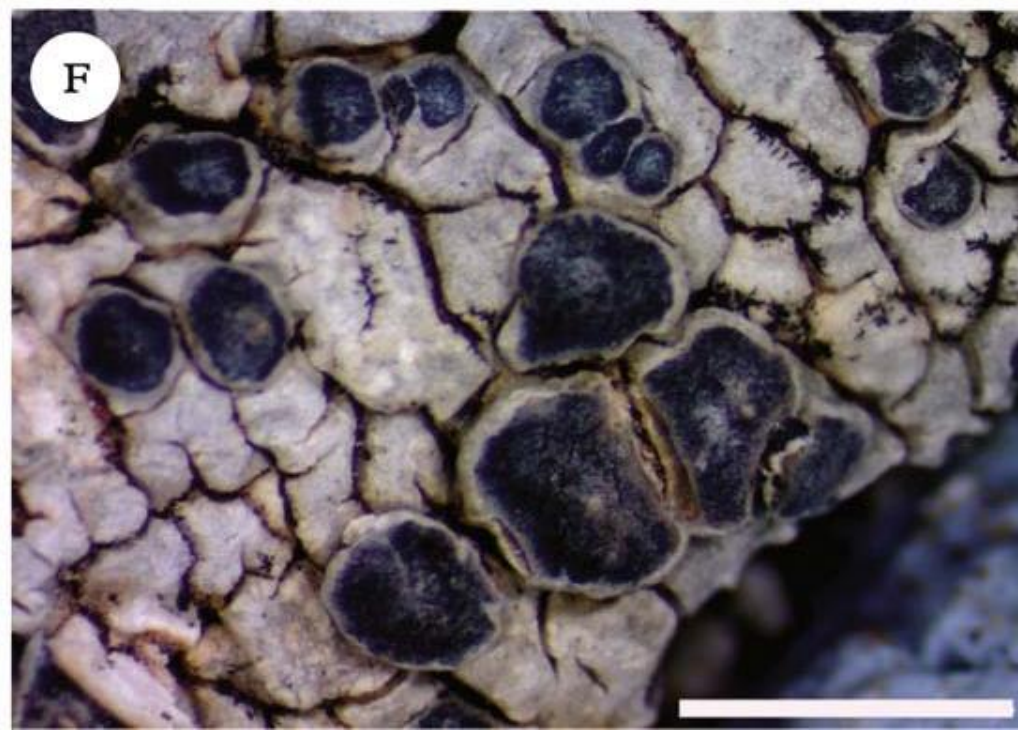
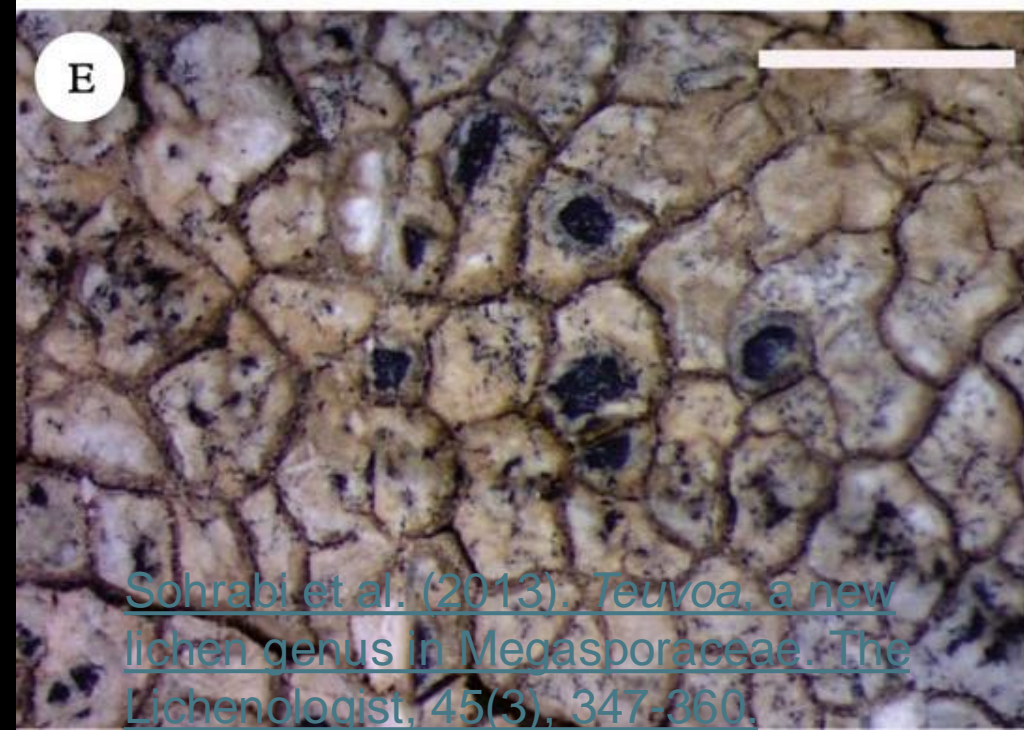
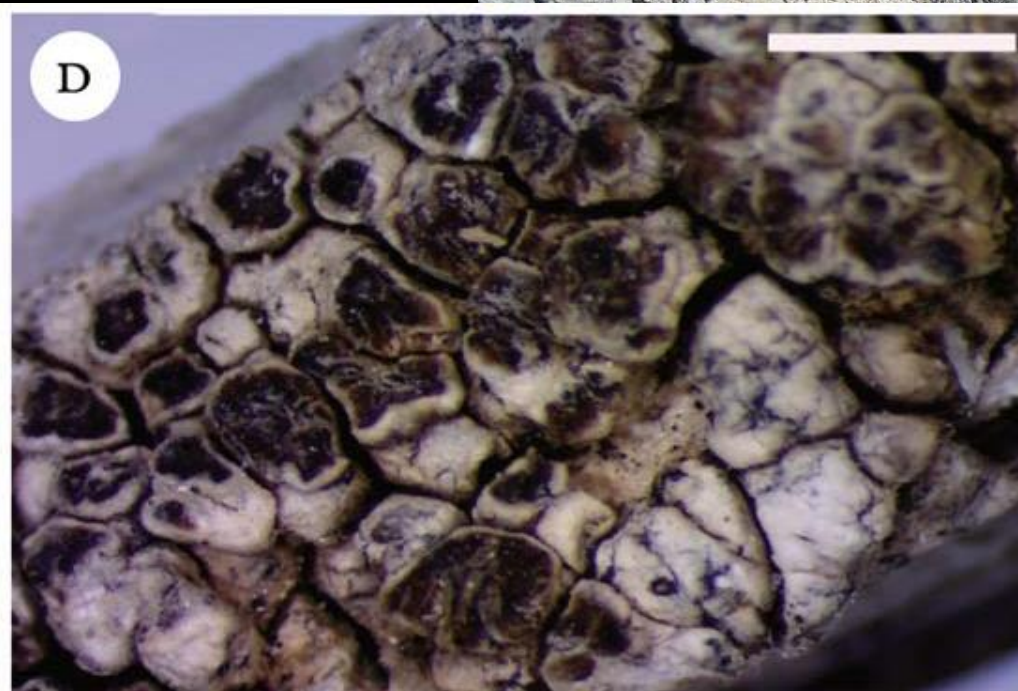
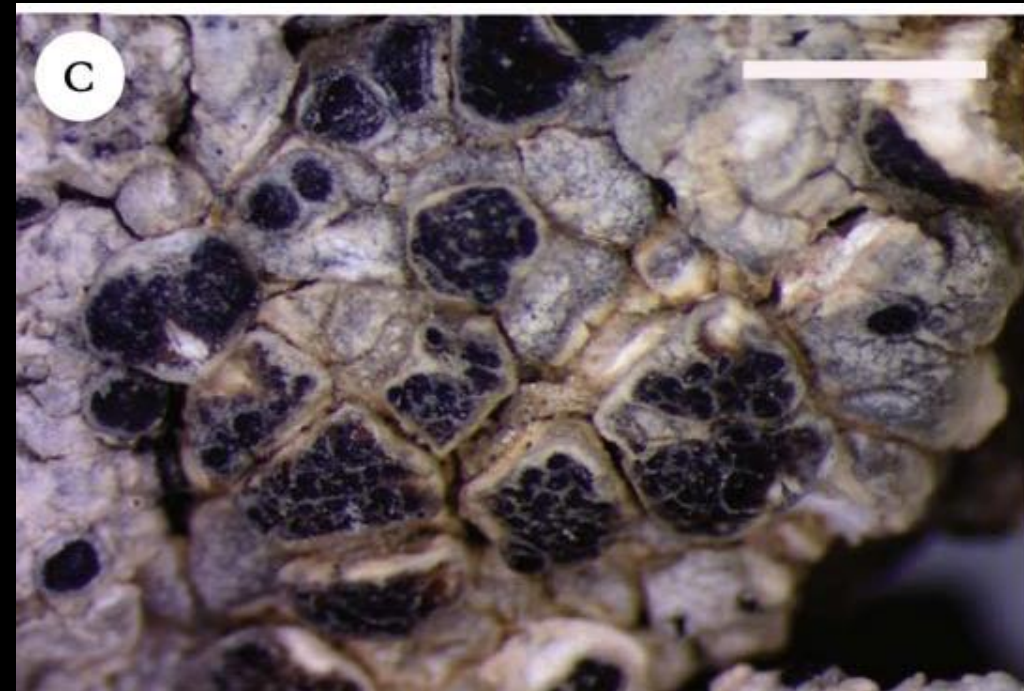




Space survivors among us – what lichens can tell us about inter-ness

steve_leavitt@byu.edu



[Sohrabi et al. \(2013\). *Teuvoa*, a new lichen genus in Megasporaceae. The Lichenologist, 45\(3\), 347-360.](#)



A person can know himself only insofar as he knows the world, which he perceives only in himself, and himself only in it. Every new object, well investigated, opens up a new organ in oneself.

-- Johann Wolfgang von Goethe



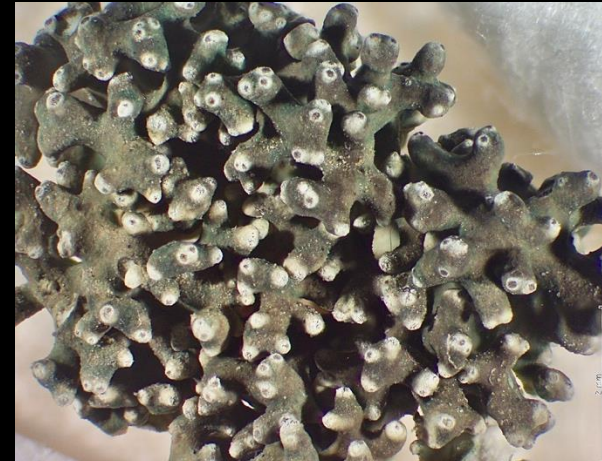
Elegant Sunburst
Lichen



Map Lichen



Manna Lichen





Buellia frigida



Microorganisms in the Atacama Desert

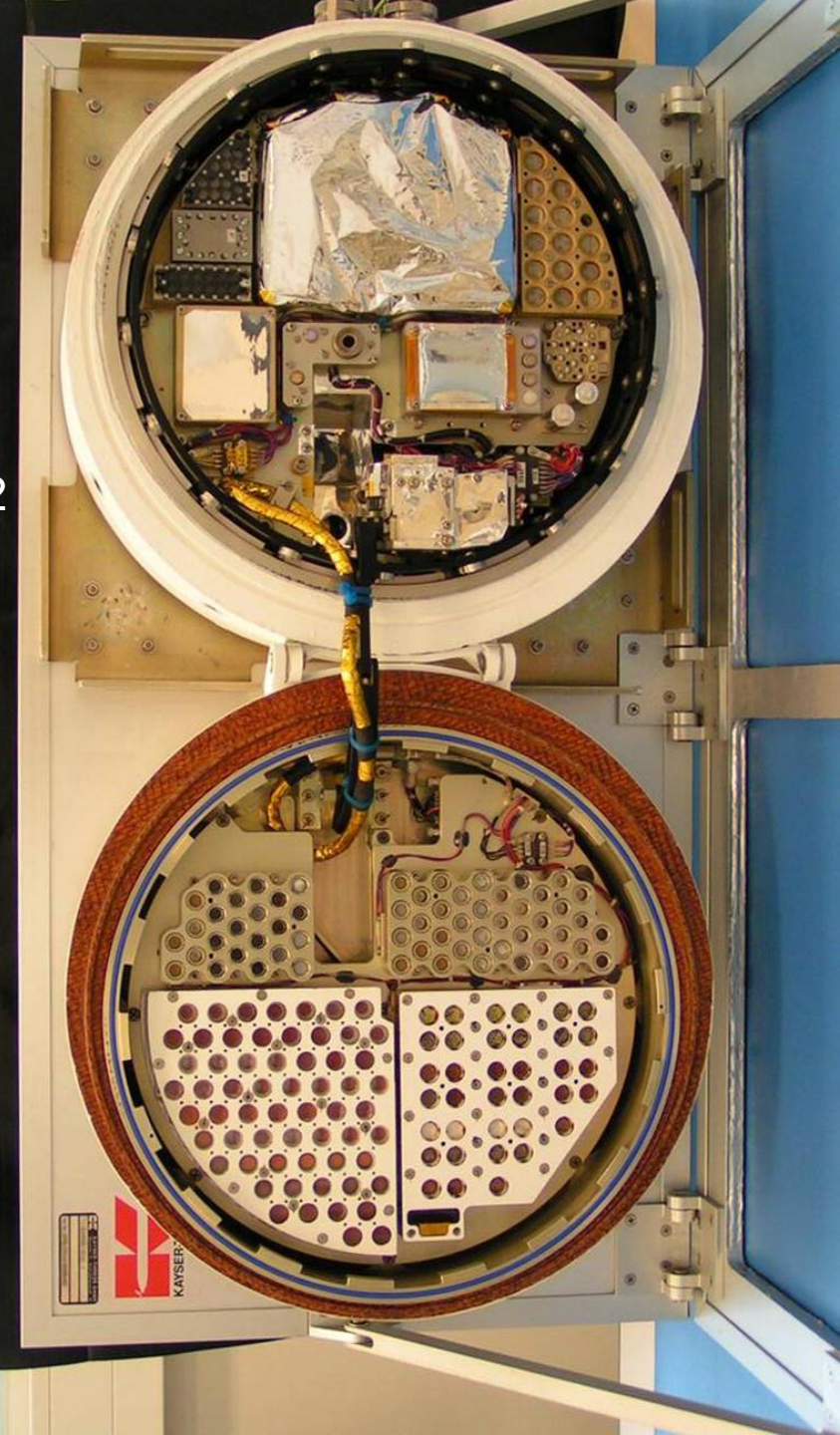


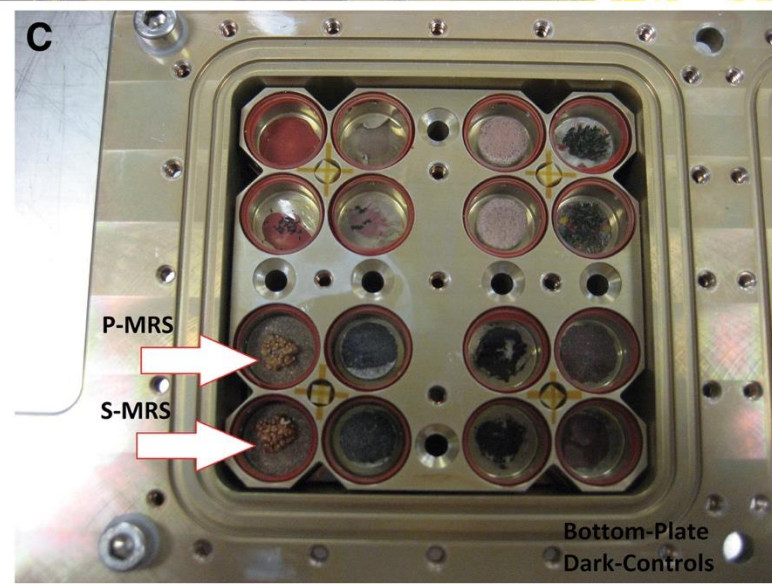
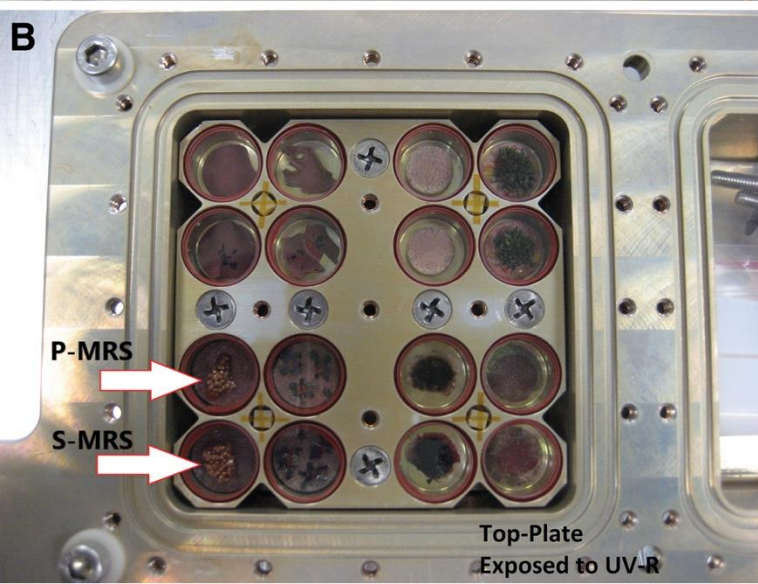
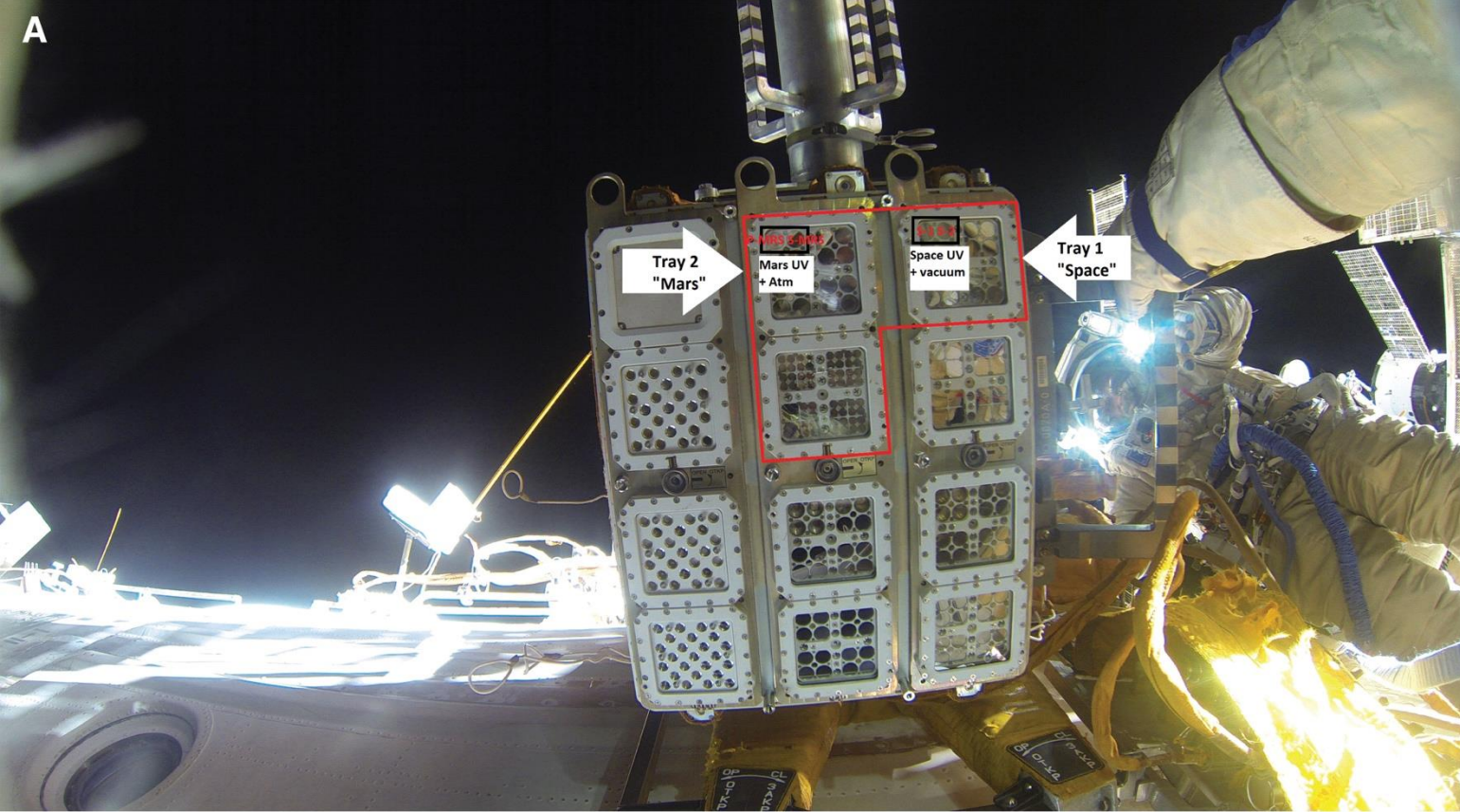
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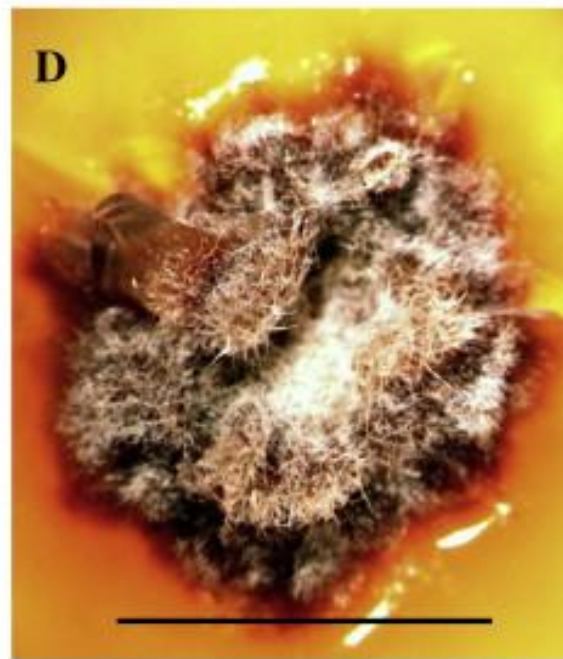
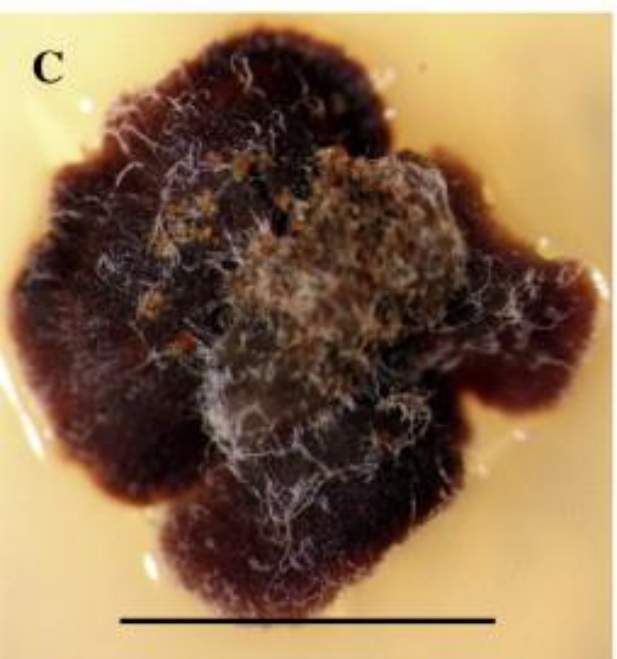
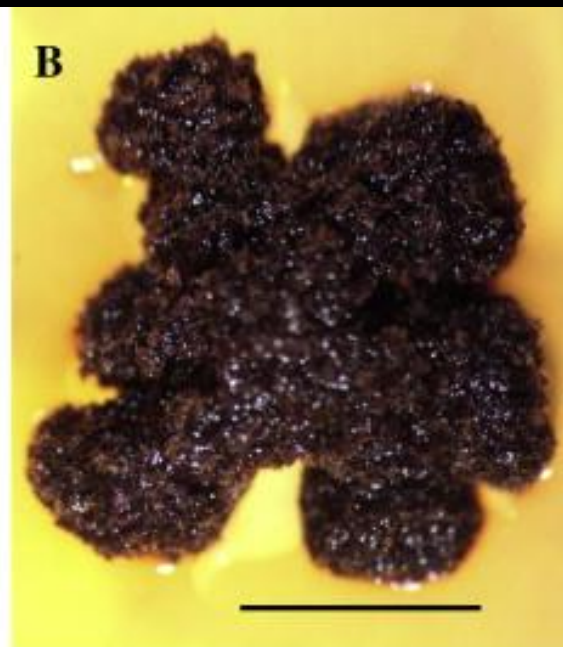
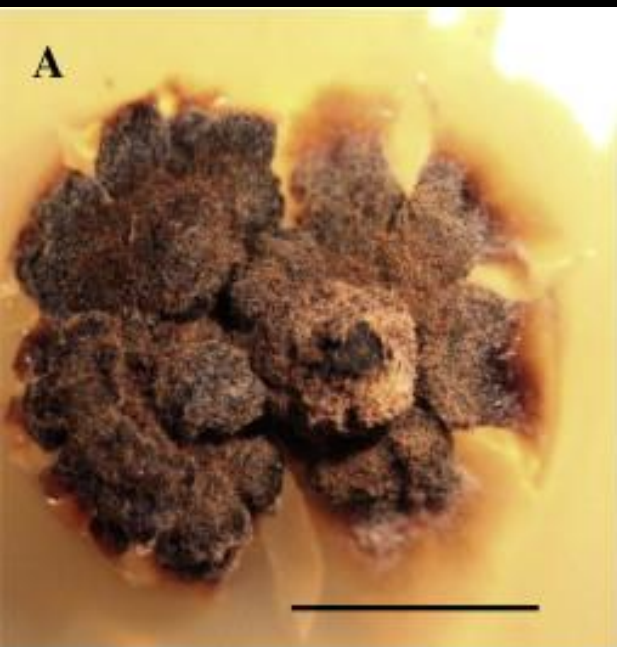
B

de La Torre, et al. (2010). [Survival of lichens and bacteria exposed to outer space conditions—results of the Lithopanspermia experiments](#). *Icarus*, 208(2), 735-748

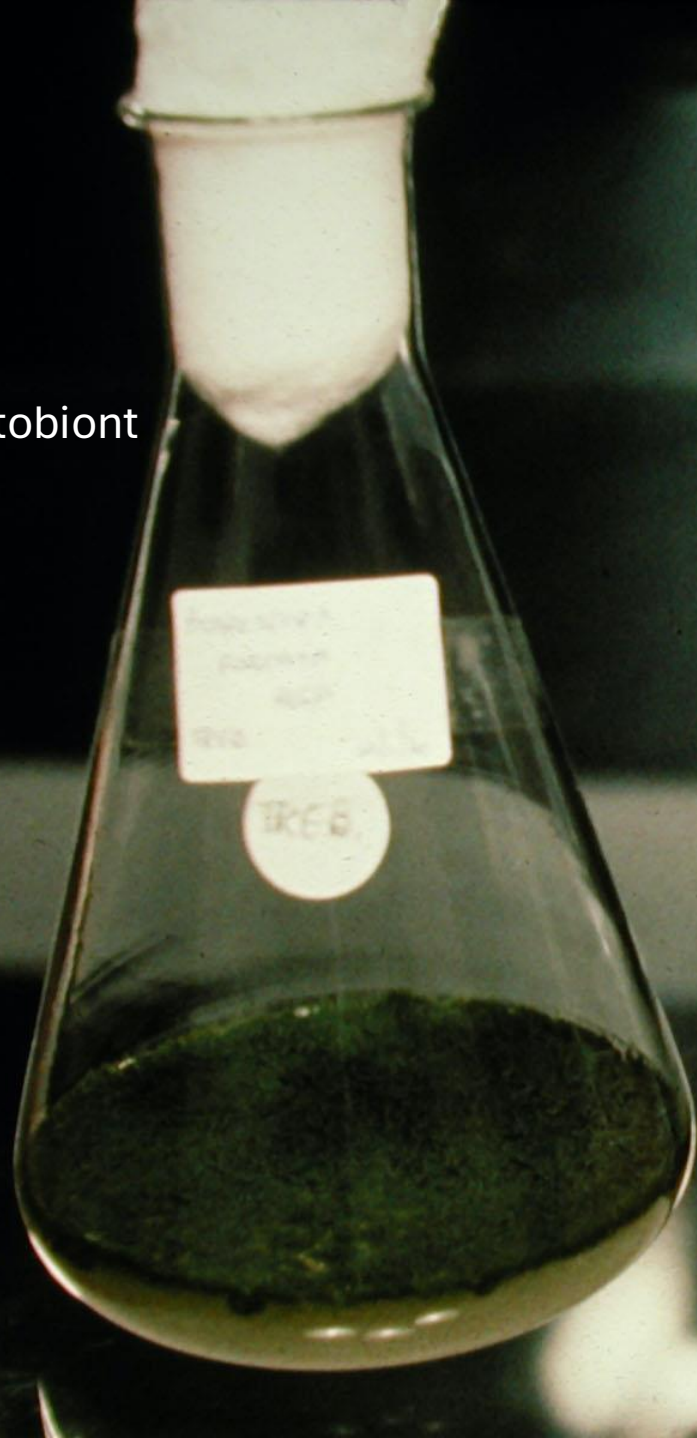




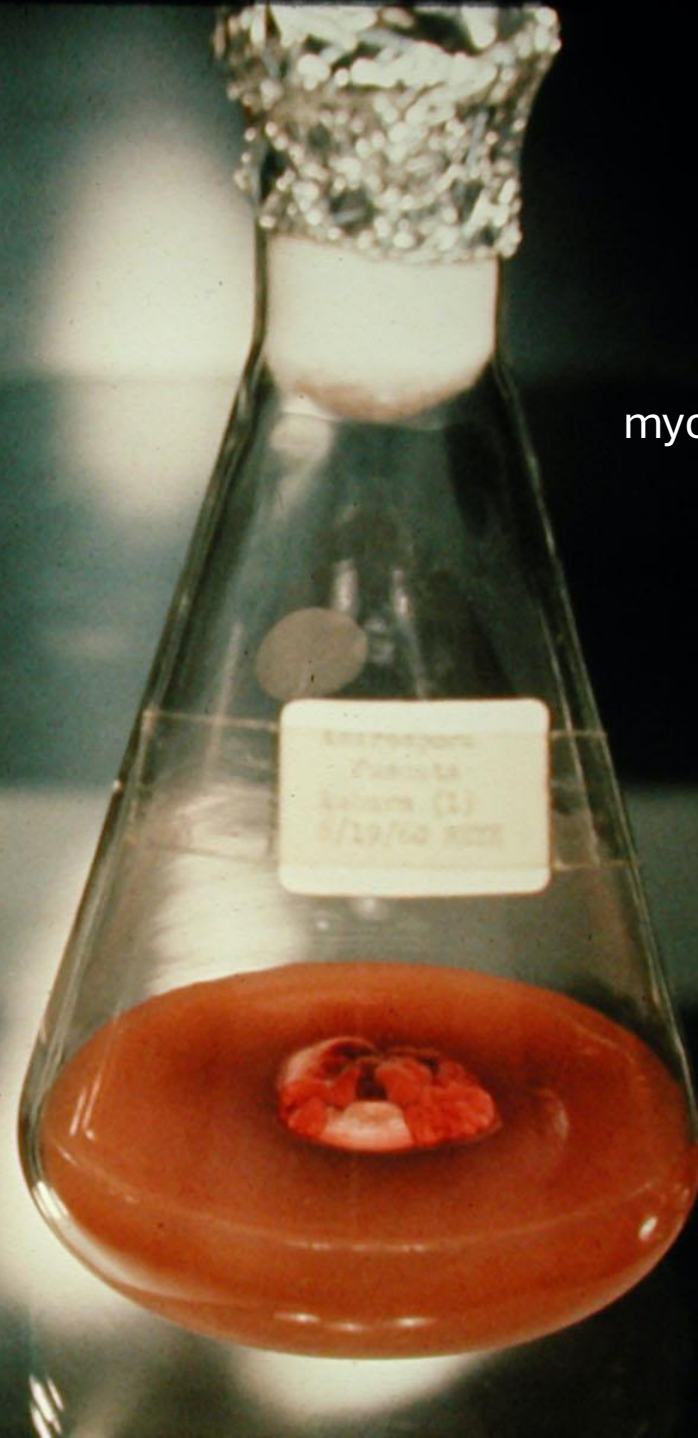
de la Torre Noetzel et al. 2020. [Lichen vitality after a space flight on board the EXPOSE-R2 facility outside the international space station: results of the biology and Mars experiment.](#) Astrobiology, 20(5), 583-600.

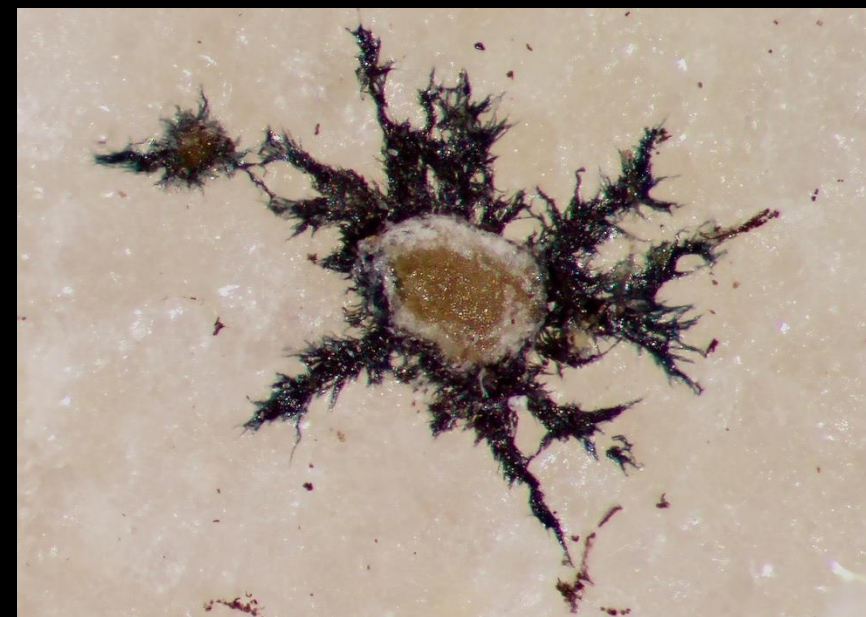
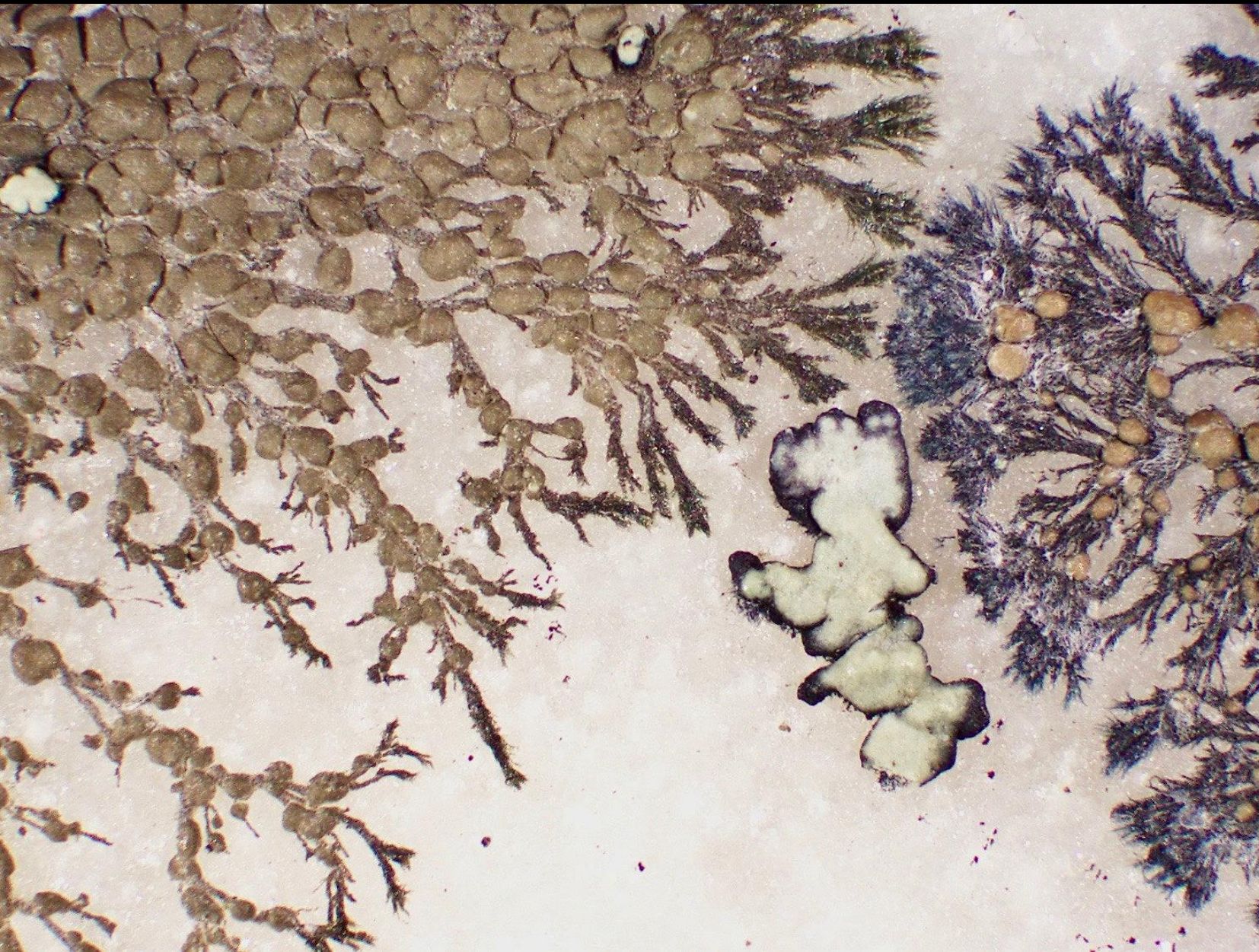


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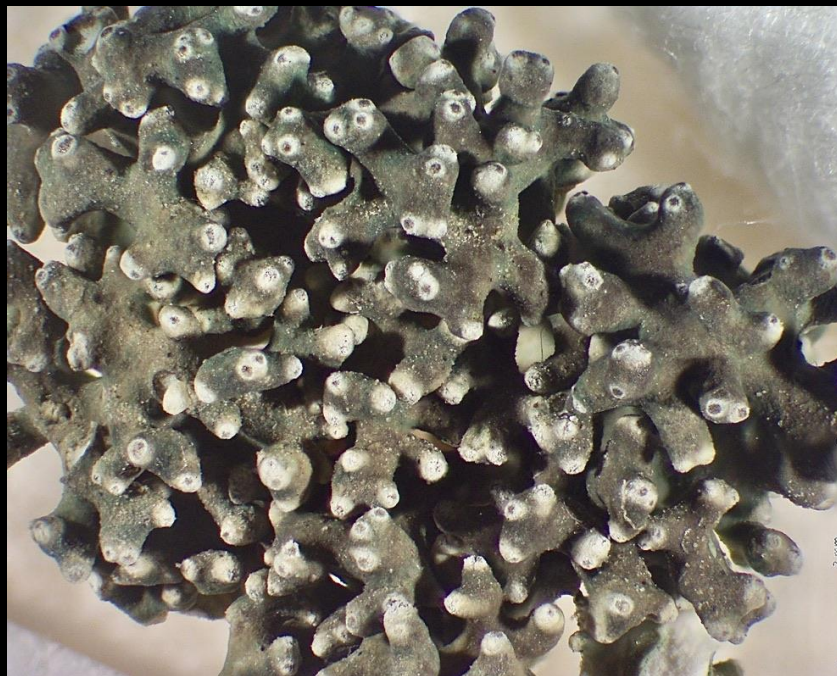


mycobiont

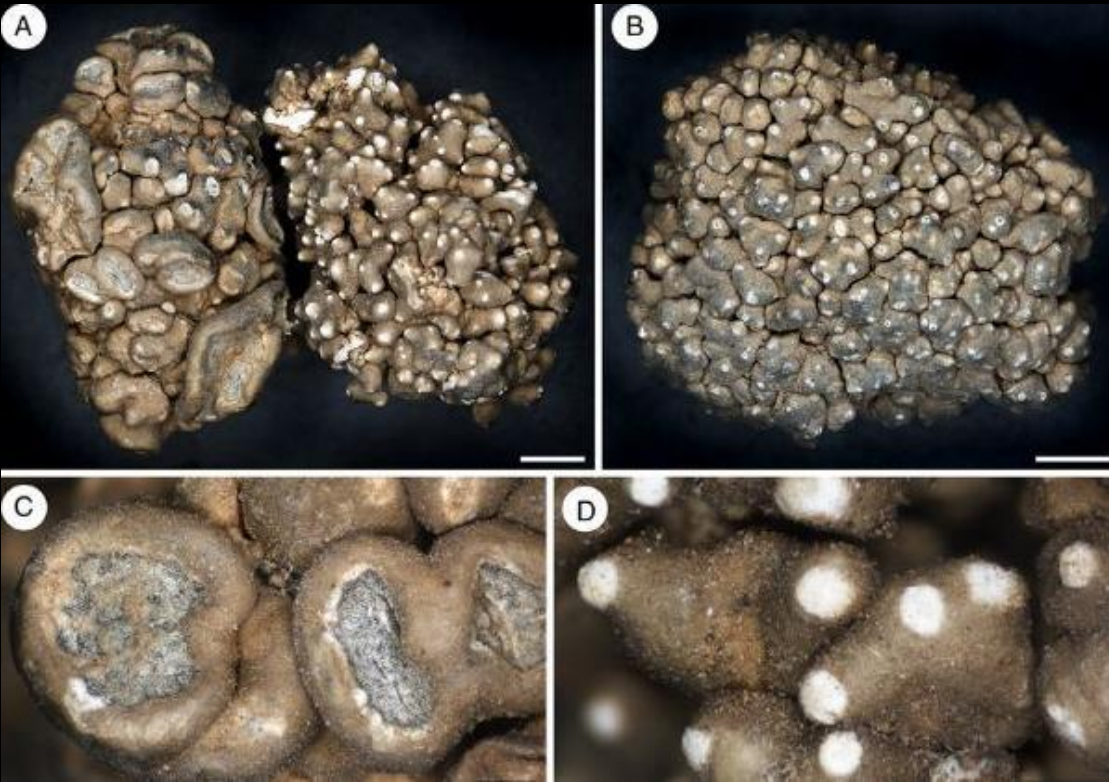




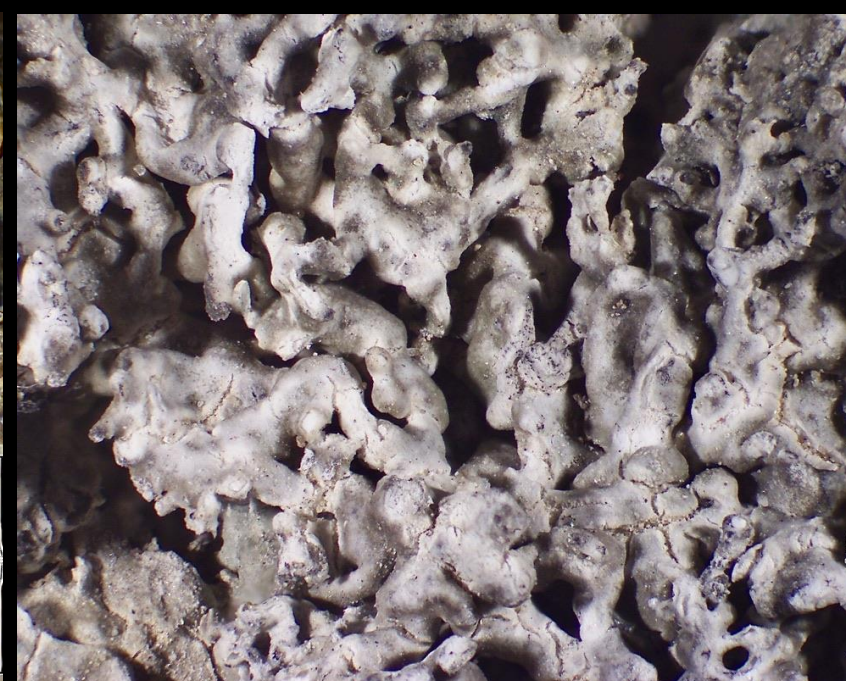
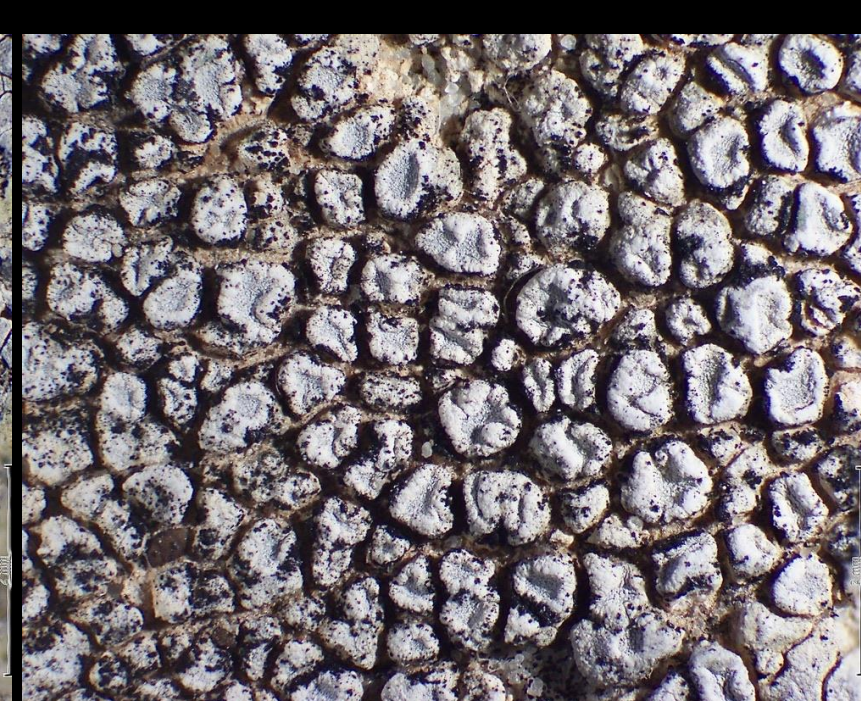




"fat of the earth" – "honey earth" – "pigeon dung" – "earth excrement" –
"manna"



Sohrabi, M., Leavitt, S. D., Obermayer, W., & Mayrhofer, H. (2023). *Circinaria nimisii* (Megasporeaceae, lichenized Ascomycota), a new manna lichen from Greece. The Lichenologist, 55(5), 367-376.



How many lichen partners?

- How scientists got it wrong for 150 years – YouTube video
 - Research article describing “third” lichen partner
 - More recent findings

Super-Earths throw
theorists for a loop p. 438

Molecular defenses in
warring plants pp. 442 & 478

Positive discrimination
in France p. 474

Science

\$15
29 JULY 2016
sciencemag.org

AAAS

lichen SYMBIOSIS

Two fungal partners, not one p. 438



SCIENCE

How a Guy From a Montana Trailer Park Overturned 150 Years of Biology

Biology textbooks tell us that lichens are alliances between two organisms—a fungus and an alga. They are wrong.

ED YONG JUL 21, 2016



SCIENCE

The Overlooked Organisms That Keep Challenging Our Assumptions About Life

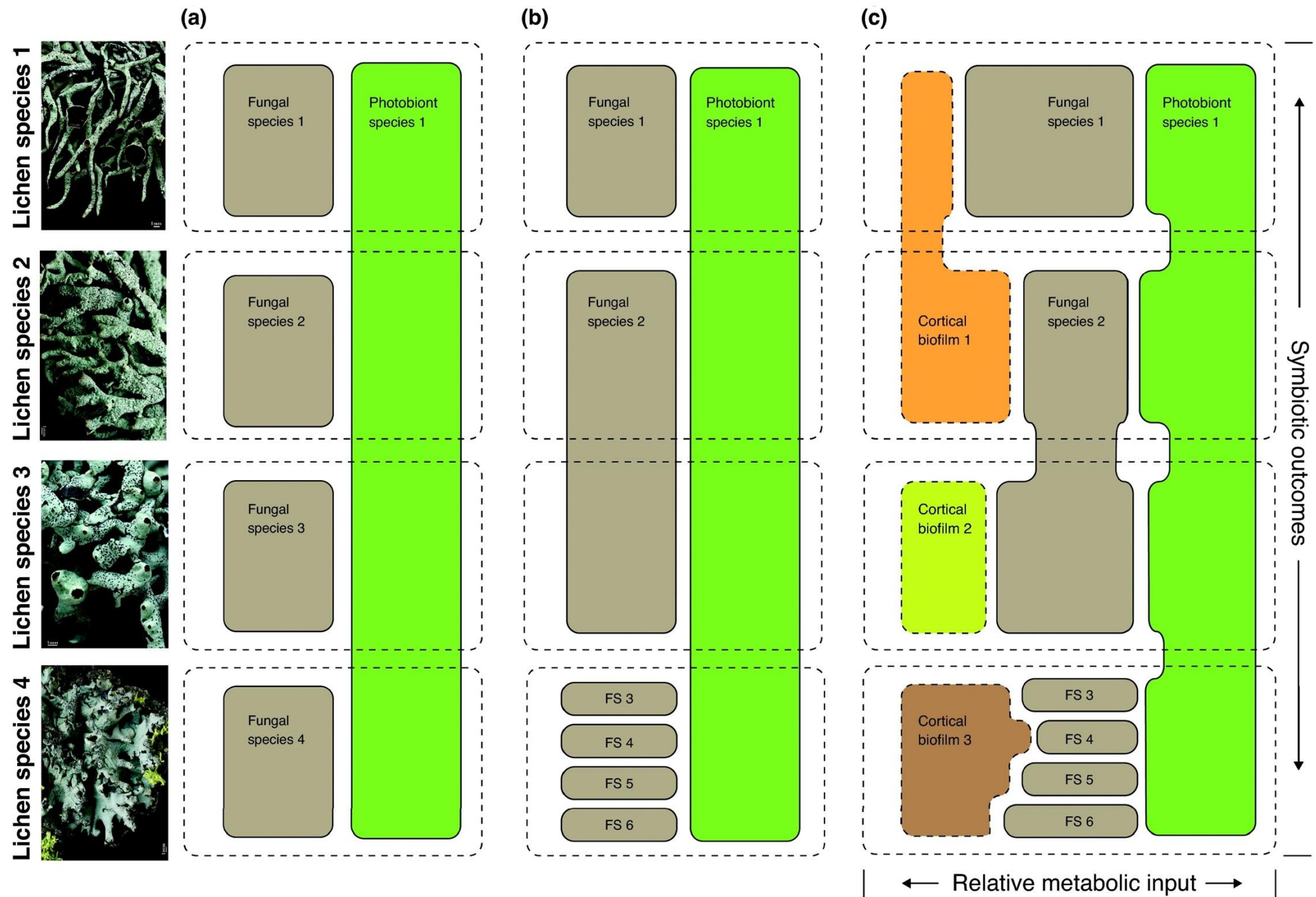
Gorgeous and weird, lichens have pushed the boundaries of our understanding of nature—and our way of studying it.

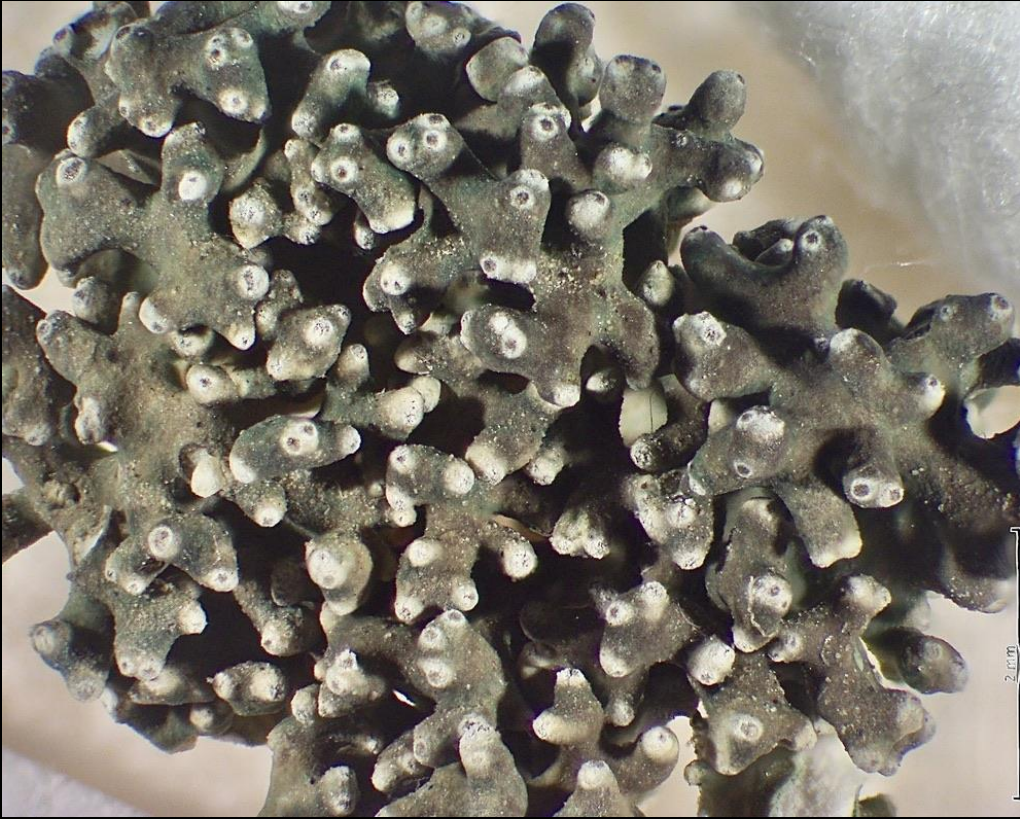
ED YONG JANUARY 17, 2019



Now on TheAtlantic.com

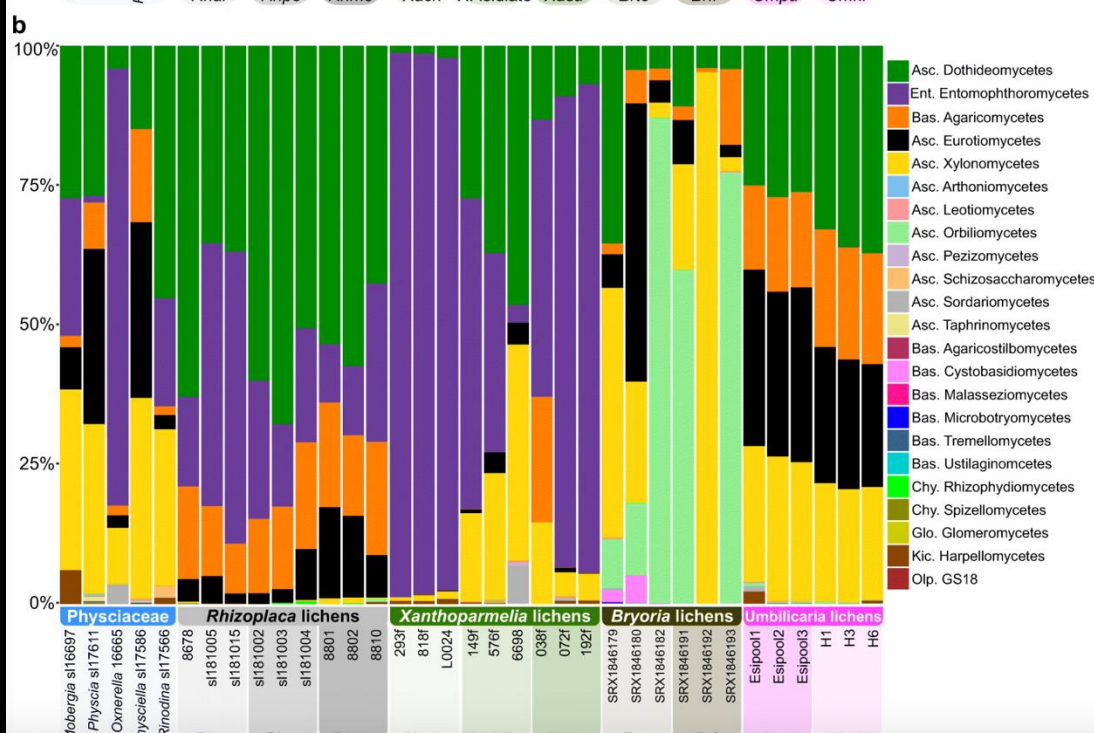
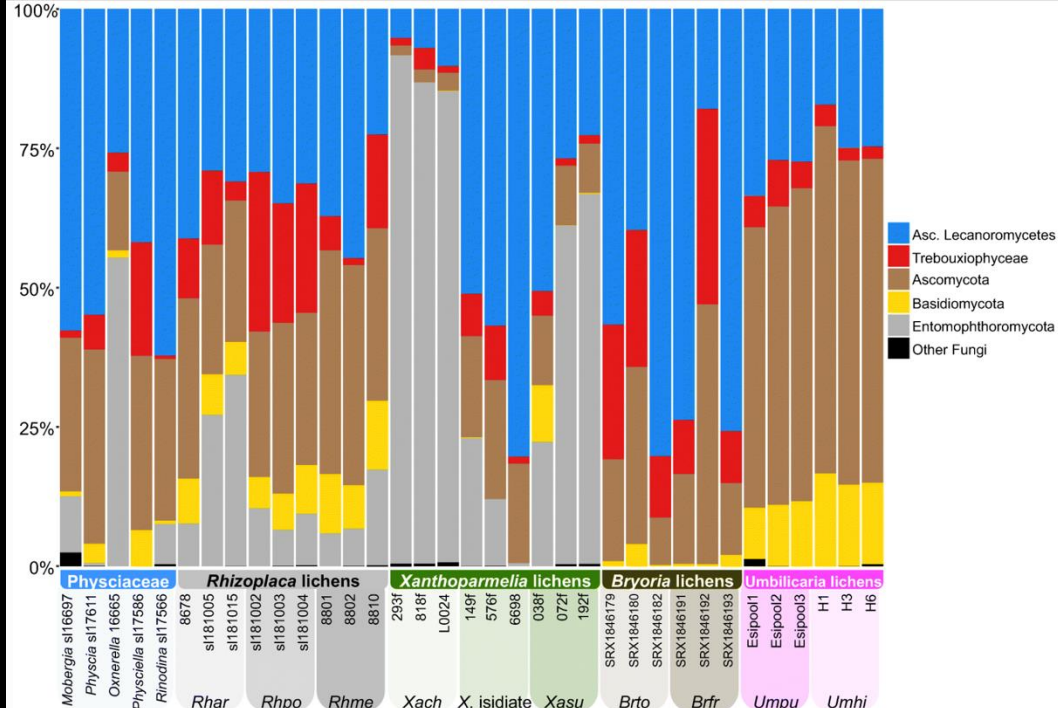
THE ORIGINAL SERIES
DISRUPTING
WITHIN





If a lichen is a fungus and an alga – what would you see if you could sequence a lichen's DNA?

What if it was two fungi and an alga?



Published: 22 October 2020

Metagenomic data reveal diverse fungal and algal communities associated with the lichen symbiosis

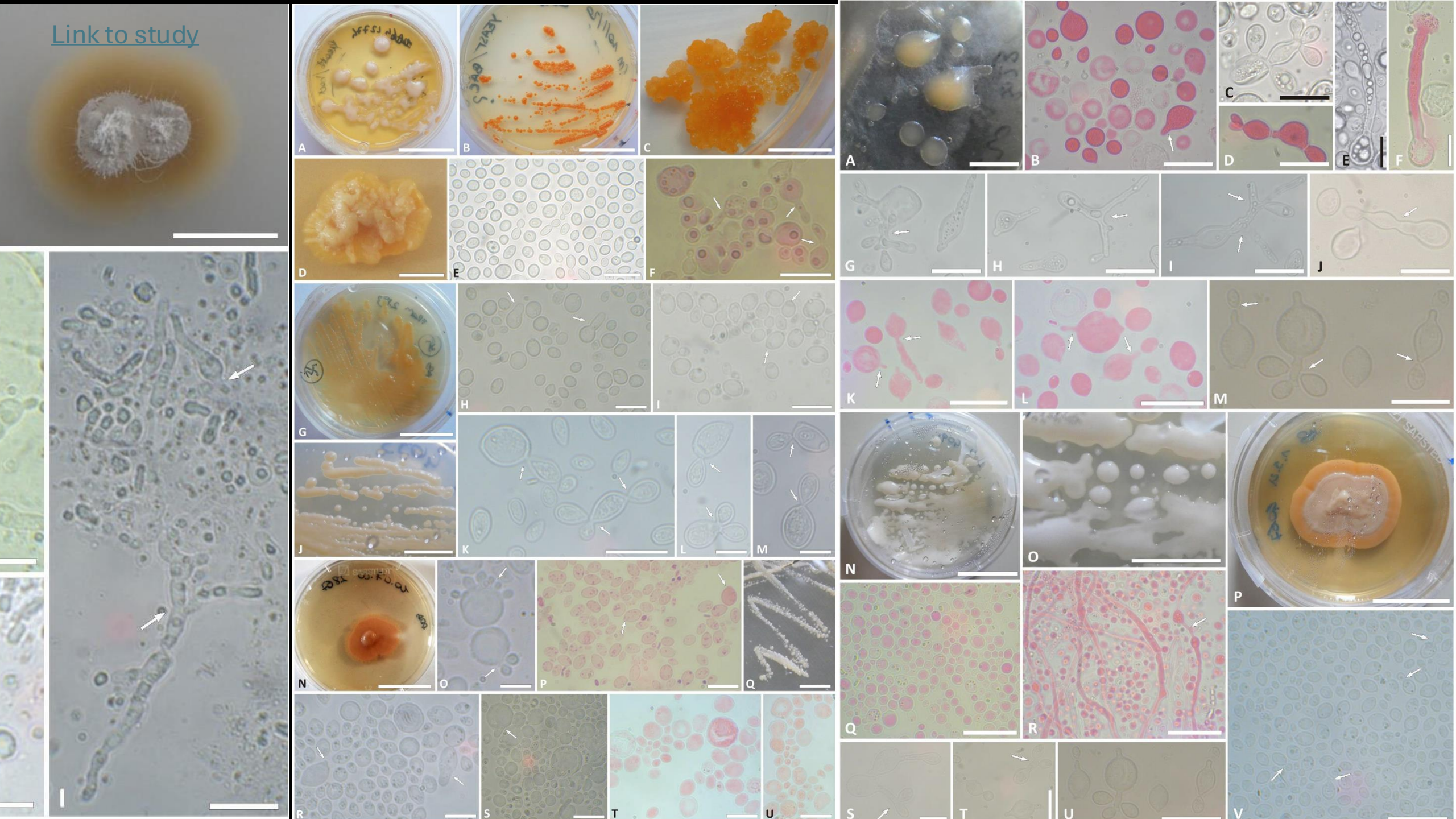
Hayden B. Smith, Francesco Dal Grande, Lucia Muggia, Rachel Keuler, Pradeep K. Divakar, Felix Grewe, Imke Schmitt, H. Thorsten Lumbsch & Steven D. Leavitt ✉

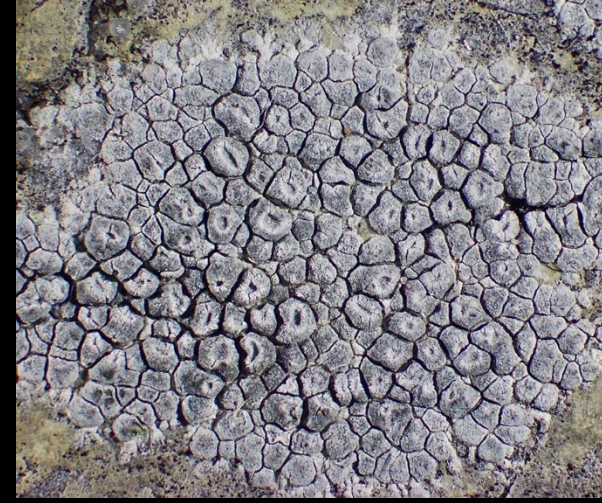
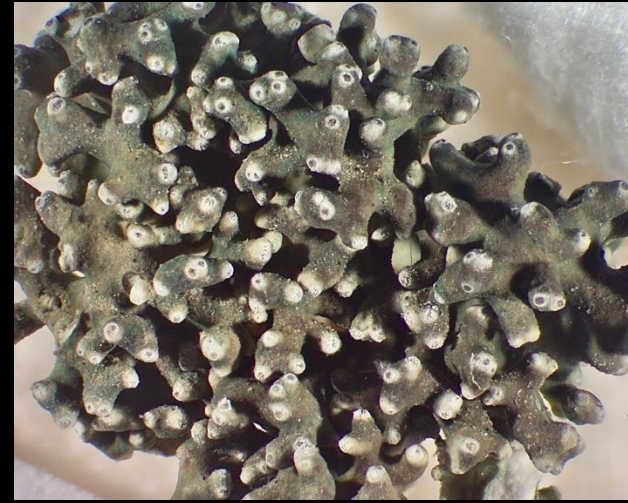
Symbiosis 82, 133–147(2020) | [Cite this article](#)

207 Accesses | 11 Altmetric | [Metrics](#)



[Link to study](#)





Implies assimilation rather than just living together

Process & non-ephemeral

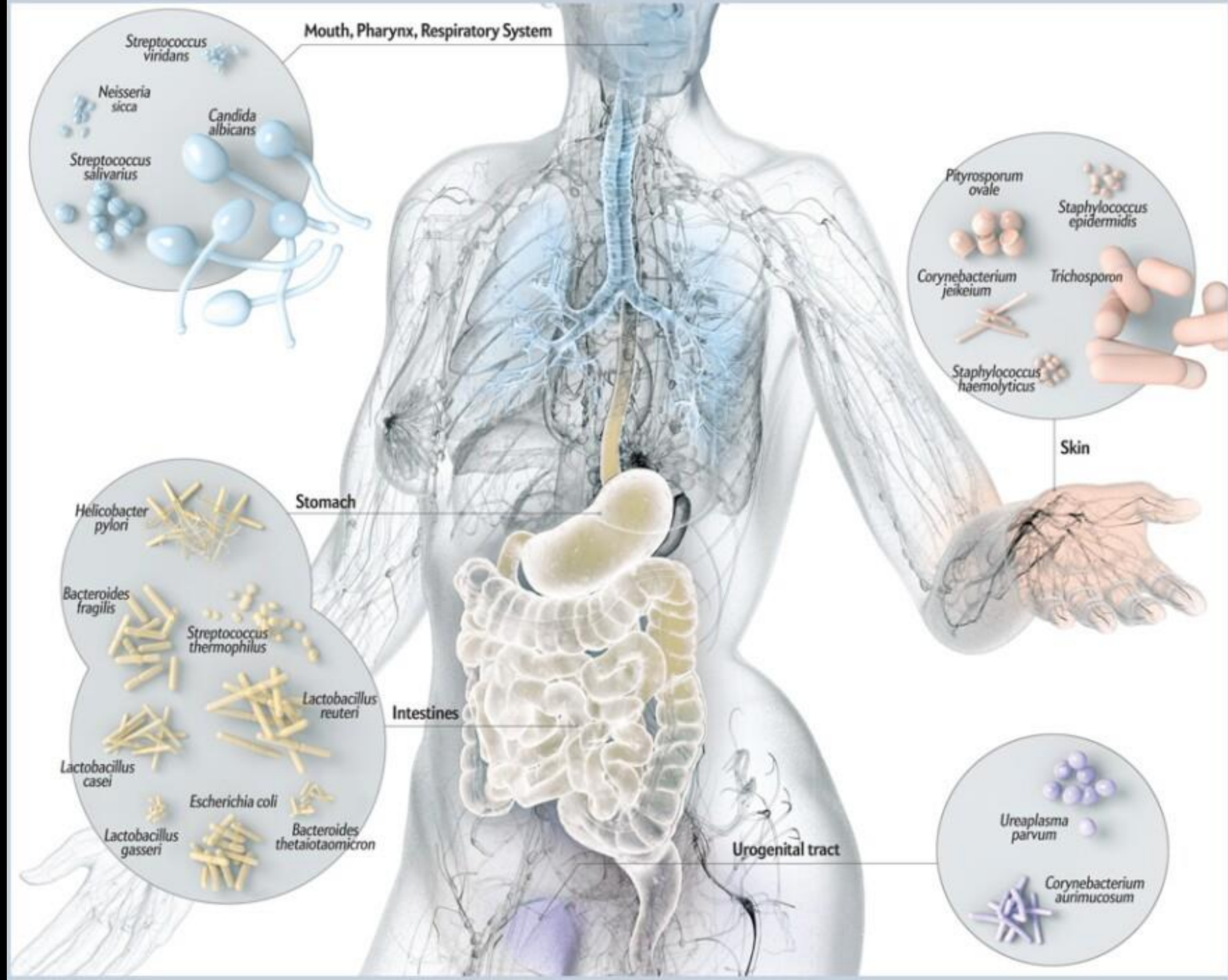
- the **acquisition** of an organism(s) by another unlike organism(s), and through subsequent long-term **integration**, new structures and metabolism(s) emerge.

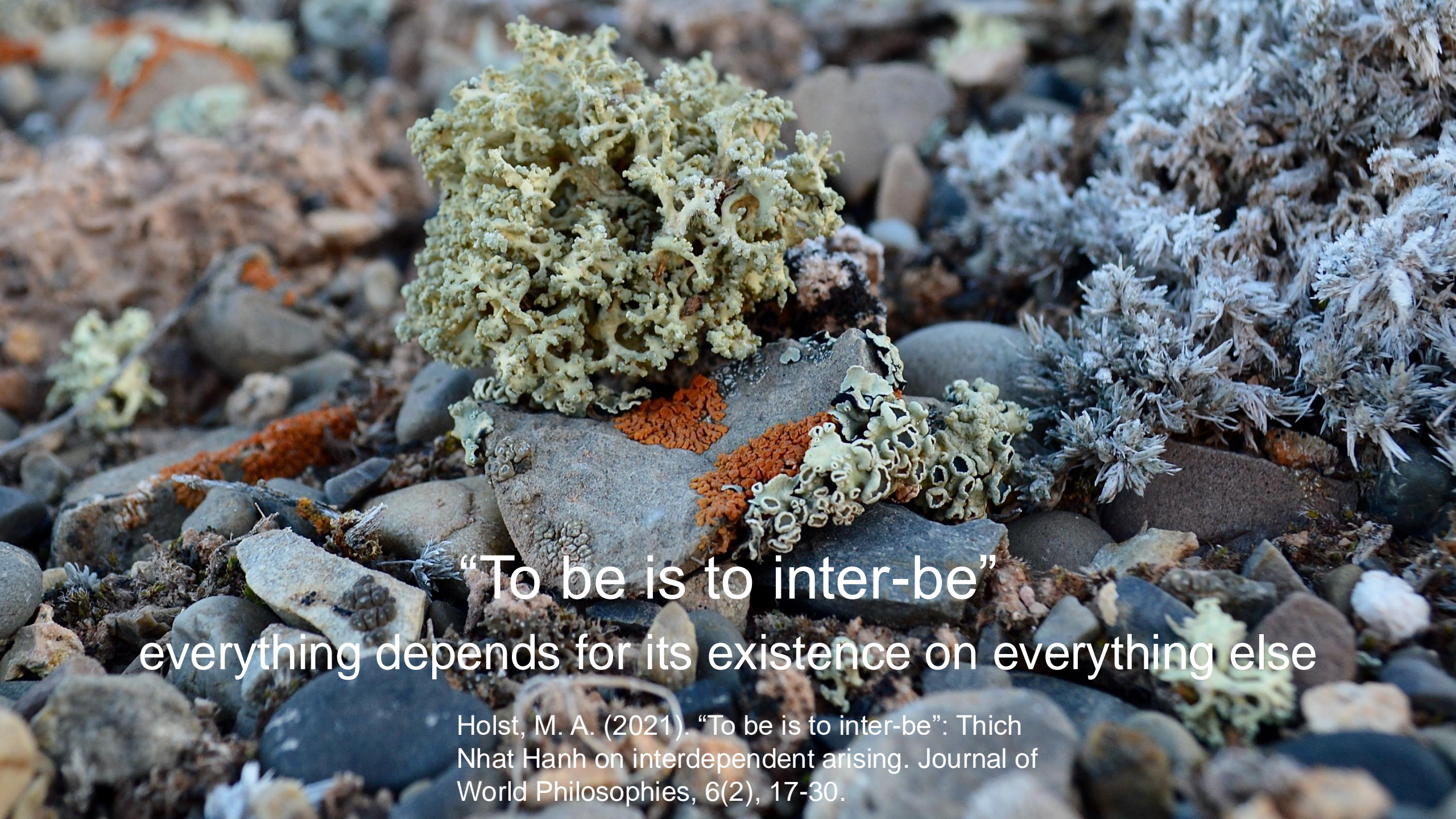
1+1=1

Viewable, comparative, cellular or macro

testable

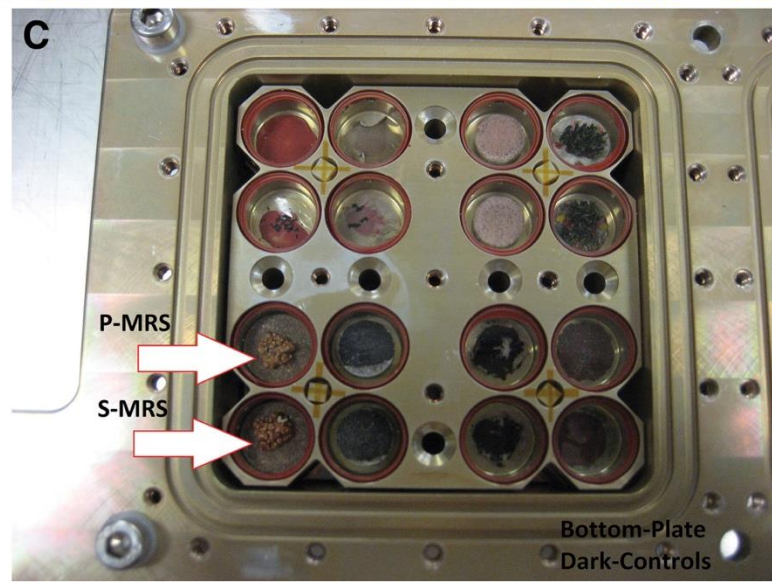
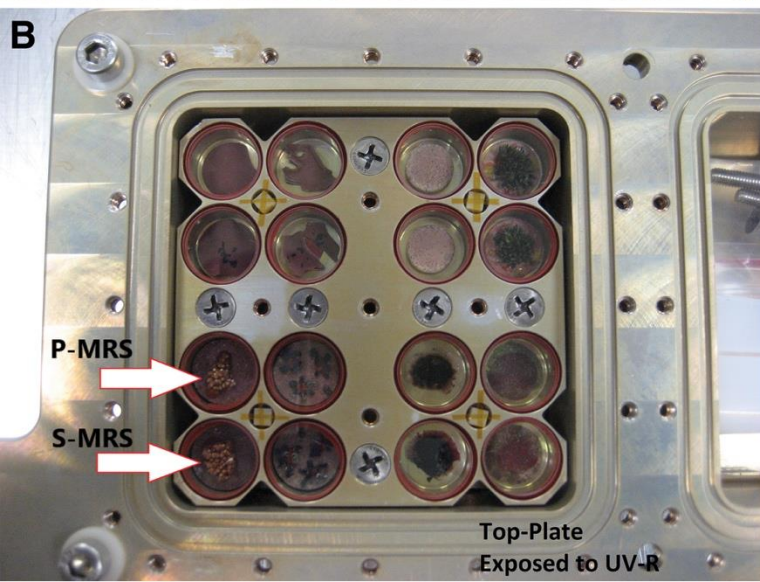
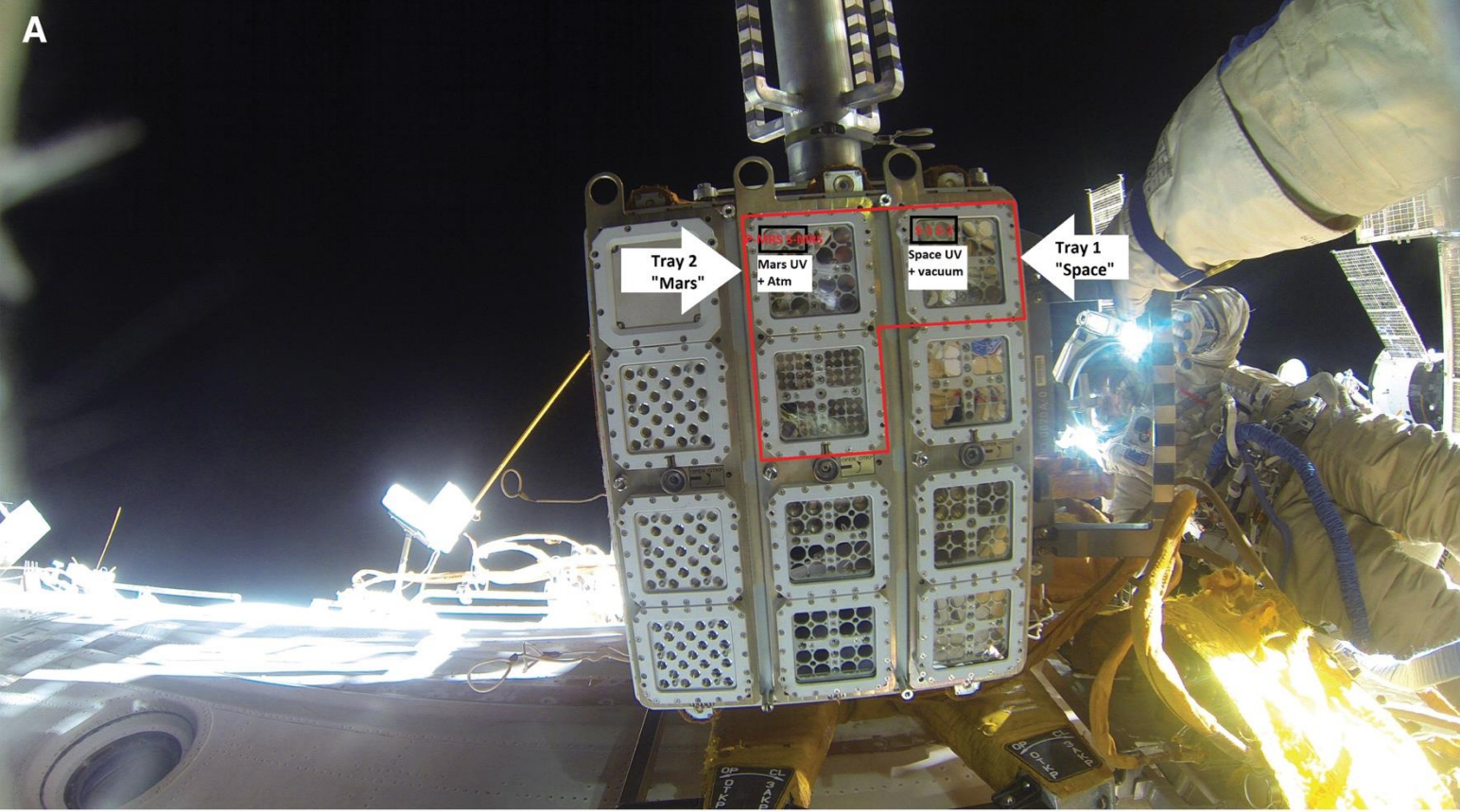
Symbiosis





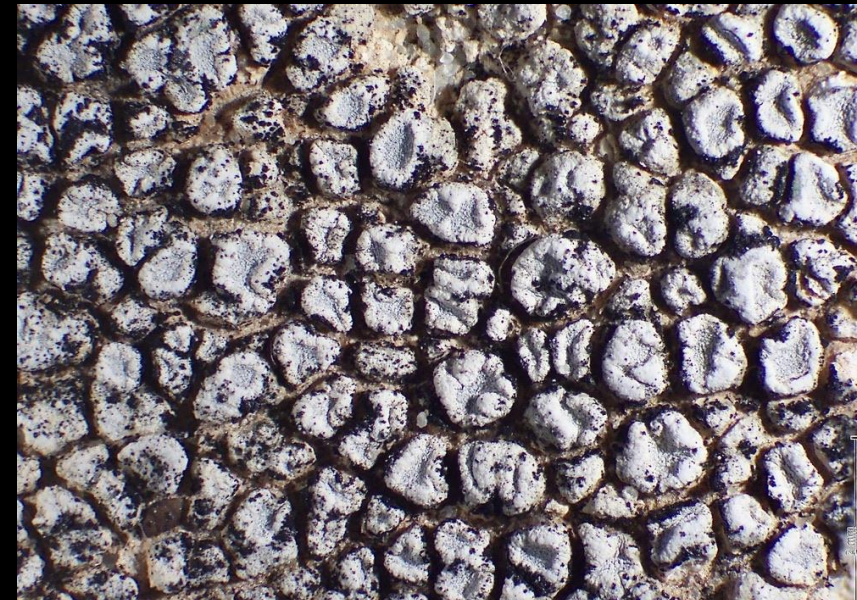
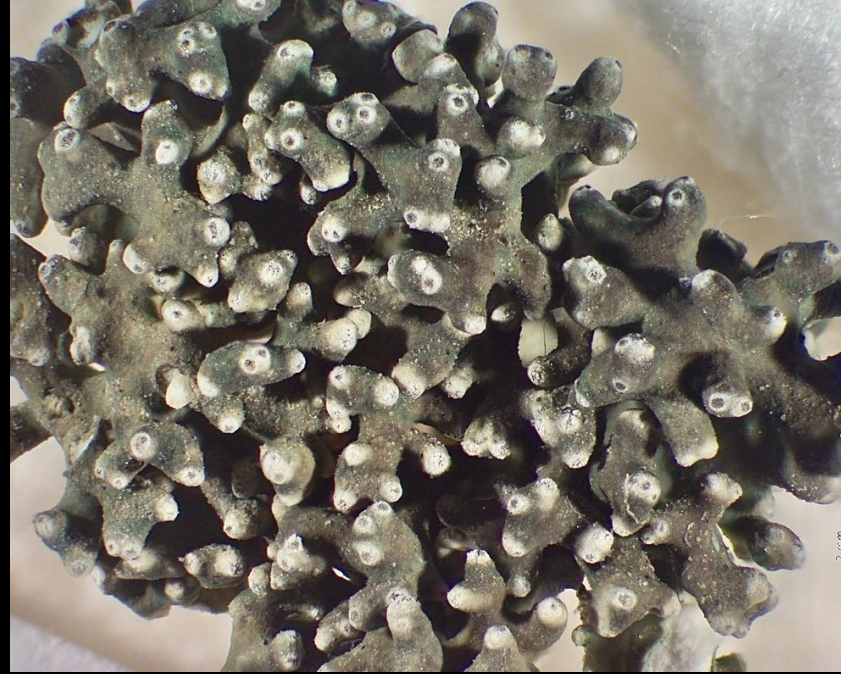
“To be is to inter-be”
everything depends for its existence on everything else

Holst, M. A. (2021). “To be is to inter-be”: Thich Nhat Hanh on interdependent arising. *Journal of World Philosophies*, 6(2), 17-30.

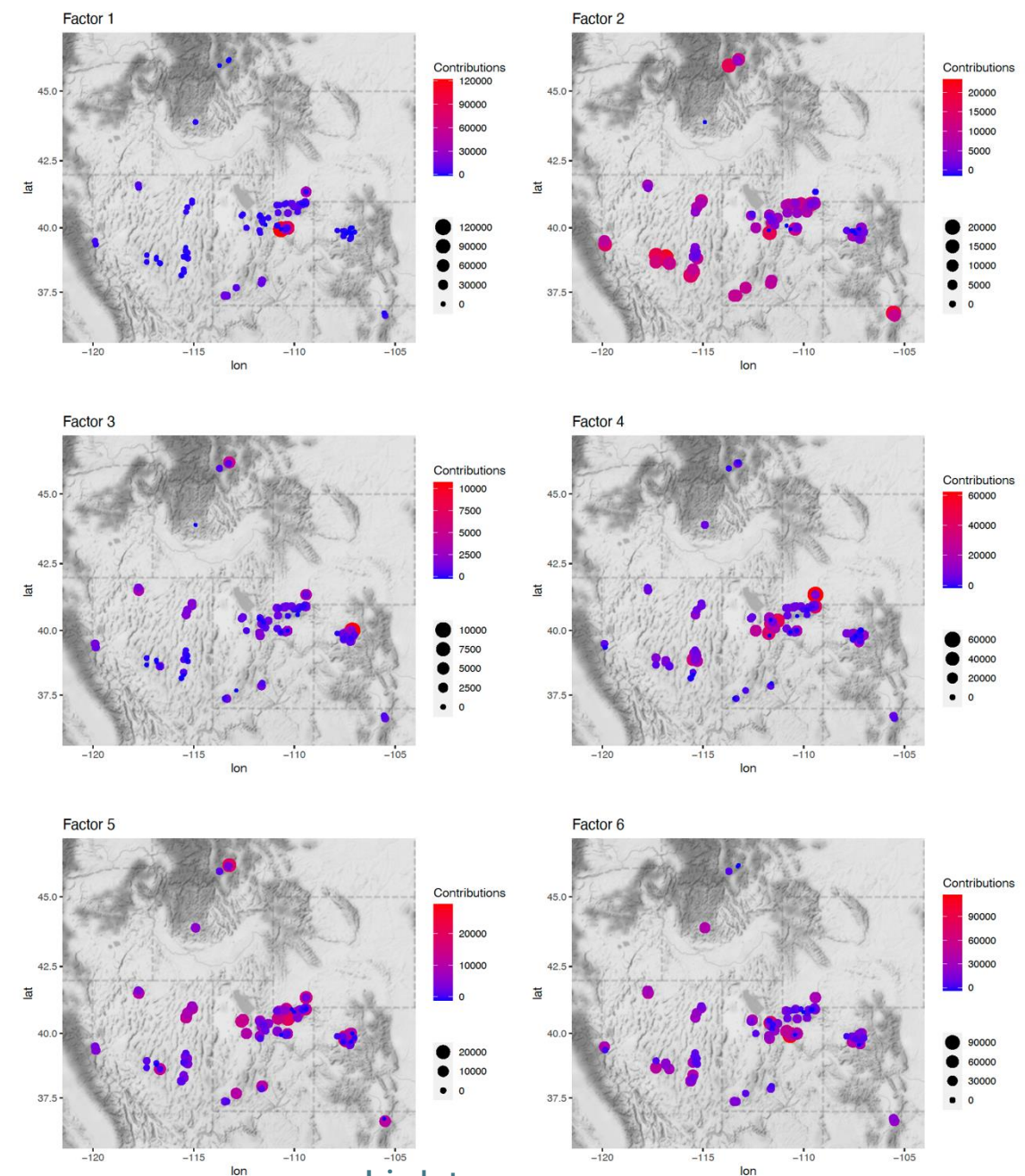
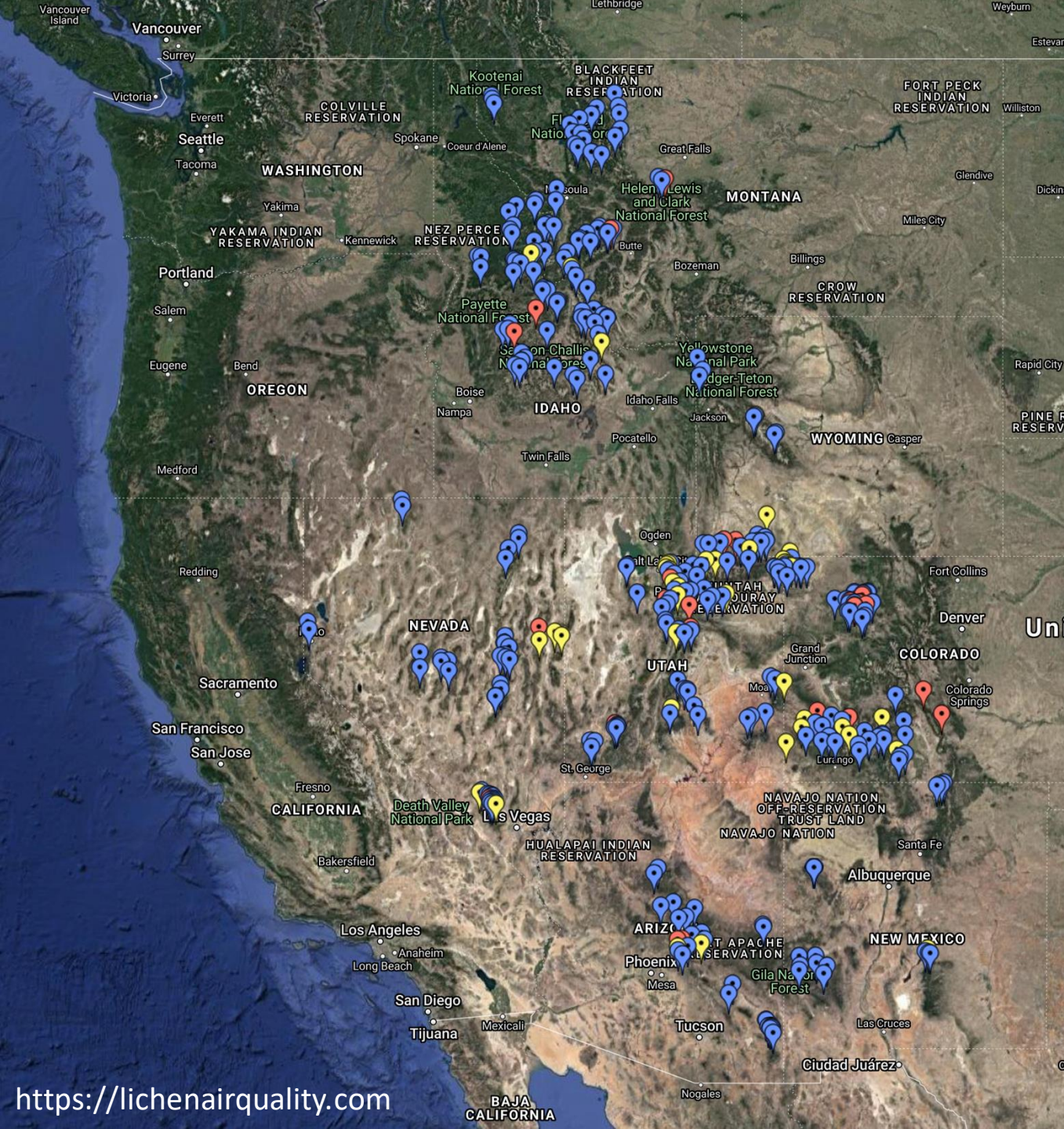


de la Torre Noetzel et al. 2020. Lichen vitality after a space flight on board the EXPOSE-R2 facility outside the international space station: results of the biology and mars

"fat of the earth" – "honey earth" – "pigeon dung" – "earth excrement" –
"manure"



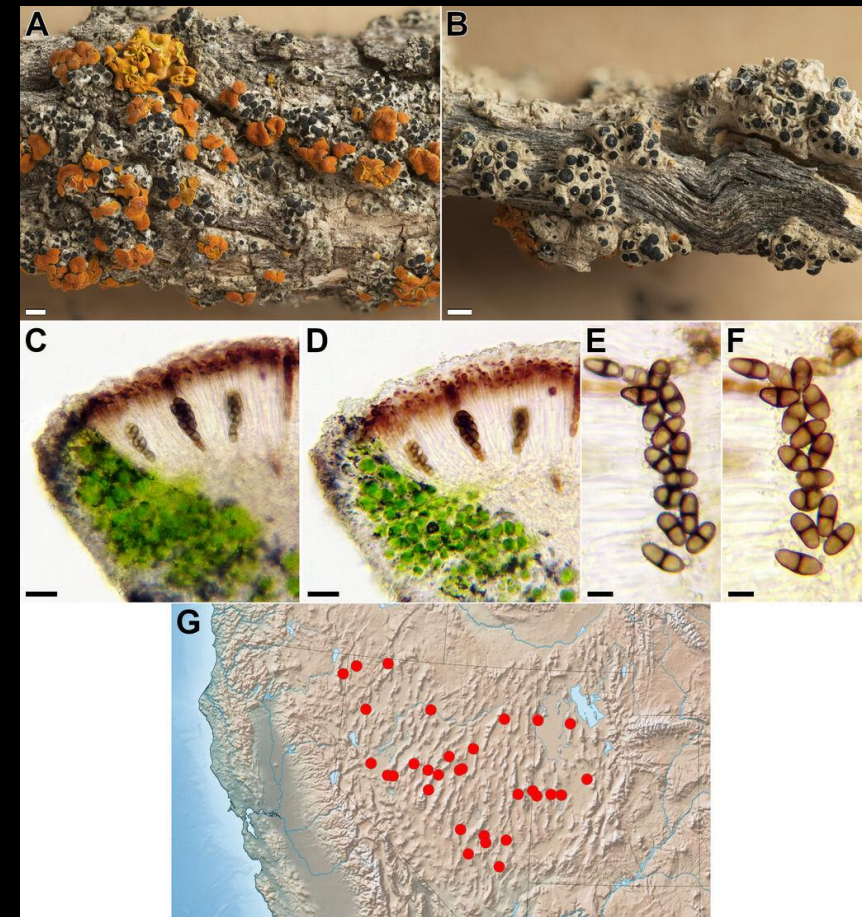
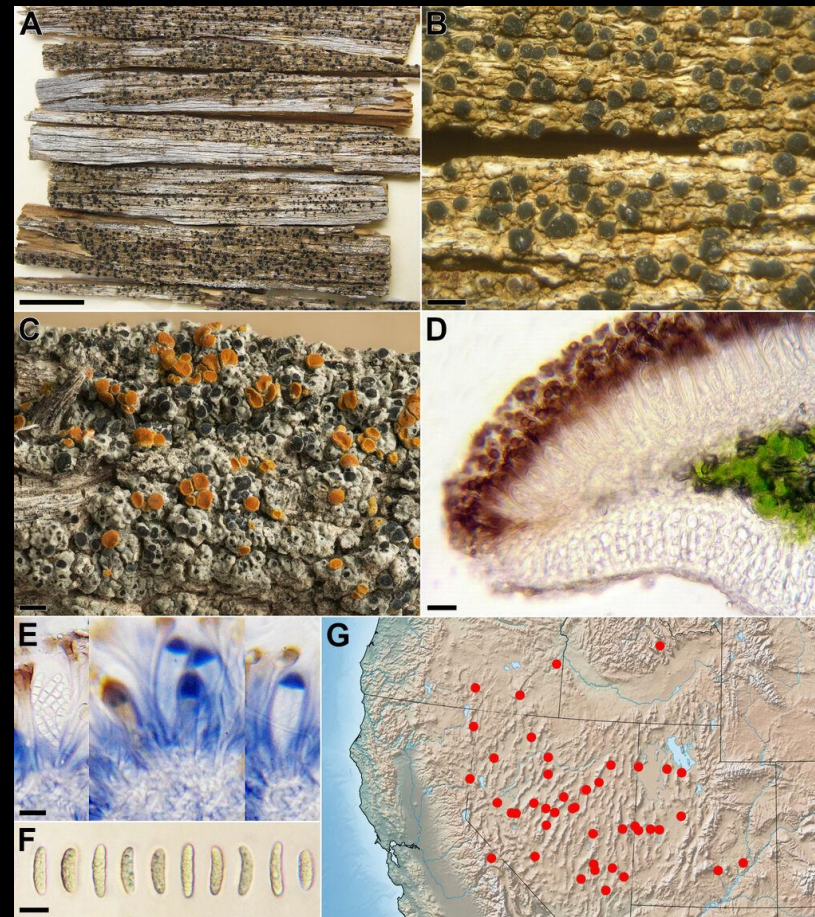
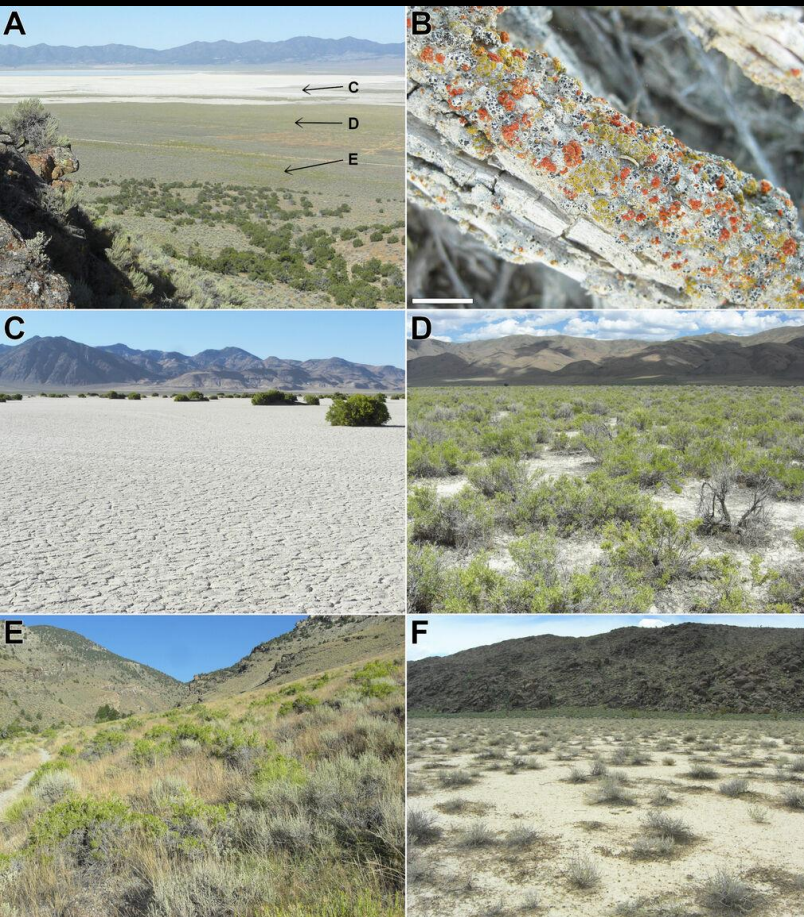




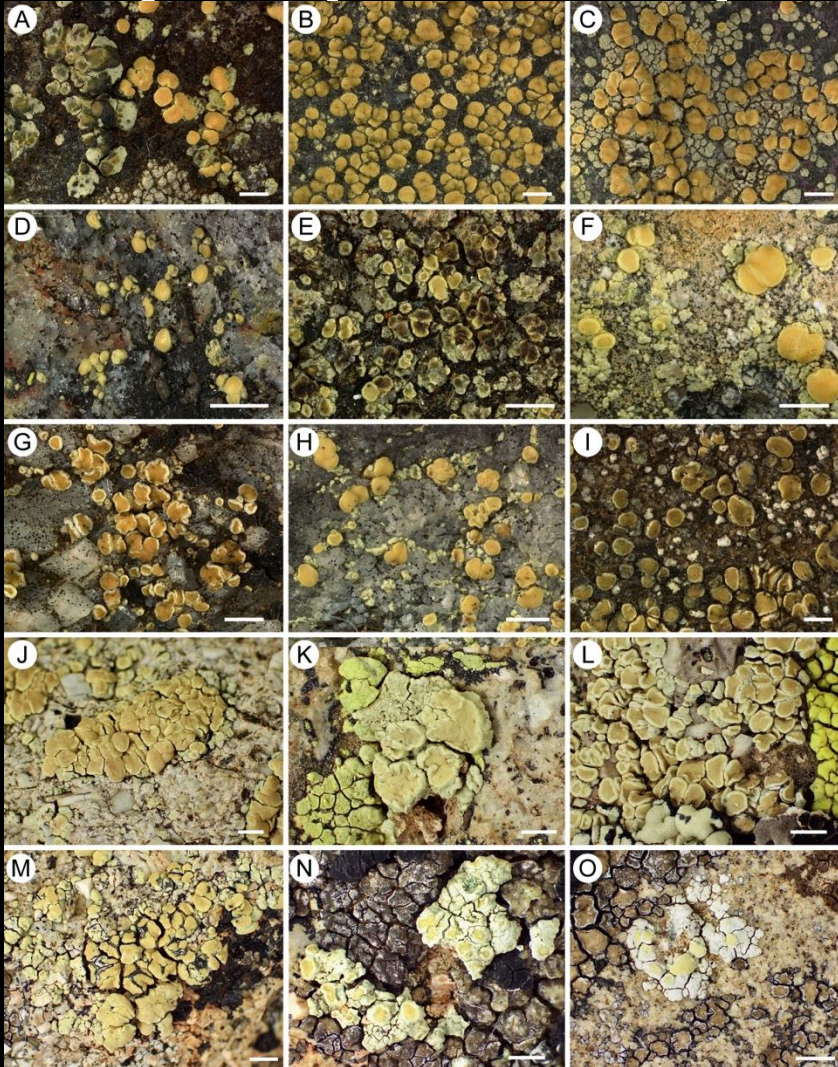
[Link to paper](#)

Figure 3: Maps of estimated factor (source) contributions from the six-factor EPA PMF model fit. Note the distinct scales for each panel.

Lichen communities associated with playas in the Great Basin Desert



Granite rock speck lichens – *Lecanora polytropa* complex



The nominal taxon represents more than 100 candidate species worldwide

High species-level diversity at local sites and mountain ranges with high proportions of endemic lineages

Most sampled specimens belong to cosmopolitan lineages

More site-specific endemics than cosmopolitan lineages

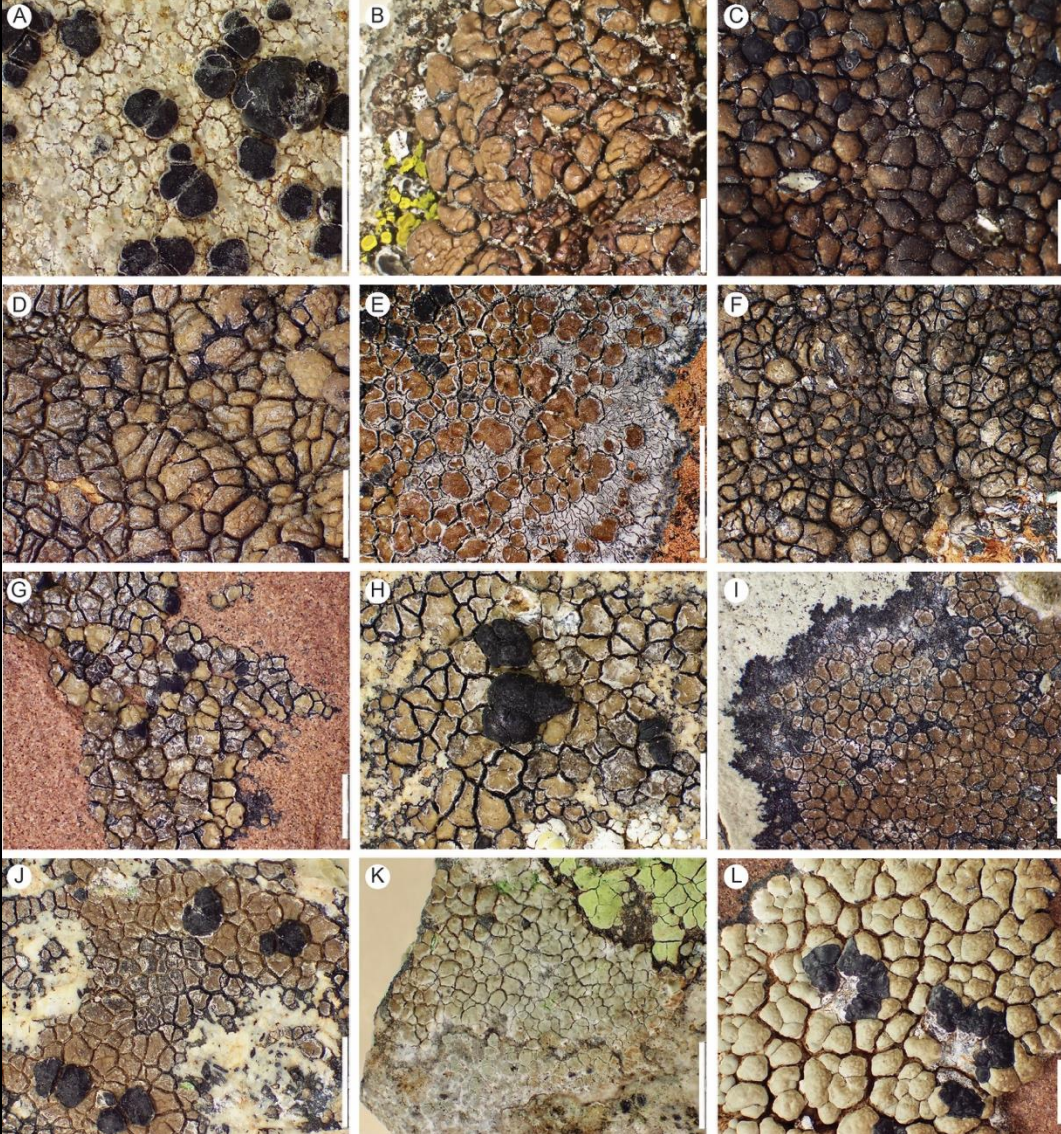
the La Sal Mountains had up to 14 candidate species, while candidate species other nearby mountains had only partly overlapping suites of candidate species

J. Fungi 2022, 8(5), 490; <https://doi.org/10.3390/jf8050490>

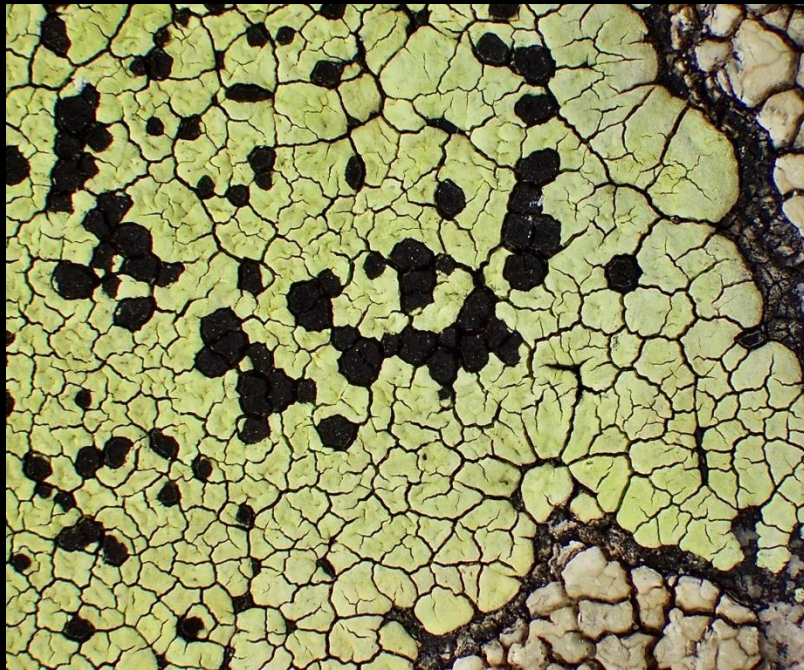
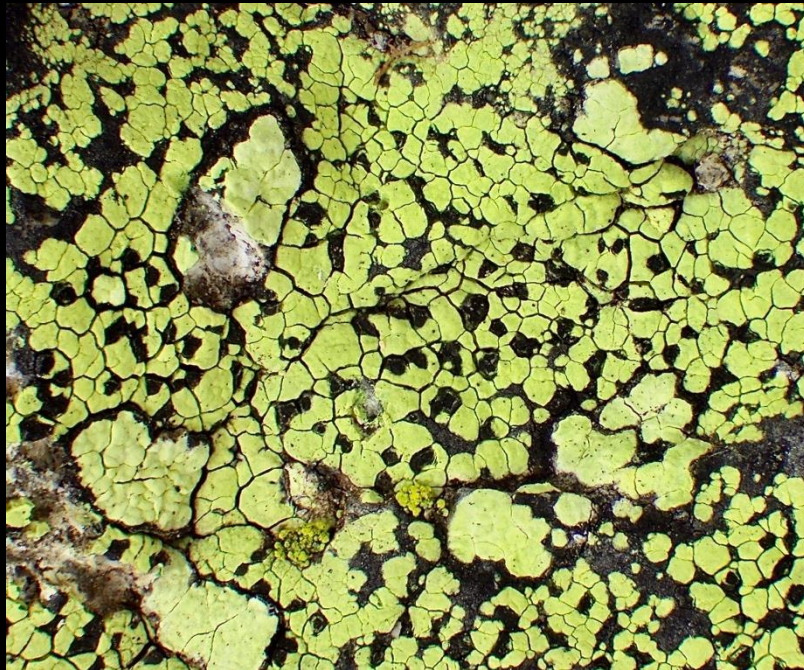
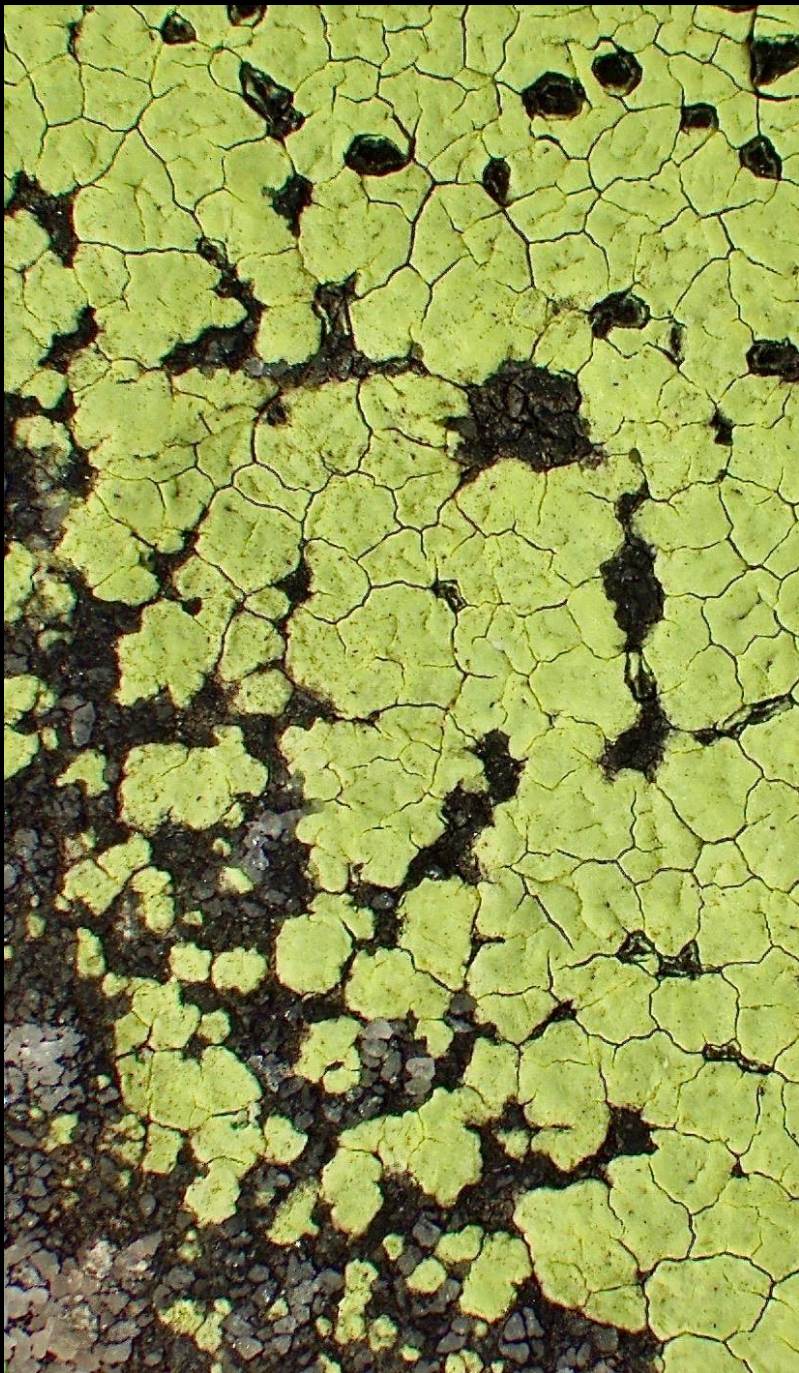
Diversity 2024, 16(2), 88;

<https://doi.org/10.3390/d16020088>

Brown tile lichens – *Lecidea atrobrunnea* complex



- in western North America, a dizzying array of morphologies and chemistry occur at local scales
- Genetic data show geographically restricted species, with fascinating biogeographical patterns, challenging the assumed cosmopolitan distribution of *L. atrobrunnea* s. lat.
- ten candidate species in the La Sals
- Other mountain ranges have distinct suites of species



“We can only ask questions that we have imagination for”



steve_leavitt@byu.edu