

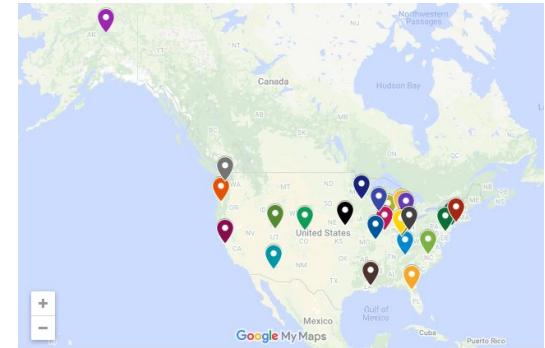
Building a Global Consortium of Bryophytes and Lichens: Keystones of Cryptobiotic Communities (GLOBAL)



Jessica Budke & Matt von Konrat



- Collaborators: 25 US Herbaria
- Project Start Date: 15 September 2021
- Project Duration: 3 years





GLOBAL Goals

- I. Establish a novel cryptobiotic consortium integrating 6M records.

Consortium of
NORTH AMERICAN BRYOPHYTE HERBARIA



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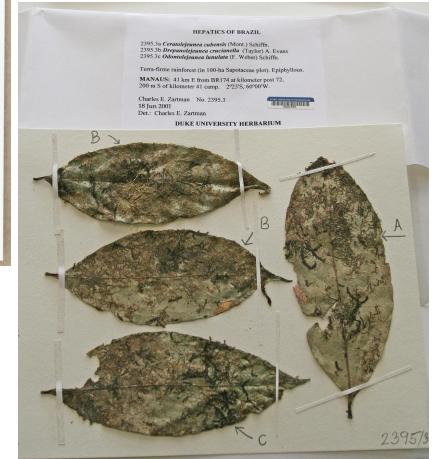
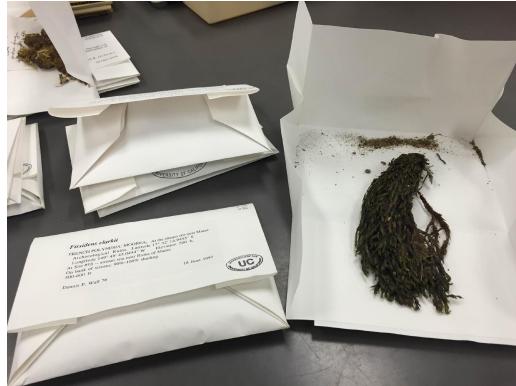
Consortium of
NORTH AMERICAN LICHEN HERBARIA



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GLOBAL Goals

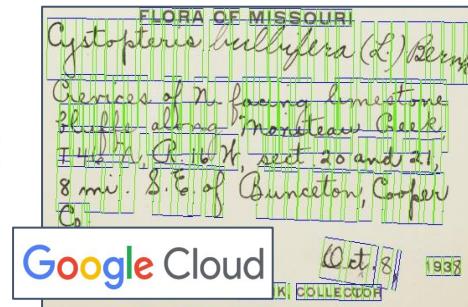
- I. Establish a novel cryptobiotic consortium integrating 6M records.
- II. Digitize label data and specimens for 1.2M bryophytes/lichens focusing on non-North American specimens from 25 US herbaria.



GLOBAL Goals

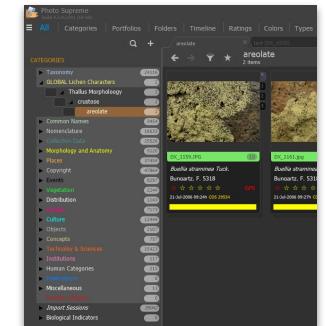
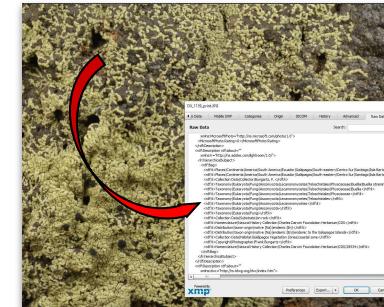
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- III. Create a connected world: Innovative automation, integration, image tagging, and machine learning.

MORPHOBANK
HOMOLOGY OF PHENOTYPES OVER THE WEB &
A database of peer-reviewed morphological matrices



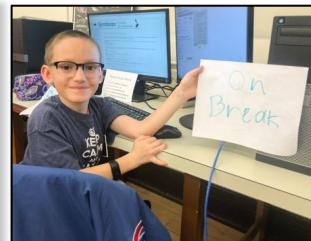
Google Cloud

Oct 8 1937
K COLLECTOR

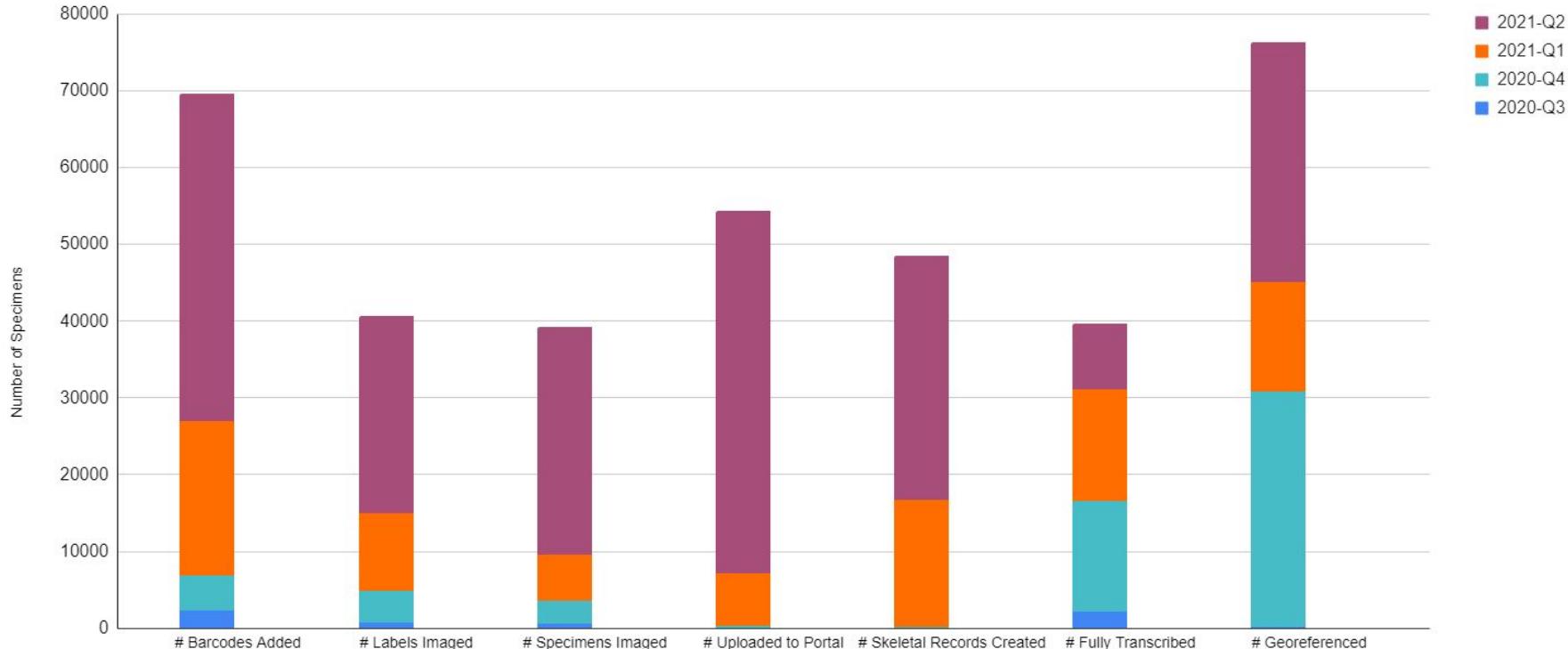


GLOBAL Goals

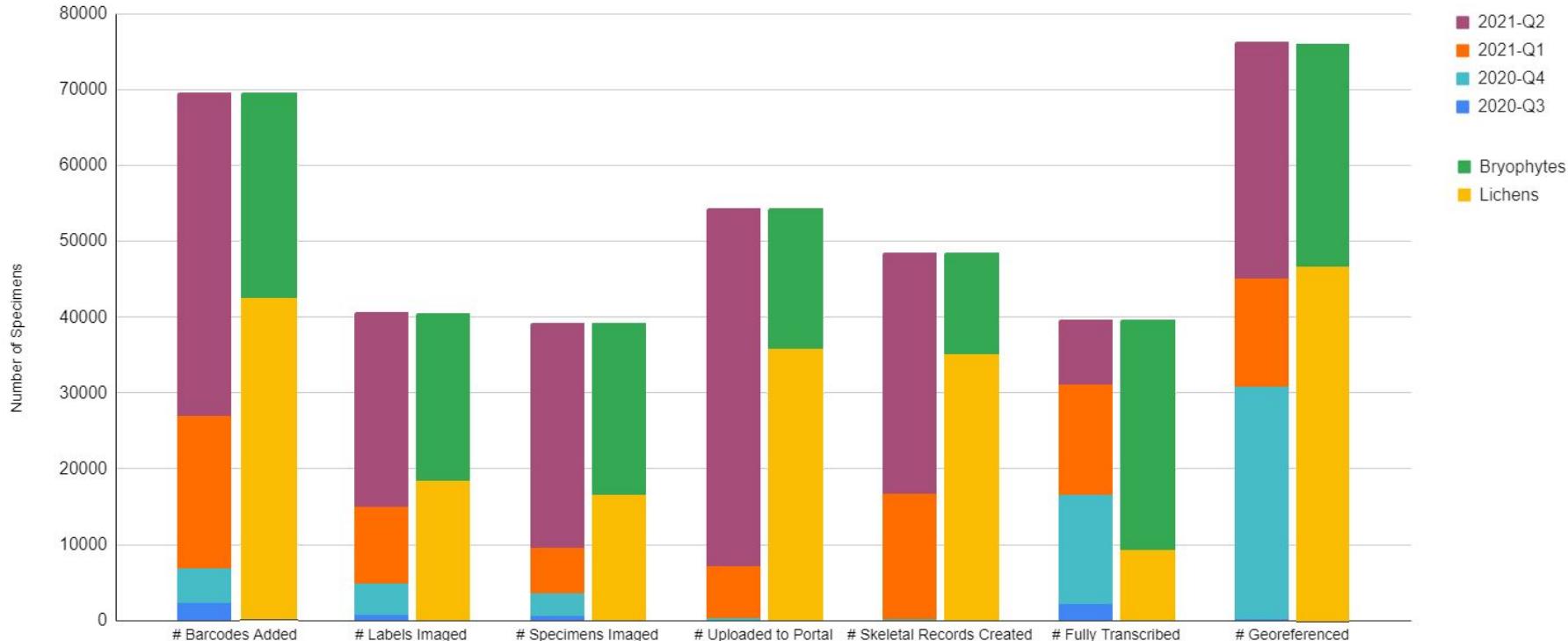
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- IV. Focus on public engagement and education.



GLOBAL Digitization Progress



GLOBAL Digitization Progress



GLOBAL Participants

Other Professionals

10.4%

Staff Scientists

2.1%

Faculty Members

6.3%

Technicians

13.5%

Students - Graduate

3.1%

PI's and Co-PI's

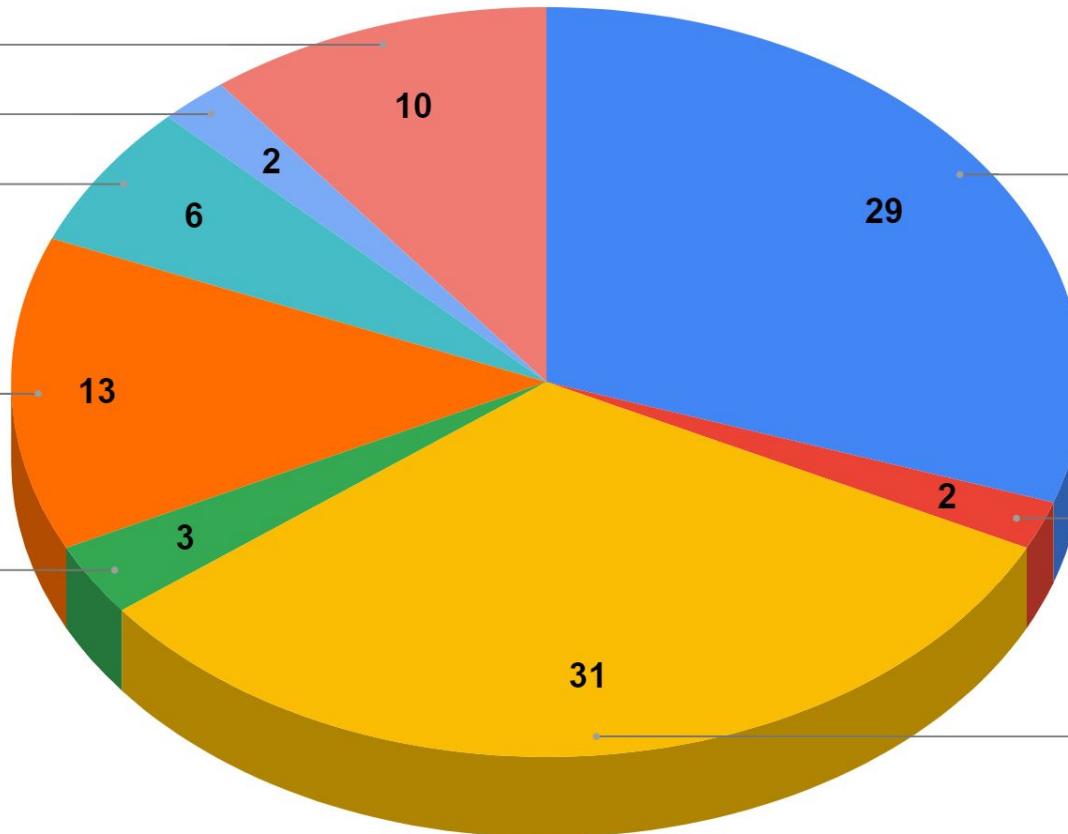
30.2%

Students - High School

2.1%

Students - Undergraduate

32.3%



Acknowledge the Traditional Custodians of the land on which we virtually gather today, and pay my respects to their Elders, past and present. I extend that respect to Indigenous and First Nation people all around the world that are joining us today.

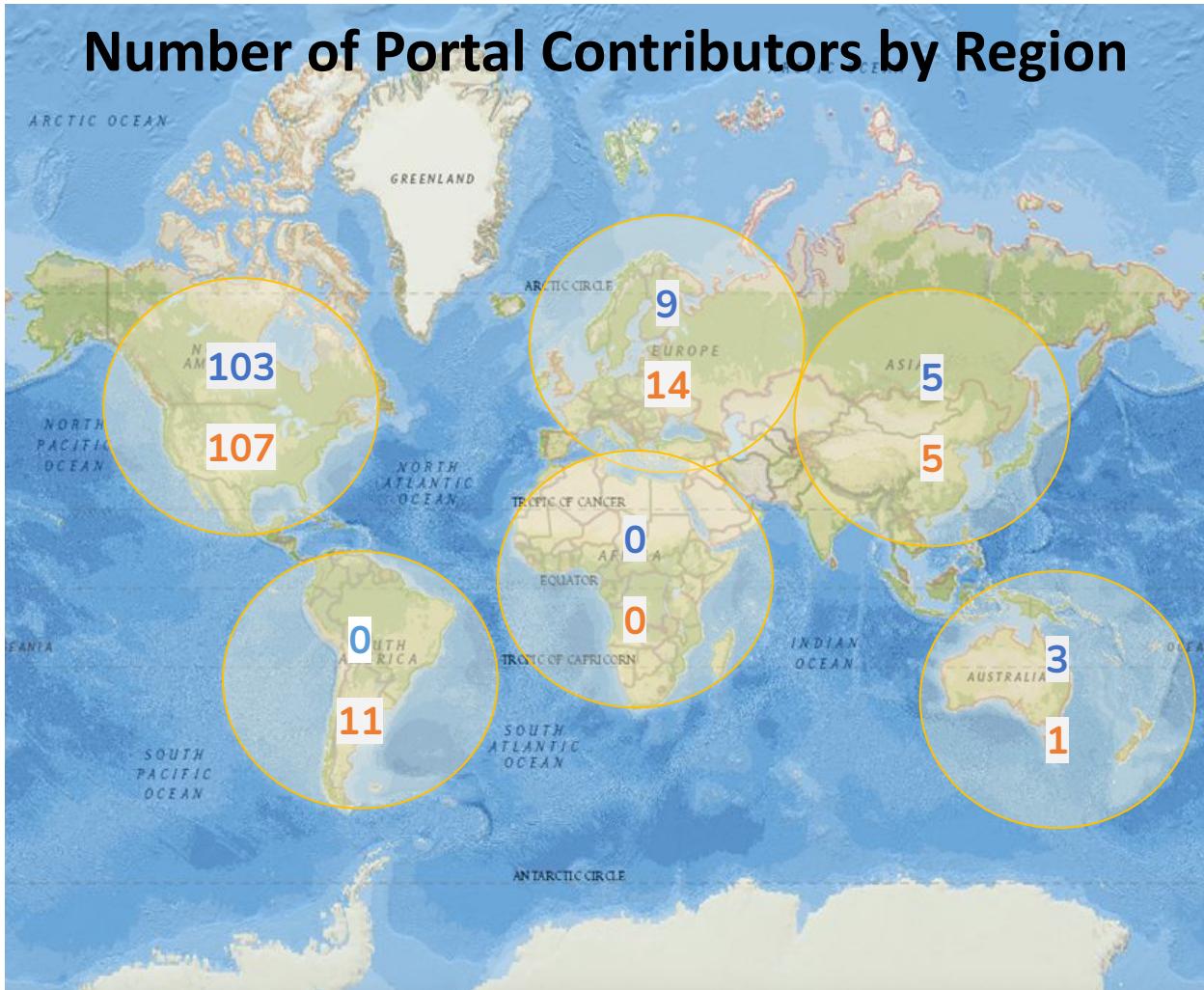
Building a Global Consortium of Bryophytes and Lichens: Keystones of Cryptobiotic Communities

- I. Establish a novel cryptobiotic consortium integrating 6M records.
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- III. **Create a connected world: Innovative automation, integration, image tagging, and machine learning.**

Number of Portal Contributors by Region

Added to CNABH or CNALH

- 21 new international herbaria
- 9 new countries
- 972,743 new bryophyte specimen records
- 998,083 new lichen specimen records





Duplicate Matching



Duplicate Coordinate R Script

- Run for 13 collections
- Julie and Katie cleaned up lists of possible duplicates
- 8,000 imported to portals (30,000+ additional awaiting review)

International Collections Data

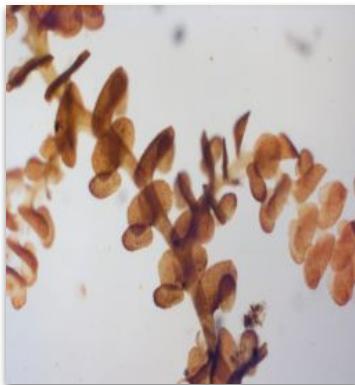
- 4 more international collections added to the portals in 2021-Q2
- 21 total collections, 970,000+ Bryophyte and 980,000+ Lichen records

Exsiccatae List and Field Updates

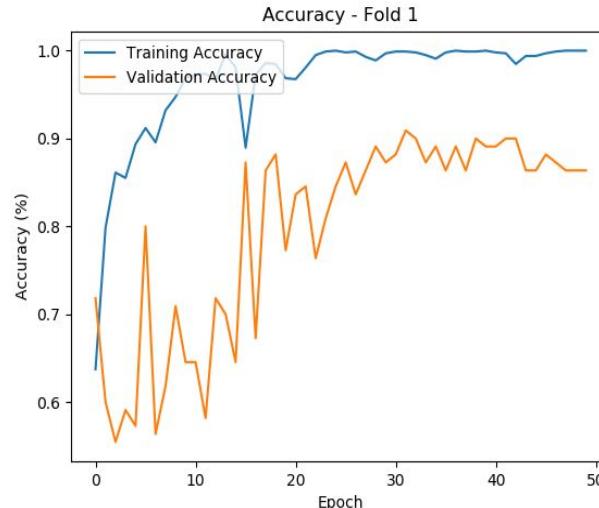
- ASU working on protocols to add exsiccati identifier for Snapshots
- Blanka cleaned 1/5 of the exsiccatae library on the Bryophyte Portal

GloBal: Deep-learning approaches

- taxonomy
- natural history collection management
- species identification, co-occurrences



von Konrat et al. in review



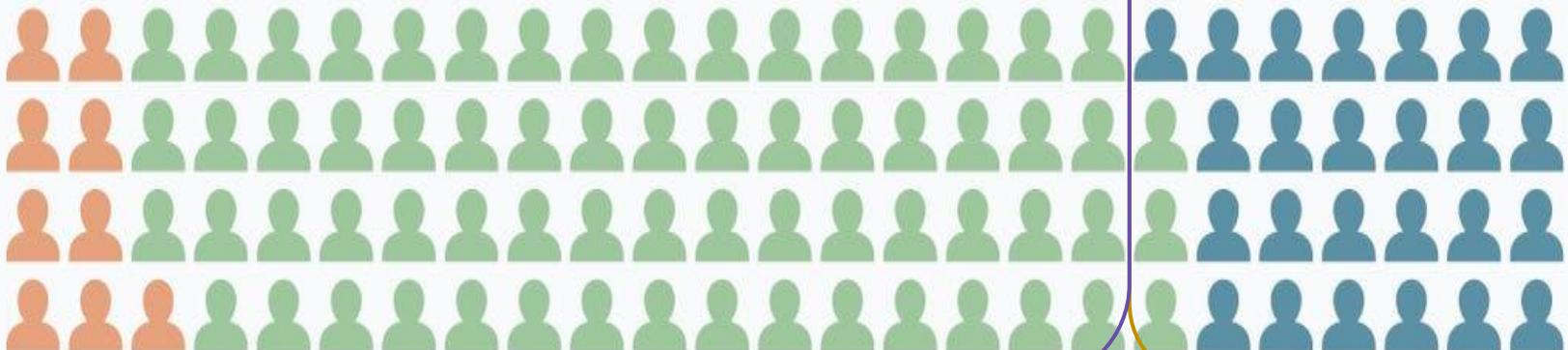
Accuracy
Training: 100%
Validation: 86%

Convolutional Neural Networks (CNN)

Step 1: Train NN

Step 2: Test & use NN

Training & Validation images



Epochs - rounds of training (5 epochs = each training image is used 5 times)

Results

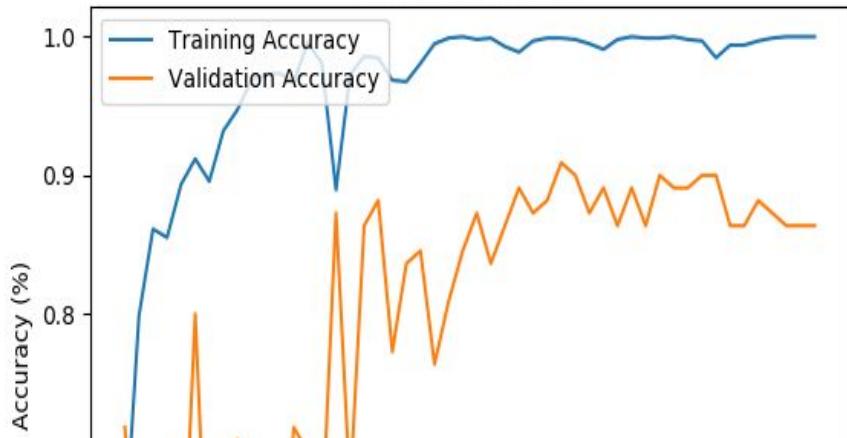


Frullania rostrata

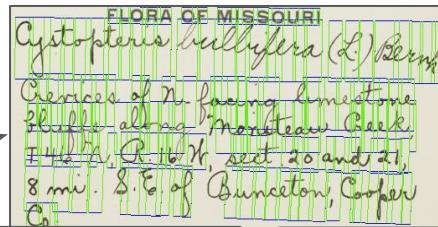
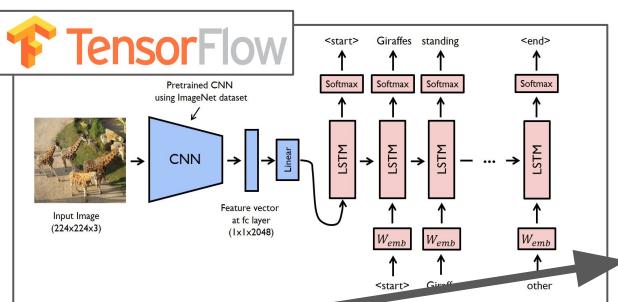
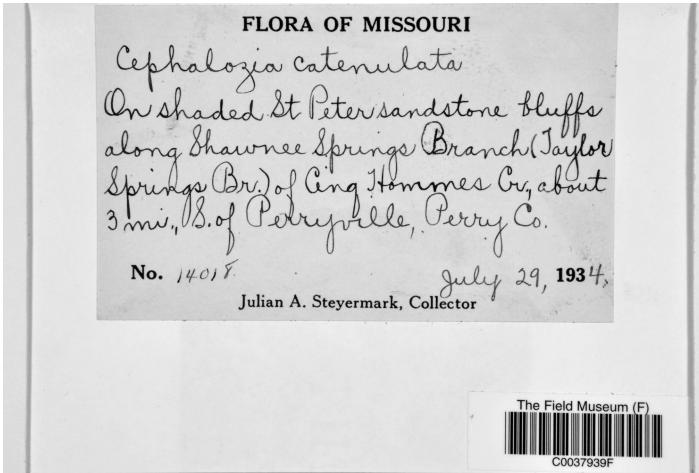


undescribed species

CNN: ~91% accuracy in differentiating species



Unlocking handwritten text using Machine learning solutions



Great work! Looks like this project is out of data at the moment!
See the results or dismiss this message

FLORA OF MISSOURI

Selaginella apoda (L.) Fern.
moist limestone bluffs along
Noblett creek in Carrman Spring
Branch, 726 ft. R. 10W, sec. 9, 5 mi.
southwest of Willow Springs,
Howell Co.

No. 23572 July 22, 1937

JULIAN A. STEYERMARK, COLLECTOR

Task Tutorial

Type the word which appears in the image inside the blue box.
(If the box is empty or nearly empty, select the Unclear button.)

unclear

NEED SOME HELP WITH THIS TASK?

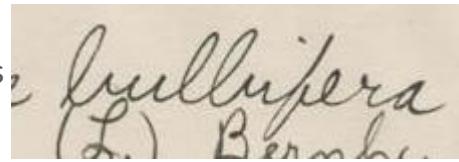
Back Done & Talk Done

Catalog #: C0037939F
Occurrence ID (GUID): b1e5a1bc-4d92-4f0a-8986-eb72476ea438
Secondary Catalog #: 886028
Taxon: *Cephalozia catenulata* (Huebener) Lindb.
Family: Cephaloziaceae
Collector: J. A. Steyermark
Number: 14018
Date: 1934-07-29
Verbatim Date: 7/29/1934
Locality: United States of America, Missouri, Perry, Shawnee Springs Branch
Cinque Homme Creek, about 3 miles south of Perryville
Habitat: On shaded St. Peter sandstone bluffs

Specimen Images

CNN-RNN-CTC + handwritten *word* images

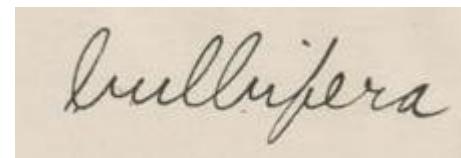
Raw Google Cloud images



Cropped whitespace



Padded all words to
the same image size



Manually cleaned

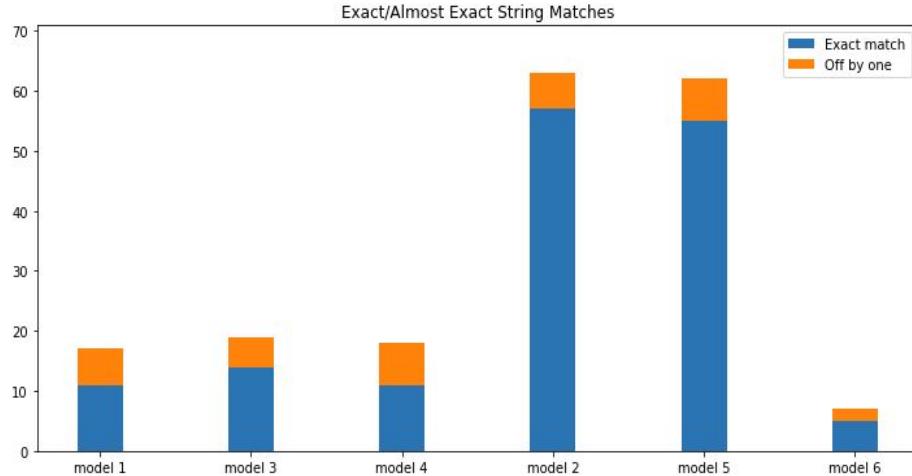
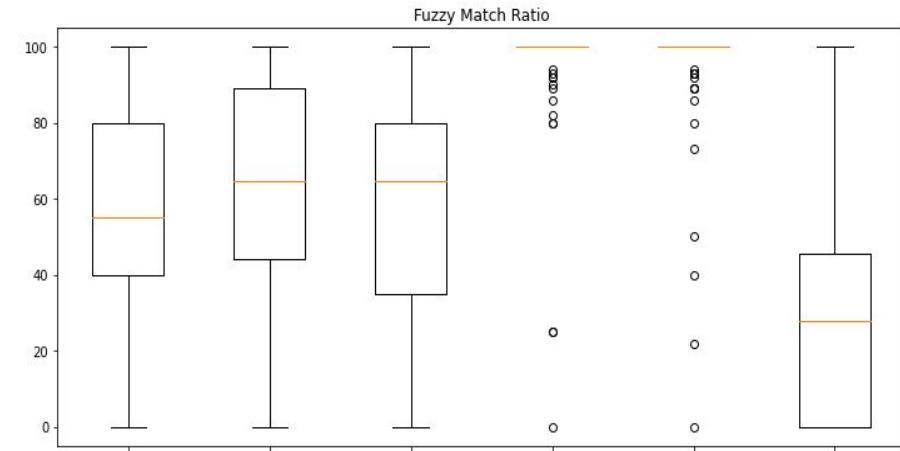
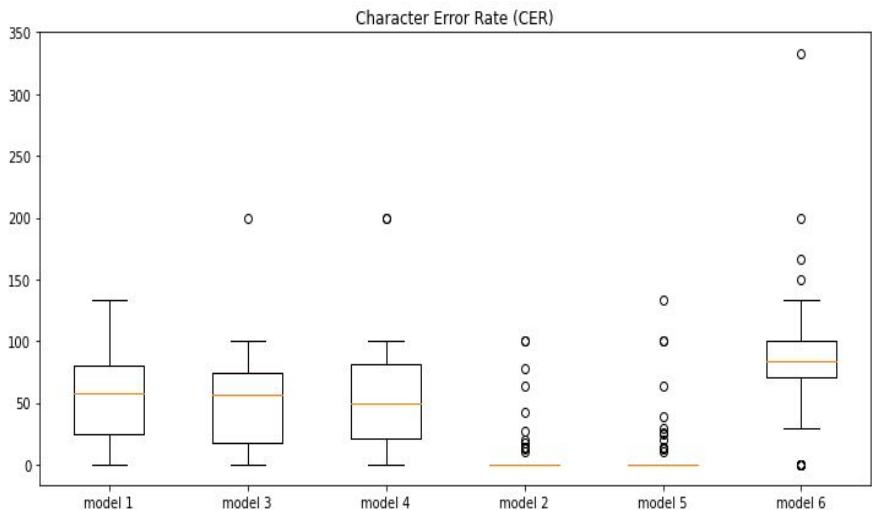


Thresholding

CNN-RNN-CTC initial models

626 training images, 70 testing images

Random seed	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	10010	10011	10012	10013	10014	10015	10016	10017	10018	10019	10020	10021	10022	10023	10024	10025	10026	10027	10028	10029	10030	10031	10032	10033	10034	10035	10036	10037	10038	10039	10040	10041	10042	10043	10044	10045	10046	10047	10048	10049	10050	10051	10052	10053	10054	10055	10056	10057	10058	10059	10060	10061	10062	10063	10064	10065	10066	10067	10068	10069	10070	10071	10072	10073	10074	10075	10076	10077	10078	10079	10080	10081	10082	10083	10084	10085	10086	10087	10088	10089	10090	10091	10092	10093	10094	10095	10096	10097	10098	10099	100100	100101	100102	100103	100104	100105	100106	100107	100108	100109	100110	100111	100112	100113	100114	100115	100116	100117	100118	100119	100120	100121	100122	100123	100124	100125	100126	100127	100128	100129	100130	100131	100132	100133	100134	100135	100136	100137	100138	100139	100140	100141	100142	100143	100144	100145	100146	100147	100148	100149	100150	100151	100152	100153	100154	100155	100156	100157	100158	100159	100160	100161	100162	100163	100164	100165	100166	100167	100168	100169	100170	100171	100172	100173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Python 3 with Tensorflow 2

Google Colab (~Jupyter Notebook with virtual GPU)

Building a Global Consortium of Bryophytes and Lichens: Keystones of Cryptobiotic Communities

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Unfolding of Microplant Mysteries

ABOUT CLASSIFY TALK COLLECT

Welcome! Bienvenidos! Bem-vinda! Namaste! Marhaba! Unlock mysteries, become a scientific detective!

Help discover the microscopic
world of tiny plants

Learn more

What secrets lie within the microplants?



Microplants, scientifically named bryophytes, are a group of green land plants. They include liverworts, mosses, and hornworts. There are an estimated 25,000 species in the world. They prefer damp habitats although some species can survive in drier environments. Bryophytes are non-vascular land plants, i.e., do not have a complex transport system. They are seedless plants and do not (gametangia and sporangia).

Get started ↓

Determining the Reproductive Structure of a Liverwort - Refer to field guide and tutorial Stem and Branching Patterns:

[Determining the Reproductive Structure of a Liverwort](#)

[Stem and Branching Patterns](#)





TASK

TUTORIAL

Please identify if the image of the microplant shown best corresponds to a female, male, sterile, or both a female and a male structure.

Female

Male

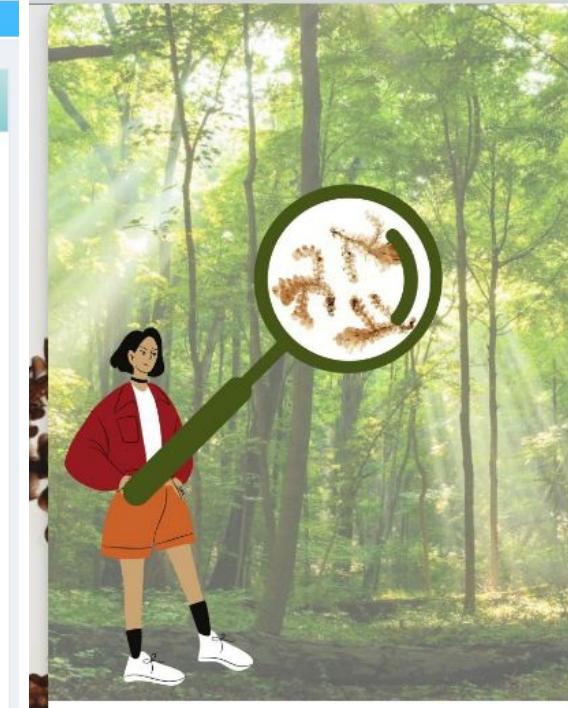
Both Female and Male

Sterile

NEED SOME HELP WITH THIS TASK?

Done & Talk

Done



Thanks for volunteering your time and your efforts to help us collect data to advance the identification and classification of these microplants.

Please don't worry about a wrong

Continue



Acknowledgements

National Science Foundation

- Advancing Digitization of Biodiversity Collections

Collectors & Researchers of the past and present

2011 Bryophyte/Lichen TCN: Leadership & Participants

Especially, Tom Nash & Corinna Gries

Collaborating Herbaria: ALA, ASU, BRU, BRY, CINC, COLO, DUKE, F, FLAS, ILL/ILLS, LSU, MICH, MIN, MO, MSC, MU, NEB, NY, OSC, PH, TENN, UC, WIS, WTU, YU

CONTACT US: globaltcn@utk.edu

<http://globaltcn.utk.edu>

#GlobalTCN



iDigBio
Integrated Digitized Biocollections



GLOBAL Team

Aaron Liston	Daniel Stanton	James Mickley	Laurie Heldman	Phillip Anders
Aimee Davis	Diego Inclan	Jason Alexander	Leanna McMillin	Rosa Batallas
Alan Fryday	Dina Clark	Jeffrey Clancy	Leanne Sheffer	Scott LaGreca
Alan Prather	Edward Gilbert	Jennifer Kluse	Lilli Young	Stefanie Ickert-Bond
Alison Staelgraeve	Elana Benamy	Jessica Budke	Lucas C. Majure	Stephanie Zaborac-Reed
Amanda Chandler	Elizabeth H. Teresi	Jessie Uehling	Lucas Ferguson	Steve Leavitt
Amy Harmon	Emily Clark	Jesus Hernandez	Madison Dyer	Stuart McDaniel
Andrew Gallardo	Emma Kruse	John Brinda	Madison Latiolais	Thomas Barlow
Andy Miller	Eric J. Tepe	Jordan Teisher	Margaret Oliver	Thomas Nash
Ardath Dixon	Erin Tripp	Joshua Jacobs	Maria L. Montero	Thorsten Lumbsch
Arthur J. Shaw	Francois Lutzoni	Julie Smith	Matt Chansler	Timothy Hogan
Barbara Thiers	Frank Bungartz	Katie Pearson	Matt von Konrat	Timothy James
Blanka Aguero	Gaby Mata	Kayla M. Wheatley	Maya Mahoney	Timothy Whitfield
Brent Mishler	Garth Holman	Kenneth Cameron	Miranda Zwingelberg	Todd Widholm
Brian Heitz	George Weiblen	Kent Perkins	Natalie Detwiler	Tyson J. Thorpe
Brian Schuh	Ginger Apolo	Kim Kersh	Nico Franz	Wendy Quinlan
Cameron Lala	J. Ryan Allen	Kim Watson	Nicole Tineo	William A. Rivero
Campbell Webb	Jack Haynes	Klara Scharnagl	Nidhi Thirthamattur	William Seely
Carson Parham	Jaclyn Jones	Kyelle Corcoran	Nkosi Evans	Wyatt Gaswick
Christina Mozzicato	Jake Burgoyne	Laura Briscoe	Olivia Leek	Yarency Rodriguez
Cristian Cartuche	Jake Henrie	Laura Lagomarsino	Olivia Taylor	Zoe Ryans
Daniel Le	James Lendemer	Lauren Keeling	Patrick Sweeney	Zoey Molsberry





Questions?