Glyphosate & the Swirl

An Agroindustrial Chemical on the Move

Vincanne Adams

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To my dear friend and colleague,
Sharon R. Kaufman, whose wisdom,
devotion, and love for our work will
persist far beyond her foreshortened life

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1

From blossoms comes
this brown paper bag of peaches
we bought from the boy
at the bend in the road where we turned toward
signs painted *Peaches*.

From laden boughs, from hands,
from sweet fellowship in the bins,
comes nectar at the roadside, succulent
peaches we devour, dusty skin and all,
comes the familiar dust of summer, dust we eat.

O, to take what we love inside,
to carry within us an orchard, to eat
not only the skin, but the shade,
not only the sugar, but the days, to hold
the fruit in our hands, adore it, then bite into
the round jubilance of peach.

There are days we live
as if death were nowhere
in the background; from joy
to joy to joy, from wing to wing,
from blossom to blossom to
impossible blossom, to sweet impossible blossom.

—Li-Young Lee, "From Blossoms" (1986)

From Blossoms

The story of how I first met glyphosate begins with an encounter not unlike that with the peach and its impossible blossoms—with things that seem too good to last, with my recognition that something as simple and tasty as a peach might be something about which to be worried, or that it could be unstable in its peachiness. It happened for me during the summer of 2013 while on a walk with my neighbor, an integrative pediatrician named Michelle Perro. She told me that our food was causing a public health disaster.

"Our kids are in crisis," she said, as we made our way along the ridge trail behind my home. "The kids I see are sicker than any generation before them

with chronic health problems, and these problems have become the new normal," were her words. Chronic gut issues, including irritable bowels and recurring diarrhea; chronic headaches and brain fog; persistent eczema; a host of immune system disorders, from asthma and rheumatoid arthritis to ulcerative colitis; and a cornucopia of mental health issues, from depression to hyperactivity and anxiety, were all on the rise among the children and teens she saw on a daily basis. According to Michelle, they were sick from the food they were eating, which was chock full of pesticides. Chief among the pathogenic culprits was something called *glyphosate*.

Glyphosate, she explained, is the active ingredient in Roundup, the powerful herbicide patented by the Monsanto Company. It is used in the agro-industrial production of the four major cash crops in the United States, including the genetically modified Roundup Ready crops of rapeseed (used to make canola oil), corn, soybeans, and sugar beets. This means that a good deal of the processed and packaged foods on supermarket shelves not just in the United States but globally—including breads, crackers, pastas, prepared foods made with canola oil or sugar from sugar beets—are a likely source of glyphosate. It is also used in the production of genetically modified cotton and alfalfa, which is used in animal feed for livestock and poultry that are turned into food. Glyphosate-based herbicides are used on wheat crops as a desiccant just before harvesting, she said, even though wheat has not yet been genetically designed to be grown with Roundup. Roundup is also used with other non-GE crops during fallow seasons to clear the soil of weeds before the growing season. Thus, in addition to being in food, glyphosate is in water systems, soil, parks and playgrounds, and in residential backyards when gardeners spray their beloved flower beds and walkways to get rid of unwanted plants or to eliminate poison oak and ivy. "Glyphosate is everywhere," Michelle said. Thus began my journey into a swirl of glyphosate-laden presences and possibilities.

I learned from Michelle that in the five decades since the creation of this chemical, particularly the last twenty or so years of genetically engineered (GE or GMO) crop proliferation, glyphosate had become the one of the most widely used pesticides in the world. Its pervasiveness in the lived and consumed environment meant, for Michelle, that it was seeping into not only foods and gardens but also into the soft tissues of humans where it produced a cascade of disruptions, undermining nutritional, digestive, pulmonary, neurological, and immune systems in unsuspecting kids who showed up at her clinic every day.

It was not just that these kids were undernourished or under too much stress, eating overly fattening foods or too much sugar, or getting too little exercise. These were the common refrains offered by her medical colleagues about the food-based health issues of children in the United States. Most of the kids Michelle saw in her clinic had plenty of food, and they often ate grains, legumes, fruits, and vegetables along with their cereals, breads, meats, chips, and sweets. They ate peaches. These children were mostly not overweight or underweight, and yet they were chronically sick. The kids she saw would limp along in partial health for years, sometimes getting worse, sometimes better, but never becoming fully healthy. By the time they got to her, these children had been through multiple therapeutic failures and been on and off antibiotics, steroids, painkillers, and psychoactive drugs. So long as they continued to eat foods laced with pesticides and glyphosate, Michelle argued, they would never get well.

This was "the GMO generation," Michelle said. These were the kids and young adults who had grown up eating this glyphosate-rich food. She offered a concerned rage about the situation, angry over the fact that so little medical science was devoted to sleuthing the health effects of foodborne toxic pesticides and frustrated about the pushback and skepticism she often received from her medical colleagues when she tried to tell them that genetically modified foods were dangerous for health because of these pesticides. She had become, in her own words, a warrior for the parents and children who she believed were fighting against an agrochemical industrial food empire that had enabled this slow poisoning to occur and a medical industry that refused to pay attention to this problem.

I was pulled into the whirlwind of Michelle's concern. Blossom to blossom, wing to wing, I came to realize that this little chemical—now saturating the planet and penetrating into soils, water, plants, foods, and bodies in swirling formations always on the move—was both pervasive and impactful. But glyphosate also presented a particular conundrum. The juries deliberating on its toxicity were many: scientists, activists, clinicians, and industry representatives had all weighed in with loud voices on this little chemical, but there was little agreement about how safe it was for humans who were likely absorbing it through their food or drinking water or from spraying it in their backyards. Michelle was convinced that claims about glyphosate being safe were not trustworthy because the agrochemical industry had paid for the research behind these claims. To be sure, it would not be the first time chemical industries had manufactured a consensus on the safety of their

products when used as advised. But glyphosate didn't lend itself to an easy critique of the agrochemical industry either, and not all of the claims about its safety were coming from industry.

Before long, I found myself deep in the controversy that had emerged around glyphosate. The closer I got to glyphosate and its potencies, the more I realized this chemical was, like the contested knowledge about it, not settling. The facts about it formed atmospheric clusters that coalesced sometimes in one way and other times in other ways, but never in stable ones. Like glyphosate itself, moving into plants and soils and water and guts and cells in shifting, swirling patterns of impact, the idea of stable certainty from scientific, legislative, regulatory, and activist commitments remained unsettled. Glyphosate was best understood, I realized, as a kind of swirl.

Over the next five years, I explored the kinds of evidence Michelle relied on in her clinical rounds, tracing patients' stories and also the debates about foods and pesticides. I shadowed Michelle and watched in awe as her skillful efforts to care for her pediatric clients often led to remarkable recoveries, sometimes after years of frustration and little help from mainstream doctors. I tried to make sense of the contested evidence she drew from about the harm of glyphosate and foods in which it is found. I attended retreats with organic farmers, plant biologists, and food activists. I interviewed families with very sick kids. I tagged along with food activists as they lobbied members of the California Assembly, warning legislators of the probable dangers of glyphosate.

Some of this ethnographic work resulted in a coauthored book with Michelle, who, early on, told me she had been thinking for many years about writing a book about GE foods and sick kids. I wanted to be collaborative, so I crafted a narrative that described her practice and the wealth of evidence to support her views. That book, which was truly a collaboration, was called *What's Making Our Children Sick?* It describes the limits of mainstream medical practice in relation to chronic morbidities, the frustrations of patients, and the science about harm from GE foods and their associated pesticides. The book's subtitle, *Exploring the Links between GM Foods, Glyphosate, and Gut Health*, got right to the point. We described the perfect storm that meant children's health was likely being compromised from the inside out by food that was serving up an ample dose of chemicals along with its nutrition. The links between cause and effect, we argued, could be seen only by connecting the dots between the available science about genetically engineered foods, a reluctant medical establishment, a regulatory system full of holes, and families struggling with sick kids.

The book was taken up with praise in alternative and integrative medical circles and by activists who were already convinced of the danger of GE foods. Michelle went on to have a robust side career as a speaker on the topic. Our book was applauded in the echo chamber. But I went on to feel the story was incomplete. Michelle wanted a book that would convincingly show how dangerous GE foods and glyphosate were, but I found myself having to set aside many of the competing facts that kept coming up as I went through the scientific material. Were we cherry-picking the facts to make our case, using only facts that Michelle insisted were reliable because they were not industry-derived? What about the facts that we pushed aside, the other ways of knowing glyphosate, that still felt to me as though they needed attention? What was going on with the science here? What was going on with chemical harm and its mysterious unaccountabilities? Over time, I was pushed toward a more complex set of anthropological questions about chemical exposure through food and about how chemicals work in bodies, in science, and in activism, and I nurtured my lingering concern over how one *could* and *should* go about making a case against a chemical when the evidence was so controversial and contested. I began to build another archive for what I realized would have to be a different book.

There were many things that troubled me about the book we wrote. For instance, I was troubled by its prioritization of children as a sentinel community for a much larger problem faced by anyone living in the ruins of agrochemical industrialism. Child health panics have, particularly in the United States, fueled a generational narrative about futures and climate demise that prioritizes a gendered labor of care, reinforcing heteronormative demands that align scientific facts with problematic inequalities (Edelman 2004; Lancaster 2011). While Michelle's work offered the spark that first interested me in chemical harm from agroindustrialism, and while most of the ethnographic materials I gathered were drawn from shadowing her, I also knew that these well-rehearsed idioms of concern over children were problematic and that I was more interested in chemical-human entanglements not necessarily invested in heteronormative reproductive futurity. I wanted to explore the larger engagement with science and politics and the potential for understanding this chemical that a broader field of inquiry would afford.

I also knew a second book would have to move not only beyond harm to children but also beyond the role that human suffering plays in relation to activism around this chemical. Glyphosate has come to hold larger-than-life potencies because of its histories, its many constituencies, its chemical

opportunisms, and its ability to create all kinds of relationships with science, bodies, activism, and the facts. Glyphosate has many of what Eben Kirksey (2020) calls *chemosocialities* across environments, sensations, scientific archives, and capitalist and political opportunities. How glyphosate builds its constituencies and how clinicians learn to sense the presence of glyphosate in damaged body tissues are processes that shift our focus from abject suffering to wider questions about how we live with the chemicals that have become ubiquitous in our times.

Tracing accountability for chemical harm from food, much like tracing environmental chemical harm from anything, leads to a recognition of how quickly such accountability is diffracted in the scientific literatures, histories, regulatory practices, and activist efforts that offer competing facts about them, about which social scientists have written much. So, while it is not hard to tell at least one story of glyphosate's toxicity—indeed, that is what Michelle and I did—one can also tell other stories about how we got here with this chemical and how it alters our ability to do things like trace harm and form accountabilities at all. This is not just because industry science has whitewashed the facts. It is also, I would argue, because of the ways that glyphosate has altered the way we live.

A Chemical on the Move

Competing accounts about glyphosate's safety line up in confusing ways—or one might say that they refuse to line up. For instance, just as Michelle and I were finishing our book, the International Agency for Research on Cancer in Europe (IARC) reported that glyphosate was a category 2 carcinogen. Soon after the report came out, several lawsuits were launched in California by people who were diagnosed with non-Hodgkin's lymphoma and had used large quantities of Roundup at some point in their lives (Levin 2018; Egelko 2019). These lawsuits ended with favorable decisions for the plaintiffs, and Monsanto (which holds most of the patents for glyphosate-based herbicides) was held liable for large payouts to them and their families. But this report by no means brought an end to the debate over glyphosate's toxicity, nor did it end the struggle of the plaintiffs, some now dead, for compensation. Soon after the lawsuits concluded, lawyers and scientists hired by Monsanto began to appear in public debates about glyphosate, protesting the idea that it was toxic when used safely (using the argument that "the dose makes the poison"). On public television shows and popular websites, they argued that the levels currently approved by the EPA for glyphosate use were safe. As

another tactic, they noted that glyphosate's WHO classification as a category 2a carcinogen made it only as carcinogenic as "manufacturing glass, burning wood, emissions from high temperature frying, and work exposure as a hairdresser" or even drinking coffee (GMO Answers 2015).

Monsanto filed legal appeals to the court decisions, though not on grounds that the company could not be held responsible for knowledge of glyphosate's toxicity at the time the plaintiffs used Roundup (indeed, company reports maintained it was harmless to humans when it was patented as a weed killer). Nor were its legal arguments based on the idea that category 2a carcinogenesis means the toxicity is relatively benign, especially when compared to the toxicity of other pesticides. Rather, the appeals were based on the claim that the current scientific evidence used by the IARC was not, in fact, sufficient to show carcinogenicity. Researchers from the European Food and Safety Agency (EFSA, a competing EU policy making scientific organization) revisited the data in the studies used by the IARC and argued that the scientific conclusions of that report were untrustworthy (Portier et al. 2016). The US Environmental Protection Agency (EPA) weighed in, ruling that glyphosate was safe at levels currently being used. This was not the end of the story, and later I will return to the continuing arbitration over the science.

To this day, the debate over the safety of glyphosate to humans who are exposed to it at levels currently approved by the EPA remains unsettled as multiple constituencies continue to defend, impugn, or ignore its reputation. So, despite the spiraling increase in evidence-based data proving glyphosate is or is not safe, the debate has simply become more prolific, more heated, more contested, more of a swirl.

Probing why and how glyphosate was produced, I came to understand its complex origin story and how hard it would be to know for sure how safe the foods grown with it were for humans, let alone soils, ecosystems, and farmers. What it is and how it was created make it able to circulate in multiple spaces of opportunity. Its multiplicity has given rise to competing claims about its danger and safety, as have the people and constituencies who have come to know it and care about it. Indeed, the several-decades-old debate about both GE foods and their associated pesticides among concerned publics, activists, and scientists has produced a veritable ocean of skepticism about all of the facts about them, including deliberation over the ample evidence of their potential harm but equally compelling arguments about their utility and safety. There is a growing chorus of voices arguing that glyphosate is toxic, but glyphosate continues to have advocates who believe in its utility

for farming and its harmlessness to humans. Its advocates include scientists from many different kinds of institutions and with many different kinds of expertise. The praise for glyphosate is not just from agrochemical industries that continue to make profits on glyphosate products; it is also from farmers, organic farmers, and pro-science activists who have lumped opposition to glyphosate with the sentiment driving anti-vaxxers and science-deniers.

Glyphosate has become the poster child for a radically successful agro-industrial empire, replacing more toxic pesticides and herbicides like Agent Orange by being paired with genetically engineered crops. But glyphosate has also become a poster child for harm from GE foods—the anchor for activists and scientists—in courts of law and legislative bodies where the goal is to eliminate it altogether, along with GE foods. Watching these debates unfold and tracing glyphosate's origin story in this book, I aim to show that glyphosate is an unstable and unreliable actor despite the fact that it has radically changed worlds. This is a different argument than one that says that glyphosate's toxicity is under- or overplayed. My focus offers an engaged anthropological tracing of what happens when we try to take an activist position against chemical harm when the chemical itself is both pervasive and hard to know. It offers a glimpse of life in the swirl.

Making sense of all the competing positions on glyphosate takes more than simply carving through the data to decide where the preponderance of evidence lies. Navigating the claims about the safety and toxicity of glyphosate means getting comfortable with the refusals of clarity and certainty that we try to rely on to arbitrate these things. One must become comfortable with a bit of vertigo. This vertigo may be familiar to anyone who has tried to decipher the scientists' and activists' claims about industrially generated chemical harm authorized by policy (Murphy 2006, 2018a, 2018b, 2018c; Ofrias 2017; Nading 2015; Shapiro 2015; Chen 2011). It will also feel familiar to those whose commitments to the social-scientific analysis of "the facts" as sociomaterial constructions leave them standing on a slippery slope in their desire to harness scientific facts and produce lines of accountability in relation to chemical harm (Boudia and Jas 2014b; Liboiron et al. 2017; Frickel and Edwards 2014). The science of chemical toxicity frequently lets us down in efforts to source accountability and redress. So too does the analytical toolkit of science studies scholarship when it comes to aligning activism with science. We cannot use the scientific facts when they go our way but dismiss them when they align with a consensus we disagree with.

What we are left with in the case of glyphosate is, to press the point, a swirl of animated possibilities: knowledge, policies, activisms, cancerous

growths, cellular images, and empirical facts that are often contradictory yet occupy the same space temporarily and in persistently mutating ways. Like the clustering movement of a flock of starlings in the evening sky, glyphosate's presence moves and swirls, producing ideas about its potencies that appear certain in one moment and dissipate in the next. This book endeavors to trace the multiple paths into and through scenarios and circulations of the lively presence of glyphosate as a provocateur and animated example of the swirl—a swirl that also disrupts many a conventional assumption about being able to trust a scientific consensus.

A swirl offers only temporary agreements and certainties, forming clusters of activism in one direction in one moment, then at other times forming clusters of free-market opportunities that enable glyphosate products to be sold far beyond the wastelands of agroindustrialism and deployed in backyards and parks. Like the spray of pesticide-filled glyphosate products across fields of genetically engineered crops in the United States—spray that, as Vanessa Agard-Jones (2014) notes, settles in ways that cannot be easily managed or accounted for—the swirl of chemicals that we live with seems to be ever in motion and difficult to trace even as its effects remain potent across a wide swath of material and social spaces.

No matter how much anyone might want to hold fast to the facts and materialities of glyphosate, they will be left with a dizzying sense of its ephemerality in terms of what exactly it is, despite its ubiquity. Its swirling presence can be seen at the largest scale of inquiry (in environments and agroindustrial empires) but also in the most minute places (such as the human bodies that apparently now absorb large quantities of it). There too, it has a swirl-like presence; harm in bodies may settle in tumors and mutated lymph cells, damaged guts and disrupted digestion, or systemic dysbiotic failures, but it does not do so in every body, nor all the time. Its potential mutagenicity in human lymph cells, guts, and organs—just like its deadliness to plants and its capacity to give life in genetically engineered crops—make glyphosate a powerful thing, with potencies that bend, flex, and swirl.

Unlike other accounts of the dead-ends of science in relation to chemical harm (which I'll return to later), the problem of harm from GE foods and glyphosate seemed, the closer I looked, indisputably productive in the ways that it refused to settle. Thus, as my stack of materials that didn't fit into the first book grew, I shifted toward another book that was less about sick children than the radically impaired politics of knowledge and the lack of traction this chemical engendered in dealing with chemical harm more generally. For that book, I have found glyphosate to be a singularly useful guide.

Glyphosate and the Swirl is about how we have taken a chemical with many different potencies and nurtured its ambivalence in and through practices of science, capitalism, regulation, and activism that have come to govern our engagements with both chemicals and the facts about them. This book is about how all of these possibilities—all of glyphosate's constituencies—are in some way co-constituted by the chemical itself in its ability to shape-shift into a biological-then-chemical-then-biological thing and by the human constituencies, institutions, and politics that have played important roles in making these possibilities form a swirl. To study glyphosate ethnographically is to be swept up in the swirl of unstable certainties that have made it what it is.

Follow the Chemical

In following glyphosate I take inspiration from George Marcus, who advised us to follow the thing in undertaking multisited ethnography (Marcus 1995), and also from Arjun Appadurai's (1986) earlier recognition that things have vivid and complex social lives, even when tangled up in commodity systems that appear to have unalterable demands for them. These efforts to focus on *the thing* have lately come into conversation with a new ontologies approach that shifts focus away from the human and human sociality and toward explorations of how material things co-constitute worlds—a tactic that also carefully avoids reproducing simplistic scientific accounts of these things while using them to "think" in new ways about these beyond-the-human encounters (Puig de la Bellacasa 2017; Murphy 2017b; Weston 2017). My interest is in following glyphosate attentively, ethnographically, through its many contacts, engagements, and ontological transformations, in order to learn something about how knowledge production and sociality operate in its wake and how to rethink the meaning of knowledge in relation to its material exigencies.

Glyphosate, because of its ubiquity and multiple potencies, has created what Karen Barad (2010), borrowing from quantum physics, refers to as a *diffraction* of its potencies as it participates in different political and material ecosystems. Indeed, it is a chemical that has created many effects as it has moved through various terrains, sometimes creating blind spots and other times forging sensationalist visibility in its relations with the agrochemical industry, farmers, scientists, activists, and juries in courts of law. The demands made upon it constantly shift and swirl, and it offers a continuous stream of data and interruptions from a cellular level all the way up to larger infrastructural and social worlds. These travels disrupt even the firmest com-

mitments to singular modes of accountability. This multifaceted chemical, in other words, wreaks havoc with our sense of truth making, erasing distinctions between innocent and non-innocent (Ticktin 2017) scientists, industry and activist science, consensus and corrupt claims to the facts.

I also take inspiration here from Anna Tsing's (2015) *patchy anthropology* as a model for an ethnographic journey guided by one's object of study—for her a mushroom, for me a chemical. Tsing shows how various social and material infrastructures become visible as we track the matsutake from its itinerant harvesting communities in the Pacific Northwest to seller's markets in Asia and the laboratories and archives of mycologists, and the histories of capitalism that created environmental conditions ripe for this mushroom's growth. Along the way, the matsutake gives us a roadmap, an ethnographic cartography that guides us to these places in ways that are connected by the fungal landscape, much as the mushroom enables itself to live in the world. Another useful term for this sort of work is *rhizomatic*—literally, in the way mushrooms grow, and figuratively, the way that other scholars have imagined moving away from ethnographic, theoretical, and narrative linearity (Deleuze and Guattari 1987).

Glyphosate cannot provide me with a tidy linear narrative or a series of cause and effect relationships and events—only multiple unstable homes for blame and accountability in relation to its safety or harm. This makes sense, as chemical harm does not work in ways that form firm linear lines of cause and effect; chemicals don't work this way. Glyphosate offers a multiplicity of pathways to think about chemical harm in bodies. It suffuses itself through different environments and bodily sites in heterogeneous ways in laboratories, soils, plants, foods, bodies, and governmental panels. The resulting ethnography offers a patchiness that emerges from the lives of glyphosate itself, which are different in different places, though connected by the chemical.

Although Tsing's notion of plantation economies might also direct our attention to a critique of agrochemical industrialism in relation to the ethnic and racial inequalities that have come with these food systems (Reese 2019; Guthman 2019), I will not focus in this book on those most harmed by the infrastructural choices of agrochemical capitalism (farmworkers and industrial livestock workers [Holmes 2013; Blanchette 2020]), nor on the other chemicals used in agrochemical industrial farming that are considered to be much more toxic than glyphosate (Saxton 2015; Eskenazi et al. 1999; Agard-Jones 2014; Lyons 2018). Although some of the problems I trace and analytics I borrow from in order to follow glyphosate are elucidated by others who have parsed these problems, my focus has been in the other direction, among those who are not laborers of the agrochemical industrial enterprise and yet

still suffer from its effects, and among the metaworlds where glyphosate has caused trouble, including the regulatory, scientific, and activist worlds. My focus, in other words, is on the upstream problems—the slippery way that facts about this chemical are diffracted at the very moment that traction on accountability for its harms becomes possible. Because of this diffraction, the effects of glyphosate show up in unlikely places all the way up the social architectures of privilege that it inhabits. The upstream social and epistemological problem sites on the agricultural food system axis are partly ones that this chemical has created.

I see this work as situated in conversation with other anthropological efforts to *follow the chemicals* in their lively relations with humans, including Brett Walker's (2010) careful tracing of mercury in Japan, Michelle Murphy's (2006, 2018b) explication of PCBs as chemical kin, Nicholas Shapiro's (2015) attunements to formaldehyde, and Hannah Landecker's (2019) metabolic approach to arsenic. These authors are joined by innovative scholars who are reimagining how to live and deal with chemical injury and environmental pollutants. We need new ways of talking about life with chemicals that inspire new ways of theorizing our already chemically altered life, or *alterlife,* as Michelle Murphy (2018a) calls it, or that reveal how chemicals form, again, chemosocialities, in Kirksey's (2020) sense. These approaches ask us to take the chemical form and its capacities as a starting point for experiencing and thinking about them, including their sensorial impingements and opportunisms (Chen 2011), in their encounters in many worlds.

With glyphosate as my guide, I will trace both how we have come to live with so much of it and how, as a particular chemical, it opens spaces for thinking about chemical injury as a swirl in much the same way that the chemical moves from soils to foods to guts in swirling formations of varied parts per billion of absorption and perhaps deadliness. Glyphosate offers multiple opportunities for thinking about the reliability and utility of the facts about it, animating certain kinds of politics, activisms, and relationships to knowledge that are in constant motion. Glyphosate is, in this sense, not a fact but a set of relations and possibilities that are constantly being redistributed (Murphy 2017a). This is true for many chemicals. I am interested in this one.

To reiterate that I am offering an engaged anthropological account and not a typical science studies account of glyphosate, I do have a position about glyphosate, and my goal is to show how we have gotten into our current predicament in trying to be activist about it. I think we should be concerned about glyphosate. To make a case for this, I focus on the key

moments, places, and processes that have enabled this chemical to flourish, including those tied to capitalism (particularly academic capitalism). I am invested in showing how, when we try to be activist about chemical harm, we are caught up in a swirl.

For instance, the birthplace of glyphosate as we know it in the United States is the Monsanto Company. If one wants to know how glyphosate came to be so pervasive in the world today, one must spend some time on what Monsanto is and why it cared so much about this chemical, and what kind of chemical glyphosate was made to be. Having said that, I offer the caveat that I am not neutral about the way I read this company and its scientists' activities. I am weighing in on corporate innocence. To be sure, their goals, which led them to achieve glyphosate ubiquity, may have had fits and starts and lots of uncertainty in the ways they understood and promoted this chemical (and some of this is captured in the materials I present here), but that did not prevent the company from making it seem as if the facts about its safety were certain (along with the foods they designed to be used with it). The scientific breakthroughs that made it possible to create GE foods that could withstand the spraying of glyphosate were never, in this sense, much debated, nor were the scientists apparently much concerned about caveats in their knowledge base. When questions were raised about the possible toxicity of this chemical or its use in GE foods at Monsanto or its partner companies, such concerns were mostly answered in ways that mitigated interference in corporate goals, as we will see in the next chapters.

At the same time, I am not trying to offer a simplistic tribunal against the scientists or companies of agrochemical industrialism. It is easy to be against Monsanto. It is perhaps easier to be against it now than ever before, even though it no longer exists as a company per se. My goal is simpler and riskier. I follow glyphosate as a key actor in the creation of chemically rich foods, tracking its lively relations in nonliving and living systems, in bodies and soils, in scientific archives, and in the politics, activisms, and clinical encounters it has spawned. In all these sites, glyphosate has been made to serve agrocapitalism in specific ways; it also, as a chemical, afforded certain silences and slippages around its potencies. These affordances have been taken up by constituencies who have cared about glyphosate in ways that have come to seem oppositional. No matter what one is convinced about in terms of glyphosate's toxicity, the conditions of its presence in the world now disrupt our conventional ways of being certain about harm even while those potency-derived silences and slippages continue to alter the things that glyphosate touches. My goal is to emphasize that we are in a pickle not

only from environmental and public health perspectives, but also in our approaches to knowledge, science, and certainty because of the presence of chemicals like glyphosate in our world.

I also take as inspirational the probability that glyphosate's swirl—in which we cannot see an easy path to living with or without it despite its ephemeral appearances in one scientific consensus or another—is a situation that we have gotten into because of the effort to solve certain problems in and through structures that are themselves harmful. I believe glyphosate has become what Julie Livingston calls an ouroboros (a snake eating its own tail): offering new opportunities for farmers, for feeding the world, for reducing chemical harm, but in ways that have likely also been damaging and, in that damage, have generated new kinds of fixes that, in turn, may be even more harmful. Glyphosate-driven agriculture has altered people and US farmland. Its novelty as a safer and more effective alternative to other herbicides distributed alongside harsh pesticides like Agent Orange made it appealing for use in the biotechnological revolution of genetically redesigning foods, but these foods may be producing wastelands of dead soils that must now be propped up with costly seeds, pesticides, fertilizers, and nutrient additives. Glyphosate may be responsible for foods carrying doses of gut-microbe-killing toxicants, and thus responsible for large numbers of people who live from one chronic ailment to the next.

All of this is contested by those who feel glyphosate remains safe and effective in agriculture, even while the company that now makes glyphosate-ready foods and Roundup products (and profits on patents from it) have begun talking about retiring it in favor of more harmful combinations and formulas of pesticides and genetically engineered products. Choices that were made long ago with a sense of urgency and moral certainty about the future created chemically partnered foods that now must be reckoned with not just in bodies but also in the social and scientific architectures that have been mobilized to ferret out evidence of chemical injury and respond.

Finally, a geographical disclaimer. Although glyphosate is a global chemical, as is the knowledge produced about it, my ethnographic materials and concerns are almost entirely specific to the United States. Some of the insights I talk about here may be useful in other places since many activist communities work globally and in connection with one another (especially around GE foods), and I draw from European scholarship because it is so widely circulated in the United States, but I point to those places and studies in this text infrequently because I am focused mostly on the situation that is unfolding in the United States.

Glyphosate has traveled in ways that have given rise to many different activities and mobilized all kinds of certainties about what it is and what it can do. The forms of reason that we have come to rely on to adjudicate glyphosate in our world are diffracted and rendered multiple by this multipotent chemical. In this sense, glyphosate has changed my understanding of both what happens and what matters in efforts to deal with chemical harm. Glyphosate, in other words, is an exemplary chemical through which to understand the formation of competing certainties around chemical harm, disrupting and persistently displacing the scientific consensus in and through what I am calling *the swirl*. I think that the lessons from the United States are also helpful to those deliberating its presence in other places.

Glyphosate has demanded certain kinds of doublethink, ambivalence, multiplicity, certainty, and uncertainty in its many relations with food, environments, and bodies. Recognizing this invites more thinking about how, as a ubiquitous chemical, it continues to shape my engagement with it as an anthropological interlocutor that shakes up certainty about facts. To think beyond certainty means to think imaginatively about different ways of reckoning life with and theories of chemical harm. Glyphosate invites me to move beyond the politics of knowledge (in which all facts are situated) to cultivate new languages for talking about chemical harm by shifting focus away from chemicals' constructed qualities and toward their material capacities to alter life. Like others, I am continually being swept up in, swirling, and shifting certainty in ever mutable ways. Living with toxic chemicals may require cultivating skill in the arts of ephemerality—of keeping knowledge trembling and acknowledging it as always partial, uncertain, and unstable—while still holding onto its material and actionable effects.

If, at this point, dear reader, you feel that you are looping and circling and settling and unsettling with my repetitions of the sense of movement of the things I am trying to say, then I have done my job. Welcome to the swirl.

To begin our journey with glyphosate, I turn to one of its origin stories in the next chapter. I start with how this chemical became a historical object that solved certain problems even while creating others. Glyphosate-resistant foods were products of agrocapitalist investment—peculiar objects that crossed and blurred boundaries between biology and chemistry, viral genetics and information systems—and these investments required certainties about them to be forged in order for them to "live" in human ecosystems. That story takes us into the company that has had the most invested in its success: Monsanto.