# Fungi:

## engineers of the woods

Seen as the ugly duckling —except for few species that conquered gastronomy—fungi have a fascinating history to tell: they are in charge of building and shaping a forest because they have an interdependent relationship with plants. Researchers from Universidad del Rosario jointly with international colleagues found a fungus species with two subspecies. This is their story.

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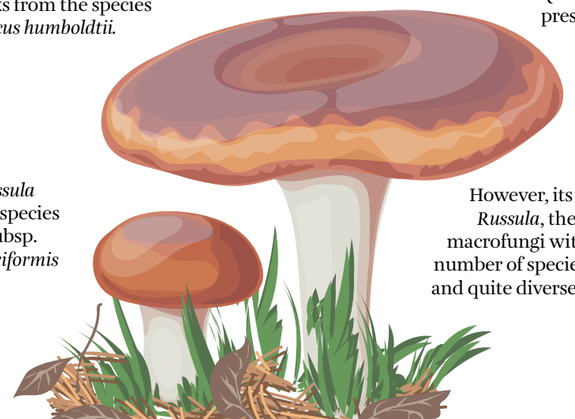
Photos: Adriana Corrales

From the same creators of "without bees, there is no food," which is a naked truth, there is just another undeniable: "without fungi, there are no plants." Why? Because fungi give the plant mineral nutrients and water and, in exchange, obtain energy—carbohydrates—and vitamins that they could not synthesize on their own, but can get through their green friend via photosynthesis and other internal processes. This symbiotic relationship is known as mycorrhizae, from the Greek *mycos* (fungus) and *rhizos* (roots) of a **plant**.

Forest engineer **Adriana Corrales**, PhD in plant biology, and her undergraduate student from the biology degree Michelle Vera, **discovered** a new species of fungus with two subspecies, one in Colombia and another in Panama, associated with oak woods. This discovery sheds light on how this interplay has evolved. The details of this happy marriage are as follows.

*Russula floriformis* subsp. *floriformis* found in the Chicaque Natural Park, approximately 55 km from Bogotá. Six specimens were collected for study, its host plant: oaks from the species *Quercus humboldtii.*

Only this type of oak is found in Colombia, which, in turn, is the only South American country having oaks. Its closest relative is the *Quercus costaricensis*, present in Costa Rica and Panamá.



The species found is *Russula floriformis* and the two subspecies are *Russula floriformis* subsp. floriformis and *Russula floriformis* subsp. *symphoniae.*

However, its partner is *Russula*, the genus of macrofungi with the largest number of species in the world and quite diverse in the tropics.

"About fungi, their reproduction method draws my attention, how diverse they are, and the number of life form they have. I like to study them from an ecological standpoint, particularly their communication with plants," claims Michelle Vera, who won a grant from the International Association for Plant Taxonomy to visit Dr. Adamčík's lab in Slovakia.

Slovakian mycologist Dr. Slavomír Adamčík is considered a world expert on *Russula*. Together with other international collaborators, he carried out part of the study developed by the two researchers from the Universidad del Rosario.

However, they are subsampled in this region. That is to say, in Colombia, only 15 species of *Russula* (among some 2,000 in the world) have been identified, but along this connection between Central and South America, the scientists suspect there is a vast diversity. Identifying them is a promising challenge.

Life was originated in the water, and fungi terrestrial environments. This association was set from the beginning of the evolution of terrestrial plants that is why there are no plants without fungi. The *fungus* kingdom is essential for the survival of the plantae kingdom.

Fungi, for a good reason, make connection between plants because roots are not usually connected. Fungi form is known as the "*Wood Wide Web*" or the internet of plants.

A type of fungus can be associated with different trees, and, conversely, a type of tree can be related to diverse fungi. There are two kinds of association, called mycorrhizae: endomycorrhizae (arbuscular) and ectomycorrhizae.

The *Russulas* are ectomycorrhizal, accounting for only 2% of mycorrhizae growing in the country. They are only found in oak trees and arboreal species that are not frequently found in Colombia.

"Besides being an essential part of the survival of plants, mycorrhizae shape the forests; they are like ecosystem engineers because they can change the cycles of nutrients to favor the species associated with them," as Adriana Corrales explains.

The oak tree renders an important socioecological service: its wood is fine and the slow and long-lasting growth enables a higher rate of plant regeneration in the forest; in other words, it promotes the high growth of diverse species or their survival in this area.

In every pairing, complications arise and, in this case, agro inputs break and replace that relationship.

"When fertilizers, such as nitrogen or phosphorus, are supplied to the soil, the plant intakes them by itself, stopping the passing of sugars and vitamins to the fungus and focusing on enlarging its roots to obtain more nutrients directly. This makes the plants more dependent on agrochemicals and disrupts the relationship with fungus, whose ecosystemic services get into a tight corner," asserts Adriana Corrales, researcher at the Faculty of Natural Sciences.

"About fungi, their reproduction method draws my attention, how diverse they are, and the number of life forms they have. I'd like to study them from an ecological standpoint, particularly their communication with plants," comments Michelle Vera, biologist.

"As there is still a great lack of knowledge about the fungal species in Colombia and what associations they form with which hosts, we are missing the chance to know how our forests behave," warns Michelle Vera, co-researcher of a study that discovered one species and two subspecies of fungi.

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"Needless to mention the fungicides: besides killing pathogenic fungi in the plant, they may affect those present in the roots," she adds.

Another threat is the introduction of exotic species into the reforestation process. Traditionally, pines and eucalyptus have been applied, which come, for example, from Australia or Europe, and bring their own fungi, competing with the native species and becoming invasive. That is how a "fungi war" breaks out.

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For example, some species of *Russula* from Panamá and Colombia are quite alike, and some have the same type of host. How are these similar species related? What was the evolutionary process of the migration of fungal species between Central America and South America?

These questions lead to studies, such as Corrales and Vera's, who were particularly interested in comparing species collected in Panamá between 2012 and 2015, with those picked in Colombia in 2019. In this research, they found that the collected are 99% similar and therefore, are classified as subspecies.

For now, it is known that the oak tree, for instance, migrated from North America to Central America, and that the formation of the Isthmus of Panamá provided a bridge for an enormous biotic exchange.

This migration occurred between the Pliocene and Pleistocene, between 5 and 3.5 million years ago.

Thus, the oak tree and its dear fungi arrived in Colombia, where we witness today the beginning of the evolutionary separation of fungal species.