5-2015

Leveraging Capacity: Technical Solutions to Hunger in the Era of Neoliberalism

Elizabeth Perry Bullock
Graduate Center, City University of New York

LEVERAGING CAPACITY:
TECHNICAL SOLUTIONS TO HUNGER IN THE ERA OF NEOLIBERALISM

by

Elizabeth Perry Bullock

A dissertation submitted to the Graduate Faculty in Sociology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

2015

This manuscript has been read and accepted for the
Graduate Faculty in Sociology in satisfaction of the
dissertation requirement for the degree of Doctor of Philosophy.

Professor Patricia Ticineto Clough

Date

Chair of Examining Committee

Professor Philip Kasinitz

Date

Executive Officer

Professor Lynn Chancer

Professor Michelle Fine

Supervision Committee

THE CITY UNIVERSITY OF NEW YORK

ABSTRACT

LEVERAGING CAPACITY:
TECHNICAL SOLUTIONS TO HUNGER IN THE ERA OF NEOLIBERALISM

by

Elizabeth Perry Bullock

Advisor: Professor Patricia Ticineto Clough

Leveraging Capacity: Technical Solutions to Hunger in the Era of Neoliberalism takes the Global Seed Vault and the value of "global crop diversity" as a point of departure for raising questions about the influence of digital technology on the seed and about the solution to hunger known as "global food security." Discussions about food security among food studies scholars highlight either the failures of global public health advocates to regulate the food and beverage industry or they view food security, like earlier campaigns against global hunger, as an instrument for U.S. foreign policy. On either side of this debate, the body is made to fit the conclusions of these scholars in terms of the impact of economic or state-based forces on our global food supply. But these debates are complicated by the recent turn to seed vaults promising crop diversity in perpetuity, where "value" for crop diversity is mobilized by political organizations and industry alike.

Asking about the relationship of technology to the seed in this arrangement, I examine six discourses that have attended the turn to food security: nutrition, information, epigenetics, cybernetics, biotechnology, and biological diversity. In these discourses I chart instances where social problems begin to be defined as technical solutions in discourses on global hunger,

discussions about scientific philanthropy, microbiology, and in discussions about biological diversity prospecting. While separately these discourses are inadequate to the task of understanding the turn to food security, when treated together however we can begin to see new articulations of relations of the body, the object, subjectivity, and institutionality as they are emerging in these discourses that should be considered a part of our contemporary neoliberal moment. Part of the reconfiguration of the body, I argue that we should view the turn to food security as a technical innovation and security for the "body-as-data."

ACKNOWLEDGEMENTS

I am grateful to friends and colleagues at the CUNY Graduate Center who taught me so well what it means to be a "colleague." Special thanks to study partners Rachel Swaner, Megha Ramaswamy, Liza Reisel, and Theresa Horvath for their early support and advice as we navigated through coursework and exams. Thank you to Sam Han, Rachel Schiff, Karen Gregory, Polly Sylvia, Kim Cunningham, Craig Willse, and Greg Goldberg for their playful exploration of questions of sociological methodology and the limits of the discipline in our "Dossiers on Methods" group. And thank you again to Karen Gregory and Mitra Rastegar for welcoming me to their writing circle and reading early drafts of chapters. Special thanks to Greg Goldberg for sharing his ideas and work on information theory and peer-to-peer networks in relation to which many of my ideas about food security were initially explored.

I have an enormous gratitude and respect for the Graduate Center professors and staff who contributed time, resources, and encouragement to my work. First I want to thank the members of my committee, Professors Lynn Chancer and Michelle Fine. Their readings and comments helped to define this work in its present iteration. Thank you to Mitchell Duneier for his dedication to ethnographic research and for his support even when my scholarly interests deviated from his own. Thank you to Roopali Muhkerjee for her guidance and enthusiasm for this project in its early stages. Sincere thanks to Rati Kashyap whose direction I required for every step of this process, and to Erin Martineau for her insightful edits and comments. And a very heartfelt thank you to my advisor, Patricia Clough, for whom I have such great appreciation and affection. Without her patience, attention, and support this work would have never come to life.

In addition to everyone at the Graduate Center, I want to thank my parents, Ervin and Jim Bullock, for their love and support. Their commitment to social justice continues to shape my relationship to politics today. Thank you to my brothers Christopher and John for sharing with me all the miseries and pleasures of our lives then and now. And thank you to Darrell, Dwayne, Robert, and Jesse whose presence and friendship has given me a greater understanding of what it means to be a family.

Most of all, a very special thank you to Jerel Johnson, whose love and friendship has been a great gift without which I never would have started this journey. His interest in and support for my work lighted my way through to the end. This work is dedicated to Jasper Johnson who reminds me every day of all the joy to be discovered when trying to decide what to do next.

CONTENTS

CHAPTER 4. *continued*

LIST OF FIGURES

INTRODUCTION

This dissertation began as an exploration of the conditions surrounding the Global Seed Vault or, as it is sometimes called, the "Doomsday Vault." The vault is located inside Plataberget ("plateau mountain") in Svalbard, Norway, 621 miles from the North Pole. In 2008 the Seed Vault began accepting "black box" deposits of seeds and plant materials from seed banks around the world with the intent to insure the safety of the world's food supply from natural and manmade disasters.

The foundation that supports the Seed Vault, Global Crop Diversity Trust (the "Crop Trust"), owes its inception to two organizations: the United Nations Food and Agriculture Organization (FAO) and Bioversity International. While the FAO was officially founded in 1945, the work of the FAO is a continuation of David Lubin's proposal at the turn of the twentieth century to Italian King Victor Immanuel III to create an international organization dedicated to collecting statistics on food and agriculture. Realized in 1908 with the foundation of the International Institute of Agriculture in Rome, after World War II the mission and mandates of the International Institute of Agriculture were handed over the newly established FAO.

Bioversity International brings to this program an effort to collect, build, and expand upon national, regional, and international gene banks. Founded in 1974 as the International Board for Plant Genetic Resources (IBPGR), Bioversity International belongs to a consortium of International Agricultural Research Centers (IARCs) affiliated with the Consultative Group on International Agricultural Research (CGIAR). Renamed Bioversity International in 2006, its mission and goal is to insure the conservation and use of the world's "crop diversity."

Formally established in 1971, CGIAR's mission is to improve food security while reducing rural poverty, strengthening nutrition and health, and managing resources sustainably. Different from international political institutions like the United Nations, CGIAR's mission is carried out by a consortium of international agricultural research centers (IARCs). Support for this work comes from CGIAR's membership including country governments, international institutions, and philanthropic organizations. Figure 1 provides an overview of this complex of institutions and resources and their affiliations with the Global Seed Vault (Johnson 2015).

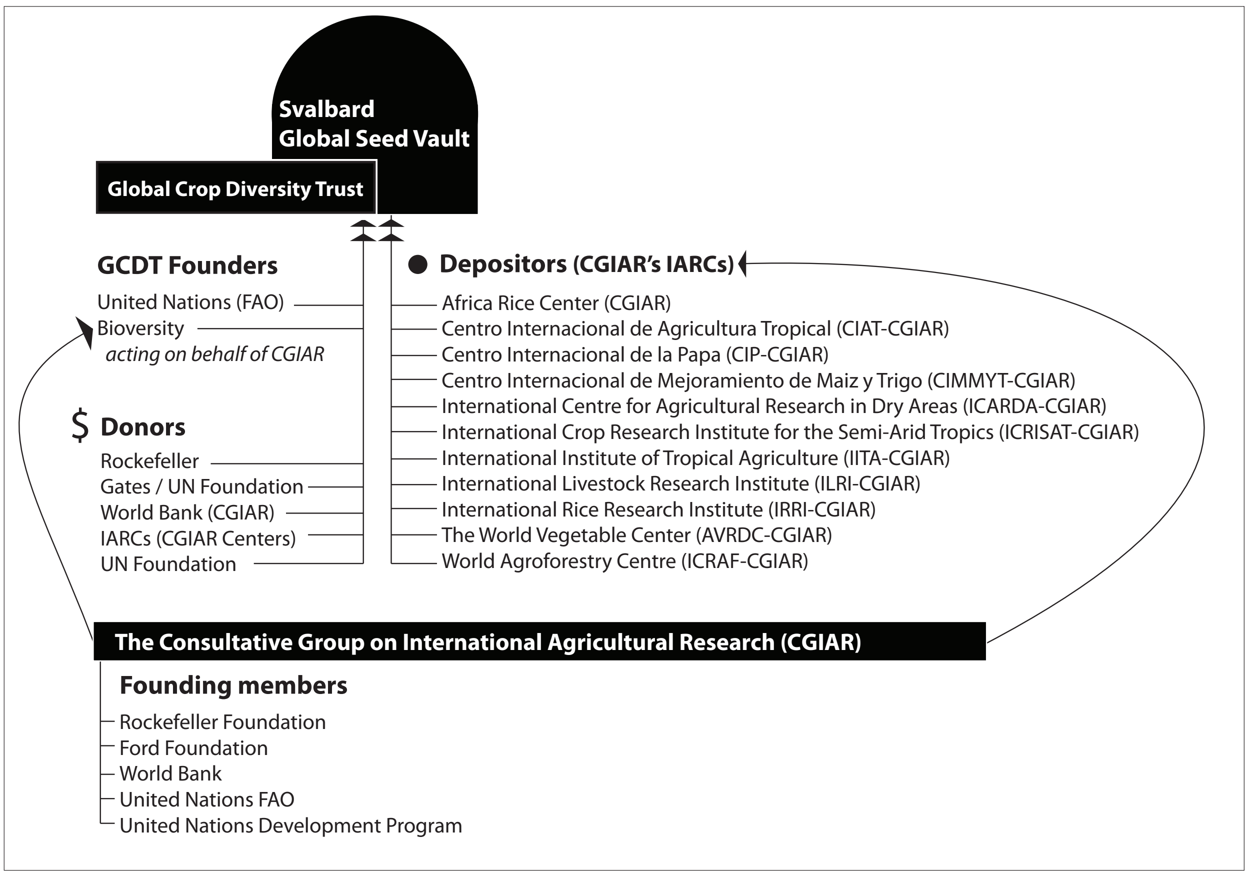

Figure 1. The Global Seed Vault: Founders, Donors, and First Depositors

Frequently described as a "back-up," part of the mission of the Global Vault is to provide an insurance mechanism for seed collections around the world in danger of any number of risks including war, natural catastrophes, and, more commonly, lack of funding, poor management, and equipment failure. The Crop Trust oversees the management and operations of the vault and is a funding mechanism for these resources. As defined in the Relationship Agreement between the Crop Trust and the United Nations International Treaty on Plant Genetic Resources for Food and Agriculture (the "Plant Treaty"), the objective of the Crop Trust is to provide "a permanent source of funds to support the long-term conservation of the *ex situ* germplasm on which the world depends for food security, to operate as an essential element of the Funding Strategy of the International Treaty, with overall policy guidance from the Governing Body of the International Treaty, and within the framework of the International treaty" (Relationship Agreement 2006:1). An endowment fund established by the Crop Trust provides financial security in perpetuity to 17 crops identified as critical to the world's food security: bananas, plantains, barley, beans, cassava, chickpeas, faba beans, forages, grass peas, lentils, maize, pearl millet, rice, sorghum, sweet potatoes, wheat, and yams.

The history of the Plant Treaty underlines again the complicated arrangement that attends the turn to food security. Where "plant genetic resources" were once viewed as part of our "common heritage," after the Convention on Biological Diversity in 1993 these resources were reallocated to nation-states. At the 1983 FAO conference, delegates explored questions about access to plant genetic resources in terms of common heritage and adopted the International Undertaking on Plant Genetic Resources. Then, following the Convention on Biological Diversity (CBD, or "the Convention"), the terms of this earlier undertaking were revised so that the jurisdiction and sovereignty of the seed was allocated to national governments and made subject to benefit-sharing contracts. As I detail in chapter 5, with these contracts, the provision by researchers and local collaborators of plants and knowledge to agricultural and pharmaceutical companies is made in exchange for research funding or for a percentage of the royalties derived from these resources.

Another aspect of this arrangement involves data systems, both international and national, that, when linked to a global portal called "the GeneSys online portal," permit researchers, plant breeders, and others to access information on seed collections. If the objective of the partnership of the Crop Trust with CGIAR is to conserve the crop diversity of plant genetic resources housed at CGIAR gene banks, this goal is achieved by making crop diversity freely available to plant breeders and scientific researchers in a manner described as supportive of the Plant Treaty and "cost efficient, secure, reliable, sustainable over the long-term" (Global Crop Diversity Trust n.d.). In this arrangement, as we will discover, the potential of biological diversity that makes its conservation a necessity is expressed in relationship to a technical innovation and security.

Connected to earlier campaigns against global hunger and in particular to the "Green Revolution,"[1] CGIAR and its consortium of IARCs grew out of four research centers established by the Ford and Rockefeller foundations after World War II. Noting the relationship of CGIAR to questions about seeds and sovereignty, in the 1980s leading geneticist and noted leader of India's Green Revolution,M. S. Swaminathan (1988:231) underlined a transformation of the pessimistic mood brought on by these institutions as they lent optimism to questions about our

[1] The Green Revolution is characterized in terms of the high-yielding grain varieties pioneered by Nobel laureate Norman Borlaug and other plant biologists between the 1940s and 1960s to increase worldwide agricultural production. This work was sponsored by the Rockefeller and Ford Foundations. Since then, other efforts have sought to create similar revolutions in specific places. In 2006, for example, the Rockefeller Foundation, in partnership with the Bill & Melinda Gates Foundation, founded the Alliance for a Green Revolution in Africa (AGRA), an independent organization devised to bring a green revolution to Africa, often referred to as the "second green revolution."

global food supply. But if a sense of optimism accompanied these institutions initially, we should keep in mind that food security today is an engagement with risk drawn from questions about our access to food in the future. The optimism Swaminathan underlines is countered in the recent quote below from Michael J. Roberts, professor of economics at North Carolina University, which gives prominence to an uncertainty about food that is being translated into a discourse on risk.[2] Roberts (2009) writes, "There is a real threat to worldwide food security over the next 10 to 40 years. The threat comes from global income inequality combined with projected global warming, which could cause tremendous declines in crop yields."

The Problem

Outlining some of the debates over what food security is and how it can be improved, the anthropologist Johan Pottier has noted that it is important to return to the World Food Conference of 1974[3] where we find in evidence different understandings of how to measure food insecurity. On one side there is a focus on supply-side indicators, the stabilization of prices and the circulation of food, and on the other side attention is drawn to the concerns raised by Amartya Sen about "physical and economic access" (see Pottier 1999:11; Sen 1982). These debates suggest, that as a matter of politics and economy, the concern underlying discussions of food security is the conversion of food into energy for the "body-as-organism." My argument is that food security involves a reconfiguration of the body. Throughout this work, I borrow this

---

[2] Roberts, along with Paul Collier, Vandana Shiva, Per Pinstrup-Andersen, Raj Patel, and Jonathan Foley, was invited by the *New York Times* in 2009 to discuss whether biotechnology can cure world hunger.

[3] At the World Food Conference of 1974 food security was defined as the "availability at all times of adequate world food supplies of basic food stuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (United Nations 1975).

term "body-as-organism," as used by Luciana Parisi and Tiziana Terranova (2000) and developed by Patricia Clough (2008), to highlight transformations to the body as it is reconfigured by food security, becoming what I call the "body-as-data."[4]

A critical point of reference for debates about measuring food insecurity is the commitment of the Plant Treaty to insure the "crop diversity" of the world's food supply in perpetuity against various, complexly interrelated, and impending environmental, political, and economic threats. Taking the value of the seed in this arrangement as a point of departure, this dissertation asks several separate though interrelated questions in relation to six discourses on nutrition, information, and epigenetics, cybernetics, biotechnology, and biological diversity examined in subsequent chapters. Noting the bearing of these discourses on the turn to food security, I ask: What is the relationship of technology and science to the seed? How do we connect these technological and scientific developments to solutions like food security that are altering the way we think about the body? And what issues do these questions raise for discussions about our contemporary political economy and the turn to neoliberalism?

When addressed in connection with the first Green Revolution, questions about the relationship of technology and science to the seed point to the Rockefeller Foundation's vision for "scientific philanthropy." Also part of this relationship between technology and the seed are different ways of framing concerns about "limits to growth" that emerged in the 1960s and '70s.

---

[4] As I explain in chapter 2, Terranova and Parisi distinguish the body-as-organism of disciplinary society from the body that emerges in societies of control. As they explain, the body-as-organism is "the disciplined body is the thermodynamic organism, the hierarchical organizations of organs, bounded within a self, crossed by currents of energy tending towards entropy and death" (2000:1). Elaborating on this work, Clough further clarifies differences of the body-as-organism from what she calls the biomediated body, that is "a specific mode of organization of material forces, invested by capital into being as well as elaborated through various discourses of biology and physics, thermodynamics and complexity, metastability and nonlinear relationality, reconfiguring bodies, work and reproduction."

These concerns have been associated with the end of industrial production, and the suggestion that investments in the U.S. biotech industry were devised to "overcome" limits inherent to the biological human body and human ecology on which continued economic growth depended. But the recent turn to seed vaults promising crop diversity in perpetuity requires we consider a "value" of biological or crop diversity that is mobilized by political organizations and industry alike. In tracking this "value," I trace the contours of a neoliberal conditionality, an affective capacity for the body-as-data, that food security helps define.

This dissertation asks about the relationship of science and technology to the seed and to the solution to hunger that food security introduces. Taking up discourses on nutrition, information, epigenetics, cybernetics, biotechnology and biological diversity, I argue food security should be understood as a "technical solution." But in order to understand what a technical solution is we must carefully consider the unevenly developing transformations in our thinking about the body emerging in the discourses I critique, and which remains largely unacknowledged by the authors whose works I will address. Tracing this rethinking of the body initiated in each of these discourses is the first objective of this dissertation.

A second objective involves bringing these discourses together. While separately inadequate to the task of understanding the turn from global hunger to food security, when these discourses are treated together we begin to see new articulations of the relations emerging that have attended to the turn to food security and should be considered a part of a biopolitical economy. I pay special attention to the changes in the body, the object, subjectivity, and institutionality emerging in discourses on nutrition, information, epigenetics, cybernetics, biotechnology, and biological diversity, and, in tracking these changes, I focus on their production of the body-as-data.

Methods

To consider the reconfiguration of the body I identify as part of the turn to food security, I assemble a genealogy on six discourses of the nutrition sciences, information theory, cybernetics, biotechnology, and biological diversity. Beginning in the 1960s, we begin to see in each of these discourses evidence of social problems being framed as “technical solutions.” More important than defining what technical solutions are, I note an intermeshing of social issues and problems with technology, ending with the impact of digital technology on the “solution” referred to as global food security.

Prior to World War II, campaigns against global hunger initiated by the United States already viewed statistical data on food and agriculture worldwide as integral to the development of solutions to hunger. Developments in the nutritional sciences fueled these campaigns by establishing a measure of conversion for the heat in food relative to heat energy in the body-as-organism. The Green Revolution brought to this interconversion the suggestion that plant breeding, irrigation development, and agrochemicals could increase crop yields. In these iterations of the problem of global hunger, the relationship of food and the body continues to be addressed in terms of an energetic metabolism, one whose fallout points to the loss of biological diversity.

With the turn to food security, however, biological diversity is not a reference to the inherent limits of the body-as-organism and our human ecology but rather the resource that permits uncertainty about our global food supply to be encountered in perpetuity. Part of this encounter as well, different understandings of technology, the economy, and the body are now refashioned as data rather than in terms of the energetic metabolism of the body-as-organism. This processes was not straightforward and involved many detours along the way; however, in the end I focused on discourses of technology that have an explicit relationship to food in addition to those that address technology in relation to life or information and life. Through this process I highlight the emergence of two neoliberalisms, places where we begin to see a shift in the relation between food and the body, even if we can only begin to speculate on its effects.

Chapter Overview

Chapter 1: "Energetic Metabolisms and the Body in Food Studies." In the field of food studies, many scholars addressing food problems, including food security, focus on developments in the nutrition sciences. In these discussions there is an understanding of food security based on the caloric or nutritional value of food for the biological, human body measured in terms of energy. These sciences reinforce particular conclusions about the Green Revolution and earlier campaigns against global hunger. I argue that food security should be understood in relationship to the longer history of information that has shaped both the development of the social sciences in the United States, as well as the vision of scientific philanthropy at the Rockefeller Foundation. This notion of metabolism has an influence on the discourses addressed in subsequent chapters, on epigenetics, cybernetics, biotechnology and biological diversity. Together with the history of information detailed in chapter 2, metabolism allows us to begin to understand the shift from body-as-organism to body-as-data in discourse on global food security.

Chapter 2: "Information Theory and the Body." Following the mathematical definition of information developed by Claude E. Shannon and Warren Weaver at AT&T Bell Laboratories in the 1940s, this chapter explores the relevance of information theory for our thinking about the body. Different from the more common association of information with meaning, Shannon identifies a physical quality of information, a quantity he calculates in response to the problem of sending messages more efficiently from one place to another. Stressing the nonlinear relationship of information and life in Shannon's formula, I consider how communication theory points as well to the indeterminate relationship of micrological and macrological levels of organization. Rather than a representation of a physical state, information is a measure of the metastability of micrological levels of organization.

As many have noted, this unfolding of life unsettles the suggestion that we view informational structures including DNA and biophysical phenomena such as the organism as mediated by the relationship of parts and the whole. When the broader influence of Shannon's formula is taken into consideration we are encouraged to consider how digital technologies make life irreducible to the phenomenological subject.[5] Following arguments that build on Shannon's mathematical theory of information to stress an engagement with capacities of matter that are intrinsically unstable and immeasurable, I argue that more attention should be afforded to the different configurations of the body emerging in discourses that build on the informational sciences. Rather than speculating on the effects of these transformations that are only just emerging, I take as my focus this shift, the displacement of the body-as-organism with the body-as-data.

To further address this shift, I point to the metabolism Hannah Landecker (2013) defines in her work on epigenetics, a metabolism that should be distinguished from the connection

[5] I refer here to current debates in the new materialisms, object-oriented ontology, and affect theory, looking at pre-conscious or non-conscious affects in their relationship to digital technologies, which I address in more detail in subsequent chapters. For the moment it is sufficient to note we have yet to perceive the affects of food security on human beings.

between food and the body described by nutrition scientists Marion Nestle and Malden Nesheim (2012). Different from a metabolism of energetics, whose point of reference is an industrial economy, in epigenetics the body becomes both a conceptual domain and a set of experimental practices. I underline this shift as instrumental to understanding the value of the body-as-data that is emerging in discourses on food security. Critical to the timing of this metabolism is its production after industry, that is, a metabolism accelerated by scientific and technological developments as such knowledge is "always already generated to be pipeline amenable" (Landecker 2013:498).

Chapter 3: "Institutionality and Difference in Knowledge." To contextualize the solution to food security in relationship to discourses on cybernetics and current thinking about technological solutions, I turn to Bernard Geoghegan's (2012) work. Geoghegan's "cybernetic apparatus" is defined in relationship to a capacity he describes for liberal techniques and technologies to neutralize difference. Growing divisions among the social body in nineteenth-century America were accompanied by the rise of forms of association that moved beyond the limits of the space and time of the individual human body. Geoghegan's technological solutions involve this displacement of the public and its interests onto a global cybernetic apparatus, a displacement that neutralizes social differences. Philanthropic institutions like the Rockefeller Foundation have contributed to this displacement with their support for scientific philanthropy or "technological solutions" imbued with the capacity to overcome social differences by making them scientific rather than state-based (Geoghegan 2012:83).

Differing with Geoghegan, I argue the Rockefeller Foundation's support for scientific philanthropy ought not be viewed in terms of an interest in overcoming differences by attributing the public and its interests to a technology of culture and communication. Instead, solutions like food security suggest the capacity, aided by the development of digital technologies, to multiply distinctions among species-populations (see Clough 2013). For Geoghegan developments in cybernetics facilitate a depersonalization of interest that is a liberation of knowledge from the individual human body. But when constituted as a part of a "drive to institutionality,"[6] the non-representational knowledge employed in technical solutions like food security suggests a body-as-data, made to adapt to increasing levels of uncertainty and added layers of complexity.

Chapter 4: "Securitization, the Body, and Two Neoliberalisms." To further question the relationship of security to the body and to the knowledge that food security mobilizes, I consider Melinda Cooper's (2008) work on the growth of bioeconomies. By comparing Cooper's work with Michel Foucault's (2007) 1977-78 lectures on biopolitics, in this chapter I further clarify what distinguishes the two neoliberalisms I identify in the discourses examined: one understood in terms of the human body and forms of growth arising in regenerative medicine, and another pointing to the species-body that arises in Foucault's discussion of "the problem of the population."

Cooper connects the forms of growth she identifies to Francois Ewald's (1986) discussion of Foucault's work, emphasizing how the subject of human rights is economized under the welfare state. The bioeconomy that began to emerge in the United States during the 1960s and '70s was, in part, a counter-reaction to futurological literature from this period on "limits to growth." Members of the new right, including Daniel Bell (1974) and others, charted a

[6] I borrow this phrase from Patricia Clough (2013) who uses it in reference to Roderick Ferguson's description of social differences that are recalibrated by the project of interdisciplinarity in the academy. Ferguson (2012:34) writes that the subject of difference "had to learn what it meant to have a particularized history, the one who would have to access how the probabilities for life have everything to do with those particularities; this is the subject who has to confront publicly or privately how those particularities and differences have historically shaped the quality and meanings of life, and whether to maneuver these historic legacies for conservative or disruptive ends."

radical restructuring of the U.S. economy that involved moving heavy industry offshore and growing innovation economies at home. Thus, for Cooper (2008:11), neoliberalism and discourses on biotechnology are defined in terms of their common ambition "to overcome the ecological and economic limits to growth associated with the end of industrial production, through a speculative reinvention of the future."

The forms of growth Cooper describes have implications for the shift I am tracing from the body-as-organism to the body-as-data. While Cooper maintains a concern for the inherent biological limits of the body, I read Foucault's biopolitics in a different direction, focusing on his discussion of the "problem of the population" (2007). In this lecture, developments in the statistical sciences introduce a conditionality that doesn't address the body-as-organism, instead targeting species-populations. In this way I move Cooper's argument about neoliberalism, that is an economization that makes biological limits inherent to an understanding of neoliberalism both as an economization and securitization.

Chapter 5: "Resourcing Biological Diversity." To further outline the contours of the body and subjectivity that food security gives rise to, I address Cori Hayden's (2003) work on bioprospecting. Elaborating on the history of bioprospecting contracts, Hayden notes how legal developments and the evolution of molecular sciences reinforce a mutability of the "public" domain, in distinction from the "private" realm of novelty and innovation. The emergence of the term "biological diversity" is connected to these developments in the molecular sciences and the law. The development of genetic screening technologies and international agreements including the Convention on Biological Diversity alter (once again) the status of resources designated as part of the "public domain."

Careful to characterize these recent developments as part of a longer set of debates on what distinguishes private property from public resources, Hayden stresses how the reorganization of private property facilitates new forms of social and political inclusion and exclusion governed through the bioprospecting contract. In these contracts, American ethnobotanists, plant chemists, and other scientists become "epistemological advocates" whose translation of the value of plants and local knowledge resourced from indigenous communities is integral to their use for industry. Experts give legitimacy to indigenous classification systems while at the same time becoming advocates and defenders of these communities.

Stressing the uncertain value of biological diversity, Hayden notes that scientists and development organizations interested in conservation began to define nature in terms of its immeasurable worth to industry just as pharmaceutical industries began to recast drug and crop development as a catalyst for human adaptability and evolution. Together, these events show how understandings of the value of biological diversity merged together questions about rights and obligations with questions about rewards and incentives.

In the political economy Hayden describes, the division of subjective aspirations and material interests is governed by the prospecting contract. I suggest the turn to food security marks the introduction of a conditionality where appreciation no longer requires contractual mediation. Instead, the value of biological diversity becomes an aspirational condition for the subject of human capital, much as Michel Feher (2009) describes the connection of a neoliberal subjectivity to health, culture, and education. While in a liberal political economy these sectors are understood as external to the reproduction of the free laborer who owns his or her labor power, in a neoliberal political economy they specify instead the conditions of a subjectivity whose "means of either diversifying or modifying their behaviors and social interactions" becomes entirely speculative (Feher 2009:34; see also Clough et al. 2015:162).

Conclusion

Food studies scholars addressing food security have viewed this global initiative alongside developments in the nutrition sciences. But, I will argue, the body conceptualized by these scholars is made to fit their conclusions about the impact of the economy or state-based forces on our global food supply. In my discussion of discourses on epigenetics, cybernetics, biotechnology, and biological diversity, I chart transformations in our thinking about the body, subjectivity, the object, and institutionality that have accompanied the turn to food security. Instead of focusing on the effects of this transformation, which is only beginning to emerge, I take as my focus the reconfiguration of the body-as-data as it is unfolding in these discourses.

CHAPTER ONE

ENERGETIC METABOLISMS AND THE BODY IN FOOD STUDIES

INTRODUCTION

Recently in the field of food studies scholars have returned to the history of the nutrition sciences to stress, if somewhat differently from each other, the political and economic factors that shape our global food supply. Addressing the work of Amy Bentley (2012), Marion Nestle and Malden Nesheim (2012), Nick Cullather (2010), David Stuckler and Marion Nestle (2012), Raj Patel (2012), Michael Pollan (2006), and others, in this chapter I consider how the body figured in these discussions is made to fit the authors' conclusions about the impact of the economy or state-based forces on our global food supply. These authors make the body an account of political and / or economic forces that influence processes of conversion, of food into energy. I discuss the way the Green Revolution and earlier campaigns against global hunger are mobilized by these authors and emphasize some of what the nutrition sciences keep out of view, that is, bodily capacities that are operative in a biopolitical economy.

GLOBAL HUNGER, THE NUTRITION SCIENCES, AND THE CALORIE

"Big Food"

Discussions about food problems among food studies scholars often concentrate on "Big Food," the large and concentrated power wielded by multinational food and beverage industries in the global market today (see Barbour, Clark, and Veitch 2012). Arguing that our global public health system fails to properly regulate food as an industry, David Stuckler and Marion Nestle (2012:1) note a common factor in the seemingly contradictory increases in the numbers of people worldwide who are hungry and overweight: the power of Big Food in system that is “not driven to deliver optimal human diets but to maximize profits.” The solution, they argue, is better maintenance of the regulatory arm of global public health over Big Food because these industries present no evidence that they might align their interests with the concerns of public health officials addressing obesity (2012:2). Profit growth in a competitive market requires food industries to exist in opposition to the regulatory aims of public health officials, which seek to tax and limit the production of unhealthy food as well as advance healthy eating campaigns. From a nutritional standpoint, Stuckler and Nestle (2012:2) note, “industry support for research might be seen as one place to align interests, [but] studies funded by industry are 4–8 fold more likely to support conclusions favorable to the industry.” Therefore, the authors conclude, “[p]ublic health professionals must recognize that Big Food’s influence on global food systems is a problem, and do what is needed to reach a consensus and engage critically” (2012:2).

Two recent works on the nutrition sciences illustrate how scholars in food studies make the body fit their conclusions about the impact of the economy or state-based forces on our global food supply. Malden Nesheim and Marion Nestle (2012:182) recap the history of the nutrition sciences to describe food politics in the United States and globally in terms of poorly regulated food industries and the rise of “high-calorie, low-nutrient-density convenience foods.” Also looking at the history of the nutrition sciences, Nick Cullather (2010) argues that the history of the calorie aided the development of a state-based rationale for comparing diets across nations. As the concept of the calorie contributed to the professionalization of demography, Cullather explains, the nutrition sciences introduced a measure for progress that, by defining nations in terms of “development,” was used in U.S. foreign policy during and after the Cold War.

In reviewing these histories, I underscore how in these studies questions about the relationship of technology to social problems and their solutions are made to fit conclusions about the body-as-organism. Meanwhile, as detailed in chapter 2, the history of information theory introduces terms that make metabolism different from the metabolism of energetics supported in the nutrition sciences.

The Calorie, Heat, and Industrialized Systems

The history of metabolism put forth by Nestle and Nesheim (2012) stresses the conversion of food into energy. In this narrative, food molecules—classified in terms of proteins, fats, and carbohydrates—are broken down by digestive enzymes so the body can create new molecules, make muscles contract, and stay warm.

Although early understandings of a modern conceptualization of human metabolism can be traced to the writings of the Greek physician Hippocrates (~460–370 B.C.E.) and Galen (~130–200 C.E.), Nestle and Nesheim stress that it was not until the 1700s, in the work of Antoine Lavoisier, that the understanding of metabolism as an oxidation process appeared. Lavoisier's understanding of metabolism focused on the chemical reactions generated by the body in relationship to its tendency to burn the molecules present in food. Though he didn't use the word "calorie," Lavoisier invented a device called the "calorimeter" that used the terms "caloric" and "heat" in relation to observations of animal metabolism.

To Lavoisier's work, in the mid-1800s German physiologist Julius Mayer added knowledge of the basic laws of physics, measuring body heat relative to food molecules. The first law of thermodynamics, which states that energy can be neither created nor destroyed but can only change forms, introduced a measure of conversion. Food energy was measured in relationship to heat energy in the body, or, as "the chemical energy of biosynthesis, the electrical energy of nerve action, or the mechanical energy of muscle work" (Nestle and Nesheim 2012:26). With these conversion processes came the knowledge of a metabolism whose capacity for work is equal to the heat available in food, allowing scientists to develop a tool that generates an energy value for food that is thoroughly incinerated or "bombed."

These historical developments are viewed as precursors to discoveries attributed to the father of the modern nutritional sciences, Wilbur O. Atwater (1844–1907). Atwater analyzed the content of calories and nutrients in foods based on measuring both the heat produced in whole-body calorimeters and the calories stored in proteins, fats, and carbohydrates. He summarized the then current knowledge of food calories in a series of popular articles published by *Century* magazine in 1887. Nestle and Nesheim (2012:26) write:

> There he explained that a gram of protein or carbohydrate yields less than half the energy of a gram of fat and that these differences – and variations in water content – account for variations in food calories. Most food energy, Atwater explained, is "used for interior work of the body, breathing, keeping the blood in circulation, digestion, etc., but a large part of this is transformed into heat before it leaves the body."

Summarizing the essence of nutritional energetics in 1894, Atwater noted, "energy from the sun is stored in the protein and fats and carbohydrates of food, and … is transmuted into the heat that warms our bodies and into strength for our work and thought" (quoted in Nestle and Nesheim 2012:27; see Atwater 1894:9).

Atwater's conclusions were widely accepted by the public, a response Nestle and Nesheim attribute to his professionalization; he soon held three positions simultaneously in three different cities. In addition to serving as a professor at Wesleyan University in Middletown, Connecticut, where he established his food analysis laboratory, Atwater was the director of two

United States Department of Agriculture (USDA) Office of Experiment Stations, one in Storrs, Connecticut, and the other in Washington, DC.

The Calorie, Economy, and Food Problems

Sympathetic to Atwater's goal of designing an economical diet that would meet the nutritional needs of most people regardless of their age, occupation, or social class, Nestle and Nesheim defend Atwater from Cullather's claim that he contributed to the professionalization of demography as well as to programs and policies that, with support from Rockefeller Foundation, made hunger relief complicit with the interests of capitalist industry in the 1900s.

They emphasize the utility of Atwater's research for global public health as, for example, in recent reports by the United Nations Food and Agriculture Organization (FAO) that stress that calculations of available calories (for total human consumption by country, as well as by household) are based not only on estimates of the amount of food produced, used for seed, and used for animal feed, but also the amounts that are wasted, imported, and exported (see www.fao.org/hunger/en). Nestle and Nesheim (2012:123) write:

> The United States has the largest number of calories available for its population, 3,750 per person per day (the USDA's figure is 3,900). In sharp contrast, the FAO estimates that Eritrea, in sub-Sahara Africa has only 1,650 calories available per person per day. In the United States … 15 percent of the population is considered "food insecure" but not necessarily hungry or undernourished. In contrast, the FAO deems 75 percent of the Eritrean population to be chronically food deprived.

Private industry is diametrically opposed to the nutritional concerns raised by the FAO and other organizations, making issues like food security about the unequal distribution of calories among nations, including estimates of calories drawn from plant and animal resources.

Populations in the United States designated as "food insecure," though not necessarily malnourished or hungry, are explained by the underlying social conditions that cause nutrient deficiencies.[7] People designated as "food insecure" lack the ability to acquire sufficient food in ways that are deemed socially acceptable, a situation not related to food shortages (Nestle and Nesheim 2012:129). These figures are viewed alongside increases in the average available calories per day per person that grew from 3,200 in the twentieth century to 3,900 in the early twenty-first century. Food problems in the United States must be understood in terms of the high-calorie foods available to Americans. Data from the National Health and Nutrition Examination Survey (NHANES), from 2005–2006, indicate that desserts, sodas, pizza, chips, and hamburgers are the leading sources of calories in American diets. Food insecurity exists even among populations defined as obese, Nestle and Nesheim (2012) argue, due to foods that are readily available even when a household lacks reliable access to food.

As Nestle and Nesheim tell us, the "shareholder value" movement that took hold in the United States between 1973 and 1977 deregulated production thereby increasing the number of calories available at the market today (2012:182–183). Deregulation allowed corporations to coerce the farming industry into producing more immediate and higher returns on investments, increasing food production and the number of calories available. Invoking Jack Welch, head of General Electric in 1981, Nestle and Nesheim (2012:182–183) point to the pressure placed on food companies to consolidate and seek out new markets:

[7] Nestle and Nesheim (2012:129) use the USDA's definition of food security: "a reliable ability to acquire sufficient food in socially acceptable ways."

> [Welch's] company would now focus on producing faster growth and higher profit margins and returns to investors. The movement caught on quickly, and Wall Street soon began to press companies to report not only profit but also increased growth on a quarterly basis. Food companies were having enough trouble producing profits in an overabundant food economy. Now they had to demonstrate profit growth every ninety days.

The increase in calories now available in the United States makes possible populations who are both food insecure and obese.

The Calorie, "Development," and U.S. Imperialism

Cullather (2010) notes Atwater's work to draw us to a different set of conclusions, joining U.S. policies on global economic development to campaigns against global hunger supported by the Rockefeller Foundation, especially the Green Revolution. Directing us to campaigns begun under Rockefeller Foundation president Raymond B. Fosdick, Cullather notes how the concept of the calorie contributed to the professionalization of demography. As a statistical problem, discussions about global hunger began to be viewed alongside political concerns and, in particular, in relationship to the spread of communism.

Measuring food consumption around the world had until this point stymied efforts in the United States to create a modern food policy. But financial support from the Rockefeller Foundation and developments in the nutrition sciences facilitated the professionalization of the field of demography. The calorie could now be used to measure a nation's progress in correlation to the adoption of agricultural technologies affiliated with the Green Revolution. With these developments, food and population could be treated as controllable variables, unlocking questions about human consumption and reproduction (Cullather 2010:15).

Atwater's experiments at Wesleyan University in the late 1800s made the abstract relationship theorized by Thomas Robert Malthus between food supply and population growth tangible. In 1896, Atwater sealed a graduate student in an airtight chamber in the basement of Judd Hall at Wesleyan University. In this apparatus quantities of food consumed by the occupant were measured in relationship to periods of mental and physical exertion and rest at alternating intervals. A device once used to measure the combustive efficiency of engines and explosives, the calorimeter measured the food intake and labor output of the occupant in units of thermal energy (Cullather 2010:11).

Atwater's work contributed to theories of development on a standard of living that might be enhanced by science and technology:

> [The calorie] conceptually rolled all commodities, all farms into one big farm and all markets into an aggregate national or even world market, as if all people were drawing on a single larder. It made the abstract idea of food supply tangible, taking a hypothetical limit on human potential and distilling it into a political problem that had scientific and organizational solutions. (Cullather 2010:13)

Atwater's investigations were allied with those of Frederick Winslow Taylor, who treated labor unrest as a target for "scientific management" (2010:16). Much like Taylor's view that the leisure, meat, and bread demanded by the labor force could be measured in terms of its efficiency and cost to industry, Atwater led an effort to make "standards of living" a scientific measurement of the relationship between wage levels and the contentment and health of the workforce.

In mechanical terms, Cullather attributes to Atwater's work political and social forms of optimization established in connection to "human fuel." With the possibility that human appetites could be balanced, he stresses the evolution of a new consciousness of physical vitality and human security. Prior to these developments, diplomatic practices took stock of agricultural evolutions in foreign lands based on differences in their material conditions. But alongside the standards Atwater devised was a growing belief that technology could be used to control production and consumption. On this basis, though associated with Malthusianism, Cullather (2010:14) argues, "the awareness of the 'world food problem' that peaked in the 1960s and remains central to international humanitarianism today owes less to eighteenth-century inheritances than to twentieth-century methods of reading the social and physical world by the numbers."

These standards contributed to a new discourse on "development" that measured the status of nations in relationship to their adoption of science and technology. The absence of scientific and technological measures devised to facilitate agriculture improvements was viewed as evidence of "societal failure" in discourses on development that connected questions about food scarcity to concerns about war.

Measures of Progress

There is a longer history of the statistical sciences connected to the modern theory of information that involves a different way of understanding technological developments: in terms that reach beyond the individual, and bodily and caloric conversions. Cullather views developments in the nutrition sciences as the limit for technologies that measure food in relationship to the energy of the body-as-organism. In the discourses I address in subsequent chapters, we find references to forms of measure different than these energy conversions pursued in the nutritional sciences.

Cullather (2010:18) stresses how social debates in the United States were transformed by Atwater's calorimeter, as it "translated the vernacular customs of food into the numerical language of empire." In 1898, the U.S. Bureau of Statistics reformatted its publications, issuing weekly bulletins rather than annual publications, and soon after the Census Bureau followed suit. Alongside these numerical expressions there emerged an altered worldview. No longer framed in relationship to moral and legal codes, numbers were used to make arguments about the relative progress of nations. Such a framework permitted a conceptual coherence to be applied to food as it appeared in schedules ranking the nutritional value of different varieties of foodstuff:

> Atwater's schedules ranked grain, meat and dairy goods as important national resources; while fruits, leafy vegetables, and fish registered such slight nutritional value they could scarcely be classified as food. Tea, coffee, and spices, on which whole imperial systems had once flourished, had no value at all. (2010:18)

Food acquired a more uniform value that could be the basis for comparing the diets of populations living in different places and at different times. When C. F. Langworthy replaced Atwater as head of nutrition investigation at the USDA in 1911, he continued the work of ranking different countries and epochs based on a scale of caloric consumption. Surveys compiled by missionaries and ethnographers were complied into ranked lists on a scale of caloric consumption with "the 'native laborer' of the Congo at the bottom (2,812 calories) and the American athlete at the top (4,510 calories)" (Cullather 2010:18).

Cullather explains that evaluating societies as closed systems permitted nutritionists like Atwater and Langworthy to suggest there was a "'physiological economy' of food [that] governed institutions and nations and that 'scientific eating' would increase national efficiency" (2010:19). An economy of this sort meant the possibility for optimization as well, hinging on the discrepancy between "natural" behavior and the balance that might be achieved with appropriate regulation of calories. Self-control over diet became an expectation for U.S. citizens. In popular and official discourse on the global food supply, such an expectation became linked to

"America's future security. … Calories added a measure of certitude to assessments of current threats or dangers farther off, in Asia or in the distant future" (2010:24).

Physiological Economy, U.S. Imperialism

Developments in the statistical sciences came to be a guiding force for international economic and political relations. Particularly during the interwar years, under the direction of Herbert Hoover, development was understood as a concept that embraced "the whole spiritual, social, and political life of our country and world" (Hoover quoted in Cullather 2010:14; see Hogan 1977:212).

In 1917, as head of the national food authority, the Food Administration, under President Woodrow Wilson, Hoover defined food as "both a core vulnerability in the international order and an instrument of U.S. influence" (quoted in Cullather 2010:22). Ledgers created by Food Administration experts, of global food resources and caloric requirements, were referenced by Hoover as evidence of the relief efforts that would be required in European nations "if we are to preserve these countries from Bolshevism and rank anarchy" (quoted in Cullather 2010:22). The resources that the new American Relief Administration poured through German ports were evaluated in terms of the order and peace that they secured.

Rather than viewing security in more traditional terms, as a balance of power or, as defined by Wilson, as a matter of international law and world opinion, Hoover believed material abundance was the greatest protection against future war. Forestalling war, according to Hoover, meant the United States would have to provide routes to progress measured in relation to increases in standards of living (Cullather 2010:22–23).

This was not the planned production and consumption for which British economist John Maynard Keynes or French planners Jean Monnet and Albert Thomas advocated, efforts designed to create allies among nations. For Hoover, tactics devised to introduce progress to these nations made scientific management an American response to Leninism (Cullather 2010:23). In his work, *American Individualism* (1922), Hoover outlined a stage-based theory of history, based on Marx's work, which culminated in an era of intense mass consumption. Rather than being marked by crises, transitions between the phases that included "[t]echniques of social optimization – such as advertising, standardization, market research, and dietetics – would harmonize wages, production, consumption, labor, and health" (2010:23). Violent demands for peace, land, and bread, such as those made by the Bolsheviks, would be neutralized in a statistical language addressing these demands as entitlements.

On this basis, Cullather draws a connection between Hoover's work and the growing interest in demography, developed at the Rockefeller Foundation, which made solutions to global hunger a matter of scientific expertise. In the early years, protocols developed at the Rockefeller Foundation already emphasized inquiries based in statistics. Funding was dedicated to the creation of standardized measures of inquiry such that a problem might be brought to a conclusive and dramatic conclusion, a process meant to highlight the techniques that were required in order for progress to be achieved (2010:26–27). He (2010:26) explains, "The starting point of any project was a survey to distinguish the 'local background' from generic, and presumably global, norms and goals." In this way, projects, cures, and reforms advanced by the foundation came to be viewed as models, and its emphasis on measurement, demonstration, and conversion contributed to official discourses emerging at the time on development.

Solving for Complexity

When Raymond B. Fosdick left his position as under-secretary general at the League of Nations in the 1920s, to first preside over all the boards of the Rockefeller charities and later to become president of the Rockefeller Foundation in 1936, he brought with him an interest in replacing balance-of-power politics with a more systemic approach. Fosdick believed the root causes of international conflicts were better addressed by "adjusting systems of labor, migration, production and consumption" (Cullather 2010:28). Following Fosdick's influence, the League Health Organization adopted a global dietary standard of "2,500 calories per day for a laboring adult," drawn from national nutritional surveys that used Atwater's methods (2010:28).

At the Rockefeller Foundation, Fosdick applied his faith in technological change to questions facing the world's food supply. Quoting from Fosdick's commencement address at the University of Iowa in June 1924, Cullather (2010:29) underscores Fosdick's interest in treating questions about the world food supply in technical terms:

> "Through modern statistics we are able, in our generation, to get a complete picture of supply and demand in relation to the world's food," [Fosdick] explained. Modern censuses covered enough of the globe to allow a rough estimate of the total population—1.6 billion—as well as the rate at which it was rising. By joining national censuses with figures on food output and number of calories required, a statistician could work out a plan of global distribution. "The field has been surveyed and the factors are known," Fosdick told the class of 1924. "What we need now is synthetic thinking, constructive brains, and a plan, laid down in world terms."

Fosdick consolidated programs on nutrition and agriculture into the Division of the Natural Sciences at the foundation so that census figures might be viewed alongside harvest figures as "vital indicators, potential determinants of growth, instability, or war" (Cullather 2010:4). Connecting population growth to food supply generated new ways of theorizing the possibilities and risks of hunger, and suggested that demographic questions need not be restricted to understandings of "natural" laws or to limits of population growth.

Cullather (2010:35) emphasizes that, following these developments, "[t]he Rockefeller Foundation took the lead in developing demography as a profession, separating it from nativism and eugenics, and elevating it to the level of international policy science." In 1935, under the direction of economists Frank Notestein and Irene B. Taeuber, the Office of Population Research at Princeton University trained a generation of demographers whose work targeted demography as a way of understanding "processes of change" (Cullather 2010:37). Demographers including Dudley Kirk, Ansley Coale, and Kingsley Davis elaborated on an approach first explored by Louis I. Dublin and Alfred J. Lotka at the statistical office of the Metropolitan Life Insurance Company. As Cullather (2010:37–38) notes, "[r]ather than concentrating on fertility and mortality as binary variables, they positioned population within a spreadsheet of social indicators—incomes, education, distribution, socioeconomic status, and a host of psychological and political factors—and looked for patterns, an approach that reflected their own uncertainty about the processes they were exploring."

Problems once reducible to one or two variables were now conceptualized in relationship to dozens, even thousands, of factors. Noting remarks from Warren Weaver, director of the Natural Sciences Program at the Rockefeller Foundation at the time, that "probability theory and new statistical methods mounted 'an attack on nature of an essentially and dramatically new kind,'" Cullather (2010:38) adds, "[s]cientists tackled complexity, investigating the dynamics of large systems with a combination of uncertainty and confidence." The Rockefeller Foundation became a principal benefactor of the Princeton office, whose overriding concern about population was neither growth nor decline but rather the connection of still-undefined relationships "between fertility, mortality, and a mix of determinants loosely connected to modernization: education, sanitation, food supply, political awareness, income levels, and industrialization" (2010:38).

A check on processes attributed to a nation's economic and social evolution, Notestein's articulation of "transition theory," publicly formulated in 1944, was a guide to reading undefined elements of the international environment for "ranges of possibility and points of potential influence" (Cullather 2010:38). The theory gained influence by designating a set of processes as indicative of the moment modernization takes hold in a country, for example when urbanization and improvements in health care align with declining death rates as well as birth rates. A slower decline in birth rates was attributed to the requisite psychological adjustments thought to follow modernization, of "growing individualism, a consumerist outlook, and changing functions in the family [that] contradicted customs and religious codes deeply rooted in agrarian, traditional societies" (2010:38). Arguing that transition theory "rescued Malthusianism from Malthus," Dudley Kirk, who left Princeton in 1947 to become the first official demographer of the U.S. State Department, argues that if once discourse on demography was filled with the dangers of overpopulation there was now "a re-evaluation of the relationship between population growth and economic development in the modern world" (quoted in Cullather 2010:39).

This history of the calorie and demography tied modernization to these ideals "embedded in the numbers" (Cullather 2010:41), and paved the way for the programs in agriculture developed by the Rockefeller Foundation in the 1940s. When Elvin Stakeman, Paul Manglesdorf, and Richard Bradfield traveled to Mexico in 1941, it was to begin creating a prototype, a program for transforming the economy of "developing" nations. These solutions in Mexico were not in response to its "food/population" gap, but rather in response to "a type of backwardness that could be found throughout the colonial areas of the world" (Cullather 2010:44). Building on the quantification of development thinking established by the foundation, the Green Revolution was a solution for post-revolutionary countries for problems attributed to agrarian change rather than populations outrunning their food supplies.

Disciplinary Institutionality

Another way of looking at the relationship of technology to social problems and their solutions is to examine the mathematical theory of information developed by Claude E. Shannon in collaboration with Warren Weaver after World War II. I historicize the relationship of the statistical sciences to Shannon's theory of information in chapter 2, bringing needed attention to the bearing of these sciences on the reconfiguration of the body-as-organism.

The history of the Green Revolution outlined in Cullather's work and elsewhere (see Feder 1976; Perkins 1997; Ross 1998), Raj Patel (2012:1) stresses how global production was re-conceptualized after this point. Governments and foundations began instituting policies and programs to teach developing countries fundamental truths about agriculture underscored by these technological developments. Referencing the concept of "food regimes," developed by Harriett Friedmann and Philip McMichael, Patel (2012:3) underscores the institutional capacity that was required to achieve a global scale for the production and consumption of food (see also Friedmann 1993:30).

Patel (2012:3) quotes Friedmann to stress how this institutional structure is not only an arrangement of power and property, but also that the legitimacy of food aid is dependent on two developments:

> (1) convergent interests and expectations among diverse and highly unequal actors, including US farm commodity groups and legislators, Third World governments, grain trading corporations, consumers who benefited from falling grain and meat prices; and (2) an ideological framework that defined these as humanitarian, developmental, or anything but a trade relation, even though the scale of food aid shipments dominated world price formation for three decades.

While conceding that the problem of scarcity addressed by the Green Revolution required certain "truths" about agriculture to be altered, Patel argues that these alterations were brought about by juridical and disciplinary measures, like subsidies, used to ensure the adoption of green revolution technologies.

By the 1980s subsidized exports were no longer part of the practice of food aid, though such subsidies were required to introduce an appreciation for the improved methods of farming affiliated with the Green Revolution, including new seeds, better water management, and improved pesticides and insecticides. Institutional interventions into the market instructed farmers and governments on the value of technology. Subsidies used to persuade governments to value these technological enhancements, however, ultimately outstripped the budgets of the Rockefeller and Ford foundations. In the 1960s, the United States government assumed responsibility for the fiscal commitment to the Green Revolution (Patel 2012:16; see Dowie 2001:113). During the 1960s subsidies continued to hold prices for these crops above the competitive level to encourage farmers to adopt green revolution technologies.

If proponents of the Green Revolution often ignore questions about distribution that make hunger prevalent despite yield increases, the individualizing tendencies of the nutrition sciences are treated by Patel (2012:47) as a natural corollary to this oversight:

> [C]ommon to the approach presented by foundations is a discourse that enables the symptoms of poverty while postponing or even ignoring the deeper causes of that poor diet. The rise of nutritionism pulls the locus of policy action towards the individual body, rather than on the relations that humans have to one another and the world around them.

Interested in the changes in accumulation that accompanied both the Green Revolution and more recent calls for a "second green revolution" in Africa, Patel (2012:30) points to Jack Kloppenburg's (2010) argument, borrowed from David Harvey, of a process of "accumulation by dispossession" that is a feature of this approach to global hunger. Patel (2012:30) explains: "the biological realm has been increasingly commodified. … [T]he ownership of global seed supply has become increasingly concentrated, such that the top four companies control more than half the global proprietary seed supply." But there is another way of understanding these developments, as I will demonstrate in chapter 2. Following a connection of the history of information to the statistical sciences, I note how a reconfiguration of the body-as-data moves us beyond considering capital's expansion as dependent on these questions about ownership.

Referencing Foucault's (2008) 1978-79 lectures on biopolitics, Patel (2012:5) argues, "those pushing the new Green Revolution reveal a project that is more biopolitical—more focused on the management of individual bodies—than the original Green Revolution." But, I will demonstrate, affiliated with the initiative for food security, the new (second) green revolution is part of a more complicated reorganization of the public domain and private industry, where presumptions about the distinctions between these realms become blurred. Integral to this reorganization is the increasing significance attributed to biological diversity following the Green Revolution and the vitality this resource assumes as data in discussions about food security.

DIVERSITY AND INSTITUTIONALITY

Biological Diversity and Technological Solutions

Commonly understood in terms of the influence of technology on traditional agriculture, the erosion of biological diversity is often framed in relationship to the distinction between landraces and cultivars. Landraces are different from standardized varieties of cultivars whose desirable characteristics are selected through propagation. Stressing this distinction, Cary Fowler and Pat Mooney (1990) argue that the potato famine in Ireland in the 1840s should not be blamed on the weather but instead on the varieties of potatoes growing in Europe at the same time.[8]

The social system caused the famine, Fowler and Mooney (1990:45) argue, stressing the fact that so few people were allowed to own and control so much agricultural growth: "How else can we explain the fact that eighty percent of the countryside was still being grazed, not cultivated, and that grain continued to be exported at a time when hundreds of thousands were perishing? Even as people were starving, Ireland produced enough food for everyone." Developments in modern plant breeding in the 1800s allowed varieties of crops to be tailored to particular situations; however, these genetically restricted varieties replaced the "wide open diversity, the 'harmonious disorder' of the landraces" (1990:46).

[8] Fowler and Mooney worked together at the ETC Group (formerly the Rural Advancement Foundation International, or RAFI), an organization founded to support the conservation of seeds. In the 1980s Fowler left RAFI to join the Norwegian University of the Life Sciences. While professor and director of research for the Department in International Environment and Development Studies, Fowler was a senior advisor to the director general of Bioversity International and represented the interests of CGIAR in negotiations of the International Treaty on Plant Based and Genetic Resources. In 2008, Fowler became the first executive director of the Global Crop Diversity Trust where he served until 2012.

Discussing the Green Revolution, Fowler and Mooney (1990) underscore the genetic erosion that accompanied the development of high-yielding seeds. In the 1950s and ’60s, funding from the Rockefeller Foundation was used to establish international agricultural research centers (IARCs), primarily in “Southern” nations. An increase in crop productivity was produced by introducing genetic materials that contained “dwarfing genes,” which encouraged biomass to shift from the stems and leaves into the grain (1990:57). New varieties of seeds proved very responsive when used in combination with nitrogen-based fertilizers, making possible a 10 to 100 percent increase in crop yields (1990:58). By designing a model environment for agricultural growth, scientists could harness agricultural technology and introduce uniform varieties of crops well suited to vast expanses of land (1990:60).

With the rapid spread of these new varieties, which was “more dramatic than anything that had ever happened in agriculture before” (Fowler and Mooney 1990:60–61), agricultural scientists began to express concern over the genetic erosion that accompanied the adoption of these newer varieties. First noted in the lists compiled by the USDA of varieties sold by commercial U.S. seed houses in the early twentieth century, a study undertaken by RAFI details the loss of fruit and vegetable varieties. Among 75 types of vegetables, RAFI noted that approximately 97 percent of varieties included in the USDA tables were now extinct, and losses in the U.S. are considered much lower than losses estimated for other countries during the twentieth century (Fowler and Mooney 1990:63).

I draw our attention to the incalculable value biological diversity acquires in discussions about food security, where this value is often at the same time a reference to the potential for scientific and technological innovation. Fowler and Mooney reference a value of biological diversity in these terms when they describe the wheat collected by agronomist Jack Harlan in

Turkey. As they (1990:69) note, although the wheat was initially described as "miserable looking wheat, tall, thin-stemmed, lodges badly, is susceptible to leaf rust, lacks winter hardiness … and has poor baking qualities," it turned out to be resistant to "four races of stripe rust, ten races of dwarf bunt and to have good tolerance to flag smut and snow mould" (see also Frankel and Hawkes 1975:114–115). Further, Fowler and Mooney (1990:89) explain: "whether or not we salvage and save enough diversity to allow future generations to mold crops to suit their needs should be of secondary concern. There is an even more fundamental question: Will we save enough diversity to ensure the very survival of our major food crops?"

Biodiversity and Survival

Alongside these calls linking biodiversity to our future survival, there now exists a network of organizations dedicated to this task. As noted in the introduction, central among these organizations is Bioversity International. Bioversity was established in 1974 to prioritize crops for conservation based on "the crop's economic and social importance; the materials that need collecting; the needs of plant breeders; and the quality of present collections" (Fowler and Mooney 1990:79). Founded by CGIAR, Bioversity has deep ties to the collection of international agricultural research centers that grew out of the Green Revolution.

With a mission "to promote an international network of genetic resource centres to further the collection, documentation, evaluation, and use of plant germplasm" (quoted in Fowler and Mooney 1990:79; see IPBGR Annual Report 1982), the International Board for Plant Genetic Resources (IBPGR) went on to become Bioversity International, and to contribute to founding the Global Seed Vault in Svalbard, Norway. In partnership with the Crop Trust, Bioversity is working with members of CGIAR to revamp its Systemwide Genetic Resources

Programme to make available Genesys, an online information portal that links gene banks worldwide. In this configuration, an indefinite value of biological diversity connected to scientific innovation is treated as integral to our very survival.

"Cultural Casualties" of Eating

Appeals to conserve biological diversity bear an affinity to the "cultural casualties" of eating explored in the work of journalist Michael Pollan (2006). Defining eating as an engagement between the human body and the natural world, one in which "our eating turns nature into culture, transforming the body of the world into our bodies and minds" (2006:10), Pollan connects human life to the lives of dozens of other species, including plants, animals, and fungi. As he explains, "[W]e have coevolved to the point where our fates are deeply entwined. Many of these species have evolved expressly to gratify our desires, in the intricate dance of domestication that has allowed us and them to prosper together as we could never have prospered apart" (2006:10).

Due to all of the expert advice available from food scientists, nutritionists, and journalists, and because there are so many choices about what to eat, Pollan argues that Americans are anxious and confused about eating in addition to being unhealthy. Drawing on the work of Canadian historian Harvey Levenstein (1993), Pollan (2006:300) explains that Americans believe that "taste is not a true guide to what should be eaten; that one should not simply eat what one enjoys; that the important components of food cannot be seen or tasted, but are discernible only in scientific laboratories; and that experimental science has produced rules of nutrition that will prevent illness and encourage longevity." Americans are an unhealthy people obsessed by the idea of eating healthily, and their anxiety about eating is a cultural casualty, much like the eradication of culture described by sociologist Daniel Bell (1976)—a byproduct of capitalism's drive for expansion (Pollan 2006:302). He contrasts our relationship to food in America with a French culinary culture based on pleasure and habit rather than nutritional science. The result, Pollan claims, is that the French have lower incidence of diet-related health troubles.

The latest casualties of the drive for expansion are the family dinner and any cultural consensus on eating. The desire of the food industry to sell more food to an already well-fed population led to ways of processing, packaging, and marketing food that could supersede cultural rules and rituals on eating. As a species we are now almost back where we started, requiring experts to tell us what we once knew instinctually: "Such has been the genius of capitalism, to re-create something akin to a state of nature in the modern supermarket or fast-food outlet, throwing us back on a perplexing, nutritionally perilous landscape deeply shadowed again by the omnivore's dilemma" (Pollan 2006:303).

Pollan suggests that industrial processes of commodification and the creation of scientific experts have served as the conditions of a market that overcomes more natural rules and rituals of eating while introducing the knowledge required for their healing. Rather than questioning whether or not we are at risk of these cultural and biological casualties, I address a shift in our thinking about the body that, after World War II, makes possible the reconfiguration of the body-as-data that appears in discussions about food security.

A MODERN FOOD SUPPLY: FROM THE STEAM ENGINE TO INFORMATICS

In their discussion of the "one level standpoint" (1-LS) Latour et al. (2012:2) note how "[t]he whole is always smaller than its parts." Drawing evidence from the experience of navigating through digital platforms, Latour et al. (2012:3) consider how “an entity is entirely defined by the open-ended lists in the databases.” They continue:

> Using the terminology of actor-network-theory (ANT), an actor is defined by its network (Law, 1999). This network is not a second level added to that of the individual, but exactly the same level differently deployed. In going from the actor to its network, we remain safely inside the 1-LS.

Building on this framework, Clough, Gregory, Haber, and Scannell (2015:154) describe the logic for a datalogical turn where “the definition of the bodily broadens beyond the human body or the body as autopoietic organism and as such bodily practices themselves instantiate as data, which in turn produces a surplus of bodily practices.” Noting how food security is part of this discussion, in subsequent chapters I consider how biological diversity, as a resource for food security, blurs distinctions between production and reproduction that have been foundational to the rights of political subjects.

In his description of the changes that food systems have undergone over the last 200 years or so, Christopher Otter (2014:8) notes how advances in food production, processing, storage, and distribution have produced “systems [that] operate as new environments within which natural selection operates.” The “eco-technical” problems now facing food systems follow the invention of steam and internal combustion engines, which increased the distance food travels before its consumption while producing a systemic reliance on fossil fuels. The distance the average American food item travels from farm to plate is now between 1,500 and 2,500 miles (Otter 2014:8). Complementary to transporting food, Otter (2014:8) notes that 17 percent of energy goes to feeding processes, whether these are affiliated with production, processing, distribution, or cooking (see Nye 2006:82).

Fully functional by the 1880s, the technology of mechanical refrigeration involves a "cold chain" of processes that weave together the transportation of perishables like meat, milk, and fruit through "abattoirs, dairies, trains, storage depots, and delivery trucks … a relatively streamlined network characterized by calculated temperature control" (Otter 2014:8–9). This "scaling-up of production" meant that smaller institutions involved with production were replaced by "elongated transportation and distribution trains," comprised of "[g]rain elevators, mills, bakeries, sugar refineries, dairies, cold stores, feedlots, and abattoirs" (2014:9). The problems in contemporary food systems can be described, therefore, in terms of the "nodes" of these longer transportation and distribution chains, where the slack between, say, the abattoir and the fast food restaurant reinforces the size of food systems and the energy these systems require.

Alongside these developments, a novel form of evolutionary space has come into view, the "microbiome" or a physical environment for new life forms including the molds and slimes that began to appear on the surfaces of frozen carcasses and the wingless insects found in wheat granaries (Otter 2014:10). The great distances that define production, processing, and consumption define the conditionality of food systems today, revealing them as "giant 'ecotechnologies' which extract, process, and distribute vast amounts of edible matter to human populations" (2014:10). Boundaries between technology and nature are blurred by a distance that makes it difficult to distinguish food systems from the environment.

But changes in politics and economy that follow the turn to food security are not only a matter of scale. The "problem" that food security addresses is also shaped by the modern theory of communication developed by Claude E. Shannon after World War II. If we view the logic of food infrastructures in the informational terms, as Xaq Frohlich (2014) proposes, we begin to realize what histories of the nutrition sciences prevent us from questioning, concerns about food production, storage, processing, and consumption made in relationship to a biopolitical economy.

Frolich argues that information on food labels suggests some of what regulators, advertisers, public health advocates, doctors, scientists, and food manufacturers contribute to this technology, which operates more as an aesthetic value to get the attention of consumers. Viewed as information, we can see nutrition labels as part of a restructuring of the marketplace, introducing changes in food itself when markets and product classifications become used to distinguish foods from drugs and medicines.

Developed together with the American Medical Association, in the 1960s, the Food and Drug Administration (FDA) introduced a prescription drug system that aided the standardization of physician practices through information labeling (Frohlich 2014:44). Passed in 1938, the goal of the FDA was to remove products that were deemed ineffective or harmful, or that were marketed as drugs or as having drug-like powers. Central to how distinctions were made between foods and drugs and medicine, Frohlich (2014:44) argues, is "a legally constructed terrain of intertextual or hypertextual references." Food informational labels were introduced in the 1970s and revised in the 1990s, but these labels do more than assist consumers interested in healthy foods. Decisions on whether a product was labeled as a food or drug determined where products would appear in the marketplace as well as who was permitted to sell them. If we consider the confusion introduced by "borderline products," like Sweet'N Low, for example, we can see how such products generate a whole new demographic of consumers defined by the decision to package a product in a sachet. Packaging carries the implication that it might be used as a supplement in addition to being promoted as a food additive. Campaigns to distinguish between special medical products and ordinary foods can therefore be understood as part of a transition towards the continuum of healthfulness Joseph Dumit (2012) describes. Labeling has a capacity to introduce a responsibility for health in relationship to different kinds of subjects, "informed, active consumers managing their own lifestyles" (Frohlich 2014:44).

CONCLUSION

Noting advances in the nutrition sciences, scholars in food studies have made the body fit their conclusions about "Big Food" and U.S. imperialism, noting either the failures of global public health to regulate industry or the efforts of U.S. government officials, policy makers, and foundations to make the adoption of green revolution technologies a gauge for economic development. In these discussions, the social world is an effect of scientific and technological developments. But in discussions about food security, biological diversity is a resource for politics and innovation.

To explore these informational capacities of the body that food security mobilizes, in the following chapter I trace the history of the modern theory of communications developed by Claude Shannon and Warren Weaver at AT&T Bell Labs after World War II. Noting scientific and technological developments that build on Shannon and Weaver's theory of communications, I explain how we are able to clearly distinguish two ways of understanding the body, in terms of energetics and informatics, relative to the turn from global hunger to food security.

CHAPTER TWO

INFORMATION THEORY AND BODIES OF NONKNOWLEDGE

INTRODUCTION

In this chapter I note a history of information defined in relation to Claude E. Shannon's paper titled "The Mathematical Theory of Communication," published in the Bell System Technical Journal in 1948,[9] as evidence of another way of thinking about the body and bodily capacity different from the notions of energetic metabolism used to theorize social functions in terms of the body's capacity to do work. This understanding of bodily capacity bears on the way we define relations between food and the body. Rather than inborn, the body is conceived as informational. And bodily capacity becomes linked to what Hannah Landecker (2013:496) describes as "constituted by a web of cellular signals, built by and responding to environmental information."

I stress this relationality to extend discussion about bodily metabolism beyond political economic configurations that stress a caloric or nutritional value for food as fuel or the raw material correspondent with bodily expenditures of energy. Noting how developments in the communication sciences alter the way we account for the capacity of biological diversity that food security insures, I will delineate two political economies and two bodies. This argument follows Landecker's discussion of the informational metabolism in epigenetics, where there is a shift from an energetic metabolism where food is fuel to an informational metabolism that is more of an interface of food, time and biology.

[9] Shannon's paper was republished by the University of Illinois Press in a volume entitled *The Mathematical Theory of Communication* (1949) with an introduction by Warren Weaver.

RETHINKING INFORMATION

Signal to Noise

In her study of information, Tiziana Terranova (2004) foregrounds the informational dynamics identified by Shannon's mathematical theory of information as well as the transformative potential of his theorem for modern mass media. In this theorization, information is "not simply the *reproduction* of culture, but also an indeterminate production crossing the entirety of the social (from factories to office to homes and leisure spaces)" (Terranova 2004:9). Shannon's theory of communication makes information not an object that is defined in relationship to privacy, property, or copyright. Instead, as Terranova (2004:10) explains, "information flows displace the question of linguistic representation and cultural identity from the centre of cultural struggle in [favor] of a problematic of mutations and movement within immersive and multidimensional informational topologies."

Relevant to Shannon's formula is the particular context in which it emerged. In the 1940s, Shannon was working with members of the cybernetic group and engineers at AT&T Bell Laboratories. Communication engineers in corporate labs in the United States were working in an environment that was "particularly rife for such technical and scientific breakthroughs," as Terranova (2004:11) notes, citing the work of Jérôme Segal (2003). Both interdisciplinary and international, communication labs for North American telecommunication engineers were not like those of their European counterparts. In Europe there were stricter disciplinary divisions between theoretical and practical work. U.S. engineers, by way of contrast, were well versed in physics debates while simultaneously grappling with the complex problems facing large telecommunication networks. These material circumstances set the stage for Shannon's theory of information while at the same time paving the way for evolutions in the biosciences that make possible technical solutions like "food security."

At its most basic element, Shannon's theory identifies a physical quantity that is calculated in response to the problem of sending messages from one place to another in the most efficient way possible. Connected to research in engineering at a time when the field was responding to insights from linguistics and cryptoanalysis for its understanding of communication codes, Shannon's formula makes information "explicitly subordinate to the technical demands of communication engineering" (Terranova 2004:12). Shannon's formula is a response, therefore, to the classic problem of background static that accompanies signal transmission, which, through amplification, causes messages or signals to become overwhelmed by their own energy. To resolve this problem, Shannon determined the accurate reproduction of the signal across a range of media channels, which requires a technique for encoding the signal so that a system can differentiate signal from noise and thereby resolve any corruption of messages. This formula is still the foundation for modern communication devices including cellular phones, modems, and compact-disc players—the logarithmic measure Shannon devised that makes a signal *mathematically* distinguishable from noise.

To illustrate this process, Terranova points to Shannon's famous diagram that identifies five discrete elements of communication: the information source, the transmitter, the message, the channel of communications, and the receiver. As she explains, "The information source, or sender, selects the message to be coded into a signal that is then transmitted through a channel to a receiver. Information is the content of communication, in the sense that it is what needs to be transported with the minimum loss of quality, from the sender to a receiver" (Terranova 2004:13).

In older modes of communication, like the postal system, information can be conceived as the content of communication in the sense that it requires physical transport "with the minimum loss of quality, from sender to receiver" (Terranova 2004:13). In communication theory as well, information requires this process of physical transport. However, digital information also involves a process of redundancy and frequency that makes possible its differentiation by the communication machine, introducing a capacity that makes the transmission of information more efficient.

Information and Probability

While Shannon's theory of information did not emerge until the late 1940s, earlier developments in information theory can be traced to advances in the fields of statistics, physics, and telecommunications in the 1920s. As Terranova (2004:28) explains, "The question of information was posed first of all in the context of statistics of 'populations.'" Quoting Segal, she underlines the problematic raised by a statistical theory of information: "[t]he scientific reduction of a mass of data to a relatively small number of quantities which must correctly represent this mass, or, in other words, [that] must contain the largest possible part of the totality of relevant information contained in the original data" (2004:28, Terranova's translation).

This process of compressing data such that it maintains a connection to its mass draws upon the field of social physics. Adolphe Quetelet, in the mid-nineteenth century, compiled mortality and criminality tables and authored a study on the "propensity to suicide," work that provided the groundwork for Emile Durkheim's famous sociological study. But, as Terranova (2004:28) tells us, the foundations of the modern theory of probability can be found even earlier, in the mathematical treatments of games of dice from the mid-seventeenth century (see Campbell

1982:39). In chapter 4, I extend the relevance of this connection of information theory and statistical probability to describe two neoliberalisms: the bioeconomy that Melinda Cooper (2008) describes as emerging from the welfare state, and another that builds upon the body-species that Foucault (2007) describes in his discussion of the "problem of the population."

Boltzmann's Theorem

Shannon's mathematical theory of information drew inspiration from the theory of entropy developed by Ludwig Boltzmann at the end of the nineteenth century. Elaborating on a theory of speed distribution established by James Clerk Maxwell in the mid-nineteenth century, Boltmann argued that the behavior of human molecules could be addressed by averages. Working in the field of mathematical physics in the mid-nineteenth century, Maxwell had connected questions about probability to variable speeds and collisions among the particles found in kinetic systems such as gases (Terranova 2004:29).

Boltzmann noted that the behavior of human molecules could be addressed by averages if the specific behavior of individual molecules at a particular moment was not known, and that a system's high entropy corresponds to its (im)probability. As Terranova (2004:29) explains, "[a]s the system becomes more disorderly and temperatures differences are lost, its entropy (the amount of 'energy unavailable for work') increases and the limited knowledge allowed for by the average disappears." Terranova quotes Jeremy Campbell, who explains Boltzmann's theorem as follows "when the system is in a high state of entropy then it is *improbable* that [such parts] will be found in any special arrangement at a particular time" (emphasis Terranova's; see Campbell 1982:44).

Referred to as “the H-theorem,” *H* is a measure of “the difference between the distribution of probabilities at any given time and those that exist at an equilibrium state of maximum entropy” (Terranova 2004:29). Working with these ideas in the mid-twentieth century at Bell Labs, Shannon determined that the positive correlation that Boltzmann established between the entropy of the system and the limited knowledge allowed for by the average can also be used to measure information. In other words, Shannon’s insight was to use Boltzmann’s formula to measure information, drawing on the understanding that as the entropy of the system increases so does our uncertainty.

While emphatic that his formula for information pertained to the context of communication engineering, Shannon’s work allowed twentieth-century scientists in cybernetics and quantum theory to connect their work to the nineteenth-century interest in entropy, as defined in terms of heat engines, energy, death, and irreversibility. Nineteenth-century physics defined entropy as “the tendency of life to run out of differences and hence of available energy in its drive towards death” (Terranova 2004:30). Shannon’s formula introduced the possibility of a positive equivalence between information and entropy, suggesting that information is “a kind of form determining the material unfolding of life” (2004:31).

Information and Social Physics

Terranova (2004:30) elaborates on the implications of Shannon’s formula by noting its influence on the nineteenth-century thought experiment called “Maxwell’s Demon,” which asked “whether it was possible to counteract the tendency of closed systems to run out of energy … to identify a physical capacity that ran against the stream of entropy.” The positive correlation of entropy and information drawn in Shannon’s work introduces the understanding of entropy in relationship to life forces not bound to the thermodynamic system, for example, in terms of probabilities.

To expand on this point, Terranova (2004:30) points to a 1945 lecture entitled "What Is Life?" by Erwin Schrödinger that conceptualizes the relationship of information to life as "an upstream movement against the entropic tide." Schrödinger asks, "What is life if not negative entropy, a movement that runs against the second law of thermodynamics, whose existence is witnessed by the varieties of forms of life as they exist in the physical world?" (Terranova 2004:30).

Following Schrödinger's assertion of the positive function of "negentropic forces," Terranova (2004:31) notes discourses in the life sciences that began to imbue DNA with a power to generate life; DNA was seen as "an informational microstructure able to produce living organisms by inducing chemical reactions leading to the conversion of energy into differentiated cells." But while the life sciences attribute to DNA a microstructure that is "a kind of form determining the material unfolding of life," molecular biology instead understands it as "a simple inductor within the complex environment of the cell" (2004:31).

What Shannon's formula underscores, therefore, is a nonlinear relationship between information and life, and an indeterminate relationship between the micro- and macrolevels of organization. Information does not represent a physical state through resemblance; instead, the technical and scientific understanding of representation as an average or norm correlates to a variety of microstates. As Terranova (2004:31) explains:

> Rather than expressing a deterministic relation between informational structures such as the DNA and a biophysical phenomenon such as the organism, the informational trend emphasizes the nonlinear relationship between molecular or micro levels of organization and molar or macro layers. … [A] macro-state or a molar formation (such as an average temperature; or an organism; or an 'identity')

> does not have a linear or deterministic relation to the multiplicity of the microscopic states that define it.[10]

The statistical averages and norms found in Quetelet's social physics were based on representations of a macrostate that does not really exist therefore, as Terranova (2004:31) explains, such representations exhibit a capacity "to regulate a social body and stabilize it." For example, "[a]n average might be the same for a number of different possibilities (an average height of feet in a population of 100 people might be realized by many different distributions of possible heights)" (2004:31). Writing in the 1800s, Quetelet's social physics suggests a disciplinary capacity for social concerns. As Terranova (2004:31–32) notes, "[l]ike the mass society that in those same years was increasingly preoccupying conservative and radical critics alike, thermodynamics and statistical mechanics too were concerned with formations such as masses, quantities such as averages and qualities such as homogeneity and heterogeneity."

From Infinitesimal Numbers to Information-as-Space

If continuous quantities were thought to be suitable for the governing of averages found in the social physics of the 1800s, new strategies using digital technologies generate with greater precision the microscopic levels of organization. These are based on the discovery that, at the microlevel, organizations are inherently metastable or predictably irregular, and are not capture-able using analytical tools based on continuous representation. Chaos theory, for example, perceives no linear or direct relationship of the behavior of individual particles to the overall flow dynamics, as Terranova (2004:32) explains: "The state of flow is always a function of

[10] The relevance of this point is particularly critical when noting the impact of Shannon's work on the professionalization of the social sciences, as I do in the conclusion to this chapter and again in chapter 3. At this point, however, I mean to stress a more general relationship of information to how "social" concerns are organized.

aggregate behavior of a microscopical multiplicity." Strategies deployed in cybernetics and in the mathematical theory of communication seek to understand the potential for change and transformation that is expressed in organizations at the microscopic level.

Pointing to Norbert Wiener's discussion of these problems, Terranova (2004:32) considers how the capture of digital information, as "the microscopic instability of the matter energy continuum," is different from analogue forms of measure that produce a gap between representation and reality. She writes, "For [Wiener], machines that represent the object by following and reproducing the variations in intensity of light, texture or sound on a material substrate always end up producing an unbridgeable gap between representation and reality, a gap which can only produce the dreaded interference of *noise*" (2004:32, emphasis Terranova's).

Measuring physical phenomena using continuous quantities is therefore a material impossibility. Due to the imprecision of the capacity of perception, "defined phenomenologically as the power of human eyes," and their rigid quality, analogue machines can measure averages and identities but overlook micro-variation and mutation (Terranova 2004:33). Digital machines are understood by cyberneticians to facilitate a more precise form of "capture" as these machines permit engagement with the intrinsically unstable and immeasurable aspects of matter itself. Digitization extends "the principle of counting to fractions and infinitesimal numbers," as Terranova (2004:33) explains, "turning numbers into the infinite combinations of zeros and ones … that produce exact yet mobile snapshots of material processes."

Quoting Wiener, Terranova (2004:34) notes how these "representations" produced by digital machines are not exhaustive but instead "an incomplete determinism, almost an irrationality in the world … a fundamental element of chance." The emergence of robotics illustrates how space can be reduced to a matter of probabilities. Early efforts in robotics relied on a “representational approach to cognition and movement,” in which “[a] robot was provided with sensors (such as cameras) able to scan a space for obstacle and directions” (Terranova 2004:36).

The approach was unsuccessful, however, because the robot’s computational capacity was exceeded by an environment that was inherently informational. The map generated by the robot was never accurate enough and often overlooked relevant bits of information (Terranova 2004:36; see Brooks 2002). Robotics cognition, in fact, required that the machine keep its distance from space in order to represent it. The solution devised was to get rid of the cognition box all together so that the robot’s sensors and motors might interact directly with its environment (2004:36–37). Terranova (2004:37) explains: “Space becomes informational not so much when it is computed by a machine, but when it presents an excess of sensory data, a radical indeterminacy in our knowledge, and a nonlinear temporality involving a multiplicity of mutating variables and different intersecting levels of observation and interaction.”

INFORMATION AND BIOMEDIATED BODIES

From Entropy to Turbulence

In their work on “heat-death,” Terranova and Parisi (2000:1) explain the index of different historical formations that can be described for the relationship between science and the body. Noting how hierarchy and classification operated in the sciences prior to the emergence of complexity theory, they view the body-as-organism as “a biophysical pattern through which the organism can be conceived as homeostatic, borrowing energy from the Outside” (2000:2). If the body is understood to exist in conditions of equilibrium, maintaining its boundaries against the energy outside the system that seeks to engulf the body-as-organism, this perception of the body draws from the science of thermodynamics. Terranova and Parisi (2000:3) relate this conception to its implications for capitalism:

> Within a thermodynamic system, entropy is inevitable, it does not matter how efficiently the organism performs its charge/discharge cycle. Thermodynamics is a law of nature on which industrial capitalism built a technological, economic and biosocial order. The centrality of thermodynamic principles to its technological machines and its organization of the social body means that the entirety of the social order constructed by industrialism was affected by its implications. It is not only the universe which one day will run towards heat-death, but also the social order, which builds itself on thermodynamic principles. The threat of entropy was real to the natural and political sciences of industrial capitalism, it was a problem that needed a solution.

In contrast, the body of food insecurity that we can extrapolate from the informational metabolism Landecker describes breaks with the representational subject and its thermodynamic phenomenology. This body of technoscience, as Terranova and Parisi (2000:4) explain, is made open to information, "to particles, waves and attractors, which constitute it as far from equilibrium system." Entropy is perceived as vital rather than lethal for this body-as-data that is more an understanding of the turbulence that is integral to the origins of life than a vitality derived from "entropic collapse" (2000:4).

Bodies for Thermodynamics and Technoscience

This evolution of the conception of the body from thermodynamics to technoscience returns to our attention the influence of Boltzmann's theorem on Shannon's theory of communication. Boltzmann's theorem led to "a process of intensification of the perception of a body," which is, as Terranova and Parisi (2000:1) note:

> a perception which abstracts and produces power/knowledges through the body. So the organism is a mode of organization of the body, which was not so much constructed as latched on by disciplinary science in the context of larger historical

> movements. Similarly the turbulent flows of molecular biology and chaos theory have been not so much constructed or represented as (literally) invested into by technoscience, experimented on and inserted into the technical machine of simulation.

In the thermodynamic, entropic system, stabilization is a defense against the forces of entropy. As underlined in Wiener's work, the process of saving life from "heat-death" requires "an enclave of organization in the face of nature's overwhelming tendency to disorder" (Terranova and Parisi 2000:5).

The principles that underline this form of control are displaced in technoscience. Technoscience positively correlates information and entropy rather than opposing them. While early cybernetics manages the problem of entropy by making the cybernetic system reactive to it, later phases of cybernetics incorporate entropy as an active generator of difference that is connected to a universe that is both cybernetic and probabilistic.

The separation of entropy from thermodynamic systems begins with Boltzmann's theorem, as he made entropy equivalent with randomness. Connecting Boltzmann's theorem to cybernetics Shannon reincorporated entropy into his formula for information, reversing the trend established by Leon Brillouin, the father of modern information theory, who had defined information as negative entropy ("negentropy"). Noted as well by postmodern literary critic N. Katherine Hayles (1999), Terranova and Parisi (2000:5) explain that Shannon "*identified* information and entropy rather than opposed them … saying that the more unexpected (or random) a message is, the more information it conveys."

THE DATALOGICAL TURN

Biomediated Bodies

Building on Terranova and Parisi's (2000) discussion of entropy, Patricia Clough (2008:2) describes the "biomediated body" that is the result of this organization of material forces—a reconfiguration of the body, work, and production whose elaboration can be found in contemporary scientific discourses. Defined by an affective capacity, the biomediated body is drawn from a political economic and theoretical investment in information, that is, an "investment in the self-organization inherent to matter or matter's capacity to be informational, to give bodily form" (2008:2). Developments in digital information technologies that permit us "to 'see' matter as informational or self-organizing," have at the same time attached to and expanded "the informational substrate of bodily matter and matter generally, and thereby mark the introduction of a 'postbiological threshold' into 'life itself'" (2008:2).

Stressing Parisi's (2004) point that political economic investments in the technosciences introduce forms of measure that target the affective capacities of the body rather than its reproduction, Clough emphasizes how Shannon's formula reconceptualizes entropy to underline the emergence of a new measure of uncertainty, in terms of life itself. Shannon makes entropy the condition of possibility for information, as Clough (2008:13) explains, noting how he moves information from an organization of the body in terms of the closed mechanics of thermodynamics to open systems in which "the irreversibility or the passing of time is disconnected from heat-death." Relative to Shannon's definition, Clough (2008:13) notes that cybernetician Wiener's theorization of information is somewhat different: "Although Shannon's theorization of information in the late 1940s followed his dissertation dealing with 'the algorithmic and combinatoric properties of genetic code' (Thacker 2005:52), Norbert Wiener's theorization of information at around the same time was more directly linked to biology and "life itself."

However, Clough (2008:13) suggests that we not view these definitions as contradictory. Shannon describes a positive correlation of information and entropy—"the more entropy, the more improbable the message being sent, and therefore the more information"—while Wiener saw information as an "an ordering in the indifferent differences of entropy or noise, and thus [decreasing] entropy" (Clough 2008:13). As Clough (2008:13) tells us, for Wiener, "[i]nformation is a local organization against entropy, a temporary deferral of entropy – that is life. Even as entropy increases in the universe as a whole, information can prevent entropic collapse temporarily as extrinsic resources of informational order or energy arise." By treating these two definitions of information as complementary, taking Shannon's definition at the point of sending messages and Wiener's at the point of receiving them, Clough underscores that both definitions "fit" the mathematical definition of information. Therefore, we might add to Terranova and Parisi's work on heat-death those capacities of the body Clough attends to whose mobilization is more a matter of affect than an investment in thermodynamics and forms of energy organized for work in the biological, human body.

The work of Ilya Prigogine and Isabelle Stengers (1984) illuminates further still this relation of bodily capacities to uncertainty or entropy. According to Clough (2008:13), Prigogine and Stengers maintain that in the "far-from-equilibrium conditions of an open system … the dissipation of entropy is itself dissipated or temporarily reversed in the chance emergence of a dissipative structure." With this insight, we can perceive a body for whom contact is biomediated, that is, "not only a matter of the real arising in the exclusion of all other possibilities," as the mathematical formula for information proposes, but also the site of emergence and the deferral of entropy, understood "in terms of the metastability of open systems under far-from-equilibrium conditions" (2008:14).

My point, in underlining this body that I call the body-as-data, is to stress its relationship to the technical solutions we find emerging in discourses on epigenetics, cybernetics, biotechnology, and biological diversity. The transformations emerging in these discourses, on the body, subjectivity, the object, and institutionality are integral to how we imagine solutions like global food security.

Postindustrial Metabolism

In contrast to the "energetic" understanding of food and the body that Nestle and Nesheim (2012) describe, a relationship that, as I discuss in chapter 1, many scholars of food studies reiterate, Hannah Landecker's (2013) work directs us to an emerging model of metabolism based on these developments in cybernetics. Landecker's study of epigenetics allows us to visualize how, for the body of food security, the "far-from equilibrium" conditions articulated by Clough unfold in correlation to what Landecker describes as "a postindustrial metabolism."

Like the system used by Karl Marx to explain commodities of exchange, Landecker (2013:495) explains how the nineteenth-century science of metabolism suggests a factory-like conversion of food into energy. The basis for this model can be found in the rational account of nutrition described by Max Rubner, the German physiologist who made "tables of the energy contents of foods with the direct intent of rationalizing nutrition" (Landecker 2013:495; see Gratzer 2005). Later expanded upon by Wilbur Olin Atwater, Landecker (2013:495) notes that Atwater "brought home both the techniques and the politics of Rubner's *Arbeitsphysiologie* (physiology of work)" through his tables that compare, for example, amounts of energy found in wheat versus cabbage. What these sciences of interconversion demonstrate are the deep links in early twentieth-century America “between nutrition science and the politics of the living wage” (2013:495; see Aronson 1982; Mudry 2009).

Disorders of industrial bodies diagnosed with “inborn errors of metabolism,” Landecker (2013:496) argues, might be viewed “as one broken part of the productive machinery … [as] substrate buildup could not be converted to the next step on the line.” She continues: “Different metabolisms might run slower or faster, or they might be balanced differently, but having a metabolism was a universal—it was a defining characteristic of all life, that which allowed organisms to live as free and autonomous beings in an ever-changing environment” (2013:496). Operating between the organism and the environment, this concept of metabolism, and differences among bodies, is based on exact determinations of enzymes and vitamin cofactors required for catalyzing particular reactions in cells.

This factory-like image of metabolism and its logic of catalyzed interconversion were powerful enough to persist into the early twentieth century in medicine and science, as well as in political theory, philosophy, and anthropology, as a metaphorical resource for “theories of society and social functioning” (Landecker 2013:496). As she notes:

> In biology, metabolism was central to the practical and physical understanding of the maintenance of the individual body of the eating organism even in the face of the necessity of constantly ingesting the outside world—eating others. In philosophy, metabolism came to occupy a role as part of the defining line between the living and the not living; to metabolize was to live. (2013:496)

But articulating a new concept of metabolism emerging today, Landecker delineates a regulatory zone where metabolism is both a conceptual domain and a set of experimental practices.

The Regulation of Bodily Signals

The distinctive mode of this new metabolism is "a dynamic of cellular signals, built by and responding to environmental information—food molecules or food's pollutants" (Landecker 2013:496). Rather than the chemical reactions for the nutrition sciences, whose rationale is framed by manufacturing and energy, metabolic survival requires a more flexible network of information engineering reliant on the signal. Flagging this as a regulatory zone, Landecker (2013:497) points to experimental evidence and explanatory models in subfields of the life sciences where metabolic regulation is harnessed "to the nested times of cell cycle, circadian rhythm, life cycle and longevity." The body and sociality, now "suffused with environmental risk, regulation, and information," follows a shift "from the language and temporality of energetics to that of information and from a concern with manufacturing to the regulation of manufacturing" (2013:497).

In thinking through this transition, we are drawn to consider the timing of an informational metabolism that is produced by industrial metabolism, but comes after it. In this sense, Landecker (2013:497) writes, "metabolism is *in* history: the material of the bodies fed by an industrial agriculture and food processing system built with knowledge of (industrial) metabolism subtends these conceptual shifts." Landecker (2013:498) situates this shift in relation to "translational" research, particularly in American biomedicine, where the direction of research is from the outset a question of how it will be "translated" into application. Within this framework, metabolism has an accelerated timing, moving, as Landecker (2013:498) explains, "from knowledge to application or value"; it is knowledge that is "always already generated to be pipeline amenable."

Taken as one pervasive "end" of translational research, Landecker (2013:498) focuses on treatments for obesity, diabetes, and metabolic syndrome. Emphasizing that such research "is already framed to be applicable to metabolic crisis management or prevention," Landecker (2013:498) directs us to consider the knowledge effects of this "metabolic disorder": "the impact that the concerted practical effort to comprehend and treat metabolic disorders is having on knowledge of life" (see MacKenzie 2006).

In considering the relationship of food, time, and biology that follows the transition "from metabolism as factory to metabolism as iteratively generated interface," Landecker (2013:499) highlights a simultaneous shift in bodily timing that moves from energetics to information. I am suggesting that we might easily understand food security as another "end" of such research, another result of this shift for studies of metabolism now drawn to the timing of information.

Food as Signal: Glucose, Sirtuins, Timing, and Epigenetics

In each of the four examples that follow there is a different spatial and temporal scale of metabolic investigation. Chosen to illuminate a more general shift from industrial to postindustrial metabolism, the change in logic—from food as fuel to food as signal—points to a corresponding shift in concerns from energy (manufacturing substrate, waste accumulation, labor, and fatigue) to information (regulation, signal, functional asynchrony, sleeping, and aging). Rather than a metabolism based on calorie intake and energy expenditure, where food is evaluated in terms of its value as fuel or raw material (Landecker 2013:499; see Nestle and Nesheim 2011), diet here has a sideways functionality and a "signaling economy." What we find in each case are implications for "the material and conceptual constitution of environment," as Clough (2013:1) notes on Landecker's work, where a "multiplication of insides and outsides, rather than the deconstruction of inside and outside, is precisely what gives a new model of the body, a model of the body that replaces autopoiesis as the primary characteristic of life and replaces the organism as the primary model of the body."

The first example stresses the language and temporality that follows the shift from glucose to gene, detailed in a 2009 *Science* study of ATP-citrate lyase by researchers at the University of Pennsylvania (Landecker 2013:500–502; see Wellen et al. 2009). In this case, researchers studying cultured cells given glucose discovered that a molecule presumed to exist in the cell's body also exists in the cell's nucleus. This discovery, as Landecker (2013:500) notes, is constitutive of a reordering of our understanding of the function of molecules, "[which were once] assumed to be in the body of the cell busy converting one substance to another in order to store the energy taken in as food in transubstantiated form – glucose to lipids, for example – [but have] now also been found in the nucleus, participating in gene regulation." What's more, as this knowledge becomes part of an environment that generates the body, it disrupts the factory system metaphor and its gendered order. Metabolism is now characterized abstractly in terms of "a dynamic web of cellular signals, built by and responding to environmental information – food molecules or food pollutants" (2013:496).

Researchers culturing cells in glucose believe it to be what they describe as "an experimental image of humans in the contemporary world" (Landecker 2013:502). To stress this point, Landecker (2013:502) quotes researchers Dass, Thompson, and Vincent: "We never saw the obesity associated component of carcinogenesis until people started getting refrigerators and as they became popular we started to overeat and each generation for three generations got bigger" (see Dass et al. 2012). The changes in conceptions of the body and sociality required to make this conclusion involve bodily alterations that become more expansive to follow the therapies emerging in contemporary Western medicine. In other words, as Landecker (2013:502) explains: "[the] world, including its refrigerators, has gotten to the gene via the bodies to which contemporary Western medicine is administering: treatments for illnesses of fat are the ends of translational research, and cells cultured in excess glucose are the means fashioned to understand these illnesses." In the case of glucose metabolism, metabolic intermediaries "have a direct role in regulation of the genes involved in metabolism" (Landecker 2013:502). In other words, in terms of the body and sociality we have moved from self-sufficient genomes that cannot account for the world outside, including "refrigerators or other aspects of the human industrialized environment" to metabolism elements that "themselves can regulate the regulators" (2013:502). We have regulatory elements that, as Landecker (2013:502) explains, "carry the world into the body, because they are formed through what a body ingests."

A second example of the shift from substrate to signal involves the activation of animal sirtuin proteins in attempts to simulate biochemical substances found in plants. Sirtuins evidence an extension of "the regulatory role of metabolites to processes farther afield: cell cycle regulation, cell division, cell death, oxidative stress response, immunity, aging, and longevity" (Landecker 2013:503–504). Between the internal regulation of a diversity of cellular process and an external sensing, "via 'reading' the cell's nutritional state," there is a multiplication of intersections – the conceptual and practical articulation of the body-as-data, that is, the intersections among plant metabolism, animal metabolism, cell cycle, and life span (2013:504; Howitz et al. 2003).

With research into sirtuins we find that rather than a source of nutrients, an informational signal is attributed to plant matter relative to the animal body. This signal bears on cell fate decisions and gene expressions for the body. This research builds on the finding that calorie restriction is an effective protection against disorders that accompany aging. Mediated in the animal body by sirtuin proteins, the positive effects of calorie restriction are increased by ingesting secondary metabolites produced by plants. Therefore, academic and pharmaceutical researchers are attempting to generate substances similar to these secondary metabolites, "[s]irtuin-activating calorie-restriction mimicking substances such as resveratrol" (Landecker 2013:503). Landecker (2013:503) explains, "The hope is to put calorie restriction in a pill, to mimic the positive effects of limiting the diet by up-regulating sirtuin action, without actually dieting. In other words, signaling food shortage in a time of food abundance, deep in the cell."

Theoretical elaboration on the capacity of sirtuins to mediate the positive effects of calorie restriction is explored through the framework of xenohormesis, wherein "an animal or fungal species uses chemical cues from other species about the status of its environment to mount a preemptive defense response that increases its chance of survival" (Howitz and Sinclair, quoted in Landecker 2013:503). Researchers have hypothesized that plant molecules interact directly with animal enzymes, and have the capacity to promote health by signaling animals when stressful environmental conditions begin to emerge. Landecker (2013:503) emphasizes how this discovery allows organisms to take advantage of "food as a form of environmental information," a development that is "providing a target for anti-aging medicine for the populace that suffers an ad libitum food environment." As she notes, "it is as though we are seeking to extract and concentrate the effects of evolution in order to counter the ills of industrialization, quite literally, thinking about these objects as therapy for a populace maladapted to its modern environment" (2013:503).

Alongside these instances in which the biologies of disorders of excess glucose are developed, the timing of food intake has become a subject of research, particularly in relation to a biological "object" called the "food-entrainable oscillator" (FEO). In this case, Landecker

(2013:505) explains, “the timing of food intake, or even its rhythmicity [may] matter as much as (or more than) its substantive content or its quantity.” These studies focus on the circadian rhythms of organisms and correlate the timing of intake with evaluations of the connections perceived among sirtuin biology, calorie restriction, and longevity.

Given that most lab rodents “eat ad libitum, are not given exercise wheels or much space, and in general live the nutrient-dense, plastic-suffused lives of their human keepers,” Landecker (2013:505) notes their metabolic morbidity. FEO research emphasizes an intersection of the organism and the time of eating that is “an as-of-yet unidentified physical location in the body where the rhythmic, periodic intake of food tunes a kind of molecular clock that in turn runs gene expression in distinct cycles” (2013:505). Building on the observation that a regime of periodic feeding lengthens the lives of laboratory rodents to a considerable extent, researchers have sought to determine more precisely how FEOs make possible a “‘meter of metabolism’ that ties the timing of appetite and eating with the time of waking and sleeping” (2013:507).

The hierarchical image that the FEO conceptualizes is not one in which eating dictates the cycles for being awake or asleep, or the reverse (Landecker 2013:507). In an experiment on diet-induced obesity in male mice, when the male mice were fed a high-fat diet they began to lose their diurnal rhythm, eating during the day as well as at night. In further experiments, when food was given in limited periods, the diurnal rhythm of the mice remained robust and thermogenesis (body heat generation) increased, which prevented their suffering from certain conditions, including obesity, fatty liver, and high cholesterol. In this “meter of metabolism,” Landecker (2013:508) explains, “No one element is broken—it is a question not of mutation, blockage, or malfunction but of loss of equilibrium in the delicate balance of sleep, light, food, and body weight and perhaps even in the loss of rhythm itself.” Here then metabolism is more a matter of temporality than of the quantity of food consumed: a subject whose weight control is a matter of sleep control and vice versa.

In a final example, we are drawn to consider research on food and timing that has as its focus the nutritive milieu related to the organism's development, a milieu that has an intergenerational time span rather than being restricted to the lifetime of the individual. As part of this milieu, the pregnant body is theorized in terms of its "predictive adaptive response" to ingestions that cross individual lives. As with each of the examples described above, this involves food as signal—here with a capacity to bring to the body an exposure that manifests "as gene expression potential through the molecular mechanisms of epigenetics" (Landecker 2013:508; see also Landecker 2011). In this case, the mechanism of methylation investigated through genetic-sequencing technologies becomes a quantifiable sign of the changes that draw together "the macroscopic world of diets, wars, and social forms to the microscopic terrain of gene expression" (2013:508–509).

With methylation, food that is ingested "at one time by one individual sets off metabolic controls in another individual at another time, or the early life eating individual constitutes its own future of gene-regulatory form" (Landecker 2013:509). For example, women who were pregnant and suffered starvation during the Dutch "Hunger Winter" of 1944–1945, caused by the German blockade, gave birth to children who now have a higher prevalence of methylation, a condition linked to diabetes. We can consider as well cases where low intake of carbohydrates during the first trimester of pregnancy has been associated with the child's "altered methylation patterns in specific genes correlated with elevated adiposity at age six" (2013:509; see Godfrey et al. 2011). In mice fed diets with supplemented or depleted methyl levels during pregnancy or early in life, changed levels of gene expression and gene physiology have been found (Landecker

2013:509). In each case, alterations in the parent, fetus, or infant diet are linked to a "closure or openness of certain stretches of the genome to transcription and translation" (Landecker 2013:509). Not a linear relationship, this is a step-by-step process where pathways are interlinked such that other pathways and capacities of these pathways are affected "by the 'settings' encoded epigenetically by prior experience" (Landecker 2013:509). The paradigm shift affected through this logic, of food as signal, points to a more thorough transition from energetics, both in metabolism and political economy, to information, a shift that has as its basis developments in cybernetics.

Noting this transition in Landecker's work, Clough (2013:1) recalls the four stages of the development of automata, elaborated by Wiener in 1948, as a different model of the body was generated in relationship to each stage:

> The first is the golem, a malleable magical clay figure. The second is the body as mechanism in the age of clocks and the third is the body as a heat engine, the thermodynamic autopoietic organism. And finally Weiner described the body of the age of communication and control, the body marked by a shift in the 20th century from power engineering to communication engineering, from an economy of energy to an economy based on 'the accurate reproduction of signal.'

The use of "signal," as Clough (2013:1) stresses, makes information a cue for what the world is:

> here signal stands in for the world – say of the mother's diet cuing the in utero offspring about the world it will live in and at the same time the signal is the actual mechanism for transmitting this information and also being a trigger for the expression of this information in another time or place, another environment, such as in the gene expression in the infant all through its life or even at another time in another later generation.

Environmental factors, therefore, are not simply external changes that can be measured in the individual biological organism but rather suggest a more thorough reconfiguration of the distinction between entity and environment, whether of "the organism, a fetus in utero, a cell in a tissue, even DNA in its immediate nuclear milieu" (2013:1).

Method and Measure

Connected to these developments is a different way of theorizing the "social" logic of the body, as it is animated by digital information technologies. Classified by Clough, Gregory, Haber, and Scannell (2015:147) as the turn to the "datalogical," these authors note in particular the challenge that the coupling of large-scale databases and adaptive algorithms pose for the discipline of sociology, which "[a]s the study of social systems of human behavior, has provided a modern frame for configuring bodies, subjects, contexts or environments in relationship to the political and the economic." Understood in relationship to these technological developments, the onto-logic that the body calls forth is especially challenging to the underlying epistemology and ontology of sociological thought.

In thinking through the logic of this body, my interest is in the connection of these developments to the turn from global hunger to food security. Attributing to the discipline of sociology the "epistemological unconscious" that George Steinmetz describes, Clough and her peers (2015:147) trace how the discipline's entanglement with systems theory and cybernetics during the post-World War II years follows a turn from the operational logic of the closed system, with its presumption of "statistically predictable populations," to a logic that "override[s] the possibilities of a closed system and predictable populations, opening sociality to the post-probabilistic."

While nonrepresentational data has long influenced sociological methodology unconsciously, with the turn to the datalogical, the discipline is being "outflanked" by the processing of adaptive algorithmic data that introduces "forms" of measurement that are not mere representations (Clough et al. 2015:156). Part of a turn from representational to nonrepresentational, these authors stress how the algorithms that parse "big data" in the sciences, as well as in finance, marketing, education, and urban development, are no longer figured in relationship to numbers, a configuration that presumes a representation authorized by the observer/self-observer of social systems, in other words, the social scientist. Rather than a deployment of analogous technologies of measure, the datalogical turn points to an onto-logic for the "social," that is, a generative form of knowledge irreducible to the phenomenon of the self.

CONCLUSION

In this chapter I have outlined another way of thinking about the body and bodily capacity, one that is different from an energetic metabolism that stresses the body's capacity to do work in relationship to food as fuel or the raw material for energy expenditures. Continuing this line of inquiry, in the chapter that follows I examine how developments in cybernetics underline two different ways of thinking through the Rockefeller Foundation's longstanding interest in "scientific philanthropy." These distinctions, as I will explain, carry heavy implications for how we address the turn to food security.

Examining the contributions of liberal techniques and technologies to a global cybernetic apparatus, Bernard Geoghegan (2012) argues that new media should be understood as transcending disciplinary, ethnic, regional, and economic differences. Taking into consideration Geoghegan's view of this apparatus, specifically how the Rockefeller Foundation's interest in "scientific philanthropy" contributes to a displacement of the public and its interests onto an impartial apparatus, I suggest instead that we must account for the incorporation of nonrepresentational data that is part of the technical solution that Rockefeller and others have devised.

CHAPTER THREE

INSTITUTIONALITY AND DIFFERENCE IN KNOWLEDGE

INTRODUCTION

Technology and Liberalism(s)

If critics, historians, and philosophers argue that cybernetics and new media have contributed to the reordering of science and society, in his doctoral dissertation Bernard Geoghegan (2012) argues these scholars do not attend enough to the political stakes of this reordering. Martin Heidegger, Friedrich Kittler, and Paul Virilio stress a displacement of the distinction between human and nonhuman rather than paying attention to what Geoghegan (2012:14) calls the "technological enframement" made possible by developments in the communication sciences:

> Situating their analysis in a posthistorical moment […] these accounts accepted as a fait accompli precisely those claims and phenomena that seemed to merit critical investigation. They read more like manifestations of the problem under consideration – the attempt to construe cybernetics or electronic technologies as a rubric for global analysis – than critical reflections upon that problem.

In his description of these political and social arrangements that emerged in the early American Republic and spanned through to the mid-twentieth century, Geoghegan stresses an expanding belief in the capacity of communications to transcend the limits of the space and time of the individual human body. Publics and interests are displaced by liberal techniques and technologies; Geoghegan underscores the professionalization of the social sciences and the Rockefeller Foundation's support for "scientific philanthropy" as supports for this displacement.

But another way of reading the history of cybernetics emphasizes the "ontologic" that has accompanied new modes of communication and "Big Data," what Clough et al. (2015) describe as the datalogical turn. Exploring the connection of sociological studies of social systems of human behavior and developments in cybernetics, these authors (2015:148) suggest a longer transition from representation to nonrepresentation that is not the end of the modern but rather the intensification of measuring human populations now facilitated by digital technology.

A LIBERAL APPARATUS

False Neutrality

Geoghegan defines a technological liberalism that has as its basis the work of German political theorist Carl Schmitt and that of Richard Sennett. Schmitt's contention is that liberalism has substituted by mistake the inherently contentious elements of politics with the false neutrality of technology (Geoghegan 2012:15; see Schmitt 2007:90–91). Geoghegan (2012:17) frames the false neutrality of technology that Schmitt addresses in relationship to the truer meaning of liberalism identified by Sennett as "liberalism [that] depends upon retaining heterogeneity, difference, occlusion, and even incommunicability."

Following Schmitt, Geoghegan (2012:15) affiliates the celebration of technology with "a much older liberal search for a neutral means of adjudicating and accommodating competing interests." As evidenced in the writings of the founders and framers of the American Republic, Geoghegan (2012:22) quotes Thomas Paine's indictment of the limited capacity of language, as "incapable of being used as the means of unchangeable and universal information." If in the more classic liberal conception of communication there was a limit of government that was perceived as natural, Geoghegan's study of liberal techniques and technologies underscores how these instruments were devised to overcome such limitations.

As noted in Sennett's work, Geoghegan (2012:17) stresses the perception that "the degradation of modern liberal politics can be directly traced to the search for neutrality, immediacy and unchecked communion with all" (see Sennett 1976). Sennett (quoted in Geoghegan 2012:17) defines modern communications technologies as "both an emblem of an engine for the death of civil polity and practice," a heterogeneity Geoghegan aligns with the work of Adam Smith and John Dewey, as each argues the notion of complete access of interests among persons is obscene.

Communication technology, including the rise of the telegraph, the railroad, and photography in the nineteenth century, altered this more fundamental value for the agonism liberalism ought to protect. Geoghegan (2012:23) views these technologies as an extension of an earlier technicist framework that viewed national unity as connected to "the development of standardized, ubiquitous, and rational communications." The liberalism that he traces involves therefore an earlier transposition: when "the task of articulating and adjudicating the public and its interests was displaced onto an impartial and technical apparatus – as well as the expanding bureaucratic apparatus of experts, engineers, and professional identities charged with its maintenance – and credited it with the power to resolve difference through technological solutions" (2012:24).

In distinction from Geoghegan, I argue that the relationship of modern communication technologies ought not be understood in terms of such a transposition, of an apparatus formed by the displacement of the public and its interests from the "social" body. Instead, we should return to Foucault's (2007) 1977-78 lectures on biopolitics, as I will in chapter 4, where the body is addressed in terms of the problem of the population.

Liberal Techniques

In the early American Republic, techniques of communication including the free press, political association, and free commerce, cultivated a private, self-possessing individual for society that at the same time protected the republic against excessive "self-interest." Alongside a widening array of associations, political parties, and commercial opportunities, Geoghegan stresses a "depersonalization" that facilitated forms of interests not requiring state or governmental intervention and that were therefore self-regulatory.

Evidence of this depersonalization can already be found in the statements of the early founders and framers of the republic including, for example, James Madison's statement in 1788, that by extending the public sphere "you make it less probable that a majority of the whole will have a common motive to invade the rights of other citizens; or if such a common motive exists, it will be more difficult for all who feel it to discover their own strength in unison with each other" (quoted in Geoghegan 2012:29). Techniques that bridge a greater diversity of interests are understood as making it unlikely that a single unified position will develop among a group of people. Rather than contributing to an exchange of representations and beliefs, techniques of liberalism regulated the diversity of articulations, governing the terms of their association.

Formed from and by liberalism in the early United States, Geoghegan (2012:29) argues "negative liberty or freedom from interference" is involved with these techniques that are an articulation of the self through others, which at the same time disrupt or defer an identification of individual or self-interest with the self. As he explains, the self and political body were "ongoing productions of individuation, differentiation, deferral and re-articulation" restrained by both collaboration and communication, and elaborated through techniques like the printing press that expanded the forces of "otherness" through which self-interest was addressed (2012:31). He continues:

> In contrast to the town hall and village green, which favored face-to-face interactions, the new press encouraged the prurient circulation of voices and opinions independent of any verifiable face or human body. It supported the cultivation of parties and political alignments whose commonality was articulated by shared interest as well as shared literature. The subject-citizen, private press, and the political cause cultivated new styles of political subjects, political movements, and political writings. (2012:31)

Thomas Paine's "Common Sense" (1776) promotes and exemplifies the "emerging and characteristic American configuration of subject-citizen, private press, and the political cause" that Geoghegan (2012:32) describes as encoded into the juridical, political, and economic structure of the state. In this configuration, he explains, "passion, interest, and stripped-down rhetorical style circulated pruriently, animating face-to-face dialogues with far-away words while uniting people around opposition – occasionally to foreign governments, more often to one another" (2012:32). Technical media therefore facilitated a disruption, deferral, and delay of discourse that all at once undermined and articulated a "free-speaking subject" whose composition was the amalgamation "of words, printing instruments, juridical regimes of copyright and ownership, public and private halls of reading and discourse" (2012:33).

Deferral and the Free-Speaking Subject

Evidence that highlights how technical media is integral to the constitution and deferral of rights attributed to the free-speaking subject in the American Republic includes Harold Innis's description of the special rights afforded to the printing press by the First Amendment (Geoghegan 2012:32). Innis articulates two biases afforded to the press by this amendment. The first is an economic bias as the press carries an association to the private industry of printing. The second is affiliated with a uniformity of texts, across space and time, thought to undermine the fragility and locality of oral cultures (see Carey 2009:125). Focusing especially on the ontological nature of the latter bias, Geoghegan (2012:34) notes at the basis of Innis's critique, "a skepticism of technique that dated back to Plato's attack on the Sophists. Absent of free and spontaneous speech, there could be no freedom of expression."

But what Innis views as undermining freedom of expression, the private ownership of the printing press and the permanency of print, which undermines more local and immediate oral culture, are understood by Alexis de Tocqueville in different terms. De Tocqueville claims these techniques as a positive opposition to tyranny: "I do not see freedom of the press in the same way that I consider *patriotism* or *virtue,* for example. I love it much more from consideration of the evils it prevents than for the good things that it does. … Liberty cannot live without it and order can hardly be maintained with it" (quoted in Geoghegan 2012:35). Undermining the biases of presence and provincialism, the printing press is perceived by de Tocqueville as an operation against tyranny.

Geoghegan defines this fixed aspect of print, its delays and deferrals in the delivery of private ownership and the vested interests of the individual, as a technique of liberalism. Drawing on de Tocqueville, Geoghegan (2012:36) notes the rationale behind such a technique without which public opinion might fall into dangerous hands.

From Techniques to Technologies

The transition from techniques to technologies of liberalism, including the railroad and growth of social science, follows perceptions among political leaders in the United States of the limited scope and power of liberal techniques. Growing awareness of these limitations led to the promotion of an infrastructure project, what Geoghegan (2012:36–37) describes as technologies that would increase a circulation of “good, words, and human bodies.”

Countering the suspicion of the state and of centralization that persisted in the early nineteenth century, Thomas Jefferson proposed that infrastructure would amplify and extend the autonomy of local communities. The Jefferson administration’s proposal for developing an infrastructure under the control of the federal government was an exercise “in the name of individual and local interests that, if furthered, would promote national and collective well-being. … Good roads and canals facilitated the pursuit of commercial interests and interpersonal exchange. Unity through civil engineering furthered the ideals of local, private, and regional autonomy, rather than abridging them within a central state (Geoghegan 2012:37).

Viewing this proposal as evidence of a new technological disposition of the nation, Geoghegan notes historian David Nye’s (1994) description of the construction of the Erie Canal between 1817 and 1825 as “one of the most potent early expressions of the belief that ‘sublime technological objects … were active forces working for democracy’” (2012:38, quoting Nye 1994:33). Rather than an object that affirmed the powers of government, these works affirmed a technological wonder of “the exceptionalism of the people and the prospects of democratic cooperation,” and with this wonder there “resounded … the promise of semi-private and democratic labors” (2012:38). Geoghegan (2102:38) writes:

> Nye quotes a newspaper which claimed that the canal’s opening provided proof “of the capabilities of a free people, whose energies, undirected by the absolute authority, have accomplished...a work of greater public utility than the congregated forces of Kings have effected since the foundations of the earth” (1994: 36). The key to this new power, and the public it revealed, was its strategic enlistment of engineering: between the state, the people, and the public, technology intervened to express the will and interest of all.

Systematization of Interests

Though careful not to suggest that an emerging belief in a systemization of interests can be attributed to the development of machines, Geoghegan (2012:38) argues this transition returns our attention to arguments from the works of Schmitt and Heidegger, on the modern and technical iteration of *logos* (see Heidegger 1977). Further illustrative of this transposition, Jacob Bigelow's work from 1828, entitled *Elements of Technology*, describes how a systematic and synthetic application of the arts gained its legitimacy from the rationalizing power of the modern sciences (Geoghegan 2012:38).

Emphasis placed on the word "elements" in Bigelow's title is intended to stress a synthetic process that for Bigelow describes how varying domains are brought into a relationship of continuity and coordination. Such domains included writing, printing, engraving, lithography, architecture, building, heating, ventilation, illumination, locomotion, horology, and metallurgy, now understood in terms of operations afforded a singular logic. Noting how attempts to separate the sciences from the arts were not absolute but rather comparative, the task of overcoming such distinctions, particularly for "human knowledge," is valued precisely in terms of this possibility: "of these elements' integration to the modern logos par excellence: writing and the printing press" (Geoghegan 2012:38). He continues:

> Writing, [Bigelow] argued, had liberated knowledge from the individual body and made it available to a community of practitioners distributed across space and time. Printing, in turn, enabled the first steps towards a science. "This art [printing], which was to give permanency to all the rest ... seems to be at the root of all human knowledge," Bigelow averred. He predicted that the nineteenth century would realize the final systematization of science, art and industry. (2012:39; see Bigelow 1831)

Technology is made to embody an application of science to practice defined in terms of a fulfillment of "human destiny that enabled communications across time, space, bodies, and which took gradual steps towards achieving the 'absolute'" (Geoghegan 2012:39). If support for the private, autonomous individual began to lose authority after the 1850s, this was in no small way due to an inefficacy of the public sphere based on the exclusion and marginalization of large segments of the population. Evidence of the "distended society" emerging during the latter half of the nineteenth century described by Robert Wiebe (1967), stresses how unification of the nation during this period was formed around "a set of divided and opposed communities of interests … depending on your perspective, either of the realization or the undoing of techniques of liberalism" (Geoghegan 2012:14).

Those systematically excluded from main avenues of communication, segments of the populations denied access to suffrage, literacy, and representation, in addition to the right to carry on a business or to sell labor and travel, were not the only ones dissatisfied with existing liberal schemas. As Wiebe notes:

> Remote interests driven by towering corporations, national markets, and national communications networks overwhelmed the calculus, autonomy, and foresight of the autonomous individual. Industrialization and immigration gave rise to ethnic and economic ghettoes and an organized labor movement, as well as a small class of inconceivably wealthy industrial magnates. White middle- and upper-class Protestants identified both groups with the threat of factionalism and tyranny. (quoted in Geoghegan 2012:40)

In this context, a growing dissatisfaction among citizens from all classes is understood in relationship to a liberal schema organized to exacerbate and displace competing interests, as such dissatisfaction was perceived to carry disadvantages for each group's personal and collective interests. Technologies of liberalism that emerged on the scene—the rise of railroads, telegraphy, radio, telephony, industrial communications—promised "to 'extend the sphere' sufficiently to take in 'the greater variety of parties and interests' generated by modern liberalism" (Geoghegan 2012:41). But accompanying these promises were the means of neutralizing such interests.

Developments in industrialization, of the national railroad networks and national communication, while driving the growth of national and financial markets, are understand as facilitating a shift of power away from local communities. As Geoghegan (2012:44) explains, these shifts "drove the development of centralized bureaucracies, national markets, standardized labor rates, and professions charged with governing labor," at each instance fostering the substitution of personal rivalries among individuals with an apparatus of regulation and control thought of as impartial and technical.

LIBERAL TECHNOLOGIES

The Railroad

On par with these shifts, the railroad was celebrated among members of professional political classes for its promise to bridge the regional differences of the nation. As noted in the declaration of Daniel Webster, speaking in 1847 at the opening of the Northern Railroad in New Hampshire, calculations of the value of the railroad were correlated with an equalization of the conditions of men. Geoghegan (2012:44) describes the equality afforded by such technology in terms of its capacity to cram together rich and poor into a single vehicle that "maximized speed while minimizing cost, and abridging distant locals."

Treated in contrast with the personal liberty afforded to federal roads, Geoghegan (2012:44) highlights the technical constraints that were made to accompany a new medium of communication: "private networks." Not limited, however, to the transportation of goods and people across the United States, explanations of the railroad as a technology of liberalism point to its influence on technological innovation. We see through the growth of the railroad the way innovation becomes a technology that carries along with it "a definite set of juridical, professional, and spatial practices crafted around [the] free market" (2012:45).

Until the 1880s, innovation for the railroad was a patchwork of inventors, engineers, salesmen, and railway corporations working in "parallel and overlapping systems of innovation, often duplicating one another's efforts"; meanwhile, patent laws during this time continued to be based on the concept of a single inventor (Geoghegan 2012:46). But this model was ill suited for the kind of technological innovation that the railroad produced. As Geoghegan (2012:46) explains, a "juridical notion of invention and ownership modeled on the ideal private individual of liberal techniques did not correspond with the reality of collective labor and technical innovation in an age of techno-industrial communications." Court dockets were clogged with lawsuits during the 1870s and 1880s charging railroad corporations with patent infringement. When these cases threatened to bankrupt corporate enterprises and to shut down regional railways, a resolution was devised that redeployed both labor and law to insure technological innovation might proceed unencumbered (2012:46).

Systemic Innovation

In response to the glut of lawsuits, Geoghegan notes that railroad corporations began to limit innovation to closed laboratories. By making innovation a matter of professional association, licenses could be established, thereby making the dissemination of innovation more systematic. Accompanying these associations, reforms in patent laws protected the interests and practices of these large technical systems, reforms devised to protect corporations against claims that might be lodged by individual investors. Only after these legal "innovations" did railroads truly become technologies of liberalism:

> Intensively, the railroad industry itself had become a rapid and logical system for standardized transmission (of innovations). Extensively, the haphazard patchwork of regional railways began a new process of national standardization that enabled the standardized integration of time and space via a single network integrated according to shared technologies of communications. (Geoghegan 2012:47)

By no means was the railroad the only technology of liberalism to arise during this period (others noted include the rise of professions, the development of a modern commercial press, new patterns of bureaucracy and management, and spiritual practices). However, Geoghegan (2012:47) views the railroad as exemplary in that it evidences a transformation of "a disciplined series of techniques that, under the banner of freedom of free communication and rational or systematized techniques, re-aligned the individual with a technical logos that transposed the contradictions of social and political life."

In this way, Geoghegan's (2012:35) argument stresses a broader shift, from the techniques he affiliates with the early American Republic, techniques that "gave liberty occasion and space to live," to the modern commercial press that exists today. Liberal techniques have not disappeared; instead, they gave way to the technologies that exist today.

> The press did not fade away. Its importance as a local and situated technique of sustaining and producing a liberal order persist to this day, albeit supplemented by a modern commercial press whose series of wire services, collating and distributing news across regions, and patterns of hierarchy and ownership comprise a parallel technology of liberalism. (2012:48)

Between the press and its modern commercial predecessor, the railroad is viewed as a technology that was instrumental to the engine of growth that governs American life, of a standardization that was developed for labor, prices, and subsequent technological developments.

Social Science

By way of noting the problems generated by the railroad, including labor strife, corruption, ethnic antagonism, class inequity, "moral decay," social dislocation, and the decentering or distention of local life, Geoghegan describes a second technology of liberalism. Calibrated to new scales of dissonance and difference and new forms of technical, technological, and economic "development," this liberal technology is the professionalization of the social sciences.

This technology was brought on by the increasing factionalism in American life during the nineteenth century, facilitated in part by the development of the railroad as a form of technological innovation. While the technological capacity of the social sciences was not exclusive to its development in the United States, as a professional class the development and purpose of the American social sciences is distinct from its developments in Europe (Geoghegan 2012:49).

Alongside the disciplinary development of the social sciences, consensus was growing among the educational elite in the United States, in opposition to both the violent tendencies of left-wing activism and the greed and power of industry barons. To this elite, Geoghegan (2012:50) attributes an understanding of society that was "allied or driven by techno-logic amenable to description and adjustment by professional experts." As Dorothy Ross argues, "the rise of sociology, psychology, anthropology, economics, and other fields of social science was driven by the search for professionalism and impartial techniques that would furnish liberal solutions to pressing issues" (quoted in Geoghegan 2012:49; see Ross 1991).

The appeal for the systematization of social sciences aligned US universities with private capital and industry with researchers who borrowed "modes of reasoning, analysis, and representation from industrial management. … Academic societies for the systematization of social scientific technique sprang up. Leaders championed the development of empirical methodologies devoid of partisan rancor. Social scientists were to be engineers that studied societies as rational systems suitable for technical and harmonious optimization" (Geoghegan 2012:49). With new attention focused on how society is conceptualized, Geoghegan stresses how society was reconceived in and through communications (2012:51). Departing from Geoghegan, rather than suggesting that differences among members of a society are neutralized through communications technology, I mean to suggest that such differences contribute to a reconfiguration of the "social" body that is becoming datalogical.

"Society in and through Communications"

The spirit of this expression of social science is drawn from the work of philosopher C. S. Peirce, whose interest in professionalism, science, experimentation, and communications, as Geoghegan (2012:51–52) notes, "was very much in the mold of the late nineteenth century social scientific mindset." Though often remembered for his work in founding semiotics, Geoghegan stresses that Peirce's work was deeply influenced by the context of industry, the sciences, and the politics that contributed to such work:

> In an age when a baffling array of images, signals, and forces seemed to confer complete disorder on the everyday, Peirce believed in the possibility of a practical, applied science of signs, beliefs, and images. His project in semiotics was only a small part of this project. He advocated for the cultivation of an apparatus of laboratories, experimental methods, and scientific communities bound by technical vocabulary as an alternative, or at least a supplement, to the blinkered reflections of these traditional and contemporary authorities. (2012:52; see Peirce 1955)

In the fields of sociology and economics we find even more radical understandings of the relationship of society and communications. For example, in a seminal book entitled *Social Control* (1901), American sociologist E. A. Ross, who based his analysis on the French concept of *contrôle*, uses this term to point to the positive condition of liberty that is constituted in sociological and political contexts (Geoghegan 2012:53; Ross 1901).

> For Ross, "social control," designated varieties of communication and feedback that played a productive role in social life. He was not interested in the control of society, but rather how society itself was composed of immanent mechanisms of control. Aberrancy was to be corrected by strengthening the internal and communicative bonds *in society* rather than through the imposition of authoritarian or violent controls by a sovereign or police force that acted external to society. (2012:53)

A corollary of this understanding of control, whose focus is the "improved means of communications," is an embodiment of liberalism that underscores the "free" market as a support for "free" scientific inquiry, as these endeavors are understood in relationship to "ever 'freer' communications among the populace" (2012:53).

Ross's "social-equilibrating apparatus," which was imbued with the capacity to consolidate members of society into a unified social body attuned to the well-being of mankind, is joined to Charles Henderson's work on "The Scope of Social Technology" by Geoghegan (2012:53; Henderson 1901). For Ross, the well-being of society was achieved through a rapid circulation of sentiment. A variation of what Ross called "the social-equilibriating apparatus," it is a technology described by Henderson, a sociologist at the University of Chicago, as "a system of conscious and purposeful organization of persons," which facilitates for all members a true place to be found in an "actual, natural social organization" (Geoghegan 2012:53–54; quoting Henderson 1901).

Similar to Bigelow's understanding of techniques whose practical purpose suggests a natural unity, Henderson articulated a "true social technology" that could be applied to public sanitation, free markets, and organized communities for the appreciation of art and marriage (Geoghegan 2012:54). More still, these technologies were offset against signs of malfunctioning technologies such as deviancy, crime, and class struggle. Therefore, the task of the social scientist was, in part, to "recast society in the form of a true social technology" (2012:54). Problems like economic inequality and ghettoization could be extracted from the realm of politics, and, through social technology, re-inscribed "within the sanitized space of social scientific theory and reflection" (2012:54).

> The concepts of a social-equilibrating apparatus and social technology transposed the often diffuse and speculative claims associated with the technologies of liberalism onto a concrete program for scientific and social reform. No longer were technologies mere instruments for articulating society: society itself was a technology. (2012:54)

In this way, the redevelopment of American society as a liberal technology is based on scientific developments, facilitated by the professionalization of the social sciences, now "a system of uniform techniques freely communicated among supposedly partial practitioners" (2012:54).

SCIENTIFIC PHILANTHROPY

Technological Solutions

Contributing to the theories and methods for a social technology elaborated by American social scientists during the early twentieth century was the program of "scientific philanthropy" developed and instituted at the Rockefeller Foundation. Not quite yet a liberal technology, Geoghegan (2012:57) suggests the Rockefeller's vision for scientific philanthropy lent a programmatic value to the speculative projects of Ross and Henderson. What the speculations articulated by Ross and Henderson required were successors who could translate this vision for technological and political progress for institutions, technologies, laboratories, and scientific communities, as Geoghegan (2012:56) notes: "Just as each new liberal technology seemed to transpose and re-arrange the faults of its predecessors, it might also be said that every technology of the present dreams into being successors that would perfect it." Throughout the 1880s and 1890s, many Americans including large numbers of the educated class began to view technological and political progress as mutually constitutive, and with the development of scientific philanthropy there began to emerge an apparatus that could translated these requirements for institutions, technologies, laboratories, and scientific communities (2012:57).

At the dawn of the twentieth century, John D. Rockefeller and Andrew Carnegie expressed their explicit commitment to founding a form of social philanthropy that would "redistribute the benefits of industrialization without resorting to state intervention" (Geoghegan 2012:57–58). The founders of these institutions, working in consultation with experts in science, industry, and government, began to develop an apparatus devised from diverse institutions including libraries, universities, museums, laboratories, and centers of social work, an apparatus that embraced this task of readjusting a troubled population. As Geoghegan (2012:60) notes, "In the face of ethnic strife, economic stratification, and the development of labor, anarchist, and socialist movements, these wealthy institutions proposed solutions for curbing the worst inequities while leaving existing economic and political structures intact."

Reconfiguring the "Social"

Other social critics have argued that the Rockefeller Foundation and other foundations established during the Progressive Era were founded on the premise that private support for the sciences by philanthropic interests could promote non-state solutions to social and political problems. For Geoghegan, however, such projects are neither hegemonic nor ideological. He writes that Lily Kay (1993), Mark Dowie (2001), and Giuliana Gemelli (2000) have argued these philanthropic projects primarily involve a redirection of "the forces, values and resources of a wealthy industrial elite towards social reform, while masking or suppressing critical politics through recourse to a technocratic elite" (Geoghegan 2012:60).

In these works, the focus on culture, values, and hegemony obscures from our view the impersonal mechanisms of a technical content "nominally substituted" for ideological values (Geoghegan 2012:61). Attending more to a moral rectitude that is emphasized by proponents of scientific philanthropy and emblematized in the development of an apparatus for impersonal gift giving, Geoghegan (2012:61) stresses "a cultural technique of giving that transformed benefactor and beneficiary alike through the construction of sociotechnical ensembles." Although hegemony and ideology are identified as playing some part in the emergence of these ensembles, the set of techniques and technologies utilized involves a redistribution and reconstitution of the social body (2012:61).

The concept of scientific philanthropy can be traced to Andrew Carnegie (1900) and his well-known essay, "Gospel of Wealth," in which he argues that affluent members of society have an obligation to use their wealth and powers of administration. Intended to counter the influence of progressive politicians and socialists who might "sap society of its productive power," Carnegie envisioned a flexible apparatus that could turn public and political problems into "semi-private and technical problems to be handled by an array of experts … [thereby cultivating] a new class of citizen that was entrepreneurial, rational, and industrious" (2012:62).

If at the Carnegie Foundation these ideals remained indistinct, the Rockefeller Foundation perfected this vision in an apparatus comprised of “administrators, institutions, endowments, public-private partnerships, and ‘expert’ givers and receivers of funding” (Geoghegan 2012:62). Such an apparatus transformed the relationship of philanthropy and policy to collective and personal practices on agriculture, education, hygiene, and other programs in the United States and abroad (2012:62–63). Pointing to the 1913 charter for the Rockefeller Foundation, Geoghegan (2012:63) notes its charge, “with further ‘promot[ing] the well-being of mankind throughout the world,’ and programs [that] put a priority on solving ‘realistic’ and ‘practical’ problems such as hygiene via the efficient administration of social programs.” Support for exceptional and entrepreneurial scientific researchers was henceforth viewed as a part of a mechanism for enhancing, through global communications, the market-friendly values of progressivism, tolerance, and openness, the shape of which Geoghegan attributes to two foundation administrators: Raymond Fosdick and Warren Weaver.

Raymond Fosdick’s Social Scientific Reforms

Noting Kay’s (1993) description of Fosdick’s disposition as “authoritarian in nature,” Geoghegan (2012:64) comments, “[i]f ‘authoritarian’ means an endorsement of strict obedience to the state or to a strong sovereign at the expense of personal freedom, then the critique is misplaced.” Affiliated with the foundation for more than three decades, including a term as president from 1936–1948, Fosdick synthesized and brought a global scope to the diverse agendas that the foundation straddled from the early- to mid-twentieth century, including policing. But rather than a mechanism for state-based authorization, Geoghegan (2012:64) explains, “[f]or Fosdick and his patrons, studies in policing were part of a broader effort to determine the mechanisms that enabled individual autonomy." On this point, we should note that Fosdick viewed the police as a social body charged with protecting the personal property and constitutional rights of individuals. Exceptions to constitutional rights were made for suppressing union laborers who occupied factories or others kinds of challenges to industrial production, as such suppression signaled the rational and scientific potential of the police force to "help society and industrious individuals reach their full potential without interference from their fellow man or the government" (Geoghegan 2012:65).

With tendencies similar to those of his nineteenth-century predecessors, Fosdick perceived a direct correlation in the United States between the elevated crime rates and "large numbers of foreign races, uprooted and often adrift" (quoted in Geoghegan 2012:65). The role of the police in response to this problem was "to develop techniques to recognize, navigate, and discriminate among ethnic and racial proclivities without resorting to prejudicial or nativistic impulses" (2012:65). Fosdick believed such a technique or technology for policing would elevate its practice. The response to the problems facing the police force in the United States required what was referred to at the Rockefeller Foundation as "social hygiene," or programs that would "root out the irrationality of prejudices organizing social institutions and put in their place efficient and systematic techniques that reflected the science of their age" (2012:66).

Like contemporaries Walter Lippmann and John Dewey, Fosdick viewed global order and global communications as intimately connected. If a proliferation of global communications threatened to undermine the autonomy of local, individual citizens now subjected to "the capricious effects of remote political events," Fosdick viewed the League of Nations as an outcome of such developments and their proper response (Geoghegan 2012:67). An outgrowth and embodiment of mechanical developments from the previous century, the league administered a proximity among individuals introduced by global communications technology (2012:67). Fosdick spoke of "[o]ur machine civilization [that] has wired the world together in a vast, intricate circuit; the electric spark that starts anywhere on the line will travel to the end" (quoted in Geoghegan 2012:67). Modern civilization was seen by Fosdick as "vast nervous system" (quoted in Geoghegan 2012:67). He warned, "[w]hen shock comes it grows in the process of transmission, carrying its reactions to all the cells of the body. … It is this very unity, this solidarity, that threatens the future" (Fosdick quoted in Geoghegan 2012:67).

Fosdick's general fondness for systems was expressed alongside an ambivalence towards the systematization of communications. He distrusted the solidarity and unity of global communications, believing that such avenues of public opinion also carried "anti-liberal tendencies that threatened any model of democracy organized around self-possessive individualism" (Geoghegan 2012:67). Like other "realist progressive," Fosdick believed that rather than turning control or decision-making over to the masses, "public opinion" was a device for social control, "usurped from the individual and the demagogue and refashioned … to remain an important tool for elites and an object for scientific investigation" (2012:68; see Fosdick 1929: 50-51). Geoghegan explains, "Elites would act as the stewards of the public will, while expert scientists enabled by every modern technique of investigation and instrumentation would identify the best way to optimize a truer democracy" (2012:68).

Warren Weaver's Rational Human Subject

While Fosdick's contribution to the Rockefeller Foundation included these broader reflections about the role of science in reforming society, Geoghegan (2012:69) describes Weaver's contribution in terms of "the styles of patronage, collaboration and policy advising that came to define much of postwar American science." Director of the Natural Sciences Division at the Rockefeller Foundation from 1932 until 1955, Weaver developed a theory of society and social order that, based on the scientific method, could be used to make subjects and citizens of a particular kind: "restrained, reflective, and circumspect, open to input from others and resistant to passion and demagoguery" (Geoghegan 2012:69). As Geoghegan (2012:69–70) describes this, "[Weaver] argued that the scientific method cultivated 'objectivity, mental honesty, tolerance for other view points, a calm suspension of judgment, a willingness to abandon tradition, a desire to scrutinize basic assumptions, an unprejudiced passion for verifiable relationships'."

In a 1933 memorandum from Weaver entitled "The Benefits of Science," for example, he underscores that the scientific method could be used as "a prophylactic against political instability" (Geoghegan 2012:70). Weaver writes:

> It is claimed … that in the record of history nothing is more typical of or more closely associated with the emergence of intelligence than the growth of the scientific spirit. It is claimed that there is no more effective enemy of passion and prejudice than the calm temper of the scientific mind. (quoted in Geoghegan 2012:69)

A form of social engineering drawn from support for science and the scientific method would permit the development of "cadres of scientists" (2012:69). Part of this social engineering involved "a stoic overcoming of the self" that, Geoghegan (2012:70) stresses, was not only a different kind of self but a different sociality all together. If united in their impersonality, scientists might promote a "world-wide fraternity," and Weaver aligned this capacity with the founding principles of the Rockefeller charities: "that science offered the surest mechanisms for global governance" (2012:70).

TECHNICAL SOLUTIONS

The "Epistemological Unconscious"

But there is another way of addressing the liberal techniques and technologies that Geoghegan describes. Rather than stressing a concept of universal communications that is characterized by an aspiration "to overcome the limits of time, space, and the human body," I will describe a scientific engagement with uncertainty. This engagement belongs alongside Clough and colleagues' (2015) discussion of a datalogical drive that is overriding the logic of the closed system. This work, which views phases of cybernetics in relationship to U.S. sociology and method, returns to Steinmetz's (2005) suggestion that we view the focus on methodological positivism in U.S. sociology as part of the discipline's "epistemological unconscious."

Following the rise of the Fordist welfare state after World War II and the transition to post-Fordism that began to emerge in the 1960s and 1970s, Steinmetz suggests that the emphasis on regulation theory in U.S. sociology contributed to the methodological foundations of the discipline while at the same time facilitating a state-based complicity in managing the accumulation of capital during this period. Referring to this entrenchment in methodological positivism as the discipline's "epistemological unconscious," Steinmetz observes that even as non-positivist methodological approaches began to emerge in the 1970s, approaches that resonated more with the conditions of post-Fordism, these did little to upset the discipline's staunch orientation to positivism and its foundation in empiricism (see also Clough 2009).

Closely observing Steinmetz's discussion of the discipline's "epistemological unconscious," Clough and her colleagues note an entrenchment of the discipline in methods that return to the figure of the human subject alongside iterations of systems theory emerging in the field of cybernetics after World War II. Treated together not as causal relationship but instead as an entanglement, these authors trace a transformation in sociality emerging during this period "from an operational logic of closed systems and its statistically predictable populations to algorithmic architectures that override the possibilities of a closed system and predictable populations, opening sociality to the post-probabilistic" (Clough et al. 2015:148). Describing this as the turn to the "datalogical," affiliations of this entanglement are noted alongside the challenges to empiricism posed by new modes of computation and "Big Data."

If uncertainty has long driven the attention granted to elements of society that are observable, Clough and her colleagues (2015:147) note that uncertainty is becoming automated through algorithms capable of "allowing for indeterminacies in the capacities of programs to reprogram their parameters in real time." When considering how these capacities bear on liberal technologies, we begin to see a sociality of the body that is different from the neutrality and rationality the Geoghegan attributes to a technological liberalism. Instead, for technical solutions like food security we should attend to the nonrepresentational knowledge that is called forth by data processing, data that, as Clough et al. (2015:148) stress, ought not be confused with the representations "authorized by an observer/self-observer of social systems of human behavior."

Methods and Correlations

In the 1950s, there was an understanding that the maintenance and capacity of the social system should be understood in terms of a social reproduction or "in terms of a boundary—that which marks the outside of a system" (Clough et al. 2015:149). Identified with a regularity of the interactions that were understood as part of the constitution of the system, the boundary between the inside and the outside of the system was subject to modeling that allowed its behavior to become predictable at the level of statistical populations. As Clough et al. (2015:149–150) explain:

> Aspects of sociality outside of the system are "made static" turned into control variables in order to see the patterned movements of the experimental variables. This movement, if repeatable, could be translated into durable predictions about behavioral dynamics that are technically expressed as the statistical probabilities of populations.

These correlations made possible by statistical modeling depend on a single factor, a system that is relatively closed. Sociologists affiliated with systems theory, and in particular with Talcott Parsons, have viewed sociality in precisely these terms, emphasizing that "both the biophysical or the organic and the sociocultural are self-contained systems driven to evolutionary reproduction" (Clough et al. 2015:149). Only a sociality organized into discrete systems that remain closed to the outside permits the forms of knowledge captured by statistical models.

This model of inquiry depends of the same epistemological orientation assumed in first-order cybernetics, as Clough and her collaborators explain. Similar to the way inquiry is framed in sociology, cybernetics preserves a duality between systems that is based on a distinction between "the systems to be observed and the apparatuses of observation" (2015:152). The same duality exists in sociology, noted in terms of methodological distinctions between the observer and the observed. That is, a separation is defined "between a stable researcher on the one hand and a systematized research environment of human behavior on the other" (2015:152).

More still, in addition to these similarities in how inquiry is framed, second-order cybernetics and more "reflexive" sociological methods developed during the 1970s attempted to correct problems posed by making the construction and networking of a machine, organism, or system apart from its interactions with an outside environment. Conceptualized in sociology and cybernetics as "autopoiesis," corrections to this problem typically stress the identification of the researcher and the researched in "methodologies such as autoethnography and textual analysis

[that] would demonstrate that, in an autopoietic system, the researcher cannot stand outside the system and observe its feedback loops" (Clough et al. 2015:151). As part of the system's feedback loop the researcher's input becomes part of the self-organizing functioning of the system.[11]

In sociology, debates between those who adopt a more positivistic approach and those who insist on reflexivity are recurrent. But, as Clough and her colleagues (2015:151) stress, these approaches are not so different after all: "[B]oth rely on the figure of the human subject, and the insular, thermodynamic system. In both cases, the role of the observer is one of calculated disturbance and translation." Thus on both sides we find an articulation of the human phenomenological subject.

Similar to the mode of reasoning these authors describe part of what is missing from discussions about food security is the "redistribution of the technologies of collection and analysis of 'social' data away from the academy" (2015:153). This redistribution, they argue, "[is] challenging empirical sociology, if not putting it into crisis" (2015:153). Noting the datafied terrains that human lives continually pass through, and data collection processes that are now distributed, albeit unevenly, throughout the world, everyday behaviors "such as making a phone call from a cell phone, using a mobile devise to access the internet, clicking through web links, swiping a credit card to make a purchase, or even visiting a hospital or accruing a speeding ticket have now become dynamic sites of data collection" (2015:153). By noting this relationality, I mean to suggest that we be more wary when scholars referencing such processes suggest they be

[11] As Clough et al. (2015:151) note, this idea was "[m]ost famously translated into sociology through Nikolas Luhmann's systems theories (1996), [but] the concept was more broadly used as a theoretical and methodological guide amongst so-called post-modern or critical theorists and researchers of the 1970s and 1980s."

viewed as representations of the social.

As Clough and her peers (2015:153) argue, for these processes "it is those data that are typically bracketed out as noise in sociological methods—i.e. affect or the dynamism of nonconscious or even non-human capacity—that are central to the datalogical turn." In other words we should think of this turn as a move away from the correlations that Geoghegan attributes to liberal technologies, that is, as a depersonalized representation. The datalogical is an engagement with uncertainty that is reconfiguring the body alongside new understandings of productive capacity.

In the following chapter, I note how elaborations of this apparatus share more in common with the apparatus of security that Foucault (2007) describes in his 1977-78 lectures on biopolitics than with the cybernetic apparatus to which Geoghegan points. However, in making this distinction I will begin to note some of what this apparatus portends for a neoliberal subjectivity, objects, and institutionality by addressing Michel Feher's (2009) work on self-appreciation.

Techniques of Self-Appreciation

Drawing our attention to the conditionality of liberal capitalism as distinct from that of neoliberalism, Feher (2009:23) notes how our freedom to rid ourselves of the resources we own, whether such resources are of capital or labor power, underscores that "liberalism can legitimately claim to be a humanism [because] it never confuses what we are with what we own and therefore never treats us as commodities that can be appropriated." This freedom of dispossession has as its basis this distinction of needs and aspirations that are irreducible to interests. As Feher (2009:23) explains:

> In other words, liberal capitalism recognizes and even presupposes that we do not grow spiritually rich in the same way we acquire material wealth. The difference between the two kinds of growth is an essential feature of the liberal condition insofar as the latter predicates the reproduction of subjects who will make good use of their natural propensity to optimize their interests on various forms of nurturing through which disinterested care is both provided as emotional nourishment and morally valued as a necessary complement to profitable endeavors.

More than a complement or supplement to the market, in liberalism the human subject is defined in relationship to this distinction "between the negotiable and the inalienable" (2009:24). Such distinctions between the subject and the commodity must be clear in order to address the moral dignity and political sovereignty of the liberal subject.

Noting incidences when this dual conditionality has been appropriated by members of the labor movement, Feher considers how the alienation of free laborers refers to both their inability to direct their lives when the means of production and its output belong to others as well as to laws and ideology that rob workers of "the consciousness of their exploitation (since they are invited to consider themselves as owners of their labor power and thus as subjects endowed with a freedom that is equivalent to that of their employer)" (2009:24). Therefore members of the labor movement have sought to raise the price of labor power while at the same time criticizing working conditions that violated "the essential distinction between man and commodity, between the laborer and his inalienable dignity and the labor power that he or she owns and rents out" (2009:24).

But these victories achieved by the labor movement are in no small part due to their ability to inhabit dual forms of appropriating the figure of the free laborer from within. The split being of the free laborer refers to both an inalienable subjectivity and his or her labor power. Such a split implies "the reproduction of a society of free laborers (i.e., its biological, social, cultural, and moral reproduction) and the production, circulation, and consumption of commodities" (Feher 2009:29). Added to this, liberalism requires a distinction of spiritual aspirations and material interests, of the commensurable and incommensurable. In this division there is an implied distinction between principles and values that belong in the market and those that exist outside of the market.

But when love, religion, and culture are no longer beyond the realm of the calculable and become figured in terms of interests—in the feelings of divine charity, parental and spousal devotion, social and national solidarity, and love and compassion for humanity—we find the subjectivity of neoliberal capital, of human capital. Noting crises wrought by the Fordist socioeconomic compact on "the bargaining power of labor vis-à-vis capital," Feher (2009:25) addresses this turn of the "decline of the type of free laborer and its gradual replacement by a new form of subjectivity." In a neoliberal political economy, the subjectivity of human capital is defined in terms of motives towards self-appreciation wherein seeking to value the self becomes a survival strategy.

As all behaviors and events are viewed in terms of their capacity for appreciation or depreciation, governance becomes a matter of acting on the way that subjectivity is already governed "by inciting [persons] to adopt conducts deemed valorizing and to follow models for self-valuation that modify their priorities and inflect their strategic choices" (2009:28). In that human capital does not presuppose a separation of the spheres of production and reproduction, all the various things we do "in any existential domain (dietary, erotic, religious, etc.)" are viewed as additions or subtractions of human capital (2009:30).

More than a commodification of everything and everyone, noting Foucault's view of human capital, Feher (2009:30–31) explains that "neoliberalism in fact treats people not as consumers but as producers, as entrepreneurs of themselves or, more precisely, as investors in themselves, as human capital that wishes to appreciate and to value its skills accordingly."

CONCLUSION

To further this line of questioning that considers how the body should be addressed as a matter of food security, in the following chapter I take up the forms of growth Melinda Cooper (2008) describes in her account of a neoliberal political economy. Cooper emphasizes changes in trade relations and developments in intellectual property that, once calibrated to economic growth for the welfare state, now constitute a reorganization of the relationship of industry and science. Faced with the limits to growth outlined by the Club of Rome's world futures report in 1972 (see Meadows et al. 1972), members of the new right charted a radical restructuring of the U.S. economy: moving heavy industry offshore and investing in biological technology at home. This conjunction of interests had a particular result, Cooper explains, forcing risks once mediated by the welfare state to be absorbed by the body of the liberal human subject.

Pointing to Foucault's (2008) 1978-79 lectures on biopolitics, Cooper views the growth of the biosciences in relationship to the labor of the liberal, human subject. I will read Foucault in a different direction. Foucault's (2007) description of governance under neoliberalism can also be read to illustrate how the management of populations relies on forms of labor more affective than reductive to the body-as-organism, in terms of the body-as-data.

CHAPTER FOUR

SECURITIZATION, THE BODY, AND TWO NEOLIBERALMS

INTRODUCTION

Aligning her study of neoliberalism with economic models influenced by complexity and chaos theory, Melinda Cooper (2008:65) describes a "new security agenda" that is joining the separate spheres in the United States previously afforded to civilian and military life. Part of this agenda are the rhetorical forms of violence found in discourses on biological security as well as the humanitarian concept of "complex emergency," an emergency framed as "simultaneously against the United States' own underclasses and those of the developing world" (2008:12). Different from the state of exception that Giorgio Agamben (1998) points to and the state of immunity that Roberto Esposito (2002) describes, both of which are figured in relationship to the sovereign's exercise of power, for Cooper the new security agenda directs us to the speculative logic of financial capital that is now defined in connection to an accumulation of biological futures.

Paying close attention to the body that Cooper addresses, particularly as it is framed in relationship to Michel Foucault's (2008, 2004) work, I stress another way of reading the biopolitical economy that Foucault describes. Foucault's (2007) articulation of an apparatus of security made in connection to what he describes as "the problem of the population" permits us to question Cooper's assumption that the labor of the body-as-organism is the "social" operator driving growth in a biopolitical economy. Returning to Feher's (2009) work on "Self-Appreciation," I suggest "value" be understood instead in terms of the subject of human capital, for whom we might qualify an affective capacity that is being made in relation to risks like food insecurity.

LIFE AND REPRESENTATION

Life and Labor

Two moments in the work of Michel Foucault are referenced in the introduction to Cooper's work on the growth of the U.S. bioeconomy in neoliberalism. The first is drawn from *The Order of Things* (1973), where Foucault describes a turning point in the late eighteenth and early nineteenth century:

> when the classical sciences of wealth (from the mercantilists to the physiocrats were replaced by the modern science of political economy (Adam Smith and David Ricardo) and the natural history of the classical period (Comte Georges-Louis Leclerc de Buffon and Carolus Linnaeus) gave way to the science of life itself, the modern biology of Xavier Bichat and Baron Georges Cuvier. (quoted in Cooper 2008:5)

In the modern life sciences of the late 1700s, the categories of resemblance and difference that organized nature in the classical sciences are revised, and nature is addressed instead as matter of the organism's physiology and metabolism. Biology is no longer referenced in relationship to the taxonomic system, as Cooper (2008:6) stresses, quoting Foucault: "[f]rom Bichat to Cuvier the conditions for a modern biology are established when life 'assumes its autonomy in relation to the concepts of classification.'" This shift in how life is organized introduces distinctions between organic and inorganic life forms, now determining understandings of nature, distinctions that require "new forms of knowledge, science, and experiment" (2008:6; see Foucault 1973:160).

The birth of the modern life sciences has as its parallel a move in the founding texts of modern political economy. As Foucault explains, value is separated from "its representativity"; Cooper (2008:6) further explains that it is in the word of Ricardo rather than Smith that Foucault finds this transition, noting that where:

> the economists of the classical period saw value as a function of trade, exchange, and circulation whose movements could be charted in the construction of elaborate economic tables, Ricardo inaugurated the properly modern science of economics by separating value from "its representativity" and relocating the source of all wealth behind the surface effects of exchange, in the time-processes of force, labor, and fatigue (ibid., 254).

Wealth is not measured in terms of a representative value drawn from the fruits of the land and becomes instead an expression of "the creative forces of human biological life" (Cooper 2008:6). Remarking on this shift, Cooper (2008:7) stresses how the economy begins to expand for the first time in the 1800s when life and labor are made to follow the terms of the biological organism and its development, "just as life comes to be understood as a process of evolution and ontogenetic development." Quoting Foucault, Cooper (2008:7) emphasizes that the "organic becomes the living and the living becomes that which *produces, grows and reproduces*; the inorganic is the non-living, that which neither develops nor reproduces; it lies at the frontiers of life, the inert, the unfruitful—death" (see Foucault 1973:232). At the introduction of modern political economy, then, human biological reproduction is made in terms that are inseparable from the processes of human, biological labor, a point Cooper (2008:7) emphasizes to stress how "the question of population growth thereby becomes inseparable from that of economic growth."

Constitutional Form

A second point of reference for Cooper's work is drawn from Foucault's 1975–76 lectures on biopolitics. Noting Foucault's discussion of mathematics and the statistical sciences in these lectures, Cooper underlines the organization of a constitutional form that is realized in the welfare state. Strategies invented by the state in the eighteenth and nineteenth centuries to organize processes, including those of reproduction, disease, and mortality, are read by Cooper (2008:7) as a genealogy of the welfare or social state in the mid-twentieth century, of the "constitutional form that most successfully brings together the administration of demographics with that of economic growth."

This line of thought is pursued in the work of historian François Ewald (1986), whose own reading of Foucault's lectures stresses juridical forms under the welfare state, based on what he calls "actuarial strategies of risk socialization" (quoted in Cooper 2008:7). Borrowing from the discourse of life insurance, Ewald notes how these strategies reference the entire chronology of human biological life, from birth to death. Summarizing Ewald, Cooper (2008:7–8) observes, "[u]nlike its liberal precursors the welfare state […] is interested not only in the productive life of the laborer, but in the reproductive life of the nation as a whole." In the social contract established under the welfare state, the value of life is constituted in terms of a social reproduction that makes life "infinitely indebted to society" (Ewald quoted in Cooper 2008:8).

The welfare state contract is pivotal to the political, economic, and social transformations Cooper attributes to neoliberalism, transformations that draw explicitly from what Ewald (quoted in Cooper 2008:8) calls an "economy of obligations":

> The notion of a right to life or right to existence is linked to an economy of obligations which is very different from the liberal economy. It demands to be formulated more in the form of duties than rights. Society gives life and pledges to protect it. What does it ask for in exchange? That one gives one's life to society. … The counterpart to the right to life can only be the engagement, without reserve, of one's own life. The basis of the new language of rights is devotion.

In his 1977–78 lectures on biopolitics, Foucault (2007:83–110) outlines "the problem of the population," another way of understanding the relationship of the statistical sciences to the body. Here Foucault suggests the relevance of information to different configurations of the body, the implications of which I will underline in connection with the two ways of articulating neoliberalism described in this chapter.

Catastrophe Risk

Noting again the work of Ewald (2002), Cooper (2008:63) explains that while classical risk theory is calculated in terms of the likelihood that a risk will be prevented, as part of a new discourse on security, the concept of "catastrophic risk" introduces fundamentally novel ways of formulating "the whole problematic of danger." Risks are no longer conceptualized in terms of what is outside the body of the nation-state, but instead made to carry a calculus of the accident, where preparation is treated as an extravagance (2008:82). As Cooper (2008:82) explains, "From nuclear winter, global warming, and ozone depletion to emerging disease and foodborne, transgenic, and biomedical epidemics, the 'catastrophe risk' has come to designate a technological accident of biospheric proportions, operating simultaneously at the microscopic and the pandemic levels."

Ewald (1993) distinguishes the classical notion of risk from catastrophe risk in terms of probabilities. In classical risk theory, probabilities are more accurate when calculated in relation to a longer time scale and a wider scope of our field of vision. In contrast to these calculations, Cooper (2008:82) notes, catastrophe risk is not a singular event; instead, "the accident [is] amplified across a whole even field, a phase transition that may emerge without warning, instantaneously and irreversibly transforming the conditions of life on earth." The danger that manifests is addressed not in terms of probability but rather in terms of what can be apprehended but not assessed. This discourse is an affective one, of a future fear that is influencing an individual's capacity to make a decision, a risk that is viewed as both speculative and entrepreneurial:

> What it provokes is not so much fear (of an identifiable threat) as a state of alertness, without foreseeable end. It exhorts us to respond to what we suspect without being able to discern; to prepare for the emergent, long before we can predict how and when it will be actualized; to counter the unknowable, before it is even realized. In short, the very concept of the catastrophe event seems to suggest that our only possible response to the emergent crisis (of whatever kind—biomedical, environmental, economic) is one of speculative *preemption*. (Cooper 2008:83, emphasis in original)

Noting this shift from classical to catastrophic risk theory, Cooper (2008:83) explains how the models for economic growth associated with complexity and chaos theory, formulated by economic theorists like Joseph Schumpeter, permit us to follow a "defining predicament of the neoliberal politics of security" detailed in the work of Ewald. Schumpeter's (1934) analyses reveal the debt imperialism introduced by neoliberalism, in distinction from forms of growth calibrated under Keynesianism to avoid risk. Protections from the reserve bank under the welfare state, such as fixed exchange rates and a family wage, have evaporated under a neoliberalism that is interested instead in "biological catastrophism" or the intention of "profiting from the 'unregulated' distribution of life chances, however extreme" (Cooper 2008:11).

Biotechnology and Speculation

Discussions of catastrophic risk are treated by Cooper alongside an erosion of ecological boundaries that have proceeded by way of legal regulations pursued by the biotech industry in the 1970s and '80s to favor U.S. drug companies, agribusinesses, and biotech businesses. These regulations unfolded in response to futurological literature from the late 1960s and mid-1970s, in particular the 1972 world futures report produced by the Club of Rome called *Limits to Growth*.

Drawing on systems theory, the authors of *Limits to Growth* (the "Meadows team") concluded that "[t]he exponential growth of population and industry could not continue indefinitely without running up against the limits inherent in … agricultural production, energy supplies and pollution" (quoted in Cooper 2008:16). Reactions to the report were varied. President Jimmy Carter commissioned a follow-up, *The Global 2000 Report,* that led to governmental legislation on a series of environmental issues (Cooper 2008:17). However, a counter-reaction from members of the new right, including sociologist Daniel Bell, contended that the model of growth described by the Club of Rome was bound to encounter limits.

Quoting Bell, Cooper (2008:17) explains the problem according to the new right was a model of growth that "was based on a 'simplified quantitative metric' and a 'closed system.'" These groups concluded, therefore, that the economic model the report described was bound to encounter limits because "[i]t was incapable of thinking through the kind of systemic 'qualitative change' that […] characterized the successive phases of the evolution of capital" (Bell quoted in Cooper 2008:18). This reaction led to calls from the new right for radical restructuring. Reassertion of world dominance by the U.S. required economic restructuring: "the United States would need to move from heavy industry to an innovation-based economy, one in which the creativity of the human mind (a resource without limits) would replace the mass-production of tangible commodities" (Cooper 2008:17–18).

These ambitions led to regulations in the United States and United Kingdom that essentially encouraged industries in these countries to relocate. For Bell and others the solution to the problems raised by the Meadows team, Cooper (2008:22) explains, was "not to falter in the face of undeniable limits but rather to relocate beyond the limits of industrial production – in the new spaces opened up by molecular biology."

Intellectual Property Rights

Pivotal to this restructuring of the U.S. economy beyond the limits of industry were reforms to intellectual property rights that allowed "one to own the organism's *principle of generation* without having to own the actual organism" (Cooper 2008:24). These legal developments accelerated the forms of growth pursued in the life sciences in the U.S., allowing industries to generate changes in reproduction. Cooper (2008:24) writes:

> In the age of postmechanical reproduction the point is no longer to reproduce the standardized Ford-T model in nature, but to generate and capture production itself, in all its emergent possibilities. Its success is dependent on the constant transformation of (re)production, the rapid emergence and obsolescence of new life forms, and the novel recombination of DNA rather than the mass monoculture of standardized germplasm.

Such developments in intellectual property, understood in the context of the convergence of life science production with capital accumulation, came with promises that technology could "overcome hunger, pollution, the loss of biodiversity, and waste in general" (2008:11). All the while, Cooper argues, the ecological and biopolitical problems associated with industrial capitalism only continued to worsen.

Federal regulations adopted by the Carter and Reagan administrations actively encouraged speculative financial activity by incentivizing alliances between the academic sciences and the private sector. Central among these regulations was the *Bayh-Dole Act*, which required scientific institutions and labs to patent the results of their research. Resulting from the *Bayh-Dole Act*, Cooper (2008:27) notes, was "an entrepreneurial public-private alliance." Patents initially funded through public institutions were sold to private companies who had the capacity to commercialize the results. From these developments, Cooper (2008:27) argues, "[t]he *Bayh-Dole Act* effectively gave rise to a new academic personage, the scientist entrepreneur, and a new form of public-private alliance, the joint-venture start up, in which academics and venture capitalists come together to commercialize the results of public research."

These reforms—coupled with the deregulation of banking and financial markets—made possible investments in high-risk ventures that relied on the liquidity of the stock market and the securitization of pensions (Cooper 2008:27–28). Investors who found wealth through the privatization of American pensions were able to divert a percentage of their portfolios into venture capital funds, including biotech. The foundation of NASDAQ allowed high-risk start-up firms, some with very little collateral, to include speculative assets in their portfolios, including patents that were not yet commercial products (2008:28).

Alongside changes in intellectual property rights, therefore, deregulation of the stock market made possible a promissory market in life science innovation. Regulations curbing industrial growth prompted corporate agribusinesses to stop pursuing petrochemical production in the 1960s and 1970s. Practices based on the extraction of natural resources without their renewal were subject to environmental regulations. Meanwhile, however, new investment opportunities were available to businesses interested in genetic technologies "through licensing agreements with biotech start-ups or by developing their own in-house research units" (Cooper 2008:22). Limits imposed on industrial production in the U.S. and the U.K. were mitigated by moving industrial production offshore and through the emergence of a bioeconomy.

Cori Hayden (2003) provides another way of thinking through these developments in intellectual property rights and the life sciences, as I explain in chapter 5. Different from Cooper's suggestion that biotechnology promises to overcome the loss of biodiversity and other problems including global hunger, pollution, and waste, by investing in the principle of generation, Hayden stresses how the production of knowledge is being made to carry new forms of social and political responsibility.

A SECURITY APPARATUS

Cancelling Out Scarcity

Different from Cooper's focus on the constitutional form of the welfare state, another way of reading Foucault's discussion of the mathematics of risk and statistical normalization in his lectures on biopolitics gives to support to the body-as-data that I describe in chapters 2 and 3. Part of his discussion of security apparatuses, Foucault (2007) considers how European physiocrats in the seventeenth and eighteenth centuries arrived at a new unit of analysis for framing questions about scarcity. Stressing that juridical and disciplinary measures established to prevent scarcity, including price controls, control over the right to store grain, prohibition of hoarding, limitations on exports, and limitations on cultivation, led to "precisely the scourge [they] sought to avoid," Foucault (2007:33) argues these measures paved the way for apparatuses that treated scarcity as a "natural" occurrence rather than an object to be prevented.

Drawing on the work of French economists and physiocrats Francois Quesnay (1694–1774), Vincent de Gournay (1712–1759), and Louis-Paul Abeille (1719–1807), among others, Foucault (2007:33–34) underlines the emergence of knowledge of scarcity that is a matter of the "freedom of commerce and of circulation of grain," or what was referred to as a "fundamental principle of economic government."[12] As such knowledge was treated as instrumental to unblocking the system, Foucault stresses a shift in the shape of politics at the beginning of the eighteenth century when it takes statistical measures as its object. Addressing the problem of scarcity, Foucault (2007:36) notes how from this point forward knowledge of scarcity refers "not so much the phenomenon of scarcity-dearness, but … the history of the grain from the moment it is put in the ground, with what this implies in terms of work, time passed, and fields sown—of cost, consequently."

Political measures no longer targeted the prevention of scarcity, measures that would make scarcity as a phenomenon in terms that return to the individual body of the human organism. Instead techniques were developed that target the "reality of the grain" as the unit of analysis. In other words, these "statistical" measures do not avoid scarcity but rather treat it as a configuration that is in formation. Addressing this biopolitical reality as different from that of a juridical disciplinary system, Foucault notes how the entire reality of the grain, its whole history including any and all fluctuations and events that altered its course, were grafted onto an apparatus. The point in considering these fluctuations and events was now to insure that the disciplinary system did not prevent or prohibit them. As Foucault (2007:36–37) explains:

[12] The phrase "economic government" comes from the writings of Quesnay (see Foucault 2007:33).

> Abeille, the physiocrats, and the economic theorists of the eighteenth century, tried to arrive at an apparatus (*dispositif*) for arranging things so that, by connecting up with the very reality of these fluctuations, and by establishing a series of connections with other elements of reality, the phenomenon is gradually compensated for, checked, finally limited, and, in the final degree, cancelled out, without it being prevented or losing any of its reality. In other words, by working within the reality of fluctuations between abundance/scarcity, dearness/cheapness, and not by trying to prevent it in advance, an apparatus is installed, which is, I think, precisely an apparatus of security and no longer a juridical-disciplinary system.

Cooper views the biopolitical measures addressed by Foucault as logically consistent with ontogenetic development, or the development of an individual or organism. But in these lectures Foucault stresses that the models consistent with normalization do not emerge from a fundamental distinction between the normal and the abnormal. Rather it is the model itself that makes possible such a distinction:

> Due to the primacy of the norm in relation to the normal, to the fact that disciplinary normalization goes from the norm to the final division between the normal and the abnormal, I would rather say that what is involved in disciplinary techniques is a normation (*normation*) rather than normalization. Forgive the barbaric word, I use it to underline the primary and fundamental character of the norm. (2007:57)

If normation as a model is logically coherent with the law, the apparatus of security introduces a further point of distinction, as its mode is not to impose the norm but to "normalize" (2007:57). Here we should remember that the mechanisms of security devised by economists and physiocrats in the mid-eighteenth century, rather than attempting to prevent scarcity as a phenomenon, find support within these processes affiliated with scarcity, a calculation for the fluctuations that sometimes produce abundance and sometimes produce scarcity (2007:59). The apparatus of security draws on these techniques used to "[find] support in the reality of the phenomenon, and instead of trying to prevent it, making other elements of reality function in relation to it in such a way that the phenomenon is cancelled out, as it were" (2007:59).

Taking, as an example the deadly epidemic of smallpox in the eighteenth century, Foucault (2007:60) notes how, in the figure of the population and the quantitative analyses that accompany this figure, individual phenomena become subordinate to the case. The prevailing understanding of disease in seventeenth- and eighteenth-century medicine was of a mass, or defined in terms of "[the] overall relationship between a disease and a place, a disease and a group of people" (2007:60). At the level of the group, individuals are identified in terms of their risk of catching smallpox, dying, and/or being cured, meaning the determination of risk is not the same "for all individuals, all ages, or in every condition, place or milieu" (2007:61). Facilitated by the development of statistical instruments and the importation of such instruments into medical theory, governmental processes emerge whose goal is to find a support for scarcity in the reality of the phenomenon (2007:59).

Techniques affiliated with the apparatus of security, therefore, emerge from an impulse to codify the juridical, human subject in relationship to legal operations, as normativity is intrinsic to the law, but that as a result introduce results for a body not reducible to its legal operations. As Foucault (2007:56) writes:

> I think it really is necessary to show that the relationship of the law to the norm does in fact indicate that there is something that we could call a normativity intrinsic to any legal imperative, but this normativity intrinsic to the law, perhaps founding the law, cannot be confused with what we are trying to pinpoint here under the name of procedures, processes, and techniques of normalization. … [T]he problem that I am trying to mark out is how techniques of normalization develop from and below a system of law, in its margins and maybe even against it.

In her discussion of neoliberalism, Cooper (2008:12) notes that new patent laws and pricing strategies pursued by U.S. and European drug conglomerates are part of a contemporary debt imperialism. But as her notion of these strategies remains attached to a body whose life is indebted to society her understanding of "security" as a form of biopolitical governance should be distinguished from the apparatus of security Foucault describes.

The Biological Turn

The new security agenda that Cooper describes is guided by changes in the early 2000s, when U.S. foreign policy and international relations analysts began to address "*the whole of life*, from the micro- to the eco-systemic level" as military threats (2008:80, emphasis Cooper's). Prior to this agenda were cutbacks in public health, changes that all but guaranteed the catastrophic impacts that these analysts later securitized. Underling as well deregulation from the 1960s and 70s, Cooper notes how a concept of "emergence," developing in the work of microbiologist Rene Dubos, came to be accepted among mainstream microbiologists and adopted by U.S. foreign policy analysts and international relations theorists now addressing infectious diseases as a complex emergency.

At odds with the orthodoxies expressed by public health officials in the United States in the 1950s, Dubos conceptualized emergence in terms of "the relentless, sometimes catastrophic upheaval of entire coevolving ecologies; sudden field transitions that could never be predicted in linear terms from a single mutation" (quoted in Cooper 2008:78). More mainstream views on emergence at the time stressed a "gradual accumulation of local mutations," as Cooper (2008:78) notes. But challenging the concept of emergence also altered how resistance was defined. No longer understood as pathological, Dubos claimed, "there can be no final equilibrium in the battle against germs […] because there is no assignable limit to the coevolution of resistance and counterproliferation, emergence and counteremergence" (quoted in Cooper 2008:78).

To explain how Dubos's concept of emergence became a more mainstream view within the field of microbiology, Cooper (2008:28) highlights evolutions in intellectual property rights that, initiated by the Reagan administration, incorporated "all kinds of biological products and processes within the scope of patentable invention." More still, the same interests in the U.S. that sought to liberalize patent laws were waging an international campaign that led to the signing of the 1986 Trade-Related Intellectual Property Rights [TRIPs] agreement (2008:28; see Sell 2003).[13] Careful to stress that these developments should not be mistaken as evidence of an information economy, Cooper argues instead that the TRIPs agreement altered the landscape of world trade and imperialism in the post-World War II era, making possible a value for knowledge that, conceptualized in terms of "security," does not alter the configuration of the body-as-organism (2008:57). As she explains:

> [TRIPs] militates against the idea that the so-called process of globalization, with its attendant shifts toward knowledge and innovation economies, is embracing the entire world and is devoid of vectors of power or control. What it suggests, rather, is that the very value of knowledge – its surplus and its promise – is the result of a quite deliberate self-transformation of the U.S. economy and its allies, one that was pursued through the international organizations created in the post-World War II era, but with the ultimate effect of entirely redefining the landscape of world trade and its imperialism. (2008:57)

Behind a shift in how resistance was addressed in mainstream microbiology we find the dismantling of the public health system after World War II. Cutbacks in public health initiated during the Reagan-era left the United States "structurally incapable of dealing with even the most familiar of infections" (Cooper 2008:81). An effect of these cutbacks, Cooper (2008:75–76)

[13] Administered by the World Trade Organization (WTO), the TRIPs agreement is an international agreement that establishes a minimum standard for the forms of intellectual property regulation applied to WTO members.

describes a “biological turn” in U.S. defense policy, that is, an effort to arm the state against the threat of infectious diseases, or what she calls the “new security agenda.”

After World War II, public health officials declared the war on infectious diseases was almost over, and that we were the victors. At odds with official public health doctrine, Dubos advocated at the time that public health be treated as an exercise in permanent warfare: a “guerrilla counterresistance without foreseeable end, against a threat whose precise ‘when’ and ‘how’ we can only speculate on” (2008:79). Dubos believed “[t]here can be no final equilibrium in the battle against germs […] because there is no assignable limit to the coevolution of resistance and counterproliferation, emergence and counteremergence” (Cooper 2008:78). As Cooper (2008:79) explains:

> If humans are to survive the inevitable “counterstrike” from microbial life, [Dubos] argues, we need to prepare for the unexpected; learn to counter the unknowable, the virtual, the emergent. The new science of life, Dubos writes, must cultivate “an alertness to the advent of the unpredictable,” a responsiveness to the threat that is merely felt or apprehended (ibid., 271). We must become capable of responding to the emergent, long before it has actualized in a form we can locate or even recognize. Life is a gamble, Dubos contends – a kind of speculative warfare (ibid., 267). And war is necessarily preemptive, as much an attempt to resist the counter contagion as a creative reinvention of the conditions of human existence, beyond whatever actual limits we might have adapted to in the present.

The adoption of a new security agenda equating public health with permanent warfare, Cooper argues, followed deregulation and cutbacks that guaranteed the catastrophic impact on microbiological life Dubos envisioned in the 1950s. Microbial resistance is more intense today because deregulation permits unchecked increases in the use of antibiotics and the commercial scale use of transgenic organisms (2008:183n2). Rather than an institutional response to this issue, we have an agenda that securitizes “a general loss of preparedness in relation to the emergent event”:

> Paradoxically, while neoliberalism insists on the utter unpredictability of the biological threat, it also establishes it as inevitable and pervasive. The event will have taken place, although we can never be sure when or how. And although we are exhorted to feel prepared, it leaves us constitutively unprepared for even the mildest of surprises. (Cooper 2008:81)

But, as I explain in chapter 5, there is another way of reading post-World War II developments in intellectual property and the sciences, one that highlights how resources like biological diversity become supports for both industry and politics when the body is reconfigured as data.

THE BODY ORGANISM AND A NEW SOCIALITY

From Discipline to Circulation

The target of the new security agenda for Cooper is the human, biological body impacted by developments in patent law, as catastrophic risks are now managed through speculative preemption. But the techniques Foucault (2007:63) describes for determining a population's probable morbidity or mortality with respect to epidemic diseases stresses the "interplay between these different distributions of normality and [in] acting to bring the most unfavorable in line with the more favorable." This circulatory apparatus is different from the regulations Cooper describes that are more focused on training individuals to comply with a norm. The governance of populations, Foucault (2007:66) argues, is not a relationship "between the individual and the collectivity, between the totality of the social body and its elementary fragments."

The techniques that define the concerns of the prince direct us to the problem of "fixing and demarcating a territory" (Foucault 2007:65). But the probable morbidity of the population relative to epidemics like small pox, Foucault (2007:65) explains, is a matter of "allowing circulations to take place, of controlling them, sifting the good and the bad, ensuring things are always in movement, constantly moving around, continually going from one point to another, but in such a way that the inherent dangers of this circulation are cancelled out."

Mercantilists treated the population as a disciplinary regulatory apparatus, viewing the population as a source of wealth that must be conditioned to be a source of the state's wealth and power. But the physiocrats and economists of the eighteenth century did not understand the population in relationship to such disciplinary practices. Instead, Foucault (2007:70) explains:

> [W]ith the physiocrats and, more generally, with the eighteenth century economists, I think the population no longer appears as a collection of subjects of right, as a collection of subject wills who must obey the sovereign's will through the intermediary of regulations, laws, edicts, and so on. It will be considered as a set of processes to be managed.

Administration of a "social" body, as a population, stresses how the identification of new processes, of new knowledge, makes possible further definition of the forms of an organization. As Foucault (2007:79) describes this:

> A constant interplay between techniques of power and their object gradually carves out in reality, as a field of reality, population and its specific phenomena. A whole series of objects were made visible for possible forms of knowledge on the basis of the constitution of the population as the correlate of techniques of power. In turn, because these forms of knowledge constantly carve out new objects, the population could be formed, continue, and remain as the privileged correlate of modern mechanisms of power.

In short, what Foucault describes is a shift that occurs in three stages: from considering life in terms of the classificatory characteristics of living beings (sovereign power), to the internal organization of the organism (disciplinary power), and finally to the relationality of life constituted in terms of governing a population (securitization or control). In this final stage, the population functions as "the operator of a transformation," away from the closed systems of sovereign states, involving instead the management of open systems (Foucault 2007:78).

Thinking about the population as an operator of this kind presses us to consider the forms of measure that are adopted in discussions about food security. Following this point, in chapter 5 I suggest how Cori Hayden's (2003) work on biodiversity prospecting points to the logic that underlies the turn to food security. However, before addressing this logic we should note how Cooper defines bodily capacities relative to the technological and legal developments she describes so that we are able to appreciate the affective capacity that the body acquires as a matter of food security.

The Potentiality of Biology

The two different forms of bodily generation described by Cooper (2008:132) follow a division of genetics and embryology into two distinct disciplines.[14] This division bears on the form of labor attributable to embryonic cells, in distinction from the labor treated in reproductive medicine. Reproductive medicine remains within the parameters of the paradigm established by the German biologist August Weismann, who defined labor as a "sexual, germinal transmission" (Cooper 2008:130). Meanwhile, stem cell science introduces a different way of understanding cellular regeneration. Cooper stresses different forms of labor for the cells treated that correspond to how legal regulations have been applied to these two disciplines. Foucault's (2007:56) discussion of normalization underscores another way of imagining the influence of technical developments on bodily growth through techniques that "develop from and below a system of law" and its impulse: "to codify a norm."

[14] Cooper (2008:131) notes Adele Clark's (1998) historical work on the emergence of mammalian reproduction in the midst of this split between genetics and embryology. As Clarke explains, this split occurred just as the agricultural sciences were reorganized in compliance with the demands of private industry.

Noting that different economic infrastructures can be described for stem cell science and reproductive medicine, Cooper underlines the legal regulations that correspond to these two "tissue economies." Human embryos in reproductive science are "accorded the status of inalienable, familial property but barred from circulating as freely tradable commodities" (Cooper 2008:136). Meanwhile the embryos in regenerative medicine, and particularly in the field of stem cell science, are commercialized differently due to different forms of legal valuation (2008:141). As she puts it:

> [in stem cell science] what has prevailed is not so much the commodification of tissues and processes – or a limited form thereof – but rather their integration into … highly financialized, promissory forms of accumulation. … What is being constituted here … is something like a market in embryonic futures, one that brings the promise of capital together with the biological potentiality of cell lines and attempts to conflate the two. (2008:141)

To explain the differences between these two fields of medicine, Cooper (2008:130) notes the Weismannian theory of generation. This theory states that the generation of the body of the organism is conceived vertically, so that hereditary information passes through germ lines from generation to generation (in other words, the immortality of the germ line is governed by its reproduction through the mortal bodies of organisms) (2008:130). While reproductive medicine can be understood as an industrialization of the processes described in Weismannian reproduction, regenerative medicine questions the essential premise of this theory. Cooper (2008:140) emphasizes that "what stem cell science seeks to produce is not the potential organism – nor even this or that particular type of differentiated cell – but rather *biological promise itself, in a state of nascent transformability*."

With differences between regenerative and reproductive medicine reduced to these terms, we can begin to see how the achronolgical temporality that Cooper attributes to regenerative medicine has as its basis forms of accumulation that remain grounded in the logic of the body-as-organism. This point is further illustrated by the distinctions Cooper (2008:137) underlines between the somatic and germ cells attributed to the Weismannian theory of generation and Charles Minot's study of the growth and aging of cells. Minot believed the loss of potential of somatic cells due to their aging process is determined by an adoption of functions defined in relationship to the organization of the biological organism. As Cooper (2008:137) explains:

> If we assume that all cells begin in a state of high embryonic plasticity, growth is the process through which the cell differentiates, attains a specialized function, and contributes to the functional organization of the body. Minot thus formulates an inverse relationship between differentiation, organization, and function, on the one hand, and cellular potency, on the other.

The inherent "growth power" of somatic cells is derived from functions that contribute to the overall organization of the body of the organism, even though they lose their specialized role as they age.

> [A]ll somatic cells … are subject to a loss of potentiality; in taking on specific functions, cells sacrifice some of their embryonic plasticity; cell differentiation thus moves through a progressive, irreversible exhaustion of possibilities, to final cell senescence and death. (2008:137)

Stressing Minot's study, Cooper underlines the forms of bodily generation found in regenerative and reproductive medicine. This distinction is coherent with the "pathological exception" that Minot established in relationship to the rule of cellular development, namely, the "indifferent divisibility" of cancerous cells that overtake the body by avoiding aging and death. Minot writes:

> The phenomenon of things escaping from inhibitory control and overgrowing is familiar. Such escapes we encounter in tumors, cancers, sarcoma, and various other forms of abnormal growth that occur in the body. They are due to the inherent growth power of cells kept more or less in the young type, which for some reason have got beyond the power of the inhibitory force, the regulatory power which ordinarily keeps them in. (quoted in Cooper 2008:138)

The pathological exception established by Minot fuels Cooper's (2008:142) characterization of regenerative medicine as the "high risk areas of life science experimentation such as stem cell science." By drawing regenerative medicine together with these principles of generation Cooper emphasizes a transformation that biological reproduction, the transmission of property, and the laws of invention, once treated as "mutually exclusive, yet *analogic*," are currently undergoing (2008:145, emphasis Cooper's).

Overproduction and Autopoiesis

Deviating from the taxonomy of growth affiliated with the Weismannian theory of generation, stem cell science introduces forms of growth different from the conditions that define an industrial economy. Evidence of an unchecked economic and biological overproduction, the forms of bodily generation found emerging in stem cell science coincide with developments in patent law that have altered the conditions of labor and capital accumulation. Noting these developments, Cooper (2008:145) underscores "the ways in which recent developments in patent law have overhauled the legal status of both technical invention and biological regeneration."

Although human reproductive medicine draws on many of the same technological advances found in the agricultural sciences, assisted reproductive technologies (ARTs) have regulations that limit the mass commodification now standard in the field of agriculture. In contrast with human reproductive medicine, the North American cattle industry has deployed reproductive technologies on an industrial scale since the 1970s, the goal of which has been to eliminate unreproductive time. This is achieved by:

> extending the fertility of animals beyond their naturally fertile years or freezing and preserving embryos for later use; to maximize surplus value, by augmenting the number of eggs produced at one time (superovulation) and twinning; to do away with obstacles of space and time, by freezing and transporting materials through the use of artificial insemination, tissue transfer methods, and in vitro fertilization; and finally to standardize reproduction and eliminate mistakes using dissection microscopy and preimplantation genetic diagnosis. (Cooper 2008:132–133)

Like manufacture under Fordism, these procedures "increase the production of relative surplus value … by getting the most out of each unit time of reproductive labor" (2008:132).

Embryonic cells bear the influence of the agricultural sciences only as a "technological kinship." As Charis Thompson (2005) explains, restrictions to the commodification of ARTs are strictly based on the labor of embryonic cells in reproductive medicine, labor that conforms to the Weismannian theory of generation. With these procedures "the whole point is to culture the fertilized egg cell to term – in other words, to actualize its biological promise in the form of the future individual organism" (quoted in Cooper 2008:140).

By way of contrast, the production of "biological promise itself" for embryonic cells in regenerative medicine belongs to what Cooper (2008:141) characterizes as "a market in embryonic futures, one that brings together the promise of capital with the biological potentiality of cell lines and attempts to conflate the two." To further illustrate this point, Cooper draws a parallel between stem cell science and the complex systems described by Austrian economist Joseph Schumpeter, whose work she views as central to the forms of growth we find in a neoliberal political economy. As she writes, "[stem cell science] seeks to discover the culture conditions under which biological promise becomes *self-regenerative, self-accumulative, and* *self-renewing*. It wants to culture the [embryonic stem] cell in such a way that it is able to perpetually regenerate its own potentiality, in the form of a not-yet realized surplus of life" (2008:140; emphasis Cooper's).

Patents and Property

Mindful of how the intensification of futures trading in the United States and globally has influenced both the economy and technological development, Cooper (2008:142) argues that "in a real sense the post-Fordist model of accumulation brings speculation into the core of production, so that the two become inseparable." But these developments would not have been possible if not for a full-scale legislative and political campaign to make property something more than just persons and things. If suitable to industrial production, changes in patents have facilitated the transition to post-Fordism that Cooper (2008:145) describes to overcome "a fundamental division of labor between technological production distinct from biological life."

To describe evolutions in patent laws that make possible the forms of accumulation affiliated with stem cell science, Cooper looks to the work of legal historian Bernard Edelman (1989). According to Edelman, between the seventeenth and nineteenth centuries patent law defined the act of invention in relationship to inorganic matter: an invention that was machinic and distinct from biological reproduction (Cooper 2008:142). This division allowed patent law to exist alongside an older tradition of legal personhood where the legal and spiritual capacity of personhood was defined in opposition to the material thing or object of right (2008:145). But with changes in the legal status of technical invention and bodily regeneration, biotechnological invention drew the potential reproduction of the organism into the realm of exchange relations.

The problem, as Cooper (2008:146) explains it, is "not so much in the legal tradition of patent law itself (which is quite clear about the immunity of the human from commercial relations), but rather the growing tension between biological and legal discourses on generation." Stem cell science unsettles the legal concept of personhood because it reformulates "the whole problematic of mammalian regeneration […] and the Weismannian model of germ-line reproduction" (Cooper 2008:146).

> In its strict separation of spheres the industrial revolution presupposed a mutually exclusive, yet analogical relation between biological reproduction, the transmission of property, and the laws of invention. European and U.S. patent law, for example, describe invention as an act of original "conception," while figuring the "reproduction" of the patented machine as a transmission of the father's name (Strathern 1999[a], 163–65). In a similar way the early twentieth-century science of genetic heredity borrowed its language from the laws of inheritance: when Weismann formulated the theory of germinal reproduction at the turn of the century, he conceived of life itself by analogy with the transmission of legal personhood (the germ line, he claimed, was equivalent to a "person" and left "in trust" to each generation). (Cooper 2008:145–146)

The relationship of patent laws to these two fields of medicine stresses a difference in the timing of production relative to the organism's generation or displacement. Embryonic cells in reproductive medicine remain within the paradigm of sexual, germinal transmission, as their labor is directed towards the reproduction of the organism. In stem cell science, however, embryonic cells introduce an "overproduction" that is pathological because potential is targeted, encapsulated, and displaced.

To reinforce the idea that stem cell science counters a particular taxonomy of growth prevalent in the late nineteenth and twentieth century, Cooper underlines conclusions found in phenomenologist Aurel Kolnai's work on pathology (see Kolnai [1929]2004). Here again Cooper (2008:138), quoting Kolnai, notes how an overproduction bears on the different measures she attributes to accumulation under Fordism and post-Fordist neoliberalism:

> What provokes disgust and thus signifies the pathological, [Kolnai] claims, is not so much the absence or negative of life—the lifeless corpse—as the manic, uninhibited overproduction of life, life that reproduces itself outside the proper ends of germinal, sexual reproduction and organic form. It is the “surplus of life,” “extreme propagation and growth”—not the growth that grows toward death—that we associate with the pathological.

The “life” targeted in stem cell science, viewed as a “surplus,” cannot but provoke disgust as it signifies a pathological reproduction in excess of the life of the organism. This surplus life, as Cooper (2008:138) tells us, finds its value in the sickness of cancer, that is, in a “metastasizing overproduction of life rather than its simple negation.”

> If cancer kills, it is not so much through a direct decomposition of the organism, as an extortion of the vital life force of organic life (cellular division), which it deflects from all ends – other than its own accumulation. There is an overproduction of life, writes Kolnai, when the generative process of growth, reproduction, and regeneration escape the boundaries of organic space and time. (2008:138)

The forms of growth Cooper describes are determined by a collapse of reproduction and production of the labor of embryonic cells, whose capacity is understood in relation to the life of biological, human body. But the distinction between the normation and normalization that Foucault connects to an apparatus of security suggests another way of imagining governmental techniques and technical solutions like food security: relative to a security that is imagined for human populations and for which there is an attendant shift from the body-as-organism to the body-as-data.

NEOLIBERAL SUBJECTIVITY

Human Capital

Foucault’s elaboration on apparatuses of security raises questions about forms of governance not based on the subject’s representation under the law. Taking this point further, Feher (2009:22) proposes we consider the concept of “human capital” as evidence of a neoliberal conditionality in which the goal is not disciplining the subject to a norm or convention, but rather imparting a subjectivity with new meanings and “unforeseen uses.” In the conclusion, I explain how, with the turn to food security, the collapse of production and reproduction is better understood in relationship to the affective capacity of the body-as-data, as an ongoing generation of meanings and uses for the body is conceived as integral to its securitization.

Cooper conceptualizes neoliberalism in relationship to different schools of economic theory, comparing forms of neoliberal accumulation with those belonging to the welfare state and the New Deal model of social reproduction. Keynesian economic strategies stress that cycles of production, reproduction, and capital accumulation should be calibrated to avoid “capital’s perennial catastrophic risks”:

> Social state economics is a science of mediated growth, one that establishes institutional measures and foundational values from the reserve bank to fixed exchange rates and the family wage, as a means of warding off both social disruption and financial bubbles. (Cooper 2008:10)

However, if the welfare state pursued models of growth that offset risk, Cooper emphasizes by way of comparison the non-normalizable accidents that are integral to growth in a neoliberal political economy.

Different from Cooper, Feher (2009:25) invites us to think of neoliberalism as a conditionality in which the concept of human capital is not symptomatic of the commodification of a liberal human subject but instead “the expression of an emergent neoliberal condition, the novelty of which has been so far underestimated.” Initially devised by economists to measure how schooling and forms of professional training impact future incomes, sociologists Theodor W. Schultz and Gary S. Becker broadened the concept to note how everything we do and everything that happens to us, as well as all the things we inherit contribute to our "human capital," the capacity of which can be maintained and/or can deteriorate (Feher 2009:25–26).

While Schultz and Becker attribute a utilitarian sensibility to this concept that marks it as pre-neoliberal, insofar as they measure returns in terms of income, Feher (2009:26) notes a capacity for growth that no longer requires the instantiation of the liberal human subject:

> [I]n the neoliberal world of globalized and unregulated financial markets, corporate governance is concerned less with optimizing returns on investment over time than with maximizing the distribution of dividends in the short run. Accordingly, its major preoccupation is capital growth or appreciation rather than income, stock value rather than commercial profit.

Affective Labor

The distinction between Schultz and Becker's understanding of human capital and his own, as Feher points out, leads us to consider questions about measurement. But rather than associating this question with the subject of the law, whose subjectivity is akin to the free laborer of liberal capitalism, human capital is itself the target of governance under neoliberalism. On this point we should note how the reading of the collapse of production and reproduction in relationship to the subjectivity of human capital emphasizes a labor that is more affective than defined by the biological, human body, in the manner that Cooper describes.

For the subjectivity of the free laborer characterized under liberal capitalism, there is a rift that exists between the subject's inalienable human rights and his or her labor power, which is rented out. While the subject's rights are reproduced, vis-à-vis a society of free laborers, her labor power is circulated and consumed as commodities. The liberal, human subject is split, therefore, between his spiritual aspirations and material interests. As Feher (2009:29) argues, "the former are necessarily specific to the individual and are thus incommensurable, while the latter are universal, or at least commensurable, and thus lend themselves to possible modeling and calculations." These distinctions, Feher (2009:29) argues, are reinforced through the values and principles found inside the market and outside of it: "for free laborers to think of their labor power as a commodity, they must be certain that they are not themselves commodities, which is to say that some aspects and regions of themselves remain inalienable, lest they end up entirely robbed of their selves."

By way of comparison, the deterioration between production and reproduction under neoliberalism is "a subject without reference to a system" (Clough et al. 2015:161), as an ongoing appreciation that makes illegible differences under liberal capital calculated in terms of "society" and "commodity" forms.[15] When the criticisms launched against neoliberalism focus solely on commodification, likening neoliberalism, as Feher explains (2009:30), to "a free laborer besieged by an ever-expanding market and thus reduced to a mere consumer where once he or she was also a citizen," resistance can only figure in the form of the humanist. And in this form, we should remember, resistance is nothing greater than the figure of the free laborer under liberal capitalism.

While Cooper highlights an erosion of production and reproduction found in the labor of the embryoid cells, Feher's focus on Foucault's discussion of the German Ordoliberals in the 1940s and 1950s suggests how governmental configurations might support an affective subjectivity. The Ordoliberals viewed the "politics of society" as "arranging and protecting the proper functioning of this fragile thing that is the market, by giving people the means and desire to behave as competing entrepreneurs" (Feher 2009:32). This signaled a reversal from the original core of liberalism that treated market competition as a gift of nature, and a movement

[15] Clough et al. (2015:161) use this phrase to describe a subjectivity that is impacted by big data and derivative pricing and trading.

towards its definition as a social form that must be produced and reproduced (2009:32). Where subjectivity under liberalism is understood as free or inalienable, under neoliberalism optimization belongs to the formation of subjectivity itself. It was this idea—"of a society of entrepreneurs that must be produced and maintained"—that members of the Chicago school of economics endorsed (2009:33). Feher (2009:33) writes that:

> American neoliberals … devoted themselves to challenging the confinement of the market to the sphere of production and thus to allowing market relations to conquer the space of the politics of society, which Ordoliberal economists had understood as necessary for the (re)production of the market but as obeying a different rationality. In other words, what was at stake for Schultz, Becker, and their associates was to challenge the alleged heterogeneity between the aspirations of the authentic self and the kind of optimizing calculations required by the business world (a heterogeneity that, until then, liberalism had understood as indispensable to the proper functioning of the business world).

Speculation and the Self

The erosion of a division between the personal (inalienable) and the universal (entrepreneurial) contributes to a subjectivity that neoliberalism targets through human capital, which encourages "the presentation of the individual as 'investor in himself or herself'" (Feher 2009:33). Alongside this alteration in our "subjective frame," domains once conceived as external to the reproduction of the free laborer, including health, education, and culture, are now conditional to the valorization of the self that is figured in terms of human capital (2009:33). Such a "presentation of self" ought not be understood as a property that is owned, because this would resurrect the very distinction between the self and the property form that human capital undermines. Instead, Feher views human capital as targeting an affective capacity that is entirely speculative—a form of investment, but where all activity is viewed as contributing to or weakening the portfolio of behaviors (2009:34). In sum, as he writes: "rather than a *possessive* relationship, as that of the free laborer with his or her labor power, the relationship between the neoliberal subject and his or her human capital should be called *speculative*, in every sense of the word" (2009:34).

It is the question of measure, then, that allows us to outline two neoliberalisms. The first, described by Cooper (2008), views the dissolution of reproduction and production a matter of the body-as-organism. For this body, as Cooper (2008:9) notes, "the whole space of reproduction … becomes potentially available for commodification":

> [W]hat neoliberalism wants to capitalize is not simply the public sphere and its institutions, but more pertinently the life of the nation, social and biological reproduction as a national reserve and foundational value of the welfare state. In so doing, it undoes the constitutive mediations of the Keynesian social state, exposing the realm of reproduction to the harsh light of direct economic calculus.

The second, described by Feher (2009:30), stresses the affective labor that neoliberalism targets for the subject of human capital by establishing the conditions for "appreciation":

> Accordingly, state polices and corporate strategies aimed at governing neoliberal subjects […] expose them to measures intended to influence the rate of each stock in their portfolio with little regard for venerable oppositions such as productive versus reproductive activities (production of commodities versus reproduction of the labor force), public versus private, or professional versus domestic.

CONCLUSION

In this chapter, I have defined two neoliberalisms corresponding to the two bodies I have identified: the body-as-organism and the body-as-data. For Cooper (2008:25) neoliberalism points to forms of accumulation made possible by deregulation, such that profits can be drawn from the biological futures found in regenerative medicine. As part of this arrangement, Cooper defines a new security agenda wherein catastrophic risks for the body-as-organism are treated as a complex emergency. Different from Cooper, Foucault's apparatus of security has relevance for the reconfiguration of the body-as-data that I describe as part of the turn from global hunger to food security. To address the contours of this arrangement in relationship to developments in molecular biology and intellectual property law, in the final chapter I address Cori Hayden's (2003) ethnography of bioprospecting agreements. Hayden's discussion of "social" forms of responsibility made to follow technological and legal developments emerging after World War II are noted to offset the forms of growth Cooper defines.

CHAPTER FIVE

RESOURCING BIOLOGICAL DIVERSITY FOR SECURITY

INTRODUCTION

In this chapter I offer another way of thinking about the history of the life sciences and developments in intellectual property rights relative to the body that is mobilized in discussions about food security. Closely reading Cori Hayden's (2003) ethnographic study of bioprospecting, I consider how we might connect the neoliberal forms of sociality and politics she describes as introduced through bioprospecting agreements to the reconfiguration of the body that is part of the turn to food security.

Different from the labor that Cooper (2008) views as integral to accumulation in a neoliberal political economy, Hayden stresses how developments in genetic engineering and intellectual property rights make possible economies of innovation that at the same time introduce forms of responsibility and sociality.[16] Changes in patent law have proceeded apace with developments in the field of molecular biology that make DNA, genetically modified organisms, and gene sequences resources for capitalization. Linked to these developments, I will note how the capacity of biological diversity moves beyond the production and reproduction affiliated with the labor of the body-as-organism.

An enhancement of the conditionality that Hayden describes, with the foundation of the Global Seed Vault that insures crop diversity in perpetuity as well as online systems intended to secure access for researchers, plant breeders, and others interested in this information, I will suggest the forms of innovation Hayden links to the potential of biological diversity are no

---

[16] In this chapter I reference both Hayden's (2003) book *When Nature Goes Public* and her doctoral dissertation (2000) on which the book is based.

longer dependent on bioprospecting contracts. Different, therefore, from the forms of responsibility attached to prospecting contracts, forms that are, as Hayden notes, simultaneously an exercise in nation building, I will suggest food security is an extra-legal arrangement. More coherent with the apparatus of security Foucault (2007:56) describes, food security is emerging "from and below a system of law," for a subjectivity whose conditionality is becoming entirely speculative (Feher 2009:34).

NATURE AND ITS PUBLICS

The Convention, the Plant Treaty, and Food Security

Bioprospecting agreements follow mandates introduced by the 1992 Convention on Biological Diversity ("the Convention") that drug and biotech companies share some percentage of profits with the communities from which biological resources are culled. Instituted after the Convention, these agreements stress the allocation of biological resources back to nation-states and local communities from their prior designation as resources belonging to "the common heritage of mankind."

The agreements are meant to facilitate exchange between "Northern" nations and corporations and "Southern" nations of "local" knowledge and resources for biotechnologically derived benefits, and provide the grounds for continued access to biological resources in Southern nations. As I noted in the introduction to this dissertation, renegotiations of the International Treaty on Plant Genetic Resources for Food and Agriculture (the "Plant Treaty") followed the 1992 Convention and its benefit-sharing mandates. An earlier version of the Plant Treaty, the 1983 International Undertaking on Plant Genetic Resources for Food and Agriculture, relied on the principle that genetic resources are the common heritage of humanity.

But if “social” relations are now joined to a potential that is linked to biodiversity, what biological diversity is remains an open question. Rather than attempting to answer this question, in this chapter I closely detail the relationships Hayden describes of the legal and technological developments that have influenced renegotiations of the public and private domains. By considering the implications Hayden details of these developments for bioprospecting agreements, we can begin to define as well their implications for technical solutions like food security and the reconfiguration of the body-as-data.

The “Value” of Biological Diversity

A departure from the work of scholars who have argued that bioprospecting is just another form of biopiracy, including the work of Vandana Shiva (1993), Jack Kloppenburg (1991), Keith Aoki (2008), and others, Hayden (2000, 2003) considers how the scientific research practices negotiated through benefit-sharing contracts are places where new kinds of social and political relationships are forged. The focus of Hayden’s ethnographic project is a particular agreement between plant researchers at Mexico’s National Autonomous University (UNAM) and the University of Arizona and their industrial partners in the United States. In order to follow the forms of inclusion and exclusion that are generated by prospecting agreements, we must keep in mind the admission stressed by the participants in Hayden’s study: that a drug is the least likely result of a bioprospecting agreement. “No product has even made it into the pipeline” (Hayden 2003:3).

Responding, therefore, to assumptions that the value of biological diversity can be reduced to the labor of the biological human body, Hayden is careful to stress how in the context of bioprospecting, biological diversity directs us to a promise, one that makes questions about "value" ethnographic. As she explains, "[value] is neither a thing that inheres in biodiversity or cultural knowledge, nor something that can be understood solely with reference to prospecting's matrix of dollars, *pesos*, and percentages" (Hayden 2000:10). Instead, biological diversity's value involves the social and political processes articulated through prospecting contracts "tak[ing] us to domains beyond the privileged Marxian question of labor power, hidden away in the production of commodities" (2000:10).

When we are focused on the relations that are forged "in and through biological diversity," as they manifest in pharmaceuticals as well as in other forms of knowledge about plants, medicines, and chemical compounds, questions about these relations direct us to the scientific practices that determine which objects and knowledge are mediated through prospecting agreements. These decisions, Hayden argues, follow shifts in the trade and property status of biological material and knowledge, the implications of which give shape to, produce and invoke the "objects," "subjects," and "interests" of these agreements.

THE POLITICS OF BIOPROSPECTING

Knowledge, Interests, and Publics

Straightforward work in science studies that draws on Bruno Latour and Michel Callon's actor-network theory (ANT) underscores the interests that reside in "knowledge" and "nature." From the outset of her study, however, Hayden means to underscore how bioprospecting agreements complicate such work. Not a container for interests, the interests and knowledge thought to reside in biological diversity are shaped instead through bioprospecting agreements. Her ethnographic inquiry into these processes complicates, therefore, some of the central claims of science studies, in particular the idea that knowledge and bioartifacts "contain, reproduce, or represent people's interests" (Hayden 2003:19).

Noting how, in constructivist analyses in the sociology of science, a stabilization of facts occurs alongside those institutional and rhetorical networks that lend legitimacy to scientific claims, Hayden points to scholars in the anthropology of science whose work explores instead the cultural meanings of scientific knowledge (Hayden 2003:38, see Latour 1987). Following the influence of feminist kinship theorist David Schneider, these scholars note that Western biological models of reproduction are often times treated as a foundation against which to measure cultural variation. Rather than treating them as foundational, these models of reproduction are treated instead as "'folk categories' that themselves must be understood symbolically" (Hayden 2003:238n2).[17] Following Schneider, Hayden stresses that nature, the presumed reference point for scientific knowledge, is in fact already mediated.

However, not only emphasizing how, for the forms of sociality and politics joined to bioprospecting, scientific knowledge is already mediated, Hayden notes as well the tendency in liberal theory to treat interests as explanations for why people do the things they do. If theories of liberalism suggest we live in a world populated by "rational actors whose behavior can be attributed to efforts to calculate and maximize our own gain (whether measured in accumulation of capital, or in other currencies such as reward, reputation, or credibility)" (2003:20; see also Hirschman 1977), Hayden points out how the interests connected to bioprospecting are

[17] As Hayden (2003:238n2) notes: "There has been a direct feed from feminist kinship theory to much of the work currently being done in the anthropology of science on new reproductive technologies, biotechnology, cloning, conservation biology, genomics, and artificial life, among other domains (Helmreich 1998; Franklin 1995 and 2001; Franklin and Ragoné 1998; Haraway 1997; Strathern 1992b and 1999; Ginsburg and Rapp 1996). These studies tell us a great deal about how knowledge practices and technology are changing relationships among people, capital, and nature, just as they tell us about 'traditional' anthropological concerns such as the relationships between specific notions of nature and culture; or, what counts as a person and a relative."

irreducible to the object. In the context of bioprospecting, interests instead become what Hayden refers to as “an ethnographic object, or a term that does a great deal of work ‘on the ground’” (2003:22).

The forms of participation mobilized by prospecting agreements follow, therefore, what Hayden (2003:22) describes as the “dual notion of representation—claims *to* and *about* biological materials and knowledge,” a “formula” that lays bare the requirements for inclusion mediated by these agreements.

Economics, Knowledge, Property

Connected to developments in intellectual property law, the relationships mobilized by prospecting have as their basis forms of growth attributed to a knowledge economy (Hayden 2003:22–23; see Strathern 1999b). In this context, however, monetary capital, natural resources, and land are no longer the driving forces of economic growth. “Nature” remains as site and source of value, as Hayden is careful to clarify (see Etzkowitz and Webster 1995:481). However, what is integral to consider here is how a new kind of nature emerges, different from the timber, land, minerals, and petroleum typically associated with capitalization in an industrial economy.

Different from Cooper, who considers how legal regulations permit ownership over the organism’s principle of generation, Hayden stresses how this new nature follows distinctions in intellectual property law that renegotiate (again and again) the boundary between what is “already existing” and an “innovation.” If the capitalization of knowledge involves “life itself,” or “DNA, genetically modified organisms, [and] gene sequences” (2003:23), the techniques for recombining, “engineering,” and manipulating DNA have been accompanied by shifts in the articulations of life that are subject to patent claims.

The basis of these shifts point to John Locke's Enlightenment notions of property in the self, where Locke defines intellectual property rights primarily as a tool of exclusion that grants exclusive rights to an idea, technique, or process (Hayden 2003:24). Highlighting that nation building is explicitly connected to this process, Hayden underscores how inventions rewarded by the patent are granted and protected by the state. The discourse of patent law is not only written to encourage individual innovation but is aligned with a larger project: to protect and produce national storehouses of intellectual capital and innovation (2003:24).

Locke's notions of property in the self lays the ground for the kind of innovation protected by the patent, that is, a mixture of intellectual labor and something taken out of its "natural state," but integral here as well is the idea of nation building that Hayden (2000:90) points to, as "patents were seen (by then-President Thomas Jefferson, among others) as the spark that would fire the industry of a young America" (see also Chon 1993). An enhancement of the conditionality that Hayden points to, I will argue that with the introduction of seed vaults promising to insure biological diversity in perpetuity *by making crop diversity freely available* we have to question whether innovation economies are now or will remain explicitly a nation-building exercise.

Biological Diversity and Products of Nature

Putting aside for the moment this question of the relationship of innovation economies and the project of nation building, we should consider the changes in patent law that Hayden makes instrumental to the forms of participation and responsibility that accompany prospecting agreements, as these changes permit us to see how "biological diversity" becomes a resource amenable all at once to both biotechnological enterprise and the politics of environmental sustainability.

Evolutions in intellectual property law permit us to see where the social and political forms joined to bioprospecting are hitched to the very terms upon which innovation is founded: boundaries between the public domain, where life is already existing, and the private realm, where innovation and novelty are made. As Hayden (2003:25–26) is careful to stress, these boundaries have always been open to “reengineering”:

> Evidence of this mutable boundary is found in the expansion of the drug industry, from seeking patents on enzymes and chemical compounds, where patent examiners for over a hundred years qualified “nature” as subject to the realm of patents so long as the compounds were “isolated” and “purified,” to its current consideration of microbiological processes as subject to patent.

These boundaries became more complicated in the 1980s when, with changes in the “products of nature doctrine,” the U.S. identified as patentable subject matter an array of “life forms” previously excluded from the realm of patentable innovation.

These changes paved the way for the U.S. Supreme Court decision in *Diamond v. Chakrabarty* that held a genetically engineered microorganism designed to clean up oil spills could be patented just like an inanimate invention. At this point we should note how the court broadened its interpretations of patentable subject matter to “anything under the sun that is made by man” (Supreme Court quoted in Hayden 2003:26; see *Diamond v. Chakrabarty*, 447 U.S. 303). Hayden (2003:26) continues:

> The *Chakrabarty* decision thus literally enabled the emergence of a whole new class of property by prying wide open an already thinkable (and yet still head-spinning) gap between “things of nature that occur naturally” and “things of nature that occur by man’s handiwork.” (see also Sherwood 1990:47)

But the relevance of *Chakrabarty*, as many scholars including Hayden have noted, points to a more extensive reorganization of public bioscientific research, venture capital, and industrial research and development, both in the United States and internationally. The 1992 Convention renegotiated the statuses of cultural knowledge and wild genetic/biological resources, creating new distinctions among "the appropriable public domain" and "the privatizable realm of novelty and innovation" (Hayden 2003:24). But if these changes introduced contests between UN countries and within the UN itself, such contests became even more fraught in light of the legal developments Hayden describes, as these developments further unsettled the premise that nature is "always already existing and, thus, not a (human) invention" (2003:25).

Commenting on the relevance of changes to the "products of nature" doctrine in the 1980s, as it defined existing life for the first time as a subject for innovation,[18] Paul Rabinow (quoted in Hayden 2003:26) notes the altered configuration of knowledge and power it emblematized:

> The Supreme Court's ringing proclamation that "congress intended statutory subject matter to include anything under the sun that is made by man," coming as it did in the same year as the election of Ronald Reagan as president of the United States and the massive influx of venture capital into the biotechnology world, not only opened up "new frontiers" in the law but can appropriately be seen as an emblem of an emerging constellation of knowledge and power.

Also part of this reorganization, however, are changes in the regulatory structure of the biosciences in the United States that made an enterprising approach to academic knowledge all but unavoidable (Hayden 2003:27; see Wright 1994).

[18] Hayden's discussion of this doctrine echoes Feher's (2009:32) description of the constructionist character of liberalism, whose endpoint is the "social market economy" as conceived by German Ordoliberals in the 1940s and 1950s, a point I return to at the conclusion of this chapter.

These legal developments that make the production of scientific knowledge a form of intellectual property make those science studies that focus on the "social interests" that reside in nature and knowledge something of a redundancy. Henry Etzkowitz and Andrew Webster make the same point in their 1995 article, "Science as Intellectual Property":

> Formerly, academic scientists were content to capture the reputational rewards and leave the financial rewards of their research to industry; [however] this division of institutional labor is breaking down, hastened by the financial pressures as professors and universities view their research enterprises as akin to businesses that must generate revenues to survive. … [In a knowledge economy], science policy and industrial policy merge into one. (quoted in Hayden 2003:28, see Etzkowitz and Webster 1995:481)

Studying bioprospecting contracts requires, therefore, a different approach than one that treats networks of interests and collaborations as latent to scientific practice, as we must now account for forms of inclusion and exclusion that are political and at the same time entrepreneurial. What's required, as Hayden (2003:29) explains, is a methodology trained to the promises joined to biological diversity, a method that permits us to see the abundance "of political liabilities and property claims, accountabilities and social relationships [that] are being actively written into scientific practices, tools, and objects of intervention and back out again, in ways not quite anticipated by the traditional science studies approach."

OTHER PEOPLE'S INTERESTS

To frame these questions about the interests generated through prospecting agreements, Hayden explores scientific research in ethnobiology and ethnobotany that has been made to represent "'other' people's interests" (Hayden 2003:30). A precursor to contemporary bioprospecting collaborations, ethnobotanists and plant chemists who have adopted this tactic have promoted the idea that knowledge production can at the same time be an effort to defend or promote the interests of peoples with whom they work. At the basis of this endeavor is a kind of translation: the process of turning plants and sometimes knowledge about the uses of plants into "industrially useful, biologically active, chemical compounds" (2003:31). In this way we can imagine the precursors for ethnobotanists today: scientific researchers funded by the U.S. National Cancer Institute to lead searches for drugs that might cure cancer or HIV have as their ancestors the American botanists and ethnoscientists during and after World War II who were sent in search natural sources of rubber and penicillin (2003:31).

There is a complicated legacy for bioprospecting agreements, one in which resource extraction is intertwined with histories of colonialism, natural history, and botany (Hayden 2003:30). However, only since the late nineteenth century has the field of economic botany become explicitly devoted to the task of turning plants and local knowledge into industrial products. With this process, we find resource extraction joined together with the political project of making ethnobotanists and ethnobiologists the chroniclers and "translators" of local knowledges (Hayden 2003:31). As advocates for traditional knowledges, these scientists view their task as rendering legible indigenous or traditional classification schemes in order to demonstrate their "scientific veracity, rationality, efficacy or (more recently) sustainability" (Hayden 2003:31). Scientists design studies or use their laboratories "precisely as if they were courtrooms—staging grounds for proving the legitimacy of local knowledge, and in turn, using these validations as tools for the advocacy and defense of the communities with whom they work" (Hayden 2003:31).

The production of scientific knowledge in these fields combines a production of interests for industry that are at the same time a way of lending legitimacy to particular knowledges and communities. But if such practices draw our attention to the self-maximizing actor that Hayden identifies as pivotal to articulations of bioprospecting agreements, I will argue a different sort of "actor" emerges in discourses on food security: the "figure" of human populations and nonrepresentational knowledge.

Epistemological Advocacy

Hayden draws on the work of Adriana Maya (2000) to note several different ways that "epistemological advocacy" works. Maya's work focuses on ethnobotanists who are the "intellectual allies" of indigenous and Afro-Columbian peoples. To describe how ethnobotanists have become allies of peoples engaged in rights-based struggles, Maya references ethnobiologist Eugene Hunn's (1999) reflections on his experiences as a witness for the Squaxin Island Tribe in Washington state. In this instance, a tribe that was seeking access to tidelands to harvest shellfish was defended on the basis that Hunn's research gave their knowledge a scientific basis. Hayden (2003:31) quotes Hunn to explain:

> Hunn writes that his research proved an effective tool for supporting indigenous claims precisely because of the correspondence of native knowledge with Western science: "ethnobiological testimony with rare exceptions is supportive of native claims. This is by virtue of the fact that indigenous knowledge is, as ethnobiologists have shown, essentially scientific." (see Hunn 1999)

Underlying this brand of defense is the understanding that ethnoscience can be used to calibrate traditional classification systems and resource management "to provide evidence for the fundamental unity and rationality of knowledge about nature" (Hayden 2003:31).

Another mode of epistemological advocacy makes the benefits of this arrangement to science more explicit. This form of advocacy, Hayden (2003:32) notes, has been used to oppose "the well-sedimented ideological move—by the World Bank, international conservation groups, and developing nation governments—to justify interventions into peasant and indigenous communities by labeling their practices as backward, dangerous, and/or environmentally destructive.” In these instances, the cases made by Northern ethnobotanists and ethnoecologists are for indigenous modes of cultivation and management techniques that are exemplary of sustainable forestry and agriculture and models for local development and conservation (2003:32). Operating between nation-states and indigenous communities, Hayden explains here how the “explicitly politicized defenses of marginalized peoples and practices” generated by these scientists are calibrated “to the notions of sustainability and conservation that have permeated international discourse in the last two decades” (2003:32).

When combined with resource extraction, epistemological advocacy produces both credibility and dividends for traditional knowledge. This way of practicing ethnobotany mirrors Richard Evan Schultes’s (1995) description of ethnobotany as an “activist discipline.” Mentor to many ethnobotanists, including Mexico’s National Autonomous University researcher Robert Bye who is prominent in Hayden’s ethnographic research, Schultes and his students see themselves as “culturally sensitive plant-hunting Davids, taking on the Goliaths of Western ethnocentrism, scientific hubris, modernizing violence, and bureaucratic idiocy” (Hayden 2003:32).

Legendary in the field, Schultes is well known for his advocacy of indigenous knowledge as well as his ability to tease out and reveal the chemical abstracts of various traditional or folk remedies. Not exclusive to Schultes or his students, this more enterprising form of epistemological advocacy is promoted by other prominent ethnobotanists, including Mark Plotkin (1993), and Michael Balick and Paul Cox (1996). This particular form of epistemological advocacy follows turns in international development and conservation as these now attend to biological diversity, cultural diversity, and market-oriented sustainable development initiatives

(Hayden 2003:33).

Benefit-Sharing Programs

Vocal proponents of benefit-sharing programs, the work of Plotkin (1993) and Balick and Cox (1996) highlights the connection between the ethnosciences and the National Cancer Institute (NCI). Hayden (2003:33) underlines that the NCI is "one of the world's most important institutional homes and funding sources for the twinned projects of 'valorizing' traditional knowledge by channeling it into pharmacological pipelines." Through its ongoing support for natural products and ethnobotanical screening as well as in its relationship to the National Institute of Health (NIH), the NCI is a powerful influence on current bioprospecting initiatives. The long-standing mission of the NCI is to search for plants, and more recently for microbes, that contain compounds that could be used to generate drugs that fight cancer. From 1960 through 1982, and again from 1986 through the late 1990s, this U.S. government program "has supported basic research, contracted with collectors in tropical counties and entered into licensing agreements with companies once a promising lead is fleshed out" (Hayden 2003:33; see also Aseby 1996; Chapela 1996; Goodman and Walsh 2001).

Consistent support for natural products and ethnobotanical screening by the NCI has shaped current bioprospecting initiatives as well as the view that biological diversity contains the secret to the health of the planet and human life (Hayden 2003:33). Pointing to the rates of pharmaceutical activity for the medicinal plants referenced by Plotkin, Balick, and Cox, Hayden underscores how in their view bioprospecting reveals a pharmacological value of traditional knowledge. But at the same time this value makes epistemology and biochemistry correspondent with the revenue streams for the scientists who are stewards for traditional knowledge (see

Plotkin 1995; Balick and Cox 1996). As she argues,

> This promissory equation gives us a pointed reading of the representational work that knowledge is being asked to do in this formulation: knowledge is posed here as a resource with a capacity to represent and reproduce indigenous peoples' interests as it travels through drug discovery circuits. (Hayden 2003:34)

From this vantage point, we can see how academic researchers claim a space "as champions of an embattled, liberal scientific effort to 'promote and maintain diversity' in the face of some of the most profitable and resource-intensive sampling and mapping projects of the late twentieth and early twenty-first centuries" (2003:34; see Haraway 1997:248).

Academic Research and the Defense of Diversity

If we pause to consider how these defenses of diversity alter the way we view "representation," we must note as well how indigenous people and biological diversity together become resources for research and development at the same time that they are viewed as having transparent and desirable benefits for humanity (Hayden 2003:34; see Reardon 2001). It is this context Hayden means to highlight for bioprospecting, focused as she is on the collection strategies and ethical protocols of professional societies, where the politics of prospecting are played out. In this context, we have on the one hand practices of "collecting, 'translating,' promoting and facilitating access to indigenous knowledge and resources as leads for industrial research and development" and on the other hand the institutionalized shifts pioneered by researchers from ethnobotany and ethnobiology "in what counts as ethical research practice" (Hayden 2003:35).

The Declaration of Belém is part of this complicated academic legacy that has "long mixed takings and givings" (Hayden 2003:35; see also Povinelli 2002). Issued by the International Society of Ethnobiology in 1988, the declaration is a statement of professional conduct and call to arms urging academic researchers to save cultural and biological diversity. In 1988, members of universities invited representatives of indigenous and traditional communities to meetings in Brazil to discuss the development of a common strategy for conservation of biological and cultural diversity. The resulting Declaration of Belém states: "native peoples have been the stewards of 99 percent of the world's genetic resources" and "there is an inextricable link between cultural and biological diversity," and submits that "mechanisms be developed for compensating traditional peoples for use of their resources" (as quoted in Hayden 2003:35; see ISE 1988; Posey 1996).

Here then we find evidence of the complicated interests promoted by prospecting agreements, joining together "a 'globalist' concern with biodiversity conservation" and "indigenous rights to resource management" (Hayden 2003:35–36). On the statement of conduct attached to this call to arms, Hayden (2003:35–36) notes:

> The Declaration of Belém was among the first protocols to place compensation of native peoples for their genetic resources on the menu as a form of *responsible research practice*. At a subsequent ISE gathering in Kunming, China, the Society [of Ethnobiology] founded The Global Coalition for Biological and Cultural Diversity as a mechanism to put the Declaration of Belém into practice. (emphasis Hayden's; see also Posey 1994:238)

Scientific practices that have contributed to making these resources an identifiable, codeable "object" can be connected to a host of multilateral initiatives, including those affiliated with the World Bank's Indigenous Knowledge for Development Initiative, the 1992 UN Conference on Environment and Development, and the UN World Intellectual Property Organization's working group on indigenous intellectual property.

INDIGENOUS KNOWLEDGE AND INTELLECTUAL PROPERTY RIGHTS

Now connected to an economic or otherwise appropriable value, genetic resources permit traditional knowledge to be conceived "as an entity to which its original stewards might well be able to claim property or property-like protection" (Hayden 2003:36). Biodiversity and traditional knowledge become objects that "can/must be drawn upon to make development projects work better, or to make drug discovery go faster, or to conserve biodiversity" (Hayden 2003:36). Such objects—whether knowledge, biological material, or intellectual property—become "central points of contest not just in and between corporate boardrooms and academic laboratories, but as part of the palette in which contemporary struggles are being painted" (Hayden 2003:37).

Corporate patent claims have not only expanded, intellectual property has become a way of extending an economy of rights to indigenous peoples through prospecting agreements. Intellectual labor and contributions to innovation become the basis for a claim to entitlement rather than a claim to physical property. First promoted among Northern academics and activists in the 1980s and 1990s, within and outside UN-level and multilateral policy discussions as well as among policy makers and critical legal scholars, the notion that intellectual property might serve as a basis for political mobilization is now supported among indigenous working groups as well those organized through the UN Convention on Biological Diversity, the UN Economic and Social Council (ECOSOC), Native American tribes in the United States, First Peoples groups in Canada, and indigenous organizations worldwide.

For example, the charter of the newly formed International Alliance of Indigenous-Tribal Peoples of the Tropical Forests includes, as Hayden (2003:38) explains: "an explicit nod to intellectual property and a democratized claim on privileged modes of industrial production." The charter reads: "Since we highly value our traditional knowledge and believe that our biotechnologies can make an important contribution to humanity, including 'developed' countries, we demand guaranteed rights to our intellectual property, and control over the development and manipulation of this knowledge" (quoted in Hayden 2003:38, see Posey 1994:235).

Codified in the Declaration of Belém (1988) is a formulation that makes indigenous people's knowledge joined to "the very fabric of biological diversity itself," thus illustrating how biodiversity conservation has been the lever for granting indigenous communities access to intellectual property rights.[19] Summarizing this formulation, Hayden stresses that, "efforts either to conserve or to industrialize these resources (or both) must take into account the prior rights, interests, and claims that reside within them" (2003:39). Jack Kloppenburg, rural sociologist and activist of Southern communities and farmers, puts the formula in the following terms:

> Genetic and cultural information has been produced and reproduced over the millennia by peasant and indigenous people. Yet, like the unwaged labor of women, the fruits of this work are given no value despite their recognized utility. On the other hand, when such information is processed and transformed in the developed nations, the realization of its value is enforced by legal and political mandate. (quoted in Hayden 2003:39)

Biological resources are already mixtures of labor and nature of the people who cultivate them. Therefore, those people deserve "some share—materially—in profits derived from them" (Hayden 2003:39).

This view that "wild" resources are "in fact always already managed" is highly charged

---

[19] As stated in the Declaration (1988): "GIVEN—that economic, agricultural, and health conditions of people are dependent on these resources, that native peoples have been stewards of 99% of the world's genetic resources, and that there is an inextricable link between cultural and biological diversity."

because of the uncertainty surrounding intellectual property rights and the material gains potentially derived from these resources. Promoted by the ETC group, with whom Pat Mooney and Cary Fowler are both affiliated, this view informs a code of ethical conduct aimed at bioprospectors that lists as its first point: "No 'Wild Kingdoms': Bioprospectors must assume—unless there is proof otherwise—that all materials they encounter have been nurtured and enhanced by communities" (quoted in Hayden 2003:39). But highlighting this mandate introduces questions about whether the interests of indigenous communities can be well represented by these frameworks. This question about the capacity of intellectual property to be used as an instrument for enfranchisement and protection is explicitly related to the forms of "inclusions" and "exclusions" articulated in benefit-sharing contracts. As Hayden (2003:40) asks, "[b]enefit sharing contracts, for some of their proponents in the worlds of sustainable development and ethnobotany, constitutes a bid to include people by 'including their knowledge' in the drug discovery process. But include people in *what*, we might ask?" (emphasis Hayden's).

Locke's formula (nature + intellectual labor = value) looms large in these agreements that frame both "a promise of inclusion as well as a threat of exclusion" (Hayden 2003:40). But we ought not conclude that the contingencies of the boundaries drawn between invention and discover, labor and innovation, nature and artifice are coincidental to how contributions are rewarded. On the contrary, contributions are rewarded by degree, according to boundaries drawn between discovery and invention. Raw contributions are rewarded, in most cases, for labor, knowledge, or the provision of plant materials; in some situations, differential returns are negotiated relative to the relationship between inputs and eventual outputs: "Higher royalty payments [are negotiated] for specimens that lead directly to a marketable product, and lower returns if the participating company has to work harder to squeeze a marketable product out of the chemical compounds sent their way" (Hayden 2003:40).

Undergirding these differences in the degree of contribution to innovation is the Lockean subject, or the individual who retains the right to sell his intellectual labor. This model however, as Hayden (2003:41) underscores, is not particularly well suited to granting protections to "collective, cosmopolitan knowledges." While many indigenous organizations, alliances, and networks support benefit-sharing contracts as the basis for imagining how indigenous communities can become participants in the "global economy," others are more wary. Lorenzo Muelas Hurtado, for example, a Guambiano Indian and former Colombian senator, points out that the fundamental distinction upheld by benefit-sharing contracts—between biological resources and traditional knowledge—is at odds with fundamental indigenous principles.

In a speech to the International Indigenous Forum on Biodiversity, a group that convenes before each of the Conference Parties to the UN Convention on Biological Diversity, Muelas Hurtado's distinguished between the biodiversity addressed by world governments and a vision of the universe held by indigenous communities. Hayden (2003:41) writes:

> In his appeal to both indigenous and non-indigenous of the UN Working Groups, Muelas Hurtado reminds his audience of a number of clear statements generated by previous meetings of the International Indigenous Forums on Biodiversity. Among these is the declaration that [Convention on Biological Diversity] members should "impose a moratorium on all bioprospecting and/or the collecting of biological materials in territories of indigenous peoples and protected areas and on the patenting of these collections."

But Muelas Hurtado's vision is undermined by discussions that focus on negotiating the wealth and knowledge between some indigenous groups and some governments.

Ethnobotanists like Victor Toledo, for example, take another tack, seeking instead to make Mexican ethnobotanists the intellectual allies of indigenous movements. In the configuration Toledo proposes, which focuses on the relationship of indigenous communities to nation-states rather than on the logics of innovation now supported by pharmacology labs, Mexican ethnobotany is directed towards making ethnobotanical knowledge "work in the interests of indigenous peoples in their struggles against the nation-state, and/but also in the interest of the nation, against the colonial north" (Hayden 2003:43).

Toledo argues that Mexican scientists at the UNAM and elsewhere can be intellectual allies to indigenous movements in Mexico and elsewhere by "putting ethnobotany to work for Indian communities first (for example, by incorporating ethnobotanical courses into popular education programs supported by the government); and making attempts to revert knowledge to communities" (Hayden 2003:42). But contradictory ideas follow this formulation of the "the indigenous" within the nation, ideas that are further exacerbated by the politics of prospecting, as Hayden (2003:43) explains:

> With this formulation, in which "the nation" is central—that is, in the middle, between indigenous peoples and transnational companies—comes an ambivalent story about the place of "the indigenous" within the nation. This ambivalence is a deeply sedimented one in Mexico that feeds back into the representational politics of prospecting in some complex and significant ways. For, in fact, one of the most active fronts of ethnobotanical and plant research has been an ongoing legacy of nationalist projects with the goal, precisely, of turning traditional knowledge into a national resource base for pharmaceutical development—not for foreign companies, but rather in the name of the republic.

PROSPECTING AND THE COMPETING PUBLICS OF ETHNOSCIENCE

Alongside those advocating for intellectual property rights for indigenous knowledge, others like anthropologist Michael Brown (1998:205) insist that such projects come at the expense of a "wider principle": the public domain. But the publics of prospecting differ from the juridical public of the public domain, as Hayden (2003:44) notes:

> Brown argues that it is a robustly protected right to the free flow of information and knowledge—the principle hallmarks after all, of liberal democracy—for which we should 'all' be fighting, rather than a (potentially counter-productive) balkanization of intellectual fiefdoms in the name of indigenous rights.

Putting aside for the moment the question of whether Brown's case is tenable, the notion that there is a public domain absent of private property claims provides an interesting point of comparison for the publics of ethnoscience, and one that is complicated by the reconfiguration of institutionality that attends the turn to food security.

The juridical public is typically defined in terms of the absence of property claims. As Hayden (2003:45) asks, if the publics of ethnoscience are tied to intellectual property, how should we define the capacities of knowledge and nature to "represent something called interests"? If the public domain is "an arena where, simultaneously/alternatively, everyone and no one might have a claim," in the case of prospecting agreements "[t]his, then is the same public that constitutes the raw, appropriable material for patentable innovation or copyrighting" (Hayden 2003:45; see Coombe 1998).

Hayden underlines that the public domain is an entity that owes its existence to state power. Considering how prospecting agreements activate "the 'representative' capacities of knowledge and nature" in Latin America and elsewhere, the (national) public domain becomes a site for making claims in which the nation can take precedence over and above the interests of indigenous communities (Hayden 2003:45). The decisions of companies, Latin American officials, and university researchers to collect resources "safely in the public domain" are often accompanied by declarations from scientists who are "daunted (rather than … moved to direct representational action) by the prospect of negotiating benefits with indigenous communities" (Hayden 2003:45).

The national public domain becomes a safety zone, therefore, constituted not so much by any common division between public and private property but instead according to its distinction from sites that are affiliated with indigenous communities (Hayden 2003:45–46). What emerges is an institutional arrangement bolstered by the UN Convention on Biological Diversity that recognizes communal rights at the same time that it designates biological resources and cultural knowledge as "national sovereignty," thus setting up "communities and nations as competing publics to whom benefits must be returns" (Hayden 2003:46).

"The public" is invoked among those involved in prospecting agreements not as a site of refuge but as a defense against the charge that ethnobotanists and chemists participating in prospecting agreements are stealing traditional knowledge and community resources.

> The constitution of prospecting's publics thus enrolls a few more dimensions here: not just an "ownerless" juridical space, but an anticipated and messy public sphere of contest, debate, and protest, which may ostensibly be avoided or closed off through recourse to the safe publics of non-community resources. (Hayden 2003:36)

But in light of Brown's concern—that the public domain is not more broadly supported by indigenous peoples—we might consider how the public, both its sites and resources, is animated by the reconfiguration of the body-as-data that follows the turn to food security. Hayden (2003) considers how various aspects of public-ness (of sectors, accountabilities, and juridical publics) are now made to "mix and mingle" through the publics that prospecting produces, leading her to ask: How do these multiple publics become involved in the contests over rights, obligations, and interests that are mediated by and through prospecting contracts? To which I wish to add, if we are able to see the publics produced by bioprospecting, what should we make of the turn to food security with the Global Seed Vault promising crop diversity in perpetuity and free access to crop diversity data online?

BIOLOGICAL DIVERSITY AS AN OBJECT

Related to these questions about publics, interests, and prospecting's circuits of exchange are the discursive and institutional international frameworks that shape bioprospecting and biological diversity (Hayden 2003:49). Notable here is a paradigm of sustainable development that began to emerge in the 1980s, when economic development and "modernization" began to be framed in terms of "environmental sustainability." An understanding of development that stresses an ability to meet our needs in the present without comprising the livelihoods of future generations, this framework for development requires we consider once again the capacity of biological diversity as an "object." Noting its "magical attributes" that began to be attributed to the market in the 1980s, Hayden (2003:49) explains how the paradigm of sustainable development emerged alongside the neoliberal mantra that "what the state, and in this case international development organizations, might once have done (whether well or poorly), 'the market' can do better" (see Escobar 1996).

Hayden connects the emergence of biological diversity as a particular kind of object to the shifts in discourses and frameworks for development and conservation found at the World Bank, the UN, and other major players in the international arena: from conventional economic development to the principle of sustainability. Along with this shift, we find a corresponding internalization "not just of nature into the market, but of 'people' into nature, development, and indeed, the biodiversity-derived production of value itself" (Hayden 2003:49). This mode of inclusion can be attributed to the particular conception of biological diversity "as a storehouse of valuable genetic resources and as a resource to be managed as an explicitly economic enterprise" (2003:49). Such inclusion joins a politics of accountability with one of participation, a connection that becomes even more remarkable when we read them alongside the imperatives, promises, and obligations that appear in bioprospecting contracts.

From Development to Biodiversity

The World Bank, the UN, and other prominent voices in the international arena first promoted the principle of sustainability in response to criticisms—voiced by Southern activists and policy makers, as well as a growing body of NGOs and other sectors of civil society—that conventional models of development were both environmentally and economically disastrous. Biodiversity prospecting emerged in response to concerns among several U.S. scientists and conservationists over what was conceptualized as a fundamental obstacle to implementing conservation programs in developing countries. As Hayden (2003:50) claims, alarmed scientists and conservationists suspected "that for 'gene rich' but 'cash poor' third world governments under pressure from the International Monetary Fund, the World Bank, and other international financial institutions, logging forests was a much more appealing economic strategy than conserving them." Early proponents of prospecting argued that Southern nations had no economic incentive to conserve their biological resources. Prospecting was proposed as a remedy that could guarantee returns to source countries and communities for the use of their biological resources (Hayden 2003:50; see Eisner 1989–1990; Eisner and Beiring 1994).

Thomas Eisner, an entomologist at Cornell University, was among the first to suggest using benefit-sharing contracts as "a profit-generating engine for conservation" (Hayden 2003:50). Noting the lack of property rights for wild genetic resources as an obstacle to implementing conservation programs in developing companies, in 1989 Eisner suggested benefit sharing could be a mechanism for generating profits from industrial screening of chemical compounds from natural specimens.

Eisner later contributed to one of the first and most widely publicized prospecting agreements: the arrangement that in 1991 connected Costa Rica's National Biodiversity Institute (INBio) with the U.S.-based pharmaceutical company Merck Sharpe & Dohme (Hayden 2003:50). Eisner used the phrase "chemical prospecting" to describe the practice of searching for useful chemical compounds from plants, insects, and other forms of nature in order to pay for conservation. Referencing Eisner (1989–1990:33), Hayden (2003:50) describes this as "an idealized and efficient feedback loop: industries would help pay for the conservation of raw material and, at the same time, the new-found economic value of this resource would inspire developing nations to conserve their forests rather than '[chop] them down.'"[20]

Only later did "biodiversity" replace the moniker "chemical" among researchers and policy makers when referencing this process, an attention to "branding" that is not insignificant to Hayden. If "biological diversity" is a fairly recent object, Hayden (2003:50) argues this is "a new inflection of an old concept." First used by U.S. biologists and conservationists who wanted to bring conservation to the attention of policy makers in the United States and internationally, biological diversity was later shortened to "biodiversity." The term assumed new life in the latter half of the 1980s, figuring prominently as international actors emphasized the importance of "a wide range of 'productive activities'… at the center of larger calls to begin fusing economic development with conservation" (Hayden 2003:51). But part of the promise of biodiversity, Hayden (2003:51) argues, occurs through its laundering of "that *other* kind of prospecting—leaving only a trail of redistributed value (and more biodiversity) in its wake" (emphasis Hayden's).

[20] Hayden (2003:50) notes that the word "chemical" "has since been dropped by most researchers and policy makers in favor of the ubiquitous and perhaps gentler, 'biodiversity,' but in either case, 'prospecting' itself has remained a durable image and metaphor."

Growing interest among biologists and conservationists in redefining development and conservation by "fusing economic development with conservation" can be traced to a report issued by the Brundtland Commission in 1987. The report cited the failures of traditional development and modernizing schemes, and proposed linking environmentalism and economic development. Shortly thereafter a series of publications emerged in response, including those from the UN's Environmental Program and the Food and Agriculture Organization and the International Union for Conservation of Nature and the World Resources Institute, among others, wherein "biological diversity" was put forth as an emblem for a new market-mediated approach to development (Hayden 2003:52).[21]

In comparison to the more defensive posture that follows conceptions of nature as "wilderness," responses to the Brundtland report attribute to biodiversity an offensive posture that is simultaneously "'participatory,' productive, and informational" (Hayden 2003:53). Prior to this point, discourse on conservation stressed nature in terms of a public domain in need of our defense. However, referencing the 1992 *Global Biodiversity Strategy,* Hayden (2003:53) explains that what biodiversity promises for "the development community's understanding of enterprise" alters the posture of "nature" as well: "Biodiversity conservation entails a shift from a defensive posture—protecting nature from the impacts of development—to an offensive effort seeking to meet people's needs from biological resources while ensuring the long-term

[21] Among these reports by other institutions and NGOs, Hayden notes: the *World Conservation Strategy* (IUCN et al. 1980) and *Conserving the World's Biological Diversity* (McNeely et al. 1990), published by the UN's Environmental Program and Food and Agriculture Organization in cooperation with Northern NGOs, including the International Union for Conservation of Nature and the World Resources Institute. Also together with the UN Convention on Biological Diversity, these organizations published the *Global Biodiversity Strategy* (World Resources Institute et al. 1992). As Hayden (2003:52) mentions, "[m]embers of these institutions, joined by members of Costa Rica's INBio, came together again in 1993 to publish *Biodiversity Prospecting*, a manual for prospecting that uses the pioneering collaboration between INBio and Merck as its central exemplar."

sustainability of the Earth's biotic wealth" (see World Resources Institute et al. 1992:5).

More firmly on the conventional economic radar, in the 1990s the development community began to stress biodiversity as "a kind of nature that seems more explicitly compatible with ideas of industrial and economic management and intervention" (Hayden 2003:52). Scientists including E.O. Wilson, Thomas Eisner, Anne and Paul Ehrlich, and Michael Soulé emphasized the variety of problems to which biological diversity could be a response. Hayden (2003:52) writes:

> As a distinctive articulation of nature, biodiversity weighs in across these calls to arms as a remarkable object: an ecological workhorse, essential raw material for evolution, a sustainable economic resource, the source of aesthetic and ecological value, of option and existence value, a global heritage, genetic capital, the key to survival of life itself. (see Flitner 1998)

The offensive posture biological resources are made to assume in discourses on sustainable development are exemplified too in the following comment by the authors of the *Global Biodiversity Strategy* (quoted in Hayden 2003:53):

> Over time, the greatest value of the variety of life may be found in the opportunities it provides humanity for adapting to local and global change. The unknown potential of genes, species, and ecosystems represents a never-ending biological frontier of inestimable but certainly high value. Genetic diversity will enable breeders to tailor crops to new climatic conditions. Earth's biota—a biochemical laboratory unmatched for size and innovation—hold the still-secret cures for emerging diseases. A diverse array of genes, species, and ecosystems is a resource that can be tapped as human needs and demands change.

This promise of biodiversity now connected to conservation strategies is made possible, as Hayden (2003:54) explains, "by its newly heightened status as potentially lucrative raw material for the drug, biotechnology, and agrochemical industries." The drug industry and, in particular, agrochemical and crop development industries, have long relied on these resources, and in the late 1980s, shifts in the property and trade status of biological materials alongside liberal efforts to promote and sustain biological diversity "ricocheted off of and fueled what turned out to be a noteworthy return of corporate interest in genetic diversity of all kinds" (Hayden 2003:54).

Natural Products Research: Technology and Competition

Before the middle of the twentieth century, drug development was focused on plant compounds. However, beginning in the 1950s, pharmaceutical companies began to target research and development efforts through synthetic chemistry, focusing research and development on designing chemical compounds from the ground up. Chemical compounds, Hayden (2003:54) explains, were designed with materials "derived directly or indirectly from plants or microorganisms, or built/modified from existing biochemical libraries and databases that provide a baseline idea of the structure of molecules that might have desired biological effects on human bodies or on pathogens."

Corporate interest in natural products research was sparked again after techniques in genetic engineering made plant compounds a competitive source for the bioactive compounds from which lucrative drugs are developed. Development of new bioassay techniques and genetic engineering technologies in the 1980s furthered this interest as these techniques, as well as the genetic engineering technologies that grew out of the Human Genome Project, sped up the pace of natural products research and allowed researchers to screen hundreds of plant extracts at a time (Hayden 2003:55). Among pharmaceutical companies, such developments led to renewed or novel commitments to screen plants for leads on bioactive compounds (Hayden 2003:55).

These developments ought to also be understood in relationship to the slowed rate of innovation in the field of synthetic chemistry in the early 1990s. As Hayden (2003:55) explains: "despite its extraordinary wealth, [the pharmaceutical industry] was confronting some significantly ‘dry’ pipelines for new products in the early 1990s.” Most of the drugs in use at that time had been discovered 20 years previously, and the patents (which last 17 to 20 years) on many of the keystone revenue-generating drugs were on the verge of expiry (Hayden 2003:56). With patents expiring, major companies began to invest first in natural products screening divisions and, starting in the mid-1990s, in even more innovative modes of research and development, including pharmacogenomics and bioinformatics (Hayden 2003:55–56). They did so, “by upgrading or starting natural products screening divisions in-house, by investing in or licensing products or databases from smaller biotechnology startups or bioinformatics companies, and by becoming involved in bioprospecting contracts with researchers and institutions across the Southern Hemisphere, and in the north as well” (Hayden 2003:56).

FROM SUSTAINABILITY TO SECURITY

The opportunism that precipitated the pharmaceutical industries’ “return to nature” was followed by a more explicit decision “to recast conservation as a matter of pegging the ‘value’ of nature to quantifiable measures of industrial worth” (Hayden 2003:57). As Hayden (2003:54) proposes, “if earth itself is a biochemical laboratory, why not pose drug and crop development as central catalysts for human adaptability and evolution?” This decision on the part of the pharmaceutical industry to take stock of biodiversity took hold just as biological scientists and development organizations began to cast nature in terms of its measurable worth to industry.

> Rapid rates of species extinction (conservatively estimated at 4,000 per year), coupled with the now familiar argument that one-quarter of prescription drugs is derived from plants, provided a calculus of endangerment and value that prospecting proponents used to galvanize support for conservation—and for positioning drug and biotechnology industries as central to generating funds necessary for such efforts. (2003:54)

As an example, we can note Bruce Aylward's diagnosis of Eli Lilly's investments in natural products research, which emphasizes the "option value" or idiom of loss connected to biodiversity. Aylward explains, "Eli Lilly's recent equity investment of $4 million in Shaman Pharmaceuticals, a California-based company that exclusively screens ethnobotanical leads, indicates that the industry *cannot afford to ignore* such sources of leads as the existing drug pipelines dry up" (quoted in Hayden 2003:56, emphasis Hayden's).

Coinciding with this decision to treat biodiversity as a storehouse of information (and potential profit), scientists and development organizations began to address species extinction in terms of the value of unknown information. In such discourses the loss of species is treated as a threat to knowledge. Species endangerment began to be framed as "a taxonomic call to arms," Hayden (2003:57) explains, making "scientific knowledge of species diversity … the opening line of a powerful salvage story that places bioprospecting in a rather heroic role: it is precisely the acts of classification and cataloguing that will make a nation's plants and animals more accessible to foreign researchers and industry—and thus more appealing as an investment."

CONCLUSION

By taking us through Hayden's work, my point has been to stress the promise we find in discourses on biological diversity as it is articulated through the bioprospecting contract. But if framed in terms similar to those Hayden describes, with food security these promises are no longer tethered exclusively to prospecting contracts. Now posed in relationship to a global seed vault and online data, conservation of global crop diversity makes insurance of food security, whose insurance is its promise of free access. Meanwhile food security discourse, referencing the imminent collapse of our world food economy and our global civilization, emits an ongoing incitement to innovate.

In discourses on environmental sustainability, biological diversity becomes dependent on developments in genetic engineering and new bioassay techniques, techniques for which there are speculative calculations on the plant extracts that fuel "prospecting architects' unabashed faith in the capacity of industrial exploitation to serve as the key to biodiversity's salvation" (Hayden 2003:58). But when viewed along with the history of information and the reconfiguration of the body-as-data, we might argue that the turn to food security begins with measures of statistical populations.

A Diffused System

If the 1992 Convention on Biological Diversity was an attempt to redress the inequities affiliated with the management of biological diversity as intellectual property, it also reinforced the notion that biological diversity should be treated as biomass for biotech. Hayden (2003:61) describes a configuration where scientific practice generates the interests and publics required for "a self-interested, maximizing actor—a rural plant collector, member of a community, a researcher, a representative of a national government, even, in some ways, a pharmaceutical company—who will respond appropriately (rationally) to biodiversity's newly attributed and articulated value."

But techniques devised to address biological diversity for food security alter once again the legality and economy that Hayden describes. Different from the self-interested, maximizing actor made in relationship to discourses and frameworks promoting environmental sustainability, subjectivity is conditional in the terms that Feher (2009:33) defines, of human capital where there is no distinction between the personal (inalienable) and the universal (entrepreneurial).

Hayden highlights a moral discourse on biological diversity that developed alongside genetic engineering and bioassay techniques. The language of stakeholder theory is used “to distribute rights and obligations across several temporal, spatial, and geopolitical scales” (Hayden 2003:60). In this discourse:

> short-term gains are hedged against long-term benefits; the Northern grassroots imperative to “think globally, act locally” is instrumentalized as an exchange of Southern stewardship for the Northern/global good; and numerous explicit and implicit decisions are being made not just about carrots and sticks but also about the types of persons that will be on the receiving end of such cajoling. (2003:60)

Access to participation through the bioprospecting contract is double-edged, merging questions about rights and obligations, and about rewards and incentives. Even in the eyes of its earliest and most prominent advocates, prospecting is not meant to promote social justice but instead “is framed first and foremost as an incentive structure” (Hayden 2003:61).

Interest in biodiversity becomes axiomatic in liberal discourses in ethnobotany and ethnobiology that extend intellectual property rights to indigenous peoples. Hayden (2003:61) writes, “[t]he notions of compensation within discussions of indigenous intellectual property rights emphasize that indigenous ‘interests’ (i.e., claims) in biodiversity axiomatically exist (indigenous peoples have an interest in their knowledge and should be compensated for it).” As a conservation strategy, bioprospecting agreements become a mechanism for “creating interest in biodiversity in the first place” (2003:61). This double-edged version of participation draws us to consider what Hayden (2003:61) describes as the primary goal of prospecting agreements: turning conflicting parties into mutually dependent “investors.” Developing nations, indigenous and local communities, and pharmaceutical and agrochemical industries are brought together by the one piece of shared ground produced through the contract: “each has something tangible to gain from the sustainable management of biodiversity” (Hayden 2003:61).

In the years following the *Chakrabarty* decision, Hayden explains how U.S. trade policy and multilateral trade pacts "formalized the idea of the management of (and traffic in) biodiversity as a question of intellectual property rights, the transfer of genetic resources, and, at times, of genetic material as a 'technology' to be traded in and of itself" (Hayden 2003:62; Lesser 1994). Pointing to these agreements, Hayden (2003:62) notes how newly industrializing nations became morally obliged to extend intellectual property protection to genetic resources:

> Among the most significant measures in this regard was the 1993 Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement of the Uruguay Round of the General Agreement on Tariffs and Trade (GATT). This agreement obliged GATT/WTO member states to provide patent protection in all fields of technology—including patents on microorganisms, and patent-like protection on plant varieties.

But there are glaring inequities affiliated with intellectual property distribution. Scientific and technological infrastructures that large transnational companies and highly capitalized biotechnology firms have access to make it difficult for developing countries to produce patentable modifications on genetic material.

> The genetic resources on which companies build new suites of patents have been until recently designated as part of the "international commons"—meaning, in many cases, that developing countries have had few grounds on which to control corporate access to raw material that is marketed back to them in form of patents (patents that they are required, by TRIPS, to respect). (Hayden 2003:63)

A First Neoliberalism

As Feher (2009:33) reminds us, in neoliberalism there is a framing of subjectivity in which public domains, "are no longer conceived as 'external' conditions necessary for the reproduction of the entrepreneur/free laborer: they instead become sectors of the valorizing of the self (understood as capital)." A first neoliberalism arranges and protects the market, Feher

(2009:32) explains, when the market is “no longer conceived as a gift of nature to be preserved but rather as a social form to be produced and reproduced, because it is optimal without being given.”

On a similar note, Hayden (2003:24) describes the “formal boost” for those who patent biological processes once “existing life” is no longer excluded from the realm of patentable innovation. But this presentation of the self doesn’t end with a nationalization of resources, in the terms that Hayden associates with the Convention on Biological Diversity, as this distinction resurrects the division between the self and the form of property that human capital undermines. Instead, with the turn to global food security biological diversity becomes an investment, but one in which all activity is viewed as contributing to or weakening a portfolio of behaviors. Like the neoliberal conditionality Feher (2009:34) characterizes in terms of human capital, food security introduces a conditionality for life that is entirely speculative.

CONCLUSION

While in the midst of wrapping up this project, I came across an advertisement for the film *Seeds of Time*, to be released to the general public in spring 2015 in partnership with the Crop Trust (McCleod 2015). In the synopsis of the film, former executive director of the Crop Trust, Cary Fowler, races against time to protect the future of the world's food supply:

> Gene banks of the world are crumbling, crop failures are producing starvation-inspired rioting, and the accelerating effects of climate change are already affecting farmers globally. […] From Rome to Russia and, finally, a remote island under the Arctic Circle, [Fowler's] passionate and personal journey may hold the key to saving the one resource we cannot live without: our seeds.
>
> As the stakes of maintaining a secure global food system continue to rise, adaptation will become a requisite for our own survival. How can we best maintain the diversity that still exists for our food crops? How do we create new diversity to adapt our fields to a changing climate? The answers are as complex as the system they intend to fix. It will require a combination of efforts: from scientists, plant breeders, researchers, farmers, politicians, and even gardeners.

But against this background, I propose we consider how our understanding of the body is also changing.

Throughout this dissertation, I treat food security as a "technical solution." By this I mean to stress that what we should be asking about food security is not so much what is it precisely, but rather how it allows us to say all that it does about life, technology, and the body. With this turn, investments in the body—in the life of the body—are not in relationship to an exchange that directs us to the social reproduction of the organism. Instead, as an investment in a capacity that is conceived as open-ended, food security suggests that our understanding of economy is changing as well as what it means to be political in the present moment. And so by raising these questions about the solution that is called "food security," a solution that, as I have argued, we ought to think of in terms of a reconfiguration of the body, we have to look critically at how technology is linked to the body in the discourses that I have identified, on food and the environment, biotechnology, and biological diversity. These discourses can be understood as part of a dual shift: from global hunger to food security, and from a liberal to a neoliberal political economy.

In these discourses, where technology, life, and the body become part of a more critical discussion about what politics looks like in the present moment, I have focused on how capital is being invested and in what precisely. In each of the chapters, I take up these discourses in an attempt to shift our attention so that we might rethink particular assumptions about the body in relationship to biology, technology, and life. But we can follow this discussion as well to consider how conceptualizations of subjectivity, institutionality and the object are undergoing a transformation in critical discussions about epigenetics, microbiology, regenerative medicine, and environmental sustainability especially where distinctions between productive and reproductive life are beginning to erode. I argue that new forms of political and economic investment in digital technology are integral to a reconfiguration of the body, of the "body-as-data." These investments take shape after World War II, in the discourses I point to, just as campaigns against hunger begin to give way to discourses on food security.

In the discourse on biotechnology, for example, we find investments of wealth and capital in forms of biological generation that change the way life is addressed in the field of biology and as a matter of intellectual property. In following these revisions to biological knowledge and intellectual property law, Melinda Cooper (2008) emphasizes how capital invests in forms of social reproduction that were previously excluded from the market. In her discussion of biotechnology she stresses a timing for embryonic stem cells whose potential is made in relationship to highly promissory financial capital and as distinct from investments in the reproduction of the biological organism.

When our focus is on biological diversity, however, the relationship of technology and the body shifts again. Instead of cells whose social reproduction is made to follow the more technical forms of accumulation we find operating in a neoliberal political economy, Cori Hayden (2003) suggests the law should be viewed in conjunction with technological developments that introduce a promissory value for biological diversity. Investments in the promise that is now linked to biological diversity demand contracts that name stewards who are attuned to its promise. By noting how technological developments have proceeded apace with revisions in intellectual property law, revisions that keep redefining the boundaries between "existing life" and "innovation," we are able to consider new forms of responsibility emerging in a biopolitical economy—responsibility that is linked to this promise. This is a framework that makes discussions about investing in scientific innovation and the politics of conservation, climate change, and "local," organic food mutually constitutive.

And, to take one last example, when we focus on epigenetics then the timing of cellular life that Cooper views in relationship to economy shifts again. No longer calibrated in relation to catastrophic risk, the timing of the cell is viewed by Hannah Landecker (2013) as following changes in our metabolism. When the environment is no longer the outside that instantiates the life of the biological human body, then metabolism becomes more a matter of information than of energetics, and we find ourselves far from the universal terms used by Wilbur Atwater to characterize the energetic metabolism of a body-as-organism who draws its energy from the outside environment. Instead of a body whose conditionality remains the same while the world around it is in flux, bodily metabolism becomes part of a flexible network that is always open, and receptive to the signal, or what Landecker (2013:499) describes as the "iteratively generative interface."

In the very early stages of this project, I visited a small defunct seed bank located on a ranch in Abiquiu, New Mexico. I was surprised by what I found inside the bank, which I will say was more like a large garage sitting in the middle of the desert. Rows of cans lined on the shelves were neatly labeled with the places and dates for each variety of seed. After returning from this trip, I learned about the mission of the Global Seed Vault to protect seed banks around the world from various uncertainties including perhaps what afflicted the seed bank I had visited and to ensure conservation and maintenance for the world's crop diversity.

After learning about the relationship of the Rockefeller Foundation to the Global Seed Vault, I arranged to visit their archives in Tarrytown, New York. At the archives, I began to consider the connection of food security to earlier campaigns against hunger supported by the Rockefeller Foundation, in particular their involvement in the first Green Revolution. I learned about Rockefeller's involvement in the establishment of the international agricultural research centers that are now part of the Consultative Group on International Agricultural Research (CGIAR) and the history of Bioversity International, one of the founders of the Global Seed Vault. I also examined the relationship agreement between the vault and the United Nations Treaty on Plant Genetic Resources for Food and Agriculture to insure, in perpetuity, those crops identified as critical to the world's food security by making crop diversity freely available over the Internet.

In considering how this solution differs from the earlier campaigns against global hunger supported by the Rockefeller Foundation, I began to study very closely works in critical theory that, though in most cases not addressing food security directly, take up discourses that are part of this turn. In each of the discourses I address—epigenetics, cybernetics, biotechnology, and biological diversity—the discourse itself is treated by the author as an object of research, which is why the details of these works are so important to the change I am trying to bring to light. I have emphasized this detail to demonstrate how, with each of these objects, we are drawn to think about a reorganization of politics and economy after World War II that at the same time attends to new ways of thinking about the body. In looking across these works, I have carefully studied how changes in our thinking about the body, technology, nature, and the environment began to emerge through these discourses, even if the authors researching them allow the biological organism to remain as a limit for the questions they raise.

As I imagined these discourses already in relationship to my own questions about the turn from global hunger to food security, I began to focus on places in these works where the authors were very nearly already in conversation: where, for example, developments in the life sciences after World War II led to revisions in intellectual property law, or how the Rockefeller Foundation's interest in the statistical sciences was imagined in relationship to different political ends, or in terms of the challenges that information poses for thinking about the body as a closed system.

I noticed how each discourse was a kind of technical solution, by which I mean that each discourse offers a solution that redefines what the "social" means, whether we are discussing concerns about limits to growth emerging in the 1970s, or interests that align private industry and academic science for the conservation of biological diversity, or the belief that communication might be used to neutralize growing divisions among different populations in America in the late nineteenth and early twentieth centuries. I should note, the changes in sociality that Bernard

Geoghegan (2012) points to, however, are more technological and therefore different from the technical difference that I want to highlight as constitutive to solutions like food security.

As I began to bring these works into a conversation about food security and technical solutions to hunger, I was guided by how Patricia Clough (2008) has put discourses of the body into history, focusing especially on the development of digital information, and has accentuated how this history leads us to consider whether the body is already in some sense technological. In thinking about the history of information in relationship to discussions about food security, Tiziana Terranova's (2004) study of Claude Shannon's mathematical formula of information shaped how I understood the relationship of the statistical sciences to the life that is addressed in discourses on food security. And Terranova details the relationship of information theory to the Rockefeller Foundation as well, noting Warren Weaver's contributions to Claude Shannon's theory.

Finally, I considered how this history of information can be aligned with Foucault's (2007) discussion of security apparatuses that target the species-body of human populations. This is much different from the individual human body that is the focus of Geoghegan's cybernetic apparatus. Where Geoghegan views the history of cybernetics as making possible technological solutions for populations of individuals, I have argued that we focus instead on the emergence of technical solutions for human populations.

Pointing to concepts of emergence in the field of microbiology that began to shift after World War II, Cooper argues that the acceptance of these views among more mainstream microbiologists was due to changes in intellectual property law, and specifically the expanded scope of patents that now included biological products like embryonic stem cells. Cooper treats this as a liberalization of patent law, indicating a new valuation of forms of life that necessitate a politics of militarized human security. Disassembling the public health system, Cooper argues, introduces the risks that make a war on infectious diseases a necessity.

But when discourses about risk are instead understood in relationship to human populations, as Foucault describes in his discussion of the problem of the population, there is evidence of a body-as-data that can be identified very early on in discussions about scarcity among physiocrats in the seventeenth and eighteenth centuries when they arrive at a new unit of analysis for framing such questions. In these discussions, as Foucault (2007:33) argues, and as I mean to underline, measures that were previously established to prevent scarcity gave way to new forms of knowledge, what Foucault calls the "fundamental principle of economic government." I have considered how these elements often referenced in discussions about food security—biotechnology, epigenetics, cybernetics, biological diversity—make possible measures of risk that are generative. Rather than reducible to their impact on the individual human subject, I suggest these elements form a measure of risk for the body-as-data that is administered to life and its capacities.

REFERENCES

Agamben, Giorgio and Daniel Heller-Roazen. 1998. *Homo Sacer.* Stanford, CA: Stanford University Press.

Alcorn, Janis B. 1984. “Development Policy, Forests, and Peasant Farms: Reflections on Huastec-Managed Forests’ Contributions to Commercial Production and Resource Conservation.” *Economic Botany* 38(4):389–406.

Alcorn, Janis B. 1995. “The Scope and Aim of Ethnobotany in a Developing World.” Pp. 23–39 in *Ethnobotany: Evolution of a Discipline*, edited by Richard Evans Schultes and Siri Von Reis. Portland, OR: Dioscorides Press.

Aoki, Keith. 2008. *Seed Wars: Controversies and Cases on Plant Genetic Resources and Intellectual Property*. Durham, NC: Carolina Academic Press.

Aronson, Naomi. 1982. “Nutrition as a Social Problem: A Case Study of Entrepreneurial Strategy in Science.” *Social Problems Social Problems* 29(5):474–87.

Atwater, Wilbur O. 1887. “The Potential Energy of Food.” *Century* 34:397–405.

Atwater, Wilbur O. 1894. *Foods: Nutritive Value and Cost*. Washington: U.S. Dept. of Agriculture.

Balick, Michael J. and Paul Alan Cox. 1996. *Plants, People, and Culture: The Science of Ethnobotany*. New York: Scientific American Library.

Barbour, Virginia, Jocalyn Clark, Laureen Connell, Paul Simpson, Margaret Winker, and Emma Veitch . 2012. “Bringing Clarity to the Reporting of Health Equity.” *PLoS Medicine* 9(10): e1001334.

Belasco, Warren James. 2006. *Meals to Come: A History of the Future of Food*. Berkeley: University of California Press.

Bell, Daniel. 1974. *The Coming of Post-Industrial Society: A Venture in Social Forecasting*. London: Heinemann Educational.

Bell, Daniel. 1996. *The Cultural Contradictions of Capitalism*. New York: Basic Books.

Bentley, Amy, ed. 2012. *A Cultural History of Food in the Modern Age*. Oxford: Bloomsbury Academic.

Brooks, Rodney Allen. 2002. *Flesh and Machines: How Robots Will Change Us*. New York: Pantheon Books.

Brown, Michael. 1998. “Can Culture Be Copyrighted?” *Current Anthropology* 39(2):193–222.

Caballero, Javier and Cristina Mapes. 1985. "Gathering and Subsistence Patterns among the P'urhepecha Indians of Mexico." *Journal of Ethnobiology* 5(1):31–47.

Campbell, Jeremy. 1992. *Grammatical Man: Information, Entropy, Language and Life*. New York: Simon & Schuster.

Carey, James W. 2009. *Communication as Culture: Essays on Media and Society.* New York: Routeldge.

Chapela, Ignacio. 1996. "Biodiversity in the Age of Information: A Critical Analysis of Conservation Initiatives Associated with Discovery of New Pharmaceuticals." Pp. 29–49 in *Biodiversity, Biotechnology, and Sustainable Development in Health and Agriculture: Emerging Connections*, edited by Pan American Health Organization. Washington, DC: Pan American Health Organization.

Chon, Margaret. 1993. "Postmodern Progress: Reconsidering the Copyright and Patent Power." *DePaul Law Review* 43:97–146.

Clarke, Adele. 1998. *Disciplining Reproduction Modernity, American Life Sciences, and "the Problems of Sex."* Berkeley: University of California Press.

Clough, Patricia. 2008. "The Affective Turn." *Theory, Culture & Society* 25(1):1–22.

Clough, Patricia. 2009. "The New Empiricism: Affect and Sociological Method." *European Journal of Social Theory* 12(1):43–61.

Clough, Patricia. 2013. "Commentary for Hannah Landecker's Metabolic Objects." Personal Collection of Patricia Clough, CUNY Graduate Center, New York, NY.

Clough, Patricia. 2013. "Remarks on Roderick Ferguson's Reordering of Things." Personal Collection of Patricia Clough, CUNY Graduate Center, New York, NY.

Clough, Patricia, Karen Gregory, Benjamin Haber, and Josh Scannell. 2015. "The Datalogical Turn." Pp. 145–162 in *Non-Representational Methodologies: Re-envisioning Research*, edited by Phillip Vannini. New York: Routledge.

Coombe, Rosemary J. 1998. *The Cultural Life of Intellectual Properties: Authorship, Appropriation, and the Law*. Durham, NC: Duke University Press.

Cooper, Melinda. 2008. *Life As Surplus: Biotechnology and Capitalism in the Neoliberal Era*. 1st ed. Seattle: University of Washington Press.

Cullather, Nick. 2010. *The Hungry World: America's Cold War Battle against Poverty in Asia*. Cambridge, MA: Harvard University Press.

Dass, Randall A., Craig B. Thompson, and C. Theresa Vincent. 2012. "A Dialogue with Dr. Craig B. Thompson about Metabolism and Its Relevance for Tumor Growth, Progression and Metastasis." *Seminars in Cancer Biology* 22(5–6):484–88.

Davis, Wade. 1996. *One River: Explorations and Discoveries in the Amazon Rain Forest*. New York: Simon & Schuster.

Diamond v. Chakrabarty. 447 U.S. at 303.

Dowie, Mark. 2001. *American Foundations: An Investigative History*. Cambridge, MA; London: MIT.

Dubos, René J. 1987. *Mirage of Health: Utopias, Progress and Biological Change*. New Brunswick, NJ: Rutgers University Press.

Dumit, Joseph. 2012. *Drugs for Life: How Pharmaceutical Companies Define Our Health*. Durham, NC: Duke University Press.

Edelman, Bernard. 1989. “Le droit et le vivant.” *Recherche: Société d’éditions scientifiques* 20 (212), pp. 966–976.

Eisner, Thomas. 1989–90. “Prospecting for Nature’s Chemical Riches.” *Issues in Science and Technology.* 6(2):31–4.

Eisner, Thomas and Elizabeth A. Beiring. 1994. “Biotic Exploration Fund—Protecting Biodiversity Through Chemical Prospecting.” *Bioscience* 44(2): 95–98.

Escobar, Arturo. 1996. “Constructing Nature: Elements for a Poststructural Political Ecology.” Pp. 46–68 in *Liberation Ecologies: Environment, Development, Social Movements*, edited by Richard Pete and Michael Watts. London and New York: Routledge.

Esposito, Roberto. 2002. *Immunitas: Protezione e negazione della vita*. Torino: Einaudi.

Etzkowitz, Henry and Andrew Webster. 1995. “Science as Intellectual Property.” Pp. 480–506 in *Handbook of Science and Technology Studies*, edited by Sheila Jasanoff, Gerald Markle, James Peterson, and Trevor Pinch. Thousand Oaks, CA: Sage Publications.

Ewald, François. 1986. *L’Etat providence.* Paris: B. Grasset.

Ewald, François. 1993. “Two Infinities of Risk.” Pp. 221–28 in *The Politics of Everyday Fear*, edited by Brian Massumi. Minneapolis: University of Minneapolis Press.

Ewald, François. 2002. “The Return of Descartes’s Malicious Demon: An Outline of a Philosophy of Precaution.” Pp. 273–301 in *Embracing Risk: The Changing Culture of Insurance and Responsibility*, edited by Tom Baker and Jonathan Simon. Chicago: University of Chicago Press.

Feder, Ernest. 1976. “McNamara’s Little Green Revolution: World Bank Scheme for Self-Liquidation of Third World Peasantry.” *Economic and Political Weekly* 11(14):532–41.

Feher M. 2009. “Self-Appreciation; Or, the Aspirations of Human Capital.” *Public Culture* 21(1):21–41.

Ferguson, Roderick. 2012. *The Reorder of Things: The University and its Pedagogies of Minority Difference*. Minneapolis: Minnesota University Press.

Flitner, Michael. 1998. “Biodiversity: Of Local Commons and Global Commodities.” Pp. 144-66 in *Privatizing Nature: Political Struggles for Global Commons*, edited by Michael Goldman. New Brunswick, NJ: Rutgers University Press.

Fosdick, Raymond B. 1921. *Police Administration.* Cleveland: The Cleveland Foundation.

Fosdick, Raymond B. 1929. *Selections from the Old Savage in the New Civilization: The Challenging Study of Contemporary Man*. New York: Doubleday, Doran.

Fosdick, Raymond B. 1915. *European Police Systems*. New York, NY: Century.

Foucault, Michel. 1973. *The Order of Things: An Archaeology of the Human Sciences.* New York: Vintage Books.

Foucault, Michel. 2004. *Naissance de la Biopolitique: Cours au Collège de France (1978–1979)*. Paris: Gallimard: Seuil.

Foucault, Michel. 2007. *Security, Territory, Population: Lectures at the Collège de France, 1977–78*. Basingstoke: Palgrave Macmillan: République Française.

Foucault, Michel. 2008. *The Birth of Biopolitics: Lectures at the Collège de France, 1978–79*. Basingstoke: Palgrave Macmillan.

Fowler, Cary and P. R. Mooney. 1990. *Shattering: Food, Politics, and the Loss of Genetic Diversity*. Tucson: University of Arizona Press.

Frankel, O. H. and J. G. Hawkes. 1975. *Crop Genetic Resources for Today and Tomorrow*. Cambridge: Cambridge University Press.

Franklin, Sarah. 1995. “Science as Culture, Cultures of Science.” *Annual Review of Anthropology* 24:163–84.

Franklin, Sarah and Susan McKinnon. 2001. “Biologization Revisited: Kinship Theory in the Context of New Biologies.” Pp. 1–25 in *Relative Values: Reconfiguring Kinship Studies*. Durham, NC: Duke University Press.

Franklin, Sarah and Helena Ragoné. 1998. *Reproducing Reproduction: Kinship, Power, and Technological Innovation*. Philadelphia: University of Pennsylvania Press.

Friedmann, Harriet. 1993. “The Political Economy of Food: A Global Crisis.” *New Left Review* (197):29–57.

Frohlich, Xaq. 2014. “Labels for Life.” *Limn* 4:42–45.

Gemelli, Giuliana. 2000. *The “Unacceptables”: American Foundations and Refugee Scholars between the Two Wars and after*. Brussels: P.I.E.-Peter Lang.

Geoghegan, Bernard Dionysius. 2012. "The Cybernetic Apparatus Media, Liberalism, and the Reform of the Human Sciences." Ph.D. dissertation, Screen Cultures, Northwestern University. Retrieved March 12, 2015 from http://search.proquest.com.ezproxy.gc.cuny.edu/pqdtft/docview/1018060796/C28E27512BE545E3PQ/2?accountid=7287.

Ginsburg, Faye D. and Rayna Rapp. 1995. *Conceiving the New World Order: The Global Politics of Reproduction*. Berkeley: University of California Press.

Global 2000 Study (U.S.), Gerald O. Barney, Council on Environmental Quality (U.S.), United States, and Department of State. 1980. *The Global 2000 Report to the President: Entering the Twenty-First Century: A Report*. U.S. Government Printing Office: Washington, D.C.

Global Crop Diversity Trust. n.d. *Global Genebank Partnership.* Retrieved April 15, 2015 from https://www.croptrust.org/what-we-do/supporting-the-global-system/global-genebank-partnership/.

Godfrey, Keith M., Allan Sheppard, Peter D. Gluckman, Karen A. Lillycrop, Graham C. Burdge, Camerson McLean, Joanne Rodford, Joanne L. Slater-Jefferies, Emma Garratt, Sarah R. Crozier, B. Starling Emerald, Catharine R. Gale, Hazel M. Inskip, Cyrus Cooper and Mark A. Hanson. 2011. "Epigenetic Gene Promoter Methylation at Birth Is Associated With Child's Later Adiposity." *Diabetes* 60(5):1528–34.

Goodman, Jordan and Vivien Walsh. 2001. *The Story of Taxol: Nature and Politics in the Pursuit of an Anti-Cancer Drug*. Cambridge: Cambridge University Press.

Gratzer, Walter. 2005. *Terrors of the Table: The Curious History of Nutrition*. 1st ed. Oxford: Oxford University Press.

Haraway, Donna Jeanne. 1997. *ModestWitness@Second_Millennium. FemaleMan_Meets_OncoMouse: Feminism and Technoscience*. New York: Routledge.

Hayden, Cori. 2000. "When Nature Goes Public: An Ethnography of Bio-Prospecting in Mexico." Ph.D. dissertation, Anthropology, University of California, Santa Cruz. Retrieved March 12, 2015 (http://search.proquest.com.ezproxy.gc.cuny.edu/pqdtft/docview/304596136/abstract/49ED18BDB61B4695PQ/1?accountid=7287).

Hayden, Cori. 2003. *When Nature Goes Public: The Making and Unmaking of Bioprospecting in Mexico*. Princeton, NJ: Princeton University Press.

Hayek, Friedrich A. von. 1969. *Studies in Philosophy, Politics and Economics*. New York: Simon and Schuster.

Hayles, N. Katherine. 1999. *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. 1st ed. Chicago: University of Chicago Press.

Heidegger, Martin. 1977. *The Question Concerning Technology, and Other Essays*. New York: Harper & Row.

Helmreich, Stefan. 1998. *Silicon Second Nature Culturing Artificial Life in a Digital World*. Berkeley: University of California Press.

Henderson, C. R. 1901. "The Scope of Social Technology." *American Journal of Sociology* 6(4):465–86.

Hirschman, Albert O. 1977. *The Passions and the Interests: Political Arguments for Capitalism before Its Triumph*. Princeton, NJ: Princeton University Press.

Hogan, Michael J. 1977. *Informal Entente: The Private Structure of Cooperation in Anglo-American Economic Diplomacy, 1918–1928*. Columbia: University of Missouri Press.

Hoover, Herbert. 1922. *American Individualism*. Garden City, NY: Doubleday, Page & Co.

Hoover, Herbert. 1960. *An American Epic Vol 2: Famine Behind the Front: Organization behind the Front 1914-1923*. Chicago: Regnery.

Hunn, Eugene S. 1999. "Ethnobiology in Court: The Paradoxes of Relativism, Authenticity, and Advocacy." Pp. 1–11 in *Ethnoecology: Knowledge, Resources, and Rights*, edited by Ted Gragson and Ben G. Blount. Athens and London: University of Georgia Press.

IBPGR (International Board for Plant Genetic Resources). 1983. *Annual Report for 1982*. Rome: International Board for Plant Genetic Resources.

International Society of Ethnobiology. 1988. *Declaration of Belem*. Retrieved April 21, 2015 from http://www.ethnobiology.net/what-we-do/core-programs/global-coalition/declaration-of-belem/.

Johnson, Jerel. 2015. *The Global Seed Vault: Founders, Funders, and First Depositors*. Unpublished diagram. [Figure 1].

Kay, Lily E. 1993. *The Molecular Vision of Life: Caltech, the Rockefeller Foundation, and the Rise of the New Biology*. New York: Oxford University Press.

Kloppenburg, Jack. 1988. *First the Seed: The Political Economy of Plant Biotechnology, 1492–2000*. Cambridge: Cambridge University Press.

Kloppenburg, Jack. 1991. "No Hunting! Biodiversity, Indigenous Rights, and Scientific Poaching." *Cultural Survival Quarterly* 14:104–108.

Kloppenburg, Jack. 2010. "Impeding Dispossession, Enabling Repossession: Biological Open Source and the Recovery of Seed Sovereignty." *Journal of Agrarian Change* 10(3):367–88.

Kolnai, Aurel. 2003. "Disgust." Pp. 29–91 in *On disgust*, edited by Carolyn Korsmeyer and

Barry Smith. Chicago: Open Court.

Landecker, Hannah. 2011. "Food as Exposure: Nutritional Epigenetics and the New Metabolism." *BioSocieties* 6(2):167–94.

Landecker, Hannah. 2013. "Postindustrial Metabolism: Fat Knowledge." *Public Culture* 25(3):495–522.

Latour, Bruno. 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press.

Latour B, Jensen P, Venturini T, Grauwin S, and Boullier D. 2012. "'The Whole Is Always Smaller Than Its Parts': A Digital Test of Gabriel Tardes' Monads." *The British Journal of Sociology* 63(4):590–615.

Lesser, Williams. 1994. *Institutional Mechanisms Supporting Trade in Genetic Materials: issues Under the Biodiversity Convention and GATT/ TRIPS.* Geneva, Switzerland: United Nations Environmental Programme.

Levenstein, Harvey A. 1993. *Paradox of Plenty: A Social History of Eating in Modern America*. New York: Oxford University Press.

MacKenzie, Donald A. 2006. *An Engine, Not a Camera: How Financial Models Shape Markets*. Cambridge, MA: MIT Press.

Maya Restrepo, Luz Adriana. 1998. *Los Afrocolombianos*. Bogotá: Instituto Colombiano de Cultura Hispánica.

McMichael, Philip. 2009. "Banking on Agriculture: A Review of the World Development Report 2008." *Journal of Agrarian Change* 9(2):235–46.

McCleod, Sandy. (Producer and Director). 2015. *Seeds of Time*. [Film]. Hungry.

Meadows, Donella H., Club of Rome, and Potomac Associates. 1972. *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind*. London: Earth Island.

Mudry, Jessica J. 2009. *Measured Meals: Nutrition in America*. Albany: SUNY Press.

Nestle, Marion and Malden C. Nesheim. 2012. *Why Calories Count: From Science to Politics*. Berkeley: University of California Press.

Nye, David E. 1994. *American Technological Sublime*. Cambridge, MA: The MIT Press.

Nye, David E. 2006. *Technology Matters: Questions to Live With*. Cambridge, MA: MIT Press.

Otter, Christopher. 2014. "Scale, Evolution and Emergence in Food Systems." *Limn* 4:8–10.

Pan American Health Organization and Edgar J. Aseby, eds. 1996. "Andes Pharmaceuticals, Inc.: A New Model for Bio-Prospecting." Pp. 50–82 in *Biodiversity, Biotechnology, and Sustainable Development in Health and Agriculture: Emerging Connections*. Washington, DC: Pan American Health Organization.

Parisi, Luciana. 2004. *Abstract Sex: Philosophy, Biotechnology and the Mutations of Desire*. 1st ed. London: Bloomsbury Academic.

Patel, Raj. 2012. "The Long Green Revolution." *Journal of Peasant Studies* 40(1):1–63.

Pierce, Charles S. 1955. "Concerning the Author." In *Philosophical Writings of Pierce*, edited by Justus Buchler, 1–4. New York: Dover Publications.

Perkins, John H. 1997. *Geopolitics and the Green Revolution: Wheat, Genes, and the Cold War*. New York: Oxford University Press.

Plotkin, Mark J. 1993. *Tales of a Shaman's Apprentice: An Ethnobotanist Searches for New Medicines in the Amazon Rain Forest*. New York: Viking.

Plotkin, Mark J. 1995. "The Importance of Ethnobotany for Tropical Rain Forest Conservation." Pp. 147–56 in *Ethnobotany: Evolution of a Discipline*, edited by Richard Evans Schultes and Siri Von Reis. Portland, OR: Dioscorides Press.

Pollan, Michael. 2006. *Omnivore's Dilemma: A Natural History of Four Meals*. New York: The Penguin Press.

Pottier, Johan.1999. *Anthropology of Food. The Social Dynamics of Food Security*. Cambridge: Polity Press.

Posey, Darrell Addison. 1985. "Indigenous Management of Tropical Forest Ecosystems: The Case of the Kayap Indians of the Brazilian Amazon." *Agroforestry Systems* 3(2):139–58.

Posey, Darrell Addison. 1992. "Reply to Parker." *American Anthropologist* 94(2):441–43.

Posey, Darrell Addison and IUCN Biodiversity Programme. 1996. *Traditional Resource Rights: International Instruments for Protection and Compensation for Indigenous Peoples and Local Communities*. Gland, Switzerland: World Conservation Union (IUCN).

Povinelli, Elizabeth A. 2002. *The Cunning of Recognition: Indigenous Alterities and the Making of Australian Multiculturalism*. Durham, NC: Duke University Press.

Prigogine, Ilya, Isabelle Stengers, and Alvin Toffler. 1984. *Order Out of Chaos*. 1st ed. New York: Bantam.

Rajan, Kaushik Sunder. 2006. *Biocapital: The Constitution of Postgenomic Life*. 1st ed. Durham, NC: Duke University Press Books.

Relationship Agreement. Global Crop Diversity Trust–Governing Body of the UN Treaty on Plant Genetic Resources for Food and Agriculture. June 16, 2006. Retrieved April 15, 2015 from https://www.croptrust.org/wp-content/uploads/2014/12/Signed-Relationship-Agreement_0.pdf.

Reardon, Jenny. 2001. "The Human Genome Diversity Project: A Case Study in Coproduction." *Social Studies of Science* 31(3):357–88.

Roberts, Michael J. 2009. "Can Biotech Food Cure World Hunger?" *New York Times*, October 16. Retrieved April 21, 2015 from http://roomfordebate.blogs.nytimes.com/2009/10/26/can-biotech-food-cure-world-hunger/.

Ross, Dorothy. 1991. *The Origins of American Social Science*. Cambridge: Cambridge University Press.

Ross, Edward Alsworth. 1901. *Social Control: A Survey of the Foundations of Order*. New York: Macmillan & Co., Ltd.

Ross, Eric B. 1998. *The Malthus Factor: Poverty, Politics and Population in Capitalist Development*. London: Zed Books.

Schmitt, Carl. 2008. *The Concept of the Political: Expanded Edition*. Chicago: University of Chicago Press.

Schultes, Richard Evans and Siri von Reis, eds. 1995. *Ethnobotany: Evolution of a Discipline*. Portland, OR: Dioscorides Press.

Schumpeter, Joseph A. 1934. *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle*. Translated by Redvers Opie. Cambridge, MA: Harvard University Press.

Segal, Jérôme. 2003. Théorie de l'information : sciences, techniques et société de la seconde guerre mondiale à l'aube du XXIe siècle (Thèse de Doctorat, Faculté d'Histoire de l'Université Lyon II, Chaire Interuniversitaire d'Histoire des Sciences et des Techniques, 1988), http://www.mpiwg-berlin.mpg.de/staff/segal/thesis/.

Sell, Susan K. 2003. *Private Power, Public Law the Globalization of Intellectual Property Rights*. Cambridge: Cambridge University Press.

Sen, Amartya. 1982. *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford New York: Clarendon Press Oxford University Press.

Sennett, Richard. 1992. *The Fall of Public Man*. Reissue Edition. New York: W. W. Norton & Company.

Shannon, Claude Elwood. 1948. "A Mathematical Theory of Communication." *Bell System Technical Journal* 27(3):379–423.

Shannon, Claude Elwood and Warren Weaver. 1949. *The Mathematical Theory of*

Communication. Urbana: University of Illinois Press.

Sherwood, Robert M. 1990. *Intellectual Property and Economic Development*. Boulder, CO: Westview Press.

Sherwood, Robert M. 1991. “Pharmaceuticals: A U.S. Perspective.” Pp. 161–79 in *U.S.–Mexican Industrial Integration: The Road to Free Trade*, edited by Sidney Weintraub, Luis Rubio-Freidberg, and Alan D Jones. Boulder, CO: Westview Press.

Shiva, Vandana. 1993. *Monocultures of the Mind: Perspectives on Biodiversity and Biotechnology*. London: Zed Books.

Steinmetz. 2005. “The Epistemological Unconscious of U.S. Sociology and the Transition to Post Fordism: The Case of Historical Sociology.” Pp. 109–160 in *Remaking Modernity: Politics, History, and Sociology*, edited by Julia Adams, Elisabeth Stephanie Clemens, and Ann Shola Orloff. Durham, NC: Duke University Press.

Strathern, Marilyn. 1992. *Reproducing the Future: Essays on Anthropology, Kinship, and the New Reproductive Technologies*. New York: Routledge.

Strathern, Marilyn. 1999a. “Potential Property: Intellectual Rights and Property in Persons.” Pp. 161–78 in *Property, Substance, and Effect: Anthropological Essays on Persons and Things*. London: Athlone Press.

Strathern, Marilyn. 1999b. “What Is Intellectual Property After?” Pp. 170–203 in *Property, Substance, and Effect: Anthropological Essays on Persons and Things*. London: Athlone Press.

Stuckler D. and Nestle M. 2012. “Big Food, Food Systems, and Global Health.” *PLoS medicine* 9(6):1–5.

Swaminathan. M. S. 1988. "Seeds and Property Rights: A View from the CGIAR System." In J. Kloppenburg, Jr. (ed.), *Seeds and Sovereignty.* Durham: Duke University Press.

Terranova, Tiziana. 2004. *Network Culture: Politics for the Information Age*. London: Pluto Press.

Terranova, Tiziana and Luciana Parisi. 2000. “Heat Death: Emergence and Control in Genetic Engineering and Artificial Life.” *CTheory.net*.

Thacker, Eugene. 2005. *The Global Genome, Biotechnology, Politics and Culture.* Cambridge, MA: MIT Press.

Thompson, Charis. 2005. *Making Parents: The Ontological Choreography of Reproductive Technologies*. Cambridge, Mass.: MIT Press.

Tocqueville, Alexis de, Eduardo Nolla, and James T. Schleifer. 2010. *Democracy in America: Historical-Critical Edition of* De La Démocratie En Amérique. Indianapolis: Liberty

Fund.

Toledo, Victor M. 1996. “The Ecological Crisis: A Second Contradiction of Capitalism?” in *The Greening of Marxism*, edited by Ted Benton. New York: Guilford Press.

United Nations. 1975. Report of the World Food Conference. New York: United Nations.

Wellen, Kathryn E., Georgia Hatzivassiliou, Uma M. Sachdeva, Thi V. Bui, Justin Cross and Craig B. Thompson. 2009. “ATP-Citrate Lyase Links Cellular Metabolism to Histone Acetylation.” *Science* 324(5930):1076–80.

Wiebe, Robert H. 1967. *The Search for Order, 1877–1920*. New York: Hill and Wang.

Wiener, Norbert. 1989. *The Human Use of Human Beings: Cybernetics and Society*. London: Free Association.

World Resources Institute. The World Conservation Union, United Nations Environment Programme, Food and Agriculture Organization of the United Nations, and United Nations Educational Scientific and Cultural Organization. 1992. *Global Biodiversity Strategy: Guidelines for Action to Save, Study and Use Earth’s Biotic Wealth Sustainably and Equitably.* Washington D.C.: World Resources Institute.

Wright, Susan. 1994. *Molecular Politics: Developing American and British Regulatory Policy for Genetic Engineering, 1972–1982*. Chicago: University of Chicago Press.