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Biotechnology as End Game: Ontological and Ethical Collapse in the "Biotech Century"

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Abstract I argue in this paper that animal biotechnology constitutes a dangerous ontological collapse between animals and the technical-economic apparatus. By ontological collapse, I mean the elimination of fundamental ontological tensions between embodied subjects and the principles of scientific, technological, and economic rationalization. Biotechnology imposes this collapse in various ways: by genetically "reprogramming" animals to serve as uniform commodities, by abstracting them into data and code, and, in some cases, by literally manipulating their movements with computer technologies. These and other forms of ontological violence not only lead to profound physical suffering for the animals involved, but also distort the phenomenological basis of their existence, especially their perceptual experience and expression of subjective time and space. In subordinating nonhuman animals to the logic of "technological rationality" or "technique," to borrow Herbert Marcuse and Jacques Ellul's respective terms, biotechnology perpetuates the productive extermination of animals. Biotech animals are exterminated in the sense of being "drive[n] beyond the boundaries" of meaningful existence and "destroyed completely" or "completely wiped out" as subjects. But they are also exterminated in the sense of being "overproduced" and "overgenerated," both quantitatively and qualitatively. I go on to argue that the collapse of the ontological is accompanied by a collapse of the ethical. This ethical collapse is characterized by the internalization of the logic of technique and the corresponding failure both within technoscientific culture itself and within some scholarly discourses about biotechnology to evaluate from a genuinely critical vantage point the fundamental ethical issues that animal biotechnology raises. The aim of this paper is to offer an alternative analysis of the ontological and ethical implications of biotechnology from the standpoint of Marcuse and Ellul's critical theory of technology. To explore other ramifications of animal biotechnology, I draw on Theodor Adorno and Max Horkheimer's insights into ideologies of extermination and Maurice Merleau-Ponty's phenomenology of embodiment.

Keywords Biotechnology · Ontology · Ethics · Animal subjectivity · Critical theory · Phenomenology · Species integrity · Technological rationality · Time-space compression

> Being is not a general notion that can be separated from objects. It is one with that which exists. . . . Being is the positing of essence. That which is my essence is my being. The fish exists in water; you cannot, however, separate its essence from this being.
> Ludwig von Feuerbach [1].

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> There are 1.7 million known species of life on earth. Two years ago scientists introduced the first one ever designed by a computer. And in the last 10 years there have been over 3000 patents issued for genetically modified organisms and other transgenic innovations. Within 50 years we could have more life forms invented in the lab than we've ever identified in nature. We now have goats whose milk can be spun into spider silk that's stronger than steel, jumbo salmon that grow twice as fast as their natural cousins, bacteria that produce antimalarial drugs once available only from plants. Innovations like these can increase the supply of essential products, inspire new investing ideas, and launch or up end entire industries. It's all part of the new science called synthetic biology, using nature as a manufacturing platform and DNA as the raw material. Pharmaceutical companies see it as a pipeline for extraordinary new drugs and treatments. Energy companies see a route to cleaner more sustainable fuels like algae that produce biofuels and eat carbon dioxide. Someday computers may run a DNA based circuit, and biological paint could help heat and cool your home. Around the world and across borders, academics, entrepreneurs, and even students are working with over 5000 DNA sequences called Biobricks™ to explore ideas and invent new organisms. The DNA is available online in an open source data base, and a collaborative, crowd-sourced approach means experiments that used to take years now take weeks, constantly redefining what's possible. Although synthetic biology is still in the very early experimental phase, it could become the defining technology of the 21st century, bringing with it radical new thinking, new questions, and new opportunities—*because nothing has the power to change how we live more than changing life itself.* Think about it. We do.
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> Robert Chan, Fidelity Investments [2].

Animal biotechnology is fast becoming a key player in the global agricultural and biomedical industries. AquaBounty Technologies has filed an application to the Food and Drug Administration (FDA) for the commercial distribution of AquAdvantage®, the biotech company's "first advanced hybrid," a genetically modified salmon which grows at half its normal rate and which they claim is "an environmentally sustainable alternative to current farmed salmon" and "the future of salmon aquaculture" [3]. There is now growing demand for so-called "pharm animals," or animals who have been genetically spliced with other species to produce drugs and vaccines for the treatment of human diseases. Plans are underway to mass-produce genome-engineered "knockout" pigs to serve as "harvest-machines" for xenotransplantation.[1] Biotechnology even extends into the arts. In 2000, pioneering "bioartist" Eduardo Kac commissioned the production of "GFP Bunny," a glow-in-the-dark rabbit created by injecting the zygote of a rabbit with a fluorescent protein from a Pacific jellyfish.[2] The pet industry is also cashing in on biotechnology. Transgenic Pets LLC is seeking to engineer allergen-free transgenic cats, while GloFish, another commercial biotech company, produces iridescent fish with names like Starfire Red®, Electric Green®, Sunburst Orange®, Cosmic Blue®, Galactic Purple®, and Moonrise Pink™ [6]. Other biotech companies such as RNL Bio in South Korea specialize in cloning dogs and cats and other companion animals [7]. Meanwhile, biotechnology is also being mobilized in "de-extinction" programs which hope to repopulate the earth with extinct animals such as woolly mammoths and passenger pigeons [8, 9].

While these and other biotech projects are often hailed as great scientific achievements that promise to

[1] Hai et al [4]; Best [5]. I also refer to these biotechnologies in the context of a critique of posthumanism in Zipporah Weisberg, "The Trouble with Posthumanism: Bacteria are People Too," in *Critical Animal Studies: Thinking the Unthinkable*, ed. John Sorenson (Toronto: Canadian Scholars Press, 2014), 99. I explore a number of the key issues addressed in this article (viz., technological rationality, the symbolic and material integration of animals with the technical apparatus within and beyond the context of biotech, posthumanists' tendency to glorify technoscience at the expense of ethics, and the derogation of species integrity) in two previous publications: Zipporah Weisberg, "The Trouble with Posthumanism: Bacteria are People Too," in Critical Animal Studies: Thinking the Unthinkable, ed. John Sorenson (Toronto: Canadian Scholars Press, 2014), 99 and Zipporah Weisberg, The broken promises of monsters: Haraway, animals, and the humanist legacy, Journal for Critical Animal Studies 2:2 (2009). This article develops these ideas into a much more focused and systematic critique of biotechnology as a form of productive extermination than I have hitherto undertaken. I also pay much closer attention here to the phenomenological implications for other animals of genetic manipulation.

[2] Carol Gigliotti, "Introduction," in Leonardo's Choice, xii.

promote human and nonhuman health and well-being, I argue in this paper that they in fact constitute a dangerous *ontological collapse* between animals[3] and the technical-economic apparatus.[4] By ontological collapse, I mean the elimination of fundamental ontological tensions between embodied subjects and the principles of scientific, technological, and economic rationalization. Biotechnology imposes this collapse in various ways: by genetically "reprogramming" animals to serve as uniform commodities, by abstracting them into data and code, and, in some cases, by literally manipulating their movements with computer technologies. These and other forms of ontological violence not only lead to profound physical suffering for the animals involved, but also distort the phenomenological basis of their existence, especially their perceptual experience and expression of subjective time and space. In subordinating nonhuman animals to the logic of "technological rationality" or "technique," to borrow Herbert Marcuse and Jacques Ellul's respective terms, biotechnology perpetuates the productive extermination of animals. Biotech animals are exterminated in the sense of being "drive[n] beyond the boundaries" of meaningful existence and "destroyed completely" or "completely wiped out" as subjects.[5] But they are also exterminated in the sense of being "overproduced" and "overgenerated," both quantitatively and qualitatively [10].

It is no secret that biotechnology is wedded to corporate technoscience and seeks above all to produce profitable commodities. In fact, its commercial applicability is one of its defining features. The Organization for Economic Co-operation and Development defines biotechnology as "the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services."[6] The Canadian Council on Animal Care (CCAC) defines biotechnology as "the use or development of techniques using organisms or parts of organisms to provide or improve goods or services."[7] The Canadian Biotechnology Strategy (CBS) states that biotechnology "involves the use of living organisms, or parts of living organisms, to provide new methods of production, make new products and find new ways to improve our quality of life."[8] In the agricultural industry, transgenic animals are produced "for specific *economic* traits" and "to improve yields of meat and other animal products" [14]. Pointing to the ever-expanding industrial and commercial applications of animal biotechnology, the CCAC observes that "the use of transgenic animals is likely to expand in the future" [15].

As I have argued elsewhere, as the manifestation of perfectly integrated scientific, technological, and economic aims, biotechnology brings Francis Bacon's "utopian" vision of nature as one giant laboratory for "scientist-priests" to tamper with as they please to terrifying fruition.[9] In his scientific writings in the late sixteenth and early seventeenth centuries, Bacon presented an image of nonhuman beings as ontologically elastic raw material for unbridled manipulation and transformation in the pursuit of scientific and economic progress. A primary scientific aim was to create "perfect creatures" from imperfect ones and maximize their utility. Truth and utility, Bacon insisted, were inextricably linked: "Truth . . . and utility are here the very same things," a view reflected in the definitions of biotech outlined above.[10]

The Baconian instrumentalization of reason and nonhuman life over the centuries has culminated not only in

[3] I do not wish to reinforce human/animal dualism; however, for the sake of simplicity and clarity, I refer to nonhuman animals (i.e., vertebrates and invertebrates) throughout this paper simply as "animals."

[4] See, for example, "Expiration Fate: Can 'De-Extinction' Bring Back Lost Species?" *Scientific American*, March 31, 2013, accessed June 11, 2013, http://www.scientificamerican.com/article.cfm?id=what-is-the-de-extinction-movement-all-about.

[5] Webster's New Twentieth Century Dictionary Unabridged, 2nd ed., s.v. "exterminate."

[6] Cited in [11]

[7] CCAC guidelines: on procurement of animals used in science [12]. The United Nations Convention on Biological Diversity defines biotechnology as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use" (Article 2). UN Convention on Biological Diversity [13] The Canadian Environmental Protection Act (CEPA) describes biotechnology as the "the application of science and engineering in the direct or indirect use of living organisms or parts or products of living organisms in their natural or modified forms." "What is Biotechnology," "Canadian Environmental Protection Act, 1999," Environment Canada, accessed June 5, 2012, http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=24374285-1&offset=1&toc=show.

[8] "The 1998 Canadian Biotechnology Strategy: An Ongoing Renewal Process," 1998, Government of Canada: Biostrategy, accessed June 5, 2012, http://www.biostrategy.gc.ca/english/View.asp?pmiid=520&x=535.

[9] Bacon [16]. For a discussion of Bacon's relevance to modern technoscience, see Weisberg [17].

[10] Rose-Mary Sargent, "Introduction," in Francis Bacon, xvi.

an ontological collapse between animals and the technical artifice, but also in an ethical collapse–that is, a collapse between critical analysis and the prevailing technological ideology. The ethical collapse is characterized by the internalization of the logic of technique and the corresponding failure, both within technoscientific culture itself and some scholarly discourses about technology, to critically evaluate the fundamental ethical issues that animal biotechnology raises. Bioethicists such as Bernard Rollin are properly critical of the egregious ethical violations that mainstream biomedical and commercial biotechnologies—such as the production of chimeric "bioreactors," "ideal protein manufacturing plants," "drug factories," "avian systems," and the like—constitute. Yet Rollin and others are nevertheless willing to explore the possibility that (at least some) biotechnologies have liberatory potential, or could at least improve animal welfare [18]. I argue that these explorations of biotechnology's emancipatory potential, no matter how cautious, fail to address the *fundamental* ontological and ethical issues at stake in the genetic manipulation of other animals for *whatever* purpose. A new framework for analysis is needed, which is what I attempt to provide here.

To this end, I draw primarily on the critical theory of Marcuse and Ellul to examine how biotechnology cannot be disentangled from the technocapitalist apparatus with which it is so intimately connected. To explore the other ramifications of animal biotechnology I have outlined above, I turn to Theodor Adorno and Max Horkheimer's insights into ideologies of extermination and Maurice Merleau-Ponty's phenomenology of embodiment.

Extermination-by-Integration

Biotechnology exterminates animals as subjects-of-meaningful-lives, to appropriate Tom Regan's term,[11] by eliminating crucial ontological oppositions between and integrating them with the technical-economic apparatus.[12] In the area of agricultural biotechnology, for example, the goal is to "edit" animals genetically so that they not only no longer present a conflict with but, in fact, become the living embodiments of the machinery of production.[13] This, Ellul observes, is technique's chief strategy for achieving its conquest: "Whenever technique collides with a natural obstacle it tends to get around it either by replacing the living organism by a machine, or by modifying the organism so that it no longer presents any specifically organic reaction" [20].

The following examples illustrate how seamlessly biotechnology integrates animals with the technical-economic apparatus. In 2009, a group of researchers led by Erika Sasaki at the Central Institute for Experimental Animals in Kawasaki, Japan, created "designer monkeys" who glowed green under ultraviolet light. Sasaki claims that the ultimate goal of her project is to mass-produce genetically modified (GM) marmosets with various genetic faults inscribed in their genetic makeup to serve as ideal disease models [21]. Anthony Chan, a geneticist at the Yerkes National Primate Research Center of Emory University in Atlanta, Georgia—who collaborated with Gerald Shatten to create ANDi, a rhesus macaque engineered to develop Huntington's disease—considers Sasaki's work to be a "great advancement" which "will bring more attention to primate models from people who do not normally think about primates" [22]. In 1999, Cecil Forsberg and his colleagues at the University of Guelph spliced pig genes with mouse genes to create Enviropig™, a pig that was able to digest phosphorous more efficiently and therefore produce less waste and less water pollution than its nongenetically modified counterparts.[14] Recalling the Fidelity Investment ad cited above, which declares that "nothing has the power to change how we live more than changing life itself," the slogan for Enviropig on the

[11] "Subjects-of-a-life," on Regan's definition, are nonhuman animals that "bring the mystery of a unified psychological presence to the world." Among other things, they "see and hear, believe and desire, remember and anticipate, plan and intend." I qualify Regan's definition by emphasizing how meaningful animals' lives are (to themselves, to each other, and to us) in the phenomenological as well as the conventional sense of the term to which Regan refers. In so doing, I expand the applicability of the category to a much wider array of animals than "mentally normal mammals of a year or more" to which Regan initially restricts it. Tom Regan, The Case for Animal Rights (Berkeley; Los Angeles: University of California Press, 2004), xvi.

[12] See in Weisberg, "The trouble with posthumanism. See especially page 99, where I state, "These and other transgenic animals are wholly integrated into the machinery of production."

[13] See note 10, where I indicate that I have discussed this concept of integration elsewhere.

[14] Meidinger et al. [23]; Forsberg et al. [24]; Pollack [25]. In 2010, the Canadian government approved the reproduction of Enviropig, but not its sale and consumption. As a result, Ontario Pork pulled its funding from the project. Another reason the industry backed out was because it turns out that farmers can simply provide their pigs with a supplement to aid digestion of phosphorous at a very low cost, which cancels the need for genetic modifications. When the project was abandoned, the pigs were not rehoused in a sanctuary to live out the rest of their lives in relative peace but were killed and disposed of as biowaste.

Guelph University website reads: "Changing lives. Improving Life" [26]. Another well-known example of interspecies genetic splicing is the "spider goat" that researchers at Nexia Biotechnologies Inc. and the US Army Soldier and Biological Chemical Command created by introducing the dragline silk gene from an orb-weaver spider into the DNA responsible for milk production in goats' udders.[15] Apparently, the "ultrastrong, flexible fibres" can be used for anything from "artificial tendons and ligaments to lightweight body armor and high-strength composites" [27]. The spider goats' milk is also being used in the production of BioSteel®, a material used in the manufacturing of bullet-proof vests, and in aerospace and engineering projects. Tellingly, the spider goats are slated to be housed in thousands of small holding pens in former weapons storage buildings.[16]

Machine-animal hybrids, such as so-called "roboanimals," embody the collapse of contradictions between the technological, the economic, and the biological even more explicitly. In 2007, scientists at the Robot Engineering Technology Research Centre at Shandong University of Science and Technology implanted microchip receivers into pigeons' brains. With electronic impulses generated from a computer, the researchers were able to control the direction of the pigeons' flight and prevent them from flying in a circular route, as per their natural tendency [28]. The scientist in charge of the mechanical pigeon experiment boasts, "Via a computer, we forced the bird to comply with our commands. We hope the technology could be put into practical use in future."[17] It is unclear what this "practical use" might be.

"Brain-machine interfaces," or BMIs, also explode crucial ontological tensions between animals, machines, and technology. According to Jose M. Carmena et al., BMIs that manipulate the brains of primates and other animals to control computer cursors can serve "as a potential alternative for spinal cord rehabilitation" [29]. In March 2013, it was announced that researchers at Duke University and scientists at the Edmond and Lily Safra International Institute for Neuroscience created a so-called "superbrain" by linking the brains of two rats in a "telepathy" experiment. One rat, dubbed the "encoder," was responsible for producing thoughts or "electrical brain activity," while the other rat, the "decoder," acted in response to the encoder's brain waves as though they were its own. Remarkably, one rat was located in the Safra Institute in Brazil while the other was in Miguel Nicolelis' lab at the Duke campus in North Carolina. Brain signals were exchanged through the Internet [30]. In this case, the rats were subjected to a dual ontological collapse: they were integrated both with computer technology and with one another in an involuntary expropriation of each other's embodied consciousness. In a similar project, Seung-Schik Yoo of Harvard Medical School recently led an experiment that enabled human beings to control the movements of rats "telepathically." According to *New Scientist* reporter Sara Reardon, "By linking the technologies of two brain/computer interfaces, human volunteers were able to trigger movement in a rat's tail using their minds" [31]. In this case, the ontological collapse manifests itself in the rat's colonization by the computer interface and by a human being's brain.

Cloning is another technoscientific practice that exterminates animals as subjects—in this case, by eliminating their particularity and transforming them into infinitely replicable objects. By definition, replication consists of the deliberate and systematic erasure of singularity, individuality, uniqueness, and variation among and between species and individual animals. The elimination of particularity is part and parcel of every exterminationist program. It occurs both epistemically and ontologically. Adorno refers to this tendency as "identity-thinking" or the collapse of difference and multiplicity into a forced unity, identity, and adequacy. "Identity is the primal form of ideology," and "adequacy has always been subjection to dominant purposes" [32]. Marcuse explains that, within a technologically totalitarian system, a concept is "universalized" by being abstracted from its "particular substance" [33]. In the process of universalization and abstraction all particularity is leveled out into repeatable generalities and empty universal categories [34]. The universalized and abstracted concept is so detached from its object that both the concept and the object are stripped of meaning, thereby creating the conditions for physical extermination.[18] Likewise, the universalization of individual animals into infinitely reproducible types—the primary goal of animal cloning—delegitimizes any claim the animals might have to subjecthood. This, in turn, gives license to commit further systemic atrocities against the animals, on top of the violence they were already subjected to by the original genetic erasures. In the

[15] Rutherford, Synthetic biology.
[16] Best, "Genetic Science," 8.
[17] Robo-pigeon, Daily Mail.
[18] Marcuse, One-Dimensional Man, 87; 94.

words of Horkheimer and Adorno, "Abstraction, the instrument of enlightenment stands in the same relationship to its objects as fate, whose concept it eradicates: as liquidation."[19]

An Ontological Paradox

Eugene Thacker has pointed out that biotechnologically altered animals are suspended in an unresolvable ontological paradox [35]. They are at once reduced to sheer materiality—or raw material for production—and immateriality in the form of computer-generated information/feedback systems, data, and code. As I noted above, the aim of synthetic biology is to overcome the obstacles posed by biological, genetic, and behavioral variability in nonhuman beings by applying the principles of computer engineering to them.[20] Ron Weiss, professor at the Massachusetts Institute of Technology and pioneer of synthetic biology, summarizes this approach when he describes his own early explorations in the field: "I decided to take what we understand in computing and apply that to *programming biology*. To me, that's really the essence of synthetic biology [19]."[21] For Weiss, anything that falls outside of the highly regimented order of technological artifice is a threat to the latter's very survival, cannot continue to exist on its own terms, and must, in effect, be reprogrammed so it can carry out its designated functions most efficiently. Carol Gigliotti points out the irony that just as ethologists are producing reams of indisputable evidence of animals' rich and complex psychosocial and emotional lives, and thereby offering an important challenge to the reductive mechanistic perspective that has prevailed for centuries, "much of the work in genetic technologies is reinforcing an understanding of animals as suited to act as a *material language*, a *symbolic technique*."[22]

Yet, as Thacker notes, biotechnology does not stop at the transformation of biological life into code. Rather, it perpetuates a cycle whereby nonhuman organisms are radically de-materialized, re-materialized, and de-materialized again, ad infinitum. The goal of synthetic biology, mirroring the goal of technique itself, is not to *eliminate* materiality altogether, but to reprogram it to better suit the needs of production, thereby "complet[-ing] a loop, from an interest in encoding the body into data to an interest in programming and reprogramming that genetic-informatic body, and finally to an investment in the capabilities of informatics to help synthesize and generate biological materiality."[23]

While biotechnology is the epitome of Baconian-Cartesian mechanism, it also signals a departure from the early modern scientific framework in its relegation of animals to a kind of virtual ideality. Marcuse has observed that with the rise of technological rationality, the stark Cartesian division between *res extensa* and *res cogitans* gave way to the usurpation of the former by the latter:

> Modern scientific philosophy may well begin with the notion of two substances, *res cogitans* and *res extensa*—but as the extended matter becomes comprehensible in mathematical equations which, translated into technology, "remake" this matter, the *res extensa* loses its character as independent substance.[24]

In other words, as per the idealist conceit, "matter" (i.e., sensuous animal life) is no longer autonomous but is in fact a projection of "mind" (i.e., the principles of rationalization).

This tendency reaches its apotheosis in biotechnology where, on one hand, animals are defined in opposition to human beings as sheer materiality and, on the other hand, are constructed as quantifiable ideality, mere extensions of the human mind.

Patenting and the New Divinity

The patenting of biotech animal commodities reinforces biotechnologists' effective role as modern-day scientist-priests and omniscient and omnipotent creators. In quasi-religious and overtly patriarchal language, Ian Wilmut is often referred to as the "father" of Dolly, the first cloned sheep [36]. In 2010, American biologist Craig Venter claimed a similar god-like status when he declared that (10 years and 40 million dollars later) he had actually created "the world's first synthetic life form," Synthia, a

[19] Horkheimer and Adorno, Dialectic of enlightenment, 9. Rationalization.
[20] Although synthetic biology typically deals with microorganisms and not animals as such, the term is sometimes used interchangeably with biotechnology. See the Fidelity Investment ad cited above, for example.
[21] Rutherford, Synthetic biology.
[22] Gigliotti, Introduction, xvii. Italics added.
[23] Thacker, Data made flesh, 92.
[24] Marcuse, One-dimensional man, 152.

synthetic genome "constructed using chemicals in a laboratory," whose genetic code, which includes literary quotations and URLs, was built by a computer [37, 38]. Synthia is a creation, which according to *Guardian* science correspondent Ian Sample, "paves the way for *designer organisms* that are built rather than evolved."[25] Julian Savulescu, an Oxford University professor of practical ethics, is quoted in Sample's article as asserting that,

> Venter is creaking open the most profound door in humanity's history, potentially peeking into its destiny. He is not merely copying life artificially…or modifying it radically by genetic engineering. He is going towards the role of a god: creating artificial life that could never have existed naturally.[26]

With this connection in mind, Steve Best, borrowing Jeremy Rifkin's term, appropriately suggests that biotechnology is ushering in a "commodified 'Second Genesis.'"[27]

The patent on the animal, and by extension the animal itself, is not only the producer's creation but also its property. Even if the owner of a patent owns the patent on the animal and not the animal itself, the implication for the animal is effectively the same. The patented animal is always already a commodity without any prior or potential existence as an autonomous subject. The producer capitalizes not only on the sale of the physical animal but on its *essence*, the contours of which are predetermined in the laboratory. The holder of the patent makes not only an economic claim over the animal, nor merely a physical claim over its biological existence, but also a *metaphysical* one, such as has never been asserted before in human-animal history.

While patenting biological life was originally frowned upon, it is now standard industry practice. This suggests a radical decline in ethical concern for nonhuman beings over the decades and a problematic shift in the way scientists, industry regulators, and the general public regard the natural world—a shift propelled by the triumph of technological rationality. Early attempts in the 1970s to patent biological life such as bacteria were rejected on the grounds that, even if tampered with, microorganisms were natural, living beings and so could not be hailed as inventions. However, there was a quick about-face, and in 1980 the Supreme Court of the USA determined that any human-altered microorganism or biological entity could be regarded under the law as any other human invention would be and therefore could be subject to patenting [39]. Susan K. Sell has pointed out that the expansion of intellectual property rights over anything from software algorithms to genes to plant and animal species, combined with weakened antitrust policies—which began to take hold in 1996 with the implementation of World Trade Organization's (WTO) agreement on Trade-related Aspects of Intellectual Property (TRIPS)—"has promoted economic concentration in high technology sectors and particularly in the life sciences industries" [40]. Fiona Murray from the MIT Sloan School of Management observes that beginning in the 1980s, the decade that saw DuPont Corporation's patenting of OncoMouse®,

> academics in [the life sciences] were quick to recognize that their discoveries were also the foundation of commercial products that, following the Bayh-Dole Act, could easily be published and patented. A critical 1980 Supreme Court decision expanded the scope of patent law, confirming that discoveries such as simple modified organisms and later mammals (including the oncomouse) could be patented [41].

The reduction of animals to patentable inventions further confirms that we have reached a calamitous stage in the history of human-animal relations. According to Oxford theologian Andrew Linzey, when animals are regarded as patentable inventions, any remaining duties of care towards them that we may have otherwise upheld evaporate. Linzey concludes, rightly, that the patenting of animals "mark[s] the lowest status granted to animals in the history of European ethics" [42].

Time-Space Compression: a Phenomenological Nightmare

Biotechnology is a phenomenological nightmare for the animals involved. Biotech animals suffer devastating deformities, injuries, and illnesses as a result of the dramatic alteration of their genetic makeup and the ontological collapse this process entails. As is well known, Dolly was euthanized at the age of six, at half the normal life expectancy for a sheep, after developing lung disease, an ailment that typically afflicts older animals [43]. Unlike traditional breeding practices,

[25] Ian Sample, Craig Venter. Italics added.
[26] Sample, Craig Venter.
[27] Best, Genetic science, 4.

which, although also exploitative, introduce genetic, anatomical, and behavioural changes relatively gradually, genetic engineering imposes these changes aggressively and abruptly. It therefore compounds the ontological violence constitutive of breeding. While biotechnologists and other apologists of genetic engineering attempt to naturalize their practices as the inevitable and therefore acceptable evolution of traditional breeding practices, genetic engineering is in a proverbial league of its own.[28] As Niall Shanks and Ray Greek have pointed out, biotechnology treats genes as though they exist independently of the animals of which they form an essential part [44]. The changes to which transgenic animals are subjected are so immediate, invasive, and dramatic that the animals quite literally fall apart as a result. For example, Best notes that many "transgenic animals are often born deformed and suffer from fatal bleeding disorders, arthritis, tumors, stomach ailments, kidney disease, diabetes, inability to nurse and reproduce, behavioral and metabolic disturbances, high mortality rates and large offspring syndrome."[29] Thus, transgenic animals join the ranks of the "crippled monstrosities" that capitalism has so indifferently churned out over the centuries [45].

It is precisely in the conflict between what an animal is in its distorted form as a biogenetic commodity and what it is or could be in its undisturbed form as a subject-of-meaningful-life that the unimaginable physical and psychological suffering of the genetically engineered animal lies [46].

If we turn to Merleau-Ponty's phenomenology of embodiment, the ontological outrage that biotechnology constitutes becomes even more apparent. We learn that as it integrates animals with the technical-economic apparatus, biotechnology subjects animals to phenomenological *dis*integration.[30] According to Maurice Merleau-Ponty, each animal has its own "style of being," or its own species-specific trajectory of behaviors and perceptual nuances, and a particular way of expressing itself in and engaging with the world. But the biotechnologically manipulated animal is subjected to multiple temporalities and spatialities that do not, to use Merleau-Ponty's expression, "belong" to it. Because of its violent subordination to the principles of corporate technoscience, which are otherwise ontologically foreign to it, the genetically manipulated animal is the ultimate example of a being that "exists in distortion, limitation, and denial of its nature (essence)," to recall Marcuse's critique.[31] The genetic alignment of animals with the apparatus of production impedes and cancels their claim to being what they *are*, or at least *could* be, outside the domain of technological control.

From a phenomenological standpoint, appropriate temporal and spatial organization is central to a being's flourishing. An animal literally embodies the subjective space and time of the *Umwelt*, or the perceptual world of meaning it co-constitutes [47]. Phenomenologically speaking, the subject *is* the time and space it inhabits [48]. "We must understand time as the subject and the subject as time".[32] Likewise, "space is bound up with the animal's own body as part of its flesh."[33] Every human and nonhuman animal subject is accustomed to a particular "spatial level"—that is, it is oriented towards a specific spatial and directional relation between itself and other objects. Every embodied subject also has a "preferential plane," or a spatial and directional configuration which is most conducive to its flourishing.[34]

Biotechnological interventions completely mangle the spatiotemporal orientation of each subject. For example, by engineering animals to grow disproportionately large at an accelerated rate, biotech replaces animals' subjective time and space with the compressed time and space of neoliberal capital. Similarly, robo-pigeons very likely suffer a kind of perceptual implosion. A creature whose subjective experience is largely defined by its aerodynamic autonomy could not withstand such radical technical intervention in its spatial orientation and remain phenomenologically intact. The "telepathic" rat whose movements are dictated by another rat via a computer interface is also subjected to a violation of its organic relationship to time and space. It is separated from the "brain" controlling its movements by thousands of miles of geographical space and the temporality it inhabits within that space. As David Harvey has shown, the implosion of time/space barriers is a defining feature of neoliberal capitalism [49]. This

[28] Gigliotti, Introduction, xv–xvi.
[29] Best, Genetic science, 10.
[30] I refer for the first time to the disintegration of transgenic animals in Weisberg, "The trouble with posthumanism," 99.
[31] Marcuse, One-dimensional man, 125.
[32] Merleau-Ponty, Phenomenology of perception, 483; 490
[33] Cited in Merleau-Ponty, Phenomenology of perception, 30.
[34] Merleau-Ponty, Phenomenology of perception, 292.

implosion is particularly nefarious when it plays itself out on the bodies of living beings.

Acceleration is especially phenomenologically injurious. For animals trapped in the animal industrial complex, acceleration is paradoxically a deceleration of their subjective experience of time into an eternal present characterized by unrelenting agony. They are uprooted from any natural temporal context and are instead condemned to sheer immanence and infinite repetition; to a ceaseless, torturous present. Progress today not only translates into the "annihilation of space through time," but also dangerously prioritizes becoming, qua limitless transformation, over being, qua ontological stability.[35] The genetically modified animal languishing helplessly in a stall, crate, or cage, immobilized as barely living flesh, the animal who is made to be what it is *not* is in perpetual conflict with itself. It knows in its body that it wants to do things it cannot and is forced to do things it does not want or is unfit to do. It knows in its body that its body is the basis of its self-negation and alienation. *It knows that its very own body is the limit of the freedom of which it has been stripped*.

This implosion of space and time also advances the late modern project of total technical domination of the lifeworld by eliminating *historical* consciousness. Through the normalization of biotechnology, we are forgetting what animals are, what they were "prior" (ontologically speaking) to their biotechnological manipulation, and what they could be if we let them be who they are. This is not romanticizing an imaginary, idyllic "before" (human intervention) and comparing it with an inevitably doomed "after." Rather, it is acknowledging that the prevailing technological ideology has systematically violated animals' ontological integrity so much so that they are unrecognizable to themselves.

The preoccupation with speed that fuels many biotechnology projects (and characterizes late modernity more generally) is especially pernicious. Speed propels us into the future and vanquishes memory and history along the way. "Time and Space died yesterday. We already live in the absolute, because we have created eternal, omnipresent speed," the fascist futurist F.T. Marinetti once proclaimed [50]. Paul Virilio reminds us that speed holds people in thrall to its power and sends out a note of caution that speed is the time of the dystopian future: "The violence of speed has become both the location and the law, the world's destiny and its destination" [51]. Neoliberal temporality boasts of a future with no grounding in the past, a future without a referent. In the biotech century,[36] "the present is all there is."[37] Swift movement "forward" on the backs of those destined to serve as barely living slave commodities is the meaning of "progress" in this new world order. "Eternal, omnipresent speed" is the time of machines, not embodied subjects. To subordinate the latter to the former is an ontological, phenomenological, and ethical abomination.

Biotechnological Rationality as Ethical Arbiter

The ontological collapse biotechnology engenders is coupled with an ethical collapse. This collapse is characterized by a lack of critical distance from which to properly evaluate the pressing ethical concerns that biotechnology raises. Marcuse argued that technological rationality has penetrated into and transformed the very consciousness of individuals, reducing them to "one-dimensional thought and behavior."[38] As a result, robust "negative" or critical thinking that might oppose the dictates of the technical-corporate apparatus is ultimately flattened and neutralized, leaving only the possibility of "affirmative" thought and action—in other words, the reproduction of the status quo. As indicated briefly above in the discussion of patenting, this internalization of the logic of technique is reflected in the ethical trajectory biotechnology has been on since its initial appearance.

In the early stages of biotechnology's development, some concern for the potentially catastrophic implications of genetic manipulation was still expressed. Ironically, the pioneers of biotechnology were among the most vociferous opponents of its expansion. For example, in 1974, Paul Berg, the scientist responsible for developing gene transfer technology, published a paper that called for an immediate halt of all genetic engineering research.[39] Herbert Boyer and Stanley Cohen, who introduced recombinant DNA technology, were co-signatories. In 1975, these and other scientists held a conference devoted to discussing the ethical implications of DNA research and genetic engineering. Among their

[35] Harvey, The condition of postmodernity, 205.

[36] I am borrowing this term from Rifkin, The biotech century, 101

[37] Harvey, The condition of postmodernity, 240.

[38] Marcuse, One-dimensional man, 12.

[39] Newell-McLaughlin and Re, The evolution of biotechnology, 47.

fears was the potential use of genetic research for biological warfare. They also worried about the spread of epidemics as a potential consequence of transferring viruses and bacteria. They eventually lifted the moratorium, but they produced a set of guidelines that, according to Martina Newell-McLaughlin and Edward Re, "involved levels of physical and biological containment [such as] the requirement to use an organism that would not survive outside the laboratory environment."[40] Although animals were not the focus of concern, in the nascent stages of biotechnology's development there was arguably a greater degree of critical consciousness about the ethical dangers it poses than there is today.

To be sure, some contemporary scholars are well attuned to the devastating implications of biotechnology and indeed foreshadow the argument I have been making explicit here. Carol Gigliotti, for example, argues in no uncertain terms that the rise of biotechnology ushers in "*the* catastrophic moment in the centuries-long shift from our understanding of our communion and solidarity with the nonhuman, ensouled world, to a world in which we see ourselves as the creators of all life," a point echoed by Steve Best [52]. Jeremy Rifkin laments that the "Biotech century" is "the final articulation of the mechanistic, industrial frame of mind," which "needs to be opposed by every caring and compassionate human being who believes in the intrinsic value of life" [53]. Karen Davis describes the obliteration of the animal subject by way of genetic manipulation (and systemic exploitation more generally) as "the Procrustean solutio[n] to animal identity" [54]. Like Procrustes' victims, Davis observes, "animals are physically altered, rhetorically disfigured, and ontologically obliterated to mirror and model the goals of their exploiters."[41]

However, unapologetically critical assessments of biotechnology such as these appear to be in the minority. Not surprisingly, when confronted with ethical concerns about their work, biotechnologists are often defensive or hostile, at least in the context of interviews in the popular media. For example, Mark Westhusin, the scientist who developed the antimalaria vaccine using transgenic goats, refers to those who question the ethics of his use of animals with undisguised contempt. As if even considering for a moment that there might be something ethically problematic about genetically manipulating animals is offensive to all modern scientific sensibilities, Westhusin exclaims, "One of the first [obstacles to pursuing pharm animal projects] are the animal welfare groups who jump on top of this, and say we shouldn't be using animals for anything. You know, blah, blah, blah."[42] Ethics, for Westhusin, is literally sheer nonsense. Westhusin's attitude is symptomatic of technological rationality which reduces ethics to a kind of sentimental excess.[43] One of technique's defining characteristics is "its refusal to tolerate moral judgments."[44] Technique is concerned only with technical matters; it is its own ethical arbiter.[45] "Technique, in sitting in judgment on itself, is clearly freed from this principal obstacle [i.e. ethics] to human action." It simply gives itself license to do whatever is necessary to reproduce itself.[46] If ethical or moral considerations interfere with efficiency, they are dispensed with.[47] By excluding moral judgments from its purview, technique "create[s] a completely independent technical morality."[48]

The industry and government bodies expressly assigned to ensure that animals' welfare is protected are also beholden to this technical morality. They promote the interests of the biotech industry and only pay lip service to the interests of animals, which are at best an afterthought. The CBS, for example, outlines as one of its principles "Respect for Animals: A Commitment to the Ethical Use of Animals in Research," but offers nothing in the way of an explanation as to what such "ethical use" consists of.[49] Ethical concern for the suffering of animals is similarly conspicuously absent in the Canadian Environmental Protection Act (CEPA), which is almost exclusively concerned with the "containment" of "animate products of biotechnology." [55]. The CCAC, which is responsible for approving and overseeing biotechnological research, teaching, and testing in Canada, provides a four-page document outlining guidelines (which are not binding, as regulations would be) for the development and use of transgenic animals. The document only refers once in passing to concerns about "animal suffering caused by the expression of transgenes inducing tumors or

[40] Newell-McLaughlin and Re, The evolution of biotechnology, 48.
[41] Davis, Procrustean solutions, 35.
[42] Cited in Hannah Rubenstein, Goats.
[43] Ellul, The technological society, 74.
[44] Ellul, The technological society, 97.
[45] Ellul, The technological society, 134.
[46] Ellul, The technological society, 134.
[47] Ellul, The technological society, 74.
[48] Ellul, The technological society, 97.
[49] "Annex C: Federal Regulatory Framework for Biotechnology," The 1998 Canadian Biotechnology Strategy: An Ongoing Renewal Process, 1998, accessed June 5, 2012, http://www.biostrategy.gc.ca/english/View.asp?pmiid=520&x=535.

neurodegenerative diseases, etc.," but does not address these concerns in any further detail, nor does it outline other forms of suffering transgenic animals are likely to experience.[50] The remainder of the CCAC guidelines on transgenic animals are concerned with "accounting" (i.e., keeping track of the numbers of animals used) and, as in the CEPA guidelines, "containment." One research protocol requirement is that "endpoints for survival are clearly defined", a statement that reflects the exterminationist character of biotechnology.[51]

Despite the violence against animals that biotechnology inevitably involves, commentators often present it as a potential *remedy* for animal suffering. In a recent opinion piece in the *New York Times*, Emily Anthes, author of *Frankenstein's Cat: Cuddling Up to Biotech's Brave New Beasts* (2013), warns that if we block the approval of products like AquAdvantage Salmon, "we'll be closing the door on innovations that could help us face the public health and environmental threats of the future, saving countless animals — and perhaps ourselves" [56]. The following abstract from the scientific journal *Animal Biotechnology* makes equally spurious claims. In the same breath, it both hails biotechnology as the means for reducing the numbers of animals used in experiments *and* boasts of its capacity to create "uniform" commodities: "The potential applications of producing genetically identical individuals range from reducing the number of animals needed for experimentation to providing a more uniform product in the freezer at the grocery store" [57]. To suggest that biotechnology will reduce the numbers of animals needed for experimentation is misleading given how many animals will have to suffer in laboratories in order to accomplish such a feat. In fact, as Arianna Ferrari observed, in 2006 GM technologies were considered "to be the largest factor contributing to the continuous increase in the total number of laboratory animal procedures reported during the last couple of years," and research suggests that "there is a great probability that this trend will further increase…" [58]. Though statistics on the use (and development) of transgenic animals in Canada are not readily available to the public, the CCAC's assertion outlined earlier that "the use of transgenic animals is likely to expand in the future" confirms that more, not fewer animals will be brought into existence and used for invasive experimentation in the coming years. And the claim above begs the question: even if biotechnology did manage to reduce the number of lab animals, what about the fate of all the animals it turned into "a more uniform product in the freezer at the grocery store"?

The Assault on Species Integrity

Another serious concern is the lack of robust ethical critique biotechnology faces from bioethicists and other theorists of technology.While they typically offer compelling critiques of biotechnology's service to global capital and its grounding in the broader speciesist structure of oppression, many theorists ultimately misdiagnose the essential problem. As a result, they arrive at troubling conclusions about the potentially positive role biotechnology could play in dissolving those same structures of oppression. As I have argued elsewhere, posthumanists tend to romanticize biotechnology's role in "queering" and "transgressing" boundaries between humans, other animals, and technics.[52] In their explorations of the "latent liberatory imaginary" of biotechnology, some posthumanists enthusiastically endorse the potential discursive and semiotic transformations (i.e., the symbolic questioning of species boundaries) that biotechnology supposedly engenders, at the expense of the material (i.e., the concrete experiences of the animals themselves).[53] While the binary between "the human" and "the animal" has certainly proven to be one of the key conceptual foundations for animal exploitation, the indiscriminate erasure of conceptual and material boundaries between humans, animals, and technics characterizes a new and even more troubling development in the history of animal oppression [59].

Yet many posthumanist scholars, as well as bioethicists, remain oblivious to the dangers of these erasures, or if they do acknowledge them, fail to take them as seriously as they should. This is evinced in part by the growing assault on the concept of "species integrity," which is increasingly, and dangerously, dismissed as the fruit of an embarrassing "essentialism".[54] For example, Bernard Rollin claims that concern for preserving species integrity is the product of a "common but scientifically unsophisticated and rather muddled

[50] CCAC guidelines on transgenic animals.
[51] CCAC guidelines on transgenic animals.
[52] This brief critique of some posthumanists' glorification of hybridity is anticipated by two previously published pieces already cited in this article: Weisberg, "The broken promises of monsters: Haraway, animals, and the humanist legacy"
[53] Twine and Stephens, Introduction, 125.
[54] Weisberg. The trouble with posthumanism. 101–103

understanding by a virtually scientifically illiterate public of species as being…the building blocks or atoms of the biological world….” [60]. Species, he insists, are “dynamic rather than static.”[55] He is, of course, correct in one sense. But the healthy dynamism of a species is an evolutionary dynamism, and the dynamism qua variation between individual members of each species, not the violent dynamism of the radical and abrupt genetic manipulation that biotechnology entails. Rollin does oppose subjecting animals to conditions that prevent them from realizing their telos, entelechy, or species-specific ends. “It is pivotal” to the “new ethic” he proposes “to protect in animals their most fundamental interests as determined by their nature or telos” [61]. But, he is quick to point out, he does not oppose radically altering their telos so that there is no longer a conflict between it and the principles and machinery of production.[56] “If animals could be happier in changing their natures,” he maintains, “I see no moral problem in doing so.”[57] He thereby reinforces the very mandate of exterminationism, which is, precisely, to change animals' natures so that they pose no conflict with the technical apparatus, but in fact become indistinguishable from it.

In a similarly dismissive vein, bioethicists Jason Scott Robert and Françoise Baylis claim that despite scientific evidence to the contrary, anachronistic “notions of ‘species essences’ and ‘universal properties’ persist” and must be dispelled [62]. They claim that research in evolutionary biology and genomics indicates that “there would appear to be no such thing as fixed species identities.”[58] Again, it is one thing to acknowledge that species have evolved and adapted over the course of millennia and are in that sense fluid, and quite another to naturalize technologically mediated genetic modifications that have been imposed onto animals in laboratories almost overnight (in evolutionary terms).

Robert and Baylis echo Rollin further when they suggest that ethical concerns around the production of “novel beings” is symptomatic of “folk essentialism.” Any claim that there is anything specific to human beings (which would be undermined by the production of human-animal chimeras or xenotransplantation) is, in their estimation, “always already an essentialist idea.” This stubborn essentialism has generated “the inexorable threat of moral confusion.”[59] Human-animal hybrids and chimeras “represent a metaphysical threat to our self-image.”[60] Another reason hybrid or chimeric animals may arouse (unjustified) horror in the public, Robert and Baylis suggest, is simply “the intuitive ‘yuck’ response” or the fear that “the creation of interspecies creatures from human materials evokes the idea of bestiality.”[61] The upshot of Robert’s and Baylis’ analysis is that by disabusing ourselves of our obsessive attachment to anachronistic notions of species integrity, we might be less horrified about at least some forms of biotechnology than we are at present.

Though much more sensitive than Rollin and Robert and Baylis are to the actual dangers to animals that biotechnology poses, Richard Twine also suggests that at least some expressions of repulsion at biotechnological innovations are in fact thinly disguised expressions of essentialism: “One kind of yuck factor response may speak to a fear that the material mixings of human and animal are accompanied by the symbolics of animality breaching and ‘degrading’ the human” [63]. Although there might be some truth to this, I am not convinced that this is really what is at stake. More than a fear of undermining the essence of the human, expressions of disgust at biotechnological mixings speak to a profound intuitive repulsion at the moral wrongness of turning living beings into something they are not, of blurring boundaries so radically that animals become unrecognizable to themselves and to others. To be clear, it goes without saying that it is crucial to destabilize the narcissistic view that human beings occupy a special and unique metaphysical status. But biotechnology, which is wedded to global capital and is by its very nature a form of radical ontological violence, could not be a worse vehicle for this paradigm shift.

The Biotechnological Fix

Another problem is that discussions of biotechnology, at least among animal studies scholars and bioethicists, are typically situated within the competing frameworks of consequentialism, most notably Peter Singer’s preference utilitarianism, or Tom Regan’s Kantian deontology. Neither of these models provides adequate tools for subjecting

[55] Rollin, The ‘Frankenstein thing’, 284.
[56] Rollin, The ‘Frankenstein thing’, 284.
[57] Rollin, The Frankenstein syndrome, 171.
[58] Robert and Baylis, Crossing species boundaries, 6.
[59] Robert and Baylis, Crossing species boundaries, 5.
[60] Robert and Baylis, Crossing species boundaries, 8.
[61] Robert and Baylis, Crossing species boundaries, 7.

biotechnology to the rigorous ethical scrutiny it deserves. As Ferrari has noted, these models are too limited in their scope. Among other things, they fail to adequately account for the socioeconomic and political contexts within which biotechnologies are developing, or to ask pressing questions surrounding the problem of human entitlement and the "technologization of nature." In many cases, the net effect is to reduce the ethical analysis of biotechnology to a series of philosophical "conundrums" [64].

A special issue of *NanoEthics* (April 2012) bears Ferrari's critique out. This issue of the journal features a lively discussion about the ethics of "disenhancement," which involves "removing or otherwise disabling" animals' ability to see or feel pain. Disenhancement is achieved "either genetically or through a nano-mechanical intervention in cellular or neurological processes" [65]. Paul Thompson and Clare Palmer recognize that animal disenhancement poses philosophical and ethical conundrums, but they do not regard it as necessarily problematic in and of itself. In fact, in their view, it may even be worth pursuing if it promises to alleviate animal suffering in the context of the increasing global consumption of animal flesh [66]. Thompson, for instance, suggests, albeit tentatively, that animal disenhancement could help mitigate or eliminate the suffering caused by the myriad "production diseases" that animals are afflicted with as a result of the horrific conditions of factory farming.[62] "Blind chickens" are the paradigmatic example of animal welfare-based disenhancement. Blind chickens do not, the theory goes, experience the same degree of distress as a result of overcrowding than their sighted counterparts who, suffering "cage madness," often cannibalize each other.[63] Unlike Rollin, Thompson concedes that it would be preferable to change the environment to suit the animal, rather than vice versa. But, he argues, because it is unlikely that factory farming will come to an end in the near future, disenhancement might be the best interim solution we have at our disposal.[64]

Thompson notes that both a utilitarian and a deontological position would theoretically support disenhancement. With regard to the former, the view would be that "Organisms that lack the capacity to suffer cannot be harmed, so taking steps to create such organisms seems to be what a utilitarian would have us do."[65] While this may be so, the problem with this formulation is that it depends on Singer's problematic reduction of animal subjectivity to the "interest" in avoiding suffering. However, ethologists and phenomenologists have both shown that the capacities to feel pleasure and pain are not isolated, but are part and parcel of the intricate web of adaptive perceptual, biological, physiological, and neurological capacities that together make up each individual animal's subjectivity. As John Hadley asks rhetorically, "…is the presence or absence of the capacity to experience pleasure or pain really all or nothing for highly complex adaptive organisms?" [67]. With Hadley's more holistic view in mind, it is clear that being deprived of vision, or any other capacity that forms part of the larger whole of each embodied subject, would not only compound animals' existing suffering, but would also very likely create *new* forms of suffering.

From a deontological perspective, "If we can develop an animal that produces meat, milk or eggs and is not a subject-of-a-life, there is nothing or no one to be harmed by doing so."[66] In other words, if we develop animals without the "variety of sensory, cognitive, and volitional capacities" they normally possess, or without the ability to "see and hear, believe and desire, remember and anticipate, plan and intend," among other things, there is no ethical barrier to exploiting these automaton-like creatures. What Thompson does not acknowledge here are the grave injustices involved in imposing such ontological distortions in the first place. *What we ought to be asking ourselves is not how we can use biotechnology to strip animals of any last vestiges of their subjectivity, but how we can free animals from the grip of technological rationality, and so create the conditions for animals to be who they are, as themselves and for themselves*.

Clare Palmer points out that different ethical issues are raised depending on whether an animal is disenhanced after or prior to birth and whether we are referring to a species or a particular animal. She explains that a "disenhanced animal has not been disenhanced relative to some already existing, 'enhanced' state of itself, since, as an individual, it did not exist prior to being created with exactly the capacities it actually has. *It* has not been deprived of anything."[67] This putative lack of prior identity presents what Palmer refers to as the "nonidentity problem." But, as Ferrari has observed, in many, if not most,

[62] Thompson, The opposite of human enhancement, 305–316.
[63] Thompson, The opposite of human enhancement, 308.
[64] Thompson, The opposite of human enhancement, 311.
[65] Thompson, The opposite of human enhancement, 309.
[66] Thompson, The opposite of human enhancement, 309.
[67] Palmer, Animal disenhancement, 45.

cases in which animals are genetically altered, their identity has already been formed.[68]

Twine, meanwhile, wonders if "de-domesticating" animals through "corrective genetics" may not be one way to emancipate domesticated animals from genetically encoded servitude [68]. Twine also explores how genetic de-domestication techniques can undermine human/animal dualism, underscore the "fluidity" of species boundaries, and "seed alternative human/animal futures" [69]. However, as Matthew Cole and Karen Morgan point out, de-domestication programs tend to implicitly and explicitly hierarchize rare and exotic animals over domesticated ones [70]. Despite its pernicious applications and implications, however, Twine remains interested in keeping open the possibility that "corrective genetics" could be of benefit to some animals.[69]

Neil Stephens explores different perspectives on whether the development of in vitro (or cultured) meat (IVM) could fulfill its "animal-liberatory promissory narrative" by obviating the need to intensively rear and slaughter animals for food [71]. Some animal advocacy groups have also supported this initiative. For example, People for the Ethical Treatment of Animals (PETA) has offered a one-million-dollar prize to whomever is able to sell the most IVM in the USA.[70] Their belief is that the introduction of IVM would precipitate the cessation of factory farming much more quickly than veganism, which stands little chance of being adopted worldwide. However, critics of IVM point out that many animals are harmed in the research and development phase. For example, one of the leading techniques for developing muscle tissue involves extracting "fetal bovine serum" from a calf embryo, shortly after its mother has been slaughtered.[71]Another issue to consider is whether or not the production of IVM inadvertently perpetuates the idea that eating meat is "normal, natural, and necessary."[72] When IVM is not available, who is to say people won't eat meat from factory farmed animals in the meantime to satisfy their palates? Unless it completely replaces "regular" meat (i.e. meat from animals), IVM could also ultimately contribute to the global increase of meat consumption. Ultimately, looking to biotechnology to solve ethical crises is fraught with danger and should be avoided. Embracing biotechnological fixes occurs when ethics has been "redefined by the rationality of the given system and of its quantitative extension."[73]

Conclusion

In this paper, I have argued that animal biotechnology constitutes an ontological and ethical calamity of the highest order. The collapse of crucial ontological tensions between sentient beings and the technical-economic apparatus, and the corresponding ethical collapse, signal the triumph of humans' centuries-long war of extermination against other animals. Although some theorists are open to the possibility that biotechnology could be mobilized to mitigate some of the worst harms perpetuated against animals today, the evidence overwhelmingly points to the contrary. With the devastation biotechnology wreaks on animals and on our ethical commitments to them, I cannot but agree with Andrew Linzey that "Nothing less than the dismantling of this science as an institution can satisfy those who advocate moral justice for animals."[74] Linzey, a theologian speaking to fellow Christians, continues, "We reach here the absolute limits of what any reputable creation theology can tolerate."[75] Those of us not beholden to Christian doctrine might argue instead that we reach here the absolute limits of what any society that calls itself "civilized" can tolerate.

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[68] Ferrari, Animal disenhancement, 68.
[69] Twine, Is biotechnology deconstructing animal domestication, 146.
[70] Stephens, Growing meat in laboratories, 175.
[71] Stephens, Growing meat in laboratories, 166.
[72] Joy [72] And, as with other non-vegan alternatives such as "humane" farming, IVM would actually encourage people to continue eating factory-farmed meat when IVM was not available. Their conscience would be alleviated because they could reassure themselves that "most of the time," whenever it is available, they eat cruelty-free IVM instead.
[73] Marcuse, One-dimensional man, 12.
[74] Linzey, Genetic engineering, 325.
[75] Linzey, Genetic engineering, 325.

References

1. von Feuerbach L (1986) Principles of the philosophy of the future, trans. Manfred Vogel (Indianapolis; Cambridge: Hackett Publishing Company), 42
2. Chan R (2012) Thinking big: synthetic biology. Fidelity Investments. http://thinkingbig.fidelity.com/bio. Accessed June 24, 2012
3. Anthes E (2013) Don't be afraid of genetic modification. *The New York Times*, March 9, 2013. http://www.nytimes.com/2013/03/10/opinion/sunday/dont-be-afraid-of-genetic-modification.html?pagewanted=all&_r=1&. AquaBounty Technologies. 2014. "Products." http://aquabounty.com/company/products/. Accessed March 17, 2013
4. Hai T et al (2014) One-step generation of knockout pigs by zygote injection of CRISPR/Cas system. Cell Research 24:372–375. doi:10.1038/cr.2014.11. Accessed 29 Oct. 2014
5. Best S (2011) Genetic science, animal exploitation, and the challenge for democracy. In: Carol G (ed) Leonardo's choice: genetic technologies and animals. Springer, Dordrecht, p 7
6. Best S (2013) Genetic science, 9. "GloFish® FAQ," GloFish®. http://www.glofish.com/about/faq/. Accessed 12 June 2013
7. Firm hails dog clone breakthrough (2009) BBC News. http://news.bbc.co.uk/2/hi/asia-pacific/7858566.stm. Accessed 11 June 2013
8. Jørgenson D (2013) Reintroduction and de-extinction. BioScience 63(9):719–720. doi:10.1525/bio.2013.63.9.6
9. Cohen S (2104) The ethics of de-extinction. NanoEthics 8: 165–178. doi:10.1007/s11569-014-0201-2
10. Derrida J (2008) The animal that therefore I am, trans. In: David W (ed) Marie-Louise Mallet. Fordham University Press, New York, p 26, Italics added
11. Bud R (1993) The uses of life: a history of biotechnology. Cambridge University Press, Cambridge, p 1
12. CCAC guidelines: on procurement of animals used in science (2007) The Canadian Council on Animal Care. http://www.ccac.ca/Documents/Standards/Guidelines/Procurement.pdf. Accessed 17 March 2013
13. "UN Convention on Biological Diversity (1992)" United Nations. http://www.cbd.int/convention/text/default.shtml. Accessed 22 Feb 2012
14. Margawati ET (2003) Transgenic animals: their benefits to human welfare. ActionBioscience. http://www.actionbioscience.org/biotech/margawati.html. Accessed 17 March 2013. Italics added
15. CCAC guidelines: on transgenic animals (1997) The Canadian Council on Animal Care. http://www.ccac.ca/Documents/Standards/Guidelines/Transgenic_Animals.pdf. Accessed 7 May 2013
16. Bacon F (1999) "New Atlantis,". In: Sargent R-M (ed) Francis Bacon: selected philosophical works. Hackett Publishing Company, Indianapolis, p 263f
17. Weisberg Z (2009) The broken promises of monsters: Haraway, animals, and the humanist legacy. Journal for Critical Animal Studies 2(2):50
18. Stix G (2006) The land of milk and money. *Scientific American*. http://www.scientificamerican.com/article.cfm?id=atryn-the-land-of-milk-and-mone. Accessed 7 May 2013
19. Rutherford A (2012) Synthetic biology and the rise of 'spider-goats'. *The Guardian*. http://www.guardian.co.uk/science/2012/jan/14/synthetic-biology-spider-goat-genetics. Accessed 17 March 2013
20. Ellul J (1964) The technological society, trans. John Wilkinson. Knopf, New York, p 135
21. Sample I (2009) Genetically modified monkeys give birth to designer babies. *The Guardian*. http://www.guardian.co.uk/science/2009/may/27/genetically-modified-gm-monkeys-germline. Accessed 28 May 2012
22. Cyranoski D (2009) Marmoset model takes centre stage. Nature 459, 492. doi:10.1038/459492a, Accessed 28 Oct. 2014
23. Meidinger RM et al (2014) The EnviropigTM: reducing the environmental impact of animal agriculture through high health-status pigs that efficiently utilize dietary plant phosphorus. Journal of Biotechnology, IV1-O-001. doi:10.1016/j.jbiotec.2008.07.458, Accessed 28 Oct 2014
24. Forsberg CW et al (2013) Integration, stability and expression of the E. coli phytase transgene in the Cassie line of Yorkshire Enviropig™. Transgenic Res 22:379–389. doi:10.1007/s11248-012-9646-7, Accessed 28 Oct. 2014
25. Pollack A (2012) Move to market gene-altered pigs in Canada is halted. The New York Times. http://www.nytimes.com/2012/04/04/science/gene-altered-pig-project-in-canada-is-halted.html. Accessed 27 May 2012. Italics added
26. Chan R (2013) Thinking big: "Enviropig™". University of Guelph. http://www.uoguelph.ca/enviropig/. Accessed 3 Oct. 2013
27. Service RF (2002) Mammalian cells spin a spidery new yarn. *Science* 295. doi:10.1126/science.295.5554.419b, Accessed 28 Oct. 2014
28. Robo-pigeon: the pigeon that flies wherever you fancy. Daily Mail. http://www.dailymail.co.uk/sciencetech/article-439025/Robo-pigeon-pigeon-flies-fancy.html#ixzz1wHd6SaR6. Accessed 29 May 2012
29. Carmena JM et al (2003) Learning to control a brain–machine interface for reaching and grasping by primates. *PLoS Biology* 1: 2 . doi:10.1371/journal.pbio.0000042, Accessed 28 Oc. 2014
30. Heaven D (2013) First mind-reading implant gives rats telepathic power. NewScientist, http://www.newscientist.com/article/dn23221-first-mindreading-implant-gives-rats-telepathic-power.html. Accessed 8 May 2013
31. Reardon S (2013) Interspecies telepathy: human thoughts make rats move. *NewScientist*. http://www.newscientist.com/article/dn23343-interspecies-telepathy-human-thoughts-make-rat-move.html. Accessed 8 May 2013
32. Adorno TW (1983) Negative dialectics, trans. E. B. Ashton. Continuum, New York, p 148
33. Marcuse H (1964) One-dimensional man: studies in the ideology of advanced industrial society. Beacon Press, Boston, p 137
34. Horkheimer M, Adorno TW (2002) Dialectic of enlightenment: philosophical fragments. In: Gunzelin Schmid N (ed) trans. Edmund Jephcott. Stanford University Press, Stanford, p 4

35. Thacker E (2003) Data made flesh: biotechnology and the discourse of the posthuman. Cultural Critique 53:89
36. Eunice KY (2005) Britain pro-lifers row over cloning license to Dolly's father, Christian Today. http://www.christiantoday.com/article/britain.prolifers.row.over.cloning.license.to.dollys.father/2109.htm. Accessed 28 May 2012
37. Sample I (2010) Craig Venter creates synthetic life form. The Guardian. http://www.guardian.co.uk/science/2010/may/20/craig-venter-synthetic-life-form, Accessed 29 May 2012
38. Rutherford A (2012) Synthetic biology and the rise of the 'spider-goats'. http://www.guardian.co.uk/science/2012/jan/14/synthetic-biology-spider-goat-genetics/print. Accessed 29 May 2012
39. Newell-McGloughlin M, Re E (2006) The evolution of biotechnology: from Natufians to nanotechnology. Springer, Dordrecht, p 52
40. Sell SK (2007) International institutions, intellectual property, and the HIV/AIDS pandemic. In: Ostergard RL Jr (ed) HIV/AIDS and the threat to national and international security. Palgrave MacMillan, New York, p 151
41. Murray F (September 2010) The Oncomouse that roared: resistance and accommodation to patenting in academic science. American Journal of Sociology 116:351. doi:10.1086/653599. Accessed 28 May 2012
42. Linzey A (2002) Genetic engineering. In: Richard S, Morrey JD (eds) Ethical issues in biotechnology. Rowman and Littlefield, Lanham, p 330, Author's italics
43. Knight W (2003) Dolly the sheep dies young, New Scientist'. http://www.newscientist.com/article/dn3393-dollythe-sheep-dies-young.html. Accessed 5 June 2012
44. Shanks N, Greek R (2009) Animal models in light of evolution. BrownWalker Press, Boca Raton, p 310
45. Best S (1990) Genetic science 10; KarlMarx, Capital Volume 1, trans. Ben Fowkes (London; New York: Penguin Books) 481
46. Noske B (1997) Beyond boundaries: humans and animals. Black Rose Books, Montreal, p 18
47. Von Uexküll J (2010) A foray into the worlds of animals and humans with a theory of meaning. In: Cary W (ed) trans. Joseph D. O'Neil, Posthumanities, vol. 12. University of Minnesota Press, Minneapolis, p 43
48. Merleau-Ponty M (2002) Phenomenology of perception, trans. Colin Smith. Routledge Classics, London; New York, Italics added
49. Harvey D (1990) The condition of postmodernity: an enquiry into the origins of cultural change. Oxford: Blackwell Publishing, Cambridge, p 240
50. Marinetti FT (1973) The founding and manifesto of futurism 1909. In: Umbro A, Robert B, Flint RW, Higgitt JC, Caroline T (eds) Futurist Manifestos. Thames and Hudson, London, p 22
51. Virilio P (2007) Speed and politics: an essay on dromology, trans. Mark Polizzotti. Semiotext(e), Los Angeles, p 167
52. Gigliotti C (2013) "Introduction," xiv. Italics added. Best, "Genetic Science," 3. Italics added. See also Matthew Cole and Karen Morgan, "Engineering Freedom? A Critique of Biotechnological Routes to Animal Liberation,". Configurations 21:219
53. Rifkin J (1998) The biotech century: harnessing the gene and remaking the world. Tarcher/Putnam, New York, p 101
54. Davis K (2011) Procrustean solutions to animal identity and welfare problems. In: Sanbonmatsu J, Gottlieb R (eds) Critical theory and animal liberation, Nature's Meaning. Boulder: Rowman and Littlefield, Lanham, p 35
55. "Canadian Environmental Protection Act (1999)" Environment Canada. http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=24374285-1&offset=1&toc=show. Accessed 5 June 2012
56. Anthes E (2013) Don't be afraid of genetic modification. The New York Times. http://www.nytimes.com/2013/03/10/opinion/sunday/dont-be-afraid-of-genetic-modification.html?pagewanted=all&_r=1&. Accessed 10 May 2013
57. Prather RS, Stumpf TT, Rickords LF (1992) Nuclear transplantation as a method of producing genetically identical livestock. Animal Biotechnology 3:1–67. doi:10.1080/10495399209525763. Accessed 22 Feb 2012
58. Ferrari A (2006) Genetically modified laboratory animals in the name of the 3Rs? Altex 23:299
59. Twine R, Stephens N (2013) Introduction to special issue on animal biotechnology: do animal biotechnologies have a latent liberatory imaginary? Configurations 21:130
60. Rollin BE, Morrey JD (2002) The 'Frankenstein thing'. In: Richard S (ed) Ethical issues in biotechnology. Rowman and Littlefield, Landham, p 275
61. Rollin BE (1995) The Frankenstein syndrome: ethical and social issues in the genetic engineering of animals. Cambridge University Press, Cambridge, p 171
62. Robert JS and Baylis F (2003) Crossing species boundaries. The American Journal of Bioethics 3, no. 3 (Summer 2003), 4
63. Twine R (2010) Genomic natures read through posthumanisms. The Sociological Review 58(1):188
64. Ferrari A (2012) Animal disenhancement for animal welfare: the apparent philosophical conundrums and the real exploitation of animals. A response to Thompson and Palmer. Nanoethics 6:70
65. Thompson PB (2008) The opposite of human enhancement: nanotechnology and the blind chicken problem. Nanoethics 2:308
66. Palmer C (2011) Animal disenhancement and the non-identity problem: a response to Thompson. Nanoethics 5:43–48
67. Hadley J (2012) Confining 'disenhanced' animals. Nanoethics 6:42
68. Twine R (2013) Is biotechnology deconstructing animal domestication? Movements toward liberation. Configurations 21(2):146
69. Twine R (2013) Is biotechnology deconstructing animal domestication. 138; 140
70. Cole M, Morgan K (2011) Engineering freedom? Nanoethics 5:207
71. Stephens N (2013) Growing meat in laboratories: the promise, ontology, and ethical boundary-work of using muscle cells to make food. Configurations 21(2):167
72. Joy M (2011) Why we love dogs, eat pigs, and wear cows: an introduction to carnism. Conari Press, San Francisco, pp 96–98