

# Complex life may only exist because of millions of years of groundwork by ancient fungi

May 23 2019, by Katie Field

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Credit: AI-generated image ([disclaimer](#))

Because of their delicate organic and decomposing nature, fossilized fungi are extremely rare. So rare, in fact, that a [new discovery](#) has just pushed back the earliest evidence of fungi by at least 500m years—doubling their age.

Until now, the oldest [confirmed fungal fossils](#) dated to around 450m years ago—about the same time that [plants](#) migrated from sea to land. One of the most famous fossilized fungi from this period is the *[Prototaxites](#)*, which could grow up to eight meters tall—leading to its misidentification for many years as a [tree](#).

But previous examination of the fungal "[molecular clock](#)", using DNA-based methods, [suggested](#) that fungi may have evolved much earlier, between 760m and 1.06 billion years ago. Extracted from Arctic Canadian shales, the [newly discovered](#) billion-year-old fossilised [fungal spores](#) and hyphae (long thin tubes) plug the gap in the [fossil record](#) and suggest that fungi may have occupied land well before plants.

The fungal fossils were found in rocks that were probably once part a shallow-water estuary. Such environments are typically [great for fungi](#) thanks to nutrient-rich waters and the build up of washed-up [organic matter](#) to feed on. The high salinity, high mineral and low oxygen content of these ancient coastal habitats also provided great conditions to perfectly preserve the tough [chitin](#) molecules embedded within fungal [cell walls](#) that otherwise would have decomposed.



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While it's not certain whether the [newly-discovered](#) ancient fungi actually lived within the estuary or were washed into the sediments from the land, they show many of the distinctive features you'd expect in modern terrestrial fungi. The germinating spores are clearly defined, as are the branching, thread-like tubes that help fungi explore their environment, named *hyphae*. Even the cell walls are distinctively fungal, being made up of two clear layers. In fact, if you didn't know they were so old, you'd be hard-pressed to distinguish them from modern fungi.

## Fungal forefathers

As you might imagine from their ancient origins, fungi have played a critical role in shaping Earth's terrestrial biosphere over the last billion



years. The first plants to emerge onto land [500m years ago](#) formed [intimate partnerships](#) with fungi. Lacking roots, these early plants relied on their [fungal partners](#) to grow inside them and spread outwards into the primordial mineral soil. In a process known as [biological weathering](#), fungal hyphae would secrete organic acids to dissolve rocks and extract nutrients held within. In return, the plants would transfer nutrients produced through photosynthesis to the fungi.

This [exchange of resources](#) between early plants and fungi powered the [growth, evolution and diversification](#) of Earth's flora into ever more complex species, communities and ecosystems, and remains the norm today. Over [90% of land plants](#) associate with a fungal partner of one type or another, and some are [entirely dependent](#) on fungal assistance to survive.



Credit: AI-generated image ([disclaimer](#))

The symbiotic rise of land plants and their fungal partners also had dramatic effects on our [atmosphere](#). Now with abundant access to mineral-based energy building blocks, plants evolved more [efficient mechanisms](#) for photosynthesis to capture this energy, for example through better control of the movement of carbon dioxide and water into and out of leaves. Over millions of years, this increased absorption of carbon dioxide produced a massive rise in oxygen concentrations, supporting the emergence of much larger, more complex animal life than the tiny [insect-like](#) life forms that [previous](#) oxygen levels could support.

From there, the [evolutionary story](#) is clear. But in showing that fungi probably arrived on land 500m years before plants, the new fossil evidence raises fundamental questions about the start of this [symbiotic journey](#).

It was previously thought that plants made the transition to terrestrial life simultaneously with [aquatic fungal partners](#), but the new discovery opens up the possibility that Earth's lands may have been already being prepared for successful plant life for hundreds of millions of years. Dissolving mineral-rich rocks and secreting carbon-based [organic acids](#), we know that fungi were extremely important in converting barren lands into the fertile, carbon-rich [soils](#) we know today. It could be that the emergence of plant life was only made possible by aeons of groundwork by ancient fungal forefathers.

The outstanding challenge for scientists now is to resolve with certainty whether these ancient fungi were terrestrial in origin, and pinpoint their placement on the evolutionary tree of life. With the focus now on finding further fossil fungi, our understanding of the evolution of the early biosphere will make leaps and bounds.

What is already clear is that without fungi, we would not exist. Playing a

vital role in the maintenance of healthy ecosystems across the planet, from the [Antarctic deserts](#) to the tropical rainforests, [fungi](#) underpin all life on Earth today. Now, it appears we may have another 500m years to thank them for.

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