# ECOLOGIES OF DISEASE CONTROL

# SPACES OF HEALTH SECURITY IN HISTORICAL PERSPECTIVE

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How has health security been shaped by ecological thinking? The COVID-19 pandemic made clear that the current regime of health security is inextricably linked to ecology through the problematizations of interspecies contacts, global microbial traffic, and environmental determinants of disease. Though often understood as a recent paradigm, this volume seeks to illuminate the much longer history of this relationship. Assembling a range of disciplinary perspectives from the social sciences and the humanities, it investigates the varying ecological orientations that have informed practices of disease control since the late eighteenth century. The case studies examine the historically situated ways in which health and security are linked in attempts to intervene in relational spatial arrangements-rendered intelligible through concepts such as environment, topology, surroundings, milieu, or ecosystem-to counter disease. By adding historical depth to contemporary articulations of health security, the volume also reassesses the recent rise and the promises of ecological thinking in social theory and the humanities.

This introduction proceeds in four steps. First, it identifies three exemplary ecological moments in the COVID-19 pandemic, when human-animal relations, population topologies, and atmospheric surroundings became matters of concern. These moments are used to demonstrate the analytical scope we've termed *ecologies of disease control* that is central to the research in this volume. With a multidisciplinary readership in mind, the next two sections introduce approaches to the relationship between disease, security, and ecology from a historical, historiographical, and social science perspective. More specifically, the second section challenges the conventional and "presentist" understanding that the securitization of health started in the 1990s. Building on this, the third section reflects on the volume's conceptual approach and discusses the use of ecological thought to analyze forms of disease control in the humanities and social sciences, sometimes referred to in terms of a "general ecology" or an "ecology of powers." Finally, the last section introduces the chapters and highlights the common threads running through the individual case studies.

### COVID ECOLOGIES, OR HOW TO ANALYZE ECOLOGIES OF DISEASE CONTROL

Although governments' efforts to control COVID-19 typically offered unilinear responses to the pandemic, such as the emphasis on vaccines as "magic bullets," it was thought of and framed as an ecological problem. Practices of disease control drew on relational notions of environmental complexity and acknowledged the active role of surrounding factors at various scales. These tendencies become particularly, though not exclusively, visible in three moments that characterized health security during COVID-19: (1) more-than-human entanglements, (2) population topologies, and (3) atmospheric renderings.

First, perhaps most visibly, ecological orientations have informed our understanding of the pandemic's very beginning. To investigate where and how SARS-CoV-2 emerged, the World Health Organization (WHO), partner organizations, and member countries sent a joint expert mission to trace its origin. The aim was to investigate possible zoonotic sources of the virus, trace "intermediate hosts" along the "routes of introduction" into human populations, help prevent the establishment of other possible "zoonotic reservoirs," and limit "further emergence and transmission" (WHA 2020, 6). This ecological scheme of pathogenic emergence and evolution kept reappearing throughout the pandemic, as was the case when, for example, a mutation of the virus was detected at Dutch mink farms. In response thousands of animals were culled to avoid further spillover between animal and human bodies (Chen 2020). This exemplifies the trope of the (re)emergence of diseases in more-thanhuman spaces of cohabitation, which is the main epistemological catalyst behind the so-called securitization of global health since the late 1980s. This trope, as we will discuss below, resonates with longer histories of international health collaboration and has led to considerable changes in the contemporary governance formation of global health security.

Second, during COVID-19 population security was also cast in ecological terms. The notion of "herd immunity" is a case in point. It relegates the individual body's vulnerability to the surrounding bodies' infectious status. Originally a veterinarian concept, the idea informed many national responses during the pandemic (Jones and Helmreich 2020). As the population body of the human "herd" is understood to impact individual disease susceptibility, vaccination appeared as the most promising intervention. Struggles around vaccine distribution, however, show that territorial biopolitical regimes segregate the global herd of vulnerable (human) bodies. This back-and-forth shape-shift between the governance of a global, transactional reality and segmented administrative spaces reappeared in several forms during the pandemic. Whereas the imperative to protect the networks of liberal traffic has been at the core of global health security for decades, interventions during COVID-19 cut through global supply chains and disrupted the transnational mobility assemblages (Ferhani and Rushton 2020; Gebrekidan et al. 2020; Yu and Keralis 2020). Border closings and travel restrictions constantly reconfigured possible connections.

By representational means, populations were formed in the topological spaces of dashboards, lists, diagrams, and heat maps (Everts 2020; Bowe, Simmons and Mattern 2020). They were rendered legible as segregated entities through systems of epidemiological intelligence, case reporting, and quantitative modeling. These socio-technical environments facilitated the circulation of statistical numbers in real time, as well as the simulation of possible pandemic futures. Populations were classified, redivided, and made globally comparable. In particular, the pandemic data regimes positioned populations in relation to those infrastructures deemed critical for their material subsistence. The strategy to "flatten the curve" enacted a security rationale oriented toward the continuance of "vital systems" (Collier and Lakoff 2021) for the provision of health care. During COVID-19 population security thus took the shape of an uneven and multifarious set of relations involving modes of bodily cohabitation, fractured administrative landscapes, media ecologies, and infrastructural environments. The politics of disease control operated through a population topology made up of highly heterogeneous adjacencies.

Third, COVID-19 has reintroduced ambient air into the repertoire

of elemental concerns of disease control. Socially shared spaces morphed into possibly dangerous sites of atmospheric transmission, highlighting the permeability of breathing bodies to their surroundings. The finding that SARS-CoV-2 not only travels via larger respiratory droplets but also through smaller and more volatile aerosols complicated the idea of a clearly demarcated microbial "safe distance" (Li et al. 2021; Opitz 2020). Countermeasures were introduced to address this environmental aspect of pandemic space: the face mask functions as a barrier, and ventilation systems exchange and filter shared air. Atmospheric notions of disease space also informed observations that relate infection severity to other matters of aerial circulation, be it pollen exposure or particles from cigarette smoke or industrial sites, which remain in human bodies after inhalation and affect their capacities to interact with pathogens (Frontera et al. 2020; Damialis et al. 2021).

In relation to ambient air and global atmospheres, yet another dimension of COVID-19's ecological reasoning came to the fore. The pandemic reintroduced human impact on the environment as part of the problematization of health security. As the quality of water and air improved in some places due to the lockdown-enforced "anthropause," attempts were made to connect the pandemic to efforts at healing the planet from the ailments of CO<sub>2</sub> emission and environmental pollution (Searle, Turnbull, and Lorimer 2020). Global health governance actors demand that we "build back better," while scholars continue to urge governments to combine measures against climate change and biodiversity loss with issues of animal and planetary health. Both aim to tackle the challenges of the Anthropocene (OECD 2020; FAO 2020; Carlson, Albery and Phelan 2021).

Human-animal entanglements, population topologies, and atmospheric envelopment: these nexuses indicate how current ecological conceptualizations of infectious diseases translate into practices of health security—and vice versa, how practices of disease control frame the pandemic in terms of ecological management. Responding to SARS-CoV-2 has become a matter of dealing with the reality of being situated in, and environed by, dense webs of causative forces, a matter of regulating dynamic situations of material relationality and codependence. This is not to say that COVID-19 marks the beginning of an ecological paradigm in infectious disease control. Rather, in important respects it iterates those epidemic worldviews that have informed the so-called securitization of global health for about three decades. Responses to the pandemic, however, have brought to the fore the ecological tendencies already at work in the regime of global health security.

At the same time current modes of ecological reasoning strongly res-

onate with historical forms of disease control that have, in their own ways, foregrounded elemental envelopments, populations as part of a material milieu, the role of landscapes, encounters with animals, or the topologies of imperial networks, inter alia. This volume explores these resonances and puts the following question center stage: How have epidemics been thought of, controlled, analyzed, and politically dealt with as matters of ecological relatedness? This question presupposes a notion of ecology that understands disease as the result of complex patterns of interconnectedness, thereby challenging causal and one-directional explanations. With such a broad framing, the chapters are neither limited to situations when the term *ecology* is explicitly used, nor to the scientific development of the concept. Rather, and partly inspired by Etienne Benson's (2020) approach of studying how ideas take shape in practical settings, this volume traces how notions of diseases as relational entities have been operative in a diverse array of attempts at controlling them. Hence we do not understand ecology as a fixed concept but rather trace the multiple articulations of spatial relationality in practices of health security. The case studies excavate different forms of material interdependence, the vital role of environmental surroundings, and the entangled nature of modes of cohabitation at play in outbreak situations.

With this focus, we seek a new way of analyzing and historicizing processes that are conceived of as a "securitization" of health. The Copenhagen School in International Relations has put forward this concept in order to shed light on how security logics have spread beyond the narrow field of military affairs and how existential threats are rhetorically conjured up to justify extraordinary protective measures (Buzan, Wæver, and De Wilde 1998). This perspective is instructive to investigate how diseases have been framed as threats to national security since the late 1980s, both in terms of bioterrorism and the destabilizing potential of outbreaks in regions with weak public health infrastructure (Davies 2013; McInnes and Rushton 2013). However, securitization analysis of this sort has two limitations in capturing how the apparatus of health security places disease within an ecological framework—limitations that this volume seeks to overcome.

First, due to the "grammar" of securitizing speech acts, security in the field of health becomes associated with an adversarial logic. Focusing on securitization processes tends to highlight exceptional policies that target pathogens as inimical intruders, triggering militarized responses to protect the boundaries of healthy organisms, both individually and collectively. While this focus is insightful, it risks overlooking important features of security at work. Since it presupposes clear-cut, unilinear oppositions, it is not well equipped to conceive a rationale of security that accommodates principles of ecological complexity. Moreover, the relatively narrow view on speech acts has difficulties taking into account the spatial features of material entanglements and the technological repertoires deployed to act on them. The case studies therefore turn their attention toward ecological orientations as a hinge between conceptualizations of disease and practices of disease control to demonstrate the intricate workings of power in relational configurations of health security. This not only sharpens the critical sensibilities of security studies but also reminds us of the importance of thinking about power itself as relational.

The second shortcoming of securitization analysis lies in its historical limitations. The current regime of global health security is often said to be relatively recent, not older than three or four decades. Even though some scholars point to the long tradition of legal collaboration in international health, most descriptions of the changes since the late 1980s remain "presentist" in their understanding (Elbe 2010; McInnes and Lee 2012). In contrast, this volume sets out to historicize recent dynamics, proposing the lens of the ecological as an entry point for investigating how epidemic configurations have been problematized and rendered governable as relational enitites since the late eighteenth century. It explores how changing ideas about entanglement, networked dynamics, topological enfolding, or surroundedness were imbricated in historically diverse practices of controlling disease. The historical perspective therefore exposes a multitude of concepts and techniques that complicate germ-centered, monocausal concepts of disease (Honigsbaum and Méthot 2020; also Mendelsohn 1998; D'Abramo and Neumeyer 2020). Even in the heyday of germ theory, scientific concepts highlighted the role climate, landscape, and technology played in the interactions between living beings and microbes—a perspective deeply entwined with the (in)security of colonial expansion, as well as with the perception of societal risks of intruding into the web of life (Anderson 2004). Ecological "styles of reasoning" (Hacking 1994) are integral to frameworks of disease control that predate the emergence of ecology as a scientific discourse, but that nevertheless conceive of disease in terms of patterns of interconnectedness, socio-material environments, and spatial relatedness. Excavating those frameworks is instructive for putting the current modes of disease control into sharper relief and at the same time correcting the assumption about the relatively recent origin of health security.

## AIRS, WATERS, AND PLACES, OR HOW TO HISTORICIZE ECOLOGIES OF DISEASE CONTROL

The current global health security apparatus has developed alongside the concept of emerging infectious diseases (EID), which has served as a

major epistemic driver, evoking the constantly looming threat of disease, setting the "world on alert" (Weir and Mykhalovskiy 2010), and demanding preparedness for as yet unknown public health dangers (Lakoff 2007; Sanford, Polzer, and McDonough 2016). Since the 1990s an "emerging disease worldview" has come to govern threat perceptions as well as preventive and countermeasures (King 2002), a trend that intensified around the turn of the millennium, fueled by concerns about biosecurity, biological warfare, and bioterrorism (Cooper 2006; Davies 2008; Rushton 2011; Wenham 2019; Elbe 2010).

At its inception, against the backdrop of the HIV/AIDS crisis (Elbe 2009), the EID concept was a powerful rejection of post-World War II overconfident expectations about the eradication of epidemics, when antibiotics, vaccines, and pesticides seemed to promise ultimate control over infectious diseases. Amid such scientific optimism, and shortly after WHO had declared the global eradication of smallpox in 1980, the outbreak of an unknown deadly epidemic in North America, and shortly after in Europe, shocked the Western medical community and the public alike (Snowden 2008; Lederberg, Shope, and Oaks 1992; Morse 1996). HIV/AIDS can be seen as a prototype of new diseases resulting from a zoonotic spillover of pathogens between animal hosts and humans, which occurs more frequently due to closer interspecies contact in the wake of population growth, extensive land use, and changes in ecosystems (Narat et al. 2017; Keck and Lynteris 2018). As the mantra of the EID worldview has it, "in today's interconnected world, a health threat anywhere is a threat everywhere: an outbreak in a remote village can spread to major cities on all six continents in less than 36 hours" (CDC 2017). This sense of global proximity is tightly coupled with ecological renderings of infectious diseases in both the thinking about EIDs and wider global health security efforts. It also informs current projects, such as the One Health initiative, that argues against the artificial boundaries set between human and veterinarian medicine (for a critical discussion, see Wolf 2015; for a historical perspective, see Woods et al. 2017). Antimicrobial resistance and planetary health are other examples of the intertwined nature of medical theories, ecological thinking, and health security. Problematizations of antimicrobial resistance relate health to the well-being of vital microbial communities in the socio-natural environment of vulnerable bodies (Landecker 2016; Hinchliffe 2021). The discourse on "planetary health" considers the climate, the quality of the soil, or the composition of the air as crucial for human health (Dunk et al. 2019). However, from a medical history perspective, such ecological frames appear all but specific to the period since the 1990s.

Regarding the spatial rendering of global health security, it is important to note that the trope of the unprecedented speed at which epidemics spread is not new. Rather, it resonates with historical discourses about the health-related dangers of economic integration, specifically in imperial contexts. In their analysis of late nineteenth- and early twentiethcentury maritime hygiene technology, Lukas Engelmann and Christos Lynteris point out that "the trope in itself is in fact the product of the turn of the nineteenth century. The fact is best illustrated by the identical nature of maps used to warn about pandemic danger, where the globe appears to be spanned by a thick web of lines; now airplane flights, then shipping routes" (Engelmann and Lynteris 2020, 12). It was along the routes of traffic, trade, war, and slavery that "the 1800s saw the greatest redistribution of pathogens the world has ever known" (Harrison 2015, 652). Imperial economies and colonial rule depended on humans, cattle, and goods moving between colonies and imperial metropoles, as well as on the productivity of enslaved and exploited populations. Therefore, to lessen economic damage caused by heterogeneous and disparate quarantine regulations and, simultaneously, to address the issue of increasingly global epidemics, attempts at international agreements were made as early as 1851 at the first International Sanitary Conference. Four decades later, in 1892 the participating states of the seventh conference adopted the first International Sanitary Convention (Huber 2006; Harrison 2006; de Almeida 2015). Whereas the politico-juridical framework changed considerably with the EID concept, collaborative efforts at health security date back much further.

Indeed, concepts that link health to factors outside the body and in turn instruct efforts of disease control, also have a longer history. The chapters in this volume focus on this nexus as it materialized in the past, but also more recently in moments of communal response to epidemic outbreaks. However, the case studies do not simply project contemporary concepts onto historical cases to identify forerunners of current thinking or "securitizing moves" but heed the caution of historians, such as Mark Harrison, who warn against ahistorically reducing the past to a teleological prehistory of the present (Harrison 2017). With this in mind, we investigate how relational understandings of disease took shape in historically situated practices of disease control by analyzing how such practices were constitutively attuned to ideas about environmental complexity, the active role of surroundings, and material interdependencies between more-than-human agencies. The chapters consider changing ideas of relatedness and spatial situatedness by engaging with casespecific settings, such as the built environment, infrastructural conditions, human and more-than-human disease reservoirs, underlying

metabolic conditions in the body, landscapes, and climates. In doing so, distinct and sometimes conflicting notions of (in)security come into view that concern not only questions of health but also, for instance, economic or political interests.

With respect to the deeper history of ecologies of disease control, two aspects appear crucial. First, and closely connected with Harrison's warning, narrowing the focus to prominent features of current debates runs the risk of missing important parts of the story. As the following chapters show, there is a veritable multitude of ecological orientations at work in historical projects of disease control. The relationship between climate and race is a case in point. Especially from the eighteenth century on, geographically and increasingly biologically deterministic notions of racial differences informed medical assumptions about susceptibility to diseases that became immensely influential in the history of colonial expansion and slavery (Chakrabarti 2014, 57–70; Nash 2014). Expanded historical perspective is therefore an opportunity to identify the enduring political and medical legacies of such racialized concepts in ecological thinking (Anderson 2006; Harrison 1999).

Second, we are well advised not to overstate continuities or, as Conevery Bolton Valencius (2000, 24) puts it, to mistake a "family resemblance" for a "shared history." A historicizing perspective can reveal any traditions that strongly resonate with recent configurations of infectious disease control, but also highlight discontinuities and disruptions. Hippocratic thinking about Airs, Waters, and Places, an important reference point to approach the environmental dimension of medical history (e.g., Valencius 2002; Jankovic 2010), simultaneously underscores and illustrates this aspect. Advocating a holistic perspective on health and disease, the ancient physician Hippocrates and his disciples focused on the relationship between human bodies and their surroundings. In this view environmental influences played a critical role in causing diseases by disturbing the bodily balance of "humors." Though refined, amended, and challenged, these concepts remained critical to medical thought and practice well into the eighteenth and nineteenth centuries, not least because they proved to be "remarkably resilient and adaptable" (Bashford and Tracy 2012, 495; see also Cantor 2002). Moreover, as Charles Rosenberg reminds us, the "emphasis on the body as always situated and always in process, always interacting with the environment that sustains and threatens it" (2012, 668) connects Hippocratic views even with current medical concepts.

Regardless of these continuities, over time crucial shifts have taken place. Not only has our understanding of the human body and its boundaries and relationship with the environment changed, as ideas about the (inter)dependency between climate and humans exemplify (Bashford and Tracy 2012), but also the medical thinking about environmental surroundings. In this respect, interpretations of the environment as a potential "harbourer of pathogens" (Valencius 2000, 20), following the rise of bacteriology, were not identical to the older emphasis on airs, waters, and places, even though they similarly stressed the relevance of environmental factors for human health.

Around the turn from the eighteenth to the nineteenth centurythe chronological starting point of our volume-a radical break with ancient medical authorities occurred in Europe as diseases were situated in a socio-technical urban milieu. With the emergence of clinical medicine, especially in Paris during and after the French Revolution, the hospital became the main place of knowledge production. Clinical physicians not only firmly established the thinking of diseases as discrete phenomena; they also began to study statistical correlations between the occurrence of diseases and environmental factors, such as foul odors. These accounts directly influenced the powerful sanitary movement that emerged in Britain during the 1830s and 1840s (Snowden 2020, 168-87). The advocates of sanitary reform promoted a strictly localist understanding of infectious diseases, attributing them to filth and the resulting corruption of the surrounding air. Illness appeared less a result of poverty and problems created, or worsened, by urbanization and industrialization; rather, public health issues seemed solvable through sanitation programs addressing water supply, drainage, sewerage, cleanup campaigns, and personal cleanliness. This approach presented authorities with a straightforward technical fix for social issues (Berridge 2016, 42–60; Hamlin 1998; Kiechle 2017).

Despite their focus on what we now might call an infrastructural ecology, the rather one-directional, causal relation between filth and disease propagated by the sanitary movement was considerably less complex than later ecological concepts of mutual entanglements. Within this narrower framework, the sanitarians nevertheless touched on concerns that are important within a shared history of ecological orientations in disease control. A case in point is the example of human-animal relations, which are today at the heart of efforts to protect health security. The sanitarians drew attention to dangerous interspecies proximities that, in their view, exposed humans to noxious smells in urban spaces (Kirk and Worboys 2013, 566). The problem of disease transmission across species began to occupy medical research from the mid-nineteenth century on (Hardy 2003, 201; also Cassidy 2019; Keck 2019). With the advent of germ theories, animals became increasingly seen as pathogen carriers or "epidemic villains" (Lynteris 2019), and therefore the targets of counter-

measures. Historically, interrelations with nonhuman animals have been problematized in various ways under the aegis of health protection. For instance, in the early 1900s the knowledge that rat fleas were disease vectors of the plague led to a veritable war on rats aimed at combating and preventing outbreaks (Dyl 2006; Wiegeshoff 2021). Threatening intimacy between species resulted not only from urbanization processes that brought human and nonhuman animals into closer contact. Interspecies relations were also changed by the large-scale interventions into ecosystems that characterize the history of colonialism, imperialism, and capitalism, demonstrating the need to understand today's spillover scenarios within their longer history (Sivasundaram 2020, 296–97; see also Beinart and Hughes 2007; Ross 2017).

The fact that research increasingly focuses on such aspects of the history of health and disease points to certain recent historiographical trends. Historical studies on the environmental and ecological dimensions of medical history have gained considerable steam since the early 2000s. Although questions of place and space characterized the work of medical historians in the United States and Europe as early as in the 1930s and 1940s (Valencius 2000, 3-5), the "Hippocratic turn in medical history" (Sellers 2013, 450) is a relatively recent development. Over the last twenty years, studies have shown where and how relational notions of space continued to matter in medical sciences (e.g., Honigsbaum and Méthot 2020; Honigsbaum 2016; Tilley 2004; Jones 2004). In the late twentieth and early twenty-first centuries this focus of inquiry was inspired particularly by the discipline of disease ecology, as well as the EID framework (Sellers 2013). It is unlikely a coincidence that renowned historians in this field, such as Warwick Anderson, Chris Sellers, and Susan Jones, also have a background in the medical and veterinary sciences.

Moreover, environmental history, a field that has prospered since the 1990s, has begun to influence the history of medicine and decenter human agency in the process (Nash 2014; Mitman, Murphy, and Sellers 2004). Such perspectives found their way into analyses concerned with the history of infectious diseases (e.g., Nash 2006; Fressoz 2012; Honigsbaum 2020; Snowden 2020; Crosby 1972; McNeill 1976; Mc-Neill 2010). However, much is still to be done to integrate environmental, ecological, and medical perspectives into historical research, not least in conceptual and analytical terms (Alagona et al. 2020; Sellers 2018; Green 2020; Diener 2021; Otter, Breyfogle, and Brooke 2015). With this volume we contribute to this discussion by bringing together perspectives on ecologically oriented practices of disease control from historical, sociological, anthropological, and human geographic approaches. But as Linda Nash (2015) reminds us, although we beneficially draw inspiration from today's scientific concepts to frame morethan-human histories, it is crucial to understand these very concepts within their own historical moment, shaped by (geo)political, social, and cultural developments. We reflect on this analytical challenge in the next section.

# CRITICAL TENSIONS BETWEEN GENERAL ECOLOGY AND ENVIRONMENTALITY

Today, we argue, the ecological appears in two distinct ways: on the one hand, we have identified ecological orientations immanent to the field of health security; on the other, ecological frameworks have attracted scholars from various disciplines, dissolving any phenomenon into a set of constitutive relations favored as a non-reductionist analytical strategy. In order to qualify this overlap between the empirical and the conceptual, this section delineates how ecological modes of inquiry have become the linchpin of critical analyses in the social sciences and humanities. We then discuss the Foucauldian notion of "environmentality" as exemplary for navigating the current tensions of the ecological, recognizing it as integral to health security *and* adopting its critical analytical capacities.

A turn to ecology as a conceptual, if not ontological frame is epitomized in Bruno Latour's call not to modernize but to "ecologize" (Latour 2007). According to Latour (2017, 220-55), such reorientation is necessary to render visible the vital ties of the "earthbound" to their surroundings. Subscribing to an even stronger premise of entanglement, Donna Haraway (2016, 49) stresses the ethical implications embedded in the "webbed ecologies" of collective life. By dissolving being into "multispecies-becoming-with," Haraway's ontology of "co-existence" is inseparable from the invocation to cultivate mutual "response-ability" (Haraway 2016, 63, 34). Her playful suggestion to rename the humanities into "humusities" (in the sense of humus) captures the ecological reorientation she has in mind. Both Haraway and Latour were inspired by Isabelle Stengers's (2005) account of an "ecology of practices." Primarily concerned with scientific knowledge production, Stengers (2010, 32) points to the "ecological situation" of material interdependencies that operate in "truth telling" events. Still other authors, such as Jane Bennett (2010), stipulate that the ecological framework extends from organic life to inorganic matter of all kinds. Her "political ecology of things" circumscribes the "agentic assemblages" of minerals, debris, fatty acids, or electricity grids. In this way, ecology becomes the universal key to a vital materialism (Bennett 2010, 107).

Modes of earthbound existence, more-than-human ethics, knowl-

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edge production, inorganic things (this list could go on)-in each case, the turn to ecology is part of a wide-ranging conceptual move. First, ecology is taken beyond the concerns of traditional environmentalism to traverse the boundaries between nature and culture, society and the elemental, life and technology. In this sense ecology morphs into "general ecology" (Hörl 2017, 7-8) to study the transversal lines running between environmental, societal, and affective "registers" operating in parallel (Guattari 2000, 28). Second, the approaches pit the ecological framework against a particular blend of social constructivism. The dissolution of any given entity into a heterogeneous network of relations not only highlights the complexities of interdependence and the shortcomings of causal explanations, but also promises a step beyond "culturalist" accounts that focus too narrowly on language, meaning, or symbolic orders (Coole and Frost 2010). This (re)turn to the material dimensions of the social in the early twenty-first century points beyond a purely academic discourse as it is closely connected to scientific findings about the Anthropocene which underscore the limitations of human agency and human dependency on natural forces and resources. Under these conditions, the critical gesture of pointing to the socially constructed nature of seemingly fixed entities has lost touch with the agentic properties of the world, and has therefore "run out of steam" (Latour 2004, 225). The orientation toward neighborly associations, entanglements, and assemblages is intended to open novel avenues for critique.

This generalized ecological framework has been productively applied to health security. For instance, Stephen Collier, Andrew Lakoff, and Christopher Kelty asked authors to contribute to a special issue on the investigation of "Ebola's ecologies": "The concept of 'disease ecology' typically refers to a pathogen's relationship to a natural milieu—particularly animal hosts and their environmental niche—and to how this milieu is affected by human behavior. Here, however, we conceive of Ebola's ecologies more broadly to include the administrative, technical, political, and social relationships through which disease outbreaks evolve, and into which experts and officials are now trying to intervene in anticipation of future outbreaks" (Lakoff, Collier, and Kelty 2015). In this way they extend the ecological analysis to trace the multiple elements involved in making up Ebola across the divide of culture and nature. Hence, Ebola's ecologies are more-than-human without being less social or less political.

Another example is Steve Hinchliffe and colleagues' (2016, 54–67) collaborative work on biosecurity in livestock farming, in which they propose the topological concept of the "disease situation" to articulate similar ecological sensibilities. In order to avoid linking disease to the

causative agent of a pathogen or contaminant, they propose to think of "pathogenicity" as a potential that is inherent to particular disease situations, understood as configurations of "intra-active" entities. From this view, bacterial foodborne diseases emerge from a web of heterogeneous relations that reach across specific sites: "The way labour practices intra-act with poultry guts, . . . or changing farming practices intra-act with pig bodies and microbes, . . . or the way local authority budgets intra-act with food safety inspections . . . all affect the disease potential of the situation" (Hinchliffe et al. 2016, 15). This general ecology of disease situations is invested with a decisively critical edge. By adding economic schemes, nutritional habits, or logistical regimes to the repertoire of pathogenic actors, it provides an analytical vantage point on the material conditions of disease emergence.

Ecology thus seems good to think with, especially in attempts to provide a material account of health security without sticking to the biomedical model and its reductionism (for a general critique see King 2017, 22–27). Yet what happens to the critical aspirations of this conceptual strategy when, as outlined above, ecological orientations become an organizing feature of health security itself? The historical gaze reveals that the complicity of ecological orientations with structures of power and exploitation runs deep, as ecological modes of reasoning often function as a lever for, at times, highly invasive control practices and interventions. This does not in itself limit the analytical potential of ecological thinking but it reminds us of the legacies it carries with it and invites further critical inquiry. We are, of course, far from being the first to address such a ghostly relation, in which the empirical material haunts the analytical apparatus. Most notably, and almost paradigmatically, this is at the core of Michel Foucault's notion of an "environmental" security dispositif. His otherwise well-rehearsed take on biopolitics offers insight into maneuvering the doubled appearance of the ecological.

Dealing with the governmental response to smallpox, Foucault points out a proto-ecological form of spatial ordering at the core of the liberal security dispositif. Since the late eighteenth century liberal security has tied the life of populations not only to the flow of resources and commodities, but also to the local climate, vegetation, and weather. Instead of directly targeting individuals, it reckons with the risks emerging from the material forces of the milieu in which collective life exists and "circulation is carried out" (Foucault 2007, 20). At one point in his analysis, Foucault (2008, 261) even changes the notion of *gouvernementalité* into *environmentalité* to qualify the shift in the political logic: liberal security presupposes that "environmental spaces" operate "autonomously" and therefore resorts to the "regulation of environmental effects." Over the last decades the concept of environmentality has been used to shed light on the widespread insertion of "eco-knowledges" into biopolitical calculations, especially during the second half of the twentieth century (Luke 1995, 69). Considering populations as "biologically bound to the materiality within which they live" (Foucault 2007, 21) has intensified security concerns reckoning with a "generalized crisis environment" (Massumi 2009, 155). Across a "spectrum of threat" (154) that ranges from war to weather, environments appear as reservoirs that incubate highly uncertain and sudden events of emergence triggering emergencies (Cooper 2006). Accordingly, "environmental power" does not seek to protect the environment. It treats it as a complex, unpredictable, and potentially catastrophic force field to be reckoned with. In this way environmentality is always already immersed in an "ecology of powers" (Massumi 2009, 173).

Many studies have observed how such modes of power play out in current practices of health security and epidemic control. Against the backdrop of the rediscovery of infectious diseases in the medical sciences and the EID concept, scholars examine how the governmentality of health security conceives of disease threats in terms of a "microbial traffic" (Morse 1992, 1362) that is entangled with a variety of circulatory processes (Barker 2015; Voelkner 2011). Various studies demonstrate how WHO's International Health Regulations relate the control of disease events to the immanent potential of a wider ecology of mobile elements. In this ecology human movement is closely connected to the mobility of vital materialities such as containers, food, water, or animals (Opitz 2016). Further, the referent object of health security-what is deemed worthy of protection-shifts from the individual body and the population to the resilience of wider socio-technical systems considered vital (Lakoff 2017, Mezes 2024). At the same time the aim of mapping "the highways and bridges of viral traffic" also directed the focus of public health authorities to "landscape drivers of disease emergence" (Fearnley 2020, 61, 58). In an attempt to forestall the emergence of avian influenza, a "turn to eco-virology" (54) has taken place that employs remote sensing technologies to identify "host networks" (57). Already during the Ebola crisis of 2014–2015, the tele-epidemiological gaze from above, via satellite technologies, harbored the promise of spotting "ecological 'fault-lines' where disease might arise" (Peckham and Sinha 2017, 29). These examples exhibit the multiple ways in which practices of health security operate in an environmental mode when it comes to monitoring and controlling disease outbreaks. Even the most recent treatment of the microbiome is cast in terms of a "probiotic environmentality" (Lorimer 2017, 34). Other than traditional hygiene practices,

new forms of environmental probiotic management try to foster health through the production of new vital ties.

The notion of environmentality thus has proven useful in showing that a "general-ecological relationism . . . is inscribed, to a certain extent, within the history of control" (Hörl 2017, 7–8). It is therefore indicative of the problem at the core of this volume. Through specific case studies, we learn what "ecological relationism" in disease control consists of, and how environmentalities unfold in situated practices of health security. In and with this focus, the ecological appears as an overdetermined political epistemology. The observation that there are two ecological orientations, namely one in practices of health control and disease security and another in recent social science and humanities' analyses, demands a delicate maneuver: the capacity to critically conceive of ecological orientations within the field of health security while at the same time subscribing to a relational model of power.

#### **CONTRIBUTIONS TO THE DEBATE**

To translate our initial observations about a nexus between ecology, health, and security into a broader interdisciplinary conversation, we deliberately sought to include a diverse range of approaches to empirical material, methodology, theorizing, and conceptual work. The result was an authors' conference at the end of 2021, with scholars at different career stages and from backgrounds in history, sociology, human geography, and cultural anthropology, as well as contributions from interdisciplinary research networks including veterinarian and entomological expertise. Overall, the history of the publication was itself influenced by the new and intermittent ecologies of disease control imposed by COVID-19, albeit locally in different ways. These experiences made their way into some of the case studies that follow.

In terms of time and space of specific ecologies of health security, the contributions cover case studies from the late eighteenth century until the present, on topics ranging from disease-ridden slave plantations in the British Caribbean to the COVID-19 crisis. We thus concentrate on the period during which the idea of diseases as distinct entities became firmly established in the medical sciences and, at the same time, epidemics turned truly global in their geographical reach. It was in the long nineteenth century that epidemic diseases started to affect all inhabited continents (Harrison 2017). Since then medical history has seen multiple efforts and attempts to control what was perceived, time and again, as almost unstoppable outbreaks. Such time-, place-, and group-specific problematizations of infectious diseases reflect different understandings of disease-inducing factors and, in turn, of effective countermeasures.

They also involve a large variety of spatial configurations with their respective means of knowing.

Whereas each chapter makes its own case about the relationship between disease, security, and ecological orientations, read together they contribute important insights to the very multi- and interdisciplinary debate the volume wishes to start. Each highlights different ways in which forms of relational thinking in disease control were tied to power and, in turn, time and again stabilized societal orders within their hegemonic structures. Some of the cases show how control practices concerned with environmental relations and more-than-human ecologies selectively excluded aspects such as poverty or social vulnerability, and thereby in fact reduced complexity and ignored sociopolitical factors. Other contributions critize the promises of contemporary ecological concepts in health security such as One Health. Further still, in several case studies conceptual or methodological suggestions are made to reframe ecologies of disease control. Yet others re-narrate a generic account of a modern era of reductionism in health and disease control. While many of the chapters speak to more than just one aspect, the structure of the volume follows three organizing themes: first, the observation that understanding ecologies of disease control entails analyzing them as ecologies of power; second, the insight that knowing disease ecologies does not necessarily entail ecological modes of knowing; and third, that conceptualizing forms of ecological relatedness through and by way of case materials is a productive analytical approach.

## Ecologies of Disease Control as Ecologies of Power

This section deciphers ecologies of disease control as ecologies of power. Ecologically oriented practices of disease control are not necessarily an alternative to hegemonic forms of power and knowledge, but they are often shaped by them. They may undergird structures of oppression, exploitation, deprivation, or neglect, and divert governmental attention away from inequities. Thus they may be used to impose and perpetuate socioeconomic assymetries, be it of individuals or social classes.

Susan Jones's case study on disease control in Central Asia during the 1920s and 1940s underscores this point and simultaneously adds layers to the early history of disease ecology. The Soviet lens of her case reveals a strand of epidemiology that largely avoided reductionist bacteriological approaches. Soviet disease ecologists studied ecological interactions and focused their countermeasures on disrupting these connections. Crucially, such efforts on the ground formed an essential part of governmental strategies to control land and people in the Soviet hinterlands and along its borders. However, not only did the local environments of the Central Asian steppe prove resilient and hard to control; struggles and conflicts around interventions highlight rather different, often competing notions of security in relation to health. From the government's perspective, unruly people and unhealthy landscapes endangered the stability of the regime, border security, and productivity, whereas local resistance shows that there were different needs and threat perceptions. In this context problematizations of ecologies of disease unveil the heterogeneous character as well as the limits of territorial orderings.

Karina Turmann's work turns to late eighteenth-century control of "the yaws" on British slave plantations in the Caribbean. In this case the historical perspective opens a variety of spatial problematizations and imaginaries of environmental control, which are infused by extremely reductionist, racist accounts of human life and disease. Considered a noncontagious disease caused by unhealthy environments, efforts to control yaws were closely intertwined with attempts to secure the reproduction of slave populations. Together with the growing abolitionist movement, such diseases posed an imminent threat to the economic welfare of planters. Turmann shows how European medical practitioners framed their control measures around the highly racialized, enslaved maternal body as an object and the enslaved women as a threat to their newborn's health. Her account of the various spaces where notions of dangerous environments formed at the turn of the century also includes the trope of the island climate. It highlights the allegedly unhealthy entanglements of food and racialized bodies in the "tropics," the problem of lodgings and built environments in specific climates, and the socio-spatial stratifications of the plantation estate.

Focusing on the research on pellagra in the southern states of the United States in the early 1900s, Julia Engelschalt demonstrates how US public health experts framed a disease caused by malnutrition as an insect-borne "disease of place" and in turn closely monitored local environmental conditions in affected regions. American officials effectively downplayed the crucial role poverty played, thus legitimizing specific environmental approaches, such as vector eradication, while drawing attention away from the underlying social problems. Moreover, as Engelschalt demonstrates, such frameworks proved to be compatible with germ-centered theories of disease and reductionist approaches to disease control. Her analysis challenges conventional narratives about ecological approaches as successful ways to more fully capture the complex realities of outbreaks.

Moving to very recent history, Oswaldo Santos Baquero, Sara Cristina Aparecida da Silva, and Júlia Amorim Faria provide insight on the ecologies of violence emerging in and at the same time copro-

ducing health emergencies, as in the COVID-19 pandemic. Building on the notion of multispecies health and ethnographical observations from community research on the living conditions in a São Paulo favela, their analysis points out a specific more-than-human landscape of syndemic violence which is shaped by "marginalizing apparatuses." They challenge overly optimistic narratives about the critical reach of One Health. Stressing the role of violence in the urban periphery and thus highlighting insecurity, precarity, and vulnerability, the chapter critically reframes the question of ecology in analyses of health security and disease control.

#### **Knowing Ecologies?**

The second group of case studies demonstrates that practices of "knowing ecologies of disease" are by no means practices of "ecological knowing." Looking at innovations in diagnostics, at topological understandings of diseases in epidemiological models, or at systems of syndromic disease surveillance, the case studies trace important conceptual shifts in health security and public health. But they also show that knowledge practices emphasizing the relational quality of disease do not necessarily produce more comprehensive or integrated accounts. Rather, across modern history they often tended to reduce relational complexity or introduce reductionist accounts, albeit in different disguises.

In his chapter on disease modeling between the 1880s and the 1920s, Lukas Engelmann traces the history of a technique that holds a central place in ecologically oriented notions of disease causation and control as well as in epidemiological knowledge production. Discussing a crucial shift in epidemic theory, in which space was reconfigured from a topographical environment into a set of topological vectors, Engelmann demonstrates how the modeling of infectious diseases, on the one hand, rejected a causal or deterministic influence of the environment while turning it, on the other hand, into a uniform and abstracted variable. As a result, disease models inspired visions of controlling and eradicating diseases, such as malaria, through universally applicable measures. Rather than engaging with different features of the natural or built environment, early modelers developed theories in which epidemics were, to a certain degree, conceptualized independently from place and time-a moment of dis-environmentalization inherent to the spatialized account of disease in modeling.

Focusing on a more recent development, Henning Füller investigates "syndromic surveillance" as it emerged in the United States. Based on ethnographic material, his chapter outlines how the surveillance of outbreak events—one of the core moments in the "securitization" of health—has developed since the early 1990s. Füller extrapolates on how this specific "way of knowing" (Pickstone 2001, 1), by virtue of its infrastructural basis, enfolds a twofold problematization of the ecological. On the one hand, the surveillance problem of situational awareness is turned into an environmental problem for infection control, as the infrastructurally created "baseline" normalizes specific contexts and becomes an abstract topological milieu for event detection. On the other hand, the chapter analyzes how the idea of One Health is deployed in syndromic surveillance, rendering it a rather hollow form of cross-sector holism. His critical assessment of One Health in practice resonates with Baquero's, da Silva's, and Faria's account.

Finally, Steve Hinchliffe's chapter critically engages with the promise of the emergence of new diagnostic tools intended to improve knowledge and treatment of disease in lifestock farming. Building on the social science of classification and diagnoses, he argues that recent shifts in livestock farming toward on-farm and data-intensive systems may, paradoxically, perpetuate the very threats they seek to allay. In the formulation of the "diagnostic machine," diagnosis is understood as a style of knowing that is not only concerned with making disease present, but also helping to consolidate and perform a set of social, material, and living relationships-not least relations of a capitalization of food production and marketization of health devices. Despite their promissory security logic, diagnostics may do little to ameliorate the ecological and health insecurities associated with livestock systems. They allow perpetuation of a mode of production that has been-due to its tendencies toward simplification and densification, medicalization and exploitation—at the center of health security concerns for years.

#### Thinking with and Rethinking Ecologies of Disease Control

The case studies in this section develop an analytical sensibility for the "doubling" of the ecological moment described above: its appearance in health security as well as in the analytical accounts thereof. Folding the empirical into the conceptual and vice versa, the chapters put forward new ways of thinking the ecological in disease control. They understand, for instance, the biological discourse on metabolism as a resource for situating the planetary condition of the Anthropocene within the human body; they address infrastructure not only as a research site but as a frame for conceiving of entanglement; or they take the risks of breathing as a model for elemental relatedness. In this sense the contributions in this final section oscillate between thinking *about* and thinking *with* ecologies of disease control.

Ann Kelly and Clare Herrick's chapter turns to contemporary in-

terventions into disease ecologies. They analyze three spatial rationales that organized control efforts during Ebola outbreaks: the ring, the reservoir, and the frontier. Their case provides an example of the recent paradigm shift in global health security, in which so-called emergency R&D-the accelerated development, approval, and deployment of medical countermeasures-has become a cornerstone of emergency response and governance. In a study on vaccination trials during outbreaks, they track the highly fraught politics of inclusion in Ebola immunization and lay bare a repertoire of three spatial "infra-logics" on which the biopolitics of emergency R&D relies. With the practices of ring vaccination, the efforts to secure the human viral reservoir, and the attempt to push the health emergency frontier in R&D, new ecologies of global health knowledge and action emerge that aim to balance humanitarian demands caused by a public health care crisis, commercial investment in medical countermeasures, and the realities of supply shortage. Through and from the empirical material, their analysis develops the aforementioned three spatial figures that can guide critical analyses of complex and complicated relations in disease control.

In their contribution Uli Beisel and Carsten Wergin highlight the hybrid entanglement of mosquitoes, people, landscapes, and transportation systems linked to the ecological transformations that are responsible for the spread of vector-borne diseases. They draw on the notion of "transecology" to rethink current approaches to health security in these domains. Focusing on how *Aedes* mosquitoes—which transmit diseases such as dengue, West Nile, and yellow fever-figure as invasive species, Beisel and Wergin argue that, in addition to warming climates, mobility infrastructures are key actants in shaping disease ecologies. The authors introduce the ethnographic method of "infrastructural go-along" to delineate such complex, technologically saturated "transecologies." Ethnographic knowledge not only complicates the notion of "invasions" as it is to be found in health security discourse; it also complements and corrects the visual knowledge provided through public health maps that spatialize disease risks emanating from modes of being with mosquitoes in particular ways.

Hannah Landecker takes the notion of ecology into the human body. Her chapter shows how SARS-CoV-2 exposed the extent to which metabolic disorders form an "underlying condition" that increases the risk for a more severe course of the disease. In Landecker's account, the underlying condition reveals a relational biology that is thoroughly anthropogenic: air pollution or industrialized diets have disrupted the fragile interactions between mucus fluids and microbiota that secure bodily surfaces against viral entry; chronic inflammations provoked through exposure to endocrine-disrupting chemicals have put the body in a constant state of alarm, thereby ultimately exhausting its defense mechanisms. This particular ecological rendering of the body leads to a refined understanding of the Anthropocene: it is not to be found on some higher, planetary scale but registers in the metabolic milieu, an event that is "also taking place at the gut wall." With this radical change in perspective, Landecker abducts matters of disease control from hegemonic practices of preparedness planning, disease detection, and outbreak response. She ties them instead to the ecological dynamics that secure or disturb the maintenance of bodily boundaries.

The final case study focuses on health's elemental dimension from a related, yet different angle. Sven Opitz analyzes how air, as a transmission medium for virus-laden aerosols, has brought ecologies of breath to the fore in our lives, but not yet to that of analysis. For attuning sociology to this elemental condition, the chapter puts forward the concept of the "atmosocial" and elaborates three features: First, with its voluminous extent, the atmosocial exceeds "territories of the self" (Goffman 1971, 28) and challenges their ordering principles. Second, it conjoins the turbulent fluid dynamics of respiratory life with the affective dynamics of highly uncertain atmospheric encounters. Third, its cloudy texture denotes a cohabitation of bodies that do not interrelate as clearly demarcated entities. In materially sharing intimacies of breath, they are enmeshed in their milieu. The atmosocial thus differs from modes of relatedness more familiar in sociology, such as interactions or networks, and points to a form of ecological entanglement that does away with the idea of a clearly demarcated Umwelt.

The book closes with a commentary by Melanie Kiechle. As a historian, she explores the question of change over time and structures her observations along the question of authority and power, the role of technology, and social relations as they run through the case studies. In doing so, Kiechle reflects on the difficulties of thinking with and through ecology, particularly paying attention to long-term impacts of disease events.