Why using genetics to address welfare may not be a good idea[1]

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ABSTRACT Welfare of animals in livestock production systems is now widely defined in terms of 3 classes of measures: veterinary health, mental well-being (or feelings), and natural behaviors. Several well-documented points of tension exist among welfare indicators in these 3 classes. Strategies that aim to improve welfare using genetics can increase resistance to disease and may also be able to relieve stress or injury. One strategy is to reduce the genetic proclivity of the bird to engage in behaviors that are frustrated in modern production systems. Another is to develop strains less prone to behaviors hurtful to other hens. Yet another is to make overall temperament a goal for genetic adjustments. These genetic approaches may score well in terms of veterinary and psychological well-being. Yet they also involve changes in behavioral repertoire and tendencies of the resulting bird. Although it has seemed reasonable to argue that such animals are better off than frustrated or injured animals reflecting more species-typical behaviors, there is a point of view that holds that modification of a species-typical trait is ipso facto a decline in the well-being of the animal. Additionally, a significant amount of anecdotal evidence has been accumulated that suggests that many animal advocates and members of the public find manipulation of genetics to be an ethically unacceptable approach to animal welfare, especially when modifications in the environment could also be a response to welfare problems. Hence, though promising from one perspective, genetic strategies to improve welfare may not be acceptable to the public.

Key words: animal welfare, genetics, veterinary health, mental well-being, natural behavior

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INTRODUCTION

The purpose of the 2009 Poultry Science Association symposium "Tomorrow's Poultry: Genomics, Physiology, and Well-Being" is to debate whether genetic change or change in production systems is the way to address the welfare of birds in poultry production systems. It is well to begin by stating my own interpretation of the presuppositions implied by this. To structure the symposium as a debate presumes that there are questions of welfare that need to be addressed and that adjusting the genetics of the birds used in various poultry production settings is one of several ways to address them. The alternatives to genetic adjustment involve changes in housing and husbandry. The idea of a debate usually implies that the alternatives being debated are mutually exclusive. It should be noted at the outset that this is not the case with respect to the welfare of birds being kept in contemporary poultry production systems. In fact, it is reasonable to expect that measures to address animal welfare will include adjustments of several distinct kinds. Given these assumptions, this paper presents the argument that relying exclusively on genetic adjustments to address welfare is a very bad idea, and that relying heavily or primarily on genetic changes in the birds used in production systems is deeply problematic and unlikely to succeed.

The argument begins with a more extensive clarification of the framing assumptions for this debate. It continues by examining how approaches that would involve genetic change have been evaluated in the literature on ethical use of animals. There is, in fact, a surprisingly large body of literature, although most of it is focused narrowly on genetic engineering and cloning (Thompson, 2008a). In sum, the weight of opinion in this literature finds the use of genetic manipulation problematic, especially when it is done to remediate welfare problems that were initially caused by changes associated with the intensification of animal production. The argument of the paper moves next to a consideration of the public acceptability of genetic adjustment. Here, research on public opinion is used to estimate the likelihood that proceeding with the strategy would provoke reprobation and resistance movements among members of the public. The conclusion of the argument is that both ethical considerations and the likely public reac-

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tion to using genetic adjustments provide dual strands of evidence for the conclusion that using genetics to address welfare may not be a good idea. As developed here, the argument does not provide the case in favor of changing husbandry or production systems. It is developed solely as an argument for moving carefully along any trajectory that approaches welfare through strategies of genetic change.

APPROACH

It may be worth commenting briefly on the use of the phrase "good idea" in the title of the paper. As used here, the word "idea" conveys the vague sense or meaning that the word typically has in ordinary language. Ideas frame or circumscribe goals and aims. A goal or aim is the end toward which effort is directed. An end can be defined simply as the cessation of activity. However, when activity terminates in virtue of having achieved its purpose or aim, the relevant sense of the word "end"(Grinnell, 1992) implies a result proper to and fulfilling of the purposes for which the activity has been conducted. Activities that cease without reaching a satisfactory result have failed to achieve the end sought. Dictionary definitions of terms such as "goal," "aim," or "end" tend to rely heavily on games and sporting activities in which there is a specific point of reference and clear criteria for a successful achievement. These illustrative examples suggest human activities conducted under circumstances where success and failure have been stipulated in a structure of rules. Alternatively, success and failure may be specified relative to the initial intention of agents undertaking the activity, but in such cases, the potential for learning and drift in intention of the agent limit the extent to which unambiguous criteria for success can be stipulated in advance.

In both commerce and science, goals or aims become specifiable when the scope can be narrowed to operational or quantifiable measures. Scientists thus commonly insist upon detailed operational or quantifiable criteria for definitions and for determining the result of an experimental procedure. However, the operational measures that specify such ends in view are themselves reflective of larger and less readily specifiable purposes: why is this scientific study being undertaken in the first place? The ideas that articulate purposes or goals for undertaking a given set of scientific research activities are often necessarily vague. They become more specific as the activity is pursued, but they are also subject to revision, adaptation, and even rejection as a result of what is learned through pursuit of the activity (Grinnell, 1992). My point is this: while it may be appropriate to stipulate fairly narrow definitions of goal-defining terminology for the purposes of scientific practice and communication, such stipulations defeat the purpose implied by a broader discussion of strategies to address animal welfare. This is especially true when the reaction of nonscientists has a significant bearing on the criteria for success. Nonscientists are not socialized in the practice of stipulating narrow definitions or in offering operational or quantitative tests for satisfying definitional conditions. The very practice of insisting on such conditions can be off-putting for members of the public (Thompson, 1997b).

In the present case, the word "idea" is used in reference to a set of activities that might be undertaken by poultry scientists to address problems with animal welfare. These, in turn, imply activities that would be pursued by the poultry industry itself. In this context, "good ideas" are those that suggest activities that promise to address the problem so that the situation can, at the cessation of activity, be regarded as improved or solved, whereas "bad ideas" lack such promise. The current view of how animal welfare has become problematic thus plays a critical role in determining whether any given strategy of action is a good or a bad idea. However, a complete development of the problematic nature of animal welfare within the full range of poultry production systems is beyond the scope of the current paper. Importantly, it would include not only dimensions associated with behavior and animal health but also a discussion of profitability both now and as projected given the potential for changes in the regulations or market environment for poultry production. Readers who lack familiarity with this background information may wish to consult some of the prior studies conducted by Mench and others (Mench and Duncan, 1998; Fraser et al., 2001; Mench, 2003, 2008).

As noted above, there is also a great deal that is already being assumed in presuming that a debate over the promise of adjustments in the genetics of birds is worthwhile. This general framing can be applied to egg production, where alternative forms of housing and husbandry have been the focus of recent political activity (Anonymous, 2009), but where changes in the underlying genetics of laying hens might also conceivably be an appropriate response (Appleby and Hughes, 1991). It is less clear how it might be applied to broiler production, where welfare problems associated with the growth rate and skeletal weaknesses in birds will almost certainly require some form of genetic response (Julian, 1998). Without belaboring the point, it is thus worth emphasizing how the context for a debate over the usefulness of a genetics approach in addressing animal welfare involves a very broad array of stage-setting assumptions and qualifying premises. As with the problematic character of animal welfare itself, a full articulation of these assumptions and premises exceeds the scope of the paper. Specific qualifying definitional remarks are introduced in context.

ANIMAL WELFARE AND ETHICS

The welfare of any animal, including human beings, is understood to be a combination of multiple dimensions including physical and mental health, experienced or perceived well-being, and the ability to satisfy drives

or needs. Characterizing welfare conjoins empirical analysis of these dimensions with normative or ethical judgment. Recent empirical work on the welfare of nonhuman animals recognizes 3 domains that contribute to welfare. The first domain includes standard veterinary measures of health, mortality, and morbidity. The second is determined by the psychological state of the animal, including experiences of pain and frustration, or conversely satisfaction or satiety. The third domain is characterized by species-typical behaviors, including the ability to move and to perform routine actions related to hygiene, feeding, or reproduction. These 3 domains have been characterized, respectively, as animal bodies, animal minds, and animal natures (Appleby, 1999).

The ethical component of welfare characterization includes a rationale for seeing the properties or dimensions identified as having normative significance (that is, for taking them to be good or bad) as well as a rationale for ranking the relative contribution of different dimensions and for reconciling trade-offs when positive contributions to welfare along one dimension are offset by negative welfare effects along another dimension. Thus, for example, it is widely recognized that caged layer production systems have achieved mortality rates that are not matched by cage-free systems. At the same time, cage systems restrict movement and many designs restrict behaviors such as dust bathing or nesting. Thus, a choice between these 2 production systems involves a trade-off between animal bodies and animal natures. Developing criteria for evaluating or justifying such trade-offs is a classic task for animal ethics (Fraser et al., 1997; Fraser, 1999).

There are also multiple schools of thought on the justification for making ethical judgments. The utilitarian school has been most closely associated with decision making for human welfare. Here the model is to make a complete survey and ranking of contributions to welfare and to judge the course of action that maximizes total welfare as the one that is ethically mandated. However, utilitarian philosophers recognized the difficulty of executing such a survey, as well as the likelihood that different people would have their priorities among multiple dimensions. As such, utilitarians have argued that for a single individual the course of action that maximizes the freedom of that individual to choose among options will be the course of action that maximizes his or her total welfare. But because the choice of one person may reduce the welfare of another person, the utilitarian ideal accepts constraints on personal freedom when a potential course of action harms others (Mill, 1979). What is critical to notice here is that human freedom to choose is justified because it is thought to be the best means for achieving maximal welfare.

In contrast to the utilitarian model, many ethical theorists have followed Immanuel Kant in arguing that the ability to make a free choice is itself the central guiding principle for ethics. Although the philosophical development of the Kantian approach can become complex, it is sometimes summarized as an ethic consistent with the familiar Golden Rule: do unto others as you would have them do unto you (Wattles, 1987). In the present context, the important point to notice is that ethics is seen not as a welfare-maximizing calculation but as an activity of rule-following. Kant's approach stresses the need for logical consistency to make rule-following nonarbitrary. One can freely adopt the Golden Rule as one's guiding ethic because it provides a source of constraint on one's actions that is derived from an introspective consideration of how one would want to be treated. It thus provides genuine normative guidance and constraint while being consistent with the ideal of freedom and self-governance (Cunningham, 1998).

There are 2 points to note in connection with the rule-based (or deontological) approach in ethics. First, Kant believed that ethics derives from an imperative to respect other human beings because they are (like oneself) rational agents capable of acting according to rules. Because nonhuman animals were not, in Kant's view, rational agents, they could not be the proper objects of moral regard. This view amounts to the claim that animal natures do not include a capability for rational action, and this lack disqualifies them as moral subjects. Many contemporary theorists in animal ethics have deployed strategies to "lower the bar" so that animal natures do meet the criteria for rule-governed respect. One involves the so-called marginal cases argument, which notes that a strict application of Kant's principle would imply that human beings with reduced mental capacities also fail to meet the test of rational capability (Dombrowski, 1997). Tom Regan has argued that merely being "the subject of a life," that is, having a limited unity and coherence in one's intelligence and cognitive experience, is sufficient for moral standing. Regan believes that this is a sufficient reason for viewing all uses of animals that require their death as morally unacceptable (Regan, 1983, 2003). It is worth noticing that just as Kantians do not take calculating effect on human welfare to be a guideline for ethics, Regan does not think calculating effect on animal welfare provides insight into ethics.

The second point is more pertinent in the present context. In emphasizing the capability for reasoned choice as the focus of ethical significance, Kantians hang their approach on a characteristic of human nature that animals putatively lack. In this they take animal natures to be decisive for ethics. This point is important because it illustrates the way that an influential philosophical approach to understanding ethical obligations can place great emphasis on both human and animal nature. In fact, this emphasis is so great as to override considerations pertaining to health and physical well-being (human or animal bodies) or to emotional or cognitive experiences of satisfaction or distress (human or animal minds). Consistent with Kantian rejection of utilitarian thinking, our consideration for others derives not from the regard that we have for their welfare as articulated in terms of either physical or cognitive well-

being. Rather, it derives from their nature as free or rational beings. If nonhuman animals are shown to have natures that are similar in relevant respects (Glock, 2009), then Kantians would presumably need to revise their assessment of their moral standing. Although in other contexts this leads to extended discussion of animal capabilities and the concept of rationality, what is critical to note in the present context is the way that animal natures rise to a paramount status in evaluating the basis for ethical obligations to them.

In summary, animal welfare can be understood as a complex phenomenon composed of effects on animal bodies, animal minds, and animal natures. As will be seen below, ethics can be understood as attempting to adjudicate real and apparent conflicts in calculating how these effects are to be added and subtracted in arriving at an overall assessment of total welfare. The utilitarian tradition in ethical philosophy has endorsed a decision approach focused on maximizing (or reaching some optimum state) of total welfare. However, with respect to human ethics, the utilitarian tradition has always been opposed by a deontological alternative that stresses the theme that ethics is fundamentally a rule-following endeavor grounded in human freedom. With respect to nonhuman animals, this deontological or Kantian approach has taken animal natures—facts about animal capabilities—to be the most important domain for understanding human obligations to nonhumans. There is thus an important strand in ethical thinking that emphasizes animal natures as the singular locus for determining ethical duties to nonhuman animals, rather than seeing animal natures as 1 of 3 domains that contribute equally in determining ethical responsibility.

ANIMAL ETHICS AND GENETIC CHANGE

The prospect of radical change in the genome of domesticated animals due to genetic engineering has precipitated an extensive debate over the ethics of animal genetics during the last 30 yr. The touchstone for much of this work was a paper by Bernard Rollin, which drew heavily on his notion of animal telos. Rollin had used the Greek word telos to indicate genetically based drives or instincts that, if frustrated, would result in a significant compromise to welfare of an animal. He noted that nonhuman animals have different drives, instincts, and needs than humans; hence, understanding ethical duties to nonhuman animals required an appreciation of their species-typical behaviors (Rollin, 1981). Rollin's seminal paper on genetic change argued that although it would be unethical to undertake changes in animal genetics that resulted in congenital suffering or disease, there was nothing unethical about changing the telos of an animal as such (Rollin, 1986). Rollin has continued to reiterate and refine this view in a succession of publications (Rollin, 1995, 1998, 2003, 2006).

Although focused on genetic engineering, Rollin's basic position can be readily applied to ways of changing biological capabilities of an animal including conventional animal breeding or surgical modification (Thompson, 1997a). Peter Sandøe has applied a similar analysis in making the argument that pathologies associated with production traits such as high-producing dairy cows and large-breasted turkeys are the result of unethical breeding practices. Skeletal deformities associated with rapid growth are also noted. This work singles out susceptibilities to disease associated with animals that have been bred to grow faster or produce more. Working with several different groups of co-authors, Sandøe argues that because these breeding practices have resulted in compromises to welfare indicators in the domain of animal bodies (e.g., standards defined in terms of veterinary health), they are unethical (Sandøe, 1999; Gamborg and Sandoe, 2002; Sandøe et al., 2003). Working more broadly on the ethics of genetic change in nonhuman animals, Autumn Fiester has argued that there should always be a presumption of restraint that must be overcome through explicit argument before genetic changes can be undertaken through programs of scientific research (Fiester, 2008). The view that genetic changes may be ethically mandatory to reverse these trends provides a rational for a specific type of genetic modification to achieve animal welfare (Star et al., 2008; Thompson, 2008b).

Other authors have taken issue with the basic approach developed by Rollin and Sandøe, utilizing an array of strategies to argue that genetic modifications of animals are inherently wrong. Although some of these authors limit their objections to the use of recombinant DNA techniques for accomplishing these modifications (Fiester, 2008), others have expressed objections that would appear to apply to conventional breeding technologies that led to a change in telos of the animals (Bovenkerk et al., 2002). The literature on genetic modification through genetic engineering has become extensive and convoluted, and an extended summary is not warranted in the present context. Many of the authors are not careful to indicate whether their objections would apply to genetic changes brought about through breeding, nor do they show awareness of the way that their arguments have the potential to block genetic changes that might relieve animal pathologies or distress (Thompson, 2007). However, Appleby's entry in this literature is especially significant. While not dismissing the possibility of ethically justifiable genetic modification out of hand, Appleby stipulates that the genetic approach would not be acceptable in cases where changes in housing or husbandry are responsible for problems in the first place (Appleby, 1998).

The upshot of this literature might be summarized as follows. The view favored by Rollin accepts the analysis of animal welfare into the 3 domains of animal bodies, animal minds, and animal natures. This view agrees that the ability to perform species-typical behavior is critical to animal welfare because animals have biological needs and drives that are frustrated when they are unable to perform these behaviors. However, this view

does not take having a particular nature or telos to be ethically significant in and of itself. That is, it is important for animals to able to satisfy genetically based needs and drives in so far as they actually have these genetically based needs and drives, but whether or not a given animal does or does not have these drives is immaterial. Or put differently, one cannot harm an animal by frustrating a need or drive that it does not have. Because this view revolves around the needs and drives—the telos—that individual animals actually have, it does not see anything problematic about producing animals that have different needs and drives (Appleby and Sandøe, 2002).

An alternative view sees animal natures as constitutive of the welfare of an animal. In this view, animals should live a "natural life," so that the life typical of a species becomes a model having normative force. Animals whose lives deviate from that model to a significant degree can be said to have been deprived to a morally significant degree. This standard can be applied to the living conditions in which the animal lives, but it would also apply to animals that do not have species-typical traits. Blindness or deafness, for example, would be characterized as a defect (Blandford and Fulponi, 1999; Musschenga, 2002). An animal whose genetics have been altered, whether through breeding or biotechnology, in such a way that it lacks a capacity or behavioral drive that would be typical of other animals of its species is, in this view, a lesser animal. It can be said to have been harmed, even if there is no corresponding adverse affect in terms of animal bodies or animal minds. Appleby and Sandøe characterize this as a "perfectionist" view, meaning that there are objective traits against which the life of any animal (including humans) can be measured (Appleby and Sandøe, 2002).

This alternative or perfectionist view may be said to lay additional stress on the animal natures dimension of animal welfare in much the same way that Kantian or deontological views do. Although perfectionist views in human ethics may or may not be linked to deontology, the alternative view sketched above is consistent with ethical views that stipulate and defend a particular conception of human nature or potential, and then go on to argue that conduct is ethically justified to the extent that it is consistent with a realization of that nature. As in the account immediately above, perfectionist views in human ethics regard the question of whether realization of one's nature is desired or satisfying as irrelevant to ethical evaluation (Wall, 2007). Although many theorists of animal welfare find the predominance given to animal natures puzzling, views that appeal to animal natures have been vigorously defended by animal advocates (Sørensen, 2004). Given the implicit emphasis on animal natures in the Kantian-deontological tradition—a tradition that is not committed to animal rights—the resilience of views that stress animal natures should not be surprising.

The "middle road" between views that stress animal natures, on the one hand, and views that stress animal bodies and animal minds, on the other, might be found in Appleby's qualification of when genetic modification is unacceptable. As noted, Appleby does not rule out all applications of genetic modification, but he does argue that it is not acceptable as a palliative for welfare problems that were originally caused by changes in housing or husbandry (Appleby, 1998). Although the details of this argument are not supplied, it appears that traditional farming methods in which animals are permitted a range of movement and opportunities to express species-typical behaviors represent a kind of baseline for animal natures in Appleby's view. Even though confinement systems may produce improvements in physiological measures (notably mortality) defined within the domain of animal bodies, Appleby regards the losses in the domain of animal natures as more significant. This type of ranking judgment corresponds exactly to the role accorded to ethics (as opposed to animal welfare science) in conceptualizing animal welfare. The judgment that genetic change should not be used to breed out or otherwise remove the genetic basis for these already-compromised species-typical behaviors is a further indication of the weight that Appleby is giving to the domain of animal natures (Appleby, 2004).

PUBLIC ACCEPTABILITY OF GENETIC CHANGE

Rollin provides the strongest ethical argument in favor of using genetics to address problems in the veterinary health (animal bodies) and cognitive (animal minds) domains of animal welfare. Nevertheless, Rollin does not believe that genetics will provide a practical solution to difficulties in livestock or poultry production, especially in so far as the methods of genetic change involve the utilization of recombinant DNA methods. Rollin states that these methods are not acceptable to the public. He expands upon this remark by stating that such genetic change is aesthetically repulsive, and he asserts (without data) that the public will find such approaches to welfare unacceptable. On this basis, he further asserts that producers will be loathe to tarnish the reputation of their products and their industry by introducing breeds or strains that have been subjected to extensive genetic modification as a means to relieving or remediating the conditions adverse to animal welfare in contemporary production systems (Rollin, 1998). Thus, although Rollin does not believe that there are any ethical barriers to using genetics to address problems in welfare, he believes that such approaches are not practical for use in industry.

The pattern of Rollin's remarks here is indicative of the difficulties that anyone will encounter in attempting to argue against a practice on the grounds that it is unacceptable to the public. Not only is "the public" an extremely diffuse and ambiguous concept, but there are many senses in which a practice might be asserted to be acceptable or unacceptable. Many practices that

are commonplace are nonetheless highly stigmatized, and some are illegal. Sexual infidelity and prostitution are examples. Closer to the issue at hand, it is not likely that many consumers would find contemporary animal production to be aesthetically pleasing, yet this has not deterred most of them from consuming animal products. The multiple ways in which a practice can be defined as "acceptable" or "accepted" permits plausible claims that one and the same practice are both "widely accepted" and "not accepted," as evidenced by the fact of continuing controversy, debate, and activism around genetically engineered crops, despite the widespread use of these crops by farmers in North America, Latin America, and China (Thompson, 2001).

Given this ambiguity, how should the idea of public acceptability be understood? The basic criterion that may be implicit in Rollin's remarks is that a practice capable of generating an organized and sustained resistance movement is of questionable acceptability. As yet, there is very little theoretical consensus among researchers who have studied resistance movements about what factors provoke successful opposition. The following hypothesis encapsulates much of what has been learned from controversies over nuclear power and waste disposal and citing of hazardous facilities, as well as biotechnology: The practice that is the object of organized resistance will be judged unacceptable to the extent that a) the movement is successful in recruiting new participants and expanding its monetary support or media coverage, b) targets of the movement are vulnerable to persuasion, coercion, or tactics of shame and public embarrassment, or both (David, 2008; Wolfe and Bjornstad, 2008). Although still open-ended, this characterization provides indicators that are potentially quantifiable and that could yield an operational assessment of public acceptability.

It is possible to assemble a fair amount of survey data to support the claim that large segments of the population in Europe and North America find genetic modification of animals to be troubling and morally problematic. One of the first studies of the attitude of the US population toward genetic engineering revealed more people expressing ethical concern about applying the technique to animals than to humans (Hoban and Kendall, 1993). This trend of concern about genetic modification of animals has continued, even as attitudes toward human medical applications and plant applications have mellowed (Hoban, 1998; Saba et al., 1998; Gaskel et al., 2003; Group, 2006). Although this research focuses on genetic engineering, a few studies have attempted a more nuanced probe into attitudes toward genetic techniques as they relate to conceptions of naturalness (Lindeman and Sirelius, 2001; Lusk and Fox, 2002; Lusk and Briggeman, 2009). Here, too, there is support for the conclusion that a broad segment of the population would regard genetic changes brought about to make animal welfare more compatible with housing and husbandry applied in concentrated animal feeding operations as less natural and as undesirable.

In addition, one recent study provides somewhat more direct support for the hypothesis proposed above. Based upon a series of questionnaires, interviews, and economic experiments, Prickett et al. (2008) have classified American food consumers into 3 groups based on their attitudes to animal welfare as reflected in their purchase of animal products: naturalists, basic welfarists, and price seekers. Naturalists place a great emphasis on allowing farm animals to exercise outdoors and exhibit normal animal behaviors, such as nest building. Basic welfarists are willing to pay higher prices to ensure animal well-being, but they believe high animal welfare can be obtained simply by providing ample food, water, and health care. Price seekers care mostly about price and will willingly sacrifice animal welfare in exchange for lower prices. Prickett et al. (2008) have found that naturalists, basic welfarists, and price seekers constitute 46, 40, and 14% of the US population, respectively,

It is reasonable to interpret this data as providing evidence to support the claim that that using genetics to address problems in animal welfare may not be a good idea. However, it should be stated clearly that these studies do not prove that genetic strategies are unacceptable to the public. Nor do they provide strong evidence that consumers making ordinary food consumption decisions would be influenced by knowledge that genetic modification strategies have been used to develop the breeds or strains of animals from which the products are derived. The trends in survey data are best interpreted within a context of political action intended to influence governance of animal production systems by both government and private sector means. In this connection, attitudes measured by public opinion researchers provide insight into what segment of the broader public might be induced to support measures undertaken by governments or by leading firms in the food sector. Thus, for example, the surveys do provide some measure of the base support for ballot initiatives, though not necessarily an indication of how people would vote following campaigns mounted to sway opinion in one direction or the other. The Prickett, Norwood, and Lusk survey is especially significant in light of its emphasis on consumer attitudes toward natural behavior. The surveys also provide at least a weak measure of how actions taken by food industry leaders to secure supply chains might be discussed, especially in gray literature such as internet blogs. It is in these limited respects that such empirical studies do provide a reason for producers to be cautious in launching a genetics-based response to problems in animal welfare.

The importance of social science research that measures and theorizes public attitudes notwithstanding, it is useful to acknowledge that impressions drawn from common sense and personal experience may be equally useful indicators. My own sense that animal producers can expect trouble if they pursue a genetic adjustment without also making changes in housing systems and husbandry is based on my interactions with students,

with audiences from speaking engagements, and with activists who have a broad interest in food system issues (not just animal activists). It is likely that the point of view Rollin expressed in his 1998 article was based on similar experiences. Although such experience falls far short of respectable social science data, it does provide a window on a phenomenon that has eluded more rigorous and systematic methodologies (Wolfe and Bjornstad, 2008). Although one cannot prove that an exclusive reliance on genetic strategies would provoke a social resistance movement, there is sufficient evidence of both objective and anecdotal form to suggest that it might not be a good idea.

CONCLUSIONS

The reasons for urging caution in the pursuit of genetic adjustments for addressing welfare problems lie in 2 domains. First, there are philosophical considerations that can be drawn from the literature of debate on the ethics of human-animal relations. This literature has utilized the category of natural behavior as one of the key dimensions for understanding both the ethical significance on nonhuman animals in general and for deriving standards for the use or care of animals in specific situations. The category of natural behavior can be interpreted in ways that would find modifications in animal genetics that resulted in changes to the behavioral drives of the animal or to the cognitive and physiological dysfunctionalities associated with the frustration of species-typical behavior ethically unproblematic. But alternative interpretations that take repertoires of species-typical behavior to be constitutive of welfare are also well-represented in this literature, as are arguments to the effect that changes in this repertoire brought about by changes in the underlying genetics should be thought of as a form of harm. This is consistent with the emphasis placed on animal natures in Kantian approaches to ethical duties to animals. Thus, although the case in animal ethics cannot be regarded as settled, it is clear that many participants in the growing philosophical discussions of animal welfare and animal rights do regard the use of genetics to address animal welfare as morally problematic.

Second, a variety of public opinion studies on attitudes toward animals suggest that a large segment of the public would regard the use of genetic strategies to address welfare problems as morally problematic. This conclusion is based on multiple studies that have been conducted over more than 10 yr. The recent study by Prickett et al. (2008) is particularly indicative of this conclusion because their telephone survey suggests that a plurality of the American public (46%) believe that ability to perform "natural" or species-typical behavior is a key indicator of welfare for animals being raised for food production (Prickett et al., 2008). As with the evidence from ethical debates, these studies are not conclusive. Public opinion could shift. Yet they do provide a strong basis for questioning whether heavy reliance on genetic strategies to address welfare would be well received by consumers of poultry products.

Heavy reliance on ethical criteria of "naturalness" is widely regarded as problematic in the domain of bioethics, and there are reasons to question its application in the food arena as well (Bergin, 2009). Indeed, I opposed philosophical arguments that rely on the "natural behavior" category to reject other instances of genetic modification, noting that the practical result of this strategy leaves animals in situations of unnecessary suffering and frustration (Thompson, 2008c). Thus, although arguments against genetic strategies have been marshaled in the above remarks, the final conclusion is not that such strategies should simply be removed from consideration. In fact, the debate should continue, and there should be a concerted attempt to involve broader segments of the food-consuming public in the discussion. Conducting a broader and more inclusive debate might itself be recommended as one of the strategies that should be followed to address all controversial issues in animal production (Schillo and Thompson, 2003). Nonetheless, the evidence against exclusive reliance on genetic strategies is overwhelming. That would be a bad idea.

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