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SPECIAL ISSUE
FUNGI

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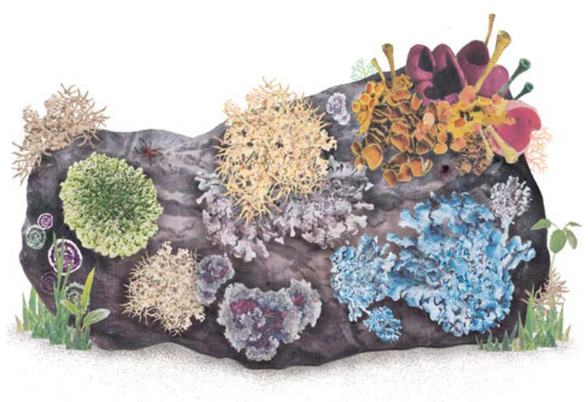

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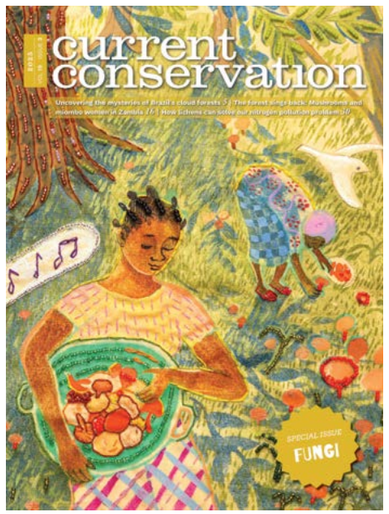

Cover art **Reshu Singh**

Before their ecological relevance and unique properties were revealed to me, my earliest memory of fungi was as a whimsical toadstool in the background of a fairytale book. Growing up, I also saw them as decorations on fallen tree trunks or as ephemeral mushrooms that mysteriously unearthed themselves after a thunderstorm. In all their forms, these intriguing and lesser-known species appeared almost like magic. Later, I would come to realise that their complex underground networks, rich history across cultures, many uses, and vital ecological functions only make them profoundly more magical.

This issue, guest edited by Elizabeth Barron, welcomes you to an exploration of the familiar yet fantastical world of fungi. The authors bring their diverse perspectives, experiences, and learnings from the field of fungal conservation. To reflect the fungal spirit of symbiosis, the artists in this issue have created mixed-media illustrations—combining two or more visual media to make something new. We hope you find the insights in these articles as exciting as we have.

– Greta Ann Sam

Welcome to the world of fungi

Author **Elizabeth Barron** | *Illustrator* **Labonie Roy**

Over the years I have read many books in which senior mycologists have expounded on the many virtues, fascinations, and wonders of fungi in an effort to win over the general public. After decades working on the science of fungi, they brought their work out of the dark recesses of botany journals and microscopy labs in university basements, and into books with catchy titles to show people, no—convince them, of the amazing significance and wonder beheld in this relatively unknown, massive grouping of organisms. The titles say it all: David Moore's *Slayers, Saviours, Servants, and Sex* (2001); Nik Money's 2004 *Carpet Monsters and Killer Spores* or comparatively directly titled 2024 text, *Molds, Mushrooms and Medicines: Our Lifelong Relationship with Fungi;* or Paul Stamet's widely read *Mycelium Running: How Mushrooms Can Help Save the World* (2005).

Then there is Merlin Sheldrake's recent text, *Entangled Life,* which has captured the public's attention at an astonishing level Moore, Money, or even Stamets could only dream about. The homepage for the book lists numerous awards and accolades, and includes rave reviews from other nature writers, journalists, and academics. Sheldrake has nearly 1 million followers on Instagram, where you can see videos of him eating fungi that have sprouted from his book (using a copy of his book as a growth medium), read about his various research publications and collaborations, and even purchase the microbially-rich Sheldrake and Sheldrake hot sauce, a fermented sauce which comes in packaging material grown out of fungal mycelium and hemp stalks. *Entangled Life* has been re-released as a coffeetable photobook, and is the basis for a documentary narrated by none other than Icelandic musician Björk.

We are truly in a fungal moment fuelled by TV and film, media, books, and music about fungi. Interventions range from the whimsies of fermented hot sauce to the radical writings of Maymana Arefin, on how fungi and decomposition can inspire abolitionist futures and the collapse of linear capitalism. Why fungi, and why now? Have decades of environmental education paid off and people finally realise the awesome powers of these lifeforms? In fact, fungi keep us from literally drowning in dead material through decomposition. They nurture us as food and medicine. They clean our air, keep our trees alive, help us grow our crops, and not least, they are beautiful, wondrous living beings with which we share this planet.

While everything I have said about fungi is true, I wonder if there is something deeper, something a bit more troubling, going on in our collective human psyche when it comes to our newfound love and delight with things that go squish in the night. Have we given up on plants and animals? On the idea that we can save them or that they can resist the onslaught of environmental destruction we endure every day. Is there some sort of collective unnamed search going on for organisms that may outlast our environmental crises? Are we desperate to find somethings and someones that may be able to save us from ourselves because despite our best efforts, they seem more powerful than humans? Can fungi really save humanity???

This special issue of *Current Conservation*, its first dedicated to fungal conservation, will not attempt to answer the question about whether or not fungi are our collective saviours; I for one would never put the responsibility on another kingdom of organisms to do the work that we, humans, must do to take responsibility for our own actions and choices. A bit more humbly, our hope for this special edition is that it continues to make visible the many ways in which we, people around the world, continue to get to know fungi, to learn about them, to interact with them, and to discover how others do so and have been doing so for lifetimes.

Our special issue is an attempt to provide an overview of the many facets of the wide-ranging and rapidly growing field of fungal conservation. It includes two Feature articles, two Field Notes, a Photo Essay, two Perspectives, and a set of illustrations. We have authors and pieces hailing from 10 countries across six continents.

While the organisms are distinct and the species different, the themes of this special edition are much like those you might find in other issues of *Current Conservation;* for example, balancing the role of scientific discovery in pieces by Ellis and Drechsler-Santos et al., with that of joy in scientific work as experienced in rural Benin and told by Dramani et al. Løvaas highlights the role of women's work and knowledge in ethnomycology in Zambia. Cantiero et al. point to the importance of including fungi in key international environmental conventions and strategies, and Barron et al. outline a new research agenda to bring together women's livelihoods, ethnomycology, fungal conservation and access to reproductive health care in rural communities. Through their artwork and accompanying text, Pouliot and Shafie show us fungi through their eyes and help us appreciate the aesthetic and cultural presence of these amazing organisms.

And good news! This special issue is just a tasting menu of so much work happening now in fungal conservation. The articles include references to related work and future readings so you may continue to explore these topics further.

One theme that runs throughout all the pieces is that of visibility, but unlike previous mycological works trying to bring fungi into the light, the pieces in this special issue demonstrate that the relational values created among humans and fungi affect the very meaning of conservation itself, thus **bringing a new form of conservation to light.** Through fungi we learn about the role of aesthetics in conservation (Pouliot), about the importance of joy and care when doing conservation work (Løvaas, Dramani et al.), and about working in partnership with fungi to imagine new ways to protect and conserve areas without requiring high-tech monitoring systems and expensive labs (Ellis). Barron et al. argue that the link between basic needs for reproductive care go hand-in-hand with conservation in ways that have also been invisible until now. What this issue makes visible is that fungi can remake how we practice, plan, and understand conservation itself.

Elizabeth Barron *is Professor of Environmental Geography, specialising in the human dimensions of fungal conservation, biodiversity politics, and environmental knowledge.*

Labonie Roy *is a mixed media illustrator, nature learning resource creator and Managing Editor of Art and Design at Current Conservation Magazine.*

Uncovering the mysteries of Brazil's cloud forests

Authors **Elisandro Ricardo Drechsler-Santos, Genivaldo Alves-Silva and Daniela Werner Ribeiro-Santos** | *Illustrator* **Devangana Dash**

It was on the mist-covered slopes of the Serra Geral mountains that our journey began. Back in 2011, we were not looking for a rare species—we were just mycologists wandering through Brazil's southern cloud forests, curious about the fungi hiding in the bark, branches, and soil of that unique ecosystem. What we found, however, would shape more than a decade of work and redefine our activities to include a lasting dedication to fungal conservation in Brazil.

Fomitiporia nubicola was, at first, a curious brown bracket (or polypore) fungus clinging to the trunk of *Drimys angustifolia*, a relict broadleaf tree that thrives in those foggy heights. Over the years, this fungus slowly revealed its secrets. We followed—season after season—often returning empty-handed, occasionally rewarded with a few elusive basidiomes (reproductive structures). We documented, collected, and monitored until, in 2020, we formally described it as a species new to science: *Fomitiporia nubicola,* the tapir's bark polypore.

But that was only the beginning.

In 2022, with a conservation grant, our team at the MIND.Funga research group intensified field surveys across high-altitude areas in southern Brazil, hoping to find the species beyond its two known locations. We did not. And its absence spoke volumes.

The fungus' apparent reliance on *D. angustifolia,* its extremely narrow range, and the ongoing threats to cloud forest ecosystems led us to reassess its conservation status. It became the first fungus in the world to be reclassified on the IUCN Global Red List—from Vulnerable to Critically Endangered. Being Critically Endangered means *F. nubicola* faces an extremely high risk of extinction in the wild—potentially within 50 years—if no conservation action is taken. If current threats—habitat loss, climate change, and lack of *in situ* protection—persist, the species could disappear entirely from nature in a single human lifetime.

Shared purpose

These highland landscapes are complex mosaics of grassland and forest, with cloud forests tucked into sheltered slopes. Both grassland and forests in the highest regions act as natural water reservoirs, with patches of peatland and cloud forest capturing moisture from rain and orographic clouds (formed when air is forced upwards

by the topography of the land, typically mountains). These ecosystems feed springs that sustain life downstream. Among the twisted branches and moss-covered trunks, old-growth species such as *Drimys angustifolia*, *Dicksonia sellowiana* (a tree fern), and *Araucaria angustifolia* (the iconic Brazilian pine), hold stories from a distant evolutionary past.

The first time we stepped into a cloud forest, it felt like pure enchantment—mosses draping every surface, tree ferns from 'the age of dinosaurs', and ancient trees whose bark seemed to whisper stories of the past. It was magical, intimate, and timeless. Fungal conservation is often solitary work—underfunded and overlooked. Yet, in the foggy quiet of the cloud forests, accompanied by students, local guides, and park staff, we found a shared purpose. Our commitment grew not only from scientific interest, but also from the privilege of witnessing life in one of the most threatened and beautiful ecosystems of Brazil's Atlantic Forest biodiversity hotspot.

The cloud forests are marvels unto themselves. From the outside, their small, fragmented patches might seem unremarkable. But stepping into them feels like entering another world—damp, protected, and oddly warm, a stark contrast to the harsh winds and biting cold outside. In the summer heat, they offer a natural refuge; in the chill of the highlands, they wrap around you like a cloak.

It is no surprise that even free-ranging grazing cattle seek shelter in these remnants during sudden weather shifts—a local phenomenon known as *viração*. These animals, though part of the landscape for generations, have increased in number in recent years and now represent one of the greatest threats to the cloud forests by trampling and feeding on the understorey vegetation, altering the forest's regeneration dynamics.

Many firsts

Currently, with conservation grants and vital support from the managers of Parque Nacional de São Joaquim—the only known location where the *F. nubicola* occurs—we are expanding our efforts. We are monitoring the species *in situ* to better understand its phenology, including the timing of reproduction, the length of the life cycle, and the conditions it needs to survive in the wild.

We are establishing Brazil's first *ex situ* conservation programme for fungi by creating a living culture collection to safeguard the genetic diversity of threatened species, including *F. nubicola*. In the collections we store pieces and clones of individuals. We are especially interested in investigating how *F. nubicola* responds to different storage conditions, such as temperature, nutrient availability, and substrate composition. These studies will help us assess the short and long-term viability of cultures in *ex situ* conservation and evaluate their potential for future reintroduction into natural habitats.

We are particularly intrigued by *F. nubicola's* reproductive biology. How long do individual fungi persist on their hosts? Why do some basidiomes abort before maturing? In many cases, the trees hosting *F. nubicola* are already dead, and in cloud forests decomposition occurs vertically—fallen trees take years to hit the ground, but we are seeing those trunks fall, and no new ones are taking their place.

One individual we documented more than a decade ago is now dead. A dead tree was hosting this most remarkable basidiome—with evidence of potentially 20 years of sporulation—which has finally collapsed. That basidiome may have begun forming long before we first encountered it, and now it is gone. How many other individuals will follow it before we can fully understand the ecological requirements and life cycle of this unique fungus?

Further complicating the story, we suspect that the reproductive individuals of *F. nubicola* may only

emerge on centenary trees—raising even more questions about forest maturity and fungal persistence. We are now developing experimental methods to estimate the duration of its life cycle and how spores survive and start the relationship with the host. How long does the host tree *D. angustifolia* live? What microhabitats does *F. nubicola* require? And why does its distribution seem so restricted?

Ex situ conservation is more than a safeguard—it is a strategy for the future. By preserving diverse genetic strains, we lay the foundation for potential translocation and reintroduction, should conditions ever improve. The timeline may span decades, but the groundwork is being laid. These are the most advanced fungal conservation efforts in Brazil.

Fungal conservation is still young in the country. But with every expedition into the cloud forests, every conversation in the field and lab, and every basidiome found or missed, we are building a legacy—one that recognises fungi as vital and imperilled, just like the forests they inhabit.

Further Reading

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Elisandro Ricardo Drechsler-Santos *is a mycologist specialising in fungal conservation, and chair of the IUCN SSC Brazil Fungal Specialist Group.* **Genivaldo Alves-Silva** *is a mycologist focused on Neotropical macrofungi diversity and conservation.* **Daniela Werner Ribeiro-Santos** *is a forestry engineer specialist in genetic resources and in vitro cultivation, and coordinator of the CFAB-MIND.Funga team. They are all based at the Federal University of Santa Catarina, Brazil.*

Devangana Dash *is an award-winning visual designer, illustrator, and educator from India, specialising in editorial design, bookmaking, and narrative storytelling.*

ENDLESS FORMS MOST BIZARRE

FUNGI, AESTHETICS, AND CONSERVATION

Author and photographer **Alison Pouliot**

The smooth cage *(Ileodictylon gracile)* is among the more bizarre fungal forms

Beyond forayers and foragers, fungi are attracting new fans from many fields. From bioengineers to fashion designers, an emerging league of mycophiles is delving into the depths of kingdom Fungi. Yet for many people, fungi are unnerving. Perplexing. They do things we don't understand and upend ideas about how we order and make sense of nature.

In my book *The Allure of Fungi,* I pose the question: why are fungi regarded so differently to other forms of life? Understanding historical inattention to fungi is a good starting point, but bigger questions swirl around too.

What defines life? Who defines beauty? How might fungal forms challenge the notion of 'aesthetic nature'? It's at the nexus of the science and aesthetics of fungi that interesting possibilities arise for their conservation.

Like *Homo sapiens*, a single fungus species can appear in many guises. Working out who's who is just part of the fun. As a photographer, I try to reflect a fungus in its different outfits, not so much to classify it, but to convey its character and quirk. Beyond their extraordinary beauty, it's the strangeness of fungi, their bizarre forms and bewildering habits that might make us question how they challenge ideas about aesthetics and charisma when it comes to valuing nature.

Images of beautiful species and places have been vital to conservation and the aesthetics of nature was an important driver of the early conservation movement. To be equipped with a backbone and warm blood (mammals), showy blooms (many plants) or a melodious song and colourful plumage (some birds) is to be deemed charismatic. Such organisms have been the focus of conservation. Bad luck if you happen to be a blobfish, stinkhorn or slime mould. The perceived picturesque qualities of a place were paramount to its protection or designation as a national park.

However, as ecological knowledge has grown the need to protect areas for their ecological value has also grown, creating a tension between aesthetics and science in conservation. If we prioritise charismatic appeal over ecology, we overlook places of higher ecological value but less aesthetic appeal. Fungi that rely on the conditions and ecologies of aesthetically undervalued habitats such as coastal scrub can find

The elfin saddle *(Helvella crispa)* is strikingly irregular in form

themselves in trouble, because despite ecological recognition, neither coastal scrub nor the fungi who live there are particularly charismatic by conservation standards.

It's hard to please everyone with the legion of considerations in conservation and land management decision-making. However, could our growing ecological knowledge affect our conservation aesthetics through increased understanding of what is vital to the future survival and resilience of species and ecosystems?

The unassuming candlesnuff fungus *(Xylaria hypoxylon)* grows in clusters on decaying hardwood

When charisma backfires

For many people, fungal forms are less familiar than those of plants and vertebrates. The unexpected or bizarre forms of fungus sporing bodies can either enthral or repel those trying to make sense of fungi. Idiosyncratic sporing bodies such as those with eccentric forms, odours or habits sometimes appear 'unbelievable', inflating their ambiguity and potency. Beauty rather than bizarreness drives the aesthetics of nature. Yet these curious fungus forms can challenge us to reconsider traditional notions of beauty in nature.

Photographs and artistic impressions of fungi, along with conservation tools such as flagship species, all help put fungi in the spotlight. Yet beauty can also come at a price. What happens when an alluring fungus becomes a potential problem? Aesthetic pleasures in one place are invasive pests in another. The reputation of a fungus can slide from virtue to invader if it relocates or ecological concepts change. **Mycorrhizal**[1] hitchhikers have expanded their 'natural range' as people ferry plants around the world, and the local fungi are not always pleased.

The accompanying photographs highlight beautiful and intriguing fungi from around the world. And two stories demonstrate the tension between aesthetics and changing ecologies.

[1]**Mycorrhiza** refers to the mutually beneficial association between a fungus and the roots of a plant.

The fly agaric *(Amanita muscaria)* is arguably the world's most familiar and photographed species

Take, for example, the alluring fly agaric *(Amanita muscaria)*. This striking species is probably the world's most familiar and photographed fungus. Shamans have sought this northern hemisphere fungus for centuries, and plantation forestry unintentionally introduced it to the southern hemisphere. For about a century, the fly agaric seemed happy to cohabit with its host trees in southern hemisphere plantations, parks and gardens. However, more recently in southeast Australia and in New Zealand, it has hooked up with native myrtle beech trees.

Once revered for its fairytale appeal, in Australia and New Zealand the fly agaric is toppling from its fungal pedestal and land managers now condemn it as a 'regulated pest'. We do not yet know whether it displaces the myrtle beech's native mycorrhizal fungus partners, but it is likely. What's the concern? Loss of native fungi could not only diminish fungal diversity, but the myrtle beeches could become less tolerant of stress and disease. Weaker trees and fewer native fungal partners could compromise the overall resilience of these forests. Yet, as fungi become ever more popular among the public, the fly agaric's fame surges. Its common and widespread appearance on social media, in shop windows and private collections of favourite fungus photos suggest its magnetic allure. The appeal of beauty and perhaps nostalgia for childhood stories that feature this beguiling fungus could overshadow the possible havoc playing out in the subterrain.

The orange ping-pong bat *(Favolaschia calocera)* is another fungal conundrum. Occurring naturally in Madagascar and parts of southern Asia, its range is expanding globally and it is settling in ruderal (disturbed) environments worldwide. Like the fly agaric, mycologists worry it's displacing native fungi and dub it a 'fungal weed'. However, unlike the fly agaric, which is limited to the distribution of its mycorrhizal partners, the orange-ping pong bat is a saprotroph that feeds on dead wood. In New Zealand alone, it grows on the wood of over 50 different tree species.

There are benefits for a fungus in having a broad diet: eats wood, will travel. The orange ping-pong bat's sporing bodies may be tiny, but its endearing appearance further complicates the scenario. Like the fly agaric, this fungus is irresistibly attractive, with the risk it might be collected by fungal enthusiasts, who are then unwittingly contributing to its spread.

Both species highlight the challenge of negotiating aesthetics and ecology in conservation. As highly charismatic and highly mobile species, there's a great need to understand their invasive potential and threat to native species. While handsome flagships can catalyse conservation, 'charismatic invasives' can hinder its success. Yet the endless forms most bizarre of the fungal kingdom are a reminder that they all arose for one purpose—each is an evolutionary improvisation for getting spores out into the world, to continue their existence, regardless of what *Homo sapiens* make of them.

Note: The ideas in this brief essay are discussed in more detail in Alison's books, especially The Allure of Fungi *and* Underground Lovers.

Alison Pouliot ***is an ecologist and professional environmental photographer with a focus on fungi. She has authored several books, including*** **The Allure of Fungi, Underground Lovers, Funga Obscura *and* Mushroom Day.**

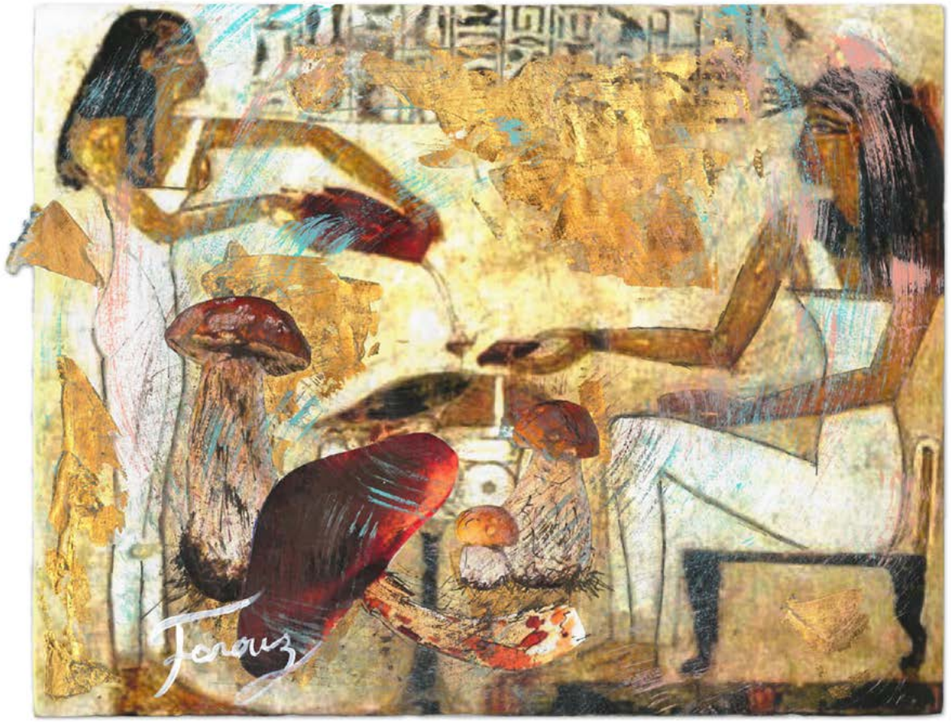
The stunning orange ping-pong bat *(Favolaschia calocera)* is now considered a fungal weed in many countries

SACRED MUSHROOMS
AND THE SPIRITUAL LEGACY OF ANCIENT EGYPT

Forouz Shafie *is an Iranian artist inspired by the mysteries of Ancient Egypt and the sacred use of psychedelic mushrooms. Her paintings bridge the past with the unseen, revealing the hidden layers of human experience.*

In Ancient Egypt, queens and high priests sought ways to communicate with the gods and gain deeper insights into existence. One of their tools was psychedelic mushrooms, believed to alter perception and open portals to other dimensions. Historical evidence suggests that these mushrooms played a role in religious ceremonies, spirit communication, and even political decision-making.

Forouz Shafie reflects these ancient beliefs in her artwork, blending Egyptian symbols with natural elements like mushrooms to highlight humanity's connection with nature. These paintings are not merely recreations of the past but representations of humanity's eternal quest to understand the unknown. Just as the queens of Egypt sought hidden truths, modern societies continue to explore the mysteries of consciousness and existence. In this creative journey, reality and imagination merge, creating a space where ancient wisdom meets contemporary exploration.



This painting blends mythology and nature, placing mushrooms alongside ancient Egyptian symbols.
The use of gold leaf in the execution of this work enhances the connection to ancient knowledge and mystical forces.

This artwork connects ancient wisdom and nature's mysteries. Hieroglyphs and mushrooms symbolise lost knowledge, echoing the belief that fungi were gateways to other realms in ancient civilisations.

THE FOREST SINGS BACK

MUSHROOMS AND MIOMBO WOMEN IN ZAMBIA

Author **Mai Løvaas** | *Illustrator* **Reshu Singh**

I hadn't been in Zambia long before I discovered that it is a mycophilic society. Getting into taxis in Lusaka, the capital, the drivers would ask me what brought me to the country. And I would respond: "I'm here because of the mushrooms. I'm here to interview the mushroom gatherers for my master's thesis." Every one of them would light up and say, "Mushrooms! I love mushrooms!"

Some taxi drivers would tell me that their grandmother, back in the village, used to pick mushrooms. They also explained that during the rainy season mushrooms can be bought in urban markets and purchased along the highways and roads. Indeed, driving up the Copperbelt Highway in Zambia, I would see women and children with bowls full of red chanterelles or suede brown milk caps, holding them up high towards the truck driver window.

During the course of my research, I learned a lot about the popular wild mushrooms in Zambia. Traditionally women have the role of mushroom gatherers and holders of knowledge about fungi and their local surroundings. They celebrate this knowledge as it brings them closer to their environments and their families. During my fieldwork with rural women, they told me they look forward to mushroom season every year. We leave our problems at home, they would say. Or as one woman put it, "If you take your problems with you into the forest, that is when you will meet snakes!"

Women are known to be the custodians of knowledge passed down from their mothers and grandmothers. Their eyes would light up as they recounted how the women in the family took them into the forest and taught them to tell the edible mushrooms apart from the poisonous ones. They shared how they teach their own children about mushroom gathering from an early age. The children love going out to hunt for mushrooms.

The children learn not only about edible and poisonous species, but also gain ecological awareness—which trees host what fungi, which trails are dangerous. They learn about the trees the mushrooms grow under, and about termite mushrooms so large that deer can be found underneath the cap, coiled around the stem. They learn to be aware of snakes so big the tall grass parts in their approach, and about the dangers of crossing the river due to crocodiles. They hear the stories grandmothers tell, the fairytales about mushrooms, and they come along as the women sing songs about them. These songs, fairytales, and foraging rituals weave cultural memory. They are oral libraries of ecological knowledge.

Food and medicine

Provisioning is another important role women maintain in rural Zambia, and one in which mushrooms play an important role. At the beginning of the rainy season that extends from November to April, food can be scarce. Being able to gather mushrooms at this time of year is important for food security in many African countries, as highlighted by the World Health Organisation (WHO) and the Food and Agriculture Organisation of the United Nations.

As people plant seeds for crops of cassava, potatoes, maize, and legumes, mushrooms are often the main subsistence food that helps them get by until the crops start to yield. Many long for all the varieties of flavour the different species have and the different preparations. Mushrooms are most often boiled with onions and tomatoes and eaten with *nshima,* a maize porridge. In rural villages they provide an important substitute for meat, which can be quite expensive. I was told that some mushrooms taste like fish, and some taste like meat. Women fondly talked about cooking *Tente* mushrooms with onions and tomatoes, the sweet smell wafting through the air in the village.

Young women growing up in rural Zambia also learn about mushrooms as part of the home medicine cabinet. Women spoke about three species they gather for healthcare purposes. The mushrooms are woody and dry already when picked and are soaked or burned to ash before they are ingested or applied topically and they are used for treating a variety of ailments, from earache and diarrhoea in children, to wounds, skin issues, anxiety, and women's health issues.

During my fieldwork I did not ask whether women used these mushrooms for health issues because they didn't have access to health services, or whether they used them in addition to the health services they could access at the rural health posts.

Art by Reshu Singh
Current Conservation Issue 19.3
currentconservation.org

A Kaonde woman in the North-Western Province explained that some years ago during a stressful period of many problems with her family, she suffered from terrible anxiety. She would crush *Kyowankunku* mushroom, roll it into a cigar and smoke it, which she said really helped with her anxiety during that difficult time.

The WHO suggests that up to 80 percent of people in Africa rely on traditional medicine for their primary health-care needs. Being able to gather and use traditional medicine contributes to the resilience of people who directly depend on the forest in many parts of the world. What is gathered in the forest is often the most available, accessible, affordable, and culturally acceptable form of healthcare.

Fragile economies

Miombo forests represent a vast ecoregion of tropical grasslands, savannas and shrublands covering much of central and southern Africa. These semi-deciduous forests are dominated by trees in the legume family from the genera *Brachystegia, Julbernardia,* and *Isoberlinia*.

In the miombo forests of Zambia, mushrooms are more than food—they are memory, medicine, and music. Women pass down fungal knowledge through song, storytelling, and daily survival. Yet with urbanisation and extractive industries such as mining and charcoal production, many forests are being bulldozed or burned. In many areas where women used to go, the forest is gone, and with it, the mushrooms.

Miombo forest trees are mainly chopped for fuel. Women in rural areas referred to the men who cut these trees as 'charcoal burners': they stack the trees in a pile and cover them with dirt before setting them on fire and letting them slowly smoke until the wood turns into bits of charcoal. When the charcoal has cooled, it is bundled up, transported to the highway and sold.

The goods of the forest present a gendered tension: charcoal production is often done by men, mushroom gathering by women. On my drive along dirt roads into villages to interview mushroom gatherers, I would see men riding their bicycles or mopeds in the opposite direction, with large charcoal bundles strapped to the back. Back on the highway, I would see women sitting side by side with the charcoal burners selling their product.

I would ask the women, what can be done about this? What can be done about the men cutting the trees for charcoal, the very trees that provide mushrooms you pick to eat, to sell? A sad sentiment would hang over the group, sighs and mostly silence, lowered voices. "We can't do anything. We beg them not to cut the trees. Sometimes we shout at them. Some of them are our husbands. There is nothing we can do. They need to make money too."

Mushrooms were always food and medicine in Zambia, but these days they also present an important source of income for the women who gather mushrooms during the Emerald Season—as the rainy season is called, characterised by lush green vegetation and high water levels in rivers—and sell them along the highways. With the ever expanding mining industry in Zambia, massive highways run through the country with trucks that carry heavy loads of copper, the country's main export.

The irony is that as much as the copper transport truck drivers from the mining companies love to buy mushrooms on their drive up the Copperbelt Highway, they are also part of the problem. International companies own the mining operations and are constantly expanding into forested areas. In the wake of mining sludge, runoff, and deposits the size of mountains, the trees of the miombo forest are bulldozed, and the mushrooms with them.

Beyond biodiversity

For some, mushroom gathering has become nothing but a distant memory. As forests and lands disappear, people move to cities.

The women I talked to in the city only have faint recollections of mushroom gathering, and they are no longer able to pass on the knowledge between generations. Current fungal conservation logic centers on rare species lists and habitat maps. But this misses the human connection—the songs, stories, livelihoods that disappear silently. The food and medicine that vanish. Preservation must include cultural conservation, especially gendered and Indigenous practices.

What if fungal conservation was not just about rare species, but also about preserving this vital thread in the tapestry of human resilience? Fungal conservation is unlike animal and plant conservation—you cannot count mushrooms like you can count elephants, and fungi were, in fact, only understood to not be plants as recently as the late 1960s. Ectomycorrhizal mushrooms, the aboveground mushrooms we can see, often appear fleetingly, unpredictably, and depend on intact forest ecosystems. Yet they shape livelihoods, culture, and health in deeply rooted, though less visible, ways.

What if we preserved forests not only for the fungi themselves, but for the women who sing to them? In a world of measurable data, the value of mushrooms may be hard to quantify, but in the miombo, their worth is sung, tasted, and remembered. Fungal conservation is not just environmental. It is cultural continuity, economic survival, and medicinal resilience—and the women of the forest are its frontline stewards.

Mai Løvaas *is a mushroom identification expert who incorporated her passion for fungi into her MSc in Global Health at the Norwegian University of Science and Technology.*

Reshu Singh *is a visual artist and illustrator. She works with mixed media techniques, and has an exploratory approach to drawing and storytelling.*

Healthy women, healthy fungi:

A collaborative approach to conservation

Authors **Elizabeth Barron, David Johnson, Donatha Tibulwa and Jennifer Infanti**
Illustrator **Shivani Shenoy**

Global inequalities in access to, and quality of, public services disproportionately affect rural communities. These communities often rely more directly on their local ecosystems for their health, livelihoods, and climate resilience compared to their urban counterparts, thus exacerbating social exclusion and environmental exploitation. Rural communities are subject to increasing conservation-related pressures as national governments race to fulfil commitments to the Kunming-Montreal Global Biodiversity Framework—mainly to set aside 30 percent of the Earth's surface as protected areas by 2030 (also known as the "30 by 30" initiative).

These efforts prioritise biodiversity "hotspots" and charismatic flagship species, overlooking less conspicuous but ecologically crucial resources. Fungi, for example, are essential for ecosystem functions, facilitating nutrient cycling, carbon sequestration, and habitat formation. They are also central to rural livelihoods, supporting food security and generating income. But both rural communities and fungi are on the margins, and risk further exclusion through conservation strategies focused narrowly on protected areas.

Future conservation will benefit from bringing the knowledge, strategies, and needs of rural communities and fungi in from the margins and towards the centre, to balance ecological integrity with support for cultural practices, and to meet social and economic needs. Our team has been developing an interdisciplinary research agenda to integrate studies on fungal conservation and sustainable use of wild fungal species with the provisioning of health services, particularly for sexual and reproductive health (SRH).

SRH services, development, and conservation initiatives remain largely siloed, despite growing evidence that when integrated, more effective outcomes become possible. Coupling research on wild species with efforts to ensure everyone has access to the full range of quality health services they need, when and where they need them is a novel approach to conservation. And it aligns with new fungi-inspired conservation advocating caring for abundant natures is as important as protecting rare natures.

Cross-sectoral connections

Our main research question is: how does integrating reproductive health services and sustainable fungal resource use improve community well-being and conservation outcomes? We are hoping to work in Zambia, and perhaps eventually extend our work to communities in Tanzania, Zimbabwe, Malawi, and Benin. We are particularly interested in how traditional gender roles affect peoples' lives with regards to collecting wild mushrooms and accessing health services, and how these topics may be taken together to inform gender-sensitive policy and practice. We wonder what sort of socio-economic and ecological synergies might emerge when integrating SRH services and fungal conservation? What challenges might arise?

We plan to examine how traditional mushroom gathering for self-provisioning and medicinal needs provides knowledge about sustainable use of wild fungal species, and how this can contribute directly to the underrepresentation of fungi in conservation science. We recognise there are connections between how we experience and perceive our health, livelihood, environmental and climate challenges, and that the connections are often acute in rural communities in low and middle-income countries. What is special about our approach is that we will use the connections between how communities perceive their interconnected challenges, and the solutions they have already identified between them, to co-create an integrated health, livelihood and environmental education programme using multi-sector messaging, with SRH and

other health services, and delivered as part of a broader livelihood and conservation intervention.

Recent research highlighting the many benefits of this approach demonstrated that greater attention to community members and their self-expressed needs was essential to design effective programmes addressing health, environment, and livelihood needs. By developing culturally sensitive strategies that attend concurrently to these interrelated issues, we further gender equity in resource management by recognising women's pivotal roles in conserving fungal resources and enhancing their access to SRH services.

Our work contributes directly to calls for the need for evidence on the impacts of projects integrating health, conservation and livelihood action to support work for policy change. It is designed to simultaneously address a range of UN Sustainable Development Goals: good health and wellbeing (SDG3), gender equality (SDG5), climate action (SDG13), and life on land (SDG15), by bringing together a transdisciplinary team of academics from the Global South and Global North, along with NGOs working locally and internationally (SDG17). This also increases awareness of the role of fungi in sustainable development (see also Cantiero et al. in this issue).

We use an approach called the Population, Health, and Environment (PHE) framework developed to bridge health, conservation, and sustainable livelihoods. Recognising fungi's ecological and socio-economic roles in enhancing community resilience, ecological stability, and climate regulation, one of our key aims is to highlight women's critical roles in maintaining traditional knowledge about wild mushrooms (see also Løvaas in this issue). This knowledge exemplifies how fungi are at a nexus between conservation and SRH, addressing household food and nutrition security, income generation, and community-centred solutions for environmental and social resilience.

Further Reading

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Elizabeth Barron *is Professor of Environmental Geography, specialising in the human dimensions of fungal conservation, biodiversity politics, and environmental knowledge.* **David Johnson** *is an environmental conservation NGO leader, focussed on the connections between human and environmental health.* **Donatha Tibuhwa** *is Professor of Microbiology, specialising in fungal diversity, taxonomy, and ethnomycology, particularly mushrooms of ecological and socio-economic importance.* **Jennifer Infanti** *is Associate Professor in Public Health and Nursing, with interests in reproductive health, migration and health, medical anthropology, and resilience.*

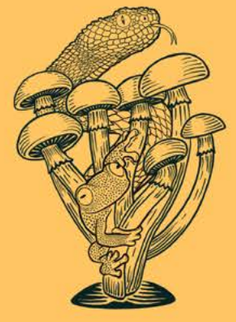
Shivani Shenoy *is an illustrator and visual designer. A storyteller at heart, Shivani enjoys playing with colours and patterns in her creative expressions. Her creative works are often based on her explorations with themes of nature and culture.*

TEMPORARY tattoo design CONTEST FUNGI

ANOMALIE TATT CO. X current conservation

This year, Current Conservation and Anomalie Tattoo Co., a Bangalore-based temporary tattoo brand, teamed up to celebrate fungi through a tattoo design contest. We invited submissions from artists across South Asia, and received a number of wild, whacky, and wonderful designs. After a rigorous selection process by a panel of judges, **we're delighted to congratulate the five winners!** The winning designs are now available on *www.anomalietattoo.com*.

ARNAB SIKDER



AKSHAY CHAUHAN

SHANYU BIHANI

DANYA SETHI

SOURAV PAUL

We're deeply grateful to our myco-minded guest judges Prithvi Kini and Malavika Bhatia (aka M) for lending their time and expertise to the selection process. Above all, we thank everyone who participated for sharing their creativity with us!

FESTIVITY AS A CONSERVATION STRATEGY IN WEST AFRICA

Authors **Ramdan Dramani, Adjimoti K. Wilfrid and Yorou S. Nourou** | *Illustrator* **Hitesh Sonar**

Scientific fieldwork often conjures images of solitude, sweat, and lots of insects, with maybe a few exciting discoveries along the way. For those of us working in fungal-rich forest habitats, the reality often encompasses all of that and more. In our case, it also includes celebrations.

Over the past year, we have been immersed in a research project on fungal conservation in Sub-Saharan Africa, looking at sustainability and implications for livelihoods. One of the project's goals is to restore fungi-rich habitat in sacred and community forests by planting native trees that live in symbiotic relationship with fungi, called ectomycorrhizal trees. These fungi are not just essential for forest health, they are also deeply woven into the lives, diets, and cosmologies of local communities across West Africa.

By working closely with these communities, we have come to understand something essential, not only about fungi and forests, but about joy, resilience, and the power of celebration in conservation.

Our work is based in northern Benin, in a landscape shaped by farming, fires, and fragmentation of natural habitats. The forests are home to a remarkable diversity of ectomycorrhizal fungi, including edible and medicinal species. Restoration in these areas is not just a matter of planting trees, it involves reviving whole ecological networks, and honouring the people who know them intimately. While this work is grounded in science, it is also grounded in local practice. The real magic happened not in the controlled conditions of the nursery, but in the beautiful, messy, communal space of the field.

Celebrating restoration

It started in Papatia village, comprising Fulani, Ditamari, and Baatonu ethnic groups. As community mobilisation dragged on, we began to worry about the level of motivation for our project. Sure, a few people were active, perhaps encouraged by the remuneration involved. The plan was to mobilise the local population around 8 AM every day to start filling bags with potting soil and installing firewalls around the transplanted seedlings.

In retrospect, we were going about it the wrong way by expecting to implement our protocol. We had arrived with our methodologies, but we were not really listening. One village elder, watching us linger until nearly 11 AM for work that was supposed to start at 9 AM, finally said, "This is not how things work here."

He was right. Then, he showed up with Pastis, a locally popular alcoholic drink. Children began gathering around the nursery, followed by their mothers. They came chatting and laughing among themselves, curious and relaxed. A few women began to sing softly. Within minutes, the singing grew louder. Someone clapped along. We had not planned a party, but a party, it seemed, had found us.

Women had been mobilised, and they quickly organised themselves. As songs echoed through the trees, one group threw themselves into the restoration activities while the other got busy preparing food. Over the course of the project, these spontaneous celebrations became a recurring theme, which helped sustain momentum and motivation throughout the restoration process. At each new planting site, community members brought their own way of celebrating.

There were moments when we wondered whether we were there to restore the forest or to attend a festival in its honour. At first, we were not sure what to make of it. As researchers, trained in scientific method and measurement, we had our eyes fixed on our data: numbers of bags filled with potting soil, survival rates of planted seedlings, numbers of participants, and gender balance. With time, we found ourselves setting aside the clipboard and joining in the festivities.

It was the first time we had witnessed this in the context of habitat restoration activities. However, such practices are common in Benin during farming work. Communities, often organised in cooperatives, gather by the dozens in a member's field to carry out the planned tasks collectively. While some focus on the work, others play drums or sing to motivate the group. We began to realise that these celebrations were not distractions, but rather a genuine source of motivation for our activities, even helping to increase the visibility of our project. Admittedly, some participants were more immersed in the festive atmosphere, but alcohol consumption was regulated and kept moderate. This aspect did tend to extend the duration of the work to longer than initially planned, and it required additional focus to avoid losing track of the data we needed to collect during the day, particularly survival rates. Most of the other data were usually collected at the end of the activities.

From a practical standpoint, the celebrations helped a lot. They brought people together across generations, inspired participation, and made everyone feel connected to the restoration sites. Hard work became something joyful. Even when the sun was merciless and the work physically demanding, people smiled and laughed.

Something more subtle was happening as well. These moments offered glimpses into the cultural dimensions of fungal knowledge, how these communities name, gather, cook, and value mushrooms. Women explained the songs they sang while working, which often carry messages of motivation and hope. These experiences showed us that cultural habits can in fact be the foundation of collaboration with local populations. Through their joy, people expressed a profound relationship with the land, one that has survived through generations.

Lessons for conservation scientists

There is a temptation in conservation work to treat community engagement as a box to be ticked, a stakeholder meeting here, a workshop there. However, policy frameworks, research collaborations, and project designs increasingly acknowledge that local communities are not just passive stakeholders, but active stewards of the landscapes they inhabit.

We recorded measurable indicators, but we also learned to listen to stories and attune ourselves to the emotional undercurrents that shaped these gatherings. What we witnessed during these activities challenged some of our own assumptions. The most powerful connections we experienced came from walking with villagers under a full sun, our hands still dirty from planting trees. Those moments taught us to rethink what counts as data.

In conservation science, we are trained to strive for measurable outcomes, to approach nature through the lens of management and protection. The communities we worked with taught us that conservation does not have to be serious. In fact, joy can be a strategy, one that builds stronger bonds between people and ecosystems, and that sustains engagement over the long, often difficult, arc of restoration work.

Incorporating festivities into restoration activities does not mean abandoning scientific rigour. It means broadening our definition of what success looks like. It means understanding that ecological resilience is deeply intertwined with cultural vitality. Restoration efforts that ignore the human dimension risk being shallow and short-lived.

While celebration may at first seem unrelated to ecological restoration, it can play a vital role in building trust and strengthening collaboration between researchers and local communities. Participating in shared moments dancing, eating together, exchanging stories beneath trees allows us to step beyond our roles as scientists. The success of restoration initiatives cannot always be fully captured by metrics like seedling survival rates or carbon storage. It is also reflected in more subtle but important outcomes, such as the quiet pride felt by local communities who took part in restoration efforts and now benefit from the ecosystem services provided by the restored sites.

In this way, restoration becomes not only an ecological process but a relational one about reweaving connections between people and their environments, and among community members themselves. Acknowledging and participating in these shared cultural expressions, including song and dance, is not a distraction from conservation. It can be a meaningful part of it.

Dramani Ramdan *is a conservation ecologist and mycologist working at the research unit Tropical Mycology and Plant-Soil Fungi Interactions at the University of Parakou, Benin.* **Adjimoti K. Wilfrid** *is a socio-economist working on the sustainable use of wild edible fungi to address gender equality and to foster rural women's empowerment.* **Yorou S. Nourou** *is a Professor in Environmental Science at the Faculty of Agronomy and head of the research unit Tropical Mycology and Plant-Soil Fungi Interactions at the University of Parakou, Benin.*

Hitesh Sonar *is an illustrator and graphic artist from Mumbai. He has worked on various projects from book illustrations, magazines, to editorial illustrations and animation backgrounds.*

HOW LICHENS CAN SOLVE OUR NITROGEN POLLUTION PROBLEM

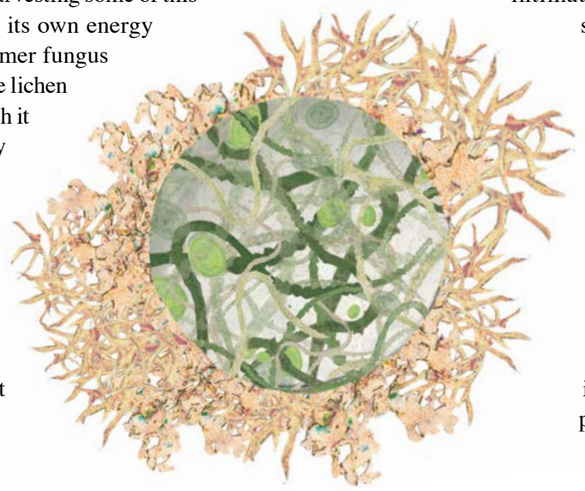
Author **Christopher Ellis**
Illustrator **Deepika Nandan**

You might have noticed lichens growing on trees, or rocks, or soil, in both rural and urban environments. These relatively small but beautiful organisms can be powerful bioindicators used to monitor, manage, and reverse environmental harm in the transition to a more sustainable future.

Lichens are sometimes referred to as 'mini-ecosystems'. This is because they are not one thing but composed of at least two functionally different partners that coexist in regulatory balance. One partner—an alga or a cyanobacteria—is a primary producer, using photosynthesis to create sugars for food. The other partner—a fungus—is a consumer, harvesting some of this food production to meet its own energy requirements. The consumer fungus creates the structure of the lichen (the 'thallus'), within which it protects the primary producer from harm, be that herbivores or excess light. Lichens are therefore created by fungi that have evolved this specialist mode of nutrition, and different lichens represent different fungal species.

A key feature of lichens is that they are very sensitive to ambient environmental conditions. When conditions are wet, they hydrate and become physiologically active. When conditions are dry, they desiccate and become physiologically dormant. They also absorb atmospheric nutrients to meet their mineral requirements. This ability to live independently of the soil, by accessing water and sequestering nutrients from the surrounding air, or rainfall, allows lichens to live in extreme habitats, such as on the surface of rocks, or attached to tree-bark as epiphytes.

Ecologically successful, lichens can be found from the tops of the highest mountains to the seashore, and from tropical rainforests to deserts. However, their intimate connection with the surrounding environment also creates a vulnerability. As well as allowing lichens to colonise into extreme habitats where few other organisms can survive, they are rendered extremely sensitive to changes in the wider chemical environment, including the effects of pollution.



The global pollution problem

Pollution—waste from human consumption unsustainably emitted—is not a new problem. Lead pollution from Roman metallurgy can be detected in peat and lake cores across northern Europe and is thought to have increased human mortality rates at that time. However, particularly since the industrial revolution, the environmental damage from pollution has accelerated. Pollution is now identified as one the major drivers of biodiversity loss and ecosystem harm worldwide, along with habitat loss, climate change, and invasive species.

Arguably, one of the planet's greatest problems is nitrogen pollution. The invention of the Haber-Bosch process in the early 20th century allowed the industrial production of ammonia, including for chemical fertilisers that supply extra 'reactive nitrogen' (Nr) to remove key limits on plant growth, fuelling the 'green revolution'. Despite clear success in feeding the global population, on average about only half of the Nr supplied as either natural (slurry) or industrial fertiliser is taken up by crops, with the rest leaked into the wider environment as air or water pollution.

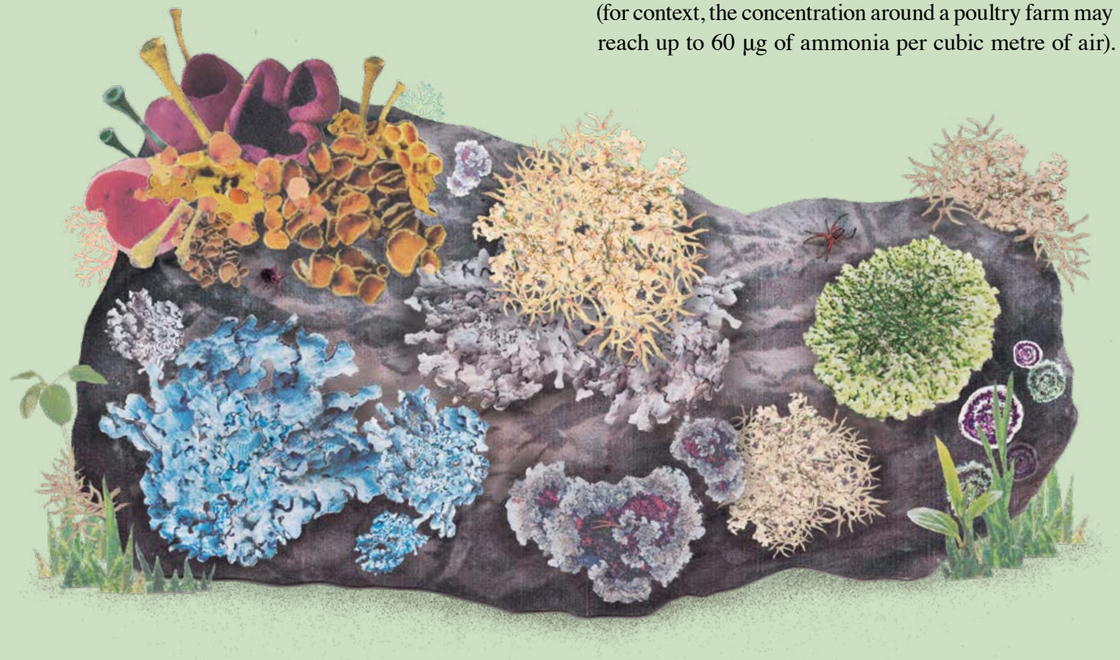
This excess nitrogen kills sensitive species and simplifies ecosystems. It's also a precursor to atmospheric particulate matters (PM2.5 and PM10) that are estimated to contribute to approximately 7 million excess human deaths annually, and overall results in a global economic cost estimated at US$200-2,000 billion per annum in terms of environmental remediation.

Can lichens help?

Lichens sequester nitrogen directly from atmospheric sources in solution or as dry deposition, and different lichen species are adapted to contrasting levels of nitrogen. On this basis, the types of lichen that are found at a given location can be used as bioindicators to assess how much nitrogen is present.

The sensitivity of some lichen species makes them excellent indicators of emerging ecosystem harm, measured as the point at which these lichens are negatively impacted by nitrogen.

For example, 1 µg of ammonia per cubic metre of air has been used to set a 'critical level' for monitoring and managing nitrogen air pollution in the UK and Europe (for context, the concentration around a poultry farm may reach up to 60 µg of ammonia per cubic metre of air).



In this way, lichens can help to make invisible air pollution visible. As such, lichens are a powerful tool for citizen science and wider public education.

Research in many temperate regions (including Europe and North America) has helped to establish critical levels (concentration limits) and critical loads (deposition limits) around which to regulate and control nitrogen pollution. However, the nitrogen problem has swung towards the tropics. In South Asia, the Indo-Gangetic Plain in northeastern India is where global nitrogen pollution is accelerating most rapidly at 2–7 percent per annum based on trends for 2000–2015, and it already has among the highest concentrations of ammonia globally.

The wider South Asia region is a biodiversity hotspot as well as home to approximately 1.9 billion people, posing the risk that if nitrogen pollution continues unabated then nature-based socio-economic structures could collapse. To address this problem, the UK Research and Innovation South Asian Nitrogen Hub (SANH)—which aims to reduce regional nitrogen pollution for the benefit of people and nature—sought to establish a robust set of critical levels and critical loads for the South Asian tropics, based around the use of lichens as bioindicators.

The deeper relevance of using lichens as bioindicators within South Asia is that they are also a commercially important non-timber forest product, being traded into the perfume industry, as well as having wider cultural value—as a source of food and medicine, and for ritual symbolic purposes.

New evidence

To better understand the sensitivity of tropical lichens to nitrogen, the SANH team generated a new experimental platform in which ammonia was released into a forest plot, creating high concentrations close to the source, and diminishing to background concentrations within 30–40 metres. Under close control depending on the weather conditions, it was possible to generate a predictable plume of ammonia along which lichens could be monitored, and into which lichens could be translocated, and their response measured.

Tested initially for a site close to Edinburgh in Scotland, with help from the Dilmah tea company, the experimental platform was recreated in an upland tropical forest in Sri Lanka. In a first ever direct comparison across temperate and tropical zones, the paired sites are now revealing how the combination of nitrogen dose and exposure period affect lichen physiology, and cause changes in lichen diversity for a tropical forest.

This research has several important repercussions. A benchmark SANH report, *Nitrogen Pollution in South Asia: Scientific Evidence, Current Initiatives and Policy Landscape,* reviewed 966 policy instruments operative in 2019 and concluded: "South Asian nitrogen-related policies are typically qualitative in nature and rarely set quantitative targets for reduction. Very few policies try to manage [nitrogen] pollution in a measurable way."

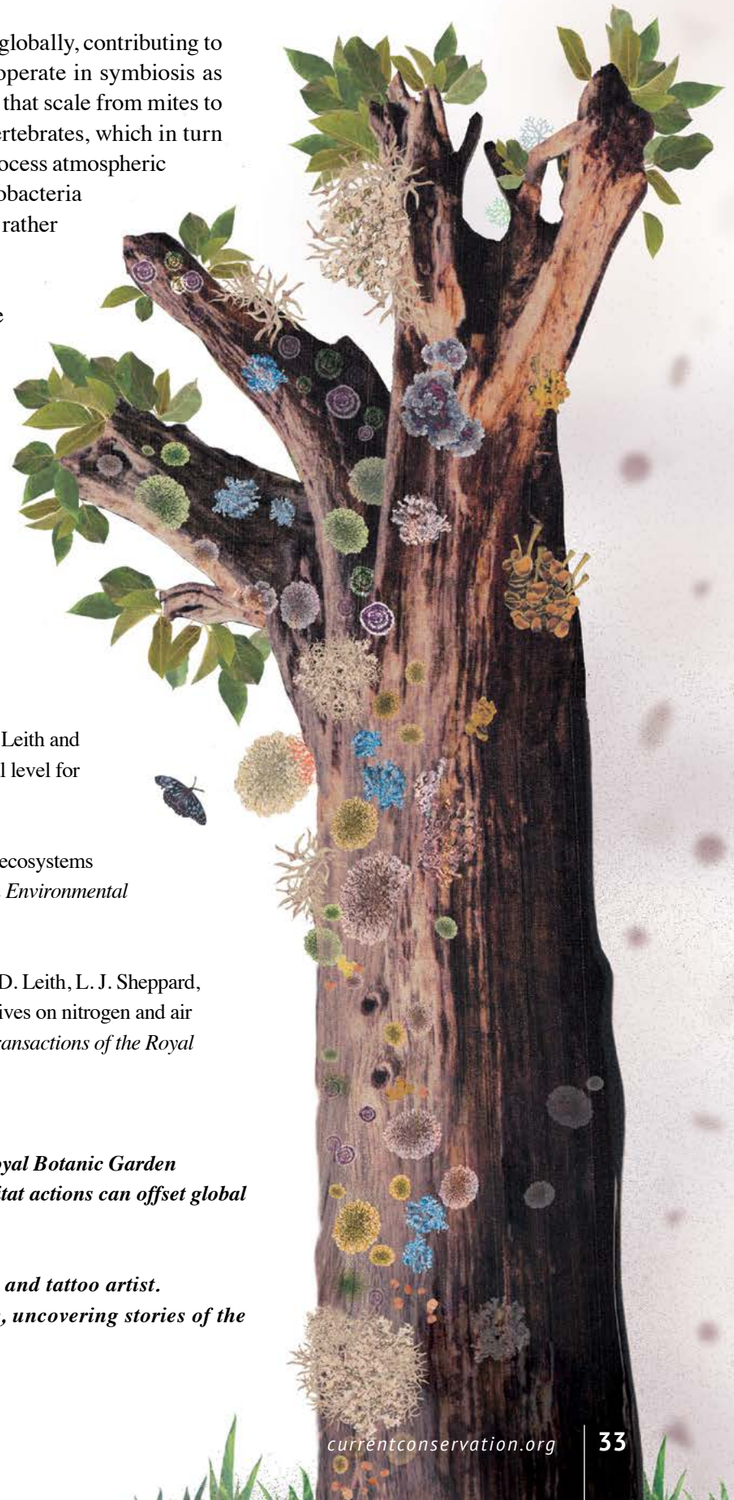
The new data generated for tropical lichens by SANH can be used—as has been the case in the UK and Europe—to provide the quantitative targets (critical levels and critical loads) around which the regulation and management of nitrogen can be formulated. However, nitrogen monitoring is also essential to achieve adaptable and goal-orientated nitrogen management.

Monitoring capacity is limited in South Asia, which has only 2 percent of the capacity delivered in the UK by the National Ammonia Monitoring Network, despite it being a region that is far larger and more geographically complex. Here again, the lichens can help. Having created a better understanding of the nitrogen response of lichens in the region (which species are more or less sensitive to excess nitrogen), they can be used as bioindicators to monitor nitrogen levels, and assist with mapping and managing nitrogen pollution in South Asia. To this end, the experimental studies paired between sites in Scotland and Sri Lanka are complemented by field-based monitoring of lichens for different climatic regions of the Himalayas, in Pakistan, Nepal, and Bhutan.

Lichens matter

There are about 30,000 species of lichen-fungi globally, contributing to the Earth's extraordinary biodiversity. They operate in symbiosis as primary producers, providing food for animals that scale from mites to caribou. They create habitat structures for invertebrates, which in turn support bird populations. They sequester and process atmospheric water and nutrients, and the lichens with cyanobacteria can 'fix' nitrogen directly from the atmosphere, rather like the nodules of legume roots.

As described for this regional South Asian case study, lichens can be both commercially and culturally important. They are also vulnerable to habitat loss, to climate change, and to pollution. However, as demonstrated here for nitrogen, the vulnerability of lichens can be characterised and used to bolster our efforts to become more aware of and to reverse environmental harm.



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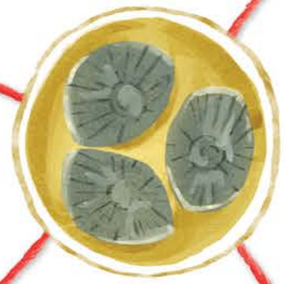
Christopher Ellis *is a lichenologist at the Royal Botanic Garden Edinburgh. His research explores how local habitat actions can offset global change threats to biodiversity.*

Deepika Nandan *is an illustrator, animator, and tattoo artist. Her practice draws from place and community, uncovering stories of the biosphere, care, and coexistence.*

Integrating fungi in policy for a sustainable future

Authors **Cátia Canteiro, Adriana Corrales, Toby Kiers and Kelcie Walther**
Illustrator **Manvi Vakharia**

Conservation is at a critical juncture, as many acknowledge the need for a new paradigm that centres collaboration with living systems. And this new paradigm is increasingly recognising the role of fungi in shaping our world.



Fungi are the second most diverse group of species after insects, with an estimated total of 2.5 million species across terrestrial, freshwater, and marine environments. Fungi underpin all life on Earth, playing important roles in nutrient-carbon cycling, decomposition, and regeneration. Most plants depend on fungi for survival, and many animals rely on them for food and water. Fungi are also crucial for our food security, livelihoods, and the economy, supporting multi-billion dollar industries in edible mushrooms, antibiotics, biofuels, and even plastics and building materials. Coffee, bread, chocolate, and penicillin would not exist without fungi!

How can we leverage the power of fungi for effective change at the policy level? First, we need to understand where these organisms live. The Society for the Protection of Underground Networks (SPUN) is one of various organisations and initiatives focusing on the collection, monitoring, and conservation of soil microbial communities. Other initiatives include the African Microbiome Initiative, the Australian Microbiome Initiative, the China Soil Microbiome Initiative, SoilBON, the European LUCAS soil survey, the Earth Microbiome Project, the Global Soil Mycobiome consortium, and GlobalFungi.

This work, leveraged with a growing body of scholarship on fungal conservation science and social science, can make important contributions to a range of international policies and initiatives. Here we present an overview of a possible first set of interventions.

Fungi in the spotlight

Historically, fungi have been overlooked in climate solutions, biodiversity assessments, and conservation targets due to a lack of data and expertise, as well as a misunderstanding that they were plants rather than an independent kingdom with unique chemical and physical attributes. Fungal conservation efforts began slowly in the 1980s and 1990s with initial research on the impact of air pollution on mycorrhizal species (which form symbiotic relationships with plant roots) in Europe, the impact of deforestation on fungi in the northwestern US, and organisations being formed in Cuba and within the International Union for the Conservation of Nature (IUCN).

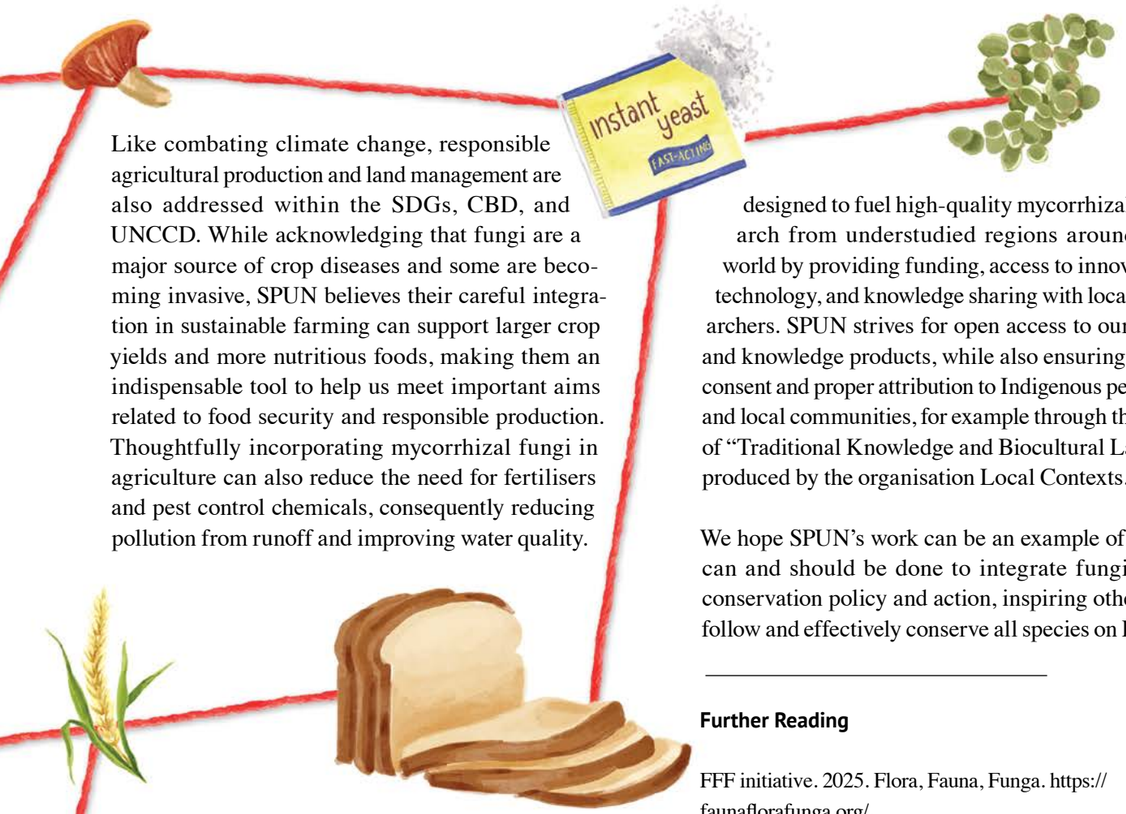
The 2000s saw a more rapid change, with expansion to five IUCN specialist groups in 2005 and the Declaration of Cordoba in 2007, calling for effective conservation and sustainable use of fungi. Since 2015, there has been a significant increase in efforts to evaluate the extinction risk of fungal species through the Global Fungal Red List Initiative. Supported by the IUCN, newer organisations such as Fungi Foundation have called for an increased recognition of fungi as one of the three kingdoms of life critical for conservation (see Flora, Fauna, Funga initiative). As a consequence of this campaign, in 2024 the National Geographic Society even changed its definition of 'wildlife' to include fungi.

Nature-based solutions

With many fungal species at high risk of extinction due to habitat loss, climate change, and pollution, urgent recovery action, restoration, and protection of fungi are needed. Because of their intrinsic relationships with plants, animals, and humans, protecting fungi offers a wide variety of nature-based solutions to support plants, ecosystems, and human communities. There are a host of international agreements and programmes whose goals will be enhanced and better met by taking these points into consideration, including the United Nations Sustainable Development Goals (SDGs), Convention on Biological Diversity (CBD), and United Nations Convention to Combat Desertification (UNCCD).

Protecting and ensuring the sustainable harvesting of wild edible and medicinal fungi will contribute to the protection of biodiversity as suggested by the CBD, and to SDGs related to combating world hunger, providing work and economic security through responsible means, and managing nature in ways that benefit nature and people. Furthermore, mushroom hunting is often an important source of income for women in rural communities. Thus, ensuring the sustainable and equitable use of fungi also promotes gender equality, an important goal for the SDGs and the UNCCD.

Fungi can also be integrated as a nature-based solution to prevent and mitigate some threats related to climate change, farming, and pollution. More than 90 percent of plants—including trees and food crops—have mycorrhizal fungi associated with their roots through symbiotic relationships. This particular group of fungi helps plants efficiently absorb nitrogen, phosphorus, and other critical nutrients, while drawing carbon down into the soil. Mycorrhizae also improve plants' capacity to absorb water from the soil and their resilience to drought. Soils store 75 percent of terrestrial carbon, and mycorrhizal fungi play a crucial role in keeping that carbon in the ground, which helps regulate the Earth's climate—an important part of all the international agreements mentioned above. These fungi also support crop resilience against pests and diseases, and maintain soil health and stability.



Like combating climate change, responsible agricultural production and land management are also addressed within the SDGs, CBD, and UNCCD. While acknowledging that fungi are a major source of crop diseases and some are becoming invasive, SPUN believes their careful integration in sustainable farming can support larger crop yields and more nutritious foods, making them an indispensable tool to help us meet important aims related to food security and responsible production. Thoughtfully incorporating mycorrhizal fungi in agriculture can also reduce the need for fertilisers and pest control chemicals, consequently reducing pollution from runoff and improving water quality.

Protecting underground networks

A key priority for SPUN is identifying hotspots of diversity and endemism of mycorrhizal fungi to inform effective spatial planning, management, and protection, and to map the contribution of these fungi to carbon drawdown and climate mitigation. Additionally, SPUN has been partnering with other organisations, such as The Nature Conservancy, to implement more effective, evidence-based restoration and management practices, and priorities informed by data on mycorrhizal fungi diversity.

SPUN participates in international meetings, such as the recent 16th meeting of the Conference of the Parties to the Convention on Biological Diversity. It's also part of a group of experts leading the development of a Global Strategy for Fungal Conservation that closely aligns conservation and research strategies with the CBD Global Biodiversity Framework targets. This strategy will support mycologists, conservation practitioners, decisionmakers, and governments in integrating fungi into the implementation of the CBD targets.

At the core of SPUN is a network of external collaborators sampling mycorrhizal fungi worldwide as part of our Underground Explorers Program. This granting programme is designed to fuel high-quality mycorrhizal research from understudied regions around the world by providing funding, access to innovative technology, and knowledge sharing with local researchers. SPUN strives for open access to our data and knowledge products, while also ensuring prior consent and proper attribution to Indigenous peoples and local communities, for example through the use of "Traditional Knowledge and Biocultural Labels" produced by the organisation Local Contexts.

We hope SPUN's work can be an example of what can and should be done to integrate fungi into conservation policy and action, inspiring others to follow and effectively conserve all species on Earth.

Further Reading

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Cátia Canteiro *is the Biodiversity Conservation Strategist,* **Adriana Corrales** *is the Lead Field Research Scientist & Underground Explorers Program Director,* **Toby Kiers** *is the Executive Director & Chief Scientist (as well as a Professor at Vrije Universiteit Amsterdam), and* **Kelcie Walther** *is the Press & Media Relations Lead, Science Communications, at the Society for the Protection of Underground Networks (SPUN).*

Manvi Vakharia *is a freelance illustrator and visual designer based in Mumbai, India. Her work is drawn from her experiences with the natural world, heritage, culture and travel.*