CULTURAL ANTHROPOLOGY

WILD GOOSE CHASE: The Displacement of Influenza Research in the Fields of Poyang Lake, China

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On a damp December day in 2007, an American wildlife veterinarian named Scott Newman stood in the cultivated fields near Poyang Lake in southern China. Neck craned upward, he watched a flock of swan geese circle overhead. Poyang Lake, located just south of the Yangtze River, is an important overwintering site for migratory birds, and each winter many ornithologists and bird-watchers travel to the lake's bird refuge to observe rare species of waterfowl. During the past decade, however, Poyang's flourishing bird life has acquired an aura of danger, for the lake has been placed at the center of research on the avian viruses that may cause the next influenza pandemic. Newman himself was at the lake to capture and mark migratory birds for an international project investigating the origins of the highly pathogenic avian flu virus known as H5N1.

During the ongoing avian influenza epizootic, scientists have come to locate pathology in ecological and multispecies arrangements in addition to the virus proper. Anthropological accounts describe scientists situating influenza within a "biology of context" (Caduff 2012, 344), at the "frontiers between species" (Keck 2014, 59), or amid a "multispecies cloud" (Lowe 2010, 626).[1] As a result, scientific research into avian influenza is now as likely to be conducted in wetlands as in "wet" labs, and often includes wild-bird specialists alongside virologists. Assessing influenza in its milieu rather than analyzing influenza under the microscope, contemporary influenza research is shifting the setting of experiments from

CULTURAL ANTHROPOLOGY, Vol. 30, Issue 1, pp. 12–35, ISSN 0886-7356, online ISSN 1548-1360. *DOI: 10.14506/ca30.1.03*

the laboratory to field sites like Poyang Lake. This article asks how this relocation of flu research is changing scientific knowledge production, a transformation that challenges anthropological concepts of scientific practice drawn from the model of the laboratory sciences.

At Poyang Lake, Newman and his team surgically attached transponder tags and antennas to migratory birds, including swan geese, planning to track them by satellite when the birds flew north to Siberia in the spring. The team designed the study to better understand how, where, and when wild birds come into contact with domestic poultry. According to their hypothesis, contacts at what they called the "wild bird–domestic poultry disease interface" (Xiao et al. 2010, 1) may encourage the emergence of pandemic flu viruses. Distinguishing birds into two opposed categories—wild and domestic—the hypothesis suggested that viruses develop into more dangerous forms when they pass from wild to domestic bird populations, or vice versa.

As he watched the flock of swan geese flying above him, Newman felt puzzled, he later recounted to me. Swan geese (*Anser cygnoides*) are an endangered species of wild waterfowl. But according to what a poultry breeder had just told him, the geese above him were not wild at all. Indeed, these swan geese belonged to the breeder, who had bred, incubated, raised, housed, and fed them in preparation for slaughter and sale. Then again, Newman found that they were by no means simply domestic fowl either. At least, the breeder kept insisting that precisely their *wildness* made their meat delicious and highly valuable. And Newman agreed that they resembled wild swan geese so closely that even true wild birds would be unable to recognize the difference.

Newman had come to Poyang Lake to study the interface between wild and domestic birds. But he found that poultry breeders were actively recomposing the qualities of wildness and domesticity in their husbandry of swan geese. Despite the apparent contradiction in terms, they were *breeding wildness*. In this article, I describe how Newman and his research team brought their experiments to Poyang Lake, as well as their subsequent encounter with wild goose breeders. I then examine the cultivation of wildness by swan goose breeders, drawing from my own participant observation at farms around Poyang Lake, and show how breeding wildness creates new forms of bird that cannot be categorized as simply wild or domestic. Finally, I explain how the encounter with this anomaly brought about a shift in the way influenza scientists conceived of the transmission of disease across the boundary of wild and domestic.

Based on the evident significance of the field encounter in reshaping the trajectory of flu research at Poyang Lake, I argue for the need to examine and modify current anthropological models of scientific knowledge production. These models have focused on the role of the experimental apparatus and of scientific intervention in the production of new knowledge, but they have done so largely on the basis of ethnographic studies inside laboratories. The encounter in the field moves research along different pathways, and it demands a distinct model of how new scientific knowledge is made and who participates in its making. Rather than translating the world into the laboratory, the production of scientific knowledge in the field relies on recognizing how the practices of others rework the objects of experimental inquiry.

FROM LAB TO FIELD

My argument builds on a contrast between lab and field sciences suggested by recent anthropological and historical research. The historical emergence of the laboratory is central to the rise of modern science and medicine (Shapin and Schaffer 1985; Cunningham and Williams 1992). Equally important, ethnographic studies *of* laboratories transformed anthropological understandings of science, because fieldwork inside labs showed how new scientific knowledge is *constructed*, *produced*, or *manufactured*. The foundational laboratory studies established the concept of science *as* practice (cf. Pickering 1992),[2] a model later extended to analyze scientific inquiry in many other sites, applying the concept of laboratory practice beyond the physical "site which houses experiments" (Knorr-Cetina 1992, 134). In this view, science undertaken in other settings, such as farms and fields, necessitates the detachment and translation of the outside world back into the laboratory "centres of calculation" (Latour 1987, 215), or at least onto a lab-like ground, a controlled or purified site that allows for the "reproduction of favourable laboratory practices" (Latour 1999, 166).

Historians, however, have pointed out that the laboratory is only one among many sites of scientific inquiry, and that these differences matter for the way in which knowledge is produced (Livingstone 2003). Historians of the field sciences show that as the laboratory rose in epistemic status, "'the field' was simultaneously reconstructed as the residuum of messy, complex, and uncontrollable nature" (Vetter 2010, 2; cf. Kohler 2002; Schneider 2000). Henrika Kucklick and Robert Kohler (1996, 4) argue that field sciences are distinctive because "unlike laboratories, natural sites can never be exclusively scientific domains." The field experiment takes place within a "working landscape" (White 1995). According to these historical studies, scientific knowledge of the field does not fully detach objects of inquiry from the forms of life and modes of production that are practiced in and on the scientific site.

In this article, I follow contemporary influenza scientists as they move their experiments from the lab to the field. This movement from lab to field not only brings new working objects into view but also calls forth new methods and norms of scientific practice (Schwartz and Krohn 2011; cf. Bachelard 1984). In particular, I argue that the encounter with the field gives shape to a distinctive trajectory of scientific production.

Opposing both Whig histories of progressive discovery and theory-centered accounts of revolution (Kuhn 1962), laboratory studies emphasized the role of experimental practice and material infrastructure in the production of new scientific knowledge. The historian of science Hans-Jörg Rheinberger's concept of scientific displacement, which draws from historical and ethnographic studies of laboratories, provides a particularly sophisticated model. Rheinberger (1997, 134) argues that "unprecedented events"—the surprising occurrences traditionally glossed as scientific discoveries—are in fact *engendered by* experimental practice and the laboratory apparatus: "They come as a surprise but nevertheless do not just so happen. They are made to happen through the inner workings of the experimental machinery for making the future." Although made by experimental practice, they also "commit experimenters to completely changing the direction of their research activities." The paradoxical "research object," (Rheinberger 1997, 28),[3] the object of scientific inquiry, is constructed by the experimental system yet remains irreducibly vague, embodying the unknown rather than the known and enabling the concerted creation of the unexpected. Rheinberger (1997, 11) describes the production of scientific knowledge as a process of *displacement* rather than discovery, one in which the sciences "reshap[e] their agenda through their own action," but without foreknowledge of how their objects will take shape.

When situated in the field, however, the scientific research object is also the object of other modes of creative practice that already inhabit the field site. This essay articulates how these other modes of practice rework and transform scientific research objects, causing displacements that cannot be attributed to the inner workings of the experimental system. In flu research at Poyang Lake, the wild bird–domestic poultry interface constitutes a research object whose forms, the wildness and domesticity of the birds themselves, are at the same time being transformed by poultry breeders. I argue that displacements, the primary source of scientific change or discovery, can therefore result as much from an encounter with a poultry breeder's techniques as from the apparatus of the experimental system. In what I describe as "field displacements," scientific knowledge in the field develops through encounters with the outside of the experimental system.

Contemporary scholars have heralded such fissures in the autonomy of the laboratory as evidence of an important historical shift in the relation of science to society. In their influential diagnosis of what they call "Mode 2" science, for instance, Helga Nowotny and her colleagues observed that the sciences, once exclusive and autonomous domains, had now been "superseded by a new paradigm of knowledge production, which was socially distributed, application-oriented, trans-disciplinary, and subject to multiple accountabilities" (Nowotny et al. 2003, 179). Previous studies have focused on *political* or *ethical* drivers of this transformation, such as patients' organizations (Epstein 1996; Callon and Rabeharisoa 2003), risk assessments (Wynne 1998), and ethics regimes (Strathern 2003; Rabinow and Bennett 2012). These studies describe new actors entering into the previously circumscribed space of scientific expertise and collaborating in, or contesting, the production of knowledge.

What has been overlooked, however, is how the shifting *sites* of scientific research reroute the trajectories of knowledge production, adjusting science's relation to nature rather than to society. The process of field displacement suggests that the production of scientific knowledge in the field depends on, and works within, a natural world already given form by other productive engagements. Following the movement from laboratory to field, encounters with wild bird breeders forced influenza researchers to study the natural world as an artifact of human practices.[4] Making scientific knowledge in the field does not bring society into the laboratory in response to a politics of participation, but rather demands that scientists exit the laboratory and build new methods for understanding the creative practices transforming the natural world.

VIRAL TRAFFIC (IN THE LAB)

Newman first visited Poyang Lake while attending the 2006 International Living Lakes Conference, an environmental conservation meeting held in the nearby city of Nanchang. Speaking on a panel about "Avian Influenza, Wildlife, and Environment," Newman focused on "integrated fish farming" in China as a possible mechanism for virus transmission from domestic poultry to wild birds. These integrated fish farms "directly use fresh poultry waste as a production input," that is, as an inexpensive fish feed. High quantities of virus are known to be excreted by birds infected with the H5N1 strain of influenza virus. Newman concluded that "in such systems with little or no biosecurity measures in place, the likelihood of multiple wild species interaction and possibility of disease . . . transmission could be considerable" (Newman et al. 2006, 57).

In itself, the hypothesis that multispecies interactions in China's wetlands, rice paddies, and poultry systems may contribute to pandemic emergence was hardly new. After the Second World War, the World Health Organization's (WHO) global network of laboratories traced the appearance of the 1957 Asian and 1968 Hong Kong pandemics to southern China. Kennedy Shortridge, the director of a WHO reference laboratory at the University of Hong Kong, subsequently hypothesized that southern China could be an "influenza epicentre" (Shortridge and Stuart-Harris 1982, 812). In a 1982 paper, Shortridge and his coauthor argued that the region was a likely "point of origin for pandemic viruses" due to the intensity of "interchanges of virus" between animals and humans. "The closeness between man and animals could provide an ecosystem for the interaction of their viruses," they wrote.

For an influenza pandemic to arise, a new form of the virus is necessary, one able to escape the immune responses cultivated by human populations during previous flu outbreaks. The American Robert Webster had previously shown that such new viruses can be experimentally produced in the laboratory: taking viruses derived from different species, he co-infected a single animal host, a process that Webster and his coauthors observed had encouraged the two viruses to swap genetic material and create "recombinant" forms (Webster, Campbell, and Granoff 1973, 318). Shortridge simply added that the multispecies associations Webster simulated in his lab already flourished in the actual villages of southern China.

But Shortridge never brought his experiments out into the paddies and villages, nor did he design a research program to study the ecology of these landscapes. Instead, Shortridge tracked influenza viruses from inside his Hong Kong lab. The lab collected thousands of samples from poultry-processing plants and duck farms in Hong Kong and southern Guangdong. The samples were first filtered and assayed for influenza viruses, then classified in terms of their phylogeny. Hong Kong proved to be "an extremely fruitful source of influenza A viruses" (Shortridge, Alexander, and Collins 1980, 260). As Frédérick Keck (2014) has argued, Shortridge constructed his laboratory as a "sentinel" for pandemic influenza viruses, a device able to isolate new viruses as they emerged in southern China but before they spread to the world (cf. MacPhail 2014).

Warwick Anderson (2004) has described a minor tradition of "ecological vision" among twentieth-century infectious disease researchers. Desiring a more "integrative" understanding of disease processes, scientists such as F. Macfarlane Burnet argued that microbes are situated in ecological relations among organisms and environments. Yet as Anderson (2004, 51) points out, the concepts of ecology employed by these researchers were more "metaphoric resource" than "analytic tool," and drew little on contemporary advances in the scientific field of ecology. Although Shortridge located the hypothetical conditions of pandemic emergence in particular natural environments and "age-old" cultures, he too never turned them into research objects. His characterizations of southern China drew from personal communications, travelers' reports, and Joseph Needham's classic historical series, *Science and Civilization in China*. He spoke of the "ecology of influenza viruses," but his investigations took place at a microbiological or even molecular scale, and always inside the laboratory (Shortridge and Stuart-Harris 1982, 812).

In 1997, Shortridge's lab attributed the cause of a boy's death to an avian influenza virus (typed as H5N1) that was causing concurrent outbreaks on Hong Kong's poultry farms. Scientists widely saw the interspecies transmission from poultry to humans as a confirmation of the influenza epicenter hypothesis and raised alarm about an imminent pandemic (Jong et al. 1997). Avian influenza became an exemplar of an "emerging infection," a powerful new object of public health that has attracted substantial research funds from wealthy donor countries and international organizations (King 2004). Developed primarily by U.S.-based researchers in the early 1990s, the concept of disease emergence proposes that changing ecological relationships are responsible for the production of new diseases from HIV to Ebola. The virologist Stephen Morse (1990), who coined the term, describes disease emergence as the transfer of disease-causing pathogens into novel host populations, and argues that this "viral traffic" should form the special object of infectious disease research.

The historian Nicholas King (2004) has called attention to the "scale politics" of the "emerging diseases worldview." On the one hand, the emerging diseases worldview narrated local configurations of nature and society, often in the developing tropical regions, as sources of disease that threatened the entire globe. At the same time, the worldview figured environmental crisis and social dislocation as problems that could be solved at a laboratory scale. As King (2004, 66) puts it, "since the 'laws of viral traffic' were universal, monitoring and intervening need not be bound to the same scale as either cause or consequence. Addressing 'global' risks meant making ecological change legible to laboratory investigation or information processing at multiple locations, often far removed from the specific site of disease outbreaks."

Through the logic of disease emergence, China's local multispecies ecology came to stand in for the avian influenza virus and the threat of future pandemics. Although this framework reaffirmed Shortridge's model of monitoring China's virological landscapes from the sentinel laboratory, the growth in scientific attention and funding also set the stage for moving flu research out into the fields of the influenza epicenter.

VICTIMS OR VECTORS (IN THE FIELD)

The mass mediated "fascination" with the specter of global pandemic (MacPhail 2014), alongside models of pandemic futures elaborated in scientific journals and military preparedness plans (Lakoff 2008), led to an enormous growth in funds for research on the emergence of flu viruses. The WHO—along with its animal health counterpart at the Food and Agriculture Organization (FAO)—adopted an interagency framework known as One Health to coordinate the growth in flu research (Chien 2013; Porter 2013). According to One Health principles, disease-causing pathogens are often shared among wild animals, domestic livestock, and human populations. As a result, the framework of One Health has become a resource for encouraging a wide variety of experts not typically involved in influenza research, including wildlife specialists, to begin unprecedented field investigations into the disease.[5]

A 2005 outbreak of avian influenza H5N1 on China's northwestern plateau crystallized the movement from laboratory to field around the figure of the migratory bird. During that spring, Chinese park rangers found thousands of dead birds on an island in the middle of the remote Qinghai Lake. Scott Newman later declared the outbreak "the single largest H5N1 wild bird mortality event that has ever occurred" (Jiao 2010). In its sheer scale, the Qinghai epizootic indicated sustained transmission of the virus among wild birds. Influenza researchers began to suggest that wild birds might play an unexpected role in the long-distance transmission of highly pathogenic flu viruses. As Newman and his research collaborators aptly captured it, everyone wanted to know whether wild waterfowl were "victims or vectors" of the virus (Takekawa et al. 2010).

As funding for wild bird studies grew, the FAO hired Newman to coordinate international research on the role of wild birds in avian influenza. In 2006, he helped organize a study of wild bird migration at the Qinghai Lake, along with collaborators from the U.S. Geological Survey and the Chinese Academy of Science. The researchers hoped to find out, among other things, how the H5N1 virus had arrived in this remote region of China. Recently published research from Chinese and Hong Kong virology labs brought their attention to Poyang Lake, far to the east in the richly cultivated plains of the Yangtze delta. Lei Fumin, an ornithologist from the Chinese Academy of Sciences Institute of Zoology, plainly stated their reasoning: “Qinghai strains can be traced to one early strain from Poyang based on the genomic analysis” (Jiao 2010).

When Newman and his colleagues organized research at Poyang Lake, however, they were no longer concerned only with wild bird migration. To understand the role of migratory birds in the emergence of the H5N1 virus, they believed they needed to find out how flu viruses passed from domestic poultry populations to wild birds in the first place. They designed what they called an “integrated pilot study” at Poyang that drew together, or integrated, a wide range of disciplinary perspectives. Funded by a grant from the U.S. National Institutes of Health (NIH), the pilot study included a spatial analysis of landscape and land use from satellite imagery; surveys of domestic poultry density and market chains; and virological sampling of both wild and domestic birds, among other projects. Population ecologists, livestock veterinarians, geospatial analysts, and geographers hailing from the United States, Europe, and China joined the wild bird specialists. I refer to this scientific collective as “the NIH group” in accordance with their own colloquial reference to their funding source.

Members of the NIH group described their integration of a wide variety of disciplines around a common question as a “One Health approach” (e.g., Newman, Siriaroonat, and Xiao 2012), and they wrote of adopting an “ecological research perspective” (Takekawa et al. 2010, 3). They contrasted this perspective with what a geographer participating in the NIH group called “reductionist” understandings of influenza focused on the virus alone. For example, the NIH group criticized previous studies conducted at Poyang Lake for a “lack of detail in identifying migratory waterfowl to species level [that] precludes analysis of ecological aspects of the disease” (Takekawa et al. 2010). As an NIH-group bird migration specialist told me:

> A lot of the [virus] sampling has been done without designation. Now, it’s fine if you can get to species level, its better than you started, I mean initially it was just like “duck.” And there’s like huge differences in species, right? And so all this is to us [wild bird specialists] common in that you look at a bird and you know that “Well, that’s a different bird, and its different from this one over here, cause its doing this bit of behavior, its completely, its not going to be found in that habitat, all of those things you automatically

> know, and you hardly think about it, you don't realize that over there a virologist is thinking, "That's a duck." You know? A tree's a tree. And that redwood and that oak tree, it's all the same.

With the concept of viral traffic, influenza experts had already blamed ecological and multispecies relationships for the emergence of pandemic flu viruses, it is true. Yet this traffic had been studied at the scale of the virus, mostly by virologists, with little or no research on the multispecies ecologies that host and transmit viruses. The NIH group, rather than analyzing and classifying viruses in the laboratory, investigated the ecological relationships that contributed to the transmission of flu viruses into new populations—relationships that one might call the highways and bridges of viral traffic.

Although the NIH-group pilot study at Poyang Lake included a large number of distinct projects, its members integrated the study as a whole around a common research object: what they called the "wild bird–domestic poultry disease interface" (Xiao et al. 2010). Situated at an ecosystem, rather than a molecular, scale, this research object aimed to uncover the highways of viral traffic between wild birds and domestic poultry. The scientists believed that this transmission of viruses across the wild–domestic interface was a "key factor integral to the evolution of LPAI [low pathogenic avian influenza] into HPAI [highly pathogenic avian influenza]" (Takekawa et al. 2010, 4). By describing the contours and pathways of the wild bird–domestic poultry interface at Poyang Lake, they believed they would map the route along which avian flu viruses emerged into pandemics.

When he arrived at Poyang Lake with equipment in hand, however, Newman discovered to his surprise that poultry breeders did much more than raise domestic poultry. The poultry breeders at Poyang also *qualitatively* transformed the interface of wild and domestic itself, mixing and recombining the qualities of wildness and domesticity in the breeding of wild birds. The NIH group had derided virologists for their inability to recognize the differences between mallard and pintail ducks. But they came to realize that their own distinction of wild and domestic kinds of bird was equally inadequate.

BREEDING WILDNESS

Just inside one of the large embankments that keep the flood waters of Poyang Lake at bay, on the outskirts of his natal village, Wang Fenglian raises his wild swan geese (*da yan*). I first visited his farm in the summer of 2011, brought there by one of the NIH group's Jiangxi Province collaborators, and was fortunately welcomed as a frequent guest by Wang and his son. They own a moderately sized plot of land that contains a house where Wang, his family, and employees live; a few sheds for the wild geese and ducks; and a pond where the birds often swim. Born into a family of rice farmers, Wang Fenglian had risked a wide range of enterprises since the beginning of economic reforms: he had raised fish in a small pond; he had bred dogs; he had even done business in the provincial capital. Some of these enterprises had brought great profits, others great losses. In 2001, he began to breed wild swan geese and incorporated the Po Lake Wild Animal Breed Co. Ltd, which now ranges among the largest wild bird farms in the area.

China's post-Mao reform policies simultaneously expanded wildlife conservation and promoted agricultural commercialization, trends that frequently came into direct conflict (Hathaway 2013). At Poyang Lake, a large section of wetland was set aside as a migratory bird refuge in 1983, while other sections were designated as an "agricultural production base" focused on duck breeding. As early as the 1980s, Jiangxi Province officials suggested that wild bird breeding could help resolve conflicts between social and ecological interests by meeting demand without poaching from the wild (Studies 1988). The breeding of wild swan geese began to grow rapidly about a decade later, encouraged by expanding elite consumption. An exemplary article, published in a Henan Province agricultural extension journal in 1999, promotes the activity as a timely response to unprecedented markets in the quickly growing coastal cities: "Swan goose is a special poultry that our nation has only recently begun to breed from the wild [*xunyang*], and in some coastal cities there is a rather large market for its consumption. . . . As a result, the prospects are good for the development of swan goose breeding" (Chen 1999, 21; cf. Sichuan 1999).

A Chinese newspaper has described the rapid increase in the breeding of wild animals in the past two decades as a contemporary "fever" (*re*), drawing on a term often used to depict the cultural trends of the post-Mao period (Li 2001; cf. Ellis and Turner 2007). This feverish growth is itself a symptom of the even more dramatic expansion in domestic livestock production, and in particular of layer and broiler chickens. The breeding of domestic poultry was one of the first sectors opened to market sale in rural China following Deng Xiaoping's reforms of the planned economy, and during the 1980s, poultry breeding quickly became an important source of rural livelihood and entrepreneurship. However, during the 1990s, large industrial poultry enterprises, organized as vertically integrated "dragon-head corporations" (*longtou qiye*), began to steadily increase market share. Statistics show a rapid drop in smallholder poultry farms (Ke and Han 2008).

During fieldwork, I discovered that many of these smallholders have not necessarily abandoned poultry production altogether, but instead now specialize in local or unusual breeds. One manner of specializing production, which aims to meet the growing demand for distinctive foods among wealthy elites, is to breed wild animals.

China's administrative system includes a category of "special type husbandry" (*tezhong yangzhi*) devoted to the management of wild animal breeding. This category defines wild animals bred under human management as still *wild*, thereby placing them under the jurisdiction of the State Forestry Administration rather than the Ministry of Agriculture. As an article in the newspaper *Peasant Daily* explains, "wild animals [*yesheng dongwu*], even when they are under conditions of human-directed husbandry, no matter how many generations they have been bred, as long as they have not passed through human directed cultivation [*dingxing peiyu*], nor produced new hereditary characteristics, that raised animal still is classified as a wild animal, and cannot be called a domestic poultry or livestock" (Li 2001). According to the policy, the impact of breeding practice on an animal can be ignored if the practice does not actively cultivate new traits in the animal. Much like the NIH group's wild–domestic interface, the policy presumes a stable distinction between wild and domestic animals. Yet I found that for the wild goose breeders at Poyang Lake, the wildness (*yexing*) of the geese could not be presumed as a stable characteristic that passively maintained itself. Rather, the traits of wildness themselves became direct objects of hereditary cultivation.

The wildness of their birds, breeders claim, constitutes the key site of distinction from industrial poultry, and therefore the primary source of market value. Maintaining this wildness requires technical interventions of both symbolic and material kinds, a practice that I describe as *breeding wildness*. Birds raised in this manner, I argue, can no longer be grouped into existing categories of wild and domestic, because the breeders recompose wildness and domesticity to produce the novel and distinctive forms that carry higher value on the market. In doing so, these techniques of breeding wildness displaced the research object of the NIH group, an object grounded on a presumed categorical difference separating wild and domestic birds.

On Wang's farm, I first recognized the importance of these practices of recomposition when I observed the effort the breeders put into demonstrating wildness to their clients. When a prospective buyer expresses interest in purchasing chicks, Wang invites them for an "inspection" of the farm, billed as a complimentary course of instruction in the special techniques required to raise wild geese (feeds, housing, etc.). Wang's son Haohua acknowledged that otherwise customers might not believe the birds were actually wild, and he repeated a popular saying about fake goods to drive the point home: "Hang up a sheep's head outside the shop, but sell butchered dog meat [*gua yangtou, mai gourou*]."

Wildness, according to the Wang family, is embodied primarily in three traits: general external appearance, such as coloring and shape; the absence of a growth on the base of the beak that appears on domesticated geese; and above all, the ability to fly. Promotional materials, including the Wang family's website, pamphlets, and packaging materials, draw a close symbolic connection between the birds' ability to fly and their wildness. For example, one pamphlet praises "wild taste," while images of bred wild geese in flight are cut and pasted over pictures of undeveloped sections of Poyang Lake.

In addition to this symbolic work of marking wildness, though, the Wang family is also concerned to ensure their geese physically embody the traits they identify as wild. And this is not as simple as selecting a species of goose from the wild or one broadly categorized as wild and then raising it on the farm. Wang found, to his chagrin, that after four or five generations of human breeding, the geese lose their distinctive wildness, growing knobs on the base of the beak and losing their ability to fly. His son described this loss of wildness as degeneration or regression (*tuihua*). As a result, techniques of cultivating wildness lie at the center of the Wang family's breeding practice.

First, they carefully manage the breeding of the geese. They blame the degeneration of the geese in part on inbreeding (*jinxing fanzhi*), that is, the reproduction of offspring in sexual relations between individuals too closely related. In explaining their practice to me, Haohua drew on an analogy of the incest prohibitions in classical China: those of the same family line cannot have sexual relations if they are within three generations of relatedness. The geese are divided into families (*jiating*), and during breeding seasons the male offspring are kept in pens separate from their ancestral family.

At the same time, the Wang family also works to enhance the wildness of the geese by managing the influence of the environment. In a promotional brochure that I helped hand out at the China International Forestry Exposition in 2011, Wang describes such environmental management as his innovation (*chuangxin*). "Our company courageously seeks innovation," the brochure reads, "bravely explores frontiers, in the whole nation the first to free-graze wild geese and wild ducks in the natural wild [*tianran yewai fangyang*]." In addition to the main farm, the Wang family also established what they call an experimental base much closer to the shore of Poyang Lake's open waters. Whereas the main farm is on the inside of the embankments that keep flood waters from human settlement, the experimental base is on the outside of the embankment, exposed to the lake's untempered force. As Haohua put it, by compelling the birds to accustom themselves to a wild living environment (*yewaide yi ge shengcunde huanjing*), their wildness will grow and intensify.

For swan goose breeders like the Wang family, wildness is not a quality opposed to human touch, for it is through specific techniques of breeding that they ensure their geese embody the qualities of wildness. Wildness is a collection of qualities, both symbolic and material, that can be cultivated or lost. Yet this breeding practice also differs quite markedly from domestication. Where domestication seeks to transform a wild animal into one oriented toward human benefits (such as greater meat production, tame personality, and so on), the swan goose breeder takes wildness as a form that can itself be cultivated. Seeking to achieve market values by raising distinctive forms of bird, they breed wildness in a manner that escapes simple substantive classifications of the wild and the domestic.

Anthropologists from Marilyn Strathern (1980) to Phillipe Descola (2013) have urged attention to variation in the conceptual and practical arrangements of wild and domestic across different forms of life. Similarly, environmental historians and geographers emphasize the particularity of the idea of wilderness and wildlife as untouched by human activity, an idea particular to the modern histories of Europe and the United States (Cronon 1996; Benson 2010). These works emphasize that differences in the ordering of the wild and wilderness are *practical* as much as conceptual. Certainly, wild bird breeders are not enacting a static Chinese conception of wildness. For one thing, they are engaged with a contemporary configuration of the wild and the domestic shaped by China's recent post-socialist transformations, including the rise of industrial broiler farming, the revaluation of wildlife (Coggins 2003; Zhan 2008; Hathaway 2013), and emergence of new consumer lifestyles (Farquhar 2002). Second, and more important, the wild goose breeder takes these distinctions not as rules to enact but as the object of strategic practice, a matter to be reflexively reformulated in the effort to mark products with distinctive value. Not content to remain producers of domestic poultry, the breeders manipulate the distinction of wild and domestic itself to produce new forms and new values.

FIELD DISPLACEMENTS

In the design of their research object—the wild bird–domestic poultry interface—the NIH group presumed wild and domestic birds are two distinct populations. The wild goose breeders, on the other hand, saw the wild–domestic distinction very differently—as a value differential that could be practically exploited through techniques of *breeding wildness*. When the NIH group encountered the swan goose breeders during field studies at Poyang Lake, they quickly saw the limits of their own concepts and developed new research objects. Yet this process differed from Rheinberger's model of laboratory displacement. For rather than deriving from the infrastructure and design of the experimental system itself—Rheinberger's (1997, 134) "machine for making a future"—the research object was displaced by poultry breeders whose breeding techniques and values reconstructed the interface of wild and domestic.

During their initial migratory bird studies at Poyang Lake, Newman and other members of the NIH group stayed at the migratory bird refuge in the town of Wucheng, surrounded on all sides by the Poyang wetlands. Newman recalls that each day they set out to capture and mark wild birds in the refuge van,

> To drive anywhere, from any point A to point B, you see lots of duck farming. We started talking to people, and then you get to know some of the local people, get to know some of the people at the wildlife reserve, and start talking, in those broader discussions, asking them about what was being raised, what kinds of species? So they started going into different species of ducks. And some of these were pretty unusual species to be raised, so we were wondering.

Later, after they asked their driver to stop by some farms, Newman encountered the swan goose breeder and his wild swan geese in the moment I described at the beginning of the essay. This encounter "led us over to farmed wild birds, [a] whole new level of interest," Newman told me, explaining that the encounter completely transformed the NIH group's understanding of "connectivity and interface between wild and domestic birds."

The shifting conceptual terms used by the NIH group to describe how connections form across the wild–domestic interface make visible the contours of this displacement. Before research at Poyang was begun, Newman coauthored the FAO technical manual introducing field research on wild birds and avian influenza. In a section explaining the hypothetical role of wild birds in influenza transmission, the authors point to the importance of what they call "'bridge' species." They write:

> Several bird groups without particularly strong ties to wetland habitats, but with a high tolerance for human-altered habitats, have also been known to become infected fatally from H5N1 [including crows, sparrows, mynas, and pigeons]. . . . these species may serve as links between wild birds in natural habitats and domestic poultry, acting as a "bridge" in the transmission of AI viruses from poultry to wildlife or vice versa. (Whitworth et al. 2007, 27–28)

Following the encounter with the wild swan goose breeders, the NIH group developed a new concept: "farmed wild birds." Clearly drawing on the earlier notion of bridge species, Newman explained to me in 2012 that farmed wild birds "could be the link between wild and domestic birds. They are the perfect intermediary. Because they look identical to their conspecifics, when they are foraging, a wild bird would come right up to them, because phenotypically they are the same. But then, they go home at night, and there are other poultry around at the farm. So there's your transmission!" Yet despite resemblance to the earlier notion, the new concept subtly displaced the form of the NIH group's working object, the wild–domestic interface. In the original design of their pilot study, the NIH group understood the interface as a *spatial setting* in which contacts between wild and domestic bird populations took place, such as the fish ponds described in Newman's presentation to the Living Lakes conference. A diagram of the original plan for the pilot study (Xiao et al. 2010) depicts white boxes marked "migratory birds" and "free-ranging ducks/geese" on either side of a blue oval identified as "Paddy rice fields/Natural wetlands/Fish ponds." The bridge species was an existing wild bird species that frequented such settings of interface, birds such as pigeons able to tolerate both natural and human-altered habitats.

With the concept of "farmed wild bird," on the other hand, the researchers transposed the conceptual boundary between wild and domestic from a spatial setting or habitat to the bird itself. In doing so, they drew attention to the breeding practices that cultivate birds able to double as either wild or domestic, practices that *internalize* the wild–domestic interface within the farmed wild bird. The subsequent research projects the NIH group conducted at Poyang Lake made the significance of this displacement clear. Following the discovery of the farmed wild bird, the NIH group focused inquiry on the human practices responsible for breeding wildness: they counted and mapped the households that farmed wild birds, conducted surveys to understand vaccination regimes, and followed the market chains along which farmed wild birds were traded. And when the NIH group updated their diagram of the wild–domestic interface to include farmed wild birds (Newman, Siriaroonat, and Xiao 2012), this new vector of human agency was also added, a new white textbox containing the words "production, market, trade, transport systems, vaccine, movement control, culture, behavior."

CONCLUSION

In this article, I do not argue that the field has entirely replaced the lab in influenza research: indeed, laboratory analysis of viral samples remains an important component of flu research at Poyang Lake. Rather, the movement to the field displaces the predominance of laboratory *practice* as a model for understanding the process through which new scientific knowledge is made. For the classic laboratory ethnographies, the lab was a tactical site where science could be studied as a cultural practice, thereby calling into question the importance of theoretical structures and mental cognition as sources of scientific knowledge and change. Yet this focus on experimental practice, the significance of which is so evident inside the laboratory, has obscured from view the more variable trajectories of scientific discovery.

Based on my analysis of encounters between flu researchers and poultry breeders at Poyang Lake, this essay proposes an anthropological investigation into the diverse routes along which scientists adjust their research objects and come to know new things. Without denying the important insights provided by the model of laboratory practice, the anthropology of science I propose goes beyond analyzing the detachment of inscriptions and their accumulation in laboratory centers. Nor do I presume that the field is a simple externality of the laboratory, a messy or complex inversion of the purified lab. Instead, I draw attention to the specific moments at which scientists depart from laboratory protocol and encounter the others who shape the world outside.

To be sure, the defining features of laboratory practice could be found in the initial setup of the migration study at Poyang Lake. Transponders attached to wild birds sent signals to orbiting satellites, transforming migratory movements into detached "traces" (Knorr Cetina 1992, 116) available for scientific manipulation and analysis back in laboratory centers (cf. Benson 2010). In the end, however, the traces detached from the flights of birds did not displace the NIH group's research object: an encounter with poultry breeders did.

When Newman first told me about farmed wild birds, he laughed and recalled how he had posed as an American poultry buyer on his first trip to a Poyang Lake farm. Whether or not he was fooled, the breeder went along with the performance, asking which seaports would be most convenient for shipments to the United States, proudly describing the wildness of his birds, and sending a whole, fresh-killed swan goose to Newman that evening. The insights about the farming of wild birds that shifted the NIH group's research objects came not from an extension of his laboratory to the lake, but rather from Newman's momentary abandonment of the subject position of scientific expert. By taking on the pose of the buyer, Newman came to understand the concept of wildness guiding the practice of wild goose breeding, an understanding that the "inner workings" (Rheinberger 1997, 134) of his experimental system could not provide.

Shifting influenza research to the field constructs research objects on sites of already ongoing labor and production. This colabor on the same sites can cause unexpected field displacements to scientific research objects. When both scientists and breeders work on the same birds, as described in this article, breeding techniques become as important as experimental design for the production of novelty that lies at the heart of scientific change. But recognizing these field displacements, and thereby incorporating them in the trajectory of knowledge production, requires a shift away from the laboratory practices of detachment and purification. In his encounter with the breeder, Newman relied on techniques more familiar to the human than the natural sciences (Dilthey 1989). Viewed as part of external nature, the geese flying above him looked like any wild swan geese, *Anser cygnoides*. Playing the part of a participant in the breeder's world of food markets and gourmet tastes, on the other hand, Newman learned that the birds are human works, and he strove to understand the ideas and values driving the cultivation of wildness.

Influenza research at Poyang Lake describes an anthropological arc of sorts, one in which knowledge of natural objects first passes through an understanding of human engagements with the natural environment. Of course, this is not to say that the harmonious integration of the human and the natural sciences is at hand (Rabinow and Bennett 2012; Rabinow and Stavrianakis 2013). Though I did collaborate with NIH group researchers as a consultant in anthropology, I found that they sought an expert knowledge of culture that few anthropologists today would uphold (cf. Helmreich 2001).[6] Still, the trajectory of influenza research at Poyang Lake carries significant epistemological implications, if not such epochal ones. Many studies have shown that the sciences today are forming new relations with society through patients' organizations and bioethics regimes, transforming how knowledge is made in the process. In this essay, I argue that the changing sites and objects of contemporary influenza research are shifting the epistemological relation of the sciences to nature as scientists in the field come to see natural sites as human artifacts.

Laboratory ethnographies exposed the material infrastructure and scientific labor required to construct the spaces where scientists encounter nature and take its measure. The field displacement of influenza research at Poyang Lake reflects a different epistemological question: How do scientists account for the practical engagements, such as poultry breeding, that creatively transform the natural sites where field experiments are undertaken? Similar field displacements can be found, I suggest, in a range of scientific domains—from biodiversity conservation to climate change—in which nature is increasingly understood as *anthropogenic*, as a product of human works (Lowe 2006; Tsing 2005; Whitington 2013). When poultry breeders cultivate wildness and factories change climates, scientific knowledge about wildlife or atmosphere relies on more than experimental infrastructure and laboratory practice. Natural knowledge is also constructed on understandings of the human engagements that reshape the natural world; engagements that, through techniques of breeding or production, displace the objects of scientific research.

ABSTRACT
This article follows transnational avian influenza scientists as they move their experimental systems and research objects into what they refer to as the "epicenter" of flu pandemics, southern China. Based on the hypothesis that contact between wild and domestic bird species could produce new pandemic flu viruses, scientists set up a research program into the wild–domestic interface at China's Poyang Lake. As influenza comes to be understood in terms of multispecies relations and ecologies in addition to the virus proper, the scientific knowledge of influenza is increasingly dependent on research conducted at particular sites, such as Poyang Lake. What does this movement of influenza research from laboratory to field mean for anthropological concepts of scientific knowledge? A widely shared premise among anthropologists is that scientific knowledge is made in experimental practice, but this practice turn in science studies draws largely from fieldwork inside laboratories. In this article, drawing on fieldwork with both influenza scientists and poultry breeders, I show how scientific research objects can be displaced by the practices of poultry breeders rather than by experimental practice itself. For these poultry breeders, refusing to respect the distinction of wild and domestic, were breeding wild birds. [anthropology of science; epidemics; human–animal relations; multispecies ethnography; China]

NOTES

Acknowledgments I am particularly grateful to Scott Newman and other NIH Group researchers, as well as the Wang family (a pseudonym) and other breeders in the Poyang Lake region, for inviting and assisting my inquiry. I am indebted to Paul Rabinow, Andrew Lakoff, Frédéric Keck, Xin Liu, Dorothy Porter, Liu Ying, Emily Chua, Laurence Tessier, Ruth Goldstein, Bruno Reinhardt, Leticia Cesarino, Bharat Venkat, Anthony Stavrianakis, and my colleagues in the Humanities, Science and Society Research Cluster at Nanyang Technological University for incisive critiques and advice along the way. I thank two anonymous reviewers and the editors of *Cultural Anthropology*, James Faubion, Dominic Boyer, and Cymene Howe, for invaluable comments and suggestions. Research and writing were supported by Fulbright-Hays Doctoral Dissertation Research Abroad and Chiang Ching-Kuo Doctoral Fellowships.

1. See also Lakoff 2008; Hinchliffe and Bingham 2008; Porter 2012, 2013; Chien 2013; Hinchliffe and Lavau 2013; MacPhail 2014.
2. The foundational works are Knorr-Cetina 1981; Latour and Woolgar 1986; Traweek 1988. For a review, see Knorr-Cetina 1995.
3. Rheinberger's neologism is *epistemic thing*, but he indicates that the term is synonymous with the more widely used *research object*, *scientific object*, or *working object*. See Rheinberger 1997, 28.
4. On nature as artifact, see Haraway 1991; Rabinow 1996; Descola 2013.
5. Previous scholarship is divided about the import of One Health models on influenza research and control programs. While Porter (2013) describes an emerging "'One Health' paradigmatic order" implemented in Vietnam that redefined the risks of interspecies contacts in spite of resistance from "local knowledge hierarchies," Chien (2013) describes extensive disagreement among transnational scientists about the meaning of One Health and warns that the concept could become "merely ceremonial." Both presume that One Health models are produced largely at global centers such as Manhattan or Geneva, and disagree only about the extent to which these models applied a unified vision of multispecies order. In this essay, I document the field implementation of a One Health research project. In doing so, I show how scientific knowledge production in the field can displace One Health models of disease transmission and suggest the need for new concepts of scientific practice that highlight the importance of such field encounters.
6. And to the extent that attention to culture and behavior may result in scapegoating poultry breeders for influenza emergence, the consequences of this anthropological turn may be troubling. See Zhan 2008 and Porter 2012.

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