Emerging Matsutake Worlds

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Note to Agrarian Studies:
This is a preliminary draft of a chapter for a new book that is based on my research as a member of the Matsutake Worlds Research Group (MWRG). We are a collaborative research group consisting of Tim Choy at UC Davis, Lieba Faier at UCLA, Miyako Inoue at Stanford, Shiho Satsuka at the University of Toronto, Anna Tsing at UC Santa Cruz, and myself. We have been investigating the kinds of social worlds that matsutake is part of and fostering in several different countries, especially Canada, the US, Japan and China. We've been intrigued by the ways that the social configurations that are built around matsutake can be so strikingly divergent, yet are still deeply connected through commercial and scientific networks with Japan as the global center. One of the group's experiments has been to carry out joint fieldwork, with one expert in a particular site leading the rest of the group. This situation makes for more demanding fieldwork than the typical scenario in anthropology of the lone researcher. It also allows the non-experts to ask surprising questions, questions that the local expert can no longer ask. Our joint fieldwork and writing sessions also provoke a lively conversation, which draws on understandings informed by immersion of the emergent matsutake worlds in other countries. My role in the team has been to lead the fieldwork in China, and this chapter will be in a monograph that mainly focuses on the role of China in these global networks. My goal in the monograph is to craft a book for a wider audience than professional anthropologists and anthropology students. This may be difficult, however, as I will likely publish with a university press. In any rate, I plan to eventually place most of academic discussion in footnotes, but I leave it in this draft as I am still actively thinking through it, and welcome your input in thinking through these issues.

At dawn during the late summer and early fall, one can stand on a hillside high on the Tibetan Plateau of Yunnan Province, in Southwest China and discover an interesting site. It looks like the stars are emerging, but in reverse, for the night is ending rather than beginning. One is not looking up into the sky but down into the valley as hundreds of lights flicker from the villages below. Unlike stars in the sky, these points of light are moving. They are flashlights, carried by villagers walking up into the mountains to hunt for a mushroom the Japanese call *matsutake* and the Chinese call *song rong*. These people, mainly ethnic Tibetans whose lives often centered on growing grains in small valleys and herding their yaks and yak hybrids, grazing them up into the mountains as the snow melted and a wide range of grasses and flowering plants reappeared.

People collect all morning and return home when the dealers arrive at a village market or drive along the roads, buying from mushroom hunters as they go, for the matsutake is highly valued in Japan. The mushrooms are carried in a shoulder satchel, often hand-fashioned from bags once used for fertilizer or pig food, the durable everyday sack of rural China. When hunters find a prize specimen, they wrap it in a layer of thin plastic film, or they may snap off the tip of a rhododendron branch, place the mushroom against it, and wrap grass around the mushroom, cinching it snugly, like a swaddled baby. The mushrooms are carefully cushioned in these satchels, as they can be easily damaged during the long hike over steep terrain. Over the season, millions of mushrooms travel from villages to local buying centers and bulking stations, and then to Japan. This moves quickly, for not only is the mushroom flesh very delicate, but insects are already starting to eat them.

There is a rhythm to these orchestrated movements. It starts with fall rains and decreasing temperatures. Yet, in ways that remain mysterious to scientists, some combination of factors stimulates underground mycelia (root-like filaments) to grow into “fruiting bodies” --- what we typically call a mushroom. When the mushrooms start to grow, several species of insects seek out it, flying through the air, and tunneling through the soil. Humans of various kinds feel the pulse of excitement, will they strike it rich this year—what will the market demand, what will the soil produce? As the mushrooms appear, more than half a million people enter into the fray. They gather, they walk, ride bicycles and motorcycles, drive cars and trucks, clean and grade the mushrooms, and keep passing them on all the way to Japan. Some will make lots of money if all falls into place, but those with the most to win also have the most to lose, for their stocks can spoil quickly or the price can plummet overnight.

The main reason why so many people devote their lives to this mushroom and that we know so much about it is because people love to eat them so much in Japan. They are also prized in Korea, but almost all of the mushrooms involved in the global trade head to Japan: they invented the world matsutake craze. There, it has been highly prized for centuries, and seen as a sumptuary object, a food only fit for royals. Within the last century, anyone could eat them, providing that they were willing to pay the high prices. After World War II, domestic production began to wane considerably, and many began to worry about its fate. Matsutake had become a powerful symbol of national identity, almost like the Irish potato, or the French green bean. By the 1980s, scientists and salesmen joined forces, and sent out expeditions around the world to find matsutake and begin global trade. They were surprised to find that it grew in over a

dozen countries, and also surprised that almost nowhere was it a well-loved food. The Scandinavians, for example, had a matsutake, but they gave it the Latin species name of *nauseosum*, the mushroom which makes you nauseous.

This global trade of matsutake is now organized like a vast wheel, where it travels one way towards a single center in Japan. During the height of the global matsutake boom, during what was later called the Japanese bubble economy, these mushrooms could fetch nearly $1500 a pound, but it is often much lower. This year, the price in China is often around 5$ a pound. It is still lucrative and risky: it is often said to be a 3 billion dollar industry, but one where the price fluctuates drastically, even during a period of 24 hours, it can go up 100% or down 50%. The season is usually only two or three months a year and it is amazing to watch this vast social system re-organize itself every year. In China, there are many thousands of pickers, hundreds of buyers, and dozens of wholesalers, with only a handful of international exporters. The exporters need large buildings where they clean and cool the mushrooms, a staff for the intense and brief season. The pace is frenetic in part because the fresh mushrooms need to travel from Yunnan's mountains to markets in Kyoto or Tokyo in less than 48 hours. The Japanese are largely uninterested in matsutake that have been frozen or dried, this would diminish the smell and change the pleasurable texture.

This is a dramatic transformation: a transnational commodity chain linking China and Japan was built virtually from scratch in the last thirty years. People have created a complex and yet fluid network, which includes government officials, scientists, conservationists, pickers, sellers and buyers. The main scholarly frame for understanding such relationships has been to view this as a case of commodification.

Humans scour the world for potential objects of value, they understand them as resources, extract them and then insert them into commodity chains. The most common version of this narrative is one of human mastery, as people create more efficient means of extraction, find solutions to problems, and increase production. At other times, the resources are overexploited: the trees in the forest trees too small to mill into timber, the iron ore too low grade to smelt into rebar, the cod too few to turn into frozen fillets. The objects themselves, once living or not, are often regarded as largely passive, almost bystanders to their transformation into resource.

More recently, however, scholars from a number of fields (including geography, history, anthropology and sociology, among others) have started to actively explore what it might mean if humans are not the only active subject. In some ways, taking nonhumans seriously is quite novel; Western intellectual and political legacy is almost thoroughly anthropocentric. Social theory of all sorts has been typically concerned with only one kind of animal: human beings. While the move to expand this consideration into the more-than-human in the field of geography might be least surprising, in my own field of anthropology (the study of humankind), interest in the more-than-human might be less expected. As Severin Fowles, an archaeologist who is a keen critic of what he calls the “rise of thing theory” suggests: “It is easy to understand the puzzlement of colleagues who are unsure what to make of the increasing number of anthropologists who bemoan anthropocentrism” (2010:23). I am not sure how to write and think anthropologically without some forms of anthrocentrism, but I am interested in understandings that challenge human moral and political exceptionalism.

Academically and personally, I not only hope to better describe the kinds of multispecies worlds we live in, but wish to imagine more creative efforts at living intentionally not only with other humans but also with other beings. How would this displace our typical understandings of history? How might it challenge our human-centered understandings of agency? How could it help us think differently about humans as one species among many, part of life worlds beyond those deliberately fashioned by humankind?

The rest of this chapter contains four sections. First I consider how scholars have worked to expand their notion of the social, beyond the merely human. Second, I look closely at the species biology of mushrooms, showing how it survives, reproduces and travels may challenge some of our expectations about the forms of agency generated by humans and other animals. Third, I look at how humans and the matsutake are interacting in the forest and in the laboratory, and how debates about their being wild or unintentionally cultivated affect these relations. Last, I show how the relations between China and Japan have long been mediated by fears over pollution and contamination. The species biology of the matsutake, as it now interacts with Fukushima radiation, is now once again shaping the ways the matsutake economy is developing.

1) Agency in multispecies worlds

These studies work to displace certain dualisms that have structured Western understandings of the world, such as the divisions between culture and nature, or between humans and animals. Such studies also challenge the idea that individual subjects, or even individual species, carry out their lives as free and autonomous

choice-makers. Drawing on a notion of relationality, some argue that ourselves are made through our relations to others, we do not exist in the same way prior.[1]

Terms such as assemblages, collectives and networks can expand our understandings beyond an exclusive interest in human will and activity. If we switch from understanding the matsutake example as a commodity chain to viewing it as a network, we can see something quite different. Obviously, people are not the only agents in the chain: it relies totally on the mushrooms themselves, and then if one looks further, these mushrooms are deeply entangled with certain insects, trees and other species. We can see how networks expand and contract, and how new actants such as laws and bureaucracies can shape the flows of goods in different ways.

The language of the network conceives of agency in a less conventional way. Rather than seeing agency as a human monopoly, with rational human actors working intentionally towards certain goals, Bruno Latour and other advocates of Actor Network Theory (ANT) conceive of agency as the ability to affect a state of affairs, and use the term “actant” to describe any actor in the network, whether human, nonhuman animal, or machine. Thus, like humans, the mushrooms, trees, insects and planes are actants, too. While I find this concept productive and it widens our attention to a much greater array of actors, and an interest in their role in such networks,[2] these concepts may come with some shortcomings I would like to raise.

Some work from an ANT approach may tend to have a conceptual flatness, especially without a particular emphasis on certain parts of the network, or when scholars don’t distinguish between the capacities and properties of different actants. When we talk about networks containing a wide variety of actants, do we have to

understand them as equal participants? In Latour's study of Louis Pasteur, is he an actant of the same degree as the blue ink he used in taking his notes? Although actants are involved in making worlds, and do so in ways ultimately beyond human comprehension, they do so with different capacities, engendering differing effects. One can ask how does the presence or absence of a particular actant, and its properties and capacities might shape the resulting network? How might we understand such networks in terms of history and power (Kirsch and Mitchell 2004)? In doing ANT studies, is there no inherent stopping point to a network, no place where a network might end, no center or even nodes, places that are more dense with importance than others?

For the last decade, I have been exploring how the multispecies world of the matsutake mushroom has arisen in China, and how particular sets of relations produce specific outcomes. Probably the most extensive vein of such work comes from posthuman geography by scholars such as Jamie Lorimer, Sarah Whatmore, Lorraine Thorne, Juanita Sundberg, Bruce Braum, and Noel Castree. One of the preeminent scholars of capital and capitalism, David Harvey, now argues that nonhuman organisms should be seen as 'active subjects' capable of 'transforming nature' and 'adapting to the ecosystem they themselves construct' (1996:186). The work of Donna Haraway, Anna Tsing, Myra Hird, Timothy Mitchell and other social scientists have also made significant contributions. Historians, such as Richard White, Virginia Anderson, and others are enriching the field, showing us the active role of nonhumans in making history, as well as trying to grasp how different human collectives understood and interacted with the same animals.[3]

How might we specify the kinds of effect that each actant is having in particular worlds?[4] I am also interested in arriving at understandings in which humans are not always the main subject or one of two subjects (such as studies of human-elephant, human-tomato or human-rat), but for now this project can start to get at some of the kind of grounding that I seek, a kind of historical and physical emplacement in studying these relations.

In this aim, we can ask how humans working with other species are shaped by that engagement, as a kind of co-emergent quality. The general concept is not new. Marx and some of his contemporaries, of course, talked about how human forms of alienating labor, or forms of the simple, repetitive activities that arose during the industrial revolution, could lead to a kind of economic and social impoverishment. We also know about physical transformations that occur by repeated exposure not only to certain chemicals, such as black lung or other industrial ailments, but also the ways physical labor literally shaped the human skeleton: the longshoremen who in Ancient Greece unloaded amphora, large ceramic vessels filled with wine, eventually developed misshaped spines and scapulas as the strain of the weight permanently re-arranged their skeletal formation. These are all of interest, but I am particularly curious about how these engagements might not only affect the biological body, but more.

We are most familiar with hearing about human-nonhuman engagements as largely a one-way process, where human actions cause other species to change: killing them off or degrading their habitat. For example, cougars once roamed across a wide range of ecosystems in North America but were so targeted as a pest by European settlers so they only survived in mountains (becoming “mountain lions”). In turn, after

humans eliminated cougars and other predators, deer populations exploded. Some work in animal studies, drawing on Michel Foucault, explores how nonhuman animals are brought within new forms of human discipline.[5] The bulk of these studies look at domesticated animals and how humans shape their bodies and health, for human benefit, or how animals are managed in zoos. These tend to understand these relations in terms of a unidirectional flow of power and discipline, from humans to animals (Novek 2005; Williams 2004). The abundant literature on animal domestication, for instance, often regards this process as a "reign of dominance by humans over animals" (Mendum 2009).[6] Challenging these trends, Jason Hribal argues that even in the most influential books on animal studies,

> "animals are not seen as agents. They are not active, as laborers, prisoners, or resistors. Rather, the animals are presented as static characters that have, over time, been used, displayed, and abused by humans. They emerge as objects — empty of any real substance" (2007: 102).

These are strong charges. His book *Fear of the Animal Planet: The Hidden History of Animal Resistance*, however, does relatively little to advance his counter-thesis, that animals actively resist human uses (2011). Although the book contains many well-told stories about how captive animals try to escape or fight back against their human captors its thesis falls short because resistance as a concept is undertheorized and over utilized as an explanation for why animals do what they do. In other animal studies texts, even by sophisticated thinkers such as Chris Philo and Chris Wilbert, agency is basically conflated with what is taken to be "resistance" (2000). Yet, as I have elaborated elsewhere (Hathaway 2013), such a focus on resistance to the exclusion of a wide repertoire of behaviors and actions results in an impoverished understanding of

action and motivation, whether we are trying to explain the lives of humans or nonhuman animals.

Moving somewhat beyond accounts of human coercion and animal resistance, Lewis Holloway and Carol Morris, consider the ways in which "nonintentional nonhuman agency and capacity are implicated" (2014). Their study of a cow breeding society borrows some aspects of network theory to understand this as a collectivity that includes breeders, management books, barns, and the cows themselves. In their case, nonhuman resistance plays a role in this dynamic, but is not their exclusive focus, and they are interested in how the cows themselves are part of a “looping effect,” shaping the kinds of collectivities that humans are attempting to build. This is part of what I am after, an interest in how the materialities and capacities of the organisms themselves shape the kinds of networks that include them. These qualities do not create the network in a deterministic way; instead, there is a kind of co-creation involved through repeated engagements, as we might expect from relational theory. This might help to expand the idea of agency beyond it as the product of intentional, conscious acts entirely authored by humans, but do so in a way that doesn’t stretch it so broadly as to lose analytic precision.

Almost all scholarship regarding nonhuman agency looks at animals, and relatively few scholars examine plants in terms of subjectivity and agency. Ruth Mendum explores questions of plant subjectivity and agency in her study of vegetable breeding (2009). She argues, for instance, that some vegetable breeders are particularly successful because they keenly observe the wide variety of forms that

seedlings take, and they choose to enhance or exaggerate particular characteristics, even if they weren't initially intended outcomes.[7]

Although there are some whispers of "critical plant studies" these days, few are apparently willing to endorse the kind of liberationist agenda that is often attached to the term "critical" in animal studies. In one recent workshop, participants argued that just as animal studies scholars question the line between humans and other animals, they

> "have questioned the similarly political line between plants and animals: plants communicate, move, decide, transform, and transgress in ways that are sometimes uncomfortably "like" animals (including humans), and sometimes so completely Other to animality that conventional metaphysical principles are radically denaturalized."[8]

I applaud the rise of plant studies, as I am interesting in pushing concepts originally designed to understand human-only worlds, to see where they will take us, where they break down, and how they might be reformulated. However, when I see the list of references used by members of this workshop, I see that they are also drawing on fungal studies (referencing the work of Matsutake Worlds Research Group member, Anna Tsing), perhaps unwittingly placing mushrooms under the plant umbrella.

In the rest of this chapter, I consider several ways in which looking at mushrooms in terms of agency and networks might contribute to such discussions. Especially as most studies of nonhumans in this vein look at animals "big like us" (as compared to microbes), I wonder how attention to fungal qualities might disturb certain assumptions about how things live and act.[9] Perhaps human agency has particular characteristics tied to the characteristics of the human species being and these include consciousness or intentionality. If so, what are the characteristics of fungal organisms or matsutake in particular that would give their agency specific qualities? I wonder if attention to the

"species biology" of mushrooms (their properties, qualities, and behavior), might challenge in some ways the kinds of assumptions made about agency that can emerge from more familiar creatures, like dogs and horses. In other words, if we are committed to breaking open the idea of agency for the nonhuman world, then we might have to be committed to doing the same precise conceptual work on nonhuman agency that we do for human agency.[10]

2) Mushrooms as beings: fungal species biology

Although many people still regard mushrooms as more like plants than animals, mycologists know that the opposite is true. Even among scientists, fungus (along with algae and bacteria) were only regarded as different in kind from plants as late as 1969, when taxonomists accepted a five-kingdom system to divide the living organisms of the world. Previously, in a four-kingdom system, fungus were regarded as a subset of plants because they had a cell wall and were seen as not ingesting food material. Let me look briefly at some of the differing characteristics of animals, plants and fungi. Both animals and fungi need to obtain their food from other organisms, whereas plants use photosynthesis to convert sunlight into energy. Although they may appear passive to humans, mushrooms can be amazingly active and animal-like in their search for food. Some use a noose that is used to snare nematodes, a tiny worm-like organism that lives in the soil. Although fungus are often seen as like scavengers, feeding off the dead wood of trees or their decaying leaves, such actions make them seem more like predators.

This hunting is happening below ground, in a place that people often think of as a zone of largely passive roots, which absorb water but mainly support the above-ground structure. This is not quite true, however for not only are a mushroom's "roots" actively hunting, digesting nutrients, and taking in water--- they are less roots and more the main body of the organism. As one mycologist told me, people think of mushrooms as if they are apple trees, but in fact, mushrooms are more like apples: they are the fruiting bodies of vast networks of mycelia.

Mushrooms in relationship to space

The spatial relationship of mushrooms is wide ranging. One can think of their spores as the most incredible travelers on the planet. Unlike seeds, which contain complete organisms, mushroom spores have to find other compatible spores to fuse with. Although we tend to think of plants and animals in terms of a dichotomous two sex system of male and female, spore compatibility is quite varied and complex.[11] Spores can travel vast distances by wind, much farther than most plant seeds. Living spores have been found under extreme conditions, including over 30,000 feet in height in and above the jet stream, where it is estimated that they could travel over 8,000 miles in one week, landing in another hemisphere.[12] They are everywhere. As you breath while reading this paper, whether inside or outside, you are inhaling many species. I hope few species take hold within your body, unless they are those that are benign or even helpful to our survival and flourishing.

For many years, I was taught that the largest living thing on the planet was a blue whale, and that's probably still true if we only considers animals and especially if we limit ourselves to individuals, and don't consider colonies of coral and other organisms.

We recently, know, however, that unlike how we often imagine mushrooms in terms of individual “toadstools” or even fairy rings, which can fit within the front lawn of an average American suburban house, fungal mycelia can extend vast distances underground. It is only by fluke and dint of hard work that we can determine the spatial parameters of a “single” mushroom, and in the case of what is now recognized as the world’s largest organism, a honey mushroom, which has created a mycorrhizalnetwork extending over 2000 acres in Oregon’s Blue Mountains. As I will soon explain, these mycelia, in turn, have formed intimate connections with millions of trees, making it difficult to truly say where the honey mushroom begins and ends.

Mushrooms in relationship to time

Fungus have an interesting relationship to time. Evolutionarily, many are relatively ancient, found on the earth far before dinosaurs. They created symbiotic relationships with alga, forming lichen in the process, which can survive in some of the most extreme conditions of any easily visible organism. Scientists have relatively little knowledge about the lifespan of most fungus, but we think that some mycelia can exist for centuries, if not millennia, whereas others are quite fleeting. Their fruiting bodies, the above-ground structures that are the main ways that humans apprehend their presence, are often short-lived: existing for days or weeks rather than months or years. Unlike trees, which can remain visible at sites for centuries or more, mushrooms can remain underground, invisible for 90% of the year, or only fruiting episodically, when all of the mysterious conditions that prompt their fruiting happen to align. Fungal spores, in contrast, are often relatively short-lived, but there may be conditions in which the spores

of some species can survive for a long time. Overall, we know relatively little about the wide-ranging characteristics of this kingdom, and there is reason to believe that there might be a much wider range of characteristics among fungi than there are among animals or plants.

The fleeting above-ground visibility of mushrooms makes human interventions quite challenging, especially in creating plans for their management. Humans find it quire difficult to produce statistics about the health of mushroom populations; tracking their rate of reproduction is even harder. Mushrooms' life history, wherein the vast majority of living fungus components are either underground, as mycelia or as not-easily-detected spores that are carried by the winds, renders it quite difficult to get a firm grasp of population estimates. Humans have created techniques for the census for humans and other animals "big like us;" creating a microscopic census may take a different set of tools, and one quite challenging to conduct over a large terrain. As it stands, humans tend to know about the relative numbers of mushroom populations in a given place as they do for other species that are not easily visible, such as salmon. In these cases, scientists learn about their populations only through numbers generated by human harvests: the species only becomes scientifically counted after it is dead, and it is often difficult to know the proportion of organisms that avoided human capture.

Mushrooms in relationship to others

Scientists often divide mushrooms into three different categories, based on how they obtain food: saprotrophs, parasites, and symbionts. Saprotrophs are those that consume already dead plants or animals. Parasites are those species that, in

detrimental ways, take nutrients from a living host. Symbionts are mushrooms, whose form of mycelia forges connections with other species. Mychorrizae are root-like filaments that grow through a growth medium, like soil. They form a living bridge between mushrooms and “host species” such as trees.

In terms of relationships to humans, of the many thousands of mushroom species, only a handful have joined forces with humans to fruit in predictable and abundant ways.[13] Almost all of these mushrooms are saprotrophs, like oyster mushrooms that are willing to grow on pasteurized sawdust and shitake that grow on oak logs stacked under shade cloth. Humans have long-tried to bring mushroom mushrooms under their management, for many of the world’s most treasured species such as chanterelles and truffles, as well as mastuake. The fact that saprotrophs are much more amenable to fostering and mycorrhizals are not indicates forms of fungal agency. Humans are not giving up and thousands of people devote their lives to the proliferation of some of these choice species such as the morel mushroom, working in the lab and in the field to find ways to coax them into being in new places, or increase their productivity in already existing places.

Although it was originally thought that they might only connect with one or two plants of the same species, scientists discovered that mycorhizzae can end up connecting many different species together. They thus form multispecies networks, active conduits for critical supplies of food, water, and nutrients. Mycorrhizal mushrooms need other life forms, and create relations with them in important and complicated ways. Mycorrhizae grow like a rhizome, and they can cover vast distances. The relationship with their host is called a “mutualism,” a relationship that is mutually beneficial. The tips

secrete enzymes that are able to dissolve minerals into nutrients, some of these nutrients are taken up by the mycorrhizae and some are consumed by other nearby species. In turn, the fungi take from the sugars from the plant's roots, food that plants produce through photosynthesis.

3) Wild or domesticated, or nether?

Instead of reproducing a long-standing dichotomies of viewing organisms as either wild or domesticated, a number of scholars take a different approach. Some like Sarah Whatmore and Lorraine Thorne show how many so-called wild animals have long histories of human entanglement, such the Romans creating a massive trade in live wild cats, such as lions and tigers, for use as gladiatorial sport (1998). Others promote the notion of a spectrum, where depending on the situation, organisms exist at different points between wild and domesticated (Anderson 2005). Is the organism completely reliant on human care for their reproduction (like corn), do humans merely assist and facilitate its continuation, or do they have little to do with shaping its life? Where do matsutake fit on this spectrum? It turns out whether we look at the lab or the forest we get different answers.

In terms of raising matsutake in the laboratory, humans have failed almost entirely. Despite decades of intense efforts by dozens of top scientists, and millions of dollars in equipment and salaries, matsutake refuse to fruit outside of the forest. Once when I conducted fieldwork in Japan, I heard from colleagues that newspapers announced headline news, an exciting discovery: scientists had finally succeeded in

growing matsutake. Several days later the newspaper wrote a retraction, maybe the scientists had been able to grow mycelium or transfer it to another medium, but matsutake refused to fruit. Even though creating the conditions that precipitate fruiting has remained beyond their grasp, these scientists have learned quite a lot about matsutake's biology, growth, and so forth. Of all the world's mushrooms, matsutake was the first to have its genome sequenced (Varma 2008), and it was once assumed that genomic knowledge would allow humans to grow it on demand. The matsutake did not oblige, so evidently this information, in and of itself, does not a domesticate make.

In part inspired by work from Foucault, we often assume that the capacity for managing and disciplining populations is based on the accumulation of accurate and actionable knowledge, often in the form of statistics. Yet, in the case of matsutake, the knowledge needed for its proliferation is less than clear. As part of the Matsutake Worlds Research Group, we read many scientific reports from the leading countries of matsutake research, Japan and the US. Two members of our group, Anna Tsing and Shiho Satsuka, found that matsutake scientists from the US and Japan often had different conceptual frameworks that influenced how they produced knowledge (2008).

In Japan, the enthusiasm for cultivating matsutake in the lab has waned (and it has now moved on to China, where Chinese scientists actively translate Japanese scientific papers, searching for clues). Yet, Japan still maintains the world's most robust program on matsutake research at experimental forestry centers. Researchers work with local farmers to study the conditions that result in plentiful harvest years, and try ways to enhance local production. These are not always high-tech experiments: we were shown one site with a dozen upside down umbrellas, suspended low in trees.

Scientists cut a hole in the bottom of the umbrella-cum-rainwater catchment device and attached surgical tubing, aiming the end towards a particular patch. They wondered if increased irrigation would affect the patch, make it fruit earlier, or increase the size or number of mushrooms. They had a number of other creative experiments under way, such as raking away the duff in varying degrees and opening up the forest canopy to one of three different levels of shade, among others.

In Japan, many people suspect that a major reason why the levels of matsutake production fell after World War II is because so few people now live in rural Japan. Before, people used vast areas of forest, raking leaves to use as animal bedding, cutting back hardwoods for use as firewood, and so forth, but they have largely left for the cities, and those who have stayed in rural areas no longer use the forest so intensively. There is a kind of nostalgia for a Japan with vibrant rural communities, and matsutake is knotted up in these forms of national longings.

Some of Japan's top researchers describe matsutake as the product of an "unintentional orchard," fostered through many people harvesting forest materials. When we asked what kind of forest was best for matsutake, we often got the answer of a pine forest of between 20 and 50 years old, with a structure that allowed a geisha, wearing high heeled sandals and carrying a parasol, to walk through easily. The ground should not be too thick in duff, and the trees spaced widely apart.

Out of this context emerged an energetic grassroots group, mainly of retired professionals, known as the "Matsutake Crusaders." Based outside of Kyoto they get together frequently and work to restore matsutake mountains, a kind of intentional orchard-making. They rake duff and clear hardwood trees, all in a spirit of communal

conviviality. They make shared meals, use the firewood to fire their handmade pottery and enjoy their time together. They have attracted much international attention, receiving groups from other matsutake producing countries, such as Sweden. In Japan, people see the crusaders as caring for a forest that is otherwise seen as “abandoned” and “deteriorating,” terms that make little sense within the framework of wilderness and wild nature so prevalent in the United States. Despite the best efforts of American logging companies to convince the public that forests need human labor to thrive, it is a prevalent popular belief that human work tends to damage forests and that forests, when left alone, will recover.

Taking a wilderness perspective, American researchers have often viewed matsutake as wild. They assume that human actions in the forest can only be damaging and thus their experiments tend to fortify that expectation; indeed their scientific experiments are structured to do so. They tend to believe that matsutake are most abundant without humans.[14] Japanese research, however, assumes that without human intervention, matsutake will be relatively sparse. Japan and the US have different ecosystems, and perhaps different species, so each group could be basically correct about its own theories of human-mushroom relations. Nonetheless, powerful epistemologies underpin their approach to producing knowledge, and their strategies for managing human activity in the forest follow from these beliefs.

Thus, this section showed how differing legacies of rural development led to the creation of matsutake rich environments, and how notions of human involvement are leading to divergent approaches. In this next section, I show how the history of

exchanges between Japan and China has shaped the transnational matsutake economy, especially in terms of concerns over pollution, broadly conceived.

4) Contamination and purity

Japan has long viewed its food production system with confidence, as orderly, reliable, and safe, especially in comparison to its understanding of China as a place of relative disorder and risk. During my fieldwork in Japan starting in 2004, pride in domestic food was abundantly clear, and the matsutake was both one of the most valued and regarded as one the most emblematic foods of Japanese culture.[15] At that point the main fear for matsutake dealers was receiving Chinese mushrooms that were contaminated by pesticide. Yet, on my most recent visit during the fall of 2013, two and a half years after Japan's triple disaster of an earthquake, tsunami, and nuclear radiation releases, I found such confidence deeply troubled. The Fukushima disaster was both immediate and extends far into the future. As many as 20,000 people might have been killed by the tsunami and earthquake, and there is extensive concern that the extent of the radiation leaks, which are still on-going as of April 2014, are much more severe than the government admits. Overall, these ongoing incidents have not only reconfigured notions of purity and safety in Japan, but also relations between the public and the state, leading to a loss of faith in governmental authority and its concern for public well-being. In turn, citizen groups have been questioning the reliability of Japan's food supplies. They are also modifying existing food networks and building new ones.

A brief history of the flow of pollution between Japan and China

The threat of pollution and contamination has long been a theme in relations between China and Japan, moving from air to food. In the 1970s, a number of Japanese scientists started to investigate why the red pine forests that nurtured their matsutake had begun to decline. They had long known that their own factories, especially smelters, damaged the surrounding forests, but they were stunned to learn that Chinese factories, hundreds or even more than a thousand miles away, were polluting their rain. Japan was already one of China's most important trade partners, but this finding motivated Japan to become China's largest aid donor (Muldavin 2000). Japan focused on reducing the emission of coal precipitates and other chemicals that could produce acid rain, sending experts and technologies designed to capture pollutants (Wilkening 2004).

By the 1990s, threats to Japan's food safety started to gain prominence. In particular, of all countries, products from China were subject to a series of scandals, with lead-contaminated children's toys and dangerous foods, such as tainted milk. This fostered an impression of China as a place of ubiquitous toxic chemicals and little concern for human safety. Whereas people in other countries often found it alarming, they did not necessarily feel targeted. In 2008, however, Japanese delegates accused Chinese workers of deliberately contaminating food intended for Japanese consumers (McCurry 2008). Some called this "global food terror" after a number of people were sickened by Chinese pork dumplings (Rosenberger 2009). The incident stimulated public acknowledgment that Japan relies heavily on cheap imported foods, and many consumers were shocked to hear that China, as a single country, provided more of Japan's vegetable imports than all other countries combined (Dyck and Ito 2004). Media reports emphasized that Japanese food is relatively safe but also acknowledged that

most ordinary citizens found it too expensive to buy exclusively; likewise, as toxic goods from China, sometimes called “black hearted products” are discovered elsewhere, there is a growing wariness of Chinese goods and at the same time a sense of resignation that there are few economically viable alternatives (Chinoy 2009).

In terms of matsutake, before pesticides became a concern, Japanese dealers worried about other contaminants: iron. They were receiving mushrooms that had slivers of iron inside, in order to add weight and thus value to the mushrooms. [16] After metal detectors put a dent in this strategy, some people in China switched to adding slivers of wood. Japanese dealers explained to me that this kind of behavior would not occur in Japan, but it happened in China for two reasons: the low cost of labor means that even labor intensive practices with little pay off can still be at least marginally profitable, and the low status of public moral responsibility.

Because the Japanese food safety standards place matsutake in the category of wild as compared to cultivated, they demand higher levels for purity than for domesticated vegetables. This is somewhat ironic because Japanese scientists often regard matsutake as a product of human activity, unlike in the US, where it is regarded by scientists as truly wild. It should be noted that the contamination levels considered unacceptable for matsutake are not necessarily alarmingly high, what would be considered problematic for matsutake would be considered perfectly normal and acceptable for many vegetables.

In 2002, Japan found pesticide on a shipment of Chinese matsutake and banned that importer for the rest of the year.[17] As I explain more below, such pesticides are likely on the mushrooms because their species biology attracts many species of insects,

and humans fight back. Since that time, pesticide detection machines were installed at major export companies so that shipments of contaminated mushrooms can be identified before they leave China.

History of making the countryside in China and Japan

The divergent histories of how rural landscapes were made in the US, Japan and China have configured the risk of contamination in different ways. The main threat is the risk of agricultural pesticide contamination, either accidental or deliberate. Places in the US with the greatest matsutake populations mainly occur in vast stretches of forest service land. There are relatively few farms scattered through this area, in large part due to the dryness and the mainly infertile soils. In Japan, there are relatively few active farms near matsutake mountains because of a mass exodus of rural farmers who left for the cities starting in the 1970s. Their absence likely means less matsutake in the forest and also less threat of pesticide contamination.

In China, however, many of the main matsutake areas are close to active farms. This is due to the ways the countryside was developed. Starting in the late 1940s, the Chinese Communist Party brought land under its control; cadres confiscated and redistributed landlord's property such as their tools, animals, and most importantly their agricultural and forestlands. The first plots were given to small collective units, consisting of a handful of families. Next, larger and larger collective units were formed until 1958, the heyday of collectivization when Yunnan's massive land area (the size of California or thirty times the size of Connecticut) had only 833 communes, each averaging between 3,000 to 5,000 families. During this time, long-existing divisions of

individual properties and even village boundaries were completely ignored, as such land claims were regarded as a vestige of a capitalist or feudalist past.

Mao died in 1976, and China changed gears so that by 1978, cadres started to divide communes into village holdings, but the land was never marked out, mapped and pinned.[18] At first, such approximations of village boundaries had relatively little importance, as the lands in questions were mainly considered of low value, as they were usually degraded, sloping lands without potential for irrigation or much agricultural use. Villages were often built in dense clusters around lands already crafted into agricultural plots, and outlying lands were mainly used for gathering forest resources, such as pine needles, kindling and firewood. Conflict between villages was mainly about access to water, which was the most precious and unevenly distributed good. Yet, as documented by Emily Yeh, with the rise of the matsutake market in the late 1980s, some forests became markedly valuable, and neighboring villages struggled over land claims (2000). At times, such conflicts became deadly, or initiated long-lasting feuds. For those villages where matsutake was found, picking these mushrooms was often far more lucrative than any other alternative. In order to buttress their right to valuable matsutake forest, some villages sent delegates to the cities to find the cadres who divided their commune's lands, asking them to delineate older boundaries.

Since that time, the price of matsutake has gone down, tempers have cooled, and more land struggles between villages have been negotiated. During the 1990s, governmental officials carried out a campaign to subdivide village forest lands into private family plots. However, a number of those villages with matsutake forest decided to latter recollectivize this land, at least for gathering matsutake. This made policing far

easier--- with small private plots it was quite difficult for each family to patrol their own land. When the land was re-collectivized, it was acceptable to harvest any mushroom on village lands, and only rarely can one claim dibs on a growing mushroom for future harvest—it tends to be first come, first picked.

The Chinese strategy of focusing on urban heavy industry, and turning the countryside into a “grain factory” meant that even today, virtually everyone in the Chinese countryside is a farmer. For many years and until quite recently, rural residents were required to pay annual taxes in grain rather than in cash, which thus obligated families to produce surplus grain for the state coffers. There are few opportunities to earn a salary in most rural places, and most of those who work in the city are not allowed to live there permanently, without an official urban residence permit, they are denied access to schooling, medical care, and other urban benefits. Almost everywhere I have visited in rural Yunnan, especially in places where people live relatively far from daily markets, they tend to strive towards self-sufficiency in grains, whether in rice, corn, potatoes and raise animals for their own consumption, and sometimes for sale. This means that their incomes are very low, often under $400 USD annually, which increases the cash importance of the matsutake harvest.

As farmers, almost all families have access to pesticide: it’s easily procured at markets and seen as an effective and scientifically advanced tool in the modern farmer’s arsenal. Chinese pesticides are even correlated with national pride, and the government has made significant efforts to encourage their use. Agricultural extension agents have beamed with pride to tell me that in China, unlike in Latin American countries that receive chemicals banned in the US and with directions only in English,

they make their own chemicals and print directions in Chinese--- they are relatively cheap and state regulated. In China, the term for pesticides is *nongyao*, or “agricultural medicine,” giving the connotation of it as relatively safe, necessary, and promoting life. This contrasts with the term “pesticide” in English. The prefix refers to a category of organisms (pests) seen as a problem and not deserving of life. The suffix refers to the chemical’s act of killing. Despite the abundance and familiarity of pesticide, matsutake pickers typically understand that these chemicals represent a great risk to the mushroom economy. Experienced pickers recollect the times when the industry ground to a halt after Japanese inspection agents claimed to have detected unacceptable pesticide levels.

Pesticide may contact matsutake either deliberately or accidentally. Pickers, who are often also farmers, may apply chemicals to protect the matsutake, just as they have been doing for decades with their crops. In this case it almost doesn’t make sense to call it contamination. If they use them deliberately, it is almost surely to deal with insects. Pickers have found that many animal species, such as deer, pigs, and birds, seek out matsutake, but insects are the most common and serious threat.

Indeed, it is quite rare to find mature matsutake without any insect damage. Although relatively large pests such as slugs slowly chew on the fungus and are easily seen and detached, other pests burrow into its flesh, making them hard to see and impossible to remove. Insects are attracted to the matsutake because of its species biology. Although scientists in the US often assumed that the impressive range of chemicals that the matsutake produced were designed as defensive mechanisms against insect attack (i.e. Wood and Lefevre 2007), scientists in Japan were also

investigating the possibility that the mushroom produces chemicals as a means of attraction.[19] A number of other mushrooms use mammals, birds, and insects to disperse their spores, and some spores are well-designed to survive intact or even benefit by passing through the digestive tract of particular species (Gange and Bower 1979).

Some species of insects search out the mushroom by crawling though soil to enter from the base, while others fly through the air. In many cases, insects lay eggs in the mushroom, and the larvae hatch and create small tunnels in the soft flesh. Pickers and dealers have a strong incentive to reduce insect damage. Not only do insects harm individual mushrooms, but dealers may bulk their goods for more than twenty-four hours before they are shipped to Japan. During this time, thousands of mushrooms can be packed in close quarters, and the whole shipment is at risk of damage. Some dealers told me that they use a "secret formula" to keep the mushrooms looking fresh but insisted that it was perfectly safe.

Most cases of contact, however, probably occur by accident. As many farmers in China use pesticide sprayers, the chemicals can drift on the wind and enter the nearby forests. Pesticides may also enter the commodity chain through the carrying sacks that pickers use for both matsutake and farm products. Urban exporters, who cultivate a cosmopolitan manner, often repeat widely spoken refrains about the lack of "quality" (*suzhi*) of rural Chinese people, and worry that the pickers will recklessly endanger their trade. Yet, villagers are among others such as Chinese scientists and NGO activists who are responding creatively to these regulations by developing methods that will foster chemical-free farming or reduce the risk of mushroom contamination.

Villagers use a variety of non-chemical techniques to deal with insects. One innovation, said to have started around northern Yunnan's towns of Lijiang and Dali, has been to sprinkle a bucket of sand over the mushroom. This covering poses a challenge to flying insects, which have little ability to dig. Another option, more widely practiced after the year 2009, is to place a clear plastic tent over the mushroom, weighing it down around the sides to prevent flying insects from crawling under the edge. Some pickers say that the tent increases the internal humidity and warmth, making the mushroom grow faster. The use of either sand or plastic, however, increases the mushroom's visibility to other pickers. In most places, matsutake-picking grounds located close to villages are extremely well traveled and searched, with many people covering the same ground every day during the growing season. Although pickers often disguise their prize by sprinkling duff over sand- or plastic-covered mushrooms, pickers in highly traveled areas do not frequently use such techniques.

Another powerful player in promoting chemical-free mushrooms is the Yunnan Matsutake Association. In the early 2000s, the provincial government limited the number of exporting companies, in part to reduce the number of companies that they had to oversee and permit. By 2006, only twenty matsutake export companies had licenses and they formed an association. In 2011, the association's leaders expressed interest in creating a "Yunnan Brand" for matsutake that was based on confidence in purity but admitted that there are several weak points in managing the commodity chain. The sheer proliferation of sites and large number of people who pick matsutake, as well as the frequency with which the mushrooms change hands,[20] means that tracing a particular mushroom "from field to table" has been nearly impossible. They are working

to create more forms of accountability, and tracing back mushrooms to the region they were gathered from as a first step. In the matsutake commodity chain, at least 90% of the participants are pickers, collecting over a wide area. In contrast to mushroom exports, vegetables sent to Japan are often raised on large commercial farms, where it is relatively straight-forward to connect product to source. This highlights some of the difficult challenges

Eating matsutake in a post-Fukushima world

The dominant vision in Japan of its own country as relatively clean and China as relatively dirty was challenged by the Fukushima disaster, what is referred to in Japan as 3.11. Although reports vary on the numbers of people killed during the tsunami and earthquake, it may be as high as 20,000. More than one million buildings were impacted, leaving many people without access to their homes or offices. The impact of the radioactivity is even less certain, in terms of immediate human deaths, long-term suffering, and what the radiation will do as it circulates through the ecosystem. The disaster has re-arranged the food landscape, especially for a certain segment of people, often professional urban couples with young children, who are trying to find clean food. The public has reacted to the government's actions with skepticism, as they have seen the official allowable levels of radiation fluctuate in response to public pressure. The state has decided to allow farmers to continue to grow food closer to the nuclear reactor than is deemed acceptable by many international organizations (Belovologa 2012). There are rumors that such radioactive food is being re-circulated back into the food system by the Yakuza, Japan's mafia. While food laws in Japan state that domestic

food is labeled by its provenience, the Yakuza would scrub off such a connection and add Fukushima grown food to stocks from other places. What have consumers done about the daunting problem? A number of consumers are become more involved in their food supply--- buying food from grocers that claim to proactively avoid contaminated produce, and even monitor their stock with Geiger counters. Another group, however, see the disaster in terms of "loyalty" to Japan and to the Fukushima region itself--- deliberately purchasing "loyalty rice" and other vegetables from the affected region, in order to support those who stay behind. Yet, considered even more susceptible to radiation than grain or vegetables is the "wild mushroom."[21]

In 2004, when I and other members of the Matsutake Worlds Research Group asked scientists about studies investigating the impact of the nuclear bombs dropped on Japan during World War II on mushrooms, the scientists replied that such studies were "basically taboo." Some people were curious, but no scientists seemed willing to take the risks, at least in a visible and public way. The species biology of mushrooms, with their fine mycelia, means that they can be more efficient than trees in absorbing small particles. They may act as sponges, accumulating more radiation than surrounding plants. Although "wild mushrooms" are often assumed to be functionally equivalent, species can vary substantially in their relationship to radiation (Kammerer, Hiersche, and Wirth 1994), with some absorbing far more than others. Unlike the visibility of insect damage in mushrooms, or they ways radiation may produce aberrant bodies (Raffles 2010), the radiation sequestered by mushrooms is not visible, nor does it leave any detectable taste.

In turn, radiation levels rise as they move up the food chain; mushroom-loving wild pigs may contain quite high levels. In post-Chernobyl Germany, for instance, hunters let officials measure the Cesium-137 levels in the wild boar they have shot, and the government will compensate hunters whose boar is higher than acceptable limits (Baetz 2011). Such compensation cost the government $650,000 dollars in 2011. These animals are nearly 950 miles (1500 kilometers) away from the Chernobyl nuclear disaster of 1986. Japanese scientists and consumers have increasing looked to Chernobyl to consider possibly unanticipated outcomes, such as radioactive mushrooms or boars, both of which are a popular luxury food item in Japan.[22] Evidently, government officials bar or discourage Japanese scientists from making public comparisons with Chernobyl, as they wish to see it these as accidents that are different in kind. Thus, the mushrooms may plan a critical role in how radiation is accumulated and redistributed in food chains in Japan, far beyond what is intended by human desires.

Conclusion

In conclusion, this paper was inspired by scholarship that reveals the multispecies worlds that we are part of. It was also inspired by my relationships with mushrooms, and in particular with matsutake, which I have been curious about for some time, but which have been somewhat of an obsession for the past decade. It is an obsession not only born of a fascination with learning about their lives through print and speech, but also fostered through heading out to the woods in Canada, the US, China and Japan: hunting, drawing, photographing and consuming them with gusto. Thus although I experience these mushrooms in terms of a kind of charisma (Lorimer 2007), I don't

mean charisma as an inherent quality, the ways that so-called “charismatic mega-fauna” such as panda bears are expected to automatically generate human interest and compassion. Rather, I refer to a charisma that I have seen in many people who previously paid little attention to mushrooms, but that after they have learned to hunt mushrooms has awakened their senses and curiosity and desires, as almost any mushroom hunter would admit. Scientists, too, are not immune to their charm, and are shaped by their repeated encounters with the matsutake, their relations with it in forests and labs, pursuing questions that can take them around the world. More surprisingly, many mushroom hunters who supposedly are motivated solely by economic gain, continue to hunt even when the prices fall to record lows.[23]

This paper is an initial effort to see how a mushroom, with its highly specific qualities, itself plays a role in the transnational commodity chains formed around it. Matsutake is both shaped and shaper. The species biology of the mushroom influences the practices of land tenure, the politics of radiation in Japan, and the rapid tempo of the matsutake trade between China and Japan. It lives and thrives under two divergent understandings of its existence, it motivates people and insects. It is the center of a gigantic intermeshing network, that springs into life when the mushrooms appear in the fall, and two months later, fades away into society, almost like the fruiting body itself, as pickers turn back to tending their crops, their animals, or maybe hunt other kinds fungus, like the truffle, which exists with its own very particular economy.

Alongside the goal of displacing human moral and agentive exceptionalism, perhaps we need to engage questions of multispecies agency with more consideration of power, self-making, discipline, and so forth. Concepts popular in multispecies

scholarship like networks, assemblages and actants might benefit by more specification: not all of the actants are equal players, they have uneven qualities and capacities. I am interested in the places where these ideas might come together, appreciating the work of Foucault and others but coming from a place of greater humility, with less presumption about the efficacy of human intentions, whether it is the creation of new subjects or the mastery of biopower. Certainly, the case of matsutake shows us how some species are brought within new realms of governance, but still largely elude human attempts to foster and manage their lives in predictable ways. It fosters a greater curiosity about the range of overlapping projects that humans are creating for and with other species (whether they are used as food, as objects of conservation, as pets, and so forth), and more attention to how the species being of various organisms, whether fungi, animal, plant or other life form, situate themselves in the world and their networks in unique, but also changing, ways.

BIBLIOGRAPHY:

Anderson, K. 2005*. Tending the Wild: The management of California's natural resources*. Berkeley: University of California Press.

Anderson, V. D. 2006. *Creatures of Empire: How Domestic Animals Transformed Early America*. New York: Oxford University Press.

Anonymous. 2002. "Chemical Residue Found on 'Matsutake' Imports," *Japan Times*, August 30.

Baetz, Juergen. 2011. "Radioactive Boars in Germany a Legacy of Chernobyl." *Christian Science Monitor*, April 1. Retrieved April 6, 2014.

Belogolova, Olga. "Rumors and Prejudice Plague Fukushima Farmers Two Years Later." *The Atlantic*, March 22, 2013. http://www.theatlantic.com/international/archive/2013/03/rumors-and-prejudice-plague-fukushima-farmers-two-years-later/274283/.

Birke, Lynda, Mette Bryld, and Nina Lykke. 2004. "Animal Performances An Exploration of Intersections between Feminist Science Studies and Studies of Human/Animal Relationships." *Feminist Theory* 5(2):167–83.

Braun, Bruce. 2004. "Modalities of Posthumanism." *Environment and Planning A* 36(8):1352–55.

Braverman, Irus. 2012. *Zooland: The Institution of Captivity*. Stanford: Stanford University Press.

Cadman, Louisa. 2009. "Life and Death Decisions in Our Posthuman (ist) Times." *Antipode* 41(1):133–58.

Castree, Noel, and Catherine Nash. 2006. "Posthuman Geographies." *Social and Cultural Geography* 7(4):501–4.

Chinoy, Daniel. 2009. "Black-Hearted Products: The Causes of China's Product Safety Problems." *Columbia East Asia Review* 2:29–36.

Collard, R. C. 2012. "Cougar–human Entanglements and the Biopolitical Un/making of Safe Space." *Environment and Planning-Part D* 30(1):23-42.

Crosby, Alfred W. 1972. *The Columbian Exchange: Biological and Cultural Consequences of 1492*. Westport, CT: Greenwood Press.

Despret, Vinciane. 2008. "The Becomings of Subjectivity in Animal Worlds." *Subjectivity* 23(1):123–39.

Dyck, J., and Kenzo Ito. 2004. "Japan's Fruit and Vegetable Market." Pp. 64–76 in *Global Trade Patterns in Fruits and Vegetables*.

Fackler, Martin. 2012. “Japanese Struggle to Protect Their Food Supply.” *New York Times Online*.

Fowles, Severin. 2010. ‘People without things’. In: *An Anthropology of Absence: Materializations of Transcendence and Loss*, M. Bille *et al* (eds.). New York: Springer, 23-41

Gange AC, Bower E. 1997 Interactions between insects and mycorrhizal fungi. *Multitrophic interactions in terrestrial systems*. 115–32.

Gormat, E., and A. Hennion. 1999. “A Sociology of Attachment: Music Amateurs, Drug Users.” Pp. 220–47 in *Actor Network Theory and After*, edited by J Law and J Hassard. Oxford: Blackwell.

Hanski, I. 1989. Fungivory: fungi, insects and ecology. *Insect–fungus interactions*. 25–68.

Haraway, D. J. 2008. *When Species Meet*. Minneapolis: University of Minnesota Press.

Hathaway, Michael J. 2013. *Environmental Winds: Making the Global in Southwest China*. University of California Press.

Hird, Myra J. 2009. *The Origins of Sociable Life: Evolution after Science Studies*. New York: Palgrave Macmillan.

Holloway, Lewis, and Carol Morris. 2007. “Exploring Biopower in the Regulation of Farm Animal Bodies: Genetic Policy Interventions in UK Livestock.” *Life Sciences, Society and Policy* 3(2):82.

Hribal, J. 2011. *Fear of the Animal Planet: The Hidden History of Animal Resistance*. New York: AK Press Distribution.

Hribal, Jason. 2007. “Animals, Agency, and Class: Writing the History of Animals from below.” *Human Ecology Review* 14(1):101–12.

Ingold, Tim. 2000. *The Perception of the Environment: Essays on Livelihood, Dwelling and Skill*. New York: Psychology Press.

Jones, Owain, and Paul Cloke. 2008. “Non-Human Agencies: Trees in Place and Time.” Pp. 79–96 in *Material Agency*, edited by C Knappett and L Malafouris. Springer.

Kammerer L, Hiersche L, Wirth E. 1994. Uptake of radiocaesium by different species of mushrooms. *Journal of Environmental Radioactivity*. 23(2):135–50.

Kirsch S and Mitchell D. 2004. The nature of things: dead labor, nonhuman actors, and the persistence of Marxism. *Antipode*. 36(4):687–705.

Latour, Bruno. 2008. *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.

Lorimer, Jamie. 2007. “Nonhuman Charisma.” *Environment and Planning D* 25(5):911–32.

McCurry J. 2008. Japan dumpling mystery deepens with poisoning claim. *The Guardian* [Internet]. Feb 5. Accessed February 12, 2014.

McIlveen WD, Cole Jr. 1976. Spore dispersal of Endogonaceae by worms, ants, wasps, and birds. *Canadian Journal of Botany*. 54(13):1486–9.

Keller, Evelyn Fox. 1984. *A Feeling for the Organism: The Life and Work of Barbara McClintock*. New York: Macmillan.

Mendum, Ruth M. 2009. “Subjectivity and Plant Domestication: Decoding the Agency of Vegetable Food Crops.” *Subjectivity* 28(1):316–33.

Mitchell, T. 2002. *Rule of Experts: Egypt, Techno-Politics, Modernity*. Berkeley: University of California Press.

Morris, Carol, and Lewis Holloway. 2014. “Genetics and Livestock Breeding in the UK: Co-Constructing Technologies and Heterogeneous Biosocial Collectivities.” *Journal of Rural Studies* 33:150–60.

Muldavin, J. 2000. “The Geography of Japanese Development Aid to China, 1978-98.” *Environment and Planning A* 32(5):925–46.

Novek, Joel. 2005. “Pigs and People: Sociological Perspectives on the Discipline of Nonhuman Animals in Intensive Confinement.” *Society and Animals* 13(3):221–44.

Pepperberg, Irene M. 2009. *The Alex Studies: Cognitive and Communicative Abilities of Grey Parrots*. Cambridge, MA: Harvard University Press.

Philo C and Wilbert C. 2000. *Animal spaces, beastly places: New geographies of human-animal relations*. Routledge: London.

Prestholdt, Jeremy. 2008. *Domesticating the World: African Consumerism and the Genealogies of Globalization*. Berkeley: University of California Press.

Raffles, Hugh. 2010. *Insectopedia*. New York: Random House.

Rosenberger, N. 2009. “Global Food Terror in Japan: Media Shaping Risk Perception, the Nation, and Women.” *Ecology of food and nutrition* 48(4):237–62.

Shukin, Nicole. 2009. *Animal Capital: Rendering Life in Biopolitical Times*. MInneapolis: University of Minnesota Press.

Srinivasan, Krithika. 2013. “The Biopolitics of Animal Being and Welfare: Dog Control and Care in the UK and India.” *Transactions of the Institute of British Geographers* 38(1):106–19.

Sundberg, Juanita. 2011. “Diabolic Caminos in the Desert and Cat Fights on the Rio: A Posthumanist Political Ecology of Boundary Enforcement in the United States–Mexico Borderlands.” *Annals of the Association of American Geographers* 101(2):318–36.

Taylor, Chloë. 2013. “Foucault and Critical Animal Studies: Genealogies of Agricultural Power.” *Philosophy Compass* 8(6):539–51.

Thorne, Lorraine. 1998. “Kangaroos: The Non-Issue.” *Society and Animals* 6(2):167–82.

Tsing, A., and S. Satsuka. 2008. “Diverging Understandings of Forest Management in Matsutake Science.” *Economic Botany* 62(3):244–53.

Tsing, Anna. 2011. “Unruly Edges: Mushrooms as Companion Species.” *Thinking with Donna Haraway. Ed. Sharon Ghamari-Tabrizi. Cambridge, MA: MIT Press, forthcoming*.

Twine, Richard. 2007. “Animal Genomics and Ambivalence: A Sociology of Animal Bodies in Agricultural Biotechnology.” *Life Sciences, Society and Policy* 3(2):99.

Varma A. 2008. *Mycorrhiza - State of the Art, Genetics and Molecular Biology, Eco-Function, Biotechnology, Eco-Physiology, Structure and Systematics*. New York: Springer.

Wadiwel, Dinesh. 2002. “Cows and Sovereignty: Biopower and Animal Life.” *Borderlands* 1(2).

Whatmore S, Thorne L. 1998. Wild (er) ness: reconfiguring the geographies of wildlife. Transactions of the Institute of British Geographers. 23(4):435–54.

Whatmore, Sarah, and Lorraine Thorne. 2000. “Elephants on the Move: Spatial Formations of Wildlife Exchange.” *Environment and Planning D: Society and Space* 18(2):185–203.

Whatmore, Sarah. 2002. *Hybrid Geographies: Natures Cultures Spaces*. London: Sage.

White, R. 1991. *The Middle Ground: Indians, Empires, and Republics in the Great Lakes Region, 1650-1815*. Cambridge: Cambridge University Press.

White, Richard. 1994. “Animals and Enterprise.” Pp. 237–73 in *Oxford History of the American West*, edited by CA Milner, CA O’Connor, and MA Sandweiss. New York: Oxford University Press.

Wilkening, K. E. 2004. *Acid Rain Science and Politics in Japan: A History of Knowledge and Action Toward Sustainability*. Cambridge, MA: MIT Press.

Williams, Anna. 2004. “Disciplining Animals: Sentience, Production, and Critique.” *International Journal of Sociology and Social Policy* 24(9):45–57.

Williams, Dee Mack. 2002. *Beyond Great Walls: Environment, Identity, and Development on the Chinese Grasslands of Inner Mongolia*. Stanford: Stanford University Press.

Wolch, Jennifer R., and Jody Emel, eds. 1998. *Animal Geographies: Place, Politics, and Identity in the Nature-Culture Borderlands*. London: Verso.

Wood WF, Lefevre CK. 2007. Changing volatile compounds from mycelium and sporocarp of American matsutake mushroom, *Tricholoma magnivelare*. *Biochemical systematics and ecology*. 35(9):634–6.

Yeh, E. T. 2000. “Forest Claims, Conflict and Commodification: The Political Ecology of Tibetan Mushroom-Harvesting Villages in Yunnan Province, China.” *China Quarterly* 161:264–78.

Youatt, Rafi. 2008. “Counting Species: Biopower and the Global Biodiversity Census.” *Environmental Values* 17(3):393–417.

ENDNOTES

[1] Some, like the geographer Sarah Whatmore, label their approach as a “relational ontology,” a perspective that refuses to understand humans as an ontological given (2002). This shares many affinities with work by Donna Haraway, who used the metaphor of the cyborg to understand more-than-human worlds of enmeshment between humans and various technologies, and her notion of companion species to understand “co-habitation, co-evolution, and embodied cross-species sociality” between

people and dogs. In such tales, "the partners do not preexist their relating; all that is, is the fruit of becoming with" (Haraway 2008:17, Sundberg 2011:320). As Juanita Sundberg explains, "A relational perspective accounts for the materiality and physicality of bodies while emphasizing that their properties and capacities are historically contingent and geographically situated outcomes of association, relations between things" (2011: 323).

[2] In a similar fashion, working to displace historian's focus on "big men" and assumptions that the Global North shapes the Global South but not vice-versa, historian Jeremy Prestholdt (2008), advocates the concept of "distributed agency." It locates agency within wider communities or networks, not just individuals, and does not necessarily imply intentional or goal-directed behavior, but nonetheless has social effects. Prestholdt's case shows how Africans' consumer desires shaped the landscape of industry in England and other European sites. The same term, but with a different use, is also found in the work of sociologists Emilie Gomart and Antoine Hennion (1999), among others.

[3] Alfred Crosby's work on the role of European plants and animals from the early 1970s was a vanguard, and it demonstrated the important role of nonhumans in European's colonial endeavors (1972). Although I greatly appreciate his extensive work, my only reservation is the degree to which such accounts might be crafted with a teleological framework. Knowing the contemporary outcome, it is difficult to avoid the tendency to explain the past as leading inevitably towards the present. Richard White's *The Middle Ground* represents one excellent example of such an effort to avoid teleology, to re-inhabit the sense of contingency and potential in the colonial encounter (1991).

[4] This work can draw on some of the insights found in more phenomenological work, such as by Tim Ingold (2000 and others), but work it through particular socio-historical examples.

[5] Related work includes Braverman 2013; Cadman, 2009; Collard 2012; Franklin, 2007; Haraway, 2008; Holloway and Morris, 2007; Shukin, 2009; Srinivasan 2013; Taylor 2013; Twine 2007; Wadiwel, 2002; Wolch and Emel 1998; and Youatt, 2009.

[6] There are a handful of notable exceptions to these trends such as work by Haraway on dogs (2003), Pepperburg on parrots (2009) and Despret (2008) on animal breeding (2009: 317).There is likely much more work in this vein, but it is widely scattered in journals from many disciplines. See also inspiring work on humans and lab rats that uses the concepts of performance and intra-action (Birke, Bryld and Lykke 2004), and Jones and Cloke's consideration of four forms of agency that emerge from trees in themselves and in relation to humans (2008).

[7] Similarly, Evelyn Fox Keller describes the practices used by scientists in attuning themselves to the particular organisms they study (1984).

[8] (http://asle.ku.edu/Preconference/adamson-sandilands.php) They refer to work by a range of scholars, much of which is recently published, and critical plant studies has not yet garnered a critical mass in any one discipline.

[9] I recognize that similar concerns inspired Hugh Raffles, who in response to the important work of Donna Haraway on companion species, wanted to study animals with far more alterity than dogs or cats, and wrote his book, *Insectopedia* (2010). Even this was not far enough, and Raffles is now writing an ethnography of stones, which in comparison makes fungus look nearly human.

[10] This provocative point was made by Kathleen Millar who offered a stimulating and insightful reading of an earlier draft.

[11] Scientists are only recently discovering the possible fusions of spores that can and cannot germinate and form mycelia, a kind of root-like structure.

[12] (http://www.botany.hawaii.edu/faculty/wong/BOT135/Lect05_c.htm, accessed March 3, 2013).

[13] A number of other species, such as termites, actively farm fungal saprotrophs, feeding them cut up leaves and raising them in humidity-controlled chambers.

[14] Indeed, the places where matsutake grows the most abundantly in China, Japan, and the US are intensely anthropogenic landscapes. Matsutake is rarely found in old growth forests. It is no accident that environmentalists in the US Pacific Northwest chose the spotted owl, dependent on ancient trees, as their mascot. Matsutake, in contrast, grows on forest lands that were clearcut and often now filled with unmarketable, unremarkable trees: scraggly pines growing close to each other, like "dog fur," not the scenes of Sierra Club calendar photos.

[15] Domestic produce is almost always more valuable in Japan than imported vegetables, and in the case of matsutake, domestic ones are considered whiter, with better smell, and more rare---in part because so few people go looking for them. The prices of domestic matsutake can be ten times greater than foreign

matsutake, even if they are quite difficult to actually distinguish and there are cases of foreign mushrooms bulking out so-called domestic stocks. There was also an assumption that Japanese mushrooms would be more reliably pure and uncontaminated. Japan has been one of the world's leaders in terms of creating systems of commodity accountability from farm to table, domestically and internationally. In 2007, for example, a US governmental delegation toured Japan and recommended that its government adopt its strict system of testing imported food, using the risk of food from China as its prime example of potential threat (Fackler 2007).

[16] The addition of other ingredients that cut the purity of valuable goods or increase the heft of objects sold by weight--for example, of bundles of wool or medicinal roots--is a common technique elsewhere in China and around the world (Williams 2002). Many of these common adulterants (sand, water, dirt) create no real threat to consumer health, but contamination with pesticides raises serious issues.

[17] Japanese reports did not specify where the matsutake were from. Chinese officials are also unclear, and those in the southwest often point to northeast China. Japanese quarantine officials found 2.8 parts per million of dichlorvos, an organophosphoric agent used in fumigation and pesticides; the limit is 0.1 parts per million (anonymous 2002). This discovery led to decreased Japanese demand for Chinese mushrooms and increased interest in matsutake from places deemed "safe," such as Canada and Sweden.

[18] The land books I have seen, mainly received by villagers as late as the 1990s or 2000s, often referred to land holdings in quite approximate ways, in relationship to north of another family's land and south of a season creek or a ridge. Land is linked with responsibility, for officials estimate its capacity to grow grain, and each family's agricultural land taxes are based on this estimate, not the actual production.

[19] There are exceptions such as work by Hanski that challenges the assumptions that plants and fungus produce chemicals for defensive purposes (1989:26).

[20] David Arora once watched a basket of matsutake change hands six times at a market in the course of several hours (pers. comm., 2010).

[21] http://fukushimaforum.wordpress.com/workshops/sts-forum-on-the-2011-fukushima-east-japan-disaster/manuscripts/session-4a-when-disasters-end-part-i/safe-and-trustworthy-food-safety-after-fukushima/ accessed March 31, 2014.

[22] Although there are stronger connections with American scientists than German ones, a number of people in Japan admire Germany's high safety standards; in terms of radiation, sometimes the allowable limits are nearly a thousand times less than in the United States, a place seen as more reckless.

[23] In part, many have few alternatives to make money, but there are aspects to the hunt that draw them back, year after year. Picking mushrooms is strikingly different than factory work, and within the matsutake economy only a very small percentage of the participants work indoors and are paid an hourly wage. Few people who pick even refer to this activity as "work:" it might be crucial to their annual family incomes, but they think of picking as different in kind from forms of waged labor.