



Deposited via The University of Leeds.

White Rose Research Online URL for this paper:

<https://eprints.whiterose.ac.uk/id/eprint/141532/>

Version: Accepted Version

Article:

Giraud, E, Hadley Kershaw, E, Helliwell, R et al. (2019) Abundance in the Anthropocene. *The Sociological Review*, 67 (2). pp. 357-373. ISSN: 0038-0261

<https://doi.org/10.1177/0038026119830907>

© The Author(s) 2019. This is an author produced version of a paper accepted for publication in the *Sociological Review*. Uploaded in accordance with the publisher's self-archiving policy.

Reuse

Items deposited in White Rose Research Online are protected by copyright, with all rights reserved unless indicated otherwise. They may be downloaded and/or printed for private study, or other acts as permitted by national copyright laws. The publisher or other rights holders may allow further reproduction and re-use of the full text version. This is indicated by the licence information on the White Rose Research Online record for the item.

Takedown

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.

Abundance in the Anthropocene

Eva Giraud, Eleanor Hadley Kershaw, Richard Helliwell, Gregory Hollin

Abstract

Numerous attempts have been made to understand the Anthropocene in relation to overwhelming species and habitat loss. However, amidst these losses ecological niches have emerged and been taken as signs of resilience and hope: from mushrooms that flourish in damaged forests (Tsing, 2015) to urban wildlife in brownfield sites (Lorimer, 2015). This paper offers an alternative conception of abundance, which addresses the sociological and conceptual challenges posed when abundance is a characteristic of so-called pests, parasites, and pathogens. The paper draws together research from three case studies: bed-bugs, hookworms, and antibiotic resistant microbes, all of which have become intimately entangled with particular human communities as other lifeforms have declined. Through contrasting these cases we elucidate how the affordances of abundant lifeforms, including the dangers they pose to other forms of life, are entwined with failed 'technofixes', colonial legacies and contemporary inequalities. In doing so we situate abundance as a constitutive element of the Anthropocene that requires as sustained ethical engagement as questions of species loss. We conclude by arguing that further ethical attention needs to be paid to finding ways of 'being alongside' (Latimer, 2013) life that is difficult to live with, but is becoming intimately re-entangled with human worlds. In doing so, we complicate existing theoretical work that has drawn hope from multispecies abundance and entanglement.

Introduction

In recent years there have been concerted attempts to expand the purview of the social sciences beyond the human, in what has been labelled an 'animal turn' (Franklin, 2007, p.7). There is now a well-established body of work concerned with Human-Animal studies (Wilkie, 2015; Hamilton and Taylor, 2017), with a particular emphasis on companion species' co-shaping relations with humans (Cudworth, 2015; Charles, 2016). This research has engaged extensively with a body of cultural theory that foregrounds the entangled, co-constitutive relationships between humans and other species, which includes (but is not limited to) posthumanism (eg Wolfe, 2010; Braidotti, 2012), feminist materialisms (Barad, 2007; Alaimo, 2016), more-than-human geographies (Whatmore, 2006; Lorimer, 2015), multispecies anthropology (Kirksey and Helmreich, 2010), and work within feminist science studies (Haraway, 2008, 2016).

In this article we engage with an emerging theme in this body of theory: extinction. Or, more specifically, extinction in the current moment, often named the 'Anthropocene.' The label

Anthropocene was originally proposed in Earth System Science circles (Crutzen and Stoermer, 2000) in order to designate a new epoch in which humankind has become both an ecological and 'major geological force' (2000, p.18). The term's uptake has prompted a wide-ranging set of responses across the social sciences and humanities (for overviews see Lorimer 2012, 2017).¹ The emerging field of extinction studies itself draws attention to the overwhelming losses precipitated by anthropogenic problems (van Dooren, 2014; Rose, van Dooren & Chrulew, 2017). For scholars in extinction studies it is not simply that 'we have never been human' (Haraway, 2008), but that a consideration of the 'more-than-humaness' of the social world is crucial at *this* particular moment when inter-related processes of climate change and mass extinction make reaching beyond the human a crucial political task.

The Anthropocene, however, is not just bound up with loss but with abundance.² Michelle Bastian's (2012, 2017) accounts of leatherback turtles, for example, chart the devastating impact of human activities on the animals' slow lifecycles. Yet changing oceanic conditions due to acidification and oceanic waste have also produced an 'abundance of jellyfish' (Bastian, 2017, p.167) which could help to ameliorate these changes by offering a more desirable food source than the plastic bags that turtles often ingest when food is scarce. Jamie Lorimer (2015, p.159-178), similarly, points out that brownfield sites can foster precisely the ruderal and saproxylic ecologies necessary for stag beetles and other insects to thrive, while Kirksey et al. (2018) describe flourishing cockatoo communities in suburban Sydney.

Other theorists have taken this argument further, framing abundance as a form of resilience that offers inspiration – as Anna Tsing et al. (2017) put it in their eponymous text – for crafting *Arts for Living on a Damaged Planet*. Tsing takes the matsutake mushroom, which thrives in industrially-damaged forests, as illustrative of this point: 'Matsutake's willingness to emerge in blasted landscapes' Tsing argues, 'allows us to explore the ruin that has become our collective home' (2015, p.3). These arguments are anchored through an emphasis on the ethical and political potentials of the resurgence of life within 'disturbance-based ecologies' (2015, p.5). In Tsing's words: 'People and trees are

caught in irreversible histories of disturbance. But some kinds of disturbance have been followed by regrowth of a sort that nurtures many lives' (2015, p.190).

According to Tsing resurgence is both environmental and economic and she draws inspiration from examples ranging from economically-precarious migrant mushroom pickers in Oregon, to communities in Borneo who were 'left with a pile of disintegrating machines' after a timber company had exhausted the local forest of trees and then sold the dismantled machines as scrap (2015, p.132). While Tsing repeatedly notes the 'ambivalence' (2015, p.132) surrounding these economies – noting that the resurgence of 'blasted landscapes' is often constituted through 'the play of imperial power, with its property forms, its taxes, and its wars' (2015, p.181) – she still maintains their value in offering a sense of how to 'radically imagine worlds that are possible because they are already here' (Tsing, Bubandt & Swanson, 2017, p.12).

In this paper we offer an alternative conception of the affordances of abundance and tease out the social and conceptual implications of these affordances. Unlike Tsing, we focus on more 'awkward' (Ginn, Beisel & Barua, 2014) species – so-called pests, parasites, and pathogens – that have become abundant as other species decline. We foreground that, in particular circumstances, the abundance of life within the Anthropocene does not offer a site of hope for navigating the 'ruins' of capitalism (Tsing, 2015) but exacerbates these ruins. By tracing how the affordances of particular instances of abundant life are entwined with failed technological interventions and contemporary inequalities, we show that just as the effects of other anthropogenic problems are unevenly distributed (DeLoughrey, Didur & Carrigan, 2015) so too are the consequences of abundance. Abundance thus needs to be situated as a constitutive element of the Anthropocene that requires as sustained critical engagement as questions of species loss.

Approaching abundance

In the main body of the paper we focus on three lifeforms that have flourished in the Anthropocene: bed bugs, microbes that have become resistant to antibiotics, and hookworms. Each case foregrounds some of the ways that humans have been intimately re-entangled with so-called pests, parasites and

microbes, after the degradation or pathologisation of the technologies, infrastructures and situations that previously kept them at bay. We approach these examples through a critical reading of relevant literature, including scientific papers and commentaries, historical documents, and popular histories, in addition to existing humanities and social science research on these topics.

After providing an overview of the history and contemporary social concerns related to our three case studies, we contrast the affordances – or different ‘textures’ of abundance – offered by each case to draw out the conceptual and ethical issues they pose. Each case shows that the affordances of abundance are bound up with particular socio-technical infrastructures and cultural histories. More specifically, abundance here relates to the (partial) *failure* of technoscientific initiatives. David Kinkela, drawing upon the terminology of Lewis Mumford, argues that the inter- and immediately post- War period, marked by an ideology of technologically enforced eradication, might be known as the ‘age of wreckers and exterminators’ (Kinkela, 2011, p.84) . The effects of this ideology saw the emergence of infrastructures associated with large-scale public health initiatives, changes in living arrangements, and particular technological developments that created space between ‘undesirable’ lifeforms and particular human populations. These infrastructural arrangements have become difficult to sustain in our current moment, with socio-economically uneven consequences. Each of the cases we engage with is thus also tied to specific configurations of class and race, and imbricated in geopolitical inequalities. The affordances of abundant life and, crucially, the ethical promise and perils they offer, are impossible to extricate from these relations.

Throughout the paper we illustrate how the affordances of abundance, as constituted through its connections with inequality and technoscientific intervention, require finding new ways of living with lifeforms that might be difficult or even dangerous, but are becoming intimately re-entangled with human worlds. As such, abundance complicates broader theoretical work that has seen ethical potential in multispecies intimacies and entanglements.

Bed bugs: Undesirable re-entanglements

Cimex lectularius, or the common bed bug, is a small, ectoparasitic insect which feeds almost exclusively upon human blood (Usinger, 1966). Unlike species such as lice, bed bugs do not make their home upon the human body, but emerge at night from within bedframes and behind furniture in order to feed 'like pigs at a trough' (Borel, 2015, p.3). Bed bugs offer a clear case of abundance in the Anthropocene: Since the 1990s there have been remarkable estimates of a 100-fold increase in bed bug infestations in the US (Kane, 2016) and a 4,500% increase in Australia (Doggett, Dwyer, Peñas & Russell, 2012, p.164-165).

In Haraway's (2008) terms, humans and bed bugs have been 'becoming with' one another for as long as either species has existed. Archaeological evidence places bed bugs in Egypt some 3,500 years ago (Panagiotakopulu & Buckland, 1999), while analyses of mitochondrial DNA suggest that bed bugs and humans have lived and co-evolved alongside each other for around a quarter of a million years (Balvín, Munclinger, Kratochvíl & Vilímová, 2012).

As Latimer (2013) argues, however, understanding the intimate entanglements between animals – both animal species and particular animal bodies – also requires that we think about animals as being *alongside* humans. In the case of bed bugs it is important to grasp how the strings of 'matter and meaning' (Barad, 2007, p.3) that connect entities can shift both on a moment-by-moment basis and over a number of decades. As the cultural history of human-bed bug relations indicates, co-evolutionary narratives do not fully explain the 'ordering of relations' (Strathern, 1995) between our bodies or species.

Well into the twentieth century, bed bugs and humans in the Global North lived in close proximity. As Dawn Biehler makes clear in her book *Pests in the City*, bed bugs flourished in the early twentieth century due to both rapid urbanization and rampant inequality. Pests such as bed bugs:

...were not only "hitched" to physical conditions such as the presence of garbage or house foundations in ill-repair. They also thrived on racial segregation, underfunded housing inspection programs, and cultural stigmas that led residents to try to hide infestations. (Biehler, 2013, p.14)

Despite the evident persistence of these 'ecologies of injustice' (Mitman, 2008, p.134), this situation changed radically in the mid-twentieth century. A number of technological innovations – vacuum cleaners (Krause-Parello & Sciscione, 2009, p.127), washing machines (Biehler, 2013, p.90) and newly designed bed frames (Potter, 2011, p.19), for example – contributed to the near complete extirpation of bed bugs from the Global North. It was, however, the recognition that Dichlorodiphenyltrichloroethane (DDT) was an effective and apparently safe insecticide for individuals to use within the home which had the most significant effect upon the relations between bed bugs and their human companions (Kinkela, 2011, p.20). By the mid-1950s, and following the widespread use of DDT, bed bugs were so rare that most citizens would move through life without ever encountering one of the insects.

Yet the chasm between bed bugs and humans in the Global North has recently closed and global cities like London, Sydney, and most notably New York have seen remarkable increases in bed bug infestations. A 'perfect storm' (Potter, 2006) of diverse factors has apparently led to the explosion in bed bug numbers. Mobility allowed bed bugs to disperse more readily and increases in second-hand furniture sales and international travel have both facilitated a rise in bed bug numbers, often leading to bed bug discourse assuming racialized and xenophobic undertones (Potter, 2006, p.104). In her book *Infested*, for instance, Brooke Borel devotes significant attention to the fall of the iron curtain in Europe when discussing increased international travel, figuring resurgent bed bugs as, quite literally, beasts from the east (2015, chap 9). Second, our relationship with chemicals such as DDT has changed significantly since the 1950s. This is beautifully illustrated in Elizabeth Povinelli's autobiographical account of a childhood pastime which involved running alongside trucks spraying DDT into her local neighbourhood, seeing 'who could run the longest, the closest, to the nozzle spewing the pesticides in great clouds...' (Povinelli, 2017, p.505). Now, in the twenty-first century, and in the wake of Rachel Carson's (1962/2002) ground-breaking environmentalism, Povinelli asks instead '...what were we thinking? What was anyone thinking?' (2017, p.505). Third, and finally, there is increasing pesticide resistance on the part of the insect themselves. While resistance to DDT was first noted in 1947 (Usinger, 1966, p.47) pesticide resistance is now exceptionally common (Zhu

et al., 2010) and makes the eradication of bed bugs exceptionally difficult even when chemicals are put to use.

The increase in bed bug numbers has been met by a sometimes-panicked response from those who encounter them. There have been substantial claims of damages that have left hotel chains and landlords fearful of legal action (Lockwood, 2013, p.184; Doggett et al., 2012, p.177). Perhaps more significantly, a range of mental health problems have been associated with bed bug infestations: Anxiety, depression, and insomnia are frequent responses, and occasional reported cases of both post-traumatic stress syndrome and delusory parasitosis (Goddard & de Shazo, 2012, p.101-3; Rieder et al., 2012). For these reasons, entomologist Michael Potter has argued that 'Other household insects will take their toll, but bed bugs will transform the way people live, sleep, and travel, especially in developed areas of the world' (2006, p.102).

Re-entanglements between (some) humans and bed bugs within the Anthropocene, we suggest, foreground how abundance needs to be situated in relation to the legacies of historical acts and contemporary responses. Historical use of DDT led to the near extirpation of bed bugs in the middle of the twentieth century, and a subsequent deskilling as scientists ceased to conduct research on the insects during this time (Borel, 2015, p.61), while homeowners' knowledges of bed bug control came to be lost (Biehler, 2013, p.213). A further legacy of wrecking and exterminating persists in the form of pesticide resistance (Borel, 2015, p.11).

The affordances of re-entanglements between particular human populations and bed bugs, therefore, mean that these insects are both difficult to live with and to detach from. These difficulties, however, become more pronounced when turning to lifeforms that are still more intimately entangled with human bodies: microbes, which help to develop a clearer picture of the ethical *stakes* of abundance.

Anti-microbial resistance: The impossibility of disentanglement

Unlike bed bugs, humans have never been estranged from bacterial life. Bacteria have long been recognised as commensal organisms and are increasingly positioned as constitutive elements of healthy human and non-human animal bodies. The absence of certain bacteria has been linked to the

risks of non-infectious diseases such as autoimmunity, allergies and cancer (Round & Mazmanian, 2009; Walker & Lawley, 2013; Wang & Kasper, 2014; Janssens, et al., 2018). Indeed, *When Species Meet* opens with Haraway elucidating her central argument – ‘To be one is always to become with many’ (2008, p.4) – by drawing attention to the role of ‘bacteria, fungi, protists, and such’ within her own body. Conversely, bacterial life has also long caused death, disfigurement and discomfort to human and non-human animals; a point noted by Haraway’s caveat that: ‘Some of these personal microscopic biota are dangerous to the me who is writing this sentence’ (2008, p.4). As with Tsing’s reference to ambivalence, however, this recognition does not unsettle the fundamental ethical valorisation of being-in-relation that is evoked through Haraway’s reference to microbial life.

In this section we focus on the increasing abundance of antimicrobial resistance (AMR) amongst bacterial life which undermines our ability to treat bacterial disease with antimicrobial chemicals, most notably antibiotics. Unlike bed bugs, the increased incidence of AMR infections does not represent a case of quantitative resurgence in bacteria per se. Rather AMR draws attention to the challenges posed by the transformation and transition of life within the Anthropocene as bacterial communities have shifted to be increasingly composed of resilient bacteria while susceptible bacteria decline.

The discovery of sulphonamides in the 1930s and the industrialised production of penicillin in the 1940s heralded a new era of medicine, and with it hope that human life could flourish through the eradication of pathogenic life. The significance of these developments for the experience of disease and medical practice cannot be over-stated. Prior to antibiotic use a typical case of pneumonia lasted three to four weeks, typhoid fever twelve to sixteen weeks (Thomas, 1977), while diseases such as tuberculosis (TB), or ‘consumption’, slowly progressed over months and years (Daniel, 2006).

Although these diseases infected people of all classes, health inequalities – rooted in class, gender and ethnic background – meant the poor and people of colour were disproportionately affected with higher infection and death rates. Such deeply rooted health inequalities continue to persist within the UK and globally (DoH, 2011).

Pre-antibiotic medical care, for those able to afford it, more closely resembled what we would recognise today as palliative care: an effort to make individuals comfortable, manage their pain and other symptoms while they either recovered, although often afflicted with serious disabilities, or died (Yoshikawa, 2002). This is to say nothing of the herbal concoctions, dietary interventions, climatic prescriptions, bleeding and purging which at best offered benign relief and at worse quickened mortality (Iseman, 2002). In contrast antibiotics offered the hope of genuinely curing previously deadly infections, often in a matter of days (Thomas, 1977; Bud, 2007). However, such optimism went hand in hand with much more muted concerns that 'in place of vulnerable strains, weeded out by medical assault, resistant bacteria would often flourish' (Bud, 2007, p.116). It is this latter scenario that has come to represent our present and emerging future situation.

The show of life's resilience offered by AMR, however, does not represent hope that life can flourish within the chemical infrastructures that permeate and toxify our environments. Instead it is a direct and serious threat to the efficacy of antibiotics and their crucial place in modern medical practice, not only important for treating bacterial infection in the first instance, but also reducing the risks of surgery and chemotherapy. At present,

Antimicrobial-resistant infections currently claim at least 50,000 lives each year across Europe and the US alone, with many hundreds of thousands more dying in other areas of the world. But reliable estimates of the true burden are scarce. (O'Neill, 2014, p.3)

And it is likely that this burden will only increase over time (DoH & DEFRA, 2013; WHO, 2015; O'Neill, 2016).

The immediate response to the development of antibiotic resistant life has been a replay of past strategies for disease control, the further eradication of bacterial life within specific spaces. The threat of Methicillin-Resistant *Staphylococcus aureus* or MRSA in UK hospitals, for instance, was met primarily with alcohol hand wash, 'deep cleans' of infected wards and calls for matrons to return as 'guardians of cleanliness' (Koteyko, Nerlich, Crawford & Wright, 2008). At their core these strategies rely on antimicrobial chemicals to eradicate unwanted bacterial life from human bodies and hospital

environments. This has acted as a further catalyst for the accumulation of resistance genes and bacteria. Bacterial species are now becoming increasingly resistant not only to multiple antibiotics but the alcohol-based disinfectants used as a means of infection control (Pidot, et al., 2018).

The abundance of microbes, their intimate entanglement and enabling of other forms of life means the ongoing cultivation of interspecies distance is not only counter-productive but also futile. Indeed, it is often commensal bacteria, those that inhabit the many spaces of our body and are often crucial to its health, that represent a major infectious and resistance threat (Krismer, Weidenmaier, Zipperer & Peschel, 2017). *Staphylococcus aureus* is a bacterial species that routinely colonises human skin and nasal passages without problem. The sorts of cohabitation from which Haraway takes hope, however, are precisely what make microbes well-placed to opportunistically transition from benign commensal to deadly pathogen if the occupied human become immunocompromised.

Similarly to bed-bugs, AMR's abundance is bound up with socio-economic and political factors. The collapse of the Soviet Union and the ensuing 'shock therapy' advised by the IMF and World Bank, resulted in major socio-economic upheaval and with it a tuberculosis epidemic as living conditions declined, and unemployment, homelessness and malnutrition increased across the states of the former Soviet Union (Toungousova, Bjune & Caugnant, 2006). The concurrent decline in government healthcare funding, numbers of medical personnel, a lack of equipment and drugs meant that treatment regimens for TB were routinely interrupted or ended prematurely and resilient bacteria were able to flourish (Toungousova, et al., 2006). Prisons – underfunded, damp and over-crowded – became some of the most active hotspots of resistant TB infections, acting as an 'epidemiological pump' with the steady release of infected prisoners enabling the spread of the disease more broadly (Holden, 1999).

Furthermore, the proliferation of and spread of resistant bacteria and genes is entwined with broader ongoing geo-political events and trends, including the globalised movement of goods, non-human animals, and people (whether as a result of travel, trade or refugees displaced by war) (DoH, 2011; Maltezos, Theodoridou & Daikos, 2017). Refugees are particularly at risk due to the collapsing

housing, hygiene and healthcare infrastructures associated with conflicts and the potentially impoverished conditions they experience during their journey to refuge (Maltezou, et al., 2017). Thus the development and spread of AMR is further entangled in much longer histories of colonialism and Western military intervention, as well as systems of class, race and gendered discrimination and inequality that make certain people more vulnerable to infectious disease and AMR infections.

AMR poses urgent questions about how to live alongside lifeforms that are both impossible to disentangle from human worlds and – due to legacies of past technofixes – equally impossible to live with, especially for communities who are already facing poverty, discrimination and violence. The situatedness of pathogenicity in this context, therefore, forces attention to the conditions in which it emerges and shows how the more dangerous affordances of abundance are often entangled with inequality. It is the uneven ethical stakes of abundance that, we suggest, demand further exploration; in our final case we thus work to bring these ethical concerns to the fore.

Hookworms: Differential entanglements

Hookworms are a type of soil-transmitted helminth (parasitic worm) that inhabit the small intestine of human and non-human animals, feeding on their blood (NHS, 2015; Hotez, 2013). The two main species of hookworm infecting humans are *Necator americanus* (the American killer or “New World hookworm”) and *Ancylostoma duodenale* (“Old World hookworm”) (Palmer and Reeder, 2001).

Hookworm eggs are excreted in faeces and mature into larvae in warm, moist and shady soil; infection primarily occurs through skin contact with such soil. The larvae travel through the blood to the heart then the lungs, penetrating the alveoli and climbing to the throat, where they are swallowed. When they reach the small intestine, they grow to full size (7-13 mm), attach to the intestinal wall, mate, and reside for years (Hotez, 2013; CDC, 2017).

An estimated 576-740 million people in the world are infected with hookworm (CDC, 2013), which are abundant in tropical and subtropical, rural, low- and middle-income regions in Africa, Asia, Oceania and the Americas (Pullan, Smith, Jasrasaria & Brooker, 2014). Light-intensity infections are usually asymptomatic, while high-intensity infections can result in abdominal pain, diarrhoea, protein

deficiency, anaemia and associated fatigue, weight loss, complications in pregnancy, and impaired physical and cognitive development in children (CDC, 2013; Hotez et al., 2013). Soil-transmitted helminth infections are considered to be the most common 'neglected tropical disease', and are the target of deworming initiatives through the distribution of anthelmintic drugs to schoolchildren (Hotez, 2013).

In contrast with bed bugs but in common with bacteria, there has not been a recent global quantitative increase in abundance of hookworms: while hookworm infections are endemic in tropical and sub-tropical regions, there appear to have been recent declines in infection levels in some countries in those regions³ (Pullan et al., 2014). However, despite these declines, hookworms remain abundant (e.g. in 2010 'globally, 77% of the world's population lived in areas of risk of stable [hookworm] transmission' (Pullan and Brooker, 2012, p.13)), and there is also a (controlled) resurgence in regions including North America, Europe and Australia.

Like bed bugs, hookworms have a long, co-evolutionary history with humans, perhaps dating back 12,000 years (or longer) (Palmer, 2009; Cox, 2002). Medical historians, anthropologists and others have explored aspects of this history (Palmer, 2009; Ettlting, 1981/2013; Couacaud, 2014), but, most notably, geographer Jamie Lorimer (2016, 2017a, 2017b, 2018) has charted human-hookworm relations from ancient times to present day. Lorimer (2017a, 2018) traces human-hookworm entanglement, disentanglement and re-entanglement through three transitions: a period of sudden infection intensity and increasing scientific and medical attention in the 19th century; a separation (in some regions) in the 20th century onwards; and increasing contemporary attempts to restore hookworms as a key part of the human microbiome. These periods are shaped by and echoed in three figures of the hookworm – the parasite, ghost and mutualist (Lorimer, 2017a) – across which the hookworm emerges as ambivalent: in different situations the worms can become pathological through excessive presence and total absence, whilst in moderation they are potentially beneficial.

Until the second half of the 19th century, hookworm infection had been more or less present in people of tropical and warm temperate regions (including in Europe and North America) without significant

attention or concern on the part of 'Western' medical science (Palmer, 2009; Lorimer, 2018).

However, the political-ecological intensities of colonial capitalism in India, Africa, the Americas and Australia created conditions for hookworms to become parasitic: colonial mines, railroad beds, reserves and plantations were hotspots for hookworm disease due to high density populations of displaced, poorly nourished people living with poor sanitation and suitable soil (Lorimer, 2018). This led to frequent re-infection and excessively high wormloads: hookworm *infection* tipped over into hookworm *disease* (Palmer, 2009).

Concerns about the effect of hookworm on labour productivity, particularly in the Southern states of the US, led to it becoming known as 'the germ of laziness' (Ettling, 2013), perpetuating the stigmatisation of poor, rural communities (Gulland, 2017; Nuwer, 2016). In the early 20th century the Rockefeller Sanitary Commission for the Eradication of Hookworm Disease rolled out a public health programme to eliminate hookworm in the Southern US through deworming treatment, education campaigns and improved sanitation, aiming to prevent (re-)infection by reducing contamination of soil and distributing shoes⁴ (Farley, 2003; Hotez, 2013). This initial programme was followed by international efforts, with the secretary of the Rockefeller Foundation arguing that hookworm eradication 'must be made a world campaign – not for altruistic motives merely but because no one country can be safe until all have been cleared of this pest' (Greene, 1913, cited in Farley, 2004, p.4). By the 1930s, owing to a combination of rural depopulation, urbanisation and economic development, hookworms were no longer endemic in the Southern US, and they were also largely eliminated in other countries including Japan and South Korea by the 1950s and 1960s, supported by the introduction of first-generation anthelmintic drugs (Hotez, 2013; Brooker et al., 2004).

In the Global North and urban Global South, however, since the late 1980s a turn towards ecological understandings of the microbiome and immunity has given rise to a new hookworm figure – that of the ghost (Lorimer, 2017a, 2018). This understanding of human-hookworm relations builds on the 'hygiene hypothesis' (Strachan, 1989) and 'biome depletion theory' (Parker, 2014), in which benign commensal bacteria or 'old friends' (Rook and Brunet, 2005) who used to calibrate the immune system from birth are no longer present due to 'Western' health and lifestyle practices, leading the

immune system to turn on itself in 'epidemics of absence' (Velasquez-Manoff, 2013). The absence of helminths in the human microbiome has been linked to increased allergic, autoimmune and inflammatory disease, with research suggesting that a low intensity infection can be tolerated without detrimental effect on the host (Wammes, Mpairwe, Elliott & Yazdanbakhsh, 2014; Zaiss et al., 2015).

Building on these developments, since 2004 clinical trials have explored the safety and efficacy of helminthic therapy (deliberate, controlled hookworm infection) to treat autoimmune, allergic and inflammatory conditions including asthma, coeliac disease, multiple sclerosis, and autism (Wammes et al., 2013). Outside these formal trials, networks of expert patients (predominantly based in Europe, North America and Australia) breed and distribute hookworms – and helminthic knowledge – for self-infection with 'gut buddies' or 'colon comrades' (Lorimer 2016, 2017a). Here, the figure of the hookworm as mutualist suggests a return to a mutually beneficial symbiotic mode of being alongside, wherein the hookworm – with which we co-evolved – is allowed to (re-)enter into dialogue with the host immune system and recalibrate it (Lorimer 2017a). As such hookworms pose important questions about the *differential* distribution of abundance and access to therapies for diseases of absence.

Textures of 'being alongside'

As hinted at in the above cases, the problem with centring an ethics on entanglements between species is that a 'vitalist emphasis on gathering together and relationality leaves little "room for the radical otherness of the other," or anything that might question the desirability of being attached' (Ginn, 2014, p.540). An emphasis on irreducible relations makes it difficult to negotiate relationships that involve violence toward other species (Collard, 2014) or, conversely, the forms of pathogenic and parasitic relations we have delineated here (cf. Beisel, 2010). Latimer's concept of 'becoming with' attempts to respond to these tensions. Rather than understanding the relationships between particular lifeforms as being wholly determinate of one another, Latimer instead (drawing on Strathern) argues that these are only ever partial connections. Though the relationship between a human and animal might be *partially* constitutive of one another's identity, it is not *wholly* constitutive because the self also emerges through a myriad of other affective and social relationships. Being alongside is thus intended to recognise the co-constitutive nature of relations between species whilst – in

contradistinction to Haraway and related work that has foregrounded multispecies entanglements – also creating space for the partners in a given relation: ‘to move on, to push away from each other, to disconnect and separate, and attach to other extensions’ (Latimer, 2013, p.96).

In the rest of the paper we contrast the different textures of ‘being alongside’ offered by our three cases. Firstly, through contrasting the re- or dis- entanglements that have been engendered by abundant lifeforms, our cases elucidate how the affordances of abundance need to be situated in relation to specific histories and forms of inequality. The ways in which we encounter, live with, and alongside abundant life forms in *this* moment are radically shaped by *previous* modes of living with, alongside, and encountering. Historical and contemporary socio-technical interventions have left and continue to leave biological and sociological imprints that may render the restoration of ‘ideal’ prior states impossible (Landecker, 2015; Lorimer, 2018). In the case of bed bugs this was reflected by the deskilling of homeowners and lack of contemporary scientific research on the insects, in the wake of their near extirpation. With AMR, similarly, past technological interventions – and the types of distance they created between human and bacterial life – actively precipitated the proliferation of resistant microbes. Our prodigious use of antimicrobial chemicals has toxified and disturbed microbial worlds, producing new forms of abundance as microbial life has been transformed through such exposures. In both cases, the past has informed the affordances of abundance in the present and what forms of detachment and re-attachment are possible. Hookworms underline this point, whilst adding further complication. The three figures of the hookworm – the parasite, ghost and mutualist (Lorimer, 2017a) – emphasise how pathogenicity itself is situated, posing questions about the conditions under which certain forms of abundance become particularly difficult to live with.

The relational nature of pathogenicity in the context of hookworms leads to our second argument; it is vitally important to situate abundance in relation to not just historical but contemporary inequalities. Our cases highlight intertwined geo-political, socio-material patterns (of uneven power and development, of classed, racialized histories and presents) spanning macro and micro scales. Furthermore, in our cases, pathogenicity, (in)tolerance or mutualism is emergent from particular intimate social, cultural, economic, spatial, material, bodily and affective configurations (cf.

Hinchliffe et al 2016; Lorimer 2017a). Consequently, while bed bugs, microbes or hookworms do not discriminate in the bodies they relate to, the distribution of particular forms of abundant life concentrates in 'sticky associations' (Ahmed, 2013, p.8 & Chen, 2012, p.89) with certain groups of people and places. Focusing on abundance thus draws attention to the unequal burdens of the Anthropocene that are created not just by the 'capitalist ruins' (Tsing, 2015) but by the unexpected abundance that flourishes amidst these ruins.

Situating abundance

The three cases we have engaged with point towards the importance of considering not just how to cope with loss, but abundance in the Anthropocene. These cases cannot be homogenised and show that careful attention must be paid to the modes of entanglement offered by particular forms of abundance. For example, while bed bugs threaten composure, resistant pathogenic microbes threaten lives. This raising of the stakes is not just linked to the pathogenicity of microbes in comparison to bed bugs but also, to echo Haraway, that we have never been and will never be alienated from microbial life, resistant or otherwise, and have no choice but to be intimately entangled with it. The modes of relation offered by hookworms are yet more complex, serving as a reminder that the affordances of abundance cannot be separated from socio-economic concerns.

Together these cases have built up a multi-layered picture of abundance, which show how the stakes of intimate entanglements with abundant life are intensely uneven. For instance, the resurgence of bed bugs has reproduced stigma long attached to the insects (due to, often racialized, associations with poverty). Although AMR represents a broader problem – the end of abilities to consistently estrange humans from microbial life and prevent the more violent consequences of such an entanglement – it is important to underline that these consequences are entwined with and re-inscribe inequality. In contrast, for now there seems to remain some element of choice in the extent to which some humans are entangled with hookworms (though it has been suggested this will diminish in the face of anthelmintic resistance and climate change (Vercruyse et al. 2011)). Understanding the implications and limits of such choice, and,

importantly, extending the agency to make it to those affected the most, is a neglected yet vital ethical programme.

This re-conceptualisation of abundance has wider theoretical implications. The patches of resurgence and new assemblages that Tsing, for instance, draws hope from, sit uneasily when considering that in many instances abundance is not just bound up with colonial histories (deLoughrey et al, 2015: 115-186), but actively intensifies the unequal burden of living amidst the ruins wrought by prior industry and technological intervention. Understanding abundance as something that can constitute (rather than ameliorate) anthropogenic problems unsettles both the hopeful potential of resurgent ecologies and broader appeals to an ethics of being-in-relation, as responses to loss within the Anthropocene.

Collectively, therefore, these cases foreground that in some contexts it is necessary to actively *confront* ethical questions posed by abundance, and the ramifications of past and present intervention, upon contemporary inequalities within the Anthropocene. Situating abundance as a constitutive dimension of the Anthropocene highlights the importance not just of finding new ways to 'become with' with other species, but exist *alongside* them through realising situated detachments or re-attachments (cf Latimer, 2013; Ginn, 2014). Centralising the ethical questions posed not just by abundance but dangerous entanglements and intimacies more broadly, is vital in order to take responsibility for the consequences of past technofixes and to avoid replaying both historical and contemporary injustices and inequalities.

References

- Ahmed, S. (2013). *The cultural politics of emotion*. London and New York: Routledge.
- Alaimo, S. (2016). *Exposed*. Minneapolis: University of Minnesota Press.
- Balvín O., Munclinger P., Kratochvíl L., & Vilímová J. (2012). Mitochondrial DNA and morphology show independent evolutionary histories of bedbug *Cimex lectularius* (Heteroptera: Cimicidae) on bats and humans. *Parasitology Research*, 111(1), 457-469.
- Barad, K. (2007). *Meeting the universe halfway*. Durham & London: Duke University Press.
- Bartsch, S.M., Hotez, P.J., Asti, L., Zapf, K.M., Bottazzi, M.E., Diemert, D.J., & Lee, B.Y. (2016). The global economic and health burden of human hookworm infection. *PLOS Neglected Tropical Diseases*, 10(9), e0004922.

- Bastian, M. (2017). 'Encountering leatherbacks in multispecies knots of time.' In D. Bird Rose, T. van Dooren, & M. Chrulow (Eds.), *Extinction Studies* (149-186). New York: Columbia.
- Bastian, M. (2012). Fatally confused: Telling the time in the midst of ecological crises. *Environmental Philosophy*, 9(1), 23-48.
- Beisel, U. (2010). Jumping hurdles with mosquitoes? *Environment and Planning D: Society and Space*, 28(1), 46-49.
- Biehler, D.D. (2013). *Pests in the city*. Seattle: University of Washington Press.
- Boase, C. (2001). Bedbugs – back from the brink. *Pesticide Outlook*, 12(4), 159-162.
- Borel, B. (2015). *Infested*. Chicago: University of Chicago Press.
- Braidotti, R. (2012). *The posthuman*. London: Polity.
- Brooker, S., Bethony, J., & Hotez, P.J. (2004). Human hookworm infection in the 21st century. *Advances in Parasitology*, 58, 197-288.
- Bud, R. (2007). *Penicillin: triumph and tragedy*. Oxford: Oxford University Press.
- Carlson, C.J., Burgio, K.R., Dougherty, E.R., Phillips, A.J., Bueno, V.M., Clements, C.F., ... Getz, W.M. (2017). Parasite biodiversity faces extinction and redistribution in a changing climate. *Science Advances*, 3(9), e1602422.
- Carson, R. (2002) *Silent spring*. Boston and New York: Houghton Mifflin.
- CDC (2013) Hookworm. Retrieved 12 September 2018, from <https://www.cdc.gov/parasites/hookworm/index.html>
- CDC (2017) Hookworm (DPDx). Retrieved 12 September 2018, from <https://www.cdc.gov/dpdx/hookworm/index.html>
- Chen, M.Y. (2012). *Animacies*. Durham and New York: Duke University Press.
- Collard, R.C. (2014). Putting animals back together, taking commodities apart. *Annals of the Association of American Geographers*, 104(1): 151-165.
- Couacaud, L. (2014). Hookworm disease and its relationship to capitalism and urban development. *Journal of Political Ecology*, 21(1), 349-371.
- Cox, F.E.G. (2002), History of human parasitology. *Clinical Microbiology Reviews*, 15(4), 595-612.
- Crutzen, P.J. & Stoermer, E.F. (2000). The 'Anthropocene'. *Global Change Newsletter. The International Geosphere-Biosphere Programme (IGBP): A Study of Global Change of the International Council for Science (ICSU)*, 41, 17-18.
- Cudworth, E. (2015). Killing animals: Sociology, species relations and institutionalized violence. *The Sociological Review*, 63(1), 1-18.
- Daniel, T. (2006). The history of tuberculosis. *Respiratory Medicine*, 100(11): 1862-1870.
- DeLoughrey, E., Didur, J. and Carrigan, A. (2015). *Global ecologies and the environmental humanities*. London and New York: Routledge.
- DoH & DEFRA (2013). *UK five year antimicrobial resistance strategy: 2013-2018*. London: Department of Health.

- DoH (2011). *Annual Report of the chief medical officer, volume two: Infections and the rise of antimicrobial*. London: Department of Health.
- Doggett, S.L., Dwyer D.E., Peñas P.F., & Russell, R.C. (2012). Bed bugs: clinical relevance and control options. *Clinical Microbiology Reviews*, 25(1), 164-192.
- Ettling, J. (2014). *The germ of laziness* (Reprint 2013 ed. [1981]). Cambridge, Mass.: Harvard University Press.
- Farley, J. (2003). *To cast out disease: A history of the international health division of the Rockefeller Foundation (1913-1951)*. Oxford: Oxford University Press.
- Franklin, S. (2007). *Dolly mixtures*. Durham and New York: Duke University Press.
- Ginn, F. (2014). Sticky lives: Slugs, detachment and more-than-human ethics in the garden. *Transactions of the Institute of British Geographers*, 39(4), 532-544.
- Ginn, F., Beisel, U., & Barua, M. (2014). Living with awkward creatures: Vulnerability, togetherness, killing. *Environmental Humanities*, 4, 113-123.
- Goddard, J. and de Shazo, R. (2012). Psychological effects of bed bug attacks (*Cimex lectularius* L.). *The American Journal of Medicine*, 125(1), 101-103.
- Greene, J. (1913, January 18). Unknown. *New York Times*.
- Gulland, A. (2017). Sixty seconds on . . . hookworm. *BMJ: British Medical Journal (Online); London*, 358.
- Hamilton, L., & Taylor, N. (2017). *Ethnography after humanism*. Basingstoke: Palgrave MacMillan.
- Haraway, D. (2016). *Staying with the trouble*. Durham and New York: Duke University Press.
- Haraway, D. (2008). *When species meet*. Minneapolis: University of Minnesota Press.
- Hinchliffe, S., Bingham, N., Allen, J., & Carter, S. (2016). *Pathological lives*. Chichester: Wiley.
- Holden, C. (1999). Stalking a killer in Russia's prisons. *Science*, 286(5445), 1670.
- Hotez, P.J. (2013). *Forgotten people, forgotten diseases*. Washington, US: ASM Press.
- Hotez, P.J., Diemert, D., Bacon, K.M., Beaumier, C., Bethony, J.M., Bottazzi, M.E., . . . Russell, P.K. (2013). The human hookworm vaccine. *Vaccine*, 31, B227-B232.
- Iseman, M. (2002). Tuberculosis therapy: Past, present and future. *European Respiratory Journal*, 20(S36), 87s-94s.
- Janssens, Y. et al. (2018). Disbiome database: linking the microbiome to disease. *BMC Microbiology*, 18(50), 2-6.
- Kane, E. (2016). Beagle vs. bedbug: The hunt is on. *DVM360*, 3. Retrieved from: <http://veterinarynews.dvm360.com/beagle-vs-bedbug-hunt?pageID=3>
- Kinkela, D. (2011) *DDT and the American century*. North Carolina: Univ of North Carolina Press.
- Kirksey, E. and Helmreich, S. (2010). The emergence of multispecies ethnography. *Cultural Anthropology*, 25, 525-576.
- Kirksey, E. (2018). Feeding the flock: Wild cockatoos and their facebook friends. *Environment & Planning E: Nature & Space*. DOI: 10.1177/2514848618799294

- Koteyko, N., Nerlich, B., Crawford, P., & Wright, N. (2008). 'Not rocket science' or 'No silver bullet'? Media and government discourses about MRSA and cleanliness. *Applied Linguistics*, 29(1), 223-243.
- Krause-Parello, C.A. and Sciscione, P. (2009). Bedbugs: an equal opportunist and cosmopolitan creature. *The Journal of School Nursing*, 25(2), 126-132.
- Krismer, B., Weidenmaier, C., Zipperer, A., & Peschel, A. (2017). The commensal lifestyle of *Staphylococcus aureus* and its interactions with the nasal microbiota. *Nature Reviews Microbiology*, 15, 675-687.
- Luckey, T. (1965). Effects of microbes on germfree animals. *Advances in Applied Microbiology*, 7, 169-223.
- Landecker, H. (2016). Antibiotic resistance and the biology of history. *Body & Society*, 22(4), 19-52.
- Latimer, J. (2013) Being alongside: Rethinking relations amongst different kinds. *Theory, Culture & Society*, 30(7-8), 77-104.
- Lewis, S. (2017). Cthulu plays no role for me. *Viewpoint Magazine*, 8th May. Retrieved from: <https://www.viewpointmag.com/2017/05/08/cthulhu-plays-no-role-for-me/>
- Lockwood, J. (2013). *The infested mind*. Oxford: Oxford University Press.
- Lorimer, J. (2018). Hookworms make Us human: The microbiome, eco-immunology, and a probiotic turn in western health care. *Medical Anthropology Quarterly*, 0(ja). <https://doi.org/10.1111/maq.12466>
- Lorimer, J. (2017). The Anthro-po-scene: A guide for the perplexed. *Social Studies of Science*, 47(1), 117-142.
- Lorimer, J. (2017a). Parasites, ghosts and mutualists: a relational geography of microbes for global health. *Transactions of the Institute of British Geographers*, 42(4), 544-558.
- Lorimer, J. (2017b). Probiotic environmentalities: Rewilding with wolves and worms. *Theory, Culture & Society*, 34(4), 27-48.
- Lorimer, J. (2016). Gut buddies: Multispecies studies and the microbiome. *Environmental Humanities*, 8(1), 57-76.
- Lorimer, J. (2015). *Wildlife in the Anthropocene*. Minneapolis: University of Minnesota Press.
- Lorimer, J. (2012). Multinatural geographies for the Anthropocene. *Progress in Human Geography*, 36(5), 593-612.
- Lorimer, J. (2007). Nonhuman charisma. *Environment and Planning D: Society and Space*, 25(5), 911-932.
- Maltezou, H., Theodoridou, M., & Daikos, G. (2017). Antimicrobial resistance and the current refugee crisis. *Journal of Global Antimicrobial Resistance*, 10, 75-79.
- Mas-Coma, S., Valero, M.A., & Bargues, M.D. (2008). Effects of climate change on animal and zoonotic helminthiasis. *Scientific and Technical Review of the Office International Des Epizooties (Paris)*, 27(2), 443-452.
- Mitman, G. (2008) *Breathing space*. New Haven & London: Yale University Press.
- NHS (2015). Hookworm infection. Retrieved from: <https://www.nhs.uk/conditions/hookworm/>

- Nuwer, R. (2016, April 27). How a worm gave the south a bad name. Retrieved from <http://www.pbs.org/wgbh/nova/next/nature/how-a-worm-gave-the-south-a-bad-name/>
- O'Neill, J. (2014). *Antimicrobial resistance: Tackling a crisis for the health and wealth of nations: Review on antimicrobial resistance*. London: HM Government.
- O'Neill, J. (2016). *Tackling drug-resistant infections globally: Final report and recommendations*. London: HM Government.
- Palmer, P.E.S., & Reeder, M.M. (2001). Ancylostomiasis (hookworm disease). In *The Imaging of Tropical Diseases: With Epidemiological, Pathological and Clinical Correlation* (Vol. 2, pp. 51–65). Berlin: Springer.
- Palmer, S. (2009). Migrant clinics and hookworm science: Peripheral origins of international health, 1840–1920. *Bulletin of the History of Medicine*, 83(4), 676–709.
- Panagiotakopulu, E. & Buckland P.C. (1999). *Cimex lectularius* L., the common bed bug from Pharaonic Egypt. *Antiquity*, 73(282), 908-911.
- Parker, W. (2014). The “hygiene hypothesis” for allergic disease is a misnomer. *BMJ*, 349, g5267.
- Pidot, S. et al (2018) Increasing tolerance of hospital *Enterococcus faecium* to handwash alcohols. *Science Translational Medicine*, 10(452): eaar6115.
- Puig de la Bellacasa, M. (2016). *Matters of care*. Minneapolis: University of Minnesota Press.
- Potter, M.F. (2006). The perfect storm: an extension view on bed bugs. *American Entomologist*, 52(2): 102-104.
- Potter, M.F. (2011). The history of bed bug management. *American Entomologist*, 57(1): 14-25.
- Povinelli, E.A. (2017). Fires, fogs, winds. *Cultural Anthropology*, 32(4): 504-513.
- Puig de la Bellacasa M (2011) Matters of care in technoscience: Assembling neglected things. *Social Studies of Science*, 41(1): 85–106.
- Pullan, R.L., & Brooker, S.J. (2012). The global limits and population at risk of soil-transmitted helminth infections in 2010. *Parasites & Vectors*, 5(1), 81.
- Pullan, R.L., Smith, J.L., Jasrasaria, R., & Brooker, SJ (2014). Global numbers of infection and disease burden of soil transmitted helminth infections in 2010. *Parasites & Vectors*, 7(1), 37.
- Rieder, E., Hamalian G., Maloy, K., Streicker, E., Sjulson, L., & Ying, P. (2012). Psychiatric consequences of actual versus feared and perceived bed bug infestations: a case series examining a current epidemic. *Psychosomatics*, 53(1): 85-91.
- Rook, G.A.W., & Brunet, L.R. (2005). Old friends for breakfast. *Clinical & Experimental Allergy*, 35(7), 841–842.
- Rose, D.B., van Dooren, T. and Chrulew, M. (Eds) (2017). *Extinction Studies*. New York: Columbia.
- Round, J. & Mazmanian, S. (2009). The gut microbiome shapes intestinal immune responses during health and disease. *Nature Reviews Immunology*, 9(5): 313-323.
- Seidel, C., & Reinhardt, K. (2013). Bugging forecast: unknown, disliked, occasionally intimate. Bed bugs in Germany meet unprepared people. *PloS one*, 8(1): p.e51083.
- Strachan, D.P. (1989). Hay fever, hygiene, and household size. *BMJ: British Medical Journal*, 299(6710), 1259–1260.

- Strathern, M. (1995) *Relation*. North America: Prickly Pear Pamphlets.
- Thomas, C.D. (2013). The Anthropocene could raise biological diversity. *Nature*, 502(7469). Available from: <https://www.nature.com/news/the-anthropocene-could-raise-biological-diversity-1.13863> Accessed 4.9.18.
- Thomas, L. (1977). On the Science and Technology of Medicine. *Daedalus*, 106(1, Doing Better and Feeling Worse: Health in the United States): 35-46.
- Toungousova, O., Bjune, G., & Caugnant, D. (2006). Epidemic of tuberculosis in the former Soviet Union: Social and biological reasons. *Tuberculosis*, 86(1): 1-10.
- Tsing, A.L., Bubandt, N., Gan, E., & Swanson, H.A. (2017). *Arts of living on a damaged planet*. Minneapolis: University of Minnesota Press.
- Tsing, A.L. (2015). *The mushroom at the end of the world*. Princeton and Oxford: Princeton University Press.
- Usinger, R.L. (1966). *Monograph of cimicidae (Hemiptera, Heteroptera)*. Baltimore: Horn-Shafer.
- van Dooren, T. (2014). *Flight ways*. New York: Columbia.
- Velasquez-Manoff, M. (2012). *An epidemic of absence*. New York: Scribner.
- Vercruyse, J., Albonico, M., Behnke, J.M., Kotze, A.C., Prichard, R.K., McCarthy, J.S., ... Levecke, B., (2011). Is anthelmintic resistance a concern for the control of human soil-transmitted helminths? *International Journal for Parasitology*, 1(1), 14–27.
- Walker, A., & Lawley, T. (2013). Therapeutic modulation of intestinal dysbiosis. *Pharmacological Research*, 69(1): 75–86.
- Wammes, L.J., Mpairwe, H., Elliott, A.M., & Yazdanbakhsh, M. (2014). Helminth therapy or elimination: epidemiological, immunological, and clinical considerations. *The Lancet Infectious Diseases*, 14(11), 1150–1162.
- Wang, Y. & Kasper, L. (2014). The role of microbiome in central nervous system disorders. *Brain, Behavior, and Immunity*, 38: 1-12.
- Whatmore, S. (2006). Materialist returns: practising cultural geography in and for a more-than-human world. *Cultural Geographies*, 13(4): 600-609.
- WHO, (2015). *Global action plan on antimicrobial resistance*. Geneva: World Health Organisation.
- Wilkie, R. (2015). Multispecies scholarship and encounters: Changing assumptions at the human-animal nexus. *Sociology*, 49(2): 323-339.
- Wolfe, C. (2010). *What is posthumanism?* Minneapolis: University of Minnesota Press.
- Yoshikawa, T. (2002). Antimicrobial resistance and aging: beginning of the end of the antibiotic era? *Journal of the American Geriatrics Society*, 50(7): S226–S229.
- Zaiss, M.M., Rabin, A., Lebon, L., Dubey, L.K., Mosconi, I., Sarter, K., ... Harris, N.L. (2015). The intestinal microbiota contributes to the ability of helminths to modulate allergic inflammation. *Immunity*, 43(5), 998–1010.
- Zhu, F., Wigginton, J., Romero, A., Moore, A., Ferguson, K., Palli, R., Potter, M.F., Haynes, K.F., & Palli, S.R. (2010). Widespread distribution of knockdown resistance mutations in the bed bug,

Cimex lectularius (Hemiptera: Cimicidae), populations in the United States. *Archives of Insect Biochemistry and Physiology*, 73(4): 245-257.

¹ Numerous theorists have questioned the value of the term Anthropocene, but given its centrality in the literature under consideration and its prominence across disciplines we have continued to use it here. See Lorimer (2015, p.2-4) for a defence of ongoing engagement with the concept in the social sciences and humanities.

² It has not escaped the notice of more-than-human scholars that one of the most abundant species within the Anthropocene is the human species. Concerns within this body of work about, first, an apparent *over*-abundance of humans and, second, a need to ameliorate the impact of human activity, has led to prominent theoretical work arguing for the need to reduce rates of reproduction in order to share the world more convivially with other lifeforms. This position is crystallised by Haraway's controversial calls to 'make kin not babies' (Haraway, 2016, p103; for an important critique, Lewis, 2017).

³ The variable quality and spread of data is a major hurdle to estimating prevalence, infection intensity and disease burden (Pullan et al., 2014; Bartsch et al., 2016).

⁴ The efficacy of the distribution of footwear as a measure to reduce (re-)infection was questionable, as hookworm larvae can penetrate any skin that comes into contact with soil (Hotez, 2013).