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The killing fields: Science and politics at Berkeley, California, USA

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Abstract. Over the past several decades, a group of scholars at the Berkeley campus of the University of California have frequently challenged many of the dominant themes of contemporary agricultural research. In their work, they have organized curricula questioning the assumptions of conventional agriculture and its sciences while encouraging the development of alternative agricultural practices based on principles of ecology. Their collective critique has stimulated an intellectual climate calling forth a scrutiny of the university's role in the production of knowledge and the social consequences of its works. The result of this intellectual project has been a group that has also largely challenged the dominant themes of the modern university. In place of a setting where ideas are a passive currency, the modern university is a place where knowledge and power are manifest in a dialectic that is revealed not simply by the production of knowledge, but its destruction as well. It is in this context that the recent history of a group of scholars at the University of California provides a striking testimony concerning the disturbing character of science in the modern university. The ecological and social dimensions of "killing fields" that captures the contemporary hazards of food and fiber production in California is also reflected in the gradual demise of a group of researchers at Berkeley who have endeavored to provide an alternative vision of agriculture.

Key words: Biological control, Environmental policy issues, Agricultural research

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Introduction

In recent years, substantial changes have occurred in the composition of scientific disciplines at major universities throughout the USA. How does one evaluate the significance of such changes?[1]

For the general public, and indeed many professionals, the rise and fall of different fields of teaching and research is a part of the progress of science. According to this popular view, some lines of inquiry appear more promising than others, certain technological innovations provide new tools for investigations, or groups of investigators are drawn to a more popular set of problems. Paralleling the explanations offered by Thomas Kuhn, changes in science are largely a function of decisions among scientists about science.[2] Correspondingly, the proper conduct of science is a process best left to scientists as a means of assuring the integrity of science and protecting against intrusion of political considerations. Protecting science from the influence of politics frequently turns toward a discussion of methodological rigor, peer review, intersubjectivity, and related norms of scientific procedure.

What does the proper conduct of science mean where methods, peers, and the formulation of problems are influenced by social forces beyond the university? How does one evaluate differing science-based recommendations in the context of faculty and research units that have a differential access to grants, journals, and technology? And how does one view the emergence of a dominant problem-solving approach in the university?

For many professionals, the changes in university research, such as those occurring at Berkeley, are merely a part of the process of modernization. Thus, as disciplines advance, the work of older investigations are melded with newer discoveries and the whole field of science is viewed as a progression. Examination of the contemporary changes with the Division of Biological Control, however, does not lend itself well to this model of uncomplicated accumulation of knowledge.

A cursory review of biological control across the nation would suggest that it is a growing and vital field, as measured in terms of recent job announcements, funding programs, and conferences. The history of the Division of Biological Control at Berkeley, however, should draw one's attention to other issues – what precisely is occurring within this research arena? For some observers, the demise of the Division at Berkeley will be consigned to explanations that come easily to those within the university: the lack of publications, an absence of attending professional meetings, or a failure to obtain grants for research. On the face of it, the Berkeley group does not appear to lack any such professional achievements; yet, as will be argued, to look for evidence in such arenas is, at best, misleading and, by itself, misdirects attention from the more political dimensions of the modern university.

For others, however, the loss of this research and teaching unit poses an especially troubling question: if groups of scholars identify goals (e.g., the protection of farmworkers and the environment) that place them at odds with dominant themes in the university (e.g., investigations directed at productivity) that influence access to funding, professional associations, and the selection of faculty, can such an academic orientation long survive in the modern university? And perhaps more troubling, if the modern university is less well characterized by the freedom of researchers and faculty, but more the intrusion of capital and the preoccupation with productivity, in what sense can the contours of disciplines reflect some progression of knowledge? What does one make of such changes in the "modern" university?

Science: Theory and politics

During the latter half of the nineteenth century and accelerating in the twentieth century, American universities have experienced dramatic changes in the production of technical knowledge.[3] Academia as a place of quiet thought and reflection has become gradually transformed into a center of activity that is closely linked to commerce and technology. Integral with this transformation are alterations that have affected the organization and pursuit of knowledge within and across disciplines.

Administrative changes within the university have affected more than simply the names on doors or titles on plaques. At the Berkeley campus of the University of California, reorganization in the biological sciences has altered the focus and orientation of various departments and academic units.[4] In the case of the Division of Biological Control, these changes have significantly diminished a decades-long tradition of challenging the dominant constituents of modern agriculture – production practices based on an intensive use of capital and chemicals.[5]

The project of reorganizing departments at Berkeley conforms to the larger theme of modernizing the university. Just as new laboratory equipment replaces older devices, disciplinary boundaries must be deconstructed and reconfigured to advance more novel inquiries. Or has reorganization merely served as a convenient pretext for disguising newly emerging relationships within the university? As will be argued in the following pages, reorganizing the biological sciences at Berkeley confronts the broader community with a more profound question – is the modern university a place where knowledge is not merely accumulated, but where science is constructed towards particular ends? If indeed science and its applications are actively engineered, what is the process for evaluating its consequences for society?

A word of caution, however, is necessary before continuing with the discussion of biological control at Berkeley. The argument presented here is not directed toward demonstrating that industry has influenced the course of university research; as various contemporary observers have noted, such relations can largely be taken for granted.[6] Beyond the imposition of financial interests on a scientific process by non-scientists, the contemporary history of biological control at Berkeley raises a more profound question – in what ways has the entry of economic interests in the university begun to limit not simply specific research projects, but influenced the paths of inquiry pursued by groups of scholars, perhaps entire disciplines?

In contrast to the passivity of many scientists, various scholars examining the American university have frequently argued that the process of scientific modernization is profoundly political; some voices arguing that contrary to Kuhn's notion, the process of scientific inquiry is better understood as counter-revolutionary.[7] Changes occurring within such fields as medicine and engineering have provided the groundwork for accumulation of massive wealth; assisted in defining relationships between the citizen, the state, and the corporation; and, fostered centers that have shaped the production of knowledge.[8]

The production of knowledge in the modern university, therefore, is marked not simply by the expansion of particular fields, but an elimination of alternative approaches. This dialectical process has posed particularly difficult problems for understanding the consequences of modernization; it has demanded an evaluation of that which no longer exists.

Moreover, many of the time-honored procedures for assuring impartiality in the production of knowledge (e.g., peer reviews, reliability of data, intersubjectivity) fail to address the loss of alternative lines of inquiry. Ostensibly removing themselves from the poverty, violence, and the context of social struggles as a means of assuring objectivity, scientists are frequently discouraged from ascertaining the wider consequences of their works in the world.[9] The nature of the revolution wrought by the modern university is assumed, in many instances, to provide knowledge in service of humankind. A significant literature exists, nevertheless, challenging this view of contemporary university-based science.

While the discussion of politics and knowledge calls forth a complex realm of debate, the purpose of this work is to examine recent changes accompanying modernization in a specific instance – the Division of Biological Control at the University of California, Berkeley – to consider what may be a rapidly disappearing subfield within the biological sciences. This case might also serve to illustrate similar changes occurring across the United States.

Biological control

> Examples of successful biological control of serious pests by importing their natural enemies are to be found in some 40 countries distributed over much of the world. The advantages of such control over chemicals are obvious: it is relatively inexpensive, it is permanent, it leaves no poisonous residues. Yet biological control has suffered from lack of support. California is virtually alone among the states in having a formal program in biological control, and many have not even one entomologist who devotes full time to it. (Rachel Carson)[10]

Researchers in biological control have accumulated a long and impressive record of accomplishments in California over the past several decades. Beginning with the successful control of a highly destructive pest of citrus in the latter part of the 19th century, California researchers have made additional and substantial contributions to the non-chemical control of pests in grapes, tomatoes, olives, and ornamentals as well as weeds. After first establishing a biological control research unit with the University of California at Riverside in 1923, another research unit at the Berkeley campus was opened in 1944.

Early research in biological control was based almost entirely on the classical approach of foreign exploration, release, and colonization of parasites and predators for suppression of agricultural pests. The fundamental disciplinary elements of research serving this approach were systematics and applied ecology.

A popular portrayal of biological control is a method of pest control that relies on "good bugs to control bad bugs"; for professionals in the field, their endeavor is a complex research process based on predator-prey, parasite-host, and herbivore-plant relationships. As a technique for controlling insects, it reflects a tradition of non-chemical control and a method that depends on extensive scientific investigation and field study, drawing on examinations that include behavior, habitat characteristics, population dynamics and modeling, nutrition, and physiology.

To be sure, biological control is not a panacea providing answers to most pest problems in agriculture. Among farmers, its principal weakness is seen as the lack of a readily available technique that can provide economically acceptable pest suppression in cropping systems.[11] The critique of biological control, however, goes well beyond simple problems of commercial availability. Potential and actual problems have included the suppression of nontarget species resulting in loss of biological diversity, disruption in the existing control of weed species, the release of otherwise innocuous species, disruption of plant community structure, and the destabilization of food chains as well as nutrient cycling processes.[12]

Biological control represents a method that, when successful, proceeds without continuing need of human intervention; this objective, as we shall see, is of particular importance for certain members of the profession. Insect pests that might otherwise pose a significant threat to a specific crop are frequently kept at low populations and controlled by one or more predators or parasites. For many of those working with biological control, however, their field of study has often represented more than a collection of methodologies designed to merely fix problems in tandem with conventional agricultural practices.

To understand the evolution of Berkeley's research group, it is essential to understand that since at least the 1960s, biological control reflected sharply divergent paths. As noted by one of the most celebrated analysts of contemporary entomology, Dr. John H. Perkins, biological control encompassed two major schools of thought. At Berkeley, the initial nomenclature claimed by members of the Division was the title of "integrated pest management (IPM)," an expression used to identify a holistic approach designed to minimize pest impact while simultaneously maintaining the integrity of the ecosystem.[13] The Berkeley faculty, along with other like-minded faculty elsewhere, also tended to adopt the phrase "classical biological control" to describe themselves and their work. Other entomologists, characterized by a commitment to the control of insect(s) over a large geographic area were referred to by the term "total population management (TPM)."[14]

Distinguishing between the two groups was not uniformly clear across departments or even within research groups. Thus, while another of the UC campuses, at Riverside, contained another important group of researchers in biological control, their faculty were more divided with respect to the role of pesticides in agriculture. At UC Davis a greater orientation toward TPM predominated for much of its history up until the present time. The Division of Biological Control at Berkeley by the early 1960s, however, was marked by a growing distinction from their colleagues in other units within the university.

The distinction is not simply that the Berkeley group was composed of saints and all others in entomology were sinners. Indeed, anecdotal evidence indicates that the Berkeley group included faculty who applied hazardous pesticides and were in the employment of large agribusinesses.[15] Rather than celebrating such practices, however, such experiences among the Division's members contributed to a growing critique beginning in the 1960s. By the early 1970s, the Division adopted a distinctive, some might say flamboyant, camaraderie among its faculty and their antagonism toward the over-reliance on pesticides and agrochemicals in American agriculture.

During the early years, the prestige and expertise of the Division's work was sufficient to attract substantial funding. The International Biological Program, initiated in the mid-1960s and predecessor projects, including the Huffaker Project, extending though the late 1970s placed Berkeley at the center of a worldwide research effort that spanned numerous land grant universities and the US Department of Agriculture. Integral to much of the Division's work were prominent faculty, such as Carl Huffaker, who expressed considerable disenchantment with the approaches pursued by other of his colleagues beyond Berkeley who accepted total population management and were more passive regarding the use of pesticides. Indeed, Dr. Huffaker expressed disappointment over the celebrated project that carried his name; "Despite the influx of more than $20 million to develop IPM programs for some major US crops, only a small amount has gone to develop the use of parasites, predators, pathogens, and antagonists. In fact, the so-called 'Huffaker' project, shortly after it was well under way, was stripped of funds for this specific area."[16]

For the Berkeley team, conventional farming practices and their reliance on agrochemicals frequently constituted an essential part of the problem affecting the successful application of biological controls. First, conventional farming often impeded the ability of predators, pathogens, or parasites to effectively control pests. The extensive cultivation of a single crop (monoculture) results in ecological settings that are inhospitable to a variety of insects, including natural predators. Second, and no less important, pesticide applications to various crops threatened the survival of biological controls.

The impediments to the widespread use and adoption of biological controls are not simply located in field practices, but also include inhospitable research settings. This lack of institutional support is peculiar in light of the important benefits that California's growers received from the Division of Biological Control. Ken Hagen, for example, documented that within the USA since the 1940s, biological control brought 60 major pests under complete biological control, 60 others under substantial control, and 40 more under partial control.[17] Assessments by others have identified that the introduction of exotic natural enemies (parasitoids, predators, or pathogens) have achieved permanent reduction of densities of 421 pest species in 517 successful projects in 196 countries or islands.[18] In addition to direct savings, various communities were spared the release of untold quantities of toxic substances to the environment.

Agribusiness's lack of enthusiasm toward the Division was less surprising given the unveiled attacks its researchers made on pesticides. In 1970, Dr. Donald Dahlsten, Richard Garcia, John Laing, and Robert Van den Bosch published a workbook with an introduction by Barry Commoner. Their work critiqued pesticides from various angles and the group of professors offered a final word of caution to the readers emphasizing the political nature of many environmental problems – "it's your world . . . don't leave it to the experts."[19]

If pesticide manufacturers were unhappy with many of the earlier writers who later comprised the Division of Biological Control, Robert Van den Bosch raised even more attention with his publication, *The Pesticide Conspiracy*, containing an even more explicit attack on the influence of the chemical industry in academia. A sampling of his work illustrates why both industry and faculty had trouble with Van den Bosch:

> By and large, the aggie colleges and their associated experiment station and extension services are social anachronisms that view their mission as one narrowly oriented to crop production and agri-business and hardly concerned with broader societal interests. What else explains their virtual neglect of the concerns of the farm worker, the consumer, the urban homemaker, and the environmentalist? This narrowness is perhaps explainable in largely agricultural states, where the universities are dominated by farming interests.[20]

According to his friends in the Division, Van den Bosch was spared the same level of castigation that Rachel Carson received only by a similar, untimely death, shortly following the publication of his work. Nevertheless, Van den Bosch left a legacy of like-minded colleagues at Berkeley who maintained a critical posture toward the modern university and its responsiveness to corporate interests.

For researchers in classical biological control, the integration of biological control with chemical-based technologies represented nothing less than a direct attack on the objectives of their work to establish an ecological basis for controlling pests in agriculture, forest, and other settings that did not rely on pesticides. But the fact that biological control was increasingly seen by organic farmers as the basis for alternative agriculture did not mean that it was well-received by mainstream scientists or their professional organizations. Thus, even as members of the Division began to meld their work in biological control more closely with investigations in ecology, professional organizations in the agricultural sciences presented a distinctly more hostile reception to such research, as suggested in the following episode:

> Unfortunately, the formal analysis of these (agroecological) systems is sometimes manipulated to deliberately discredit alternative agriculture. For example, members of the Council on Agricultural Science and Technology (CAST) panel on organic farming were informed by the chairman that the purpose of the panel was not to evaluate the effectiveness, limitations and applicability of organic farming, but rather to show that it is thoroughly and entirely inappropriate.[21]

The lack of institutional support for classical biological control, which appears to the uninitiated as just another academic turf war, upon closer inspection, reflected a fundamental conflict about the vision of California's agriculture for the next century. Resolving this dispute affected not simply a few faculty members; it would influence, along with other decisions, the university's research directions and priorities into the next century.

Biological control and alternative agriculture

In 1989, the National Research Council released its long-awaited report on agriculture. Alternative Agriculture began by referring to the various problems that resulted from conventional farming, including water pollution, soil erosion, pest resistance, and pesticide residues in food. As a result of these problems, it noted that farmers had become increasingly emphatic about their need for alternative practices based on naturally occurring beneficial interactions.[22]

The National Research Council's report concluded that a fundamental basis for achieving a transition from conventional to alternative farming practices depended on "a fuller understanding of biological and ecological interactions, nutrient cycles, and management systems geared toward sustaining and maximizing on-farm resources."[23] Unmentioned, however, was any elaboration on biological and ecological interactions. Nor did the discussion extend to the structure of agriculture and its relationship to malnutrition affecting millions of Americans, the routine exposure of tens of thousands of farmers and farmworkers to an array of toxic substances, or the purposeful misdirection of agricultural research. The recommendation that farmers should pursue an alternative form of agriculture based on a dramatic reduction of chemicals evoked an angry response from many representatives of industry. Although no formal record exists, many persons close to the National Research Council's Board on Agriculture speculated that relieving the Board's chair, Dr. Chuck Benbrook, of his duties was no mere coincidence.[24]

The National Research Council's Committee on the Role of Alternative Farming Methods in Modern Production Agriculture reported that among the various obstacles confronting a rapid transformation to alternative agriculture was the lack of resources in crucially important areas. "Inadequate funding," according to the Committee, "has postponed work in several areas, including the development of monitoring processes and analytic tools, biological control methods, cover crops, alternative animal care systems, rotations, plant health and nutrition, and many others (emphasis added)."[25]

It was little wonder that during the 1980s and 1990s efforts to support and expand the uses of biological control were often predicated on a reductionist, even molecular approach that turned a blind eye toward the context of its applications. Thus, those entomologists who developed pesticide resistance in predators and parasites fostered closer links with inputs provided by the agri-chemical industry by extending the marketability of pesticides with increasing numbers of resistant pest populations.[26]

The role of biological control at the University of California, therefore, set the stage regarding the pace and extent to which the nation's farmers would be able to achieve the transition to alternative agricultural practices. With the unspecified nature of these alternatives, particularly with respect to the social dimensions of corporate agriculture and its activities in the University, the Division now confronted losing support amidst an apparent victory of "alternatives" that were sweeping the land grant system.

Biological control at the University of California: Applications and activists

The Divisions' notoriety did not end with Professor Van den Bosch's indictment of corporate farming or the university's failure to pursue more socially-beneficial alternatives. Various of his colleagues were inspired by his words and shared in his sentiments that novel forms of research needed to be pursued at the Berkeley campus.

During the course of the next decade, the faculty in Biological Control pursued a variety of activities, including active participation in farmworker causes, the support of small farm activities, coordination of classes and seminars with public interest groups, while simultaneously promoting non-chemical controls throughout the state.

The Division's critical treatment of prevailing research and policy, however, was perhaps even more noteworthy. Division researchers were active participants in public campaigns opposing the aerial application of pesticides in Los Angeles for treating the Medfly, the planning of statewide ballot measures to change agricultural policy, local campaigns challenging conventional pesticide practices, and legislative hearings promoting the phased-elimination of pesticides. As a group of researchers, they were widely viewed by community organizers as among the few research units actively engaged in promoting an end to pesticides.

On one occasion in the late 1980s, for example, during a negotiation in the California Legislature, the amendment of a University of California research measure contained a conflict of interest provision eliminating any nominee for a proposed Pest Research Center who had received research support from a major pesticide manufacturer in the previous 10 years. A spokesperson for the University of California insisted that the proposed language was untenable since nearly every faculty member of the University would be compromised. When members of the Division were suggested as viable candidates, the response was that they were too much outside of commercial agriculture and would only antagonize major agribusinesses.[27]

As a research group supporting public initiatives, however, they were also viewed with disdain by many faculty and researchers who had greater political power and access to substantial resources. Thus, public activists who sought to name the Division's members to statewide agricultural panels, sustainable agricultural research projects, and similar bodies were repeatedly thwarted during the 1980s.[28]

Although the Division of the University of California at Berkeley broadened its research scope over the years, its emphasis on applied ecology still remained an essential foundation for teaching and research. Whereas their colleagues frequently accommodated the agrichemical industry's insistence on pesticides, the Division's scientists approached pest problems as best resolved by avoiding toxic substances entirely.

In 1987, the Congressional Office of Technology Assessment (OTA) reported that federal programs for the protection of biological diversity were essentially nonexistent. "They are aimed at recovery of species that are already on the verge of extinction rather than at prevention of future losses."[29] The Congressional study also noted that regions with relatively small agricultural holdings and a variety of crops frequently provided a landscape able to support natural enemies of crop pests and a greater likelihood of supporting species and varieties resisting disease outbreaks. The study noted that whereas considerable support had gone to large-scale farming units utilizing modern machinery and agricultural chemicals for the production of a single commodity, "As yet, relatively little scientific effort is being made to determine how biologically diverse farming could be made more profitable. Thus, the continuing loss of agroecosystem diversity in the United States and throughout the world seems to be a function of both economic development and research priorities."[30]

Dr. Miguel Altieri noted that monocultures do not necessarily provide a dependable means of food production, citing the potato blight and subsequent famine in Ireland during the mid-19th century.[31] In addition to the obvious benefits of reducing or eliminating especially hazardous pesticides, biological controls in agriculture also offer the potential for maintaining or enhancing biological diversity. Biologists have expressed increasing concern over the loss of biological diversity as having subtle, but profound importance for society.

Even as societal pressures were mounting to support an enlarged role for biological control, Berkeley's own faculty became more outspoken regarding the failures of conventional agriculture. Dr. Altieri, for example, launched one of his first major publications, arguing emphatically for an ecological basis for agricultural research and policy:

> Under conventional agriculture, humans have simplified the structure of the environment over vast areas, replacing nature's diversity with a small number of cultivated plants and domesticated animals. This process of simplification reaches an extreme form in a monoculture . . . Commercial seed-bed preparation and mechanized planting replace natural methods of seed dispersal; chemical pesticides replace natural controls on populations of weeds, insects, and pathogens; and genetic manipulation replaces natural processes of plant evolution and selection. Even decomposition is altered since plant growth is harvested and soil fertility maintained, not through nutrient recycling, but with fertilizers.[32]

The growing importance of biological control, especially as practiced by certain members of Berkeley's faculty, such as Dr. Altieri, corresponded to a growing recognition among researchers, policy-makers, and others of necessary elements for addressing the increasing evidence of the damaging effects of pesticides on the ecosystem. Paralleling this evidence was an increased scrutiny surrounding the potential economic merits of biological control relative to the blossoming hazards of conventional pesticides.

Biological control and economic considerations

The National Research Council's report, Alternative Agriculture, identified a variety of handicaps hampering the research supporting biological control. Central to these handicaps, however, was the difficulty in finding commercial support for biological control "products" in the face of inexpensive and profitable chemical controls.[33] The Council recognized that the expense of biological controls were usually understood in terms too narrow to appreciate the broader and more long-term costs associated with chemical pesticides.

Dr. Andrew Gutierrez with the Division of Biological Control at Berkeley argued eloquently that the alleged affordability of pesticides was not only false; it also eroded the authentic value of biological controls.[34] Dr. Gutierrez concluded that taxing pesticide users to fund biological control efforts would be socially responsible way to fund permanent solutions for pest problems.[35]

The National Research Council report also indicated that by its very nature, biological control depended on public sector support for two important reasons. First, biological controls that prove effective frequently resulted in a "product" that is naturally established and no longer requires further purchases. Second, developing biological controls is a complex investigation, the results of which, however, are usually location and management specific.[36]

In spite of the need for publicly funded support for biological control, the historic emphasis of land grant universities has been to neglect biological control. The National Research Council summarizes this neglect in the following passage:

> Public funds for the development and delivery of biological pest control products or systems to growers are often lacking, as are funds to adequately assess conditions on individual farms. Private and public research and development expenditures for chemical control technologies in the United States have been estimated as at least five times greater than those spent for biological control. As a result, scientific opportunities to research new biological control methods remain largely unexploited. In general, a relatively modest effort has been made to fully use those biological control systems that have been discovered.[37]

To be certain, the NAS findings do not necessarily favor a universal application of biological controls; there appear to be specific instances in which such applications need to be carefully scrutinized.[38] In the midst of such debates, however, the dimensions and costs of pesticide-induced hazards expand as novel hazards are documented for a growing number of active ingredients, inert or secret ingredients, their corresponding metabolites, and synergisms among combined materials.[39]

Beyond the NAS analysis of insufficient public resources for biological control, however, is a more insidious problem, namely opposition among private firms to classical biological control. Patrick Madden provides a compelling example of the imperative for public intervention in the marketplace:

The federal Agricultural Research Service discovered and helped disseminate a half dozen natural pests that within a decade virtually eliminated the need to spray for the alfalfa weevil in the northeastern USA. A private entrepreneur recently told him [Madden] that her firm had discovered a perfect natural enemy for controlling another pest. But it would form self-sustaining colonies immediately and thus could only be sold once. The firm never released the predator. "It's in the public interest to figure out profitable, productive alternatives to chemicals," Madden said, – "it's not in the interests of private firms, whose profits are keyed to the sale of insecticides."[40]

The institutional support provided by the University of California, nevertheless, could be crucial to the long term success of alternative farming practices as well as the reduction, or even elimination, of pesticides posing a known or documented hazard. For many advocates of environmental quality, public health, and organic agriculture, biological control represented a public good that would not necessarily find support in the marketplace.

In April 1989, certain members of the Division pursued an explicit strategy for building a constituency from outside of the University to provide a base of public support. Noting that many researchers relied on contributions from chemical companies, commodity boards, or global food corporations, some of the Division's scientists concluded that the only "way out" of their dilemma was to become associated with environmental and other public organizations that might provide a countervailing force to pressure the University from outside. When Professor Altieri prepared a memo inviting guests from various nonprofit organizations in the Bay Area to a campus meeting to discuss the formation of a public advisory board, he outlined some of the problems confronting the Division:

> Although the contributions of biological control have been substantial, our capabilities to respond to current crises affecting California's agriculture and food system are being increasingly affected by internal developments in the University. As biological control researchers we are not just confronted by an urgent need for ecologically sound pest management, but we are facing assaults on our research and organizational integrity. Government and University biological control research units are being pared back, or eliminated, or "reorganized." Efforts to redefine biological

> control to include molecular biology approaches are starting to divert our already limited resources into biotechnology.[41]

The meeting, however, was canceled at the last minute when the Dean of the College threatened unspecified sanctions should the meeting take place. Many of the faculty, already feeling besieged by a hostile administration, counseled Dr. Altieri to cancel the meeting. The Dean's strategy not only further divided the faculty internally, it also distanced the Division's relationship with non-profit organizations. At the same time, traditional advocates of biological control found it difficult to engage in the subtle struggles over science within the corridors of academia.

Research priorities at the University of California

Since the mid-1980s, the University had come under increasing pressure from various quarters to explain its rationale for research priorities and support among its faculty and departments. Not the least of these pressures was a long-standing law suit filed in the 1970s by the California Rural Legal Assistance Foundation on behalf of farmworkers challenging the University's agricultural research efforts with respect to the alleged beneficiaries of its applied science. Early meetings with representatives of the Legislature confirmed an embarrassing disarray of projects with no apparent rationale. Even as University spokespersons suggested that faculty were largely free to pursue whatever projects they found interesting, arguments were advanced that in toto the university's works provided benefits for the environment and farm laborers.[42] Such statements only begged the obvious question – "Who were the primary beneficiaries of the University's research programs in agriculture?"

Turning to an assessment of both federal and the University's accounting systems, however, illuminated a listing process that disguised more than it revealed; categories such as biological control certainly contained significant projects that had little ecological integrity to them, just as certain cultural control projects on occasion included efforts closely related to biological control.

Past evaluations of land grant college research indicated that significant numbers of research projects have been dedicated to pesticide strategies. David Pimentel, for example, estimated that in pest control research, 92 percent of the research effort was focused on the use of herbicides, and 55 percent and 89 percent, respectively, of the research is focused on applied pesticidal tactics in insect and pathogen control.[43]

By 1989, the University of California expressed a renewed interest in biological control. The renewed interest included the formation of a University Task Force on Biological Control. The Task Force noted the importance of biological control as a foundation for identifying alternatives to chemical pesticides.

> The continuation of a pest control technology in agriculture which relies primarily on synthetic chemicals is unrealistic, given the dwindling number of newly registered chemicals, the development of resistance in many pest populations, and the public's attitude toward chemical residues with respect to both their actual or perceived threat to environmental quality and human health.
>
> This growing negative sentiment towards chemicals has generated increased support for re-examining older, non-chemical technologies and for developing additional pest control approaches based upon new concepts.[44]

But the University's statements suggesting the end of chemically-based agriculture were premature, to say the least. Indeed, during the next several years, the changing political landscape both in California and nationally suggested that more conservative voices were coming to the fore to re-establish an agenda for agriculture that various observers referred to as a return to the 1950s. Without going into the details of the changing political landscape, in March 1992, the California Commodity Committee (CCC), a group supported by agribusiness, initiated a review of the University's Division of Agriculture and Natural Resources. The CCC represented state and federal commodity marketing programs and affiliated organizations.

On January 18, 1994, the CCC presented Dr. Kenneth R. Farrell, the University's Vice President for Agriculture and Natural Resources, with its recommendations for transforming agricultural research. In addition to other points, the CCC recommended that academic performance be reviewed with respect to focus on agriculture and the food production system and that industry receive greater involvement in university policy and program development.[45] Most significant for Berkeley's faculty, however, was the recommendation to transfer all agriculture-related research and extension programs at Berkeley to the Davis and Riverside campuses.[46]

As a response, the University's system-wide headquarters for agricultural research, the Division of Agriculture and Natural Resources (DANR) issued its own report, "Toward Realignment of the Agricultural Experiment Station." The DANR report reflected various of the recommendations contained in the CCC report. This was regarded with considerable suspicion by Berkeley faculty, particularly when it became known that Dr. R. K. Webster served as both an Assistant Director for DANR programs as well as an ex officio member of the Executive Committee of the CCC.[47]

The reorganization of research that followed from the issuance of the DANR-CCC proposals was extremely disruptive for departments within the College of Natural Resources. The consequences for the Division of Biological Control, however, were shattering. By 1995, the Division saw its faculty numbers drop by more than 50 percent. With a complement of approximately 10 faculty members in 1975, the newly organized division had, at best, 4 faculty members in 1995. To be certain, other departments had also suffered substantial losses. But whereas entomology, for example, had experienced a percentage drop of the same magnitude, it still had sufficient numbers to provide for both teaching and research to sustain a large number of graduate students, thus assuring the reproduction of its line of inquiry. For biological control, the faculty were stretched sufficiently thin that it was unlikely to generate sufficient numbers to reproduce itself through training of graduate students and other professionals needed to bring forward alternative systems not founded on pesticides. The problem, however, was compounded by the fact that the model of research being promoted at Berkeley and other major universities did not have a significant role for biological control.

Still, for many observers, the problems that the Division encountered must surely have been linked to a lack of professionalism. A failure to attract top-notch faculty, the absence of grants and contracts, a dearth of publications – these were no doubt the issues that provided a less biased explanation for the Division's fall from grace. While this essay does not delve into a comparative analysis, there appears no compelling evidence to suggest that the Division's work was anything less than excellent with respect to professional achievements. Without doubt, certain members of the faculty occasionally proposed grants, authored papers, and conducted experiments that various of their peers regarded as lacking merit. In the absence of notorious successive failures, something no professional or administrative group has ever suggested, the pursuit of analyzing what went wrong internally with the Division at Berkeley falls prey to the usual scientific orthodoxy – their decline must surely have been related to their own failure as scientists. Even in the absence of any evidence regarding their scientific work, fellow scientists were loathe to consider the more obvious and substantial evidence – the hostility of a research setting that circumscribes the opportunity to obtain grants, publish articles, hire faculty, and attract graduate students.

Several members of the faculty, such as Miguel Altieri and Donald Dahlsten, continued to attract international recognition for their work in biological control, producing significant written works and research projects, and being widely seen as outstanding members of the academic community at Berkeley. The more pertinent question, especially in light of the Division's impressive history, its widely recognized faculty, and the broad demands for its works, is why was the Division beginning to disappear as early as the 1980s?

Biological control versus biotechnology

> The direction of technical change in capitalist agriculture and the research strategies that support this direction are the result of two kinds of factors: the quest for profit by industry and the pursuit of social control by the capitalist class as a whole. (Richard Levins and Richard Lewontin)[48]

The dismantling of biological control raises questions about the need to maintain a diversity of research directions at the University of California. In addition to spreading one's research bets, there is an obvious need to expand the resources and linkage of researchers working in classical biological control. The need for an expanded program is based on both (1) the public demand for alternatives to pesticides, and (2) the rising scientific concerns surrounding biotechnology.[49]

Other critics of the land grant system have expressed concern that the benefits of classical biological control may be lost in the "biotechnology stampede." Professors R. G. Van Driesche and D. N. Ferro, for example, note that with the scale of successes that have been achieved with classical biological control, its imminent loss "is a ringing indictment of our priorities for the allocation of resources." The two professors bluntly presented the case for no longer neglecting a safe, proven, and effective means of pest control:

> Clearly, biological control has been underutilized. Overshadowed by chemical pesticides since the 1950s, it is now losing more ground to the glamour of biotechnology. Genetically engineered microbes or resistant plants are currently seen as a possible "new generation" of pest controls of great promise. However, there are large costs associated with this as yet unproven approach. Like other control strategies, pest controls based on genetically modified organisms are likely to be of value in specific cases, but will not be a panacea. Yet in the rush by the USDA and the entomology departments in land grant universities to create biotechnology centers, support for classical biological control has seriously diminished. Positions are being lost. Classical biological control specialists are being reassigned to other duties. Laboratory budgets and staffing are being drastically cut.[50]

Van Driesche and Ferro noted that the role of institutional support for classical biological control will no doubt play a critical role for identifying substitutes for chemical pesticides.

The truism that what you get out depends on what you put in is certainly true for biological control. We cannot simultaneously allow biological control's infrastructure (positions, agency focus, funding) to be eliminated and also expect to reduce US agriculture's dependence on chemical pesticides. Biotechnology has yet to control its first pest; classical biological control has worked for 100 years and yet its potential has barely been touched. Clearly, one of the best ways to control pests without using pesticides is to use biological control methods.[51]

The Amherst researchers concluded that while universities and the US Department of Agriculture rush to embrace biotechnology, "their neglect of biological control seriously threatens to make a poor situation worse." Yet, the notion that the USDA would rescue biological control from the vagaries of market forces is counter to a long tradition that the federal agency has richly supported – the production of knowledge as an extension of the marketplace.

Summary and conclusions

Since the end of World War II, chemically-intensive farming techniques have been adopted by most farmers across the USA. Farmers now spread nearly one billion pounds of pesticides annually.[52] While providing only some measure of crop protection among hundreds of resistant pests, the billions of dollars that farmers spend each year on pesticides also generates a complex of hazards affecting society and environment and costing billions of dollars in damages annually.[53] These problems include a broad scope of negative consequences, including ecological damage (e.g., loss of species and their habitat,[54] environmental degradation (e.g., pollutants in groundwater, toxic air contaminanst,[55] hazardous contaminants in food,[56] air,[57] and water, and a range of adverse public health effects (e.g., childhood cancer,[58] immune system effects,[59] and endocrine disruption[60]). More than simply the result of a listing of certain isolated events, contemporary summaries of pesticide hazards direct our attention to a set of policies that, in light of scientific findings, are insufficient to afford protection for either human or environmental health. [61]

Given the proliferation of substantial negative consequences surrounding the use of pesticides in agriculture, particularly given the emergence of many of these studies during the past decade, one might well expect to witness the blossoming of any research unit offering a possibility for avoiding such hazards. The fact that the Division at Berkeley offered one of the best demonstrated records for advancing such applications among various academic units should have resulted in its expansion, despite the reduction in funding experienced among various academic units with the loss of state and federal funding sources. Anticipating such an outcome, however, would confuse a compelling social need and an intellectually challenging project with the basis for organizing priorities in the modern university.

The knowledge basis for alternative practices has been depleted as resources for research and extension services have been significantly reduced at land grant colleges throughout the USA. Across the board reduction of support for agriculture has masked a more fundamental shift in research as the basis for alternatives to chemical-intensive agriculture. The ironic twist is that just as the public has grown more demanding of a chemical-free agriculture, the institutional basis for changing agricultural practices has become more anchored in technically- and capital-intensive production orientations.

The story surrounding the demise of the Division of Biological Control is necessarily incomplete and therefore contestable. Others will, no doubt, argue that its decline is primarily the result of other factors – the vindictiveness of key administrators; the collusion of agribusiness interests and college deans; or simply the result of the Division's own ineptness as a political actor. Establishing a complete record of actions and intentions, however, is an increasingly difficult endeavor. As corporate counsel might suggest, an incomplete historic record provides some measure of deniability for parties avoiding evidence that might otherwise impugn their conduct or actions. A prominent theme emerging from the record that does exist supports an interpretation that the Division's demise cannot be easily explained by a lack of achievements.

This argument notwithstanding, the loss of the Division's work in classical biological control coupled with a broad scope of natural and social ecology reflects a troubling state of affairs. The loss of such inquiry, and more specifically the loss of ecologically oriented projects in agriculture, makes little sense from the perspective of socially-desirable projects. As an intellectual project, the Division's work paralleled a growing interest among other communities of scholars (e.g., environmental studies, ecological science, social studies) and various constituencies beyond the university (e.g., environmental organizations, public health advocates, labor organizers).

What the Division lacked, however, was any significant contribution to the existing structure of agriculture, particularly in terms of a commitment to capital and chemical inputs. The antagonistic relation between many of the Division's most prominent scientists and these factors of production generated two important forces of opposition. In terms of gaining access to extramural capital, representing an important basis for advancing along a line of university criteria for advancement, the Division positioned itself in a more marginal category relative to other departments. Perhaps more important, its growing emphasis over the years on works that emphasized a vigorous stance relative to ecology and labor also signaled increasingly difficult relations within the agricultural experiment station. One of the most important manifestations of this situation was from the Division's failure to generate patentable products as an outcome of its work.

The situation confronting the Division of Biological Control, because it is reminiscent of the kind of problem that has plagued land grant universities generally, suggests solutions that have been advanced over many years. One of the clearer thinkers on the subject of what is to be done to address the problems of agricultural research emerges from a project popularized in the 1970s by the author of Hard Tomatoes, Hard Times – Jim Hightower. Among several recommendations, the former Texas Commissioner for Agriculture suggested that it was essential for land grant institutions to construct tough conflict-of-interest provisions, prevent corporations from earmarking contributions for proprietary research, and restrict patenting practices that merely provide for private gain.[62]

The Division's dilemma, however, suggests that there is something more at stake than simply revealing the corporate ties to science research in the modern university. Biological control, like agroecology and other pursuits on behalf of the public, needs to have support irrespective of private sector calculations of value added to profitability. Indeed, the history of the Division suggests that public interest research may frequently be viewed as a threat to the private accumulation of wealth. It is all the more imperative, therefore, that funds be made available to support research that benefits the public-at-large.[63]

The controversies surrounding biological control are not merely ones of esoteric scientific debates. Rather, these conflicts speak directly to such issues as whether consumers must risk dietary exposures to cancer-causing pesticides on foods, farm workers must be subjected to reproductive and other damages, or California's agriculture must continually pose a threat to habitat and wildlife.

In its most visible sense, the marginalization of classical biological control signals the loss of alternatives that seek as a goal to end the poisoning of workers, consumers, and the environment. At a more profound level, its loss signifies a political closure to inquiries directed at other visions of agriculture.

It may be that the case of the Berkeley faculty is but a further example indicating the privatization of public resources. The dismantling of public institutions with the corresponding increase in corporate freedoms as a solution to current social ills represents but further closure to public voice and control. Addressing the problems in research, agriculture, and society in general requires attention to a basic principle – the need to nurture and expand democratic practices.

The University has no doubt always witnessed the rise of certain forms of knowledge and the loss of others. But in the late twentieth century, the metaphor of the marketplace suggests that being out-of-step with commerce may hasten the obliteration of entire disciplines. In this context, Kuhn's notion of normal science must be radically revised to understand science not as a function of paradigms produced by groups of intellectuals, but as the result of a political economy that shapes the production of knowledge.[64]

The gradual loss of the Division of Biological Control may be difficult to observe within the university, particularly in the context of a lingering presence. In the wider society and especially amidst California's fields where pesticide hazards are most threatening, the absence of alternatives will continue to be suffered most acutely. The attendant loss of alternatives will probably continue to be best captured by Rachel Carson's words:

> We stand now where two roads diverge. But unlike the roads in Robert Frost's familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lie s disaster. The other fork of the road – the one "less traveled by" – offers our last, our only chance to reach a destination that assures the preservation of our earth.
>
> The choice, after all, is ours to make. If, having endured much, we have at last asserted our "right to know," and if, knowing, we have concluded that we are being asked to take senseless and frightening risks, then we should no longer accept the counsel of those who tell us that we must fill our world with poisonous chemicals; we should look about and see what other course is open to us. (Rachael Carson, *Silent Spring*)[65]

Notes

1. While I possess sole responsibility for the content of this essay, the work has been significantly improved over earlier versions by virtue of the time contributed by various persons who are not otherwise accountable for the results, despite their best efforts. I wish to acknowledge the comments of anonymous reviewers as well as others I called upon for assistance. Special thanks are due to John H. Perkins and Cheri Lucas Jennings with the Evergreen State College and Donald Dahlsten with the Center for Biological Control at the University of California, Berkeley.
2. Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1971).
3. David Noble, *America by Design* (New York: Oxford University Press, 1977).
4. These other units include scientists working with such departments as Forestry, Entomology, and Biology as well as academic units such as the Energy Resource Group. Among the most dramatically affected majors is the primary undergraduate major that has existed since 1970, Conservation and Resource Studies.
5. For the purposes of this text, the Division of Biological Control is the term of reference used to identify a particular group of researchers for most of its history, although its current name, the Center for Biological Control, was changed in 1993 and is its official organizational title at the moment.

6. Angus Wright, *The Death of Ramon Gonzalez* (Austin: University of Texas Press, 1990), p. xiv. The actual passage of Dr. Wright's prose is worth reciting here at length: "I do not reject Van den Bosch's conspiracy theory – in its broad outlines I think it can be taken for granted. Any industry with a profitable product to sell will do all it can to protect and expand the market and will not hesitate to attempt to dominate scientific research and governmental actions related to the product. But to dwell on this alone is to leave very important questions . . . Why do particular technologies seem to prevail over others? I believe that for very large conspiracies to work over large geographical areas and for decades at a time, the conspiracy must be transformed into something else – a belief system, an ideology, a world view, a concept of proper professional behavior . . . "
7. Ruth Hubbard, "Introductory essay: The many faces of ideology," in Hilary and Steven Rose, eds., *Ideology of/in the Natural Sciences* (Boston: G. K. Hall, 1976).
8. David Noble, *America by Design* (New York: Oxford University Press, 1977); Richard Brown, *Rockefeller Medicine Men* (Berkeley: University of California Press, 1979).
9. In addition to the aforementioned texts, see Richard Levins and Richard Lewontin's analysis, especially "The commoditization of science," in their edited work, *The Dialectical Biologist* (Cambridge: Harvard University Press, 1985), pp. 197–208. Other contemporary studies following this theme are also to be found in the journal edited by James O'Connor, *Capitalism, Nature, Socialism.*
10. Rachel Carson, *Silent Spring* (Boston: Houghton Mifflin, 1978), p. 292.
11. M. J. Tauber, M. A. Hoy, and D. C. Herzog, "Biological control in agricultural systems: A brief overview of the current status and future prospects," in Marjorie Hoy and Donald Herzog, eds., *Biological Control in Agricultural IPM Systems* (San Diego: Academic Press, 1985), p. 3.
12. Jeffrey A. Lockwood, "Environmental issues involved in biological control of rangeland grasshoppers (Orthoptera: Acrididae) with exotic agents," *Environmental Entomology* 22 (1993): 503–518.
13. David Pimentel, John H. Perkins, eds., *Pest Control: Cultural and Environmental Aspects* (Boulder, CO: Westview Press, 1980), p. 40.
14. Ibid., p. 41. It is worth noting that the dichotomy used here collapses TPM with what John Perkins would term the chemical control strategy. While a further distinction might be useful, the IPM-TPM distinction is employed here for purposes of maintaining a concise argument.
15. Based on conversations with John H. Perkins and Steve Herman with the Evergreen State College during March and April 1997.
16. Carl B. Huffaker, "Biological control in integrated pest management: An entomological perspective," in Marjorie Hoy and Donald Herzog, eds., *Biological Control in Agricultural IPM Systems*, op. cit., p. 16.
17. Peter Tonge, "The no-pesticide revolution," *World Monitor* (June 1989): 58.
18. D. J. Greathead and A. H. Greathead, "Biological control of insect pests by insect parasitoids and predators: The BIOCAT database," *Biocontrol News Information* 13(4): 61N-68N as cited in R. G. Van Driesche and T. S. Bellows, Jr., "Introduction," *Steps in Classical Arthropod Biological Control* (Lanham, MD: Entomological Society of America, 1993), p. 3.
19. Donald L. Dahlsten, Richard Garcia, John E. Laing, and Robert van den Bosch, *Pesticides* (New York: Scientists' Institute for Public Information, 1970). The final passage of the workbook sought to rally scientists to a larger political campaign: "It is time for the entire community of scientists to take up the task of environmental information. And then voters will be able to carry out their responsibility, which is to listen, to weigh, and finally to decide for themselves."
20. Robert Van den Bosch, *The Pesticide Conspiracy* (Garden City, NY: Doubleday, 1978), p. 185.
21. Miguel Altieri, *Agroecology* (Boulder, CO: Westview Press, 1987) citing the work of Larry Busch and William Lacey, p. xiii.
22. National Research Council, *Alternative Agriculture* (Washington, DC: National Academy of Sciences, 1989), p. 3.
23. Ibid., p. 9.
24. Based on interviews with staff working with the Board on Agriculture and involved in the publication of *Alternative Agriculture*.
25. National Research Council, op. cit., p. 15. The NRC reported that even though biological control represented a crucial factor for alternative practices, in the absence of adequate resources, biological controls would be neglected (see pp. 223–224 of the same report).
26. See, for example, the work of Marjorie Hoy, such as contained in an article co-authored with Steven K. Beckendorf, "Genetic improvement of arthropod natural enemies through selection, hybridization or genetic engineering techniques," in Majorie Hoy and Donald Herzog, op. cit., pp. 167–187.
27. The controversy arose with reference to a proposed Center for Pest Management. When a proposed condition for nominating the Center's Director include a prohibition on receipt of pesticide industry funded research during the previous ten years, a spokesperson for the University responded that such a condition would likely exclude the vast majority of all senior scientists in the University.
28. The author's personal observation as a senior policy advisor to the California Senate between 1985 and 1991. During this time I negotiated legislative and budget proposals relating to Senator Nicholas C. Petris' Sustainable Agriculture Research and Education Program and Assembly member Richard Katz's Pest Control Center legislation, among other such measures.
29. US Office of Technology Assessment, *Technologies to Maintain Biological Diversity* (Washington, DC: US Congress, 1987), p. 64.
30. Ibid., p. 67.
31. Ibid., p. 44.
32. Miguel A. Altieri, *Agroecology: The Scientific Basis of Alternative Agriculture* (Boulder, CO: Westview Press, 1987), p. 39.
33. National Research Council, op. cit., pp. 223–224.
34. A. P. Gutierrez, L. E. Caltagirone and W. Meikle, "Economics of biological control" (Berkeley: University of

California Division of Biological Control), pp. 15–16 and 18.
35. A. P. Gutierrez, L. E. Caltagirone and W. Meikle, "Economics of biological control" (Berkeley: University of California Division of Biological Control), p. 18.
36. National Research Council, op. cit., p. 224.
37. Ibid., p. 224.
38. Jeffrey A. Lockwood, "Benefits and costs of controlling rangeland grasshoppers (Orthoptera: Acrididae) with exotic organisms: Search for a null hypothesis and regulatory compromise," *Environmental Entomology* 22 (1993): 904–914.
39. The listing of studies documenting known and suspected hazards of pesticides in terms of ecological and human health effects is difficult to list exhaustively, but includes dozens of carcinogens, reproductive toxicants, and endocrine disrupting pesticides with respect to chronic hazards. For fuller documentation consult various issues of the *Journal of Pesticide Reform* (Eugene: Northwest Coalition for Alternatives to Pesticides).
40. David Moberg, "High-chem farming is getting back to earth," *In These Times* (4–10 October 1989), p. 7.
41. Public correspondence from Miguel Altieri to "colleague and friend," 14 April 1989.
42. Based on conversations between representatives of the University of California and the author, in his capacity as a senior consultant with the Senate Office of Research and investigating a request by Senator Nicholas C. Petris (D-Berkeley).
43. David Pimentel, "Extent of pesticide use, food supply and pollution," *Proceedings of the New York Entomological Society* 81 (1973): 13–33.
44. "University's Task Force on Biological Control," Memorandum, 11 April 1989.
45. News – University of California – Division of Agriculture and Natural Resources, "Commodity groups urge UC to strengthen agricultural programs (UC Davis, 24 January 1994).
46. *Agriculture and Natural Resources Report*, "Division issues its response to CCC report" (Oakland: DANR, 4 October 1994).
47. Carroll B. Williams memorandum, to Dean Wilford Gardner, 28 February 1994, p. 4.
48. Richard Levins and Richard Lewontin, *The Dialectical Biologist* (Cambridge: Harvard University Press, 1985), p. 209.
49. See, for example: Rebecca Goldburg, Jane Rissler, Hope Shand, and Chuck Hassebrook's report: *Biotechnologies Bitter Harvest: Herbicide-Tolerant Crops and the Threat to Sustainable Agriculture* (Washington, DC: The Biotechnology Working Group, 1990)
50. R. G. Van Driesche and D. N. Ferro, "Will the benefits of classical biological control be lost in the 'biotechnology stampede'," *American Journal of Alternative Agriculture* 2 (1987): 50.
51. Ibid., p. 97.
52. Allen Rosenfeld, Patty M. Morris, Caroline Smith DeWaal, and Mark, *Bellinger Agrichemicals in America: Farmers' Reliance on Pesticides and Fertilizers* (Washington, DC: Public Voice for Food and Health Policy, 1993).
53. David Pimentel and Hugh Lehman, eds., *The Pesticide Question* (New York: Chapman and Hall, 1993).
54. William Pease and James Liebmann, *Pesticide Impacts on California Ecosystems* (Berkeley: Center for Occupational and Environmental Health, May 1994).
55. Michael S. Majewski and Paul D. Capel, *Pesticides in the Atmosphere* (Chelsea, MI: Ann Arbor Press, 1995).
56. John Wargo, *Our children's toxic legacy: How science and law fail to protect us from pesticides* (New Haven: Yale University Press, 1996).
57. Margaret E. Scarborough, Richard Ames, Michael Lipsett, and Richard Jackson, "Acute health effects of community exposure to cotton defoliants" (Berkeley: Office of Environmental Health Hazard Assessment, Department of Health Services, March 1989).
58. J. R. Davis, "Family pesticide use and childhood brain cancer," *Arch. Enviro Contam. Toxicology* 24 (1993): 87–92.
59. Robert Repetto and Sanjay S. Baliga, *Pesticides and the Immune System: The Public Health Risks* (Baltimore: World Resources Institute, 1996).
60. Theo Colburn, Dianne Dumanoski, and John Peterson Myers, *Our Stolen Future* (New York: Penguin, 1996).
61. Bruce Jennings, *Pesticides and Regulation: The Myth of Safety* (Sacramento: The Senate Office of Research, 1991).
62. Jim Hightower, *Hard Tomatoes, Hard Times: The Failure of the Land Grant College Complex* (Washington, DC: Agribusines Accountability Project, 1972), pp. 251–252.
63. The problems that the Division of Biological Control has encountered are by no means unique within the University of California. Although beyond the scope of this paper, somewhat parallel problems have affected other programs, such as the Agroecology Program at UC Santa Cruz and the Sustainable Agriculture Research and Education Project at UC Davis.
64. Ludwig Fleck, *Genesis and Development of a Scientific Fact*, translated and edited by Thaddeus J. Trenn and Robert K. Merton (Chicago: University of Chicago Press, 1979), pp. vii–xi.
65. Rachel Carson, *Silent Spring* (Boston: Houghton Mifflin, 1987), pp. 277–278.

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