Humans, Animals, and Health

From Ecology to Entanglement

Alex M. Nading

ABSTRACT: Medical and environmental social scientists have recently become interested in how health brings human and nonhuman animals together. This article discusses historical approaches to this question. It then explores applied disease ecology, which examines how anthropogenic landscape change leads to "disease emergence." The article goes on to review two critical approaches to the question. Critics of biosecurity concern themselves with the ways in which animal and human lives are regulated in the context of "emerging diseases" such as avian influenza and foot and mouth disease. Scholarship on human-animal "entanglement" focuses on the ways in which disease, instead of alienating humans from other life forms, brings their intimate relationships into sharper relief. The article argues that health is one terrain for developing a critical environmental analysis of the production of life, where life is the ongoing, dynamic result of human and nonhuman interactions over time.

KEYWORDS: biopolitics, biosecurity, disease ecology, emerging disease, entanglement, health, human-animal studies

Bill Gates rails against the scourge of malaria mosquitoes. Reports about avian or swine flu send schools and airports into a hygienic tailspin. Food activists report the alarming statistic that animals, not people, consume the vast majority of antibiotics sold in the United States. West Nile scares turn playing outside in Dallas in July into a risky proposition. Though avian influenza, malaria, and antibiotic-infused meats attest to the intertwining of human and animal lives, health remains a peripheral concern in most compendia of "animal studies." Likewise, animals have occupied a marginal place in most social studies of medicine. Given the persistence of animal-related ailments, and the emergence of new ones, that gap is shortening. This article identifies a recent set of works that bridge animal studies, the medical humanities and social sciences, and human ecology.

Animal Inclusive Disease

I define "health" here as the combination of practice and epistemology by which people confront *disease,* the manifestation of symptoms associated with biophysical disorder, and *illness,* the socially and culturally mediated experience of suffering. This review asks where animals fit into this definition of health. Often, animals appear in Western and non-Western ethnomedical

Environment and Society: Advances in Research 4 (2013): 60–78 © Berghahn Books
doi:10.3167/ares.2013.040105

conceptions of health as vectors of disease.[1] The vector remains perhaps the most common trope of the animal in health. Vectors include the *Anopheles* and *Aedes* mosquitoes that carry malaria plasmodium, yellow fever, and dengue viruses, perhaps the three most politically and economically significant diseases in human history. They also include the tsetse flies that carry sleeping sickness; the fleas that allegedly spurred the Black Death; and the ticks that transmit Lyme disease. That these animal vectors are all insects makes them easier, perhaps, to treat as Others, objects of cultural scorn and as subjects of detached strategies of technological control, as indeed they have been since scientists began associating infectious diseases with insect vectors at the end of the nineteenth century (Raffles 2010). In the past few years, however, genetic technology has permitted a dramatic shift in this human-insect relationship. The invention of transgenic malaria and dengue mosquitoes, for example, has turned these antagonists into "tools," raising a host of novel ethical and ontological questions (Beisel and Boete 2013). I discuss the role of genetically modified animals in contemporary disease control in further detail below, but the partial shift in the status of mosquitoes from vector to tool underscores another key facet of health. Health not only entails confrontation with disease but also the production of life itself. Until recently, social scientific critiques of the production of life have focused mostly on human vitality, as measured and regulated through epidemiological statistics, public health, and humanitarian interventions (see Fassin 2009; Foucault 1990; Hacking 1991; Rose 2007). I push back against the anthropocentrism of such analyses, arguing that concerns about the production of nonhuman lives—even those of animal vectors—have also been central to health-related projects.

To do so, I highlight literature from the social sciences on vector-borne diseases as well as zoonotic diseases. Zoonotic diseases are animal diseases that "jump" to human hosts (World Health Organization 2013). These include rabies; Bovine Spongiform Encephalitis (BSE, or "mad cow" disease); Ebola virus (emerging from contact with nonhuman primates); and influenza viruses. Zoonoses become epidemics when they become transmissible from person to person, without the animal link. By this definition, dengue fever, which may have originated in primates, is vector-borne but not zoonotic (Endy et al. 2010). HIV, which almost certainly originated in primates, began as a zoonosis but is now transmitted through human sexual contact. Although I refer to zoonotic and vector-borne diseases separately, I occasionally refer to them together as *animal inclusive diseases.*

Readers will note that when speaking of animal inclusive disease, I am privileging half of the disease/illness dyad. This is partly because most of the recent literature in the social sciences that examines the human-animal health nexus takes biomedical disease categories for granted. In this view, malaria—a familiar subject of human-animal health studies—is a system with a clear, agreed-on pathogen (the plasmodium), animal vectors (*Anopheles* mosquitoes), and a set of identifiable responses from human bodies. Environmental social scientists have been less concerned than their medically oriented counterparts about illness: how different kinds of people suffer from malaria, what it means in different cultural or geographical contexts, and how it might be explained in different ways.[2] Nevertheless, human-animal relations have been mediated by notions of health at least as much as by notions perhaps more familiar to environmental social scientists: religion and ritual (e.g., Biersack 1999; Rappaport [1968] 1984), language and symbols (e.g., Sillitoe 2002); economies (e.g., Nadasdy 2007); politics (e.g., Evans-Pritchard [1940] 1969); or conservation (e.g., Lowe 2006). It is worth noting, however, that the potential for animal inclusive diseases, particularly malaria, to disrupt the "balanced" ecological relationships between small-scale societies and their environments was at the forefront of early criticisms of the uses of ecological equilibrium models in anthropology, and the subsequent turn to the study of resilience in the face of hazards (see Vayda and Mccay 1975: 297). Animal inclusive diseases all depend on the transmission of other nonhuman components: bacteria, viruses,

fungi, and other microscopic life forms. While it may seem unusual to couch such life forms as "animal," I argue that microscopic life is increasingly prominent in environmental social scientists' analyses of health.

Though what follows focuses on disease, a discussion of what happens, socioenvironmentally, when animals become ill remains relevant. Animals can contract diseases, but to perform illness and healing roles, in the anthropological sense, requires the ability to socially and symbolically interact (Kleinman 1988). After all, zoonoses begin as animal diseases, making sick birds, horses, pigs, and cows harbingers of human pandemics. For this reason, among others, a productive meeting of the medical and environmental social sciences requires a suspension of the "human exceptionalism" that has long distinguished the former and has only recently loosened its hold on the latter (Haraway 2008). The works I review in this article grapple with how disease has forced human beings to reconsider the ways in which they are materially, economically, and even symbolically connected to animals. Because much of the literature deals with the manner in which diseases "jump" from nonhuman to human, and vice versa, it appears that disease marks not a rigid boundary between humans and other animals, but rather, as Hinchliffe and colleagues (2012) have recently argued, a more fluid and interactive "borderland."

This article, then, distinguishes animal inclusive disease as one avenue for critically examining the production of life. Below, I review the literature on humans, animals, and health from four prominent perspectives: history, disease ecology, biopolitics, and entanglement. I argue that both the environmental and medical social sciences are based on the conviction that "life"—rather than being a baseline from which culture and society spring—is best understood as the ongoing, dynamic forms of material and symbolic relationship among humans, other life forms, and their environments.

Historical Approaches: Constructing Knowledge and Politics through Vectors

As disease carriers, insects have acted as animal mediators of state power and scientific knowledge production. The histories of dengue and yellow fever, for example, parallel that of transcontinental trade, especially in slaves, sugar, and spices, and the circulation of people and mosquitoes from forest-village zones to the new cities of Southeast Asia, where the virus is thought to have originated (Endy et al. 2010). In the Americas, the coming of dengue was probably preceded by that of *Ae. aegypti* and the yellow fever virus. Historian John McNeill (2010) suggests that mosquitoes and the yellow fever virus were important factors in the geopolitics of the colonial Caribbean. Applying the tools of contemporary disease ecology to the eighteenth-century context, McNeill argues that the establishment of sugar plantations and fortified garrisons permitted the proliferation of *Ae. aegypti,* which bred in the clay pots laborers used to drain molasses from sugar (McNeill 1999: 178). According to McNeill, the mosquito and the virus preyed on immunologically ignorant soldiers (usually young white males, usually from invading armies), rather than on soldiers with footholds in Caribbean forts, whose bodies, like those of African slaves, were immunologically more robust due to prior exposure to the virus (1999: 180). He gives the mosquito and the virus a great deal of credit for permitting, first, the successful slave uprising in Haiti, and, second, the maintenance of Spanish colonial hegemony in the inner Caribbean (Venezuela, Cuba, and the Yucatán). For McNeill, imperial environments were constitutive of epidemic patterns.[3]

Today's more casual student of mosquito-borne disease might know a few key names: that of Ronald Ross, who gets credit for discovering the symbiosis between mosquitoes and the malaria

parasite; or that of Walter Reed, who did the same for *Ae. aegypti* and the yellow fever virus; or that of William Gorgas, who successfully demonstrated that *Ae. aegypti* and *Anopheles* species could be controlled through manipulation of their aquatic habitats, first in Havana, Cuba, and later in the Panama Canal Zone. These were early disease ecologists, but they were also scientists of empire. Ross was part of the British Imperial medical complex; Reed and Gorgas were U.S. military men whose early work took place in the context of the occupation of Cuba during the Spanish-American War (Espinosa 2009; Packard 2007). (Indeed Reed's work around the turn of the century was actually a confirmation of a theory put forth in 1881 by Cuban physician Carlos Finlay [Cueto 2007: 30–32]). These men managed to make mosquito eradication the focus of public health science for the better part of the twentieth century. Their aggressive stance against mosquitoes fit into a narrative of Western colonial triumphalism, which was predicated on the idea that through scientific rationality and technical prowess, white men could conquer and civilize the landscapes to which they came. Mosquitoes and the pathogens they carried complicated this narrative. Warwick Anderson has argued that a colonial priority on insulating (white) human bodies from dangerous tropical environments was paralleled by a recognition not only of the inherent porosity of human bodies (the circulation of blood, parasites, and viruses via mosquito bites is just one example), but also of the role of colonialism itself in producing dangerous environments (Anderson 2004: 40–41, 2006; see also Sawyer and Agrawal 2000).

Examining mosquito control programs in Panama, Sutter (2007) finds that entomological technicians working on the American canal project carried on an internal dialogue about the origins of the malaria problem there. Entomological workers in the Canal Zone believed that environments conducive to malaria were not simply products of untamed tropical nature; rather, malaria was—at least in some instances—a product of colonial landscaping itself. Sutter recounts a debate between Gorgas's mosquito team and the Quartermaster's Department in the Canal Zone. Gorgas believed that the Quartermaster was preferentially cutting grass in the "(white) married quarters while neglecting other important sanitary cutting in areas that bred and harbored vector mosquitoes" (Sutter 2007: 749). The debate about mosquito control between Gorgas and the Panama quartermaster shows "how the dominant U.S. ideology of tropical conquest, manifest here as a landscape aesthetic, came into conflict with the perceived ecological dictates of mosquito control" (Sutter 2007: 750). For the early mosquito hunters, bent though they were on "eradicating" the insect scourge, health would arise not just from careful insulation of bodies from insects but also from careful governance of how those bodies moved through space. This approach was perfected in the quasi-military disease eradication work of Fred Soper, and the eventual adoption of DDT (dichloro-diphenyl-trichloroethane) as a weapon against mosquitoes. Though the DDT project was in some ways the first "global" health campaign, it largely excluded Africa, where work with DDT never progressed beyond the experimental phase, and where worldwide attention to malaria was muted until decades after World War II (Dobson et al. 2000; Kinkela 2011; Packard 2007).[4]

In his essays on colonial development and science in Egypt, Timothy Mitchell discusses the ways in which Egyptian institutions of public health and infrastructure worked to tame the Nile and stop the *Anopheles gambiae* mosquitoes that carried malaria. Mitchell introduces the concept of "techno-politics" to describe the rise of institutions of economic development, public health, and public works. Techno-politics involves the manufacture of an illusion, namely, "that the human, the intellectual, the realm of intention and ideas seem to come first and to control and organize the nonhuman" (2002: 43). Techno-political power coalesces when the illusion of a divide between human intention and nonhuman "resistance" can be maintained, but as Mitchell argues, the Nile and the *Anopheles* mosquito were anything but static. They came into being, as material forces and as objects of knowledge, along with the technologies and policies designed

to contain and organize them. At every turn, water and mosquitoes adapted to and infiltrated systems of control.

Carter's (2012) research on the history of malaria control in turn-of-the-twentieth-century Argentina addresses similar questions about the way in which malaria and mosquitoes helped facilitate a convergence of medical knowledge production and state formation. He argues that the Argentine state's claim on malaria prevention as its province (hardly a given in the early 1900s) was one way in which the state itself came into being. Malaria control created "state spaces," such as mosquito control districts, clinics, and hospitals (Carter 2008: 280). Argentine malaria control tactics adjusted to the unique ecology of the country's malarious zones, and over the course of the twentieth century, state power coalesced around the "malaria problem." As the scientific apparatuses of insect and landscape ecology became more fine-tuned, precise, "rational" control of the disease became disaggregated from wider social development agendas (Carter 2007: 644). This does not mean that science and state power were always in accord (Carter 2008: 280; cf. Nading 2013). As Tilley (2004) suggests in a study of sleeping sickness in British colonial Africa during the same period, the recognition that vector-borne diseases were complex and dynamic partially undermined the assumption that a "rational" organization of insect and human habitats could lead to a more effective government. What such a recognition did do, according to Tilley (2004: 27), was bring the sciences of ecology and tropical medicine closer together in an "integrated and comprehensive" approach: a "disease ecology" focused on the fluid relationships among microbes, vectors, human hosts, and landscapes. This focus on fluidity, or what I call "entanglement," did not lead to a questioning of the clarity of species borders on the part of scientists and public health experts. Rather, species categories remained resilient and were perhaps even strengthened. Paradoxically, then, entanglement and hierarchical species separation appeared to go hand in hand as colonial and postcolonial biomedicine penetrated the global South (see Livingston and Puar 2011).[5]

Environmental histories of animal-inclusive diseases tend to begin with the idea that a transformation occurred with the domestication of animals and the rise of sedentary societies. The building of settlements and the intensification of animal husbandry—which also contributed to the invention and refinement of species categories—exposed populations to pathogens such as influenza, which used animals as reservoirs, and to disease vectors, from ticks to mosquitoes. Urbanization put people and animals into closer proximity, with populations of both increasing. According to this narrative, agriculture, settled husbandry, and urbanization led to an "epidemiologic transition" that introduced the major epidemics of the next several centuries. Such a narrative has long been orthodoxy in disease ecology, and it has been the basis for scholarly and popular understandings of animal inclusive disease (Barrett et al. 1998). Indeed, zoonotic pathogens that emerged in this way in Africa, Europe, and Asia constituted many of the "germs" of Jared Diamond's wildly popular *Guns, Germs, and Steel* (1997). This was an attempt at what Harriet Ritvo calls "epic" historical narrative that purports to explain the success of "old world" human populations economically and militarily using ecological concepts (Ritvo 2004; see also McNeill 1976). Thus, the making of distinct spaces and categories of "domestic" and "wild" in human practice over time may have contributed to a recognition of precarious interspecies connection.

Spillover: Social Science in Disease Ecology

Recently, the "epidemiologic transition" thesis has been tempered by findings that indicate that the plagues that make news most often today, including HIV, Ebola virus, and *vivax* malaria,

originated not in domesticated livestock but in nondomesticated primates (Wolfe et al. 2007). Beginning in the 1990s, these "emerging infectious diseases" (EIDs) began receiving regular attention in the popular press and mass media (e.g., Garrett 1995; Quammen 2012). For disease ecologists, "emergence" references the multifactorial, often unpredictable evolution of human-animal-pathogen relations. Seen as emergent, the forms of relation between animals and humans outlined in contemporary disease ecology are nonlinear and stochastic, yet measureable and even possibly predictable through complex computer modeling. Since it entered common usage in public health in the 1990s, the concept of emergence has been criticized and analyzed thoroughly in medical anthropology, most notably by Paul Farmer (1999), who has emphasized that the pathogens labeled in Northern public health discourse as "emerging" have remained consistent scourges in the global South. Still, disease—much less disease emergence—figures little in reviews of the uses of nonequilibrium ecology in the social sciences over the same period (e.g., Kottak 1999; Scoones 2000). Disease ecology merges the human dimensions of disease origins with the evolution of pathogens; however, disease ecology is as much an applied study of the future of EIDs as a retrospective analysis of their origins. Its proponents laud its potential become a "predictive," rather than a "reactive" science (Daszak 2006; Wolfe et al. 2007).

The revitalized study of "conservation medicine," a branch of disease ecology that tracks emerging infectious diseases that result from contact between wild primates, birds, and other animals, places anthropogenic landscape change at the center of its research agenda (Parkes et al 2005; Patz et al. 2004; Wilcox and Colwell 2005; Daszak, et al. 2001). From the perspective of conservation medicine, changes in human relationships to nondomesticated animals, including "encroachment, road building, deforestation, [and] hunting and trading them globally," may precipitate new diseases and exacerbate old ones (Daszak 2006: 366). Scholars of conservation medicine have been particularly concerned with the relationship between "bushmeat" consumption (the hunting and killing of primates for food) and the emergence of novel pathogens (Chapman et al. 2005). A multidisciplinary study in Cameroon (Wolfe et al. 2005) examined the links between logging, poverty, and the proliferation of bushmeat consumption. While bushmeat hunting in Cameroon is nothing new, the growing number of logging roads has produced a wider variety of contact points between hunters and primates, producing increased opportunities for pathogens to jump from primates to people or livestock (Wolfe et al. 2005: 1823). These changes in land use patterns were paralleled by changes in urban bushmeat consumption patterns. As urban demand for bushmeat increased, thanks in part to poverty, hunting increased, and the chances for people to be exposed to zoonotic pathogens, mainly through blood and tissue contact, also rose (Wolfe et al. 2005: 1824).

This kind of study, linking environmental change to economic activity, has been replicated across conservation medicine (see, e.g., Aguirre et al. 2012; Goldberg et al. 2008). The construction of national parks and protected areas, for example, may actually promote the circulation of parasitic pathogens in forest islands around park edges in Uganda, and the collection of date palm sap likely leads to exposure to bat-borne Nipah virus in Bangladesh (see Nahar et al. 2010; Salyer et al. 2012). Though the relationship between parks and people has been an interest of political ecologists (e.g., Goldman 2007; West 2006; West and Brockington 2006), the political side of disease ecology remains largely underexamined. Few political ecologies of conservation medicine exist, as a group of medical anthropologists told the *Lancet:*

> In the same way that ecologists talk about ecological cascades that facilitate disease emergence, social scientists speak of the scalar and multifaceted dimensions of influence in social systems—from an individual in a community to the wider political economy—that guide, constrain, or otherwise affect disease risk. (Janes et al. 2012: 1885)

Critical analysis of the linkages between poverty, political change, violence, and gendered inequalities to the twin problems of conservation and disease emergence remain relatively rare in environmental anthropology and geography.

Exceptions to this have been in studies of dengue (e.g., Nading 2012, 2013; Whiteford 1997), SARS (e.g., Ali and Keil 2008), and avian influenza (Porter 2012). Indeed, Janes et al. (2012: 1885) suggest avian influenza as a possible starting point for integrating ecological models of disease exposure to social models of labor, market, and household dynamics. They thus push for a turn in attention in the social science of disease ecology from the processes whereby human ecologies encroach on animal ecologies to the processes whereby animal ecologies encroach on human ones. Because highly pathogenic avian influenza (H5N1) circulates in fowl (e.g., chickens, ducks) and migratory birds (e.g., geese), people who live and work in close proximity to those animals, for example in Asia and North Africa, have great potential for exposure. The intensification of commercial bird cultivation, combined with urbanization and trade liberalization, forms the backdrop of Mike Davis's (2005) critical geography of the disease. Davis's title, *The Monster at Our Door,* reflects the anticipatory and predictive turn in ecological health, yet it is unclear whether the "monster" is H5N1, birds themselves, or the "pathological" system of accumulation that has brought them into conflict with people (Hinchliffe et al. 2012: 12; Waltner-Toews 2007).

Biosecurity and Its Critics

Some proponents of conservation medicine, notably Nathan Wolfe (2011), have used findings about the tendency of plagues to originate in nondomesticated animals to advocate for the development of a disease "early warning system," an ecomedical modeling apparatus for anticipating the emergence of new pathogens (mostly viral) that might arise out of intensified human-animal contact. In popular accounts of Wolfe's work, the tropical African interior becomes a kind of "ground zero" for such emergence, but public interest in the early warning idea spans all the way to the U.S. Department of Defense (Specter 2010; see also Lakoff 2010). Animal inclusive disease has thus become the latest terrain for the post–9/11 rise of biosecurity. Biosecurity is partly a project of military defense, but it also includes a broader set of experimental, economic, and political efforts to "secure health" in the context of EIDs and the new forms of knowledge and expertise that they engender (Lakoff and Collier 2008: 8–9). In a biosecurity framework, risks to health appear to be emerging not just from tropical "hot zones" (Preston 1995) but from other points of species contact, including laboratories, markets, farms, and airports.

Most critiques of biosecurity draw on Foucault's formulation of biopolitics—the coalescing of disciplinary codes, population surveillance mechanisms, and discourses concerned with the production and protection of (mostly human, mostly Western) "life" (Foucault 1990; Rabinow and Rose 2006; Rose 2007). Such critiques tend to focus on the implications of biosecurity and the discourse of disease emergence for human-human relationships. These include the way in which military and market security become blended (King 2002); the unsettling links between biosecurity and humanitarianism in discourses of "global health" (Briggs and Nichter 2009; Lakoff 2010); the way in which ideas of anticipation and preparedness change how health science is practiced, from laboratories to policy centers (Caduff 2012; Lakoff 2008); how emphasis on possible future threats may deplete attention to lower-profile and less potentially pandemic diseases, such as sleeping sickness (Redfield 2012); and the novel "aggregates" of academic, corporate, and state power that anti-EID projects produce (Stephenson 2011).

While most critiques of biosecurity do engage somewhat with human-animal dimensions, a clear sense of how biosecurity changes interspecies relations is only now being fully developed. Recent work has examined attempts made in the name of biosecurity to secure the borders between people and animals, and between people themselves. For example, the threat of H5N1, "mad cow," and other zoonoses has led to the high-profile, systematic slaughter of domestic livestock and poultry. Such "killing in the name of life" is the most glaring manifestation of a larger set of processes by which biosecurity illuminates the spatial and conceptual contradictions of global capitalism, and the uncertainty of what kind of life is good to protect (and produce).

Davis's (2005) examination of avian influenza is perhaps the liveliest description of the ways in which the intensified circulation of live animals in the food system exacerbates EID threats. Capital is increasingly taking the form of animal life (e.g., industrially farmed pigs and birds), yet even as pandemics demonstrate the porosity of human-animal borders, the tendency among security-minded policymakers has been to redraw those borders—to govern animal and human interactions through surveillance, medication, and regulation (Robbins and Miller 2013; Shukin 2009: 183–84; White 2012;).[6] Lowe's (2010) exploration of the discourse of anticipation that surrounded the H5N1 threat in Indonesia shows how the virus itself, a "quasi species" constituted of slivers of animal, porcine, and avian DNA, served to bring together a novel array of people and animals, rather than to segregate them (Lowe 2010: 629; see also Porter 2013). In Indonesia, the nebulous, "cloudy" nature of the H5N1 pathogen, which constantly subverted species borders, mirrored the cloudy nature of the relations between the human and animal life on either side. Birds, once symbols of Indonesian biodiversity, became subjects of global biosecurity. As poultry culls became accepted practice in the management of potential H5N1 outbreaks, bird life went from sanctified to dispensable (Lowe 2010: 632). Deeply tied to their domestic poultry, and ambivalent about their country's position as a pandemic ground zero, some Indonesians came to question the potential of biosecurity to reinscribe an uneven geography in which they, too, were dispensable stand-ins for more valued Western bodies.

The fight against bird flu, in the words of an United Nations Food and Agriculture Organization official, has been waged "in the backyard of the world's poor," in places as disparate as the southeast Asian countryside and inner city Cairo (Hinchliffe and Bingham 2008: 221). Mass killing of domestic animal stock has been a hallmark not only of H5N1 scares, but also of responses to foot and mouth disease (FMD) and Bovine Spongiform Encephalitis, or "mad cow disease" (Law 2006). But killing is not the only tactic for managing human-animal relations in the context of biosecurity threats. For example, Law and Mol (2008: 137) explore the end of the practice of feeding pigs "swill" made from human food waste (i.e., restaurant and catering scraps) in the UK. As a result of the 2001 FMD epidemic, the UK government banned pigswill altogether, suspecting that a failure to properly boil it was one reason for the epidemic. Pigswill boiling had, until the epidemic, been central to the national strategy for keeping the British Isles FMD free. Law and Mol (2008: 137) couch pigswill boiling as a "political" practice that *enacted* a boundary between the hygienic, modern, civilized, disease-free UK and other nations, even as it *maintained* a centuries-old "metabolic intimacy" between humans and pigs. Furthermore, the use of pigswill (as opposed to industrially produced feed) "fed some of the excesses" of the affluent UK food system back into the "metabolic circuit" instead of contributing to the unsustainable and often exploitative production of feed, often by poor farmers in the Global South (Law and Mol 2008: 141). Thus the ban on pigswill, which occurred alongside a series of well-publicized and controversial livestock culls, marked the replacement of one form of biopolitical practice (boiling) with another, as well as the passage of a vestigial, noncapitalist form of producing life.

Law and Mol eulogize boiled pigswill as the marker of a porous species boundary, albeit one that depended on a rigid (if unsustainable) hygienic boundary between the UK and other places. Law and Mol's pig farmers, like Lowe's Indonesian chicken keepers, felt alternately connected to and alienated from capitalist circuits and centralized nodes of health management. Indeed, avian flu, FMD, and other food-related EIDs prompt scholars to call into question the scalar thinking that separates "local," place-bound production from a "global," borderless counterpoint. In the bodies of diseased pigs and sheep, the "global" and the "rural" collapse (Franklin 2007). FMD, a disease that only rarely affects humans, nonetheless does political work: it "divides the world's nations … into the haves and the have nots" (Franklin 2007: 171). Amid the FMD outbreak in the UK, human-animal borders were strategically reversed. Opponents of sheep culls depicted mass killing as "inhuman," and press accounts repeatedly couched sheep, already laden with religious and cultural significance, in anthropomorphic ways (Franklin 2007). FMD, "mad cow disease" and avian and "swine" influenza reveal the vagueness of the *bio* being secured in biosecurity.

Frédéric Keck, reflecting on a conflict between French veterinarians and public health officials over the meaning of biosecurity during the avian flu crisis, identifies a contradiction in "animal" diseases. They can be considered from an "epizootic," "whole animal" point of view or from a "pandemic," human-centered point of view (Keck 2008: 195). This contradiction, coupled with the glaring empirical evidence that human and animal fates are economically and symbolically entwined under conditions of global capitalism, suggests that a more relational, less managerial alternative to biosecurity needs to emerge. After all, human and animal health have been tied together for some time. In the anthropological record, ecological studies originate with the observation that pastoralists (e.g., the Nuer) and gardeners (e.g., the Maring) alike trace their well-being to that of cows and swine (Evans-Pritchard [1940] 1969; Rappaport [1968] 1984). In the 1960s, the epidemiologist Calvin Schwabe coined the term "one medicine" to draw attention to the common fates of animals and people. Recently, Schawbe's call has been recharged in the guise of the "one health" movement, and social scientists have begun advocating an approach that accounts for the political and social dynamics that cause suffering in people and animals (Rock et al. 2009).

A socially engaged attention to the shared fate of humans and animals might supplant the managerialism of biosecurity, but it raises further biopolitical questions, as Blue and Rock (2011) argue in their analysis of how domestic felines were affected by the BSE outbreak of the 1990s and 2000s in the UK and Canada. BSE was transmitted from cow to cow—and into felines—via feed that included infected cow meat. Reform of this practice was at the heart of the public health response to BSE, yet regulations of pet food were enacted

> not really to protect cats from developing spongiform encephalopathy, but to ensure the integrity of livestock feed and, by extension, the human food chain. Government regulations and public relations efforts do not currently accord to pets the status of lives that merit or warrant protection in their own right, but as citizens, many people seek to prolong and enhance the lives of housecats and other pets. (Blue and Rock 2011: 361)

The authors criticize the human exceptionalism of BSE prophylaxis, suggesting an alternative "politics of life" that foregrounds human-nonhuman relationality.

Entanglement

I begin my discussion of entanglement with a return to avian influenza. In Southeast Asia, public health experts have long operated on the assumption that while novel H5N1 strains probably

develop in close-knit industrial poultry operations, domestic birds (household chickens and ducks, rather than wild birds or industrial poultry) must be the main vessels through which H5N1 viruses "spill over" into human bodies. Porter's (2012: 112) examination of public health officials' attempts to use community mapping to manage human-domestic poultry relations in Vietnam identifies a disconnect between global health practitioners, who saw poultry as part of a landscape that humans could and should dominate, and "local participants," who located threats to poultry and people in nonhuman forces such as wind and water flows. Porter (2012: 107) argues that by focusing on domestic poultry, Vietnam's anti-avian influenza policy left the intensified industrialization of agriculture unquestioned. Public health policy tended to confront disease ecologies as knowable, stable, and bounded in local "places," even though the intersection of domestic and wild birds, farmers, experts, and state officials meant that that influenza ecology was far more complex. The ecology of bird flu was "co-produced" and "constantly changing," and given the interaction of industrial and domestic birds with wild species, not to mention wind and water, hardly limited to discrete "places" (Porter 2012: 118). Community "risk maps" became sites of debate over how people should "share habitats" with birds (2012: 107). Porter explores what I have called in my own work on the prevention of mosquito-borne dengue fever in Nicaragua an ecological and political "entanglement" between humans and animals (Nading 2012). I document the ways in which state-employed mosquito control workers used the process of searching for mosquito larvae in a suburb of Managua to "open" an otherwise oppressive and threatening urban landscape. As an "ecological aesthetic" process, mosquito surveys became a way for female public health workers to reflect on the ways in which their lives intersected, symbolically and materially, with other life forms in that landscape.

From the perspective of entanglement, people, birds, pathogens, and spaces are connected in a process of "mutual becoming" (Deleuze and Guattari 1987; Ingold 2011; Kirksey and Helmreich 2010; Shaw, et al. 2010). As Laura Ogden suggests, human being "is constituted through changing relations with other animals, plants, material objects, and the like" (2011: 2). Entanglement maintains the nonlinear and stochastic elements of emergence, the concept that drives disease ecology, while integrating the critical approaches of biosecurity, which emphasize the porosity of species borders and the ethical quandaries that arise when institutions and scientists attempt to redraw those borders in the name of protecting "life" (Lakoff and Collier 2008; Shukin 2009). An entanglement approach uses ethnography to ask how humans—even in the context of disease—strive to live well together with animals (Beisel 2010; Haraway 2008). Though it might seem that the community-based mosquito control programs I describe, much like the community mapping exercises Porter documents, would serve to alienate people from birds and insects, our findings show how they reinforced a deep connection between them.

For "local participants," the benefits of participation in animal-related disease prevention are more than utilitarian. Mapping "zoographies" (Porter 2012), following mosquitoes through urban space (Nading 2012), or "hosting" malaria mosquitoes in experimental huts designed for "human landing catches" (the testing of mosquito densities, using people as "bait") (Kelly 2012), are forms of deep engagement with life. Seen as entanglement, life is not simply a vitality to be secured but "the unfolding, often incidental attachments and affinities, antagonisms and animosities that bring people, nonhuman animals, and materials into each other's worlds" (Nading 2012: 574). Such engagements manifest human-animal sociality, but they are also crucial to the creation and stabilization of biomedical knowledge (Kelly 2011). This fact goes unrecognized in many biopolitical analyses, which see disease control as synonymous with political control (but see Lowe 2010).

Of course, people and animals have been entangled by the practices of biomedical science for quite some time. One need think only of the way experimental "animal models" such as

the cancer gene-carrying OncoMouse™ defy simple species definitions (Haraway 1997; see also Davies 2012). Biomedical experiments in drug development have long made animals stand-ins for people, or, in the case of the brine shrimp described by Cori Hayden (2003), testing sites for the toxicity or chemical activity of wild plants. Hayden describes how brine shrimp mediate between the "field" in which bioprospectors search for new plant compounds with medical applications and the "controlled" experimental spaces where those compounds are tested. The apparent stability of brine shrimp colonies reinforces ideas about the "natural" behavior of chemicals. In rendering animals into laboratory "models," however, the "nature" of the species category comes into question. In an age of chimeras and genetically modified organisms, speciation seems less and less a natural phenomenon.

The animal as biomedical tool is now moving back out of the laboratory. For example, the Bill and Melinda Gates foundation, among others, has begun funding the development of genetically sterilized or otherwise modified mosquitoes. Genetically-modified (GM) versions of dengue and malaria mosquitoes designed to suppress wild, disease carrying colonies or to deliver inoculation, have been field-tested in several countries. As Beisel and Boete argue (2013), the conversion of mosquitoes from public health menaces to "tools" entails a radical shift in the practice of public health. GM mosquitoes are not only new forms of "biocapital" (Sunder Rajan 2012), they also displace low-tech, place-based, local forms of disease control (Beisel and Boete 2013: 49). Tellingly, Beisel and Boete describe this displacement with the verb "disentangle."

But GM mosquitoes, like other biomedical chimeras, may perform the opposite function. As obvious and uncanny manifestations of the porosity of species borders, these creatures may cause public health and environmental activists, scholars, and policymakers to recognize the longer-standing entanglements of human bodies, animal bodies, and environments. As Haraway (1997, 2008) has argued, genetically modified organisms and other tools remind us less of a bygone era of clean divisions between body and biosphere, or between human and environment, than of an ongoing era of interspecies becoming, under conditions of neither the humans nor the animals' choosing. Human and animal bodies are not the product of linear, taxonomic evolution but of "symbiogenesis"—the merging and blending of species to create new forms of life.

In 2011, biologist Dorion Sagan (2011) told a gathering of anthropologists, "At bottom we are part virus, the offspring not just of our parents but of promiscuous pieces of DNA and RNA. The road to humanity is paved with genetic indiscretions and transgressions." Indeed, Sagan continues, quoting biologist Margaret McFall-Ngai,

> the immune system evolved not to eliminate pathogens but to select for symbionts in the microbe-packed waters of our metazoan ancestors. The immune system in its origin may thus be more like an employment agency, recruiting desired species, than like a national security state, recognizing and refusing entry to guard the fake purity of the Self.

In other words, the creation of transgenic creatures in the laboratory may well allow us to question the historical, political processes that have turned something normal—the interaction between people, animals, and microbes—into something pathological.

GM mosquitoes call attention to the blurriness of the human-environment boundary. Those mediating creatures, like viruses and bacteria, deserve further consideration by environmental social scientists. I have found in my ongoing study of dengue prevention that viruses, not mosquitoes, sit at the cutting edge of the field. Corporate and academic laboratories are inventing genetically altered versions of dengue viruses in hopes of creating a vaccine. This viral "chimera," like the GM mosquito, has caused scientists to reassess human-microbe relations, and it has brought into relief the sometimes contradictory priorities of global health (Nading 2011).

Humanitarian, biosecurity, and capitalist interests all converge in the creation of chimeric dengue vaccines, even as environment and health ministries struggle to decide how to regulate them.

The understanding of the microbiome favored by Sagan requires an understanding of the human body itself as a kind of ecosystem: a Gaia in miniature that houses countless distinct beings living symbiotically with the larger vessel. At the same time, microbial life is, like insect life, distinctly "other" (Helmreich 2009: 14–15). If human-animal studies has moved in the past decade toward an understanding of the fates and identities of human and nonhuman fauna as economically, socially, medically, and politically entangled, it appears that such an understanding of human-microbial relations is at hand as well (Hird 2009; Latour 1988; Paxson 2008). Calls for a collaborative "anthropology of microbes" (Benezra et al. 2012; Gordon 2012) do not strictly mimic earlier calls for an early-warning "ecological health" complex. Rather, they recognize the potential for a social ecology of the microbiome to reframe the way that public health interventions see human bodies in relation to nonhuman ones. Recognition that we must share microbiota, viruses, and genetic material can, potentially, enrich the ethic of "living well" with nonhuman others.

Coda: Return to Illness

Human-animal studies have done much to reveal the ontological plurality of disease, and, through disease ecology, social scientists are becoming more attuned to the entanglement of human and animal well-being. The nature of our connection to animals and microbes—and thus the meaning of disease itself—is in constant flux. "Biological embodiment," as Helmreich notes, "is always multiple, manifold" (2009: 14). As I noted earlier, most recent studies of humans, animals, and health in the social sciences tend to examine disease, rather than illness, which I shorthanded as the performed experience of pathologies as suffering. By way of conclusion, however, I want to point to one way in which human-animal sociality has provided insights into the lived experience of illness, particularly autism spectrum disorder (ASD). ASD is not a zoonotic disease, and it is not, as far as I understand, documented in nonhuman animals. Philosophical understandings of the human relationship to nonhumans shifted with Jeremy Bentham's ([1789] 1907) declaration that a shared capacity to suffer—to feel pain and discomfort bodily, rather than to express it linguistically—forges a moral connection between humans and other animals. Bentham was probably not thinking explicitly in terms of animal health, but the idea of animal suffering as a basis for moral standing calls to mind the distinction between "disease" and "illness" with which I began this article. Medical social scientists understand *disease* as the manifestation of symptoms associated with biophysical disorder, however defined ethnomedically. Conversely, *illness* is the explanation, experience, and performance of those symptoms: the culturally mediated experience of suffering (Parsons 1951).

The experience of ASD—what it means to *be autistic*—has until recently been difficult for autistic people to express. It has been well known for some time that "companion animals," particularly dogs, are therapeutically useful for people with ASD. The fact that dogs can bring supposedly "closed" or "antisocial" autistic persons into meaningful social relations calls into question the linguistic basis for subjectivity itself (Solomon 2012; cf. Wolfe 2008: 111). Dogs and primates have helped autistic people make the case that in addition to a diversity of cultures, a "diversity of minds" and of forms of sociality may also exist (Solomon 2012). Animals have thus made autism intelligible and helped alleviate the suffering of those whom nonautistic society has ostracized as pathologically asocial. But as Temple Grandin (1995) has shown, autistic people can return the favor, providing insights into the nature of animal suffering. Grandin

has helped improve animal experiences in industrial processing and holding facilities by drawing on "her special understanding of how nonhuman animals experience the world" (Wolfe 2008: 111). Using this brief example, we can imagine how neurodiversity might offer ecologists and environmental social scientists a way to understand animal *illness,* reviving and extending Bentham's consideration of the capacity to suffer into a "multispecies" ethics (Kirksey and Helmreich 2010).[7]

Zoonotic and vector-borne diseases continue to proliferate, and they continue to cause animals of all kinds to suffer. A host of technological solutions, from quarantine to DDT to antibiotics to GM viruses, have been proffered against these problems, but environmental social science still has a great deal to offer. By paying critical attention to the entanglement of humans and animals—to their mutual becoming and "shared suffering" in the context of capitalism and (post)colonialism—social scientists can productively destabilize the anthropocentrism of conventional public health. As Haraway (2008) suggests in her discussion of the ethics of laboratory experiments on animals, which may cause pain and death, there is no abstract, absolute moral standard for weighing animal suffering against human suffering in such situations. Rather, scientists must operate on a "mundane ethics" that recognizes the inequality among humans and animals without "disavowing" the "instrumental relationships" that obtain between them: the inequality of the "precise and *changeable* labor practices of the lab" (Haraway 2008: 70, 77).

Social science research can attest to the connected futures and pasts of human and animal bodies and the ecosystems they coinhabit. But much work remains to be done. Political ecologies of conservation medicine, for example, remain too few and far between. The areas of environmental justice, food studies, and climate change studies could benefit from further attention to the shared fates of human and nonhuman animals. Finally, as disease ecology moves from forest edges to microbiomes, anthropological studies of enteric diseases and nutrition might begin to consider the political and cultural problems that attend dynamic human ecosystems. But what the environmental and medical social sciences share, in the end, is a concern about a fluid, precarious, yet meaningful thing called "life."

ACKNOWLEDGMENTS

Support for this article was provided by Franklin and Marshall College, as well as a Fulbright-Hays Doctoral Dissertation Research Award, the Social Science Research Council, and a National Science Foundation Doctoral Dissertation Improvement Grant (No. 0849650). I am grateful to the editors of *Environment and Society: Advances in Research,* to Sarah Besky, and to the anonymous reviewers whose suggestions made the arguments stronger. Any errors are my own.

ALEX NADING is a medical and environmental anthropologist with a regional focus on Latin America. His research has explored the multispecies aspects of infectious diseases and the relationship between place and health in the age of global biomedical interventions. Most of his fieldwork has taken place in a low-income suburb of Managua, Nicaragua, but he has also done research in Puerto Rico, Cuba, and the United States. His current research is on the development and deployment of genetically modified viruses and mosquitoes with global health applications and the role of human microbiome science in reshaping global health.

NOTES

1. One of the earliest anthropological accounts of indigenous healing practices, W. H. R. Rivers's "Massage in Melanesia" (1926), described Solomon Islanders' attempts to cure constipation by removing an octopus from within the patient's body. Rivers concluded that the presence of the octopus was the Islanders' way of explaining the effectiveness of massage, a practice, he conjectured, that must have been imported to the Islands from Polynesia. In Rivers's telling, the octopus was a culture-bound fiction. In the Solomon Islanders' framework, the octopus was a causative agent: an antagonist, whose well-being was not a concern.
2. Although I have chosen to focus on animal inclusive disease, I had to narrow my discussion for this article. I do not, for example, examine the evolutionary origins of health-seeking behavior. Elsewhere, Sapolsky (2004) has reviewed evidence of an evolutionary component to the observation, familiar to social epidemiology, that social rank and health status are positively correlated (see Baer et al. 2003; Krieger 2005). As Waldstein and Adams (2006: S107) note in a review of the interface between anthropology and ethnobiology, a form of self-medication has been documented in chimpanzees, who consume stimulant, bitter, or bristly leaves with felicitous health effects, including the expulsion of tapeworm fragments. I also give less attention to the areas of ethnobiology and ethnomethodology, where there is a growing literature on the pharmacological uses of animal products (Alves and Alves 2011; Alves and Rosa 2006; Benítez 2011; Mahawar and Jaroli 2008).

   The meeting of ethnomedicine with the market has been seen by some as a threat to biodiversity, since the exploitation of animal species for traditional medicine has threatened rhinoceros (valued for their horns); bears (whose gall bladders are used in Asian medicinal practice); and snakes and other reptiles in Brazilian pharmacopeia (Alves and Rosa 2010; Feng et al. 2009; Kikuchi 2012). In many ways, the study of zoopharmacology reaches to the heart of environment-society concerns: the long-term viability of "ecosystem services," the extent to which the domestication of "wild" species protects them or their habitats, and the fraught relationship between cultural autonomy and global environmental governance.
3. This observation resonates with the perhaps more familiar findings of William McNeill (1976) and Jared Diamond (1997), but John McNeill gives more thorough attention to the specific kinds of ecosystems that colonial productive and military power engendered in the greater Caribbean.
4. I am grateful to an anonymous reviewer for pointing this out.
5. I am indebted to an anonymous reviewer for calling attention to this. As Livingston and Puar (2011: 4) suggest in their call for "interspecies" inquiry, "Even as interspecies relations are acknowledged, affirmed, and hailed as fragile and precious, or fundamental and symbiotic, dividing animate life by species implies a whole series of boundaries—ontological ones—which are then ranked into hierarchies, shifted and manipulated for various capitalist and knowledge-making projects."
6. Animal life is not the only new space for capital accumulation. The atmosphere itself, in the form of "carbon credits," has also become a new market space. Thanks to an anonymous reviewer for making this connection.
7. If social scientists are to make meaningful contributions not just to "solving" health problems but to positively refining the notion of health itself, a clear recognition of the ways (both companionate and antagonistic) in which human and animal subjects coconstitute one another seems necessary. This requires not simply studying how humans relate to other living beings, but—as in the case of microbiome studies—examining how the constitution of "human" bodies occurs in a sometimes symbiotic, sometimes antagonistic interspecies "dance" (Haraway 2008; Ingold 2011; Livingston and Puar 2011).

REFERENCES

Aguirre, Alonso, Richard Ostfeld, and Peter Daszak. 2012. *New Directions in Conservation Medicine: Applied Cases of Ecological Health.* New York: Oxford University Press.

Ali, S. Harris and Roger Keil. 2008. *Networked Disease: Emerging Infections in the Global City.* Malden, MA: Wiley-Blackwell.

Alves, Romulo, and Humberto Alves. 2011. "The Faunal Drugstore: Animal-Based Remedies Used in Traditional Medicine in Latin America." *Journal of Ethnobiology and Ethnomedicine* 7: 9, doi: 10.1186/1746-4269-7-9.

Alves, Romulo, and Irece Rosa. 2006. "From Cnidarians to Mammals: The Use of Animals as Remedies in NE Brazil." *Journal of Ethnopharmacology* 107, no. 2: 259–276.

Alves, Romulo, and Irece Rosa. 2010. "Trade of Animals Used in Brazilian Traditional Medicine: Trends and Implications for Conservation." *Human Ecology* 38, no. 5: 691–704.

Anderson, Warwick. 2004. "Natural Histories of Infectious Diseases: Ecological Vision in Twentieth-Century Biomedical Science." *Osiris* 19: 39–61.

Anderson, Warwick. 2006. *Colonial Pathologies: American Tropical Medicine, Race, and Hygiene in the Philippines.* Durham, NC: Duke University Press.

Baer, Hans A., Merrill Singer, and Ida Susser, eds. 2003. *Medical Anthropology and the World System.* 2nd ed. Westport, CT: Praeger.

Barrett, Ronald, Christopher Kuzawa, Thomas McDade, and George Armelagos. 1998. "Emerging and Re-Emerging Infectious Diseases: The Third Epidemiologic Transition." *Annual Review of Anthropology* 27: 247–71.

Benezra, Amber, Joseph deStefano, and Jeffrey Gordon. 2012. "Anthropology of Microbes." *Proceedings of the National Academy of Sciences* 109, no. 17: 6378–81.

Benitez, Guillermo. 2011. "Animals Used for Medicinal and Magico-Religious Purposes in Western Granada Province, Andalusia (Spain)." *Journal of Ethnopharmacology* 137, no. 3: 1113–23.

Bentham, Jeremy. [1789] 1907. *An Introduction to the Principles of Morals and Legislation.* Oxford: Clarendon Press.

Beisel, Uli. 2010. "Jumping Hurdles with Mosquitoes." *Environment and Planning D: Society and Space* 28, no. 1: 46–49.

Beisel, Uli, and Christophe Boete. 2013. "The Flying Public Health Tool: Genetically Modified Mosquitoes and Malaria Control." *Science as Culture* 22, no. 1: 38–60, doi: 10.1080/09505431.2013.776364.

Biersack, Aletta. 1999. "The Mount Kare Python and His Gold: Totemism and Ecology in the Papua New Guinea Highlands." *American Anthropologist* 101, no. 1: 68–87.

Blue, Gwendolyn and Melanie Rock. 2011. "Trans-Biopolitics: Complexity in Interspecies Relations." *Health* 15, no. 4: 353–368.

Briggs, Charles, and Mark Nichter. 2009. "Biocommunicability and the Biopolitics of Pandemic Threats." *Medical Anthropology* 28, no. 3: 189–98.

Caduff, Carlo. 2012. "The Semiotics of Security: Infectious Disease Research and the Biopolitics of Informational Bodies in the United States." *Cultural Anthropology* 27, no. 2: 333–57.

Carter, Eric. 2007. "Development Narratives and the Uses of Ecology: Malaria Control in Northwest Argentina: 1890-1940." *Journal of Historical Geography* 33, no. 3: 619–50.

Carter, Eric. 2008. "State Visions, Landscape, and Disease: Discovering Malaria in Argentina, 1890–1920." *Geoforum* 39, no. 1: 278–93.

Carter, Eric. 2012. *Enemy in the Blood: Malaria, Environment, and Development in Argentina.* Tuscaloosa: University of Alabama Press.

Chapman, Colin, Thomas Gillespie, and Tony Goldberg. 2005. "Primates and the Ecology of their Infectious Diseases: How Will Anthropogenic Change Affect Host Parasite Interactions?" *Evolutionary Anthropology* 14: 134–44.

Cueto, Marcos. 2007. *The Value of Health: A History of the Pan American Health Organization.* Rochester, NY: University of Rochester Press.

Daszak, Peter. 2006. "Risky Behavior in the Ebola Zone." *Animal Conservation* 9, no. 4: 366–67.

Daszak, Peter, Andrew Cunningham, and A. D. Hyatt. 2001. "Anthropogenic Environmental Changes and the Emergence of Infectious Diseases in Wildlife." *Acta Tropica* 78, no. 2: 103–16.

Davies, Gail. 2012. "What Is a Humanized Mouse? Remaking the Species and Spaces of Translational Medicine." *Body and Society* 18, nos. 3–4: 126–55.

Davis, Mike. 2005. *The Monster at Our Door: The Global Threat of Avian Flu.* New York: New Press.
Deleuze, Gilles, and Felix Guattari. 1987. *A Thousand Plateaus: Capitalism and Schizophrenia.* Minneapolis: University of Minnesota Press.
Diamond, Jared. 1997. *Guns, Germs, and Steel: The Fates of Human Societies.* New York: Norton.
Dobson, Michael, Maureen Malowany, and Robert W. Snow. 2000. "Malaria Control in East Africa: the Kampala Conference and the Pare-Taveta Scheme: A Meeting of Common and High Ground." *Parassitologia* 42, nos. 1–2: 149–66.
Endy, Timothy P., Scott Weaver, and Kathryn Hanley. 2010. "Dengue Virus: Past, Present and Future." Pp. 3–12 in *Frontiers in Dengue Virus Research,* ed. K. Hanley and S. Weaver. Norfolk, UK: Caister Academic Press.
Espinosa, Mariola. 2009. *Epidemic Invasions: Yellow Fever and the Limits of Cuban Independence, 1878–1930.* Chicago: University of Chicago Press.
Evans-Pritchard, E. E. [1940]1969. *The Nuer.* Oxford: Oxford University Press.
Farmer, Paul. 1999. *Infections and Inequalities: The Modern Plagues.* Berkeley: University of California Press.
Fassin, Didier. 2009. "Another Politics of Life Is Possible." *Theory, Culture and Society* 26, no. 5: 44–60.
Feng, Ybin, Kayu Siu, Ning Wang, Kwan-Ming-Ng, Sai-Wah Tsao, Tadashi Nagamatsu, and Yao Tong. 2008. "Bear Bile—Dilemma of Traditional Medicinal Use and Animal Protection." *Journal of Ethnobiology and Ethnomedicine* 5: 2, doi: 10.1186/1746-4269-5-2.
Foucault, Michel. 1990. *The History of Sexuality: An Introduction.* New York: Vintage Books.
Franklin, Sarah. 2007. *Dolly Mixtures: The Remaking of Genealogy.* Durham, NC: Duke University Press.
Garrett, Laurie. 1995. *The Coming Plague: Newly Emerging Diseases in a World Out of Balance.* New York: Penguin.
Goldberg, Tony, Thomas R. Gillespie, Innocent B. Rwego, Elizabeth L. Estoff, and Colin A. Chapman. 2008. "Forest Fragmentation as Cause of Bacterial Transmission among Nonhuman Primates, Humans, and Livestock, Uganda." *Emerging Infectious Diseases* 13, no. 9: 1375–82.
Goldman, M. 2007. "Tracking Wildebeest, Locating Knowledge: Maasai and Conservation Biology Understandings of Wildebeest Behavior in Northern Tanzania." *Environment and Planning D* 25, no. 2: 307–31.
Gordon, Jeffrey. 2012. "Honor Thy Gut Symbionts Redux." *Science* 336: 1251–53.
Grandin, Temple. 1995. *Thinking in Pictures, and Other Reports from My Life with Autism.* New York: Random House.
Hacking, Ian. 1991. "How Should We Do the History of Statistics?" Pp. 181–97 in *The Foucault Effect: Studies in Governmentality,* ed. G. Burchell, C. Gordon, and P. Miller. Chicago: University of Chicago Press.
Haraway, Donna. 1997. *Modest_witness@Second_Millenium_Female_Man_Meets_Oncomouse™: Feminism and Technoscience.* New York: Routledge.
Haraway, Donna. 2008. *When Species Meet.* Minneapolis: University of Minnesota Press.
Hayden, Cori. 2003. *When Nature Goes Public: The Making and Unmaking of Bioprospecting in Mexico.* Princeton, NJ: Princeton University Press.
Helmreich, Stefan. 2009. *Alien Ocean: Anthropological Voyages in Microbial Seas.* Berkeley: University of California Press.
Hinchliffe, Steve, John Allen, Stephanie Lavau, Nick Bingham, and Simon Carter. 2012. "Biosecurity and the Topologies of Infected Life: From Borderlines to Borderlands" *Transactions of the Institute of British Geographers.* http://dx.doi.org/10.1111/j.1475-5661.2012.00538.x (accessed 11 January 2013).
Hinchliffe, Steve, and Nick Bingham. 2008. "People, Animals, and Biosecurity in and Through Cities." Pp. 214–27 in *Networked Disease: Emerging Infections in the Global City,* eds. S. Ali and R. Kiel. Malden, MA: Wiley-Blackwell.
Hird, Myra. 2009. *The Origins of Sociable Life: Human Evolution after Science Studies.* Houndsmills, Basingstoke: Palgrave.
Ingold, Tim. 2011. *Being Alive: Essays on Movement, Knowledge, and Description.* New York: Routledge.

Janes, Craig, Kitty Corbett, James Jones, and James Trostle. 2012. "Emerging Infectious Diseases: The Role of the Social Sciences." *Lancet* 380, no. 9857: 1884–86.
Keck, Frédéric. 2008. "From Mad Cow Disease to Bird Flu: Transformations of Food Safety in France." Pp. 195–226 in *Biosecurity Interventions: Global Health and Security in Question,* ed. A. Lakoff and S. Collier. New York: Columbia University Press.
Kelly, Ann. 2011. "Will He Be There? Mediating Malaria, Immobilizing Science." *Journal of Cultural Economy* 4, no. 1: 65–79.
Kelly, Ann. 2012. "The Experimental Hut: Hosting Vectors." *Journal of the Royal Anthropological Institute* (N.S.): S145–S160.
Kikuchi, Ryonosuke. 2012. "Captive Bears in Human-Animal Welfare Conflict: A Case Study of Bile Extraction on Asia's Bear Farms." *Journal of Agricultural and Environmental Ethics* 25, no. 1: 55–77.
King, Nicholas. 2002. "Security, Disease, Commerce: Ideologies of Post-Colonial Global Health." *Social Studies of Science* 35, no. 5–6: 763–89.
Kinkela, David. 2011. *DDT and the American Century: Global Health, Environmental Politics, and the Pesticide that Changed the World.* Chapel Hill, NC: University of North Carolina Press.
Kirksey, Eben, and Stefan Helmreich. 2010. "The Emergence of Multispecies Ethnography." *Cultural Anthropology* 25, no. 4: 545–76.
Kleinman, Arthur. 1988. *The Illness Narratives: Suffering, Healing and the Human Condition.* New York: Basic Books.
Kottak, Conrad. 1999. "The New Ecological Anthropology." *American Anthropologist* 101, no. 1: 23–25.
Krieger, Nancy, ed. 2005. *Embodying Inequality: Epidemiologic Perspectives.* Amityville, MA: Baywood.
Lakoff, Andrew. 2008. "The Generic Biothreat, or, How We Became Unprepared." *Cultural Anthropology* 23, no. 3: 399–428.
Lakoff, Andrew. 2010. "Two Regimes of Global Health." *Humanity* 1, no. 1: 59–79.
Lakoff, Andrew, and Stephen Collier. 2008. "The Problem of Securing Health." Pp. 7–33 in, *Biosecurity Interventions: Global Health and Security in Question,* ed. A. Lakoff and S. Collier. New York: Columbia University Press.
Latour, Bruno. 1988. *The Pasteurization of France.* Trans. Alan Sheridan and John Law. Cambridge, MA: Harvard University Press.
Law, John. 2006. "Disaster in Agriculture: or Foot and Mouth Mobilities." *Environment and Planning A* 38, no. 2: 227–39.
Law, John, and Annemarie Mol. 2008. "Globalization in Practice: On the Politics of Boiling Pigswill." *Geoforum* 39, no. 1: 133–43.
Livingston, Julie, and Jasbir Puar. 2011. "Interspecies." *Social Text* 29, no. 1: 3–14.
Lowe, Celia. 2006. *Wild Profusion: Biodiversity Conservation in an Indonesian Archipelago.* Princeton, NJ: Princeton University Press.
Lowe, Celia. 2010. "Viral Clouds: Becoming H5N1 in Indonesia." *Cultural Anthropology* 25, no. 4: 625–649.
Mahawar, Madan, and D. P. Jaroli. 2008. "Traditional Zootherapeutic Studies in India: A Review." *Journal of Ethnobiology and Ethnomedicine* 4: 17, doi:10.1186/1746-4269-4-17.
McNeill, J. R. 1999. "Epidemics, Environment, and Empire: Yellow Fever and Geopolitics in the American Tropics, 1620–1825." *Environment and History* 5, no. 2: 175–84.
McNeill, J.R. 2010. *Mosquito Empires: Ecology and War in the Greater Caribbean, 1640–1914.* New York: Cambridge University Press.
McNeill, William. 1976. *Plagues and Peoples.* New York: Anchor Books.
Mitchell, Timothy. 2002. *Rule of Experts: Egypt, Techno-Politics, Modernity.* Berkeley: University of California Press.
Nadasdy, Paul. 2007. "The Gift in the Animal: The Ontology of Hunting and Human-Animal Relations." *American Ethnologist* 34, no. 1: 25–43.
Nading, Alex. 2012. "'Dengue Mosquitoes are Single Mothers': Biopolitics Meets Ecological Aesthetics in Nicaraguan Community Health Work." *Cultural Anthropology* 27, no. 4: 572–96.
Nading, Alex. 2013. "'Love Isn't There in Your Stomach': A Moral Economy of Medical Citizenship among Nicaraguan Community Health Workers." *Medical Anthropology Quarterly* 27, no. 1: 84–102.

Nading, Alex. 2011. "Chimeric Globalism: Embodying Public Health Science in the Shadow of the Dengue Vaccine." Paper presented at the Society for Social Studies of Science (4S) Annual Meeting, Cleveland, OH, 5 November 5.

Nahar, Nazmun, Rebeca Sultana, Emily S. Gurley, M. Jahangir Hussain, and Stephen P. Luby. 2010. "Date Palm Sap Collection: Exploring Opportunities to Prevent Nipah Transmission." *Ecohealth* 7, no. 2: 196–203.

Ogden, Laura. 2011. *Swamplife: People, Gators, and Mangroves Entangled in the Everglades.* Minneapolis: University of Minnesota Press.

Packard, Randall. 2007. *The Making of a Tropical Disease: A Short History of Malaria.* Baltimore: Johns Hopkins University Press.

Parkes, Margot, Leslie Bienen, Jamie Breilh, Lee-Nah Hsu, Marion McDonald, Jonathan Patz, Joshua P. Rosnthal, Mazuara Sahani, Adrian Sleigh, David Waltner-Toews, and Annalee Yassi. 2005. "All Hands on Deck: Transdisciplinary Approaches to Emerging Infectious Disease." *Ecohealth* 2, no. 4: 258–72.

Parsons, Talcott. 1951. "Illness and the Role of the Physician: A Sociological Perspective." *American Journal of Orthopsychiatry* 21, no. 3: 452–60.

Patz, Jonathan, Peter Daszak, Gary M. Tabor, A. Alonso Aguirre, Mary Pearl, Jon Epstein, Nathan Wolfe, A. Marm Kilpatrick, Johannes Foufopolous, David Molyneux, David Bradley, and Members of the Working Group on Land Use Change Disease Emergence. 2004. "Unhealthy Landscapes: Policy Recommendations on Land Use Change and Infectious Disease Emergence." *Environmental Health Perspectives* 112, no. 10: 1092–98.

Paxson, Heather. 2008. "Post-Pasteurian Cultures: The Microbiopolitics of Raw Milk Cheese in the United States." *Cultural Anthropology* 23, no. 1: 15–47.

Porter, Natalie. 2012. "Risky Zoographies: The Limits of Place in Avian Influenza Management." *Environmental Humanities* 1, no. 1: 103–21.

Porter, Natalie. 2013. "Bird Flu Biopower: Strategies for Multispecies Coexistence in Viet Nam." *American Ethnologist* 40, no. 1: 132–48, doi10.1111/amet.12010

Preston, Richard. 1995. *The Hot Zone*: *A Terrifying True Story.* New York: Anchor.

Quammen, David. 2012. *Spillover: Animal Infections and the Next Human Pandemic.* New York: Norton.

Rabinow, Paul, and Nikolas Rose. 2006. "Biopower Today." *Biosocieties* 1, no. 1: 195–217.

Raffles, Hugh. 2010. *Insectopedia.* New York: Vintage Books.

Rappaport, Roy. [1968] 1984. *Pigs for the Ancestors: Ritual in the Ecology of a New Guinea People.* New Haven, CT: Yale University Press.

Redfield, Peter. 2012. "Bioexpectations: Life Technologies as Humanitarian Goods." *Public Culture* 24, no. 1: 157–84.

Ritvo, Harriet. 2004. "Animal Planet." *Environmental History* 9, no. 2: 204–20.

Rivers, W. H. R. 1926 "Massage in Melanesia." Pp. 57–61 in *Psychology and Ethnology.* New York: Harcourt Brace.

Robbins, Paul, and Jacob Miller. 2013. "The Mosquito State: How Technology, Capital, and State Practice Mediate the Ecologies of Public Health." Pp. 196–215 in *Ecologies and Politics of Health,* ed. B. King and K. Crews. New York: Routledge.

Rock, Melanie, Bonnie Buntain, Jennifer Hatfield, and Benedikt Hallgrímsson. 2009. "Animal-Human Connections, 'One Health,' and the Syndemic Approach to Prevention." *Social Science and Medicine* 68, no. 6: 991–95.

Rose, Nikolas. 2007. *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century.* Princeton, NJ: Princeton University Press.

Sagan, Dorion. 2011. "The Human Is More Than Human: Interspecies Communities and the New 'Facts of Life.'" Paper presented at the American Anthropological Association Meeting, Montreal, QC, November.

Salyer, Stephanie, Thomas R. Gillespie, Innocent B. Rwego, Colin A. Chapman, and Tony L. Goldberg. 2012. "Epidemiology and Molecular Relationships of Cryptosporidium spp. in People, Primates, and Livestock from Western Uganda." *PLoS Neglected Tropical Diseases* 6: e1597.

Sapolsky, Robert. 2004. "Social Status and Health in Humans and Other Animals." *Annual Review of Anthropology* 33: 393–418.
Sawyer, Suzana, and Arun Agrawal. 2000. "Environmental Orientalisms." *Cultural Critique* 45: 71–108.
Scoones, Ian. 2000. "New Ecology and the Social Sciences: What Prospects for a Fruitful Engagement?" *Annual Review of Anthropology* 28: 479–507.
Shaw, Ian, Paul Robbins, and John Paul Jones. 2010. "A Bug's Life and the Spatial Ontologies of Mosquito Management." *Annals of the Association of American Geographers* 100, no. 2: 373–92.
Shukin, Nicole. 2009. *Animal Capital: Rendering Life in Biopolitical Times.* Minneapolis: University of Minnesota Press.
Sillitoe, Paul. 2002. "Contested Knowledge, Contingent Classification: Animals in the Highlands of Papua New Guinea." *American Anthropologist* 104, no. 4: 1162–71.
Solomon, Olga. 2012. "Doing, Being, and Becoming: The Sociality of Children with Autism in Activities with Therapy Dogs and Other People." *Cambridge Anthropology* 30, no. 1: 109–26.
Specter, Michael. 2010. "The Doomsday Strain." *New Yorker,* 20 December, 50–63.
Stephenson, Niamh. 2011. "Emerging Infectious Disease/Emerging Forms of Biological Sovereignty." *Science, Technology, and Human Values* 36, no. 5: 616–37.
Sunder Rajan, Kaushik, ed. 2012. *Lively Capital: Biotechnologies, Ethics, and Governance in Global Markets.* Durham, NC: Duke University Press.
Sutter, Paul. 2007. "Nature's Agents or Agents of Empire? Entomological Workers and Environmental Change during the Construction of the Panama Canal." *Isis* 98: 724–54.
Tilley, Helen. 2004. "Ecologies of Complexity: Tropical Environments, African Trypanosomiasis, and the Science of Disease Control Strategies in British Colonial Africa, 1900–1940." *Osiris* 19: 79–92.
Vayda, Andrew, and Bonnie Mccay. 1975. "New Directions in Ecology and Ecological Anthropology." *Annual Review of Anthropology* 4: 293–306.
Waldstein, Anna, and Cameron Adams. 2006. "The Interface between Medical Anthropology and Medical Ethnobiology." *Journal of the Royal Anthropological Institute* 12: S95–S118.
Waltner-Toews, David. 2007. *The Chickens Fight Back: Pandemic Panics and Deadly Diseases that Jump from Animals to Humans.* Vancouver: Greystone Books.
West, Paige. 2006. *Conservation is Our Government Now: The Politics of Ecology in Papua New Guinea.* Durham, NC: Duke University Press.
West, Paige, and Daniel Brockington. 2006. "Some Unexpected Consequences of Protected Areas: An Anthropological Perspective." *Conservation Biology* 20, no. 3: 609–16.
White, Melissa. 2012. "Viral/Species/Crossing: Border Panics and Zoonotic Vulnerabilities." *Women's Studies Quarterly* 40, nos. 1–2: 117–37.
Whiteford, Linda. 1997. "The Ethnoecology of Dengue Fever." *Medical Anthropology Quarterly* 11, no. 2: 202–23.
Wilcox, Bruce, and Rita Colwell. 2005. "Emerging and Reemerging Infectious Diseases: Biocomplexity as an Interdisciplinary Paradigm." *EcoHealth* 2, no. 4: 244–57.
Wolfe, Cary. 2008. "Learning from Temple Grandin, or, Animal Studies, Disability Studies and Who Comes after the Subject." *New Formations* 64: 110–23.
Wolfe, Nathan. 2011. *The Viral Storm: The Dawn of a New Pandemic Age.* New York: Times Books.
Wolfe, Nathan, Peter Daszak, Marm Kilpatrick, and Donald Burke. 2005. "Bushmeat Hunting, Deforestation, and Prediction of Zoonotic Disease." *Emerging Infectious Diseases.* http://dx.doi.org/10.3201/eid1112.040789 (accessed 9 January 2013).
Wolfe, Nathan, Claire Dunavan, and Jared Diamond. 2007. "Origins of Major Human Infectious Diseases." *Nature* 447: 279–83, doi:10.1038/nature05775.
World Health Organization. 2013. "Zoonoses and Veterinary Public Health." http://www.who.int/zoonoses/en/ (accessed 9 January 2013).