CATALYST
feminism, theory, technoscience

Troubling Figures: Endocrine Disruptors, Intersex Frogs, and the Logics of Environmental Science

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Abstract

This essay examines the figure of the pesticide-exposed intersex frog, a canary in the coal mine for public endocrinological health. Through feminist science studies and critical discourse analysis, I explore the fields that bring this figure into being (endocrinology, toxicology, and pest science) and the colonial and racial logics that shape these fields. In so doing, I attend to the multiple nonhuman actors shaping this figure, including the pesky weeds and insects who prompt pesticides' very existence, "male" frogs who function as test subjects, and systemic environmental racism that disproportionately exposes people of color to environmental toxicants. I encourage careful examination of galvanizing environmental figures like this toxic intersex frog and I offer a method to do so.

Introduction

"The second most commonly used pesticide [in the United States], atrazine,…led one of my frogs to develop a set of testes here, ovaries here, another testis, and more ovaries…which is NOT normal, even for amphibians," chuckles Dr. Tyrone Hayes while gesturing to the image of a frog's gonads in his 2010 TED Talk (Hayes & Chaffer, 2010; Figure 1). In his words, atrazine makes frogs "abnormal," "gender-bending," "homosexual," and therefore "unsuccessful at mating" (Hayes et al., 2002; Hayes et al., 2003; Hayes & Chaffer, 2010). Other environmental scientists have studied the concerning effects of toxicants on frogs. For instance,

O'Laughlin, Logan Natalie. (2020). Troubling figures: Endocrine disruptors, intersex frogs, and the logics of environmental science. *Catalyst: Feminism, Theory, Technoscience*, *6*(1), 1-28
http://www.catalystjournal.org | ISSN: 2380-3312
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David Skelly found that frog populations living in manicured suburban ponds have a high female-to-male sex ratio and higher rates of frogs who are intersex, both of which he has described as "creepy" and "bizarre" in interviews (Barringer, 2008; Skelly, Bolden, & Dion 2010; Zimmer, 2011). Hayes's creative performance style, which incorporates rhyme and comedy, has helped popularize inflammatory language about intersex frogs and make this toxic animal figure all the more compelling. In Hayes's and Skelly's work, frogs become a touchstone for broader anxieties about pesticide effects on sex and sexuality.

Figure 1. Slide representation of frog with hermaphroditic traits (Hayes & Chaffer, 2010).

It is no surprise that this environmental anxiety has been picked up by right-wing extremists such as Alex Jones (2017), who asserts that "the government is putting chemicals in the water turning the frogs gay!" and by comedian-journalist John Oliver (2017), who, in a 2017 episode of *Last Week Tonight*, projects an image of a pair of frogs on a lily pad with a rainbow flag. Pop science news sites riff of Skelly's frog research with titles such as "Your Lawn Is Giving Frogs a Sex Change" and "Frogs A-Courtin' Trouble on Tidy Lawns" (Knapton, 2015; Philpott, 2015). These examples highlight how anxiety about sex and sexuality is not only ubiquitous but directly informed by the figure of the pesticide-exposed frog.

Feminist and queer environmental scholars have contested this kind of language for its implicit slandering of being queer, trans, or intersex (Di Chiro, 2010; Kier, 2010; Sturgeon, 2010). Few have spent time deconstructing this figure and its colonial underpinnings, however. In this article, I examine the figure of the toxicant-exposed intersex frog, a figure which has been puzzling me for several years.[1] Through feminist science studies and critical discourse analysis, I explore the colonial and racial logics undergirding endocrinology, toxicology, and pest

science that bring this figure into being.

Responding to Queer Ecologies and Feminist New Materialisms

This essay brings together several fields that often speak past one another, including queer and feminist environmental studies, critical science studies, critical animal studies, and critical race studies. Queer ecocriticism and feminist environmentalisms have recently drawn attention to the role of heteronormativity and homophobia to popular conceptions of the environment, building upon a history of ecofeminist scholarship highlighting the gendered implications of environmental destruction. The amalgamation of fields sometimes referred to as "queer ecologies" has made important interventions, particularly in highlighting how Western myths of queerness as "unnatural" surface at moments of ecological crisis (Di Chiro, 2010; Mortimer-Sandilands, 2010; Sturgeon, 2010; Alaimo, 2016; Pollock, 2016). Contributors to queer ecologies have playfully framed endocrine-disrupting toxicants as opportunities to disrupt the social equation of binary sex and biological reproduction and/as indicators of wellbeing (Di Chiro, 2010; Pollock, 2016). Mel Chen (2012) and Vanessa Agard-Jones (2013) have helpfully tempered some of this excitement about environmental toxicants by highlighting the racialized and sexualized trajectories of environmental toxicants.

The related scholarship of queer and feminist ecological thought, feminist new materialism, and object-oriented feminisms has offered generative ways to think about environmental harm from the perspective of seemingly inanimate objects, such as rocks, plants, or environmental toxins and toxicants. However, the feminist new materialist turn, even when attentive to race, fails to think about the unique function of entities commonly understood as *animate* nonhumans under Western scientific paradigms (animals). I have been shaped by growing scholarship at the intersection of critical race theory and critical animal studies that attends to the ontological collusion of the human/animal divide with the dehumanization of people of color; using theories produced at this intersection in tandem with decolonial analytics, I explore how nonhuman animal figures are crucial mechanisms for the biopolitical functions of dominant scientific method, both dehumanizing humans racialized as non-white and obfuscating Indigenous onto-epistemologies (Wynter, 1994; Deckha, 2006; Murphy, 2007; Kimmerer, 2013; Weheliye, 2014; Kim, 2015; Ahuja, 2016; Ko & Ko, 2017). In reifying logics of science, the figure of the toxicant-exposed frog functions as a specific kind of immaterial animal capital. In using the phrase "animal capital," I invoke Nicole Shukin's (2009) eponymous analytic, which traces how nonhuman animals are

rendered into both symbolic and material capital. Animals can function as cultural stand-ins for nation-states as well as physical flesh commodities that feed human economies (Shukin, 2009). In this work, I examine how the scientific uptake of nonhuman animal figures as indicator species enacts a racially charged and sexualized affective symbolic power.

A map of the essay: To conduct a feminist science studies analysis of the figure of the pesticide-exposed intersex frog, I seek to understand it from multiple angles. To better peel the layers back of this palimpsestic test subject, its contradictions, and its effects, I interrogate the many actors that shape it: the pesky weeds and critters who prompt the production of pesticides, African clawed frogs who function as indicator species, endocrinological ontologies of sex, and systemic environmental racism that disproportionately exposes people of color to toxicants. I ask several questions to query the making of this figure: How do colonial pest sciences bring the toxic frog into being? What kinds of logics subtend the production of pesticides? And, on the other hand, how has this figure affected pesticide production? How have African clawed frogs come to function as an indicator species? Whence do endocrinological norms about intersex emerge?

To explore the first two questions, I provide an abridged review of disturbance ecology and pesticide history from key scholars in the field to reveal how the rise in pests was likely stimulated by European colonialism of North America. I trace how scientific development of pesticides codified understandings of species difference as a means of making "progress." By interrogating the colonial roots of pest science, I highlight how these logics devalue humans who are racialized as non-white and vilifies racially charged nonhuman plants.

I argue that we must use this historical context to understand the frog. In returning to this figure, I study why African clawed frogs are used as indicator species and conduct a close reading of a study by Hayes et al. (2010) to unpack how traditional endocrinological approaches frame intersex as both a pathology and a disability, conveniently ignoring the impossibility of binary sex. Noting this figure's entanglement with contemporary racial formations in the United States, I trace how Hayes explicitly constructs this frog as a rallying cry against environmental racism. The essay concludes where it begins by exploring how pests are framed as being contrary to progress in racially charged ways, focusing on one chemical company's rebuttal of the validity of the toxic frog figure. Along the way, I use *toxic* as an adjective to identify something exposed to toxicants as well as to indicate harmful discursive formations that emerge from encounters with toxicants.[2]

Through this winding and seemingly circular trajectory, I argue that toxic animal figures, such as the intersex frog, are shaped by harmful scientific logics about sex, gender, and race, and obfuscate histories of violence. I urge us, as feminist environmental scholars and activists, to recognize the complexity of these galvanizing environmental figures.

Reviewing Colonial Ecological Histories: (Un)making Agricultural Pests

To understand the figure of the toxic frog, we must trace how the ontologies and epistemologies of the past haunt the present moment.[3] Pesticides are not often described as colonial technologies in popular environmental discourses in the US. But a (de)colonial analysis of pesticide development is necessary to understand this figure and its effects; colonialism shapes dominant institutions of science and obfuscates Indigenous scientific epistemologies.

The work of disturbance ecologists is useful to understand the stakes of pesticides because the intersex frog figure is entangled with the looming specter of "invasive" pests. Recognizing the limitations of the environmental historical scholarship that often makes sweeping claims, I nonetheless query these histories. After all, these pesky critters have not been a constant and timeless feature of North America. The creation of pesticides likely facilitated the rise of pest animals and ironically co-produced their bodies and immaterial figures.

According to several disturbance ecology historians, European colonial settlement of North America likely stimulated the need for pest control (Williams, 1992; Taylor, Holley, & Kirk, 2007; McWilliams, 2008). Settler colonialism thrived by carrying plants, insects, animals, and viruses from Europe that helped ensure the success of white settlers against the Indigenous residents, a process that Alfred Crosby (2015) has described as "ecological imperialism" (Subramaniam, 2014).[4] Despite the trope of the pristine and untouched "New World" that circulated among colonial settlers, many tribes carefully cultivated and maintained forests. One prominent Indigenous scientific method used was controlled burning of plants and trees to foster biodiverse ecosystems, including moist forests, open oak forests, and grasslands (McWilliams, 2008; Stewart, 2009; Crane, 2014; Lake et al., 2017). For instance, a member of the Coquille Tribe explained that burning was a means of preventing the Douglas fir from "encroaching on the open prairies and crowd[ing] out the other timber" (Lucy Thompson qtd. in Wells, 2011). This practice was likely not recognized as the scientific method that it is today in large

part because colonial sciences operated in direct opposition to Indigenous onto-epistemologies of the natural world (Verran, 2008; Kimmerer, 2013). The eviction and genocide of Indigenous Peoples and the subordination of Indigenous sciences often coincided with and facilitated the overgrowth of forests. In other words, settler colonialism likely encouraged the proliferation of what many deem "pest" species, especially insects and plants that may grow along or in competition with food crops in these forests (McWilliams, 2008; Wells, 2011).

European settlers' apparent aversion to these overgrowing forests led to another kind of disruption for forest-dwelling nonhuman species of North America. Settlers' destruction of the woods killed many natural predators of insects and upset ecosystems on a large scale. For instance, thinning tree cover from previously lush woods in the seventeenth and eighteenth centuries made many winter freezes less severe (McWilliams, 2008). Many European settlers hypothesized that thinning out woods and clearing land for farming would reduce insect populations by decreasing the amount of moisture and foliage protection. However, the opposite likely occurred; the ground thawed faster during winter freezes, allowing insect larvae that would have previously died under the severe cold to survive and even thrive (Cronon, 2003; McWilliams, 2008; Steinberg, 2012). While deforestation led to the demise of many plants, it also encouraged the growth of plants that thrive under direct sunlight; these kinds of plants often have thicker leaves with denser nutrients and are thus especially appealing to insects (McWilliams, 2008).

It would be inaccurate to suggest that settler colonialism had a singularly detrimental effect on the nonhuman landscape, that Indigenous stewardship of the land was always oriented towards environmental longevity, or that competition among nonhuman species only existed after colonialism. However, colonial destruction of habitats has had marked effects on the land through encouraging the proliferation of densely nutritious plants. Pests and pesticides are thus always materially and discursively connected to colonialism. This material history is often obscured from the popular framing of pests as invaders. This obfuscation gives them more power as animal figures who maliciously foist themselves onto unsuspecting humans, rather than creatures whose existence has been co-produced by humans.

Despite the major influence that "American" settlement played in the proliferation of unwanted insect and plant populations in North America, pests have often been described as being un-American in their obstruction of US agricultural progress. Ontologically, the very categories of "pest" and "invasive

species" are founded in colonial logic, as others such as Banu Subramaniam (2014) have noted: one is described as a justified resident and the other as an intruder (Kim, 2015; Head, 2017). It is revealing that species marked as "invasive," "alien," or "non-native" do not match a specific biological taxonomy. On the contrary, these are loosely used signifiers that can span many unwanted species. This discourse demonstrates the arbitrariness of which colonial values are placed on nonhuman species. Many different kinds of "pests," such as mosquitos, moths, and beetles as well as plethora of "weed" plants, were seen as unpatriotic simply because they threatened the colonial agricultural economy in the US. For instance, the Hessian fly received its name during the American Revolution because it seemed to appear just after the arrival of Hessian troops, otherwise known as German soldiers hired by Britain (McWilliams, 2008). The Hessian fly continued to be a scourge on wheat, barley, and rye crops, and its name functioned as a reminder of its foreignness. Plants and insects thus became useful vessels and vectors of nationalist sentiment.

The labels "invasive" and "pest" are subjective and capacious. "Invasive," for example, indicates nothing about the comestible value of a plant. These labels demonstrate how abstract and arbitrary values become attached to plants. Many of the weeds ostensibly encroaching on food crops were and are nutritious to humans. Sometimes the invasive plants were even more nutrient dense than the crops they invaded, but their inferior sociocultural value justified their continued vilification. Other plants that were cultivated during the eighteenth century in US colonies as valuable crops—such as velvetleaf, a rich source of dietary fiber—are now deemed invasive. Velvetleaf is currently listed as invasive in forty-eight US states and "noxious" in four (Integrated Pest Management, 2015). Portrayal of pests as invasive is thus geographically and temporally specific. The ideological variation over time further emphasizes the socially constructed nature of the term *invasive*.

Growing anxieties about pests in the US in the mid-1800s became especially palpable through the concomitant development of biological sciences, including entomology (the study of insects), botany (the study of plants), and economic ornithology (the study of birds as key actors in pest management). These fields of study provided a rich opportunity for US settlers to codify colonial ontologies of nuisance species and to justify the need for pesticides (McWilliams, 2008). Under the rubric of objectivity, these life sciences articulated differences across plants and animals not only to understand but also better control them. In so doing, they attributed differential value to species by determining their potential usefulness and/or harm to human civilization. The biological sciences were helpful in

engraining white settler ideologies in popular farming cultures; cross-industry collaboration meant that farmers were soon taught how to identify species and subspecies of invasive insects and plants by their morphologies, assessed via observation of roots, leaves, and flowers, in order to apply the appropriate antidote to the "problem," though, at the time, the available pesticides were largely ineffective (McWilliams, 2008). Though the biological sciences operated under the scientific method to ensure accurate findings, there was infrequent interrogation of the logics of pests.

Since the US is a nation centered around monocropped corn, pesticides are helpful to its survival. This is the landscape from which the pesticide-exposed intersex frog figure emerges. With this history, we can appreciate how the frog is a figure of friction because it focuses on a different enemy: pesticides. Carrying this history forward, I will use the next section to demonstrate that the toxic intersex frog reveals important insights about normative and dehumanizing logics in endocrinology and environmental science.

Scientia Intersexualis: The Construction of "Creepy" Hermaphroditic Frogs

Frogs are culturally significant in the US, which makes them powerful as environmental soothsayers. They are often gregarious and lovable creatures in children's stories that anthropomorphize them, such as *The Princess and the Frog*, Kermit the Frog from *Sesame Street*, and *Frog and Toad*. Frogs are featured in backyard-science projects that invite children to approach and gently study how these amphibians diligently catch flies with their lightning-fast tongues. These frogs are what Skelly has described as the "Look Mom I found a frog!" frogs (qtd. in Barringer, 2008). In this capacity, frogs are valued as nonhuman teachers of how the natural world works. Reports of their declining populations and their sex "anomalies" thus evoke concern and dismay, as the international Save the Frogs! campaign demonstrates.

But frogs are not just an indicator species based on people's observation of them in the wild. Frogs are also captured, bred, studied, and euthanized as test subjects. The seeming contradiction of their simultaneous value and disposability complicates the toxic intersex frog figure. Frogs' cultural significance is in their longevity as a population rather than their sentience. African clawed frogs (*Xenopus laevis* or *X. laevis*, for short) in particular are subjected to scientific testing because they are perceived to be an invasive species. Their resilience in new habitats and their ability to crowd out competitors have prompted African

clawed frogs to be listed as illegal to own without a permit in many US states and sometimes even illegal to possess at all (California Department of Fish and Wildlife, n.d.; Matier & Ross, 2007). *X. laevis's* disposability as a species is what makes them logical test subjects in a utilitarian sense: extracting, breeding, confining, and studying them can help prevent environmental harm to other more valuable animals such as humans *and* can help regulate their populations.

X. laevis's famed history in one of the first pregnancy tests in the 1930s has also made them a common choice in endocrinological research (Kirksey, Hannah, Lotterman, & Moore, 2016). *X. laevis* frogs have been particularly useful in this field because they develop in ways similar to humans. They can live remarkably long lives, from fifteen to thirty years, and can thus be part of longitudinal studies. So, too, are *X. laevis* frogs easy to control because they spend a great deal of their lives underwater. African clawed frogs in the lab live very different lives from the tree frogs in people's backyards and public ponds in large part because of this cultural value.

Frogs who have been exposed to environmental toxicants become vectors for slandering rhetoric of non-normative sex organs. For instance, Hayes reports that exposure to low levels of atrazine led his male frogs to develop eggs in their testes, to develop multiple testes and ovaries, and to mount other males to copulate, a phenomenon he calls "chemical castration" (Hayes & Chaffer, 2010). As mentioned earlier, Skelly refers to frogs who develop hermaphroditic traits as "creepy" and "bizarre" in public news about his research (Skelly qtd. in Barringer, 2008; Zimmer, 2011). Though these value-laden descriptions of these frogs are inflammatory, they are not dismissed wholesale since they are based on consistent findings and otherwise sound science.[5]

The fact that these inflammatory descriptions evoke laughter, shares, and retweets suggests that they align with longstanding ideologies in contemporary US society that presume intersex is (1) an aberration of traditional anatomical development; (2) a sexual perversion (lacking an easily identifiable binary sex is an immediate failure to be a heterosexual subject, since heterosexuality presumes the existence of only two sexes); and (3) an immediate sign of infertility. This resistance to sex and sexual norms rears its head most commonly in fears about intersex as a sign of permanent sterility. It often manifests as a failure to recognize that fertility, sex, and sexuality exist on a spectrum across humans and nonhuman animals.

The figure of the endocrine-disrupted frog functions because it often collapses

several forms of alterity: intersex, infertility, and homosexuality. For instance, Hayes draws out the ongoing social discomfort with intersex by describing intersex frogs as "genetic males," implying an essential trait from which the frogs have veered, and who engage in sex with other males, both traits which he implies are associated to atrazine (Hayes & Chaffer, 2010; Hayes et al., 2010. Hayes positions intersex as sexually deviant when he projects an image of two frogs engaging in intercourse and says, "These are just two brothers consummating their relationship" (Chaffer & Hayes, 2010).

Environmental toxicologists ring the alarm on "genetic males" being "feminized" by pesticides, both morphologically and behaviorally. But the shock value of the toxicant-exposed frog only functions under the assumption that intersex is indeed a pathology. Despite intersex justice organizing as well as feminist science studies scholarship reminding the public that intersex is common, irrespective of the presence of endocrine-disrupting chemicals, this scientific literature emphasizes the novelty of these findings. For instance, Hayes et al. (2002) note, "these abnormalities [of intersex] were never observed in control animals in the current experiments or in over 10,000 observations of control animals in our laboratory over the last 6 years" (p. 5477). Missing from the public discussion of these studies, however, is the fact that many animals lack easily distinguishable sexes in the first place (Roughgarden, 2004; Avise, 2011).

The making of a male test subject: Closer analysis suggests that environmental scientific research, which posits intersex as a pathology, requires both a social and biological construction of binary sex in the first place. By analyzing the making of the intersex frog in the lab, we can witness the biopolitics of science through its binaristic articulation and regulation of sex. To delve into greater detail, I interrogate the scientific method of one such study, Hayes's and his colleagues' 2010 study, "Atrazine induces complete feminization and chemical castration in male African clawed frogs." In it, I examine how studying endocrinological effects of toxicants requires *creating* "true" males, which Hayes et al. (2010) explain in their "Supporting Information, Data & Methods" Appendix. I juxtapose it with the history of intersex violence against humans in order to evaluate the implications of articulating intersex as a nonhuman phenomenon resulting from and in toxicity.

Despite the dramatic, binary language of demasculinization castration, and feminization in both scientific literature and popular culture, African clawed frogs cannot be sexed on sight alone. Male and female African clawed frogs do have some differences on average: females are generally larger, males often have darker colored pads on their arms (nuptial pads), and females have slightly larger

bumps between their legs (cloacal labia). However, a frog that might have "male" characteristics cannot be presumed to be male. Biological sex in frogs is elusive and this is part of its rambunctious power.

Because Hayes's study uses "sex chromosomes" as the primary indicator of sex, I will first remain in this register to trace the differences between human and frog sex chromosomes (and what they reveal) and will then critique the sex-chromosome model used in this project (a multispecies logic). Humans, unlike frogs, can have any permutation of X and Y chromosomes, having a single or multiple X chromosomes, which are quite large, and Y chromosomes, which are small. The presence of a single Y chromosome in humans usually marks that human as "male," even though many XY humans develop as phenotypically as female. (Humans cannot survive without an X chromosome, as it carries the bulk of genetic information necessary for life.) The Y chromosome is often described as "dominant" in humans because it carries the SRY gene, which activates the shift in development of ovaries to the development of testes. There are many permutations of X and Y chromosomes, each with different possible physical expressions (phenotypes). Researchers can look at the number and size of human chromosomes (karyotype) by breaking apart a single cell to examine the genetic material therein, assembling each of the chromosomes as pairs, and displaying it as an image called a karyogram (Figure 2).

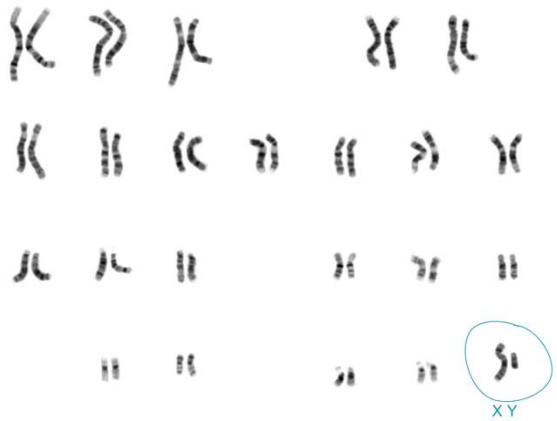

Figure 2. Karyogram of human chromosomes. Image adapted by author from Wiki Commons.

Frogs' chromosomes differ dramatically from humans', and African clawed frogs' chromosomes are particularly unique. Frog chromosomes have been named different letters to help distinguish them from the human X and Y chromosomes: W (female) and Z (male). Unlike humans' chromosomes, which are commonly described as male-dominant, African clawed frog chromosomes are "female-

dominant," meaning the existence of a single W chromosome triggers a development cascade for the growth of ovaries. Thus, ZW is intended to denote a female African clawed frog and ZZ a male. Unlike the large X chromosome and the small Y chromosome, which are easily viewable on a human karyogram, the sex chromosomes of this frog cannot be morphologically distinguished on a karyogram (Figures 3 and 4). In other words, you cannot visually distinguish ZZ and ZW frogs by examining a karyotype because both Z and W chromosomes usually look the same in size and shape.

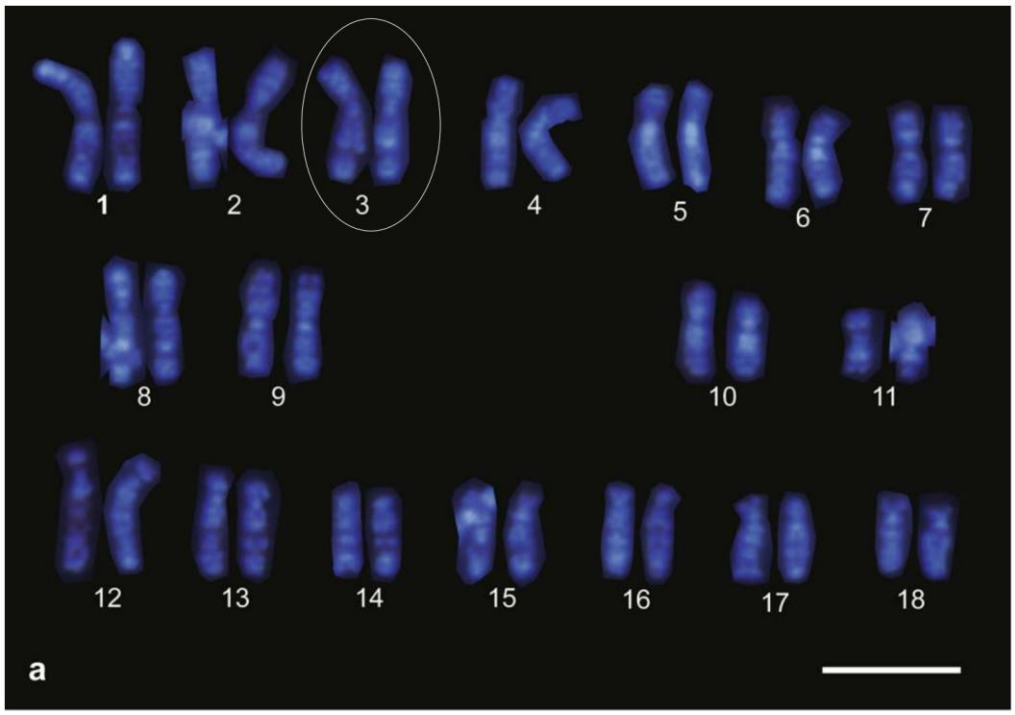

Figure 3. Karyogram modified to emphasize the sex chromosomes of a Xenopus laevis ZW female, identical in size (Uno et al., 2008).

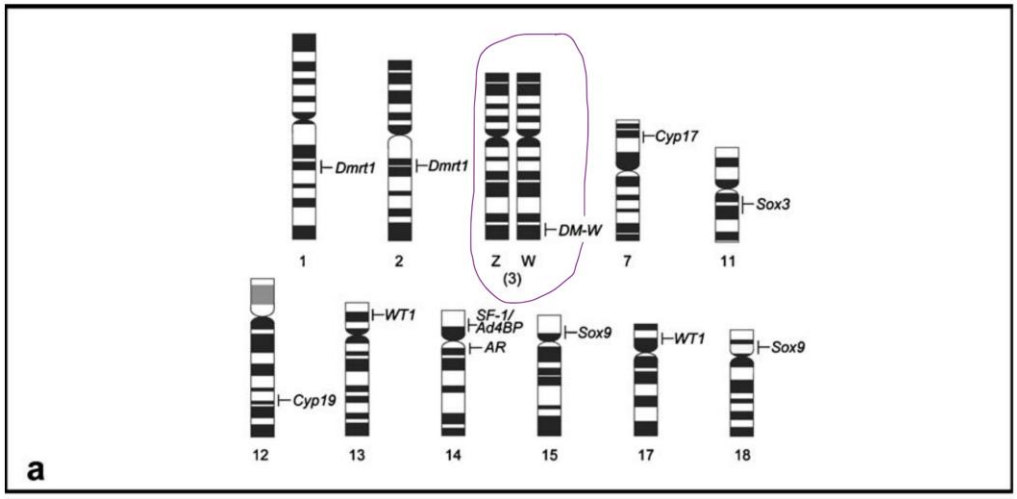

Figure 4. Ideogram of a X. laevis ZW female to demonstrate identical alleles on the sex chromosomes (adapted from Uno et al., 2008).

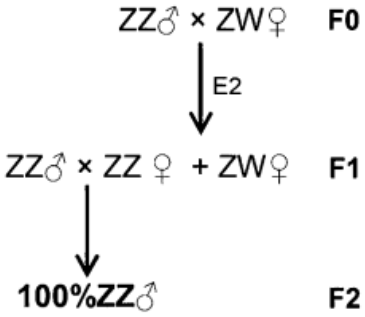

Figure 5. Rearing process for the ZZ colony prior to experiment conducted by Roger Liu (Hayes et al., 2010). Note: E2 refers to estradiol exposure used to convert the frog population to female-appearing frogs, both ZW females and ZZ "sex-reversed" genetic males. F0, F1, and F2 refer to the multiple breeding phrases necessary.

Given the phenotypic similarities across amphibian sexes, and because phenotypic differences are not reliable indicators of genetic sex, it was not possible for Hayes's team to put together a sample of genetically male (ZZ) frogs through visual sorting. Hayes and his team had to construct such a group by creating "sex-reversed" wild frogs, as they called it (Hayes et al. 2010 p. 4614). This tedious process was delegated to a research assistant and only discussed in the appendix (Hayes et al., 2010; see Figure 5). The genetically male frog population (ZZ) was developed in the following manner: first, the researchers captured a sample of wild *X. laevis* frogs, which presumably contained a mix of male and female (ZZ and ZW) frogs, and exposed them to estradiol in order to stimulate the production of female traits in the developing frogs. These frogs were still both male and female genetically, even though they all had female characteristics. The second phase (F1 in Figure 5) entailed breeding these now

phenotypically female frogs (both ZZ and ZW) with male-appearing wild frogs (presumed ZZ but not confirmed for the aforementioned reasons). After this breeding cycle, Hayes identified the lab-altered phenotypically female frogs (again both ZZ and ZW) who produced only male-appearing offspring (when mated with the wild ZZ but possibly also ZW frogs), since these must have been ZZ "sex-reversed" genetic males. (Estradiol-exposed ZZ frogs who bred with wild ZZ males would always result in ZZ offspring; whereas ZW frogs who bred with ZZ frogs would be expected to produce a mix of ZZ and ZW offspring.) The lab-altered ZZ frogs identified through this step (albeit exposed to estradiol at this point and thus phenotypically female) were then bred with already confirmed ZZ frogs from a former study to produce the F2 generation of ZZ male frogs. The offspring of this second and somewhat queer phase of breeding were ultimately the sample population that Hayes and his colleagues used in his study of atrazine (Hayes et al. 2010).

This method is revealing: researchers studying the "feminizing" effects of hormones have to do extensive work to create a test group of confirmed males before even starting their experiments. Hayes' et al. acknowledge the importance of their study in acknowledging "the possibility of natural variation in sex differentiation processes between species and even between populations (or strains) within a species" (2010, p. 4614). Their controlling for variations of sex is far more rigorous than studies of other species, such as humans who have more easily observable chromosomal differences.[6] Yet frogs are still somehow deemed a good indicator species for predicting human health.

It is revealing that the "natural" genetic males who haven't yet been affected by endocrine disruption are not actually naturally occurring in the sense that genetic males cannot be identified outside of the laboratory; the frogs used in Hayes's research have been bred twice under human supervision before ever arriving at the state of a confirmed "genetic male," waiting to be possibly feminized by atrazine. The optics of pop science frame atrazine as causing same-sex mating, yet it is crucial to remember that Hayes has already been mating "genetic males" together to develop his F2 generation.

Moreover, it is worth noting that the model of using sex chromosome as a measure of sex is risky in and of itself. Intersex activists and feminist scholars have critiqued the language of Y-chromosome dominance for its assumptions (Y chromosomes are "dominant" and "active" and X chromosomes are "passive"). As Vernon Rosario (2009) has asserted, "rapid advances in the genetics of sex determination have completely trashed the 1950s notion that the human Y

chromosome alone determines male sex" (p. 274). The discovery of sex-determining genes on non-sex chromosomes in particular have challenged the myths of only X and Y chromosomes determining sex, as well as Y-chromosome dominance (Rosario, 2009). Intersex scholars have urged endocrinologists and geneticists to nuance their conception of sex, for instance, calling for a "shift [in molecular genetics] from binary sex to quantum sex, with a dozen or more genes each conferring a small percentage likelihood of male or female sex that is still further dependent on micro- and macro-environmental interactions" (Rosario, 2009, p. 279). The fact that Z and W sex chromosomes are treated as the indicator of biological sex in frogs (who are female dominant) reifies the antiquated logic of sex chromosomes in humans. Certainly, it is easier to rely on a single variable to determine sex, and analyzing a full profile of the chromosomes (both traditionally marked as sex chromosomes and not) would be an extensive study. But ruminating upon the failures of the sex-chromosome model are crucial.

Analyzing frogs' chromosomal differences compared to humans' may have highlighted that frogs are not a good indicator species for humans in the first place. So, too, could it pose important questions for humans about the stability of sex across species, à la Anne Fausto-Sterling (2000). The figure of the atrazine-exposed intersex frog, thus, is created through an omission of how frogs' sexes exist in the first place and reifies a myth that sex chromosomes are the identifier of sex.

Toxic frog rhetoric and/as pathologizing human intersex: In obscuring that wild *X. laevis* frogs cannot technically be test subjects for this study yet because their sex is unknown, Hayes contributes to a broader scientific and cultural practice of othering intersex as a sex/ual pathology and a disability of reproductive capacity. Endocrinological studies rely on the construction of a control group against which to compare the rates of "abnormality," whether existing in controlled exposure to chemicals in the lab (such as in the work of Hayes) or in that of observing rates of naturally occurring intersex depending on proximity to households (as in the work of Skelly.) The implications of these complex discourses are significant, as many intersex activists and scholars have emphasized.

By assuming that non-normative sex is a specifically toxic phenomenon that might someday affect humans, these figures enact discursive sex/ual violence. Contrary to popular belief, intersex precedes the advent of synthetic pesticides, substantiated by the archives of intersex activism, and thus cannot be characterized as a quintessentially new phenomenon. Failing to mention current and historical intersex humans is awkward (and not in a particularly generative

way). Since Hayes positions humans that are intersex as a forthcoming anomaly, they should theoretically not exist. These panics ignore the existence of past and present intersex people by placing them temporally out of sync.

Failing to describe intersex as an extant human trait follows the historical rhetoric that has objectified and dehumanized people with intersex traits as somehow animal. In particular, this ontology echoes thirteen-century European literary descriptions of intersex and hermaphroditism, where it was thought that what distinguishes a human from an animal is the possession of an easily distinguishable sex (DeVun, 2014). Certainly Hayes does make allusions to human intersex but only as evidence of the presumed recent effects of endocrine-disrupting chemicals. For instance, Hayes juxtaposes pictures of his dissected intersex frogs with different images of disembodied human genitals that do not neatly fit the category of male. He shows these images to emphasize that what frogs are experiencing may indeed be foreshadowing what could happen to humans. Intersex thus continues to live at the edge of the human and nonhuman, through bringing certain humans into the fold of the sub- or nonhuman (DeVun, 2014). Though Hayes's pathologization of intersex frogs never mentions historical ontologies of intersex, he uses the same frames when he describes intersex as never fully human.

According to many intersex activists and scholars, asserting that sex is naturally binary is not only inaccurate but is also violent (Fausto-Sterling, 2000; Karkazis, 2008; Creighton, Greenberg, Roen, & Volcano, 2009). The rhetoric of binary sex not only ignores the ubiquity of intersex traits among humans and nonhumans but has pronounced material effects. For instance, medicalization of intersex has justified the nonconsensual medical surveillance of infants, children, and adults with non-normative sex morphologies (Karkazis, 2008). Infants born with genitals that are not easily identifiable as male or female have historically undergone surgeries to "correct" their bodies without adequate informed consent, often even to the parents. Unwanted surgeries create long-term health issues for many intersex people, including discomfort when urinating or having sex (Fausto-Sterling, 2000; Dreger & Herndon, 2009). Anxieties about intersex children in the 1950s and the toll they might take on society at large ushered in the era of John Money's "Optimum of Gender Rearing Model," which strictly policed intersex children to present and behave exclusively as either a boy or girl with heterosexual desires and punished any who failed to do so (Money, Hampson, & Hampson, 1955; Dreger & Herndon, 2009). The pathologization of intersex continues to be haunted by the vestiges of Money's widely-used model, even if it has largely fallen out of favor.

Ableist language describing toxicant-exposed frogs has important implications for intersex politics for human. For instance, Hayes describes his intersex frogs as "impaired," "retarded," and "messed up inside" (Hayes & Chaffer, 2010). This language flies in the face of recent and ongoing debates in the intersex justice movement surrounding the recent medical nomenclature shift from "intersex" to "disorders of sex development" (DSD). Though some had hoped this would improve the lives of people with intersex traits, many activists felt that "DSD" marked an assimilation of intersex justice work to fit the needs of a mainstream audience of non-intersex physicians and a broader public. Intersex activist-scholar Georgiann Davis (2015) herself believes that the "renaming of intersex as a disorder of sex development allowed medical professionals to reclaim their authority and jurisdiction over intersex" (p. 57). While the discursive histories and implications are, indeed, different, Hayes's pathologization of intersex in nonhuman animals does recenter his authority and jurisdiction over nonhuman animals. More broadly, environmental toxicology research on endocrine disruptors undermines the lively destigmatization campaigns of intersex activists.

Constructing "Darnell," the African American frog: The toxic frog has significant and lasting effects in the way it is constructed as intersex. To fully understand it, though, it must simultaneously be understood from a critical race analysis. After all, one of the key wielders of the toxic intersex frog figure, Tyrone Hayes, uses his frogs as a rallying cry against environmental racism.

Some context about Hayes is necessary to understand how he constructs this figure. In discussing his findings, Hayes often centers his experiences as a Black scholar. The tenured Berkeley professor tells his students, lecture attendees, and interviewers that he grew up in the segregated US South and faced ongoing, systemic racism to reach his current position (Hayes & Chaffer, 2010; Slater, 2012; Mock, 2015). In interviews, Hayes has said that he feels privileged having gone to go to Harvard on scholarship and thus feels obligated to tell people the truth about the effects of chemicals on their communities (Slater, 2012). He speaks frankly about how systems of poverty and regulatory academic norms often prevent scholars of color from attaining tenured research positions. Hayes connects this structural inequality in the field to his own research by explicitly critiquing environmental racism and the corporate greed at the core of contemporary pesticide production. He does so even in the face of vociferous slander campaigns from the behemoth pesticide producer Syngenta (Nadel, 2010; Slater, 2012; Democracy Now!, 2014; Beroset, 2016). Hayes used to do research for the chemical company but severed ties when they asked him not to publish his

findings. By depicting Hayes as unprofessional, unhinged, and possibly threatening in online forums and through hired op-eds and planted audience members at his lectures, the company has tried to discredit Hayes (Nadel, 2010; Slater, 2012; Democracy Now!, 2014; Beroset, 2016).

Hayes projects his own racial identity onto his African clawed frogs, playing on the link between his own African Americanness and the African origin of the species. Hayes joked in a lecture in December 2017 that these are technically African American frogs since he often collects them as discarded test subjects from other labs in San Diego (Hayes, 2017).[7] He sometimes describes atrazine as affecting a single frog, who he affectionately calls Darnell. "The big news this year," Hayes says, "will be Darnell (*Xenopus laevis)* and his atrazine-treated brothers and sisters…brothers with severely impaired fertility and sisters (genetic males) who lay eggs" (Hayes in Nadel, 2010).

Hayes has also said he is reclaiming the power of his traditionally Black name, Tyrone, in a largely white-dominated field. He teased a chemical industry employee who referred to him as "black and quite articulate" by adding an abbreviation of "articulate black man" to his email signature: "Tyrone Hayes, PhD ABM" (Aviv, 2014).[8] Naming his frog Darnell, a Black name in contemporary US culture, is thus a related move. Naming the frogs as a singular Darnell connects them to the frogs that he studied in his backyard when he was growing up, and even taking photos with one of his amphibian subjects conveys Hayes's complex relationship to *X. laevis* frogs (Aviv, 2014). Hayes's social construction of his intersex frog as African American is intended to be disruptive from its inception.

The strategic construction of the African American frog allows Hayes to allude to the racialized effects of pesticides, even though he doesn't talk about the effects of atrazine on Black people specifically. Citing US Department of Agriculture data that the majority of US farmworkers are Latinx, Hayes notes that "they have levels of atrazine in their urine that are 24,000 times what we use in our laboratory" (Hayes & Chaffer, 2010). In his public lectures, Hayes often notes that people of color across the globe are more likely to experience atrazine-exposed infertility or reduced sperm count. The toxic animal figure of Darnell thus acts as a powerful reminder of the environmental racism that pesticides enact (Hayes & Chaffer, 2010). Hayes implicitly suggests that we critically examine why certain crops are deemed more valuable than the reproductive health of the workers applying the pesticides to them, many of whom reside in his own home state of California.

In this context, Hayes positions Darnell as a rallying cry of environmental reproductive justice, though he does not explicitly use this language. The environmental risks of agricultural labor have long shown effects on fertility and reproduction, and here Hayes contributes to growing attention to this issue. For instance, in the 1970s and '80s, many of the majority male Latinx workers overseeing the production of the pesticide Nemagon in California discovered they were infertile. The same was true of Nicaraguan banana workers who applied the same chemical to crops well after the discovered effects in California. Many became sterile or had children with health complications (Bohme, 2014). There was also documented evidence that the employing companies—DOW Chemical, Dole Food Companies, United Fruit, and Chiquita—had been aware of the serious health risks of pesticide use and nonetheless allowed workers to be exposed (Bohme, 2014). This collateral damage has been profitable to pesticide producers, albeit less so when they are successfully sued by affected workers (see *Tellez v. Dole*, for instance).

Hayes uses Darnell to remind us that pesticides have disproportionate effects on communities of color who are more likely to be exposed through their place of residence (near agricultural facilities) or as an occupational hazard (spraying pesticides on crops, for example). The anxieties he wields about fertility, though relying on misconceptions about intersex, are grounded in fraught politics of environmental reproductive violence in North America. Hayes has expressed gratefulness that his work has reached "minorities who would never have had access to this information" because he recognizes the barriers and paywalls the public has to accessing scientific research (qtd. in Slater, 2012). He believes his unconventional presentation style and using inflammatory language "to piss off the chemical companies" is central to this success (Slater, 2012; Democracy Now!, 2014).

Hayes's construction of race in this incendiary nonhuman figure further demonstrates how scientific norms shape these galvanizing environmental figures. These figures are shaped not only by normative logics about binary sex, but also by the racially charged norms of knowledge production and the disproportionate exposure of toxicants to marginalized communities. These galvanizing animal figures, thus, require careful and nuanced analysis.

Syngenta's Resistance Fighter Campaign: Reifying a Familiar Pest Figure

"Frogs are doing quite fine in Kansas," said the head of the Kansas Corn Growers and Kansas Grain Sorghum Producers Associations, a major proponent of Syngenta's pesticides and herbicides. "Anecdotally, I'd say they must not have read Dr. Hayes' studies" (qtd. in Slater, 2012). After failing to slow Hayes's research, Syngenta rerouted the conversation *away* from Darnell, as is evidenced by the fact that there is no mention of frogs on the company's website. This is common practice in public relations, as spending time debunking claims might inadvertently add credence to them. Instead, Syngenta seems to have put its energy into attempting to construct a different galvanizing figure: pests. Analyzing one of their advertising campaigns can demonstrate the effects of Darnell and trace the colonial scientific logics of pesticides discussed at the start of this paper.

Figure 6. Syngenta, Resistance Fighter home page, 2017.

Syngenta's Resistance Fighter campaign, once housed at the aptly named web domain resistancefighter.com, reveals the company's broader strategy in countering the figure of Darnell (Figure 6). In this campaign, US farmers work are encouraged to work with Syngenta to fight against weeds that are not killed by the common pesticide glyphosate. One advertisement pitches the campaign succinctly: "Resistance is a problem. Be part of the solution. Become a resistance fighter" (Syngenta, 2017). In this campaign, Syngenta (2017) raises awareness about regional-, state-, and crop-specific invasive species and provides the ammunition to fight "the enemy," wherever in the US a farmer might be. To encourage public participation, Syngenta chooses annual Resistance Fighter leaders for each major region of the US to be model farmers and mentors for other farmers in the area. The Resistance Fighter campaign posts training videos on its website and maintains a strong Twitter presence via the hashtags #toughweeds or #resistancefighter. Syngenta (2019) continues its long history of

recruiting farmers to use their products, which have been developed in "collaborat[ion] with university experts," and reinforce the idea that chemical pesticides are necessary. It frames an invasive species as "the enemy" to reify xenophobic logic, constructing certain beings as worthy insiders and others as intruders, eerily similar to the environmental nationalism that historians noted in the eighteenth and nineteenth centuries in the US.

This seemingly run-of-the-mill marketing campaign reveals the long history of racial violence in the production of pesticides. The rallying logo is a stark yellow fist emerging out of a rocky ground paired with the phrase "Resistance Fighter." At first glance, this might look like a call for political resistance solidarity. On the contrary, Syngenta uses the power fist to depict the rambunctious weeds who refuse to be squelched. Though the clenched power fist has been used across social movements from socialist uprisings in Mexico in the early 1900s to various second- and third-wave feminists to the Black Panther Party, the specific clip-art style fist with a thick outline most resembles the power fist used by the Black Panther party. recently taken up in the Black Lives Matter campaign in the US. Syngenta's appropriation of this fist to symbolize that corn treated with its products will prevail, and therefore result in economic gain, obscures the colonial, racist roots of pesticide development.

As evident in Syngenta's simultaneous efforts to first debunk the power of Darnell as "bad science" and later to silence Hayes, being a good Resistance Fighter means fighting resistance from environmental activists who might use the very power fist that Syngenta appropriates. The racial politics here are no coincidence. Hayes's activist-scholarship in African American Vernacular English, his formulation of Darnell as an African American frog, and the company's obfuscation of environmental racism work in tandem. Syngenta's white-washing of its power fist ignores racism as an issue here, whereas Hayes points out that environmental racism is endemic to pest science and endocrinology alike.

Figuring Environmental Futures

Exploring the well-traveled figure of the toxicant-exposed intersex frog has important implications. Deconstructing the different elements that comprise it—pesticides and their historical ontologies, endocrinological norms on creating clearly sexed subjects, racialized environmental violence, and inflammatory advertisement campaigns by chemical producers—provides a helpful opportunity to understand and rethink how we conceptualize environmental health.
Hayes has begun to question his own "freaky" frog figure, Darnell. In a 2017

lecture hosted by the UCLA Center for Women, Hayes notes that the language of binary sex is alienating to people who should be involved in the conversation: "Words like *top* and *bottom* [to describe frogs' coitus], *male* and *female*, can be isolating to individuals that we really need to be our allies outside of the scientific community. I think we can all learn a lesson and…get rid of our binary thinking about what sex means so that we can really be more effective at spreading this [information about pesticides]."

As feminist and queer anti-racist scholars and activists, it behooves us to further recognize the entanglement of sex/uality, dis/ability, race, and species in environmental panics. Doing so through analyzing toxic animal figures like Darnell is one important avenue. These widely circulating figures of environmental harm usher in colonial and normative logics. Querying the disciplinary onto-epistemologies of these figures and the histories they obscure can foster more ethical modes of being in and of the world.

Acknowledgements

This project was supported by a Postdoctoral Fellowship in Feminist Environmental Studies at Duke University. Thank you to Priti Ramamurthy, Amanda Swarr, María Elena García, Louisa Mackenzie, Kathryn Gillespie, and Anna Luisa Patiño West for your invaluable input. I am also grateful for the detailed and generative suggestions from Rachel Lee and Joanne Muzak at *Catalyst* as well as from two anonymous reviewers.

Notes

[1] In this essay, I focus primarily on intersex rather than a more explicit transgender and/or queer analysis. This is intentional. I have examined the blurring of queer and trans in endocrine disruptor discourses elsewhere (2016) and there has been rich scholarship at this intersection by Bailey Kier (2010), Giovanna di Chiro (2010), and Cleo Woelfle-Erskine and July Cole (2015). As a non-intersex transgender person who has watched as intersex debates are casually folded into queer and trans studies, I take time in this essay to examine the specificity of intersex as a unique regulatory formation.

[2] Here I am informed by Max Liboiron, Manuel Tironi, and Nerea Calvillo's "Toxic Politics" (2018).

[3] Here I nod to Avery Gordon's framework of hauntology (2008) and I channel María Elena García's conceptualization of "multispecies hauntings" (2015, p. 161). While I argue for tracing the legacies of historical violence, I do not intend to

suggest that colonialism and xenophobia exist in the past; they are well and alive.

[4] I refer to settler colonialism here as the material invasion of North America by Europeans during the sixteenth through eighteenth centuries, as exploration, colonization, and settlement. I recognize there are far more modes of settlement that have occurred and continue to occur on the continent.

[5] Chemical castration is a value-laden phrase often associated with the punishment of sex offenders and male prisoners. Using chemical castration to discuss potential effects on human fertility thus alludes to the involuntary and coercive aspect of this "castration."

[6] "Observable" here refers to the chromosomes examined via karyotype, not phenotypical traits.

[7] Hayes describes the African clawed frog as the "lab rat of amphibians" because they were useful as a human pregnancy test given their hormonal similarities with humans.

[8] Former US President Barack Obama remarked on the racialized politics of being described as an articulate black man (Mills, 2007).

References

Agard-Jones, V. (2013). *Sovereign intimacies: Scaling sexual politics in Martinique* (Unpublished doctoral dissertation). New York University, New York, NY.

Ahuja, N. (2016). *Bioinsecurities: Disease interventions, empire, and the government of species*. Durham, NC: Duke University Press.

Alaimo, S. (2016). *Exposed: Environmental politics and pleasures in posthuman times*. Minneapolis, MN: University of Minnesota Press.

Avise, J. (2011). *Hermaphroditism: A primer on the biology, ecology, and evolution of dual sexuality*. New York, NY: Columbia University Press.

Aviv, R. (2014, February 10). A valuable reputation: After Tyrone Hayes said that a chemical was harmful, its maker pursued him. *The New Yorker*. Retrieved from http://www.nwyorker.com/magazine/2014/02/10/a-valuable-reputation

Barringer, F. (2008, April 8). Hermaphrodite frogs found in suburban ponds. *The New York Times*. Retrieved from https://www.nytimes.com/2008/04/08/science/08frog.html

Beroset, F. (2016, November 15). A message they didn't want to hear: Researcher Tyrone Hayes recounts ongoing battle with agribusiness company Syngenta. *The Chronicle* [Duke University]. Retrieved from http://www.dukechronicle.com/article/2016/11/protecting-frogs-rights-researcher-tyrone-hayes-recounts-ongoing-battle-with-pharmaceutical-company-syngenta

Bohme, S. (2014). *Toxic injustice: A transnational history of exposure and struggle*. Berkeley, CA: University of California Press.

California Department of Fish and Wildlife. (n.d.). *California's invaders: African clawed frog*. Retrieved from https://www.wildlife.ca.gov/Conservation/Invasives/Species/Clawed-Frog

Chen, M. Y. (2012). *Animacies: Biopolitics, racial mattering, and queer affect*. Durham, NC: Duke University Press.

Crane, J. (2014). *The environment in American history: Nature and the formation of the United States*. New York, NY: Routledge.

Creighton, S. M., Greenberg, J.A., Roen, K., & Volcano, D. L. (2009). Intersex practice, theory, and activism: A roundtable discussion. *GLQ: A Journal of Lesbian and Gay Studies, 15*(2): 249-260.

Cronon, W. (2003). *Changes in the land: Indians, colonists, and the ecology of New England.* New York, NY: Hill and Wang.

Crosby, A. W. (2015). *Ecological imperialism: The biological expansion of Europe, 900–1900*. New York, NY: Cambridge University Press.

Davis, G. (2015). *Contesting intersex: The dubious diagnosis*. New York, NY: NYU Press.

Deckha, M. (2006). The salience of species difference for feminist theory. *Hastings Women's Law Journal, 1,* 17-30.

Democracy Now! (2014, February 2). Silencing the scientist: Tyrone Hayes on being targeted by herbicide firm Syngenta [Video file]. Retrieved from https://www.youtube.com/watch?v=mP-6Gp5RbjQ

Devun, L. (2014). Animal appetites. *GLQ: A Journal of Lesbian and Gay Studies, 20*(4), 461-490.

Di Chiro, G. (2010). Polluted politics? Confronting toxic discourse, sex panic, and eco-normativity. In C. Mortimer-Sandilands & B. Erickson (Eds.), *Queer ecologies: Sex, nature, politics, desire* (pp. 199-230). Bloomington, IN: Indiana University Press.

Dreger, A. D., & Herndon, A. M. (2009). Progress and politics in the intersex rights movement: Feminist theory in action. *GLQ: A Journal of Lesbian and Gay Studies, 15*(2), 199-224.

Fausto-Sterling, A. (2000). *Sexing the body: Gender politics and the construction of sexuality.* New York, NY: Basic Books.

García, M. E. (2015). Love, death, food, and other ghost stories: Hauntings of intimacy and violence in contemporary Peru. In K. Gillespie, & P. Lopez (Eds.), *Economies of death: Economic logics of killable life and grievable death* (pp. 160-178). New York, NY: Routledge.

Gordon, A. (2008). *Ghostly matters: Haunting and the sociological imagination*. Minneapolis, MN: University of Minnesota Press.

Hayes, T. (2016, November 22). To be hone$t: When scientific integrity and corporate interests clash. *Duke University Crown Lecture in Ethics* [Video file]. Retrieved from https://www.youtube.com/watch?v=GyFzsORl5r8.

Hayes, T. (2017, June 5). From silent spring to silent night: A tale of toads and men. Lecture presented at David and Goliath panel, *Chemical entanglements: A symposium on gender and exposure.* University of California, Los Angeles, CA. Retrieved from https://www.youtube.com/watch?v=UrzEL7P3710

Hayes, T. (2017, December 4). From silent spring to silent night: A tale of toads and men. Lecture presented at Trinity University's Distinguished Scientists Lecture Series. Trinity University, San Antonio, TX. Retrieved from https://www.youtube.com/watch?v=sLOKA5JE0jk&t=1814s

Hayes, T., & Chaffer, P. J. (2010). The toxic baby. *TED Talks* [Video file]. Retrieved from http://www.ted.com/talks/tyrone_hayes_penelope_jagessar_chaffer_the_toxic_baby?language=en

Hayes, T. B., Collins, A., Lee, M., Mendoza, M., Noriega, N., Stuart, A. A., & Vonk, A. (2002). Hermaphroditic, demasculinized frogs after exposure to the herbicide atrazine at low ecologically relevant doses. *Proceedings of the National Academy of Sciences, 99*(8), 5476-5480.

Hayes, T., Haston, K., Tsui, M., Hoang, A., Haeffele, C., & Vonk, A. (2003). Atrazine-exposed hermaphroditism at 0.1 ppb in American Leopard Frogs. (Rana Pipiens): Laboratory and field evidence. *Environmental Health Perspectives, 111*(4), 568-575.

Hayes, T. B., Khoury, V., Narayan, A., Nazir, M., Park, A., Brown, T., ... Gallipeau, S. (2010). Atrazine induces complete feminization and chemical castration in male African clawed frogs (Xenopus laevis). *Proceedings of the National Academy of Sciences of the United States of America*, *107*(10), 4612-4617. doi:10.1073/pnas.0909519107

Head, L. (2017). The social dimensions of invasive plants. *Nature Plants, 3*(6), 1-7.

Integrated Pest Management, University of Missouri. (2015, May 28). *Weed of the month: Velvetleaf.* Retrieved from https://ipm.missouri.edu/IPCM/2015/5/Weed-of-the-Month-Velvetleaf/

Jones, A. (2017, February 18). *Turning the freaking frogs gay* [Video file]. https://www.youtube.com/watch?v=_ePLkAm8i2s

Karkazis, K. (2008). *Fixing sex: Intersex, medical authority, and lived experience*. Durham, NC: Duke University Press.

Kier, B. (2010). Interdependent ecological transsex: Notes on re/production, "transgender fish," and the management of populations, species and resources. *Women & Performance: A Journal of Feminist Theory, 20*(3), 299-319.

Kim, C. J. (2015). *Dangerous crossings: Race, species, and nature in a multicultural age.* New York, NY: Cambridge University Press.

Kimmerer, R. W. (2013). *Braiding sweetgrass: Indigenous wisdom, scientific knowledge, and the teachings of plants*. Minneapolis, MN: Milkweed Editions.

Kirksey, E., Hannah, D., Lotterman, C., & Moore, L. J. (2016). The xenopus pregnancy test: A performative experiment. *Environmental Humanities, 8*(1), 37-56.

Knapton, S. (2015, September 8). Frogs a-courtin' trouble on tidy lawns. *Telegraph*. Retrieved from https://www.telegraph.co.uk/news/health/news/11850084/Frogs-a-courtin-trouble-on-tidy-lawns.html

Ko, A., & Ko, S. (2017). *Aphro-ism: Essays on pop culture, feminism, and black veganism from two sisters*. New York, NY: Lantern Books.

Lake, F. K., Wright, V., Morgan, P., McFadzen, M., McWethy, D., & Stevens-Rumann, C. (2017). Returning fire to the land: Celebrating traditional knowledge and fire. *Journal of Forestry, 115*(5), 343-353.

Liboiron, M., Tironi, M., & Calvillo, N. (2018). Toxic politics: Acting polluted in a permanently polluted world. *Social Studies of Science, 48*(3), 331-349.

Matier, P., & Ross, A. (2007, March 12). The killer frogs of lily pond: San Francisco poised to checkmate amphibious african predators of Golden Gate Park. *SFGate.* Retrieved from https://www.sfgate.com/bayarea/matier-ross/article/THE-KILLER-FROGS-OF-LILY-POND-San-Francisco-2610411.php

McWilliams, J. E. (2008). *American pests: The losing war on insects from colonial times to DDT*. New York, NY: Columbia University Press.

Mills, D. (2007, January 29). Obama the "articulate." *Huffpost*. Retrieved from https://www.huffpost.com/entry/obama-the-articulate_b_39919

Mock, B. (2015, January 27). How a black kid who grew up in the segregated south

became a barefisted biologist. *Grist.* Retrieved from http://grist.org/climate-energy/tyrone-hayes-amazon-new-yorker-hannibal-buress/

Money, J., Hampson, J.G., & Hampson, J.L. (1955). Hermaphroditism: Recommendations concerning assignment of sex, change of sex and psychologic management. *Bulletin Johns Hopkins Hospital, 97*(4):284-300.

Mortimer-Sandilands, C., & Erickson, B. (Eds.). (2010). *Queer ecologies: Sex, nature, politics, desire*. Bloomington, IN: Indiana University Press.

Murphy, M. (2017). Alterlife and decolonial chemical relations. *Cultural Anthropology, 32*(4), 494-503.

Nadel, A. (2010, September 24.) Re: Tyrone Hayes. Retrieved from http://www.atrazine.com/amphibians/combined_large_pdf-r-opt.pdf

O'Laughlin, L. (2016). Interrogating ecofeminisms: Reading endocrine disruptor panics as assemblages. *Green Theory & Praxis, 9*(3), 29-38.

Oliver, J. (2017, February 12). *Trump vs. truth* [Video file]. https://www.youtube.com/watch?v=xecEV4dSAXE&t=875s

Philpott, T. (2015, September 9). Your lawn is giving frogs a sex change. *Mother Jones*. Retrieved from https://www.motherjones.com/food/2015/09/your-lawn-giving-frogs-sex-change/

Pollock, A. (2016). Queering endocrine disruption. In K. Behar (Ed.), *Object-oriented feminism* (pp. 183-200). Minneapolis, MN: University of Minnesota Press.

Rosario, V. A. (2009). Quantum sex: Intersex and the molecular deconstruction of sex. *GLQ: A Journal of Lesbian and Gay Studies, 15*(2), 267-284.

Roughgarden, J. (2004). *Evolution's rainbow: Diversity, gender, and sexuality in nature and people*. Berkeley, CA: University of California Press.

Shukin, N. (2009). *Animal capital: Rendering life in biopolitical times*. Minneapolis, MN: University of Minnesota Press.

Skelly, D. K., Bolden, S. R., & Dion, K. B. (2010). Intersex frogs concentrated in suburban and urban landscapes. *EcoHealth, 7*(3), 374-379.

Slater, D. (2012). The frog of war. *Mother Jones.* Retrieved from http://www.motherjones.com/environment/2011/11/tyrone-hayes-atrazine-syngenta-feud-frog-endangered

Steinberg, T. (2012). *Down to earth: Nature's role in American history*. Oxford, UK: Oxford University Press.

Stewart, O. C. (2009). *Forgotten fires: Native Americans and the transient wilderness*.

Norman, OK: University of Oklahoma Press.

Sturgeon, N. (2010). Penguin family values: The nature of planetary environmental justice. In C. Mortimer-Sandilands & B. Erickson (Eds.), *Queer ecologies: Sex, nature, politics, desire* (pp. 102-133). Bloomington, IN: Indiana University Press.

Subramaniam, B. (2014). *Ghost stories for Darwin: The science of variation and the politics of diversity.* Champaign, IL: University of Illinois Press.

Syngenta. (2017). *Resistance fighter*. Retrieved from http://www.syngenta-us.com/herbicides/resistance-fighter

Syngenta. (2019). *Resistance fighter: Herbicide resistance management*. Retrieved from http://www.syngenta-us.com/herbicides/resistance-fighter

Taylor, E. L., Holley, A. G., & Kirk, M. (2007). *Pesticide development: A brief look at the history*. Southern Regional Extension Forestry.

Union of Concerned Scientists. (n.d.). Syngenta harassed the scientist who exposed risks of its herbicide Atrazine. Retrieved from https://www.ucsusa.org/harassing-scientistmessenger-exposing-risks-herbicide-atrazine

United States Department of Agriculture. (2017). *Corn policy.* Retrieved from https://www.ers.usda.gov/topics/crops/corn/policy/

Uno, Y., Nishida, C., Yoshimoto, S., Ito, M., Oshima, Y., Yokoyama, S., Nakamura, M., & Matsuda, Y. (2008). Diversity in the origins of sex chromosomes in anurans inferred from comparative mapping of sexual differentiation genes for three species of the raninae and xenopodinae. *Chromosome Research, 16*(7), 999-1011.

Verran, H. (2008). Science and the dreaming. *Issues,* 23-26. Retrieved from http://www.issuesmagazine.com.au/article/issue-march-2008/science-anddreaming.html

Weheliye, A. (2014). *Habeas viscus: Racializing assemblages, biopolitics, and black feminist theories of the human*. Durham, NC: Duke University Press.

Wells, G. (2011, November 23). Native American forestry combines traditional wisdom with modern science. *Resilience*. Retrieved from http://www.resilience.org/stories/2011-11-23/native-american-forestry-combines-traditional-wisdom-modern-science/

Williams, M. (1992). A*mericans and their forests: A historical geography*. Cambridge, UK: Cambridge University Press.

Woelfle-Erskine, C., & Cole, J. (2015). Transfiguring the Anthropocene: Stochastic reimaginings of human-beaver worlds. *Transgender Studies Quarterly, 2*(2), 297-316.

Wynter, S. (1994). No humans involved: An open letter to my colleagues. *Forum*

N.H.I.: Knowledge for the 21st Century, 1(1), 42-73.

Zimmer, C. (2011, February 21). Unraveling the mystery of the bizarre deformed frogs. *Yale Environment 360.* Retrieved from https://e360.yale.edu/features/unraveling_the_mystery_of_the_bizarre_deformed_frogs

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