Agriculture and Human Values (2023) 40:359–371
https://doi.org/10.1007/s10460-022-10366-7

Sympoietic growth: living and producing with fungi in times of ecological distress

Tereza Stöckelová[1] · **Lukáš Senft**[1] · **Kateřina Kolářová**[1]

Accepted: 15 September 2022 / Published online: 15 October 2022

Abstract
Drawing upon ethnographic research on human living and producing with fungi, and Haraway's theorization of sympoiesis and the model ecosystems of mycorrhizae developed in current mycological research, we offer a concept of *sympoietic growth*. Sympoiesis is a concept that suggests a way of thinking about growth as a more-than-human process and provides an alternative political imaginary both to current forms of economic growth and to the idea of "degrowth." We explore human-fungi co-operation in forests, an urban park, and a shopping mall, on a miso production farm, and in a Catholic parish to provide insights into the logic and relationships involved in sympoietic growth in the field of agriculture and food production. We argue that this form of food provision has a sustainable, (re)generative potential not only in ecological and social but also economic terms. In conclusion, we highlight three patterns of sympoietic growth: the absence of any urge to "take (back) control" over the multispecies dynamic on the part of the humans; a non-instrumental passion for more-than-human life; and a combination of intellectual and manual labor as a form of attachment to the more-than-human world.

Keywords Degrowth · Fungi · Model ecosystems · Mushroom foraging · Sympoiesis

Introduction

The current prevailing forms of economic growth, which require constant acceleration of industrial, agricultural, and cultural production, are causing environmental and climate disruption. Even the strategies for "green growth" have been repeatedly criticized for their environmental (un)sustainability (Parrique et al. 2019). Despite this, economic growth has retained its nearly hegemonic position. It is again being hailed as the way to recover from the Covid-19 pandemic. At the same time, the ongoing global crises have highlighted the fact that food security can no longer be taken for granted even in the countries of the global North. The changes that need to be made in the agricultural sector must take into account and address multiple challenges, including the ecological and climate impacts of food production, and economic affordability of basic foods (European Commission 2020).

Efforts to substantially rethink the current forms of growth have mobilized concepts such as "degrowth" (Kallis 2011), "responsible stagnation" (De Saille and Medvecky 2016), and "growth agnosticism" (Raworth 2017). However, like the concepts of growth that have been criticized, these counter-concepts presume a dualism of society and nature, where human production is in conflict with the limits of the planet and results in the destruction of nature. Contemporary discussions about the future of (de)growth are moreover essentially anthropocentric (Richter 2019). Humans control the exploitation of ecosystems and, from the degrowth perspective, humans can thus also control, for example, the liberation of animals (Leitinger 2020). The anthropocentric perspective implies questions such as: What resources will *people* use? How much will *humankind* produce? Or how can *we humans* land, following a controlled descent, the airplane of economic growth? (Raworth 2017, p. 218; emphasis added).

"Doughnut economics," which "highlights the dangers of ignoring the role of energy and nature's resources—and the far-reaching implications for economic growth" (Raworth

✉ Tereza Stöckelová
tereza.stockelova@soc.cas.cz

Lukáš Senft
lukas.senft@soc.cas.cz

Kateřina Kolářová
katerina.kolarova@soc.cas.cz

[1] Institute of Sociology of the Czech Academy of Sciences, Jilská 1, 110 00 Prague 1, Czech Republic

2017, p. 3), is an illustrative example of a concept based on the dualism of society and nature. In Raworth's model, the outer edge of the doughnut denotes nature's resources, which impose limits on economic growth, while the inner boundary represents the limits of social wellbeing. The "embedded economics" of the doughnut then defines the possible space for an economy that neither exceeds the planet's limits nor compromises human needs.

The ideas of degrowth, stagnation, or agnosticism challenge the prevailing model of economic growth as the only realistic possibility. But so far, they have failed to secure broader political support. We believe this cannot be fully explained by theories about the "growth addiction" of contemporary societies (Raworth 2017, pp. 221–230). If we look at life beyond the human, degrowth and stagnation seem counter-intuitive. Life around us grows. The modes of growth may be diverse, be marked by conflicts, and involve the decay of organisms. But it is doubtful that life beyond the human can serve as a model for the notion of degrowth or stagnation. As Gomiero (2018) noted, the concept of degrowth has so far engaged with agriculture only to a limited degree. We argue that a focus on agriculture and food production could provide an important source of inspiration and social imaginaries for transforming the growth economy without abandoning the notion of growth itself and for rethinking the growth economy along ecological lines.

Drawing on an ethnographic study of humans living and producing with fungi in the Czech lands, we examine how fungi can help us envision other modes of growth in the agriculture and food production sector. The recently published book *Food for Degrowth* (Nelson and Edwards 2021) initiated an important debate with a focus on alternative food production. Yet it leaves aside practices of foraging, and does not engage with fungi and the possible roles they can play in sustainable food provision. We follow up on the issues raised in that publication and explore the ways in which economic growth can be conceived of as more-than-human and as an extension of nonhuman life.

For our speculative fabulation (Haraway 2016) on the possibilities of growth, we turn to forests, markets, and kitchens in the Czech Republic. Mushroom foraging and cultivation have long been popular activities in the country, engaging and (re)producing a dense network of more-than-human or multispecies collectives. Mushrooms are part of the Czech Republic's formal and informal economies and its food production, and its articulation of its moral values. These practices include various models of more-than-human cooperation and socioeconomic relations, and thus lend themselves as suitable terrain for imagining and analyzing novel modes of growth.

We ask: What are the conditions in which non-humans co-produce and benefit from human growth? What kinds of multispecies ethics and passions support such forms of growth? Do forms of more-than-human cooperation offer modes of labor division that are alternatives to the ever-increasing specialization and speciation? What are the possibilities for growing relationally and with an acknowledgement of the presence of decay and extinction?

Drawing on the concept of sympoiesis or "worlding-with, in company" developed by Donna Haraway (2016), we develop here the concept of "sympoietic growth." Haraway builds on Beth Dempster (2000), who describes sympoietic systems as collectively made, where information and control are distributed among components. As Haraway puts it: "If it is true that neither biology nor philosophy any longer supports the notion of independent organisms in environments, […] then sympoiesis is the name of the game in spades. Bounded (or neoliberal) individualism amended by autopoiesis is not good enough figuratively or scientifically; it misleads us down deadly paths." (Haraway 2016, p. 33) Building on Haraway and the recent scholarship concerned with multispecies coexistence (in particular Tsing 2015; Lorimer 2020; Faier and Hathaway 2021), we propose to include more-than-human agency into the terms and imaginary of the (de)growth debate, and consider economic growth to be a sympoietic creation, the dynamics and control of which are distributed among human and non-human growers.

First we describe our research design and data and the tradition of mushroom picking and use in the Czech lands. We then discuss selected developments in the field of mycological studies today that informs our research participants' and our own biosocial imagination. We develop our core argument through three case studies of human-fungal coexistence, in which we examine human economies and modes of living in extension with fungi growth. We conclude by outlining the main features of a transformation that might constitute an alternative mode of economic growth.

Fieldwork and forest work

This paper draws upon ethnographic fieldwork conducted in forests, markets, shopping malls, kitchens, labs, and other spaces and venues where mushrooms grow and are studied, cultivated, and traded. The fieldwork started in 2020 and has been ongoing with varying intensity and in different forms, reflecting both the rhythm of local mushroom growth and the course of the Covid-19 pandemic. Participant observation allowed us not only to follow people as they engaged in activities connected to mushroom picking and use but also to partake in and sense (smell, taste, and feel) our research participants' engagement with multispecies collectives. Accompanying our research participants as they were *moving* through space and *relating* to more-than-human forms

of life proved to be a valuable strategy for generating data (Springgay and Truman 2018).

In addition, we carried out 16 in-depth research interviews with Czech mushroom foragers, growers, and users. The interviews focused on how our research partners obtained and how they shared their knowledge about mushrooms, on how they find and identify mushrooms, and on the specific features of the mushroom economy. Three interviews were with miso producers who use *Aspergillus oryzae* (koji) in their products and one interview was with a practitioner of Traditional Chinese Medicine, who is a major importer of medicinal mushrooms. We also fielded an online semi-structured questionnaire among the members of the Czech Mycological Society, which yielded 41 responses.

This paper is the outcome of a larger project in which we explore human coexistence with fungi and microbes and the forms of biopolitical citizenship this engenders. We arrived at our conceptual focus on sympoietic growth after carrying out open data coding of our project dataset, on which basis we also selected and conducted further research into three case studies. Guided by Flyvbjerg (2006) we selected cases that could be identified as "paradigmatic" in that they represent the more general characteristics of the practices in question. At the same time, we sought to explore the concept's "variability" and therefore chose cases that that differ from one another in some significant parameters (such as the type of fungi and scope of the economic transactions).

We approached our human research participants not only as mushroom connoisseurs but also as intellectual partners. Many of them are to different extents and in different ways engaged in caring for the wider cultural and ecological aspects of their mushroom practice and the political economies they are embedded in. Some of them think of their practices as contributing to a much needed socioeconomic and ecological transformation; others do not. We discussed these issues with them but we also shared existing anthropological studies to seek their comments. Sometimes they surprised us with deeply engaging and fresh insights that enriched our own conceptual approach.

The Czech tradition of mushroom picking and use

In the Czech Republic, the picking, cooking, and eating of mushrooms is a part of the popular culture. According to the Ministry of Agriculture, 83.5% of households practiced mushroom foraging in 2020. Between 2010 and 2020, on average over 25,000 tons of edible mushrooms—with an estimated value of 165 million EUR—were picked annually in the country's forests (Ministry of Agriculture 2021, pp. 46–48). Most of these mushrooms never reach the official market; they are collected for private use, and gifted to family members, friends, and neighbors.

Like in Finland (Tsing 2015, pp. 175–176), in the Czech Republic the principles of public forest use developed out of historical laws that date back to the Middle Ages. Today, collecting forest crops, including mushrooms, is allowed under the principle of general forest use. As the "productive function" of the forest only covers the cultivation of wood, anyone can harness the "non-productive functions" and collect forest crops and dry wood for personal use. A rich network of activities extends from the intergenerational transfer of the knowledge and skills of mushroom collecting and from the passion that feeds this practice.

The founding figure behind the organized activities connected with mushroom picking was František Smotlacha. In 1921, he established the Czechoslovak Mycological Society—one of the first mycological organizations in the world (Lišková 2017). In 1947, Smotlacha published the *Atlas of Edible and Non-Edible Mushrooms*, where he claimed to have tested the edibility of 1700 mushroom species and recommended more than a thousand species as suitable for consumption (Kamen 2017, p. 62). With no formal education in biology, he was a sort of citizen scientist. The Czechoslovak and later Czech Mycological Society brought together experts and amateur mycologists throughout the turbulent 20th century and under all of its different political regimes.

Currently, the Czech Mycological Society has branches in many locations around the country. In recent years, mushroom foragers have also started to form groups on social media. For example, the popular Facebook group "Fungi and where to find them" has 78,000 members. These channels of exchange cut across generations, regions, and educational backgrounds. Mushroom foragers use these resources not only to learn how to identify mushrooms, but also to gain an understanding of the ethics of foraging and the use of forests as a commons.

Microfungi (brewer's yeasts in particular) have been widely used in food and beverage production for centuries. However, koji mold, which features in one of our ethnographic case studies, is a recent newcomer to Czech kitchens and agrifood production. Koji-based products only began to be imported in the 1990s and mostly for use in communities pursuing a macrobiotic and other alternative diets (cf. Shurtleff and Aoyagi 2021, p. 579). The first Czech (small-scale or domestic) producers of koji products only started to emerge in connection with the recent wider interest in fermented foods.

Knowing fungal growth

Mushrooms have become a topic of interest across the global North. The non-expert public has become fascinated with "entangled life" (Sheldrake 2020) and with fungal

microcosmos, in which "a single gram of soil can contain up to 90 m of mycelium" and "the total length of mycorrhizal mycelium in the top ten centimeters of soil is around 450 quadrillion kilometers: around half the width of our galaxy." (SPUN n.d.) Mycelium has been described as a "forest internet" in which a supposedly altruistic sharing of information and substances takes place. It has thus become a metaphor for solidary networks that facilitate mutual gift-giving.

Studies on the beneficial uses and positive externalities of mycorrhizal mutualism and fungal growth are widespread. They are mostly concerned with how fungal networks protect plants from pathogens, herbivores, and drought, and how mycorrhizal fungi also contribute to the heavy metal tolerance (Hildebrandt et al. 2007) and water uptake of plants (Khalvati et al. 2005). Dried mycelia that provide material for "green" business are praised as a "revolutionary, smart, and sustainable manufacturing platform" that will "shape the future." (Gandia et al. 2021) Another strand of research focuses on the substances in some mushrooms that cause altered states of consciousness, such as psilocybin intoxication, and their potential use in the treatment of anxiety and depression (e.g. Tylš et al. 2016; Carhart-Harris et al. 2017).

However, mycologists have recognized mycorrhizal relations that go far beyond (and even challenge) the popular romanticized metaphor of the "socialist forest." (Mcfarlane 2016) For instance, orchid mycorrhizal fungi are asymmetrically exploited by related plants that obtain both the carbon and nutrients they need from the fungi. Arbuscular mycorrhizal fungi penetrate the roots of plants and "forage" for valuable nutrients in the soil (e.g., phosphorus), which they then exchange with the plant mainly for carbon.

Evolutionary biologist Toby Kiers and her colleagues conducted a study of how arbuscular mycorrhizal fungi cope with resource inequality. They established that when there was *less* phosphorus in the soil, i.e., when it was a scarcer resource, the plant provided *more* carbon in return (Whiteside et al. 2019). These mycorrhizal networks seem to follow a "supply and demand" rule (Sheldrake 2020, p. 142). The effort of fungi and plants to increase the benefit from their mutual relationship are currently conceptualized by mycologists as business strategies and in terms of "biological markets" (Van't Padje et al. 2021).

Finally, fungi are also researched to understand their adaptability to changing environments (Winder 2013). While some studies point to the threats to mycorrhizal fungi from climate change (Větrovský et al. 2019), mycorrhizal fungi are frequently modeled as flexible networks that are able to reduce plant stress (Bidartondo et al. 2018) and should be considered "allies" in the climate change crises because of their ability to function as a "major global carbon sink" (Kiers and Sheldrake 2021). In these studies, fungi come out as resilient, highly adaptable life forms that can respond to climate change by, for instance, extending their fruiting season (Boddy et al. 2014) and/or exhibiting high resistance to drought stress (Alster et al. 2021).

In current mycological research, fungal ecosystems are thus represented with and in a heterogeneous set of scientific models. Paxson and Helmreich (2014) analyzed the current public uptake of microbiology and argued that microbes—and we would add fungi—"are being upheld as *model ecosystems* in a prescriptive sense, as tokens of how organisms and human ecological relations with them *could, should*, or *might* be" and how "dominant representations of microbial life have shifted from an idiom of peril to one of promise" (2014, p. 165). Inspired by Paxson and Helmreich, we trace how Czech mushroom foraging and cultivation practices engage fungal ecologies as prescriptive models for negotiating multispecies economies, social associations, and environmentality.

Our researcher participants are not professional mycologists and they may not be up-to-date on all the latest findings from current mycological research. However, they are avid readers of other forms of academic literature, including work on paleoclimatology, microbiology, and ecology, which they combine with their own daily engagements with fungi and more-than-human life more generally. In our study, we observe how scientific models of fungal ecologies shape and are shaped by the everyday practices of our participants—their social and economic relations, ontological assumptions, ethics, and spirituality. We ask what modes of multispecies growth the models implicate.

Given the diversity of mycological research as sketched above, it is clear that our research participants draw on different model ecosystems and different aspects of fungal "nature." As we show in the following section, the fungal normativity that co-shapes our participants' practices engage four features of fungal ecologies in particular: (1) the forest underground as a selfless and solidary community of plants and fungi; (2) fungi as highly resilient "smart" organisms capable of adapting to the changing environment; (3) mycorrhizal relationships as a complex market system determined by supply and demand; (4) the fungal microcosm as a vast and interconnected network that mediates sustainable planetary relationships. Each case study presented below involves a distinct assemblage of these features and deploys them in a process of sympoietic growth.

Growing with fungi: three biosocial mycorrhizae

This section draws upon ethnographic material involving the diverse ways and places in which humans live and coexist with fungi and other life forms. We invite the reader to engage with three *mycorrhizae,* which we refer to as "Woodspeople," "Artisans," and "Parish." We introduce

mycorrhizae here as an alternative to a "case study" in order to attune our and the reader's conceptual register to the organic and mutable character of the actor-networks involved. Our human interlocutors should not be regarded as the "center" around which the mycorrhizae extend. We see them instead as (one of the many) fruiting bodies that grow out of vast biosocial assemblages that the humans are not in command of.

In focusing on these three particular mycorrhizae, it is not our aim to establish any one single model of sympoietic growth or classify this growth into distinct subtypes. Rather, the mycorrhizae we selected allow us to explore the variety and richness of possible modes of human growing with fungi. We examine the variability of sympoietic growth. As noted above, two of the studies involve macromycetes collected in forests and one engages with a micromycete cultivated on a farm. In two of the three studies, growing with fungi is a significant source of income for the humans and the fungi become commodities; in one case, any financial transactions are minor and the mushrooms circulate mostly as gifts in the multispecies community involved. The three mycorrhizae also differ with regard to the scale and modality of the key economic transactions (production, trade, and the exchange of ideas, substances, and values) that they deploy. Table 1 summarizes key characteristics that will be further explained in the following ethnographic accounts.

The "Woodspeople": growing into biosocial markets and the geostory

> Last year's situation was amazing. Almost no mushrooms were growing within a distance of 200 km from Prague, but there was one spot in the remote mountains. And we sold [the mushrooms] for 300 crowns [12 EUR] a kilo. That was unbelievable, we earned maybe twenty, thirty thousand Crowns [approx. 1000 EUR] a day just from mushrooms!

This section focuses on the economic and ecological strategies that a pair of mushroom foragers (whom we refer to here as the Woodspeople) use to make their living as beekeepers and mushroom sellers. One of the authors used to buy mushrooms from this pair at a Prague farmers' market for years and often chatted with the Woodswoman about the picking, tastes, and uses of mushrooms. When we started our fieldwork, it seemed natural to ask the Woodspeople for a research interview and were not surprised when they agreed. What we did not expect was that following the couple would take us to the temple of consumer capitalism—a large shopping mall—and to a forested park on the outskirts of the capital.

The Woodsman has a degree in pharmacy and learned about medicinal mushrooms from an expert in indoor mushroom cultivation in whose lab he had worked. He also has extensive know-how acquired through everyday foraging and experimentation. He developed his own methods for finding and predicting where fungi will grow: he uses information from meteorological satellites and geological maps, including information on the character of the land in different places, its species composition, and geological subsoil. Valorizing this knowledge, he offers his customers a special service and forages specific mushrooms on demand. The Woodsman knows a lot about mushrooms and bees. And he knows how to make money from his knowledge. Whether he is in a shopping mall, a posh farmers' market, or a socially excluded place, the Woodsman is able to adapt his behavior and language in such a way as to earn his customers' and business partners' trust, and obtain plenty of mushrooms, find new opportunities, and make significant earnings along the way.

We explored these questions while following the Woodspeople: How do professional mushroom foragers grow to become capitalist and fungal biological market actors? How do they adapt to the ecological changes of the Anthropocene that make it harder for them to obtain their goods? To what extent do mushrooms co-create the foragers' business ethics and what kind of ecological responsibility is curated in foraging-entrepreneurship? How do private business and the ecological commons connect in the foragers' practices?

The business of ecosystems

The Woodspeople's knowledge of where to find mushrooms and how to ensure they have enough is what allows them to sell mushrooms at prices that earn them a living. To achieve this, the Woodspeople must be successfully embedded in not just the forests and mushroom sites they frequent but also in urban business ecologies. As well

Table 1 The selected case studies—key characteristics

	Woodspeople	Artisans	Parish
Type of fungi	macromycetes	micromycetes	macromycetes
Source of income for humans	major	significant	no
The scale and modality of key transactions	national; Gaian (incl. geological coevolution)	regional; planetary (incl. cosmopolitan relationships)	communal; transcendental (incl. God)

as the farmers' market, they sell mushrooms and honey in a large shopping mall. After learning that the mall's management was looking for a way "to go green," i.e., present themselves as being environmentally responsible, the Woodsman installed his eleven beehives on the roof of the mall. Corporate support for "the environment" has for him become an opportunity to expand the Woodspeople's business. And not just in a human sense: the bees housed in the center of Prague pollinate and enable the growth of other species in the vicinity. And as the Woodsman himself noted with surprise, after he installed his beehives, Wood Blewit (*Clitocybe nuda*) mushrooms spontaneously started growing on the roof of the shopping mall.

Foragers do not always work in inclusive ways. One spring afternoon, one of the authors accompanied the Woodspeople to a forest park on the outskirts of Prague where unhoused people often camp; most city residents avoid this place because of their presence. The Woodspeople collect valuable morel mushrooms there. The socially excluded nature of this location helps to transform what should be a common space into a semi-private site for the Woodspeople's business. However, when the unhoused people asked the Woodman if the collected mushrooms are edible, he answered: "Yes, but you can't drink alcohol the week before and the week after you've eaten them." This pragmatic "diplomacy", as the Woodman calls it, is a strategy he uses to keep the site and the mushrooms for himself.

There is no "forest socialism" here. The Woodsman adopts the callous mycorrhizal trade exchange (Whiteside et al. 2019) as a prescriptive model (socio)ecosystem for his own strategic choices to secure his foraging system. While the Woodspeople's actions work to effectively privatize the forest space for their own mushroom-foraging purposes, this is still very far from the private monocultural modes of production that are managed with pesticides and expel many field species, including soil fungi—and certainly offer no shelter to people without housing.

Despite his business strategies, the Woodsman is not an exploitative capitalist without environmental ethics. The Woodspeople's business success depends on maintaining the ecological commons. Once, when picking mushrooms in an urban forest park, the Woodman mentioned Hardin's *The Tragedy of the Commons*, and complained that some foragers take as many mushrooms as they possibly can, including "baby" mushrooms. This "greedy" behavior damages the mycelium, while leaving mushroom pickers (including themselves) who come later at a disadvantage. Protecting the mycelium is the only way to guarantee more mushrooms will grow in the future and, ultimately, the Woodspeople's economic profit as foragers can usually benefit from multiple harvests per year (Tucker et al. 2010). Their economic and ecological activities are not mutually exclusive, they engender each other. It is their entrepreneurship that pushes the Woodspeople to be concerned about the long-term health of the mycelium and the ethics of foraging.

Freedom of adaptation

Although the Woodsman stresses the importance of protecting the mycelium, he rejects the "alarmism" and asceticism of contemporary environmental activists. This is not because he is a climate skeptic. Rather, he conceptualizes ecosystems and the place of humans within them through a different narrative and different mundane practices. The Woodsman acknowledges that ecosystems are transforming as a result of climate change, and he witnesses this every day when foraging in the changing species composition of fungi and insects. However, he does not panic or fear the change. His thinking on ecosystems has mainly been informed by geology books that discuss how contemporary ecosystems are often the result of random and erratic geo-processes. He displays a sort of Gaian thinking (Lorimer 2020, p. 13) as he draws upon natural science, pictures the planetary system as holistic and resilient, and considers ecological transformations in their geological temporality.

The Woodsman does not regard the environmental changes occurring today as unique and "eschatological" events (Rossing and Buitendag 2020) but sees them instead as one of the many transformations inherent to planetary dynamics. By viewing ecosystems as part of the processes that take place in geological rather than human time, and as subject to erratic events, the Woodsman is able to adopt a pragmatic attitude towards environmental transformations. He does not conceive of himself as a modern subject striving for control over planetary dynamics. His environmentality features a consistent anti-anthropocentrism, as he positions himself as an ordinary and equal member of the ecosystems he inhabits. He does not ignore the human impact on ecosystems but considers his own place (as a human) in the "geostory" to be just one of the many "ingredients" that build "their own world" (Latour 2014).

His response to ecological change is, therefore, not political activism, but fieldwork. The Woodsman rejects the public discourse that represents the planet's ecosystem as endangered Nature or a fragile hyperobject. Instead, the model ecosystem he draws on is based on geological representations of a resilient and ever-transforming planet. Consequently, Woodsman uses his knowledge and skills to materially prepare himself for the changes currently occurring. He seeks to adapt and survive in the changing environment. "Fortune favors the prepared" is a phrase that the Woodsman uttered several times when we were discussing climate change with him. He answered most of our questions about how he deals with environmental changes by describing how he adapts his mushroom picking strategies to changes in the ecosystem: he tries to determine what altitude he now has

to forage at, what new mushroom species he should prepare for, and which species not to count on anymore. He moves through and relates to ecosystems in a flexible, adaptable way. While biologists are examining what effect climate change may have on species composition and migration, the Woodspeople operate in a way that reflects experts' observations: they adapt, move to new locations, and look for new sites with good conditions for mushroom growth.

Rather than an ethical discourse shaped by contemporary environmental narratives, the Woodspeople's environmentality is an embodied ontology that is shaped by the logic of mycorrhizal trading, mushroom flexibility, and geological temporality. Their environmentality entails strategies for growing with and into ecosystems, while acknowledging the geological and erratic aspects of those systems. They position themselves as participants in the uncontrollable changes the ecosystem is going through, and they consider their mission to be that of flexibly adapting to the ongoing transformations.

The Woodspeople's trading and foraging strategies and the way they are able to move flexibly between different places are their "practices of freedom" (Tsing 2015, p. 94). The Woodsman in particular enjoys creating unexpected and heterogenic business zones, but he is also, in a sense, free from feelings of anxiety about ecological catastrophe. An essential part of the Woodsman's environmentality is the conviction that he can adapt to current changes in ecosystems and that he will in any circumstances still be able to find enough mushrooms or other forest plants such as wild garlic. He is an adaptable and tough organism, and a confident participant in the growth and trade of fungi.

The Artisans: localizing production and good reasons to grow

> Their low-salt misos spoil easily and they are attacked by yeasts and acetic bacteria. As such, they cannot be stored for a long time and are good just for generating a quick profit, without the social benefits of energy-free storage. […] Noma and Empirical are taste and flavor companies. They do not care about context but make their money off of foodies and whisky connoisseurs.

This is a quote from feedback that we received from a research participant, whom we will call "the Artisan," after we sent him the article by Evans and Lorimer (2021) reporting on their ethnography of the fermentation practices in the famous Copenhagen restaurant Noma. The Artisan was critical—first of the ethnographers, who, in his judgment, allowed themselves become enchanted by Noma without considering the wider implications of its operations, and second and foremost of Noma itself. Noma ignores what, in his view, is the most important aspect of koji fermentation: the socioecological transformation it can engender. It is not only about localizing production; it is equally about producing high-quality, nutritious foods that are economically accessible and can be stored without using much energy resources.

This section takes a closer look at growing with microfungi, specifically the *Aspergillus oryzae*. Unlike the macromyceta discussed above, *Aspergillus oryzae* is not a species endemic to the Czech lands, and the foods they help to produce are not a traditional part of Czech cuisine. Koji-based products (such as miso) are still used to just a limited degree in the country and the majority of these products are imported from Asia. The Artisans are one of the few producers who currently aim to change this in an attempt to localize koji-based food production.

The Artisan family moved out of Prague a few years ago. For a long time, they produced apple vinegar, miso, and other fermented products for themselves, friends, and acquaintances, but in recent years they have gradually turned this work into the source of much of their income and made it part of their overall subsistence strategy. The Artisan man, who used to work for Czech public television, is now primarily in charge of the factory. The Artisan woman still occasionally commutes to Prague to work. They home-school their two children. They also to a strong degree align themselves with the key principles of degrowth as distilled by Banerjee et al. (2021): frugal abundance as a means to basic self-sufficiency for all humans; the emphasis on conviviality and low-tech means of sustenance and life; the central importance of care and a recalibration of the gendered division of labor; and the relocalization of production. They would not really describe their way of life in the terms of degrowth or stagnation. On the contrary, when we visited them at their home farm, the Artisan enthusiastically introduced us to the abundance of multispecies growth all around.

These are the salient issues that arise in this biosocial mycorrhizae: What are the best ways to re-localize foreign species in a new place and what are the reasons for doing so? How can globalization and cosmopolitanism be done well in the Anthropocene? What are the technological thresholds and the scalability of production and their microbiological and ecological implications and what constitute good reasons for surpassing the technological thresholds or not?

The localization of production and raw material

The Artisan loves Japan but has never been there. He does not need to travel there to produce his excellent miso. Alongside his concerns about the environmental impacts of international travel, he believes he would be overwhelmed by too many shallow impressions, which are all that he would be able to get on a short trip. He learned about miso by reading literature in English, translating information from

Japanese with the help of Google translator, and "deciphering" visual material that is available online—and, of course, also through extensive hands-on and tongues-on experimentation.

He uses local raw ingredients in his miso and other koji-based products: peas and barley grown in the Czech Republic and rice from Northern Italy. He dreams about getting as many of his ingredients as possible from the very region in which his factory is located. This is what he already does for another product he manufactures—cider vinegar. He sources his apples regionally, and he keeps bees to pollinate the neighborhood plants. He leaves most of the honey to the bees and only occasionally takes some of the excess honey. Like the 450 quadrillion kilometers (i.e., around half the width of our galaxy) of mycorrhizal networks that are woven through the top ten centimeters of the planet's soil (SPUN n.d.) and never unfold into the cosmic space, the Artisan's produce spins a connection to far-away Japan, where most of the raw ingredients he uses have never been. If we adopt the distinction proposed by Dipesh Chakrabarty, who claims that "[t]he global is a humanocentric construction; the planet decenters the human" (2021, p. 19), the Artisans' miso relocation engenders *planetarization* rather than globalization.

The same logic of localization applies to sales. The Artisan currently sells most of his misos online. He hopes, however, to "cultivate" a h base of consumers in his region that is large enough for him to be able to abandon online sales and offer his products only within his region—selling them at local farmers' markets and shops and to people who come to buy from his garden. This is the main way he sells his cider vinegar—although he could probably export it internationally given its high quality. He cares for both the environmental and the social benefits of this approach to sales. He likes getting to know the people who consume his products and to get feedback from them and cultivate these relationships. Even with online sales, he telephones the people who have placed orders—to learn who they are. When we suggest he is in fact a sociologist, he avidly agrees—with the caveat that he does not keep any systematic records.

Despite his diligence about localizing production, he comes across as cosmopolitan: note his love for and inspiration from Japan, his English skills, his tweeting about miso under the hashtag #peaso and thereby appealing to an international community. He is the opposite of a nationalist and in spite of his consistent adherence to and passion for natural processes and materials, he is no "back-to-nature" essentialist. When we asked him about using antibiotics, he acknowledged that his family uses standard Western medicine, including antibiotics, when necessary and that they were also vaccinated against Covid-19. In many respects, he thus shares the cosmopolitanism and drive for innovation that is espoused by Noma, which he harshly criticized. Yet, unlike Noma, he is fundamentally concerned with ensuring his products are accessible, and this is encoded in the microbiological qualities of the produce and the economics of its production. Rather than the international (higher-)middle class, he aims to engage his local rural neighbors and make them (and their tastes) more cosmopolitan.

Ecological and technological thresholds in growth

Not only the peas and barley are locally sourced, but the containers the Artisan uses to make miso and vinegar are as well. He refuses to use stainless steel instead of wooden barrels. He disapproves of the logic of the production economy, which depends on raw materials from around the globe, and sees this as the embodiment of harmful globalization:

> I simply want to make the best miso in the most ordinary way from the most ordinary organic ingredients. This means not coming up with nonsense but doing it 'in wood'. (...) If I had a kitchen with stainless steel equipment, it would cost roughly a million, while it actually cost me 50,000 [Czech crowns]. [If I'd opted for steel equipment] I'd now have to pay that back to the bank or an investor (...) which means I'd have to cheat on quality, I'd have to produce large volumes. That's what sets the whirl of the pseudo-economy in motion. That kind of economy is based on the practice where a Ukrainian will do it for you, (...) for half the salary than what's ethical. Then it apparently works. But nobody learns the truth about how it comes about.

He further explained that when producers use wooden equipment instead of steel, they soon reach a maximum threshold. "It works on a small scale, and it stops working in large-scale production." Moreover, stainless steel and wood-based production entail different modes of microbiopolitics. In steel containers, fermentation can be almost fully controlled, and steel equipment may produce a standardized output that cannot be achieved using wood. But this uncontrollable aspect is precisely what fascinates the Artisan: "With uncontrolled microbiological processes, you aren't in charge, you're assisting. You give it a chance to happen, but you aren't the one who can veto anything. It happens by itself."

This reasoning actually led him to split from the business partner with whom he had originally started producing miso for market sale. He opposed the push for steel-based growth and fully controlled fermentation, which is scalable and does not produce "bad smells." Wood-based production not only corresponds to his politics of (re)making the world through fermentation; it also infuses his house with the rich sensuality of unexpected flavors and odors. Reminders of microfungi processes that have taken place in the past remain in the air: wooden equipment holds aromas and microorganisms from the past and transmits them into the present. Describing the olfactoric power of mushroom

powder, Miyako Inoue (2021) notes that aromatic signals "connect now to then and here and there." The Artisans are passionate about microbial life and the experimental embedding of microbial life in their local setting—much like what Chartier (2021) observed among French natural winemakers.

This rich sensuality mediates the Artisan's everyday relations with the microfungi and bacteria, which he likens to human sexuality and eroticism, and it also drives his fascination with and passion for non-human life. This could be a mode of doing "queer love," which Eben Kirksey (2018) has called for in the context of the (post)Anthropocene, where there is a real possibility that we are killing ourselves and the companion species we have learned to love. As we have seen in the case of the Artisan, acknowledging this possibility does not necessarily mean giving up on any attempt to (re)make the systems of production and consumption and to rethink economic growth to avoid an environmental disaster.

The Parish: growing through multispecies sharing

Throwing away wormy mushrooms is an absolute sin!

This is what a Catholic priest and entomologist proclaimed with slight exaggeration during a mushroom exhibition that he organized in his Prague parish in October 2021. He explained that the worms come out during the drying process and even improve the flavor of the mushrooms. He expressed appreciation for the nonhuman labor of the worms, welcoming them as part of the parish collective. In his view, there is a moral dimension to human-nonhuman relationships. On his first visit to the parish, one of the authors was given a textbook on ecological ethics written by the Priest. The second visit earned him a jar of pickled mushrooms labelled "Mushrooms from the Priest" and an invitation to collaborate on a book of interviews concerning the relationship between ecology and Catholic theology.

Compared to the two previous mycorrhizae the parish mushrooms are not directly involved in any formal economy. The Priest is paid by the church and doesn't want to monetize the mushrooms he collects. However, mushrooms are not just a hobby for him. On the contrary, they are significantly involved in two offshoots of sympoietic growth in the Parish: they facilitate the growth of the collective and, in the Priest's experience, the individual's spiritual growth as well.

Many of the current environmental approaches emerging in Europe and North America take inspiration from "indigenous" cosmologies and ethics relating to naturecultures situated outside the Euro-American West. We suggest that there never ceased to be valuable ecological concepts that resonate with "indigenous" ecologies and are part of Western cosmologies. In this section, we ask: How specifically do mushrooms partake in the formation, growth, and sustaining of the Parish collective? If it is a "sin" to throw out wormy mushrooms, what virtues does coexistence with non-humans engender? What resources may mushrooms provide for nourishing a Christian more-than-human spirituality?

Growth of the Parish collective

When one of the authors suggested to the Priest that mushrooms also play a role in maintaining parish cohesion, the Priest eagerly agreed. Thanks to mushrooms, he says, it is always possible to find people to work with. He organizes mushroom events with "kindred spirits" amongst the parishioners, and with people from "outside" the church as well. In his previous Parish, he co-founded "something like a mycological club" with a hunter and mushroom picker who was not religious, but through their shared passion for mushrooms "became part of the Parish collective."

Exhibitions are not, however, the only way that mushrooms stabilize the collective. The gift economy is similarly important. The Priest uses pickled or dried mushrooms as a gift. Sometimes he collects a "truckload" of mushrooms, knowing that he will give many of them away. In exchange, some parishioners bring him walnuts or eggs. The Priest and parishioners also share information with each other about mushrooms. Parishioners come for advice when they cannot identify what kind of mushroom they have found. In turn, they pass on information to the Priest—for example, if any mushrooms are growing in their garden and if so what kind. The mushrooms thereby draw more people into the parish and also open the parishioners' doors to the Priest.

The Priest gifts people mushrooms for helping out in the parish. "Mushrooms from the Priest" is used as an expression of appreciation. As Yamin-Pasternak (2008) shows in her study in Chukotka, a jar of mushrooms serves as a gift that expresses gratitude also in other regions. Pickled or dried mushrooms moreover nourish not just horizontal relationships but vertical ones as well within the church hierarchy. The Priest gives jars of mushrooms to his superiors. However, he only gifts mushrooms when he is sure that the person will really enjoy them, and that the gift will be "appreciated." Jasarevic notes that in Bosnian gifting practices "poison is not readily suspected in the mushroom gift" (2015, p. 55); similarly, recipients of the Priest's gifts must also have trust in the Priest's goodwill and knowledge of mushrooms and not be afraid of being poisoned. Mushrooms are a "gift for friends" and serve as a way of making friends and maintaining such relationships.

As in the case of Tsing's matsutake, mushrooms "build relationships, and as gifts they cannot be separated from these relationships" (Tsing 2015, p. 123) in this Parish in Prague. They are intimately tied up with the act of foraging. The recipients of the gifts know that the Priest picked and pickled or dried the mushrooms with his own hands. It is this chain of activities in which the wild mushrooms

are transformed into gifts that gives these mushrooms their value and establishes their role in sustaining community relationships. The mushroom gifts embody the Priest's labor and care for the community.

Spiritual growth and the theology of sharing

The mushrooms help to maintaining the social cohesion of the Parish collective, but they also mediate the relationship between humans and God. While the spiritual dimension of mushrooms is mostly attributed to "magic mushrooms" (Letcher 2008), here it is ordinary mushrooms that are the co-creators of human spiritual growth. The involvement of mushrooms in the process of such growth is based on the theology of sharing that the Priest cultivates.

According to him, a biosphere is a place of divine action and God's generosity. Humans should show their gratitude for God's gifts manifested through the biosphere and should pass on this generosity in their own actions. This kind of spiritual ecology resembles the Russians' appreciation of landscape as the place where "God lives" and where God offers gifts to humans, as Melisa Caldwell (2011) describes in her ethnography of the "dacha idylls." Importantly, the Priest notes that gifts from the biosphere are given without any call for reciprocation, and could be conceptualized as sources of material and spiritual growth.

The Priest's conceptualization of fungal ecologies correlates with an understanding of the mycorrhizae (socio) ecosystem as a solidary and altruistic network that engages multiple organisms. The Priest notes that some contribute to the networks, and some merely "feed off" it. He acknowledges that the growth in the mycorrhizae is enabled by the trade symbiosis but emphasizes that these calculating habits produce a surplus that is available to all. Fungi produce a "surplus" that is "never owned so much as received to be redistributed," as Jasarevic (2015, p. 51) observed in the case of the widespread existence and circulation of kombucha in Bosnia. The Priest considers this sharing capacity, this side-effect of mycorrhizae growth, as a model for human ethics. Although according to the notorious dictum of Marcel Mauss (2000), every gift generates an obligation, the Priest insists that sometimes we should do what we do "in vain and for free": we do not always expect reciprocity but rather share our spiritual, social, and material capacities without narrow calculations about future gain.

The Priest is adhering to this principle when he shares the capacities of the parish collective not just with people but also with nonhumans. Ethics is inspired by nonhuman beings as much as it is applied to nonhuman beings, in this case by the Priest. For example, on the Feast of Saint Francis of Assisi, he blesses animals (dogs, cats, or tarantulas) in the Parish garden. The prayer used in this ceremony expresses thanks for the blessings that God delivers through the animals and the blessing itself grants to animals the protection of God and prepares the blessed animals for cooperation with the church. Spiritual benefits mostly attributed to humans are shared with animals, who become part of the parish collective through this particular ritual. The Priest was the first Catholic priest to introduce the blessing of animals as a regular activity in this Parish and it remains a rather rare event in Czech parishes.

Parishioners, mushrooms, and animals participate, materially and spiritually, in the sympoietic growth that the economy of sharing generates. Drawing upon Yochai Benkler's conception of sharing as "nonreciprocal pro-social behavior," Russel Belk distinguishes sharing practices from gift giving and commodity exchange and uses family as a prototypical example of sharing that involves "the act and process of distributing what is ours to others for their use and/or the act and process of receiving or taking something from others for our use" (2010, p. 717). The parish collective engages in such sharing practices, but these practices involve more-than-human kin and are engendered by the spiritual and material resources provided by God's generosity.

The Parish economy resembles the economies in Columbian and Panamanian peripheries that Stephen Gudeman analyzed, where giving "starts not with the individual or social relationships but with the Divinity. The divine gift of vital energy or strength, offered without recompense, underpins the economy" (2012, p. 63). In the parish, the Christian God similarly constitutes a fundamental source of (spiritual) commons (cf. Mcwilliam, 2009). Mycorrhizae mediate God's material generosity to humans, while the parish collective mediates God's spiritual benefits to nonhumans.

Like the symbiotic forest mycorrhizae, the Parish sharing is a specific configuration that is made possible by particular conditions, the first of which is the relatively secure economic position of the Priest. Selling mushrooms is in conflict with his theology of sharing; but he also has no financial need to sell them. Moreover, as the Priest himself emphasizes, the priestly ministry is a vocation that is "free" from many of the obligations that lay people have (including caring for a family). This allows him to pursue his hobbies, organize events, and share his time and skills with the Parish community. Therefore, the Priest's role as an intermediary in more-than-human growth in the Parish is co-constituted by the specific nature of the priestly ministry and the resources of the Catholic Church.

The contours of sympoietic growth

Most concepts of degrowth have been developed in the field of economics and focus primarily on macroeconomy and indicators of production and productivity. We do not dispute the importance of the (macro)economic parameters. At the

same time, the discussion of (de)growth needs to be concerned with much more than just the economy in its narrow sense. It must address modes of living and their particular (bio)aesthetics, (bio)ethics, (bio)socialities, and (micro) biopolitics. The three mycorrhizae we explored in this paper exemplify different economic arrangements, strategies, and thresholds of production, and are concerned with the very practical issues of how to secure an economic living. But they also highlight particular sympoietic aesthetics, ethics, sensualities, and spiritualities.

There are many different modes of fungal growth. Fungal-plant relations may involve different forms of asymmetry. Similarly, the three mycorrhizae we studied differ in some of their constitutive characteristics and multispecies arrangements. We do not seek here to identify any singular model of sympoietic growth or to even to prescribe any one model as a "good" one. In contrast, we made the normativity that is implied in the different model (socio)ecosystems an object of research. We do not claim that all aspects and operations of the three mycorrhizae count as helpful elements that engender sympoietic growth. Our aim here was to identify patterns of such growth that cut across all three mycorrhizae and simultaneously highlight the rich repertoire of actors, conjunctions, and strategies of growth that are suited to our planet's current condition. Below, we highlight the three most significant cross-cutting patterns.

The first pattern of sympoietic growth manifests as a letting go of the urge to "take (back) control" over the multispecies dynamic. It is the multispecies (over)flows that play the central role. In the mycorrhizae the agency of nonhuman life forms is not tamed but "assisted." The humans we encountered adopt a modest position as agents within the ecosystems. They are neither (nor do they fashion themselves as) the terrible destroyers nor the almighty saviors of ecosystems. Matter remains alive in the strong sense of it retaining its agency and unpredictability. In sympoietic ecosystems, it is neither possible nor desirable for humans to tightly control the multispecies (over)flows. At the same time our research participants are well aware that multispecies engagement is always accompanied by the potential of (deadly) intoxication. If a koji thrives to the point where it blossoms, it becomes toxic and potentially deadly to humans. Some mushrooms cannot be eaten by people or can only be eaten under certain conditions. However, rather than avoid all the risks (of spoiled production or poisoning), the humans who engage with all three of these mycorrhizae are constantly calibrating the specific zones in which their and other humans' sympoietic growth with particular fungi is possible. Like Paxson's (2013) artisanal cheesemakers who have developed post-Pasteurian relations to microbial life, our research participants are not aiming for antiseptic control and are constantly attentive to and calibrating the potentialities and modalities of microbial and fungal lives.

Second, the humans engaged in these mycorrhizae show a non-instrumental passion for more-than-human life, which they treat neither as a calculable external resource nor as a calculable external limit. Our research participants feel creatively challenged by nonhuman agency, even if it sometimes results in ferments that are "spoiled" for human consumption or mushrooms "hijacked" by worms. Unlike the popular green narratives, however, mushrooms and other nonhumans are not "respected" by people; rather, they become a part of the humans' everyday practices, in which they are mimicked or creatively assisted by humans in their own heterogeneous (re)production processes. The nonhuman labor in these collaborations is recognized and appreciated, but not exploited. Furthermore, the passion for more-than-human life seems to provide relief from the ecological grief experienced by many (Ojala et al. 2021).

Third, we highlight a tendency in the three mycorrhizae to resist specialization. The Woodspeople, the Artisans, and the Priest are all intellectuals as much as they are skilled manual workers. They all enjoy very different types of labor. In the Czech context, they build on the long tradition of a do-it-yourself approach to solving problems and tinkering with things that thrived under state socialism Gibas (2019). Manual labor is a part of everyday production processes and is the way in which our participants stay in touch, day by day, with realities beyond the human, in a material as well as an emotional and spiritual sense. Manual labor creates a commitment to nonhuman life that is both a burden and sometimes a physical pain, but it is also the source of the strength of attachments. It is not a part of the job that they would like to delegate to anyone else. While in modern production driven by the standard indicators of economic growth most employment positions tend to rely on heavy specialization, we suggest that the embodied combination of manual and intellectual labor may represent a novel and promising form of (post-)work (Deranty 2022). Rather than simply delegating labor to nonhuman machines or beings, some of the manual labor may be redistributed among workers. This way of reversing specialization not only combats excessive speciesism and gives recognition to nonhuman labor, it also supports the everyday praxis of and sensibility to sympoietic growth.

Acknowledgements The authors would like to thank Dan Sosna and Luděk Brož for their valuable comments on the draft of the article and Robin Cassling for language editing. The authors also appreciate the detailed feedback from the reviewers and editorial guidance, which helped to substantially improve the article.

Funding This work was supported by the Czech Science Foundation [Grant Number 20-09830S].

References

Alster, C.J., S.D. Allison, S.I. Glassman, A.C. Martiny, and K.K. Treseder. 2021. Exploring trait trade-offs for fungal decomposers in a Southern California grassland. *Frontiers in Microbiology* 12: 655987. https://doi.org/10.3389/fmicb.2021.655987.

Banerjee, S.B., J.M. Jermier, A.M. Peredo, R. Perey, and A. Reichel. 2021. Theoretical perspectives on organizations and organizing in a post-growth era. *Organization* 28 (3): 337–357. https://doi.org/10.1177/1350508420973629.

Belk, R. 2010. Sharing. *Journal of Consumer Research* 36 (5): 715–734. https://doi.org/10.1086/612649.

Bidartondo, M.I., C. Ellis, H. Kauserud, P.G. Kennedy, E. Lilleskov, L. Suz, and C. Andrew. 2018. Climate change: Fungal responses and effects. In *State of the world's fungi: Report*, ed. K.J. Willis, 62–69. Kew: Royal Botanic Gardens.

Boddy, L., U. Büntgen, S. Egli, A.C. Gange, E. Heegaard, P.M. Kirk, A. Mohammad, and H. Kauserud. 2014. Climate variation effects on fungal fruiting. *Fungal Ecology* 10 (1): 20–33. https://doi.org/10.1016/j.funeco.2013.10.006.

Caldwell, M. 2011. *Dacha idylls: Living organically in Russia's countryside*. Oakland, CA: University of California Press.

Carhart-Harris, R.L., L. Roseman, M. Bolstridge, L. Demetriou, J.N. Pannekoek, M.B. Wall, M. Tanner, M. Kaelen, J. McGonigle, K. Murphy, R. Leech, H.V. Curran, and D.J. Nutt. 2017. Psilocybin for treatment-resistant depression: FMRI-measured brain mechanisms. *Scientific Reports* 7: 13187. https://doi.org/10.1038/s41598-017-13282-7.

Chakrabarty, D. 2021. *The climate of history in a planetary age*. Chicago, IL: The University of Chicago Press.

Chartier, D. 2021. The Deplantationocene: Listening to yeasts and rejecting the plantation worldview. In *With microbes*, ed. C. Brives, M. Rest, and S. Sariolla, 43–63. Manchester, UK: Mattering Press.

De Saille, S., and F. Medvecky. 2016. Innovation for a steady state: A case for responsible stagnation. *Economy and Society* 45 (1): 1–23. https://doi.org/10.1080/03085147.2016.1143727.

Dempster, B. 2000. Sympoietic and autopoietic systems: A new distinction for self-organizing systems. In *Proceedings of the World Congress of the Systems Sciences and ISSS*, ed. J.K. Allen and J.M. Wilby, 1–18. Toronto: International Society for the Systems Sciences.

Deranty, J.-P. 2022. Post-work society as an oxymoron: Why we cannot, and should not, wish work away. *European Journal of Social Theory* 25 (3): 422–439. https://doi.org/10.1177/13684310211012169.

European Commission. 2020. *Food 2030 pathways for action - Research and innovation policy as a driver for sustainable, healthy and inclusive food systems*. ec.europa.eu, October. https://ec.europa.eu/info/publications/food-2030-pathways-action-research-and-innovation-policy-driver-sustainable-healthy-and-inclusive-food-systems_en. Accessed 12 Aug 2021.

Evans, J., and J. Lorimer. 2021. Taste-shaping-natures: Making novel miso with charismatic microbes and new Nordic fermenters in Copenhagen. *Current Anthropology* 62 (suppl): 24. https://doi.org/10.1086/714851.

Faier, L., and M.J. Hathaway, eds. 2021. *Matsutake worlds*. Oxford; New York: Berghahn Books.

Flyvbjerg, B. 2006. Five misunderstandings about case-study research. *Qualitative Inquiry* 12 (2): 219–245. https://doi.org/10.1177/1077800405284363.

Gandia, A., J.G. Brandhof, F.V.W. Appels, and M.P. Jones. 2021. Flexible fungal materials: Shaping the future. *Trends in Biotechnology* 39 (12): 1321–1331. https://doi.org/10.1016/j.tibtech.2021.03.002.

Gibas, P., H. Daňková, T. Hodúlová, K. Pauknerová, K. Šima, J. Woitsch, V. Aresta, B. Nyklová, T. Hoření Samec,and P. Vašát. 2019. *Kutilství*. Prague, CR: Sociologický ústav AV ČR, v.v.i.

Gomiero, T. 2018. Agriculture and degrowth: State of the art and assessment of organic and biotech-based agriculture from a degrowth perspective. *Journal of Cleaner Production* 197 (2): 1823–1839. https://doi.org/10.1016/j.jclepro.2017.03.237.

Gudeman, S. 2012. Vital energy: The current of relations. *Social Analysis: THe International Journal of Social and Cultural Practice* 56 (1): 57–73. https://doi.org/10.3167/sa.2012.560105.

Haraway, D.J. 2016. *Staying with the trouble: Making kin in the Chthulucene*. Durham, NC: Duke University Press Books.

Hildebrandt, U., M. Regvar, and H. Bothe. 2007. Arbuscular mycorrhiza and heavy metal tolerance. *Phytochemistry* 68 (1): 139–146. https://doi.org/10.1016/j.phytochem.2006.09.023.

Inoue, M. 2021. Matsutake, so aromatic in its absence. In *Matsutake worlds*, ed. L. Faier and M.J. Hathaway, 78–87. Oxford; New York: Berghahn Books.

Jasarevic, L. 2015. The thing in a jar: Mushrooms and ontological speculations in post-Yugoslavia. *Cultural Anthropology* 30 (1): 36–64. https://doi.org/10.14506/ca30.1.04.

Kallis, G. 2011. In defence of degrowth. *Ecological Economics* 70 (5): 873–880. https://doi.org/10.1016/j.ecolecon.2010.12.007.

Kamen, J. 2017. *Báječný svět hub*. Prague, CR: Mladá fronta.

Khalvati, M.A., Y. Hu, A. Mozafar, and U. Schmidhalter. 2005. Quantification of water uptake by arbuscular mycorrhizal hyphae and its significance for leaf growth, water relations, and gas exchange of barley subjected to drought stress. *Plant Biology* 7 (6): 706–712. https://doi.org/10.1055/s-2005-872893.

Kiers, T., and M. Sheldrake. 2021. A powerful and underappreciated ally in the climate crisis? Fungi. *The Guardian*, 30 November. https://www.theguardian.com/commentisfree/2021/nov/30/fungi-climate-crisis-ally. Accessed 10 Aug 2022.

Kirksey, E. 2018. Queer love, gender bending bacteria, and life after the Anthropocene. *Theory, Culture & Society* 36 (6): 197–219. https://doi.org/10.1177/0263276418769995.

Latour, B. 2014. Anthropology at the time of the Anthropocene—personal view of what is to be studied. In *American Association of Anthropologists Meeting*, Washington, DC, 10 December. http://www.bruno-latour.fr/sites/default/files/139-AAA-Washington.pdf. Accessed 15 Dec 2021.

Leitinger, L. 2020. Degrowth and domesecration: A historical view on nonhuman and human violence. *degrowth.info,* 1 June. https://www.degrowth.info/en/blog/degrowth-and-domesecration-a-historical-view-on-nonhuman-and-human-violence. Accessed 2 Jan 2022.

Letcher, A. 2008. *Shroom: A cultural history of the magic mushroom*. New York: Ecco.

Lišková, M. 2017. Chcete vědět, jaké jste našli houby? *Denik.cz,* 15 October. https://www.denik.cz/z_domova/chcete-vedet-jake-jste-nasli-houby-vlozte-je-do-schranky-v-karmelitske-ulici-20181013.html. Accessed 27 July 2021.

Lorimer, J. 2020. *The probiotic planet: Using life to manage life*. Minneapolis, MN: University of Minnesota Press.

Mauss, M. 2000. *The gift*. New York: W.W. Norton.

Mcfarlane, R. 2016. The Secrets of the Wood Wide Web. *New Yorker,* 7 August. https://www.newyorker.com/tech/annals-of-technology/the-secrets-of-the-wood-wide-web. Accessed 12 Oct 2021.

McWilliam, A. 2009. The spiritual commons: Some immaterial aspects of community economies in eastern Indonesia. *The Australian Journal of Anthropology* 20 (2): 163–177. https://doi.org/10.1111/j.1757-6547.2009.00024.x.

Ministry of Agriculture. 2021. *Zpráva o stavu lesa a lesního hospodářství České republiky v roce 2020*. Prague, CR: Ministerstvo zemědělství.

Nelson, A., and F. Edwards, eds. 2021. *Food for degrowth*. Abingdon-on-Thames: Routledge.

Ojala, M., A. Cunsolo, C.A. Ogunbode, and J. Middleton. 2021. Anxiety, worry, and grief in a time of environmental and climate crisis: A narrative review. *Annual Review of Environment and Resources* 46: 35–58. https://doi.org/10.1146/annurev-environ-012220-022716.

Parrique, T., J. Barth, F. Briens, C. Kerschner, A. Kraus-Polk, A. Kuokkanen, and J.H. Spangenberg. 2019. *Decoupling debunked—Evidence and arguments against green growth as a sole strategy for sustainability*. Brussels, BE: European Environmental Bureau.

Paxson, H. 2013. *The life of cheese: Crafting food and value in America*. Oakland, CA: University of California Press.

Paxson, H., and S. Helmreich. 2014. The perils and promises of microbial abundance: Novel natures and model ecosystems, from artisanal cheese to alien seas. *Social Studies of Science* 44 (2): 165–193. https://doi.org/10.1177/0306312713505003.

Raworth, K. 2017. *Doughnut economics: Seven ways to think like a 21st-century economist*. Hartford, VT: Chelsea Green Publishing.

Richter, K. 2019. Struggling for another life: the ontology of degrowth. *Transtext(e)s Transcultures*. https://doi.org/10.4000/transtexts.1242.

Rossing, B., and J. Buitendag. 2020. Life in its fullness: Ecology, eschatology and economy in a time of climate change. *HTS Theological Studies* 76 (1): a6245. https://doi.org/10.4102/hts.v76i1.6245.

Sheldrake, M. 2020. *Entangled life: How fungi make our worlds, change our minds & shape our futures*. New York: Random House.

Shurtleff, W., and A. Aoyagi. 2021. *Grains and/or soybeans enrobed with a mold culture (300 BCE to 2021)*. Lafayette, LA: Soyinfo Center.

Springgay, S., and S.E. Truman. 2018. *Walking methodologies in a more-than-human world*. Abingdon-on-Thames: Routledge.

SPUN. n.d. Networks. https://spun.earth/networks. Accessed 11 Dec 2021.

Tsing, A.L. 2015. *The mushroom at the end of the world*. Princeton, NJ: Princeton University Press.

Tucker, B., F. Tsimitamby, S. Benbow. Humber, and T. Iida. 2010. Foraging for development: a comparison of food insecurity, production, and risk among farmers, forest foragers, and marine foragers in Southwestern Madagascar. *Human Organisation* 69 (4): 375–386. https://doi.org/10.17730/humo.69.4.m1n76k5272632873.

Tylš, F., T. Páleníček, and J. Horáček. 2016. Neurobiology of psilocybin effects in relation to its potential therapeutic targets. In *Neuropathology of drug addictions and substance misuse*, ed. V.R. Preedy, 782–793. London: Kings College London.

Van't Padje, A., G.D.A. Werner, and E.T. Kiers. 2021. Mycorrhizal fungi control phosphorus value in trade symbiosis with host roots when exposed to abrupt 'crashes' and 'booms' of resource availability. *New Phytologist* 229: 2933–2944. https://doi.org/10.1111/nph.17055.

Větrovský, T., P. Kohout, M. Kopecký, A. Machac, M. Man, B.D. Bahnmann, V. Brabcová, J. Choi, L. Meszárošová, Z.R. Human, C. Lepinay, S. Lladó, R. López-Mondéjar, T. Martinović, T. Mašínová, D. Morais, D. Navrátilová, I. Odriozola, M. Štursová, K. Švec, V. Tláskal, M. Urbanová, J. Wan, L. Žifčáková, A. Howe, J. Ladau, K.G. Peay, D. Storch, J. Wild, and P. Baldrian. 2019. A meta-analysis of global fungal distribution reveals climate-driven patterns. *Nature Communications* 10 (1): 5142. https://doi.org/10.1038/s41467-019-13164-8.

Whiteside, M.D., G.D.A. Werner, V.E.A. Caldas, A. Van't Padje, S.E. Dupin, B. Elbers, M. Bakker, G.A.K. Wyatt, M. Klein, M.A. Hink, M. Postma, B. Vaitla, R. Noë, T.S. Shimizu, S.A. West, and E. Toby Kiers. 2019. Mycorrhizal fungi respond to resource inequality by moving phosphorus from rich to poor patches across networks. *Current Biology* 29 (12): 2043-2050.e8. https://doi.org/10.1016/j.cub.2019.04.061.

Winder, R. S. 2013. The impact of climate change on the distribution of mycorrhizal mushroom species. In *International Symposium on Forest Mushrooms.* Korea Forest Research Institute, Seoul, Korea.

Yamin-Pasternak, S. 2008. A means of survival, a marker of feasts: Mushrooms in the Russian far east. *Ethnology* 47 (2/3): 95–107.

Tereza Stöckelová is a researcher at the Institute of Sociology of the Czech Academy of Sciences, and lectures at the Department of Sociocultural Anthropology, Charles University. She works in the field of science and technology studies (STS) and draws upon material semiotic methodologies. She has investigated academic practices in the context of current policy changes, science and society relations, environmental controversies, and the interfaces between biomedical and alternative therapeutic practices. Her current research is concerned with microbiological citizenship. Since 2020 she has been a member of the World Commission on the Ethics of Scientific Knowledge and Technology, an advisory body and forum of reflection set up by UNESCO (ORCID no. 0000-0001-9251-7987).

Lukáš Senft graduated in social anthropology and religious studies and is currently a doctoral student at the Faculty of Social Sciences, Charles University. His doctoral research is concerned with foraging practices and mushroom economics in Czechia. He has worked as a journalist for the daily *Deník Referendum* newspaper, a documentary filmmaker and synopsis developer, and an editor of the monthly literary magazine *Tvar*. He collaborates with Greenpeace Czech Republic, and occasionally works as a book editor. ORCID no. 0000–0001-9297–7721

Kateřina Kolářová teaches in Gender Studies, Charles University, and is a researcher at the Institute of Sociology of the Czech Academy of Sciences. Her work explores the intersections of disability, crip, queer, and race theories (ORCID no. 0000-0002-9864-2356).