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Queer Love, Gender Bending Bacteria, and Life after the Anthropocene

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Abstract

The timeline of the Anthropocene – a geological epoch that Paul Crutzen and Eugene Stoermer say began in the late 18th century with the invention of the steam engine – seems like a brief and inconsequential blip, against the time scales embodied by the microbial communities. *Wolbachia* bacteria predate *Anthropos* by some 150 million years, and will likely outlast us. *Wolbachia* bacteria are worthy of their own geological epoch because they offer a fresh vantage point on one of the most pressing ethical questions of our time: 'How should we love in a time of extinction?' Narratives about the Wolbachiacene have the potential to disrupt the overwhelming stories of tragedy orbiting around *Anthropos*, with disquieting and generative accounts of interspecies romance. *Wolbachia* often perform queer tricks inside their invertebrate hosts. In some host species these bacteria induce parthenogenesis – completely eliminating males from the population. *Wolbachia* can also transform genetic males into reproductively viable females.

Keywords

Anthropocene, extinction, microbiopolitics, multispecies studies, posthumanities, queer theory

Hannah Arendt anticipated the current moment. While her contemporaries celebrated progress, and imagined a society where the human would be liberated by technology, she wrote about modern fairy tales gone awry. As many saw exciting possibilities for the human species emerging with synthetic chemistry and atomic energy, Arendt noted in *The Human Condition* (1958) that modern experiments were already starting to go astray. *Homo faber*, the builder of the world, had created an artificial environment by the mid-20th century that was starting to seem fragile,

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needy of care. Pointing to the possibility of a nuclear holocaust, Arendt wrote: 'there is no reason to doubt our present ability to destroy all organic life on earth' (Arendt, 1958: 3).

While Arendt's warning about the tragic tendencies of the human species is more salient than ever, new research in microbiology suggests that humans do not have the capacity to destroy all life on earth. Certain forms of life would likely survive and proliferate during a nuclear holocaust, even though this would probably mean extinction for birds, mammals, and reptiles. Penelope Boston, a microbiologist at New Mexico Tech, specializes in extremophiles – microbes that thrive in extreme cold, dryness, heat, pressure, radiation, or vacuums. She has discovered bubbles of air inside huge calcium sulfate crystals, inside extremely hot and abyssal caves, with living microbes inside. A 'geological genome bank' is trapped underground, in her words, which periodically reseeds the surface of the earth. 'Time capsules have been entombed in rocks for millions of years,' she told me (Penelope Boston, 2012, personal communication). Microbes would thus likely survive nuclear war or other threats to planetary ecologies, such as run-away global warming.

The timeline of the Anthropocene – a geological epoch that Paul Crutzen and Eugene Stoermer say began in the late 18th century with the invention of the steam engine – seems like a brief and inconsequential blip, against the time scales embodied by the microbial communities that are entombed deep underground. *Anthropos* – the creature situated between the divine and the bestial that Enlightenment Europeans conjured as inheritance from ancient Greece – appears as a tragic and shortsighted figure in accounts of this new geological era. 'In a few generations mankind is exhausting the fossil fuels that were generated over several hundred million years', write Crutzen and Stoermer, in the original article proposing a name for the current epoch. Even as *Anthropos* is tragically myopic, it is imagined to possess an outsized agency capable of embracing and endangering the entire planet: 'thirty to fifty percent of the land surface has been transformed by human action; more nitrogen is now fixed synthetically and applied as fertilizers in agriculture than fixed naturally in all terrestrial ecosystems' (Crutzen and Stoermer, 2000).

Viewing planetary destruction in terms of our species, blaming 'mankind' as an undifferentiated whole for the ecological problems at hand, risks distracting attention from the political and economic forces that are generating ongoing disasters. With the flurry of publications that have emerged under the banner of the Anthropocene, Eileen Crist suggests that there has been a 'poverty of our nomenclature'. The name of this era itself – Anthropocene, or the Age of Man – evokes 'the human-centeredness that is at the root of our ecological predicament' (Crist, 2013: 129). Jason Moore responded to these critiques by introducing the notion of the Capitalocene – moving beyond the claim that *Anthropos* is responsible for climate change and other ecological catastrophes. The elite,

who are relentlessly focused on capital accumulation and the pursuit of power, are having a disproportionate impact on global ecologies in the Age of Capitalism. Nature is being remade in the Capitalocene in ways that exacerbate inequality, imperialism, patriarchy, and racism (Moore, 2015: ch. 7).

A sense of tragedy, in the classic sense described by Hayden White (1992), runs through dominant discourse about the Anthropocene, as well as counter-narratives about flaws in human industrial, political, and economic systems. But this is not the only way to tell stories about our current historical moment. White insists that historical facts do not speak for themselves: 'One narrative account may represent a set of events as having the form and meaning of an epic or tragic story, and another may represent the same set of events – with equal plausibility and without doing any violence to the factual record – as describing a farce' (White, 1992: 38). Experimenting with alternate narratives, working beyond a politics of blame and shame, Donna Haraway invites us to forge surprising new connections and reconstitute old lively assemblages in an epoch that she dubs the Cthulucene, playing with the ancient Greek word *khthonios*, 'of the earth'. The human, in this epochal framing, is of *humus*, or propelled 'into the soil, into the multispecies, biotic and abiotic working of the Earth' (Haraway in Franklin, 2017: 2). Haraway's slogan for the Chthulucene – 'make kin, not babies!' – comes with a key question (Haraway, 2016): 'Who lives and who dies, and how, in this kinship rather than that one?'

Conservation biologists, animal lovers, and policy-makers who care about the environment have long recognized our kinship with others and have worked to sustain spaces of survival in the interstices of destructive assemblages. But despite the best efforts of caretakers, many nature refuges have become places characterized by unhappiness, violence, and frozen life (Abrell, 2016; Kirksey, 2015a; Radin and Kowal, 2017; van Dooren, 2014). If the Anthropocene/Capitalocene/Chthulucene comes to an untimely end, this could mean extinction for many life forms that we love. But if we kill ourselves, and those we love, a multitude of unloved others will continue with their own affairs (cf. Rose and van Dooren, 2011).[1]Many kinds of life are involved in their own interspecies love stories. Humans are not exceptional in our capacity to experience entangled empathy – many other creatures have an awareness of others' interests and a motivation to satisfy those interests (Gruen, 2013; cf. Haraway, 2008; Kirksey, 2015a).

As *Anthropos* races towards a possible catastrophic future, lively multispecies communities are already emerging in the wreckage of industrial civilization. Diverse forms of life are running wild beyond the limits of human ethics, hopes, dreams, and schemes. Microbes are constantly moving, hesitating, vibrating, spawning possibilities within a spectrum of fuzzy values (Serres, 2007: 161). Emergent forms of microbial life are

disrupting human agricultural, political, and economic systems, flying in the face of long-term human agendas (see e.g. Lowe, 2010). Microbes are also anchoring collective hopes (Kirksey et al., 2014a). One particularly interesting living figure of post-human hope is a gender-bending bacteria called *Wolbachia*.

Wolbachia bacteria are all around you. If you are reading indoors, these bacteria are likely inside the bodies of spiders and cockroaches lurking in the nooks and crannies of your room. These promiscuous microbes are found in many different groups of invertebrate animals (Figure 1a). *Wolbachia* could be living within mites in your hair – as parasites within parasites – or in nematodes within your gut, or in filarial worms in your blood. These bacteria also live in garden variety insects – including ladybird beetles, ants, and fruit flies – as well as more unusual animals – like amphipod crustaceans and isopods – subtly shaping the behavior and ecology of diverse forms of life.

Narratives about *Wolbachia* have the potential to disrupt the overwhelming stories of tragedy orbiting around *Anthropos*, with disquieting and generative accounts of interspecies love. *Wolbachia* pre-date *Anthropos* by some 150 million years (Werren et al., 1995) and will likely outlast us. Tragedy gives way to comedy, irony, and queer romance – other master tropes of historical discourse (White, 1999) – when one starts to seriously consider the past entanglements and possible futures of *Wolbachia*. If the Age of Capitalism ends with *Anthropos*, these bacteria will likely continue to be a dynamic and ongoing symchthonic force for recuperation and recomposition against the backdrop of irreversible losses (Haraway, 2016: 101). *Wolbachia* bacteria continue to promiscuously make love in ways that will not be disrupted by climate change and global war.

Some forms of love are self-interested. Symbiotic love – involving parasites, hosts, and other partners in uneasy coalition – entails diverging values and obligations, complex articulations that are often characterized by mutual utility and mutual exploitation (cf. Stengers, 2010). Other approaches to love involve more distant forms of affection. The polyamorous community has developed a sophisticated set of ethics around voyeurism. People who refuse to accept monogamy as a norm have invented a word, *compersion*, to describe 'the feeling of taking joy in the joy that others you love share among themselves, especially taking joy in the knowledge that your beloveds are expressing their love for one another' (Ritchie and Barker, 2006: 595). Compersion, in multispecies communities, involves appreciating symbiotic entanglements from afar. Voyeuristically gazing into the entangled worlds of *Wolbachia* it is possible to appreciate the love stories of others from a tactful distance.

The symbiotic bubbles inhabited by *Wolbachia* involve intimate relations of mutual utility and mutual exploitation. Studies of how *Wolbachia* control their invertebrate hosts might thus help us better

understand our own bodies and selves. The human microbiome, the flora and fauna of our gut, contains a multitude of symbiotic companion species (Haraway, 2008; Wilson, 2015; Helmreich, 2016). Pushing beyond anthropocentric concerns, into the world of this microbe, also offers an opportunity to imagine the possibilities of life without us. Even if *Anthropos* destroys itself, and other creatures we love, perhaps it is possible to embrace post-human futures with compersion. Learning how to love and care for invertebrates, and their microbial companions, in an era of extinction could open up lively post-human possibilities.

Queer Microbial Companions

Wolbachia often perform queer tricks inside their invertebrate hosts. If classic biomedical textbooks contain tales about human sperm and eggs that naturalize patriarchical stereotypes about productive men and wasteful women (Martin, 1991: 485), the *Wolbachia* literature refracts related tales through the microbe's imagined point of view: 'Because males are not transmitters, they are ''waste'' from the perspective of the bacteria' (Stouthamer et al., 1999: 82). *Wolbachia* bacteria are too large to fit inside sperm, and thus tend to be transmitted vertically, through the eggs of mothers to their children, rather than horizontally by infection. 'Wasteful' males are killed by *Wolbachia* in some host insect species, like the two-spot ladybird beetle (Figure 1b). When an infected ladybird beetle lays male eggs, the bacteria terminate the larvae before they become adults.

Maximizing their transmission from parents to children, *Wolbachia* adjust and transform the bodies and the reproductive dynamics of their invertebrate hosts. In some host species these bacteria induce parthenogenesis – completely eliminating males from the population. Parthenogenesis involves asexual reproduction, where mothers give birth to clone daughters without the need to mate with males. These clones are produced when the bacteria disrupt the cell cycle of their hosts during early embryonic development – producing viable eggs, with two copies of each chromosome, even though they have not been fertilized (Werren et al., 2008: 745). Myra Hird cautions that 'we need to resist the temptation to name certain species as queer – queer barnacles, queer *Schizophyllum*, queer fish, queer lichen. It is much more interesting to consider how we might understand trans in humans from, say, a bacterial perspective' (2013: 163). *Wolbachia* are useful figures for such interspecies speculative imagining.

Wolbachia can perform a gender-bending trick in some hosts: they transform genetic males into reproductively viable females. Amphipod crustaceans, terrestrial isopods, and at least one insect species (the Asian corn borer), are all known to experience these microbial transformations. 'The exact mechanism of feminization is currently unclear', according to

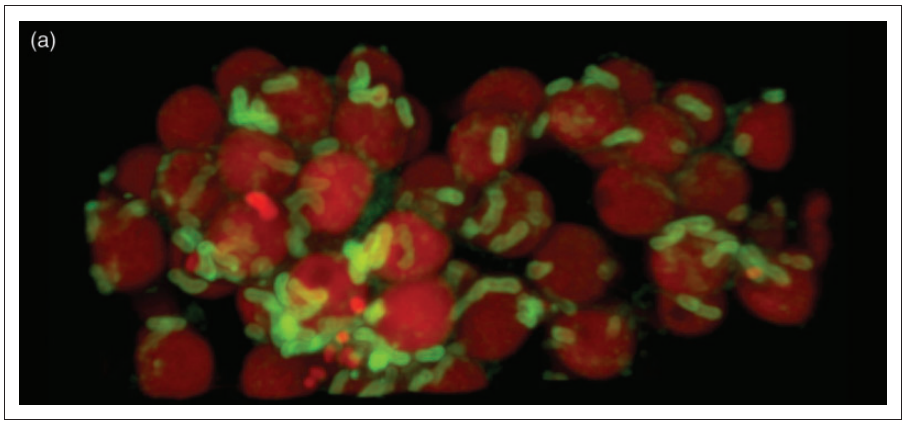
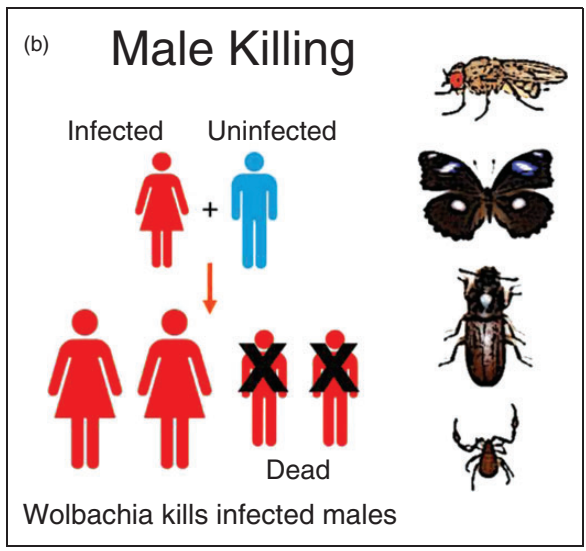


Figure 1a and 1b. *Wolbachia* bacteria live inside of the cells of their invertebrate hosts. In the above image the nuclei of the host cells appear red, while the *Wolbachia* are rendered green by florescent molecular tags. Since sperm are too small to physically contain Wolbachia, they are a "dead end" from the bacteria's point of view. In some host species all male offspring infected with the bacteria are simply killed before they reach maturity (below). Images courtesy of Frederic Landmann (above) and Jack Werren (below).



Jack Werren, an evolutionary biologist who is a leading *Wolbachia* expert, says that *Wolbachia* seems 'to interfere with the sex-determination pathway and must continuously act throughout development for complete feminization' (Werren et al., 2008: 746). These invertebrates are certainly what Eva Hayward and Lindsay Kelley call 'tranimals', that

is, organisms animated by trans-formations of life. Trans in this context suggests 'material crossings that disrupt bifurcated categories'. The portmanteau of tranimals blends sound and meaning to invoke animals which are 'literal organisms, not metaphoric or purely representational beings' (Kelley and Hayward, 2010: 115–16). *Wolbachia* are promiscuous parasites that are subtly transforming the known world.

There are many other microorganisms that have transformed planetary ecologies and have even become geomorphic forces. Cyanobacteria, the first microbes to produce oxygen by photosynthesis, have a clear claim to early paleontological fame. They drove the Oxygen Catastrophe, the first mass-extinction event, 2.3 billion years ago. Cyanobacteria continue to play an important role in planetary carbon cycles. *Escherichia coli* (often abbreviated *E. coli*) could claim the Cenozoic era – now popularly known as the Age of the Mammals (65 million years ago to present) – since they flourish in the guts of vertebrates. But if current extinction trends continue, *E. coli* will not fare well. These bacteria do not generally thrive outside of the nutrient-rich, warm, and moist intestinal environment of mammals and birds (Winfield and Groisman, 2003). *Wolbachia* will likely proliferate if the Age of Mammals comes to an end. This promiscuous microbe will endure many possible apocalyptic futures inside of its abundant invertebrate hosts.

Wolbachia already survived one mass extinction event. Sixty-six million years ago this adaptable bacteria flourished in the aftermath of disaster as 75 percent of all species – including all non-avian dinosaurs – were driven extinct during the K-Pg event. *Wolbachia* bacteria emerged 142 to 162 million years ago, according to molecular evidence (Werren et al., 1995), compared with only around 2.8 million years for the genus *Homo*. Cockroaches, just one prolific host of *Wolbachia*, were once thought to be likely survivors of a nuclear war. The United Nations Scientific Committee on the Effects of Atomic Radiation no longer thinks that cockroaches will make it through a nuclear winter. The latest research shows that flour beetles, a kind of insect that *Wolbachia* subjects to male-killing, are now thought to be among the beings that will inherit the earth after a nuclear holocaust (UNSCEAR, 1996).

I propose yet another alternate name for our current geological era, the Wolbachiacene, to give presence to multiple overlapping histories and intersecting agencies that impinge upon contemporary modes of existence (cf. Schrader, 2010: 287). This neologism playfully pushes against the latent teleologies and anthropocentric assumptions undergirding other recent attempts at epochal naming. The Wolbachiacene comes both before and after the Anthropocene/Capitalocene. Following principles of evolution, which do not proceed linearly from simple to complex, this epochal proposal instead involves 'the doubling and disassociation of time-matter' (Parisi, 2004: 52). *Wolbachia* are

posthuman figures that displace and diffract humanist fantasies of disembodiment, autonomy, and exceptionalism (Wolfe, 2010: xv). These microbes are worthy of their own geological epoch because they offer a fresh vantage point on one of the most pressing ethical questions of our time, which was first asked by Matthew Chrulew (2011: 139): 'How should we love in a time of extinction?'

Endosymbiotic Love

When asked to define love, Gregory Bateson – the anthropologist, biologist, psychologist, and cybernetician – offered an unusual definition: 'You might say that "I love X" could be spelled out as "I regard myself as a system, whatever that might mean, and I accept with positive valuation the fact that I am one, preferring to be one rather than fall to pieces and die. And I regard the person whom I love as systemic, and I regard my system and his or her system as together constituting a larger system with some degree of conformability within itself"' (Gregory Bateson quoted in M.C. Bateson, 2012). While Bateson's definition of love leaves much to be desired in the affective registers of human romance, it has expansive possibilities in more-than-human worlds. Machines, microbes, and diversity of other self-regulating systems all conform as objects and subjects of love in Bateson's mind.

Love in the Wolbachiacene involves self-knowledge and recognition across species lines (cf. Bateson, 2012). *Wolbachia* bacteria lovingly embrace their hosts in ways that offer an opportunity to torque Haraway's slogan for the Chthulucene: they make queer kin along with tranimal babies. When they generate tranimals, these parasites bring larger systems – the bodies and populations of their hosts – into conformity with their own systemic needs and the needs of their own offspring. Some hosts have also come to depend on their *Wolbachia* parasites. Female insect clones have been liberated from one kind of love – they no longer have amorous attachments to wasteful males – and have become dependent on *Wolbachia* for reproduction through parthenogenesis. Some kinds of filarial worms have developed symbiotic attachments to *Wolbachia*. These worms die without their microbial companions (Stouthamer et al., 1999).

Charles Darwin was narrow-minded when it came to thinking about sex and love (cf. Grosz, 2011). His theory of natural selection treated individual organisms – and their associated family lines, races, and species – as the units of survival. Sex, in Darwin's mind, took place in a field of competition, scarcity, fitness, and adaptation (Parisi, 2004: 45). Darwinism naturalizes heterosexual desire and has become an ideological force in dominant social, economic, and political systems (Haraway, 1991; Roughgarden, 2004; Sleigh, 2007). Pathologies are embedded in Darwinian epistemology, according to Gregory Bateson. 'The unit of

survival is *organism* plus *environment*', according to Bateson. 'We are learning by bitter experience that the organism which destroys its environment destroys itself' (Bateson, 1972: 491). Humans, who understand themselves as unique individuals driven by the principle of the 'survival of the fittest', are arguably bringing about the large-scale destruction of the Anthropocene/Capitalocene.

Unique genetic individuals, the products of meiotic recombination during sex, comprise a relatively small proportion of life on earth (Margulis and Sagan, 2002; Parisi, 2004: 35). If current trends continue, perhaps paleontologists of the future will understand the Anthropocene/Capitalocene as the tragic outcome of a failed experiment with sex. If *Homo faber* destroys large branches of the tree of life that produce unique genetic individuals through fixed modes of heterosexual reproduction, then the planet may well see an explosion of queer diversity through endosymbiosis.

Symbiotic associations involve beings with a mutual interest in the continued existence of one another (cf. Stengers, 2010: 35). Endosymbiosis, the incorporation of these associations inside a body, involves 'the co-opting of strangers, the involvement and infolding of others' (Margulis and Sagan, 2002: 20). Species emerge, in an endosymbiotic account of evolution, when genes of the other are brought into the self. If the planet sees a proliferation of life after the Anthropocene, *Wolbachia* may be the figure of a model love story. *Wolbachia* were involved in one of the only speciation events observed in real time, according to Dorion Sagan. Endosymbiotic speciation was unintentionally produced during a laboratory experiment in the 1930s by Columbia University geneticist Theodosius Dobzhansky when he selected fruit flies for their ability to withstand heat and cold. By Sagan's account:

> Dobzhansky found that after two years the heat-adapted flies could no longer successfully fertilize cold-living ones. The two separated populations of *Drosophila paulistorium* now conformed to the traditional zoological definition of new animal species. They had been reproductively and geographically isolated, and were now only able to breed with their own kind. (Sagan, 2011)

Subsequent studies demonstrated that the 'cold-fertile fly population' had *Wolbachia* bacteria living in their bodies whereas the 'hot-fertile flies' had none. In other words, Sagan concludes, 'the presence or absence of a bacterium' experimentally produced speciation, while Darwin's 'much-vaunted but still theoretical gradual accumulation of random genetic variations' has thus far not been validated by experimental evidence (Sagan, 2011).

Speciation events involving *Wolbachia* come about as a result of destructive elements at play in their story of interspecies love. The

bacteria sterilize the unsuspecting sexual partners of their invertebrate hosts – producing reproductive isolation and the conditions for speciation. In this sadistic love story, the bacteria use wasteful male bodies for mischief, rather than killing them outright or turning them into females. While *Wolbachia* bacteria are too big to fit inside of sperm, they are able to play toxic tricks with the sperm cytoplasm – the material-semiotic fluid inside of all cells. The sperm of males infected with *Wolbachia* can become weaponized, turned into what researchers jokingly call 'smart bombs' that destroy the eggs of uninfected females (Jack Werren, 2015, personal communication). These chemically altered sperm have been well studied in mosquitoes that transmit malaria, dengue, and zika. But the molecular mechanisms behind the selective destruction of uninfected eggs is puzzling. One hypothesis, the 'modification-rescue' model, posits that *Wolbachia* 'modify' the sperm inside infected males and then female eggs (also infected with the same bacterial strain) and then perform a 'rescue' (Werren et al., 2008: 745). This means that female mosquitoes with *Wolbachia* infections can make babies with infected males after their compatible parasites defuse the sperm 'bomb'.

Military metaphors of weaponized sperm and smart bombs might conceal aspects of this symbiotic entanglement as much as they reveal. Reading *Wolbachia*'s love stories with more compersion, it is possible to see that these microbes are not purely self-interested. Perhaps the bacteria, situated within their own microbial *umwelt* (cf. Sagan, 2010), have entangled empathy with their hosts (cf. Gruen, 2013; Kirksey, 2015a). Even if the microbes cannot fully grasp the affective dimensions of sexual love and desire among invertebrates, even if their mode of life is limited to Bateson's affectless definition of love, perhaps some chemosensory pleasure principle is at work. *Wolbachia* bacteria living in the gonads of infected males could experience a loving sense of well-being as their hosts mate – experiencing pleasure as they telegraphically destroy the eggs of uninfected females. Making love, rather than war with sperm smart bombs, these bacteria do biopolitical work as they care for kin and kind, creating different species of hosts.

Endosymbiotic love stories from the Wolbachiacene are in accord with recent studies of the female orgasm among people: as with some other mammals, the female orgasm is not linked to ovulation, or other direct reproductive functions (Pavlicev and Wagner, 2016). These love stories interrupt evolutionary accounts that attribute a functional significance to sex (cf. Roughgarden, 2004). Bacteria are not tiny little Darwinian calculators. Microbes are desiring machines, bodies without organelles, that lack a clear teleology oriented towards climax and orgasm (cf. Bateson, 1972: 111; Deleuze and Guttari, 1987; Hird 2013). As parasites they often interrupt Bateson's emotionless love story: 'I regard myself as a system . . . And I regard the person whom I love as systemic . . .'. Rather than remain confined with the homeostatic world that Bateson lovingly

described, parasites are ever-expanding – growing, overflowing, filling space, and running past commands to stop (Serres, 2007: 253). Rather than relentlessly march towards differentiation, specialization, and speciation, the promiscuous microbes of the Wolbachiacene are disorganizing the bodies of their hosts at a molecular level (cf. Willey, 2016: 23).

Queer Biopolitics

Endosymbiotic love involves ensembles of selves – associations of entangled agents involved in relations of reciprocity and accountability, assemblages that can generate feelings of empathy and desire (cf. Kirksey, 2015a: 34). *Wolbachia* proliferate in nerve cells and brain tissue in several species of insect hosts – a fruit fly, a parasitoid wasp, and a woodlouse. 'Such close association with the nervous tissue may allow for a very direct influencing . . . of the host's behavior', according to one authoritative review (Stouthamer et al., 1999: 74). *Wolbachia* cannot live inside vertebrate animals, unless they are inside the body of another parasite – like a filarial worm. Even still, the love stories of this bacteria offer insight into the human condition.

Queer communities are conducting their own unregulated biological experiments with microbes – disrupting dominant norms governing health and life (cf. Foucault, 1984). Gay men are experimenting with the possibilities of endosymbiotic love – creating fragile bubbles of happiness involving moments of pleasure that sometimes alternate with pain (cf. Ahmed, 2010). Tim Dean's careful ethnography of gay barebacking culture – where men have unprotected sex to exchange HIV as a viral 'gift' – describes the erotic possibilities latent in encounters with otherness (Dean, 2009: 179). 'HIV transmission has the potential to create social bonds that are both symbolic and material', Dean argues. Viral 'gift giving establishes relations specifically of kinship' (Dean, 2009: 77). Describing communities that value pleasure over health, Dean asks: 'What would it mean for a young gay man today to be able to trace his virus back to, say, Michel Foucault?' (Dean, 2009: 89).

Michel Serres has celebrated the promiscuous nature of the parasite – playing with alterity to blur the distinction between the other and the self. Departing from the double meaning of the French word *hôte*, which corresponds to both 'host' and 'guest', Serres writes 'the host, the guest: the same word; he gives and receives, offers and accepts, invites and is invited' (Serres, 2007: 15). But rather than maintaining a radical openness to the other – whether human, microbe, or other parasite – Serres ultimately concludes: 'It might be dangerous not to decide who is the host and who is the guest, who gives and who receives, who is the parasite and who is the table *d'hôte*, who has the gift and who has the loss, and where hostility begins within hospitality' (Serres, 2007: 15–16). Heather Paxson has made a similar move. Rather than simply celebrate

entanglements with microbes, or make any absolute distinctions between 'good' and 'bad' kinds of organisms, she suggests that we evaluate our companion species 'microbiopolitically' – on the basis of situated effects and contingent actions (Paxson, 2014). Scope for microbiopolitical action has recently been broadened by PrEP – a daily prophylactic pill that prevents HIV infection and enables novel safe-sex practices. Those who take a daily dose of PrEP to stay virus-free are forming promiscuous chemosocial communities – where inclusion comes with a prescription (Shapiro and Kirksey, 2017).

Certainly many promiscuous people – both queer and straight – make careful microbiopolitical calculations. Conversations on apps like Tinder and Grindr often circle around to microbial matters before two strangers agree to meet for sex. Yet, despite pervasive fears of HIV and other diseases, the productive force of human eros is overwhelming the destructive force of microbial thanatos. As the human population skyrockets exponentially, projected to grow from 2 billion in 1950 to 11 billion in 2100 (Haraway, 2016), straight sex is becoming increasingly problematic. Queer barebackers are making kin and not babies. Queer communities are making laudable ethical decisions that are helping stem the destructive environmental tendencies of *Anthropos* on a planetary scale. Rather than harbor a future-negating death drive, queer communities are helping produce the conditions for planetary life (Edelman, 2004: 48). Microbiopolitical calculations shift with scale – a virus deemed 'bad' for the body could become 'good' for the community, the population, or the biosphere.

While some queer theorists see gay promiscuity as genocidal (Rotello, 1997), Tim Dean suggests that abandoning promiscuity would be genocidal – arguing that harmful or constraining practices deemed fundamental to a culture's self-definition should be protected (Dean, 2009: 58). In a similar vein, Sharif Mowlabocus insists that barebacking lets gay men 'reclaim their sexuality outside of the dominant "parental" discourses of HIV prevention' (Mowlabocus, 2010: 168). People who participate in queer kinship networks involving HIV do not want to die, but to give birth – the virus is less a harbinger of death than a complex generator of life, bringing new people into the community (Dean, 2009: 93). In an era of new prophylactic drugs and cures like PrEP, promiscuous sexualities are situated in a capitalist economic system, where the business plans of large pharmaceutical companies involve creating classes of life-long patients (cf. Dumit, 2012). Still, queer endosymbiotic love illustrates opportunities for flourishing in multispecies worlds.

Beyond the small group of people who participate in the barebacking scene, mainstream gay male culture involves a form of endosymbiotic love – ass play – that might be characterized as an open-ended microbiopolitical experiment. Medical microbiologists have long been interested in diseases – like cholera, giardia, and dysentery – that are

transmitted through the fecal-oral route. The human microbiome is also full of thousands of other symbiotic species that help keep diseases at bay. Initially reports about the microbiome, which were widely cited, suggested that only about 10 percent of cells in our bodies are human – the bacteria, fungi, and other microbes living in our guts and on our skin account for the other 90 percent of cells (see e.g. Haraway, 2008). More recent studies suggest that these initial reports were overestimates and show that 'the number of bacteria in the body is actually of the same order as the number of human cells, and their total mass is about 0.2 kg' (Sender et al., 2016). New research also suggests that microbes living in us can influence and mediate processes like digestion, immunity, and even cognition (Dunn, 2011; Lorimer, 2016; Helmreich, 2016). While *Wolbachia* interpenetrate the nerves and brains of some hosts, components of the human microbiome may influence host behavior telegraphically. The production of serotonin, a neurotransmitter associated with feelings of well-being and happiness, is mediated by microbes living in our guts (Wilson, 2015; Stilling et al., 2015).

Rather than make clear distinctions among 'good' and 'bad' kinds of microbes, rather than use a careful microbiopolitical calculus to evaluate organisms on the basis of situated effects and contingent actions (Paxson, 2014), people who engage in ass play are opening their bodies to unknown strangers (Dean, 2009). A queer microbiome is turning strangers into kin. Similar microbial kinship networks are emerging as straight men and women begin to conduct their own open-ended microbiopolitical experiments with fecal transplants. Hopeful patients with diverse maladies – like irritable bowel syndrome, depression, and allergies – are starting to seek fecal matter from strangers (High, 2016; Lorimer, 2016). As physicians and medical researchers remain focused on the human condition, searching through human feces for new cures, many other biologists are approaching multispecies worlds with compersion. Sharing love with their microbial subjects, these scientists are finding joy as others they love share love among themselves (cf. Ritchie and Barker, 2006: 595).

Rather than fitting the script of monogamous love, where one kind of invertebrate becomes the center of a bacteria's world, the ecological arenas inhabited by *Wolbachia* have become sites of ongoing polyamorous liaisons (Willey, 2016: 7). Love in the Wolbachiacene involves temporary alliances and symbiotic attachments – connections that are established like a rhizome between different kingdoms, classes, and families (cf. Deleuze and Guattari, 1987: 238). Queer kinship, for *Wolbachia*, involves becoming-molecular – in swarms of multiplicities, as elements of the self cross over into the other. *Wolbachia* create kin as they trade genes with other species – blurring the boundaries between the other and the self. Amidst the chaos of jumping genes and rapid evolution, these wily bacteria continue to work as microbiopolitical agents – making some kinds of

life live, while letting others die. In some arenas the biopolitical work of *Wolbachia* grates against human dreams and schemes, generating disease and death. In other arenas these bacteria are generating shared bubbles of pleasure and happiness (Kirksey, 2015a: 59).

Emergent Worlds

Against the backdrop of bleak possible futures, scientific enterprises are identifying, isolating, and eliminating possible threats to the human species. Microbiology, for many decades, has invested the lion's share of research dollars in projects focused on microbial enemies. *Wolbachia* can impinge on human health indirectly, through the lifecycles of parasitic invertebrate hosts. The spaces where the lives of *Wolbachia* and humans overlap are generally on the margins of the modern world system. If many biomedical initiatives have reinforced the dynamics of inequality, imperialism, and racism that persist in the Capitalocene, public health research orbiting around *Wolbachia* has worked to reverse these systemic problems.

Medical research on *Wolbachia* has characterized shared worlds nested within other worlds – microcosms inside human bodies created by *Wolbachia* tooth and nail together with their invertebrate hosts (cf. Latour, 2002). Filarial worms – slender, threadlike creatures that cause river blindness and elephantiasis – are obligate symbionts of *Wolbachia*. Without the bacteria, the worms die. Over 120 million people, primarily in Africa and Southeast Asia, have elephantiasis – a disfiguring filarial disease that can cause massive swelling of the scrotum or extremely inflamed legs, which can grow to elephant-like proportions. About 18 million people suffer from river blindness, another filarial disease that is the second most common cause of blindness in the world. Scores of researchers are trying to develop a drug that will disrupt entanglements connecting *Wolbachia* to filarial hosts (Taylor et al., 2005). These researchers are working at the intersection of powerful forces – ethical imperatives to cure diseases of the rural poor in the Global South, alluring promises of biocapitalism, and curiosity about queer microbial agents.

Public health officials are starting to experiment with new biopolitical strategies, exploring potential human/microbe collaborations, in hopes of diminishing populations of an unloved insect: the mosquito. Thousands of male Asian tiger mosquitoes (*Aedes albopictus*) infected with *Wolbachia* were released at multiple sites in the United States in 2016 by a company called Mosquito Mate (Regalado, 2016). Their hope was that the smart-bomb sperm of these males would destroy the eggs of uninfected females. Similar initiatives have targeted other mosquito species in different milieus: *Aedes polynesiensis* in French Polynesia (O'Connor et al., 2012) and *Aedes aegypti* in Australia (Murray et al.,

2016). While these initiatives have met with some success, seasoned reviewers who have devoted their careers to malaria control have been circumspect about these temporary population suppression measures. Since 'perfect sexing mechanisms' do not exist, these initiatives will undoubtedly release some *Wolbachia* infected females with the potential to found new mosquito populations (Benelli, 2015).

Introducing new species into ecosystems has long generated unintended consequences. Twenty-first century technoscience often has 'bad memory practices', in the words of Donna Haraway – it is 'always announcing new worlds, proposing the novel as the solution to the old, figuring creation as radical invention and replacement, rushing toward a future that wobbles between ultimate salvation and destruction' (Haraway, 2014: 243). As public health officials and drug companies start to use *Wolbachia* to explore novel ways that this bacteria might be used to deal deadly blows to old human foes, confining their imagination to the domains of risk and thanatology, ecologists are describing lively multispecies entanglements that are persisting in the face of ongoing disasters.

Wolbachia are integral to symbiotic love stories in shared ecological worlds. Rather than just be figures of the enemy – microbial diseases that might make us sick – or possible allies that might further enable *Anthropos* to remake the world to serve a narrow set of interests, *Wolbachia* are involved in symbiotic entanglements that disrupt anthropocentric concerns. One particular multispecies assemblage – involving fig trees (genus *Ficus*), pollinating wasps, and *Wolbachia* – might stand in as an example of the subtle world-making force of this microbe (Figure 2). *Wolbachia* bacteria are pervasive within the bodies of most wasps that pollinate fig trees. Experts on wasps and figs speculate that reproductive incompatibilities mediated by *Wolbachia* may have helped produce partial or complete reproductive isolation. Like the laboratory experiments in the 1930s by Theodosius Dobzhansky, which produced a 'cold-fertile fly population' and 'hot-fertile flies', wasp experts concluded that *Wolbachia* can help produce new species. 'The disruptive action of these microbial endosymbionts', write James Cook and Simon Segar, may 'facilitate or reinforce speciation, allowing it to proceed more rapidly than otherwise' (Cook and Segar, 2010: 60).

Coevolution, a process of becoming species together, has been well documented for many figs and their pollinating wasps, even if countervailing interests and affects sometimes pull them apart (reviewed in Jousselin et al., 2003; see also Jander et al., 2012). Fig wasps depend entirely on *Ficus* trees for their own existence. Host plants thus shape the species of their pollinators. Wasps also play key roles in the enactment of fig species – being very selective with respect to the kinds of fig fruits they pollinate. Once wasps are inside the fig fruit, and bring pollen to the hundreds of florets, they are entombed inside. Before they die the

Figure 2. A fig fruit on a fig tree (*Ficus macrophylla f. columnaris*) with pollinating wasps (Pleistodontes froggatti) trying to get inside. *Wolbachia* bacteria shape the boundaries of wasp populations, bringing species into being, which by extension shape the forms of figs. Photograph by Eben Kirksey.

adult wasps lay eggs in the fruity pulp – the larvae hatch, pupate, and then the next generation of adult wasps escapes outside a hole in the fruit to pollinate the next generation of figs. Figs and wasps are companion species that have reached a symbiotic agreement, 'integrating a reference to the other for their own benefit' (Stengers, 2010: 36). Figs and wasps are also good to think with, when considering how *Wolbachia* shapes the emergence of new kinds of life within heterogeneous fields of interests.

Wolbachia appear to be torquing wasp species with practices of classification, recognition, and differentiation. By extension, these bacteria are probably also indirectly manipulating speciation in fig trees, in intergenerational dances (see Kirksey, 2015b). Researchers in the online journal PLOS One report 'Chaos of *Wolbachia*' genes inside wasps that pollinate Weeping Fig trees (*Ficus benjamina*). After sequencing the *Wolbachia* genes inside about 1000 fig fruits, this study concluded that genes are jumping among the bacterial strains, infecting 17 different species of wasp larvae. The bacteria are transforming themselves, undergoing 'rapid evolution' while switching among different wasp species (Yang et al., 2012). In other words, *Wolbachia* are key agents mediating

ontological choreography in multispecies worlds (cf. Thompson, 2005; Kirksey et al., 2016). Keeping the other dancers alive, moving through the world in particular ways, has become a shared telos of *Wolbachia* and their multitude of companion species.

Conclusion

Invertebrate populations crashed, falling by nearly half over a 35-year period in which the human population doubled, according to a recent paper in *Science* (Dirzo et al., 2014). While some prolific and tenacious hosts of *Wolbachia* – like flour beetles – are likely to flourish even in the aftermath of a nuclear holocaust (UNSCEAR, 1996), many others are in decline. While endangered mammals, birds, and amphibians have been widely studied, invertebrates have been neglected. Populations of many insects, such as beetles, butterflies, bees, and wasps, have been declining by as much as 30 to 60 percent. 'Currently we are in the potentially dangerous position of losing integral parts of ecosystems without knowing what roles they play within it', said Ben Collen, one of the authors of the study. The lead author, Rodolfo Dirzo of Stanford University, said that he was concerned with 'a loss of critical ecosystem functioning'. 'We have long considered that defaunation is a cryptic phenomenon', Dirzo added, 'but I think we will end up with a situation that is noncryptic because of the increasingly obvious consequences to the planet and to human well-being.'[2] A study in Germany found that the abundance of flying insects has decreased by 82 percent in mid-summer over the past 27 years, leading an author of the study to proclaim that 'ecological Armageddon' is taking place (Hallmann et al., 2017; Carrington, 2017).

Invertebrates can be useful to people because they play a role in pollination, pest control, nutrient cycling, and decomposition. In reporting catastrophic crashes of invertebrate populations, biologists bemoan the loss of these utilitarian functions. Ecosystems have long been shaped by the loss of previous species, the addition of new organisms through migration, and the emergence of novel multispecies assemblages (Kirksey, 2015a). A. G. Tansley, who coined the term 'ecosystem' in 1935, argued that ecological communities do not have essential functional parts, but instead are contingent associations of organisms with relationships in constant flux (Tansley, 1935: 299–301; see also Gleason, 1926). Rather than continue to bemoan the loss of critical functions (as emergent ecological communities flourish around us), it is time to more fully appreciate the possibilities of love in the Wolbachiacene.

Gregory Bateson's systemic definition of love only functions well in stable settings of homeostasis. In an era of capitalism and schizophrenia, as market forces and the capricious whims of *Anthropos* disrupt deeply rooted ecological assemblages, we need more promiscuous and

polyamorous forms of attachment (Willey, 2016). The Critical Polyamorist, the blog of Kimberly Tallbear, explores relations of ethical non-monogamy in a cultural landscape deeply scarred by legacies of colonialism. In a post titled 'Settler Love is Breaking My Heart', Tallbear writes about how monogamy contains vestiges of 'the utopic but destructive ideal of settlement in its multiple meanings: not moving or transitioning; settling for the best thing we can imagine; closure, no open doors'.[3] Microbes are helping humans forge new promiscuous and convivial associations – breaking down filial divisions along lines of race, class, and nationality to generate new queer kinship networks (Dean, 2009; Serres, 2007). The forms of endosymbiotic love enjoyed by *Wolbachia*, and their multiple species of invertebrate companions, inspire my own feelings of compersion. Speculating across the species interface – returning the unflinching gaze of insects and other invertebrates – I join Deborah Bird Rose in taking pleasure in the happiness of others, appreciating the importance of the 'hap' in what happens (Ahmed, 2010; Rose, 2012).

Love for insects has generated fads around the world, like the beetle craze in Japan, which inspired a multitude of men and boys to care for these creatures in their own homes (Raffles, 2010). Others are recognizing inherent limits to human practices of care. Organic intellectuals are cultivating spaces of generative disinterest: compost bins where earthworms flourish beyond regimes of management and control, reforestation projects where insect pollinators and seed dispersers help stabilize convivial multispecies assemblages in the aftermath of destruction by agents of capitalism (Kirksey, 2015a: 200–2).

Amidst the chaos and destruction of contemporary times, *Wolbachia* are co-laboring with a multitude of unloved invertebrates, critters that are living and dying in the shadows of human dreams and schemes. Haraway insists that in the Chthulucene 'we have a mammalian job to do, with our biotic and abiotic sym-poetic collaborators, co-laborers' (Haraway, 2016). Poaching Haraway's words with the playful spirit that she encourages, I suggest that we do not just have a mammalian job to do, but also an 'invert' job to do. In biological circles, inverts (slang for 'invertebrates') are animals without backbones, while queer theorists explore the playful work of people who transpose gender roles and interrupt heteronormativity – sharing the activity of making bodies pliable, mobile, and transposable (Hayward, 2010: 589). In the current era of extinction, we urgently need to refine our cyborg politics: taking 'pleasure in the confusion of boundaries' and making arguments 'for responsibility in their construction' (Haraway, 1991). In maintaining refuges, spaces for wild and unruly forms of life, we need to make sure that homes for inverts and queer microbes are included too.

Notes

1. Queer communities also produce 'unloved others', ethnic minorities and structurally marginalized working-class communities, who do not figure in dominant desires and ideals. Queer people who loyally repeat rather than 'breach' structures of racism and classism produce unloved subjects who are alienated from prevailing affects (Haritaworn, 2015 ; cf. Ahmed, 2010). Still, these alienated and unruly subjects are releasing themselves from the bonds of socio-economic and ethnic identities to develop their own love stories.
2. See: https://www.ucl.ac.uk/news/news-articles/0714/240714_invertebrate-numbers
3. See: http://www.criticalpolyamorist.com/homeblog/settler-love-is-breaking-my-heart

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