

After the livestock revolution

Free-grazing ducks and
influenza uncertainties in South China

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Abstract

Since the 1970s, virologists have pointed to South China as a hypothetical ‘epicenter’ of influenza pandemics. In particular, several key studies highlighted the farming practice of ‘free-grazing’ ducks (*fangyang*) as the crucial ecological factor driving the emergence of new flu viruses. Following the emergence of highly pathogenic avian influenza viruses in 1997 and 2004, free-grazing ducks became a primary target of biosecurity interventions from global health agencies and China’s national government. This article compares the global health ‘problematization’ of free-grazing ducks as a pandemic threat with the manner in which duck farmers around Poyang Lake, China, engage with the dangers of disease in their flocks. Showing how both global health experts and duck farmers configure the uncertainty of disease against ideal modes of ordering the relations among species, I conclude by examining how these two problematizations interact in ways that mutually intensify – rather than moderate – uncertainty.

Keywords

pandemics, influenza, agrarian change, multispecies, human-animal relations, uncertainty

Out in the rice fields and waterways that surround China's enormous Poyang Lake, located in southern Jiangxi Province, ducks are a common sight. The lowland environment of the lake region, filled with canals and small ponds, is certainly suitable for the husbandry of waterfowl. Provincial planning reports from the 1980s called for the lake region to be developed as a 'production base' for commercial waterfowl (Studies on Poyang Lake Editorial Committee 1988). According to recent data collected from provincial yearbooks, there are well over fourteen million ducks raised in the region today (Capelle et al. 2014).¹

Ducks are a common sight not only because of their large numbers but also because of how they are raised: free-grazing (in Chinese, *fangyang*). For at least some portion of their life, farmers allow the ducks out of sheds and enclosures to graze in fields, canals, and ponds. Rice paddies, in particular, play an important role. Poyang Lake is an important rice-growing region where paddy rice cultivation makes up more than 90 percent of the sown area of all crops (Li et al. 2012, 654). In what is known as the *daotian yangya* agricultural system, or 'rice-duck co-culture', ducks are allowed into rice paddies for grazing. Ducks get supplemental feed by gleaning rice left after the harvest and by eating weeds and small insects, and at the same time the ducks provide the rice crop with pest control and fertilization (see for example J. E. Zhang et al. 2009).

Recent scientific research on pandemic influenza, however, asserts that this pastoral scene is actually a pathogenic landscape. Immediately after the avian influenza A (H5N1) virus spread throughout Southeast Asia in 2004, a team of population ecologists produced a spatial model of influenza risk in Thailand, a country badly affected by the epidemic. In the study, Marius Gilbert and his colleagues (2006) showed that the spatial distribution of outbreaks of H5N1 avian influenza closely matched the distribution of 'traditional free-grazing duck husbandry'. The correlation was even stronger when the variable of intensive rice cultivation was added (Gilbert et al. 2008). The work of Gilbert and his colleagues in Thailand was later extended to Vietnam, Laos, and finally China, where risk models continued to highlight the importance of free-grazing ducks in rice paddies.

Scientific concerns about the role of free-grazing ducks in influenza emergence initially emphasized the possibilities of human contact with infected ducks. For example, in a classic article, microbiologists Kennedy Shortridge and C. H. Stuart-Harris (1982) proposed that the farmed ecology of southern China could be an 'influenza epicentre': a 'point of origin' for

¹ According to statistics from the Food and Agricultural Organization of the United Nations (FAO), China as a whole produced 685.5 million ducks in 2013, accounting for 73 percent of world duck production (FAO Statistics Division 2015).

the influenza viruses that cause human pandemics. The reason, they suggested, lay in what they called ‘age-old’ agricultural practices such as free-grazing ducks. Rice-duck co-culture ‘provides a close bird/water/rice/man association that varies with the seasons of rice-growing’, and thereby promotes the ‘interchange of viruses between host species’ (Shortridge and Stuart-Harris 1982, 812).

More recently, as attention focused on the possible role of wild birds in the long-distance transport of avian influenza viruses, researchers initiated studies into the risks of the ‘wild bird-domestic poultry interface’ (Fearnley 2015). Poyang Lake is famous for its migratory wild birds, which overwinter there in the tens of thousands, and many studies emphasized the role of free-grazing ducks in enabling contact between wild and domestic birds (Capelle et al. 2014; Prosser et al. 2013). As a recent Chinese-led study synthesizing the risk factors for infectious disease at Poyang Lake puts it, ‘Most backyard poultry raised in the Poyang Lake area are in a free ranging style. This may increase the chance of poultry’s being exposed to neighboring poultry and wild birds, which will in turn increase the disease risk of backyard poultry’ (Wang et al. 2013, 7–8).

In this article, I examine the causes and consequences of the contemporary problematization of free-grazing ducks in the Poyang Lake region. A ‘problematization’, in the conceptual terms of Michel Foucault (2001, 172), is ‘an “answer” to a concrete situation which is real’. To analyze a historical situation as a problematization is to inquire into ‘how and why certain things (behavior, phenomena, processes) became a problem’ (Foucault and Pearson 2001, 171). In Foucault’s (2006) early work on madness, for instance, he writes that he does not aim to provide a history of ‘the language of psychiatry’ (xxviii) (that would be the work of a historian of ideas or science), but rather to identify the prior ‘decision that both bound and separated reason and madness’ (xxxiii). His historical inquiry unearthed the practices through which madness was constituted as an object, revealing the primary acts of separation that opened up a space in which the scientific discourses of psychiatry became possible. In this sense, working with problematizations ‘is an act of modal transformation from the constative to the subjunctive, from the necessary to the contingent’ (Rabinow and Rose 2003, 13).

In this article, although I do briefly trace how influenza researchers came to identify free-grazing ducks as a problem, my main goal is not to illuminate the historical contingency of this problematization but instead to draw attention to what could be called its contemporary contingency. I do so by juxtaposing this problematization with how duck farmers articulate other problems, and therefore other answers, related to duck farming in the Poyang Lake region today. While duck farmers are concerned about duck diseases, including influenza, they formulate this concern as a completely different problem from the one formulated by influenza scientists.

For duck farmers, the diseases that afflict ducks are not considered in terms of their potential threat to global health, but rather as possible threats to the household's wealth. In the four decades that have followed the decollectivization of China's agricultural communes and the introduction of market institutions in agricultural purchasing and distribution, duck farming has become an important site for increasing household wealth. The raising of ducks has shifted from a small sideline activity to a specialized business. Yet as wealth and opportunities to grow wealth have increased, so too have the frequency of diseases. One farmer told me, 'the one change we always note: more diseases'. Disease has emerged as a problem alongside the exponential growth in commercial duck farming, part of China's so-called livestock revolution. This is not only, or even primarily, because the frequency of duck diseases may have increased with the growth in the scale and number of poultry farms. What is more important is that the duck bound for market makes duck disease into a problem by turning birds into commercial commodities, whose values are now tied to the uncertainties of market profits and losses.

My analysis therefore is comparative, not genealogical.² I undertake this comparison by focusing on the different 'modes of ordering' (Law and Mol 2008) that flu scientists and duck farmers have proposed or adopted, such as the concrete practices (housing, feeds, management systems) through which ducks are brought into relation with, and separated from, humans (Law and Lien 2013). I then discuss the different modes of uncertainty that arise when such modes of ordering are understood as problems and the various technologies that are deployed to manage uncertain dangers (Samimian-Darash and Rabinow 2015).

My ultimate purpose is not to produce a static comparison of types, but to explore the mutual consequences of these problematizations in their actual encounters. This article therefore delineates the consequences that the problematization of free-grazing ducks (as pandemic threat) has had on the farmers' own problems (of raising ducks for market). I show how pandemic flu-prevention programs intensify the uncertainty experienced by farmers and make their problems more difficult to accommodate, forcing them towards increasingly extreme technologies for managing uncertainty and, in some cases, driving them to financial ruin. As a result, I argue, biosecurity interventions that intend to reduce the pandemic threat will extend, rather than reduce, the practice of free-grazing ducks. Free-grazing remains a crucial answer to the farmer's troubles with markets.

² On the relation of genealogy to historical problematization, see Koopman (2013).

How free-grazing ducks became a problem

The story of free-grazing ducks and influenza begins in a New York laboratory, far from any Chinese landscape. In the early 1960s, microbiologist Edwin Kilbourne designed experiments demonstrating that influenza A viruses can undergo a process of reassortment: the mutual exchange of complete gene segments. In his lab, he was able to accomplish the *in vitro* reassortment of genes derived from animal and human strains of the flu virus. Kilbourne (1968) argued that reassortment could be a source of the genetic novelty that is required for the emergence of pandemic strains, and highlighted the possible role of animal reservoirs and intermediary animal hosts in the emergence of human flu pandemics.

By the next decade, laboratory research on influenza viruses was describing an ‘ecology of influenza’ (Downie, Hinshaw, and Laver 1977). Inside a laboratory at St. Jude Children’s Hospital in Memphis, Tennessee, Robert Webster and his colleagues developed an experimental system that focused on the relationships among animal species in the production of pandemic viruses. Taking influenza A viruses extracted from two animal species, Webster coinfecting a single animal host, a pig, with both viruses. Webster later isolated a hybrid or ‘new’ virus that could infect and kill a chicken previously immunized against both ‘parental’ viruses. Pandemic flu viruses most likely derive from the reassortment of human and animal influenza viruses, Webster and Campbell (1972) argued, and therefore depend on the exchange of viruses among species, rather than on the processes of gradual mutation intrinsic to the virus itself.

When Shortridge and Stuart-Harris (1982) described southern China as an influenza epicenter, they did so based on these laboratory-based hypotheses of the ecology of influenza. Lab studies provided a model of the ‘frontiers of the living’ (Keck 2014), or interspecies boundaries, that flu viruses pass through as they emerge into pandemic forms. In zoonotic diagrams (Lynteris 2017), viruses leap from wild birds to domestic poultry, and then perhaps to pigs before appearing in human populations. When applied to an actual landscape, this diagram inscribed danger onto apparently pastoral settings, as when folksy scenes of pigs, ducks, and rice paddies are painted as possible ‘points of origin’ for influenza pandemics. The diagram marked out a pathogenic landscape where multispecies relations and points of contact become – as much as the viruses themselves – sites of global health danger. At Poyang Lake, research has focused on the ‘wild bird-domestic poultry interface’ as a key hot spot of viral emergence and the reason that the lake might be a pandemic epicenter.

As the Poyang Lake landscape is repainted in this pathogenic hue, the free-grazing duck comes to the foreground of influenza research set among its agricultural ecologies. The free-grazing duck is considered to be a likely risk factor for influenza virus transmission between

wild and domestic birds (Capelle et al. 2014; Prosser et al. 2013). However, the importance of the free-grazing duck as a point of viral exchange only bears relevance within a particular mode of uncertainty. As Limor Samimian-Darash and Paul Rabinow (2015, 1) suggest, despite the proliferation of languages and technologies of risk management today, it is imperative to distinguish among different modes of uncertainty ‘because the world is increasingly being populated by forms, practices, and events of uncertainty that cannot be reduced to risk’. Scientists at Poyang Lake are studying viral transmission or transmissibility between species in the absence of an actual pandemic, in order to prepare for a potential pandemic for which the causal virus remains unknown. Rather than a probabilistic risk calculation, Samimian-Darash (2013) has called this a situation of ‘potential uncertainty’. The potential uncertainty of future pandemics turns the free-grazing duck into a highly dangerous being.

Biosecurity on the farm

In avian influenza research, the potential uncertainty of pandemics has brought global health from the lab to the farm. On the farm, the problematization of multispecies interfaces and free-grazing is often met with ‘a set of narratives, technologies, and practices’ referred to as ‘biosecurity’ (Hinchliffe et al. 2013). According to the Food and Agricultural Organization (FAO 2008, 1), biosecurity refers to the ‘implementation of practices that create barriers in order to reduce the risk of the introduction and spread of disease agents’. Biosecurity regulates the conduct of relations between humans and animals, including poultry (Porter 2013). At the core of agricultural biosecurity is a ‘will to closure’ and containment (Hinchliffe et al. 2013, 533).

According to the FAO, ‘the three principle elements of biosecurity’ are segregation, cleaning, and disinfection. Each is a technique of separation or enclosure (FAO 2008, 1). Biosecurity practices ensure that humans are separated from animals (by gloves or shoe covers, for example), domestic birds are separated from wild birds (by proper housing), and each flock or farm is separated from others (by disinfection protocols). Often the biosecurity mode of ordering extends from the material arrangement of animals to encompass the relations of humans to animals, as well as the social relations among humans (see also Hinchliffe and Bingham 2008; Law and Mol 2008; Keck 2015; Blanchette 2015).

Biosecurity regimes often propose to accomplish this mode of ordering through the integration of agricultural commodity chains, the intensification of production processes, and the expansion of farm scale. In part this is a consequence of the simple fact that biosecurity infrastructures require significant capital investment, often putting them out of reach of independent smallholders. But there is also a more implicit correspondence

between the standardized forms of industrial farming and the spatial enclosures of biosecurity. In his study of the geography of foot and mouth disease, John Law (2006) notes that industrialized agriculture attempts to regulate the flows of living, the hydraulics of meat and viruses, through logics of standardization and uniformity. ‘The aspiration’, he writes, ‘is to standardise flows and exchanges on a global scale’ (Law 2006, 12). As Hinchliffe and colleagues (2013, 534) explain, the vertical integration of the production process, from breeding to supermarket, ‘is thought to enable the ‘tight control of biosecurity’: ‘In the industry, biosecurity is perceived to be more effective in tightly coupled, highly integrated production processes, where large organizations can effectively exercise control across the length and breadth of the food chain and design-in barriers and buffers to keep the system disease-free’.³

Discourses of biosecurity often come with this developmental teleology attached. According to this narrative, increasing growth in commercial poultry markets and the integration of poultry farming operations will lead to better biosecurity governance, including the gradual elimination of free-grazing practices. Indeed, this model follows the historical experience of duck farmers in the United States, where duck production has rapidly intensified since the 1960s. There, ‘housing, methods of heating and ventilation have been “borrowed” from the broiler industry’ as duck production grew in scale (Cherry and Morris 2008, 23). Farms where ducks roamed outdoors inside fenced fields were slowly replaced by fully enclosed, intensive duck farms ‘supplied with fresh air by pressure jets and ventilated with electric fans’ (Cherry and Morris 2008, 23).⁴

Yet such a relationship between commercial integration and biosecurity, including its vision of a transformed and nonpathogenic ‘biosecure’ landscape, encounters serious obstacles in the actual practices of duck farmers at Poyang Lake.

³ Sometimes integration and biosecurity are seen to run together, almost by definition. For example, in the study of infectious disease risk factors in the Poyang Lake region I cited above (Wang et al. 2013, 2), the authors distinguish ‘commercial production’ from ‘backyard poultry keeping’: ‘Local veterinarians told us that commercial farms usually operate on a large scale and poultry is generally kept in high density and enclosed housing conditions with high biosecurity measures. On the contrary, the majority of backyard poultry owners raises the poultry in open yards in a small scale, and do [*sic*] not apply much [*sic*] biosecurity measures. The flocks are raised for owners’ consumption only’.

⁴ Of course, an important tension lies at the heart of biosecurity practices: each enhancement of biosecurity produces new risks because the incursion of pathogens will have higher consequences (Law 2006). This in turn leads to more biosecurity interventions in a cycle that continuously restructures natural and social relations alike (Blanchette 2015).

Livestock revolutions

Duck farming, and indeed the practice of free-grazing ducks, has a very long history in China.⁵ After the Communist Revolution in 1949, however, duck farming was restricted in scale and number. By the late 1950s, rural land had been organized into large collective farms and rural villagers organized into agricultural work teams. Through a centralized state procurement system (*tonggou tongxiao*), the state managed nearly all agricultural production. In some select communes, duck farming at a large scale continued, including for the purpose of ‘biological’ pest control in a context of limited pesticide availability (Schmalzer 2016). In most areas, however, duck husbandry – along with other ‘sideline’ activities – was redefined as work-time outside of obligations to the collective farm. As a result, duck farming was strictly regulated and limited by state policy and surveillance. For example, during political campaigns the government ‘forced through reductions in the size of private plots [and] implemented very strict limits on the number of ducks and chickens farmers could raise’, according to historian Jonathan Unger (2015, 21).

By the late 1970s, China’s political leaders began to introduce market reforms to the socialist economy, beginning with rural areas. At the very outset of what is known as the Reform and Opening Up Era (*gaige kaifang*), rural land was distributed to individual households (*hu*). Each household had a responsibility to meet grain quotas but otherwise could manage agricultural production and work-time as they wished. The breakup of collectivist institutions did not lead to the return of pre-communist lineage systems, and it left the household as the primary rural unit (Santos 2011; Santos and Donzelli 2007). At the same time, unified state procurement was gradually relaxed, with poultry among the first products that were authorized for sale in markets.

According to historian Phillip Huang (1990), the most dynamic sectors of the rural economy during the reform era have been the increasingly market-oriented sidelines, including livestock husbandry. Poultry production has grown rapidly, even exponentially. According to FAO Statistics (2015), chicken production has grown nearly five-fold since 1980, to nearly five billion animals per year. And though on a smaller scale, duck production has grown even more rapidly, increasing nearly seven-fold to almost seven hundred million animals per year (FAO Statistics 2015). By 2013, China accounted for 73 percent of world duck production. This growth is what has prompted observers to announce China’s ‘livestock revolution’ (Delgado et al. 2000; Waldron 2007).

⁵ The earliest records of free-grazing ducks date to the Ming dynasty (1500 CE) (Huang 1986; Z. Zhang et al. 2015).

As anthropologists and sociologists have shown, the livestock revolution is more than a quantitative increase in the number of animals raised. More importantly, the livestock revolution has involved changes to the mode of farming and to human-animal relations. Sociologist Li Huaiyin (2009, 280), for example, describes a transition from ‘sideline’ (*fuye*) to ‘family business’ (*jiating jingying*) modes of animal husbandry:

Before the 1980s, each household raised a limited number of chickens, pigs, or goats only to augment its primary income from the production team. The team members, who spent most of their time on collective farms, took care of the domestic animals only during their spare time in the early morning or evening, or let their children or the elderly do so. Therefore, they did not care much about the cost and profit of such *sidelines*. After 1980, especially from the 1990s onward, raising a large number of such animals became a *family business* that generated most of the family’s income. Therefore, the family had to carefully calculate its labor and capital input to make a profit. (emphasis added)

The emergence of poultry husbandry as a family business, in what is sometimes referred to as ‘specialized households’ (*zhuanqiyehu*) because of their focus on producing a single crop or raising a single animal breed, significantly changes human-animal relations. As I will show, this shift also has significant implications for how farmers engage practically with animal diseases.

Li Huaiyin’s distinction between ‘sideline’ and ‘family business’ modes of husbandry is crucial. However, his account implies a unified historical transition from sideline to business that seems eerily close to the narrative of biosecurity modernization that I outlined above. In my own fieldwork around Poyang Lake, I quickly found that farmers’ arrangements significantly differ from the ideal narrative. By and large, those farmers who have begun to raise ducks as part of a family business have not stopped free-grazing their birds in rice paddies. Even more surprising, perhaps, they have not abandoned sideline farming either. Instead, they commonly raise ducks in both family business and sideline modes of farming, simultaneously.

The emergence of a new mode of duck farming as a specialized business has not replaced small-scale sideline duck husbandry, then, but rather given rise to a novel opposition between two ends and values of duck farming. It is to this difference in farming practices that I turn in the following sections. Drawing from anthropological concepts of the household as simultaneously a built space and a symbolic ordering of social relations, I

compare different modes of ordering the relationship of ducks to the household.⁶ More precisely, by analyzing the different practices of inclusion or exclusion of ducks in the household, I show how ordering practices relate to valuing practices (Heuts and Mol 2013). Finally, I show how the exclusion of ducks from the household, associated with market valuing practices, gives rise to an emerging mode of uncertainty regarding the threat of disease in duck farming.

Modes of ordering: Inclusion or exclusion

One day I took a drive out into the Nanchang countryside with Xiao, a graduate student from a local university. We spotted a pond with ducks and stopped to talk to the farmer, and he and his wife invited us to look at the ducks. We walked through an inner room of the farmhouse, which opened toward a kitchen and out toward a courtyard on the left-hand side. The courtyard itself was made of concrete and sloped down toward a pond that wrapped around the back edge of the house. Around forty ducks and geese of various sizes, colors, and breeds swam in the pond.

As we looked at the birds, Xiao asked the farmer whether he made money primarily from the sale of eggs. The man looked at us and laughed, saying, ‘These birds aren’t any good to sell! All of these our family raises to eat [*nongbu yangde chide*], for eating at New Year!’ Minutes later, it was our turn to laugh, as we learned that he also raised almost five thousand layer ducks in a *peng*, or duck shed, about a ten-minute walk from the house. But he, like many duck farmers in the Poyang Lake region, made strict distinctions regarding the spatial location, type, taste, and value of these two flocks of ducks.

The most apparent difference lies in the spatial practices and material techniques for including or excluding ducks from the built architecture of the family home. In sideline farming of ducks, as well as chickens and geese, farmers keep ducks immediately adjacent to the house. Placed overnight in very small sheds or even left in the open air, the birds move freely during the day: waddling down to rice paddies or ponds in the day and returning near to the home at night (though not usually permitted inside). Indeed, ducks are famous for their ability to find their way home in the evening; a line of ducks will return to the village as the sky darkens, peeling off in twos and threes to return to the household where they belong. The number of ducks raised in this manner can range from two or three to forty or more. Figure 1 represents how the family I introduced above raises ducks (and, notably, geese) in a pond immediately behind their house.

⁶ See especially Carsten and Hugh-Jones (1995); Bourdieu (1990); Tambiah (1969).



Figure 1.

Figure 2 shows other ducks raised by the same family in the mode of business enterprise. The duck shed is located a ten-minute walk from the family's home, encloses a stretch of water for the ducks to swim in, and is encircled by a fence. The space is characteristic of an emerging spatial form in rural China that has accompanied the livestock revolution: the *yangzhiqu*, or 'husbandry zone'. The husbandry zone is a special area of rural village land set apart from households and from agricultural fields, designated for and devoted to the construction of livestock facilities such as duck sheds. Government policy created these husbandry zones in response to the challenges and ambiguities of rural land-use laws in reform-era China. According to law, rural land is divided into three categories: basic farmland, construction land (for houses), and unused land. Importantly, 'basic farmland'

cannot be converted from crop cultivation to other uses, such as animal husbandry.⁷ In response to the growth in livestock farming, many villages have designated certain areas of village land – at some remove from the village proper – as ‘husbandry zones’ and contracted land to entrepreneurial villagers for constructing sheds.



Figure 2.

⁷ Zhang Yimou’s film *The Story of Qiu Ju* (1992) demonstrates some of the obstacles to livestock or commercial farming that can result. In the film, the family of the protagonist Qiu Ju is a ‘specialized household’ that grows and dries chili peppers for commercial sale. The inside of their home is completely filled with chili peppers. When they want to expand their business by building a storage shed, however, they are prohibited by village authorities from constructing one due to land-use restrictions. See Anagnost (1989).

A second dimension of inclusion/exclusion is enacted through feed. The business ducks are fed almost exclusively with industrially manufactured feeds, bought in large sacks at the market. Indeed, the existence and use of manufactured feeds is a key correlate to the livestock revolution and the rise of business farming since the 1970s. Ke Bingsheng (2010, 101), a scholar of China's rural economy, points out that 'the emergence and development of the processed feed industry have played a decisive role in shaping the structure of the livestock sector in China. Starting in the late 1970s, the feed industry developed virtually from scratch'.

Sideline ducks, by contrast, are given leftover scraps from the kitchen table, as well as unshucked and unpolished rice (*daozi*) harvested from the household's own fields. Practices of eating together, or commensality, are fundamental to the formation of social relationships, as well as the marking of social boundaries through inclusion and exclusion (Kerner, Chou, and Warmind 2015). Although sideline ducks do not literally eat together at table with the human members of the household, the feeding of kitchen scraps – rather than manufactured and processed feeds – invokes the sharing of food. In this sense, much like the spatial boundaries of the 'husbandry zone', feeding practices mark the inclusion of sideline ducks and the exclusion of business ducks from the household.

A third difference lies in the bodily form of the birds themselves. In poultry farming, there is wide variation in the degree of standardization and control placed over the breeding of stock. The most integrated poultry operations, in which only the 'growing out' of the birds is contracted to farmers, carefully control the breeding stock through proprietary 'pure' lines. In broiler (meat chicken) or table duckling (meat duck) operations, the 'pure lines' are maintained at so-called primary breeding farms. These farms produce 'grandparent' stock – at least two generations removed from the bird that ends up on a table – through sophisticated techniques involving genetics research and artificial insemination. These grandparents are sold to production breeders, who then raise the chicks that are ultimately sold to poultry farmers. Poultry farmers thus have absolutely no control over breeding. An extensive selection process, similar to quality control measures in other commodity production domains, ensures that all of the birds grown by farmers are close to identical (Law and Lien 2013).

Commercial duck farmers in the Poyang Lake region, however, are not contracted to such intensive, vertically integrated operations. Yet family business farmers do purchase their chicks from other farmers who specialize exclusively in breeding. Within the nets, fences, and sheds of the husbandry zone, all of the birds will be of a relatively homogenous type. Sideline farming, by contrast, mixes an extraordinary variety of types, breeds, and even species. Chickens, ducks, and geese, large, small, and of many colors make up 'the rural family traditional mixed-breed' (*nongjia chuantongde zaijiao*), as one farmer put it.

All three of these differences are configured within specific circuits of duck production and consumption. As Tim Ingold (1987) has argued, the distinct purposes of human production reflect the difference between purely material relations of extraction and the social economies of appropriation. It is the purpose of appropriation that grants the ‘intentionality that “drives” productive action’ and thereby shapes the arrangements of human production (Ingold 1987, 126). What are these purposes and modes of appropriation?

Good to sell or good to eat?

In the Poyang Lake region, the business of duck farming is centered on the production of ‘layer’ ducks, those that, for the majority of their life, are raised for the eggs that they lay. These eggs are sold at the regional wholesale market, the Xiaolan Poultry Egg Wholesale Market, just south of Nanchang city. At the market, farmers sell the eggs to representatives from *pidan* or ‘century egg’ factories, who will bring the eggs to the factories where they will be preserved in a mixture of clay, ash, salt, quicklime, and rice husks until they become almost black in color. Through this chemical process, a duck egg becomes a delicacy. In addition, a fresh egg with a rather limited shelf life becomes a preserved egg, enabling its shipment to consumers across a greater area and over a longer period of time.

I was at first confused to find that farmers make very little or no money from the sale of eggs: although prices fluctuate, on most days farmers only break even after they factor in the cost of purchasing feed. Some farmers complained that they were not even paid in cash, but rather in credit slips that are used to directly acquire feed from vendors at the Xiaolan market.

Upon further inquiry, I learned that whether or not the *pidan* bosses colluded to fix prices, the sale of eggs was only one part of the story. Indeed, the economy of farming layer ducks is as much about the ducks themselves as the eggs that they lay. The farmers earn money when the egg-laying productivity of the ducks begins to decline, at the end of one year. These ‘spent ducks’, as they are called in English, or ‘old mother ducks’ (*laomuya*) as they are more melodiously named in Chinese, are a delicacy that can be sold on the market for a higher price than standard, raised-for-meat ducks.

The reason for their higher price is precisely because of their long life. Ducks farmed exclusively for their meat, known as meat ducks (*rouya*), are raised in highly managed circumstances in timeframes as short as forty-five days before being slaughtered. Rapid growth rate is prized because it is the most important trait for the efficient conversion of feed into meat. Much like the broiler or meat chicken (*rouji*), the production of meat ducks is monopolized by vertically integrated corporations that control the entire production,

processing, and distribution process. Only the forty-five-day ‘grow-out’ period is contracted to farmers.

In this context of industrial meat-duck production, many consumers consider ‘old mother ducks’, because of their age, to have taste and health qualities that are not present in the rapidly raised meat ducks. Served in soups with a simple ginger broth, ‘old mother ducks’ are a classic *bu* (restorative) cuisine.

And this brings us to the central paradox: the farmers that raise ‘old mother ducks’ don’t eat them. Moreover, they consider them inedible. These ducks raised in ‘husbandry zones’ are destined for a food market, of course: each and every one of them will eventually be eaten by someone, as the farmers well know. The ducks will become food, indeed, valued food. Yet farmers themselves consider these ducks unpalatable, of poor taste, bad to eat.

This, then, is where the sideline birds come in. At one time, raising ducks was a sideline to the main activity of rice farming. During the early reform period, these sidelines grew into specialized businesses focusing on the commercial sale of ducks or duck eggs. Today, however, farmers continue to raise some ducks in a sideline manner in order to have tasty, healthy duck meat for their own consumption, often for ceremonial occasions such as the New Year. As one farmer added, such ducks are ‘good to eat, an authentic “local” product [*zhenzhenqiangde tuchanpin*]; they haven’t eaten commercial feeds [*siliao*]. Those that eat commercial feeds aren’t good to eat’.

At this point it is useful to draw a comparison to the contemporary crop cultivation practices of farmers in rural China. Anna Lora-Wainwright (2013), in an anthropological study of cancer in rural China, describes how farmers willingly use farm chemicals – such as pesticides and fertilizers – on cash crops. Yet they refuse to use these chemicals on ‘food intended for home consumption’ (Lora-Wainwright 2013, 110). Although they acknowledge that these chemicals lead to higher productivity, they don’t use them on the kitchen gardens and crops that they will consume themselves. Significantly, this difference in practices is associated with a difference in evaluations: farmers say that crops grown in their kitchen gardens, without farm chemicals, taste better. Finally, they attribute cancer to the consumption of cash crops treated with farm chemicals or to work in those fields, indicating that they favorably appraise the healthfulness of food grown in the kitchen gardens.

Other anthropologists have noted a similar opposition at work in China’s rural farm practices. Goncalo Santos (2011) also remarks on the persistent use of human manure – and especially urine – as a fertilizer in contemporary China, despite the prevalence and availability of industrially produced chemical fertilizers. While ‘nightsoil’ was used on most fields before the introduction of chemical fertilizers (King 1911), today human manure is applied

exclusively on private kitchen gardens. One farmer cited by Santos (2011, 495) argued that “urine-fed vegetables” taste better than vegetables grown with farm chemicals’. This farmer pointed out that the rationale for using industrial farm chemicals was largely ‘economic’ – to increase yields – but that most villagers ‘producing vegetable for self consumption use “watered urine” in their small gardens’ (Santos 2011, 495).

For the farmers, the purpose of the business mode of farming, as a mode of appropriation, is to produce money, not food. Strikingly, this mode of ordering the ducks involves their symbolic and material exclusion from the household. As the raising of the ducks becomes an intermediary moment between market origins (of ducklings, feed, etc.) and ends (eggs, meat), they are removed from the cycles of household life and consumption.⁸

Yet these households, as with all farm households, are both producers and consumers.⁹ The sideline mode of raising ducks produces birds suitable for the household’s own consumption. As such, the sideline mode of raising ducks includes them within the domain of the household: spatially they are raised near the family home, they share in foods prepared for household consumption, and duck eggs and meat end up on the household table, perhaps in conjunction with important dates in the ritual calendar, such as the New Year.

These distinctive modes of value production give shape to distinctive ways of perceiving and managing diseases in the ducks. In the following section, I explore how the emergence of the business mode of duck husbandry is opening up new domains of uncertainty in the lives and livelihoods of Poyang Lake farmers – and turning disease into a problem.

Mode of uncertainty: Disease as ruin

The rise of business duck farming, and the distinctive valuation of relations between humans and ducks that accompanies it, has opened up a novel domain of uncertainty for duck farmers. For as the birds are excluded from the household, as they come to stand for their market value rather than their edibility, they take on a novel temporal character: they stand as possible futures of gain or loss, wealth or ruin. Put another way, rather than participants in the life of the household, business ducks become embodiments of household capital, merely a moment in the transformation of money into more (or less) money.

⁸ Lai Lili (2014, 650) argues that the heavy reliance on chemical fertilizer by rural farmers has ‘much to do with their deepened dependence on a cash economy’.

⁹ See Scott (1976).

Of course, all capitalist economy is driven by the uncertainty of investment. However, the making of living beings into commodities creates modes of uncertainty all its own. A farmer told me of an idiomatic expression, one that, he said, would help me understand how poultry farmers perceive their birds: ‘The household’s wealth of one thousand strings of cash doesn’t include those possessions with fur and feathers’ (*jia cai wan guan dai maode bu suan* 家财万贯带毛的不算). This was the traditional view of Chinese farmers, he claimed: despite the money that can be made from livestock farming, one can never be certain that animals count as part of the household’s wealth. ‘Why?’ I asked him. ‘Because they are living beings’, he replied, vulnerable to die from disease unexpectedly.

Whether or not the expression accurately represents ‘traditional’ viewpoints, the uncertainty of placing the household’s wealth in the bodies of domestic animals is a useful key to the viewpoints and effects of duck farmers in the Poyang Lake region today. The lowlands around the lake are scattered with abandoned duck sheds, literal ruins that exist as visible reminders of farmers who tried out the duck-raising business and failed (see figure 3). When farmers spoke about what had changed in the farming of poultry over recent years, almost always they pointed to disease: ‘These days raising ducks is no good’, one farmer told me. ‘Too many diseases. Especially the flu [*lingan*]. That *lingan*, it’s hard to cure. For one, it’s hard to cure; for another, it’s dangerous, it’s highly contagious. We really fear that *lingan*’. There is a widespread sense among Poyang Lake duck farmers that diseases have increased in recent years, often in ways that exceed the farmers’ experience-based understanding. There is no historical precedent, they suggest, and in a sense no experience to draw from.



Figure 3.

Agricultural production contains a distinctive mode of uncertainty because human labor only contributes one part to the production process. Since the object of production is a living being, production involves processes of natural growth that are, to a greater or lesser extent, independent of human labor. Marx (1925) pointed out that not all 'production time' is made up of 'working time'; that is, the time of production is not completely occupied by human labor. In addition to human labor's transformation of objects into products, many spheres of production also contain times 'during which the object of labor is for a longer or shorter time subjected to lasting natural processes, causing physical, chemical, or physiological changes and suspending the labor-process entirely or partially' (Marx 1925, 272). Marx suggested that this time of production played an especially important role when production involved processes of fermentation, preservation, or agricultural growth.¹⁰

¹⁰ 'For instance, grape juice, after being pressed, must ferment for a while and then rest for some time, in order to reach a certain degree of perfection. In many branches of industry the product must pass through a drying process, for instance in pottery, or be exposed to certain conditions which change its chemical nature, for instance in bleaching. Winter grain needs about nine months to mature. Between the time of sowing and harvesting the labor-process is almost entirely suspended. In timber

The capital or wealth invested in agricultural production depends as much on these nonlabor growth processes as it does on the transformative work of human labor. When ducks are excluded from the household and designated as carriers of household wealth, this wealth is exposed to a mode of uncertainty that goes beyond the characteristic risks of capital investment, one that lies at the intersection of biological disease and market institutions. What if growth does not happen?

To be clear, it is not the case that sideline duck farming is less vulnerable to disease than is business farming. Many farmers spoke of disease afflicting sideline flocks, and on numerous occasions I was treated to an unexpected feast when a household chicken or duck died, or was slaughtered due to a drop in egg-laying productivity. Yet it is telling that the sideline farming of ducks does not produce the same effect of uncertainty in the face of disease. When sideline ducks sicken or die from disease, farmers happily consume the birds. Since little or no capital is invested in their living bodies, the household's wealth or ruin was never at stake. And though the bird's life might have been shorter than expected, its end was the same: food for the household table. When disease strikes a business flock, by contrast, the outcome is quite different. In many cases, the birds cannot be sold at all, but must be burned, buried, or otherwise disposed of. In other cases, they are sold or exchanged for government compensation but at a severe loss.¹¹

As farmers aim to mitigate this uncertainty, new practices have emerged. Anthropologists have long noted that although labor has no material impact during the time of production, this by no means is associated with the absence of agricultural practices. Farmers frequently visited the fields when there was nothing to do there, Pierre Bourdieu (1990) noted. Trobriand gardeners had a 'surprising care for the aesthetics of gardening', as Bronislaw Malinowski (1965, 56) put it. Malinowski developed this into a conceptual distinction between 'the way of garden work', or technical labor, and 'the way of magic', such as the spells incanted over the garden that aimed to assist the tubers in their underground growth. Malinowski's 'way of magic', in short, refers to those practices intended to encourage growth without the direct application of labor.

raising, after the sowing and the incidental preliminary work are completed, the seed may require 100 years in order to be transformed into a finished product, and during all this time it requires very insignificant contributions of labor' (Marx 1925, 272).

¹¹ Compensation rates are notoriously too low, often prompting farmers to attempt the illegal sale of sick or condemned birds. See Mei (2011) and Porter (2013).

In truth, such practices in the time of production go far beyond what Malinowski considered to be magical. What is at stake is the response to a general problem: what are the techniques that farmers adopt to manage the uncertainty of growth? The first technique that I want to discuss is a consequence of a state policy intervention: in 2005, China mandated the universal vaccination of all poultry against the H5NI avian influenza virus. A policy developed in response to the potential threat of human pandemic, universal vaccination – even though it is not exactly universal – has become an everyday and accepted part of business duck farming in the Poyang region. Indeed, vaccination has concretized an orientation toward the future based around the idea of ‘prevention’. The slogan ‘Make prevention the priority’, a popular slogan in Maoist politics and public health, is now painted on walls and posters throughout the countryside. In this translation of the concept of ‘prevention’ from public health to animal husbandry, the temporality of *yufang* has been concretized in the vaccine needle. ‘It is necessary to “hit prevention” [*da yufang*]’, farmers will say, further shortening the colloquial phrase for ‘hitting’, or injecting vaccines (*da yufangzhen*), by dropping the word ‘needle’ (*zhen*) altogether. ‘Prevention’ is equated with the act of vaccination.

Yet many other techniques for managing uncertainty exist beyond the purview of state management. As I approached the Xiaolan wholesale duck egg market for the first time, I was surprised to see an enormous, red, square banner hung outside the entrance, emblazoned with a single white character: 药 (*yao*, medicine). I thought for a moment that I must have arrived at the wrong place, a wholesale medicine market. In fact, the egg market was lined both outside and inside with small shops selling medicinal preparations to treat poultry diseases, including both Chinese herbs and ‘Western’ pharmaceuticals in pill bottles. The owners of these shops act as veterinarians, despite a lack of official license and often with little training. They diagnose disease, sometimes visiting farms or cutting open dead birds, and prescribe treatments.

What is particularly remarkable about this is the novelty of the practice and institution of the duck doctor. Although veterinary practice is an ancient tradition in China, and although the modern Chinese state has long had a veterinary bureaucracy that extends to the village level – including so-called ‘barefoot veterinarians’ (*chijiao shouyi*), a parallel institution to the more famous barefoot doctors – the practice of treating poultry and duck diseases is almost entirely new. This is not to say that duck disease did not exist, but rather that it was not prioritized as an object of practice or technique. Hagiographic texts from the 1960s and 1970s describe the hard work and sacrifice of the barefoot veterinarian treating cattle and swine, sheep and horses, and – as one text puts it – ‘even dogs’, but never mention ducks or chickens (Zhang, Li, and Zhao 1998). Poultry diseases did not seem worth treating.

With the rise of business duck farming, it is clear that this has changed: poultry disease now poses a significant threat to the wealth of the household. Furthermore, farmers associate the rise of business farming with the increase in diseases, and even the ‘emergence’ of new diseases. Conversations with farmers suggest that this state of affairs now exceeds their own knowledge, grounded in experience, and farmers are now seeking the expertise of specialists. As one farmer told me, ‘those common diseases, we can see what they are, even without cutting open [the bird] we all can tell what disease it is. It’s only those newly “emerging” diseases [*xin fashengde jibing*] that we don’t know. . . . We have practice and experience [*shijian jingyan*], without practice and experience we don’t know, isn’t it?’

When I most recently returned to the Poyang region, I found that a third technology for managing uncertainty had now appeared. A farmer told me that he had signed up for ‘duck-raising insurance’ (*yangya baoxian*). Over the past couple of years, the government had permitted insurance companies to sell insurance to duck farmers because of the threat of disease. A payment of 1 yuan per bird, for example, would merit a payout of 3 yuan if the bird died from disease. Duck disease, like eggs and the ducks themselves, now circulated on the market.

Conclusion: The amplification of problems

Critical medical anthropologists have argued that the ‘apocalyptic scenarios’ of pandemic influenza emerging from the poultry of Asia lack ‘rigorous analysis of local contexts’ (Kleinman et al. 2008, 1). They have criticized the ‘geography of blame’ in which ‘traditional ecologies, economies and societies figure as “natural reservoirs” of deadly viruses’ (Caduff 2015, 181). Put another way, these critiques point out that the problematization of poultry disease in terms of the potential uncertainty of a global flu pandemic is disconnected from the actual everyday problems faced by duck farmers.

By specifying and characterizing each of these problematizations in terms of ordering and uncertainty as I have done here, it is possible to go beyond a critique of their disconnection toward an analysis of their interaction. How are the discourses of pandemic influenza and the practices of biosecurity taken up within the practices of duck farmers in the Poyang Lake region?

Many farmers carefully distinguish between *lingan* (‘flu’) and *qinlingan* (‘avian influenza’). While complaining of the *lingan* that afflicted their flocks almost every year, they would vigorously insist that *qinlingan* never infected their birds. At first this was perplexing to me: since ducks are an avian (*qin*) species, wouldn’t any duck *lingan* be, by definition, *qinlingan*?

One farmer finally enlightened me. In addition to disease and market pressures, he said, farmers struggled with the impact of what he called ‘the greater environment’. *Qinlingan*, he explained, exemplified such recontextualizing forces. Not only a disease, the term embodied the aura of popular fear and state interventions associated with the prospects of pandemic flu. When *qinlingan* broke out anywhere in China, he continued, the actual infection of poultry flocks with the virus was by no means the most devastating impact on farmers. Rather, farmers suffered because of government interventions and consumer reactions to the publicity of the outbreak.¹² The government legally restricted trade in poultry, closed poultry markets, and enforced the massive slaughter of birds. Compensation was absent or inadequate. Consumers, for their part, suddenly refused to purchase or eat any poultry (see also Zhang and Pan 2008).

As duck farmers in the Poyang region began to engage in business-oriented farming, the exposure of the ‘time of production’ to disease led them to see a possible ruin in the growing and vital bodies of their ducks. But the encounter with the figures of pandemic flu further increased the intensity of their uncertainty: now a disease could plague their flocks even if the birds never fell sick at all.

Paradoxically, this intensification of uncertainty caused by biosecurity responses to avian influenza is likely to increase, rather than decrease, the practice of free-grazing. Because duck farmers manage uncertainty at the intersection of disease and the market, techniques for managing uncertainty work on both the life of the duck and the cycles of the market. In other words, the extent to which the scissor-like market pressure of purchasing inputs and selling outputs can be reduced, so too will the uncertainty be moderated. Duck-raising insurance is a great example: it does nothing to prevent, treat, or cure actual duck disease, but it does manage the uncertainty of duck diseases by transforming them into financially calculable risks.

Much like insurance, free-grazing is a practice that manages uncertainty by working on the cycles of the market, rather than the life of the duck. Free-grazing ducks allows farmers to reduce costs spent on feed, thereby reducing the amount of the household’s wealth staked in the life of the ducks. As duck farming has grown in intensity and scale, free-grazing has not disappeared. What has changed over the years is the tempo of free-grazing. Today, business ducks are kept in husbandry zones, semi-enclosed, for most of the year. Then, during periodic intensive grazing phases, they are driven by trucks to rice paddies throughout a broad region (usually immediately after harvest or before planting; see Capelle et al. 2014).

¹² On the biocommunicability of the pandemic threat, see Briggs and Nichter (2009).

Although for flu researchers free-grazing is the problem that drives biosecurity interventions, for duck farmers it may be the answer to a problem that is intensified by those same biosecurity interventions. Rather than a neat and linear transition from backyard to biosecurity, what is taking shape looks much more like a positive feedback loop: a circuit for which the final output is troublingly uncertain.

About the author

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References

- Anagnost, Ann. 1989. ‘Prosperity and Counterprosperity: The Moral Discourse on Wealth in Post-Mao China’. In *Marxism and the Chinese Experience: Issues in Contemporary Chinese Socialism*, edited by Arif Dirlik and Maurice J. Meisner, 210–34. Armonk, NY: M.E. Sharpe.
- Blanchette, Alex. 2015. ‘Herding Species: Biosecurity, Posthuman Labor, and the American Industrial Pig’. *Cultural Anthropology* 30 (4): 640–69.
<https://doi.org/10.14506/ca30.4.09>.
- Bourdieu, Pierre. 1990. *The Logic of Practice*. Stanford, CA: Stanford University Press.
- Briggs, Charles L., and Mark Nichter. 2009. ‘Biocommunicability and the Biopolitics of Pandemic Threats’. *Medical Anthropology* 28 (3): 189–98.
<https://doi.org/10.1080/01459740903070410>.
- Caduff, Carlo. 2015. *The Pandemic Perhaps: Dramatic Events in a Public Culture of Danger*. Berkeley: University of California Press.
- Capelle, Julien, DeLong Zhao, Marius Gilbert, Martha I. Nelson, Scott H. Newman, John Y. Takekawa, Nicolas Gaidet, Liu Ying, et al. 2014. ‘Risks of Avian Influenza Transmission in Areas of Intensive Free-Ranging Duck Production with Wild Waterfowl’. *EcoHealth* 11: 109–19. <https://doi.org/10.1007/s10393-014-0914-2>.
- Carsten, Janet, and Stephen Hugh-Jones. 1995. *About the House: Lévi-Strauss and Beyond*. Cambridge: Cambridge University Press.

- Cherry, Peter, and Trevor Raymond Morris. 2008. *Domestic Duck Production: Science and Practice*. Cambridge, MA: CABI.
- Delgado, Christopher L., Mark W. Rosegrant, Henning Steinfeld, Simeon Ehui, and Claude Courbois. 2001. 'Livestock to 2020: The Next Food Revolution'. *Outlook on Agriculture* 30 (1): 27–29. <https://doi.org/10.5367/000000001101293427>.
- Downie J. C., V. Hinshaw, and W. G. Laver. 1977. 'The Ecology of Influenza: Isolation of Type "A" Influenza Viruses from Australian Pelagic Birds'. *Australian Journal of Experimental Biology and Medical Science* 55 (6): 635–43.
- FAO. 2008. *Biosecurity for Highly Pathogenic Avian Influenza: Issues and Options*. Report. Rome: Food and Agriculture Organization of the United Nations.
- FAO Statistics Division. 2015. *FAOSTAT*. Rome: Food and Agricultural Organization of the United Nations. <http://faostat.fao.org/>.
- Fearnley, Lyle. 2015. 'Wild Goose Chase: The Displacement of Influenza Research in the Fields of Poyang Lake, China'. *Cultural Anthropology* 30 (1): 12–35. <https://doi.org/10.14506/ca30.1.03>.
- Foucault, Michel. 2006. *History of Madness*. Edited by Jean Khalfa. Translated by Jonathan Murphy. New York: Routledge.
- Foucault, Michel, and Joseph Pearson. 2001. *Fearless Speech*. Los Angeles, CA: Semiotext(e).
- Gilbert, Marius, Prasit Chaitaweesub, Tippawon Parakamawongsa, Sith Premashtira, Thanawat Tiensin, Wantanee Kalpravidh, Hans Wagner, and Jan Slingenbergh. 2006. 'Free-Grazing Ducks and Highly Pathogenic Avian Influenza, Thailand'. *Emerging Infectious Diseases* 12 (2): 227–34. <https://doi.org/10.3201/eid1202.050640>.
- Gilbert, Marius, Xiangming Xiao, Dirk U. Pfeiffer, M. Epprecht, Stephen Boles, Christina Czarnecki, Prasit Chaitaweesub, et al. 2008. 'Mapping H5N1 Highly Pathogenic Avian Influenza Risk in Southeast Asia'. *Proceedings of the National Academy of Sciences* 105 (12): 469–74. <https://doi.org/10.1073/pnas.0710581105>.
- Heuts, Frank, and Annemarie Mol. 2013. 'What Is a Good Tomato? A Case of Valuing in Practice'. *Valuation Studies* 1 (2): 125–46. <https://doi.org/10.3384/vs.2001-5992.1312125>.
- Hinchliffe, Steve, and Nick Bingham. 2008. 'Securing Life: The Emerging Practices of Biosecurity'. *Environment and Planning A* 40 (7): 1534–51. <https://doi.org/10.1068/a4054>.
- Hinchliffe, Steve, Stephanie Lavau, John Allen, Nick Bingham, and Simon Carter. 2013. 'Biosecurity and the Topologies of Infected Life: From Borderlines to Borderlands'. *Transactions of the Institute of British Geographers* 38 (4): 531–43. <https://doi.org/10.1111/j.1475-5661.2012.00538.x>.

- Huang, Hsing-Tsung. 1986. 'Plants and Insects in Man's Service'. In *Science and Civilization in China*, vol. 6. *Biology and Biological Technology*, part 1: *Botany*, edited by Joseph Needham and Lu Gwei-djen, 471–554. Cambridge: Cambridge University Press.
- Huang, Philip C. 1990. *The Peasant Family and Rural Development in the Yangzi Delta, 1350–1988*. Stanford, CA: Stanford University Press.
- Ingold, Tim. 1987. *The Appropriation of Nature: Essays on Human Ecology and Social Relations*. Iowa City: University of Iowa Press.
- Ke, Bingsheng. 2010. 'China: The East-West Dichotomy'. In *Livestock in a Changing Landscape: Experiences and Regional Perspectives*, edited by Pierre Gerber, Harold A. Mooney, Jeroen Dijkman, Shirley Tarawali, and Cees de Haan, 96–114. Washington, DC: Island Press.
- Keck, Frédéric. 2014. 'From Purgatory to Sentinel: "Forms/Events" in the Field of Zoonoses'. In 'Climate Histories and Environmental Change'. Special issue, *Cambridge Anthropology* 32 (1): 47–61.
- Keck, Frédéric. 2015. 'Feeding Sentinels: Logics of Care and Biosecurity in Farms and Labs?'. *BioSocieties* 10 (2): 162–76.
- Kerner, Susanne, Cynthia Chou, and Morten Warmind, eds. 2015. *Commensality: From Everyday Food to Feast*. London: Bloomsbury Academic.
- Kilbourne, E. D. 1968. 'Recombination of Influenza A Viruses of Human and Animal Origin'. *Science* 160 (3823): 74–76.
- King, F. H. 1911. *Farmers of Forty Centuries, or, Permanent Agriculture in China, Korea and Japan*. Emmaus, PA: Rodale Press.
- Kleinman, Arthur, Barry Bloom, Anthony Saich, Katherine Mason, and Felicity Aulino. 2008. 'Asian Flus in Ethnographic and Political Context: A Biosocial Approach'. *Anthropology & Medicine* 15 (1): 1–5. <https://doi.org/10.1080/13648470801918968>.
- Koopman, Colin. 2013. *Genealogy as Critique: Foucault and the Problems of Modernity*. Bloomington: Indiana University Press.
- Lai, Lili. 2014. 'Everyday Hygiene in Rural Henan'. *Positions: Asia Critique* 22 (3): 635–59. <https://www.muse.jhu.edu/article/552123>.
- Law, John. 2006. 'Disaster in Agriculture: Or Foot and Mouth Mobilities'. *Environment and Planning A* 38 (2): 227–39. <https://doi.org/10.1068%2Fa37273>.
- Law, John, and Marianne E. Lien. 2013. 'Slippery: Field Notes in Empirical Ontology'. *Social Studies of Science* 43 (3): 363–78. <https://doi.org/10.1177%2F0306312712456947>.
- Law, John, and Annemarie Mol. 2008. 'Globalisation in Practice: On the Politics of Boiling Pigswill'. *Geoforum* 39 (1): 133–43. <https://doi.org/10.1016/j.geoforum.2006.08.010>.
- Li, Huaiyin. 2009. *Village China under Socialism and Reform: A Micro History, 1948–2008*. Stanford, CA: Stanford University Press.
- Li, Peng, Zhiming Feng, Luguang Jiang, Yujie Liu, and Xiangming Xiao. 2012. 'Changes in Rice Cropping Systems in the Poyang Lake Region, China, during 2004–2010'.

- Journal of Geographical Sciences* 22 (4): 653–68. <https://doi.org/10.1007/s11442-012-0954-x>.
- Lora-Wainwright, Anna. 2013. *Fighting for Breath: Living Morally and Dying of Cancer in a Chinese Village*. Honolulu: University of Hawaii Press.
- Lynteris, Christos. 2017. ‘Zoonotic Diagrams: Mastering and Unsettling Human-Animal Relations’. *Journal of the Royal Anthropological Institute* 23 (3): 463–85. <https://doi.org/10.1111/1467-9655.12649>.
- Malinowski, Bronislaw. 1965. *Coral Gardens and Their Magic*. Bloomington: Indiana University Press.
- Marx, Karl. 1925. *Capital: A Critique of Political Economy*. Vol. 2. Translated by Ernest Untermann. Chicago: Charles H. Kerr and Company.
- Mei Fuchun. 2011. 梅付春, 政府应对禽流感突发事件的捕杀补偿政策研究. 北京: 中国农业出版社 [Research on government compensation policy for culled birds against avian influenza]. Beijing: China Agriculture Publishers.
- Porter, Natalie. 2013. ‘Bird Flu Biopower: Strategies for Multispecies Coexistence in Việt Nam’. *American Ethnologist* 40 (1): 132–48. <https://doi.org/10.1111/amet.12010>.
- Prosser, Diann, Laura L. Hungerford, R. Michael Erwin, Mary Ann Ottinger, John Y. Takekawa, and Erle C. Ellis. 2013. ‘Mapping Avian Influenza Transmission Risk at the Interface of Domestic Poultry and Wild Birds’. *Frontiers of Public Health* 1 (28): 1–11. <https://doi.org/10.3389/fpubh.2013.00028>.
- Rabinow, Paul, and Nicholas Rose. 2003. ‘Foucault Today’. In *The Essential Foucault: Selections from Essential Works of Foucault, 1954–1984*, edited by Michel Foucault, Paul Rabinow, and Nikolas S. Rose, vii–xxxv. New York: New Press.
- Samimian-Darash, Limor. 2013. ‘Governing Future Potential Biothreats: Toward an Anthropology of Uncertainty’. *Current Anthropology* 54 (1): 1–22.
- Samimian-Darash, Limor, and Paul Rabinow. 2015. *Modes of Uncertainty: Anthropological Cases*. Chicago: University of Chicago Press.
- Santos, G. 2011. ‘Rethinking the Green Revolution in South China: Technological Materialities and Human-Environment Relations’. *East Asian Science, Technology and Society* 5 (4): 479–504.
- Santos, Gonçalo D., and Aurora Donzelli. 2007. ‘Rice Intimacies: Reflections on the “House” in Upland Sulawesi and South China’. *Archiv Für Völkerkunde* 57-58: 37–64.
- Schmalzer, Sigrid. 2016. *Red Revolution, Green Revolution: Scientific Farming in Socialist China*. Chicago: University of Chicago Press.
- Scott, James C. 1976. *The Moral Economy of the Peasant: Rebellion and Subsistence in Southeast Asia*. New Haven, CT: Yale University Press.
- Shortridge, Kennedy, and C. H. Stuart-Harris. 1982. ‘An Influenza Epicentre?’ *Lancet* 320 (8302): 812–13.

- Studies on Poyang Lake Editorial Committee. 1988. *Poyanghu Yanjiu* [Studies on Poyang Lake]. Shanghai: Shanghai Science and Technology Press.
- Tambiah, S. J. 1969. 'Animals Are Good to Think and Good to Prohibit'. *Ethnology* 8 (4): 423–59.
- Unger, Jonathan. 2015. *The Transformation of Rural China*. London: Routledge, eBook Collection.
- Waldron, Scott A. 2007. *China's Livestock Revolution: Agribusiness and Policy Developments in the Sheep Meat Sector*. Wallingford, Oxfordshire, UK: CAB International.
- Wang, Yong, Zhiben Jiang, Zhenyu Jin, Hua Tan, and Bing Xu. 2013. 'Risk Factors for Infectious Diseases in Backyard Poultry Farms in the Poyang Lake Area, China'. *PLoS ONE* 8 (6): e67366. <https://doi.org/10.1371/journal.pone.0067366>.
- Webster, R. G., and C. H. Campbell. 1972. 'The in Vivo Production of "New" Influenza A Viruses'. *Virology* 48 (2): 528–36.
- Zhang Bo, Jinchao Qiu, Yufeng Wang, Chengcheng Luo, and Anqiang Xiang. 2015. '从'稻田养鸭'到'稻鸭共生': 民国以来'稻田养鸭'技术的过渡与转型—以广东地区为中心'. *农业考古 (Agricultural Archaeology)* 3: 145–48.
- Zhang, Jia-En, Rongbao Xu, Xin Chen, and Guoming Quan. 2009. 'Effects of Duck Activities on a Weed Community under a Transplanted Rice-Duck Farming System in Southern China'. *Weed Biology and Management* 9 (3): 250–57. <https://doi.org/10.1111/j.1445-6664.2009.00346.x>.
- Zhang, Letian, and Tianshu Pan. 2008. 'Surviving the Crisis: Adaptive Wisdom, Coping Mechanisms and Local Responses to Avian Influenza Threats in Haining, China'. *Anthropology & Medicine* 15 (1): 19–30. <https://doi.org/10.1080/13648470801919008>.
- Zhang, Yimou, dir. 1992. *The Story of Qiu Ju*. Sil-Metropole Organisation, Youth Film Studio of Beijing Film Academy.
- Zhang Zhengzhen, Li Xifu, and Zhao Guoji. 1998. '一位'傻'赤脚兽医的人生追求'. *山东农业 (Shandong Agriculture)* 12: 20–22.