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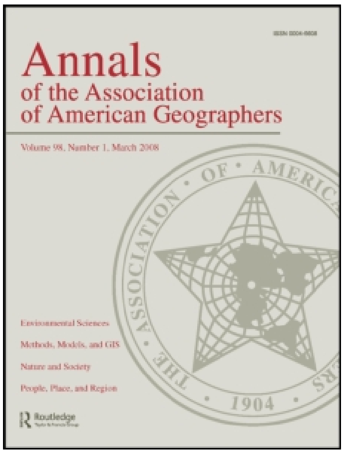

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A Bug's Life and the Spatial Ontologies of Mosquito Management

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A Bug's Life and the Spatial Ontologies of Mosquito Management

Ian Graham Ronald Shaw, Paul F. Robbins, and John Paul Jones III

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This article uses the theory of Gilles Deleuze to address the disjuncture between (1) the mechanical, chemical, and thermal processes of transduction that determine the biogeographical life of the mosquito; and (2) the spatialities of historic and contemporary management strategies. The history of mosquito management reveals two operative spatial ontologies, one an immanent horizontalism underwriting an intimate strategy of detection and destruction of breeding sites, the other a transcendent verticalism appropriate for the partitioning of space in support of widespread chemical spraying of adult populations. We find that two institutions in contemporary, mosquito-rich Arizona—the Pima County Health Department and Maricopa County Vector Control—are representative of this split in management. In this article we attempt to account for the observed interagency differences. Doing so, we suggest, requires an assemblage theory that brings together managers, institutions, and sociocultural-environmental-technological-political contexts with the flights of the mosquito itself. *Key Words: assemblage theory, Deleuze, integrated vector management, mosquito, spatial ontology.*

本文使用了德勒兹理论以解决下列分析之间的脱节问题：（1）机械，化工，和热传导过程，以确定蚊子的生物地理生活，（2）历史和现代管理战略的空间性。蚊虫治理的历史表明存在两个执行的空间本体，一个是内在的水平式管理，承担探测和摧毁蚊虫滋生地的密切策略，另一个是超越的垂直式管理，通过对成蚊进行广泛的化学喷洒而实现空间分割。我们发现当代的两个机构是这种分裂式管理的代表，在蚊子丰富的美国亚利桑那州，一个是皮马县的卫生署，另一个是马里科帕县的矢量控制。在本文中，我们试图说明观测间的差异。为此，我们建议，需要一种组合理论，汇集管理人员，机构，以及蚊子治理涉及的社会－文化－环境－科技－政治背景。*关键词：组合理论，德勒兹，病媒综合管理，蚊子，空间本体论。*

Este artículo hace uso de la teoría de Gilles Deleuze para abocar la disyunción entre (1) los procesos mecánicos, químicos y térmicos de transducción que determinan la existencia biogeográfica del mosquito; y (2) las espacialidades históricas y contemporáneas de estrategias de manejo. La historia del manejo del mosquito pone de presente dos ontologías espaciales operativas, una de las cuales es un horizontalismo inmanente que asegura una estrategia íntima de detección y destrucción de sitios de reproducción, la otra un verticalismo trascendente apropiado para parcelar el espacio en apoyo de fumigación química generalizada de poblaciones adultas. Encontramos que dos instituciones de la Arizona contemporánea, pródiga en mosquitos—el Departamento de Salubridad del Condado Pima y el Control de Vectores del Condado Maricopa—son representativas de esta división de enfoques de manejo. En este artículo intentamos explicar las diferencias registradas entre las dos agencias. Hacer esto, sugerimos, requiere una teoría de ensamblaje o encaje [*assemblage theory*] que integre a los administradores, instituciones y los contextos socioculturales-ambientales-tecnológicos-políticos con los vuelos del propio mosquito. *Palabras clave: teoría de ensamblaje, Deleuze, manejo integrado de vectores, mosquitos, ontología espacial.*

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> It may be difficult to love the mosquito, but anyone who comes to know her well develops a deep appreciation. A few species . . . are truly beautiful. All manifest exquisite adaptation to their environment. As a larva, the mosquito feeds and navigates in water. As an adult, she walks on water as well as land. She flies through the night air with the aid of the stars. She not only sees and smells but also senses heat from a distance. Lacking our kind of brain, she nevertheless *thinks* with her skin, changing direction, and fleeing danger in response to myriad changes in her surroundings.
>
> —Spielman and D'Antonio 2001, xviii

Meet Elizabeth Willott, PhD, a biochemist in the University of Arizona's Department of Entomology. An expert in mosquito ecology and environmental ethics, Willott spends her summer evenings setting traps across a selection of Tucson's backyards—sites chosen in part for their uneven proximity to the city's distribution of houses and horse ranches, wetlands and washes. From properties with lawns and dense tree stands to the more common xeriscapes of cacti and mesquite, Willott's backyard sampling is purposive rather than random, pursued to

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optimize her monitoring of species diversity and summer growth patterns, but unscientific in the fact that access is largely determined by her social network, largely composed of fellow scientists, philosopher friends, musicians, and campers, rather than by rigorous fidelity to the standards of spatial sampling. During each warm trapping night, she drives from home to home placing some twenty traps, crude but effective devices with but one working part: a small battery-operated fan positioned above a net, into which airflow is directed. Mosquitoes are attracted to the trap by dry ice, which is placed in a small plastic cooler suspended from a tree branch or fencepost. The hole punched in the bottom of the cooler allows a plume of heavy carbon dioxide, secreted from the dry ice, to fall onto and cascade over a plastic disk positioned under the cooler. Mosquitoes following the trail of the emission are snared in the fan underneath the disk and pushed down into the net, unable to escape. Willott harvests these mosquitoes in the sunrise hours of the following morning, tagging the nets with identifiers and placing the live captives in a household cooler for transport. Later, in her campus lab, they are frozen in preparation for the tedious microscopic operations of sex and species identification. Later still, the mosquitoes are sent off to labs in the state capital, Phoenix, where they are tested for the presence of West Nile virus (WNV).

In our research on institutional responses to the growing mosquito hazard in Arizona, we each had occasion to ride along with Willott, helping her set up traps and assisting in the lab's identification procedures. The site selection process, we found, was especially interesting. We watched as her acquaintances' backyards were surveyed for what she predicted would be the most productive settings for hanging traps: under the densest leaf cover of an old tree, at the intersection of two lines of fencing, at the point where a roof's gutter gives way to a downward spigot, or adjacent to a yard's most mundane water features—a birdbath, a leaky spa, a pet's water bowl, a hastily curled garden hose. More than once were we to remark after our excursions to set or pick up traps: Elizabeth Willott thinks like a mosquito.

Or perhaps, as we learn from mosquito physiology, she thinks like a mosquito *transduces*. For it is the process of transduction that converts environmental stimuli into the electrical nerve impulses that govern the spatial practices of the mosquito and inform Willott's on-the-ground knowledge of optimal trap placement.[1] During transduction, environmental data are detected by receptor neurons on the insect's antennae and palps (small furry receptors; Ignell et al. 2005). Both hold sensilla, sensory equipment containing bundles of detector neurons (Bowen, Davis, and Haggart 1988) that are the receptive sites of the nervous system, which are activated by alterations in membrane potential or permeability, leading to a series of enzyme-driven biochemical reactions that generate "action potentials," or electric signals. This transductive capacity spans mechanoreception, thermoreception, and chemoreception, in addition to vision and hearing. All told, these give the mosquito the ability to cue into human and other mammalian signatures, notably the shapes and fluctuations of plumes of carbon dioxide and other sensory cues, such as lactic acid and mammalian thermal gradients at up to 40 cm (Kellogg 1970; Service 1980; Grant et al. 1995; Geier, Bosch, and Boeckh 1999; Zwiebel and Takken 2004). To "think" like a mosquito is to understand how the insect's seemingly haphazard flights are always coupled with environmental stimuli, the result of millions of years of evolution for the world's 2,500 species (Spielman and D'Antonio 2001; American Mosquito Control Association 2008).

Transduction is, one might say, a bug's life. It governs everything associated with the female's search for bloodmeal and nectar, as well as standing water for breeding (males do not seek hosts or "bite" but live solely off nectar[2]). Only when its antennae and other body parts collect debris and become inefficient will it pause to groom its forelegs and hind legs (Walker and Archer 1988). The bug thus lives in the relational nexus between environmental variations and its sensory receptors: tree canopies with sufficient density for the protection of nesting young birds, the odd fold in a woodpile's tarpaulin that acts as a cauldron for stagnant water and organic waste, or a colorful swingset that by dusk becomes a pheromone-induced gathering point for swarming males (Hancock, Foster, and Lee 1990). Such are the backyard assemblages that inform Willott's trap placement.

Yet collecting mosquitoes in backyards is not the same as managing them at the institutional level, say from within a public health office or environmental resource department. For the insect, there is transduction; for institutions, there are social structures and power relations, discourses and practices, financial resources and technological capacities, disciplinary knowledges and myopias, and embeddedness in geohistoric path dependencies, territorial patchworks, and the like. Out of these complexities, a range of agencies across the country are attempting to respond

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to the presence of mosquitoes and to the associated growing threats of WNV and the other diseases they vector.

In this article we report on the environmental management strategies of two Arizona agencies charged with governing the unruly mosquito. The state of Arizona provides a remarkable laboratory in this regard, for although public health mandates related to the mosquito are driven from the state-level Arizona Department of Health Services, operational decisions, enforcement, and abatement techniques are entirely discretionary at the county level. As a result, multiple and divergent approaches to mosquito management are in evidence throughout the state, including areas with similar ecologies. The research reported here focuses on the management strategies of the state's two largest counties, Pima and Maricopa. The former includes the second largest city, Tucson, and is home to the Pima County Health Department (PCHD); the latter includes Phoenix, the nation's fifth largest city, and the offices of Maricopa County Vector Control (MCVC). The aim of this article is to understand their responses to the threat posed by mosquitoes.

In the following section, we elaborate on the development of a profound historical difference in the environmental management of mosquitoes, a distinction that pivots on diverging spatial ontologies (Deleuze and Guattari 1987). On the one hand, there exists an "immanent horizontalism" underwriting an intimate strategy of detection and destruction of breeding sites; on the other hand, there is a "transcendent verticalism" underwriting the partitioning of space in support of chemical spraying of adult populations. Our research problem stems from the fact that these two historically important strategies effectively characterize contemporary differences in management between Arizona's two largest mosquito agencies. To address this divergence, we next describe the rise of the mosquito population in Arizona and offer some background behind the two institutions. We then discuss the results of interviews with personnel and observations of operations at both sites. Here we learn how agency operatives understand and implement different management alternatives and how these are underpinned by spatial ontologies that are, by degrees and in practice, variously mapped onto the mosquito. Finally, we draw on assemblage theory (Deleuze 1994; DeLanda 2006; Robbins and Marks 2010) to confront the multiplicity of sociocultural, political-economic, and ecological contingencies that produce the distinct management strategies of PCHD and MCVC.

Tracking the Mosquito

Human history is intimately bound to the mosquito (Spielman and D'Antonio 2001; Packard 2007). Able to transmit deadly pathogens such as malaria, dengue, and yellow fever, the insect contributed to Sir Francis Drake's victory over the Spanish Armada, hastened the decline of the Roman Empire, checked the global ambitions of both Alexander the Great and Genghis Khan, and thwarted the first effort to construct a canal through the Panamanian isthmus, where the French lost more than 20,000 lives to malaria.[3] Long entangled with not only disease but development, the mosquito is intimately linked to state power, often becoming both its object and its *raison d'être* (Demeritt 2002; Mitchell 2002; Ingram 2005; Keil and Ali 2007; E. Carter 2008a, 2008b, 2009). One of the most vivid examples of this process is the antimalarial project of Italy's Fascist regime in the 1920s, where the malarial-ridden Pontine Marshes served as the ideological "quilting point" for nationalist discourses over the domination of a "wild" nature by modern technology and development (Caprotti 2006). Mussolini's model of disease control soon spread to Argentina, where eliminating the mosquito was as much about aping European modernity as ridding the populace of illness (E. Carter 2007).

Although such efforts have largely been a twentieth-century affair, directly tied to the mosquito's discovery as a vector for disease transmission, historical records reveal considerable knowledge of its ecological correlates (Spielman and D'Antonio 2001). In the nineteenth century, Italy prohibited irrigated land from within 500 m of housing; such land was also mandated to be at least 8 km from the kingdom's capital (R. Carter, Mendis, and Roberts 2000). This spatial fix was part and parcel of the miasma theory of disease, which held that diseases were transmitted by noxious plumes.[4] It was not until the close of the nineteenth century, however, that Sir Ronald Ross—a British physician working in India—conclusively proved that mosquitoes transmit malarial parasites.[5] Although some scientists and members of the public were unconvinced that a small insect could be responsible for such widespread and often fatal diseases, Ross's experiments eventually led entomologists, epidemiologists, public health officials, scientists, military leaders, and politicians on nothing

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less than a global strategy to find, control, and eliminate mosquitoes. Today, there exists a rich patchwork of mosquito abatement strategies in operation around the world (Townson et al. 2005; Kramer, Styer, and Ebel 2008), most of which draw on one or both of the approaches exemplified by the world's most famous mosquito killers, W. C. Gorgas and Fred L. Soper.[6]

W. C. Gorgas and Fred L. Soper

The source reduction of mosquito habitats has had demonstrated successes the world over, including John B. Smith's efforts in the early 1900s to make New Jersey mosquito free by introducing predatory fish species into the state's extensive salt marshes; the crusade against the insect in the American South, led by the Tennessee Valley Authority's control over breeding sites through extensive modification of rivers and reservoirs; and Surgeon Major W. C. Gorgas's intensive larvae elimination methods, which led to the disappearance of yellow fever and significant declines in malarial infection during the U.S. occupation of Cuba and Panama in the early 1900s. Although not averse to larviciding or oiling swamps, Gorgas (1854–1920) especially is viewed as a pioneer of chemical-free mosquito source reduction (Centers for Disease Control 2004; Figure 1). Immune to yellow fever following the contraction of the disease at the start of his U.S. military service, Gorgas's expert sanitary skills spawned an illustrious career that culminated in an honorary knighthood from King George in 1920. In Cuba and later Panama, he tailored a range of microstrategies that targeted the unruly interface between human and mosquito, including the drainage of all pools and ditches around a set perimeter of towns and villages; widespread brush removal combined with the cutting of grass above one foot in height; and the window-screening of residences, the quarantining of the sick, and the capturing of adult mosquitoes by hired squads of workers (Gorgas 1915). His zeal to purge the city of Havana and the Isthmus of yellow fever was unrivaled, and his microscopic attention to detail was renowned. From swamps and ditches to flower pots and gutters, Gorgas saw the potential for mosquito colonization in every nook and cranny of natural and urban spaces. Preventing these spaces from becoming breeding sites was fundamental to his method. A five-dollar fine awaited the householder reluctant to obey the program.

Gorgas's on-the-ground, labor-intensive, and environmentally complex approach, conducted by what Spielman and D'Antonio (2001, 151) call "shoe-leather epidemiologists," would eventually be matched if not overshadowed by the chemically intensive warfare waged by American doctor Fred L. Soper (1893–1977; Figure 2). He is credited with the

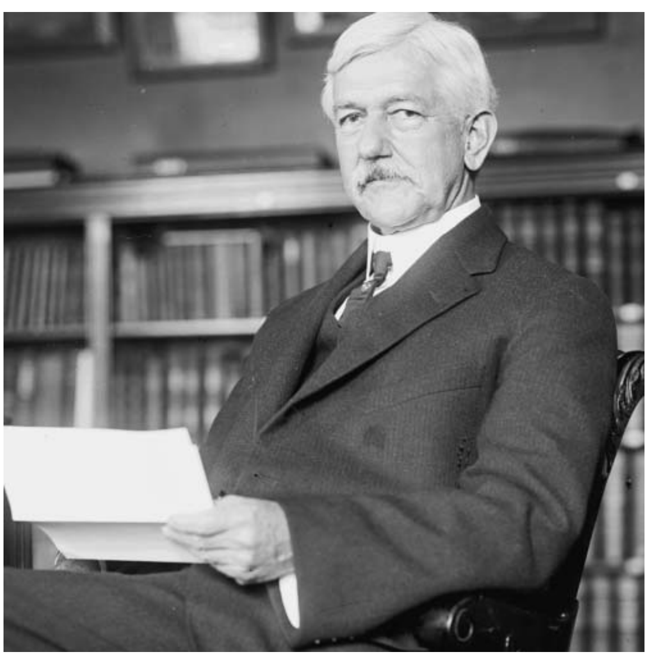

Figure 1. William C. Gorgas. *Source:* Library of Congress.

Figure 2. Fred L. Soper. *Source:* National Institutes of Health.

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complete eradication of a malaria-carrying African import, *Anopheles gambiae*, from northeast Brazil in the late 1930s. Like Gorgas, Soper was given the authority of martial law for his efforts, opening all forms of private property to his then-preferred insecticide, Paris Green, or copper acetoarsenate. Soper secured his reputation as the world's insect killer (Gladwell 2001), however, when he mobilized the large-scale industrial production of dichloro-diphenyl-trichloroethane, or DDT, during and following World War II. He discovered its value in killing lice and its associated typhus bacteria in Algeria and Italy, where applications to clothing and bedding were said to have greatly aided in the war effort. Soper's successes set a new historical standard for zero tolerance, or "species sanitation" (Spielman and D'Antonio 2001, 147). In focusing on the widespread application of agents, outdoor as well as indoor,[7] rather than the elimination of breeding sites, the contrast between Gorgas and Soper is sharpened. As Gladwell (2001, 44) put it, "Gorgas, Soper's legendary predecessor, said that in order to fight malaria, you had to learn to think like a mosquito. Soper disagreed. Fighting malaria, he said, had very little to do with the intricacies of science and biology."[8]

Soper's doctrine led to the worldwide application of DDT in the 1950s and 1960s, under the banner of the Global Malaria Eradication Program. In part funded by the U.S. government and carried out through the United States Agency for International Development, as well as the World Health Organization and other agencies, the program was a public health effort cum geopolitical strategy, as U.S.-manufactured and labeled agents were distributed throughout the tropics. DDT is credited with having saved millions of lives. As chemical controls came to virtually eliminate malaria everywhere outside of Africa, officials across the globe had reason to believe that mosquito-transmitted diseases would soon become relics of the past (Townson et al. 2005). It was not long before the mosquito began to develop resistances, however, first in Sardinia and then in Greece, both of which saw insect populations rebound after extensive aerial spraying. The 1962 publication of *Silent Spring* by Rachel Carson documented the detrimental effects of DDT, and the compound was eventually banned a decade later in the United States. Although DDT is still in use in a handful of countries, in most places it has been replaced by ultra-low-volume (ULV) insecticides, usually delivered by sprayers mounted on trucks or aerial vehicles. These solutions from the road and sky are able to cover vast geographic areas, dispersing chemical residues across patchworks of jurisdictional boundaries and pockets of ecological singularity.

Integrated Vector Management

Gorgas's and Soper's strategies coexist today in what is known as integrated vector management (IVM; see Rose 2001a, 2001b; Rupp 2001; World Health Organization 2004; Townson et al. 2005; Berg and Takken 2007; Kramer, Styer, and Ebel 2008; Toledo et al. 2008). IVM is multifaceted in its integrations. It often coordinates between public health outreach and environmental controls, includes both centralized and decentralized decision making, relies on both chemical and nonchemical and indoor and outdoor solutions, seeks to balance the rule of experts with community involvement, and bridges the gap between ground-truth field work and vector-tracking geographic information systems (GIS; R. Carter, Mendis, and Roberts 2000; Dongus et al. 2007; Rakotomanana et al. 2007; Carney et al. 2008; Eisen and Eisen 2008; Mondini and Chiaravalloti-Neto 2008). According to the World Health Organization (2004, 9), IVM "integrates all available and effective measures, whether chemical, biological or environmental . . . [and] encourages effective coordination of the control activities of all sectors that have an impact on vector-borne diseases, including health, water, solid waste and sewage disposal, housing and agriculture."

One area illustrative of IVM is the management of wetlands. With nutrient-rich stagnant water and dense vegetation, wetlands can nurture hundreds of thousands of mosquitoes (Karpiscak et al. 2004; Willott 2004), yet their importance in terms of wastewater treatment, wildlife preservation, and multiuse public recreation means that they cannot usually be eliminated (Knight et al. 2003). The jobs of public health and vector control officials in these spatially heterogeneous niches are complicated by the fact that wetlands have interwoven connectivities to other human and environmental topographies, including vast networks of natural and artificial water flows and important zoological vectors, such as migrating birds. What is more, a single oversight agency might often have to work with multiple types of water bodies, including swamps, irrigation canals, drainage works, lakes, ponds, sinkholes, reservoirs, rivers, and washes. All of these make mosquito management a complex job and invite integrated solutions.

In one repsonse, following Soper's model, insecticides are sprayed over large areas of wetlands either

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through aerial spraying by plane, helicopter, or remote-controlled drone or by foggers mounted on trucks. Unable to discriminate among ecological niches and microhabitats, the official response is typically triggered by a threshold exceeded in mosquito traps or residents' complaints. The success of this method is nearly instant and widespread, ranging from small reservoirs to entire cities (Carney et al. 2008; Elnaiem et al. 2008). Yet although fogging offers a rapid response, it remains a controversial choice for wetland managers. Concern exists over the widespread and indiscriminate application of insecticides over residential areas (Rose 2001b)—a fear that some believe is unfounded (Weston et al. 2006). Others point to pathogen and vector resistance following repeated microbial and pesticide applications (Brogdon and McAllister 1998; Zaim and Guillet 2002; World Health Organization 2004; Berg and Takken 2007). Furthermore, as Berg and Takken (2007, 1232) explained, these sorts of applications have to be centrally "planned, managed and evaluated as vertical programmes," a paradigmatic example of expert knowledge that might require the trusting acceptance or quiet acquiescence of community members. Finally, due to cost and resource pressures (Gubler and Clark 1996), insecticide solutions are often recognized as unsustainable in developing countries.

The second response, dating back to Gorgas, is to modify wetland breeding sites in ways that disrupt the insect's microspaces (Knudsen and Slooff 1992; Walton 2003). A common approach is to produce aquatic currents that break water surface tension, thereby disrupting the breathing of pupae whose young lives depend on maintaining an air supply through specially adapted siphons that act like snorkels. Vegetation thinning and removal also reduce the mosquito's breeding sites and have the bonus of extending the time it takes for a female to lay eggs in the first place (Gu et al. 2006). Raising vegetation in island pods called *hummocks* has similarly been found to reduce mosquito habitat (Thullen, Sartoris, and Walton 2002), just as the process of cutting steep-sided walls on the edges of a wetland's basin can prevent larval rafts from attaching to vegetation in shallow water. Both hummocks and steep walls promote predation from mosquito-eating fish such as the common *Gambusia affinis* and other larvivorous species (Howard, Zhou, and Omlin 2007). Introducing these predators is part of a multipronged bioengineering approach that ranges from encouraging habitats for bats and dragonflies to the introduction of microbial agents, particularly mosquito-specific bacteria such as *Bacillus thuringiensis israelensis* (*Bti*) and *Bacillus sphaericus* (*Bs*; Knight et al. 2003). Although wholly unlike approaches that depend on large-scale insecticiding, this tactic is by no means necessarily a more "natural" one: It, too, reflects an equally inventive human intervention into the life and reproduction of mosquito environments.

Spatial Ontologies of Mosquito Management

So far we have described management practices, but there is another level at which the differences between Gorgas and Soper are manifested: spatial ontology. Although one seldom finds a social theoretic vocabulary in the literature on mosquito management, it is at this level where different practices emerge, intertwined with what Deleuze and Guattari labeled *immanent and transcendent spatial ontologies* (Deleuze and Guattari 1987; Bonta and Protevi 2004; Buchanan and Lambert 2005). The distinction between immanence and transcendence rests on Deleuze's (1994) inversion of the traditional philosophical definition of difference. Usually understood as the boundary conditions between two or more states (i.e., x is x because it is not y), difference in this sense results from judgments over similarity and resemblance, as well as analogy and opposition. This is the sort of difference we encounter when we designate individuals to particular social groups. Such a priori categorization is transcendent: Categories preordain their contents, even though they might have initially been derived inductively from them. Deleuze liberates difference from transcendence through his affirmation of "difference-in-itself." Rather than seeing difference as a derivation or deviation from some preexisting unity, he insists with difference-in-itself the productive force of life prior to its categorization. This "in-itself" is immanence: a real, empirical world characterized by emergence and complexity; a world that arises from material bodies and forces that conform to internal rather than external rules and that precede rather than follow our constructed systems of representation. Relative to other theorists one might draw on in studying the mosquito, Deleuze articulated the excess of difference-in-itself (biological transduction) over categorical difference (vector management). Yet the relative surplus of this excess is not absolute: it is our contention here that Gorgas's on-the-ground horizontalism, like Willott's backyard navigations, is more attuned to capturing the immanence of the bug's life.

This is not to suggest that Gorgas's and Soper's ontological coordinates translate into clearly cut abatement binaries. For one, Soper's spraying was not a silver bullet that ignored Gorgas's work—certainly, the species

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sanitation model popularized throughout the malariology community was attentive to mosquito biology and ecology. Nor is it the case that if DDT had been at the disposal of Gorgas he would have chosen to ignore it. Rather, each of the two men constructed their mosquito strategies at distinct geohistorical junctures, where social, ecological, ideological, and technological assemblages were unevenly in play. As E. Carter (2007, 650) explained, "Ecology, holism, and local knowledge do not always line up on the same side, against technology, reductionism, and universal methods. Science in action—indeed, people in action—constantly blur these lines."

Moreover, Gorgas and Soper explicitly shared commonalities: Both put their faith in scientific explanation; neither was averse to extreme environmental interventions, mechanical, chemical, or otherwise; and both pursued and surveyed the insect with a militaristic zeal underwritten by the authority bestowed on them by senior officials and politicians. Yet their spatialities were different: Just as one navigated space rhizomatically to reveal the bug's environmental couplings and hiding places, the other sought to suffocate the insect by blanketing all surfaces with deadly chemicals, both in homes and from the sky.

In what ways do these management differences designate alternative spatial ontologies? The oppositions put forth in Table 1, although not intended to neatly cleave complex and situated practices, do suggest theoretical distinctions between Gorgas's horizontalism and Soper's verticalism. They contrast the former's commitment to the intimacies of immanence, where bugs are not easily separable with environment but instead threaded through the emergent unfoldings of space, with the latter's axiomatics of transcendence realized through Cartesian perspectivalism. This is not to assert that either Gorgas or Soper reflexively tailored his strategies to alternative horizontal and vertical foundations but that, rather, their practices cannot be separated from these spatialities. In particular, both encountered the mosquito's problematics and their fields of solvability at specific geohistorical junctures. Both came face to face with site-specific materialities that were constantly assembling, multiplying, dispersing, and congealing (Deleuze and Guattari 1987; Marston, Jones, and Woodward 2005; Robbins and Marks 2009; Woodward, Jones, and Marston forthcoming). It is at this moment when the machinic productivities of materiality are translated into and integrated with practice—when worlds confronted translate into worlds to be navigated, harnessed, and managed. At the same time that these worlds are assembling and connecting—as happens in the late discovery of DDT's eradication potentials (Russell 2001)—they are also decaying, exploding, and stratifying: transcendent structures in one moment only to be collapsed into a rhizome at another. In this sense, immanence is not a prescription but rather a unique sensitivity to the world's production of difference at each unfolding site, discovered and rehearsed within the realm of practice.

Table 1. Binaries informing different management practices of mosquito abatement

Gorgas's horizontalism	Soper's verticalism
Complexity	Order
Nonlinearity	Linearity
Contingent	Universal
Immanent	Transcendent
Rhizomatic	Arborescent
Point	Surface
Mutualist	Dualist
Emergence	Equilibrium
Asynchronous	Synchronous
Folds	Striations

Note: Table prepared after Marston, Jones, and Woodward (2005).

One import of Deleuzian difference for understanding abatement histories is that they can no longer be situated solely within the confines of categorical subjectivity—Gorgas and Soper are immanently bound to their respective sites. Context is vital, difference is productive: Neither is simply extant. Thus, Soper's absolutist calls for extermination depended, particularly in later stages of his career, on an aerial perspectivalism made possible through flight. The same technology was not, however, an option during Gorgas's time in Cuba and Panama. As a result, we find him on the ground, navigating pockets of environmental complexities piece by piece. In sum, spatial ontologies, complex materialities, and concrete practices are triply looped, producing shifting configurations that change along with the interfaces between humans, environments, technologies, and, of course, mosquitoes.

If these contextually laced coordinates meant that Gorgas—like Willott today—navigated space alongside the mosquito itself, then it follows that his management strategies revolved around the emergence of ecological forces that circulate through contingent multiplicities of land and water. With Gorgas, abatement methods were mutualistic: The connection between mosquito and environment was flow-like, a constantly *becoming* mosquito–environment coupling in which the bug is immanent to the unfolding of nature, and where "transduction of intensive states replaces topology" (Deleuze and Guattari 1987, 17). Even without an advanced scientific knowledge of transduction, Gorgas was intimately attuned to the spaces of the bug's life: "In yellow-fever work this system of destroying mosquito larvae is the essential; everything else is secondary to it . . . caring for the cisterns, water barrels and containers is the essential work" (Gorgas 1915, 61). Source reduction, consequently, eschewed universal coverage and was instead attuned to the microvariabilities actualized by reshuffling materialities.

Soper, by contrast, was able to view space from above and map it on the ground, imposing a grid epistemology (Dixon and Jones 1998) that stopped space in its tracks, freezing the complex happenings into a two-dimensional plane that could be cellularized, enumerated, and manipulated. The coiled and complex mosquito–environment Möbius strip was pulled apart, replaced by Soperian spaces of replication, efficiency, completeness, and control. Space under this approach became little more than a container, a background for fogging and a catchment for the dispersion of chemicals. As Soper (1962) remarked, "The mathematics of eradication is simple; what can be done in one square meter can be done in two square meters; what can be done in two square meters can be done in four. Thus, by geometrical progression the world is soon covered" (5).

Arizona's Mosquitoes and Institutions

Arizona is the home to several mosquito species, including members of all three of the insect's principle genera: the *Aedes*, the *Anopheles*, and the *Culex* (Figure 3). The *Anopheles*, the primary vector of malaria, is largely a nuisance insect in Arizona, but surveys in and around Tucson reveal that *Aedes aegypti*, the mosquito responsible for transmitting dengue, has claimed a multitude of mundane and surprising spaces in cities and towns throughout the region (Botz 2002; Merrill, Ramberg, and Hagedorn 2005). Meanwhile, *Culex quinquefasciatus*, found in both wetland and residential areas, is the principal vector of WNV, which is of concern in Arizona and elsewhere in the United States (Zinser 2004; Zinser, Ramberg, and Willott 2004).[9] The most widespread arbovirus in the world, WNV affected a reported 3,630 people in the country during 2007 (Petersen and Marfin 2002) and has

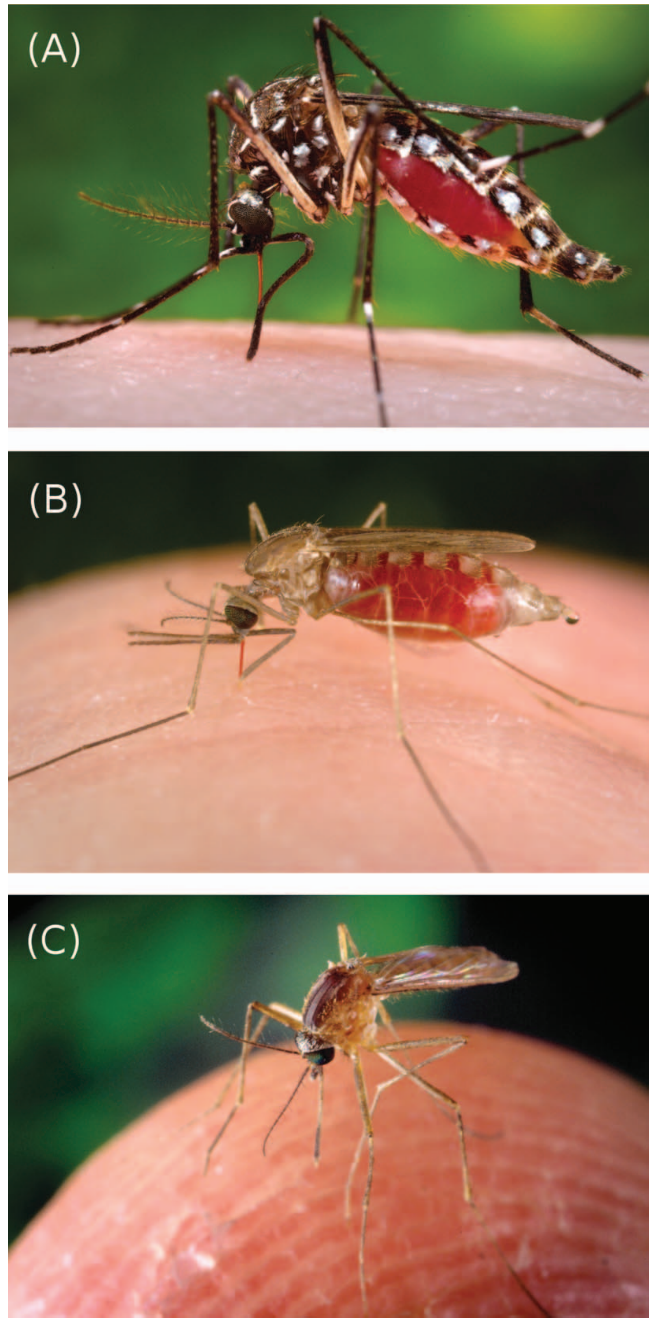

Figure 3. Common Arizona mosquitoes: (A) *Aedes aegypti*; (B) *Anopheles freeborni;* (C) *Culex quinquefasciatus*. *Source:* Centers for Disease Control and Prevention. 3A courtesy of Professor Frank Hadley Collins, Director, Center for Global Health and Infectious Diseases, University of Notre Dame. 3B courtesy of James Gathany. 3C courtesy of William Brogdon.

caused 1,000 fatalities since its arrival in New York City in 1999 (Kramer, Styer, and Ebel 2008). Migratory birds are thought to be important vectors for the long-distance transmission of the disease, but other animals, such as horses, can also act as disease reservoirs (Marra

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et al. 2004). Populations of peridomestic birds, such as the American robin, have dwindled since the invasion of WNV (Rahbek 2007), and the American crow's numbers are down a staggering 45 percent (LaDeau, Kilpatrick, and Marra 2007).

Although casual observers might presume that the mosquito's invasion of the arid lands of Arizona is a recent phenomenon, due to rapid population growth, the increased presence of lawns and pools, and the conversion of desert to farmland, the southern Arizona portion of the U.S.-Mexico Sonoran Desert ecosystem has long been a center of mosquito-borne nuisances and diseases (see Robbins, Farnsworth, and Jones 2008). Riparian river flats in the region have nurtured breeding grounds for mosquitoes since at least colonization, as recorded in the earliest records of missionaries. Complaints about mosquitoes were common throughout the late summer monsoon season of Tucson in the 1750s (Dobyns 1976), with reports of malarial fever experienced by Mormon settlers (McClintock 1921), pioneer families (Teeples 1929), and U.S. Army personnel (Kessell 1976; Fink 1998). These problems were compounded by the unscreened buildings of Anglo settlers (Boehringer 1930). The malarial landscape displayed a high level of clustering, such that residents of Salt River Valley remained virtually free of fever, whereas nearby Gila Valley residents were to report constant sickness in the 1800s (Alsap 1936).

Mosquito populations in the mid-twentieth century began to decline with the arrival of both industrial agriculture and large numbers of people, both of which caused lowered water tables and a decrease in the number of stagnant wetlands. As elsewhere, the chemically informed call to arms trumpeted by Soper was also heard across the region, with early tests of DDT conducted in Arizona during World War II (Russell 2001). These insecticide solutions spurred an aggressive abatement campaign, slashing the mosquito hazard for several decades, even if some mosquitoes (*Aedes aegypti*) were never seriously affected by pesticides (Reiter and Gubler 1997). For many years the mosquito hovered beneath the relaxed watch of sanitarians, policymakers, planners, and development officials. Since the 1980s, however, mosquito populations have surged. Heavily irrigated agriculture has become popular in many areas of the state, including 7,000 acres of irrigated pecans near Tucson (Herrera 1995, 2005). The restoration of wetlands is also noteworthy, given their ability to rapidly increase mosquito populations (Karpiscak et al. 2004). As urban development (and now foreclosures) has peppered the region with green swimming pools, clogged roof gutters, and discarded tires, Arizona's backyards warehouse an endless inventory of objects suitable for mosquito colonization.

Tucson and Phoenix provide the methodological settings for the two institutions we studied—PCHD and MCVC. Both institutions operate in desert cities experiencing recent and sustained suburban growth, but the differences between them are striking—even if they are only 100 miles apart. Tucson, nicknamed the "Old Pueblo," has the feel of being much smaller than its population of 1 million would suggest. The city is by reputation an environmental beacon in the state, its mostly Democratic-voting residents often said to be more attuned to xeriscaping, bicycling, and water harvesting than those of Republican-leaning Phoenix, whose nearly 4 million county residents live in a metropolitan area that until recently boasted the highest growth rate in the United States and a network of new suburbs and shopping centers to match. Their relative qualities are part of state lore, with Tucson discursively cast as "scruffier" and "funkier" than its northern counterpart: a more organic and haphazard patchwork of houses and desert spaces, where less wealthy self-described "hippies" long ago abandoned irrigated lawns in favor of cacti. Phoenix, on the other hand, is a state capital, housing not only the seat of political but also economic power, with amenities, conveniences, and urban character to match. It replaced a traditional southwestern motif with an urban growth fed by thousands of acres of irrigated lawns, hundreds of artificial lakes, and a dense network of newly built highways, giving the city a decidedly urbane and "classier" feel.

Against this backdrop, the 2003 arrival of WNV in the state of Arizona saw a manifold of responses to a deadly public health threat. With little historical precedent or established protocols, institutions had to rapidly mobilize resources against a new public enemy. The resulting scramble was underscored by divergent knowledge regimes, practical skills, and organizational capacities: From water management and public health to agriculture and transport, agencies drew on different disciplinary backgrounds as they incorporated mosquito abatement into their regular activities. Such agencies also encountered a complex map of often overlapping jurisdictions, including the Central Arizona Project that provides water for Phoenix and Tucson. Central to this landscape were the two institutions we studied. Although sharing a goal to promote public health, PCHD and MCVC take quite different approaches in mosquito abatement. Their institutional responses, always coupled with spatial ontology, are described next.

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Abatement Worlds

The empirical materials for this project are drawn from in-depth interviews with fourteen personnel between August 2006 and March 2008. As well as interviewing staff from our two described institutions, we spoke to workers from Tucson Water, the Arizona Department of Health Services, Maricopa County Health Department, the University of Arizona, and the City of Phoenix. A series of semistructured, open-ended questions were used to elicit a broad range of perspectives on mosquito management from both managers and lower level field workers. The interviews were digitally recorded and transcribed, and these data were then coded and organized according to dominant themes. In addition to these in-depth interviews, the authors were present in vector control conferences, agency board meetings, and scientific laboratories; we also made numerous outings to wetlands and other problematic mosquito sites across both counties.

The selection of PCHD and MCVC was neither arbitrary nor accidental: These are the primary institutions on the front line of mosquito management in the state's two largest counties. Although both agencies are empowered by the same law (Arizona Revised Statutes §36–601), which designates the mosquito officially as a "public nuisance dangerous to public health," each rose to the problem of mosquitoes at different times and under different political conditions. As archival research has shown, the PCHD has a nearly fifty-year history of tackling a broad range of health issues since the 1960s, with mosquitoes forming only one part of a larger mosaic of concerns (Robbins, Farnsworth, and Jones 2008). MCVC's decade-long concentration solely on vectors such as mosquitoes and other nuisances, on the other hand, emerged within the last fifteen years, directed by state statutes and environmental codes, and coincident with the arrival of new disease hazards, including WNV. Together, the agencies offer an assortment of disciplinary and organizational orientations to go along with their different management strategies. What follows describes the agencies' settings and the views of the women and men on the front lines and in the back offices of mosquito abatement in the counties.[10]

Institutional Settings

Given the unique social and cultural milieu of Tucson, we had, frankly, expected a more bohemian setting for the work lives of our PCHD informants. Instead, on arrival, we were confronted by a sprawling parking lot where chains of automobiles glistened under the desert sun, with the PCHD housed in a large, modern, multistory brick building. Eschewing all aesthetics other than the announcement, "government building," the front doors open automatically, revealing a barren lobby broken only by the placement of the occasional office plant. Workers at the security reception desk require visitors to sign in before their appointments come to the lobby to retrieve them, all under the eye of closed circuit televisions. It was in Phoenix, by contrast, where we found workers in an old postwar shed of a building never intended for more than a decade's worth of use. Set on the fringe of the city in an industrial nowhere land, MCVC's command center was humble and functional, suggesting little more than "work done here." Gravel, dirt, and stones blanketed the Phoenix parking lot, its uneven surface dotted with hastily parked cars and trucks. The official vehicles, regimented by barbed wire fences on the perimeter, were mounted with the fogging devices that would disperse ULV insecticide throughout Maricopa County. Inside MCVC, the contrast to Pima's grid of Dilbert-like cubicles and its unassuming furniture was striking: A large table in a central meeting room was the heart and soul of operations. This was where staff members congregated for their morning briefing, sipping coffee before picking up one of the truck keys dangling from the well-scribbled whiteboard.

Organizationally speaking, the PCHD's mission "is to exercise a leadership role in protecting health, preventing disease and promoting community well being through adoption of core public health functions and national standards."[11] Unlike MCVC, the agency has responsibility for a wide range of services, from family planning to bioterrorism preparedness. Not coincidentally, given the gendered makeup of public health disciplines, all of our interviewees were women. Mosquito control is largely in the hands of the PCHD's Consumer Health and Food Safety division, the same division charged with enforcing health codes, inspections, and certifications of food vendors, swimming pools, and other sites of public concern. Of fifteen staff members, four sanitarians do double duty by responding to phoned complaints about nuisance mosquitoes while also having jurisdiction over the inspection of hundreds of Tucson restaurants, in addition to responding to the occasional rodent and roach complaint. Problem mosquitoes usually prompt a site visit to a stagnant swimming pool or some other problematic breeding site—in one of our ride-alongs, we journeyed with a sanitarian as she collected wriggling mosquito pupae

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Figure 4. Mosquito collection at Globe Berry wash, Pima County, Arizona. *Source:* Authors.

that had amassed in the puddles of a small urban arroyo (Figure 4). Mosquitoes are also a part of the PCHD's wider program of disease control; its four epidemiologists, operating in a different division, are charged with investigating more than 200 human and nonhuman diseases, including instances of WNV. It is these two divisions—always in communication with each other, whether over e-mail or talking down the corridor—that form the official mosquito response in Pima County.

Meanwhile, MCVC is composed of some twenty-five staff members—nearly all men—whose primary mission is mosquito control. In their words, "Vector Control staff investigate citizen complaints dealing with mosquitoes, flies and non-native rodents. . . . Vector Control inspectors identify routine breeding sites and apply the appropriate treatments. They also perform surveillance activities in their 'districts' to identify new or potential breeding sites."[12] Such labor-intensive practices are generated by public telephone complaints, or, in contrast to Pima's more limited resources, as an automatic response to an exceeded threshold of mosquitoes at a trap site. Logistically speaking, MCVC breaks down the entire city of Phoenix into a gridded map of unit square miles, with each worker assigned to specific areas. In each square, a trap is positioned to monitor mosquito populations. MCVC counts and tests its mosquitoes in-house rather than sending them to the state laboratories, as the PCHD does. This painstaking task is performed in the building's lab, a rear room equipped with microscopes and a tank full of mosquito-eating *Gambusia* fish, as well as heaps of dry ice ready to be loaded into one of many mosquito traps destined to be positioned about the 9,000-square-mile county.

Pima County Health Department

Much like Gorgas's squads of workers, the PCHD's field operatives work as an on-the-ground response team, attending to backyards, washes, and other sites of infestation. Hence, we should not be too surprised to find that each of the interviewees from the division expressed an appreciation for Tucson's muddled landscape. Among the opinions of PCHD's staff, the mosquito is thought of as one part of a mutualistic loop: Emergent in a multitude of places, the mosquito's outbreaks are part and parcel of the heterogeneity of urban space. Notably, Tucson is dissected by washes, their uneven contours shaping its landscape and providing spaces for stagnant water. What is more, these washes are often sites of human interference: At the juncture of a few rocks, a small dam of discarded plastic bags or other household debris can slow their natural flow, creating a haphazard chain of pools ideal for colonization. According to one PCHD worker's estimate, between 80 and 90 percent of all mosquito-related complaints are directly tied to these sorts of human interventions. In this vein, backyard items like Gorgas's infamous flower pots were repeatedly mentioned by PCHD staff as breeding sites:

> All too often people point at a humongous lake, yet when was the last time that they checked their rain gutters for clogged leaves that would dam water and cause mosquitoes to breed in the standing water during the monsoon season? It's all the stupid stuff that people don't think about [that's to blame].

As a center-less and always unfolding multiplicity with surveillance that is triggered by the phone call rather than the trap, the environment for the PCHD is a repeated novelty within a pointillist spatiality: "out of one puddle, ten thousand mosquitoes or more can hatch." Just as likely were the mentioned sites small and transitory: a coming-into-being habitat the size of a salsa jar was said to be big enough "to make the neighborhood miserable."

With practices attuned to such immanence, PCHD's staff relies on public education as an important aspect of their management strategy. As one staff member explained, "Even though you can make some generalizations, because of the environment you can't make a whole lot . . . it's behavioral, it's environmental, it's ecological, it's everything." This means that "you can't have one message . . . nothing is homogenous, you have to have diverse messages . . . you have diverse needs and diverse issues all sitting next to each other." As a result, people "are at risk everywhere," so the PCHD is constantly "trying to educate people about the land around them," through leaflets, pamphlets, television and radio, and neighborhood meetings. These approaches resound in an aphorism repeated by the personnel we interviewed at the PCHD: "If you eliminate the breeding sites, you eliminate the mosquito." It is a message crystallized in the agency's promotion of "policing the backyard" as "the single outstanding communication objective. Make sure our yards are mosquito free, and this is how you do it." Full participation is seen as crucial, because "We need to be collaborative," and yet collaboration depends on individual responsibility: "People need . . . to protect their environment first."

Given this philosophy of environmental intervention (see Reiter 2001; Pruss-Ustun and Corvalan 2007), the PCHD does not promote or undertake adulticiding; that is, the spraying of ULV chemicals to kill adult mosquitoes. For the personnel at the PCHD, spraying overshadows the importance of education, individual accountability, and backyard policing. Adulticiding is perceived by staff members to shift responsibility from people and into the hands of government agencies, which is problematic because "it's a false sense of security when they see the trucks going down the street. It gives people a false . . . sense that they don't have to do anything." This view was supported by another informant who argued that "If you don't attend to doing those things and the education and eliminat[ing] the standing water, the spray is only a temporary fix." Yet the reasons for this anti-adulticide culture do not simply reflect the institution's focus on source reduction. Politics also muddies the management waters. As we learned from PCHD personnel, there are voices from within Tucson's community that "are much more ecologically conscious, so they don't want those chemicals being sprayed." Overall, criticisms of chemical-based adulticide were widespread throughout the agency, usually focused on the futility of spraying if mosquito breeding sites are not actively first targeted by individual homeowners. Or, put a different way, the PCHD believes in "Gorgas on the ground":

> in order for adulticide to be effective it has to actually hit the mosquito, and if you don't address the breeding sites, it doesn't really matter how many adult mosquitoes you kill, if you haven't eliminated the breeding sites you're not truly addressing the issues of the mosquito population . . . a female mosquito can lay hundreds of egg rafts at a time, and if you don't prevent the eggs from hatching and developing, then your chances of eliminating mosquitoes from the environment goes down dramatically because if the adulticide doesn't hit the adult mosquito it's not going to kill it. (PCHD staff interview)

Maricopa County Vector Control

Such comments from the PCHD seem to be targeted directly to the mosquito managers up the road in Maricopa County, where spraying is the norm. Yet it would be wrong to assert that the staff at MCVC ignores the importance of backyard surveillance. All of those we spoke to agreed that mosquitoes live intimately with humans and the microenvironments they disrupt. As one MCVC staff member noted, "*Aedes aegypti* is adapted to living with humans, it's almost as if it was quasi-domestic."

Keeping track of the bug's wanderings in Phoenix, however, turns out to be a more complicated project than in Tucson, far out of proportion to the difference in city sizes: "We're setting 500 traps a week. We're analyzing 500 traps a week." Springing from a doctrine of proactive (go-out) rather than just passive (call-in) surveillance, MCVC's mosquito traps are distributed evenly across the city of Phoenix, spaced for

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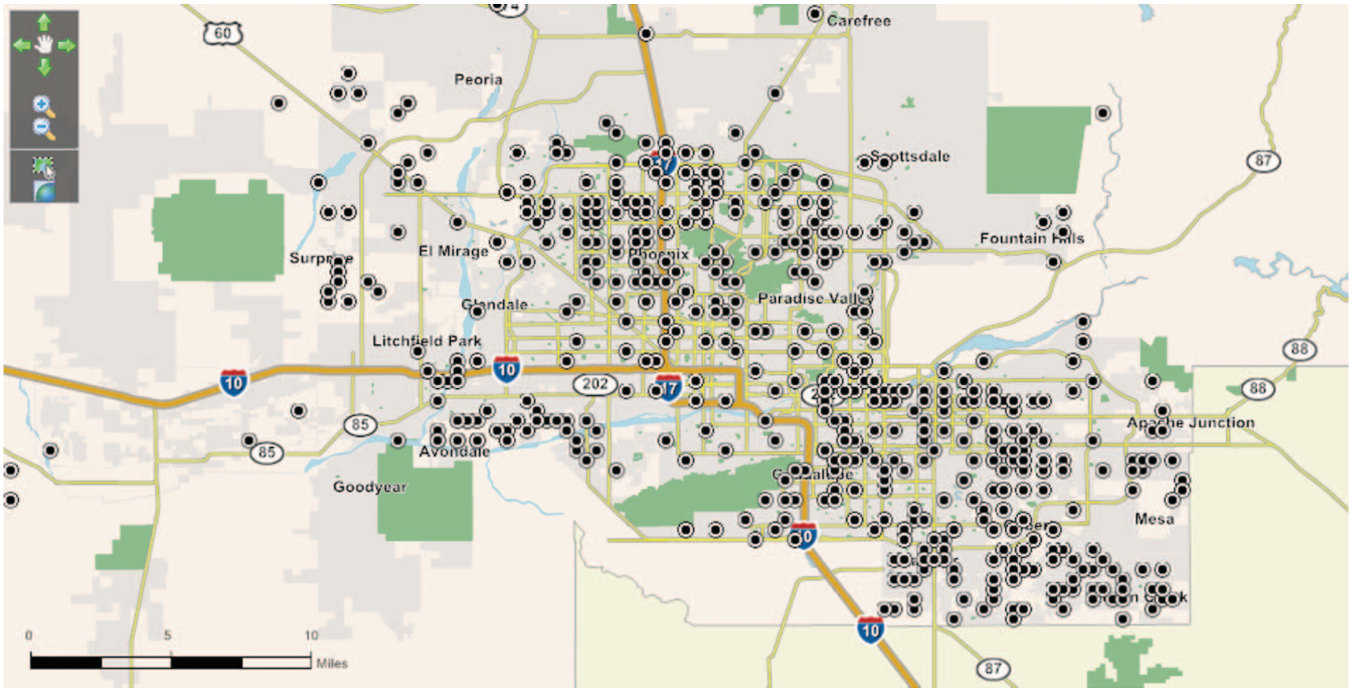

Figure 5. Maricopa County Vector Control's routine trap sites. *Source:* http://www.maricopa.gov/envsmaps/ vectorcontrol/rtall.aspx (last accessed 16 October 2009).

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the most part in square mile increments (Figure 5). And these square mile cells constitute different abatement regions: "They're based on complaint numbers, they're based on mosquito numbers . . . we try to break them up so that each person has about the same number of CO_2 traps and areas to larvicide." Such coverage is important at MCVC, as highlighted by one male operative who noted, "I'm a field man, and trapping is extremely important to me. If you don't look you're not going to find anything," adding, "I can tell you what, if you don't set traps, and you don't look, you're going to use your humans and horses and sentinel chickens as your monitors." Field data from the traps are fed into the Vector Control Management System, a commercially available geospatial database program designed specifically for professional pest managers. Significant organizational resources are required to support the software. As a worker stated, "We now have five people working on it, and we could probably use six, to support the 27 people in the field." Although labor intensive, it is deemed "really useful because basically from within 24 hours we can know if we've got a problem in an area."

What is more, MCVC's in-house WNV testing capacity decreases the response time between trap counts and disease identification: "That's why we sort of do our own in-house sampling because it took so long to get the data back [from the state]; we were always at least two weeks from a positive [identification of WNV]." Turnaround time from MCVC's lab can be shorter than twenty-four hours, so that if "a trap is brought in today, we will have the results in by this afternoon." Positive cases of WNV will then bend the agency's management strategy toward a Gorgas-style backyard intervention, for it is at that point that MCVC's staff are sent to problem sites to deploy larvicide or serve notices on residents with green pools: "That's why we have an enforcement group . . . to go out, serve warrants on green pools, [make] inspections. And this year to date [2007] we have served over a thousand warrants."

Most important at MCVC, however, is adulticiding, an approach made possible by the institution's budget and resources (asked about the difference with the PCHD, one worker joked, "I believe Pima County has a very good sentinel human program going!"). Adulticide responses at MCVC are triggered by high trap counts, the presence of more than thirty insects from the dangerous *Culex tarsalis* or *quinquefaciatus* species, or the discovery of mosquitoes positive with WNV. The response, which involves dispatching specially equipped trucks with ULV chemicals, is organized by the GIS software, which churns out a set of geospatial targets. Among those we spoke to, adulticiding was seen as a necessary, even satisfying strategy: "We have

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a tremendous budget for larviciding, and we have a tremendous budget for adulticiding also. But the thing is really, my attitude is that once they become adults it's revenge." The sense of urgency in eliminating adult mosquitoes seemed ever present within MCVC's organizational culture: "And that's what this job is, hunt them down and kill them."

This at-war mentality underwrites MCVC's commitment to a command and control response to Maricopa's mosquitoes. Echoing Soper's injunction to simply multiply meters by geometrical progression, one staff member revealed:

> Okay, so my whole game plan has always been to look big. Big, big, big. With the understanding that really it's just like a big Mandelbrot. . . . And if you understand what's driving the system then you can begin to make plans.

Unlike at the PCHD, staff at MCVC expressed cynicism surrounding the "green" or "ecological voices" dissenting over the application of adulticide in Maricopa, with the opinion that:

> You know what, if you have enough money you can afford to be chemically sensitive. And if you don't have enough money, you can't afford to be chemically sensitive. And Scottsdale [a wealthy Phoenix suburb] has more chemically sensitive people per square mile than any place I know.

Discussion

To explain the divergent strategies of the PCHD and MCVC—which look less like integrated vector management than endpoints of a continuum—is not as easy as it might at first seem. Yes, it is tempting to point to the workers themselves—knowledgeable agents of the state who harbor a variety of opinions on mosquito abatement and whose associated practices have come to nest within specific institutional settings. But how then would we go about measuring the impacts of the different gender (PCHD mostly women; MCVC mostly men) and disciplinary backgrounds (PCHD mostly public health; MCVC mostly life sciences) of the agencies' staff? Can we distinguish between the effects of gender and disciplinary backgrounds when the latter are already gendered in terms of knowledge regimes, training programs, and their mix of students, teachers, and professionals? And shouldn't we be suspicious of an analytic strategy that reads management practices off of worker positionalities, with the all-too-predictable result: The backyard, house-to-house, ecologically sensitive approach is "preferred" by PCHD's women public health workers, which stands in stark contrast to the "hard science" men at MCVC, equipped with their high-tech toys: traps, Global Positioning System devices, trucks, and spraying machines.

For this, it is best to be cautious about explanations that emphasize staff characteristics. What is more, as much as their biographies are always present in their rehearsals of institutional practices, like all performance (Butler 1990, 1993) theirs is not theirs alone but enunciated within citational regimes. These include legitimating narratives about societal risks and dangers to public health, modern science and technology, and the proper role of the state in protecting individuals. These provide not only the discursive tools for mosquito work but the means by which we, as interpreters, decode their subjectivities. And although no one performs the role of mosquito hunter in a position that transcends his or her location within a governmental hierarchy—or for that matter beyond his or her insertion into ideas about what constitutes proper management—we also know that with each overcoded repetition of identity, we are also likely to find slippages, disjunctures, refusals, and inchoate moments. Attributing a narrow causal pathway from personnel differences to management strategies overlooks these complexities, just as it washes over the myriad variabilities that are formed across a daily calendar filled with meetings, e-mails, phone calls, site visits, budget cuts, agency directives, and the like.

At another level, we could return to the wider urban contexts within which the PCHD and MCVC operate and from that draw explanations for the different management strategies. There is surely something to this mode of explanation. As a worker at MCVC said:

> We have a lot more people here, number one, than you do down there [in Tucson]. And I think that one of [the] things that happened here is we have a lot more areas that have been developed longer. So you . . . guys don't really permit people to have lawns. So you don't have over watering, you don't have water running down drains to collect in underground connected systems. There are a lot of valid reasons why you could have a very different [management] environment.

To be sure, Tucson and Phoenix do differ on many environmental, sociocultural, and political fronts, and a number of these could be valid explanations for institutional differences. Disentangling each factor's potential in an explanation of this sort, however, would require holding constant a variety of already coupled human–environment variables: more people, traffic, money, lawns, reservoirs, and industrial agriculture in Phoenix;

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more rainfall, lower temperatures, a ruttier topography, and a more eco-conscious population in Tucson. Nor is it possible to perform a policy experiment: We will never know how effective PCHD's strategy would be if implemented in Phoenix, nor do we know how many cases of WNV would be prevented by adopting MCVC's strategy in Tucson (see Smith, Dushoff, and McKenzie 2004).

Then there is the insect itself: To quote Mitchell (2002, 19–53), "Can the mosquito speak?" For, if abatement strategies cannot be reduced to the agency of staff members or to the institutions' socioenvironmental contexts, then what remains is the biological actor in its own right.[13] As mentioned earlier, WNV came to Arizona in 2003, and in 2004 Maricopa County experienced an unprecedentedly large outbreak of more than 350 cases. As one worker from PCHD explained to us, MCVC was "really under pressure to do something that the public could see." Faced with an anxious public that had never experienced a WNV epidemic, MCVC turned to an intensive and immediate solution: annihilation of the vector. The response came in the form of raising the number of fogging trucks delivering high levels of adulticide to neighborhoods across the city. One worker who was present during the outbreak told us, "We hired a whole bunch of people to go out and fog in 2004, we had about a forty-person staff to go around fogging." The equivalent public health crisis did not, however, occur in Pima County. As an interviewee at the PCHD noted, "We didn't really have hundreds and hundreds of cases [Pima had seven confirmed cases] that would have forced the hand of the people way above us that make those kinds of decisions [to adulticide]." Although not wanting to overstate the influence of this outbreak, it seems that PCHD's and MCVC's divergent strategies were formed alongside the mosquito's agency. In this sense, WNV acted as an event that crystallized nascent institutional practices at each site. This finding parallels those of other human–environment studies that focus on the socially transformative capacities of nature and related materialities (Hinchliffe 2001; Perkins 2007; Robins 2007; Moore 2008). In such cases, it is not only social actors working on nature, but bits of nature producing social action.

Perhaps then the institutional divergences we encounter require an explanation drawn from an assemblage theory (DeLanda 2006; Robbins and Marks 2010) capable of accounting for the "machinic" aggregations that are the institutions themselves. As Colebrook (2002, 55–56) explained, "Deleuze uses the machine to describe a production that is immanent: not the production *of* something *by* something—but production for the sake of production itself. . . . Because a machine has no subjectivity or organizing centre it *is* nothing more than the connections and productions it makes; it is what it does." Within the institutions, for example, are the staff biographies and organizational settings, relations sealed by the glue of jurisdictional geographies, budgets and invoices, trappings and phenotypings, meetings and presentations. These, in turn, are all linked to the institutions' contextualization within and emergence from shifting sociocultural, political, and economic forces that invite or discourage spraying. Then there is the bug, a biological assemblage composed of antennae and palps that transduce a variety of ecological signals into millions of electrical impulses. Its swarms are unevenly distributed over the human–environmental contexts of Tucson and Phoenix, which are themselves constantly rearranging without so much as a nod to the mosquito or the diseases it vectors. All of these, meanwhile, are part of the longer term production of two different management regimes and their spatial ontologies, both developed long ago and far away from these contemporary sites of difference production.

Conclusion

This article addressed the disjunctive spatialities of mosquito transduction and institutional practices. We learned that (1) mosquito management strategies are highly differentiated, entwined not only with history, technology, and available chemical resources but the spatial ontologies that enable their mobilization; and (2) the actualization of this diversity in Arizona is the result of complex assemblages of human and nonhuman productions, including knowledge regimes, institutional settings, socioeconomic and political contexts, complex ecologies, and their emergent interactions. We believe, moreover, that the continued existence of this diversity is perforce guaranteed by the impossibility of capturing the ontological nature of the insect itself.

Such findings derail the reflex to impose normative prescriptions. As we have seen, vector management in Arizona is characterized by situated efforts to grapple with the "becoming-mosquito" (Deleuze and Guattari 1987), a process held together by scaffoldings of spatially complex, technologically limited, politically controversial, and ecologically surprising materialities (see, for example, Braun 2004; Whatmore 2006). As these are not stable or constructed differences, but the emergent productions of difference-in-itself (Deleuze 1994),

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it stands to reason that, from a practical point of view, any evaluation of management strategies must be open to the effectivities of both ecological and chemical approaches, as well as to their combination. Imposing a universal abatement strategy could—in practice and theory—limit the fields of solvability field workers can draw from and managers can mandate. The assemblings we have described, therefore, might therefore not be consistent with this simple question: Which management strategy do you prefer, PCHD or MCVC? Instead, the distinctiveness we encountered might be key to enabling adaptive reinvention in the face of realigning assemblages, such as new ecological conditions (e.g., climate change) and new political pressures (e.g., budgetary crises).

Not least, geographically speaking we commit a form of ontological bulldozing when we give in to either–or choices over mosquito management. This is because complexity in the world is not unraveled at some source; it arises in itself. The challenge such difference poses to geography is, quite simply, an ontological *indifference* to our categorizations. Privileging horizontality over verticality assumes that abatement worlds balance unprecariously on the disjunction between smooth spaces (or spaces of immanence) and striated spaces (or spaces of transcendence; see Deleuze and Guattari 1987, 474–500). Institutions, however, are machinic assemblages that constantly deterritorialize (or smooth) space in one instant only to reterritorialize (or striate) space in the next. Speaking of the difference between smooth and striated spaces, Deleuze and Guattari (1987) wrote:

> No sooner do we note a simple opposition between the two kinds of space than we must indicate a much more complex difference by virtue of which the successive terms of the oppositions fail to coincide entirely. And no sooner have we done that than we must remind ourselves that the two spaces in fact exist only in mixture: smooth space is constantly being translated, transversed into a striated space; striated space is constantly being reversed, returned to a smooth space. (474)

An alternative narration therefore requires careful examination of the ongoing transformation and mixture of the specificities of these spaces, coupled with grounded critical evaluation of their intended and unintended consequences in the world. We have seen, for example, how striated and vertical vector management is assembled through forms of institutional control that depend on passive and chemically tolerant citizen consumers. Simultaneously, smooth and horizontal mosquito control can be panoptic and disciplining, enrolling the public as self-policing subjects who carry out mutual surveillance and community control. Within the ontology of difference-in-itself, such socio-spatial alignments are necessarily contingent. Whether in the laboratory, the wetland, the office, or the backyard, assemblages come together to write and be inscribed by the bug's life, as well as by the social and political lives of their human neighbors and hosts.

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Notes

1. The process of transduction carries different meanings in diverse fields. In physics and engineering it refers to the conversion of one energy form into another; in genetics it involves the transfer of DNA from one microorganism to another via a viral agent; and in biology—relevant to the case here—it is the cellular conversion of one stimulus to another. All of these definitions share a processual understanding of change and conversion.
2. Transductively speaking, males have fewer olfactory sensory cells and are attuned primarily to the beating patterns of a female's wings, through what entomologists label the *Johnston organ* (see Boo 1980; Hancock, Foster, and Lee 1990; Ignell et al. 2005).
3. Today malaria kills a staggering 800,000 persons a year, most of whom are children in sub-Saharan Africa, and it causes serious illness in a further 247 million people (World Health Organization 2008b). Dengue ravages vast swathes of the earth's surface—more than 2.5 billion people are vulnerable to the disease, many of whom are

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in developing countries. In 2007, in the Americas alone, there were 890,000 reported dengue cases (World Health Organization 2008a), with a total of approximately 50 million cases worldwide responsible for 24,000 associated deaths (Zaim and Guillet 2002).

4. In this context it is worth noting that the word *malaria* stems from the Italian *mala aria*, or bad air.
5. In Spielman's and D'Antonio's (2001) fascinating historical account of the natural history of the mosquito, Ross's single-minded rush to prove that the mosquito was the malaria vector was bound up in national politics, something equivalent to a zoological space race that also involved Italian scientist Giovanni Battista Grassi and Canadian-American pathologist William George MacCallum.
6. *Exemplified* is a strategic descriptor, because as one reviewer of this article pointed out, "the history of mosquito control is complicated; it's hard to draw easy lessons from it." First, the relative influence of Gorgas and Soper is by no means settled—compare, for example, the historical accounts of Spielman and D'Antonio (2001) and Gladwell (2001) with Cueto (2007) and Packard (2007). Second, both Gorgas and Soper worked on mosquito control for decades, during which technology and scientific knowledge changed immensely. Hence, we should not be surprised to find, as the same reviewer emphasized to us, that neither fits into neatly packaged categories of spatial practice. And yet, we do find that at certain junctures in their lives, they exemplified management strategies at opposite ends of the abatement continuum.
7. Indoor residual spraying is a management strategy that combines the intimacy of door-to-door geographies with faith in a universal and chemical solution.
8. As E. Carter (2007, 2009) showed in his historical studies of mosquito abatement in Argentina since the 1890s, this divergence was similarly expressed in the opposition between a spatially intensive, ecological scientific strategy (*policía de focos*) and a spatially extensive, developmentalist, and authoritarian abatement method (*saneamiento*).
9. In addition to these insects, climate change and the mobile materialities associated with U.S.–Mexico trade might increase the potential for introducing new species such as *Aedes albopictus*, a dengue and yellow fever vector.
10. In terms of researcher-researched dynamics, we came away feeling that our interviews were relatively unconstrained by many of the uneven power relations often encountered in social science research. First, on both sides of the tape recorder were found educated employees of the state. Second, we guaranteed anonymity to all staff (hence, the job titles are concealed in the interviews). Overall, we found our informants to be earnest, enthusiastic about their work, and committed to their organization's stated goals.
11. See http://www.pimahealth.org/about/aboutus.html (last accessed 16 October 2009).
12. See http://www.maricopa.gov/EnvSvc/VectorControl/ (last accessed 16 October 2009).
13. What is more—and beyond what can be addressed here—is the fact that although all mosquitoes are transducers, they and the parasites they carry have vastly different ecologies.

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