Soil Redemption Song

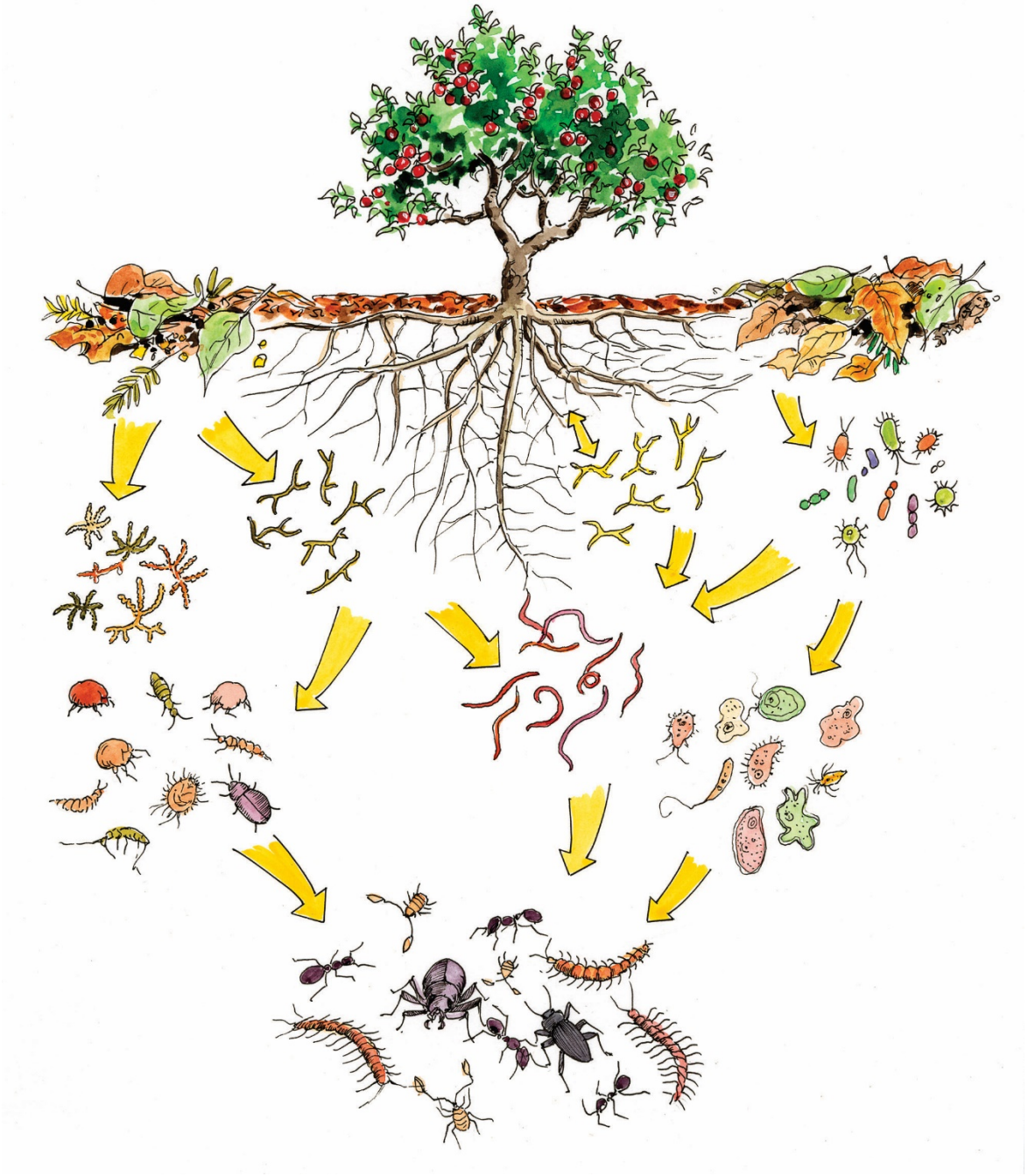
Embracing the Mycelium
to Grow Healthier Crops

Understanding fungal nuance is integral to being a savvy grower.

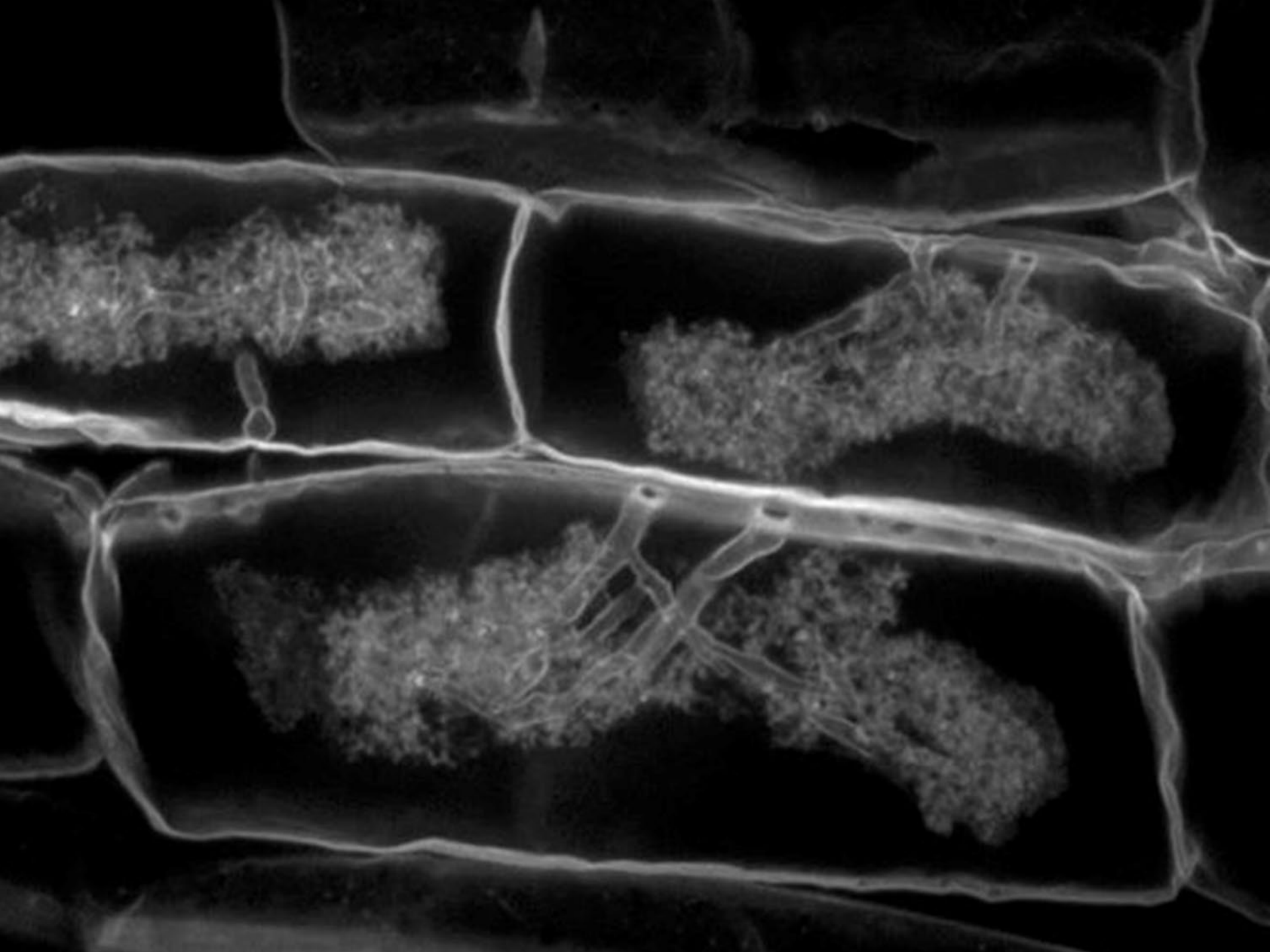
mycorrhiza

We have much to learn from fungus-root symbiosis.

The Soil Food Web



Microbe “feeding frenzy” keeps the immobilization / mineralization balance humming right along.

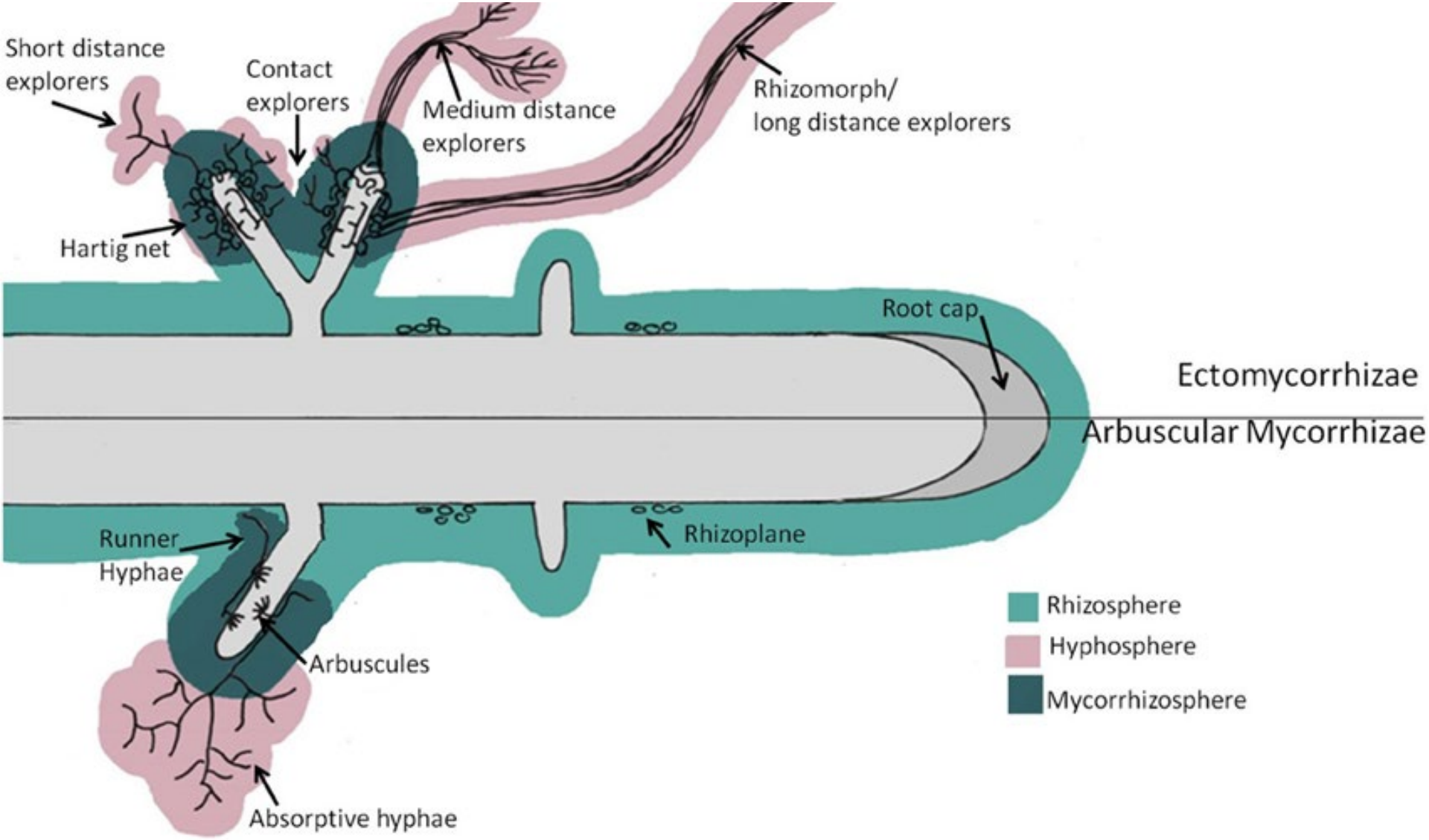


Setting Planetary Norms

A good 95% of plants on this precious earth desire the symbiotic exchange of mycorrhizal fungi.

Mycorrhizal Advantage

- Protects roots from soil borne diseases.
- Increases soil volume reach of roots
- Abets healthy plant metabolism
- Provides messaging capability throughout a plant community
- Induces systemic resistance to disease
- Makes ecosystems resilient
- *Oh yeah. One more little thing.* Fungal/ plant dynamics tuck away soil carbon

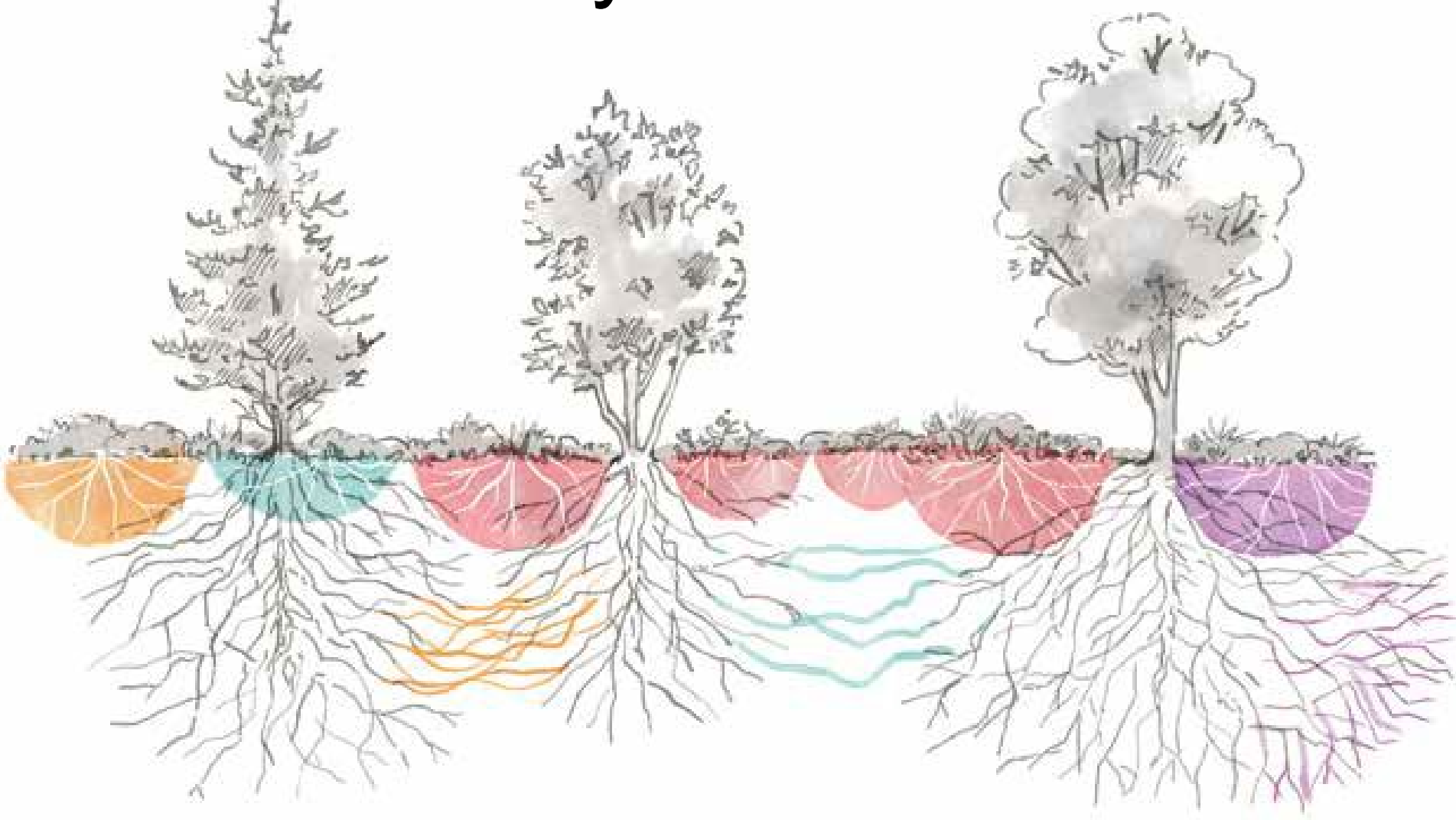

Short distance explorers
Contact explorers
Medium distance explorers
Rhizomorph/ long distance explorers
Hartig net
Root cap
Ectomycorrhizae
Arbuscular Mycorrhizae
Runner Hyphae
Rhizoplane
Arbuscules
Absorptive hyphae
Rhizosphere
Hyphosphere
Mycorrhizosphere

Suppose I were to plant a whole number of herbaceous plants in the soil . . . so that their roots intertwined and merged with one another . . . until it all became a regular mush of roots, merging into one another . . . would not allow itself to remain a mere tangle, it would grow organized into a single entity . . . the saps and fluids would flow into one another . . . a **common root being** would arise for these plants.

—Rudolf Steiner,

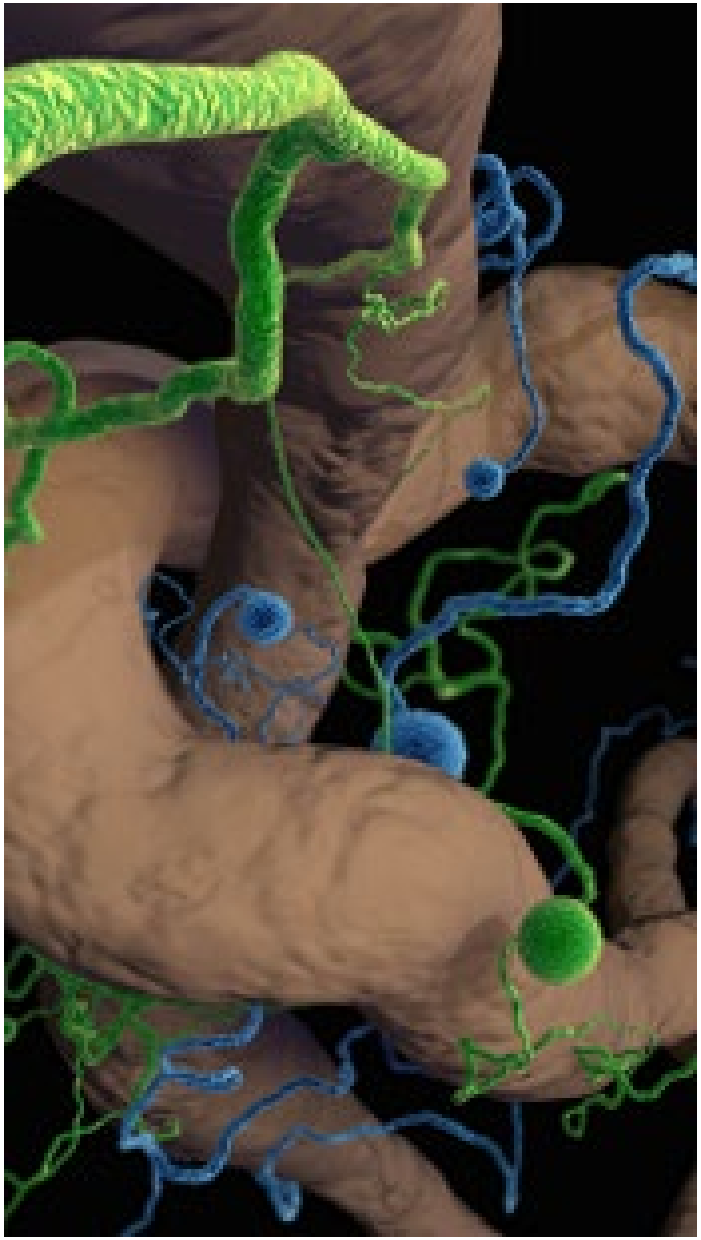
The Agricultural Course 1924

Common Mycorrhizal Network



Bridge Trees

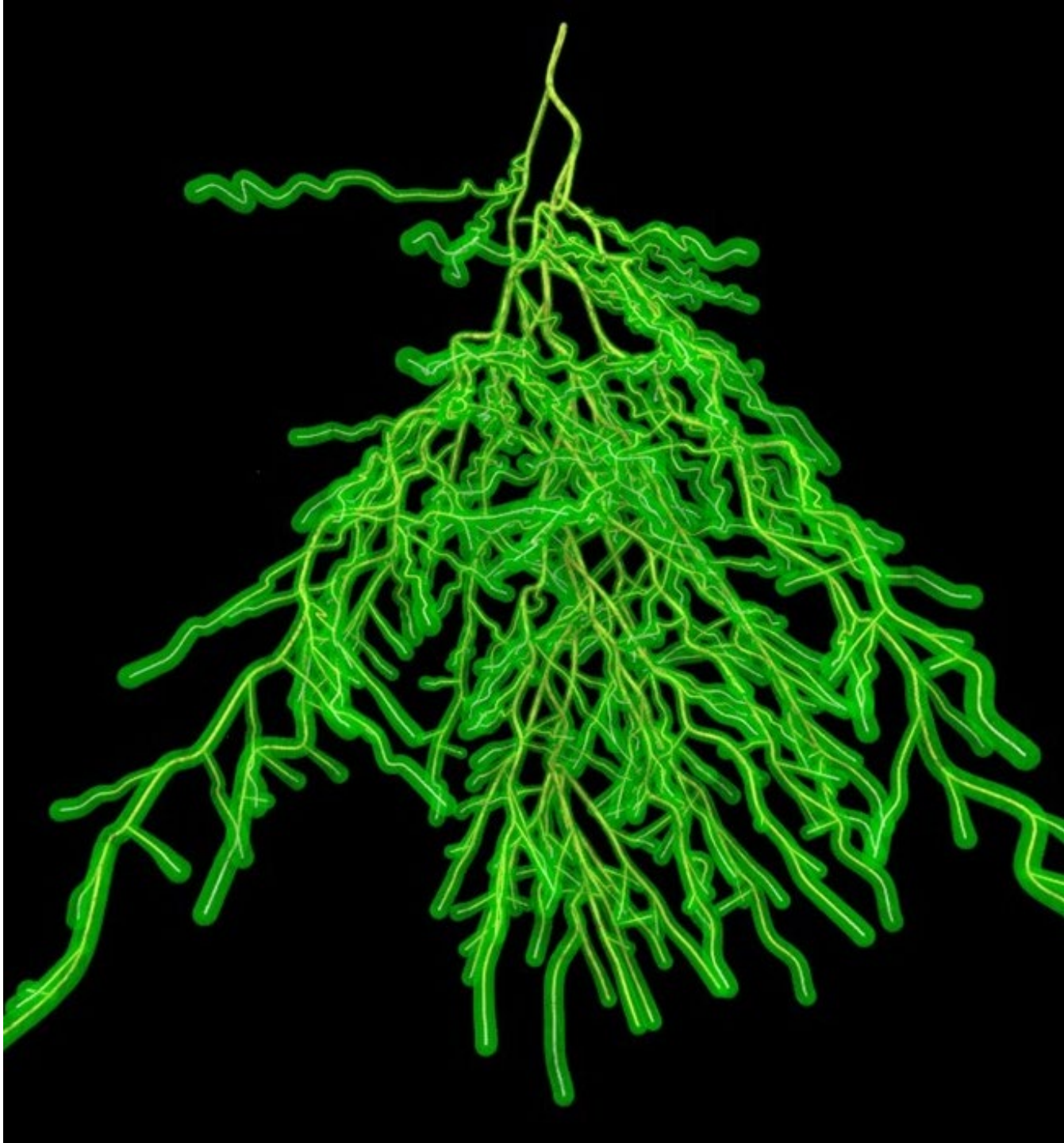
The so-called “soft hardwoods” like willow and alder bring ectomycorrhizal advantage to an otherwise endomycorrhizal orchard ecosystem.

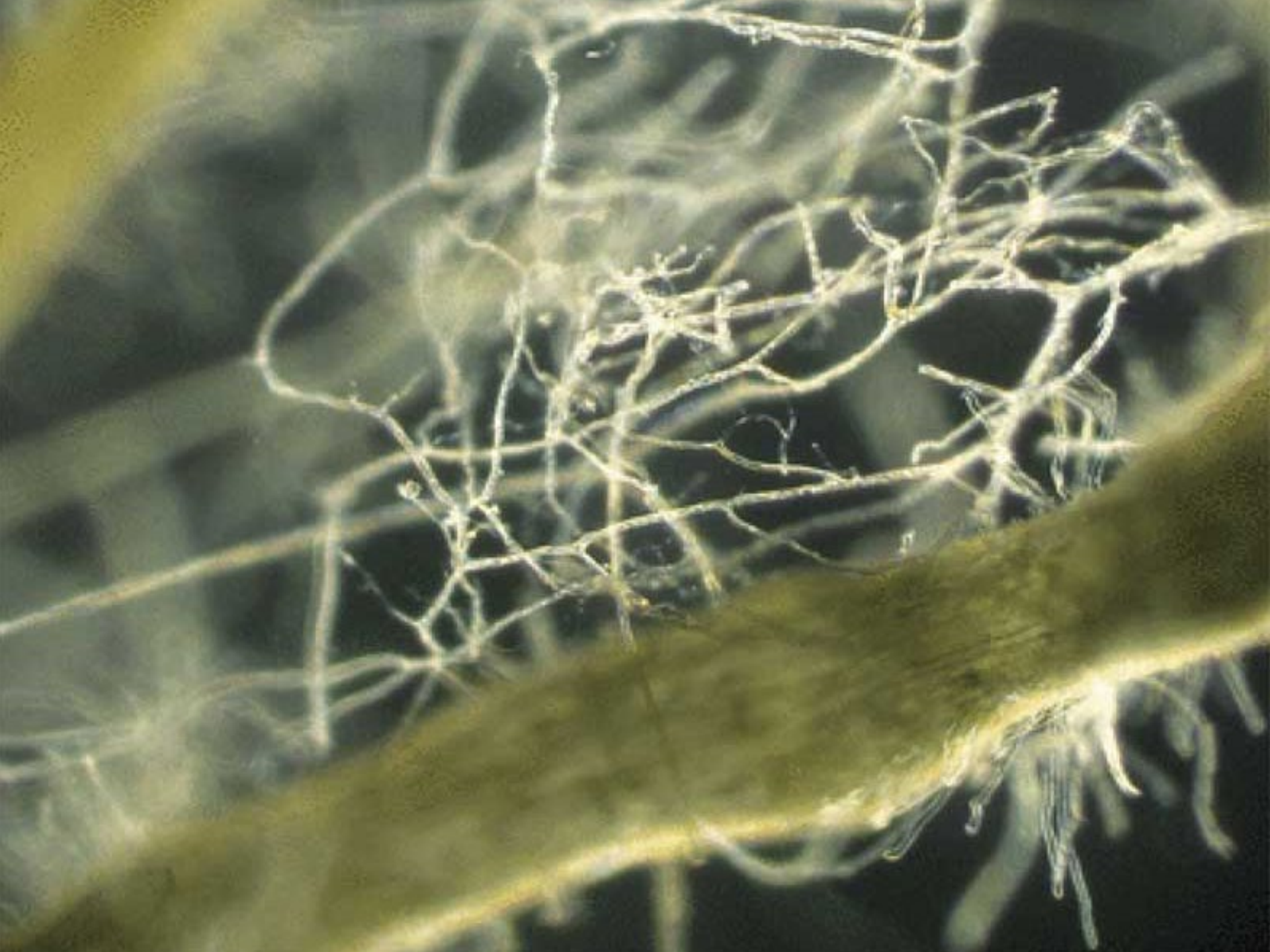


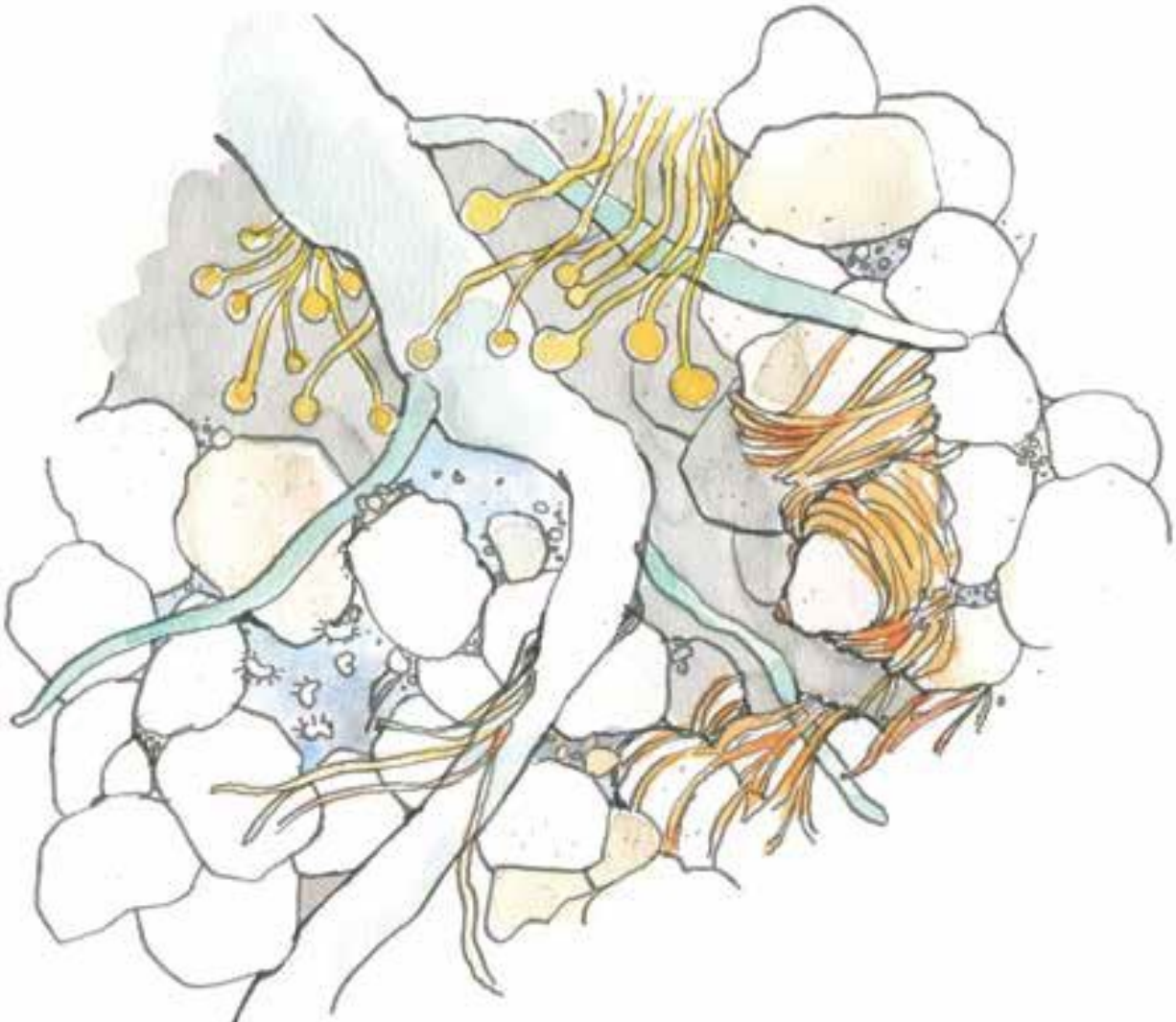
Underground Economy

Researchers grew the legume *Medicago truncatula* with three species of mycorrhizal fungi that contribute different levels of phosphorous to the plant. Over the span of a day, the most generous species received the highest levels of carbon in return, suggesting the plants somehow monitor their nutrient intake and “decide” what’s most needed.

Plants dedicate as much as two-thirds of leaf sugar production to “fair trade” with the biology in the rhizosphere.



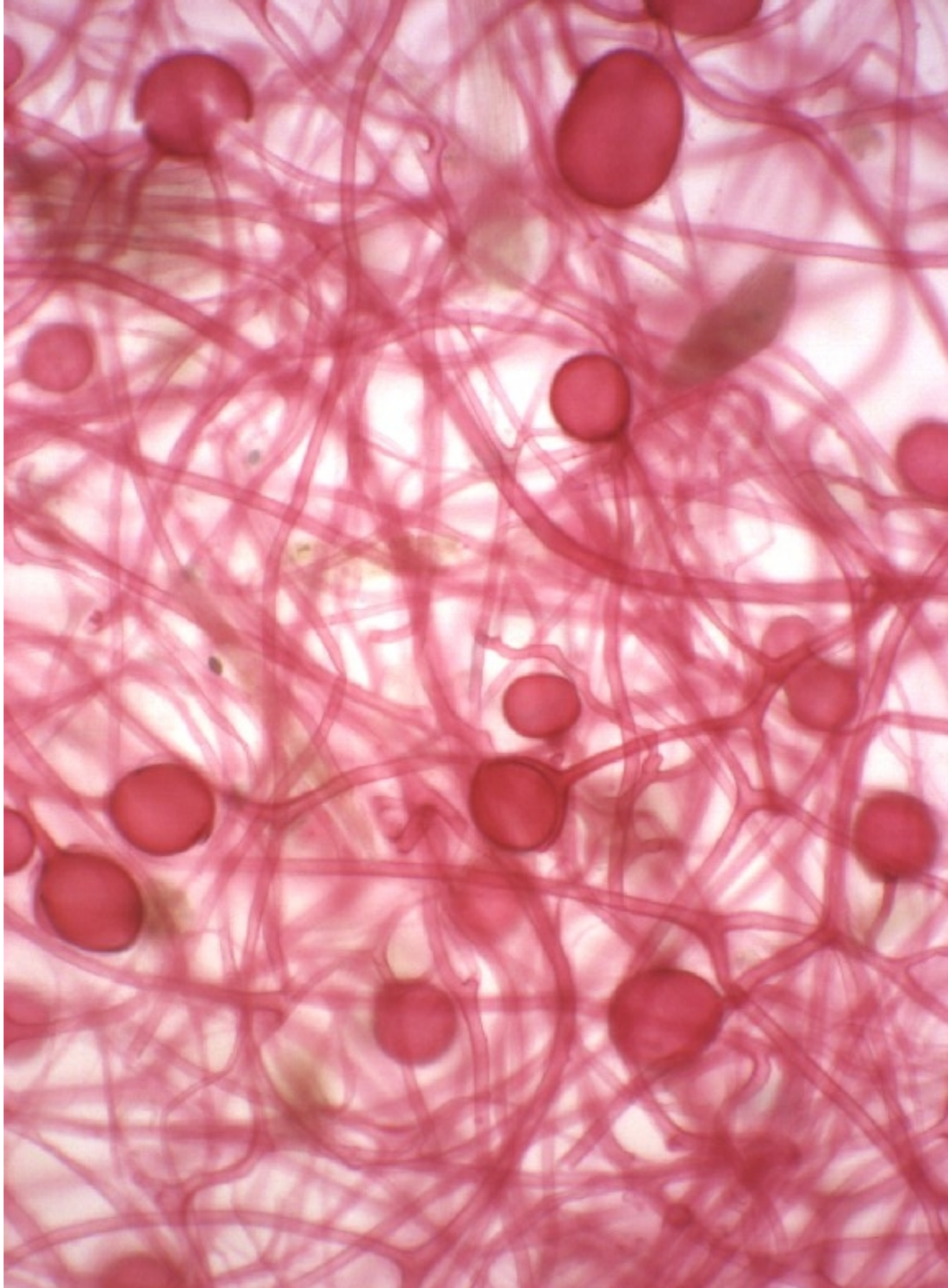




Soil aggregates are the result of good fungal stewardship. Hyphae will abide within, delivering fertility in long-lasting fashion.

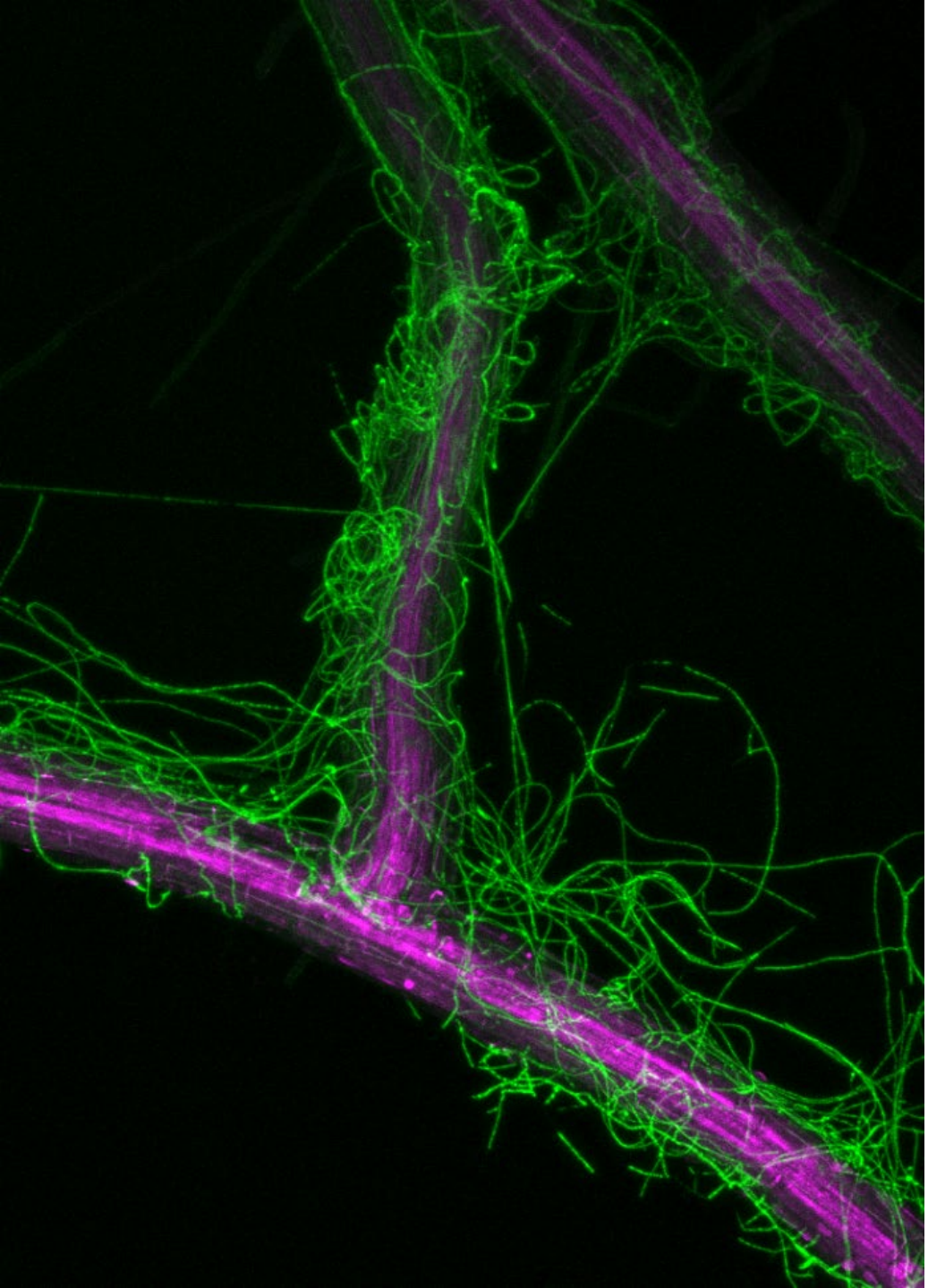
Propagule Nuance

- Mycelial outreach
- Root fragments
- Spores and more spores



Symbiotic Teamwork

Non-disturbed ecosystems typically contain 20 to 50 different species of mycorrhizal fungi



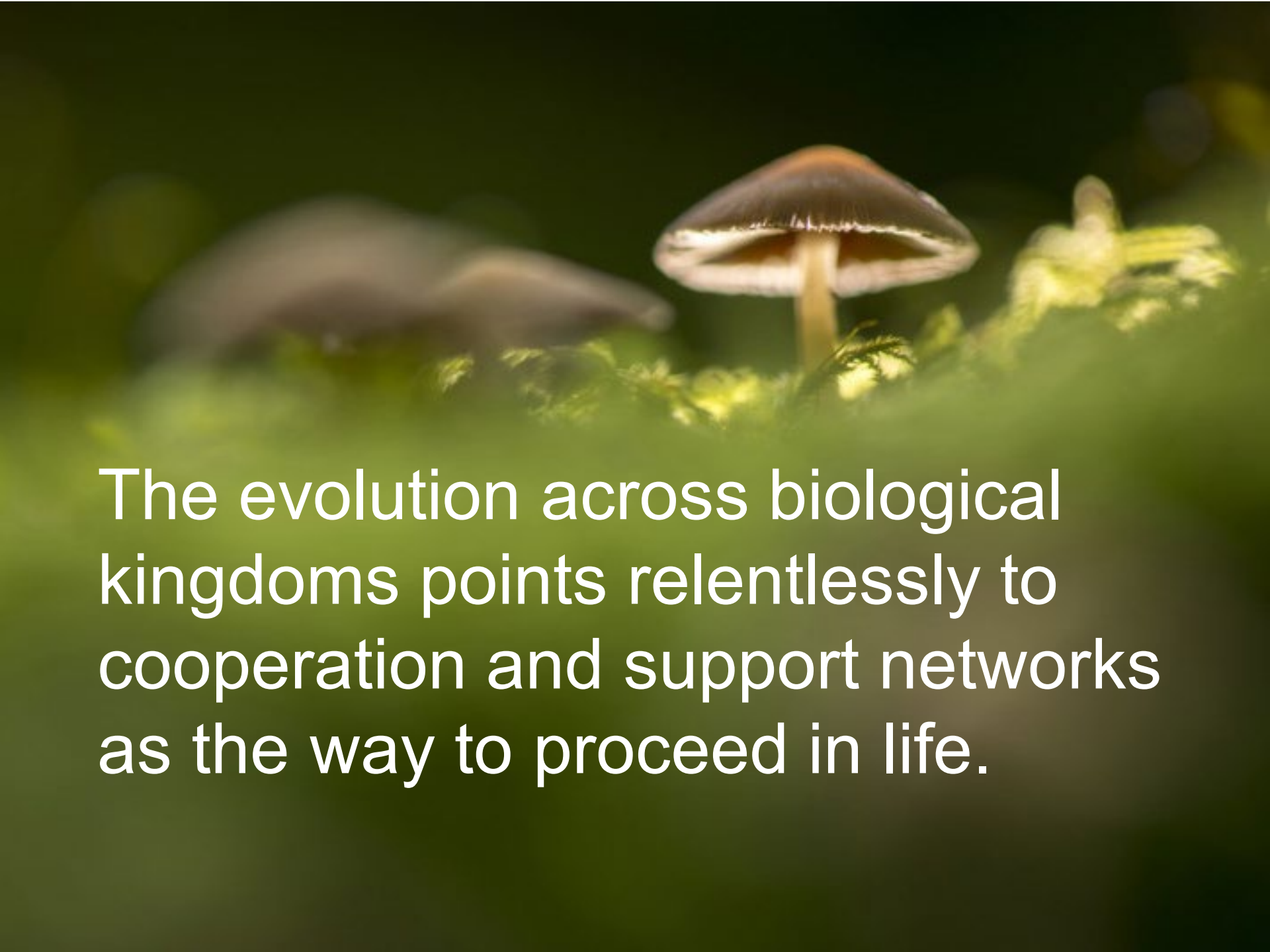
Niche Specialties

Just as we understand diversity aboveground to be profound, greater diversity belowground ties to seasonal rhythms and nutrient ebb and flow.

Drought Relief

Mycorrhizae distribute water throughout a plant community:

- ***Glomus deserticola***
- ***Glomus fasciculatum***
- ***Glomus mosseae***


The evolution across biological kingdoms points relentlessly to cooperation and support networks as the way to proceed in life.

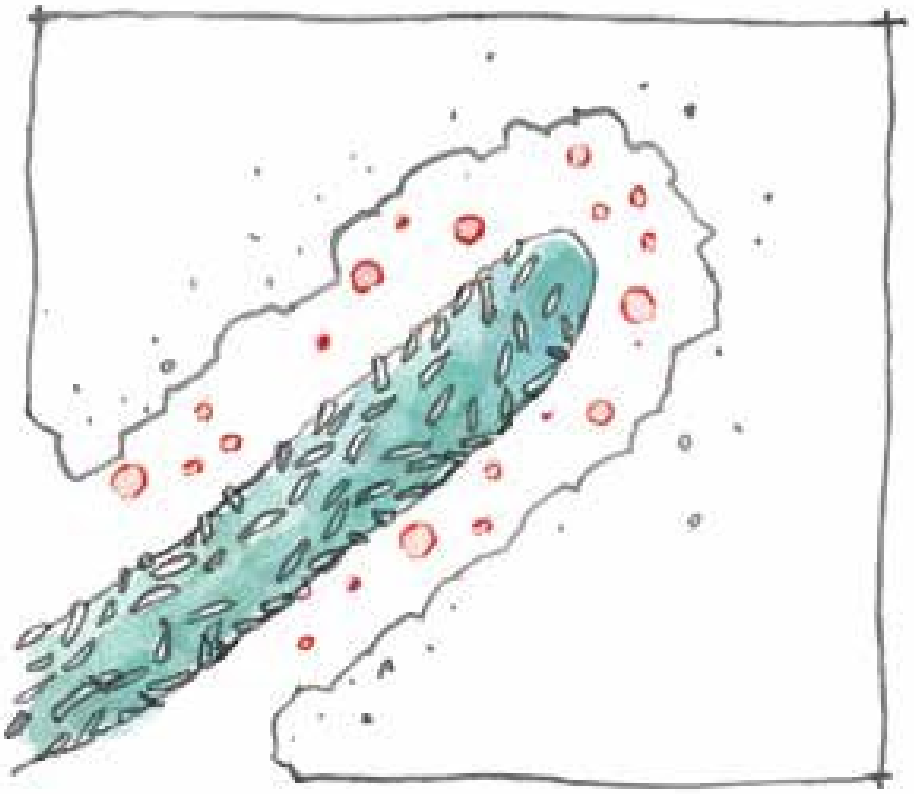
The Making of a Healthy Plant

- Sunshine launches plant metabolism.
- Nitrogen combines with plant sugars to create proteins and fatty lipids.
- Secondary plant metabolites provide “immune function” against disease

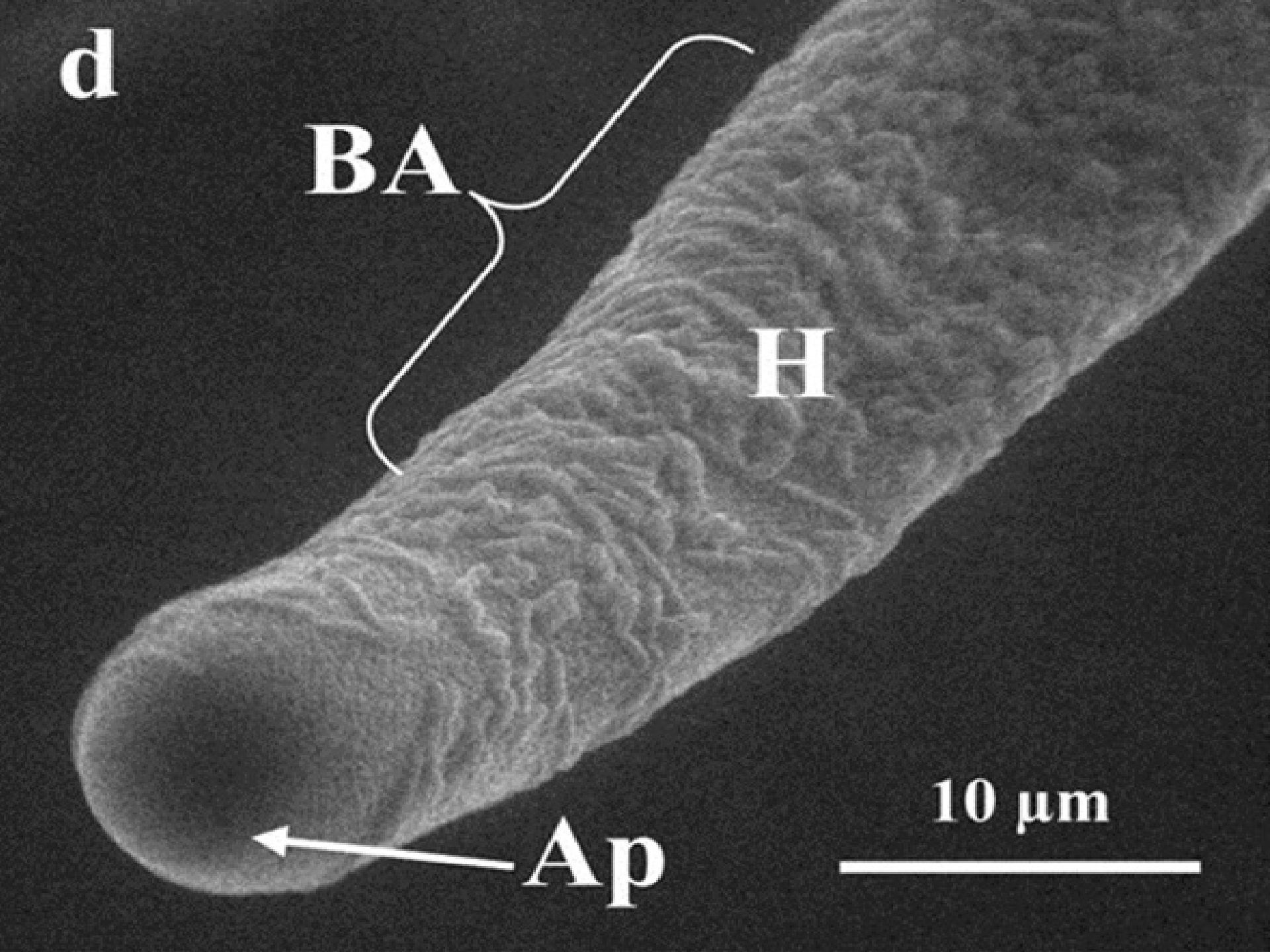
Photosynthesis Efficiency

- Mn, Cl, and B are activators of enzymes.
- Cu, Fe, Zn, and Mo are components of enzymes.
- Micronutrients play a key role in protein synthesis as well.

The Bacterial Bore



Fungal exudates from the hyphal tip feed bacteria cohorts whose metabolites in turn “weather” bedrock to extract minerals at a blistering pace measured in micrometers.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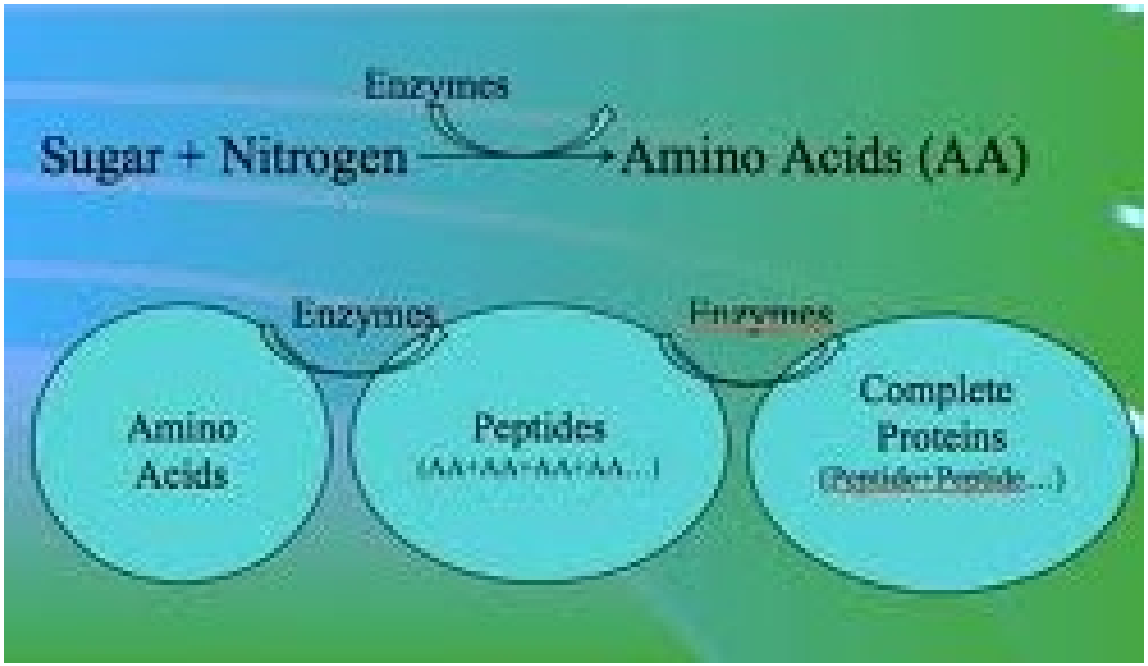
10 µm

Protein Synthesis

Amino acids are the building blocks of proteins.

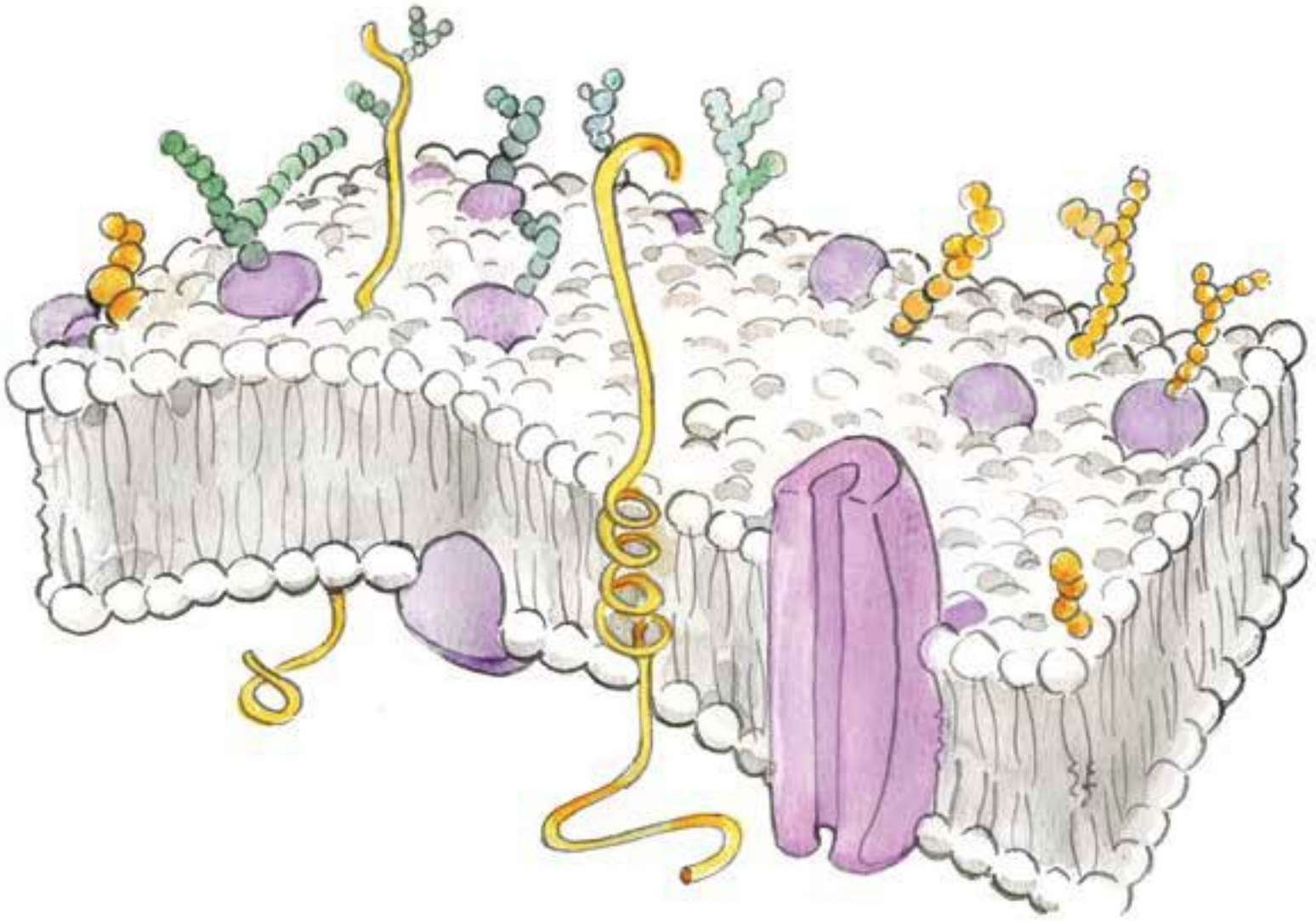
Much hinges on enzymes quickening this process.



Protoplasm Incentive

An excess of soluble amino acids in plant sap (resulting from incomplete protein synthesis) are a prime draw for foliar pests and pathogenic fungi.

Cell Membrane Dynamics



Beneficial patterns show up consistently throughout creation. The vast network of mycelia lying beneath the surface of the soil and indeed the ocean floor could be thought of as the planetary membrane holding life’s sacred trust.

Fat Energy

Fatty acids profoundly stimulate the arboreal and soil biology.

Essential oils act as a foil to insect interest.

Lipid reserves in plants counter *proteolysis* during times of limited photosynthesis.

Resistance Metabolites

Phenolic compounds are the IMMUNE FUNCTION of the tree.

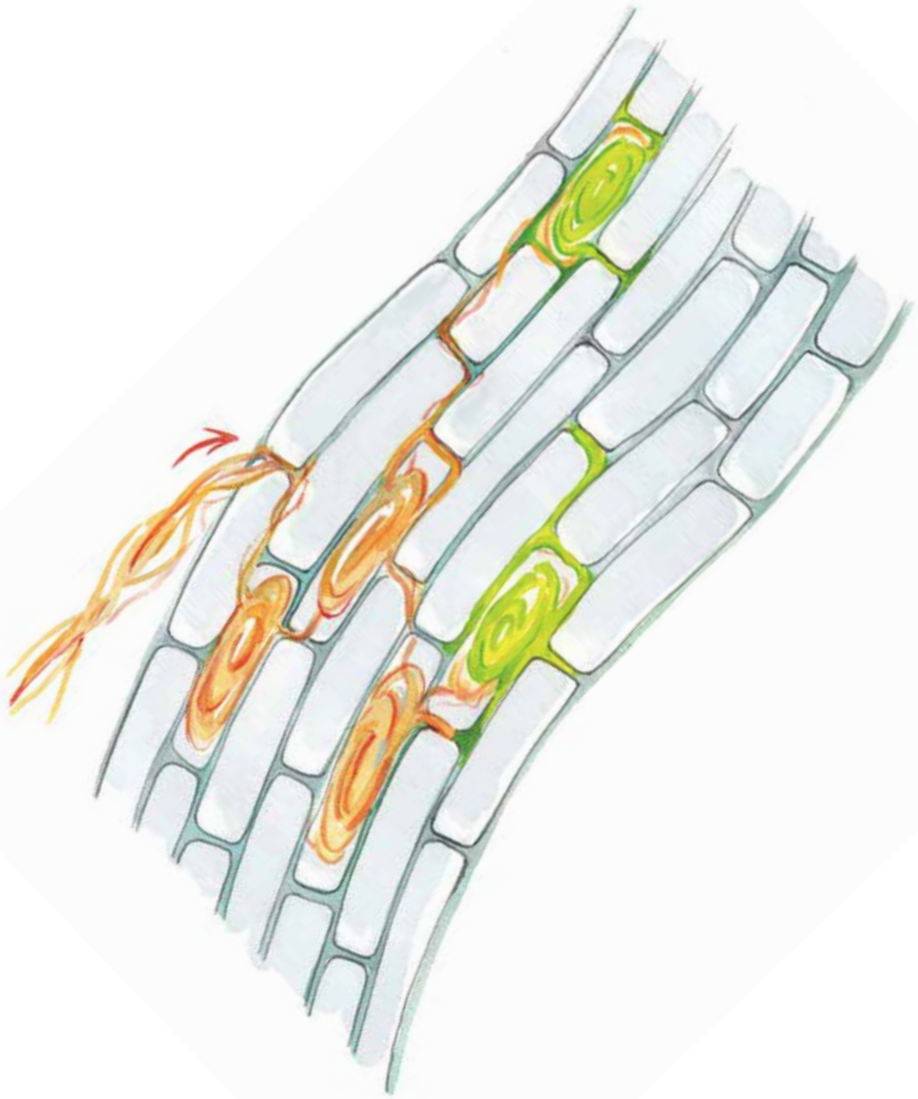
Terpenoid and flavonoid stimulation can be used to further boost core resistance mechanisms.

Bitter-tasting alkaloids thwart higher order insect feeding.

Effective Digestion

Nutrient uptake by feeder roots in a “partially built form” allows the tree to reach this apex of phytochemistry.

This predigestion of nutrients in the rhizosphere is akin to what the rumen does for the cow.



Hyphal Lysis

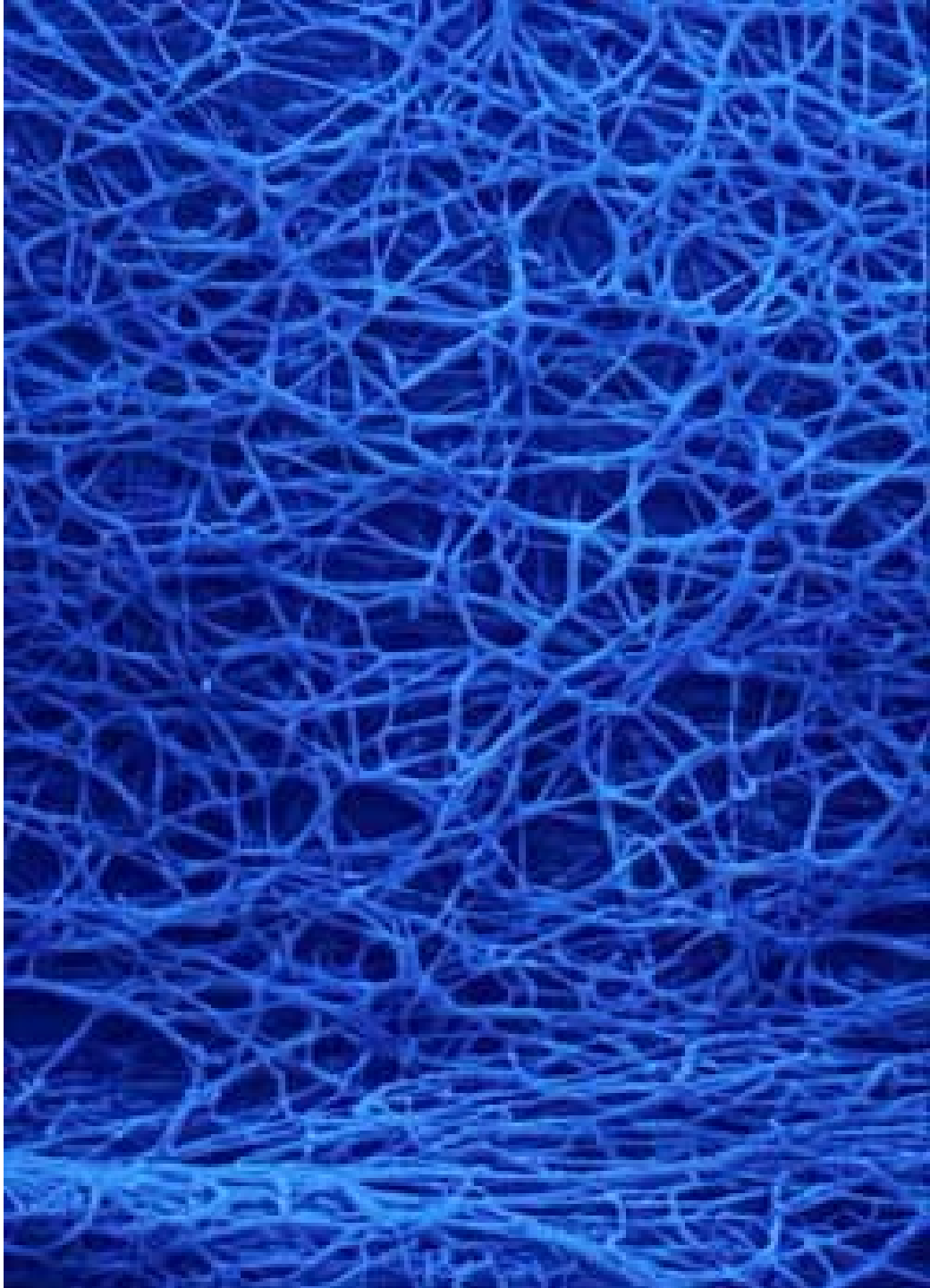
The end result of fungal disintegration within the roots is the release of lipids and complex proteins directly into plant protoplasm.

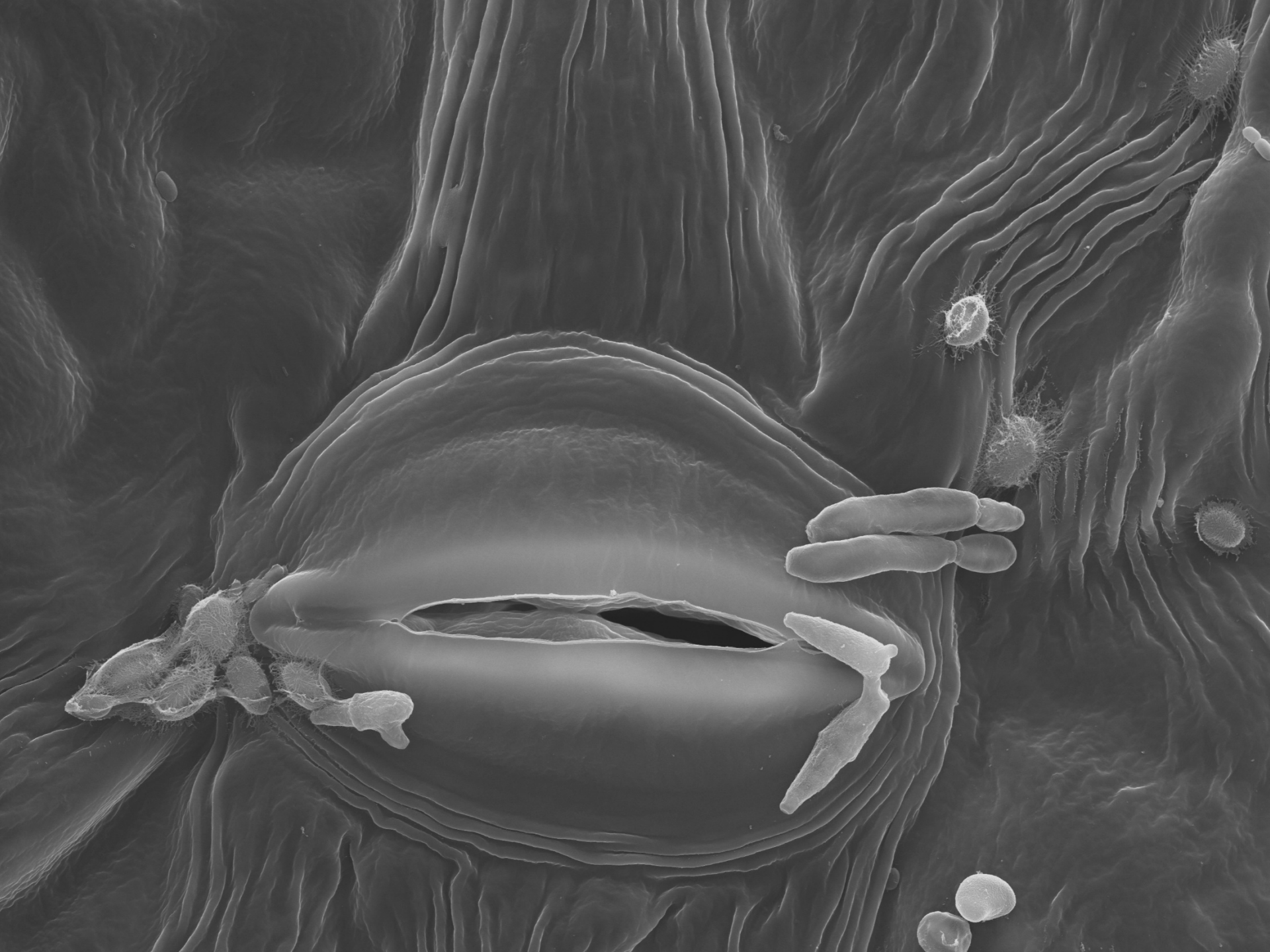
Meaning what exactly?

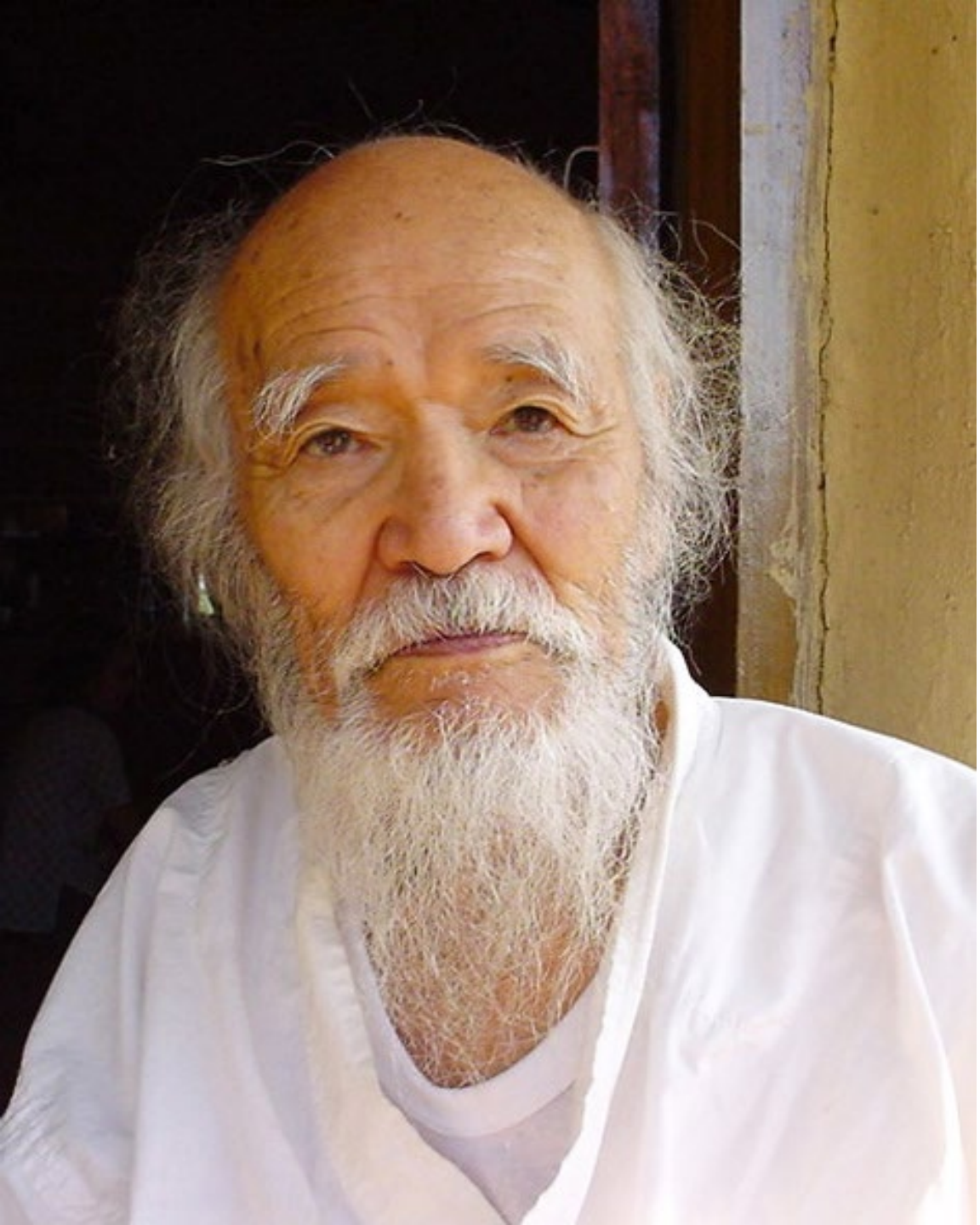
Phantasmagoria!

Fungal Groupings

- Mycorrhizal fungi
- Saprotrophic fungi
- Arboreal fungi (yeasts, shelf mushrooms, endophytic fungi)
- Parasitic and pathogenic fungi

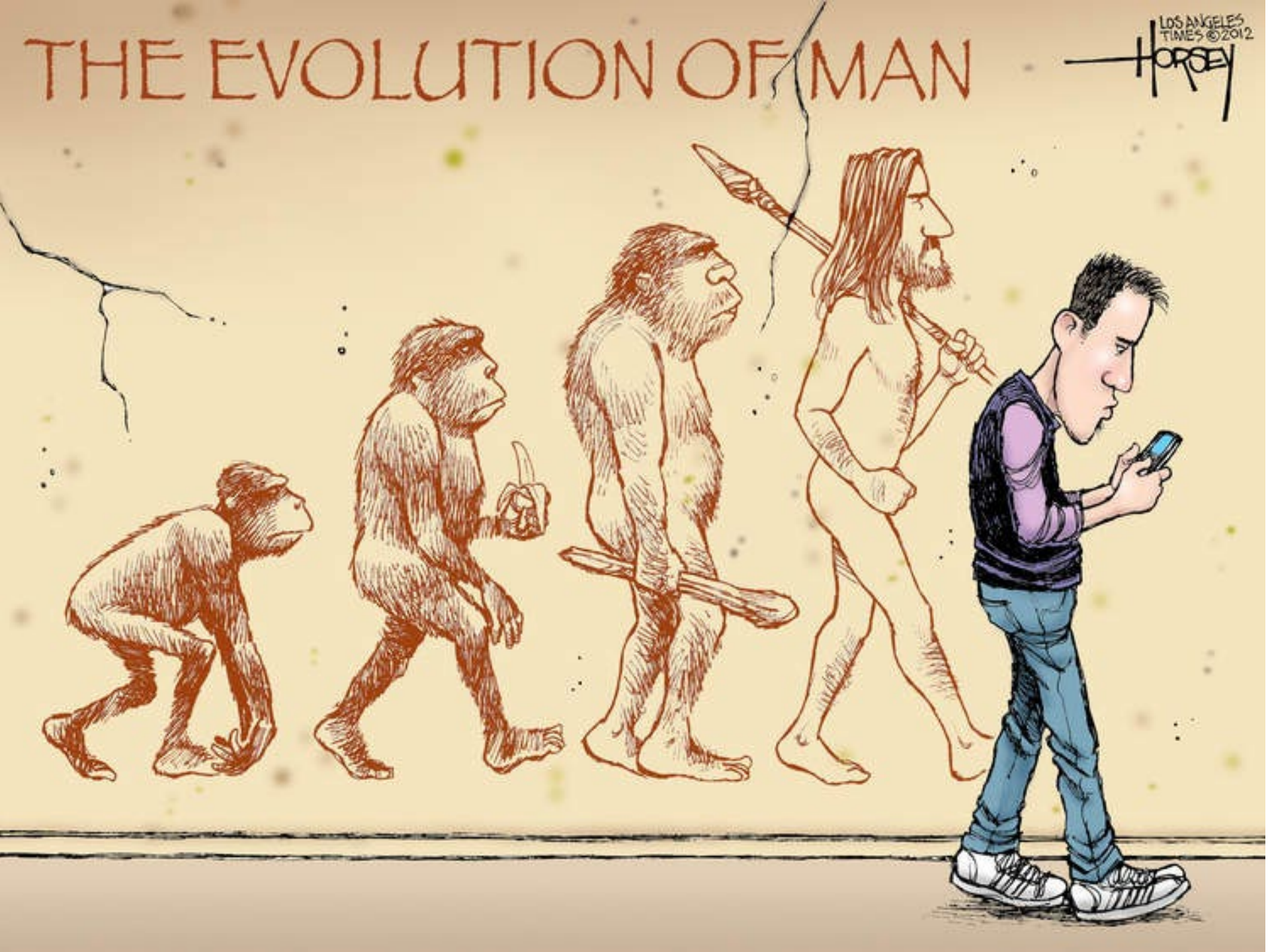






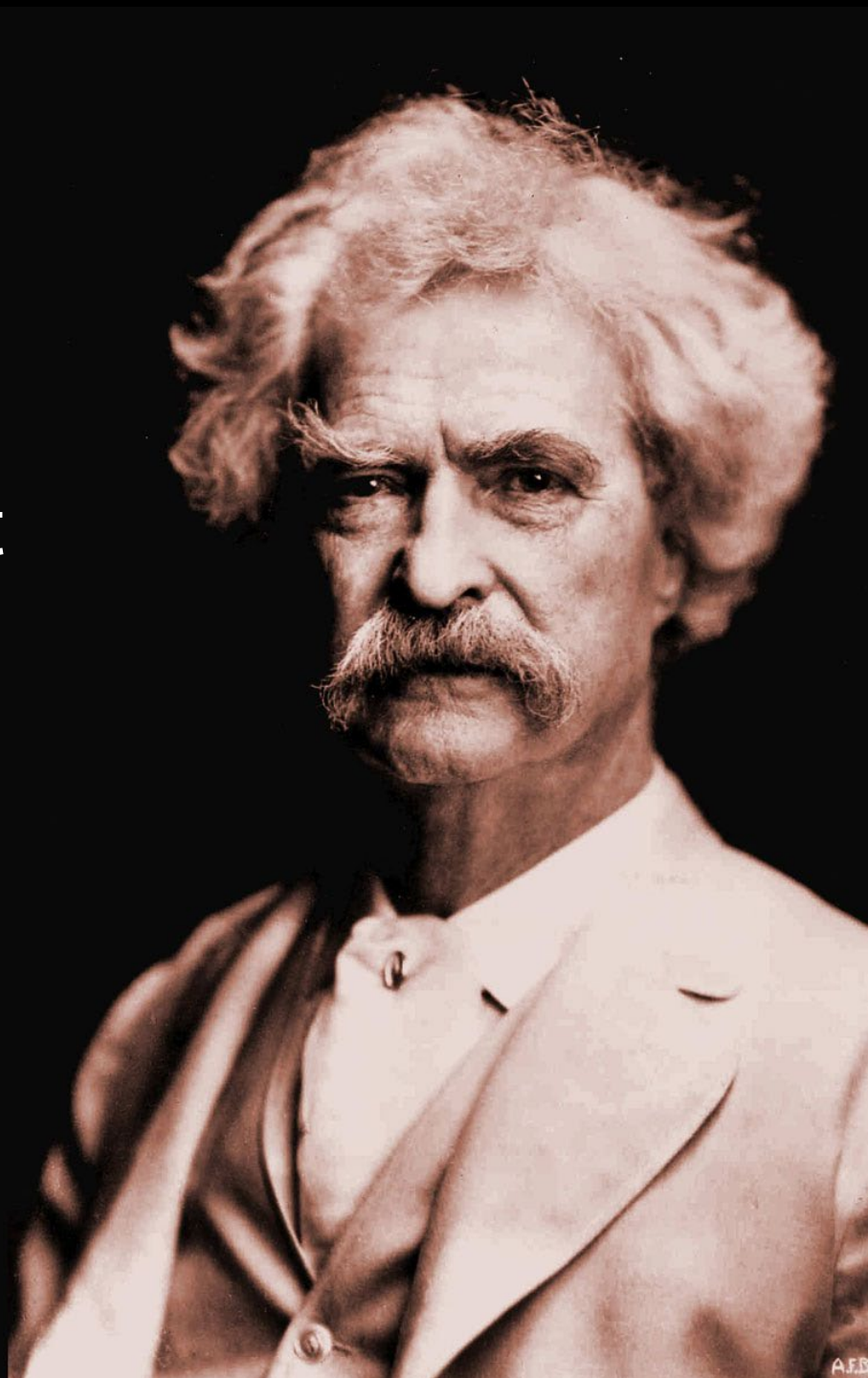
The healing of the land and the purification of the human spirit is the same process.

- Masanobu Fukuoka


THE EVOLUTION OF MAN
LOS ANGELES TIMES ©2012
HORSEY

If voting made any difference, they wouldn't let us do it.

— Mark Twain

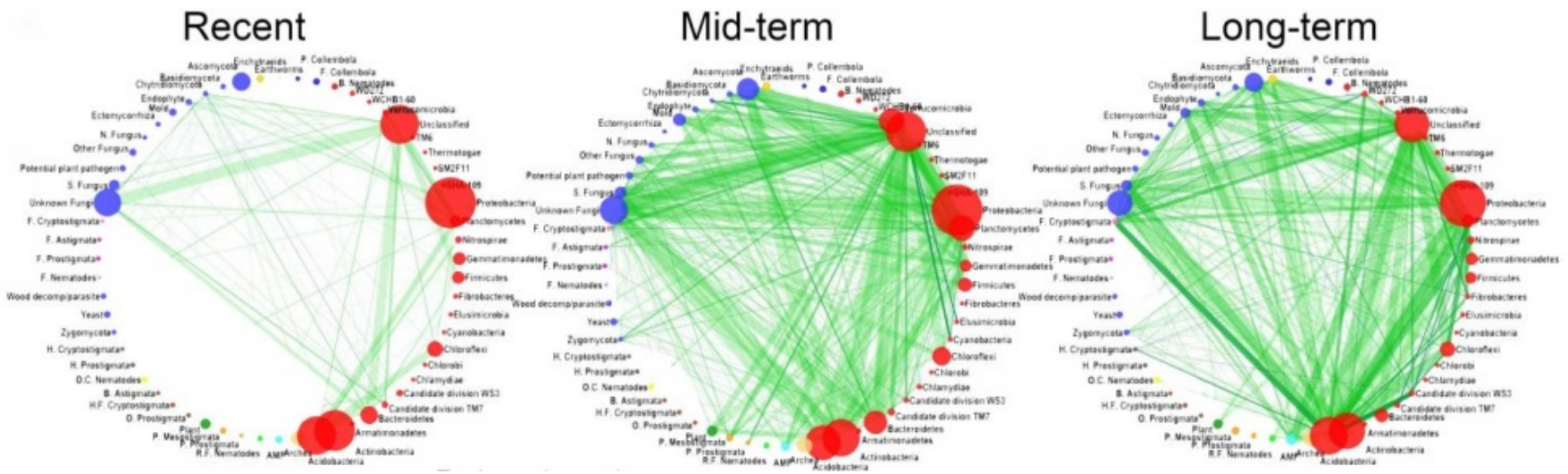


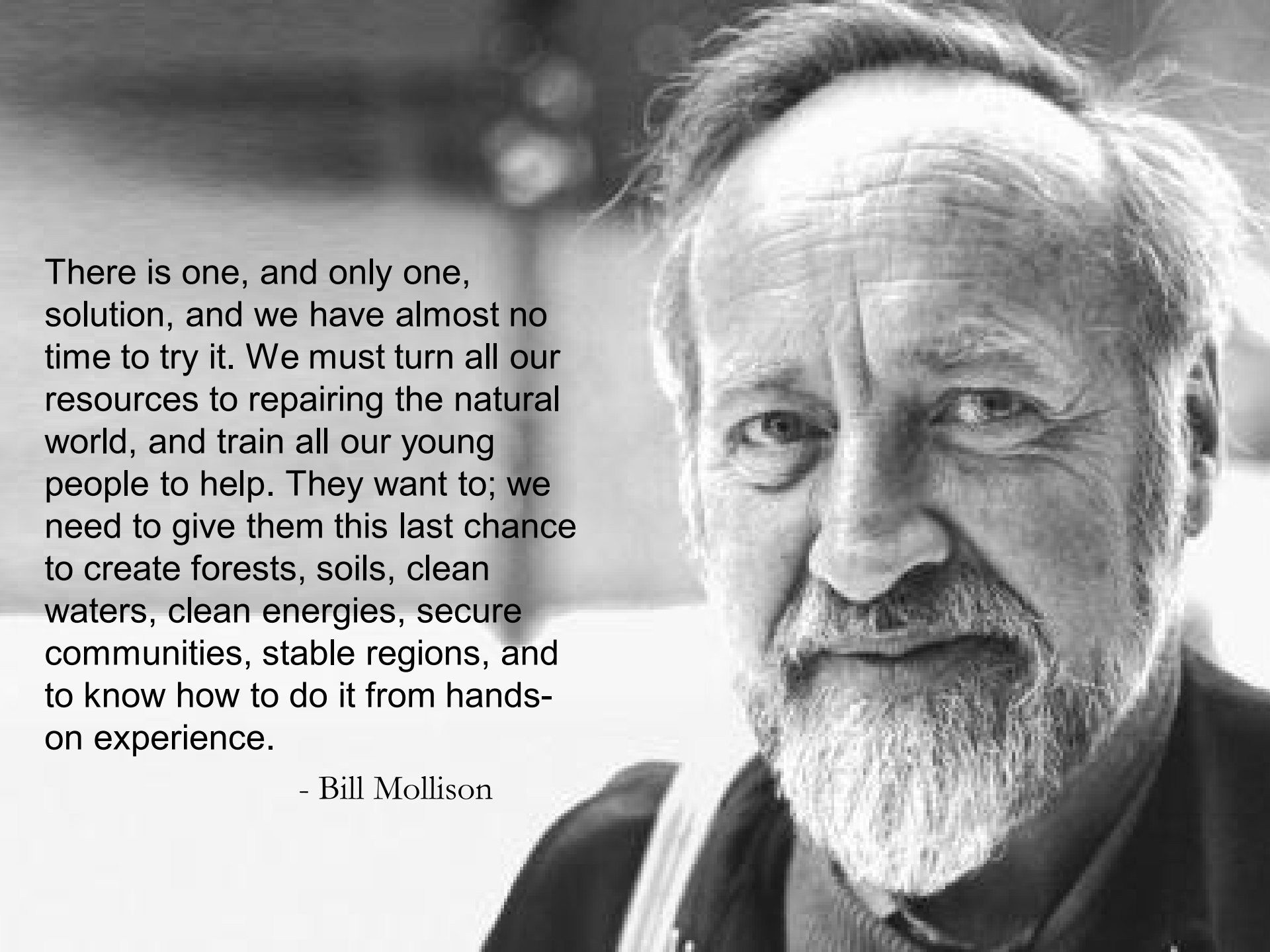

Woohoo, it's Friday!
Oh wait, I'm a farmer.

Nondisturbance Principle

- Begin with Gratefulness
- Don’t Screw Up
- Do Fungal Things
- Honor the Earth

Biological Transition




There is one, and only one, solution, and we have almost no time to try it. We must turn all our resources to repairing the natural world, and train all our young people to help. They want to; we need to give them this last chance to create forests, soils, clean waters, clean energies, secure communities, stable regions, and to know how to do it from hands-on experience.
- Bill Mollison

Fungal Carryover

- Cover crop riffs
- Diversity superstars
- Inoculate following a nonmycorrhizal phase
- Root fragments remain when practicing surface decomposition

Inoculate Seeds, Roots, Bulbs!

Mycorrhizal connection needs to be restored in disturbed soils.

The concept of “bacterial gardening” overlooks critical plant wisdom.

Gaia's Secret

The mycorrhizal engine runs on photosynthesis.

FUNGUS-ROOT: never ever lose sight of the fact that this is a symbiotic partnership of species.

It takes two to tango!

Keep ground in cover throughout the bulk of the year, across the seasons, active green pumping carbon down into holy earth.

Going Fungal at Farm Scale

Soil aggregate formation lies at the heart of fungal-friendly farming. Honoring this mycorrhizal pledge determines the wiser choices to be made at every turn.

Cover Crop Cocktails

Seed mixes of a dozen or more cover species ensures fungal diversity and carryover.

Plant Quorum Sensing

- Different plants have different affinities for selected beneficial soil microbial communities.
- The wider you are able to establish these microbial communities the better the “production system” will work.


when
diversity
truly
resonates ...

Those who contemplate the beauty of the earth find reserves of strength that will endure as long as life lasts.

— Rachel Carson

The fungus-root stands revealed. Now it is up to each of us to care about mycorrhizae in the ecosystems we call home.