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Ball jars, bacteria, and labor: CO-producing nature through cooperative enterprise

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ABSTRACT

The production of nature has been employed to theorize shifts in nature-society relations that have accompanied historical transformations in production and social reproduction. While Marxist scholars have employed this framework to theorize the nature-society relations that accompany capitalist production, they have paid less attention to those that accompany non-capitalist production. In the meantime critical food studies has grown abundant with more-than-human and more-than-capitalist encounters with nature. This paper attempts to bring these two streams of thought together, in order to explore what they reveal about encounters and entanglements with microbes and non-human labor in the non-capitalist production of yogurt. Drawing on ethnographic research with a yogurt making cooperative in Somerville, Massachusetts, USA, I explore the contribution of microbial labor to the co-production of nature and post-human ethics in a cooperative food enterprise.

KEYWORDS

Boston; food provisioning; cooperatives; production of nature; ethnography

"It's the bacteria who do all the work of making the cheese—they make the flavor, they make the texture. All we have to do is not get in their way" (Vermont Cheese Maker, in Paxson 2008, 28).

"It [food work] doesn't feel like work, when it's taking care of my [microbial] cultures" (Urban Homesteader, Male, Cambridge).

"From the first successful batch of kombucha to that thrilling taste of homemade sauerkraut, the practice of fermentation is one of partnership with microscopic life" (Fallon 2003, xii).

Introduction

In agri-food studies, urban political ecology, and science and technology studies there has been a long standing interest in dismantling the modernist binaries that separate nature from society in order to explore nature and society as co-produced through creative activities that are more-than-human (Latour 2005; Haraway 2008; Swyngedouw and Heynen 2003;

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Goodman 1999). Rethinking the relationship between nature and society forms the political grounds for crafting potentially less exploitative social and ecological relations. During my ethnographic research with Urban Homesteaders (members of a sustainable lifestyle movement) and artisan food producers in Boston, I was repeatedly drawn in and surprised by the intimate, creative, and caring relationships that humans developed with non-human natures in the production of food. While many of the people I met during my research sought to lessen the environmental impacts of their food practices by, for example, self-provisioning, bartering, or purchasing food from local growers, they also showed me that diverse food economies depend on reconfiguring the relations between humans and non-humans in the production and distribution of food as a use value (a point also made by a range of scholars; Cameron and Wright 2014; Hill 2011; White 2014; Trauger and Passidomo 2012). Numerous urban beekeepers told me they didn't produce honey, but merely cared for bees that did. When I asked an urban homesteader how he made time for self-provisioning fermented foods for his family and neighbors each week, he explained that it didn't feel like work, because he was merely "taking care" of the microbial cultures that did this work for him. Care provides an opening for considering more-than-human ethics in food studies which, as Pitt (2018) observes, is one of the primary ways that humans relate to non-humans in the production of food and nature.

My experience as a member and ethnographer of a neighborhood yogurt making co-op in Somerville led me to become mutually fascinated and comforted by the "magic" of microbes who transformed milk into yogurt overnight. Analyzing the production process helped me to understand that community scale yogurt production is possible because humans labor for only a fraction of the time it takes to turn milk into yogurt. Exploring how co-op members experienced yogurt making, I began to realize that microbes do *more* than ferment milk into yogurt – they also co-produce enabling environments in which trust, cooperation, and community food economies are possible. It is the metabolic activities of microbes, rather than the skill or trustworthiness of any individual yogurt maker, that makes co-op yogurt good to think (Levi-Strauss 1966) and safe to eat, in the absence of food safety regulations.

Lactobacillus acidophilus are what Louis Pasteur would call "domesticated" nature, and what Neil Smith would call "second nature". Domesticating acidophilus has been a spatial and embodied practice that has been accomplished by introducing "lactic acid bacteria whose natural habitat is the intestine and vagina of warm–blooded animals" (Teuber 2000, 541) into human-made vessels containing food. Just how acidophilus got out of mammals and into food is another question, but most food historians and

scientists agree that fermentation began by accident, and later developed into a culinary art and science reflecting the particular microbiome, ecologies, and tastes of different regions and people over thousands of years of culturing particularly tasty strains of food-friendly microbes (Katz 2003, Paxson 2008).

In this paper I expand upon Neil Smith's production of nature thesis (2008) in order to think about the ways that humans and microbes participate in the social production of nature when they make yogurt together in a cooperative food enterprise. The yogurt co-op presents an interesting case for exploring how humans and microbes become entangled in bio-social relations of production through yogurt making and eating, and demonstrates the utility of combining the production of nature thesis with more-than-human ethics. This paper proceeds in three parts. First, I contextualize my concerns with diverse forms of production within current scholarship on the production of nature. Second, I explore non-human labor from the perspective of metabolism. Third, I introduce my case study and analyze the diverse forms of human and non-human labor in the yogurt making co-op. I conclude with a discussion of the broader relevance of these findings to food studies scholars.

Rethinking production in the production of nature

In *Uneven Development* Neil Smith (2008), building upon Marx's observations that every kind of production requires the appropriation of nature, examines how humans not only appropriate nature but also produce it, materially and discursively, in the process of meeting their bodily needs, and producing objects, dwellings, commodities, and capital. These activities range from the daily activities of social reproduction, to the marketized activities of production for exchange, to the waged activities of capitalist production. Despite Smith's inclusive view of production, research on the production of nature has tended to focus almost exclusively on the capitalist production of nature (Braun 2008; Ekers and Loftus 2013). This has led to the misconception that nature is merely the product of capitalist social relations, effectively reducing the diverse landscape of nature-society relations to nature-capitalism relations (Castree 2002). This essentialist readings of production, as capitalist production, has led post-structural critics to argue that the production of nature thesis, as well as strong social-constructionist approaches, have over-socialized nature and ignored its materiality, biophysical processes, and productive capacities (Bakker and Bridge 2006; Castree 2002; Braun 2008; Demeritt 2002).

The political economy of nature has been extensively theorized by political ecologists and resource geographers (Peet and Watts 2002; Robbins

2012), as well as agri-food scholars (Goodman 1999, Kloppenburg 2005, Guthman 2011b). For capitalist production to occur nature must be "produced" as a resource for capital accumulation. While there is widespread acceptance that capitalist production (or any production for that matter) depends intimately upon the appropriation of nature as resource there have been few attempts to theorize how nature might be more than a passive input for production. Resource geographers Bakker and Bridge (2006) come closest to theorizing nature as *doing something* in production, when they bring our attention to the ways in which non-human natures like water, fish, and wood, can shape and resist the extractive processes and regulatory regimes of capitalist production, especially when their material qualities make them (un)cooperative, accommodating, slippery, or fugitive commodities. Attending to the biophysical qualities of particular natures leads Bakker and Bridge to argue that the production of nature thesis should be revised as the co-production of nature (2006, 19).

Geographies of food production and consumption have proven to be particularly fertile grounds for enlivening the production of nature thesis, by examining how nature and society are co-produced (Eaton 2011; Guthman 1998; Goodman and DuPuis 2002). "Food, as co-production is the central unifying material and symbolic linkage that bridges and binds the social and natural together" (Goodman 1999, 33). The socio-nature of food is produced by diverse forms of human and non-human labor, including the human cultivation of particular varieties of plants, the non-human labor of photosynthesis, the human labors of harvesting, processing, regulating, and distributing food, and the non-human labor of the microbial communities living in the human gut that allow us to digest food (Alkon 2013, 664). The socio-nature of food provisioning can be understood in terms of co-production, but also non-capitalist production. This is partially because food production practices like agriculture have never been entirely capitalist, as evidenced by the persistence of the family farm (Eaton 2011).

Utilizing the diverse economies framework (Gibson-Graham 2006), feminist political ecologists and community economies scholars have illuminated more-than-capitalist productions of nature in fisheries (St. Martin 2007), non-timber forest products (Barron 2015), urban parks (Gabriel 2011), community gardens (Hill 2011), and community supported agriculture (White 2014; Jarosz 2011). The diverse economies framework employs the analytic of class, as a process of surplus appropriation and distribution, to brings attention to the diversity of non-capitalist forms of production and labor in our midst, such as cooperative enterprises and unpaid food work. However, if we were to extend this lens to microbes, we would need to think about their labor as already social (Latour 2005)

and already entangled 'in relations with significant others,' (Tsing 2013). To delve deeper into the question of non-human labor I revisit Marx's notion of metabolism and consider the work that production of nature scholars and animal geographers have done to expand our account of labor beyond the human.

Rethinking labor in the production of nature

According to Ekers and Loftus, labor is "the ontological key to understanding how nature is produced" (2013, 235). But, labor, as it is conceptualized in debates around the production of nature has become an abstract and universal category that is distant from the particular social relations and material differences that shape our lived and embodied experiences of work and environment (Ekers and Loftus 2013). To bring out the material dimensions of laboring Marx employed metabolism as a metaphor to understand the material interchanges that occur within and between human bodies and non-human natures.

According to Marx, labor is a creative process between humans and nature, whereby humans mediate, regulate, and control the metabolism between their bodies and nature. We confront the materials of nature, setting in motion "the natural forces which belong to the body, arms, legs, head, and hands, in order to appropriate the materials of nature in a form adapted to our own needs. Through this movement we act upon external nature and change it, and in this way simultaneously change our own nature (1976, 283). Although Marx famously distinguishes between the creative activities of bees and the labor of architects when he writes, "what distinguishes the worst of architects from the best of bees is that the architect builds the cell in his mind before he builds it in wax' (1976, 284). Metabolism unsettles the distinction between human and non-human labor, since it occurs across human and non-human species as well as fungi and bacteria. In order to live, all living things from bacteria to bees and beavers must metabolize nature to meet their needs. Marx tells us that we live because we labor and others have labored before us. But we are also alive (and thus able to labor) because microbes live and labor within and around us. Microbes co-produce the human body and many of the socio-natures (yogurt, beer, cheese, wine, and medicine) we consume on a daily basis. How would the production of nature thesis change if we took the metabolism in Marx literally? If we defined metabolism as a *kind* of labor, we might value a broader range of actors and activities in the production of nature and better accommodate the more-than-human and more-than-capitalist sociality of nature and labor (Pitt 2018, Tsing 2013).

Production of nature scholars have begun to open up the black box of labor, not just to non-capitalist forms of production, but to non-human labor as well. Perkins (2007), writing about the significance of elm trees to American industrial cities, suggests that the shade cast by these trees provided for the social reproduction of workers, when these amenities were consumed as use values. Tree labor, in this case, is visible through its contribution to human well-being. Although Perkins is careful to acknowledge the human (in his view social) labor that is necessary for planting and maintaining these trees, he also speculates on the possibility that these trees labor independently of humans. "Their development as urban organisms was not solely due to social labor. Tree growth is decidedly a biophysical and material action; as organisms they had to adapt to and metabolize their changing environment in order to survive and proliferate after they were planted" (2007, 1156). Taking a diverse economies (Gibson-Graham and Dombroski 2020) approach, Barron and Hess (2020) argue for a just accounting of the metabolic labor that is constantly being exchanged between fungi and other non-humans, as well as humans, in life sustaining webs of ecological interdependence.

Animal geographers have also brought attention to the ways in which non-humans participate in production, not just as medical experiments, food sources, and transportation, but also as workers. Previous research on animal labor ranges from the emotional labor and disability services that pets produce for humans (Haraway 2008; Nast 2006) to milk production by dairy cows (Porcher and Schmitt 2012; Stuart, Schewe, and Gunderson 2013). In the production of nature thesis domesticated pets and livestock represent "second natures" that have been altered to meet human needs. Non-human labor escapes critical analysis when it is regarded as instinct or an extension of human agency. Porcher and Schmitt argue that domesticated animals labor precisely because humans notice when they stop, "As in the case of human work, animals' collaboration at work is visible when it is not obtained. Ordinarily their work is invisible" (2012, 43). Adopting a minimalist definition of labor as metabolism we can see that non-humans (some "domesticated" others "wild") labor and produce socio-natures in cooperation with humans (e.g. bomb sniffing rats), but also on their own (e.g. feral cat colonies and fungal networks). The socio-natures that are produced by non-humans are sometimes appropriated by humans as food, energy, knowledge, and so on, but these products are also appropriated, distributed, and consumed within non-human communities to meet necessity.

In the final segment of this paper, I turn to my empirical case, a neighborhood yogurt making co-op, and answer some of the questions I raised at the start of the paper: Do microbes labor? And if so, how does microbial labor shape social relations in this cooperative enterprise and vice versa?

The data was gathered as part of a broader research project on the diverse economies and gender dimensions of urban homesteading and urban agriculture in greater Boston. The research involved two years of participant observation at local food, gardening, urban agriculture and sustainability events, home and garden tours, and forty in depth interviews with men and women involved in urban homesteading or urban agriculture. As part of the research I joined a neighborhood yogurt making co-op.

During this time I observed members making yogurt at regular shifts and public workshops, made yogurt with several different partners, taught new members to make yogurt, and enjoyed eating one quart of yogurt a week. I also attended quarterly meetings and dinners, participated in email discussions, talked informally with members, and conducted five in depth interviews with co-op members. The coop is located in a gentrifying Somerville neighborhood that is proximate to numerous universities in greater Boston. Most co-op members live within walking or biking distance of the co-op and they reflect the shifting demographic of the neighborhood. Participants were highly educated, mostly white, and mostly women between the ages of 20 and 60. All participants had the time and resources to participate in the co-op alongside other forms of paid and unpaid work. They lived in diverse housing arrangements that included intentional communities and cooperative houses, student and shared houses, same sex households, and nuclear families. For the purpose of this paper, I focus on the interactions between humans and microbes during yogurt making and eating. The italicized ethnographic vignettes are compiled from field notes, informal conversations, and interviews.

Co-producing yogurt

The Somerville yogurt making co-op is a food provisioning collective of some thirty households that coordinates the cooperative purchase of milk, kitchen space, and supplies, and the cooperative production and distribution of yogurt to working member-owners. The co-op aims to provide its members with low cost, delicious, community produced yogurt. At quarterly meetings and over an email list-serv member participate in collective decision making about which local dairies to source milk from, how to improve yogurt production and access, and how to distribute any surplus money or yogurt. Each week, two members meet at a community kitchen in a local church basement to produce yogurt for the other members on a rotating basis. The majority of co-op members have no prior experience making yogurt. New members are surprised by how "easy" it is to make yogurt, while others are amazed that our collective inexperience (and the fun we have while making yogurt) doesn't lead to more mistakes. Members

attribute the quality of the yogurt and the ease of production to the resilience of the microbes living in the yogurt culture. As one member explains, "Yeah and I don't know if it's like our particular sort of like cultures or starter or whatever that we make, but it seems to be like there's a pretty wide margin of error. It's been very *forgiving*…And I don't know if that's typical for like other yogurt or if it's just particularly *easy* to make (Yogurt co-op member, Female, Somerville)"

> *First we gather the necessary tools (green notebook, instructions and starter formula, double boilers, spoon, ladle, measuring cup, meat thermometer) and begin counting up the empty Ball jars. Using a worksheet we calculate how much milk and "starter" we will need to fill this week's yogurt share. In the green notebook, we write down the time we poured the milk.…When the milk reaches 180 degrees Fahrenheit we record the time in the green notebook, and immerse the milk filled pots in a sink full of cold water. Heating the milk to 180 ensures that any competing microorganisms in the milk are killed (although the milk has already been pasteurized) and helps create a thicker yogurt. We pour what hot water is left in the double boilers into two quart sized Ball jars that are then placed in some donated camping coolers on the floor. While we wait for the milk to cool and the coolers to warm, we prepare the ratio of starter.*

Our "starter" is a mixture of acidophilus bacteria and milk that originated in a quart of commercially produced Stonyfield brand yogurt. Stonyfield was founded in 1983 as an organic farmstead yogurt, and is now one of the largest organic yogurt companies in America. Since being acquired by Danone and later Lactalis, Stonyfield has been in the business of acquiring other organic yogurt producers, while donating 10% of profits to environmental causes. Hacking Stonyfield yogurt for community yogurt brings *Lactobacillus acidophilus* into cooperative economic relations with a different set of socialities, materialities and temporalities in the yogurt co-op, which aim to decommodify and democratize yogurt making.

The choice to continue using Stonyfield starter only became apparent when a friend of a friend offered the co-op a family heirloom – a yogurt starter from Bulgaria that had been in continuous use for decades. After piloting the Bulgarian yogurt starter, co-op members determined that they actually preferred the mild taste and thick consistency that the Stonyfield starter created. Through discussing preferences for taste and texture and comparing the results of the commercial starter to the heritage starter it became apparent that even as yogurt co-op members desired artisanal non-capitalist forms of food production, they also craved the consistent and homogenized tastes of the food industry. Members even processed their yogurt at home, straining it through cheesecloth for example, to create the thickness of industrially produced "Greek style" yogurt.

Making and eating co-op yogurt does not occur in a vacuum, the qualities of this yogurt are understood in relation to every other yogurt that members have tasted and enjoyed. And members expect co-op yogurt

to be just as good if not better than "mainstream" yogurt. Situating yogurt making and eating within its broader economic and cultural context shows that co-op yogurt exists relationally, with other food economies. Yet the origin story of the starter also demonstrates that the knowledge, tools, and ingredients of "mainstream" industrial capitalist yogurt can be hacked, appropriated, and reused for non-capitalist ends. This differentiates yogurt from other agri-food commodities, for example GMO seeds, which have been altered and patented to prevent their sharing and reuse. *Lactobacillus acidophilus* resist capitalist enclosure through their ubiquity - they are simply everywhere, living in and around the bodies of humans and other mammals as well as the foods they consume.

More-than-human encounters with microbes occur across all kinds of food enterprises including capitalist enterprises such as Danone, where milk and patented strains of *Lactobacillus acidophilus* combine as a commodity, and producers and consumers are in theory alienated from the products of their labor. What sets co-operative yogurt making apart is not only the social and economic relations of production, but the spatial and temporal scales at which human-microbial encounters take place. Scaling yogurt making down to the regional milk shed, the production capacity of a church basement kitchen, and the demands of some 30 households makes the supply chain, production practices, and material entanglements accessible to all participants. Making yogurt for collective consumption rather than commodity exchange allows for modes of production that privilege care, sharing, and connecting over efficiency and profit. Fermenting together at a slower time and finer scale affords participants the time and space to reflect on the more-than-human encounters they participate in. While this slowing and scaling down is in theory possible in any kind of yogurt enterprise, when yogurt is a commodity it must compete with other yogurts, whilst generating profits for owners and shareholders. Cooperative yogurt making allows for other relationalities and intimacies with non-human natures that are devalued in the capitalist production of nature.

> *When the milk has cooled to 120 degrees we prepare a "slurry" of yogurt starter and warm milk which we divide between the cooling pots. A milk temperature that is warmer than 120 degrees will kill the microbes in our yogurt starter and cause the milk to curdle. After the starter slurry has been mixed into the pots of warm milk we begin filling the Ball jars. Each jar is labeled with a household's last name and a milk preference (whole or nonfat). If our calculations are correct all of the shares will be filled, along with a starter jar for next week. The jars of milk are then moved to the warming coolers. In the green note book we write down the time the yogurt jars were put into "incubation", and begin cleaning the pots, rinsing the returnable milk bottles, and wiping down the kitchen surfaces we've spattered with milk. Then we turn off the lights, make sure that the gas stove is turned off, lock the door, and part ways. The entire process takes less than two hours.*

Yogurt making at this cooperative enterprise occurs in a broader context of capitalist food production, unpaid food and care work, and industrial food technologies – including the humble "Ball" brand mason jar. The invention and sustained popularity of the Ball jar is inseparable from the industrialized and sanitized approach to food safety that has facilitated the removal of microbes (harmful and beneficial) from the American diet. The Ball jar, which can be boiled and pressure sealed at high temperatures with a two piece rubberized metal lid, allows households to create factorylike conditions for food preservation by killing off potentially harmful micro-organisms.

The antiseptic technology of the Ball jar is an odd choice for fermentation, it contrasts with the open ended and generative human-microbe encounters that are essential for yogurt making. Members use Ball jars because they are inexpensive and durable, and suit the zero-waste philosophy of the co-op. Although the milk is heated to kill unwanted bacteria, the Ball jars are not. They are rinsed in warm soapy water, but not sterilized in boiling water. Once the yogurt is poured the lids are screwed on just tight enough, to allow air to escape. As fermentation vessels the Ball jars are key sites for microbial labor and metabolism, they hold space for yogurt to happen. But as commodities and symbols, with their own history and meaning Ball jars mediate human-microbe interactions and contribute to the idea of a safe, trustworthy, and 'simple' product – thereby elevating the status of homemade food.

Co-op members place an extraordinary amount of trust in one another and the foods they produce and consume, even when they cannot put a face to a name on a jar. As one member explains, "I know when I make yogurt, I'm very aware that I'm making something that other people are going to eat…And you can pinpoint who like made yogurt, your yogurt, that week (Yogurt Co-op member, Female, Somerville)." Eating foods prepared by others is an intimate experience that involves moments of bodily vulnerability and microbial boundary crossing (Probyn 1999). The social relations in the yogurt co-op make these microbial and bodily encounters more visible. Discussing her motivations for participating in the co-op, one member says, "I do eat yogurt and there's something nice about like making it in such a way that does like minimize the waste and its *collective* and I know *exactly* what has gone into it and I know *exactly* – more or less I know *who* has made it. You know, at least I can kind of identify that process (Yogurt Co-op member, Female, Somerville)." The social relations that make the yogurt good to think and safe to eat come from knowing who made the yogurt and belonging to a collective of yogurt makers and eaters, but they also come from knowing the ingredients and production process, and this means knowing microbes, a problem I discuss later.

… While I sleep at night the acidophilus bacteria are working continuously to create lactic acid and break down the sugars and proteins in the milk into a thick tart yogurt. Through their metabolic activities acidophilus bacteria metabolize milk's nature, transforming one material into another. Human labor seems so insignificant to this production process. As much as we labor for a community of yogurt eaters what our "yogurt making" labor really amounts to is creating the environmental conditions under which acidophilus bacteria can live well. I wonder if my yogurt making companion and I have really made yogurt at all, or if we have only helped assemble a small, warm, milky world in a Ball jar for the lactobacillus to live in, a miniature yogurt factory in a jar for microbial workers to labor in.

Yogurt making, like cheese making, depends on creating the clean-enough environments where the particular microbes we favor can thrive and work (Paxson 2008). This acidophilus friendly environment is possible because other humans and non-humans have labored before us. Our two hours of work time feels *easy* because we are appropriating the "dead labor" of other workers, and the "live labor" of acidophilus, not to mention the thousands of years of human-microbe collaboration involved in domesticating *acidophilus* yogurt cultures. We could read these uneven labor geographies in terms of class, to show how the yogurt making co-op participates in the collective appropriation, and even exploitation of the metabolic labors of bacterial cultures, by crafting social relations and material environments in which bacteria labor "for us" and generate use values that are good for our bodies. Put another way, through cooperative relations of production the yogurt co-op is appropriating the "natural" metabolic activities of bacteria, and reducing the (human) labor time necessary for food production and by extension social reproduction in the individual households who belong to this co-op. Attending to microbial labor in this way can bring us to a more relational and embodied understanding of human labor and metabolism in the production of nature thesis.

Within the co-op there are many conversations about yogurt that cover such topics as yogurt texture and taste, incubation time, animal health and happiness, environmental impacts, and equity in human labor – but the subject of microbial labor rarely comes up. Only when the yogurt "doesn't work out" do we concern ourselves with the health, vitality, resilience and labor of our microbial cultures. Like animal labor (Porcher and Schmitt 2012), microbial labor only becomes visible when it is not done. When the yogurt tastes "off" or is too liquid it is usually because our microbial culture "the starter" has died. Sometimes microbial cultures are "killed" by human error, when we add the starter to the milk too soon, or forget to move the yogurt jars and they incubate too long. But the microbial cultures also periodically die off from natural causes, and need to be revitalized with newer cultures from other yogurts. As one member explains, "It was like, oh, this starter is *fatigued*, this yogurt isn't going

to *work*. So every so often we'd get a brand new like cup of yogurt and we'd just kind of go from there" (Yogurt Co-op member, Female, Somerville).

Describing the production process, co-op members recognize microbes as workers, who labor and are capable of getting "fatigued".

> *As co-producers of yogurt, we get to know microbes in subtle ways. In the green note book there is a record of human and microbial labor time; the time the culture was added to milk and the time the jars were put into incubation. As eaters we know microbes through our everyday and embodied encounters with them. When we open our yogurt for the first time, the pop of the rubberized metal lid separating from the glass yogurt jar and hiss of confined CO2 escaping alerts the ear to a small world of microbial possibility. When we eat the yogurt, the tart tang on the tongue and the feeling in our guts as the yogurt mixes with and replenishes our own intestinal microflora, tells the body that these bacteria are doing something "good" for us.*

Co-op members have "learned to be affected" (Latour 2004) by microbes through collective and embodied practices of yogurt making and eating. However, our ability to imagine and even talk about what microbes are up to is due, in part, to the proliferation scientific and popular discourses on microbes as companions and health providers. There are diverse ways that the production of nature is being performed in the discursive and material production of microbial nature. Among food producers, scientists, and activists, there is growing recognition that "'eating well' intimately depends upon bacterial encounters and entanglements: bacteria produce the food we eat; bacteria inhabit the food we eat; and if not for our bacterial gut companions, we could not digest what we eat" (Hird 2010, 38). This represents a significant departure from the pathogenic understandings of microbes as threats to human health and well-being that have shaped food regulations in the U.S. (Paxson 2008). Representations of bacteria as friendly co-producers can be found in Activia yogurt commercials where actress Jamie Lee Curtis talks freely about the joys of regular bowel movements while eating probiotically "enhanced" yogurt, and in the anti-consumerist writings of fermentation and HIV activist Sandor Katz who encourages readers to reclaim their health from corporations by making their own fermented foods and getting in touch with their bodies and the environment. In this new microbe-loving class habitus microbe-eaters embrace the "liveliness" of bacteria not as a threat to human life, but as a means of regulating and enhancing their own digestive and immune system. Here the production of nature thesis can bring attention to the ways in which the nature of microbes and yogurt is being materially and discursively produced, while also opening up discussion about the ways in which bodies and socially inscribed bodily differences mediate the production of nature and the scale and tempo of our more-than-human metabolism.

Encounters with microbes become more complex from the perspective of more-than-human ethics (Ginn 2014, Pitt 2018). Agri-food scholars have explored how encounters and intimacies with non-humans can lead to new sensitivities, attachments, and relationships of regard and care for the more-than-human world. However not all non-human encounters are positive, and tending to and caring for some non-humans may necessitate the exclusion or killing of others (Pitt 2018, Brice 2014). The darker side of non-human encounters has been observed in gardening activities, where the killing of slugs (Ginn 2014) and weeds (Doody et al. 2014) often accompanies the tending of more desirable non-humans, and feelings of moral ambivalence. Pitt (2018) develops a typology of ethical encounters on a spectrum from killing to caring in order to challenge the widespread assumption that more-than-human encounters necessarily result in care and connection. Her research shows that caring for non-humans often happens in relations of dependence, and is motivated by an instrumentality which privileges human needs (260-261). This seems especially obvious when humans depend on non-humans to meet health and nutritional needs. However, another possible relationship which Pitt observes is a relation of interdependence characterized by mutual care and benefit that is typical of permaculture. Interdependence is possible when humans give up power to control the direction of care and allow space for non-humans to flourish, whether or not they draw benefit.

Cooperative yogurt making includes the full spectrum of more-than-human encounters, from caring to killing. Milk is heated to kill competing and potentially harmful microorganisms. This killing is done to create an environment where the desired bacteria *lactobacillus* can flourish. Care for *lactobacillus* is motivated by the instrumental wish to produce food, and meet human needs with tasty, probiotic, and safe yogurt. However, this 'caring for' does not preclude the possibility of other interdependent encounters with microbes. For fermentation to occur humans must cede control of milk to microbes, if only for one wild night in the incubation cooler. Humans also cede control to the microbes when they eat yogurt, and invite *lactobacillus* to join their gut bacteria and engage in all kinds of metabolic activities beyond their control. While humans may derive health benefits from these activities, and may even feel well cared for by their gut microbiome, they are not in control of their microbes. Recognition of this interdependence reveals a limitation of the production of nature thesis, and shows the numerous ways that the vitality of microbes routinely overflows their discursive and material production.

Concluding remarks

The paper began with the questions, do microbes labor? And if so, how does microbial labor shape social relations in a cooperative enterprise and

vice versa? In answering this question I was inspired by attempts to revitalize the production of nature thesis (Ekers and Loftus 2013), which attend to material embodiments – both human and non-human (Guthman 2011a, Bakker and Bridge 2006). While labor is central to the production of nature thesis, this labor is not restricted to humans. Attending to the cooperative labors of microbes and humans, makes apparent that the nature that is co-produced through these entanglements between humans, Ball jars, milk, and microbes, is not limited to yogurt - but extends to the human gut and body, ideas of food safety and health, and shifting bodily and affective sensibilities toward microbes. Bringing the production of nature thesis to a neighborhood yogurt co-op destabilizes the ontological ground of production and labor, and reveals the more-than-human sociality (Tsing 2013) that occurs in yogurt making. Following the microbes, as they metabolize humans *and* nature, in biosocial relations of yogurt making and eating led me to question the capitalocentrism of "production" and the anthropocentrism of "labor" in the production of nature thesis. It also revealed the limitations of the production of nature thesis for attending to more-than-human relations beyond production, that are oriented toward care and interdependence, rather than the instrumental production of use and exchange values. When microbial labors are embedded in social and economic relations which privilege collective care, trust, reciprocity – such as those found in the Somerville Yogurt Co-op our interdependence with microbes and one another becomes intelligible. It is this interdependence that the metabolic activities of microbes help us grasp, thereby making co-op yogurt good to think and good to eat in a community food economy.

Examining how microbes, and their labor, become intelligible in the context of cooperative food production brings us full circle to the production of nature thesis – to ask about the discursive and material production of nature. Which discourses on microbes are valued and why? How are the benefits of microbial labor appropriated, experienced, and shared? How do shifting understandings of human and microbial labor shape food policies and economies? And how are relational entanglements with microbes embodied in different modes of production?

Answering these questions will require food studies to consider the discursive, material, and economic "work" that microbes do in realizing biological and economic diversity in food systems (Cameron and Wright 2014, Trauger and Passidomo 2012). This research agenda can contribute to a vibrant body of post-humanist, new materialist, and feminist scholarship in food studies that attends to the vital agency of non-human actors, visceral feelings, affect and emotion (Sarmiento 2017, Beacham 2018, Hayes-Conroy 2010, Bennett 2007) – and calls to decenter the human and contemplate the more-than-human in food studies (Elton 2019). As

Elton writes, "Nonhuman systems and nonhuman beings (sentient and not) are food system actors (Goodman 1999). Water, soil nematodes, plants and animals, all contribute to the growing of food to nourish humans. Then even more nonhuman life forms participate with producers and cooks to transform raw ingredients into tasty foods—just think of all the work we need microorganisms to perform, like *Lactobacillis sanfranciscensis* in sourdough bread or the different bacteria that bring us Camembert versus Pecorino, miso versus natto. Nonhumans are not only key food system actors but are also direct participants in the production of human health." (2019, 11). Including non-humans and their labor in the production of nature thesis is not only essential for a robust and materially grounded analysis of agri-food systems, but for cultivating a sensitivity to the unexpected political and ethical openings, interdependencies, agencies, and solidarities that can drive food systems transformations.

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