Parking
Hospital
Airport
Connecting Rail Systems
Transfer Station
Station in Service
Under Construction
Full-Time Service
Rush-Only Service: Monday-Friday 6:30am - 9:00am 3:30pm - 6:00pm
wmata.com
Customer Information Service: 202 637-7000
TTY Phone: 202 638-3780
Metro Transit Police: 202 962-2121
Glenmont
Wheaton
Forest Glen
Silver Spring
Takoma
Shady Grove
Rockville
Twinbrook
White Flint
Grosvenor-Strathmore
Medical Center
Bethesda
Friendship Heights
Tenleytown-AU
Van Ness-UDC
Cleveland Park
Woodley Park
Dupont Circle
Farragut North
Georgia Ave-Petworth
Columbia Heights
U St
Shaw-Howard U
Mt Vernon Sq
Gallery Place
McPherson Sq
Brookland-CUA
Rhode Island Ave
NoMa-Gallaudet U
Union Station
Fort Totten
Greenbelt
College Park-U of Md
Prince George's Plaza
West Hyattsville
New Carrollton
Landover
Cheverly
Deanwood
Minnesota Ave
Wiehle-Reston East
Spring Hill
Greensboro
Tysons Corner
McLean
Rossyln
Foggy Bottom-GWU
Farragut West
Metro Center
Federal Triangle
Smithsonian
Archives
L'Enfant Plaza
Judiciary Sq
Ballston-MU
Virginia Sq-GMU
Clarendon
Court House
Vienna
Dunn Loring
West Falls Church
East Falls Church
Arlington Cemetery
Pentagon
Pentagon City
Crystal City
Reagan National
Braddock Rd
King St-Old Town
Eisenhower Ave
Huntington
Van Dorn St
Franconia-Springfield
Federal Center
Capitol South
Eastern Market
Potomac Ave
Stadium-Armory
Benning Rd
Capitol Heights
Addison Rd
Morgan Blvd
Largo Town Center
Waterfront
Navy Yard-Ballpark
Anacostia
Congress Heights
Southern Ave
Naylor Rd
Suitland
Branch Ave
Metrorail Operating Times
Mon-Thu 5am–midnight
Fri 5am–3am
Sat 7am–3am
Sun 7am–midnight
Times are approximate
Metro is accessible.
Map is not to scale
No Smoking
No Eating or Drinking
No Animals (except service animals)
No Audio (without earphones)
No Littering or Spitting
No Dangerous or Flammable Items


Wells Fargo Bank
First Down Sports Bar & Grill
Uart St
Willow
Uncle Julio's Arlington/Ballston
Nature Conservancy
3 min
0.1 mile
Ascot Diamonds of Washington, DC
N Fairfax Dr
237
900-998 N Stuart St
2 min
0.1 mile
IHOP
A-Town Bar & Grill
Cambridge Associates
Potbelly Sandwich Shop
Cosi
N Staff


HILTON ARLINGTON - SECOND FLOOR
GALLERY I
GALLERY II
GALLERY III
1
2
stairs
Conf. Services Office
pre-function space
Catering Office
3
4
5
restrooms
stairs to lobby level
elevators to guestroom floors
1. RENOIR
2. REMBRANDT
3. PICASSO
4. DA VINCI
5. MATISSE

Area Restaurants (all are Arlington 22203)

Dan and Brad's (inside the Hilton Arlington)
Cosi (Healthy Fare/Coffee)
3503 Fairfax Dr.
http://www.getcosi.com/

Potbelly Sandwich Shop (Sandwiches)
4250 Fairfax Dr.
http://www.potbelly.com/

A-Town Bar & Grill (American/Sushi/Pizza)
4100 Fairfax Dr.
http://a-townballston.com/

Uncle Julio's (Mexican)
4301 Fairfax Dr, #100
http://www.unclejulios.com/

Grand Cru Wine Bar & Bistro (Upscale)
4401 Wilson Blvd.
http://www.grandcru-wine.com/

Front Page Arlington (American)
4201 Wilson Blvd.
http://www.frontpagearlington.com/

First Down Sports Bar & Grill (Pub Fare)
4213 N. Fairfax Dr.
http://www.firstdownsportsbar.com/

Tara Temple Restaurant (Asian)
4001 Fairfax Dr.
http://www.taratemplearlington.com/

Sweetgreen (Healthy Fare)
4075 Wilson Blvd
http://sweetgreen.com/

Rustico Restaurant & Bar (American)
4075 Wilson Blvd
http://www.rusticorestaurant.com/

Tuesday, November 3, 2015

Time	Pre-Function Space or Other	Gallery I-II	Gallery III	Picasso & DaVince	Matisse
7:00pm	Check-In Informal Gathering (Dan & Brad's)				

Wednesday, November 4, 2015

Time	Pre-Function Space or Other	Gallery I -II	Gallery III	Picasso & DaVinci	Matisse
8:00 - 9:00	Breakfast Check-In				
9:00 - 10:30			Microfungi Meeting	GBIF Task Force Meeting	iDigBio External Advisory Board Meeting (closed) **9:30 - 10:30**
10:30 - 11:00	Break				
11:00 - 12:30			Microfungi Meeting cont'd.	GBIF Task Force Meeting cont'd.	
12:30 - 1:30	Lunch				
1:30 - 3:00		Welcome to New TCNs		GBIF Task Force Meeting cont'd.	
3:00 - 3:30	Break				
3:30 - 4:30		Intro to Project Management		GBIF Task Force Meeting cont'd.	
4:30 - 5:00		Q & A			
5:30 - 6:30	Summit Check-In				
Evening	Informal Gathering (Dan & Brad's)				

Thursday, November 5, 2015

Time	Pre-Function Space or Other	Gallery I -II	Gallery III	Picasso & DaVinci	Matisse
8:00 - 9:00	Breakfast Check-in		Poster Set Up		
9:00 - 9:30		Welcome			
9:30 - 10:20		iDigBio Presentations			
10:20 - 10:40		2015 TCN Presentations			
10:40 - 11:15	Break				

Thursday continued

Time	Pre-Function Space or Other	Gallery I -II	Gallery III	Picasso & DaVinci	Matisse
11:15 - 11:45		2014 TCN Presentations			
11:45 - 12:15		2013 TCN Presentations			
12:15	Group Photo				
12:30 - 1:30	Lunch				
1:30 - 2:45		Data Management	Education & Outreach	iDigBio Resources	Ad Hoc Discussion
2:45 - 3:45	Break		Poster Session		
3:45 - 5:00		Research Tool Development	iDigSTEAM Workshop	Project Management	Ad Hoc Discussion
5:00 - 5:30		Day 1 Wrap-Up			
6:30 - 9:00	Reception at U.S. Botanic Garden				

Friday, November 6, 2015

Time	Pre-Function Space or Other	Gallery I -II	Gallery III	Picasso & DaVinci	Matisse
8:00 - 9:00	Breakfast				
9:00 - 9:20		Orientation BCon			
9:20 - 10:00		2012 TCN Presentations			
10:00 - 10:30		2011 TCN Presentations			
10:30 - 11:00	Break				
11:00 - 12:15		Biodiversity Initiatives			
12:15 - 1:15	Lunch				
1:15 - 2:30		Citizen Science	Sustainability	Symbiota	Ad Hoc Discussion
2:30 - 3:30	Break		Poster Session		
3:30 - 4:45		Data Use	Attribution	Collaboration & Communication	Ad Hoc Discussion
4:45 - 5:15		Day 2 Wrap-Up			
5:15 - 5:45		Summit Wrap-Up			

Tuesday, November 3, 2015

Travel Day for Microfungi TCN, EPICC TCN, iDigBio EAB, and iDigBio Planning Team

7:00pm - 9:00pm	Summit Check-In Informal Welcome Gathering (cash bar available)		Dan & Brad's
Evening	Dinner on your own		

Wednesday, November 4, 2015

Business Meetings; Travel Day for All Other Attendees

8:00am - 9:00am	Breakfast (provided) Summit Check-in		Pre-function
9:00am - 10:30am	Microfungi TCN Meeting • The Microfungi Project • Digitization Workflows & the MyCoPortal	 Andrew Miller Elizabeth Lippoldt	Gallery III
9:00am - 10:30am	GBIF Task Force Meeting		Picasso/DaVinci
9:30am - 10:30am	iDigbio External Advisoty Board Meeting (closed session)		Matisse
10:30am - 11:00am	Morning Break (provided)		Pre-function
11:00am - 12:30pm	Microfungi TCN Meeting (continued) • The Voice Data Command Control • The MyCoPortal Taxonomic Thesaurus • Questions & Answers	 Phil Anders Scott Bates	Gallery III
11:00am - 12:30pm	GBIF Task Force Meeting (continued)		Picasso/DaVinci
12:30pm - 1:30pm	Lunch (provided)		Pre-function
1:30pm - 3:00pm	GBIF Task Force Meeting (continued)		Picasso/DaVinci
1:30pm - 3:00pm	Welcome to iDigBio for New TCNs	Joanna McCaffrey, David Jennings, Dan Stoner	Gallery I-II
3:00pm - 3:30pm	Afternoon Break (provided)		Pre-function
3:30pm - 4:30pm	GBIF Task Force Meeting (continued)		Picasso/DaVinci
3:30pm - 4:30pm	Introduction to Project Management	David Jennings	Gallery I-II
4:30pm - 5:00pm	Questions & Answers	Joanna McCaffrey, David Jennings, Dan Stoner	Gallery I-II
5:00pm	Adjourn		
5:30pm - 6:30pm	Summit Check-in		Pre-function
7:00pm	Informal Wecome Gathering (cash bar available)		Dan & Brad's
Evening	Dinner on your own		

Thursday, November 5, 2015

iDigBio Summit Day 1

8:00am - 9:00am	Breakfast (provided) Summit Check-in		Pre-function
8:00am - 9:00am	Poster Setup		Gallery III
9:00am - 9:10am	Welcome & Orientation	David Jennings	Gallery I-II
9:10am - 9:20am	Welcome from the National Science Foundation	James Olds	Gallery I-II
9:20am - 9:30am	NSF's Advancing Digitization of Biodiversity Collections	Roland Roberts	Gallery I-II
9:30am - 10:20am	iDigBio Presentations • Progress & Challenges for the National Digitization Effort • Digitized Data in Biodiversity Research • Education & Outreach • Enabling Digitization • Cyberinfrastructure Status Report	 Larry Page Pam Soltis Bruce MacFadden Greg Riccardi José Fortes	Gallery I-II
10:20am - 10:40am	2015 TCN Presentations • The Microfungi Collections Consortium • Documenting Fossil Marine Invertebrates of the East Pacific	 Andrew Miller Charles Marshall	Gallery I-II
10:40am - 11:15am	Morning break (provided)		Pre-function
11:15am - 11:45am	2014 TCN Presentations • Great Lakes Aquatic Invasives: Where are we one year later? • InvertEBase: Current Status • SERNEC - TCN: Current status, citizen science and outreach activities	 Ken Cameron Petra Sierwald Michael Denslow	Gallery I-II
11:45am - 12:15pm	2013 TCN LPresentations • Fossil Insect Collaborative • Vouchered Animal Communication Signals • Macroalgal Herbarium Digitization Project	 Dena Smith Matthew Medler Chris Neefus	Gallery I-II
12:15pm	Group Photo	Joanna McCaffrey	Pre-function
12:30pm - 1:30pm	Lunch (provided)		Pre-function
1:30pm - 2:45pm	**Discussion Groups**		
	Data Management **https://goo.gl/ptJrjB**	Kevin Love, Alex Thompson	Gallery I-II

Keeping up with data requires certain skills and infrastructure. Managing data is integral to the research process, and how data are managed depends on the types of data involved, how data are collected and stored, and how data are used. This group will discuss issues surrounding shared data and will discuss strategies for data cleaning, augmentation, annotations, and more.

Thursday continued

Education & Outreach **https://goo.gl/vkodnc** Molly Phillips, Bruce MacFadden — Gallery III

This discussion session will serve as an in-person Education & Outreach Working Group meeting. Individuals interested in joining the working group, or anyone interested in the topics proposed, are encouraged to attend. All are welcome. During the session, we will be discussing, and trying to identify, appropriate target audiences for current and projected outreach activities across ADBC. We will also be discussing and selecting topics for an upcoming E & O webinar series. Other E & O topics are welcome as time permits.

iDigBio Resources **https://goo.gl/KRDQp7** Joanna McCaffrey, David Jennings — Picasso/DaVinci

Resources on the iDigBio website and wiki have grown considerably over the last 4½ years. This session will briefly review what resources are available and where they can be found. We invite you to share your digitization materials and discuss what other materials you would like to see developed and/or collated.

Ad Hoc Discussion **https://goo.gl/W01n0I** — Matisse

This room is available for ad hoc meetings and discussions.

2:45pm - 3:45pm	Afternoon Break (provided)	Pre-function
2:45pm - 3:45pm	**Working Groups & Interest Group Poster Session**	Gallery III
	• Augmented Reality Public Education/Outreach — Anne Basham	
	• Augmenting OCR — Deb Paul	
	• Data Management Interest Group — Shelley James	
	• Developing Robust Object to Image to Data — Gil Nelson	
	• Education & Outreach — Molly Phillips, Bruce MacFadden, Mari Roberts	
	• Georeferencing Working Group — Deb Paul	
	• WeDigBio: Worldwide Engagement for Digitizing Biocollections — Austin Mast, Libby Ellwood	
	• Small Collections Network & North American Network of Small Herbaria — Gil Nelson	
	• Paleo Digitization Working Group — Talia Karim	
3:45pm - 5:00pm	**Discussion Groups**	

Research Tool Development **https://goo.gl/eNhuXK** Pam Soltis — Gallery I-II

Learn about the tools currently available for synthetic biodiversity research using digitized specimen data and discuss those that need to be developed to facilitate innovative research using collections data available via the iDigBio portal and other aggregators. What data and/or tools would you like to see available through the iDigBio portal? The discussion will also provide a forum for sharing ideas about how iDigBio can facilitate research through training worshops on data carpentry and analysis.

iDigSTEAM Workshop **https://goo.gl/MckbVi** Anne Basham — Gallery III

From "Insect Love Motels" to "Libraries of Life"—this session will give an overview of the exploding movement of STEAM (science, technology, engineering, math, and the arts) which integrates new technologies and the arts in teaching. Participants will be provided with some tools and resources that will serve educators and outreach specialists in the ADBC community who arelooking to better serve broader impacts but are not quite sure how or what is available. New tools and technologies are increasingly being used in both informal and formal learning environments to educate and connect diverse audiences with collections and their data in highly visual and interactive ways

Thursday continued

	Project Management **https://goo.gl/2gT9EW**	David Jennings, Joanna McCaffrey	Picasso/DaVinci
	This group will discuss the importance of project management & administration in keeping your project on time and within budget. We will discuss lessons learned, what worked, and what didn't work based on your experiences and then brainstorm new approaches. We encourage older TCNs to mentor and advise younger TCNs.		
	Ad Hoc Discussion **https://goo.gl/7lXVbw** *This room is available for ad hoc meetings and discussions.*		Matisse
5:00pm - 5:30pm	Day 1 Wrap-up: Discussion Group Summaries		
5:30pm	Adjourn		
6:30pm - 9:00pm	**Dinner and Reception at the U.S. Botanic Garden** • The trip from Ballston to Federal Center SW on either the Orange or Silver metro lines will take about 30 minutes. • Guests are welcome to tour the Conservatory.		**www.usbg.gov**

Friday, November 6, 2015

iDigBio Summit Day 2

8:00am - 9:00am	Breakfast (provided)		Pre-function
9:00am - 9:10am	Orientation to the Day	David Jennings	Gallery I-II
9:10am - 9:20am	Biodiversity Collections Network (BCoN)	Robert Gropp	Gallery I-II
9:20am - 10:00am	**2012 TCN Presentations** • Mobilizing New England Vascular Plant Data to Track Environmental Change • PaleoNICHES • The Macrofungi Collection Consortium • Symbiota Collections of Arthropods Network	 Patrick Sweeney Susan Butts Barbara Thiers Neil Cobb	Gallery I-II
10:00am - 10:30pm	**2011 TCN Lightning Presentations** • InvertNet: Year 5 and Beyond • The Tri-Trophic Thematic Collection Network: A summary of four years of progress and learning • Lichen, Bryophytes and Climate Change, 4.2 million records later	 Chris Dietrich Katja Seltmann Thomas Nash	Gallery I-II
10:30am - 11:00am	Morning Break (provided)		Pre-function
11:00am - 12:15pm	**Presentations from National & International Biodiversity Informatics Initiatives** • Update on BISON, ITIS and EcoINFORMA Activities Relevant to iDigBio • GBIF's Accelerating the Discovery of Biocollections Data Task Force • Getting More From Image Libraries – New Computer Vision Tools	 Stinger Guala Siro Masinde John LaSalle	Gallery I-II

Friday continued

	• Brazil's Virtual Herbarium: Outputs, Outcomes and Challenges	Dora Canhos
	• Biodiversity Information and Sharing Status in China	Zheping XU
	• Canadensys: Biodiversity Across the Borders	David Shorthouse
	• A Network Connecting Science With Conservation	Mary Klein
	• Interoperability: Fomenting Opportunities at the Intersection of Collections and Ecology	Brian Wee
12:15pm - 1:15pm	Lunch (provided)	Pre-function
1:15pm - 2:30pm	**Discussion Groups**	

Citizen Science **https://goo.gl/ynSpTG** — Austin Mast, Libby Ellwood, Betty Dunckel — Gallery I-II

The field of citizen science is rapidly expanding, and iDigBio is actively involved in exploring, understanding, and implementing citizen science practices in digitization activities. To this end, we have hosted hackathons, imaging and transcription blitzes, and the recent Worldwide Engagement for Digitizing Biocollections (WeDigBio) Event. Two iDigBio Working Groups are devoted to advancing citizen science in digitization. The Interoperability for Public Participation in Digitization Working Group is working to improve interoperability among the several online tools that involve public participants in digitization in order to streamline the flow of information between the currently disparate platforms. The User Engagement for Public Participation in Digitization Working Group is working on expanding our knowledge of volunteer motivations and accuracy, as well as developing resources to assist new projects with effective volunteer engagement. Join us in this discussion group to learn more about what we've been up to and the resources that are available to you, to help develop an integrated pipeline for making citizen science and crowdsourcing adaptable across the TCNs, and to become involved in our long-term efforts.

Sustainability **https://goo.gl/w3M6wM** — Larry Page, Mary Klein — Gallery III

Realizing the potential of biological collections as a source of "Big Data" through digitization is a long-term endeavor. The goal of this session is to consider the long-term sustainability of the national digitization effort and its component elements, including Thematic Collections Networks (TCNs) and iDigBio. We will address some of the following issues: (1) What economic models do you know that that might be useful? (2) Which funding agencies promote and support ongoing digitization activities, directly and indirectly, and how can these be leveraged? (3) What are the most effective methods to secure institutional support for digitization and the staff and infrastructure required to underpin this work? (4) What is the long-term technological vision for the next generation of digitization activities? (5) Who and what organizations might support our efforts?

Symbiota Users **https://goo.gl/KUtfo7** — Neil Cobb — Picasso/DaVinci

Participate in a forum to discuss Symbiota sustainability, collaborative activities among portals, and Symbiota software developments to promote research, education, and outreach.

Ad Hoc Discussion **https://goo.gl/prTZw0** — Matisse

This room is available for ad hoc meetings and discussions.

2:30pm - 3:30pm	Afternoon Break (provided)	Pre-function

Friday continued

2:30pm - 3:30pm	**Working Groups & Interest Group Poster Session**		Gallery III
	• Augmented Reality Public Education/Outreach	Anne Basham	
	• Augmenting OCR	Deb Paul	
	• Data Management Interest Group	Shelley James	
	• Developing Robust Object to Image to Data	Gil Nelson	
	• Education & Outreach	Molly Phillips, Bruce MacFadden,	
	• Georeferencing Working Group	Mari Roberts	
	• WeDigBio: Worldwide Engagement for Digitizing Biocollections	Deb Paul Austin Mast,	
	• Small Collections Network & North American Network of Small Herbaria	Libby Ellwood Gil Nelson	
	• Paleo Digitization Working Group	Talia Karim	
3:45pm - 4:45pm	**Discussion Groups**		
	Data Use in Research & Education **https://goo.gl/6tmQbZ**	Pam Soltis, Molly Phillips, Bruce MacFadden	Gallery I-II
	Explore ways to use specimen-based data in research and education. Discussion topics will include use of georeferenced locality data for species distribution modeling and extension to studies of phylogenetic diversity, species' responses to climate change, and conservation. Research applications that make use of specimen images for extraction of species traits – for taxonomy, phylogenetics, or ecological inference – will also be explored. The discussion will emphasize opportunities that link heterogeneous data in novel ways and the methods, cyberinfrastructure, and software needed to do so. We will also discuss how to use specimen data to inform and create outreach materials, curricula/ lesson plans, and other resources to engage the public with collections-based science.		
	Attribution **https://goo.gl/duLDyV**	Shelley James, Gil Nelson	Gallery III
	Licensing, citation of data—what are the recommended practices, what is proper attributionfor collections data in publications, grant applications, and other documents? In this session we will discuss strategies to motivate the scientific community to cite specimen usage, and explore ideas for best practice from data generation to publication.		
	Collaboration & Communication **https://goo.gl/E9icMk**	Deb Paul	Picasso/DaVinci
	The ADBC effort has now funded 15 TCNs involving a diversity of collections – different sizes, preparation types, etc. While parts of the collections community are "involved," others, for a variety of reasons, are not. A "clearinghouse" for sharing information may be a way to assist expansion of the digitization efforts. Come and explore opportunities to foster communication, interaction, and collaboration across TCNs and related organizations and initiatives.		
	Ad Hoc Discussion **https://goo.gl/o5e9UP**		Matisse
	This room is available for ad hoc meetings and discussions.		
4:45pm - 5:15pm	Day 2 Wrap-up: Discussion Group Summaries		Gallery I-II
5:15pm - 5:45pm	Summit Wrap-up	David Jennings, Larry Page	
5:45pm	Adjourn		
Evening	Dinner on your own		

Biodiversity Collection Network (BCoN)

Project Summary

The Biodiversity Collections Network (BCoN) is a five-year national initiative funded by the U.S. National Science Foundation to support the development of a new, sustainable community of practice that will ensure that all U.S. biodiversity collections are digitally available for research, education, informed decision-making, and other scholarly and creative activities.

Scientists have amassed, annotated, and curated more than one billion specimens in more than 1600 institutions across the United States. Although these specimens and their associated data are heavily used for research and education, their benefits could be exponentially increased if the data could be accessed and mined online.

BCoN is an outgrowth of recent scientific meetings in which scientists have articulated a need to digitally capture biological specimens and associated data held in natural science collections for use in research, education, and for the public interest. The initiative was founded by the American Institute of Biological Sciences, the Society for the Preservation of Natural History Collections, and the Natural Science Collections Alliance.

Goals for establishing a biological collections network:

- Advance engineering of the U.S. biodiversity collections cyber-infrastructure to support efficient workflows, innovative research, effective policy, and educational engagement.
- Enhance training of existing collections staff and create the next generation of biodiversity information managers.
- Increase buy-in and participation from a broader range of stakeholders.
- Establish an enduring and sustainable knowledge base.
- Infuse specimen-based learning and exploration into formal and informal science education.

Project Sponsor

American Institute of Biological Sciences
NSF Award Number 1441785

Principal Investigators

Robert Gropp & Andrew Bentley

Project Website

http://bcon.aibs.org

Supporting Organizations

American Institute of Biological Sciences
American Society of Plant Taxonomists
Angelo State Natural History Collections
Biodiversity Institute, University of Kansas
Bishop Museum
C.A. Triplehorn Insect Collection,
The Ohio State University
Central Michigan University Herbarium
Chicago Botanic Garden
Florida Museum of Natural History
H.A. Stephens Herbarium, Emporia State University
Harvard University Museum of Comparative Zoology
iDigBio
Illinois Natural History Survey Herbarium
Milwaukee Public Museum
Museum of Southwestern Biology, University of New Mexico
Natural Science Collections Alliance
New York Botanical Garden
North American Network of Small Herbaria
Small Collections Network
Society for Preservation of Natural History Collections
SUNY College of Environmental Science and Forestry
The Academy of Natural Sciences of Drexel University
The Field Museum
University of Michigan Herbarium
University of Wisconsin Insect Research Collection
Yale Peabody Museum of Natural History

Integrated Digitized Biocollections (iDigBio)

Project Summary

Integrated Digitized Biocollections (iDigBio) is the national coordinating center for the Advancing Digitization of Biodiversity Collections (ADBC) program funded by the U.S. National Science Foundation (NSF). iDigBio is enabling digitization of data and media for millions of biodiversity specimens from U.S. natural history collections and is making the data available online for the research community, government agencies, students, educators, citizen scientists and the general public to promote understanding of biodiversity and societal consequences of environmental issues.

The vision for ADBC is a permanent repository of digitized information from all U.S. biodiversity collections that leads to new discoveries through research and a better understanding and appreciation of biodiversity through improved outreach, which then leads to improved environmental and economic policies.

The mission of iDigBio is to develop a national infrastructure that supports the vision of ADBC by overseeing implementation of standards and best practices for digitization; building and deploying a customized cloud computing environment for collections; recruiting and training personnel, including underserved groups; engaging the research community, collections community, citizen scientists and the general public through outreach activities; and planning for long-term sustainability of the national digitization effort.

iDigBio Goals

Develop efficient and effective digitization standards and workflows

- Provide portal access to biodiversity data in a cloud computing environment
- Respond to cyberinfrastructure needs

Facilitate use of biodiversity data to address environmental and economic challenges

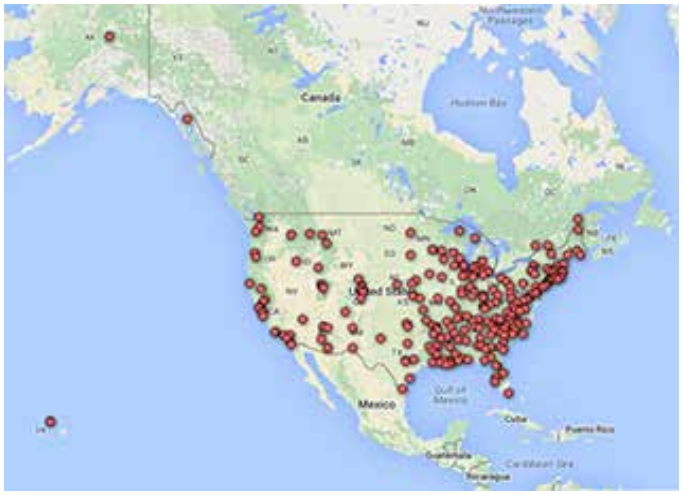
- Researchers
- Educators
- General public
- Policy-makers

Plan for long-term sustainability of the national digitization effort

- Expand participation: partners and data sources

Project Sponsors

University of Florida
Florida State University
NSF Cooperative Agreement Number EF-1115210



Principal Investigators

Larry Page (Principal Investigator)
José Fortes (Co - Principal Investigator)
Bruce MacFadden (Co - Principal Investigator)
Greg Riccardi (Co - Principal Investigator)
Pam Soltis (Co - Principal Investigator)

Project Website

http://www.idigbio.org

Social Media

https://www.facebook.com/idigbio
https://twitter.com/idigbio
https://vimeo.com/idigbio

Thematic Collections Networks At a Glance

TCN	Funding Period	PI	Email	Software Interface with iDigBio
Microfungi Consortium (MiCC)	2015 - 2018	Andrew Miller	amiller7@illinois.edu	Symbiota
Fossil Marine Invertebrates (EPICC)	2015 - 2019	Charles Marshall	crmarshall@berkeley.edu	Symbiota
Great Lakes Invasives (GLI)	2014 - 2017	Ken Cameron	kmcameron@wisc.edu	Symbiota
InvertEBase	2014 - 2018	Petra Sierwald	psierwald@fieldmuseum.org	Symbiota
Fossil Insect Collaborative (FIC)	2014 - 2018	Dena Smith	dena@colorado.edu	Specify, EMu and others; developing the iDigPaleo Portal for our main interface
The Key to the Cabinets (SERNEC - TCN)	2014 - 2018	Zack Murrell	murrellze@appstate.edu	Symbiota
Vouchered Animal Communication Sytems (VACS)	2013 - 2017	Michael Webster	msw244@cornell.edu	Symbiota
Macroalgal Herbarium Consortium (MHC)	2013 - 2017	Chris Neefus	chris.neefus@unh.edu	Symbiota
New England Vascular Plants (NEVP)	2012 - 2016	Patrick Sweeney	patrick.sweeney@yale.edu	Symbiota, EMu
PALEONICHES	2012 - 2015	Bruce Lieberman	blieber@ku.edu	Specify
Macrofungi Collection Consortium	2012 - 2015	Barbara Thiers	bthiers@nybg.org	Symbiota
Symbiota Collections of Arthropods (SCAN)	2012 - 2015	Neil Cobb	neil.cobb@nau.edu	Symbiota
InvertNet	2011 - 2015	Chris Dietrich	dietrich@inhs.uiuc.edu	Symbiota
Tri-trophic Databasing (TTD)	2011 - 2015	Randall Schuh	schuh@amnh.org	Arthropod Easy Capture, Symbiota, other institutional databases including Specify
Lichens & Bryophytes (LBCC)	2011 - 2015	Corinna Gries Tom Nash	cgries@wisc.edu tom.nash@asu.edu	Symbiota

Organisms	Digitization Methods	# of Specimens / Images	# of Collaborators
microfungi	under development	>1.2M	38
fossil marine invertebrates	under development		6
fish, clams, snails, mussels, algae, plants	imaging herbarium sheets and animal specimen lots with the Photo eBox Plus	1.73M	29
insects, arachnids, mollusks	data capture from labels and label images, data capture via voice recognition and OCR	>2M	7
fossil insects	Visionary Digital workflow, most specimen data already captured	500k/200k	7 (1 PEN)
plants	rapid imaging coupled with citizen science based label transcription and collaborative georeferencing	>3M	45
birds, frogs, fish, insects	digitizing analog sound recordings, imaging specimens & labels	58K / 23K	7
macroalgae	imaging herbarium sheets with the Photo eBox Plus	1.14M / 1.14M	50
vascular plants	robotic scanning apparatus for herbarium sheets, specimen-by-specimen label data capture	1.29M / 1.29M	19 (2 PENS)
fossils: arthropods, brachiopods, echinoderms, and mollusks	specimen-by-specimen label data capture	650K / 3.6K	8 (2 PENS)
macrofungi	label imaging, crowd-sourcing of label data	1.39M / 1.3M	38 (2 PENS)
ground dwelling arthropods	Visionary Digital workflow, specimen-by-specimen label data capture, plus ff16K specimen image suites (ff40K images)	.73M / 15K	16 (3 PENS)
arthropods	robotic scanning of vials, slides and drawers, crowd-sourcing of label data from images	6.1M / .89M	16 (1 PEN)
insects (Hemiptera, Hymenoptera) and vascular plants	imaging herbarium sheets with the Photo eBox Plus and direct transcription of insect labels into a database without imaging	1.2M (insects) 1.2M (plants) / 611K	32
lichens & bryophytes	label imaging, OCR for data capture	2.3M / 2.3M	76 (4 PENS)

The Microfungi Collections Consortium: A Networked Approach to Digitizing Small Fungi with Large Impacts on the Function and Health of Ecosystems (MiCC)

Project Summary

Microscopic fungi (microfungi) represent a diverse assemblage that is distributed worldwide and includes bread molds, plant pathogens, powdery mildews, rusts, slime molds, and water molds. A large percentage of these organisms are harmless or even beneficial, but some cause disease and death in animals, plants, and other fungi resulting in major economic loss and serious negative implications for human and ecosystem health. Despite their importance, little is known about their distribution, diversity, ecology, or host associations. This project is a collaborative effort involving 38 institutions in 31 states and aims to consolidate data from specimens housed in biodiversity collections for 2.3 million microfungi specimens and make these data available through online resources. The consolidation and increased accessibility of these data is critical to inform and promote new and innovative research, education, and community engagement around this little-known but important group of organisms.

Specimen data generated by this project will be used to assess natural and human-induced environmental changes on microfungi distributions, and evaluate the impact of these changes on the function and health of ecosystems. This project fills a critical gap in the national digitization effort by contributing images, digitizing specimen label data, and linking associated ancillary data for over 1.2 million North American specimens of microfungi. Additionally, nomenclature and taxonomic information will be updated to reflect the newest practices as dictated by the International Codes for Nomenclature. These data will provide a foundation for making informed decisions by agribusinesses, educators, forest managers, government agencies, horticulturalists, policy makers, researchers, and the general public. The broader education goals of this project will be facilitated through the development and implementation of a teaching module for high school biology on the economic importance of microfungi.

Proposed Research

- What are the effects of anthropogenic disturbance to the environment on the temporal and spatial distribution and phenology of microfungi? Human-induced impacts may include downstream effects due to land use changes in agricultural and natural ecosystems, the introduction of herbicides, fungicides, and pesticides, and increased atmospheric pollution.
- Can we use historic and current distributional patterns of microfungi as models for the early detection of invasive species to reduce their potential deleterious effects? Can we use these same data to detect endemism and biodiversity hotspots in microfungi?
- How do climatic changes influence the dispersal, distribution, and functioning of soil microfungi?

Citizen Science and Outreach Projects

WeDigBio @ UIUC

Project Sponsor

University of Illinois at Urbana-Champaign
NSF Award Number 1502735

Principal Investigators

Andrew Miller (Principal Investigator)	Illinois Natural History Survey
Phil Anders (Biological Informatician)	Illinois Natural History Survey
Elizabeth Lippoldt (Project Manager)	Ilinois Natural History Survey
Scott Bates (Project Consultant)	University of Illinois at Urbana-Champaign
Alex Kuhn (Digitizer)	Purdue University North Central

Project Website

http://www.microfungi.org

Social Media
https://www.facebook.com/microfungi.org

Instagram @microfungi_inhs

Project Collaborators

Tatyana Livshultz	Academy of Natural Sciences
Barbara Kennedy	Bishop Museum
Richard Pyle	Bishop Museum
Julia Kerrigan	Clemson University
Cathie Hodge	Cornell University
Scott LaGreca	Cornell University
Melissa Islam	Denver Botanic Garden
Vera Evenson	Denver Botanic Garden
Don Pfister	Farlow Herbarium
Thorsten Lumbsch	Field Museum
Deborah Lewis	Iowa State University
Jennie Kluse	Louisiana State University
Michael Vincent	Miami University
Alan Fryday	Michigan State University
Marc Cubeta	North Carolina State University
Roy Halling	New York Botanical Garden
Joey Spatafora	Oregon State University
Cathie Aime	Purdue University
Brian Geils	Rocky Mountain Research Station
Jim White	Rutgers University
Ning Zhang	Rutgers University
Dennis Desjardin	San Francisco State University
Alex Weir	State University of New York
Lisa Castelbury	U.S. National Fungus Collections
Martha Powell	University of Alabama
Steve Stephenson	University of Arkansas
Betsy Arnold	University of Arizona
Brent Mishler	University of California, Berkeley
Andrew Doran	University of California, Berkeley
Matthew Smith	University of Florida
Marin Brewer	University of Georgia
Robert Lichtwardt	University of Kansas
Tim James	University of Michigan
Matthew Foltz	University of Michigan
George Weiblen	University of Minnesota
Robert Kaul	University of Nebraska
Carol Ann McCormick	University of North Carolina
John Hayden	University of Richmond
Karen Hughes	University of Tennessee
Mary Ann Feist	University of Wisconsin
Sharon West	University of Wisconsin
Larry Schmidt	University of Wyoming
Mary Barkworth	Utah State University
Dean Glawe	Washington State University

Documenting Fossil Marine Invertebrate Communities of the Eastern Pacific - Faunal Responses to Environmental Change over the last 66 million years (EPICC)

Project Summary

Fossils provide our only direct evidence of past biodiversity and how individual organisms to ecosystems have responded to past and long-term environmental change. This project fills a major gap in the documentation of past environmental change, making available digitized data from the especially rich fossil record of the eastern Pacific marine invertebrate communities of the Cenozoic, the 66 million years that have passed since the extinction of the dinosaurs. Digitization and integration of these data will foster increased accessibility, efficient analysis to understand past change, the identification of factors involved in that change, and enable predictions for how current biodiversity may be impacted by future change. Development of virtual fieldwork experiences will assist stakeholders and educators in understanding how field data and fossil collections are used to infer past ecosystem and environmental conditions.

The data currently exist as a vast collection of fossil specimens and printed materials distributed among multiple natural history collections: this project involves seven primary institutions, one small collection and one federal institution and will integrate this digitized specimen data with the other two ongoing fossil networks through the web portal iDigPaleo, expanding the resource for fossil invertebrate information by spanning over 500 million years. This wealth of data will provide resources not only to researchers, but will be made available to K-16 educators, government, industry, and the general public. Through the national resource (iDigBio), these data will be integrated with information on modern organisms providing the means to understand important questions on niches, environmental change, transitions in sea levels, etc. Additionally, undergraduate and graduate students will be trained in the modern uses of natural history collections.

Proposed research (using collections data of eastern Pacific marine invertebrate fossil collections of the Cenozoic)

- Assessment of how individual species, communities, and ecosystems respond to environmental change on evolutionary and long-term ecological timescales
- Modeling predictions of response to future environmental change
- Verification and standardization of taxonomic assemblages for analysis of distribution
- Food web analysis
- Study of tectonically-induced change on biodiversity

Project Sponsor

University of California-Berkeley
NSF Award Number 1503678

Principal Investigators and Senior Personnel

Charles Marshall (PI)	UC-Berkeley	Lisa White (Co-PI)	UC-Berkeley
Seth Finnegan (Co-PI)	UC-Berkeley	Patricia Holroyd (Co-PI)	UC-Berkeley
Erica Clites	UC-Berkeley	Peter Roopnarine (PI)	California Academy of Sciences
Edward Davis (PI)	University of Oregon		
Elizabeth Nesbitt (PI)	University of Washington Burke Museum		
Ron Eng	University of Washington Burke Museum		
Jere Lipps (PI)	John D. Cooper Archaeological and Paleontological Center		
Jann Vendetti (PI)	Los Angeles County Museum		
Austin Hendy	Los Angeles County Museum		
Gregory Dietl (PI)	Paleontological Research Institute		
Don Duggan-Haas	Paleontological Research Institute		
Robert Ross	Paleontological Research Institute		
Leslie Skibinski	Paleontological Research Institute		
Patrick Druckenmiller (PI)	University of Alaska Museum of the North		
Kathy Hollis (PI)	Smithsonian Institution National Museum of Natural History		

Social Media

https://twitter.com/epicc_tcn

Documenting the Occurrence through Space and Time of Aquatic Non-indigenous Fish, Mollusks, Algae, and Plants Threatening North America's Great Lakes (GLI)

Project Summary

One of the greatest threats to the health of North America's Great Lakes is invasion by exotic species, several of which already have had catastrophic impacts on property values, the fisheries, shipping, and tourism industries, and continue to threaten the survival of native species and wetland ecosystems. Additional species have been placed on watchlists because of their potential to become aquatic invasives. This project will create a network of herbaria and zoology museums from among the Great Lakes states of MN, WI, IL, IN, MI, OH, and NY to better document the occurrence of these species in space and time by imaging and providing online access to the information on the specimens of the critical organisms. Several initiatives are already in place to alert citizens to the dangers of spreading aquatic invasives among our nation's waterways, but this project will develop complementary scientific and educational tools for scientists, students, wildlife officers, teachers, and the public who have had little access to images or data derived directly from preserved specimens collected over the past three centuries.

This bi-national Thematic Collections Network of >25 institutions from eight states and Canada will digitize 1.73 million historical specimens representing 2,550 species of exotic fish, clams, snails, mussels, algae, plants, and their look-alikes documented to occur in the Great Lakes Basin. It is one of the first efforts to digitize liquid preserved specimens and to integrate cross-kingdom taxa and these methods could become national standards for cross taxon digitization. Students will be provided with hands-on experience in modern methods of specimen curation and this cross-taxon network will provide greater flexibility to existing web platforms for integration of data.

Proposed research

- Identification and documentation of presence and spread of non-indigenous and potentially invasive or harmful species in the Great Lakes
- Track, monitor, and predict the spread of invasives through space and time, especially in the face of a more rapidly changing climate in the upper Midwest
- Studying points of access, migration routes, lag times, and speed of colonization of different lineages of non-indigenous organisms already established in the Great Lakes to help prevent future invasions

Project Sponsor

University of Wisconsin - Madison
NSF Award Number 1410683

Principal Investigator

Kenneth Cameron	University of Wisconsin - Madison

Collaboratoring Award PIs

Kevin Cummings	UI Urbana-Champaign	Rick Phillippe	UI Urbana-Champaign
Marymegan Daly	Ohio State University	Richard Rabeler	University of Michigan - Ann Arbor
Thomas Duda	University of Michigan, Ann Arbor	David Seigler	UI Urbana-Champaign
John Freudenstein	Ohio State University	Andrew Simons	University of Minnesota-Twin Cities
Andrew Hipp	Morton Arboretum	Chris Taylor	UI Urbana-Champaign
Brenda Molano-Flores	UI Urbana-Champaign	Melissa Tulig	New York Botanical Garden
Christine Niezgoda	Field Museum of Natural History	George Watters	Ohio State University

Project Website

http://greatlakesinvasives.org/portal/index.php

InvertEBase: Reaching Back to See the Future: Species-rich Invertebrate Faunas Document Causes and Consequences of Biodiversity Shifts(InvertEBse)

Project Summary

The rapid biodiversity change in North America has significant effects on essential ecosystem services, from impact on soil health and nutrient cycling, to agriculture, forestry and water quality. Exploding populations of invasive species threaten fresh water and terrestrial habitats and potentially impact the natural resources of the nation. Easy access to robust, expertly vetted baseline data for species occurrences, abundances, and distribution ranges, and monitoring how these parameters have changed through time, will facilitate the protection of the nation's natural resources, and vastly improve the capacity for effective restoration, land management planning, and conservation management. Numerous undergraduate students will receive training in digitization technologies and a modular exhibit will be developed to engage public interest in biodiversity changes.

Effective monitoring requires easy electronic access to historical specimen baseline information for temporal and regional species diversity comparisons that can facilitate informed land management decisions. Vast amounts of specimen data are housed within the nation's natural history collections, but most of these data are not readily accessible from digital resources. Size and complexity of scientific specimen collections require major technological advances in capturing specimen data. The goal of this four-year collaborative project is the rapid digitization of >2 million specimens and their locality data from ten arthropod and mollusk collections housed at six major U.S. museums in six states (Il, OH, AL,MI, DE, PA). This project will significantly automate specimen data capture by utilizing optical character and voice-recognition technologies. The digitized data from this project will be immediately deployed for habitat-based distribution modeling and analyses.

Proposed Research

- Study of temporally and spatially correlated changes in species distribution patterns of eastern North American terrestrial and freshwater mollusks and arthropods (e.g., range changes of ecologically interconnected species at landscape scales, along latitudinal gradients, and particular points on the earth's surface)
- Development of historical and present day niche-based distribution models using predictive tools
- Assessment of impact of climate change on invertebrate diversity and distribution in the eastern United States
- Assessment of protected areas for the conservation of invertebrate diversity
- Workflow development for invertebrate collections in differing forms of preservation

Project Sponsor

Field Museum of Natural History
NSF Award Number 1402667

Principal Investigator

Petra Sierwald Field Museum of Natural History

Collaboratoring Award PIs

Nasreen Aziz	Delaware Museum of Natural History
Rüdiger Bieler	Field Museum of Natural History
Jason Bond	Auburn University
Andrew Deans	Pennsylvania State University - University Park
James Hanken	Harvard University
Taehwan Lee	University of Michigan, Ann Arbor
Paul Morris	Harvard University
Diarmaid O'Foighil	University of Michigan - Ann Arbor
Elizabeth Shea	Delaware Museum of Natural History
Gavin Svenson	Cleveland Museum of Natural History

Project Website

http://www.invertebase.org/portal/index.php

Fossil Insect Collaborative: A Deep-Time Approach to Studying Diversification and Response to Environmental Change (FIC)

Project Summary

Fossil insects provide a unique deep-time record of ecological and evolutionary response to past environmental changes and therefore are invaluable for understanding the impacts of climate change on the current biodiversity crisis. Given current models of future climate change and the important role that insects play in human society (biodiversity, pests, pollination, vectors of disease) the ability to access these data and make predictions about future insect populations becomes even more urgent. The Fossil Insect Collaborative will make available all the major collections of fossil insect specimens in the United States by creating electronic specimen records consisting of digital images and associated collection data.

The digitized fossil insect collections will be made broadly accessible to the research community, K-16 education, government and industry, the general public, and the media through the project website and a central site integrating all the paleobiological Thematic Collections Networks called iDigPaleo. Mobile apps and activities that allow a wide variety of users to experience and interact directly with the collections data will be developed.

Proposed Research

The fossil insect data are of great importance to understanding insect response to environmental change and patterns of biodiversity through time. These fossils can aid in phylogenetic reconstruction, examinations of the evolution of morphological characteristics and in studies of overall patterns of diversification in deep time.

Digitization of fossil insect collections can support studies related to :

- parasitic insect co-evolution,
- insect pollination,
- insects as vectors of disease, and
- gigantism as a result of climate change.

Project Sponsor

University of Colorado at Boulder
NSF Award Number 1305066

Principal Investigators

Dena Smith (Principal Investigator)	Museum of Natural History, University of Colorado, Boulder
Talia Karim (Co-Principal Investigator)	Museum of Natural History, University of Colorado, Boulder

Collaboratoring Award PIs

Sam Heads	University of Illinois Urbana-Champaign
David Grimaldi	American Museum of Natural History
Alton Dooley	Virginia Museum of Natural History
Michael Engel	University of Kansas
Brian Farrell	Harvard University
Susan Butts	Yale University
Christopher Norris	Yale University
Diane Erwin	University of California, Berkeley

Project Website

http://fossilinsects.colorado.edu/

The Key to the Cabinets: Building and Sustaining a Research Database for a Global Biodiversity Hotspot (SERNEC)

Project Summary

The southeastern USA is botanically rich, with areas of high global biodiversity in both the Appalachians and the coastal plain. Millions of plant specimens have been collected from this region over the past four centuries, and these specimens and the information they contain currently reside in museums, or herbaria, at universities across the area. Scientists study these specimens intently; however, it is difficult to retrieve information at broad geographic and taxonomic scales without pipelines to move the information electronically from the specimen to an accessible pool of data. SERNEC, or the SouthEast Regional Network of Expertise and Collections, is a large regional network of botanical experts and collections that has, through an NSF-sponsored research coordination network (RCN) project, developed critical skills in biodiversity informatics. The current project will allow the SERNEC group to make data available for over 3 million specimens using the latest photography and information capture tools and to engage citizen scientists and students to assist in transcribing and georeferencing this large dataset. The research generated through this project can help regional planners, land managers and communities to manage their natural resources in our ever-changing environment.

The interaction of scientists, citizen scientists, and students will provide a synergy to build a research tool of an unparalleled scale and scope. The ultimate goal of this project is to develop an imaged and databased set of over 3 million specimens from over 100 herbaria in one of the most floristically diverse regions in North America and a global hotspot of plant diversity. This will represent a valuable data source for research on the response of vegetation to climate change, human development, and rapid migrations of introduced species. This region has been a biodiversity hotspot for 100 million years and this project should encourage research on changes over time to develop better predictive models as areas of biodiversity change. By partnering with Symbiota, Notes from Nature, GEOLocate, Adler Planetarium, iPlant/TACC, and Specify, the project will develop ways to best integrate various efforts for data accessibility.

Citizen Science and Outreach Projects

This project will utilize Notes From Nature (http://www.notesfromnature.org/) to engage citizen scientists in museum related science activities.

The project will develop Notes From Nature-based lesson plans to target state-based standards of learning (SOLs) for grades 6 - 12.

FSU's Robert K. Godfrey Herbarium hosted a successful crowdfunding campaign raising over $2000 to provision six 1-day citizen science events in 2015. We brought 100+ people from the Tallahassee region onto campus to learn about local biodiversity and the role of biodiversity specimens in research and education. The longer-term, bigger-picture goal is to develop a new model for sustaining biodiversity data creation by providing resources to the nation's 1500 museums, universities, field stations, and other institutions with similar collections so that they find it easier to do something similar. Those collections together house about a billion specimens—plants, fossils, birds, mammals, sponges, insects, etc. The plan is to establish a virtuous circle in which, as the collections engage more people in their local communities in the events, the crowdfunding support for those events grows. Visit http://spark.fsu.edu/Projects/121/Blazing-a-New-Trail-for-Sustainability-with-Citizen-Science for more information.

Proposed Research

This project proposes to utilize plant collection data to determine the threats to the native biota of the southeastern region of North America, including:

- climate change,
- invasive species,
- human population growth, and
- species extinction.

Compare of geographic distributions and habitat requirements of endemic species with non-endemics.
Determine the origins of biogeographic richness of the region and maintenance of diversity over geologic time.
Ecological niche or species distribution modeling of current and future distributions of rare and endemic species.

Project Sponsor
Appalachian State University
NSF Award Number 1410069

Principal Investigator
Zack Murrell Appalachian State University

Project Website
http://sernec.appstate.edu/

Collaboratoring Award PIs

Alan Harvey	Georgia Southern University	Alan Weakley	UNC-Chapel Hill
Alexander Krings	NC State University	Allen Risk	Morehead State University
Andrea Weeks	George Mason University	Ashley Morris	Middle Tennessee State
Austin Mast	Florida State University	Ben Montgomery	USC- Upstate
Brad Ruhfel	Eastern Kentucky University	Charles Horn	Newberry College
Daniel Stanzione	iPlant, University of Texas	Dayle Saar	Murray State University
Dixie Damrel	Clemson University	Donna Ford-Werntz	West Virginia University
Douglas Jensen	Converse College	Ed Gilbert	Arizona State University
Emily Gillespie	Marshall University	Eran Kilpatrick	USC - Salkehatchie
Erika Gonzalez	Longwood College	George Johnson	Arkansas Tech University
Gerald Long	Francis Marion University	Hank Bart	Tulane University
James Carter	Valdosta State University	Joe Pollard	Furman University
Joey Shaw	UT - Chattanooga	John Clark	UA - Tuscaloosa
John Nelson	USC - Columbia	Jon Evans	University of the South
Katherine Mathews	Western Carolina University	Kelly Major	University of South Alabama
Kunsiri Grubbs	Winthrop University	L. D. Estes	BRIT
Laura Whyte	Adler Museum	Leslie Goertzen	Auburn University
Lisa Krueger	UT - Martin	Lisa Wallace	Mississippi State University
Mary (Maggie) Whitson	Northern Kentucky University	Mary Priestley	University of the South
Michael Windham	Duke University	Nelson Rios	Tulane University
Nico Franz	Arizona State University	Norris Williams	University of Florida
Rachel Jabaily	Rhodes College	Robert Guralnick	University of Colorado - Boulder
Shawn Krosnick	Tenn. Technological University	Thomas Sasek	University of Louisiana – Monroe
Timothy McDowell	East Tennessee State	Travis Marsico	ASU - Jonesboro
Wendy Zomlefer	University of Georgia		

Developing a Centralized Digital Archive of Vouchered Animal Communication Signals (VACS)

Project Summary

This thematic collection network will digitize and make accessible media recordings associated with physical voucher specimens, broadly organized around the research theme of understanding the evolution and ecology of communication signals. Research on these questions has been challenged by the relative inaccessibility of the signal recordings and their associated physical specimens. This project will meet this challenge by partnering together multiple biological research collections and the Macaulay Library of Natural Sounds, the world's largest scientific archive of animal signal recordings. Collectively, these institutions will co-curate and make accessible digitized and vouchered recordings of the communication signals of birds, frogs, fish and insects, and will establish direct and transparent links across collections between physical voucher specimens and their digitized recordings. This project will make accessible digital audio recordings of animal signals that can be used to address a host of scientific questions, including the responses of animals to anthropogenic noise and other human activities. By providing a useful co-curation system and encouraging collection of recordings along with physical specimens, this project will have a transformative influence on the way that researchers collect and use biological specimens in the future, and will serve as a useful model for collections facing similar co-curation challenges.

This project will also provide materials for extensive educational outreach at all age levels, and will have significant conservation impacts because the digitized material will contribute directly to our ability to assess and monitor biodiversity. Finally, this project will expand biological collection methods and help train the "next generation" of museum curators, collectors, and researchers.

Proposed Research

- Understanding the response of organisms to anthropogenic noise and other perturbations
- Discovery of cryptic species
- Determining the extent to which vocal and other signals evolve in concert, mechanisms of sound production, role of morphology in signal evolution
- Influence of habitat and ecological selection pressures on animal signals
- Population variation both temporally and geographically
- Behavioral variation and sexual selection
- Seasonality and circadian dependencies

Project Sponsor

Cornell University
NSF Award Number 1304425

Principal Investigators

Michael Webster (Principal Investigator)	Cornell University
Gregory Budney (Co-Principal Investigator)	Cornell University
Edwin Scholes (Co-Principal Investigator)	Cornell University

Collaboratoring Award PIs

Rafe Brown	University of Kansas
David Kavanaugh	California Academy of Sciences
Travis LaDuc	University of Texas at Austin
Daniel Lane	Louisiana State University & Agricultural and Mechanical College

The Macroalgal Herbarium Consortium: Accessing 150 Years of Specimen Data to Understand Changes in the Marine/Aquatic Environment (MHC)

Project Summary

This project is supporting investigators from a consortium of 50 herbaria at universities, botanical gardens, and natural history museums across the U.S. to digitize their collections of macroalgae. When they have finished, high resolution images and information about when and where each specimen was collected will be openly accessible for more than a million specimens through the consortium's web portal and the iDigBio web resource. Macroalgae are the foundation of marine, estuarine and freshwater benthic ecosystems providing food, substrata and protection for a myriad of other aquatic organisms. Many macroalgal species are sensitive to environmental change. The data provided through the portal will allow researchers and the public at large determine how macroalgal biodiversity and our aquatic ecosystems have changed over the past 150 years as a result of climate change, bioinvasions, and a wide range of human activity.

A number of macroalgal species, including kelp, nori, and others are grown extensively via aquaculture or harvested from the wild for human food and for extraction of colloids used in cosmetics, food products, and pharmaceuticals. The consortium's web portal will provide opportunities for the public to learn about the economic and ecological importance of macroalgae. Tools will be provided for citizen scientists to contribute to the project by helping transcribe some of the ancillary details from specimen labels into the database. Interactive exhibits and educational modules will be developed by the education departments of the museums in the consortium where hundreds of thousands of visitors will experience them each year. The project will also provide integrative training in collections and informatics research for undergraduate and graduate students through participation in the digitization effort and through internships at one of the museums.

Proposed Research (focusing on ecological changes in marine, estuarine and freshwater environments)

- Temporal and spatial data on macroalgal distribution will help track the spread of invasive species, identify the dispersal vectors, allow assessment of the impact on native community structure
- Assessment of the effects of climate change on aquatic environments temporal changes in the geographic distribution of macroalgae can be used to understand the impact of human activity on aquatic ecosystems
- Taxonomic research, species identification, species distribution and documentation of range extensions

Project Sponsor

University of New Hampshire
NSF Award Number1304924

Principal Investigator

Christopher Neefus	University of New Hampshire

Collaboratoring Award PIs

Christopher Dick	University of Michigan, Ann Arbor
Brent Mishler	University of California Berkeley
David Giblin	University of Washington
Alan Weakley	University of North Carolina at Chapel Hill
Kenneth Karol	New York Botanical Garden

Project Website

http://macroalgae.org

Mobilizing New England Vascular Plant Specimen Data to Track Environmental Change (NEVP)

Project Summary

Herbarium specimens provide a source of historical information useful to the study of global environmental change. The goal of this project is to provide data to support studies of the nature and consequences of environmental change in the New England region over the last three centuries. This project will digitally capture specimen data and images from about 1.3 million vascular plant specimens from herbaria across New England, enhancing the data with georeferencing, habitat, and phonological information. The digitization process will integrate with existing community efforts and will develop novel high-throughput digitization technologies to increase efficiency and decrease costs. All resulting data and images will be freely available on-line.

The data from this project will be of immediate use to scientists who study climate and land-use change, and will provide a better understanding of how global changes will impact the distribution of native and introduced plant species. This project will benefit research in taxonomy, ecology, morphology, biogeography, and evolutionary history by making available data on an entire regional flora in an electronic format. The methodologies developed will provide a model for other regions around the nation. In addition the project will utilize citizen scientists, school groups, and students providing training, research, and educational opportunities.

Proposed Research

- Understanding the effects of rising temperature on the phenology (flowering and leafing-out stage) for New England taxa
- Impact on landscape of human activity through deforestation, agriculture, and the development of human infrastructure on New England habitat
- Intersection of climate change and land use and effects on biotic systems in New England, such as sensitivity of habitats, changes in species abundance and phenology
- Documentation and conservation of biological diversity, including assessing the distribution of rare and endangered species, changes in species abundance over time, arrival and expansion of non-native and invasive species

Project Sponsor

Yale University
NSF Award Number 1209149

Principal Investigators

Patrick Sweeney (Principal Investigator)	Yale University
Michael Donoghue (Co-Principal Investigator)	Yale University

Project Website

http://nevp.org/

http://portal.neherbaria.org/portal/

Digitizing Fossils to Enable New Syntheses in Biogeography - Creating a PALEONICHES

Digital Atlas of Ancient Life

Project Summary

Museum collections of fossils, along with their associated locality data, provide millions of records representing data on the temporal and geographic distribution of species in deep time. However, to reach their greatest scientific potential, these collections data need to be available on-line and in a format that facilitates quantitative biogeographic analyses. We will enter information about the age and precise location of fossil specimens from parts of several key paleontological collections into electronic databases. During this process improvements to computer programs for collections will be enhanced to allow paleontological specimens to be integrated with modern specimen data, thereby benefiting research on distribution of organisms over time. Our efforts will digitize nearly 450,000 specimens belonging to 900 species from several museums throughout the U.S. and will focus on three different time periods in the history of life: the Ordovician, Pennsylvanian, and Neogene. We will create on line digital atlases illustrating and describing these fossils and providing maps showing where they can be found. We will also create an 'app' so these atlases can be used on handheld devices.

The museum collections and fossils provide large amounts of data useful for studying what causes species to migrate, go extinct, or evolve over long time periods. They are of great relevance for considering how global change has and will continue to affect life on this planet. Our study will make these data available on line and accessible to scientists, facilitating many scientific analyses. The on-line and portable device digital atlases will be useful for educating amateur paleontologists and K-12 students about fossils both in classrooms and in the field. We will also provide training to students and scholars.

Proposed Research

Using Ecological Niche Modeling for analyzing neontological and paleontological data in biogeographic and ecological studies pertaining to:

- the biotic effects of climate change,
- changes to species associations in the face of changes in physical environment,
- influences of abiotic and biotic factors on species distribution, and
- determining species distributions from the Ordovician, the Pennsylvanian, and the Neogene time periods.

Thus far around 700,000 specimens have been databased and 9,000 localities have been georeferenced. Further, these data have been shared with iDigBio and provided on line via institutional websites. We have created online digital atlases, www.digitalatlasofancientlife.org, for more than 900 species from the time intervals studied. For each species ecological, stratigraphic, and taxonomic information is provided, along with images and geographic range maps. Our Digital Atlas of Ancient Life project is described in greater detail in an article in Palaeontologia Electronica in 2015. Our Digital Atlas of Ancient Life "App" is available at the Apple App Store for free download. Studies associated with the project have been published by the PIs in several journals including: Global Biogeography and Ecology; Journal of Biogeography; Paleobiology; and Proceedings of the Royal Society, Series B. A total of nine graduate students (seven of them women), ten undergraduate students (eight of them women), and one female post-doctoral fellow received training and were supported by this project.

Project Sponsor

University of Kansas
NSF Award Number 1206757

Principal Investigators

Bruce Lieberman (Principal Investigator)	University of Kansas
Jonathon Hendricks (Principal Investigator)	San Jose State University
Alycia Stigall (Principal Investigator)	Ohio University
James Beach (Co-Principal Investigator)	University of Kansas
Una Farrell (Co-Principal Investigator)	University of Kansas

Project Website

http://www.digitalatlasofancientlife.org/

The Macrofungi Collection Consortium: Unlocking a Biodiversity Resource for Understanding Biotec Interactions, Nutrient Cycling and Human Affairs (MaCC)

Project Summary

Mushrooms and related fungi (macrofungi) play a critical role in the lives of plants and animals, including humans, yet their diversity is underestimated. Understanding this diversity will be critical in analyzing impacts of habitat change, nutrient cycling in ecosystems, and distributions and diversity of host organisms. Scientists in the U.S. have been studying these fungi for the past 150 years, resulting in a legacy of approximately 1.4 million dried scientific specimens conserved in 35 institutions in 24 states. These institutions have now joined in an effort to digitize and share online all data associated with macrofungi specimens. The resulting resource will enable a national census of macrofungi, never before attempted, and will allow researchers to better understand the diversity of these organisms and the relationship between macrofungi and the organisms with which they form intimate relationships.

Organized into clubs across the country, citizen mycologists play an important role in documenting macrofungi diversity, and these enthusiastic individuals are the conduit between professional scientists and the general public for critical information about wild edible and poisonous fungi. Citizen mycologists will join the collections institutions in this project to help to create the online resource. The project will fund two workshops for high school teachers to promote classroom study of fungi. University students employed by the project will gain work experience in digitization and formal training about fungi. Students will share the knowledge they gain through oral and video presentations.

Current Research

Herbarium collections of fungi with conspicuous spore-bearing structures commonly known as macrofungi (e.g., mushrooms, boletes, puffballs, club fungi, morels, stink horns, truffles and cup fungi) are the subject of this Thematic Collections Network. We propose to unite established and nascent collections of macrofungi into the Macrofungi Collections Consortium (MaCC) of 35 institutions that collectively will digitize collection information from about 700,000 specimen labels, capture 110,000 images of fungal specimens and digitize about 500,000 critical ancillary items such as photographs, field notes and fieldbook pages. The result will be a dataset of almost 1.4 million enriched specimen records that includes essentially all the macrofungal collections deposited in U.S. herbaria during the past 150 years. The data generated through this project will allow researchers to address the questions: To what extent do the diversity and distribution of macrofungi determine the diversity and distribution of the organisms with which they form commensal or symbiotic relationships, and by extension, how will changes in macrofungal diversity and distribution affect those organisms and ultimately human affairs?

So far, approximately 650,000 items have been newly digitized (includes specimens, specimen labels, photographs, field notes, field book records), and 1,933,000 specimen records have been added to the Mycoportal (http://mycoportal.org/portal/index.php). This total includes specimens digitized prior to the start of this project as well as newly digitized specimens. The Portal contains 54,000 are skeletal records (i.e. locality data yet to be added), 1,824,000 are records with complete text locality information, and approx. 300,000 records have complete locality data with geocoordinates. The MycoPortal also has been populated with 509,000 images (approximately 25,000 of these are living fungi, the remainder are images of dried fungi, labels, and field notes), 41 checklists, including a checklist for North American fungi with more than 15,000 entries). With eight months remaining in the grant, we have already exceeded the number of specimens to be digitized through this project by 50,000, and the Mycoportal contains more than 300,000 more records than originally anticipated.

Three training courses were held at NYBG for 12 participants in the project, and three training courses were held at participant institutions for 10 participants. A 125 page training manual was prepared to guide the training sessions. The procedure manual provides step-by-step instructions for all aspects of the project, with the majority of time spent on learning to set up the camera equipment, capturing images of specimen labels and specimens, creating skeletal records, and uploading data to the portal. Follow up included phone calls and emails with NYBG staff, and sessions via phone or skype with Portal Manager to

review data upload procedures for newly digitized data as well as helping institutions to configure existing data for upload. All training documents were placed on the project website for additional reference.

Approximately 200 people have been actively engaged in the Macrofungi Collection Consortium project across the funded institutions, including 42 senior personnel, 32 paid staff, and 126 student workers (or recent graduates). At least 33 presentations or articles have been produced for a scientific audience, and 55 presentations or publications (including blogs) have been produced for a general audience. Instead of developing our own crowdsourcing application, we decided to join forces with Notes from Nature, a Zooniverse crowdsourcing application (13). To date, approximately 50,000 records have been transcribed.

At least 12 presentations or articles have been given to a scientific audience about the project during the period 1 July – 31 March, and 15 Presentations, publications (including blogs) about the project have been presented or published for a general audience. About 200 university students (not including student workers on the project) have attended demonstrations, lectures or tours relating to the MaCC project.

The first high school teacher training course for the project was held at North Carolina State University in Raleigh, NC 5-7 August 2013 for five high school teachers from North Carolina, one Assistant Professor (Dr. Mozley-Standridge) and four undergraduate students from Middle Georgia State College. The workshop taught participants about macrofungi in both the field and the lab, and included training in the use of the MycoPortal, and ways to use macrofungi and the MycoPortal in high school biology courses to meet curriculum standards for North Carolina. A second course for high school teachers will be offered in conjunction with the annual meeting of the Mycological Society of America at University of California, Berkeley in June 2016.

Two PEN awards have supplemented the original consortium: University of Vermont and University of Maine. The project is currently in a one year no-cost extension that will continue the project through June 2016.

Project Sponsor
New York Botanical Garden
NSF Award Number 1207526

Principal Investigator

Barbara Thiers	New York Botanical Garden

Collaborating Award PIs

Rytas Vilgalys	Duke University
Meredith Blackwell	Louisiana State University Herbaria
Peter White	North Carolina State University

Project Websites
http://www.nybg.org/science/new_20120723.php
http://mycoportal.org

Symbiota Collections of Arthropods Network: A Model for Collections Digitization to Promote Taxonomic and Ecological Research (SCAN)

Project Summary

The Symbiota Collections of Arthropods Network (SCAN) brings together 10 diverse arthropod collections at universities and museums throughout the Southwest to create a virtual network of ground dwelling arthropods which are notably responsive to temporal and spatial environmental changes. These 10 collections document much of the Southwest's biodiversity, but currently the data associated with millions of arthropod specimens are not easily accessible. To overcome this, SCAN will develop methods for integrating existing databases, catalogue-image specimens, develop new electronic identification techniques, and produce a virtual library of ground-dwelling arthropods (beetles, grasshoppers, spiders, ants). In addition the project will work with the existing project Filtered Push to increase the capacity of experts to provide remote identifications and annotations of data that can be sent throughout the network.

The comprehensive SCAN online library and expert information will be available to the public as well as professionals in taxonomy, ecology, and climate change science. Smaller institutions will be provided increased access to large data sets for promoting research. The SCAN datasets will support a number of ongoing projects examining the effects of environmental and land-use change on individual arthropod species. By increasing access to this information, SCAN will stimulate new research and increased awareness in biodiversity conservation throughout the region. Over 50 undergraduates also will be trained in cyberinfrastructure, systematics, and ecology.

Current Research

The current research focus is to use the data for niche/biodiversity modeling, historical ecology, and improving taxonomic resources for inventories, monitoring, and ecological studies that do not have the direct involvement of taxonomists.

The modeling aspect involves a suite of possible activities including present-day niche modeling, species distribution modeling (e.g., MaxEnt), and multi-species modeling to examine patterns of biodiversity. All formal modeling can include both forward projections under various climate change scenarios, and backward projections to understand possible historical or paleo distributions.

Project Sponsor

Northern Arizona University
NSF Award Number 1207371

Principal Investigators

Neil Cobb (Principal Investigator)	Northern Arizona University
Kelly Miller (Co-Principal Investigator)	Northern Arizona University
Paul Heinrich (Co-Principal Investigator)	University of New Mexico

Collaborating Award PIs

Nico Franz	Arizona State University	Ed Gilbert	Arizona State University
Boris Kondratieff	Colorado State University	Frank Krell	DMNS
Paula Cushing	DMNS	John Oswald	Texas A&M
Scott Bundy	New Mexico State University	Ed Riley	Texas A&M
Wendy Moore	University of Arizona	Deane Bowers	UC - Boulder
Kelly Miller	University of New Mexico	James Cokendolpher	Texas Tech University
James Hanken	Harvard University	Paul Morris	Harvard University

Project Websites

http://scan1.acis.ufl.edu
http://symbiota4.acis.ufl.edu/scan/portal/index.php

InvertNet: An Integrative Platform for Research on Environmental Change, Species Discovery and Identification (InvertNet)

Project Summary

Arthropods (insects, spiders, crabs) are the most diverse and abundant group of macro-organisms in biological collections, but are underrepresented in databases accessible online or elsewhere. This project will centralize access to and synthesize information from 160 years of North American arthropod collections. It will use innovative technology, including optical 3D imaging and reconstruction, to support scientific inquiry on the effects of land use change on biodiversity, and basic research on species discovery and identification. The award will provide IT infrastructure for collection digitization, digitally-assisted curation, and collection management; availability of specimen-level data for scientific inquiry on human impacts on biodiversity; and greater use of and appreciation for scientific collections by non-scientists through access to specimen images and related data.

Current Research

The main research focus of the InvertNet team has been on developing robust hardware and efficient workflows for digitizing various kinds of objects deposited in arthropod collections (vials, slides, and pinned specimens). A ZooKeys paper (doi: 10.3897/zookeys.209.3571) describes our approach, the goal of which is to achieve the $0.10/specimen cost benchmark while, at the same time, minimizing damage to specimens through excessive handling and obtaining the highest quality of data possible. To date, we have tested and implemented workflows for digitizing vials of ethanol-preserved specimens and trays of slide-mounted specimens. We have also tested three prototype robotic systems for capturing images of whole drawers of pinned specimens. The most recent prototype, based on a four-armed linear delta robot, is in the final stages of testing; we anticipate implementing the system at collaborating institutions beginning later this year. Two graduate students in computer science have so far been involved in developing and testing algorithms that will enable us to create 3D models of drawers of pinned insects, allowing for virtual tilting to reveal details of specimens and labels not visible in a top-down view.

Project Sponsor

University of Illinois at Urbana-Champaign
NSF Award Number 1115112

Principal Investigators

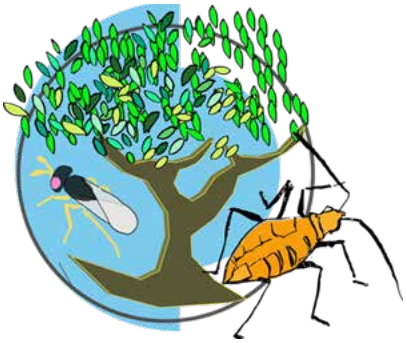
Christopher Dietrich (Principal Investigator)	University of Illinois at Urbana-Champaign
Umberto Ravaioli (Co-Principal Investigator)	University of Illinois at Urbana-Champaign
Nahil Sobh (Co-Principal Investigator)	University of Illinois at Urbana-Champaign
John Hart (Co-Principal Investigator)	University of Illinois at Urbana-Champaign
Christopher Taylor (Co-Principal Investigator)	University of Illinois at Urbana-Champaign

Collaborating Award PIs

Gregory Zolnerowich	Kansas State University	Anthony Cognato	Michigan State University
Paul Tinerella	University of Minnesota	Paul Johnson	South Dakota State
Daniel Young	UW Madison	Johannes Klompen	Ohio State University
Jennifer Zaspel	UW Oshkosh	Andrew Short	University of Kansas
Jeffrey Holland	Purdue University	John Rawlins	Carnegie Institute
Robert Sites	UM Columbia	Gregory Courtney	Iowa State University
David Rider	NDSU-Fargo		

Project Website

http://invertnet.org



Plants, Herbivores, and Parasitoids: A Model System for the Study of Tri-trophic Associations

Project Summary

All the nearly 20,000 plant species in North America are attacked by insect pests, including those in the group Hemiptera (known as the "true bugs"), which are in turn attacked by parasitoid insects in the Hymenoptera (sawflies, wasps, ants), widely used for biological control of agricultural pests. This project will unify some eight million records in 34 collections to answer how the distributions and phenologies of the plants, pests and parasitoids relate to each other, in a Tri-Trophic Databasing and imaging project – the TTD. Data from this approach will benefit basic scientific questions and practical applications in the agricultural sciences, conservation biology, ecosystem studies and climate change and biogeography research. Technological tools and methods will be introduced to graduate students, affiliated universities, and grant-sponsored students from other institutions through a short course. A data-mining and species-distribution modeling symposium at the University of California-Riverside will foster interactions between systematics and ecological researchers, and explore the TTD as a platform for instruction and inquiry.

A few recent highlights include:

- Many newly digitized records! TTD had approximately 1,151,424 newly transformed insect records and 1,325,086plant images completed as of June, 2015.
- Dissemination of information through attendance at iDigBio workshops, meetings, and two articles in the recent ZooKeys special issue, No Specimen Left Behind (http://www.pensoft.net/journals/zookeys/issue/209/).
- An intensive, research focused, specimen level biodiversity informatics short course was held in 2013.
- Numerous volunteers increased georeferencing and databasing productivity at participating institutions, particularly at the NYBG and AMNH.
- The TTD at AMNH offered a Research Experience for Undergraduates in Summer 2014 to Jeremy Frank, who is now an incoming Richard Gilder Graduate Student.
- DiscoverLife, one of the TTD partners, had developed a host interaction public portal (http://www.discoverlife.org/tttcn/) and a series of sophisticated locality cleaning and matching services for the project.
- One of our AMNH digitizers received an EOL Rubenstein Fellow (http://eol.org/info/52) to pursue her interest in altitude specificity in floral coloration.
- The principal software for capturing host – insect –parasitoid data from natural history collections, Arthropod
- Easy Data Capture, has been open-sourced (http://sourceforge.net/projects/arthropodeasy/).

Current Research

All the nearly 20,000 plant species in North America are attacked by insect pests, including those in the group Hemiptera (known as the "true bugs"), which are in turn attacked by parasitoid insects in the Hymenoptera (sawflies, wasps, ants), widely used for biological control of agricultural pests. This project will unify some three million records in 34 collections to answer how the distributions and phenologies of the plants, pests and parasitoids relate to each other, in a Tri-Trophic Databasing and imaging project – the TTD. Data from this approach will benefit basic scientific questions and practical applications in the agricultural sciences, conservation biology, ecosystem studies and climate change and biogeography research.

Project Sponsor

American Museum of Natural History (AMNH)
NSF Award Number 1115080

Principal Investigator

Randall T. Schuh (Principal Investigator) — American Museum of Natural History (AMNH)
Christine Johnson (Co-Principal Investigator) — American Museum of Natural History (AMNH)

Collaborating Award PIs

Richard Rabeler	University of Michigan, Ann Arbor
Charles Bartlett	University of Delaware
Robert Naczi	New York Botanical Garden
Melissa Tulig	New York Botanical Garden
Robert Magill	Missouri Botanical Garden
John Heraty	University of California, Riverside
Christiane Weirauch	University of California, Riverside
Benjamin Normark	University of Massachusetts, Amherst

Project Website

http://tcn.amnh.org/

Social Media

https://www.facebook.com/Insects-Plants-and-Parasites-Digitizing-Natural-History-Collections-330373400373054/

Award winning digitizers at the American Museum of Natural History. The top contender digitized 40,000 specimens.

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

Project Summary

Lichens and bryophytes (mosses and their relatives) are sensitive indicators of environmental change, and are dominant organisms in arctic-alpine and desert habitats, where the effects of climate change are well-documented. This project will image about 2.3 million North American lichen and bryophyte specimens from more than 60 collections to address questions of how species distributions change after major environmental events, both in the past and projected into the future. Large-scale distribution mapping will help identify regions where such changes are likely, fostering programs designed to protect these organisms. Awardees plan to build and enhance a national volunteer community, and provide online seminars, extensive online training materials, and local workshops and field trips.

Proposed Research

How are changes in distribution patterns of lichens and bryophytes over time correlated with man-made environmental changes, such as land use change, atmospheric pollution, global climate change due to greenhouse gases, and damage to the ozone layer?

Can mapping of historic and recent lichen and bryophyte collections be used to document such changes and can these organisms be used as bioindicators to draw our attention to issues and geographic regions where action is required to maintain a healthy environment?

How accurately can we predict where specific species can be found using existing herbarium data and GIS information, both currently and in the future?

Flora projects include:

- Arctic lichen flora and of the Southern Subpolar region
- Bryophyte flora of Fiji
- Bryophytes of Illinois, Maine, Missouri, North Carolina and Pennsylvania
- Frullania species
- Lichens of Alaska, Arizona, California, Colorado, Florida, Massachusetts, North & South Carolina, and Wisconsin
- Lichens of U.S. National Parks

Project Sponsor

University of Wisconsin - Madison
NSF Award Number 1115116

Principal Investigators

Corinna Gries (Principal Investigator)	University of Wisconsin - Madison
Thomas Nash (Co-Principal Investigator)	University of Wisconsin - Madison

Collaborating Award PIs

Andrew Miller	University of Illinois at Urbana-Champaign
Edward Schilling	University of Tennessee Knoxville
Meredith Blackwell	Louisiana State University & Agricultural and Mechanical College
Donald Pfister	Harvard University
Francois Lutzoni	Duke University
Robert Luecking	Field Museum of Natural History
Bruce Allen	Missouri Botanical Garden
Timothy James	University of Michigan, Ann Arbor
Larry St.Clair	Brigham Young University
Stefanie Ickert-Bond	University of Alaska, Fairbanks
William Buck	New York Botanical Garden
John Freudenstein	Ohio State University
Tatyana Livschultz	Academy of Natural Sciences Philadelphia
David Giblin	University of Washington
Alan Fryday	Michigan State University
Brent Mishler	University of California, Berkeley

Project Websites

http://lbcc1.acis.ufl.edu
http://lichenportal.org/
http://bryophyteportal.org/
http://symbiota.org/nalichens/index.php
http://symbiota.org/bryophytes/index.php

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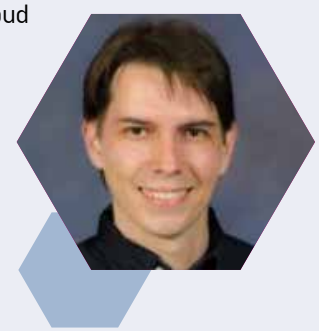

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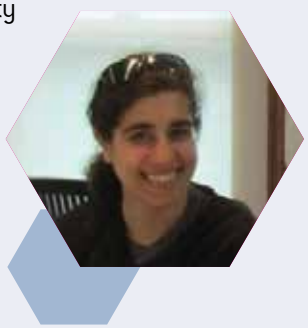

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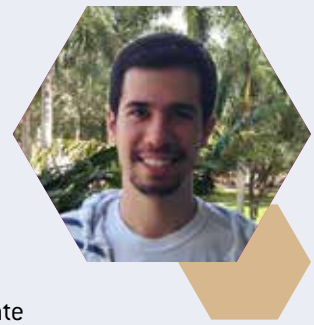

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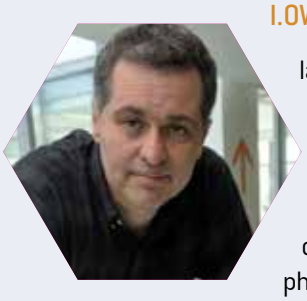

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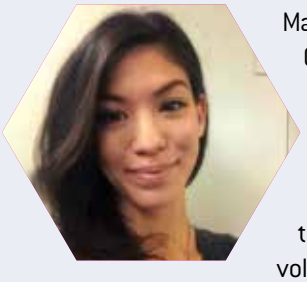

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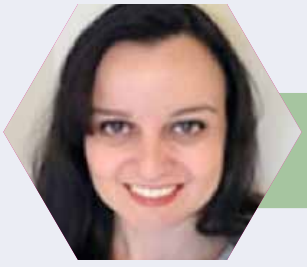

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