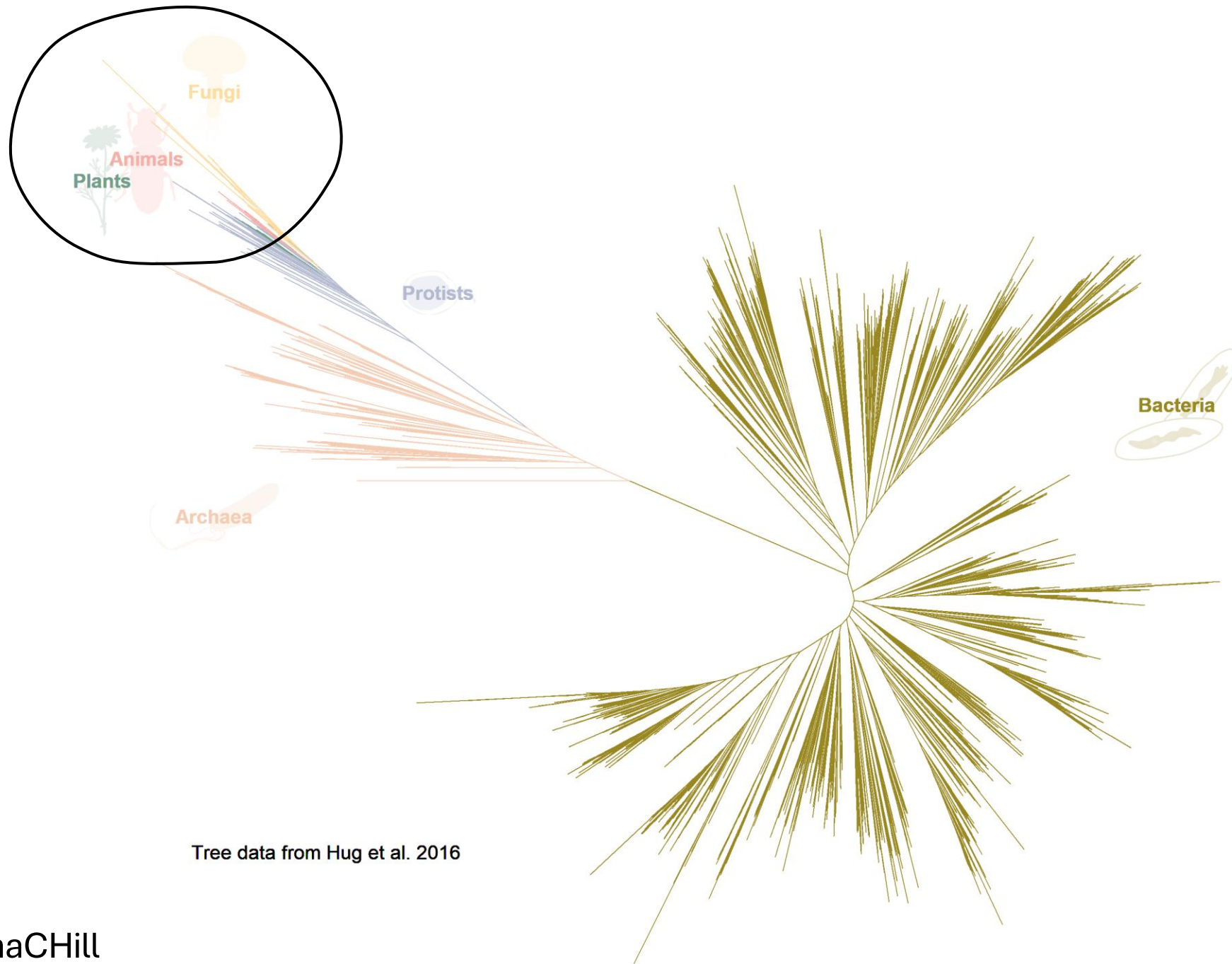


How fungi support our forests

(and teach us about the pitfalls of runaway ideas)

What are fungi?





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They're everywhere and interact with everything

Plants

Water

Animals

Permafrost

Soil

Rocks

Air



They're indispensable to us

Soy sauce and miso Alcohol Dairy

Edible fungi **Food**

Breadmaking Meat substitutes

Statins **Medicine**

Psychedelics Immunosuppressants

Antibiotics

Biofuels Leather and cotton processing

Manufacturing and industry

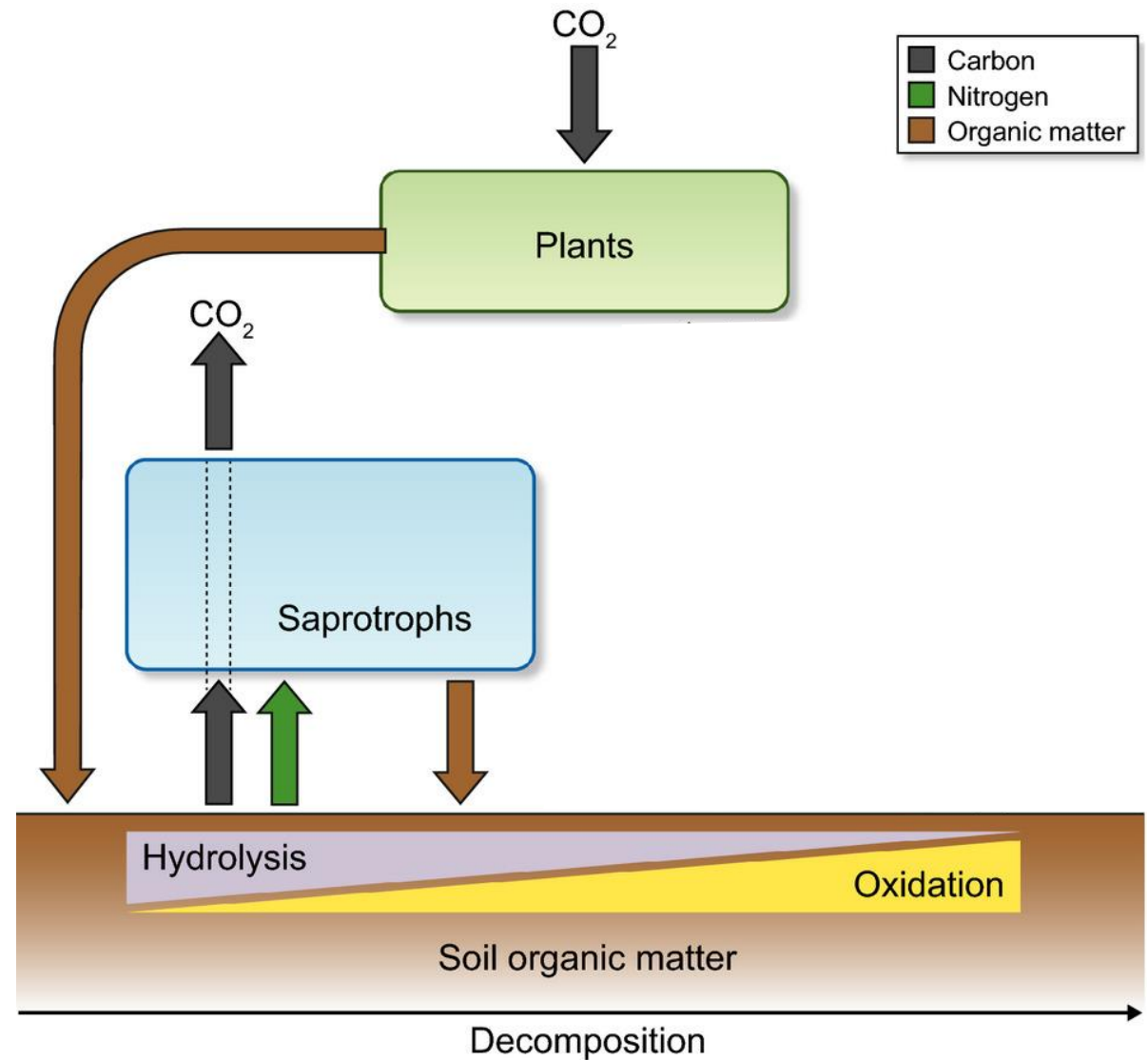
Paper manufacturing Plastics and biomaterials

Washing detergents



They support our forests

Decomposers (saprotrophs) are essential to carbon and nutrient cycling and the formation and stabilisation of soil aggregates in forest ecosystems



[Lindahl and Tunlid \(2014\)](#)



They support our forests



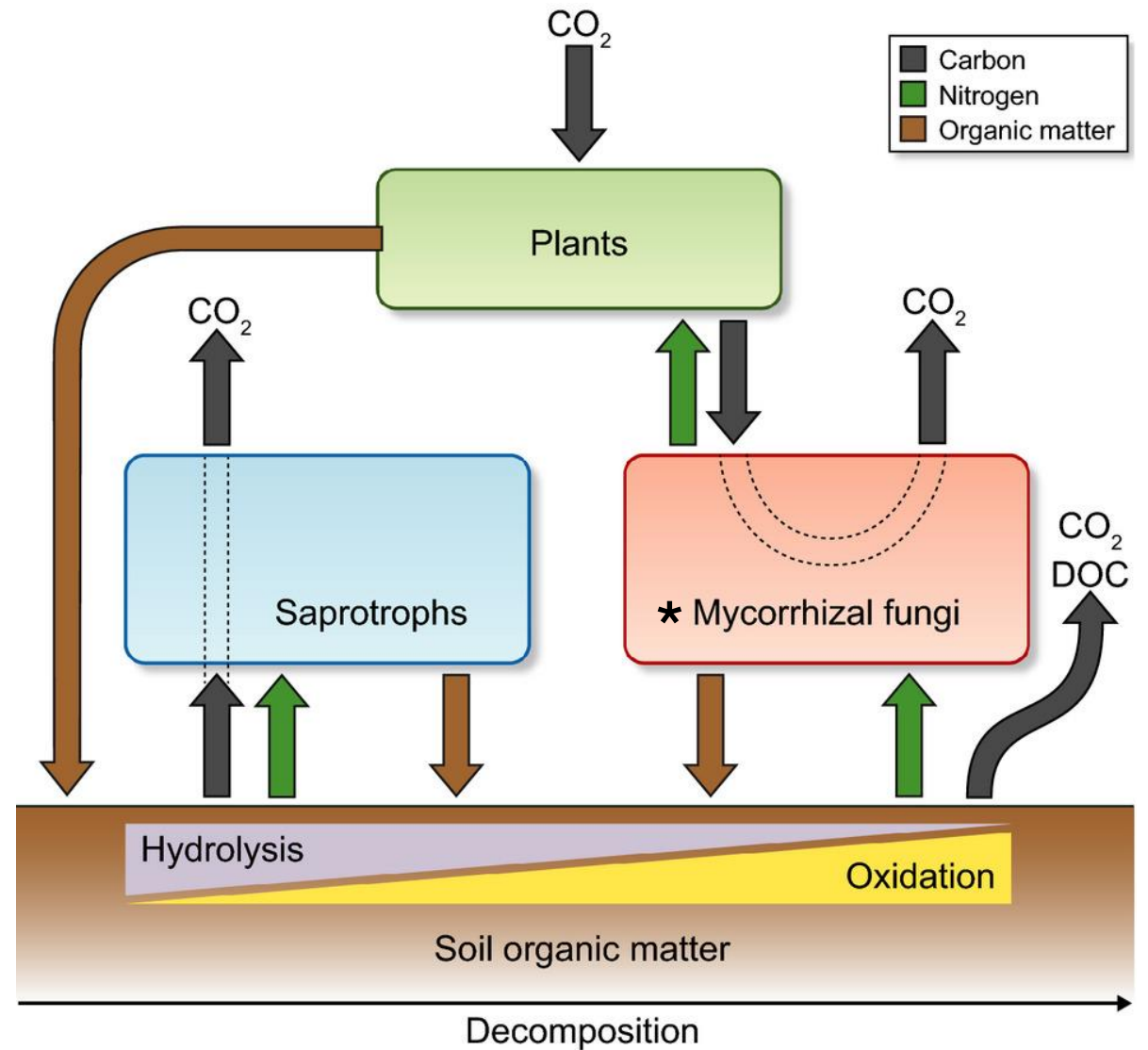
<https://foreverfungi.co.uk/oakfungisurvey/>



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They support our forests

Decomposers (saprotrophs)* are essential to carbon and nutrient cycling and the formation and stabilisation of soil aggregates in forest ecosystems



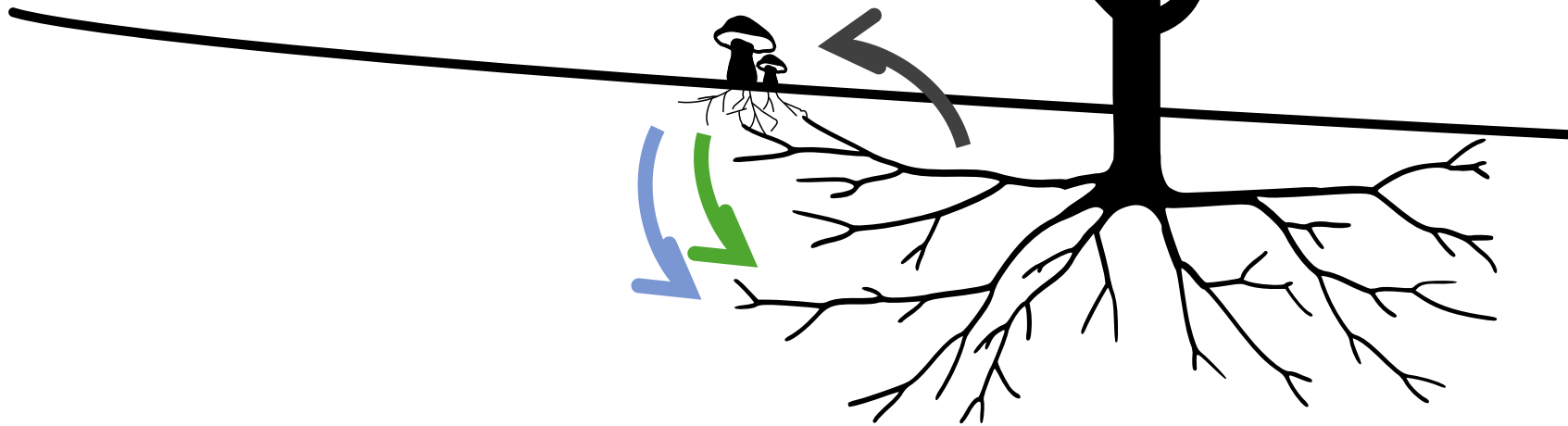
[Lindahl and Tunlid \(2014\)](#)



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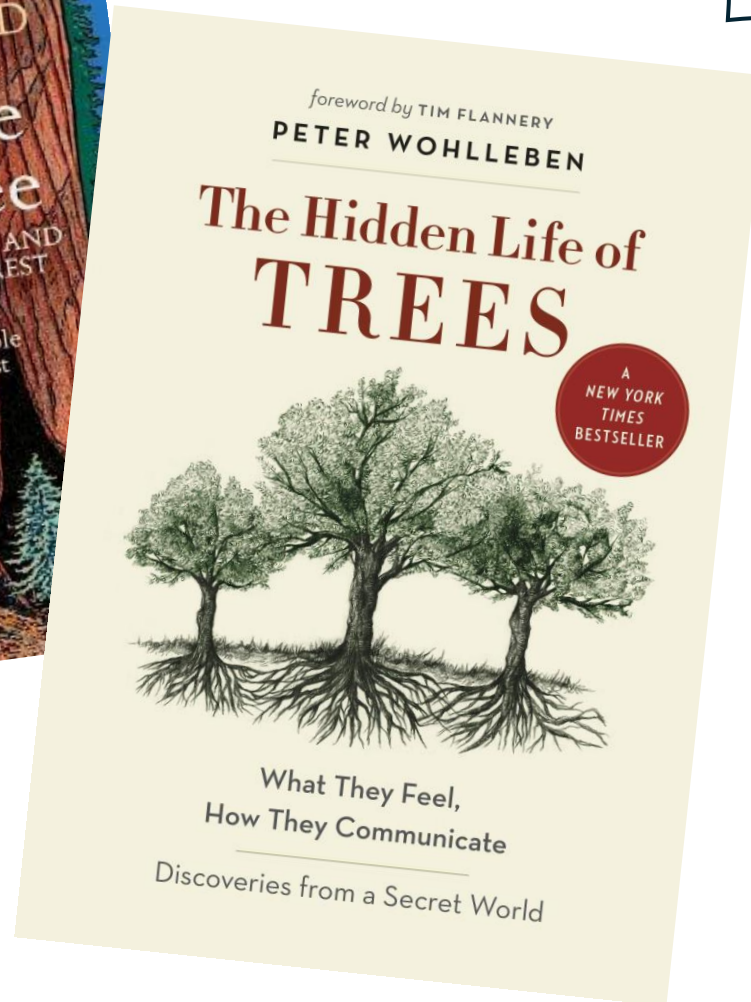
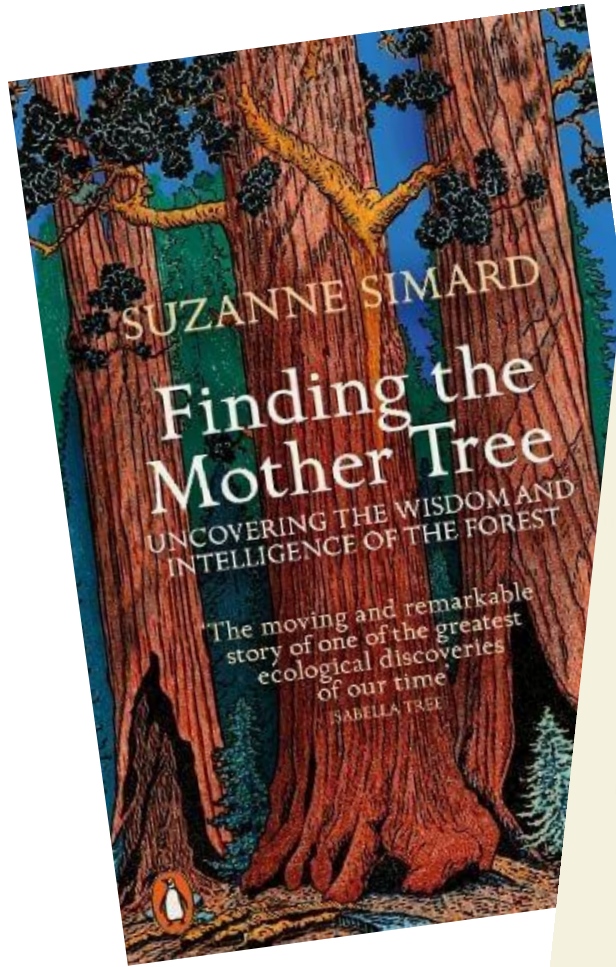
> 80% of plant species have
mycorrhizal associations

[van der Heijden et al. \(2015\)](#)



“...most of the stored carbon in boreal forested
islands in Sweden is in fact derived from mycorrhizal
mycelium rather than from plant litter.” [Clemmensen et al. \(2013\)](#)





THE SECRETS OF THE WOOD WIDE WEB

In London's Epping Forest, a scientist named Merlin eavesdrops on trees' underground conversations.

By Robert Macfarlane

August 7, 2016

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Science & Environment

Wood wide web: Trees' social networks are mapped

15 May 2019

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NEWS | PLANTS & ANIMALS

'Wood wide web'—the underground network of microbes that connects trees—mapped for first time

Global census of forest fungi suggests warming could trigger soil carbon bomb

15 MAY 2019 • BY GABRIEL POPKIN



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Positive citation bias and overinterpreted results lead to misinformation on common mycorrhizal networks in forests

Received: 18 August 2022

Justine Karst ¹✉, Melanie D. Jones ² & Jason D. Hoeksema ³


Accepted: 6 January 2023



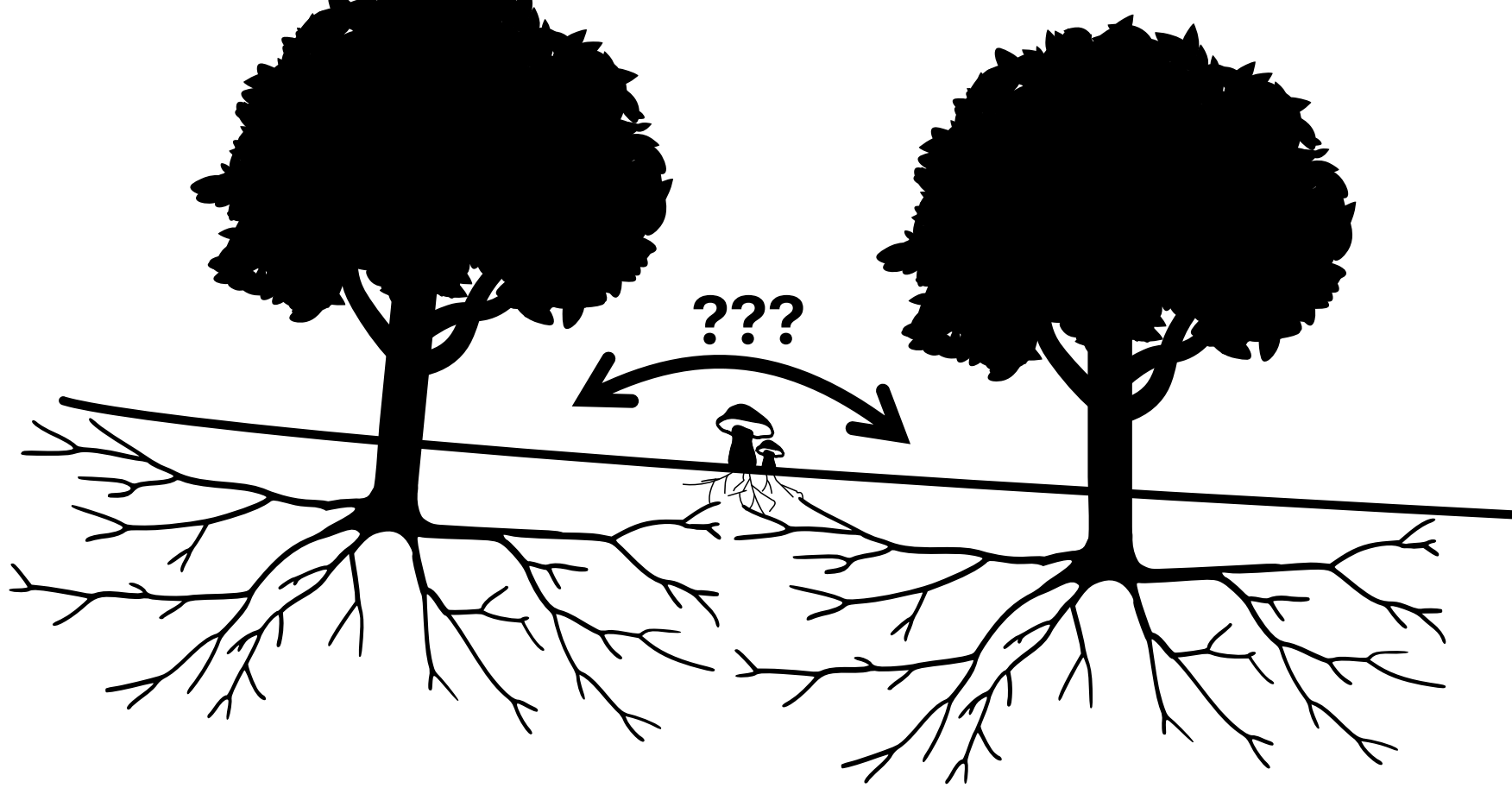
Trends in
Plant Science

Opinion

Mother trees, altruistic fungi, and the perils of plant personification

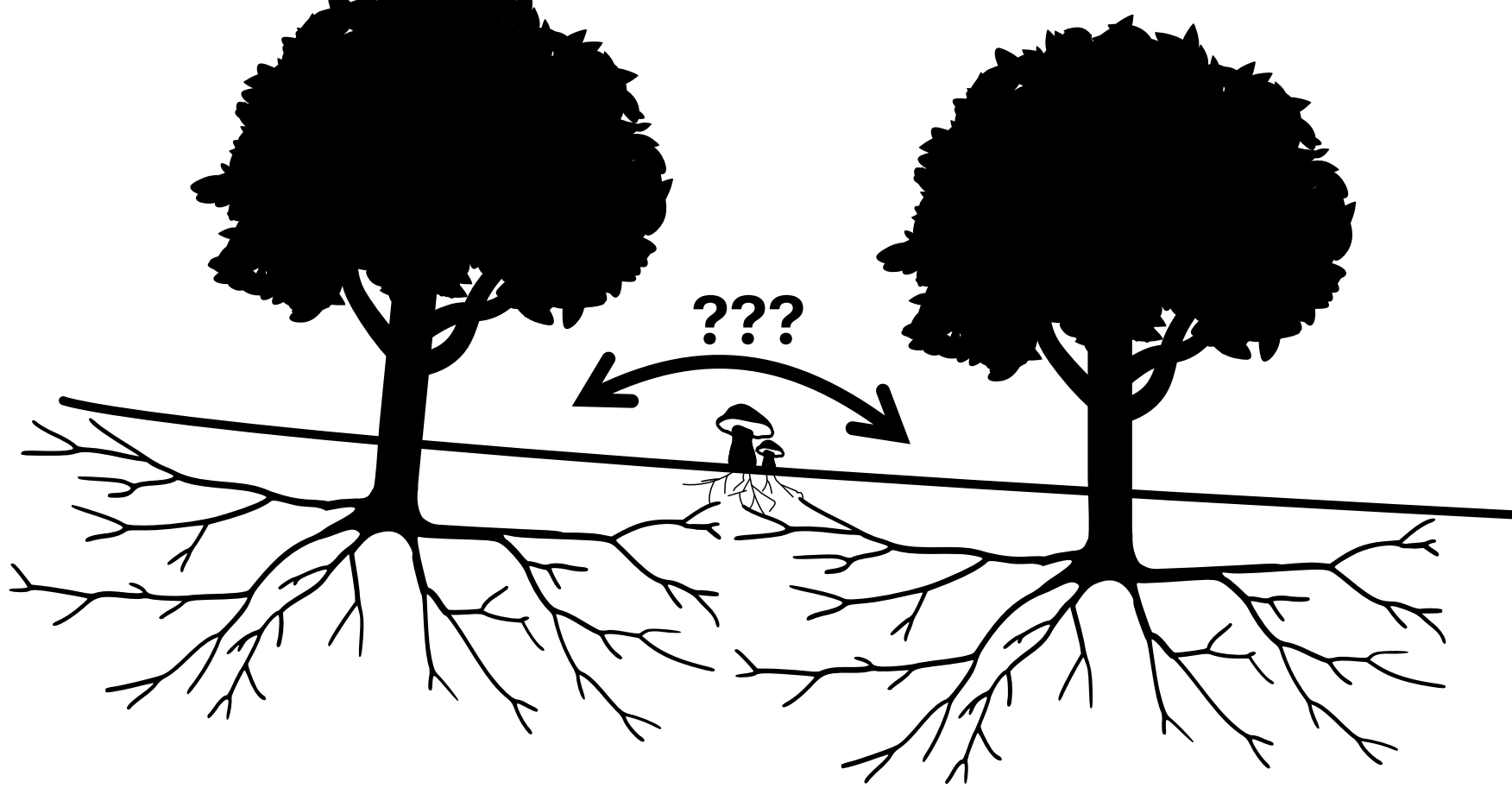
David G. Robinson ^{1,*}, Christian Ammer,² Andrea Polle,³ Jürgen Bauhus,⁴ Roni Aloni,⁵ Peter Annighöfer,⁶ Tobias I. Baskin,⁷ Michael R. Blatt,⁸ Andreas Bolte,⁹ Harald Bugmann,¹⁰ Jerry D. Cohen,¹¹ Peter J. Davies,¹² Andreas Draguhn,¹³ Henrik Hartmann,¹⁴ Hubert Hasenauer,¹⁵ Peter K. Hepler,⁷ Ulrich Kohnle,¹⁶ Friederike Lang,¹⁷ Magnus Löf,¹⁸ Christian Messier,¹⁹ Sergi Munné-Bosch,²⁰ Angus Murphy,²¹ Klaus J. Puettmann,²² Iván Quiroz Marchant,²³ Peter H. Raven,²⁴ David Robinson,²⁵ Dale Sanders,²⁶ Dominik Seidel,²⁷ Claus Schwechheimer,²⁸ Peter Spathelf,²⁹ Martin Steer,³⁰ Lincoln Taiz,³¹ Sven Wagner,³² Nils Henriksson,³³ and Torgny Näsholm³³





“The claim that mature trees preferentially send resources and defence signals to offspring through [mycorrhizal fungi] has no peer-reviewed, published evidence.” [Karst et al. 2023](#)





“[...] transfer from mother trees to seedlings [...] would imply a remarkably collaborative fungal behavior, with questionable adaptive benefits, especially to the fungus.”

[Henriksson et al. 2023](#)





 Quantamagazine

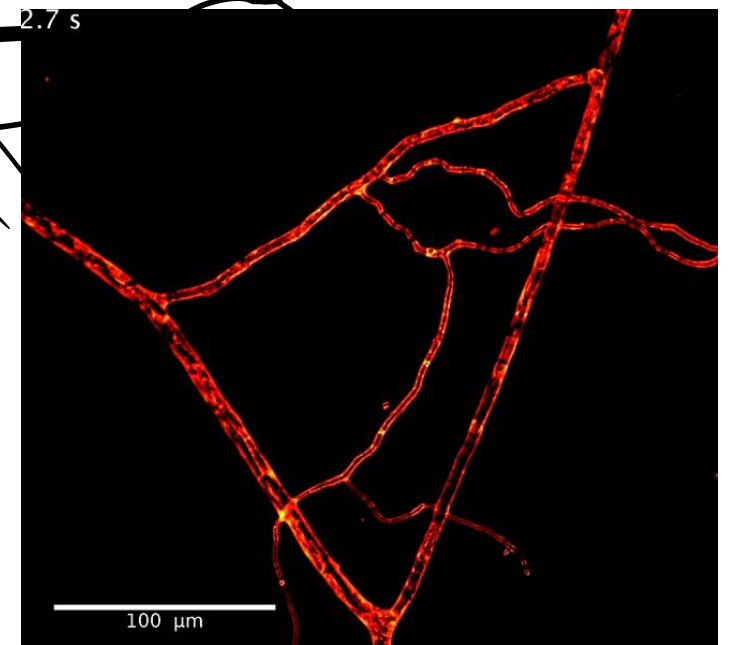
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ECOLOGY

Soil's Microbial Market Shows the Ruthless Side of Forests

 7 | 

In the “underground economy” for soil nutrients, fungi strike hard bargains and punish plants that won’t meet their price.



[Whiteside et al. 2019](#)



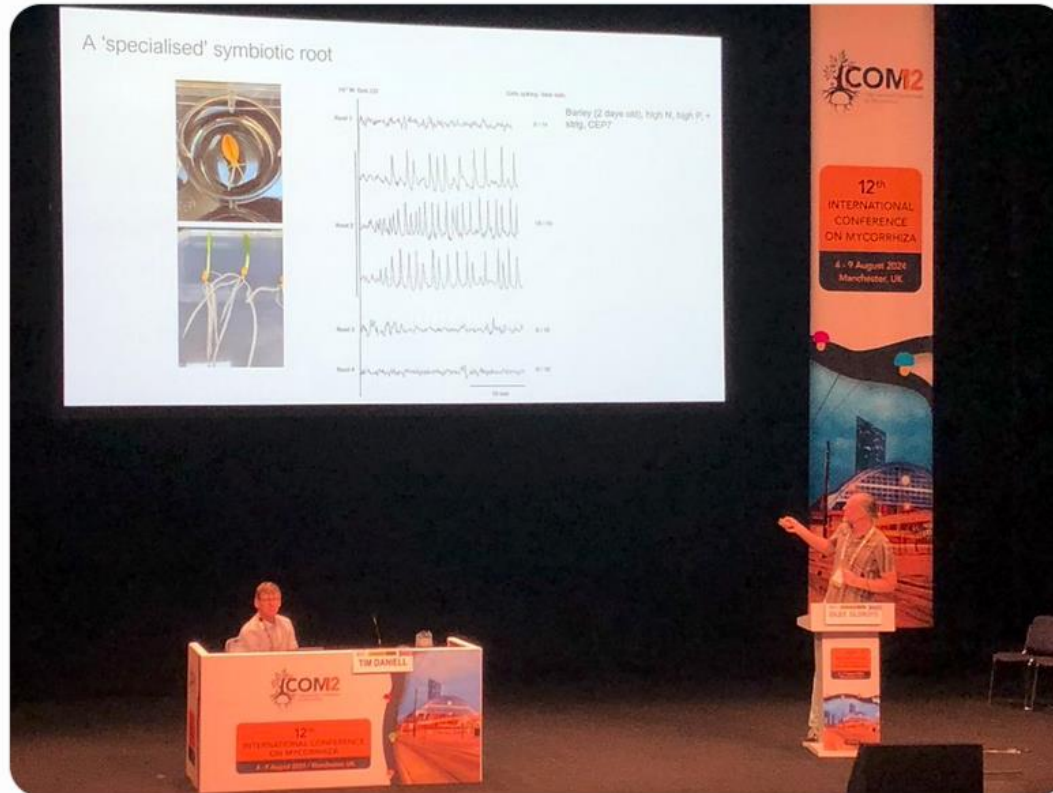
@RowenaCHill



Plant Evolutionary Ecology lab @PlantEcoEvoUT · 2h

...

Wonderful talk by @gilesdoldroyd - plants may do bet hedging with their roots - they might signal readiness to engage in mycorrhizal symbiosis in only one root at a time while keeping others non-symbiotic, just to keep options open! #ICOM12



1

1

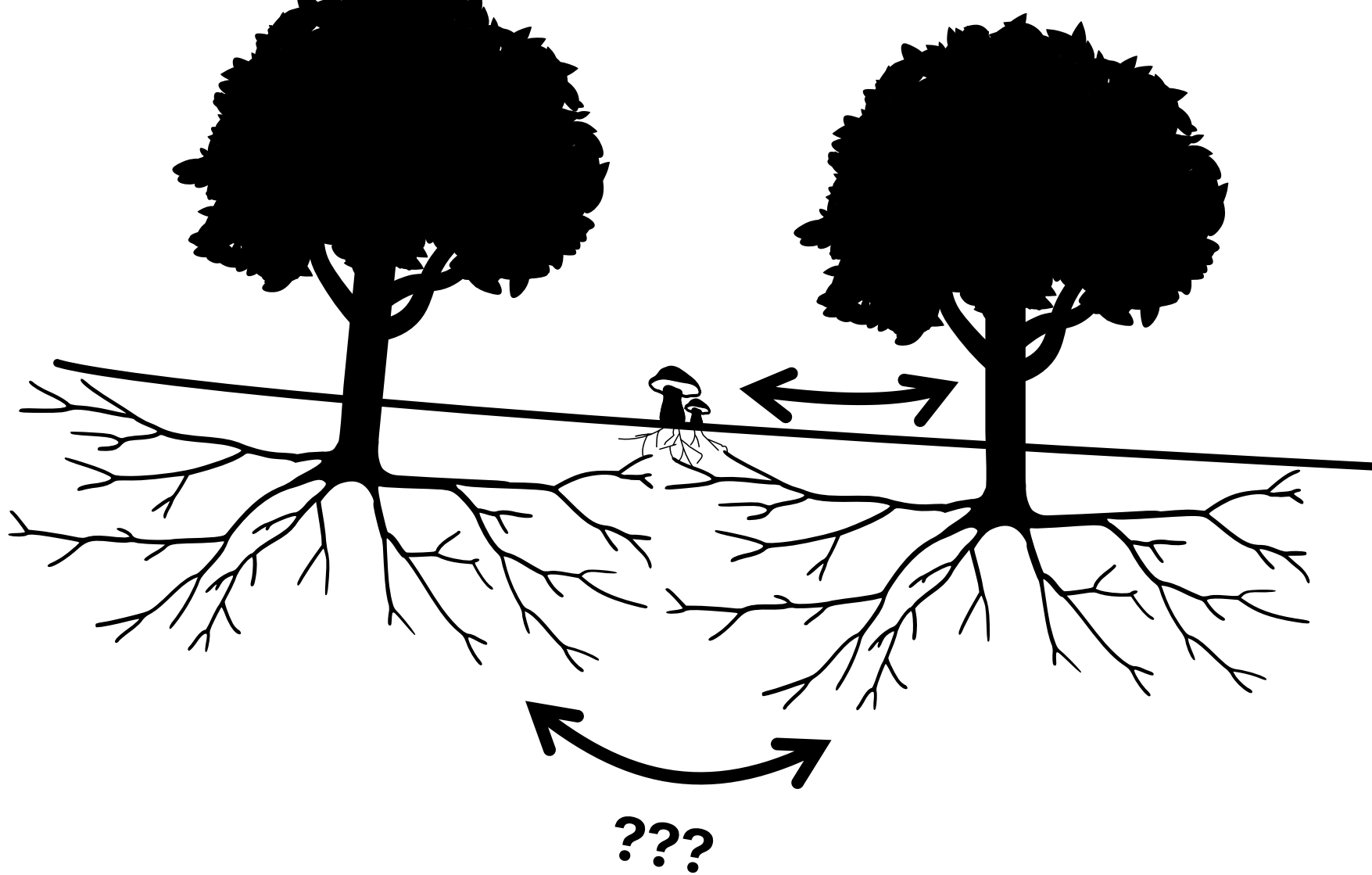
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188

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BOX 3

Future experiments testing the structure and function of CMNs in forests

There remains much potential for field experiments to inform our understanding of the structure and function of CMNs in forests, as many of the potential confounding factors and alternative explanations that we identified can be minimized.

We recommend several potential research directions:

- Map the genotypes of trees and mycorrhizal fungi in a wide range of forests worldwide; include fine-scale temporal and spatial^{31,32} surveys to demonstrate continuous fungal connections associated with more than one tree and understand the permanence of these connections.
- Test the relevance of CMN topology on tree growth¹²⁶ and the resilience of fungal networks³³.
- Design experiments that rank CMN effects on interplant resource transfer and seedling performance against a range of ecological factors^{65,67,68}.
- Focus on ecologically relevant resources when evaluating CMN-mediated resource transfer between plants, such as water and nitrogen⁵⁶.
- Use dye tracers to test for plant-to-plant water flow through root and CMN pathways⁶⁴.
- In experiments using natural barriers to CMN connections:
 - Collect additional data to attempt to quantify the relative strength of the soil versus CMN pathways; for example, the relative densities of arbuscular mycorrhizal and ectomycorrhizal hyphae in soils.
 - Take care to evaluate resource uptake between plants of different mycorrhizal types under similar physiological conditions (for example, similar leaf phenology) to avoid confounding effects on the transpiration stream.
- In experiments using physical barriers to CMN connections:
 - Examine the effects on the composition of the whole fungal community (including pathogens) to generate hypotheses on the roles of different fungal taxa or guilds.
 - Include air-gap treatments to separate the pathway of bulk water flow through soil from CMNs⁶⁴.

- Minimize container effects on both seedling roots and associated mycorrhizal hyphae by using larger containers, or control for these effects experimentally^{72,73}.
- Include a treatment where roots of the experimental plants can grow together, as they would under natural conditions, so that root versus CMN effects can be estimated, with the recognition that root effects may be of primary importance in some cases.
- Include efforts to genotype fungi putatively connecting root systems to provide better evidence that CMNs have formed⁵⁸, or include treatments that would make confirmation of CMN formation easier. For example, if seedlings were planted into sterile soil inside mesh bags with a pore size of 20–250 µm, mycorrhiza formation would occur only if hyphae entered from outside, thereby indicating the formation of a CMN⁶⁰. In two other treatments, inoculation or not of the sterile soil in mesh bags with a pore size of <1 µm with inoculum-containing soil would allow mycorrhiza-mediated effects to be separated from CMN-mediated effects.
- Combine natural with physical barriers to investigate CMNs. For example, use plant species of a different mycorrhizal type^{71,72} or inoculated with host-specific mycorrhizal fungi¹¹⁷ into experiments using physical barriers. This approach would help to quantify soil pathways in resource transfer and account for container effects and shifts in microbial community composition with mesh treatments.
- Use novel approaches to visualizing the movement of elements through CMNs¹²⁷.
Incorporate the myco-perspective into field experiments:
 - Investigate tree-mediated resource transfer between fungi.
 - Investigate CMN effects on fungal performance.
 - Investigate how CMN structure and function may be determined by fungal behaviour in response to variation in the relative nutrient status or traits of alternative tree hosts.
 - Investigate how nutrients absorbed by hyphae from the soil are distributed among plants within the CMN^{116,117}.



Opinion
Trees and forests

The 'wood wide web' theory charmed us all - but now it's the subject of a bitter fight among scientists

Sophie Yeo



Tue 9 Jul 2024 13.00 BST

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The debate about the degree to which forests and fungi communicate raises the painful question of confirmation bias

● Sophie Yeo is editor of Inkap Journal

“The explosion of interest comes not from an unaccountable passion for fungal networks but for what the theory implies: that the natural world is not static and cruel, but rather a living community governed by the same moral principles as our own.”

FIRST IMPRESSIONS MATTER: A MODEL OF CONFIRMATORY BIAS*

MATTHEW RABIN AND JOEL L. SCHRAG

Psychological research indicates that people have a cognitive bias that leads them to misinterpret new information as supporting previously held hypotheses. We show in a simple model that such *confirmatory bias* induces overconfidence: given any probabilistic assessment by an agent that one of two hypotheses is true, the appropriate beliefs would deem it less likely to be true. Indeed, the hypothesis that the agent believes in may be more likely to be *wrong* than right. We also show that the agent may come to believe with near certainty in a false hypothesis despite receiving an infinite amount of information.

The human understanding when it has once adopted an opinion draws all things else to support and agree with it. And though there be a greater number and weight of instances to be found on the other side, yet these it either neglects and despises, or else by some distinction sets aside and rejects, in order that by this great and pernicious predetermination the authority of its former conclusion may remain inviolate.

Francis Bacon¹



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How we discovered a hidden world of fungi inside the world's biggest seed bank

Published: March 22, 2021 10:52am GMT

And maybe most famously there are the symbiotic partners known as mycorrhizal fungi, which form a relationship with plant roots, usually for mutual benefit: they can help the plant take up water and nutrients in return for carbohydrates. These fungi can form vast underground networks of nutrient exchange between plants, popularly known as the “wood wide web”. As if that wasn't enough, mycorrhizal fungi also help to increase the amount of carbon stored in the soil, and so play an important role in regulating global climate.

Author



Rowena Hill

PhD Candidate, Fungi, at Kew Gardens and, Queen Mary University of London



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Why does it matter if it means that people are more invested in nature and fungi and it makes them want to protect forests?

By increasing interest and popularity, there was more funding given and the study area grew. Maybe 'the ends justify the means'.

Facts matter – governments use them (and the attention they attract) to inform policy

JOURNAL ARTICLE EDITOR'S CHOICE

Where Tree Planting and for Biodiversity and Eco

Joseph W. Veldman, Gerhard E. Overbeek
Soizig Le Stradic, G. Wilson Fernandes, G
William J. Bond

BioScience, Volume 65, Issue 10, 01 Octo

doi.org/10.1093/biosci/biv118

Published: 09 September 2015

 GOV.UK

Right tree, right place, right reason

[Mark Broadmeadow](#), 17 July 2020 - [Climate change and resilience](#), [Woodland creation](#)



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What can we learn?

Scientists and science communicators have the responsibility to get important work out there, but also the responsibility to do their best to make sure it's not misconstrued (and try not to get carried away with messaging)

Scientists are human, not perfectly rational beings

Try and be open to changing our minds

The 'wood wide web' is nuanced, but mycorrhizal fungi are still fascinating!



Thanks for listening!

Check out these slides @ <https://github.com/Rowena-h/Presentations>