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, 2024.

Workflows, Equipment, and Personnel

Most GLOBAL institutions continued steady GLOBAL progress during 2024-Q2.

At ASU, specimen digitization continued, but has been slower during the summer while student workers were travelling. In addition to digitizing specimens, ASU student workers Mrinaal Arora and Ramisa Zaman have uploaded chromatograms of lichen secondary metabolites that can now be browsed through the computer program Mytabolites developed at ASU. The students are also updating the secondary metabolite database of the Consortium, adding data from the Culberson's Chemical and Botanical Guide to Lichen Products, so that the data can be accessed through Mytabolites. All specimens are in the process of receiving new barcodes to make sure

[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, BISH = Bishop Museum, 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, PTBG = National Tropical Botanical Garden, TENN = University of Tennessee, Knoxville, UC = University of California, Berkeley, WIS = University of Wisconsin, YU = Yale University

that legacy loans from the Sonoran Project are completely returned and again integrated into the collections.

BISH continued to digitize specimens at a regular pace with over 1,600 specimens imaged and fully data-entered during the quarter. They created new protocols for georeferencing and have begun georeferencing Hawaiian specimens.

Progress on GLOBAL at CINC & MU slowed during the last quarter as they shifted all of the CINC student workers to the All-Asia project to finish that project before the end date of the grant. They have completed their commitments to All-Asia, and workers are again focusing on GLOBAL. During the last quarter, they barcoded and added 500 bryophytes and 40 lichens. Transcriptions were completed for all of them, and they are in the imaging queue and will be imaged during the 3rd quarter.

COLO continued barcoding and capturing images of lichen and bryophyte packets. Images and all skeletal data captured through 6/30/2024 have been uploaded to the portal and transcription continued.

DUKE barcoded 1,556 bryophyte specimens, imaged 1,861 labels and 98 plants in the second quarter of 2024. All images and skeletal data have been uploaded to the Bryophyte Portal. They fully transcribed 98 specimens, and georeferenced 26.

For lichens, F photographed 4763 specimens, produced 3368 skeletal records and 283 georeferenced/fully transcribed specimens. The entirety of Thorsten Lumbsch's lichen collection, brought to F from Germany when he started working as a curator, has all been skeletally transcribed, photographed, and filed into the main collection. With a large focus on lichens, they will now enter into solely focusing on bryophytes in a requested no-cost extension. This past quarter 3,600 bryophytes specimens were barcoded, over 8,000 labels and specimens imaged, over 6,000 specimens have been partially databased and over 10,000 specimens completely databased.

At FLAS, two students are working diligently at transcribing, and imaging bryophyte specimens. They have progressed to bryophyte genus *Scorpidium* for imaging. They have barcoded/carded most of a donation of several hundred lichens from the Neotropics from FGCU. They have also barcoded/carded several hundred old bryophyte/lichen specimens that were previously mounted on sheets, and are now being carded can be queued into the digitization pipeline (some of which are now imaged).

MICH continued to transcribe data from specimen labels.

MIN conducted some geographic data cleaning.

MO barcoded 7,981 bryophyte specimens and imaged 15,036 bryophyte labels. They created 15036 skeletal records and fully transcribed 308 labels. They also georeferenced 145 specimens.

OSC imaged 1,134 lichen specimens.

PTBG produced 4,281 images (and each image is a composite of stacked images) representing 1,746 specimens of mosses and lichens.

TENN student technicians continued barcoding, imaging, and transcribing some remaining bryophyte specimens and completed georeferencing of additional bryophyte and lichen specimens. The Lead Digitizer interviewed undergraduate students in June to hire for an Herbarium Training Bootcamp in July.

UC continued imaging bryophytes.

WIS's experienced student imager graduated, but they recruited a new student volunteer to continue imaging over the summer. They received an exchange of bryophyte exsiccati and easily imported label information and georeferences to complete transcription. They also completed transcribing BRU bryophytes and are now able to begin georeferencing them. WIS continues its collaborative georeferencing, reviewing localities, and returning files to snapshot collections.

YU continued transcribing label data. Undergraduate students and volunteers generated 1,579 fully transcribed records.

Digitization

Fourteen GLOBAL institutions (ASU, CINC & MU, COLO, DUKE, F, FLAS, ILL & ILLS, MICH, MO, OSC, TENN, UC, WIS, and YU) reported progress on digitization deliverables, with a total of 26,352 specimens barcoded (19,101 bryophytes and 7,251 lichens), 49,222 labels imaged (39,896 bryophytes and 9,326 lichens), 22,429 specimens imaged (18,023 bryophytes and 4,406 lichens), 25,673 specimen records uploaded to the portal (17,742 bryophytes and 7,931 lichens), 37,414 skeletal records created (32,284 bryophytes and 5,130 lichens), 32,141 labels

fully transcribed (24,606 bryophytes and 7,535 lichens), and 21,476 specimens georeferenced (17,846 bryophytes and 3,630 lichens) (See Table 1 & Figure 1).

PEN partners BISH and PTBG reported a total of 7,080 specimens barcoded (6,577 bryophytes and 503 lichens), 12,729 labels imaged (11,758 bryophytes and 971 lichens), 15,216 specimens imaged (14,245 bryophytes and 971 lichens), 31,227 specimen records uploaded to the portal (27,575 bryophytes and 3,652 lichens), 15,115 skeletal records created (13,171 bryophytes and 1,944 lichens), 15,388 labels fully transcribed (13,300 bryophytes and 2,088 lichens), and 3,073 specimens georeferenced (2,692 bryophytes and 381 lichens).

Table 1: Digitization progress by GLOBAL collaborators in 2024-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														
ASU		104		111		104		104				104		
BRY														
CINC & MU	500	40					500	40	500	40	500	40		
COLO	4,796	136	4,796	136			4,796	136	4,796	136	572	137		
DUKE	1,556		1,861		201		2,062		1,556		98		26	
F	3,600	3,651	8,686	6,359	8,686	779	2,086		6,545	3,368	10,750	283		283
FLAS		600	5,597		5,597		5,597				7,325			
ILL & ILLS		1,093		1,093		1,093		1,093		1,093		1,093		
LSU														
MICH	392	493	392	493	11	6	2,435	5,870	392	493	2,435	5,870		
MIN														
MO	7,981		15,036						15,036		308		145	
MSC														
NY														
OSC		1,134		1,134		1,134								
PH														
TENN	136		298		298		266		83		258	8	342	18
UC	140		3,230		3,230				3,230					
WIS						1,290		688	146		781		17,333	3,329
YU											1,579			
Totals	**19,101**	**7,251**	**39,896**	**9,326**	**18,023**	**4,406**	**17,742**	**7,931**	**32,284**	**5,130**	**24,606**	**7,535**	**17,846**	**3,630**
B+L Totals		**26,352**		**49,222**		**22,429**		**25,673**		**37,414**		**32,141**		**21,476**

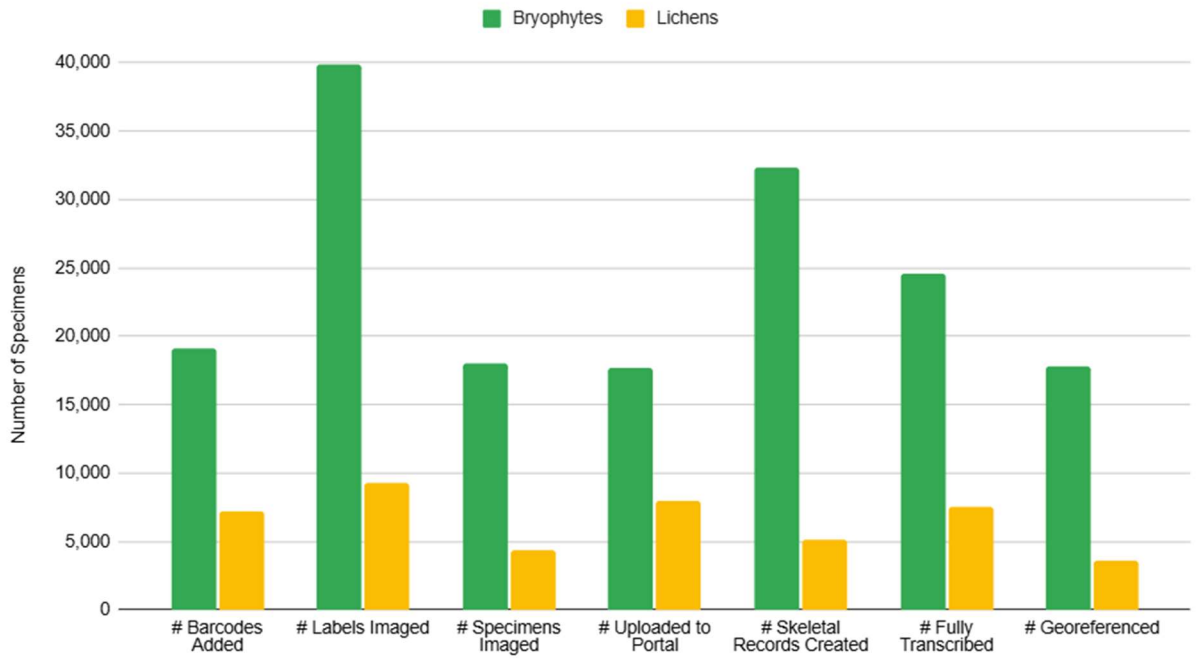

Figure 1: Digitization progress for the GLOBAL collaboration in 2024-Q2, separated by Bryophyte and Lichen specimens.

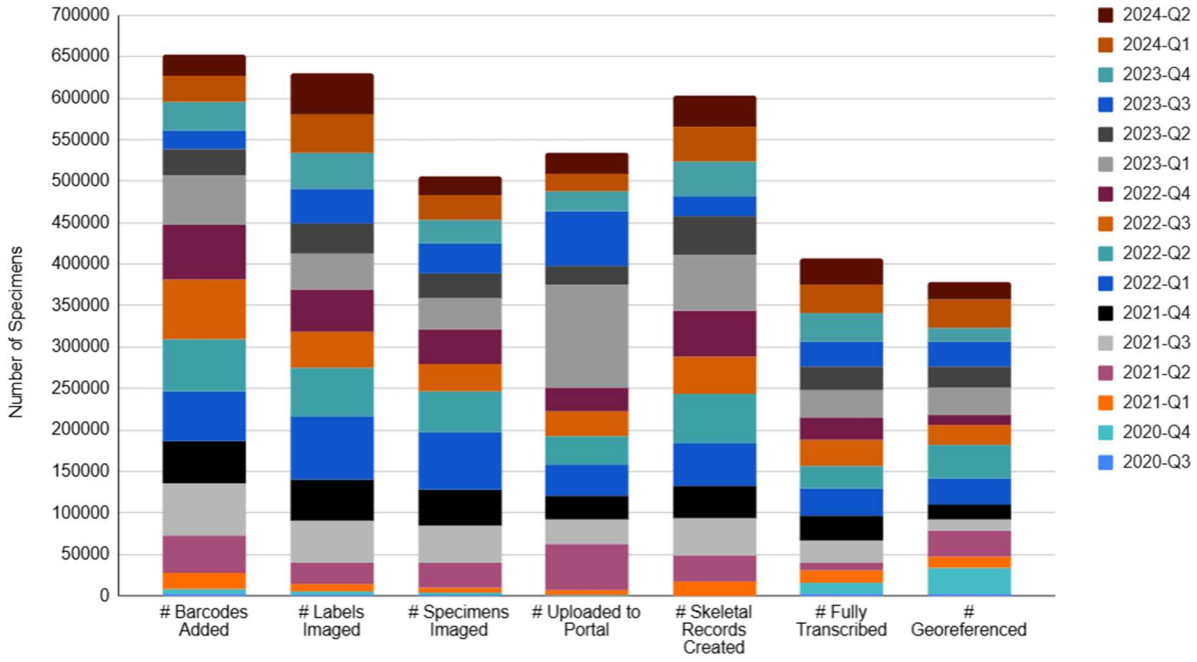

Figure 2: Cumulative digitization progress for the GLOBAL collaboration by quarter.

Share Best Practices, Standards, and Lessons Learned

Flexible Workflows

The GLOBAL teams continued to make use of flexible digitization workflows in 2024-Q2, including a mixture of virtual and 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 georeference.

Since no transcription work was completed on our non-North American specimens before the project, they did not have records for the first wave of georeferencing work at WIS. They have been prioritizing records from Australia, Chile, England, Finland, France, Japan, Norway, Scotland, Sweden and Wales for transcription to build sets for georeferencing. They have now added South America and Africa to our focus regions. They are also transcribing specimens from Sweden for our Bryophytes. They are continuing to work with the team at University of Michigan in the hope of incorporating VoucherVision into future transcription work. Their transcription efforts were hampered by the Lichen and Bryophyte Portal outages in June. PM Allen is also using a backlog of vacation time over the summer now that the COLO Collection Manager position has been filled.

Collaboration

Team members continued to make use of Basecamp, Zoom, and email to communicate and collaborate during 2024-Q2. New collaborators and students were given access to Basecamp group resources. A Management Committee Meeting was held in May open to all GLOBAL members to review progress from 2024-Q1, and to provide an open forum to the GLOBAL team. A meeting with the IT and Taxonomy and Nomenclature Groups to discuss updating the taxonomic thesaurus in the Bryophyte and Lichen Portals has been scheduled for August.

WIS continued its collaborative georeferencing, creating new communities in the CoGe interface and georeferencing as fully transcribed records become available. The GLOBAL

Georeferencing Manager (WIS) and Portal Manager (ASU) continued to consult on georeferencing workflows, especially those involving GEOLocate CoGe.

ALA, in collaboration with F and WIS posted the lichen and bryophyte educational videos on their website. See the outreach section for links.

WIS contacted a graduate student who is a native Chinese speaker to assist with some difficult localities in China and have been reworking some of the localities. It was very helpful to have their insight into the romanization of Chinese (Tongyong Pinyin) to better understand label information.

Share Identified Gaps in Digitization Areas and Technology

New Software Tools

The newest version of ASU's Mytabolites (1.0.1.4) now includes an integrated image viewer with detailed chromatograms for 598 secondary metabolites from the Atlas of Chromatograms of Lichen Substances published by German lichenologist Felix Schumm. The program will officially be launched during the annual meeting of the American Bryological and Lichenological Society (ABLS) in Ohio in July and then be made available for download from the Help and Resources website of the Lichen Consortium. Information about the program will be disseminated among the international community via the Lichen Listerv email list, and at the meeting of the Grupo Latinoamericano de Liquenólogos (GLAL) in October 2024.

Chromatograms and detailed data on secondary metabolites are also available through the Glossary, an example is atranorin.

For July, the launch of Symbiota version 3.1 will introduce new functionality to the portals; as one of the first portals that will receive the updated code, the Lichen Consortium will be beta testing these new features:

- Updated and unified icons & fonts (better scaling of the site, particularly on handheld devices such as tablet and phones)
- Advanced Search Page
- Additional fields in occurrence editor
- Leaflet maps instead of Google Maps
- Improved Map Search

- Extended Data Import
- Improved Linked Resources

At F, they are exploring the potential of Large Language Models such as ChatGPT to accelerate the process of transcription. Artificial Intelligence remains of great largely untapped potential in transcription efforts.

Geofererencing

WIS has found that georeferencing with Symbiota's Batch georeferencing interface allows the user to better group duplicate localities to map together than CoGe. They find we are seeing similar localities over and over in CoGe because of small typos or small wording differences.

Share Opportunities to Enhance Training Efforts

The GLOBAL Project Manager (TENN) and Georeferencing Manager (WIS) continued compiling resources during 2024-Q2 to share on Basecamp and all resources were posted to the project website (https://globaltcn.utk.edu).

ASU continues 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. Updates to programs provided as part of the grant (BCRWatcher, Mytabolites) are regularly made available. Symbiota tutorials continue to be added to the Symbiota Documentation by the Symbiota Support Hub at https://biokic.github.io/symbiota-docs/.

The Lichen and Bryophyte Consortium Portal Campaign in April/May for the GLOBAL community was enthusiastically received and very well attended. We managed to engage 75 unique campaign participants during Office Hours, with over half of these attendees (58%) participating in multiple training sessions. As a result, 7 collection profiles were added to the portals, contributing 61,023 and 102,053 new occurrence records to each portal, respectively. Over 40 new datasets were published, 25 datasets from the Bryophyte Portal and 16 datasets from the Lichen Portal, in turn sending 193k+ new records to GBIF. Also, an additional 253k occurrences from affiliated vascular plant collections were sent to GBIF. 2 very large snapshot collections were updated in each portal (=398k records refreshed or newly added). The team responded to 25 data cleaning inquiries from 17 different collections. Contacts for 26+ collections across were updated across both portals.

As part of the campaign one session featured a workshop on how to use the checklist tools to create species checklist, using the recently published Ecuador Checklist as an example for managing biodiversity datasets of megadiverse countries (see open access publication in the peer-reviewed journal The Lichenologist).

At the campaign's conclusion, the Lichen Portal included 187 collections contributing 4.3M+ occurrences to the portal, and, likewise, 156 collections were sharing 5.3M+ occurrences to the Bryophyte Portal.

At F, Summer internships began in this quarter which is allowing exposure to natural history collections and training the next generation of scientists.

The TENN Project Manager corresponded with the Lead Digitizer on structure and schedule of the Herbarium Bootcamp trainings used at the TENN Herbarium to onboard students during breaks in classes. This format has been an effective way to quickly train students on the tasks without having to work around varied class schedules during term.

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

Collaboration between GLOBAL teams and other TCN projects occurring concurrently at their sites continued. CINC is also part of the All-Asia TCN and students regularly work side-by-side and share tips and tricks. This process has improved the imaging and transcription workflows for both projects. COLO is also a member of the SoRo TCN and the All-Asia TCN. They continue to share info and technology between projects to help optimize workflows. MICH is participating in the All-Asia TCN and the two TCNs share workflows and expertise.

International institutions and collaborators continue to join the Consortium of Lichen Herbaria. As a result of the April/May Portal Campaign, 7 new collection profiles were added to the portals, contributing 61,023 and 102,053 new occurrence records to each portal, respectively. F. Bungartz (ASU) continues leading regular monthly meetings with a group of Mexican lichenologists from the Universidad Nacional Autónoma de México (UNAM), the Benemérita Universidad Autónoma de Puebla, and the Universidad de Sonora. In preparation for an International Workshop at the meeting of the Grupo Latinoamericano de Liquenólogos (GLAL) in Mexico City in October 2024, they are revising and updating the current Checklist of Lichens and Lichenicolous Fungi of Mexico, shared through the Consortium.

BISH has been working closely with Dr. Cliff Smith, Professor Emeritus from the University of Hawaii to transfer his extensive lichen collection to the Bishop Museum Herbarium. He has been visiting the herbarium weekly to annotate his specimens.

Duke's B. Aguero participated in the beta-testing of the Cross-portal searching tool in development by the Symbiota team.

Cliff Smith from the University of Hawaii continued to visited the PTBG herbarium to identify their lichen collections.

The TENN Project Manager corresponded with the Hawaii PEN partners regarding their Year 1 Annual Reporting and created reporting templates for their use.

WIS communicated and sent pamphlets of "Common Lichens of Wisconsin" to a Master Naturalist of Wisconsin program from the WI DNR for their use in an upcoming class. This program provides a 40-hour course for adults who may then volunteer throughout the state in citizen scientists, stewardship and education.

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.

Symbiota API

At ASU, the Symbiota Support Hub team continues to work on strategies to use the new API to facilitate data queries across different Symbiota platforms.

Back Ups

CINC's JPGs are now stored on, and served from, servers at the University of Cincinnati. All original images and JPG derivatives are backed up on one of two herbarium computers, two external hard drives, and in the cloud.

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.

TENN Collections Manager backed up all archived GLOBAL images onto a HERBDATA server through the UTK NIMBioS computer cluster.

JPGs and CR2 files are being moved to the research server at WIS. They will be returning original images to our partner institutions for their long-term maintenance (BRU, WTU, NEB).

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.

The first round of learning glass videos has been produced by ALA, including Steffi Ickert-Bond, and her team. This was led by Todd Widhelm of F and two graduate students from WIS. They are now available online:

- Bryophytes Versus Lichens Comparison - https://media.uaf.edu/media/t/1_0k9hwi0o
- How to ID Mosses - https://media.uaf.edu/media/t/1_d75j0o1k
- Life Cycles of Bryophytes and Lichens - https://media.uaf.edu/media/t/1_b7j7ba5i
- Lichen Biology - https://media.uaf.edu/media/t/1_avubjnps

The ASU Lichen Herbarium regularly attends to visitors interested in learning about the collection as the largest and most representative lichen herbarium in the Southwest. Mexican student Eduardo Gutierrez got accepted into the masters program at ASU and will start his MS at ASU in January 2025.

DUKE's B. Aguero gave "Botany Spotlight: Mosses of Duke Forest" bryophyte walk on Apr 19. J. Shaw and B. Aguero gave a bryophyte walk for the Wild Ones (group of Duke undergraduate

naturalists) on Apr 23. B. Aguero taught two 5-day workshops on liverwort ecology and identification, at Polly Hill Arboretum (May 6-10), and at Eagle Hill Institute (June 24-28).

A variety of education resources produced at F are now online showcasing digitization efforts. These range from podcast to teaching educational resources. These can be accessed here: https://www.fieldmuseum.org/plants-and-animals These include the following:

- Adventures in the Herbarium: Museums and Medicines
- Adventures in the Herbarium: Pixels and Petals
- Biodiversity and Ecosystems
- Plant Biomimicry
- Plant Structure and Function | Hands-on Version
- Plant Structure and Function | ThingLink Digital Version

They have hosted two Collections Club events that have aided in pre-curation activities as part of the current project.

MICH gave herbarium tours to nearly 800 undergraduate students in April, which featured lichen/bryophyte specimens and descriptions of our digitization process and grants.

The TENN Herbarium held a “Specimens and Scones” open house event on April 10, welcoming faculty, staff, students, and other off-campus groups to visit and tour the herbarium. The Collections Manager and TENN PI conducted tours of the herbarium for the Plant Science Club, McClung Museum Student Interns, Interior Architecture Students, Loghaven art residents, and Field Botany Class.

Share Information About Your Website and/or Portal Usage

The GLOBAL project website, https://globaltcn.utk.edu, was utilized by 242 users during 2024-Q2, including 35 from Europe, 25 from Asia, 13 from South America, 3 from Africa, 3 from Oceania and 2 from the Middle East (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. 7,500 users visited the Bryophyte Portal, and 20,000 users visited the Lichen Portal during 2024-Q2 (see Figures 4 & 5).

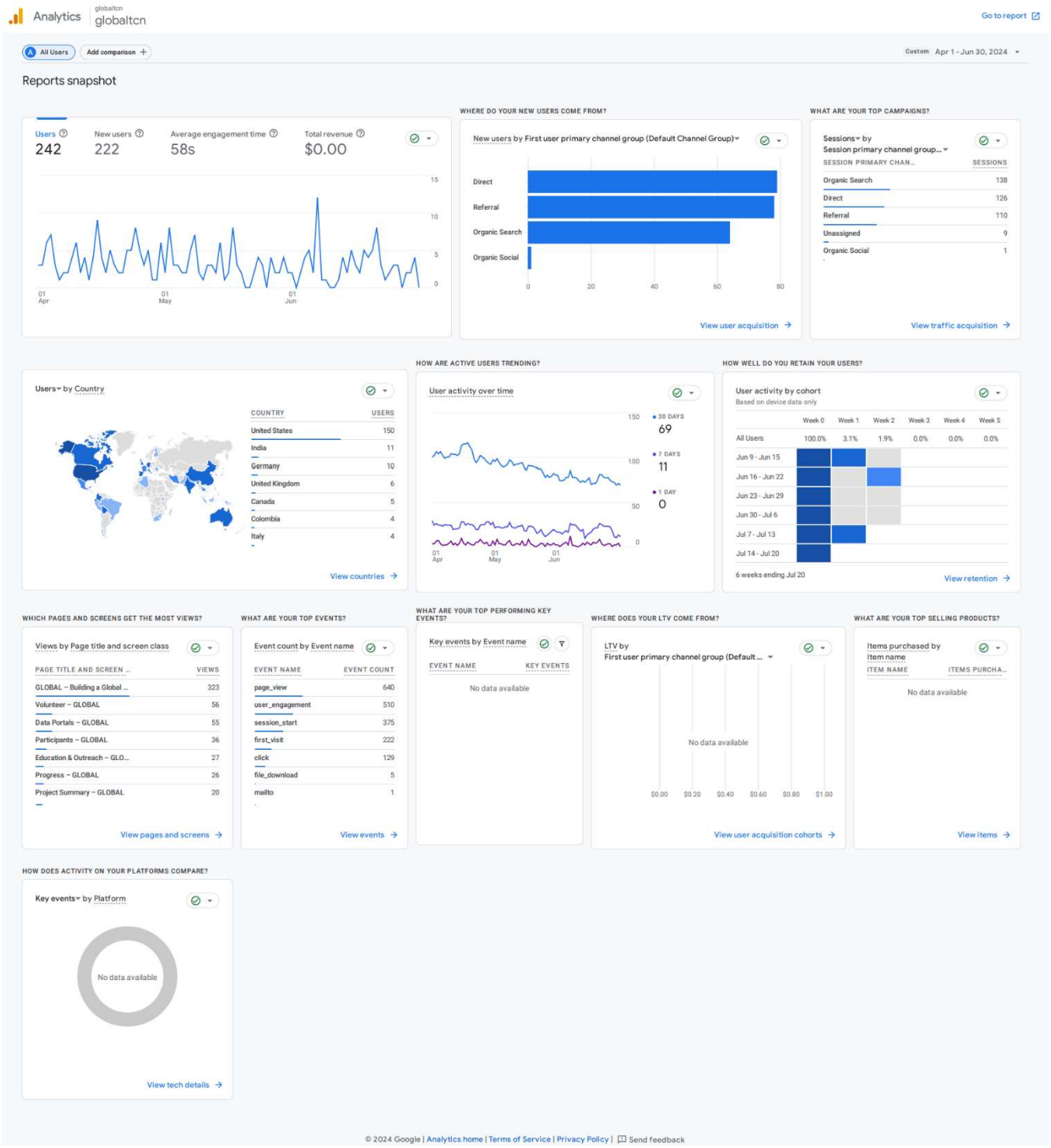

Figure 3: Use metrics for the GLOBAL project website (https://globaltcn.utk.edu) from April 1 – June 30, 2024.

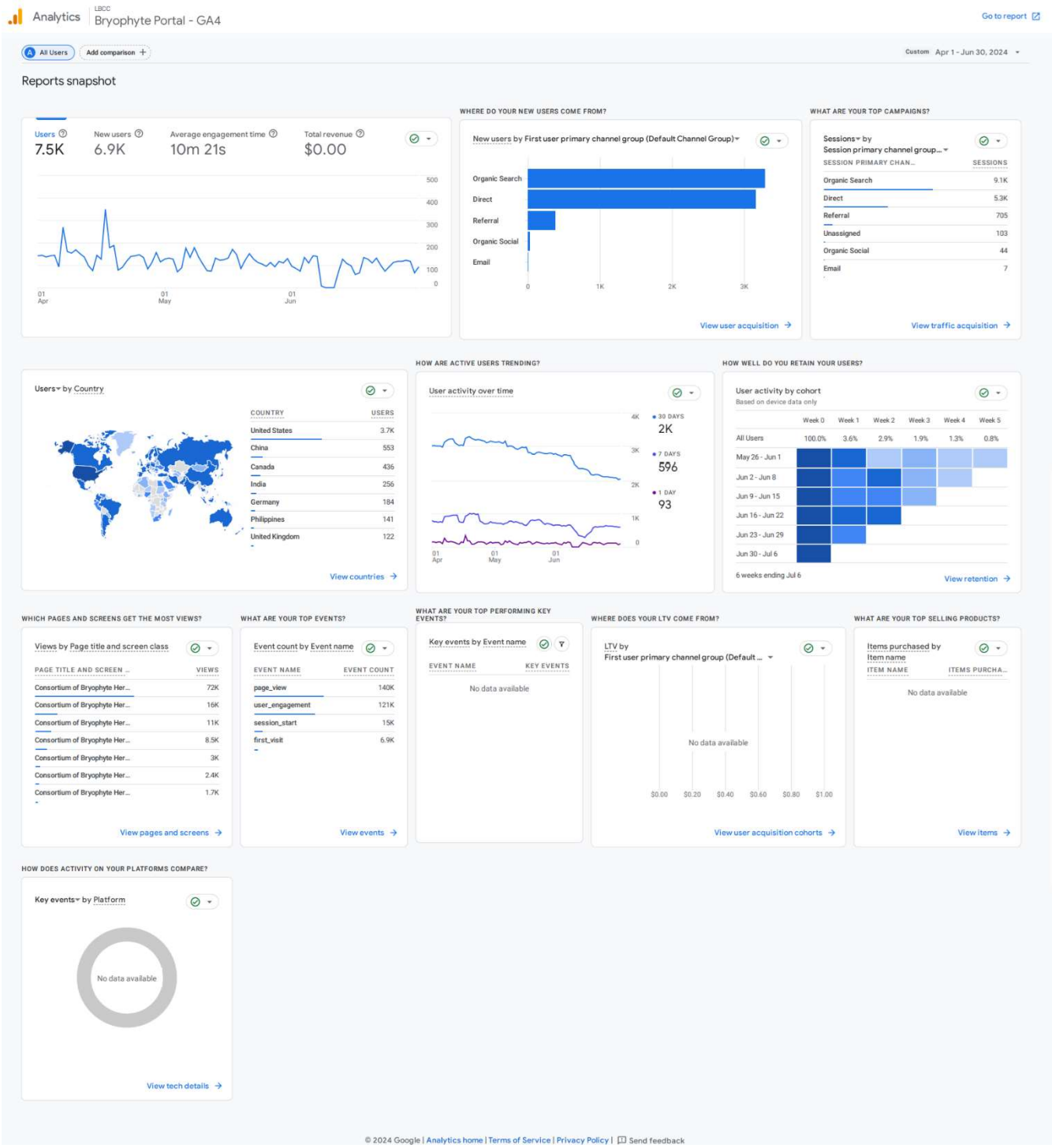

Figure 4: Use metrics for the Bryophyte Portal (https://bryophyteportal.org/portal/) from April 1 – June 30, 2024.

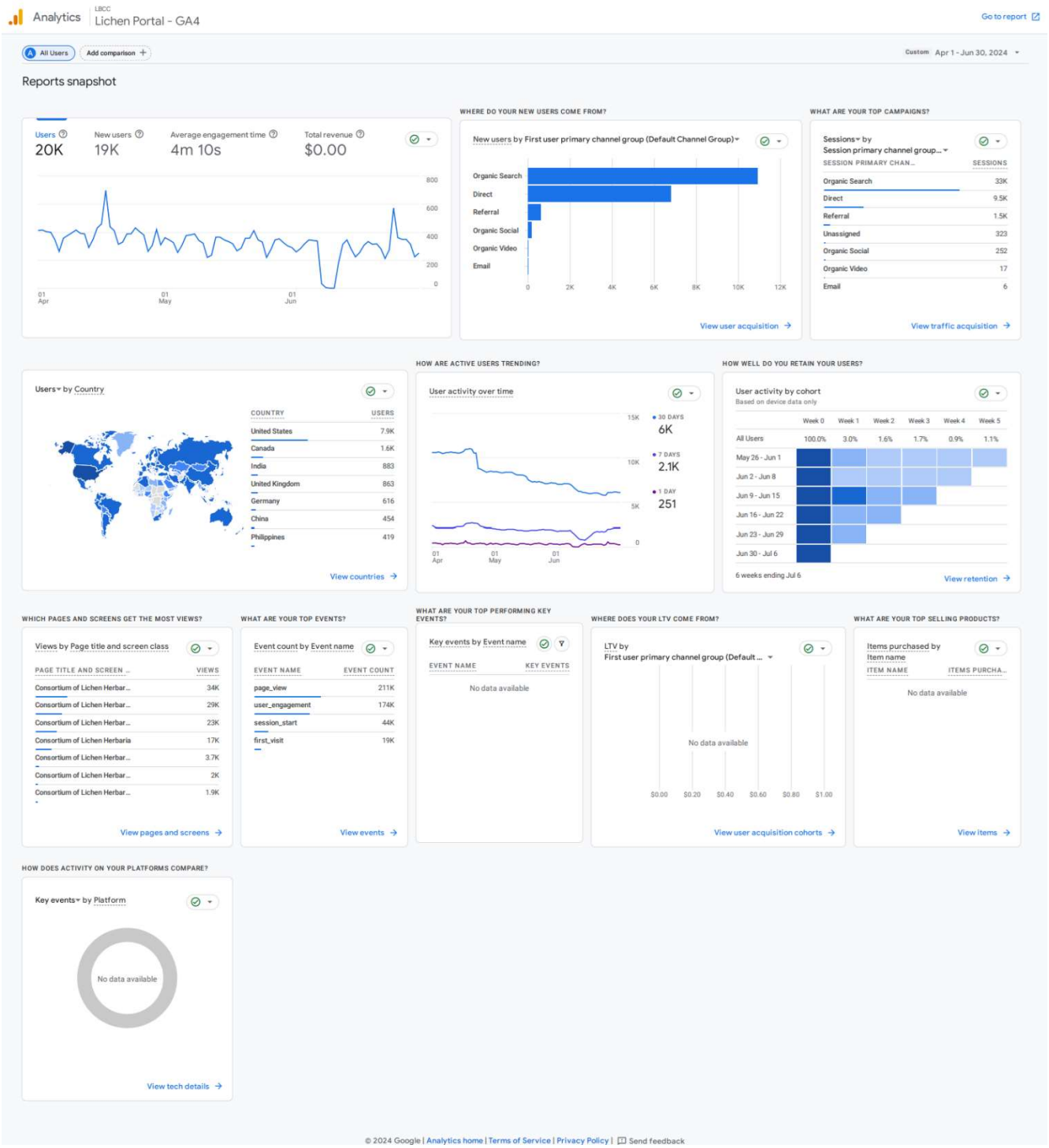

Figure 5: Use metrics for the Lichen Portal (https://lichenportal.org/cnalh/) from April 1 – June 30, 2024.

Share Other Activities and/or Progress

Image Tagging

Progress continued at ASU on character revision for tagging and identification keys and the glossary. A draft Controlled Vocabulary for import into Image Cataloging Software is currently being reviewed and tested. Default image tagging categories in the Consortia of Lichen and Bryophyte Herbaria have been updated and with the launch of the new 3.1 version of Symbiota new tagging function will be available for batch tagging images directly in the portal.

Images from German lichenologist Felix Schumm continue to be processed/tagged for upload into the Consortium. Updating the taxon profiles of North American species of *Rinodina* from a monograph published by John Sheard is now complete.

No-Cost Extensions

Most GLOBAL collaborators requested a second no-cost extension to continue GLOBAL work into a Year 5.