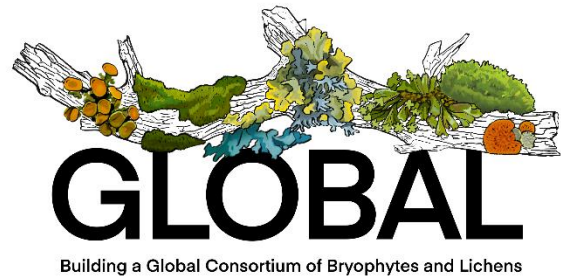


TCN Quarterly Progress Report

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 October 1 – December 31, 2023.

Workflows, Equipment, and Personnel

Most GLOBAL institutions continued steady GLOBAL progress during 2023-Q4.

ALA continued imaging of the remaining lichens and bryophytes. A new graduate curatorial assistant has started transcriptions of bryophytes.

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

Progress at CINC & MU slowed toward the end of Fall semester and over Winter break. They have completed imaging of the CINC accessioned collection and continue to process specimens from the backlog from the CINC CSBR project. These are mostly liverworts but include some mosses and lichens. The herbarium is in the process of moving into its newly renovated space

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

as part of the CINC CSBR project. This has slowed GLOBAL progress somewhat due to periodic chaotic conditions but will ultimately accelerate progress once organization and accessibility of the collection are dramatically improved.

COLO continued barcoding and capturing images of lichen and bryophyte packets. Images and all skeletal data captured through 12/31/2023 have been uploaded to the portal and transcription continued. Digitization numbers for this quarter are up from last quarter. The quarter total of 8,400 packets imaged represents the second-best quarter for the project even with shutdowns for Thanksgiving and Winter Breaks. Only one of the three new students hired in the fall of 2023 is returning for next quarter, so they are back to trying to restaff the project.

DUKE barcoded bryophyte specimens, imaged labels, and uploaded skeletal data to the bryophyte portal. They incorporated a Zerene Stacker into their plant imaging workflow for bulky specimens (very small proportion of plant images). Approximately 100 newly discovered lichen type specimens from DUKE's lichen exsiccati were also imaged.

F focused largely on imaging lichen packets from the Thorsten Lumbsch Herbarium. The skeletal records for these specimens generated in EMu will be uploaded to the portal in the near future. Bryophyte and lichen imaging, skeletal data, and transcription continued.

At FLAS imaging progress was made on genera starting with Ph in mosses, proceeding towards Z. Liverworts and hornworts will be next for imaging.

All of the ILL bryophyte images were uploaded to the Bryophyte Portal.

LSU completed digitization (labels imaged and fully transcribed) of their existing lichen and bryophyte collections this quarter! All bryophyte specimens have been imaged, which went beyond project expectations. They held off imaging lichen specimens so that they can all be done in one pass at a later date. Georeferencing is ongoing, both in-house and at WIS. Grant funding was exhausted this quarter.

During this period, MICH shifted its focus back to imaging bryophyte specimens. They barcoded, imaged labels, and created skeletal records for 9,405 specimens. They fully transcribed 608 lichen specimen records before they switched efforts to imaging. New data continued to be sent to their Symbiota portals via the IPT.

MIN connected 18,312 lichen exsiccati records to their titles and exsiccati numbers. They integrated Cliff Wetmore's transcription with the imaged skeletal records. They hired graduate student curatorial assistant Ana Favaro to help with integrating exsiccatae titles and data.

MO barcoded and imaged 4,672 bryophyte labels and specimens. They created 4,672 skeletal records and fully transcribed 677 labels. They also georeferenced 194 specimens.

At PH, bryophyte packets pinned to sheets are being removed and repacketed (funding for curation provided in-house) and these packets are being barcoded and databased.

PTBG produced 3,531 images (and each image is a composite of stacked images) representing 1,369 specimens of Hawaiian mosses. They mounted, barcoded and fully transcribed 163 new specimens.

At TENN, the Collections Manager interviewed and hired four new undergraduate technicians to begin work in January 2024. Alex Dowd was hired as a Lead Digitizer and began tracking down GLOBAL specimens in need of additional imaging, while also assisting WIS with georeferencing. The Collections Manager began repackaging and printing labels for a series of bryophytes collected by D.K. Smith in China.

At UC, the Museum Assistant helped to barcode and file specimens, which streamlined the process for students to make skeletal records and image bryophyte specimens.

Students continued imaging WIS lichens as well as imaging and transcribing BRU lichens and bryophytes. Collaborative georeferencing continued at a steady pace as transcribed records across collections were added to established CoGe communities. WIS Georeferencing lead continues to verify coordinates and has sent another set of completed records back to MO for ingestion into their database. Returning corrected coordinates for other snapshot collections will begin in earnest the next quarter. WIS Georeferencing lead met with Alex Dowd (TENN) for training to assist with collaborative georeferencing efforts.

YU continued transcribing label data. Undergraduate students generated 1363 fully transcribed records.

Digitization

Eighteen institutions (ALA, ASU, CINC & MU, COLO, DUKE, F, FLAS, ILL & ILLS, LSU, MICH, MIN, MO, PH, PTBG, TENN, UC, WIS, and YU) reported progress on digitization deliverables, with a total of 33,679 specimens barcoded (30,726 bryophytes and 2,953 lichens), 44,015 labels

imaged (36,369 bryophytes and 7,646 lichens), 28,674 specimens imaged (17,659 bryophytes and 11,015 lichens), 24,357 specimen records uploaded to the portal (22,362 bryophytes and 1,995 lichens), 40,671 skeletal records created (37,619 bryophytes and 3,052 lichens), 34,908 labels fully transcribed (13,082 bryophytes and 21,826 lichens), and 23,774 specimens georeferenced (13,837 bryophytes and 9,937 lichens) (See Table 1 & Figure 1).

PEN partner PTBG reported their first project activity for 2023-Q4, with a total of 163 bryophyte specimens barcoded, 1,369 bryophyte labels imaged, 1,369 bryophyte specimens imaged, 8,680 skeletal records were created (6,961 bryophytes and 1,719 lichens), and 8,680 labels fully transcribed (6,961 bryophytes and 1,719 lichens).

Table 1: Digitization progress by GLOBAL collaborators in 2023-Q4, 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						2,095			25		41			
ASU		997		997		837		837		837		837		
BRY														
CINC & MU	1,234	107	441	106	441	106	559	107	1,234	107	1,153	2		
COLO	8,021	379	8,021	379			8,021	379	8,021	379	580	1,037		
DUKE	2,758		3,261		345		3,606		2,758		347		32	
F	2,185	1,333	2,521	5,990	2,521	5,990	2,521		5,512	1,592	4,116	742		452
FLAS			2,531		2,531		2,531				1,196			
ILL & ILLS											100			
LSU	146	134	146	171	533		146	134	146	134	435	208	356	597
MICH	9,405		9,405		1,045		2,020		9,405			680		16
MIN												18,312		
MO	4,726		4,672		4,672				4,672		677		194	
MSC														
NY														
OSC														
PH	318						318		318		318		213	
TENN	1,683	3	1,742	3	1,742	3	1,742	3	1,669	3	2,110	8	1,285	2
UC	250		3,629		3,629				3,629					
WIS					200	1,984	898	535	230		646		11,757	8,870
YU											1,363			
Totals	30,726	2,953	36,369	7,646	17,659	11,015	22,362	1,995	37,619	3,052	13,082	21,826	13,837	9,937
B+L Totals	33,679		44,015		28,674		24,357		40,671		34,908		23,774	

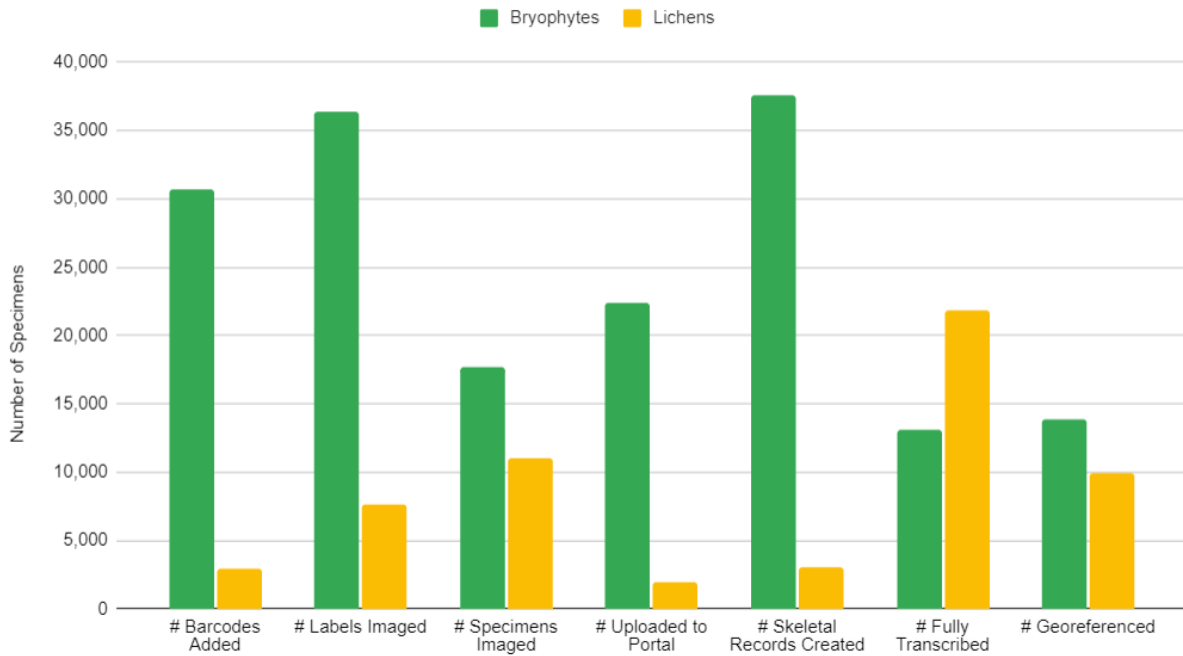


Figure 1: Digitization progress for the GLOBAL collaboration in 2023-Q4, separated by Bryophyte and Lichen specimens.

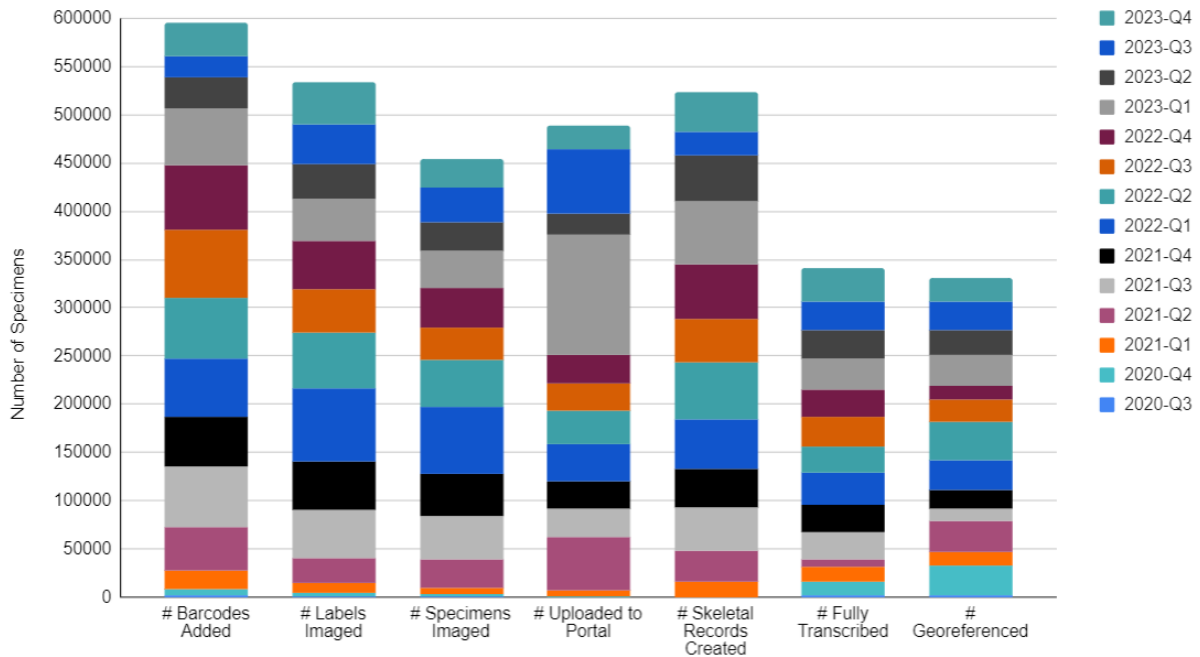


Figure 2: Cumulative digitization progress for the GLOBAL collaboration by quarter.

Share Best Practices, Standards, and Lessons Learned

Flexible Workflows

The GLOBAL teams continued to make use of flexible digitization workflows in 2023-Q4, 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. We set a goal to transition at 75% of packets imaged across the project. We expect this pivot to happen next quarter. Since no transcription work was completed on their 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 and have now added South America and Africa to their focus regions.

Collaboration

Team members continued to make use of Basecamp, Zoom, and email to communicate and collaborate during 2023-Q4. New collaborators and students were given access to Basecamp group resources. The Outreach & Education Group met in September and October to finalize planning for the October WeDigBio event. The Executive Committee (F, NY, TENN, UC) met in October to discuss progress and priorities for Year 4. A Management Committee Meeting was held in November open to all GLOBAL members to review progress from 2023-Q3, and to provide an open forum to the GLOBAL team. Lead PI Budke had individual check-in meetings over Zoom with ALA, ASU, CINC, COLO, DUKE, F, FLAS, ILL&ILLS, LSU, MICH, MO, NY, OSC, PH, PTBG, UC, WIS, and YU.

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. WIS began

communication and training with Alex Dowd (TENN) regarding contributing to collaborative georeferencing efforts.

Share Identified Gaps in Digitization Areas and Technology

New Software Tools

ASU continued to make updates to programs provided as part of the grant (BCRWatcher, Mytabolites) regularly available. The newest version of Mytabolites (1.0.0.0) is the first official non-beta version. This version now supports data download through a secure connection directly from the Lichen Consortium. Each time the program is started, it checks whether data sets online have changed. This means records for the secondary metabolite data can be efficiently updated online and the user can then update/refresh the local database. This newest version has been shared with a select group of beta testers. A manuscript on how to use Mytabolites to facilitate the analysis of lichen secondary metabolites by more efficiently interpreting thin-layer chromatography plates is currently in preparation, to be submitted to a peer-reviewed journal.

At F, both lichens and bryophyte imaging stations have started using the BCRWatcher tool: <https://help.lichenportal.org/index.php/en/bcrwatcher/> that is helping increase efficiencies with downstream databasing as it includes some meta data.

Progress continued at ILL&ILLS with updates to existing Symbiota toolkit (Symbtk) features, and new developments for portal image management, which includes functions for searching, and tagging. The Symbtk Taxonomic Reporting tool has been effective in contributing to the addition of over three thousand new and updated taxa in the MyCoPortal. The Symbtk Genbank meta-data tool has assisted the addition of 1,280 new genetic associations with portal data in the past year, and the Symbtk file upload component has transferred over 12 thousand images in 2023.

MICH worked with a graduate student Will Weaver who developed an automated image cropping tool for our image processing pipeline

Share Opportunities to Enhance Training Efforts

The GLOBAL Project Manager (TENN) and Georeferencing Manager (WIS) continued compiling resources during 2023-Q4 to share on Basecamp and all resources were posted to the project website (<https://globaltcn.utk.edu>).

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/>. A portal campaign introducing new features to participating institutions of GLOBAL is planned for March/April and the results be presented at the annual meeting of the American Lichenological and Bryological Society (ABLS) in the summer. For the annual meeting of the Grupo Latinoamericano de Liquenólogos (GLAL XVI) in the Ciudad de México this October a round table and workshop are planned to encourage more Latin American lichen collection to join the Consortium.

Four undergraduate interns from Roosevelt University as part of a biodiversity class worked half a day each at F throughout the fall and winter and were trained on imaging and databasing and curation. One undergraduate from Chicago State University was also trained.

At YU, undergraduate students were trained in transcription of bryophyte and lichen specimens.

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

International institutions and collaborators continue to join the Consortium of Lichen Herbaria. A collaboration agreement (convenio) of ASU's Biodiversity Integration Knowledge Center (BioKIC) and the Instituto Nacional de Biodiversidad en Ecuador (INABIO) was signed last month. Under this convenio ASU provides Symbiota support for Ecuador's National Biodiversity Database (BNBD) and Ecuador shares their Symbiota data with the Consortium of Lichen Herbaria at ASU.

Collaboration between GLOBAL teams and other TCN projects occurring concurrently at their sites continued. CINC (also processing MU) is part of the All-Asia TCN, and workflows are shared between the two 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, with shared workflows and best practices.

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-List of Lichens was recently updated and now includes 141 taxa.

Symbiota API

ASU, The Symbiota Support Hub team continues to work on strategies to use the new API to facilitate data queries across different Symbiota platforms. ASU student worker Ramisa Zaman (undergraduate student, computer science major) has just started her internship in Java and C++ programming to develop a prototype for a cross platform search for ecological data analysis. New student worker Mrinaal Arora is being hired to continue routine specimen digitization, while Ramisa Zaman is expected to dedicate more of her time to programming.

Back Ups

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.

All ILLS and ILL data are archived on mirrored servers at the University of Illinois.

Images are backed up on the LSU herbarium's local RAID drive and pushed to an herbarium server managed at the Frey Computing center on the LSU campus. A copy is archived in the

cloud using LSU supported Box software. This process is semi-manual using a custom script to file images, create image derivatives, and produce portal mappings.

MICH's images are archived at the U-M Digital Library.

All MIN data is archived on servers at the Minnesota Supercomputing Institute.

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

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. Our PEN partners from Hawaii were added to the website. 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. These can be accessed here: <https://f.io/tMLx1a64> - and are in review stage. This was led by Todd Widhelm of F and two graduate students from WIS.

At ASU, in November 2023, 14 participants joined a virtual workshop on specimen management and the creation of checklists using the tools available in the Consortium of Lichen Herbaria. The workshop was organized by the International Association for Lichenology. The Middle East Lichen Symposium, February 5-7, organized by Mohammad Sohrabi has been canceled, due to the currently unstable political situation in the region.

A podcast was developed by high school students at F, including an episode about digitization efforts, including bryophytes and lichens. These can be accessed here: <https://rss.com/podcasts/teenstudio>.

The MICH Herbarium gave tours to approximately 800 undergraduate students during this period.

PTBG posted on their social media accounts (X, Facebook, Instagram) an introduction to the digitization project using #globalTCN.

UC hosted one Herbarium tour to a course during this time.

WeDigBio

Six GLOBAL collaborators (COLO, DUKE, F, FLAS, LSU, and TENN) participated in the October 2023 WeDigBio. They held one additional Planning Meeting in October to finalize plans. The team from F again helped host and manage the event with assistance from the GLOBAL team. Community scientists from across the United States and around the globe participated on each of the two GLOBAL days. A hybrid event, the virtual volunteers databased over 1,200 records while in-person volunteers at F added barcode labels to specimens. The event included three presentations: “Bryophyte communities change over a 12-year period along an elevational gradient in the Great Smoky Mountains National Park” – Eric Shershen (University of Tennessee), “Aquatic transitions and interspecific relationships in Fissidens mosses” – Julia Butler (University of Tennessee), and “Behind-the-scenes Tour of the Shirley Tucker Herbarium at Louisiana State University” – LSU Herbarium Team (Louisiana State University).

Share Information About Your Website and/or Portal Usage

The GLOBAL project website, <https://globaltcn.utk.edu>, was utilized by 327 users during 2023-Q4, including 57 from Europe, 30 from Asia, 10 from South America, and 5 from Oceania (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. 27,000 users visited the Bryophyte Portal, and 39,000 users visited the Lichen Portal during 2023-Q4 (see Figures 4 & 5).

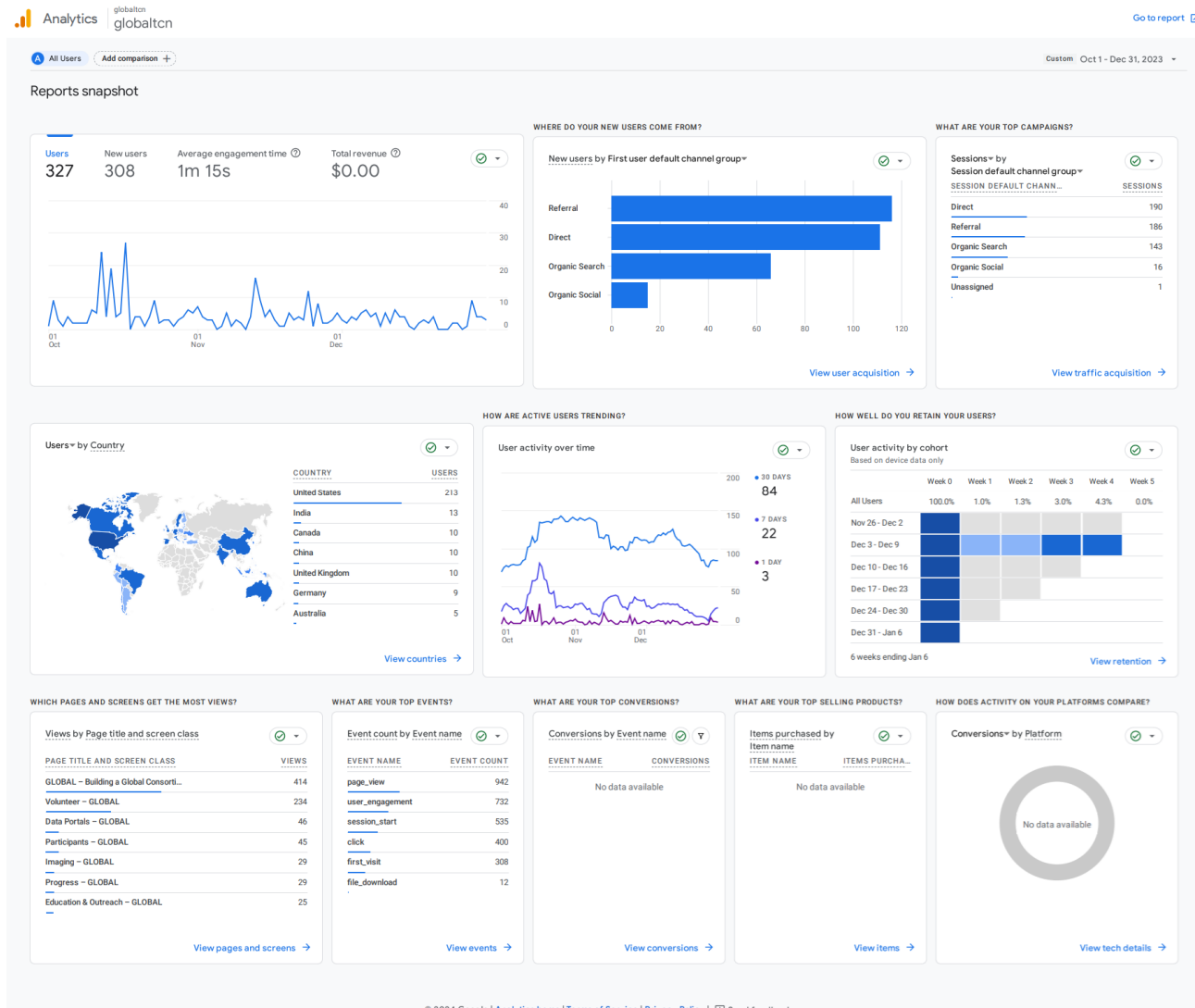


Figure 3: Use metrics for the GLOBAL project website (<https://globaltcn.utk.edu>) from October 1 – December 31, 2023.

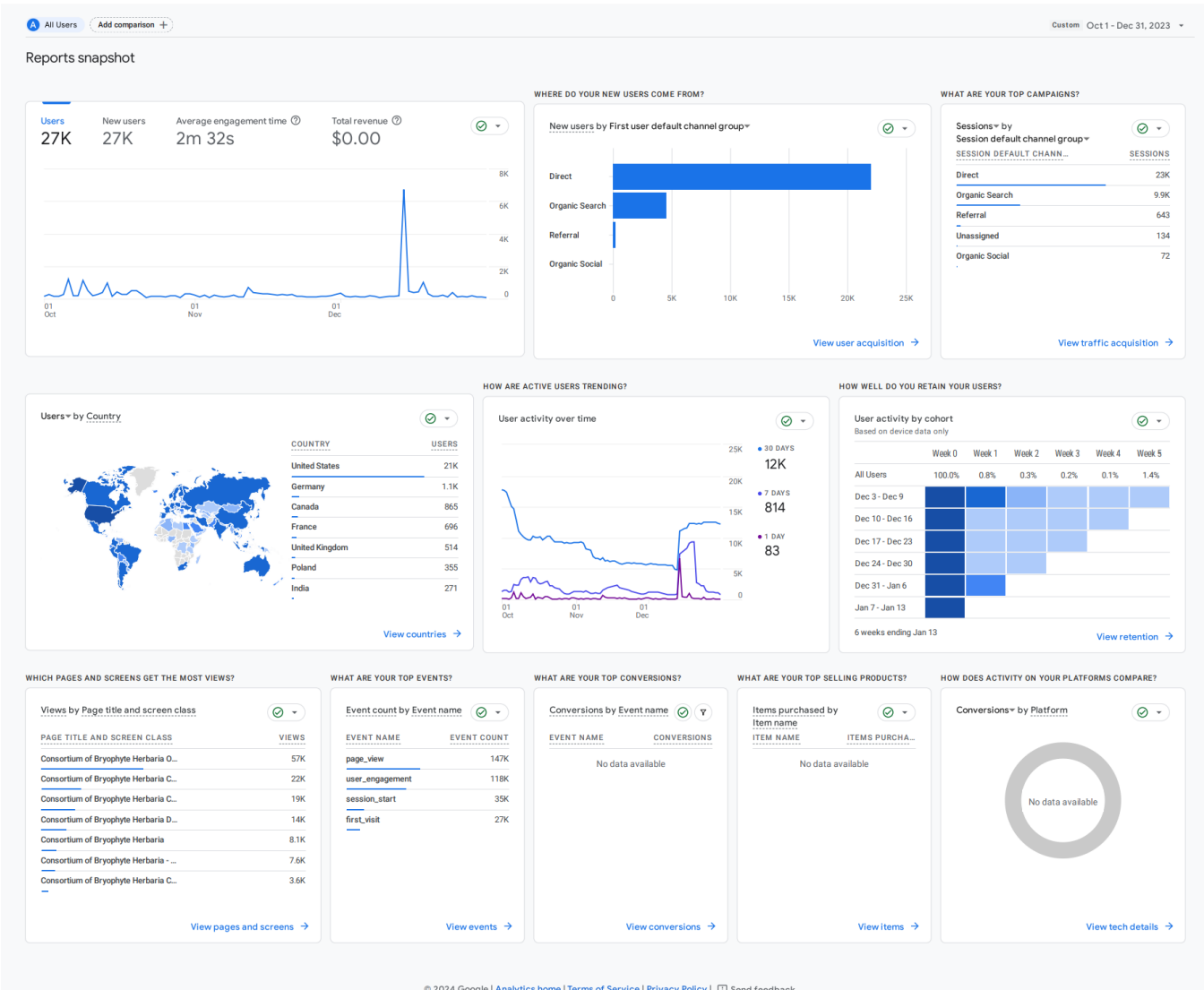


Figure 4: Use metrics for the Bryophyte Portal (<https://bryophyteportal.org/portal/>) from October 1 – December 31, 2023.

All Users Add comparison

Custom Oct 1 - Dec 31, 2023

Reports snapshot

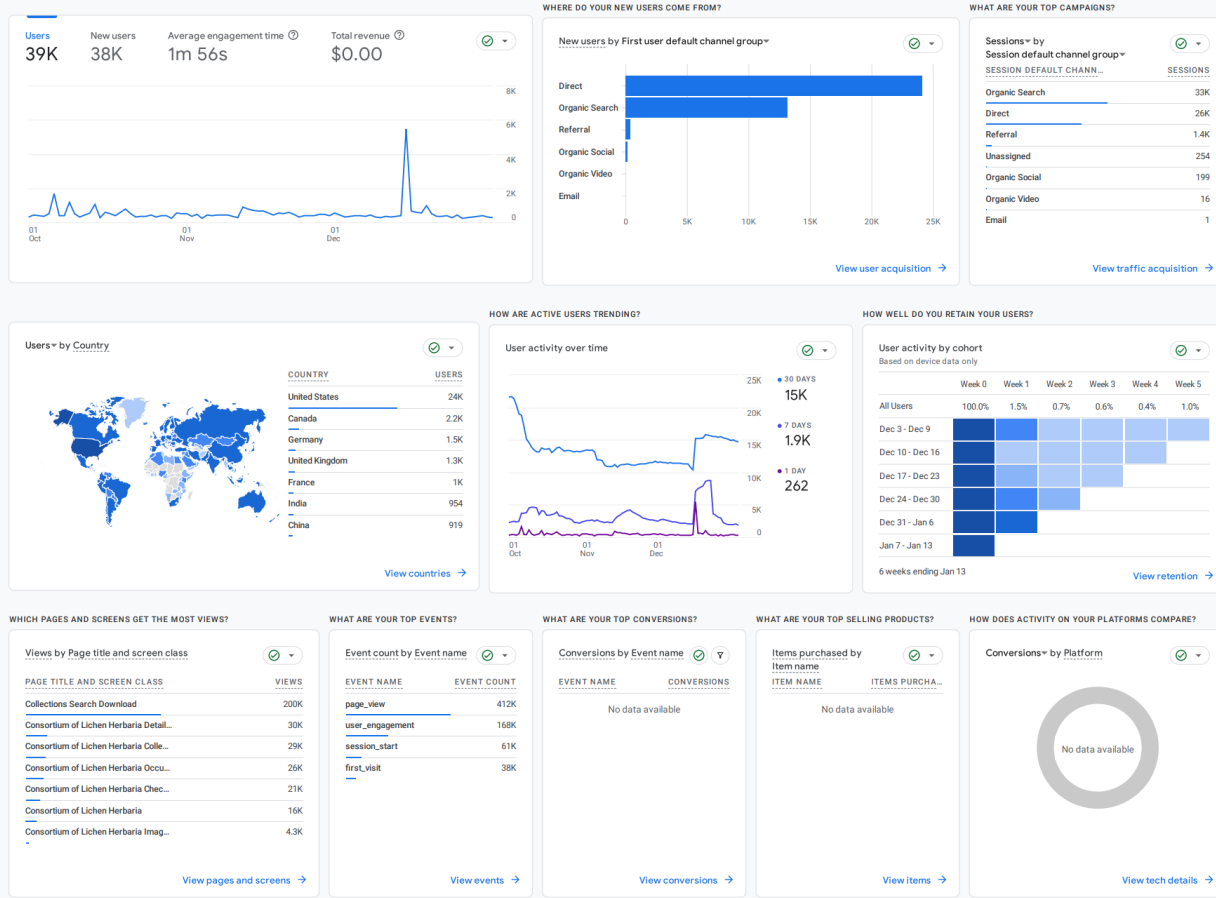


Figure 5: Use metrics for the Lichen Portal (<https://lichenportal.org/cnalh/>) from October 1 – December 31, 2023.

Share Other Activities and/or Progress

Image Tagging

Progress continued at ASU on character revision for tagging and identification keys and the glossary. 486 glossary terms are now illustrated with schematic drawings and/or macro photos, for many of these terms several images show a range of different examples, e.g., lecanorine, isidium. A German lichenologist recently agreed to have his collection join the Lichen Consortium; he shared several hundred high-quality macro- and micro images to be linked to his specimens, the majority of these from Brazil (e.g., *Abrothallus parmeliarum*). In addition to uploading images, ASU is also updating select taxon profiles (e.g., the descriptions and images of North American species of *Rinodina* from a monograph published by John Sheard, one example is *Rinodina albertana*).