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Containment and competition: Transgenic animals in the One Health agenda

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ABSTRACT

The development of the One World, One Health agenda coincides in time with the appearance of a different model for the management of human–animal relations: the genetic manipulation of animal species in order to curtail their ability as carriers of human pathogens. In this paper we examine two examples of this emergent transgenic approach to disease control: the development of transgenic chickens incapable of shedding avian flu viruses, and the creation of transgenic mosquitoes refractory to dengue or malaria infection. Our analysis elaborates three distinctions between the One World, One Health agenda and its transgenic counterpoint. The first concerns the conceptualization of outbreaks and the forms of surveillance that support disease control efforts. The second addresses the nature of the interspecies interface, and the relative role of humans and animals in preventing pathogen transmission. The third axis of comparison considers the proprietary dimensions of transgenic animals and their implications for the assumed *public* health ethos of One Health programs. We argue that the fundamental difference between these two approaches to infectious disease control can be summarized as one between strategies of *containment* and strategies of *competition*. While One World, One Health programs seek to establish an equilibrium in the human–animal interface in order to contain the circulation of pathogens across species, transgenic strategies deliberately trigger a new ecological dynamic by introducing novel animal varieties designed to out-compete pathogen-carrying hosts and vectors. In other words, while One World, One Health policies focus on introducing measures of inter-species containment, transgenic approaches derive their prophylactic benefit from provoking new cycles of intra-species competition between GM animals and their wild-type counterparts. The coexistence of these divergent health protection strategies, we suggest, helps to elucidate enduring tensions and concerns about how humans should relate to, appraise, and intervene on animals and their habitats.

"Birds and insects don't need passports. But we must do all we can to closely monitor their health and movements and be vigilant in the control and containment of a range of "carriers" on which these agents can piggyback."

—One Health initiative coordinator, USA

"One of the really powerful aspects of GM would be to develop novel ways of making animals resistant to the major diseases that are a problem … and then those would be essentially given as replacements as a means of disease control."

—Transgenic chicken developer, UK

1. Introduction: competing agendas

The emergence of the contemporary One World, One Health (OWOH) agenda coincides with the rise of an alternative approach to the management of human–animal relations: the genetic manipulation of animals to reduce their capacity as hosts or vectors of human pathogens. Transgenic and One Health strategies both seek to reconfigure the pattern of human–animal interaction, and one can envision scenarios in which GM animals are deployed in interventions that incorporate tenets of OWOH. Yet each of these

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disease control philosophies resolves differently the key terms of the equation – "animal", "human" and "health" – and implies a distinct mode of intervention into the complex interspecies ecologies of pathogen transmission.

While the OWOH agenda integrates the pursuit of human and (non-human) animal health through a broad consideration of their shared biological, social, and environmental contexts, the transgenic alternative hopes to interrupt the circulation of pathogens across species by rendering the animal carrier refractory to infection or incapable of transmission. This fundamental difference manifests itself in distinct sites, scales and temporalities of intervention. Whereas the OWOH model seeks to reshape shared human–animal ecosystems, transgenic technologies hope to find in the genome of the pertinent animal species a molecular "switch" that would short-circuit transmission to humans. Considerations of what should count as the relevant context for the human–animal interface, as well as the point of intervention and its duration, vary widely across these two approaches.

Here we explore this contrast in reference to two transgenic animal species: chickens genetically modified to combat avian influenza viruses and mosquitoes engineered to prevent malaria or dengue transmission. Chickens and mosquitoes might seem to occupy very different spaces in the public health imaginary – the former an emerging threat deeply embedded in commercial economies of food production, the latter a perennial and persistent disease vector of no intrinsic value (cf. Lakoff, 2010). Yet as our analysis suggests, and as others have eloquently pointed out (Hinchliffe et al., 2012; Keck, 2008; see also Wald, 2008), one of the peculiar features of the topology of biosecurity is precisely its ability to collapse seemingly unbridgeable distances – between the lab and the farm, the emergent and the entrenched, the worthless and the valuable.

We elaborate three key areas of contrast and contradiction between the OWOH agenda and its transgenic counterpoint. The first concerns the conceptualization of outbreaks and the form of surveillance that supports disease control efforts. The second focuses on the nature of the interspecies interface, and the relative role of human and animal capacities in the suppression of pathogenic encounters. Finally, we explore the balance of public and private interests that characterizes transgenic strategies, and specifically how the proprietary status of genetically modified (GM) animals might alter the public health ethos of OWOH strategies.

The fundamental difference to be distilled from this comparison is one between strategies of *containment* and strategies of *competition*. The OWOH agenda proceeds from a recognition that pathogens continually circulate in animal species, and deploys surveillance, biosecurity and biodiversity measures to limit infectious agents to circumscribed animal populations and environments. In contrast, transgenic alternatives refuse to relegate animals to their pre-defined role as hosts or vectors of human pathogens, seeking instead to reposition them as therapeutic barriers to infection. Thus, while OWOH programs try to maintain an equilibrium in the human–animal interface in order to limit the opportunities for pathogen circulation, transgenic strategies deliberately provoke a new ecological dynamic by introducing varieties of the host and vector species able to out-compete pathogen-carrying populations.

In delineating a transgenic foil to the OWOH agenda we hope to shed light on the fabric of unspoken assumptions that drive efforts to re-engineer human–animal exchanges, and to illuminate emerging points of friction between these two approaches to the management of infection. The juxtaposition of these distinct yet concurrent disease control models should direct our attention to the multiplicity of species entanglements in contemporary global health, and remind us of the fact that an interspecies contact zone is not simply an interface between discrete animal natures, but rather a locus of interaction that continually generates new and unpredictable agencies and encounters (Haraway, 2007; Kirksey and Helmreich, 2010; Brown and Kelly, 2014). The human–animal–ecosystem nexus is in this sense a dynamic one, where interspecies relations can be simultaneously symbiotic and parasitic (Lowe, 2010; MacPhail, 2004), and where biological niches are constantly being co-constructed and co-adapted (Fuentes, 2010; Margulis, 1999). With its focus on the integration of human and animal health, and its alertness to exchanges and mutations, OWOH discourse and activities accommodate some of these unpredictable organic agencies and ecological adaptations. The transgenic alternative, in contrast, operates by finding molecular triggers to interrupt pathogen transmission, repurposing the competencies of disease vectors and hosts for the benefit of human health. Genetic modification thus promises a kind of directed animal evolution, which would absolve humans from the need to alter their behavior in the service of disease prevention. Under this model, the *public* of public health programs acquires a very particular valence. Freed of the duties of care and restrain that typically come with OWOH policies, the public's burden is seemingly simplified and alleviated, its role reduced to providing (or refusing) consent for technoscientific interventions.

2. Methods

In contrasting biotechnological approaches to disease control with the assumptions and premises that underpin OWOH strategies we are necessarily sketching speculative scenarios. Although the development of genetically modified animals is proceeding apace, most of the transgenic organisms we discuss in this paper are currently laboratory creatures only: their experimental release, let alone their use under open field conditions, is still a distant prospect. Only one transgenic variety, *Aedes aegypti* mosquitoes modified to carry a conditional lethal gene that makes their offspring non-viable, has been released into the wild in large quantities. A full review of their performance, however, still awaits.

As a consequence, our analysis of transgenic animals and their effects on disease control programs is necessarily conceptual and conjectural. We have examined scientific publications, regulatory submissions and the limited evidence available from field trials in order to construct a series of hypotheses about the implications of these technologies. In addition, we interviewed transgenic chicken developers in the UK on the research and development process (3 recorded, transcribed, and de-identified interviews between 40 and 90 min each), and scientists involved in the development and experimental deployment of transgenic mosquitoes (2 recorded, transcribed, and de-identified interviews between 60 and 90 min each). This research was conducted between November 2012 and May 2014, with ethics approval obtained by the Central University Research and Ethics Committee at the University of Oxford. In order to appraise the likely impact of transgenic varieties on traditional practices of disease control we have also drawn on our own ongoing ethnographic research into poultry management practices in the context of avian flu (Porter, 2012, 2013) and mosquito control strategies in malaria-endemic contexts (Kelly and Lezaun, 2013, 2014). Below, we begin by outlining key trends in the development of animal biotechnologies for public health interventions.

3. Current transgenic options in a nutshell

The purposeful genetic modification of insects has a long history. Techniques of insect sterilization through radiation (SIT) have been used since the 1950s, primarily in the control of agricultural pests (Knipling, 1959; Krasfur, 1998). Beginning in the 1980s,