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The mosquito's umwelt, or one monster's standpoint ontology

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ABSTRACT

Mosquitoes are able to vector malaria and other diseases across the planet, leading to hundreds of thousands of deaths each year. Not only is this a challenging management problem, we also find it to be underlined by an important philosophical problem, namely: the impossibility of controlling "life". Influential Estonian biologist Jakob von Uexküll wrote that every creature on Earth, from sea urchins to spiders, lives within a unique sphere of existence called an "umwelt", or "surrounding world". The umwelt defines the specificity of relations shared between an organism and its environment. Using this concept we complement existing work on monstrous natures in geography by arguing that "monstrosity" arises in the excesses and discontinuities between the mosquito's umwelt and the human efforts that seek to eliminate it. This finding arises from fieldwork undertaken with public health and vector control officials in the US state of Arizona over several years. Their focus on reducing mosquito breeding sites suggests the complex and emergent spatialities of the monstrous.

1. Introduction

Jacob Johann von Uexküll was born in Estonia in 1864 and spent his life as a biologist writing about animals. His contention was simple but no less radical: there is no clear "divide" between organisms and their environments, and to separate these two spheres is to miss their relationality. Instead, each organism is defined by its particular "umwelt" – its "surrounding world". Such a conviction was the antipode of prevailing (Darwinian) scientific worldviews, which, for Uexküll, reduced animals to robotic reflexes shorn from the habitats they dwelt within: "Whoever wants to hold on to the conviction that all living things are only machines should abandon all hope of glimpsing their environments" (Uexküll, 2010, p. 41). Uexküll's analysis pivots on the role that ecological "signs" play in the lifeworld of an organism. The stand-out example is the tick, the blood-sucking arachnid that patiently waits atop a blade of grass for a passing animal. It only responds to three signs: the odor of butyric acid (given off by mammals), the temperature of 37 °C (corresponding to the blood of mammals), and the feel of exposed flesh. Uexküll thus fused biology with semiotics—leaving a legacy that would impress itself on philosophers ranging from Heidegger and Merleau-Ponty to Deleuze and Guattari. For anthropologist Tim Ingold (2000, p. 4, emphasis in original), the idea that organisms and environment interpenetrate each other was a profound realization: "if *every organism is not so much a discrete entity* as a node in a field of relationships, then we have to think in a new way about not only the interdependence of organisms and their environments but also about their evolution".

Such an appreciation of the umwelt is nowhere more important than with the mosquito, whose micro-breeding spaces continually defy human control and eradication. From their Jurassic beginnings some 100 million years ago to their stubborn persistence today, mosquitoes are a permanent feature on the planet. And for the insect itself—of which there are some 3500 species worldwide today—the human being has proven ideal prey: an easily penetrable blood source that is vital for its continued reproduction. This intimate coupling, which has claimed millions of lives historically, continues to be a fatal attraction. As a vector for the malarial parasite, the *Anopholes* genus is responsible for claiming around one million lives a year, while causing serious illness in a further 250–500 million people—90% of whom live in sub-Saharan Africa. Additionally, one in three people in the world live in a dengue active region, a disease carried by the *Aedes* mosquito that causes illness in 100 million people each year (Center for Disease Control, 2010a). Other potentially deadly diseases mosquitoes vector include *arboviral encephalitides*, such as St. Louis, West Nile, La Crosse, Eastern Equine, Western Equine, and Japanese encephalitis, most of which are spread by *Culex* mosquitoes (Center for Disease Control, 2010b).

Efforts to control mosquitoes have persisted throughout human history, even before humans knew they vectored diseases (Spielman and D'Antonio, 2001). But once that fact was definitively proven in the late 19th century, public health officials, military

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leaders, and politicians embarked on a worldwide strategy to eliminate mosquitoes, which had transitioned, by the early 20th century, from mere nuisances to deadly enemies. In the early 1960s, over a hundred countries participated in the World Health Organization's (WHO) "The World United Against Malaria" campaign, a global program designed to eradicate malaria and raise public awareness. As part of this strategy, special postage stamps were issued, using mosquitoes as visual themes. Johnston and Fritz (1963) examined these different stamps and found that the WHO's campaign was often represented in warlike terms as a clash between humanity and mosquitoes (see Fig. 1). Such apocalyptic metaphors were not only mobilized in various nationalist projects (Caprotti, 2006; Carter, 2007, 2008), they were also mirrored in political and scientific debates over mosquito control (e.g., should martial law be invoked to achieve "species sanitation"?). Even today discussions continue to center on whether larval (i.e. habitat reduction) or adult (i.e. death by chemicals) control is most effective (Luck et al., 1977; Shaw et al., 2010). The near future points toward genetic engineering as an additional solution, with entomologists at the University of Arizona recently declaring that they have successfully engineered the world's first "malaria-proof" mosquito (Stotle, 2010). Similarly in the UK, a British company called Oxitec is developing "sterile males" for release. These genetically engineered bugs follow a long-lineage of animals spliced and diced with different DNA concoctions (Dixon, 2008; Davies, 2003, 2013; Thompson, 2005).

Small wonder, then, that mosquitoes are often referred to as "little monsters". Such a label is of course evocative of fictional figures, from werewolves roaming in forests to many-headed hydras plaguing Greek legends. Indeed, geographers have recently directed attention toward understanding precisely how the boundaries between "fictional" and "real" monsters are established and maintained by scientific practices and knowledges (e.g., Davies, 2003; Dixon, 2008). In the course of doing so, they have found useful both poststructuralist and psychoanalytic approaches, in which monsters are theorized as posing *epistemological* threats to discursive and symbolic orderings as they go about disrupting the fields of subjective reality (Derrida, 1988, 1997; Foucault, 2003a; Žižek, 1999; 2006a,b). In Foucault's words, "...the monster is the transgression of natural limits, the transgression of classifications, of the table, and of the law as table: this is actually what is involved in monstrosity" (Foucault, 2003b, p. 63).

Our engagement with the mosquito thus adds to an established literature on monstrosity that seeks to destabilize some of the central and enduring pillars of Western philosophy: the superiority of transcendence and Cartesian dualism, the ordering of things, and the insistence on discrete elements (Derrida, 1988, 1997; Foucault, 2003a; Deleuze and Guattari, 2004; Haraway, 1991, 1992, 2008; Latour, 1993; Whatmore, 2002, 2006). It also contributes to the list of nonhuman (and often hybrid) nature 'objects' that geographers and others investigate, from cockroaches (Biehler, 2009), dogs (Haraway, 2008) and elephants (Lorimer, 2010) to lawns (Robbins, 2007). In this sense, we do not stray too far from Latour's (2005) observation that object-oriented analyses are not new. To be sure, geographers have long taken up bits of and pieces of the planet in their analyses of difference. But here we hint at a deeper, more philosophically inflected finding: that the monstrous emerges *through* the distinctiveness and particularity of umwelts. Inspired by the work of Harding (1986) and Harstock (1986), who invite us to think of knowledge as a kaleidoscope of different standpoints, we put forward the concept of an organism's "standpoint ontology" – a term aimed at capturing the specific, even idiosyncratic umwelts of life itself. This perspectivalism is not anthropomorphized as emergent from within thought or reason, but—following Deleuze—is considered at the level of the molecular. Such a molecular conception of the mosquito's lifeworld is, we argue, central to understanding its monstrosity.

Our theoretical argument is informed by fieldwork carried out in Arizona between 2006 and 2011. The fieldworkers, managers, and health officials we spoke to all expressed the difficulty in eradicating an organism that dwelt within a completely different world to ours, despite the fact that humans and mosquitoes share the same physical space, from bedrooms to backyards. This foremost suggests the spatiality of the monstrous, an individuation emergent from the difference that is the umwelt.

Fig. 1. Tunisia's 1962 'The World United Against Malaria' stamp.

2. A multiplicity of monsters

> "It is called a mosquito—pronounced *moskeeto*—and it is, perhaps, the most tormenting, the most persevering, savage, vicious little monster on the face of the earth. Other flies go to sleep at night; the mosquito never does. Darkness puts down other flies—it seems to encourage the mosquito. Day and night it persecutes man and beast, and the only time of the twenty-four hours in which it seems to rest is about noon, when the heat puts *it* down for a little. But this period of rest strengthens it for a renewal of war during the remainder of the day and night. In form the mosquito very much resembles the gnat, but is somewhat larger. This instrument of torture is his nose, which is quite as long as his body, and sharper than the finest needle" (Ballantyne, 2007, np).

From bedtime beasts to vampiric vectors, monsters roam the popular imagination. But they also stalk philosophical landscapes, posing challenges to modes of thought that clamber for certainty. In this section we briefly explore a few intertwined approaches to monstrosity. Whether pivoting on the leftovers from the "order of things" or on the unsettling pleasures and fears that arise in crossing the borders of psycho-sexual normativity, monsters are often unified in the disruptions they bring to epistemic "truths". Our purpose in discussing these disruptions is not to be comprehensive, but rather to signal the monster's historical presence within the deepest recesses of Western thought. It is also to set the stage for a complementary reading of monstrosity situated in the thought of Uexküll.

Foucault's life work revealed the discursive systems through which ab(normality) was produced and maintained, whether in terms of sexuality, criminality, or sanity. In doing so, he critiqued the entrenched logics that structured post-Enlightenment thought and practice (see also Derrida, 1995; Haraway, 1991). And indeed, one might say that the monstrous was a central part of the architecture of Foucault's thought: "The monster is problematic,

challenging both the medical and the judicial system. It is around the monster that the entire problematic of abnormality is set out... The monster is the fundamental figure around which bodies of power and domains of knowledge are disturbed and reorganized" (2003b, p. 62). Foucault's collected lectures, *Abnormal: Lectures at the College de France, 1974–1975*, set out a variety of monsters: moral monsters, political monsters, juridico-biological monsters, and monsters of criminal psychiatry (Foucault, 2003b). All of these are aberrations of the norm – a threat to the political and social *status quo*: thus, "Monstrosity requires a transgression of the natural limit, of the law-table, to fall under, or at any rate challenge, an interdiction of civil and religious or divine law. There is monstrosity only when the confusion comes up against, overturns, or disturbs civil, canon, or religious law" (Foucault, 2003b, p. 63).

In this sense, Foucault's monsters fundamentally challenge sedimented discursive practices. They frequently name a mixing of "natures" (such as human and animal kingdoms), transgressing the legal instruments that police the borders of the "natural". This inability to recognize an unnameable difference exterior to classification, bundled within an anxiety over the strange, leads Dixon (2008, p. 686) to conclude that: "The monster has been and still is an accomplished means of ordering difference. This is achieved not through a binary process of inclusion and exclusion, but rather through a refusal of the ordering principle itself. The monster is to be located in its own taxonomy, inviting horror and suppression but also, sometimes, empathy and pity".

Thus, in contrast to the dialectical interfilliations of co-constitutive productions based on the "trace of the Other" that Derrida describes (see Dixon and Jones, 1998), here Dixon points to the unclassifiability of monsters, a unique taxonomy that rejects "the ordering principle itself". Derrida's hybrids, while composite figures, anticipate Dixon's point, for they are "heterogeneous organisms that are grafted onto each other" (Derrida, 1995, p. 385) and not the sort of "always already" monsters that arise from *différance*. Yet this is not to say that monsters cannot be tamed, for as Derrida was to write, although the "the notion of the monster is rather difficult to deal with, to get a hold on, to stabilize" (Derrida, 1995, p. 385):

> "... as soon as one perceives a monster in a monster, one begins to domesticate it, one begins, because of the 'as such' – it is a monster *as* monster – to compare it to the norms, to analyze it, consequently to master whatever could be frightening in this figure of the monster. And the movement of accustoming oneself, but also of legitimation, and, consequently, of normalization has already begun" (Derrida, 1995, p. 386).

While the Foucaultian–Derridian monstrous is characterized by an anxiety over unnameable amalgams, psychoanalysis locates the monstrous within the field of subjective reality itself. Lacan articulated the trauma of confronting the Real beyond the mediation of symbolic interaction, an unbearable Real that is itself at the core of human subjectivity (Lacan, 2005; Žižek, 1999). This hysteria is induced by the essential 'voidness' of human existence—a terrifying *lack*—that is captured most forcefully in Žižek's use of Hegel's 'night of the world':

> "The human being is this night, this empty nothing, that contains everything in its simplicity—and unending wealth of many representations, images, of which none belongs to him—or which are not present. This night, the interior or nature, that exists here—pure self—in phantasmagorical representations, is night all around it, in which here shoots a bloody head—there another white ghastly apparition, suddenly here before it, and just so disappears. One catches sight of this night when one looks human beings in the eye—into a night that becomes awful" (Hegel, cited in Žižek (1999, pp. 29–30)).

Psychoanalysis often contains reference to these partial objects, these "bloody heads" and "white ghastly apparitions". Lacan terms them *lamella*, the monstrous undead, the indestructible Things that embody the terrifying void of existence. The lamella "... stands for the Real in its most terrifying dimension, as the primordial abyss which swallows everything, dissolving all identities" (Žižek, 2006a, p. 64). Aside from the more obvious linking of the lamella with Ridley Scott's *Alien* (1979), Žižek (2006b), famous for relating psychoanalysis to popular culture, applies his monstrous theory to Alfred Hitchcock's cinematic masterpiece, *The Birds* (1963). The winged creatures are not the uncategorizable monsters of Foucault and Derrida (as one might interpret the Frankenstein hybrid of Mary Shelley); they are the impossible eruptions of the Real that fly into the Oedipal living rooms and children's playgrounds of California's Bodega Bay—a place torn apart by a rain of terror.

These contributions to understanding the monstrous—while by no means exhaustive—point to the monster's central place in Western philosophy and imagination. Hybrid, disruptive, and eruptive, the monster is a catalyst for change and anxiety. But, as we argue here, these understandings, overlain as they are with anthropocentrism, can mask a monstrosity that emerges precisely from the attempts to control a world that is (in)different to ours.

3. Uexküll's umwelt

Uexküll is guided by surprisingly simple observations and questions. For example, what is the world of the mosquito like? What about the tick? And how exactly does a dog perceive its world? For the Estonian biologist, these are questions that should lie at the heart of biology. But at the time of writing, Uexküll was up against the domination of Darwinian theory, which for him at least, prescribed an overly "vertical" approach to biology, reducing animals to their genetic, temporal, and evolutionary qualities, to the detriment of their spatial, organismic, and ecological features (Kull, 2001). And this is why Uexküll is of such importance to geographers, for he emphasizes the unique spatial relations of animals through his concept of the umwelt – meaning environment or surrounding world.

Uexküll insisted that there is not a single environment, a single space, or a single time – but as many spaces and times as there are species of creatures. Describing the mosquito's umwelt, he illustrates this point as follows: "When mosquitoes dance in the sunset, they do not see our big human sun, setting six kilometers away, but small mosquito suns that set about half a meter away. The moon and stars are absent from the sky of the mosquito" (Uexküll, 2001a, p. 108). Uexküll thus argued that animals are not objects that operate in a world of causal chains and blind survivalism, but *subjects* that perceive and act from the standpoint of their own, unique world. In his words, "Every subject spins out, like the spider's threads, its relations to certain qualities of things and weaves them into a solid web, which carries its existence" (2010, p. 53). This web-like connection between creature and umwelt is a product of difference. Each living thing possesses unique "signatures" of existence called "functional cycles" that name the particular stimuli that it perceives and effects:

> "From the enormous world surrounding the tick, three stimuli glow like signal lights in the darkness and serve as directional signs that lead the tick surely to its target. In order to make this possible, the tick has been given, beyond its body's receptors and effectors, three perception signs, which it can use as features. Through these features, the progression of the tick's actions is so strictly prescribed that the tick can only produce very determinate effect marks" (Uexküll, 2010, p. 50).

The radicality of Uexküll's biology should now be coming into focus: there is no single space or universal time, but rather a kaleidoscope of worlds called umwelten (umwelts). The mosquito shares the same physical space as a human being, yet is only cued into certain signs; its life is worlded differently. In this sense semiotics are not simply textual devices or superior human inventions, but are materialized within the very functioning of life. This is not to argue that mosquitoes and ticks are thinking *a priori* subjects that exist independently of the world – it is instead to argue for an *a posteriori* subject-object dyad; an umwelt of sense organs and bits and pieces of nature. As Bains (2001, p. 145) puts it, the reality of experience "...is neither reducible to the mind's own workings (e.g., as in the Kantian synthesis) nor to that of a prejacent external physical world in which the mind has no part. It is a limitless interface where the line between what is and what is not independent of interpretive activity is a continually shifting semiotic process". Accordingly, "All living beings have their origin in a duet" (Uexküll, 2001b, p. 118). Uexküll illustrates this contrapuntal relationship by reference to the spider:

> "In the case of the spider's web it is easy to point out the properties that are contrapuntal to the fly. Here we have the strength of the threads that have to withstand the collision of the fly, and the thinness of the threads to make them invisible to the fly. The threads are of two kinds: smooth radial ones that the spider uses as steps and sticky ones that are for catching flies. The mesh of the net is also matched to the size of the fly's body" (Uexküll, 2001b, p. 122).

Uexküll's theoretical biology would inspire many after him, and his work still retains a certain freshness and verve. Yet his legacy is controversial. He insisted that life was guided by a "plan" and his biology is underwritten by musical metaphors of harmony and orchestral melodies that can feel at odds with his otherwise immanent instincts. For example he writes: "...umwelten intersect in many ways without disturbing each other. They do not interact mechanically but are still connected according to a plan as the notes of an oratorio are harmonically connected. It is thus musical and not mechanical laws that we need to study if we want to find out about the laws of Life" (Uexküll, 2001b, p. 117). On the one hand then, his "master plan" takes him very close to "intelligent design" or creationism. Yet on the other hand, his emphasis on the inner-worlds of animals and the causal priority of the whole over the parts is consonant with modern science and a useful challenge to Darwinian mechanics. As Sagan (2010, p. 7) concludes: "One need not embrace a transcendental master plan or nature moving towards a unified single goal (e.g., God, or the end of history) to see purposeful activity deeply embedded in living things, and emerging often in diverse, unpredictable ways".

4. Towards a standpoint ontology

If Uexküll asks us to see the world through the perspective of ticks and mosquitoes, then the Deleuzian challenge is to go one step further: to see the world in its *molecular* unfolding. Deleuze and Guattari (2004, p. 283) wrote that "Von Uexküll... looks for the active and passive affects of which the animal is capable in the individuated assemblage of which it is part". Their philosophy intersects with Uexküll's theoretical biology in notable ways, particularly in defining animals in terms of their ability to affect and be affected by the world. For Deleuze and Guattari, this resulted in defining ethology, the study of animal behavior, as the ontological study of affects. As Buchanan (2008, p. 190) writes: "... rather than thinking of animal lives in terms of strictly defined patterns of embryology or behavior, Deleuze finds in Uexküll a fellow Spinozian ethologist already engaged in counting the affects of animal becomings. Whether this is addressed at the level of molecules, sensations, organism, milieus, or territories, being can be said univocally across the plane of nature". In other words, Deleuze saw that an animal *is* what it *does* with the world: "every point has its counterpoints: the plant and the rain, the spider and the fly. So an animal, a thing, is never separable from its relations with the world" (Deleuze, 1988, p. 125).

Both Uexküll and Deleuze ask us to see animals and their worlds as mutually constitutive. This descent into the world of organisms also invites us, in line with contemporary geography aimed at challenging the supremacy of the human (Braun, 2004; Whatmore, 2006), to see monstrosity not simply as an affront to our established systems of reason, *but from the perspective of the monster itself*. For us, this perspectivalism is not located within thought or reason, but within the molecular relationship between an organism and its umwelt: what we call a "standpoint ontology". Our reference here, of course, is to the feminist standpoint theories that discern all knowledge as socially situated, contextual, and highly uneven in both its production and distribution (Harding, 1986; Harstock, 1986). Such a politically inflected understanding, centered on the role of gender, colonialism, class, and race, suggests the irreducible particularity of knowledge claims, in contradiction to universal, transcendent, and scientific worldviews. In broadening this charge to ontology, we see lived experience as unavoidably partial and fragmented: as very particular experiences of "being-in-the-world". To understand the mosquito's standpoint is thus to delve beneath molar forms and discover a world of chemicals, ions, and sparks: where environment and organism pulsate together. For example, when it lands on the warm flesh of a human, it does not perceive a human 'as such,' but an immanent set of signs unique to its standpoint, which in turn triggers a set of sensory and affective responses. As Buchanan (2008, p. 36) describes:

> "We assume things, entities, beings, substance. But it would seem that the relations do not involve 'individuals' per se; instead they are a means of connecting an olfactory organ with a temperature, or a web with a line of flight, one melody and rhythm with another. By emphasizing relations, and the ontology of these relations, Uexküll opens the way for a critique of bodies as individual entities by way of the Umwelt".

For the mosquito, the ontology of these relations with the world is centered upon biological *transduction*: the conversion of molecules from one state to another—usually the translation of chemicals in the mosquito's umwelt to electric signals in its body. The nervous system of a mosquito or any living thing functions to detect and react to events sensed in the environment. Usually, sensory cells respond to alterations in cellular membrane potentials, which then produce action potentials commensurate with the intensity of the stimulus. Understanding how the mosquito works on a molecular level is important, and not just for theoretical reasons; there is a significant epidemiological payoff. As Zwiebel (quoted in Salisbury (2001, online)) describes: "The mosquito is the most dangerous animal on the planet. It relies on its sense of smell to find the source of its blood meals. So understanding how its olfactory system works at the molecular level should suggest new and novel ways to keep it from spreading catastrophic diseases".

At least part of the mosquito's reputation as a monster centers on its vampiric extraction of human blood. This process, vital to its reproduction, is guided by a long-honed ability to sense mammalian traces, particularly carbon dioxide (carboxylic acid) and body odor (lactic acid). Fig. 2 is an image taken from a scanning electron microscope, and illustrates the mosquito's impressive system of olfactory sensors. The two feathery feelers are the mosquito's antennae; the proboscis is a needle-like tool used by females to ex-

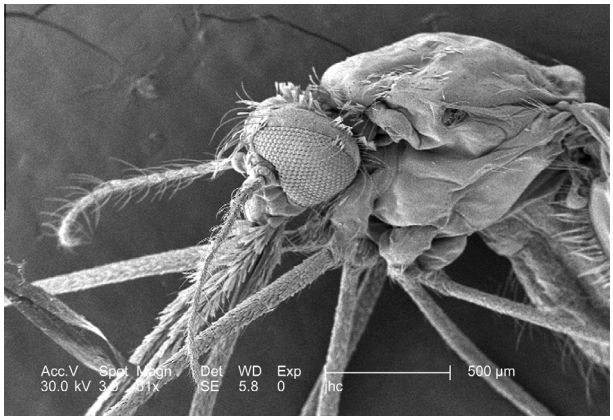

Fig. 2. *Anopheles gambiae* mosquito head. *Source*: Centers for Disease Control Public Image Library, courtesy of Janice Haney Carr.

tract blood; and the maxillary palpi found on either side are responsive to carbon dioxide emissions. Like hundreds of "nostrils", specialized "grooved peg sensillum" function as lactic acid receptors. In the words of Salisbury (2007, online): "The mosquito's elaborate 'nose' consists of hundreds of hollow hair-like structures called sensilla attached to its antennae, maxillary palps and proboscis. The tips of these structures are perforated with thousands of tiny holes that let aromatic compounds penetrate to their interior, where they encounter thread-like extensions from neurons which are tuned to detect specific molecules".

The sensilla extending along the mosquito's "nose" connect to the dendrites of olfactory receptor neurons. It is here that odorant receptor proteins, themselves coupled to "G-proteins" that populate the plasma membrane of the cells, react to chemicals in the air. After a receptor has bound with an odorant it changes to activate its coupled G-protein, causing enzymes downstream to catalyze the ionic balance within the cell, leading to a neuronal membrane potential – an electrical charge that produces action potentials – the language of nervous systems (Zwiebel and Takken, 2004). This electrical information is integrated in the mosquito's tiny antennal lobe (Ignell et al., 2005), and the zigzagging flight of the mosquito towards its target is intensified. Upon landing on the skin of its mammalian blood meal, the insect chooses a site that is the most accessible to facilitate the easy extraction of blood – the protein substance needed for development of its eggs. Since less than 5% of human skin contains blood vessels, the mosquito

Fig. 3. *Aedes aegypti* engorged with blood. *Source*: Centers for Disease Control Public Image Library, courtesy of James Gathany.

"fishes" (in 10 s intervals) with its sharp proboscis until a vessel or capillary is struck. After this feast, the female mosquito becomes relatively inactive and ceases its host-seeking, the result of stretch receptors firing in its now massively swollen abdomen (Fig. 3; Bowen et al., 1988; Takken et al., 2001). After a successful blood meal the female mosquito must then detect a suitable body of water to lay her eggs—a process known as oviposition.

The location of an oviposition site is essential to the lifecycle of the mosquito, and indeed, as Bentley and Day (1989, p. 402) note, "Electrophysiological studies have demonstrated that as the blood meal is digested in *Aedes aegypti*, neurons sensitive to host-produced cues, such as lactic acid, become less sensitive, while neurons sensitive to oviposition site attractants, such as methyl butyrate, become more sensitive". Oviposition involves visual, olfactory, and tactile responses. As Ponnusamy et al. (2008, p. 9262) summarize, "Visual cues associated with the oviposition site attract gravid mosquitoes from a distance, and olfactory cues guide the female to water-filled containers; upon landing, contact with the water surface stimulates the female to oviposit". Some mosquito species are very selective in their choice of oviposition site, whereas others are far more opportunistic and can breed in all sorts of artificial containers—much depends on the mosquito's detection of bacteria and microbial levels in the water through its chemoreceptors. For example, water with fresh leaf or grass infusions was more attractive to *Aedes* than water without it (Santana et al., 2006); and *Aegypti* are known to skip over suitable containers if other *Aegypti* eggs are already there (Chadee et al., 1990). The intricacy of oviposition suggests the mosquito's radically unique standpoint. It further suggests the importance of breeding sites to disease transmission: "Because mosquitos return to water to oviposit, water bodies become a starting point in the search of a blood meal host" (Le Menach et al., 2005, np). Even non-suitable water bodies still attract mosquitos, which leads Le Meach et al. to conclude that "an intervention that eliminates water where mosquitos may oviposit, or fouls the water to deter oviposition, would be more effective for malaria control than using larvicide to reduce mosquito density."

This truncated overview of the standpoint ontology of the mosquito is aimed at teasing out the unique and molecular "signs" the insect detects in its surrounding world. The mosquito dwells in an umwelt far removed from our own, tuned into the carbon dioxide plumes seeping from the nostrils of a dog or to the pH of water collecting in an abandoned bird bath. The bug's ability to detect mechanical, thermal, and chemical signs is embodied in a highly specialized architecture that has evolved over millions of years. As Uexküll states: "Each sensory organ has, as we have seen, a sensory sphere of its own" (2001a, p. 108). The mosquito *is* its umwelt – a molecular transduction of chemicals and sparks triggered by the insect's specific standpoint within the world.

Such a world of pure immanence is not only a philosophical challenge—it is also a practical challenge to mosquito control and management. For in the encounter between insect and human, the mosquito's umwelt far exceeds our cartographies of control (Shaw et al., 2010). And so far, no amount of chemical spraying, environmental control, or genetic modification has extinguished the mosquito's sphere of existence. It is within this relationship of gaps and excesses, between mosquito and human standpoints, that the monster is born. Such a bug is not monstrous because it is a Minotaur-esque hybrid, a mixing of human and animal kingdoms (Haraway, 1991); it is not a strange text or a yet-to-arrive future (Derrida, 1995); nor is the insect synonymous with the worms wriggling beneath the suburban façade of David Lynch's *Blue Velvet* (1986; Žižek, 2006b); nor, finally, is the mosquito a social deviant – a madman, a masturbator (Foucault, 2003b). Rather, the mosquito is monstrous because it *escapes* and *defies* the standpoint ontology of human control.

5. The monster killers

Arizona has long provided residence for mosquitoes (Robbins et al., 2008). Complaints in territorial Arizona about mosquitoes were common during the earliest records of missionaries and settlers in the 18th and 19th centuries. During the mid-20th century mosquito populations declined as industrial agriculture lowered water tables and reduced the number of wetlands. This decline was accelerated by the early testing of the insecticide DDT. It was only from the 1980s onwards that numbers started to surge, as large-scale suburban development provided swimming pools, roof gutters, and the discarded desiteratum for mosquito colonization. Today the state is home to all three of the bug's principal genera: the *Anopheles*, *Aedes*, and the *Culex*, the primary vectors of malaria, dengue, and West Nile virus, respectively. Accordingly, the bug is treated as a serious public health threat, as it continues to claim lives year upon year. West Nile virus, the world's most widespread arbovirus, arrived in the US in 1999 (Kramer et al., 2008), and nearly 400 cases were reported in Phoenix during the summer of 2004.

In what follows, we present the views from personnel positioned throughout Pima County Health Department (PCHD), Maricopa County Vector Control (MCVC), the Arizona Department of Health Services (AZDHS), and the City of Phoenix, who were interviewed between 2006 and 2011. Interviews followed semi-structured questions, and included one group meeting in the summer of 2011. All interviews were recorded and then transcribed by the authors. The interviews were undertaken as part of a larger project bringing together entomologists, climatologists, biogeographers, and political ecologists to better understand the dynamics of mosquito management in the state of Arizona, especially under changing vegetative and climatic regimes. Our focus in the beginning of the project was the spatial ontologies of mosquito management (Shaw et al., 2010). But this soon evolved as the unruliness of the mosquito's environment became ever more a starting point for our conversations. Indeed, one of our biggest surprises when interviewing health officials and fieldworkers, and what drove us to arrive at the umwelt as our central analytic, were the repeated references to the bug's breeding environment as a management problematic—over and above references to the mosquito itself. In short then, what we learned through our interviews was that the monstrous was inherently "spatial". Of course, alongside this spatial understanding was a more explicitly monstrous thematic. Colorful language abounded when describing them as a public health nuisance. One public health official remarked that "they're nasty...I'm looking at the little 'fight the bite' sticker over there, and yes, I want to fight you!", later adding "if you open your door they can fly in right away and fly out at any point, feasting on human blood. That is something that makes them harder [to manage]". The "swarming" capacity of mosquitoes was remarked upon by one vector control official, who stated that the public is scared of "being swarmed" by the bugs in their home.

As already noted, the female mosquito can oviposit in a range of different bodies of water, from discarded soda cans to temporary water puddles following a summer monsoon. This creates nearly overwhelming management problems, since it is impossible to ever fully account for both the spatial heterogeneity and extent of these breeding sites. As one PCHD health official frames this emergence: "I know that mosquitoes can survive in a bottle cap filled with water, so they're pretty hardy and they'll find anything, anywhere, any niche they can find they'll use it and exploit it". A vector control worker added that: "Any surface, brackish water, anywhere, is the perfect breeding site for mosquitoes. It's like, between them and the cockroaches, they're going to be here forever"! Such persistence—rivaling even the cockroach—was also touched on by another employee at the Tucson-based agency: "Chances are in a week's time, out of one puddle, ten thousand mosquitoes or more can hatch and become adults". Another PCHD public health official was blunt with their diagnosis: "We sometimes leave them no other option. We have all this water right outside our house, right outside our door in our backyard, so what are they gonna do? We're giving them a meal on a silver platter – ourselves. If we can learn how to prevent that then we won't be an accidental host. That's what we are with West Nile virus. They don't really want us, but they're like 'oh I can bite you and not have to fly a mile, sure! I'll bite you!'" At MCVC, this vector control problematic was put succinctly by a manager: "The problem with *Aedes aegypti* is once it is in place it's damn near impossible to get rid of".

There was also a sense that the mosquito's umwelt—while overlapping with the bits and pieces of our world—was simultaneously *different*: what may look like backyard trash from our standpoint, is an ideal breeding site for the bug. Speaking to this, a vector official from PCHD said "I think the humans are the biggest problem, it's in their own backyard; buckets, tires, pools not being maintained, overwatering, are all big problems in the city". Echoing Uexküll's lesson that the same objects can be worlded differently by different living things, many health and vector officials asked the public to "think" like a mosquito and see the world through the standpoint of the bug. One PCHD health official told us that: "I think also that would be so helpful for people to try to get in their [the mosquito's] head, so they're like 'oh I see, so now I'll do this and this so they don't want to find this interesting or comfortable'", adding "It would be important for everybody to see it like that. If we [public health officials] saw only not the human component but also the vector component together [speaking to thinking about the bug's perspective], we could probably create better strategies". The disjuncture between two standpoint ontologies, the human and the mosquito, was a gap that public education strategies often tried to overcome: education leaflets showing a cartoon of a backyard with all the micro-scale spaces of the mosquito was one such strategy in Tucson.

The mosquito is able to instantly adapt and readapt to changing environmental forces such as fresh rainfall or the passing of a human host. Such complexity means that accurate spatial prediction—such as that provided by commercially available GIS products specifically designed for vector control—is extremely difficult. At the state-level health organization, the Arizona Department of Health Services, one manager told us about the underlying futility of accurate predicting: "I think there are too many variables, which makes this mother nature very unpredictable, she's kinda [going to do] what she's going to do and all we can do is keep this surveillance going to try and identify the risks and address them as they happen". At PCHD and elsewhere mapping was viewed as essential for prediction and control. As one worker told us: "I think [mapping is] going to be one of the most important tools," adding "the spatial [perspective] allows us to actually do some prevention". Yet, on the other hand, the public are still "at risk everywhere" given that mosquito-borne problems are "not something you can control". After funding a study that would attempt to identify and correlate nuisance mosquito spaces, the same manager from AZDHS admitted:

> "As it turns out, we really didn't have much of correlation for much of the things; we would have predicted that the older neighborhoods that still had the irrigation and had all the big tree canopies, all the birds around the property and so forth, probably had higher humidity, we were really thinking those would probably come out to be. That was our hypothesis. And it didn't really pan out to that".

Yet doing nothing is not an option at AZDHS, for as one official noted: "The analogy that I always use is that 'you don't wait for the enemy to overrun your front lines before you get your guns out'.

You want to start controlling it before it gets it". This military metaphor to describe mosquito abatement was shared at MCVC, where one manager said that "And that's what this job is, hunt them down and kill them". Such battle-speak was not uncommon among public officials.

Not only, then, is the mosquito's monstrosity a result of an umwelt deeply interpenetrated with our own—endlessly becoming different as our lifeworlds shift—it is at core a result of our *inability* to completely control it. Speaking of control strategies at PCHD, we find one worker putting it succinctly: "You can spray and knock them down, but then the next batch is waiting to hatch". Over at the City of Phoenix, one worker who dealt with wetlands for years reflected that: "You find them in fossils; mosquitoes they've been here forever. They're not going anywhere". The same employee also stated that: "I would go out there to those wetlands and I would spray to the maximum the label would allow me to per some equation. We'd drain them, we fill them back with water. We did everything. We worked on that for months and months and months. And we could not get the mosquitoes to stop breeding in there no matter what we did".

The mosquito, it seems, always persists; its monstrous reputation is at least in part due to its ability to escape strategies and tactics of control. As one vector control official from PCHD we spoke to said: "There's no way to get rid of them. We can control them, but eliminating them is a different story". Another vector control official reinforced this claim: "The most difficult part of controlling them is that [in the background another one says, "there's too many of them!", which is followed by laughter], they're such a hardy species, they're able to breed in anything". Vector management therefore relies on tools and technologies that do not (and cannot) fully capture the complexity of the bug's life and breeding cycles. Reflecting on the limitations of abatement and control, one vector official reported: "We have enough different types of products to handle any type of situation. But say if there's a vacant pool and lots of buckets and flowerpots and stuff, and you're trying to spread it, you might not get it into those spots. So even if you treat most of the pool, there might be that one little spot that didn't get it and is still breeding like crazy".

Our interviews revealed a type of monster that was continually able to elude, surpass, and exceed management efforts. And yet, one would think that modern, scientifically trained public health officials and mosquito control agents—although different in their backgrounds and approaches to mosquito management (Shaw et al., 2010)—would be the *least* likely to invoke metaphors of monstrosity. After all, these experts have an intimate knowledge of both disease ecology and mosquito habitats; equally, the chemical sprayers and GIS experts in MCVC rely on detailed geographic data covering well over 500 trapping sites throughout the county. Still it was not unusual for these managers and fieldworkers to occasionally slip into "monster-speak" when discussing the mosquito. The anxieties underlying such monstrosity arise from the diseases the bug vectors, its complex and immanent umwelt, and the difficulty of accurate spatial prediction. But most of all, the mosquito's monstrosity lies in the impossibility of complete control: the bug just keeps coming back, breeding "everywhere" and in "anything", despite the best efforts of health and vector officials.

6. Conclusion

The monster is pivotal to Western philosophy and imagination: hybrid and disruptive, a source of anxiety and abjection. In this paper we have defined the mosquito as *monstrous*, a term usually associated with fictional beasts, scientific experiments, epistemological outcasts, or psychological terrors. Yet our interviews with workers on the frontline of mosquito abatement in Tucson and Phoenix suggested that the monstrous was an inherently *spatial* construct, arising through the bug's immanent and emergent relationship with its umwelt. Because mosquitos are able to oviposit "anywhere" and in nearly "anything" dotted around the city, it was difficult to predict, much less control, their populations, which could explode in a matter of days. A chorus of personnel therefore singled out the mosquito's ability to elude and surpass apparatuses of control as a central concern. Mosquitos should not, therefore, be reified as "flying monsters". They are equally the very spaces that sustain them: from an exposed ankle to a discarded soda can. This is Uexküll's central insight: evolved over millions of years, the mosquito reduces our world of neighborhood streets, fences, and walls – and the warm bodies that occupy them – to a set of molecular signs. Understanding this monstrous standpoint is vital for managing the bug.

The umwelt is at once a biological, philosophical, and analytical device. It opens up a supposedly singular "nature" to a plurality of spheres of existence, which, like foaming bubbles, exist side-by-side without ever fully overlapping. It is this heterogeneous landscape where mosquitos and humans mingle: sharing the same bits and pieces of the planet, but "worlding" them differently. In our travels and talks with managers and fieldworkers, the innocent looking "bird bath" or "dog bowl" in a back yard became a source of anxiety—a possible location that a bloated female mosquito may lay her eggs after dining on a nearby human. What makes this banal example philosophically exciting is just how contingent the "material" actually is. Rather than being a concrete and intractable expression of an underlying purpose, the objects that we encounter on a daily basis are completely different "signs" for the mosquito, which takes a different "standpoint" to ours. Such a semiotics need not imply a transcendent heuristic or Kantian perspectivalism. After all, it was Deleuze who read in Uexküll's theoretical biology a way of understanding organisms as assemblages of affect that participate with the world in a molecular exchange that is as frantic as it is harmonious; unique as it is encompassing; elusive as it is obvious.

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