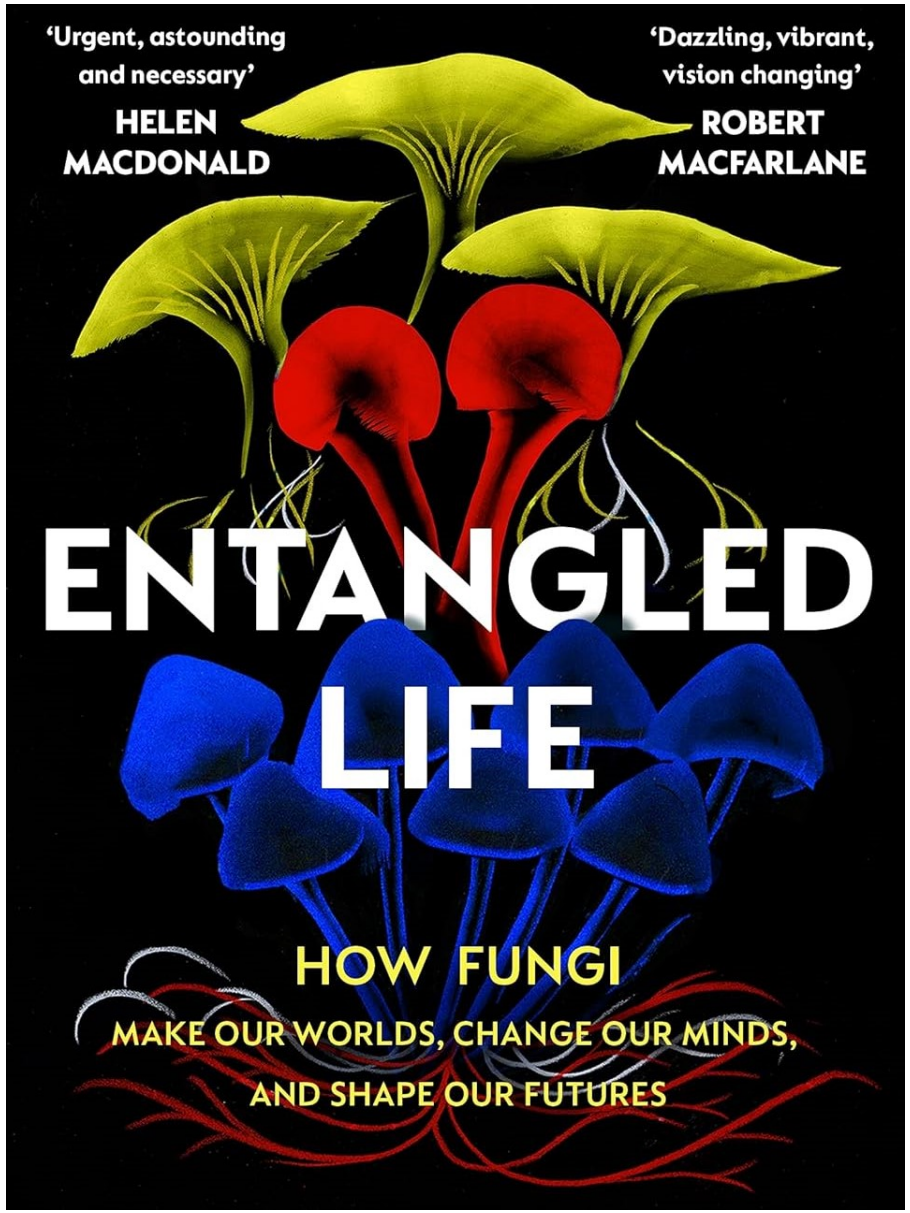
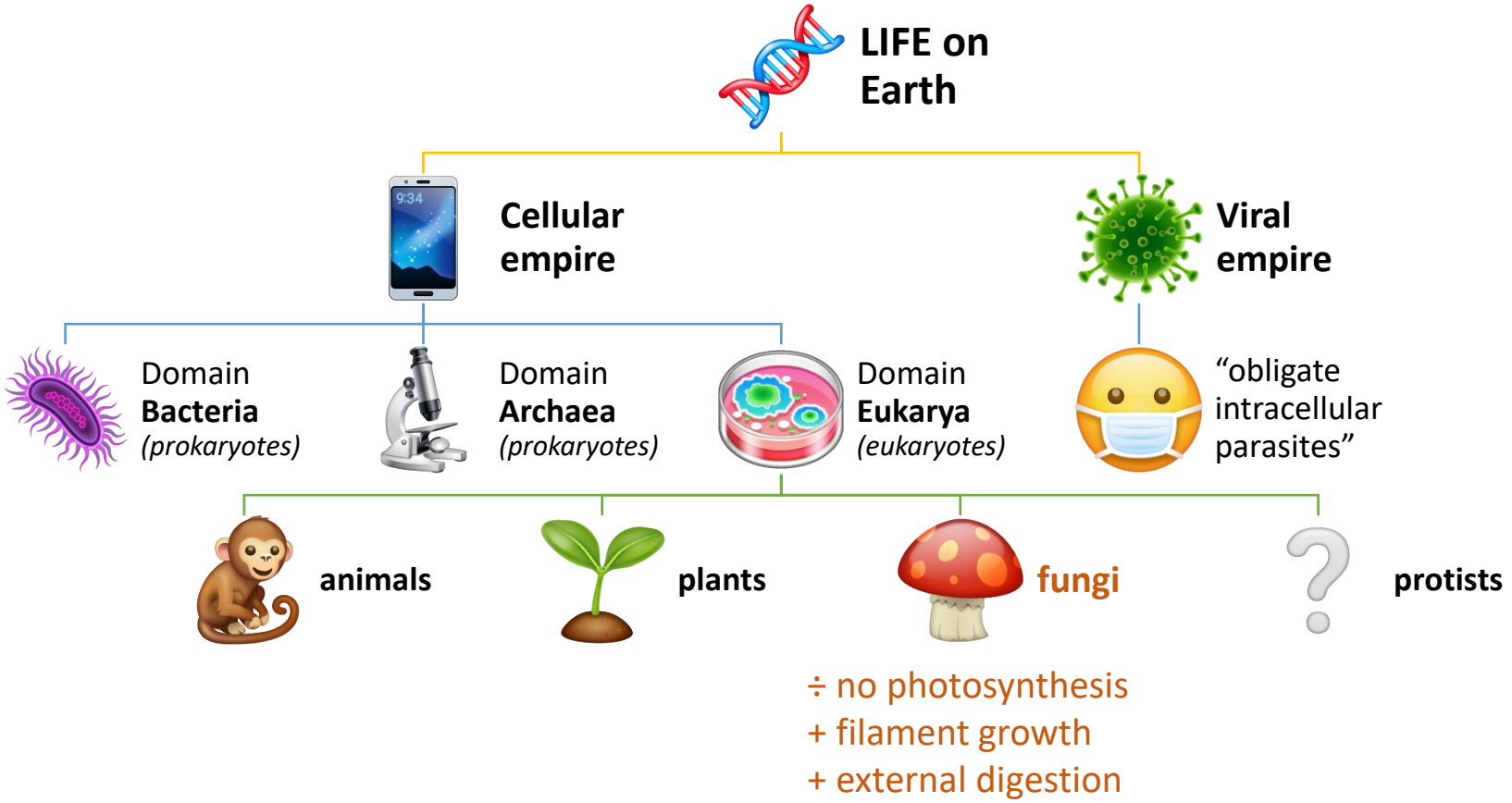
Tessellate fungal edition: *Entangled Life*

Book Club 05.12.2023

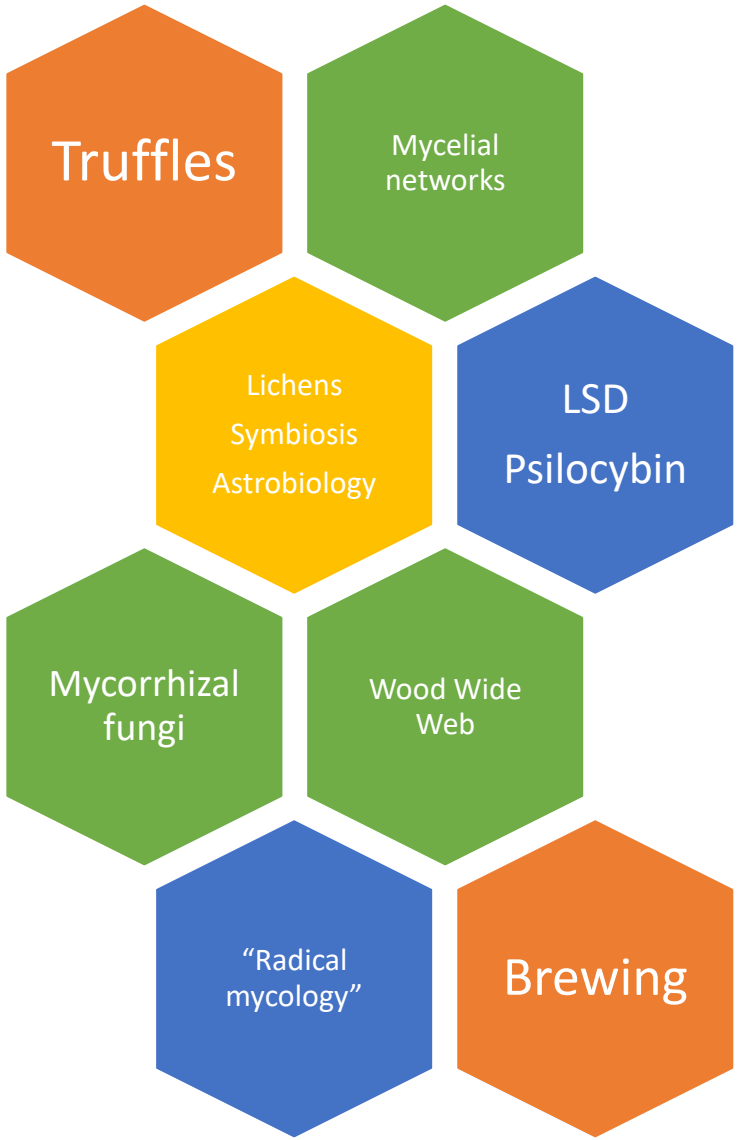

'Urgent, astounding and necessary'
HELEN MACDONALD
'Dazzling, vibrant, vision changing'
ROBERT MACFARLANE
ENTANGLED LIFE
HOW FUNGI
MAKE OUR WORLDS, CHANGE OUR MINDS,
AND SHAPE OUR FUTURES



Koonin, E. V. (2010) The Two Empires and Three Domains of Life in the Postgenomic Age. *Nature Education* 3(9):27

Fantastic fungi

- Break down organic matter
- Vital participants in the carbon, oxygen, nitrogen, and phosphorus cycles in the soil and atmosphere
- Give us our daily bread, wine, beer, and cheese
- Provide essential drugs, including penicillin and other antibiotics
- Enable plant nutrient uptake and interplant communication via symbiotic relationships with roots in the rhizosphere
- Major food source of the future
- Likely to sicken/kill us and our agricultural products


Truffles
Mycelial networks
Lichens
Symbiosis
Astrobiology
LSD
Psilocybin
Mycorrhizal fungi
Wood Wide Web
“Radical mycology”
Brewing

Shaggy ink cap mushrooms, *Coprinus comatus*, drawn with ink made from shaggy ink cap mushrooms

TRUFFLE-HUNTING,— TRAINED HOGS ROOTING FOR THE VALUABLE ESCULENT.

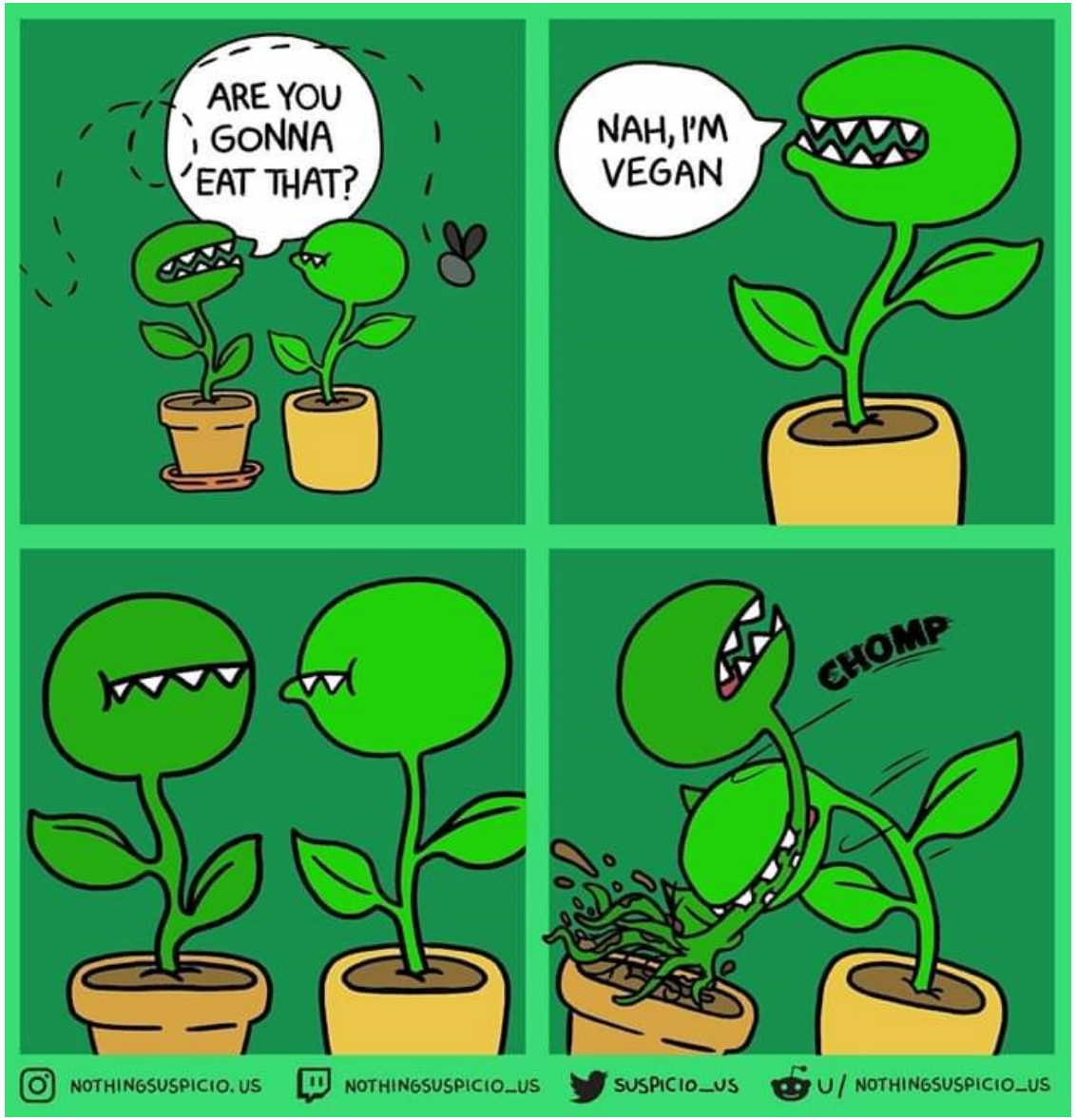
On fungal sex

- **Some fungi have tens of thousands of mating types, approximately equivalent to our sexes** … The mycelium of many fungi can fuse with other mycelial networks if they are genetically similar enough, even if they aren't sexually compatible.
- [Truffle] sex happens when a '-' hypha attracts and fuses with a '+' hypha. One partner plays a paternal role, providing genetic material only. The other plays a maternal role, providing genetic material and growing the flesh that matures into truffles and spores. **Truffles differ from humans in that either '+' or '-' mating types can be maternal or paternal.**

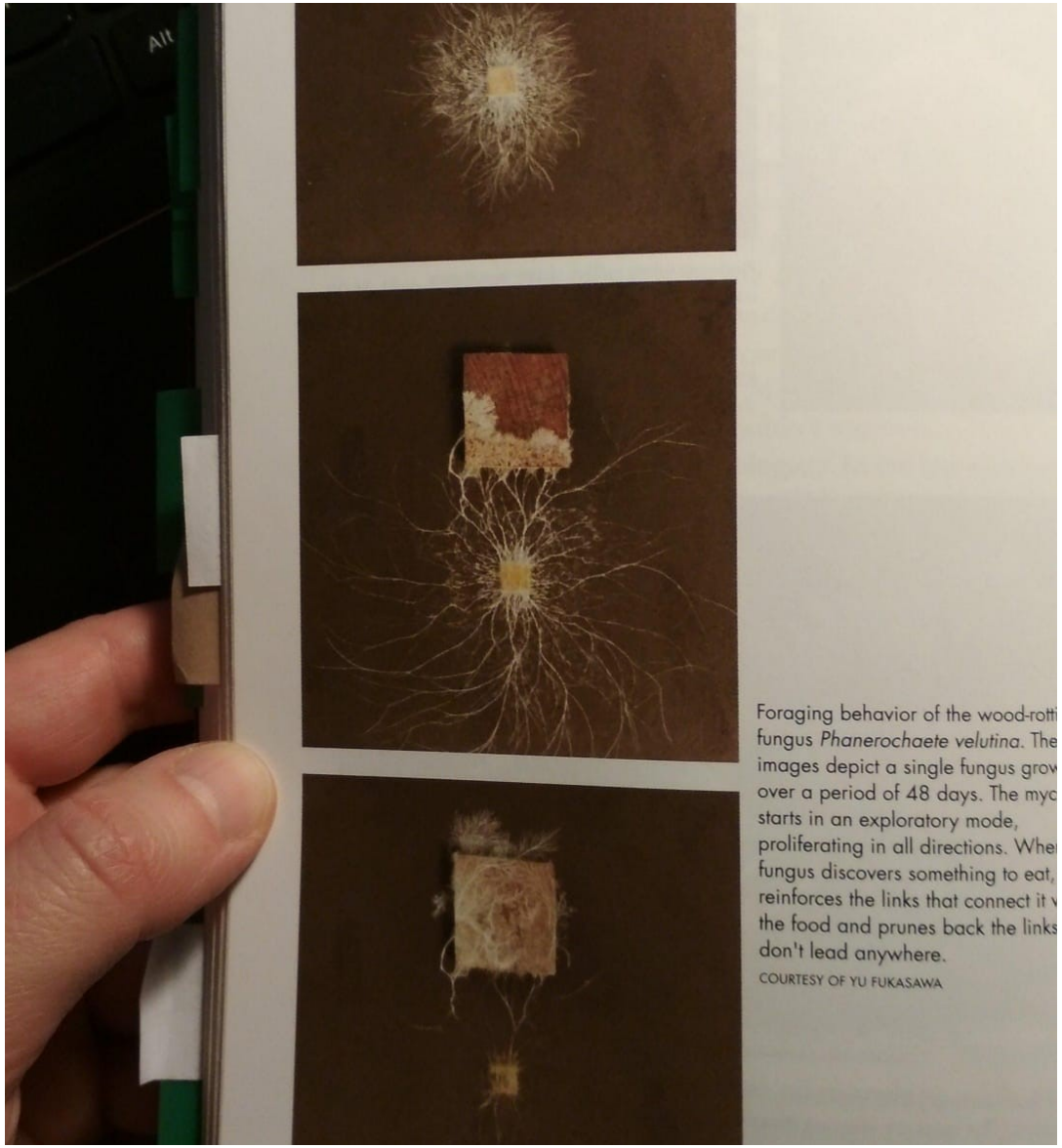
On fungal chemistry

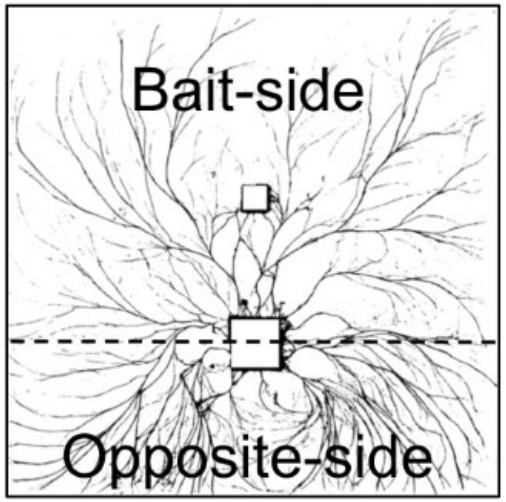
- Both plant and fungus use **volatile chemicals** to make themselves attractive to one another, just as truffles make themselves attractive to animals in a forest.
- Receptive **plant roots produce plumes of volatile compounds that drift through the soil** and cause spores to sprout and hyphae to branch and grow faster.
- **Fungi produce plant growth hormones that manipulate roots**, causing them to proliferate into masses of feathery branches.

Carnivory… not only for plants

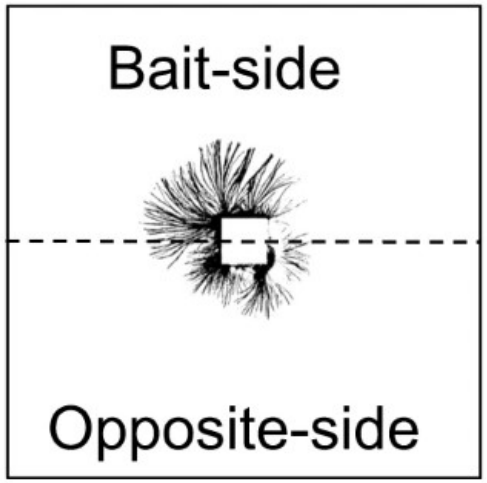


YouTube: Fungal predators of nematode worms
https://youtu.be/OHgxM2HVnkQ





Period II



Fukasawa, Y., Savoury, M. & Boddy, L. Ecological memory and relocation decisions in fungal mycelial networks: responses to quantity and location of new resources. *ISME J* **14**, 380–388 (2020). https://doi.org/10.1038/s41396-019-0536-3

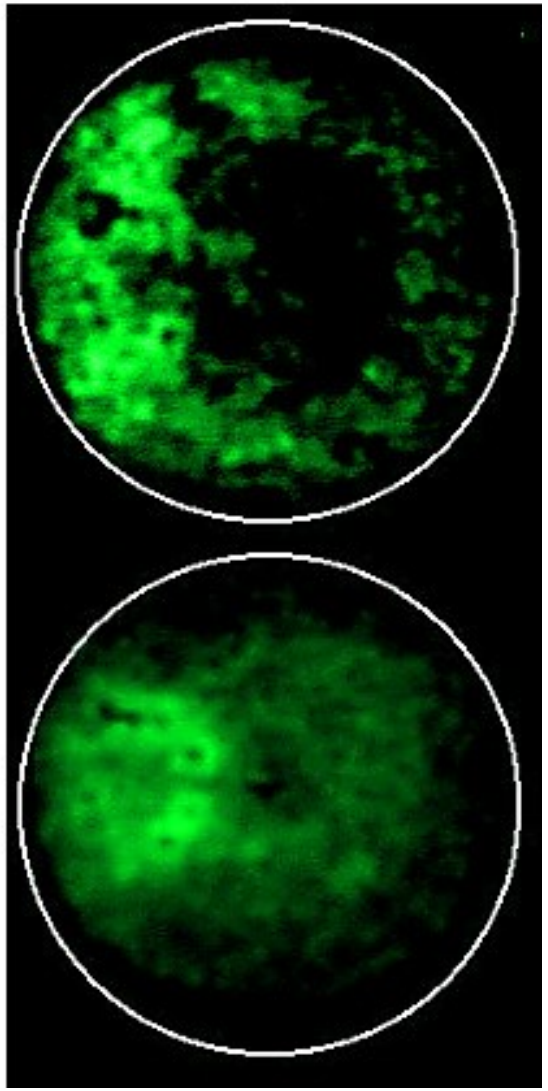
Global reactions in mycelia:

The stabbing of a culture of *Panellus stipticus*.

Bioluminescence increase:

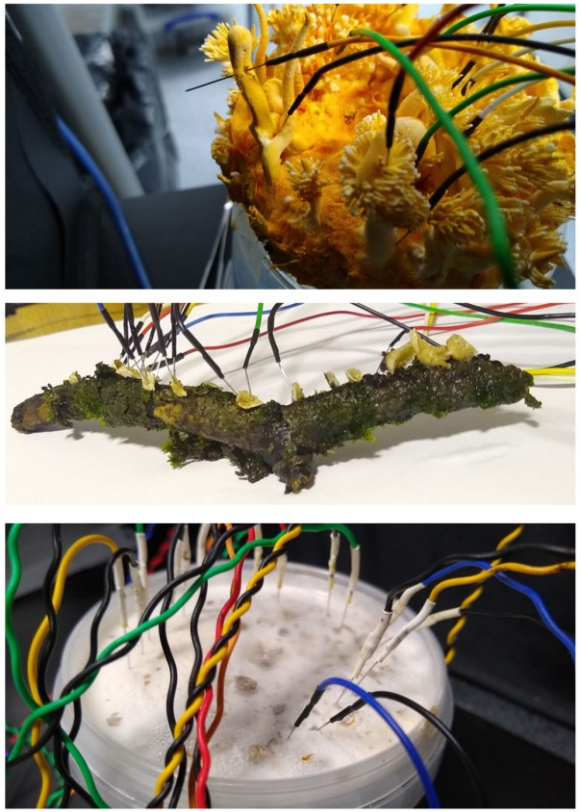
10 minutes after the stabbing

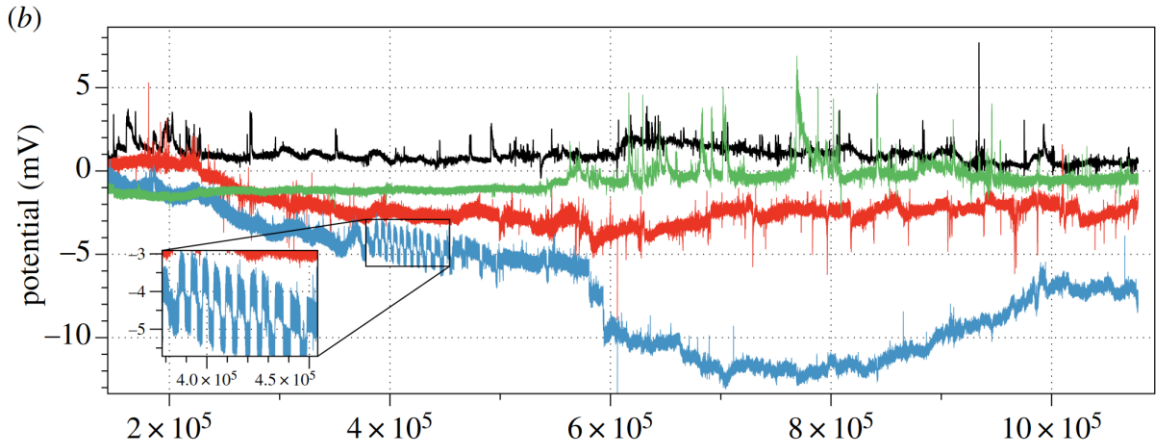
60 minutes after the stabbing



Olsson, unpublished results

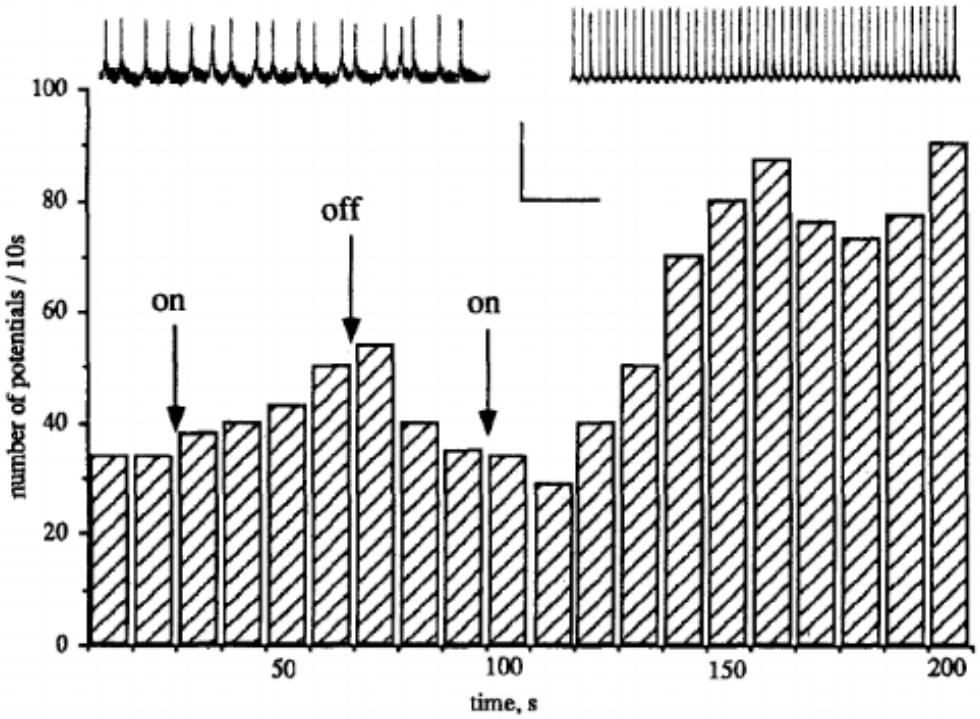
Olsson, Stefan (2019). Fast bioluminescence signal spread in a colony of Panellus stipticus "stabbed" by a pipette tip.. figshare. Figure. https://doi.org/10.6084/m9.figshare.8381108.v1





The electric fungus

Adamatzky Andrew. 2022 Language of fungi derived from their electrical spiking activity. *R. Soc. open sci.* 9:211926. 211926. http://doi.org/10.1098/rsos.211926



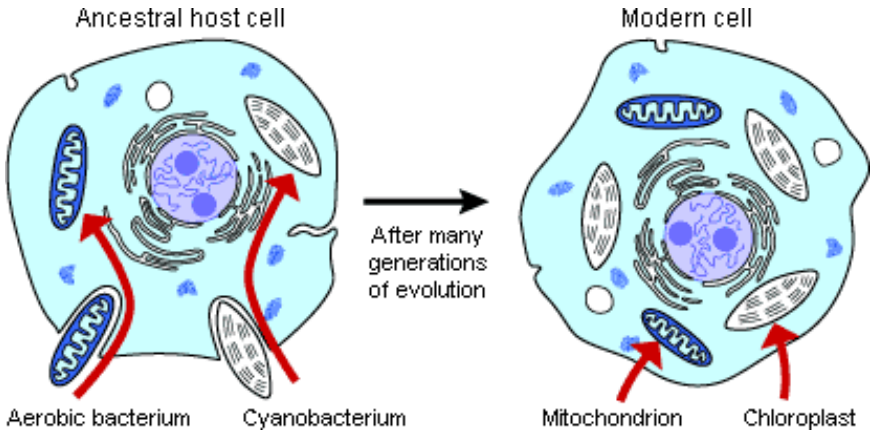
Naturwissenschaften 82, 30–31 (1995)

Action Potential-Like Activity Found in Fungal Mycelia Is Sensitive to Stimulation

S. Olsson and B.S. Hansson

Department of Ecology, Lund University, S-223 62 Lund

Olsson, Stefan (2019). Recording of action-potential like firing in the wood decomposing fungus Armillaria bulbosa when being fed a piece of wood. **Media (audio). https://doi.org/10.6084/m9.figshare.8379170.v1**



Endosymbiosis: Lynn Margulis

The Modern Synthesis established that over time, natural selection acting on mutations could generate new adaptations and new species. But did that mean that new lineages and adaptations *only* form by branching off of old ones and inheriting the genes of the old lineage? Some researchers answered no. Evolutionist Lynn Margulis showed that a major organizational event in the history of life probably involved the merging of two or more lineages through symbiosis.

https://evolution.berkeley.edu/the-history-of-evolutionary-thought/1900-to-present/endosymbiosis-lynn-margulis/

"one of the heroes of twentieth-century biology"
- Richard Dawkins

Britannica

Lichen, any of about 15,000 species of plantlike organisms that consist of a symbiotic association of algae (usually green) or cyanobacteria and fungi (mostly ascomycetes and basidiomycetes).

lichen

symbiotic organism

FUNGAL BIOLOGY REVIEWS 22 (2008) 103–109

ELSEVIER

British Mycological Society promoting fungal science

journal homepage: www.elsevier.com/locate/fbr

Fungal Biology Reviews

Review

Lichens, new and promising material from experiments in astrobiology

Leopoldo G. SANCHO[a,*], *Rosa DE LA TORRE*[b], *Ana PINTADO*[a]

[a]*Departamento de Biología Vegetal II, Universidad Complutense, Plaza Ramon y Cajal s.n., 28040 Madrid, Spain*
[b]*Instituto Nacional de Técnica Aeroespacial, Torrejón, Madrid, Spain*

On lichen chemistry

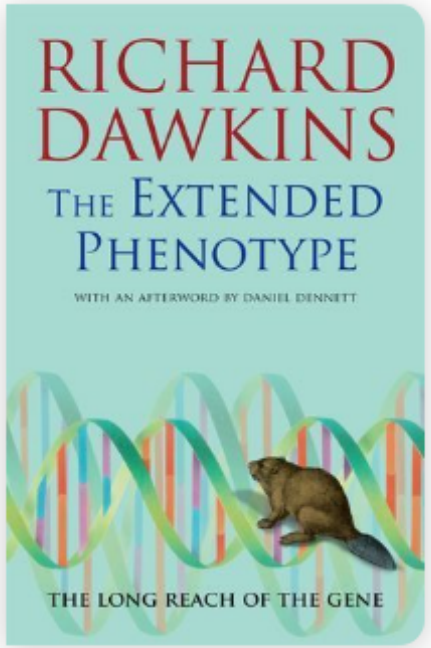
- Lichens … **produce more than a thousand chemicals** that are not found in any other life forms, some of which act as sunscreens.
- … these chemicals have led lichens into all sorts of relationships with humans over the years: from **medicines (antibiotics)** to **perfumes (oak moss)**, to **dyes (tweeds, tartan, the pH indicator litmus)**, to foods—a lichen is one of the principal ingredients in the spice mix **garam masala**.

Queer theory for lichens suggests that we have never been invidivuals, and that attention to this can have positive biomedical consequences.

Queer Theory for Lichens

DAVID GRIFFITHS

Focussing on lichens draws attention to natural limits in taxonomy while destabilizing species boundaries.



Want to read

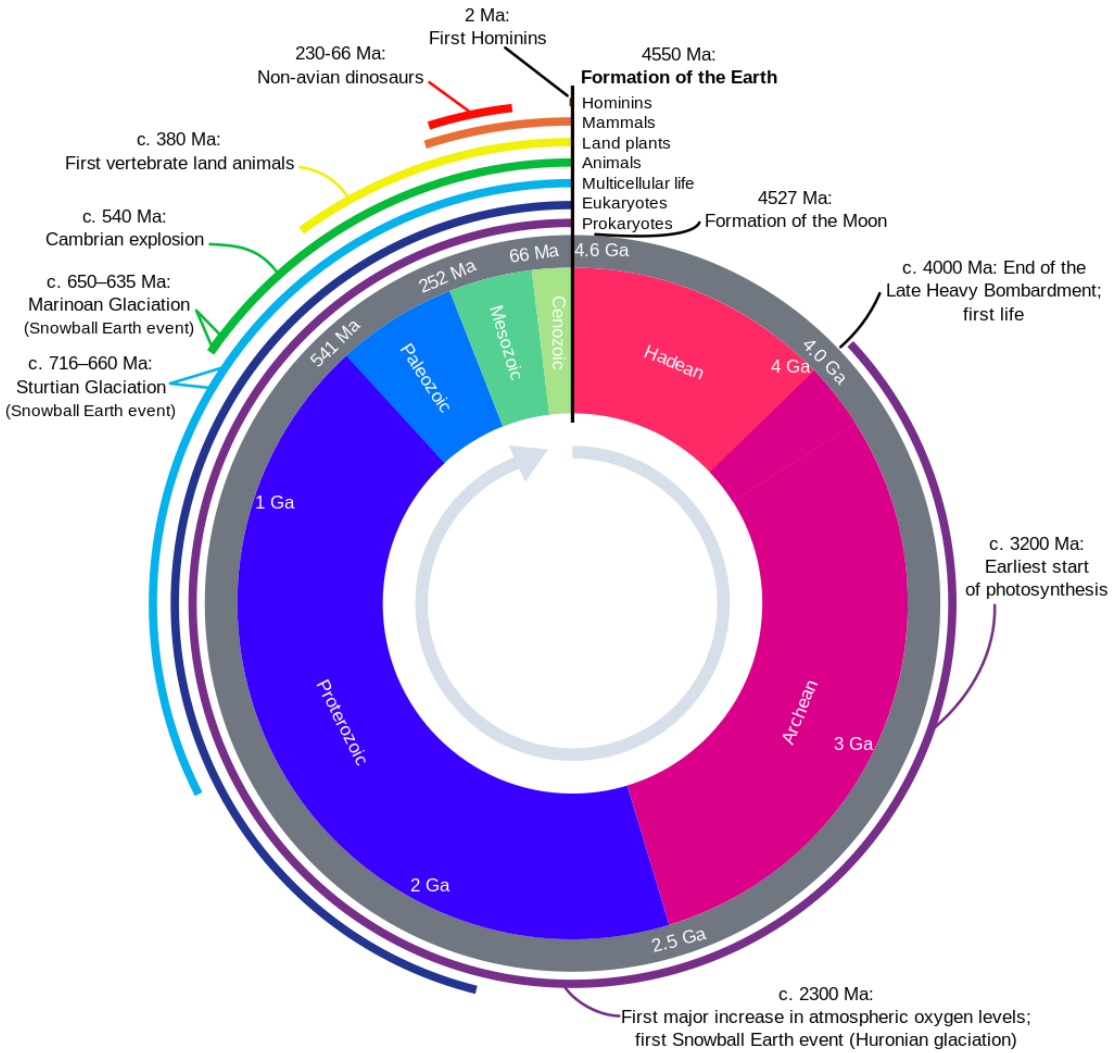
The Extended Phenotype: The Long Reach of the Gene

Richard Dawkins

★★★★½ 4.11 9,141 ratings · 221 reviews

People commonly view evolution as a process of competition between individuals—known as "survival of the fittest"—with the individual representing the "unit of selection." Richard Dawkins offers a controversial reinterpretation of that idea in The Extended Phenotype, now being reissued to coincide with the publication of the second edition of his highly-acclaimed The Selfish Gene. He proposes that we look at evolution as a battle between genes instead of between whole organisms. We can then view changes in phenotypes—the end products of genes, like eye color or leaf shape, which are usually considered to increase the fitness of an individual—as serving the evolutionary interests of genes.

citymag.indaily.com.au / blogs.biomedcentral.com / reddit.com



By Woudloper - Derivative work: Hardwigg - This file was derived from: Geologic clock.jpg, Public Domain, https://commons.wikimedia.org/w/index.php?curid=11926892

BioSystems 6 (1975) 153–164

THE ORIGIN OF LAND PLANTS: A MATTER OF MYCOTROPHISM

K.A. PIROZYNSKI and D.W. MALLOCH

Biosystematics Research Institute, Research Branch, Agriculture Canada, Ottawa, Canada K1A OC6

It is hypothesized that terrestrial plants are the product of an ancient and continuing symbiosis of a semi-aquatic ancestral green alga and an aquatic fungus - an oomycete. The Siluro-Devonian "explosive" colonization of land, and indeed the very evolution of plants, was possible only through such mutualistic partnerships - partnerships that were equipped to cope with the problems of desiccation and starvation associated with terrestrial existence.

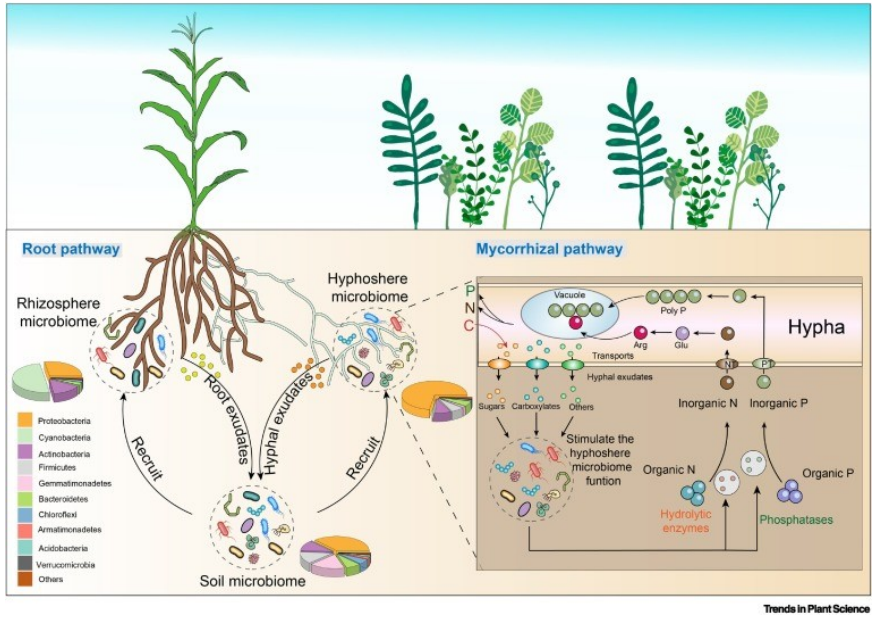
CellPress

Trends in Plant Science

Review

Arbuscular mycorrhizal fungi conducting the hyphosphere bacterial orchestra

Lin Zhang [1], Jiachao Zhou [1], Timothy S. George [2], Erik Limpens [3] and Gu Feng [1,*]



Toby Kiers' TED talk

Toby Kiers

Lessons from fungi on markets and economics

Posted Oct 2019

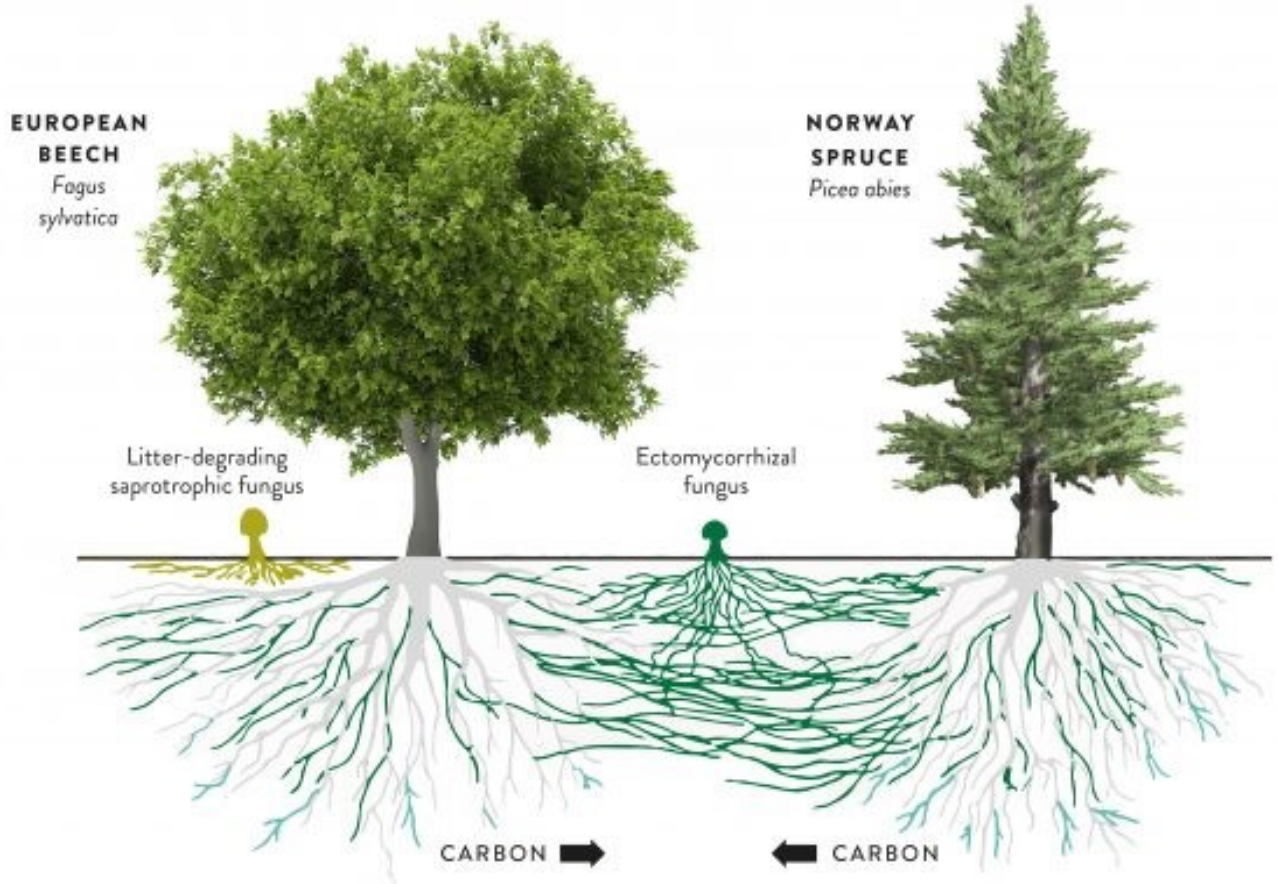
Letter | Open access | Published: 07 August 1997

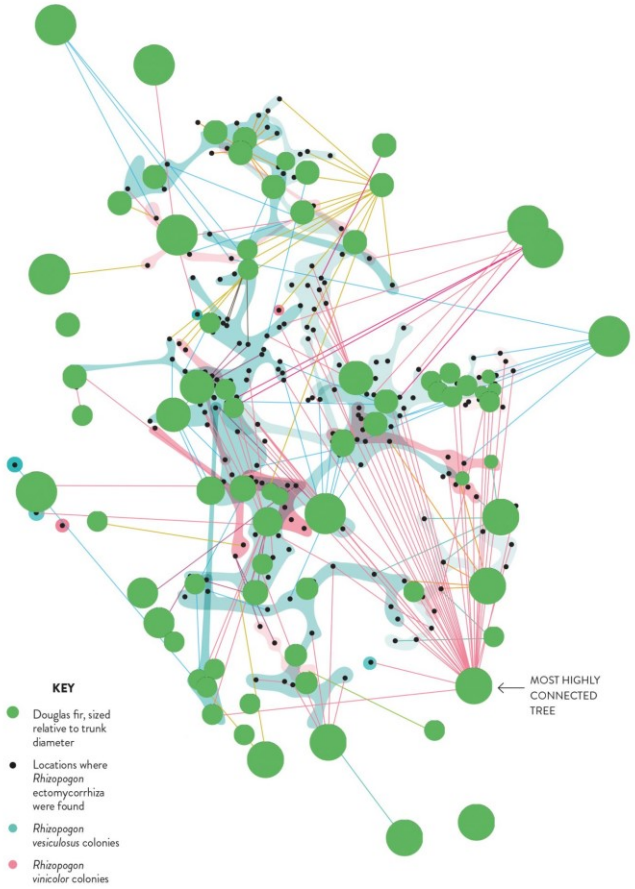
Net transfer of carbon between ectomycorrhizal tree species in the field

Suzanne W. Simard, David A. Perry, Melanie D. Jones, David D. Myrold, Daniel M. Durall & Randy Molina

Nature **388**, 579–582 (1997) | Cite this article

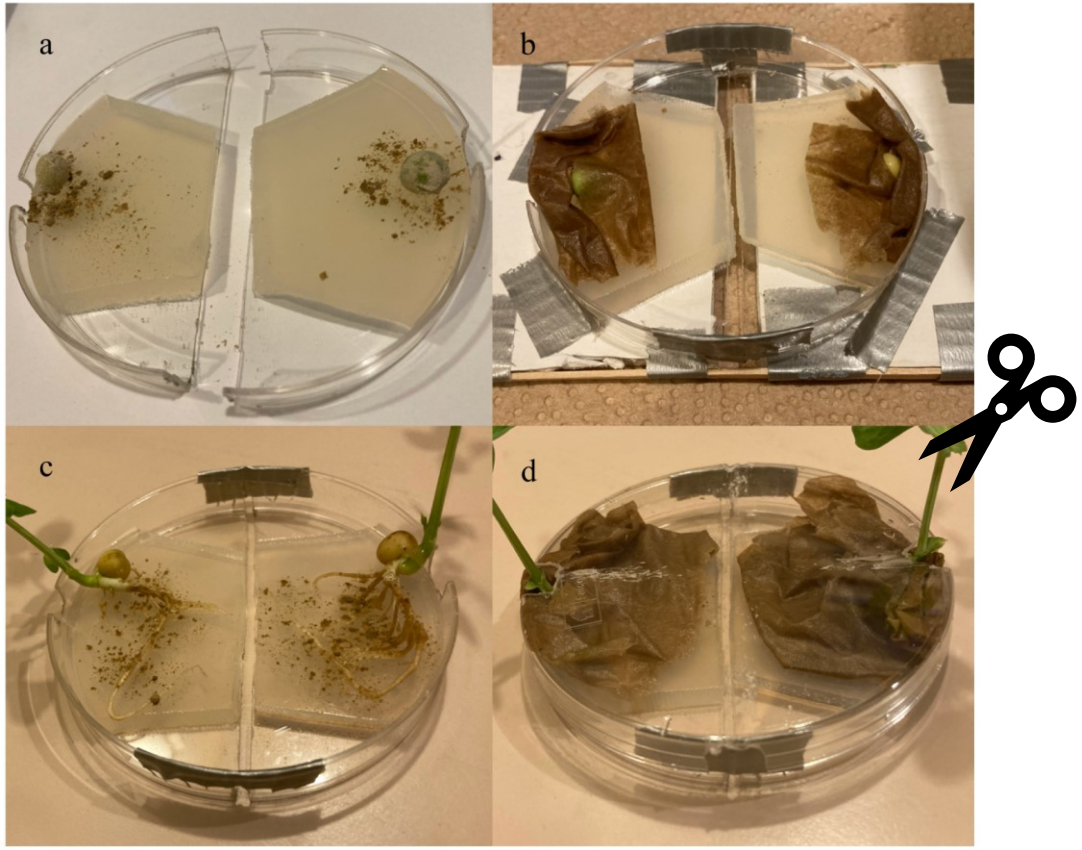
“The Wood Wide Web”

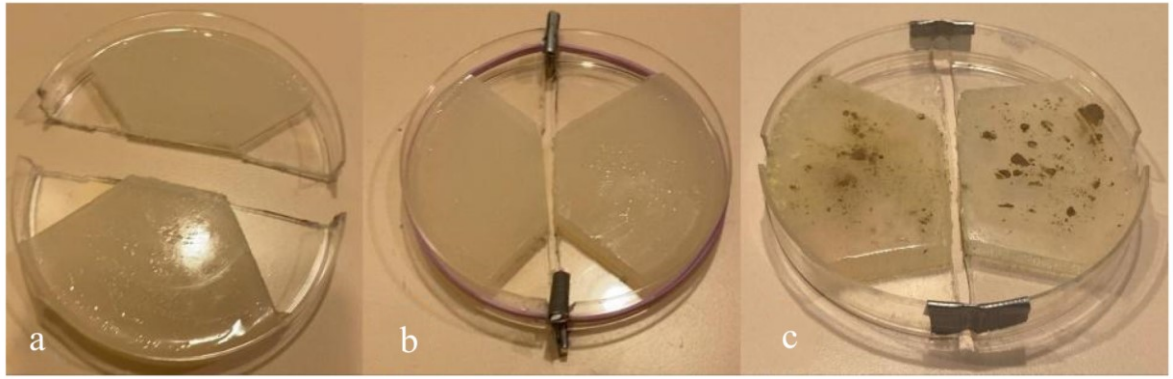


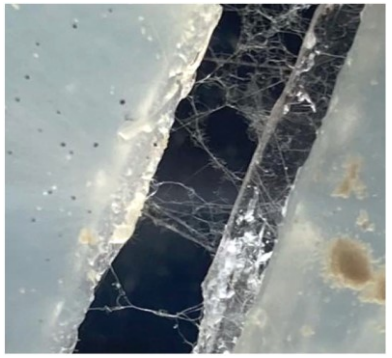


New Zealand Geographic

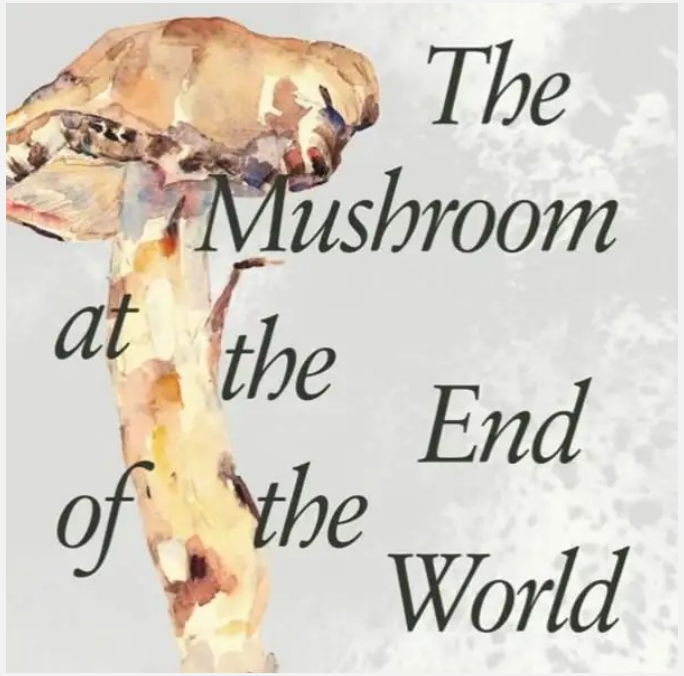
Mycelium-mediated interplant communication







Matthew Adam Thomas & Robin Lewis Cooper (2022) Building bridges: mycelium–mediated plant–plant electrophysiological communication, Plant Signaling & Behavior, 17:1, DOI: 10.1080/15592324.2022.2129291



On fungus saving the world

- … the mess humans have made might look like an opportunity from a fungal perspective. **Fungi have persisted through Earth's five major extinction events**, each of which eliminated between 75 and 95 per cent of species on the plant.
- Following the **Cretaceous-Tertiary extinction**, credited with the dispatch of dinosaurs and the mass destruction of forests across the globe, fungal abundance surged …
- **Radiotrophic fungi** … flourish in the ruins of Chernobyl … After Hiroshima was destroyed by an atomic bomb … the first living thing to emerge from the devastation was a matsutake mushroom.

OCTOBER 10, 2023 | HEALTH & MEDICINE

The Forgotten Mother of Penicillin

How "Moldy Mary" helped produce the lifesaving drug and turned an insult into a triumph.

Douglas Gorsline's oil painting of scientist Mary Hunt examining a piece of cantaloupe for mold, 1948.
University of Wisconsin

https://sciencehistory.org/stories/disappearing-pod/the-forgotten-mother-of-penicillin/


ecovative
We grow materials.
IKEA

On antiviral fungus

- **Wood-rotting fungi are a rich source of antiviral compounds**, many of which have been used as medicines, particularly in China.
- After 9/11 … Project BioShield [searched] for compounds that could be used to fight viral storms unleashed by **biological terrorists**.
- … extracts from wood-rotting fungi had the strongest activity against a number of deadly viruses, including **smallpox, herpes, and flu**.
- [The effects on] **bees' viral infections** were unambiguous.

YouTube / EarthFixMedia

On metaphors in science

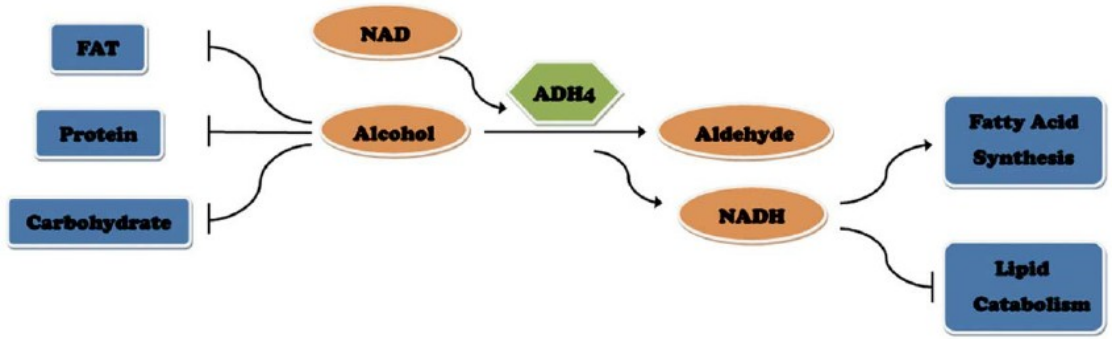
The evolutionary biologist Richard Lewontin pointed out that … almost **‘the entire body of modern science is an attempt to explain phenomena that cannot be experience directly by human beings’**.

Metaphors and analogies … come laced with human stories and values, meaning that **no discussion of scientific ideas … can be free of cultural bias**.

How the Drunken Monkey Hypothesis Explains Our Taste for Liquor

Early apes' ability to metabolize alcohol increased about 20-fold due to a single-point mutation in their genes.

By Robert Dudley and Aeon




CORAL MILKY CAP
RED-CAP BOLETUS
HONEY FUNGUS
LACTARIUS INDIGO
BLACK TRUFFLE
CHANTERELLE
SHAMPIGNON
SUILLUS
SHIITAKE
ENOKI
PORCINI
RUSSULA
OYSTER
CEP
MOREL