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Resistance Is Fertile
Canadian Struggles on the BioCommons

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Contents

Abbreviations

APHIS	Animal and Plant Health Inspection Service
BACC	Biotechnology Assistant Deputy Minister Coordinating Committee
BMCC	Biotechnology Ministerial Co-ordinating Committee
Bt	*Bacillus thuringiensis*
CBAC	Canadian Biotechnology Advisory Committee
CBAN	Canadian Biotechnology Action Network
CBD	United Nations *Convention on Biological Diversity*
CBI	Council for Biotechnology Information
CBS	Canadian Biotechnology Strategy
CFIA	Canadian Food Inspection Agency
CGIAR	Consultative Group on International Agricultural Research
COP	Conference of the Parties to the United Nations Convention on Biological Diversity
DNA	Deoxyribonucleic acid
EFSA	European Food Safety Authority
ETC Group	Action Group on Erosion, Technology, and Concentration
FAO	Food and Agriculture Organization of the United Nations
FBCN	Food Biotechnology Communications Network
FDA	US Food and Drug Administration
GURT	Genetic Use Restriction Technology
HUGO	Human Genome Organization
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
MOSST	Ministry of State for Science and Technology

NBAC	National Biotechnology Advisory Committee
NBS	National Biotechnology Strategy
NFU	National Farmers Union
NGOs	Non-governmental organizations
rBGH	Recombinant Bovine Growth Hormone
TRIPS	*Agreement on Trade Related Aspects of Intellectual Property Rights*
WTO	World Trade Organization

Introduction

When it comes to biotechnology, the mainstream media, governments, and self-styled life science companies articulate one uniform message: biotechnology promises to yield a wealth of benefits that will improve health, lifestyles, diet, environment, and economy.[1] It is claimed that this science and its attendant technological applications will help medical researchers identify disease genes and develop prophylactic measures or new treatments for ailments. Similarly, human vaccines produced with bacteria through recombinant deoxyribonucleic acid (DNA) procedures are purported not only to reduce costs, thus theoretically making them available to a wider range of the population, but also to be safer than vaccines manufactured using animal organs (for example, the pancreas of cattle or swine were previously used to produce insulin for the treatment of diabetes). Biotech "pharming" (pharmaceutical farming) will apparently allow scientists to genetically engineer animals to induce their bodies to produce proteins and medicines that offer human therapeutic value. Environmentally focused biotechnologies are billed as the next technological panacea that will help reverse the environmental degradation wrought on the world by the last two centuries of industrial development. New applications in the realm of agricultural biotechnology are supposed to increase crop yields and thus help the world feed itself while simultaneously reducing the volume of harmful chemicals required for agricultural production. These are just some of the benefits that biotechnology proponents in the corporate world and government foretell for this science and its technological applications.

As Robert Bud (1993, 3-4) points out, such rhetoric has helped pave the way for intensive investment in biotechnology: "In the early 1980s when prophesies of genetic engineering were articulated and employed to win resources, the seers foretold a world in which wealth would relate to the ability to manipulate the new science. After numerous reports extolled its importance and power, every major industrial power invested heavily."

Indeed, by the beginning of the current millennium, a number of developed and developing countries had articulated leadership in biotechnology as a national economic goal.[2] Canada is among the growing number of countries around the globe that have embarked on a path of government-sanctioned commodification of biotechnology. In fact, Canadian governments have been actively attempting to position this country as a world leader in biotechnology for almost three decades. According to the International Service for the Acquisition of Agri-biotech Applications, as of 2011, Canada ranked fifth in the world behind the United States, Brazil, Argentina, and India in terms of arable land cultivated with genetically engineered crops – some 10.4 million hectares (James 2011). However, as we will see in Chapter 2, the veracity of the statistics published by this organization is subject to debate.

Canadian government biotechnology policy, which has been informed by a national strategy since 1983, is typically articulated in the following terms:

> Biotechnology is a powerful "enabling technology" with applications in many industrial sectors and holding much promise for the future. It has great potential to add to industrial efficiency, output and jobs, enhance the productivity and competitiveness of Canada's important natural resource sectors, safeguard the environment and enhance our quality of life through improved pharmaceuticals, diagnostic medicine and food production. Many people see biotechnology as the next important "change maker" after the convergence of information, computer and telecommunications technologies, which have transformed our lives. All Canadians – producers and consumers across the country, including people in smaller communities and rural areas – will benefit from the new transformation. (Industry Canada 1998, 2)

This passage, and, indeed, the full policy document from which it derives, sums up succinctly what the proponents of biotechnology contend this science and its attendant technological developments portend for humanity. Aside from hundreds of millions of dollars in direct federal funding of biotechnology research, such pronouncements are supported concretely through the allocation of additional federal funds to finance biotechnology commercialization projects such as: the Industrial Research Assistance Program, which invested $60 million between 1998 and 2006; Technology Partnerships Canada, which provided $293 million between 2001 and 2006; the Canadian Institutes of Health Research, which disbursed $13.8 million between 2001 and 2006; the Scientific Research and Experimental Development Tax Incentive Program, which furnished over $3 billion in tax assistance to Canadian businesses in 2006; and the Business Development Bank of Canada, which has committed $154 million to life science projects, with plans to

increase this amount to $191 million over the fiscal 2006-10 planning period (Canadian Biotechnology Advisory Committee 2006b; Treasury Board of Canada Secretariat 2006).[3]

Specific to agricultural biotechnology, the Government of Canada claims that biotechnology helps "develop better diagnoses and treatments of human, animal and crop diseases, breed new crops that are more stress tolerant, nutritious and higher yielding, and reduce the need for pesticides and fertilizers in food production" (Government of Canada 2004, 16). In an attempt to realize some of these purported benefits, the federal government developed the Canadian Crop Genome Initiative, which was a major project led by Agriculture and Agri-Food Canada, the federal department responsible for agricultural matters, including food and feed crops developed using biotechnology. This project was tasked with developing corn, soybean, canola, and wheat varieties that were resistant to disease, insect attack, cold, and drought and that yielded improved crops in terms of both quantity and quality (ibid.). As of mid-2012, Agriculture and Agri-Food Canada has approved sixty-three genetically engineered seed events for unconfined release into the environment, and Health Canada has approved eighty-four foods for human consumption (although the actual marketed crop varieties that have been genetically engineered in this country are limited to canola, soybean, corn, and sugar beets).[4] Perhaps more indicative of the degree to which genetically engineered organisms have become commonplace in Canada is the estimate by groups such as Greenpeace and the Council of Canadians that 70 percent of processed foods sold in this country contain at least one genetically engineered ingredient. Biotechnology companies have also been attempting to develop virus-resistant transgenic seeds that are designed to protect the resulting crops from particular blights and viruses. Synthetic chemicals and genetic engineering techniques are also being employed to speed up the maturation process of meat animals while simultaneously reducing their required feed levels. These very brief examples only touch the surface of the range of agricultural products and applications that researchers believe are yet to be developed through genetic engineering.[5]

However, despite two decades of research and almost fifteen years of active marketing in a number of countries around the world, genetically engineered crops still fail to deliver consistently higher yields, enhanced stress tolerance, or improved sustainability through a reduced need for tilling and chemical fertilizer and pesticide applications. Moreover, both industry and government continue to downplay the mounting evidence about the safety and environmental risks that are connected to genetically engineered organisms, and public debate in regard to biotechnology has been severely circumscribed, to the point of being almost non-existent. Instead, what passes for information and discussion about this technoscience is often limited to one-dimensional and celebratory accounts.

It is against such a backdrop that this book seeks to develop a critical analysis of agricultural biotechnology in Canada, including the Canadian Biotechnology Strategy (CBS), a policy that poses considerable ramifications for the developmental trajectory of biotechnology in this country. Biotechnology in its Canadian context is a large, profitable domain, and one that proffers basic questions about the organization of our social life. The following examination will define and answer some of these queries by adapting a Marxist theoretical framework and relating it to documentary evidence and interview data. The research reported in this book was driven by the following three overarching questions: how does the federal government's CBS facilitate the commodification of science in general and of biotechnology in particular; what counterstruggles have emerged in Canada that attempt to re-appropriate or foreclose the products and processes developed by biotechnological capital; and what are the information and knowledge issues encompassed by such struggles? Marxism is uniquely suited to this explanatory task because of its conceptual strength in engaging social domination and conflict in a historical context of episodic change in society's relations of production and exchange. However, before elaborating on the appositeness of a Marxist critique of contemporary Canadian biotechnology, I want to rehearse briefly some of the relevant extant literature that establishes both the historical context in which this technoscience has been developed and some of the ways this development has been conceptualized.

Situating and Conceptualizing the Historical Context of Biotechnology Development

Basic biological processes such as fermentation and the use of yeast have been exploited for millennia. Moreover, in the mid-nineteenth century, the Austrian Augustinian monk Gregor Johann Mendel experimented with peas to determine the way in which genetic traits are passed on to a plant's progeny.[6] Similarly, the roots of gene mapping lie in studies from the 1910s that examined the common fruit fly, *Drosophila*, although large-scale mapping would not be technically possible until the advent of powerful computer technologies in the 1980s.[7] It has been more than half a century since James Watson and Francis Crick, in their now famous letter to the journal *Nature* in 1953, described DNA as a molecule composed of two twisting, paired strands that run in the opposite direction of one another, giving rise to its double helix shape.[8] Their work furnished the conceptual advances that fostered the expansion of the biological sciences, as researchers went on to determine that DNA facilitates the synthesis of proteins. Messenger ribonucleic acid was subsequently discovered in 1960. By 1967, scientists had succeeded in isolating the enzyme (DNA ligase) that is responsible for

joining DNA chains. In 1970, restriction enzymes (endonuclease) that cut DNA strands at specific sites were isolated. Within three years, scientists were using these newly discovered enzymes to introduce foreign DNA into bacteria by cutting and splicing gene fragments in a process known as "recombinant DNA" since the genetic information contained within the DNA is recombined *in vitro*.

Despite these starting points in biological research, it was not until the late 1980s that biotechnology as we know it today began in earnest. To a large extent, the growth of biotechnology as a science and industrial sector was enabled by the expanding computing capacity of increasingly sophisticated information and communication technologies developed in this same period. Steven Best and Douglas Kellner (2001) employ the term "biocybernetic era" to capture the synthesis between genetic engineering and computers. Thomas Mitchell (2003, 483) speaks of "biocybernetic reproduction." According to Manuel Castells (2000, 63), prominent sociologist and theorist of the "network society," "technological convergence increasingly extends the growing interdependence between the biological and microelectronics revolutions, both materially and methodologically. Thus, decisive advances in biological research, such as the identification of human genes or segments of human DNA, can only proceed because of massive computing power." Although this contention understates some of the fundamental advances made in the fields of biology, cybernetics, and information theory, the importance of advanced computer applications to the massive growth in biotechnological research and application development remains clear.

Seizing on the vital connections between biology and information, some individuals go so far as to assert that biology is being transformed into an information science and that genetic engineering is a type of information technology (Voigt 2008; Yoxen 1981; Zweiger 2001). As one prominent molecular biologist has argued, "the decisive, energizing perception of biotechnology since the Second World War, the key to its strength and vigour, has been one that treats organisms as information-processing machines ... biology has become a kind of flatland in which the only activity is the processing and transmission of genetic information" (Yoxen 1983, 18-19). As a number of observers have elaborated, the computer metaphor has come to be employed widely in discourses on biotechnology, through which life is represented as being reducible to a genetic code that can be read, edited, and copied (Boyle 1996; Castells 1989; de Landa 1991; Levidow and Tait 1995; Rifkin 1998).

The problematic notion of DNA as code actually goes back to Watson and Crick's early work on the structure of DNA as well as to the research conducted by Marshall Nirenberg and Heinrich Matthaei, which determined

that messenger ribonucleic acid transcribes genetic information from DNA by directing the assembly of amino acids into complex proteins. Colloquially referred to as "breaking the genetic code," this discovery represented molecular biology's Rosetta Stone (Crick 1962a, 1962b, 1963; Matthaei et al. 1962; Nirenberg 1963). Prominent scientific historian Lily Kay (2000) offers a detailed history of the intersections of molecular biology and cybernetics and information theory, including the rise to prominence of the information metaphor in biology. Critical of the unproblematized manner in which information metaphors were easily imported from information theory into biology, she characterizes her work as a study of the "epistemic rupture from purely material and energetic to an informational view of nature and society" (328). However, as she demonstrates in her well-documented historical account, the importation of informational metaphors into molecular biology was based on a utilitarian calculus; it was not "because they worked in the narrow epistemic sense (they did not) but because they positioned molecular biology within post-war discourse and culture, within the transition to a postmodern information-based society" (609). Kathleen McAfee (2003, 203) is similarly critical of the trope of the "genetic code," claiming that its attendant conception of easily adding, deleting, or otherwise manipulating genetic material belies the empirical evidence and experience of most molecular scientists, who are unable to transfer genetic material between organisms with any exacting degree of precision.

Framing DNA as information is a reductionist discourse that disregards the adeptness of living organisms. In ways still not well understood by science, organisms adjust to additions or deletions of genetic material by substituting alternate pathways for those altered in some way, thus preventing – or otherwise reacting to – the organic change that the genetic engineering was designed to induce. More problematic, at least from the perspective offered in this volume, is that the informational metaphors that have infiltrated biology discourses have quickly become literalized in a way that promotes an informational approach to the study of biotechnology that lends itself to corporate capture (Fox Keller 2000; Haraway 1997; Kay 2000). As a result of the technological advances in biological information processing software and hardware, the metaphor of "life as information" can now be given material reality that lends itself to commodification, particularly through the expanding contemporary intellectual property regime (Bowker 2000; Sunder Rajan 2006). In Chapter 4, we will return to a more in-depth examination of how capital is employing the notion of "gene equals information" to facilitate accumulation.

In their trenchant assessment of the development of biotechnology, Dorothy Nelkin and Susan Lindee (2004, xiii) write that "[i]n the 50 years since the famous Watson and Crick paper, genetics has become an import-

ant corporate enterprise, and much of the promotion of genes and DNA reflects this commercial nexus." In the 1980s, a number of commentators who were already critical of the increasing commodification of biotechnology began to identify the inability of regulatory and other scientific assessment mechanisms to accommodate social interests such as ecological impacts, human health effects, ethical considerations, distributive justice, social need, economic productivity, and market demand (Krimsky 1991; Yoxen 1981). Instead, the development of new biotechnological products was, and continues to be, driven largely by market incentives to create new commodities and improve production methods. The result, according to Best and Kellner (2004, 198), is that "all natural reality – from microorganisms and plants to animals and human beings – is subject to genetic reconstruction in a commodified 'Second Genesis.'"

Biotechnology also offers a solution, at least a temporary one, to the finite territory problem that plagues capital. As members of the Critical Art Ensemble (2002, 30) emphasize, "[t]he molecular invasion of the body is the new frontier where untold resources and profits may be appropriated." Nature, according to one geography scholar, "is consequently now undergoing an 'involution' much as space did in the first few years of the twentieth century when planetary expansion was effectively at an end ... when productions of space no longer pushed the borders of the unknown so much as re-worked its internal subdivisions. Faced with the loss of extensive nature, capital re-grouped to plumb an everyday more intensive nature" (Katz 1998, 47). These developments in molecular biology have prompted others to consider the biology-information nexus from a political economic perspective, situating biotechnology firmly within the domain of "information capitalism," in which information assumes a prominent role as both a factor of production across multiple economic sectors and a commodity in its own right (Dyer-Witheford 1999; Heller 2001; Schiller 2007).

Within this broader political economic context, the conceptual redefinition of nature as information, communication, and control supports and reinforces its increasing commercial exploitation. Facilitating this process, chemistry and biology have been applied as instruments to link organic processes to their technological and commercial exploitation (Guattari 1992). Two decades ago, Jack Kloppenburg (1988) left room for the possibility that biotechnological material would increasingly derive its value from its informational content rather than from its material form. Given the ability of emerging technology to transform fundamental genetic and biochemical properties, other writers of the time postulated that the tradition of valuing biotechnological materials as material resources alone would have to accommodate a new assessment that also reflects their informational resource aspects (Doyle 1985; Mooney 1983).

In more recent work, Eugene Thacker (2005) analyzes the impact of broader globalization processes on the development of biotechnological knowledge and practice (focusing predominantly on biomedical and genetic research). The bulk of his work, which seeks to address how ontological questions in regard to biotechnology are insinuated in broader social, economic, and cultural questions, is devoted to an investigation of the interstices between biology and informatics, including the way advances in the latter have facilitated innovation in the former. He is, therefore, also interested in interrogating the often contradictory dichotomies found in biotechnology between the natural and the artificial, the biological and the technological. Building on the work of Castells in regard to the informatization of biotechnology, Thacker examines the way genetic materials are rendered into digital forms that capture the informational content of the embodied artifacts and, in turn, are manipulated and recombined to produce novel biological materiality.[9]

Biotechnology and its accompanying information technologies now render it possible to not only derive biochemical information from organic material but also use such information independently of the original biological sample. That is, these new biotechnologies interact synergistically with the information embodied in the organic specimens to produce additional types of information that become sources of productivity and value. Increasingly, it is precisely the derived biotechnological information rather than the material form that is of interest to researchers. As Bronwyn Parry (2004, 59) reminds us, "[a]lthough this may not seem of any great significance, changing the way in which the information is embodied or presented proves to have profound effects on the dynamics of trade and exchange" as well as on production.

In our current conjuncture, we are witnessing an expansion of capitalist social relations into more fields of social labour and a consequent growing application of market exchange to a mounting range of commodified objects, including information. Martin Kenney (1986, 4) made explicit the political economic implications of the connection between biology and information over two decades ago, at the outset of what some have coined the "biotechnology revolution." He stated that "[b]iotechnology is an information-intensive technology and will very easily fit into a restructured economy based on information. Indeed, biotechnology will provide one of the new economy's crucial underpinnings." However, as Sheldon Krimsky (1991, 17) pointed out at around the same time, "[w]e do not yet know whether the revolution in applied genetics will establish higher standards for civilization as a whole, will respect diverse forms of life and habitats, will liberate us from disease or enslave us to a genetic determinism, whether its achievements will be shared equitably, or whether its significance will be mixed with a favorable outcome to narrow interest groups." Close to two decades

later, this current book seeks to pick up on some of these considerations and sketch a picture of how they are being worked out in Canada.

Situating the Present Work

While such a brief overview of some of the existing literature clearly overlooks much of the depth of the arguments and theories developed by these leading scholars, it is sufficient to demonstrate that the nexus between the informational and biological inherent in contemporary biotechnology has been a topic of discussion since at least the early 1980s. Moreover, this subject has been debated from a variety of perspectives, ranging from the ontological, to the metaphorical, to the political and the economic. Within this broader context, the present work seeks to situate empirically and theoretically some of the ways in which agricultural biotechnology has been appropriated by capital as an element of broader accumulation strategies, including the way that the increasing commodification of both biotechnological information and materiality have been insinuated in the trajectory of contemporary capitalist social relations. Where this book differs from its predecessors, particularly those that have looked specifically at Canada, is in how it emphasizes the major instances of social resistance that are being mobilized against particular aspects of biotechnology in this country. As it turns out, these aspects tend to revolve predominantly around issues implicated in agricultural biotechnology.

While biotechnology has yielded some groundbreaking discoveries in a variety of areas, a plethora of issues that go beyond the science and that have wide-ranging implications for contemporary society follow in the wake of this new technoscience. A more balanced account of the development of biotechnology must challenge the assumption, either implicit or explicit, that scientific progress derives from the capacity of scientists to surmount technical barriers, public apprehension, or the obstacles placed by bureaucratic and political elites. Rather than blindly adopting an uncritical assessment of innovation, we must understand scientific research and advancement in terms of the social and political processes that constitute its context of development. That is, science and technology need to be conceptualized as social and cultural practices constituted within and by the dominant power structures and values of the societies in which they are a part.

Members of the Critical Art Ensemble (2002, 43) poignantly sum up the dangers of uncritically equating technological development in the service of capital with progress:

> Of course there is no real gain, only relative gain. Class structure replicates itself in the technology ... decades of technoculture have taught us only that the greater the intensity of technology, the greater the workload. Much the

> same is true of efficiency. Improved efficiency only means more profit and speed for capital, while the implied promise of individual benefit never seems to materialize. Taken together, a working definition of progress emerges that means nothing more than the expansion of capital, but presents itself as advancement of the common good.

We thus need to engage in political economic analyses that problematize the role of capital and the state in the developmental trajectory of science and, particularly, of biotechnology. As Karl Marx (1993, 704) pointed out long ago in the *Grundrisse*, scientific innovation migrates with relative ease into the realm of capital: "Invention then becomes a business, and the application of science to direct production itself becomes a prospect which determines and solicits it."[10] Harry Braverman (1974, 156) develops this idea in his own work when contrasting the Industrial Revolution of the nineteenth century to the scientific-technical developments of the twentieth century: "Science as generalized social property incidental to production and science as capitalist property at the very center of production."

While certainly not subscribing to a Marxist perspective, the Canadian government nonetheless has long realized the exchange value potential of biotechnology. For example, federal policy documents tend to attribute a variety of economic benefits to biotechnology: "In the last twenty years, biotechnology has become an increasingly important engine for economic growth and social development. It is now widely held that the transformative power of biotechnology will change forever the way we do things and interact with each other and the natural world, and that it will concomitantly change the culture of societies" (Canadian Biotechnology Advisory Committee 2006b, 3). Rejecting the underlying teleological tone of this contention, this book strives to contribute to the continuing academic, policy, and popular debates surrounding the role of biotechnology as a critical site within the present conjuncture of capitalist development.

Indeed, biotechnology might be considered to present a microcosm of the dominant characteristics of contemporary capitalist social relations: high capital intensity as reflected in the relatively small number of firms and workers involved in this sector; extensive control and command over the labour force; the involvement of both the state and capital in research and funding; the international focus of the large multinational biotechnology firms; and the intense use of information and communication technologies. As this book endeavours to argue, in order to inject some modicum of democratic control over the trajectory of biotechnology, we need to move beyond conceptualizing this technoscience as merely a particular combinatory set of scientific and technological knowledge and innovation and admit a discussion of the broader implications that it portends for contemporary social relations.

Introduction to a Marxian Analysis of Biotechnology

In an effort to conceptualize the empirical evidence presented in the following pages, I will develop and draw upon a theoretical framework informed by Marx's foundational notion of "primitive accumulation" and its relationship to enclosures and commons. Together, these concepts provide suitable registers for apprehending both the commodification of biotechnology and its consequent opposition by those social subjects that typically fall outside the more orthodox Marxist pre-occupation with the factory and skilled labour. At its most elemental level, Marx's (1992, 899) conceptualization of primitive accumulation conceives of it as a practice that separates producers from the means of production: "Thus were the agricultural folk first forcibly expropriated from the soil, driven from their homes, turned into vagabonds, and then whipped, branded and tortured by grotesquely terroristic laws into accepting the discipline necessary for the system of wage-labour." This process in England began as early as the fifteenth century and reached its zenith between the late seventeenth and early nineteenth centuries when members of the aristocratic class appropriated previously common lands, to which traditional usufruct rights of access and use for all were attached, and transformed them into deeded, private property.

In contradistinction to traditional exegetical accounts of Marx's primitive accumulation, recent scholars posit a basic ontological connection between primitive accumulation and expanded reproduction, believing that, for Marx, accumulation in general is a form of intensified primitive accumulation. Primitive accumulation should thus be understood as a continuous process that endures beyond the traditionally cited historical examples of land enclosure. Moreover, primitive accumulation, according to these contemporary theorists, should be conceived of as the extra-economic prerequisite to capitalist production that not only endures in contemporary society but also has been extended across the globe (Bonefeld 2001, 2002; De Angelis 2001, 2007; Glassman 2006; Harvey 2003). For example, structural adjustment programs foisted on Africa in the 1990s by the International Monetary Fund as a response to the debt crises in the 1980s resulted in massive shifts of land ownership that robbed local populations of their traditional means of subsistence. Through international trade agreements, Western intellectual property regimes were forced on developing nations in a way that commodified indigenous knowledge. Capital was also engaging in concerted efforts to privatize and commodify a variety of common resources, including such elemental ones as water, genetic material, and information.

Taking primitive accumulation and the consequent organization of capital around private property and wage labour as its conceptual starting points, the analysis in this book rejects the traditional dichotomies of state and market and political and economic. Instead, it conceives of these concepts

as different expressions or forms of the conceptually prior separation between the actual producers and their means, processes, and products of production that give rise to antagonistic social relations. Articulated in broad strokes, the following chapters will rehearse the various practices of corporate and government enclosures of both terrestrial and informational commons that can be conceptualized as contemporary instances of primitive accumulation. Put more explicitly, by engaging the concept of primitive accumulation, we will see how the exploitation of biotechnology renders organic existence as a new source of profit in service of capitalist accumulation imperatives.

Yet in keeping with the goal of interrogating counterstruggles, we will also see that capital's drive to engulf expanding realms of social and biological existence within the logic of its social relations ignites multiple revolts by resistant political subjects. Juxtaposing the concept of the commons with the enclosing practices of primitive accumulation will help bring into focus a critical thread in this book that interweaves diverse points of resistance among social subjects struggling against various aspects of agricultural biotechnology beyond the immediate point of production. Indeed, a basic contention of the present work is that any analysis of contemporary capitalist society should proceed from the underlying assumptions that inherent to that society is an antagonistic relationship between class subjects and that attempts at domination provoke resistance aimed at emancipation – a resistance that will be interrogated throughout this book.

In the same way that Marx's methodological orientation is based on the perspective of the working class rooted in its own historical activity within the capital-labour relation,[11] contemporary efforts at understanding and situating the current conjuncture of capitalist social relations can be advanced through research into the genealogy of social and political opposition movements. Remaining consonant with the theoretical framework informing this work, social movements that resist the extension of capitalist relations of exploitation into the sphere of social reproduction might be construed as being just as much a part of contemporary class struggles as are the workers at the direct sites of production (Bieler and Morton 2006). Following Harry Cleaver (1992), the exposition offered in the subsequent chapters seeks to interrogate the "nature of the totality/globality that capital has sought to impose, the diversity of self-activity which has resisted that totality and the evolution of each in terms of the other." An extended analysis of the opposition in Canada that resists the enclosure of the biological and knowledge commons (or what I will sometimes group together throughout this volume under the rubric "BioCommons") will allow us to engage with the second query driving this research – namely, what counterstruggles have emerged in Canada that seek to challenge and foreclose the products and processes developed by biotechnological capital? I employ the term

"commons" to refer less to a specific institutional form and more to its inherent social practices that structure the way resources – be they material or immaterial – are accessed, used, and managed by a group of people beyond the logic of the capitalist market. The commons thus involves the production of meanings and values through active engagement among subjects who struggle to maintain or regain social control over social wealth through opposition to capitalist and state practices of enclosure.

By interrogating the various forms of struggles that have emerged in defiance of the progressive enclosure of biotechnology, this monograph aspires to go beyond past investigations of biotechnology that tend to give short shrift to, or completely ignore, issues of resistance.[12] My elaboration of these counterstruggles will place particular emphasis on the implications they have for both the biological and the knowledge commons. This focus will permit me to respond to the third question informing the current work – what are the information and knowledge issues encompassed by such struggles? As mentioned earlier, the increased importance of information as both a commodity that possesses exchange value and as an input into a variety of production processes across economic sectors has significantly intensified the enclosure of information and knowledge commons. Biotechnology provides a particularly apropos example of the scope and implications of such enclosure.

At this point, I would like to clarify some terminological use throughout this volume. Taking a cue from Massimo De Angelis (2007), who himself follows Marx's usage of the term, I will avoid the *ism* of "capitalism," discussing instead "capital" and "capitalist social relations." Indeed, Marx never referred to capitalism, instead preferring to talk about the capitalist mode of production. By adopting this perspective, Marx was in a position to develop a critique of capital as an all-encompassing social relation or, what a more contemporary theorist refers to, as a system of social metabolic control: "Capital is not simply a material entity. We must think of capital as a historically determinate way of controlling social metabolic reproduction. That is the fundamental meaning of capital" (Mészáros 2008, 75). Such a conceptualization permits us to apprehend capital, or a capitalist mode of production, as one mode of organizing livelihoods that co-exists with, and is related to, others. In this way, we can conceive of the social field as a space open to strategic contestation among different forces. Similarly, I would like to clarify my use of the term "capital." My intent is not to hypostatize capital as a monolithic entity that develops and executes an internally consistent program of accumulation. Instead, I employ "capital" as shorthand for the aggregation of individual capitalists that, in general, represent a class in the broader system of capitalist social relations.[13] Finally, this work consciously employs the term "genetically engineered" in direct opposition to

the industry preferred appellation "genetically modified," which is meant to convey a sense of naturalness and line of continuity from conventional (natural) agricultural, to breeding practices, to modern biotechnology.

A Brief Note on Methodology and Scope

The methodology that guided the research presented in this book represents a synthetic approach that reflects a combination of two strains of Marxist thought – a classical political economic analysis of capital and the state and an autonomist bottom-up approach that commences with struggle. While I certainly privilege struggle, as demonstrated by my choice of interview informants, the study began with a documentary analysis designed to sketch the broad contours of the biotechnology industry and biotechnological development in this country. The documentary analysis focuses on the CBS, and, aside from the actual documents that articulate this government policy, position briefs, publications, and other relevant material produced by federal bodies such as the Canadian Biotechnology Advisory Committee and the Biotechnology Assistant Deputy Minister Coordinating Committee of the Government of Canada were also examined. Having established this macro context, interviews were then conducted with key informants involved in the resistance against various aspects of biotechnology, which, as already mentioned, revolve predominantly around agricultural and food issues. After compilation, the results were offered back to the interview participants for further review and comment. Given the oppositional nature of such struggles, it was unlikely that documentary analysis alone would have revealed their true scope. Indeed, a lack of resources often circumscribes the documentary material that resistance movements can make available. Interviewing ensured that important evidence was not omitted from the study. These struggles, which themselves were approached as interruptions in the circuit of capital, were then analyzed in terms of their development, content, direction, and means of circulation along the entire circuit of capital. Finally, the analysis moved upward to relate all of these aspects of struggle to the broader capitalist initiative in terms of general social planning, investment, and technological innovation, as established through the documentary analysis.

Although it is perhaps already clear, the material presented in this book focuses predominantly on the Canadian domestic context. In part, this decision speaks to what I perceive to be a gap in the literature on biotechnology and, particularly, the resistance to biotechnology in Canada. Nonetheless, I think that a number of the issues and lessons illustrated in this work might find a certain degree of resonance in other countries grappling with agricultural biotechnology questions. Certainly, some cursory international comparisons are drawn where applicable and, of course, all of the biotechnology companies examined are multinational corporations, but, in general, this work does not engage with the international context. This is due, in part,

to the richness of the material in the Canadian context. It is, similarly, a result of the empirical fact that many groups opposing agricultural biotechnology in this country focus on the domestic environment. And, finally, it comes from my belief that the scope and breadth of the issues surrounding biotechnology at the international level warrant their own separate, future research project.

Moving Forward

Before proceeding to the substantive content of this book, I would first like to offer a roadmap to help guide the reader in following the argumentation as it is developed in the pages that follow. In an attempt to answer our first research question about the prescriptive role of the CBS in facilitating the commodification of biotechnology in Canada, and in a manner that sets the context for responding to the other two, Chapter 1 is dedicated to outlining federal government policies and other pronouncements that serve to harness the vitality of the biotechnology sector as a motor for scientific innovation and economic growth. In addition to articulating the major elements of the CBS, I will introduce the players mobilizing against various aspects of agricultural biotechnology in Canada. Chapter 2 contemplates the capitalist appropriation of seeds and agriculture. This chapter also examines some of the resistance being organized against a particularly insidious example of corporate control of seeds – Terminator technology. This chapter also will begin to outline the theoretical constructs highlighted earlier that I propose can most usefully help assess the empirical findings with respect to the corporate capture of agricultural biotechnology. In part, the Terminator discussion provides a segue into Chapter 3, which rehearses the major past and present battles fought against specific genetically engineered technologies. Here, in the context of resistance, an elaboration of the concept of the "commons" will complete our theoretical framework. Chapter 4 investigates and elaborates the ways through which the intellectual property regime might be conceived of as a contemporary form of primitive accumulation that facilitates the enclosure of biological information and resources. In addition to presenting three of the major judicial cases waged to date in Canadian courts over genetically engineered organisms, this chapter will offer findings that demonstrate ways in which contemporary patent practices in regard to biotechnology actually offend against many traditional justifications invoked in support of the intellectual property system. Chapter 5 analyzes the biotechnology regulatory regime as a mechanism that facilitates enclosure of this science and its attendant technological applications. Deaf to pleas by both civil society and some scientific actors to expand the terms of reference of our current system of regulation, Canadian policy-makers remain steadfastly committed to an increasingly deficient linear model of scientific assessment that stubbornly refuses to admit broader social and political

economic concerns into its deliberations. Chapter 6 describes some of the strategies and tactics employed by government and business to construct a deliberately circumscribed discourse around biotechnology, in what can be understood as a purposive enclosure of the knowledge commons.[14] The concluding chapter offers an overview of the major empirical findings that emerge from this research project.

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