

– THE ZONOTIC CITY: Urban Political Ecology and the Pandemic Imaginary

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Abstract

In the context of the Covid-19 pandemic this article takes a longer view of the evolving relationship between urbanization and the range of zoonotic diseases that have spread from animals to humans. I suggest that the existing interpretation of epidemiological transitions remains overly Eurocentric and requires a more nuanced conception of global environmental history. Similarly, the conceptualization of urban space within these teleological schemas has relied on a narrow range of examples and has failed to fully engage with networked dimensions to urbanization. At an analytical level I consider the potential for extending the conceptual framework offered by urban political ecology to take greater account of the epidemiological dimensions to contemporary urbanization and its associated pandemic imaginary. I examine how contemporary health threats intersect with complex patterns of environmental change, including the destruction of biodiversity (and trade in live animals), the co-evolutionary dynamics of viruses and other pathogens, and wider dimensions to the global technosphere, including food production, infrastructure networks, and the shifting topographies of peri- or ex-urban contact zones.

'viruses and other microbial agents are material-symbolic representations of an emerging and uncontrollable nature.'
Meike Wolf (2016: 972)

In the early 1970s the French historian Emmanuel Le Roy Ladurie could suggest that the age when microbes were able to shape global affairs was effectively over.¹ For the mediaevalist Le Roy Ladurie, writing at the peak of public health optimism, the possibility of another vast global disruption wrought by disease must have seemed very remote. Yet, as an influential contributor to the Annales school, Le Roy Ladurie's insights into long-term shifts in relations between human culture and the unpredictable dynamics of pathogens provide a useful entry point into an environmental history of pandemics. In this article I draw on the related but more recent analytical field of urban political ecology as a lens through which to interpret the history of zoonoses and pandemics, including the current impact of Covid-19. I seek to extend a political ecology framework to take better account of the dynamics of urban epidemiology, the agency of non-human nature, and the articulation of the pandemic imaginary as a microbial counterpart to the delineation of ecological imaginaries.

The meaning of the word pandemic has its own historiography in relation to shifting public health discourses and the term was not widely deployed until the global influenza outbreak of 1918–1919 (see Harrison, 2016). Interest in pandemics resurfaced from the 1990s onwards, especially in the wake of the rising global incidence

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1 Le Roy Ladurie (1973). As early as 1959 the microbiologist René Dubos had warned against a false sense of scientific omnipotence in the face of disease (see Honigsbaum, [2019] 2020: xv).

of HIV, the H1N1 avian flu outbreak of 1997, as well as growing concerns with the little-known Ebola virus and a range of other previously unknown pathogens. Existing conceptions of international health, with an emphasis on regional threats from malaria, polio, and other diseases in the global South, have been gradually displaced by more risk-oriented conceptions of ‘bio-security’, ‘global health’, and the ‘new public health’ (see Fassin, 2012; Harrison, 2016). This change in perceptions involves not only a greater scale of potential threat but also a reordering of key actors—both human and non-human. For the legal scholar David Fidler, the appearance of SARS in 2002 marks the entry of a ‘post-Westphalian pathogen’ onto the world stage that upends existing approaches to public health (see Fidler, 2003: 406). Yet, as this article will show, the notion of a neat or definitive break between one global health regime and another needs to be treated with caution; it is preferable to consider a number of intersecting developments with heterogenous outcomes.

Zoonotic pathogens derived from animals are pivotal to the increasing prevalence of new and emerging diseases. Indeed, around two thirds of human diseases are likely to be zoonotic in origin.² From the 1990s onwards there has been particular interest in a series of zoonotic ‘spillover events’ that have contributed to public health crises (see Quammen, 2012; Keck and Lynteris, 2018). The zoonosis itself has become transformed into a ‘charismatic epistemic thing’ at the intersection between several scientific fields (Lynteris, 2019: 6). To invoke the ‘zoonotic city’ is to emphasize that the independent dynamics of nature, including genetic changes underlying microbial threats, remains pivotal to urban epidemiology, implying a shift away from the organizational and political parameters of the ‘bacteriological city’ framed by increasingly standardized socio-technical formations (see Gandy, 2006). In one sense, the ‘zoonotic city’ has always been present, in terms of the epidemiological dynamics of the earliest human settlements, but the recent shift of global health concerns towards new and emerging diseases denotes a renewed sense of apprehension with the unpredictable dynamics of the microbial realm, and its associated vectors, intermediaries and zones of inter-species encounter.

How should we define the zoonotic city in relation to the existing intellectual parameters of urban epidemiology? Does urban epidemiology represent a coherent body of ideas or rather a field of concern? The anthropologist Meike Wolf (2016) suggests that three main frameworks have been adopted within the urban epidemiology literature: firstly, a longstanding biocultural model that relates the ‘molecularized body’ à la Margaret Lock (2012) to its environment as part of ‘new disease ecologies’ that look beyond the limits of medical or technical containment strategies towards the specific topographies or architectonic formations within which pathogens can flourish; secondly, an emerging emphasis on multispecies entanglements that render urban space ‘permeable and fragile’ thereby highlighting a series of zoonotic and vector borne interactions; and thirdly, a series of network oriented studies of bio-security strategies and the identification of zoonotic transfer zones, urban amplifier effects, and a wider set of threats associated with new and emerging diseases. These geographies of heightened epidemiological risk are increasingly associated with zoonotic spillover events, the identification of ecological border zones, and a variety of specific milieus that can facilitate animal-to-animal, animal-to-person and person-to-person modes of transmission. Interest in zoonotic landscapes brings together insights from bio-security research, critical animal studies, political ecology and many other fields and is reflected in tensions between different types of collaborative epistemologies and institutional settings (see Keck and Lynteris, 2018). The increasing

2 Although some authors restrict their definition of zoonoses to those diseases passed by vertebrates to humans, the wider definition adopted here extends to vector-borne diseases such as dengue and malaria. See, for example, Hubálek (2003), Karesh *et al.* (2012), May (2007), Osterhaus (2001), and Woolhouse and Gaunt (2007).

significance of zoonoses, as part of the current epidemiological transition, marks a breaching of what Lynteris (2019: 16) refers to as the ‘sanitary-utopian paradigm’ in which the scale of threat to human societies from disease was perceived as largely knowable and controllable.

Since the late 1970s, and possibly earlier according to some accounts, there has been a shift from perceptions of a relatively stable, and for the most part improving, phase in the field of global public health towards a ‘new age of pandemics’ (see Harrison, 2016; Honigsbaum, [2019] 2020). In many cases previously unknown diseases have been traced to forms of ecological disturbance, bringing new or little-known viruses and other pathogens into contact with human societies. Bats in particular are now recognized as perhaps the single most important source of current and future zoonotic threats since they harbour a huge number of viruses—many of which remain unknown to science—that are capable of jumping between species and ultimately infecting people (see Afelt *et al.*, 2018).³ Two global epicentres for zoonotic spillover events are now recognized—west central Africa and south Asia—both of which coincide with extensive biodiversity hotspots under intensifying threat of environmental destruction.⁴ Interestingly, research in more remote areas of southern China has detected the presence of human antibodies towards a wide variety of bat-borne viruses suggesting that non-lethal spillover events may be increasingly frequent (Li *et al.*, 2019). Potentially dangerous zones of zoonotic transfer are not, however, restricted to the global South: the H1N1 swine flu pandemic of 2009 originated in North American factory farms whilst variant Creutzfeldt–Jakob disease was traced to the UK beef industry using contaminated animal feed after deregulation in the 1980s (see, for example, Smith and Bradley, 2003; Mena *et al.*, 2016). Elevated levels of zoonotic risk associated with capitalist agriculture unsettle ideologically driven variants of the pandemic imaginary based on the exoticization of distant locales, the castigation of small-scale producers or a reliance on racialized topographic stereotypes such as the ‘Asian city’ (see Karesh *et al.*, 2012; Peckham, 2015; Harrison, 2016; Lynteris, 2019; Kaup, 2021).

In the first part of the article I consider the evolving relationships between zoonoses, urbanization, and epidemiological transitions. I then turn to different modes of interpreting ‘zoonotic urbanization’ as a key facet to growing concerns with new and emerging diseases. In the next section I focus specifically on urban dimensions to the on-going Covid-19 pandemic, including differential patterns of exposure and vulnerability. I then move on to consider the distinctive insights for contemporary urban epidemiology that can be gained from the analytical lens of urban political ecology. In the final section I reflect on the concept of the pandemic imaginary as part of an emerging conceptual articulation between political ecology, urban epidemiology and contrasting modes of cultural representation.

Decentring urban epidemiology

The term ‘epidemiological transition’ generally refers to a moment of far-reaching change in the relationship between human societies and disease. Many diseases have occurred in cycles since their first appearance: influenza, for example, has been marked by a series of retreats, returns, and mutations since its emergence in the late sixteenth century. The ‘smouldering embers’ of the 1918 Spanish flu that killed around 50 million people, equivalent to some 2.4% of the then global population, remain in circulation and flared up as the Asian flu (H2N2) outbreak of 1957 (with 1.1 million dead) and the Hong Kong flu (H3N2) epidemic of 1968 (with 1 million dead) (see Gross, 2021).

3 In the cases of SARS-Cov-1 and SARS-CoV-2, both of these viruses have now been traced to specific bat species located in southern China and potentially elsewhere in South East Asia.

4 An additional zoonotic ‘spillover zone’ associated with MERS and other diseases in the Arabian Peninsula remains little studied.

By comparison, at the time of writing, the Covid-19 pandemic has caused nearly 5 million deaths, equivalent to around 0.07% of the global population.⁵

In many classic accounts of the history of disease it is the impact of migration that takes centre stage, exemplified by the spread of plague, cholera and other diseases along trade routes, devastating city after city in their path. These major outbreaks of disease are presented as a kind of disturbance to the intelligibility of social change; a set of exceptional events that lie outside the usual parameters of historical explanation. The historian William McNeill's emphasis on 'equilibrium patterns', for example, operating at every level from the 'molecular' to the 'social' rests on the assertion of an epistemological unity that is prevalent within systems-based analysis of social and ecological relations (see McNeil, 1976). In particular, it had been assumed that most diseases would become less virulent over time as a result of the evolving dynamics of pathogens in conjunction with specific medical advances.

Conventional periodizations of disease are framed around three epidemiological transitions. The first of these transitions is associated with the early Neolithic period, around 11,000 years ago, and is connected with the rise of agriculture, the first cities, and expanding trade routes. This first phase is marked by the appearance of a number of zoonotic diseases traced to the domestication of animals such as plague, tuberculosis, trypanosomiasis (sleeping sickness) and rabies. The emergence of more stratified and sedentary human societies is also linked to a widespread deterioration in human health and the creation of environmental conditions under which many pathogens could flourish. A second transition is framed by the growth of industrial cities and the impact of disease pandemics such as cholera, typhus and yellow fever. The global spread of cholera in particular since the 1830s became closely associated with absent or dysfunctional urban infrastructure systems and squalid living conditions. Similarly, the repeated yellow fever outbreaks along the eastern seaboard of North America focused attention on the sanitary conditions of port cities. A third and more recent transition spans an increase in chronic 'lifestyle'-related sources of ill health, rising levels of pathogenic resistance to existing treatments and the increasing significance of new and emerging diseases such as Ebola, HIV, SARS and Covid-19.

This widely deployed epidemiological typology—framed by Neolithic animal domestication, the impact of the industrial metropolis and the contemporary focus on new or emerging diseases—has been highly Eurocentric or, at least more recently, Euro-American in terms of its analytical framing. As the historian Monica Green (2020) notes, the long timespan posited between the first and second epidemiological transitions, between the early human settlements of the Neolithic era and the rise of industrial cities in the nineteenth century, is analytically problematic. We need to add at least one further transition to redress this historiographic imbalance, stemming from what Le Roy Ladurie refers to as 'le génocide amérindien' (the Amerindian genocide), experienced after the arrival of the Europeans in the New World (Ladurie, 1973: 682). The rise of global capitalism, and the concomitant surge in the urban prevalence of diseases such as smallpox, syphilis and typhus, also had consequences at a global scale, in particular through the spread of syphilis from the New World to Europe, and then via European colonial contact to Asia and Africa. This global shift predates the rise of the industrial metropolis and serves as an epidemiological marker for what Andreas Malm, Jason Moore, and others have referred to as the Capitalocene, although the alternative moniker Plantationocene is equally apposite in relation to the expansion of

5 If we examine the global history of pandemics, we encounter estimated regional death rates of around 39% for the Black Death in Europe (1347-1351), 55% for the Plague of Justinian across Europe, the Middle East and North Africa (541-542), and 93% for the New World smallpox epidemic that nearly eliminated the Indigenous population (see Gross, 2021). The official global death toll from Covid-19 is clearly a huge underestimate because of widespread under recording, along with the unreliability of many data sources. India, for example, has an excess mortality measure that is around 10 times higher than reported death rates from Covid-19 (see Spiegelhalter and Masters, 2021).

slavery and the plantation system (see, for example, Wolford, 2021). Indeed, the rise of the Plantationocene has specific zoonotic connotations in terms of extractive frontiers for agriculture, cash crops and ecologically destructive monocultures.

The epidemiological emphasis on nineteenth-century industrial cities requires some qualification. European cities between the fourteenth and eighteenth centuries are among the most unhealthy ever recorded, with a clear ‘urban penalty’ in evidence before the full transition to industrial modernity (see, for example, Landers, 1993). In late eighteenth-century London, for example, around 20% of the adult population was infected with syphilis (Szreter and Siena, 2021). Average life expectancies in eighteenth-century London, Paris, Naples, and other European cities barely exceeded 30 years and compared unfavourably with many East Asian cities at this time (Voigtländer and Voth, 2013).⁶ The emerging public health focus on populations in eighteenth-century European cities extends beyond the use of emergency measures against plague or the expulsion of diseased individuals from the community (see, for example, Elden, 2003). There is a ‘denaturalization’ of existing conceptions of relations between individual and society to produce what Michel Foucault terms ‘a versatile equilibrium’ between different strategies for the maintenance of societal wellbeing (see Lemke, 2001: 204). Furthermore, the relationship between urbanization, changing practices of food production, and alterations in human diet drives a series of epidemiological developments that lie beyond the analytical nexus of the industrial (or even postindustrial) metropolis. The historian Chris Otter (2020:2), for example, notes that since the eighteenth century there has been a shift away from ‘locally produced, plant-based food’ towards an increasingly health-threatening and ecologically destructive global agricultural system.

A narrow emphasis on the experience of cities in Europe and North America fails to engage with global patterns of urbanization. The virulence and timing of disease outbreaks in colonial Bombay, Calcutta, Hong Kong, Lagos and other cities denotes a different set of epidemiological dynamics (see, for example, Echenberg, 2007; Peckham, 2015; Bigon, 2016).⁷ The global spread of HIV, for example, can be traced to emerging patterns of urbanization in sub-Saharan Africa. There is evidence for early concentrations of the disease in the colonial cities of West Africa such as Léopoldville (now Kinshasa), long before it reached Los Angeles, San Francisco, New York and other American cities (see Chitnis, 2000; Giles-Vernick *et al.*, 2013; Worobey *et al.*, 2008). The growth of cities under colonial rule in West Africa served as the starting point for the subsequent spread of the HIV-1 strain, including potential intersections with ulcerative sexually transmitted diseases (including syphilis, which is also of zoonotic origin). Additionally, since syphilis was brought to Europe from the New World, we could argue that the origins of the HIV-AIDS crisis lie in the phased and geographically interrelated impact of European colonialism, both in the Americas and in sub-Saharan Africa. Recent analysis of stored blood samples traces the first definitive human case of HIV-1 to around 1900, along with the possibility that poor medical practices by colonial authorities, including the reuse of syringes, may have played a contributory role in the later spread of the virus (see Pépin, 2021). Of particular interest is the precise set of circumstances that allowed HIV strains to spread from natural simian reservoirs into the wider human population through the impact of colonialism, the use of the plantation system for rubber and other crops and the emergence of a regional outbreak in sub-Saharan Africa that would subsequently become a global pandemic.

The decline in public health optimism during the last quarter of the twentieth century has been accompanied by new and intensified patterns of health inequality

6 The better living conditions in the cities of East Asia during the early modern period are in part due to the extensive utilization of human waste and organic refuse for agriculture.

7 The epidemiological transition that gathered momentum under industrial modernity was highly uneven. Although the smallpox vaccine has been available since the eighteenth century, for example, some 500 million people died from the disease during the twentieth century.

experienced at a global scale. Key indicators include the global spread of HIV, the resurgence of malaria and tuberculosis, and the widening incidence of dengue in cities of the global South (see Gandy, 2003). The rapid rise of tuberculosis in New York City since the late 1970s, for example, can be linked to rising levels of poverty, homelessness, and co-infection with HIV. At a global level, tuberculosis, including more dangerous drug-resistant strains, has been steadily increasing since the 1980s. And the more recent outbreaks of dengue, Zika, and most recently the Covid-19 pandemic, have all exposed a range of existing structural inequalities and corporeal vulnerabilities, that unsettle dominant epistemological paradigms within the health sciences.

Zoonotic urbanization

What role has urbanization played in the epidemiological dynamics of new and emerging diseases? How should urban space be conceptualized as a constituent element within emerging landscapes of epidemiological risk and corporeal vulnerability? ‘What exactly constitutes “the urban”’, asks Meike Wolf (2016: 959), ‘within the complex assemblages of disease interactions’. Clearly, the question of the urban transcends bounded conceptions of city form but how can different elements of urban mobility or topography be combined analytically? Wolf highlights *both* global and local dimensions to urbanization: the impact of international mobility, for example, and the precise micro-topographies that facilitate the transmission of disease. She offers an implicit critique of the neo-Lefebvrian emphasis on ‘complete urbanization’ as a highly generalized analytical tool for urban epidemiology since it does not illuminate geographically restricted landscapes of risk. In particular, under the current global health paradigm, cities have become a renewed focus of vulnerability, marked by emerging networks of contagion and shifting patterns of corporeal exposure (see Connolly *et al.*, 2021). A network-based conceptualization of urban epidemiology highlights multiplying lines of threat as well as circulatory flows of knowledge and expertise.

Public health optimists perceived ‘the microbial world as largely static or only very slowly evolving’ (Snowden, 2008: 11). The declining virulence of smallpox, syphilis, cholera and other diseases since their first historical appearance engendered a conception of ‘epidemiological equilibrium’ over time, marked by varying degrees of resistance or herd immunity. In particular, the marked decline of plague across most of Europe towards the end of the seventeenth century, for reasons that are not fully understood, underpinned a sense of inevitable improvement (see Omran, 2005: 739). Yet this perception of the microbial world as relatively stable, or at least controllable, lies in tension with the co-evolutionary dynamics of human modified environments: a range of studies now suggest that accelerated rates of evolution and genetic mutation are underway in cities. This stems in part from the evolutionary selection pressures produced by urban environments but also from the role of the human body as an ‘incubator’ that can facilitate the emergence of new strains of disease. In fact, the global spread of diseases such as dengue since the early 1950s has revealed both the capacity for pathogens to become more virulent *and* the specific evolutionary dynamics engendered by global patterns of urbanization.

The intensification of global health concerns during the 1990s was marked by a series of specific events: first, the spread of Asiatic cholera from the city of Lima in 1991, eventually reaching 16 countries; second, the appearance of plague (both bubonic and pneumonic) in the city of Surat in 1994, with cases subsequently recorded in at least five Indian states; third, the first major outbreak of Ebola haemorrhagic fever in Zaire (now the Democratic Republic of Congo) in 1995; and, fourth, the H5N1 avian flu outbreak in Hong Kong in 1997 (see, for example, Davis, 2005). If the cholera and plague outbreaks were clearly linked to inadequate infrastructure, exacerbated by flooding and other factors, the spread of Ebola has been linked to deforestation, bushmeat consumption, and the disturbance of the natural virus-carrying hosts (various species of fruit bats)

(see Wolfe *et al.*, 2005; Olivero *et al.*, 2017), while the outbreak of avian flu was traced to poultry farms, with putative lines of infection associated with migratory birds on urban wetlands (see Chan, 2002; Keck, 2020).

For many commentators, however, it is the outbreak of SARS that marks the key juncture in global health discourse, as a threat posed by a highly contagious unknown pathogen. First recognized as a human infection in the Chinese city of Foshan in Guangdong province in 2002, SARS subsequently spread to Guangzhou, Hong Kong, Hanoi, Toronto, and a number of other cities within weeks, before being brought under control. Yet the relative success of global containment for the SARS pandemic had paradoxical consequences. It appeared that the deficiencies exposed in public health preparedness could be relatively easily addressed; the concentration of cases in the cities of East Asia, with the notable exception of Toronto, perpetuated a sense that disease risks were regionally restricted rather than globally threatening; and within a few years the sense of political urgency, including the need for intense vaccine research, had gradually dissipated.

In the wake of the SARS outbreak, the animal health specialist Bernard Vallat referred to a 'global biological cauldron' produced through the increasing opportunities for pathogens to spread between different species (cited in Braun, 2008: 260). In a sense, the Covid-19 pandemic marks simply the most striking manifestation of Vallat's prognosis, bringing bats, people and other animals into a new and unpredictable epidemiological assemblage. Furthermore, the increased global mixing of pathogenic serotypes, as in the case of dengue, adds an additional layer of complexity and uncertainty to this emerging epidemiological dynamic. For the geographer Bruce Braun, drawing on Deleuzian theory, the implications of SARS and other zoonoses highlight the 'unbounded' nature of both bodies and cities. The presence of zoonoses in urban space underlines the role of 'absent actors'—both animate and inanimate—that blur the boundaries between bodies, spaces and material topographies (Braun, 2008: 251). Braun posits a network-based conception of urban epidemiology as an arena of biopolitical contestation that necessitates reflection on how 'these complex city-nature formations are stretched across time and space' (*ibid.*: 257).

The intersections between zoonoses, corporeal vulnerability and urban epidemiology can also be illustrated by the shifting ecologies of disease vectors. The Zika virus, for example, first identified in Uganda in the late 1940s, is spread by mosquitoes as well as through sexual transmission and blood transfusions. The principal vector for Zika is the highly adaptable mosquito *Aedes aegypti*, which is also a carrier for dengue, yellow fever, and Chikungunya, and has been steadily extending its global range in response to climate change, urbanization and the international trade in tyres, potted plants and other items that can form micro niches for larval development (see Kraemer *et al.*, 2019). Yet as Brent Kaup (2021) has pointed out in the case of Brazil, the spread of Zika, a disease first recognized in the country in 2015, involves a number of factors extending beyond the socio-ecological or topographic characteristics of poorer urban neighbourhoods. In particular, Kaup (2021: 568) stresses metabolic interactions between ostensibly urban and rural spaces across a diverse set of spatial scales, drawing insights from political ecology to explore the wider impacts of 'neoliberal agricultural extractivism'. Other mosquito species such as *Culex pipiens*, the vector for West Nile virus and Saint Louis encephalitis, have also advanced in response to ecological opportunities provided by dilapidated infrastructure systems, half-finished construction sites, abandoned swimming pools, and other sources of standing water (see, for example, Filipović, 2021). The appearance of 'new mosquito landscapes', largely devoid of natural predators such as fish or dragonflies, forms part of the emerging ecology of urban space (see Kaup, 2021; Gandy, 2022).

The spread of dengue fever since the early 1950s is one of the clearest indicators of the epidemiological impact of globalization, urbanization, and more recently climate

change. Major outbreaks of dengue in Manila 1953–54, and again in 1956, and then in Bangkok in 1958, signalled the beginnings of a global pandemic that is also marked by the increased virulence of recombinant dengue strains. The global dengue pandemic has enabled the four closely related yet geographically separate serotypes to mix with an increased risk of reinfections and more dangerous haemorrhagic strains (see Holmes and Twiddy, 2003; Ooi and Gubler, 2009). In the case of dengue, we encounter an ‘urban amplifier effect’ through the repeated exposure of human hosts serving as disease incubators, the mingling of dengue strains within individual bodies, and the proliferation of breeding opportunities for insect vectors. The resurgence of the mosquito *Aedes aegypti* in Latin America during the 1980s, was followed by a series of major outbreaks across the region, with particular concentrations of cases in the cities of Brazil, Costa Rica, Colombia, Honduras, Mexico and Venezuela where ‘overcrowding, poor sanitation and extreme poverty’ provide ‘optimal conditions for the establishment of vector breeding sites and dengue epidemics’ (Tapia-Conyer *et al.*, 2012: 15). Similarly, the spread of Zika across the cities of Latin America in 2016 is clearly indicative of the interplay between the spread of the same insect vector, higher temperatures, and contributory forms of ecological disruption (see Paixão *et al.*, 2018).

The urbanization of disease reflects the behavioural and ecological adaptation of pathogens, vectors, and intermediate hosts, as well as the wider epidemiological dynamics of landscape change. In the most serious Ebola outbreak to date in 2013–16, for example, the disease spread out from an ‘index case’ of a child in Guinea who had been infected by fruit bats displaced by deforestation. Unlike the predominantly rural outbreaks of the past, this latest manifestation spread quickly through a series of West African cities, including Conakry, Freetown and Monrovia. The urbanization of Ebola has been facilitated by intensified patterns of rural–urban migration along with infrastructure projects such as new roads improving connectivity with more remote areas where there are natural reservoirs for the disease (see Munster *et al.*, 2018; Connolly *et al.*, 2021). These zoonotic ‘accelerator landscapes’ of environmental degradation are inseparable from the wider dynamics of extractive capitalism, plantation agriculture, and increasing rates of deforestation. Additionally, in the case of Ebola, the imposition of quarantine measures in Monrovia, Freetown and other West African cities repeatedly failed to contain the spread of the disease.

Covid-19 and techno-feudal landscapes of risk

The Covid-19 pandemic has placed the question of urban epidemiology under intense scrutiny. In particular, the status of this previously unknown zoonosis in the coronavirus group has highlighted a complex web of interactions between human societies and non-human forms of life, including the multiple socio-ecological entanglements that underpin urban epidemiology. Among the factors underpinning the current Covid-19 pandemic, the historian Monica Green (2020: 238) highlights the role of ‘extreme urbanism’. For Green, extreme urbanism presents a synthesis of density, size and mobility that moves beyond existing spatial tropes such as the ‘mega city’ to encompass more intense forms of density and connectivity. Yet to what degree can we relate urban density to the on-going Covid-19 pandemic? An immediate observation is that many high-density cities in East Asia, close to the original epicentre of the pandemic, have successfully contained the spread of the virus: Hong Kong, Seoul, Singapore, Taipei and the original epicentre Wuhan have all brought infection rates under control. The question of density is not, therefore, a simple matter of topography or urban form but a more complex set of interactions between urban space, household structure, and corporeal vulnerabilities (see also Kaup, 2021; McFarlane, 2021).⁸ In the

8 On rethinking notions of informality, urban peripherality, and the use of dualistic paradigms, see, for example, Caldeira (2017), Keil (2018) and Varley (2013).

case of New York City, for example, the highest prevalence of Covid-19 has been in the poorer low-rise districts of outer boroughs such as Queens rather than the dense hub of Manhattan Island (see, for example, Correal and Jacobs, 2020). Similarly, research in Canada and Italy has highlighted the concentration of cases in peripheral low-wage zones at the edge of metropolitan regions (see Biglieri *et al.*, 2020). The question of the urban periphery needs to be recast in epidemiological terms to take account of changing patterns of social and spatial marginalization.

The Covid-19 pandemic has flourished under the extreme labour market inequalities marked by various forms of ‘exposed work’. The rise of ‘techno-feudalism,’ to use the economist Yanis Varoufakis’s term, has become a marker of global capitalism with both political and epidemiological consequences. In the UK, for example, almost half of the workforce is engaged in low-skill, low-paid occupations, and income has remained static for years. The Covid-19 pandemic has led to a digitized retrenchment of existing socio-economic and health inequalities epitomized by middle-class homeworking compared with a variety of more exposed and insecure work environments. In particular, the spread of Covid-19 has been ‘sustained and amplified by moving through the classes of local service-worker populations’ and especially low-paid workers who service the needs of the wealthy (Green, 2020). In a North American context, for example, Timothy De Ver Dye and his colleagues note how ‘class privilege’ has led to ‘some groups willfully disregarding social-physical distancing orders while disadvantaging others who serve them in restaurants, stores, and delivery services’ (De Ver Dye *et al.*, 2020: 5).

High rates of infection are recorded in confined or crowded workplaces such as meat-packing plants where elevated levels of ambient noise require workers to yell or shout in close proximity. Furthermore, pervasive job insecurity and draconian labour laws may compel sick workers to show up for work, as in the USA where meat production was designated as ‘critical infrastructure’ during the early stages of the pandemic (Taylor *et al.*, 2020; Yearby, 2021). In the case of Singapore, around 90% of recorded Covid-19 infections have occurred in migrant workers restricted to overcrowded accommodation (Koh, 2020). Similarly, a recent survey in east London found exceptionally high rates of infection concentrated within specific communities, occupations and socio-economic profiles. In multi-generational households, for example, family members may be exposed to multiple high-risk workplaces or modes of transport (Raval, 2021). The intersectional dimensions to vulnerability by age, ethnicity, occupation, household structure and other factors have operated in conjunction with workplace racism so that degrees of exposure for front-line staff, including medical staff and care workers, reflect unfavourable contracts, rotas, or the inadequate use of risk assessments.

Under the Covid-19 pandemic many of the incipient public health tensions produced by the SARS outbreak have been more extensively played out. At the time of writing, the Covid-19 pandemic lies in an ambiguous zone between two biopolitical modes of intervention: first, a disciplinary nexus of control under the plague-based quarantine model, that became fully manifest in the early-modern metropolis; and second, the inoculation model, stemming from the development of the first vaccine against smallpox in 1796, and later encompassing further advances in bacteriology, virology and bio-medicine (see Sarasin, 2008). The public health measures adopted to contain the Covid-19 virus include the largest quarantine ever attempted in the case of Wuhan—a city of 11 million people. Other metropolitan areas experiencing partial or complete lockdowns include Bnei Brak (Israel), Buenos Aires, Chi Ling (Vietnam), Leicester and Melbourne. In conjunction with large-scale containment measures, there have been a variety of attempts to track individual cases, implement testing regimes, and impose individual quarantines. From early 2021 onwards, a number of mass vaccination programmes have been rolled out, predominantly in the global North, locked in tension with virus mutations, vaccine hesitancy, anti-lockdown protests and ‘herd immunity’ advocates.

The Covid-19 pandemic has highlighted historical continuities with neo-colonial modes of governmentality by exception. In this respect, the upsurge of xenophobia in response to Covid-19 is little different from longstanding conjunctions between racism, cultural othering, and public health. In seventeenth-century Venice, for instance, Richard Sennett shows how fear of the plague became oriented towards the Jewish ghetto with associated discourses of suspicion and the 'othering' of epidemiological inequalities. Similarly, under colonial regimes of governmentality we encounter an exoticization of the domestic interior, along with an emphasis on deception, concealment and impurity. A succession of colonial administrations used advances in epidemiological science as a pretext for the application of 'scientific racism' in the field of urban planning in order to protect European enclaves from the threat of disease.⁹ As the historian Michael G. Vann (2012: 152) notes in relation to colonial Hanoi, 'there was a stark racial asymmetry in the application of medical policies as the white colonizers were not subject to the same regime of medical discipline involving the loss of property and control of one's body'. The power of the 'white colonial state' in the field of public health policy flowed from 'the new matrix of power produced by the fusion of a colonial racism and an authoritarian bureaucracy'. An increasingly scientifically inflected public health discourse shifted its emphasis from various kinds of unhealthy environments towards more specific concerns with contagion, mobility and the enforcement of socio-spatial separation. Although leprosy was not a 'tropical disease', for instance, it nevertheless became a focus of imperial anxieties in the late nineteenth century 'that it would return to Europe in a kind of bacterial countercolonization, reinfecting the metropolitan centers from which it had long disappeared' (Edmond, 2005: 185). Fears of racial contamination marked both public and governmental discourse during the Los Angeles plague outbreak of 1924, for example, leading not only to a variety of quarantine measures but the violent destruction of an entire Mexican-American neighbourhood (see Molina, 2006; Rasmussen, 2006). And more recently, the higher incidence of covid-related illness and death among ethnic minorities has been misleadingly attributed to innate cultural or genetic differences rather than the structural outcome of pre-existing inequalities (see, for example, Kendi, 2020). Furthermore, the trope of the asymptomatic disease carrier, a notion that can be traced back to Robert Koch's post-bacteriological naming of the 'healthy carrier' has periodically added an aura of suspicion towards entire populations (see Edmond, 2005: 186; Wald, 2008).

The Covid-19 virus, as an example of a retrovirus based on RNA rather than DNA, is capable of rapid mutation, hence the dangers of on-going reservoirs of human infection responsible for new variants of the disease. An increasingly significant facet to the Covid-19 pandemic is the role of the human body as an incubator for the emergence of new strains of the virus: by late 2020 the high prevalence in Brazil, India, South Africa and the UK had already generated new and more infectious strains of the virus.¹⁰ The Brazilian city of Manaus, for instance, emerged as an epicentre for the emergence of a new and more infectious strain. The Amazon basin has been marked by very high rates of infection affecting around three quarters of the urban population. The emergence of these new strains has also undermined the case for 'herd immunity' and other more laissez-faire responses to the public health emergency (Sabino *et al.*, 2021). As the global public health scholar Devi Sridhar has pointed out, along with other signatories to the John Snow memorandum of October 2020, a distinctive feature of coronaviruses is that immunity levels quickly fade and reinfections are possible. Indeed, Sridhar notes that there is no herd immunity for many of the most dangerous pathogens in human history including cholera, yellow fever, polio, measles, tuberculosis, malaria and plague. In all

9 On colonial and neo-colonial legacies of public health interventions see, for example, Ahuja (2016), Anderson (2006) and Harrison (2020).

10 Recently emerging clusters of mutation for the Covid-19 virus that are being monitored by the WHO include the Eta variant in Nigeria and the Lambda variant in Peru (see, for instance, von Eichhorn, 2021).

of these cases ‘public health measures were used to control their spread until vaccines or elimination strategies were developed’ (Sridhar, 2020).

Although public health advocates have stressed the need to eradicate the Covid-19 virus from human societies, as was achieved for smallpox in the 1970s, there is little evidence that this goal is currently achievable at a global scale. The high infectivity of the virus through respiratory transmission in comparison with measles, polio and other diseases suggests a more likely emphasis on various forms of containment rather than complete eradication. The lack of international cooperation has undoubtedly hampered control efforts in Latin America and elsewhere, along with manifestations of ‘vaccine nationalism’ that are undermining access to medicines, especially in the global South (see Pagliarini, 2021). The precariousness of global cooperation and evident limits to the legitimacy of the World Health Organization in the face of belligerent or inward-looking nation-state responses suggest that the claimed transition to a post-Westphalian form of globalized public health governance, as articulated by David Fidler (2003) in the wake of the SARS outbreak, is far more ambiguous or fragile than some scholars suggest.

One likely scenario is that Covid-19 becomes an endemic disease of poorer communities, of the immunocompromised and of older demographics not unlike the persistence of tuberculosis in marginalized populations of the global North. The experience of Covid-19 has demonstrated elements of systemic global threat yet has at the same time exposed the contours of racial capitalism through inequalities in workplace exposure, the exploitation of migrant labour and many other fields. The uneven take-up of vaccines, for example, is partly related to underlying degrees of scepticism or mistrust towards state agencies, the fracturing of the public realm, as well as wider forms of alienation from scientific discourse. Forms of epidemiological mistrust have multiple origins, and are easily mobilized through social media and other communication networks. Contributory factors in some communities include suspicion towards public health agencies as a result of historical injustices such as unethical medical trials or violent biomedical interventions in fields such as reproductive health (see, for example, Patchin, 2020).

Rescaling urban epidemiology

An initial challenge for urban political ecology is the conceptualization of emerging epidemiological dynamics for extended patterns of urbanization, infrastructure provision and food production. Brent Kaup (2021), for instance, calls for a ‘decentring’ of urban epidemiological research away from more densely populated areas to examine different forms of urbanization including low-density suburbs and other peri-urban developments. Kaup (2018: 382) advances an analytical framework that can overcome a series of ‘false dualisms’ in terms of the epistemological reification of specific types of urban form or the perpetuation of urban–rural dichotomies. In particular, the adoption of a multiscalar approach helps to destigmatize specific people or places and offers a more nuanced account of the global ecological dynamics of urbanization. The systematic externalization of risk in food production, for example, is an integral element in a relational political ecology of disease (see Wallace *et al.*, 2020). Similarly, cyclical dimensions to investment patterns in the built environment, including the effects of disruption or abandonment, can produce distinctive ecological landscapes of epidemiological risk.

An urban political ecology of extended patterns of urbanization must contend with several interrelated developments: the proliferation of ‘edge landscapes’ or other types of zoonotic spillover zones produced by intensified forms of ecological disturbance and fragmentation; the accelerated evolutionary dynamics occurring within modified environments such as infrastructure systems or other kinds of ‘closed ecosystems’ devoid of natural predators; the emergence of new socio-ecological relations, including novel socio-ecological assemblages that favour specific pathogens; and the impact of intensified forms of connectivity or zoonotic time-space compression between

different components of the global biosphere. An illustration of these emerging sets of epidemiological and ecological relations is the spread of malaria and other diseases in response to habitat destruction. A recent study found that some 20% of increased malaria risk in zones of deforestation in the global South can be directly attributed to international demand for commodities associated with forest clearance such as cocoa, coffee, timber and other wood products (see Chaves *et al.*, 2020). Here we find a direct conjunction between regional ecological dynamics and a global political economy.

A modified urban political ecology framework brings several elements of the global epidemiological landscape into focus. In a recent intervention, for example, Creighton Connolly, Roger Keil and S. Harris Ali highlight how ‘the new and evolving global periphery’ is steadily increasing the threat of zoonoses. This heightened state of epidemiological risk is advancing through a series of ‘socio-ecological metabolisms’ that reach ever further into existing ecosystems and agricultural landscapes (Connolly *et al.*, 2021: 247, 258). A metabolic reading of epistemological risk places extractive frontiers in a broader analytical context that can bring together organizational dimensions to the commodification of nature at multiple scales. The steady incursion of large-scale plantation agriculture into fragile ecosystems, for instance, must be related to multiple skeins of connectivity and power within a globalized political economy. The earlier emphasis on ‘the networked matrix’ developed by Roger Keil (2011: 716) has more recently been elaborated into a ‘landscape political ecology framework’ that explicitly recognizes a diversity of peri-urban and ex-urban socio-ecological assemblages. An emphasis on landscape political ecology clearly differs from the design idiom of ‘landscape ecology’ thereby highlighting tensions between different interpretations of human modified landscapes (see, for example, Connolly, 2017). A critical landscape dimension to epidemiology can bring into focus those precise zones of zoonotic transfer such as extractive frontiers that are producing heightened levels of epidemiological risk. The aim of landscape political ecology, therefore, is to elucidate ‘the political-economic and biopolitical factors influencing the spread of disease through a range of spatial scales in an age of extended urbanization’ (Connolly *et al.*, 2021: 258). Yet is the term ‘biopolitical’ being used here to refer to the underlying causes of disease or as a set of governmental strategies for handling epidemiological threats? Or perhaps this expanded urban political ecology framework implies a combination of both?

The zoonotic dynamics of urbanization extend to the illegal trade in wildlife, various forms of confinement for different species that would not normally mix and wider dimensions to the production of food, including the role of poverty or fluctuations in market prices for various kinds of ‘bushmeat’ affecting hundreds of species of bats, monkeys, snakes and other organisms, many of which are of conservation concern. Specific zoonotic topographies include ‘transfer zones’ at the interface between extended urban biomes and more intact kinds of ecosystems, thereby highlighting the limitations to existing ecological typologies that rest on ‘natural’ vegetation types or other idealized schemas. The molecular biologist Robin Weiss (2000: 78) describes a specific zoonotic transfer event in relation to infrastructure construction in Malaysia during the 1990s:

The Nipah virus is believed to have made the cross-species leap from fruit bats to pigs to humans following construction of a new airport serving Kuala Lumpur, the Malaysian capital. Fruit bats nesting in the tropical forest destroyed by the construction relocated to trees on nearby farms where domestic pigs were kept. The pigs were exposed to their droppings, fell ill, and infected their keepers, and this eventually led to infection of abattoir workers as far away as Singapore.

This example parallels elements of the narrative structure for the film *Contagion* (Dir.: Stephen Soderbergh, 2011) where the close of the film reveals a scene of deforestation

followed by a bat dropping a half-eaten banana into a crowded pig pen. Note in this case how domesticated pigs serve as an intermediate host linking naturally occurring reservoirs for disease with the global technosphere for food production, travel and consumption. The rapid spread of the fictitious MEV-1 virus in Soderbergh's *Contagion* draws on many scientific insights, including the dramatic use of now familiar epidemiological jargon such as the R rate, but it also reproduces certain cultural-topographic tropes, including the emphasis on urban density in Kowloon and elsewhere, along with a momentary glimpse of a 'wet market' to instil a sense of epidemiological othering.

The political ecology of zoonoses highlights a 'triple crisis' spanning climate change, biodiversity loss and the growing threat of new and emerging diseases. In 2020, for example, the rate of global deforestation stood at its highest level in 20 years, according to the Global Forest Watch monitoring programme based at the University of Maryland, with epicentres of destruction identified in Brazil, the Democratic Republic of the Congo, Bolivia, Indonesia, and Peru (Harvey, 2021). In South East Asia there is an escalating biodiversity crisis emerging in parallel with zoonotic public health risks, driven by increased commodity prices and rising consumer demand for illegal wildlife products (see Bell *et al.*, 2004; Bezerra-Santos *et al.*, 2021). Similarly, in the equatorial belt of sub-Saharan Africa, the other global epicentre for zoonoses, the consumption of bushmeat, has also significantly expanded during recent decades, driven by poverty, socio-economic disruption, war, deforestation, and emerging international markets for animal products, as well as the ecologically devastating extractive frontier for 'petro-capitalism' (see also Thibault and Blaney, 2003; Jones *et al.*, 2008; Malm, 2020).

An interesting point of tension exists between urban political ecology and existing attempts to apply ecological theory to urban epidemiology. An emphasis on the role of 'ecological niches', for example, can illuminate the emergence of specific diseases but not the wider spatial and temporal dynamics of socio-ecological change. How might capitalist periodicities, for instance, be related to existing ecological theory, including the paradigm shift towards non-equilibrium dynamics? And how should an emphasis on 'extended urbanization', which includes a variety of extractive zones or operational landscapes, be incorporated into existing models of an urban ecosystem? In other words, where does the conceptual interface lie between urban ecology, the delineation of urban ecosystems, and the wider field of urban epidemiology? The global dynamics of urban epidemiology clearly unsettle a variety of organicist or systems-based conceptualizations of the bounded city form. A critical reading of urban metabolic processes can illuminate multiple scales and temporalities of socio-ecological entanglement as part of an alternative perspective on the growing significance of zoonotic diseases. Urban political ecology can highlight specific weaknesses in systems-based analytical approaches to the elucidation of socio-ecological relations yet this body of work has been less clear about the conceptualization of agency, the body, and alternate social or ecological imaginaries.

Pandemic imaginaries

The anthropologist Christos Lynteris (2019) elaborates on the analytical significance of a 'pandemic imaginary' as the cultural counterpart to heightened levels of anxiety over the destructive potential of new and emerging diseases. Drawing on the insights of Cornelius Castoriadis, in which the imaginary serves as an 'instituting force of the social', Lynteris explores how the imaginary can bring collective forms of social action into being, transcending representational idioms, cultural hegemonies or ideological inflections (Lynteris, 2019: 10). For Lynteris, the critical delineation of a pandemic imaginary stems from a pervasive anxiety over loss of control. Indeed, an immunological biopolitical paradigm à la Roberto Esposito is marked by its continual failure to achieve complete protection from some kind of external threat even if it

arises from the internally generated ecological contradictions of modernity (see Swyngedouw and Ernstson, 2019: 27). ‘In contemporary technoscientific societies’, argues Lynteris (2019: 12–13), ‘the pandemic imaginary plays an irreducibly dynamic role. On the one hand, it can enable us to conceptualize a future where human mastery over human/nonhuman relations has ceased to be humanity’s condition or destiny’, yet it also constitutes a more concrete set of constraints derived from ‘the biopolitical apparatus of preparedness’. This polyvalent cultural formation, as outlined by Lynteris, points towards a post-biopolitical sensibility in which modernity begins to encounter a series of socio-ecological limits. There is certainly an amorphous dimension to the pandemic imaginary that evokes the generalized sense of threat or uncertainty associated with Ulrich Beck’s reading of reflexive modernization: in this case, however, we are contending with the microbial realm rather than global environmental disequilibria such as climate change. But how does a pandemic imaginary map onto urban form? The idea of a pandemic imaginary, in the context of new and emerging diseases, stems from a sense of inevitability rather than avoidance. Or, as the sociologist Andrew Lakoff suggests, building on the insights of Niklas Luhmann, there has been a shift of focus from risks that cannot be calculated towards a more fatalistic trope of attempts to prepare for unforeseen events. Yet even this emerging emphasis on varying degrees of ‘preparedness’, notes Lakoff (2007: 253), ‘does not prescribe avoidance; rather, it enacts a vision of the dystopian future in order to develop a set of operational criteria for response’. Furthermore, as Lakoff (*ibid.*: 271) aptly observes, the question of preparedness raises systemic concerns with indicators such as ‘hospital surge capacity’ rather than the structural determinants of corporeal vulnerability.

Urban density is a recurrent cultural motif that has elevated generic stereotypes such as the ‘Chinese city’ to a prominent position within the Euro-American epidemiological imagination. I use the alternative formulation ‘epidemiological imagination’ in this instance to emphasize the particular concern with zoonotic origins and putative chains of connection that link disparate locales and individuals. Similarly, the question of density has often been elided with a neo-Malthusian emphasis on demographic growth or uncontrolled urbanization as a driver for new and emerging disease threats. Can we have a theory of the zoonotic city that challenges an epidemiological imaginary that resides in an ‘urban other’ exemplified by variants of high-rise density, the ‘amorphous urbanism’ of the unplanned metropolis, or the hidden realms of extractive capitalism? In other words, can there be a pandemic imaginary that does not rest on the othering of specific types of urban topography or the ‘marked bodies’ of different categories of urban inhabitants?

Thinking through the epidemiology of Covid-19 illuminates a series of conceptual disjunctures in relation to contemporary urbanization and the possibilities for global modes of theorization. An emphasis on extreme topographies belies a certain kind of pandemic imaginary that traces connections between spillover sites such as remote caves, dense forests, or newly exploited pockets of biodiversity, to intermediate zones of zoonotic transfer such as ‘wet markets’ for live animals, culminating in specific forms of human density such as overcrowded tenements, informal settlements or high-rise apartment complexes. But what kind of relations are occluded in this putative chain of infective proximity? Less clear in these representational tropes are the underlying connections between changes in agricultural practices, labour mobility, or other factors that constitute regional as well as global patterns of interconnection and corporeal precarity.

Conclusions

The World Health Organization’s report on ‘global preparedness’ for public health threats published in 2019, just months before the Covid-19 crisis, refers to both ‘increased urbanization’ and ‘dense urbanization’ and notes that ‘there is a very real threat of a

rapidly moving, highly lethal pandemic of a respiratory pathogen killing 50 to 80 million people and wiping out nearly 5% of the world's economy' (WHO, 2019). Interestingly, as recently as 2018, the International Bank for Reconstruction and Development was predicting that the level of vulnerability to pandemic-related economic loss ranged from around 2% through much of sub-Saharan Africa and South Asia, to close to 0% in Europe, North America, Japan, Australia and New Zealand. At the time of writing, however, the IMF has estimated that Covid-19 caused the global economy to shrink by 4.4% in 2020, which is significantly worse than during the 2008–2009 financial crisis.

The widespread restructuring of everyday life during the Covid-19 pandemic has engendered speculation about the nature of the 'post-covid city'. A series of speculative interventions have explored opportunities for far-reaching socio-technical change that might emerge from the crisis. Examples include a greater emphasis on walking, marked by interest in the 'fifteen-minute city' envisaged by urbanist Carlos Moreno, along with a permanent shift towards new patterns of home working. There has been a surge of interest in 'living streets' and ways of incorporating the non-human into architecture, planning and design. A flurry of contributions from social psychology and other fields have emphasized the mental health benefits of contact with urban nature, extending to the affective realm of birdsong and the multi-sensory experience of parks and gardens. At the same time, however, there is emerging interest in new geographies of anxiety and isolation under a permanent state of epidemiological and environmental risk.

The mutability of zoonoses highlights a series of distinct yet intersecting temporalities encompassing the historical dynamics of urbanization and also the evolutionary dynamics of pathogens themselves. The independent agency of nature also resonates with emerging critiques of the 'adaptive Anthropocene' and limits to bio-constructivism. More specifically, an emphasis on emerging infectious diseases such as Covid-19 unsettles confidence in techno-managerial interventions, resilience discourse, and the infinite malleability of nature. As we move from static to dynamic conceptions of urban epidemiological landscapes a number of more threatening dimensions to zoonotic urbanization come into view. Furthermore, the movement away from more narrowly techno-scientific analytical schemas readmits an expanded conception of the human environment into urban epidemiological discourse, thereby introducing a myriad of relational dimensions to public health discourse. A recognition of the zoonotic city necessitates elements of a post-bacteriological framework for analysis.

The conceptual terrain of the zoonotic city poses an interesting tension between an 'early Anthropocene' emerging from the rise of the first cities, agriculture, and animal domestication, and a series of later starting points encompassing the pathogenic exchange in the wake of the European conquest of the New World, the rise of the industrial metropolis and its colonial hinterland, and the late-modern conjunction of global urbanism with new and emerging diseases. The related term Plantationocene emphasizes the organizational interface with the non-human that has generated a series of spillover zones for zoonoses such as the early-modern transfer of smallpox and yellow fever to the Americas via European conquest and the slave trade, the early spread of HIV through the cities of colonial-era West Africa and a range of recently recognized diseases associated with deforestation and construction activity in South East Asia and elsewhere. The identification of multiple starting points works against the impetus towards epistemological reductionism in the interpretation of urban environmental histories (see Saldanha, 2020). Similarly, it makes sense to recognize a wider range of epidemiological transitions in order to decentre the European and North American experience as a template for global histories of public health.

To what extent do epidemiological transitions map onto urban periodicities? There is clearly a degree of mismatch between conventional typologies of epidemiological transitions and global patterns of urbanization. The post-1950s scale of global urbanization, especially in the global South, initially coincides with the high-water

mark for the antibiotic era of public health optimism. Yet this period also coincides with the origins of the global dengue pandemic, moving first through the cities of South East Asia, and now posing a threat to at least a third of the global population. Also, during this period, initially unseen, yet intimately tied to the dynamics of colonial and post-colonial urbanization, is the emergence of the global HIV pandemic. Varieties of dense or 'unplanned' urbanization have been widely portrayed as part of the underlying dynamic behind the surge of new and emerging diseases, along with other factors such as increased poverty, greater mobility and new forms of microbial resistance. Yet a narrowly topographic reading of urban epidemiology obscures the variety of material forms and structural relations that have underpinned the zoonotic dimensions to the global public health crisis.

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