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ORIGINAL PAPER

Splices: When Science Catches Up with Science Fiction

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Abstract This paper examines human-nonhuman splices from a multidisciplinary approach, involving bioengineering and literary studies. Splices are hybrid beings, created through gene-splicing—a process which combines the DNA of the two species, resulting in a hybrid or chimeric being. A current trend in biotechnological research is the use of spliced pigs for xenotransplantation. Hiromitsu Nakauchi's pancreas study that splices pigs with human iPS [induced pluripotent stem] cells in order to grow human organs inside pigs is being compared to a highly similar case of porcine hybrids: the pigoon from Margaret Atwood's fictional MaddAddam trilogy. Atwood's pigoons are pigs, genetically modified with human stem cells to facilitate the growth of various human organs for use in organ transplants with no risk of rejection. The case studies from science and science fiction overlap significantly and thus allow for a critical reading of the two highly different sources with a focus on ethical and moral questions regarding the use and abuse of nonhuman animals for human purposes. Furthermore, the context of the fictional works adds new layers of knowledge and new perspectives to the problematic issue of animal "enhancement." Through the dynamic agency that can be detected within Atwood's novels and that encompasses human, animal, and hybrid agency, the reader can develop empathy for other-than-human experiences and use this new perspective for a critical reflection of actual technoscientific developments that affect both human and nonhuman animal life. The combination of the two discourses reveals a value of science fiction for both the scientific community and society at large, demonstrating how its critical reception can result in enhanced ethical standards.

Keywords Animal enhancement · Bioethics · Current trends in bioengineering · Human-animal boundary · Margaret Atwood · Pigs · Science fiction · Splices · Xenotransplantation

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Introduction

Science fiction, notably that of Margaret Atwood, both examines contemporary critical discourse and, in turn, informs future discussion. This paper reveals the potential of fictional works to inform and influence a readership interested in human–animal relations, the environment, science, biology, and ethics in regard to human and other animal life. The combination of a critical reading of fictional works and of ongoing scientific experimentation enables to adopt a new perspective on the topic of bioengineering that involves nonhuman animals. The utilization of fictional characters allows for a greater sphere in which moral questions can be reframed and applied to actual scientific developments.

In the first part of this paper, I begin with a critical discussion of Atwood's MaddAddam trilogy, with a focus on the ethical questions surrounding human-nonhuman splices. Atwood's narration offers abundant depictions of genetically engineered nonhuman animals,

comparable to existing hybrids and ongoing scientific experimentation. The most prominent example from Atwood is the fictional pigoon project. I compare this to a specific case of chimeric embryo research that uses pigs as animal "models." Both the fictional pigoon project and the real experimentation with the porcine hybrids aim at growing human organs inside pigs for transplantation to human patients in need of organ transplants. By contrasting the two sources and discussing their contentual and rhetorical overlap, I will show how readers of this particular science fiction trilogy and bioethicists can enter a critical discourse on the future and value of nonhuman beings in human-dominated societies.

The second part of this paper examines the ethics of cross-species living. Here, I focus on various fictional splices that appear in Atwood's trilogy and demonstrate how their genetic make-up influences their agency and their status. I argue that agency, be it nonhuman or human, is in flux in the narration. By analyzing this fluctuation, it becomes apparent species' boundaries are not the determinant factors for well-being and ethical treatment. Instead, the way an individual is treated by others depends on various factors, such as the value given to the living being in a specific context. Examples from the novels will show that this context can be a speech act, an experimental setting, or a state of emergency. The being in question can thus become a moral agent, a property, or even a food item. With references to Atwood's fictional humanoid race, the Crakers, I discuss how animal "enhancement"[1] can lead to the blurring of species boundaries and to misconceptions of the superiority of human nature.

Pigs and Pigoons

Science Fiction: the MaddAddam Trilogy and Its Pigoon Project

The Canadian writer Margaret Atwood is known for her science fiction, or speculative fiction, as she prefers to call it,[2] which satirizes current trends she observes in contemporary Western society. Being brought up among scientists, as she reports in *Curious Pursuits*, she found inspiration in her family's discussions of scientific experiments they conducted themselves, in addition to popular scientific magazines she read. This paper views the connection of fiction and science from two angles: first, how science fiction is inspired by science and second, how science fiction might inspire science. I argue there are mutual exchanges which can lead to reciprocal influence, and I agree with Katherine Hayles, who published on the relations of science and science fiction, that both disciplines complement each other. "The scientific texts often reveal […] the foundational assumptions that gave theoretical scope and […] efficacy to a particular approach. The literary texts often reveal […] the complex cultural, social, and representational issues tied up with conceptual shifts and technological innovations."[3] My focus lies on Atwood's imagined biotechnological innovations that overlap to a high degree with actual research.

In the following, I will examine Atwood's MaddAddam trilogy, which consists of the novels *Oryx and Crake* (2003), *The Year of the Flood* (2009), and *MaddAddam* (2013). Atwood herself describes the writing of the first novel *Oryx and Crake* as following her train of thoughts regarding a "what if," an extrapolation of inventions we already encounter in our present environment. "The what if of Oryx and Crake is simply,

[1] In this context, enhancement has to be regarded as a euphemism used to disguise the act of manipulating nonhuman animals' bodies for different reasons, such as making "dairy cows" more efficient for the production of milk or reducing feed costs and phosphorus pollution of factory farmed pigs, as is the case with the Enviropig™. For a critical discussion of animal enhancement in relation to bioethics and the species boundary, see for example Richard Twine's chapter "Thinking Across Species in the Ethics of 'Enhancement'" in *Animals as Biotechnology*: *Ethics*, *Sustainability and Critical Animal Studies* [28]. German speakers should take a look at the extensive study on animal and human enhancement and ethical questions surrounding such practices by Arianna Ferrari et al.: *Animal Enhancement*: *Neue technische Möglichkeiten und ethische Fragen* [9]. There is also a recent symposium on animal disenhancement published in Nanoethics 6 (1) in 2012. The debate that triggered the symposium started with the publication of the paper "The Opposite of Human Enhancement: Nanotechnology and the Blind Chicken Problem" by P. Thompson in 2008 [27], followed by C. Palmer's "Animal Disenhancement and the Non-Identity Problem: A Response to Thompson" in 2011 [21], and includes a variety of critical essays.

[2] "What I mean by "science fiction" is those books that descend from H. G. Wells's *The War of the Worlds*, which treats of an invasion by tentacled blood-sucking Martians shot to Earth in metal canisters–things that could not possibly happen–whereas, for me, "speculative fiction" means plots that descend from Jules Verne's books about submarines and balloon travel and such–things that really could happen but just hadn't completely happened when the authors wrote the books. I would place my own books in this second category." Atwood [4: 6]

[3] Hayles [11: 24]

What if we continue down the road we're already on? How slippery is the slope? What are our saving graces? Who's got the will to stop us?"[4] These considerations refer directly to ethical, moral and biological implications of these imagined scenarios. All three novels depict a bioengineered future where humanity has reached a dead end. The country is run by biotechnological corporations and their police forces. Leading scientists' aim is creating perfect nonhuman and human animals with the ultimate aim of human immortality.

Throughout the novels, the reader encounters various splices, most notably the pigoons—enormous pigs that grow human organs inside their bodies to be harvested.[5] The various splices repopulate the earth after a man-made pandemic has wiped out its human inhabitants. This imagined world is quite different from other apocalyptic stories that either feature zombies, present the world after a nuclear attack, or after an environmental catastrophe, where nothing but rubble is left behind, because the reader is aware the peculiar hybrid animals roam and revive the once human-dominated planet. From a biocentric perspective, this renders Atwood's trilogy an optimistic future scenario. Not only do the splices thrive in the absence of humanity, flora and fauna do, as well. In his article "Liminal Ecologies," Lee Rozelle approaches *Oryx and Crake* from this point of view when he invites readers to pay attention to the biological diversity and the quick adaptation of nonhuman life in general. Quoting Ronald B. Hatch, Rozelle points us toward a reading that underlines the novel's nonanthropomorphic undertone: "Atwood has something in common with recent ecocentrist writers in her rejection of the anthropomorphic viewpoint and their struggles to re-position humanity as one species among many in a web of natural connections."[6] Overall, the perspective in the trilogy alternates between anthropocentric, animalcentric and hybrid forms, allowing the reader repeatedly to posit her or himself closer to the nonhuman experience.

In the annotation to her latest publication, *MaddAddam*, Atwood also comments on these new life forms: "Although *MaddAddam* is a work of fiction, it does not include any technologies or biobeings that do not already exist, are not under construction or are not possible in theory."[7] I will investigate how much of this is true by looking at the specific case of the pigoons as "biobeings." In her study of science fiction texts and how they can inform the academic field of human–animal studies (HAS), Sherryl Vint stresses fiction's "capacity to show open-ended and heterogeneous responses to the complexities of animals in/and human life." Vint especially refers to biotechnological advances and science fiction when she writes that fiction "can stage the problems that confront us in rich, concrete detail and thus potentially enable its readers to perceive the world and other species in new ways." She concludes that science fiction "is a fruitful way of making alternative realities intelligible."[8] Atwood's trilogy, I argue, fulfills a similar role: it depicts a future where biotechnological innovations, especially in the field of human and animal "enhancement", significantly affect shared human–animal life by redistributing power and authority, as well as by blurring the human–animal boundary. The imagined world borrows from contemporary biotechnology, thus creating a fictional future scenario that can help understand the impact of today's animal experiments. By incorporating detailed descriptions of experimental settings and their outcomes the trilogy manages to paint a vivid picture of biotechnological procedures and possible effects. It is this overlapping of science and science fiction that makes Atwood's narration so useful in reflecting upon current technoscientific developments and their consequences for bioethics—especially those not yet being openly discussed among a mass audience.

I will now move on to the fictional case study of the spliced pigs. The pigoons Atwood invents are enormous porcine hybrids that grow human organs and tissue inside their bodies. Thus, they serve as organ and tissue donors for wealthy humans wanting to replace malfunctioning organs, needing to recover from severe accidents, or seeking to prolong their life. The novels present pigoons from several perspectives, at different points in time. The reader first learns about them from the young boy Jimmy who visits his father working for

[4] Atwood [2: 323]

[5] Other splices, some of which I refer back to in the course of this paper, are as follows: rabbits that glow in the dark; liobams—a cross between lion and lamb; rakunks—a cross between skunk and raccoon; Mo'hairs—sheep that grow human hair from human DNA in all possible colors; ChickieNobs—headless chicken used as food source and without brains in order to make farming and eating them "cruelty-free"; or wolvogs—canines that look like harmless dogs but will attack when approached.

[6] Rozelle [22: 64]

[7] Atwood [5: 393]

[8] Vint [31: 211]

OrganInc Farms—the birthplace of bioengineered pigs. This scene takes places before the lethal pandemic hits.

> Jimmy's father worked for OrganInc Farms […] [where] he'd been one of the foremost architects of the pigoon project, along with a team of transplant experts and the microbiologists who were splicing against infections. […] The goal of the pigoon project was to grow an assortment of foolproof human-tissue organs in a transgenic knockout pig host – organs that would transplant smoothly and avoid rejection […]. A rapid-maturity gene was spliced in so the pigoon kidneys and livers and hearts would be ready sooner, and now they were perfecting a pigoon that could grow five or six kidneys at a time. Such a host animal could be reaped of its extra kidneys; then, rather than being destroyed, it could keep on living and grow more organs […]. That would be less wasteful, as it took a lot of food and care to grow a pigoon.[9]

Atwood's description of the pigoon project contains several characteristics which render it especially realistic. The project is based within a large corporation, OrganInc Farms. This matches the corporation dominated dystopian future portrayed by the trilogy. The aim of the pigoon project is to grow human organs inside one host animal for transplantion to multiple humans without the danger of cross-species infection. The focus lies on the avoidance of organ rejection after transplantation. When compared to the case study of Nakauchi's pigs, it becomes apparent that Atwood's vision is quite realistic and possibly based upon advancing research within bioengineering. The high value of the individual pigoons is stressed, as well, and rightly so, as it is likely these spliced animals would be subject to theft or corporate espionage.

After the lethal pandemic, caused by Crake's invention of the BlissPluss Pill,[10] has wiped out the majority of the human population, there is no one left to control the spliced pigs. Jimmy, who has grown up watching the pigoons from a safe distance, now faces a group of them out in the open. The following scene shows how his perception of the animals has changed over time and how he turns into prey.

> Seven pigoons have materialized from nowhere. They're staring at him, ears forward. […] As he watches, they begin to amble in his direction. They have something in mind, all right. […] He looks over his shoulder: they're trotting now. He speeds up, breaks into a jog. Then he spots another group through the gateway up ahead, eight or nine of them, coming towards him across No Man's Land. They're almost at the main gate, cutting him off in that direction. It's as if they've had it planned, between the two groups; as if they've known for some time that he was in the gatehouse and have been waiting for him to come out, far enough out so they can surround him.[11]

The pigoons described here have already gone feral. Being confronted with two formations of pigoons that clearly outnumber him, Jimmy's fear of being eaten by them breaks through. It is striking to see how role reversal takes place in this novel: the reader is introduced to the pigoons within a confined, secured space at OrganInc Farms and later encounters them as potentially dangerous group animals, apparently hunting a single defenseless human being. The power has shifted from the humans to the pigoons. The features designed to make the pigoons useful for human ends—the size of their bodies to hold all the extra organs and the human brain tissue that can be transplanted smoothly—now function as weapons to the disadvantage of Jimmy: Their massive bodies could easily crush him, and the neocortex tissue enhancing their brains adds to their intelligence which they use in order to make strategic plans of how to ambush and capture him.

The turn of events allowing the spliced animals in the trilogy to go feral is a literary device mirroring society. It can be seen as indirectly criticizing the methods and goals of bioengineering and technoscientific developments which have the potential to lead to such dystopian scenarios as shown in the MaddAddam trilogy. The pigoons can be regarded as not only hybrid, but also as liminal beings in the sense that Susan Squier's study *Liminal Lives* defines beings that originate from xenotransplantation.

[9] Atwood [1: 25–26]

[10] The BlissPluss Pill promises its consumers prolonged youth, protection against sexually transmitted diseases, and "an unlimited supply of libido and sexual prowess, coupled with a generalized sense of energy and well-being." Atwood [1: 346] The pill also contains a secret ingredient that Crake uses to wipe out the human population: a genetically modified virulent pathogen that is the cause for the deaths of all users of the pill, and those infected by them.

[11] Atwood [1: 313–314]

> As medical interventions are reshaping our ways of conceiving, being born, growing, aging, and dying, liminal lives surround us […] anywhere that the expected shape or span of human life is being changed through biomedicine. If we think about the social response to in vitro fertilization, organ transplantation, and stem cell therapies, for example, we will realize that after some initial resistance […], these liminal beings are generally accepted by culture and society. As quickly as these beings are normalized, we lose awareness of them. Despite – or perhaps because of – their increasing importance to culturally dominant zones of representation and practice (science, politics, economics), they escape categorization and detection, appearing only as elements of fantasy in culturally subordinate areas of representation and practice (literature and visual or performance art).[12]

Due to the pandemic in Atwood's trilogy, the pigoons no longer live in confined spaces where they present no harm to other beings. Thereby, they leave behind their liminality and become full moral agents who present a potential danger to their human creators. The process of the social response to, and eventual acceptance of, liminal lives described by Squier can be traced in the MaddAddam trilogy where, initially, the pigoons are only visible and meaningful to those who either work with or profit from the porcine hybrids. Through the boy Jimmy, the reader learns that the uneasiness with the pigoon project subsides after a while. Only after the securing walls of the laboratories and factories have come down do people pay attention to them again, which can be seen in the scenes where the adult Jimmy fears for his life because he is being pursued by a group of feral pigoons. It is interesting to follow the pigoons throughout the trilogy and to notice how their status changes from caged, harmless "enhanced" pigs to dangerous, and no longer liminal, predators. In the end, as Susan McHugh argues, the pigoons are agents who "even as people mess with them, cannot help but mess with people, too."[13]

Another encounter between humans and feral pigoons takes place in the third book *MaddAddam*. At this stage, the human survivors are not outnumbered, but they still fear the pigs. This scene shows that the status of the pigoons has changed once again to that of meat animals.

> "Only those pigs again," said Crozier. "Trying to dig under the garden fence. We shone the lights on them and they ran off. They know what a spraygun is."
> "Ever since we turned a couple of them into bacon," said Manatee.
> "Frankenbacon, considering they're splices. I still feel kind of weird about eating them. They've got human neocortex tissue."[14]

Unlike the defenseless Jimmy, this group of humans is able to defend themselves with weapons against the pigoons. Whenever a pigoon tries to break into their make-shift home in the wilderness, they shoot and eat the animal. Even though the shortage of food is a crucial factor, the act of killing and consuming the pigoons causes concern among the (once) vegetarian group of survivors. Many feel uncomfortable eating another being, especially one that is partly human. This uneasiness with the posthuman creatures leads to a nickname for the pigoons in this last novel: frankenbacon, referring to the laboratory origin of the pigoons and marking them as meat animals. This change of behavior among the community pictured in the quote above stands in sharp contrast to the status of pigoons in the first novel, where they were promoted to human customers as spare parts depots, an investment into one's future health and youth. The brochure marketing the pigoon project addressed those concerned about the possible conversion of pigoons into food items: "it was claimed that none of the defunct pigoons ended up as bacon and sausages: no one would want to eat an animal whose cells might be identical with at least some of their own."[15]

The fundamental change of attitude toward the spliced pigs reflects how morals and ethics are prone to change depending on circumstances. For bioethics, this means that with the help of imagined scenarios such as in science fiction, ethical concerns can be made visible and debated in a less constricted space. Liminal beings emerging from xenotransplantation do not need to remain shadowy figures, they can be revived in the fictional context, which helps to make them more approachable and understandable. Repercussions of biomedical research can equally be made more comprehensible within the fictional realm. Both bioethics and

[12] Squier [25: 4–5]
[13] McHugh [18: 208]
[14] Atwood [5: 19]
[15] Atwood [1: 27]

literary studies can thus inform each other on critical topics that affect us all. Squier goes a step further by predicting that: "A reinvigorated bioethics will reposition fiction and literature as contributions to social knowledge, rather than cordoning them off into the realm of the textual and aesthetic, a zone with no purchase on the material conditions of the present."[16]

Eventually, at the end of the last novel, the pigoons and the human survivors make an agreement not to harm each other. They base this truce on their shared gene pool and shared sense of moral community. Atwood achieves two things with this truce: she reinstates the integrity of the vegetarian community that was formerly fighting against the corporations and their inventions, and she also makes the pigoons moral agents and pays them respect within the narration. The pigoons are no longer dangerous monsters, neither are they spare parts depots nor food. In the second part of this paper, the cooperation of pigoons and humans will be discussed in more detail. It will show how Atwood manages to provide her readers with a new angle in regarding the topic of bioengineering nonhuman animals through the embodied agency that the spliced pigs display.

Science: Xenotransplantation and Chimeric Embryo Research

The use of nonhuman animals in scientific research proliferates. Groundbreaking work has been done in many fields, but I want to restrict the discussion to transplantation and animal "enhancement". Both of these play an important role in Atwood's trilogy and both focus on human-animal splices. The increasing demand for organ and tissue transplantation worldwide, especially in industrialized countries such as the USA, Canada, Australia, or many parts of Europe, leads to the application of new methods to meet this demand. In the USA alone, as of April 14th, 2014, there were 122,182 registered patients in need of organ transplantation. On this waiting list, 100,054 patients were for example waiting for a kidney, 15,727 for a liver, 1,188 for a pancreas, 3906 for a heart, and 1657 for a lung.[17] The not-for-profit organization, Donate Life America, states on its website that, "90 % of Americans say they support donation, but only 30 % know the essential steps to take to be a donor."[18] These are merely the numbers for the USA and meant to illustrate that organ transplantation is a critical, and potentially growing, field of interest in bioethics.

Worldwide, it is important to create a functional system for transplant donors and receivers. This is however especially problematic in developed countries, where organ donation and transplantation face another problem—the gap between the rich and the poor. In the worst case, the market can dictate prices for organs and if one can afford it, chances are higher one might survive. In an interview with Deutsche Welle, World Health Organization (WHO) specialist Dr. Luc Noel adds to this, "Of course the unscrupulous individuals making profits are taking advantage of a gap between the available supply in organs for transplantation and the demand of patients."[19] He suggests "a society willing to provide a transplantation service needs to invest, needs to organize but also needs to check that things are well carried out – that the trust of the public is well-justified."[20] As Noel also mentions, the WHO estimates that organ transplantation covers only 10% of the global need. The gap between supply and demand clearly shows organ transplantation is a field of regenerative medicine with high social significance. The whole debate about social responsibility shows transplantation is a topic which relies heavily on public opinion and needs the public in order to function.

Since the problem seems unlikely to be solved with human donors alone in the near future, researchers are working on alternatives. Xenotransplantation is such an alternative, where transplantation of organs or tissue is performed between different species—for example, from pig to human. The risk of xenotransplantation lies in the different genetic make-up of species. It can be said the closer the species, the less likely it is the transplanted organ will be rejected. An organ originating from another species could also contain unknown viruses, with unknown effects for the host. This is one area where much research is being done to avoid complications of xenotransplantation. Currently, the animal of choice for such procedures is the pig. According to HumanXenoTransplant, recent research in xenotransplantation "has focused largely on the pig as potential source animal instead of nonhuman primates" because "excellent breeding characteristics of pigs allow to

[16] Squier [25: 23]
[17] U.S. Department of Health & Human Services [29]
[18] Donate Life America [8]
[19] Schmidt & Noel [24]
[20] Schmidt & Noel [24]

generate large numbers of animals in closed colonies and to develop transgenic and cloned animals."[21] Moreover, the internal organs of pigs and humans are roughly the same size. Ethical concerns regarding the use of primates, who are genetically closer to humans, play a role, as well. This point, however, is not often mentioned in justifications for projects involving animal experiments. The reason might be that pigs are already used for human food production and are bred in large numbers. In addition, humans in general do not regard themselves as very close to pigs and many do not oppose using them as a food source. The use of primates would pose different ethical concerns, as our species are so closely related and the public opinion has an increased understanding of animal welfare, or even animal rights, when it comes to primates.

Due to aforementioned concerns, researchers interested in replacing or cloning human organs focus on the use of pigs in their experiments. The newest development that I will examine is the use of pigs for xenotransplantation that have been manipulated with human stem cells to avoid organ rejection after transplantation. The procedure works like this: human stem cells are implanted into genetically engineered pig embryos which are unable to grow a certain organ. These human stem cells then evolve into the desired organ within the pig's body and can later be taken out of the mature pig in order to be transferred to the human host who provided the original stem cells. The specific case study I selected is the research group led by Prof. Nakauchi, who has conducted this experiment with pancreases. Nakauchi, former professor of stem cell studies at the University of Tokyo, Japan, has been recruited to the faculty of the Stanford Institute for Stem Cell Biology and Regenerative Medicine in November 2013.

Prof. Nakauchi's study involves the use of so-called large animal "models," pigs. His research is classified as "high-risk, high-reward research"[22] because it could lead to an almost unlimited supply of organs for all patients on the waiting lists for organ transplantation. The risk is the high uncertainty that these organs will be fully functioning once they are transplanted. Currently, the organ of interest is the pancreas with an anticipated extension toward other organs. The abstract of his current research project summarizes the state of the art in chimeric embryo research as follows.

> In a preliminary study, we generated preclinical models that could not develop pancreases. When we injected stem cells into these models, they developed functional pancreases derived from the injected cells and survived to adulthood. We hope that within 10 years, we will be able to provide a needed organ to a patient by growing it from the patient's own PSCs [also known as iPS cells: induced pluripotent stem cells] in a compatible animal.[23]

Here, it becomes clear that this method aims at minimizing the risk of rejection after transplantation with the help of generating "genetically matched organs."[24] That this proposition raises a number of ethical concerns is not surprising because it means living human and porcine bodies are being combined, spliced. Japan is said to be the current world leader when it comes to embryonic research. For example, "iPS cells were first created in 2006 by Japanese medical researcher Dr. Shinya Yamanaka. In 2012, he won the Nobel Prize for his discovery."[25] In Japan's recent past, ethical concerns regarding the use of iPS cells were the reason for stricter guidelines. "Japan currently has a ban on what's called 'in vivo' experiments, meaning 'within the living.'"[26] As a consequence, Nakauchi had to move his research from Japan to the USA as his home country instituted a ban on the growing of baby animals from animal embryos previously injected with human iPS cells. In June 2013, however, it was discussed whether these guidelines should be reviewed in order to facilitate further research in Japan. It was reported that, "Nakauchi has for years been campaigning to change this law."[27] So far, there has been no effective change of the law. The expert panel under Japan's Council for Science and Technology Policy proclaimed that "there should be measures to protect the dignity of humans. It stated certain restrictions should be imposed on studies using primates and on studies to engineer human brain cells

[21] HumanXenoTransplant [14]
[22] Vaughan [30]
[23] Nakauchi [19]
[24] Vaughan [30]
[25] Wingfield-Hayes [32]
[26] Nosowitz [20]
[27] Nosowitz [20]

and generative cells."[28] The wording in this report, taken from the website of the Asahi Shimbun, is striking. The main concern, it can be gathered, lies not in the use of nonhuman animals' bodies, but in the effects this hybrid organ could have for the lives of patients who receive such an organ. In this quotation, it can also be noted that primates are explicitly being excluded from this branch of xenotransplantation due to their closeness to human beings. Overall, the concern regarding human dignity has a much higher priority than any concerns about the dignity of nonhuman animals.

Despite all ethical concerns, the development of Nakauchi's research has progressed quickly. In 2011, Nakauchi was not yet allowed to perform chimeric embryo research—let alone use human stem cells—but had successfully created chimeric animals.[29] The experimentation then included mice and rats. The group was skeptical about utilizing the method that worked with rats and mice and applying it for use on pigs and humans.

> The organ generation system described may be applied to treat organ failure in humans if pigs or other large animals are used. There are, however, several issues that need to be addressed to bring this principle into the clinic. […] Livestock animals such as pigs or sheep may be too distant evolutionarily for successful complementation.[30]

Back then, the species barrier seemed to be a problem. In 2013, Nakauchi was already more optimistic about the next steps this method could take:

> "We can apply the same principles to human stem cells and pigs, although the guidelines have not permitted us to do this yet," he said. […] Prof Nakauchi believes the first pig carrying a human organ can be produced "quite quickly, because the technique has been established already."[31]

The rhetoric of the quote above, which is pointed and deliberate, illustrates the procedure has merely been put on hold. The group has already moved on to working with nonhuman animal embryos and human DNA—two things that were not possible a few years earlier. The speed of the development could be an indicator for the speed with which ethical concerns might be dispelled, as well. For example when it comes to the blurring of the species boundary, which is directly mentioned in the report from the Asahi Shimbun: "The envisioned creation of animal-human chimeras, which have both human and nonhuman cells, could blur the boundary of humans and nonhumans."[32] This consideration is of importance as it prepares for the next step: comparing the fictional to the scientific case studies. Not only are the boundaries between nonhuman and human blurred in the actual experiment, the line between fact and fiction is blurred, as well.

The Fine Line Between Fact and Fiction

Important components of state-of-the-art biotechnology can be found in Atwood's trilogy, where she invents porcine hybrids that closely resemble those bred at Stanford. After having examined recent trends of xenotransplantation, the pigoons' status as organ producers for humans might sound less futuristic and more like Nakauchi's research taken to its logical progression. Comparing the chimeric embryo research on pigs to the fictional pigoon project, it is not difficult to detect similarities: Both projects are based on a human demand for organs for regenerative medicine. Both use pigs for their experiments and conduct research on living animals. The concern regarding the overstepping of the human–animal binary by genetically engineering pigs and creating hybrid biobeings that contain human DNA is equally present in the trilogy and in the press surrounding Nakauchi's project.

Atwood's imagined future does not involve Stanford, it instead goes one step further and invents OrganInc Farms, a nonacademic space where the production and harvesting of pigoons takes place. OrganInc Farms employs the most famous scientists, educated at the best universities. Not only do they work in secluded areas, but they also live in their special compounds, in order to avoid brain drain from the own company to a rival company. The character of xenotransplantation has thus shifted from a scientific to a commercial undertaking. The environment in which the pigoon project is carried out however is quite similar to that where the pigs of Nakauchi's research group live. Atwood depicts the space of the pigoons as highly secured and sterile: "They were kept in special buildings, heavily secured:

[28] The Asahi Shimbun [26]
[29] Grey [10]
[30] Kobayashi et al. [15: 797]
[31] Ryall [23]
[32] The Asahi Shimbun

the kidnapping of a pigoon and its finely honed genetic material by a rival outfit would have been a disaster." The protagonist Jimmy, who visits the pigoons when he is a young boy, "has to put on a biosuit that was too big for him, and wear a face mask, and wash his hands first with disinfectant soap."[33] Jimmy needs to take these precautions in order not to infect the pigoons with any viruses coming from the outside. In a recent report for BBC, Rupert Wingfield-Hayes discusses his visit to the research lab of Nakauchi's group, including a guided tour through the area where the pigs are held. In a short video, he is seen wearing an outfit that resembles that of a surgeon working in an operating room, not a person visiting regular pigs in their pens.

> In a nearby shed Prof Nagashima takes me to see his most prized possessions. For this I have to change into full smock, hat, boots and mask. It is not to protect me, it is to protect the occupants - fully grown chimeric pigs.[34]

It appears that these pigs are as valuable and protected as the fictional pigoons. Their environment as well as the precautions visitors need to take when passing by the pigs' pens shows many parallels to the fictional setting at OrganInc Farms.

Nakauchi's pigs are being experimented upon right now. What will happen to them in the future is only speculation. Atwood's trilogy allows her readers to follow the pigoons through different stages, providing her readership with a past, present, and future. This enables an extensive thought experiment that pays special attention to the long-term risks of genetic engineering. After the pandemic, the pigoons have developed into highly intelligent beings due to their special genetic make-up. They have adopted traits usually associated with humans and display a fair amount of deceit and unpredictable behavior. At various points in the trilogy, as shown in quotations earlier, human survivors face pigoons and fear for their lives. With this changed status of the pigoons, Atwood clearly poses the question whether the promises of biotechnological developments, such as splicing animals with human DNA, outweigh the dangers of the possibilities of their abuse. Are researchers such as Nakauchi aware of their social responsibility, and are they sufficiently weighing possible consequences for society and the environment when conducting their research? Do they ask the question "what if something goes wrong" or does this work need to be done by others?

The lines between science and science fiction breached in the two case studies discussed are fragile. Fictional scenarios can help to shift the focus away from the anticipated positive outcome to that of the ethical and moral concerns not being examined in the context of the experiments themselves and not being written down in the proposals for research grants. By involving bioethics with science fiction, public awareness for animal experimentation may be increased. It is much easier to express certain imagined outcomes in fiction than in other genres of text and I agree with Squier that "fiction gives us access to the biomedical imaginary." Atwood's trilogy paired with Nakauchi's research is just one example where fiction makes biomedical research more approachable for a lay audience. "Fiction, the zone where objective truth is not told, […] becomes the site where one specific kind of truth is best articulated: the workings of the biomedical imaginary, the desires propelling biomedicine, can be expressed in fiction."[35] The combination of science and science fiction is fruitful—especially for bioethics and the public—because contrasting the two shows how fine the line separating fact from fiction can be.

In the next section of this paper, I will discuss the implications for the constructed species boundary posed by the existence of spliced biobeings. The main point of discussion will be to show how agency in the literary texts becomes a dynamic category when species lines are blurred and the power shifts from a human-dominated environment to a post-apocalyptic setting where human and nonhuman life coexists.

The Ethics of Cross-Species Living

From Property to Agency

Similar to the pigoons, most of the other animal splices Atwood invents have been given their own names: liobams, rakunks, kanga-lambs, and wolvogs. Their names either reflect their mixed genetic makeup or

[33] Atwood [1: 29]
[34] Wingfield-Hayes [32]
[35] Squier [25: 17]

describe their looks. Pigoons look bloated and massive like balloons. Additionally, their name is also close to pigeon.[36] The creators of these splices did not give them corporate names or names that mark them as trademarks, like the aforementioned Enviropig™ or the famous OncoMouse™ (or Harvard Mouse) that has been genetically engineered at Harvard University in the 1980s. Atwood's literary device of naming ascribes agency to the nonhuman animals in question. Exceptions include the ChickieNobs as well as the Mo'hairs ("Hair today, Mo'hair tomorrow") whose names have been invented by marketing departments as catchy product names which clearly label them as commodities. These last two species are literally branded by their brand names. Like the OncoMouse™, they lose their individuality and their right to live as beings in themselves because the reason why they were brought into existence affects their ontological status.

Donna Haraway, the famous feminist theorist and philosopher of science and technology, published a feminist critique of phenomena such as the OncoMouse™, where she stresses that narrative practices undeniably link science practice and cultural theory. Trained in zoology and biology, Haraway perceives the dynamic agency of nonhuman animals that are brought into existence within the setting of scientific experiments from a multifaceted angle. For the context of this study, it is interesting to see how her characterization of nonhuman animals, which have been genetically engineered and become trademarks, applies well to Atwood's imagined splices. "Property is the kind of relationality that poses as the-thing-in-itself, the commodity, the thing outside relationship, the thing that can be exhaustively measured, mapped, owned, appropriated, disposed."[37] Haraway's definition of property here shows how the animal that falls under this definition becomes dissolved in the technoscientific context. Moreover, the animal loses her or his identity as an individual being in the process because the only thing that matters in the experimental setting is the animal's body and this body's reaction toward certain manipulations. That the individual animals chosen for the experiment differ in their personalities, that their subjectivity might matter to them is not of importance. Instead of being chosen for their identity, something that marks them as unique and singular, they are not supposed to stand out from one another, but are instead treated as a renewable resource, a commodity. This is the case for the genetically engineered animals in Atwood's novels before the lethal pandemic hits. Afterwards, except for the ChickieNobs who are not capable of surviving on their own because they lack heads, the nonhuman splices gain agency and escape their property-status. Even the Mo'hairs and pigoons, who both contain human DNA and are therefore custom-made to suit individual human's needs, shed their label of commodity and thing-ness and gain identities. Their ontological status depends no longer on the semantics, but on their being in the world as subjects.

The fear experienced by the human survivors that this being in the world outside of confined cages, pens, and zones causes them is displayed by denying the pigoons their original names. This is done on yet another semantic level, on which they refer to the pigoons as frankenbacon. The speakers associate the pigoons with the uncountable food item bacon, thereby turning the pigoons into meat animals. While the name pigoon refers to a member of the unique species of the hybrid pigs, frankenbacon cannot be regarded as a proper name for an individual animal because it contains the word "bacon," meaning "the back and sides of the pig, 'cured' by salting, drying, etc. Formerly also the fresh flesh now called pork."[38] Frankenbacon therefore signifies that the speakers regard the pigoons as defined by parts of their bodies that are potentially edible. This speech act rips the pigoons momentarily of their identity, their agency, and gives power and domination back to the human speakers who put themselves into the position of the consumers.

In addition, the act of calling the pigs frankenbacon is used to disguise a deeper fear of being eaten. The shortage of food and the fear of turning into prey themselves are the two main issues that the survivors are facing right after the pandemic. Here is one example from *The Year of the Flood*:

[36] This similarity to pigeon is a pun that has the same intention as the illustration on the cover of the last novel (the 2013 hardcover edition by Bloomsbury Publishing), where the image of a pig is superimposed on the image of a bird that spreads its wings: both hints refer to the idiom "Pigs can fly" that is used for a situation one finds highly unlikely to become reality. In this case, Atwood's trilogy works as a suggestion that "pigs might fly one day," and that her dystopia is not as unlikely as science fiction usually appears to be.

[37] Haraway [12: 8]

[38] Oxford Dictionaries Online, s.v. "bacon," accessed August 10, 2014, http://www.oed.com

> Is that what the pigs want her to do? Go outside her defensive walls, into the open, so they can jump her, knock her down, then rip her open? Have a pig-style outdoor picnic. A pig-out. She has a fair idea of what that would look like. The Gardeners weren't squeamish about describing the eating habits of God's various Creatures: to flinch at these would be hypocritical. No one comes into the world clutching a knife and fork and a frying pan, Zeb was fond of saying. Or a table napkin. And if we eat pigs, why shouldn't pigs eat us?[39]

This passage reflects Toby's thoughts while she is stuck at her hiding place without any food left to eat and with a group of pigoons apparently waiting for her outside. Her reflection shows that her human status, which is often taken to be superior to that of nonhumans, does not protect her in a world where human and nonhuman animals fight for survival on equal terms. By depriving humans of most of their lethal weapons, and by allowing nonhuman animal splices to procreate and evolve without spatial or other confinements, species belonging changes categories of agency.

The trilogy contains numerous passages where dynamic agency can be detected. In the last part of the trilogy, animal agency is reinstated, when the pigoons, the Crakers, and the other human survivors decide to work together. Their common enemy is a group of so-called Painballers, who are extremely brutal prisoners of the Corps, representing the ultimate evil: the merciless human being. They are described as dehumanized and portrayed as monstrous, uncivilized, and wild. These characteristics make them stand out from the rest of the characters—no matter whether human, nonhuman or a mix of both. Atwood uses the Painballers to show how a dystopian society like the one she invents can manipulate moral actors and turn them into selfish, unethical criminals that have lost respect for other living beings.

The fight between good and evil at the end of the trilogy is not a new device, neither is the joint force of human and animal fighters. What is new is the way in which the pigoons stimulate the action and become the main force in the restoration of peace. They are the first to propose a truce that leads to the cooperation of pigoons, MaddAddamites, God's Gardeners, and the Crakers—and eventually to the elimination of the Painballers. Due to their unique ability to communicate with the animal world, the Crakers negotiate with the pigoons and interpret everything they regard worthy of sharing into human language. These skills of the Crakers to communicate with humans, nonhumans, and the natural world alike ascribe power to the hybrid nonhuman agents and turn them into the ultimate decision-makers. The same applies to the pigoons whose enhanced sensory skills and refined moral behavior turns them into powerful agents without whom the human community would not be able to destroy the common enemy at the end.

The descriptions of the pigoons' thoughts remain opaque and render them somewhat mysterious, as illustrated in this passage from the march to the final battle:

> The Pigoons alongside tilt their heads to look up at their human allies from time to time, but their thoughts can only be guessed. […] Are they irritated? Solicitous? Impatient? Glad of the artillery support? All of those, no doubt, since they have human brain tissue and can therefore juggle several contradictions at once.[40]

The comment regarding the brain tissue allowing the pigoons to be contradicting themselves can be interpreted as making fun of the human condition as contradictory by nature; this is another satirical element added to the narration that shows the downside of animal "enhancement". It also reflects the unapproachability of the pigoons, which is expressed in the next quotation where Toby observes the group of the pigoons who are at the forefront of the interspecies infantry: "To either side of them, two more act as outriders, testing the air with the wet disks of their snouts. Odour radar, thinks Toby. What vibrations well beyond our blunted senses are they picking up?"[41] Here, Toby has to admit to herself that the pigoons have the advantage of both porcine and human senses and that her own abilities are less helpful in detecting the enemy.

Especially in this last book, Atwood paints nonhuman animal characters that are highly intelligent and have abilities beyond human imagination. The human survivors gradually learn to work together and not against them and accept and admire them for their different skills. This outcome of the story with the pigoons as heroes should be regarded in light of the

[39] Atwood [3: 384]

[40] Atwood [5: 348]

[41] Atwood [5: 346]

spliced pigs that are currently being experimented upon. The issue that has not been discussed yet is the point of view of the pigs: how does the manipulation with human DNA change the pigs' perception of their surroundings and of themselves, if at all? This is something that cannot be known but being taken into account may better inform ethical discussions regarding the treatment of pigs in scientific research. Pigs have been shown to be highly intelligent beings and treating them as such would lend more ethical credentials to research. The pigoons might help readers to get a better idea of what hybrid beings could develop into in the future. Furthermore, thinking about their needs and feelings can bring one closer to seeing them as companion species in Haraway's sense of the term: "coshapings all the way down, in all sorts of temporalities and corporealities – […] a not-humanism in which species of all sorts are in question."[42] Haraway does not restrict the term companion species to domesticated animals, such as dogs or horses that are commonly seen as being companions to humans. She extends the term explicitly and applies it deliberately within the context of animal experimentation. By applying the label companion species to spliced pigs, these animals theoretically gain agency and become partners/subjects instead of objects. Fully aware of the imbalanced power relations inside laboratories where animal experimentation takes place, Haraway nevertheless urges her readership to take responsibility through the application of the concept of companion species.

> We are face-to-face, in the company of significant others, companions species to one another. That is not romantic or idealist but mundane and consequential in the little things that make lives. Instead of being finished when we say this experimental science is good, including the kind that kills animals when necessary […], our debt is just opening up to speculative and so possible material, affective, practical reworlding in the concrete and detailed situation of *here* […]. This "here" might be quite big, even global, if abstractions are really well built and full of grappling hooks for connections. Maybe sf worlding – speculative fiction and speculative fact – is the language I need.[43]

[42] Haraway [13: 164]
[43] Haraway [13: 93]

Science fiction (or speculative fiction) is taken as a tool to think through, and eventually put into practice, new forms of engagement with laboratory animals. For this study, it is quite useful to recall that Haraway explicitly points to science fiction as a source for information and a site that can be used to learn new forms of ethical and moral interaction with nonhuman others—to be applied in biomedical contexts. This underlines my argument that bioethicists and practitioners can learn from science fictional sources, which might result in ameliorated conditions for nonhuman subjects involved in animal experiments.

The pigoons in Atwood's trilogy have gained agency and stand as equal partners next to the human survivors at the end of the last book. This is not to say that the spliced pigs Nakauchi's group is working with might one day cooperate with humans toward a common goal, but it should remind readers that pigs are individuals who experience emotions, who care for each other, and who have a high sense of a social community. The MaddAddam trilogy can teach its readers this important lesson with the help of the pigoons: respect is key. The human protagonists learn to respect their nonhuman others through the entanglement and necessary cooperation. This leads to new conceptions of personal well-being, subjectivity and responsibility for human-animal life.

The New Human Race

In her trilogy, Atwood creates a set of highly antagonistic characters. On one side, there are the God's Gardeners, a vegetarian, peaceful community led by Adam One and his successors. They call themselves "Adams" and "Eves" and assign tasks such as talking to the bees, preparing medicine from plants and mushrooms, or tending the garden that keeps them self-sustained. The God's Gardeners are linked to a collective named MaddAddam, whose members meet on a virtual base in an online game called Extinctathon. ("Adam named the living animals, MaddAddam names the dead ones. Do you want to play?") Since their aim is to minimize the power of the corporations by liberating genetically engineered animals, and by inventing harmful splices and biobeings that attack infrastructures, they are referred to as "bioterrorists."

On the other side are the well-situated, mostly corporate people who live in affluent, gated communities. The scientists among them are afforded an even greater

social status and are sealed off from those who cannot afford to live in a secure environment. Interestingly, scientists have a special status in this dystopia. This is due to their power to manipulate living beings and create new live forms. Their challenge is to create perfect or fool-proof nonhuman and human animals, with the ultimate aim of finding a way to achieve human immortality.

The project of fool-proof humans is being led by Crake. The Crakers, also referred to as frankenpeople, are an artificially created splice named after their creator. Unlike the pigoons, they do not serve a purpose for human beings but are secretly being bioengineered in order to replace the human race in the posthuman future. They are a new species that is designed to be self-sufficient, pacifist, plant-based, with no sexual drives, no need for clothes or shelter. In light of increasingly greedy individuals, a shortage of resources of all kinds and a severe gap between the rich and the poor, Crake, who is also responsible for the lethal pandemic, gives life to these new people because he wants to replace humanity that he regards as having failed. By building a secluded area in a scientific research compound, he is able to keep the Crakers isolated from the pandemic. In *MaddAddam*, they are finally ready to populate the planet.

The Crakers have many different elements borrowed from other species that Crake and his team of bioengineers carefully selected. Crake's aim to eliminate all negative and potentially destructive human qualities and enhance the new species with harmless nonhuman features results in a strange mixture of characteristics: They have insect-repellent smell. They breed only in season when their genitalia and adjacent areas turn blue. They engage in group sex—a couple of males for one female until she is pregnant. Apart from that, they have no interest in sexual activities, which is meant to prevent the Crakers from developing potentially dangerous emotions such as envy, love, and hate.

> What had been altered was nothing less than the ancient primate brain. Gone were […] the features responsible for the world's current illnesses. For instance, racism – or, as they referred to it […] pseudospeciation – had been eliminated […] by switching the bonding mechanism. […] Best of all, they recycled their own excrement.[44]

The Crakers are not designed to mingle with human beings or biologically cross their own species boundary. Nevertheless, in *MaddAddam*, the Crakers join the remaining humans and mate with them after all. The following conversation takes place upon the arrival of the Crakers at the temporary home of the human survivors. The conversation illustrates how the Crakers were "customized" to fit Crake's vision of a peaceful, harmless species. It also shows how their creators, who are now faced with the arrival of their splices into their community, struggle to accept them.

> "I hope Crake's Frankenpeople aren't moving in with us," said a blond woman. […]
> "I don't know why you brought them with you," said Swift Fox. "There's too many of them. We can't feed them."
> "We won't have to," said Manatee. "They eat leaves, remember? That's how Crake designed them. So they'd never need agriculture."
> "Right," said Swift Fox. "You worked on that module. Me, I did the brains. The frontal lobes, the sensory-input modifications. I tried to make them less boring, but Crake wanted no aggression, no jokes even. They're walking potatoes."[45]

From this short exchange between former bioengineers who helped construct the humanoid species, it can be gathered the Crakers are not yet accepted as equal by the group. Their creators talk about them as if they were objects and express this by calling them "walking potatoes." Even though they assisted with designing the "perfect" posthuman race, the last "real" humans initially reject and ridicule the Crakers.

Eventually, the Crakers become part of the community. Their otherness, mostly their naïveté and their animalistic behavior, keeps puzzling the humans. This is illustrated in the following quotation, where the Crakers purr like cats over the injured Jimmy, whom they have come to regard as a saint:

> Three Crakers are purring over [Jimmy] […]. It's a different three every few hours. Do they have only so much purring quotient, are they like batteries that have to be recharged? Naturally they need time off to graze and water themselves, but does the purring itself have a sort of electrical frequency? We'll never know, thinks Toby […]: no way

[44] Atwood [1: 358–359]

[45] Atwood [5: 19]

> of wiring up their brains for scientific studies, not any more. Which is lucky for them. In the olden days they'd have been kidnapped […] by some rival Corp, then injected and jolted and probed and sliced apart to see how they were put together. […] They'd have ended up as slabs of DNA in a freezer.[46]

In this passage, Toby reflects upon the nature of the Crakers. What is remarkable is her comparison of their fate to nonhuman animals used in experimentation. She instantly links the hybrid nature of the Crakers to nonhuman animals that would be subject to excessive scientific study. Animal experimentation, such as chimeric embryo research, inevitably leads to murder. This is something that Atwood reminds her readership of with the help of this scene. The Crakers were destined to outlive human beings, but the danger of ending up as dissected, dead bodies was always there, nevertheless. This demonstrates the ethical failings of both Atwood's fictional—and by extension—today's society.

Due to the hybrid being of the Crakers, the boundaries between human and nonhuman are blurred in all of the Craker passages. Their posthuman condition, I argue, is meant to encourage readers to scrutinize their own behavior in a world that faces many problems that Atwood's trilogy depicts in exaggerated form. Readers are thus led to think through various scenarios that might become ubiquitous in a couple of years. Is a future where humans are extensively enhanced and perfected by bioengineering desirable after all? Can they even be said to be human? Should the boundaries between species be crossed for the purpose of prolonging the life of one singular species among the great variety of natural life? These are questions that need to be asked in light of recent technoscientific developments; they can very well be asked in the realm of science fiction, where the possibility of imagining the outcome of such experiments is inviting and almost limitless.

Even the innocent Crakers develop and adapt over time with the result that they learn to read and write, have their own religion and story of creation, and worship some of the humans. In a pessimistic reading, it could be concluded that a negative influence of humanity does not stop even after the majority of human life has become extinct. Another reading could be that the lines between species are less strict and more easily breached than we believe. This would suggest we should not underestimate nonhuman beings' intelligence and their sense of community and empathy and treat them accordingly. This applies equally to the pigoons whom we have come to know as moral agents. Even though Atwood paints the Crakers as somewhat childish or naiive, their veganism and compassion make them the true pacifists and presents them in a positive light. As I have argued before, part of her writing is a unique way of alerting a large readership of humanity's destructive force. Ultimately, the fact that the Crakers are designed to live longer and will outlive the humans points toward a utopian cruelty-free future with thriving nature and wildlife and no humans left to destroy it. Whether this would still be a dystopia, or a utopia instead, remains unanswered. Rozelle, from his ecocritical perspective, offers a slightly different reading of the Crakers that leaves room for more optimism.

> The Crakers embody genetically what Atwood's millennial "green" readers might aspire to behaviorally, and thus part of Atwood's novel's ecological optimism might be found in the capacity of culture to embrace an ethos of environmental stewardship. […] The Crakers also help us to remember that as a species, humans are not exempt from adaptations and mutations that occur through processes of evolution […]. Crake compels readers to speculate that as liminal creatures ourselves in passage among multiple states of being, humanity has the capacity over time to shed the genetic basis for attributes that lead to war and acts of ecocide.[47]

This reading implies an instructive message, as well. Rozelle assumes that many readers of Atwood's trilogy are sympathetic with "green" political concepts and might, in the long run, adopt a more ecofriendly lifestyle. I agree with Rozelle that the trilogy points its readers toward humanity's potential for improvement—no matter whether it is read from an ecocritical or critical animal studies perspective.

Animals and Humans as Food Items

The majority of the human population today encounters nonhuman animals on a daily basis—as food items. The trilogy adopts this angle of nonhuman animal exploitation, as well, and mixes it up with bioengineering. The

[46] Atwood [5: 99]

[47] Rozelle [22: 69]

ChickieNobs are one example of a horrifying extrapolation of the broiler chicken. Their heads have been spliced away, leaving them no option except for passively existing until their untimely death. On a guided tour through Crake's university, Jimmy gets introduced to this newly created species: "You get chicken breasts in two weeks – that's a three-week improvement on the most efficient low-light, high-density chicken farming operation so far devised. And the animal-welfare freaks won't be able to say a word, because this thing feels no pain."[48] This description of the genetically modified chickens shows that the emphasis lies on the efficiency of this "renewable resource." There is not much left of a real chicken, except for the parts that are edible. The bizarre idea behind this splice is that, without a brain, a ChickieNob does not fall under the category "living being" and its creators, as well as its consumers, can thus not be accused of animal cruelty. McHugh summarizes this in her analysis of *Oryx and Crake* as follows: "Questions about whether and how tissue-cultured meat remains animal – and consequently what it means to read such creations as agents or things – emerge […] through the spectacle of ChickieNob."[49] Jimmy's thoughts after his first encounter with these creatures are meant to provoke the reader to pose a similar question: "He wasn't paying close attention, he was worrying about the ChickieNobs […]. Why is it he feels some line has been crossed, some boundary transgressed? How much is too much, how far is too far?"[50] The ChickieNobs might very well be part of humans' future food items and it is worthwhile to think about the ethical implications beforehand. Indeed, the idea of ChickieNobs, Mc Hugh argues, dates back quite a while: "Atwood's choice of source species historically ties ChickieNobs to Nobel laureate Alexis Carrel's success with keeping an embryonic chicken muscle growing in a bowl fed with nutrients for thirty-two years."[51] This illustrates that Atwood is not the first to imagine this reduced version of a chicken. The origin of the ChickieNob can be traced even further: In 1932, Winston Churchill proclaimed something similar regarding our future food choices: "We shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium."[52] So far, Churchill's vision has not yet come true but bioengineers are attempting to develop in vitro meat, such as the first lab-grown burger that was presented and publicly eaten in London in 2013.[53] The famous burger, for which no cow had to be slaughtered, cost roughly €250,000, according to its inventor Mark Post of Maastricht University. Although this one burger was merely a prototype to demonstrate meat tissue can be grown in the laboratory, the demand for cultured beef is present and could be satisfied in the near future: "Of course it is hard to predict this sort of thing, but we might see Cultured Beef, and other cultured meats, available commercially within 10 to 20 years."[54]

Although in vitro meat exists in Atwood's dystopia, the cravings for real meat, coming from "regular" animals, persists. On one hand, there are expensive restaurants that sell the flesh of almost extinct animals to gourmets. On the other hand, there are cheap fast food chains that sell any kind of meat that is available. Through Toby, an unfortunate female character that later joins the God's Gardeners, the reader encounters both sides of this future food industry.

> On the floor below her there was an endangered-species luxury couture operation called Slink. They sold Halloween costumes over the counter to fool the animal-righter extremists and cured the skins in the backrooms. […] Sometimes there was roaring and bleating as well – they killed the animals on the premises because the customers didn't want goat dressed up as oryx or dyed wolf instead of wolverine.[55]

The use of nonhuman animals for fashion that we see today is brought to another level by Atwood. The nonchalance with which these developments of a capitalist consumer society are being described has a puzzling effect on its readership: when the availability of protected animal species for goods merely depends on monetary issues, where does this lead such a society and from what kinds of practices, or species, does it still shy away? Is such a scenario possible or unlikely, and where does its development stop? Human life is construed as precious whereas nonhuman life is viewed as having no

[48] Atwood [1: 238]
[49] McHugh [18: 203]
[50] Atwood [1: 242]
[51] McHugh [18: 203]
[52] Churchill [7]
[53] Maastricht University [16]
[54] Maastricht University [17]
[55] Atwood [3: 37]

value in itself, useful only for human well-being, good looks, and entertainment. On the other hand, human life, especially that of the poor and disadvantaged, lacks in justification, as well. A novel like *The Year of the Flood* that mostly focuses on Toby's life in the pleeblands, which are the outskirts of gated communities, and how she is being mistreated and later rescued, paints a pessimistic picture: the depicted society lacks morals and ethics in human-animal and interpersonal relations.

> The skinned carcasses were sold on to a chain of gourmet restaurants called Rarity. The public dining rooms served steak and lamb and venison and buffalo, certified disease-free so it could be cooked rare – that was what "Rarity" pretended to mean. But in the private banquet rooms […] you could eat endangered species.[56]

The meat of the endangered species whose skin is being sold under the counter for the fashion-obsessed is served, again under the counter, to those who can afford to eat the last specimens of tigers, or oryx. With details like this, Atwood's trilogy seems to aim at provoking the reader, filling her or him with disgust for its voracious species. The MaddAddam trilogy would not be considered futuristic if it did not go further than this. Toby also takes the reader to the next level of fraud that confirms the suspicion that her society is truly unethical: she begins working at the fast food chain SecretBurgers, where the secret consists in what kind of animal protein is used in the burgers. "The meat grinders weren't 100 percent efficient; you might find a swatch of cat fur in your burger or a fragment of mouse tail. Was there a human fingernail, once? It was possible."[57] SecretBurgers becomes a possible dumpster for dead human bodies because the control of its business by officials is being avoided:

> The local pleebmobs paid the CorpSeCorpsMen to turn a blind eye. In return, the CorpSeCorps let the pleebmobs run the low-level kidnappings and assassinations […]. They also ran corpse disposals, harvesting organs for transplant, then running the gutted carcasses through the SecretBurgers grinders. […] During the glory days of SecretBurgers, there were very few bodies found in vacant lots.[58]

Human meat is being eaten by SecretBurgers' customers. They do not necessarily know that they are eating their own kind but it seems unlikely that they care. As long as they get some kind of animal protein to keep them full, no questions are asked. Atwood's narration thus imagines a future where it becomes less obvious how to differentiate between consumers and the consumed body. This scenario evokes memories of scenes from the American science fiction movie *Soylent Green* from 1973 directed by Richard Fleischer. In this dystopia, which is set in the year 2022, earth is heavily polluted and overpopulated. The company Soylent Industries provides the human population with nutrition that looks artificial but is said to be plant-based. The scandal of the movie consists in the newly introduced food item Soylent Green that is made of the meat of human corpses that have been executed. The secret of Soylent Green is the same secret of SecretBrugers, only that Atwood's fictional characters get some more variety in their animal protein.

Even though the trilogy depicts cannibalism, animal exploitation, and other practices of unethical treatment of humans and animals, these negative depictions do not make up the majority of the narration. Other scenes, where relatively harmless biotechnological innovations are made, are strewn in to make the story a fun read. Atwood's invention of the Mo'hair is such an example. In an interview from 2013, where she talks about how biotechnological developments come close to her fictional worlds, she mentions how the Mo'hair is something that has not been picked up yet by bioengineers—unlike tissue-cultured meat or cross-species splices.

> "Mohair sheep, they haven't done that yet," she says in the Atwoodian tone, a kind of steely levity. "I think it would be quite a good commercial venture. You can imagine a lot of people wanting to get their own DNA hair." The 73-year-old smiles, thinly. "I'm offering it as a free gift to the world."[59]

From the interviewer's comment, it appears that Atwood is not absolutely serious about her offer. She does however realize that there is a potential within her writing that can be used and also abused, by the biotechnological industry. Through the invention of splices like Mo'hairs, Atwood makes biotechnology fun and

[56] Atwood [3: 37]
[57] Atwood [3: 40]
[58] Atwood [3: 40]
[59] Brockes & Atwood [6]

colorful, which can appeal to readers by making the story more entertaining. She nevertheless manages to stir up the debate over bioengineering and the value of human and nonhuman life in ways that invite a critical outlook on the topics she raises. The power and influence of corporations when it comes to human DNA is merely one example. Compared to the restricted and highly controlled channels that are used to report upon splicing animals, such fictional works have the power to express ethical concerns also in a lighter tone.

Conclusion

The comparison of actual scientific research on hybrid nonhuman animals with Margaret Atwood's diverse imagined human-nonhuman splices showed that overlap exists. Science and science fiction can be rightly viewed as divided by a fine line. This line, as well as the boundary between human and nonhuman animal life, is more fragile than it often appears to be. The critical practices within bioengineering that manipulate nonhuman animals to the degree where they reach property status and are genetically mixed with human DNA are not being discussed by a large public. This is problematic because such practices have the potential to affect the lives of countless human and nonhuman beings. In the case of xenotransplantation, the social significance is particularly high because there is a severe gap between patients in need of organ transplants and organ donors that cannot be overlooked. The need to act upon this is felt within regenerative medicine. The measures taken to minimize the gap are, from a critical animal studies' perspective, highly unethical because they rest on the exploitation of nonhuman beings. This paper showed how this critical perspective, which is not the dominant view—neither in the public, nor in scientific, or bioethical circles—can be heard with the help of fiction. Engaging with literary works that treat the problematic relationship between human and nonhuman beings in future capitalist consumer societies can help readers better understand their current society. The trends that Atwood extrapolates are dystopian, but they are also realistic and eerily possible. Her writing focuses on topics that are highly relevant for today's world and it thus has the power to get the reader's attention.

In the dystopian world of the MaddAddam trilogy, the gap between the rich and the poor is widening and affecting not only areas such as education, housing, nutrition, and medical care, but also cosmetic treatment and consumerism. These trends, which are to a high degree based on animal experimentation, can also be detected in the present and should be publicly discussed instead of remaining within their secluded spheres. Regarding these trends, the characters in Atwood's novels have exactly the conversations that we do not yet have in public. By reading about possible future scenarios that come as close to reality as the pigoon project, who can overlook the value of fiction for today's world? Bioengineers might view their research as too important or cryptic for a mass audience to understand. Science fiction then does an important favor to its readership by translating biomedical and other scientific developments to the world of their imagination, thereby inviting a greater audience to engage with critical topics. In addition, the perspective that changes from human to nonhuman or hybrid beings within the novels invites the reader to change her or his own perspective for once. This can create empathy and lead to more sensitivity toward other beings. Most importantly, the factor of emotion, which is left out of scientific practice, is added to the picture.

> Science was just coming into being in the age of Swift. Now it's fully formed, but we're still afraid of it. Partly, we fear its Moreau-like coldness, a coldness that is in fact real, for science as such does not have emotions or a system of morality built into it, any more than a toaster does. It's a tool – a tool for actualizing what we desire and defending against what we fear – and like any other tool, it can be used for good or ill.[60]

Bioengineering is a powerful tool indeed, and its use (and abuse) can decide over the lives of countless beings, ranging from beneficiaries such as patients receiving organs to spliced pigs being killed in experiments. It is crucial that more people become aware of the power of genetic engineering and are stimulated to think through possible long-term implications. Studying fictional scenarios paired with a critical reading of scientific reports, or regular newspaper articles, can help one ask the right questions and make well-informed, ethical decisions.

Throughout this paper, I sketched several readings of Atwood's trilogy, more pessimistic than optimistic ones. In the end, I would still opt for the pessimistic reading with an additional proposition: I propose to take literary

[60] Atwood [4: 209–210]

imagination as a reminder in order to act. As a call to individual readers, and teachers of literary studies to engage with texts that breach the species boundary. Multidisciplinary research, such as combining findings from biotechnology with critical readings of literary works, can open up new questions and debates that are of high importance regarding human and other animal life, and especially regarding future scenarios of how all beings can live together in greater harmony without destroying other species, or the environment. Atwood's work paints a dark picture of humanity's future where humans have managed to almost erase themselves completely. This post-human vision is based on unethical behavior that is guided by megalomaniac desires. The MaddAddam trilogy, as a science fictional text with realistic elements, draws the reader's attention to the dangers of real developments, as they are happening right now. Atwood would possibly summarize the situation like this:

> We want to be immortal. We want to be as gods. But in addition, we want wisdom and justice. We want hope. We want to be good. Therefore we tell ourselves warning stories that deal with the shadow side of our other wants. Swift's Grand Academy and its projectors, and their descendants the mad scientists, are among those shadows.[61]

Her work can be regarded as a warning story that shows where such specific desires and excessive lifestyles may lead. After all, would it be desirable to live in a world full of splices, to have offspring whose DNA was pre-designed, to know that corporations have the power to control and manipulate one's genetic material, and to strive for immortality? The MaddAddam trilogy cleverly satirizes these scenarios without losing touch to realistic common grounds, on which the stories are based. Ultimately, humanity is undone by bioengineering and gives rise to new nonhuman animal species and the new humanoid race that repopulate the earth. A critical outlook on current technoscientific developments, with the enhanced perspective of fictional future scenarios can help to inform a mass audience, and motivate individuals to rethink their footsteps.

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[61] Atwood [4: 210]

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