SACRIFICE OR SALVATION: HOW CAN ANIMAL LIVES BE SPARED AND HUMAN HEALTH IMPROVED BY TOXICS REFORM?

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Abstract

This dissertation investigates the complexities of the entwined relations between animal cognition, the use of animals in toxicity testing, and the proliferation and impacts of harmful chemicals in our society. It asks how, in light of the most current research on animal sentience and the ethics of responsibility, a reorientation of chemical testing at a theoretical, ethical and practical level could spare animal suffering and improve human health outcomes. Its starting point is the unfolding scientific research on animal cognition, and the consequent implications for reconsidering the ethical relationships, historically established and currently assumed, between human and non-human animals. The central issue, which infuses this dissertation, is whether humans are obliged by this knowledge to expand our moral arena to encompass animals, to acknowledge their entitlement *not* to be used for toxicity experimentation, and the implications of such an entitlement for the future use of animals in toxicity testing.

The work is based on a social constructivist process centred on the multiple facets of toxicity testing – the philosophical viewpoints of those who have expressed concern for the well-being of animals, governments' animal protection laws that fail to spare animals from painful experimentation, toxics laws that promote the use of animals in toxicity tests, the pain and suffering of the tests themselves, the championing of the mouse as the favoured animal for experimentation, and the limitations and failure of toxicity testing itself to safeguard public health and the environment from widespread contamination. In addition, this examination of toxicity testing looks at the potential differences between advocates of expanded testing of toxic chemicals and animal advocates concerned about the implications of expanded testing for the increased use of animals. Finally, building on qualitative methods for assessing the current state of knowledge regarding the use of animals in toxicity testing, this dissertation evaluates how this system could be redrawn to both spare animals and better gauge the toxicity of chemicals.

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Chapter One: General Introduction, Themes and Methodology

Introduction and Themes

This dissertation draws on and marries two of my most passionate interests – first, the lives and intelligence of animals, and second, the effects of toxic chemical exposures on both human, non-human animals and the natural world. Combining these interests has led me to search for alternatives to the use of animals as "guinea pigs" in order to measure the toxicity of chemicals -- alternatives that might also avoid human animals becoming "guinea pigs" as a result of the less-than-thorough evaluation of toxic chemicals. This double problem has prompted me to explore innovative techniques for the evaluation of chemicals that avoid the use of animal testing, hoping to find mechanisms and strategies that would offer more accurate knowledge of those chemicals that are toxic and those that are not, and, additionally, would reveal what the range of toxic effects might be for those that are. The critical theoretical work, which each diverse chapter is intended to support, builds on the question of our ethical responsibility to animals. In addressing the expansion of our moral arena to animals and our commitment to "corporeal citizenship," this work also asks how our current moral universe can be reconstructed to better protect human health and the environment, and whether these aspirations are compatible.

In this dissertation, then, I will specifically investigate methods of toxicity testing and the use of animals, focussing particularly on mice, which have become essential to this testing. The research questions, which have guided this work, include: who are the actors/players in the realm of animal testing, what are their roles and their vested interests. Related to this first question, I ask what are the specific ways in which mice are used in toxicity testing, and how has this been influenced by conventional approaches to science based on a reductionist approach. Another related question I ask is: how is an individual chemical assessed. As part of this analysis, I also enquire about the way

in which legal structures influence how toxicity testing is done. The second major question I am asking is: how can conventional approaches to toxicity testing be adapted to take into account current research on animal suffering and ethics, and embrace a more holistic perspective. The third major question to be answered in this dissertation is: how realistic is the possibility of a reorientation of chemical testing at a theoretical, ethical and practical level in light of the most current research on animal sentience, suffering and the ethics of responsibility. Further, can this reorientation be reconciled with the need to screen toxic chemicals more effectively without resulting in vastly expanded animal testing?

I begin this paper with a review of the most recent revelations regarding the breadth and depth of animal intelligence that have become apparent from studies of animal behaviour and animal cognition. I also explore the philosophical and ethical discussions that arise from this research. My goal in focussing on the sentience of animals and our human ethical responsibilities is to consider how our moral community, now exclusively limited to human concerns when it comes to toxicity testing, can be extended beyond its present boundaries to include non-human animals and nature. This is the main thread that I endeavour to carry through this dissertation. Building on these two pillars of sentience and ethics, I have been inspired to delve more deeply into the commercialization of animals and their service in research, particularly the use of animals to test the toxicity of chemicals of every kind, and to document not only the harm done to these animals but also the lack of effectiveness of these trials as chemical gateways to commercial use.

My contribution to expanding the parameters and current knowledge regarding the use of animals in toxicity testing is to consider different perspectives and different legislative frameworks, and to evaluate how the current system of toxicity testing could be redrawn. By investigating the harm imposed on research animals and by aspiring to extend our moral community to encompass their well-being, we can at the same time address the broader issue of how we have failed to protect

the vulnerability of humans and of nature to the consequences of the proliferation of toxics. Because of the multi-faceted nature of this investigation, I have offered different theories in each chapter to give depth and understanding to the wide range of issues covered in this paper. For example, in Chapter Seven I discuss Ulrich Beck's theory of the risk society to illuminate the problem of toxic chemical exposures to humans and the weakness of animal testing with respect to predicting human outcomes.

My dissertation is generally guided by a social constructivist orientation, in which I interpret what each social actor is saying, consider the claims they are making, and examine the background and consequences of their situated actions (Hannigan 2006, 63). Social constructionism is based on the development and analysis of an "issue history," examining the way in which an issue becomes a public concern depending on the work of different actors involved. The three stages of the social construction process consist of: the assembly of claims, the presentation of claims and the contestation of claims. In this dissertation, the specific issue that I am exploring is the use of animals in the testing of toxic chemicals and the question of whether this practice should continue given our enhanced understanding of animal minds and the development of alternative testing methods. As part of this investigation, I trace the different actors including the lab mouse, legal actors, governments, scientists, academics, ethicists, and different types of activists, and the currents involved in developing this issue history.

The different stages of the social construction process are represented in my discussion as it unfolds in different chapters. Each chapter focusses to varying degrees on how different actors assemble and present their claims in a number of different venues such as academia, bureaucratic and policy arenas, and in activist circles. For example, in Chapter Two, the assembly and presentation of claims of animal cognition are shown in the academic research and commentary of ethologists, specializing in the study of animal minds. Similarly, Chapter Three examines the range

of philosophical claims and counter-claims with respect to human-animal relations as they have been presented in the media, popular books and academic writing. In the venue of government policy and bureaucratic circles, claims are expressed through the laws and policies respecting animal protection and the regulation of toxics and their defence of these laws, while counterclaims are put forward by academics and activists. Chapters Seven and Eight present the most detailed examination of the contestation of claims and counter-claims brought to the public by animal advocates, toxics activists, government ministries, and chemical companies, as these actors seek to influence public policy and affect change.

Dissertation Outline

Each of my chapters, then, addresses a different aspect or dimension of the problems outlined in my research questions, as set out in my introduction to this chapter. The trajectory of this dissertation, as reflected in the eight chapters is as follows: Chapter Two lays the foundational and most recent science on animals, which has radically reconfigured our knowledge of and our attitudes towards animals and their minds. Chapter Three surveys the theoretical basis for extending the moral community to animals, including historically important philosophical perspectives and the more cautious perspectives of contemporary research scientists. Chapter Four reviews the animal protection laws in the United States (U.S.), Canada and the European Union in order to illustrate the limits to these laws and the need for a re-consideration of our obligations to animals and their welfare. In Chapter Five, I look at the way in which the mouse became the most popular research animal in science, as an illustration of both the prevailing attitudes towards animals in research, and the mouse in particular. Chapter Six documents the many possibilities of toxicity testing to which the mouse is subjected, attempting to capture the pain and harm inflicted on research animals in general and the mouse in particular. These experiments reflect the way in which reductionist science breaks down each part of an animal, such as its skin or its reproductive capabilities, and attempts to

gauge the degree of harm, which can then be extrapolated to humans. Chapters Seven and Eight turn to the problems created by the proliferation of toxic chemicals in our society, which, despite painful tests on animals, still find their way into commerce and put humans and the natural world at risk. As this chapter illustrates, the laws, which were intended to screen out or minimize the use of these toxins, fail to do this job. Finally, Chapter Nine takes us to the possibilities of resolving these complex issues. By shifting to non-animal methods in an orderly and comprehensive way, we can envisage a world in which there could be little or no need for animal testing, and a world in which more accurate predictions of the toxic effects of new and old chemicals might better protect human health. These alternative tests offer hope that not only could animals be spared the pain and suffering imposed on them by toxicity testing, but that also human animals and the natural world, including wild animals, might be spared the harmful effects of poorly-assessed and poorly-regulated chemicals.

Methodology and Sources of Data

In this dissertation, the methodology and the methods, which I have used to investigate and answer my research questions and probe their possible answers, have been derived primarily from the following sources. First, my qualitative methodology for gathering data in specific areas was through informal and semi-structured interviews with key informants as discussed here in terms of each chapter. Each key informant was chosen for their knowledge and expertise in a different area related to my specific chapters, and given the choice of being anonymous or not. To guide my interviews, I formulated questions related to each interviewee's professional field and used these questions as a guide with which to conduct the discussion. From my previous work and collaborations, I was able to identify interviewees with expertise in different areas linked with the subject of each chapter: a scientist with experience and knowledge in the field of animal cognition, a community representative with experience on an animal care committee set up to oversee the way in

which animal research was conducted in an institution, activists critical of animal protection legislation and programs, a legal researcher knowledgeable about toxics laws with experience and a history critiquing these laws, an expert on hazardous chemicals and their non-toxic alternatives, a lawyer who pursued law reform and legal remedies for a major Canadian environmental organization and who is now the legal director of an animal law organization, and, finally, a scholar and former executive director of a non-governmental organization promoting alternatives to the use of animals in research. In these interviews, I was looking for both confirmation of data drawn from books, articles and internet searches in each specialized area, and an expansion of my knowledge of specific topics featured in each chapter. These individuals, their professional qualifications and their contribution to this dissertation are discussed in the following section describing my research methods. In total, I interviewed seven people, all of them by phone, as directed in my Ethics Approval. This approval was granted by York University's Office of Research Ethics on August 27, 2020.

With respect to the quantitative findings discussed in my research, I have used secondary data gathered by searching academically significant books and published journal articles in both the fields of animal studies and of toxic chemicals. In this literature, I took up discussions of theory related to these two fields as well as discussion of legislation by experts, academic and lay, who have influenced the development of both animal protection laws and toxics laws. This information has been accessed by using the library while many authoritative documents were also accessible on the internet. My research has been supplemented by popular literature available on the internet, including articles in newspapers and magazines featuring stories on animal rights and reports on environmental health issues and toxic chemicals. It includes examinations of legislation and explanations of the coverage and limitations of both animal protection legislation and laws governing toxic chemicals. As well, I have used internet searches of the websites of high profile

groups that set out the views of animal activists and those of toxic activists, as well as the websites of companies offering toxicity testing services.

In writing this dissertation, I have also benefitted from participation in the University of Toronto's Animal Law Group that is attended by a number of professors, graduate students and guest speakers, who are well-versed in various aspects of animal studies. Animal studies is a relatively new field of academic scholarship, which studies animals in a variety of cross-disciplinary ways.[1] For example, I learned of the radioactive mice buried near Niagara Falls from a presentation to the Animal Law Group on "animals in art." I have also benefitted from my long-time involvement with the Canadian Environmental Law Association in Toronto and my current position as Chair of the Toronto Cancer Prevention Coalition, a project of the Toronto Board of Health, which includes a working group focused on environmental and occupational health and well-being. I have been helped immeasurably by my association with the network of people active in the environmental health field, who provided comments and guidance on the current problems with the control of toxic chemicals. To be more precise about my methods, I offer the following chapter by chapter breakdown of my methods and sources.

In Chapter Two, I review and explain the most recent scientific research that consolidates our knowledge of animal cognition. Although this chapter does not explicitly discuss the problems of animal testing, it is intended to provide the background and to extend our appreciation of the scope of animal cognition and to foreshadow the injury that we impose on animals for the benefit of human knowledge. This chapter lays the groundwork for understanding the concern for the treatment of animals in our society and our prejudices with respect to their intelligence. For this

[1] Wesleyan University defines animal studies "as an emerging field that builds on scholarship in the humanities, social sciences, and sciences to investigate past and present relations between human and non-human animals**,** the representation of those relations, their ethical implications and their social, political, and ecological effects in and on the world. (Wesleyan University. 2022. "Animal Studies." Accessed on May 11. 2022 at: www.wesleyan.edu/animalstudies/)

first chapter, rather than studying the biological cognition work being done in animal studies, I focussed primarily on the work of moral cognition theorists, published in journals specializing in this topic, such as: *Animal Sentience*, *Journal of Comparative Psychology,* and *Learning and Behavior*. To understand the importance of these studies, I was guided by the academic work of moral philosopher David DeGrazia of George Washington University who has written "Taking Animals Seriously," and who has compiled a list of the most significant of those scientific studies breaking new ground in the field of animal cognition. DeGrazia is also a high profile proponent of a new approach to the use of animals in research. My key informant interview for this chapter was Carolyn Ristau, who offered considerable insight into the field of ethology and the study of animal minds. She confirmed, and added to, the most recent thinking and developments offered in the many books and journal articles that I consulted. Carolyn was not only a close friend and colleague of the late Donald Griffin, who pioneered the study of animal minds, but she is also his biographer. She has embraced and promoted Griffin's concept of cognitive ethology, and her own field research has contributed to and supported his theories on animal thinking.

Other information in this chapter came from a number of important books and articles written by celebrated animal researchers, in particular Frans de Waal who is known for his work with chimpanzees, and Marc Bekoff, a specialist in wolves, who has published extensively and has not only brought attention to the emotional lives of animals but has also fostered an appreciation for the complexity of this area and its relevance to our views and treatment of animals. Both these specialists in animal behaviour have offered their insights not only in the published scientific literature, but have also written more popular articles in magazines and in reputable newspapers such as the *New York Times*. I have also used these more readily accessed sources, generally available through internet searches, to broaden my understanding of their points of view and to put them across in the chapter.

Chapter Three explores the ethical implications of acknowledging that animals are sentient. For this chapter, I drew on my previous comprehensive research, which relied primarily on books and published articles that featured the views of disparate philosophers on our relationship to non-human animals. Just a few decades ago, philosophers, such as Peter Singer and Tom Regan, raised concerns about humans' treatment of animals, and are credited with bringing these concerns to a large audience and reviving the debates about human/non-human animal relations. They have had considerable influence on public opinion and fuelled not only debates over the use of animals but they have also stimulated the development of animal activism. Consequently, I have relied on their published work including their pivotal books easily accessed in libraries and their writings and debates circulating on the internet. In particular, I reference the views of those philosophers who have clearly stated their positions on the use of animals in research laboratories and the conditions under which they are used. Chapters Four, Five and Six flow from the theoretical observations of those philosophers who have pioneered and developed the concept of animal justice.

Although my primary sources for this second chapter were the paradigm shifting books written by those philosophers that have had such an impact on bringing awareness to these issues, I also explored the academic literature for recent papers and discussions that more specifically address the issues surrounding the use of animals for research purposes, often written by researchers participating in experiments with animals. In this area, Donna Haraway has played a major role in influencing the culture of animal research, in particular with her book, *When Species Meet*, which I relied on for my understanding of the current discussions surrounding how animals should be treated in laboratory settings. In the more recent academic literature, which I also consulted for this chapter, I have featured a number of researchers who have struggled with the ethical implications of using animals and how they are used, and I have included these voices in this chapter.

In Chapter Four, my critique of the legislation focused on animal protection was informed by a number of sources. Statistics on the number of animals used in research world-wide were drawn from published peer-reviewed journals, while more detailed statistics were found in the annual published reports of the Canadian Council on Animal Care, the U.S. Department of Agriculture and the European Union's Report from the Commission to the European Parliament and Council. The data on public opinion were based on internet searches of polling that has been done in various countries and which has contributed to our understanding of the changing attitudes towards animals used in research. This discussion of polling includes the very insightful discussion of public attitudes found in the published paper of Ormandy and Schuppli (2014).

The limitations of animal protection laws have been influenced by the information and views of those animal advocates who have been deeply immersed in these issues for many years. The Animal Law Lab at the University of Toronto introduced me to a number of specialists in animal law, including in particular Angela Fernandez and Lesli Bisgould, who have both written about and taught concepts of animal law at the University of Toronto. Both critiqued my original paper on animal law and the testing requirements, and helped me with their positive suggestions. The other important sources include my interviews with a number of people active in this field. These include my interview with a community representative on a university's animal care committee who wished to remain anonymous, and interviews with a number of animal advocates: Erika Ritter, author of *The Dog by the Cradle*, *The Serpent Underneath*; Kaitlyn Mitchell, staff lawyer with Canada's only animal law advocacy organization, formerly a lawyer with the environmental group, Ecojustice; and Elisabeth Ormandy, who worked previously with the Canadian Council on Animal Care (CCAC), a neuroscientist who is currently the Director of Research for Animal Charity Evaluators. Also, I was entrusted with access to an unpublished critique of the CCAC from the animal activists. The other sources on which I drew for my understanding of the limitations of the animal protection laws were

the websites of the relevant government agencies and arms-length agencies such as the CCAC; the legislation itself from Canada, Europe and the United States, which was also readily available on government websites; in addition to information from key books such as Lesli Bisgould's *Animals and the Law*, numerous journal articles, and the websites of animal advocacy organizations critical of animal protection laws. Another important source, which helped me to understand the limitations of the current laws and how they might be reformed, came from the conference report of the U.S.-based Hastings Center Report on the changing ethics of animal research.

In Chapter Five, the life of a natural mouse is imagined and its commodification and transformation into an object of science is detailed. I think it is fair to say that the mouse elicits less sympathy from society in general than the more iconic animals, including such species as chimpanzees that have in the past been subjected to a number of very invasive procedures in the name of research but who now enjoy a modicum of protection. I draw on Jakob von Uexkull, the biologist known for his phenomenological approach to ecology, and try to imagine how he might have analyzed the mouse as he did the tick. Like the ape in Franz Kafka's short story, "A Report to the Academy," we can only imagine what a mouse endowed with human reasoning but bound by its own physical limitations and habits might say.[2] I also look at those theorists who have analyzed the transition of the natural mouse to the hero of science. My primary source for the history of the commercialization of the mouse from the early nineteenth century until the present day has been the writings of Karen Rader, a cultural and social historian at Virginia Commonwealth University who is recognized as the expert in this field.

Chapter Six is a detailed discussion of toxicity testing, its methods and the way in which these tests are carried out. The method used to uncover this data came in part from internet

[22] Introduction by translator, Stanley Applebaum to Franz Kafka's *The Metamorphosis and Other Stories* published by Dover Press in New York, 1996.

searches of testing laboratories in North America and an evaluation of the services they offered. In many cases, the websites of these laboratories offered very little explicit information on the exact tests and the numbers of animals used. However, there was one website, Medicilon, a Shanghai based contract research organization, which advertised the tests that they could do and the number of animals used in each test. The detailed information on this website, however, was not advertised the next time that I accessed it, and the website had been significantly altered. Other sources of information that were used in this chapter include published peer-reviewed articles in scientific journals, such as the *Journal of Pharmacology and Pharmacokinetics*, as well as specific information on websites of animal activist groups detailing practices to which they were opposed. Another important source for this chapter was the in-depth 2005 report, "The Ethics of Research Involving Animals," which was compiled by a Working Party of the U.K.-based Nuffield Council on Bioethics, comprised of academic and industry scientists, philosophers, members of animal protection groups, and a lawyer, as well as the "The Hastings Report," referred to earlier. Another essential source for this chapter was the AltTox website. The AltTox organization offers considerable detail on various alternatives to animal tests as well as describing traditional animal tests, such as eye and skin tests. This chapter documents and demonstrates the pain and suffering of test animals, and reinforces the way in which humans have demarcated an ethical line above which animals can never be included.

Chapter Seven explores the environmental consequences of toxic chemicals and the failure to test these chemicals for their potentially harmful effects. The theoretical basis that grounds this chapter rests on several scholars who have discussed the impacts of toxics on natural and human life. In this section of my dissertation, I depart from the theories of animal justice and take up the frame of the proliferation of toxic chemicals and their potential harm. This departure reflects the dual nature of this dissertation, looking at the intelligence and use of animals first and then

considering the issue of toxic chemicals as a discreet concern, which will later be linked to the animal justice theories. In discussing the issue of exposure to toxic chemicals, the influential writing of sociologist, Ulrich Beck, and his analysis of the risk society provide the overarching context for the status of poorly regulated toxic chemicals and their proliferation in our world today. Taking this idea further, Stacy Alaimo, advances the theme of the risk society to consider transcorporeality, looking at the permeable borders between nature, human and non-human animals, and their vulnerability to toxic chemicals. My primary sources for the theories used in this chapter were the books written by each of these authors.

The itemization in Chapter Seven of the individual chemicals and the health outcomes associated with them comes primarily from scientific studies published in peer-reviewed journals, supplemented in some cases with media reports of these impacts. I have also had the benefit of continuously learning about these issues in my past work in the field of environmental health and my current position as chair of the Toronto Cancer Prevention Coalition. I am grateful to Fe DeLeon, toxics specialist at the Canadian Environmental Law Association, for her help with this chapter. Fe suggested in her interview that siloxanes would be a recent and illustrative case demonstrating the difficulties in moving ahead with the regulation of toxic chemicals in Canada, and she reviewed my discussion of how the story of siloxane D5 played out in Canada for errors. The information on which I depended for writing this chapter came from official government documents found online from both Canada and the European Union, presentations to the D5 panel by the Canadian Environmental Law Association and other environmental groups, as well as the industry's analysis of D5 and the response of different jurisdictions. Following up on the example of Siloxane D5, I have also used the theory put forward by Liora Salter and her fellow authors with respect to "political chemicals." Although Salter was writing several decades ago, her observations of

the regulatory system and its limitations remain as salient today as they were at the time of the publication of her book.

In Chapter Eight, I begin the task of combining the discussions of animal rights and of toxic chemicals and the activist campaigns, which both unite and divide these two important concerns. To shed light on the different perspectives, my interviews with Canadian-based animal advocates provided not only critiques of the animal protection laws but also contributed important perspectives on the struggle to move forward with minimizing the use of animals in research and particularly the use of animals to test cosmetics. To understand the historical context of the animal rights movement and the campaigns to reduce or eliminate the use of animals to test cosmetics, I have drawn on Peter Singer's historical account of Henry Spira, *Ethics into Action*, and Spira's effectiveness in raising awareness of this issue, in addition to popular articles on the same subject. For this chapter, I relied heavily on government websites for detailed descriptions of the toxics laws in Canada, the United States and the European Union, as well as published peer-reviewed articles in academic journals discussing the effectiveness or lack of effectiveness in the different statutes. I also consulted the websites of environmental groups who have published in-depth critiques of these toxics laws on-line, and relied on academic research and published papers of Dayna Scott and other academic writers who have articulated the problems of precautionary consumption and the need to address the problem of toxics in consumer products at national and international levels of government, rather than having it fall to individuals. This chapter has also built on testimony offered to the Standing Committee reviewing the *Canadian Environmental Protection Act (CEPA*), and government press releases related to the review. Information specifically relating to *CEPA*'s new substances regulations has come from email exchanges with government departments, specifically Health Canada and Environment and Climate Change Canada.

Chapter Nine is an introduction to the possibilities of non-animal methods (NAMs) that could reduce or replace the current animal testing regimes. For this chapter, I was helped immeasurably by my interview with Elisabeth Ormandy, the B.C.-based Director of Research for Animal Charity Evaluators, who is knowledgeable about non-animal testing and research methods in Canada as well as the oversight work of the Canadian Council on Animal Care, where she had previously worked. The Animals in Science Policy Institute website, which Elisabeth Ormandy founded, is one of the few websites on which alternative tests and their application are well- described. This chapter is also influenced by the landmark report of the National Academy of Sciences, *Toxicity Testing in the 21st Century*, which has had significant success in changing the animal testing paradigm. In addition, I have found very useful information on the websites of the American and Canadian centres for alternatives to animal testing -- the Center for Alternatives to Animal Testing at Johns Hopkins University in the U.S. and the Canadian Centre for Alternatives to Animal Methods in Windsor, Ontario. Not only were these websites very helpful but their writings and their on-line videos supplemented my understanding of the complexities of non-animal testing methods. I also benefitted from discussions with Lisa Kramer of the Animal Law Group, who with Ray Greek, has published critiques of the concordance issue, challenging the way in which information from animal studies is extrapolated to human responses, which she argues is in error. In Chapter Ten, I draw my conclusions. Borrowing from Martha Nussbaum's article, "What we Owe Our Fellow Animals," I find that, with respect to both our human and non-human kin, we cause immense injustice every day, injustice that "cries out for accountability and remediation" (Nussbaum 2022).

Chapter Two: Animal Cognition and Animal Intelligence

…to practice the vocation of the winter wren or black-tailed deer or black bear, or the vocation of human being, a standard share in the species' genetic bankroll is simply not enough. An education is required. Culture is not a luxury. It is life-support.

Robert Bringhurst, The Tree of Meaning

Emotions are the gifts of our ancestors. We have them and so do other animals. We must never forget this.

Jane Goodall, Preface, The Emotional Lives of Animals

Introduction

In this, the second chapter of my dissertation, I investigate the research on animals that challenges the human-perceived limits of animal intelligence. This chapter is intended as a foundation for exploring our current attitudes toward animal minds and an entry into the theoretical and ethical implications of the way in which animals are used in toxicity testing. To this end, I offer a descriptive, but abbreviated, review of evidence from particular studies on animal cognition that challenge conventional prejudices towards animals. I then discuss how these lines of demarcation between humans and animals should be reconsidered in light of recent research. To understand and analyze these studies is to accept that we cannot rest on a conviction that humans are superior to animals and unique in "culture" and consciousness. Much has been written about the toppling of these barriers that situate the animal as less gifted than the human – barriers, which have historically contributed to humans' belief in their own exceptionalism. However, my point in detailing the most striking examples of animal cognition, and our deepening understanding of it, is to gain an appreciation of the various and intricate components of cognition that animals possess, and to consider the ethical implications of this knowledge. Animal cognition, as defined by University of Toronto psychologist Sara Shettleworth, includes "all ways in which animals take in information through the senses, process, retain and decide to act on it" (Shettleworth 2001, 277), or, put another

way, animal cognition is "what permits flexible goal-oriented behaviour through information processing" (Stanford Encyclopedia of Philosophy 2021).

The rules, regulations and practices that were initially formulated to offer animals a small umbrella of protection are deeply flawed, and still mired in the antiquated perception of animals' lesser intelligence and relative insensitivity to pain and suffering, many of these laws initiated decades ago with little enlightened revision since. And despite evidence of their mental capabilities, animals are still offered as commodities, purchased as scientific equipment, and used for experiments in laboratories of the world, a subject that I address in later chapters. In this chapter, though, I start with: in the second section, a description of the human exceptionalism paradigm, which can no longer be sustained given the mounting evidence of animal cognition, and the historical and scientific context for the revival of interest in studying animal minds. In the third and most lengthy section, I show select groupings of recent experiments in animal behavior and cognition that validate the cognition and consciousness of many animal species. Lastly, I offer a short summary of the implications of acknowledging the mental life of animals.

The Dominant Paradigm of Human Exceptionalism

The notion of human superiority over animals has historically been fed by a stream of philosophical speculation that can best be captured in the sociological concept of "human exceptionalism." The human exceptionalist paradigm, as defined by sociologists William Catton and Riley Dunlap in the 1970s, maintains that "humans are unique among the earth's creatures for they have culture" (Catton and Dunlap 1978). This paradigm captures the essence of the anthropocentric world view that humans have held for a long time. According to this notion of "culture," different human capacities constitute markers of particular gifts that humans, but not

animals,[3] were deemed to possess, capacities such as language, tool use or planning for the future. The origins of these assumptions about the superiority of humans, as illustrated by human language and technical skills, in contrast with the perceived limitations of non-human animals in these areas, have been linked with Biblical assertions of human dominion over the earth found in Genesis and the Enlightenment pronouncements of Rene Descartes who claimed that animals were merely unfeeling automatons in contrast to humans fortunately endowed with souls (de Waal 2016; Bekoff 2000). Although the celebrated nineteenth century scientist, Charles Darwin, who gave us the theory of evolution, believed that humans and animals shared emotional states, his ideas were eclipsed for decades by the ascendancy of the school of behaviorist psychology,[4] which insisted that we cannot assume animals have their own emotional lives because there is no incontrovertible proof (de Waal 2016; Bekoff 2000).

These assumptions were seriously challenged almost 50 years ago in 1976 when zoologist Donald Griffin published *The Question of Animal Awareness: Evolutionary Continuity of Mental Experience,* and recovered the study of animal minds as a respectable scientific pursuit. Now, thanks to the many scientists following his lead and owing to their dedication to the study of animal behaviour over the last half century, we currently hold more knowledge and understanding than ever before about many of those characteristics that we previously believed set us apart from non-human animals. We currently have in hand considerable evidence, compelling but still incomplete, of the corresponding presence of many characteristics, once thought to be uniquely human, and now shown to be possessed by non-human animals (de Waal 2019, Bekoff 2017).[5] The researchers -- ethologists, cognitive neurobiologists and comparative psychologists who have explored animal

[3] I generally choose to use the term "animals," the equivalent of the term "non-human animals,." to refer to species other than the human animal species, except where I would like to stress the negative attitude of human animals.
[4] The predominant psychological school of behaviourism, established in the early twentieth century by John B. Watson, held that human and animal behavior could only be understood through observable actions.
[5] The term "animal" includes both vertebrate and invertebrate animals, including, for example, octopi, fish, birds and insects such as bees.

sentience and cognition – have become the 'mind readers' and spokespeople for our fellow animals, identifying a convincing range of shared attributes that were previously ascribed only to humans (Cognitive Science Summer School 2018). As primatologist Frans de Waal has expressed it, when so many pieces of the larger human phenomena are broken down into smaller pieces, "some of these pieces can be found elsewhere" (de Waal 2016, 107). In addition to their role as spokespeople for many different species, these scientists have also become their advocates, arguing for more ethical treatment of non-human animals (Bekoff and Pierce 2017). Starting with Thomas Nagel's famous question, "What is it like to be a bat?," (Nagel 1974), we now have a glimpse of what it may be like to be an ape, an elephant, a dolphin, a monkey, a crow, a rat or a mouse, insights opened up by the windows of many published scientific studies on these animals, some of which will be set out in the next section of this chapter.

Picking up again where Charles Darwin left off in the nineteenth century, the present-day conversation concerning animal minds has expanded to include many dimensions of cognition. Writing in the nineteenth century, Darwin sought, as an extension of his study of evolutionary development, to establish a continuum between humans and animals (Midgley 1989, 6), particularly an emotional continuum. Now, scientists have observed and documented the complex emotional lives of animals (de Waal 2019), of which Darwin was convinced, as well as the remarkable capacities of animals to learn, reason and anticipate the future (Taylor et al. 2009, Crystal and Foote 2009, Naqshbandi and Roberts 2006). Not only has research uncovered many attributes now recognized as common to both humans and animals, but a number of influential scientists are convinced of the consciousness of non-human animals, and a respected group of them have publicly proclaimed their conviction in its existence (The Cambridge Declaration on Consciousness 2012). In my interview with Carolyn Ristau, for example, ethologist and friend and biographer of the late Donald Griffin, she described consciousness as existing on a number of levels – sentience or awareness, which can

be simply whether things are hot or cold or it can encompass emotions such as pain, joy and love (Carolyn Ristau, Interview, March 3, 2021). Consciousness can also involve experiences, which are amplified by cognition and language, such as looking at how beautiful a sunset is and how the mauves mix with the pinks. These experiences demonstrate the overarching concept of a sunset and a sense of things such as colour. Consciousness, then, is "an awareness of all these levels."

The Mental Lives of Animals

In the 1970s, Donald Griffin challenged the scientific orthodoxy that only animal behaviour, and not animal minds, could be studied and known. Renowned in his own right as the scientist who discovered the echolocation abilities of bats, he pioneered the field of cognitive ethology, which legitimized the investigation of the mental experiences of animals, posing the question "what is it like to be an animal?" (Griffin 1984, 1). Griffin suggested that evidence for animal consciousness and mental experiences could be found in three different areas: 1) the neural correlates of consciousness, 2) versatility in meeting novel challenges, and 3) communication, regarded as a potential window into animals' mental experiences (Griffin and Speck 2002). Many researchers have been investigating these areas since his ground-breaking books were published. What have we learned, then, in the last four decades of concerted research into the minds of animals? Cognition, intelligence, sentience, and even consciousness (with consciousness being the most controversial) are all terms used to describe those mental states that we now attribute to animals. All speak to how drastically we have underestimated both the shared and the unique attributes of human and non-human species.

In this section, I review a selection of the most significant studies that show the previously unknown depths of animal cognition, or more precisely, the "mental life" of animals. These studies are based on the knowledge gained from experiments on animals in the laboratory and observations of animals in the wild. Ironically, much of what we know about animal cognition has been learned

from animals in captivity – laboratories, zoos, or protected reserves, while studying animals in their natural environments has been the purview of behavioural ecologists (Pritchard et al. 2016). However, there has recently been an increasing focus on taking the study of animal cognition into the field to test cognition in its natural habitat, "rather than taking ecologically interesting animals into the laboratory" (41). In my own experience, I was lucky enough to accompany psychologist Carolyn Ristau, who is known for her studies of broken wing display in killdeer and other birds as an example of versatility, to a chimpanzee reserve in Nigeria. With her, I witnessed firsthand acts of living that I might naively have imagined before this trip as being solely human -- the camaraderie of the chimps grooming each other, chimps drinking from improvised coconut shell mugs, hostile chimps hurling stones at us as unwelcome intruders (as we were), and the most rebellious of the chimps trying his best to escape from the compound by commandeering a tree branch as a ladder. I believe the physical and mental life of these chimpanzees was fully on display even in that limited experience, although I admit that I have no scientific credentials with which to make any claims.

The animal studies, which I have chosen to highlight, reveal "an enormous plurality of cognitions with many peaks of specialization" or "magic wells," as scientists have christened them (de Waal 2016 NYT). They are "magic wells" because, as de Waal explains, "the more scientists learn about them, the deeper the mystery gets". Investigating these magic wells, scientists have discovered a spectrum of animal emotions, the capacity of animals to express empathy and show altruism, their ability to use tools, to recognize themselves in the mirror and to recognize faces, to remember things, to plan for the future, to communicate complex ideas, and to "mind read" in the sense of being able to understand or adopt another's view point, also known as the "theory of mind." These magic wells were once considered to be exclusively human prerogatives, but, as these experiments show in each case, strategically-designed studies of animals have demonstrated that those qualities are also shared by many animals. The significance of this work, as psychologist

Carolyn Ristau maintains, is that: "we are more likely to be concerned about animals' wellbeing and conservation of their habitat if we understand them to be conscious, intelligent beings" (Ristau 2013, 493).

i. Emotions

Take animal emotions as a sign of animal intelligence. Countering Darwin's 1872 investigation of the relationship between human and animal emotions in his book, *The Expression of Emotion in Man and Animals*, Rene Descartes and later, twentieth century behavioral psychologists John B. Watson and B.F. Skinner, have prevailed since Darwin with the view that animals were robotic and deemed to be guided by instinct alone (Bekoff 2000). Defying this denial of animals' emotional lives, ethologist Marc Bekoff has been instrumental in documenting the range and complexity of animal emotions and raising awareness of them, although he concedes that the study of animal emotions is in its infancy. As Bekoff reminds us, "Darwin argued that 'there is continuity between the emotional lives of humans and those of other animals, and that the differences among many animals are in degree rather than in kind'" (Bekoff 2000, 861).

Bekoff defines emotions as "psychological phenomena that help in behavioral management and control" (Bekoff 2000, 862). While laughter, or the ability to express joy, for example, has long been recognized as a feature of the human species, joy, it seems, can be experienced by other animals. Jaak Panksepp and Jeffrey Burgdorf maintain that the chirping, which results from laboratory rats being tickled, is likely analogous to human laughter (Panksepp and Burgdorf 2000). Not only rats, but great apes respond to tickling with hoots, hollering and panting, just as humans do (Davila Ross et al. 2009; Panksepp and Burgdorf 2000). From watching the behaviour of chimpanzees, de Waal comments that "tickling a juvenile chimpanzee is a lot like tickling a child.

The ape has the same sensitive spots: under the armpits, on the side, in the belly" and, like a child, often returns for more (de Waal 2016).

Other emotions, as well as joy – hope, worry, gratitude, revenge and grief -- have been observed in animals. De Waal calls some emotions, such as hope and worry, "future oriented," while other emotions, such as gratitude, forgiveness, and what he calls "the ugly sister of gratitude," revenge, relate to the past (de Waal 2019, 130), 132). Gratitude, among chimpanzees, is expressed through exchanges of food, grooming, sex and other favours that circulate in a colony. De Waal, in his 2019 book, *Mama's Last Hug*, distinguishes between animals' emotions and their feelings, explaining that there is a "world of difference between behaviour that expresses emotions and conscious or unconscious experience of those states" (de Waal 2019, 7). He believes that we can understand the emotions of animals, their bodily and mental states, but their feelings remain inaccessible. Similarly, with humans, we may observe their emotional states but we may not always know their feelings unless they verbally express them.

Animals have also been observed displaying sadness and grief. While it is challenging for researchers to be present at the moment an elephant dies in the wild, zoologist Iain Douglas-Hamilton was on hand for the death of an elephant matriarch in Kenya. He witnessed elephants responding to the suffering and death of another elephant, regardless of whether they were related or not (Douglas-Hamilton et al. 2006). He concluded that elephants have both an awareness and an interest in death, and that their responses demonstrated "how elephants and humans may share emotions, such as compassion" (15). Emotions like compassion and grief are regarded as secondary, because rather than being automatic, they "are experienced or felt, evaluated, and reflected on" (Bekoff 2000, 863). Although most emotional responses may be generated unconsciously, Bekoff believes that these secondary emotions reflect a consciousness that "allows an

individual to make connections between feelings and action and allows for variability and flexibility in behavior" (863).

Other emotions considered to be in a higher realm of response have also been demonstrated in a number of species ranging from monkeys to mice. Empathy and altruism are two other examples of higher level emotions. Frans de Waal, in writing on empathy, defines cognitive empathy as "empathy combined with contextual appraisal and an understanding of what caused the object's emotional state" (de Waal 2008, 283). He finds that "empathy is an ideal candidate mechanism to underlie so-called directed altruism" (279), a mechanism that he contends is "phylogenetically ancient, probably as old as mammals and birds" (279). The expression of empathy in animals was captured in studies of rhesus monkeys that refused to pull a chain for food when they realized that another monkey was receiving a painful electric shock each time the chain was pulled (Wechkin et al. 1964; Masserman et al. 1964).

Rats and mice have also have shown empathy for their fellow rodents (Panksepp et al. 2011). Free rats, placed in an arena with another rat trapped in a restrainer, learned to quickly and intentionally open the cage (Bartal et al. 2011). This was done with no social rewards, and researchers concluded that rats "behave pro-socially" when they perceive another rat experiencing distress, providing strong evidence for the biological roots of empathy (1427). In one of the first studies of mice subjected to painful procedures, Langford and his colleagues found that mice were sensitive to a social partner that was also experiencing pain and, as a result, expressed greater pain-related behavior themselves (Langford et al. 2006). As I discuss in Chapter Five, such a sensibility attributed to mice flies in the face of conventional attitudes to laboratory mice as creatures without significant feelings. This pro-social behaviour has been called "emotional contagion" because rats and mice become distressed seeing others in distress (de Waal 2019, 118). De Waal has concluded that "without the emotional engagement brought about by empathy, it is unclear what could

motivate the extremely costly helping behavior occasionally observed in social animals" (de Waal 2008, 292). Not only have animals been found to express concern for the distress of others, but they have also been shown to rebel against favouritism where one animal is treated more generously than another, in what has been termed "inequity aversion" (Brosnan and de Waal 2003, 297). According to Ristau, morality is believed to have its roots in this emotional and empathetic behaviour (Ristau 2013, 502). Empathy is a higher level emotion that we, as humans, may also feel, and one that hopefully could motivate us to feel concern for either the distress or for the unfair treatment of non-human animals.

ii. Mirror Self-recognition

Self-awareness is also regarded as another higher cognitive capacity, and has been the subject of considerable study and debate since the first mirror self-recognition tests were conducted in 1970. Self-awareness is the ability to recognize or conceptualize an independent self, a being capable of reflecting on its own consciousness, a capacity considered rare outside of the human species. This type of awareness in animals, however, was first, and most famously, demonstrated by mirror self-recognition (MSR) tests, which, although they have been the subject of many critiques, are still widely-accepted indicators of animal self-awareness. Most recently, for example, they have come under scrutiny as a result of MSR tests conducted on cleaner wrasse. When these fish attempted to remove coloured marks they saw reflected in the mirror, scientists concluded that they passed the mirror self-recognition test (Kohda et al. 2019). Jennifer Vonk of Oakland University, however, finds that these conclusions are not warranted on the basis of a single test or scientists' preconceived expectations (Vonk 2020). Rather, she argues that species' abilities should be based on a body of data that includes other studies of sophisticated cognitive abilities.

The initial mirror studies were devised and conducted on chimpanzees and monkeys by psychologist Gordon Gallup, Jr. (Gallup 1970). He showed that chimpanzees that had been marked with a red spot on their eyebrows, upon examining their own faces in a mirror, touched the spot, indicating that they recognized themselves. However, monkeys did not demonstrate the same behaviour.

Since then, similar experiments have been done on a number of other species, and, although not all species have demonstrated the ability to recognize themselves in mirrors, conclusions of self-awareness have been credited to killer whales (Delfour and Marten 2001), Asian elephants (Plotnick, de Waal and Reiss 2006), bottlenose dolphins (Reiss and Marino 2001) and magpies (Prior, Schwartz and Gunturkun 2008). Mirror self-recognition is thought to have co-evolved with empathy and altruism, since both have been found in animals, such as dolphins and elephants, known for helping others of their own species (Plotnik, de Waal and Reiss 2006, 17053). Frans de Waal, who has studied mirror self-recognition, believes its importance lies in its "cognitive correlates," finding that the capacity to distinguish between the social environment and the self "may allow for more advanced forms of intersubjectivity in which a subject connects with an object's emotional state, such as distress, without losing sight of who actually is in the situation that caused this state." (de Waal 2005, 11140). Thus, mirror self-recognition not only signifies an awareness of one's own body as distinct from others, but it also suggests that one's own emotions and another's can be separated. Consequently, mirror self-recognition is regarded as "a marker of mind, along with empathy and attribution" (11140).

iii. Social self-awareness

Philosopher David DeGrazia of George Washington University has pointed out that there are different types of self-awareness, exhibited by animals, which he maintains have been significantly underestimated by both scientists and philosophers (DeGrazia 2009, 201). Not only

have animals demonstrated body awareness (as in mirror self-recognition), but they have also shown that they have social self-awareness, that is, the ability to understand themselves as part of "a social unit with different expectations attaching to different positions" (202). This social self-awareness applies particularly to those animals that live in groups, such as chimpanzees or whales. It allows them to interact with each other effectively by understanding the expectations that come with their place in the social hierarchy, and improving their chances of survival (202). In his widely-read book, *Chimpanzee Politics,* Frans de Waal contributed the results of his years observing chimpanzees at the Netherlands' Arnhem Zoo to illuminate the complexities of their social organization. His book documents both their bids for power, and the way in which the chimpanzees' rankings within the group affected their sexual privileges (de Waal 2007, 5).

Elephants are another social species that operate within highly-structured groups, and Wittemeyer and Getz, working with African elephants in Nairobi, Kenya, found that competition between groups and within groups affects their social organization (Wittemeyer and Getz 2006). They found, for example, that elephant matriarchs established dominance primarily through age rather than by their physical size or by the size of their group (671). Social self-awareness has also been observed in sea mammals, with different species of whales and dolphins living within different social structures. Killer whales off the west coast of Canada, for example, travel in stable matrilineal groups that feed on fish and travel together in pods, with each pod having a distinctive repertoire of calls used to establish pod pedigrees (Mann, Connor, Tyack and Whitehead 2000, 6).

For these social animals, the skill of being able to know others by their faces is essential, allowing them to recognize other individuals and to discriminate between friends and enemies in their structured communities. Although it is taken for granted that humans have this skill, other animals, such as rhesus monkeys, have been found to share with humans a parallel perceptual mechanism that allows them to differentiate the many faces they encounter in their daily lives

(Adachi et al. 2009), both human and non-human. Crows have also been found to recognize faces. John Marzluff, a wildlife biologist at the University of Washington, tested the ability of crows to recognize individual human faces by creating "dangerous" and "neutral" human masks, worn by his researchers. The dangerously masked humans trapped and banded several crows who continued for at least 2 ½ years to scold any humans wearing the same "dangerous masks," while those who wore the neutral masks were left alone (Marzluff et al. 2010). Similarly, dogs remember their owners' faces when they are presented with the sound of their owner's voice (Adachi et al. 2007). Even honeybees, with no evolutionary history for discriminating among human faces, learned to recognize and visit target faces (Dyer et al. 2005). According to Ristau, this ability to recognize faces is how some animals conceptualize the world, and is, therefore, an important part of their world and an important class of social skills (Carolyn Ristau, Interview, March 3, 2021).

iv. Tool Use

Another cognitive skill demonstrated by animals is the use of tools, described by ethologist Gordon Burghardt as a "major cognitive and behavioural component of 'mental evolution'" (Shumaker et al. 2011). Once regarded as solely a human facility, animals' ability to use tools is no longer questioned; rather, the debate now focuses on whether "such use is mostly inflexible and innately specified or involves experience, innovation, adaptation and cognitive planning" (Pepperberg 2019). Griffin considers the making of tools as the type of versatile behaviour that suggests consciousness in animals (Griffin and Speck 2002). Chimpanzees are one of the most well-known examples of a species that excels in tool use. They have been credited with developing a sophisticated tool kit to facilitate their access to food, using first, woody stems to perforate ant nests and, then switching to dipping sticks to harvest the ants (Sanz 2009).

Not only chimpanzees but several bird species have demonstrated an impressive proficiency in tool use. Clever New Caledonian crows, for example, in their search for food, have been

observed sculpting sticks, stems or twigs to create hooks for fishing out insect prey (Hunt 1996). And, in addition to their proficiency in straightforward tool use, Alex Taylor and his fellow researchers at the University of Auckland in New Zealand, have documented the capacity of the New Caledonian crows for "metatool" use -- that is, using tools to obtain other tools, a feat that requires causal reasoning, and indicates a higher level of cognition (Taylor et al. 2009). In the case of the metatool experiments, the crows became adept at using a short tool to extract another longer tool, which was then used to extract meat.

In recent experiments with another bird species, Goffin's cockatoos, the cockatoos showed an ability to successfully match, orient and insert three-dimensional shaped "keys" into corresponding "keyholes" (Habl and Auersperg 2017). Tool use is of special interest because the acts of creating and using tools seem to demand at least short-term planning, problem solving and are performed with intention. Thomas Bugnyar, based on his own experiments with New Caledonian crows at the University of Vienna, has concluded that crows are capable of mental planning. He has speculated that, like humans, some animals seem able to mentally represent the problem, imagine the solution and the stages along the way when they need to use one tool to act on another (Bugnyar 2019). The use of tools, then, according to Ristau, "implies a goal or purpose, requires at least short-term planning (sometimes longer) and depending on the contest, can require flexible behavior" (Ristau 2013, 499).

v. Complex Communication Abilities

Donald Griffin considered communication to be a significant 'window' on animal minds, "a source of objective evidence about the thoughts and feelings that have previously seemed to be inaccessible to scientific investigation" (Griffin 1984, 164). To illustrate how animal communication is more symbolic than verbal, he cited the actions and body language of weaver ants and the well-

studied waggle dance of honeybees, both methods of conveying critical information about distance and direction of food sources back to their colonies (187). More recently, the basic messages of the waggle dances have been found to be fine-tuned by tremble dances, stop signals and shaking signals (Griffin 2004, 14). Another widely-cited example of animal communication is the work of Dorothy Cheney and Robert Seyfarth studying the behaviour of vervet monkeys in Africa. They found that vervet monkeys use three different alarm calls to warn other monkeys of predators: the leopard alarm sends the monkeys into the trees, the eagle alarm prompts them to look up, and the snake alarm alerts them to look down (Seyfarth, Cheney and Marler 1980). Cetaceans – that is, whales, dolphins, seals and other aquatic animals – are also capable of complex and varied communication. Peter Tyack of the Marine Mammal Behavior Laboratory, Woods Hole Oceanographic Institution, has looked at, and written eloquently about, the mating songs of humpback whales, the low-frequency echolocation of finback and blue whales, which may be used for navigation, and the whistling that keeps a mother dolphin in touch with her offspring (Tyack 2000).

vi. Theory of Mind

Another important animal capability is mind-reading or "theory of mind." Put another way, mind-reading is the capacity to know your own mental state and the state of others (Premack and Woodruff 1978, 515). Theory of mind is considered a theory because mental states are not directly observable (515). However, experiments with different species have convinced researchers that at least certain animals have the ability to understand another animal's thinking. Josep Call and Michael Tomasello, from the Max Planck Institute for Evolutionary Anthropology in Germany, found that chimpanzees, for example, could indeed "understand the goals and intentions of others" (Call and Tomasello 2008). In one of their studies observing two chimpanzees, a subordinate chimpanzee was able to see food being hidden or moved by researchers to places that the dominant chimpanzee could not see. Sensitive to what the dominant chimpanzee could or could not see, the

subordinate chimpanzee was able to approach and successfully retrieve the food that the other chimpanzee did not observe being hidden and did not know was there (Hare, Call and Tomasello 2001). The action of the subordinate chimpanzee shows both an awareness of the first chimpanzee's spatial perspective and a grasp of its mental state.

Similarly, in Hawaii's Kewalo Basin Marine Mammal Laboratory, over many years of studying sensory, cognitive and communicative skills of bottlenose dolphins, Louis Herman and his fellow researchers found that dolphins have a range of cognitive skills, related to the theory of mind. These skills included "broad imitative abilities, abilities to understand another's indicative cues, and the spontaneous use of pointing to communicate with human companions" (Pack and Herman 2006). As particular evidence of the dolphins' abilities to understand the minds of others, researchers found that dolphins responded to human pointing gestures directing them to swim under a hoop even though they had not been explicitly trained to do so (Herman, 2010, 310). Dolphins understood not only where humans were pointing but what they were pointing at (321). Understanding another's viewpoint or emotional state may cause a matching emotional state. According to de Waal, this can activate concern for another's welfare, the expression of empathy, and opens up the possibility of altruistic behaviour (de Waal 2008, 279).

vii. Episodic Memory

Memory – the encoding, storage and retrieval of information -- is another capacity once thought to be exclusive to humans, but, which animals have also been found to possess. The study of memory in animals has, in fact, a long and rich history (Healy 2018, 129). A particular type of memory, episodic memory, enables both humans and animals to collect and store memories from the past, and provides them with information for the future (Tulving 2002; Crystal 2008). The psychologist, Endel Tulving, who was instrumental in defining the concept of episodic memory, described it as a "neurocognitive (brain/mind) system, uniquely different from other memory

systems, which enable human beings to remember past experiences" (Tulving 2002, 1). He called it "a true, even if as yet generally unappreciated, marvel of nature" (1).

Now, experiments have shown a number of different animals have the ability to collect and store memories, and to use these memories to assist them in the future. Corvids and their close relatives are particularly popular with researchers investigating cognitive abilities such as causal reasoning and memory (Healy 2019). Nutcrackers, marsh tits, black-capped chickadees (Feeney et al. 2011), and scrub jays (Clayton and Dickinson 1998) have all been shown to cache food and return later to retrieve it, with some species surpassing humans with an impressive ability to remember where they stored their food (Paxton 2021, 33). In their ground-breaking research on scrub jays in particular, Clayton and Dickinson showed that jays preferentially searched for wax worms, their favoured food, when the worms were fresh, but avoided searching for them later when the worms had decayed. This behaviour "demonstrates memory of where and when particular food items were cached," and, according to the researchers, fulfills the criteria for episodic-like memory (Clayton and Dickinson 1998). Another important feature of episodic memory is that it allows adaptive behaviour in the future (Shettleworth 2010). Experiments with wild black-capped chickadees have found that chickadees will learn to cache food in locations where that food will be available in the future, and learn to avoid hiding it in places where it will be pilfered, demonstrating that chickadees are able to anticipate that future foraging would be affected by their current caching choices. The authors conclude, then, that relying on episodic memory enables chickadees to forage by cognitively travelling in time both retrospectively and prospectively (Feeney et al. 2011).

viii. Future Planning

In the last thirty years, a wealth of scientific investigation and a corresponding public fascination with animals and their lives has revealed that not only do animals remember, as we do, things that happened in the past, referred to as episodic memory, but it has also been determined

that animals can, and do, plan for the future. Psychologist William Roberts, from the University of Western Ontario, reviewed those studies that evaluated whether animals prepared for the future, and concluded that the evidence from these studies confirms that they do (Roberts 2012). He defines mental time travel as the "ability to travel backward and forward mentally from the present moment to remember specific past experiences stored in memory and to anticipate or plan future activities" (Roberts 2012, 169). He offers as evidence his own experiments on squirrel monkeys, conducted with Miriam Naqshbandi, as supporting the existence of mental time travel in animals (Naqshbandi and Roberts 2006). In their studies, they were able to show that monkeys, who were not thirsty at the time of being presented with dates to eat, learned to anticipate the future consequences of choosing between one date and four dates. Choosing only one date meant the return of their water bottles later, while choosing the more attractive option of four dates meant the water bottles were not returned (Naqshbandi & Roberts 2006). The monkeys learned to choose one date in anticipation of having their water bottles given back, and the experimenters concluded that monkeys could anticipate future outcomes, and adjust their behaviour based on their past experiences.

Perhaps the most compelling evidence of future planning is the experimental outcomes of work with western scrub jays. Jays, who had previously pilfered the food caches of other scrub jays, were observed carefully caching their foods in one location and then hiding them again in another location, if they had been observed by a fellow scrub jay while initially hiding their food (Emery and Clayton 2001). Roberts also cites planned tool use as another example of mental time travel. Based on tests of apes conducted by scientists at the Max Planck Institute, Nicholas Mulcahey and Josep Call, bonobos and orangutans were both found to be able to select and transport appropriate tools for use one hour later, and then again fourteen hours later, when they were allowed to revisit a baited apparatus (Mulcahey and Call 2006). Given a choice between suitable and unsuitable tools, bonobos and orangutans selected the hook to take out of the room with them. The hook was the

appropriate tool that would later enable them to reach a juice bottle suspended by a string and get their reward (1039). Mulcahey and Call, who set up this elaborate study, call planning for future needs "one of the most formidable of human cognitive achievements" (103). Based on their experience, they conclude that animals also plan for the future, and that planning for the future is not a uniquely human ability, but an ability enjoyed by at least some nonhuman species.

ix. Meta-cognition

Meta-cognition refers to an awareness and understanding of one's own thought processes and the ability to consciously access stored information from one's memory – or, as Jonathan Crystal puts it, meta-cognition is "thinking about thinking" (Crystal and Foote, 2009). DeGrazia finds that animals, in addition to body self-awareness, social self-awareness and temporal self-awareness, also evince "introspective self-awareness," his description of meta-cognition (DeGrazia 2009, 216). Humans, for example, can consciously retrieve some memories and report on them, while others cannot be brought to consciousness even though they influence behaviour (Hampton 2001). Although scientists have learned much about cognition, less is known about meta-cognition (Kornell, Sun and Terrace 2007). In order to gauge whether animals, like humans, have meta-cognition, Shettleworth and Inman asserted that it was critical to demonstrate the accuracy of animal responses where the animals had the choice to accept or decline difficult tests (Inman and Shettleworth 1999). An animal capable of meta-cognition would theoretically show more accuracy in a test where they had the opportunity to choose whether to take the test or not.

Just such an experiment was carried out by Emory University professor of psychology, Robert Hampton, convincing him that rhesus monkeys can discern the presence and absence of memory. According to Robert Hampton, the ability to access stored information is a feature of human cognition, and "linked to many forms of learning, complex thinking, and planning for the future," as discussed in the previous section (Hampton 2001, 5359). In a series of visual tests that

Hampton designed to assess the monkeys' capacity for meta-cognition, food rewards were contingent on the monkey's recall accuracy. Monkeys were able to decline tests that were difficult for them and that might jeopardize their food rewards (Hampton 2001; Crystal and Foote 2009). Hampton found that monkeys, after recently viewing clip-art images, were not only aware of their own memories, but were also able to assess their own memory capacity to determine when they were able and not able to remember specific images (Hampton 2001). Similarly, in tests on rats administered by Jonathon Crystal and Allison Foote, rats were rewarded with food for their accuracy in determining the length of a noise, either short or long. The rats were given the choice of declining a test where declining meant a less desirable food reward, but where being wrong meant no food reward at all (Crystal and Foote 2009). Again the rats, like rhesus monkeys, seemed to respond by declining tests where the problems were difficult in order to claim at least a partial reward (5). American psychologists Smith and Washburn have described meta-cognition as "one of humans' most sophisticated cognitive capacities," and state that the analogous capacity in animals would suggest awareness and consciousness, rivalling "language and tool use for its potential to reveal basic continuities or discontinuities between human and animal minds" (Smith and Washburn 2005, 19).

Conclusion

Frans de Waal describes these accumulating studies on animal cognition, or "intelligence," as having "blown big drafty holes in the wall that supposedly separates humans from the rest of the animal kingdom" (de Waal 2019, 9). However, de Waal sees no reason to compare the cognition of humans to those of non-humans, arguing that it is more likely that each animal has its own cognition, adapted to its own senses and natural history. I agree with this analysis: even though the point of this chapter has been, at least partially, to deconstruct illusions of humans having unique capabilities that set them above animals on Aristotle's scala naturae, the overall objective is to instill

in the reader a sense of humility and respect in our relationship with animals, an understanding that we do not know as much as we may think we know. Alluding to the abilities of octopi and bats, de Waal has commented that: "it makes no sense to compare our cognition with one that is distributed over eight independently moving arms, each with its own neural supply, or one that enables a flying organism to catch mobile prey by picking up the echoes of its own shrieks" (de Waal 2016, New York Times). While championing the deep wells of animal cognition and promoting our understanding of them, he warns that measuring other species against our own is just another way of reinforcing our own superiority; he would rather that we recognize and appreciate the immense richness of nature (de Waal 2016, NYT). If we do accept this recognition and appreciation of the richness of nature, we must also accept the responsibility to recognize and appreciate that animals, other than ourselves, are conscious and deserving of a consideration that we have so far failed to extend to them.

Many of the characteristics attributed to animals in this chapter are regarded as higher level cognitive capacities, taken for granted as part of the human cognitive make-up, and considered to be morally relevant capacities for both humans and animals. The insight and knowledge, most recently derived from the scientific studies of the mental lives of animals. has, according to David DeGrazia, "resulted in a higher estimation of the cognitive, psychological, and behavioral complexity of many animals, in turn fostering increased respect for them, and thereby greater interest in ethical and scientific issues regarding their proper treatment, including their care and use in biomedical and behavioral research" (DeGrazia and Beauchamp 2019, 2). I suggest, then, that these cognitive studies represent the scaffolding on which to construct an ethical relationship between human and non-human animals. The insight, which we have now acquired, and that we are still gathering, into the minds of animals, imposes on us an obligation to reconsider our ethical relationship with animals, to reconsider the laws that supposedly offer animals protection, and to re-evaluate our use

of them in research in general, and in toxicity testing, in particular, which will be discussed in depth in this dissertation.

Using an animal justice lens, in the next chapter I will reflect on the theoretical arguments constructed by those philosophers who have considered the ethics of animal issues, particularly those who seek to extend the moral community beyond humans to non-human animals. Many of their arguments have garnered widespread interest in academic circles and influenced the public whose support for animal rights has steadily grown. At the same time, these philosophical positions speak to the great divide between contemporary societal values and the practice and treatment of animals in the laboratory, in which researchers are guided by their own set of principles.

Chapter Three: The Ethical Implications of Cognition

At its heart, animal experimentation is a dilemmatic enterprise; it builds on the modernist ideology of 'human exceptionalism' but is still quite often publicly contested, often by animal advocates.

Tara Holmberg, Mortal Love: Care practices in animal experimentation

The relations between human and animals must change. They must, both in the senses of an 'ontological' necessity and of an 'ethical' duty.

Jacques Derrida, For What Tomorrow…A Dialogue

Introduction

If we accept the accumulating scientific evidence on the intelligence of animals, then we must ask ourselves how to conduct our multiple and historically-entrenched human-animal relationships in an ethical way. As David DeGrazia has said, the "sorts of mental capacities that we attribute to animals have a great deal to do with how we think they should be treated" (DeGrazia 1996, 1). In this chapter, I examine the spectrum of arguments for extending moral consideration to animals, ranging from the "abolitionists" who oppose any exploitation of animals, to those theorists, both in and outside the laboratory, that assert the value of research using animals but with reservations and conditions. I am asking what the theoretical and ethical bases are for re-orienting our practice of using animals in research in general and for toxicity testing in particular, given our present and growing knowledge of animal cognition. As Martha Nussbaum has written, "knowledge will help us to think better about the ethical questions before us and especially, to develop a good theoretical orientation toward animal lives, which can direct law and policy well, rather than, as in the past crudely and obtusely" (Nussbaum 2022).

After this introduction, this chapter is organized in the following way: initially, in the next section, in response to the question "are we animals," I look at how we have distanced ourselves from an understanding of ourselves as animals, and how that dissociation has provided a justification for not only our attitudes but for our instrumentalization of animals. Then, in the third

section, I look at the differing philosophical perspectives on what constitutes an ethical relationship between human and non-human animals. I consider not only the influential philosophical arguments that have led to organized opposition against the use of animals in research, but also, the views of those who might have sympathies and compassion for animals, but who still accept the role of experimental animals. They argue that such research benefits humans, and in some instances, animals themselves. In the fourth section of this chapter, I explore the scientists' own ethical principles, which have guided laboratory research for the past 60 years, highlighting the limitations of these principles. Finally, in my fifth and last section, I draw my conclusions on the need to respect the cognitive capacities of animals, the need to expand the moral community to include animals, and the need to conduct ourselves ethically in our interactions with them.

The Meaning of the "Animal"

British philosopher Mary Midgley has asked the question "are you an animal?" To consider the way in which humans perceive themselves, either as animals or not as animals, is to understand how we justify the conversion of non-human animals into research subjects. According to Midgley, there are, in our society, two distinctly different ways of responding to the question, and those two different responses are situated at the interchange of both scientific and everyday thinking (Midgley 1989, 1). The first and technically correct interpretation of the word, "animal," encompasses all living creatures on the planet, including ourselves. We, humans and non-humans, are collectively bound up in the concept of being animal. On the other hand, in its second sense, the term "animal" has been used to distance ourselves from all other species. It is used to describe the unhuman or anti-human, often in a derogatory way (2).

Midgley characterizes this second attitude – that animals are something different from ourselves – as the traditional attitude. She calls it "a powerful, ancient, imaginative background that works by being taken for granted" (2). The first meaning may be held up as the "scientific" meaning

in accordance with current taxonomy and our understanding of evolution and, therefore, the correct meaning. However, the second meaning is often regarded as the real "scientific" meaning, in the sense of being "necessary for the practice of science" (3). She finds:

> …others would certainly say that, in the interests of truth itself, the scientific approach demands that the difference between humans and all other creatures should be treated as paramount, because these creatures are in fact beings of a distinct kind, much more like machines than they are like humans (3).

This second meaning -- that nonhuman animals are different than, or less than human, and, therefore, acceptable machinery in the practice of science -- has become the conflicted, but predominant view, that continues to provide the rationale for scientists in government, academic institutions and private laboratories to continue the conventional use of animals in research.

Consistent with Midgley's second meaning, American philosophers David DeGrazia and Tom Beauchamp sum up the beliefs that justify animal research in a similar vein: that nonhuman animals are less than, or inferior to, humans, and, therefore, acceptable subjects for experimentation. DeGrazia and Beauchamp identify the factual and moral assumptions that underlie the institutionalization and widespread acceptance of animal research (DeGrazia and Beauchamp 2015):

> The *factual assumption* was that animal research is sufficiently reliable as a basis for predicting the effects of drugs, products, and other materials on human beings that animal trials can be expected to yield significant scientific conclusions and medical benefits to humanity…The *moral assumption* was that the moral status of animals is inferior to the moral status of human beings—a thesis commonly expressed in the language of "human dignity" (Italics in the original, 386).

The question, then, of "are we animals," and the assumption of our supposed moral and cultural superiority, has become less acceptable as ethologists have deepened our knowledge of animal cognition, and provided strong evidence of consciousness in non-human animals, as documented in the first chapter. The idea that we are animals and that, in many ways, animals are

like us, is the premise on which many of the current philosophers argue for animal justice and the more ethical treatment of animals.

The Ethics of Human/Animal Relations and the Question of Animal Research

At about the same time that Donald Griffin began championing the study of animal minds, three philosophers -- Peter Singer, Tom Regan and Bernard Rollin -- came to prominence as advocates for more ethical human/animal relations. All three philosophers insisted that animals had intrinsic moral worth. Confronting the assumption that humans are unique and the only proper subjects of moral concern, they questioned "the existence of a clear distinction between all humans and all animals with regard to the possession of certain relevant moral capacities" (Jones 2013). Identifying morally relevant capacities was their way "to demonstrate ethically relevant similarities between human beings and animals and then to argue that equal consideration entails that similar beings should receive similar moral consideration" (Calarco 2015, 28). These arguments have subsequently been amplified by research affirming the cognitive capacity of animals, as discussed in the last chapter. Singer, Regan and Rollin, among others, share a commitment to the equal consideration of the interests of both humans and animals, regarding animals as equally deserving as humans of ethical treatment, treating "likes alike."

Singer, a professor of bioethics at Princeton University, is widely regarded as the first to bring the ethics of human/nonhuman animal relations to a wide audience with the publication in 1976 of his influential work, *Animal Liberation*. His book is often cited as the inspiration for the animal rights' movement (Nuffield Council on Bioethics 2005). Gary Steiner, professor of philosophy at Bucknell University, described Western philosophy, before Singer's contribution to the debate, as taking it for granted that "a being's moral status is…a function of its cognitive abilities," and assuming that animals had little or no cognition (Steiner 2013, 83). Singer's book critically assessed the way in which animals were being treated (or perhaps more accurately,

mistreated), highlighting the practices imposed on experimental animals and the conditions that animals endured before being slaughtered for food. Singer, drawing on the writings of Jeremy Bentham[6] and applying Bentham's philosophy of utilitarianism, argued that the critical issue is the suffering of animals. Singer asserted that:

> If a being suffers there can be no moral justification for refusing to take that suffering into consideration. No matter what the nature of the being, the principle of equality requires that its suffering be counted equally with the like suffering – insofar as comparisons can be made – of any other being. (Singer 1990, 8).

Suffering, then, is the "vital characteristic that gives a being the right to equal consideration" for both Bentham in the eighteenth century and Singer almost two centuries later (Singer 1990, 7). Utilitarians argue that the well-being or interest of any being, whether human or animal, must be taken into account, and that it is incumbent on society to legislate in a way that creates the greatest happiness for the greatest number. Singer maintains that the capacity for suffering and enjoyment is sufficient to justify that a being has interests – at an absolute minimum, an interest in not suffering (8). Therefore, there is no morally defensible reason to consider animal suffering as any less important than human suffering.

Singer, consistent with his demand for equal consideration for animals, has been a critic of animal experimentation. In *Animal Liberation,* he cites many examples of the abuse and suffering of laboratory animals, concluding that "all this can happen only because of our prejudice against taking seriously the suffering of a being who is not a member of our own species" (Singer 40). This he attributes to "speciesism," which, like racism or sexism, ranks one group, in this case the human species, above another -- the animal species. However, although he offers a stinging indictment of animal experimentation based on his concept of "speciesism," he does not absolutely rule it out. His stance, influenced by the Benthamite view that society must act for the greatest good for the

[6] Writing in the late 1700s, Jeremy Bentham was an English philosopher and reformer known for his advocacy of "utilitarianism" as a guiding principle for conduct and law (Stanford Encyclopedia of Philosophy).

greatest number, is that society must take into account not only the interests of animals but the interests of humans as well. Consequently, Singer could theoretically justify a scenario in which animals could be used in experiments if they were not subjected to suffering, and if the experiments were to arrive at a result that offered the greatest good to the greatest number. Gary Francione, professor of law and philosophy at Rutgers University, finds Singer's logic weak, pointing out that, Singer, in arguing that the interests of humans and non-humans should be given equal consideration, concedes that the exploitation of animals could be permitted if the consequences "properly characterized and considered, outweighed the animal's interest in not being exploited" (Francione 1995, 7).

Singer does, however, unilaterally rule out the use of animals in product testing, which he characterizes as not serving any useful ends. So, although the public may consider it justifiable to perform tests on animals for developing potentially life-saving drugs, the same kinds of tests used for evaluating chemicals are only destined, in his view, for frivolous products like cosmetics, food coloring and floor polishes. He asks, "Should thousands of animals suffer that a new kind of lipstick or floor wax can be put on the market? Don't we already have an excess of these products? Who benefits from their introduction, except the companies that hope to profit from them?" (Singer 1991, 53). Ultimately, he views experimentation on animals as discriminatory, and perhaps "a clear instance of the sacrifice of the most important interests of other beings in order to satisfy trivial interests of our own" (79).

Philosopher Tom Regan, who published his well-known book, *The Case for Animal Rights*, in 1980, ranks with Peter Singer as one of the most influential champions of animals. A Professor Emeritus at North Carolina State University, he takes a different stance than Singer's utilitarian view that relies on an appeal to consequences (Francione 1995, 9). Instead, Regan insists that both animals and humans are subjects-of-a-life, and as such have inherent value and a moral right to be

treated respectfully. His position is referred to as "the rights view." Francione describes having a right as having something "that stands as a barrier between the holder of the right and everyone else," -- something that cannot be taken away because it would benefit someone else (8). Regan reasons that:

> Some nonhuman animals resemble normal humans in morally relevant ways…Like us, they possess a variety of sensory, cognitive, conative, and volitional capacities…These and a host of other psychological states and dispositions collectively help define the mental life and relative well-being of those (in my terminology) subjects-of-a-life we know better as raccoons and rabbits, beaver and bison, chipmunks and chimpanzees, you and I." (Regan 2004, xvi)

The specific criteria for being a subject-of-a-life is the capacity for: beliefs and desires; perception, memory and a sense of one's own future; an emotional life together with feelings of pleasure and pain; preference and welfare interests; the ability to initiate action in pursuit of one's desires and goals; a psychophysical identity over time; and an individual welfare (Regan 1993, 321). Regan was asserting the rights of animals, based on their status as subjects-of-a-life, before many of the definitive studies on animal cognition had been published. Interestingly, what he considered morally relevant capacities, such as memory, a sense of the future and an emotional life, which he ascribed to animals and to which he attached so much significance, have since been confirmed in meticulously undertaken scientific studies.

With respect to animal experimentation, Regan categorically opposes the use of animals for experimental purposes of any kind. Ironically, when he first wrote *The Case for Animal Rights* in 1983, he intended to defend the use of animals in biomedical research if they suffered no unnecessary pain (Regan 2004, xii). However, in the course of developing his arguments, he was converted to an abolitionist position and is the strongest voice *against any use of animals in research*, whether it be for biological and medical education, toxicity testing, or original and applied research (italics mine). He views the knowledge acquired through animal experiments as "ill-gotten gains," that is, knowledge

that is gained at the expense of other species (Regan 1989, 40). Consistent with his position on respecting animals as "subjects-of-a-life," he believes that "a fair measure of our moral integrity will be the extent of our resolve to work against allowing our scientific, economic, health and other interests to serve as a reason for the wrongful exploitation of members of species other than our own" (40).

Like Singer, he is particularly critical of toxicological testing, in which substances intended for commercial use are first tested on animals. He finds that "these harmful tests violate the basic moral right of these animals not to be harmed" (Regan 2004, 375). Although the purpose of toxicity testing is to evaluate the threats to humans, Regan's rights view categorically refuses to countenance harming animals in order to reduce potential risks to humans. He insists that there is no moral justification for developing new products whose pre-market testing makes animals worse off than consumers. Although he does not oppose outright the introduction of new products, he believes their safety must be determined by the use of alternative non-animal toxicity tests. This call for the replacement of animal tests with non-animal alternatives by Regan, Singer and other philosophers has been a consistent plea to scientists and governments over the last four decades.

Bernard Rollin, another philosopher and author of *The Unheeded Cry: Animal Consciousness, Animal Pain and Scientific Change*, is also well-known for his promotion of animal interests. He argues that animals should be included in our "moral arena," on the basis that there are no morally relevant differences between humans and animals: "Just as skin colour or gender cannot morally justify discrimination against humans, certain beliefs about animals— for example, that they lack a soul, are 'inferior' to humans in power or evolution, and lack reason or language— cannot morally justify their exclusion" (Rollin 2007, 523). He also argues for including animals in the "moral arena" on the basis that what we do to animals matters to them. Like Darwin, he finds there is overwhelming evidence that animals feel not only pain, but "the full range of emotions that

feature in our moral deliberations about humans: fear, loneliness, boredom, frustration, anxiety" (523). Concerned about animal welfare, he criticizes laboratory scientists for being concerned primarily with the control of acute pain (Rollin 2012, S6). Rather than focusing only on pain, he argues that animal ethics must recognize the "full range of possible 'matterings' unique to different sorts of animals" (S6).

Following Aristotle, he argues that animals' *telos*, that is, their species-specific behaviours, must be expressed if the animal is to be respected – that is, "the 'pigness' of the pig, the 'dogness' of the dog"(S6). This telos, or ability of a species to meet its needs, is what allows an animal to flourish, and, like sentience and higher cognitive capacities, is a morally relevant consideration with respect to laboratory animals (Nuffield Council on Bioethics 2005, 44). Rollin too raises the important question of whether there is any moral justification for using animals in research, and contends that invasive experiments on animals that cause them pain must be considered unethical. He includes toxicology testing in the class of painful unethical experiments that do not provide any significant benefits, and characterizes toxicity testing as "experiments that only provide some legal protection for corporations from lawsuits regarding product liability" (Rollin 2012, S5). He concludes that restricting invasive animal use will evolve slowly over time, but *depends on the creation of non-animal alternatives* (italics mine).

Rollin was involved in drafting the 1985 U.S. *Animal Welfare Act* with the expectation that the revised Act would improve the welfare of laboratory animals. As a result of this experience, he came to understand the scientific community's attitude toward the ethical issues arising from the use of animals in biomedical research (Rollin 2012, S4). He describes the ideology of most scientists as "a set of basic uncriticized assumptions about twentieth century science," stemming from the belief that science must be based on objective experience (Rollin 2007, 522). Rollin has been critical of this scientific reductionism, particularly the movement known as logical positivism, which seeks to

"exclude the unverifiable from science" (522). As a result of this belief in positivism, scientists largely steer away from ethical debates, even though science might be providing the knowledge relevant to making moral decisions (522).

Although Singer, Regan and Rollin share similarities in their advocacy for more ethical treatment of animals, Gary Francione embraces a radically different approach, taking issue with what he calls "legal welfarism." Legal welfarism is, according to Francione "the prevailing legal theory implicit in the law," which prohibits the infliction of unnecessary pain on animals and requires they be treated "humanely." Although animal protection laws purport to mitigate animals' pain and suffering, they are always interpreted in light of the legal status of animals as property; and, being property, animals are not accorded a level of protection that can transcend "the most economically efficient exploitation of the animal" (Francione 1995, 6). This theory of legal welfarism, therefore, in his view, deems it morally acceptable to kill animals or subject them to suffering as long as the animal is treated "humanely" (6). Francione is particularly critical of Singer, describing him as an animal welfarist who does not accept that animals are forward looking and might have a continuity of consciousness over time (Francione and Charlton 2015, 35). He characterizes Singer's position, inherited from Bentham's utilitarianism, as being that: as long as animals were suffering, humans had a moral obligation to give weight to the animals' interests in not suffering; however, if animals are living in an eternal present in which they are well looked after, harming or killing them could be acceptable if they did not suffer (35). Francione believes this philosophy encourages people on the street to think that animals matter morally, but not as much as humans do.

It is 'legal welfarism' – the principle that animals should not suffer unnecessarily and should be treated as humanely as possible -- that is the basis of our animal laws, according to Francione. He points out that there is almost no one who would disagree that animals should be treated humanely. However, legal welfarism is "characterized by the notion that the law can best assure the

"welfare" of animals by allowing the property owner to determine what will maximize the value of the property to the property owner" (5). This, for Francione, is the flaw that invalidates the efficacy of any law in protecting animals from harm. As long as animals have the status of property and humans are in possession of rights over animals, there can be no protection and no justice guaranteed to animals. Francione's prescription for correcting this and ensuring animals are treated as equals, is to confer on all sentient beings, human and non-human, one right – the right not to be treated as the property of others (Francione and Charlton 2015, 11).

Another advocate for the ethical treatment of animals is the French philosopher, Jacques Derrida. Matthew Calarco, in his book *Thinking Through Animals,* characterizes Derrida as a "difference" theorist, describing Derrida and others as those who "seek to develop and promote a pro-animal ethic and philosophy based not on similarity, continuity or identity, but instead on the manifold differences that exist between and among human beings and animals" (28). A difference theorist would, therefore, *not* focus on the similarities between humans and animals as their primary argument, but instead would appreciate the differences between humans and animals, while emphasizing the ethical responsibilities of humans to their fellow animals (Calarco 2015; italics mine). Difference theorists acknowledge the uniqueness and singularity of others, and enter into, and develop, ethical relationships with "the other" on this basis.

Derrida is known for his encounter with his cat and the philosophical ruminations that arose from this encounter. In his essay, "The Animal that Therefore I Am," Derrida maintains that animals not only "react" to humans, but also "respond," a mental capacity that cannot be the unique preserve of humans (Derrida 2008). Derrida recognizes his cat as a particular "other" that calls forth a morally relevant response in Derrida, and forces him to acknowledge the cat's unique being. Animals are, therefore, unique "others" deserving of ethical consideration:

> …it can look at me. It has its point of view regarding me. The point of view of the absolute other, and nothing will have ever done more to make me think through this absolute alterity of the neighbor than these moments when I see myself seen naked under the gaze of a cat. (380)

Recognizing his cat as an "other" is, for Derrida, an act of affirmation and transformation, which, although it arises from an ethics of difference, can lead to a genuinely ethical relationship. It is Derrida's call for us to rethink our way of living and to move our lives "in the direction of justice for other animals" (Calarco 2015, 40). However, Derrida's vision of justice does not mean extending rights to animals, as it does for Singer and Regan. He argues that granting rights to a certain category of animals is untenable, and "would reproduce the philosophical and juridicial machine thanks to which the exploitation of animal material for food, work, experimentation, etc. has been practiced" (Derrida 2004, 65). He believes a transformation is "necessary and inevitable" in relations between humans and animals (65), but, unlike Rollin and other theorists, he does not believe that the way forward is through legal avenues. He cannot support the "miracle of legislation," pointing out that current laws do nothing to prevent the "techno-scientific" pathologies of the market or of industrial production (65).

Despite his skepticism about enshrining animal rights in law, Derrida is very critical of the use of animals for experimentation, seeing it as part of the great violence that has forever been practiced against animals (64). He considers Bentham's question as to whether they suffer to be "the *first* and *decisive* question" (Derrida 2008, 396), and he decries the cruelty, which animals have endured in the last two centuries through industrial agriculture and experimentation. In his essay on "'The Animal' after Derrida: Interrogating the Bioethics of Geno-Cide," Norman Swazo of Alfaisal University seeks to clarify Derrida's position on the question of bioethics,[7] that is: that humans must dispossess themselves of expropriating a sovereign right to use animals. To be a responsible

[7] In his essay on Derrida's question of "The Animal" and its implications for bioethics, Swazo points out that Derrida's work has not received any reception in the field of biomedical ethics.

scientist, then, is to be guided not by "the obligation of non-maleficence as the first of principles in biomedical ethics, but rather, in a world of heightened scientific-technological pathologies…the architectonic rule is *to endure the undecidable*" (Derrida cited in Swazo 2013, 118, emphasis in the original). This would mean a reassessment of the way in which animals are used in scientific experiments, and it would mean imposing limits on human claims to knowledge and human exploitation of animals. Derrida is adamant that, with respect to the violence done to animals, whether carried out "for the production of food or in the form of experimentation, it is necessary to set up rules so that one cannot do just whatever one pleases with nonhuman living beings" (Derrida 2004, 73). Where the present system allows cruelty to experimental animals within the regulatory structure, for Derrida some experiments should be allocated to the "undecidable," and ruled out as impermissible.

Another important figure in the discussion of animal ethics is biologist, feminist and contemporary culture critic, Donna Haraway, who has influenced attitudes towards scientific procedures and experimentation with her writings on laboratory life (Davies et al. 2018). In contrast to those who criticize animal experimentation, Haraway, in her book, *When Species Meet,* proposes a different way of thinking about ethical relations among humans and animals in bioscience research laboratories. She introduces the idea of human and animal "entangled subjectivities," (Davies et al. 2018, 604), accepting the inevitability of pain that accompanies scientific research but within a context of caring and responsibility (Haraway 2008, 83). She characterizes animal experimentation as the responsible sharing of suffering between laboratory animals and "their people," the scientists and technicians that attend to them (Haraway 2008, 70). Based on this idea of entangled subjectivities, Haraway builds on Belgian science philosopher Vinciane Despret's theory of emotions and the affected and affecting bodies (Despret 2004). Despret illustrates her theory with the empirical example of the student experimenter and the laboratory rat becoming linked through their

mutual engagement in the process of experimentation (123). Emotional relations of expectations, faith, belief and trust, tie each rat to their student experimenter, and constitute a process of domestication, "practices that create and transform through the miracle of *attunement*" (italics in original, 125).

Haraway accepts experimentation on animals if it reduces animal or human suffering, and, in a different twist on the issue, if the scientist is prepared to share the experience of the animal. She writes that the "animal caretaker is engaged not in the heroics of self-experimentation…but in the practical and moral obligation to mitigate suffering among mortals – and not just human mortals – and where possible to share the conditions of work, including the suffering of the most vulnerable of lab actors" (Haraway 2008, 70). She argues that using a model organism is necessary in research, but the necessity, or the justifications, "do not obviate the obligations of care and sharing pain response and responsibility" (70), between humans and animals. She puts the emphasis on shared relations and an ongoing "intra-action" between the experimenter and the experimentee, even though she acknowledges that these relationships are necessarily unequal (71). She asks: what if experimental animals are regarded as "significantly unfree partners and not mechanical substitutes" (72), observing that animals work in labs, but not under conditions of their own making or design. It is a question of "non-symmetrical suffering and death," and she is looking for ways that "the multispecies labor practices of the lab be less deadly, less painful and freer for all the workers" (77).

With respect to the sacrifice and killing of animals, Haraway writes that she considers it a misstep to separate the world's beings into those that can be killed and those that cannot, and a "misstep to pretend to live outside killing" (79). Her way through the dilemma of to kill or not to kill is to live responsibly "within the multiplicitous necessity of labor and killing," (80): for humans to "learn to kill responsibly" and become better at dying, forgoing cures that might come at too high a cost for animals (81). In other words, in her view, humans cannot justify the indiscriminate killing

of animals, but, as long as humans respond, or are responsive, to animals, there may be instances in which animals will be killed, presumably where research benefits human and/or animal lives. In her emphasis on "response" and "responsibility," Haraway is echoing Jacques Derrida's essay on "The Animal that Therefore I Am," asserting that responsibility develops from the capacity for recognizing that animals respond, not react (71). Response is a recognition of the other's presence or face, in the sense of being face to face with another being. Responsibility, then, is a capacity that is necessarily multidirectional, expressed in animal to human and human to animal intra-action.

Tara Holmberg, from Sweden's Uppsala University, gives us a more intimate insight into the moral dilemmas of animal research from a feminist ethics of care perspective. The feminist ethics of care posits that women's sense of morality is concerned with the activity of care and responsibility, and that these principles should apply to the relationship with animals (Donovan and Adams 2007, 2). Holmberg attempts to reconcile the dialectics of care with the exploitation of animals within the apparatus of laboratory experimentation (Holmberg 2011, 148). Aligned with Haraway's thinking, this theory emphasizes the importance of attention, and considers the situational and contextual ethics that allow for flexibility. Holmberg asks how laboratory workers, in talk and practice, reconcile the handling and killing of animals with their own emotional and moral concerns. In the context of Haraway's response-able laboratory practices, she finds laboratory workers are engaged with the animals in both an emotional dimension: empathy and attention, and a corporeal one: handling lifting, feeding (Holmberg 2011). Laboratory workers speak of love and friendship -- important terms in feminist care theory -- in describing their relationship with the animals they care for. Even the act of killing these animals becomes a responsible act when the laboratory worker performs it well.

Holmberg grants Haraway's analogy that mice and other laboratory animals can be viewed as laboratory workers, together with humans, but she also reinforces the idea that power relations exist,

and that the experiments done with animals are in fact forced on them (151). Although Haraway's response-able practices include the shared suffering of animal and laboratory worker, Holmberg, like Haraway, finds "experimental practice involves a certain amount of wickedness," where wickedness is a symbolic term for the harm done to laboratory animals (Holmberg 2011,158). Holmberg argues that, in the laboratory, a loveable animal "can be made killable, whereas the object that is not cared about is killed without any social preparation" (159). "Mortal love" is how Holmberg ultimately describes the dialectic of the instrumentalization and exploitation of animals. She sees love and friendship as intrinsic dimensions of the experimental human-animal relations, and "mortal love" as consistent with the feminist theory of love, dependency and care. Feminist animal care theory, then, differs significantly from the precepts of animal rights theory and utilitarianism, which are criticized for universalizing experience and ignoring the specific circumstances of an ethical event. In contrast, care theory would consider the context and potential situational responses that take place in the laboratory (Donovan and Adams 2007, 2).

The Ethics of the Laboratory

The preceding summary of philosophical perspectives on the ethics of the use of animals for experimentation ranges from Tom Regan's absolute denial of any justification that would allow the use of animals in research, referred to as the "abolitionist" perspective, to the more nuanced concessions of Singer and Rollin, who accept some situations in which animals could be used for biomedical research. Perhaps the most accommodating of all perspectives, however, is that of Haraway, who proposes shared suffering and response-ability between all laboratory actors, including animals, their handlers and the researchers. Haraway's arguments have attracted a following among laboratory workers who seek to improve the welfare of animals that live and die in laboratories, and those scientists who wish to respect the lives of animals while still interacting with them in laboratory settings (Davies et al. 2018).

The tension between advocating for animal rights and the performance of laboratory science has been described by Gail Davies from the University of Exeter and her colleagues, as "a contested area of technoscience" (Davies et al. 2018, 603). Concern for animal welfare, brought to the fore by those philosophers who have argued for expanding the moral arena to include animals, has been a driver of activism for at least a half century, activism which has challenged the activities of the research world, sometimes with violence. Within the world of the laboratory, though, the most significant articulation of ethical concerns came from two British scientists, William Russell and Rex Burch. Their book, *The Principles of Humane Experimental Technique* was written in 1959. A ground-breaking book for its time, Russell and Burch argued for the need to address the inhumane treatment of animals, noting that the number of animals used in research was steadily increasing year after year and that "biology is by now an industry" (Russell and Burch as cited by Bekoff and Pierce 2017, 63).

The book set down three enduring principles that are still widely accepted and that underpin many of the laws and policies that have been developed since its publication. These principles are known as the 3Rs: reduction, replacement and refinement. Reduction encourages researchers to look at the number of animals used in experimentation and the pain and fear that will accompany such experiments, and to reduce both if possible. Replacement is meant to promote the substitution of sentient animals with non-sentient forms of life such as cell cultures, or to replace "higher" animals with "lower" animals. It can also mean replacing animals altogether with non-animal alternatives such as computer models (Bekoff and Pierce 2017, 63). Refinement refers to the practice of altering research designs to incur less suffering and distress to the animals used in experimentation. These principles have in the past, and still today, influence the treatment of animals in the laboratory and the regulation of these activities. They would, if strictly adhered to, make methods of animal research more humane.

In addition to the implementation of the 3Rs principles, Davies et al. identify local cultures of care as the most recent notable change in the culture of laboratory animal research (Davies et al. 2018, 612). The expectation is that a culture of care within the laboratory would go beyond just the culture of compliance, or what existing laws and policies currently require. Davies and her colleagues, in their examination of the history and future of the 3Rs principles, have written that Haraway's ideas presented in *When Species Meet* have "shaped a new set of narratives about animal research, which not only stress the processes of instrumentalizing or calculating within animal research but also show how 'people and animals in labs are both subjects and objects to each other in ongoing intra-action'" (Davies et al 2018, 605). However, despite the widespread acceptance of the 3Rs principles by laboratory scientists, even enriched by the culture of care, there has been growing concern that these principles are not sufficient to address the ethical questions that have arisen since they were first presented in the 1950s. With respect to the idea of reduction, for example, the number of animals used in research has continued to climb, thereby raising serious ethical and scientific questions about the effectiveness and observance of these principles (Ferdowsian and Beck 2011).

Furthermore, Hope Ferdowsian and Nancy Beck from the U.S. based Physicians Committee for Responsible Medicine, in a review of the ethical and scientific considerations of animal testing and research, stress that, although the 3Rs are crucially important concepts, they "do not adequately reflect the substantial developments in our new knowledge about the cognitive and emotional capabilities of animals, the individual interests of animals, or an updated understanding of potential harms associated with animal research" (Ferdowsian and Beck 2011, e24059) They point out that the majority of experiments involving animal research proceed on the assumption that they are based on "broad, perceived benefits to human research," and as such are broadly permissive (2).

Francione has also underscored the fact that the "primary source of regulation of laboratory animals is by those who use and own the animals" (Francione 1995, 5).

The 3Rs principle of replacement also raises the question of "alternatives" as an ethical issue of importance in and of itself. In their report, "The ethics of research involving animals," The Nuffield Council on Bioethics, as well as discussing the issue of the benefits associated with animal research, asks whether the unavailability of alternatives plays a role in the justification of research involving animals (Nuffield Council on Bioethics 2005, 33). Conversely, if non-animal alternatives are available, how can the use of animals be ethically justified? This possibility of alternatives being available has been advanced as a new first principle of laboratory ethics, proposed by Beauchamp and DeGrazia (Beauchamp and DeGrazia 2020). Arguing that the 3Rs principles need to be updated, they have developed six new principles, which they recommend be accepted as the necessary conditions of morally justified research. Their objective is the reconciliation of animal concerns with scientific ones. Their first principle is "the principle of no alternative method" (7). According to the principle of no alternative method, the use of animal subjects can only be justified if the knowledge and social benefits of the research are not ethically attainable through alternative research methods that do not use live animals" (7). Or, more simply put, animals should not be harmed if suitable alternative models are available to achieve the goals of the research (7).

Conclusion

Technically we, human and non-humans, are all collectively bound up in being "animal." The implication of accepting that reality is that we must let go of our notions of human superiority and accept the responsibility for extending the moral community to non-human animals. This is particularly urgent as we come to understand better the shared cognitive capacities of human and non-human animals. Singer, Regan, Rollin, and other contemporary philosophers have long refuted the assumption that the moral status of animals is inferior to the moral status of human beings, and,

through their writings, have argued that animals are equals and must be treated as such in the larger moral community. Their arguments have contributed to a growing discomfort among the public with the practices of animal experimentation, so much so that invasive animal research is now seen "as a significant moral issue" (Rollin 2007, 525). The writings of these theorists have been an inspiration to the community of animal activists and advocates who have organized around issues of animal welfare, and who are, in some cases, having success in changing the laws that affect animals.

However, although their ideas have resonated with the public, these philosophical arguments in defence of animals have been a challenge, sometimes a threat, to the autonomy of the scientific community and the work that goes on inside the laboratories. Scientists and laboratory workers are guided by their own ethical principles, designed to spare animals undue suffering and pain. In this contested area of technoscience, the lives and well-being of animals is at stake, caught between those who want to rescue them from their life and death in laboratories and those who would treat them with care but still, under certain circumstances, harm them and ultimately take their lives. In this discussion, it is critical to acknowledge the growing body of research on animal cognition that has shown us that the cost to animals has been underestimated and the potential for animals to experience harm is much greater than previously understood (Ferdowsian and Hope 2011). This dawning awareness compels us to reconsider the ethical relationship between humans and animals, and to pursue solutions that would obviate the need for using animals in our service. In the next chapter, I examine the animal protection laws currently in place and their inadequacy in meeting either the ethical standards called for by philosophers or the principles set out by scientists themselves for the laboratory.

Chapter Four: The Limitations of Animal Protection Laws

…animals are always the observed. The fact that they can observe us has lost all significance. They are the objects of our ever-extending knowledge. What we know about them is an index of our power, and thus an index of what separates us from them. The more we know, the further away they are.

John Cage, Why Look at Animals

The science of animal sentience underpins the entire animal welfare movement. Demonstrating objectively what animals are capable of is key to achieving a positive change in attitudes and actions towards animals, and a real, sustainable difference for animal welfare.

Helen Proctor, Animal Sentience

Introduction

In this chapter, I examine the laws related to animal protection, and ask how these laws reflect or reject the deep, often surprising, knowledge revealed by studies of animal cognition, and the ethical obligations arising from this knowledge. Are today's animal protection laws influenced by the philosophical promotion of the rights of animals or by proposals to expand the moral arena beyond humans to include animals? This chapter explores the role of governments and their responsibility in the realm of animal protection in general, and asks whether animal protection laws benefit those animals used in toxicity testing. The first challenge, presented in section two, is to gauge the extent of the problem by calculating how many animals are used in research each year. Although it is difficult to obtain accurate data, the available data suggest that the use of animals in research is on the upswing world-wide despite the near-universal adoption of the 3Rs (reduction, replacement and refinement) principles. In the third section, I explore how the public perceives animal research in order to draw attention to the fact that public attitudes show a greater respect for animal cognition and a desire to see animal use replaced by alternatives, views that are not embodied in the existing legislation. Drawing on a survey of public opinion surveys, I also look at the ways in which the concerns expressed by the public could be taken into account in recalibrating our relationship with animals. The principle focus of this chapter is, however, section four, in which I

give an overview of the current legislative and policy regimes in Canada, the United States and Europe, look at the economic and political reasons why they offer limited protection to laboratory animals, and examine the claims of animal advocates with respect to animal protection laws. Finally, in section five, I offer some conclusions.

Statistics on the Use of Animals in Scientific Research

From the earliest forays into vivisection, the breeding and manipulation of laboratory animals has become a well-established industry involving millions of animals living and dying each year. To understand the dimensions of the use of animals in research and its entrenched place in our society, it is critical to know the number and kinds of animals performing laboratory work for scientists. Institutions such as universities, hospitals, federal and provincial government departments, pharmaceutical, biotechnological and various other commercial operations, such as testing labs, all use animals for teaching, testing and research (Bisgould 2011, 202).

Unfortunately, accurate statistical information on the number of animals used in these institutions is difficult to acquire due to the limitations of the information collected under different national laws or policies. Despite the difficulties, however, the statistical information that countries do report provides a glimpse into the scope of the industry and the number of animals used to service it. This number, extrapolated from the statistics that do exist, was most recently estimated at *192.1 million animals* in 2015, or almost 200 million world-wide (Taylor and Alvarez 2020, 196, italics mine). Based on a prediction model developed by Katy Taylor and Lauren Rego Alvarez of Cruelty Free International, this number is considered to be one of the few reliable estimates available.

Taylor, who participated in the preparation of an earlier report based on 2005 data, concluded that their updated study suggests "that there has been a significant increase in the worldwide use of laboratory animals over a period of 10 years" (Taylor and Alvarez 2020, 210).

Their figures include animals killed for their tissues, normal and genetically modified animals without a harmful genetic mutation, and animals bred for laboratory use but not used. The large number of animals used in research globally seems to indicate that, despite the aspirational goals of the 3Rs, this ethical dictum to reduce the numbers used is not having a significant impact in most countries. Taylor and Alvarez conclude that "the fact that the overall figure is approaching 200 million animals per year should be a cause for concern, particularly with respect to the impact of the development of alternative methods" (210).

Canada is one of the countries that does report animal use, although this reporting cannot be relied on as comprehensive. Statistics are collected by the Canadian Council on Animal Care (CCAC), a national organization responsible for ensuring a degree of care and ethical treatment for animals.[8] The CCAC's 2020 data indicate that more than 5 million animals (5,067,778) were used in research, teaching and testing by Canadian institutions co-operating with the CCAC (CCAC Animal Data Report 2020, 2021). This represents a significant increase over the year 2019, during which just over 4.5 million animals were used (4,562,522) and 2018 when 3.8 million animals were used (3,832,817). However, these totals are most likely an under-representation of the total number of animals used in Canadian-sponsored research, as only those institutions that participate in the CCAC's programs are required to report their data (CCAC Animal Data Report 2019, 2020, 2).[9]

The CCAC also calculates the invasiveness of procedures used on animals, evaluating the level of pain or distress to which animals could potentially be exposed. The most invasive category is defined as those protocols that cause severe pain "near, at, or above the pain tolerance threshold of unanaesthetized conscious animals" (CCAC Animal Data Report 2019, 2020, 6). According to the CCAC's most recent figures, of the 1.8 per cent of animals that suffered from the most invasive

[8] The CCAC is considered to be quasi-governmental because it does not answer directly to any government Minister, and it is financed primarily by two Canadian government institutions, the Canadian Institutes of Health Research and the Natural Sciences and Engineering Research Council of Canada.

[9] Of the many species selected for research, mice are the most common, representing about 30 per cent of the total.

protocols, approximately one-third (29.3 per cent) were used for testing purposes. In this category mice are the species most affected. Similarly, in 2018, it was reported that animals, exposed to the most invasive and painful procedures, were those used to satisfy tests required by the federal government to ensure "new drugs, vaccines and products are safe and efficacious for use in humans and animals" (CCAC Animal Data Report 2018, 2019, 6).[10] These findings reinforce the assumption that toxicity testing is responsible for the most agonizing laboratory procedures, to which animals are subjected.

The use of animals in research is considerably higher in the United States (U.S.). However, due to exceptions in the legislation, the U.S. Department of Agriculture reported that less than a million animals were used in research in the U.S. in 2019 – only 797,546 to be exact (U.S. Department of Agriculture Annual Report Animal Usage by Fiscal Year, 2020), equivalent to less than a fifth of the animals used in Canada, despite the fact that there are many more institutions and research centres in the U.S. that rely on animals. According to Speaking of Research, an international advocacy group that tracks the number of animals used in research, the U.S. Department of Agriculture statistics represent an estimated increase of 2.2 per cent from 2018 (Speaking of Research, Animal Research U.S. Statistics, n.d.) -- an increase, which again supports the conclusion that there is a steadily increasing use of animals, despite institutional commitments to the reduction of animal use under the principles of the 3Rs.

The low numbers reported in the U.S. can be explained by the gaping loopholes in their primary legislation governing animal welfare. This legislation, the U.S. *Animal Welfare Act* (AWA) does not include birds, rats of the genus *Rattus*, and mice of the genus *Mus*, bred for use in research (U.S. Department of Agriculture APHIS, n.d.). This effectively excludes the bulk of the animals

[10] The 3 per cent of animals that fell into this unfortunate category of the highest level of invasiveness were fish, mice and guinea pigs (CCAC Animal Data Report 2018, 2019, 2).

used in research. Marc Bekoff has frequently written about the failure of U.S. legislation to allow mice and rats even the most "measly protections afforded to the sentient creatures," those protections awarded to other mammals, who, unlike birds, rats and mice, made the list of "animals" under the Act (Bekoff 2017, 67). A more realistic, but conservative, estimate of the actual number of animals used in U.S. research in a single year has been pegged at between 14 and 15 million, or almost 20 times the number officially reported (Taylor and Alvarez 2019). Based on these estimates, the United States as a country ranks with China and Japan as one of the world's heaviest users of animals for experimentation (Taylor and Alvarez 2020).

The European Union, where concern for animal welfare is a highly visible public issue, indicated in their 2019 report from the European Commission to the Parliament and Council that the total number of animals used for research and testing in the years 2015, 2016 and 2017, was just under 10 million for each year while in 2018 it was just over 10 million at 10,894,854 (Report from the Commission to the European Parliament and Council 2021). In 2019 it was reported that just over 2 million of these animals were allocated for regulatory purposes (13). Although animal use is not increasing dramatically in Europe, the 2019 report expressed concern that animals are still being used in areas "where alternative methods have reached regulatory acceptance (for example in areas of skin irritation/corrosion, serious eye damage/eye irritation and pyrogenicity testing)," and advises that using animal tests where alternatives are available requires further attention from authorities approving projects (20).

Overall, statistics from individual countries reinforce the findings of Taylor and Alvarez that the worldwide use of animals in research is increasing in most jurisdictions, unaffected by ethical concerns as articulated by the 3Rs principles, or by scientific revelations about animal intelligence and abilities to experience pain. The European Union has estimated that 23 per cent of the European total is used for testing chemicals and products on animals to satisfy regulatory

requirements (European Commission 2019, 8).[11] Extrapolating from this percentage to a global scale, of the almost 200 million research animals used in the world annually, close to 46 million animals might conceivably be used in toxicity testing around the world. These figures suggest, then, that the adoption of non-animal alternatives for toxicity testing might spare the lives of significant numbers of animals – primarily mice, rats, rabbits, guinea pigs, and birds.

The Power of Public Opinion

The last 20 years of public opinion polling can best be understood as a barometer of change, reflecting an increasing public concern about animal welfare and the situation of laboratory animals, and a call to scientists to reconsider the heavy reliance on animal models. In the past, those who supported the use of animals in research were relatively successful in persuading the public that animal experimentation was justified for medical and public health purposes (Festing and Wilkinson 2007, 526), and most public opinion polls reflected these sentiments, showing a general acceptance of the use of animals in medical research on two conditions: *if* the research was for serious medical reasons and *where there were no alternatives* (Ipsos 2016, my italics). However, that foundation of public support for the use of animals in research has slowly eroded over the last two decades.

This becomes apparent in the tracking survey conducted by Ipsos MORI for Britain's Department for Business Innovation and Skills, for example, which has followed the attitudes of the British public to animal research over the last several years. The tracker survey, initiated in 2014 and repeated twice since then, found in its latest 2018 interviews that the public acceptability of the use of animals in research is conditional on the purpose and context of the research, as well as conditional on the type of animal used (Ipsos MORI 2019). This survey also found an increasing concern for animal welfare, citing evidence that there has been a shift towards greater questioning of

animal research and a desire to know more about alternatives (6). The report states that: "Perhaps most notably, the proportion of the public who agree that the use of animals for medical research is important to human health has fallen significantly, from close to half in 2016 (46%) to four in ten this year (41%) (7). This finding challenges the conventionally accepted view that people will unquestioningly accept the use of animals as research tools if the information that it yields will improve medical treatments and knowledge about human disease. As well, the percentage of people interviewed who say that animals should not be used in research at all has risen from 31 per cent in 2014 to 38 per cent in 2018.

Surveys of public opinion in the United States and Canada show similar trends. In the U.S., the Pew Research Center has been monitoring attitudes towards animal research over the last decade and has found American opinion just about evenly divided in its most recent surveys. In 2009, more than half of Americans -- 52 per cent -- favoured the use of animals in research, while 43 per cent opposed it (Pew Research Center 2015). However, in 2018, positions had tilted the other way with 47 per cent favouring animal research while 50 per cent said they were opposed (Pew Research Center 2015).

In a 2013 poll of Canadians conducted by Nanos on behalf of the Canadian Council on Animal Care, the public was likewise divided (National Nanos Survey for the Canadian Council on Animal Care 2013). The poll found that 54 per cent of those interviewed felt that the welfare of an animal was important in determining what constituted the acceptable or unacceptable use of animals, while 30 per cent believed that the benefits of advancing science and medicine outweighed the welfare of the animal. According to Nanos, more than half of Canadians agreed that "the potential suffering of animals is at least somewhat acceptable," with men being more likely to accept animal suffering. However, a *significant* minority (about 18 per cent) did not accept potential animal suffering, regardless of the type of research for which the animals were being used (italics mine).

Elisabeth Ormandy and Catherine Schuppli of the Animal Welfare Program at the University of British Columbia have dug more deeply into the subtleties of polling results on animals in research and the values that underlie the responses of people that offer their views (Ormandy and Schuppli 2014, 391). The two researchers reviewed the literature on public attitudes towards animal use, and undertook a detailed analysis of the polling. They point out that in most public polling of opinions on animal research, attitudes are often simplified into categories of those who oppose animal experimentation and those who support it. It makes little distinction between different types of animal use and assumes people's attitudes are uni-dimensional (392). However, more detailed attention to the influential factors in this polling shows that many more issues are at play in determining how the public views the use of animals in research. Variations in attitudes arise from some obvious factors and some more subtle ones, including: personal and cultural characteristics such as age, sex, religion, personality, and belief in animal minds; animal characteristics, such as species, sentience and appeal, and genetic modification; as well as research characteristics, such as the type of research, the availability of alternatives and the level of harm.

With respect to animal factors, for example, polls find people have more sympathy for primates and pets, believed to have 'higher' mental abilities, and less concern about species such as rats and mice. They find that "the same person may support the use of mice and rats for dissection purposes, but not support the use of chimpanzees, cats or dogs for the same purpose" (397). This is a telling detail: that the public often perceive animals, such as chimpanzees, which seem closer to humans, or companion animals such as dogs and cats, as more intelligent and therefore more worthy of concern than fish, rats and mice, a view that surfaces in animal welfare legislation and in 3Rs principles. This attitude also surfaced in an earlier study by Schuppli, for example, in which members of an animal care committee expressed less comfort with research using non-human primates and companion animals (Schuppli 2009). However, in another study on the use of animals

to create models of skin cancer, respondents showed equal concern for test animals no matter where they were situated on the phylogenetic scale. Ormandy and Schuppli (2014) speculate that attitudes toward the use of different species in research may also change as we learn more about animal behaviour and welfare. For example, recent research suggests that fish (that are often considered an acceptable replacement for mammals in research) have the capacity to feel pain[12] (397). As the public recognition of cognitive capacities, such as this, increases, polling might, therefore, find more reluctance to the use of animals in research, or at least to subjecting them to pain.

Ormandy and Schuppli also observe that public attitudes vary depending on: the purpose of the research being undertaken, with, for example, more tolerance for the use of animals in medical research than for cosmetic testing; the level of harm that will be imposed on the animal; and, the availability of non-animal alternatives (398). Participants in several surveys were more opposed to the use of animals in research if they believed that non-animal alternatives were available (398). They were also more likely to object to animal experimentation if they believed the experiments were invasive, and involved a significant level of harm experienced by the animals.

The intention of Ormandy and Schuppli in analyzing the limitations of the public opinion polls, which are relied on as a measure of attitudes towards the use of animals in research, was to improve the assessments being made in order to facilitate more openness and further the democratization of scientific research. They believe that more reliable and in-depth polling would help ensure that scientific practice, including animal research, "remains in step with societal values," a particularly important consideration since the public is generally assumed to be the beneficiary of the products that are developed and tested using animals (402). It is possible to conclude, therefore, as the authors imply, that, where accurate and sensitive polling is done, scientific practice

[12] Although it was assumed that fish did not feel pain, recent studies by Sneddon et al. show aquatic invertebrates may be capable of experiencing pain and that this evidence should be considered when making decisions about animal welfare and their treatment (Sneddon, L. 2015. "Pain in aquatic animals." *The Journal of Experimental Biology* 218: 967-76).

should take into account the public's reservations about the unrestrained use of animals in research and pursue the public interest in adopting alternatives to animal use.

Where Do the Laws Stand in Relation to Our Knowledge of Animal Cognition and Animal Sentience?

In this section, I look at the legislative and policy structures that determine the treatment of animals, specifically laboratory animals, in Canada, the United States (U.S.) and the European Union, countries where concern for animals registers high in the public mind, with the intention of illustrating where these regimes leave laboratory animals vulnerable to pain and suffering. Although animal legislation and policy regimes aspire to offer some protection to research animals, their principle contribution is to promote more humane[13] treatment of animals by providing better housing and care, and some limited accountability for their handling in laboratory settings (Latham 2013, S35). Ultimately, though, these regimes fail to incorporate the ethical concerns that arise with the growing understanding of animal cognition, a deficit, which Marc Bekoff and Jessica Pierce see as a failure of knowledge translation. As they have pointed out in their book, *The Animals' Agenda*, there is "a huge body of scientific literature available to guide our interpretive work with animals, but this knowledge is simply not being put to use in the service of animals" (Bekoff and Pierce 2017, 13). Similarly, philosopher Robert C. Jones of California State University argues that current animal welfare policies "lag behind, are ignorant of, or arbitrarily disregard the science on sentience and cognition," a science that has revealed morally relevant capacities of animals (Jones 2013, 1).

Those morally relevant capacities, to which Jones alludes, are those capacities that we recognize in others and affect the way in which we treat them. Sentience, which often explicitly refers to the

[13]According to the glossary of The Hastings Center, "humane" is defined by the U.S. *Animal Welfare Act* as "minimum requirements with respect to handling, housing, feeding, watering, sanitation, ventilation, shelter from extremes of weather and temperatures, adequate veterinary care, including the appropriate use of anesthetic, analgesic or tranquilizing drugs…and separation by species." They note that this definition excludes other efforts to meet species-specific needs, such as companionship.

ability to feel pleasure or pain, is one of the most important and frequently cited morally relevant capacities. Since it is now accepted that many animals feel pain, and are, therefore, sentient, knowingly inflicting pain on animals becomes morally problematic (Nuffield Council on Bioethics 2005, 42). Other higher cognitive capacities, such as those discussed in the first chapter -- emotions, memory and future planning, for example -- are also considered morally relevant and deserving of a higher standard of ethical consideration. Likewise, the capacity to flourish, sociability and the possession of a life qualify both humans and animals as moral subjects, and would be expected to constrain or limit how they might be treated (Nuffield Council on Bioethics, 2005, xxii). Such morally relevant capacities constitute the basis for rejecting the use of humans in experimental research on the grounds that these experiments might cause them pain, fear, or possibly even the loss of liberty and life. Yet, although many non-human animals have the same morally relevant capacities, they have not been exempted from painful experiments. Nor have any constraints or limits on pain and suffering been incorporated into the legislation that affects them. Consequently, as Jones maintains, animal protection laws, particularly in the United States and Canada, "express a severe disconnect from the science on animal sentience and cognition," thus allowing animals to be the subjects of violent experimentation with often dire consequences (Jones 2013, 22).

Although the laws and policies of each jurisdiction – Europe, the United States and Canada -- have distinct features, they also share a number of common elements in their basic frameworks for the care and handling of animals. These laws, with their focus on animal welfare rather than an intention to protect animals from undue suffering and death, exist separately from the laws governing toxics, which I discuss later in Chapter Eight. However, these laws must be understood in conversation with each other: where one suite of laws governing animal protection sets out the constraints on the use of animals in laboratory settings, the other suite of laws, governing the introduction and use of toxic chemicals in our society, sets up a tacit structure of animal exploitation

that has recently been recognized and addressed by animal advocates in their campaigns to restrict or eliminate the use of animals in toxicity testing. Toxicity testing, which will be discussed in depth in Chapter Six, is done to assess the potential harm of chemicals and to understand the mechanisms of toxicity, primarily through administering chemicals to animals by different routes (Nuffield Council on Ethics 2005, 155).

Animal protection laws, in their present incarnation, presumably exist to limit the pain and suffering of animals and protect them from cruelty and undue harm. They are based on the premise that research on animals is needed for medical progress and that this research is "morally permissible" (Latham 2012). In theory, if the purpose of these animal welfare laws was to minimize the pain and suffering of animals, they should be designed to ensure that research protocols are well-justified scientifically, that the amount of animal suffering caused by the experiment is necessary, and that animals do not suffer as a result of inadequate housing, handling and feeding practices (Latham 2012); more generally, laws and policies should strive to offer these limited concessions to animal welfare. However, as Francione makes clear, it is assumed that animals will be used in research, and the laws determine what sort of treatment animals may be given in the approved experiments for the approved uses (Francione 1995, 186). With respect to animal protection laws in general and the U.S. *Animal Welfare Act* in particular, he argues that as long as animals are regarded as property, humans will be balancing their own interests against those of animals, and human interest in instrumentalizing animals will always take precedence over the interests of animals (Francione 2020, 31).

i. Canada

In Canada, the primary responsibility for experimentation using animals lies with the provinces,[14] although only Ontario has an explicit law governing experimental animals.[15] However, even though the federal government does not regulate the use of animals in research, a number of federal laws explicitly require it as does, for example, the New Substances Notification Regulations of the *Canadian Environmental Protection Act* (Guidelines for the Notification and Testing of New Substances, n.d.). The federal government under the Criminal Code of Canada, Sections 444 to 447, does protect animals in general from "cruelty, abuse and neglect," but this provision has almost never been applied to animals in research (Bisgould 2011, 214). In effect, the federal government has allocated responsibility for the welfare of experimental animals to the quasi-regulatory Canadian Council on Animal Care (CCAC),[16] which was incorporated in 1982 as a non-profit independent advisory council, responsible for setting standards for the ethical use and care of animals used in science (CCAC, About the CCAC. N.D.).

The CCAC's purpose is to act in the interests of the people of Canada "to ensure that animal-based science in Canada takes place only when necessary and that the animals in the studies receive optimal care according to high quality, research-informed standards" (CCAC, Vision, Mission and Mandate. n.d.). The 22 permanent members of the CCAC include scientists, educators, industry representatives, generally representing organizations and agencies that are directly involved in the business of animal research (Bisgould 2011, 209). Those institutions that receive funding from granting agencies of the government of Canada, such as the Canadian Institutes for Health Research, must be certified by the CCAC for animal-based projects, and are presumably obliged to consider the use of alternatives in the design of their research protocols. However, as lawyer Lesli

[14] Under the *Constitution Act 1867*, the authority to legislate experiments involving animals falls to the provincial governments rather than the federal government.

[15] *Animals for Research Act, R.S.O. 1990, c. A.22. This Act* registers research facilities and issues licences for animal suppliers. Under the legislation, animals used in experiments likely to cause pain are to be euthanized in order to avoid further pain.

[16] The CCAC was established in 1968 in response to public concern that pets were being abducted and ending up as test animals in North American laboratories (Bisgould 2011, 208).

Bisgould points out in her book, *Animals and the Law*, there is no obligation or meaningful incentives to consider alternatives (209). Furthermore, institutions that do not receive federal government funding have no obligation to report their use of animals (CCAC Facts and Legislation, Animal Data N.D.), or to follow the recommendations of the CCAC except where required by provincial laws. Private companies, such as research laboratories, may choose to be under the purview of the CCAC,[17] but without legislation that requires this, there are no obligations and there is no public accountability required of these companies, according to Elisabeth Ormandy, Director of Research for Animal Charity Evaluators, who worked briefly for the CCAC (Interview, Elisabeth Ormandy, May 27, 2021).

The CCAC, following the lead of other national legislation, requires research facilities to establish "animal care committees" that are responsible for the oversight and welfare of the animals used in their laboratories. It is estimated that there are over 200 of these committees in Canada (Fenwick, Tellier and Griffin 2011). One community representative on a university animal care committee, who wished to speak anonymously, has found her participation on this committee to be very rewarding and interesting (Interview, Community Representative on Animal Care Committee, January 7, 2021). She has been designated by the chair as the "common sense" in the room, and is one of eight members including a veterinarian, university scientists and researchers, and the head of the animal ethics department on the CCAC Committee. Erika Ritter, however, author and volunteer with Animal Alliance, is critical of these committees. From her observations and research,

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[17] Erika Ritter points to the undercover investigation of ITR Labs in Montreal, a private testing lab that was a member of the CCAC as an example (Interview with Erika Ritter, April 14, 2021). The investigation, conducted by Los Angeles-based group, Last Chance for Animals, in 2017 found research animals, dogs, pigs and monkeys, at the facility being badly abused, even though the company said they were following federal and provincial guidelines (Kevin Newman, W5, CTV News "Undercover investigation reveals what goes on inside Montreal animal research lab," March 11, 2017.

she notes that "the councils set up by the CCAC are 'all in the family' and researchers overseeing other researchers pay only lip service to oversight" (Interview, Erika Ritter, April 14, 2021). She points out that no Good Animal Practice reports (GAP), giving institutions permission to practice research based on annual inspections, have ever been revoked for bad animal practice, suggesting that oversight of these committees and their work is not rigorous.

The 3Rs principles – replacement, reduction, and refinement -- are the foundation of Canada's approach to the "care" of animals used in this country's research activities, and are widely promoted on the CCAC's website. According to the CCAC, principal investigators are required to implement the 3Rs in any animal research that they undertake. Research proposals are sent to the animal care committees in advance of their meetings, reviewed by the committee members and discussed with particular attention paid to implementation of the 3Rs, which are "deeply respected," according to the community representative interviewed for this dissertation. Researchers are asked if they are using too many animals and if this is the lowest level of animal that could be used; they are asked whether they have reduced the negative effects on the animals through anesthesia, housing and other considerations for the animal, and whether replacement is possible (Interview, Community Representative on Animal Care Committee, January 7, 2021). However, with respect to reduction, research that has been done for 50 years in the same way, using only one gender such as females, means that the males are probably euthanized. In some cases cultured cell lines can be used in research but physiological studies can't be done this way, according to the community representative on the committee. In her opinion, "the world is changing with respect to the use of animals, particularly in teaching; people are starting to say why not artificial intelligence instead, but not much is implemented because there is no appetite for it" (Interview, Community Representative on Animal Care Committee, January 7, 2021).

The difficulties in moving towards a 3Rs approach were documented in a 2011 web-based survey of principal investigators and researchers working with animals in Canada. Although replacement can be the act of replacing sentient animals with forms of life such as cell cultures, or replacing "higher" animals such as chimpanzees with "lower" animals such as mice, respondents in this survey indicated the goal of replacement was not achievable (Fenwick, Danielson and Griffin 2011). Replacement was often not considered an option when certain types of animals were the subject of specific research. Similarly, reduction was generally resisted as researchers viewed experimental protocols as requiring a certain number of animals. In order to make a valid statistical inference from study results, for example, a certain sample size might be considered necessary by the researchers conducting the experiment. Bekoff also points out that the strategy of "replacement" – substituting mice or rats for apes – is flawed. He argues that advocating replacement assumes a hierarchy of animal intelligence with apes being more like us and therefore more intelligent and likely to experience more suffering, even though, scientifically, "cross-species comparisons of intelligence are fraught with errors" (Bekoff 2019, 65).

Consistent with the intent of most animal protection legislation, the CCAC sets out goals for the welfare of animals including the stipulation that "animals should be relatively free from negative states, including pain, fear, discomfort and distress, and capable of experiencing normal pleasures and comforts," as well as being well-fed and housed, and able to carry out normal patterns of behaviour (CCAC, Three Rs Microsite, N.D.). Distress is used instead of suffering because the term, "suffering" may not be applicable to some species. Pain is defined as "an unpleasant sensory and emotional experience associated with actual or potential damage, or described in terms of such damage," and is the experience most often associated with sentience. Although the CCAC refers to animal welfare as freedom from pain, judgments on the degree of pain and suffering, to which "sentient" laboratory animals are subjected, is unregulated and left to the discretion of individual

research institutions and their animal care committees. Marc Bekoff and Jessica Pierce have commented that animal welfarism means "what's good for animals is a matter of scientific investigation, and scientists are the best judges of what animals need," a position that assumes animals are here for us to experiment on and imposing harm is a scientific necessity (Bekoff and Pierce 2017, 64). A survey done by the CCAC itself on the use of pain-relieving analgesics indicated that pain relief was still being withheld from some experimental animals even though the number of animals affected was deemed to be a small percentage (Fenwick, Tellier and Griffin 2011). The most likely studies in which animals were being denied analgesics were in those cases where animals were used as models of pain, inflammation and arthritis or in pharmacology, physiology and immunology research. In some cases, animals, primarily mice, rats, guinea pigs, fish, rabbits and cattle, were subjected to procedures deemed to be Category D, a level of invasiveness that the CCAC describe as causing moderate to severe distress or discomfort (Fenwick, Tellier and Griffin 2011). Clearly, then, the problem of animal pain and suffering is a continuing and significant problem, despite the CCAC's efforts to invest scientific practice in Canada with the principles of the 3Rs.

ii. United States

The most immediately relevant legislation governing animal welfare in the United States is the *Animal Welfare Act of 1966 (AWA)*. Stephen Latham, Director of the Yale Interdisciplinary Center for Bioethics, has described this legislation as falling in the middle between countries with "strong, centralized state legislation and monitoring of all experimentation to a hands-on reliance on professional self-regulation among laboratory researchers" (Latham 2019, S36). In his view, although many countries protect particular kinds of animals – such as great apes and endangered species -- from being used in experiments, it is rare to find concrete limitations on what researchers may cause animals to suffer (S35). Like Canada, the *AWA* was originally designed to rein in the

breeding and sale of pets, arising from a public outcry over the mistreatment of dogs sold to laboratories. Consequently, in its first iteration, this statute covered dogs, cats, rabbits and monkeys (Latham 2012, S36). At that time, concerned about high regulatory costs, the U.S. Department of Agriculture excluded birds, rats and mice bred for use in research from its definition of "animal." To this day, this has meant that, not only are they not counted as research animals, but any welfare benefits accruing from the *AWA* have never been extended to those species that make up the bulk of "warm-blooded animals" (S36). Despite the lobbying of pro-animal activists, the exclusion of these species was once again formally legalized as recently as 2002 (S36). It effectively eliminates more than 90 per cent of laboratory animals, including those most exposed to toxicity testing, from even the most minimal requirements for good housing and basic standards of pain control, leaving them vulnerable to whatever practices are deemed acceptable by researchers. Ethologist Marc Bekoff has expressed his outrage at these exclusions:

> We know from detailed scientific research that they (mice and rats) have highly evolved cognitive and emotional capacities, they experience empathy, and rats laugh and like to be tickled. And we know that tickling laboratory rats is good for science. What more do we need to show that these are sentient beings with rich and deep emotional lives?" (Bekoff 2016, blog)

The U.S. animal protection framework also relies on the National Institute of Health's *Guide for the Care and Use of Laboratory Animals*, as a key part of its self-regulatory approach. The Guide was introduced as a set of voluntary professional standards for laboratory animal research, but is now mandatory for all research facilities receiving federal funding (Latham S36). In 1985, amendments to the Act and the Guide both required the establishment of Institutional Care and Use Committees (IACUCs) at all research institutions to review and approve activities involving regulated animals with a view to minimizing pain and distress (National Association for Biomedical Research 2021 n.d.). Federal standards are explicit with respect to questions of animal housing and care, but they provide less guidance for the evaluation of research protocols, the ways in which animal suffering is

affected by protocols, and the application of the three Rs (Latham 2012, S36). These concerns are left to the discretion of the IACUCs. Although these committees are a standard feature of animal protection regimes in Canada, the United States and Europe, the effectiveness of these committees depends on the quality and thoroughness of the oversight, which its members choose to apply.

Both in the U.S. and Canada, the problems arise with the decentralized nature of this oversight. These problems include: the lack of transparency and accountability, since few people outside these committees know of their existence or are aware of the identity of their members; the lack of uniformity in the decision-making of various institutional care committees; and, the concern that governments do not effectively audit their work (Latham S38). With respect to whether alternatives to animal use are considered in the committees' deliberations, the Public Health Service and the Department of Agriculture offer guidance documents and educational resources to assist them in their evaluations. This includes up-to-date information about newly developed computer models that could be used in laboratory research as a substitute for animals (S37). However, since the discussions of the IACUCs are confidential, it is not possible to ascertain whether this information has any impact on reducing animal use in laboratories.

iii. <u>European Union</u>

Of the three jurisdictions, animal welfare concerns have the highest public profile in Europe, and animal protection laws are correspondingly more honed and more specific in their direction on how laboratory animals must be treated. In 2012, the European Union adopted its revised legislation on research animals, which came into effect on January 1, 2018. This relatively new legislation, entitled *Directive 2010/63/EU on the protection of animals used for scientific purposes*, was meant to strengthen the previous legislation and to improve the situation of experimental animals. It sets a high bar for animal welfare compared to other countries in the world, and the Directive explicitly recognizes that emerging scientific knowledge has led to a new appreciation of "the capacity of

animals to sense and express pain, suffering, distress and lasting harm" (Directive 2010/63/EU Section 6, 2010). Under this legislation, all experiments with animals are subject to pre-authorization and an ethical review, and the Directive sets minimum housing and care requirements.

It also aims to entrench the principles of the 3Rs, to replace, reduce and refine animal use, within the legislation, and therefore within the laboratories of its European member countries. As Gail Davies and her Exeter University colleagues have described it, "the 3Rs now provide the core of political commitments to, and social understandings of, ethical animal experimentation; they are embedded in national and European Union (EU) legislation" (Davies et al. 2018, 606). Unlike the limited coverage of the U.S. *Animal Welfare Act*, the EU legislation covers all vertebrate animals, including birds, fish, mice and rats, and adds cephalopods and cyclostomes (EU Directive 2010/63/EU, 2010). It also regards replacement of animals as its ultimate goal, while reducing animal use or refining methods to reduce animal suffering are seen as short-term goals. The European Union has called this Directive an important step in moving towards a final goal of replacing animal tests with non-animal testing as soon as it is scientifically possible (Section 10).

The goal of completely replacing animal testing with non-animal tests cannot come soon enough for the many dedicated animal advocates in Europe. Through their efforts, a European Citizen's Initiative, "Stop Vivisection," signed by 1.7 million people, called on the European Commission in 2015 to "put forward a new proposal to completely phase out the practice of experimentation on animals, making compulsory the use – in biomedical and toxicological research -- of data relevant for the human species" (European Union, European Citizens' Initiative 2015). The Commission responded by agreeing that the development of new medicines, basic research and the predictive safety testing of substances need no longer rely exclusively on animal models, but maintaining that animal models are still needed in areas of greater biological complexity "where existing alternatives do not yet provide sufficient predictive power" (European Union,

Communication from the Commission on the European Citizens' Initiative "Stop Vivisection" 2015, 7).

Although the 3Rs have served to bring more enlightened and humane treatment to animals in scientific settings, there have also been efforts to bring these principles more in line with what we know now of animal sentience. As discussed briefly in Chapter Three, Tom Beauchamp and David DeGrazia have proposed a new framework of ethical and moral principles to guide animal research – a framework that takes into account the more recent available evidence supporting consciousness or awareness in a wide range of animal species (DeGrazia and Beauchamp 2019). Their goal is to reconcile animal research with animal ethics. They argue that a new framework is needed for a variety of reasons: 1) advances in scientific studies, such as those studies on animal cognition described in Chapter One; 2) growing public concerns about animal welfare, (which are reflected in public opinion polls); 3) the development of ethics as a scholarly discipline; 4) significant gaps in the 3Rs; 5) growing concerns among scientists about the reliability of animal tests as models for humans; and 6) the fact that different moral perspectives on the use of animals are irreconcilable (1).

Conclusion

Despite the expansion and insight into the capacities of species other than our own, we remain fixed in our human exceptionalism, our laws offering only limited legislative protection to animals or, infrequently, protection to select species under select circumstances. This overview of the animal protection legislation of Canada, the United States and, to a certain extent, the European Union, illustrates the limitations of the regimes currently set up to protect animals. Despite the scientific breakthroughs in animal cognition and the pressure of ethical arguments and animal rights activism, animal welfare laws continue to uphold the status quo, barely acknowledging the shifting moral ground brought about by a new awareness of animal cognition or the desire of the public to avoid animal experimentation where there are alternatives. At the same time, the number of animals

used in research continues to climb. Even though considerations of animal welfare, such as housing and temperatures, have considerable impact on the lives of animals used in research and must be incorporated into legislation, there are no prescribed limits on how much pain or suffering an animal might be forced to endure in the interests of scientific reductionism.

One of the major discussion points with respect to the issue of what constitutes an ethical human/animal relationship is the question of what are the morally relevant capacities of animals that must be respected (The Nuffield Council on Bioethics, 2005), and how can legislation accommodate morally relevant capacities. Influenced by utilitarianism, it is usually sentience, the capacity to "feel" pleasure and pain and to suffer, which is most frequently cited as a morally relevant concern, and the one which in the past has dominated discussions of animal welfare. Sentience, however, is not necessarily limited to basic bodily sensations and feelings such as pain and happiness, but may now also refer to a higher consciousness, including, at least for some species, a sense of self-awareness, the ability to think about one's own mental states or feelings, and the ability to understand another's mind (Ristau 2013). In addition to sentience, these capacities should be incorporated into animal protection regimes.

However, even the most progressive legislation, such as that of the European Union, does not bridge the "severe disconnect" between welfare policies and the science on animal sentience and cognition (Jones 2013, 22). The 3Rs, on which all three jurisdictions rely for ethical judgements in the laboratory, are only effective to the extent that scientists and committees, overseeing these experiments, accept, understand and apply them. This legislation falls short of expanding the moral community, as it applies to humans, to the animals bred for research. As I have noted, there is a reluctance to consider the replacement of animals (probably aggravated by a lack of knowledge about alternatives), and there are often challenges to refinement and reduction within the discussions of the committees as scientists defend the protocols they have developed. Within the

field of toxicity testing, the discretion with which the 3Rs may be applied varies considerably with different jurisdictions and different knowledge sets. Consequently, there is a pressing need to reconsider current animal protection legislation and other relevant statutes that pertain to the use of animals in light of the ethical and scientific literature that has revealed the morally relevant properties of animals. This is particularly urgent for the practice of toxicity testing, where sentient animals are subjected to the most painful and deadly procedures, discussed in Chapter Six. In the next chapter, I focus on the most popular of all laboratory animals, the mouse itself, its sentience and its transformation from wild animal to laboratory artifact.

Chapter Five – The Laboratory Mouse: Its Life and Loves

Mice in the House

One of them scampers down the curtain

and up to my motionless feet –

I have the feeling watching that

representatives of two powerful races

are meeting here calmly as equals –

but the mouse will not be damn fool enough

to go away and write a poem.

Al Purdy, Beyond Remembering

The rat and mouse, like the coyote are shape-changers: They can be much-loved pet and hated adversary; they can be dirt personified, and they can symbolize the eradication of disease. In the laboratory, they are both animals and not quite animals; they are vermin in the pipework under the lab but a useful piece of equipment in the lab; they are equipment, yet we can be mindful of their minds; they are bearers of disease while promising to liberate us from disease.

Lynda Birke, Who – or What – are the Rats (and Mice) in the Laboratory

Introduction

This chapter is about the laboratory mouse and how it came to be. The laboratory mouse, like its fellow rodent, the rat, has been celebrated as a "hero of science," and simultaneously vilified as vermin and a household pest, the profitable business of exterminators in every major city (Burt 2006, 89). As the hero of science, the ordinary mouse is purported to have many attributes that have established its reputation as a perennial research favourite – its size, which makes it easy to handle and house, its fertility with short pregnancies and large litters, and the similarity of its body functions to those of humans (Canadian Blood Services n.d.). Hence, in the service of science advancing human interests, mice have been burned, drugged, cloned, vaccinated, genetically altered, exposed to carcinogens, infected with malaria and tuberculosis, electrically shocked, irradiated,

implanted with human brains, sent into space and routinely euthanized (Schipani 2019). However, as the polling shows, mice, like rats, evoke little public sympathy compared to other species, like rabbits, dogs or apes, which have also been popular candidate animals for laboratory research (Ormandy and Schuppli 2014; Bekoff and Pierce 2017). As testimony to their abuse and disposability, Donna Szoke of Brock University, in her interactive art piece, *Invisible Histories*, has drawn attention to the unofficial graves of more than 270,000 radioactive mice interred at a nuclear storage site in Niagara Falls, New York (Szoke, 2014). The small radioactive bodies of these mice are the hidden evidence of their use in the Manhattan Project's atomic testing program and the subsequent dumping of its radioactive waste at the Niagara Falls Storage Site. By highlighting the fate of these mice, Szoke asks us to consider the ways in which mice and animal "others" are engaged, abused and memorialized. Szoke's artistic interpretation of the burial of these animals is also emblematic of the way in which animal experimentation takes place out of the public eye, and highlights the way in which the incriminating evidence of their abused bodies is disposed of surreptitiously.

In the next section of this chapter, I am asking how the mouse came to be the preferred research animal of science and how its use in the laboratory has been influenced by conventional approaches to science based on a reductionist approach. I explore, first, the world of the naturalistic mouse, its emotional life and the characteristics for which it is known in the wild, following the guidance of biologist Jakob von Uexkull. In the third section, I recount the history of the development of the mouse as a scientific instrument largely orchestrated by geneticist, C.C. Little, and culminating in the mouse model industry of the Jackson Laboratory in Maine. The fourth section in this chapter presents a theoretical discussion of the conversion of the natural mouse to its identity as a laboratory artifact. In the fifth section, I conclude that the mouse as a model has been, and still is, the focus of considerable debate among scientists and laypeople. The question of where

the boundaries lie between human and animal, or, in this case between human and mouse, speak directly to the question of whether it is ethical to inflict pain and suffering on a creature that is both like us and not like us. Consistent with the dominant question in this study of human treatment of animals, in this chapter I am looking at whether our moral sphere should be expanded to include animals, and specifically animals such as mice that are often denigrated or seen as lesser than other animals.

The Naturalistic Mouse

Jakob von Uexkull, the Estonian-born biologist, has given us the concept of imagining the world from the animal's perspective. In this section, we try to imagine the world from the point of view of the naturalistic mouse, predecessor of its laboratory counterpart. Von Uexkull called the animal's perspective on the world its "Umwelt," meaning "the surrounding world," (de Waal 2016, 7). Writing in the 1930s, von Uexkull, who is considered to be the founder of modern ecology, imagined the Umwelt as each animal's subjective self-centred world, representing "only a small tranche of all available worlds" (de Waal 2016, 8). He described it as "a piece cut out of its surroundings, which we see stretching out on all sides of the animal" (von Uexkull 2010, 53). Each animal's piece constitutes a slice of the larger environment within which all species, including ourselves, co-exist. For von Uexkull, space and time are not equal for all living creatures: animals exist in a world in which "carriers of significance" or "perception marks" represent those things that interest the animal, although not necessarily us (Agamben 2004, 40). As Italian philosopher Giorgio Agamben has described it, "where classical science saw a single world that comprised within it all living species hierarchically ordered from the most elementary forms up to the highest organisms, von Uexkull instead supposes an infinite variety of perceptual worlds that, though they are uncommunicating and reciprocally exclusive, are all linked together as if in a gigantic musical score" (40). This vision represented a radical departure from the accepted order in which, historically,

humans were situated at the top of the species' ladder with all other species below and, therefore, implicitly inferior.

The holistic naturalistic mouse, then, following von Uexkull, is an integral part of that musical score and lives in the earthly world occupying its own particular environment space. If we take a walk in the woods or a "foray" in the fields with Jakob von Uexkull, we can try with the limited perceptual tools of the human species to understand the perspective of another living being. Guided by this visionary ecologist, we can look at the world of the wild mouse and its piece cut out of the surroundings, making the kinds of observations that he might make if he were here with us now. How does the mouse perceive the world then? What are those things of particular interest to the animal – those "carriers of significance" that exist in the self-centred world of the mouse? What are the "perception marks" that the mouse needs to see, move and touch, as it lives its free life in wild nature?

First, let's eavesdrop. Perhaps it is night and we hike through the woods with biologist Matina Kalcounis-Rueppel and her colleagues from the University of North Carolina listening in on the siren songs of the elusive male mouse. Hoping to seduce an available female, the male mouse sings what researchers have characterized as "surprisingly complex songs," songs that range so high we can't appreciate their intricate melodies (Kalcounis-Rueppel et al. 2018). They are known to scientists as ultrasonic vocalizations, but to mice, of course, they are just a serenade to attract a mate. These songs become more complex and louder when the male mouse smells the urine of the female mouse but can't see her, and simpler when she is in sight (Chabout et al. 2015). Scientists have speculated that in the wild, the male mouse could be singing these more complex "calling" songs when he knows the female is within earshot in order to draw her closer and possibly to convince her of his own attractive qualities. The male mouse can also change his repertoire and use different

syntax to build his songs according to the female mouse's preference. To us the untrained, these high-pitched songs sound like undistinguished chirps, but to a mouse being hailed, different songs and sounds convey different meanings, just as birds' songs do. If we could understand the differences in tones from these ultrasonic vocalizations heard in the wild, we might also catch the cries of a mouse pup calling for its mother to retrieve it, or the intimidating barks of a male mouse shouting aggressively at a rival, perhaps when another male attempts to enter its established territory. These mouse vocalizations are believed to play an important role in triggering and maintaining social interactions between male mice (2). Songs, then, are carriers of significance for both the male and female mouse.

At night, not only are they singing but wild mice are moving around the woods and the fields, often underground although never straying too far from home. Von Uexkull observes that not all animals have territories -- animals like the fly move about everywhere -- but some animals, like mice and rats and moles, burrow and create networks of passages where not only an individual passage can constitute a mouse's sovereign domain (Schmid-Holmes et al. 2009), (although sometimes shared with another mouse) but the whole territory, around or under, where they make their homes may be claimed as their environment space (von Uexkull 2010, 103). Von Uexkull would describe these systems of burrowed tracks as "the familiar path," where there are few path markers and no sign that would make the way known to anyone unfamiliar with it (98). And even though it would be dark and difficult for humans to navigate, the mouse can burrow through such a labyrinth using its whiskers to create a tactile map of its surroundings (61). The mouse, like all nocturnal animals, lives predominantly in what von Uexkull would call its tactile space, a space "which represents a melding of places and directional steps" (61). When the mouse decides to explore the landscape outside and look for seeds or plants, whatever food it can find, never wandering too far from home, he becomes a tri-athlete running, climbing and even swimming

(Williams n.d.). If his courtship song is successful, within the burrowed territory in which the male mouse has established his home, we would likely find his female companion stationed in a sheltered place -- a mate or partner, who has built a complex multi-entrance nest, has given birth to, and is now raising his pups. After the formalities of courtship and pair-bonding are performed, a wild mouse couple of the California genus, and most likely other wild species as well, will settle down into a monogamous lifelong relationship (Kalcounis-Rueppell at al. 2018).

But what do we know about the interior life of the mouse, and for this, we must turn to the laboratory to know what the mouse feels and how the mouse navigates the world mentally. From psychological experiments, we have some sparse but telling information about their emotions. For instance, mice can experience sadness and introversion. We know this because they are used as models to test drugs for mental disorders (Bekoff 2007, 10). When they are bullied or dominated by other older mice, they become withdrawn and depressed, but they respond, as humans do, to treatment with certain drugs (10). Marc Bekoff observes that "if animals respond to these drugs as humans do, then it's highly likely that they have similar neural underpinnings to their emotions and probably similar feelings" (10). It has also been demonstrated in several studies that mice feel what Bekoff calls secondary emotions, such as empathy. Imagine that you are a mouse, then, in your cage looking on as your cage-mate writhes pain, and then you yourself are subjected to pain. Dr. Jeffrey Mogil, Professor of Pain Studies, along with his colleagues at McGill University, as noted in Chapter One, found that mice, who witness the pain of their cage mates, experienced more intense pain themselves (Langford et al. 2006). Even in the unnatural Umwelt of the laboratory, mice can understand the pain of others simply by watching the suffering of their fellow mice, the suffering giving visual cues that generate an empathic response.

And we know also from laboratory experiments that mice have impressive memories. They have been shown to have the gift of episodic memory, which Tulving called "a marvel of nature"

that allows humans, and at least some animals, to remember events and things (Tulving 2002, 1). It seems that not only do mice remember events and things, but, remarkably, they also remember where they found objects, what it was that they found and when that finding occurred. We can watch the mice with Dere and his fellow scientists at Center for Biological and Medical Research at the Heinrich-Heine-University of Dusseldorf, then, as the mice recognize and explore old familiar objects in locations where they have seen them before. Then, we can be surprised when they recognize the same familiar objects, but, this time, in a new location in which they had never before seen them. Finally, we notice that they are only interested in the old familiar objects and show little interest in new unfamiliar objects placed nearby -- suggesting that they remember what they saw before and recognize it (Dere et al. 2006, 1215). Through these experiments, it becomes clear that mice remember unique personal experiences in terms of the details -- what happened, where and when (1206).

We also know that they can recollect events that are unpleasant – foot shocks for instance. Scientists, looking for that part of the brain associated with fear, have subjected them, after hearing a neutral tone, to "mildly aversive" foot shocks (Josselyn 2010). When the tone is replayed again and the mice hear the sound, they freeze in fear anticipating fresh injuries. Not only in these experiments do mice show evidence of their distinctive memories recalling and reacting to previous instances of being subjected to pain, but we can also add the emotion of "fear" to the panoply of emotions that we can know that they experience. The response of mice to pain, and their memory of it, as well as their fear, all speak to the exceptional abilities of mice, their sentience, and our need to re-consider our rote use of animals as beings on which any kind of experiment, no matter how painful, may be conducted. How then did the mouse, once a wild and free animal living out its life in the fields and forests of the world, an animal with a vivid emotional life and the ability to

remember and anticipate, become transformed into the model experimental animal, confined to a caged life devoid of almost any natural stimulation?

The Mouse as Model and How it Came to Be

The mouse, or *mus musculus* has come to be, for at least three decades, one of the most, and possibly the most, widely-used animal in biomedical research in the world, allegedly because of its close similarity to humans. Historian Karen Rader of Virginia Commonwealth University, who has written extensively on the history of the development of the mouse as a technological artifact, challenges the conventional wisdom that mice became the pre-eminent laboratory animal because they are easy to house and handle, cheap to feed and reproduce quickly (Rader 2002). For Rader, these traits, which are said to qualify mice for research purposes, "decontextualize these animals from the places and the circumstances under which they were developed into useful experimental tools, and thus render invisible the very nexus of politics and practices that defines what counts as their success" (391). The issues, which Rader raises and the history she recounts, uncover the historical and political developments that have resulted in the commercial success of the mouse as the world's premier experimental model. The decontextualization of these animals from the natural world outside the laboratory and their consolidation as technological instruments of research inside the laboratory has resulted in the situation that we have today – where it is assumed that mice are the natural candidates for exploratory research, no matter how invasive or painful.

To support her argument that laboratory mice were artifacts molded by politics and practices, Karen Rader has documented the history of the development of the mouse industry, and meticulously tracked the career and ambitions of geneticist Clarence Cook Little ("C.C." Little), who was instrumental in making the mouse model the most sought-after research animal in the world (Rader 1998). In the early 1900s before the mouse`s status as a research model became enshrined through Little`s committed campaigns, other possible candidates for research included the

Drosophilia fly or even the dog. Little began his career studying with William E. Castle, a pioneer in mammalian genetics and director of Harvard University's Bussey Institution between 1909 and 1936 (Rader 1998, 327). Castle was one of the first scientists to recognize the potential of the mouse as a model for human disease. Many of the original mice that early geneticists such as Castle acquired came from mouse fanciers, such as Abbie Lathrop, known as "The Mouse Woman of Granby" in Massachusetts. A dedicated "fancier" in the early 1900s, Lathrop bred mice and rats, which she first sold to collectors and keepers of exotic pets, and then later to scientific researchers, at one point accommodating more than 11,000 mice at her farm in Granby (Steensma et al. 2010).

It was Little, Castle's student, however, who cemented the status of the mouse as an indispensable part of scientific experimentation. Rader comments that:

> In the case of the mouse, then, the drama of its laboratory success has played out in terms of traffic across culturally constructed borders, but the historical actors themselves have staged it this way, and their stake in the outcome reflects local goals and material enterprises (Rader 2002, 390).

In her essay, "The Multiple Meanings of Laboratory Animals: Standardizing Mice for American Cancer Research 1910-1950," she traces the steps by which Little successfully carried out a sustained campaign to establish standardized mouse strains and models as fixtures in laboratory research in general, and cancer research in particular (391). While at Harvard, Little began to systematically inbreed mice for experimental use and as a way to eliminate their natural variability (392). This inbreeding was the first step in domesticating the mouse for use in the laboratory, or the "laboratization" of the mouse as it has been called (Lockyard cited by Shapiro 2002, 441). Around the same period in the early 1900s, albino Wistar rats were being selected from a breed of Norway rats, also with the intention of using them as experimental animals (Shapiro 2002, 441).

From Harvard, Little moved on to various laboratories, research institutions and universities, always taking his mouse colonies with him. Because inbred mice were found to be prone to the

development of spontaneous cancers, Little was convinced that inbred mice were ideal for the study of cancer inheritance, and he had faith that this research held out the promise of understanding the production of cancer. His own work, carried on for a while at Cold Springs Harbor, New York and later at the University of Maine, along with his writings for a wider public audience, drew growing attention to the possibilities of this research, and convinced some geneticists and medical practitioners of its value. However, as Rader points out, despite Little's promotion of mice as models for cancer research, there was no well-established infrastructure that could provide the cancer research community with mouse materials of the standard, for which Little was advocating (Rader 2002, 398).

Little and the other mouse geneticists had been raising their own inbred mice and scraping together funding for their living conditions through different institutional arrangements. However, in the late 1920s the lack of supply of animals for research was becoming a difficulty while at the same time cancer was gaining momentum as a public health problem (401). Little had argued that only knowledge gained from controlled laboratory rodents could be done quickly enough to address cancer's true causes (402). In 1926, Little proposed a special inbred research laboratory as "a valuable organizational and institutional contribution to the applied cancer effort" to Roscoe Jackson, president of the Hudson Motor Car Company in Detroit, and a friend of Little's, who agreed to help finance the project (402). The crowning achievement of Little's efforts was the establishment of his Jackson Laboratory in 1929 in Bar Harbour, Maine, a reflection of the success of his campaign to market the mouse as the single most sought-after research commodity. Kenneth Shapiro, founder of the Animals and Society Institute, has pointed out that, from the outset, the Jackson Lab was influenced by the "industrial strategy" of mass production as its major benefactors came from the automotive industry (Shapiro 2002, 454).

Although the Jackson Laboratory faced a number of challenges over the next three decades, it evolved from a research centre and inbred mouse production facility to become the largest industrial supplier of mice in the United States, "defined by its ability to meet a wide variety of user needs in different disciplinary and institutional contexts" (Rader 2002, 406). As Rader so eloquently puts it, "the inbred mouse's meaning as a tool for curing cancer was usurped by its meaning as a controlled, predictable commodity for use in a range of biological and medical research products" (408). The success of Little's commitment to the distribution of inbred mice as an indispensable research tool are reflected in the current world-wide sales from the Jackson Lab of approximately 3 million mice per year (The Economist 2016). By following the trajectory of the careers of Little and other Harvard-trained geneticists of that era, Rader concludes that the suitability of the mouse for research is best-described as "the product of, rather than the cause of, its mobilization as a tool for solving experimental, as well as organizational and larger cultural problems" (Rader 2002, 391). In addition to providing mice to research facilities, Little was also successful in making these animals an essential product of the cancer research industry.

The stark, sterile world of the laboratory, however, is the antithesis of the world of the fields and woods, and the mouse is the laboratory's most populous inhabitant. In a *Scientific American* article published in 1935, Little promoted the use of mice in laboratories using images and rhetoric that Rader describes as characterizing the suffering of the laboratory mouse as "a small price to pay for future well-being" of humans who would be cured from illnesses and diseases such as cancer (409). In his successful partnership with the U.S. National Cancer Institute, Little was primarily concerned with the use of the mouse as a vehicle to understand cancer as a disease and motivated to develop suitable treatments, based on mouse models. Mice were lauded as disease fighters that must "lose their lives on the cancer battleground as a stand-in for humans" (412). Although they were initially envisioned as the surrogate for humans in cancer research, mice became the popular choice for all

types of research. This rationale of Little's – that they must be sacrificed in order to cure human illnesses -- has persisted as the predominant argument in support of animal research throughout the twentieth and twenty-first century.

The Conversion of the Wild Mouse to the Laboratory Mouse

At the same time that the wild mouse was being transformed into its laboratory counterpart, corresponding changes were taking place with respect to the laboratory itself, the practice of science, and the fluctuating public perception of animal experimentation. Kristen Asdal, Professor of Science, Technology and Culture at the University of Oslo, examines how, despite the fact that the final years of the 19th century saw the rise of the powerful anti-vivisection movement and its strong opposition to the use of animals as research tools, during this same period the laboratory "became a relatively closed space in which scientists, the experts, were delegated the task of negotiating and transforming the interpretative sense of the animal – from sentient beings to analytic objects" (Asdal 2008, 900). Using the history of animal laws in Norway as an illustration of how animal research was gradually consolidated as an accepted practice, Asdal documents the process by which arguments about the value of pursuing science for its own sake were eclipsed by arguments that claimed problems outside of the laboratory could be solved through experimental medicine – that human pain and suffering could be relieved by inflicting pain on animals (901). Scientists were cast as having esoteric knowledge compared to the common sense of ordinary citizens (903). The question of when an animal should be sacrificed for superior ends was deemed too difficult for a lay person to handle, and laboratories were situated as places where progress was pursued in the name of beneficial results for society.

Consequently, laboratory space became a 'sub-place' where practices had to serve a purpose for society, even though the experts within these laboratories were carrying out activities that would be punishable in other parts of society – that is, under laws that forbid cruelty to animals (904).

Strangely, in that initial period, society had to be given access to the laboratory, had to keep a watchful eye on these activities, and ensure that these painful experiments were socially useful (904). She argues that this demand for society to have access to the laboratory illustrated *not* a critique or mistrust of science, but "an immense faith in science and the practical results that may follow from experimental medicine" (my italics, 905). Society's interest, then, in the issue of socially relevant medicine became linked with the issue of materials – or the animal bodies. This view of the laboratory, however, then changed again to a view of the laboratory as an exclusive and special place where sacrificing animals necessitated experiments that the public would not understand and were not in a position to judge (908).

These changes, then, in which the laboratory became a special place where scientists operated out of public view and performed research on animals that might not be publicly palatable, also consolidated a scientific practice, in which researchers became distanced from their animal subjects. Philosopher Mary Midgley has examined the scientific decontextualization of natural animals, such as mice, and the denial by scientists of their intelligence and capabilities when animals make the transition from the natural world to the laboratory. Examining the relationship between the researchers and the animals upon which they experiment, Midgley points out that laboratory scientists become desensitized to positive conceptions of different species (Midgley 1989, 17). Although she knows rats and mice as intelligent creatures, naturally eager to explore their environments, and animals who become bored when these explorations are frustrated, she observes that their intelligence, empathy and lively behaviour are largely left out of their public image; nor are they viewed this way in the laboratory (14). Rather, Midgley finds that mice and rats are generally viewed as insignificant and robotic, an impression that scientists could absorb if they continually see "a stack of standard small metal cages, each containing one bored white rodent which is never seen otherwise occupied" (14). Midgley also sees the conditioning of scientists as verbal. She points out

that in scientific articles, "experimental animals never moan, scream, cry, growl, whimper, howl, snarl or whine; they just discreetly 'vocalize'" (15). And finally, Midgley observes that for scientists, mice like other laboratory animals, don't do anything so vulgar as being killed, but are politely "sacrificed" in laboratory parlance.

Biologist Lynda Birke of the University of Lancaster, also finds that scientists, in order to produce results in the laboratory, distance themselves from the rodents so that those animals that ate, slept and played with their friends – hidden from human eyes – disappear. She examines the "overlapping and contradictory" meanings of laboratory rodents, both rats and mice, pointing out that their many meanings draw on "widespread cultural metaphors of medical triumph and the conquest of disease," as Asdal pointed out. However, at the same time they are believed to be carrying filth and disease (Birke 2003, 211). In this iconography of medical triumph, laboratory rodents are often portrayed as saviours that stand in for humans in their suffering. The transformation, then, of the natural animal into "the" laboratory animal is a transformation from something we would call an animal into something that stands in for data and scientific analysis, a kind of living laboratory equipment (Birke 2003, 213). Birke comments that rodents are medical models in a massive industry of research and testing, but they are still "not quite" animals according to the American *Animal Welfare Act*.

In her exploration of the meaning and metaphor of the laboratory mouse, Birke also comments on an apparent irony – that millions of rodents are used as models for human physiology to test chemicals and drugs to which we are exposed; however, the ideal species for helping scientists gain information about chemical exposures would be the rodents that "live so commensally with us in and around our habitations" (Birke 218). As she points out, though, we cannot use them as sentinels outside the laboratory for the simple reason that we are also trying to poison them by putting down rodenticides (218). Birke also finds that laboratory rodents are

"doubly othered" – first, because they are othered as animals in relation to humans, and, secondly, because they are also made "other" to other kinds of animals when they leave the wild and become transferred to the laboratory (219). Their otherness in the laboratory is doubly othered ethically as well, because the procedures to which they are subjected in the laboratory would not be permitted outside the laboratory.

Michael Lynch, professor emeritus at the Department of Science and Technology Studies at Cornell University, has written insightfully on how the world of the laboratory transforms the holistic naturalistic animal that we know as the mouse, the animal in which human-like feelings, perceptions, sensitivities and even 'thoughts' are attributed, into an "analytic" object of technical investigation (Lynch, 266). The 'naturalistic animal' with feelings and thoughts is the animal known to the layperson, the same animal championed by animal rights advocates, while the analytic animal is an artifact – "a product of human intervention, actively shaped by human agency, and in some cases literally carved up" (269). According to Lynch, the 'analytic' animal "becomes the real animal in a scientific system of knowledge, while tacitly depending upon the 'naturalistic animal' for its practical foundation" (Lynch 267).

Lynch also addresses the issue of how, at the end of the scientific process, animals are "sacrificed," the technical term for killing laboratory animals. Sacrifice in Western culture implies "making sacred," and Lynch comments that, while the animal is not transformed into a sacred object *per se*, "its material body and the interpretive sense of that body are radically transformed through a series of preparatory practices which turn the animal into the bearer of a generalized knowledge" (266). He argues that, if the "sacrifice" of animals were more fully embraced by scientists, the idea could reinforce the ritual nature of laboratory work, and emphasize respect for the lost lives of these animals and for the knowledge gained through experimentation with them (283).

Kenneth Shapiro refutes Lynch's concept of the laboratory animal as being "sacrificed" in the sense of being venerated, and maintains that the social construction of the rat or mouse is a reduction of the animal that remains just that (459). Shapiro has characterized the lab animal as "a construction achieved through the complex of philosophy, purpose and practice that constitute the laboratory animal enterprise" (Shapiro 2002, 440). In his words, the "laboratory animal," is also constructed more subtly:

> … through the philosophy of science underlying lab science; the language scientists use both formally in publications and research proposals, and informally, in the lab, to refer to lab animals; the ethics and policies they support and develop regulating their treatment of animals; and, finally, the architecture and layout of the labs they help design. (440).

He finds the social construction of the laboratory animal to be largely reductionist, and that this reductionism diminishes laboratory animals in comparison to the natural or wild animals of the same species. For Shapiro, the laboratory rat and mouse have been de-speciated as well as de-individualized and de-animalized (459). This de-speciation plays down their sentience and consciousness at the same time that scientists are showing a renewed interest in the cognition and awareness of animals.

Conclusion

As the formerly well-delineated boundaries between humans and animals has become ever more blurred by animal cognition studies, even the "lowly" mouse has been revealed as an emotional being with painful memories. Yet, the mouse has been conscripted into a deprived life in the laboratory and "de-animalized" through restrictions on its movements, its burrowing and other features of its life in the wild. The transformation of the wild and naturalistic mouse into a laboratory research tool is, as Karen Rader has shown, not only the political story of one man's campaign to entrench the mouse as the pre-eminent model for cancer research, but also the story of how the mouse became a laboratory artifact and the most widely used animal in a quickly expanding

industry of scientific exploration. Little's passion for promoting the genetically altered mouse as a research model developed into a multibillion dollar production and merchandising of animals, in what Rader has characterized as the nexus of politics and practice. Ironically, the use of mice in the search for a cure for cancer, championed by Little, has yielded few significant breakthroughs. As Dr. Richard Klausner, former director of the National Cancer Institute observed in 1998: "The history of cancer research has been a history of curing cancer in the mouse. We have cured mice of cancer for decades--and it simply didn't work in humans" (Cimons et al. 1998). Nevertheless, Little's campaigns and his focus on finding a cure for cancer using mice as a stand-in for humans has dominated the approach to cancer research and given little weight to the benefits of prevention. Considering the array of known and suspected environmental carcinogens to which humans are heavily exposed, a more effective approach to reduce cancer rates in the human population would be to work towards reducing exposure to environmental carcinogens (see Chapter Seven).

Rader also comments that scientific researchers and laypeople alike must "come to terms with the boundaries between 'humans' and 'animals,' and the 'natural' and 'technological'" (Rader 2002, 390). What has been minimized or downplayed in the process of the transformation and processing of the mouse is the cost to the animal -- that even "de-animalized" lab animals feel pain, as well as distress, anxiety, fear, deprivation and even boredom (Shapiro 2002, 459). The work being done on animal cognition, however, has contributed to the "re-minding" of animals after years of behaviourist insistence on animals as unfeeling and automatic (456). This appreciation of animal minds compels us to reconsider the way in which mice have been relegated to serve as tools in the pursuit of scientific knowledge. It necessitates a radical re-thinking of the "de-contextualization" of mice as they are moved from their natural settings to laboratory cages, and demands a "de-escalation" of an industry heavily reliant on the availability and potential suffering of this one species, the mouse. As York University biologist Leesa Fawcett asks in her essay on rats, if we

know that mice and rats are empathic at some level, "what does that mean for their ubiquitous use in intrusive experiments? What does that say about humans who use them in experiments and humans who claim benefits from those experiments? Perhaps, that we are too unimaginative, too lazy, and too stuck in our ways to devise different means of testing that do not cause such harm to so many other animals" (Fawcett 2016, 460.) In the next chapter, I consider the specific tests that are done for the purposes of testing the toxicity of the chemicals that are part of our daily lives, of which the mouse is a key actor and vector for evaluating toxicity.

Chapter Six: Toxicity Testing and Its Toll on Animals

Three blind mice, three blind mice. See how they run, see how they run. They all ran after the farmer's wife, who cut off their tails with a carving knife. Did you ever see such a sight in your life, as three blind mice?

Children's Nursery Rhyme

The three blind mice of the nursery rhyme had it easy compared to the millions of mice who are bred, experimented on, and sold to other laboratories each year by the Jackson Laboratory (JAX).

People for the Ethical Treatment of Animals (PETA)

Introduction

Of the millions of industrial animals bought and sold each year from laboratories such as the Jackson Lab, a significant percentage are sacrificed on the altar of toxicity testing, a schedule of tests, which primarily involves exposing animals to chemicals. The objective of this testing is to assess the degree to which specific chemicals are toxic to humans, wildlife or the environment, and to investigate the mechanisms of each chemical's toxicity (Nuffield Council on Bioethics, 157). From the Jackson Laboratory, the mice are sold to testing laboratories where laboratory technicians carry out procedures on these animals, or in some cases, labs like the Charles River Laboratories, offer toxicity testing services themselves. The information gleaned from these tests is solicited and paid for by companies hoping to commercialize a new chemical or product and compiling test results needed to satisfy regulatory requirements.

In this chapter, I examine how the toxicity of chemicals is assessed, what types of tests determine the possible harm of a chemical, and the specific ways in which mice are used in toxicity testing centred on a reductionist approach. I extend my search to answer the question of how mice are regarded and instrumentalized and whether mice should be included in the moral community defined by humans. I first offer an overview of toxicity testing and its purpose. Then, in my third section, I look at the use of animals in toxicity tests and describe the principle testing methods, emphasizing those that are most commonly conducted, followed by a fourth section noting the pain,

suffering and death of test animals. In my fifth section, I look briefly at the lucrative businesses of animal breeding and toxicity testing and their environmental implications, followed by a last section for my conclusions. I note that toxicity tests are generally used to provide only very basic data in support of the introduction of new chemicals. It is important to understand that, although many different types of tests are available, there are often no requirements for many of the more complex, longer-term tests to be conducted. These longer-term tests, such as those necessary for the study of carcinogenicity or endocrine disruption, have important implications for public health and the environment; yet, they are not considered an essential part of testing regimes. In the past, many chemicals found their way onto the market even though they lacked very basic and crucial data that might have been derived from these tests. Therefore, I emphasize that, although I describe the tests that are available and offered by testing services, they are not carried out for every new chemical, and many toxic effects are not necessarily captured. This is particularly true of data-poor chemicals that were introduced onto the market before current toxics laws were tightened, as will be discussed in Chapter Eight.

Toxicity Testing

Toxicity testing refers to a range of tests that are performed, almost exclusively on animals, in order to assess the potential toxicity of a new chemical or product. These tests are carried out on pesticides, industrial chemicals, drugs, cosmetics, personal care, household and other consumer products or their ingredients (Charles River Toxicology Services n.d.). They are primarily performed to satisfy the requirements of regulatory agencies, seeking assurance that, once on the market, these chemicals or products will not cause significant harm to human health or the environment. The agencies, which require this assurance, include government departments overseeing the environment, food and drug safety, labelling, pesticides and occupational health, with departments of the environment as the gatekeepers for industrial chemicals. The various tests that can, and must

be, submitted to federal departments for approval vary according to the type of end use for the product or ingredient and the legal or generally expected requirements established by different agencies. Acute toxicity tests are, for example, legally required by the U.S. Environmental Protection Agency for pesticides and by Environment and Climate Change Canada for new substances. In the case of cosmetics, no explicit testing regime is set out in most jurisdictions although generally new cosmetic ingredients or products are subjected to a specific suite of tests; however, the legislation usually states only that it is the responsibility of the companies themselves to ensure that products are safe.

Of the many different ways in which animals are used in scientific research, considerable concern has been directed specifically at toxicity testing. This is primarily due to the fact that toxicity testing involves potentially very painful procedures, in which animals are deliberately exposed to new chemicals and chemical compounds in order to observe the effects or damage (Nuffield Council on Bioethics 2005, xvii). As Lesli Bisgould in her book, *Animals and the Law*, vividly sums it up:

> …Some animals have chemicals applied to their eyes or skin in order to test new cosmetics or personal care, household cleaning, and industrial products. Sometimes animals are force-fed toxic substances to see what level causes reactions like convulsions, paralysis, tremors, bleeding from bodily cavities or death; they can be put in chambers where they are forced to inhale heavy concentrations of substances like hair spray, disinfectants, and industrial chemicals (Bisgould 2011, 202).

Toxicity testing, then, by its very nature, is likely to expose animals to considerable suffering and, either at some point during these procedures or at the end, ushers them to their deaths (Nuffield Council on Bioethics 2005, 165). This sacrifice highlights the moral dilemma of using animals for toxicity testing: if it is acknowledged that animals, as Peter Singer contends, have the right *not* to suffer, or as Tom Regan believes, are the "subjects-of-a-life," then toxicity testing would be ethically

unacceptable (italics mine). As demonstrated in the last chapter, mice are sentient creatures who are "subjects of a life" and who demonstrate morally relevant capacities, but they are also creatures who have been transformed into scientific artifacts, ubiquitous in research and often subjected to prolonged agony without regard for their suffering.

The Use of Animals in Toxicity Testing

Toxicity testing has been, and still is for the most part, carried out on live animals, although the number of animals required for each test varies widely. Animals are regarded as "sentinels" of the potential risk to humans or as models for studying human disease (National Academy of Sciences 2007, 26). Unless there are known differences in species responses, the assumption is that the effects seen in mice and rats and other test animals would mirror the effects that would be experienced by humans, and that the sensitivity of a mouse would represent the average sensitivity of a human (Nuffield Council on Bioethics 2005, 157). According to the 2005 report of the Nuffield Council on Bioethics, "The Ethics of Research Involving Animals," the majority of the tests done to assess toxicity are performed on mice and rats, with a smaller percentage carried out on rabbits, guinea pigs, and dogs. Although chimpanzees were used in the past, their role as experimental animals has been drastically reduced or eliminated in most countries as the result of campaigns to recognize the close relationship of humans and primates (Hastings Center Report 2012, S2).

There are two important components to toxicity testing – first, not only to determine the multitude of possible effects of a particular chemical, but, secondly, to calculate the level of exposure or dose at which an effect is observed (Nuffield Council on Bioethics 2005, 157). The specific types of adverse effects are referred to as "endpoints" (AltTox Toxicity Testing Overview 2016). Some endpoints in toxicity testing examine particular adverse effects such as eye irritation, skin sensitivity

or carcinogenicity. Other tests, such as acute systemic toxicity and repeated-dose toxicity, are more general in nature (AltTox Toxicity Testing Overview 2016), and are designed to detect a wide range of less-specific effects on organs or body systems (Nuffield Council on Bioethics 2005, 157). More recently, government agencies have been asking for tests to be submitted on endocrine disruption, which disturbs hormonal systems in humans or wildlife, a focus of increasing public concern. All the tests described below are intended to evaluate the possible adverse effects on human health. However, tests for ecotoxicity, which investigate harmful effects on the environment and wildlife, are also an important part of the testing packages that must be submitted for the approval of certain types of chemicals. A range of aquatic ecotoxicology tests are offered by testing services to assess the general adverse effects of chemicals on ecosystems, particularly the potential of a chemical for water contamination (Charles River Environmental Safety n.d.). These tests are performed primarily with large numbers of fish, as well as with birds and amphibians, although in smaller numbers (Nuffield Council on Bioethics 2005, 162).

It has been estimated that a standard series of toxicity tests may use from 6,000 up to 12,000 animals and take years to complete (Groff et al. 2014, 16). For the registration of a pesticide, the mandatory toxicity tests would require at least 4,500 animals, and up to 6,700 animals for more complete testing packages (Sullivan et al. 2011). Acute toxicity tests are usually the first tests conducted (Medicilon n.d.)[18], and are the standard toxicity tests submitted to all regulatory agencies, even if this requirement is not explicitly spelled out in the legislation. These tests look for adverse effects that are likely to occur from a brief exposure to a single dose of a substance (Nuffield Council on Bioethics 2005, 158). Because all chemicals may cause toxicity at sufficiently high doses, acute toxicity tests were developed to evaluate the hazards of chemicals and to establish safety

[18] The Medicilon website originally offered detailed information about toxicity tests, including the number of animals used in each test and the number of times they were dosed (in February 2021). However, as of May 2021, this information was no longer available on its site. Medicilon is a Chinese-based laboratory serving international clients.

precautions (AltTox Acute Systemic Toxicity 2017), as well as to provide information about the selection of doses for more prolonged animal tests (Strickland et al. 2019).

Acute toxicity tests may involve doses of chemicals administered orally, dermally, or by inhalation, and are usually conducted on two different species, and given at different dose levels (Parasuraman 2011). Studies that measure acute systemic toxicity include tests such as the LD50, which was introduced in 1920 and which marked an increase in the use of animals for regulatory testing (Fischer et al. 2020). This controversial test has for many years been the standard test for oral toxicity in the suite of acute systemic toxicity tests (Parasuraman 2011). As the first toxicity test to use animals, the LD50 test relies on establishing the dose of a substance, which would kill 50 per cent of the test animals, in this case most likely rats or mice. Hence, the name LD50 or lethal dose 50. According to the International Association Against Painful Experiments on Animals (IAAPEA), oral dosing to determine the LD50 level was commonly done by inserting a tube down an animal's throat. The tests go on for 14 days, if the animals have not died by then. Humanely killing an animal in distress before the full 14 days elapses could invalidate the test results as the animal might have survived longer (IAAPEA n.d.). Because of the pain and suffering this test inflicts on mice, rats, rabbits, birds and fish, or other animals used for this test, it became not only a target of animal activist campaigns to ban it, but its use has also been criticized by the scientific community (IAAPEA n.d.).

Although acute systemic toxicity testing is most commonly done by oral dosing or applying the chemical to the skin (as in the LD50 test), inhalation tests may also be conducted, depending on the expected route of human exposure. These tests are usually done using the original LD50 format, but the results are presented as LC50 or lethal concentration 50 (Strickland et al. 2019). To test the effects of inhaling a chemical, for example, on a mouse or rat, the animal may be forced to breathe the vapour of the test substance for a minimum of four hours and then observed for 14 days with

no food and, in some cases, no water (Parasuraman 2011). During this period, they are monitored for tremors, convulsions, salivation, diarrhea, lethargy, sleep and coma, and death if it happens during this exposure period. In the case of death, the animal is then examined for histological and pathological changes (Parasuraman 2011).

Newer tests that avoid death as an end point have been developed to replace the LD 50 test, such as the fixed dose procedure, the acute toxic class method, and the "up and down" method[19] (Erhirhie et al. 2018). Although these tests use fewer animals, they still rely on observations of signs of toxicity at one of a series of fixed dose levels administered to an animal in a stepwise manner. The data from acute systemic toxicity testing – the dose at which animals either show signs of toxicity or succumb to the toxic effects of the candidate chemical -- are used to calculate an assessment of the risk to humans based on the relationship between the dose and the toxicological response and the potential human exposure (Nuffield Council on Bioethics 2005, 157). This test is also the decisive test for determining what type of warning label is needed for a particular product or substance, what safety measures should be in place, and whether protective equipment is necessary during the manufacture, exposure and use of the product.

Other acute toxicity tests include tests for eye irritation or corrosion, skin irritation or corrosion and dermal sensitization. All are important endpoints that must be investigated separately, and are essential to many applications for regulatory approval. The results of discrete eye and skin irritation, as well as skin sensitization tests provide critical information, for example, on chemicals considered for topical use, such as a cosmetic or pharmaceutical. Traditionally and to this day, tests for potential eye damage have been done on rabbits, using the infamous Draize test, developed in 1944,

[19] The "up and down" method, now recommended by most regulatory agencies, involves dosing single animals sequentially at 48 hour intervals, giving them first a dose less than the estimated LD50 dose and then observing them for 48 hours. If the animal survives, the dose is doubled; if the animal dies, another animal of the same sex is given a lower dose (Parasuraman 2011, 76). This "staircase design" establishes an LD50 dose similar to the original LD50 test.

and still the standard method for evaluating the potential of a chemical to irritate or corrode the eye (AltTox Eye Irritation 2016). The Draize eye irritation test measures the harm when a certain amount of chemical is administered to one eye of an albino rabbit, the other eye serving as the negative control. The rabbit's eye is monitored for a period of up to 21 days until the magnitude and reversibility of any injury to the eye can be evaluated. The eye is assessed for redness, swelling, discharge, ulceration, hemorrhage and blindness (Parasuraman 2011). It is noteworthy that the data from this test has not proven to be 100 per cent accurate in predicting human eye damage, in some cases being overpredictive of human eye injuries and sometimes incorrect due to response differences between humans and rabbits (AltTox Eye Irritation 2016).

The skin irritation or corrosion test is done to evaluate localized toxic effects resulting from the exposure of the skin to a chemical substance. Skin irritation refers to reversible damage, while skin corrosion refers to damage that is irreversible (AltTox Skin Irritation/Corrosion 2010). For this test, as with the eye irritation test, a certain amount of test substance is applied to the shaved bare surface of an albino rabbit's skin for four hours, and observed for up to 14 days for signs of reddening of the skin or swelling. These eye and skin tests, like the LD50 tests, are viewed by the animal activist community as inflicting deliberate harm and pain on laboratory animals, and these two tests, the Draize skin test and the Draize eye test, but particularly the Draize eye test, have been two of the most visible targets of the cruelty-free cosmetic campaigns. In the lists of endpoints targeted by toxicity testing, the dermal or skin sensitization test is also important as a single test for indicating possible allergic responses. It would, for example, be used to detect the potential for contact dermatitis, the second most commonly reported occupational disease (AltTox Skin Sensitization 2016).

Recently replacing the traditional skin sensitization tests on guinea pigs is the local lymph node assay (LLNA). In this test, the candidate chemical is applied to the back of the ears of four or five

young adult female mice for three consecutive days. The mice are rested for two days, and then injected intravenously with H-thymidine. Hours later, they are euthanized and the lymph nodes behind their ears are drained, excised and examined in order to evaluate the relative allergenic potency of the test chemical (Gwaltney-Brant 2014; Guy 2014). Before the LLNA was developed using mice, guinea pigs were the animal of choice for dermal sensitization tests, but tests with guinea pigs took longer to complete and required more animals. The local lymph node assay test is often used as an example of a test, which, because it requires fewer animals, meets the 3Rs goal of reducing animal use (Guy 2014). However, it is another test in which mice been conscripted as substitutes for other animals.

A standard package of acute toxicity tests is often referred to as a "six-pack." The six-pack includes the three acute systemic toxicity tests done dermally, orally and by inhalation, (in standard toxicity testing measured by LD50 and LC50), and the three separate tests for eye irritation, skin irritation and skin corrosion (Product Safety Labs n.d.). It represents a baseline for many chemicals being assessed for future commercial use. In the U.S., for example, these six tests are required by each of these six government agencies: the Environmental Protection Agency, the Food and Drug Administration, the Consumer Product Safety Commission, the Occupational Safety and Health Administration, the Department of Defense and the Department of Transport (Strickland et al. 2019).

Repeated dose toxicity tests are often the next area of investigation after acute toxicity tests are done. They measure the toxicity that might develop over a certain length of continuous exposure to a substance, the organs most affected by the chemical substance, and the dose at which different effects occur (Nuffield Council on Bioethics 2005, 160). Repeated dose toxicity tests are conducted by repeatedly administering doses of a chemical, again orally, dermally or by inhalation, for periods lasting either 28 days or 90 days. For pesticides or pharmaceuticals, these tests are

usually done on rats and mice. The culmination of this testing includes an evaluation of clinical observations, a blood analysis, whole body gross necropsy and the microscopic examination of all organs and tissues, (AltTox Organ Toxicity 2007), indicators of what organ systems might be affected. The purpose of the repeated dose toxicity tests is not only to evaluate the chronic toxic effects on different organ systems, but also to establish a no observed effect level (NOEL) (Nuffield Council on Bioethics 2005). The no observed effect level is derived from finding the highest administered dose at which the animal does not show significant toxic effects. The NOEL is used in risk assessment and risk management to limit the exposure of humans by adopting an exposure level that is a fraction of the NOEL (160). This "reference dose" also serves to establish safety factors for pesticides and food additives on the assumption that no adverse health effects will result from these lower exposures.

The other important endpoints, critical to public and occupational health and offered by testing services, are tests for carcinogenicity, genotoxicity, neurotoxicity, reproductive and developmental toxicity, and endocrine disruption. Many of these tests involve large numbers of animals, and are both expensive and time consuming. Tests for carcinogenicity, the ability of a chemical to cause cancer, for example, are conducted on two species of animals including equal numbers of both sexes. Mice and rats are the animals of choice for this test because of their short life spans. Like chronic toxicity tests, the animals are dosed orally, dermally or by inhalation, depending on the expected route of human exposure. Carcinogenicity tests generally involve 800 animals (400 of each sex) and take up to two years, which is the expected lifespan of the animals (Nuffield Council on Bioethics 2005, 157).

Tests for reproductive or developmental toxicity, as the names suggest, examine the toxic effects of a substance on the reproductive ability of an animal and the development of the offspring. Like carcinogenicity tests, they are expensive and time-consuming. Each test uses at least 80 adult

animals of each sex, usually mice or rats, as well as their fetuses and offspring (157). For reproductive toxicity, a chemical substance is given to the animals, usually rats, prior to mating, during pregnancy, and to offspring during weaning, so that the effects of the chemical may be observed over two generations (Medicilon n.d.). In developmental toxicity tests, chemical substances are tested in pregnant animals, usually rats and mice, for their potential to cause birth defects or for other toxic effects during the development of the fetus (National Toxicology Program n.d.). Pregnant female animals are exposed during pregnancy from the time the embryo becomes attached to the uterus to the day before birth. After the investigations carried out in these tests, the animals are killed, and the fetuses weighed and examined for problems (Medicilon n.d.). Tests for neurotoxicity, or the adverse effects of a chemical on the nervous system, have traditionally been carried out by dosing hens or rats either orally, dermally or by inhalation once daily for 28 days or longer, observing their behavior and looking for effects on their nervous systems (AltTox Neurotoxicity 2014). Genotoxicity studies examine the potential of substances to interact with genetic material (Nuffield Council on Bioethics 2005, 155). They are used to identify gene mutations, chromosome changes, and alterations in DNA sequencing (Parasuraman 2011). For evaluating genotoxicity, a number of different tests, many of them using mice, are carried out, including the mouse-specific locus test, a major gene mutation test that uses whole animals. For this test chemically-exposed mice are bred and observed for hereditary changes. In other genetic toxicity tests, the rodent chromosomal assay and dominant lethal assay, mice or rats are chemically exposed and studied for chromosomal effects (Medicilon n.d.). There are also short-term *in vitro* studies, which investigate interactions with genetic material, such as the Ames test, looking for mutations in bacteria, and which are widely used to screen chemicals for the potential to cause cancer or heritable mutations (Nuffield Council on Bioethics 2005, 160).

Pain, Suffering and Death, The Final Blow

The report of the Nuffield Council on Bioethics, "The Ethics of Research involving Animals," identifies many aspects of toxicity testing that can be detrimental to the welfare of the test animals, based on the type of tests to which they are subjected and the species involved. These aspects include: transport, housing and husbandry, dosing and sampling procedures (which may be repeated), the length of the observation period, and most importantly, the toxic consequences of dosing. Because the practice of toxicity testing depends on inducing toxicity in the test animals, "some form of harm to animals is an integral part of animal-based toxicity testing," and is seen as unavoidable (164).

The report finds that it is impossible to fully predict the pain and suffering that animals, individually or collectively, will experience from toxicity testing (163). Adverse effects can range from minor effects such as weight gain, intermediate effects that result in tissue being destroyed and causing the animal pain and suffering, to major effects such as organ function loss leading to death. In a review of eighty published studies, Jonathan Balcombe and his colleagues confirmed that even routine laboratory procedures cause animals considerable stress (Balcombe et al. 2004). Procedures that seem relatively innocuous, such as routine handling, blood collection and orogastric gavage, were found to be intrinsically and significantly stressful to animals, regardless of the care and skill with which they are performed (49). Young mice that were handled daily – removed from their cages, placed in a small container and then returned to their cages – had significantly lower survival rates following implantation of leukemia cells compared to unhandled controls (45).

It is inevitable that the dosing of laboratory animals to determine the level at which a chemical causes acute harm, is likely to cause them great stress and often suffering (163). Tests that are purposely intended to evaluate overt signs of toxicity mean that "significant pain and distress could occur depending on the type of toxicity" (167). Skin irritation tests, for example, in which

chemicals are applied to shaved areas of rabbits, can result in painful swelling and itching (165). Acute toxicity testing can cause the animals bleeding internally and externally, diarrhea, loss of appetite, aggression, salivation, changes in blood pressure, coma, convulsions, tremors, loss of fur and hair, dehydration, or nasal discharge (165). Serious adverse effects would also include the development of tumours as a result of carcinogenicity testing, which very likely lead to pain and discomfort (164).

Ultimately, all animals are killed or "sacrificed" when they have fulfilled their role as stand-ins for humans in this world of toxicity testing. There are five commonly used ways of killing animals but none are recognized as sparing the animals pain. Some are killed by lethal injection or decapitated under strict guidelines, but asphyxiation by carbon dioxide emerges as not only one of the most common but also possibly one of the most brutal (Cressey 2013). When the coronavirus pandemic of 2019 first shut down research activities and workers left their laboratories to shelter-in-place at home, thousands of mice had to be sacrificed or "sacced," rather than left to die in their cages. One worker in a laboratory described carrying out the euthanization of the mice with carbon dioxide? in this way:

> It's actually very simple. You take their cages, take off the tops, put it in a machine called the Euthan-X — which I have a lot of feelings about, but it's essentially just a CO2 chamber. And you turn the button on, and you wait for 20 minutes to half an hour, and they die (Sleiman, 2020).

In this example of a laboratory worker, who is responsible for getting rid of the surplus mice, it becomes apparent that, as Kenneth Shapiro points out, animals lose their individuality and become "deindividualized" in the laboratory setting. This deindividualization applies not only to the routine sacrifice or killing of laboratory animals when their use is finished, but it also applies more generally to the acts of dosing and monitoring chemically-exposed animals in laboratories, as in the case of the

LD50 test forcing the animals to swallow or breathe progressively higher amounts of chemicals until they can no longer survive their exposure. Those factors that Shapiro identifies as contributing to this de-individualization include: "the large numbers of animals used; the brief time many of them live; the focus on parts of animals rather than on whole animals, the press for genetically identical animals; the need to kill the animals; and the production of animals solely for research" (Shapiro 2002, 450).

Toxicity testing is an outstanding example of the way in which scientific reductionism breaks down complex interactions into separate events. Testing different responses and functions of the de-individualized, deconstructed animal bodies is done presumably to facilitate an understanding of, and predict, the potential responses of humans to chemical exposures. In this case, the different elements of the animal – skin, nerves, organs, lungs – are constituent parts of a whole being that are isolated individually and tested separately. The scientific assumption is that by determining the degree of harm inflicted on each separate body-related part or function of an animal, it will be possible to reconstruct these elements into a comprehensible understanding of a chemical and its toxic effects on humans, based on the various reactions of animals. This composite of different exposures will then be transferable to the potential response of humans and the risk of toxic responses assessed and minimized. A certain level of toxic exposure to an animal that causes death can be reduced to a mathematical calculation, say divided by 100 to insert a safety factor, and a level of exposure that is unlikely to harm humans is then thought to be derived or determined on that basis.

There are many concerns with these partial methods of testing, based on the reductionist approach. Important criticisms have been raised with respect to the potential limitations of scientific reductionism in toxicity testing: 1) that species, strains and gender variations in animals may not extrapolate accurately to humans; 2) that scaling up from small short-lived animals like

mice and rats who are given large doses of chemicals to large longer-living animals like humans may pose problems; 3) that test animals represent a generally homogeneous population in contrast with human populations where there are significant differences; and, 4) there are limitations using animal tests with regard to testing chemical mixtures or interactions between chemicals, to which humans will inevitably be exposed in the more complex world outside of the laboratory (Nuffield Council on Bioethics 2005, 158).

The Economics of Animal Testing

Animal research is a competitive, multi-billion dollar industry whose procedures, processes, and products earn substantial profits (Bisgould 2011, 206). That segment of the animal research industry, known as the "*in vivo*" (meaning live animal) toxicology market, is a subset of a lucrative enterprise. It is comprised of animal models, toxicity testing methods (such as repeated dose toxicity), toxicity endpoints, testing facilities (some of which are outsourced and some in-house), and end users, including academic and research institutions, and contract companies hired to do research (Marketsandmarkets 2020). If we consider the *in vivo* toxicology market alone, it is predicted to reach a value of $6.6 billion by 2025 up from 5 billion in 2020 (Research and Markets 2017), based on expectations that drug companies will increase their research and development, that there will be continued innovation in animal models as well as the development of exclusive *in vivo* toxicological tests, and an increasing demand for personalized medicine.

In addition to the Jackson Laboratory, leading suppliers in the animal model industry include Charles River Laboratories International, Envigo, genOway SA, Horizon Discovery Group, Taconic Biosciences, and Trans Genic (Global Market Insights 2020). Under the sub-heading "Not Just Squeaking By," in *Genetic Engineering and Biotechnology News*, a 2020 article indicates that animal model providers, such as the Jackson Laboratory, are part of a robust global market, serving not just the toxicological sector but the whole animal research industry, projected to reach a value of $24 billion

by 2025 from $13.4 billion in 2018. This is considered to still be a realistic estimate given the relatively stable use of animals world-wide (Meigs et al. 2018). The clients of the "*in vivo*" toxicology market include academic and research institutes, pharmaceutical and biotechnology companies, contract research organizations, cosmetic companies and food laboratories. Global Market Insights shows the U.S. dominating the animal model market, although Canada also has sales. Toxicity testing for regulatory purposes makes up a significant part of this animal market.

Government regulations are an important driver of toxicity tests that require the use of animals (Nuffield Council on Bioethics 2005, 156). Elisabeth Ormandy, Director of Research for Animal Charity Evaluators and, in my interview with her, identified regulatory requirements as one of the areas of animal use most difficult to address: "there's nothing you can do about it" (Interview, Elisabeth Ormandy, May 27, 2021). As I have noted earlier, data from established animal tests are demanded by regulatory agencies as part of a company's submission for the approval of a new chemical, drug, pesticide or cosmetic ingredient. Ormandy identifies the various pieces of legislation in Canada, which demand implicitly or explicitly animal testing, as the *Canadian Environment Protection Act* under the purview of Environment Canada and Health Canada and Health Canada's requirements for testing food additives, pesticides and drugs under the *Food and Drugs Act* (Ormandy 2021). Tests like the LD50 can be part of a check list that some countries demand even though others may discourage it. Therefore, in order to maximize returns, companies strive to market their chemicals world-wide, and decide, therefore, to conform to the regulatory requirements of many different jurisdictions (156). *In vivo* toxicity tests may also be of value later to manufacturers if they have to defend themselves against consumer claims regarding their products (International Association Against Painful Experiments on Animals n.d.). The Organization for Economic Cooperation and Development (OECD), of which Canada is a member, has promoted the "harmonization of international regulatory acceptance of adequately validated test methods" (AltTox

Toxicity Testing Overview 2016). Harmonization would standardize test methods so that member countries could agree on data and remove the need for different testing protocols required for regulators in different countries (Nuffield Council on Bioethics 2005, 156). It could also facilitate new and better testing methods, although this is still a work in progress. As a result of the OECD's work validating new testing methods, there has been some reduction in the numbers of animals used for certain standard tests (156).

JAX, the Jackson Laboratory in Bar Harbour, Maine, is still not only one of the most successful mouse-selling businesses in the United States, but internationally as well. It advertises its mice as "the most published and well-characterized mouse models in the world," supplying approximately 3 million mice annually to research laboratories, universities and pharmaceutical companies (The Jackson Laboratory n.d.). The JAX Lab`s best-selling mouse is the C57BLe6, or "Black Six," a long-established inbred strain. These customized mice can be extremely expensive, some with custom-ordered genomes costing tens of thousands of dollars. The trend in the development of animal models currently focuses on humanized animal models, where demand has been increasing across all sectors.

Another prominent supplier of laboratory animals, who, like the Jackson Laboratory, ships out millions of mice annually to institutions in the U.S. and to international clients, is the Charles River Laboratory, headquartered in Boston. Charles River laboratory established its reputation as a supplier of the Wistar rat, developed originally from the breed of Norway rats and now the most common breed of laboratory rat (Shapiro 2002, 441). At Charles River, they advertise their mouse and rat breeding as "a full-service rodent colony management program to deliver animals to you when you need them, in the exact quantities you specify, and with the health status that you require" (Charles River, n.d.). Charles River, the Jackson Laboratory and the other major companies in the animal production industry, ThermoFisher, Danaher, Covance, Eurofins, Envigo, DSI, also function

as contract research organizations employing regulatory toxicologists who commission testing (Meigs et al. 2018).

In addition to the acquisition of mice for toxicity testing, another segment of the animal research industry includes the equipment, food and bedding, needed to accommodate the animals. Laboratory animals, from the earliest days of their breeding, required special cages, bedding, substantial food, and caretakers to maintain them (Rader 1998, 338). The laboratory animal cage industry is also world-wide, with companies like Thoren Caging Systems in Pennsylvania specializing in modular and specialized caging, as well as offering a rodent euthanasia rack that allows the monitoring of CO2 levels (Thoren n.d.).

These animal models, as well as the care and feeding of the animals themselves, all have significant environmental consequences, which are rarely documented or discussed. According to a study by Katherine Groff and her colleagues at the New England Anti-Vivisection Society, the evidence suggests that the use and disposal of the millions of animals in research and testing, and the chemicals and other supplies associated with this use, not only contribute to pollution, but have impacts on laboratory workers' health and on biodiversity (Groff et al. 2014, 14). They note that the number of animals used in research and testing, already a large number, is believed to be growing as a result of the development of genetically modified (GM) mice: "the creation of GM mice has inherent scientific flaws which lead to significant waste in the form of animals bred which are not usually used in research or testing and instead become waste or unusable industrial by-products" (15). These mice can become waste when their offspring do not have the desired trait or deformity for which they are bred, or they have another unintended deformity, which make them unsuitable for sale to research laboratories. These animals are euthanized and their numbers never reported, making the estimates of animal use in research artificially lower than the reality.

This points to another problematic aspect of the animal model production industry – the destruction of used animals and the waste practices associated with it. The disposal of laboratory mice and other sacrificed animals from research laboratories is a serious challenge for the industry because of the hazardous nature of the remains. These remains may be contaminated with harmful substances that have been found to be corrosive, reactive and toxic, or they may contain harmful chemicals such as mercury, formaldehyde, benzene, arsenic or other known carcinogenic compounds (Groff et al. 2014, 18). As well, the disposal of significant amounts of other laboratory waste, including bedding, excess feed, caging, needles, syringes and gavages, used in carrying out toxicity testing, may also carry with it potentially harmful contaminants (18). Incineration is the recommended method for destroying the animals and the associated waste, even though incineration itself is known to distribute hazardous chemicals as air pollution due to incomplete destruction of materials (18). Occupational health concerns also deserve consideration in this discussion of the animal model industry. Asthma, allergic reactions, exposure to waste anesthetic gases, and infections transferred from infected animals to laboratory workers, all pose potential hazards for those who work closely with breeding and caretaking animals for sale to research facilities and for those personnel who work in animal research and toxicity testing facilities (22).

Conclusion

What can a mouse, then, born in the Jackson Laboratory and sold and shipped to Product Safety Labs in New Jersey expect from its life? In this abbreviated review of the major toxicity tests being offered by toxicity testing services, it is evident that mice are often the species of choice for this work, as the Nuffield Council on Bioethics stated in its comprehensive review of animal research. The reasons are largely commercial – not that mice are more accurate indicators of human response, but they are cheaper than other animals making the tests less costly, and they have shorter lifespans so tests can be concluded more quickly. This is why the mouse finds itself undergoing tests that

induce cancers with regular force-feeding or infusions of chemicals, or having their lymph nodes dabbed with chemicals and then cut out, so scientists can ascertain whether a chemical causes cancer or dermal sensitization. But it is not only carcinogenicity or dermal sensitization tests, which require mice to submit to different chemical exposures, commercial mice are also animals of choice for acute and repeated dose toxicity tests, reproductive and developmental toxicity studies, and genetic toxicity tests, compounding the agony for mice of being the heavily favoured laboratory animal (Medicilon n.d.).

Toxicity testing, without a doubt, is one of the most violent uses of animals within the larger animal research industry. To attain its desired goal, it must inflict considerable pain and suffering on any sentient animal that has to undergo chemicals forced into or onto their bodies. Animal welfare laws, no matter how lofty their intentions, cannot spare animals the pain accruing from the procedures dictated by standard toxicity testing. Better bedding, lighting, and more companions are minor comforts to a mouse that will ultimately have to endure the harms of the various toxicity tests. It is, therefore, toxics laws to which we have to turn our attention if we wish to spare animals the trauma of these experiences, as explained in Chapter Eight. The irony of the toxicity testing, which has been done to date, is that despite the pain and suffering caused to animals in the name of consumer safety, the public has not been shielded from many subtle but damaging toxic effects of chemicals, as discussed in the next chapter. Many scientists in government, private companies and the testing industry are working hard to develop alternatives to the tests described here, but change comes very slowly. Not only is an overhaul needed to eliminate the use of animals in toxicity testing and spare them the pain and death that these tests elicit, but the whole regime of toxicity testing needs to be redone in order to protect both animals and human health, as well as the environment.

Chapter Seven: Toxic Trans-Corporeality

arsenic in calculators, mercury in felt
hats, mad as a poisoned hatter
pyrophoric undercurrent in mundane
acts assume poison unless otherwise
informed crowded alloys detect no
health damage until generations later i
brush my teeth with nuclear intensity
the cavities i avoid destined for others
fall into hazardous-waste piles up as
i sleep smells though i don't see it
transported across oceans & into sad
rural neglect how shiny my teeth are
this cold crisp morning

Rita Wong, fluorine from "forage"

Introduction

In theory, toxicity testing based on animals is the safety screen that precedes the approval of chemicals, which then go on to become an integral part of the products in everyday use. We know these chemicals as the aerosols that "freshen" our indoor air, the pesticides sprayed on our gardens, the miraculous cleaning products that shine our countertops and buff our floors, the face creams, nail polishes and shampoos regularly applied for the sake of beauty, and the fire retardants that keep our phones, our computers and our furniture from bursting into flame. In this chapter, the question I am investigating is the question of how effective toxicity tests using animals have been in preventing disease and injury to human health and in preventing contamination of the environment.

To answer the question of how effective the reductionist approach to toxicity testing using animals has been in preventing environmental disease and contamination, I look at the conventional ways in which chemicals are assessed and the outcomes of a regulatory approval process based primarily on animal testing. I begin by looking at the paradigm of the risk society, in which we are now living, at least partially as a result of the unleashing of these toxic chemicals onto the world. In the third section, I investigate the more recent phenomenon of their invisible effects becoming

visible and the societal response to this phenomenon. In the fourth section of this chapter, I review, with specific examples, the increasing visibility and knowledge of the impact of these chemicals on our health and the environment, including the rising incidence of diseases like cancer and problems such as asthma, diabetes, infertility and learning disabilities, as well as the environmental damage to fish and wildlife. In the fifth section, I give an account of the regulatory inadequacies of toxics control and how the political economy of chemicals plays out in the process of risk assessment. As a result, the problem of widespread toxic contamination is never brought under control. The laws themselves and their shortcomings are discussed in detail in Chapter Eight, the next chapter. And finally, in the last section, I draw my conclusions on how to move forward in our attempts to solve these problems.

The Risk Society

The German sociologist, Ulrich Beck, has characterized the postmodern world as a "risk society" because of the extent to which environmental problems that once were localized now constitute a threat to all society (Beck 1992). As he puts it, ecological and high-tech risks are no longer tied to places of origin, such as industrial chemical sites or waste landfills, but by their nature, now endanger all forms of life on this planet. Those risks, as he presents them, are problems of reflexive modernization, in which corporations unchecked by governments have allowed the global dispersal of radiation, pesticides, toxic chemicals and other environmental threats, including even unemployment. As society has moved from industrialization to a technological orientation, the risk society has become defined not just by the distribution of "goods," but also by the distribution of "bads," pollutants that could be kept in check but are not (Baxter 2020). These pollutants have become an invisible, yet potent, risk to everyone everywhere on the planet. And although everyone is exposed, it should be noted that marginalized, low income, racialized and indigenous communities have borne an unfair and uneven burden of the "bads," with chemical factories and landfill sites

often situated near their homes.[20] However, these threats are difficult to comprehend without recourse to scientific technology or institutions (Alaimo 2012, 19).

This is especially true of toxic chemicals. In industrialized societies, the technological drive to develop and market chemicals without due concern for their toxic effects, has become an almost universal risk, with an increasing incidence of disease. Studies of environmental exposures by independent scientists, however, have illuminated some of these risks. The Silent Spring Institute, for example, has linked breast cancer with exposures to common chemicals like those used in stain-resistant textiles or as flame retardants, methylene chloride found in specialty cleaning products, or gasoline (Brody et al. 2007). Ann Phillips notes that women are exposed to environmental contaminants in different ways than men, and the effects of those exposures are also likely to differ (Phillips 2015, 40). More specifically, Scott and Lewis state that "women can be more biologically vulnerable to certain exposures during *critical windows of vulnerability,"* times of development or hormonal activity in which women are more sensitive to chemical exposures (Scott and Lewis 2015, 82). Yet, not only have the risks of toxics to society in general been poorly scrutinized, but gendered concerns, like the different impacts of toxic chemicals on women, have been sorely neglected in the discussion and assessment of toxic chemicals.

For Beck, the invisibility of risk comes from what he calls "the stowaways of normal consumption," the things that we may ingest and breathe, and that can be present in anything and everything, including the necessities of life (Beck 1992, 40).[21] However, these risks are not immediately obvious but are only recognized through the politics of knowledge. If we are at risk of

[20] This unfair distribution of environmental hazards has led to the creation of the environmental justice movement. The U.S. Environmental Protection Agency defines "environmental justice" as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (U.S Environmental Protection Agency, "Environmental Justice." March 23, 2002.)

[21] Beck is writing from a global risk perspective, which does not consider important environmental justice issues. It is now recognized that some parts of our society, the more vulnerable and oppressed, are likely to be exposed to more risk as a result of the siting of toxic waste sites or chemical manufacturing plants in their communities.

contracting breast cancer by our exposure to gasoline or methylene chloride, the degree of risk related to this exposure is not determinable by cognitive means or by experience, but rather depends on external knowledge (53). We may perceive a risk, but "science" has determined what that risk might be. In Beck's risk society, this "scientization" of risks has been increasing as more potential environmental hazards are introduced, as the number of chemicals continues to mount, and as commerce with risks grows (Beck 1992, 56). The failure of techno-scientific rationality to address the potential harm of these chemical exposures is, according to Beck, grounded in "the institutional and methodological approach of the sciences to risk" (59). Scientists determine acceptable levels of risk, but these levels permit the emissions of toxins and legitimize them to just that limited degree (64). This, Beck says, "may indeed prevent the very worst from happening, but they are at the same time 'blank cheques' to poison nature and mankind (sic) *a bit*" (64, italics in original).

Beck's critique of risk assessment also asks how it is possible to determine acceptable values for individual substances, striking out at the bioaccumulation of chemicals. Beck argues that as more and more substances are ushered into circulation, the toxic threat grows, the total volume of various toxic substances results in a higher degree of overall toxicity, and, in the case of some chemicals, they accumulate in our bodies and in natural systems. People and nature, he claims, are "*collecting vessels* for all sorts of pollutants in the air, water, the soil, food, furniture, etc. Whoever would determine threshold values of toleration must take account of this *summation*" (66, italics in original). He also raises the failure of risk assessment to incorporate the unpredictable effects of synergism, pointing out that it ignores the possibilities that toxic chemicals can minimize or maximize each other's effects. These concerns have been raised for decades by toxics activists who have challenged risk assessments on the basis of their failure to consider the bioaccumulation of chemicals in humans and nature and the synergistic effects of chemicals acting in unpredictable ways

when they come into contact with each other, interactions that Beck calls the "the cock-eyed plane of possible, partial toxic effects" (67).

Beck's analysis of the risk society is an indictment of the chemical industry and government regulators who have established these prescribed rituals of conventional animal testing and the subsequent assessment of risk. Together, these two steps in the process of regulatory approval offer only a very limited window into the real harm that will be done to human health and the environment. After their approval by government agencies, these chemicals become integrated into industrial processes and products that enjoy worldwide distribution. The lack of rigour in the rituals of testing and risk assessment, which presumably have been set up to spare society and the environment from toxic invasion, in effect prioritizes the development, manufacturing and global sales of chemicals over considerations of public health and environmental harm.

Beck also speaks directly to the issue of using animals to assess human health effects, insisting that there is no value in using animals for estimating human exposure to risks. He categorically asserts that "*false conclusions on the reactions of people are drawn from the results of animal experiments"* (68, italics in original). If animal testing actually reduced or eliminated risks, we would not be in the situation in which, according to Beck, "the experiment on people does take place, but invisibly, *without* scientific checking, *without* surveys, *without* statistics, *without* correlation analysis, under the condition that the victims are not informed – and with an *inverted* burden of proof, if they should happen to detect something" (Beck 1992, 68, italics in original). This experiment takes place by administering the substance to people in small doses, as is done with research animals. Thus, humans become the "guinea pigs" in the laboratory of the world, in which toxic chemicals are widely distributed and humans widely exposed.

The Invisible Becoming Visible

In Beck's view, it is necessary to make the invisibility of this chemical contamination visible; similarly the goal for environmental health activists is raising awareness of these hazards, which are present but unseen. The infiltration of toxic chemicals into our bodies is a specific area of concern, with a focus on making them visible through publishing and publicizing studies that document chemical trespasses and draw public attention to these issues. Rachel Carson, whose book, *Silent Spring*, published in 1962, is credited with launching the environmental movement, was one of the first people to attempt to make contaminants visible to a somewhat unsuspecting public. In *Silent Spring,* she called attention to both the perils of mass pesticide spraying, as well as to "the innumerable small-scale exposures to which we are subjected day by day, year after year" (Carson 2018, 173). Carson recognized that those poisons, which are distributed into the atmosphere, the oceans, and the soil, as a result of human intervention, have the potential to infiltrate all the natural world. Residues of chemicals linger in the soil, and "have entered and lodged in the bodies of fish, birds, reptiles, and domestic and wild animals" (15).

Not only did Carson recognize the toll that chemicals were taking on the ecological integrity of nature, but she recognized the vulnerability of humans to the onslaught of contamination from birth to death, noting in her prescient writings that "each of these recurrent exposures, no matter how slight, contributes to the progressive buildup of chemicals in our bodies and so to cumulative poisoning" (173). Ultimately, Carson concludes that the delicate and destructible fabric of nature is being ignored by the practitioners of chemical control, largely the major pesticide and chemical manufacturing companies that became powerful after the Second World War. These "practitioners" that distribute their chemicals for use in communities and forests everywhere are characterized by their arrogance and their lack of humility "before the vast forces with which they tamper" (297). As a result of her implicating pesticides in the damage done to insects, birds, animals, waterways, and

human health, Carson became the target of campaigns to discredit her work Led by the "practitioners," American Cyanamid, Monsanto, and Velsicol, and joined by the Department of Agriculture, the chemical industry launched television and print ads to convince the public that her concerns had no merit. Rather than addressing the issues raised by Carson with respect to the limitations of pesticide efficacy and their effects on human health and the environment, the chemical companies and their allies focused on personal attacks, seeding doubt and misinformation, as Sandra Steingraber documents in her introduction to the most recent re-issue of *Silent Spring* (Steingraber 2018, Introduction to Silent Spring xxxviii).

Despite the fact that Carson was writing in the 1960s, the issues, which she brought to the fore and the conclusions that she drew, have, as biologist and writer Sandra Steingraber finds, stood the test of time (xxiv). An example of Carson's meticulous research was the evidence that she laid out linking pesticide exposure to cancer risk. Years later, these links have been confirmed many times over, with, for example, a 2015 study of 15,000 California women and their daughters, which found a fourfold increase in the risk of developing breast cancer for women exposed in the womb to high levels of DDT (Cohn et al. 2015; Steingraber 2018, xxxv). Carson also hypothesized that some pesticides could mimic estrogen, a phenomenon now known as endocrine disruption. Endocrine disruption, which emerged more recently as a disturbing new threat, describes the ability of certain chemicals to interfere with hormone metabolism and to affect development during pregnancy and puberty (xxxv). Early life exposures to endocrine disrupting chemicals have been linked with a "dramatic increase in the incidence of contested illnesses and disorders over the last two decades, especially in women," including possible links to breast and thyroid cancer, multiple chemical sensitivities and other autoimmune diseases (Scott and Lewis 2015, 86). Carson, then, was prophetically accurate in her anticipation of the environmental health movement and the issues that would become pressing in the past several decades since the publication of her book. *Silent Spring* is

an early testimonial to the knowledge of chemical effects on human health and the corresponding failure of governments and corporations to translate this knowledge into preventive action.

Stacy Alaimo, who today carries on the legacy of Carson's visionary writing, also observes that "containment is not possible" in the world described by Carson, and in the contemporary world that she herself explores (Alaimo 2012, 486). Alaimo, in her 2010 book, *Bodily Natures: Science, Environment and the Material Self,* introduces the theory of "trans-corporeality," in which penetrable human bodies are part of a fluctuating environment intermeshed with animal bodies and inseparable from the whole natural world (Alaimo 2010). She describes "trans-corporeality" as "a new materialist and posthumanist sense of the human as substantially and perpetually interconnected with the flows of substances and the agencies of environments" (Alaimo 2012, 476). By underscoring that "trans" indicates movement across various sites, then trans-corporeality opens up a space "that acknowledges the often unpredictable and unwanted actions of human bodies, nonhuman creatures, ecological systems, chemical agents, and other actors," which can lead to ethical and political positions relevant to twenty-first century realities (Alaimo 2010, 2).

Alaimo looks at the material forces of our posthumanist world and explores their increasingly harmful effects on human bodies. Consistent with her contention that material bodies have agency, Alaimo considers the means by which toxic chemicals can penetrate, interact and act on biological bodies in powerful ways. The way Alaimo conceptualizes trans-corporeality is vividly descriptive of the permeability of human and natural systems. Transcorporeality helps us to understand ourselves, not as isolated entities within a separate landscape, but as permeable beings within a network of inter-relationships. Thus, the chemical that is factory produced and incorporated into a product finds many pathways into human bodies, sometimes through direct exposures or perhaps through the infiltration of the natural systems that also interact with our bodies -- the landscapes, the waterways, the air, and the living creatures within these systems. There are few barriers and, as

agents with their own unpredictable movements, chemicals can insinuate themselves in all aspects of life.

The Politics of Knowledge

The consequences of the lack of rigour in the testing and assessment of chemicals are borne out by the information that we glean from toxic reports. The transcorporeality of our bodies, for example, has now become visible from biomonitoring studies, which can detect the body burden of chemicals that most of us carry. We are informed (and suitably horrified) that babies are born "pre-polluted" from their mother's exposure to toxic chemicals (Environmental Working Group 2005). This first became evident in a 2005 report from the U.S. Environmental Working Group (EWG), a report that dispelled the commonly-held belief that the placenta would protect a developing baby from chemical contamination. Contrary to that assumption, the EWG study found an average of 200 industrial chemicals and pollutants in umbilical cord blood. In the wake of this study, numerous biomonitoring reports have confirmed the presence of hundreds of these chemicals in human bodies.

The visibility of these chemicals, then, gives us some partial knowledge allowing us "not only to assess risks but to survey the landscape of the self," as Alaimo puts it (Alaimo 2010, 19). In North America, the most comprehensive studies have been conducted by the U.S. Centers for Disease Control (CDC) in Atlanta, whose findings not only confirm, but expand, the range of chemicals detected by EWG. The CDC has documented more than 300 specific industrial chemicals, to which people in the U.S. have been exposed, detecting these chemicals in their bodies – primarily through blood and urine samples (Centers for Disease Control and Prevention 2021). [22] However, what we don't know is what the presence of these chemicals in our bodies means. We must settle for some

[22] The United States Centers for Disease Control conducts these studies under their National Biomonitoring Program. Similarly, Canada has the Human Health Measures Survey, a program under which Health Canada has sampled Canadians and also detected found numerous chemicals in human tissues and fluids.

insight into significant health problems: they tell us, for example, that approximately half a million children in the U.S. have blood lead levels above a 5 micrograms/deciliter level, a level that can damage the brain and nervous system and cause learning and behaviour problems, the legacy of old lead-based paint or the cost of living too near an airport (Centers for Disease Control and Prevention 2021).

Trans-corporeal ethics require us, in Alaimo's view, to "inquire about all of the substances that surround us, those for which we may be responsible, those that may harm us, those that may harm others, and those that we suspect we do not know enough about" (Alaimo 2010, 18). The "politics of knowledge," then, to which Beck refers, is the singular means by which we can grasp the dimensions of our society's risk. Science becomes a critical piece in seeking to name and identify the invisible "risks," that must be made visible in order to reduce or eliminate them. This is the work, for example, of the pioneering Silent Spring Institute in Massachusetts. Named as a tribute to Rachel Carson, the Silent Spring Institute is dedicated to investigating those exposures, which are most likely to cause us grief. Their focus is on identifying chemicals that cause breast cancer,[23] how women are exposed and the health risks. Silent Spring has researched the transcorporeality of such notorious chemicals as DDT, dioxins, and the highly fluorinated chemical PFOSA, whose infiltration into a woman's body increase her risk of breast cancer by two to five times (Silent Spring Institute 2021). They inquire, as Alaimo suggests, about all those substances that surround us and may harm us, and those substances that we suspect we do not know enough about. They urge people to reduce their exposure to the flame retardant PBDEs, used in upholstered materials and found in household dust, by replacing old couches with newer safer ones without PBDEs. The harm, they suggest from flame retardants, may be cancer, thyroid disease, decreased fertility, lower IQs and other damaging effects (Rodgers et al. 2021).

[23] Breast cancer is the most common cancer for women world-wide (Silent Spring Institute 2021).

This call to seek out safer products or toxic-free products has been described by sociologist Norah MacKendrick as "precautionary consumption" (MacKendrick. 2015). "Precautionary consumption" promotes the concept of taking personal action to reduce exposures to everyday toxic chemicals and thereby reducing chemical body burdens through the purchase of "less toxic" consumer items (Scott, Haw and Lee 2016, 1). It reflects both an acknowledgement and a concern for the infiltration of toxics into the body and a belief that individual consumer choices can offer protection against toxic exposures. It bears similarities to "green citizenship" in which individuals are empowered to "understand, or imagine, and potentially engage in, a very particular green 'good life' that draws heavily on Western conceptions of the nonhuman natural world and humans' appropriate relation to it" (Gabrielson and Parady 2010, 377). MacKendrick points out that a shopper engages in precautionary consumption because she is in effect "attempting to circumvent the conventional consumer landscape, which is characterized by a lack of precautionary decision-making by chemical producers, product manufacturers, and governments charged with overseeing chemical safety"(MacKendrick 2015, 60).

Both toxics activists and animal activists promote "precautionary consumption," as a strategy to raise awareness and build a constituency that will support their campaigns. In the case of toxics activists, precautionary consumption is directed at identifying specifically harmful toxics, arguing that chemicals, which are, for example, carcinogens, reproductive toxins and hormone disruptors, should not be in everyday products and they urge consumers to avoid them. Similarly, animal activists award "cruelty-free" labels to cosmetic companies that do not test their products on animals. In their case, the strategy is not directed at safeguarding public health but, rather uses individual consumption choices to target animal testing and to further their overall objectives of eliminating all animal testing for cosmetics.

However, this individualized response to the proliferation of toxic chemicals, particularly in consumer products, ignores the process of 'active materiality,' as York University law professor, Dayna Scott, has characterized it, and does not recognize the possibilities of transcorporeality. Transcorporeality, as defined by Alaimo, "conceptualizes the idea of 'the time space where human corporeality in all its material fleshiness, is inseparable from 'nature' and the 'environment' (Gabrielson and Parady 2010, 382). Active materiality "undermines the notion that we can exercise perfect control over the movement of toxics through our world" (Scott et al. 2016). Scott, Haw and Lee argue that precautionary consumption is a misguided strategy, and that resistance to toxics should be oriented towards "corporeal citizenship" (Scott et al. 2016). In Scott, Haw and Lee's "WannaBe Toxic-Free," they stress the importance of the collective action of citizens in challenging the current approach of governments to toxics control:

> Rather than a narrow focus on 'downstream' actions of individual consumption, a corporeal citizenship approach involves 'upstream' collective engagement to agitate for changes in policy and legislation. Many of these consumer-based campaigns launched by advocacy organizations are reacting to the broader trends of individualization promoted by neoliberal influences on current environmental governance (Scott, Haw and Lee 2016, 337).

The concept of corporeal citizenship, as advanced by Gabrielson and Parady, argues that individualistic conceptions of human agency must be replaced by a more collective one (Gabrielson and Parady 2010, 383). As Gabrielson and Parady point out, humans are inescapably embedded "in both social and natural contexts" and corporeal citizenship begins with "an understanding of the human body as porous but resistant, plural and connected" (Gabrielson and Parady 2010, 382). They note that individualized consumption practices fail to take into account the uneven and unequal exposures of different communities. Precautionary consumption also falls disproportionately to women, according to MacKendrick, because of their primary role in household consumption decisions, in managing their family's health, and in planning and shopping for meals (MacKendrick 2015, 62). Therefore, rather than trying to insulate ourselves from toxic exposures

and bodily infiltration through individual consumption choices, corporeal citizens would work for changes in legislation and policy regimes that would benefit all (Scott, Haw and Lee 2016, 14). Precautionary consumption, then, not only places an unfair burden on individuals, and women in particular, but, in the case of the proliferation of toxics, does not address many exposures that cannot be avoided through individual buying choices.

Toxic Consequences

There are many ways in which we are exposed to toxic chemicals, over which we have little or no control: at work, at school, in public spaces like libraries or parks where gardens may be sprayed, and in drinking water. Spray cleaners, for example, that are used to clean or freshen up our houses and offices, have been associated with an increased risk of new-onset asthma in adults (Zock et al. 2011). For children, the more cleaners that are used, the more likely they are to have wheeze or asthma, with scented products posing the highest risk (Parks et al. 2020; Abrams 2020). Still, as many of those concerned with environmental health have pointed out, even though research has shown that specific products contribute to adverse health effects, identifying their contributions is "hindered by limited and inconsistent disclosure" of their chemical ingredients (Dodson et al. 2012).

Other sobering links have been made between fertility problems in both men and women and the endocrine-disrupting activity of non-persistent chemicals, such as Bisphenol A, parabens, triclosan and phthalates (Gross 2020), and both women and men are heavily exposed to these chemicals in plastics, medical equipment, detergents and cosmetics, with chemicals like phthalates making products "flexible, durable and fragrant" in spite of their association with reproductive problems (Gross 2020). Even though, as non-persistent or "pseudo-persistent" chemicals, they may be short-lived in the body, they have been found to affect women's reproductive health – interfering with menstrual cycles, and contributing to endometriosis, uterine fibroids, polycystic ovarian syndrome and infertility (Cho et al. 2019). Although the exact mechanisms by which these

chemicals lead to changes in women's bodies are not clear, even low dose exposures can cause adverse effects, which are not limited to the reproductive age of women but can occur at any time in her life and into the next generation (Cho et al. 2019).

In the case of BPA, over 50 years ago, using traditional toxicological evaluations that administered high doses to animals, BPA was determined not to be harmful to humans (Warner and Flaws 2018). Once the "no observable adverse effect level" was reached, a safety threshold of 100 to 1,000 times was added, and BPA was deemed safe for humans (Warner and Flaws). The estrogen-mimicking properties of BPA were observed, but not considered problematic in the 1930s. However, in more recent years, scientists have discovered that exposure to endocrine-disrupting chemicals such as BPA can be more harmful at low levels than at high levels. As Warner and Flaws have pointed out, in the case of BPA, and phthalates too, the traditional toxicological assumption that the "dose makes the poison" does not apply (246).

Similarly, men throughout the world have been struggling with low sperm counts and infertility associated with environmental exposures. Dramatic decreases in sperm counts, for example, have been found in men working in pesticide factories manufacturing the pesticide, DBCP (Gabrielsen and Tanrikut 2016). As well, a study of men, who were one half of "subfertile couples" seeking medical help, showed an association between decreased sperm counts and at least one phthalate, mono-benzo-phthalate (Duty et al. 2003). These concerns have been captured in the book, *Count Down*, by Shanna Swain, an epidemiologist at Icahn School of Medicine at Mount Sinai in New York, who sees falling sperm counts and changes to sexual development, resulting from lifestyles and "everywhere chemicals," as a threat to human survival (Bryant 2021).

Environmental contaminants are also, at least partially, to blame for the rising incidence of developmental problems in children, although many independent experts question whether this rise

is a result of improved diagnosis or an actual rise in the number of problems being recorded. Neurotoxins, which affect prenatal and early childhood brain development, can cause learning disabilities, attention deficit hyperactivity disorder, developmental delays and emotional and behavioural problems. Ted Schettler, of the Science and Environmental Health Network in Boston, has reviewed those chemicals known to be neurotoxic and their role in the development of neurologic problems in children (Schettler 2001). Inquiring about the substances that surround us and that may harm us, his list includes lead, mercury, manganese, polychlorinated biphenyls, alcohol, nicotine, and agricultural pesticides, although he points out that only limited data on agricultural chemicals are available despite their widespread use (815).

Although the most publicized chemical concerns tend to spotlight human health effects, the release of toxins has also resulted in significant damage to the environment and to wild animals exposed to these chemicals. Often, the presence of these toxins can be traced back to discharges from sewage treatment plants. Fish, for example, are susceptible to many toxic chemicals that are flushed from sewage treatment plants into the lakes or other waterways. Exposed to triclosan, a popular antimicrobial agent added to soaps and detergents and flushed through thousands of sewage treatment plants, fish have experienced reproductive and developmental problems (Dann and Hontela 2011).

Other significant sources exposing animals to toxins are industrial discharges, leaking landfill sites, and airborne contaminants. Eagles, eating fish, accumulated levels of the pesticide, DDT, before it was banned – levels that were high enough to damage the eagles' ability to have young and high enough to endanger their survival as a species (Colborn 1999). Controlled feeding studies of wild fish, mammals and birds found diets, laced with methylmercury at environmentally realistic concentrations, resulted in a range of toxic effects, including behavioral, neurochemical, hormonal and reproductive changes (Scheuhammer et al. 2007). Field-based studies with birds, including the

common loon, further implicated methylmercury exposure in impaired reproduction (Burgess and Meyer 2008).

The accumulation of toxins, like mercury in fish from the Great Lakes and other bodies of water, has elicited health warnings from governments to people who might be catching and eating them, the consequences particularly threatening for indigenous populations who rely on fishing for food (Gandhi et al. 2017). If we look for an example of Alaimo's attention to the agency of contaminants and her monitoring of the interconnected flows of substances, it is a pregnant woman eating mercury-contaminated fish where she does not know that even small amounts of mercury may lead to learning problems in her unborn child. The methylmercury in fish threatens the developing child with its neurotoxicity, and the persistent organic pollutants, like polychlorinated biphenyls or DDE increase the likelihood of developing diabetes for sports fishers and their families (Turyk et al. 2009).

Just as toxicity testing is woefully inadequate for assessing the true and varied nature of chemicals, the limitations of ecotoxicity studies have also been noted. Katagi, in his research on the fate of pesticides in water systems, finds that laboratory exposure studies are insufficient when dealing the complexity of parameters that occur in the natural environment (Katagi 2010). Those factors, which are not taken into account in traditional ecotoxicity studies, include the site-specific chemistry of water systems and sediment, as well as the climate. He calls for ecotoxicological assessments to include more in-depth investigations of the relationships between the residues of pesticides in organisms and ecotoxicological endpoints. The prevalence of persistent organic pollutants in remote areas such as the Canadian Arctic and Alaska also demonstrates the shortcomings of ecotoxicity studies. Caribou, seals and fish, which provide indigenous people with their basic foods, are contaminated with PCBs, dioxins and pesticides like DDT, endrin and heptachlor, chemicals that last in the environment indefinitely. Yet, their persistence and their

mobility were never investigated before their presence was documented in remote areas. Although these examples offer only a glimpse of the movement of toxics across lines and do not constitute a comprehensive list, they underline Alaimo's thesis that the intermeshing of human corporeality with the more than human world underlines the inseparability of the two, and raises the issue of environmental justice (Alaimo 2010, 2).

Political Chemicals

One of the questions that this awareness of bodily and ecological contamination begs is this: how did these chemicals pass through the regulatory gateways that were supposed to filter out or hold back the most dangerous of them? It is well-known, and often repeated, that thousands of toxic chemicals have been approved or released onto the market with little or no data and little scrutiny of their safety (Dellarco et al. 2010).[24] Their environmental fates are "unknown" and their potential for human exposure "poorly understood" (Mitchell et al. 2013). The number generally suggested, based on national government figures, is between 80,000 and 100,000 chemicals. More recently, however, it has been suggested that this may be an underestimate (Pelley 2020), and the real figure may be closer to 350,000 (Wang et al. 2020). Of these chemicals it is estimated that less than 5 per cent have been fully tested (Fischetti 2010).

Like the problem of legislative and policy regimes that do little for laboratory animals, weak toxics laws even when animal tests are done have failed to prevent widespread contamination of the environment and damaged public health by allowing tens of thousands of relatively untested chemicals to come onto the market. These weak laws have served companies well, particularly large

[24] A 2013 U.S. study, for example, of food additives found that "in practice, almost 80% of chemical additives directly – intentionally – added to food lack the relevant information needed to estimate the amount that consumers can safely eat in FDA's (Food and Drug Administration) own database and 93% lack reproductive or developmental toxicity data, although FDA requires feed toxicology data for these chemicals." (Neltner, Thomas G. et al. 2013. "Data gaps in toxicity testing of chemicals allowed in food in the United States." *Reproductive Toxicology* 42: 85-94).

chemical corporations, who have profited from the proliferation of chemicals in our society. There has been little onus on them to generate and provide data that would remove any doubt about safety concerns, or to raise concerns when new data are generated. Where research has shown significant health and environmental problems, attempts to rein in these chemicals have been frustrated by the influence of the major chemical companies on bureaucrats and politicians. Consequently, where chemicals have been found to have serious adverse effects, only limited progress has been made in curbing their use. In some cases, regulatory restrictions on one chemical have led to "regrettable substitutions" where another similar chemical is substituted for the restricted chemical in the same products.

Liora Salter and her co-authors, William Leiss and Edward Levy, in their 1988 book, *Mandated Science: Science and Scientists in the Making of Standards,* label certain chemicals that have gained notoriety in our society as "political chemicals"[25] (Salter et al. 1988). By political chemicals they mean those chemicals, where scientific research has pointed to health effects of concern and which, consequently, have sparked public debates about the broader issues of chemical contamination and pollution control (Salter et al. 1988, 99). Although writing in the 1980s and focusing on early environmental contaminants such as lead, Salter recognized the political forces that were at play in the determination of how potentially toxic chemicals were being managed. The negative impacts of "political chemicals," which they identify, included the growing realization that these chemicals have been responsible for the many subtle, but devastating, effects on human health, described in the previous section, including their impacts on vulnerable groups such as children and low-income communities. In the last 30 years, the list of political chemicals, identified as culprits in serious health problems, has grown from the unresolved problems of legacy chemicals such as lead and

[25] Political chemicals are those that have become known as a result of claims, usually from scientists or toxics activists. These claims have raised specific chemicals to a level of public concern for their perceived threat to public health or the environment. They would include, for example, lead from lead smelters, methylmercury in fish or more recently, Bisphenol A in baby bottles.

mercury, often from industrial sources, to include high profile chemicals associated with consumer products, such as Bisphenol A, phthalates, parabens, PBDEs and other flame retardants, and triclosan, to name just a few of the most well-known and most controversial. Of particular concern currently are the per- and polyfluoroalkyl substances (PFAS), particularly PFOS and PFOA, chemicals in the PFAS group, often referred to as "forever chemicals" because of their persistence in the environment. As Fe de Leon, toxics researcher at the Canadian Environmental Law Association, has observed: chemicals like phthalates that are present in consumer products have garnered scientific and regulatory attention over the last decade while at the same time "no real progress has been made to address the impacts association with older known hazards such as lead and mercury" (Interview, Fe de Leon, May 6, 2021).

An instructive tale of the difficult struggle to control potentially damaging chemicals already widely distributed is the story of the siloxanes group, a group of chemicals that were candidates for Canada's screening process of chemicals already on the market. The siloxanes group illustrate the way in which chemicals, already in wide use, become the focus of long drawn-out battles between government regulators, politicians, the chemical industry, academics and toxics activists, even as these political chemicals are nudged towards being designated as 'toxic' and controlled under the *Canadian Environmental Protection Act*. In Canada, a chemical can be designated 'toxic' under Part 5, Section 64 of the Act, under the following conditions: if it is entering or may enter the environment in a quantity or concentration or under conditions that "have or may have an immediate or long-term harmful effect on the environment or its biological diversity," or if it "constitutes or may constitute a danger to the environment on which life depends; or constitute or may constitute a danger in Canada to human life or health" (*CEPA 1999*, Section 64). In 2008, a screening report

done by Environment Canada[26] and Health Canada on a particular Siloxane, D5,[27] a high volume chemical common in cosmetic products such as shower gels, shaving foams and shampoos, and in cleaning products, found this chemical was entering the environment in ways that "have or may have an immediate or long-term harmful effect on the environment or its biological diversity" (Environment Canada and Health Canada 2008), and the Ministers of both Environment and Health recommended that it be added to the "List of Toxic Substances." Environment Canada found that both siloxanes D4 and D5 were toxic, persistent and could bioaccumulate in aquatic organisms; similarly, the European Union found that D5 was very persistent and bioaccumulative (European Chemicals Agency 2016). However, even adding D5 to the List of Toxic Substances, as recommended, would not necessarily have compelled the government to restrict its use (Scott 2016).

In an unprecedented intervention, an industry group, the Silicones Environmental, Health and Safety Council of North America ("SEHSC"), a subgroup of the American Chemistry Council, asked the Ministers in 2008 to establish a board of review that would inquire further into the "extent and danger" of Siloxane D5. The government complied in August 2011, and as Fe de Leon of CELA notes: "it is interesting that the government released the decision to establish a review on the same day the government had scheduled a consultation to discuss 'regulations' on D4 and D5" (Interview, Fe de Leon, May 6, 20211). In 2011, the Board of Review, composed of three toxicologists,[28] concluded that D5 was persistent but did not bioaccumulate *enough* to be a problem (Siloxane D5 Board of Review. 2011; my italics). Therefore, the Board concluded it did *not* in fact

[26] I refer here to Environment Canada, Canada's environmental department, as it was known at that time. However, in 2015, the name was changed to Environment and Climate Change Canada.

[27] Although referred to as D5, the chemical name of Siloxane D5 is Decamethylcyclopentasiloxane.

[28] The CBC has reported that the state of Minnesota, in a lawsuit against chemical company 3M, alleges that John Geisy, a professor at the University of Saskatchewan and Chair of the Board of Review, worked with 3M to suppress information on cancer-causing chemicals (Jason Warwick CBC. "U of S professor denies suppressing toxic pollution research for 3M." Accessed on April 6, 2022 at https://www.cbc.ca/news/canada/saskatoon/u-of-s-professor-denies-suppressing-toxic-pollution-research-for-3m-1.4554634.

constitute a danger (my italics). The Board went even further and recommended a re-evaluation of the screening assessment process under *CEPA*. A coalition of concerned groups, alarmed by this decision and led by the Canadian Environmental Law Association (CELA), appealed to the Minister in 2012 to reject the Board's conclusions, to proceed with designating D5 as a 'toxic' substance, and to "virtually eliminate" its use in Canada (Canadian Environmental Law Association 2012). Invoking the precautionary principle enshrined in the act, CELA lawyer Joseph Castrilli reminded the Minister:

> While the Board of Review consisted of a panel of three scientists, the inquiry they conducted took place in the context of a regulatory statute that is designed to protect the public and the environment and, in doing so, incorporates precautionary principles, provides preventive and remedial measures, and imposes administrative duties on the Government of Canada, to achieve such ends. Where science may insist that a thing is not proven unless there is 99.9 per cent certainty, a regulatory statute, such as CEPA, 1999, does not require proof to that degree of certainty before a conclusion may be drawn and action taken.

However, in 2012, the government accepted the Board of Review's findings and reversed its previous conclusion, and declared that D5 was in fact not entering the environment in a quantity or under conditions that constitute a danger to the environment (Government of Canada n.d.). This decision annulled any initiatives to control the importation and use of D5 in Canada.

The siloxane in question, D5, demonstrates the slippery art of identifying and controlling toxics, particularly faced with well-financed industry opposition exerting its political influence. It illustrates the difficulty of gaining even a minimal amount of control over apparently destructive chemicals, and explains the challenges faced by environmental activists in detoxifying the environment. A similar discussion on siloxanes has also taken place in Europe, but with a somewhat different outcome. In 2016, the European Chemical Agency's (ECHA) Committee for Risk Assessment found that the siloxanes D5, as well as D4 and D6, were persistent and bioaccumulative (European Chemicals Agency 2016). As such, they recommended classifying them as substances of very high concern, a designation that adds them to the Candidate List and imposes obligations on

the company to provide enough information about the chemicals to ensure safe use (Steiger 2016). Given that this designation would likely lead to restrictions on the use of these chemicals, industry was adamantly opposed to this designation. Under REACH, the European Union's chemical regulation, which is discussed in detail in Chapter Eight, those substances found to be of "very high concern" are regularly reviewed to determine which ones should be given priority for "authorization," and D5 is a potential candidate for authorization. The goal of authorizing substances is to allow their time-limited use, giving companies a period in which to gradually eliminate them from commerce and replace them with safer substitutes (European Chemicals Agency n.d.).

Aside from the European Union, the Global Silicones Council has successfully overcome all governments that have tried to limit the use of silicones. They argue that countries, following Canada's example, must adopt a weight of evidence approach that considers exposure and ultimately rests on the assessment of risk rather than the absolute damage that these chemicals inflict (Global Silicones Council 2021). The European Union is portrayed by the Council as an outlier, the only jurisdiction that has regulated siloxanes. The Council suggests that the EU has erred in their assessments, commenting that: "These restrictions are the direct result of the EU's precautionary approach for assessing the environmental risks associated with chemicals in commerce that meet overly rigid laboratory criteria and the EU's failure to consider the unique properties of silicone substances or exposure in its evaluation of these substances." The potential for siloxanes to be persistent and to bioaccumulate is characterized as a "suspicion" (Global Silicones Council 2021).

This example of siloxanes illustrates the contested site of toxics control, in which environmental groups representing the public's interest in eliminating harmful chemicals from products in daily use, such as siloxanes in body creams, are pitted against well-financed globally-

situated industry lobbies organized by the chemical companies, with both groups seeking to influence government decision-making. Yet decision-making is not an open process, as the different regulatory decisions made by different jurisdictions on siloxanes demonstrate. And, as with many of the commercial chemicals currently circulating, permissive toxics laws of the past ensure that there is limited toxicological data available to inform the bureaucratic and political decision-making processes.[29]

Liora Salter has discussed the way in which regulatory decisions are made, and standards set, based on what she calls "mandated science," the scientific work prepared for decision-making (Salter 1985). Mandated science describes the process of evaluating scientific research on chemicals and translating this data into standards that will stand as markers for societal acceptability and set the bar for public policy. Risk assessment and its determination of acceptable levels of risk have long been the basis on which new chemicals are approved and older chemicals are assessed, as siloxanes have recently been. Although she is writing from an earlier perspective, many of her observations on the process of risk assessment and decision-making still apply to the risk assessment processes going on today, such as those being undertaken by the Canadian government under the Chemicals Management Plan (CMP). Scott and Lewis, in their essay on Sex and Gender in Canada's Chemical Management Plan, point out that "new theoretical considerations regarding toxicology and modes of action of various chemicals challenge pre-existing assessment methodologies," such as those generally applied to chemicals being assessed under the CMP (Scott and Lewis 2015, 87).

[29] A report from the Danish Ministry of Environment in 2005 evaluated the toxicity of siloxanes, observing that "Although siloxanes are used in many products including consumer products and have been so for many years, there is relatively little information available about their toxicity apart from the information provided by the Siloxane Research Program." The concern of the report is the possible reproductive toxicity and endocrine disrupting effects of siloxanes, given new uses of these substances such as breast implants. (Danish Ministry of the Environment, "Siloxanes – Consumption, Toxicity and Alternatives." Accessed on June 2, 2021 at: https://www2.mst.dk/udgiv/publications/2005/87-7614-756-8/pdf/87-7614-757-6.pdf).

Risk assessments are historically and contemporarily based on two premises: first, that the higher the dose the greater the harm to human health, and, second, that humans can safely accommodate some degree of exposure to toxic chemicals based on thresholds (87). Yet, a new understanding of the way in which some chemicals, such as endocrine disruptors, act in the body and cause harm at lower rather than higher doses calls into question the traditional practise of risk assessment. Scott and Lewis call this accepted but questionable approach "inadequate for ensuring the safety of Canadians, and the health of women in particular" (87).

Concerns about the reliability and predictability of risk assessment have also been raised by the National Academy of Sciences (NAS) in several reports. First, in its 1994 report, "Science and Judgment in Risk Assessment," (National Research Council Executive Summary 1994, 1), in response to public concerns about health effects related to environmental contaminants, the NAS raised questions around the reliability of scientific predictions about the risks to public health, stating flatly that "skepticism has arisen in part because scientists disagree" (1). They cite the particular public concerns about cancer incidence, finding that:

> Sometimes the decision that a substance is a carcinogen is based on evidence from workers exposed to high concentrations in the workplace, but more often it is based on evidence obtained in animals exposed to high concentrations in the laboratory. When such substances are found to occur in the general environment (even in much lower concentrations), efforts are made to determine the exposed population's risk of developing cancer, so that rational decisions can be made about the need for reducing exposure. However, scientists do not have and will not soon have reliable ways to measure carcinogenic risks to humans when exposures are small. In the absence of an ability to measure risk directly, they can offer only indirect and somewhat uncertain estimates (1).

In a 2009 report, *Science and Decisions*, the NAS looked again at the weaknesses in risk assessment, finding that risk assessments were hindered by a lack of data on chemicals leading to uncertainty in the assessments (NRC 2009). They were also concerned about the lengthy delays in evaluating chemicals, citing the example of formaldehyde, which took the U.S. EPA more than a decade to complete (Whittaker 2015, 2129). Another shortcoming was the inability of risk assessments to

"adequately inform decision making both in terms of timeliness and answering questions that help guide decision makers" (2129).

In Canada, the risk assessment process is conducted by authorities in the departments of Environment and Health, generally without peer review or public hearings except in exceptional circumstances as with siloxanes. Risk assessment is described as taking into account data on the amount of substances entering the environment, its chemical properties, how it is distributed, its persistence and whether the chemical will be present at levels that may be harmful to health or the environment (Environment and Climate Change Canada, Risk Assessment of Chemical Substances, n.d.). This is coupled with risk management, which takes into account socio-economic factors and stresses control, rather than prevention, of risks (Environment Canada 2007, 1). Salter observes that even "when the concept of risk, for example, is considered in a scientific discourse, measurements of risk are often presented in a quantified form even if the variables being assessed – like quality of life or cultural identity – defy easy or appropriate quantification in any other context" (Salter 1985, 39). She points out that although some scientific studies are part of the open literature, many are not, and companies submitting scientific studies for assessment by policy makers are in a position to decide what research they will make available (38).

As outsiders to the process, we cannot know what data are presented and how comprehensive they are, how the different scientific studies are discussed, how much weight is given to different scientific inputs and to the importance of potential adverse effects on public health and the environment, and, finally, whether the precautionary principle, which is part of the Act, is ever applied.[30] Nor do we know how much consideration is given to the industry perspective and the

[30] In many cases, the government has stayed away from using the term precautionary principle but rather describes its approach as precautionary approach, although what this means is not clear (Interview, Fe deLeon, January 21, 2021). See: Overview of the Existing Substance Program. April 2007, Section 2.4 Precaution in Science-based Decision Making

amount of disruption to commerce that strict regulations would incur. Evidence of toxicity is not necessarily a death knell for the manufacture and use of a chemical. Salter views scientific knowledge and the risk assessment process as a "product of negotiation within the scientific community and through its various legitimating institutions" (Salter et al. 1988, 11). She also points out that politicians retain final control over decisions made by regulatory authorities on specific cases (Salter 1985, 42). Consequently, the negotiations, to which she alludes, can favour corporate economic interests over scientific concerns.

Salter's principle objection to this negotiation between scientific knowledge and bureaucratic and corporate concerns is moral; she maintains that, in these negotiations, "it *does* matter which chemicals are carcinogens and that some chemicals are more dangerous to human health than others," (11, emphasis mine) and yet these characteristics do not necessarily mean a chemical is banned or even restricted. Indeed, even where carcinogenicity tests may have been done, many substances with cancer-causing potential still pass through the regulatory process. Witness the Silent Spring Institute's review of 28 approved pesticides. Analyzing the data, the Silent Spring study found that the EPA recognized tumour development in only nine of these pesticides, and dismissed the effects in the other 19, even though all 28 showed problems (Cardona and Rudel 2020). The evaluation of risk, then, which precedes standards being set or restrictions being put in place is *not*, as Salter explains, a strictly scientific exercise (Salter 1985, italics mine). Consequently, a pesticide is not going to be denied approval because it may cause cancer. Salter does not deny the relevance of science generally, but argues that we need to understand the pressures and constraints that affect these decisions in order to have confidence in medicines, clean air and water and the safety of products. The risk-based approach, applied to decision-making, however, is fraught with pitfalls for

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accessed at https://www.ec.gc.ca/lcpe-cepa/715BA6D1-03F3-A724-B164-901EDE6723C3/OverviewOfESP_en.pdf on June 21, 2022.

the public seeking precautionary or more effective controls on chemicals. In the case of Canada's decision on the siloxane D5, although the federal Minister of the Environment is obliged to consider decisions made in other jurisdictions to restrict or prohibit a substance, ultimately decisions in Canada can be influenced by corporations and presented to the public as managing risk, rather than eliminating it.

Since Salter theorized about the relationships between science and standards, there has been an increasing unease with the standard setting process and its failure to keep toxic chemicals in check. Beck finds that a "demystification of science" has developed in concert with a growing consciousness and social recognition of environmental risks (Beck 1988 as quoted in Marshall and Picou, 238). As the contamination of the environment and even of our bodies becomes more evident, permissive decisions on toxic releases and the approval of chemicals with toxic properties erode the public trust in governments. Agreeing with Beck, Marshall and Picou argue that applied science, based on a reductionist mechanistic model of the empirical world, has privileged scientific rigor over individual and community health, and discounted the public as non-experts and their knowledge as value-laden (234). Methodologically, for Marshall and Picou, the burden has now shifted:

> from proving that a cause-and-effect relationship does not exist between chemical exposure and health in a laboratory setting, where experimental designs allow for control of external factors, to the field, where it is impossible to control for numerous external factors with any degree of certainty. While shifting the burden of proof benefits those who produce and release hazardous materials, it harms the environment, individuals, and communities (236).

Marshall and Picou also observe that the independence of science has been steadily compromised by commercial interests, with the autonomy of scientists constrained by the "capture" of regulatory agencies (Marshall and Picou 2008, 231). Agency capture is described as the situation in which "a regulatory agency comes to hold views more similar to the industry it is supposed to be regulating than the public it is supposed to protect" (Gramling and Krogman 1997, as quoted in

Marshall and Picou 2008, 232). As the public has lost trust in those organizations responsible for risk management and regulation, citizens have by necessity become "'lay scientists' in environmental risk areas that are directly related to their own health, welfare and community well-being" (Marshall and Picou 2008, 240). Lay scientists from a Canadian public interest group, for example, Safe Food Matters, illustrate the concern over "agency capture." They challenged the decision of Health Canada's Pest Management Regulatory Agency (PMRA), the body that oversees pesticide use in Canada, to re-register glyphosate, a widely used herbicide that has been linked to cancer. They characterized the Agency's approval as putting the pesticide industry's interests ahead of the public's. In 2022, the organization, along with other environmental groups, David Suzuki Foundation, Environmental Defence and Friends of the Earth Canada, persuaded the Federal Court of Appeal, to send the permissive decision of the PMRA back for re-consideration (Sustainable Pulse 2022).

Conclusion

The damaging effects of this proliferation of chemicals, now becoming "visible," have resulted in part from an earlier era when weak toxics laws allowed chemicals to be introduced onto the market with little or no testing. Consequently, we live with the legacy of chemical assaults on human and animal health and on the environment, and every day we understand and learn more about those impacts. Just as science has informed us about the intelligence of animals, science is likewise exploring and explaining the toxic effects of chemicals in our world. While scrutiny of the many chemicals already in commerce has begun, new chemicals are still being introduced at a furious pace, and even with revamped toxics laws, the testing of any one chemical is never so thorough as to be fully predictive of the many negative possibilities of toxicity. Despite the tests on animals, described in the last chapter, we are living in a world of constant, multiple and varied exposures to toxic chemicals.

The concept of corporeal citizenship, discussed in this chapter, asserts that humans are inextricably entwined with nature. It puts forward the broader concept that, not only are governments responsible for managing and protecting the health of its citizens, but they are also responsible for managing the environment. This inclusive view of corporeal citizenship, which because it encompasses a responsibility towards the natural environment, can, therefore, be theoretically extended to include the duty to manage and protect the health and well-being of animals, both those that exist as part of the natural world and those extracted from the natural world for human experimentation. As Scott, Haw and Lee point out in "WannaBe Toxic Free?", "the sphere of ethical and political responsibility of 'individual' citizens expands to include not only caring for oneself but also the wider social community and environment" (Scott, Haw and Lee 2016, 13). Taking this concept further, it can be argued that expanding our moral concern for the integrity of animal life would also constitute a concern of the "corporeal citizen."

Chapter Eight: Contested Toxics Laws

Brutal pursuit of profits, unfettered by legal and moral restraints, can lead to unnecessary suffering and deaths, destruction of the environment, and a pathologically short-term perspective.

Howard Steven Friedman, Ultimate Price: The Value We Place on Life

Regulatory testing is still a necessary evil.

Lucy Meigs, AltTox

Introduction

In Chapter Two, the starting point of this dissertation, I chose to examine the strength of the evidence that animals are sentient beings, with more cognitive abilities than we humans had grasped, and to ask whether our growing awareness of their cognition compels us, human animals, to act more ethically in our relationships with non-human animals, enfolding them within our moral circle. Being aware of their many abilities, both similar and dissimilar to our own, means that we can no longer disregard their intelligence, and we can no longer use them as dull instruments of research in the same habitual but outmoded ways. Animal protection laws have barely been permeated by this robust and huge body of knowledge of animal cognition, acquired over the last fifty years. Consequently, laboratory animals remain vulnerable to experimental research that imposes unknowable suffering on them and premature death, with few legally-sanctioned comforts.

In this chapter I am asking what role toxics laws play in the promulgation of testing on laboratory animals, and what the possibilities are that toxics laws could be reoriented at a theoretical, ethical and practical level in such a way as to reconcile the need to screen significant numbers of toxic chemicals for which we have little data given that this screening might require vastly expanded animal testing. I look at the different jurisdictions: the European Union, the United States and Canada and examine the way in which chemicals are assessed.

Toxicity testing, as explained in Chapter Six, is known to be particularly brutal in its treatment of animals that serve as barometers of toxic measurement compared to other types of animal research. Because animal tests are often required by statutes, or performed as routine practice to satisfy less explicit federal laws, on the premise that this testing will prevent damage to human health and the environment, it is within the ambit of toxics laws that we need to find ways to establish the elusive ethical relationship. At the same time, even with traditional toxicity tests being in place presumably to anticipate and manage the possible adverse effects of a chemical, it is clear that this approach has not been effective. Even with the sacrifice of countless animals, toxics laws have failed to protect humans and the environment from many disturbing effects, ranging from asthma and diabetes to cancer and reproductive problems. It is, therefore, critical to examine toxics laws and to locate ways in which changing these laws could not only spare animal lives but, at the same time, put in place a stronger regime for protecting public health and the environment.

In this chapter, I look at the precepts of toxics legislation, reviewing both the laws and policies governing cosmetics and those governing industrial chemicals, comparing and contrasting the statutory and policy regimes of Canada, the United States and the European Union. I examine these laws and policies as politically contested arenas. Here, diverse interest groups, all of which claim a stake in the way in which these laws are constructed and implemented, try to exclude, accommodate, and reconcile different, and often opposing, interests. Through the social construction of knowledge process, the major players -- politicians, government bureaucrats, scientists, chemical companies, and those activists campaigning for measures that protect environmental health and those concerned with ending animal testing – articulate their views and seek to convince the public of the validity of their positions. In each jurisdiction, these groups use tactics to establish a base of public awareness and support in the struggle to ensure that their interests prevail, or are, at least, met; and yet, as a review of the three contests will demonstrate,

there are different complexities in the struggles and outcomes in all three jurisdictions. These differences reflect the dynamics at play in each of these separate jurisdictions and the strengths or weaknesses of the actors in each struggle. Although political and economic factors are critically important in these struggles, their influence does not result in a consistent or predetermined outcome.

With respect to advocacy, both animal advocates and toxics activists want reform of toxics laws, but they often do not share the same vision or goals. Toxics activists want more stringent laws to prevent the chemical consequences described in the last chapter, a vision that would include more rigorous testing of chemicals. If protocols are not changed and conventional testing continues to be favoured, it is estimated that the reform of toxics laws would result in a significant increase in the numbers of animals required for the expanded testing set out in these more stringent requirements. For example, various estimates of the additional impact on animal use resulting from the reform of the European Union's toxic laws ranged from 9 million to 54 million (Taylor 2018, 348) At the same time, animal advocates have proposed abolishing all toxicity testing using animals in favour of non-animal alternative tests. In addition to reconciling these sometimes competing interests, both groups must confront the reluctance of governments to make major legislative and policy changes, as well as the influence of major corporate players who view regulation as unnecessary interference in the way they conduct their businesses. Not only are toxics laws the contested site of struggle between these various actors, but these laws are in a constant state of flux, and issues around animal testing, acceptable degrees of risk and the stringency of controls on selected chemicals, continue to be the subject of ongoing disputes. In this chapter, therefore, in order to further the project of addressing both the damage of toxics done to human health and the environment and of alleviating the harm done to animals through toxicity testing, I look at the claims put forward in the struggles

between activists, governments, scientists and chemical companies and the results of these struggles in order to understand the challenges faced by this project and to locate the way forward.

In the next section of this chapter, then, I open the discussion with an examination of cosmetics regulation in the European Union and its ban on the use of animals to test cosmetic products and ingredients; in the third section, I document the efforts of animal advocates in the United States and Canada to match the success of activists in the European Union, and in my fourth section, the efforts of toxics activists to ban toxic chemicals from cosmetic products. In the fifth section, I investigate the second area of "contested laws," the toxics regimes of Canada, the United States and the European Union, which govern industrial chemicals: the European Union's Regulation that controls toxic chemicals, known as REACH (the Regulation concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals); the United States' recently revised *Toxic Substances Control Act*, and in Canada, the *Canadian Environmental Protection Act 1999*. In particular, I look at the ways in which this legislation has been revised under pressure from toxics activists and animal activists, and the current debates over the effectiveness of these laws. The purpose of reviewing these laws is to understand the ways in which toxic chemicals filter through onto the markets, and to examine how toxics activists and animal advocates could find common ground in amending these laws to make them effective in both preventing environmental and health damage and preserving animal lives. The sixth section concludes this discussion.

The Campaigns for Cosmetic Regulatory Reform

Cosmetics were one of the first areas to be targeted by both animal advocates and toxics activists for reform. Cosmetics are broadly defined to include not only lipsticks and mascaras but personal care products such as shampoos, deodorants and toothpastes as well. In Canada, cosmetics include any substance used to clean, improve or change the complexion, skin, hair, nails or teeth (Government of Canada Cosmetics n.d.). Concern about the practice of using animals to test

cosmetics, which has now evolved into a world-wide "anti-cruelty campaign," was originally sparked by New York-based animal rights activist, Henry Spira. In 1980, Spira, influenced by the teachings of philosopher Peter Singer, launched a high-profile publicity campaign against using animals for testing cosmetics, targeting Revlon's use of the Draize eye test (Singer 1998). This infamous test had been used by manufacturers of cosmetics and household products since the 1940s to assess products, ranging from baby shampoos to oven cleaners, but, by the 1980s, even research scientists were suggesting that this practice be replaced with non-animal methods (Singer 1998). A full-page ad in the New York Times, orchestrated by Spira, asked, "how many rabbits does Revlon blind for beauty's sake?" and pictured a graphic image of a chemical being dropped into a rabbit's open eye. This shocking image sparked the mobilization of animal rights' campaigns against using animals to test cosmetics in many countries of the world, campaigns which still rage today. In a striking example of a socially constructed interaction that created a public issue out of a non-issue, Spira's tactic of publicizing the painful tests done on animals for cosmetic purposes brought a relatively unknown issue of the day to the public fore and made it a significant public concern. Revlon, whose practices were targeted in this ad, responded with financial commitments and promises to fund the research and the development of alternatives. Followed quickly by funding from other major cosmetics companies such as Avon, Max Factor and Estee Lauder, a Center for Alternatives to Animal Testing was established. Despite this commitment and the eventual development of a non-animal alternative to the Draize eye test, what had originally been anticipated as only a few years before a replacement was developed turned into years of research and testing. Even today, the Draize eye test continues to be used, with PETA publicizing the fact that 100 tests are still being submitted to the U.S. EPA every year (Waldman 2021).

The most successful campaign for the regulatory reform of cosmetics, in which both animal advocates and environmental health activists realized a degree of success in pursuing their separate,

but not necessarily incompatible, goals, has been the European Union's *Cosmetics Regulation.* In 1990, the leading animal groups across Europe formed the European Coalition to End Animal Experiments (ECEAE), with the explicit goal of ending the use of animal tests for cosmetics (ECEAE n.d.). After the ECEAE had toured Europe lobbying politicians and organizing large demonstrations, the European Parliament in 1992 voted to end the use of animals for cosmetic testing (6th Amendment to EU Directive 76/768/EEC). To ensure that adequate time was given to phase-in the ban, an initial deadline of 1998 was given. However, bogged down by opposition from the cosmetics industry and the difficulties in developing non-animal alternatives that would replace traditional toxicity tests, it took over ten years to put the legislation firmly in place. Finally, though, in March 2013, the European Union, a world leader in the cosmetics market, implemented a full ban on the use of animals for the testing of any cosmetic products or any ingredients in cosmetics, manufactured or imported into Europe (Akbarsha and Mascarenhas 2019). Despite industry's initial opposition, the coalition strength of animal advocacy organizations, the commitment of European politicians in the European Parliament, and a supportive public combined to enshrine this ground-breaking legislation.

At the time the *Cosmetics Directive* was introduced, many of the standard tests used to support the regulatory approval of cosmetics and their ingredients did not have equivalent non-animal testing methods, although many were under development. The "six-pack," that suite of acute toxicity tests heavily dependent on animal use including tests such as those applied to the skin of animals to evaluate skin sensitivity, was the standard testing regime used in Europe at that time, and still used now by many jurisdictions as a basis for hazard identification and risk assessment (Prior et al. 2019).[31] These tests have been, and continue to be, considered fundamental to demonstrating the

[31] The "six-pack" as described in Chapter Six on toxicity testing includes acute oral toxicity, acute dermal toxicity, acute inhalation toxicity, eye irritation/corrosion (usually the Draize eye test), skin irritation/corrosion, and skin sensitization (Prior et al. 2019).

safety of cosmetics as well as other industrial chemicals. In addition to finding non-animal alternatives for acute toxicity tests, the European Union required the development of non-animal tests for more complex human health issues such as repeat dose toxicity, reproductive toxicity and toxicokinetics, which were more challenging to develop and which gave industry more reason to argue for a longer time frame in which to implement the legislation (European Animal Research Association, n.d.). Nevertheless, by 2013, when the Directive became a regulation, the ban became all-inclusive, regardless of whether alternative tests had been developed or not.

In addition to the ground-breaking ban on animal testing, the *Cosmetics Regulation,* in its Article 15, met many of the concerns of toxics activists with its provisions for banning the use of substances that are classified as carcinogenic, mutagenic or toxic for reproduction (CMR). This amounted to at least 1,300 chemicals finding their way onto the list of prohibited substances (Milman 2019).[32] Many of these listed as CMR chemicals are substances still widely-used in North American cosmetic products, including formaldehyde, butylated hydroxianisole (BHA), propyl paraben, fragrance, triclosan and oxybenzone. This initiative – prohibiting known toxic substances in cosmetics – arguably gives the European Union the highest regulated standard of cosmetic quality in the world. Although both animal advocates and environmental health activists have made progress in meeting their goals with the EU's Cosmetics Regulation, animal rights groups have seen some of that success eroded by the prevailing dictates of REACH and its testing requirements, as will be discussed in the next section.

Banning Animal Testing for Cosmetics

Animal rights activists, not only in North America but world-wide, have tried to capitalize on the success of their European counterparts but it has been an uphill battle on this side of the

[32] These carcinogenic, mutagenic and reproductive toxins are listed in Annex II of the Cosmetic Products Regulation of Prohibited Substances.

Atlantic. The focus of their campaigns has been a straightforward call for an outright ban on the use of animals for testing cosmetics and their ingredients. Building on Henry Spira's campaign to discredit the Draize eye test, they have targeted consumer practices, mounting an effective labelling campaign that has convinced many people to seek out cosmetics that have *not* been tested on animals (italics mine). Through their talent for publicity, the influential animal rights group, PETA, has carried on the strategies of publicly embarrassing and naming companies that use animals to test cosmetics. According to the Humane Society International, more than 1,000 companies world-wide have been certified as "cruelty free," meaning that they do not test their ingredients or their products on animals (Humane Society International n.d.). As a result of these "be cruelty-free" campaigns and in response to an increasingly critical public aware of the violence done to animals in the development of novel cosmetics, many major cosmetic companies in Canada, the United States and other countries, where using animals for cosmetic testing is still legal, have voluntarily given up the use of animals to evaluate acute toxicity. Instead, companies like British cosmetics retailer, Lush, which leads the charge against animal testing, rely on ingredients that have been shown to be safe in non-animal tests or use existing ingredients with a history of safe use (Humane Society International n.d.)

Animal activists in the United States under the leadership of PETA, the Humane Society and the Physicians Committee for Responsible Medicine (PCRM), and in Canada, led by Animal Alliance and the Humane Society, have been lobbying hard for many years to convince their respective governments to introduce legislation that would ban the testing of cosmetics on animals. The U.S. Food and Drug Administration (FDA) publicly state that it is the responsibility of the companies themselves to determine whether animal testing should or should not be used (U.S. Food and Drug Administration 2006). It advises only that "consideration should be given to the use of scientifically valid alternative methods to whole-animal testing."

In Canada, Animal Alliance and their allies in other prominent animal groups have also worked hard to achieve the goal of eliminating the use of animals in cosmetic testing. They were hopeful that a bill introduced in the Senate in 2019, *The Cruelty Free Cosmetics Act*, would receive the support it needed to pass into law. The bill would have brought Canada in line with European Union's ban on domestic cosmetic animal testing as well as prohibiting the sale of cosmetics that have undergone any form of new animal testing after the ban came into effect (Animal Alliance 2019). It would have amended the *Food and Drugs Act* with a simple dictate that "No person shall conduct or cause cosmetic animal testing to be conducted in Canada." The Cosmetics Alliance Canada, representing the cosmetics industry in Canada, like its U.S. counterpart, had agreed on the principles for such a ban. However, two private members' bills, initiated in the Senate, were not moved forward by the Canadian government. Unlike the EU's cosmetics legislation, these bills focused solely on eliminating animal testing and did not include provisions that would screen chemicals more effectively for adverse health effects; nor did it prohibit the use of carcinogens, mutagens and reproductive toxins. Kaitlyn Mitchell, the staff lawyer at Animal Justice Canada, who previously worked for the environmental group, Ecojustice, suggests that it is likely that industry is comfortable with cosmetic bills that ban animal testing but "may not have been so keen if the bill banned carcinogens" (Interview, Kaitlyn Mitchell, May 12, 2021).

The Challenge for Toxics Activists in North America

Although both animal activists and toxics activists seek to reform cosmetics laws, the discourse of environmental health groups and toxics activists differs significantly from that of animal advocates. Environmental health groups are focused almost exclusively on making cosmetics safer for humans by removing and restricting dangerous ingredients, while animal activists are motivated by ending the suffering and death of research animals. Despite the high bar set by European legislation, the U.S. and Canada have not yet made any significant regulatory advances or towards

banning potentially hazardous cosmetics or their ingredients from cosmetics. Without a specific cosmetics law, toxics activists in North America do not have an easily recognizable target for reform, as do their European counterparts. And critics have pointed out that, while 1,300 potentially harmful chemicals are restricted in the European Union, under the U.S. *Food, Drug and Cosmetic Act,* the principle statute in the U.S. governing chemicals, only 9 have been restricted (Personal Care Products Council n.d.). In an article in *The Guardian*, Connecticut State Senator, Alex Bergstein, who introduced a bill calling for cosmetics in his state to meet European standards, commented on the disparity in regulation between the European Union and the United States: "In the U.S. we have a strong favouritism towards companies and manufacturers, to the extent that public health and the environment is being harmed" (Milman 2019).

Without any requirements for pre-approval of cosmetic products or their ingredients, the U.S. Food and Drug Administration (FDA), under the *Food, Drug and Cosmetic Act (FD&C Act, Title 21, Chapter 1, Subchapter G, Part 700),* stipulates only that cosmetic products placed on the market be safe and properly labeled, with the exception of colour additives, which must be approved for specific uses (U.S. FDA "Cosmetics and U.S. Law"). This skeletal law merely prohibits the introduction of any cosmetic that is "adulterated" or "misbranded" (*FD&C Act*, sec. 301(b); 21 U.S.C. 331(b)). Rather, the influential industry has set its own rules for the safety of cosmetics and their ingredients for almost a century. Questions of cosmetic safety have been adjudicated by a voluntary industry-led Cosmetic Ingredient Review process (CIR), and even compliance with their safety recommendations has been voluntary (Campaign for Safe Cosmetics n.d.). The Cosmetic Ingredient Review advertises that it has worked with the FDA, the cosmetic industry and consumers for 40 years (Cosmetic Ingredient Review n.d.). According to the Campaign for Safe Cosmetics, a U.S. toxics activist group, however, the CIR has reviewed only 20 per cent of the estimated 12,500 chemicals used in cosmetics for safety (Campaign for Safe Cosmetics, n.d.). This situation is

changing, however, as public pressure, influenced by groups like the Campaign for Safe Cosmetics, has built for legislative reform, and a number of cosmetic safety bills have been introduced at both federal and state levels.

On the political level, representatives in both the Senate and the House of Representatives have championed cosmetic reform bills. Partly as a result of widely-publicized product failures and a concern for an increasing degree of consumer skepticism about the safety of many products, the beauty industry itself has become supportive of some legislative reform to address the issue of toxic chemicals in cosmetics. One sobering event that received considerable publicity was the discovery of formaldehyde, a recognized carcinogen, in a popular hair straightening product called Brazilian Blowout, found to be causing allergic reactions like hives and asthma (Iftikhar 2019). Brazilian Blowout is an illustration of the way in which women may be exposed to environmental contaminants in different ways than men (Phillips 2015, 40). In this case, women with curly hair and women of colour in particular, targeted by products such as these, may be vulnerable to increased exposure to chemicals and at greater risk of harm as a result of behaviour and lifestyles (Scott 2015, 8). As well, salon workers, usually women, have for years reported increased difficulty breathing, eye irritation and nosebleeds with the use of Brazilian Blowout with little legislative response (Women's Voices for the Earth n.d.) The negative publicity surrounding this product, however, has pushed the industry towards supporting some regulatory reform (WWD n.d.).

Likewise, Canada has made no significant changes to its cosmetic rules, the *Food and Drugs Act* (*FDA*) and the accompanying Cosmetic Regulations, since the passage of Europe's Cosmetics Directive. Under Section 16 of the *FDA*, Canada has only a general prohibition on the sale of any cosmetic that may cause injury, and demands little evidence of cosmetic safety. The *Cosmetic Regulations*, administered by Health Canada under the *Food and Drugs Act (FDA),* set out labeling

requirements, and prohibit a few select toxins such as mercury and coal tar dyes (Cosmetic Regulations, C.R.C., c. 869). With respect to carcinogens, mutagens and reproductive toxins, there are no specific prohibitions on their use in cosmetics, as there are in Europe. However, Health Canada does publish a Cosmetics Hotlist, similar to the CMR list in the European Union's Cosmetic Regulation. The Cosmetics Hotlist is described by Health Canada as an "administrative tool" that is used "to communicate to manufacturers and others that certain substances may be prohibited or restricted for use in cosmetics" (Government of Canada, n.d.). Although federal government officials often present the Hotlist as an official curb on harmful ingredients in cosmetics, the Hotlist is not so much a regulatory instrument as it is a regulatory point of reference or guidance document.

Environmental health groups in North America have waged a hard-fought and ongoing battle against a free-for-all acceptance of cosmetics with little regulatory scrutiny. One tactic embraced by a number of anti-toxics groups is to turn the spotlight on specific chemicals of concern, the "political chemicals" (Salter 1988, 99). As part of the social construction of an issue, this tactic of singling out specific chemicals or products such as Brazilian Blowout brings chemicals to the attention of the public, making these chemicals publicly recognizable and spawning a concern for their potentially harmful effects, which were previously unknown or unrecognized. These "political chemicals" are those chemicals deemed to be the most potentially harmful by the toxics activists, many of them banned or restricted in the EU. In their pursuit of stricter laws governing cosmetics, toxics activists from groups like the Environmental Working Group in the U.S., and like Environmental Defence in Canada, have created lists of chemicals in cosmetics that they not only want to see banned but that they warn consumers to avoid. This tactic of advising consumers to avoid specific toxins has contributed to the growth of "precautionary consumption," the drawbacks of which have been discussed in Chapter Seven.

Environmental Defence, however, rather than focussing on the Cosmetic Regulations, is asking for changes to Canada's primary toxics statute, the *Canadian Environmental Protection Act, 1999 (CEPA*), calling on the Minister to use *CEPA* to require full disclosure of ingredients in cosmetics. So far, no comprehensive legislation has made it through the circuitous paths necessary for success in the United States, and in Canada, groups concerned with environmental health have had to argue on a chemical by chemical basis for the restriction of toxins widely used in cosmetics, such as the Siloxane D5, and others. However, even the cosmetic companies are showing signs of concern about the image of their products and are looking for some government regulation that would assure consumers that their products are "clean" (Harris 2019).

Laws, Loopholes and Lobbying

Let's turn more specifically to toxics laws where the demand for animal testing is sometimes explicitly required and sometimes implicit in demands for ensuring chemicals are "safe." The toxicity tests performed for proving the safety of cosmetics and their ingredients is a relatively small percentage of the overall total of toxicity testing that is done in comparison with the number of toxicity tests used to determine the characteristics of industrial chemicals. Cosmetics are estimated to be between 5 and 15 per cent of the overall use of animals in biomedical laboratories (Rowan 2015, 454). For industrial chemicals, traditional toxicity tests, heavily dependent on the use of animals, are still the normal practice. Toxics activists have lobbied intensely for the reform of toxics laws, reforms that are directed at the backlog of chemicals that have barely been tested or assessed, and those "new" chemicals being introduced into the market. Their goals are to ensure the collection of data for those relatively untested chemicals already in play, to eliminate or phase out those chemicals that are toxic, and to establish more stringent requirements for new chemicals. These goals, however, can only be accomplished through an expansion of toxicity testing; and requiring additional toxicity tests would necessitate an untold additional number of tests, using

animals if the usual practice is followed. The gains, therefore, made in substituting non-animal tests for screening cosmetics, is more than offset by the dramatically increased need for tests on laboratory-bred animals demanded by the revised and more stringent toxics laws (Taylor 2018, 348).

This rewriting of toxics laws similarly entangles corporate interests, government bureaucracies and political decision-makers as well as environmental health activists, animal activists, scientists and academics. As with the regulation of cosmetics, the European Union has leapt ahead in formulating legislation designed to *post hoc* investigate those chemicals without safety data already on the market, and to strengthen the portals through which new chemicals pass on their way to commercial use. Successfully lobbied by environmental health activists and sympathetic politicians, the U.S. has also made strides in significantly renovating a national toxics law that was previously incapable of restricting even the most egregious of chemicals, while Canada too has introduced amendments to its primary toxics legislation, the *Canadian Environmental Protection Act*, although it has been very slow to convert these proposed amendments into law (Environment and Climate Change Canada, 2021). At the same time, animal advocates in all jurisdictions have pressed their governments to stop animal testing as the accepted means of testing chemicals, making some inroads in all three jurisdictions.

i. European Union:

In comparison with Canada and the United States, the European Union (EU) was the first to respond to criticisms of the damage being done to human health and the environment through the proliferation of poorly-regulated chemicals, and the first to incorporate the concerns of animal protection groups into the overhaul of its toxics laws. Following a White Paper introduced by the European Commission in 2001 and extensive public consultation throughout Europe, the European Parliament passed an innovative toxics control regulation for members of the EU, known as

REACH, the Registration, Evaluation, Authorisation and Restriction of Chemicals.[33] This regulation came into effect in 2007 (European Commission n.d.). Under the legislation, the EU has undertaken a step-by-step process of addressing the backlog of untested chemicals already on the market and establishing more stringent requirements for those coming to their door. It also promotes as part of its mandate the replacement of animal tests with non-animal methods for hazard assessment (ECHA Understanding REACH n.d.).

Under REACH, the first step was setting up a registration system that required companies over a ten year period to submit dossiers on the health and environmental effects of all chemicals manufactured or imported into the European Union in quantities of over one tonne per year. This requirement compels those companies manufacturing, importing or using existing chemicals to provide information on the safety or hazards of those chemicals already in circulation, as well as those chemicals, which companies propose to introduce to the market. This approach to chemical regulation is known as "reverse onus." Adam Briand explains the way in which REACH using a hazard-based approach departs from other toxics legislation:

> Unlike traditional risk management models, reverse onus inverses the burden of proof, or analytical burden, from the risk mitigators (government) to the risk generators (industry). Simply put, reverse onus asserts that it is not the responsibility of government to prove that a substance is unsafe and requires action. Instead, it is incumbent on industry to prove that its substance is safe for authorization, including all appropriate measures to control and manage any potential risk or hazard associated with the substance and its use (490).

Companies in Europe are now obliged to register their chemicals by filing reports and submitting data on the physicochemical characteristics, as well as toxicological and ecotoxicological properties. With this data, the European Chemicals Agency (ECHA), administering REACH, aimed to fill in the data gaps on chemicals already in use, as well as for new chemicals being introduced. In

[33] The full title is Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency.

the evaluation phase of REACH, the dossiers submitted for registration would be checked for compliance by ECHA, and the data assessed for potential hazards by member countries of the EU. More than 22,000 chemicals have now been registered for use in Europe (European Environmental Bureau 2019). If a chemical is identified as a substance of very high concern based on its hazardous properties, it may be placed on the Candidate List (as siloxane D5 was) and considered for authorization (ECHA Understanding REACH n.d.). Substances of very high concern include carcinogens, mutagens and reproductive toxins, substances that are persistent and bioaccumulative, and substances about which there are other concerns such as endocrine disruption. Once placed on the Candidate List, a substance becomes a candidate for authorization. An "authorized" chemical can only be used until a set sunset date. After that date, companies may still apply for an "authorization" to use the chemical if they can demonstrate that the risk associated with the chemical can be adequately controlled or if the benefits outweigh the risk and there is no suitable alternative (Briand 2010, 495). The overall aim of the process is to promote the substitution of a safer chemical to replace the "authorized" chemical.[34] Restrictions are another tool under REACH used to limit or ban the manufacture or importation of chemicals that will damage health and the environment.

On the toxics side, the European experience illustrates how uphill the battle is to gather the comprehensive and accurate data needed to evaluate the toxicity of already existing chemicals. Despite the regulation's lofty goals, the registration dossiers submitted by industry continue to have missing and poor quality data on the substances companies are using. The European Environmental Bureau, an influential environmental group in Europe, has pointed out the problems that were made clear in a 2018 report on compliance with REACH. The European Chemicals Agency (ECHA),

[34] ECHA. "Prioritisation of substances of very high concern (SVHCs) for inclusion in the Authorisation List (Annex XIV)." Updated March 5, 2020. Accessed on March 3, 2022 at echa.europa.eu/documents/10162/17232/recom_gen_approach_svhc_prior_2020_en.pdf/fbbd748b-22dc-38c2-9b4c-58c6bc80c930

overseeing REACH, looked at the progress being made and reported that 74 per cent of the industry dossiers were missing "important safety information" (European Chemicals Agency 2018). Furthermore, a substance evaluation program found that, after in-depth safety checks were done on 94 of those substances being registered, based on their potentially harmful properties and exposures to humans and the environment, almost half of them (46) were "unsafe" (European Environmental Bureau Press Release, 2019). Yet, these substances remain in commercial use. Progress, then, on filling in the data gaps on existing chemicals is a slow and painstaking progress for government authorities, and has disappointed many of the environmental health groups monitoring its rollout.

Animal advocates in the EU have also been heavily focused on the requirements of the REACH regulation, and how it plays out with respect to animal testing. Well aware when REACH was first proposed of the possibility that more testing of chemicals would mean more animal testing, animal activists lobbied heavily to avoid a massive expansion of animal experimentation, which filling in data gaps would inevitably entail. Estimates of how many more animals would be needed for testing varied dramatically from 9 million to as high as 54 million (Taylor 2018). Initially, it was estimated in a British White Paper that up to 12.8 million animals could be required to fill in the data gaps of approximately 30,000 existing chemicals (Taylor 2018), and questions were raised around whether the scale of testing and this use of animals justified the additional protection that society would be afforded by this testing (Nuffield Council on Bioethics 2005, xxxiv). An alliance of animal advocates was heavily involved in the negotiations leading up to REACH, and those drafting the legislation were also cognizant of the concerns about drastically increasing the use of animals for testing. As a result of the influence of animal advocates in Europe and the high public profile that they have given to the brutality of animal experimentation, one of the REACH principles stipulates that the testing of chemical substances on animals should only be done as a last resort (European Chemicals Agency 2014).

The legislation suggests a number of ways in which animal testing can be minimized or avoided. These include data-sharing between companies required to submit dossiers in support of the safety of the same chemicals, using alternatives to generate the necessary data, and submitting testing proposals for new studies to investigate properties of chemicals only where information is not available. An initial 2014 report and subsequent follow-up reports from ECHA on the use of alternatives found that, as a way of reducing the number of animal tests necessary for registration, industries were in fact sharing data, as ECHA had advised (European Chemicals Agency 2020). They also found that the most commonly chosen alternative to animal testing was "read-across," a technique in which the properties of substances are predicted by using existing information from similar substances. The other alternatives identified from the company dossiers were the use of *in vitro* or non-animal methods for generating information on skin and eye irritation and corrosion (European Chemicals Agency 2020). The ECHA reports concluded that these suggested alternatives were being widely used.

In spite of this nod to reducing the use of animals for producing safety data, REACH itself stipulates that animal testing must be done for specific safety assessments, and analysts watching the progress of the legislation believe that the unexpectedly high number of chemicals registered under REACH will necessitate a correspondingly high number of test animals (Rovida and Hartung 2009). Annex IX of REACH lays out the procedures for animal tests that must be performed based on the results of other preliminary testing (REACH Annex 9(8)). For example, Section 8.6.2.in Annex IX requires a 90 day sub-chronic toxicity study "using one species, rodent, male and female, and taking into account the most appropriate route of administration, having regard to the likely route of human exposure" (REACH Annex IX, Column 1). An estimate by Rovida and Hartung of the Johns Hopkins University's Centre for Alternatives to Animal Testing, suggested, based on preregistration and registrations, that 54 million vertebrate animals could be needed, a number which would double

the overall animal use in Europe, at a cost of 9.5 billion euros (Rovida and Hartung 2009). This estimate was refuted by ECHA, which calculated a lesser figure of 9 million animals would be needed at a cost of 1.3 billion euros (European Chemicals Agency 2009). However, Rovida and Hartung contend that the original lower estimates of animal use were based on the most optimistic assumptions of minimal animal tests without the need for re-testing and confirmatory re-tests (Rovida and Hartung 2009). ECHA's estimate also failed to consider tests that might be requested such as those for endocrine disruption, respiratory irritation, and developmental neurotoxicity.

To the dismay of animal advocates and the European cosmetic industry, the ban on animal testing under the Cosmetics Regulation has been compromised by decisions that defer to REACH, and both have been vocal in their criticism (Animal Free Safety Assessment Collaboration (AFSA) 2020). Stemming from regulatory decisions made in March 2018 by ECHA and its Board of Appeal, chemicals used in cosmetics may have to be registered, in some cases at least, and accompanied by data based on animal tests (European Chemicals Agency 2020). ECHA and the Board ruled that animal testing in support of REACH registration is permitted if chemicals are used in other applications and not exclusively as cosmetic ingredients. These decisions also make it clear that animal tests must be performed under REACH for chemicals in cosmetics where the health and safety of workers may be at risk.

REACH is considered by the European Commission to be a resounding success, despite the fact that many chemicals with hazardous properties are still widely circulating. In a visionary document that imagines a circular economy in the European Union by 2050, "Chemicals Strategy for Sustainability: Towards a Toxic-Free Environment," the Commission aspires to create an efficiently functioning internal market for chemicals while at the same time reducing risks to humans and the environment (European Commission 2020). The Commission cites a study estimating 1

million new cases of cancer have been prevented over the last 20 years as a result of stricter controls on toxic chemicals (1).

ii. United States:

The United States, like the European Union, also overhauled its toxics legislation in the last decade. After years of lobbying by environmental health activists and in response to widespread criticism of the lack of governmental authority under the *Toxic Substances Control Act (TSCA)* to control toxic substances, the U.S. government finally amended *TSCA* with the *Frank R. Lautenberg Chemical Safety Act for the 21st Century,* passed on June 16, 2016. Before the Lautenberg Act, the U.S. Environmental Protection Agency (EPA) had been responsible for attempting to control the more than 84,000 chemicals estimated to be in play in the United States (U.S. EPA 2021) and with trying to evaluate another 500 to 1,000 new chemicals introduced each year (Denison 2017). All this was to be done with their hands tied by legislation that did not require producers to generate or submit even basic information on chemical uses, health effects, or potential exposures (Denison 2017; Wilson and Schwarzman 2009). As Marshall and Picou have pointed out, the toxicity of chemicals was being discovered after a chemical had already made its way into commerce with the health effects manifesting in communities: "in the U.S., rather than requiring proof of *pre hoc* nontoxicity before certain chemicals are released into the environment, the regulatory/legal system requires proof of *post hoc* toxicity when assessing whether community health problems are a result of toxic chemical exposure" (Marshall and Picou 2008, 235).

The revised Act was intended to redress the problems in the outdated and weak TSCA, passed in 1976, problems that became evident in the failure manifested in its inability to restrict the use of asbestos, one of the most widely-recognized human carcinogens and the subject of bans in most developed countries. In 1989, the Environmental Protection Agency (EPA) moved to ban asbestos, but the chemical and consumer products industries sued to prevent it, and the U.S. Court

of Appeals for the Fifth Circuit, in the resulting case of Corrosion Proof Fittings v. EPA, ruled against the Agency deciding that they "had failed to adequately consider less burdensome ways to reduce the risk of asbestos exposure, such as labeling products that contain it" (Schmidt, 2016). Flexing their corporate muscle, industry further undermined any controls the EPA might hope to exert in the restriction of toxic chemicals. The *Lautenberg Act*, then, replacing *TSCA*, was a fresh start aimed at giving the Environmental Protection Agency the authority to more effectively address the problems of those chemicals already on the market and those coming onto the market.

Under the new *TSCA*, the EPA can now regulate the manufacture, processing, distribution, use, and disposal of chemical substances found to present an "unreasonable risk" of injury to health or the environment, although the term "unreasonable risk" is not defined in the law (Schmidt 2016). The EPA's Office of Pollution Prevention and Toxics, which administers the amended Act, has been made accountable for reviewing and assessing existing chemicals, starting with those that potentially pose the greatest risk (U.S. Environmental Protection Agency n.d.). The Act establishes clear and enforceable deadlines for reviewing chemicals of high priority and acting on their risks, as well as empowering the EPA to demand the development of information it deems necessary to evaluate the risk of a chemical. The revised law provides for greater transparency by limiting the ability of companies to make unwarranted confidentiality claims, thereby allowing information on a chemical's toxicity to be shared with states and health professionals (Denison 2017). With respect to the safety of new chemicals coming on the market, there can now be no introduction of a new chemical and no new use of an existing chemical without an EPA finding that the chemical does not, or is not likely to, present an unreasonable risk (Denison 2017). New chemicals include any chemical not listed on the *TSCA* Inventory of existing chemicals. Previously, under the old TSCA, the EPA had 90 days to determine the safety of a chemical, often without the benefit of data, before the chemical went onto the market, with or without EPA approval (Denison 2017).

It might have been anticipated that *TSCA* would reflect the legislative initiatives already adopted in the E.U. However, the U.S. did not incorporate the obligations under REACH that would have compelled industry to bear the burden of data generation, embodied in REACH's reverse-onus design (Botos et al. 2017). Although the *Lautenberg Act* improves on the permissiveness of its older *TSCA* self, it still reflects the heft of the U.S. chemical industry that has steered the U.S. towards a less regulatory vehicle than REACH. It has been observed, with respect to the revised *TSCA*, that "Europe has become a pacemaker of regulation with international consequences, while the US, which was rather light in regulations in many areas already…goes even further in this direction" (Meigs et al. 2018). Consequently, U.S. companies are more likely to address product liabilities in court while European companies, legally required to do more extensive testing, are largely protected from such liability claims (Silbergeld et al. 2015).

In reforming its toxics laws, the United States has also seen tensions arise between environmental health activists pushing for more data and hence more testing, and animal activists seeking to reduce or eliminate the use of animals in toxicity testing. The ongoing efforts of environmental health activists to reform toxics laws drew the attention and concern of animal activists. For those animal activists who steadfastly oppose animal testing, the reform of these laws threatened their long-established and ambitious campaigns to stop animal testing by requiring that more chemicals undergo testing and, therefore, would mean the use of more animals as required by traditional toxicity testing. Unlike the slow progress in the U.S. on banning animal testing for cosmetics, animal activists have had a significant influence on the revised U.S. toxics legislation. As in Europe, the concerted lobbying of animal activists has resulted in the new *Lautenberg Act* containing provisions that would potentially reduce the number of animals required for toxicity testing. Incorporating principles of the 3Rs, Section 4 of the Act directs EPA to "reduce and replace, to the extent practicable and scientifically justified…the use of vertebrate animals in the

testing of chemical substances or mixtures," (Section 4, h (1)) and "promote the development and timely incorporation of alternative test methods or strategies that do not require new vertebrate animal testing" (Section 4, h(2)). To comply with the legislation, the EPA is to encourage those companies submitting data on chemical toxicity to consider using alternatives, such as high-throughput screening methods and *in vitro* tests,[35] before resorting to animal tests.

The revised legislation also requires the EPA to create a strategic plan to promote the use and development of alternative test methods and strategies to reduce, refine or replace vertebrate animal testing, and report to Congress on its progress on alternatives (U.S. Environmental Protection Agency, n.d.). In 2019, the director of the EPA signed a directive announcing a move away from animal testing and a commitment to develop more accurate, quicker and more cost-effective test methods, in addition to "a goal of reducing mammal testing and funding 30 per cent by 2025 and eliminating it by 2035" (U.S. Environmental Protection Agency Press Release, 2020). However, monitoring the rollout of the new *TSCA*, the Physicians Committee for Responsible Medicine (PCRM) and People for the Ethical Treatment of Animals (PETA), two of the most active animal groups scrutinizing developments under the Act, have expressed concerns about the way in which EPA is carrying out its mandate. Their research showed that during the first year after its enactment, the EPA asked for, or required, roughly 10 times the number of animal tests for new chemicals than it had in previous years, fuelling activist fears that an increase in testing chemicals would result in the sacrifice of more animals (Zainzinger 2018).

Estimating that more than 77,000 animals would be needed to support the approval of 352 new chemicals, Physicians Committee for Responsible Medicine pressed the EPA to notify companies that alternatives to skin sensitization tests done on animals are acceptable (Physicians

[35] *In vitro* refers to an experiment or test done within a test tube or laboratory dish while *in vivo* refers to testing or research that is done on a whole living organism such as an animal or human.

Committee for Responsible Medicine 2018). At the same time, toxics activists want to ensure that the EPA, always under pressure from industry groups, be vigilant in assessing the human health and environmental effects of chemicals, particularly new chemicals coming on the market. During the last presidency, the EPA did not follow through on several rules envisioned by Congress, including: reducing exposure to persistent, bioaccumulative and toxic chemicals such as PFAS; failing to ban methylene chloride for occupational uses; and, including *all* sources of exposure when evaluating chemicals (Safer Chemicals, Healthy Families 2021). The anti-toxics group, Safer Chemicals, has identified these three demands as priorities for the U.S. government. There exists, then, in the United States, considerable need for improving not only the EPA's initiatives in making companies aware of effective non-animal alternatives, but also in fulfilling its mandate to restrict chemicals that are known to be hazardous, such as methylene chloride.

iii. Canada:

In Canada, the *Canadian Environmental Protection Act*, *1999*, commonly referred to as *CEPA*, is the legislation that establishes the framework for toxics control through its mandate to protect the environment and human health. As such, it is the joint responsibility of Environment and Climate Change Canada and Health Canada. It is intended to be reviewed by Parliament every five years, thus providing an opportunity for public input (Government of Canada *Canadian Environmental Protection Act* Review n.d.). A comprehensive review of this legislation was done in 2017 by the government's all-party Standing Committee on Environment and Sustainable Development, and in 2021 amendments were finally proposed subsequent to the last Parliamentary review. In contrast to the U.S. toxics regime, Canadian legislation has historically offered more authority for controlling toxics than the former *TSCA*, including the establishment of information collection systems, the review and assessment of risks for those substances already on the market, the provision of a variety of instruments not only to manage substances but also to allow for the most harmful to be banned

or phased out, as well as having regulations that require specific safety data before new substances are introduced (Canada National Report to CSD-18/19 n.d.).

As in each of the jurisdictions discussed here, there was an urgency to address the backlog of untested chemicals circulating in commerce, whose adverse effects were beginning to surface. Where the EU chose to require data and dossiers for all chemicals in use, Canada created a so-called "Domestic Substances List" of approximately 23,000 chemicals. Little or no data were available for these chemicals, all of which were actively manufactured, imported or used on a commercial scale in the mid-1980s when the list was compiled. These chemicals are often referred to as "existing substances," as opposed to those chemicals considered new substances because they have been more recently introduced into commerce (Government of Canada Domestic Substances List, n.d.). Under *CEPA*, "new substances," those manufactured or imported into Canada above certain thresholds since 1994, were required to undergo health and environmental assessments. For the so-called existing substances with little or no data on hand, the government initiated a major initiative called the Chemicals Management Plan (CMP) to categorize them and to try and identify those that needed further attention in terms of their potential to harm human health or the environment. A similar backlog of chemical substances with little supporting data was identified in both Europe and the United States. However, in contrast to the European initiative that made manufacturers and downstream users responsible for establishing the safety of the chemicals they were using, the Canadian government assumed the job of ascertaining which chemicals were of the highest concern. Rather than adopting a model of 'reverse onus" as Europe had done, the Canadian government chose to adopt a precautionary approach (Briand 2010), asking industry and stakeholders to submit additional information about the substances being assessed on a case by case basis. Consequently, the onus remained with the government to shoulder the burden of evaluating and cataloguing the toxicity of existing chemicals. As Scott and Tessaro have characterized this approach to regulation,

"uncertain, contested and incomplete scientific evidence about the health harms associated with exposures to toxic chemicals has enabled a 'permissive' approach…in which the onus of proof falls on those trying to show that chemicals are harmful" (Scott and Tessaro 2022, X.3)

About 4,000 substances were identified as requiring screening assessment after the categorization exercise, (Government of Canada "Categorizing Substances on the Domestic Substances List" n.d.). If a screening assessment detects problems with a chemical, such as toxicity or persistence in the environment, *CEPA* contains provisions that allow the government to impose regulations on those that are shown to have harmful effects on the environment or to constitute a danger to health, if they are designated as 'toxic substances' under the Act. Eventually, if the process works, the most harmful of these substances may be designated as 'toxic' by the Ministers of Health and Environment and Climate Change through a complex legislative process.

As a result of the Canadian framework, the screening assessment process has become the ring in which environmental activists wrestle with the industry's protection of the profitable business of manufacturing and selling specific chemicals, particularly those sold in high volumes. Two hundred chemicals were categorized as representing the highest priorities, and under the government's Challenge process, batches of chemicals are periodically released for comments for industry and stakeholder groups. In addition to the environmental and industry groups who are active in this decision-making process, the important players are the government bureaucrats, who evaluate them and propose the way in which these chemicals should be controlled, and their political masters who have the last word on the fate of individual chemicals. The results of these consultations and the government's risk assessments are ultimately delivered by the government as to whether a chemical is in need of risk management and what controls might be appropriate. In some instances, chemicals may be classified as 'toxic' and therefore posing a risk to human health and the environment.

However, these controls may be very limited in scope or even voluntary. Although Canada must develop some kind of regulation or instrument to prevent or control exposures to chemicals identified as toxic, under *CEPA* "Canada has no positive legal duties to do anything specific to reduce overall exposures to the toxic substances, let alone any legal duty to reduce exposures experienced by vulnerable populations or marginalized communities"(Scott and Tessaro 2022, X.3.2). The leniency with which 'toxic' substances are treated, allow chemicals, such as Bisphenol A (BPA), to continue their life in the marketplace. In the case of Bisphenol A, its "toxicity" is supposedly limited by regulations that stipulate that babies can no longer be exposed directly to BPA through its use in baby bottles or sippy cups (Government of Canada Bisphenol A 2020). However, as the Canadian group, Environmental Defence, has shown with the release of their biomonitoring results, Canadians are still heavily exposed to BPA and its questionable substitutes by handling plasticized store receipts and by using cans with linings that leach BPA into food (Environmental Defence 2019). Despite its known endocrine disrupting properties and the concern about its reproductive and developmental toxicity, controls on its widespread use have been very limited.

Another example of the lack of rigour in the Canadian assessment process is perchloroethylene. Widely used as a dry cleaning solvent and a likely carcinogen,[36] perchloroethylene was declared "toxic" by the Canadian government in 2003. Environment Canada compiled an extensive report on alternatives to perchloroethylene, which was promoted to dry cleaners by the now defunct Canadian Centre for Pollution Prevention. However, outreach ended with the demise of the Centre, and Canada's regulations call only for reducing exposure rather than mandating replacement with safer alternatives (Thorpe 2019). The result of this provision, which defines a chemical as 'toxic' but still permits widespread use and exposure, has resulted in toxics

[36] According to the U.S. EPA's monogram on perchloroethylene or tetrachloroethylene, "studies of people exposed in the workplace have found associations with several types of cancer including bladder cancer, non-Hodgkin lymphoma, and multiple myeloma. EPA has classified tetrachloroethylene as likely to be carcinogenic to humans." (tetrachloroethylene.pdf (epa.gov)

activists having to fight each chemical on a case-by-case basis. The issue, then, of increasing the kind and number of toxicity tests and the use of animals has, therefore, not registered as a significant issue for environmental health activists in Canada. The need for better data on toxic chemicals has been overshadowed by the struggle to convince the government, bureaucrats and politicians, to take stronger action on the control, restriction and outright banning of those chemicals already known to be "toxic." The risk assessment process, as it is practiced in Canada, reflects Salter's moral misgivings – it does in fact matter to people which chemicals are carcinogens, and yet, the process itself allows these concerns to be subjugated to bureaucratic decisions, influenced by corporate arguments, and leading to relaxed restrictions on potentially harmful chemicals.

Animal advocates have faced similar frustrations in Canada. Organizations like Animal Justice have worked hard to bring cosmetics legislation into line with the European Union and with the many other jurisdictions that have banned the use of animals for testing cosmetics. However, despite considerable effort and lobbying, they have not yet been able to get federal cosmetics legislation beyond the introduction stage in the Senate, perhaps because so many products sold in Canada are manufactured in the United States. Similarly, their concerns with animal testing have also been frustrated with the demands of *CEPA* and other federal statutes such as the *Food and Drugs Act*, pointing out that assessing the environmental and health risks of chemicals is "the most harmful and painful use of animals in scientific research" (Animal Justice 2022).

Currently, *CEPA* requires standard toxicity tests for the approval of new substances not on the Domestic Substances List (Section 69, New Substances Notification Regulations). The approval process begins when companies wishing to use a chemical not previously used in Canada must, prior to its introduction, submit information to the federal government attesting to the safety of the proposed new chemical and evaluating its impact on human health and the environment. The regulations, known as the New Substances Notification Regulations, govern chemicals and

polymers, as well as food additives. They require that a New Substances Notification package be submitted to the government, containing the notification and testing information prescribed by the regulations, and described by Health Canada as a "safety narrative."

It is difficult to pin down exactly what tests are required to gain approval for a new chemical or food additive, as these can vary according to what is accepted by government departments and on the notification schedule. As Elisabeth Ormandy points out, legislation often contains words such as "safety," terms which are vague enough but mean that safety must be demonstrated by animal testing (Interview, Elisabeth Ormandy, May 27, 2021). For Health Canada, for example, to win the approval of a food additive, a safety narrative is required. As Christopher Rudyk of the Bureau of Chemical Safety writes: "a good safety narrative typically includes pharmacokinetic studies, toxicological testing, and may include clinical trials. Although *no specific toxicological tests* are required, the safety narrative must address a wide-variety of toxicologically significant endpoints, such as systemic toxicity, cancer development and birth defects (my italics). These endpoints are most often addressed by a set of toxicological tests. The set includes tests which examine acute, short-term, and long-term oral toxicity; developmental and reproductive oral toxicity; and genotoxicity" (Correspondence with Christopher Rudyk, Scientific Evaluator, Health Canada, Bureau of Chemical Safety, Food Directorate, May 6, 2021).

Although it is not spelled out, it is understood that acute, short-term and long term oral toxicity tests, to which Health Canada refers, are conventional toxicity tests using animals. Acute toxicity testing, as discussed in Chapter Six, usually involves administering doses of chemicals at different levels by inhalation, orally or dermally, to evaluate the level of toxicity of a food additive or chemical. Similarly, long-term oral toxicity tests would also be conducted on animals. Health Canada goes on to say, however, that "in place of a specific toxicological test, a scientifically-based rationale may be acceptable. The tests are expected to be conducted in accordance with the high

testing standards, usually those outlined in The Organization for Economic Co-operations and Development (OECD) Guidelines for Testing of Chemicals and with OECD Principles of Good Laboratory practice."[37] Consistent with other assessments or evaluations, this toxicological testing is considered; and, based on the tests and additional safety factors, "acceptable daily intake factors" are established, and new additives are approved if they meet these criteria.

Similarly, the New Substances Notification Regulations for chemical and polymers also require a subset of the physical and chemical tests described in the OECD Guidelines for Testing of Chemicals, the requirements of which may vary depending on other factors such as how much material is produced. This information is intended to apprise the Minister of whether these new substances are "toxic or capable of becoming toxic" within the meaning of the Act (Purpose 2.1). Approximately 400 risk assessments are done every year under the New Substances program (Correspondence with Science and Technology Branch, Environment and Climate Change Canada, April 26, 2022). The number of animal tests required depends on the notification Schedule appropriate to the type of new chemical being introduced. Part B.3 of the notification schedule lists the physicochemical information that must be provided and specific environmental and health toxicity studies that are to be submitted to the Ministers of Health and Environment and Climate Change.

Ecotoxicity studies require three acute aquatic toxicity tests done on fish, daphnia, and algae (New Substances Notification Regulations, Notification Forms, B.2. Ecotoxicity Information). To

[37] The OECD *Guidelines for the Testing of Chemicals* is a collection of about 150 of the most relevant internationally agreed testing methods used by government, industry and independent laboratories to identify and characterise potential hazards of chemicals. They are a set of tools for professionals, used primarily in regulatory safety testing and subsequent chemical and chemical product notification, chemical registration and in chemical evaluation. They can also be used for the selection and ranking of candidate chemicals during the development of new chemicals and products and in toxicology research (OECD Library).

address toxicity related to health effects, the Notification forms include specific studies that must be submitted for approval of a new chemical. They are: acute mammalian toxicity (oral, dermal and inhalation); a second acute mammalian toxicity (oral, dermal and inhalation); skin irritation; skin sensitization; repeated dose mammalian toxicity (oral, dermal and inhalation); *in vitro* test for gene mutation; *in vitro* test for chromosomal aberrations; and, *in vivo* mammalian mutagenicity test for chromosomal aberration or gene mutation.

Acute mammalian toxicity and repeated dose mammalian toxicity tests, in support of the request for approval of a new substance, require the use of animals, specifically mammals and usually rats or mice. Additionally, the proposed new chemical must be administered orally, dermally and by inhalation. Acute toxicity tests are meant to determine whether a substance is too toxic for short-term human exposure while repeated dose toxicity determines if adverse effects will occur over prolonged periods. For acute toxicity tests, such as oral gavage, ten animals per dose are often used according to the Science and Technology Branch, Environment and Climate Change Canada (Correspondence Science and Technology Branch, April 26, 2022). For longer-term tests such as repeated dose toxicity (14 or 28 days) and subchronic toxicity (90 day) studies, the number of experimental animals used varies. The New Substances Notification Regulations also require mutagenicity testing to be done using mammals. With respect to skin irritation and skin sensitivity tests, these tests are currently done primarily, if not exclusively, through the use of animals.

With respect to shifting away from animal testing to non-animal methods, however, some progress has been made with proposed amendments that update *CEPA,* Canada's primary toxics statute. The new amendments appear to open the door for alternative animal testing by recognizing, as they say, not only the role of science in decision-making but also the "importance of promoting the development and timely incorporation of scientifically justified alternative methods and strategies in testing" that would reduce, refine or replace vertebrate animals (CEPA amendments

(5)). As Kaitlyn Mitchell of Animal Justice Canada observes, "previously *CEPA* amendments were not on the radar of animal groups" (Interview, Mitchell, May 12, 2021). In her opinion, this was an oversight mainly due to the fact that "animal groups do not have the bandwidth to get involved with these issues." However, Animal Justice has since been working with legislators to strengthen the provisions for alternatives to animal testing under *CEPA*. Their concerns about increasing toxicity testing and sparing animals were summed up in their submission to the Senate debate on the *CEPA* amendments: "Animal Justice has significant concerns that as drafted, Bill S-5 could lead to an increase in the number of animals used in painful experiments. As regulators have acknowledged in other jurisdictions, including the U.S. and the E.U., strengthening toxics laws can have the unintended effect of increasing the number of animals subject to painful and unnecessary toxicity testing. Thankfully, as these other jurisdictions have also realized, there is a way to improve our toxics law while also working to phase out toxicity testing on animals and replace animal models with non-animal methods. In fact, the objectives of protecting the environment and human health, as well as phasing out toxicity testing on animals, are complimentary."[38]

The shift to using new technologies, which is reflected in the amendments, was impressed upon the Environment and Sustainable Development Committee in their 2016 review of *CEPA 1999* by Dr. Daniel Krewski, a professor of medicine, epidemiology and community medicine at the University of Ottawa, who has been at the forefront of advancing different approaches such as high throughput *in vitro* screens and computational technologies, among others. The Committee, reviewing *CEPA* 1999 in order to recommend changes to the government, heard from Dr. Krewski that the world of toxicological risk assessment is changing and that these new technologies "offer the potential to greatly accelerate the rate at which we can test the tens of thousands of agents that

are present in the environment at reduced cost" (Daniel Krewski, Presentation to the Environment and Sustainable Development Committee, 2016).

This recognition of alternatives to animal testing in the proposed *CEPA* amendments has been welcomed by animal rights' activists in Canada (Animal Justice 2021). However, the reference to non-animal alternatives is only included in the preamble to the legislation and, like the preamble's reference to "the precautionary principle" does not impose any obligations on the government to accept non-animal methods. It also falls short of the significant commitments already made by both the European Union and the United States to the development and use of non-animal alternatives. Although Canadian public interest groups have worked hard to press for better toxics laws -- for stricter controls on high risk chemicals in the case of toxics activists, and for eliminating animal testing, in the case of animal advocates -- the Canadian government has been slow to take strong and definitive action in response to either cause.

Conclusion

Animal advocates and toxics activists are both significant actors in the struggle to reform toxics laws. These toxics laws, as they were historically constructed, have heavily favoured the interests of powerful chemical companies over non-governmental organizations. The publicity surrounding the successful Cruelty-Free campaign, and the example of the European Union's Cosmetics Regulation banning animal tests, have increased the pressure on politicians and the cosmetics industry in the United States and Canada to reform cosmetics laws. Animal rights groups in North America have been galvanized by the success of their European counterparts in their rewriting of cosmetics laws and the subsequent European ban on animal testing for cosmetics and ingredients. In the case of cosmetics, animal advocates appear close to bringing American and Canadian legislation in line with the European ban; however, more uncertain is the regulation and

restriction of toxic chemicals widely used in North American cosmetic products, which has long been a focus and concern for environmental health groups.

With respect to toxics laws, the strong advocacy work of toxics activists and the accumulating scientific evidence backing them up has persuaded politicians to reform long-outdated toxics laws, first in the European Union, then followed by the United States and, more recently and more tentatively, in Canada. Animal advocates have targeted these toxics laws as areas of concern, mindful of the prospect that considerably expanded toxicity testing means the use of more animals. At the same time, toxics activists are pressing for the most rigorous regimes possible in order to stem the flow of harmful toxic chemicals into the environment. This has created opportunities to intensify the development and adoption of alternatives to animal methods in the field of toxicity testing and more movement towards incorporating them into current legislative frameworks. These alternatives also hold out the promise of a different and more respectful treatment of animals, as well as opening up the possibilities of more effective toxicity testing, as I will explore in the next chapter.

Chapter Nine: Alternative Non-Animal Testing and The Road Less Travelled

The systematic and widespread use of animals for toxicity testing and risk assessment is a relatively recent phenomenon. The first such toxicity testing conducted on behalf of public authorities in the United States, in the first decade of the twentieth century, used not animals but human volunteers. Dr. Harvey Wiley's famed Poison Squad consisted of twelve young males who were the subjects of feeding experiments from 1902 to 1904 that involved benzoate, borax, and formaldehyde. The use of humans then gave way to an increasingly heavy use of laboratory animals for both safety tests and risk evaluation as well as for biomedical research.

Andrew Rowan, Ending the Use of Animals in Toxicity Testing and Risk Evaluation

Models are analogies. A model is analogous, not identical to the original. Models have to do with similarity but they do not imply identity.

Kenneth Shapiro, Social Construction of Animal Models

Introduction

The shift from the use of animals in research to non-animal alternatives has been gaining momentum over the last twenty years, moving towards a significant rethinking of the way in which animals have traditionally been used to evaluate toxicity. In this chapter, I investigate whether it is possible to adapt and/or replace conventional approaches to toxicity testing in ways that would take into account the current research on animal suffering and the ethical treatment of animals by adopting the alternatives that are becoming available and embracing a more holistic perspective – including notably, sensitivity to issues of trans-corporeality reality. In my second section after this introduction, in order to answer these questions I investigate the paradigm shift in toxicity testing from animal testing to non-animal alternatives. In the third section, I look at the issue of concordance and the questions around the applicability of animal testing and animal models for predicting human responses. In the fourth section, I describe the alternatives that are becoming available and the promise that they hold for moving beyond animal testing in Europe, the United States and Canada, followed by the fifth section, in which the current barriers to their acceptance are discussed. In addition to adopting non-animal alternatives for toxicity testing, in my sixth section, I

offer other viable solutions put forward by environmental health activists that would reduce the need for either animal testing or non-animal testing, and which could also address the problems of a toxic-careless society. After considering these solutions, I look at the ethical implications of these changes in a seventh section, and finally, in section eight, I offer my conclusions.

The Paradigm Shift in Animal Testing

While many voices have been raised in support of reducing or eliminating animal testing, the ground-breaking report of the U.S. National Academy of Sciences (NAS) in 2007 captured the growing sentiment that toxicity testing was approaching a scientific pivot point "that builds on previous history and opens the door to a new era" (National Research Council 2007, 1). The NAS's Committee on Toxicity Testing and Assessment of Environmental Agents called for a paradigm shift in toxicity testing away from whole animal testing "to one founded primarily on *in vitro*[39] methods that evaluate changes in biological processes using cells, cell lines, or cellular components, preferably of human origin"(1). The authors of the report advocated looking not just at disease endpoints such as tumours or birth defects, but also looking at "upstream events," that is, early changes in developmental processes that might lead to the subsequent development of disease.

The paradigm shift, made possible by new chemical testing methods, would not only have the benefit of minimizing or eliminating animal testing, but the alternatives envisioned in the report, "Toxicity Testing in the 21st Century: A Vision and a Strategy," were deemed to offer data that would be more robust than data derived from animal models and would assess chemical toxicity more efficiently (National Research Council 2007). In the words of the report, "the envisioned change is expected to generate more robust data on the potential risk to humans posed by exposure to environmental agents and to expand capabilities to test chemicals more efficiently" (2). The

[39] As explained in footnote 55, *in vivo* refers to testing or research that is done on a whole living organism while *in vitro* refers to an experiment or test done within a test tube or laboratory dish. Additionally, in this chapter, *in silico* is discussed also as a means of research that describes testing or research performed on computer or via computer simulation.

principal authors of the NAS report, Melvin Andersen, from the Computational Biology Division of Research Triangle Park, North Carolina, and Daniel Krewski, Director of the McLaughlin Centre for Population Health Risk Assessment in Ottawa, have described the path forward as requiring the "use of multiple approaches for identifying targets of toxicity and the methods for querying how biological perturbations of these targets lead to toxic responses" (Andersen et al. 2015). There is considerable agreement, then, from those following the field of toxicity testing, that technical developments and policy initiatives have come together in the last decade making it possible to envision a toxicity testing regime that is "attainable, desirable and ethically obligatory," as Andrew Rowan of Humane Society International has expressed it (Rowan 2015, 448). Since the release of this report, efforts to incorporate non-animal testing into many areas of research and testing have been accelerated, and governments have made major commitments to reducing or eliminating animal tests. Elisabeth Ormandy who also founded the Society for Humane Science, which promotes non-animal methods, makes the point that these methods are better both in terms of science considering the limited ability of animal models to predict human responses and in terms of cost (Interview, Elisabeth Ormandy, May 27, 2021). However, despite the enthusiasm and support for the transition to non-animal alternatives in toxicity testing, the adoption of these alternatives has only slowly materialized in the face of commercial pressures to maintain the status quo and the caution exercised by regulatory agencies challenged by such a major transition (Prior et al. 2019; Pain et al. 2020).

Concordance and the Reliability of Animal Models

The shift to non-animal testing methods would also address an important question that has long plagued animal testing: whether conventional animal tests, relied on for biomedical and toxicological evaluation, are dependable indicators of human response. The assumption -- that tests

on animals accurately predict human outcomes and are essential to analyzing toxic effects and understanding disease is not universally accepted.

There have been many well-founded concerns over the decades since animals became a fixture of research about whether the data derived from animal testing can be extrapolated to humans. Neurologist and public health specialist, Aysha Akhtar, identifies some of the major areas that undermine the reliability of animal testing (Akhtar 2015, 2.). She cites both the lack of congruence between animal models of disease and corresponding human disease, as well as the interspecies differences in physiology and genetics between animals and humans. Thomas Hartung, at the Center for Alternatives to Animal Testing at Johns Hopkins University, also argues that animal experiments fall short in predicting human responses (Hartung 2017). In fact, he goes farther maintaining that when studying human physiology, pharmacology and toxicology, animal models are just as misleading as they are helpful (193). In toxicology, for example, where the best reproducibility should be expected, he finds that, of the 3,500 cancer bioassays that have been done on animals, the reproducibility was only 57 per cent for 121 substances that were repeatedly tested (Hartung citing Gottman et al. 2001, 195). Even simpler and shorter animal tests, such as those for eye irritation, have been found to be just 70 per cent reproducible (195).

Leist and Hartung also make the point that "a culture of stringent validation" has been developed for the new approaches to toxicological testing that are currently being embraced, "while the quality and usefulness of animal experiments have been little scrutinized" (Leist and Hartung 2013, 563). They offer as an example the comprehensive study of inflammation, conducted as part of the Large Scale Collaborative Research Program, which compared the predictivity of mouse models to human responses, and found a markedly poor correlation (Seok et al 2013). Leist and Hartung conclude that this study, and other animal experiments in research areas that allow direct comparisons of mouse versus human data, "puts strong doubt on the usefulness of animal data as

key technology to predict human safety" (Leist and Hartung 2013, 563). They summed it up by pronouncing that, "humans are not simply 70-kg. mice, neither in pharmacology, nor in toxicology" (565).

A large number of studies support these critiques of animal testing and their questionable predictive power. In particular, an expert panel of toxicologists, looking at the results of animal tests in 2000, found that the data ranged from 43 per cent accuracy extrapolating from rodent studies to human responses to 63 per cent for non-rodent studies (Olson et al. 2000). When both rodent and non-rodent studies were combined, the predictability rose to 71 per cent. According to Andrew Rowan, since most toxicological studies are conducted with rats and one non-rodent species, in practice routine animal testing would therefore be likely to predict human toxicity only "somewhere between 50-60 percent of the time" (Rowan 2015, 452).

Like Akhtar, Hartung also argues that animal experiments do not reflect human diversity, exposure and treatment. In toxicological tests, animals are subjected to high doses of chemicals and the local effects calculated. He points out that humans are "different from inbred mice in many aspects: our weights, our age, our lifestyle, our genetics, our history of diseases" (Hartung 2017, 196). For human populations, "we should be concerned about low and chronic exposures" and about our exposure to mixtures of chemicals in products (Hartung 2017, 196). Because animal models, then, do not necessarily predict human outcomes, the concern is that animal experimentation may result in misleading safety studies that ultimately cause harm to human beings (Akhtar 2015). By continuing to prioritize and fund animal research, the opportunity to invest in tests that more accurately reflect human biology is being lost. In Akhtar's view, and the view of many others, resources would be better directed at the development and use of new technologies that can replace animal tests.

The Non-Animal Alternatives to Animal Modelling and Their Viability

The alternatives already in development or in use for the prediction of toxic effects include computational modelling techniques, cell-based technologies using tissue cultures, microbiological systems, stem cells, and DNA chips as well as next-generation sequencing or omics technologies (Burden et al. 2015, 2; Arora et al. 2011,1). Natalie Burden and her colleagues at Great Britain's National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs), have described it as the "beginnings of a move towards a future in which more human-relevant, non-animal systems are used in the study of biological processes and in the early stages of the development of novel pharmaceutical compounds" (Burden et al. 2015).

Computational modelling techniques, as alternatives to animal methods, are already being used by many government agencies to evaluate chemicals and to fill in data gaps. These include techniques such as "Structure Activity Relationship and Quantitative Structure-Activity Relationship models, referred to as (Q)SARs), and another technique known as "read-across." Computational modelling has the capacity to incorporate large data bases of biological information, which are inputted into the computer, and mathematical models then applied (Lamb n.d.). According to Thomas Hartung who promotes alternatives, using computer software and the power of big data means that "we can produce a tool more predictive than many animal tests" (van Noorden 2018). QSAR models predict biological or toxicological properties of chemicals on the basis of a chemical's physicochemical and structural properties (European Commission EU Science Hub n.d.). They are desirable as a tool to characterize the toxicity of chemicals because the technology is practical and cost-effective (Worth et al. 2004), particularly in comparison with the expense and the time that it takes to do animal studies. However, the amount and quality of the data needed for building QSAR models that shed light on human toxicity endpoints are often insufficient for modelling purposes, because of the "enormous data gaps" missing for most chemicals (AltTox 2014; Cronin et al. 2003).

Mark Cronin of Liverpool John Moores University and his fellow authors note that "we should be emphasizing the chemical information that is lacking…and attempt to obtain these missing data." (1839). Without replicating data that already exists within current databases, he advises increasing our knowledge in a range of toxic endpoints, for which no, or few, meaningful QSAR models are available.

Another computer technology, "read-across," that relies on structure-activity relationships, has been adopted by many companies trying to meet the data requirements of REACH without resorting to animal testing, and by government scientists, such as those at Environment Canada, seeking to characterize chemicals and support assessments (Canada 2020). "Read-across" predicts chemical properties and the probability of toxic effects by grouping chemicals on the basis of their structural and biological similarity, and comparing the relevant properties of data-poor chemicals with similar data-rich chemicals (Stanton and Kruzewski 2016). Chemicals with structural similarities are likely to have similar environmental fates and similar physical-chemical and toxicological properties (250). Read-across, then, has been useful for addressing specific data gaps for groups of chemicals, where the chemical and human health data, as well as ecotoxicological properties, are likely to be similar or to follow a pattern (AltTox 2014).

In the United States, federal agencies have concentrated on high-throughput robotics using *in vitro* assays as their preferred way to screen the thousands of chemicals with little or no data. Under the Tox21 program, several U.S. agencies have collaborated to develop new testing methods that would more rapidly evaluate the effects on human health and "minimize the number of laboratory animals used" (National Toxicology Program 2017). Tox21 acknowledges that results from animal tests "don't always translate easily from animals to humans" (National Toxicology Program (NTP)

2017). Using high-throughput cell-based assays, the U.S. EPA's ToxCast program[40] forecasts the toxicity of thousands of chemicals tested at the same time at different concentrations. From 1,000 to 2,000 cells of each chemical are added to tiny wells, installed in an incubator; and the chemical responses of these cells are measured (NTP 2017). The government's goal is to evaluate the thousands of chemicals already on the market, identify those most likely to harm human health; this information is then used to inform regulatory decisions. Using ToxCast, EPA's high-throughput assay program, more than 10,000 chemicals have already been screened.[41] Taking steps to fulfill its promise to reduce animal testing, the EPA also maintains a list of non-animal alternatives or New Approach Methodologies (NAMs), which do not require vertebrate testing. The list of NAMS includes not just replacements for animal testing, but also tests that reduce the number of animals needed.

Other toxicity tests using stem cells and cell lines are among the most widely-adopted alternatives to traditional toxicity tests using animals, a number of them forced into being by the EU's Cosmetics Directive ban on animal testing and by REACH's encouragement of alternatives. Sometimes referred to as tissue culture, these techniques involve keeping cells or pieces of organs alive "*in vitro*" or outside the body. They can range from cell cultures involving single layers of one cell type, to organs-on-a-chip or organoids – "complex three-dimensional structures which closely mimic organs" (Abdulla 2019). Dr. Charu Chandrasekera, Director of the Canadian Ccntre for Alternatives to Animal Methods, is a strong advocate of replacing animals in regulatory testing, as well as in medical and pharmaceutical research. Rather than subjecting animals to painful

[40] The high throughput assays or rapid experiments constitute the ToxCast program of the U.S. Environmental Protection Agency. ToxCast is part of the larger Tox21 collaborative initiative that developed from the 2007 report of the National Research Council, "Toxicity Testing in the 21st Century." Tox21 includes four government agencies including the EPA, and the U.S. Food and Drug Administration.

[41] According to the National Toxicology Program, using the robotic high throughput assays for 3 days and using 1,536 well-plates is the equivalent of the work that it would take one person working eight hours a day, five days a week for 12 years to do using standard 96-well plates (National Toxicology Program, Tox 21: Chemical testing in the 21st Century, March 2017).

procedures, she points out that cells can now be collected from surgeries, remains or biopsies, put on a chip and used to understand the toxicological impacts of chemicals (Chandrasekera n.d.). For instance, human cells can be used instead of mice to test for allergies; engineered human skin daubed with chemicals can indicate skin irritation rather than applying the chemical to the skin of a rabbit; and, rather than using dogs, human lung epithelial cells or "lungs on a chip" can indicate the toxicity of a chemical spray. These organs-on-chips are "lined by human cells and reconstitute organ-level functions, enabling them to be accurate models that can better predict the human situation" (Greer n.d.). In addition to organs-on-chips, human mini-organs or organoids mostly around half a millimeter in size, are derived from human stem cells and share the main functional features of human brains, livers, kidneys or other organs (Zietek 2019).[42]

Researchers at Boston University, for example, collaborating with the U.S. National Toxicology Program, developed a new approach using gene expression profiling to determine whether exposure to certain chemicals would increase the long-term risk of cancer (National Institute of Environmental Health Sciences 2019). Human liver cell lines were exposed to hundreds of individual chemicals either known to cause cancer or known *not* to cause cancer (my italics). By measuring the activity of genes to discover what was happening in a cell after being exposed to a chemical, researchers were able to use a computer model to infer the specific biological changes that would predict the carcinogenic potential of a chemical. Noting that less than two per cent of chemicals in commercial use have been thoroughly tested for carcinogenicity, this technique has been described as a "promising solution that could be used to prioritize chemicals for further cancer testing" (1).

[42] Organoids are not a tiny organ but three-dimensional cell cultures; a lung organoid is not a tiny lung but a miniature version of alveolar sacs made from stem cells (Dolotova, Tamara n.d. "Alternatives Series: Organoids," Society for Humane Science. Accessed on July 15, 2022 at: www.forhumanescience.org/blog/alternatives-series-organoids/).

Toxicogenomics, defined as "the study of the relationship between the genome and the adverse biological effects of external agents," is another technique in the new generation of alternative testing methods under development (Pain et al. 2020, 105002-1). Using techniques of toxicogenomics, scientists can study genes and changes in protein expression to assess toxicity pathways and a chemical's potential for harm. Working with gene editing techniques, for example, researchers have been able to contribute information on chemical methods of action by inhibiting or promoting select genes (Rager et al. 2019). Toxicogenomics, although still in its early stages of development, is considered to have the potential to identify chemical and disease-specific genes and pathways that cause environmentally-induced diseases, and to be useful as a tool in risk assessment. (17).

It is the hope of animal advocates that cell-based techniques and other alternatives will eventually end all scientific testing using animals (Greer n.d.). Many of the alternative test methods are now regarded as reliable and suitable substitutes, the equivalent of traditional animal tests, and in many ways more relevant to human physiology. At the same time that REACH was driving the demand for test data, it also promoted the use of many non-animal alternatives through its guidance documents, one of which made non-animal testing the default testing method and favoured the use of cell-based tests for skin corrosion/irritation, eye irritation and skin sensitisation (European Chemicals Agency 2017). In many cases, non-animal tests are considered more reliable indicators of the toxic potential of these chemicals and of the likely human response, and are more reproducible than results from animal testing. For example, a 2019 study, which compared applying chemicals to rabbit models and to human skin cells as assays for predicting skin sensitization, found that human skin data predicted the human response much more accurately (Jirova et al. 2010). The incentives to move away from animal testing reflect not only the potential for more clearly evaluating human responses, but also include the ethical concerns of alleviating or avoiding the

suffering of animals, the scientific concerns about the differences in the biology of humans and animals, the legislative encouragement and, in some cases, imperative to use non-animal methods, and the likely advantages for business in reducing resource-intensive animal costs (Burden et al. 2015).

What is Holding Back the Transition to Non-Animal Toxicity Testing?

There are a number of explanations to the question of why non-animal alternatives are not being embraced more quickly by industry, governments and the scientific community. The vision put forward by the NAS report anticipated a ten to twenty year period in which the availability and reliability of alternatives would steadily progress, and, according to its authors, considerable progress has been made since its release (Krewski et al. 2020). However, a key prerequisite of this "paradigm shift" was a "commitment to change in the scientific community" (Krewski et al. 2010).

A survey done ten years after the NAS report, designed to assess the progress made towards the use of alternative methods, found there were technological and validation issues, and a general resistance to change. As well, the survey found that concerns about regulatory acceptance were inhibiting the pace at which alternatives were being adopted and used (Zaunbrecher et al. 2017). The authors of this survey suggested a two-pronged effort was needed – a bottom-up effort from stakeholders, such as non-governmental organizations, to encourage the adoption of alternatives, coupled with top-down legal and institutional changes focused on regulatory acceptance. They noted that "real change within regulatory programs may necessitate mandating the use of ATS (alternative testing strategies) approaches where scientifically appropriate" (087024-8).

As a result of this slow progress, there remains a "significant reliance on the use of experimental animals for the purposes of hazard identification and risk assessment," even though the toxicology and regulatory communities have shown interest in moving towards non-animal tests (Prior et al. 2019, 30). This is true even for the assessment of acute toxicity, where non-animal tests have been

developed and validated (Prior et al. 2019). The practice of using animals for demonstrating the safety of cosmetics – relying on a suite of tests known as the acute toxicity "six pack"[43] -- is now prohibited in many countries. Yet, this suite of animal tests continues to be a pre-requisite for the classification and labelling of agrochemicals and for information regarding the emergency spillage of industrial chemicals, despite scientific, business and legislative drivers to replace them with alternatives (Prior et al. 2019).

Burden and her co-authors at Britain's NC3Rs have clarified the hurdles that must be negotiated before the goal of non-animal approaches can be achieved (Burden et al. 2015). As well as a general resistance to change, they have highlighted other significant barriers to the adoption of non-animal methods. Perhaps the most important one, and the one most commonly cited by a number of authors, is the problem of validating non-animal tests and the difficulty in ensuring that these new non-animal methods are reliable and fit for their intended purpose (Prior et al 2019; Pain et al. 2020). This is compounded currently by a lack of global acceptance of the validity of non-animal methods (Prior et al. 2019), resulting in industries continuing to test on animals to meet demands in regions of the world that do not accept alternatives (Meigs et al. 2018). Another barrier is the problem of scientific credibility and the reluctance of regulators to use the non-animal test data to inform safety decisions. Regulators have little flexibility in adapting to alternative methods and perceive more traditional methods as less "risky" (Burden et al. 2015). Risk assessment and how the data from alternative methods should be interpreted is also a barrier for regulatory acceptance, particularly in the interpretation of risk assessments.

A third problem, identified by the NC3Rs authors, is that toxicity testing using non-animal methods may involve multiple defined approaches rather than offering a single one-to-one replacement (Prior et al. 2019). This adds complexity to interpreting the results of these new testing

[43] As mentioned previously, the acute toxicity "six pack" is the suite of standard toxicity tests that include those for acute oral toxicity, acute dermal toxicity, acute inhalation toxicity, eye irritation/corrosion, skin irritation/corrosion and skin sensitization. These were commonly used for testing cosmetics as well as pesticides and industrial chemicals.

regimes (Pain et al. 2020). There are also a number of industry concerns about these new methods – ensuring that they are not only reliable and time-effective, but that they do not require an extremely high level of investment (Prior et al. 2019; Pain et al. 2020). Lastly, the authors identify, as a barrier towards incorporating non-animal methods into testing regimes, the need for a framework that allows for accurate and comprehensive reporting of *in vitro* methods such as cell lines, primary cells and tissues (32-33). A similar problem or barrier to the uptake of non-animal methods has been described by Guillaume Pain and his co-authors, as a lack of standardization in the field of non-animal tests (Pain et al. 2020).

Another key to the slow adoption of non-animal testing methods is due to the fact that, as Ray Greek and Lisa Kramer point out, "there are many stakeholders with vested interests in the continued use of non-human animals in research" (Greek and Kramer 2019, 67). Testing and research are industries that employ many scientists and non-scientists in both the private and public sectors. Greek and Kramer estimate that at least $10 billion is spent annually in the United States on animal-based testing from the National Institutes of Health alone. It might be expected, then, that those involved in this industry would generally oppose changes that make their jobs obsolete. As well, many of these workers may be "reluctant to embrace technological change that simply alters the specific tasks they undertake in completing their work" (67).

Consequently, as a result of the barriers to adopting non-animal methods, little progress has been made in reducing the overall use of animals. This can be explained by a number of factors: that the animal tests that are being replaced are mostly acute and topical tests that use relatively small numbers of animals; that the reduction in animals that has been achieved is being offset by the rising numbers of animals used in basic research, especially genetically modified mice (Daneshian et al. 2015), and that regulatory programs, such as REACH, are creating additional demands for testing, which often includes animals (Meigs et al 2018).

An Environmental Vision: Going Beyond Toxicity Testing in the 21st Century

Although regulatory agencies are receptive to the possibilities of replacing animal tests with non-animal methods, scientists and environmental health activists, concerned with harnessing the toxicity of unleashed chemicals, have proposed a number of other approaches. These have not been eagerly received either on the political or the regulatory level, even though they not only avoid the use of animals but also help to characterize or contain toxic chemicals. If the objective of regulatory agencies was truly to control or eliminate the harmful effects of chemicals on human health and the environment, there are many routes to this end. Yet, there has been little uptake of other promising ways, and regulatory agencies remain attached to conventional practices and uncertain risk assessments. These approaches start with the same goal of improving our understanding of chemical exposures and the development of human disease or adverse environmental impacts, while also avoiding the costly and time-consuming reliance on animal tests.

One important area that has been underused by the scientific and regulatory communities is the examination of human data, particularly the use of epidemiological studies, which could shed considerable light on the worst toxic actors. Looking at the burden of cancer from chemical exposures, scientists at the Silent Spring Institute have pointed out that, as the testing and regulation of carcinogens remains inadequate, epidemiologic observations are one of the many ways to identify the unwanted health effects of toxics, and to reduce their burden on society (Kripke et al. 2020). They give the example of higher leukemia incidence in children living near roadways and industrial sources of pollution. Kripke and her colleagues at Silent Spring Institute welcome the new *in vitro* technologies that can decode carcinogenesis at the molecular level and, therefore, offer the possibility of identifying carcinogens and reducing exposures. Hartung also suggests that an alternative to animal experiments is to study humans in order to understand human physiology, disease and treatment (Hartung 2017). He urges taking advantage of monitoring our ongoing daily

exposures, and using epidemiology, advances in biomonitoring, biomarkers, biobanking[44] and even microdosing to understand the toxic effects of chemicals.

Another example of using existing options to understand toxicity without using animals is the work of University of California scientists who convened an interdisciplinary panel to investigate the potential of innovative chemical safety testing to identify chemicals that could increase the risk of breast cancer (Schwarzmann et al. 2015). Their study, the "Hazard Identification Approach for Breast Carcinogens" was directed at working back from the development of breast cancer "through the biological mechanisms associated with it to identify appropriate assays for disease-specific chemical risk assessment."(Nicole 2015). This is consistent with the NRC report that proposed looking at "upstream events," that is, early changes in biological processes linked to the development of disease, rather than considering only disease endpoints such as tumours (National Research Council 2007). The team of scientists, working for the Berkeley Breast Cancer and Chemicals Policy Project, looked at 11 chemicals, known or suspected to be breast carcinogens. They found that these chemicals tested positive on several assays, although almost none of them had gone through a full toxicological assessment. Their findings suggest that, in addition to the high-throughput screening that helps identify potentially harmful chemicals, the development of toxicity testing that targets mechanisms relevant to specific diseases such as breast cancer could provide a basis for identifying problematic chemicals for regulatory action. Since breast and other cancers have been difficult to link definitively to specific chemicals because of long latency periods and tumour development as well as the difficulty in measuring previous exposures (Young and Seely in Scott 2015, 312), this hazard identification approach contributes important data by identifying mechanisms implicated in diseases such as cancer.

[44] Biobanking refers to the storage of biological samples (such as human tissue, blood, or DNA) that may be used for future medical research (Merriam Webster Dictionary).

There are, then, many ways in which to bring down the level of toxic risk without resorting to additional animal testing. First and foremost would be for governments to begin accepting and acting on prevention-oriented evidence by applying the precautionary principle in the assessment and management of chemicals (Young and Seely in Scott 2015, 314). The absence of data, including information on chemical use and exposures based on sex or on marginal communities, should not "prevent the government from taking action to protect Canadians…more fully through precautionary measures" (Scott and Lewis 2015, 89). As Young and Seely have pointed out, "adopting the precautionary principle broadens current research objectives to include the primary goal of *prevention,* requiring that government act in the face of uncertainty if evidence for a given chemical demonstrates the potential for harm" (Young and Seely in Scott 2015, 314, italics theirs). Prevention-oriented evidence, as Brody, Tickner and Rudel have pointed out, can be "derived from a broad set of methods that include hypothesis testing, epidemiological studies toxicology, exposure assessment, risk assessment, wildlife studies and human case reports," (Brody, Tickner and Rudel 2005). Their vision of controlling toxic exposures includes the engagement of activist groups, or "citizen scientists" as Marshall and Picou have called them, to expand research applications and to further the public awareness of the risk factors of environmental contaminants.

Governments could also pass laws that promote or compel the reduction of toxics, similar to the Massachusetts *Toxics U.S. Reduction Act*, in effect now for over 20 years. The principle of toxics use reduction has been defined as "a regulatory approach to pollution prevention that seeks to target and measure reductions in the upstream use of toxic chemicals instead of the downstream assessment of risks to health and the environment" (Scott 2015, 401). The Massachusetts *Act* requires companies producing large quantities of toxic chemicals to develop toxics reduction plans, and to pay fees based on their use of specifically identified toxics (Government of Massachusetts 2022). The benefits of the reduction of toxics use and release in the state are estimated to amount

to $91 million, including "less pollution and cleaner environments, safer consumer products and work environments, improvements in public health" and more innovative green technologies (Young and Seely in Scott 2015, 318).

"Informed substitution" or "safer substitution" is another strategic avenue for identifying and restricting potentially hazardous chemicals in processes and products – a straightforward call for safer products and processes (Thorpe and Rossi 2007). Yet, as Joel Tickner and his associates at Public Health Lowell, Massachusetts, point out, when problematic chemicals are identified by public health scientists, and substitute chemicals are pursued, it is rare that those substitute chemicals are safer (Tickner et al. 2017). They give many examples of "regrettable substitutions," such as replacing trichloroethylene, a carcinogenic solvent used in degreasing operations, with n-propyl bromide, an even more potent but unregulated carcinogen (Tickner et al. 2017, 655).

Preferable to this phenomenon of regrettable substitution would be identifying safer chemicals with lower inherent hazards. As Beverly Thorpe of Clean Production Action points out, acute toxicity tests tell us little about chemicals and shed no light on the persistence and bioaccumulation of chemicals (Interview, Thorpe, May 25. 2021). In her view, decisions should be based on hazards rather than on risk assessments. A full hazard assessment would be conducted by a literature review and not by animal testing. She is a vocal proponent of "alternatives assessment," and questions "why millions are spent on animal testing, the results of which are confidential, when it would be better to just move to safer alternatives." (Interview, Thorpe, May 25, 2021).

A growing field in science policy, "alternatives assessment" is the process of identifying, comparing and selecting safer alternatives to chemicals of concern, on the basis of their hazards, performance and economic viability (Tickner et al. 2017, 655). It is an action-oriented process that addresses exposure in contrast to risk assessment, which only quantifies the risk of a chemical associated with a specific hazard endpoint and a certain level of exposure. Thorpe and Rossi go

further, advocating regulatory reform that would make the principle of "safer substitution," or, as it is sometimes referred to, the "least toxics alternatives" principle, an essential feature of toxics regimes (Thorpe and Rossi 2007). They propose making it mandatory that when chemicals are categorized as toxic or hazardous, they must be replaced with less hazardous alternatives or, more preferably, with chemicals for which no hazards can be identified.[45] The principle of safe substitution is not limited to finding a drop-in chemical alternative but also looking at systems, materials and process changes. In some cases, according to Thorpe, entire classes of chemicals, such as those with the fluorine carbon bond like per- and polyfluoroalkyl substances (PFAS) which can persist tens to thousands of years, should be phased out (Thorpe, Interview, May 25, 2021).

Another environmental solution to reducing toxics exposure and "chemical harm" is the Six Classes of Chemicals approach pioneered by the Green Science Policy Institute, founded by Arlene Blum in California (Six Classes n.d.) These six classes, known for the damage that they have inflicted on humans and the environment, are PFAS, antimicrobials, flame retardants, bisphenols and phthalates, some solvents and certain metals. Drawing on the already known toxicity of these classes and with the same goal of safer substitution, the use of chemicals from these classes would be avoided, and chemicals from these six classes would not be used to replace others from these classes. These are straightforward and easily accomplished solutions to a long-standing toxics problem that a simple regulation could rectify. Yet, safer substitution and green chemistry initiatives have not been embraced by industry. Addressing the untapped potential of green chemistry, Wilson and Schwarzman explain:

> This primarily reflects the priorities of the U.S. chemicals market, in which chemical safety is undervalued relative to function, price, and performance. Hazardous chemicals have thus remained competitive, despite the many costs society bears as a result of their production, use, and eventual disposal (Wilson and Schwarzman 2009, 1207).

[45] Safer substitutes can be identified through the green screen, an open data source, that allows a comparison of a hazardous chemical with less hazardous alternatives at greenscreenchemicals.org

Conclusion

One of the primary drivers for accelerating the development and application of non-animal methods has been, and still is, the ethics of the human/animal relationship and the moral imperative to end our exploitation of animals. As Natalie Burden of NC3Rs has pointed out, toxicity testing is known to use large numbers of animals and be responsible for high levels of suffering (Burden et al.), so pivoting to alternative non-animal methods can answer these concerns. Thomas Hartung puts the ethics of animal testing more bluntly, "It is not only criminal, but no sane person will make animals suffer if there is no need to do so, i.e., an alternative is practically available" (Hartung 2017). There is considerable consensus on this principle: if alternatives are available, they should be used. As noted in Chapter Four, philosophers Tom Beauchamp and David DeGrazia have developed six new principles to update the 3Rs, the first of which is "the principle of no alternative method." (Beauchamp and DeGrazia 2020). This principle is, simply, that animals should not be harmed if suitable alternative models are available to achieve the goals of the research (6).

However, rather than resorting to a set of principles, like the 3Rs, to guide research and testing, barring the use of animals in toxicity testing has been shown to be a more direct route to ensure that non-animal alternatives become the regulatory gold standard. The European Union, in legislating the ban on animal testing for cosmetics, forced the development of non-animal alternative methods, and these tests are now validated and available to replace the traditional animal tests. Therefore, it would seem to be a realistic and compelling next step, as disruptive to business as it might be, to legislate the end of toxicity testing using animals, as animal advocates and others have called for. Like the success of the ban on animals for cosmetic testing, this legislation would fast-track the developing non-animal methods and push governments and industry to resolve the issues around validation and regulatory acceptance. Such a bold move would align with an animal rights position

that animals have rights that are violated by using them as subjects of toxicity tests, rather than as "subjects-of-a-life" (Francione 1995, 13). It would also end the scientific reliance "on the "humaneness" of research or the "necessity of pain" that privileges the human over the animal (13), and perhaps begin the dispersal of respect for the sentience and cognition of animals into a broader realm.

Ironically, not only would ending the use of animals in toxicity testing benefit animals, but it is also likely that the replacement methods would be more cost-effective, quicker and more accurate in their portraits of chemicals. These new predictive toxicology tools are regarded as being able to prioritize those chemicals, which need further scrutiny, as well as holding out the promise of understanding better their toxic effects, an obvious pre-requisite for protecting human health and the environment (Smith and Faustman n.d.). From the point of view of the chemical industry, its one drawback would be the generation of data that would reveal the toxicity of many of those chemicals already in use and hasten their exit, or the possibility that better characterization of chemicals might block the entrance for many of those under development.

Chapter Ten: Final Conclusion

A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.

Aldo Leopold

For the first time in the history of the world, every human being is now subjected to contact with dangerous chemicals, from the moment of conception until death.

Rachel Carson, Silent Spring

I started this journey asking how a reorientation of conventional toxicity testing might, in theoretical, ethical and practical terms, result in animals, now forced to undergo painful toxicity tests that evaluate the harm to humans or the environment, be spared suffering and death through the adoption of alternative testing methods. At the same time, it seemed important to investigate how non-animal methods of toxicity testing could potentially mean that chemicals coming on to the market or already in commerce could be evaluated more scrupulously, and that by using these advanced methods, those chemicals that would cause the most damage to human health and the environment could either be prevented from introduction onto the market or removed if they were already in circulation.

As a result of my investigation into animal cognition and the ethical issues arising from the recent advances in our understanding of animal minds, the principle theoretical consideration underlying the many facets of this paper is the question of whether we should extend our moral community beyond the current human boundaries to encompass animals, and if so, how should we do it. Paying attention to the scientific literature on animal cognition reveals that we have vastly underestimated animal minds. It also becomes clear that those "magic wells" of animal cognition will continue to yield more impressive evidence of cognition. It is a moral question, then, whether we are justified in injuring and sacrificing sentient beings in the name of creating more products and developing more complex technologies to serve or to entertain humans, as philosophers Peter

Singer and Tom Reagan have argued. Although many in the scientific community have embraced the idea of reduction or replacement of animals in experimentation, the fact remains that animal protection laws and laboratory practices do not reflect our understanding of animal cognition. And animals, particularly those that are bred and bought to undergo toxicity tests, suffer from the most agonizing of scientific experiments, condoned or expressly mandated by laws that govern toxic chemicals.

And yet, at the same time that animals have been sacrificed, humans and wild animals have also become unwitting victims of this toxic rush to greater productivity and the accumulation and use of goods. The toxicity testing that is done in the name of ensuring the safety of chemicals is a flawed process that, even as it harms animals, has also failed to protect human health and the environment. In my investigation of toxicity testing, the inadequacies of the animal testing regime have become painfully evident – a reliance on high dose, acute toxicity testing using animals as the basic system with which to gauge human health and environmental effects, and the questionable use of this information in risk assessments based on scanty knowledge of possible human exposure or environmental consequences. The larger problem, encompassing the issue of animal testing, is the lack of data, for which the answer does not have to be more animal testing. The lack of data is either the result of older toxics laws through which many modern-day high volume chemicals initially passed with little information required, or the result of the toxicity testing regimes currently in place that demand only very basic information on chemicals. As Ida Fischer and her colleagues at the University of Aberdeen have described regulatory toxicity testing, "the effective management of the use and safety of such chemicals is crucial to the well-being of all" (Fischer et al. 2020, 67). Yet, regulatory agencies can never get ahead of the backlog of old chemicals and the avalanche of new. Nor can they stand up to the powerful chemical industry and their influence on politicians.

However, this does not have to be so. Through the course of this research, it has become apparent that a creative suite of non-animal testing methods could be constructed as viable replacements for standard toxicity tests, as animal activists contend. It is also likely that these non-animal testing methods would be more accurate in predicting effects on human health and the environment than traditional toxicity testing methods using animals, and that less harm to humans and natural environments would result from a shift away from animal testing and the adoption of *in vitro* and *in silico* methods. It has been noted, for example, that chemical groups being proposed for children's products such as engineered nanomaterials cannot be adequately characterized using traditional toxicological approaches and that predictive methods using *in vitro* and *in silico* tools would be valuable additions to ensuring safer products (Smith and Faustman n.d.).

At this moment "when governments are rethinking regulatory approaches" and facing up to the challenges of multiple chemical exposures, exposures at low doses or at critical windows of vulnerability, issues of unknown, often higher, exposures for women and low-income communities (Scott 2015, 388), there is an opportunity to move away from traditional risk assessment and risk management procedures and shift to a more precautionary approach to chemicals, for which toxic activists have long advocated. Additionally, toxics use reduction programs or the application of a green screen to chemicals that have been implicated in their toxic effects could both reduce the need for animal testing and the uncertain consequences of human exposure. As Dayna Scott has summed it up: "this is the movement that says: we don't need to spend any more time and resources endlessly engaged in contested and convoluted risk assessment processes, we can simply get on with the business of finding safer alternatives, finding better ways to achieve our social objectives, and reducing our reliance on toxic substances" (Scott 2015, 389) Therefore, it seems appropriate to conclude that the answer to the title of my dissertation is: yes, animal lives could be spared and human health improved by toxics reform -- that is, by reforming toxicity testing in a way that would

adopt more predictive non-animal methods and by mandating safer substitution for chemicals known to be toxic. This also assumes that governments and regulatory agencies would support the movement towards reducing or eliminating toxic exposures and stand up to corporate pressure.

In the course of examining the many aspects of toxicity testing, however, it has also become clear that there are larger unanswered questions that hover over these issues. The overwhelming problem of how poorly chemicals are tested, how little we know about their stealthy and negative effects on human health and the natural environment, their persistence and their accumulation, as well as the shaky nature of risk assessments, will not be entirely resolved by a conversion to non-animal testing, even though these tests may more accurately describe human responses to these chemicals and better characterize our knowledge of a chemical's potential harm. The flood of chemicals, developed, engineered and pushed through the regulatory systems by the powerful chemical industry, can never be adequately assessed with the tools we are using, and at the pace, which we are now witnessing and which is anticipated to continue into the future. This is the very legitimate and pressing concern of many environmental scientists and health activists.

Beginning in 1945 initially and then ramping up during the 1970s, chemical companies have exponentially expanded their production and their profits, and become a central element in the growth of the global capitalist economy (Hudson 1983). Global chemical production has been projected to continue its rapid growth of 3 per cent a year, resulting in a doubling of production every 24 years (Wilson and Schwarzmann 2009, 1203).[46] In 2018, the revenues of the global chemical industry amounted to more than four trillion U.S. dollars (Fernandez 2021). This escalation of chemical use was the situation, which faced Rachel Carson in the 1960s, when she recognized the drastic toll that chemical proliferation was taking on both the environment and

[46] The year 2020 saw a 3.6 per cent drop in U.S. chemical production due to the Covid 19 epidemic but is expected to recover this loss and increase by 3.9 per cent in 2021 (Statista 2021 accessed on August 4 at www.statista.com/statistics/407803/forecast-for-annual-growth-in-chemical-industry-in-the-us/)

human health and that "science and technology…had become the handmaidens of the chemical industry's rush for profits and control of markets" (Carson 2002, xv). And this is the same situation that we still face today. Commodity capitalism drives the expansion of the chemical industry and its development of more novel products for the world's citizens to consume with little responsibility for the consequences of this production. The philosophers' questions are legitimate – do we need more cosmetic products or more sophisticated floor cleaners at the expense of animal lives and the proliferation of toxics? Although the European Union is still far from practicing a sustainable chemical strategy, it is moving in that direction. It is working towards the adoption of a generic approach to risk management with the goal of ensuring that at least consumer products do not contain chemicals that cause cancers, gene mutations, affect the reproductive or endocrine system or are persistent and bioaccumulative (European Commission 2020, 10). This would mean denying approval to new chemicals and eliminating chemicals from commerce, which exhibit these properties. Given what we know now, this seems a reasonable place to start the daunting uphill climb.

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