TCN Quarterly Progress Report

TCN Name

Building a global consortium of bryophytes and lichens: keystones of cryptobiotic communities (GLOBAL)[1]

Person Completing the Report

Miranda Zwingelberg (GLOBAL Project Manager)

Share Progress in Digitization Efforts

This report covers progress completed during the period of April 1 – June 30, 2023.

Workflows, Equipment, and Personnel

Most GLOBAL institutions continued steady GLOBAL progress during 2023-Q2.

At ALA new archival boxes have been constructed and integrated into the collection. Imaging of the remaining lichens and bryophytes is continuing.

At ASU, specimen digitization continued, focusing on lichen specimens.

The herbarium of non-vascular cryptogams at BRY started a major renovation project in January. Digitization efforts have been halted temporarily in preparation for the major construction that will continue into November 2023.

[1] Throughout this report, herbaria are referred to by their Index Herbariorum acronyms, which correspond to institutional names as follows: ALA = University of Alaska, Fairbanks, ASU = Arizona State University, BRY = Brigham Young University, CINC & MU = University of Cincinnati & Miami University, COLO = University of Colorado, DUKE = Duke University, F = The Field Museum, FLAS = University of Florida, ILL & ILLS = University of Illinois at Urbana-Champaign & Illinois Natural History Survey, LSU = Louisiana State University, MICH = University of Michigan, MIN = University of Minnesota, MO = Missouri Botanical Garden, MSC = Michigan State University, NY = New York Botanical Garden, OSC = Oregon State University, PH = The Academy of Natural Sciences of Drexel University, TENN = University of Tennessee, Knoxville, UC = University of California, Berkeley, WIS = University of Wisconsin, YU = Yale University

CINC worked on finishing imaging of an exsiccate set - Schiffner's Hepaticae Europeae Exsiccatae - that was brought out of backlog as part of the CINC CSBR funding. Only one student has been working over the summer so progress is slower than at the beginning of the quarter.

COLO continued work on imaging and transcribing specimens and uploaded data to the Bryophyte and Lichen Portals. They are getting a start with the bryophyte collection using the same workflow as the lichens to maximize the number of labels in the system. They want to get as many transcribed records into the system as possible to give WIS specimens to georeference.

DUKE continued barcoding, imaging, transcribing, and georeferencing activities for their bryophyte collection.

At F, photography of previously databased lichen images continued. Barcoding, imaging, skeletal data, and transcription continued for bryophyte specimens.

At FLAS, nearly all bryophytes are carded and barcoded. They are now focused on barcoding lichens, ramping up the transcription effort, and barcoding some old bryophyte collections which is a tad slower because they are in different types of packets.

Almost all of ILL's bryophytes have been imaged, transcribed and transferred to new archival packets.

LSU completed imaging the last 286 specimens in the bryophyte collection, with the exception of a small percentage of historic specimens that will be transitioned from sheets to packets. Data for fully transcribed bryophytes and lichens were cleaned and standardized to prepare for further georeferencing.

MICH continued digitizing bryophytes after completing imaging the lichens in the previous quarter. Two technicians worked on imaging and transcription, but they shifted resources to the last push of the PCC digitization grant which slowed progress.

MO continued digitization work on their bryophyte specimens, including barcoding, imaging, databasing, and georeferencing.

NY had two interns dedicated to barcoding and photography, while their lead digitizer focused more directly on transcription. They overshot their stated goals for barcoding new bryophytes and the number of lichens imaged, and they have come very close to completing the imaging of the general lichen collection. They started transcribing in earnest, and have put in institutional

requisitions to hire the next two interns. They have also begun to utilize some volunteers for imaging boxed lichen specimens.

At PH, an undergraduate student was trained to image, but focusing on another grant. Bryophyte sheets will be a focus during the next quarter.

TENN students continued imaging the liverwort collection and transcribing bryophyte specimens. The herbarium has had 8 undergrads technicians and 3 interns working on the GLOBAL project during the semester. Three new undergrads, including one former intern, were hired and trained to work on GLOBAL imaging and transcription over the summer.

The efforts of UC's Museum Assistant Acacia and their three work-study undergraduate students have made substantial progress in bryophyte digitization and imaging.

WIS students finished digitizing and imaging bryophyte specimens from WTU and NEB. They resumed imaging lichens from the WIS collection, and are turning their attention to BRU bryophytes that were received this quarter for digitization and imaging.

YU continued digitization work on their bryophyte specimens, uploading images, creating skeletal records, and transcribing labels.

Digitization

Seventeen institutions (ALA, ASU, CINC & MU, COLO, DUKE, F, FLAS, ILL & ILLS, LSU, MICH, MO, NY, PH, TENN, UC, WIS, and YU) reported progress on digitization deliverables, with a total of 31,652 specimens barcoded (28,268 bryophytes and 3,384 lichens), 35,224 labels imaged (26,900 bryophytes and 8,324 lichens), 29,393 specimens imaged (20,766 bryophytes and 8,627 lichens), 21,687 specimen records uploaded to the portal (17,831 bryophytes and 3,856 lichens), 47,006 skeletal records created (25,702 bryophytes and 21,304 lichens), 29,272 labels fully transcribed (21,837 bryophytes and 7,435 lichens), and 25,927 specimens georeferenced (16,350 bryophytes and 9,577 lichens) (See Table 1 & Figure 1).

Table 1: Digitization progress by GLOBAL collaborators in 2023-Q2, separated by Bryophyte (B) and Lichen (L) specimens.

	# Barcodes Added		# Labels Imaged		# Specimens Imaged		# Uploaded to Portal		# Skeletal Records Created		# Fully Transcribed		# Georeferenced	
	B	L	B	L	B	L	B	L	B	L	B	L	B	L
ALA						22				18,990				
ASU		1,107		1,107		1,107		1,107						
BRY														
CINC & MU			969		969		49		969		1,882		3,221	
COLO	4,813	830	4,813	830			4,813	830	4,813	830		2,717		
DUKE	1,253		1,485		83		754		607		1,842			
F	11,861	177	3,636	595	3,636	595	2,008		5,707		6,078	177		177
FLAS	3,500	300	2,000		2,000		2,000				1,600			
ILL & ILLS											4,300			
LSU					286								18	260
MICH	770		770		86		213		770		983		8	
MIN														
MO	4,137		5,512		5,512				5,512		255		72	
MSC														
NY	688	877		5,699		5,699			688	877	22	3,827	74	1,695
OSC														
PH												622		
TENN	384		3,980		3,961		3,381		308		2,844		1,851	
UC	100	1	3,258	1	3,258	1			3,258	1				
WIS	762	92	477	92	975	1,203	975	1,843	477	92	1,076	92	11,081	7,445
YU							3,638	76	2,593	514	955			
Totals	**28,268**	**3,384**	**26,900**	**8,324**	**20,766**	**8,627**	**17,831**	**3,856**	**25,702**	**21,304**	**21,837**	**7,435**	**16,350**	**9,577**
B+L Totals		**31,652**		**35,224**		**29,393**		**21,687**		**47,006**		**29,272**		**25,927**

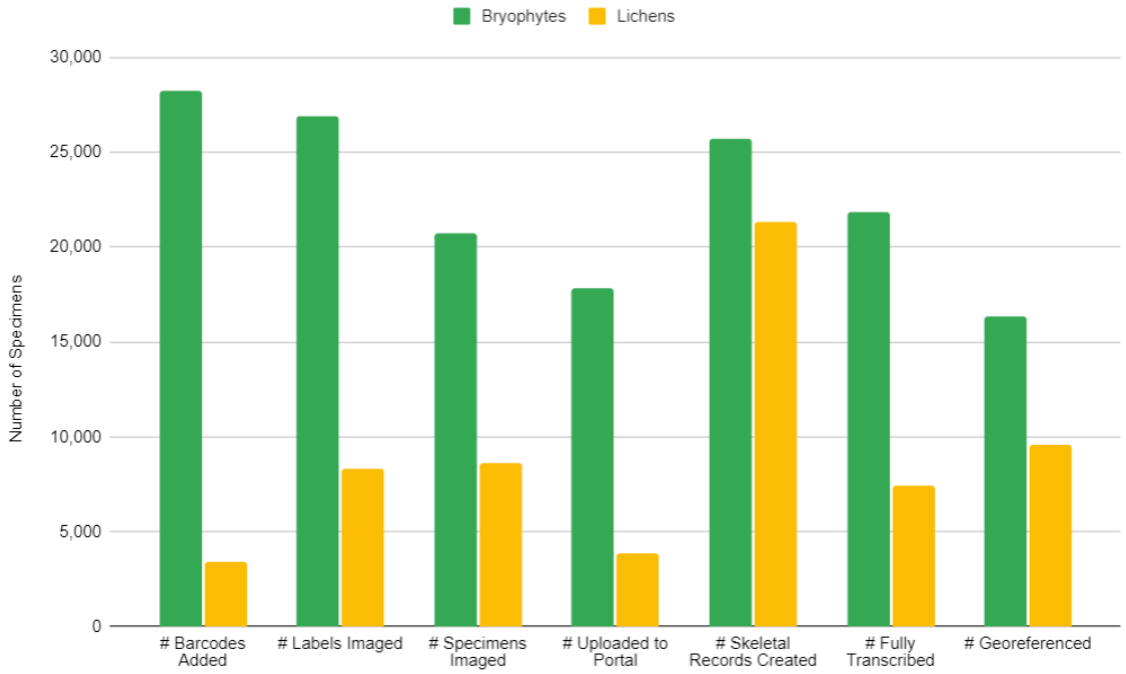

Figure 1: Digitization progress for the GLOBAL collaboration in 2023-Q2, separated by Bryophyte and Lichen specimens.

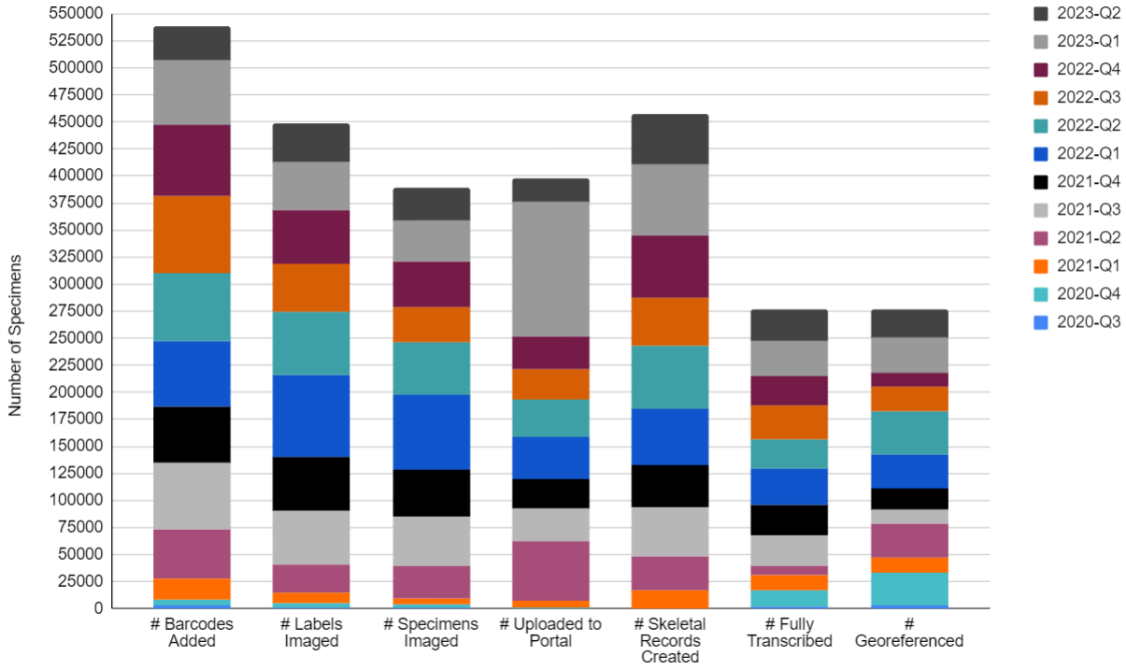

Figure 2: Cumulative digitization progress for the GLOBAL collaboration by quarter.

Share Best Practices, Standards, and Lessons Learned

Flexible Workflows

The GLOBAL teams continued to make use of flexible digitization workflows in 2023-Q2, including some use of virtual transcription work and prioritizing label imaging, while most collaborators were able to continue on-site work.

At COLO, based on preliminary work, the quality of specimen images is hampered by using a fixed imaging system to capture both packet/label data and specimens. They will most likely retake the specimen images later in the project when we have a system in place for capturing better specimen images. They are planning to capture both packets and specimens for the bryophyte collection in the same pass using two separate cameras and will circle back for lichen specimen images. They are getting a start with the bryophyte collection using the same workflow as the lichens to maximize the number of labels in the system. They want to get as many transcribed records into the system as possible to give WIS specimens to georeferenced, and are targeting the fall to make the switch.

At LSU, with their medium-sized collection, they find it's best to image all specimens in a single taxon group all at once because it's difficult to sort imaged vs. not imaged collections within a shelf, let alone a series of cabinets. Thus, they decided to image all bryophytes at once and leave lichens un-imaged due to their much larger collection size. As new specimens come into the collection, they have to keep up with the new protocols of imaging and skeletal transcription in order that processing status within the collections match.

BRU bryophytes have been received at WIS for imaging. They are glued to large sheets and will require a tweaking of their workflow (setup for single packets). They are looking at the posted imaging workflows for other institutions' best practices for guidance.

Georeferencing / Duplicate Matching

Georeferencing Manager Smith (WIS) has been verifying completed georeferences and began sending csv files to those with snapshot collections (MO). With Portal Manager K. Pearson's help, they re-ran the duplicate coordinate matching tool for a few collections to see if they can leverage their georeferencing efforts. Georeferencing in CoGe continues across collections as records are transcribed. WIS has reached out via e-mail and Basecamp to those collections that participate in collaborative georeferencing for feedback.

Collaboration

Team members continued to make use of Basecamp, Zoom, and email to communicate and collaborate during 2023-Q2. New collaborators and students were given access to Basecamp group resources. The Outreach & Education Group met in April to finalize plans for the WeDigBio event. A Management Committee Meeting was held in May open to all GLOBAL members to review 2023-Q1 grant progress and provide an open forum to the GLOBAL team.

WIS continued its collaborative georeferencing, creating new communities in the CoGe interface and georeferencing as fully transcribed records become available. The GLOBAL Geoferencing Manager (WIS) and Portal Manager (ASU) continued to consult on georeferencing workflows, especially those involving GEOLocate CoGe.

Share Identified Gaps in Digitization Areas and Technology

Image Renaming

Based on user requests, new versions of the program BCRWatcher were made available to provide more flexibility when using the program (additional watch mode options, more skeletal data fields).

Share Opportunities to Enhance Training Efforts

The GLOBAL Project Manager (TENN) and Georeferencing Manager (WIS) continued compiling resources during 2023-Q2 to share on Basecamp and all resources were posted to the project website (https://globaltcn.utk.edu), including additional and updated georeferencing and transcription links and resources.

ASU continued to provide regular user support through the Symbiota Support Hub. Monthly Monday meetings by the Support Group are open to all members of the Symbiota community and generally well attended. More tutorials have been added to the Symbiota Documentation by the Symbiota Support Hub at https://biokic.github.io/symbiota-docs/. Student workers and volunteers continue to be trained in routine image acquisition, specimen curation and data management.

F has been training high school interns and undergraduate interns, including digital learning high school interns.

ILL & ILLS trained a new student in imaging, barcoding and accessioning of bryophytes.

Several GLOBAL team members from ASU, COLO, MSC, OSC, PH, TENN, and UC collection manager attended the Society for the Preservation of Natural History Collections (SPNHC) annual meeting May 30-June 1.

The TENN Project Manager along with the Georeferencing Manager (WIS) and Portal Manager (ASU) led an Introduction to Georeferencing in Co-Ge virtual workshop on 4/14. It was attended by 2 additional GLOBAL team members, 5 students, and 4 volunteers. Follow up co-working sessions were held on 5/16 and 5/23.

Undergraduate students in TENN PI Budke's May mini-term class were trained to transcribe specimen records in the Bryophyte Portal as part of a class exercise.

The TENN Project Manager continued to supervise one of the undergraduate technicians in creating a video about the GLOBAL project for his leadership course. The student was able to develop film and audio-recording, editing, and science communication skills, and successfully completed and presented the video at the April WeDigBio event.

YU undergraduate students were trained in specimen handling and barcoding, imaging and transcription of bryophyte and lichen specimens.

Share Collaborations with other TCNs, Institutions, and/or Organizations

ASU is in the process of adding the new PEN institutions (BISH and PTBG) to the Bryophyte and Lichen Portals. The previous platforms have been merged and renamed into the "Consortium of Lichen Herbaria" and the "Consortium of Bryophyte Herbaria", both bilingual. Participating institutions have been informed about these changes and widely welcomed the improved data integration. A workshop on managing the taxonomic thesaurus, making use of newly integrated data cleaning tools, is planned for fall 2023 for collaborators in Ecuador.

The manuscript entitled "Towards a dynamic checklist of lichen-forming, lichenicolous and allied fungi of Ecuador – using the Consortium of Lichen Herbaria to manage fungal biodiversity in a megadiverse country" has recently been accepted by the peer-reviewed *The Lichenologist*, to be published in the fall 2023. The publication is the result of collaboration between 31 authors from North and Latin America. It provides a detailed discussion and recommendations

on how to best use Symbiota checklist tools available through the Consortium of Lichen Herbaria to manage large biodiversity data sets.

Collaboration between GLOBAL teams and other TCN projects occurring concurrently at their sites continued. CINC is also a member of the All-Asia TCN. The students work in the same space and regularly exchange tips and work together to improve workflows. COLO is also a member of the SoRo TCN and the All-Asia TCN and continued to share info and technology between projects to help optimize workflows. At MICH, ongoing collaboration continued between the PCC and GLOBAL TCNs, which share many resources including facilities, digitization and management staff, training, some equipment, and workflow. Though the grant objectives and specimens being imaged are separate, much of the institutional infrastructure is shared between the projects.

TENN Project Manager participated in the quarterly iDigBio Stakeholder Engagement Meeting (Formerly Internal Advisory Committee Meeting) in May with other TCN participants.

TENN Project Manager shared some insights on collaborative georeferencing in response to a request from TORCH TCN Project Manager Diego Barrosa and forwarded him to the WIS team for more information. GLOBAL resources on cryptogam digitization were shared with Ahart Herbarium (CHSC) Director Colleen Hatfield.

WIS exchanged emails with TORCH Project Manager regarding CoGe organization strategies for their large georeferencing project.

The Cornell University Plant Pathology Herbarium (CUP) joined GLOBAL during the April WeDigBio event.

The Hawaii PEN was officially approved by the NSF. Meetings were held on 5/18 to discuss planning and 6/22 to discuss portal workflows for new collaborators BISH and PTBG. They await word of their official start date, but expect to begin work this summer.

Share Opportunities and Strategies for Sustainability

Portal Management

The Symbiota Support Hub at ASU continued to provide portal management and maintenance, including uploading and linking images to GLOBAL collections, updating snapshot data from international partners to facilitate duplicate matching and import, and providing assistance

with data cleaning and other issues. The Symbiota Support Hub continued to provide regular training sessions, documentation and tutorials.

The Global IUCN Red-Lists of Lichens continued to be regularly updated in the Consortium of Lichen Herbaria.

Back Ups

CINC recently began storing images locally on servers at the University of Cincinnati. This process took ca. 6 months, and included the development of new digital infrastructure, but their solution should be a stable, long-term, in-house solution for CINC image storage.

COLO's raw images and JPGs continue to be uploaded to the University of Colorado Research Computing. These images are in addition to the local copies housed in the CU Herbarium. The hope is that these images will never need to be accessed, but to serve as a catastrophic backup if they have a computer or hard drive failure. Monthly backups of the COLO database in the Lichen and Bryophyte Portals are made on the first working day of the month. These files are housed locally and will be archived on Research Computing in case they ever need a point in time backup of their data.

GLOBAL staff at DUKE met with the DUKE IT team to explore resources available for hosting herbarium images.

TENN continues to back-up project images on external hard drives.

Post-Grant Planning

FLAS plans to always devote at least one part-time student to the bryophyte/lichen digitization effort after the grant is finished to maintain positive progress.

Share Education, Outreach, Diversity, & Inclusion (EODI) Activities

The GLOBAL TCN website (https://globaltcn.utk.edu) was maintained and updated with additional links to developed protocols and workflows. Social media accounts belonging to collaborators continued using #GlobalTCN as a way to share progress with the community.

Plans progressed for producing the GLOBAL educational videos in conjunction with the team at ALA. Members from ALA, F, WIS, and TENN continued to meet bi-weekly to discuss updates on logistics and content. In May 2023, Todd Widhelm, traveled to the University of Alaska-Fairbanks (ALA) with Nkosi Evans and Brandon Corder (grad students at WIS) to film the educational videos under the guidance of Steffi Ickert-Bond (ALA). The educational videos fulfilled the educational outreach component of the grant and covered lichen and bryophyte biology. Topics included: 1) a comparison of bryophytes and lichens; 2) basic lichen biology; 3) how to ID mosses; 4) life cycles of bryophytes and lichens; and 5) liverworts vs. hornworts vs. mosses. The videos are currently still being cut and edited.

DUKE's Aguero and Shaw led a bryophyte walk with a group of 7 Duke undergraduate naturalists in April. A 6-day field course on peat mosses was held at the Eagle Hill Institute for 12 attendees by DUKE's PI Jon Shaw. DUKE's Scott LaGreca led a Lichen Workshop at Duke Gardens including a tour of the DUKE Lichen Herbarium (15 people, non-students) and a Lichen Walk for Duke's undergraduate naturalist club (9 undergraduates).

An Oak Springs Foundation bryophyte and lichen workshop was co-taught by DUKE's Blanka Aguero and F's Matt von Konrat and Todd Widhelm.

FLAS submitted an abstract to Botany 2023 in Boise, ID.

ILLS's Phil Anders recently presented two talks on his development efforts with Symbiota, one at SPNHC and one at the iDigBio 7th Annual Digital Data Conference.

A Master Naturalist connected with the LSU herbarium to conduct a unique lichen project that involved artistic renderings of Louisiana lichens and their biology.

NY submitted abstracts to Botany 2023 in Boise, ID for a poster with imaging workflow standards, and talks on data transcription standards and using collections for public outreach

The TENN Herbarium hosted another "Specimens and Scones" open house for 30 students, staff, faculty, and public visitors including tours of the herbarium. TENN continued hosting the GLOBAL weekly transcription event on Fridays during 2023-Q2. Eleven community science volunteers from three countries participated (US, Canada, Sweden) and transcribed skeletal data for over 400 specimens. Two undergraduate students from CSU presented on their project sending mosses in a high-altitude balloon to the group in April. Volunteers were also able to see a number of "Collector Spotlight" presentations on specimens and collectors compiled by the TENN GLOBAL Project Manager. GLOBAL stickers were sent to our regular volunteers.

UC led several tours of the lichen and bryophyte collections as well as the digitizing lab for SPNHC attendees, researchers, and the general public.

WeDigBio

Six GLOBAL collaborators (CINC & MU, DUKE, F, FLAS, PH and TENN) participated in the April 2023 WeDigBio and were joined by the Cornell Plant Pathology Herbarium (CUP). They held one final WeDigBio Planning Meeting in April and two GLOBAL events on Thursday and Saturday.

Over 50 community scientists participated on each of the two GLOBAL days. A hybrid event, the virtual volunteers (including participants from across the globe) databased over 2,400 records and those in-person barcoded over 8,000 specimens. The event included four presentations: Todd Widhelm (F), " Mada-Lichen Project: Metagenomic DNA Barcoding of lichenized fungi in one of the world's most endemic biodiversity hotspots," Eric Tepe (CINC), "Updating the University of Cincinnati Herbarium: A Tour of a Collection in the Midst of an Upgrade," Miranda Zwingelberg (TENN), "Herbarium Collector Spotlight - M. Monet," and Cruz Gouveia (TENN), "GLOBAL TCN @ TENN Herbarium."

Share Information About Your Website and/or Portal Usage

The GLOBAL project website, https://globaltcn.utk.edu, was utilized by 421 users during 2023-Q2, including 199 from Asia, 107 from Europe, 24 from South America, 9 from Central America, 7 from Oceania, 4 from the Middle East, 3 from Africa (see Figure 3).

The Bryophyte and Lichen Portals, created as part of the original LBCC grant, host new images and data produced by the GLOBAL collaborators. 3,972 users visited the Bryophyte Portal and 1,236 users visited the Lichen Portal during 2023-Q2 (see Figures 4 & 5).

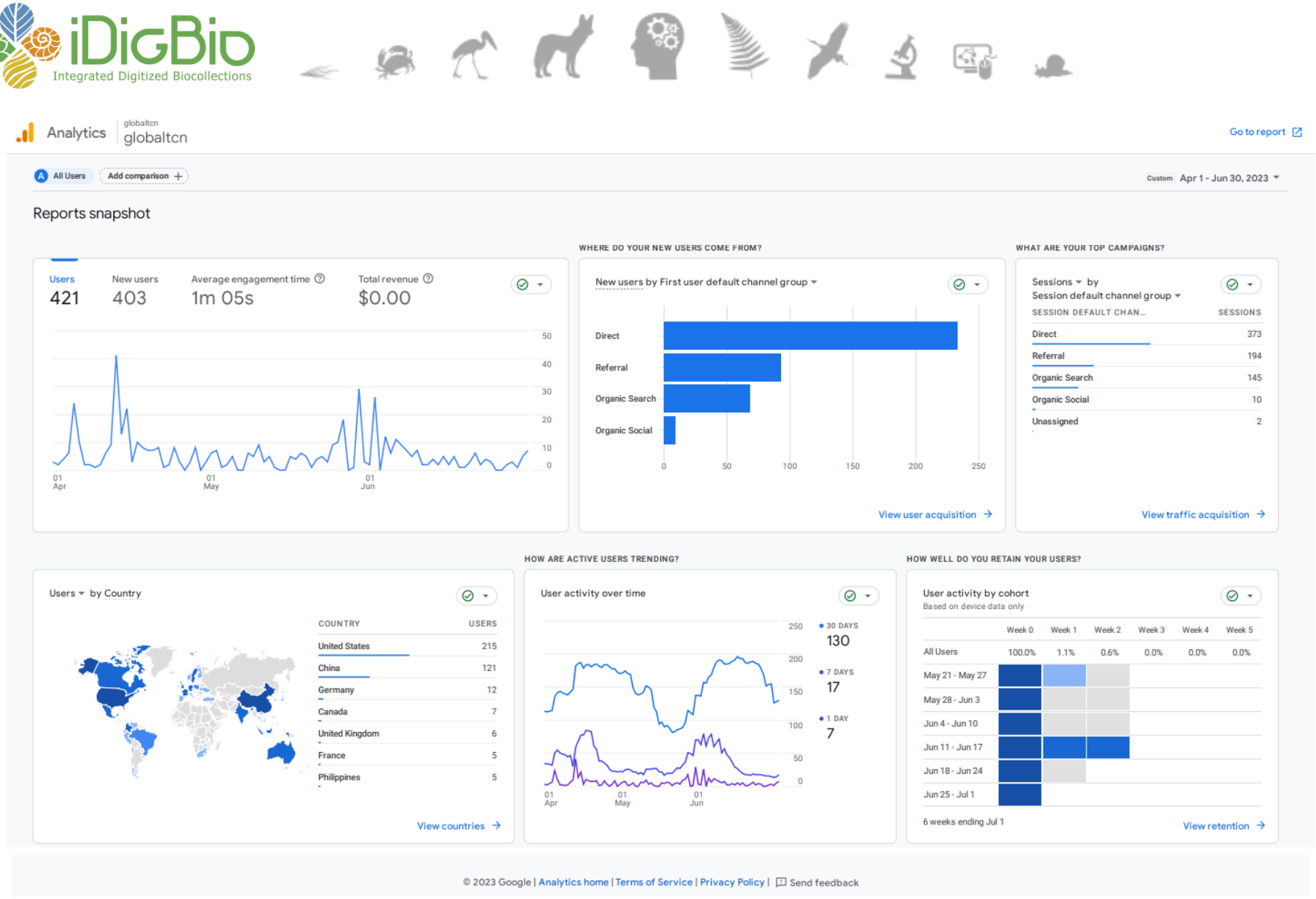

Figure 3: Use metrics for the GLOBAL project website (https://globaltcn.utk.edu) from April 1 – June 30, 2023.

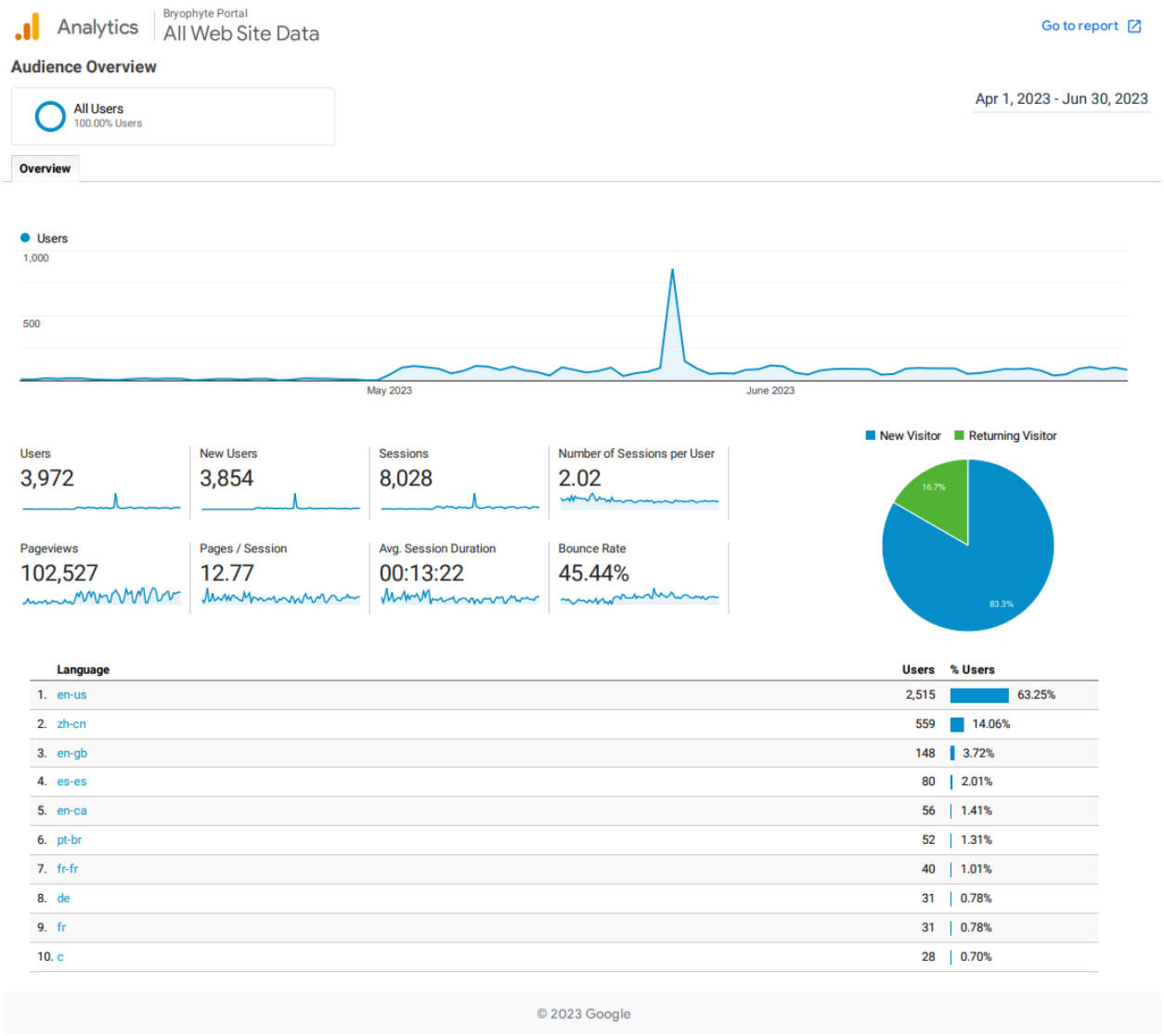

Figure 4: Use metrics for the Bryophyte Portal (https://bryophyteportal.org/portal/) from April 1 – June 30, 2023.

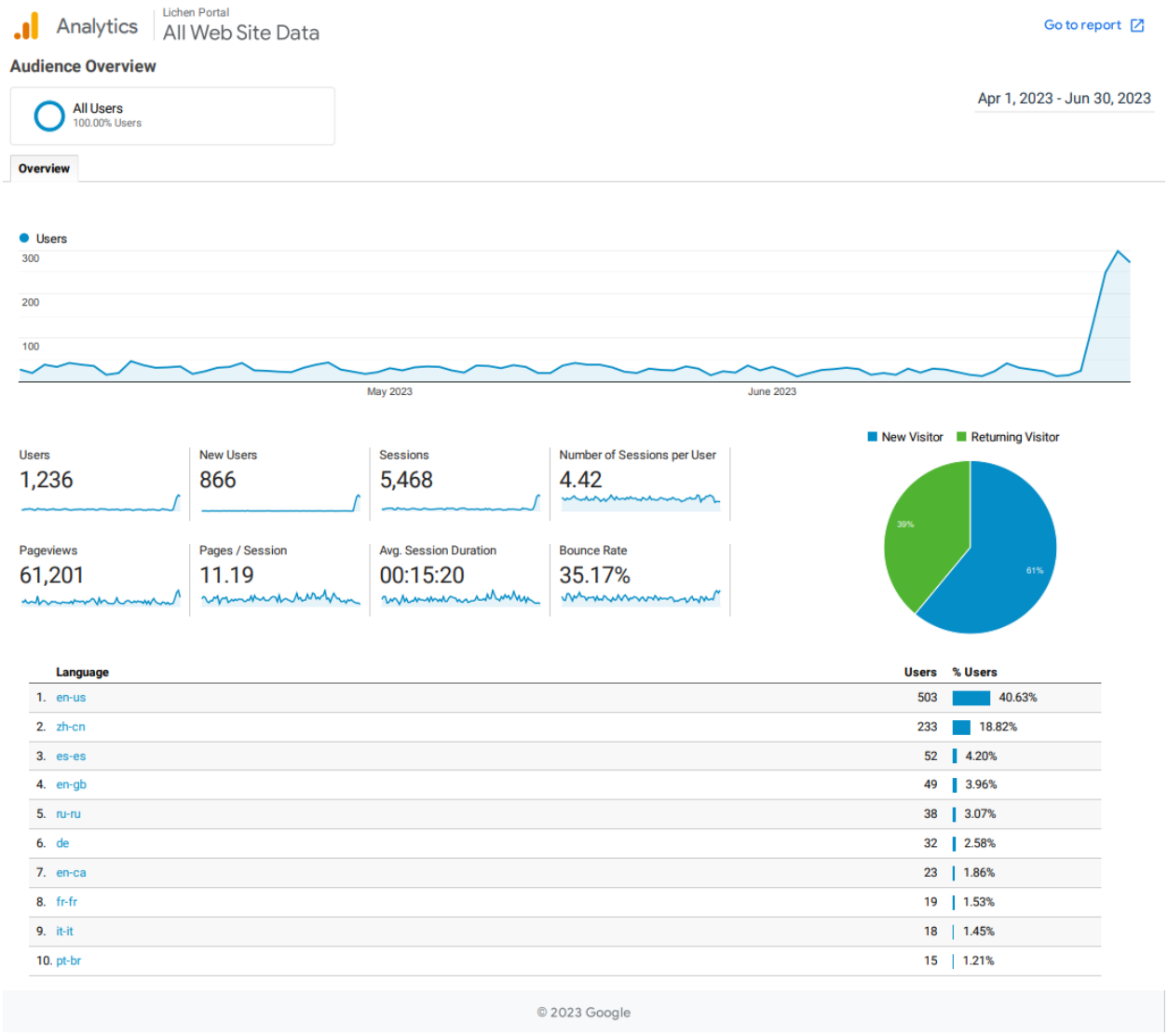

Figure 5: Use metrics for the Lichen Portal (https://lichenportal.org/cnalh/) from April 1- June 30, 2023.

Share Other Activities and/or Progress

Image Tagging

Progress continued at ASU on the character revision for tagging and identification keys. The glossary now contains 130 illustrations (schematic drawings and labeled photographs) that illustrate some of the more common terms used in lichenology.

No-Cost Extensions

GLOBAL Collaborators began requesting No Cost Extensions to continue GLOBAL work that was delayed by COVID into Year 4.

NSF Annual Reporting

TENN Project Manager updated reporting sheets for the Year 3 NSF Annual Reporting that will be completed in July.