

Contesting genetic knowledge-practices in livestock breeding: biopower, biosocial collectivities, and heterogeneous resistances

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Abstract. Cattle and sheep breeders in the UK and elsewhere increasingly draw on genetic techniques in order to make breeding decisions. Many breeders support such techniques, while others argue against them for a variety of reasons, including their preference for the 'traditions' of visual-based and pedigree-based selections. Meanwhile, even for those institutions and breeders who promote genetic techniques, the outcomes are not always as predicted. We build on our recent use of Foucault's discussions of biopower to examine the effects of the introduction of genetic techniques in UK livestock breeding in order to begin to explore the diffuse and capillary nature of resistance within relations of biopower. We focus specifically on how resistance and contestation can be understood through the joint lenses of biopower and an understanding of livestock breeding as knowledge -- practices enacted within heterogeneous biosocial collectivities. In some instances these collectivities coalesce around shared endeavour, such as increasing the valency of genetic evaluation within livestock breeding. Yet such mixed collectivities also open up opportunities for counter-conduct: heterogeneous resistances to and contestations of genetic evaluation as something represented as progressive and inevitable. We focus on exploring such modes of resistance using detailed empirical research with livestock breeders and breeding institutions. We demonstrate how in different and specific ways geneticisation becomes problematised, and is contested and made more complex, through the knowledge-practices of breeders, the bodies of animals, and the complex relationships between different institutions in livestock breeding and rearing.

Introduction

Cattle and sheep breeders in the UK and elsewhere increasingly draw on genetic knowledge-practices in order to make breeding decisions. Such knowledge-practices contrast to traditions of assessing animals visually and on the basis of pedigree records. Particular genetic techniques include 'classical' statistical genetics, which use a series of measurements taken from animals' bodies to provide an estimate of their 'genetic merit', and genetic markers, which are identifiable genetic material supposedly related to particular phenotypic qualities. We build on our recent use of

Foucault's discussions of biopower to examine the effects of the introduction of particular genetic techniques in UK livestock breeding (Holloway, 2005; Holloway and Morris, 2007; Holloway et al, 2009; forthcoming a; Morris and Holloway, 2009) to begin to explore the nature of resistance within biopower, drawing on Foucault's own conception of resistance as "counterconduct" (2007) as well as on the ideas of commentators such as Coppin (2003), Haraway (2008), Nealon (2008), and Rose (2007). In examining a situation involving human nonhuman relationships, we focus specifically on how resistance and contestation can be understood through the joint lenses of biopower and an understanding of livestock breeding as knowledge-practices enacted within heterogeneous biosocial collectivities.

We begin the paper by establishing a theoretical perspective on how resistance and contestation might be expressed in multiple ways in situations where the intervention by humans in the lives of livestock animals involves complex associations of nonhuman animals, different groups of breeders, and diverse institutions. We first outline ideas we draw from Foucault's conceptualisation of biopower and from Rabinow's (1999) identification of biosocial collectivities as a useful way of understanding social groups with a shared experience of life informed by genetic science. We then rehearse arguments about including nonhuman life within these conceptualisations, so that relations of biopower and biosocial collectivities encompass heterogeneous forms of life rather than being limited to the human. We thus conceptualise genetic interventions in livestock as representing a mode of biopower jointly enacting forms of human and nonhuman life and argue that an understanding of *heterogeneous* biosocial collectivity is useful in understanding assemblages of humans and nonhumans ordered around complex understandings of genetics, bodies, relatedness, and markets. In some instances these collectivities coalesce around shared endeavour, such as increasing the valency of genetic evaluation within livestock breeding. Yet such mixed collectivities also open up opportunities for heterogeneous resistances to and contestations of genetic evaluation as something represented as progressive and inevitable. Several writers have focused on how resistance takes shape as counter to, or in relation to, biopower, in particular social circumstances (eg, Hannah, 2009; Legg, 2007; Ziarek, 2008) As Haraway (1991) notes, Foucault's approach is characterised by the sense that there is a continuous dialectic between power and resistance to power that power constitutes forms of resistance to itself. We focus here, then, on how resistance and contestation might be expressed in relation to biopower and through heterogeneous biosocial collectivities in the particular case of geneticisation and livestock breeding, drawing on Nealon's (2008) arguments about resistance and biopower.

In the subsequent empirical sections of the paper we explore various modes of heterogeneous resistances and contestation, focusing on the heterogeneous biosocial collectivities we studied during research into some of the genetic knowledge-practices which are increasingly drawn upon by cattle and sheep breeders in making decisions about breeding future generations of livestock that is, choosing which animals to mate with which (Gibbs et al, 2009; Holloway et al, 2009; Morris and Holloway, 2009). This 'geneticisation' (Gannett, 1999) of livestock breeding accords with a more general sense in which life has become increasingly apprehended through

various genetic knowledge-practices (eg, Haraway, 1997; Keller, 1992; 2000; Rose, 2001). Social scientists have in response called for critical analysis of the increasing valency of biotechnological knowledge-practices both at the large scale (eg, Braun, 2007; Parry, 2004; Rose, 2001; 2007) and, increasingly, at the localised scale of very specific and everyday encounters with genetic knowledge-practices in particular social contexts (Greenhough, 2006; Greenhough and Roe, 2006; Spencer and Whatmore, 2001).

In the case of livestock breeding we have focused on two genetic knowledge -- practices which are increasingly used on farms by individual breeders: estimated breeding values (EBVs) and genetic markers. EBVs represent classical genetics, and are a statistical calculation of the genetic merit of an animal based on a series of measurements taken from the body of an animal and from its relatives. Each measurement (for example, the animal's weight at 200 days old or the depth of fat in a certain part of the body) has an associated EBV. EBVs thus claim to provide a guide to the genetic strengths and weaknesses of an animal, providing an estimate of the genetic qualities of its offspring. EBVs can then be used in making selection decisions or in marketing animals as they allow comparison between different animals within a breed.

Genetic markers, in contrast, relate to actual genetic sites in an animal's genome which are associated with particular traits, such as meat tenderness. Tests on blood or hair samples are performed by private companies, with results being made available to the breeders who commission them. As a result some breeders are able to claim, for example, that their animals 'contain' high concentrations of particularly valuable genetic material.

These genetic knowledge-practices are strongly promoted by state institutions and private companies in the UK which claim that they are imperative to modernising and rationalising livestock breeding (Holloway and Morris, 2008; Twine, 2010). Indeed, EBVs and genetic markers are now represented as at the relatively 'low-tech' end of the geneticisation of livestock breeding, with moves towards techniques such as molecular profiling now seen as offering the possibility for a new "seismic shift in breeding practices" (Strauss, 2010, page 540). Despite this, consistent efforts are still thought necessary to legitimise EBVs and markers in order to persuade breeders on the ground to use them and to represent them as superseding 'traditional' ways of assessing livestock animals based largely on visual appraisal and records of ancestry (Holloway and Morris, 2008). Regular articles in the farming press, for example, showcase breeders using genetic knowledge-practices to achieve commercial success. The Welsh Assembly Government, via Hybu Cig Cymru (Meat Promotion Wales), has subsidised farmers' purchase of bulls with 'good' EBVs as part of its Welsh Beef Quality Improvement Project. In England the English Beef and Lamb Executive⁽¹⁾ (Eblex) is highly active in promoting EBVs through its Better Returns Programme newsletters and via training and discussion events held on livestock farms. A recent newsletter (Eblex, 2010, unpaginated), for example, urged breeders to consider that,

Good genetics are the basic building blocks of animal production. No amount of good feed or

management can overcome poor genetics. So it is worth taking time when buying a stock sire to source genetics that will have the greatest economic impact on your flock or herd ... In the past it was difficult to identify animals with superior genetics. But this is no longer the case. Tools like Estimated Breeding Values and Breeding Indexes are increasingly used by sellers of breeding stock to promote their animals, and to help buyers choose the right sires for their farms."

Meanwhile, Merial, a company selling genetic marker tests for cattle under the name IGENITY[®], promotes its technology thus (<http://uk.igenity.com>):

IGENITY[®] provides the beef industry with the most comprehensive genetic profile for multiple traits of economic importance. The insights gained from an IGENITY[®] profile help producers make more confident selection, management and marketing decisions.

The science behind IGENITY[®] gives dairy and beef producers the ability to know now -- with high accuracy -- a new dimension of an animal's genetic potential for milk, and meat production and quality."

These examples, of a public sector body and a private company, indicate how a genetic agenda is being constructed in the field of livestock breeding. Many breeders also support such techniques, yet others argue against them for a variety of reasons, including their preference for the 'traditions' of visual-based and pedigree-based selections. Indeed, the fact that the promoters of genetic knowledge-practices have to *continually* remake their arguments via the farming press, written and online materials circulated to breeders, and at on-farm presentations and discussions emphasises that scepticism about these techniques is deeply embedded. Meanwhile, even for those institutions and breeders who use genetic techniques, the outcomes are not always as predicted: animal bodies do not match their genetic markers, customers query the validity of quantitative measures of genetic merit, or markets fail to recognise the supposedly enhanced value of animals with particular genetic qualities. Focusing on the UK, our research engaged with breed societies,⁽²⁾ pedigree and commercial livestock breeders, and a wide range of institutions associated with the beef and sheep meat sectors. These institutions included state agencies and private companies with an interest in promoting more 'progressive' agricultural techniques, research institutes involved in developing genetic knowledge-practices for livestock breeding, and companies involved in the meat 'supply chain' as food processors, abattoirs, and so on (see Holloway et al, forthcoming b). In this paper we draw specifically on in-depth interview research with representatives of a diverse range of twenty-one beef cattle and sheep breed societies and with twenty-five livestock breeders. We focus on how genetic legitimisation practices are contested and resisted through the knowledge-practices of breeders, through the bodies of animals, and through the complex relationships between different institutions in livestock breeding and rearing. It is important to acknowledge from the outset that our empirical context, concerning the relationships between an increasingly powerful geneticisation in livestock breeding and forms of resistance to that geneticisation, is situated within an agricultural framework in which the commodification and

exploitation of livestock animals is not in itself in ethical question. While recognising the existence and importance of alternative perspectives on the ethics of animal agriculture (see Twine, 2010), in this paper we explore tensions between different knowledge-practices constrained by a common agricultural worldview.

Biopower, heterogeneity, and resistance

Foucault's (1990; 2003; 2007; 2008) descriptions of biopower can be seen in essence as a turn towards the *fostering of life* as the point of attention and intervention of power knowledge relations. For Foucault the emergence of biopower as what Nealon (2008) has described as an intensification and generalisation of existing disciplinary relations came about from the late 18th century in Western Europe and was associated with the establishment of new forms of scientific and demographic knowledge-practices concerning humans as living beings and as populations. Foucault argued that, as such, biopower consists of an anatamopolitics focused on the capacities and subjectification of individuals, which was articulated with a biopolitics focused on knowledge of and interventions in the biological *processes* (eg, birth and death rates, levels of ability to contribute productive labour) through which the constitution of the population of a particular territory was understood. As Rose (2007, page 53) argues, biopower emerges from struggles to understand and intervene in the specific problems of constituting and managing populations and "the vital processes of their subjects ... a multitude of attempts to manage their life, to turn their individual and collective lives into information and knowledge, and to intervene on them."

For the purposes of this paper four further ideas are important. First, the emergence of biopower is necessarily linked to capitalism, which "would not have been possible without the controlled insertion of bodies into the machinery of production and the adjustment of the phenomena of population to economic processes" (Foucault, 1990, page 141). At the same time as the modelling of bodies so that they were fit for such insertion, collective shortcomings within populations could be identified and tackled. Biopower thus implies a dual focus on enhancing, or the 'optimisation' of, life and on mapping the susceptibility of populations to illness and other shortcomings (Rose, 2007).

Second, in intervening in the life processes constituting populations, normalisation or regularisation becomes important. For Foucault (1990), then, a biopower "whose task is to take charge of life needs continuous regulatory and corrective mechanisms ... such a power has to qualify, measure, appraise, and hierarchise ... it effects distributions around the norm" (page 144; 2003). The norm is something which circulates between and associates anatamopolitics and biopolitics (Nealon, 2008) and which is produced by and produces systems of measurement as well as understandings of deviation and distribution within the biological processes constituting populations. Third, given the importance of normalisation and regularisation, it becomes important to develop techniques which deal with variation in such a way that probabilities can be calculated, and that the probability of achieving desired effects can be increased. Deleuze (1988) writes that

biopower thus implies "administering and controlling life in a particular multiplicity, provided the multiplicity is large (a population) and the space spread out or open. It is here that 'making something probable' takes on its meaning" (page 61). This sense of a 'spread out' or 'open' field is echoed in Nealon's (2008) argument that relations of biopower go beyond the institutionalised settings of Foucault's earlier disciplinary conceptualisations of power, saturating the spaces of everyday life and entire populations. Fourth, biopower is associated with a mode of subjectification which encourages the individual to regard themselves as an enterprise-as an "entrepreneur of himself [sic]" (Foucault, 2008, page 226). Anatomopolitics is framed here explicitly in terms of the individual's genetic inheritance and in terms of the investment needed to invest in and enhance that inheritance. As McNay (2009) argues, "Individuals would be encouraged to view their lives and identities as a type of enterprise, understood as a relation to the self based ultimately on a notion of incontestable economic interest" (page 56). We return to these four ideas shortly.

Attempting to provide an analytical framework for framing particular moments of biopower, Rabinow and Rose (2006) summarise it as comprising the establishment of truths and authorities concerning life, interventions in the 'life' of populations and individuals, and modes of subjectification through which individuals come to work upon themselves as living beings, aligning their individual consciousness and behaviour with truth discourses and strategies concerning the improvement of their life. They discuss how the interventions associated with biopower can be directed at specific populations defined as 'biosocial collectivities' (see Rabinow, 1999) groups associated with the emerging truth discourses of genetic science and the (for example) industrial and academic power knowledge structures which surround it (Gibbon and Novas, 2008). Rose (2007) argues that biosocial collectivities are activist in nature, forming in relation to shared medical experience, for example. We argue that this *intentional*, activist understanding makes biosocial collectivities different from the more passive sense in which populations might be understood and see them as groupings in which what is at stake in a set of social relationships is fundamentally a biological issue. Increasingly, such issues are expressed around genetic sites of knowledge (Gibbon and Novas, 2008).

Developing these ideas for the empirical case (livestock breeding) with which this paper is concerned, we argue that it becomes important to think about how nonhuman animals -- cattle and sheep -- can be conceptualised, in their coconstitutive relationships with humans, as enrolled into relations of biopower and into biosocial collectivities. Several writers have argued that nonhuman life, as well as human life, is in some instances subject to relations of biopower. Haraway (1997), for example, refers to its interventions in living organisms, without specifying that these need be human. For some, 'nature' or life generally has been seen as something intervened in, in ways related to Foucault's conceptualisation (eg, Rutherford, 2007; Youatt, 2008), whereas for others claims have been made that it is an appropriate lens for viewing animals specifically (eg, Holloway et al, 2009; Morris and Holloway, 2009; Twine, 2007; 2010). These authors have argued that the focus of biopower on the fostering or enhancement of life-and on

the processes constituting populations, such as birth, death, and morbidity rates-make its power knowledge relations something which permeates nonhuman as well as the human species. A more heterogeneous understanding can thus emerge despite Foucault's anthropocentrism.

In addition, as we have argued elsewhere (Holloway et al, 2009), we might also understand some sorts of biosocial collectivities in such a heterogeneous fashion, regarding them in some circumstances, such as livestock breeding, as assemblages of humans and nonhuman animals taking shape around different and changing knowledges concerning the fostering of life in agricultural and food systems. In a similar fashion van Dooren (2008) describes the heterogeneous biosocialities associated with agribiodiversity: they "are *biosocial* networks in which humans are mixed up with countless nonhumans" (page 682, original emphasis). Genetic truths and interventions coconstitute humans and nonhumans in heterogeneous biosocial collectivities from which effects of agency emerge (Latour, 2004). Although in some circumstances this heterogeneous, emergent agency may be aligned with discourses and practices interested in fostering life in accordance with modernising, rationalising, and geneticising impulses, it may also involve resistance to or contestation of anatomopolitical or biopolitical knowledges and interventions. A useful example of this in relation to pig farming is provided by Coppin (2003), whose analysis of farmers and pigs in 'mega-hog farms' articulates their joint agency in modes of resistance as well as their mutual subjection to disciplinary relations. As a conceptualisation descended in part from Foucault's biopower, then, heterogeneous biosocial collectivities centred around the life of mixed-up human and nonhuman entities provide a useful way to start thinking about resistance and contestation.

Returning briefly to the four ideas introduced in relation to biopower above, we can address them to this heterogeneous sense of biopower and biosocial collectivity in the specific case of genetic knowledge-practices and livestock breeding. First, we address capitalist enterprise. Livestock breeding in contemporary agriculture is very much to do with the controlled production of animal bodies suited for insertion into particular farming assemblages of humans, nonhumans, land, buildings, and technologies, and it is certainly to do with adjusting bodies (for example, their corporeal compositions of meat, fat, and bone) and the processes (such as growth and birth rates) constituting the populations they are part of to suit particular economic conditions. Genetic knowledge-practices are increasingly playing a role in this control, subtly affecting how decisions are made, what becomes the target at which interventions are aimed, and what kinds of bodies are produced. Second and third, we address normalisation and making probable. The way in which genetic knowledge-practices in livestock breeding rely on sets of quantitative measurements and the generation of statistical estimates of the likelihood that animals will pass on desirable traits to their offspring creates possibilities for generating and representing new kinds of norm. Individual animals can, for example, be compared according to their statistical EBVs, while calculating population (eg, herd or flock) average EBV allows change over time and differences between populations to be represented graphically. It can thus be suggested that animals or populations *should* embody particular statistical or genetic characteristics, and their

conformity to or deviation from such norms are easily measured. As such, these norms mediate between the anamopolitics of individual animals and the biopolitics of groups of animals situated in breed biosocial collectivities.

Since these particular norms relate to the genetic 'potential' of animals, they are interlocked with interventions aimed at making more probable the production of future generations of animals with desired characteristics. Fourth, we address subjectification. In breed-society heterogeneous biosocial collectivities breeders work on themselves simultaneously with their work on their animals, aligning both with the sense of 'enterprise' that Foucault identifies as a central discourse of (human) subjectification. Genetic knowledge-practices imply investment and intervention in both the human and nonhuman members of such collectivities, inscribing discourses and practices of improvement and genetic 'truth' onto breeders and livestock animals alike. Working on themselves in accordance with such discourses (by, for example, seeking to become more knowledgeable about genetic techniques), human members of the collectivity enrol animal members with particular implications for their bodies and 'life'.

Given the complexity of interventions implied by the process, knowledges, and practices of geneticisation that is, the progressive scientific preoccupation with understanding and manipulating living organisms on the basis of genetics (Gannett, 1999; Keller, 1992; 2000; Rose, 2001) the capability of Foucault's conception of biopower for encompassing how life is framed in the heterogeneous biosocial collectivities of contemporary livestock breeding might be open to some questioning. Haraway (1991), for example, argues that "biopolitics is a flaccid premonition of cyborg politics" (page 150). Her cyborg ontology -- a hybridity of bodies and technologies -- suggests a need to be able to account for relations of biopower that explicitly draw in technologies (such as biotechnologies and information technologies) which were not conceived of in Foucault's thinking. Haraway (eg, 1997; 2008) has thus referred to an expanded conception of 'technobiopower'. But, she also confirms that relations of technobiopower ought not to be limited to humans. As she confesses, "Foucault's own species chauvinism had fooled me into forgetting that dogs too might live in the domains of technobiopower" (2008, page 60). This applies to cattle and sheep too. A shift from biopower to technobiopower, then, suggests a need to take into the account the particular technological qualities of geneticised 'truths' and interventions relating to heterogeneous livestock breeding biosocial collectivities. How such collectivities are constituted needs consideration alongside how, in varying ways, they may embody resistance towards the modernising impulses associated with geneticisation.

Biopower, biosocial collectivity, and (heterogeneous) resistance

As Foucault (2008) argues, anamopolitical and biopolitical strategies are susceptible to challenge. First, for example, while individuals become expected to regard their bodies and capacities in terms of an enterprise from which they generate income as "abilities-machines"

(page 229), there is no certainty that they will understand themselves and act upon themselves thus. Second, attempts to intervene in the life processes which constitute populations may not always be successful; "If one says to a population 'do this', there is not only no guarantee that it will do it, but there is quite simply no guarantee that it can do it" (Foucault, 2007, page 71). Nevertheless, continuous attempts are made to make sense of and transform populations, even if they cannot be changed by decree. Here, we note some general points about biopower and resistance and explore two particular dimensions of resistance or contestation in relation to the geneticisation of livestock breeding knowledge-practices.

For Nealon (2008) Foucault's perspective is that there is potential for resistance in all power relations. As Haraway (1991) suggests, it is characteristic of Foucauldian thought that power relations dialectically produce their own modes of resistance.

In the case of biopower Rose (2007) reminds us that it is not a homogeneous set of relations: as

a fragmented field of contested truths, heterogeneous and often conflicting authorities, diverse practices of individual and collective subjectification, competing ways of thinking and acting, and divergent opinions about what were the most important, and most appropriate, objectives for authoritative action" (page 54),

the power-knowledge relations constituting biopower leave open multiple spaces for resistance and contestation. Nealon (2008) argues that, in the same way as biopower involves the becoming-mundane of disciplinary power relations, resistance to biopower is also mundane and draws on subjugated, 'disqualified' knowledges 'from below' which act against the imposition of forces 'from above'. He writes, "as power becomes increasingly more invested in the minute details of our lives, so too have our modes of resistance become increasingly subtle and intense" (page 108). In a similar fashion Haraway's (1991) concept of 'situated knowledge' represents the tacit knowledge-practices of (some) practitioners in an arena such as livestock breeding, contesting increasingly powerful genetic knowledge-practices represented as objective, scientific tools for intervening in agricultural biosocial collectivities. Far from resistance being simply in dialectical opposition to power, then, biopower and resistance to biopower involve complex, shifting and unpredictable fields of relations between different actors and knowledge-practices.

In his 1977-78 lectures, Foucault (2007) tackled the problematic way in which 'resistance' is often taken to imply the deliberate and responsive actions of particular subjects, settling on the term 'counter-conduct' to suggest "much more diffuse and subdued forms of resistance" (page 200) that are necessarily copresent with attempts to guide the conduct of individuals through the production of specific truths (Porter, 2010). Counter-conduct is "the sense of struggle against the processes implemented for conducting others" (Foucault, 2007, page 201). In using the term 'resistance', then, following Nealon (2008), we are drawing on an explicitly Foucauldian understanding of it, not as something invested in particular subjects or actions, nor as

something merely responsive to and following from an attempt to exert power, but as something which is always already alongside power and which is part of capillary processes of counter-conduct which pose alternate truths, authorities, knowledges, and moralities to those being established by 'power'.

In relation to livestock breeding we make two more specific points which also allow us to develop a more heterogeneous and distributed perspective on resistance in livestock breeding biosocial collectivities. The first relates more to the human members of collectivities, the second to human and nonhuman members.

First, as noted above, individuals will not necessarily respond to subjectification processes by aligning themselves with discourses encouraging them to work on themselves in particular ways. New categories of 'problematic person' may thus emerge, consisting of those who reject the calls to act upon themselves in accordance with the demands of emergent genetic knowledges of health, reproduction, and so on (Rose, 2007). For Rose, acting in relation to such genetic knowledges can itself become a norm, an expectation, with nonalignment attracting critical judgments. Extending this, individual and groups of humans may not align themselves with discourses encouraging them to work in particular geneticised ways on the animal bodies and populations with which they are entangled in heterogeneous biosocial collectivities. They may similarly attract criticism. In many cases resistance is associated with a disjunction between existing and new knowledge-practices. In instances of human genetic knowledge-practices resistance to alignment with genetic discourses may, for example, be associated with the persistence of "older categories of classification[which] inform, provide the framework for or exist in tension with new kinds of biological identities ... older cultural categories have as much potential to be reinforced in relation to biological trajectories as novel modes of identity and identification" (Gibbon and Novas, 2008, page 6; see also Rabinow, 2008). Foucault (1990, page 147) himself notes the importance of the metaphor of "blood" and the "value of descent lines" in how people understand themselves and their relations to others, contrasting to the sense, under biopower, that what are important are the characteristics and capacity of the population as a whole. Again, in these cases there are clear associations with the worlds of livestock breeding, in which 'traditional' knowledge-practices, in part based around the 'blood' relations of pedigree and ancestry, remain significant (Derry, 2003; Orland, 2004; Ritvo, 1987).

Second, the focus of biopower on 'life' suggests that the heterogeneity of livestock breeding biosocial collectivities might present novel inflections on how resistance and contestation take form in relation to the "re-problematisation of 'life'" (Rabinow, 2008, page 188) which geneticisation represents. A similar example is suggested in Porter's (2010) example of counter-conduct emerging in attempts to deal with avian influenza in Vietnam. Life, for Foucault (1990), continually escapes the techniques of biopower. In heterogeneous collectivities resistance can be thought of as extending beyond human intentionality, becoming distributed in the relationships between humans and animals in livestock breeding. For Deleuze (1988), for instance, resistance to biopower emerges from a vitality which transcends species boundaries; "when power becomes bio-

power, resistance becomes the power of life, a vital power that cannot be confined within species, environment or the paths of a particular diagram" (page 77). A further point is made by Youatt (2008) in considering how nonhumans are engaged in relations of biopower with humans. He argues that nonhumans, as subjects of biopower, are different from humans, yet that their capacities to act make them potentially more important as sources of disruption and resistance. Youatt's contention is that we should consider the dialectics of the relationships between nonhumans and biopower in particular circumstances -- biopower involves a range of interventions in the lives of nonhumans, but at the same time the particular capacities of nonhumans transform relations of biopower. Going back to Foucault's comments about the inability to *make* populations transform in accordance with interventions aimed at making certain outcomes more probable, where we are dealing with heterogeneous biosocial collectivities, the ways in which such interventions are or may be resisted are thus extended by considering some of the ways in which nonintentional nonhuman agency and capacity are implicated. An important point here is the openness of the set of probabilities regarded as the 'life' of the (human and nonhuman) subjects of biopower, and this is key to a conceptualisation of heterogeneous resistance in livestock breeding. Foucault (2007) describes how biopower is in part to do with controlling circulations (in livestock breeding this might include of bodies and genes) so as to deal with future uncertainties. Biopower is a process of "maximising the positive elements, for which one provides the best possible circulations, and of minimising what is risky and inconvenient ... while knowing that they will never be completely suppressed" (page 19). At the same time, then, as human nonhuman inability or unwillingness to conform to a geneticised regime of biopower there is also inevitable uncertainty on the part of the promoters of geneticisation both of the immediate corporeal and collective effects of specific genetic interventions and of the future conditions into which the heterogeneous products of such intervention will be placed. Here, again, resistance or contestation may take shape, with uncertainty about plural possible futures acting back on present truths, authorities, interventions, and subjectivities.

In the following empirical sections we focus on bringing these two points together and discussing them with reference to the interview research mentioned at the start of the paper. We suggest that, instead of simply focusing on the problematic persons identified by Rose (2007), such 'persons' are actually produced by sets of heterogeneous relationships associated with genetic knowledge-practices in livestock breeding. This allows us to move away from the representations which have figured so heavily in much 'innovation adoption' research of individual actors as either 'adopters' or 'nonadopters' of new knowledge-practices (Fish et al, 2003) and to understand the resistance which is immanent to relations of biopower (Haraway, 1991) as an effect of heterogeneous biosocial collectivity. As such, then, we try to identify sets of relationships which constitute what have become 'problematic heterogeneous *biosocial collectivities*' -- not *individual people*, which in different ways enact resistance to the increasing establishment and legitimisation of

genetic knowledge-practices. We suggest that such collectivities can exist at different scales. At larger scales a collectivity could be equivalent to a breed society, including its human and nonhuman members. At smaller scales a collectivity could represent the breeder(s) and animals located on an individual farm. As such, even within a larger-scale 'breed-society' collectivity which, as some do, strongly engages with genetic knowledge-practices (Holloway et al, 2009), there may exist smaller-scale 'problematic' collectivities which express resistance to the geneticisation being practised by the larger collectivity of which they are part.

Heterogeneous resistance and livestock breeding biosocial collectivities

In this section we draw on our empirical research with breed-society representatives and breeders⁽³⁾ to briefly explore just two examples of the kinds of heterogeneous relationships that effect resistance to livestock breeding geneticisation. First, we look at the idea of resistance which derives from 'interference' (following Mol, 2002). Second, we look at how resistance emerges alongside particular experiences of genetic knowledge-practices. The examples illustrate how particular sets of relations produce resistance to geneticisation and biopower across the different scales described above. In each case we use the comments derived from in-depth interviews to illustrate how it is different and specific sets of relationships, rather than individual human actors, which produce resistance and also focus on how breeders articulate resistance and contestation from their positions within the collectivities they are part of. In these instances 'problematic collectivities' emerge from relations of resistance. Using Rabinow and Rose's (2006) summary of biopower, the key truths, authorities, interventions, and subjectivities of discourses of geneticisation are contested within heterogeneous collectivities of the human and the nonhuman.

Resistance and 'interference'

Heterogeneous, distributed resistance to geneticisation was evident in relation to interference (Mol, 2002) where a variety of factors, both human and nonhuman, act in relation to one another to literally interfere with and disrupt genetic knowledge-practices and their predicted outcomes. In the following cases resistance was evident in the breeders' questioning of the utility of EBVs in the face of both the breeders' very variable management practices (eg, different feeding regimes) and the nonhuman 'external' influences (eg, variable weather conditions) over which breeders have very little control. A pedigree Lleyn sheep breeder prefaced the following by emphasising his scientific background in biology and chemistry:

When you're talking to someone about genetic influences, I know damn well that there are an awful lot of influences that are involved in the way that a lamb grows and it's not all down to genetics. *There's a hell of a lot of external influences there.* When they're trying to sell me something that says "This will give you the best approximation possible of an animal's genetics" there are some ways that you do feel a little bit sceptical. Because things like prolapses in sheep some of it is genetic, yes, but a lot of it is down to management. If you

overfeed those ewes then they are more likely to prolapse Same with mastitis and growth rates. I know they try to take into account different effects, such as climate and stuff, but even on my farm I've got different land types, I know that some fields are better than others, some might have a terrible time with worms or rain. Sheep do not do well when it's raining all summer, they hate it and they don't grow. That is not a genetic effect. It is purely a climate effect and some sheep may fare better than others. Although I think it's a useful tool, I think people need to be careful that we don't just go down that route 100% because *there are other things that affect how a sheep or cattle grow*" (emphasis added).

Although he used genetic marker technologies on some of his sheep, a commercial cattle and sheep breeder highlighted the futility of any effort to 'manipulate' his hill flock through the use of performance recording because "[t]he weather manipulates the hill flock. So whatever you do is going to ... it will be what it will be. You can spend as much time as you like trying to improve it and if you had like we had this summer, two months of rain, it just knocks it on the head."

The difficulties in controlling for the effects of genetics, as predicted by genetic breeding technologies, when many other factors and processes (complex combinations of the human and nonhuman) are likely to interfere with the outcomes were also illustrated by a beef breed society representative when discussing genetic markers for tenderness:

Various things affect tenderness. Genetic makeup is one thing, management, the way it's killed the way it's hung, the ways it's packed. All those things affect the tenderness and we were looking at the genetic side of it. Within the genetic side of it is there is very little variation. So in theory, there is no reason why all [name of breed] meat shouldn't be of similar tenderness when it's killed which, of course, other factors affect that."

This interviewee refers to the breed society's involvement in testing genetic markers in his breed's population, but their scepticism about the purported value of such testing derives from the more complex set of relationships which surround rearing, slaughtering, and butchering animal bodies within this particular human nonhuman collectivity. These complexities interfere with the apparently objective work done by the test, to produce a heterogeneous resistance to the genetic enactment of an animal. Humans, and nonhuman entities (as animals or meat), will not necessarily act in ways which confirm the expectations produced by genetic testing.

These examples suggest that a whole set of factors, related both to human management of animals and to external, 'environmental' conditions, 'interfere' with what might be expected of an animal on the basis of the use of genetic techniques.

Interference can also derive from an active attempt to intervene in the lives of livestock animals with the intention of disproving and challenging genetic information which presents particular animals badly. The following comment was made by a cattle breed-society representative and refers to a breeder who is trying to overcome a prevalent perception that his breed suffers from high levels of calving problems, resulting in high numbers of births by caesarean section, a costly process also detrimental to animal welfare. What is important here is that use of EBVs is resisted because of the disjuncture between their tendency, due to the way they are calculated on

the basis of a wider breed population, to show 'poor calving' for the breed and the high level of 'natural calving' achieved for this particular farm's collectivity attributed to the breeder's specific management interventions.

Now, he won't record because a lot of the [EBV] stats coming up are showing that he has poor calving, and in actual fact everything on his farm he virtually calves naturally, and this is where his ... I would argue strongly, *his management influence is overriding the genetics* ... and I would say his experience and his management stuff, that he calves all his cows down in a very lean condition, so his management is overriding the problem there and they all calve naturally" (emphasis added).

Here, then, the breeder's action (nutrition management of the in-calf cow) in association with the bodies of both cow and calf (weight loss prior to birth producing a smaller calf that can be delivered without intervention) interferes with -- and hence effects a resistance to --the genetic evaluation of that cow, and other cows within the same herd, as being problematic in genetic terms.

In this section we illustrate how resistance in livestock breeding collectivities can be produced by very specific interferences which destabilise the purported truths and authorities associated with geneticisation. Interferences can relate to 'external' environmental factors, or to 'internal' management practices, but in all cases make the interventions of genetic knowledge-practices more complex and problematic for a collectivity than is suggested by their proponents. Genetic techniques are often represented as simplifying decision making, yet in the specific and heterogeneous contexts of particular collectivities things instead become more complicated. As such, here, the sort of diffuse resistance or counter-conduct which is evident is an effect of both the internal relationships constituting a collectivity and the relationships between the collectivity and its 'environmental' situation.

Resistance, experiences, and entangled ways of knowing life

In our second empirical section we deal with how discourses of geneticisation become compromised within a heterogeneous biosocial collectivity by specific experiences of genetic techniques and their effects. These experiences can relate to a breeder's own experiments with a technique or, more frequently, relate to knowledge of what has happened to other breeder animal collectivities when genetic techniques have been deployed. The tendency here is for particular experiences to show that the use of genetic techniques in specific collective circumstances is complex, contrasting to their representation as a way of simplifying breeding decisions. The 'complexification' of genetic techniques represents another way in which particular collectivities become problematic for geneticisation as a mechanism through which biopower's interventions in the life of livestock animals is expressed.

For some breeders experimentation with genetic techniques produces dissonances between different ways of knowing their animals. As one cattle breeder said, referring to attempts to use EBVs,

... from the experiments that I've done with my own cattle ... it doesn't seem to particularly tie in with my knowledge of the animal."

In cases like this the production and circulation of different sorts of knowledge, such as 'traditional' visual assessments of animals and genetic valuation, within a collectivity produce a resistance to geneticisation where the results of the genetic technique do not accord with a tacit knowledge of the animal body. This is a heterogeneous resistance as it depends on what becomes a problematised relationship between knowledges and bodies within a collectivity.

This coexistence of and tension between traditional and genetic truths is a persistent theme in breeders' expressions of how they act counter to geneticisation. The representative of a sheep breed society discussed how she had experimented with EBVs with some of her own sheep but it had "gone against everything that my gut feeling has told me ... in some instances". She went on to elaborate that in the case of specific ewes the genetic evaluation for those ewes put them "on the bottom of the scale" and yet "they are still consistently breeding because I know what rams put in them". What is important here is what the ewes *do* that is, they 'breed consistently' -- and it is this evidence, the outcome of an ongoing association or relationship between breeder and animal within this farm-scale collectivity, that produces resistance to the alternative genetic truth expressed in this animal's EBV record.

Evaluating animals through visual observation and touch which involve, as in the above cases, the breeder acting in relation to individual animals' bodies also emerged as a significant source of resistance to genetic ways of knowing. Frequently referred to as 'the stockman's [sic] eye', the following comments from representatives of sheep and beef breed societies illustrate how EBVs are rejected in favour of an animal selected through visual knowledge-practices:

there are still people who are trying to improve the breed through recording schemes ... that happens with every breed ... those that just want to breed based on numbers, and the other people that want the breed say, well *it might have a good number but it looks crap, so it's out*. You know, using the stockman's eye ..." (sheep breed society representative, emphasis added).

People still go by eye. ... I mean, *if you don't like the look of something, you're not going to buy it anyway ... no matter what the performance figures are*, if it doesn't look right, you know. ... [Y]ou may get these figures as good and then you get there [to a bull sale] and he has long plain face, which you absolutely hate, and you wouldn't buy that. ... [*Y]ou have got to have, to look at the thing every day, and if you don't like the look of him ...*" (beef breed society representative, emphasis added).

The continued valency of traditional, visual assessments within breed collectivities, in which formal statements of ideal animal appearances are very significant, produces resistance to geneticisation where genetic techniques give very different evaluations of animals' relative quality. Likewise, the power of the visual is invoked in problematising genetic marker technologies. One breeder of pedigree Suffolk sheep, for example, stated he "just couldn't see it [genetic markers] working at all. I went to a meeting and one top pedigree guy summed it up, if a sheep doesn't please the eye it doesn't please nothing. I go visual all the time with my sheep more or less."

Visual assessment of animals is often accompanied by touch, a practice that necessarily brings breeder and animal into close physical association with one another. The same breeder of pedigree Suffolk sheep explained that he does not use a ram "just because they are high EBVs, you have got to handle them, got to handle them and feel the muscle on them and make sure they are structurally sound, good feet and good jaw and everything. I mean it [performance recording] is ... not the be all and end all." The materiality of an animal's body, experienced directly through touch, remains important to breeders when selecting animals for breeding and a means through which genetic evaluation can be brought into question even in those cases where some value in this approach to breeding is acknowledged.

In these collectivities, then, relations between humans and livestock animals are strongly dependent on 'traditions' of visual assessment and experiential knowledge. Indeed, breed-society collectivities are very much constituted *around* such traditions, such that, for example, what an (animal) member of the collectivity should look like is written down, guiding the knowledge-practices of other (human) members. We are careful here not to naturalise or valorise visual and experiential traditions, but draw on distinctions made by breeders (and many other actors in livestock breeding networks) between these and 'new' genetic knowledge-practices. Here, resistance and counter-conduct emerge in specific situations as the existing knowledge-practices of a collectivity encounter new genetic techniques which in many cases explicitly challenge the ways of thinking and doing which are central to the constitution of breeding collectivities.

In many other circumstances breeders commented on their perceptions of the negative effects of other collectivities' attempts to deploy genetic techniques. What again becomes problematic here is the emergence within a collectivity of the often unexpected consequences of geneticised breeding strategies. One breeder described how he had:

spoken to a few people that used to be with the Charollais sheep and they went into recording [EBVs] in a big way, well years ago now, and some of them, and they are top breeders within the Charollais breed, they said that it spoilt the breed ... I think what they said was that they went for too lean you know, ... the indexes were better for a leaner carcass and of course what happened then, people were buying these rams and the lambs weren't fattening quick enough" (sheep breeder).

Another commented that:

You'll see a flock that had gone figures [EBVs], figures, figures, high indexes all the time, but you'll have seen that his sheep have just got less and less and less appealing and less in size and just haven't got anything about them, you can't help but thinking the system is letting him down. And we've been to shows, and there was one flock in Lincolnshire in particular that used to do quite well at the Lincolnshire Show when he was breeding by eye, and he went into sire referencing and he went extreme with figures and his sheep ended up coming bottom in a line every time to the point where he had an argument with the judge one year and refused to show his sheep again" (sheep breeder).

In these two cases geneticisation is contested by other ways of knowing and valuing animals

within a collectivity. The first emphasises the potentially damaging consequences for overall bodily conformation and carcass value of basing breeding decisions on genetic techniques which measure only one trait (leanness, in this case). The second suggests that genetic techniques can open up aesthetic differences between breeding in accordance with EBVs and breeding to the visual criteria of a set of breed standards/criteria which are important in holding a heterogeneous biosocial collectivity together as they articulate essential relations between animal bodies and breeding decisions.

Conclusions

That these forms of heterogeneous resistance are regarded as problematic by actors promoting genetic interventions in the life of livestock animals is evident in continual efforts to promote genetic techniques, as pointed out earlier in this paper. What become seen as 'problematic persons' (although we have articulated them here as the product of problematic collectivities caught up in specific sets of relationships, rather than as individual breeders who resist genetic techniques) are continually targeted by efforts to persuade them to transform their collectivities by adopting genetic techniques. One breeder described such persistent efforts to enroll breeders, at the same time reemphasising how for this collectivity geneticisation was very much open to contestation:

But they will keep pumping it and pumping it in these magazines at the moment, trying to get people to latch onto it I suppose. But it's not worked. They've been recording for all these years and it's not worked. You've still not converted the commercial farmer into buying rams with high indexes. ... I think if the recording system was right, and they were getting it right and they were depicting those better rams, then everybody would have gone down that line and commercial farmers would be using that line. But I think it proves to you that because they've had some sort of recording system for 30 or more years and it's never really taken off or grown any, and because there's so many breeders like myself that have just lost heart in it, doesn't that tell them that they've not got it right?" (sheep breeder).

We see this as biopower in operation in relation to heterogeneous biosocial collectivities. What this breeder is referring to are the strategies used by authoritative actors to spread genetic truth discourses and to foster genetic modes of intervention in livestock breeding practices, to work on breeders' subjectivities, and to get them to work on their animals in accordance with genetic truths. But what is simultaneously present is the heterogeneous, collective resistance to this that Haraway (1991) argues must be the dialectical effect of strategies of biopower and the emergence of what become, for the 'authorities', problematic collectivities which actively and discursively contest geneticisation.

As we noted earlier in the paper, Foucault (2007) argues that "If one says to a population 'do this', there is not only no guarantee that it will do it, but there is quite simply no guarantee that it can do it" (page 71). In some of his work, so Revel (2009, page 52) argues, Foucault "seems to turn the definition of biopowers into a space for possible resistance, proposing that life can assert its own capacity or force for creative becoming, a potential that cannot be owned by power,

emerging in the very space invested by the procedures of management, control, exploitation and captation of individuals." The inweavement by or artfulness of power's truths and authorities implied by Revel's term 'captation' suggests that the way in which collectivities become problematic for the promoters of geneticisation is in part to do with how actors remain sceptical of or directly challenge genetic truth and authority. But, in addition to the (human) scepticism and resistance which might be expressed, the empirical examples used in this paper begin to suggest why, in particular circumstances, heterogeneous biosocial collectivities will not act in accordance with the 'truths' contained in (in this case) discourses of geneticisation. Within such collectivities of humans and livestock animals 'life' and the relationships it is constituted within can, in the specific ways we have suggested, produce diffuse, capillary modes of resistance to the biopower of geneticisation. Livestock breeding intertwines the lives and life of humans and nonhuman animals so that counter-conduct in relation to geneticisation is coproduced in the materiality of animal bodies and the agency of humans in acting on themselves and their animals.

The paper has thus extended an emerging literature on Foucault and biopower which attempts to use concepts of biopower to analyse heterogeneous sets of relations involving humans and nonhumans. In particular, the paper has focused on a diffuse, capillary, and decentred notion of resistance or counter-conduct which is necessarily simultaneous with relations of biopower, in heterogeneous biosocial collectivities which can be articulated at different scales. We have referred, for example, to the farm scale (eg, a breeder and his or her animals) and a breed-society scale (a formally constituted national organisation consisting of the society's officers, many breeders, many groups of animals, and more-or-less formalised records, written rules, and membership criteria, etc). Focusing on collectivity, then, the paper has extended Rose's (2007) concept of the 'problematic person' (that is, the person who does not accept injunctions to work on themselves in particular ways) within an increasingly geneticised society to argue that in the cases we have examined what is more important is the specific and heterogeneous relations which, at different scales, constitute what we have called 'problematic heterogeneous biosocial collectivities'. These collectivities express, in very specific and relational ways, resistance to geneticisation as a form of biopower.

As such, the paper demonstrates that resistance to biopower and geneticisation can be expressed in different ways, at different scales, but is always heterogeneous rather than dependent on human actors. How resistance is articulated is always specific to particular sets of relations and to particular places and moments.

Yet, despite this particularity we argue that it is possible, in an heuristic fashion, to describe 'categories' or modes of resistance in examining a particular empirical field. We have used but two of these to illustrate our empirical discussion. The relations of resistance explored through our research into the contested geneticisation of UK livestock breeding suggest that resistance in these cases is complex and never complete: the resistances to geneticisation we have expressed are subtle

and sometimes ambivalent. Baldly, it is not an either/or situation in which breeders or collectivities either do or do not 'accept' or 'adopt' new genetic techniques in livestock breeding (cf the traditions of 'technology transfer' or 'innovation diffusion' literatures). Instead, collectivities are associated with complex mixtures of acceptances and resistances which change over time, are expressed differently in relation to different genetic techniques or in relation to different populations of animals, and so on. For example, at the scale of the breed society a collectivity may actively embrace and promote a particular genetic technique, at the same time as some farm-scale collectivities affiliated to the breed society are, in their particular ways, resisting it via a counter-conduct which articulates different truths or knowledges concerning the 'right' way to breed animals. At the same time the very heterogeneity of livestock breeding collectivities means that the material nature of animal bodies can also provide a focus for forms of bodily resistance. As Twine (2010) argues concerning attempts to capitalise animal bodies, "Animal science can be viewed as a struggle against animal bodies to solve this problem of substance and surplus, materiality and margin" (page 100); here Twine hints at how attempts to produce particular bodies may simultaneously produce unexpected, unwanted effects such as declining fertility or reduced disease resistance. Yet, as we have shown, it is not always that the resistance effected by bodies is unexpected but also that in some circumstances animal bodies become enrolled into counter-conduct in the context of a particular collectivity.

Focusing on specific resistances and scepticisms allows us to express the complex, ambivalent, and transformative *agency* of heterogeneous biosocial collectivities in the face of the relations of biopower associated with geneticisation. Collectivities, let alone individual human actors, are not passive recipients of new technologies. Instead, technologies are coconstituted in their relationships with the collectivities they become part of, and collectivities and their constitutive relationships become transformed as they engage with or counter (or some complex combination of these) new knowledgepractices. From the perspective of the advocates of geneticisation such processes can produce problematic collectivities in which powerful genetic truths are questioned and made complex in messy worlds of practice. Continued efforts to enrol or 'captate' breeders into using genetic techniques are evidence of both efforts to assert the authority of genetic truth and of resistance to and complexification of that truth. Trying to persuade breeders alone may be insufficient, however, where it is the enrolment of a heterogeneous collectivity which proves problematic: it may not, or may not be able to, do what such an authority urges.

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Footnotes

- (1) Eblex is part of England's Agriculture and Horticulture Development Board, and is funded by a levy paid on sales of beef cattle and sheep in England.
- (2) Breed societies are key institutions in pedigree livestock breeding. In the UK they are constituted as charities and have the fundamental objectives of promoting their particular breeds and registering newly born animals as members of the breed.
- (3) Breed society and breeder names, and other identifying characteristics, have been removed.

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