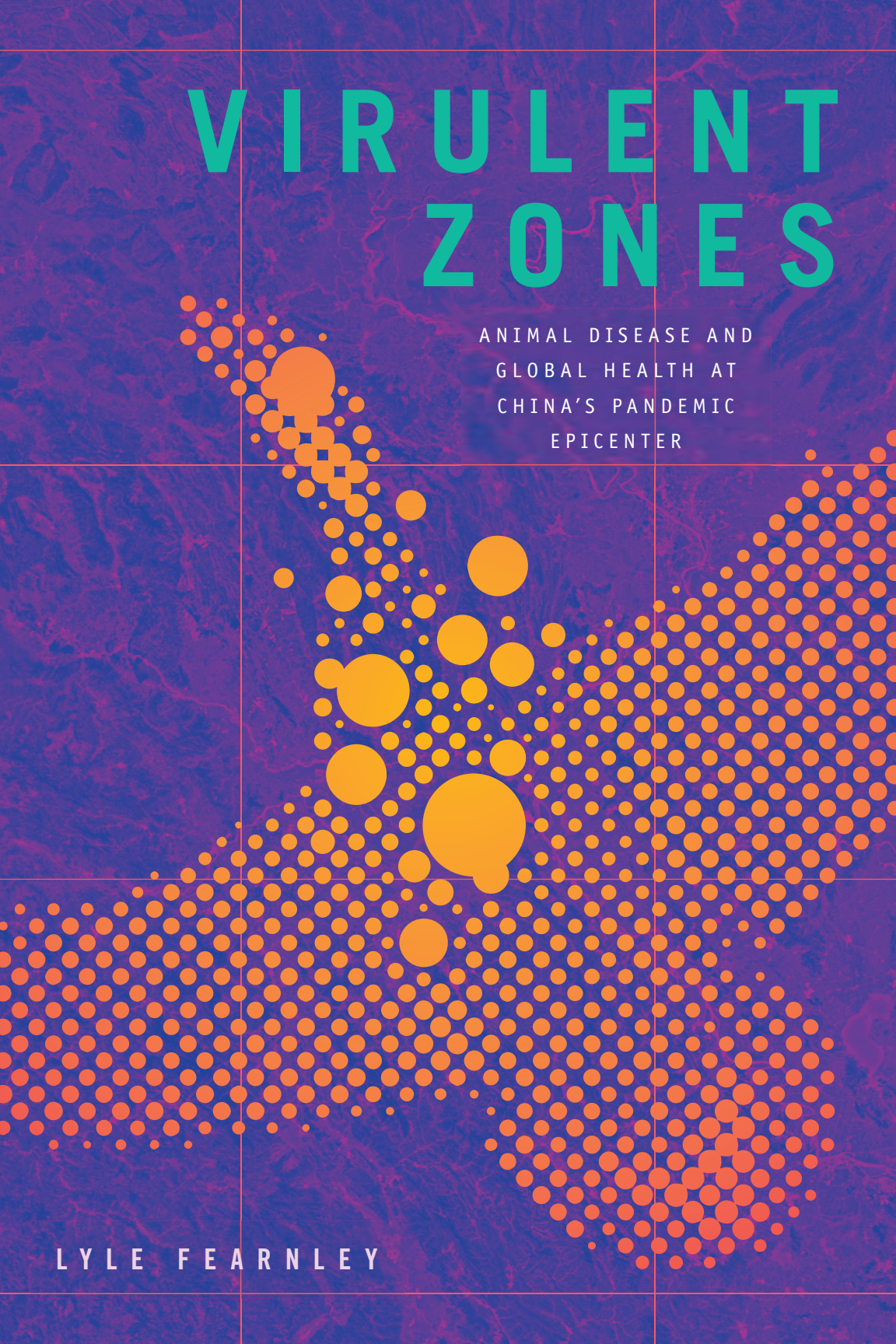
VIRULENT ZONES
ANIMAL DISEASE AND GLOBAL HEALTH AT CHINA'S PANDEMIC EPICENTER
LYLE FEARNLEY

VIRULENT ZONES

EXPERIMENTAL FUTURES: TECHNOLOGICAL LIVES, SCIENTIFIC ARTS, ANTHROPOLOGICAL VOICES

A series edited by Michael M. J. Fischer and Joseph Dumit

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Duke University Press · *Durham and London* · 2020

Printed in the United States of America on acid-free paper ∞
Designed by Aimee C. Harrison, Courtney Leigh Richardson,
Drew Sisk, and Matthew Tauch
Typeset in Portrait Text and Trade Gothic LT Std by
Westchester Publishing Services

Library of Congress Cataloging-in-Publication Data
Names: Fearnley, Lyle, author.
Title: Virulent zones : animal disease and global health at China's pandemic epicenter / Lyle Fearnley.
Other titles: Experimental futures.
Description: Durham : Duke University Press, 2020. | Series: Experimental futures | Includes bibliographical references and index.
Identifiers: LCCN 2019060213 (print) | LCCN 2019060214 (ebook)
ISBN 9781478009993 (hardcover)
ISBN 9781478011057 (paperback)
ISBN 9781478012580 (ebook)
Subjects: LCSH: Influenza—Research—China—Poyang Lake. | Viruses—Research—China—Poyang Lake. | Agriculture—Environmental aspects—China—Poyang Lake. | Animals as carriers of disease. | Zoonoses.
Classification: LCC RA644.I6 F44 2020 (print) | LCC RA644.I6 (ebook) | DDC 614.5/1809512222—dc23
LC record available at https://lccn.loc.gov/2019060213
LC ebook record available at https://lccn.loc.gov/2019060214

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ACKNOWLEDGMENTS

Like the scientific research on pandemic influenza that it follows, this book is the product of a journey filled with displacements.

The journey began in New York, where Stephen J. Collier introduced me to the anthropology of the contemporary. I was then fortunate to participate in discussions on biosecurity and preparedness that Stephen organized with Andrew Lakoff, along with Carlo Caduff and Frédéric Keck, which helped shape the research problems and questions I address here.

During my graduate studies at University of California, Berkeley, Paul Rabinow inspired every aspect of this project, particularly the vision of an anthropology that goes to the field not only to find something but also to make something, and remains open to displacements in unexpected directions. I am always grateful for the conceptual and ethical equipment.

At Berkeley this project developed under the influence of wonderful teachers, including Aihwa Ong, Liu Xin, Dorothy Porter, Vincanne Adams, Lawrence Cohen, and Massimo Mazzotti.

During my fieldwork I incurred incalculable debts to my interlocutors at the FAO, in Beijing, and around Poyang Lake. I am particularly grateful for the displacement of my research plans that followed from my early meetings with Vincent Martin at the FAO Emergency Center.

In the drafts through which this book slowly took shape, many people provided crucial insights and commentary. I am grateful to my fellow graduate students in the Department of Anthropology at Berkeley; my former colleagues at the History and Sociology of Science Cluster, Nanyang Technological University; and my current colleagues in Humanities, Arts, and Social Sciences at Singapore University of Technology and Design (SUTD). Nicholas Bartlett, Leticia Cesarino, Ruth Goldstein, Bruno Reinhardt, Anthony Stavrianakis, Hallam Stevens, Laurence Tessier, and Bharat Venkat read drafts both early and late. Emily Chua gave crucial comments and encouragement at many turning points. Warwick Anderson introduced a good number of edge effects to the manuscript from the borderlands of history and anthropology.

It was truly unexpected good fortune to meet Michael M. J. Fischer in Singapore, as he was hard at work cultivating anthropological STS in Asia. Mike provided detailed commentary on the draft manuscript and incredible support

for the project over the past several years. I am delighted to be included within the Experimental Futures series that he edits with Joe Dumit.

At Duke University Press, Ken Wissoker provided a sharp eye for synthesis and impeccable clarity during the process of review and revision. Joshua Tranen gave insightful and timely advice. Tim Stallman created the dynamic maps of the 1957 pandemic and Poyang Lake. The book also greatly benefited from the commentary of two anonymous reviewers, whom I would like to thank here.

I am grateful to the institutions that supported this project with grant funding. During my fieldwork in China, I was supported by a Fulbright-Hays Doctoral Dissertation Research Abroad Grant. During the writing of my dissertation, I was supported by a Chiang Ching-kuo Foundation Doctoral Fellowship. The writing of the book manuscript was supported by an SUTD Start-Up Research Grant.

Portions of chapter 3 were previously published as "After the Livestock Revolution: Free-Grazing Ducks and Influenza Uncertainties in South China," *Medicine Anthropology Theory* 5, no. 3 (2018): 72–98. Portions of chapter 4 were previously published as "Wild Goose Chase: The Displacement of Influenza Research in the Fields of Poyang Lake, China," *Cultural Anthropology* 30, no. 1 (2015): 12–35.

Most important of all, I have been inspired and sustained throughout by the vision, sincerity, and love of my parents, Marie and Neill; my brother, Will; and my three Es: Emily, Eliotte, and Edith.

INTRODUCTION

"Is China Ground Zero for the Next Pandemic?"
—*Smithsonian Magazine*, November 2017

With a striking persistence, scientific publications and mass media reports identify China as the possible source of future pandemics. The trope of origins gives the anticipation of future outbreaks a spatial form: suggesting that the seeds of the next pandemic already exist, perhaps hidden, waiting, somewhere in China.[1] The peculiar temporality of pandemic preparedness—focused on potential catastrophic outbreaks rather than already prevalent illness—is an important theme in critical discussions of global health.[2] But what are the spatial consequences of anticipation? How does pandemic preparedness transform the geography of global health research and intervention? And, in particular, how does preparedness differ in those regions of the world marked as sources of disease, instead of the countries that seek "self-protection" from foreign epidemic threats?[3]

To address these questions, this book provides an anthropological accompaniment to the scientific search for the origins of influenza pandemics in China. Adopting the narrative form of the journey or quest, I follow virologists, veterinarians, and wild-bird trackers into the farms and fields of the hypothetical source of flu pandemics. Yet this quest did not result in simple moments of scientific discovery or a definitive arrival at a point of origin. Instead, I show how China's landscapes of intensive livestock farming and state biopolitics created ecologies of influenza that exceeded global health models and assumptions,

forcing scientists to reconsider their objects, their experimental systems, and even their own expertise. The search for origins was constantly pushed to the outside, toward new questions about cause and context; knowledge changed when experiments moved along a vector of displacement.

The search for the origins of influenza pandemics is closely intertwined with the idea of world health and related plans for governance of disease across a global scale. After World War II, the newly formed World Health Organization (WHO) set up an international network of laboratories to monitor "the appearance and spread of influenza" across the planet. In 1957, tested for the first time by a new influenza strain, the WHO's World Influenza Programme traced the so-called Asian flu pandemic to an origin somewhere in China (see figure I.1). Chinese scientists later confirmed that the pandemic began in China, although because of cold war politics China was excluded from the United Nations—including UN agencies such as the WHO—during this period. Eleven years later, the WHO reported that the first cases of the Hong Kong pandemic were identified in refugees fleeing the Cultural Revolution for the British colonial city, again indexing a source in China. However, the WHO's identification of China as a point of origin for pandemic influenza viruses immediately opened new questions: How did the new virus appear? And why did it originate in China and not elsewhere?

In the early 1980s, Hong Kong University virologist Kennedy Shortridge answered that South China could be a "point of origin of influenza pandemics" because of the distinctive ecosystem created by "age-old" farming practices, animal husbandry systems, and wet-rice-paddy landscapes. Shortridge drew closely on laboratory studies, including his own, that suggested human influenza pandemics begin from an animal reservoir. Lab experiments showed, for example, that new strains of influenza could be artificially created by co-infecting a lab animal with two virus strains derived from distinct animal species (such as birds, pigs, or humans). Inside the animal host the two virus strains exchanged genetic material in a horizontal transfer known as reassortment, creating a wholly new strain. Transposing the laboratory model onto China's landscapes, Shortridge argued that South China's farms and fields provided plentiful opportunities for cross-species infections and, therefore, reassortment events: "The closeness between man and animals could provide an ecosystem for the interaction of their viruses." To capture this new ecological concept of pandemic origins, Shortridge called South China the "influenza epicentre."

Countries shown approximate 1958 boundaries. Site locations are approximate.

MAP I.1. The origin and spread of the 1957 influenza pandemic. Map by Tim Stallman, based on WHO's reconstruction of pandemic origin and spread.

Less than fifteen years later, Shortridge's epicenter hypothesis seemed to be coming true, though not exactly in the way anyone expected. In April 1997, the Hong Kong University laboratory isolated a novel strain of influenza from chickens after disease broke out on three poultry farms in the New Territories, close to the border with the People's Republic of China, sickening and killing thousands of birds. Using tests known as inhibition assays, lab workers identified the hemagglutinin (HA) and neuraminidase (NA) protein subtypes of the strain, enabling them to classify the virus as H5N1. Because H5 viruses are known to be highly pathogenic in domestic poultry, they immediately reported the results to the World Organization for Animal Health (OIE). But H5 viruses had never been isolated from humans or even any mammals, so the lab did not report the finding to the WHO.[4]

Then, in May, a three-year-old boy fell ill with what seemed to be a typical cold. After trips to the local doctor and community hospital did no good, he was admitted to the Queen Elizabeth Hospital in Kowloon. In the hospital's intensive-care unit, his breathing problems increased until, despite mechanical ventilation and antibiotic treatment, he died. Because of the severity of the case, a sample was taken from the boy's throat and sent to the Department of Health (DOH). The DOH identified influenza virus in the sample but could not identify the subtype with existing reagents in its lab. Instead, it sent the virus to the better-equipped WHO reference labs in London and Atlanta, as well as the laboratory of Jan de Jong at the Dutch National Institute of Public Health. Two months later, de Jong called the chief virologist in Hong Kong's Department of Health, Wilina Lim, and told her he was flying to Hong Kong. He had identified the sample as the first known human case of H5 influenza.[5]

As new human cases accumulated, laboratory tests conducted by Shortridge and other researchers showed that the chicken and human viruses were nearly identical. Challenging previous assumptions about interspecies viral transmissions, the virus had apparently jumped directly from birds to humans, probably amid the visceral interspecies exchanges of live-poultry markets. In interviews with the media, Shortridge reiterated his claim that "southern China is the influenza epicentre." News reports began to herald a threatening "bird flu" that could cause the next pandemic. The outbreak was a "pandemic warning," announced a team of virologists that included de Jong and Robert Webster.[6]

On December 27 the Hong Kong government ordered Leslie Sims, assistant director of agriculture quarantine, to kill and destroy all poultry in the territory. Vendors slaughtered chickens at wet markets and left them for government workers to collect in black garbage bags. On farms, government workers

gassed entire flocks in their sheds. When I spoke with him a few years later, Sims told me he "probably slept about twelve hours" during that week. He described to me the complex challenges of organizing his staff to go out and kill millions of chickens, especially when many of them, though working in a livestock department, had never even been to a poultry farm before. How to ensure they wore face masks and gloves at all times? Where to dispose of the entire poultry stock of Hong Kong? In total, they killed approximately 1.2 million chickens and 400,000 other birds. After the poultry massacre, no new human cases appeared. The rapid global response seemed to have contained an emerging disease at its point of origin, preventing a potential pandemic.

In fact, the H5N1 virus never disappeared. As Sims explained to me, "Virus continued to circulate in China all through from 1996 to 2004 and the absence of reports of disease does not reflect the true infection status. . . . It is clear from basic biology that disease must have been occurring in the mainland but for whatever reason was not being reported." In 2003 the H5N1 virus reemerged in Hong Kong, in a slightly different molecular form. This time, it quickly spread throughout Southeast Asia, striking Thailand, Vietnam, Cambodia, and Indonesia in quick succession. Later, the virus moved north and west, reaching Egypt and sub-Saharan Africa, Bangladesh, India, and Europe.

As fears of a pandemic grew, a new vision of global health "beyond the human" took shape. In January 2004 the WHO (historically focused on human health), the Food and Agriculture Organization (FAO, historically focused on food security), and the World Organization for Animal Health (OIE, historically focused on animal health) issued a joint statement calling for "broad collaboration" and appealing for international funds in response to the "unprecedented spread of avian influenza." Defining avian influenza as a "serious global threat to human health," the statement explained that if avian influenza "circulates long enough in humans and farm animals, there is increased risk that it may evolve into a pandemic influenza strain which could cause disease worldwide."[7] Within several years the FAO/WHO/OIE would together develop a new strategy for interagency collaboration based on the principle of "One World, One Health," which holds that human health and animal health are "intimately connected," particularly by the zoonotic diseases that spread chains of infection among wildlife, domestic animals, and humans. Proponents of One Health argue that this common vulnerability to disease requires a unified medical, scientific, and governmental response, going beyond the modern disciplinary "silos" of human and veterinary medicine.[8]

Despite the initiation of new interagency lines of communication, however, the WHO continued primarily to fund virus surveillance, vaccine development,

and preparedness planning. The FAO, on the other hand, put forward a completely new strategy to control the emerging virus "at source." In an appeal to funders, the FAO declared: "Control of highly pathogenic avian influenza (HPAI) at source means managing transmission of the virus where the disease occurs—in poultry, specifically free range chickens and in wetland dwelling ducks—and curbing HPAI occurrence in . . . Asia before other regions of the globe are affected."[9] In this adaptation of the search for origins, the FAO defined a "source" of pandemics as both a geographic region and a species reservoir, overlaying ecology on geography. With funding secured from donors, the FAO began to build new regional veterinary networks, redeploy staff members, fund scientific studies, and invent new institutional collaborations in Asia and in China. In order to understand and contain the source of emerging influenza viruses, global health moved into the epicenter.

ENTRY POINTS

I began to accompany this movement into the epicenter when I met Vincent Martin, a French livestock veterinarian and career official with the FAO, at the Beijing office of the FAO's newly formed Emergency Center for Transboundary Animal Diseases (ECTAD). Martin established the ECTAD China office (hereafter "the Emergency Center") in 2006 and remained its senior technical director during the main period of my fieldwork (2010–12).

The existence of the Emergency Center and its focus on "transboundary disease" reflected significant internal change within the FAO. "We are a very old, very slow organization," Martin told me, "but the bird flu really forced us to change some things." The FAO had been established after World War II, along with the UN and other agencies such as the WHO, with a special mandate to solve world hunger. Over the years the agency had shifted from provision of food aid toward technical assistance in agricultural development, including some work on disease outbreaks and pest emergencies. Martin himself had many years of experience with control of infectious animal diseases, but the FAO's concern had previously focused on diseases that posed a threat to food security, such as rinderpest or foot-and-mouth disease (FMD). The FAO was not an organization that typically came up in discussions of international or global health, or human pandemics.

After the reemergence of the HPAI H5N1 virus in 2003, all of this began to change. The FAO began to reposition animal health work as a crucial component of pandemic preparedness, a kind of cordon sanitaire at the boundaries of species. "Where animal disease poses a threat to human health," states an

FAO position paper, "FAO's role is to advise on the best methods to contain the disease at the level of animals, prevent its recurrence and undertake research to identify ways of eradicating the disease. . . . The current state of play is that avian influenza is an animal health issue and the focus must be on attacking the problem at source—in animals."[10]

Martin helped to draft the original concept note for the ECTAD system. By collecting information about disease outbreaks from around the world, ECTAD aimed to provide new analytics and advice to both the FAO and member states on emergency response and biosecurity intervention. Initially, ECTAD consisted of a handful of expert analysts based within the Rome headquarters of the FAO, which expanded to hundreds of staff as the avian influenza outbreak spread across the world. However, Martin and others soon ran into a problem: how to validate and interpret the information they collected. As one staff member explained, "We quickly reach the limit of our system. We need expertise in the corridor to recognise what is going on." Some countries offered detailed reports, but others only reported when "everyone already knows."[11]

In 2005 the FAO established the ECTAD Regional Office for Asia Pacific (ECTAD-RAP) in Bangkok. This office became a crucial base for conducting research on avian influenza in southeast Asia, which by that time had spread to Thailand, Cambodia, Laos, Vietnam, and Indonesia. But Martin was not satisfied by this regional presence. He began to travel to China to lobby for establishing an office in Beijing, finally getting approval from China's Ministry of Agriculture in 2008 after one year of meetings with government officials. As he later explained to me, he had been "pushing for having an ECTAD office also in China because I thought that it was meaningless to work in all the surrounding countries, trying to curb the spread of disease, while the epicenter—if we can say so—was in China in a way and it was not good just to have remote collaborations with them, but I thought it was also important to establish an office there." China "was also quite difficult to get in, to have such a close relationship . . . as we had with other countries," he acknowledged. Nevertheless, Martin's arrival in Beijing was the beginning, rather than culmination, of his global health diplomacy.

When I arrived in September 2010, I found the Emergency Center in a sleek high-rise tower on the edge of the Sanlitun diplomatic district, just beyond the East Gate of Beijing's ancient center city. After the formation of the People's Republic of China in 1949, the government had moved foreign embassies from the Legation Quarter, a small *hutong* alley with European-style buildings, to Sanlitun, outside the second ring road. Wide, tree-shaded streets are lined with buildings in a socialist modernist style of gray concrete terrazzo, housing

embassies, offices of international organizations, hotels, and residences. Armed military guards in green uniforms are stationed outside each embassy building, adding a subtle hint of contained violence to the peaceful streets. There are also many restaurants catering to expatriate clientele, popular bars and clubs, and tourist-oriented shopping areas such as the so-called Silk Market. Sanlitun is a cosmopolitan space but with a diplomatic cast, reflecting both opportunities of exchange and the sober political negotiations often needed for their enactment. Inside the Emergency Center on the fifteenth floor, the six-person national staff of Chinese veterinarians, statisticians, and program officers worked on desktop computers at cramped cubicles. In Martin's corner office, a large desk with a PC was juxtaposed with a bright red modernist couch. Floor-to-ceiling windows looked out over Old Beijing.

The location of the Emergency Center in Sanlitun reflected the complex international diplomacy that lay behind the movement of global health programs into the epicenter. Looming over everything Martin attempted in China was the recent controversy over China's management of the severe acute respiratory syndrome (SARS) outbreak. In late 2002 an "atypical" pneumonia caused by an unknown virus had spread across southern China's Guangdong Province. But China's government did not inform the World Health Organization of the outbreak until February 2003, after cases of disease had already spread to Vietnam, Hong Kong, and Singapore. Because of the government's continued reluctance to acknowledge the scale of the outbreak, China was widely described as a "global pariah." In response, the WHO announced an unprecedented advisory against travel to affected countries. According to international legal scholar David Fidler, the controversy over reporting led to a "governance revolution" that helped drive the transition from international to global public health. For the WHO and others, SARS demonstrated that control of emerging epidemics should be considered a form of "global public good" that exceeded sovereign state interests.[12]

The SARS crisis also drove a process of administrative and technical reform in China's public health sector. As Fidler has put it, "China was the epicenter of the SARS outbreak; thus, it was the governance epicenter."[13] Once the discrepancy between China's official reports and the actual scale of the epidemic became clear—notably after a whistle-blower, a Beijing military doctor, revealed the number of cases in Beijing hospitals to the international media—China's government reversed course, began cooperating closely with the WHO, built new SARS isolation hospitals, and directed mass campaigns for hygiene and health communication. In the summer of 2003 the outbreak was contained, and China was now considered a "global hero," in part because of

the "draconian techniques" used to control the disease.[14] In the aftermath of the outbreak, China realigned public health institutions with international standards of pandemic preparedness, including reconfiguring Mao-era anti-epidemic stations (*fangyizhan*) into Centers for Disease Control and Prevention (CDCs), based on an American model.[15]

Although China's public health sector was increasingly seen as a technically able and cooperative partner with global health agencies, Martin encountered a different set of challenges as he implemented the FAO's plan to control pandemic influenza "at source." Because avian flu primarily infected animals rather than people, epidemic response was largely managed by the Ministry of Agriculture, not Health. "HPAI was just like SARS," Martin complained to me, "but the Ministry of Agriculture hasn't changed." In 2005, for example, the WHO publicly issued a request for timely and comprehensive sharing of virus samples, noting that "from more than 30 reported outbreaks in animals in 2005, no viruses have been made available so far."[16] Much like Indonesia's more famous refusal to share influenza virus samples with the WHO, China continued to assert what Aihwa Ong calls its "national biosovereignty" against global health norms of transparency and sharing.[17]

The movement of experimental systems into the epicenter encountered the legacies of these disputes, leading to the displacement of research toward new forms of scientific communication and collaboration. "Veterinarians don't want to work with medical doctors, and Chinese scientists don't want to share viruses," Martin complained to me in the same breath at our first meeting at the Emergency Center. He described how an initial proposal to sample flu viruses at a lake in southern China was rejected by the ministry, requiring him to work for months to cultivate the right relationships with ministry officials before the proposal was eventually approved. Despite the optimism of the catchphrase "One World, One Health," the world was neither unified nor flat: the geopolitics of territorial sovereignty still governed the pathway to the pandemic epicenter.

The pandemic epicenter carved out a distinctive space where scientific experiments intersected geopolitical territories, reconfiguring knowledge and politics around an exceptional site. On the one hand, the scientific meaning and value of the epicenter were marked as global, because the epicenter was considered the source of pandemics that might spread across the world. On the other hand, the location of the epicenter was inherently singular, a point of origin, and this point was located within China's sovereign territory. The global urgency of pandemic preparedness could be compared to the interventions of humanitarian groups, in which a planetary humanity provides an

ethical imperative for constituting "spaces of exception" to the sovereign rule of nation-states.[18] However, the negotiations over access and exchange that I observed led me instead to consider the epicenter as a zone of "differentiated sovereignty," or what Michael Fischer has called a "switching point" between national politics and transnational knowledge circuits,[19] particularly when the objects that Martin and other scientists sought were not as easy to isolate, extract, and transport across borders as influenza viruses.

THE NONVIROLOGICAL

Scientific and popular accounts of the search for the origins of emerging pandemics—including influenza, SARS, HIV/AIDS, and Ebola—are typically narrated as epic tales of heroic virus hunters. In these stories, eccentric and obsessed experts travel to remote and obscure regions of developing nations, particularly sites at the "fringes of the nonhuman world," in order to sample viruses from wild animals, farmed livestock, or the local people. Dressed in full-body hazmat suits, they enter dark bat caves or dense poultry markets, risk bodily contamination, extract viruses, and contain outbreaks. The chaos of the pandemic epicenter, where abominable mixtures give birth to dangerous pathogens, is contrasted with the pure and clear space of the laboratory, where boundaries are preserved, objective knowledge is produced, and danger is controlled.[20]

But when I followed FAO scientists as they moved experimental systems into China in search of the origins of influenza pandemics, what I observed looked nothing like virus hunting. For as scientists got closer and closer to the hypothetical influenza epicenter, the purview of their search expanded in a centrifugal trajectory far beyond the influenza virus to encompass the bodies and behaviors of ducks, traditional techniques of duck husbandry, the geography of rice-paddy landscapes, wild-bird migration flyways, the socioeconomy of live-bird markets, and many other objects inscribed within the ever-widening circles of the ecology of influenza.[21] Rather than traveling to the epicenter in order to bring samples back to the lab, it seemed that scientists felt the need to turn aside and look around, tracing the circumstances and conditions of viral emergence. Their search for the influenza epicenter followed a double movement into China and beyond the scale of the virus, during which research objects shifted from the molecular structure of the virus toward wider zones of virulence.[22]

A few weeks after our first meeting, Martin invited me to a meeting of a United Nations interagency working group, "One Health in China," that

he had organized. The meeting took place in the WHO China offices, also in Sanlitun, and included participants from China CDC, China's State Forestry Administration, the Red Cross, and several embassies. In his opening remarks, Martin made an unusual turn of phrase that caught my attention. As he described the global spread of the H5N1 virus from China to Southeast Asia, Africa, and Europe and decried the failure of global institutions to control the outbreak, he pointed to the importance of "nonvirological factors" in the emergence of the H5N1 strain. Migrations of wildlife species, rapid population growth, and an explosion in livestock production, he argued, played crucial roles in the initial appearance and subsequent spread of the new influenza virus. I was struck by this idea of the nonvirological because the term implicitly indexed the predominance of virus-based research in pandemic preparedness. Yet the concept of the nonvirological did not substitute a different causal agent in place of viruses, but outlined a relational approach to viral agency, a virology of the in-between.[23] This concept directs scientific inquiry and global health intervention toward the specific environments of the influenza virus or, put another way, the viral habitat. Instead of studying the virus in the experimentally constructed milieu of the laboratory, Martin highlighted the importance of understanding the actual living environment of the virus in order to understand how, why, when, and where new diseases emerge.[24]

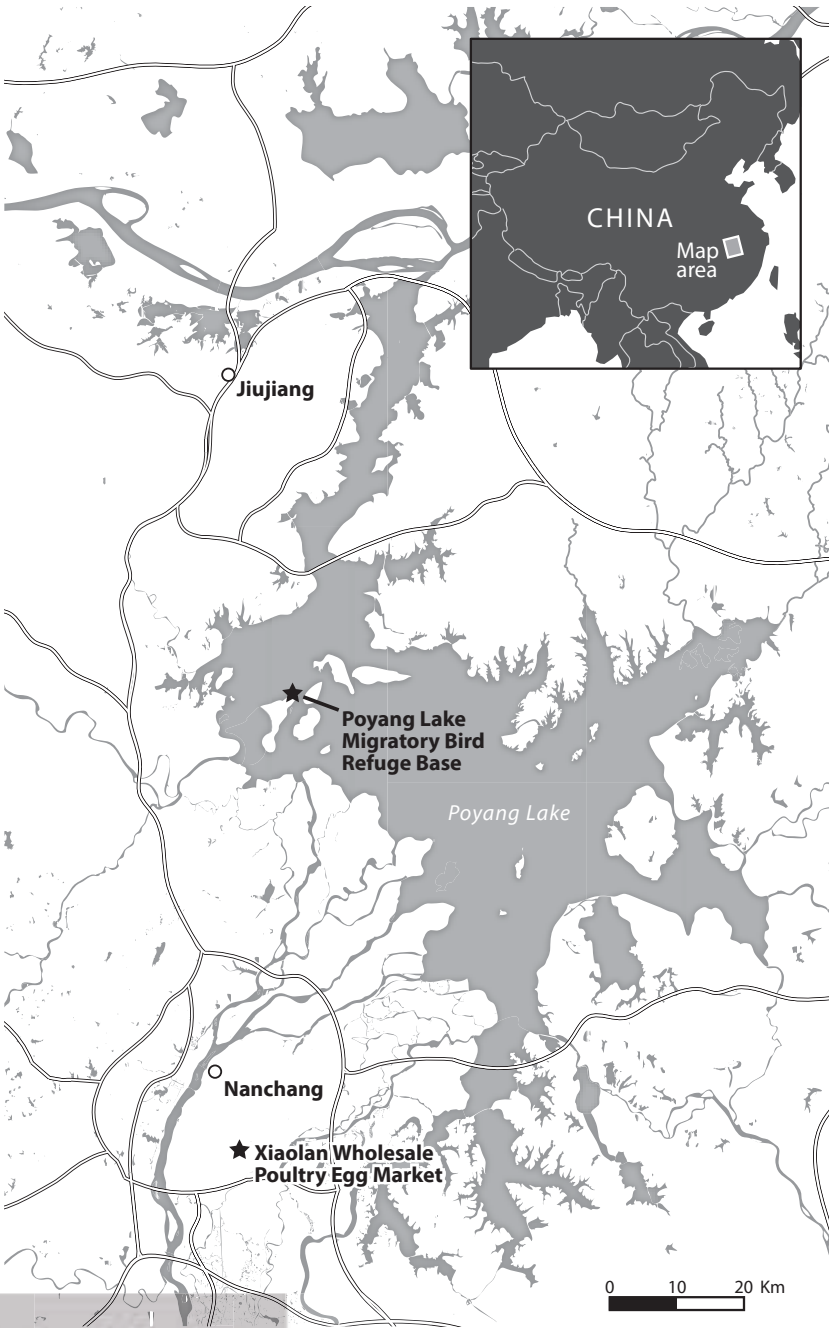
But where could this viral habitat be observed? How could the context of viral emergence be made into a scientific object? At our first meeting in his office, Martin had briefly mentioned the complex negotiations he had undertaken in order to conduct a field research trip at a place called Poyang Lake. I had never heard of the lake before, and I badly misspelled the name in my fieldnotes. Now, in his talk, he referred to Poyang Lake again, this time as an example of the nonvirological factors driving the emergence of influenza viruses. China's largest freshwater lake, Martin explained, is both an overwintering site for hundreds of thousands of migratory birds and a large-scale duck-producing region. With a bucolic photograph of white cranes landing near a duck farm projected behind him, Martin argued that the extensive interface between wild and domestic birds at Poyang Lake could promote the transmission of avian influenza viruses across species and therefore drive the emergence of new, more virulent strains. I soon realized that this was not the last I would hear of the birds at the lake. Over the next few months, almost everyone I met who was working on pandemic influenza in China mentioned Poyang Lake. "Poyang Lake is a perfect storm," warned Scott Newman, a wildlife biologist specializing in the health of migratory birds.

Martin later told me that just as he had begun working to establish the Emergency Center in China, he had read an article written by "Chinese scientists" that brought his attention to Poyang Lake. The main finding of the article reported the establishment of multiple sublineages, or substrains, of the H5N1 virus in southern China. In passing, though, the article also mentioned that the research team had isolated HPAI H5N1 viruses from six "apparently healthy" wild birds at Poyang Lake. Linking the finding with the influenza epicenter hypothesis, the researchers suggested that the birds could be long-distance vectors transporting viruses out of China. And if wild birds were vectors radiating new influenza viruses out of China, Martin knew, Poyang Lake could be a pandemic epicenter.

In the spring of 2006, Martin visited China to make the case for establishing an Emergency Center, and in his presentation he "talked a lot about the Poyang Lake and the potential interest we had in conducting research." By 2010, the Emergency Center already supported a broad range of research initiatives at Poyang Lake, including viral sampling, wild bird tracking, poultry surveys, free-grazing duck movement studies, and satellite image analysis of land use. I was especially interested to hear that many of the scientists traveled to Poyang Lake to conduct these studies. At the lake they captured and tagged wild birds with satellite transponders, counted chicken farms, and measured rice fields. They spoke of Poyang Lake as a fully developed experimental field or, as one ecological modeler put it, as a "geographical unit where we have a critical mass of data to address a question in a new way."[25] The pandemic epicenter was no longer the distant object or objective of a search for the origins of pandemics. It was also becoming the site and venue where that search was conducted. When the chance came, I went, too.

EMBANKMENTS AND INTERFACES

The twenty-seat bus bounced over a high levee and dipped sharply down, following a rough dirt road across bright green wetlands before bounding up another embankment and into Wucheng, a small town on a island in Poyang Lake. Spilling below the south bank of the Yangtze River about halfway between the Three Gorges Dam and the sea at Shanghai, Poyang Lake is China's largest freshwater lake (see figure I.2). Or at least it is during the rainy season. In the wet, summer months, when the lake's vast catchment area swells with rain and the Yangtze rises, the high river pushes water back into the Poyang basin, sometimes causing dangerous floods. But in the winter, when the Yangtze drops, water in the lake ebbs away, exposing vast grasslands in its wake.



MAP I.2. Map of Poyang Lake. I conducted most of my fieldwork in the intensive rice- and duck-farming counties between Nanchang and the lake. Map by Tim Stallman.

Through these complex hydraulics, the depth of the lake fluctuates as much as fifteen meters, and the surface area covered by water during the flood doubles that of the dry season. The dirt road that my bus followed to cross the wetlands, built several years earlier, is passable only during the dry season. In the wet season, Wucheng is an island.

The lake's peculiar expansion and retraction support a distinctive ecosystem. When the water retreats in late autumn, an enormous green meadow slowly emerges, filled with the exposed roots of water plants and the young shoots of wetland grasses. By November, these green fields attract the eyes of migratory birds flying south from breeding grounds in Mongolia and Siberia. According to estimates, more than 350,000 birds from 105 species overwinter at the lake, including the critically endangered snow crane (*Grus leucogeranus*).[26] Since ancient times, the lake has been a famous site for poetry and landscape painting, often featuring images of soaring wild birds and rising mist. More recently, government decree designated a section of the lake as one of China's first wild-bird refuges and placed the refuge headquarters—including offices, a museum, and a hotel—in Wucheng.

But the lake region is also a "working landscape," a place where centuries of land reclamation and irrigation works have rerouted flows of water and farming systems have transformed ecological communities of plants and animals.[27] Some of the earliest archaeological evidence of rice cultivation in the world comes from sites near the lake, and integrated rice–duck farming dates back centuries. In the 1950s and 1960s, rural residents built enormous embankments during mass mobilization campaigns, reclaiming agricultural land and constructing new irrigation networks.[28] More recently, Poyang Lake has also been caught up in China's "livestock revolution," a term introduced by FAO analysts to describe the growth and intensification of animal production across the developing world. Much like the earlier Green Revolution, modern strategies of technology transfer—including hybrid breeds, manufactured animal feeds, and pharmaceuticals—have begun to disembed livestock farming from environmental constraints, driving intensification of production and enormous growth in outputs.[29]

In both quantitative and qualitative terms, China's livestock sector is perhaps the most dramatic instance of revolutionary change, in part because China's livestock revolution coincided with the country's shift from a planned to a market economy. After the Communist Revolution in 1949, the government organized rural households into production brigades and communes, and smallholder market farming more or less disappeared. Along with rice fields, the commune took over the raising of draft animals and livestock, including

pigs and poultry.[30] During political campaigns such as the Cultural Revolution, the state even "forced through reductions in the size of private plots [and] implemented very strict limits on the number of ducks and chicken farmers could raise," according to historian Jonathan Unger.[31] But in 1978, China's political leadership outlined a policy of "reform and opening up" to the planned economy. In rural areas, collective farming was ended and the use rights for cultivation of land distributed to individual households. The state also legalized rural markets, which began to supplant the centralized state procurement system. Poultry was among the first rural products opened up for market trade, along with fish.[32] According to FAO statistics, annual production of meat chickens grew from around 600 million in 1970 to almost 10 billion in 2017, while duck production increased almost fifteenfold, from 150 million to 2.25 billion during the same period. China now accounts for roughly three-fourths of ducks produced in the entire world (see figures I.1 and I.2).[33]

The impact was soon felt at Poyang Lake. In the early 1980s, Jiangxi Province designated the lake region as a "production base" for rice and commercial waterfowl. As villages disbanded collectively farmed land and distributed land-use rights to households, many farmers turned to noncrop activities, such as fish or duck raising. From 1978 to 1998, livestock and fish farming grew from around 10 percent to nearly half of agricultural production in the lake region (by value), and this while overall farm production itself increased tenfold.[34] According to recent data collected from agricultural yearbooks, there are more than fourteen million ducks raised around the lake today—almost half as many as in the entire United States.[35]

When the bus pulled into Wucheng, I walked out of town and along one of the many roads that run atop the embankments. I marveled at these twisting earthwork lines that separate wetlands from gridded rice fields, wild from domestic space. Yet I knew that for influenza scientists, these peaceful embankments could also be understood as dangerous interfaces where wild and domestic birds interact and viruses spread. As Diann Prosser, a wildlife scientist from the U.S. Geological Survey and an FAO research collaborator, has described it, Poyang Lake is a "mixing bowl of people and wildlife and birds." When a virus is transmitted from wild to domestic birds, as Prosser explains, it can reassort or mutate and gain virulence; if the new virus is transmitted back to wild birds, they may "carry it thousands of miles away," seeding a global pandemic.[36]

At the end of the road I found the gated entrance to the Poyang Lake Migratory Bird Refuge. On my first visit to the refuge a few months earlier, Yu, the wiry and gregarious army man who both ran the hotel and led inspections against poaching, insisted on bringing me to see the stuffed rare-bird museum and then

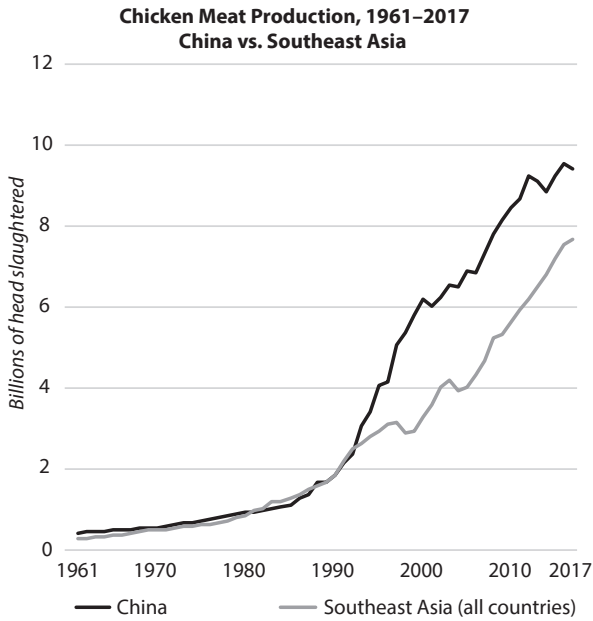


FIGURE I.1. China's livestock revolution in poultry. Graph by Tim Stallman

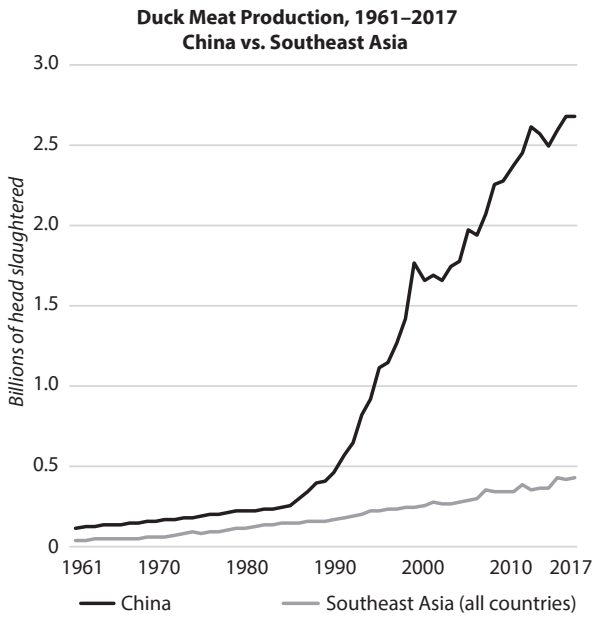


FIGURE I.2. Duck-meat production grew even faster. Graph by Tim Stallman.

out to the refuge to catch a last sight of the migratory birds before they flew north. This time, however, I told him I wanted to see the birds on the other side of the embankment: Poyang Lake's duck farms. The next day we woke up early and, after a quick breakfast in town, Yu drove the white refuge van out along the road back to the mainland, crossing the low passage across the lake. Reaching the end of the lake-bed crossing, Yu drove up the embankment and took a hard right so that we were now driving along the embankment. Pointing out of the driver's-side window, Yu explained that the refuge's core zone was on our right, where only scientific and touristic activities are allowed, and wetlands stretched as far as the eye could see. On the left of the embankment a checkerboard of rice fields and small homes indicated a nearby village within the Experimental Zone, where some economic and production activities could take place.

As we followed the embankment around, a flock of white farmed ducks appeared in a patch of water to our right, swimming inside the boundary of the protected core zone. Immediately ahead of us, I saw two small tents perched on the embankment, and Yu stopped the van so we could get out. Inside one of the tents, on a small raised platform, sat Tang, who greeted us and joined us in the shade of the van to chat. Tang explained he was not the boss who owns these ducks, but a hired technician. The boss, Tang said, had bought about five thousand ducklings, but something like five hundred or more had died from disease. Lacking experience and knowledge of duck diseases, he had hired Tang to take care of the birds. On that particular day, Tang had sent the boss into Nanchang, the provincial capital, to buy medicines.

Tang told me he had raised ducks for over thirty years, first in his home province of Anhui and then in Jiangxi, where he moved when he was twenty-two. I asked him about what had changed about duck raising over the past three decades. He said the biggest change is that back then there weren't so many diseases. Nowadays you really have to raise the birds well, or else they will get sick and die. The problem is pollution. The challenge is that there's no space for duck raising.

Indeed, throughout the Poyang Lake region, the density of duck raising is remarkable. In some villages, nearly every household has a duck shed. As one farmer explained, raising ducks in this lowland area is entirely traditional: "My father raised ducks; my grandfather raised ducks." Yet since the 1980s the scale had changed, he added: rather than ten or at most one hundred birds, today each household raises one thousand, two thousand, or as many as ten thousand ducks. Moreover, the sheds are often clustered around a common water body or along a roadside canal, together creating an even greater scale and density (see figure I.3).

FIGURE I.3. Duck sheds near pond.

China's livestock revolution created enormous growth in animal production but also brought new risks.[37] On the one hand, the increasing quantity and density of animal populations created new opportunities for disease emergence and transmission, leading to widespread outbreaks of porcine reproductive and respiratory syndrome, brucellosis in cattle, and both Newcastle disease and influenza in poultry. On the other, market saturation, increasing cost of inputs, and the industrial restructuring of poultry production intensified market-based uncertainties for farmers, contributing to the growing struggles that in China are referred to as the "three rural issues": an interrelated and multifaceted crisis of countryside, agriculture, and peasantry. Afflicted by flock infections and fluctuating markets, some farmers have abandoned duck raising, leaving empty, ruined sheds behind. Others, like Tang and his boss, have sought out open space, less polluted and at or beyond the very margins of legal land use, including the farming of ducks in the wild wetlands of the refuge.

Faced with new uncertainties, farmers are innovating coping strategies, including the use of pharmaceuticals, relocation of farm sites, and the husbandry of new breeds. As a result, just as scientists moved experimental systems to Poyang Lake and began studying how the "interface" of wild and domestic

drove the emergence of new flu viruses, farmers were busily reconfiguring the relationships between wild and domestic birds. The interface, one might say, as much as the disease, was emerging. As scientists reckoned with these unexpected changes to their research objects, epistemological assumptions were put in motion, experimental systems were adjusted, and norms of scientific practice were modified: a process that I call scientific displacement.

SCIENTIFIC DISPLACEMENTS

By describing the movement into the epicenter as a process of displacement, I am extending a spatial metaphor developed in historical and anthropological studies of scientific practice. The concept of displacement has been used to describe the unique trajectory of scientific knowledge production and its transformative effects, and in particular the ways that scientific practice makes new knowledge. As Hans-Jörg Rheinberger explains, experimental systems are characterized by an "economy of epistemic displacement, such that everything intended as a mere substitution or addition within the confines of a system will reconfigure that very system." The production of scientific knowledge is neither a process of discovery, unveiling something that is waiting "out there," nor a process of architectural design in which scientists construct their results according to plan. Rather, scientists create experimental systems that produce "surprises." Experimental systems, Rheinberger argues, produce "unprecedented events" that, although made to happen, also "commit experiments to completely changing the direction of their research objects."[38]

Bruno Latour extends the idea of scientific displacement across a broader anthropological scale. For Latour, *displacement* is a synonym for *metaphor* or *translation*: "the creation of a link that did not exist before and that to some degree modifies two elements or agents."[39] For example, Latour shows how French bacteriologist Louis Pasteur's vaccine for anthrax disease relied on "the displacement of the laboratory" into actual cattle farms, where he conducted field experiments and tests, and then the subsequent "transform[ation] of the farm back into the guise of a laboratory."[40] Successful scientific practice "displaces" or redirects the interests of other actors so that scientific research objectives gain the support of powerful allies.[41] Laboratories create displacements through mastery of scale, as when Pasteur re-creates a cattle farm in miniature inside his lab in order to make microbes visible. In the end the movement of the world through the lab changes the world as well. After Pasteur's demonstration of the microbial cause of disease, for instance, all sorts of problems, from medical practice to urban planning to military strategy, become microbial problems:

"French society . . . has been transformed through the displacements of a few laboratories."[42]

The concept of scientific displacement has been developed primarily based on historical and ethnographic studies of laboratories, prominently including those of Rheinberger and Latour.[43] The choice of laboratories as sites for conducting ethnographic and historical "micro-studies" of scientific practice was in part strategic, because laboratories offered contained spaces where scientific practice and process are readily observable. However, as Karin Knorr-Cetina points out, the laboratory also came to carry a certain "weight" as a key "theoretical notion in our understanding of science." The laboratory came to be understood as "itself an important agent of scientific development" because laboratory displacement enabled observers to explain "the success of science" in terms of everyday practices, rather than theory-driven change or individual discovery.[44] As a result, the model of laboratory practice has subsequently been extended far beyond the "site which houses experiments."[45] In this view, science undertaken in other settings, such as farms and fields, requires the displacement of natural objects onto a controlled or purified site that allows for the "reproduction of favourable laboratory practices."[46] As Latour puts the point most forcefully, "For the world to become knowable, it must become a laboratory."[47]

As I followed the movement of experimental systems into the pandemic epicenter, however, I began to see the contours of another trajectory of scientific displacement that did not begin and end in the laboratory. Julien Cappelle, a graduate student working with the FAO Emergency Center on spatial ecology models, recalled to me his first visit to Poyang Lake:

> The scale was crazy. I mean it was huge, the productivity of the area; the rice, it was, you know, trucks loaded with rice coming from the paddy fields, and in the other way it was trucks loaded with fertilizers and pesticides at a crazy scale. The domestic birds, poultry, it was crazy also; it was like thousands of them every five hundred meters. I've never seen something like that before. What was another thing that was really striking, was, I think it was a farmer that we discussed with, and, because after a while of driving there we saw ducks ducks ducks ducks ducks but no chicken. Which is really surprising because usually you see chicken a lot and ducks less often, and they told us that, uh, there were no more chicken because when you put chicken outside they die. So you're just like, wow, so there's rice everywhere, ducks everywhere, and virus everywhere.

Again and again, when scientists arrived at Poyang Lake, the assumptions underlying their experimental systems were displaced. Scientists quickly

recognized that their research objects were also objects of other forms of practice. Farmers were experimenting, too, and at scales that outstripped models or experience. In the laboratory, displacements are "made to happen" by the controlled practices of scientific researchers. But at Poyang Lake, poultry farmers reproduced and changed the objects of scientific research, displacing scientific inquiry into new directions. "Unlike laboratories," historians Henrika Kuklick and Robert Kohler note, "natural sites can never be exclusively scientific domains."[48] The "tracks" that scientists follow in the field are laid in advance, as Cori Hayden puts it, well-worn and "ever-deepening," by the historical and cultural legacies embedded in the landscape.[49] Latour has written that in order to produce scientific facts, researchers should extend their laboratory systems to farms and fields, and make sure not to abandon the protocols of laboratory practice: "never go outside" is the mantra. But at Poyang Lake, it was only when scientists left the lab, looked around, and listened to farmers that they were truly surprised.

At stake is not only a different trajectory of scientific change but also a different account of the scientific subject and scientific agency. Displacement is simultaneously a spatial and a social process. There is an intimate connection between the trajectory of laboratory displacement—a trajectory that Knorr-Cetina specifies as "the detachment of objects from a natural environment and their installation in a new phenomenal field defined by social agents"—and the detachment of scientific experts from broader society.[50] In Latour's account of Pasteur's bacteriology, for instance, the displacement of the microbe from the farm to the lab produced a twofold "reversal of strength": "The change of scale makes possible a reversal of the actors' strengths; 'outside' animals, farmers and veterinarians were weaker than the invisible anthrax bacillus; inside Pasteur's lab, man becomes stronger than the bacillus, and as a corollary, the scientist in his lab gets the edge over the local, devoted, experienced veterinarian."[51] When laboratories extract objects from the environment, they also construct scientists as objective observers of nature. Amateurs, laypeople, and practitioners like farmers or veterinarians are all subordinated to the authority of laboratory expertise.

By highlighting the movement into the pandemic epicenter, rather than the detachment of objects and their circulation back to the lab, this book charts a distinct trajectory of displacement to both scientific objects and scientific subjects.[52] As scientists turned from the virus to the nonvirological and attempted to turn the context of influenza viruses into a research object, their inquiry was repeatedly displaced by their encounters with the artifacts of human practices. Rather than constituting researchers as "scientific entrepreneur-generals

[who] go about waging war to conquer and discipline new allies,"[53] winning carefully staged battles over farmers or local veterinarians through the mastery of scale, the pathway into the epicenter forced scientists to build new connections to the nonexperts that inhabit the research site. In a partial reversal of Latour's reversal of strength, the experts realized how much they needed to learn from those outside of the lab. Not least from farmers and their devoted veterinarians.

AFTER THE EPICENTER

To guide the reader along this pathway into the epicenter, the book is divided into three parts. Each part highlights one layer or strata of the pandemic epicenter, one dimension of the site that causes displacements to the trajectory of global health intervention.[54] Part I, "Ecology," draws on archival research at the WHO in Geneva and interviews to explain the initial movement of pandemic influenza research into the hypothetical epicenter. After showing how laboratory research on viruses played a crucial role in constructing the influenza epicenter hypothesis, I then trace how the current outbreak led to the epistemological displacement of influenza research from virological to ecological disciplines, and follow its spatial displacement from laboratories in Rome or Atlanta to the farms and fields of places like China's Poyang Lake. Within a virological frame, the search for the origins of pandemics had involved a "condensation" of the pandemic threat into a microscopic pathogen. Much like modern biology's treatment of the gene as a metonym for life itself, "the part became the whole." By contrast, the search for the nonvirological environments that produce pandemic viruses drove an expansion in the scale of research objects as scientists sought to understand the "complex systems" from which the virus had previously been "extracted as one tiny part."[55]

However, as Cappelle's shock upon arrival at Poyang Lake makes clear, these contexts expanded in unexpected directions, drawing researchers to question the social, cultural, and political circumstances that shape the ecology of influenza. In the subsequent two parts I show how the scientific movement into the pandemic epicenter encountered displacements produced by two different layers of social and political circumstances. Part II, "Landscape," focuses on the encounters of scientific models and experimental systems with the historical and cultural practice of farm production. These "working landscapes," I argue, continually make and remake the physical environments and interspecies ecologies of the pandemic epicenter. In this part I draw on fieldwork that I conducted with both FAO-affiliated scientists and poultry farmers in the

Poyang Lake region in order to juxtapose the micro-practices of fact construction with the practical configurations of human–environment interaction. Finally, part III, "Territory," examines the intersection of global health projects with China's investments in "biosovereignty," charting how research into the epicenter intersects with national claims over biological resources, agricultural development programs, and state-led veterinary reform. I explore how FAO officers and researchers negotiated with Chinese counterparts to access research sites, virus samples, and information, and I examine how the FAO's efforts to build epidemic response capacity in China's veterinary sector intersected, in unexpected ways, with ongoing post-Mao transformations in the vocation of state-employed veterinarians.

Of necessity, I adopted something like a "multisited" research approach in order to follow the movement of global health into the epicenter. Although Poyang Lake is a central orienting site for both the influenza researchers and myself, other sites such as the Emergency Center in Beijing were equally important in my fieldwork, not to mention the globally distributed locations—Geneva, Rome, London, Hong Kong—that I explored through archival materials. Furthermore, the pandemic epicenter should not be understood as a "local" site confronted by the "global" interventions of international agencies and plans for pandemic preparedness. Rather, the pandemic epicenter is both global and singular, and is stratified by layers of significance that embody different qualities but also cover different spatial scales: ecosystems, regional landscapes, and political territories. As a result, the book is not a documentation of any site or sites, per se, but an account of a journey in search of the epicenter.[56] I examine how the objects of global knowledge become the situated contexts in which knowledge is produced, leading to the emergence of new forms of scientific ethos, livestock production, and political exchange.[57]

During this passage I explore both sides of the doubled relationship between scientific practice and the pandemic epicenter. On the one hand, I document the scientific practices that have made and remade the hypothesis that China is the epicenter of influenza pandemics. On the other, I explore how the hypothesis of the pandemic epicenter produced a displacement in scientific practices by drawing experimental systems into the epicenter and onto the farms and fields of rural working landscapes. Anthropologists and other scholars have recently suggested that scientific and journalistic identifications of China as a pandemic epicenter map a "geography of blame" in which "traditional ecologies, economies and societies figure as 'natural reservoirs' of deadly viruses."[58] As Arthur Kleinman and colleagues put it, "Global discourses regarding the origin and spread of H5N1 avian influenza all too often consist of

allegations of blame and assumptions of cultural shortcoming rather than of serious investigations of the political, cultural and socio-economic realities of the societies that have come to be associated with the virus."[59] In this book I investigate China's pandemic epicenter by tacking between sites (Beijing and Poyang Lake) and points of view (FAO livestock specialist, state-employed official veterinarian, duck farmer, etc.) to document the complex interplay among science, blame, politics, socioeconomics, and culture. However, my primary goal is not to provide a better account of the real contexts of the hypothetical epicenter but to follow how scientists and their experimental systems turned these contexts into objects of inquiry. Ultimately, I suggest, only by following scientists and experimental systems in their search for the pandemic epicenter can we hope to reconstruct the constantly reiterated claims that China is "ground zero" for influenza pandemics. In doing so we may also articulate a different understanding of scientific knowledge and expert authority along the way.

INTRODUCTION

1 Although this book focuses on pandemic influenza, contemporary global health approaches to the challenge of emerging diseases, such as the U.S. Agency for International Development's Emerging Pandemic Threats Program, invoke a similar logic.

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3 Lakoff, *Unprepared*, 73.

4 Malik Peiris, personal communication.

5 Pete Davies, "The Plague in Waiting," *Guardian*, August 7, 1999.

6 J. C. de Jong et al., "A Pandemic Warning?," *Nature* 389, no. 6651 (October 1997): 554, doi.org/10.1038/39218.

7 FAO/WHO/OIE, "Unprecedented Spread of Avian Influenza Requires Broad Collaboration," January 27, 2004, www.fao.org/newsroom/en/news/2004/35988/index.html. Celia Lowe points out that constructing avian influenza as a global-scale threat "raised the stakes of the problem and made targeted groups of people responsible for the health and well-being of other far-flung humans on the planet." Lowe, "Viral Clouds: Becoming H5N1 in Indonesia," *Cultural Anthropology* 25, no. 4 (2010): 625–49.

8 The title "One World, One Health" was first introduced by the Wildlife Conservation Society (WCS) as part of its "Manhattan principles" in 2004. After the WCS trademarked the phrase, most other organizations referred only to the short form, "One Health." See Yu-Ju Chien, "How Did International Agencies Perceive the Avian Influenza Problem? The Adoption and Manufacture of the 'One World, One Health' Framework," *Sociology of Health and Illness* 35, no. 2 (February 2013): 213–26, doi.org/10.1111/j.1467–9566.2012.01534.x; Abigail Woods et al., *Animals and the Shaping of Modern Medicine: One Health and Its Histories* (London: Palgrave Macmillan, 2017); Susan Craddock and Steve Hinchliffe, "One World, One Health? Social Science Engagements with the One Health Agenda," *Social Science and Medicine* 129 (2015): 2, doi.org/10.1016/j.socscimed.2014.11.016.

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10 Phil Harris, "Avian Influenza: An Animal Health Issue," August 2006, www.fao.org/avianflu/en/issue.html.

11 Quoted in Ian Scoones and Paul Forster, "The International Response to Highly Pathogenic Avian Influenza: Science, Policy and Practice" (STEPS Working Paper 10, STEPS Centre, Brighton, 2008, 46).

12 David P. Fidler, "Germs, Governance, and Global Public Health in the Wake of SARS," *Journal of Clinical Investigation* 113, no. 6 (March 15, 2004): 799, doi.org/10.1172/JCI200421328. See also the discussion in Lakoff, *Unprepared*.

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15 Mason, *Infectious Change*.

16 "China Is Committed to the Fight against H5N1 Avian Influenza, but Challenges Remain; Opening Remarks by Dr. Shigeru Omi, WHO Regional Director for the Western Pacific Region, News Conference on China's Response to Avian Influenza," PR *Newswire*, December 23, 2005, www.prnewswire.com/news-releases/china-is-committed-to-the-fight-against-h5n1-avian-influenza-but-challenges-remain-55655887.html.

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22 Paul Rabinow introduced the concept of "zones of virulence" in early formulations of his work on global biopolitics of security. Personal communication.

23 Paraphrasing Hannah Landecker. "Biology of the in-between" and "relational biology" are from Landecker, "Food as Exposure: Nutritional Epigenetics and the New Metabolism," *BioSocieties* 6, no. 2 (2011): 167–94.

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35 Julien Cappelle et al., "Risks of Avian Influenza Transmission in Areas of Intensive Free-Ranging Duck Production with Wild Waterfowl," *EcoHealth* 11 (2014): 109–19, doi:10.1007/s10393-014-0914-2.

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37 The contemporary dynamics of China's rural working landscapes reflect the conditions of unintended consequences and reflexivity that Ulrich Beck calls "risk society," Kim Fortun calls "late industrialism," and Hannah Landecker calls the "biology of history." Ulrich Beck, *Risk Society: Towards a New Modernity* (London: SAGE, 1992); Kim Fortun, "Ethnography in Late Industrialism," *Cultural Anthropology* 27, no. 3 (2012): 446–64; Hannah Landecker, "Antibiotic Resistance and the Biology of History," *Body and Society* 22, no. 4 (2016): 19–52.

38 Hans-Jörg Rheinberger, *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube* (Stanford, CA: Stanford University Press, 1997).

39 Bruno Latour, "On Technical Mediation—Philosophy, Sociology, Geneaology," *Common Knowledge* 3, no. 2 (1994): 32.

40 Bruno Latour, "Give Me a Laboratory and I Will Raise the World," in *Science Observed: Perspectives on the Social Study of Science*, ed. Karin D. Knorr-Cetina and Michael Mulkay (London: SAGE, 1983), 151–52; see also Bruno Latour, *The Pasteurization of France* (Cambridge, MA: Harvard University Press, 1988).

41 Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, MA: Harvard University Press, 1987).

42 Latour, "Give Me a Laboratory," 153.

43 Other notable laboratory ethnographies include Karin Knorr-Cetina, *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science*, ed. Sheila Jasanoff, Gerald E. Markle, James C. Peterson, and Trevor Pinch (Oxford: Pergamon, 1981); Sharon Traweek, *Beamtimes and Lifetimes: The World of High Energy Physicists* (Cambridge, MA: Harvard University Press, 1992); Paul Rabinow, *Making PCR: A Story of Biotechnology* (Chicago: University of Chicago Press, 1996). For review, see Karin Knorr-Cetina, "Laboratory Studies: The Cultural Approach to the Study of Science," in *Handbook of Science and Technology Studies* (Thousand Oaks, CA: SAGE, 1995).

44 Karin Knorr-Cetina, "The Couch, the Cathedral, and the Laboratory: On the Relationship between Experiment and Laboratory in Science," in *Science as Practice and Culture*, ed. Andrew Pickering (Chicago: University of Chicago Press, 1992), 114–16; Hannah Landecker, "The Matter of Practice in the Historiography of the Experimental Life Sciences," in *Handbook of the Historiography of Biology*, ed.