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ESSAY

Ecologies of drug war and more-than-human health: The case of a chemical at war with a plant

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Abstract

Drawing on an ecological approach, we trace how the political-economy of drug wars are locally materialised in relation to health. We take the case of coca cultivation and eradication as our example. To make our analysis, we trace the different ways that the chemical glyphosate is materialised in a war with the coca plant in Colombia. Glyphosate has been used for decades in aerial fumigation campaigns to eradicate illicit coca cultivation. Our analysis traces the more-than-human effects of glyphosate in relation to health. This leads us to outline a more-than-human approach to harm reduction; a harm reduction which positions health as a matter of *ecology*, paying attention not only to the nonhuman actors affecting human health but also to the health of *environments* which are themselves always in-the-making. We envisage harm reduction as a collaboration in which humans 'become-with' their environments.

Keywords

Colombia; Drug eradication; Coca; Harm reduction; Ecologies; Glyphosate.

Introduction

> Contaminated diversity is collaborative adaptation to human-disturbed ecosystems. It emerges as the detritus of environmental destruction, imperial conquest, profit making, racism, and authoritarian rule—as well as creative becoming. It is not always pretty. But it is who we are and what we have as available working partners for a liveable earth. (Tsing, 2012: 95)

Anna Lowenhaupt Tsing sees 'contaminated diversity' as a 'slow disturbance' in which multiple forms of species intermingle through ongoing processes of extinction and emergence. Her focus is the matsutake mushroom and interspecies collaborations which entangle humans and pine forests in relations of destruction and survival. Tsing (2012, 2015) calls attention to what emerges in damaged landscapes. Here, our focus is the contaminated diversity of drug wars, and in particular, coca crops and their eradications. These also enact a slow disturbance in the ecosystems in which multiple species, human and nonhuman, entangle. We therefore envisage drug eradication events as environment-making interventions.

Our concern here is tracing how drug wars, and the emergent ecological effects of these for health, are materialised locally. To make this story, we focus specifically on tracing the harms and effects afforded to the chemical glyphosate in a war with the coca plant in Colombia. Our initial protagonists then, are a chemical and a plant, and how they relate together as conflicting matters-of-concern. Each of these actors, glyphosate and coca, are nonhuman elements, which afford more-than-human

effects, altering the health and life potentials of environments, humans and other living species. Neither act alone, for each are afforded agency through their entanglements in evolving assemblages of war, science and policy. We use this essay then, to trace the material life of a chemical in relation to a plant to see what this can tell us about the ecologies of health that a drug war can make. But first we want to introduce our case for a more-than-human approach to health and harm reduction.

From risk environments to ecologies of health

There is an established body of work in the field of drug use and harm reduction that accentuates health as a matter of contingency in relation to environment (Rhodes, 2009; Duff, 2011, 2013; Collins et al., 2019). This has led to various articulations of 'risk environment' and 'enabling environment' which appreciate harm as an emergent dynamic of reciprocal relations produced in adaptive systems of which individuals and drugs are entangling elements among many (Bourgois, 2003; Rhodes, 2009; Duff, 2007). Yet, ecological models of drug harm, including those of a political-economic persuasion, have tended to underplay how the materiality of drug harms and environments are situated in local actor-networks and practices (Duff, 2003; Fraser and Moore, 2011). A tendency in social science studies of harm reduction is to "describe a set of stable, reliable and predictable features of social organisation" which reify "a near monolithic set of social structures that are said to mediate patterns", rather than elucidate a "unique material trace, a domain that might be amenable to empirical inquiry" (Duff, 2013: 3). For Duff, "the whole notion of social context risks being reduced to a rhetorical trope" and "monolithic constant" unless investigated as a matter of its situated materialisations in particular actor-networks (Duff, 2013: 4). Here then, the actor-network, or assemblage, "generates the cause just as it expresses the effect", with harm *and* environment, in fact any object or activity, an effect not of the causal relations attributable to singular or particular actors in the network (such as humans or environmental forces) but of the "associations" which are "immanent" to the actor-network as a whole (Duff, 2013: 2).

We move from ecological models of environment and context assumed relatively stable (even if considered 'complex' and 'adaptable') to environments and contexts which *emerge* as relational effects of their local materialisations (Race, 2004; Dilkes-Frayne, 2014; Rhodes and Lancaster, 2019). This shift might sound like a subtle distinction from the claims made by most political-economic theories, which emphasise the context-based materiality of drug harms, but it is significant one, for it disrupts the idea of environment or context being anything other than a relational effect of its enactments. Environments are always in-the-making. We suggest that there is a tendency in political-economic models to separate out environment or context as a kind of "super object" into which, or against which, human actors are presumed to inter-lock or relate (Bryant, 2011: 271). This then, is a distinction between an approach which investigates how humans 'relate *to*' their environments (common to political-economic approaches) and one which investigates how humans and environments 'relate *with*' the other (a focus of critical social science drawing on relational materialist ideas; Braidotti, 2013; Fox and Allred, 2017); a "joint make-up of entities, not as separate interacting components but always together, in their making, that is, a difference-in-itself" (Dennis, 2019: 29). Rather than treating humans and environments as separable, where environment performs 'everything that is not human' in a culture/nature binary, these *relate with* and *become* together (Braidotti, 2013; Van Dooren et al., 2016).

Ecologies of health

We are arguing then, for a 'more-than-human' harm reduction; a harm reduction which positions health as a matter of *ecology* which pays attention not only to the *nonhuman actors* affecting human health but also to the health of *environments* which are themselves always in-the-making. In a more-than-human harm reduction, the environment is not held momentarily stable as a thing 'out there' against which the 'in here' of human contingency is assessed, but is itself emergent and contingent, afforded as well as affording agency, in relation to ecologies of health (Braidotti, 2013; Duff, 2014). Notions of ecology imply more open and emergent versions of environment than ordinarily applied in public health (Stevens, 2012; Van Dooren et al., 2016).

In this essay, we take inspiration for approaching harm reduction as an ecological concern from Anna Lowenhaupt Tsing's ethnographic work tracing more-than-human collaborations in contaminated ecologies (2012, 2015). Tsing envisages the actor-networks and assemblages affecting ecologies as "open-ended gatherings", as "patterns of unintentional coordination", between human and nonhuman elements which come together to produce "lifeways" as well as "non-living ways of being" (2015: 23). For instance, Tsing traces the commodity chains of the matsutake mushroom, a highly valued delicacy of Japan whose existence has become threatened through a mix of human driven development and ecological disturbance to the pine forests in which matsutake thrive. Matsutake's survival is shaped through various multispecies collaborations and adaptations, including between matsutake and pine trees which depend on the other for survival in human damaged environments, and it is these multispecies entanglements which sustain precarious livelihoods for foragers and traders in different parts of the world. Through a focus on the material life of the matsutake mushroom global political-economic relations can be traced.

In a similar fashion, we can follow how the chemicals and plants linked to crop cultivation entangle in global assemblages of drug war and policy. Here, we select for attention two nonhuman elements – a chemical (glyphosate) and a plant (coca) – to explore how these become-with the other in assemblages of drug war to enact 'contaminated diversity' affecting ecologies of health. In addition to Tsing, on multispecies intra-actions in the making of ecological adaptations, we can also draw on work in science studies on the embodied ecological effects of chemicals and substances (Murphy, 2008, 2017; Agard-Jones, 2013; Liboiron, Tironi and Calvillo, 2018; Shapiro and Kirksey, 2017). Helpful to us here, is the ethnographic work of Vanessa Agard-Jones on the hormone-altering pesticide *chlordécone* (or "kepone"), which while banned in most countries was distributed through aerial spraying in the banana plantations of Martinque, and subsequently linked to contamination of soil and foods, endocrine disturbance, male infertility, and prostate cancer (2013). Like Tsing, Agard-Jones imagines bodies as assemblages rather than as singular entities, that is, as "multiply constituted things, as blendings of companion species and inorganic material, containing multiple forms of agency and bearing the traces of multiple forms of power" (2013: 187). We can thus 'jump scale', moving from the local embodied effects of small things, like chemicals and plants, to the global political-economic relations which connect to these. As put by Agard-Jones, we move "from the innards of embodiment to the space of global capital" (2013: 187), calling attention to how "bodies are connected to commodity chains" (2013: 192). Ingested chemicals become-with bodies and environments; bodies that are human as well as nonhuman, bodies that are made-up of people as well as plants and other species (Murphy, 2008). A focus on ecological health thus orientates attention to the embodiment of the nonhuman, also taking the environment, and not only the human body, as a driving matter of concern. A focus on a chemical, as in the work of Agard-Jones, or a plant (or fungi), as in the work of

Tsing, is an effort to "scale inward" by tracing the materiality of embodied social relations, thereby "recognising the multiple levels at which our material entanglements – be they cellular, chemical, or commercial – might be connected to global politics" (2013: 192).

This then, is an ecological approach which traces the local material life, and more-than-human affects, of political-economy. It seeks to "*revitalise* political economy" (italics added) because "assemblages drag political economy inside them, and not just for humans" (Tsing, 2015: 23). Assemblages "cannot hide from capital and the state; they are sites for watching how political economy works" (Tsing, 2015: 23). Through following glyphosate in its assemblages of drug war, science and policy, we can notice how political-economy is materialised locally. Glyphosate circulates in what Michelle Murphy describes as a "chemical regime of living", wherein "molecular relations extend outside of the organic realm and create interconnections with landscapes, production, and consumption, requiring us to tie the history of technoscience with political economy" (Murphy, 2008: 697).

In what follows, we give particular mention to the ethnographic research of Kristina Lyons (2018) as an exemplar of work exploring the more-than-human environment of drug production. She traces 'chemical regimes of living' linked to glyphosate in its war with the coca plant. Lyons follows the compensation claims, known as *quejas*, of rural communities in Putumayo, Colombia, in response to the damage wrought to crops and livelihoods from aerial spraying. At the same time as seeking compensation from the Colombian Government, farmers engage in everyday repair work to remake their damaged environments, including through replanting and reforestation to the extent that the altered land allows. In response to the systematic rejection of compensation claims, farmers' work with the land becomes a practice of 'evidentiary ecology' which performs reparation and justice (aerial fumigation also disrupts the farming of licit crops). Lyons accentuates the ecological materiality of drug war harms which are always more-than-human and in a process of emergence. For example:

> A fourth round of aerial fumigation hit Pedro's now coca-less farm on September 16, 2013, killing approximately 350 […] trees, among other flora, and of course forest inhabitants, such as the butterflies we witnessed that morning. The fumigated trees remained leafless. Their white branches splayed out like bony figures. Skeletons of trees entangled with the living vegetation that had not been misted with an indeterminate herbicidal agent. Pedro told me that he left the trees standing as evidence. Toxic imprints in the ecology; the traces of what was – is becoming forest. (Lyons, 2018: 417)

The material life of glyphosate in relation to coca

The cultivation of the coca leaf is prohibited for anything other than scientific or medical purposes by the United Nations' Single Convention on Narcotic Drugs of 1961, yet materialised in local practices in parts of Colombia as a way of life and means of livelihood. Coca, a non-perishable and robust crop, is suited to poorer agricultural conditions, and provides a high value of economic return relative to labour, including in the face of ecological and other disruptions linked to eradication efforts. With insecure access to land for many farmers and their families, the coca plant constitutes a resource for living, affording up to six crops a year (Ramírez, 2001). Coca holds greater resilience and resource potential than many alternative crops. The precarious livelihood that coca affords to rural communities is situated within broader political-economic contexts of precarity, shaped by colonial

and urban-centred developments and by ongoing conflicts (Ramírez, 2001; Torres, 2011; Gutiérrez Sanin, 2019). The coca plant, and its cultivation, potentiates 'generous constraint' (Gomart, 2002); a material resource for living-with an environment of indeterminacy and even hostility. Beyond enabling a means of adaptive protection, or safety-net, to livelihood, coca cultivation capacitates development and diversity, through the transference of economic to other forms of capital, including education and health (Gutiérrez Sanin, 2020a).

Glyphosate – N-(phosphonomethyl) glycine – is a herbicide, a killer of weeds and plants, produced by Monsanto, and a key ingredient in what is known commercially as Roundup Ultra. Once absorbed by the foliage of a plant, glyphosate spreads throughout the plant "resulting in death after several days" (Van Bruggen et al., 2018). Introduced in 1974, it has been used as an agricultural herbicide worldwide to prepare land for agricultural use and to maximise yield (Benbrook, 2016). But glyphosate is made multiple according to its situations of implementation. In concentrated and enhanced forms, which are much more potent than commercial available versions, glyphosate has been used, over decades, as a key element in an aerial war waged on the illicit cultivation of the coca plant. Glyphosate interferes with so much more than the life of a plant, altering human and multispecies arrangements which intra-act to shape the liveability of worlds.

Glyphosate and the coca plant are but two actors in assemblages, which operate at different scales, to entangle multiple human and nonhuman elements, including global agencies, national governments, military and paramilitaries, guerrilla organisations, local authorities, laws and policies, indigenous traditions, farming communities, animals, scientists, technocrats, planes and helicopters, trees and soil, and so on. Below we synthesise previous research on glyphosate and coca eradication in Colombia to call attention to how the political economy of drug war is materialised in the ways glyphosate is enacted in relation to policy, health and the environment. Our analysis allows us to jump scale to notice the political-economy of chemical regimes of living (Murphy, 2008), and their more-than-human health effects.

Matters of political concern

Glyphosate is afforded agency as an element of its actor-network. Key actors here include the United Nations Office of Drugs and Crime (UNODC) and the US (United States of America). The US has provided funding and materials (aircraft and supplies) to Colombia to militarise the delivery of aerial fumigation campaigns (O'Shaughnessy and Branford, 2005). Plan Colombia emerged as a US-Colombian collaboration between 2000 and 2012 as a strategy to disrupt illicit drug production and insurgency. The fumigation of coca cultivation was core to Plan Colombia, with an average of 128,000 hectares per year subjected to aerial spraying with glyphosate (Camachio and Mejía, 2017; Mejía, 2015). This chemical is not cheap. It is said that 33 hectares need to be sprayed to eliminate one hectare of coca crops at a cost of around USD$79,000 per hectare for which the U.S. was paying around USD$24,750, with an estimated market value of coca leaf in one hectare around USD$450 (Mejía et al., 2017). Other economic analyses suggest that the cost of eradicating the coca needed to produce 1kg of cocaine is around USD$240,000 (Mejía, 2015). Aerial fumigation is not cost-effective (Mejía, 2015; Mejía et al., 2017). In the period 2006-2011, an estimated USD$1.2 billion a year, equivalent to more than 1% of the gross domestic product of Colombia, was spent fumigating the coca plant (Mejía and Restrepo, 2013). Estimates suggest that between 2000 and 2015, the United States

invested USD$9.6 million in Plan Colombia, with the war on the coca plant a prime beneficiary of foreign aid (Lozano, 2018).

Following the terrorist events of September 11, 2001, in the United States, and the Colombian government's failure to broker a peace agreement with the Revolutionary Armed Forces of Colombia (FARC), Plan Colombia accentuated the war on drugs as a war on terror (Borda, 2012; Rincón-Ruiz et al., 2016). Plan Colombia enabled the mobilisation of resources in a wider military struggle against criminalised guerrilla and peasant groups, before United States' contributions to Plan Colombia and allocations for fumigation reduced, as peace negotiations with FARC resumed in the years immediately prior to fumigation ending in 2015. While declared a success, the hectares of coca plant eradicated only ever represented a minority fraction of the estimated hectares used for cultivating coca (Rincón-Ruiz and Kallis, 2013). Fumigation has not prevented the continuation or re-emergence of coca cultivation and its displacement elsewhere (Rincón-Ruiz et al., 2016; Franz, 2016).

How glyphosate is evidenced in relation to crop reduction as well as health and environmental effects is a matter of contested political concern (Franz, 2016; Camacho and Mejía, 2017; Lyons, 2018; Huezo, 2019). Drug wars, somewhat like viral pandemics, enact narratives of biosecurity threat of unknown yet great potential which afford governments freedom to act decisively, including in the relative absence of 'evidence' (Lakoff, 2017; Keen and Andersson, 2018). As Lyons notes of the "mutual reinforcement" enabled by the confluence of global wars on terror and on drugs: "The threat of narco-terrorism legitimised the suspension of law and the precautionary principle, as well as the pervasive criminalisation and surveillance that conforms to illicit crop monitoring and eradication-based antidrug policy". Glyphosate is not a mere killer of weeds but is mobilised as an instrument of governance in the criminalisation of people constituted as societal threats and as a bilateral political-economic matter-of-concern.

The political-economic capitals of glyphosate continue to flow, even despite aerial fumigation ending as official Colombian policy in October 2015. Gutiérrez Sanin (2020b) traces recent Colombian government attempts to reinstitute aerial fumigation, in addition to military supported manual coca eradication, alongside the dilution of other commitments, including crop substitution programming, linked to the 2016 Peace Agreement. Glyphosate, once again, folds into an actor-network in which the nation-states of Colombia and the US entangle in wars on drugs and terror. The US is reportedly supportive of Colombian President Duque's push for a return to aerial fumigation (*Wall Street Journal*, 2018) while resistant to supporting crop substitution programmes involving former FARC as "material support to terrorism" (*WOLA*, 2019). While the "immediate target" presents as "illicit crops" in deliberations about glyphosate's return, the "fight against nacro-trafficking and crime is broad enough to include *any other target*, including the guerrillas" (Gutiérrez Sanin, 2020b). In tracing glyphosate as a matter of political concern, we scale-up attention from the local to the global to notice how glyphosate's gathering in a drug-war assemblage affords political and economic capital.

Matters of health concern

The Colombian Government decision to suspend the license to use glyphosate in aerial spraying was made after a World Health Organization (WHO) supported evidence review by the International Agency for Research on Cancer concluded that glyphosate was "probably carcinogenic to humans" (Guyton et al., 2015). The WHO reclassification of glyphosate coincided with growing concerns about

its toxic side-effects to plant, animal and human health (Camachio and Mejía, 2017; Bai and Ogbourne, 2016; Guyton et al., 2015). A recent review estimates over 1000 scientific papers investigating glyphosate harms since the WHO reclassification (Van Bruggen et al., 2018). One such study, for instance, analysed the records of millions of medical consultations alongside daily data on aerial spraying between 2003 and 2007, to evidence glyphosate exposure with dermatological and respiratory conditions as well as increased odds of miscarriage (Camachio and Mejía, 2017). Studies also link glyphosate to various forms of cancer, kidney damage and mental health conditions (Van Bruggen et al., 2018). The government of Ecuador filed evidence to the International Court of Justice that glyphosate spraying in Colombia was linked to "burning, itching eyes, skin sores, intestinal bleeding, and even death" across the border, resulting in an out of court settlement, a borderland buffer zone, and compensation (Menendez, 2013; Csete et al., 2016). While the decision to halt aerial fumigation was made in May 2015, spraying continued for six months while enforcement agencies capitalised on the glyphosate already purchased (Lyons, 2018).

Glyphosate is no simple matter-of-fact in relation to its effects on human health but is a matter of controversy in a science war extending over many years (Lyons, 2018; Lozano, 2018). Successive Colombian and US governments have defended drug eradication through crop spraying by maintaining that glyphosate kills *illicit* crops, and "poses no scientifically proven harm to other bodies and ecologies" (Lyons, 2018: 415). An evidence review, for instance, of the Comisión Interamericana para el Control del Abuso de Drogas (CICAD), or Inter-American Drug Abuse Control Commission, linked to the Organisation of American States, presented eradication through aerial spraying as safer to human health than by crop burning or manual deracination (Solomon et al., 2005). The case has also been made that the damage of coca production and processing outweighs the health risks of glyphosate exposure (Rincón-Ruiz and Kallis, 2013; Bernal et al., 2009). Beyond scientific evidence review, staged demonstrations of glyphosate's safety have included government officials subjecting themselves and those of visiting delegations to chemical spray:

> Bolero (the Minister of Defence) knew about the plan. The plane flew over them three times and sprayed them all. The minister gave the order […] to spread the chemical over him and the other 30 or so members of the delegation. They were being sprayed with a chemical that was considered dangerous for people, animals and the environment." (*El Tiempo*, 1995, quoted in Lozano, 2018)

Colombian civil society have also responded by staging demonstrations, including protests and strikes (Lozano, 2018), and by producing counter evidence, including through collating the thousands of complaints of ill health (skin, respiratory, digestive and eye conditions) linked to glyphosate reported to the Colombian government and seemingly unnoticed by CICAD (Rincón-Ruiz and Kallis, 2013; Transnational Institute, 2005). Lyons (2018) documents how farmers filed *quejas* – compensation claims – for having been 'wrongfully fumigated', having had their licit crops destroyed, land damaged, and livelihoods harmed, but almost always to no avail. Nationally, 17,643 such complaints were filed, and 96% rejected, as were 93.5% of the 2,265 claims made in the Putumayo region since 2001 (Lyons, 2018). Aside from various difficult-to-navigate bureaucratic hurdles, claims were uniformly rejected on the basis that no licit crops were evidenced at claimants' farms, that coca plants were instead found to be present, and that there was no causal relation between fumigation and licit crop damage. Such evidence contestations, especially state rejections of rural farmers' claims, enact governance through

epistemic displacement (Huezo, 2017, 2019). *Displacement* is materialised in *wars over evidence* and the *right-to-know* as it is in *wars over land* and the *right-to-grow*. Huezo (2017) has mapped the performativity of evidence-making in relation to the 'success' of aerial drug eradications, arguing that drug control authorities have downplayed the incidence of collateral spraying to legal crops, invalidated local reports of health and environmental harm, and demanded technical evidence beyond the means that rural farmers can provide. What constitutes 'evidence' in relation to health, and what is performed as 'success' in relation to intervention, is materialised in relation to *political* matters-of-concern. This is a process described elsewhere in times of war as a 'game' of 'performance' in the uneven distribution of risk and benefit for political-economic gain (Keen and Andersson, 2018).

Far from stable, glyphosate emerges as a fluid object of 'evidence-making intervention' (Rhodes and Lancaster, 2019). Human health and intervention success are translated as conflicting matters-of-concern; an evidence dispute which "demonstrates par excellence the cycles of mutual reinforcement between contested scientific discourses, corporate seed/chemical/pharmaceutical giants, and militarized geopolitical interventions" (Lyons, 2018: 418). This accentuates evidence-making as one of many fields of materialised conflict in drug-war assemblages; one site, among many, for watching how political-economy is afforded material life. The Colombian Constitutional Court, for instance, has made a return to aerial fumigation contingent on there being "objective and conclusive" evidence of no associated health or environmental harm. In the game of political wins by the Colombian government to bring back glyphosate, Gutiérrez Sanin (2020b) notes how the COVID-19 pandemic and policies of population lockdown were used in an attempt to push through virtual public hearings to create the necessary 'evidence' to support a return to aerial fumigation rather than stage public hearings, as per Constitutional Court rulings, that farmers and peasant organisations could actually attend. Evidence is in-the-making, and tracing evidence-making events in relation to health is one way to explore how glyphosate comes to be.

Matters of ecological concern

Evidence of spatial overlap between illicit crop cultivation and deforestation has helped to mobilise claims that aerial fumigation is a form of conservation policy (Burns-Edel, 2016; Dávalos et al., 2016). Glyphosate, in combination with the promise of alternative development interventions, is here performed as *environmentally friendly* through preventing ecological harm linked to coca cultivation (UNODC, 2015; Huezo, 2019). For instance, in mapping the "intense environmental degradation" and "ecosystem injury" of illicit drug production, Burns-Edle (2016: 1,10) argues the case to "stop production of illicit drugs in their initial stages", including by developing "chemical compounds and pesticides designed to thoroughly exterminate illicit drug crops", given the "notable success of aerial detection and spraying of coca crops". Illicit coca cultivation is not merely enacted as a crime against society but also as a crime against the environment (Gootenberg and Dávalos, 2018).

Let us consider deforestation. An 'immiserisation model' of deforestation assumes that forest clearing results from migration to lowland forests among impoverished farmers seeking economic survival through coca as the ultimate cash crop (Dávalos et al, 2016). In this articulation of environmental harm, deforestation links to land clearing as well as land grabbing enabling the production and distribution of drugs, including through the building of roads and airstrips, resulting in the slow erosion of the land through 'slash and burn' clearance (McSweeney et al., 2014; Fergusson et al., 2014; Burns-Edel, 2016; Negret et al., 2019). The emergence of additional markets alongside those of coca, such

as palm oil production or cattle ranching, further exacerbates the ecological harms of land clearing efforts (McSweeney et al., 2014). Deforestation becomes trackable spatially as an after-effect of coca cultivation (McSweeney et al, 2014). Forest lost to coca or cocaine production is said to be "rampant", with over 290,000 hectares lost between 2001 and 2003 (Buns-Edle, 2016). For every hectare of coca produced, it has been said that 1-2 hectares of forest is lost (Jelsma, 2001; Suarez et al., 2017). The overuse of fertilizers and pesticides to increase coca production introduces further damage to wildlife and aquatic ecosystems (Burns-Edel, 2016). This is the prima facie case that performs fumigation as environmental harm reduction.

Yet coca cultivation is one element in the materialisation of deforestation linked to colonial and other political-economic developments. A 'frontier model' of deforestation assumes that land clearing and migration follows investment and development initiatives, especially through the building of roads and infrastructure (Barber et al., 2014; Dávalos et al., 2016; Gooteborg and Dávalos, 2018). Here, coca cultivation is "not a dominant cause of direct deforestation" and there is "little evidence that coca cultivation increases deforestation rates, independent of the dynamics already prevalent" (Dávalos et al., 2016: 979). Rather, the resource frontiers and deforestation hotspots of Amazonia reside in a colonial development history of ecological disturbance linked to state-sponsored construction and settlement projects, which also generated a situation of land insecurity and economic impoverishment for many small farmers and indigenous communities (Dávalos et al., 2016; Armenteras et al., 2013, 2017). It is in this context that a pattern of *displacement* from the land, for the coca plant (made mobile as an asset and commodity), as well as for farmers (made mobile in search of less precarious land), has a trajectory (Bradley and Millington, 2008; Dávalos et al., 2011, 2016).

Modelling analyses thus indicate that "migration strongly correlates with deforestation, but coca cultivation explains neither deforestation rates nor migration" (Dávalos et al., 2016: 979). When roads and migration are included in analyses, coca cultivation fails to explain Amazonian deforestation rates (Armenteras et al., 2013). Dávalos et al (2016) thus note that studies which link forest loss with coca cultivation fail to acknowledge how coca cultivation and deforestation entangle as part of trajectories of economic development and armed conflict (Alvarez, 2003; Negret et al., 2019). Post-conflict economic development and land reform following the 2016 Peace Agreement also link with ecological disturbance, as well as new coca cultivation, especially in regions of apparent weak governance (Brodzinsky, 2017; Negret et al., 2019). Rather than linked singularly to expanding illicit agricultural production, deforestation is thus exacerbated by displacement, of human as well as nonhuman kinds, linked to precarity (Dávalos et al., 2016; Sánchez-Cuervo and Aide, 2013; Negret et al., 2019). Forced crop eradications, including through aerial fumigations, encourage population and crop displacements, often to more hostile and remote environments, which can reproduce the risk of poverty and food insecurity for farmers, reproducing ecological harms, especially when original sites of coca cultivation better managed deforestation (Rincon-Ruiz and Kallis, 2013; McSweeney et al., 2014; Huezo, 2017). Here, coca crop eradication promotes deforestation through migration, not only for cultivating coca but also other crops (Bradley and Millington, 2008; Salisbury and Fagan, 2011; Moreno-Sanchez et al., 2013; Rincón-Ruiz et al., 2016; Dávalos et al., 2016). Becoming detached from the land, through cycles of crop eradication and conflict, and re-locating elsewhere, materialises ecological disturbance. The environment becomes increasingly precarious as a resource. Glyphosate and the coca plant fold into a political-economic dynamic which materially alters the liveability of the environment: "As more and more people become destitute as a result of the fumigations, the supply

of mobile coca labourers increases, making coca production more responsive and adaptable to fumigation, labour and production moving back and forth from fumigated areas with more ease" (Rincón-Ruiz and Kallis, 2013: 75). This is the case that performs drug eradication as environmental harm production.

The cultivation of the coca plant and its eradication are thus elements in an assemblage of multiple practices which affect ecological health, including colonial developments, industry investments, land and armed conflicts, economic hardships, international drug controls, scientific and policy discourses, and so on. While singled out, in different ways, for attention as objects in a drug war, neither glyphosate nor the coca plant act alone, but are afforded agency through their relations. We can first appreciate that glyphosate and the coca plant are enacted multiply in relation to harm or conservation according to how apparent *facts* are differently materialised as *concerns* in the course of a war (Latour, 2004). And second, we can appreciate that this evidence-making process is not merely a matter of science or policy discourse, as if this were detached from material practices, but is an evidence-making that is *embodied* in the landscape, which glyphosate and cocoa, among other actors, are *becoming-with* and *altering*, even as we speak (Murphy, 2008; Agard-Jones, 2013). Tracing glyphosate's war with the coca plant accentuates their materiality in multiple ways, as relational objects made-up in the materials of science and policy, and as elements of ecological disturbance in the becoming environment (Lyons, 2018). In both cases, we can notice the more-than-human effects of these nonhuman actors.

Moreover, given the latent ecological impacts of glyphosate, the chemical materialises an 'absent-presence' in the environment (Murphy, 2008; Law, 2004), affording an ongoing agency (Van Bruggen et al., 2018). This reiterates glyphosate as a slow disturbance on the liveability of environments through its emergent effects, which collapse the past into the now and future. The land holds the sedimented and contaminated effects of glyphosate, which accumulate in soils over time (Sidoli et al., 2016; Okada et al., 2016; Van Bruggen et al., 2018). Rain and erosion transport soil particles with glyphosate, and its main degradation metabolite aminomthylphosphonic acid (AMPA), into surface water and rivers where it sediments (Maqueda et al., 2017; Van Bruggen et al., 2018). Residues of glyphosate and AMPA in water and in plants are taken up by animals and humans (Niemann et al., 2015). The slow ecological disturbance enacted by glyphosate affects human health directly through embodied illness and indirectly through loss of farming and livelihood linked to degraded land and food insecurity (Lyons, 2018). With glyphosate already having 'landed', the future "is already altered" (Murphy, 2008). Even if aerial spraying was to disappear as an intervention of drug control (see above), glyphosate continues to become-with the environment.

Matters of care

Kristina Lyons' ethnography of evidentiary ecologies in the chemical war waged on the coca plant accentuates the presence of the environment in affecting human health and developing harm reduction. Following aerial fumigations, the farmers of Putumayo work-with their damaged land through practices of reparation, not merely because they must find ways to "carry on" but because they seek to "transform chemically degraded life" (Lyons, 2018). Faced with routine rejections of their compensation claims for wrongful fumigation, they tinker with the land, remaking it through diversification and reforestation and other transformation efforts, to create a liveable environment. Both practices – making legal claims against state violence on the environment, and working-with the

land – are forms of ecological evidence-making intervention which materialise the environment, and health with it, as not-only human. Lyons shows us that interventions of resistance (here, anti-state claims-making) as well as altering practices (here, tinkering with material conditions) constitute a more-than-human care (See also, Puig de la Bellacasa, 2017). By moving beyond a conception of evidencing that seeks to separate out evidence from practice, and science from society, and humans from nature, to one that treats these elements as always entangled and emerging in local material practices, we can see how health affected by drug wars is always made in, and *makes*, environment.

Efforts to reduce harm must therefore not only seek to generate the 'best quality evidence' in support of interventions, but can build on the everyday material practices which seek to alter situations of constraint to make environments safer (Harris, 2020). This is fundamentally a difference in emphasis between a mainstream 'evidence-based intervention' approach to harm reduction (which valorises the best evidence as a matter-of-fact to make claims for human and environmental change), and an 'evidence-making intervention' approach (which also intervenes materially in relation to local matters-of-concern and altered conditions of emergence) (See also; Rhodes and Lancaster, 2019; Latour, 2004). As Lyons says of the Putumayo farmers, they seek to make peace not only through evidence-based claims but through adapting-with their environment:

> These farmers do not attempt to further penetrate the recesses of state bureaucracies to dispute their social exclusion, but rather have begun to enact justice in their everyday material and affective relations on and beyond the farm. (Lyon, 2018: 431)

An ecological approach therefore draws attention to harm reduction as an emergent practice of adapting-with the environment, including to make it liveable. Studies accentuate, for example, how coca farmers materialise practices of harm reduction as an adaptive element of environment, for instance, by protecting plants from herbicide and preventing herbicide absorption through the leaves, by reducing the harms of fumigation by mixing coca with indigenous as well as licit crops, by planting smaller plots, by cutting back glyphosate affected plants to help them re-grow, and by adapting to higher yielding coca plants (Dávalos et al., 2009). Here, what we consider 'harm reduction' transforms in its multiple enactments, extending beyond the harms of drug consumptions to the human and environmental harms of drugs and their productions, in which protecting economic livelihoods from the effects of drug war also emerges as harm reduction. Farmers' efforts to protect their livelihoods through adapting-with the damaged environment, however, do not detract from the urgent need to better protect farmers themselves from the multiple harms they face when coming into contact with chemicals (Camachio and Mejía, 2017). A more-than-human harm reduction involves collaborative adaptations with the environment – biotic, abiotic and political – in the face of disturbance.

Ecologies and more-than-human harm reduction

A more-than-human harm reduction gives more equal ontological footing to human and nonhuman elements. Rather than treating humans and environments as isolatable yet inter-acting entities, as if they can be pulled apart, a more-than-human approach treats these elements as always entangled, intra-acting, and thus becoming-with the other (Deleuze and Guattari, 1987; Barad, 2003; Van Dooren et al., 2016; Dennis, 2019). While political-economy approaches draw attention to the structuration of health as a matter of bounded human agency (Bourgois, 2003; Krieger, 2008), they can underplay the agency of nonhuman things in materialising environments locally (Barad, 2007; Duff, 2014). There

is increasing attention in critical drug studies to the agency affording to substances and other material things, such as equipment, technology, and built environment, in local drug-using assemblages (Fraser and Moore, 2011; Malins, 2014; Duff, 2014; Vitellone, 2017; Duncan et al., 2017; Dennis, 2019). As Dennis notes of research investigating drug use: "To centre on human rationality and reason in drug-taking is to neglect the role of material things" (Dennis, 2019: 9). Here, we have drawn attention to some of the more-than-human elements of drug-production. Through honing down on the particular case of glyphosate, and how this chemical folds into livelihoods linked to coca cultivation in Colombia, we have articulated health as not only more-than-human but as *ecological matter*. We make the *environment*, at once biotic and abiotic, our focus of harm reduction attention, recognising that humans, and their bodies, rationalities and experiences, are but elements in collaborative arrangements which incorporate nonhuman things (Barad, 2007; Van Dooren et al., 2016).

This returns us to the starting point of this essay; that by paying attention to how particular things relate with others, as Anna Lowenhaupt Tsing does in her ethnography of the matsutake mushroom, we can notice how things come to be as they do. This is because "attention to the particular requires us to ask how specific worldings come to matter, and to matter differently, for given things" (Van Dooren et al., 2016: 13). In Tsing's ethnography, the matsutake mushroom is a companion species that affords the possibility of life in a blasted landscape altered by generations of capitalist development. In our reading of the literature which relates glyphosate with coca inside the political-economy of drug war, we can also jump scale by noticing how a chemical brings certain 'worldings' into being, through connection with histories of colonisation, development and displacement, to shape precarious livelihoods which teeter between extinction and possibility. We get to notice how ecologies of health are materialised in the particular.

In Tsing's ethnography, matsutake foraging makes a precarious livelihood in a globalised commodity chain; a means to "getting by for those with no other way to make a living" (2015: 5). This is a story of displacement where "people and things become mobile assets", "removed from their life worlds", to be "exchanged with other assets from other life worlds" (2015: 5). There are ecological harms in these cycles of extraction, survival and displacement: "When its singular asset can no longer be produced, a place can be abandoned. The timber has been cut; the oil has run out; the plantation soil no longer supports crops. The search for assets resumes elsewhere". In an environment of fragile assets, suggests Tsing, "we don't have choices other than looking for life". These are the 'generous constraints' (Gomart, 2002) of a companion species like matsutake:

> Matsutake are wild mushrooms that live in human-disturbed forests. Like rats, racoons, and cockroaches, they are willing to put up with some of the environmental messes humans have made. Yet they are not pests; they are valuable gourmet treats—at least in Japan, where high prices sometimes make matsutake the most valuable mushroom on earth. Through their ability to nurture trees, matsutake help forests grow in daunting places. To follow matsutake guides us to possibilities of coexistence within environmental disturbance. This is not an excuse for further damage. Still, matsutake show one kind of collaborative survival (Tsing, 2015: 4).

What might be the 'generous constraints' afforded by coca, no matter how fragile? The damage to human life and livelihood from chemical and other forms of drug war in Colombia is brutal, and

massive in scale (O'Shaughnessy and Branford, 2005; Gootenberg and Dávalos, 2018). This is a long and complex war, in which coca farmers face various forms of state violence, including armed conflict, the burning of their crops, homes and household possessions, and forced displacements from their homes, work and land. At the same time, farmers are under pressure, from guerrilla as well as paramilitary groups, to maintain coca production and to resist substituting coca for alternatives, with the balance of guerrilla and paramilitary groups oscillating since the Peace Agreement. Glyphosate enacts a "toxic politics" of dispossession and displacement through its entanglements with patterns of colonisation, development, state and non-state power, and anti-narcotics and other policy (Lyons, 2018; Liboiron et al., 2018). It is with relation to these political ecologies that the coca plant promises precarious survival in chemical regimes of living (Murphy, 2008). The coca plant emerges as 'one kind of collaborative survival' for farmers, itself not without harms to humans and environments (Rincón-Ruiz and Kallis, 2013). This is adaptive harm reduction becoming-with environment. While precarious environments generate possibility and not only damage or loss, as Tsing's story of the matsutake mushroom serves to tell, precarity can be violating and terrible. Glyphosate's relation with coca is certainly 'not pretty' (Tsing, 2015: 95), with coca's cultivation affording a dangerous survival.

Conclusion

Glyphosate and the coca plant intra-act in assemblages which affect ecologies of health; an emergent ecology which is at once more-than human as well as more-than local in time and space. In the case of the chemical glyphosate at war with the coca plant, an ecological approach to harm reduction accentuates how people and plants, and livelihoods and land, entangle to make precarious environments liveable. By tracing the 'contaminated diversity' of the embodied effects of chemical war, not only in humans but also in technologies, policies and environments, we get to see how ecologies of health are made and how they might be made otherwise (Law, 2004; Van Dooren et al., 2016; Murphy, 2017). A more-than-human harm reduction positions health as an ecological concern to take the environment, at once biosocial and political, as its focus, and not only human centred change.

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