COMMENTARY

ON THE HUMAN–ANIMAL BOUNDARY

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ABSTRACT

This paper considers contemporary Western attitudes towards animals. Whilst many studies of human–animal relations look backwards to the inheritance of Aristotle, Aquinas, Descartes and others, this paper looks to the future. I want to suggest another batch of possibilities that may serve as resources for thinking about the apparent human–animal boundary. These possibilities include Bovine Spongiform Encephalopathy (BSE) / variant Creutzfeldt-Jakob Disease (vCJD), xenotransplantation and transgenic animals.

INTRODUCTION

And God said, Let Us make man in Our image, according to Our likeness; let them have dominion over the fish of the sea, and over the birds of the air and over the cattle and over all the earth, and over every creeping thing that creeps upon the earth. (Genesis 1: 26)

A highly simplified, but orthodox, story of human–animal relations in the West tells us that Aristotelian anthropocentrism remains dominant, having gained influence through Christianity. Anthropocentrism was reinforced during the Enlightenment by figures such as Francis Bacon (1561–1626) and René Descartes (1596–1650) before being undermined in the 18th century by rapid urbanisation and industrialization (Thomas 1983). However, this attitude remains the "backcloth to our ideas about animals today" (Clutton-Brock 1999: 5).

In addition, most theorists embrace what has been called "Rowan's principle," stated as "The only thing consistent about human–animal interactions is paradox" (Rowan quoted in Herzog 1997: 236).[1] Attitudes towards animals are anything but homogenous even within the West, and dissenting voices to the orthodoxy of anthropocentrism have been identified in all its definitive historical moments.[2] The inconsistency of modern ideas about animals allows for an almost limitless process of metaphor and metonym to take place. In various contexts, for example, animals are like infants (pets), totally different from people (animals farmed for meat), people are animals (paedophiles) people are animals plus various highly significant attributes (justification for vivisection), animals are unpolluted people (heroic animals), and so on. Anthropocentrism dominates, however, and seems perfectly capable of absorbing apparent contradictions without any threat to its mantra that human beings are different and better. In other words, the change in sentiment that occurred in 18th century England was profound, but has not stopped the majority of British people eating meat and supporting the use of animals in experiments,[3] nor has it stopped people thinking of animals and humans as qualitatively different under particular circumstances.

Explicit attempts to progress "Beyond Boundaries,"[4] have been made by animal rights theorists, anthropologists, philosophers, sociologists, feminists and many others.[5] Pet-keeping,[6] meat-eating[7] and animal rights,[8] each of which implicates the boundary between humans and animals in different ways, have already received a large amount of attention. Less attention has been directed at other phenomena that have equally profound consequences for conceptualizing relation-

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ships between humans and animals. These phenomena include Bovine Spongiform Encephalopathy (BSE), variant Creutzfeldt-Jakob Disease (vCJD), xenotransplantation, and transgenic organisms.[9] These sorts of connections with animals are far from new, one need only think of anthrax, or rabies, to name just two examples of diseases that link humans and animals in dramatic and potentially devastating ways. However, these sorts of links have recently become central to debates about biotechnology, the limits of desirable intervention in "natural" processes, and the future of life itself.

I would like to suggest that anthropology has a role to play in analysing these processes. The major insight of post-structuralist anthropology has been to identify the dualisms that are inherent to much of our thinking about other people, and to show that these dualisms reside in Western knowledge making practices, rather than having any basis in verifiable "facts" outside the realm of human activity. In other words, binary oppositions that apparently structure our experience of the world, such as individual/society; male/female; nature/culture are not universals, but simply one possibility amongst others. The increased reflexivity of anthropological thinking about binary oppositions, and the simultaneous displacement of "nature" from its place as the gold standard by which artifice is judged,[10] offer an opportunity for new thinking about relationships between humans and animals. Human/animal is simply one possibility amongst others.

As the recent foot-and-mouth crisis in the UK illustrates, we are currently linked to animals in multifarious complex ways. During the crisis, the Samaritans issued a television advertisement that showed a farmer being interviewed about the loss of his sheep. As the farmer struggles to respond to the interviewer's question, he is unable to hold back his grief and breaks down in tears. The interviewer can be heard whispering, "I'm so sorry…" The wrap line of the advertisement reads: "And they wonder whether foot and mouth affects humans." The physical connections created between humans and animals by techniques such as transgenesis, and by diseases such as vCJD do not exhaust the possibilities of this redrawing of the human–animal boundary. Humans and animals can be seen to inhabit complex webs of meaning in which all sorts of apparent "boundaries" are proving increasingly permeable.

BSE, vCJD, BRITISH FARMERS AND AMERINDIAN HUNTERS

> Emerging infections are usually caused by viruses which are not strictly speaking "new." They have generally been around for millions of years but have changed their habits in some way. Most often they are viruses which naturally infect animals, co-evolving with these primary hosts until they are relatively harmless to them. Problems only arise when for some reason they cross a species barrier and colonize a new host. Occasionally it is a genetic mutation which allows this to happen, but this is much less common than was once thought. Mostly these days it is man's intrusion on the natural environment which is the all important key. (Crawford 2000: 46–47)

The first case of BSE in Britain was officially detected in November 1986 by veterinarian Colin Whitaker (Butler 1998: 533). Since this time there have been a further 180,000 cases, mainly in the United Kingdom (Abbott 2001: 275). It has been estimated that more than a million infected cattle have entered the human food chain (Thompson 2001: 661). BSE has gradually conquered Europe, apparently breaching borders in the guise of imported contaminated animal feed. France recorded 138 cases of BSE last year. The discovery of the first home grown case recently in Germany led to two ministerial resignations, and in January 2001 beef sales in Italy collapsed after the discovery of their first case. The UK still leads the BSE league table with 1337 cases recorded in the year 2000 (Abbott 2001: 275).

Of course, the concern caused by BSE is not that of the animal lover for the cow. BSE has managed to jump the species "barrier" between human and animal.[11] The consumption of infected cows is thought to have led — in 92 cases so far — to the development of variant Creutzfeldt-Jakob disease (vCJD), a prion disease that leads to the fatal degeneration of the brain (Thompson 2001: 660). In 1998 a public inquiry into the British government's handling of the BSE crisis condemned what it saw as a catalogue of errors against a backdrop of spending cuts and deregulation during the 1980s (Butler 1998: 532). Although the first cases were documented in 1986 it was only two years later in 1988 that the govern-

ment set up an ad hoc committee looking into its spread. Apparently, the delay was partly due to brain samples being mixed up, lost and sent to the wrong laboratories. The recommendations of the Tyrell Committee to ban various types, ages, and cuts of meat, were not implemented properly and potentially contaminated meat and feed was exported to Europe until recently (1998: 533).

Ironically, the delays in the British government's action have been at least partly attributed to a belief that the human-animal boundary was holding fast, based upon the fact that scrapie, also a prion disease, had not spread from sheep to humans (1998: 533). Elsewhere, this breach of the boundary may not have come as so much of a shock:

> Among Amerindians of the Amazon the notion of nature is contiguous with that of society. The same can be said of many, if not most, indigenous peoples of the world. The evidence from North America is abundant. Together nature and society constitute an integrated order, alternatively represented as a grand society or a cosmic nature. In their essential aspect, human beings (non-human), animals and plants are undifferentiated, they belong to the same ontological category of mortal beings.(Arhem 1996: 185 & 188)

Numerous examples of societies in which the separation of humans from animals is apparently meaningless have been recorded by anthropologists.[12] In particular, attitudes between hunter and prey have proved almost impossible to understand with the category distinction between human and animal in place. As Serpell and Paul have argued:

> In the vast majority of non-agricultural, hunting and gathering societies, respect for the "feelings" of animals is an important component of religious ideology and ritual. Animals are believed to possess thoughts, feelings and social systems which are analogous, if not identical, to those of humans. In addition, animals are thought to possess souls, spirits or essences which are effectively immortal and endowed with supernatural powers. (1994: 130)

BSE/vCJD is a recent, Western example of a process that forces us to confront a new relationship with animals, the border between "them" and "us" has proved permeable and new connections activated. As I was told recently by an informant, "It (BSE/vCJD) did really bring it home to me that, you know, we're made of the same stuff (as animals)."[13] Classification has long been identified as an inherently powerful act: the ability to make distinctions between Self and Other involves an act of violence. However, the polemic properties of acts of classification also ensure that they are capable of change. In this case they may be transformed both by events and also by an increased awareness of their specificity to particular historical and social contexts.

XENOTRANSPLANTATION

Xenotransplantation is the transplantation between different species of organs, tissues and cells. The transplant of a baboon kidney to a human patient was first officially reported in 1964 (Wheale 1995: 211). The patient survived for nine months before the failure of immunosuppressive drugs led to rejection of the kidney and death. The technology faded until recently, when the idea was raised that it may offer one solution to the chronic shortage of human organs available for transplant.

Although transgenically modified primates were thought to be the most obvious source of organs, they have been rejected due to their closeness to mankind, their vulnerability to extinction and the difficulty of maintaining their welfare to what is perceived as being an appropriate degree.[14] Their rejection comes at a time when strong lobbying for the re-classification of the great apes is gaining in influence:

> Humans differ from both common chimps and pygmy chimps in about 1.6% of their (our) DNA and share 98.4%. Gorillas differ somewhat more, by about 2.3% from us and both of the chimps…the chimpanzee's closest relative is not the gorilla but the human…Thus there are not one but three species of genus Homo on earth today: the common chimpanzee, *Homo troglodytes*; the pygmy chimpanzee, *Homo paniscus*; and the third chimpanzee or human chimpanzee, *Homo sapiens*. (Diamond 1992: 18–21)

Re-classification has long been supported by the work of animal behaviorists, but now that techniques for increasing knowledge about genetic make-up have become more accessi-

ble, "proof" of what was always suspected by some has become available. Whatever one's belief about the relationship between genetic similarity and taxonomic proximity or even genetic similarity and any other sort of meaningful similarity, there is no doubt that classification is now disputed. Furthermore, great apes are increasingly rejected as candidates for any sort of invasive medical research, undoubtedly for a number of complex reasons, some of which may relate to their ambivalent status in the eyes of the consuming public.[15]

In contrast to the protected primates, pigs are farmed on a huge scale for meat and so it is thought that this source of organs for xenotransplantation would be far easier to contemplate. To quote the Nuffield Council Working Party on animal to human transplants:

> While the pig is an animal of sufficient intelligence and sociability to make welfare considerations paramount, there is less evidence that it shares capacities with human beings to the extent that primates do…It is also difficult to see how, in a society in which the breeding of pigs for food and clothing is accepted, their use for life-saving medical procedures such as xenotransplantation would be unacceptable. (1996: 113)

This conclusion is in keeping with the ambivalent status of primates, as inhabitants of the boundary between human and animal, it also acknowledges the power of the separation of farm animals from humans and other animals implicit in meat-eating, a very different relationship with animals compared to that of say, pet-keeping. Pigs are already on the right (or wrong) side of a strongly reinforced divide between humans and farm animals, and so, the Working Party reasons, only the animal rights activists who deny this boundary are likely to object to their use.[16]

Xenotransplantation also has profound implications for human recipients. Following the logic of the Working Party's decision to confirm that pigs are on the correct side of the animal–human boundary to make their disposal to satisfy human interests ethically acceptable, one is forced to ask, "where does this leave the recipient?" With part of an animal inside him or her, the availability of which depends upon the sanctity of the boundary that is now physically violated. The Working Party literature admits:

> The recipient of a transplanted organ may feel that the boundary between self and other has been breached…receiving an organ from a dead donor may also disturb the recipient. With xenotransplantation, an additional boundary, that between human and animal, may become blurred. Whether, or in what ways this is perceived as a problem will depend on how the human being–animal boundary is defined and the significance that is attached to it. (Nuffield 1996: 105)

Responses to the idea of xenotransplantation reported in the Nuffield report vary, from "Using a pig organ is better than your body dying" to "We have been made superior to animals and it would be degrading to be made of part pig, part human" and "the concept of an organ being part of me seems quite distasteful." The responses show that the relationship between the body and personhood is critical. Where the self is thought to transcend the body there is less to overcome than when the self is perceived as at least partially physically constituted. In Lundin's study of diabetics' responses to receiving animal cells, she was able to conclude, perhaps unsurprisingly, that, "survival takes precedence over ethical or existential doubts" (1999: 8). The patients individually related pragmatic did not always coincide with their overall ideological stance.

Xenotransplantation raises a double bind. It encourages us to think of animals as close relatives in order to accept their organs whilst at the same time reinforcing our separateness from them by asserting our right to sacrifice their interests for ours. This partly accounts for the preference for artificial organs found amongst informants by Papagaroufali in Greece (1996). He was told that animals were "inferior creatures to humans," and "rather disgusting" (1996: 249). Artificial organs were by contrast, "clean, new, like my new pair of glasses" (1996: 248), and "definitely much closer to living humans compared to animal dead ones" (1996: 249). Apparently, the "high degree of naturalness attributed to artificial organs is based on the fact that they, unlike animals, are constructed by humans" (1996: 249). However, the most strongly rejected organs were those from transgenic animals, presumably because the application of technology just made them into "weird" animals rather than overcoming their "animalness"

and turning them into man-made and thus "natural" machines.[17] Once again the possible referents of "nature" and what is "natural" are shown to be multiple and highly contingent.

TRANSGENIC ANIMALS

> Show me someone with a heart pacemaker and I have no real difficulty in seeing which part is human, which is machine. Show me a ewe whose genes have been altered so that it secretes a human protein in its milk, and it is much less clear which part is human, which sheep. (Turney 1998: 12)

Transgenesis refers to the introduction of a "foreign" gene into an animal or other organism. Recombinant DNA technology can modify the basic genetic make-up of a living organism by inserting (or removing) sections of DNA. These techniques were first demonstrated in 1973 and since then organisms have been modified in order to yield materials which they would not otherwise produce, such as cows milk which contains pharmaceutical products, for example, human insulin, growth hormone, or enzymes.

The production of animals with novel capabilities has created a new form of property, acknowledged by changes in international patenting laws (European Federation of Biotechnology 1993: 2).[18] The first transgenic animal patent was issued in 1988 to Harvard University for claims covering the "oncomouse," a mouse in which an onco gene had been introduced to make the animal more susceptible to cancer and therefore more sensitive for testing possible carcinogens. The patent refers to:

> A transgenic non-human mammalian animal all of whose germ cells and somatic cells contain a recombinant activated oncogene sequence introduced to said animal, or an ancestor of said mammal, at an embryonic stage. (1993: 3)

Animal rights activists and environmentalists are opposed to transgenic animals on several fronts. Firstly, the modification of animals in this way represents a new use of animals when animal rights activists are seeking to reduce existing uses of animals. Furthermore, some anticipated and many unexpected side effects of modifying genetic make-up in animals have been seen as increasing animal suffering.[19] Secondly, animal rights activists have constantly campaigned against the patenting of transgenic animals. They regard the patenting of animals as an illicit commodification: a subordination of embodied life to market forces.

> The patenting of animals runs quite counter to the view of animals as our fellow creatures, and not as items placed on this earth for our convenience. (Stevenson 1995: 161)

The commercial future of super animals such as Dolly and her kin lies in their ability to produce pharmaceutical products destined for human consumption. With human genes in their genome, transgenic sheep are able to produce the enzymes lacking in humans suffering from disorders such as cystic fibrosis. Milk production offers the means by which the gene may be switched "on" and "off," creating what is referred to as a "transgenic bioreactor" in this industry report:

> Transgenic animals producing human proteins in their milk have a number of advantages compared with other production systems based on genetically modified bacteria or mammalian cells. Large quantities of material can be produced. Proteins undergo full post-translational modification. Proteins can easily be purified from milk. Costs may be lower than conventional product methods. (Bloomfield 1995: 30)

This reality produces a heady mix of human, animal, "natural" (the sheep's body), "artificial" (sheep as "transgenic bioreactor") and commercial. These novel combinations eliminate any possibility of complacency about the so-called human–animal boundary.

The production of transgenic animals speaks to a long history of animal exploitation. It forms the latest instalment of a story that began with domestication and proceeded via selective breeding to the sort of intensive farming with which we are all familiar. As such, it should not be considered as a novel process, but rather an extension of the process of domestication.[20] However, what is new about such a technology is that it affects not simply the properties of individual animals, but also their genealogies. It is not simply that properties useful to man are bred into animals through selective breeding, but rather the process by which life is reproduced is transformed. The effects of such a process

are, then, less like the acceleration that is facilitated by selective breeding and more like a paradigm shift. The effects of such a shift cannot be extrapolated from existing practices that seem similar, but must be interrogated alongside an awareness of nature as vulnerable to human intervention in a way that is unprecedented.

CONCLUSIONS

In 1796, country surgeon-apothecary Edward Jenner published details of his successful vaccination of a small boy against smallpox:

> During the investigation of the casual Cow Pox, I was struck with the idea that it might be practicable to propagate the disease by inoculation, after the manner of the Small Pox, and finally from one human being to another…The first experiment was made upon a young lad of the name of Phipps, in whose arm a little Vaccine Virus was inserted, taken from the hand of a young woman who had been accidentally infected by a cow…On his being inoculated some months afterwards, it proved that he was secure. (quoted in Fenner et al 1988: 260)

As Crawford states, "this historic human experiment…cut across all theoretical and ethical barriers to produce one of the most remarkable and important medical achievements ever recorded" (2000: 204). The breakdown of these barriers was met by opposition, as is evident in this quote from the propaganda of the National Anti Vaccination League in 1906:

> Think of the unparalleled absurdity of deliberately infecting the organism of a healthy person in this day of sanitary science and aseptic surgery with the poisonous matter obtained from a sore on a diseased calf! (quoted in Vandervelde 1991: 16)

The outcome of this story, which takes place on the human–animal boundary, is positive: smallpox killed at least 300 million people in the twentieth century before its eradication through vaccination in 1987 (Crawford 2000: viii). However, also inhabiting this borderland are newly emerging zoonoses including viral hemorragic fevers such as Ebola, hantavirus pulmonary syndrome and Lassa fever.[21] Whilst much tabloid-style reaction to new techniques in biotechnology does a disservice to its readership, there is a pressing need for informed debate. Encouragingly, many scientists employed in these fields show an openness to contributions from outside their traditional sphere of influence. As Turney reports, both the National Institute of Health and the European Commission have both contributed, "modest percentages of their human genome research budgets for ethical, legal and social studies of the new genetics" (1998: 222). However, others appear to subscribe to quaint epistemologies in which science, a matter of practicalities best left to the experts, can be separated from society, or, in the following quote, from "ethics," as though the two form distinct categories:

> The view of the present author is that transgenic animals and plants raise practical issues, but not ethical ones…There may be justified public concern about potential damage to the environment through transfer of genetic material from transgenic to wild organisms but that is a practical issue. (Bishop 1999: 15)

As is increasingly obvious, the distinction between "science" and "ethics" has lost much of its potency since biotechnology crept between the two and colonized both. What is now required is a perspective that looks at the separation of animals from humans as just one classificatory possibility amongst others, specific to a set of relationships that may now have been undermined.

Anthropomorphism and category distinction continue to inform the majority of every day interactions with animals. Indeed, many peoples' primary interaction with animals continues to be through the intermediaries of a knife and fork. However, awareness of our undoubted kinship with animals is increasing, along with diseases and technologies that exploit this closeness. There is a flurry of activity on the human–animal boundary. Separation and distinctiveness no longer provide a model by which human–animal relationships may be understood, the connections are far too complex, fundamental and vital. Recent biotechnological events demand a reappraisal of ideas about human relationships with non-human animals and in doing so, prompt an interrogation of the legacy of Aristotle and his followers. A new understanding of traffic on the human–animal boundary is called for.

ACKNOWLEDGMENTS

This article was written during a British Academy Postdoctoral Fellowship held at the Department of Social Anthropology and Trinity Hall, Cambridge University. Thanks to Joanna Swabe and an anonymous reviewer for their helpful comments.

NOTES

1. An alternative formulation can be found in the work of anthropologist Roy Willis, "The distinctive peculiarity of animals is that, being at once close to man and strange to him, both akin to him and unalterably not man, they are able to alternate, as objects of human thought, between the contiguity of the metonymic mode and the distanced, analogic mode of the metaphor." (1974: 120).

2. See, for example, Copeland (1998), who mentions Marie of France (in contrast to the bestiaries and hierarchies of the Middle Ages), Boccaccio (in contrast to Dante) and La Fontaine (in opposition to Descartes) amongst others. Also of obvious interest are Plutarch's opinions about meat-eating, "You ask me for what reason it was that Pythagoras abstained from eating flesh. I for my part do much admire in what human, with what soul or reason, the first man touched slaughter, and reached to his lips the flesh of a dead animal" (Plutarch Moral Essays: Of Eating Flesh).

3. According to a recent Guardian poll, 46% of adults in the UK support the use of animals for scientific testing. Support is highly age sensitive, for example, 59% of the 65+ who were asked supported animal testing, whilst only 35% of 18 to 24 year-olds asked were in favor (Travis and Treanor 2001: 6).

4. The title of Barbara Noske's 1997 appraisal of anthropocentrism.

5. Singer's (1976) has been the most famous attempt by an animal rights theorist to render the boundary between humans and animals morally insignificant. Anthropologists Descola and Palsson (1996) criticize the boundary between nature and society on the grounds of research based in societies in which no separation is made between humans and animals. Adams (1994) draws an analogy between meat eating as the dominance of "Man" over nature, and the dominance of men over women. Mary Midgeley (1979, 1983, 1994) has long advocated a policy of "bridge building" (1994: 188) between human and animal species.

6. See, for example, the collection on companion animals edited by Podberscek, Paul and Serpell (2000), or Serpell's seminal *In the Company of Animals* (1996).

7. Fiddes (1991) discusses the symbolic meaning of meat, a discussion given a feminist slant by Adams (1990). Vialles (1994) describes the process by which animals are transformed into meat in French abattoirs.

8. The numerous works by animal rights theorists include Singer (1976), Regan (1983) and Ryder (1998). An overview is offered by Garner (1996) and an alternative view by Tester (1991).

9. A note about method. I am an anthropologist, working on horseracing in Britain and America, but with a more general interest in human–animal relationships. Although I work on relations with horses, specifically racehorses, I have always been interested in biotechnology, and also in BSE which contextualized one of my first periods of fieldwork in Newmarket, England. This paper is not based on fieldwork in any formal, quantifiable sense, but is prompted by the concerns of my informants. Where the source of my ideas can be said to lie directly in fieldwork experience, I shall make this clear.

10. "Nature" has been displaced within kinship, for example, by technologies of assisted procreation, that replace what is "natural" with what is possible at any particular time. What is "natural" no longer constitutes the end of a debate about childlessness, for example, but rather the beginning (see Strathern 1992 and Franklin 1997).

11. Joanna Swabe, in her review of this article, has pointed out that there is a terrible double crossing of the animal–human boundary in this context. BSE crosses from the infected animal and becomes vCJD in the human victim. The human victim may then be perceived as having crossed the boundary from human to animal by means of losing characteristics conceptualized as singularly human. These characteristics include the power to control movement, thought, and speech.

12. As well as Arhem (1996), see also Ingold (1994) and Brightman (1993).

13. When I first worked in Newmarket in 1994, some of my informants would eat beef, "as a matter of principle," as a form of protest against, "the lies told by the government." My own vegetarianism provoked interest, "But what do you eat?" or derision "Oh no, not a bloody vegetarian, someone pass the rabbit food!" When I returned in 1999 I noticed that many informants had reduced their intake of red meat on the grounds that "chicken and fish are healthier." I also discovered an anxiety about vCJD,

which was expressed in terms of the threat it represented to that most highly valued capacity of racing society, one's wits. So, I was told, "CJD is an awful disease, it turns you into a vegetable." My greatest surprise came when my companion at a racecourse lunch also ordered the vegetarian option, and when I quizzed him about his choice simply asked the rhetorical question, "Well, who eats meat anymore?"

14. See the 1996 report by the Nuffield Council on Bioethics.

15. The last remaining research facility in Europe to use chimpanzees for research (Biomedical Primate Research Centre, Rijswijk, the Netherlands) has recently abandoned this practice (see Goodman 2001).

16. Reactions to the use of pigs vary within and between groups, since very few world religions are monolithic. However, Catholicism, Protestantism, Islam and Judaism all appear to have no objections, in principle, to xenotransplantation. The Jewish community has established a position based upon the divine commandment of the preservation of life: "Although Judaism prohibits the consumption of pork, it does not forbid deriving benefit from pork" (Rosner 1999: 314). The Jewish use of porcine insulin and heart valves for more than twenty five years rests on this principle. Some Hindus may not believe in transplantation due to a belief that the body must remain whole in order to pass into the next life, whilst Buddhists may decide whether to accept an animal's organ according to the "stage of perfection" they have reached. Vegetarians are generally against xenotransplantation, and Uncaged has been actively campaigning against its use since 1996.

17. A further connection between humans and animals is implied by the anxiety that "novel viruses might wreak havoc in transplant patients who receive pig organs" (Coghlan 1998: 4). This fear contains within it an example of Rowan's principle – it implies both sufficient similarity between humans and animals that diseases of either may flourish (even if in mutated form) in both, and the idea of separateness in that these diseases would be "novel" and so somehow categorically out of place.

18. With the exception of Pasteur, who in 1873 patented germ free yeast, the courts of the United States had rejected patenting "the discovery of some work of nature." This ruling was overturned by the Chakrabarty case in 1980. Here it was ruled that the Pseudomonas in question was, "a new bacterium with markedly different characteristics from any found in nature," and so worthy of a patent. (EFB 1993: 2)

19. For example, the insertion of a growth hormone gene into pigs resulted in acute arthritis (EFB 1993: 3). Animals may also experience suffering due to pleitropy, "the phenomenon in which a single gene is responsible for a number of distinct and seemingly unrelated phenotypic effects" (King and Stansfield 1997: 264). The production of transgenically modified animals is difficult, with only between 1 and 10% of mice taking up a certain genetic modification, for example, resulting in a huge number of unwanted "surplus" animals, which must be destroyed by laboratory technicians (Coghlan 1999: 324).

20. Thanks to Joanna Swabe for this point (also see Swabe 1999).

21. Lists of zoonoses are available on the Center for Disease Control and Prevention website. It must also be said of vaccination that, "Accidents can happen. Millions of people were accidentally contaminated with simian virus 40 in the 1950s through contaminated polio and adenovirus vaccines made in monkey kidney cells; luckily it seems to have done little lasting harm" (Butler 2000: 13).

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